ELECTRONIC DESIGN

JULY 22, 1959

TRANSISTOR SELECTION CHART

1959

HIGHLIGHTS OF ISSUE

CONTENTS FOR JULY 22, 1959 VOL. 7 NUMBER 15

ELECTRONIC DESIGN Hayden Publishing Co., Inc., 830 Third Avenue, New York 22, N. Y.

NEWS

EDITORIAL

TRANSISTOR DATA CHART

FEATURES

DEPARTMENTS

CIRCLE 2 ON READER-SERVICE CARD ➤

STAFF

EDITOR: Edward E. Grazda; *MANAGING EDITOR:* J. A. Lippke; *ASSOCIATE EDITORS:* L. D. Shergalis, G. H. Rostky, H. Bierman; *ASSISTANT EDITORS:* T. E. Mount, D. S. Viebig, L. N. Tolopko, A. Corneretto, F. Muehleck, A. Caprioglio; *EDITORIAL ASSISTANTS:* M. S. Buckley, J. R. Feder, A. M. Sickler, A. R. Abramoff, R. N. Ross; *ART DIRECTOR:* R. A. Schulze; *TECHNICAL ILLUSTRATOR:* B. L. Armstrong; *ART ASSISTANTS:* C. Bank, M. J. Malatak; *PRODUCTION MANAGER:* T. V. Sedita; *ASST. PRODUCTION MANAGER:* H. DePolo; *PRODUCTION ASSISTANT:* M. C. Alexich; *CIRCULATION MANAGER:* N. M. Elston; *ASST. CIRCULATION MANAGER:* A. C. Lovett; *READER SERVICE:* J. E. Medina.

CO-PUBLISHERS

T. Richard Gascoigne
James S. Mulholland, Jr.

SUBSCRIPTION POLICY

ELECTRONIC DESIGN is circulated only to qualified electronic design engineers of U. S. manufacturing companies, industrial consultants, and government agencies. If design for manufacturing is your responsibility, you qualify for subscription without charge provided you send us the following information on your company's letterhead: Your name and engineering title, your company's main products, and description of your design duties. The letter must be signed by you personally.

ANY ADDRESS CHANGES FOR OLD SUBSCRIBERS NECESSITATE A RESTATEMENT OF THESE QUALIFICATIONS. Subscription rate for non-qualified subscribers—$25.00 per year U.S.A., $30.00 per year all other countries. Single copy $1.50.

ADVERTISING REPRESENTATIVES

ADVERTISING SALES MANAGER: Bryce Gray, Jr.; *NEW YORK:* Owen A. Kean, Robert W. Gascoigne, Richard Parker, Blair McClenachan, James P. Quinn *830 Third Avenue, PLaza 1-5530; CHICAGO:* Thomas P. Kavooras, Berry Conner, Jr., Fred T. Bruce *664 N. Michigan Avenue, SUperior 7-8054; LOS ANGELES:* Robert E. Ahrensdorf, John V. Quillman, Stanley I. Ehrenclou *3275 Wilshire Blvd., DUnkirk 2-7337; SOUTHEASTERN:* Lucien Neff *15 Castle Harbour Isle, Fort Lauderdale, Florida, LOgan 6-5656.*

NBP BPA

ELECTRONIC DESIGN is published bi-weekly by Hayden Publishing Company, Inc., 830 Third Avenue, New York 22, N. Y., T. Richard Gascoigne, President; James S. Mulholland, Jr., Vice-President-Treasurer; and David B. Landis, Secretary. Printed by Hildreth Press, Bristol, Conn. Accepted as controlled circulation at Bristol, Conn. Additional entry, New York, N.Y. Copyright 1959 Hayden Publishing Company Inc. 36,150 copies this issue.

Electrostatic Printing Process

Paves Way for . . . *Faster Computer Output*
. . . *High Speed Facsimile Printing*
. . . *Remote Display of 'Live' Subjects*

USING a completely new component, printers have been developed which can keep pace with some of today's fastest digital computers. The new component, an electrostatic printing tube, enables printout of 20,000 characters per sec. That's about ten times the rate possible with conventional electromechanical printers.

The Paper Flies

With this new "Videograph" process a printer can spew forth three printed sheets of 8-1/2 x 11 in. paper per sec—180 ft of paper a minute. This paper format can carry six lines per vertical in. with 100 letters, numbers, or symbols per line.

Prints What the Eye Can See

The Videograph Printer, developed by the A. B. Dick Co. of 5700 W. Touhy Ave., Chicago, Ill., can record anything visible to the human eye. It can reproduce graphic material such as original documents, microfilm records, or photographs. It can even print out pictures of objects moving in front of a specially adapted TV camera.

In this last application it has been used to provide permanent remote records of railroad freight cars moving into and out of marshalling yards. Pictures of trains moving past the camera station, while not as sharp as good photographs or television images, can still provide valuable information (car numbers, railroad designation, etc.), and can be referred to later.

