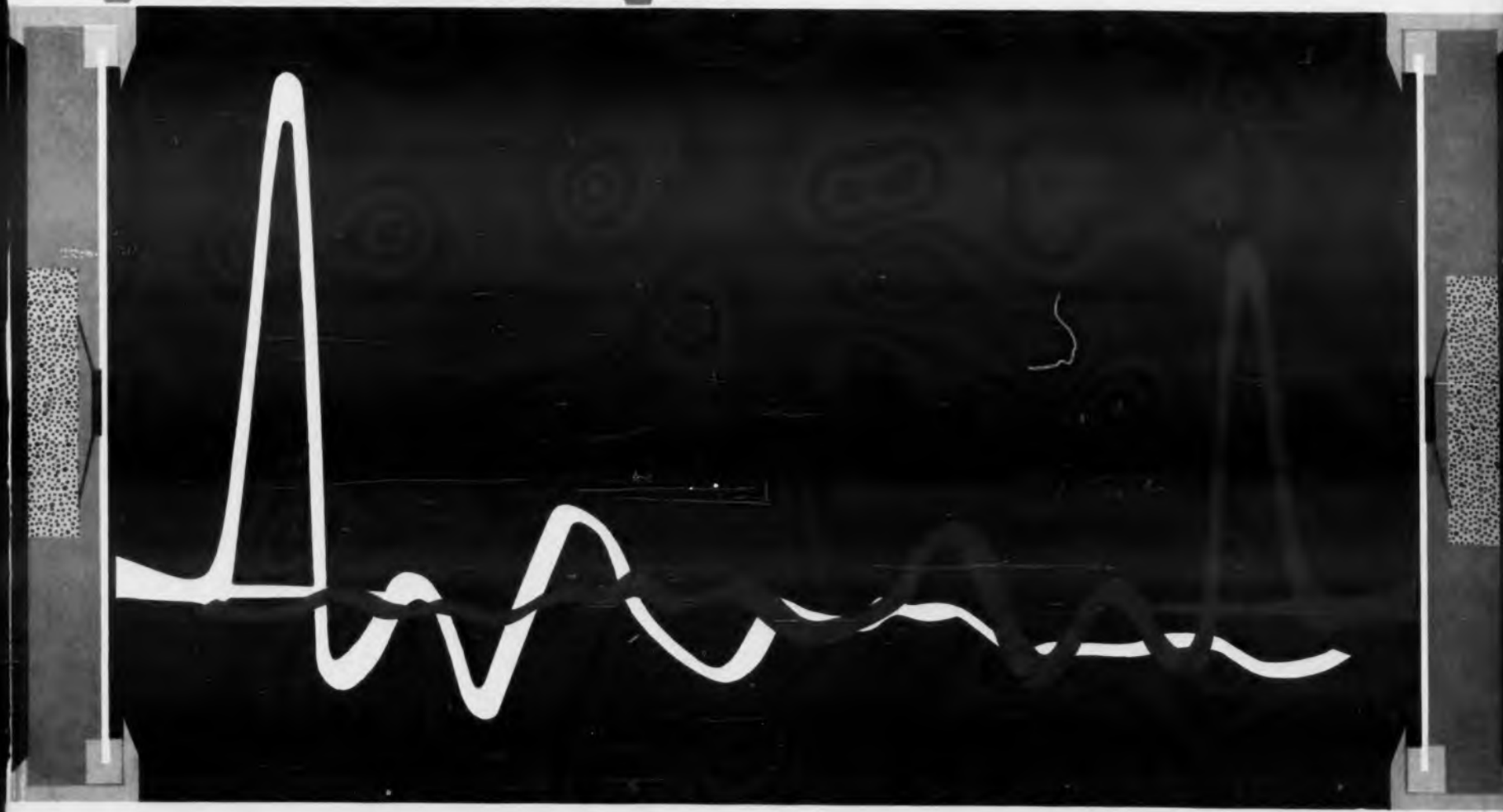
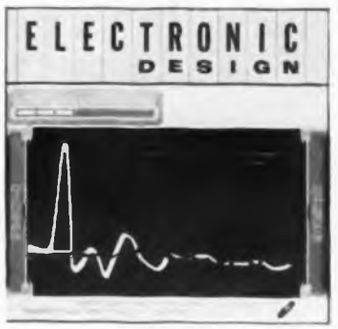
ELECTRONIC DESIGN



DESIGN IDEAS FROM THE HI-FI SHOW--THIN SPEAKER, TRANSISTOR AMPLIFIER, TUNERS, WIRELESS REMOTE CONTROL...P 54



COVER: The ever-widening world of stereophonic-sound reproduction finds ELECTRONIC DESIGN's art director right in tune with the latest development. Here he depicts a wireless remote-control unit, lower right, with which a listener could balance the stereo sound waves from this two-speaker system without leaving his chair.

Highlights of This Issue

Ever try to go back to past issues of ELECTRONIC DESIGN in search of a particular New Product needed for the job at hand? You need help. And help is precisely what the editors of ELECTRONIC DESIGN had in mind when they instituted the New Products Directory (see p 66).

All New Products (and we carry some 300 in each issue!) now are listed alphabetically and by category in the directory. Accompanying each listing is the page on which the item can be found and its one-day Reader Service number.

ELECTRONIC DESIGN publishes, as a reader service, all the New Products generally specified by electronic engineers.

A Way Out

The silicon-controlled rectifier circuit, with its high power-handling capability and efficiency, has established itself as a control element in a number of dc power supplies. Still, it has limitations—notably the susceptibility of the feedback control system to oscillations.

In the first of two installments (p 46), Albert C. Leenhouts of the Transitron Corp., Wakefield, Mass., discusses a novel way to get around oscillations. In the next installment he will give a detailed design procedure for his solution and a specific design example.

Easier reading continuous display
Higher sampling rate
Multi-period average
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Low-frequency accuracy
Versatile new modular design
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IN 4 NEW hp SOLID STATE COUNTERS!

Turn the page to learn about new measuring convenience, dependability from hp.

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LIFT PAGE

a pleasure to measure with these...

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hp 5532A, 1.2 MC

4 N

SOLID ST

Measure frequency, period, ratio, q
continuous display, no "blinking"...
...Unique low frequency accuracy...

All the advantages of solid-state design are now yours in these new hp solid state counters—offered at prices comparable to those of today's vacuum tube counters. And you get the *plus* advantages of greater readability, faster measurements, easier routine maintenance, rack-and-stack convenience of the new hp universal module instrument cabinets.

Offered in four models, these new counters have maximum counting rates of 300 KC or 1.2 MC, with a choice of Nixie or columnar readouts. The high-intensity neon readouts are stacked in compact columns for faster, easier reading. On the in-line readouts, hp-pioneered standard incorporation of the new long-life, wide-viewing Nixies gives you many extra hours of lamp life and heretofore unknown readability even at extreme angles. Polarized screen provides maximum readout brilliance with freedom from reflections.

A unique display storage feature of these new counters produces a continuous visual readout of the most recent measurement, even while the instrument is making a new measurement. Only if the new count differs from the previous count will the display change, in which case it will shift directly to the new reading. The fatigue and error possibility of a "blinking" display is eliminated. The storage feature may be disabled with a rear panel switch.

The counter's "inactive time" (when not making a new measurement) is independent of gate time and adjustable from 0.2 to 5.0 seconds, thus permitting a higher sampling rate.

Counter	Max. Counting Rate	Registration
5212A	300 KC	5 digits columnar
5512A	300 KC	5 digits Nixie
5232A	1.2 MC	6 digits columnar
5532A	1.2 MC	6 digits Nixie

High sensitivity permits low
without accessories, and multi
measurement (to 100,000 period

Note clean, compact, easy-to-service p
new hp solid-state counters.

512A, 300 KC

5212A, 300 KC

5232A, 1.2 MC

NEW hp STATE COUNTERS!

, quickly, accurately ...Compact, easy-to-use instruments provide
'...0.1 volt sensitivity ...Solid-state dependability...Higher sampling rate
y...Operation —20° to +65° C...Prices comparable to vacuum tube counters!

	Period Measurement				Frequency Measurement				Ratio Measurement			
	Range	Accuracy	Reads in	Periods Averaged	Range	Accuracy	Reads In	Gate Time	Reads	Range	Accuracy	Price
	2 cps to 10 KC in single period; up to 300 KC in multiple period average	± 10 μs ± time base accuracy ± trigger error/ periods averaged	Milliseconds with positioned decimal	1, 10, 10^2, 10^3, 10^4, 10^5	2 cps to 300 KC	± 1 count ± time base accuracy	KC with positioned decimal	10, 1, 0.1, 0.01 sec.	(f_1/f_2) x period multiplier	f_1:100 cps to 300 KC (1 v rms into 1,000 ohms) f_2: same as period	± 1 count of f_1 ± trigger error of f_2	$ 975.00
												1,175.00
	2 cps to 10 KC in single period: up to 1 MC in multiple period average	± 1 μs ± time base accuracy ± trigger error/ periods averaged	Milliseconds or microseconds with positioned decimal		2 cps to 1.2 MC					f_1: 100 cps to 1.2 MC (1 v rms into 500 ohms) f_2: same as period		1,300.00
												1,550.00

low level measurement
ıultiple period average
eriods) gives higher ac-

ice physical arrangement of

curacy in lower frequency ranges, even for noisy signals. Self-check is provided for both frequency and period measurement modes.

Only 3½" high, these counters are housed in the new hp modular cabinets ideal for both bench use and easy rack mounting. Routine maintenance is simple with snap-out decade readout units and circuit cards. Readout drive directly from photoconductors eliminates a complete stage of complex circuitry, to effect genuine cost and reliability advantages. Compact design and construction and servicing ease are illustrated at the left.

Solid state design and construction gives you the advantages of low heat dissipation with minor heating effect on adjacent equipment, fast warm-up, low power consumption and new standards of reliability.

The new counters include a four-line BCD code output. This output, with assigned weights of 1-2-2-4, is available for systems use or to operate devices such as the hp 562A Digital Recorder. Front panel controls include Input Attenuation, Display, Reset and Function.

Call or write your hp representative or call us today for information and a demonstration!

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CONTENTS

October 11, 1961
Vol. 9 Number 21

Electronic Design

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Coming Next Issue

Electronic packaging used to be a dull subject. Today, it is in the center of the revolution caused by customers who "right now" want the reliability, the miniaturization and the economy which industry publicity men have been saying are "just around the corner" with circuits fabricated from functional blocks.

The trouble is that the functional blocks aren't really here; meanwhile, the customer whose appetite has been whetted by what these functional blocks will do for his system, won't accept old-fashioned packaging.

With delivery a few months off, what does the designer do?

To find interim answers to this packaging dilemma, ELECTRONIC DESIGN assigned Technical Editor Robert Cushman to round up some of the practical methods used by alert engineers. The accent was to be on methods that are practical today.

What he found will be the subject of the next issue's staff report: "Interim Packaging."

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Flying-Spot Readers Promise Fast Data Input

Reading of Varying Type Faces and Sizes at High Rate Expected With Machines Planned by Philco, Sylvania

Robert Haavind
Chief News Editor

CHARACTER-recognition machines, based on high-resolution flying-spot scanners and sophisticated logic circuitry, promise variable-type-face, high-speed data input directly from machine-printed documents.

Techniques used in the Apple cathode-ray tube are being applied by Philco Corp. to an experimental machine recently demonstrated at the company's Blue Bell, Pa., research laboratories. The Philco recognizer readily read letters from different kinds of typewriters, and even read simulated typewriter characters drawn by a draftsman.

The techniques developed by Philco are being used in two machines being built for the Post Office Dept. A machine capable of recognizing 25 city-state locations will be delivered to the post office in Washington, D.C., in the spring. An advanced machine, capable of recognizing all 50 states and 250 major cities in the United States, will be built by Philco by sometime in 1963. This machine should be capable of reading 36,000 letters per hour.

Sylvania's Advanced Development Laboratory, Waltham, Mass., is developing a high-speed recognizer based on the flying-spot-scanner technique under a company-sponsored program. Although similar to the Philco approach, there are some important differences in the Sylvania machine.

The general construction of both readers is illustrated in the diagram. A fast-moving spot on the face of a crt is directed optically onto the character to be read, and the reflected light is picked up by a photomultiplier tube.

In Philco's system three photomultipliers are being used so that a balanced-light signal is received from any point on the document being read.

Transitions From Black-to-White Or White-to-Black Are Sensed

A raster of 12 vertical lines is scanned over each character, and sensing takes place 22 times during each scan line. The transition from black-to-white or white-to-black is sensed. In order to eliminate possible false signals, from smudges or other noise, crispening is done in a video-processing section.

The electrical signal derived from the photomultipliers and subsequent La Placian correction circuits is in effect the sum of a twice-differentiated brightness signal in both the x and y directions. The resulting terms are then summed. The sign of the resultant is sensed to determine if a black-white or white-black transition is taking place.

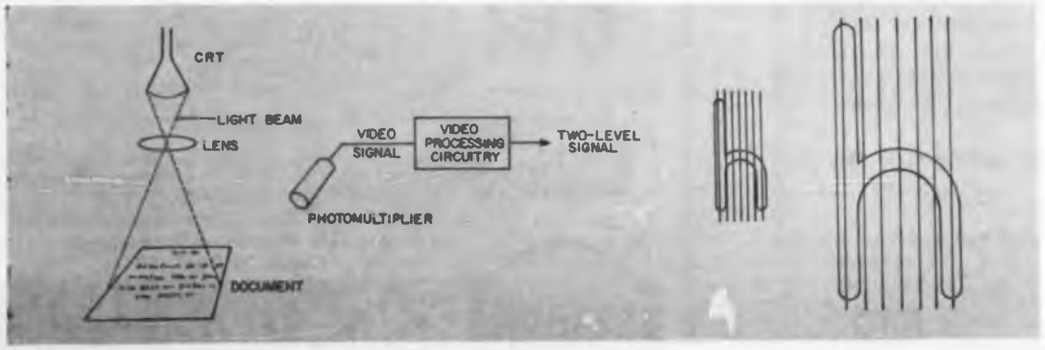
The pattern of transitions is fed simultaneously to a number of "masks," consisting of resistors of weighted values, depending on the importance of each point in recognition.

If the summed output of the masking network is above a predetermined value, a trigger is actuated indicating that the character being scanned is the one represented by the mask being used. In order to avoid errors in distinguishing between very similar characters, such as c and o, a multistep masking system is planned by Philco.

Use of about 150 masks is expected to provide recognition of all commonly used printed or typewritten characters, according to Philco researchers. This does not include script or italic letters. Variable sizes will, however, be read through the use of multiple scans for each recognition.

Reading of 1,000 characters per sec is possible with the Philco system, according to a company spokesman. A tube with 2,000-line resolution is being used, although higher resolution tubes could be built if needed. Magnetic deflection is used.

The Sylvania equipment being built is expected to achieve reading speed of about 6,000 characters per sec, according to Dr. Donald B. Brick, manager of information-processing research. Masking networks will be used but a device other than the resistor will be employed for the masking process,



General scheme of the flying spot scanner character recognition systems being built by both Philco Corp. and Sylvania's Advanced Development Laboratory. Different sized letters at right illustrate the automatic adjustment of raster size to match the size of a character. Both companies plan to do this by using more than one scan over each character.

Resistor-mask cube used in performing recognition of characters of variable type faces is plugged into the front of this experimental reading machine built at Philco Corp.'s Research Center. Lights at top of the machine indicate character recognized. Checking the equipment is Allen C. Munster, general manager of a new Data Recognition Dept. formed by Philco to carry on work in this area.

Dr. Brick said. He could not identify the device for proprietary reasons. Because of the use of this device it will be possible to use about 2,000 masks with the system, thus allowing a wide range of type faces to be recognized.

A 16-line vertical raster, with 20 samplings per line, is planned for the Sylvania equipment. The crt used has about 2,000-line resolution, according to Stephan Gray, project engineer, but electrostatic, rather than magnetic, deflection was chosen because it is expected to be faster.

Light pickup is a problem, Mr. Gray explained, because of the speed of the spot and the short persistence of the phosphor used—a P16. A 5-in. photomultiplier is being used, but tubes may have to be added when recognition is made at higher speeds.

Sylvania is using actual black and white signals, rather than transitions, to perform recognition.

Both companies are optimizing the masks for various characters by using a computer. Philco scans a great number of small typed or printed *a*'s, for example, and characteristics of the waveforms obtained are fed to a Philco 2000. The computer determines an optimal weighting pattern for the mask for this character based on the information it has received. ■ ■

SIGNIFICANT BITS

Important news items for electronic designers written for fast scanning.

A center for information on high-altitude nuclear effects will be established by General Electric Co.'s Technical Military Planning Operation (TEMPO) at Santa Barbara, Calif. GE will collect, organize and report data on the effect of nuclear blasts in the upper atomosphere. The information will be available to government, industrial and academic researchers. The center is financed by a $211,500 contract from the Defense Atomic Support Agency of the Defense Department.

0001

A speech-recognition researcher in the Soviet Union has reported development of a system that recognizes the Russian words for "zero," "one," and "stop" regardless of whether they are spoken by a male or female, or in a loud voice or whisper. A. A. Kharkevich, of the Laboratory of Systems of Transmitting Information, told the Soviet press that his laboratory has solved the problem of finding "the minimum possible number of attributes of this or that sound."

0010

A low-speed scoring computer may be added by a manufacturer of pinspotters to further automate bowling-alley equipment. A consultant approached by the manufacturer said relay logic could be used, but he added that transistors had the advantage of better lending themselves to self-checking routines.

0011

A self-propelled space power unit has been proposed to the Air Force for Project SPUR, the largest U.S. space power-generating system presently under way. Using a typewriter-size atomic reactor to heat and expand liquid metal through a turbine, SPUR is designed to generate 300,000 to 1,000,000 w of

electricity in a period of one to three years. In the latest concept, presented by the Garrett Corp.'s AiResearch Manufacturing Div., Phoenix, this power will be applied to ion motors using cesium to move the unit through space. Ground testing of the SPUR unit is expected in 1966.

0100

A smaller, brighter color TV picture will be provided in a new set being readied for spring marketing by Tokyo Shibura Electric Co. The set will have a 14-in. tube that is said to be twice as bright as the company's standard 17-in. model. The 14-in. tube is a 3-gun shadow mask type designed by Toshiba. The set will contain 28 tubes, three germanium diodes, two silicon diodes and four thermistors. It will weigh about 92 lbs.

0101

A digital flight simulator for the Boeing 727 jetliner has been ordered from the Link Div. of General Precision, Inc., Binghamton, N. Y., by Eastern Airlines. Until now commercial flight simulators have used analog, rather than digital, computation. ■ ■

Strong SC Magnet Shown

This coil of about 5,000 turns of 10-mil niobium-zirconium-base-alloy wire is able to generate a magnetic flux of 43,000 gauss when kept superconductive at a temperature of —269 c, according to Westinghouse Electric Corp., Pittsburgh, which asserts the device is the first superconducting magnet of great field strength.

Electrical-Propulsion Rockets Moving Toward Take-Off

Air Force May Flight-Test Pinched-Plasma Type Next Year; Ultimate Use Hinges on Perfection of Nuclear Power Supply

Alan Corneretto
News Editor

A PLASMA-propulsion unit capable of operating in space is under construction. This marks another step toward use of electrical engines on missions requiring propulsion over long periods.

Of the many types of proposed propulsion units that are based on electrical effects, the pinched-plasma type recently announced by Republic Aviation Corp., Farmingdale, N.Y., appears to be most advanced. One version has been tested with a self-contained battery-power supply and has demonstrated measureable thrust. Another unit, that could be sent into space, is being built for delivery to the Air Force next year, Republic says.

The pinched-plasma engine can be classified as an electromagnetic rocket, one of two main types of electric propulsion units. In such engines, an electrically induced magnetic field accelerates charged particles, which in turn provide thrust.

Ion engines, the type of electric engine under most intensive development, fall into the other main class—electrostatic. In ion engines, neutral particles are accelerated to great velocities directly by an applied voltage.

Both types are intended for the same sort of space mission—where thrusts on the order of a few pounds must be provided continuously or intermittently for years. For some missions, however, plasma and ion engines would require power supplies that could operate for years in the kilowatt range. These are not expected to be available until high-powered nuclear units are developed.

Thermionic-Converter Source Of Power Projected for '63

The engine tested by Republic has a chemical battery supply. The company expects, however, that it will be able to develop a thermionic-converter power supply by 1963, using either nuclear or solar heat.

The heart of Republic's pinched-plasma engine is an electrode-nozzle exhaust system

Pinched plasma electromagnetic engine for such space missions as satellite spin-rate stabilization and orbit modification generates thrust by ejecting a plasma beam, accelerated by the interaction of a self-induced magnetic field and electrical skin currents. Capacitor at left is charged by a novel converter capable of constant-current charging. Pressure bottle holds two-year supply of nitrogen fuel.

Engine Research Sparks Power-Supply Ideas

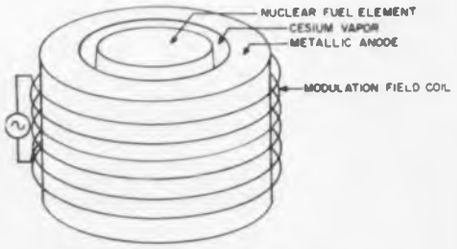
Development of electrical space engines at Republic Aviation has resulted in two interesting by-product designs. One, a thermionic power generator gets alternating current from an essentially low-voltage dc device. The other, a converter circuit for stepping up voltage, provides constant-current charging.

In the thermionic generator studied by Republic, two concentric cylinders—the inner containing a source of heat—are surrounded by a modulating coil that generates a magnetic field. Cesium vapor fills the gap between the cathode and anode cylinders. If 1 per cent of the power produced by thermionic boiling of electrons from the cathode surface is used to charge the modulating coil, it adds an ac ripple to the dc. The ac can be separated and transformed directly to higher voltages, avoiding the need to cascade thermionic elements.

Large units—Republic says it is planning multi-kilowatt devices—could weigh as little as 1 lb per kw without shielding. In the maximum mode of operation, according to the company, efficiency of ac generation could be equal to dc efficiency, which is reported to be in excess of 30 per cent. So far, Republic has achieved only about 11 per cent efficiency in laboratory thermionic converters. In other respects the generator would perform as well as other thermionic devices. These produce about 10 w per sq cm of emitting surface. Finding low-work-function, high-electron-emission materials has proved to be a problem.

A closed feedback loop is the idea behind Republic's constant-current charging circuitry, which is used in a plasma engine to raise a 24-v battery voltage to 3,000 v for a capacitor bank.

Republic developed its constant-current-charging circuitry because a capacitor



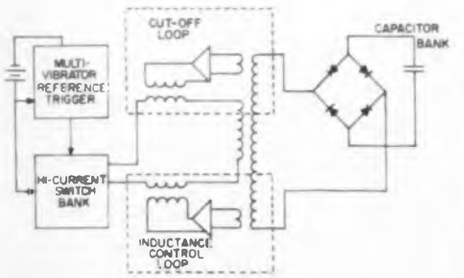
Thermionic converter surrounded by field-modulating coil is being studied as a source of ac power in kilowatt range for space applications.

consisting of a concentric pair of tapered cones. Nitrogen from a bottled supply is ionized when it is valved through the cones between two capacitor-charged electrodes on their inner rims.

As the gas is ionized, a current starts to flow and discharges the capacitors. A skin current grows rapidly, accompanied by a growing, self-induced magnetic field. The current and magnetic field interact to produce a force that directs the plasma down the diminishing diameter of the cones toward a nozzle. There it escapes at temperatures of about 200,000 F and velocities ranging above 100,000 mph. The force is exerted a "pinch" at a time, each pinch acting like a piston blow.

In addition to the electrode-nozzle exhaust system, the engine has an energy conversion system to raise 24 v to the 3,000 v needed by an electrical-discharge system, which includes a capacitor bank. The engine also has a fuel-pressure-and-regulation system and a command-control system.

The unit demonstrated by Republic weighs about 150 lb, including power supply, requires 1 lb of nitrogen a year, is said to be



Conversion circuitry uses feedback loop to maintain inductance of path from switch bank to capacitor bank at a high value so that constant-current pulses are provided efficiently. Circuit raises 24 v to 3,000 v.

bank on its plasma engine had to be charged with constant-current pulses. By using a closed feedback loop to keep the inductance value of the current path, from the supply to the capacitors, at a very high level, pulses are provided that are square in both voltage and current. A sensing amplifier is included in the inductance-control loop and in a similar cut-off control loop. According to the company, 70 to 80 per cent converting and charging efficiency has been achieved in going from 24 v to 3,000 v at 1 kw.

CIRCLE 9 ON READER-SERVICE CARD ▶

NEWS

Electrical Rockets...

(continued from p 9)

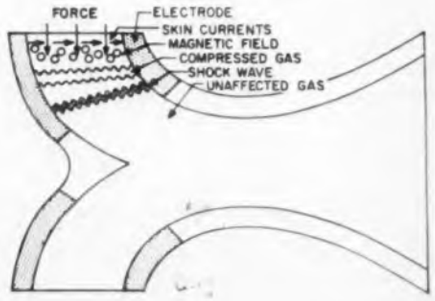
well over 50 per cent efficient, has a specific impulse of from 2,000 to 10,000 sec, and provides 0.01 lb of thrust per kw.

United Overcomes Drawback Of Ion-Engine Propulsion

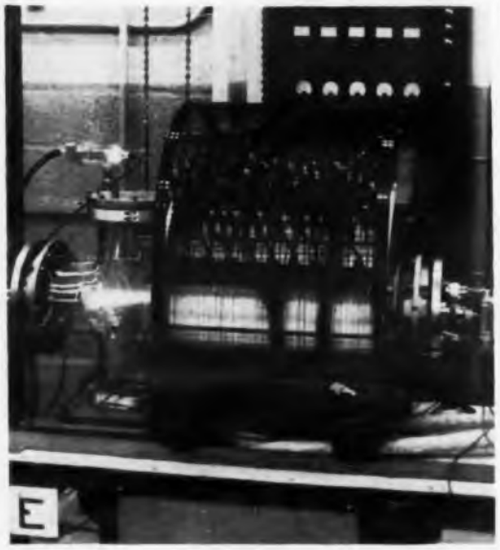
An equally novel engine, but of the electrostatic type is under development at United Aircraft Corp., East Hartford, Conn. United calls its engine an oscillating-electron-ion unit. One disadvantage of ion streams as a source of propulsion is that their space charge tends to inhibit operation of such engines once they have started working. Most proposed ion engines include some means of neutralizing the charge of the ejected beam. The United unit achieves neutralization in an unusual way.

The basic source of ions in the United engine is a cylindrical anode surrounding an electron-emitting cathode. A ground ring traps some of the electrons within the anode cavity. These oscillate axially, moving in helical paths under the effects of a solenoid-induced magnetic field.

When a neutral gas is introduced into the region of the cavity occupied by the oscillating electrons, its molecules are ionized by electron impact. The ions and the liberated electrons form an anisotropic plasma, with the electrons contributing to the trapped electron flux. The ions formed by the bombardment are accelerated from the engine by self-generated electrostatic potential gra-



Pinched plasma engine changes gas introduced betwen electrodes to a plasma and expels it at high velocity. As gas is ionized and a skin current develops around the narrowing input cones, a self-induced magnetic field appears. This field interacts with the skin current to produce a piston-like force that pulses the plasma toward the ejection nozzle at extremely high velocities and temperatures.



Oscillating-electron electrostatic ion engine in laboratory lash-up at United Aircraft ejects an electrically neutral beam of ions, accelerated by self-induced electrostatic potential gradients in the plasma used to form the beam. Cathode assembly protrudes from right of cage, which houses ring-like anode cavity. Ejected ion beam containing enough electrons to be neutral can be seen in glass jar at left.

dients within the plasma.

A sufficient number of electrons emitted from the cathode escapes from the engine to neutralize the ions that leave the engine. The beam leaves at extremely high velocities as an electrically neutral plasma.

Non-Flyable Engine Set For Delivery Next Year

In many of the approaches to ion engines, the beam is neutralized by injection of additional electrons through the use of extra equipment. United is building a non-flyable version of its system for delivery to the Air Force next spring.

United engineers report they have measured specific impulses of from 1,000 to 30,000 sec in laboratory versions of their basic ion source. Efficiencies of more than 50 per cent are said to be possible, based on calculations. The oscillating-electron-ion engine is expected eventually to provide a thrust-to-weight ratio of 10^{-4} to 1, which has to be achieved at high specific impulses before electrical rockets become competitive with other systems. This is not expected, however, until suitable power supplies are developed. These sources will have to be combined with propulsion units to provide a total weight of less than 10 lb per kw of beam power. ■ ■

NEWS

Narrow-Band Transmission Schemes

GE's Nymph, GD/E's Deft Modulation Methods Described at Seventh Communications Symposium

TWO new narrow-band modulation schemes were described at a symposium in Utica, N. Y., last week. Both were designed to help keep the present system of spectrum organization in working order in the face of increasing demands on already overcrowded channels.

In a technical paper delivered at the Seventh Annual National Communications Symposium, Dr. A. D. Perry of General Electric Co., Ithaca, N. Y., reported on Nymph, a narrow-band multiphase modulation technique developed at GE. Nymph is intended for situations in telephony and radio communications where available bandwidth is not much greater than the bandwidth of data to be transmitted.

Engineers from General Dynamics/Electronics, Rochester, N. Y., described (at the company's exhibit) a modulation scheme called DEFT, for dynamic error-free transmission. DEFT, like Nymph is a phase-modulation technique, but one which uses orthogonal coding of transmitted information.

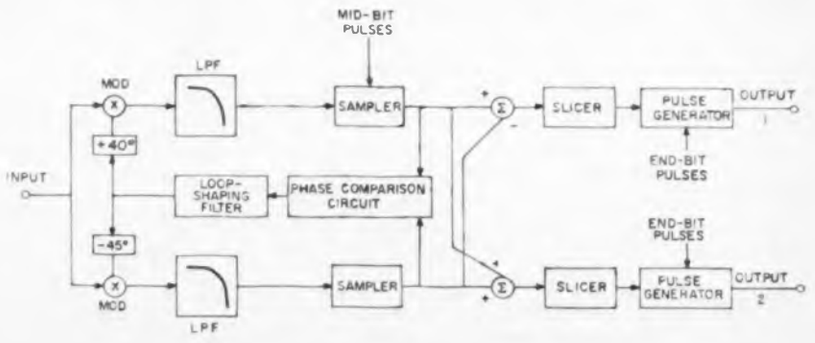
Nymph, in its simplest form, is a technique for simultaneous double-sideband suppressed-carrier transmission of two binary signals, with equal-frequency carriers in phase quadrature. This is equivalent to narrow-band four-phase transmission.

Dr. Perry said that six- and eight-phase versions also have been studied at GE and all are able to handle in one channel about the same amount of data normally carried by two—in the case where channel bandwidth is about equal to data rate.

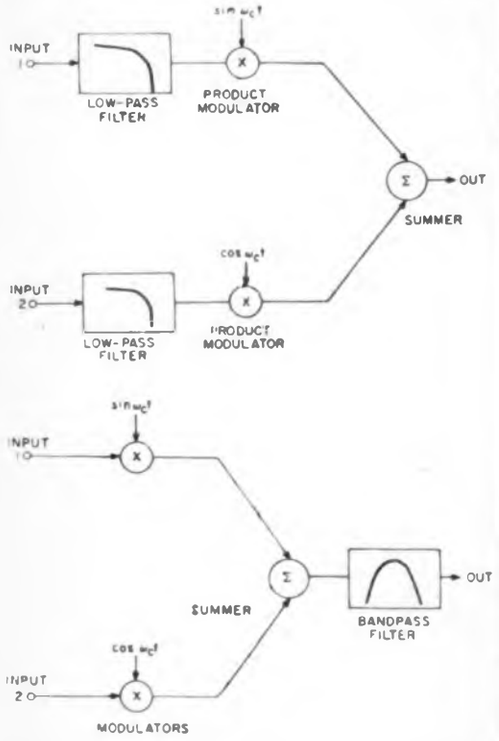
Performance in simulated telephony systems wired into an analog computer was said to be excellent. GE is building a Nymph-type communications system under a classified military contract.

In the Nymph transmitter, two synchronous binary signals, which may be derived from a single signal, are applied to two modulators, where they modulate two carriers in phase quadrature. The sum of the modulator outputs is the desired four-phase signal. Suitable filtering shapes the signals to permit narrow-band operation. Virtually all the shaping is done at the transmitter.

In the receiver, a signal taken from the output of an if strip is applied to two product demodulators that are fed with locally generated



Receiver for four-phase Nymph modulation system, which is based on phase reversal of two orthogonal carriers, is relatively simple. The critical problem is carrier recovery; this is aided by using either a steady carrier or phase-reversal keyed carrier. Received signal, applied to demodulators fed with local carrier signal in phase quadrature, is filtered for processing by decision circuit, which gives two outputs that are reshaped, retimed data signals.



Nymph transmitter that modulates two synchronous binary signals in phase quadrature to get a four-phase signal, could use either low-pass filtering (top) or bandpass filtering (bottom). Choice depends on whether carrier frequency approximates the data rate or whether it is many times the data rate, in which case, bandpass filtering would be used.

carrier signals in phase quadrature. The demodulator outputs are fitered and applied to a decision circuit and to the phase-lock local-oscillator control. The decision circuit produces reshaped, retimed data signals.

The critical problem of carrier recovery is solved by transmitting initially with a steady carrier or with a phase-reversed keyed carrier. Once initial synchronization is achieved, however, the system maintains lock despite the four-phase modulation according to Dr. Perry.

DEFT Based on Character Transmission for Radio Links

GD/E's DEFT system is based on character, rather than bit, transmission. It is designed for high-frequency radio links where both narrow-band operation and reliable reception are considerations.

The system uses orthogonal time functions to generate large alphabets. The coding is

NEWS

Narrow-Band . . .

(continued from p 13)

such that spectrum conservation can be traded off against data-reception accuracy. With enough channels and a suitably redundant orthogonal code, DEFT will permit error-free reception, says General Dynamics. In the narrow-bandwidth mode, a single 30-cps radio channel can carry 75 bits per sec, which is equivalent to 100 words per min of teletype data. Conventional frequency-shift keyed systems are said to require 170 cps of bandwidth for equivalent performance.

The heart of the DEFT system is a coherent in the receiver that operates by phase correlation. It uses static logic circuitry. Because the detector correlates without mechanical filters or storage, it is fast enough to permit extremely close spacing of transmitted data tones. This close spacing is the key to DEFT's efficient use of channel space, according to General Dynamics.

In one test of DEFT, the system was compared with a standard FSK data link. The single-side-band, high-frequency version of DEFT operated about 10 times better in terms of system accuracy than the FSK system over a 5-mc channel and a 300-mile path when both operated in parallel and sent 100 words per min of teletype data, General Dynamics says. The company reports it is refining its laboratory model of DEFT and is seeking sponsorship of further development. A marketable version of the system could be produced in about a year, the company says. ■ ■

Northwestern Adds Bionics Curriculum

Northwestern University, Evanston, Ill., will establish a curriculum in bio-medical engineering this fall.

Recognizing the growing scope of bionics research, Northwestern will both train engineers in the new science and set up research facilities. About a dozen other U.S. engineering schools offer bio-medical courses.

The Northwestern program already has 14 graduate students. It now will add an undergraduate option and for the first time offer a formal curriculum.

Extended-Interaction Circuit Boosts Klystron

Standing-wave resonator circuitry is being used in microwave klystron tubes to extend their performance significantly. Developed at Stanford University mainly to improve kylstron bandwidth for linear accelerator use, the circuits have been modified by engineers at Sperry Gyroscope Co., Great Neck, N. Y., to increase average power and efficiency as well.

The new klystrons are expected to be almost as efficient as magnetrons while maintaining the general klystron advantage of generating less interference.

The extended-interaction circuits, which include bars set transversely in interior waveguides, are designed to set up a standing-wave resonance on a slow-wave line. This permits the line to be extended in length without reducing performance, as would happen if a cavity resonator were enlarged to extend interaction.

By permitting modulation or demodulation over longer distances, the circuitry is expected to provide a four-fold increase in power output and efficiency, according to Sperry. Bandwidth is expected to be doubled and efficiency raised to more than 50 per cent. At 1 Gc, extended-interaction klystrons may have average outputs as high as 1 mw, Sperry says. Output at 10 Gc reportedly could reach 1 kw.

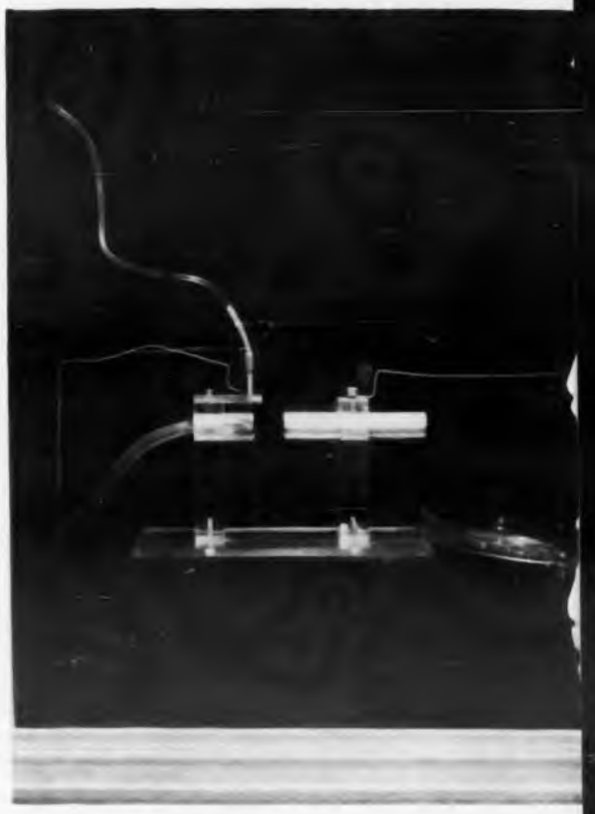
Extended-interaction circuit to increase power, efficiency and bandwidth of klystrons is tested in laboratory of Sperry Gyroscope Co. Circuit makes use of rods inserted transversely in klystron waveguide to create standing-wave resonance on slow-wave line, eliminating resonant cavity.

On Display: Designs for Space

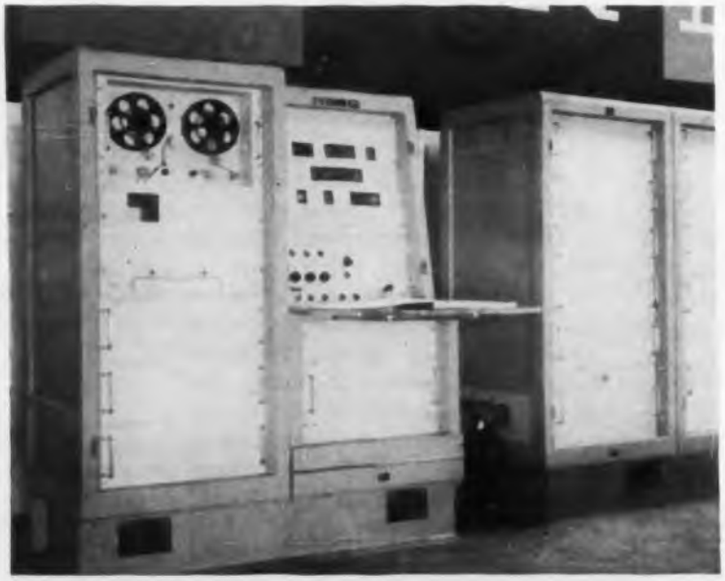
Space-age products illustrating a wide range of design ingenuity were on display at Philadelphia's Convention Hall during the Air Force Association's 15th Anniversary Convention and Aerospace Panorama, Sept. 21-24. Actual hardware used in missiles and satellites, and simulated systems for moon or planetary probes, gave visitors a representative view of trends in this branch of the industry. Some of the most interesting displays are shown here.

Falcon air-to-air missile parts were shown by Hughes Aircraft Co. although detailed information was not available because of security. Miniaturized radar-system parts are mounted on circular circuit card in foreground, with waveguide plumbing to the left. The GAR-11 version of the Falcon uses a narrow radar beam for homing. Another model of the missile—the GAR-2A—uses an infrared homing system. To the left of the circuit card is a portion of the missile's hydraulic system, mounted in cylindrical package.

Novel auxiliary electrical power generator (right) for space vehicles might use aerosol principle illustrated in this Marks Polarized Corp. display. Liquid aerosol spray, charged slightly positive, is injected from tube above into high-velocity, low-pressure point in a gas stream from cylinder at left. The positively charged aerosol particles are forced by the gas jet into the positively charged cylinder at right, increasing the positive charge on the collector. Only a small portion of the power generated is used to sustain the process.



Photos by ELECTRONIC DESIGN



Universal automatic tester built under Air Force contract by Bendix Corp. was designed, in the case of this system, for checkout of the Douglas Skybolt missile. The Checkout Sequence Programming Set uses a photoelectric tape reader to control tests of ac and dc voltages, frequencies, time intervals, events per unit of time, resistances, voltage ratios and in-phase and quadrature voltages.

Model of SNAP III (Systems for Nuclear Auxiliary Power) on display shows how isotope-thermocouples and a 2,100 curie polonium—pact power generator for space. This 4-lb, 2.5-w unit would contain 7 lead telluride thermocouples and a 2,100 curie polonium—210 source.

(Advertisement)

NEW PRODUCT

Solder BANTAM Miniature Round Connector

BURNDY now has available to the industry its BANTAM miniature round connector which conforms to the requirements of MIL-C-0026482A (WEP). These connectors are supplied with a variety of insert configurations in nine shell sizes. Number 16 and 20 size contacts are supplied depending on the insert configurations.

The miniature solder BANTAM mates with, or replaces, all connectors which conform to MIL-C-0026482A (WEP).

BANTAM plug and receptacles feature the TRI-LOK bayonet coupling, a positive coupling which can be quickly disconnected. They are vibration resistant and moisture-proof with the required temperature range of −67 to +257 degrees F. They provide an interfacial seal, per the military spec and the need for safety wiring is eliminated by the positive locking bayonet coupling. Polarized inserts and a five point key and keyaway eliminate the possibility of mismating.

BANTAM contacts are machined of high conductivity copper alloy and the sockets feature closed-entry, making them probe-proof. Extra heavy gold silver plating provides high conductivity and extra protection against corrosion. In addition, plating of contacts provides hard gold mating with soft gold, adding durability and minimizing galling. Special plating can be provided.

Solder BANTAM shells are fabricated of a high strength aluminum alloy. The standard finish is cadmium plate, type II, class C, per QQ-P-416, with olive drab iridite finish. Other finish plating can be provided.

For further information consult:

BURNDY, Norwalk, Connect.

CIRCLE 16 ON READER-SERVICE CARD

NEWS

Computer Design Assailed By Speakers Before ACM

Computer design took some harsh criticism from panelists and speakers at the recent National Conference of the Association for Computing Machinery in Los Angeles. Greater emphasis on computer education also was urged. Among the significant comments for designers at the meeting were these:

Robert S. Barton, consultant—

We're too conservative and too willing to pick up the other guy's idea and adapt it. The truth is there has been no really outstanding contribution to theory since the work of Charles Babbage 100 years ago. The so-called computer revolution may be ended unless industry and scientific leaders devote themselves to honest research, not that which is tied to business applications or military crash programs.

A lot of fast computers are not enough; we should think in terms of new devices for specialized applications, instead of trying to fit the general-purpose computer to virtually all applications.

M. O. Kappler, president, Systems Development Corp.—

There is a need for vastly improved information processing systems and techniques, based on studies of "what the user really wants and needs and not on a warmed-over adaptation of what is already available."

The field is suffering from too many programmers' programs and too few programs tailored specifically to do the user's work.

Fred Gruenberger, Rand Corp. scientist and educator—

More than 10,000 teachers of computer training will be needed in our high schools within five years. Only 35 high schools in the nation now provide training in computer usage.

Houston Site Selected For Space-Flight Center

Project Apollo, America's manned space-flight project, has found a home. A 1,000-acre tract in Houston, Tex., has been made available to the government by Rice Uni-

versity for a $60,000,000 manned space-flight laboratory. The facility, to be administered by the National Aeronautics and Space Administration, will be the command center for the manned lunar-landing mission and all follow-on manned space-flight projects.

Selection of the Houston site coincided with the appointment of D. Brainerd Holmes of Radio Corp. of America as director of manned space-flight programs for NASA. Mr. Holmes, 40, has been general manager of the Major Defense Systems Div., a unit of RCA Defense Electronic Products, Moorestown, N. J.

The Houston Apollo laboratory will be used to design, develop, evaluate and test the space vehicle and to train the crews.

Transfer-Mold Process Assembles Electron Gun

A transfer-molding process that replaces hand-crafted assembly of cathode-ray-tube electron guns has been perfected after two years of research.

The new manufacturing technique is said to simplify production and assure reproducibility and environmental stability. The process was developed by General Dynamics Corp. under a contract from the Navy Bureau of Ships.

In the new method, electron guns are made by transfer-molding a ceramic-like material in hardened tool-steel molds. The unitized "formed guns" are precision-molded and machined in symmetrical halves.

Gun elements, including electron lenses and deflection plates, are produced by firing a conductive material onto internal surfaces of the molded gun. Electrode connections, made through wires embedded in the ceramic, act as conductors from the fired-on elements to the base assembly. Conventional sealing and exhaust procedures are used.

The electron gun assembled by the new transfer-molding process (bottom) is held next to a gun assembled by hand.

WASHINGTON REPORT

Wilbur H. Baldinger
Washington Editor

QUALITATIVE COMPUTER WORK FOUND LACKING

Computer designers are obsessed with speed at the expense of "qualitative evaluation" of data, a government scientist thinks.

The criticism came from H. W. Dubach of the National Oceanographic Data Center before the Washington Chapter of the Association for Computing Machinery. The theme of the all-day symposium at George Washington University was "Computer Progress in the Nation's Capital."

The oceanographic data center has a serious problem of data digestion, Mr. Dubach said. He complained that computer designers appear to be concerned solely with the idea of making their devices run faster than the next fellow's. His staff is "swamped with observations," Mr. Dubach said, and added:

"In recent years it seems that the effort of the computer industry has been to continually upgrade the computer speed. Can we develop equipment that will do more than simply add and subtract at the speed of light?"

At the same Washington meeting, Jacob Rabinow of the Rabinow Engineering Co. in suburban Takoma Park, Md., asserted that he has a machine that can read up to 2,000 printed characters per second. It could do better than that, he said, but nobody yet has figured out how to shift the paper any faster.

Isaac L. Auerbach of the Auerbach Electronics Corp., Philadelphia, president of the International Federation of Information Processing Societies, took "An International Look at Computers." He said computers could have a "greater impact on the common man than atomic energy or any other source", by analyzing and advancing economics in underdeveloped countries. Auerbach urged the State Dept. and U. S. Information Agency to help establish overseas computer-education programs through use of films, special publications and lectures.

EIA FINDS PATENT PROPOSALS "TERRIFYING"

"Government ownership of any patent destroys incentive" in private industry, Elmer J. Gorn of Raytheon Co. testified at a National Aeronautics and Space Administration hearing. He spoke as chairman of the Electronic Industries Association's patents committee.

The EIA spokesman vehemently opposed NASA's proposals to grant exclusive licenses—particularly to small firms in labor-surplus areas—for development of government-owned inventions. He argued that such a policy would set a precedent for other federal agencies, and that this could end in empowering the government to dictate "to virtually every American exactly what he can and cannot make, use and sell."

The result of the NASA plan could be "terrifying" to anybody who cherishes the U. S. free-enterprise system, Gorn said. He warned that

the government's vast research activities already were near the point of making it "the owner of the largest and potentially the most overwhelmingly powerful accumulation of patents in the world." Gorn urged adoption by NASA of EIA proposals for unrestricted use—"freely, unconditionally and without charge"—of inventions covered by government-owned patents.

Nor did Gorn express much sympathy with what he said were socio-political objectives of the Kennedy Administration in the NASA license-policy plan.

"The exclusive licensee is not to be chosen on the basis of whether he is the most creative, or the best qualified to develop the invention, or the one who can best afford to spend money needed for such development," Gorn said. "Rather he is to be a small businessman in a labor-surplus area." The Constitutional purpose of the U. S. patent system is to promote science and the useful arts generally—not selected sociological segments of the population, Gorn contended.

RUSSIANS DENOUNCE PROJECT WEST FORD

The USSR has called on the U. S. to call off its Project West Ford, in which the Air Force plans to put a belt of metallic needles into orbit as a reflector for long-range radio communications (See *ED*, Aug. 30, p 21). The project is too hazardous for Russian spacemen, the Soviet Academy of Sciences said in a stern protest to the U. S. National Academy of Sciences. The protest letter warned that the belt of tiny dipoles not only might interfere with international astronomical observations but also could have "dangerous consequences" for manned satellites.

WANTED: MORE DURABLE SPACE POWER PLANTS

Solar cells are not yet reliable as space power plants, panelists at an Institute of Radio Engineers session in Washington agreed.

Electronic equipment in communications satellites, they noted, should have a 10-year life if the system is to be economically feasible. Yet the effective life of current space gear is only three or four months. Power failures, the panelists concluded, are probably the main cause of malfunctions.

Researchers need to learn more about power problems in space before electronic devices in a satellite system can be given a functional O.K. tag, Dr. Rudolph Kompfner of Bell Telephone Laboratories told the panel.

