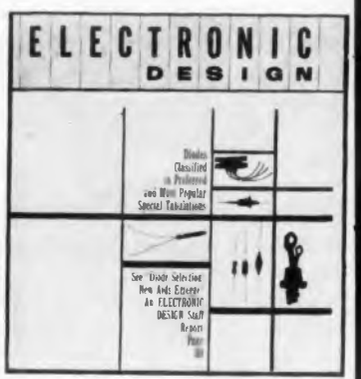
ELECTRONIC DESIGN

Diodes Classified in Preferred and Most Popular Special Tabulations

See "Diode Selection: New Aids Emerge" An ELECTRONIC DESIGN Staff Report Page 30



COVER: The handy tables and charts included in this issue's Diode Report provide *ELECTRONIC DESIGN*'s artist with a sound basis for his abstraction. The Report discusses the steps leading to a more realistic diode inventory in addition to offering aids aimed at reducing diode selection time.

Selected Topics in this Issue

Sidelights Of This Issue

Less than a year ago, *ELECTRONIC DESIGN* (June 10, 1959) focused attention on a problem that was rapidly reaching the critical stage. Design engineers were having a difficult time choosing a diode for a particular application. Over 4000 types existed making quick and efficient selection impossible.

The solution was obvious—standardization. Many users were losing patience with "improved" types that turned out to be identical to older types. Even manufacturers were concerned with the reigning confusion. But, although most agreed that standardization was necessary, many felt that it would take years to achieve.

Top executives in the diode industry and top civilian authorities in the Department of Defense were asked by *ED* what they thought could be done. The interest that was stirred up resulted in a meeting called by the Office of the Director of Defense Research and Engineering in Washington, D.C. Accepting an invitation to the meeting, *ED* editors James A. Lippke and Howard Bierman discussed with DOD and EIA officials the need for steps to alleviate confusion. The military spokesmen indicated they were at work in classifying preferred and guidance types. The results of their efforts appear in this issue.

A few months later, EIA tightened its rules on new-type registration. EIA's Standards Laboratory in Newark, N.J., is now said to serve as a standards bureau for manufacturers.

Most encouraging was the voluntary assistance of an industry member to help *ED* compile a "most popular" diode guide for common applications.

But fewer types and handy tables and charts don't necessarily make for routine diode selection. An expert in the field, Nick DeWolf, Transitron's chief electronic engineer, offers some interesting ideas in his article, "The Diode Selection Game." It complements *ED*'s Diode Report in this issue.

* * *

Things are slowly returning to normal for *ED*'s revered editor, Ed Grazda. Recently his wife gave birth to a girl—Hooray for more than one reason—Ed already has three boys! The suspense is over! Congratulations!

BPA NEP

ELECTRONIC DESIGN is published bi-weekly by Hayden Publishing Company, Inc., 830 Third Avenue, New York 22, N. Y., T. Richard Gascoigne, Chairman of the Board; James S. Mulholland, Jr., President. Printed at Hildreth Press, Bristol, Conn. Accepted as controlled circulation at Bristol Conn. Additional entry, New York, N. Y.

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New Publisher Appointed

ELECTRONIC DESIGN **is pleased to announce the appointment of Robert E. Ahrensdorf as Publisher. Founders and co-publishers J. S. Mulholland, Jr., and T. R. Gascoigne move up to President and Chairman of the Board, respectively, of Hayden Publishing Company. The move makes possible an immediate program of enlargement and the acquisition of new publishing properties.**

Well known in publishing circles, Mr. Ahrensdorf brings 15 years of valuable sales, industry and publishing experience to the magazine. As head of his own firm, he has managed western space sales for *ELECTRONIC DESIGN* for seven years, and was previously Eastern Manager, Vice President and then General Manager of Rogers Publishing Co.

ELECTRONIC DESIGN
NEWS

U. S. Air Agency Intensifies Drive For Fully Automatic Landing System

Spurred by British Autoland Advances, FAA is Pressing Three-Phase Program to Replace Present ILS and GCA

STEPPED up activity in evaluation of automatic aircraft landing systems is slated for this year by the Federal Aviation Agency's National Aviation Facilities Experimental Center, Atlantic City, N.J.

Renewed interest in all-weather landing systems has been stirred in this country by the British plan to use automatic equipment to land commercial aircraft. The British Autoland system, along with a variety of United States-designed equipment, is being studied by the FAA under a three-phase program.

The first phase of the program is the improvement of present Instrument Landing System (ILS) and Ground Controlled Approach (GCA) equipment. The second phase calls for interim testing of an all-weather landing system where the need is urgent. The third phase is the development of new techniques for an automatic landing system for air traffic of the future.

The following evaluation timetable has been set up by the FAA at the Atlantic City experimental center:

- A Bell Aircraft landing system installed in mid-January should reach completion by late August. (*ED*, March 30, p. 35).
- The Air Force AN/APN-114 system, due to arrive in early September, is set for completion by April, 1961.
- The REGAL system (Range and Elevation Guidance for Approach and Landing) installed in mid-February is scheduled for completion by January, 1961.

Schedule May Be Compressed

This time schedule may be compressed because of the importance of the program.

The system receiving high consideration for the second phase of the FAA program is the AN/APN-114 system, industry sources indicate. This system, using a flare computer developed by the Autonetics Div. of North American Aviation, Inc., Downey, Calif., and a low-level radar altimeter developed by the Government Electronics Div. of Emerson Radio, Silver Spring, Md., can be adapted to existing ILS equipment.

Sign of things to come? Boeing 707 is landed automatically with Bel Avionics' AN/GSN-5 landing system. The system, one of several being tested by the FAA, uses a computer to calculate flight paths. Computations are based on data input of precision tracking radar. Radio link carries corrective commands.

The Bell Aircraft system, involving extensive ground equipment, and the REGAL and Airborne Instruments systems, could be used to replace present ILS installations; so they are more likely to be considered for use in the third phase of the FAA program. The British Autoland system, which requires two cables to be installed for a considerable distance off the end of runways, also fits into this category.

North American's Autoflare system uses a combination of the best features of a vertical accelerometer and a radar altimeter to achieve a precise altitude rate and accuracy of 2 ft ±2 per cent from 0 to 1,000 ft.

Biangular System Developed

A biangular antenna system developed by Airborne Instruments Laboratory is now being tested

Midget Maser Put

25-Lb. Ruby Device Uses a 12-Oz. Magnet Instead of 500-Pounder

DEVELOPMENT of a mobile, tactical radar to spot the mushroom cloud of atomic blasts is being speeded at the Army Signal Corps Laboratories, Fort Monmouth. N.J. The sensitivity and mobility essential to the radar appear to have been met by the development of an ultra-miniature ruby maser, now being tested in the system.

An extension of present weather radars, the new system would permit detection and calculation of the range of the cloud—and thus its fallout zone—in darkness and poor visibility and at distances beyond optical observation.

Safer and more rapid troop movements into an area in the wake of atomic bombardment would result. The accuracy of an atomic bombardment could also be observed by the new radar.

A high order of sensitivity is required of the system to detect the comparatively small cloud of a sub-kiloton tactical weapon. Intervening cloud formations also complicate the detection problem. Nevertheless an effective range on the order of 100 mi is sought.

Small Ruby Cuts Magnet Size

The new maser weighs only 25 lb and develops but 10 K of thermal noise. Key to the successful miniaturization is the very small (1/8 in. thick by 1/2 in. sq) ruby used. The ruby fits into a very

at MacArthur Field, Islip, L.I., N.Y. This system can provide distance-to-go as well as elevation angle to instruments in an aircraft from two ground-based scanning-beam antennas spaced about 4,000 ft apart along a runway.

Pulses transmitted by the two antennas are coded according to the elevation angle of the beam. Identification coding is used for each beam. One single-channel receiver receives signals from both antennas by time-sharing.

When flare-out position is reached, at about 1,000 ft short of the runway, a simple circuit in the receiver measures the difference between the two angles to produce a signal proportional to the distance to the runway.

A computer then dead-reckons for about 10 sec to touchdown based on this computed ground

(continued on p 7)

in A-Bomb Radar

Key elements of Signal Corps' new, miniature maser. The 12-oz. magnet in foreground costs about $10 and does the job of a 500-lb $4,000 magnet used in conventional masers. Also displayed by engineer are the maser's ruby and copper transition section.

narrow waveguide section, which presents a very narrow air gap for the maser magnet. As a result, a 12-oz magnet is sufficient to provide the 4,000-gauss field necessary for operation. Con-

(continued on p 6)

NEWS

Maser

(continued from p 5)

ventional masers having larger crystals, and air gaps require magnets weighing 500 pounds or more. Both the magnet and the maser are thus immersed in the customary Dewar flask in which the device is cooled to −452 C by liquid helium.

Operating frequency of the prototype maser now in test is 9.3 kmc. It is a four-level, push-pull device with pumping (at 24 kmc) from the first to the third and from the second to the fourth energy levels of the crystal. Amplification occurs between the second and third levels. Gain of 220 db is obtained. Band width is limited to 10 mc by the resonant cavity structure of the device, but a traveling wave or other structure could provide up to 100 mc of band width.

The ruby crystal used consists of chrome-doped alumina. Higher operating frequencies are possible through the use of other materials. A similar device using chrome-doped rutile has operated at 39 kmc, and frequencies up to 90 kmc are expected with iron-doped rutile.

Other Uses for Maser Studied

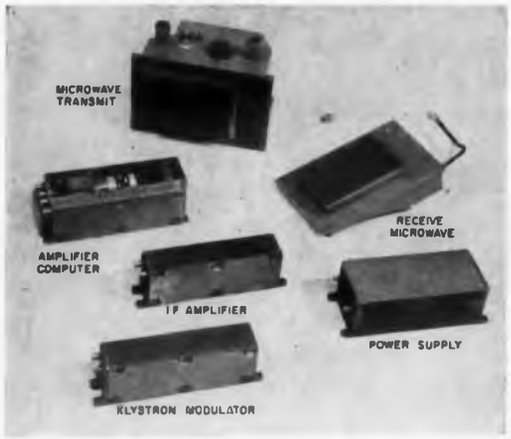
The miniature maser is now being tested in a series of low-noise radar applications. In addition to the atomic-cloud radar, weather and surveillance radars and countermeasure receivers are being evaluated in operation with the new device. In some applications, the insertion of the maser as a preamplifier has resulted in up to 20 db of over-all system gain.

The use of the maser in active radar systems is at present somewhat limited by its tendency to be saturated by the transmission pulse of the radar. Possible solutions being explored include switching systems and pulse-detuning methods to isolate the maser from the radar transmission pulse.

Satellite Applications Forcast

The extremely small size of the maser suggests a number of airborne and satellite applications. These are still very much in the "thinking" stage, however, pending final development of the maser. One suggestion put forward for its use proposes radiometric mapping of the earth's temperature pattern by measuring its thermal noise with a satellite-mounted maser receiver.

The miniature maser is the result of a two-year development program at Hughes Research Laboratories, Culver City, Calif., in cooperation with the Signal Corps Laboratory's Atomic Resonance Devices Section. Dr. Theodore H. Maiman directed the project at Hughes. ■ ■



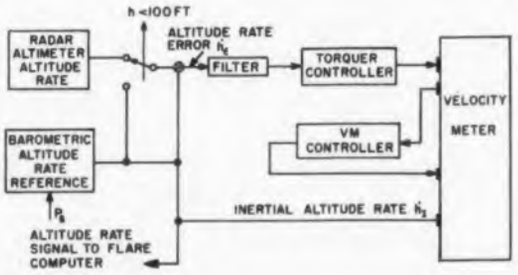
Emerson low-level radar altimeter weighs 20 lb. It operates at C-band using an fm/cw signal to provide an over-all accuracy of 2 per cent over an altitude range from 0 to 3,000 ft. A servo system continually adjusts transmitter modulation according to the difference between transmitted and received signals, so that stepping errors normally found in radar altimeters are eliminated, Emerson says.

Landing Systems

(continued from p 5)

speed. Because of the shallow angle, very small height errors are caused even by extreme distance errors, according to Mr. Battle. Accuracy is about ±150 ft in distance and ±5 ft in height at the 1,000 ft point. This improves to about ±2 ft altitude error at touchdown.

REGAL was developed by Gilfillan Bros., Inc., Los Angeles. It resembles the Airborne Instruments system in offering a pulse code to an airborne receiver-decoder, depending on elevation angle. It determines distance, however, by triggering the airborne unit with the elevation signal, so that two pulses are transmitted. These cause the transmitter on the ground to return two similar pulses, so that the time difference can be used to establish range. ■ ■



Velocity meter adapted from a North American Aviation, Inc., inertial-guidance system integrates vertical acceleration to provide a velocity signal in the AN/APN-114 automatic landing system. Radar altimeter height is differentiated to provide an initial altitude rate signal for the integration. The filter eliminates the high-frequency portion of the altimeter signal.

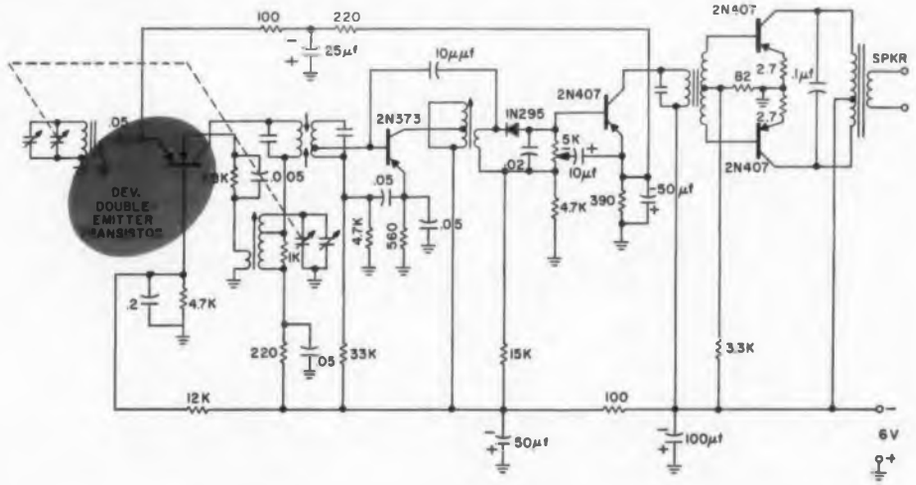
Double-Emitter Transistor May Simplify Receiver Design

DESIGNERS may soon be sampling a transistor developed to provide improved automatic gain control in transistorized broadcast-band receivers. The transistor, a double-emitter, drift-field device for mixer-oscillator application promises to simplify the design of portable and automobile radios, according to Radio Corp. of America, which is still developing the device. The company describes it as the first practicable transistor of its kind in the semiconductor industry.

Key to the operation of the transistor is its construction, which permits the device to function as both an oscillator and a mixer in the same circuit. The two emitters are processed to function independently of each other. Both emitters are p-types. The base is n-type; the collector is p-type.

In an ordinary triode, emitter current cannot be cut off, because this would interrupt oscillator current. With reduced oscillator current, feedback would decrease below the

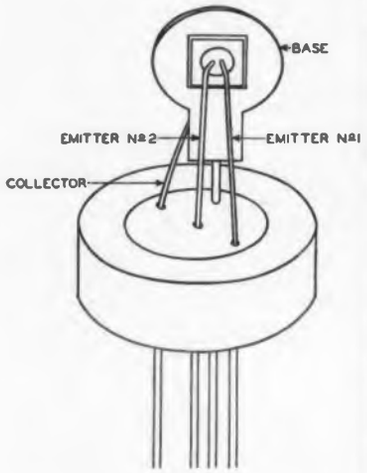
Developmental Receiver Uses Double-Emitter Transistor



A developmental, portable broadcast-band receiver has been designed by RCA engineers to incorporate the double-emitter transistor and take advantage of its characteristics. The rf and if sections of the receiver use the mixer-oscillator transistor in a common base configuration. The if circuit uses a neutralized 2N373 drift-field transistor. The mixer circuit provides a conversion power gain to 25 db into a 300,000-ohm, 455-kc if load. The if stage contributes an additional 27 db of if gain.

The audio circuit consists of a driver stage and a push-pull output circuit, both of which use 2N407 conventional alloy transistors. The over-all gain of the audio circuit is 73 db. The output circuit can deliver 150 mw of audio power to the speaker with less than 10-per-cent distortion.

The receiver has an average sensitivity of 500 μv per meter across the band for 50 mw of audio output. The image and if rejections are 28 db and 44 db at the high end of the band and 49 db and 35 db at the low end of the band. From a 100,000-μv-per-meter reference, the agc figure of merit is 46 db. A signal-to-noise ratio of 20 db occurs at 600 μv per meter.



Two emitters combined in a single package enable this drift-field transistor to separate mixer and oscillator functions in providing improved agc in transistorized, broadcast-band portable and automobile receivers. Both emitters and collector are p-type, base is n-type.

level of positive feedback needed for self-oscillation, and oscillation would stop.

In the RCA multi-purpose transistor, there is complete separation of oscillation and mixing functions. This makes it possible to apply agc directly to the mixer portion of the transistor's circuitry without affecting the oscillator portion.

In conventional transistor radios, RCA notes, only limited agc can be applied to the converter.

Another advantage claimed for the double-emitter transistor is freedom from oscillator blocking under strong signal conditions.

Technical feasibility of the device and its application in a combination oscillator-mixer capable of being gain-controlled have been demonstrated, the company reports. Among the first significant results expected of the double emitter transistor will be "the design of broadcast-band receivers exhibiting excellent agc performance with only a frequency converter stage and a single intermediate-frequency amplifier stage without an overload or clamping diode." ■ ■

CIRCLE 9 ON READER-SERVICE CARD→

NEWS

Now operating at the FAA's experimental center is this "data-processing central" built around a Librascope digital computer. The computer is a high-speed, stored-program unit, whose stored data are accessible by either fixed-address or random searching.

FAA Testing Computer as

Automatic Digital System Design to Process 440 Flight Plans an Hour and Store 1,000

THE computer planned as the highly reliable core of the nation's future air traffic control system is undergoing tests at the Federal Aviation Agency's experimental center near Atlantic City, N.J.

General Precision's Librascope Div., which developed the computer, says it is the first specifically designed for air traffic control.

The computer is designed to file, search, compute and determine flight conflicts in the nation's air lanes. Such work is now done manually by controllers.

The digital system can be programmed to process and print 1,600 flight strips an hour, process 440 flight plans an hour, store 1,000 flight plans and sequence the arrival and departure of a total of 180 aircraft.

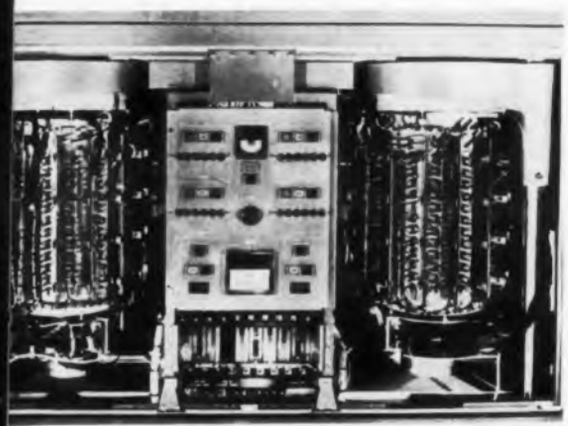
To insure reliability of operation, Librascope reports, designers used wide-tolerance transistor circuitry. Information safety is protected by circuit redundancy and advanced checking techniques. According to Librascope, data-transfer units are parity checked, and dual arithmetic units, buffer storage and magnetic drum files are incorporated. In regular operation the computer will be backed up by a stand-by unit.

The computer is a binary-coded, decimal, parallel-serial, single-address unit with a word length of eight characters. Company designers report

Key to Air Traffic Control

that the unit performs internal computations or input-output message handling while a file search is in progress.

The 4.000-word core memory operates on a 24-μsec read-write cycle. The basic clock rate is 500kc. Librascope claims that the computer system has search capabilities exceeding those of other present medium-sized data processors by a factor of 100. Search of the computer's entire 256,000-word memory file reportedly requires 0.5 sec. Additions and subtractions are said to require an average of 30 μsec, multiplication and division, 266 μsec. ■ ■



Wide-tolerance transistor circuitry and advanced checking techniques are used in computer designed specifically for air-traffic control.

HOW TO SELECT HIGH RELIABILITY CAPACITORS

At one time Sprague Electric was the only manufacturer offering true high reliability capacitors. The buyer had no problem. But today there are many manufacturers who claim that their capacitors meet high reliability standards. Some are even so bold as to claim that theirs are *the most reliable*.

Check the record before you choose

The only sound approach to evaluate these claims is to investigate the *reliability record* achieved by each of the companies under consideration. Remember, it takes test data to establish the reliability of a product. Claims are not enough.

Now let's look at the record

Sprague Electric can substantiate its claim that its HYREL® Q Capacitors are "the most reliable capacitors made" with the most extensive test data available in the entire electronic industry. The performance of HYREL Q Capacitors is virtually impossible to surpass . . . now and for some years to come.

But let's start at the beginning—*the specifications*. Sprague Electric's high reliability capacitors were originally made under Sprague Electric Specification PV-100—*the first high reliability capacitor specification for missiles and other critical applications*. This specification and a later revision, PV-100A, have proven so comprehensive and so successful in providing "the highest order of reliability known to capacitor manufacturing" that their provisions are currently reflected in *every* military specification covering high reliability capacitors. This is a distinction shared by no other capacitor manufacturer.

Now look at the record of HYREL Q Capacitors

On accelerated life tests the failure rate of HYREL Q Capacitors has been less than 0.05%, after more than 16 million unit hours accumulated on tests of 250 hours at 140% rated voltage, 125 C. On high frequency vibration tests, there hasn't been a single failure in the more than 50,000 units tested. On seal, moisture resistance, and temperature cycling and immersion tests, the failure rate has been less than 0.1%.

Such performance from production line capacitors can only be achieved through the most intensive (and expensive) kind of reliability program—in design and development, in production engineering, in manufacturing facilities, in testing intensity and extensity—all of which should be investigated thoroughly.

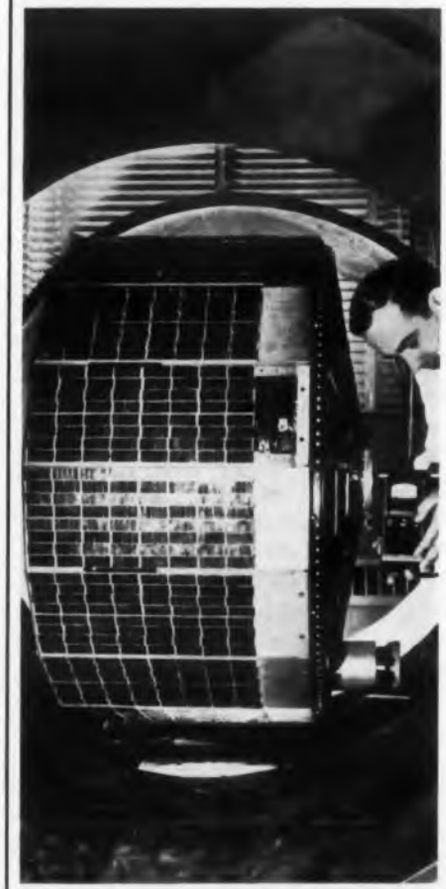
After you've checked the record, then decide for yourself which capacitor is "the most reliable made."

For complete facts and figures on HYREL Q Capacitors, call your Sprague District Office or Representative, or write for HYREL Bulletin 2900A and Specification PV-100A to Technical Literature Section, Sprague Electric Company, 347 Marshall St., North Adams, Massachusetts.

CIRCLE 11 ON READER-SERVICE CARD

Opened Tiros shows camera front and center, tape recorders under plastic bubbles.

Tiros I, U.S. Weather Eye, Shows Significant Advances in Design



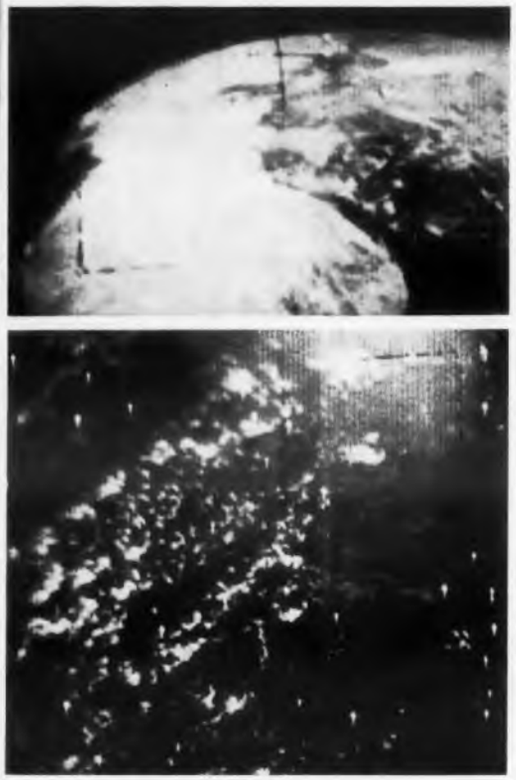
Tiros instrumentation is monitored as satellite rotates between two magnetic coils, simulating effects of earth's field.

TIROS I, the United States weather satellite, represents significant progress in the design and control of satellites.

A Bell Telephone Laboratories precision guidance system put the drum-shaped satellite into a near-circular orbit at about 450 mi above the earth, with only 32 mi variation between apogee and perigee. The radio-inertial command guidance system was designed by Bell for the Titan ICBM.

Two identical half-inch vidicons—one with a wide-angle lens for 800 sq mi of coverage, the other with a narrow field of view to cover about

Wide-angle lens projects from cylindrical base plate of Tiros satellite. Vidicon camera behind lens is adjusted by technician.



Tiros sent back these photos of cloud cover. Above, clouds over eastern United States from wide-angle lens camera. Below, clouds over eastern U. S. viewed by higher-resolution vidicon camera.

30 sq mi—are being used. The vidicon cameras, designed by Radio Corp. of America's Astro-Electronics Products Div. in Princeton, N.J., are set to take still pictures rather than a continuous scene. On command from the ground and timed so that Tiros is pointed toward the earth over a daylight area, the cameras take individual pictures of cloud cover with a 1.5-msec shutter speed.

Two 2-w fm transmitters return video signals to ground stations at 235 mc. Compressed bandwidth transmitters were designed to permit the frequency-modulated video signals to be transmitted at such a low power level, according to Max Mesner, RCA project engineer in charge of TV camera design for Tiros.

The video signals are sent either directly from the vidicon cameras or are stored on magnetic tape in the satellite and then transmitted.

Infrared horizon-sensing equipment establishes the orientation of the spin axis of the satellite, which rotates at 12 rpm. North is established through the use of nine solar cells covered by plates containing narrow slits arranged around the vehicle. A characteristic pulse is generated when each of the cells faces the sun through the slit. ■ ■

NEWS

Temperature Control Key to Design Of 'Transit' Satellite Electronics

Temperature control was cited as the major problem in designing instrumentation for "Transit 1B," the Navy's successfully orbiting navigation satellite. Since navigation data is derived from doppler measurements of the satellite's transmissions, scientists at Johns Hopkins University's Applied Physics Laboratory went to great lengths in designing out thermally induced frequency variations.

Two ultra-stable crystal oscillators delivering 3 mc with an accuracy of 2 parts in a billion are mounted in Dewar flasks to prevent short-term thermal variations as the satellite moves in and out of the earth's shadow. The Dewar flasks are suspended from the instrument tray by thin nylon cords, and the tray itself is likewise suspended within the satellite. In addition to the usual heat-stabilizing paint job on the outside of the vehicle, the inside of the sphere is lined with reflective gold plating and insulated by a multi-layer blanket of aluminum foil and fiberglass.

Crystal frequency is stepped up to 54, 162, 216, and 324 mc. These frequencies are transmitted simultaneously and continuously by a broad-band, logarithmic spiral antenna silver painted on the outside of the vehicle. As a result, APL engineers have dubbed it "our flying barber pole."

The 162-mc band carries seven telemetry channels—six of which report on temperatures within the satellite. The seventh carries information on the charging current for the nickel-cadmium batteries supplied by 1680 solar cells mounted around the waist of the sphere.

Radiated power varies from 200 mw at 54 mc to approximately 60 mw at 324 mc. The extreme upper and lower transmitting channels are powered by a silver-zinc battery expected to last about 45 days. Mean time before failure for the entire instrument package is thought to be "several months."

The satellite also carries an infra-red scanner which measures satellite rotation. Its operation and telemetry scheme are still classified.

Six ground tracking stations (five in the U. S. and one in England) are reporting data to a central computer at APL. The experiments scheduled include selection of optimum transmission frequency, measurement of ionospheric refraction characteristics, and orbit calculation.

"Transit IB" is a forerunner of a complete satellite navigation system for use by Polaris-launching submarines and is expected to be ready by 1962. Each of the four satellites to be used will be equipped with a memory system. Pre-

dicted orbit data will be transmitted daily to each satellite which will in turn telemeter this information to the ships and submarines using it for navigation. Orbit data and doppler shift of the transmitted signals as measured by an automatic navigation computer will pinpoint the position of the submarine.

APL scientists, working with the Navy's Bureau of Weapons hope to design a five-year life into the operational satellites. Civilian vessels and airplanes will also be able to take advantage of the system, though equipment for this purpose will probably not be as automated and accurate as that now being designed for the Navy.

Avco Unit Sends Teletype Messages At Ten Times Normal Speed

Equipment for sending standard teletype messages over telephone lines at ten times normal speed has been developed.

Teletype data is recorded on magnetic tape and then fed to a Bell Telephone Data-Phone unit for transmission over ordinary or leased telephone cables at 1 ips. Word speeds of 600 to 1000 wpm are said to have been achieved.

Although telephone transmission normally is more expensive than teletype, the high speed of the unit, developed by Avco Corp.'s Crosley Div., Cincinnati, is reported to have made telephone transmission economical.

The rental cost of the device, called the Comex 104, is $130 per month plus a $130 installation charge. The data phone equipment rents for $40 per month. Two-way transmission between points is accomplished by using both units at each end of the transmission path.

Comex feeds the data phone unit an on-or-off type square wave. This is converted into two frequencies by the data phone set. One frequency represents the off condition and the other the on condition.

In use, an operator dials the number where a second Comex unit is to receive a transmission. The phone is answered, and the Comex unit is switched on to receive data. Then the receiving telephone is hung up. The call is completed automatically with a signal from the transmitting Comex.

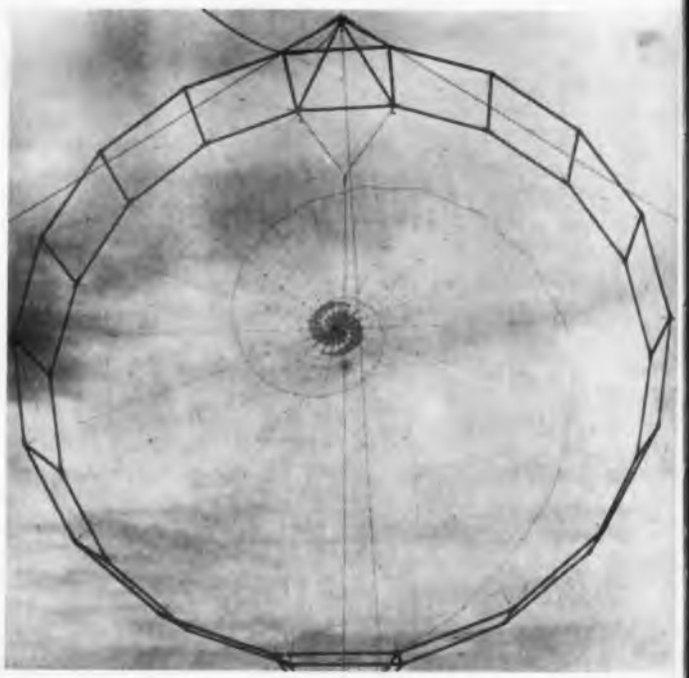
Additional work on the device is expected to produce fully automatic units so that the telephone does not have to be answered physically at the receiving end. Instead, the operator will dial the desired number along with a code number that will automatically turn on the Comex equipment at the receiving end. Comex 104 units can be adapted for use with Friden TeleData, IBM transceivers and similar equipment.

Antennas Shaping Up As Weird Creations

SYSTEM requirements that are literally out of this world are pressing the antenna designer for more power, higher gain, electronic scanning—sometimes all at the same time. Special applications may require special configurations, or portability, or perhaps multiple functions.

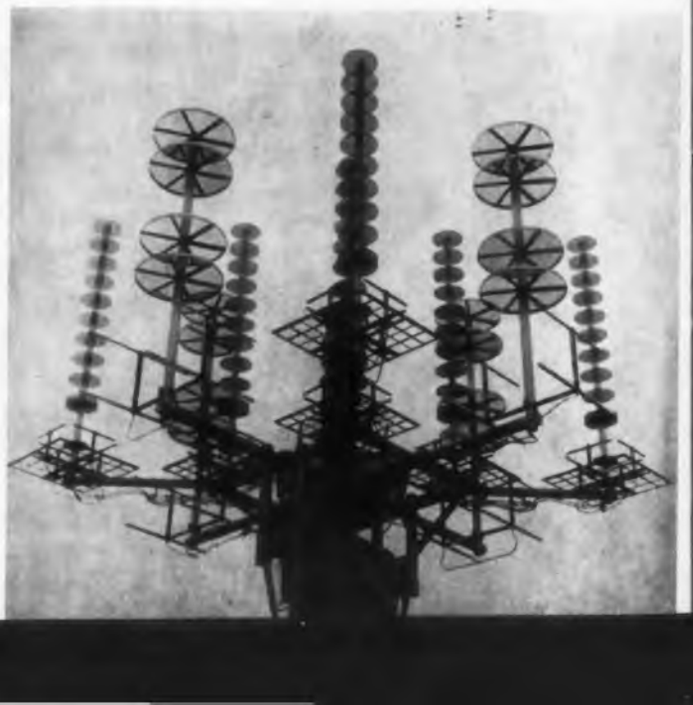
Antenna designers are looking for novel approaches—and finding them. The results are many strange shapes, hardly recognizable as microwave radiators. The geometry seems to depart farther and farther from the simplicity of the parabola. ■■

Stacked array, 26 ft high, mixes horizontally polarized uhf and vertically polarized vhf dipoles. Flat strip power divider drives this Gabriel-designed, command-control antenna.



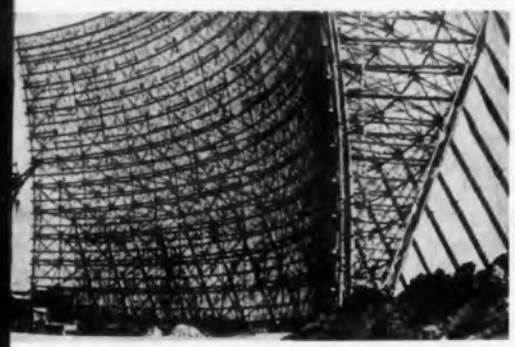
Spiral antenna (above) reduces fading by 30 per cent. This All-Products Co. half-ton 70-footer has gain comparable to a rhombic with 300-ft legs.

Tiros satellite is controlled by this vhf-uhf GB Electronics antenna. Triple array is for command, tracking and telemetry.



Geodesic radome is under test at General Electric's HMED facility. Bliss-designed dome silhouettes multi-beam AN/FPS-7 antenna.

Air pressure maintains the shape for this air-transportable 15-ft parabola. A dual-polarized horn eliminates the duplexer in the Colins scatter communications system.

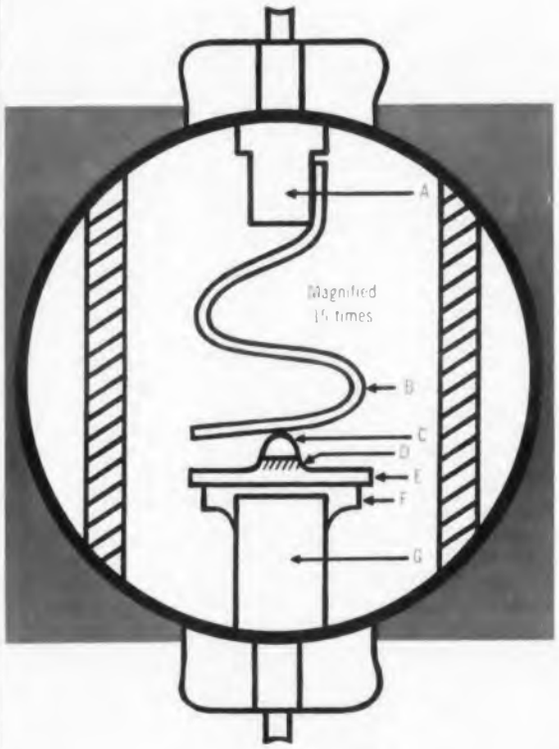


Torus reflector, 165 ft x 400 ft, is representative of fixed, high-powered antennas. This Kennedy unit is part of General Electric' BMEWS system.

Nose-cone antenna is scanned over most of forward hemisphere. Hughes-developed, it replaces flush-mounted antennas.

Passive reflector for drone radar augmentation combines the Luneberg and the Eaton-Lipman lenses. Bi-static and mono-static reflection are achieved in this Dalmo-Victor reflector.

announcing reliable diffused silicon diodes



A – dumet, **B** – platinum, **C** – gold, **D** – diffused region, **E** – N-type silicon, **F** – gold, **G** – dumet.

Active portion and consequently the capacitance of these diodes are minimized by etching away all but a small diffused section. Rugged construction provides resistance to shock and vibration exceeding MIL-STD. 202A.

More reliable products through Advanced Engineering

Advance-engineered diffusion techniques are now applied to CBS silicon diodes. Fast switching . . . high conductance . . . high temperatures . . . high voltage . . . low capacitance . . . and low reverse current are achieved.

The diffusion technique offers many other advantages over the alloying method: Close process control of all parameters, great uniformity, and high reverse voltage for a given resistivity through the graded junction. Hermetic sealing of miniature glass package also contributes to the exceptional life.

Now you can have proven CBS reliability in diffused silicon diodes. Watch for further announcements on this growing CBS silicon line.

a comprehensive line for computers

Note the two major classifications particularly designed for computers in missiles, rockets, airborne and industrial equipment. Typical applications include switching, pulse, flip-flop, modulator, demodulator, discriminator, clamping, gating and detector circuits. Write for complete technical Bulletins E-373 and E-374.

FAST RECOVERY TYPES

Type	Min. Rev. Voltage @ 100 μA (volts)	Min. Forward Current		Maximum Reverse Current @ 25°C		@ 100°C		Reverse Recovery Characteristics*	
		I_F (mA)	E_F (volts)	I_R (μA)	E_R (volts)	I_R (μA)	E_R (volts)	Zrec (Kohms)	t (μsec)
1N625	−35	4	1.5	1	−20	30	−20	400	1.0
1N626	−50	4	1.5	1	−35	30	−35	400	1.0
1N627	−100	4	1.5	1	−75	30	−75	400	1.0
1N628	−150	4	1.5	1	−125	30	−125	400	1.0
1N629	−200	4	1.5	1	−175	30	−175	400	1.0

*JEDEC 14.5-1 (Modified IBM-Y reverse recovery circuit with: I_F = 30mA, E_R = −35V, R_L = 2K ohms.)

HIGH CONDUCTANCE TYPES

Type	Min. Rev. Voltage @ 100 μA (volts)	Max. Fwd. Voltage @ 100 mA (volts)	Maximum Reverse Current @ 25°C		@ 150°C		Max. Avg. Fwd. Current @ 25°C (mA)	@ 150°C (mA)
			I_R (μA)	E_R (volts)	I_R (μA)	E_R (volts)		
1N482	−40	1.1	0.25	−30	30	−30	100	25
1N483	−80	1.1	0.25	−60	30	−60	100	25
1N484	−150	1.1	0.25	−125	30	−125	100	25
1N485	−200	1.1	0.25	−175	30	−175	100	25

CBS semiconductors

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CIRCLE 16 ON READER-SERVICE CARD

NEWS

Improved Flood Guns Planned For Direct-View Storage Tubes

An improved flood-gun configuration for direct-view storage tubes, giving better brightness and linearity, is under development by Allen B. DuMont Laboratories, Inc., Clifton, N. J.

Annular flood guns and axial write guns will be used in the new design. Present DuMont storage tubes have axial flood guns and offset write guns.

Although specific design details were not disclosed, a DuMont spokesman said that an annular cathode ring or a series of flood guns surrounding the axis of a tube might be used.

The centered write gun gives better linearity than an offset gun and permits other electron optics improvements, according to Marshall Wilder, manager of DuMont's Storage Tube Dept. Deflection power requirements in an electromagnetic deflection tube are reduced to about one-half those needed in conventional DuMont storage tubes.

Extra-flood electrons provided with the new design give a brighter display.

Many difficulties are involved in the annular flooding arrangement, it was explained. A relatively simple collimating electrostatic field can be used with the centered flood gun, but a complex field is necessary with other constructions.

Either electrostatic or electromagnetic deflection can be used with the new flood gun.

Tunnel Diodes Future Unsettled Cincinnati Conference Reveals

Although equipment using tunnel diodes will soon be on the market, the future of this component is unsettled, specialists agreed at the IRE Spring Technical Conference in Cincinnati.

A tunnel-diode oscillator operating in the lower L-band will soon be introduced by Radio Corp. of America, ELECTRONIC DESIGN learned. Power output will be of the order of 0.1 mw.

Tunnel-diode amplifiers or high-speed switching circuits suitable for field use are offering much more trouble than oscillator design, speakers indicated. A major problem is the bilateral nature of the device, it was said during a state-of-the-art discussion of the diode. This establishes high and low limits on self oscillation, so that stability becomes vital in amplifier design.

Microcircuitry offers promising prospects for tunnel diodes according to Jeffrey Bowle, of Sperry Rand Corp., Norwalk, Conn.

The device is relatively simple, he said, so that any of them can be put on a single piece of semiconductor material, such as germanium, with a reasonable number being operable. Redundancy can provide reliability.

Although alloying is not ordinarily desirable in microcircuits, the tunnel diode is a special case because of the high, relatively non-critical doping level, he said.

Peak voltage is easily controlled by spacing, be continued, whereas peak current and capacitance are a function of surface area which is also controllable. The extremely high-frequency response of the tunnel diode makes it particularly attractive for these applications because the need for long leads, undesirable in the kmc region, is eliminated.

Problems cited by Mr. Bowle include the inductance and capacitance of the junction and resistance of the semiconductor material next to the junction.

Possibilities such as evaporated germanium films on germanium, which have not proved suitable for transistors, may be feasible for tunnel diodes in microcircuits, Mr. Bowle said.

Several speakers urged designers to have patience and give the tunnel diode "a chance to grow."

Conference on Relays Set For May 3-5

Ideas, developments, research, results and problems of users, designers and manufacturers of relays will be discussed at the 8th National Conference on Electromagnetic Relays.

The conference, scheduled for May 3-5 at Oklahoma State University, Stillwater, Okla., will be sponsored by the National Association of Relay Manufacturers and the university's School of Electrical Engineering.

Forty-six papers and seven discussion periods will concentrate on new ideas and advances in relay design, application, testing, production processing and materials.

Correction Notice

CBS Electronics not CBS Laboratories is the developer of the news item 84-Bit Memory Plane For Airborne Computers on page 9 of the March 16 issue.

NEWS

Pinched-Plasma Engine Studied For Low-Fuel Space Propulsion

A prototype plasma engine, envisioned as a important step toward interplanetary travel an steerable satellites, is under test at Republic Avia tion Corp., Farmingdale, L.I.

Continuous cycling of magnetic "pinches" eject the plasma, giving the engine its thrust, the com pany reports. The engine is said to have been cycling at a rate of 30 times per min, using 3,000 v and 675 w.

The magnetic pinched-plasma engine is idea for space propulsion and control because of it extremely low-fuel consumption and low-fue weight, says Alfred Kuenen, head of the Plasma Propulsion Laboratory at Republic.

The engine's basic components are a small nuclear reactor, a turbine generator, a space ra diator, a pinch tube, a storage chamber of liquid oxygen and a thrust nozzle. With these, a series of high-velocity plasma ejections—the thrust—are produced.

The reactor, through its controlled atom-split ting, provides the primary power for the turbine generator, which produces electricity. The elec trical energy is stored in capacitors and then in stantaneously discharged in the pinch tube. At this discharge, the gas in the pinch tube is con verted to a plasma state, in which its molecules are broken up into electrons and positive ions. This heated plasma, acted upon by the magnetic field, tends to pinch down into a tiny area so de signed that the plasma shoots out the nozzle at extremely high velocity, much as a jet stream does. Each pinch lasts only four millionths of a second.

In the Republic prototype, engineers have demonstrated the physical concept of this pinching technique. Now Mr. Kunen and his staff are translating this concept into a practical working engine by developing a continuous pinching cycle.

Market Research Urged To Avoid Design Errors

Haphazard market research by design engineers can result in costly mistakes for companies, dele gates to the Semiconductor Marketing Seminar of the Electronic Industries Association were told.

"Design engineers have been doing their own market research for years without knowing it," said Dr. Wendell R. Smith, director of market research and development for the Radio Corp. of America. An engineer, from his knowledge and

contacts in the field, determines the need for new equipment and evolves designs accordingly. This is actually market research, Dr. Smith said, though it may involve only a phone call from Joe at company A to Sam at company B. But such haphazard methods sometimes lead to new products for which there is no real need, Dr. Smith noted.

Three Spots for Market Studies

He said there were three points during the development of a new product at which market research should be used. He listed these as:

- Before the commitment of R&D funds.
- When a prototype is available and the successful end of R&D is in sight.
- Before full-scale production is decided upon.

At each stage market-research men should present the concept or product to experts and potential users to determine its chances for commercial success, Dr. Smith said. The feedback of ideas obtained in this way has often improved product designs and suggested new markets, he noted.

Engineers Sometimes Resist Findings

Many engineers have been reluctant to accept the findings of market research, Dr. Smith observed—especially if the conclusions run counter to the ideas of the engineering department. Since market researchers are usually not trained as engineers, their findings may be discounted by technical men.

However, good market research requires skilled interviewing and statistical analysis rather than technical skill, Dr. Smith asserted. The market researcher, he added, by the very fact of his limited technical knowledge may prove more receptive to new concepts that an engineer may summarily dismiss as technically unfeasible.

"In today's highly competitive market," Dr. Smith said, "market research is a logical partner to technical research."

The seminar was held in New York.

Clevite Corp. Acquires Shockley Transistor Corp.

The Clevite Corp., Cleveland, Ohio, has acquired the assets of the Shockley Transistor Corp., Palo Alto, Calif., a subsidiary of Beckman Instruments, Inc.

Clevite President, W. G. Laffer, said the acquision will substantially augment the company's activities in the semiconductor component field. The Shockley unit, headed by Nobel Prize-winning physicist, Dr. William Shockley, will become part of Clevite's Transistor Div. in Waltham, Mass.

WASHINGTON REPORT

Ephraim Kahn

ELECTRONIC ENVIRONMENT TEST facility to cost over $22 million is to be built at Ft. Huachuca, Ariz. Object is to find out what incompatibilities exist among the electronic devices in current field use by the Army. Ground warfare today would find an Army corps with about 23,000 electromagnetic-emission devices in a square 60 miles on a side. As recently as 1948, there would have been about 9,000 such devices in the same area.

COST ANALYSIS OF SUBCONTRACTS is required by the latest revision in the Armed Services Procurement Regulation. Where subcontracts have been let without competition, this is mandatory. It is also required when "reasonable subcontract prices" have not resulted from competition. "In all significant subcontract transactions," price (as distinguished from cost) analysis is demanded.

FEDERAL PATENT POLICY CHANGE this year becomes less likely as sharp differences in opinion become known to Congress. Capitol Hill observers see the sharp split that has developed on this point within the House Science and Astronautics committee. They note that in an election year a concerted effort to ease matters for industry by "giving away" patent rights to inventions financed by the government would certainly have political implications. They believe, too, that while such a measure could be pushed through the House, it would bog down in the Senate.

ARMY CRITERIA FOR R&D CONTRACTING have been outlined for a House Appropriations subcommittee. The Army says it considers several factors, including technical competence, costs, managerial capability, and past performance. In evaluating technical competence, the Army looks at each prospective contractor's understanding of the scope of the work as evidenced by the proposed scientific or technical approach to the problem, the availability and competence of experienced personnel, whether the firm has the requisite facilities, the company's experience or pertinent novel ideas advanced in the specific science or technology involved, and the proposed contractor's willingness to devote resources to the proposed work. Since these are carefully weighed, the Army says that "no R&D contracts normally would be awarded to contractors who have large backlogs of work."

SUBSTITUTE FOR ELECTRONICS—pneumatic devices—are being explored as rapidly as possible by the military. Basic concept is use of a low energy flow of fluid or gas to direct a high energy fluid or gas stream. This control action, the Army says, permits elements and systems capable of

amplification, feedback, memory, logic functions, analog computation and digital computation. Combinations of these six techniques make it possible to design a "pure pneumatic" analog of most electronic circuits. Extreme ruggedness, high reliability, very low cost, and indefinite shelf life are cited among the advantages possessed by pneumatics. Though their limitations are not yet fully established, such "pure" pneumatic systems seem at present to be confined to frequencies under 20 kc.

ELECTRONICS PROCUREMENT MANAGEMENT improvements, under study by the Armed Forces Supply Support Center, probably will not be decided upon until November at the earliest. Almost 800,000 items are covered by the combined electrical-electronic categories in military supply, and there is a wide range of complexity and reliability need. Chances are that no single procurement method or technique will be recommended for buying military electronic equipment. Single procurement may be proposed for some areas of electronics, but a "commodity management center," to co-ordinate purchasing while allowing a good deal of latitude to the individual Services is also getting serious study.

RELIABILITY STUDIES for the military will be centralized within the Advanced Research Projects Agency. So far, ARPA has been assigned the job of making "preliminary" reliability analyses of the MIDAS and SAMOS early warning and surveillance systems and the TRANSIT and NOTUS navigation and communications satellites. In addition, ARPA, will undertake to "monitor," on a continuing basis, the efforts of military contractors and the Defense Department to achieve higher reliability.

ANTITRUST PROBE OF ELECTRONICS on a continuing basis is planned by the Justice Department. It believes that "vigorous application" of the antitrust laws "particularly in those sectors of our economy with the greatest growth potential—industries in their early stages of development—can shape their ultimate competitive structures to assure the competitive vigor essential to price stability and economic growth." One Justice Department project is a review of antitrust decrees in which stress will be laid on those involving patents and research. In hopes to find out whether compulsory licensing provisions, for example, "have had the effect of stimulating industrial research and technological development activities of defendants."

EVALUATION OF THE WEAPONS SYSTEM method of military procurement will be made by the General Accounting Office in the course of its procurement auditing activities. Efforts will be concentrated on selected procurement programs in order to assure that major activities will be covered. The watchdog agency will spot check virtually all major aircraft purchasing, as well as the Bomarc, Jupiter, and Polaris missile programs. Congress has been told that "particular attention" is to be paid to "missiles, electronics, communications, and construction."