Printing Tube Uses TV-like Scan

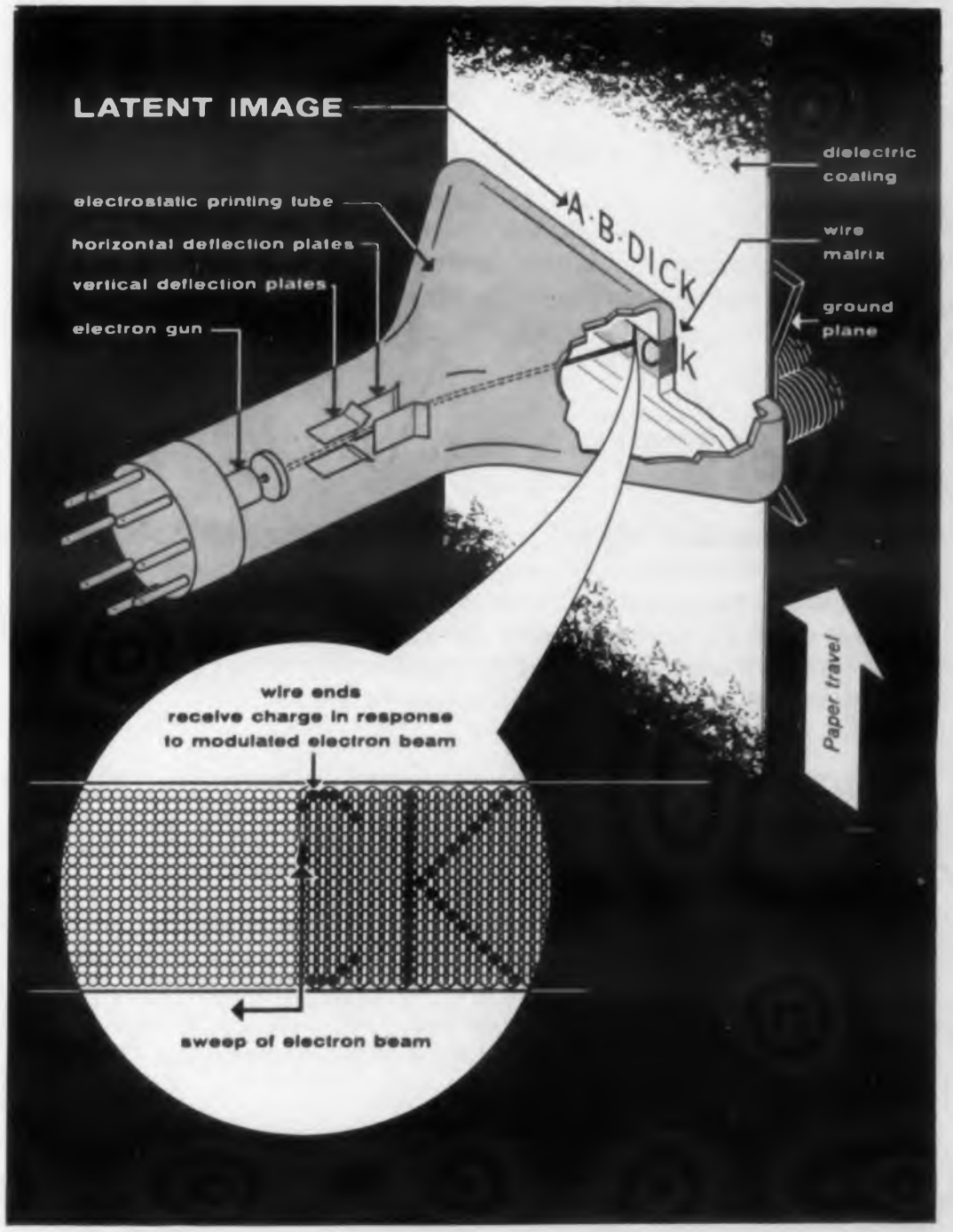
At the heart of the Videograph process is an electrostatic printing tube developed for A. B. Dick by the Stanford Research Institute at Menlo Park, Calif. This EPT is basically a cathode ray tube with a flared, rectangular faceplate. The glass faceplate supports a matrix of 250 stainless steel wires per in.

The EPT's electron gun fires a beam which is swept across the ends of the fine insulated wires. The beam is modulated by video signals applied to the grid of the electron gun.

How the Printing Tube Works

The modulated electron beam forms a pattern of negative charges on the wire ends. This charge pattern, corresponding to the desired image, is transferred to the paper, which is carried past the front of the tube. There it forms a latent electrostatic image as shown in the accompanying drawing.

(Continued on following page)



Basic operation of the electrostatic printing tube. The fine wire ends leave a negative charge pattern on the paper. This pattern later attracts positively-charged powder which is fixed by heat to form a permanent printed image.