Even the Russians do not claim to have licked the space-power problem. Coincident with the IRE session, the Commerce Dept.'s Office of Technical Services issued a translation of a 257-page Soviet treatise on solar energy. It boasted that the first real solar furnace was started in Russia in 1741, and that research had progressed to the point where Soviet optical engineers hope soon to supply many of Russia's power needs on the ground through solar energy. No mention in the brochure, however, of a surefire made-in-Russia solar plant for use in space.

CAPITAL CAPSULES

An advanced experimental digital course, sponsored by the National Association for Computing Machinery, has been completed by 12 Washington-area high-school students . . . Add Russian claims: A Commerce Dept. translation of a Soviet business journal says 300,000 accountants will be assigned to other work by 1965 if mass production of computers progresses as planned.

NEWS

Ionization Gage Designed For High-Altitude Study

A cold-cathode ionization gage, able to withstand rocket and satellite launchings, has been developed to obtain atmosphere measurements at altitudes of more than 500 miles.

The magnetron-type gage, designed for the National Aeronautics and Space Administration by Geophysics Corp. of America, Bedford, Mass., has a range of sensitivity from 1×10^{-4} to below 1×10^{-11} mm Hg pressure. This range of sensitivity is reported to be sufficient for measurements in regions where the density of particles is less than 10^{5} per cu cm.

All elements of the gage are supported within a cylindrical metal envelope by ceramic balls. The cylinder's outer diameter is 2 in. and its height is about 1-1/4 in.

Operation and control of the unit are achieved through an electron flow through crossed magnetic and electric fields, rather than by a grid-anode configuration used on conventional triode-type ionization gages.

Under typical conditions the cold cathode, which serves both as an electron emitter and ion collector, is operated near ground potential. The anode is operated at +4,000 v and draws on the order of less than 1 μa at low pressures. The metal envelope remains at ground potential and the field strength of the permanent magnet is about 1,000 gauss, the company reports.

In addition to its rocket and satellite use, the gage also will serve as a laboratory instrument to control or check out simulated high-altitude environments or other high-vacuum processing operations.

Ionization gage has range of sensitivity from 1×10^{-4} to below 1×10^{-11} mm Hg pressure. This range can be used for measurement in regions where number of particles is less than 10^{5} per cu cm.

Sorter-Reader Output Raised

Sorter-reader being tested by engineers from General Electric Co.'s Computer Dept., Phoenix, Ariz., reportedly is 70 per cent faster than GE's previous sorter-readers. The 12-pocket document handler is designed to be used "on-line" with either the GE 210 or the GE 225 computer systems. It also may be used for "off-line" reading and sorting of checks at the rate of 1,200 per min. Orders are being taken on 12 months' delivery. It will sell for $87,500 or be rented at $1,750 a month.

Portable TE Generator, Using Propane Gas, Tried by Navy

A portable back-pack thermoelectric generator, capable of producing militarily useful amounts of power, has been delivered to the Bureau of Ships, U.S. Navy.

The generator, developed by Westinghouse Electric Corp., Pittsburgh, is an experimental electric plant, light enough to be carried by one man. It burns bottled propane gas and can be adopted to burn ordinary gasoline.

Solid, semiconductor-type materials change the heat of the gas flame into electricity when a difference in temperature is maintained across them. A small fan, taking its power from the generator, blows air across the cool side of the materials. The generator develops a gross of 340 w of electric power. Eighty watts are used to drive the fan.

The 36-lb generator, Westinghouse says, operates at an average temperature of 842 F on its hot side, and 284 F on its cool side. Its 450 thermoelectric couples are mounted hexagonally around the gas burner, making a structure 11 in. in diam and 22 in. long.

Perforated End Plates Give Interferometer High Q Factor

Millimeter-wave interferometer cavities with a Q of 100,000 have been developed at the National Bureau of Standards Laboratories, Boulder, Colo. The extremely high Q factor reported for the new cavities is attributed to the use of minutely perforated end plates that improve the coupling of rf energy into the cavity.

Rectangular cavities have been built for experiments at 3- and 6-mm and spherical biconical cavities operating at 8 mm.

The rectangular cavity for 6-mm tests operates as a coventional Fabry-Perot interferometer and consists of two parallel plates, each about 1 ft square. The plates are formed of perforated silver films on glass or quartz optical flats. Brass sheets 1/32 in. thick also have been used.

Perforations for 6-mm work are 0.0236 in. across and spaced 0.057 in. between centers.

The new Fabry-Perot interferometers have been used to measure wavelengths in the millimeter region to accuracies of better than 0.04 per cent. It also is being used to measure with high accuracy the dielectric constants of materials placed in the cavity.

The spherical biconical resonator is made of gold-plated silver, with two sides of the sphere perforated. It is operated by focusing energy to the center of sphere with a horn and dielectric-lens arrangement.

The 8-mm sphere built at NBS is 4 in.

Perforated-plate Fabry-Perot interferometer for the 3- to 4-mm range is adjusted for parallelism by G. L. Strine. The device is being used as the cavity resonator in a hydrogen-cyanide gaseous maser.

Spherical biconical perforated cavity for 8-mm experiments (left). Also shown is horn to focus energy at center of the sphere. In use, the two dielectric lenses are recessed into the horn.

across. This cavity is expected to be particularly useful in generating power at millimeter and submillimeter wavelengths by forming a resonator for two- and three-level solid-state masers.

Bandwidths of the spherical cavities are said to be sufficiently high for practical application in masers.

Data System Waterproofed

Fourteen-channel analog recording system, housed in watertight pressure-type container, is said to withstand immersion in salt water depths to 200 ft. The system, developed by Leach Corp., Compton, Calif., was designed for missile-launching environments that call for highly reliable, rugged and accurate data sources. The 25-lb device will be used for recording of multiplexed fm data. The system consists of standard tape transport and electronic modules and is immediately available.

NEWS

Telemetry Under Development For NASA Satellite Observatory

Pulse Code Modulation (pcm) telemetry and data-handling equipment is under development for the National Aeronautics and Space Administration's Orbiting Astronomical Observatory (OAO) satellite. (*ED*, Jan. 4, p 12).

The OAO is a precisely stabilized 3,300-lb satellite designed to perform astronomical experiments. The basic objective of the OAO program is to create a standardized spacecraft that can be used for many scientific missions with only minor changes.

The equipment, being developed by Radiation Inc., Melbourne, Fla., under a subcontract from Grumman Aircraft Engineering Corp., Bethpage, N. Y., will report, upon earth command, on the performance of subsystems and the progress of the experiments aboard. The system will reportedly have a "satisfactory operating probability" of 98 Its 450 thermoelectric couples are mounted per cent.

Plans call for launching of the first OAO over the Atlantic Missile Range in late 1963. An Atlas-Agena-B vehicle will boost the satellite to orbital velocity. In the first experiment, the OAO will study stellar radiation in the ultra-violet range.

Drive-In Banking System

A drive-in banking system, called Autobanker, employs closed-circuit TV, high-fidelity audio, and a new type of pneumatic tube. The 7- by 4-in. oval tube carrier, lower left, can negotiate a 90-deg turn in a radius of 48 in. Up to 3-1/2 lb of material can ride the tube, at a speed of 25 ft per sec. Pressure and vacuum to propel the tube are provided by blowers in the bank's basement. The system, installed at the First National Bank of Waukesha, Wis., was designed by The Mosler Safe Co. and engineered by International Telephone and Telegraph Corp.

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says T. J. Scanlon, Purchasing Agent, Electron Tube Division
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TYPE 30—Precision I-F Attenuator
Get the highest available accuracy in this piston type attenuator.

FEATURES: 30 and 60 Mc standard frequencies. Continuously variable over 80 db range above minimum insertion loss. Accuracy ± .005 db per db from 10 to 80 db; ± .05 db from 0-10 db. Price $250 to $295. Circle publication No. 785.

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Many types of precise measurements of R-F circuits are possible with this excellent labora-

tory tool. Calibrate R-F attenuators and couplers. Measure noise figure and selectivity.

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11 Models for automatic or manual noise figure measurement.

FEATURES: Frequency range from 10 Mc to 40 Kmc. Relative excess noise temp: 15.3 db ± 0.25 db. Price $125 to $330.

Plus new, exclusive hot-cold body generator to provide highest accuracy available in 0 to 2 Kmc range, excess noise 6.83 db ± 0.1 db. Price $675. Circle publication No. 787.

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TYPE 74—Automatic Noise Figure Indicator

Widest frequency coverage is yours with this equipment. Plus maximum flexibility. Exclusive tunable I-F amplifier available.

FEATURES: R-F range 10 Mc to 40 Kmc with Type 70 noise generators. I-F range—30, 60 and 40 to 180 Mc. Noise figure ranges—0 to 25 db, ± 0.5 db; 23 to 36 db, ± 1.0 db. Prices $765 and $830. Circle publication No. 789.

Type 113030 (not illustrated)—Radar Performance Monitor. Transistorized. Measures noise figure, checks mixer crystals; checks transmitted and reflected power. Circle publication No. 790.

SPECIAL RECEIVER

NEW—TYPE 133—Parametric Amplifier

Extremely low noise amplifiers for microwave applications through X-Band featuring excellent amplitude and phase stability and simple operation. Fixed tuned narrow band, tunable narrow band and fixed tuned wide band (10%) designs available. We will gladly quote on special designs. Circle publication No. 791.

SPECIAL PURPOSE TEST EQUIPMENT (LEFT TO RIGHT)

TYPE 124C—Wide Range Power Oscillator

Watts of power over a wide range makes this Oscillator invaluable in many microwave tests.

FEATURES: 200 to 2,500 Mc. Internal or external modulation. Nominally 30 watts output. Price $2,485. Circle publication No. 792.

TYPE 120—Function Generator

Three Wave Forms are provided in one lightweight transistorized package. Sine waves, square waves or pulses with constant amplitude within ± 1 db over the 30 to 39,000 Cps range. Output amplitude and pulse width adjustable. Price $299. Circle publication No. 793.

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Smallest, lightest, lowest-cost power bridge on the market. You get the same accuracy as with higher-priced units.

FEATURES: Ranges 1.0 and 10 mw ±5%. R-F coverage 10 Mc to 40 Kmc, depending on thermistor used (not supplied). Circle publication No. 794.

TYPE 90—Circuit Design Reliability Tester

Prove and improve your circuit designs with this instrument. An especially valuable tool with low frequency circuits where the Customer demands ultimate in reliability. Uses "extreme values" technique on up to 16 parameters. Binary readout of circuit parameters at time of failure. Price $3,600. Circle publication No. 795.

TAKE A SECOND LOOK

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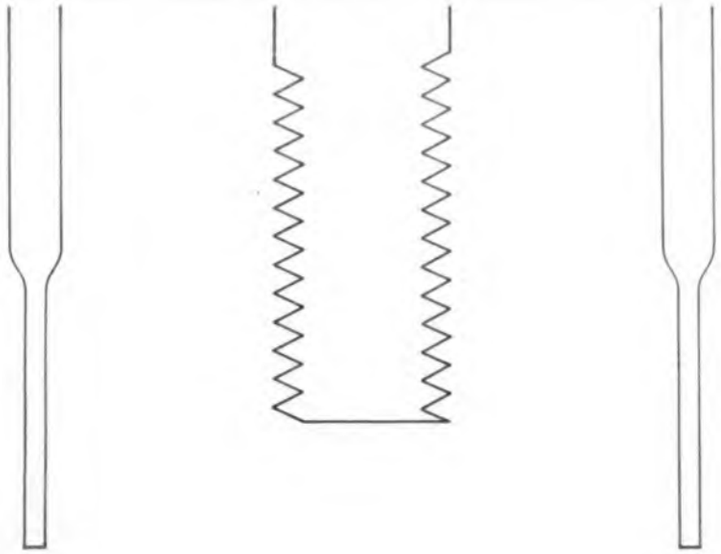

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CIRCLE 29 ON READER-SERVICE CARD

Magnetic Computer Uses Multiaperture Cores

An airborne, guidance-type computer that would use magnetic circuitry for logic as well as for memory is being built by Sperry Gyroscope Co., Great Neck, N. Y. Basic clock rate of the system is to be 600 kc sine wave, which is said to make possible more than 12,000 additions or subtractions of 24-bit single words per sec.

Except for a sense amplifier to sense memory output, and a control-pulse generator for synchronization, both of which use semiconductors, all logic, registering, gating and memory functions are implemented with magnetic elements, according to Sperry. These elements are mainly single-hole and two-hole multiaperture cores and permalloy cores of special design, the company says.

The computer is being built for the Air Force's Aeronautical Systems Division at Wright Field, Ohio. The Air Force is reported to be supporting the project in the hopes of achieving a highly reliable computer through all-magnetic design. A feasibility model is scheduled for delivery to Wright Field in April, 1962.

Performance goals include: operation for up to 20,000 hrs without maintenance; operation at temperatures from —55 to 125 C; a weight of 19 lb; a volume of 0.5 cu ft; a power consumption of less than 90 w; and high resistance to nuclear radiation. The main memory would contain 400 17-bit words in two-hole cores; a data memory would store 256 24-bit words.

The system uses four-pulse, dynamic logic. Company engineers report they are designing similar circuitry to work at more than 1 mc. One magnetic circuit is said to have operated at around 5 mc.

Mockup of ferrite-core logic circuit for airborne magnetic computer shows configuration that would permit storage of 400 17-bit programed words in two-hole multiaperture cores. Density is expected to reach 2,700 bits per cu in.

6-Lb Tape Recorder Set For Space Test

Simulated Nuclear Fuel Cells To Store and Rebroadcast Data

TESTING of a miniaturized tape recorder destined to travel at speeds of 15,000 mph in an Atlas missile, is nearing completion at the Air Force Special Weapons Center, Albuquerque, N. M.

Developed by Consolidated Electrodynamics of Pasadena, Calif., the 6-lb recorder, contained in a 500-lb package of simulated nuclear fuel capsules, will record, store and rebroadcast measurements of re-entry heat.

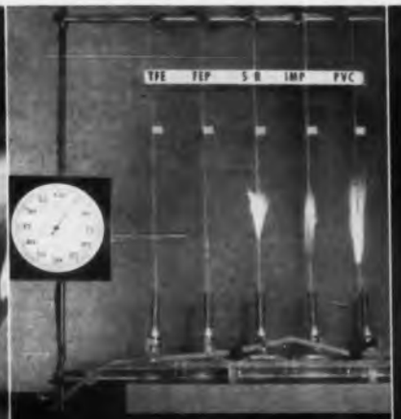
The Atlas flight will be part of a joint Atomic Energy Commission-Air Force aerospace nuclear safety program. The program is designed to verify analytical and laboratory evidence that space nuclear-auxiliary-power (SNAP) devices will burn up harmlessly when they re-enter the atmosphere from orbit.

Because intense heat builds up a plasma sheath of ionized air, which blacks out radio transmission during part of the re-entry, a tape recorder is necessary. Telemetry signals will be stored in the recorder during the blackout period and retransmitted at a lower altitude after the plasma sheath has decayed.

Twenty-five feet of 1/4 in. magnetic tape will be used at a speed of 5-1/2 in. per sec.

Power is externally supplied from the

Titanium canister, left, houses telemetry recorder unit. White lining, at open end of canister, is insulating material. White ovals are transducers. At right, is fm/fm telemetry system and closed-loop magnetic tape recorder/reproducer.



Vertical flame test 5 seconds after ignition of burners. No indication of burning on either "Teflon" FEP or TFE resins. Other insulations flame vigorously.

15 seconds after removal of flame (30 seconds after ignition), FEP and TFE show only slight discoloration. Other insulations (at right) are still burning or are badly charred. These insulations are silicone rubber, irradiated modified polyethylene and polyvinyl chloride, respectively.

FEP used in computer-wire insulation

Within its brief commercial life, Du Pont TEFLON 100 FEP resin has been accepted as primary insulation for hook-up wire by major manufacturers of data-processing equipment. Modern high-speed circuits demand uniform low capacitance. This is provided by FEP, whose low dielectric constant is unaffected by frequency or temperature. New wire-wrap techniques, including high-speed automatic wire-wrapping, require high resistance to cut-thru. Here the combination of a primary insulation of TEFLON FEP with a jacket of "Zytel" nylon resin has proved outstanding. Also important to the computer industry is the availability of insulated wire in unlimited lengths, with tinned or silver-plated conductors . . . and the exceptional toughness and flexibility of FEP insulation.

FEP insulation does not burn

One very important property of TEFLON 100 FEP resin is its complete nonflammability, illustrated above. For many applications, this nonflammability, with its accompanying safety factors, is a critical consideration.

TEFLON 100 has a dielectric constant of only 2.1. This value remains constant over the entire frequency range measured to date, and is essentially unaffected by temperature. Further, FEP retains both its electrical and mechanical properties on heat aging, and is recommended for continuous use at temperatures as high as 200°C.

CIRCLE 32 ON READER-SERVICE CARD

Downward price trend of TEFLON 100 FEP resin extends markets in insulation

In July, 1961, the price of TEFLON 100 FEP resin was reduced by 30%. This was the third reduction by Du Pont since the resin was introduced in June, 1957, and represented a 65% change from the original price. Increased sales and technical breakthroughs permit such price reductions.

This history of price decreases parallels that of TEFLON TFE resins, today selling at about one-fifth of their introductory price. In terms of today's designs, as well as for long-term development programs, reliability costs less with TEFLON.

• • •

Would you like more information about TEFLON 100 FEP-fluorocarbon resin? Just write to: E. I. du Pont de Nemours & Co. (Inc.), Dept. ED-10, Room 2526T, Nemours Bldg., Wilmington 98, Del. *In Canada:* Du Pont of Canada Limited, P.O. Box 660, Montreal, Que.

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DU PONT

Better Things for Better Living . . . through Chemistry

Magnetic tape in a continuous 25-ft loop is used in 6-lb recorder-reproducer. Tape speed is 5-1/2 in. per sec. It will record heat data when SNAP telemetry canister passes through transmission blackout area on return to earth.

telemetry system battery, 7 w for tape transport and electronics. The recorder is fully transistorized, pressure-sealed with helium gas, and designed to withstand accelerations up to 15 g.

The telemetry-recorder power source is a 19-cell silver-cell battery. Telemetry operates on 10 w and is a three-channel fm/fm system.

The recorder will be connected to 26 sensitive heat detectors in the 1/2-in.-thick titanium walls of the canister holding the recorder and telemetry equipment. Capable of withstanding temperatures in excess of 3,000 F, the canister is expected to stay intact until impact on the Atlantic Missile Range.

The antenna, with an element less than 2 in. long and positioned at each end of the telemetry canister, is covered by a high temperature, low loss ceramic radome. The antenna was developed by C. G. Electronics of Albuquerque.

The 500-lb package, mounted on the side of the Atlas missile, also will contain 32 simulated nuclear-fuel capsules loaded with flare material. When the high temperatures of re-entry ignite the flare material, brilliant yellow and violet bursts of light will appear over the missile range. High-speed cameras on the ground and in aircraft will photograph the flare bursts to help engineers determine when and at what altitude a nuclear power device will burn up in the atmosphere upon re-entry. ■ ■

NEWS

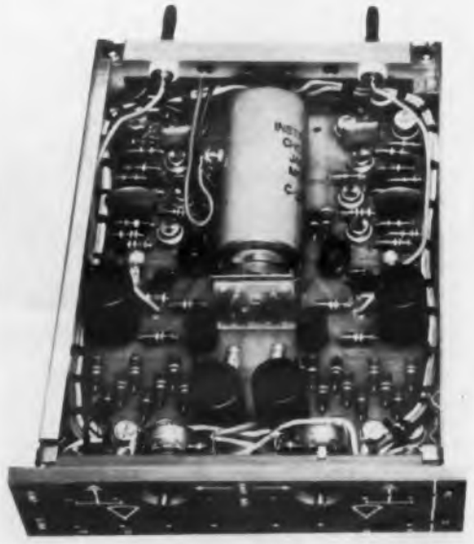
Table-Top Analog Computer Modified for Industrial Use

Industrialized versions of the modules used in a transistorized table-top analog computer are being offered as building blocks for special-purpose process-control computers.

The industrialized modules from Electronic Associates, Inc.'s TR-10 table-top computer are being made available "off-the-shelf" as part of the Long Branch, N. J., company's PC-12 process-control line. First installations of the units have been for such heavy-industry users as Jones & Laughlin Steel (for determining steel melt mix) and DuPont (for chemical process control).

The basic operational amplifiers are packaged, two to a package, in modules which Electronic Associates is selling for $350 each. Other computing modules adapted from the TR-10 include: an integrator said to be able to provide time constants of up to 10,000 sec (necessary for certain slow-reacting industrial processes) with drift rates as low as 1 mv per hr; a low-level amplifier package for thermocouple and other weak signals; variable-diode function generators; multipliers, and power supplies.

The four main changes made by Electronic Associates in industrializing the standard



Dual operational amplifier package around which the industrial PC-12 line is built. The large chopper in the middle of the package is the only non-solid-state part of the system. Note the husky ground bus at the back of the modules which isolates the amplifier summing points.

amplifier from its TR-10 counterpart were:

- Patching points were removed to rear of module, since module interconnections, once set, would be permanent.
- Connectors were gold-plated.
- Chopper was hermetically sealed.
- Amplifier summing points were isolated by Teflon bushings surrounded by husky bar-stock aluminum ground bus to prevent stray voltages from causing errors.

Image-Orthicon TV Camera To Record Night War Games

An all-transistorized image-orthicon camera system will be used in the first televised demonstration by the Air Force of night fighter-plane tactics.

The special cameras will permit work at Mach-2 speeds and with no more light than the stars and jet exhausts of the planes, according to the system's developer, Thompson Ramo Wooldridge, Inc.

The equipment will be used by the Air Defense Command to televise the Worldwide Weapons Meet, beginning Oct. 23 at Tyndall Air Force Base, Panama City, Fla.

The entire meet will be televised to judges, military observers, visitors, and to nearby communities. Kinescope tapes are expected to be released for commercial-TV showing.

Some cameras will be carried by "chase pilots" to record interceptor tactics at Mach-2 speeds.

Computer Will Keep Tabs On 2.5 Million Patients

The records of 2.5 million patients, discharged from hospitals in 1962, will be analyzed on an electronic computer to improve patient care and hospital efficiency.

The project, which will be performed in Ann Arbor, Mich., by the Commission on Professional and Hospital Activity, as part of its professional activity study, will enable hospitals to compare their patient-to-patient performance with scores of other institutions.

Early in 1962, the commission will install a Honeywell 400 high-speed computer, which can handle as many as 10,000 mathematical operations per sec.

The Honeywell computer will analyze diagnostic and hospital-care data of patients discharged from hospitals in 34 states.

NEWS

Component Design For Space Use Studied in Special Vacuum System

Considerations for components to be used in the deep vacuum of space are being studied by a research group at Hughes Aircraft Co., Culver City, Calif., using specially designed vacuum equipment.

Some of the following results have already been obtained from tests:

- Although Teflon crumbles when exposed to radiation in the earth's atmosphere, it is very radiation-resistant under high-vacuum conditions.
- Some metals, such as cadmium, zinc and some magnesium alloys, will evaporate in space, causing short-circuiting problems. Some anodic coatings have been found to reduce the evaporation rates up to 70 times.
- Cold welding of switch contacts, slip rings, communator brushes or other contacting parts is possible because of the loss of adsorbed gas on surfaces.
- Some components must be derated by as much as a factor of four because of the lack of convection cooling in space.

Some more familiar design problems, such as leakage of diode and transistor seals, evaporation of moisture from composition resistors and corona discharge also are under study.

The Hughes system consists of a series of Pyrex glass chambers separated by special

Electronic components are tested under vacuum conditions in this special "vacuum train" designed by researchers at Hughes Aircraft Co. Different environmental conditions can be maintained, and separate analyses performed, in individual portions of the vacuum system. Special valves and cement-sealed, ground-glass joints separate the individual segments. Thermal extremes, and radiation through the visible, infrared, ultraviolet and high energy range can be simulated.

valves and ground glass joints. It is regularly maintained at 5 x 10^{-7} mm Hg, equivalent to 250 miles altitude, by mercury diffusion, or can be ion-pumped to 1 x 10^{-9} mm Hg, equivalent to 450 miles altitude, for specific tests. There are provisions for collecting and analyzing outgassed or evaporated materials.

Audio-Visual Link

Two-way visual and voice communication between executives in widely separated areas is made possible by the Management Information Control System, introduced by Teleprompter Corp. Screen presentations (top) can be received by the executive at the side of his desk. Papers can be transmitted by placing them on the platform in front of the console. Transmission of the TV image is by coaxial cable or microwave link. The central control equipment (bottom) stores TV images or recorded voice information for presentation on remote consoles upon demand. Similar equipment could be used for educational closed-circuit TV system, the company says.

NEWS

Radar System Guides Space Craft to Earth

Vehicle's Safest Re-Entry Path, Landing Calculated by Computer

AN automatic landing system is under development for unpowered space vehicles and re-usable space boosters.

Developed by General Electric Co.'s Defense System Dept. of Syracuse, N. Y., the device is designed to track a vehicle on radar from 500 miles in space. It calculates a safe flight path to avoid overheating or overstressing the vehicle, and provides guidance through approach, flare-out and rollout on a predesignated runway.

The landing system incorporates an AN/TPQ-10 radar, a van with associated radar equipment and a GE 225 digital computer, and airborne equipment consisting of a transistorized track beacon, pulse type and decoder.

One of the virtues of this combination of equipment, the company reports, is that the airborne package could be used to guide the booster vehicle at launch and then re-used for the recovery operation by the landing system. Further, the beacon weighs only 12 lbs and the decoder 11 lbs, including a 5-lb antenna. Total airborne system weight would be about 28 lb.

Landing System Can Handle Manned, Unmanned Vehicles

The landing system would be applicable to manned and unmanned vehicles in free flight. Following re-entry, the vehicle's velocity might still be as much as 15,000 ft per sec. At this speed, even manned spacecraft would need some instrumentation assistance. The problem in landing the vehicle at a predesignated point is that this high kinetic energy must be dissipated without overheating the vehicle or subjecting it to destructive stress loads.

By working with the vehicle's performance characteristics, a series of safe flight paths are calculated and stored in the computer.

The computer selects the precise flight path to suit the position and velocity conditions of the vehicle, and the TPQ-10 radar sends a pulsed command signal to the track trans-

AN/TPQ-10 radar, to be used in automatic landing system for spacecraft and re-usable stages of missiles, can track a vehicle from 500 miles in space.

ponder aboard the vehicle. The transponder in turn feeds the signal to the decoder, which passes it along to the vehicle's autopilot or to a pilot display.

For an unmanned vehicle, normally, an autopilot integral to the booster or spacecraft is used for the landing-guidance function. However, if there is none, a lightweight autopilot could be tied into the landing system and perform the mechanical control functions, GE says. ■ ■

Ion Engine Tested

This repetitively pulsed plasma propulsion engine (left foreground) has been fired continuously for 60 hr at a rate of 1,000 firings per minute without appreciable electron erosion, according to General Electric. The engine was run in a 13-ft vacuum chamber in its simulated space mission. The engine (REPPAC III) produced 20 millipounds of thrust with a specific impulse of 5,000 sec. GE said the engine used 7 kw of power and operated at 32 per cent efficiency.

NEWS

Field-Azimuth Gyro Orientor Contained In Portable Unit

A field-azimuth gyro orientor, which can be carried by one man, is meeting a variety of Army corps-level field tasks.

Called Miniaturized Automatic Base Line Equipment (MABLE) by its developers, Autonetics of Downey, Calif, a division of North American Aviation, Inc., the device is carried as a back-pack unit. It measures 11 in. in diameter, is 21 in. high and weighs less than 25 lb.

Despite its small size, the unit's capabilities are said to include: target orientation by forward observers; extension of corps-area survey points; and alignment of artillery, missile launchers, radar and drone guidance.

According to Autonetics, in 10 min operating time, MABLE can determine true north to an accuracy of 60 sec of arc. This accuracy can be further improved by taking a series of successive readings and calculating an average. With north established, MABLE's integrally mounted theodolite then can be positioned to any desired true azimuth, or any sighted direction can be read out in true azimuth, the company reports.

Microminiaturized circuits in field-azimuth gyro orientor conserve weight and improve reliability. Power supply can be any 24-v source; for operation in remote areas, the unit can use small rechargeable batteries.

Computer to Speed Stock Tabulations

A computer-based system for tabulation and transmission of stock tables will be installed next year by the Associated Press.

The data-processing system will update and transmit stock quotations from the four major exchanges.

Built around a solid-state IBM 1620 computer, the system will permit the AP to transmit updated stock tables to its newspaper clients within 15 sec after the close of the stock ticker. Here is how the system will work:

Trades on the four exchanges will flow into the AP's New York office on stock tickers. The tapes will be read by two IBM 1011 paper-tape readers at up to 10,000 words per minute, simultaneously converted into machine code and fed into the computer.

Two 1620 computers, each capable of making 300,000 logical decisions per minute, will be linked to a 1405 random-access disk storage file, which can store 10,000,000 characters of data for rapid availability. The computer will update the status of each stock, regardless of the sequence in which trades are received. At the same time the 1620 will arrange the format of each newspaper line ultimately to be printed, calculate each stock's net change for the day and compute highs and lows.

Three IBM paper tape-punching units will prepare the stock-table tape—at 4,500 words per minute—for AP circuits.

Nate Polowetzky, general business editor of the Associated Press, sits at the operator's console of solid-state IBM 1620 computer, similar to one that will help the AP speed stockmarket tabulations. Explaining the system is McLain B. Smith, vice president and group executive of IBM.

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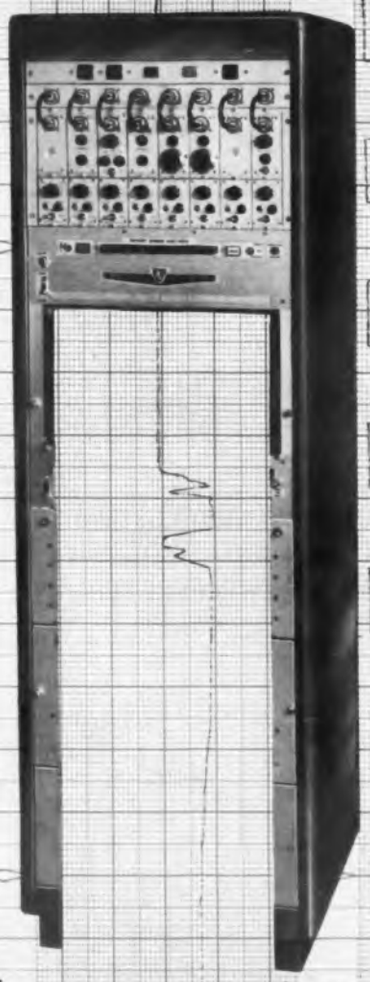

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American Optical COMPANY

INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

EDITORIAL

Are You A Decision-Maker Or Innovator?

Are you a decision-maker or an innovator? If your primary responsibility is to evaluate and judge ideas you had better be a good listener. If you are paid to be an idea man or an innovator, you had better be a good writer and talker. In this age of technical specialization the younger man, fresh from the university and full of energy, is more likely to be the innovator. The older man, aged in experience, plays more of a role in decision-making than in innovation. But both must be skilled in communication. If the young innovator's brainstorms are ignored, not many more will blow up. If the decision-maker does not encourage and facilitate every form of communication, his company will lose out in the competition. If a company's communications break down, new products and new ideas won't get out into the marketplace.

There is a definite correlation between communications and creativity, according to Raymond Stevens, president of Arthur D. Little, Inc. "Ideas will flow *if* they are received at the top," Mr. Stevens told the IRE Conference (PGEWS) on Technical Scientific Communications. He is further concerned that the industry is stifling the young creator by not giving him the opportunity to come up with innovations.

Some companies, rather than communicating with their budding engineers and scientists, isolate them in posh but sound-proof laboratory rooms. Worse, others assign the bright young man to refine minor details on a project well underway. A turn-about is needed. Management should give younger men bigger challenges. Older decision-makers should listen to their ideas. They may counsel but must never cut the communication line.—J. A. L.

Industrial Electronics Come Of Age

Computers are more surely taking over the control function in many industrial plants. One can, with considerable assurance, say that the day has arrived when the miracle of electronic control is at our disposal. This day has arrived because computer engineers have the problem of unreliability under control.

Of more than passing interest in the field of computers is the announcement of MINIVAC, the small-scale computer simulator designed to teach management how a computer works and what it can and can't do. Such teaching tools should further the orderly use of computers.—J. A. L.

Designing a Multivibrator with Complementary Transistors

Bistable multivibrators built with complementary transistors have both units either conducting (in the ON state,) or cut-off (in the OFF state). This can save quite a bit of power when several flip-flops are used in a multistage counter. Here author Steudel describes the complementary transistor multivibrator and discusses its design in a 1-mc counting circuit.

Fritz Steudel
Displays & Data Processing Section
Equipment Div.
Raytheon Co.
Wayland, Mass.

DESIGNED with complementary transistors, the bistable multivibrator can provide several advantages for counting and sequential-gating applications. The distinguishing feature of this bistable multivibrator, or flip-flop, is that in the "1" or "ON" state, both transistors conduct; in the "0" or "OFF" state, both transistors are cut off. Thus, in a counter where a single "1" is moved sequentially from stage to stage, the average power dissipated equals that of a single conducting stage, regardless of the total number of stages. Where the number of stages is large, this can save considerable power compared to the conventional counter where half the tubes or transistors must always conduct.

A second advantage of the complementary flip-flop is that it can be made to "prefer" the "0" state. In this way both transistors will remain cut off until a turn-on pulse is applied. This reduces transient overloads on the power supply and eliminates time lost in clearing the counter.

The basic circuit of the complementary counter is shown in Fig. 1. The circuit "prefers" the "OFF" state, because the voltages $+E_2$ and $+E_3$ are derived from the supply voltage $+E_1$. Thus, they must lag $+E_1$ as power is turned on. The base of Q_2 is positive with respect to the emitter, keeping Q_2 nonconducting. With no current flowing in Q_2, the collector of Q_2 is at zero potential, and the base to emitter junction of Q_1 becomes reverse-biased as power is applied.

Equations Verify Stable States of Complementary Flip-Flop

It will be instructive to obtain the equations for verifying the operation of the circuit in Fig. 1. These equations can then be applied to the 1-mc counter illustrated in Fig. 2. The circuit was designed with silicon switching transistors to operate over the temperature range of −55 C to +150 C.

The Steady State "ON" Condition. In the steady "1" or "ON" state, both transistors will remain in saturation, if:

$$I_{b1} \geq \frac{I_{c1}}{\beta_1} \qquad I_{b2} \geq \frac{I_{c2}}{\beta_2} \tag{1}$$

where β is the ratio of collector current to base current in the linear region of transistor operation. The circuit is least stable when:

a) β is minimum at lower limits of temperature, and
b) I_{c2} is maximum, which occurs when clock pulses drive the trigger amplifier into saturation.

With these worst case conditions in mind, the expressions for base and collector currents in the steady state "ON" condition can be written as follows:

$$I_{c1} = \frac{E_1 - E_{c1}}{R_1} + \frac{E_{b2} - E_{c1}}{R_2}$$

$$I_{b1} = \frac{E_{c2} - E_{b1}}{R_4}$$

$$I_{c2} = \frac{E_{c2}}{R_3} + \frac{E_{c2} - E_A}{R_5} + \frac{E_{c2} - E_{b1}}{R_4} \tag{2}$$

$$I_{b2} = \frac{E_{b2} - E_{c1}}{R_2}$$

The base-to-emitter drop of the saturated

transistor is 0.7 v for silicon types, as is the forward drop for the silicon diodes. Taking the collector-to-emitter drop as 0.4 v, there results for the circuit of Fig. 2:

$$E_1 = +10\text{ v} \quad E_{c1} = +1.8\text{ v} \quad E_B = +1.8\text{ v}$$
$$E_2 = +8.6\text{ v} \quad E_{b1} = +2.1\text{ v} \quad E_A = +2.5\text{ v}$$
$$E_3 = +1.4\text{ v} \quad E_{c2} = +8.2\text{ v}$$
$$E_{b2} = +7.9\text{ v}$$

Substituting these values into Eq. 2 yields:

$$I_{c1} = 10.1\text{ ma} \qquad I_{c2} = 13.1\text{ ma}$$
$$I_{b1} = 1.3\text{ ma} \qquad I_{b2} = 1.85\text{ ma}$$

At −55 C, the lower temperature limit:

$$\beta_1 \text{ min} = \beta_2 \text{ min} = 10$$

According to Eq. 1, the allowable collector currents are:

$$I_{c1} \text{ max} = \beta_1 I_{b1} = 13\text{ ma}$$
$$I_{c2} \text{ max} = \beta_2 I_{b2} = 18.5\text{ ma}$$

Since the collector currents are less than the allowable maximum, the "ON" state is stable for the worst conditions considered.

The Steady State "OFF" Condition. In the "OFF" condition, leakage current I_{cbo} in each transistor develops a voltage across the cross arm and load resistors of the opposite transistor. If this voltage drop is large enough to forward bias the base-to-emitter junction of the transistor by approximately 0.3 v, emitter current will flow. By normal transistor action, I_{cbo} is multiplied by a factor β and the forward biasing may become regenerative. This can cause the stage to switch from the "OFF" to the "ON" state. Since each transistor base-to-emitter junction is reverse-biased by 1.4 v, the total voltage drop resulting from leakage current must be less than 1.4 + 0.3 = 1.7 v.

The requirements for the stable "OFF" condition are then:

$$I_{cbo1} \cdot (R_3 + R_4) < 1.7\text{ v}$$
$$I_{cbo2} \cdot (R_1 + R_2) < 1.7\text{ v} \qquad (3)$$

The worst case leading to instability occurs at high temperature, where leakage current is highest. At +150 C:

I_{cbo1} max = 30 μa for the 2N706

I_{cbo1} max = 100 μa for the 2N726

The cross-arm voltage developed by Q_1 is:

$$30 \times 10^{-6}\ (1 + 4.7)\text{ K} = 0.17\text{ v}$$

and similarly, the voltage developed by Q_2 is 0.43 v. Both voltages are less than the maximum allowable voltage, and the steady "OFF" state is stable under the worst conditions assumed.

Equations for Circuit Operation—Transient Behavior

The transient behavior of the switching transistors may be understood by relating the transistor currents to the charges contained in the transistor. Equations derived for the transient response are then based on these charge quantities.

With the transistor operating in saturation, the total base current I_b may be written

$$I_b = \frac{I_c}{\beta} + I_{bs} \qquad (4a)$$

where I_c/β is the fraction of the total current required to drive the transistor into saturation. The difference $I_b - I_c/\beta$ is the excess current I_{bs} required by design procedure to assure saturation. Similarly, the total charge contained in the base region may be written

$$Q_b = Q + Q_{bs} \qquad (4b)$$

where Q is the charge in the base region before the transistor enters saturation and Q_{bs} is the excess charge after saturation resulting from the excess base current I_{bs}.

These time constants relate the base charge to the base and collector currents:

$$T_b = \frac{\beta Q}{I_c} \quad \text{— the base time constant}$$

$$T_c = \frac{Q}{I_c} \quad \text{— the collector time constant}$$

$$T_s = \frac{Q_{bs}}{I_{bs}} \quad \text{— the storage time constant} \qquad (5)$$

The base and collector time constants are related to the cut-off frequency of the transistor by:

$$T_b = \frac{1.22}{\omega(1-\alpha)}$$

$$T_c = \frac{1.22}{\alpha\,\omega} \qquad (6)$$

where α = normal emitter-to-collector current gain

ω = normal current gain angular cut-off frequency.

The storage time constant T_s is generally

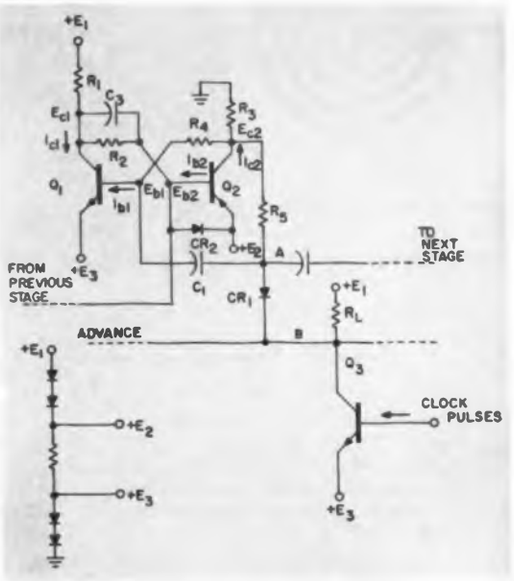


Fig. 1. Designed with complementary transistors this multivibrator offers several advantages when it is used in a multistage counter.

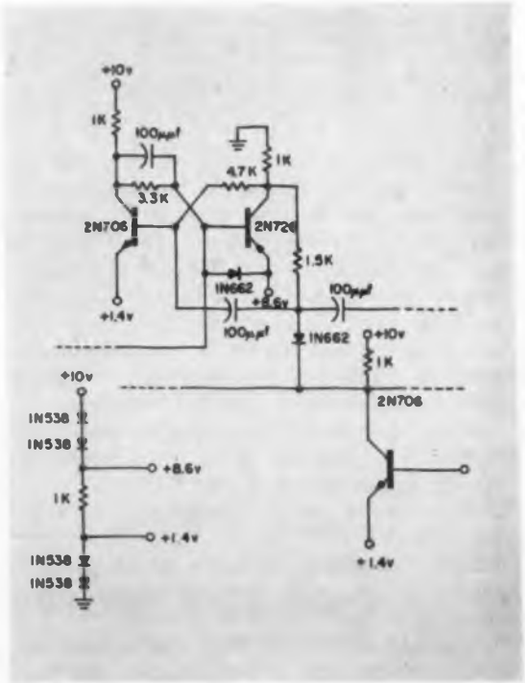


Fig. 2. Parameters given here are for a complementary-transistor multivibrator used in a 1-mc counter.

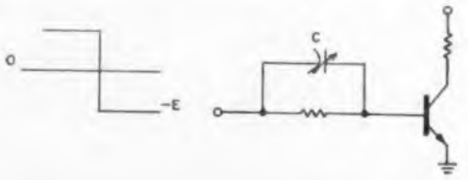


Fig. 3. Some manufacturers indirectly specify transistor storage time constant T_s by specifying Q_{bs}, excess charge after saturation resulting from excess base current, for this test circuit.

defined by the transistor manufacturer in terms of a specific test circuit, where the storage time t_s in the test circuit is related to T_s by:

$$T_s = \frac{t_s}{ln\left[\dfrac{I_{bf} - I_{br}}{\dfrac{I_c}{\beta} - I_{br}}\right]} \qquad (7)$$

I_{bf} is the forward base current during conduction, and I_{br} is the reverse current resulting from reverse biasing the transistor with charge stored in the base. Note that $t_s = 0$ if the transistor is in the linear region, where $I_{bf} = I_c/\beta$. Also, if $I_{br} >> I_{bf}$, t_s approaches zero. T_s, calculated from measurements on the test circuit, is a transistor parameter which remains essentially constant over a wide range of circuit parameters.

Some manufacturers prefer to specify T_s indirectly by specifying Q_{bs} for a given test circuit. In the circuit of Fig. 3

$$Q_{bs} = C \cdot E$$

where C is the capacitance which gives a minimum value of t_s without negative overshoot at the base.

Transistor Rise Time. With a transistor initially in the nonconducting state, application of a forward base current I_{bf} will build up the base charge Q_b according to

$$I_{bf} = \frac{Q}{T_b} + \frac{dQ}{dt} \text{ with } Q = 0 \text{ at } t \leqslant 0.$$

The solution of the equation for a constant valued I_{bf} is:

$$Q = I_{bf} T_b \left(1 - \varepsilon^{-\frac{t}{T_b}}\right) \qquad (8)$$

Substituting from Eqs. 5 and 6 yields:

$$I_c = \beta\, I_{bf} \left(1 - \varepsilon^{-\frac{t}{T_b}}\right) \qquad (9)$$

If rise time, t_r, is defined as the time required for I_c to reach I_{cs} corresponding to the saturation collector current, then:

$$t_r = -T_b \cdot ln\left[1 - \frac{I_{cs}}{\beta I_{bf}}\right] \qquad (10)$$

Transistor Storage and Fall Times. In the saturated condition, the transistor will have a collector current I_{cs} and an excess stored base charge corresponding to the forward base current I_{bf}.

$$Q_{bs} = \left(I_{bf} - \frac{I_{cs}}{\beta}\right) T_s$$

If the base current is suddenly reversed to a value I_{br}, the stored charge will decay according to the differential equation:

$$I_{br} = \frac{Q_b}{T_b} + \frac{Q_{bs}}{T_s} + \frac{dQ_{bs}}{dt}$$

Following the removal of the excess stored Q_{bs}, the base charge consists only of Q. This charge will decay as a function of the reverse base current I_{br} where:

$$I_{br} = \frac{Q}{T_b} + \frac{dQ}{dt} \text{ with } \frac{Q}{T_b} = \frac{I_{cs}}{\beta} \text{ at } t = 0.$$

The solution for a constant valued I_{br} is:

$$Q = I_{br} T_b + \left(\frac{I_{cs}}{\beta} - I_{br}\right) T_b\, \varepsilon^{-\frac{t}{T_b}} \qquad (11)$$

Again, substituting from Eqs. 5 and 6 yields:

$$I_c = \beta\, I_{br} + \beta\left(\frac{I_{cs}}{\beta} - I_{br}\right) \varepsilon^{-\frac{t}{T_b}} \qquad (12)$$

Defining fall time, t_f, as the value of t at which $I_c = 0$:

$$t_f = T_b\, ln\left(1 - \frac{I_{cs}}{\beta I_{br}}\right) \qquad (13)$$

Correction Factor for Rise and Fall Times. The previous equations for rise and fall times hold true only if $\omega_\alpha C_c R_L << 1$, where C_c is the collector capacitance, and R_L is the collector load resistance. Where the time constant $R_L C_c$ is of the same order of magnitude as $1/\omega_\alpha$, the collector capacitance increases the rise and fall times by a factor $(1 + \omega_\alpha R_L C_c)$, provided that

$$\frac{R_L}{r_c} << 1 \text{ and } \omega_\alpha r_c C_c >> 1.$$

Transistor Switching Equations: Turn-Off of the NPN

It is seen from Figs. 1 and 2 that, with the circuit in the steady "0" state, the anode of CR_1 is at zero potential, and CR_1 inhibits transmission of the advance pulse. With the circuit in the steady "1" state, the anode of CR_1 is at $E_{c2} = +8.2$ v. The bottoming of the trigger amplifier Q_2 during a clock pulse causes the diode to conduct.

Assume that only one stage is in the "1" state, and that the trigger amplifier collector current, in response to a clock pulse, is a 20-ma rectangular pulse. Since the base charge of the pnp in the following stage cannot change instantaneously, there will be a reverse current of 20 ma, minus the forward base current I_{b1}, through capacitor C_1.

Taking the reverse current as constant, the necessary parameters for calculating the storage and fall times of Q_1 are:

$I_{bf1} = I_{b1} = 1.3$ ma

$I_{br} = -(20 - I_{b1}) = -18.7$ ma

$I_{cs1} = I_{c1} = 10.1$ ma.

$\beta_1 = 25\ (\alpha = 0.964)$

$f_\alpha = 250$ mc

$T_s = 45$ nsec

$C_c = 5$ pf

} Typical values for 2N706

The storage time for Q_1 is given by Eq. 7:

$$t_{s1} = 45 \times 10^{-9}\, ln\left[\frac{1.3 + 18.7}{\frac{10.1}{25} + 18.7}\right]$$

$$= 3 \text{ nsec}$$

To find the fall time, first calculate $T_b = 21.6$ nsec (from Eq. 6). The fall time for Q_1 is then:

$$t_{f1} = 21.6 \times 10^{-9}\, ln\left[1 + \frac{10.1}{25 \times 18.7}\right]$$

$$= 0.48 \text{ nsec}$$

Following the turn-off of Q_2, the speed-up capacitor C_3 discharges through CR_2 with a time constant R_1C_3. From the formula $RT = 2.2\,RC$, the fall time is 0.22 μsec.

Turn-Off of the PNP. Following turn-off of Q_1, there will be a reverse current flowing out of the base of Q_2. If the charge available

from the speed-up capacitor is several times larger than that stored in the base of Q_2, the capacitor voltage remains approximately constant. The reverse current I_{br2} will be

$$I_{br} = \frac{E_1 - E_{c1}}{R_1} = \frac{10 - 1.8}{1} = 8.2 \text{ ma.}$$

Based on the following parameters,

$I_{bf2} = I_{b2} = 1.85$ ma
$I_{cs2} = I_{c2} = 13.2$ ma

$\beta_2 = 20$ $(\alpha = 0.954)$
$f_\alpha = 100$ mc
$T_s = 160$ nsec
$C_c = 4$ pf
} Typical values for 2N726

the following quantities can be calculated for transistor Q_2:

storage time $t_{s2} = 19.5$ nsec (from Eq. 7)
fall time $T_{b2} = 42.3$ nsec (from Eq. 6)

The fall time of the transistor, t_{f2}, is (from Eq. 13) 3.3 nsec. The effective load R_{L2}, when Q_2 is conducting, and Q_1 is cut off, is R_3 in parallel with R_5 or 600 ohms. The correction factor is:

$$(1 + \omega\alpha\ R_L C_c) = 2.5$$

Multiplying the fall time of Q_2 by 2.5 yields:

$$t_{f2} = 8 \text{ nsec}$$

Turn-On of the PNP. After the removal of the stored charge in the base of Q_1, the current flowing into the collector of the trigger amplifier will provide forward base current for the pnp of the following stage. Since collector current flows only when the base-to-emitter junction is forward biased, there is a delay time t_d, in which the emitter junction capacitance is charged from its reverse bias to a forward conducting potential (0.7 v base-to-emitter).