CHANGES IN PRICES & AVAILABILITY

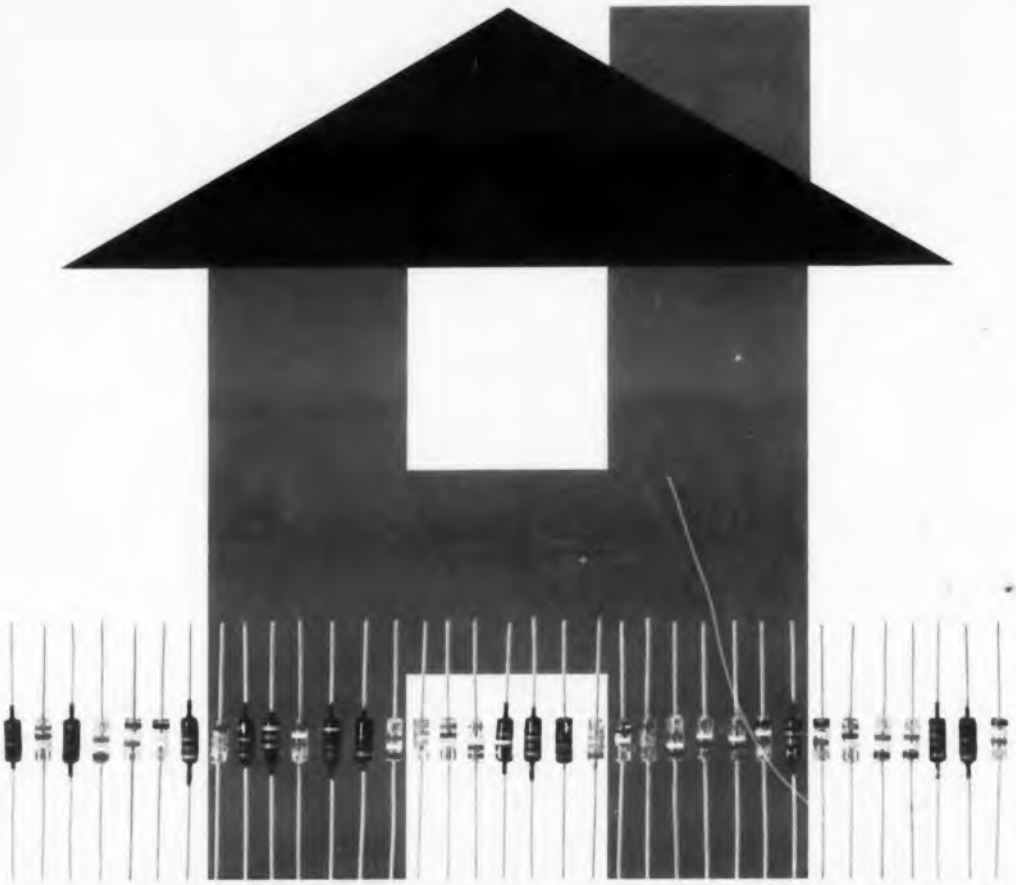
LOW CURRENT SILICON RECTIFIERS have been reduced in price by General Electric Co., Syracuse, N.Y. Thirty-nine models are affected in price by 4 per cent to 50 per cent. The new prices apply to both commercial and military types. All rectifier cells in the low current lines rated at 500 v are priced the same as the 400F v cells. As an example, types 1N540 a 400 v unit and the 1N1095 rated at 500 v have been reduced 10 per cent and 49 per cent respectively, and now are identically priced at $1.80 each, in large quantities to original equipment manufacturers. All models are immediately available in production lots.

PRINTED CIRCUIT MOTORS have been reduced in price by the Photocircuits Corp., Glen Cove, N.Y. Model PM368 is $190 and model PM488 is $240. The new figures represent an average reduction in price of 40 per cent over one year ago. Then, the motors were $300 and $450 respectively.

GERMANIUM POWER TRANSISTORS have been reduced up to 33 per cent by Motorola Inc., Phoenix, Ariz. General price reductions of up to 40 per cent have also been made on many of the firm's rectifier products. Motorola's 25 amp line is now priced to original equipment manufacturers from $5 to $10 in 100 to 999 quantities, as compared with a former $6 to $15 price range. Other reductions include the Motorola 3-amp and 10-amp power transistor series now priced from $1.70 to $12 and $3 to $9.50, respectively, both OEM prices for 100 to 999 quantities.

In addition to the new pricing structure, Motorola has announced two new low cost industrial power transistor series rated for 5- and 15-amp applications. The 5-amp line is priced from $1.65 to $8.50, the 15 amp from $3 to $8.50. Both are OEM prices for 100 to 999 quantity orders.

from the House of Semiconductors



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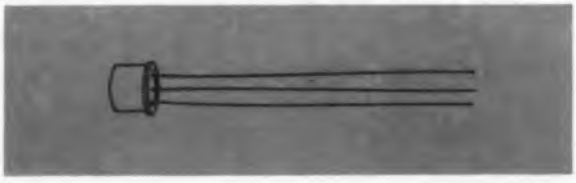


Hughes Semiconductors

SILICON GENERAL PURPOSE DIODES Package A

Type	Minimum Breakdown Voltage @ 100μA @ 25°C	Minimum Forward Current in mA at +1 V	Maximum Inverse Current @ Specified D.C. Test Voltage			Maximum Average Forward Current (mA) @ 25°C	Maximum Peak Recurrent Forward Current (mA)	Maximum Forward Surge Current 1 Sec. (mA)	Maximum D.C. Inverse Voltage (Volts)
			@ 25°C	@ 150°C	Volts				
1N456	30	40	.025 μA	.005 mA	25	90	270	700	25
†1N457	70	20	.025 μA	005 mA	60	75	225	600	60
†1N458	150	7	.025 μA	005 mA	125	55	165	500	125
†1N459	200	3	.025 μA	.005 mA	175	40	120	400	175
1N461	30	15	.5 μA	.030 mA	25	60	180	550	25
1N462	70	5	.5 μA	.030 mA	60	50	150	500	60
1N463	200	1	.5 μA	.030 mA	175	30	100	400	175
1N464	150	3	.5 μA	030 mA	125	40	120	400	125

†JAN Approved

SILICON COMPUTER DIODES Package A

Type	Minimum Es (@ 100μA)	Minimum Forward Current @ 25°C at specified voltage	Maximum Reverse Current (μA)		Reverse Recovery	
			@ 25°C	@ 100°C	Reverse Resistance (R) (ohms)	Maximum Recovery Time (μsec)
1N625	30	4 @ 1.5	1.0 @ − 20V	30 @ − 20V	400 K	1.0**
1N626	50	4 @ 1.5	1.0 @ − 35V	30 @ − 35V	400 K	1.0**
1N627	100	4 @ 1.5	1.0 @ − 75V	30 @ − 75V	400 K	1.0**
1N628	150	4 @ 1.5	1.0 @ −125V	30 @ −125V	400 K	1.0**
1N629	200	4 @ 1.5	1.0 @ −175V	30 @ −175V	400 K	1.0**
1N643	200	10 @ 1.0	.025 @ − 10V	5 @ − 10V	200 K	0.3†
			1.0 @ −100V	15 @ −100V		
1N643A	200	100 @ 1.0	.025 @ − 10V	5 @ − 10V	200 K	0.3†
			1.0 @ −100V	15 @ −100V		
1N658	120	100 @ 1.0	.05 @ − 50V	25 @ − 50V (At 150°C)	80 K	0.3†
1N659	60	6 @ 1.0	5.0 @ − 50V	25 @ − 50V	400 K	0.3*
1N662	100	10 @ 1.0	1.0 @ − 10V	20 @ − 10V	100 K	0.5†
			20.0 @ − 50V	100 @ − 50V		
1N662A	100	100 @ 1.0	1.0 @ − 10V	20 @ − 10V	100 K	0.5†
			20.0 @ − 50V	100 @ − 50V		
1N663	100	100 @ 1.0	5.0 @ − 75V	50 @ − 75V	200 K	0.5†
1N837	100	150 @ 1.0	0.1 @ − 75V	15 @ − 75V	400 K	0.5*
1N838	150	150 @ 1.0	0.1 @ −125V	15 @ −125V	400 K	0.5*
1N839	200	150 @ 1.0	0.1 @ −175V	15 @ −175V	400 K	0.5*
1N844	100	200 @ 1.0	0.1 @ − 80V	15 @ − 80V	400 K	0.5*
1N845	200	200 @ 1.0	0.1 @ −160V	15 @ −160V	400 K	0.5*

**Measured in modified IBM "Y" test circuit when switched from 30mA forward current to −35V.
†Measured in JAN 256 test circuit and switched from 5mA forward current to −40V.
*Measured in JAN 256 test circuit and switched from 30mA forward current to −35V.

HIGH CONDUCTANCE SILICON JUNCTION DIODES Package A

Type	Minimum Breakdown Voltage @ 100μA @ 25°C	Maximum Forward Voltage @ 100mA (Volts)	Maximum Inverse Current @ specified D.C. Test Voltage			Maximum Average Forward Current (mA) @ 25°C	Maximum Peak Recurrent Forward Current (mA)	Maximum Forward Surge Current 10 mSec (Amperes)	Maximum D.C. Inverse Voltage (Volts)
			@ 25°C	@ 150°C	Volts				
1N482	40	1.1	.25 μA	030 mA	−30	100	400	1.0	36
1N482A	40	1.0	.025 μA	015 mA	−30	200	650	2.0	36
1N482B	40	1.0	.025 μA	005 mA	−30	200	650	2.0	36
1N483	80	1.1	.25 μA	030 mA	−60	100	400	1.0	70
1N483A	80	1.0	.025 μA	.015 mA	−60	200	650	2.0	70
1N483B	80	1.0	.025 μA	.005 mA	−60	200	650	2.0	70
1N484	150	1.1	.25 μA	030 mA	−125	100	400	1.0	130
1N484A	150	1.0	.025 μA	.015 mA	−125	200	650	2.0	130
1N484B	150	1.0	.025 μA	.005 mA	−125	200	650	2.0	130
1N485	200	1.1	.25 μA	.030 mA	−175	100	400	1.0	180
1N485A	200	1.0	.025 μA	015 mA	−175	200	650	2.0	180
1N485B	200	1.0	.025 μA	005 mA	−175	200	650	2.0	180
1N486	250	1.1	.25 μA	.050 mA	−225	100	400	1.0	225
1N486A	250	1.0	.05 μA	025 mA	−225	200	650	2.0	225
1N487	330	1.1	.25 μA	050 mA	−300	100	400	1.0	300
1N487A	330	1.0	.1 μA	.025 mA	−300	200	650	2.0	300
1N488	420	1.1	.25 μA	050 mA	−380	100	400	1.0	380
1N488A	420	1.0	.1 μA	025 mA	−380	200	650	2.0	380

Specifications current as of February 1, 1960

SILICON GENERAL PURPOSE DIODES Package A

Type	Minimum Forward Current @ 25°C at Specified Voltage (mA)	Maximum Reverse Current @ Specified D.C. Test Voltage (μA)			Minimum Breakdown Voltage @ 25°C @ 100 μA
		@ 25°C	@ 150°C	Volts	
HD6001	15 @ 1.0V	.500	80	35	30
HD6002	5 @ 1.0V	.500	30	60	70
HD6003	1 @ 1.0V	.500	30	175	200
HD6005	40 @ 1.0V	.025	5	25	30
HD6006	20 @ 1.0V	.025	5	60	70
HD6007	7 @ 1.0V	.025	5	125	150
HD6008	3 @ 1.0V	.025	5	175	200
HD6009	3 @ 1.0V	500	30	125	150

SILICON HIGH VOLTAGE DIODES Package A

Type	PIV (V)	Minimum Forward Current @ 25°C at 1.0 Volts (mA)	Maximum Reverse Current @ PIV (μA)	Average Rectified Forward Current (mA)	Minimum Breakdown Voltage @ 25°C @ 100 μA
HD6861	225	200	.050	200	275
HD6862	300	200	.050	200	360
HD6863	400	200	.050	200	480
HD6864	500	200	.050	200	600
HD6865	600	200	.050	200	720
HD6866	700	200	.050	200	820
HD6867	800	200	.050	200	920
HD6868	900	200	.050	200	1020

SILICON COMPUTER DIODES Package A

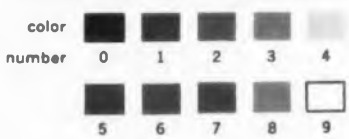
Type	Minimum Breakdown Voltage (V) @ 100 μA	Minimum Forward Current @ 25°C @ 1.5V (mA)	Maximum Reverse Current (μA)		Reverse Recovery	
			@ 25°C	@ 100°C	Reverse Resistance R (ohms)	Maximum Recovery Time (μ sec)
HD6635	50	15	1.0 @ — 30V	30 @ — 35V	400K	1.0**
HD6641	150	15	1.0 @ —125V	100 @ —125V	400K	1.0**
HD6642	50	6	1.0 @ — 30V	100 @ — 35V	400K	1.0**
HD6647	35	6	1.0 @ — 20V	30 @ — 20V	400K	1.0**
HD6648	100	6	1.0 @ — 75V	30 @ — 75V	400K	1.0**
HD6649	200	6	1.0 @ —175V	30 @ —175V	400K	1.0**
HD6651	100	15	1.0 @ — 75V	30 @ — 75V	400K	1.0**
HD6652	200	15	1.0 @ —175V	30 @ —175V	400K	1.0**

**Measured in modified IBM "Y" test circuit when switched from 30mA forward current to —35V.

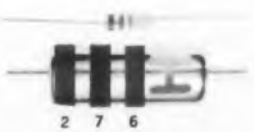
HIGH CONDUCTANCE SILICON JUNCTION DIODES Package A

Type	Minimum Forward Current @ 25°C at 1.0 Volts (mA)	Maximum Inverse Current @ Specified D.C. Test Voltage (μA)			Minimum Breakdown Voltage @ 25°C @ 100 μA
		@ 25° C	@ 150° C	Volts	
[illegible]	100	.025	5	30	40
[illegible]	150	.025	5	60	80
[illegible]	100	.025	5	125	150
[illegible]	100	.025	5	175	200
[illegible]	100	.050	25	225	250
[illegible]	100	1		150	200
[illegible]	100	1		200	250
[illegible]	100	1		250	300
[illegible]	100	1		300	350
[illegible]	100	1		350	400
[illegible]	200	.25	30	60	80
[illegible]	200	.025	5	60	80
[illegible]	200	.25	30	125	150
[illegible]	200	.025	5	125	150
[illegible]	200	.25	30	175	200
[illegible]	200	.025	5	175	200
[illegible]	200	.25	50	225	250
[illegible]	200	.25	25	225	250
[illegible]	200	.25	50	300	350
[illegible]	200	1	25	300	350
[illegible]	200	1	50	380	420
[illegible]	200	1	25	380	420
[illegible]	[illegible]	[illegible]	[illegible]	30	40

STANDARD EIA COLOR CODE



Typical E.I.A. color coding: Manufacturer is identified by gold letter "H" on anode end. Color code reads from cathode end.



SILICON PNP HIGH SPEED SWITCHING TRANSISTORS Package D (Operating Temperature Range: −65°C to +160°C)

D. C. Characteristics:

Type	Collector to Base Voltage† (BV_{CBO})	Emitter to Base Voltage† (BV_{EBO})	Collector to Emitter Voltage† (BV_{CEO})	Typ D.C. Current Gain (h_{FE}) $I_C = -10mA, V_{CE} = -1V$	Max. Collector Saturation Voltage (V_{CE}) $I_C = -10mA$ $I_B = -2$ mA	Vc
2N1254+	−15 V	−5 V	−15 V	20	−0.3 Vdc	−(
2N1255+	−15 V	−5 V	−15 V	50	−0.3 Vdc	−(
2N1256+	−30 V	−5 V	−30 V	20	−0.3 Vdc	
2N1257+	−30 V	−5 V	−30 V	50	−0.3 Vdc	
2N1258+	−50 V	−5 V	−50 V	20	−0.3 Vdc	
2N1259+	−50 V	−5 V	−50 V	50	−0.3 Vdc	

SILICON PNP FUSED JUNCTION TRANSISTORS†† Package C, D (Operating Temperature Range: −65°C to +160°C)

2N1228°° 2N1238°	−15 V	−15 V	−15 V	14	−0.2 Vdc	−(
2N1229°° 2N1239°	−15 V	−15 V	−15 V	30	−0.2 Vdc	−(
2N1230°° 2N1240°	−35 V	−35 V	−35 V	14	−0.2 Vdc	
2N1231°° 2N1241°	−35 V	−35 V	−35 V	30	−0.2 Vdc	
2N1232°° 2N1242°	−60 V	−60 V	−60 V	14	−0.2 Vdc	
2N1233°° 2N1243°	−60 V	−60 V	−60 V	30	−0.2 Vdc	
2N1234°° 2N1244°	−110 V	−110 V	−110 V	14	−0.2 Vdc	

△V_{EB}=−3V
†at 100μA

Power dissipation: ° Coaxial package—1 watt (free air), derate 7.4 mw/°C; 5 watts, derate 37 mw/°C
°° TO-5 package—400 mw (free air), derate 3.0 mw/°C (Infinite Heat Sink)

SILICON PNP HIGH FREQUENCY TRANSISTOR Package D (Operating Temperature Range: −65°C to +200°C)

Type	Collector to Base Voltage (V_{CBO}) $I_{CBO} = -100\mu A$	Emitter to Base Voltage (V_{EBO}) $I_{EBO} = -100\mu A$	Collector to Emitter Voltage (V_{CEO}) $I_{CEO} = -100\mu A$	Power Gain (PG) $I_E = 2mA, V_{CE} = -10V$ $f = 4.3$ mc		$I_E = 2$ mA, $V_{CE} = -10V$ $f = 12.5$ mc		Maximum Collector Cutoff Current (I_{CBO}) $V_{CB} = -20V$	Fre
				min.	typ.	min.	typ.		mi
2N1196	−70 V	−4 V	−70 V	24db	28db			0.25 μA	25
2N1197	−70 V	−4 V	−70 V			20db	22db	0.25 μA	25

SILICON RECTIFIERS Package A

Type	PIV	RMS Volts	Max. Average Rectified Current mA	Max. Surge Current One Cycle (amp)
1N846	50	35	200	2A
1N847	100	70	200	2A
1N848	200	140	200	2A
1N849	300	210	200	2A
1N850	400	280	200	2A
1N851	500	350	200	2A
1N852	600	420	200	2A
1N853	700	490	200	2A
1N854	800	560	200	2A
1N855	900	630	200	2A
1N856	1000	700	200	2A
1N857	50	35	150	1.5
1N858	100	70	150	1.5
1N859	200	140	150	1.5
1N860	300	210	150	1.5
1N861	400	280	150	1.5
1N862	500	350	150	1.5
1N863	600	420	150	1.5
1N864	700	490	150	1.5
1N865	800	560	150	1.5
1N866	900	630	150	1.5
1N867	1000	700	150	1.5

RECTIFIER STUD PACKAGE Package F

Type	PIV	Average Rectified Current	Max. Reverse Current°°	Temperature°	Surge
1N253	95V	1000mA	0.1mA	135°C	
1N254	190V	400mA	0.1mA	135°C	
1N255	380V	400mA	0.15mA	135°C	
1N256	570V	200mA	0.25mA	135°C	
1N562	800V	400mA	1.5μA+	100°C	
1N563	1000V	400mA	2.0μA+	100°C	
HR10671	100V	3Amp	0.5mA	150°C	
HR10673	200V	3Amp	0.5mA	150°C	
HR10675	300V	3Amp	0.5mA	150°C	
HR10677	400V	3Amp	0.5mA	150°C	
HR10679	500V	2Amp	0.5mA	135°C	
HR10681	600V	2Amp	0.5mA	135°C	

RECTIFIER TOP HAT PACKAGE Package E

1N536	50V	250mA	0.4mA	150°C	15Amp
1N537	100V	250mA	0.4mA	150°C	15Amp
1N538	200V	250mA	0.3mA	150°C	15Amp
1N539	300V	250mA	0.3mA	150°C	15Amp
1N540	400V	250mA	0.3mA	150°C	15Amp
1N547	600V	250mA	0.35mA	150°C	15Amp
1N560	800V	250mA	0.375mA+	100°C	2Amp
1N561	1000V	250mA	0.500mA+	100°C	2Amp

°applies to all forward and reverse current measurements except those marked + which are measured at 25°C
°°full cycle average in operational test.

Package C

Package D

Package E

Package F

Small Signal Characteristics:

Max. Collector & Emitter Cutoff Currents (I_{CBO}, I_{EBO}, △)						AC Current Gain (h_{fe}) $V_{CB} = -10V$, $I_E = 2mA$, f = 1Kc.			Frequency Cutoff ($F_{\alpha b}$) $V_{CB} = -10V$, $I_E = 2mA$	
$V_{CB} = -12V$	$V_{CB} = -25V$	$V_{CB} = -30V$	$V_{CB} = -40V$	$V_{CB} = -50V$	$V_{CB} = -90V$	Min.	Typ.	Max.	Min.	Typ.
−0.2μAdc△						10	25		25 Mc	55
−0.2μAdc△						25	55		40 Mc	75
	−0.2μAdc△					10	25		25 Mc	55
	−0.2μAdc△					25	55		40 Mc	75
			−0.2μAdc△			10	25		25 Mc	55
			−0.2μAdc△			25	55		40 Mc	75

						$V_{CB} = -5V$, $I_E = 1mA$, f = 1Kc			$V_{CB} = -5V$, $I_E = 1mA$	
−0.1μAdc						14		32		1.2 Mc
−0.1μAdc						28		65		1.2 Mc
		−0.1μAdc				14		32		1.2 Mc
		−0.1μAdc				28		65		1.2 Mc
				−0.1μAdc		14		32		1.0 Mc
				−0.1μAdc		28		65		1.0 Mc
					−0.1μAdc	14		32		0.8 Mc

+ TO-5 package — 250 mw (free air), derate 1.8 mw/°C

†† Collector current—limited by power dissipation

Frequency Cutoff (F_{α_b}) $V_{CB} = -10V$ $I_E = 2$ mA		Typical Output Capacity (C_{ob}) $V_{CB} = -10V$, $I_E = 0$ f = 140KC	Noise Figure (NF) $V_{CE} = -10V$, $I_E = 2mA$, f = 4.3 mc		$V_{CE} = 10V$, $I_E = 2mA$, f = 12.5mc		Typical Input Impedance (h_{ib}) $V_{CB} = -10V$, $I_E = 2mA$, f = 1KC
min.	typ.		typ.	max.	typ.	max.	
25mc	45mc	3 μμfd	7	10			20 ohms
25mc	55mc	3 μμfd			7	10	20 ohms

HIGH VOLTAGE SILICON CARTRIDGE RECTIFIERS

JEDEC Type Number	Case Style	Rated Peak Inverse Voltage[1]	Absolute Maximum Ratings: R M S Input Voltage[2]	Rectified DC Output Current 25°C	Rectified DC Output Current 100°C	Electrical Characteristics @ 25°C: Max. DC Forward Voltage Drop @ 100 mA DC	Max. DC Reverse Current @ Rated PIV (μA) @ 25°C	Max. DC Reverse Current @ Rated PIV (μA) @ 100°C
1N1730	1	1000	700	200	100	5	10	100
1N1731	1	1500	1050	200	100	5	10	100
1N1732	2	2000	1400	200	100	9	10	100
1N1733	2	3000	2100	150	75	12	10	100
1N2382	3	4000	2800	150	75	18	10	100
1N1734	3	5000	3500	100	50	18	10	100
1N2383	4	6000	4200	100	50	27	10	100
1N2384	4	8000	5000	70	35	27	10	100
1N2385	5	10000	7000	70	35	39	10	100
1N596	1	600	420	150	90	3	10	100
1N597	1	800	560	150	90	3	10	100
1N598	1	1000	700	150	90	3	10	100
1N1406	1	600	420	125	70	5	10	100
1N1407	1	800	560	125	70	5	10	100
1N1408	1	1000	700	125	70	5	10	100
1N1409	1	1200	840	125	70	5	10	100
1N1410	1	1500	1050	125	70	6.25	10	100
1N1411	2	1800	1260	125	70	7.50	10	100
1N1412	2	2000	1400	125	70	6.25	10	100
1N1413	2	2400	1680	125	70	7.50	10	100

1. Continuous DC rating same as P.I.V.
2. Resistive or inductive load

Operating Temperature Range −55°C to +150°C ambient.

POINT CONTACT GERMANIUM DIODES Package A

Type	Maximum PIV (Volts)	Forward Current @ 25°C At + 1 V (mA Min.)	Maximum Reverse Current @ 25°C (mA)	Continuous D.C. Forward Current (mA)	Forward Surge Current 1 Sec. (mA)
1N67A	100	4	.050mA @ −50V	40	300
1N68A	130	3	.625mA @ −100V	40	350
1N89	100	3.5	.100mA @ −50V	40	250
1N90	75	5	.500mA @ −50V	45	250
1N95	75	10	.500mA @ −50V	45	250
1N96	75	20	.500mA @ −50V	45	250
1N97	100	10	.100mA @ −50V	45	250
1N98	100	20	.100mA @ −50V	45	250
1N99	100	10	.050mA @ −50V	45	300
1N100	100	20	.050mA @ −50V	45	300
1N116	75	5	.100mA @ −50V	45	250
1N117	75	10	.100mA @ −50V	45	250
1N118	75	20	.100mA @ −50V	45	250
†1N126A	75	5	.850mA @ −50V	45	350
†1N127A	125	3	.300mA @ −50V	40	300
1N128	50	3	.010mA @ −10V	40	300
1N191	60	5	.125mA @ −50V*	45	300
1N192	60	5	.25mA @ −50V*	45	300
†1N198	100	5	.050mA @ −50V	40	300

†JAN approved *Measured @ 55°C

GOLD BONDED GERMANIUM DIODES Package A

1N96A	75	40	.500 @ −50V	70	400
1N98A	100	40	.100 @ −50V	70	400
1N100A	100	40	.050 @ −50V	70	400
1N118A	75	40	.100 @ −50V	70	400
†1N270	100	200	.100 @ −50V	90	500
1N273	35	100	.020 @ −20V	80	450
†1N276	60	40	.100 @ −50V	40	400
†1N277	125	100	.250 @ −50V*	75	400
1N278	60*	20	.125 @ −50V*	35*	175*
1N279	30	100	.200 @ −20V	80	450
†1N281	75	100	.500 @ −50V	80	400
1N283	25	200	.020 @ −10V	100	500

†JAN Approved *Measured at 75°C

INFRARED OPTICS — in a variety of shapes

Hughes has developed a technique for casting pure polycrystalline silicon of the highest optical quality. Starting with the cast silicon blanks in shapes of flats, domes (up to 9" diameter), lenses, and prisms, Hughes has greatly reduced the necessity of extensive grinding techniques.

Repeated spectrophotometric and scattering tests have proven that the optical properties of cast polycrystalline silicon are identical to those of single crystal silicon.
Infrared optics of germanium are also being cast utilizing the same technique.

PACKAGED ASSEMBLIES

Available in all types of circuit configuration, these Hughes packaged assemblies are designed to meet your individual requirements. In each application careful attention is given to electrical, thermal and mechanical design insuring maximum space utilization, improved temperature and mechanical stability and maximum internal electrical insulation between elements.

PARAMETRIC AMPLIFIER DIODES Package A; Package B (shown)

JEDEC Type	Package Type	Saturation Voltage (V_s) Min. @ 10μA	Parallel Capacitance (Cp) Note 1 Min.	Parallel Capacitance (Cp) Note 1 Max.	Q@ 1 KMC and Zero Bias Min.	Power Dissipation @ 25°C Max.
1N836	A	5V	2.0μμf	4.0μμf	8	80mW°
1N894	A	5V	2.0μμf	3.5μμf	10	80mW°
1N895	A	5V	2.0μμf	3.0μμf	14	80mW°
1N896	A	5V	2.0μμf	2.5μμf	18	80mW°
1N2386	B	5V	2.0μμf	4.0μμf	8	100mW†
1N2627	B	5V	2.0μμf	3.5μμf	10	100mW†
1N2628	B	5V	2.0μμf	3.0μμf	14	100mW†
1N2629	B	5V	2.0μμf	2.5μμf	18	100mW†

1. Net Parallel Capacitance measured at 100KC and Zero Bias. Stray Capacitance (C') of the type "A" package 0.1 μμf, and 0.2 μμf for the type "B" package.
°The derating factor of the "A" type package is 1.6 mw/°C in free air.
†The derating factor of the "B" type package is 2.6mw/°C with crystal end mounted in standard coaxial microwave fixture.

VOLTAGE REGULATOR DIODES Package A

Type	Zener Breakdown Voltage (Volts) Min.	Zener Breakdown Voltage (Volts) Max.	Test Current @ 25°C (mA)	Max. Dynamic° Resistance (ohms)	Max. Total Power Dissipation (mw) @ 25°C	Max. Total Power Dissipation (mw) @ 150°C
1N702	2.0	3.2	5	60	250	100
1N703	3.0	3.9	5	55	250	100
1N704	3.7	4.5	5	45	250	100
1N705	4.3	5.4	5	35	250	100
1N706	5.2	6.4	5	20	250	100
1N707	6.2	8.0	5	10	250	100

°Dynamic resistance measured at 10 mAdc with 1 mA RMS ac superimposed. Special types are available upon request. Other E.I.A. types available: 1N708-720, 1N465-470, 1N1984-1995, 1N761-769. Standard Package ± 10% Tolerance. Suffix A (± 5% Tolerance).

SILICON DIODES Dumet-stud heat sink Package G

Specifications @ 25°C

Type	PIV (V)	Average Rectified Forward Current (mA) @ 25°C	Average Rectified Forward Current (mA) @ 150°C	Peak Recurrent Forward Current (Amp)	Min. Breakdown Voltage (V) @ +100°C	Max. Reverse Current @ PIV (μA) @ 25°C	Max. Reverse Current @ PIV (μA) @ 100°C	Max. Voltage Drop at I_f=400mA (V)
1N645	225	400	150	1.25	275	0.2	15	1.0
1N646	300	400	150	1.25	360	0.2	15	1.0
1N647	400	400	150	1.25	480	0.2	20	1.0
1N648	500	400	150	1.25	600	0.2	20	1.0
1N649	600	400	150	1.25	720	0.2	25	1.0

Power Dissipation . . . 600mW
1 Sec. Surge Current @ +25°C to +150°C . . . 3 Amps
Operating Temperature . . . −65°C to +150°C

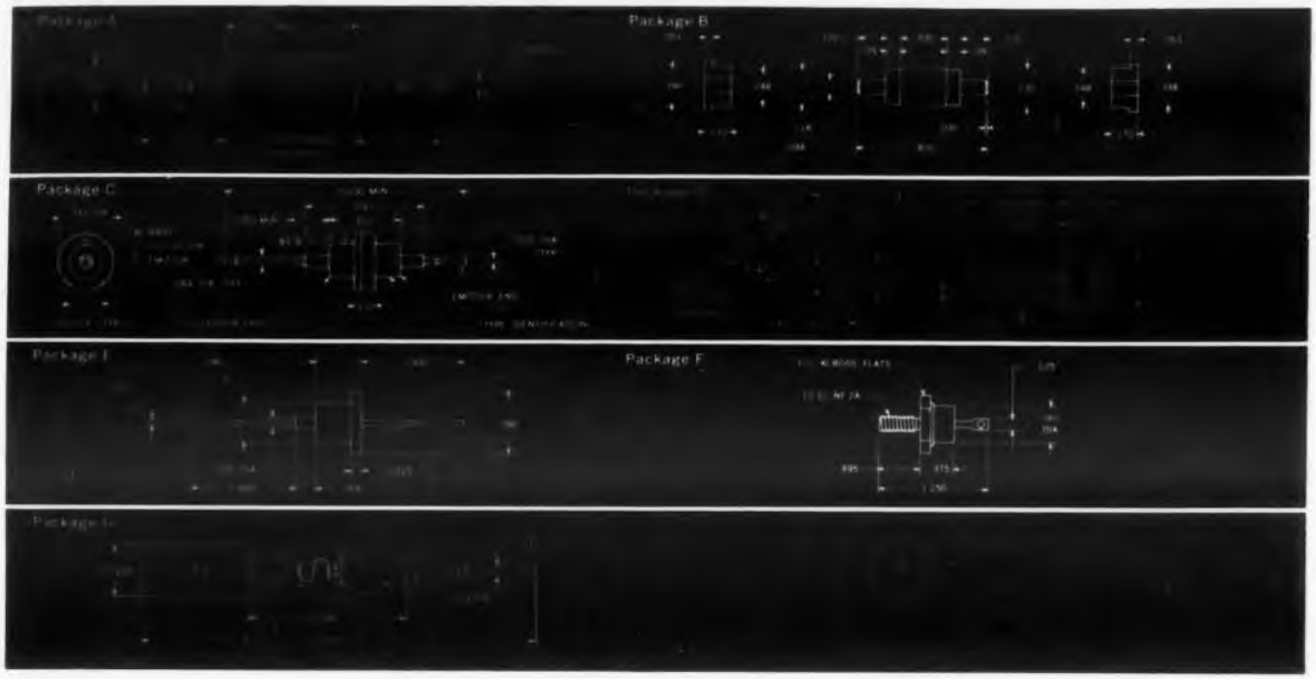
CRYSTAL FILTERS

Types — Frequency	Bandwidth (Kc)	Shape Factor 60db/3db	Maximum Passband Ripple (db)	Maximum Insertion Loss (db)	Impedance In, Out (ohms)	Carrier Rejection (db)	Approximate Size (cubic inches)
10Mc Bandpass Filter	40 @ 3db	2.2:1	0.75	6	1.5K		2.5
100Kc Bandpass Filter	2 cps @ 6db	5:1 (30db/6db)		14	1 K		11.7
30Mc Bandpass Filter	108 @ 3db	2.1:1	±1	8	2.0K		3
1.75Mc Upper Sideband Filter	2.7 @ 3db	1.3:1 (Carrier Side)	±0.5	3	50	55	8.5
2Mc Upper Sideband Filter	7.0 @ 3db	1.3:1 (Carrier Side)	±0.5	6	6.8K	27.5	8
1.75Mc Lower Sideband Filter	2.7 @ 3db	1.3:1 (Carrier Side)	±0.5	3	50	55	8.5
1Mc Discriminator	±1.5		Linearity ±2% over 90% band	Efficiency DC out / AC in 0.7 min.	In = 50 Out = 1 meg.		3.7

All specifications determined at room temperature

PACKAGE DIMENSIONS

All dimensions maximum unless otherwise stated.



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Electronics Head Sees Wide Challenge Ahead

Electronics will be used soon to disperse smog, convert sea water into fresh water and diagnose illness, an industry leader has forecast.

The predictions came from Robert S. Bell, president of Packard Bell Electronics Corp., at a luncheon meeting of the Electric League of Los Angeles.

Commenting on the television industry, Mr. Bell scoffed at the idea that color television never would be practical. Color television sales last year exceeded $50 million, he said, adding:

"By this time next year color programing by the networks will be improved and expanded. This will increase the demand for color sets, and other manufacturers will scramble to get into the business."

Another burgeoning field for manufacturers, he predicted, will be industrial television. It will be used increasingly in control processes, security work (as in banks) and educational institutions, he said.

Mr. Bell noted that industry sales to the military, other industries and individual consumers were a record $9.2 billion last year. He predicted that by 1970 the electronics industry would account for $20 billion of the gross national product.

New Projection Process Steadies Old TV Films

A new projection process promises to make old films on television late shows look like they are being rerun for the first time.

The images filmed in the days of 16-mm photography are reported to be steadier, because the effects of scratches and dirt on the film are eliminated. Nowadays 35-mm film is used for motion pictures.

The process was designed by Eastman Kodak Co. for use with General Electric's Vidicon television camera. The heart of the system embodies tilting and rotating mirrors that reflect a stable image. The device can compensate automatically for film shrinkage.

CIRCLE 24 ON READER-SERVICE CARD ➤

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CONNECTORS

with crimp-type
snap-locked contacts

Snap-lock action of Burndy coax HYFEN connectors recommends them for many applications. Contacts may be installed on cable wherever convenient and then snapped in or out as required. These connectors are now in use in critical circuits

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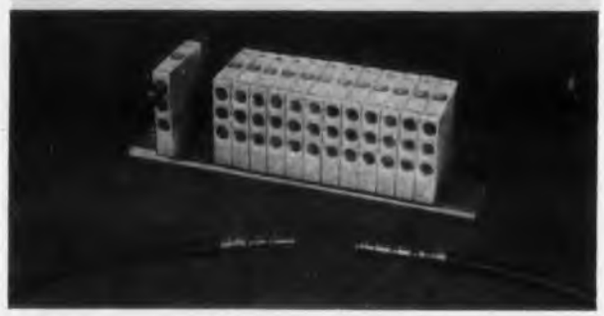
...Modular terminal block. Modules snap together or apart and are mounted on cadmium-plated steel track.



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CONNECT RELIABLY
...tool-controlled crimp provides strain relief for conductors, guarantees a uniform indent for measurable quality control. There is no heat to damage insulation.

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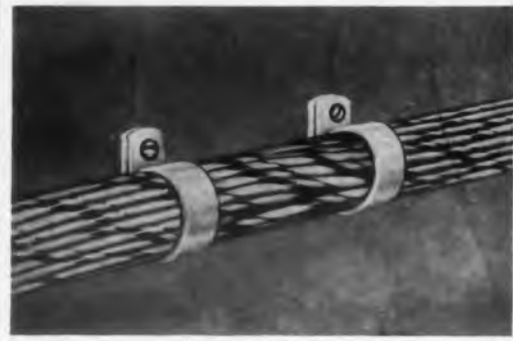
CIRCLE 25 ON READER-SERVICE CARD

(Advertisement)

NYLOCLIP



NYLOCLIP®, a product of the Burndy Corporation's Omaton Division, is a pre-formed molded nylon cable hanger which has been time-proven and widely accepted by industry.

NYLOCLIPS weigh only 30% as much as comparable metal clips and yet have high tensile strength. In addition to their light weight, the cable hangers are temperature resistant from —60° F to 250° F for sustained periods and they are unaffected by oils, gasoline, alcohol, or hydraulic fluids, including non-inflammable types.

NYLOCLIPS are available in seventeen standard diameter sizes, accommodating single cables or groups of cables from 1/8″ to over 2″. Their flexibility makes them easy to install because they are pre-formed in an almost closed position allowing them to be snapped onto cable and stay in place until mounted. Cable insulation is protected by rounded edges and matte-finish on inside surfaces prevent slippage of cable under vibration, without injuring insulation. Inside serrations provide positive alignment when screw is tightened.

BURNDY type HP-N NYLOCLIPS are self-insulating and thus cannot cause grounds or shorts, and are free from hysteresis losses. One, two, and three hole tongue types give maximum efficient diameter range with each size cable hanger.

Burndy Corporation,
Norwalk, Connect.

CIRCLE 26 ON READER-SERVICE CARD

EDITORIAL

What Are You Doing to Lessen Diode Confusion?

The military is updating a preferred diode list, the Electronic Industry Association has stiffened registration controls, the diode industry, working with ELECTRONIC DESIGN, lists in this issue the most "tried and true" diodes for various applications. These are positive steps taken to curb the avalanche of diodes that swamp you, the overworked engineer, who has to choose one. But what have you done? Have you made an effort to solve your engineering problem with a currently available type, or have you engineered a new one by issuing your own spec?

Despite the encouraging steps taken in the last ten months—it was last June that this column deplored the too-many-diode mess—the problem is not solved. The rate of producing new types has slowed, but there are still some 1,500 more this year than last. With the recent advent of tunnel diodes having manifold characteristics, lists could approach telephone-book size. You must resist the temptation to add to this list by asking for another special.

Every tightly specified device produces another ten or so, as the manufacturer must dispose of those falling outside of tolerance. Conceivably this lowers your price because you are not paying for the total output.

Some designers, no doubt, feel that the availability of many types lowers equipment costs because they can shop around to get the best price. With only sparse differences existing between diode types, they can pick any one of several.

The initial picture does show an obvious cost saving in the production of new equipment if there is wide rather than narrow latitude in diode types. However, when the scene shifts to remote military bases, airline maintenance depots, or to ships at sea, initial equipment costs are dwarfed by the cost of stocking, requisitioning, and cataloging large varieties. Standardization is good business, and it is your business.

James A. Kyprie

A UNIQUE FABRICATION PROCESS FOR THE HOFFMAN MESA TRANSISTOR

BY NORMAN GOLDEN
Vice-President,
Research and Development
Hoffman Electronics Corporation
Semiconductor Division

The Hoffman mesa transistor is a high-frequency, diffused-junction silicon semiconductor device, usable at temperatures well above the boiling point of water. The manufacturing method of this device is unique in that it uses exclusively photographic techniques for the precise registration of the contacts and mesa area.

Low-resistivity, n-type (negative electrons) silicon slices are carefully lapped and polished to a mirror finish, flat and parallel to four millionths of an inch. Then an extremely complex cleaning procedure is performed, involving the use of high-turbulence ultrasonic agitation with relatively low average power, but peaks of 500 watts. This removes all trace of contamination, yet does not mar the transistor finish. A total of 13 cleaning solutions is used in conjunction with the agitation to attain the required degree of micro-cleanliness and meet the specified Hoffman standard.

An oxide film only two millionths of an inch thick is grown on both surfaces by heating the silicon in wet oxygen at 2200° Fahrenheit. Then gallium is diffused through the oxide layer so that the material is converted from n-type to p-type (positive electrons) conductivity within 130 millionths of an inch.

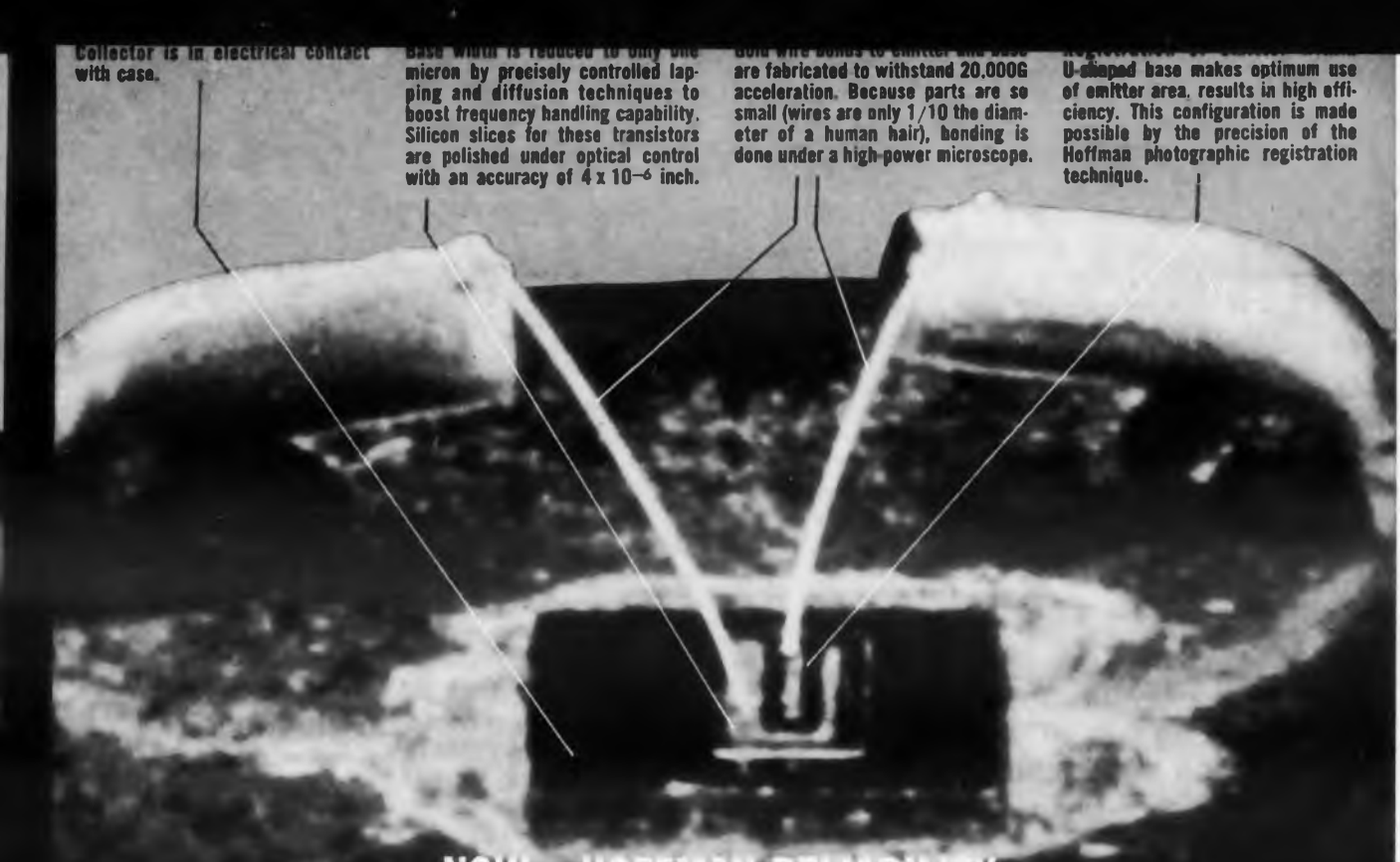
A photo-sensitive coating is deposited on the silicon slice, and an image of the 260 emitters is photographically printed on the wafer. By means of acid treatment, the oxide film is removed from the strips where the emitters are to be, the photographic emulsion serving as a protection for the remainder of the slice.

A phosphorus diffusion follows, converting the un-oxidized portions of the silicon to n-type conductivity with an approximate depth of 100 millionths of an inch.

At this stage of the Hoffman process, we have made 260 tiny transistors on each slice. However, some of the most difficult problems still remain to be solved.

PHOTOGRAPHIC REGISTRATION

For example, aluminum emitter strips must be registered into each of the 260 diffused phosphorous regions. Here each of the emitter contacts on the evaporation mask is registered with a .001" tolerance to the emitter region. In addition, none of the base contacts may short into any of the emitter regions. Here again, the tolerance is a maximum of .001". The registration itself is done under demanding optical conditions since the process is photographic. The aluminum is evaporated through photographically developed holes. Illumination must be restricted in wavelength, short in duration, and low in intensity. However, the highest accuracy of registration is still required, despite the fact that the emitter diffused regions show up as having only slightly different reflectivity than the base silicon. The registration is done on an optical comparator under conditions of essentially monochromatic illumination. A special fix-



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WITH THREE TIMES THE HIGH-FREQUENCY POWER GAIN OF SIMILAR DEVICES

By increasing the usefulness of the emitter area, Hoffman engineers have boosted the minimum high-frequency gain at large currents to 6 at 20 mc (I_C = 50ma, V_C = 10V)--more than three times the industry standard. Hoffman's unique base-emitter configuration, coupled with a photographic fabrication technique that offers control accuracy of the order of light wavelengths, has also lifted current and frequency characteristics well above industry specifications. Reasonable current gains at 40mc have been measured. Since the photo process is far more controllable than mechanical fabrication, these transistors have exceptionally uniform characteristics. Stability, too, is outstanding, because Hoffman pre-ages every transistor at 300°C and seals it hermetically in an inert-gas atmosphere.

A wide range of useful current gain and operating frequencies makes these units ideal for computer, radar and many other applications. You can count on them in your most important circuit. Reliability is built into every unit.

ABSOLUTE MAXIMUM RATINGS (25°C)

V_{CBO} Collector-to-base voltage	60V
Total dissipation at case temperature 25°C	2W
Storage temperature range	−65°C to +175°C

ELECTRICAL CHARACTERISTICS (25°C)

SYMBOL	CHARACTERISTIC	MIN.	MAX.	TEST CONDITIONS
h_{FE}	D.C. pulse current gain (2N696)	20	60	I_C = 150ma V_C = 10V
	(2N697)	40	120	I_C = 150ma V_C = 10V
V_{BE} (sat)	Base saturation voltage		1.3V	I_C = 150ma I_B = 15ma
V_{CE} (sat)	Collector saturation voltage		1.5V	I_C = 150ma I_B = 15ma
h_{fe}	Small signal current gain at f = 20mc	6	9	I_C = 50ma V_C = 10V
C_{ob}	Collector capacitance		35uuf	I_E = 0ma V_C = 10V
I_{CBO}	Collector cutoff current		1.0ua	V_C = 30V T = 25°C
			100ua	V_C = 30V T = 150°C

Physical dimensions in accordance with JEDEC 30 (TO-5). Manufactured to meet MIL-S-19500B requirements.

ture is provided so that the operator may precisely register the slice to the mask and then lock the slice into position. This operation takes two to three minutes. The fixture is designed so that the locking procedure itself does not cause any motion of the slice with respect to the mask.

After the photographic image is imprinted on the emulsion, it is developed. Care must be taken at this stage so that no shrinkage of the emulsion occurs. The aluminum is now evaporated through the emulsion holes and thoroughly bonded to the silicon by means of a high-temperature process. When the slice is cooled, a single silicon crystal re-forms, with about one part per million aluminum held in solid solution. For the p-type base connection, this serves to make a sound, non-rectifying contact. In the case of the emitter region, there is much more phosphorus than aluminum in the silicon. Therefore, the recrystallized material remains strongly n-type after the alloying process despite the presence of the aluminum.

The mesa structures are now precisely registered to the base and emitter, and photographically printed onto each slice. This photographic emulsion protects the rectangular-shaped silicon mesa region from an acid solution attack, so that only one to two ten thousandths of an inch of silicon is removed around the entire periphery of the slice except in the vicinity of the emitter and base. Thus, a raised mesa structure has been produced.

FINAL ASSEMBLY

A scribing machine, designed by Hoffman, with essentially zero backlash, accurately positions the slices, and a series of scratches is made by a diamond point. The scratches divide the slices into small (.050" x .050") squares which have the actual transistor structures on them.

The individual units must now be alloyed onto the gold-plated bases which have the necessary seals for bringing the emitter, base and collector wires through glass insulators into the package. The reliable operation of these devices requires that the glass and the metal base form a perfect seal.

Fastening of wires onto the extremely tiny emitter and base aluminum strips is now performed. Because of the minuteness of the units, this operation is conducted under a special microscope. In order to locate initially the approximate positions of the bonding chisel, transistor structure and gold wire, it is necessary to work at low magnification. However, the bonding operation itself requires high magnification. To avoid the necessity of refocusing, a stereoscopic zoom microscope is used. The base and transistor are heated to approximately 750°F and a tiny, chisel-pointed tool squeezes a fine (.0007") pure gold wire into the aluminum. This process produces an exceptionally strong bond. In fact, tests have suggested that the bond will stand acceleration in excess of 20,000 g.

Once the gold wires are fastened to the terminal posts on the base, a short acid treatment and a thorough wash are required as a final cleaning operation.

Hoffman then "pre-ages" the transistors by baking them in a high vacuum at about 300°C. The units are never again exposed to room air. They are next transferred into a chamber filled with extremely pure nitrogen. Caps are welded onto the bases, so that the units are completely sealed against contamination.

CIRCLE 28 ON READER-SERVICE CARD

An *ELECTRONIC DESIGN* Staff Report

Howard Bierman
Associate Editor

Diode Selection: New Aids Emerge

- Military Updates Diode Listing
- EIA Tightens Registration Procedure
- Industry Cooperates on "Most Popular" Diodes
- Expert Outlines Diode Selection Philosophy

Last year *ELECTRONIC DESIGN* (June 10, 1959) described a confusing situation: too many diode types with superfluous type numbers and specifications. Since then, significant steps have been taken to improve the picture. The military has updated its approved semiconductor diode list, Electronic Industries Association (EIA) has moved to enforce more strictly its rules for diode registration, and industry has cooperated with *ELECTRONIC DESIGN* in the preparation of helpful guides to diode selection.

In this report, the recommended types are arranged in convenient tables to facilitate finding the best diode for the job. Factors other than catalog specs influence final diode choice—these points are discussed in Nick DeWolf's "Diode Selection Game" on page 36.

Defense Dept. Prepares New Diode List

IN LAST year's ELECTRONIC DESIGN Diode Report some rather strong accusations were directed toward industry and the military for not taking concrete steps to limit the seemingly endless number of diode types on the market. Selecting one type for a particular application out of others that appeared similar was exhausting. Evaluating "new" diode devices only to discover they were no better than existing units wasted valuable engineering time. Trying to locate alternate sources of supply or stockpiles of obsolete types for replacement wasted more time and money.

During the last year, the military has increased its efforts to update MIL-STD-200, listing preferred and guidance type tubes and semiconductor diodes. Preferred types are defined as the "best available, have been in production and are covered in a military specification." Guidance types denote "best available, with a military specification available or in preparation."

The latest military listing, 200E, supersedes 200D, released in May, 1958. The new document, approved by the Dept. of Defense, specifies the diode types to be used in the design and production of new equipment. Joint cooperation by the Signal Corps, Bureau of Ships and the Air Force to evaluate the best available types on the basis of performance and reliability helps prevent a confusing logistic problem. Formal approval of the MIL-STD-200E listing was not completed at deadline time for this report. However, close sources reveal that our compilation is accurate and complete.

As a guide to the circuit engineer engaged in military equipment design, MIL-STD-200E types have been grouped into four categories; small signal and rectifier (see Table 2) and microwave and switching (Table 1). For those needing specification details on single-service or JAN-approved types, a tabulation of approved types with spec number and date of issue is contained in Table 3.

Table 1. MIL-STD-200E Approved Microwave and Switching Diodes.

Microwave			
UHF	SHF		EHF
1N25	1N21C 1N21WE	1N23C 1N23WE 1N23CR	1N26
	1N32 1N263	1N31 1N78	1N53
Switching			
1N251	1N658	1N643	1N662

Table 2. Silicon Small Signal and Rectifier Devices Approved on MIL-STD-200E Listing.