NEWS

Videograph printer which can print 20,000 characters per second. The opened door at the left conceals the cabinet which houses the drive circuitry for the printing tube and the power supplies. The printing tube is housed above the opened left door. The paper drive is in the upper part of the photo.

Normally concealed by the left door are the character generator and code-conversion circuitry.

This negatively-charged latent image on the moving paper then attracts a positively-charged, pigmented, thermoplastic resin powder. The powder adheres to the paper to form a visible image. The image is then fixed permanently as the paper passes before a heater.

Two Basic Signal Sources

The video signals applied to the grid of the electron gun in the EPT may originate at two types of sources. For non-digital applications, the signal may start at a remote scanner which includes a modified television type camera. The signals may travel great distances over coaxial cables or microwave links.

When the printer is used with digital data processing equipment, the signals come from a character generator which converts a parallel six-bit pulse code from the digital equipment into video information. ■ ■

Correction

The Arthur D. Little min-IR-cooler for [illegible]rared cells pictured in the June 10 issue of ELECTRONIC DESIGN should have been described as h[illegible]g of 0.25-in. diameter and able to cool to −213 [illegible]. The proposed maser cooler will chill to −271 [illegible].

BBC Sends Video Photos Through Atlantic Cable's 4.5-kc Channel

Compression of video signals into a narrow telephone-cable channel has made possible the fastest transmission so far of TV pictures across the Atlantic Ocean.

The process, developed by the British Broadcasting Corp., has successfully relayed short news telecasts of Queen Elizabeth II between Great Britain and the United States and vice versa.

Transmission with the new process, which squeezed a usable moving image into the cable's 4.5-kc channel, was at the rate of about an hour for each 30 seconds of TV film; every second frame of a 16-mm news film was sent. This is still too slow for transmission of full-length TV programs, but it is said to be 75 times faster than previous methods of facsimile transmission. Picture channels in the U. S. are normally 4 mc.

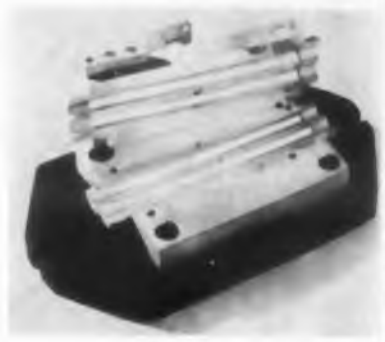
The system is described as a "break-down and build-up" one, in which the video signal from a film scanner is used to modulate a carrier for transmission. At the receiving station, the signals are demodulated and used to operate a slow-speed film telerecorder.

Development of the process is viewed as an important step toward the goal of intercontinental live television. And the signal-compression feature may prove important in permitting more broadcasting stations of all types to find room on the air.

Yes, It Works

Working model of solar-powered thermoelectric generator can produce 2.5 w according to its designers, Niles F. Shuh, of Westinghouse, (left), and Ralph Talley of Boeing.

A stream of ammonia molecules will be sent through this glass tube to . . .
The twin resonant cavity of the maser portion of the atomic clock to be orbited in a check on Einstein's Theory of Relativity. The clock is expected neither to gain nor lose one second per thousand years.



U. S. Will Orbit Maser Clock

In New Check on Relativity

HUGHES Aircraft Co. will develop for the National Aeronautics and Space Agency an ammonia maser clock weighing about 30 pounds with batteries and occupying roughly half a cubic foot.

The extremely compact, accurate clock will be orbited in an 18,000-mph satellite to check Einstein's proposition that a clock running in a different gravitational field above the earth would apparently run fast relative to a clock on the ground.

This is the primary purpose of the project. After the check is made, Hughes would like to use the clock satellite to:

- Measure precisely the earth's shape. The atomic clock would permit accurate timing of signals and would make exact triangulation possible.
- Investigate whether space is the same in all directions. The velocity of light could be measured for different satellite speeds and directions.
- Measure the velocity of light or radio waves.

The electronically controlled maser clock will work this way:

A beam of ammonia molecules with N^{15} atoms in their nuclei will be sent through a chemically evacuated tube to a double-resonant cavity, where the molecules will release their energy as 24,000-mc waves—the vibrating frequency of the nitrogen atoms in the ammonia molecules.

The high-frequency emissions will drive a phase-locked servo in a frequency-divider circuit that will synchronize a low-frequency quartz crystal timer with the maser clock.

Gold-bonded germanium diodes will be used in the maser clock. Ultimately all the circuitry will be transistorized.

The clock will be designed for life of 500 hours. ■ ■

SS Designs in BuAer's 'Preferred Circuits'

Included in the new supplement to the "Preferred Circuits" handbook of the Navy Bureau of Aeronautics are two transistorized circuits: a power supply for a 7 kv crt, and a video amplifier.

In the second supplement to the handbook, due next month, two more transistorized circuits will be included.

Other designs in the current publication are: five instrument servo circuits, two dc regulator circuits, and a pulsed automatic frequency control with a 30 mc if.