Considering the turn-on current as a constant current source, the relationship between voltage change and delay time is $C\Delta V = It_d$. For the 2N726, the emitter junction capacitance is typically 6 pf, and

$$t_{d2} = \frac{C\Delta V}{I} = \frac{6 \times 10^{-12} \times 1.4}{20 \times 10^{-3}} = 0.42 \text{ nsec.}$$

The parameters necessary to determine the rise time of the pnp are:

$I_{bf2} = 20$ ma
$I_{cs2} = I_{c2} = 13.2$ ma

$\beta_2 = 20$ $(\alpha = 0.954)$
$f_\alpha = 100$
$T_{b2} = 42.3$ nsec
} typical values

The rise time of Q_2 will be, from Eq. 10, $t_{r2} = 1.4$ nsec.

Applying the correction factor of 2.5, $t_{r2} = 3.5$ nsec.

Turn-On of the NPN. By considering the turn-on waveform at the collector of the pnp as a voltage step, a step of forward current $I_{b/1} = 1.3$ ma flows through R_1. Before base charge can build up in Q_1, the potential of the base must be raised from zero to +2.1 v (0.7 v base-to-emitter). Since the base is coupled through C_1 in series with C_2 at point A to the conducting diode CR_2 of the next stage, the change in base potential is the sum of the voltage drops across C_1 and C_2. The current through C_1 is $I_{b/1} = 1.3$ ma. The current through C_2 is the sum of $I_{b/1}$ and the current through R_3 is from Eq. 2

$$\frac{E_{r2} - E_1}{R_3} = \frac{8.2 - 2.5}{1.5} = 3.7 \text{ ma.}$$

The change in base voltage is then:

$$\Delta V = \Sigma \frac{I\Delta T}{C} = \Delta T \Sigma \frac{I}{C}$$

The delay time is:

$$t_{d1} = \Delta T = \frac{\Delta V}{\Sigma \frac{I}{C}} = \frac{\Delta V}{\frac{I_{c1}}{C_1} + \frac{I_{c2}}{C_2}} = 33 \text{ nsec}$$

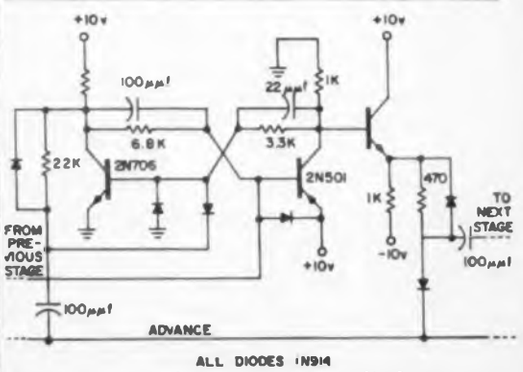


Fig. 4. Circuit of a complementary flip-flop counter designed to operate with a 10-mc clock. (Output emitter follower is a 2N706.)

The rise time of Q_1 will be:

$$t_{r1} = 21.6 \times 10^{-9} \ln \left[1 + \frac{10.1}{25 \times 1.3} \right]$$

$$= 58 \text{ nsec}$$

The time required to charge C_3 is:

$$\Delta T = \frac{C \Delta E_{c1}}{I}$$

where E_{c1} is the difference between the "OFF" and "ON" collector voltages, and I is $B_1 I_{b1}$, the collector current which flows until the transistor bottoms.

Neglecting the current flowing through R_1

$$T = \frac{10^{-9} \times (10 - 1.8)}{25 \times 1.3 \times 10^{-3}} = 25 \text{ nsec}$$

Total Switching Times. The total turn-on time of the stage will be

$$T_{on} = t_{d2} + t_{r2} + t_{d1} + t_{r1} = 94.9 \text{ nsec}$$

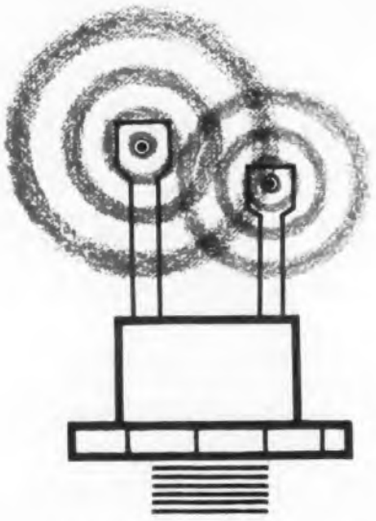
The total turn-off time will be

$$T_{off} = t_{s1} + t_{f1} + t_{s2} + t_{f2} = 21 \text{ nsec.}$$

Maximum Frequency Capabilities. In the interval between clock pulses, the diode-capacitor steering network of the conducting stage must be charged to a voltage approaching E_{c2} at point A. Since both C_1 and C_2 are connected to low-impedance points, the time constant of the charging network will be $R_3 (C_1 + C_2)$. The rise time of the network will be $2.2\ R\ (C_1 + C_2)$, so the interval between clock pulses must be greater than $T_{min} = 2.2 \times 1.5 \times 10^3 (100 + 100) \times 10^{-12} = 0.66\ \mu$sec. For operation at 1 mc, the clock pulse width is restricted.

Configurations at Higher Frequencies. The complementary circuit with modifications is suitable for higher frequency counting. Fig. 4 shows a complementary flip-flop counter designed to operate with a 10-mc clock. The turn-off and turn-on steering networks are isolated so that each will have a low-impedance charge path. The emitter follower provides a low-impedance output and reduces the charging time of the turn-on capacitor of the next stage. The turn-off capacitor is charged through the diode paralleling the 22-K resistor and through the source impedance of the advance line.

The base-to-emitter diodes restrict the voltage swing in the reverse direction and prevent the transistors from being reverse-biased by more than about 1 v. By using the diodes, the stage can be turned on shortly after being turned off. This counter was operated with a turn-on pulse to the first stage every 0.4 μsec so that each stage was on for 0.1 μsec, then off for 0.3 μsec. ■ ■



How to Use SCR's in Power Supplies

Part 1

The ideal qualities of silicon-controlled rectifiers (SCR's) for higher-power regulated dc supplies have been offset by the tendency of the SCR circuits used to oscillate. Here author Albert Leenhouts describes what he thinks is a better way to use an SCR's "thyratron" action in a power supply. In the second part he will give a detailed design procedure for his solution and a specific design example.

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THERE are a large number of applications where a stable, high-power dc source capable of delivering up to 10 kw is required. The silicon-controlled-rectifier circuit which will be described in this article is ideal for these applications. Its novelty centers around the way damping is introduced in the feedback circuit (by R_{18} and C_{11} in Fig. 9) to prevent the oscillations which can plague high-performance SCR circuits.

To appreciate the problems which led up to the design of the new circuit, consider the ways in which power supplies have been tackled in the past, both with transistors and with SCR's.

At lower power levels transistor-controlled dc supplies patterned after the block diagram, Fig. 1, do the job, but they do it in a strange way. In certain respects they do much more than required. For most power applications a ripple up to two per cent is not harmful; many transistor-controlled supplies reduce the ripple to less than one-tenth that value. For most applications 50-msec response times are sufficient; yet transistor-controlled supplies are easily capable of response times of one msec or less.

On the other hand, the efficiencies of transistor-controlled supplies are rather low due to the power dissipation in the control elements. Also the cost of the associated circuitry is relatively high because of the required capacity of the driving network. Finally, the maximum output voltage of the supply is limited by the voltage rating of the transistors.

These considerations show that the transistor types of regulatory circuits are certainly not a very practical solution to the regulation of dc power in the kw range.

The SCR with its high-power-handling capability—breakover voltages up to 500 v and current ratings over 50 amp—and its high efficiency is a much more suitable control element in certain types of dc supplies. But while a number of attempts have been made to build SCR-controlled dc power supplies with accurate regulation and reasonably low response times (in the order of a few cycles of the line input voltage), most of these SCR systems to date have had definite limitations.

Phase-Controlled Device Needs Different Circuits

The main problem in these existing SCR-controlled supplies has been the susceptibility of the feedback control system to oscillations. Part of the trouble in some of the early SCR-controlled supplies came from the designer trying to use the same design philosophy that he had previously used for transistor-controlled supplies, even though the problems of continuous amplitude control which were the basis of the transistor circuit are basically different from the problems of SCR phase control.

The SCR power supply regulation circuits that have been published show stabilities limited to a small range of load variations, additional expense due to more filtering than really required (some use very large capacitors for example), or unnecessarily sophisticated circuits (using higher-than-line-frequency carriers for example) to overcome the stability problem.

*Now with Hi-G Inc., Bradley Field, Windsor Locks, Conn.

Still, the maximum output voltage in these circuits was limited by the SCR's rating, just as the transistor's rating limited the voltage in that type of circuit.

The circuit that will be described here is based on a different approach and makes fuller use of the possibilities and advantages of SCR's in phase-controlled circuits.

Use SCR as AC Switch Ahead of Transformer

A regulated dc supply, using a silicon-controlled rectifier, is show in block diagram form in Fig. 2. The ac input voltage at the transformer T is regulated by the full wave ac switch made up of an SCR and four rectifiers. The dc current pulses, obtained from the rectifiers at the secondary winding of the transformer are smoothed out by filter capacitor C_f. Note that the dc output voltage is completely isolated from the line voltage, and that the ac input voltage—not the dc output voltage—determines the voltage rating of the SCR.

The dc output voltage is compared with a reference voltage and the result of the comparison, the error signal, is fed into a differential error signal amplifier, the output of which controls the timing circuit. The firing pulses delivered by the timing circuit are applied to the SCR by means of a pulse transformer. The timing circuit maintains a proportional relationship between the dc output of the error signal amplifier and the firing angle of the SCR. A change in output dc voltage will result in a change of the conduction angle of the SCR, passing more or less of the ac input waveform to keep the supply's output dc voltage matched to the reference.

The main causes of the oscillations, are the two variable time constants associated with this type of closed-loop system. The first time constant is determined by the smoothing elements and the load impedance (integration time) while the second is represented by the interval during which the SCR is not conducting (delay time).

By drastically reducing the response speed, stable operation can be obtained, but the resulting lengthening of the response time may be unacceptable. The problem may be overcome by building an inverter-like system operated at a much higher than line frequency,

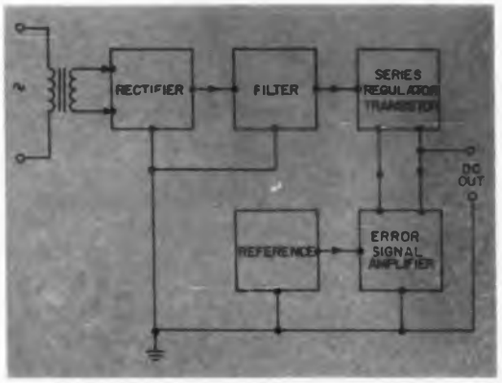

Fig. 1. Transistor-controlled supplies, although excellent in performance, are inefficient for higher-level outputs because the transistor consumes a fair share of the power it controls.

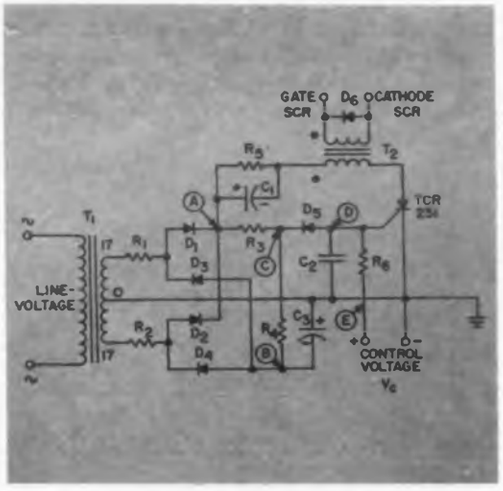

Fig. 3. Timing circuit for SCR-controlled power supply uses a smaller SCR trigger gated by charge on C_2.

but this leads to complicated circuitry and loss of efficiency.

There is a better way using an SCR in a regulator. Oscillations in the control loop can only occur if the output of the error signal amplifier has the freedom to drive the control element from one saturated status to the other. Therefore, if critical damping is introduced in the error signal amplifier preventing the rapid extreme output variations, the loop oscillations cannot occur, though small, fast variations and slow, extreme variations are permitted so that the system can still correct for both fast and extreme voltage variations

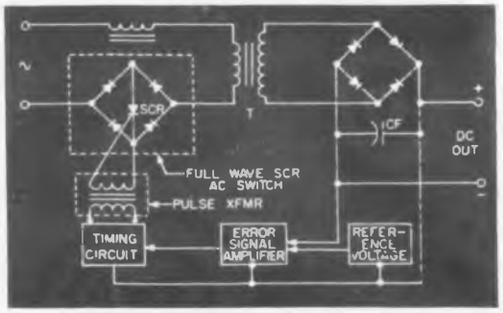

Fig. 2. SCR-controlled supplies are inherently more efficient than transistor-controlled supplies because of the SCR's switching action. However, because of this switching action superimposed on the ac input waveform, there are inherent stability problems if one wishes to begin to approach the performance of transistor-controlled supplies.

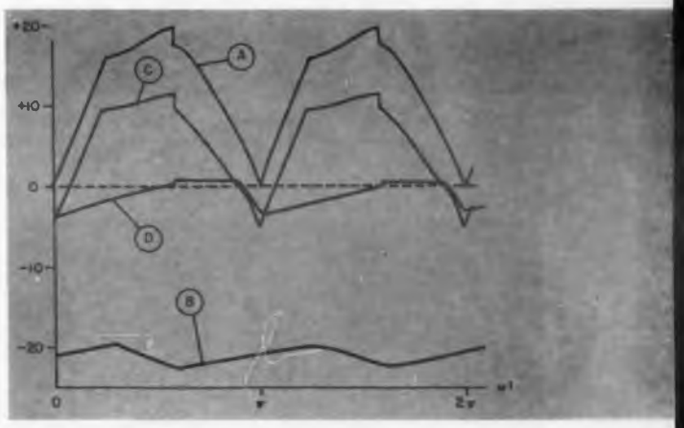

Fig. 4. Voltage waveforms in timing circuit (Fig. 3) indicate how voltage ramp (D) builds up during each half cycle of the input ac to fire the trigger SCR. Note the sudden drops in (A) and (C) plus the slight rise in (D) which indicate firing.

in the load and input with a minimum loss of response speed.

Feedback Circuit Times SCR Firing

The feedback system contains a reference voltage source, an error signal amplifier, and a circuit which transforms the output of the error signal amplifier into the timing of the firing pulses to the gate-cathode junction of the SCR. The energy required to fire the SCR is delivered by a timing circuit containing a small controlled rectifier (TCR 251) as shown in Fig. 3.

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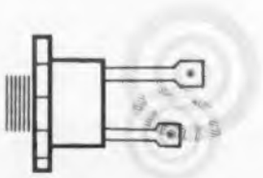

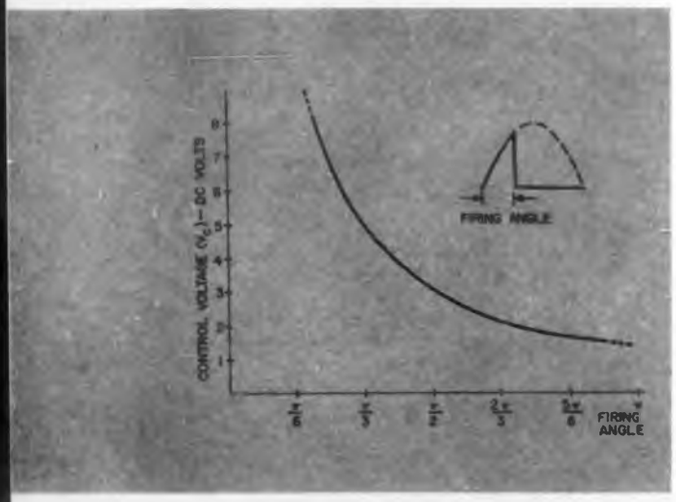

Fig. 5. SCR firing angle vs control voltage: effect of the dc control voltage into the firing circuit upon the output angle of the SCR firing pulses.

The anode voltage of the TCR 251 is a full-wave, unfiltered dc so that the device will turn off at the end of each half wave. At the end of each half wave the combination of the smoothed negative dc voltage at "*B*" and the pulsating positive dc at "*A*" recharges capacitor C_2 to the negative voltage of approximately -4 v. This voltage will hold the TCR 251 "off" during the following half cycle, until the charging current through R_6 has built up sufficient voltage at C_2 to turn the device "On" (approximately +0.5 v).

When the TCR 251 fires, a low-impedance path is closed, allowing a current pulse through the primary of pulse transformer T_1. The pulse, obtained at the secondary winding, is sufficient to fire all commercially available SCR's, while the gate of the SCR is protected against excessive negative voltages by diode D_6.

The combination of R_5 and C_1 limits the average dc current through the TCR 251, but passes the peak "leading edge" current pulses important for precisely timed firing of the SCR.

The recharge of C_2 at the end of each half wave synchronizes the timing circuit with the line. As the same parameters determine the firing angle of the TCR 251 for both half waves, the balance between the firing angles for each half of the wave is good.

Fig. 4 shows the wave forms at various points in the circuit while Fig. 5 shows the relationship between firing angle and control voltage.

This timing circuit has a feature which is attractive in closed-loop circuits. A change in line voltage will change the voltage to which C_2 is recharged at the end of each half wave. An increase in line voltage, for example, will result in a higher negative voltage at C_2 at the beginning of each new half wave. This in

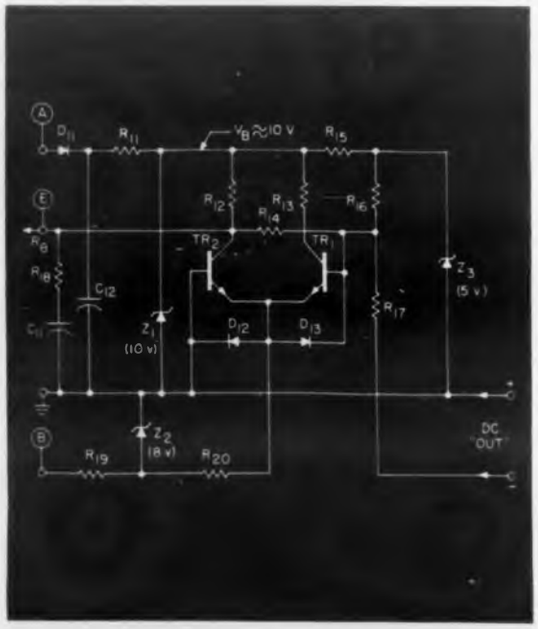

Fig. 6. Error signal amplifier (*TR1* and *TR2*) compares voltage from supply's output to reference across Zener *Z3* and because of positive feedback due to R_{14}, sends high-gain dc commands to timing circuit. Very important for stability is the damping provided by *R18* and *C11*.

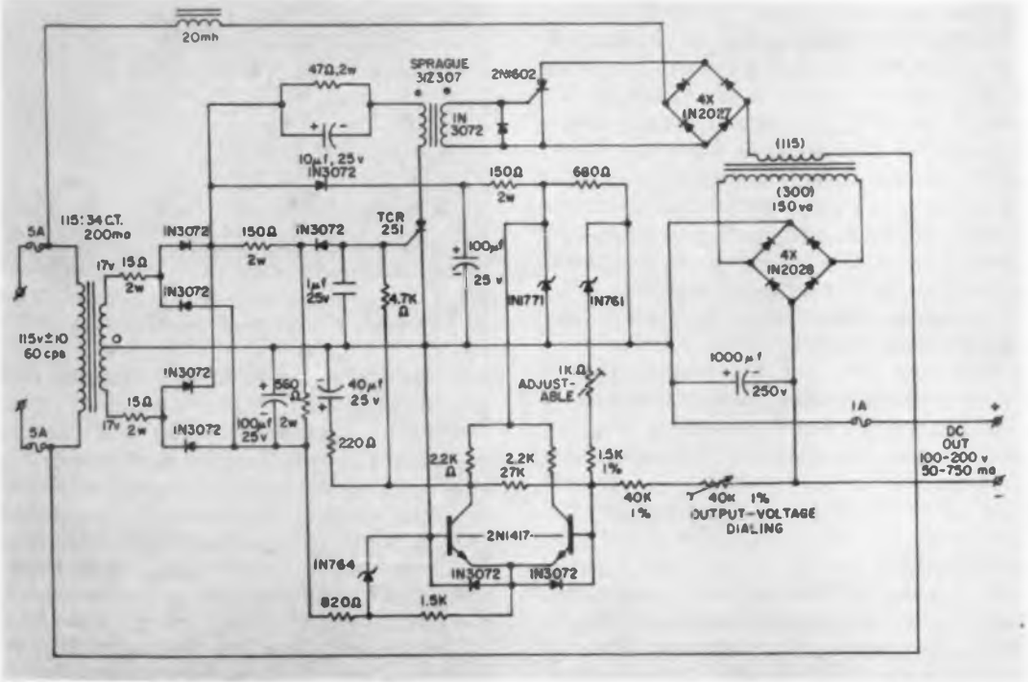

Fig. 7. Over-all diagram for SCR control indicates the relatively compact circuitry possible with this type of SCR control. The inductor in the ac input serves an important function which will be described in the second part of this article.

turn will cause a greater delay in firing the SCR at the same control voltage. This provides a very good and immediate (within one half cycle of the line voltage) compensation for line voltage variations. This means that the response time of the system will be shorter for extreme line voltage variations than it will be for extreme load variations.

Fig. 6 shows the circuit diagram of the reference and error signal amplifier. Supply voltages are obtained from the timing circuit; Zener diode Z_1 preregulates the supply voltage for reference Z_3. The comparison of output voltage vs reference voltage by means of dividers R_{16} and R_{17} results in the input voltage on the base of transistor TR_1. This transistor forms together with TR_2 and additional components a differential amplifier. The addition of R_{14} causes positive feedback to obtain very high dc gain. During the further discussion the amplifier will be considered to have an infinite dc gain.

Due to the damping circuit (R_{18} + C_{11}), fast output variations are necessarily limited to approximately

$$\frac{R_{18}}{R_{16}/R_{12}} \times V_B$$

in this case approximately 1.5 v peak-to-peak. From Fig. 5 it can be seen that a change of one volt in the control voltage results in a considerable change of firing angle of the SCR. Therefore the addition of R_{18} and C_{11} does not affect the response time of the supply for load variations in the order of ±50 per cent, but it does prevent all tendencies to oscillate.

It was found that there are two critical values for R_{18}: too low a value results in a low-frequency oscillation of the system, too high a value leads to unbalance of the two half-wave firing angles of the SCR. The range between the two critical values increases with the increase of C_{11}, so that stable, satisfactory operation can always be obtained over a wide load range.

The final part of this article will explain the design steps for this type of regulation and will give a design example. ■ ■

Human Engineering Quiz

The Quiz

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THE reader may recall the "Reliability Quiz" which appeared in the Aug. 3, 1960 issue of ELECTRONIC DESIGN. In an effort to clarify the goals, content, and scope of an emergent, sister engineering discipline, a "Human-Engineering Quiz" is offered in a similar vein.

For engineers who have had little or no contact with human engineering, this quiz should provide insight into those services that can be obtained by bringing the human engineer into the design team. It may also serve to help selected "well-rounded" design engineers.

The purpose of the quiz is primarily to stimulate the interest of the reader. The reader should not necessarily have all the information requested "on the top of his head." It will suffice if he can pinpoint these answers in a suitable reference. Questions have been specially selected to eliminate highly debatable subject matter with a result that the misleading impression of over-simplicity may be given.

The reader may notice a distinct difference between the type of information required in the first 10 questions and that in the next 30. The former requires a general knowledge of human engineering and the people and institutions in it, while the latter requires specific knowledge of human-engineering practices.

1. Define human engineering.
2. How long has the field of human engineering been in existence?
3. What academic background does the human engineer have?
4. What other terms are used to describe the most popular, but somewhat misleading, title of "human engineer"?
5. Name five large industrial companies that maintain a full-time human-engineering staff.
6. Name several human-engineering consulting firms.
7. What professional society represents the human-engineering field?
8. Name several general-reference sources for human-factors data.
9. Name several government agencies performing research in this area.
10. Name a few nationally prominent individuals in this field.
11. What is the recommended flash rate for warning indicators?
12. How far from the normal line of sight can a warning indicator that requires immediate attention be placed on a console face (degrees)?
13. What three methods are commonly used to insure against or to readily detect indicator-lamp failures during critical-operation sequences?
14. Name five considerations in selecting an indicator light for panel faces.
15. What rule is generally used to determine numerical progressions for an easy-to-read meter scale?
16. What is the minimum separation acceptable between adjacent meter-scale graduation marks when ambient illumination is adequate.
17. What is the proper relationship between a meter pointer and markings on the meter scale?
18. What is the maximum number of positions recommended for rotary selector switches?
19. What are the minimum diameter and displacement dimensions for foot-operated push-buttons?
20. What is the maximum force which should be required for an operator to rotate a 1-in.-diam knob with the fingertips?
21. What is the maximum weight of convenient size and shape that the operator should be required to lift with both hands to a height of 3 ft above the ground.
22. List five techniques for preventing accidental activation of critical controls.
23. What is the minimum spacing allowable between adjacent toggle switches for random operation?
24. How many db above the general noise level should a warning tone be?
25. What is the minimum height of an opening that a technician can crawl through?
26. What is the recommended minimum dimension of an opening that will allow passing the body thickness sideways?
27. What is the average eye height for the standing operator?
28. What knee and foot room is required for an operator seated at a writing shelf?
29. Ear-canal noise level should never exceed _____ db regardless of duration.
30. What letter height should be provided for emergency instructions to be read under low illumination at a 28-in. reading distance?
31. What is the recommended distance between rungs on a vertical ladder?
32. What percentage of the male population is left-handed?
33. What percent of the male population is color blind to some extent?

34. Name three rules for laying out panel elements.

35. At what *effective temperature* does the human operator's performance begin to deteriorate to a significant degree?

36. How many degrees of incline should be used for ramps? For stairs? For ladders?

37. When designing equipment which must take into account the body size of the operator, what percentage of the operator population should the designer try to accommodate?

38. Safety interlocks should be placed on access doors of electrical equipment when potentials exceed _____ volts rms.

39. Which of the following functions are best performed by men rather than machines?

(a) Exercising judgment.
(b) Perceiving patterns of light or sound.
(c) Storing information briefly and erasing completely.
(d) Storing large amounts of information over long periods and recalling relevant facts at appropriate times.
(e) Responding rapidly to control signals.
(f) Applying great force smoothly and precisely.
(g) Reasoning inductively.
(h) Handling highly complex operations—many tasks at once.
(i) Reasoning deductively, including capability for computation.
(j) Sensing minimum amounts of visual or acoustic energy.
(k) Improvising and using flexible procedures.
(l) Performing repetitive, routine tasks reliably.

40. Which of the above functions are best performed by modern machines?

(Answers on p 52)

The Answers

1. Human engineering is the science and art of designing machines for human use, taking into account the abilities, limitations, habits, and preferences of the human operator.

2. While a scattered handful of psychologists were concerned with knobs and dials in the 1920's and 30's, it was World War II, with its increasingly complex weapons systems that gave human engineering its big impetus.

3. Human engineers are drawn from a variety of disciplines, with psychologists and engineers predominating. Other specialists represented are physiologists, anthropologists, physicians, and pilots.

4. Biotechnologist, human-factors consultant, human-factors specialist, engineering psychologist, ergonometrician.

5. Lockheed, Douglas, Philco, Crosley, IBM, General Electric, Martin, Boeing, Bendix, Minneapolis-Honeywell, North American Aviation, and others.

6. Dunlap & Associates, Psychological Research Associates, Applied Psychology Corporation, Courtney & Company, Haller Raymond & Brown Inc.

7. Human Factors Society and Engineering Psychology Division of the American Psychological Association.

8. (a) McCormick, E. J., Human Engineering, McGraw-Hill, 1957.
   (b) Woodson, W. E., Human Engineering Guide for Equipment Designers, University of California Press, 1954.
   (c) Handbook of Human Engineering Data, Tufts College, Medford, Mass., 1952.
   (d) Chapanis, A., Garner, W. R., and Morgan, C. T., Applied Experimental Psychology, John Wiley & Sons, Inc., 1949.

9. (a) Aero Medical Laboratory, Wright Patterson Air Force Base. (b) Human Engineering Laboratory, Aberdeen Proving Grounds. (c) Naval Research Laboratories.

10. Alphonse Chapanis, Paul Fitts, Frank Taylor, Jack Dunlap, Max Lund.

11. Three to five flashes per second with *ON* time equal to *OFF* time.

12. 30 deg.

13. Dual-lamp redundancy, lamp-test circuitry, and press-to-test lamp-socket arrangements.

14. (a) Lamps should be easily removable and replaceable from the front of a panel without need for special tools.
   (b) There should be sufficient room for required legendry on the indicator face.
   (c) Enough colors should be available to provide adequate color coding.
   (d) Legend caps should be keyed to prevent inadvertent substitution of caps.
   (e) Different color indications should be equivalent in brightness.

15. Graduation interval values should be 1, 2, 5, or decimal multiples of these values.

16. 0.35 in.

17. The pointer should extend to, but not overlap, the shortest graduation mark.

18. 24 positions, with a minimum separation of 1/4 in. between adjacent position-index marks.

19. Diameter: 1/2 in. Displacement: 1/2 in. for normal footwear, 1 in. for heavy footwear.

20. 4-1/2 in.-oz.

21. About 71 lb.

22. (a) Physical isolation in out-of-the-way panel areas.
   (b) Recessing controls below level of panel surfaces.
   (c) Using protective guards.
   (d) Using locked controls, push-in-to-turn knobs, locked toggles.
   (e) Electrical interlocking, e.g., a series of preliminary functions which must be accomplished before firing button is enabled.

23. 3/4 in. between adjacent edges of the controls.

24. 10 db.

25. 32 in.

26. 13 in.

27. 65 in.

28. 20 in. wide, 25 in high, and 18 in. deep.

29. 135 db

30. 0.15 to 0.30 in. high

31. 11 to 12 in.

32. Approximately 10 per cent.

33. Approximately 10 per cent.

34. (a) When the operations to be performed and the indications observed on a panel occur in a definite sequence, the panel elements should be layed out in a left-to-right order.
   (b) Where no consistent sequence of operations is expected, panel elements should be laid out in functional grouping of controls and associated displays.
   (c) Controls, especially emergency controls, should be placed in the right-hand area of the panel to enhance right-hand operation.

35. *Effective temperature* in the middle 90's. Effective temperature is an index which takes into account temperature, humidity, and air movement.

36. Ramp: 20 deg incline or less.
   Stairs: 20 to 50 deg incline. Ladder: 50 deg incline or more.

37. 90 - 95 per cent.

38. 70 v rms.

39. Men are better at:
   (a) Exercising judgment.
   (b) Perceiving patterns of light or sound.
   (d) Storing large amounts of information over long periods and recalling relevant facts at appropriate times.
   (g) Reasoning inductively.
   (j) Sensing minimum amounts of visual or acoustic energy.
   (k) Improvising and using flexible procedures.

40. Machines are better at:
   (c) Storing information briefly and erasing completely.
   (e) Responding rapidly to control signals.
   (f) Applying great force smoothly and precisely.
   (h) Handling highly complex operations.
   (i) Reasoning deductively.
   (l) Performing repetitive routine tasks reliably. ■ ■

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Thin Speakers, FM Multiplex Score at Hi-Fi Show

Fig. 1. Thirty-eight semiconductors, 31 transistors and seven diodes are contained in a dual 30-w stereo amplifier manufactured by Omega Electronics, Phoenix, Ariz. A four-transistor bridge arrangement in each output channel provides symmetrical operation with uniform power dissipation. The three touch bars, at the lower left, perform switching for a rumble filter, scratch filter and tape-monitor circuit.

Fig. 2. Increased interest in simple-to-operate, cartridge-loading tape recorders was evident. Both RCA and Bell Sound Div., Columbus, Ohio, exhibited light, compact units permitting stereo recording as well as playback. The Bell unit shown weighs 18 lbs and measures 10-1/2 by 9 by 7-1/2 in. Blank cartridges for recording recently were made available by several leading tape manufacturers; prerecorded tapes have been available for some time.

Fig. 3. The total active radiating surface in each of three sound-producing elements is in use in the Rich 20/20 speaker system, shown by Bogen and Rich, Inc., Yonkers, N. Y. The bass frequencies are reproduced by a small (8-in.) cone-type speaker coupled to a lightweight, 18-by-22-in. foam polystyrene surface; the lightweight driver and radiating surface provide the equivalent area of a 21-in.-diam speaker without the need for a large enclosure and with excellent transient response. The current-carrying coil for the mid-range section is wound on a lightweight diaphragm placed between three pairs of high-efficiency bar magnets. The treble-range unit, extending upwards of 7 kc, makes use of an aluminum sheet driven by the magnetic field created by current through the adjacent voice coil leads.

Fig. 4. Wireless remote control for stereo listening was introduced by Clairtone Sound Ltd, Toronto. A two-transistor 27.2-mc transmitter, together with a five-tube receiver in the main chassis, permits the listener to turn the set on or off, adjust balance between left and right channels and vary volume. Twelve light-up push buttons on the main chassis permit selection of inputs, afc for fm and channel reversal.

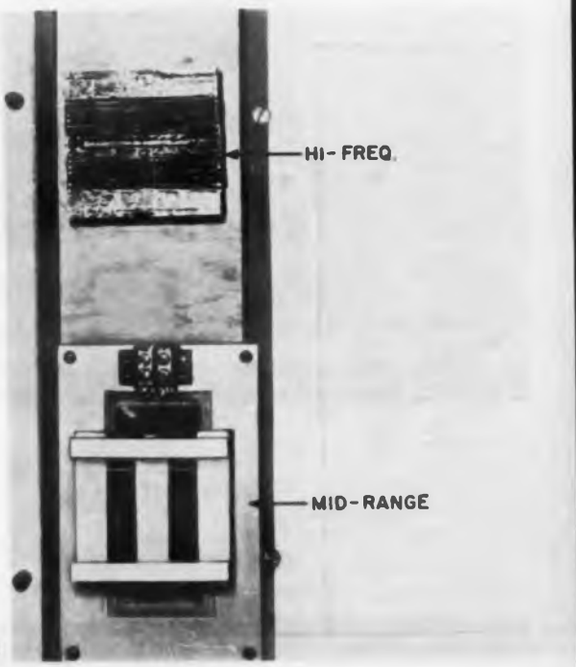
Fig. 5. Miracord Studio H, exhibited by Benjamin Electronic Sound Corp., Corona, N. Y., is advertised as the only automatic turntable and record changer to use a hysteresis synchronous motor for constant speed despite turntable load or line voltage fluctuation. The 7-lb, 12-in.-diam. one-piece turntable is nonferrous and dynamically balanced to assure constant speed. An additional feature, for language study or other educational projects, permits continuous play of a single record when the spindle is inverted.

Fig. 6. The conventional cone structure found in speakers is eliminated and a large (330 sq. in.) wooden panel serves as the piston for the Bi-Phonic Coupler developed by Advanced Acoustics Co., Cedar Grove, N. J. Only 3 in. thick by 13-1/2 and 21-3/4 in., the wide-range speaker system can be used as a room divider or hung on a wall like a picture. The 8-ohm, 20-w peak power speaker extends from 30 cps to well above the audible range. A bidirectional figure-8 radiation pattern from both sides of the unit is obtained from the completely unbaffled assembly.

Fig. 7. A completely transistorized fm-multiplex tuner, made by Transis-Tronics, Inc., Santa Monica, Calif., contains 20 transistors and nine diodes. A 1-mc wideband discriminator is used to achieve low distortion; 1.8 μv for 20 db quieting and 2.5 μv for 30 db quieting is the sensitivity claimed.

Fig. 8. The 4-in. thin Sonoteer, manufactured by Rek-O-Kut/Audax, Corona, N. Y., contains five speakers in a distinctively styled housing. Two woofers, two midrange and one tweeter provide a 40 to 18,000-cps response.

1



3

REPRESENTATIVES of more than 100 high-fidelity component manufacturers were highly pleased with the recent New York High Fidelity Show. With industry sales already up 8 per cent over last year, manufacturers foresee a record fourth quarter, thanks to the introduction of fm multiplex adapters and receivers.

Flat speakers, offering quality sound and tasteful decor, appealed to the hi-fi fans at the show who are eager to convert their spouses to stereo. Transistorized audio equipment was exhibited by only two companies. The rather large number of semiconductors needed (and the resulting cost) apparently makes such equipment unattractive to most component manufacturers.

Other hits at the hi-fi show were a Miracord turntable-changer combination and cartridge-loading tape recorders.

Most tuner and amplifier manufacturers demonstrated fm multiplex adapters—self-powered or powered from the companion tuner. ■ ■

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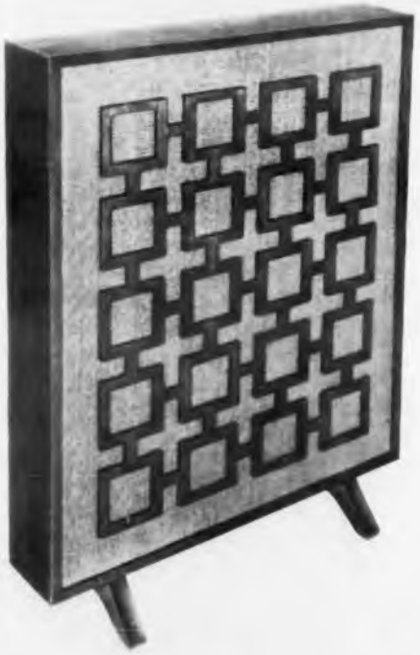
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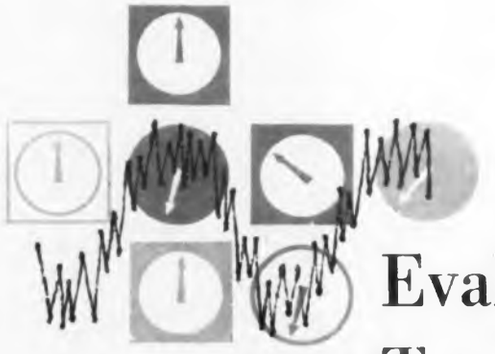

Evaluating Data for Low Noise Transistor Circuit Design

In two previous articles ("Design Considerations for Low Noise Transistor Input Stages," ED, Sept. 13, 1961, p 48 and "Measurement Techniques for Low Noise Transistor Input Stages," ED, Sept. 27, 1961, p 70) author Rheinfelder discussed various aspects of design and measurement for low noise transistor stages. This final article presents typical measurement data based on a recommended low-noise circuit design. A new equivalent noise circuit for transistors is also described.

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THE CIRCUIT shown in Fig. 1 has certain characteristics that make it extremely suitable for use in low-noise transistor input stages. These characteristics will be presented here in the light of the design considerations and measurement techniques described in the two earlier articles (see above). Measurements on the circuit were made at a frequency of 30 mc.

Capacitive tapping across the tuned circuits is used for matching and bandwidth control. For convenience, two power supplies are used to obtain independent current and voltage adjustments. The circuit is built to keep coupling between input and output circuits small. Neutralization by a coil in series with a 0.001-μf coupling capacitor between collector and base may be provided. This coil forms a parallel resonant circuit with the capacitor and converts reactive feedback into resistive feedback, so that a negative impedance cannot appear in the input. With a high-quality mesa transistor, such as the Motorola 2N828, neutralization is not required. The 2N828 was used in this investigation since it appears to have the lowest noise figure of any transistor in the industry.

As has been shown in the first article of this series, noise figure is lowest at a certain mismatch ratio. The effect is small however, if the noise figure under matched conditions exceeds 10 db. The maximum improvement possible from the matched condition is 3 db. This occurs if the circuit, when matched, has a 3-db noise figure (noiseless transistor). In this case, by mismatching, the 3-db improvement in noise figure is possible at the zero-power transfer point. Thus, in any practical case, the improvement due to mismatching is less than this value.

Noise Figure as Input Mismatch Ratio. A typical noise figure curve vs input mismatch ratio for the 2N828 is shown in Fig. 2. The mismatch ratio has been normalized, with 1.0 being the matched condition. The source was initially made 400 ohms and the impedance of the circuit was matched to it.

Noise Figure vs Bandwidth. The bandwidth may be decreased by mismatching and tapping down on the tuned circuit. A small bandwidth ahead of the first nonlinear element (the first stage tube or transistor) is essential for cross modulation to be tolerable. This can also improve the noise modulation. Generally, the objective is to achieve the highest signal-to-noise ratio in the output. However, this does not necessarily mean that the design for lowest noise figure meets the goal. Often noise modulation and cross modulation are the limiting factors in a practical receiver.

We shall now look at the loss in signal (noise figure) inherent when we decrease the bandwidth of the input circuit. The circuit used for reducing the input bandwidth was shown in Fig. 1. In Fig. 3 we see how the noise figure deteriorates as the bandwidth is decreased. All measurements were taken under matched conditions. Additional improvement is possible by purposely mismatching,

Noise Figures For Various Circuits

Circuit	Noise Fig. at 2 mc Input Bandwidth
#1 Single tuned, common emitter (Fig. 1)	5.7 db
#2 Double tuned, common emitter	12.5 db
#3 Mutual inductance coupled, common emitter	14 db
#4 Single tuned, common base	9.2 db

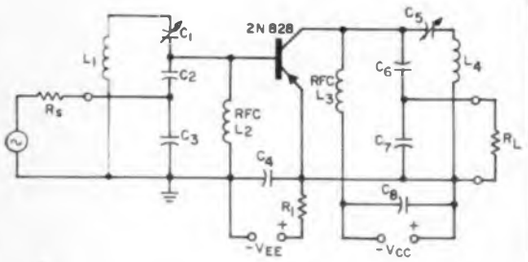


Fig. 1. Typical measurement data at 30 mc will be presented and evaluated for this specially designed low-noise input stage.

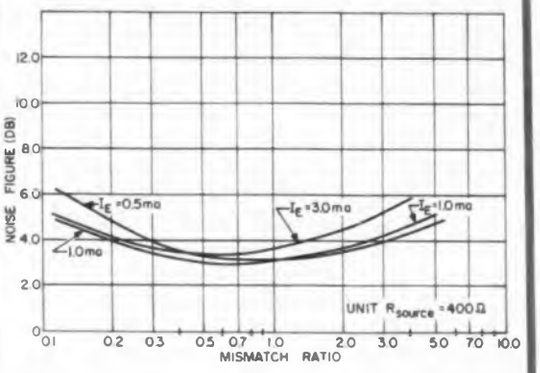


Fig. 2. Noise figure vs input mismatch ratio for the 2N828 transistor.

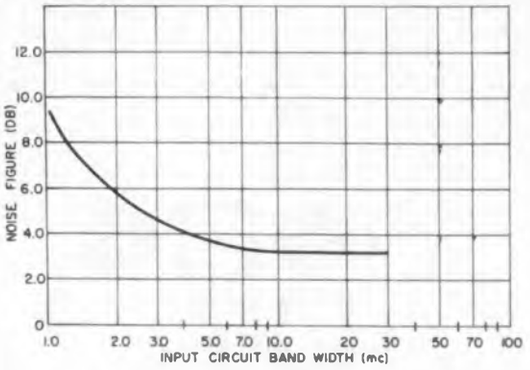


Fig. 3. As the bandwidth of the input circuit is decreased, the noise figure (taken under matched conditions) deteriorates considerably.

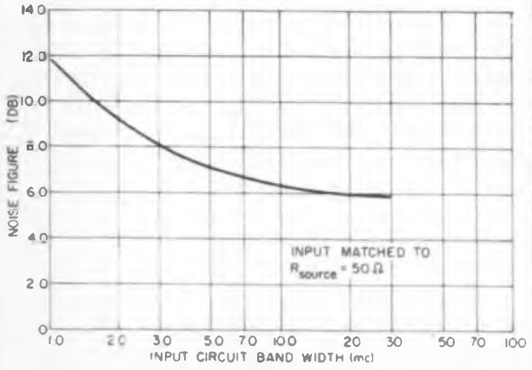


Fig. 4. Performance of the standard, single-tuned circuit, with 2N828 connected in common base configuration, usec to obtain Fig. 3.

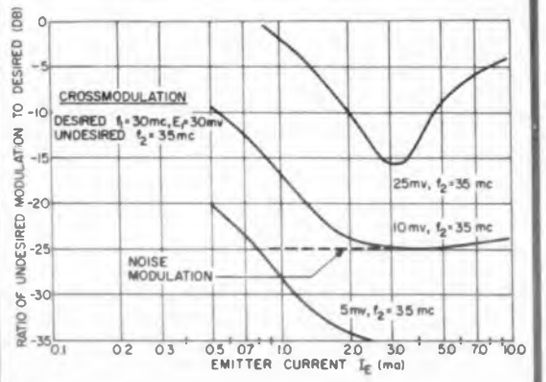


Fig. 5. Crossmodulation plotted vs. emitter current indicates shallow null due to the presence of noise modulation.

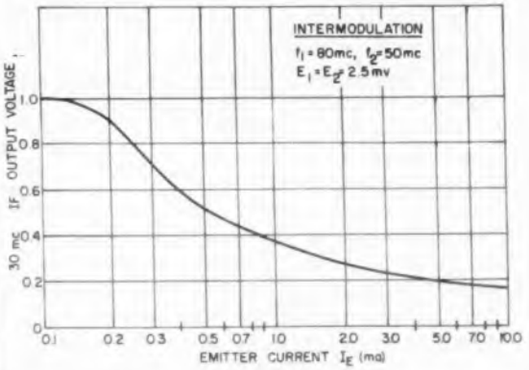


Fig. 6. Intermodulation distortion does not have a sharp null but decreases steadily with current.

as was pointed out previously. It can be seen from Fig. 3 that from an extremely wide bandwidth to a bandwidth of 3.5 mc, the noise figure deteriorates by only 1 db.

Fig. 4 shows the performance of the standard single-tuned circuit used to obtain Fig. 3, but in the common base configuration. The performances of the various circuits which can be used are summarized in the table. The best circuit is clearly circuit 1. Circuit 2 is poor mainly because a double-tuned circuit has a 6-db loss at the center frequency and the improved skirt selectivity does not appear in the bandwidth measurement. In circuit 3 additional losses are due to mutual inductance coupling. This type of coupling should be avoided where lowest noise is required. The circuit shown in Fig. 1 is also the simplest of the circuits used.

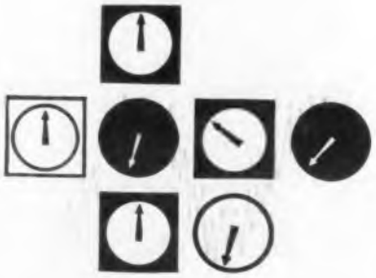
As we have seen, the noise figure is a function of signal to noise. As long as signal to noise is unchanged, the noise figure is also unchanged. Thus, if regular emitter feedback is used, the noise figure becomes worse. Although the signal is reduced, the noise is not reduced by the same amount because part of the noise is generated in the collector. A small unbypassed emitter resistance will decrease the bandwidth but will also make the noise figure worse.

Feedback from the collector does not change noise figure, because both signal and noise are affected in the same way. Positive feedback can be used to decrease the input bandwidth without changing the noise figure.

It would even be possible to decrease the noise figure if we could use some positive feedback for the signal but not the noise. This can be done by using positive emitter feedback. Although all of the signal is fed back, only part of the noise (the emitter noise) is. With proper circuitry, a high degree of stability and simplicity can be obtained. These types of feedback circuits look very promising and should be investigated further.

Cross Modulation vs Noise Modulation. In Fig. 5 cross modulation is plotted vs emitter current. The depth of the null is shallow because of the effect of noise modulation. By using an audio wave analyzer, a sharp null can be found where third order curvature is minimum. Since a measurement like this is meaningless in a practical circuit, it has not been repeated here.

Cross modulation may also be minimized by using negative feedback. Fig. 6 is a plot



of intermodulation distortion. It does not have a sharp null but decreases steadily with current. This is understandable since second order curvature is here involved.

The signal to noise is plotted vs carrier voltage in Fig. 7. Obviously the highest signal to noise occurs with high currents. This indicates that, in this case, noise modulation, as intermodulation, is apparently due largely to second order curvature. In this test it is important to know the characteristics of the measuring amplifier.

In many cases people have been misled by low noise figure values into believing they would automatically obtain the best signal to noise at higher levels. This is not necessarily true, because noise modulation is such an important factor.

Equivalent Noise Resistance Obtained From New Equivalent Noise Circuit

The measurement of equivalent noise resistance in a way that is analogous to tubes is not possible with transistors. In Fig. 8 we have a set of curves of noise figure vs source resistance with no tuned circuit placed on the input. A circuit like this would be impractical because of cross modulation but its simplicity makes it convenient for measurement purposes. The curves have a familiar shape although they have much sharper nulls.

In the conventional test for equivalent noise resistance, external resistance is added to the input circuit until the output noise doubles. The value of this resistance would then be the equivalent noise resistance of the device under test. With transistors, a determination of equivalent noise resistance is not such a simple matter. The reason is clear when we consider Fig. 9.

With the input shorted, at a 1-ma emitter current there is 11.6 db of noise (1.45 μv at the base). At 50 ohms there is a peak of 15.2 db (2.2 μv).