Forward Voltage(v)	2-10 MA	25 MA	50 MA	100 MA	150 MA	200 MA	250 MA	400 MA	1 A	5 A	12 A	20 A	50 A
50	1N198	1N457	1N276			1N270							
100	1N458			1N277					1N253			1N249B	1N2173
200	1N459				1N645		1N538			1N1614	1N1202	1N250B	1N2174
300													1N1682
400					1N647		1N540	1N255		1N1615	1N1204		
500													
600					1N649	1N256	1N547			1N1616	1N1206		

EIA Enforcing Registration Rules

ONE malpractice responsible for the swelling diode listing over the years has been the wanton registration by a few manufacturers of "new" types, seemingly identical with previously registered units. By submitting data at points other than those specified by the original registrant, exact comparison was near impossible, and new types numbers were granted by EIA.

Well then, critics asked, why not prepare a standard format for data submission so that all manufacturers' data could easily be compared? A seemingly simple solution. However, when EIA suggested that its prepared formats be used for the reservation and registration of diodes types, cooperation was not universal.

Submission on Standard Formats Mandatory

Finally EIA altered its rules pertaining to reservation and registration. At a November, 1959 meeting, the JEDEC Semiconductor Council ruled that reservation requests and registration releases would not be processed unless data were presented on a standard format. Values for certain key characteristics must be included—no blank spaces. Manufacturers are advised to include any additional data that may be needed to define the diode and distinguish it from previously registered types.

Registration Fee Aids "Soul-Searching"

Another key to the growing diode list over the years has been the registration—again by a few—of long listings of Zener or reference devices. A typical case involved one manufacturer who demanded new type numbers for a new batch of more than 60 Zener values—each type number separated from the next by 0.1 v. "Does a need exist for 4.2-v and 4.3-v and 4.4-v, etc., units?" critics asked. Perhaps. But there was certainly no need to register such devices, the critics argued, when it was well known they could be selected for a particular customer when desired. Just imagine, said the critics, the interminable tabulation that could result if each manufacturer were to resort to such ridiculous extremes.

Here again EIA simplified the problem of "soul-searching" by those contemplating the registration of a type. A fee of $50 for members, $100 for non-members, is now required to accompany each registration application. Needless to say, company executives now take a long, hard look before submitting 70 "new" types, say, for registration and paying up to $7000 in fees. For a series of truly new and upgraded diodes, an outlay of several hundred dollars to cover EIA lab and filing fees would not be overly costly. But for "gimmick" purposes, the fees give a reason for another look.

Staff engineer Reuben Wechsler, of E.I.A.'s Standards Lab, checks test setup for thermal resistance check of transistors. Other projects at the Standards Lab include test evaluations for slow- and high-speed diode reverse recovery tests.

EIA Standards Lab Checks New Types

EIA's Standards Laboratory in Newark, N.J., is entrusted with the investigation of proposed methods of testing electronic devices plus determination of the degree to which average characteristics of products differ among manufacturers. In addition it serves as a standards bureau for the manufacturers of receiving and cathode-ray tubes and semiconductors.

Semiconductor Activities Cited

According to G. F. Hohn, manager of the laboratory, semiconductor activity is currently concerned with the completion of a slow-speed diode reverse recovery test to serve as an industry standard; a simple-to-operate, high-precision bridge arrangement for measurement of transistor low-frequency parameters; and a test method for accurate determination of the thermal resistance characteristics of transistors. Next to be investigated will be a test setup for high-speed diode reverse recovery figures.

In addition the EIA laboratory is processing the reservation and registration of semiconductor devices. To simplify research and to provide prompt answers on diode or transistor characteristics, an automatic card selector system was recently installed. With data submission arriving on standard formats and then translated to the card system, it becomes relatively simple to ascertain quickly whether a new diode type has already been registered. The Standards Laboratory evaluates the submitted material and, when questions arise, follows up until a final decision is reached.

(Report continued on following pages)

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VERY FAST SWITCHING MICRO-DIODE			
TYPE	PIV	E_f @ 5 MA	RECOVERY TIME
TMD-50	50V	0.75V	4 mμsec

FAST SWITCHING MICRO-DIODE			
TYPE	PIV	E_f @ 20 MA	RECOVERY TIME
TMD-24	50V	0.85V	0.3 μsec
TMD-25	100V	0.85V	0.3 μsec
TMD-27	200V	0.85V	0.3 μsec

SILICON MICRO-REGULATOR		
TYPE	VOLTAGE @ 5 MA	POWER RATING @ 25°C
TMD-01	5.1V	100 MW
TMD-03	6.2V	100 MW
TMD-07	9.1V	100 MW

HIGH CONDUCTANCE MICRO-DIODE			
TYPE	PIV	E_f @ 100 MA	POWER RATING @ 25°C
TMD-41	50V	1.0V	100 MW
TMD-42	100V	1.0V	100 MW
TMD-45	200V	1.0V	100 MW

SILICON MICRO-STABISTOR		
TYPE	E_f @ 1 MA	DYNAMIC RESISTANCE
TMD-40	0.55V	60 OHMS

For further information, write for Bulletins:

PB-71A (High Conductance), PB-71B (Fast Switching), PB-71C (Very Fast Switching), PB-71D (Stabistor), PB-71E (Regulators); AN 1358A Application Notes.

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SAratoga 7-4242

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ALgonquin 4-9000

MASSACHUSETTS, Worcester
DeMambro Radio Supply Co., Inc.
PLeasant 7-5626

MICHIGAN, Detroit 2,
H. J. Electronics, Inc.
TRinity 1-1244

MINNESOTA, St. Paul 1
Copher Electronics Co.
CApitol 4-9666

MISSOURI, Kansas City
Burstein Applebee Co
BAltimore 1-4155

MISSOURI, St. Louis 16
Inter State Supply Co
FLanders 1-7585

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DeMambro Radio Supply Co., Inc.
NAtional 4-4006

NEW MEXICO, Albuquerque
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AMherst 8-5862

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Pioneer 8-8211

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H. L. Dalis, Inc.
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Contact Electronics, Inc.
Riverside 7-9831

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Busacker Electronic Equipment Co.
JAckson 6-4661

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CIRCLE 29 ON READER-SERVICE CARD

CIRCLE 30 ON READER-SERVICE CARD

Table 3. Tabulation of Single Service and JAN Approved Diodes

(Complete with specifications and issue date.)

Rectifiers

Type	Spec	Issue Date
1N93	MIL-E-1/895B (NAVY)	5 Jul 56
*1N249B	MIL-E-1/1148 (SIGC)	27 Jun 58
*1N250B	MIL-E-1/1149 (SIGC)	27 Jun 58
**JAN-1N253	MIL-E-1/1024A	28 Jan 58
JAN-1N254	MIL-E-1/989B	28 Jan 58
**JAN-1N255	MIL-E-1/990B	28 Jan 58
**JAN-1N256	MIL-E-1/991B	28 Jan 58
1N315 (Ge)	MIL-E-1/1088 (USAF)	24 May 57
**JAN-1N538	MIL-E-1/1084F	28 Jan 58
**JAN-1N540	MIL-E-1/1085A	28 Jan 58
**JAN-1N547	MIL-E-1/1083A	28 Jan 58
†1N1130	MIL-E-1/1287 (SIGC)	26 May 59
†1N1131	MIL-E-1/1287 (SIGC)	26 May 59
†1N1147	MIL-E-1/1305 (SIGC)	13 Aug 59
†1N1149	MIL-E-1/1306 (SIGC)	13 Aug 59
†1N1183	MIL-E-1/1135 (USAF)	28 Oct 57
†1N1184	MIL-E-1/1135 (USAF)	28 Oct 57
1N1185	MIL-E-1/1135 (USAF)	28 Oct 57
†1N1186	MIL-E-1/1135 (USAF)	28 Oct 57
†1N1187	MIL-E-1/1135 (USAF)	28 Oct 57
†1N1188	MIL-E-1/1135 (USAF)	28 Oct 57
1N1189	MIL-E-1/1135 (USAF)	28 Oct 57
†1N1190	MIL-E-1/1135 (USAF)	28 Oct 57
†1N1199	MIL-E-1/1108 (USAF)	25 Mar 58
1N1200	MIL-E-1/1108 (USAF)	25 Mar 58
1N1201	MIL-E-1/1108 (USAF)	25 Mar 58
1N1202	MIL-E-1/1108 (USAF)	25 Mar 58
1N1203	MIL-E-1/1108 (USAF)	25 Mar 58
1N1204	MIL-E-1/1108 (USAF)	25 Mar 58
1N1206	MIL-E-1/1108 (USAF)	25 Mar 58
1N1281	MIL-E-1/1136 (USAF)	28 Oct 57
1N1282	MIL-E-1/1136 (USAF)	28 Oct 57
1N1283	MIL-E-1/1136 (USAF)	28 Oct 57
1N1284	MIL-E-1/1136 (USAF)	28 Oct 57
1N1285	MIL-E-1/1136 (USAF)	28 Oct 57
1N1286	MIL-E-1/1136 (USAF)	28 Oct 57
1N1287	MIL-E-1/1136 (USAF)	28 Oct 57
1N1341	MIL-E-1/1186 (USAF)	
1N1342	MIL-E-1/1187 (USAF)	
1N1343	MIL-E-1/1188 (USAF)	
1N1344	MIL-E-1/1189 (USAF)	
1N1345	MIL-E-1/1190 (USAF)	
1N1346	MIL-E-1/1191 (USAF)	
1N1347	MIL-E-1/1192 (USAF)	
1N1348	MIL-E-1/1193 (USAF)	
1N1408	MIL-E-1/1172 (SIGC) (to be cancelled)	4 Jun 58
1N1413	MIL-E-1/1173 (SIGC) (to be cancelled)	4 Jun 58
1N1614	MIL-E-1/1240 (SIGC)	30 Oct 58
1N1615	MIL-E-1/1241 (SIGC)	30 Oct 58
1N1616	MIL-E-1/1242 (SIGC)	30 Oct 58
1N1682	MIL-E-1/1195	1 Dec 59
†1N1731	MIL-E-1/1302 (SIGC)	13 Aug 59
†1N1733	MIL-E-1/1303 (SIGC)	13 Aug 59
†1N1734	MIL-E-1/1304 (SIGC)	13 Aug 59
1N2135A	MIL-E-1/1256 (SIGC)	26 Jan 59
1N2172	MIL-E-1/1196	1 Dec 59
*1N2173	MIL-E-1/1151	1 Dec 59
*1N2174	MIL-E-1/1194	1 Dec 59

Reference

Type	Spec	Issue Date
†1N429	MIL-E-1/1134 (USAF)	28 Oct 57
†1N430	MIL-E-1/1060 (NAVY)	30 Oct 56
1N709	MIL-E-1/1238 (SIGC)	28 Oct 58
1N716	MIL-E-1/1238 (SIGC)	28 Oct 58
1N718	MIL-E-1/1238 (SIGC)	28 Oct 58
1N720	MIL-E-1/1238 (SIGC)	28 Oct 58
1N722	MIL-E-1/1238 (SIGC)	28 Oct 58
†1N746A	MIL-E-1/1258 (NAVY)	3 Jun 59
†1N747A	MIL-E-1/1258 (NAVY)	3 Jun 59
†1N748A	MIL-E-1/1258 (NAVY)	3 Jun 59
†1N749A	MIL-E-1/1258 (NAVY)	3 Jun 59
1N750	MIL-E-1/1238 (SIGC)	28 Oct 58
†1N750A	MIL-E-1/1258 (NAVY)	3 Jun 59
†1N751A	MIL-E-1/1258 (NAVY)	3 Jun 59
†1N752A	MIL-E-1/1258 (NAVY)	3 Jun 59
†1N753A	MIL-E-1/1258 (NAVY)	3 Jun 59
†1N754A	MIL-E-1/1258 (NAVY)	3 Jun 59
†1N755A	MIL-E-1/1258 (NAVY)	3 Jun 59
†1N756A	MIL-E-1/1258 (NAVY)	3 Jun 59
†1N757A	MIL-E-1/1258 NAVY)	3 Jun 59
†1N758A	MIL-E-1/1258 (NAVY)	3 Jun 59
†1N759A	MIL-E-1/1258 (NAVY)	3 Jun 59
1N1324	MIL-E-1/1176 (USAF)	
1N1353	MIL-E-1/1236 (SIGC)	10 Nov 58
1N1358	MIL-E-1/1236 (SIGC)	10 Nov 58
1N1361	MIL-E-1/1236 (SIGC)	10 Nov 58
1N1777	MIL-E-1/1235 (SIGC)	28 Oct 58
1N1778	This type not included in MIL-E-1/1235	
1N1781	MIL-E-1/1235 (SIGC)	28 Oct 58
1N1791	MIL-E-1/1235 (SIGC)	28 Oct 58
1N1795	MIL-E-1/1235 (SIGC)	28 Oct 58
1N1804	MIL-E-1/1236 (SIGC)	10 Nov 58
1N1807	MIL-E-1/1236 (SIGC)	10 Nov 58
†1N1816A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1817A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1818A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1819A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1820A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1821A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1822A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1823A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1824A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1825A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1826A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1827A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1828A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1829A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1830A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1831A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1832A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1833A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1834A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1835A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59
†1N1836A & RA	MIL-E-1/1259 (NAVY)	4 Jun 59

** MIL-STD-200 Preferred Types
* MIL-STD-200 Guidance Types
† Navy Guidance Types

Small Signal

Type	Spec	Issue Date
JAN-1N38B (Ge)	MIL-E-1/492B	17 Apr 57
1N39 (Ge)	MIL-E-1/777B (NAVY)	28 Jul 54
1N44 (Ge)	MIL-E-1/377 (NAVY)	3 Aug 53
1N48 (Ge)	MIL-E-1/378 (NAVY)	10 Aug 53
1N55A (Ge)	MIL-E-1/487A (NAVY)	23 Sept 54
1N55B (Ge)	MIL-E-1/481A (NAVY)	9 Sept 54
1N56A (Ge)	MIL-E-1/549A (NAVY)	28 Jul 54
1N63 (Ge)	MIL-E-1/376B (NAVY)	8 Feb 54
1N67A (Ge)	MIL-E-1/508A (NAVY)	15 Dec 53
JAN-1N69A (Ge)	MIL-E-1/142D	17 Apr 57
JAN-1N70A (Ge)	MIL-E-1/154D	17 Apr 57
JAN-1N81A (Ge)	MIL-E-1/155D	17 Apr 57
JAN-1N126A (Ge)	MIL-E-1/156C	17 Apr 57
JAN-1N127A (Ge)	MIL-E-1/157C	17 Apr 57
JAN-1N128 (Ge)	MIL-E-1/158B	4 Mar 54
1N145 (Ge)	MIL-E-1/811 (NAVY)	21 Sept 54
*JAN-1N198 (Ge)	MIL-E-1/700	13 Aug 54
1N212	MIL-E-1/932A (NAVY)	1 Feb 56
*JAN-1N270 (Ge)	MIL-E-1/992A	17 Apr 57
*JAN-1N276 (Ge)	MIL-E-1/1025	25 Jun 56
**JAN-1N277 (Ge)	MIL-E-1/993A	17 Apr 57
JAN-1N28 1(Ge)	MIL-E-1/961	23 Aug 55
**JAN-1N457	MIL-E-1/1026	25 Jul 56
**JAN-1N458	MIL-E-1/1027	25 Jul 56
**JAN-1N459	MIL-E-1/1028	25 Jul 56
†1N483B	Proposed (NAVY)	
†1N484B	Proposed (NAVY)	
†1N486B	Proposed (NAVY)	
*1N645	MIL-E-1/1143 (USAF)	22 Apr 58
1N646	MIL-E-1/1143 (USAF)	22 Apr 58
*1N647	MIL-E-1/1143 (USAF)	22 Apr 58
1N648	MIL-E-1/1143 (USAF)	22 Apr 58
*1N649	MIL-E-1/1143 (USAF)	22 Apr 58
T12G (Ge)	MIL-E-1/1154 (NAVY)	

Microwave

Type	Spec	Issue Date
JAN-1N21B	MIL-E-1/656	25 Mar 54
*JAN-1N21C	MIL-E-1/657	23 Mar 54
1N21E	MIL-E-1/1155 (USAF)	
*JAN-1N21WE	MIL-E-1/1115	14 Oct 58
JAN-1N23B	MIL-E-1/618	4 Mar 54
*JAN-1N23C	MIL-E-1/295B	17 May 55
*JAN-1N23CR	MIL-E-1/550A	4 Mar 54
1N23E	MIL-E-1/1231 (SIGC)	30 Sept 58
*JAN-1N23WE	MIL-E-1/1117	14 Oct 58
**JAN-1N25	MIL-E-1/658	13 Aug 54
**JAN-1N26	MIL-E-1/659B	23 Jun 55
**JAN-1N31	MIL-E-1/661A	23 Jun 55
**JAN-1N32	MIL-E-1/27A	13 Aug 54
**JAN-1N53	MIL-E-1/497B	17 May 55
1N72	MIL-E-1/780A (NAVY)	23 Sept 54
**JAN-1N78	MIL-E-1/662A	23 Jun 55
*JAN-1N263	MIL-E-1/809B	14 Oct 58

Switching

Type	Spec	Issue Date
**JAN-1N251	MIL-E-1/1023	25 Jul 56
*1N643	MIL-E-1/1171 (SIGC)	16 May 58
*1N658	MIL-E-1/1160 (SIGC)	27 Jun 58
*1N662	MIL-E-1/1139 (SIGC)	26 Feb 58
1N663	MIL-E-1/1140 (SIGC)	26 Feb 58
†1N691	Proposed Navy	
†1N696	Proposed Navy	

"Most Popular" Diodes Compiled

AS A result of ELECTRONIC DESIGN's charge last year that design engineers were spending too much time scanning listings of thousands of diodes, an industry representative offered to compile a group of charts containing the "most popular" types manufactured. The ambitious volunteer, who prefers to remain anonymous, has been closely identified with the semiconductor industry since its early days and is an active member of various industry committees.

To confirm the validity of the submitted listings, ELECTRONIC DESIGN sent them to all diode manufacturers in the U. S. and invited their comments as well as their inclusion of any additional diode types that might have been overlooked. Here again a forward step was taken by the industry. An overwhelming percentage of manufacturers responded with reserve; there was no mad dash to include their "favorites." Suggested changes were evaluated and incorporated when valid.

By dividing the application areas into four groups—silicon general-purpose, silicon computer, silicon reference and germanium—the listings offer the design engineer a choice of 178 diode types. Only registered JEDEC types are shown; "house" numbers, available from single sources, are not included. Obviously many types (of the 4,000 available) are omitted; the intent of the charts is to present the diode types that are produced in large quantities and thus generally supplied from

(text concluded on page 36)

Table 4. Silicon Voltage Regulator

V (nom)	¼ W	1 W	10 W
2.6	1N702		
3.3	1N746		
3.6	1N703		
	1N747		
3.9	1N748	1N1518	1N1599
4.2	1N704		
	1N749		
4.7	1N750	1N1519	1N1600
	1N705		1N2041
5.1	1N751		
5.6	1N708	1N1765	1N1803
	1N752		1N2042
6.2	1N753	1N1766	1N1804
	1N709	1N1485	
	1N429		
6.8	1N710	1N1767	1N1805
	1N754	1N1521	1N1602
7.5	1N711	1N1768	1N1806
	1N755		

Table 5. "Most Popular" General Purpose Silicon Diodes.

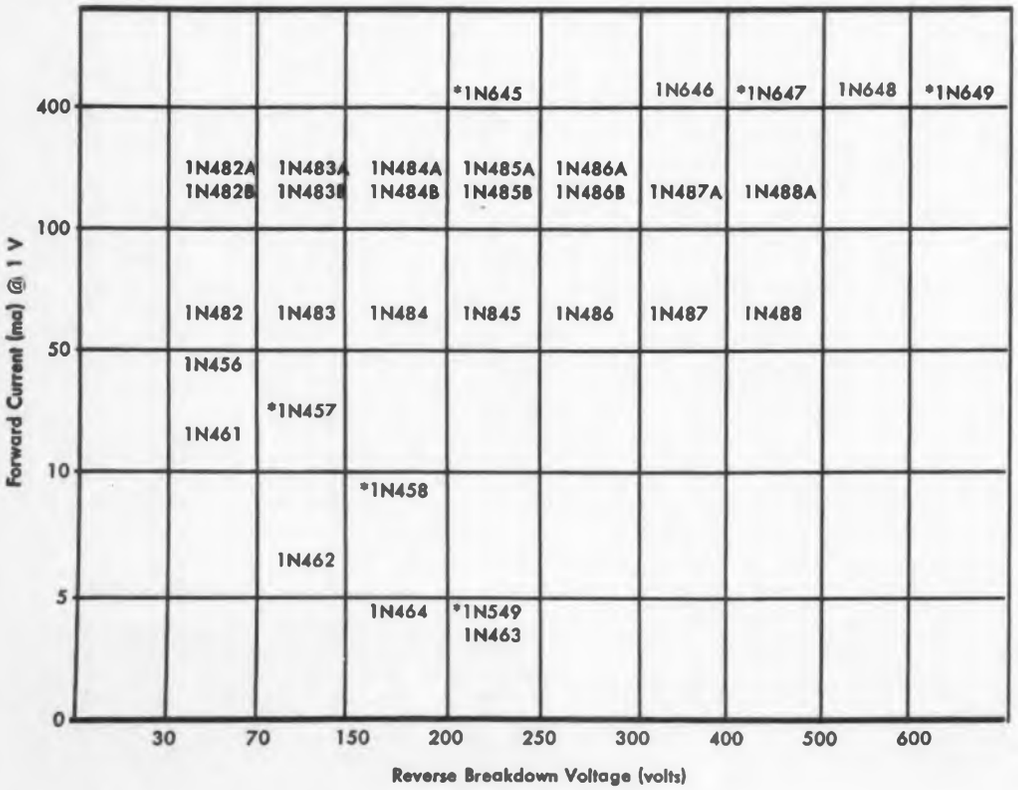
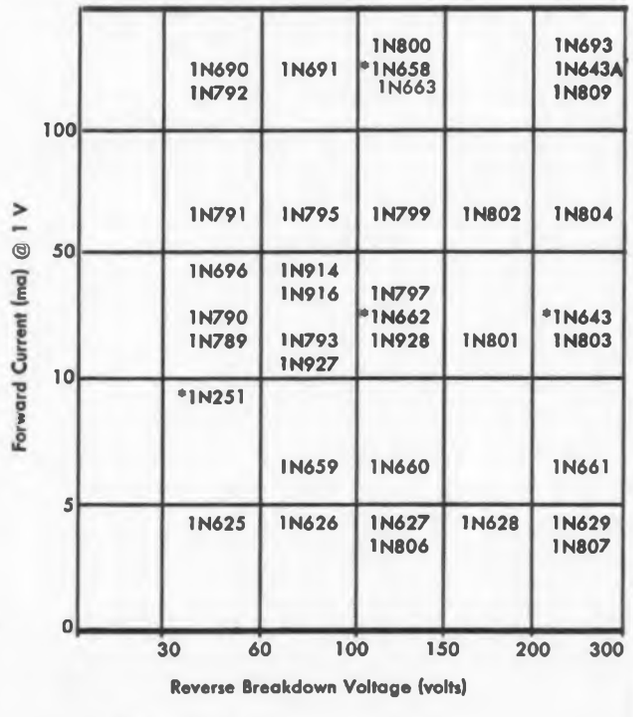


Table 6. "Most Popular" Silicon Computer Types.

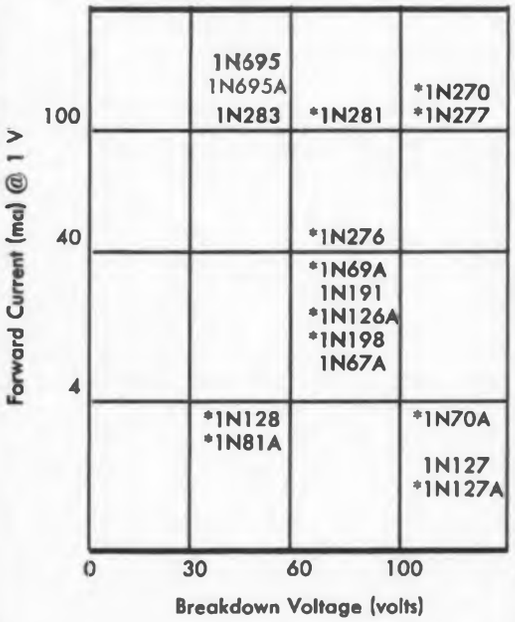


Denotes Single Service Approval
* MIL-STD-200 Type

nd Reference Diodes.

V (nom)	¼ W	1 W	10 W
8.2	1N756	1N1425	1N1416
	1N712	1N1769	1N1807
	1N430	1N1522	1N1603
9.1	1N757		
	1N713		
10.0	1N758	1N1771	1N1351
	1N714		
12.0	1N759	1N1426	1N1417
	1N716	1N1773	1N1353
13.0	1N717	1N1774	1N1354
15.0	1N718	1N1427	1N1335
		1N1775	1N1418
16.0	1N719	1N1776	1N1356
18.0	1N720	1N1428	1N1357
		1N1777	1N1419
20.0	1N721	1N1778	1N1820
22.0	1N722		1N1358
27.0	1N724	1N1781	1N1361
68.0	1N734	1N1791	1N1833
100.0	1N738	1N1795	1N1836

Table 7. "Most Popular" Germanium Types.



*JAN
Low Leakage, High Temp., Fast Recovery Type

DIFFUSED SILICON PNPN CONTROLLED RECTIFIER

A three-junction, three-terminal device for use in power control and in switching applications requiring up to 16 amps., D.C. In the reverse direction (anode negative) it will block current up to its rated PIV, while in the forward direction (anode positive) it will block up to its minimum breakover voltage, at which point it will quickly switch to the high conduction state. It may also be turned on when an appropriate voltage is impressed between gate and cathode. In this latter respect it is analogous to a thyratron. In the "on" conduction state, the forward voltage drop is essentially that of a standard silicon diode. Tentative specifications are as follows:

MAXIMUM RATINGS

Peak inverse voltage (PIV) .. 25 to 400 volts	Peak inverse gate voltage (V_{gr}) .....5 volts
Average forward current (I_f)..up to 16 amps	Storage temperature .....−65 to 175°C
Peak surge current (one cycle)....150 amps	Operating temperature .....−65 to 125°C

SPECIFICATIONS AT 25°C

Min. breakover voltage (V_{bo})..25 to 400 volts	Max. gate current to fire (I_{gt}).....80 ma
Max. leakage current (I_r) and (I_b).....5 ma	Typical gate current to fire (I_{gt}).....20 ma
Max. forward voltage (V_f avg.).....0.9 volts	Typical holding current (I_h).....10 ma
Max. gate voltage to fire (V_{gt}).....3.0 volts	Turn on time.....< 5 μsec
Min. gate voltage to fire (V_{gt}).....0.3 volts	Turn off time.....< 20 μsec

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several sources. These are used sufficiently to be recognized as dependable. Many types are indicated as approved by military; non-military types are listed where applicable in the same category, so as to provide a price advantage where a MIL type is not required. In some cases the latest improved diode types, possibly single-source now but destined for additional suppliers, are included to alert the design engineer to what the industry and military expect to use heavily.

Reference diodes, as an example, can be obtained from many sources under different type numbers than those listed. In addition considerable smaller voltage increments are available. Here again it is emphasized that the charts are intended as a helpful guide and not to be considered as a preferred or mandatory listing to be followed strictly.

There's More to Selection Than Charts

However, charts and tables are but one step in reaching a final decision on diode selection. An expert in the field, Nick DeWolf, Transitron's chief electronic engineer, offers helpful ideas in the article below, "The Diode Selection Game." Derating for reliability, with suggested rules for determining the choice of a device and supplier, are clearly outlined. ■ ■

Catalog Sheets Don't Tell All

The Diode Selection Game

N. DeWolf
Chief Electronics Engineer
Transitron Electronic Corp.
Wakefield, Mass.

Diode selection involves more than fitting a catalog spec to a circuit design. Price availability and source are important factors; general rules before reaching a final decision are outlined. ELECTRONIC DESIGN invites comments, for possible publication, on Nick DeWolf's philosophy.

Nick DeWolf, head of Transitron's electronic engineering department, has firmly established himself as one of the most outspoken men in the well-populated semiconductor field. Apparently unrestricted by conventional drawstrings, Nick often creates quite a stir by bringing up controversial points which many, for obvious commercial reasons, would rather not mention. His discussion of the diode situation is typical.

IT APPEARS that many believe that an adequate selection of a diode type may be made by perusal of specification charts and sheets and by matching circuit requirements to diode specifications. However, in practice the usual electrical specifications are among the least important factors in proper selection!

Just How Good Are Diodes?

Underlying this conflict are several very important practical facts about present-day diodes. Modern diodes are usually far better in most characteristics than circuitry actually requires. The forward drop is not only very low, but remarkably uniform and in most cases not limiting. Improvements in forward drop at typical current levels are unlikely since they are determined mainly by the basic material from which the diode is made. Leakage current is very low, and in silicon diodes is often a measurement challenge. Leakage specifications have improved more slowly than diodes and the bulk of modern diodes far exceed published specifications. Voltage ratings are, if trusted, higher than normally required, particularly for transistorized equipment.

Another hitch is that many diodes are neither stable nor faultless in workmanship. An occasional individual diode may be notoriously unreliable although the average diode may be remarkably resistant to environment. Ratings are, by present convention, not trustworthy as operating points and are actually guarantees of conditions that will induce some failures eventually. A relative comparison of these difficulties is assuredly not published on specification lists or specs.

Catalogs Don't Tell All

As a result, the bulk of diodes are today purchased under special tightened internal specifications which are aimed at reliability rather than parameter characteristics. Many of the normally unpublished specs are direct reliability indexes and tests, others are tests believed indirectly to be reliability measures. Over half of today's diodes are purchased to special specifications, which

How Much Derating for High Diode Reliability?

Temperature

The general feeling is not to use germanium types above 65 C nor silicon above 125 C.

Power Dissipation and Current Ratings

Since catalog ratings tend to be very unconservative, particularly in silicon devices, values should be reduced often by a factor of three.

Voltage Ratings

Although derating may be painful, silicon devices should not be used over 300 v nor germanium above 40 v without life-test proof of adequate reliability. Generally, use of half the voltage rating is reasonable when it is below the above figures.

often are comprised of over a dozen pages of environmental and life tests, plus quality control requirements.

The design and manufacturing techniques employed vary greatly between manufacturers and between diode families. These fundamental diode differences greatly affect reliability and high frequency properties, but are not reflected in simple specification listings. The largest single determinant in diode selection is the choice of manufacturer and family of diode. A given type number may be of entirely different construction from each producer. The resultant differences are often of far greater importance than the differences between initial specifications. These differences do not appear on condensed spec listings and are usually not evident on specification sheets. The advertising pages are more indicative here, although "dirty linen" is rarely confessed.

Derating For Reliability

The necessity for derating and conservative allowance for changes and drift cause the initial

spec to serve properly only as a guidepost and starting point. Varying degrees of conservatism in ratings should result in varying degrees of derating. The inaccuracies of arbitrary percentage derating methods rather than knowledgeable deratings can cause unrealistic comparisons and false diode selection.

Price is a dirty word, but the lack of pricing formulae recommends a careful study. Many diodes appear overpriced, an occasional one is a bargain. The game of picking out the lowest priced diode may result in a loss of manufacturer interest, with concurrent loss of many internal specifications and quality control. The higher priced diodes generally command the cream of the crop from a given production line.

Availability Key Factor in Selection

Availability is another important area. The most up-to-date good buy is almost inevitably short in supply. Diode consumption has increased very rapidly and manufacture can barely keep abreast. Many programs depend dangerously on regular delivery of appreciable quantities of the diodes that are most difficult to make and most likely to fail the tight lot inspections.

Manufacturer service, applications help, disposition towards rejects, reputation and product improvement are just as important in semiconductor diodes as in any other industrial product and should affect manufacturers' choice.

Factors Affecting Choice

There are therefore many factors to consider in choosing a diode which should not be simplified or ignored. The relative importance of these points depends on the user's circumstances. A few of these factors are:

- Reliability demands and systems' mean-time to failure
- Quantity used per system
- System performance requirements
- Miniaturization and weight requirements
- Environmental capability of equipment
- Availability of evaluation engineering
- Scheduling
- Budgeting and competition
- Importance of maintenance difficulties

Recommended Rules For Diode Selection

A method for type selection is very difficult to define absolutely, but the following recommendations are urged as a basis for type selection.

1. Establish and use a component's standards engineering group who can study and specialize in the fine flavors of diode manufacture and so extend diode selection beyond mere specifications. Circuit designers should establish close liaison with this group.
2. Use your experience and the experience of others, but be careful of generalities. A diode you may have disfavored last year because the paint chipped may be today's best diode.
3. Carefully study all requirements businesswise as well as technically. Almost every area of equipment manufacture and marketing may affect type selection.
4. Be familiar with specifications, prices and advertising literature. This is the easiest part of the job.
5. Evaluate samples of all products at least by family and continue this effort as changes take place.
6. Visit the manufacturers' plants to assess their capability. ■ ■

Roundup of Tunnel Diode Specifications

The Esaki or tunnel diode has been heralded as the most promising semiconductor development since the transistor. Low noise amplification, high frequency oscillation and super-fast switching are but a few of the predicted applications. Tabulated below are typical values of key characteristics of types available on or before March 28, 1960.

Type No.	Mfg.	Mat.	Ip(ma)	Iv	Ep mv)	Ev	$P_{T_{mw}}$	Ip/Iv	T_{op}
ZJ6-10	G.E.	GaAs	22	1.5	160	600	50	15	−55 + 150C
ZJ6-22	G.E.	GaAs	10	0.7	160	600	50	15	−55 + 150C
IN2939	G.E.	Ge	1.0	0.1	55	350	50	10	−55 + 100C
IN2940	G.E.	Ge	1.0	0.2	55	350	50	10	−55 + 100C
IN2941	G.E.	Ge	4.7	0.6	55	350	50	10	−55 + 100C
TD-1	G.T.	Ge	2.0	—	50	200	20	up to 10	−55 + 100C
HT-1 to HT-10	Hoffman	Si	1.0 to 5.6	—	65	420	20	3.5	−85 + 200C
TD100 to TD111	R.C.A.	Ge	1.5 to 7.6	—	65	280	25	4.5	−55 + 100C
TD200	R.C.A.	GaAs	50	—	100	500	125	>10	−85 + 200C
T101	Sperry	Ge	0.8	0.18	55	300	100	4.5	−55 + 100C
T102	Sperry	Ge	1.5	0.33	55	300	100	4.5	−55 + 100C
T103	Sperry	Ge	3.5	0.8	55	300	100	4.5	−55 + 100C
T104	Sperry	Ge	7.0	1.5	55	300	100	4.5	−55 + 100C
IN650	T.I.	GaAs	10	0.5	100	450	30	>15	−65 + 175C
IN651	T.I.	GaAs	10	0.5	100	450	30	>10	−65 + 175C
IN652	T.I.	GaAs	5.0	0.5	100	450	30	>5	−65 + 175C
IN653	T.I.	GaAs	5.0	0.5	100	450	30	>5	−65 + 175C

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				•		Bomac Labs., Inc., Salem Road, Beverly, Mass.
		•				Bradley Semiconductor Corp., 168 Columbus Ave., New Haven 11, Conn.
•	•				•	CBS Electronics, 900 Chelmsford St., Lowell, Mass.
•	•		•			Continental Device Corp., 12911 Cerise Ave., Hawthorne, Calif.
•	•					Clevite Transistor Products, 241 Crescent St., Waltham 54, Mass.
		•				Columbus Semiconductor Mfg. Div., 1010 Saw Mill Road, Yonkers, N. Y.
		•				Dallons Semiconductors, 5066 Santa Monica Blvd., Los Angeles 29, Calif.
		•				Delco Div. of General Motors, Kokomo, Ind.
•	•				•	Erie Electronics Div., 644 W. 12th St., Erie, Pa.
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•	•					Gahagan, Inc., Waterman Ave., Esmond 17, R. I.
•		•			•	General Electric Co., 1224 W. Genesee St., Syracuse, N. Y.
•	•	•	•			General Instrument Corp., 65 Gouvernor St., Newark 4, N. J.
•	•					General Transistor Corp., 95-18 Sutphin Blvd., Jamaica 45, N. Y.
•	•	•	•			Hoffman Electronics, 930 Pitner Ave., Evanston, Ill.
•	•	•	•			Hughes Products Semicon. Div., Intl. Airport Station, Los Angeles 45, Calif.
•		•	•		•	International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.
•						International Resistance Co., Box 393, Boone, N. C.
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W. Wahlgren, president of Electro Engineering Works, wrote this article to abate the delusion that large, husky transformers are always better and more reliable than the new smaller types.

Thermal Factors In Transformer Design

Wallace W. Wahlgren
Technical Director
Electro Engineering Works

SIZE, temperature rise, and life expectancy of transformers subjected to high temperature are determined by the cooling mechanism and the kind of insulation used. An adequate cooling mechanism can drastically reduce the temperature rise in a transformer, and when more effective,

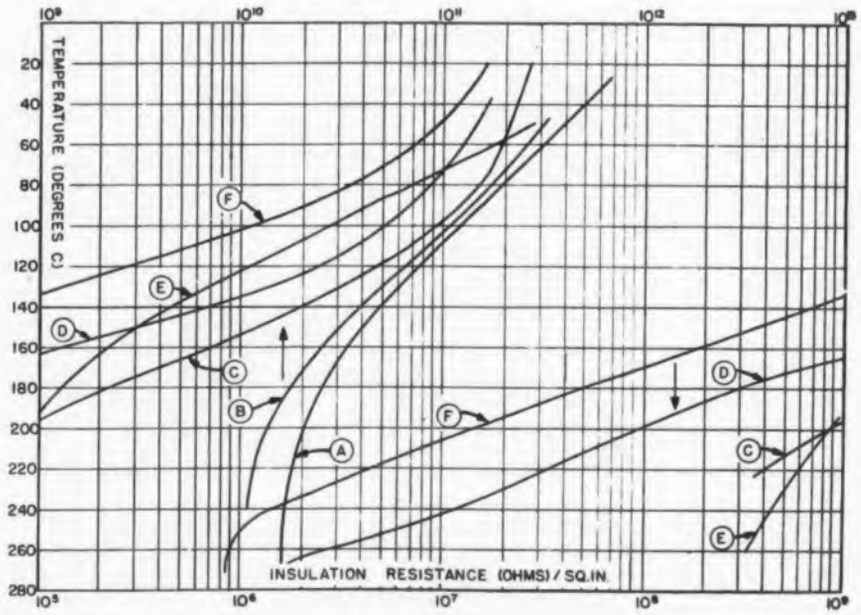


Fig. 2. Materials shown in the graph are: *A*, Teflon coated glass cloth (0.009 in.); *B*, silicon rubber glass cloth; *C*, epoxy bonded flake mica sheet (0.01 in.); *D*, epoxy impregnated asbestos paper (0.009 in.); *E*, epoxy bonded reconstituted mica or glass cloth (0.011 in.); *F*, epoxy impregnated Kraft paper (0.01 in.).

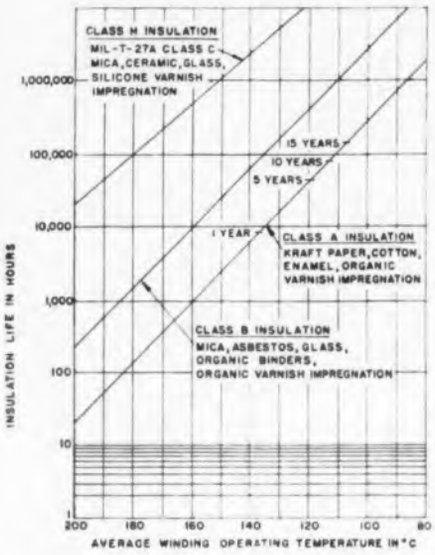


Fig. 1. Temperature vs life expectancy.

cooling is provided, transformer size can also be reduced.

Temperature rise is caused by core loss, and coil or copper loss. Core loss seldom presents a problem because the heat is generally conducted through the mounting device. Since the core does not ordinarily deteriorate as a result of high temperature operation, core loss does not have a significant effect on transformer life expectancy.

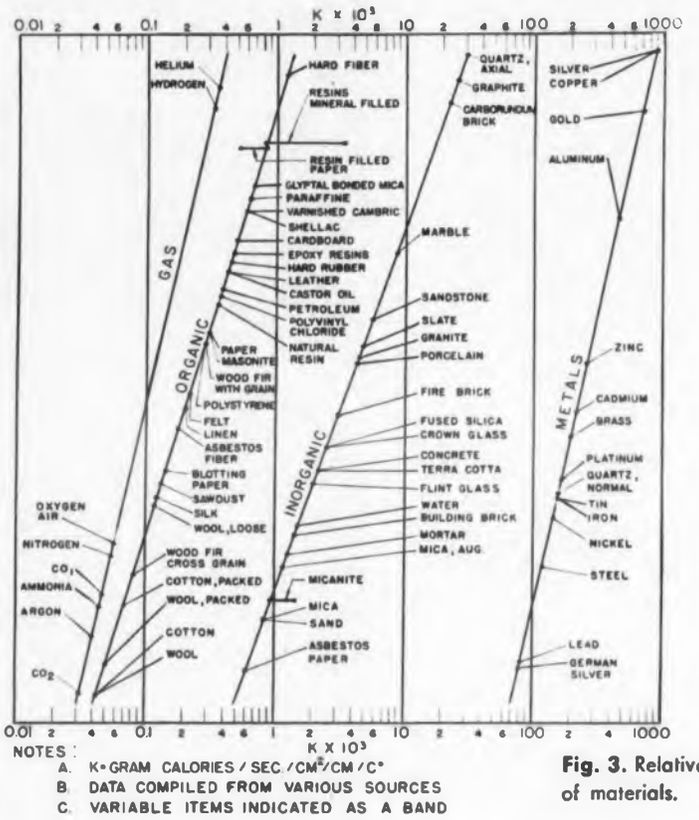
But copper loss is of great significance. As the transformer temperature rises, the winding resistance increases, sometimes as much as 60 per cent. This increased resistance causes a drop in output voltage under load.

Transformer insulation can change in electrical characteristics and its life expectancy can be reduced sharply as operating temperature increases. The relationship between temperature and life expectancy of various kinds of insulating materials used in transformers is shown in Fig. 1.

Causes of Failure

Transformers may fail due to reduction of insulation resistance of physical deterioration of the insulating material caused by excessive transformer temperature rise. Failure can be accelerated by hot spots which affect only a part of the insulation; this alone can cause premature transformer breakdown. The electrical insulation resistance of various insulating materials affected by heat is illustrated in Fig. 2. Glass, for example, can change from an insulator to a conductor at very high temperatures.

Temperature rise and hot spots can be minimized by use of insulating materials which are good thermal conductors. Hot spots are often



NOTES:
A. K = GRAM CALORIES / SEC. / CM² / CM / C°
B. DATA COMPILED FROM VARIOUS SOURCES
C. VARIABLE ITEMS INDICATED AS A BAND

Fig. 3. Relative thermal conductivity of materials.

caused by trapped air since air, as shown in Fig. 3, is one of the poorest conductors of heat. Most organic insulation materials are poor heat conductors and are on the threshold between thermal conductors and thermal insulators. Inorganic materials are also relatively poor heat conductors.

New Insulating Materials

In the absence of insulation materials which have the desired combinations of characteristics, new insulating materials have been created by blending available materials. These new materials are formed by combining epoxy resins with other insulating materials. Since epoxy is a term which identifies a whole chemical family of materials, the results obtained depend upon the formulation of the epoxy compound.

The true value of epoxy as a transformer insulation is realized by combining it with other materials. When epoxy is blended with another compatible material, a new material, in effect, is formed which possesses characteristics of both. While the "new" material may be poor in some respects, it generally is far superior in other respects than either of the two original materials.

When epoxy resin is filled with an inorganic material, its coefficient of expansion is greatly improved because of the lower coefficient of the filler. So is its mechanical stability under temperatures. The improvement in insulation resistance charac-

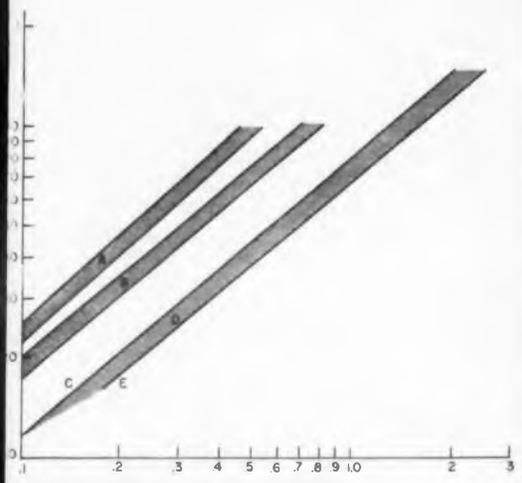


Fig. 4. Coil temperature rise of: *A*, old style potted or end bell construction; *B*, modern resin potted and molded units; *C*, steel plate vertical surface; *D*, best small encapsulated transformers (not molded); *E*, steel plate top surface.

teristics at high temperatures of such commonly used insulation materials as asbestos paper, glass cloth and kraft paper, when impregnated in an epoxy compound is shown in Fig. 2.

Life expectancy of a typical small transformer using ordinary class A kraft paper insulation is around 400 hr when operated at 170 C. When impregnated in an epoxy compound, test units operated for approximately 9000 hr at 170 C, and insulation resistance remained essentially constant for more than 8000 hr.

Hot Spots Reduced

High temperature transformers are now being manufactured which are thoroughly impregnated and encapsulated in an epoxy compound, making the coil 100 per cent solid. Voids are virtually absent and all of the materials are effectively saturated in the compound. Since the wire insulation is completely wetted, without the usual microscopic film of separation, improved heat flow from one part of the coil to another is realized. Hot spot temperatures and the thermal gradient within the coil are reduced.

The practical results of these techniques are shown graphically in Fig. 4. More than a 10,000 hr life is being obtained at 170 C. Tests are being conducted to determine life expectancy at 250 C as well as to determine top limits for 1000-hr life. ■ ■

Markings can materially improve product appearance and increase operator efficiency. The basic factors involved are discussed and several examples illustrated. (Knob design was covered in ELECTRONIC DESIGN, *Feb. 17, panel redesign in March 2, cases and housings redesign in March 16, and packaging concepts in March 30.*

An Industrial Designer Discusses . . . . "MARKINGS"

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

IN ADDITION to serving as a means of product identification, markings on electronic equipment play an important role in improving operator efficiency and reducing human error factors. Typical methods of transforming line and symbol to a product include etching, embossing, silk screening, hot stamping and the use of adhesive plates.

Basic Rules For Markings

To realize utmost benefits from nomenclature, lettering must be clear and visible and located for most convenient operator viewing. Brief descriptive terms (Off, Lo-Speed, Hi-Speed) are more desirable than meaningless numerals (Off, 1, 2) requiring reference to an instruction manual. Obvious details should not be included since any unnecessary cluttering leads to operator confusion. Common rather than abstract words must be selected and non-standard abbreviations avoided.

Functionally related controls and terminals or test jacks should be grouped together and organized so that an obvious relationship is evident. Close attention to these details make possible high operator efficiency even with relatively unskilled personnel.

Marking Technique Set By Application

Although etched or embossed markings are more durable than ink stamping, adhesive sticker or silk screen methods, the latter techniques are often more economical and are capable of greater dramatic impact. Careful evaluation of the particular application must be weighed before a final decision can be made.

For example, an adhesive foil sticker was originally used for company and product identification on the Rena heat control, see Fig. 1a. Lettering is relatively large and a minimum amount of information is to be presented. By converting to

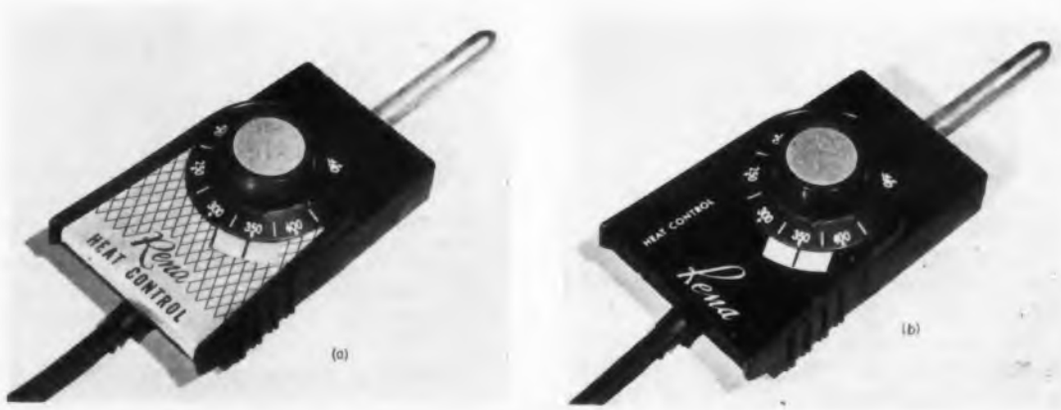


Fig. 1. Changing from an adhesive sticker (a) to a silk-screened impression reduced marking cost from 12 cents to three cents.

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a silk screen operation, Fig. 1b, the cost of product marking dropped from 12 cents to 3 cents.

Now consider the problem of applying a relatively large number of lines and letters to a small surface containing raised areas, such as a Klixon switch, manufactured by Spencer Thermostat, shown in Fig. 2 (left). Here silk screening is impractical since clean, unsmeared detail would be difficult to achieve. Etching was considered but was abandoned due to its high cost. An anodized pressure sticker, as shown in Fig. 2 (right) proved to be the most practical and pleasing solution.

Redesign of a medical unit, an Acousticon screening audiometer shown in Fig. 3a, centered around markings and an acceptable color scheme. Patients are generally troubled and dejected during initial examinations; the presence of a grim, black box does little to dampen their fears. The change in equipment design to a bright, off white-teal blue combination serves to convey a clean, refreshing impression. The interrupter switch is devoid of function identification in the original design; specific details are included in the redesigned version shown in Fig. 3b.

The markings for the Trio Labs vtvm, shown in Fig. 4a, were considered confusing and conducive to operator errors. For example, identification of the function selector switch settings (at the right) could be interpreted as applying to the center-adjust control.

By encircling the switch and applying radial markings, as shown in Fig. 4b, operator doubts are dispelled. Similarly, the range selector switch and associated input terminals are functionally bound together by an encompassing arc. Finally, to limit lettering on the instrument panel to specific operating details, the company trademark was moved to the meter bezel. ■ ■

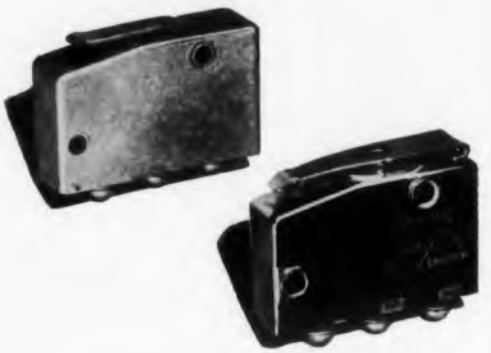

Fig. 2. Silk screening on small areas requiring much linework is impractical. For this type application, the use of an adhesive sticker is preferable.

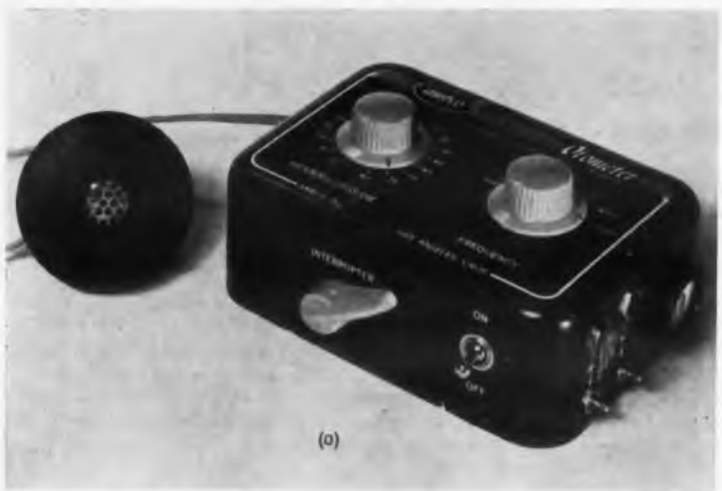

Fig. 3. Controls and switches should be identified and their functions specifically indicated. The interrupter switch in (a) does not disclose its three position settings; confusion is eliminated by appropriate marking applied as shown in (b).