The handbook and its supplements, intended to help designers reduce the number of circuits serving similar functions, are outgrowths of a six-year-old study that showed about 100 circuits could be used in more than 70 per cent of military electronic equipment without performance loss.

Unused Corporate Patents Sought

Patents, processes and ideas shelved by companies for lack of a natural outlet are being sought for exploitation by a new concern, the National Patent Development Corp. National Patent, with offices in New York and Washington, acts as agent in selling or licensing the unused discoveries to other companies prepared to develop and manufacture them.

Soviet Fuel Cells Burn Gasoline

Russian researchers have reported demonstrations of fuel cells that burn gasoline. Experimental solid-electrolyte cells, although short-lived, were said to have developed a current of 1 to 1.5 amp at a potential of 0.5 to 0.7 v. The cells were found to work best at temperatures from 700 to 750 C.

The electrolyte was prepared by high-temperature mixing of sodium carbonate, sodium silicate, cerium dioxide and tungsten trioxide.

CIRCLE 7 ON READER-SERVICE CARD ➤

NEWS

Plan 100-ft Diam Dish

A radar dish scanner 1000 feet in diameter has been designed by Cornell University scientists for construction in a limestone sink in Puerto Rico.

To operate in conjunction with an extremely powerful radar, the scanner will be used to study electrical properties of the atmosphere on Venus. The device is expected to collect electron density and temperature more quickly than satellites could.

Saturn Could Put One Ton on Moon

The Saturn space vehicle, with 1,500,000 pounds of thrust, could land 1000 to 2000 pounds of scientific instruments gently on the moon, according to the Army Ballistic Missile Agency.

Baseline Guidance Paper Wins $250 Carlton Award

Winners of the first M. Barry Carlton Award for the best paper published in the IRE Transactions on Military Electronics receive checks from E. A. Speakman, national chairman of PGMIL. Both R. S. Grisetti, center, and E. B. Mullen, right, are with General Electric defense systems department. Their paper, "Baseline Guidance Systems," surveyed guidance and tracking of space vehicles. One conclusion was that, in principle, "extremely long baselines switching from the earth to an artificial satellite or even the moon are feasible and offer exciting possibilities for the guidance of interplanetary vehicles."

CIRCLE 8 ON READER-SERVICE CARD

High-Powered Radar Studies Vertical Incidence Scatter

A new method for studying the physics of the upper atmosphere makes use of radar techniques and improves on rocket methods for long-time studies.

By using a high-power vhf radar transmitter and special antenna, the National Bureau of Standards is experimentally observing vertically returned scattering from all levels of the atmosphere. It has detected scattering results from altitudes up to 400 miles.

Signals of 41 mc generated by a 6-megawatt-peak-power transmitter are pulsed into a specially designed fixed antenna and sent into space. Beam width of the antenna is about 4 degrees. Pulses range from 50 to 150 μsec repeated often enough to maintain an average power of 40 kw.

The equipment has been placed near Long Branch, Ill., and is expected to work at greater ranges when the present experimental setup is refined.

These dipoles are part of a 4-acre array of 1024 dipoles mounted 4.5 feet above a ground reflecting screen to study vertical incidence scatter from the ionosphere.

Experimental Tunnel Diode Operated at Over 1000 mc

A pinhead-sized tunnel diode, reported capable of performing nearly all the functions of a standard, low-power transistor, has been developed by the Radio Corporation of America.

The experimental device has been fashioned from a piece of germanium crystal 0.003 in. in diameter. It has been operated in the laboratory, RCA reported, at frequencies higher than 1000 mc with a potential range beyond 10,000 mc.

The tunnel diode has been applied in a new, simplified amplifier circuit, said to have performance characteristics similar to those of the parametric amplifier.

NEWS

What's Happening in Color Television

IT DEPENDS on whom you listen to. A survey of color TV technology by ELECTRONIC DESIGN reveals two kinds of thinking. Most of the industry feel that open-circuit color TV has been carried as far as current technology permits, that color TV will never really blossom until a radical technical breakthrough leading to simplified, low-cost sets is achieved, and that advanced research rather than development of present systems is in order at this time.

Some companies, most conspicuously RCA, feel that the age of color TV is here —now—that the shadow-mask tube gives performance adequate enough to set off mass acceptance of the present dot-sequential system. Admiral is backing this thinking with money: the company has announced plans to produce color TV sets for August delivery. These will use the RCA tube.

What about other systems?