Open-circuited, the noise drops to 4.5 db (0.64 μv). This behavior is certainly in contrast to what had been theorized in the literature. In order to explain these curves it is necessary to use a new equivalent noise circuit, such as is shown in Fig. 10.

At least two independent noise sources, e_1 and e_2, must be provided; e_1 is a noise source in the base, and e_2 in the emitter. This circuit describes the curves and allows the peak in noise output to be found accurately.

After e_1 and e_2 have been found, equivalent noise resistances may be substituted. Since it is necessary to use two equivalent noise resistances, calculations for optimum noise figure may be involved.

Because the circuit, Fig. 10, is new, its analysis will be worked out in detail. First we calculate the square of the noise output voltage.

$$E_{no}^2 = a^2 (R_s + r_b) \left(\frac{R_c}{R_s + r_e + R_c}\right)^2 + e_1^2 \left(\frac{R_c}{R_s + r_b + R_c}\right)^2 + (a^2 R_c + e_2^2) \left(\frac{r_b + R_s}{R_s + r_b + R_c}\right)^2$$

$$= [a^2 (R_s + r_b) + e_1^2] \left(\frac{R_c}{R_s + r_b + R_c}\right)^2 + (a^2 R_c + e_2^2) \left(\frac{r_b + R_s}{R_s + r_b + R_c}\right)^2 \quad (1)$$

For R_s large compared with R_c, we have:

$$E_{no}^2 = a^2 R_c + e_2^2 \quad (\text{for } R_s >> R_c) \quad (2)$$

Similarly for zero source resistance, we find

$$E_{no}^2 = a^2 r_b + e_1^2) \left(\frac{R_c}{r_b + R_c}\right)^2 + (a^2 R_c + e_2^2) \left(\frac{r_b}{r_b + R_c}\right)^2 (\text{for } R_s = 0) \quad (3)$$

The last two equations allow the noise e_1 and e_2 to be determined from the empirical data of Fig. 9. The noise power output P_{no} can be calculated from:

$$P_{no} = \frac{E_{no}^2}{R_c} \quad (4)$$

From Eq. 1, we obtain:

$$P_{no} = [a^2 (R_s + r_b) + e_1^2] \frac{R_c}{(R_s + r_b + R_c)^2} + \left(a^2 + \frac{e_2^2}{R_c}\right) \left(\frac{r_b + R_s}{R_s + r_b + R_c}\right)^2 \quad (5)$$

Calculating dP/dR_s to determine the noise peak, we obtain the following solution:

$$R_s = -r_b + R_c \left(\frac{2e_1^2 - a^2 R_c}{2e_2^2 + a^2 R_c}\right) \quad (6)$$

After e_1 and e_2 have been found from Eqs. 2 and 3, R_s may be found. This value of R_s produces the noise peak of Fig. 9.

Maximum noise power gives no information on the noise figure. Although the noise power may increase, the signal power may increase even faster, resulting in a lower noise figure. The noise power measurements discussed so far are valuable in the manufacture of transistors.

As can be seen from the previous analysis the major noise source is e_1, which is in the base connection. This is in contrast to previous speculation which thought that shot noise was the major noise source in transistors. The measurements taken so far indicate that emitter noise and collector noise—that is, shot noise—and also induced base noise can, to a first approximation, be disregarded in transistors. The most important noise is base noise, which acts as a noise source in series with r_b. A more thorough investigation of this type of noise is in order.

Direct Method Evaluates Circuit Noise Figure

After e_1 and e_2 have been determined as above, two equivalent noise resistances may be found. No further simplification is possible, however, as in the tube case. It seems, therefore, that in transistors the introduction of equivalent noise resistances is too cumbersome to permit the rapid evaluation of circuit noise figure. Instead, we shall use a direct method.

First, we calculate the square of the sig-

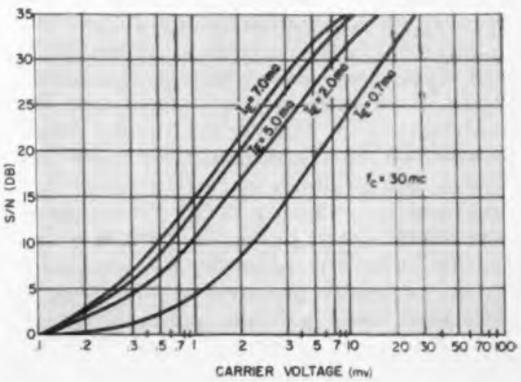


Fig. 7. Signal-to-noise ratio increases with carrier voltage.

nal output voltage, Fig. 10.

$$E_{no}^2 = \left(\frac{R_e}{R_s + r_b + R_e}\right)^2 E_{ni}^2 \quad (7)$$

The noise figure was previously defined as:

$$F = \frac{P_{si}}{P_{ni}} \frac{P_{no}}{P_{so}} = \frac{E_{si}^2}{E_{ni}^2} \frac{E_{no}^2}{E_{so}^2} \quad (8)$$

Substituting E_{no}^2, E_{so}^2 and $E_{ni}^2 = a^2 R_s$, we obtain:

$$F = \frac{E_{si}^2}{\left(\frac{R_e}{R_s + r_b + R_e}\right)^2 E_{si}^2}$$

$$\left\{ \frac{[a^2(R_s + r_b) + e_1^2]\left(\frac{R_e}{R_s + r_b + R_e}\right)^2}{a^2 R_s} \right.$$

$$\left. - \frac{(a^2 R_e + e_2^2)\left(\frac{r_b + R_s}{R_s + r_b + R_e}\right)^2}{a^2 R_s} \right\}$$

$$= \frac{R_s + r_b}{R_s} + \frac{e_1^2}{a^2 R_s}$$

$$+ \left(\frac{R_e}{R_s} + \frac{e_2^2}{a^2 R_s}\right)\left(\frac{r_b + R_s}{R_e}\right)^2$$

$$= 1 + \frac{r_b}{R_s} + \frac{e_1^2}{a^2 R_s}$$

$$+ \frac{1}{R_s}\left(R_e + \frac{e_2^2}{a^2}\right)\left(\frac{r_b + R_s}{R_e}\right)^2 \quad (9)$$

This formula permits the noise figure for any transistor circuit to be calculated from its parameters after e_1 and e_2 have been determined as discussed above. Remaining, is to calculate the value for R_s which produces the lowest noise figure. Differentiating F we obtain:

$$\frac{dF}{dR_s} = \frac{-r_b}{R_s^2} - \frac{e_1^2}{a^2 R_s^2}$$

$$- \left(R_e + \frac{e_2^2}{a^2}\right)\left(\frac{1 - \frac{r_b^2}{R_s^2}}{R_e^2}\right) \quad (10)$$

Equating to zero and solving for R_s, we finally obtain:

$$R_s =$$

$$+ \sqrt{\frac{r_b R_e(r_b + R_e) + \frac{e_1^2 R_e^2}{a^2} + \frac{e_2^2 r_b^2}{a^2}}{R_e + \frac{e_2^2}{a^2}}} \quad (11)$$

Substituting this value of R_s into Eq. 9, we find the minimum noise figure attainable by mismatching.

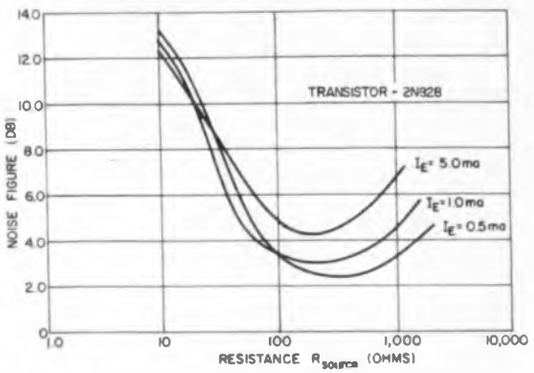


Fig. 8. Measurement of equivalent noise resistance of a transistor in a way analogous to tubes is not possible.

This has been a summary of work done so far. As we have seen there are several areas that warrant thorough investigation. We have seen that with the proper type of feedback the noise figure can be improved further. Theoretical analysis shows that in this manner the noise source e_2 of Fig. 10 may be made zero. This means that the noise figure becomes:

$$F_1 = 1 + \frac{1}{R_s}\left(r_b + \frac{e_1^2}{a^2}\right) + \frac{1}{R_e}\left(\frac{r_b}{R_s} + 1\right)^2 \quad (12)$$

and the optimum source resistance is:

$$R_s = + \sqrt{r_b^2 + R_e\left(r_b + \frac{e_1^2}{a^2}\right)} \quad (13)$$

This improvement seems to be very worthwhile and should be investigated further. The added advantage of positive feedback is to cause a decrease in bandwidth. This can be used to reduce the cross modulation.

The equivalent noise circuit of Fig. 10 does indicate that from the standpoint of noise, common-base operation is much poorer. There exists, however, a circuit which is intermediate between common base and common emitter. This circuit may produce a lower noise figure, because the lowest noise figure results under matched condition. It uses a lattice filter in the input. While it is at first sight complex, it may result in a simple, practical design.

In the preceding, discussion centered at one frequency. Since voltage e_1 and e_2 are functions of frequency, as are the other transistor parameters, the optimum circuit conditions vary with frequency. If they are regarded as constant, some reactive components will have to be introduced into the equivalent circuit of Fig. 10 (such as the capacitor shown in dashes). ■ ■

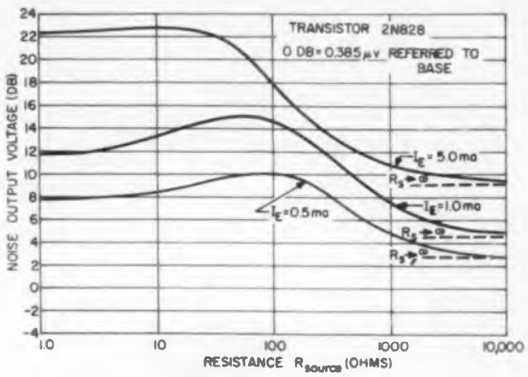


Fig. 9. Equivalent noise resistance of a transistor varies with both source resistance and emitter current.

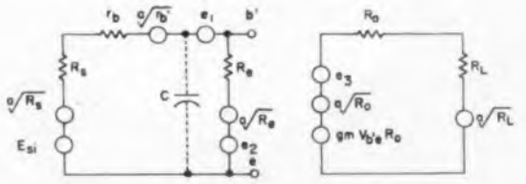


Fig. 10. New equivalent noise circuit was devised to explain the curves of Fig. 9.

References

Noise, General: 1, 3, 4, 6, 7, 14
Noise, Figure: 1, 2, 3, 13, 14
Measurements: 1, 2, 5
Cross Modulation: 3, 12, 15
Noise Modulation: 6, 7, 8, 9, 16
Equivalent Noise Resistance: 1, 3, 5, 14
Transistor Noise: 11, 13

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PRODUCT FEATURE

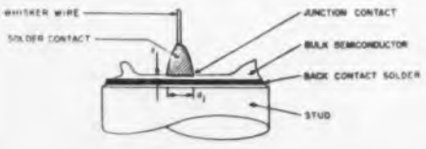
This series of germanium micro-etch varactors is designed as efficient harmonic generators and may also be used as parametric amplifiers or rf tuning devices.

High Efficiency Varactor Diodes

A NEW line of micro-etch germanium varactor diodes provides simultaneous operation at maximum frequency and maximum voltage. A very high cut-off frequency and greatly increased capacitance variation promote unusual efficiency.

Dr. C. H. Sutcliffe, general manager of the Special Products Operation, Lansdale Div. of Philco Corp., Philadelphia, reports evaluation tests were conducted on types L-4110, L-4111 and L-4112 varactors as harmonic generator devices. Their performance was continuously monitored in harmonic-generator circuits. Doublers of the shunt and series type, from 1- to 2-Gc and 2- to 4-Gc, were employed, as were quadruplers from 600-mc to 2.4-Gc and quintuplers from 600-mc to 3-Gc.

At still higher frequencies, evaluations were carried out in X-band quadruplers. For these various types of harmonic generator circuits, typical efficiencies ranged from 35 to 60 per cent in the S-band multipliers. An efficiency of 15 per cent was observed for the X-band quadrupler.



The thickness (t) of the membrane resulting from the Precision-Etch process is very small compared to the junction diameter d_j.

The abrupt junction nature of the devices, together with the low contact potential inherent in germanium, accounts for their large capacitance variation over the operating voltage range.

In the micro-etch varactors, the ratio of zero-bias capacitance to optimum bias-point capacitance typically is 6 to 1.

A simplified equivalent circuit, useful in predicting the efficiency of varactor-frequency multipliers, is the series combination of spreading resistance (R_s) and variable barrier capacitance (C_b). A useful figure of merit based on such a circuit for predicting performance of varactor multipliers at microwave frequencies is the cut-off frequency (f_c), defined as:

$$f_c = \frac{1}{2\pi R_s C_b}$$

Conventionally, varactor manufacturers arbitrarily specify C_b at −6 v when in fact that bias point may differ widely from the optimum point at which to work. Philco engineers

point out that it is much more practical to measure C_b at a bias point equal approximately to 1/3 of breakdown voltage (V_b), since it is a signal swing about this point that provides maximum conversion efficiency.

Minimum-Series Resistance Attained With Germanium

Germanium was the choice for material in current practical semi-conductors. The micro-alloy diffused transistor (MADT) precision-etch technique permits the attainment of minimum-series resistance with germanium material through the utilization of semiconductor membrane as narrow as 3×10^{-3} in.

The junction electrode is electro-chemically jet-plated with precise alignment to situate it in the center portion of the etched area. This guarantees utilization of the thinnest portion of the membrane and, consequently, achieves the lowest value of series resistance. The junction size is determined by the size of the plated metallic electrode.

The three new devices, in order of ascending cut-off frequency, were designed primarily as harmonic generators at frequencies up to 3-, 6- and 10-Gc. They also may be used as parametric amplifiers or rf tuning devices.

Typical characteristics of the L-4110 are: max power dissipation, 0.5 w; breakdown voltage, at 200 μa, 80 v; junction capacitance, at 100 kc, and varactor biased, at 1/3 V_b, 1 to 2 pf; cut-off frequency, at 1/3 V_b, 25 Gc; cartridge capacitance, 0.2 pf.

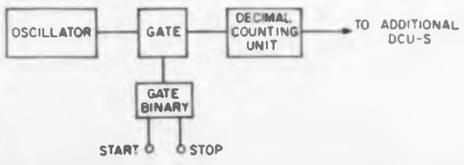
These varactors are available now, ranging from $80 for the L-4111 to $120 for the L-4110 and the L-4112. For further information on these high-efficiency varactor diodes turn to the Reader-Service Card and circle 251.

Time Interval Meter Has 2-Nsec Resolution

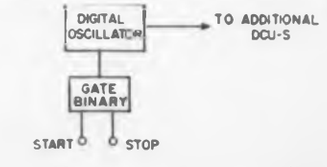
USING a novel switching-circuit principle, the Time Interval Meter, type 1-109, increases the resolution of direct digital time measurements by about an order of magnitude beyond that previously possible. Utilizing interpolation techniques, time-interval measurements can be made with better than 10-picosecond resolution.

The features of the new circuit can best be described by comparison with a conventional time-interval measuring scheme. Fig. 1 shows how previously designed TIMs work. The time interval to be measured is most commonly represented by a start and stop pulse. The start pulse turns the binary, and therefore the gate, on and the oscillator cycles are counted by the decimal counting unit until the stop pulse closes the gate.

By contrast, the new scheme, for which patent is pending, uses only one multipurpose circuit beside the gate binary. The circuit operation, according to the designer, Zoltan Tar-



Block diagram illustrates a conventional time interval meter.



New way to measure time; the digital oscillator takes the place of the oscillator-gate-DCU combination.

czy-Hornoch, technical director of Eldorado Electronics, 2821 Tenth St., Berkeley, Calif., is somewhat like a free-running multivibrator, except that it has 10 stable states.

Once started by the binary, it goes through 10 discreet steps before it provides an output pulse and then keeps on oscillating until stopped in one of its stable states by a stop pulse. The circuit functions, therefore, as its own oscillator, gate, countdown and memory unit. It is called a digital oscillator because it runs in digital steps. Accuracy of the stepping frequency is maintained by crystal control.

In addition to its extreme simplicity, the circuit has other advantages. For 2-nsec resolution, a conventional instrument would need an oscillator, gate and DCU, all operating at 500 mc. In comparison, for the same resolution, no single component will switch at a higher rate than 50 mc in the Time Interval Meter 1-109. This fact obviously improves reliability, maintainability, and accuracy, and cuts power consumption and cost.

Functionally, the circuit has another feature. Conventional units have an ambiguity of reading because the clock generator is not synchronized to the start pulse. Time interval of "N" units measure alternately "N" or "N + 1". The digital oscillator eliminates this problem by starting its oscillation precisely in synchronism with the start signal. "N" units of time measurement measure exactly "N" at all times.

Because of the extreme accuracy of the quantizing and phase-lock, a known time delay can be added to an unknown until the digital oscillator switches to the next digit. By this interpolation, time intervals can be measured to picosecond accuracy. As an example of the instrument's capabilities, a time-delay difference between two seemingly identical cables was determined, by the 1-109 TIM, to be 0.36 nsec, ±5 psec.

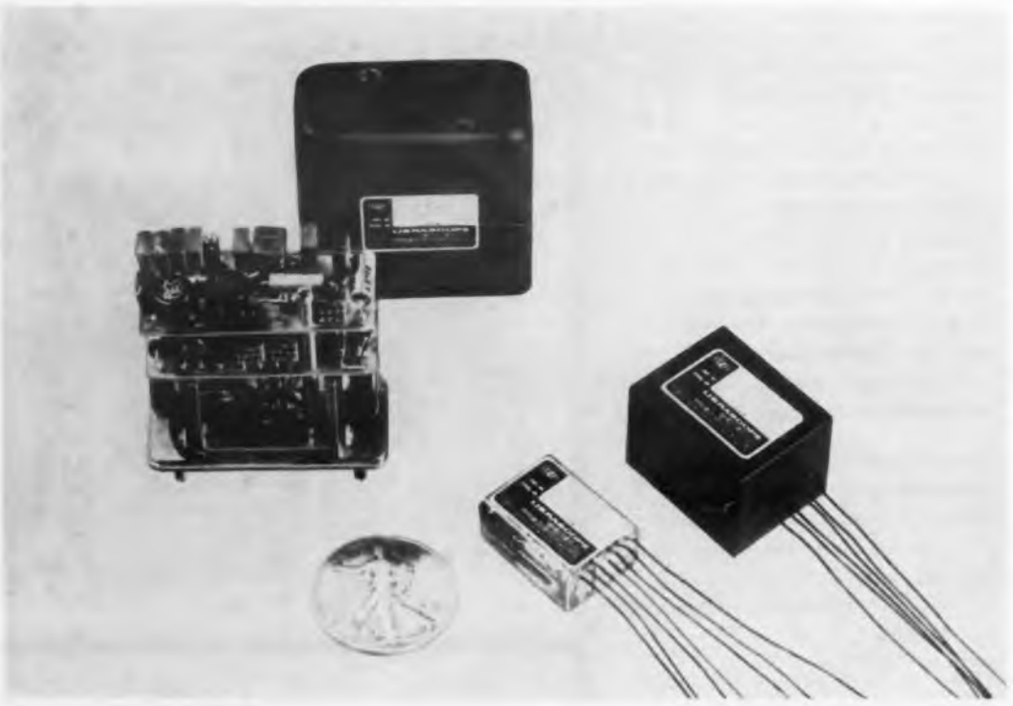
The phase-locked operation of the instrument is advantageous when multiple time intervals are measured. Any number of TIMs can be used in parallel without the usual problem in synchronizing their time bases. The Eldorado units will run synchronized automatically.

Specifications on the all-solid-state unit are: resolution, 2 nsec; time interval range, 2 nsec to 1 nsec; readout, 9-digit visual, in-line readout and print-out; input pulse requirements, for start-stop, 1 v into 50 ohms.

Delivery on this Time Interval Meter, type 1-109, manufactured by Eldorado Electronics, is scheduled for early 1962, at about $5,000. For further information on this TIM turn to the Reader-Service Card and Circle 252.

NEW PRODUCTS

Covering all new products generally specified by engineers designing electronic original equipment. Use the Reader-Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.

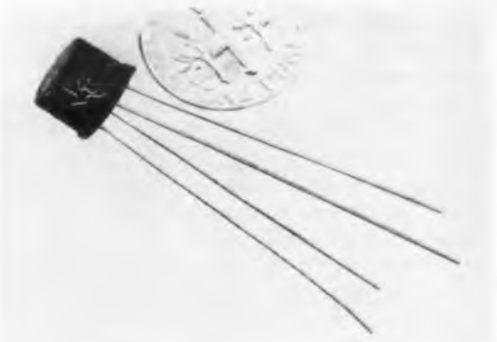


Ultraminiature Servo Amplifiers 256

Designed for use in servo systems where lightweight, small size and maximum reliability are prime factors, the model 504 servo amplifier is a 4-watt unit, weighs 1.46 oz and is 1.2 cu-in. in volume. Use of negative feed-back circuits and silicon transistors provide long term stability in severe environments. Normal voltage gain is 1,000; input impedance is 15,000 ohms at 400 cps with an amplifier gain of 1,00. Amplifier power requirement is 28 v dc.

General Precision, Inc., Librascope Div., Dept. ED, Glendale, Calif.

P&A: From $356 ea in quantities of 1 to 9 to $250 ea in quantities of 250 to 499; 1 to 2 months.



Diffused Silicon Field Effect Transistor 257

An N-channel diffused silicon device, the field effect transistor type TIX 690 features dual gate control. Typical characteristics are: a pinch-off voltage of 4 v; a drain to source voltage of 20 v; and a transconductance of 2,500 micromhos. The new unit is packaged in a four-leaded TO-5 can. Uses for the new device are in the input stages of audio and dc amplifiers, switching applications analog multipliers and other applications.

Texas Instruments Inc., Dept. ED, P. O. Box 5012, Dallas 22, Tex.

P&A: $50 ea; in limited sample quantities.

Metal-Clad Glass-Bonded Mica 259

Infinite dimensional stability is offered in Mykroy, a metal-clad, glass-bonded mica developed for use in precision circuitry design. The material cannot bend, warp or change its size or shape in any way despite extremes of temperature and humidity. It will not outgas in a vacuum and is arc-proof, fireproof and radiation resistant. It is available in sheets and rods and as custom-made insulators with finished circuitry. Shown is a commutator made of Mykroy.

Molecular Dielectrics, Inc., Dept. ED, 101 Clifton Blvd., Clifton, N. J.

P&A: sample kit $22; 2 weeks.

Magnetic Digital Computer 255

No larger than a telephone, this magnetic digital computer is the first to employ magnetic circuits throughout. It is designed to operate as the brain of space vehicle guidance and control systems. It can accurately handle more than 12,000 computations a second for up to 20,000 hours without maintenance. Extreme reliability is achieved by replacing transistors and diodes with magnetic ferrites; one ferrite replaces as many as 24 semiconductor elements.

Sperry Gyroscope Co., Dept. ED, Great Neck, N. Y.

Availability: less than one year.

Low Noise Amplifier Increases Scope Sensitivity 258

Model 103 is an ac preamplifier designed to give the best possible signal-to-noise ratio to oscilloscopes and recorders. It has a noise level of less than 0.8 μv rms between 10 cps and 10 kc. Applications include measurement of piezoelectric crystal outputs, ac Hall effect studies and investigation of if noise in semiconductors. Bandwidth can be selected between 0.1 cps and 100 kc; noise level can be altered from 10 megohms to 100-K input impedance.

Keithley Instruments, Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.

P&A: model 103 amplifier $245, power supply model 1031 $245; 45 days.

New Products Directory

A complete index of all new products contained in this issue of ELECTRONIC DESIGN, *including page and reader-service numbers.*

NEW PRODUCTS

Trimmer Potentiometers 488

Printed circuit trimmers types 50-4-1 and 60-4-1 are 3/8 in. and 1/2 in. sq. Feature humidity-proof construction. Type 50-4-1 weighs 1 g, is rated at 1 w at 50 C, range is from 50 ohms to 50 K; type 60-4-1 weighs 2 g, is rated at 2 w at 50 C, range is from 50 ohms to 100 K.

Spectrol Electronics Corp., Dept. ED, 1704 S. Del Mar Ave., San Gabriel, Calif.

P&A: *$8.10 and $7.20 each in 1-9 pieces; immediate from distributors.*

Miniature Relay 607

Life is 10 million cycles or more at 50 ma, 115 v, resistive. The Drireed relay provides unusual resistance to shock and vibration. It uses a gold-plated, glass-scaled contact set. Length is 1 in., diameter is 3.8 in. and weight is less than 4 g.

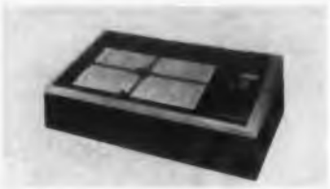
Hathaway Denver, Dept. ED, Denver, Colo.

Glass and Ceramic Parts 492

Miniaturized high-precision parts for electronic and optical applications, such as glass, quartz, ferrites and germanium, can be fabricated to very rigid tolerances. Expanded high-vacuum coating and metallizing services provide special optical finishes, such as gold, silver, aluminum, and fluoride.

Zenith Optical Laboratory, Dept. ED, Dobbs Ferry, N. Y.

Servo Recorders 610



Two types, the HR-80 and HR-87 TY recorders include a null-seeking servo which moves an ink pen in proportion to a dc signal on the Y axis and a plug-in synchronous timing motor which moves the pen on the horizontal axis. Type HR-80 is for 8-1/2 x 11 in. paper; type HR-87, 11 x 16-1/2 in.

Houston Instrument Corp., Dept. ED, P. O. Box 22234, Houston 27, Tex.

P&A: HR-80, $395; HR-87, $445; 30 days.

Plastic Potentiometers 530

Resolution of 0.005 deg or better is provided by the Fairite line of conductive plastic potentiometers. Resistance range is 2 to 50 K ±10%; standard linearity is 0.5%; power rating is 2 w at 20 C with a 300 to 400 ppm temperature coefficient. Co-molding of silver terminals with the conductive element provides for low end-loss connections.

Fairchild Controls Corp., Dept. ED, 225 Park Ave., Hicksville, L. I., N. Y.

Automatic Assembly Machine 549

Processes 6,000 transistor heads per hr. Precision operations, such as welding, punching, and threading, are all possible, and machine can assemble as many as 40 different components. Components are mounted on a carbon "boat" which resists high temperatures.

The Rhebo Corp., Dept. ED, Sunnyvale, Calif.

Quick-Release Pins 606

Single acting, quick-release pins are available in ring handle, T-handle and L-handle designs. Standard pins are of 17-4 PH and 4130 steel, with two or four balls to provide a positive lock against accidental pin removal.

The Hartwell Corp., Dept. ED, 9035 Venice Blvd., Los Angeles 34, Calif.

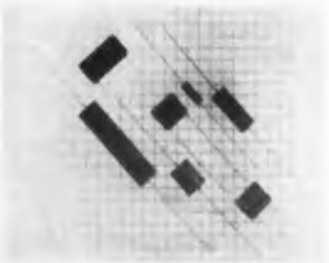
NEW PRODUCTS

Silicon Transistors 585

For power switching equipment applications, these TO-3 silicon transistors have power levels of 75 w at 25 C and 43 w at 100 C with a collector current of 7.5 amp and a collector voltage of 100 v max. They are designated types 2N1487, 2N1488, 2N1489, 2N1490, 2N1069, 2N1070, F104, F105, F115 and F116.

Fanon Transistor Corp., Dept. ED, 439 Frelinghuysen Ave., Newark 12, N. J.

Wirewound Resistors 587



Precision, encapsulated wirewound resistors are available in tolerances of 0.01%, 0.05% and 0.1%. Standard temperature coefficient is 10 ppm nominal; ratings of 1 to 6,000 ppm can be furnished. Resistances are from 1 ohm to 75 meg. They meet or exceed MIL-R-93B and MIL-R-9444.

GB Components, Inc., Dept. ED, 14621 Arminta St., Van Nuys, Calif.

Feedthrough Capacitor 605

Microminiature feedthrough capacitor type DA-718 is rated at 100 v dcw and 250 v dct and is available in capacities of 500 to 800 pf. It measures 0.16 in. in diameter by 0.165 in. high and can be inserted in a 1/8-in. diameter hole.

Globe-Union Inc., Centralab Div., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.
Availability: *4 weeks.*

Variable Speed Drives 536

Electronic and non-electronic types are both offered. Electronic speed drives rated at 1/6 to 7-1/2 hp are for applications requiring regulation of 1% or 2% over a wide speed range with varying loads. Two industrial thyratrons and a magnetic-amplifier driver are the basic control elements.

F. A. MacPherson Co., Dept. ED, 822 Harding St., P. O. Box 421, Westfield, N. J.

Dual Display TV Monitor 483

Combines two fully transistorized Mil spec TV monitors on a single 10-1/2-in. high rack-mounted chassis. Type M20002 features two 5-1/2 x 5-1/2-in. presentations. Two independent 5.5-mc video amplifiers and two independent horizontal deflection amplifiers are used. Weighs less than 35 lb. Power consumption less than 150 w.

RMS Associates, Inc., Dept. ED, 805 Mamaroneck Ave., Mamaroneck, N. Y.
P&A: *$6350; 60-90 days.*

Digital Tape Transport 618

Pneumatic pressures are used in transporting and handling the tape. Model M 3000 digital tape transport records and reads magnetic signals on reels of tape. The tape never touches rollers, only the magnetic head. Porous capstans and air-clamp orifices are used in place of rollers. The system is free of programing restrictions at tape speeds to 120 ips.

Midwestern Instruments, Dept. ED, Tulsa, Okla.

Power Supplies 616

Designed for electromagnets used in nuclear research, these power supplies have capacities of up to 75 kw with full-load voltage stability and ripple suppression of 1 part in 10,000. The output is adjustable from 10% to 100% of rated value. Long-term stabilization is by motor-driven, adjustable transformers and fast stabilization, by vacuum-tube regulators.

International Telephone and Telegraph Corp., Dept. ED, 320 Park Ave., New York 22, N. Y.

Decimal Counters 591

Center-scale decimal counters types C70 0433 and 0434 have readouts of up to 99.9 or 999.9. They are designed for military and industrial applications where high speed and low torque are required. Temperature range is −65 to +90 C.

General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

Fluorescent Detector 600

Finds cracks, flaws and leaks in materials such as aluminum, copper, plastics, stainless steel. The Seal-Lock Fluorescent detector locates minute defects not detected with most penetrants. Complete inspection takes 3 to 5 min. Black light is used to activate the fluorescent materials.

U. S. Casting Repair Corp., Dept. ED, 6432 Edmund St., Philadelphia 35, Pa.

Snap-Acting Switch 603

Rated at 25 amp, 125 or 250, v ac, making and breaking, the 2HG spot switch is for industrial control systems where high current-handling capacity is of primary importance. It is available with pin actuator, with overtravel-plunger, leaf, leaf-roller, lever and roller-lever actuators.

Unimax Switch, Dept. ED, Ives Road, Wallingford, Conn.

Miniature Panel Bulb 493

Glass-based compact bulb has no metal base or threads. Instead, glass at end of bulb is formed into a flat wedge and easily inserted into a simple socket. Bulb is merely pushed into socket with no turning or twisting needed. Electrical contact by two tiny wires crimped into recesses in base. For automotive, electronic and aircraft industries.

Westinghouse Electric Corp., Lamp Div., Dept. ED, Bloomfield, N. J.

Flame-Proof Epoxy 614

Semi-flexible, flame-proof epoxy No. 247 is for use as an impregnant and encapsulent for components designed to meet military and UL fire-resistant specifications. Surface arc resistance is 68 sec; viscosity is 25,000 centipoise at room temperature.

Minnesota Mining and Manufacturing Co., Dept. ED, 900 Bush Ave., St. Paul 6, Minn.

Rectifier Tube 611

Full-wave vacuum rectifier tube type 5BC3 is intended for use in the power supplies of TV and radio receivers and high-fidelity audio equipment having high dc current and voltage requirements. Piv is 1,700 v. Peak plate current rating is 1 amp per plate. Design is novar large glass based receiving tube type.

Radio Corp. of America, Dept. ED, 30 Rockefeller Plaza, New York 20, N. Y.

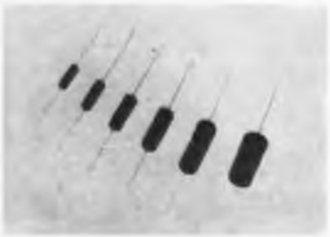
Gas-Liquid Heater 602

Inner-fin construction provides uniform heat distribution and lower surface temperatures while supplying heat for continuous operation at temperatures to 600 F. The core heater has a long-life guarantee. The heater can be installed as part of process piping.

Lytron, Inc., Dept. ED, 42 Brookford St., Cambridge 40, Mass.

NEW PRODUCTS

Molded Capacitor 586



In ratings of 0.001 to 1 μf at 200 to 1,600 v. Suitable for ac, dc and pulsed dc use, the Black Cat molded capacitor has high moisture resistance and is free from impregnant leakage. Features include a nonflammable plastic case and a dual dielectric which combines the characteristics of impregnated paper and polyester film.

Federal Pacific Electric Co., Cornell-Dubilier Electronics Div., Dept. ED, Sanford, N. C.

Wirewound Potentiometers 532

Single-turn, 1/2-in. wirewound potentiometers have a resistance range of up to 100 K. Linearity is ±0.5% on standard units and ±0.25% on special units. Dielectric strength is 1,000 v rms; power rating is 2 w at 40 C.

Fairchild Controls Corp., Dept. ED, 225 Park Ave., Hicksville, L. I., N. Y.

True RMS Voltmeter 550

Model 910A combines high accuracy with broad bandwidth. Low impedance thermocouple converts input ac to a dc voltage directly proportional to the effective heating value of input ac.

John Fluke Manufacturing Co., Inc., Dept. ED, P. O. Box 7428, Seattle 33, Wash.

AC Voltage Standard 601

Output is 100 v ±0.1% at 60 cps internal or 50 to 7,500 cps external. Model 6010 ac voltage standard has output currents of up to 10 ma, operates from an input of 105 to 130 v, 60 cps, single phase; dimensions are 8 x 8 x 6 in.; weight is 10 lb.

Tensor Electric Development Co., Inc., Dept. ED, 1873 Eastern Parkway, Brooklyn 33, N. Y.
Price: *$197.*

Planar Transistor 527

Silicon epitaxial planar transistors are for operation in circuits ranging from dc to 100 mc. Switching speed at 0.5 amp is 10 nsec; collector saturation voltage is 0.5 v at 0.5 amp; power dissipation is 3 w. Gain-bandwidth product is 400 mc and collector capacitance is 4 pf.

Motorola Semiconductor Products, Inc., Dept. ED, E. McDowell Road, Phoenix 8, Ariz.

Vacuum-Pressure Pump 588

With 1-cfm free-air flow. Suitable for laboratory or field operation, model 13152 vacuum-pressure pump operates vacuum filters and distillation units continuously. Ratings include: vacuum, 26 in. Hg max; pressure, 65 psig. Gages are located on the pump itself.

Gelman Instrument Co., Dept. ED, 106 N. Main St., Chelsea, Mich.
Price: *$69.*

Flash Lamp Pulser 615

Provides 10 million cp. Model 110 flash lamp pulser is a versatile light source for taking high-speed, short-exposure strobe pictures. Ratings include: energy up to 5 w-sec per flash, flash duration of 1 μsec, repetition rate of 10,000 flashes per sec.

Shapiro & Edwards Electronic Instrumentation, Dept. ED, 1130 Mission St., South Pasadena, Calif.

Transistor Cooler 535

Thermoelectric transistor cooler, the F-3TC Frigistor, is for use with TO-3 and TO-41 transistor cases. It provides cooling at up to 17 amp; operating voltage is 0.3 v.

General Thermoelectric Corp., Dept. ED, P. O. Box 253, Princeton, N. J.

Epoxy Plastics 622

Transparent rigid and semi-rigid epoxy plastics, designated Epocast H-1368, are cured at room temperatures overnight, followed by heating at 150 F for 1 hr for optimum cure.

Furane Plastics Inc., Dept. ED, 4516 Brazil St., Los Angeles 39, Calif.

Snap-in Connector 418

The Shur-Lok has lances in the female pin that provide for snap-in insertion into the nylon insulators. The contact cannot be pulled out of the insulator by forces less than 50 lb min. No sleeving is required. The contact is made of beryllium copper; plates of aluminum.

National Connector Corp., Dept. ED, Science Industry Center, Minneapolis 27, Minn.

Panel-Board Insulator 594

Flame-retardant, track-resistant panel board insulator type 2165-1 is designed for applications of up to 600 v. Measuring 1 in. high x 1 in. in diameter, it is molded to close dimensional tolerances. Torque strength is sufficient to twist off a 1/4-in. machine bolt.

The Glastic Corp., Dept. ED, 4321 Glenridge Road, Cleveland 21, Ohio.
P&A: *$0.45; stock.*

Display Console 590

For digital-computer monitoring, the S-C 1090 direct-view display console provides high resolution and brightness. It displays characters, symbols and vectors on a 19-in. character generator tube.

General Dynamics Electronics, Dept. ED, 1895 Hancock St., San Diego 12, Calif.
Availability: *stock.*

In-Circuit Transistor Tester 552

Can test any type of transistor while it is still soldered in circuit. Tests for shorts, open circuits, leakage, oscillation, and comparative gain. Indicates whether transistor is pnp or npn type. Also tests all types of diodes and rectifiers. Model TIC-161 is 6-1/4 x 3-3/4 x 2-3/4 in. Weight is 1 lb.

Paralan Electronics Corp., Dept. ED, 507 Fifth Ave., New York 17, N. Y.

Phenolic Glass Laminates 394

Grade PG-381 glass liminates are available in thicknesses from 0.125 to 0.750 in. and greater. Produced in accordance with MIL-R-9299 (Type II, Class 2).

The Mica Corp., Dept. ED, 4031 Elenda St., Culver City, Calif.

Insulating Coating 557

HumiSeal type 1A28, fast, air-drying solderable coating is designed for use on printed circuit boards. Offers easy application and cure. Eliminates the need for costly and time-consuming stripping. Recommended for use in the —70 deg to ±250 deg temperature range. Resistance to chamical solvents is very good.

Columbia Technical Corp., Dept. ED, Woodside 77, N. Y.

Electron Microanalyzer 621

Particles 0.1-micron in diameter can be examined and identified by means of electron micro-analyzer DEM No. 301.

Elion Instruments, Inc., Dept. ED, Bristol, Pa.
Price: $68,000.

Energy Limiter 538

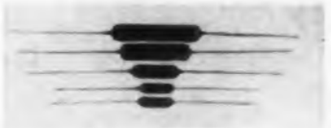
Meeting NEMA standards, the Superking energy limiter can be supplied as a class H device for fuse clips with voltage ratings of 600 and 250 v at 1 to 600 amp. It is also available for class J use for rejection-type fuse clips with a voltage rating of 600 v at 1 to 600 amp.

Monarch Electric Div., El-Tronics Inc., Dept. ED, Jamestown, N. Y.

CIRCLE 60 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Wirewound Resistors 604



Withstand up to 350 C. Series 1070 wirewound resistors have power ratings from 2 to 10 w, resistances from 1 ohm to 175 K, tolerances of ±0.1% to ±20%, dielectric strength of 1,000 v and temperature coefficient of 0.00002 per deg C. The thermally conductive, electrically insulating coating also protects against salt spray, vibration and mechanical shock.

RECO, Dept. ED, 409 McGroarty St., San Gabriel, Calif.

Availability: *1 week.*

Multiplex Inductors 620

Fm stereo multiplex inductors include models: 1351 low-pass filter, 1352 and 1353 bandpass filter series elements, 1354 19-kc locked oscillator, 1355 38-kc output transformer. Dimensions are 3/4 x 3/4 x 1-7/32 in.

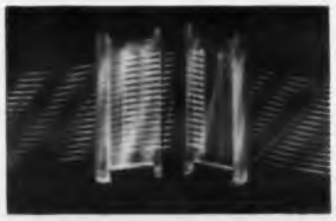
J. W. Miller Co., Dept. ED, 5917 S. Main St., Los Angeles 3, Calif.

Noise-Free Switches 529

Metal alloys are used for both conductive and non-conductive parts of these switches, resulting in long-term accuracy and noise-free switching even under conditions of high current and inductive loads. Applications are in weapons release mechanisms, industrial sensing and control devices.

Fairchild Controls Corp., Dept. ED, 225 Park Ave., Hicksville, L. I., N. Y.

Cable Connectors 598



Flat-conductor cable connectors can be used without soldering or splicing individual wires. Designed to withstand stress, it can be used in aircraft and missile data processing and readout systems. Various types accommodate pins in configurations such as flat or blade end, round or pin end, rectangular or folded end.

National Connector Corp., Dept. ED, Minneapolis 27, Minn.

CIRCLE 62 ON READER-SERVICE CARD ➤

MOVING AIR IS CHILD'S PLAY

CONTROLLING IT TAKES AN EXPERT

In years of specializing in air moving and cooling, at times we have been undersold, outmaneuvered and outtalked. But we've seldom been outdesigned or outperformed. Sooner or later most air moving problems come to Torrington. Brochure 102 proves why it should be sooner.

TORRINGTON
MANUFACTURING COMPANY
TORRINGTON ■ CONNECTICUT

QUADRATURE-FREE AC SIGNALS!

...now possible with two entirely new AC pots –precision-built by Helipot!

Even though today's potentiometers are developed to a level of performance never before achieved, their use as AC voltage dividers introduces several problems not present under DC conditions. Most important of these are quadrature voltage and phase shift–the extraneous voltage 90° out of phase with the input signal, which results from capacitance between wire turns and metallic mandrel.

How do you eliminate quadrature? And the many other considerations associated with AC applications – what about them? Helipot solves all these problems with two new AC potentiometer series.

Let's talk specifics.

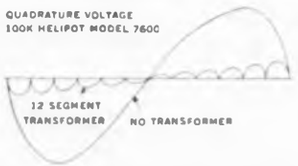
YOU'LL WANT THE ANSWERS TO THESE 5 QUESTIONS...

1. WHAT IS AN AC POTENTIOMETER?

Simply stated, a pot that's specifically designed for AC-excited circuits. It differs from ordinary wirewound pots in that quadrature effects are eliminated without the addition of elaborate compensating networks. At the same time, it provides lower output impedance, and improves linearity and reliability.

2. HOW DO AC POTS ELIMINATE QUADRATURE ERROR?

Helipot combines a multi-tapped pot with a multi-tapped autotransform-



er. The voltage existing at each pot tap point is determined by the reference voltage at the corresponding autotransformer tap. The pot resistance element is divided into a series of independent low-resistance elements–hence a reduction in quadrature.

The figure shown plots quadrature error against rotation. It illustrates the difference in phase shift between ordinary wire-wound pots and a Helipot AC unit with 12-segment autotransformer. You'll note that quadrature error is at its maximum near the midpoint between taps and is nearly zero at tap points. The result: negligible quadrature error and phase shift.

3. HOW ARE INPUT AND OUTPUT IMPEDANCE AFFECTED?

Input impedance remains high. Under AC applications, total pot resistance is paralleled by the AC impedance of the autotransformer. Since this impedance is 10 to 100 times greater than that of the pot, the addition of an autotransformer has a negligible effect on the input impedance.

Output impedance is much lower. The addition of an autotransformer to the basic pot results in a maximum output impedance occurring midway between each set of adjacent taps. It follows that total output impedance is greatly reduced–any energy required by the load is fed from the nearest auto-transformer tap.

4. HOW DOES THE AC POT IMPROVE LINEARITY?

The overall linearity of AC pots is dependent on the linearity of pot sections between taps–not total pot linearity.

An important feature of autotransformer application is the ability to easily adjust the voltage appearing at each pot tap – without affecting the voltage ratio at any other tap. It is therefore possible to pull all tap points into the desired linearity band, regardless of basic pot linearity.

Another AC pot feature: It is capable of truly zero electrical "end coil."

5. ARE AC POTS MORE RELIABLE THAN BASIC POTS?

Yes–much more so. That's because a pot winding or tap lead going open affects only that portion of the pot between taps adjacent to the open. Even the opening of CW or CCW terminals has no effect beyond the adjacent tap point. Or, simply stated – the more taps, the greater the inherent reliability. Models with up to 28 taps are available as special from Helipot.

Helipot offers two AC pot series and 26 standard models with frequency ranges from 20 to 20,000 cps. Choose your linear or non-linear version of either the 3" diameter single turn Series 5800 or the 2" diameter multiturn Series 7800. They're precision-built by Helipot to meet unusual conformities and perform in most any desired function.

Any more questions? Detailed specs and additional product information are included in a new 32-page potentiometer catalog. To get a copy, call your nearest Helipot Sales Engineering Representative...or write direct:

Beckman

INSTRUMENTS, INC.

HELIPOT DIVISION

Fullerton, Calif.

POTS : MOTORS : METERS

CIRCLE 63 ON READER-SERVICE CARD

Linear Accelerometer 356

Output of at least 1 v full scale is provided by the series AL linear accelerometers. Range is ±1 to ±20 g. Repeatability is within 0.1% of full scale. Temperature effects are less than 1% over 100 F between −65 and +250 F. Unit with self-contained calibration measures 2-1/2 x 1-1/2 x 2 in. and weighs 5 oz; another unit with external calibration is slightly smaller.

Kulite-Bytrex Corp., Dept. ED, 50 Hunt St., Newton, Mass.

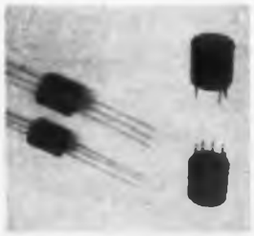
P&A: *$320 and $345; 30 days.*

Miniature Plug 352

Crimp, snap-in contacts are provided on the Mark 2 miniature plug. Part of the firm's KM series, the plug exceeds MIL-C-25955 specifications. The device offers through-grommet insertion and extraction of contacts.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 13, Calif.

Blocking Oscillator Transformers 353



Pulses of 8 μsec are produced by these miniature units. They consist of a blocking oscillator, coupling, and wide-band transformer. Devices plug into printed circuit boards, or can be wired into terminal boards. Mil specs are met. Transformers have 1 to 1, 2 to 1, and 3 to 1 ratios. Bodies measure 7/16 in. OD x 1/2 in. long and 5/8 in. OD x 5/8 in. long.

Forbes and Wagner, Inc., Dept. ED, 345 Central Ave., Silver Creek, N. Y.

NEW PRODUCTS

Semiconductor Load Cells 355

Range is ±500 to ±2,000 lb. on the SC-series semiconductor load cells. Deflection is 0.003 in. max at capacity load. Output is ±1 v full scale, with actual sensitivity of individual transducer reported to within ±0.5%. Operating temperature is −65 to +250 F.

Kulite-Bytrex Corp., Dept. ED, 50 Hunt St., Newton 58, Mass.

***P&A:** $375; 30 days.*

Switches and Keys 365

Assembled to customer's requirements from stocked parts, this line of switches and keys includes lever switches, telephone keys, turn keys, push-turn keys, and push-button banks. Contacts rated up to 10 amp, 1,250 w are available. Push-button bank can be lit or unlit. Push-turn keys meet Mil specs. Telephone keys have 1-kv breakdown voltages.

Universal Circuit Controls, Dept. ED, 3610 Oakton St., Skokie, Ill.

Pressure Transducer 371

Miniaturized differential transformer pressure transducers are for measuring pressure of high temperature liquid metals. Smallest probe size has a sensing end diameter of 0.230 in. to fit a 0.250-in. ID well at an operating temperature of 300 C.

Precision Research Inc., Dept. ED, 43 Westover Lane, Stamford, Conn.

Now you can *standardize* and really *cut costs* with

Amperex®

P·A·D·T

Industrial and Entertainment Transistors

CALIFORNIA
R. V. WEATHERFORD COMPANY
Glendale 1, Calif.
BRILL SEMICONDUCTOR CORP.
Oakland 6, Calif.
ELMAR ELECTRONICS INC.
Oakland 7, Calif.

COLORADO
INTERSTATE RADIO & SUPPLY
Denver 4, Colorado

CONNECTICUT
RADIO SHACK CORP.
Stamford, Conn.
W. Hartford, Conn.
New Haven 10, Conn.

DISTRICT OF COLUMBIA
ELECTRONIC WHOLESALERS, INC.
Washington 1, D. C.

FLORIDA
THUROW ELECTRONICS, INC.
Cocoa, Fla. • Jacksonville, Fla.
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Pensacola, Fla. • Tampa, Fla.

ILLINOIS
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Chicago, Ill.