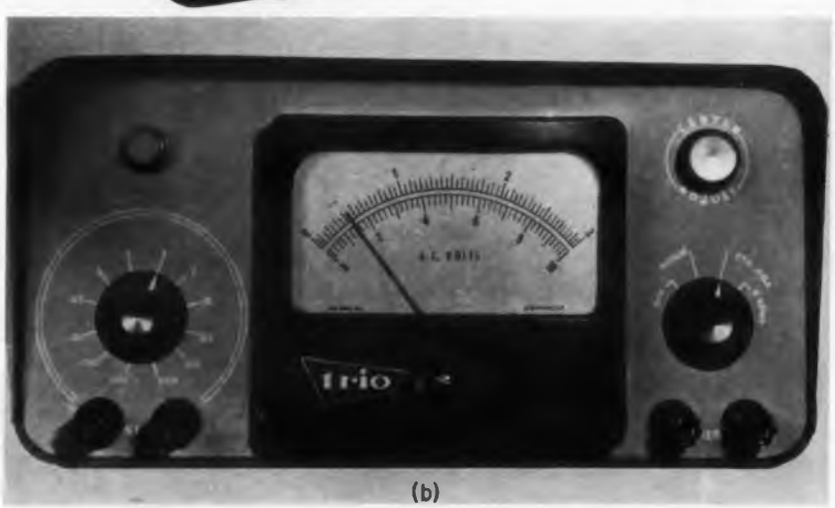

Fig. 4. By applying a circular pattern to unite lettering details to specific controls, as shown in (b), improved appearance together with a reduction of potential operator confusion are achieved.

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CONTROLLED RECTIFIERS & SWITCHES

SILICON CONTROLLED RECTIFIERS are now available in both the 7/16" hex and 11/16" hex base packages. Replacing thyratrons and magnetic amplifiers in many applications these rugged devices offer greater reliability and increased efficiency. Some typical applications are:

- industrial control
- lighting control
- solid state inverters
- overvoltage protection
- short circuit protection

Write for Bulletin TE-1356

TYPE	PIV	Max. average amps Forward current at 25°C case	at 100°C case	Hex size of Package
TCR 520	50	20	10	11/16
TCR 1020	100	20	10	11/16
TCR 1520	150	20	10	11/16
TCR 2020	200	20	10	11/16
TCR 2520	250	20	10	11/16
TCR 3020	300	20	10	11/16
TCR 3520	350	20	10	11/16
TCR 4020	400	20	10	11/16
TCR 510	50	10	5	11/16
TCR 1010	100	10	5	11/16
TCR 1510	150	10	5	11/16
TCR 2010	200	10	5	11/16
TCR 2510	250	10	5	11/16
TCR 3010	300	10	5	11/16
TCR 3510	350	10	5	11/16
TCR 4010	400	10	5	11/16
TCR 503	50	5	2	7/16
TCR 1003	100	5	2	7/16
TCR 1503	150	5	2	7/16
TCR 2003	200	5	2	7/16
TCR 2503	250	5	2	7/16
TCR 3003	300	5	2	7/16
TCR 3503	350	5	2	7/16
TCR 4003	400	5	2	7/16

THE TRANSWITCH is a new bi-stable silicon computer element that can be turned *OFF* with a gate current. Extremely uniform electrical characteristics over a wide current range (2-50 ma) permit the device to fulfill low level logic and medium power needs. The device is designed for:

- miniaturized memory circuit
- ring counters
- shift registers
- controlled rectifier driver
- flip-flop equivalent

Write for Bulletin TE-1357A

SPECIFICATIONS AND TYPICAL CHARACTERISTICS (at 25°C Unless Otherwise Stated)

		Typical	Maximum		Test Conditions
Saturation Voltage	V_s	1.0	1.5	Volts	I_C = 50 mA
Forward Leakage Current	I_F	0.1	10	μA	AT RATED VOLTAGE
Reverse Leakage Current	I_R	0.1	10	μA	AT RATED VOLTAGE
Forward Leakage Current	I_F	20	50	μA	at 125°C
Gate Voltage to Switch "ON"	$V_{C\,on}$	0.7	1.0	Volts	R_L = 1 K
Gate Current to Switch "ON"	$I_{C\,on}$	0.1	1.0	mA	R_L = 1 K
Gate Voltage to Switch "OFF"	$V_{C\,off}$	1.2	4.0	Volts	I_C = 50 mA
Gate Current to Switch "OFF"	$I_{C\,off}$	7.0	10	mA	I_C = 50 mA
Holding Current	I_H	2.0	5.0	mA	R_L = 1 K

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Is high-potential testing of rotating components semi-destructive? Some engineers say it is; claim that each successive hi-potting weakens all units, and back it up with test data. Others hold to the "weak sister" theory which claims that hi-pot tests weed out the weak units leaving a population of superior units—and also back it up with test data!

In this article, author Ben Sachs points up the basis for this difference of opinion, and establishes the actual semi-destructive nature of the tests. He feels that experiments now being made may eventually resolve the difficulty. Meanwhile, an awareness of the damage caused by hi-potting can prevent many unnecessary equipment failures.

High-Potential Testing . . .

A Semidestructive Process?

Benjamin Sachs
Manager of Advanced Planning and Quality Control
Ketay Dept., Norden Div.,
United Aircraft Corp.
Commack, L.I., N.Y.

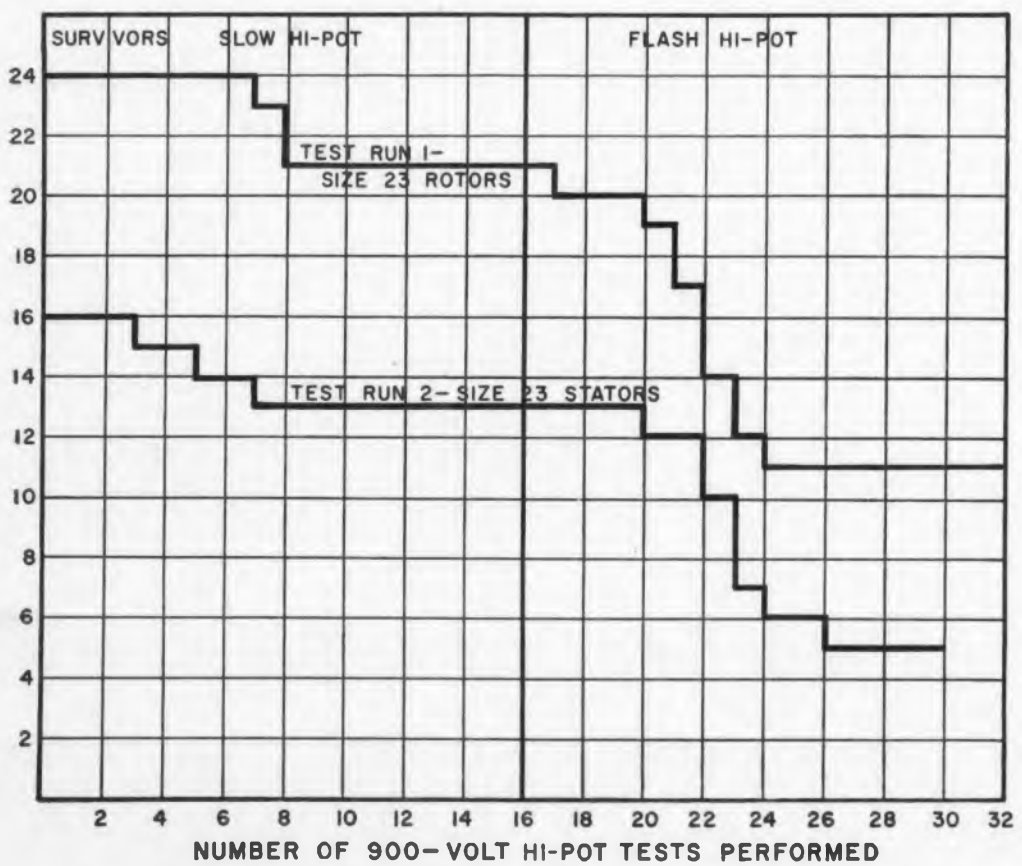


Fig. 1. Repeated hi-pot tests at 900 v continued to cause rotor and stator failures. Flash testing accelerated the rate of failure.

OF ALL the tests to which rotating components are subjected, only the high-potential test presents a question of classification as semi-destructive or non-destructive. There is no such doubt regarding the non-destructive nature of the other important tests, which include static and dynamic accuracy, null voltage, transformation ratio and impedance. A way of distinguishing between non-destructive and semi-destructive tests is the following:

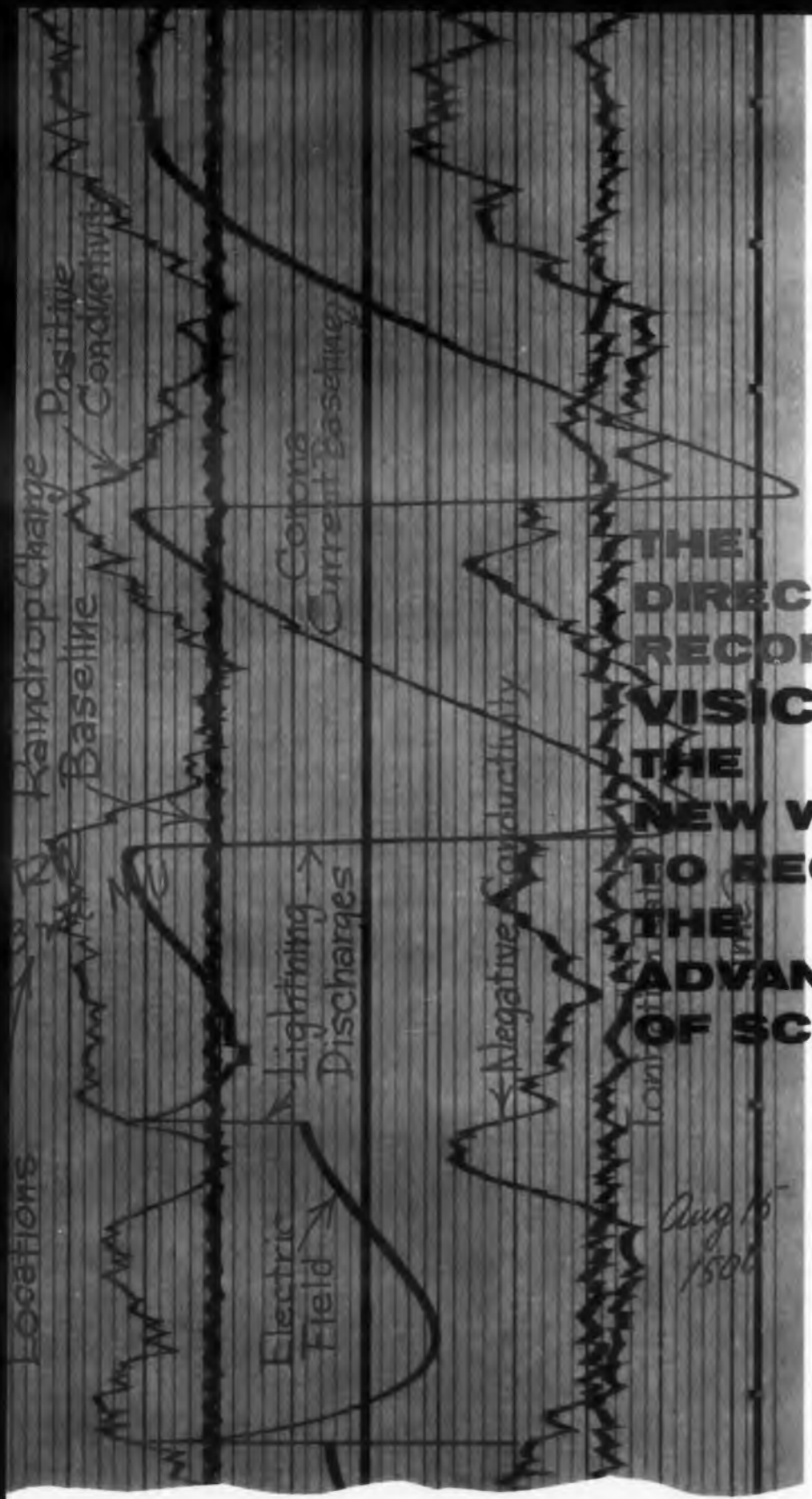
A non-destructive test does not physically affect the items tested and may therefore be repeated as many times as desired.

A semi-destructive test physically affects the item tested and the number of exposures or time duration of exposure is part of the specification of the test.

The "Weak Sister" Theory

Some engineers assume that components with sound insulation will not be affected by high-potential tests. They consider it a regular performance test and do not hesitate to repeat it when desired. In effect, they assume that the units which fail are "weak sisters" which are to be weeded out, leaving a population of "supermen" which will not be affected by additional tests.

In a typical expression of this point of view, L. B. Kilman and J. P. Dallas state in AIEE Transactions, (*Electrical Engineering*, Vol. 75, II, September 1956, p. 189), "The common concern over insulation damage is not justified when



THE DIRECT RECORDING VISICORDER... THE NEW WAY TO RECORD THE ADVANCEMENTS OF SCIENCE

HONEYWELL DEVELOPERS OF THE ULTRA-VIOLET PRINCIPLE OF OSCILLOGRAPHY, PRESENT THREE VERSATILE VISICORDER MODELS AND ASSOCIATED SIGNAL-CONDITIONING EQUIPMENT...

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MODEL 906 VISICORDER

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Two models of the 906 Series Visicorder give you a choice of recording capacity on 6″ paper.

The Model 906 B-1 uses high-sensitivity Series M sub-miniature plug-in type galvanometers that are directly interchangeable among all Honeywell oscillographs of the sub-miniature galvanometer type. Optical arms, therefore galvanometer sensitivities, are an identical 11.8 inches in all instruments.

The 906 B-1 provides for 14 channels of recording including two static reference traces —each channel operating at frequencies from DC to 5000 cps. It has provisions for recording intensity control; trace identification; grid line system (either inches or millimeters) and selectable record speeds (a choice of 5 interchangeable systems, each covering 4 speeds).

The Model 906 B-2 is identical to the 906 B-1, except that it uses solid-frame galvanometers with a capacity of 8 channels, including 2 timing or event-marking channels.

Accessories available for both models of the 906 B include a record take-up unit; record takeup and latensifier; relay rack adapters; and the Visicorder Timing Unit.

Honeywell

MODEL 1108 VISICORDER

. . . newest of the Honeywell direct-recording oscillographs

The Model 1108 delivers direct-writing Visicorder oscillography at the lowest cost per channel. Intermediate in size between the 14-channel 906 and the 36-channel 1012, the 1108 simultaneously records up to 24 channels of data on a record 8 inches wide. This instrument, like other Visicorders, records at frequencies from DC to 5000 cps with unparalleled galvanometer sensitivities.

Pushbutton controls give a choice of 15 record speeds from .05 to 80 inches per second, and time line intervals of 1, .1 and .01 seconds. Such built-in features as automatic record length control, grid-line intensity control, galvanometer spot intensity control, record numbering, reversible record drive, trace identification, provision for remote operation, and many others contribute to maximum convenience in recording high-speed analog data.

As in all Honeywell Visicorders, paper loading, access to the interior, and galvanometer adjustment is easy and convenient.

Honeywell

MODEL 1012 VISICORDER

. . . the most complete, convenient multi-channel oscillograph on the market today

The Model 1012 has been accepted as "the most versatile instrument ever devised for converting dynamic data into immediately visible read-out." It will record up to 36 channels of data simultaneously on 12" wide paper. It gives complete push-button control of 15 different paper speeds, from 0.1 to 160 in./sec., with automatic recording intensity control. Designed into the 1012 are many other convenience features: daylight paper loading; reversible record drive choice; switch selection of 5 different timing intervals (.001 to 10.0 seconds); simultaneous recording of amplitude reference (grid) lines; trace identification; automatic record length control; record numbering; jump-speed control and provisions for remote and/or multiplexed operation.

Like other Visicorders, the 1012 makes use of the sub-miniature galvanometer. All instruments are readily adaptable to rack and shock-mounting.

Honeywell

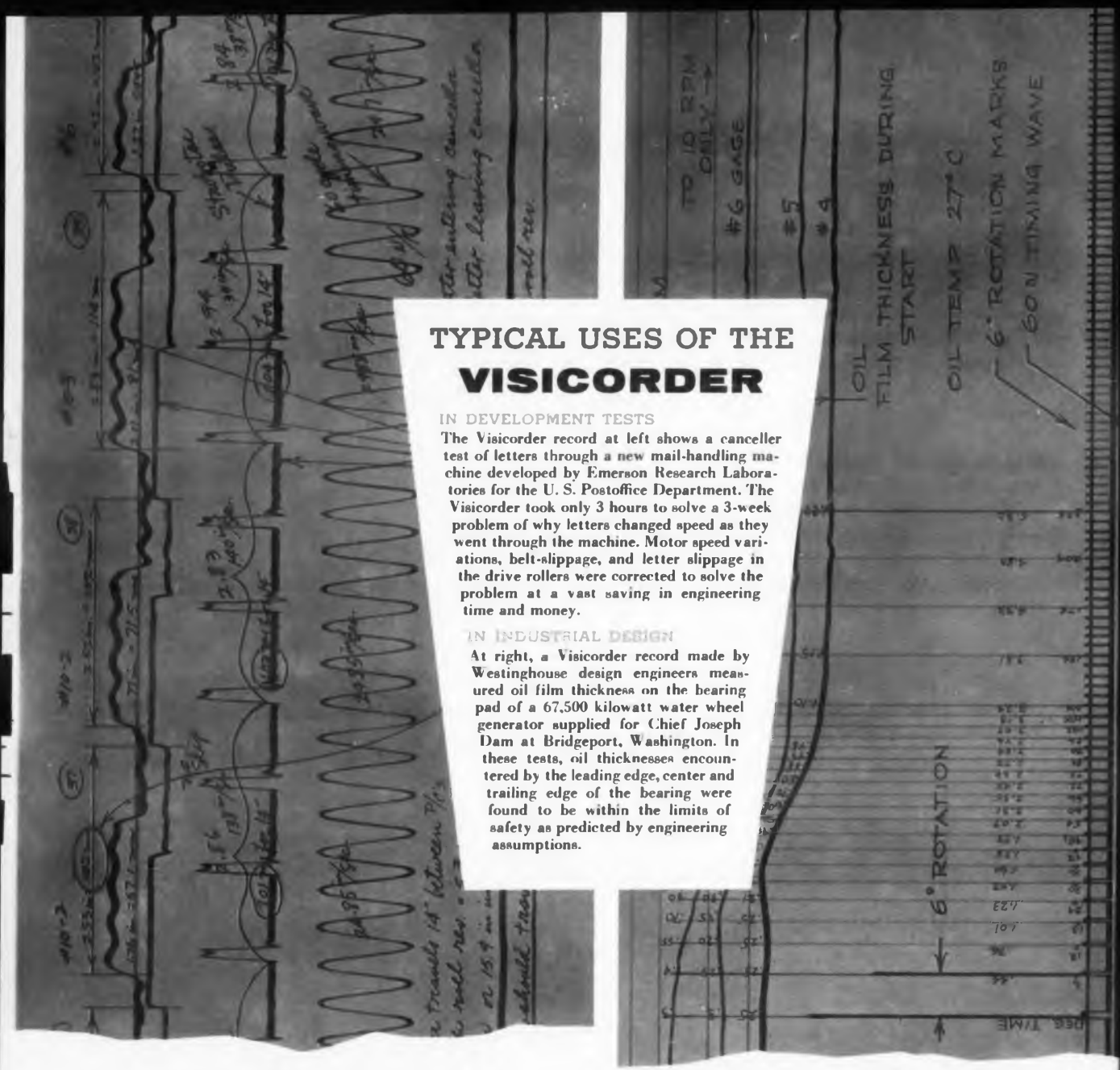
SIGNAL-CONDITIONING SYSTEMS

A. The Model 119 Amplifier System . . . a simple and accurate 6-channel carrier amplifier, for use in oscillographic recording, which may be converted to a linear/integrating system simply by installing linear/integrating channels in the same case. The carrier amplifier is designed to amplify signals from resistive, variable-reluctance, differential-transformer, and capacitive transducers. The linear/integrate amplifier is used in conjunction with self-generating transducers such as vibration pickups, etc. The carrier system provides recordings in the 0-1000 cps range at galvanometer amplitudes of 8" peak-to-peak. The linear-integrate system accommodates frequencies from 5-5000 cps.

B. The Model 130-2C Carrier Amplifier . . . a two-channel unit for use with resistance, reluctance, differential transformer, and capacitive transducers. Produces 8-inch (peak-to-peak) galvanometer deflections up to 1000 cps from as little as 0.5 mv gage output.

C. The Model 82-6 Bridge Balance and Strain Indicator . . . a simple, accurate 6-channel unit for calibrating, balancing, controlling, and measuring static and dynamic phenomena from resistive transducers.

All three of these units are suitable for convenient rack mounting.



TYPICAL USES OF THE VISICORDER

IN DEVELOPMENT TESTS

The Visicorder record at left shows a canceller test of letters through a new mail-handling machine developed by Emerson Research Laboratories for the U. S. Postoffice Department. The Visicorder took only 3 hours to solve a 3-week problem of why letters changed speed as they went through the machine. Motor speed variations, belt-slippage, and letter slippage in the drive rollers were corrected to solve the problem at a vast saving in engineering time and money.

IN INDUSTRIAL DESIGN

At right, a Visicorder record made by Westinghouse design engineers measured oil film thickness on the bearing pad of a 67,500 kilowatt water wheel generator supplied for Chief Joseph Dam at Bridgeport, Washington. In these tests, oil thicknesses encountered by the leading edge, center and trailing edge of the bearing were found to be within the limits of safety as predicted by engineering assumptions.

OTHER USES of the Visicorder . . . as a direct readout unit **IN RECORDING AND MONITORING SYSTEMS . . . IN MISSILE AND ENGINE ANALYSIS** for test stand recording . . . for analog recording **OF TELEMETERED SIGNALS . . . IN CONTROL** to monitor reference and error signals . . . **IN NUCLEAR TEST** to record temperatures, pressures, impacts, etc. . . . **IN LABORATORIES** for all-purpose analysis . . . **IN PRODUCTION** for final dynamic inspection . . . **IN COMPUTING** for immediately-readable analog records . . . **IN PILOT COMPONENT TESTS** for rapid evaluation of prototypes . . . **IN ALL TESTS** which are non-repetitive in sequence, making oscilloscopes impractical.

Write for your *free* copy of the new 36-page Visicorder Applications Manual, a comprehensive, detailed guidebook to many varied uses of the Visicorder.

Honeywell

Industrial Products Group

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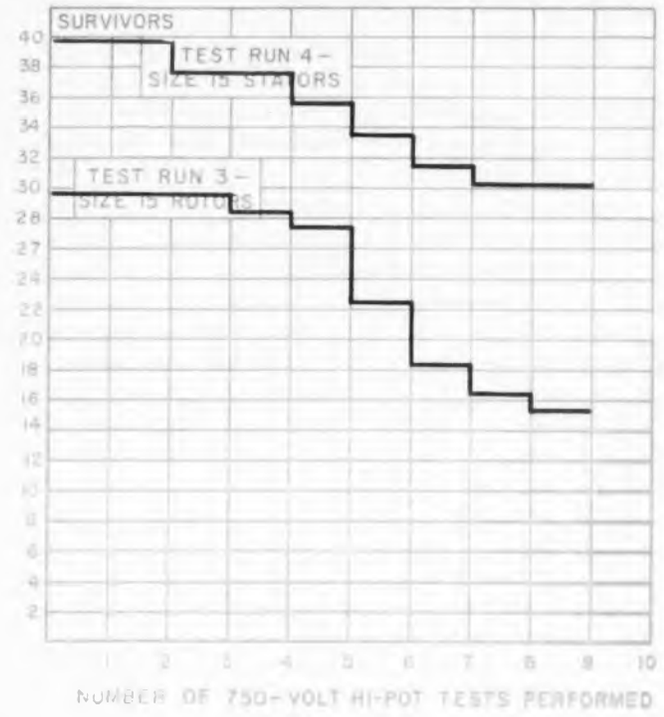


Fig. 2. Repeated hi-pot tests at 750 v confirmed results of tests at 900 v

proper high-potential test methods are used on equipment insulation which is up to acceptable standards." The same authors, in an article entitled "High Potential Tests for Aircraft and Missile Electrical Insulation" (*Electrical Manufacturing*, December 1959, p. 124) present data supporting this conclusion and point out that "no (previous) *actual test data* on repeated one minute high-potential tests have been located by the writers."

The Kilman and Dallas data, while substantial, result from tests of insulating materials *by themselves* before use in a manufactured item. Kilman and Dallas point out that: The "net" or effective electrical insulation of a given equipment is, of course, less than its initial thickness when applied. "Bedding" of the conductors into the insulation, core-surface irregularities, cold flow caused by winding tension, vibration, and thermal cycling all tend to reduce the net insulation thickness. This is one of the major problems of insulation-system design for electrical equipment. The tabulated data given here are not intended to deal with these problems. It is precisely this problem of insulation *in equipment* which is dealt with here. As might be anticipated, the results, as determined in actual test, turn out to be substantially different.

Experimental Results—Full Potential

Hundreds of experimental high-potential sequences were performed by the Ketay Quality Control department on synchro rotors and stators which were unusable for other reasons, such as accuracy or null-voltage failure. These tests prove that repeated high-potential tests will continue to produce additional failures at the same or possibly at an increasing rate. Therefore, the units which survive additional high-potential tests at full voltage very likely have a lower probability of acceptance on the next test than did the survivors of the preceding test. This is the converse of the "weak sister" theory which maintains that the first one or two high-potential tests will eliminate marginal units and that there will subsequently be no failures in repeated testing.

The tests illustrated are representative of those obtained when rotors and stators of conventional synchros are subjected to repeated high-potential tests. Since these tests were run on components which were removed from finished units because of unrelated defects (for example, high electrical errors or null voltages) they had already been subjected to the normal manufacturing and inspection high-potential tests prior to the tests on which these graphs are based.

Fig. 1 shows the results of 900-v high-potential tests on rotors and stators of conventional size 23 synchros after the regular testing is completed.[1] The first six rotor tests resulted in no failures, the seventh test produced one failure and the next test produced two additional failures. Since many of the conditions to which synchros are exposed produce more sudden voltage build-ups than the specified "slow" high-potential tests, the test components were subjected to some "flash" high-potential tests. The results are shown on the graphs after 15 or 16 "slow" high-potential tests. The use of the flash high-potential produces an accelerating number of failures.

Repeated Full-Potential Tests Prohibited

It is apparent then, that the present state of the art requires certain practical precautions. The most important of these is to avoid repeating full-voltage high-potential tests on rotary component windings. NAVORD Instruction 8200.3, issued about six years ago, required the disconnection of all synchros prior to high-potential testing of equipment in which they are contained. It also provided that wherever synchros must be high-potential tested, the test is to be performed at 80 per cent of the original high-potential voltage ± 20 v. The Government inspection officers were therefore authorized to modify NAVORD OCD'S (Ordnance Classification of Defects) accordingly.

This principle of performing all subsequent high-potential tests at no more than 80 per cent of the original high-potential test voltage was included in the SAE Industry Specification ARP-461 for rotating components. This provision has now been included by the Department of Defense in Synchro Specification MIL-S-20708.

Ketay has been including with each of its

units shipped a warning tag which reads as follows:

—CAUTION—

"This precision instrument passed a 900 volt high-potential test before shipment. High potential is a destructive test. Government specifications prohibit further high-potential tests of this component at *voltage exceeding 740 volts.*"

Experimental Results—Reduced Potential

But does even this precaution provide full protection against unit destruction? Since the present military specifications provide for use of reduced voltage when repeating high-potential tests, a group of size 15 rotors and stators were tested in this manner. The results are shown in Fig 2. These tests show as clearly as tests 1 and 2 the futility of repeating high-potential tests for quality assurance purposes even at reduced voltages!

What would this mean in an over-ambitious quality inspection routine? Consider, for example, the rotors represented in test 3. Assume that an over-zealous inspector has decided to perform repeated high-potential tests to assure the quality. From test 3, there is in fact no rotor about to fail. Our inspector performs not one but two complete high-potential tests on each of the 30 rotors. Encountering no failures, he is now content that this is a superior group of components, at least from the insulation point of view.

As test 3 clearly shows, however, all our inspector has accomplished is to bring these particular units to the point where they are ready to start failing. The quality level of the group is now distinctly inferior to what it was before these tests because the units are now in such condition that the next high-potential exposure will fail a unit. The next high-potential exposure will fail an additional unit. Let us assume that we have a super-zealous inspector and he is performing four high-potential tests on each unit so he has rejected these two units. He assumes that the survivors must be fully acceptable units but, as graph 3 indicates, this is where the trouble really starts. After the fourth repeated high-potential test the units are in such a condition that the next high-potential exposure will produce five additional failures and a subsequent high-potential exposure will produce another four failures. From the fifth to eighth high-potential exposures, 12 of the original 30 rotors will fail.[2]

Another Test Procedure Needed

Obviously, repeating high-potential tests is not a satisfactory means of assuring insulation quality. Since this is a most important characteristic, considerable attention has been devoted to finding a satisfactory substitute. While this effort is con-

tinuing, present indications are that the use of a measured value provides a more appropriate test. For example, if the actual insulation resistance (or leakage current) value is measured and recorded, a numerical indication of insulation quality is obtained. If the insulation resistance is measured successively, and the value has not declined, a fairly good indication of insulation stability is provided. If the insulation resistance value is declining, even though the unit may still meet the high-potential and insulation resistance test specifications, there should be a presumption of instability.

One of the characteristics studied in these experiments is the relationship between frequency and high-potential endurance. Virtually all the engineers queried expressed the opinion that the 400-cps high-potential test is more destructive than the 60-cps test at the same voltage. The results obtained so far run completely counter to this theory. The 60-cps tests have shown up substantially more failures. Because of this conflict, it was decided to run additional tests before publishing any conclusions on this phase of the experiment.

It is hoped that the reader will not receive an unnecessarily discouraging impression from this data. First, it must be remembered that all of the units represented had passed the high-potential tests performed by the synchro manufacturer prior to shipment. In every case, the units could have withstood at least one additional high-potential test before the failures began. Furthermore, tests are now being conducted on a new family of synchros designed to meet the requirements of MIL-S-20708.

These units, known as "throughbore" types because of the stator ID and bearing bores are produced by the same machining operation, incorporate numerous mechanical improvements. It is anticipated that these units will also exhibit superior insulation performance as measured by resistance to repeated high-potential exposures. ■

Footnotes

1. The tests were performed using a conventional Milwaukee high-potential tester set for high (1 ma) sensitivity. With the exception of the special "flash" tests noted, all tests were performed by bringing the voltage up slowly, holding it for one minute, and then reducing it slowly, in accordance with military specifications. A minimum of five minutes elapsed between successive tests of a given rotor or stator. The plant in which the tests were performed is fully air-conditioned. The tests in each sequence were performed on one day and the variation of temperature and humidity was negligible.

2. The data presented here can *not* be used to assess the effects of 900- vs 750-v tests, since the two sets of results were obtained using two different sizes of components.

Inventor cannot retain the benefits of a monopoly and apply for a patent only when danger of competition forces him to make application.

Holding out a reasonable reward to inventors and giving them an exclusive right . . . stimulates inventive effort.

Delay in applying for a patent may result in a forfeiture of your patent rights. Author Gray discusses the legal reasoning behind this decision.

Delayed Patent Application . . .

What you can lose

Albert W. Gray

IN A SUIT brought in Massachusetts for the infringement of the patent of a radio loudspeaker, the defense was that the patent claimed to be infringed was itself invalid.

In this defense of invalidity it was argued that the inventor had delayed eight years after his discovery before he had applied for a patent. Under the patent law an inventor is not entitled to a patent if his invention was known or used by others in this or a foreign country before the invention by the patent applicant.

In a decision before the United States Supreme Court several years ago, an inventor had delayed in filing his application for a patent seven years after he had perfected his discovery.

In deciding that case, the court questioned the meaning of the phrase, in reference to inventions, that application for a patent of a discovery would be granted when the invention was "not known or used before the application." That it should not mean that the thing invented was not known or used before the application, commented the court, would bar the inventor from the only means of obtaining a patent.

These words, for a rational interpretation, must mean that the invention had not been used or known by others before the application. One great object of the patent law, asserted the court, is to stimulate inventive effort.

But the main object is to promote the progress of science and the useful arts. This, according to that decision, could be

best done by allowing the public a right to use the invention at as early a period as possible, commensurate with a benefit to the inventor for his effort.

Can't Keep Monopoly

The consequences from permitting such an indefinite delay such as that assumed in the filing of the patent application for this loudspeaker would be that the discoverer could withhold from the public the secret of his invention and retain indefinitely his monopoly of the discovery. In that way he could garner all the benefits of the monopoly and apply for a patent only when the danger of competition forced him to do so for his own protection. By so doing he could not only extend the duration of his patent monopoly but gain a preference over those more prompt in making their applications.

In a later case, the inventor of a machine had withheld his application for a patent for seven years after his discovery. When he was granted a patent and suit was brought by him for an infringement, the earlier decision was followed by the court as an authority.

Every inventor, said the court, has the right to give to the public the benefits of his discovery. On the other hand he may forfeit his rights to a patent by postponing the filing of an application for a patent until the same improvement or discovery has been made by others.

While inventors are bound to fairness in their dealings with the public, commented the court, they are nevertheless entitled to protection against the frauds and wrong doing of others done with the purpose of pirating the results of perhaps a lifetime of thought and labor.

On the authority of these early decisions, the Federal Court said, in its denial of the right of the patentee to recover for the infringement of the patent of the loudspeaker, that the inventor, because of his delay in applying for this patent, without adequate excuse, had thereby forfeited any and all rights under the patent which he otherwise would have had. ■ ■

References

Utah Radio Products v. Boudette, 78 Fed. 2d 793

Pennock v. Diologue, 2 Peters (U.S.) 1

Kendall v. Windsor, 21 How. (U.S.) 322

Macbeth-Evans Glass Co. v. General Electric, 246 Fed. 695

Rugged Memory Stores Data On Paper-Thin Disk

TODAY, a paper-thin, magnetic-memory disk is a commercial reality. Just six months ago, the developmental ancestor of this flexible-disk memory made its debut at the Eastern Joint Computer Conference (*ED,* January 6, 1960).

At the Western Joint Computer Conference next week, the first commercial model of the LFE Bernoulli-Disk Data Storage Device will be shown. A 100,000-bit memory, the BD-103 is manufactured by the Computer Products Div. of Laboratory for Electronics, 1079 Commonwealth Ave., Boston.

On the surface of a 7-1/2 in. wide, 2-mil thick disk of oxide-coated Mylar, the memory has 40 tracks for data, clock pulses, revolver loops, and spares. A 1/20th-hp motor drives the disk at 3600 rpm a 180-kc bit rate for each track.

When the magnetic-tape disk is rotated, air flows under the tape, through a hole in the tape-drive shaft, up through the shaft through a hole on top of the shaft, then out between the headplate and the tape to return to the underside of the tape. The air flowing between the flattened, rotating disk and the head plate helps maintain a 3/4-mil head-to-tape separation.

The read-write heads, spirally-placed with about 30 heads to the radial inch, are mounted flush with the tape side of the head plate. The heads provide a *read* amplitude of 20 mv and require 250 ma of *write* current.

Flexible-disk memory in cutaway view, showing: (A) oxide-coated Mylar disk, (B) stabilizing headplate, (C) read-write heads, (D) motor shaft, (E) air orifice, (F) dust cover for read-write electronics and selection matrix, (G) plug board, (H) cooling fan, (J) motor housing, (K) "O" ring seal.

Heart of the memory, showing the Mylar disk and the headplate before heads are installed.

Compact disk memory fills only a 9-in. cube, weighs but 15 lb.

Unlike drum-type memories, the Bernoulli Disk can be panel- or deck-mounted or used as a bench unit in any orientation. It requires no warmup and can withstand severe thermal shock. Designed for ground-environment operation, fixed station and mobile, it can operate in a temperature range of +30 to +150 F.

The entire package, including the memory, a cooling fan, a metal wrap-around, and a plastic dust cover, fits in a 9-in. cube, and weighs 15 lb.

The plastic cover can include either a patch-cord plugboard on top, for system mock-up, or rear-mounted connectors to be used for permanent installations.

Read-write and switching circuitry for either parallel operation of the data tracks or time-shared operation will be available by August 1st. The circuitry will fit inside the dust cover.

The BD-103, which sells for under $4,000, will be available on 90-to-120-day delivery for initial orders. It is the first in the BD-100 series which will include 100,000-bit memories for operation from 1800 to 8000 rpm for bit rates from 90 to 400 kc. Synchronous and induction motors will be available for 60 or 400 cps, single- or three-phase operation.

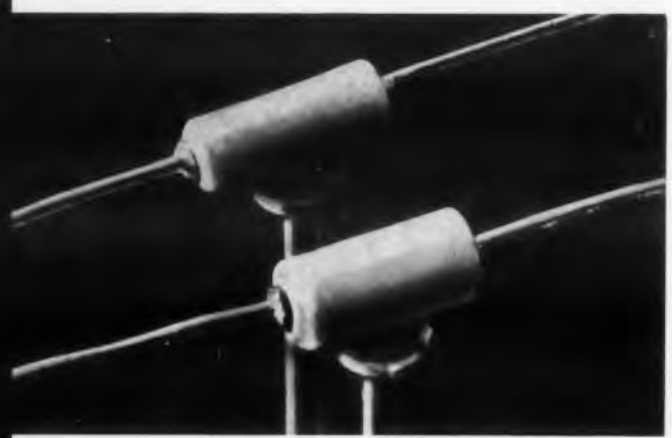
Planned for sale in November, the BD-1000 series will be a million-bit store. By the end of December, the BD-500, a 500,000-bit store should be available.

All units will be available with pre-recorded clock tracks, if required, or with variations in head placement, bit density, number of data tracks, clock tracks, and revolving-loop tracks.

For more information on this disk memory, turn to the Reader-Service Card and circle 250.

NEW PRODUCTS

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



Tantalum Capacitor Measures 0.15 x 0.06 In. 255

Size TK tantalum wire electrolytic capacitor measures 0.15 in. long and 0.06 in. in diameter. It provides as much as 2-μf capacitance. Size HK is the same length but 0.075 in. in diameter. It provides up to 3-μf capacitance. Designed for miniaturized and transistorized circuits, the series TW capacitors, which includes size TK and HK, have a tantalum wire anode in a silver case. Mylar sleeving is used as insulation.

Ohmite Manufacturing Co., Dept. ED, 3640 Howard St., Skokie, Ill.

Price & Availability: *Available from stock. Price for 1 unit is $1.61; it varies with quantity.*

NPN Germanium Switching Transistors Operate At Frequency Of 60 Mc 256

Types 2N1288 and 2N1289 germanium npn switching transistors operate at a frequency of 60 mc. Both units meet the requirements of MIL-T-19500A. The gain bandwidth of the devices is the same at 5 ma, 1 v (collector to emitter). The 2N1288 and 2N1289 have guaranteed collector to emitter voltage ratings of 10 v and 15 v, respectively; both have emitter to base guaranteed ratings of 5 v, and collector to base guaranteed ratings of 15 v and 20 v, respectively.

General Electric Co., Dept. ED, Semiconductor Products Dept., Charles Building, Liverpool, N. Y.

Price & Availability: *Immediately available from stock. The 2N1288 is priced at $4.25 each and the 2N1289 at $4.95 each in large quantities.*

Control Unit Handles All Available SCR's 257

Called Silicontrol, this unit will drive all makes and ratings of silicon controlled rectifiers. A phase shifting network applies 60-cycle, steep pulses of constant amplitude to rectifier gates and varies their phase angle over a full 180 deg to control the rectifier output from zero to maximum. It will control one or two SCR's, half or full wave or inverse parallel, up to 70 amp each. Loss of control signal turns off the SCR's; no bias is required. The silicon rectifier is proportionately controlled up to a maximum output with less than 4-mw dc control signal.

Vectrol Engineering, Inc., Dept. ED, P. O. Box 1089, Stamford, Conn.

Availability: *From stock.*

Microwave Mixer Diode Has 7.5-Db Noise Figure 258

Having a maximum conversion loss of 5.7 db, the type 1N78D silicon, point-contact diode is rated for an overall noise figure of 7.5 db. It is designed for 16,000 mc, first detector operation. The unit is hermetically sealed and can operate in temperatures up to 150 C. The if impedance range is 400 to 565 ohms; rf impedance, vswr, is 1.5. For balanced mixer operations, the unit is available in matched pairs.

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

Price & Availability: Units available from stock in production quantities. Price is $85 per unit in quantities from 1 to 9, $52 per unit from 100 up.

Voltage Reference Elements Conform To Mil Requirements 259

Conforming to MIL-E-1/1060 (Navy), the type USN-1N430 silicon Zener voltage reference element provides a reference voltage of 8.4 v, average, at 10-ma bias current and a dynamic resistance of 11 ohms, average. The unit's stability is ±16 mv or better over a temperature range of from −55 to +100 C; temperature coefficient is ±0.002% per deg C. Also available, but not covered by individual military specifications, are the 1N430A and 1N430B reference elements.

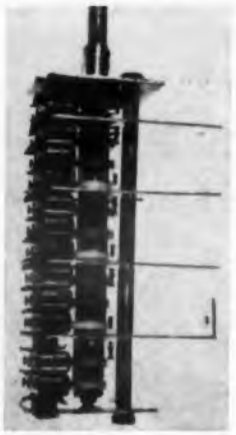
International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

Price & Availability: The USN-1N430 can be delivered from stock; price is $18 each in quantities of 1 to 99.

NEW PRODUCTS

Rotary Switch 614

Covers 1 to 20 poles



Available in both standard and custom lines, this switch can be made to cover from 1 to 20 poles and can be arranged in 1, 2, 3, or 4 rows. The design utilizes sensitive, miniature, snap-action switches that are actuated by nylon cams on the main shaft. One to 15 detent stations are available with rotation at specified degrees, the minimum being 24 deg. The unit has been adapted to missile test equipment, attenuators, and other electronic assemblies.

P. R. Mallory & Co., Inc., Milli-Switch Corp., Dept. ED, Gladwyne, Pa.

Price & Availability: *Made on order only. Delivered between 60 to 90 days. Price is generally from $10 to $25, depending on specifications and quantity.*

Diffused Silicon Rectifiers 684

PIV range is 50 to 1000 v

These miniature diffused silicon rectifiers have from 50 to 1000 v piv-ratings at 100 to 750 ma. The units are pressure-molded and hermetically-sealed. Of axial design, they measure 0.2 in. OD and 3/8 in. long.

Solitron Devices, Inc., Dept. ED, 67 S. Lexington Ave., White Plains, N.Y.

Price & Availability: *Standard units are priced from $0.40 to $3 ea. Units can be molded to customer specifications.*

Capacitance Bridge 687

Range is 0.1 to 11,000 mf

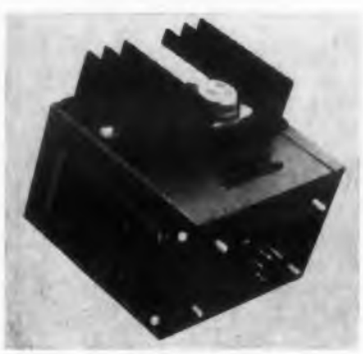
Designed for the measurement of capacity, power factor, and leakage current of electrolytic capacitors, model DB 154-D bridge has a range of 0.1 to 11,000 μf. Accuracy is ±1%. The leakage current is read on a 0- to 50-μa meter having a range of 50 ma.

United Mineral & Chemical Corp., Dept. ED, 16 Hudson St., New York, N.Y.

Price & Availability: *$693; units will be available in June 1960.*

Power Supplies 616

Come in seven models



The PI series of dc power supplies are miniaturized all-solid-state units for power-source applications in small packages. Models PI 82, 241, and 50.5, cover every voltage in the range from 1 to 50 v, adjustable over a 1-v band. Current ranges up to 2 amp are available from these units. Other PI models cover ranges up to 100 v, some with limited adjustment, others with wide-range adjustment.

Deltron Inc., Dept. ED, 2905 N. Leithgow St., Philadelphia, Pa.

Price & Availability: *Available from stock. Delivered within 3 weeks. Prices are: PI Series 1092, $45; 1090, $55; 1148, $65; 82-X, $95; 241-X, $107; 50.5-X and 100.1, $112, fob Philadelphia, Pa.*

Test Instrument 679

Measures attenuation and delay

Type 453-A test set measures the attenuation and relative delay characteristics of transmission lines, lumped-constant networks, and other transmission systems having characteristic impedances of 600 ohms. Measurements are made over a carrier frequency range of 500 cps to 50 kc. Over-all accuracy of delay measurement is ±5 μsec. The frequency indicator dial has an accuracy of ±2% of the reading.

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

Price & Availability: Price is $5142.10 ea for 1 to 9 units; $4842.10 ea for 10 to 24 units. Delivery time is 90 days.

KU-Band Phase Shifter 676

Frequency range is 15 to 17 kmc

Model 5106001 Ku-band phase shifter operates over the frequency range of 15 to 17 kmc. Phase shift is 112 deg, insertion loss is 0.5 db max, input vswr is 1.12 max, and peak power is 3 kw. Measuring 2 in. in length, the unit is for use in confined areas. It operates in ambient temperatures from −10 to +100 C.

Kearfott Div., General Precision Inc., Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

Address Correction Notice

The correct address of Electro-Logic Corp. in Venice, Calif. is 515 Boccaccio Ave., not 1515 Boccaccio Ave. as it appeared in their Digital Voltmeter article on p 74 of the March 30 issue.

NEW PRODUCTS

Standing Wave Amplifier 673

Inherent noise is 0.007 μv

Model 277-B standing wave amplifier has an inherent noise of 0.007 μv and an attenuation range of 85 db in 5-db steps. The unit has four regular vswr scales plus one expanded scale. Other specifications are: front panel adjustment of gain in the 15-db range, bandwidth from 4 to 40 cps, and center-frequency, 1000 cps, adjustable over a 2% range. The instrument is designed primarily for use with slotted sections; it can also be used in conjunction with crystal or bolometer detectors for relative power and attenuation measurements.

Polytechnic Research & Development Co., Inc., Dept. ED, 202 Tillary St., Brooklyn 1, N.Y.

Price & Availability: *$195; units will be in stock in August 1960.*

Transistor-Diode Tester 667

Checks dc parameters

Designed for checking the dc parameters of transistors and diodes, model TDT-200A tester is able to check reverse and leakage currents of silicon as well as germanium transistors and diodes. It checks voltage, reverse and forward current, and current gain. It can be used in maintenance, incoming inspection, and design work.

Transistor Electronics Corp., Dept. ED, 3357 Republic Ave., Minneapolis 26, Minn.

Price & Availability: *$325 fob Minneapolis; delivery from stock.*

Variable Delay Line 668

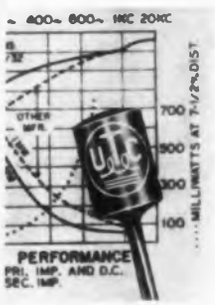
Forms intergral part of rotary switch

Type S32 variable, lumped-constant delay line is molded as an integral part of a 32-contact rotary switch. The package measures 2.75 x 1.75 in. Weight of the unit is 14 oz. The following total delays are offered: 0.5, 1, 2, 5, 7.5, and 10 μsec. Each line has a 10:1 delay-to-rise time ratio at the maximum delay. Impedance ranges from 100 to 500 ohms. The line is designed for use with a pulse generator as a double-pulse oscillator to provide variable time intervals between pulses. Other applications are: radar ranging and distance calibration, adjustment of delay triggering, phase-angle measurement, and signal time measurement.

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.

Price & Availability: *$135 ea for one to four units. Delivery time is two to four weeks.*

Transistor Transformers 671



Primaries are center-tapped

Types DO-T37 through DO-T44 transistor transformers are metal cased and hermetically sealed to meet MIL-T-27A, grade 4. The units weigh 1/10 oz. Type DO-T37 has a center-tapped primary of 2000 to 2500 ohms and a split secondary ratio of 8000 to 10,000 ohms. Type DO-T44 has a center-tapped primary of 80 to 100 ohms and a split secondary of 32 to 40 ohms.

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N.Y.

NEW PRODUCTS

Casting Compound 426

Flame retardant

Type 15-032 casting compound is made of flexible epoxy and is flame retardant. It conforms to ASTM D635-56T, MIL T27, as well as commercial requirements.

Hyson Corp., Dept. ED, Olean, N.Y.

Availability: *The product is not a regular stock item as yet.*

Telemetry System 603

Multiplexes and encodes 64 analog channels

Designed entirely with solid-state devices, this pulse code modulation telemetry system multiplexes and encodes 64 analog channels, and processes five 8-bit parallel digital data channels plus a series digital data channel at a nominal bit rate of 200 kc. The multiplexer handles low and high-level data, or a combination of both, with a single low-level amplifier. Overall accuracy of the system is ±0.25%.

Texas Instruments Inc., Apparatus Div., Dept. ED, 6000 Lemmon Ave., Dallas 9, Tex.

Price & Availability: *Dependent on format and complexity required by customer.*

Crystal Growing Furnace 601

Grows a 530-g ingot in 150 min

Using the Czochralski method, this furnace is capable of growing a crystal ingot weighing up to 530 g in 150 min or less. Each operating cycle, including pre-gas, melt-down, pulling, and drawing, is push-button controlled. Also automated is the speed of the seed rotation, withdrawal time of the ingot, and cooling rate of the molten silicon.

Hoffman Electronics Corp., Dept. ED, 3761 S. Hill St., Los Angeles 7, Calif.

Price & Availability: *Made on order only. Price is approximately $12,500, depending upon specifications and quantity.*

Battery 602

Delivers about 6000 w

Capable of delivering about 6000 w, model P-1517 battery consists of 18 cells of 20 amp-hr nominal capacity. It has an output of 35.8 w-hr per lb and 1.75 w-hr per cu in. Discharge rates range from 25 amp at 27 v nominal for 60 min, to 250 amp at 23 v for 2 min. Activation time is 2 sec. The battery weighs 20 lb, including activating mechanism, and has an overall volume of 500 cu in.

Yardney Electric Corp., Dept. ED, 40-50 Leonard St., New York City, N.Y.

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

Electronic Filter 618

Provides linear phase shift

Electronic filter model 1660 provides linear phase shift, 36 db per octave terminal slope, and cut-off frequency selectable in tenth-decade steps from 10 to 80,000 cps. It has 100 K input impedance and 1-ohm output impedance. Random signals are filtered with u minimum of information distortion in the allowed bandwidth. Each instrument has an individual fully isolated power supply, with voltage steps from 0.1 to 1 v, and 0.1% linearity.

Dynamics Instrumentation Co., Dept. ED, 1118 S. Mission St., S. Pasadena, Calif.

Price & Availability: *Delivered 30 to 60 days after order received. Price is $735 per unit.*

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NEW PRODUCTS

Digital Logic Module 664

Pulse repetition rate is 5 mc max

Designed for applications in digital systems and test equipment, type 6000A logic module operates at a maximum pulse repetition rate of 5 mc. It contains two solid-state switching circuits, which can be interconnected to form all major building blocks needed in digital systems. Each switching circuit has a four-input diode gate, an inverting amplifier, and a transition-triggered pulse generator. The module functions as a nor-gate, flip-flop, binary counter, delay flop, and shift register stage. The inverting amplifier output has a 40-mμsec rise time and an 80 mμsec fall time. The pulse has a half-amplitude duration of 100 mμsec. Power consumption is less than 1 w. The unit measures 2-1/8 x 7/8 x 3/8 in. and operates from 0 to 130 F.

Tele-Dynamics, Dept. ED, 5000 Parkside Ave., Philadelphia 31, Pa.

Availability: *Sample quantities are immediately available.*

DC Power Supply 666

Delivers 0 to 300 v at 0 to 500 ma

Model RR303 power supply delivers 0 to 300 v dc at 0 to 500 ma operating from an input of 105 to 125 v ac at 55 to 400 cps. Line regulation is 0.1%, load regulation is 0.1%, and ripple and noise are 1.5 mv rms max. The filament output is 6.3 v CT at 15 amp. The unit measures 5.25 x 19 x 14.25 in. and can be furnished with 3.5 in. meters.