DuMont Labs is still proceeding slowly

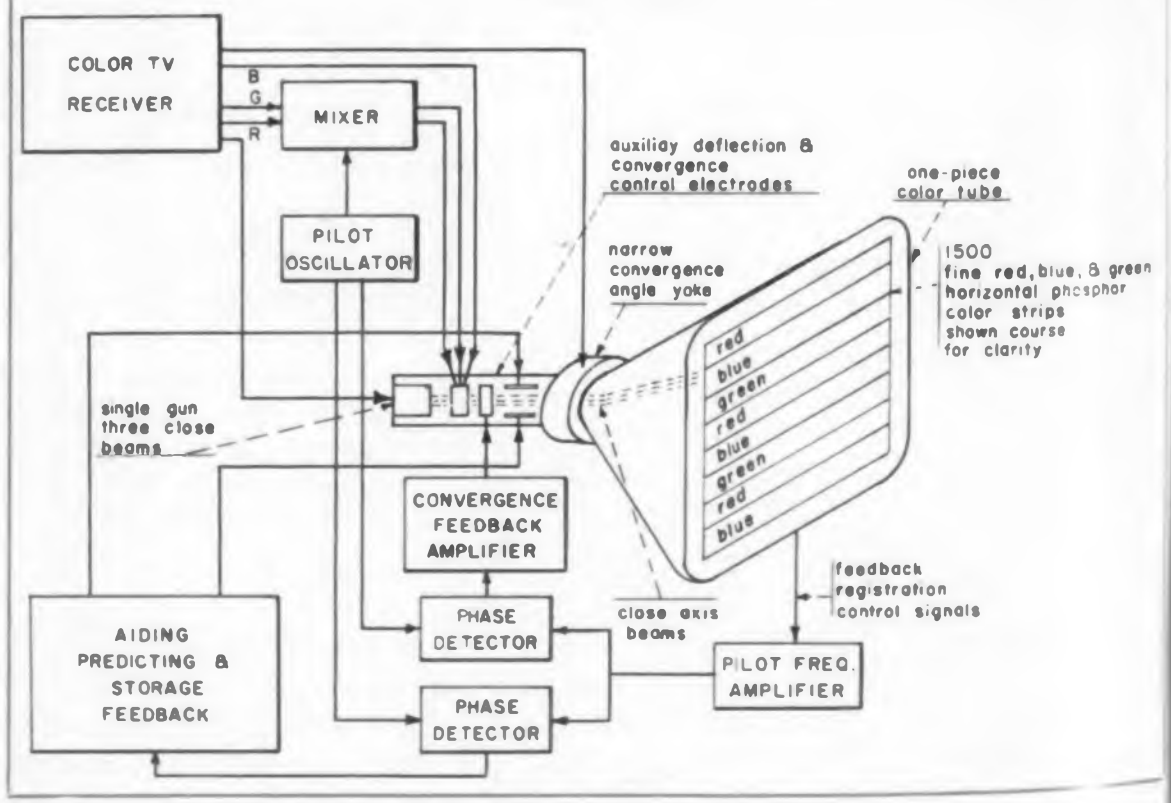
Color TV System is Designed Around Single-gun Tube

Aided feedback correction of color registration is claimed to be key principle of this color TV system. The aided feedback is said to permit use of horizontal color strips in a relatively inexpensive one-piece, single-gun tube.

The proposed tube has three closely spaced beams that are independently modulated. The green and red beams are modulated by a weak 10 mc pilot carrier said to cause no practical interference to signal, which is picture dark regions.

Feedback detection of registration errors is achieved by either phototube or secondary emission sensing and phase detection whenever the pilot frequency beams strike the blue phosphor or secondary emission surface over the blue strips. Over-all vertical deflection as well as convergence are corrected by the feedback.

Though no working model has been developed yet, parts of the system have been tested with good results, according to the designer, Andromeda, Inc. of Kensington, Md.



on development of the single-gun Lawrence tube that makes use of phosphor strips on the tube screen. This work is being carried out under a contract from another ABC-Paramount subsidiary, Chromatic Labs.

Philco's "apple" tube, a beam-index design, is also still under development, though, sources outside Philco say, on a very modest scale.

The only other recent tube design announced in detail is the Andromeda, Inc., system, which strongly resembles the apple design. (See box for design details.) The company hopes to interest the large manufacturers in its proposed system. No working models have been developed, however.

What are the other companies doing?

Motorola, Sylvania, Emerson, and General Electric are conducting small-scale color TV research to maintain a nucleus of experts, but in general agree with the GE representative who recently said ". . . color TV's potential at its present level of development is of questionable consequence . . ."

The now-famous color experiments and theories of Dr. E. H. Land may have far-ranging effects on the future of color television. But the companies working on color TV are not talking about what these effects might be. Nor is Dr. Land; he has been quoted as having no opinion on the difficulty of making individual TV images of adequate quality and consistency based on implications of his work.

He has discovered, and the experiments of other companies have supported his findings, that waves reaching the eye appear to be not direct bearers of color information as previously thought, but are part of a coding system that helps the brain assign colors to objects seen.

He has been able to transmit color information as a ratio of the quantity of light of two wavelengths, and has taken light from two parts of the spectrum and produced pictures of many colors.

Dr. Land has made "some more-or-less routine" experiments with TV. And Bell Labs has obtained some occasionally good pictures with a 3-tube color projection system modified to use only a red and white tube.