INDIANA
RADIO DISTRIBUTING COMPANY
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MASSACHUSETTS
RADIO SHACK CORP.
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ROME ELECTRONICS
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OREGON
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RADIO ELECTRIC SERVICE CO.
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TEXAS
ADLETA COMPANY
Dallas 1, Texas
Fort Worth, Texas

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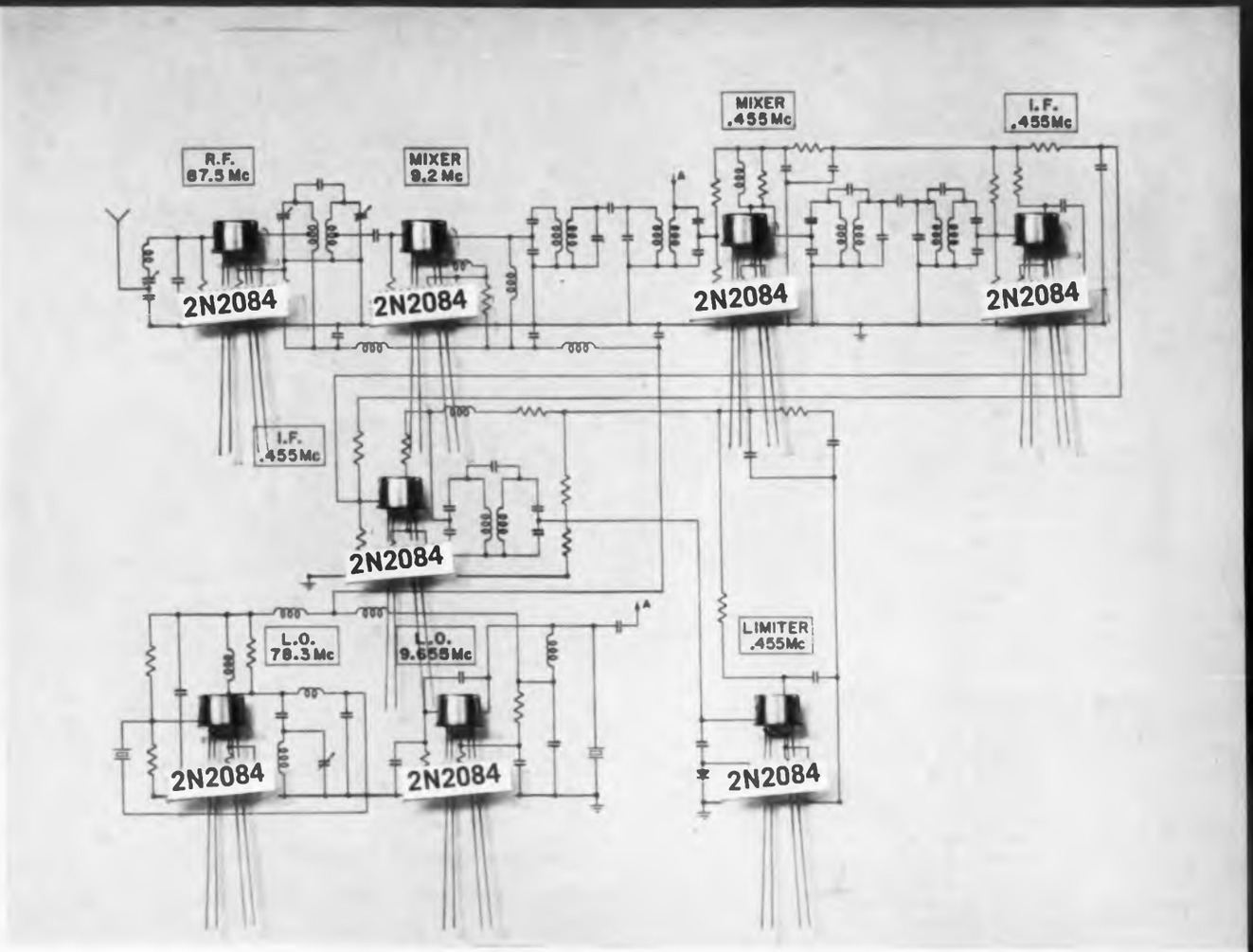
CIRCLE 67 ON READER-SERVICE CARD ➤



Now you can standardize and really cut costs with the

NEW Amperex® 2N2084

the industry's closest approach to the 'universal communications transistor'

Combining the best features—high voltage, high beta and high frequency—of many specialized front end and IF types, this new PADT germanium-alloy-mesa transistor will obsolete and replace such types* as 2N1224, 2N1225, 2N1226, 2N1395, 2N1396 and 2N1397 for HF and and VHF mobile, aircraft and radar applications.

Cuts costs 3 ways

Amperex advanced design—plus the high yields characteristic of the PADT process—now provides to the industrial equipment manufacturer *a single communications transistor* with an unrivaled combination of application flexibility, high quality and low price. The long-sought degree of universality offered by the new Amperex 2N2084 results in—

1. **Lower procurement costs:** only one type to order—with a better price break through volume purchasing.
2. **Lower designing costs:** only one type to specify—because of the wide range of desirable characteristics.
3. **Lower inventory costs:** only one type to stock—simplifies inventory control and disbursement.

It's as simple as that!

TYPE 2N2084
SPECIFICATIONS AND FEATURES

Gain Bandwidth Product	$f_T = 100$ mc
Typical Beta	$h_{FE} = 140$
Breakdown Voltage	$BV_{CBO} = 40$ V
Typical Power Gain	14 db (at 100 mc)
	27 db (at 30 mc)
Output Capacitance	$C_{ob} = 2$ μμf
Case	JEDEC TO-33

for complete data and applications information on the 2N2084 and other transistors in standard TO-33 envelopes

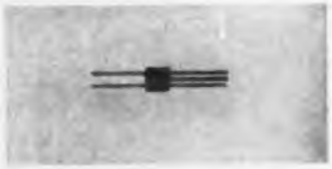
*Currently available for immediate delivery

AMPEREX ELECTRONIC CORPORATION
230 Duffy Avenue, Hicksville, Long Island, N. Y.

In Canada:
Philips Electronics Industries, Ltd., Tube, Semiconductor & Component Depts., 116 Vanderhoof Ave., Toronto 17, Ont.

NEW PRODUCTS

Miniature Chopper 460



With ±20 μv to ±20 v dynamic range and chopping rate from dc to 100 kc. Model 6 miniature chopper, called the Microchopper, alternately connects and disconnects a load from a signal source. It may also be used as a synchronous demodulator to convert ac signals to dc. Gold-plated Kovar leads are used.

Solid State Electronics Co., Dept. ED, 15321 Rayen St., Sepulveda, Calif.

Pressure Transducer 399

Models P and L miniaturized differential transformer pressure transducers are for use in systems where space, weight and temperature are problems. Model P has a body diameter of .650 in., and a body length of 1.65 in.; model L has a body diameter of .750 in. and a body length of 1.75 in. Both are sensitive to diaphragm movements of less than .005 in.

Precision Research, Inc., Dept. ED, P. O. Box 434, Stamford, Conn.

Price: $190 and up.

Test Chamber 456

Temperature-humidity test chamber model TMTH0200 is designed for MIL-E-5272C, MIL-STD-202B and MIL-STD-170 testing. It provides temperatures from 0 to 200 F and relative humidity from 20% to 95% in the dry-bulb range, limited by a dew point of +35 to +185 deg. Capacity is 5.1 cu ft.

Tenney Engineering, Inc., Dept. ED, 1090 Springfield Road, Union, N. J.

TYPE LF
relay shown (cover removed) is the 2-coil design which controls the entire latching operation within the relay. Shown twice actual size.

2-Coil Circuit Diagram

1-Coil Circuit Diagram

PHYSICAL FEATURES

Life Expectancy
Wet Circuit:
3.0 amperes, 28VDC resistive—100,000 operations
2.0 amperes, 28VDC resistive—250,000 operations
1.0 ampere, 28VDC resistive—1,000,000 operations
1.0 ampere, 28VDC inductive (100 millihenry)—100,000 operations
1.0 ampere, 115 VAC resistive—100,000 operations
Dry Circuit:
1,000,000 miss free operations when subject to conventional dry circuit requirements.

Temperature—+125° C to −65° C

Shock—100g's for 1/2 sine wave 11 ± 1 MS pulse

Linear Acceleration—100g's minimum

Vibration—.250" DA or 30 g's, 5-2000 cps.

Humidity & Salt Spray—MIL-R-5757D

Enclosures: Tinned brass cover with fungus-resistant finish. Hermetically sealed and filled with dry nitrogen at atmospheric pressure.

Contact Arrangement—2PDT latching

Terminals—Plug-in (3/16" straight), solder hook, 3" straight

Wiring—Two coils (as shown on drawing above)
One coil (as shown on drawing above)

Weights—.54 oz. for plug-in
.62 oz. for 2 studs, 3" leads

ELECTRICAL FEATURES

Operate Time—Two coil: When applying—for a minimum of 5 milliseconds—a voltage of at least two times the must operate voltage, the operate time including bounce will not exceed 5 milliseconds. One Coil: operate time will not exceed 8 milliseconds.

Sensitivity—Two coil, approximately 150 milliwatts
One coil, approximately 75 milliwatts

Dielectric Strength
Sea level: 1000 volts rms—all terminals to case
1000 volts rms—between contact sets
600 volts rms—between open contacts of a set
70,000 ft: 350 volts rms—all terminals to case

Insulation Resistance—1000 megohms minimum at +125° C between any two terminals and between all terminals and case.

Maximum Interelectrode Capacitance—
Closed contacts to case.....3.7 picofarads
Open contacts to case.....2.0 picofarads
Between contacts of a set.....2.0 picofarads
Between adjacent contact sets.....3.5 picofarads

Maximum Coil Dissipation
Two Coil: .50 watts at +125° C
.75 watts at +25° C
One Coil: 1.25 watts at +125° C
2.0 watts at +25° C

Standard Adjustment—Relay will operate and hold when the must operate voltage is applied

Contact Resistance:
Maximum: 50 milliohms at 6 volts, 100 milliamperes.
Typical: 25 milliohms at 6 volts, 100 milliamperes.

For coil and mounting data on CLARE Type LF relay send for CPC-12. Address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ontario. Cable Address: CLARELAY.

C. P. CLARE & CO. *Relays and related control components*

Multiplexer 458

Low-level multiplexer model LL-1 features individual gain and zero adjustments for each channel. It accepts transducer outputs at as low as ±5 mv and produces an output of ±4 v, full scale. Input impedance is greater than 100 K; common mode rejection is better than 10^6 at 60 cps with 120-ohm, unbalanced input. It has up to 48 channels.

Systems Engineering Laboratories, Inc., Dept. ED, P. O. Box 9148, Fort Lauderdale, Fla.

Epoxy Paper Base Laminates 396

Grades EP-800 and EP-800-T are designed for printed circuit and terminal board applications. Initial bond strengths have an average minimum of 14 lb per in. for 2 oz copper cladding, and 11 lb per in. for 1 oz copper cladding. Available in sheet sizes 18 x 36, 20 x 36, and 21 x 36 in.

The Mica Corp., Dept. ED, 4031 Elenda St., Culver City, Calif.

Aircraft Heater 455

Blower-type, electric, aircraft heater weighs slightly over 1 lb and can be used as a combination passenger compartment heater and window defroster. It operates on 12 v dc at 30 amp; other models can be furnished for special applications. Film-type ceramic heating element does not glow and is controlled by selector switch.

Therm-O-Lab Corp., Dept. ED, 6940 Farmdale Ave., North Hollywood, Calif.

◀ CIRCLE 68 ON READER-SERVICE CARD

NEW PRODUCTS

Transistorized Power Supply 360

Case has aluminum extrusions to provide for heat radiation from the series SC transistorized power supplies. With ratings up to 40 v, 1.5 amp, units measure 6-9/16 x 6-15/16 x 4-1/16 in. Line and load voltage regulation are within 0.05%; ripple is less than 1 mv rms. Unit operates in 50 C ambient temperature with forced air flow of 300 ft per min. Waterproof models are available.

Mid-Eastern Electronics Inc., Dept. ED, 32 Commerce St., Springfield, N. J.

***P&A:** $149; from stock.*

Voice-Interference Analyzer 624

Intelligibility of any type of voice communication system can be measured by the voice-interference analyzer. Test time is about 30 sec. A sub-unit generates a triangularly modulated tone at the input of the communication channel. The tone is fed into the analyzer and the resulting signal is divided into 14 frequency bands which are logarithmically summed and digitally read out.

General Electronics Laboratories, Inc., Dept. ED, 18 Ames St., Cambridge, Mass.

Inductor Lines 369

Microminiature inductor lines are offered in two types: the 03 series has a range of 10 μh to 100 mh and provides the same electrical performance as series 22 and 30; the 04 series has a range of 1 mh to 1 h and is similar to series 14 and 19. Both have Dura Clad packages and meet the environmental requirements of MIL-C-15305A, Grade 1, Class B.

Aladdin Electronics, Dept. ED, 703 Murfreesboro Road, Nashville 10, Tenn.

***Availability:** samples, 2 weeks; quantities, 3 to 4 weeks.*

Test Equipment 625

Airborne TACAN navigation systems can be tested on the bench or in the cockpit with this line of test equipment. Seven models comprise the line, including a portable ramp test unit, beacon simulator, azimuth error analyzer, peak power calibrator and instrument and power panels.

Hoffman Electronics Corp., Dept. ED, 3761 S. Hill St., Los Angeles, Calif.

400-cps Converter 358

Frequency stability of ±0.25% is provided by this converter. Output is 400 cps sine-wave, stable over inputs from 47 to 1,000 cps, regulated to 1% with input variations from 105 to 130 v. Output is 100 va max, adjustable from 105 to 130 v. Unit is all solid-state.

Magnetic Research Corp., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.

VHF-UHF Transistors 370

Low-noise characteristics are exhibited by these vhf-uhf madt transistors. Transistor type T2028 is an rf amplifier for 200 mc operation. Type T2029 is a mixer for 45 to 200 mc operation. Type T2030 is an oscillator for use at 250 mc. Uses are in military communications equipment, mobile radios and transistorized TV.

Philco Corp., Lansdale Div., Dept. ED, Lansdale, Pa.

P&A: *$1.93 to $2.48 each, 100-999; immediate.*

NEW PRODUCTS

Power Source 593

Powered by a lightweight, air-cooled diesel engine, this prime power source delivers all voltages normally associated with electronic equipment: 28.5 v dc; 120 v, 400 cps; 120/208 v 60 cps. It can deliver 4 kw dc, 6 kw 400 cps, 6 kw of 60 cps or any combination of the voltages, not exceeding a total of 7-1/2 kw.

Consolidated Diesel Electric Corp., Dept. ED, 880 Canal St., Stamford, Conn.

Single Shot Multivibrators 517

Four independent sections are provided, each of which operates over the range of 5 μsec minimum to several full sec maximum. Designated type 4AS-P, the multivibrator cards are designed for general purpose time delay and time interval applications where the exact time of the interval or delay must be known and must be adjustable.

Ransom Research, Inc., Dept. ED, 374 W. Eight Street, San Pedro, Calif.

Subminiature Counters 577

Input speed is 5,000 rpm maximum for the counters models 1005 and 1006. Model 1005 has a 200 to 1 gear reduction so that 20 revolutions of the input shaft equals 1 count on the units drum. Size is 7/16 x 5/8 x 29/64 in. high. Model 1006 is 7/16 x 15/32 x 29/64 in. high. Frames are anodized aluminum. Shafts are stainless steel.

The Haydon Instrument Co., Dept. ED, 17 Brown St., Waterbury 20, Conn.

***Price:** $44 for model 1006.*

Wrapper Insulation 438

Grade 5J42 epoxy-varnished Dacron sheets are thin and tough, with a uniform thickness that assures freedom from voids. Thin gauges of .0025 and .0055 in. save space and weight. Excellent crease and cuffing properties. In 36 in. wide rolls 25, 50 and 100 yd long. Tape widths in 36- and 72-yd rolls.

Westinghouse Electric Corp., Dept. ED, Micarta Div., Tafford, Pa.

Recorder/Reproducer 401

Model FR-100C is used in industry, medicine, scientific, military and other applications where highly accurate data storage and recovery are needed. The FR-100C system records in direct fm, pdm, or pcm modes. Features all new solid-state signal electronics.

Ampex Corp., Dept. ED, Box 5001, Redwood City, Calif.

Time Delay Control 435

Thermo-Electric control for magnetic amplifier circuits is also for use in flip-flop gating circuits in computers and analyzers. Independent of ambient temperatures to 350 F. Unaffected by external radiation and random noise. Typical control is 2 in. long and 5/16 in. in diam. Mounted in potted epoxy resin.

The Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

CIRCLE 74 ON READER-SERVICE CARD

NEW PRODUCTS

Industrial Servovalves 514

Flow ratings of 1 to 15 gallons per min are available at 1,000 psi pressure drop and maximum signal. Units are pilot operated, closed center, four-way sliding spool valves. Servovalves are used for such applications as numerical and tracer control on machine tools, printing press, radar drive controls, and submarine motion simulation systems.

Moog Servocontrols, Inc., Industrial Div., Dept. ED, P. O. Box 8, East Aurora, N. Y.

DC Relay 505

Rated at 1.3 w, pull-in power. Model SR dc relay has a contact rating of 2 amp at 28 v dc, resistive. Contact arrangement is dpdt. Dielectric strength is 1,500 v rms between open contacts, coils and contacts, contact and case; 0.5 v rms between coil and case.

Comar Electric Co., Dept. ED, 3349 W. Addison St., Chicago 18, Ill.

Power Converter 578

Efficiency is greater than 75% for the power converter model DPC-113. Unit is suited for applications where the power source is a thermoelectric generator, fuel cell or low voltage battery. For 10 w input, the converter is 3 x 2-15/16 x 2-9/16 in. deep. Unit weighs 1-3/4 lb.

The Hoover Co., Electronics Div., Dept. ED, P. O. Box 181, Baltimore 3, Md.

PROTECTION IS BUILT INTO TUCOR NOISE SOURCES

One problem faced by the designer of modern high power radar is how to couple sufficient noise power into the antenna line to provide good performance monitoring without "burning up" the tube with incident power. Tucor has solved this problem by designing special TR tubes into their noise source mounts so as to protect the noise tube. This is one reason why Tucor noise sources are unique in the microwave field where quality is critical yet the package must be compact, rugged and able to withstand the stiffest military conditions.

As for the range of these high noise output tubes, the tabulation below gives some idea of the wide variety of Tucor noise sources that are available from stock. Thirty-two noise sources currently in production are listed in our catalogue. Ask for it.

Band	*Type*	*Freq. KMC*	*Noise DB*
VHF	T44V1D	0.2-0.4	18.5
UHF	T44U1D	0.4-1.0	18.5
L	T44L1D	1.0-2.0	18.5
S	T44S11D	1.0-4.0	18.5
C	T44C1A	5.3-6.0	18.5
H	T44H1A	7.5-8.6	18.5
X	T44X7B	8.2-12.4	18.5
K	T44K1B	12.4-18.0	18.4
P	T44P1B	18.0-26.0	18.0
Q	T44Q1B	26.0-40.0	18.5

TUCOR INC.

59 Danbury Road (Route 7), Wilton, Connecticut

CIRCLE 77 ON READER-SERVICE CARD

Pocket DC Potentiometer 361

An infinite-impedance calibrator and measuring instrument, the model PC miniature dc potentiometer has a self-contained reference source, a galvanometer, and direct readout. Accuracy is 0.05% of reading or 0.5 mv, whichever is greater. Resolution is 0.01 v. Range is 0.01 to 5.09 v; a plug-in unit, model PC-1, extends the range to 5 to 500 v, 0.5 to 500 ma. Each unit measures 9 x 4-1/4 x 1-3/4 in.

Sensitive Research Instrument Corp., Dept. ED, 310 Main St., New Rochelle, N. Y.

P&A: *model PC, $325, PC-1, $125; from stock.*

Universal Transistor 379

Silicon transistor performs the jobs of 40% of the 2,000 transistor types now available. Collector-to-base voltage is 120 v max; collector-to-emitter voltage with base open is 65 v max; collector current is 1 amp max. Dissipation at case temperature of 25 C is 5 w max. Temperature range is −65 to 200 C. Designation is type 2N2102.

Radio Corp. of America, Dept. ED, 30 Rockefeller Plaza, New York 20, N. Y.

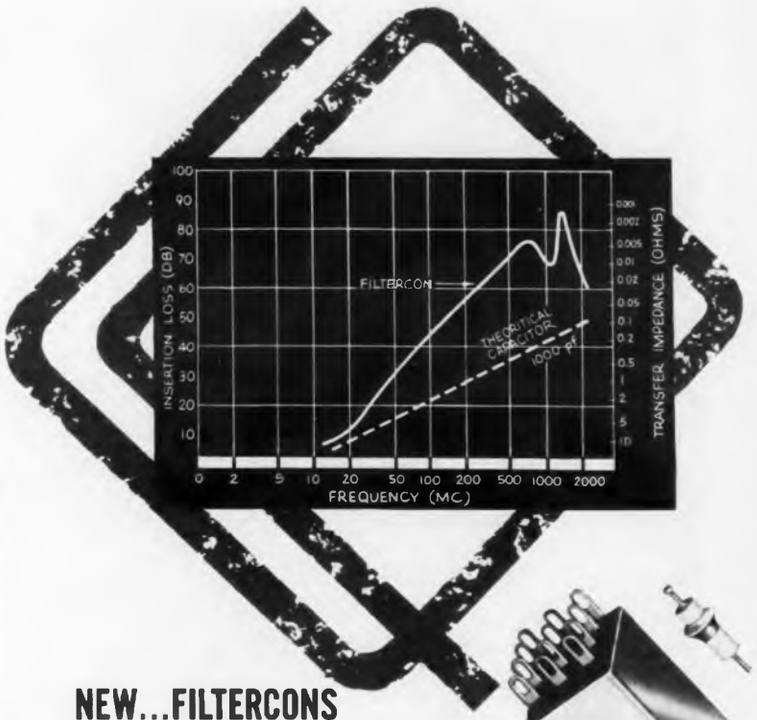
Price: *about $12.*

Digital Module Tester 592

Model DH-65 digital module tester is for fast checkout and trouble-shooting of the firms plug-in flip-flops, monostables, etc. The unit provides appropriate inputs for completely monitoring the operation of over 15 modules. External signals can be introduced and all inputs can be externally monitored.

Cubic Corp., Dept. ED, San Diego 11, Calif.

Price: *$3,150.*



NEW...FILTERCONS by ERIE for highest attenuation in the 100 MC to 2000 MC range

Erie's new line of three-terminal, high-frequency, low-pass filters is ideal for the UHF range from 100 MC to 2000 MC.

The graph above shows the superiority in transfer impedance of Erie FILTERCONS compared with a theoretical 1000pf capacitor when measured in accordance with MIL-STD-220A. Note that at 500 MC, the transfer impedance of a FILTERCON is below 0.01 ohm as compared to the theoretical impedance of 0.35 ohm. Effective filtering continues well above 1000 MC.

FILTERCONS by Erie are designed around Erie-developed flat-temperature characteristic Hi-K ceramic dielectrics and temperature-stable ferrites which produce minimum change in filtering effect due to temperature.

FILTERCONS are available in the following models in temperature ranges up to 125°C:

ERIE STYLE	DESCRIPTION	MINIMUM ATTENUATION	WORKING VOLTAGE	LOW FREQUENCY CAPACITANCE
1201 1203	Small bushing mount Small eyelet mount	45 db from 200 MC to 2000 MC	200VDC	1000pf
1202 1204	Large bushing mount Large eyelet mount	50 db from 100 MC to 2000 MC	500VDC	2000pf
1206 1212	Six section Twelve section	50 db from 100 MC to 2000 MC	350VDC	5000pf

FILTERCONS by Erie are available in quantities of less than 1000 pieces from leading electronic distributors.

Write for Bulletin 512 for complete information.

ERIE ELECTRONICS DIVISION
ERIE RESISTOR CORPORATION
645 West 12th Street • Erie 6, Pennsylvania
Sales offices in principal cities of USA, Canada, Europe

CIRCLE 78 ON READER-SERVICE CARD

NEW PRODUCTS

Self-Clinching Standoff 651

Lengths from 1/2 to 2 in. are available for this insulated self-clinching standoff. Unit has a self-locking feature for the attaching screw. Thread size is 6-32. Aluminum types may be mounted in materials having a Rockwell hardness of B-50 or less; steel and stainless steel types, B-70 or less. Unit is made of Du Pont Delrin.

Spyraflo, Inc., Dept. ED, Miami 64, Fla.

Reed-Type Relay 359

Operate and release times of 1 msec, not incluing bounce, are provided by the model 103 Magnereed reed-type relay. The device has spdt gold contacts, and is hermetically sealed in a glass capsule. Contacts are rated 10 w resistive load, 1 amp or 250 v ac max. Operating current ranges from 4.6 to 32 ma. Units measure 3-1/2 in. long and 1/2 in. in diameter.

Magnecraft Electric Co., Dept. ED, 335 W. Grand Ave., Chicago 51, Ill.

P&A: *$7.80 to $9.96; from stock.*

Microminiature Plugs 367

Made to hold 32 diodes, these microminiature plugs, called Microplugs, are 0.395 in. deep, excluding terminations. Pin contacts are twisted wire; they are self-aligning and individually shrouded in the insulator. Pins are set at 0.05-in. centers. A space 2-3/4 x 3-1/4 in. can hold 32 plugs.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.

AC/DC Transfer Standard 363

With resolution of 0.005%, the model FLH ac/dc transfer standard is a portable instrument for measuring precision dc potentiometers and ac voltages. Maximum frequency influence at 50 kc is ±0.05%. National Bureau of Standards correction figures certified 0.01% accurate are furnished. Ranges from 1.5 to 750 v are provided; unit may be used for measurements up to 1,125 v. Sensitivity is 100 ohms per v.

Sensitive Research Instrument Corp., Dept. ED, 310 Main St., New Rochelle, N. Y.
P&A: $1,685; 90 days.

Delay Network 368

Unitized. The use of a standard printed-circuit system allows maximum dimensional flexibility in this delay network. The delay per unit volume is reduced to about half that of conventional networks. Delay, impedance and rise time are furnished to specification. The network is encapsulated or housed in a metal enclosure.

Electro-Time, Inc., Dept. ED, 6 Bridge St., Concord, N. H.

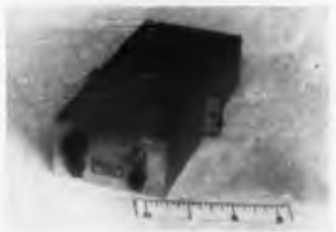
Standby Gyro 597

A 2-in. vertical gyro standby instrument is designed to support larger indicators normally used to indicate plane attitude. The gyro rotor is the size of a golf ball, considerably smaller, it is claimed, than gyros heretofore used for this purpose. Operational characteristics identical to the larger indicators are obtained.

Guidance Technology, Inc., Dept. ED, 2500 Broadway, Santa Monica, Calif.

NEW PRODUCTS

Wide-Band DC Amplifier 354



Flat from dc to 10 kc within 2%, and within 1% to 5 kc, this wideband dc amplifier is designated model AP-100. Output is ±2.5 v for 20% to 100% of rated pressure over five ranges. Input is ±20 v dc. Unit measures 1-1/2 x 2-3/4 x 6-7/8 in. and weighs 20 oz. A power supply, model PS-100, operating from 24 to 30 v, has the same dimensions and is capable of driving five amplifiers.

Bytrex Corp., Dept. ED, 50 Hunt St., Newton 58, Mass.
P&A: *$680; 30 days.*

Switching Diodes 378

Multiple silicon switching diodes are housed in a package the size of a match head. The units consist of two or three ultra-high-speed silicon diodes with common cathode connection. Reverse breakdown voltage is −40 v; reverse recovery time is 2 nsec typical; dissipation is 70 mw, max.

Radio Corp. of America, Semiconductor & Materials Div., Dept. ED, 30 Rockefeller Plaza, New York 20, N. Y.

Switching-Balancing Unit 476

For bridge balancing and switching of strain gages or gage configurations into a strain indicator. Type 525 10-channel switching and balancing unit has a sensitivity of 60 to 500 ohms for gage resistances on full bridge, 60 to 2,000 ohms on half bridge. Measurements can be made during the same test with both two and four-arm bridges.

Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div., Dept. ED, 42 Fourth Ave., Waltham 54, Mass.

Time-Delay Relays 351

For industrial applications, **delays are 100 μsec to 300 sec,** fixed or adjustable. Plug-in time-delay relays are designed to withstand temperatures from −55 to +85 C, altitudes to 15,000 ft, shock to 10 *g* for 11 msec and vibration to 5 *g* from 5 to 500 cps (non-operating). They are double throw with 1, 2 or 3 poles; contact currents are 1 to 10 amp.

Accutronics, Inc., Dept. ED, 403 N. Foothill Road, Beverly Hills, Calif.
P&A: *$29; stock to 1 week.*

Printed-Circuit Plugs 366

MIL-C-21097 specifications are met by the PBA-series printed-circuit plugs. Grids from 0.054 to 0.071 are accommodated. Contacts, gold plated, are bellows-bifurcated. Terminals accommodate three AWG-No. 20 wires. Current rating is 5 amp. Flashover rating is 2,500 v, 60 cps.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31, Calif.

Disk Capacitors 576

Capacities from 0.005 to 0.1 mfd, ±20% of disk capacitors type CK are available. Working voltage is 50 v dc. Initial leakage resistance is over 7,500 meg, while leakage resistance after humidity testing is over 1,000 meg. Power factor is 2% maximum at 1 kc. Thickness of the units is 5/32 in.; diameters range from 3/8 to 5/8 in.

Centralab, Div. of Globe-Union Inc., Dept. ED, 900A E. Keefe Ave., Milwaukee 1, Wis.
Price: *from less than one cent to $0.60 ea.*

NEW PRODUCTS

Control Switches 509

With grounded outlet. Control switches designed for snap-in panel mounting and simple wiring, are for appliance and utility applications. One switch can be used for fluorescent-light control and the other as a dummy or control of another circuit. Rating is 2 amp at 115 v ac for switch, 15 amp at 115 v ac for outlet.

Molex Products Corp., Dept. ED, 9515 Southview Ave., Brookfield, Ill.

Buffer Amplifier 504

For use at 100 to 20,000 cps, model 863 12-channel buffer amplifier distributes a locally generated am time-code signal over a land-line distribution system to remote instrumentation. Each channel has a high-impedance input and a balanced, low-impedance output. The unit is for ac use.

Electronic Engineering Co. of Calif., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif. ***P&A:*** *$1,975; 60 to 90 days.*

Power Supplies 491

Provide 3 to 20 amp. The SH series power supplies have voltage outputs of 0 to 8 up to 0 to 100 v and are remotely programable over their entire ranges. Regulation is 0.01%, noise and ripple are less than 1 mv rms, recovery time is 50 μsec max and temperature coefficient is less than 0.01% per deg C.

Deltron Inc., Dept. ED, 4th and Cambria Sts., Philadelphia 33, Pa.
Price: *$310 to $796.*

CIRCLE 88 ON READER-SERVICE CARD ➤

Frequency Standard Receiver 516

For frequency standard calibration the system model 18-20/A is a combination TRF receiver, synthesizer and phase comparator. System determines the error in the frequency of a local 100 kc standard by comparison with the standard national signals of NBA, 18 kc or WWVL, 20 kc. Receiver is fully transistorized.

RMS Engineering, Inc., Dept. ED, P. O. Box 6354, Station H, Atlanta 8, Ga.

***P&A:** $2385; 4 to 8 weeks.*

Transfer Switch 495

Low-voltage transfer switch, designated the Ther-Monic C series, enables a single-position generator to be used in two-position operation. There is little or no drop-off when the switch is used with most work coils. It has wiping contacts. Standard types have front-angle connections; right-angle connections can also be supplied.

Induction Heating Corp., Dept. ED, 181 Wythe Ave., Brooklyn, N. Y.

AC/DC Volt-Ammeter 362

Providing 51 ranges, the model UX ac/dc polyranger makes full-scale voltage measurements from 5 mv to 1 kv and current measurements from 0.2 ma to 5 amp. Unit is accurate to 0.5%. Sensitivity, dc, is 5,000 ohms per v, ac, 100 ohms per v.

Sensitive Research Instrument Corp., Dept. ED, 310 Main St., New Rochelle, N. Y.

***P&A:** $895; 60 days.*

◄ CIRCLE 88 ON READER-SERVICE CARD

NEW PRODUCTS

AC and DC Motors 652

Fractional horsepower motors are available in sizes 12 and 15, in both ac and dc types. Ac motors are available in all types; dc configurations include permanent magnet types as well as series or shunt. Motors may be supplied with options such as brake, noise filter, gear box, etc.

Transco Products, Inc., Dept. ED, 12210 Nebraska Ave., Los Angeles 25, Calif.

Regulated Power Supplies 640

Regulation is 0.01% for the regulated power supplies series CM. Ripple is 1 mv rms. Recovery time is 25 μsec, up to 300 w. Six models are available in three output voltage ranges: 0 to 18 v dc at 8 and 12 amp; 0 to 36 v dc at 3, 5 and 8 amp; 0 to 60 v dc at 5 amp.

PRL Electronics, Inc., Dept. ED, 232 Westcott Drive, Rahway, N. J.

***P&A:** $335 to $645; from stock.*

Germanium Diodes 642

Fifty-four diode quads designed as bridge rectifiers, ring modulators, voltage multipliers or series strings are now available. Units are germanium quads consisting of four matched, hermetically sealed gold-bonded diodes. Devices have a 1%, 2.5% and 5% degree of forward match at 4 ma. PIV rating is 35, 75 or 100 v.

Raytheon Co., Semiconductor Div., Dept. ED, 150 California St., Newton, Mass.

Hermetic Seals 634

For space and missile applications, high-temperature Teflon-to-Teflon and Teflon-to-wire hermetic seals are offered under the name of Tri-Point Hermiflon Teflon seals. The seals are said to have better electrical characteristics than existing methods and to afford improved reliability for the critical and use requirements.

Tri-Point Industries, Inc., Dept. ED, 175 I.U. Willets Road, Albertson, N. Y.

Transistor Tester 382

Beta range is 2 to 999 for transistor test set type 840-1, Accuracy is ±2% or 1 digit, for both npn and pnp transistors. Unit is easily programed by setting collector current and voltage on direct reading decade panel controls. Tester can be programed for collector currents from 1 μa to 1 amp and voltages from 1 to 29 v.

Fairchild Semiconductor, Dept. ED, 545 Whisman Road, Mountain View, Calif.

Price: $4,975.

Servo/Rate Turntable 384

Air bearing servo/rate turntable model T900 is for a wide range of laboratory and production tests on inertial systems and related components. Inertial grade gyros with drift rates of the order of 0.001 deg per hr can be quickly checked. Freedom about the tilt axis is ±190 deg.

Dunn Engineering Corp., Dept. ED, 225 O'Brien Highway, Cambridge 41, Mass.

Data System 707

Speeds to 75 characters per sec are possible with data set model 402. Units enable tape code to be read and transmitted in parallel over regular telephone facilities. Data sending set is designated 402A, the receiving set 402B.

Bell Telephone System, Dept. ED, New York, N. Y.

NEW PRODUCTS

Power-Line Monitor 632

Continuous response to fluctuations and changes in power-line voltage is given by this test unit, model WV-120A. The device offers an expanded scale from 100 to 140 v. It has a ±2 per cent accuracy reading at 120 v; ±3 per cent at 100 and 140 v. A moving-vane type meter indicates true rms values even when line-voltage is not pure sine wave.

Radio Corp. of America, Dept. ED, 30 Rockefeller Plaza, New York 20, N. Y.
Price: *$14.95.*

Gage Pressure Cells 375

Miniature gage pressure cells, HF-series, have pressure ranges from 5 to 500 psig. Output is 100 mv full-scale, individually calibrated to 1/2%. Units measure 0.625 to 1.125 in. in diameter. Operating temperature range is −65 to +350 F. Devices withstand shock of 1,000 g.

Kulite-Bytrex Corp., Dept. ED, 50 Hunt St., Newton, Mass.

Mica Capacitors 383

Rating is 500 wvdc over a temperature range of −55 to +200 C for Gold Seal mica capacitors. Units are available in ranges from 15 to 2,500 pf. Tolerances available are ±2% or ±1 pf, ±5%, ±10% and ±20%. Stand-off and feed-through styles are made.

Erie Resistor Corp. Dept. ED, Erie, Pa.

DC Power Supply 502

Output is 50 to 5,000 v at 0 to 20 ma. Model HSV-5-20 dc power supply has a stability of ±0.005% per hr and ±0.02% for an 8-hr period. Ripple is 5 mv max, peak-to-peak; static regulation is 0.01% for no-load to full-load and 0.01% max for line changes of 105 to 125 v ac.

NJE Corp., Dept. ED, 20 Boright Ave., Kenilworth, N. J.
Price: *$690.*

24 HOUR DELIVERY

CANNON PLUGS

KIMBALL can give you 24-hour delivery!

KIMBALL'S * CANNON authorized assembly line can assemble over 7,000 different Cannon Plugs and Connectors!

KIMBALL ELECTRONICS: one of the largest stocking electronic parts distributors in the United States!

CANNON AUTHORIZED * PLUG SPECIALIST

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1029 North 1st Street

Albuquerque, New Mexico
1307 San Mateo, N.E.

CIRCLE 92 ON READER-SERVICE CARD

Snap-in removable crimp contacts
FROM THE ORIGINATOR OF THE GOLDEN-D

U.S. Patent No. 2,790,153

CANNON SUBMINIATURE GOLDEN-D MARK II

Golden-D Mark II Subminiature, the crimp snap-in version of the famous "D" line, is available for immediate delivery! ■ MATES WITH ORIGINAL D ■ MONOBLOC INSULATORS ■ SNAP-IN REMOVABLE CRIMP CONTACTS DESIGNED TO MS 3190 ■ CADMIUM PLATED, GOLD IRIDITE FINISH SHELLS ■ FIVE SIZES WITH 9, 15, 25, 37, and 50 CONTACTS ■ PROBE-PROOF CLOSED ENTRY SOCKET CONTACTS ■ LOW ASSEMBLY COST FOR THE USER. Wherever maximum reliability is needed in a subminiature multicontact plug—for both military and industrial applications—specify the Golden-D Mark II...*it is engineered to deliver superior performance by the world's most experienced manufacturer of electrical connectors.* Write for D-8 Catalog.

CANNON PLUGS

CANNON ELECTRIC COMPANY, 3208 Humboldt Street, Los Angeles 31, California

CIRCLE 93 ON READER-SERVICE CARD

NEW PRODUCTS

Power Supplies 457

Regulation is 0.05% for line and load. Series 7400 power supplies have outputs of up to 36 v and 5 amp. Variable or fixed voltage outputs are available. Ripple is held to 1 mv. Optional features are short-circuit protection and overvoltage protection with automatic cutoff.

Systems Research Corp., Dept. ED, 7635 Tobias Ave., Van Nuys, Calif.

P&A: $135 to $225; 2 to 4 weeks.

Electroluminescent Display 400

Composed of 4 individual crossed grids, these low power devices are designed for use in data processing, radar, countermeasures, medicine, air and sea traffic control, and entertainment. Device has a 16 x 16 in. panel, and crossed grid panel has a resolution of 16 lines per in.

Sylvania Electric Products Inc., Dept. ED, 730 Third Ave., New York 17, N. Y.

Silicon Chopper 459

Electrostatically shielded Microchopper has an operating temperature range of −55 to +150 C. Range extends from less than 1 mv to ±20 v. Immune to effects of shock and vibration, the units are suitable for military, space vehicle and portable applications.

Solid State Electronics Co., Dept. ED, 15321 Raven St., Sepulveda, Calif.

Unit Oscillators 444

Transistorized model 1391 series provide high purity sine waves of fixed frequency. Available from 1 cycle to 100 kc. Plug-in units feature unusual frequency stability. Typical unit provides distortion less than .1%, amplitude stability of .05% per C, and frequency stability of .01% per C. Packaged in a 1 x 2.6 x 3.6 in. module.

Burr-Brown Research Corp., Dept. ED, Box 6444, Tucson, Ariz.
***P&A:** $125; stock to 30 days.*

Silicon Rectifiers 398

Stud-mounted types 1N3189, 1N3190, and 1N3191 weigh only 1.4 g (approx), and can handle forward currents of 1 amp at 100 C and peak surge currents (1/2 cycle surge, 60 cps) of 30 amp. Operating temperature range to 175 C. Available with piv ratings of 200, 400, and 600 v. For printed circuit and applications requiring high reliability.

Motorola Semiconductor Products, Inc., Dept. ED, 5005 E. McDowell Road, Phoenix 8, Ariz.
***Availability:** immediate delivery.*

Splice Covers 443

Polyvinyl chloride covers are easily wrapped around spliced areas of cables and locked on by a plastic zipper closure. Tracks of the zipper closure may be permanently fused together with the firm's sealer, providing a permanent water-tight protection for the area. Special sizes and shapes available.

The Zippertubing Co., Dept. ED, 13000 S. Broadway, Los Angeles 61, Calif.

◀ CIRCLE 94 ON READER-SERVICE CARD

NEW PRODUCTS

Tantalum Capacitors 641

Tolerances of ±10% and −15+20% are available for a series of cup style sintered-anode tantalum capacitors. Three case sizes are furnished: the smallest size has ratings from 30 μfd at 4 v to 1.7 μfd at 85 v; middle case size ratings are 140 μfd at 4 v to 9 μfd at 85 v; largest case size ratings are 320 μfd at 4 v to 25 μfd at 85 v.

Sprague Electric Co., Dept. ED, 347 Marshall St., North Adams, Mass.

Circuit Template 631

For semiconductor circuit drafting. The Symbol-Ease template provides the latest transistor and diode symbols as well as those for electron tubes and electronic components. Cutouts look like the symbols they make. All common symbols are made with horizontal motions of the template.

Quintec Instrument Co., Dept. ED, Box 85, Altadena, Calif.

Price: *$4.95.*

Diode Commutator 729

Silicon solid-state diode commutator contains six circuit wafers. Each wafer contains 16 diodes and four resistors. The commutator selects any one of 24 inputs and connects it to the outputs.

Philco Corp., Lansdale Div., Dept. ED, Lansdale, Pa.

Ultrasonic Cleaning Machines 439

Series of machines is designed to process metal parts and electronic components on a continuous self-contained flow basis. Can be used with any cleaning solutions. Model 30-6 can process as many as 18,000 parts per hour. All machines feature low solvent consumption.

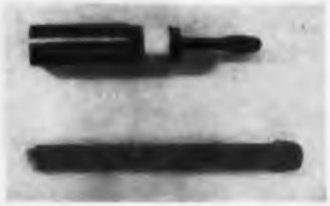
Autosonics, Inc., Dept. ED, 4217 Chestnut St., Philadelphia 4, Pa.

Clips 397

Uni-Tel clips hold and connect to electronic components lead wires. Y construction assures highest contact pressure with .010 to .050 in. diameters. Pressure edges cut through wax, lacquer, and oxide to maintain positive contact. Silver plated for greatest conductivity. May be obtained in beryllium copper as alternate to standard phosphor bronze.

Atlee Corp., Dept. ED. 47 Prospect St., Woburn, Mass.
P&A: $7.50 per 1,000 in 2,000 lots; from stock.

Fission Counter 440



Type WX-4645 measures only 1/2 in. long and is less than 1/4 in. in diam. Solder connections may be made directly. Normal operating voltage is 300 v, but up to 1,000 v can be applied without damage. Designed for temperature up to 300 C. All metal parts are made from titanium.

Westinghouse Electronic Tube Div., Dept. ED, Box 284, Elmira, N. Y.

CIRCLE 97 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Linear Amplifier 589

Non-overloading linear amplifier model 701 is for general use to amplify small pulses received from nuclear detectors or other sources. Circuit design permits easy conversion from standard line voltage to battery operation. Maximum gain is 1,000. Unit is fully transistorized. A transistorized preamplifier is available for use with this equipment.

Lockeed-Georgia Co., Div. of Lockeed Aircraft Corp., Dept. ED, Atlanta, Ga.

Shielded Coil Form 706

Doubled-ended shielded-coil form is suitable for transformer applications which require tuning from both ends. Size is 0.570 in. OD and 2.433 in. overall length. Unit is available in paper phenolic, polypenco or Kel-F.

Cambridge Termionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

***P&A:** $1.73 each for 250 pieces; from stock.*

Band Pass Filters 708

Range is 255 to 3,655 cps for band pass filters series FBH 102. Coils are adjusted to inductance of ±1%. Insertion loss is 6 db max. Bandwidth is approximately 10 to 30% of center frequency at the 3 db down point. Source and load impedance is 600 ohms for the standard versions, but other values are available.

Circuitdyne Corp., Dept. ED, 480 Mermaid Ave., Laguna Beach, Calif.

PRECISE VOLTAGE REFERENCE SOURCE for instrument calibration and lab tests, Mallory Mercury Reference Battery is accurate within ± ½% of stated voltage. Glass-free, rugged construction. Can't be damaged by overloads. Eight voltage outputs, 0 to 10.8 volts, in 1.35 volt steps.

HYPOTHERMIA PRECEDING HEART SURGERY involves remote measuring of temperatures. The Tele-Thermometer from Yellow Springs Instrument Co., Inc. does this exacting work, with Mallory Mercury Batteries providing needed high electrical capacity per unit size. (2.5 volt cells, .66" dia. by 1.3", rated 1000 milliamp-hours.)

FIRST ELECTRONIC TIMEPIECE ACCUTRON, by Bulova, guaranteed accurate to one minute per month, is designed to run a full year without battery change. To power the mechanism, Mallory Mercury Batteries assure long life, constant voltage discharge and freedom from gassing and leakage.

Miniaturization . . . portability . . . extra long life . . . name the extra sales factor, and Mallory Mercury Batteries can add it! Want fewer battery changes, longer storage life, fade-free service? Mallory offers far longer life, far higher capacity per unit size than conventional batteries! Batteries must have wide temperature range? Mustn't leak? Make yours Mallory! Their constant discharge voltage is ideal for transistor circuitry, too.

There's a wide availability on a broad line of single or multiple voltage cells. Custom power packs developed on request. Write Mallory, the mercury battery pioneers, for consultation and engineering data.

Mallory Battery Company
North Tarrytown, N.Y.
a division of

P.R. MALLORY & CO. INC.
MALLORY

In Canada: Mallory Battery Company of Canada, Limited, Toronto 4, Ontario
In Europe: Mallory Batteries, Limited, Dagenham, England

AC Power Regulator 633

A compact, solid-state variable power regulator, trademarked LabAC regulates power levels up to 4.6 kw, yet weighs only 7-1/2 lb. It may be used either for manual adjustment or automatic control of ac voltages up to 230. Four models are available, with current ratings of 10 and 20 amp and voltage ratings of 115 v or 115/230 v.

Research, Inc., Dept. ED, Box 6164, Minneapolis 24, Minn.

Printed Circuit Terminal 705

Flared hollow terminal for printed circuits permits dip soldering or wrapping wire around terminal. Terminal can be inserted in panel thicknesses from 1/6 to 5/32 in. Unit is 1/8 in. long when mounted, and requires a 0.062 in. OD mounting hold.

Cambridge Termionic Corp., Dept. ED, 445 Concord Ave., Cambridge, Mass.

Miniature Memory Module 374

Ferrite core memory type MD-100 is a 16-bit linear select memory module. Device uses 80-50 mil cores, occupies 5/8 cu in. Symmetrical internal connections of the memory cube make pin and socket orientation unnecessary. Unit weighs 3 oz. Overall height including pins is 0.875 in.

CBS Laboratories, Dept. ED, High Ridge Road, Stamford, Conn.
***Price:** $60.*

CIRCLE 98 ON READER-SERVICE CARD

NEW PRODUCTS

Delay Line 717

Time delay is 600 ms for the wire sonic delay line. Unit has a temperature coefficient of 0.5 ppm per C and an insertion loss of less than 50 db. Pulse repetition rate is to 600 kc. Unit meets military specifications for shock and vibration.

General Electric Co., Defense Electronics Div., Dept. ED, Syracuse, N. Y.

Magnetic Head 713

Double-reed design of the flying magnetic head assures completely fail-safe operation. While the drum is in operation, an adjustment screw sets heads and matches playbacks and an adjustable stop prevents the head from contacting the drum surface. Density is to 64 tracks per in.

Bryant Computer Products, Dept. ED, 852 Ladd Road, Walled Lake, Mich.

Voltage Suppressors 723

Selenium voltage surge protectors, designated Klip-Sel, have rms input ratings ranging from 25 to 500 v. Maximum leakage current is 12 ma. Maximum operating temperature is 100 C. Units are available in polarized or non-polarized configurations, stacked or cartridge assemblies.

International Rectifier Corp., Dept. ED, 233 Kansas St., El Segundo, Calif.

Static Starter For Motors 437

Modular in concept, it offers the reliability of no moving parts and it is arc-free. Firing and switching circuits are contained in a standard wall-mounted NEMA-1 enclosure. A 220-v, 3-phase static starter would measure 16 x 14 x 8 in. This represents an 86% reduction in size and a 95% reduction in weight.

Westinghouse Electric Corp., Dept. ED, General Purpose Control Dept., Buffalo, N. Y.

AC/DC Preamplifier 449

Chopper-stabilized, single-ended wideband dc amplifier, designated Kin Tel 458 C/N, can be used as a general purpose amplifier or as a preamplifier. As a preamplifier, the unit has dc and ac gain positions of 100 to increase the sensitivity of the company's digital voltmeters to 1 μv dc and 10 μv ac.

Cohu Electronics, Inc., Kin Tel Div., Dept. ED, 5725 Kearny Villa Road, San Diego 12, Calif.

P&A: $1,225; one week.

Miniature Trimming Potentiometer 468

Infinite resolution slide wire unit measures only 1-1/4 in. long x 3/8 in. wide x 1/4 in. deep. Specifications: power rating—1/4 w at 50-deg C, derated to 0 at 125-deg C; temp. range—55-deg C to +125-deg C; resistance range—3 to 17 ohms; terminals—leads or solder lugs; case—aluminum.

CON/ELCO, Div. of Edcliff Instruments, Dept. ED, 1711 S. Mountain Ave., Monrovia, Calif.