Trans Electronics, Inc., Dept. ED, 7349 Canoga Ave., Canoga Park, Calif.

Price: *$320 without meters and $360 with meters.*

SPERRY Tunnel Diodes

for engineering test or application

Any quantities available for immediate delivery from any Avnet office.

Call your Avnet Applications Engineer

For dependable service

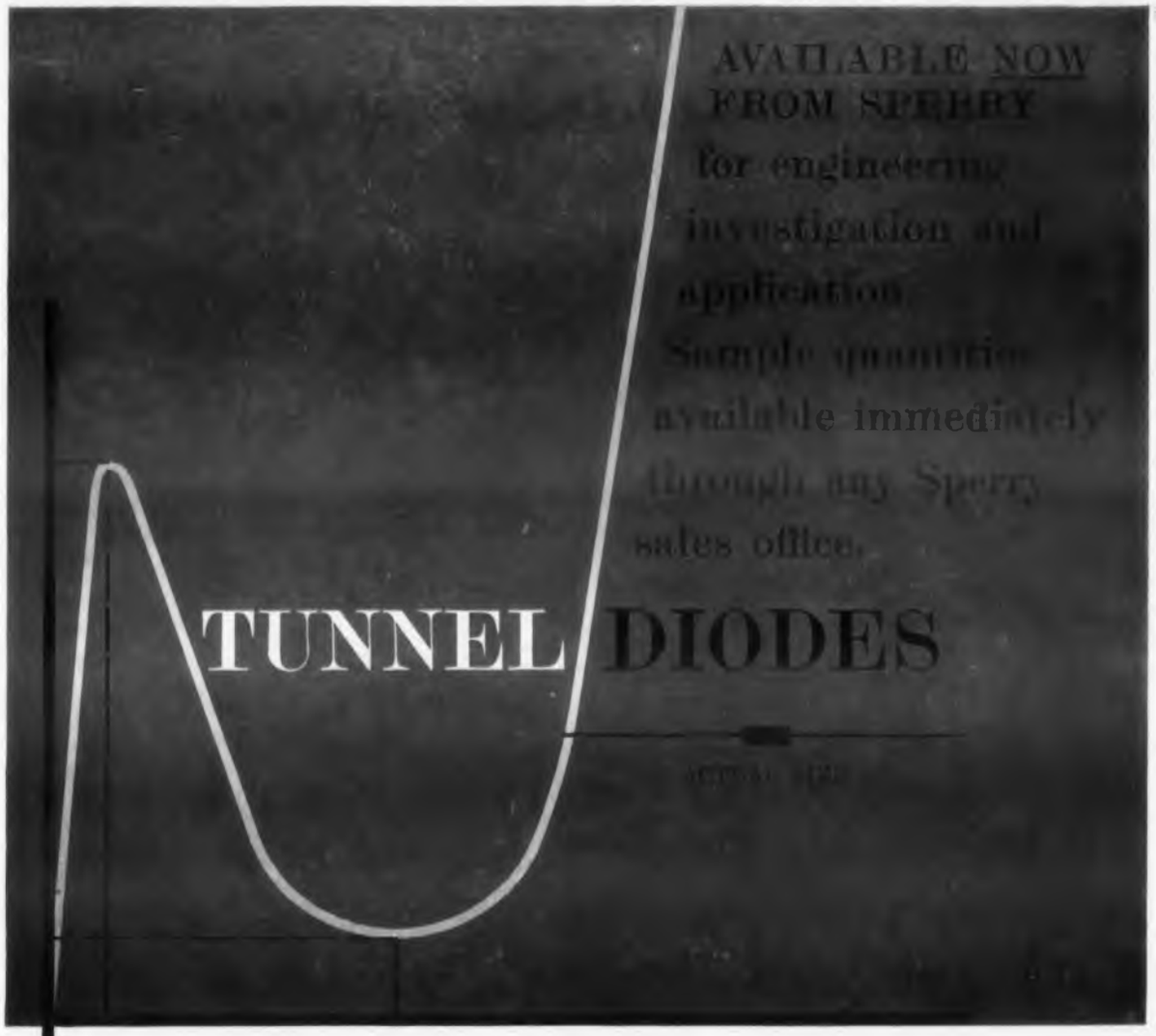
A

and immediate delivery*

AVNET

*AVNET•70 State St., Westbury, N. Y.- ED 3-5800
AVNET•751 Main St., Waltham, Mass.- TW 9-8330
AVNET•4180 Kettering Blvd., Dayton 39, Ohio- AX 8-1458
AVNET•2728 N. Mannheim Rd., Melrose Park, Ill.- GL 5-8160

CIRCLE 56 ON READER-SERVICE CARD



TENTATIVE SPECIFICATIONS

Type	(TYPICAL VALUES) I_{peak}(ma)	I_p/I_v(min)	V_{peak}(mv)	V_{valley}(mv)	T
T101	0.8	4.5	55	300	−55 to 100°C
T102	1.5	4.5	55	300	−55 to 100°C
T103	3.5	4.5	55	300	−55 to 100°C
T104	7.0	4.5	55	300	−55 to 100°C

SPERRY STOCKING DISTRIBUTORS:

AVNET ELECTRONICS CORPORATION
70 State Street Westbury, L. I., N. Y.
Tel. EDgewood 3-5800 TWX: Westbury NY 2617

AVNET ELECTRONICS CORP. OF MASSACHUSETTS
751 Main Street Waltham, Massachusetts
Tel. TWinbrook 9-8330

AVNET ELECTRONICS CORP. OF OHIO
4180 Kettering Boulevard Dayton 39, Ohio
Tel. AXminister 8-1458 TWX: DY 410

AVNET ELECTRONICS CORPORATION OF ILLINOIS
2728 No. Mannheim Road Melrose Park, Illinois
Tel. GLadstone 5-8160 TWX: Franklin Pk. 2187

RADIO PRODUCTS SALES, INC.
1501 South Hill Street Los Angeles 15, Calif.
Tel. Richmond 9-7471

SPERRY

SPERRY SEMICONDUCTOR DIVISION, *SPERRY RAND CORPORATION, SOUTH NORWALK, CONNECTICUT*
Call or write: *Sperry Semiconductor, Wilson Avenue, SOUTH NORWALK, Conn., VOlunteer 6-1841; in NEW YORK PLaza 2-0885; 3555 W. Peterson Ave., CHICAGO 45, Ill., KEystone 9-1776; 2200 East Imperial Highway, EL SEGUNDO, Calif., ORegon 8-6226.*

CIRCLE 57 ON READER-SERVICE CARD

NEW PRODUCTS

Oscilloscope 672

Low frequency type

Model 401-B low-frequency, general purpose oscilloscope has a bandwidth of 300 kc at 3 db down. Gain and pattern stability over an 8-hr period are better than 2% and drift averages less than 5 mv per hr. Sensitivity is 10 mv per mc with identical X and Y amplifiers. Synchronization includes both internal and external dc-coupling, trigger leveling, single sweep, and automatic synchronization. The single sweep mode permits only one driven sweep of the time base to appear on the crt until the sweep is reset. The common mode rejection ratio is better than 100:1.

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

Price & Availability: *The unit is low priced and will be available by early summer.*

Cathode Ray Bulb 675

Has 35,000 separate wire conductors

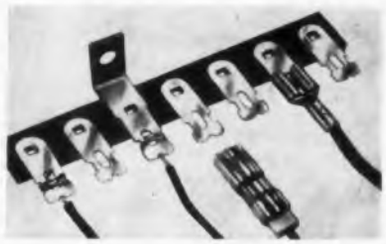
This cathode ray bulb has 35,000 separate wire conductors embedded in a face plate measuring 3 x 0.25 in. Developed for electronic printing at speeds to 20,000 characters per sec, it can also be used to transmit graphic or printed materials by microwave or wire systems. Each conductor in the rectangular matrix of the face plate measures 0.001 in. in diam; space between conductors is 0.003 in.

Corning Glass Works, Dept. ED, Corning, N.Y.

Availability: *Units are made on order. Delivery time is four to six weeks.*

Lug Terminal Strips 677

Are 0.205 in. wide



These lug terminal strips, measuring 0.205 in. wide, are for use as the plug for small-size, quick-disconnect sockets. An inside slot provides for tie point terminations; the side notches are for wrap-solder terminations.

Mandex Manufacturing Co., Inc., Dept. ED, 2614 W. 48th St., Chicago 32, Ill.

Availability: *Ten days.*

Photovoltaic Silicon Sensors 665

Complete line is offered

This complete line of photovoltaic silicon sensors includes diffused-silicon solar cells, miniature vertical and horizontal light sensors for punched-card readers, and a null-sensing device. Type LS 221 null-sensing device, consisting of two matched sensors mounted in a dielectric case measuring 0.44 in. long, is for use in such applications as photo-mechanical tracking systems, servo systems, galvanometers, and balanced choppers. Type LS 222 horizontal light sensor for card readers produces 250 μa with a load of 1000 ohms under 1250 ft-c. Type LS 223 vertical card reader produces more than 300 μa. Both the LS 222 and LS 223 have a response time of 4 μsec. The diffused-silicon solar cells come in single units or in complete solar-generator power panels and have efficiencies up to 10%. The M-2000 and M-3000 series diffused-junction indium antimonide infrared detectors, for use in the range of 2 to 5 microns, have an ac cell impedance of 100 ohms to 10 K.

Texas Instruments, Inc., Dept. ED, P.O. Box 312, Dallas, Texas.

Availability: *Production quantities are immediately available.*

NEW PRODUCTS

Toroidal Winding Machine 695

For wire sizes 25 to 29

This toroidal winding machine handles wires with sizes from 25 to 29. For use in the manufacture of TV vertical 110-deg, deflection coil, the unit operates at speeds to 600 rpm. Maximum number of layers is 12, maximum winding section is 120 deg, and minimum winding section is 8 deg. Controls are electromechanical.

Universal Manufacturing Co., Inc., Dept. ED, 1168 Grove St., Irvington 11, N.J.

Price & Availability: *$4950; three months.*

Tape Converter 605

Is bi-directional

Model D104 bi-directional tape converter handles the flow of data between remote stations and a central computer installation. In one mode, this unit converts data directly from punched paper tape produced by teletype transceivers to magnetic tape in any parallel 7-bit alphanumeric code. In the other mode, data on magnetic tape produced by the computer are converted directly to their corresponding form on teletype paper tape.

Digitronics Corp., Dept. ED, Albertson Ave., Albertson, Long Island, N.Y.

Price & Availability: *Made on order only. Delivered 180 days after order received. Price on request.*

Silicon Transistor 688

For military applications

Designed for military applications where severe environmental conditions may be encountered, type 2N1051 double-diffused, silicon mesa transistor is a vacuum-sealed npn unit. For high gain, small signal, and linear transmission uses, the transistor has a maximum collector voltage of 40 v, a typical common emitter current gain of 44, and a cut-off frequency in the 140-mc range. Maximum continuous col-

CIRCLE 59 ON READER-SERVICE CARD

lector current is 100 ma and maximum junction temperature is 150 C. The unit will dissipate 600 mw at 25 C in free air. It meets MIL-S-19500B.

Western Electric Co., Inc., Dept. ED, 195 Broadway, New York 7, N.Y.

Availability: The unit is sold to government agencies only. Delivery is immediate.

Resistance Decade Box 600

Has an accuracy of 5% or better

Designed for experimental work on transistor and vacuum-tube circuits, type RD-1 decade box has a range of 0 to 11,110 ohms, and is accurate to 5% or better. There are no short or open circuits, and therefore no current surges. The unit is made in two unconnected circuits, 0 to 110 ohms, and 0 to 11,000 ohms. When the full decade is needed, the two sections may be connected in series by means of a jumper. Dimensions are 12 × 2-1/2 × 3-1/4, and total weight is 17 oz.

Kurston Electronics, Dept. ED, 702 Bay St., Staten Island 4, N.Y.

Price & Availability: Available from stock about May 1; made on order until then. Can be delivered within 7 to 21 days. Price is $16 per unit; quantity discounts available. Price may vary according to customer specifications.

Power Supply 691

For photomultipliers

Designed for use with photomultiplier tubes, model 60 power supply has a total output of 900 to 1200 v. Normally the plus side of the high voltage supply is brought out along the anode and the 6-v dc input leads. Neither side of the 6-v input is connected to the high voltage. Ripple is less than 0.1 v peak-to-peak or 0.01% referred to the total supply voltage. Normal current drain from the input is about 12 ma. The unit weighs 7 oz and measures 2-1/8 in. in diam and 3-3/4 in. in over-all length.

Components Corp., Dept. ED, Denville, N.J.

Price: $300 fob Denville.

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NEW PRODUCTS

Microwave Diodes 682

Cover 10 to 20 kmc

These video-detector, microwave diodes cover the frequency range of 10 to 20 kmc. Type D-4104 has a minimum tangential signal sensitivity of —40 dbm and a minimum figure of merit of 15. Type D-4104A has a minimum sensitivity of —45 dbm and a minimum figure of merit of 30. Both diodes use a non-tripolar coaxial package and have a maximum video impedance of 18,000 ohms.

Sylvania Electric Products, Inc., Dept. ED, 730 Third Ave., New York 17, N.Y.

Tube Socket 686

For continuous operation at 1000 F

No. 8715 tube socket, for triode No. 7296, can be operated continuously at 1000 F. A high alumina ceramic is used as the insulator. Contacts, which are made of spring-tempered Inconel-X, are nickel-plated and gold-plated. Two holes are provided on the 1.172-in. centers for fastening the socket to a chassis or print-board.

Jettron Products, Inc., Dept. ED, 56 Route 10, Hanover, N.J.

Price & Availability: Units are in stock. Price is $9.50 ea for 1 to 12.

Vertical Acceleration Indicator 696

Sensitivity is ±2 mv

Able to supply vertical acceleration data by means of a dc input, model T8615-11 indicator has a sensitivity of ±2 mv. The information is displayed on a dial. The scale factor is 10 mv for 1000 lb. Construction is in accordance with MIL-I-983B and MIL-E-5400. A dc-to-ac chopper, an ac servo, a miniature transistorized amplifier, and a sensitivity control are contained in the unit.

Kearfott Div., General Precision Inc., Dept. ED, Little Falls, N.J.

◀ CIRCLE 61 ON READER-SERVICE CARD

CIRCLE 62 ON READER-SERVICE CARD ▶

SPECIFICATIONS

Range	Telemetering Band (216—260 Mcps)
Passband	±0.300 Mcps
Input Power	50 Watts max
Insertion Loss in Passband	≤1.25 DB at 125°C ≤1.15 DB at room temperature
VSWR in Passband	≤1.20
Isolation between Adjacent Channels at 5 Mcps Spacing	≥20 DB
Temperature Range	−65°C to +125°C
Vibration	For use in guided missiles; meets military vibration specs

Other power levels and higher frequency ranges can also be provided.

Triple Filter for "MINUTEMAN" Missile Telemetry System

Allen-Bradley Triplexer is designed to permit three simultaneous telemetry signals through one antenna without mutual interference.

These high-efficiency triple filters—employed in the Minuteman Test Program—enable three transmitters to send in-flight performance data simultaneously from a single antenna. Although extremely compact and light in weight, the Triplexer is ruggedly constructed to withstand shock and vibration—and it is gold plated to reflect high temperatures. This highly advanced filter system—developed and built by Allen-Bradley—illustrates their extensive experience in advanced electronic research, and capabilities in precision manufacturing. Allen-Bradley scientists and engineers will be pleased to cooperate in solving your problems.

ALLEN-BRADLEY

Quality Electronic Components

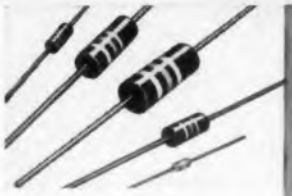
Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.

2-60-E

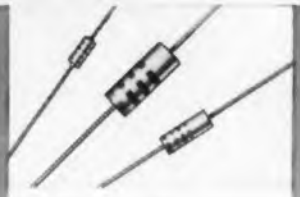
ALLEN-BRADLEY ELECTRONIC COMPONENTS

The standard of quality for long life and dependable performance

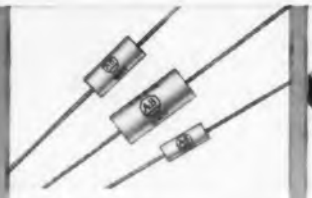
RESISTORS



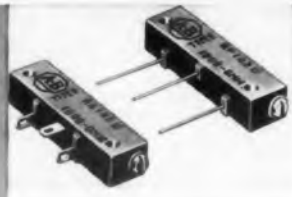
HOT MOLDED COMPOSITION RESISTORS—Quality standard of the industry. Rated at 70°C in 1/10, ¼, ½, 1, and 2 watts. Res. to 22 meg. Tol: 5, 10, and 20%.



HERMETICALLY SEALED in ceramic tubes. Solid, hot molded resistor. ¼ And 1 watt units derate to 0 at 165°C; ⅛ watt unit to 0 at 120°C. Available in values to 22 meg.

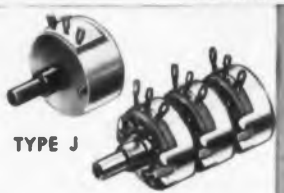


METAL GRID PRECISION RESISTORS—Hermetically sealed. Noninductive. 1, ½, And ¼ watts at 100°C. Tolerances 0.1% to 1.0%. Temp coef ± 25 PPM/°C.



ADJUSTABLE FIXED RESISTOR with hot molded dual track resistance element. Quiet, stable. Rated ¼ watt, 70°C. Values to 2.5 meg. Molded case, length 1¼".

POTENTIOMETERS



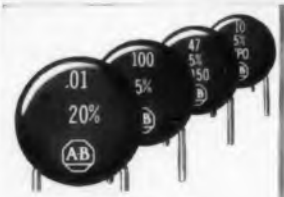
STANDARD—Type J. Solid molded element. Quiet, reliable. Rated 2 watts, 70°C. Values to 5 meg.—less than 10% change in 100,000 cycles. Exceeds MIL-R-94B.

MINIATURE—Type G. Solid molded element. Only ½" in diam. Plain or lock bushing; also with line switch. Rated 0.5 watt at 70°C. Values to 5 megohms. Exceeds MIL-R-94B.

HIGH TEMPERATURE—Type K. Same as Type J but rated 3 watts, 70°C; 2 watts, 100°C; 1 watt, 125°C. Only 1" diam. Type L same as Type G but rated 0.5 watt, 100°C.

SPECIAL TYPES with solid molded elements. Type F for printed wiring boards has gold-plated terminals. Screwdriver adjustment. Thin Type T uses molded cover as actuator.

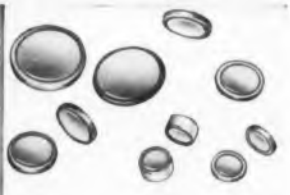
CAPACITORS



CERAMIC DIELECTRIC capacitors are ONE size—0.55 inch diam for most capacitance values. No "rundown" on leads. Made in many types. Quality appearance.

CERAMIC ENCASED capacitors for use where reliability and superior performance at high temp are important. Rated 500v DC at 150°C. Tol: 5%, 10%, and 20%.

FEED-THRU & STAND-OFF discoidal capacitors for VHF and UHF range. No parallel resonance effects at 1,000 Mcps or less. Nominal values 4.7 to 1,000 mmf.



BARE DISC ceramic capacitors for direct mounting in printed circuit boards. Mechanically strong to avoid breakage in handling, installing, and soldering.

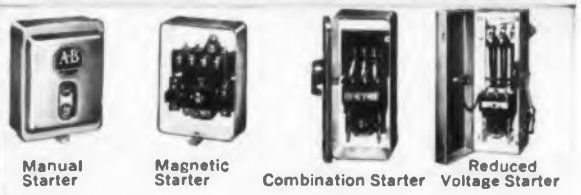
FERRITES

FERRITE CORES including lightweight flared yokes, cup cores, and others for TV. Also, U,E,L, O, and doughnut toroids. Wide range of sizes. All have uniform magnetic properties.

FILTERS

HIGH FREQUENCY low pass cascaded ceramic filters for elimination of radiation. Max ratings: 500v DC at 125°C; RF current 0.25 amp; DC or LF current 5 amp.

QUALITY MOTOR CONTROLS



Allen-Bradley also makes a complete line of manual and automatic, full voltage and reduced voltage starters—plus a full line of pilot controls, such as relays, limit switches, push buttons, pressure and temperature switches, and other devices. Allen-Bradley motor controls are universally recognized for their long life and reliability.

2-60-E

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

Memory Exerciser 567

Tests core memory systems

Designed to locate defects automatically in coincident-current-core memory systems, this memory exerciser, type 1513, can be used with systems having planes up to 128 by 128. In its sequence of operation, a pattern of information is read-in, read-out, and checked for accuracy. The machine will then recycle with either the same pattern or its complement being read into any particular digit. When detected, an error lights an indicator bulb on the front panel and is counted.

Digital Equipment Corp., Dept. ED, Maynard, Mass.

Price & Availability: *Made on order only. Delivered 90 days after order received. Price is between $15,000 and $25,000.*

Miniature Switches 622

Stand high shock and vibration

Able to stand high shock and vibration, these miniature switches are rated at 3 amp, inductive, and 5 amp, resistive, at sea level. The maximum in-rush is 24 amp. In addition to a basic spdt switch, toggle switches, roller leaf switches, and dpdt tandem toggles are offered as standard items. Straight leaf, formed leaf, and tandem roller leaf types are available on special order. Contact materials are beryllium-copper, spring-silver.

Crown Electric Products Co., Dept. ED, P.O. Box 171, Orange, N.J.

Magnetic Amplifier 625

Conversion gain is 70

Model 300 second-harmonic, magnetic amplifier is temperature-compensated to operate from 0 to 100 C. Conversion gain is 70 and maximum sensitivity is 0 to 1 mv input. The unit is internally shielded and shock mounted; it comes in a drawn metal case measuring 1.25 x 1.5 x 2.5 in.

Coldstream Engineering Co., Dept. ED, Box 1893, Tulsa, Okla.

Availability: *Delivery is in six weeks.*

CIRCLE 63 ON READER-SERVICE CARD ➤

CIRCLE 62 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Signal Simulator 513

For checkout or telemetry ground stations

Capable of providing simulated PAM commutated frame rates from 6 to 3600 pps, model ESS-200 electronic signal simulator permits calibration and check-out of telemetry ground stations. Negative and positive variable output signals are available with provisions for introducing missing pulses. Linearity and stability are within 0.2%; noise and crosstalk are less than 0.1%. The unit measures 5.25 in. high and fits a standard 19-in. relay rack.

Telemetrics, Inc., Dept. ED, Box 234, Northridge, Calif.

Sweep Generator 365

Center-Frequency range is 1 to 900 mc

Model HD-1A sweep generator has a center-frequency range of 1 to 900 mc and a sweep width that is adjustable up to 200 mc in the lower part of the range. Two uhf swept oscillators, each having a range of 400 to 900 mc, are combined in a heterodyne circuit to produce a third signal tunable over the range of 1 to 400 mc. The output of one oscillator is used for the upper range. Sweep widths are 200 kc to 200 mc in the heterodyne portion of the range; over 400 mc, sweep width is 0.06% to 10% of the center frequency. The rf output is 0.75 v, peak to peak, across the lower range, and 2 v, in the high range. Voltages are adjustable by a turret attenuator. Settings are provided for 0, 10, 20, 30, 40, and 50 db attenuations plus a 0 to 10 db vernier. The unit is suitable for laboratory and production line use.

Telonic Industries, Inc., Dept. ED, Beech Grove, Ind.

Price & Availability: *Price is $995. The unit can be delivered 30 days after receipt of order.*

ir Flow Switch 627

Stands shock and vibration

Type 113MF-E air flow interlock itch, for use in air-cooled equipent, is designed for military applitions requiring immunity to shock d vibration. The switch will oper- on static pressure or on the sum static pressure plus the velocity essure for 0.2 to 3.15 in. water lumn. Rated at 5 amp at 250 v ac, e unit has a life of 300,000 operans and measures 1/4 x 1-7/8 x 1/16 x 1-3/8 in. It is totally enosed and has screw type terminals. Henry G. Dietz Co., Inc., Dept. D, 12-16 Astoria Blvd., Long Isd City 2, N.Y.

ailability: Delivery of engineering nple for evaluation can be made m stock.

omputer Diode 593

Has 30 ma min forward current at 1 v

Suited for use in medium speed ta system applications, type 1934 diode has a minimum forrd current of 30 ma at 1 v, and naximum reverse current of 0.025 at —60 v. Recovery time at 400 is 2 μsec when switching from 30 ma to —20 v. The unit may be ed as a replacement for the 457.

United Components, Inc., Dept. D, 358 Henry St., Orange, N.J.

ata Recorder 592

Handles up to 28 channels

Capable of handling up to 28 annels in receiving and recording alog computer data, this recorder fully automatic and reproduces ta at speeds from 1 to 60 ips. pe loops can be of any length m 2 to 75 ft; other lengths can be ommodated. Standard units are ilable for tapes 1/4, 1/2, and 1 wide. Operating temperature ge is from 32 to 120 F. Power uirements are 105 to 125 v, 60 , single phase.

Telectro Industries Corp., Dept. D, 36-16 37th St., Long Island y 1, N.Y.

CIRCLE 65 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Vibration Fatigue Tester 594

Has 23 g maximum capacity

Model 150 VP-D vibration fatigue tester has a table load capacity of 150 lb at 10 g of acceleration. For higher g values, the load must be reduced. Maximum capacity is about 23 g. Acceleration and deceleration are regulated by an automatic frequency control device. Starting at 10 cps, frequency may be increased uniformly up to 60 cps; frequencies can also be changed manually.

All American Tool & Manufacturing Co., Dept. ED, 8021-C Lawndale Ave., Skokie, Ill.

Price & Availability: *Made on order only. Can be delivered within 35 days after order received. Price is $2725 per unit, regardless of quantity.*

Thermal and Thermostatic Switches 621

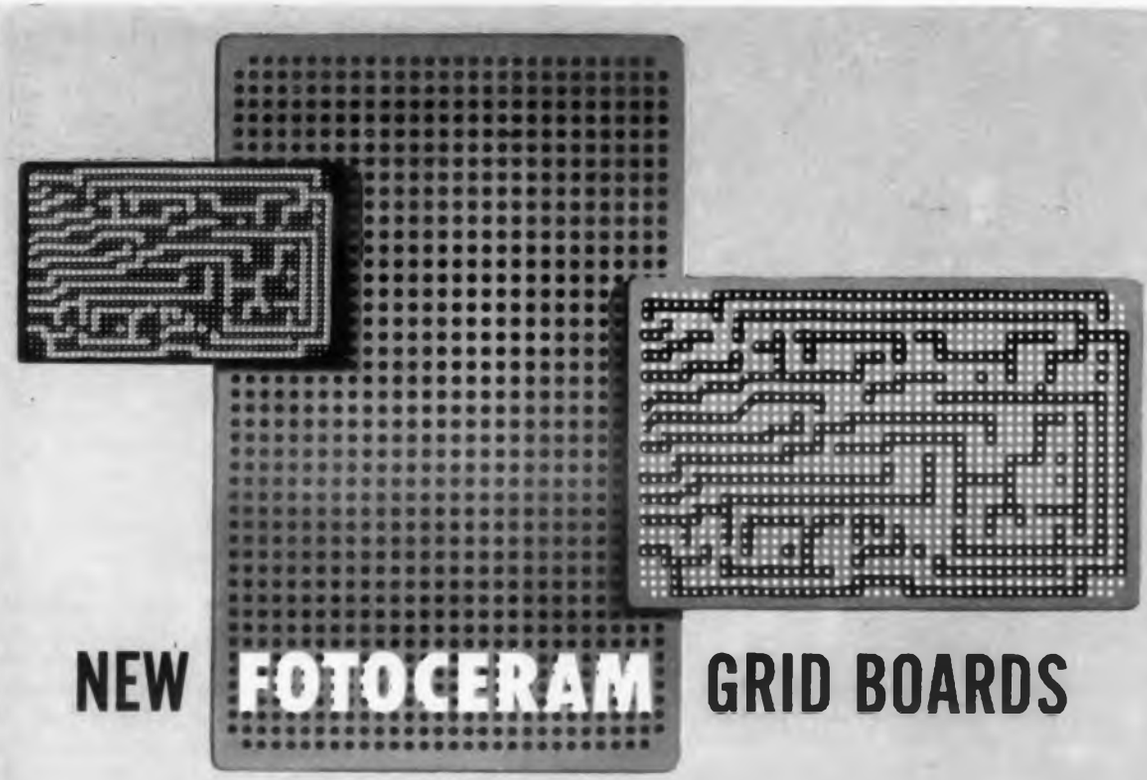
Life is 150,000 operations

Type CE-100 thermal and thermostatic switches have a minimum life of 150,000 operations. The time range is 10 sec to 15 min ±10% at 25 C. Temperature-compensated units with a range of −55 to +85 C are available. The heater voltage is 2 to 115 v ac or dc. Offered in spdt and dpdt types, the switches are rated at 5 amp at 115 v ac and at 3 amp at 30 v dc. Power rating is 2 to 4 w. They have standard 8-pin bases. The switch circuit has a common terminal, a normally open terminal, and a normally closed terminal. Switching is positive snap action. Typical applications are: power supplies, plate circuits, circuit breakers, and protection of circuits in transmitters and receivers.

Crown Electric Products Co., Dept. ED, P.O. Box 171, Orange, N.J.

Price: *For 1 to 9 units, spdt types are priced at $6.75 and dpdt types, $11.75. Temperature-compensated units are priced at $0.50 more.*

◀ CIRCLE 66 ON READER-SERVICE CARD



NEW FOTOCERAM GRID BOARDS

NOW AVAILABLE FROM YOUR CORNING DISTRIBUTOR

Now you can produce experimental or small-production-run printed circuits fast and economically in your own lab . . . just 15 minutes of simple processing with this new copper-clad FOTOCERAM grid board from Corning.

Ideal for use under severe conditions. Its strong non-organic glass-ceramic base material is dimensionally stable, non-flammable and unaffected by temperatures up to 250°C. Copper circuit pattern stays put. FOTOCERAM has zero water absorption and is impervious to chemicals that tend to peel the circuits from ordinary grid boards.

Replace components again and again if you wish . . . resolder them up to 50 times without circuit-run failure. Unexcelled through-hole plating permits two-side circuitry.

Obtain FOTOCERAM grid boards fast from your distributor . . . same day delivery at factory prices. Call him now for samples and complete information.

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ELECTRONIC COMPONENTS
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SPECIFICATIONS:
three standard sizes . . . 3" x 5", 6" x 8", 9" x 12" . . . thickness .062", component mounting holes 0.52" diameter ± .005" on 0.1" centers.

CIRCLE 67 ON READER-SERVICE CARD

FOTOCERAM GRIDBOARDS
Off-the-shelf delivery at factory prices from these Corning distributors

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817 South Park Avenue

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R. V. Weatherford Company
6921 San Fernando Road

CALIFORNIA, Inglewood
Newark Electronics Corp.
4747 West Century Blvd.

CALIFORNIA, Los Angeles 15
Universal Radio Supply Company
1179 South Los Angeles Street

CALIFORNIA, Oakland 7
Elmar Electronics, Inc.
180 19th Street

CALIFORNIA, Palo Alto
Zack Electronics
844 Main Street

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Western Radio & TV Supply Co.
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COLORADO, Denver
Inter-State Radio & Supply Company
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Electronic Industrial Sales, Inc.
1761 Florida Avenue, N.W.

FLORIDA, Melbourne
Electronic Supply
P. O. Box 1055
909 Monroe Drive

FLORIDA, Miami 32
Electronic Supply
85 N. E. 59th Street

ILLINOIS, Chicago 6
Newark Electronics Corporation
223 West Madison Street

INDIANA, Ft. Wayne 1
Ft. Wayne Electronic Supply, Inc.
1020 Maumee Avenue

INDIANA, Indianapolis 24
Graham Electronics Supply, Inc.
122 South Senate Avenue

IOWA, Cedar Rapids
Quinck, Inc.
424 First Street S. W.

LOUISIANA, New Orleans 19
Electronic Parts Corp.
2627 Tulane Street

MARYLAND, Baltimore 1
Kann-Ellert Electronics, Inc.
Howard & Redwood Streets

MARYLAND, Baltimore 1
Wholesale Radio Parts Co., Inc.
208-210 West Redwood Street

MASSACHUSETTS, Boston 16
Cramer Electronics, Inc.
811 Boylston Street

MASSACHUSETTS, Boston 17
Radio Shack Corporation
730 Commonwealth Avenue

MICHIGAN, Detroit 26
Ferguson Electronic Supply
2535 Porter Ave.

MINNESOTA, St. Paul 1
Stern Electronics
150 West University Ave. (at Rice)

NEW JERSEY, Camden 2
General Radio Supply Co. Inc.
600 Penn Avenue

NEW JERSEY, Woodbridge
Federated Purchaser, Inc.
U.S. Route 1

NEW MEXICO, Albuquerque
Radio Specialties Co., Inc.
2223 Avenue Road, S. E.

NEW YORK, Binghamton
Federal Electronics, Inc.
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Radio Equipment Corporation
317 Elm Street

NEW YORK, Hempstead
Davis Electronics Corporation
204 Main Street

NEW YORK, New York 23
Hudson Radio & TV Corp.
37 West 65th Street

NEW YORK, New York 7
Interstate Electronics, Inc.
227 Fulton Street

NEW YORK, New York 6
Milgray Electronics, Inc.
136 Liberty Street
Room 510

NEW YORK, New York 13
Slim Electronics Corporation
130 Canal Street

NEW YORK, New York 13
Terminal Electronics, Inc.
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NEW YORK, Poughkeepsie
Higgins & Sheer Electronic Dist.
201 Hutchings Terrace

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1721 Genesee Street, West

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Dalton Page Radio Supply Co., Inc.
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OHIO, Akron 9
The Sun Radio Company
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OHIO, Cincinnati 22
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1228 Sycamore Street

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111-117 East Long Street

OHIO, Cleveland 15
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1235 Prospect Avenue

OHIO, Dayton 2
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114 Lee Street

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CIRCLE 68 ON READER-SERVICE CARD

NEW PRODUCTS

Pressure Transducer 377

For missile and aircraft instrumentation

Made to meet the requirements of missile and aircraft instrumentation, model 420 absolute pressure transducer measures 1 in. in diameter and 1.6 in. in length and weighs 4 oz. Specifications for typical pressure ranges of between 0 and 10 to between 0 and 350 psia are: static error band, ±1.3%; power rating 1 w at 165 F; and operating temperature range, −65 to +200 F. Overpressure characteristics are good with no resulting calibration shift with pressure up to 150% of rated range. The pressure sensing element is a Ni-Span-C aneroid capsule.

Bourns, Inc., Dept. ED, P.O. Box 2112, Riverside, Calif.

Miniature Power Supply 379

For microwave tubes

Model 859 miniature power supply is a source of keep-alive power for microwave TR switch tubes. The output is −700 v dc at 200 μa, ripple is 5% peak-to-peak, and line power is 115 v at 400 cps. Input impedance is low. The unit is resistant to thermal shock. It weighs less than 3 oz and measures 1-1/8 x 1-1/8 x 1-3/4 in.

Burmac Electronics Co., Inc., Dept. ED, 142 S. Long Beach Road, Rockville Centre, N.Y. *Price: $49.50.*

Servo Controls 373

For rack mounting

Made for use in computing systems, indicating gage applications, and all types of control systems, types 692 and 694 servo controls mount in standard relay racks. Type 692 mounts in a panel 19 x 7 in. or in higher panels to accommodate encoders or additional retransmitting slidewires. The drum-type scale is about 22 in. long and the slidewire balancing shaft provides for mounting alarm contacts or retransmitting slidewires. Type 694 has an 11-in. scale and mounts in a rack measuring 19 x 8-3/4 in. The entire scale range is visible. Retransmitting slidewires, analog-to-digital encoders, and alarm contacts can be mounted.

The Bristol Co., Dept. ED, Waterbury 20, Conn.

Pulse Generator 380

Linearity is 0.1%

Having a linearity of 0.1%, model 816 pulse generator provides positive or negative pulses as large as 20 v. Two pulse shapes are offered: one having a 10-mμsec rise and a 250-μsec decay and one having a 0.25-μsec rise and a 2-μsec decay. Voltage ranges are 0 to 20, 0 to 10, 0 to 1, 0 to 0.1, and 0 to 0.01 v; a 10-turn potentiometer allows for division into 1000 increments. Line changes from 90 to 125 v change the output amplitude less than 0.04%. A Zener diode stabilized power supply with standard cell reference, mercury relay switching, and a panel-mounted galvanometer are used. Required input is 117 v, 50 or 60 cps, less than 5 w. The unit weighs 10 lb and has dimensions of 5.25 x 19 x 5 in.

Interstate Electronics Corp., Dept. ED, 707 E. Vermont Ave., Anaheim, Calif.

Price & Availability: *Price is $295; delivery time is three to four weeks.*

NEW PRODUCTS

Power Supplies 364

Provide 0.5 to 32 v dc

Operating from an input of 105 to 125 v at 60 or 400 cps, models 62-140 and 62-143 power supplies provide from 0.5 to 32 v dc at 2 and 15 amp, respectively. For both units, line regulation is 18 mv, load regulation is 18 mv and ripple is 1 mv rms. Dc impedance is 0.009 ohms for model 62-140 and 0.001 ohms for model 62-143; for both units the 500-kc impedance is 0.5 ohms max.

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

Price & Availability: *Units are in stock. Model 62-140 is priced at $640. Model 62-143 is priced at $985.*

Silicon Computer Diodes 555

Have recovery times down to 0.3 μsec

These silicon computer diodes are Signal Corps types that have recovery times down to 0.3 μsec with reverse voltages ranging up to 200 v. They are listed under type numbers 1N643 (MIL-E-1/1171), 1N658 (MIL-E-1/1160), 1N662 (MIL-E-1/1139), and 1N663 (MIL-E-1/1140). They are sealed in the standard glass package.

Rheem Semiconductor Corp., Dept. ED, Box 1327, Mountain View, Calif.

Toggle Switch 375

Stands 50 g shock

This miniature toggle switch stands 50 g shock and conforms to the vibration and dielectric requirements of MIL-6745. Rated at 28 v dc and at 1 amp, resistive, the switch is available with either an spdt or a dpdt arrangement and can be supplied with maintained momentary action of the batt handle. The terminals are integrally molded into a diallyl phthalate base. Contact surfaces are silver-to-silver. The unit is housed in a corrosion-resistant anodized aluminum cylindrical case and

has a behind-the-panel mounting length of 45/62 in. max.

Controls Co. Of America, Control Switch Div., Dept. ED, 9555 Soreng Ave., Schiller Park, Ill.

Umbilical Connector 369

Has 300 five-amp contacts

This umbilical connector has 300, 5-amp contacts mounted in an area of 2.75 sq in. Designed for missile use, the entire unit is sealed in a magnesium-aluminum casing. Two fluid lines are each capable of carrying 3 gal per min with a pressure drop of 6 psi max. Disengagement is by normal motion of the missile or by manually removing the plug.

Arnoux Corp., Dept. ED, 11924 W. Washington Blvd., Los Angeles 66, Calif.

Rate Gyro 376

Is 4 in. long

Series RG27 dual-axis, rate gyro is 4 in. long and has a 1-3/4 in. diam. It measures rates about two different axes, such as pitch and yaw in a missile. The unit has an independent potentiometer pick-off for each axis. Each potentiometer dissipates up to 2 w. Excitation voltage is up to 60 v. Range is 50 to 2000 deg per sec. The gyro is furnished with a 28 or 12 v dc motor. It operates over the temperature range of −65 to +180 F, with up to 100% relative humidity, and extreme vibration, acceleration and shock.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

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NEW PRODUCTS

Random Signal Correlator 366

Frequency range is 2 cps to 250 kc

Model 13A1 random signal correlator, designed to measure the normalized cross correlation between any two random or periodic signals, has a frequency range of 2 cps to 250 kc and an accuracy of 1%. It provides two identical amplifier channels with independent adjustable gains. The input voltage range is 20 mv to 2 v rms and the continuously-variable gain for each channel is 1 to 100. The instrument provides for the testing and checkout of electronic systems without the necessity of removing the equipment from service.

Flow Corp., Dept. ED, 85 Mystic St., Arlington, Mass.

Price & Availability: *Price is $945; delivery time is 30 days.*

Photoelastic Strain Gage 367

Lateral sensitivity is zero

Called the Strainline, this photoelastic strain gage is a direct reading, uniaxial device having virtually zero lateral sensitivity. It is made to indicate axial strain only in the direction of gage application. Axial static and dynamic strains, lateral bending, and torque are indicated. No external instrumentation or connections are needed; the linear displacement of visible interference fringes indicated magnitude of strain. Polarizers allow the gage to be used in natural or artificial

light. Type A-75-10 has a 3/4-in. gage length and type A-200-10, 2 in.

Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div., Dept. ED, Waltham, Mass. ***Price & Availability:*** *Price of a package of five units is $25. Delivery time is one week.*

Thermostat 558

Operates from −100 to +300 F

Measuring 1-3/16 in. in length, and 1/4 in. in diameter model 196A capsule type thermostat operates from −100 to +300 F. It is rated at 1 amp at 28 v dc, or 1 amp at 115 v ac with a non-inductive load. The terminal supports of this two-element unit are solder sealed to the ends of the triple-coated metalized ceramic tube. It is available with normally-closed contacts which open with a rise in temperature, or normally-open contacts which close with a rise in temperature.

George Ulanet Co., Defense Products Dept., Dept. ED, 413 Market St., Newark 5, N.J.

Analog Computer 363

Contains 4 to 64 amplifiers

Model AD-1 analog computer, designed to solve mechanical, electrical, and industrial problems that can be translated into mathematical data, basically contains from 4 to 32 amplifiers and can be expanded to 64. Four amplifiers are housed in each plug-in module. Simultaneous overload balance indicators are supplied on all amplifiers. All integrating capacitors, matched feedback resistors, and summing resistors are built into the unit. Basic reference voltage is 100 v.

Applied Dynamics, Inc., Dept. ED, P.O. Box 2068, Ann Arbor, Mich.

Price: *about $3000 for the 12-amplifier unit.*

Don't miss an issue of ELECTRONIC DESIGN; return your renewal card today.

FORD VIBRATION INSTRUMENTATION: The Ford Motor Company entered the experimental gas turbine engine field in 1952. The Ford Turbo Machines Department is now engaged in research and development of a turbine engine and a working model has been tested in a tilt-cab truck. An obsolete engine, the Ford 702, has developed 160 horsepower at shaft speeds up to 36,000 rpm. ■ A new supercharged 300 horsepower turbine engine was recently announced by Ford Engineers. Known as the "704," the engine weighs 650 pounds installed, compared to 2,700 pounds for a truck diesel engine of comparable horse-

ENDEVCO TRANSDUCERS SOLVE VIBRATION ANALYSIS PROBLEM

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

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

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

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

Close-up shows two Endevco Accelerometers on bearing test rig in Ford Instrumentation Section, Dearborn, Michigan. Cable passes to Endevco Amplifier (not shown on right).

CIRCLE 75 ON READER-SERVICE CARD

NEW PRODUCTS

Magnetic Switches 372

Cycling rates extend to 10 pps

Designed for use in critical missile, aircraft, and ground support equipment, these hermetically-sealed, three-pole, four-position magnetic sequencing switches have a cycling rate of up to 10 pps. Service life is better than 100,000 cycles. Qualified to MIL-E-5272, the switches stand 10 g vibration at 500 cps and operate from —65 to +280 F. Each switch weighs 26 oz and measures 5.8 in. in length by 2.5 in. in diameter.

Lundy Manufacturing Corp., Dept. ED, Glen Head, L.I., N.Y.

Availability: *Delivery time is 30 days.*

Electronic Computer 556

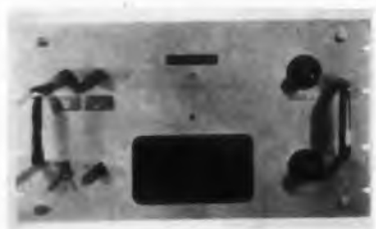
Uses a magnetic core memory

Capable of exceeding 60,000 instructions in 1 sec, model 160 solid-state electronic computer has an array of building blocks and uses a magnetic core memory. It handles data transmissions to and from input-output equipment at speeds up to 65,000 characters per sec. Storage cycle time is 6.4 μsec; basic add time is 12.8 μsec; average execution time is 15 μsec per instruction. Model 160 uses 5 mc logic.

Control Data Corp., Dept. ED, 501 Park Ave., Minneapolis 15, Minn.

DC Power Supply 370

Delivers 6 and 18 v at 30 amp



Having dual outputs, model 163 transistorized power supply provides 6 v dc at 30 amp and 18 v dc at 30 amp. Line regulated, the supply is

ccurate to ±0.5%. Tap switches on the front panel permit the output to be regulated to compensate for load changes. Ripple is 5% max. Required input is 105 to 125 v ac, 60 cps, single-phase. The unit mounts in a standard 19-in. relay rack and has a front panel measuring 10.5 in. high.

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

Price & Availability: *Price is $995 fob Springfield. Delivery is in 30 days.*

Reversible Converter 557

For systems using ac carrier signals

Having amplifier, comparator, and conversion networks that will accept frequencies to 100 kc, this reversible analog-to-digital converter is used with systems utilizing ac carrier signals. The device is entirely solid state and can be supplied to provide conversion of voltage-to-binary codes of 8 to 13 bits resolution or binary-decimal codes of 2, 3, or 4 digits resolution. It is accurate to ±0.02% of full scale, ±1/2 the least significant digit.

Epsco, Inc., Dept. ED, 275 Massachusetts Ave., Cambridge, Mass.

Trimmer Potentiometers 374

For aircraft and missile use

These wirewound trimmer potentiometers meet the resolution and size requirements for aircraft and missile applications. They also provide the stability needed for ground support instruments and systems. The 375 series has the following specifications: power rating, 1 w; resistance range, 10 to 50 K; weight, less than 1 g; and dimensions, 0.375 x 0.375 x 0.175 in. The 500 series has these specifications: power rating, 2 w; resistance range, 10 to 100 K, weight, less than 2 g; and dimensions, 0.5 x 0.5 x 0.175 in. The units are sealed for use in environmental extremes, have 25-turn, O-ring sealed adjustments, and are housed in aluminum cases.

Bamford Corp., Dept. ED, 11167 Tennessee Ave., Los Angeles 64, Calif.

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NEW PRODUCTS

Coaxial Attenuator 371

Range is 0 to 1000 mc

Model RDA-971 variable, coaxial attenuator has a variation range of 0 to 25 db with less than 1-db frequency sensitivity over the range of 0 to 1000 mc. Connectors are BNC type. Attenuation is varied by rotating the 1/4-in. shaft. Maximum insertion loss is 0.5 db and vswr is 1.3. Calibrated dial, different input-output orientation, and N, C, HN, and TNC connectors can be supplied on special order.

Radar Design Corp., Dept. ED, Pickard Dr., Syracuse, N.Y.

Price & Availability: *Price is $280 for small quantities. Delivery is in four to six weeks.*

Coaxial Line Duplexer 574

Handles 10-kw average power

Type BL-595 balanced coaxial line duplexer consists of two coaxial hybrids and two cavities for plug-in cell type TR tubes. This unit is in the 6-1/8-in. line and is rated to handle 10 kw of average power. Other units of this type are available in 1-5/8-, 3-1/8-, and 6-1/8-in. coaxial line.

Bomac Laboratories, Inc., Dept. ED, Salem Road, Beverly, Mass.

Digital Printers 378

Use a self-balancing potentiometer

Consisting of a self-balancing potentiometer, plug-in servo amplifier, power supply, servo mo-

tor, precision gear train, and a printing counter, series B, P, and V digital printers perform both measuring and recording functions. Visual and printed readouts of weight, pressure, position, voltage, current, temperature, and resistance are provided. Operation is from 115 v ac at 60 cps.

Moran Instrument Corp., Dept. ED, Orange Grove Blvd., Pasadena, Calif.

Price & Availability: *Some units are available from stock; others require 30 to 60 days for delivery. Price is $2150 to $2485.*

Rotary Switches 559

Provide from 2 to 20 circuits

Intended for use in thermocouple and resistance-thermometer applications, these switches provide from 2 to 20 circuits plus an off position with dummy load contacts. The units have silver-to-silver contact paths, high circuit-to-circuit insulation, and positive detent mechanisms. They are available in explosionproof, fungusproof, splashproof, and sand and dustproof housings.

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

Silicon Rectifier Protectors 368

Cover piv range of 50 to 600 v

Made to protect silicon power rectifiers from breakdown due to transient high voltages, the SP series protectors cover the range of 50 to 600 v. Specifications include: non-linear resistance decreasing with an increase in voltage, built-in capacitance, intermittent surge energy absorbtion to 3000 w, and less than 5 w power consumption under steady conditions.

Vickers, Inc., Electric Products Div., Dept. ED, 1815 Locust St., St. Louis 3, Mo.

Price & Availability: *Price ranges from $1.95 to $4.65 for quantities of 1 to 49. Units are available from stock.*

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NEW PRODUCTS

Peaked Amplifier 392

Range is 15 to 2000 cps

Model 107-B peaked amplifier, a three-stage, direct-coupled unit with a twin-T filter in the negative feedback loop, has a range of 15 to 2000 cps. The filter gives at least 50 db insertion loss at the balance frequency; normal feedback is 70 db or more, retaining 20 db for stabilization at the peaked frequency and resulting in a sharp, deep-shouldered response curve. Performance of the amplifier is independent of the driving point impedance and can be terminated in any high-impedance load. Q-factors of 100 can be obtained.

CES Electronic Products, Inc., Dept. ED, P. O. Box 7504, San Diego 7, Calif.

Price & Availability: *Price is $95; delivery time is two weeks.*

Relay 390

For low level switching

Designed for low-level switching, the Flocon mercury relay provides contacts with a capacitance of less than 1 μμf between signal and relay coil. Capacitance across the open contacts is less than 8 μμf and leakage resistance exceeds 150 meg. The relay operates at frequencies up to 100 cps. Switching time is less than 3 msec, each way, and mercury bridging time is less than 1 msec. The contact arrangement is spdt, make-before-break.

Beckman Instruments, Inc., Systems Div., Dept. ED, 325 N. Muller Ave., Anaheim, Calif.

Miter Gear Boxes 611

Type BA miniature miter boxes are stainless steel clear passivated, and have an aluminum anodized frame. Their approximate overall size is 7/8 x 1-1/2 x 2 in. Precision 2 miter gears offer minimum backlash to better than 10 min. with variable mounting combinations.

PIC Design Corp., Dept. ED, 477 Atlantic Ave., E. Rockaway, Long Island, N.Y.

Price & Availability: *Available from stock and delivered in 10 days. Prices range from $47.50 to $51.75, depending on unit. Quantity discounts available.*

Teflon Hook-Up Wires 643

For use at 105 C, these wires come in sizes 20 through 26. Insulation provides protection up to 260 C. Hook-up wires are offered with a wall thickness of 10 mil.

American Super-Temperature Wires, Inc., Dept. ED, 2 W. Canal St., Winooski, Vt.

Availability: *Delivery time is 10 days.*

Pressure Sensitive Drafting Materials 644

These templets, grid sheets, die-cast symbols, numbers, letters, and printed-circuit symbols are clearly printed on shrink-resistant durable, transparent materials. They are useful in drafting and design work.

Applied Graphics Corp., Dept. ED, Glenwood Landing, L.I., N. Y.

Availability: *Most materials are in stock.*

S-Meter Converter 645

Model ME-63 shows if a receiver is properly tuned and indicates the signal strength. Calibration is from 1 to 10 mv or 1 to 5 mv and S 9 to 30 db. Unit has zero adjustment control.

Olson Radio Corp., Dept. ED, 260 S. Forge St., Akron, Ohio.

Price: *$5.88.*

Ultra Fine Wire 646

Called Moleculoy, this ultra fine, low-temperature coefficient wire is now being coated with a high-temperature polyester enamel. The wire is a nickel-based, nonmagnetic, 800-ohm, ±10-ppm alloy made in diameters from 0.004 to 0.01 in. It comes in bare, enameled, oxidized, and fabric covered finishes.

Molecu-Wire Corp., Dept. ED, Scobeyville, N.J.

Precious Metal Shapes 647

Five special processed shapes in a variety of precious metals such as karat gold, platinum, and silver, are available. The processed shapes can also be supplied in rare earth metals as well.