If a green-filtered black and white picture is interlaced with a picture signal activating red phosphors on a receiver tubeface, as one writer has conjectured, a viewer might be able to see a satisfactory color picture, though blues would be of low quality. Such a system would be stable and simple.

But with the eye evidently designed to see natural scenes, with random color distribution, its subtlety could easily be lost in any artificially filtered, fragmented, two-color viewing situation.

For some designer, then, the biggest of all pots of gold is waiting at the new-approach end of TV's rainbow. ■ ■

The universe, as a 60-foot high aluminum shell, dominates the Soviet exhibit and serves as a dramatic backdrop for three Soviet Sputniks. Sputniks I's "ball" appears at the top of the photo. At the center is Sputnik II. Below it to the right is the nose of Sputnik III. Directly below the instrument package of Sputnik II is its nose cone and the doghouse which carried Laika.

What the Russians Are Showing . . . in New York

"This is the last stage of our cosmic rocket," say Russian exhibition guides. They didn't divulge how many stages there were. Through the windows, one can see . . .

. . . **the instrument container** with antennas folded forward. This package housed three chemical battery-powered radio transmitters, telemetering equipment, a magnetometer, micrometeor counters and equipment for studying the proton component of interplanetary matter. The ball weighs 80 pounds and has a diameter of 31 inches.

Asked about efforts at miniaturization, Russian guides explained that there was miniaturization but no concentrated drive to make things smaller. Their attitude: "Since plenty of lift power is available, why bother with new, small components which haven't proved themselves. We'd rather use tried and trusted reliable components."

Inside view of lots of Russian electronic equipment on display reveals resistors, capacitors, transistors, and tubes as tiny as American types. Transformers, for the most part, are much larger.

Russian transistors on display for the first time. At the lower right can be seen Russia's largest transistor. A germanium type, it can dissipate 100 watts. It is used in power converters. Faster transistor can oscillate at 400 mc, and has an alpha cutoff at 100 to 200 mc.

Russians manage with 39 transistor types and 25 diode types. Exhibition guides expressed pity for American engineers who had to cope with about 1000 transistor types and 4000 diodes.

THE USSR Exhibition of Achievements in Science, Technology, and Culture can reveal a lot to the perceptive engineering visitor—a lot that he can't find in even the most careful examination of Soviet technical literature. The show gives a visitor a first-hand view of Russian hardware.

At the three-million-dollar New York show, the Soviets are highlighting their most spectacular achievements—Sputniks. All but one of the Sputnik models on display were shown at the recent Agricultural and Industrial Exhibition in Moscow. Photographs of the models at the Moscow show appeared in the June 24th issue of ELECTRONIC DESIGN.

The one model which was not shown in Moscow is that of the last stage of "Lunik," the 3250 pound cosmic rocket fired at the moon on January 2, 1959. It is shown on these pages together with a view of the instrument container which can be seen through the windows of the model. ■ ■

(pictures continued on following page)

Important factors in specifying toroidal inductors

The powdered molybdenum permalloy toroidal inductor is finding increasing use in today's complex electronic equipment. Excellent magnetic stability, superior temperature stability, high Q values, and small physical size are but a few of the outstanding features which explain the popularity of molybdenum permalloy toroids. To fully realize the advantages of these inductors, the components application engineer must accurately specify those parameters which are of critical importance in a given application. "Under-specification" may result in a component which fails to give adequate performance in the circuit. "Over-specification", on the other hand, may result in a component of extremely high cost. An understanding of the factors involved in the design and manufacture of toroidal inductors at Sangamo will enable the components application engineer to effectively judge the consequences of his specification in relation to the cost and performance of the final product.

THE EQUIVALENT CIRCUIT of a toroidal inductor is illustrated in figure 1.

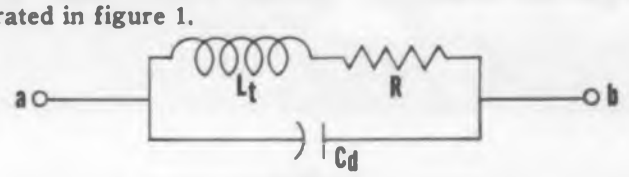


FIGURE 1

L_t is the so-called "true inductance" of the toroid and is assumed to be constant at all frequencies. R represents the sum of copper losses and core losses which increase with frequency. C_d, the distributed capacitance, approximates the capacitance between turns of the winding and between the winding and core. Due to the fact that the dielectric constant of the insulation on the windings and on the core itself is not constant with frequency, the distributed capacity will also vary with frequency. This variation, however, is usually small and may be neglected in the following discussion.

THE APPARENT INDUCTANCE (L_a) is the equivalent inductance between terminals (a) and (b). As might be expected, the apparent inductance varies with frequency. If R is neglected the expression for L_a becomes:

$$L_a = \frac{L_t}{1 - \omega^2 C_d L_t}$$

Inductors for single frequency or resonant circuit applications are usually specified in terms of apparent inductance. The standard tolerance on L_a is 1% or one turn whichever is greater.