CIRCLE 101 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Stepper Switch 470

Type 2 heavy-duty switch can accommodate up to 10 levels of 25 outlet contacts per level. Can be supplied with contact combinations to give various bridging, non-bridging, 50 point, and motoring actions. Wipers have a life of one million half-revolutions (25 million steps). Max operating voltage is 220 dc. Capacitance between contacts is 2.5 to 4.5 pf.

Etelco Limited, Dept. ED, 22 Lincoln's Inn Fields, London W. C. 2, England.

***Price:** for 5-level stepper, about $19.50 per 100.*

Controlled Rectifiers 441

Trinistor 70-amp Rock-Top series has dc current rating of 110 amp. Designed for high-power switching service. Supplied with either flexible leads or flag-type terminals. Glazed ceramic headers, hard soldered junctions, and hermetically weld-sealed cases are used.

Westinghouse Semiconductor Dept., Dept. ED, Youngwood, Pa.

Driver Amplifier 448

Bandwidth is less than 3 db down dc to 80 kc for the solid-state unity gain driver amplifier model AD123. Output capacity is

◀ CIRCLE 102 ON READER-SERVICE CARD

±10 v at ±100 ma. Gain is 1.00 with gain accuracy within 1% at dc. Dc gain stability is better than 0.1% and noise is less than 1.0 mv rms. Unit is available with up to six channels in a 19-in. rack module.

Computer Engineering Associates, Dept. ED, 350 N. Halstead, Pasadena, Calif.

P&A: *$355 for a single channel; immediate.*

Cabinets and Consoles 436

Compact and heavy-duty, MCY cabinets and consoles meet applicable MIL specs, and accept 19 or 24 in. panels. **Overall width** is 24 or 29 in.; **depth** is 18 to 48 in. in 2 in. increments; panel space in multiples of 1-3/4 in.; consoles slope 15, 30, 45 or 60 deg. Frame in choice of 12-gauge cold-rolled steel or aluminum.

Western Devices, Inc., Dept. ED, 600 W. Florence Ave., Inglewood 1, Calif.

Visual Test and Soldering Panel 442

Panel consolidates several operations into one fast and positive method of locating assembling or soldering groups of wires into various types of plugs. For wiring a given plug, operator selects a plug adaptor and chart which matches the plug. Charts furnished to correspond with plug in either letter or number configuration.

Winslow Product Engineering Corp., Dept. ED, 47 Saint Joseph St., Arcadia, Calif.

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NEW PRODUCTS

Word Generator 711

Capacity is 40 bits for the Word Master model 1040. Unit serves as a word generator, word readout and display, finite bit delay, timing signal source, pulse frequency divider, pulse code source, word memory, etc. The instrument operates at frequencies up to 500 kc with output amplitude and sync signals up to 20 v.

Digital Electronics Corp., Dept. ED, 161 Sullivan Lane, Westbury, N. Y.

***P&A:** $1,950; 90 days.*

Recycling Timer 386

For industrial use, the Dual-Trol recycling timer continuously opens and closes a spdt switch at preset intervals. Timer consists of two timing modules operating in sequence. Modules can provide any combination of time cycles from 1/10 sec to 3 hr. Contact rating is 10 amp.

Industrial Timer Corp., Dept. ED, 1407 Carter Highway, Newark 4, N. J.

***Price:** $77.50, 115-v; $79.50, 220-v.*

Telemetry Filters 380

Band pass filters are to replace conventional filters in telemetering applications. Delay is 5 cycles of sub-carrier for the numbered channels and 2-1/2 cycles for the lettered channels. Adjacent band rejection is greater than 15 db. Networks are all passive types to be driven from voltage sources.

PCA Electronics, Inc., Dept. ED, 16799 Schoenborn St., Sepulveda, Calif.

Rotary Solenoids 719

Lifetime is more than 1,000,000 cycles for rotary solenoid models 3457, 3456 and 3458. Temperature range is −55 to +100 C. Rating is 12, 18, and 24 v dc with other ratings on request. Starting torques range from 1.5 oz-in. to 65 oz-in. Weight range is 2.8 to 10.4 oz.

General Time Corp., Central Research Laboratories, Dept. ED, Progress Drive, Stamford, Conn.

Fused hemisphere front contact provides unusually good mechanical protection against shock and vibration. There are no loose parts to cause intermittent operation.

General Electric's new *PEP* silicon diodes bring you a unique design combination that can add important assurances of performance and reliability in your high speed switching circuits.

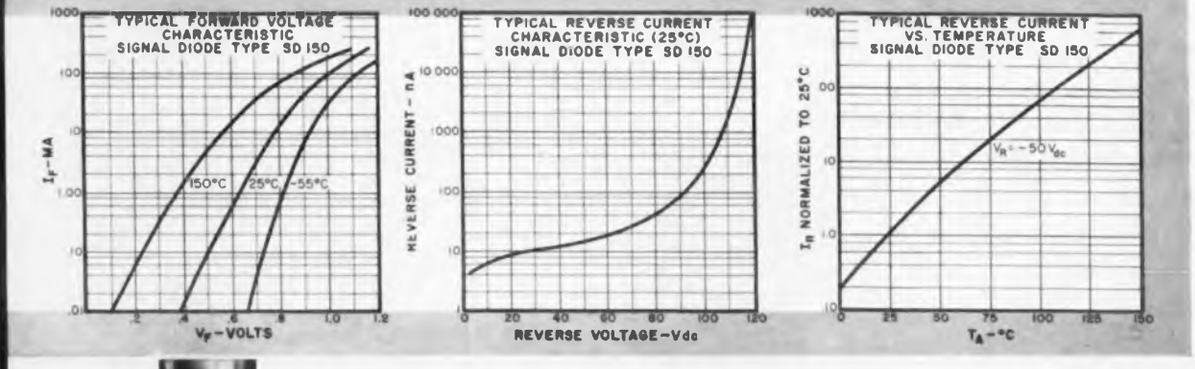
Gaseous *planar* diffused junction means high breakdown voltage with low capacitance.

Thin *epitaxial* layer on low resistivity substrate gives negligible body drop and increased uniformity from diode to diode.

Surface *passivation* is applied before the junction is formed for maximum protection against contamination.

In addition to ultra-fast switching speed, your designs benefit from a 5-to-1 improvement in conductance over presently available units. All General Electric diodes are aged at 200°C for a minimum of 60 hours. A life test of 1000 hours (50 volt reverse bias at 150°C) is made on a sample from each lot before lot shipment is allowed. This is a more severe test than the usual high temperature storage test without applied voltage. Other restrictive tests performed on a sample from each lot are: oven storage, temperature cycling, room temperature storage, moisture resistance, solderability and lead fatigue. Criteria for lot acceptability are: stability of forward voltage, breakdown voltage and reverse current.

Put *PEP* in your designs with General Electric High Speed Diodes. For complete technical information call your Semiconductor Products District Sales Manager, or write Semiconductor Products Department, Section 23J109, General Electric Company, Electronics Park, Syracuse, New York. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: International General Electric, 150 E. 42nd St., New York 17, N. Y.



GENERAL ELECTRIC

CIRCLE 104 ON READER-SERVICE CARD

Signal Conditioner 703

Thermocouple signal conditioning equipment, model TSC-1, an eight-channel, rack-mounted unit. It accepts signals from a thermocouple reference junction and converts these to useable form for direct galvanometer monitoring. Three-point calibration and four-point attenuation are offered. Biasing is either manual or semi-automatic.

Astra Technical Instrument Corp., Dept. ED, Los Angeles, Calif.

Voltage References 712

Input current is 10 ma or less with input voltage of 20 v dc ±1 v dc. Overall stability is better than ±0.2% over a temperature range of −20 to +60 C, an input voltage variation of ±5%. Output voltage is 5.0 v dc. Units are for satellite pcm telemetry applications.

Dynage, Inc., Dept. ED, 390 Capitol Ave., Hartford, Conn.

Solid-State Chopper 702

Range is dc to 10 kc for solid-state chopper model SW-103. Unit requires no external circuitry or adjustments. Noise level is below 50 μv rms at 1 kc. Switching transient does not exceed 4 mv and decays to 37% in 5 μsec. Dwell time is less than 10 deg at 1 kc. Size is 0.95 x 0.75 x 0.68 in.

Alpha-Tronics Corp., Dept. ED, 1033 Engracia, Torrance, Calif.

NEW PRODUCTS

Vibration Tester 725

Horizontal vibration test fixtures are usable to 2,000 cps for large specimens on the 20 x 20 in. model. Designated the Vibraplane, four models are available with table dimensions of 20 x 20, 30 x 30, 40 x 40 and 48 x 48 in. Table is driven by a standard vibration exciter rotated 90 deg from vertical.

MB Electronics, Dept. ED, 781 Whalley Ave., New Haven, Conn.

Elapsed Time Meter 718

Range is 0 to 99,999.9 minutes or hours for the elapsed time meter type 236. Instrument face has six digital counters. Timing mechanisms are enclosed in dust- and moisture-resistant cases. Ratings include 120, 208, 240, and 480 v for either 50 or 60 cps.

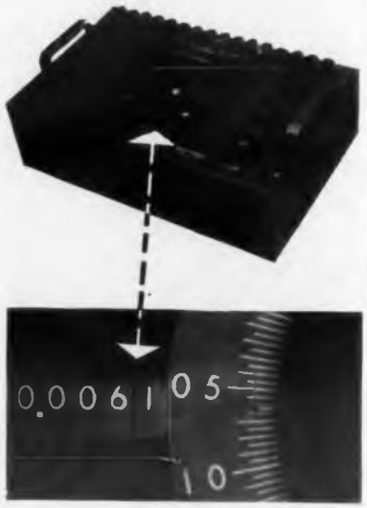
General Electric Co., Dept. ED, Schenectady, N. Y.

Sealing Machine 724

Operation time of about 8 sec is regulated by a precision timer control in high frequency sealing machine No. 1243. Unit is a 2-position machine. Parts shown being sealed together are three metal pieces with two glass pieces between. All coils are water-cooled.

Kahle Engineering Co., Dept. ED, 3322 Hudson Ave., Union City, N. J.

Rapid, precise emf measurements with this L&N Type K-3 Universal Potentiometer



Emf's read as digits plus scale value

Fast, accurate d-c voltage measurements free of effects of static, humidity and leakage are made with L&N's Type K-3 Universal Potentiometer. In calibrating d-c wattmeters or voltmeters, checking thermocouples, etc., measurements are speeded as emf's are read directly as a single row of digits plus a scale value.

Ranges—High: 0 to 1.611 v. Medium: 0 to 0.1611 v. Low: 0 to 0.01611 v.

Limits of Error—Standardized and read on range in use: High range: ±(0.01% + 20 μv). Medium range: ±(0.015% + 2 μv). Low range: ±(0.015% + 0.5 μv).

Internal Resistance—Changes from about 180 Ω at full scale to about 110 Ω at zero setting.

Galvanometer Sensitivity Keys—Four tap keys provide sensitivities of approx. 1, 1/20, 1/400 and 1/10,000. Fifth key for reversal of connections.

Standard Cell Dial—1.0174 to 1.0205 v.

Case—Aluminum, 19¼" long x 12½" wide x 5¾" high to top of panel.

Price—$730.00, f.o.b. Phila. or North Wales, Pa., (subject to change without notice). Specify List No. 7553 when ordering from Leeds & Northrup Company, 4908 Stenton Ave., Phila. 44, Pa.

LEEDS & NORTHRUP
Instruments — Automatic Controls • Furnaces

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Multi-Element Components 730

A variety of multi-element and thin film components are available including silicon 3-diode pack with common cathode, silicon 3-diode pack with common anode, and germanium full wave bridge rectifier in a four-lead TO-18 case. Also available are transistor-diode logic pack and thin film NOR logic pack.

Philco Corp., Lansdale Div., Dept. ED, Lansdale, Pa.

Miniature Relay 704

Life is 100,000 operations for spdt relay type JR. Contact rating is 1 amp at 28 v dc. Unit meets or exceeds all applicable military specifications. Size of the relay is 0.2 x 0.4 x 0.5 in. Standard units are available in several voltage ranges.

Branson Corp., Dept. ED, 41 S. Jefferson Road, Whippany, N. J.

Clutch-Brakes 714

Size 11 direct action clutch-brakes permit independent clutch or brake functions within a single unit. Two models are available: the friction-coupled F-75 and the crown tooth-coupled F-85. Model F-75 offers a clutch and brake torque of 16 oz-in. minimum, model F-85 a clutch torque of 60 oz-in. minimum.

FAE Instrument Corp., Dept. ED, 16 Norden Lane, Huntington Station, N. Y.

NEW PRODUCTS

Control Instruments 636

Pneumatik Tel-O-Set is a line of 12 major types of 4-in. indicating, recording, and controlling devices. The units are designed for manual-automatic control transfer without the complication of matching pressures. All devices operate over the usual range of 3 to 15 psi and may be combined with any compatible transmitter and final control element.

Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Dept. ED, Wayne & Windrim Aves., Philadelphia 44, Pa.

Wirewound Resistor 726

Resistances to 50 k are available with subminiature wirewound resistor MAW-01. Size is 0.188 long by 0.093 in. in diam. Tolerances are available to 0.05%. Units can be non-inductively wound, are completely encapsulated in epoxy suitable for operation at better than 125 C at 0.1 w.

Marstan Electronics Corp., Dept. ED, Roosevelt, L. I., N. Y.

Sound Analyzer 722

Sound level meter weighs 4 lb and measures 10 x 8 x 4 in. Octave band readings, overall sound levels, or A, B, and C scale readings are obtained by setting two switches. Direct reading are made from one indicating meter. Unit has a built-in battery check.

Industrial Acoustics Co., Dept. ED, 341 Jackson Ave., New York 54, N. Y.
Price: *about $800.*

Pressure Switches 721

Rotary type pressure switches series RPS 17 have operational lifetime of 500,000 cycles min. Switches actuate under pressure of 6 to 600 psig and operate to pressure of 3,000 psig. Standard ratings are 5 amp resistive, 3 amp inductive at 30 v dc and 5 amp at 125/250 v ac. Units are available in aluminum, magnesium or stainless steel.

IMC Magnetics Corp., Dept. ED, 917 W. Madison St., Phoenix, Ariz.

Recording Voltmeter 385

For unattended voltage monitoring, the model 1122B-60 recording voltmeter is sensitive to changes of 0.25 v in a 120-v system. The instrument can record pulses as short as 0.1 sec. Unit has a high-torque 12-ma recorder.

Brenner-Fiedler and Associates, Inc., Dept. ED, 7563 Melrose Ave., Los Angeles 46, Calif.

Flame-Out Casting Compound 387

Two-component heat-cure casting compound is flexible, and self-extinguishing. Designated compound C9-5041, the material is made to encapsulate transformers required to meet MIL-T-27A specifications. The system has a low working viscosity and a three-day pot life.

Hysol Corp., Dept. ED, Olean, N. Y.

P&A: sample quantity, $2.50; from stock.

Power Amplifier 709

Gain is from 0.03 to 1,000 with accuracy and linearity of ±1% for three-channel power amplifier model 8003M. Unit is for amplifying the output of piezoelectric accelerometers. Frequency response is flat within ±5% from 3 cps to 15 kc. Noise is less than 40 μv. Input impedance is 1,000 meg and output is 2 ohms.

Columbia Research Laboratories, Dept. ED, MacDade Blvd. & Bullens Lane, Woodlyn, Pa.

***Price:** $1,570 to $1,650.*

NEW PRODUCTS

Digital Pattern Generator 473

Supplies an adjustable repeating pulse pattern at a prf of 200 kc. Features an adjustable, programed, 100-bit output, and is able to produce a repetitive pulse pattern that can be changed by flick of a switch. For testing breadboard designs, prototypes, systems and subsystems. Weighs only 35 lb, and is 17 in. wide, 12-1/4 in. high, and 10-1/2 in. deep.

The Magnavox Co., Government & Industrial Div., Dept. ED, Urbana, Ill.

P&A: *$3500; 60 days.*

Thermocouple Drive 478

For profiling temperature in cryogenic and high temperature ranges. In 3 compact, portable models with speed ranges from 1.38 to 13.6 in. per hr. Accommodates thermocouples from 1/16 in. in diam to 3/8 in. in diam. Unit is able to utilize thermocouples with ceramic protection tubes.

Thermal-Tech, Dept. ED, P. O. Box 8627, Chicago 80, Ill.

10-Turn Potentiometer 445

Model 3500 offers a 20% longer resistance element in a compact case only 7/8 in. in diam x

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1 in. long. Guaranteed to meet cycling humidity specifications. Features molded all-plastic case, plus shaft seal, providing outstanding resistance to humidity. Wirewound resistances up to 250 K. Power rating 2 w at 70 C. Resolution .03 to .01%.

Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.
Price: *under $10 in average quantities.*

Ferroelectric Memory 480

In low-priced experimental kits consisting of 16 cells individually potted for ease of handling experimentation. Kits acquaint design personnel with characteristics of cells. Current cells have a typical saturation voltage of 15. May find application in prototype models or in memory matrices.

Waddell Dynamics, Inc., Dept. ED, 4364 Twain Ave., San Diego, Calif.
P&A: *$25 per kit; from stock.*

Modular Assembly 479

Model 217 low leakage rf level is obtained by use of a knit monel gasket contained in a groove in the top of the box. Leakage level with oscillator out of box was 80 db above 1 μv. With cover and gasket in place, leakage level was reduced to below receiver threshold level of 1 μv, or −127 dbm. Measurements made per MIL-I-26600.

Tridea Electronics, Inc., Dept. ED, 1020 Mission St., South Pasadena, Calif.

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NEW PRODUCTS

X-Y Recorder 720

For rack mounting the X-Y recorder model HR-95 includes a vacuum paper holddown, continuous 10 turn precision attenuators and an electric pen lifter. Unit is available with either 1 mv per in. or 10 mv per in. amplifiers. Also available are 10 or 100 mv full scale amplifiers for the 7 in. axis and 15 or 150 mv full scale amplifiers for the Y-axis.

Houston Instrument Corp., Dept. ED, P.O. Box 22234, Houston 27, Tex.
***P&A:** $875; 30 days.*

Low Leakage Current Tester 554

Essentially a go-no-go tester, type 1193 I_{cbo}/I_{ebo} tester has absolute readout capability. It tests leakage current from 1 pa to 1 μa for both npn and pnp transistors. Accuracy is better than $\pm 1\%$ above 10 pa and $\pm 5\%$ below 10 pa. Can be programed for collector-to-base and emitter-to-base voltages from 0 to 100 v in 1-v steps.

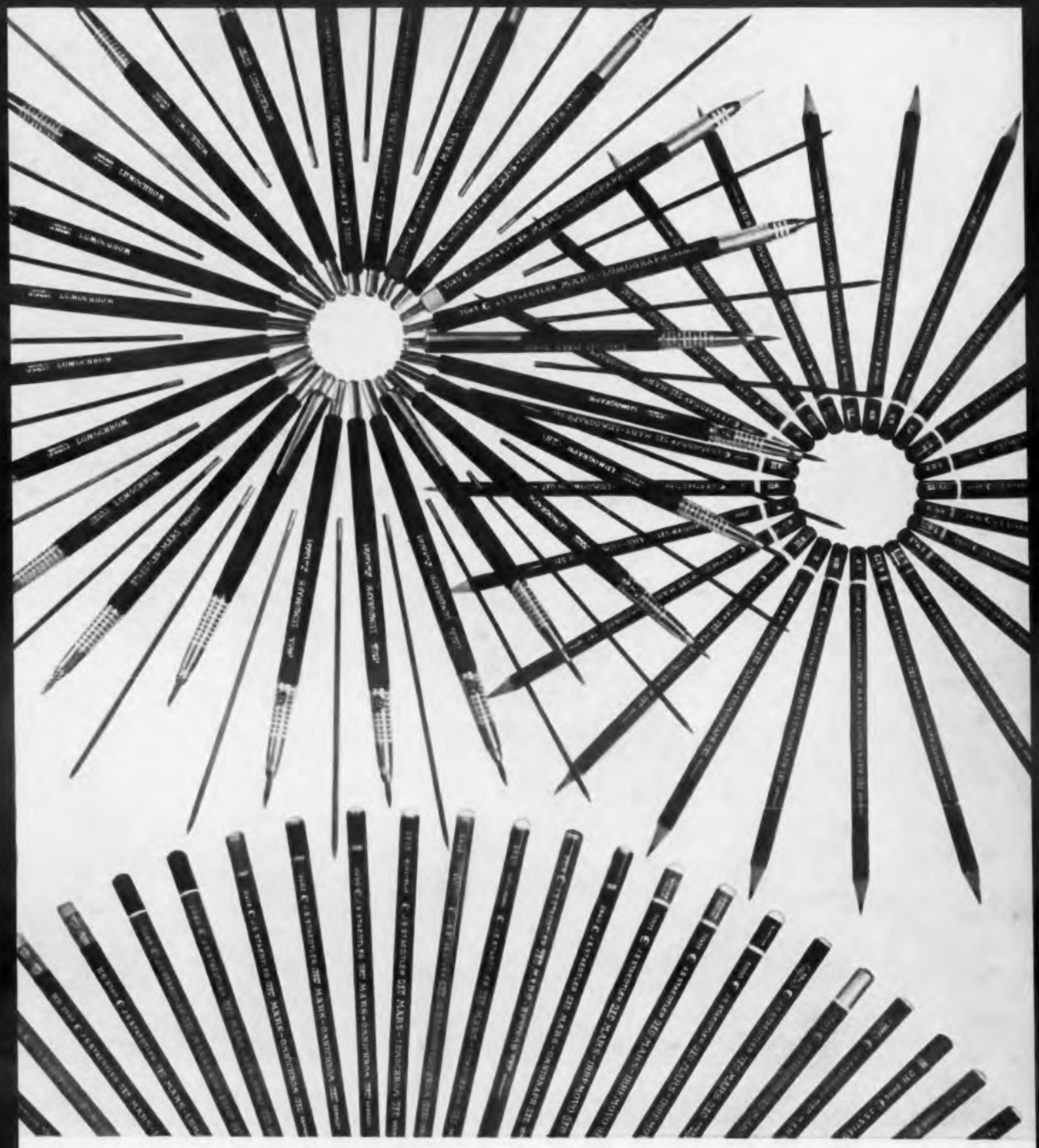
Fairchild Semiconductor, Div. of Fairchild Camera and Instrument Corp., Dept. ED, 545 Whisman Road, Mountain View, Calif.
***Price:** $1,995.*

Wideband DC Amplifier 515

Range is dc to over 20 kc for the chopper-stabilized wideband dc amplifier model 3101. Plug-in attenuators provide fixed or adjustable gain settings between 10 and 1,000, either differential or single-ended. Gain stability is $\pm 0.01\%$. Drift is less than 2 μv for 100 hr. Frequency response is ± 0.1 db at 1 kc, ± 3.0 db at 35 kc.

PM Electronics, Inc., Dept. ED, 5221 University Ave., San Diego 5, Calif.
***P&A:** $540; 60 days.*

CIRCLE 115 ON READER-SERVICE CARD ➤



ALL MARS – ALL TOPS

.... all imported from West Germany, made to meet the highest standards of professionals.

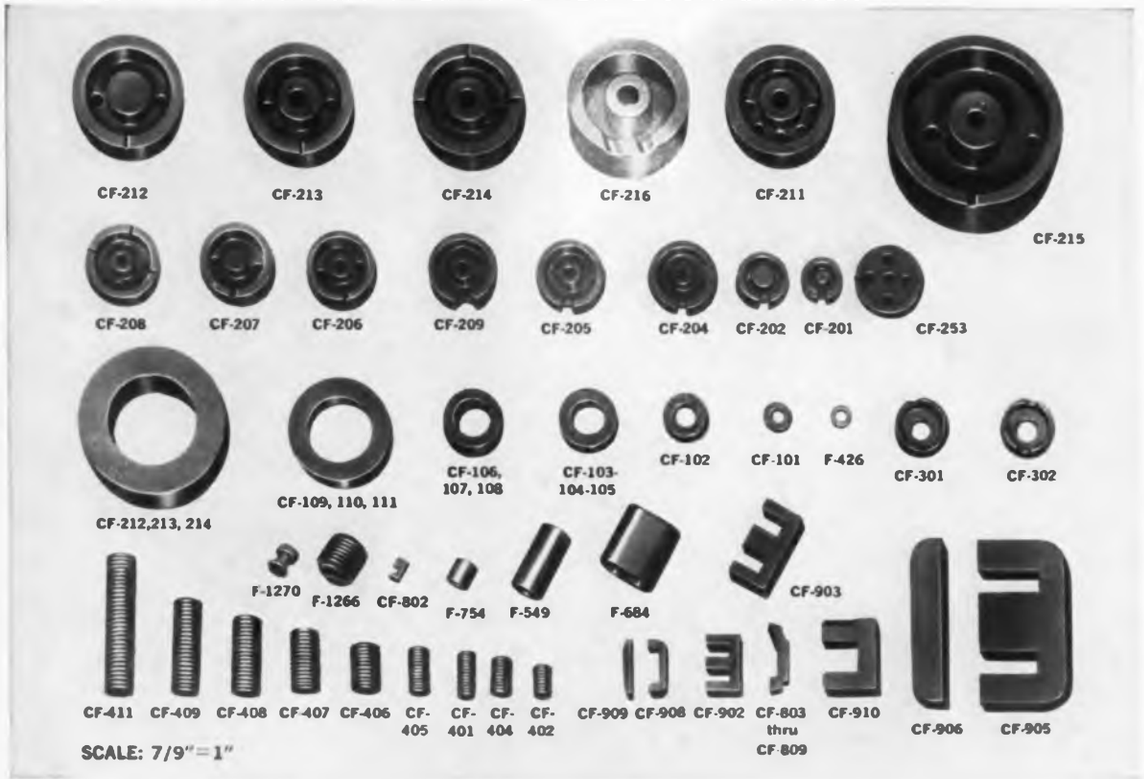
the pencil that's as good as it looks

MARS

J.S. STAEDTLER, INC.
HACKENSACK, NEW JERSEY

Mars products are available at better engineering and drafting material suppliers everywhere.

From the General Ceramics Division of **INDIANA GENERAL CORPORATION**



Now—delivery from stock on these special-purpose FERRAMIC® cores

General Ceramics Ferrite cores are available in various materials for specific frequency bands from 1 kc to 100 mcs. Use the handy materials selector chart for quick reference.

APPLICATION	DESIRED PROPERTIES	FREQUENCY	FERRAMIC BODY	SHAPES
*Filter Inductors	High μQ, magnetic stability, sometimes adjustable	Up to 200 kcs 200 kcs-10 mcs 10 mcs-60 mcs	"O-3", "T-1" "Q-1" "Q-2"	Cup cores, toroids, C-cores, E-cores, slugs
*IF Transformers	Moderate Q, high μ, magnetic stability, adjustable	465 kcs 40 mcs other	"Q-1" "Q-2" Materials for filter inductors apply	Cup cores, threaded cores, toroids
*Antennae Cores	Moderate Q, high μ, magnetic stability	5-10 mcs 10-60 mcs	"Q-1" "Q-2"	Rods, flat strips
*Wide Band Transformers	High U, moderately low loss	1 kc-400 kcs 1 kc-1 mc 200 kcs-30 mcs 10 mcs-100 mcs	"O-3", "T-1" "H" "Q-1" "Q-2"	Cup cores, toroids, C-cores, E-cores
*Adjustable Inductors	High μ, moderately low loss	Same as Wide Band Transformers	Same as Wide Band Transformers	Rods, threaded cores, tunable cup cores
*Tuners	High μ, moderate to high Q, magnetic stability, as much as 10-to-1 adjustability with mechanical or biasing methods	Up to 100 mcs	For high Q selective circuits, materials under filter inductors apply. For others, materials under wide band transformers apply	Threaded cores or rods for mechanical tuning. Toroids, C-cores, E-cores for biasing methods.
*Pulse Transformers	High μ, low loss, high saturation	Pulse	Materials under wide band transformers apply	Cup cores, toroids, C-cores, E-cores
Recording Heads	High μ, low loss, high saturation, resistance to wear	Audio, pulse	"H" "O-3", "T-1"	

*Q-3 material available on special order for high Q operation up to 225 mcs.

Fast service on sample quantities; prompt delivery on production lots. Call, wire or write for all the facts.

DIVISION OF INDIANA GENERAL CORPORATION

GENERAL CERAMICS

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KEASBEY, NEW JERSEY, U. S. A.

TECHNICAL CERAMICS, FERRITES AND MEMORY PRODUCTS

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Radio-Control System 635

Automatic selection of optimum channels is featured in the MARC Channel Master all-solid-state control system for vehicular communications networks. The unit allows the base station operator to select both the transmitter and receiver sites as well as the operating-frequency channel. Other features are low power consumption, absence of wear, and immunity to ambient temperature changes.

Moore Associates, Inc., Dept. ED, 893 American St., San Carlos, Calif.

Telemetry Amplifier 561

Covering 215 to 265 mc, model VHA-3 telemetry amplifier provides 43-db gain and 24-dbm saturated power output. Features include an output rf power monitor and dual inputs with separate calibrated adjustable attenuators. It is for use as a line amplifier in telemetry and data-link installations.

Applied Technology, Inc., Dept. ED, 930 Industrial Ave., Palo Alto, Calif.
P&A: *$3,200; 60 days.*

AC/DC Calibration Console 364

Accurate within 0.05% of reading, the model LTC-1 ac/dc calibration console measures current and voltage over ranges of 1 ma to 11.1 amp and 0.5 to 1,110 v. Readout in both percentage-error and actual figures is provided. Unit has automatic overload protection, and is self-contained for one-man operation.

Sensitive Research Instrument Corp., Dept. ED, 310 Main St., New Rochelle, N. Y.
P&A: *$5,560; 180 days max.*

NEW PRODUCTS

Miniature Servo 472

For use in analog and digital systems, model 100-2 includes a control transformer, motor-tachometer, amplifier, shaft encoder, and gear train. Weighs 12.5 oz, measures 3-1/2 in. long and is 1-3/4 in. diam. Miniaturization is achieved by using all size 8 components, including size 8 encoders.

General Precision, Inc., Librascope Div., Dept. ED, Glendale 1, Calif.

Delay Lines 521

Continuously variable delay lines types 551 through 555 have a resolution time of less than 8 x 10^{-11} sec and a maximum delay of over 16 μsec. Types 551, 552 and 553 have a long maximum delay and bandwidth is flat from dc to video frequency. Types 554 and 555 are for delay of radar if signals to 60 mc.

AD-YU Electronics Laboratory, Inc., Dept. ED, 249 Terhune Ave., Passaic, N. J.

P&A: $109; 1 to 2 weeks.

Closed Circuit TV System 467

Completely weathertight, Hawk 401 can be installed in exposed, dusty, hot or cold, and inaccessible locations without care. Under test, camera has withstood ambient temperatures from −22 F to +131 F. Resolution: horiz—600 lines at center; 525 vertical interlaced scan is available. Weight is 23 lb.

Diamond Electronics, Dept. ED, Box 415, Lancaster, Ohio.

Tape Recorder 452

Up to 1,000-g shock can be withstood by model MR-21 multichannel, miniature tape recorder. It records up to 14 channels of data simultaneously on 1-in. magnetic tape. Total tape capacity is 69 ft. Operating temperature range is −65 to ±165 F, dimensions are 4 in. in diam x 3 in. long and weight is less than 2 lb.

Borg-Warner Controls, Dept. ED, P. O. Box 1679, Santa Ana, Calif.

Optic-Mechanical Polygon 522

For calibrating angles, the 360-sided optic-mechanical polygon, a combination of a plane mirror and an indexing table, has a total accumulated error of no more than 1/4 sec of arc. Accuracy is traceable to the National Bureau of Standards. Diameter of the clamping ring is 5 in.

AA Gage Co., Dept. ED, 350 Fair St., Detroit 20, Mich.
Price: $2,495.

Limit Switch 450

Rotating-cam limit switch has 1 to 12 cam-operated switches. Maximum speed of the switch shaft is 75 rpm for the type CL switch. Contact ratings are 15 amp at 115 v ac, 10 amp at 220 v ac, 6 amp at 440 v ac, 2 amp at 115 v dc, 0.5 amp at 230 v dc, and 0.1 amp at 600 v dc. Unit has ball bearings and double-break silver-to-silver contacts.

Clark Controller Co., Dept. ED, 1146 E. 152 St., Cleveland 10, Ohio.

CIRCLE 119 ON READER-SERVICE CARD ▶

DC to DC Converter 357

For computer applications, this dc to dc converter supplies 3%-regulated ±15-v and 5%-regulated ±6-v dc power. Input is 22 to 32 v dc. Efficiency is 65% at 28v dc input. Unit, all solid-state, measures 4 x 6-1/2 x 1-1/2 in. Switching transistors are used for power conversion, and pulse-width control for primary voltage regulation. Short-circuit and overload protection is provided.

Magnetic Research Corp., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.

Dielectric Testing Equipment 544

Tests insulated materials and all kinds of insulated apparatus such as motors, generators, wires, cables, transformers, and switchgear. In 15 ac and 9 dc ratings. Ac types at 2 kva in 20, 35 and 50 kv, and at 5, 10, and 25 kva in 50, 75, 100, and 150 kv. Dc sets rated 5 and 10 ma, with voltages ranging from 30 to 150 kv.

General Electric Co., Dept. ED, Schnectady 5, N. Y.

P&A: *$1,250 to $9,500 for ac sets and $1,250 to $5,500 for dc sets; stock to 8 weeks.*

Microelectronic Device 728

Diode inverter matrix may be used as a 3-bit parallel address or to form the basis for a sequence generator to generate arbitrary 8 bit serial words at a bit rate of 2 mc. Base inputs are fed with 3 binary signals and their compliments, and each one of the eight possible input signal combinations will identify a specific one of the eight output channels.

Philco Corp., Lansdale Div., Dept. ED, Lansdale, Pa.

Fission Counter 453

Small-flux, mapping fission counter type WX-4706 has a flexible coaxial cable. It is designed for thermal neutron fluxes up to 10^8 neutrons per cm^2 or 10^8 nv. Thermal neutron sensitivity is 10^{-3} cps per nv with a minimum resistance of 10^{12} ohms. Normal operating voltage is 300 v; 1,000 v can be applied without damage.

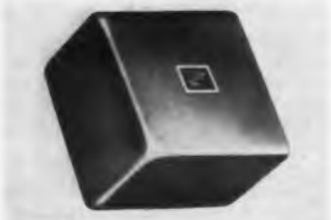
Westinghouse Electronic Tube Div., Dept. ED, Box 284, Elmira, N. Y.

Limit Switch 524

Proximity limit switch, measuring 2-3/4 x 1 x 1/2 in., uses reed switch contacts with a magnetic assembly encapsulated in an epoxy compound. It can be used to operate small industrial relays, counters and signal lamps. Capacity is 50 va, resistive. Normally closed or normally open spst contacts can be furnished.

Deshautreaux Engineering Co., Dept. ED, P. O. Box 261, Kenner, La.

Tunnel Diode Power Supply 474



Model TD-1.2-1 features recovery time from 0 to 1.2 v. Has output of 0+2 mv to 1.2 v, and 0-1 amp. Static regulation: load +0.2 mv; line +0.25 mv for +10% line. Dimensions: 4-7/8 x 4-5/8 x 4 in. Operates continuously at 45 deg C, derating linearly to zero at 75 deg C. Stability +1 mv for 8-hour period.

NJE Corp., Dept. ED, 20 Boright Ave., Kenilworth, N. J.

CIRCLE 122 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Marker Generator 569

Range is 120 to 260 mc on calibrated harmonics; 120 to 130 mc on fundamentals. Type TE-24 percision marker generator also features external modulation from −20 to +15 kc, audio output of 0 to 10 v and precision attenuation. The etched metal dial can be self-calibrated to within 0.005%.

Lafayette Radio Electronics Corp., Dept. ED, 165-08 Liberty Ave., Jamaica 33, N. Y. ***Price: $57.50.***

Welding Machine 716

Precision type welding machine butt-welds 0.006-in. diam. copper wire to 0.006-in. stainless steel wire. **Unit consists of a fixture equipped with a suitable clamping** device, a sensitive slide, optics with microscopic range, and comparator type staging in vertical and horizontal directions for rapid centering of the wires.

Federal Tool Engineering Co., Dept. ED, 1384 Pompton Ave., Cedar Grove, N. J.

Digital Encoder 623

A 16-bit absolute readout of shaft position to an accuracy of ±1/2 bit in a single turn is provided by the Vernisyn model VMI 15-216 digital shaft position encoder. The package, including electronics, measures 1/2 in. in diam x 2 in. Complete angular position answer with respect to a reference radius is provided every 10 msec. Power requirements are under 5 w.

Data Tech, Dept. ED, 238 Main St., Cambridge 42, Mass.

Annunciator Modules 570

Miniature model 360 annunciator modules each contain a single annunciator circuit, including the lamps and light box. They may be operated on NO or NC field contacts by varying external connections. Both automatic and manual reset are possible. Dimensions are 3/4 x 1-1/2 x 10 in.

McGraw-Edison Co., Dept. ED, 61 Alden St., West Orange, N. J.

Storage Tube 715

Dual-gun 10-in. storage tube type K2087 is for missile and satellite tracking. Storage time is 3 to 10 minutes. Writing speed is 200,000 in. per sec at 40 lines per in. resolution and 50 foot lamberts light output. Tube is adaptable to TV frequencies and can freeze TV presentations.

Allen B. DuMont Laboratories, Dept. ED, 750 Bloomfield Ave., Clifton, N. J. ***Price: $2,850 to $3,300.***

Pulse Generator 446

Repetition rates to 3.3 mc plus external or single shot control are available in the pulse generator model 102. Pulse delays to 10,000 μsec, pulse widths of 0.05 to 10,000 μsec, and amplitudes to 50 v into 50 ohms at rise times from 10 nsec to 0.5 μsec. are other features of the unit.

Datapulse Inc., Dept. ED, 509 Hindry Ave., Inglewood 1, Calif. ***Availability:*** *from stock.*

Edge Reading Meter 469

Unusual physical dimensions allow it to be stacked or easily assembled. Model 12 is a miniature null-type zero center tuning indicator. Max length is 1-1/4 in; max height 9/16 in. Model 13 reads various ranges (ac and dc) from 1 ma to 100 amp with 3 to 5% accuracies. Max width is only 1-13/16 in; max height is 3/4 in.

Electro-Mechanical Instrument Co., Dept. ED, 8th and Chestnut Sts., Perkasie, Pa.

Linear Accelerometer 477

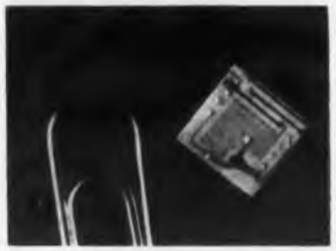
Features high natural frequency characteristics, small size, and rugged construction. Model AK 105 uses a sensitive "self-energizing" piezo-electric element for reliable measurements. Operates from −65 deg F to +250 deg F. Sensitivity is nominal 17 peak mv per peak g at room temp; weight is approximately 0.8 oz.

Statham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.

CIRCLE 125 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Microcircuit Elements 464



Thin-film microcircuit elements are made by serial manufacturing, meaning that each element is individually produced and monitored to its proper value. Shown is a NOR circuit on a 0.3-in. substrate, containing resistors, capacitors and semiconductors assembled by this technique.

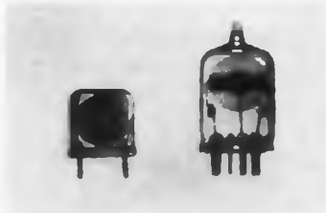
Rescon Electronics Corp., Dept. ED, 151 Bear Hill Road, Waltham 54, Mass.

Channel Slot Wedges 511

High-temperature channel slot wedges are for applications in electric motors, generators and other rotating equipment. A total of 36 sizes cover class H, silicone glass; class F, epoxy glass; class B, polyester glass. They are made of two or more layers of woven glass cloth, laminated under heat and pressure in precision molds.

Silicone Insulation, Inc., Dept. ED, 1383 Seabury Ave., Bronx 61, N. Y.

Third-Overtone Crystals 463



Highly stable, glass enclosed, third-overtone crystals are designed for divider and multiplier circuitry in both military and commercial applications. Evacuated holders type HC-27/U may be mounted in any position; T-5-1/2 and T-6-1/2 types are also available. The Q-ratio is between 1.5 and 0.25.

Scientific Radio Products, Inc., Dept. ED, Loveland, Colo.
Availability: from stock.

◀ CIRCLE 126 ON READER-SERVICE CARD

RF Capacitors 447

Values from 2.5 to 30.0 kv dc are available in ten ranges for capacitors designed for rf current and pulse work. Operating temperature range is −55 to +65 C. No flashover is experienced at barometric pressures greater than 20 in. of mercury. Units are encased in glass and sealed with silver bands.

Corson Electric Manufacturing Corp., Dept. ED, 540 39th St., Union City, N. J.

Filter Systems 461

Self-priming filter systems are of all-plastic construction. Model LPNI-30, shown, has a filtering capacity of 100 gal per hr; models with capacities of 25 to 1,200 gal per hr can be furnished in materials suitable for higher operating temperatures.

Setheo Manufacturing Corp., Dept. ED, Merrick, L. I., N. Y

Unbalance Indicator 471

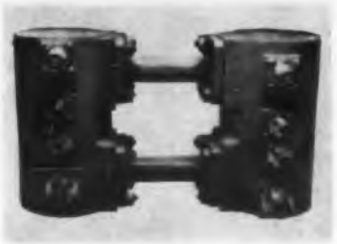
Pulse synchronized PSUI determines amount and angle of vibration caused by an unbalanced rotating part or assembly. Also indicates rpm of vibration. Filtering done by synchronous rectification circuits. Dimensions are 9 x 14 x 20 in. Weight is 40 lb. Electrical input 110 v ac, 50 to 400 cps.

General Motors Research Laboratories, Dept. ED, Warren, Mich.

CIRCLE 127 ON READER-SERVICE CARD ➤

NEW PRODUCTS

High-Power Duplexer 454



With 10-kw peak-power capability at 98 to 100 mc. Type T47V7 duplexer is for use in data links, communications and countermeasure applications. Average power rating is 200 w; insertion loss is 0.5 db; isolation is 40 db; recovery time is 100 μsec.

Tucor, Inc., Dept. ED, 59 Danbury Road, Wilton, Conn.

Epoxy Shells 507

Precision machined epoxy shells are offered in four types of epoxy: type 220 filled epoxy, type 200 unfilled, type 430 flame-resistant and filled with a coefficient of expansion of 28 x 10^{-6}, type 900 filled epoxy with a coefficient of 19 x 10^{-6}. They are available in 44 sizes.

Sayre Electronics Corp., Dept. ED, 225 Belleville Ave., Bloomfield, N. J.

Price: *$40 up (per 1,000) in quantities.*

Assembly-Work Glove 512

Specially impregnated, the glove is for handling critical components without risk of contamination by lint or other soils. Perspiration cannot escape to work objects. The glove is made of 100% nylon.

Standard Glove Co. of New Jersey, Inc., Dept. ED, 109 Frelinghuysen Ave., Newark, N. J.

Training System 465

For nuclear education. System 2300 includes a transistorized scaler, a timer for pre-set or elapsed time operation, Geiger tube, 10 calibrated absorbers, ra-

◀ CIRCLE 128 ON READER-SERVICE CARD

dioactive source set, six radioisotope solutions and 100 stainless steel planchets. Other systems can also be furnished.

Radiation Equipment & Accessories Corp., Dept. ED, Merrick Road, Lynbrook, N. Y.
Price: $550.

Gate Amplifier 475

Automatic background quieting amplifier model 40 A is suited for background noise. Attack time is less than 10 msec; release time is adjustable from 0.5 to 5 sec. Frequency response within 1 db between 50 and 15 kc. Distortion under 1%; noise is 60 db below +8 vu output level.

Ron Electric Co., Dept. ED, Box 43, Livingston, N. J.

Semiconductor Package 525

Microminiature semiconductor package consists of a cup-shaped case with three co-planar, ribbon leads and a flat cover. Platinum leads are sealed into the case by direct glass-to-metal seal. The cover is glazed with type 9361 low-temperature sealing glass and is hermetically sealed.

Corning Glass Works, Dept. ED, Corning, N. Y.

Filter Chambers 462

Corrosion-resistant filter chambers type L-80 have a filtering capacity of 800 to 1,200 gal per hr. It is rated for operation at 140 F. Threaded stainless-steel type 316 rod extends through the base. Units with other filtering capacities are available.

Sethco Manufacturing Corp., Dept. ED, Merrick, L. I., N. Y.

CIRCLE 129 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Signal Modifier 513

Range is 50 cps to 1 mc. Model 217 signal modifier is for clipping peak signal levels, positive and negative, and removing low-level noise in laboratory signal analysis. Clipping can be adjusted to any percentage of the signal. Input is 1 v at 100,000 ohms; output is 1 v at 100 ohms.

Systems Research Laboratories, Inc., Fairborn Div., Dept. ED, 500 Woods Drive, Dayton 32, Ohio.
P&A: $695; 45 to 60 days.

Epitaxial Transistors 466

Noise is 4 db and power gain is 20 db at 100 mc with 1,000-mc epitaxial mesa transistors types 2N1141, 2N1142, 2N1143 and 2N1195. Typical saturation voltage is 0.3 v at 50 ma. Applications are in hf and integrating devices in communication equipment.

Motorola Semiconductor Products Inc., Dept. ED, 5005 E. McDowell Road, Phoenix 8, Ariz.

Solder Terminals 526

For printed-circuits, they mount in 0.062-in. diam holes on panels 1/16 to 5/32 in. thick. Included are two straight-shank terminals and four flared-shank terminals. Types 2750 through 2754 have mounting heights of 0.156, 0.188, 0.188, 0.136 and 0.188 in., respectively.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

Digital Multimeter 499

Covering ±1.000 to ±1,000 v ac or dc in four ranges, in balanced or unbalanced mode. Type 5126A digital multimeter, built to ABMA specs, can be remotely controlled by a computer. Ac conversion accuracy is ±0.1%; dc,

within ±0.01%. Common mode rejection is 100 db.

Ortronix, Inc., Dept. ED, P. O. Drawer 8217A, Orlando, Fla.

Pressure Transducers 451

Range is 0 to 1, 0 to 100 psi for both model 430 absolute pressure transducer and model 530 differential pressure transducer. Suited for missile applications, they have a static error band of ±1%, resolution of 0.23%, dimensions are 2 in. in diam x 1.5 in. high, weight is 9 oz.

Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

Mercury-Vapor Rectifiers 500

PIV is 11,000 for 0.75 amp dc, mercury-vapor rectifier type NL-RX21A. Other ratings are peak anode current, 3 amp; condensed mercury-temperature limits, −20 to +60 C. It is designed for industrial power-rectifier applications.

National Electronics, Inc., Dept. ED, Geneva, Ill.

Silicon NPN Transistors 503

Planar-epitaxial silicon npn transistor type 2N1708 is for high-speed switching applications. Specs for the epitaxial structure include V_{CE} of 0.22 v at I_c of 10 ma; for the planar construction I_{CBO} is 0.025 μa at a V_{CB} of 15 v and a free-air temperature of 25 C.

Radio Corp. of America, Semiconductor and Materials Div., Dept. ED, Somerville, N. J.

Electrostatic Generator 510

Rated at 600 kv at 4 ma, model AK600-4 electrostatic generator holds ripple to ±1% peak. Full-load voltage drop is less than 10 kv; regulation is less than 0.5% for 5% line change. Output capacitance is 500 pf. Input is 220 or 380 v, 60 cps, three phase. Design is modular.

SAMES, Dept. ED, 30 Broad St., New York 4, N. Y.

CIRCLE 131 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Pointer Galvanometer 568

Taut-suspension, moving-coil galvanometer model H2000 is for use in panel or portable null-type instruments. It can be furnished with resistance values from 10 to 1,000 ohms and sensitivities of 1.25 to 0.15 μa per mm scale division. A pointer index with a zero-center, 30-mm scale is standard.

Howell Instruments, Inc., Dept. ED, 3479 W. Vickery Blvd., Fort Worth 7, Tex.

FM Deviation Meter 560

With better than 2% accuracy for measurements of peak positive or negative deviations of composite wave shapes. Model 400 fm deviation meter permits direct reading of carrier frequency from 20 to 1,000 mc at ±0.5% and of peak deviation to 1,000 kc.

Advanced Measurement Instruments, Inc., Dept. ED, Somerville, Mass.

***P&A:** $1,800 or $1,850; stock.*

Tape Handler 566

Bi-directional, perforated tape handler model 4577 accepts 5- to 8-level tapes interchangeably. Speeds are up to 500 characters per sec; rewind is 1,000 per sec. Reels hold 500 ft of 4.5-mil tape or 1,000 ft of 3-mil tape; control is by a three-zone contactor system.

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

Precision Solenoid 562

Operates at 10-g acceleration from −104 to +161 F at 25 to 28 v dc. The Synchronoid is a push-type solenoid with a spring force of 3 lb at 0.4-in. stroke and 7.5-lb at 0. The anti-rotational plunger is restrained to ±5-deg rotation. It is housed in a synchro 1-1/2 in. in diam by 2-7/8-in. long.

Automation Research & Design Association, Dept. ED, 135 Main St., Belleville 9, N. J. *P&A: $74; 3 to 4 weeks.*

Delay Network 564

Delay is 5-μsec at an impedance of 2,500 ohms. Model F618ME delay network has an output rise time of 0.5 μsec, a pulse distortion of under 5% of signal amplitude, pulse attenuation of 3 db and temperature coefficient of 200 ppm per deg C. Dimensions are 5-1/2 x 3/8 x 13/16 in.