Consolidated Reactive Metals, Inc., Dept. ED, 115 Hoyt St., Mamaroneck, N.Y.

NEW PRODUCTS

Latching Relay 391

Load is 20 amp at 26.5 v dc

Made to remain locked in either the open or the closed position, this latching relay handles a load of 20 amp at 26.5 v dc. A single pulse, regardless of polarity, causes the relay to unlatch, switch to the alternate position, and lock in the new position. Mechanical latching occurs at three different points to assure high resistance to vibration, shock, and other environmental conditions. Energizing current is 0.45 amp at 18 to 32 v dc. The unit operates over the temperature range of —65 to +125 C, at altitudes to 150,000 ft, and exceeds MIL-E-5272C for vibration.

Astromics, Dept. ED, 611 W. Harvard St., Glendale 4, Calif.

Price & Availability: For 25 or more units, price is $85. Units will be available from stock in May, 1960.

Rotary Panel Switch 386

Has in-line readout

Series 7300 rotary panel switch with in-line readout replaces octal or 10-position switches. This finger-controlled unit provides for 10-position, sp or dp, binary-coded decimal with variations, and octal 0, 1, 2, and 4 coded outputs. Internal lighting of the readout and color coding of the switch tabs can be specified. The unit is suitable for applications in automation, automatic control systems, computer designs, and other systems requiring numerical constants or coefficients.

The Digitran Co., Dept. ED, 660 S. Arroyo Parkway, Pasadena, Calif.

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Telemetering Mounting Units 384

Accept 6 and 8 units

Designated models TJS-306 and 308, these telemetering component-mounting units perform identical functions and vary only in size and number of components that can be accommodated. The TJS-306 accepts 6 modular units, and the 308 accepts 8 units. Components that may be mounted include: TAA-300 composite signal amplifier; TAA-301 voltage amplifier; and the TRE-300 voltage regulator. All necessary wiring and connectors are self-contained.

Bendix Aviation Corp., Bendix-Pacific Div., Dept. ED, 11600 Sherman Way, N. Hollywood, Calif.

Generator Regulator 388

With transistors in the switching mode

This solid-state generator regulator uses transistors in the switching mode to minimize power dissipation. The generator output is a function of the average value of the field current. Control of the average field current is maintained by varying the on-time of the switching transistors. By varying this pulse width ratio, the proper output voltage is provided and a small amount of power is dissipated. Made to meet aircraft and military requirements, the unit has a tolerance of ±0.5 v at 28 v dc. For transient conditions in starting, circuitry accepts 1 v for initiating operation. The operating temperature range is —65 to +160 F.

Hydro-Aire Co., Dept. ED, 300 Winona Ave., Burbank, Calif.

NEW PRODUCTS

Linear Potentiometer 387

Operates in temperatures to 500 F

For use in missile and aircraft control, model 3-120 linear-motion, wirewound, servo-feedback potentiometer can be used in temperatures to 500 F. It can be used with both hydraulic and electrical actuators. The unit is end-actuated with shaft coupling configurations as required by the application. Standard strokes are 1 to 5 in. in increments of 1 in. Diameter is 1/2 in. The unit has a high resolution with linearities to 0.05% and meets or exceeds all applicable Mil specs.

Edcliff Instruments, Dept. ED, 1711 S. Mountain Ave., Monrovia, Calif.

Sweep Oscillator 383

Output frequency is 800 to 1400 mc

Type 9128 sweep-signal oscillator has an output frequency of 800 to 1400 mc, and an output power of 10 mw into a 50-ohm load. Output power in the sweep mode is held flat, with ±1 db over the entire sweep range, by using a leveler circuit. The sweep mode operates at 30 cps over the full range. The manually-tuned mode also tunes over the full range. Sweeping provides a saw-tooth horizontal output and a phasing control.

CGS Laboratories, Inc., Dept. ED, 48 Danbury Road, Wilton, Conn.

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Moisture Control and the Stability of Transistor Parameters

THE technology of semiconductors is in a large degree the technology of surfaces. The junction is a surface between two layers of semiconductor material. The contact is a surface between the semiconductor and a metal. And, finally, there is a surface between the semiconductor and its environment.

It is on these surfaces that most of the significant actions of the transistor take place, and it is the composition and structure of these surfaces which determine the character of these actions. Moisture can play havoc with surface stability, and ultimately with transistor reliability. Water is, in fact, the primary cause of surface stability problems in transistor production.

If the characteristics of germanium p-n-p alloy transistors are measured immediately after the final vacuum-bake, and again after the surface has been exposed to water vapor it will be found that: Alpha increases; junction breakdown voltage changes; and reverse current increases.

If the transistor is then put through another vacuum-bake, the original characteristics will be restored. Long exposures to water before baking, however, will result in irreversible changes.

Exactly what takes place on the surface is difficult to say, but certain changes do occur in the presence of water. Whether the water actually enters into the change or acts as a catalyst has not been determined. These surface changes have the net effect of altering various paths which a carrier can take.

It would seem that a ready means of overcoming the effect of water would be to hermetically seal the transistor immediately after the vacuum-bake.

This is done in practice, but it results merely in slowing the effect since the transistor is so small that very little water is required for the change to take place and the semiconductor materials have a strong affinity for water. Since it is a practical impossibility to exclude all water during this operation, the use of a hermetic seal alone is insufficient.

There seems to be no simple solution to the problem. Therefore, Tung-Sol subjects every transistor to a multi-level water-control process, which has proved extremely successful.

Elimination of Moisture During Processing

In the final stages of production prior to encapsulation, Tung-Sol makes sure that surfaces are clean, stable and insensitive to water. First, the surface is etched to remove any impurities which might have been produced during processing. The entire structure is washed in a bath of highly deionized water. The water is then blown off with pure dry air. Next the germanium is chemically treated to provide a surface which is relatively unaffected by water. And finally the transistor is placed in a vacuum oven and baked. The unit is now ready for encapsulation.

Sealing Water Out

Three essential factors must be considered in sealing: the quality of the seal; the size of the working area; and, the effect of sealing on associated parts.

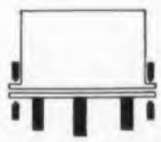
Seal Quality: The properties of water and the conditions of transistor usage require that the seal be perfect and at the same time rugged. Water in liquid form will enter through a hole as small as 2 x 10^{-8} cm. Water vapor can enter through apertures approaching the diameter of the water molecule, less than 4 Å. The seal must also be strong enough to withstand the tough operating conditions of industrial and military equipment, without developing imperfections.

Size of the Working Area: Since the transistor is a miniature component, the case must be as small as practical. The size of the working area is limited, thus complicating the tooling problem.

The Effect on other Parts: In order to attain the seal, work must be performed on the case. Depending on the kind of work performed, mechanical and thermal stresses may be transmitted to the working parts of the transistor and alter their properties.

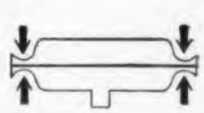
The Tung-Sol methods of sealing have overcome these serious problems. The seal is of the highest reliability, yet the processing is such that the size of the working area offers no barrier and the other working parts suffer no stress damage. The following is a capsule digest of Tung-Sol sealing methods:

Connection Leads: Kovar-hard glass seals are used to secure a tight glass to metal seal while providing the necessary electrical insulation without destroying the mechanical insulating properties of the case.



Case Sealing with Electronic Welding: The header is welded to the case by means of an extremely localized heat which is controlled electronically. (This method is more reliable than the previously used pressure fit technique in which the can was forced on to a tight fitting header. An uncertain seal resulted.)

CIRCLE 86 ON READER-SERVICE CARD



Case Sealing with Cold-Weld: For larger transistors, a more practical seal is provided by the Cold-Weld technique, an exclusive Tung-Sol development. In this process the entire case is made of pure copper. Both the can and the header have matching flanges which are pinched together under pressure. The pressure joins the two pieces together in a true weld without the application of external heat.

Controlling Water Inside the Case

When the transistor case is welded together, water is sealed out. On the other hand, any water that happens to be inside the case is sealed in. In fact there is usually enough water present to cause instability. To prevent the sealed-in water from affecting the semiconductor surface, Tung-Sol employs a "Molecular Sieve".

Molecular sieves, actually zeolite crystals, contain precisely arrayed networks of cavities. They have a great affinity for water molecules, absorbing them in preference to other substances. Under certain conditions molecular sieves reduce the amount of water in a gas or liquid to as low as four parts per million.

In Tung-Sol's transistors, the zeolites, in the form of a small pellet, are placed inside the transistor case. This pellet dries the can and draws off any water from the transistor.

Molecular sieves have a stronger affinity for water than conventional silicone oils and grease. They provide permanent absorption of water at all operating temperatures, and minimize the migration of ions.

Tung-Sol Transistors and "Extra-Reliability"

Moisture control is just part of the wide-ranging care that Tung-Sol takes of every semiconductor product, all aimed at bringing you the most reliable components. Every component is the product of manufacturing processes and quality control practices that have made Tung-Sol the name synonymous with the finest precision componentry.

Write for Full Report on Moisture Control

The latest issue of Tung-Sol's Technical Journal, *The Lattice*, features a comprehensive description of moisture control problems and their solution. You may get your copy by writing to Tung-Sol on your company stationery.

TUNG-SOL

Tung-Sol Electric Inc., Newark 4, New Jersey

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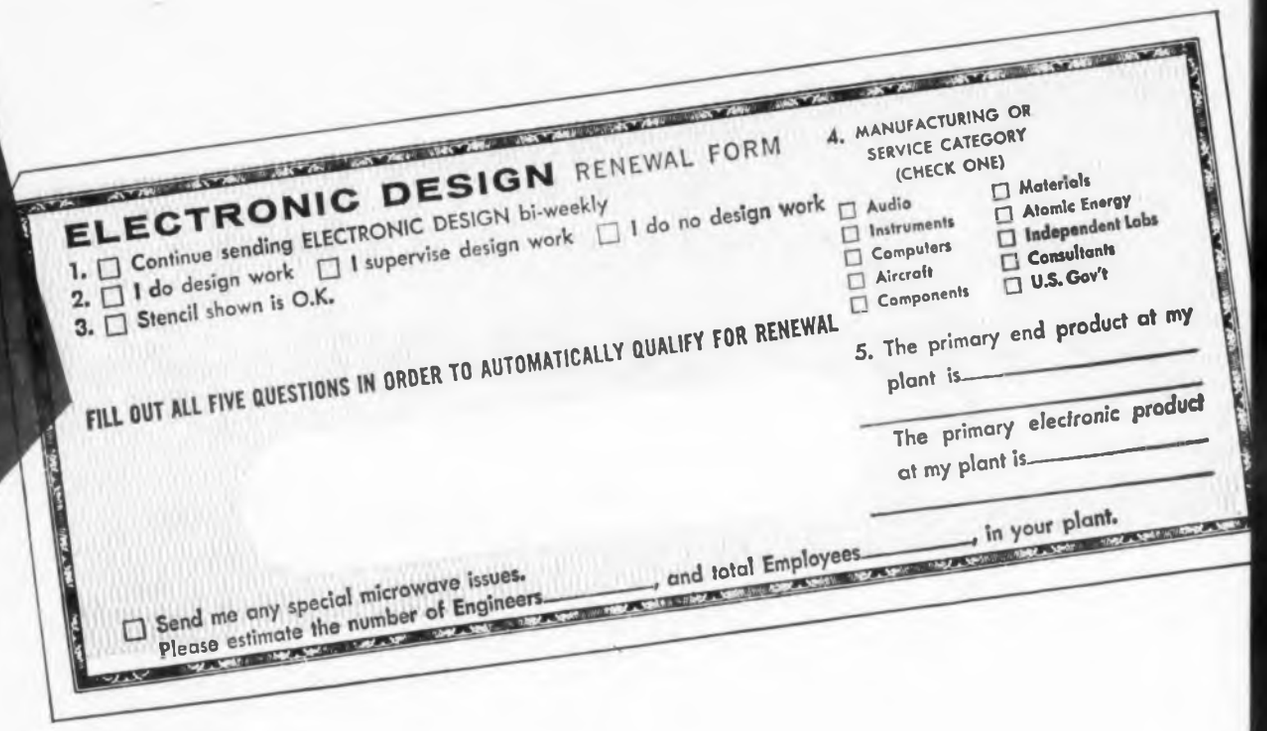

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26 ISSUES IN '60

NEW PRODUCTS

Voltmeter 382

Has a range from 0.01 to 1100 v dc

Model 25 dc voltmeter covers a range from 0.01 to 1100 v with an accuracy of 0.05%. The unit contains no motors, stepping switches or choppers. It can operate on 60 to 400 cps power for either field or laboratory use. The input resistance is infinite at null on the 110 v range, and is 1 meg on the 1100 v range. Case dimensions are 7 x 11 x 7 in.

Electro Metric Co., Dept. ED, 661 19th St., Manhattan Beach, Calif.

Price & Availability: *Can be delivered within 30 days. Price is $435, with standard cell reference. Zener reference, $55 additional. Rack mount, $20 additional. All prices fob Manhattan Beach, Calif.*

DC Power Supply 389

Provides 0 to 50 v

Operating from an input of 95 to 135 v ac, rms, 60 cps, single-phase, this power supply provides a continuously variable output of 0 to 50 v dc at 0 to 0.5 amp. The unit occupies only 5 x 5 x 6 in. Regulation is 0.02% from no load to full load, ripple is 4 mv rms, and line regulation is 0.01% for a 35 v rms change in input. After an initial stabilization period of 15 sec, the output voltage does not change more than 0.07 v.

Autotronics, Inc., Dept. ED, Box 208, Florissant, Mo.

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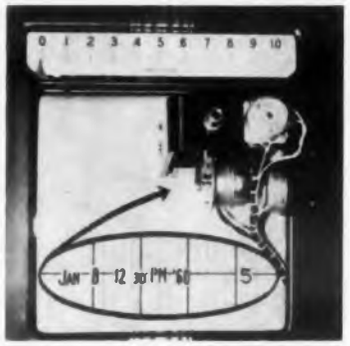
NEW PRODUCTS

Strip Chart Marker 393

Records time and code



Model RI-5 strip chart marker, a kit-form printing device, automatically prints date, time to the nearest minute, and remotely selected code number or letter on strip charts. The unit does not interfere with the recording process. The time clock operates continuously on a 60-cps line and the printing mechanism operates on 24 to 115 v ac or dc. A single printing solenoid causes simultaneous printing of time and code. Up to 12 code numbers are furnished. The unit can be used with all popular makes of strip chart recorders.

Royson Engineering Co., Dept. ED, Hatboro, Pa.

Price & Availability: *Price is $445 per unit; $430 in quantities of four. Delivery time is 60 days.*

Right-Angle Ratio Drives 385

Miniature

These worm and bevel gear, right-angle ratio drives are for use in electronic instruments and servomechanisms. The units are miniature and have dual output stainless steel shafts. Series RAWG worm type units have ratios of 5:1, 10:1, and 20:1; series RABG, bevel type, have driving ratios of 1:1, 2:1, and 3:1.

Jan Hardware Mfg. Co., Inc., Dept. ED, 38-01 Queens Blvd., Long Island City 1, N.Y.

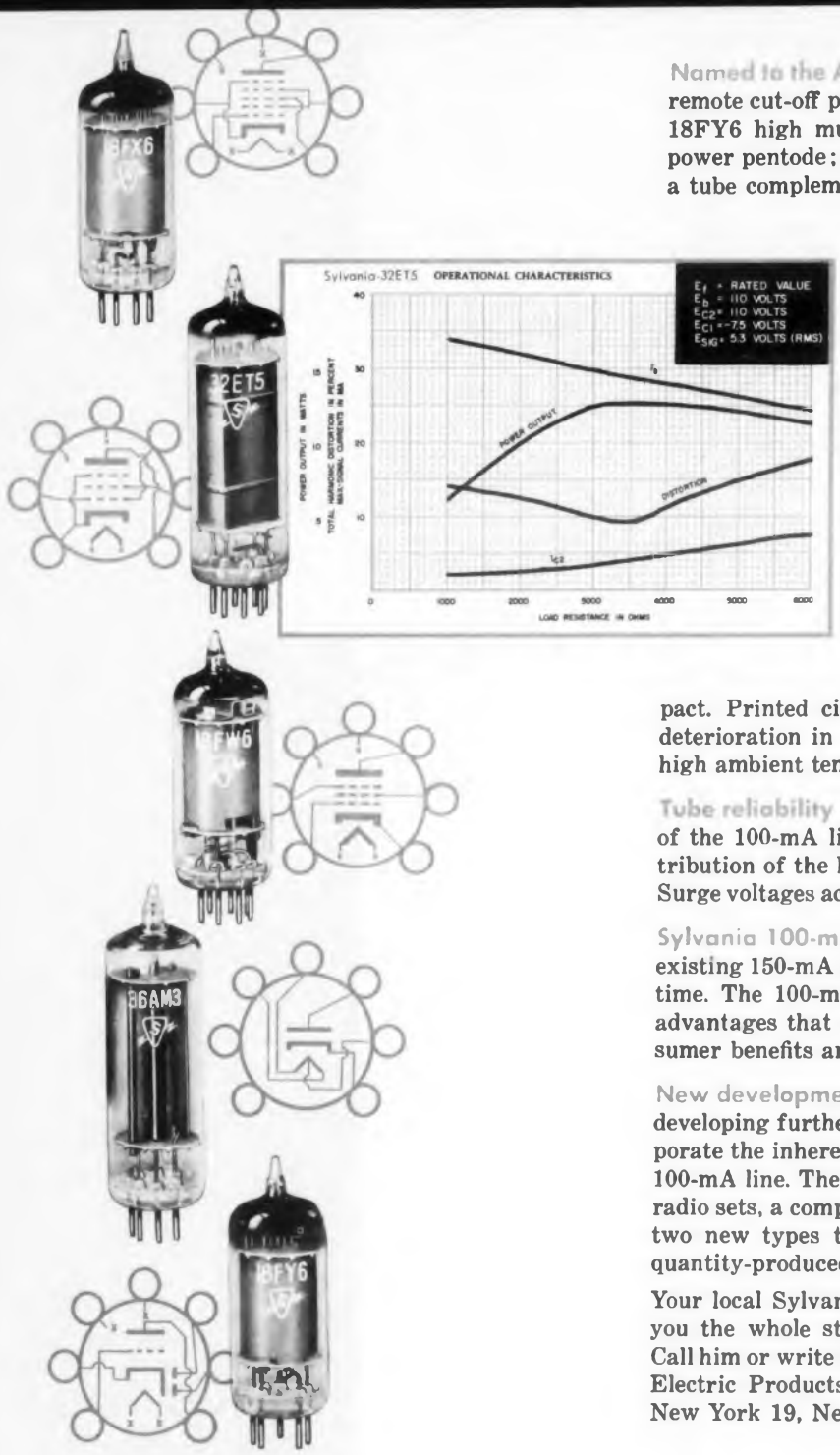
Price & Availability: *Price ranges from $5.55 to $8. Delivery is in 7 to 10 days.*

Electron Tube News ...from SYLVANIA

Cool operation sparks home-radio sales when you design around

SYLVANIA 100-mA ALL-AMERICAN FIVE

Originated by Sylvania—the 100-mA All-American Five requires ⅓ less heater power, opens new design possibilities and offers significant merchandising opportunities. Now, tube layout is comparatively unrestricted, cabinet styling is more flexible. Cost reductions in cabinetry, circuitry and components are within easy grasp. Tube reliability is enhanced. Printed circuit techniques can be used advantageously. Here, then, are important advances in home radio design—made possible by the Sylvania 100-mA All-American Five.



Named to the All-American Five are: 18FW6, semi-remote cut-off pentode; 18FX6, pentagrid converter; 18FY6 high mu triode-double diode; 32ET5, beam power pentode; and the 36AM3, half-wave rectifier—a tube complement with proven field experience.

Lower ambient temperatures increase design flexibility and offer substantial economies. Radio cabinets utilizing this carefully mated complement show temperature reductions of 20-25%. The area of the power output tube shows an even greater temperature decrease—as much as 30%. As a result, less expensive plastics can be used. Vertical chassis can be designed without special heat shielding. Placement of the power output tube is no longer critical because of heat—wide, outside "berths" are unnecessary—designs can be compact. Printed circuit boards may be used without deterioration in set life and performance caused by high ambient temperatures.

Tube reliability is increased. Sylvania heater design of the 100-mA line provides for more balanced distribution of the heater voltages in the heater string. Surge voltages across individual tubes are minimized.

Sylvania 100-mA All-American Five can be used in existing 150-mA designs with a minimum of redesign time. The 100-mA tube complement presents many advantages that can be directly translated into consumer benefits and increased home radio sales.

New developments in the 100-mA line. Sylvania is developing further tube complements that will incorporate the inherent advantages of a cooler-operating 100-mA line. These include a four tube line for home radio sets, a complement for FM radio receivers, and two new types that hold exciting possibilities for quantity-produced Hi-Fi.

Your local Sylvania Sales Engineer will gladly give you the whole story on the Sylvania 100-mA line. Call him or write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. 195, 1740 Broadway, New York 19, New York.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

Chassis Slides 394

Lock in three positions

Model C-300 chassis slides lock in three service positions: horizontal, 90 deg up, and 90 deg down. Able to support up to 50 lb, they are furnished in lengths of 12, 14, 16, 18, 20, 22, and 24 in. Construction is of hard, cold-rolled steel. The finish used meets JAN 100-hr salt-spray requirements.

Chassis-Trak, Inc., Dept. ED, 525 Webster Ave., Indianapolis 19, Ind.

Price & Availability: *Price ranges from $9.45 to $21.15. Delivery time is two weeks.*

Diffusion Furnaces 422

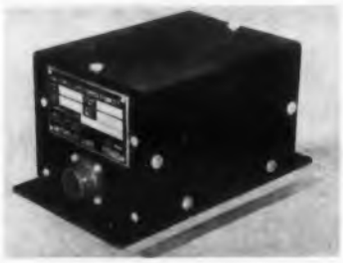
Single and multiple-zone models

For use in the manufacture of semiconductors, these gaseous and solid diffusion furnaces are offered in single and multiple zone models. Multiple tube models can also be supplied. Tube size can be as large as 4 in. ID. Refractory accessory items can be supplied.

Lindberg Engineering Co., Dept. ED, 2450 W. Hubbard St., Chicago 12, Ill.

DC Power Supply 381

For airborne use



Designed for airborne applications, model 825 dc power supply operates from 109 to 125 v, 400 cps, in accordance with MIL-E-7894. It provides two output voltages: 32 v nominal at 0 to 2 amp, regulated 0.5% for line and load; and 12 v at 10 ma, unregulated. Ripple on the 32-v output is less than 25 mv rms. The unit is completely transistorized and weighs 4 lb.

Metrolog Corp., Dept. ED, 169 N. Halstead St., Pasadena, Calif.

◀ CIRCLE 89 ON READER-SERVICE CARD

NEW PRODUCTS

Cable 484

Withstands from — 320 to + 600 F

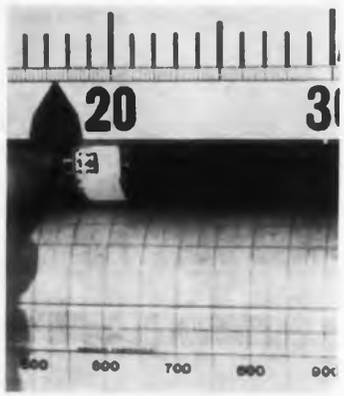
Capable of withstanding temperature ranges from —320 to +600 F, this flexible, subminiature, multiconductor cable may be used for missile, computer, and strain gage applications. Cables, with connectors, can be fabricated in lengths up to 9 ft and widths determined by the size and number of conductors. The stranded conductors are spaced and molded in a special material developed by the manufacturer.

Cicoil Corp., Dept. ED, 13833 Saticoy St., Van Nuys, Calif.

Availability: *Made to customer specifications only. Delivered 30 days after order received.*

Multipoint Recorder 511

Points, actuation, and range can be changed



Model 15 multipoint strip-chart recorder can be easily converted to change the number of points being measured, the actuation, or the range. Applications of the unit include: monitoring in rocket engine and missile tests, nuclear reactor coolants, and in nuclear radiation detection systems. Measurements can be switched from 2 to 3, 4, 6, 8, 10, 12, 16, 20, or 24 points.

Minneapolis-Honeywell Regulator Co., Dept. ED, Wayne & Windrim Ave., Philadelphia, Pa.

Price & Availability: *Price is $1370. Standard units are in stock; other units can be delivered in 3 to 6 weeks.*

Crystal Holder 482

Accepts 1N2792 crystal for 4-mm band

Model V-CH-1 crystal holder is designed to accept the 1N2792 crystal, developed for the 4-mm band. The holder must be retuned at each frequency and for each new crystal. When matched, vswr is less than 2 for all crystals, and less than 1.5 for selected crystals. It mates with RG 98/U waveguide and uses UG 385/U connectors. It is sealed with an O-ring and can be used in a pressurized system up to 30 psi. Output connector is a miniature BNC or microdot. The holder weighs 2-1/2 oz and is about 2 in. long.

TRG, Inc., Antenna & Microwave Dept., Dept. ED, 9 Union Square, Somerville 43, Mass.

Price & Availability: *Available from stock. Can be delivered 5 days after order received. Price is $220 per unit.*

Square-Wave Filter 503

Insertion loss is 0.1 db from 0 to 20 v rms

Type LF-125 square-wave filter maintains a constant insertion loss of within 0.1 db over an input signal of 0 to 20 v rms. Designed to convert a 30-cps, 60-v peak-to-peak square-wave input into a sine wave with less than 1% distortion, the filter can be furnished with an input impedance of 50 or 100 K. Both models are designed for an output to the grid and attenuation of 40 db or more at higher harmonics.

Control Electronics Co., Inc., Dept. ED, 10 Stepar Place, Huntington Station, L.I., N.Y.

Price & Availability: *Price is $65 ea for quantities of one to five. Units are made on order and can be delivered in 30 days.*

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NEW PRODUCTS

High Voltage Diodes 486

Delivers 15-amp average current

This forced-air-cooled high-vacuum diode, type XD-18, will withstand 40-kv peak-inverse-voltage and delivers 15-amp average current. As a clipper or shunt diode, it is rated at 300 amp max. The tube is designed for use in giant-size, radar power supplies and modulators. It measures 10-1/2 in. long with a diameter of 4-5/8 in. It can be mounted in a standard CEM socket.

Central Electronic Manufacturers, Dept. ED, 2 Richwood Place, Denville, N.J.

Stepping Relay 488

Operates up to 230 v ac, 110 v dc

Designed for sequential-switching applications, model CS stepping relay can be supplied for operation on all voltages up to 230 v ac and 110 v dc. Standard contacts will switch 0.25 amp and carry 5 amp. The relay comes in a choice of 2-, 3-, 4-, 5-, 6-, 9-, 10-, or 12-position single-pole, continuous rotation switching, in either shorting or non-shorting versions. It weighs about 5 oz, and measures 3-5/16 x 1-3/4 x 1-7/8 in.

Artisan Electronics Corp., Dept. ED, 171 Ridgedale Ave., Morristown, N.J.

Availability: *Available from stock. Delivered 6 to 8 weeks after order received.*

DC Power Supply 476

Has four adjustable ranges

Model P 617 dc power supply has four adjustable ranges: 1.1 to 1.3 amp at 16.5 to 33.8 w, 3 to 6 amp at 16.2 to 216 w, 6 to 9 amp at 65 to 292 w, and 3 to 5 amp at 27 to 135 w. It operates from a 208-v, 400-cps, three-phase input. Regulation is better than ±0.5% and outputs have a ripple of less than 1% rms. The unit has a life expectancy of 10,000 hr, operates in the ambient temperature range of —40 to +65 C, measures 7 x 15 x 7.5 in., and weighs 35 lb. Originally designed to supply a constant current to the focusing coils of a klystron, the device also can be used as a current reference in rotating systems, large magnetic systems, and wherever a highly regulated current supply is needed.

International Telephone and Telegraph Corp., Industrial Products Div., Dept. ED, 15191 Bledsoe St., San Fernando, Calif.

Test Chamber 480

Temperature range is — 120 to + 300 F

Able to provide temperatures from —120 to +300 F, this environmental chamber also has facilities for altitude, vacuum, and humidity testing. Work area is 19 x 19 x 19 in. It is electrically welded and resistant to high pressures. A frost proof, multipane door is illuminated by a fluorescent lamp. The unit is powered by a 230 v, 60 cps, single-phase motor. Over-all dimensions are 74 x 32 x 32 in.

Hudson Bay Co., Div. of Labline, Inc., Dept. ED, 3070-82 W. Grand Ave., Chicago 22, Ill.

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NEW PRODUCTS

Polystyrene Capacitors 485

Come in three lines

These polystyrene capacitors come in three lines, all available in bathtub cases. Types PV and PW capacitors are adjustable within the limits of ±1% of the nominal capacitance. Type PX units are stabilized and come in capacitance tolerances of 1%, 0.5%, 0.25% and 0.1%. Capacitance change per year of life is claimed to be less than 0.1%.

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

Availability: *Some models in stock. Delivery is from 30 to 45 days.*

Corrugated Vulcanized Fibre 419

Has good insulating properties

This corrugated. vulcanized fibre provides good insulating properties. The corrugations, which are 9/64 in. deep and 0.364 in. apart, act as guide channels to protect lead wires and connections. The material is 0.01 in. thick and has 16.5 corrugations per 6 in. of length.

National Vulcanized Fibre Co., Dept. ED, 1060 Beech St., Wilmington 99, Del.

Price & Availability: *Price ranges from $0.63 to $0.84 per lb. Delivery is from stock.*

Printed Circuit Boards 508

Use epoxy molding compounds

These miniature printed-circuit boards, using epoxy molding compounds, offer high temperature resistance, high dielectric characteristics, low moisture absorption, and high dimensional sta-

bility. Circuit canals are molded in the board in accordance with the customer's design. Standard thickness is 0.5 in. Length and width are supplied to fit customer specifications. Shapes other than flat boards can be supplied.

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

***Availability:** Delivery time is two to three weeks.*

DC-DC Converter 479

For telemetry applications

This dc-dc converter exceeds the requirements of most telemetry applications for regulation, output noise, and efficiency of 250-, 150-, and 5-v power supplies. It replaces the three power supplies formerly needed for airborne systems and furnished excitation voltages to sub-carrier oscillators and telemetry transmitters.

Temco Electronics, Dept. ED, P.O. Box 6191, Dallas 22, Tex.

X and Gamma-Ray Detector 420

Operates from batteries or standard line

Model 607-X gamma and X-ray detector is for detection and measurement of X-rays produced as a secondary emission from: radar transmitters, magnetrons, klystrons, high-potential cathode ray tubes, rectifiers, and beam-type tubes. A portable unit, it has a specially constructed internal shielding for making X-ray measurements accurate to ±15% over the energy level of 100 to 600 kev in the presence of high-intensity, rf pulses or other types of electromagnetic, magnetic, and electrical fields. Requirements of MIL-E-4158 are met.

Universal Transistor Products Corp., Dept. ED, 36 Sylvester St., Westbury, L.I., N.Y.

***Price & Availability:** For one or two units, price is $1750 ea. Delivery is from stock.*

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.

Flexible PC Card And Simple Densify Component

WHILE dramatic advances in microminiaturization techniques hold great promise for denser electronic packaging, they have little to offer the designer of power-dissipating circuitry with large inductive and capacitive components. The servo-amplifier designer, for example, is still restricted to conventional components. Wafer substrates and other neoteric techniques simply can't handle high-power requirements.

Nevertheless, even with conventional components, the servo designer can still cut size drastically. A review of current servo designs shows that rarely do the electronic components occupy more than 10 per cent of the total available volume. Interconnections, supporting structures, or simply air or potting compounds occupy most of the space.

The amplifier in Fig. 1 shows what can be done to improve the "payload efficiency." This amplifier was developed by Lear Inc. primarily for use in its own instruments. A linear servo amplifier, it can deliver 1.5 w to a 33-v motor in an ambient of 100 deg C. The can measures 7/8 x 7/8 x 1-1/4 in. and is one-third the size of conventional designs with comparable performance.

Fig. 1. Shrunk servo amplifier uses flexible printed-circuit board to increase component density. (Coin shows size—not price.)

Featuring the clever and unusual in packaging, appearance design and circuitry in electronic equipment.

il Filling, eat Sink ackaging

Three Contributors to Packaging Density

Contributing to the volume reduction was the exclusive use of the new TO-18-cased silicon transistors, and the elimination of the output transformer by use of a center-tapped motor. However, it is the flexible board, the oil filling, and the simplified transistor heat sink which make the difference and should be of greatest interest to the designer who must package an existing circuit.

The upper half of the module has passive components stacked vertically. This arrangement affords best volume utilization with standard axial-lead components. One drawback of this arrangement has been the difficulty of inserting leads between two parallel boards.

Flexible "S" Board Eases Lead Insertion And Hole Alignment

This is overcome by using a flexible base material for the printed wiring. This flexibility allows the board to be formed into a rectangular "S" shape. The one board, therefore, eliminates all hook-up wire except transformer leads. It is also the only structural support for the electrical components.

Besides making lead insertion easier, the flexible board makes hole alignment less critical. Also, temperature change and vibration impose less stress on the component lead when a pliable base material is used. This contributes to added reliability.

At elevated temperatures, the output transistors need a heat sink with a thermal resistance of 15 C per watt or less. The sink must provide electrical insulation from the case. The method shown in Fig. 2 satisfies these requirements in a simple and compact manner.

The base flange, the point of heat concentration, is soldered with 60/40 solder to the heat-sink bracket. This is an acceptable technique with this silicon transistor since the vendor bakes the

transistor at 300 C. Induction heating is preferred because of better heat control, but hand soldering can give satisfactory results.

To minimize the heat insulation by the dielectric, the heat-sink bracket should have the largest possible contact area to the amplifier base and should be bonded with epoxy resin with aluminum oxide filler.

Aluminum oxide crystal, a good dielectric, is a reasonably good thermal conductor and can be procured in uniform grain size to insure the desired spacing between bracket and base. Other dielectrics, such as adhesive polyester film, sheet mica, and fiber-glass impregnated with various materials, are ruled out for this application because of poor adhesive qualities, or poor or inconsistent thermal and dielectric properties.

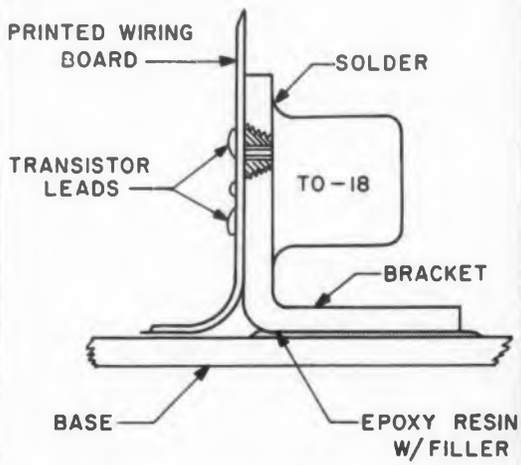


Fig. 2. Oxide-filled epoxy carries off transistor heat.

Oil-Filled Can Allows Factory Repair

The complete amplifier is hermetically sealed and filled with high viscosity silicon oil. Since epoxy has a much higher thermal-conduction coefficient and lower coefficient of expansion, it may seem surprising to find silicon oil in this application. The one overshadowing advantage of the oil is factory repairability.

In this application the primary function of the oil is to support and protect the components which it has done successfully through 10 g's of vibration and 15 g's of shock. The amplifier has also been temperature-cycled from −65 C to +125 C. An air bubble in the can is sufficient to provide for thermal expansion.

Roy Malarik, Packaging Designer, Instrument Div., Lear, Inc., Grand Rapids, Mich.

Radiation Resistance of a Loop Antenna

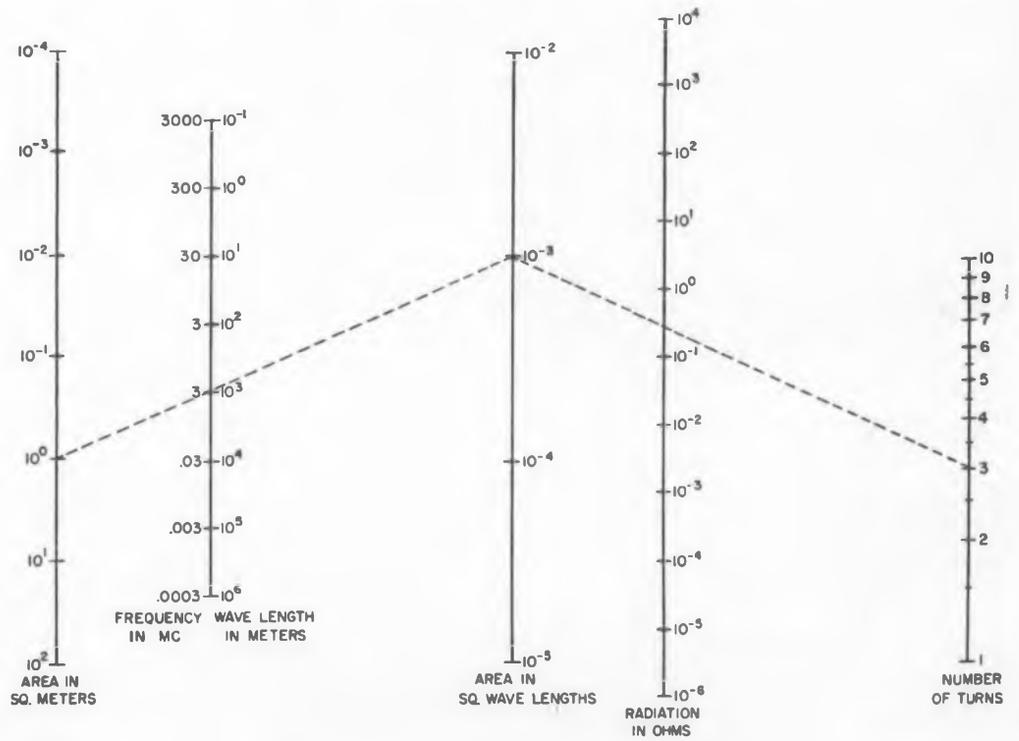
D. N. Travers
Senior Research Engineer
Southwest Research Institute

IN THE DESIGN of loop antenna systems, particularly in direction-finding applications, it is often necessary to determine whether the radiation resistance of the loop lies above or below a certain limit. With the aid of the accompanying nomogram, radiation resistance can be determined rapidly from knowledge of loop area, frequency and number of turns.

Here is an example: determine the radiation resistance of a loop of one square meter, having three turns, at a frequency of 300 kc.

A line drawn between the area and frequency points intersects the area in square wave lengths axis at 10^{-3}. A line drawn between this point and the point corresponding to three turns intersects the radiation resistance axis at approximately one-third ohm.

The results are accurate within the limits given on the nomograph. The results are accurate within the limits given. ■ ■



NEW LITERATURE

Epoxy Resins 260

This four-page bulletin is a selection chart for epoxy resins. Data on paste, impregnating, casting and molding, and potting epoxies are given in table form. Consistency, reactor, filler, properties, and suggested applications are given. John C. Dolph Co., Monmouth Junction, N.J.

Relay Manual 261

This relay manual describes 30 types of relays, with 1000 variations, for communications, computers, industry and the military. Using photographs, line drawings, tables and descriptive material, the manual presents detailed data on pile-up relay types, variation in spring arrangement, timing, coil voltage, contact ratings and other specifications. Cook Electric Co., Diaphlex Div., 2700 Southport Ave., Chicago 14, Ill.

DC-DC Converters 262

This illustrated report, 14 pages, is called "Designing DC-DC Converters." The introductory section presents data on converter design factors, including transistor selection and characteristics of magnetic cores. The second half contains step-by-step design data on two theoretical case histories. Magnetics, Inc., Butler, Pa.

Name Plates 263

This four-page, two-color brochure, entitled "The Fotocoil System," contains data on the various types of name plates and other etched metal parts which can be made by the company. Miller Dial & Name Plate Co., 4400 N. Temple City Blvd., El Monte, Calif.

DC Solenoids 264

Three models of dc solenoids are described in this four-page bulletin, No. 505-A. Mounting dimensions are given in outline drawings, and a characteristic curve depicts holding power and pull graphically. Included are descriptions on remote solenoid controls. Synchro-Start Products Inc., 8151 N. Ridgeway Ave., Skokie, Ill.

Couplings 265

This 47-page engineering catalog, No. 60, includes a description and listing of couplings for use on servo-mechanisms, computers, missiles, and other small devices. Outline drawings, bore sizes, and torque capacities are given. Thomas Flexible Coupling Co., Warren, Pa.

RF Power and VSWR Instruments 266

Catalog No. 12 contains over 60 pages describing rf power and vswr instruments, absorption-type rf wattmeters, calorimetric rf wattmeters, rf load resistors, station guardians and accessories. The illustrated catalog also contains specification tables, outline drawings and photographs of the measuring equipment. M. C. Jones Electronics Co., Inc., 185 N. Main St., Bristol, Conn.

Waveguide Filters 267

Complete design, development, production and testing services for waveguide filters are outlined in this four-page brochure. Various types of filters are pictured and described. Also included is an outline of electrical and mechanical specifications to be submitted with quotation requests. Waveline, Inc., Caldwell, N.J.

Laminates 268

Two engineering bulletins, one page each, describe grades ARF-HT and G3-HT high temperature phenolic laminated plastics. The sheet properties for each laminate are listed. Synthane Corp., Oaks, Pa.

Electroluminescent Display 269

This illustrated booklet, 46 pages, explains how the principle of electroluminescent lighting has led to the development of dynamic solid-state panel displays. It contains material on information conversion, storage or memory devices, and logic systems. The booklet also contains diagrams of multi-symbol displays designed for use in data processing, computer read-out devices, stock quotation boards, and other applications. Sylvania Electric Products Inc., 1100 Main St., Buffalo, N.Y.

Chopper Stabilization 270

Bulletin No. 375 explains the optional chopper stabilization feature of the company's programmable power supplies. Included are detailed stability and regulation specifications along with a list of models available with the chopper stabilized option. Electronic Measurements Co., Inc., Eatontown, N.J.

Tools Catalog 271

This 48-page catalog illustrates and describes 88 tools including chrome steel tapes, master vernier height gages and calipers, micrometer calipers, inside micrometers, protractors, dividers, trammels, and dial bore gages. L. S. Starrett Co., Athol, Mass.

NEW LITERATURE

Technical Digests From Europe

The *European Technical Digests* provide engineers with English translations of articles chosen from over 1000 technical journals appearing in 13 countries and in 11 different languages. Although the publication deals principally with engineering and equipment, much importance is placed on subjects of general interest, such as corrosion, materials handling, and packaging. As a free service to readers, photocopies of the original articles are supplied on request whenever possible. Price of a yearly subscription is $12; six-month subscription, $6. *European Technical Digests, Specialized Information Section, Dept. ED, E.P.A. 3, rue Andre-Pascal, Paris 16, France.*

Receiving Systems 272

This eight-page brochure describes the capabilities and facilities of the company and the range of products developed, including ultra-sensitive receiving systems and equipments in the fields of communications, telemetry, guidance and control, and navigation, LEL, Inc., 380 Oak St., Copiague, L.I., N.Y.

Self-Generating Accelerometers 273

Bulletin No. 9503 lists prices and specifications of self-generating accelerometers. These units have high first-resonance, internal-capacity, sensitivity for a given size and weight, and stable high-temperature operation. The bulletin also includes a dimensional outline-drawing, sizes of standard 5-, 10- and 20-mv g units, and optional mounting and connector specifications. Clevite Electronic Components, division of Clevite Corp., 3405 Perkins Ave., Cleveland 14, Ohio.

Data Processing 274

Model ZA-100 computer language translator is described in this 16-page application information manual. Common translation modes described through block diagrams include: magnetic tape to magnetic tape; IBM punched cards to magnetic tape; magnetic tape to IBM punched cards; magnetic tape to line printer; and on-line analog input to magnetic tape. An illustrated appendix outlines these systems now in operation in various parts of the U.S. Electronic Engineering Co. of Calif., Technical Literature Section, 1601 E. Chestnut Ave., Santa Ana, Calif.

Name Plates 275

Bulletin No. 900 describes and illustrates a complete line of name plates. Included are data on stock metal name plates, engraved bakelite name plates, and made-to-order name plates. The four-page bulletin contains wordings available and price listings. Seton Name Plate Co., 431 W. Rock Ave., New Haven 15, Conn.

Cases and Housings 276

This 14-page catalog contains sample vellums detailing standard constructions for combination, transit, storage and 19-in. rack equipment cases. Listed in the catalog are available sizes, shapes and metals as well as construction details. Mil specifications are included, where applicable. MM Enclosures, Inc., 111 Bloomingdale Road, Hicksville, L.I., N.Y.

Swageable Thermocouple Tubing 277

High-temperature swageable thermocouple tubing is described in this two-page data sheet. Included are data on standard sizes and tolerances of single and multibore tubing. Free samples are available if requested on company letterhead. Saxonburg Ceramics, Inc., Saxonburg, Pa.

Rotary Switches 278

This four-page catalog illustrates and describes the Type 212 long-life, non-drift, rotary switch. Included are dimensional drawings and a page of standard stock assembly layouts for the instrument and radio switch series. Trolex Corp., Subsidiary of Chicago Telephone Supply Corp., McHenry, Ill.

Motors and Relays 279

Typical specifications on a complete line of ac and dc fractional horsepower motors, tachometer generators and ultra-sensitive relays appear in this four-page folder. Rated horsepower, dimensions, characteristics and typical applications are listed. Reference file No. F-9765 also includes range and style data. Barber-Colman Co., Rockford, Ill.

Fasteners 280

Complete specifications and application information on Banc-Lok self-locking inserts and tapped holes are presented in this eight-page catalog. Cross-section drawings show application advantages in plastics, sheet metal, and composition materials. Charts detail thread and hole sizes, and grip lengths. Boots Corp., Newtown Turnpike, Norwalk, Conn.

NEW LITERATURE

Microphones 281

Individual problems, case histories, new ideas, and developments are discussed in the newsletter, "Microphone Facts." Electro-Voice, Inc., Buchanan, Mich.

Transistors 282

The 2N1177, 2N1178, 2N1179, and 2N1180 drift-field transistors are described in this eight-page bulletin. Included are diagrams and graphs showing collector and performance characteristics. It also gives the electrical and mechanical general data. These transistors are specifically designed for fm and am/fm radio receivers and tuners. Radio Corp. of America, Somerville, N.J.

Control Chasis 283

Bulletin 100-A gives the general description and operation of the K-100 series control chassis. Photographs and block diagrams are included in this two-page bulletin. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Flexible Insulators 284

This full-color data sheet gives complete information on the spectrum of colors available in flexible insulators for Mueller Clips. The illustrated sheet, No. 232, includes ordering data in table form. Mueller Electric Co., 1580H E. 31st St., Cleveland 14, Ohio.

Magnetohydrodynamics 285

This four-page brochure outlines the work done in magnetohydrodynamics—extracting electric power directly from ionized gas as it passes through a magnetic field. It gives the description, operation, motivating power, advantages, and significance of this new field of power generation. Included are photographs and drawings. General Electric Co., 3198 Chestnut St., Philadelphia 4, Pa.

Elements 286

This periodic table of elements is designed for use in laboratories. The table includes all elements and numbers of naturally occurring radioactive and stable isotopes. Also shown are atomic numbers in large type, weight, density, boiling and melting points, electronic configuration, half-life, and other atomic constants for physics and chemistry. Central Scientific Co., 1700 Irving Park Road, Chicago, Ill.

Sound Systems 287

Industrial sound systems are compared in this folder. A chart shows typical sound systems used in industry. The chart depicts all facilities at a glance. DuKane Corp., St. Charles, Ill.

Wire Alloy 288

Detailed technical data on Chromel-R, a modified 80-20 type nickel chromium 800-ohm alloy, appears in this 8-page bulletin. Included are performance curves, a table of physical properties, and specifications tables listing ohms per foot, feet per pound, and ohms per pound for both bare and enameled wire. Hoskins Manufacturing Co., 4445 Lawton Ave., Detroit 2, Mich.

Printed Circuits

This copy of the Proceedings of the Institute of Printed Circuits Symposium is entitled "Financial Aspects of Producing and Buying Printed Circuits." Topics discussed include: Cost vs. Tolerances; Cost vs. Quality; Cost vs. Complexity; and Cost vs. Quantity. The Proceedings also includes a special instruction sheet for completing a "Make or Buy" analysis. *Send $5 to the Institute of Printed Circuits, Dept. ED, 27 E. Monroe St., Chicago 3, Ill.*

Transistor Applications 289

One of these two booklets contains an index of available application lab reports pertaining to transistor circuit applications. The other is a guide to transistor applications. It includes tables, charts and graphs. Philco Corp., Lansdale Div., Lansdale, Pa.

Cathode Ray Tubes 290

A chart of the mechanical and electrical characteristics of 165 different industrial and military tube types covers three pages of this six-page brochure. It is conveniently designed for use as a wall chart. Typical operating conditions of the magnetic- and electrostatic-deflection types, overall length, type faceplate, basing deflection angle and deflection factor are included. Thomas Electronics, Inc., 118 Ninth St., Passaic, N.J.

Metalized Ceramic Components 291

Bulletin M-100, a one-page, two-color data sheet, describes metalized ceramic glass and mica components in preparing an electronic insulator for permanent bonding to metal. This process hermetically seals the assembly. The bulletin also lists specifications on types of metalized coatings and the available ceramic base materials. Metalizing Industries, Inc., 338 Hudson St., Hackensack, N.J.

NEW LITERATURE

Automatic Wave Analysis 292

This 16-page bulletin, No. DB 9050a, describes and illustrates automatic wave analysis, an engineering tool for Fourier and spectral power studies. Frequencies and amplitudes of vibration, flutter, noise, and other types of complex waves are automatically charted by the analyzer systems. Records can be of linear or squared amplitudes, or on a frequency vs. time basis. The bulletin shows the relation of the magnetic tape recorder, playback loop transport, and wave analyzer. Charts and specifications are included. Minneapolis-Honeywell Regulator Co., Industrial Systems Div., 10721 Hanna St., Beltsville, Md.

Generators 293

Bulletin No. 147 describes various generators ranging in complexity from command modulators to audio tone generators. The command modulators consist of audio modulated pulses or pulses of audio frequencies or combinations of both. Descriptions of gated oscillators and tone generators, completely solid state and intended for airborne or ground equipment, are included. Alto Scientific Co., 855 Commercial St., Palo Alto, Calif.

Fasteners 294

This 24-page catalog describes the company's complete line of fasteners. It includes discussion of a variety of tension and featherweight fasteners, self-broaching fasteners, self-sizing fasteners, pull-thru blind rivets, friction-lock self-plugging blind rivets, and lock spindle self-plugging blind rivets. Driving cycles, strength data, typical applications, grip ranges, dimensional data, hole size recommendations, and installation notes are included for each fastener. Huck Manufacturing Co., 2480 Bellevue Ave., Detroit 7, Mich.

Wiring Devices and Fuses 295

This specifications list details the firm's wiring devices and fuses complying with federal and REA specifications. The four-page list contains 538 catalog numbers over a range of nine categories. Complete headings, with descriptions of style and type numbers are included. Eagle Electric Manufacturing Co., Inc., 23-10 Bridge Plaza S., Long Island City 1, N.Y.

Induction Heating Equipment 296

Standard induction heating units such as motor generator sets, control stations, and fixed installation, as well as portable heating stations, are described and illustrated in this four-page folder. Company technical services including problem analysis, research, design engineering, and manufacture of custom end product, are also explained. Robotron Corp., 21300 W. Eight Mile Road, Detroit 19, Mich.

General Purpose Relay 297

Specifications and outline drawings of the series No. 10 and 20 general purpose relay are now available from the firm. The relay is a multiple arm, 16-spring device, and comes in a variety of contact arrangements. It can be supplied in open or hermetically sealed enclosures. Wheelock Signals, Inc., Long Branch, N.J.

Subminiature Capacitors 298

This engineering bulletin, No. 2110, describes the Vitamin Q and stabilized wax subminiature metal-clad paper capacitors. In addition to performance characteristics, there are outline drawings illustrating various case styles, and typical tab terminal dimensions. Characteristics curves for both types of components, and a nomograph for determining ac ratings are included in the bulletin. Sprague Electric Co., N. Adams, Mass.