THE Q FACTOR is usually specified in lieu of R since most applications are concerned with the ratio of inductive reactance to equivalent resistance. The accepted method of specifying Q is to set a limit on minimum Q at the operating frequency or over a range of frequencies. Normally, the Q of a given design at a given frequency will vary some 20% between units. Where direct current flows through the inductor it may sometimes be desirable to set a limit on the d-c resistance as well as on Q. Analysis of the equivalent circuit, assuming constant R, shows that:

$$Q_{equiv} = \frac{\omega L_t}{R} - \omega R C_d - \frac{\omega^3 L_t^2 C_d}{R}$$

From the above equation one may deduce that anything which increases the distributed capacitance must necessarily reduce the Q.

DISTRIBUTED CAPACITY becomes most important in wide band or multiple frequency applications, since C_d will determine the variation of L_a with frequency. The majority of users do not find it necessary to specify C_d. Where C_d must be specified, the accepted method is to set a limit on the maximum allowable distributed capacitance. An alternative method of specifying C_d is to set a tolerance on the apparent inductance to be measured at two different frequencies (usually corresponding to the upper and lower frequencies encountered in a given application). The design engineer controls the C_d by varying the method of winding the inductor. In decreasing order of capacity he may choose 1) random continuous windings; 2) progressive winding, or segmented winding. Unfortunately, winding costs increase as distributed capacity decreases. Wax or varnish impregnation will increase the distributed capacity. In applications where it is necessary to insure that L_a be reasonably constant over a wide frequency range, it is also usually desirable that L_a be reasonably constant with temperature and with time. These features are best achieved using a stabilized core, a low capacity winding, and an unfilled hermetically sealed enclosure. In this way, the undesirable effects of impregnation may be avoided.

REQUIREMENTS FOR STABILITY OF INDUCTANCE with temperature, with a-c voltage level, and with direct current are additional factors which will influence the cost and the size of a given inductor. Temperature stabilized cores are available only in certain core sizes and are, of course, more expensive than the standard unstabilized cores. High values of a-c voltage and direct current will lead to larger cores and increased cost.

The Sangamo design engineering department is ready to discuss your inductive components problems. Typical examples of specialty components designed and produced by Sangamo are described in engineering bulletin series IC-260. Address: Sangamo Electric Company, Inductive Components Section, Springfield, Illinois.

NEWS

Nosecone of sun-circling "Lunik" dominates prominent part of Soviet display.

Underwater TV uses a 625 line sinusoidal sweep with an image orthicon tube. Lens angle of view can be changed from 30 to 60 degrees electronically.

At the left rear is shown the miniaturized sweep generator and power supply chassis. At the bottom right, the tiny box is a remote control unit, behind which there is a remote monitor.

Inside view of the sweep generator and power supply chassis reveal components and layout very much like those in American systems.

All transistorized, general-purpose analog computer has 24 operational amplifiers including six integrators. Six of the 50 feedback networks are nonlinear. The computer contains 250 germanium transistors and 200 diodes. Most of the latter are silicon. A plug-in package is shown in the foreground.

New Radiotelescopes Announced: 2 for U.S.S.R., One Giant for U.S.

While the Navy was announcing recently the construction of a spectacular radiotelescope with a 650-foot diam rotating dish, the Soviet Union reported completion of a 98-foot fixed-dish radiotelescope and a 72-foot rotating instrument.

The U.S. telescope, now being built for scientific and military research near Sugar Grove, W. Va., 30 miles from where the National Science Foundation's 140-foot telescope is going up, will be by far the world's largest, dwarfing Great Britain's 250-foot Jodrell Bank Telescope and the 550-foot giant previously reported planned by the U.S.S.R.

The 20,000-ton dish of the Navy's telescope will be subject to such stress that servos will have to be used to keep individual sections of it in continuous alignment. Focusing will be controlled by an inertial guidance system.

The telescope's horn will be 100 feet high, and power requirements will be up in the thousands of kilowatts. Federal Communications Commission has established a 1000-square-mile "radio quiet" zone around the site.

Theoretical range of the telescope—38 billion light years—may exceed the size of the universe, according to some astronomers.

The U.S.S.R.'s recently completed 98-foot radiotelescope is dug into the earth and does not rotate, though the position of its horn can be changed. It was built primarily to study the sun and its three-centimeter waves.

NEWS

Ceramic Circuit Takes 1300 F Temperatures

Heat of 1300 F can't damage this moly-manganese circuit printed on alumina, according to its developer, Advanced Vacuum Products, Inc., of Stamford, Conn. A molybdenum-manganese compound, fired onto the alumina and brazed, is used for the wiring. Bonding is described as so adherent that it can't be removed without destroying the ceramic. The circuits are still in the development stage.

Mathematician Envisions Machine That "Thinks"

A "thinking machine" that would duplicate the learning ability of the human brain is being sought in research studies by a Lockheed mathematician.