Columbia Technical Corp., Dept. ED, Woodside 77, N. Y.

Frequency Meter 710

Range is 10 to 510 mc for this digital frequency meter. The counter section, model 737C, accepts various converter plug-in units. Three plug-in units are available: model 731B for 10 to 100 mc; model 732B for 100 to 220 mc; model 733B for 100 to 510 mc.

Computer Measurements Co., Dept. ED, 12970 Bradley Ave., San Fernando, Calif.

P&A: model 737C, $2,150; model 731B, $250; model 732B, $300; model 733B, $425; 30 days.

NEW PRODUCTS

Search Coil 559

Wire has 0.00065-in. diam and is wound on an iron core 0.0008-in. in diam. The loop of induction coil at the end of the probe consists of 200 turns of insulated wire. The coil is used to measure eddy and induction currents in small and otherwise inaccessible parts.

Batelle Memorial Institute, Dept. ED, Columbus 1, Ohio.

DC Power Supplies 727

Transistor regulated power supply modules have remote sensing and programing. Models P-56-0.5 and P-72-0.5 have outputs of 36 to 56 v at 0 to 0.5 amp and 56 to 72 v at 0 to 0.5 amp respectively, from an input of 115 v rms +10%, 1 phase, 50 to 400 cps. Maximum ripple is 5 mv peak-to-peak. Static load regulation is +0.05%.

NJE Corp., Dept. ED, 20 Boright Ave., Kenilworth, N. J.
Price: *$110.*

Navigation Equipment 518

Distance measuring equipment shows a pilot his actual distance from a fixed ground beacon in nautical miles. System 833 DME is comprised of a transmitter-receiver, instrument panel indicators and control unit, antenna and associated hookup gear. System has 126 channels. It takes a maximum of 10 sec to change channels between beacons.

Wilcox Electric Co., Inc., Dept. ED, Fourteenth and Chesnut, Kansas City 27, Mo.
Price: *between $5,000 and $7,000.*

Telephone Relay 565

Less than 1-in. high. type DT telephone-type relay has a diallyl phthalate molded stack pile-up. Contacts are dpdt gold alloy for low-level loads or 3-amp palladium for general-purpose use. The dc power required is 0.5 w for standard units, 0.15 w for special units. Volume is less than 9/16 cu in.

Davis Electric Co., Dept. ED, Cape Girardeau, Mo.

Ceramic Transfilter 563

Direct coupling of 455-kc if amplifiers in command receivers is permitted by these ceramic transfilters. Transformers are eliminated between the first and second if amplifiers and between the last if and detector stages.

Clevite Electronic Components, Dept. ED, 3405 Perkins Ave., Cleveland 14, Ohio.

Limit Switch 520

Nearly 40 million operations are possible with the Statronic limit switch. Having no make-or-break contacts, it may be used wherever roller-lever actuated switches are used. It is comprised of a solid-state switching circuit and a normally open switching element. Temperature range is 0 to 200 F.

Texas Instruments Inc., Dept. ED, P. O. Box 66027, Houston 6, Tex.

Dry-Casting Material 567

Epoxy-based, one-compound Dri-Cast casting materials are offered in two types. The C7-4862 has a specific gravity of 1.9, uncured, and 0.85% water absorption, cured. The C7-5075 has a specific gravity of 1.6 and 0.52% water absorption. Both have high thermal conductivity.

Hysol Corp., Dept. ED, Olean, N. Y.

Electrostatic Generator 508

Ripple is 0.01%. Rated at 600 kv at 4 ma, model ASK600-4 electrostatic generator is for use in nuclear physics, electron microscopy, cable and insulation testing. Ratings include: full-load voltage drop, 500 v max; regulation, less than 0.1% for 5% line change; output capacitance, 1,500 pf.

SAMES, Dept. ED, 30 Broad St., New York 4, N. Y.

Silicon Rectifiers 506

Insulating sleeves have been added to TO-1 silicon rectifiers types 1N3193 through 1N1396. Designated 1N3253 through 1N3256, the new types have PIV ratings of 200 to 800 v and forward current ratings up to 750 ma with no derating at ambient temperatures to 75 C.

Radio Corp. of America, Semiconductor and Materials Div., Dept. ED, Somerville, N. J.

CIRCLE 138 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Triple Trimmer Resistor 404

Subminiature triple trimmer resistor has each resistor in the unit rated at 0.1. Resistance range is 500 ohms to 5 meg, linear taper. Unit measures 0.406 x 1.375 in. and is 0.1 in. thick. Up to five fixed resistors can be incorporated into the unit. Additional fixed resistors can be included by removing one trimmer resistor.

Centralab, The Electronics Div. of Globe Union, Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

***P&A:** 30 to 40 cents; 4 to 6 weeks.*

Transparent Resins 555

Family of resins known as Stycast 1263 and 1264, and Eccogel 1265 are all clear, almost water-white resins whose uses and properties differ. Specific gravity of 1263 and 1264 is 1.1 and 1.04, for 1265, it is 1.0. Pot life for 1263 is 8 hr, 1264 is 3 hr, 1265 is 24 hr. Continuous use temp for 1263 is 400 deg F; for 1264 and 1265, 300 deg F.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

***Price:** $6.00 in sample kit for 1263 and 1264.*

Power Rectifiers 402

Reverse leakage of less than 1 μa is maintained by these power rectifiers at room temperature. Typical units have a forward voltage drop of less than 1 v and a dynamic impedance as low as 0.0035 ohms at rated currents. Surge currents of up to 240 amp can be safely applied on the 12 amp units for one cycle at 60 cps and the same current can be obtained with reverse polarity units.

Hughes Aircraft Co., Semiconductor Div., Dept. ED, 500 Superior Ave., Newport Beach, Calif.

Semiconductor Pressure Cell 403

Miniature pressure cell using semiconductor strain gages permits precise static measurement, fast rise time, and flat frequency response over a wide range (0-5 to 0-500 psig). Outputs in excess of 100 mv, with natural frequency in excess of 50 kc. Cell has low sensitivity to thermal gradient.

Kulite-Bytrex Corp., Dept. ED, 50 Hunt St., Newton 58, Mass.

P&A: $425; 30 days.

Memory Core 613

Switching time is 0.4 μsec for the square loop ferrite memory in 30 mil size. For use in coincident current memories, the unit requires full read and write current of less than 600 ma. Core makes possible the dropping of cycle time to 2 or 3 μsec in large computer coincident current core memories.

Ferroxcube Corp. of America, Dept. ED, Saugerties, N. Y.

Recording System 377

High-speed transient events can be studied with the model 339B photo-instrumentation system. Unit uses a sweeping-image camera and a high-speed rotating mirror to record an event on a stationary film strip. Events with velocities as high as 200,000 ft per sec and durations of 5 nsec can be studied. Recording time is 131 μsec; rate is 9 mm per μsec.

Beckman and Whitley, Inc., Dept. ED, San Carlos, Calif.

Digital Starts Counter 407

Four-digit indicator measures 1/2 in. sq by 1-9/16 in. long, and operates from a 28-v dc source. Weighs 3/4 oz, and has a 4-digit drum counter with a range of 9,999 events or starts. Driven by a microminiature motor measuring 3/8 in. diam by 9/32 in. in length that weighs 1/9 oz.

A. W. Haydon Co., Dept. ED, Waterbury, Conn.

Electronic Products NEWS
by CARBORUNDUM®

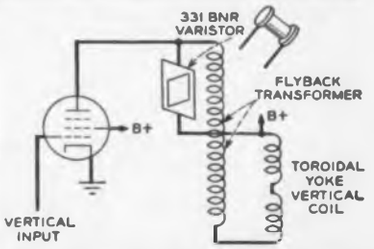
Critical Hermetic Sealing Problems Solved with metal-bonded CERAMIC-TO-METAL ASSEMBLIES and METAL-BONDED CERAMICS

High reliability requirements together with extremely rigid specifications are regularly met with custom-made metal-bonded ceramic-to-metal assemblies and metal-bonded ceramics produced by Carborundum's Latrobe Plant.

Typical of the more critical applications are those involving space capsules and guided missiles, pressure vessels, canned nuclear pumps, thermopile lead-thrus, nuclear reactors, refrigeration and air conditioning units and housings for silicon and germanium rectifiers.

Operating ranges up to 500 C in air and 1050 C in a controlled atmosphere are possible. With certain combinations of materials, installation can be made with brazing alloys melting in the vicinity of 600 C.

Helpful suggestions in solving a variety of difficult sealing problems are offered in our bulletin "Metal-Bonded Ceramic-to-Metal Assemblies and Metal-Bonded Ceramics." For your copy, or for evaluation or quotations covering your particular application, write Dept. EDC-101, Latrobe Plant, Refractories Div., Carborundum Co., Latrobe, Pa.



Flyback Transformer Voltage controlled by Carborundum Varistors

Under some operating conditions such as high line voltage, the output from the flyback transformer in a TV vertical circuit can reach 2500 volts. This far exceeds the voltage needed for normal operation and can puncture winding insulation, cause flashover at tube pins, and can damage other components.

A simple solution [illegible]e installation of a Carborundum Type 331 BNR Varistor. The voltage-sensitive resistance characteristic of the Varistor holds the flyback output to a safe 1500 volts.

Data Sheet on the reduction of induced transients using Carborundum Varistors and Bulletin GR-2 giving characteristics will be sent on request. Write Dept. EDV-101, Globar Plant, Refractories Div., Carborundum Co., Niagara Falls, N. Y.

"On Spec." yields of semi-conductor components improved with BORON NITRIDE jigs

Using graphite jigs, "on spec." yields of semi-conductor components often drop as much as 40% within 50 cycles. Manufacturers report dramatic improvement in yields when Boron Nitride jigs are used.

This material machines easily to close tolerances, resists chipping and retains internal jig details. It holds dimensions, has excellent release characteristics and is non-toxic.

Contact with silicon, germanium, indium, antimony, lead and other metals has little effect in oxidizing or reducing atmospheres. For more information, write Dept. EDB-101, Latrobe Plant, Refractories Div., Carborundum Co., Latrobe, Pa.

For ceramic parts and metallized assemblies, Kovar alloy, ceramic resistors, varistors and thermistors . . . count on CARBORUNDUM®

CIRCLE 141 ON READER-SERVICE CARD

NEW PRODUCTS

Commutating Switches 408

Miniaturized telemetering commutators have been operated under environmental conditions without drop-out, noise, bounce or signal contamination. One model, equipped with a clamped speed regulator, weighs 17 oz, has power consumption of 150 ma at 27 v dc, and provides frame rate stability of better than +3%.

Instrument Development Laboratories, Inc., Dept. ED, Attleboro, Mass.

Temperature Control 537

For use to −300 F. Model PY45 temperature control incorporates a synchronous chopper which permits response times of as fast as 20 msec. Temperature readings can be made on targets such as wire traveling at 5,000 ft per min or wire as small as 0.0003 in. It has a built-in relay to provide warning signals for manual adjustment or automatic step-control of heaters.

Mason Instrument Co., Inc., Dept. ED, 222 Valley Place, Mamaroneck, N. Y.

Recording Charts 406

Heat-sensitive recording charts provide finer trace lines, good dimensional stability, and a high degree of resistance to abrasion. Applications: industrial, military, electronic research and medical fields. Performance proven in applications as carrier signals, generator signals, and capacitor charge-discharge tests.

Graphic Controls Corp., Dept. ED, 189 Van Rensselaer St., Buffalo 10, N. Y.

Multi-layer Commutators 409

Utilize thin film techniques and a patented transfer process that provides flushness of the wiping surface to less than one micron, and dimensional tolerances of 0.0002 in. in 40 in. No drilling or soldering of interconnecting wires is necessary. Crossover circuits are imbedded in insulating material.

Intellux, Inc., Dept. ED, 30 S. Salsipuedes St., Santa Barbara, Calif.

Carbon Potentiometer 405

Model T hot-molded carbon potentiometer is actually a locking type single-turn trimmer. Rated at 1/3 w and designed for printed circuit board applications primarily. Unit is 19/32 in. in diam x 11/32 in. deep from the mounting surface. Mounts in three 1/16 in. holes in the circuit board. Available from 500 ohms to 5 meg, linear taper.

Centralab, The Electronics Div. of Globe Union, Inc., Dept ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

Availability: *immediate delivery.*

Silicon Rectifiers 416

Type D diffused junction rectifiers are for ambient operating temperatures up 125 C. Hermetically sealed case permits high-density packaging. Case is 0.240 in. in diam x 0.405 in. long. Unit is rated at 0.5 amp at 125 C. For military, industrial, home instrument and appliance applications.

Mallory Semiconductor Co., Dept. ED, DuQuoin, Ill.

P&A: *$0.415 to $0.655 in 1,000 lots; immediate.*

NEW PRODUCTS

Shielded Cabinet 498

Magnetically shielded, the NETIC sectional cabinet is for storage of magnetic tape at or near point of use. The shielding alloy is non-shock sensitive and non-retentive. Video tapes, telemetering data, audio and programing data can be stored. The cabinet is built in removable sections.

Perfection Mica Co., Magnetic Shield Div., Dept. ED, 1322 N. Elston Ave., Chicago 22, Ill.
P&A: $250 to $750; stock.

Radar-to-TV Scan Converter 410

TI-441 scan converter transforms radar ppi signals into television raster displays for easily read video presentation. Useful in air traffic control, weather observing, and harbor surveillance. Features improved resolution capability. Operates at 10-mc bandwidth and provides video picture in a 945-line system.

Intercontinental Electronics Corp., Dept. ED, 300 Shames Drive, Westbury, L. I., N. Y.
***Availability:** 30 to 60 days.*

Angle Repeater 519

With visual readout and binary-code data output of the angular position. The angle repeater has an accuracy of 20 sec of arc and a resolution of 4 sec. Specifications include: range of 0 to 360 deg, frequency to 10 kc and input impedance of 150 K. Dimensions are 19 x 15-3/4 x 12 in.

Theta Instrument Corp., Dept. ED, 520 Victor, Saddle Brook, N. J.
***Availability:** 90 days.*

Silicon NPN Transistor 501

For high-speed switching, type 2N708 planar transistor has low collector-cutoff current and excep-

◀ CIRCLE 145 ON READER-SERVICE CARD

tional stability. Ratings include: I_{CBO} of 0.025 μa at a V_{CB} of 20 and a free-air temperature of 25 C. Storage time is 25 μsec. Housing is JEDEC TO-18.

Radio Corp. of America, Semiconductor and Materials Div., Dept. ED, Somerville, N. J.

Static Inverter 415

Designed for research and development labs, production testing, and avionic and marine systems, unit delivers 1.2 kva of 3-phase, 4-wire ac output with 50 or 60-cycle input. Ac frequency is adjustable from 350 cps to 450 cps. Harmonic distortion held within 3% over this range. Ac voltage adjustable from 20 to 130-v line to neutral.

Leach Corp., Dept. ED, 18435 Susana Road, Compton, Calif.

Quick-Release Fastener 523

One-piece, molded nylon fastener is offered in No. 6, 8 and 10 sizes, accommodating wires from 0.05 in. It has a wedge or keystone shape. The base has ramp-shaped corners for tightening and pullup and the quarter-turn engagement is halted by stops molded into the central base of the fastener.

Elastic Stop Nut Corp. of America, Dept. ED, 2330 Vauxhall Road, Union, N. J.

Twin Power Pentode 553

Type 6939 can deliver an average of 5-w useful power at 500 mc under ccs conditions, and 6 w under icas conditions. In frequency-tripler service, it can deliver an average of 1.8 w useful power under ccs conditions, and 2.2 w under icas conditions. Used as a class A rf amplifier and frequency tripler.

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

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NEW PRODUCTS

Magnetic Amplifiers 417

Ultamag units are dc-to-dc amplifiers providing up to 50-db power gain at input currents as low as 20 μa for full input. Zero drift referred to the input is as low as 0.004 μa. Designed for instrumentation and control applications, and offered in standard military or industrial packages.

Military and Computer Electronics Corp., Dept. ED, 900 N. E. 13th St., Fort Lauderdale, Fla.

***P&A:** $100; stock to 3 weeks.*

Square Wave Power Sources 411

Model SQP-106T features a square wave output of 6 va, with rise time less than 250 nsec and symmetry within 500 nsec when driven by an external sine wave signal, or from a built-in source. Output voltage is variable 0 to 60 v peak-to-peak, regulation 0.5% no load to full, and 0.1% half to full load.

ELIN Div., Intercontinental Electronics Research Corp., Dept. ED, Burbank, Calif.

Electromagnetic Transducer 414

Type PR-9262 can either detect or excite vibrations without contacting object to be tested. Also permits investigation of pulsating phenomena. Features absence of any contact resonance. Sensitivity is a max of 80 mv per cm per sec. Frequency response up to 120,000 cpm, with a 15% drop-off at 60,000 cpm.

Korfund Co., Inc., Dept. ED, Cantiague Road, Westbury, L. I., N. Y.

***P&A:** $145; 2-3 weeks.*

Module Connector 419

High density micro module connector provides more than 250 terminations within a block approx 2 x 2-1/4 in. Components may be mounted between 32 printed circuit boards. Contacts are gold plated with 0.00005-in. gold over 0.0002-in. nickel. Socket contacts are beryllium copper, plated with 0.0001 in. min gold over copper flash.

National Connector Corp., Dept. ED, Science Industry Center, Minneapolis, 27, Minn.

Epoxy Paper Base Laminates 390

Flame-retardant epoxy paper base laminates are available either unclad or copper-clad. Designated types EP-800 and EP-800-T respectively, the laminates are made for printed circuits and terminal boards. Copper cladding is either one or two oz, with bond strengths of 11 and 14 psi respectively. Minimum blistering time is 30 sec. Sheet sizes 18 x 36 in. to 21 x 36 in. are available in popular thicknesses.

The Mica Corp., Dept. ED, 4031 Elenda St., Culver City, Calif.

Controlled Rectifiers 494

JEDEC 2N681 series Rock-Top Trinistors feature hard soldered junctions and hermetically weld-sealed cases. Current ratings are 16 amp half-wave (25 amp dc), with voltage ratings to 300. Units extend potential application range for static switching devices.

Westinghouse Semiconductor Dept., Dept. ED, Youngwood, Pa. ***Availability:*** *from stock in production quantities.*

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NEW PRODUCTS

Pressure Transducer 391

Measuring 1/4-in. in diameter, type PO3BA5 pressure transducer has full-scale ranges from 50 to 500 psia. The device uses semiconductor strain-sensing elements in a Wheatstone bridge arrangement. Output is 1 v for a 10-v excitation. Compensated temperature range is 30 to 130 F. Unit weighs less than 0.1 oz.

Micro Systems Inc., Dept. ED, 319 Agostino Road, San Gabriel, Calif.

Price: $395.00.

Differential DC Amplifier 420

Type 101B amplifies low-level signals in the 0-100 cps range. Input impedance is greater than 1 meg constant under all source impedance and gain conditions. Output impedance less than 1/2 ohm. Has high slewing rate of 5,000 v per sec. Filters with cutoff frequencies of 5, 10, 20 and 50 cps are directly interchangeable with 100 cps filter.

Neff Instrument Corp., Dept. ED, 1088 E. Hamilton Road, Duarte, Calif.

P&A: $625 (without rack); 6-10 weeks.

VHF Double Triode 541

Medium-mu type 8103 with strap frame design is for use as a cathode follower or rf amplifier-mixer in hybrid systems. Has 26.5-v heater and plate operation, thus requires no special plate or heater supply circuits.

Sylvania Electric Products Inc., Dept. ED, 730 Third Ave., New York 17, N. Y.

Air Valves 534

Directional air valves series HH can be served by common air supply and electrical connections by means of Add-A-Fold bases. Air supply, exhaust and electrical passages are tapped from both sides of each base to permit common connections.

Hannifin Co., Dept. ED, 501 S. Wolf Road, Des Plaines, Ill.

Cabinet Cooling Fans 392

Ultra-thin design takes up minimum space in congested electronic racks or cabinets. Provides a choice of 5 panel heights, various air discharge patterns, and air deliveries from 150 to 750 cfm. Only ball bearing motors with a very low temperature rise are used, with permanent lubrication good from −34 C to +93 C.

Kooltronic Fan Co., Dept. ED, P. O. Box 504, Princeton, N. J.

Availability: *from stock.*

Coaxial Relay 423

Subminiature coaxial relay for antenna transfer and low-power applications is less than one in. in diam and weighs less than one oz. Operating voltage is 22-32 v dc; vswr is 1.2. Cross talk is 32 db. Dimensions are: 0.980 in. diam. x 0.800 in. long. Has 50-ohm coaxial receptacles. Gold-plated contacts.

Omega Precision, Inc., Dept. ED, 757 N. Coney Ave., Azusa, Calif.

P&A: *$50 each, 1-49, $42 each, over 250; 4-6 weeks.*

Wiring Tool 539

With spring-loaded positive action, wiring tool enables quick removal of fixed wires from panels in data processing equipment. Eliminates danger of damaging terminals, marring printing, or scratching panel surfaces. Only 5-1/2 in. long, and comes with a pocket clip.

PWI Co., Dept. ED, 213 E. Grand Ave., South San Francisco, Calif.

Price: *$2.75.*

Epoxy Glass Laminates 389

For high-temperature use, these unclad and copper-clad epoxy glass laminates are flame retardant and meet Mil specs. Designated types EG-824 and EG-824-T respectively, the laminates retain 50% of their flexural strength after one-hour at 300 F. Bond strength for copper cladding is 10 to 12 psi. Laminates, made for printed-circuits, are available in popular thicknesses for sheets 18 x 36 to 21 x 36 in.

The Mica Corp., Dept. ED, 4031 Elenda St., Culver City, Calif.

NEW PRODUCTS

Subminiature Rectifiers 412

Types Q10 through Q25X can handle from 1,000 to 2,500 v prv with from 85 to 100 ma dc output over a wide range. Have maximum leakage current of 2 μa at prv at 25 C, and maximum forward voltage drop of 4 at 150 C. Operating temperature range from −20 to +130 C.

International Rectifier Corp., Dept. ED, 233 Kansas St., El Segundo, Calif.

***P&A:** $4 to $9.20, 1-to 99 quantities; from stock.*

Precision Resolver Bridge 413

Models MSB-5 and MRB-5 permit checking synchros or resolvers to 20 ppm accuracy. Both measure in 5-deg steps from 0 to 360 deg. Selector switch contact resistance has no effect on accuracy of measurements. Absolute accuracy from 0 to 800 cps is 0.002%. Frequency range extends to 10 kc at reduced accuracy. Harmonic distortion is zero.

Julie Research Laboratories, Inc., Dept. ED, 603 W. 130 St., New York 27, N. Y.

Pulse and RF Amplifiers 426

Models amplify maximum pulse widths from 10-1,000 μsec, and provide 2 to 10 nsec rise times, 0.25 to 5 peak output voltages, rf bandpass from 100 cps to 300 mc, 20 to 100-db gain, and input and output impedances from 90 to 150 ohms. Housed in bench-top instrument cases 12 in. long, x 8 in. wide x 9-1/4 in. high.

RHG Electronics Laboratory, Inc., Dept. ED, 94 Milbar Blvd., Farmingdale, N. Y.

Power Sources 429

Precision dc sources offer accuracies of 0.25% of any output voltage dialed. Model 120 provides 20 ma over the range of 500 to 2,210-v dc, model 122 provides 20 ma from 0 to 3,000-v dc, and model 123 provides 20 ma from 0 to 6,000-v dc. Stability for all models is 0.005% per hr.

Smith-Florence, Inc., Dept. ED, Seattle, Wash.
P&A: *model 120, $440, model 122, $580, model 123, $680; 30 to 45 days.*

Epoxy Resins 542

For filament winding systems requiring high tensile elongation and good handling characteristics. ERL-2256 has a viscosity range of 500 to 900 cps at room temperature; ERL-2258, for filament winders requiring ultra-low viscosity, has a range of 100 to 500 cps at 25 C. Both have long pot life and excellent mechanical properties.

Union Carbide Plastics Co., Dept. ED, 270 Park Ave., New York 17, N. Y.

Coaxial Cable Insulation 543

Series of cellular, irradiated polyolefin materials for coaxial cable designated Electrocel impart a combination of superior heat resistance and toughness with low capacitance and reduced attenuation. Especially suited to applications where space and weight savings are of prime importance.

Radiation Materials, Inc., Dept. ED, 36-32 37th St., Long Island City 1, N. Y.

Chassis Slides 428

Positive Slide Lok assures positive locking and will not unlock or open unless manually released. Fabricated from high tensile, heat-treated anodized aluminum with ball spacers, ball bearings and stop pins of passivated stainless steel. Weight capacities from 50 to 500 lb per pair, in lengths from 10 to 68 in.

Sliding Mechanisms, Inc., Dept. ED, 2401 W. Ohio St., Chicago 12, Ill.
Availability: *3 to 5 weeks.*

NEW PRODUCTS

Servomechanism Packages 430

Design of semistandard Series O packages facilitate the inclusion of special, easily adjustable damping networks to meet dynamic response specifications of specific applications. Emphasis is placed on reliability and ease of adjustment.

Superior Manufacturing & Instrument Corp., Dept. ED, 36-07 20th Ave., Long Island City 5, N. Y.

Thermometer 497

AT-14 automatic switching thermistor thermometer is available in 3, 4, 6, or 12 channels. Has fast response up to 0.4 sec per 20 C change. Accuracy 1% of full scale deflection. Automatic sequential switching between channels at 15, 30, and 60 sec intervals. Switching sequence can be controlled manually.

The Waters Corp., Dept. ED, P. O. Box 529, Rochester, Minn.

Analog-to-Digital Converter 421

Model 5000 has an overall accuracy of +0.01% plus 1 digit. Makes 15,000 complete voltage readings per second. Input impedance for the +10-v range is 6.25 k ohms. Settling time for the input amplifier is 4 μsec or less. Available in rack-mountable packages measuring 5-1/2 in. high, 19 in. wide, and 12-1/2 in. deep. Weight is 26 lb.

Non-Linear Systems, Inc., Dept. ED, Del Mar Airport, Del Mar, Calif.
P&A: $6,950; from stock.

Variable Delay Line 434

Model DL 372 delivers any delay from 0 to 0.7 μsec with resolution of 0.001 μsec by adjusting the 10-turn screwdriver-slotted shaft. Specifications: rise time 0.09 μsec; impedance 500 ohms; attenuation 1 db max; distortion 10% max. Meets shock, vibration, temperature and humidity requirements of MIL-STD-202A.

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.
***Availability:** 2 weeks.*

Amplifier Tube 617

Gain is 20 db with a bandwidth of 50 mc, ±3 db for the amplifier tube type N1044. Noise figure is less than 2 bd over a bandwidth of at least 25 mc. Saturation output power is 50 μw. Center frequency is 408 mc and the tube operates with a magnetic focusing field of 147 gauss.

English Electric Valve Co., Ltd., Dept. ED, Chelmsford, England.

High Temperature Adhesive 612

Temperatures to 1,000 F can be sustained by the adhesive designated Raiseal 350. Uses include protection of electrical components and bonding copper to glass fiber epoxy laminates and other laminating processes where high temperature and high electrical resistance are primary requirements.

Radiation Applications Inc., Dept. ED, 36-40 37 St., Long Island City 1, N. Y.

Temperature Probe 432

Whisker probe has a smaller OD than average insulated wire. Only 0.050 in. OD x 1/4 in. long, can be used wherever a wire lead can be run. Accuracy to 0.1% of full range from −452 F to 500 F. Sensing elements are available in tungsten or platinum. Standard resistance range is 20 to 1,000 ohms at 32 F.

Temtro, Inc., Dept. ED, 3016-C S. Halladay, Santa Ana, Calif.

NEW PRODUCTS

Transistorized Scanner 551

Designed to sequentially switch data points, in the form of contact closures or voltage levels, to a common output device. Consists of CM-100 series circuit modules mounted in a standard relay rack chassis. Maximum switching capacity is 199 points. Size is 7 in. high x 19 in. wide x 11 in. deep. Weight is approximately 20 lb.

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

Time Delay Relays 431

RealTime relays are designed for the breadboarding of control circuits and devices. Available in ranges from 10 msec to 90 sec. Use solid-state control circuits with silicon semiconductors. Accuracy +10%. Max over-all dimensions are 1-3/4 x 1-1/2 x 4-1/2 in.

Systems Design, Inc., Dept. ED, 7536 San Fernando Road, Sun Valley, Calif.
Price: $15.

Data Transceiver 381

Rates to 4,800 bits per sec of information are possible with the digital data transceiver HC-270. Information is coded by the transmitter on a single tone in the form of four orthogonal phases and recognized at the receiver by element-to-element comparison. Unit is completely transistorized.

Hughes Aircraft Co., Dept. ED, P. O. Box 90-902, Los Angeles 45, Calif.

Epoxy Glass Laminates 395

Grades EG 824 and EG 824-T unclad and copper clad laminates comply with MIL-P-18177B (Type GEB) and MIL-P-13949B (GB). Retain at least 50% of flexural strength after exposure to 300 F for one hour. Average minimum bond strengths approx 12 lb per in. for 2 oz copper cladding, and 10 lb per in. for 1 oz. Sheet sizes 18 x 36, 20 x 36, 21 x 36 in.

The Mica Corp., Dept. ED, 4031 Elenda St., Culver City, Calif.

Two-Conductor Plugs 485

Unusual terminal arrangement includes one clamp sleeve connection and one combination wrap-around or solder-cup connections. Made of nickel-plated brass parts with tinned terminals, plugs have red or black plastic handles. Internal insulation is of Mylar and phenolic. Plugs tested at 500 v rms.

Zoron, Inc., Dept. ED, Chicago, Ill.

Analog Multiplier 376

Static accuracy of 0.15% is rated on the model 160 analog multiplier. Amplitude is ±100 v. Input impedance is 50 K. Units are all solid-state, mounted on a 4 x 9 in. board. They plug into analog computers, or are available in chassis of up to 20 units.

Applied Dynamics, Inc., Dept. ED, 2275 Platt Road, Ann Arbor, Mich.

P&A: $470; immediate.

Fast Solenoids 388

Response of 1.5 to 2 msec is offered by a line of subminiature solenoids. Units move 1 lb a distance of 0.015 in. Power input is 3 to 6 v dc at 20 to 25 w. Pulses of greater power can be used.

Wahlgren Magnetics Div., Marshall Industries, Solenoid Dept., Dept. ED, 1900 Walker Ave., Monrovia, Calif.

Power Supply 487

High voltage source for radar, broadcasting, microwave, and other types of uhf transmission has continuously variable multiple outputs. Ac input is 208 v, +10%, arranged in a 60-cycle, 3-phase circuit. Outputs are: 15, 500 v, 5.5. amp; 7,500 v, 0.25 amp; 3,800 v, 0.25 amp; −600 v, 2 amp; −300 v, 0.075 amp.

Richardson-Allen Corp., Dept. ED, 116-15 15th Ave., College Point, L. I., N. Y.

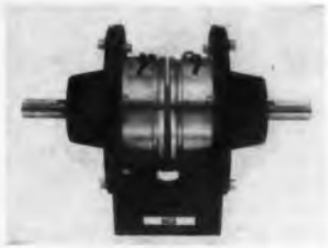
NEW PRODUCTS

Magnetic Tape Recorder 393

The 2101 system consists of a precision tape transport and an electronic module assembly. Choice of 14 tracks of wideband fm recording or 7 tracks of direct analog recording can be made. Frequency response is dc to 10 kc in wideband fm, and 50 to 100 kc in direct record at a tape speed of 30 ips. Tape packing density is 3,300 cps.

Westrex Recording Equipment Div., Dept. ED, 335 N. Maple Drive, Beverly Hills, Calif.

Clutch-Brake Drive 484



Preassembled fractional horsepower Electro-Pack drive combines electric clutch and brake in a compact prealigned unit that bolts in place with no machining. Field servicing is greatly simplified because reassembly is foolproof and realignment unnecessary. Heavy duty bearings insure maximum life under exacting conditions.

Warner Electric Brake & Clutch Co., Dept. ED, Beloit, Wis.
Price: *list $132 to $236 ea.*

Pyrometer 540

Covers industrial infrared wavelength spectrum of from 1 to 12 microns. Sensitive infrared eye watches target from a remote position, providing complete safety. Stable detector elements used throughout. Uses no mirrors. For the primary metals, fabricated metals, stone, clay, glass, chemical, paper, and textile industries.

Servo Corp. of America, Dept. ED, Hicksville, N. Y.

Regulated Power Supplies 373

Constant voltage or current operation is provided by these power supplies. Designated series ABC, the units are rated up to 40 v dc, 500 ma, continuously variable. Regulated to 0.05%, units have only 0.5 mv rms ripple. Remote programing and error sensing is possible. Units measure 4-1/2 x 8-5/32 x 5-5/8 in.

Kepco Inc., Dept. ED, 131-38 Sanford Ave., Flushing 52, N. Y.
P&A: *$99 up; 90 days.*

Recording Camera 489

C-13 directly records oscilloscope traces, and accepts Polaroid or conventional film. Has an unusual sliding back on which you can interchange the par-focal film-holding backs. Uses any of 6 interchangeable lenses in varying object-to-image ratios and maximum aperture to f/1.5. Also has one-hand portability.

Tektronix, Inc., Dept. ED, P. O. Box 500, Beaverton, Ore.

Wirewound Potentiometers 533

Single-turn, 1/8-in., sine-cosine potentiometers have a resistance range of 100 to 15,000 ohms. Standard conformity tolerance is 1.2% peak-to-peak on a single cup and 1.5% on multiple cups. Resolution in the resistance range of 100 ohms is 0.5% to 0.2% with 1.2 to 0.52-deg angular resolution.

Fairchild Controls Corp., Dept. ED, 225 Park Ave., Hicksville, L. I., N. Y.

Weighing System 528

For weighing in motion. Designed for use in steel manufacturing, the system uses an 80-ft mechanical-lever, railway-track scale linked to strain-gage load cells. A servo null-balancing system converts electric signals into printed weights in 3 sec. Loads of up to 330,000 lb can be weighed.

Fairbanks, Morse & Co., Dept. ED, 745 Fifth Ave., New York 22, N. Y.

Microminiature Pins and Sockets 424

Microminiature units are designed for printed circuit boards and limited-space applications. Over 100 different configurations are available. Sockets are closed-entry, multiple-spring types. Units accept wire diameters from 0.065 down to 0.010 in. Pin sizes range from 0.017 to 0.060 in. in diam.

Omega Precision, Inc., Dept. ED, 757 N. Coney Ave., Azusa, Calif.

Availability: *from stock.*

NEW PRODUCTS

RF Capacitor 558

Constructed of low-loss plastic, type GS is designed for rf current and pulse work. Feature conservative voltage ratings, low rf losses, minimum inductance and light weight. Operates from −55 deg C to +65 deg C. Encased in a high quality glass tubing with silver bands fused at each end. Tolerance is +10%.

Corson Electric Manufacturing Corp., Dept. ED, 540 39th St., Union City, N. J.

Silicon Power Transistors 496

Units feature saturation resistance of 0.037 ohms, low thermal impedance, 250 w continuous power dissipation, over 5,000 w pulse power dissipation, and voltage ratings through 200. Have 30-amp collector rating, and 175 C maximum junction temperature. Available with flexible and flag-type terminals.

Westinghouse Semiconductor Dept., Dept. ED, Youngwood, Pa.
Availability: *from stock.*

Control Panel Wireway 556

Designed for the compact 300-v relay, system takes advantage of natural horizontal channels formed between horizontal rows of compact relays when mounted on a control panel. Space provides room and protection for wires and permits easier wire accessibility to relay terminals. Lacing or threading of wires is eliminated.

ECP Corp., Dept. ED, 4726 Superior Ave., Cleveland 3, Ohio.

Low Background Counting System 548

Called LowBetamatic, system has compact 3-dimensional sample magazine with capacity for 84 samples in sizes of up to 3 in. in diam. Can be programed for automatic counting of any sample group without recycling to zero. Empty sample positions may be automatically bypassed.

Sharp Laboratories, Inc., Dept. ED, Box 1302, La Jolla, Calif.
Availability: *from plant.*

High-Voltage Power Supply 547

Shorting-bar shorts the high-voltage output when the set is not in use. Model 2M-40 provides a continuously variable output of 15 to 40 kv at 2 ma. For use in insulation testing, plastic pinning, electrostatic flocking and painting, spot knocking and other applications.

Spellman High Voltage Co., Dept. ED, 1930 Adee Ave., Bronx 67, N. Y.
***P&A:** $340; from stock.*

High-Speed Tester 482

Seizes both pigtails of diodes, transistors, capacitors, and resistors and makes low-resistance electric test connections without bending or breaking leads. Spring-loaded jaws are opened and part to be tested is dropped into fixture. No strain on pigtails at any time. Fixture requires bench space only 3-1/4 x 3-1/4 in.

Precision Metal Products Co., Dept. ED, 41 Elm St., Stoneham, Mass.
***Availability:** from stock.*

Epoxy Resin 546

Low viscosity epoxy resin is for electronic components and assemblies. Type B clear resin, when used with dash-one hardener, is a room temperature curing system. Has dielectric constants of 4 to 60 cps, 3.9 at 10 kc, and 3.6 at 1 mc. The B-1 epoxy system has a viscosity of 500 centipoise at 75 deg F.

Tau Engineering Co., Dept. ED, P. O. Box 304, Culver City, Calif.
***P&A:** $4.90; from stock.*

Radio Survey System 545

Hi-Fix is a mobile radio position-fixing system that gives accuracies of +1 m on the base lines. Operates in the 2 mc region of the rf spectrum, and has a range of 100 miles or more. Requires only one transmission frequency. Can be used in the hyperbolic, two-range, or hyperbolic/two-range configurations, depending on application.

Decca Navigator System, Inc., Dept. ED, 1028 Connecticut Ave., N.W., Washington, D. C.

NEW PRODUCTS

Printed Circuit Board Holder 433

Features specially formed parallel guide wires welded in pairs to longitudinal support wires. Boards are held in place by natural resilience of wire. Special flat springs are inserted between the guide wires to provide additional holding power where shock loads are severe.

E. H. Titchener & Co., Dept. ED, 8 Titchener Place, Binghamton, N. Y.

Power Supply 425

Low-voltage 10-amp power supply has a rating of 250 mv at 10 amp dc. Can hold its voltage rating to within +1% with any combination of line changes of +15%, load changes from 0 to 10 amp, and with ambient temperature range of 0 to 50 C. Can be mounted in a 19-in. rack.

Power Equipment Co., Dept. ED, Galion, Ohio.

Price: $350 in quantity.

Harness Assembly Clips 609

Diameters are 1/4 to 1-1/4 in., in eight sizes. The Q-clips hold harness assemblies until lacing. They can be used on vertical or three-dimensional harness boards. Two round holes in a flat base provide for easy fastening.

Holtronics, Electronics Components Div., Dept. ED, 7100 Avalon Blvd., Los Angeles 13, Calif.

Isolator Power Supply 490

Model PC-34 converts grounded 28 v dc to floating and filtered +12 v, +9 v dc, with more than 70% efficiency at 1.5 w. Capacitance coupling of output to ground is less than 30 pf. Operates from −40 C to +125 C ambient temperatures. A single inverter drives up to four isolators, depending on the loads.

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

Availability: from stock.

Explosive Cartridges 608

Power producing explosive cartridges actuate separation systems, electrical disconnects, data-package ejection systems and other devices. A typical cartridge weighs 14 g, produces 10,000-psi gas pressure in 5 μsec, operates from −320 to +500 F and withstands 100-g shock.

Hi-Shear Corp., Dept. ED, 2600 W. 247th St., Torrance, Calif.

DC Relay 481

Type SS hermetically sealed relay has a contact rating of 2 amp resistive at 28 v dc or 115 v ac. Contact arrangement is dpdt. Dielectric strength is 1,000 v rms, between contacts and ground. Vibration is 10 g to 2,000 cps. Life is 100,000 operations at rated load. Insulation resistance is 100 meg min.

Comar Electric Co., Dept. ED, 3349 W. Addison St., Chicago 18, Ill.

DESIGN DECISIONS

Featuring the clever and unusual in packaging, appearance design, and circuitry in electronic equipment.

Bonded Sandwich Makes Better Bus

Replacing an open-type, voltage-distribution bus of alternate layers of copper strips and insulation, a new "sandwich" bus, a bonded laminate, completely seals the conductors.

The bonded-sandwich concept, jointly developed by IBM Corp. in Poughkeepsie, N. Y., and Rogers Corp. in Rogers, Conn., is rigid enough to require only a minimum of support and installation time; it cuts installation costs; and it is impervious to solder splash, humidity, dust, and dirt.

Together with molded-plastic blocks with imbedded terminal pins, the bus lends itself to a building-block construction which allows engineering changes to be made quickly. The bus has copper tabs extending from each of 10 layers of copper strips. Ten pairs of pins in the molded block slide through mating slots in the copper tabs to facilitate connections.

Any number of connection blocks can be used as well as any length bus, so the voltage distribution system can be used in large as well as small systems. "T" connections

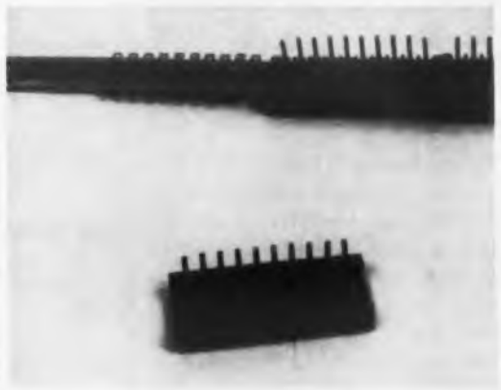


Fig. 1. Sandwich bus has bonded layers of copper strip and 5-mil insulation.

Fig. 2. Slotted tabs at each layer of copper slide over molded connection block.

Fig. 3. New distribution bus is easier to connect to and makes for easier changes than conventional wire bundle.

and "L" connections are easily made and junctions can be taped (rather than bonded) to give them the necessary flexibility for conforming to contours during assembly.

Off-the-Shelf Delay Lines Speed Prototype Design

One of those "why didn't I think of that?" solutions has been offered to meet the problem of quick delivery of one-of-a-kind, prototype delay lines. The problem—getting a special design in a hurry and at reasonable cost—is an old one.

The solution, offered by engineers at Nytronics, Inc. of Berkeley Heights, N. J., is to manufacture small, modular lines that can be stacked to provide delays to meet 80 per cent of prototype, delay-line requirements.

Called "Wee Lines," the encapsulated modules provide delays ranging from 10 to 100 nsec in 10-nsec increments. More than 200 sections can be stacked to provide a very wide range of delays.

Individual sections, basic LC circuits, include phase correction and provision for taps. To simplify selection further, Nytronics engineers developed a graph to help the

DESIGN DECISIONS

Modular delay lines can be cascaded to answer most delay-line needs quickly.

circuit designer select the proper combination of Wee Lines to provide the required delay, rise time, and impedance.

Molded Plexiglass Cuts Dust-Free-Cabinet Problems

Dust-free plexiglass cabinets are usually fabricated of sheets of optically clear plexiglass. They work well in most cases, but they always pose the danger that improper handling will spring a seam and, of course, allow dust into the enclosure.

A novel, and almost obvious approach to this problem, has been taken by Gerwen Electronics, Inc. of 7-22 149th St. in Whitestone, N. Y. Gerwen simply molded the cabinet and completely eliminated any need for seamed construction. This knocked out the possibility of sprung seams and, as a bonus, provided a larger unobstructed view of the work area.

Dust-free cabinet, of molded-plexiglass construction provides unobstructed view and eliminates possibility of sprung seams.

Phasable Wiper in Ganged Pot Allows Easy, 360-Deg Phasing

A completely different approach to the design of phasable potentiometers eliminates phasing problems inherent in previous pot designs. It allows one to adjust the phase of an individual pot in a gang through a full 360-deg rotation without upsetting the phasing of the other pots and without altering the position of a wiring harness because of changes in position of pot terminals.

Earlier phasable-pot designs took one of three forms. In the most common type, clamp rings hold the individual resistance cups together. To change the phase of one cup with respect to the others, it is necessary to loosen its clamp ring and rotate that cup. But all other cups can be thrown out of phase during the process and settings can change while tightening a clamp. Further, a setting can change under vibration.

In another type, set screws around the periphery of each cup allow for phasing. This type of pot has a more stable setting under vibration but the same problem of rephasing all cups applies.

In still another type, the resistance element is in a separate ring which can be rotated and locked with a set screw. Here, rotation for phasing is independent of other cups, but the rotation is limited to only about 40 deg of the possible 360.

A new pot, the Daystrom model 319, overcomes all these weaknesses. Patented by Elias Blanco, chief engineer of Daystrom's Potentiometer Div. in Archbald, Pa., the pot has a wiper contact whose angular position with respect to the shaft can be adjusted through a 360-deg rotation from outside the pot housing. A small Allen wrench can be inserted through a tiny hole in the casing to

Phasing of individual pots in a gang can be adjusted in 15 or 20 sec without affecting the other pots. Note that set-screw sealing plugs can be rotated to close off access ports.

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DESIGN DECISIONS

vary the wiper's angle by means of a worm-and-gear interconnection.

The access hole is an off-center opening in a captive, stainless-steel screw. The screw can be rotated through 180 deg to close off the hole and seal out dust.

Scale Expander, Useful in Lab, Is Packaged, Offered for Sale

Some of the most useful instruments, one often suspects, may have started as "trick rigs" that engineers developed for their own use in the lab. One such instrument, an "Incremental Analyzer," started just that way at Tensor Electric Development Co. of 1873 Eastern Parkway, Brooklyn.

The instrument started as a simple scale expander. It is obvious that a common volt-ohm-milliammeter (vom) can easily be modified to become a multi-range, expanded-scale instrument. The meter-coil connections are simply brought out through a bucking power supply to a sensitive, dc millivoltmeter.

For example, if an external, 1-mv meter is substituted for the 250-mv meter in the Simpson 270, its scale is expanded 250 times. This does not increase the absolute accuracy of the Simpson, but it increases the resolution so small input changes can be observed more easily.

With one such form of modification or another, any vom can serve a wide variety of functions. For example, a high-impedance servo recorder can be set up to record all or part of any range of the vom. Temperature, voltage, current, resistance—all can be recorded as easily as they can be read on the vom. Further, the modified instrument can control a sensitive relay which can be triggered at any point within the vom's range.

Any vom can be used, of course, but it is important to substitute a stable resistor for the copper meter coil. Changes in coil resistance can introduce an error of 0.4 per cent per deg F. Substituting the resistor eliminates this temperature error.

Engineers at Tensor Electric found these meter modifications so useful in their own labs that they packaged them into a commercial instrument. In their commercial version, a mercury battery and a 10-turn potentiometer provide a convenient bucking supply, and an output attenuator helps program various output devices.

Designer's Guide:

Electrical Conductivity of Copper Base Alloys

C. L. Bulow
Bridgeport Brass Co.
Bridgeport, Conn.

AS ELECTRICAL conductors are asked to do more things—to give mechanical support, conduct heat, and permit welded connections—the tendency is to explore many different alloy combinations. This can lead to alloys which have electrical conductivities quite different from familiar electrical wire, alloys which are available in different combinations of mill shapes and which may have different manufacturing characteristics.

The data tabulated here provide a rapid check list of electrical conductivity and available mill shapes for copper alloys of importance to electronics. Representative current uses for these alloys are also given. ■ ■

Item	Alloy	Chemical Composition	Electrical Conductivity	Mill Shapes	Uses
1	**Oxygen Free Copper** (Certified OFHC) (Certified OFHC°)	99.90 copper (min)	102%	SRWT°°	Radio, television, radar, computer, etc., electronic parts, for sealing to glass, bus conductors, waveguide, tubes, flanges, etc.; transistor and rectifier bases, heat sinks, hydrogen brazing. Also cold-formed and impact-forged parts.
2	**Electrolytic Tough** Pitch Copper (ETP)	99.90 copper (min)	101%	SRW	Forged electrical connectors, strip-type transformer windings and tapes, switches, bus bars, circuit breakers, radio, television electronic parts, terminals, gaskets, heat sinks.
3	**Silver Bearing Copper**	10 oz silver Troy/Ton Avoir Type STP	101%	SRW	Does not soften as readily during soldering as coppers Items 1, 2 and 8.
4	**Silver Bearing Copper**	20 oz silver Troy/Ton Avoir Type STP	101%	S	Softening point slightly higher than Copper Item 3.
5	**Sulfur Copper**	Copper 99.7% Sulfur 0.3%	97%	R	Free machining copper for screw machine or drilled parts. Conductor assemblies and connectors.