Plastics Guide and Catalog 299

This 56 page 1960 plastics catalog and price list gives complete information on grades, sizes, and tolerances of the firm's stocks of plastic sheet, rod, tubing, and other forms. Among the products listed are: plexiglas, phenolic, rigid and flexible vinyl, teflon, kel-f, fiberglas, delrin and micarta laminates, as well as plastic cements, cleaners, and polishing compounds. Also included in the catalog are tables of properties of the more widely used plastics. Almac Plastics, Inc., 600 Broadway, New York 12, N.Y.

Core Memories 300

This four-page bulletin, No. DF 115.1, describes the type RB general purpose core memories. In addition to a block diagram, the brochure contains complete specifications, and loading and unloading operation data. Telemeter Magnetics, Inc., Box 329, Culver City, Calif.

Microwave Mixer Diode Makes Sensitive, Broadband Video Detector

A BROADBAND video detector of superior performance was devised, using a 1N53B microwave diode. The tests performed on this coaxial crystal verified that sensitivity in excess of —40 dbm were obtainable over the entire 20-40-kmc bandwidth, and probably well beyond. A video bandwidth of at least dc to 8 mc was also verified.

The 1N53 is a miniature point-contact coaxial microwave crystal diode designed for mixer applications at a design frequency of 34860 mc. The "B" version provides an rf bandwidth capability (for mixer applications) of about 12 per cent. This diode has also been used as a harmonic generator in the millimeter wavelength region. The cartridge construction relationship is designed to provide an input characteristic impedance of 65 ohms. Its popularity in these applications, because of cost and construction factors, makes it a very promising detector device.

Test results of video sensitivity for eight 1N53B diodes, expressed in terms of db below 1 mw for a video amplifier bandpass of dc to 8mc were tabulated. The sensitivites are in excess of —40 dbm in all cases, ranging from —40.3 to —48.5. For such a broad rf bandwidth, these results compare favorably to advertised sensitivities of video diodes that operate in this frequency range. The 1N446 diode, for example, is specified by the crystal manufacturer as a video diode for the 26.5 kmc to 40 kmc range with a minimum sensitivity of —40 dbm.

The test results reported here do not indicate that the upper and lower rf frequency performance limits of the 1N53B as a video detector have been defined. The response at both frequency extremes indicates that this diode is still displaying good response. Hence, the rf bandwidth capability of the 1N53B diode is greater than reported in this paper.

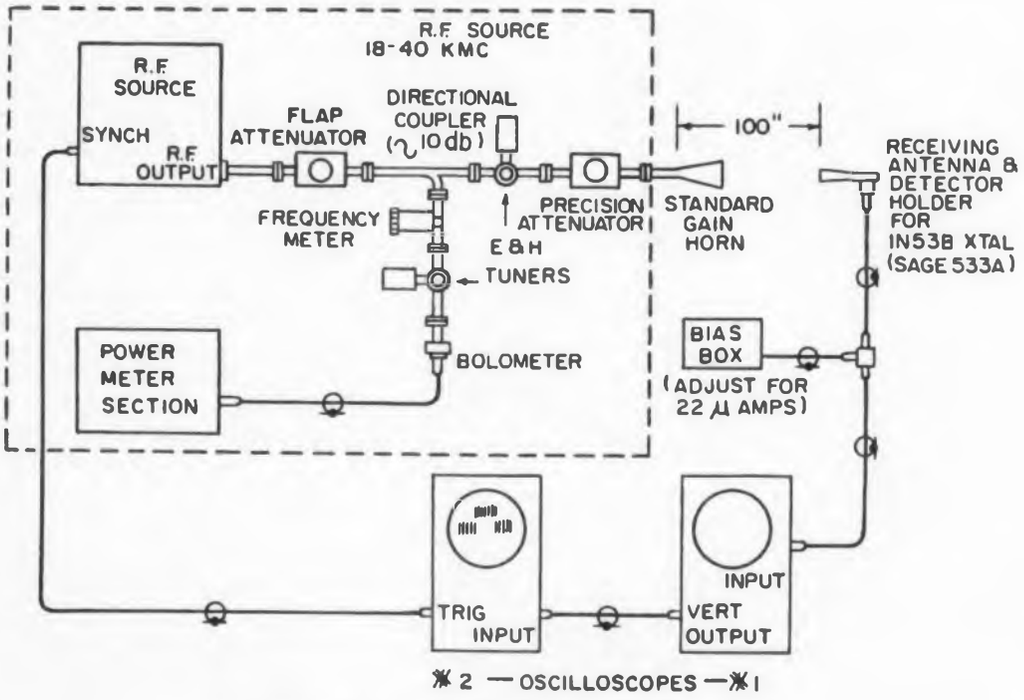


Fig. 1. Test set-up verified bandwidth and detection sensitivity of microwave crystal.

Performance Verified in Custom-Designed Test Set-Up

Fig. 1 is a schematic diagram of the test setup used to verify the crystal's detector capability. Since a single commercial waveguide crystal holder, as such, did not exist that would accept the cartridge construction of the 1N53B for the entire 20-kmc—40-kmc frequency spectrum, a broadband horn antenna and detector holder assembly was chosen. This unit, a Sage Laboratories Type 533A, provided the necessary crystal holder probe to accomplish the transformation of the waveguide impedance to a coaxial line impedance of 65 ohms to "match" the crystal. No tuning of this unit is necessary to cover the frequency band.

Separate tests were conducted on this unit to determine its effective aperture in order that power density level measurements obtained at the aperture plane of the antenna could be directly related to diode sensitivities. The effective aperture was determined to be on the order of 0.62 cm^2. A photograph of this unit is shown in Fig. 2.

An anechoic chamber, suitably lined with rf absorbing material, was selected as the test site. The rf signal generator used was custom-designed, capable of an rf output of at least 1 mw in the 18-kmc—40-kmc frequency spectrum. This unit also contained, as an integrated assembly, the waveguide plumbing, precision and flap attenuators, directional couplers, frequency meters, and a power monitoring bridge. This integrated assembly permits a known rf output power to be set up at the selected frequency. Standard horn type antennas, with 0.85-cm and 1.25-cm optimum[1] gain were used. These were fabricated in accordance with NRL design data.[2] The horns have known gains with accuracies of about ±0.5 db. The transmitting and receiving antennas were boresighted in the test set-up alignment.

1. An optimum horn has aperture dimensions chosen to give maximum gain when the slant height is held fixed.
2. "Design and Calibration of Microwave Gain Standards," by W. T. Slayton, NRL Report No. 4433, November 1954.

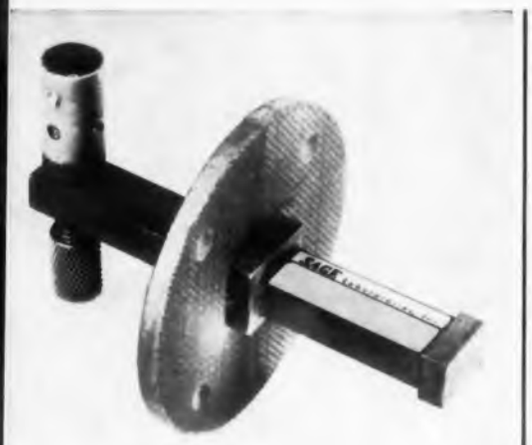


Fig. 2. Detector holder used as basis for receiver horn.

Measurement Techniques

The sensitvity measurements were performed with 22 μa of forward dc bias applied to the diode. During the tests, it was noted that bias appeared to have an adverse effect on some of the diodes. On those diodes affected, a significant increase in the signal-to-noise ratio was observed with a resulting loss of diode sensitivity of about 2 or 3 db.

A transmitting test distance of 100 in. was used for all measurements. This distance was determined to be outside the Fresnel Zone as defined by the following equation:

$$Fresnel\ Zone = \frac{2A^2}{\lambda}$$

Where:

A = longest lines dimension of the largest antenna used.
λ = free space wavelength.

The 100-in. distance was measured from the throat[3] of the optimum gain transmitting horn to the aperture plane of the Sage 533A receiving antenna.

The "Tangential Signal" was used[4] as the measurement level criteria, since tangential signal measurements may be repeated by various operators within ±1 db. The power density level that produced a tangential signal presentation on oscillo-

3. The "throat" is readily determined for an optimum gain horn and is at the position where the horn flares into the waveguide section.
4. The "Minimum Detectable Signal" level exists when the presence of the signal can just be detected in the noise level. This measurement level is subject to large variations in obtained results when performed by different operators due to the difficulty of determining the signal presence when its location along the oscilloscope trace is not known.

IDEAS FOR DESIGN

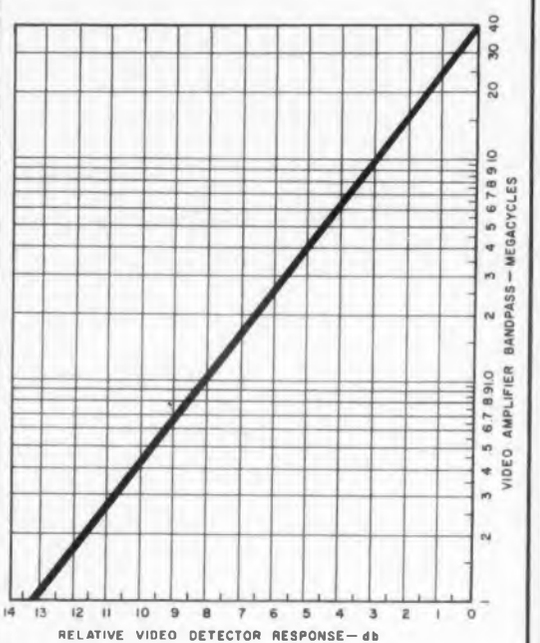


Fig. 3. Chart for converting sensitivity obtained in test to results to be expected for other amplifier bandpasses.

scope 2 (see Fig. 1) was determined at the aperture plane of the receiving antenna by the following formula:

$$Pd = \frac{Pt \cdot Gt}{4 - d^2}$$

Where:

Pd = power density level in mw/cm².
Gt = numerical gain of the transmitting antenna.
Pt = power transmitted in mw.
d = distance between throat of the transmitting antenna and the aperture plane of the receiving antenna in cm.

The diode sensitivity was determined by multiplying the power density level (in mw/cm²) by the effective aperture of the Sage 533A unit (0.62 cm²) to give sensitivity in milliwatts. This sensitivity is more usually expressed in db below 1 mw. In reporting video diode measurements it is necessary to define the bandpass of the video amplifier used. This will permit others to determine the sensitivity that may be expected of the diode in their particular systems. The curve shown in Fig. 3 is a plot of relative video diode response versus amplifier bandpass and may be used to convert sensitivities reported in this paper to expected sensitivities at any other amplifier bandpass. The amplifiers employed in these tests were Tektronix

oscilloscope types with a measured bandpass of dc-8 mc.

Sources of Error

The possible sources of error in the measurements reported are as follows:

Source	Possible Error
operator—in reading a tangential signal level.	±1.0 db.
directional coupler	±0.5 db.
precision attenuator	±0.5 db.
power bridge	±0.5 db.
standard gain horn	±0.5 db.
	Total ±3.0 db.

R. L. Thomas, Design Engineer, Reseda, Calif.

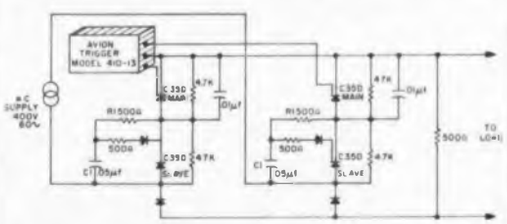
Triggering of Controlled Rectifier Fires Its Series Mate

A power supply circuit required two series pairs of silicon-controlled rectifiers.

The circuit had to be simple and yet insure accurate voltage sharing over the entire control range, without the necessity for trimming.

The circuit shown, designed for a 350 vdc-16 amp power supply, met these requirements very simply and easily. It provides very nearly equal division of voltages before firing and in all other respects behaves like the usual bridge circuit.

An Avion 410-13 trigger drives the two main control rectifiers exactly as in a conventional circuit. The "slaved" rectifier, that is, the one in series with the main devices, receives a firing pulse from the high-pass filter C_1 and R_1. This pulse is generated whenever a main rectifier fires, since as this *CR* drops voltage the slave *CR* gains voltage. This voltage change causes a charging current to flow in the 0.05 μf capacitor in a direction to fire slave. This *CR* fires almost simultaneously with the main *CR*. In fact, it is not possible to tell from any measurments at the load that this circuit is using two *CR*'s in series. The diode in series with the gate blocks a reverse polarity pulse which would otherwise appear at the gate when the other half of the bridge fires.



The "main" controlled rectifier is fired by the trigger, a pulse is passed on to its series "slave," and it also fires.

David W. Rodgers, Commercial Products Dept., Avion Div., ACF Industries Inc., Paramus N.J.

IDEAS FOR DESIGN

Biased Emitter Follower Limits Pulse Amplitude

In transistor pulse circuits, pulse amplitude limiting is usually obtained with biased clipping diodes. However, this can also be done by applying the desired limiting voltage to the collector of an emitter follower. This method is very convenient, since an emitter follower stage is often included in a complete transistorized pulse circuit design.

A conventional emitter follower is shown in Fig. 1. The collector voltage is usually the same

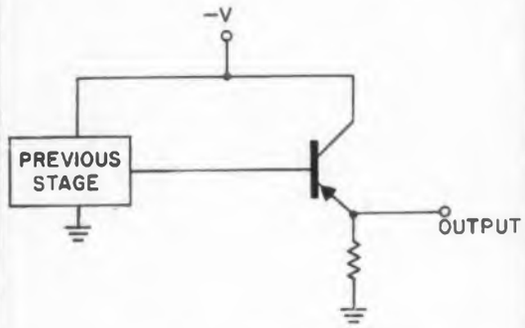


Fig. 1. Conventional emitter follower.

as that supplied to the previous stages. The input voltage swing is always less than, and the output voltage swing can never be greater than, the collector voltage. Therefore, to clip or limit the output pulses at a desired level, it is only necessary to reduce the collector voltage accordingly. This is shown in Fig. 2.

For laboratory work, a potentiometer can be used to set the desired limiting voltage value. Once the optimum resistance ratio is determined, two fixed series resistors can be used as the voltage divider. The output pulse level will be approximately equal to the collector bias voltage. Thus, pulse amplitude limiting is obtained by

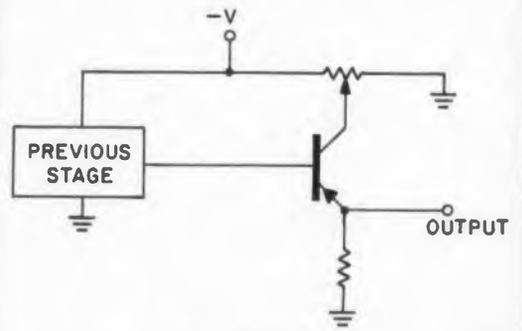


Fig. 2. Pulse amplitude limiting is obtained by applying the desired limit voltage to emitter follower collector.

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William B. Turner, Senior Engineer, Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., Long Island, N. Y.

Clamping Diodes Safeguard Variable Light Intensity Control

The idea for a variable light-intensity control, Fig. 1, (ELECTRONIC DESIGN, Dec. 9, 1959 p 159) has considerable application. However, one circuit error could cause damage to the 2N123 transistor, due to excessive voltage from collector to base in the off condition (—36 v).

The addition of diodes *D1* and *D2*, Fig. 2, clamp the base and collector voltages of the 2N123, preventing the occurrence of over-voltage. The circuit operation is not altered by these additional components.

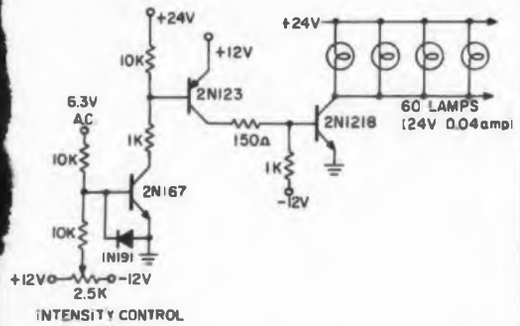


Fig. 1. Light intensity control circuit based on variable duty cycle as published in *ELECTRONIC DESIGN*, Dec. 9, 1959, p 159.

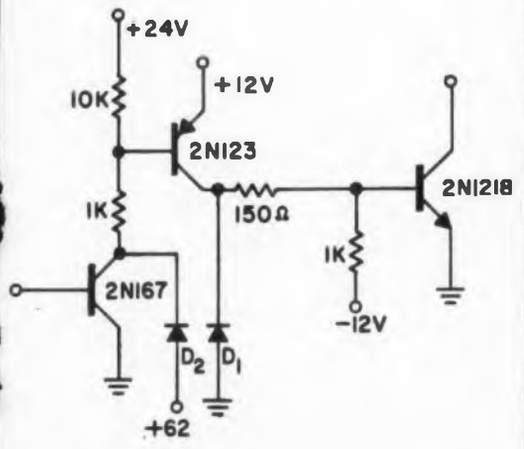


Fig. 2. The 2N123 transistor of Fig. 1 is safeguarded by adding clamp diodes *D1* and *D2*.

Roy P. Foerster, Engineer, The Martin Co., Baltimore 3, Md.

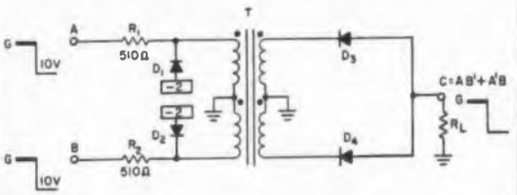
IDEAS FOR DESIGN

Pulse Transformer Helps Provide Two-Input, Exclusive-Or Logic

A high-speed, two-input, Exclusive-Or gate was needed which would work with pulse widths of about 0.2 μsec, and give good rise and fall times. It had to be a reliable, small and simple system.

The circuit shown, using a tiny pulse transformer, performs the Exclusive-Or logic usually indicated by: $AB' + A'B$. With negative pulses at either A or B (the other terminal at ground) there will be a negative pulse at output C. If there are negative pulses at A and B simultaneously, there will be no output at C because of the flux cancellation between the two input windings.

Diodes D_1 and D_2 clamp the input pulses to the same level. This insures good flux cancellation when both inputs are present.



DIODES $D_1 - D_4$ = GERMANIUM HI-SPEED
T = PULSE TRANSFORMER ! ! ! !

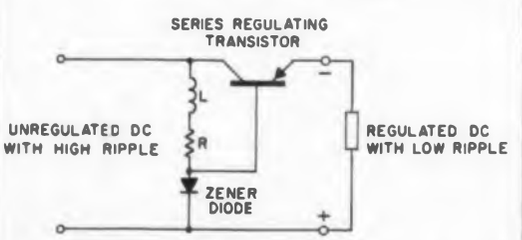
The circuit performs the Exclusive-Or logic of $AB' + A'B$.

Jack Shirman, Supervisory Engineer, Stromberg-Carlson, Rochester, N.Y.

Choke-Zener Duo Reduces Regulator Ripple

We wanted to reduce the ripple voltage in a simple, emitter follower voltage regulator, without using bulky capacitors or heavy line chokes.

We did it by placing a small choke in series with the resistor R. The ripple voltage across the Zener diode is then attenuated by a factor $\frac{R_z}{\omega L + R + R_z}$, where R_z is the dynamic resistance of the Zener and ωL is the impedance of the choke. The regulated output voltage follows the



A choke-Zener diode combination reduces the output ripple in this emitter follower voltage regulator.

Zener diode voltage, resulting in a very low output ripple.

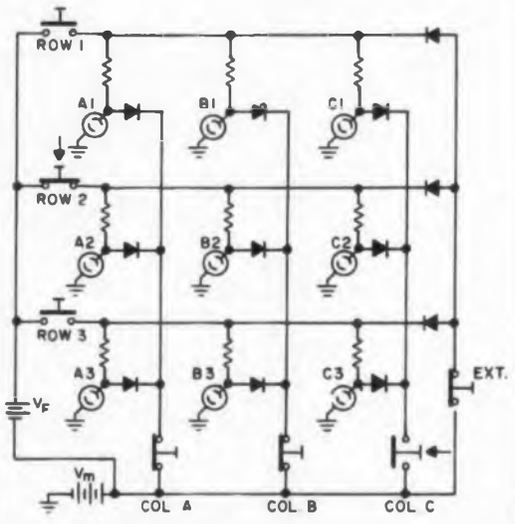
Note that the resistance of the choke becomes part of resistor R_1 and that the choke carries only a fraction of the load current.

Matthew E. A. Hermans, Project Engineer, The Western Union Telegraph Co., New York, N. Y.

Neon Lamp Matrix Stores Information Visually

The neon lamp matrix shown is a memory device for storing informatiion visually. Any number of lamps can be selected simply by pushing the appropriate row and column pushbuttons. The lamps are extinguished by operating the *EXT* pushbutton. The selection method lends itself very readily to automatic operation by relay contacts, stepping relays, and saturated transistors. Also, the matrix can have a wide range of rows and columns.

The maintenance voltage V_m is large enough to keep an ignited neon lamp on, but is too low to fire it alone. The series addition of V_f is sufficient for firing. A particular lamp is turned on by pressing the corresponding row and column pushbuttons, as shown for lamp C_2. This connects V_f to the resistors of lamps *A2*, *B2* and *C2*. Lamps *A2* and *B2* do not trigger because they are shunted through their diodes to V_m. *C2* is shunted to an open circuit, so it triggers. When the pushbuttons are released, *C2* remains on, supplied by V_m through the *EXT* pushbutton and the series diode.



NEON LAMP MATRIX

Row and column pushbuttons select desired neon lamp in visual storage device.

A. Hemel, Project Engineer, Applied Research Dept., Motorola Inc., Chicago, Ill.

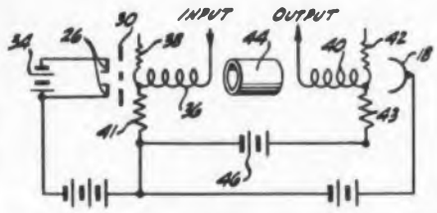
PATENTS

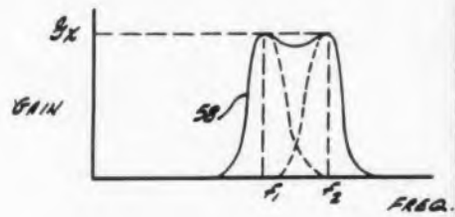
Benjamin Bernstein

Broad-Band Backward-Wave Amplifier

Patent No. 2,911,558. M. R. Curie. (Assigned to Hughes Aircraft Co.)

Backward-wave amplifiers usually have small bandwidths. For a given electron-beam velocity there is only a narrow band of frequencies in the traveling wave which can be amplified. Formerly two stagger-tuned helices were used to increase the bandwidth. Unfortunately, this also reduced the gain. The invention lies in splitting the cathode in half and operating the sections at different voltages. With stagger tuning, discrete frequency amplification bands are produced, giving a much greater operating gain-bandwidth product.





In the schematic, cathode *26* is split and the sections are biased by battery *34* to produce two separate electron streams. The input and output helices are isolated by drift tube 44 to permit stagger tuning. The dispersive characteristic of the two beams result in the composite broadband characteristic *58*. The cathode can be split into four sections or more, since backward-wave amplifiers essentially are low current devices.

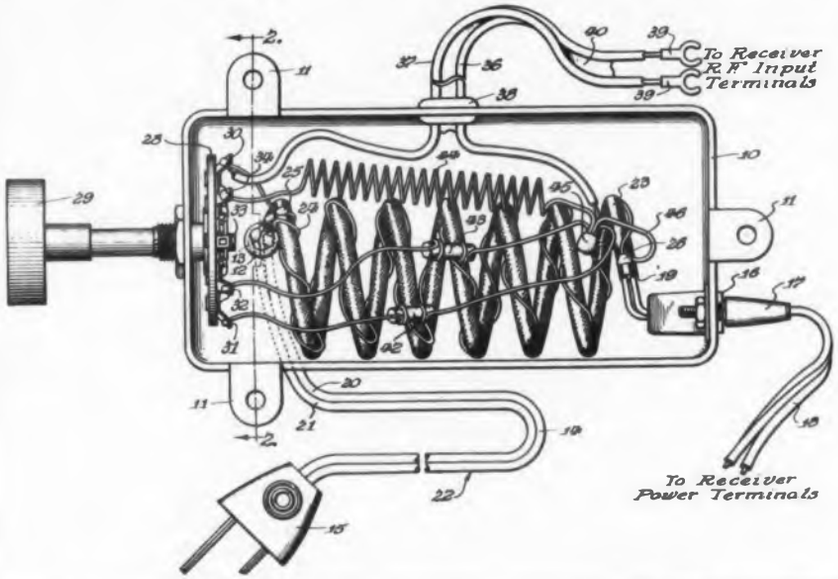
Line Cord Antenna

Patent No. 2,915,627. J. C. Spindler. (Assigned to Zenith Radio Corp.)

An economical, simple and electrically

safe indoor antenna is made from a section of power line cord. It is adaptable to TV receivers having a 300-ohm balanced antenna input.

Bifilar cord *19* is covered by an ordinary wire shield, *23*, and coiled within housing *10*. Interwound wire *24* holds the coil rigid. The coil diameter is about one inch, and is made from a line cord section 22-1/2 in. long, effectively about 3/8 wavelength in the vhf television band. Some compensation is obtained by switching in capacitor *42*, capacitor *43* or choke *44*. The receiver rf terminals are brought to wires *39*, which are connected to the ends of the stranded wire braid *23*.



BOOKS

Symposium on Basic Research

Dael Wolfle, Editor, American Association For The Advancement Of Science, 1515 Massachusetts Ave., N.W., Washington 5, D. C., 308 pp, $3.00.

Collected here are the papers presented at the Basic Research Symposium held in New York City in May, 1959. Discussed was the kind and amount of support society ought to give the scientists engaged in basic and applied research. Sponsored by The National Academy of Sciences, The American Association for the Advancement of Science, and The Alfred P. Sloan Foundation, the Symposium also dealt with the role of government, industry and the private institution in supporting research activities. In summarizing their discussion, the scientists emphasized that any proper program of basic research in science must include support for creative scholarship in the humanities, in the fine arts, and in the "whole range of man's intellectual life".

Among the authors of papers in this volume are Dwight D. Eisenhower, J. Robert Oppenheimer, James R. Killian, Jr. and James B. Fiske.

Value Engineering 1959

Proceedings of the EIA Conference on Value Engineering, Engineering Publishers, P. O. Box 2, Elizabeth, N.J., 165 pp, $6.00.

The complete versions of all of the technical papers presented at the Electronic Industries Association Conference

on Value Engineering are contained in this text. Held at the University of Pennsylvania, October 6 and 7, 1959, it was the first comprehensive industry conference on this subject. The papers cover basic concepts and philosophies, techniques, applications, and relationships with other work areas. Customer, manufacturer, and vendor viewpoints are represented.

Value Engineering, or Value Analysis as it is frequently called, is a new engineering specialty seen to pay large dividends to both supplier and customer. Originating in naval shipyards several years ago, its success attracted wide attention. Several important electronic equipment manufacturers, among others, adopted its principles with very encouraging results.

Electrical Circuits, Signals, And Systems

Samuel J. Mason and Henry J. Zimmermann, John Wiley & Sons, Inc., 440 Park Ave. S., New York 16, N. Y., 616 pp, $12.50.

Based upon an understanding of elementary electric circuit theory, this text presents matrix, topological, and signal flow methods for circuit and system analysis. In each case the formulation and solution of electronic circuit problems is stressed, but the methods are applicable to many other fields.

The treatment of signals is based on the correlation function, the Fourier integral, and the Fourier series. Pulse, periodic, almost-periodic and random signals are analyzed and synthesized. Amplifier circuits are used to illustrate the transmission of signals through linear systems, with transform techniques and convolution providing the basic mathematical tools. These tools are also applied to nonlinear and time-varying linear systems. The negative-feedback concept is introduced and its implications are illustrated by a number of examples.

This book is one of several resulting from a recent revision of the Electrical Engineering Course at The Massachusetts Institute of Technology. Although designed for an undergraduate curriculum, it covers material which many colleges offer on a post-graduate level.

RUSSIAN TRANSLATIONS

J. George Adashko

Mutual Inductance Elements Lead to Fewer Filter Circuit Components

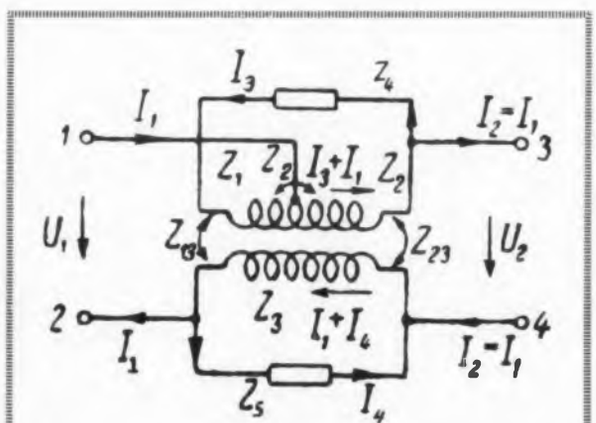


Fig. 1. An equivalent circuit, without mutual inductance elements, can be found from this circuit's mesh equations.

FILTER CIRCUIT designers will recognize that there are several filter configurations which appear fairly frequently in their designs. If two-port networks with mutual inductances are used in these filters, the required number of filter elements can usually be reduced. The attenuation characteristic of the mutual inductance filter will be the same as the one it replaces.

Several common filters without mutual inductance elements are presented here, together with their mutual inductance equivalents. In working out the design equations for the "mutual" filters, a "work backwards" approach is used. That is, we start with a mutual filter and from its princi-

al network equations the equivalent "non-utual" filter is deduced. Working in this way, a ble was obtained of mutual and non-mutual quivalents.

etermining The Mutual-Non-Mutual Filter quivalents

We will illustrate our approach with the mutual ductance circuit of Fig. 1. Using the symbols dicated in the figure and assuming equal cou-ling coefficients between the windings, the mesh quations are:

$$V_1 = I_1(Z_2 + Z_3 + 2Z_{23}) + I_3(Z_2 + Z_{12} + Z_{13} + Z_{23}) + I_4(Z_3 + Z_{23}) + U_2 \quad (1)$$

$$0 = I_1(Z_2 + Z_{12} + Z_{13} + Z_{23}) + I_3(Z_1 + Z_2 + 2Z_{12} + Z_4) + I_4(Z_{13} + Z_{23}) \quad (2)$$

$$0 = I_1(Z_3 + Z_{23}) + I_3(Z_{13} + Z_{23}) + I_4(Z_3 + Z_5), \quad (3)$$

here

$$Z_{12} = k\sqrt{Z_1 Z_2} \quad (4)$$

$$Z_{13} = k\sqrt{Z_1 Z_3} \quad (5)$$

$$Z_{23} = k\sqrt{Z_2 Z_3} \quad (6)$$

Eliminating the currents I_3 and I_4 from Eqs. 1 3, and noting that $I_1 = I_2$, we obtain the prin-pal equations for the four-terminal network:

$$U_1 = U_2 + I_2 Z, \quad (7)$$

$$I_1 = I_2. \quad (8)$$

Here:

$$Z = \frac{Z_1 Z_5 (Z_2 + Z_3 + 2Z_{23}) + Z_a^3}{Z_3 Z_4 + Z_5 (Z_1 + Z_2 + 2Z_{12} + Z_4) + Z_b^2}, \quad (9)$$

here:

$$Z_a^3 = Z_1 Z_2 Z_3 (1 - 3k^2 + 2k^3) + (1 - k^2)\{Z_2 Z_3 Z_4 + Z_5[Z_1(Z_2 + Z_3) + Z_2 Z_3]\} + 2(1-k) Z_5 (Z_{12}Z_3 + Z_1 Z_{23} - Z_2 Z_{13}), \quad (10)$$

$$Z_b^2 = (1 - k) Z_3 [(1 + k)(Z_1 + Z_2) + 2Z_{12}]. \quad (11)$$

The simple, two-port network, Fig. 2, with im-

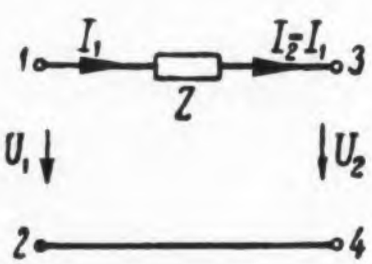


Fig. 2. This is the circuit representation of Eqs. 7 and 8.

RUSSIAN TRANSLATIONS

pedance Z in the longitudinal branch, corresponds to Eqs. 7 and 8.

In the case of very strong coupling between the windings of Fig. 1, a case of great practical interest, we have:

$$k = 1. \tag{12}$$

Then $Z_a^3 = Z_b^2$, and:

$$Z = \frac{Z_3 Z_4 Z_5 (1 + \varphi_2)^2}{Z_3 Z_4 + Z_5 [Z_2 (1 + \varphi_1)^2 + Z_4]}, \tag{13}$$

where:

$$\varphi_1 = \sqrt{\frac{Z_1}{Z_2}}, \tag{14}$$

$$\varphi_2 = \sqrt{\frac{Z_2}{Z_3}}. \tag{15}$$

The circuit of Fig. 1 is balanced if $k = 1$ and if:

$$Z_2 = Z_3. \tag{16}$$

In this case $\varphi_2 = 1$ and we obtain from Eq. 13:

$$\frac{1}{Z} = \frac{1}{4Z_2} + \frac{(1 + \varphi_1)^2}{4Z_5} + \frac{1}{4Z_5}. \tag{17}$$

The impedance arrangement corresponding to this equation is shown in Fig. 3. For the case $k = 1$ and $Z_2 = Z_3$, we have the equivalent circuit *I* shown in the Table.

From the equations above, and Figs. 2 and 3, we can derive the equivalent circuits, II to VII, of the Table. The relations between the elements of the equivalent pairs are indicated in the figures. In spite of the asymmetry in the structure of some of the two-port networks, all these circuits are balanced.

Next we will find the equivalent two-port network, without mutual inductances, to the circuit shown in Fig. 4. The coupling coefficients between all windings are assumed equal. We then

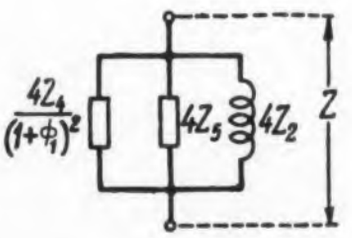


Fig. 3. General form of the circuit, without mutual inductance elements, is equivalent to the mutual inductance circuits of Fig. 1.

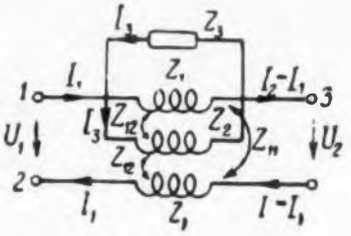


Fig. 4. This circuit, with 3 mutual inductance elements, has the same electrical characteristics as its non-mutual inductance equivalent, Fig. 5.

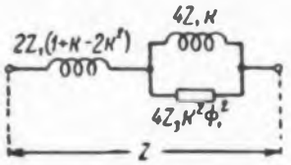


Fig. 5. Equivalent pairs VIII and IX are derived from this circuit and the circuit of Fig. 4.

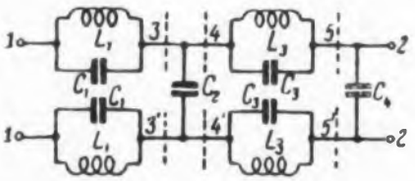


Fig. 6. Using circuit V from the Table, an equivalent, with mutual inductance elements, to this filter circuit can be found.

obtain, for matched connection of all windings:

$$U_1 = 2I_1 (Z_1 + Z_{11}) + 2I_3 Z_{12} + U_2, \quad (18)$$

$$0 = 2I_1 Z_{12} + I_3 (Z_2 + Z_3), \quad (19)$$

where:

$$Z_{11} = kZ_1 \quad (20)$$

$$Z_{12} = k\sqrt{Z_1 Z_2}. \quad (21)$$

Eliminating the current I_3 from Eqs. 18 and 19 and noting that $I_1 = I_2$, we find that the principal equations of the network of Fig. 4 are the same as Eqs. 7 and 8 if:

$$Z = 2Z_1 \frac{Z_2 (1 + k - 2k^2) + Z_3 (1 + k)}{Z_2 + Z_3}. \quad (22)$$

Thus, the circuit of Fig. 4, like that of Fig. 1, is equivalent to the four-terminal network shown in Fig. 2.

Eq. 22 can be rewritten:

$$Z = 2Z_1 (1 + k - 2k^2) + \frac{1}{\frac{1}{4Z_1 k^2} + \frac{1}{4Z_3 k^2 \varphi_1^2}}, \quad (23)$$

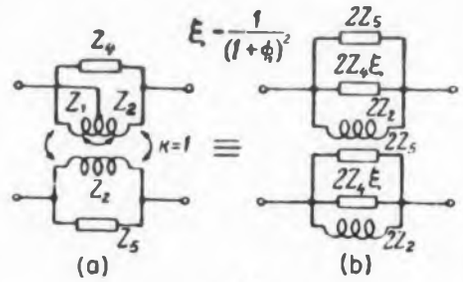
where φ_1 is determined from Eq. 14.

RUSSIAN TRANSLATIONS

The circuit corresponding to this expression is shown in Fig. 5.

Using the circuits of Figs. 2 and 5, we can obtain the equivalent circuits VIII and IX, listed in the Table.

Filter circuits with mutual inductance elements can replace their non-mutual inductance equivalent as shown in this table of filter pairs.



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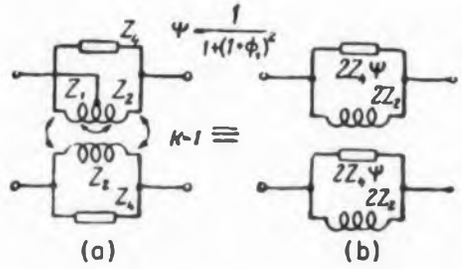

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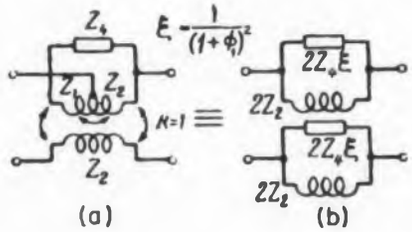

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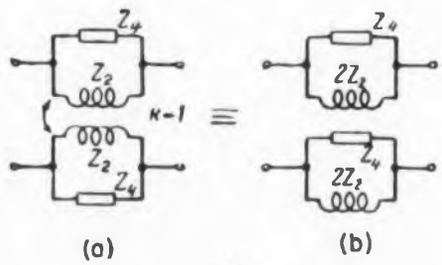

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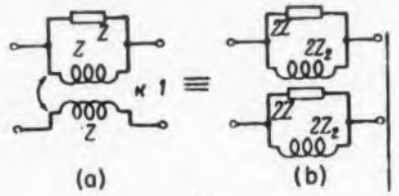

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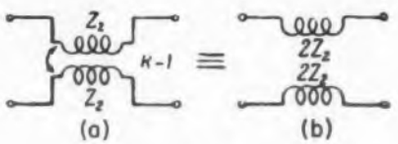

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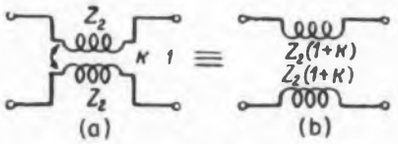
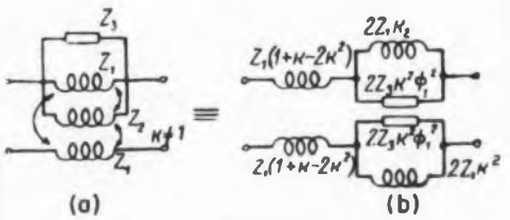
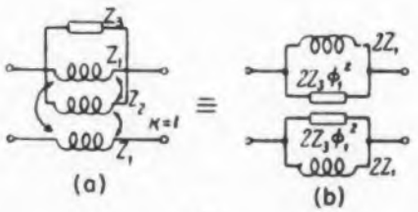


VII



VIII



IX

Applying the Equivalent Filter Circuits of the Table

Assume we are given the filter of Fig. 6 and we would like to find a mutual inductance equiva-

RUSSIAN TRANSLATIONS

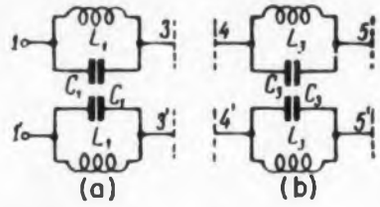


Fig. 7. The filter of Fig. 6 consists of two identical halves.

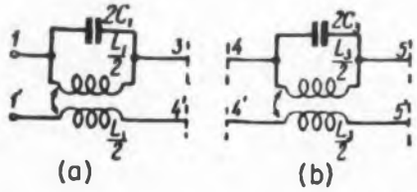


Fig. 8. These circuits are electrically equivalent to those of Fig. 7.

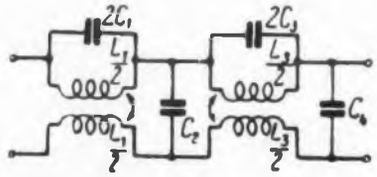


Fig. 9. With mutual inductance elements this filter is electrically equivalent to the filter of Fig. 6 and has fewer components.

lent. This circuit can be divided into two parts, Fig. 7. Comparing Fig. 7a with circuit V of the Table, we can write:

$$i\omega L_1 = 2Z_2, \tag{24}$$

$$\frac{1}{i\omega C_1} = 2Z_4. \tag{25}$$

Hence:

$$Z_2 = i\omega\frac{L_1}{2}, \tag{26}$$

$$Z_4 = \frac{1}{i\omega 2C_1}. \tag{27}$$

Thus, the circuit of Fig. 7a can be replaced

with the circuit of Fig. 8a. Similarly, we can replace Fig. 7b with the circuit of Fig. 8b. Combining these circuits we have the circuit of Fig. 9, equivalent to the filter of Fig. 6. The mutual inductance elements reduce the required filter components.

In deriving a filter equivalent, any of the networks I, II, III, VIII or IX of the Table could have been used. A feature of these networks is that their design formulas include a transformation coefficient φ_1, which can be specified arbitrarily. Thus, it is possible to specify, for example, capacitors of standard size.

Suppose we wish to replace Fig. 7a by circuit IIa of the Table. Comparing the two circuits, we can write:

$$i\,w\,L_1 = 2Z_2, \tag{28}$$

$$\frac{1}{i\,\omega\,C_1} = \frac{2Z_4}{(1+\varphi_1)^2}, \tag{29}$$

Hence

$$Z_2 = i\,\omega\frac{L_1}{2}, \tag{30}$$

$$Z_4 = \frac{(1+\varphi_1)^2}{i\,\omega\,2C_1}. \tag{31}$$

The inductance of the winding Z_1 of the transformer of circuit IIb is given, on the basis of Eqs. 14 and 31, by:

$$Z_1 = \varphi_1^2\,Z_2 = i\,\omega\,\varphi_1^2\,\frac{L_1}{2}. \tag{32}$$

Thus, instead of Fig. 7a we can use the circuit of Fig. 10. For this filter, the value of φ_1 can be arbitrarily specified.

(*Translated from Use Of Simple Two-Port Network With Mutual Inductances In Electric Filters by Kh. I. Cherne*, Elektrosvyaz', *No. 1, 1960, pp* 65-70.)

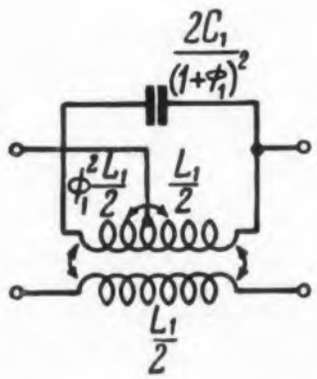


Fig. 10. Working with circuit IIa of the Table yields this circuit as the equivalent as shown in this table of filter pairs.

GERMAN ABSTRACTS

E. Brenner

Stereophonic Broadcasting

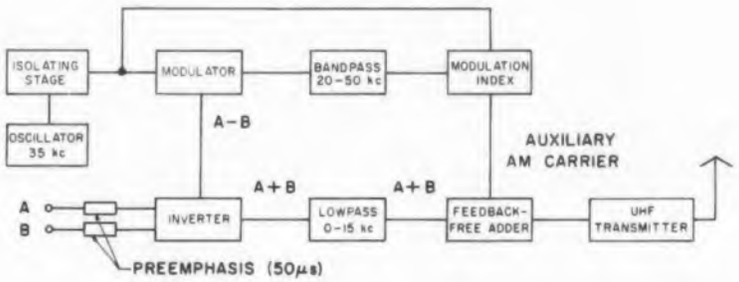


Fig. 1. Block diagram of the auxiliary am-carrier system for stereophonic transmission.

SEVERAL single carrier systems can be designed for the transmission of stereophonic broadcasts. The suitability of any one method may be judged from the following criteria: (1) The signal should be compatible—monaural receivers should be usable with no deterioration of quality. (2) The receiving circuit should be simple. (3) Signal-to-noise ratio must be acceptable for both stereo and monaural reception. (4) Reasonable bandwidth is desirable. In addition one may wish to provide for the transmission of two distinct programs when stereo transmisison is not in progress.

Auxiliary Carrier Method

A system that has remarkable receiver simplicity is the fm system, with auxiliary carrier, shown in Fig. 1. Starting with the two signals, $A(t)$ and $B(t)$, the amplitude modulated signal $a\,[1 + A(t) - B(t)]\,\cos\omega t$ is generated and added to $A(t) + B(t)$ to give the signal:

$$v(t) = A(t) + b(t) + a\,[1 + A(t) - B(t)]\,\cos\omega t$$

This is used to frequency modulate the ultra-short-wave carrier. The two filters shown in Fig. 1 require uniform time delay characteristics. Butterworth filters can provide crosstalk-damping of 30 to 40 db.

In the receiver, a symmetrical ratio-detector furnishes the input to a two-diode stereo demodulator, Fig. 2. De-emphasis is provided by the time constants in the stereo demodulator. When the auxiliary (am) carrier frequency is half of the frequency deviation (for example, 37.5 kc for a 75-kc deviation), $A(t)$ and $B(t)$ are obtained as the output of the stereo demodulator. In other cases, the resistor R, Fig. 3, produces crosstalk which is then balanced out with a variable resistor (100 k, Fig. 3) in the audio frequency section. For monaural operation, switch S, Fig. 2, is closed.

The system requires 55-μv input for a stereo output signal-to-noise ratio of 50 db. This, together with a loss in signal-to-noise ratio for the compatible signal, is the principal disadvantage of the system.

Pulse Amplitude Modulation (PAM)

A compatible PAM stereo system is shown in Fig. 4. It is assumed that the signal is bandlimited to 15 kc. A 30-kc pulse generator furnishes alternately positive and negative pulses that are modulated by $A(t)$ and $B(t)$ respectively. After filtering, the modulated pulses are the modulating sig-

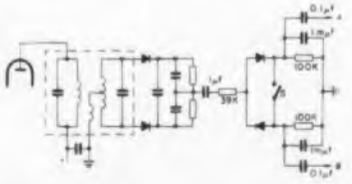


Fig. 2. Ratio detector and stereo demodulator.

nal for the fm transmitter. To assure that the transmitted signal contains the fundamental, 30-kc pulse frequency with zero signal, a dc component corresponding to 10 per cent of the peak frequency deviation is added to each of the original signals.

For stereo reception the receiver if bandwidth needs to be expanded to about 210 kc. A synchronized decoder separates the time interlaced signals. For this purpose either a synchronized local oscillator or a "self-synchronized" circuit can be used. Fig. 5 shows a self-synchronized circuit requiring two envelopes and five germanium diodes. The filtered signal from the fm-detector is fed through a cathode follower to the diode decoder and the sharply tuned, 30-kc, two-stage pentode amplifier. The amplifier output is limited and used for switching. The 10-per cent zero signal component mentioned above is adequate to provide reliable operation. After decoding each signal is de-emphasized and amplified.

Abstracted from two articles in Elektronische Rundschau, *Vol. 13, Nov. 12, December 1958: Use of Auxiliary AM Carrier by F.L.H.M. Stumpers and R. Schutte, pp 445-446; PAM System by G. Janus, pp 447-449.*

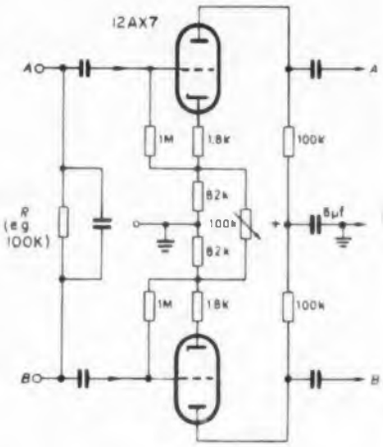


Fig. 3. Crosstalk-compensated audio stage.

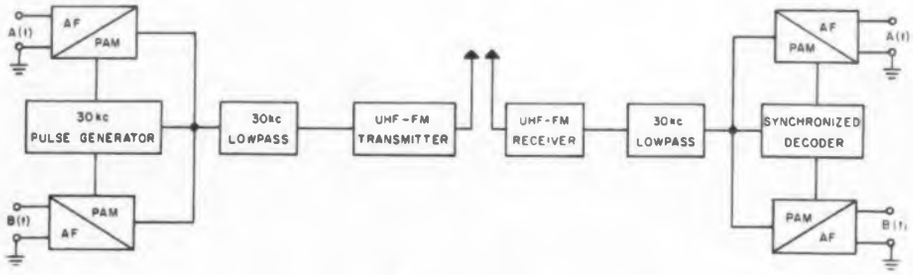


Fig. 4. Block diagram of the PAM system.

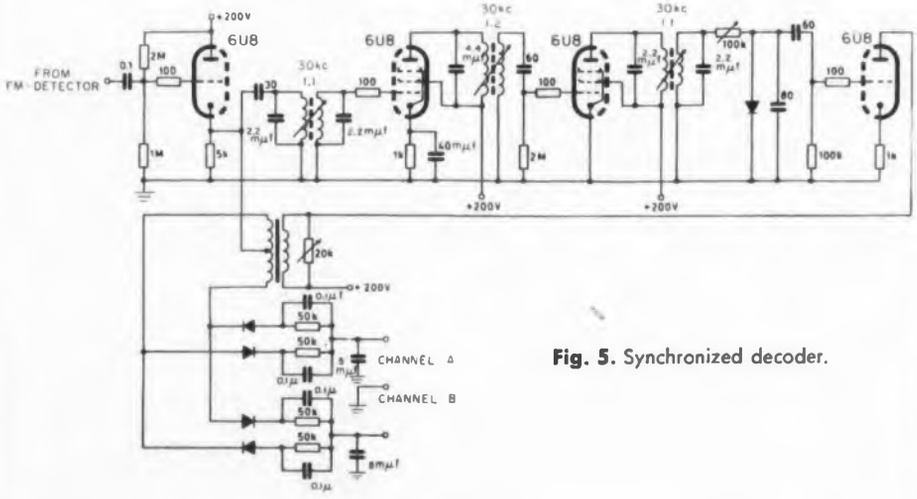


Fig. 5. Synchronized decoder.

ELECTRONIC DESIGN
DIGEST
of recent papers and literature

Resistance Network Solves Potential Distribution Problems

MANY electron-optical problems require the solution of the Laplace equation:

$$\frac{\delta^2 w}{\delta x^2} + \frac{\delta^2 w}{\delta y^2} + \frac{\delta^2 w}{\delta z^2} = 0 \qquad (1)$$

This equation can represent, for example, the potential distribution in the space-charge free region surrounding the focusing electrodes of an electron gun. A very interesting and rapid analog technique for solving Eq. 1 involves the use of a rectangular resistance network. An approximate method, it is applicable to two-dimensional problems where there is rotational symmetry.