Item	Alloy	Chemical Composition	Electrical Conductivity	Mill Shapes	Uses
6	**Tellurium Copper**	Copper 99.5% Tellurium 0.5%	90%	RW	Same uses as Copper Item 5.
7	**Zirconium-Copper**	Copper 99% Zirconium 0.15%	92% (aged)	RW	High electrical conductivity and good strength at elevated temperatures and outstandingly high softening point. Resistance welding wheels and electrodes, soldering iron tips, slip rings, rectifier and transistor bases, battery terminals, eyelets, spring contacts, etc.
8	**Deoxidized Copper** (DHP)	Copper 99.91+% Phosphorus 0.02%	85%	SRWT	Heat sinks.
9	**Red Brass**	Copper 85% Zinc [illegible]%	37%	SRWT	Screws, conduits, eyelets.
10	**Low Brass**	Copper 80% Zinc [illegible]%	32%	SRWT	Battery caps, clock dials, bellows.
11	**Cartridge Brass**	Copper 69.5% Zinc 30.5%	28%	SRWT	Eyelet machine items, electric plug caps, springs, large head cap screws, rivets, connector strips, springs, contact clips, solder lugs.
12	**Yellow Brass**	Copper 66% Zinc 34%	27%	SRWT	Screw type lamp bases, sockets, screws, cap screws, rivets, pins, springs, strips, silver plated contact clips, hardware, solder lugs.
13	**Leaded Commercial Bronze**	Copper 89.5% Lead 2% Zinc balance	42%	R	More machinable than its non-leaded counterparts. Nuts, wire and cable connector parts.
14	**Free Cutting Brass**	Copper 61.25% Lead 3.4% Zinc balance	26%	RW	Screw machine parts, clock parts, potentiometer parts, phone jacks and plugs, binding posts, screw terminals.
15	**High-Leaded Brass**	Copper 63.25% Lead 1.8% Zinc balance	26%	SRW	Screw machine parts requiring some cold working such as roll threading, knurling, forming, or expanding, toggle switch parts, binding posts, bushings.
16	**Low-Leaded Brass**	Copper 65.5% Lead 0.5% Zinc 34.0%	26%	S	Watch and instrument plates. Small gears and wheels.
17	**Contact Bronze 828**	Copper 92.0% Tin 1.9% Zinc 6.1%	26%	S	Substitute for phosphor bronze springs, spring contacts, slide contacts, etc. Higher electrical conductivity than Item 21, also higher conductivity than phosphor bronze Item 23.
18	**Naval Brass**	Copper 60% Tin 0.65% Lead 0.12% Zinc balance	26%	SRWT	Bolts, nuts, hardware, meter parts, hot forgings, bushings.

Item	Alloy	Chemical Composition	Electrical Conductivity	Mill Shapes	Uses
19	**Medium Leaded Naval Brass**	Copper 60% Lead 0.6% Tin 0.65% Zinc balance	26%	R	More readily machinable than Alloys, Item 18.
20	**Leaded Naval Brass**	Copper 60% Lead 1.75% Tin 0.65% Zinc balance	26%	R	More readily machinable than Alloy, Item 18. Phone jacks and plugs.
21	**Contact Bronze**	Copper 88.95% Tin 1.90% Phosphorus 0.15% Zinc balance	22%	S	Substitute for phosphor bronze springs, spring contacts, slide contacts, etc.
22	**Phosphor Bronze (A)** (Grade A)	Copper 95.6% Tin 4.25% Phosphorus 0.15%	18%	S	Springs, snap switches, terminals, fuse clips, meter parts, slide contacts, relay parts, lock washers, diaphragms, bellows.
23	**Phosphor Bronze 8%** (Grade A)	Copper 94.35% Tin 5.5% Phosphorus 0.15%	18%	SW	Springs, fuse and component clips, spring contacts, meter parts, slide contact contacts, relay parts, snap switches, terminals.
24	**Nironze**	Copper 97.5% Nickel 1.9% Silicon 0.6%	30%	SRW	High strength, heat treatable alloy with good electrical conductivity. Combined simultaneous heat treatment and silver brazing often possible. Suitable for springs, fuse clips, component holders, bolts, studs, clamps. Compare with Phosphor Bronze and Beryllium Copper.
25	**Nickel Silver (B) 18%**	Copper 55% Nickel 18% Zinc 26.85% Manganese 0.15%	5.5%	S	Spring parts and contacts for telephone boards, radios, controls, springs, resistance wire. diaphragms.
26	**Duronze 609***** (Low Silicon Bronze B)	Copper 98% Silicon 2%	9%	SRWT	Pole-line hardware, nuts, bolts, wire and b cable connectors, cap screws, springs, conduits, rivets.
27	**Duronze 632***** (High Silicon Bronze)	Copper 96.95% Silicon 2.95% Iron 0.10%	7%	SRWT	Similar to Item 26, but harder and stronger, though less ductile.
28	**High Silicon Bronze**	Copper 96.05% (A) Silicon 3% Manganese 0.95%	6.5%	SRWT	Pole-line hardware, nuts, bolts, wire and cable, connectors, cap screws, springs, conduits, rivets.
29	**Duronze 707*****	Copper 90.85% Silicon 2% Aluminum 7.15%	7%	R	High strength screw machine hot-formed or hot-forged parts, bolts, nuts, thrust screws, wire and cable connector parts, switchgear, gears, etc.

Notes:

* Registered trade mark, American Metal Climax Corp.

** S = Strip, R = Rod, W = Wire, T = Tube.

*** Registered trade mark, Bridgeport Brass Co.

NEW LITERATURE

Epoxies 261

Technical data on the firm's line of helix bonding agents, potting compounds, sealants, coatings, and accessories are given in this 48-page catalog. Information on high-temperature, thermally conductive, lightweight, and one-component epoxies is included. Carl H. Biggs, Co., Inc., 1547 14th St., Santa Monica, Calif.

Variable Transformers 262

The firm's line of variable transformers is described in 40-page catalog, Section One. Illustrations, descriptions, specifications, and dimensional drawings for units giving variable output up to 140 or 240 v, 7 kva, are included. An engineering section gives application data and circuit diagrams. Standard Electrical Products Co., 2240 E. Third St., Dayton, Ohio.

Ceramic Tubes 263

Data on ceramic tubes are given in this two-volume publication. Bulletin ETD-2713, 213 pages, contains technical data, including diagrams, graphs, illustrations, a selection chart, and socket data, on 35 tubes. Bulletin ETD-2134, 52 pages, contains application information and data on design, materials, performance, and reliability of small ceramic tubes. General Electric Co., Receiving Tube Dept., Owensboro, Ky.

Field-Effect Transistors 264

Operating principles and characteristics of field-effect transistors are outlined in this eight-page pamphlet entitled "Silicon Field-Effect Transistors." Equivalent circuits, typical characteristic curves, noise formulas and curves, and design data on the firm's line are included, along with notes on application in amplifier and logic circuits. Crystalonics, Inc., 249 Fifth St., Cambridge 42, Mass.

Microwave Amplifiers 265

Receiver mixer-preamplifiers, if and rf amplifiers, parametric amplifiers, and laboratory receivers are described in the firm's 48-page catalog. Over 700 units are listed. Notes on application in radar receiver design are included. LEL Inc., 75 Akron St., Copiague, N. Y.

Scientific and Test Instruments 266

The firm's line of amplifiers, components, data handling systems, potentiometers and bridges, magnetic tape instrumentation, nuclear instrumentation, oscillographs, recorders and indicators, and related devices are listed in condensed 48-page catalog No. G-10b. Illustrations and ratings are included. Minneapolis-Honeywell Regulator Co., Station M389, Wayne and Windrim Aves., Philadelphia 44, Pa.

Digital Instrumentation 267

Vacuum-tube and solid-state digital counter-timers, frequency-period meters, time interval meters, controllers, printers, and readouts are cataloged in this 20-page illustrated booklet. Descriptions, ratings, and prices and included for the firm's line. Computer Measurements Corp., 12970 Bradley Ave., San Fernando, Calif.

Antennas 268

Two-way antennas and their accessories are described and illustrated in this 24-page catalog, No. 598. Electrical and mechanical specifications, impedance curves, radiation patterns, and a discussion of antenna gain and propagation appear. Information on foam polyethylene insulated transmission line is also given. Prodelin, Inc., 307 Bergen Ave., Kearny, N. J.

Wirewound Potentiometers 269

Wirewound potentiometers rated from 1.5 to 50 w are described in 12-page catalog No. 2-61 Section 3. Single-turn, power-type, printed-circuit, waterproof, and encapsulated potentiometers are listed, with illustrations, specifications, and dimensional drawings. Power derating curves are given. Clarostat Manufacturing Co., Inc., Dover, N. H.

Sound Absorption Material 270

Use of Fiberglas to absorb sound transmitted through air and equipment is described in this 14-page pamphlet entitled "Appliance and Equipment Quieting Materials." Sound absorbing methods are discussed; tables and graphs outline properties of various materials; nomographs indicate amount of material required to reduce sounds of different frequencies. Owens-Corning Fiberglas Corp., Toledo 1, Ohio.

NEW LITERATURE

Circuit-Development Cost Reduction 271

Use of transistor testing equipment to reduce cost of developing semiconductor circuits is discussed in this eight-page pocket-size pamphlet. Six specific applications of transistor analyzers are suggested and illustrated. The firm's instruments are briefly described. Owen Laboratories, Inc., 55 Beacon Place, Pasadena, Calif.

Optical Encoders 272

Eight-page catalog contains specifications and technical descriptions of linear and sine-cosine encoders, called Dicotron, for converting angular position information into binary code. Includes principles of operation, applications, packaging features, and relationship between disk coding and degree of accuracy. Computer Control Co., Inc., 983 Concord St., Framingham, Mass.

Button-Mica Capacitors 273

Eighteen-page bulletin 318-2 describes all 90 variations of resin-sealed button-mica capacitor available. Design features make them ideal for vhf and uhf applications in the −55 C to +85 C range. Includes general description, dimensional drawings, complete specifications, and standard color code. Erie Electronics Div., Erie Resistor Corp., 645 W. 12 St., Erie, Pa.

Silicone Rubber 274

Fifty-six page fully illustrated brochure describes the uses and abuses of silicone rubber. Serves as an aid to designers, specifiers, and users. Contains classifications of silicone rubber, properties of general purpose silicones, uses of silicones in fluids, weather and heat resistance, dielectric properties, and testing of silicone rubber. Includes a properties chart. Mechanical Rubber Products Co., Warwick, N. Y.

Strain Recording 275

Twenty-page illustrated booklet describes applications of strain gages and strain gage based transducers for accurately recording strain tension, thrust, load and torque. Basic strain recording circuits shown for recording from 1, 2, or 4 active gages. Explains techniques used to obtain precise recording of both static and dynamic strain phenomena. Brush Instruments, Div. of Clevite Corp., 37th and Perkins, Cleveland 14, Ohio.

Spectrometer Systems 276

Twelve-page illustrated catalog covers the complete line of Nuclear Magnetic Resonance (NMR) and Electron Paramagnetic Resonance (EPR) systems. Contains a brief description of the technique of NMR and EPR spectroscopy and complete specifications on the A-60 system, the HR-60, the DP-60, the V-4200B, and the V-4502 systems. Varian Associates, Instrument Div., 611 Hansen Way, Palo Alto, Calif.

Wirewound Potentiometers 277

Precision wirewound potentiometers are described and illustrated in 12-page booklet No. 11-60 Section 1. Technical specifications and dimensional drawings are given for single turn, multiple turn, trimming, and special function potentiometers. Clarostat Manufacturing Co., Dover, N. H.

Tantalum Capacitors 278

Bulletin 511 contains 14 pages describing Tantacons, solid tantalum capacitors, designed for filter, bypass, coupling, blocking, and other low-voltage applications. Includes dimensional drawings, mechanical and electrical specifications, MIL-Erie cross reference chart, general specifications, typical life test data, and leakage current characteristics. Erie Electronics Div., Erie Resistor Corp., 644 W. 12th St., Erie, Pa.

Wires and Cables 279

Booklet entitled "Wires and Cables for Electronic Equipment and Systems", No. WC-3131G, is a reference for design engineers and purchasing agents. Includes complete data on multiconductor and single-conductor cables in a wide variety of constructions and combinations of thermoplastic, thermosetting, and Teflon insulation and jackets. General Electric Co., Wire & Cable Dept., Bridgeport, Conn.

Microwave Test Instruments 280

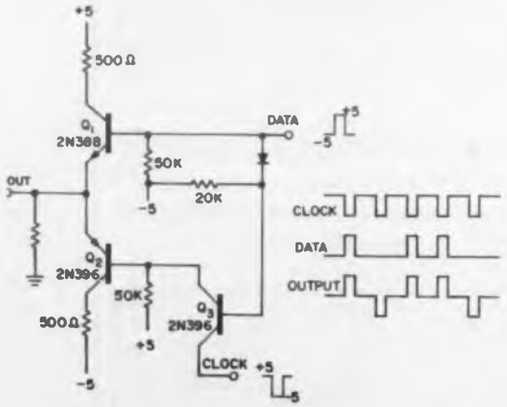
Booklet lists applications and specifications of complete line of equipment. Features a new product line of transistorized instruments, including a spectrum analyzer, microwave receiver, microwave impulse generator, and calibrated field intensity receiver. Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N. Y.

IDEAS FOR DESIGN

Circuit Transmits Two Pulse-Trains Over Single Channel 739

The recording of bipolar "clock" and "data" pulses on a single channel of a strip-chart recorder required a method for keeping simultaneous pulses from cancelling. This was accomplished with a circuit, shown in the figure, which needed no delays to achieve time separation. The circuit can also be used in any application calling for the transmission of two pulse trains over a single channel.

Presence of a data pulse turns on transistor Q_1 and holds transistors Q_3 and Q_2 off,



Circuit allows bipolar clock and data pulse trains to be recorded on a single channel.

thus inhibiting passage of the clock pulse. A clock pulse alone will turn Q_3 and Q_2 on.

In actual use the clock pulse was made wider than the data pulse so that a clock pulse would be recorded with each data pulse for easier reading. The collector resistors in Q_1 and Q_2 are for short-circuit protection and may be omitted.

David H. Brand, Supervisory Electronic Engineer, Systems Development Branch, Wright-Patterson AFB, Ohio.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 739.

Zener Diodes Trigger Time-Sequenced Pulses 749

Separate, time-sequenced signals, generated from a single trigger source, can be obtained from the Zener diode circuit shown in the figure. The desired delay times between signals are set by matching the ratings of the Zeners to the RC charge characteristics of each branch.

The time constants of the branches are approximately related by:

$$T_A \approx 3T_C \text{ and } T_B \approx 2T_C$$

These simple relations exist because the dc source voltage (300 v) is much greater than any of the Zener voltages. The circuit parameters shown are for relatively long delay times (such as used with relay triggering applications). However, fast pulses and short delays can also be obtained.

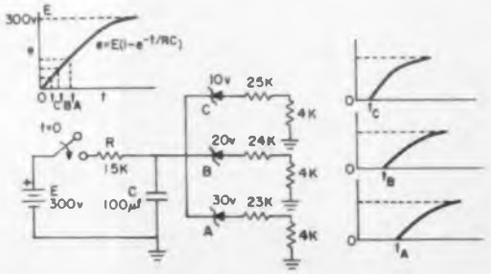
Adjustments in T_A, T_B, and T_C would have to be made for precise timing that depended, for instance, on the trigger-voltage sensitivity of the external circuitry. If this minimum triggering voltage were V_t, corresponding to T_t, the triggering times of outputs A, B, & C would then be:

$T_A + T_t$, $2/3\ T_A + T_t$, and $1/3\ T_A + T_t$.

For a linear approximation T_z, any Zener time is given by

$$E_z/_E = T_z/_{RC} \text{ and } T_z = E_z/_E\ (RC).$$

From these relations any desired delay time may be determined from a low Zener



Time-sequenced signals are obtained from a single source with this Zener diode trigger circuit.

voltage with respect to capacitor voltage. When higher Zener voltages are used, or a lower capacitor charging voltage, the linear time approximation is no longer applicable and the exponential nature of the capacitor voltage must be considered.

In general $e = E\ (1 - e^{-t/RC})$ and $e/_E - 1 = -e^{-t/RC}$; thus: $ln\ (1 - e/_E) = -t/_{RC}$.

If the Zener voltage E_z exists, then:

$$T_z = [\ -RC]\ [ln\ (1 - E_z/_E)]\ \cdot$$

George B. Smith, Electrical Engineer, High Voltage Engineering Corp., Burlington, Mass.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 749.

Vote for Ideas Valuable to You

Vote for the Ideas which are valuable to you. Other engineers will vote for the Ideas which are most valuable to them. The Idea which receives the most "Valuable" votes will be judged "Most Valuable of Issue." Its author will receive a $50 award.

Choose the Ideas which suggest a solution to a problem of your own or stimulate your thinking or which you think are clever.

The Ideas chosen as the most valuable in each issue will be eligible for the $1,000 Idea of the Year award.

So vote for the Ideas you find most valuable. And, after you've voted, why not send in an Idea of your own?

$50 "Most Valuable of Issue" Award For Multi Switching Method

Robert W. Allington, engineer with the Ampex Instrumentation Products Co., Redwood City, Calif., has won ELECTRONIC DESIGN's $50 Most Valuable of Issue Award.

Mr. Allington receives the award for his Idea for Design, "Extra Transistor Reduces Turn-Off Time in One-Shot Multi," which appeared in the June 21 issue. The idea described a method for reducing turn-off time of a monostable multi by adding an extra transistor.

How You Can Participate

Rules For Awards

Here's how you can participate in Ideas for Design's Seventh Anniversary Awards: All engineer readers of ELECTRONIC DESIGN are eligible.

Entries must be accompanied by filled-out Official Entry Blank or facsimile. Ideas submitted must be original with the author, and must not have been previously published (publication in internal company magazines and literature excepted).

Ideas suitable for publication should deal with:

1. new circuits or circuit modifications
2. new design techniques
3. designs for new production methods
4. clever use of new materials or new components in design
5. design or drafting aids
6. new methods of packaging
7. design short cuts
8. cost saving tips

Awards:

1. Each Idea published will receive an honorarium of $20.
2. The Idea selected as the most valuable in the issue in which it appears will receive $50.
3. The Idea selected as the Idea of the Year will receive a Grand Prize of $1,000 in cash.

The Idea of the Year will be selected from those entries chosen Most Valuable of the Issue.

Most Valuable of the Issue and Idea of the Year selections will be made by the readers of ELECTRONIC DESIGN. The readers will select the outstanding Ideas by circling keyed numbers on the Reader-Service cards. Payment will be made eight weeks after Ideas are published.

Exclusive publishing rights for all Ideas will remain with the Hayden Publishing Co.

SEVENTH ANNIVERSARY AWARDS

IDEAS-FOR-DESIGN

Entry Blank

Ideas-for-Design Editor
ELECTRONIC DESIGN
850 Third Ave.
New York 22, N. Y.

Idea (State the problem and then give your solution. Include sketches or photos that will help get the idea across.)

(Use separate sheet if necessary)

I submit my Idea for Design for publication in ELECTRONIC DESIGN. I understand it will be eligible for the Seventh Anniversary Awards—$20 if published, $50 if chosen Most Valuable of Issue, $1,000 if chosen Idea of the Year.

I have not submitted my Idea for Design for publication elsewhere. It is entirely original with me and does not violate or infringe any copyrights, patents or trademarks or the property rights of any other person, firm or corporation.
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Name _____ **Title** _____

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For Additional Entry Blanks, circle **750** on Reader-Service Card.

IDEAS FOR DESIGN

Modified Modulator Yields Wide-Band FM Transmitter 748

In a simple transmitter circuit, a Pacific Semiconductor Varicap was used in a basic modulating configuration, Fig. 1. Unfortunately, it was very difficult to obtain a uniform modulation index over the entire range.

The original circuit injected the audio modulation through a capacitor into the bias circuit of the Varicap. This required a very large capacitor to get down to low modulation frequencies. By making circuit changes, Fig. 2, the large input capacitor was eliminated to yield uniform modulation from dc to over 10 kc.

In modifying the circuit, the ground return of the Varicap is lifted off ground and a resistor is added between this point and ground. The resistor can be selected to match the modulation source impedance. An rf bypass completes the Varicap path to ground.

The addition of the resistor in the Varicap ground return apparently does not upset the bias on the Varicap, assuming resistor R is

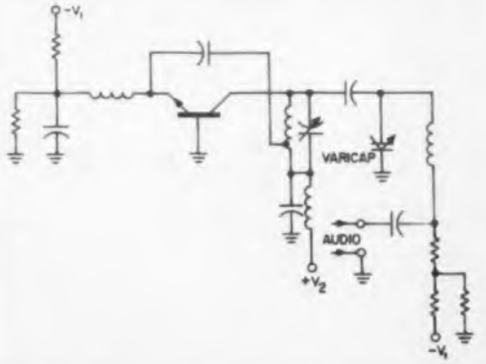

Fig. 1. Original transmitter circuit injected audio modulation through a capacitor into Varicap modulating circuit; modulation index was not uniform.

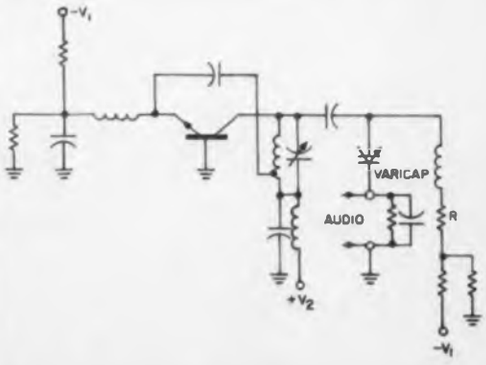

Fig. 2. Modified circuit eliminates input capacitor, allows uniform modulation from dc to over 10 kc.

a high value. Measurements showed that only 0.5 v is developed across it even with an audio matching resistor of 2 K.

Philip R. Houghton, Technician, Motorola, Inc., Scottsdale, Ariz.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 748.

Grounded-Grid Circuit Simplifies Microphone Input 733

To operate satisfactorily, carbon microphones have to have a dc bias applied to them. Thus, the conventional mike-input circuit, Fig. 1, is used. This circuit requires an input transformer and a dc source—a battery, as shown, or a resistor to $B+$.

Both the transformer and the dc source can be eliminated by using the grounded-grid circuit of Fig. 2. The dc bias is provided by

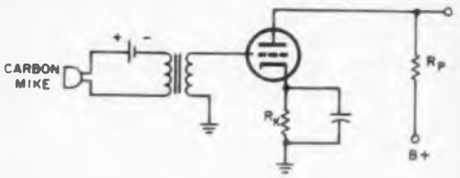

Fig. 1. Conventional carbon mike input circuit requires dc source and transformer.

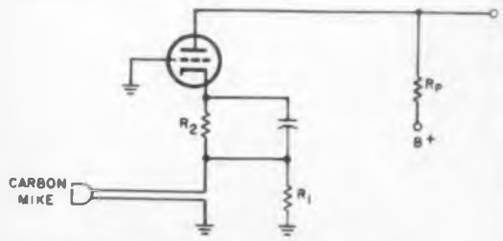

Fig. 2. Both the dc source and the transformer can be eliminated by using this grounded-grid circuit.

the tube's plate current. Impedance matching is maintained because of the lower input impedance of the grounded grid. The values of the resistors R_1 and R_2 are given by:

$$R_1 = \frac{R_m I_m}{I_p - I_m}$$

$$R_2 = R_k - \frac{R_1 R_m}{R_1 + R_m}, \text{ where}$$

I_p = plate current
R_k = design value of cathode resistance
I_m = mike bias current desired
R_m = average mike resistance

D. Ivarson, Staff Scientist, Clifton Precision Products Co., Clifton Heights, Pa.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 733.

BOOKS

Introduction to Circuit Analysis
John D. Cowan, Jr. and Herbert S. Kirschbaum, Charles E. Merrill Books, Inc., 1300 Alum Creek Drive, Columbus 16, Ohio, 307 pp, $7.95.

The treatment is purposely elementary and general enough so that the book can either serve as an introduction to circuit analysis for the electrical engineering student or provide in a single book a modern treatment of circuit analysis for the non-electrical engineering student.

The first chapters take pains to describe introductory concepts in easily grasped but engineering-oriented manner. Despite the elementary nature of the start, the text manages to cover most of the concepts and analysis techniques used by practicing engineers. However, the authors purposely avoid LaPlace transforms. The authors feel that rather than develop too early a facility in LaPlace transforms, the engineer should first acquire a firm understanding of how to describe the circuits in terms of differential equations. In line with the modern concept of giving students "breadth," the authors carry along in parallel the concepts of mechanical engineering and give a brief explanation of the use of analog computers in solving the typical differential equations which these systems have in common with electronic circuits.

Some of the chapter headings are: Physical Basis of Circuit Elements; Network Geometry; Inductive Coupling; Polyphase Steady-State Analysis; Network Theorems; and Non-Sinusoidal Waves and Fourier Analysis.

Plasmas and Controlled Fusion

David J. Rose and Melville Clark, Jr., The MIT Press, Massachusetts Institute of Technology, and John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 495 pp, $10.75.

A graduate-level text on the principles underlying plasma physics and controlled fusion, its material is based on a knowledge of atomic physics, differential equations, electricity and magnetism, and thermodynamics. Topics covered include plasma physics, hydromagnetics, elementary gaseous electronics, the controlled fusion problem, and methods of energy recovery.

The Physical Theory Of Transistors

Leopoldo B. Valdes, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 370 pp, $10.50.

Analyzes the flow of current through semiconductor materials and derives relationships between the electrical characteristics of transistors and their physical structure. Also deals with specific device structures.

Fundamentals Of UHF

Allan Lytel, John F. Rider Publisher, Inc., 116 W. 14 St., New York, N. Y., 160 pp, $3.90 (paperbound).

Deals with frequencies of from 300 to 3,000 mc, discussing antennas, transmission lines, wave propagation, generators, communications and test equipment, and techniques.

Electronic Packaging with Resins

Charles A. Harper, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 339 pp, $11.00.

A guide and reference for applications involving the casting, potting, impregnation and encapsulation of electrical and electronics components and systems.

High Fidelity Sound Engineering

Norman H. Crowhurst, Pitman Publishing Corp., 2 W. 45 St., New York 36, N. Y., 328 pp, $10

Presents procedures for designing high fidelity sound systems. Basic circuits and components are discussed and applied.

BOOKS

Cybernetics

Norbert Wiener, The MIT Press, Massachusetts Institute of Technology, and John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 212 pp, $6.50.

A revised version of the earlier work, this edition corrects the slight errors which first appeared and presents an amplification of the present status of the subject and of the new related modes of thought recently developed.

Transistors and Active Circuits

John G. Linvill and James F. Gibbons, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 515 pp, $14.50.

Discusses fundamental problems encountered in active circuits, particularly those in which the active element is a transistor. The three parts of the text deal with the physics of semiconductors, two-port network theory, and transistor circuits.

Electronic Engineering Principles

John D. Ryder, Prentice-Hall, Inc., Englewood Cliffs, N. J., 430 pp, $12.65.

Covers the theory of vacuum tubes and transistors in a combined and interwoven approach. Basic mathematical and circuit viewpoints are followed by material on Class A and Class B circuit operation at nominal frequencies.

Advances In Electronics & Electron Physics, Vol. 14

L. Marton, Editor, Academic Press Inc., 111 Fifth Ave., New York 3, N. Y., 340 pp, $11.00

Proceedings of the Second International Conference On Operational Research, Nov. 1960

Banbury & Maitland, Editors, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 810 pp, $15.00.

Oceanography

Mary Sears, Editor, American Association for the Advancement of Science, 1515 Massachusetts Ave., N. W., Washington 5, D. C., 665 pp, $12.50 (AAAS members), $14.75. ±

Science In Communist China

Sidney H. Gould, Editor, American Association For the Advancement of Science, 1515 Massachusetts Ave., N. W., Washington 5, D. C. 884 pp, $14, $12 (AAAS members).

Progress In Very High Pressure Research

F. P. Bundy, W. R. Hibbard, Jr., and M. M. Strong, Editors, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 314 pp, $12.00.

The Punched Card Data Processing Annual, Vol. 1

Eugene F. Murphy, Editor, Gille Associates, Inc., 956 Maccabees Building, Detroit 2, Mich. 240 pp, $50, $40 (pre-paid) for both volumes.

Television and Radio Repairing

John Markus, McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y., 576 pp, $8.95.

Transactions of the Symposium On Electrode Processes, May 1959

Ernest Yeager, Editor, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 375 pp, $20.00

Introduction To Hi-Fi

Clement Brown, Gernsback Library, Inc., 154 W. 14 St., New York 11, N. Y., 192 pp, $3.20 (paperbound).

Radio Control Manual

Edward L. Safford, Jr., Gernsback Library, Inc., 154 W. 14 St., New York 11, N. Y., 192 pp, $3.20 (paperbound).

A First Course In Sound Recording and Reproduction

"Decibel", Pitman Publishing Corp., 2 W. 45 St., New York 36, N. Y., 120 pp, $3.95.

REPORT BRIEFS

Linear Amplifiers

Currently known techniques for vacuum tube and circuit design that can be applied to the development of a low distortion linear amplifier at high frequencies were investigated. Beam-deflection techniques seem to offer a means of space charge control that appears capable of producing linear amplifications. Emissions from metals by high field intensities was investigated as a technique to avoid the space charge control problem. Conventional rf feedback was found superior to other types of feedback, which included envelope feedback, ultralinear circuits, and screen clamping techniques. *Techniques For Linear Amplifier Tube and Circuit Design, R. E. Meek, G. H. Smith and others, Georgia Institute of Technology Engineering Experiment Station, Atlanta, Ga., Dec. 1960, 141 pp, $11.50. Order AD-256753 from OTS, Washington 25, D. C.*

Antenna Arrays

Research was concerned with investigating the noise level of various antenna arrays. It showed that the performance of an array can be optimized by controlling several parameters such as element diameter, number of elements, spacing between elements, and feedline attenuation. The array type antenna offers certain advantages over the single aperture antenna when high power transmission, correction for atmospheric effects, extremely high gain and bandwidth control are desired. *The Design of Antenna Arrays For Maximum Signal to Noise Ratio, John W. Eberie, Antenna Laboratory, Ohio State University Research Foundation, Columbus, Ohio, March 1961, 21 pp, $2.60. Order AD-256390 from OTS, Washington 25, D. C.*

RF Propagation

Propagation of an electromagnetic wave through the earth's atmosphere is discussed. Even with the omission of effects due to the earth's megnetic field and deviations resulting from tropospheric and ionospheric inhomogeneities, ray tracing is quite difficult. The relatively simple method of dividing both the troposphere and ionosphere into a number of spherically stratified layers and summing progressively the refraction in each layer has allowed accommodation of a wide range of refractive index distributions.

From the given graphical presentations and suggestions for the programing of other relevant profiles, the tracking engineer or radio astronomer may easily determine the influential factors leading to a realistic assessment of a curve for refraction error. *Atmospheric Refraction of Radio-Frequency Electromagnetic Waves, P. F. Nicholson, Naval Research Laboratory, Washington, D. C., April 1961, 36 pp, $3.60. Order AD-256768 from OTS, Washington 25, D. C.*

Transistor Parameters

The Z-parameters of a transistor were calculated in terms of the transistor T-equivalent circuit parameters. The calculations have been made for a frequency of 1.0 kc. In addition, each of the independent equivalent circuit parameters was halved and doubled while the rest were held constant, and the effect on the Z-parameters investigated. The results indicate that in the common base and common emitter configurations the input impedance depends on r_b only, while the forward transfer impedance depends on r_b and r_c. The rest of the parameters are functions of r_c and C_c only. *Dependence of Z-Parameters On The LF Transistor T-Equivalent Circuit, Nicholas Kyriakopoulos, Diamond Ordnance Fuze Laboratories, Washington, D. C., April 1961, 27 pp, $2.60. Order AD-256478 from OTS, Washington 25, D. C.*

Sampled-Data Systems

Three problem areas associated with the design of linear sampled-data systems are considered in this report. The first arises from having the transition and distribution matrices of the system as random variables. The second arises from having multiplicative noise at the input to the system, (a special case of the first problem area). The third results from being unable to measure exactly the state vector of the system. In each of these 3 areas, the performance of the system is measured by using either a generalized sum-squared-error, a final-value, or a minimum-time criterion. The design procedures are based either upon minimizing the expected value of the performance index or upon minimizing the performance index in the presence of worst-case variations within the system. *Optimum Designs of Sampled-Data Systems With Random Parameters, T. L. Gunckel, Stanford Electronics Laboratories, Stanford University, Calif., May, 1961, 70 pp, $7.60. Order AD-255857 from OTS, Washington 25, D. C.*

YOUR CAREER

Salaries for the 119 graduating engineers of Cornell University who were processed by the school's Engineering Placement Office ranged from $444 to $833 a month, with a median of $566. This figure was for all types of engineering, but the 59 engineers in the electrical engineering category (along with metallurgical engineers) showed the greatest salary jump over last year. Of Cornell's total of 274 graduating engineering students, 91 entered graduate schools.

* * *

Salaries for graduating engineers of Illinois Institute of Technology average $550 a month. This figure is for all types of engineering, but electrical and metallurgical engineers lead the field with an average of $566 and $590 a month, respectively. Metallurgical engineers showed the greatest salary jump over last year's $520, compared with $544 for last year's electrical engineers.

The electrical-machine industry was first choice of the recent graduates, according to E. C. Kubicek, IIT director of placement and alumni relations.

Graduate work placed second, continuing the upward trend of advanced study.

* * *

Spiders' sensitive hearing has been studied, using delicate electronic techniques, by Charles Walcott of Harvard's Division of Engineering and Applied Physics.

The spider's hearing organ, located near the tip of its leg, accurately locates buzzing insects caught in its web. By tapping in on the leg nerve with tiny electrodes, Dr. Walcott measured the sensitivity of the vibration receptor over the organ's frequency range, from 20 to 50,000 cps. The receptor's peak sensitivity was found to be about 1,000 times greater than that of the grasshopper's ear, but 100 times less than that of the human ear.

* * *

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Study the employment opportunity ads in this section. Then circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

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- All forms are delivered unopened to one reliable specialist at ELECTRONIC DESIGN.
- Your form is kept confidential and is processed only by this specialist.
- The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.
- All original applications are placed in confidential files at ELECTRONIC DESIGN, and after a reasonable lapse of time, they are destroyed.

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Published Articles _____

Minimum Salary Requirements (Optional) _____

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing

Circle Career Inquiry numbers of companies that interest you

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YOUR CAREER

often waste a great deal of time looking for "uncommon men" when they should be asking themselves how to encourage the "indispensable men" they now have.

* * *

The new symbol for the General Dynamics Corporation has been bothering some engineers. This is the one that goes something like: "GIIIIIIIID." Some engineers keep seeing the word "GUILD" whenever the symbol catches them unaware.

A quick call to the corporation's headquarters in New York City provided this enlightenment: The bars between the "G" and the "D" represent the company's eight divisions. There is no high-powered "corporate-image" meaning lurking behind the logo; it was just part of art work that went into the company's 1959 annual report, and it happened to have caught top management's fancy.

The person at General Dynamics who gave out this information said she kept seeing "GUILD," too.

* * *

A biomedical computing section has been formed by New York University's College of Engineering to provide computer services for medical researchers. A $48,000 grant was received from the Nation Institute of Health to further this attempt to help medicine make use of computers for reduction of data.

A long range goal of NYU's engineering research division is to develop a highly automated computing center for the processing of medical data on a large scale. Its staff has already carried out a considerable amount of research on the application of computers to medical data analysis, including a successful prediction of coronary diseases in men under 40. The laboratory will shortly augment its IBM 650 with a CDC 1604 computer.

ENGINEER-IMPROVEMENT COURSES AND SEMINARS

Operations Research Course
New York City, Oct. 16-18

American Management Association will conduct a workshop seminar on "Effective Use of the Company's Operations Research Effort," Oct. 16 to 18, at the Hotel Astor, New York City. It is intended for both managers of O.R. groups and other corporate executives responsible for coordination of

O.R. projects within their companies.

Attendance is limited to 15 registrants, one from each company. Registration fee for the three-day meeting is $150 (AMA Members), $175 (nonmembers). *Write American Management Association, Inc., 1515 Broadway, New York 36, N. Y.*

System Reliability Conference Oct. 20, NYU College of Engineering

The New York Metropolitan Chapter of the IRE Professional Group on Reliability and Quality Control has scheduled its Second New York Conference on Electronic Reliability for Oct. 20, at New York University's College of Engineering, University Heights. It will be under the joint sponsorship of the New York, Long Island, and Northern New Jersey Sections of the IRE.

The general theme will be "System Reliability Engineering," stressing techniques needed to plan and control large, multimode electronic systems and their reliability requirements.

Morning, afternoon and evening sessions will be conducted, with special reference to mathematical models, value trade-offs, and reliability cost.

Advance registration fee is $5 payable to the New York Conference on Electronic Reliability. Send to *M. A. Benanti, Molecular Electronics Co., New Rochelle, N. Y.*

ASQC Product Maintainability Seminar, Philadelphia, Oct. 24, 25

A product maintainability working seminar will be held at the Sheraton Hotel, Philadelphia, Oct. 24 and 25. Topics for the seminar, sponsored by the Electronics Div. of the American Society for Quality Control (ASQC), will include: specifying maintainability, effects of human factors, systems level trade-offs, automation of maintenance, measurement, prediction of time needed, "throwaway" maintenance, costing and organization for maintenance. Both military and commercial interests will be considered.

For additional information contact: B. W. Marguglio, The Martin Co., Mail No. 2000, Baltimore 3, Md.

Reliability Training Course Montreal, Oct. 30 — Nov. 4

A Reliability Training Course, sponsored by the IRE and ASQC, will be held from Oct. 30 to Nov. 4 at the Sheraton Mount Royal Hotel, Montreal. The course, a number of which have been held throughout the

YOUR CAREER

USA, presents the theory, management, and application of modern reliability techniques. Details may be obtained from *L. C. Thomas, Canadian Aviation Electronics Ltd., P. O. Box 2030, Montreal, Canada.*

Automation, Computers, and Instrumentation at Georgia Tech, Feb. 12-16

Georgia Institute of Technology and the Instrument Society of America will sponsor a one-week course on Automation, Computers, and Instrumentation, Feb. 12-16, 1962, on the Georgia Tech campus, Atlanta.

The course is designed to orient technical personnel in the latest concepts of instrumentation, analog computers, digital computers and automation. Special emphasis will be placed on problems dealing with the replacement of human effort by the appropriate automatic equipment.

Tuition, including supplies and textbooks, will be $125. *Contact Director, Short Courses and Conferences, Georgia Institute of Technology, Atlanta 13, Ga.*

PAPER DEADLINES

Nov. 1: For the **1962 International Solid-State Circuits Conference** to be held **Feb. 14 - 16** at Philadelphia. The conference, sponsored jointly by the University of Pennsylvania and the IRE, will stress circuit design in such advanced areas as solid-state memory; storage and logic; solid-state microwave amplification, oscillation and conversion; solid-state devices performing an integrated circuit function; unconventional power supplies, and cryogenic and optoelectronic applications.

Papers should be sent in abstract (300 to 500 words) along with pertinent illustrations to Richard H. Baker, Room C-237, MIT Lincoln Laboratory, Lexington, Mass.

Nov. 15: Deadline for 100-word abstracts and 500-word summaries to be presented at the **1962 National Winter Convention on Military Electronics.** This will be held at the **Ambassador Hotel,** Los Angeles, Calif., on **Feb. 7, 8, and 9.**

Subjects include: system and technical management, instrumentation, reliability, undersea warfare and sonar systems, radar and fire control systems, aerospace ground equipment, reconnaissance and electronic

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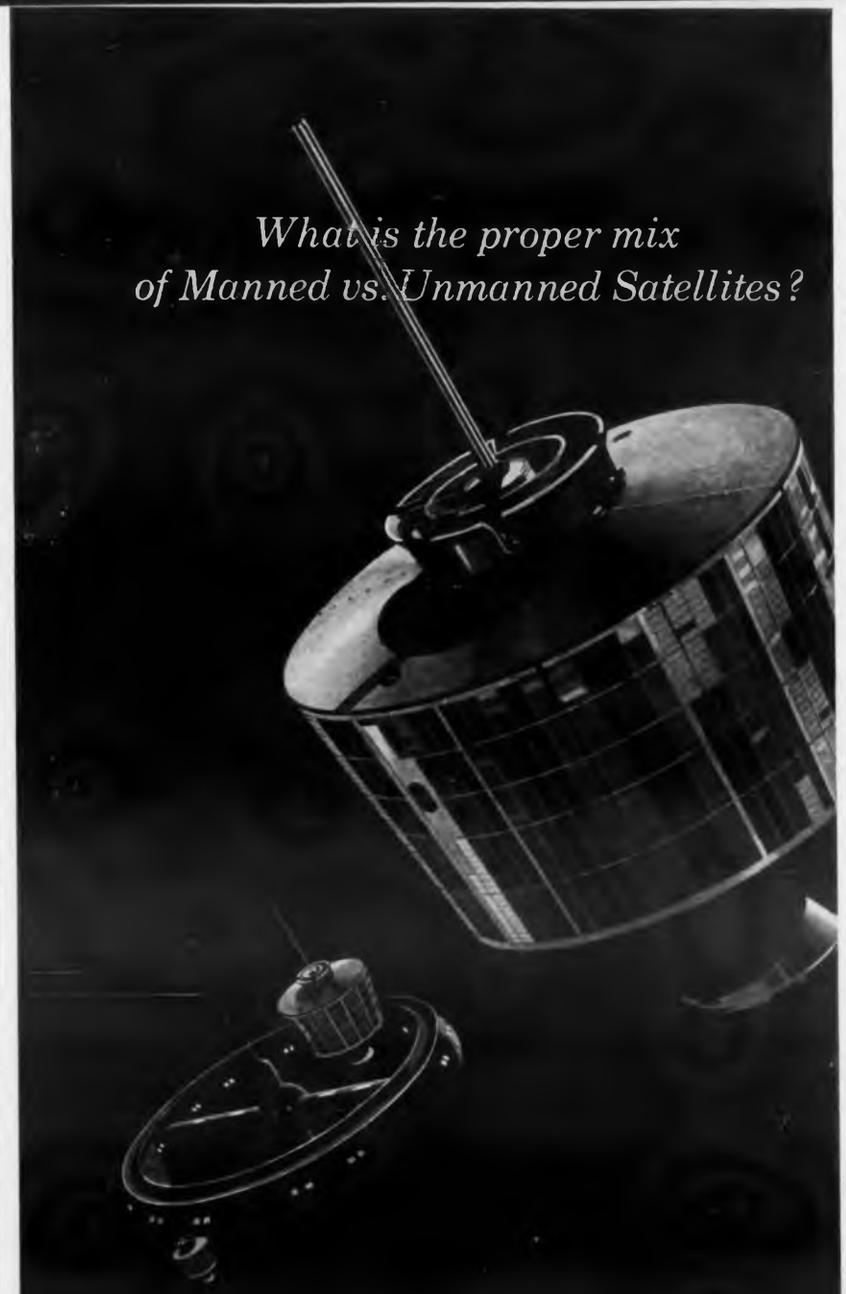

What is the proper mix of Manned vs. Unmanned Satellites?

opportunities for

systems analysts

Hughes Aerospace Engineering Division has openings for Systems Analysts to consider and analyze a wide spectrum of basic problems such as:

What are the requirements for manned space flight?

Justify choice of systems considering trade-off of choice in terms of cost effectiveness.

Automatic target recognition requirements for high speed strike reconnaissance systems or unmanned satellites.

IR systems requirements for ballistic missile defense.

Optimum signal processing techniques for inter-planetary telecommunications.

Analysis of weapon systems from conception through development, test and customer use.

Design concepts for new airborne weapon systems.

The positions involved with the solution of these basic and critical questions present opportunities for the optimum application of the technical and analytical backgrounds of graduate physicists and engineers with both systems and specialized experience.

If you are interested in helping to solve these questions and are a graduate physicist or engineer with a minimum of three years experience in weapon systems analysis, operations analysis, IR, physics of space, signal processing or communication theory, we invite your inquiry. For immediate consideration, please airmail your resume to: **Mr. Robert A. Martin,** Supervisor, Scientific Employment, Hughes Aerospace Engineering Division, Culver City 12, California.

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warfare, missile and space systems and subsystems, tracking, telemetry and command systems, military equipment design and product engineering, military systems requirements and environments, information and data handling systems, and navigation and air traffic control systems.

Authors are requested to send abstracts and summaries plus short biographies to *Matthew E. Brady, Space Technology Laboratories, P. O. Box 95001, Los Angeles 45, Calif.* Confidential papers must be cleared by authors and sent to *Major James L. Blilie, USAF, U. S. Air Force Systems Command, Regional Office, 6331 Hollywood Blvd., Los Angeles 28, Calif.* These will be considered for publication.

Dec. 1: Deadline for 800-1,200-word summaries of papers for the **Symposium on Electromagnetic Theory and Antennas** to be held **June 25-30th, 1962,** at the **Technical University of Denmark, Copenhagen.** As announced by the IRE, the international symposium will encourage papers on: electromagnetic fields in anisotropic media (plasmas and ferrites), diffraction theory, scattering in random media, quasi-static electromagnetic problems, theory of broad-band antennas, and antenna pattern synthesis. *Write to: H. Lottrup Knudsen, secretary, Symposium on Electromagnetic Theory and Antennas, Oster Volgade 10 G, Copenhagen K, Denmark.*

Jan. 1: Deadline for 200-word abstracts of papers for the **Symposium on Cleaning and Materials Processing for Electronics and Space Apparatus** to be held during the Fourth Pacific Area National Meeting of the American Society for Testing Materials, **Sept. 30 to Oct. 5, 1962,** at the **Statler-Hilton Hotel,** Los Angeles. The symposium, sponsored by ASTM Committee F-1 on Materials for Electron Tubes and Semiconductor Devices, will deal with materials and processing problems in electronic device fabrication. Subjects considered: examination of device materials; treatment and examination of specific components; processing facilities such as chemical agents, processing liquids and ambients, including dust and lint control; and device experience with ultraclean conditions. Send abstracts with titles to: *Dr. D. E. Koontz, Bell Telephone Laboratories, Inc., Murray Hill, N. J.*

ADVERTISERS' INDEX

October 11, 1961

*Manufacturers' catalog appears in 1960-1961 ELECTRONIC DESIGNERS' CATALOG

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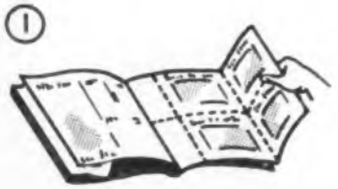
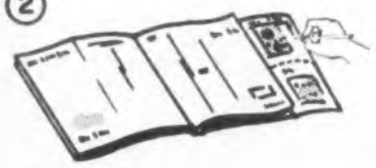
① 

Fold out card.

② 

Leave card folded out, and read magazine. No need to turn pages to reach card, or to tear out card until ready to mail. Circle to your heart's content.

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VIA AIR MAIL

FIRST CLASS
Permit No. 725
New York, N. Y.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed In U. S.

POSTAGE WILL BE PAID BY

ELECTRONIC DESIGN
ONE DAY READERS INQUIRY SERVICE
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ELECTRONIC DESIGN · ONE DAY SERVICE USE BEFORE NOVEMBER 22, 1961

Name ____________________ Title ____________________

Company ____________________

Company Address ____________________ City __________ Zone ______ State ______

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For employment brochures give home address City Zone State
Home Address

For Change of Address:
Old Company Name ____________________

Old Company Address __________ City __________ Zone ______ State ______

☐ I Do Design Work
☐ I Supervise Design Work
☐ I Do No Design Work

ELECTRONIC DESIGN · ONE DAY SERVICE USE BEFORE NOVEMBER 22, 1961

Name ____________________ Title ____________________

Company ____________________

Company Address ____________________ City __________ Zone ______ State ______

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For employment brochures give home address City Zone State
Home Address

For Change of Address:
Old Company Name ____________________

Old Company Address __________ City __________ Zone ______ State ______

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ELECTRONIC DESIGN · ONE DAY SERVICE USE BEFORE NOVEMBER 22, 1961

Name Title

Company

Company Address City Zone State

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Old Company Name

Old Company Address City Zone State

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ELECTRONIC DESIGN · ONE DAY SERVICE USE BEFORE NOVEMBER 22, 1961

Name Title

Company

Company Address City Zone State

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308	318	328	338	348	358	368	378	388	398	408	418	428	438	448	458	468	478	488	498	508	518	528	538	548	558	568	578	588	598
309	319	329	339	349	359	369	379	389	399	409	419	429	439	449	459	469	479	489	499	509	519	529	539	549	559	569	579	589	599
600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760	770	780	790	800	810	820	830	840	850	860	870	880	890
601	611	621	631	641	651	661	671	681	691	701	711	721	731	741	751	761	771	781	791	801	811	821	831	841	851	861	871	881	891
602	612	622	632	642	652	662	672	682	692	702	712	722	732	742	752	762	772	782	792	802	812	822	832	842	852	862	872	882	892
603	613	623	633	643	653	663	673	683	693	703	713	723	733	743	753	763	773	783	793	803	813	823	833	843	853	863	873	883	893
604	614	624	634	644	654	664	674	684	694	704	714	724	734	744	754	764	774	784	794	804	814	824	834	844	854	864	874	884	894
605	615	625	635	645	655	665	675	685	695	705	715	725	735	745	755	765	775	785	795	805	815	825	835	845	855	865	875	885	895
606	616	626	636	646	656	666	676	686	696	706	716	726	736	746	756	766	776	786	796	806	816	826	836	846	856	866	876	886	896
607	617	627	637	647	657	667	677	687	697	707	717	727	737	747	757	767	777	787	797	807	817	827	837	847	857	867	877	887	897
608	618	628	638	648	658	668	678	688	698	708	718	728	738	748	758	768	778	788	798	808	818	828	838	848	858	868	878	888	898
609	619	629	639	649	659	669	679	689	699	709	719	729	739	749	759	769	779	789	799	809	819	829	839	849	859	869	879	889	899

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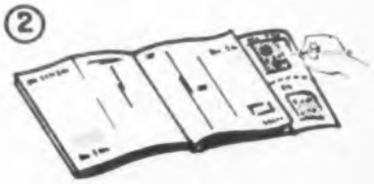
② 

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