A Finite-Difference Operator Replaces The Usual Differential Operator

Eq. 1 can be rewritten using the Laplacian op-

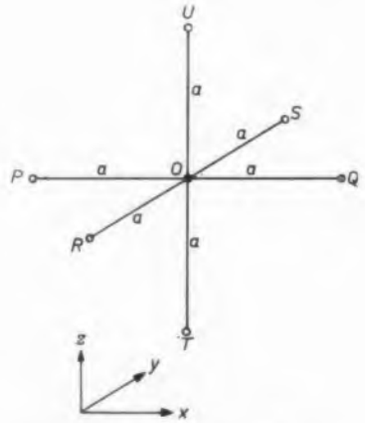


Fig. 1. In deriving the difference operator *L*, pairs of points are selected equidistant from center point O.

erator ∇^2 Thus, it becomes:

$$\nabla^2 w = 0$$

where $$\nabla^2 = \frac{\delta^2}{\delta x^2} + \frac{\delta^2}{\delta y^2} + \frac{\delta^2}{\delta z^2} \quad (1a)$$

From the differential operator ∇^2, a finite difference operator L is derived:

$$LW \approx \nabla^2 W \quad (2)$$

To derive L we select an arbitrary point O and three pairs of points, P and Q, R and S, and T and U, lying respectively in the x, y and z directions at a distance a on either side of O, Fig. 1. The difference between the values of w_Q and w_O at points Q and O can be expressed by using Taylor's theorem. This yields the difference in terms of a and the derivatives of w with respect to x at point O:

$$w_Q - w_O = a\left(\frac{\delta w}{\delta x}\right)_O + \frac{a^2}{2!}\left(\frac{\delta^2 w}{\delta x^2}\right)_O + \frac{a^3}{3!}\left(\frac{\delta^3 w}{\delta x^3}\right)_O + \frac{a^4}{4!}\left(\frac{\delta^4 w}{\delta x^4}\right)_O + \ldots \quad (3a)$$

By replacing a in the above by $-a$, we obtain a similar series for $w_P - w_O$:

$$w_P - w_O = -a\left(\frac{\delta w}{\delta x}\right)_O + \frac{a^2}{2!}\left(\frac{\delta^2 w}{\delta x^2}\right)_O - \frac{a^3}{3!}\left(\frac{\delta^3 w}{\delta x^3}\right)_O + \frac{a^4}{4!}\left(\frac{\delta^4 w}{\delta x^4}\right)_O - \ldots \quad (3b)$$

Adding these two series and solving for $(\delta^2 w/\delta x^2)_O$, we obtain:

$$\left(\frac{\delta^2 w}{\delta x^2}\right)_O = \frac{1}{a^2}\{(w_Q - w_O) + (w_P - w_O)\} - \frac{a^2}{12}\left(\frac{\delta^4 w}{\delta x^4}\right)_O - \ldots \quad (4)$$

The differential coefficient $(\delta^2 w/\delta x^2)_O$ is thus expressed in terms of the differences $(w_Q - w_O)$ and $(w_P - w_O)$ plus a number of correction terms, whose total value can be made as small as desired by making a small enough.

$(\delta^2 w/\delta y^2)_O$ and $(\delta^2 w/\delta z^2)_O$, the other differential coefficients occurring in Eq. 1, can be expressed as differences in an analogous manner. Inserting in Eq. 1 the expressions thus obtained, we have:

$$(\nabla^2 w)_O = \frac{1}{a^2}(w_P + w_Q + w_R + w_S + w_T + w_U - 6w_O) - \frac{a^2}{12}\left(\frac{\delta^4 w}{\delta x^4} + \frac{\delta^4 w}{\delta y^4} + \frac{\delta^4 w}{\delta z^4}\right)_O - \ldots \quad (5)$$

(Continued on p 140)

DIGEST

Introducing the operator L, we now put:

$$(Lw)_o = \frac{1}{a^2}(w_P + w_Q + w_R + w_S + w_T + w_U - 6w_o). \quad (6)$$

We see from Eq. 5 that $(Lw)_o$ is an approximation to $(\nabla^2 w)_o$, approaching it all the more closely as a is made smaller. L is the *finite-difference operator*. It is so called because L denotes an operation whereby the finite differences $w_P - w_o$, etc., are used.

A Resistance Network for Two-Dimensional Problems

Confining ourselves to two-dimensional cases, Laplace's equation assumes the form:

$$\frac{\delta^2\varphi}{\delta x^2} + \frac{\delta^2\varphi}{\delta y^2} = 0 \quad (7)$$

Let us consider the example shown in Fig. 2. The three closed outlines s_1, s_2 and s_3 represent sections taken at right angles through three infinitely long prisms. On the periphery of each prism, φ has a known constant value. The problem is to find a function φ which satisfies Eq. 7 in the area within s_3 but ouside s_1 and s_2, and which assumes the prescribed values along s_1, s_2 and s_3.

Over s_1, s_2 and s_3 we place a square grid, whose lines are parallel to the x and y axes and spaced at intervals of a. The "grid lines" intersect at "grid points." Two grid points are "adjacent" if their distance apart is the mesh width a. We shall refer to grid points located on the outlines s_1, s_2 and s_3 as "boundary grid points," and to the remaining ones in the area wherein φ has to be determined as "internal grid points."

The following proposition underlies the principle of the resistance network.

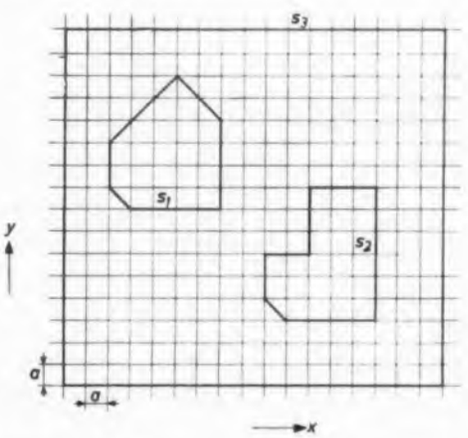


Fig. 2. The unknown function φ has known values along the outlines s_1, s_2 and s_3. Throughout the area inside s_3, but outside s_1 and s_2, it must satisfy the Laplace equation.

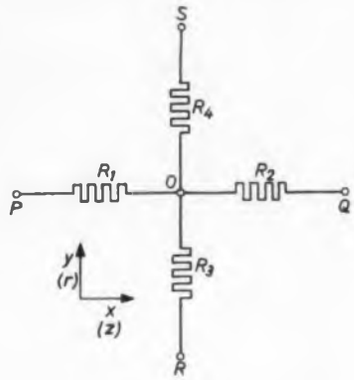


Fig. 3. Resistors R_1, R_2, R_3 and R_4 meet at O, a junction in the resistance network. In the two-dimensional case, *PQ* represents a line parallel to the x-axis, and *RS* a line parallel to the y-axis; in the rotationally-symmetric three-dimensional case *PQ* represents a line parallel to the z-axis, *RS* one parallel to the r-axis.

If each internal grid point is given a value φ° *so that between the value* φ° *and the values at adjacent grid points the relationship* $L\,\varphi^\circ = 0$ *exists, and if at the boundary grid points* φ° *has the boundary values specified for the required function* φ *then the difference between* φ° *and* φ *at the internal grid points will approach zero as the mesh width a approaches zero.*

To find the φ° values a network of resistors is built up. The junctions of the resistance network will correspond to the grid points in Fig. 2. Thus, four resistors will meet at each junction, Fig. 3. We shall refer to junctions corresponding to boundary grid points as "boundary junctions." Between the boundary junctions we may apply voltages that are proportional to the differences betweeen φ values at the corresponding boundary grid points. If the lowest value of φ at any of the boundary grid points is φ_{min} and if we take the potential of the corresponding boundary junction as a datum for measuring the potentials V_b of other boundary junctions, then any of these latter potentials is given by

$$V_b = (\varphi_b - \varphi_{min})/\beta \qquad (8)$$

The suffix b indicates a relation to the boundary grid points. $1/\beta$ is a constant of proportionality. We now allot to each internal grid point a value

$$\varphi^\circ = \beta V + \varphi_{min} \qquad (9)$$

where V is the potential measured at the corresponding junction in the resistance network. Through the resistor connecting two adjacent junctions in the network, for example, that between P and O in Fig. 3, flows a current having the value

DIGEST

$(V_P - V_O)/R_1$. Applying Kirchoff's law to junction O, we find that:

$$\frac{V_P - V_O}{R_1} + \frac{V_Q - V_O}{R_2} + \frac{V_R - V_O}{R_3} + \frac{V_S - V_O}{R_4} = 0.$$

From this and from Eq. 9 it follows that for any grid point O,

$$\frac{\varphi_P^* - \varphi_O^*}{R_1} + \frac{\varphi_Q^* - \varphi_O^*}{R_2} + \frac{\varphi_R^* - \varphi_O^*}{R_3} + \frac{\varphi_S^* - \varphi_O^*}{R_4} = 0. \quad (10)$$

If all four resistors have the same value,

$$(L\varphi^*)_O = 0$$

at any grid point O. Since, in addition, φ^* on the boundary curves has the boundary values laid down for φ, φ^* constitutes an approximation to the required function φ, provided all resistors composing the network are of the same value.

Three-Dimensional Problems With Rotational Symmetry

If the rectangular coordinates are converted to cylindrical coordinates (r, z and ε in Fig. 4)„ the z-axis being made to coincide with the axis of symmetry, the Laplace equation assumes the form:

$$\frac{\delta^2\varphi}{\delta r^2} + \frac{1}{r}\frac{\delta\varphi}{\delta r} + \frac{\delta^2\varphi}{\delta z^2} = 0 \quad (11)$$

Owing to the rotational symmetry, ε does not appear in the equation. The Laplacian operator is now

$$\frac{\delta^2}{\delta r^2} + \frac{1}{r}\frac{\delta}{\delta r} + \frac{\delta^2}{\delta z^2} \quad (12)$$

To derive a finite-difference operator from Eq. 12, we let Eq. 12 operate on an arbitrary function $u(z,r)$, and consider a point O and the two pairs of points P,Q and R,S which lie in the z and r directions respectively, at a distance a on opposite sides of O. Again expressing the differential coefficients as differences, we arrive at the following:

$$\left(\frac{\delta^2 u}{\delta r^2} + \frac{1}{r}\frac{\delta u}{\delta r} + \frac{\delta^2 u}{\delta z^2}\right)_O = (Mu)_O - \frac{a^2}{12}\left(\frac{\delta^4 u}{\delta r^4} + \frac{2}{r}\frac{\delta^3 u}{\delta r^3} + \frac{\delta^4 u}{\delta z^4}\right)_O - \ldots \quad (13)$$

where:

$$(Mu)_O = \frac{1}{a^2}\left\{(u_P - u_O) + (u_Q - u_O) + \left(1 - \frac{a}{2r}\right)(u_R - u_O) + \left(1 + \frac{a}{2r}\right)(u_S - u_O)\right\}. \quad (14)$$

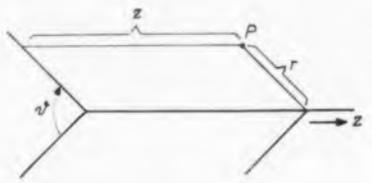


Fig. 4. r, z and v, cylindrical polar coordinates of a point *P*.

The required finite-difference operator M is thus defined by Eq. 14.

We now superpose on the z,r-plane a square grid with a mesh width of a. The values of φ° that are allotted to the internal grid points must now satisfy the relationship:

$$M\,\varphi^\circ = 0, \tag{15}$$

while φ° at the boundary grid points must have the boundary values laid down for φ. φ° will then been an approximation to φ. That is, φ° will approach φ as the mesh width a approaches zero.

As before, it is possible to build up a resistance network whose junctions have potentials corresponding to φ° values. To deduce the requirements the resistors will have to satisfy, we shall proceed as before, but this time Eq. 10 must be compared with Eq. 14. Having done this, we find that φ° satisfies the relationship $(M\varphi^\circ)_o = 0$ provided that

$$\frac{1}{R_1} : \frac{1}{R_2} : \frac{1}{R_3} : \frac{1}{R_4} = 1 : 1 : \left(1 - \frac{a}{2r}\right) : \left(1 + \frac{a}{2r}\right) \tag{16}$$

(see Fig. 3).

If the grid is so positioned that the z-axis coincides with one of the grid lines, then at each of the grid points

$$r = ja,$$

j being an integer. Eq. 16 now becomes:

$$\frac{1}{R_1} : \frac{1}{R_2} : \frac{1}{R_3} : \frac{1}{R_4} = 2j : 2j : (2j-1) : (2j+1). \tag{17}$$

In the present case, then, the resistance values must decrease with increasing distance from the z-axis. In the network shown in Fig. 5, Eq. 17 is satisfied for all values of j except $j = 0$. This exception is a point that we must look into.

Resistors Lying Along The Axis

The zero value of j, gives rise to complications. This is clear, for example, from the conclusion that can be drawn from Eq. 17: For resistors meeting at a junction on the axis, R_3 must be negative if R_1, R_2 and R_4 are positive. In addition, Eqs. 13 and 14 involve indeterminate O/O terms when $r = 0$. These complications can be avoided by reverting to the finite-difference oper-

ator L (see Eq. 6) as an approximation to the Laplace operator for points along the z-axis. The reason we abandoned L in favor of operator M when analyzing the three-dimensional case was that the former would have led to a three-dimensional network. This objection does not, however, apply to points on the axis of symmetry. Let us consider a point O on that axis. At this point:

$$w_T = w_R = w_U = w_S$$

For such a point, therefore, we can rewrite Eq. 6 in the form:

$$(Lw)_O = \frac{1}{a^2}\{(w_P - w_O) + (w_Q - w_O) + \\ + 2(w_R - w_O) + 2(w_S - w_O)\} \cdots (18)$$

Comparison of Eq. 11 with the above expression makes it clear that, in the grid points on the z-axis, $\varphi^\bullet$ will satisfy $L\varphi^\bullet = 0$ provided that:

$$\frac{1}{R_1} : \frac{1}{R_2} : \frac{1}{R_3} : \frac{1}{R_4} = 1 : 1 : 2 : 2 \qquad (19)$$

These conditions have in fact been satisfied in the

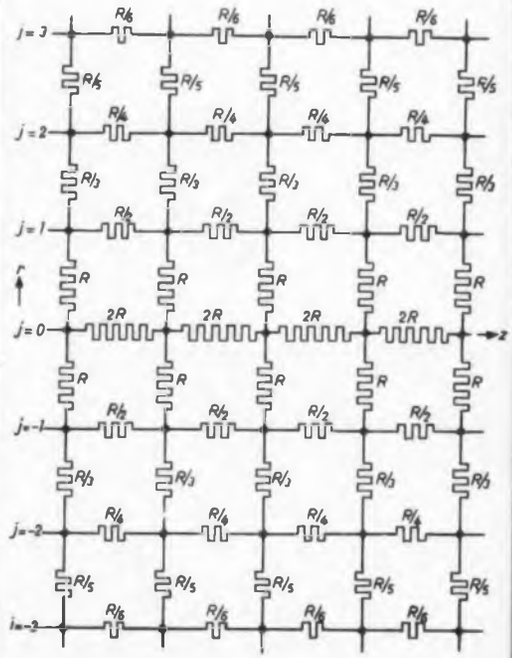


Fig. 5. Part of a network for rotationally-symmetric three-dimensional problems. Resistors meeting at junctions at which $j = 0$ have values satisfying relation (17). For $j = 0$ (junctions on the axis) the resistors satisfy (19).

CIRCLE 173 ON READER-SERVICE CARD ➤

This is a cutaway of an Epoxy encapsulated stator wound with Epoxy magnet wire. All-Epoxy—an ideal combination for severe applications.

EPOXY MAGNET WIRE . . . IDEAL FOR ENCAPSULATED SYSTEMS UP TO 130° C

A magnet wire must offer you *all* these important advantages when used in encapsulated systems.

The wire must have outstanding compatibility—a requirement for good bond strength at elevated temperatures—high dielectric strength under adverse moisture conditions.

The ideal magnet wire must also have excellent thermal and high-impact shock resistance. And—it must be able to resist corrosive and abrasive atmospheres.

Anaconda Epoxy meets all these requirements and more. For this 130°C (AIEE Class B) magnet wire is compatible with virtually every encapsulating compound tested to date. Equally important, Anaconda Epoxy contains no polyester modifiers—therefore offering greater resistance to hydrolysis.

In addition, Anaconda Epoxy costs no more than most Class A magnet wires—which means you can often thermally upgrade your components to Class B without additional cost. It's readily available, too—in a full range of round, square and rectangular sizes.

Epoxy can also be furnished in combination with Vitrotex (glass-served) for added thermal overload protection.

So you can see how it offers you many interesting possibilities for cutting costs and simplifying production through standardization.

Our technical staff and Research and Development Laboratory facilities are available to give you assistance in your encapsulating and other magnet wire problems. See the Man from Anaconda. Or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

6P252

ASK THE MAN FROM ANACONDA® *FOR* EPOXY MAGNET WIRE

ANATHERM 155°C (AIEE Class F)
high temperature resistance

NYFORM 105°C (AIEE Class A)
superior windability

PLAIN ENAMEL 105°C (AIEE Class A)
low-cost enameled magnet wire

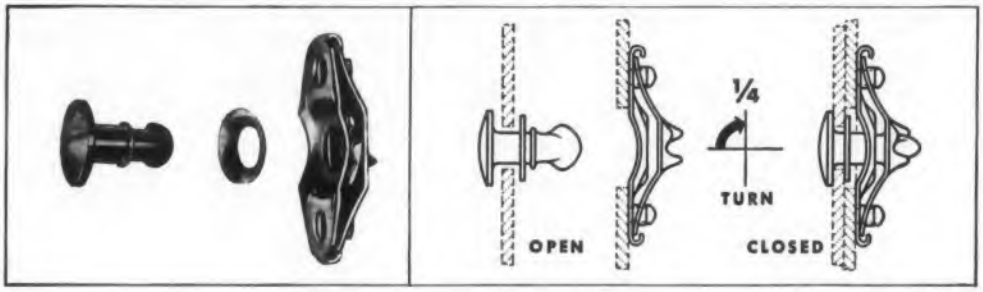
FORMVAR 105°C (AIEE Class A)
proven dependability

ANALAC 105°C (AIEE Class A)
solderable magnet wire

THIS PANEL CAN BE
OPENED OR CLOSED
IN LESS THAN 2 SECONDS

LION ¼ TURN OPEN ¼ TURN CLOSED FASTENERS

ARE FAST, POSITIVE, RELIABLE



Installation of the three parts of the Lion Fastener, shown above, is quick but not critical. Unique in design and performance, these mil spec (MIL-F 5591A-ASG) fasteners make possible quick access and smooth positive locking by only a ¼ turn.

ALIGNMENT NOT CRITICAL

Both stud and receptacle "float" to accommodate misalignment. The hole, which retains the stud, is twice as large as the stud cross-section. This permits a float of .070 in all directions. The leaf spring receptacle also floats to accommodate stud position.

WIDE VARIATIONS IN STACK HEIGHT

Total sheet thickness may vary as much as +.035 and −.015 without affecting operation. A Lion stud, specified for .160 total thickness, for example, will accommodate any stack height between .195 and .145.

SWAGED-NOSE STUD

Extra strength and smooth operation are made possible by the swaged-nose design. All the metal in the stud goes to work. There are no thin cross pins, holes or milled slots to weaken the cross-section. Case hardening is further assurance of long, trouble-free service.

WIDE VARIETY

Lion Fasteners are available in 3 sizes—No. 5, No. 2, and Miniature. An assortment of head styles are supplied—oval, flush, wing, ring, notched or knurled—according to individual requirements.

FREE!

FASTENER HANDBOOK

Send for your free copy of Southco Fastener Handbook No. 9. Gives complete engineering data on Lion Fasteners and other special fasteners. Write to Southco Division, South Chester Corporation, 235 Industrial Highway, Lester, Pennsylvania.

LION *Aviation* FASTENERS

one of the SOUTHCO LION FASTENERS

CIRCLE 126 ON READER-SERVICE CARD

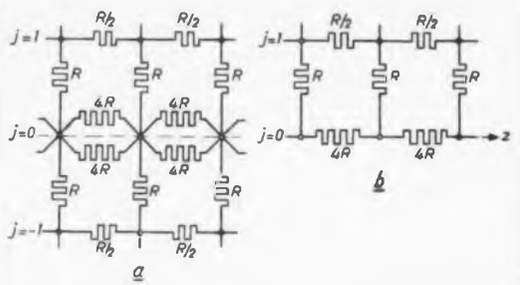


Fig. 6. Network (a) is equivalent to that in Fig. 5, the 2*R* resistors along the *z*-axis having been replaced by two parallel 4*R* resistors. Because of the symmetry, the lower half can be removed without affecting the upper half, as in (*b*).

network of Fig. 5, where the resistors forming the axis have the value 2*R*.

The network of Fig. 5 is not used in practice. Practical versions extend to one side of the *z*-axis only. Such networks are perfectly satisfactory if the axial resistors are given a value of 4*R* instead of 2*R*. The validity of this can be confirmed by reasoning as follows. Imagine the 2*R* resistance along the *z*-axis in Fig. 5 to have been replaced by two 4*R* resistances in parallel, as in Fig. 6a. On account of the rotational symmetry of the system, no current flows from the upper portion to the portion under the *z*-axis. The lower portion can therefore be omitted, Fig. 6b, without making any difference to the upper portion.

Design and Use of the Resistance Network

Resistance networks for two-dimensional problems and for three-dimensional problems with rotational symmetry are identical apart from the values of the resistors. Thus, we shall only describe the network for solving rotationally symmetric three-dimensional problems.

This network is constructed according to the arrangement shown in Fig. 6b. It extends over 50 meshes in the *z*-direction and over 25 in the *r*-direction. It is composed of (51 x 25) + (26 x 50) = 2575 resistors in all, which are mounted on the back of a sheet of insulating material. The junctions have silver-plated contact pins that pass through to the front of the panel, Fig. 8.

To determine the potential distribution in some electrode assembly, that of Fig. 7, for example, the system is simulated on the resistance network by linking the junctions corresponding to the electrode outlines with copper wire. In principle it would be possible to apply voltages across the simulated electrodes in the manner described above. This is not necessary, however. By the following simple procedure the required potential distribution can be found more conveniently. One of the electrodes, *G*, for example, is connected

to terminal B of potentiometer AB, and all the other electrodes (K and A_1 in Fig. 7) are connected to A, the other potentiometer terminal. A and B are connected to an accumulator. To measure the potential at the junction P, we connect P to the slide contact of the potentiometer via a null-indicating instrument. Once the slide has been brought to a position where a null is indicated, the potentiometer setting shows the potential difference between P and A (or B) as a proportion of the potential difference between B and A. The value found is the potential of P when electrode G has unit potential and all the other electrodes have zero potential. By repeating the measurements for the other junctions, the potential distribution under the above-mentioned circumstances is obtained. One of the other electrodes, A_1, is now given an effective potential of unity and the others are held at zero; the potential distribution is measured again. The potential distribution for any given combination of electrode potentials is then found by simply combining these results linearly (superposition).

Generalizing, if there are n electrodes instead of three, the measurements have to be repeated $n - 1$ times. Then, by linear combination of the results, a solution for any given set of electrode potentials is found. This method is convenient because no adjustment or measurement of voltage is necessary.

In view of the accuracy required, all the resistors were wound from manganin wire, to tolerances of ± 0.2 per cent. The average error arising in the measurement of potential, due to inexact resistance values, is much smaller than the errors

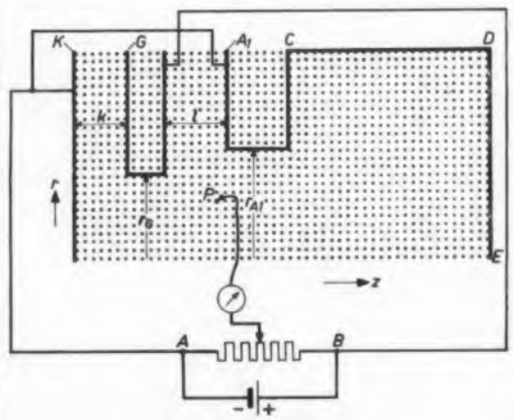


Fig. 7. Bridge circuit for measuring the potentials of junctions in the resistance network. K, G and A_1 are electrode models. The configuration is the same as in Fig. 8. AB is a 1 K potentiometer with a setting error of about 0.01 ohm. The null indicator is an electronic dc millivoltmeter with an internal resistance of 0.6 meg.

Fig. 8. The resistance network is mounted on the back of a large board of insulating material. The electrode configuration of Fig. 7 is outlined with lengths of copper wire attached to the appropriate contact points.

in the resistance themselves, being from a tenth to a hundredth thereof. This is because the statistical properties of the network level the errors out. The temperature coefficient of manganin is so small, the voltage employed (usually about 2 v) is so low and the physical dimensions of the resistors are so large that there is no fear of errors due to heating-up of the resistors.

The upper limit to the (in principle, arbitrary) value of R (see Fig. 6b) is fixed by the requirement that the highest value in the network, which is $4R$, shall not be an unreasonably high one for wirewound resistors. On the other hand the smallest resistors must not have too low a value. If they did, current through them would be large enough to set up appreciable potential differences in the copper wires representing the electrode outlines. In the present networks, R has the value 3600 Ω. The extreme resistance values are therefore $4R = 14400$ ohms and $R/50 = 72$ ohms.

A vacuum tube voltmeter serves as the null indicator. It is a dc millivoltmeter combining great sensitivity (readings down to 2 μv can be obtained) with a high internal resistance (0.6 meg). The null current is therefore less than about 3×10^{-12} A, which is so small that it makes no perceptible difference to the potential distribution. If it was other than very small it could give rise to appreciable errors, particularly in measurements on the axis of symmetry, where the highest-valued resistors lie.

The potentiometer must be very accurate, since its errors show up unchanged in the results. The potentiometer employed had an average accuracy of 1 in 10^5.

Digested from "The Resistance Network, A Simple and Accurate Aid to the Solution of Potential Problems" by J. C. Francken, Philips Technical Review, *Vol. 21, 1959-60.*

REPORT BRIEFS

Space Vehicle Communications

This report makes a preliminary evaluation of the various propagational and equipment factors affecting space vehicle communication. It is based on theoretical considerations and the limited experimental evidence from the existing satellites, moon-radar experiments, and radio astronomy measurements. A discussion is given of the noise and equipment limitations, the proper choice of earth station locations and the other factors that affect the signal-to-noise ratio at the receiver. Some of the newer technical developments that increase sensitivity to weak signals are evaluated for their potential increase in communication distance. Some consideration is given to the effects of the ionosphere, including absorption, angle errors, Faraday rotation of polarization, meteor trail and auroral interference, and to the effects of oxygen, water vapor, and other gases that cause absorption, angular deviation, and noise. Included is a selection of the better frequencies for line-of-sight and for over-the-horizon communication with space vehicles and the frequencies that would be less subject to mutual interference with earth stations for communication between vehicles. *Tentative Evaluation of Transmission Factors for Space Vehicle Communications, Luther C. Kelley, Sol Perlman and others. Army Signal Radio Propagation Agency, Fort Monmouth, N. J., Sept. 1958, 145pp, Microfilm $7.20, Photocopy $22.80. Order PB 143142 from Library of Congress, Washington 25, D. C.*

Magnetic Pulse Generation

The efficiency of magnetic pulse generators is analyzed by locating their core losses. Because of saturation of magnetic components, the major portion of losses can be found in the cores. The wattmeter and calorimetric methods are used to determine the losses of single components as well as those of the whole system. In addition, an evaluation of the voltage pulse into a resistive load is made. The results obtained in different ways vary only a few per cent and indicate almost fifty per cent efficiency for a three-stage pulse generator. Tests are reported on a pulse generator that is capable of changing the repetition rate by a ratio of 1:2, and also on a pulse generator with continuous changing repetition rate. Methods of pulse width control mentioned in earlier reports have been tested on the magnetron power level and indicate a successful solution for a variable pulse width. *New Methods of Magnetic Pulse Generation, B. M. Wolfframm, Magnetic Research Corp., El Segundo, Calif., Dec., 1957, 55pp, $1.50. Order PB 131651 from OTS, Washington 25, D C.*

Nuclear Resonance Filters

A method of artificially "shimming" the inhomogeneous field of a small magnet with a series of radio frequency pulses applied to the nuclear induction sample has been investigated. The investigation was directed toward the development of a sharp, tunable bandpass filter. Both analytical and experimental results show that two difficulties present themselves. First, the method is unstable with respect to small variations in the amplitude or width of the shimming pulses. Second, to obtain a "quiet" sample under no-signal conditions, the shimming pulses must be of impractically short duration. For the case of an initial transverse relaxation time of 200 μsec, it is shown that 1000 shimming pulses must be applied during the transient signal build-up (20 msec) in a glycerine sample, if spurious output is to be kept below a reasonable level. Under these same conditions the shimming pulse length should be about 100 mμsec. Fractional variation in the amplitude times width value of the pulses must be held to 7×10^{-6}. A brief analysis of the steady state response of a filter is given under the assumption that the pulse qualites can be met; however, a conclusion is reached that it is impractical to meet these requirements. *Nuclear Resonance Filters For Radar and Communications Applications, R. T. Daly and M. Newstein, Technical Research Group, New York, N. Y., Sept. 14, 1957, 108pp, Microfilm $5.70, Photocopy $16.80. Order PB 138551 from Library of Congress, Washington 25, D. C.*

Antenna-Multicoupler Systems

This is the third in a series of reports on the design of antenna-multicoupler systems for use where several transmitters and receivers are operated simultaneously with a single antenna system. The design formulas for the two- and three-resonator, tunable, narrow-band, symmetrical, minimum-loss, capacitively coupled filters, developed in the two previous reports, are adapted to the design of inductively coupled filters. With either type of coupling, the way in which the filter element values must vary with frequency is shown to depend upon the method of tuning employed in the resonators. Three resonator tuning methods are considered, in which either C, L, or the ratio C/L is taken as a parameter. Tables of filter design formulas are given which apply when any of the three resonator tuning methods is used. Shorter, approximate filter design formulas are given which are reasonably accurate for minimum center-frequency insertion-loss values up to about 1 db. *Design Data For Antenna-Multicoupler Systems, J. F. Cline, Stanford Research Institute, Menlo Park, Calif., Sept. 1958, 24 pp, Microfilm $2.70, Photocopy $4.80. Order PB 138601 from Library of Congress, Washington 25, D.C.*

STANDARDS AND SPECS

New Unit Prefixes

The National Bureau of Standards has adopted four new prefixes: tera, giga, nano, and pico. These prefixes were suggested by the International Committee on Weights and Measures as additions to the eight common prefixes.

Prefix	Multiple or Sub-multiple	Symbol
tera*	10^{12}	T
giga*	10^{9}	G
mega	10^{6}	M
kilo	10^{3}	k
hecto	10^{2}	h
deka	10	dk
deci	10^{-1}	d
centi	10^{-2}	c
milli	10^{-3}	m
micro	10^{-6}	u
nano*	10^{-9}	n
pico*	10^{-12}	p

**Tera* is pronounced like "terra" in "terra firma." *Giga* has the initial *g* pronounced as a *j*, *i* is pronounced as "eye," and the final *ga* is like the *ga* in *gal*. *Nano* is pronounced "nane-o." *Pico* is pronounced "pike-o."

Standards Style Manual

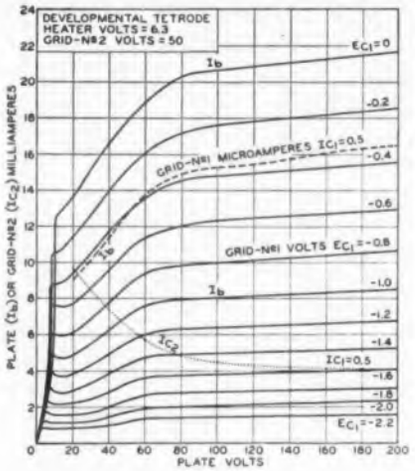
Prepared by the American Standards Association, this style manual will help anyone preparing standards or specs. Use of this manual should make for more uniform and consistent spec preparation.

Included in the manual are: general principles; an outline of reference data that should be included to help a reader use the standard (this reference data does not include technical content); a list of reference source material used as a guide; outline form and numbering of sections; certain special work usages; abbreviation principles; principles for letter symbols and formulas.

In addition, the manual shows how to present tables and figures, how to refer to other specs and how to indicate errata. It also includes recommendations on format and on preparing the manuscript.

This 24-page, indexed manual is available from the American Standards Association, 70 E. 45th St., New York 17, N.Y., $1.50. Specify ASA Style Manual.

Following RCA's announcement of the nuvistor concept and subsequent announcement of the first commercial nuvistor type—the 7586 general-purpose industrial triode—comes news that a nuvistor tetrode is now available to equipment manufacturers on a limited sampling basis. This developmental small-signal tetrode—RCA Dev. No. A-2654—promises to extend the horizons of the nuvistor concept far into the entertainment, industrial, and military electronic fields.



Incorporating all the advantages of nuvistor design, this small-signal general-purpose tetrode is Step 2 of a daring electron-tube-improvement program by RCA. Our developmental work indicates that the nuvistor tetrode will establish new high standards of tube performance for the electronics industry.

Dynamic in Concept

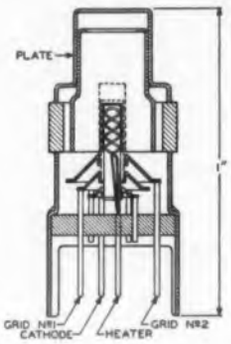
RCA had as its objective in the design of the nuvistor tetrode superior performance in many amplifier applications, particularly at the higher radio frequencies. The new tube is ⅓ the size of conventional rf-amplifier tetrodes, and consumes approximately ½ the heater power.

The nuvistor method of construction eliminates or minimizes many of the known causes of tube failure. Use of only ceramics and strong metals provides a structure of extreme ruggedness. Brazing of all connections in a hydrogen atmosphere at extremely high temperatures eliminates structural strain and element distortion. Exhaust and seal-off at very high temperatures minimizes gases and impurities from metal parts.

Opening a New Era: "Nuvistorization"

The nuvistor tetrode shows great promise for mixer, oscillator-mixer, if-amplifier and low-level video-amplifier service.

Application tests in laboratory circuits show that the nuvistor tetrode will give top performance in industrial and military equipment. Outstanding performance has been obtained in the mixer and if-amplifier stages of such equipment.



Nuvistor Developmental Small Signal Tetrode A-2654

TYPICAL DATA

ELECTRICAL:		
Heater, for Unipotential Cathode:		
Voltage (AC or DC)	6.3±10%	volts
Current	0.165	amp
DIRECT INTERELECTRODE CAPACITANCES (approx.):		
Grid No. 1 to plate	0.01	μμf
Grid No. 1 to cathode heater, grid No. 2, metal shell and internal shield	6.0	μμf
Plate to cathode, heater, grid No. 2, metal shell and internal shield	1.4	μμf
Heater to cathode	1.4	μμf
CHARACTERISTICS, CLASS A_1 AMPLIFIER:		
Plate Supply Voltage	125	volts
Grid No. 2 (Screen-Grid) Voltage	50	volts
Cathode Resistor	68	ohms
Plate Resistance (approx.)	0.2	megohm
Transconductance	10,400	μmhos
Plate Current	9.6	ma
Grid—No. 2 Current	2.9	ma
Grid—No. 1 Voltage (approx.) for plate current of 10 μa	—5	volts
MAXIMUM RATINGS, ABSOLUTE-MAXIMUM VALUES:		
PLATE VOLTAGE	250 max.	volts
GRID—NO. 2 VOLTAGE	110 max.	volts
GRID—NO. 1 VOLTAGE:		
Negative bias value	55 max.	volts
Positive bias value	2 max.	volts
GRID—NO. 2 INPUT	0.2 max.	watt
PLATE DISSIPATION	2.2 max.	watts
GRID—NO. 1 CURRENT	2 max.	ma
CATHODE CURRENT	20 max.	ma
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode	100 max.	volts
Heater positive with respect to cathode	100 max.	volts
MAXIMUM CIRCUIT VALUES:		
Grid—No. 1 Circuit Resistance:		
For cathode-bias operation	1.0 max.	megohm

DESIGN ENGINEERS: You will want to evaluate this tetrode for possible use in your equipment designs. For more details on nuvistors and information on how you may obtain samples of the tetrode call your RCA Field Representative at the Field Office nearest you.

Among other nuvistor types in development at RCA is a beam power tube for military, industrial, and entertainment applications. Half the size of its present-day counterpart, the nuvistor beam power tube will have a maximum plate-dissipation rating of 30 watts, and an output of several watts with less than 75 volts on the plate.

Airborne High-Frequency Single Sideband Am System

Requirements for airborne transmitter-receivers which can transmit and receive high frequency radio intelligence are established by this Aeronautical Radio, Inc. spec. Four basic requirements are covered in this spec.

First, SSB full-carrier transmission of voice and tone signals and am double-sideband reception. Second, SSB suppressed-carrier transmission and SSB suppressed-carrier reception of voice and other signals which do not need exact frequency synchronism.

Third, SSB floating-carrier transmission and SSB-afc reception of voice signals and data transmissions requiring frequency synchronization, but not phase synchronization.

Fourth, transmission and reception for special data applications. This document covers definitions, interchangeability standards, design, and antenna requirements. One of its purposes is to assure uniform design requirements for all airline SSB airborne equipment. This publication also takes the uncertainty of SSB application into account. Issued February 15, 1960, copies may be obtained from Aeronautical Radio, Inc., 1700 K St., Washington 6, D.C. Specify ARINC No. 533, Airborne HF SSB/AM System.

Mechanical Rectifier Definitions

Equipment terms and functional terms for mechanical rectifiers are laid down in Transaction Paper 60-35 of the AIEE. The paper also defines terms for parts and auxiliaries, rectifier circuits, excitation and control circuits and functions, ratings, rectifier characteristics, and operating faults.

These definitions were proposed by the Mechanical Rectifier Subcommittee of the AIEE Industrial Power Rectifier Committee.

The paper is available from the American Institute of Electrical Engineers, 33 W. 39th St., New York 18, N.Y. Price is 50¢ to members, $1.00 to non-members.

Method of Measuring Audio Output

Primarily issued for home-type audio equipment, this EIA standard establishes a method of measuring and expressing the capability of an amplifier to supply signal energy to its load.

As used in this standard, music power output is the single frequency (1000 cps) power obtained at 5 per cent total harmonic distortion or less, when measured immediately after the sudden application of a signal and during a time interval so short that supply voltages within the amplifier have not changed from their no-signal value.

Copies of this standard may be obtained from the Electronics Industries Association, 11 W. 42nd St., New York 36, N.Y., 25¢. Specify EIA RS-234, Power Output Ratings of Packaged Audio Equipment for Home Use, issued February 1960.

YOUR CAREER

NEWS AND NOTES

A woman engineer has made a career of telling her male colleagues to watch their language.

The woman is Eleanor McElwee, technical editor in the Commercial Engineering Dept., Electron Tube Div., Radio Corp. of America, Harrison, N.J.

Most men whose work she edits are not hostile, she said. "They generally welcome my comments, as long as the sense of the material is not changed," she observed. "Some may resist the revisions at first, but usually they agree that the edited copy is easier to understand than their original draft."

Several of her male colleagues have rewarded her assistance with gifts. One of RCA's Chinese scientists gave her a pound of an exotic tea blend and a sandalwood fan.

Miss McElwee, who reviews, rewrites and edits hundreds of engineering manuscripts annually, offers these guides to better technical writing:

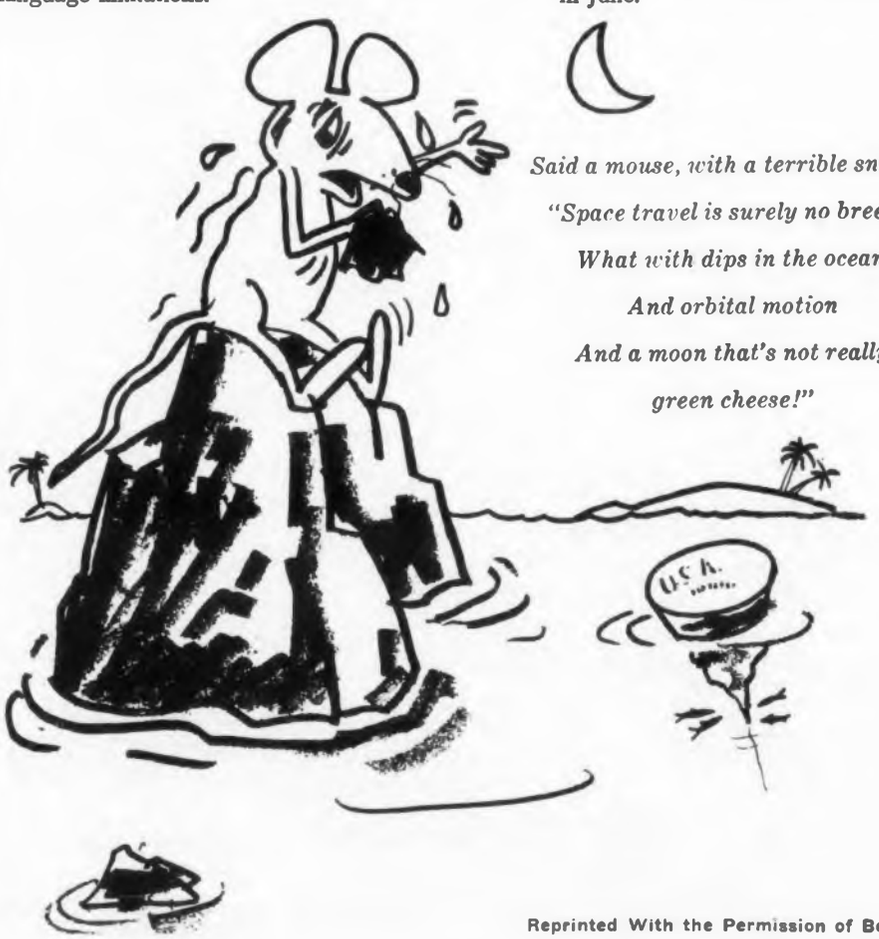
- Consider the reader's background, needs and language limitations.
- Outline content and organization.
- Insert headings and subheadings to help the reader follow the development of ideas.
- Check for correct grammar.
- Simplify tables and graphs, and put captions on all illustrations.

• • •

Western Gear Corp Foundation has donated $125,000 to the engineering building fund of the University of Santa Clara, indicative of the increasing interest shown by industry in the education of future talent.

• • •

A thousand top companies in the U.S. are being asked what they are doing to help their technical personnel write better. The survey is being conducted by the Technical Writing Improvement Society of Pasadena, Calif., with special attention to engineers. Replies to questionnaires are expected to show if the reasons for poor technical writing are basically financial, a lack of instructors, a lack of books and teaching materials, or other factors. Results are to be published by the society in June.



Said a mouse, with a terrible sneeze,
"Space travel is surely no breeze,
What with dips in the ocean
And orbital motion
And a moon that's not really
green cheese!"

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Advancement Your Goal? Use CONFIDENTIAL Action Form

ELECTRONIC DESIGN's Confidential Career Inquiry Service helps engineers "sell" themselves to employers—*as confidentially and discreetly as they would do in person.* The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

To present your job qualifications immediately to companies, simply fill in the attached resume.

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.

ELECTRONIC DESIGN will act as your secretary, type neat duplicates of your application and send them to all companies you select—*the same day the resume is received.*

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. Safeguards include:

- All forms are delivered unopened to one reliable specialist at *ELECTRONIC DESIGN.*
- Your form 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.

If you are seeking a new job, act now!

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(Please print with a soft pencil or type.)

Name _____ *Telephone* _____

Home Address _____ *City* _____ *Zone* _____ *State* _____

Date of Birth _____ *Place of Birth* _____ *Citizenship* _____

Position Desired _____

Educational History

College	*Dates*	*Degree*	*Major*	*Honors*

Recent Special Training _____

Employment History

Company	*City and State*	*Dates*	*Title*	*Engineering Specialty*

Outstanding Engineering and Administrative Experience _____

Professional Societies _____

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

900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924
925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949

ENGINEER-IMPROVEMENT COURSES AND SEMINARS

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

National Courses

Product and Brand Management Course, New York City

The Marketing Division of the American Management Association will inaugurate a new course in product and brand management the week of May 2, at the Hotel Astor, New York City.

The new two-week program is designed to increase the ability of the product manager to develop a "total marketing" effort behind his product, brand or product group. Course sessions will be divided into two non-continuous units. The first group will meet May 2-6 and June 20-24.

The first unit of the course will focus on the way in which the product manager develops plans for his product or brand; the second will stress the execution, control and evaluation of these plans. Lectures by marketing executives will be supplemented by case studies and project sessions. In addition to general sessions for all registrants, separate group meetings for product managers from consumer goods industries and industrial products firms will be featured in the program.

A second course session will begin Aug. 15-19 on the campus of Colgate University in Hamilton, N. Y. and will conclude in New York Sept. 19-23. A third course has been scheduled for New York Oct. 24-28 and Nov. 28-Dec. 2. *For further information write American Management Association, 1515 Broadway, Times Square, New York 36, N. Y.*

Space Vehicle Guidance Series, University of Michigan

The Institute of Science and Technology at the University of Michigan is sponsoring a seminar series on space vehicle guidance. On May 4 and 5, Lester M. Field (Ph.D.), associate director of research, Hughes Aircraft Corp., will address the group on "Space Communication." Prof. Samuel Silver of the University of California's Electrical Engineering Dept. will lecture on "Antennas and Antenna Techniques" May 25 and 26. The lectures will be held at 3:30 pm each day in the

CIRCLE 906 ON READER-SERVICE CARD ➤

Opportunities in Systems Development

Placing the man in a man-machine system

The operator shown above is on duty at the radar display console of an air defense system.

How effective would this system be if the operator were unable to detect the direction of movement of a target because of flickering noise pips?

Interestingly enough, this was the case. The solution to the problem came from fundamental studies by IBM systems engineers and engineering psychologists.

Data was collected on the performance of individuals at the display in relation to the rate at which the radar trails were presented. The display was redesigned by systems engineers to present radar trails at a much higher rate—making the radar data clearly visible at all times by reducing its "on-off" character.

Engineering and human factors

At IBM, when an engineering team first meets to set up the requirements for a system, the possible extent and nature of human participation are carefully analyzed. Before a prototype is built and tested, design recommendations are made based on simulation research. Task and system function analysis are employed to develop and improve total system operability and reliability.

New theories answer future questions

The IBM systems specialist has ample opportunity to investigate general theories which might answer future questions concerning the characteristics of man communicating with machines.

Studies are being conducted on decision-making, memory and learning processes, and constrained handwriting as a data processing technique.

Opportunities for achievement

But perhaps human factors engineering is not your primary interest. You might be more interested in what IBM people are doing in semiconductors, inertial guidance, or microwaves. Or the advances they are making in cryogenics and optics. In all these fields, you'll find IBM offers a world of opportunity for engineering achievement.

Right now, there are several key openings in IBM's expanding research and development staff. If you have a degree in engineering, mathematics, or one of the sciences—plus experience in your field—please write, describing your qualifications, to:

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CAREER COURSES

Cooley Memorial Laboratory, North Campus. For information contact: *Chuck Wixom, University of Michigan, Ann Arbor, Michigan (NOrmandy 3-1511, Ext. 2955).*

Regional Courses

Course in Electronic Packaging for Design Engineers, UCLA, May 2-13, Los Angeles

An intensive two-week course in Electronic Packaging for Design Engineers, covering fundamentals and new developments in the field, will be held at UCLA.

Emphasis will be on military specifications, and on the three major areas of schematic diagrams, wiring diagrams, and general design considerations for the mechanical placement of electronic components, according to Sol Maniloff of Frank Mayer Engineering Company, who will be the instructor. Enrollment will be limited. Information on the course and housing accommodations may be obtained through Engineering Extension, University of California, Los Angeles 24 (BRadshaw 2-26161, Ext. 369).

PAPER DEADLINES

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

May 16: Deadline for 10 copies of an 800-word abstract for the **Seventh National Symposium on Reliability and Quality Control in Electronics,** jointly sponsored by the IRE, the AIEE and the ASQC to be held **January 9-11, 1961,** at the Bellevue-Stratford Hotel, Philadelphia, Pa. Abstract should include the title of the paper (not to exceed 50 letters, including spaces), the author's name, position and affiliation. In the case of more than one author, please indicate who will present the paper. 10 copies of a biographical sketch of each author must accompany the abstract. Authors will be notified of acceptance by June 27, 1960. Final papers will be due October 10, 1960. Send abstracts and biographical sketches to: *R. E. Kuehn, IBM Oswego, Oswego, N. Y.*

May 31: Deadline for 3 copies of a 1000-word abstract for a **Symposium on Adaptive Control Systems,** sponsored by the Long Island Section of the IRE, to be held **October 17, 18, and 19** at the Garden City Hotel, Garden City, Long Island, N. Y. Suggested topics include: theoretical aspects, practical realization and experimental results, and analytical techniques. Final manuscripts of accepted papers will be due August 31, 1960. Send abstracts to: *Harold Levenstein, Chairman of the Program Committee, in care of W. L. Maxson Corp., 460 W. 34th St., New York 1, N. Y.*

ENGINEERS
SCIENTISTS

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CIRCLE 911 ON CAREER INQUIRY FORM

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April 27, 1960

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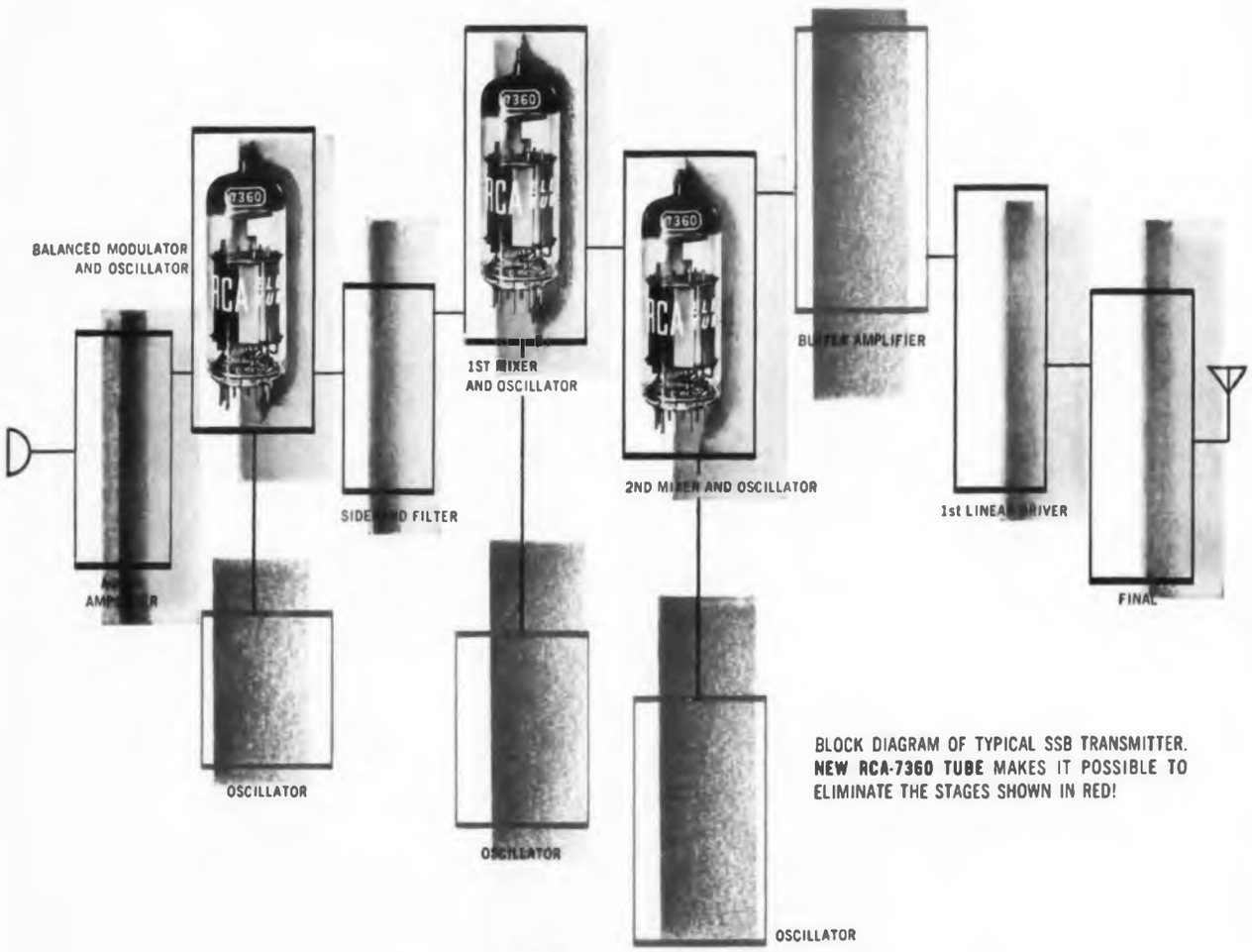

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