The scientist, Dr. David G. Willis, has developed a mathematical model of a brain neuron. He believes that when the human neuron is excited, changes take place that permanently affect the cell's behavior whenever it is subsequently stimulated. By retaining a record of

◀ CIRCLE 16 ON READER-SERVICE CARD

their activities, the neurons function as memory elements, Dr. Willis says.

The mathematician, in a paper presented recently to a United Nations information-processing conference in Paris, described an experiment of his with a system of 288 neurons simulated on a digital computer.

"To demonstrate the memory properties of the system," he said, "we excite or inhibit each neuron in the matrix. One mode of excitation forces the neurons to respond in some particular pattern."

The results, Dr. Willis reported, show that when a pattern is forced with a particular excitation, it tends to repeat itself when the same stimulus is repeated.

"But," he added, "as we force more and more patterns with other excitations, they begin to interfere."

The interesting thing, the scientist said, is not the number of patterns but the way in which they interfere with one another. It is not unlike the way in which memories may be associated in the human brain, he reported.

"Devices of this kind," Dr. Willis concluded, "appear to be sufficiently powerful and flexible that we may eventually be able to use physical realizations of them to build, economically, machines which can solve pattern recognition and learning problems."

Designer Collects $340,000 For Anti-Radar Scheme

Dr. Otto Halpern, who rejected a $50,000 Navy offer in 1952 for his anti-radar ideas in use since late in World War II, has agreed to a Defense Dept. settlement of $340,000 for complete rights to his technique.

Dr Halpern was teaching at New York University when he conceived the idea of a wave-absorbing material that could be applied to equipment to scramble radar. He developed the idea at the Massachusetts Institute of Technology. The Navy's 1952 offer was made in response to Dr. Halpern's attempts to get a cash settlement.

CIRCLE 17 ON READER-SERVICE CARD ➔

NEWS

Electronic Unit Measures Liquid-Gas Change With Optics

An electronic device that senses the presence of liquids and any change from liquid to gas is under production.

The unit is basically a light switch, with a light source, optical prism, solar cell, miniaturized transistor amplifier and a relay. It has one moving part—the relay armature. The amplifier and relay are attached to a probe but can be separated for specific applications.

Light rays from a miniaturized bulb operate the sensor. The rays go down one side of the prism, are reflected internally from two 45-degree surfaces and sent up the other side to the solar cell. When the prism end of the probe is dipped in liquid, the refraction changes, and the rays pass into the liquid without internal reflection. When the prism is in gas, the rays are reflected internally.

The equipment, being built by the Pioneer-Central Division of Bendix Aviation Corp., can be used:

As a liquid flow-control signal for missile ground-support apparatus; in test devices; as part of fuel and oxidizer control systems to fill tanks and permit full use of fuels and oxidizers in flight; for stage separation of missiles when fuel has been completely used; in tank installations to sense liquid levels for rate of filling or percentage of capacity.

It will operate on 28 v dc with a response speed of 20 msec or less, the company reported.

Automatic Voice System Warns Pilot of Perils

An automatic alerting system that can announce to a pilot in a clear voice, "Warning! Do not land; your landing gear is not extended," or give other warnings has been developed for the Air Force.

Northrop's Nortronic Div. calls the system VIP (Voice Interruption Priority) and says it is the first automatic one using voice to alert pilots to dangers and to give them corrective directions.

Present versions of VIP can continuously monitor 12 potentially dangerous situations. If any of 12 sensors is activated by a dangerous condition, a prerecorded warning with remedial directions is set off. A logic network determines priority if other dangerous conditions occur while a warning is being given.

According to Nortronics, the system can be adapted to supply verbal checklists, procedure training instructions, and messages for airline passengers.

Cockpit TV Planned To Show Pilot His Exact Location

An attempt will be made to develop an aircraft television system that would show a pilot his exact position over the terrain under him.

A contract to determine the feasibility of the cathode-ray unit has been awarded to the Avion division of ACF Industries, Inc., at Paramus, N.J. Avion calls its instrument the Horizontal Navigation Situation Display.

The system correlates information fed into it by navigational computers and instruments and presents a closed-circuit TV picture of the terrain below the plane. A plane image, projected over this map, corresponds to the craft's exact position. Radar and tactical targets would be superimposed on the map, and all the pilot would do, once in range, would be to "fly" the image of his plane on the screen to the target.

The unit is being studied under the Army-Navy Instrument Program. Avion's contract was awarded by the Douglas Aircraft Co., which has prime responsibility for the Navy research in the program.

Robot Minds the Baby

World Wide Photo

An ever-nagging parental question—"Where did Junior go?"—is being answered electronically for one engineer in Lancashire, England. Using tin cans, pipes, wires, lights and other hardware, he built Robbie the Robot, here keeping an eye on Junior. When baby moves out of sight, Robbie lights up.

For high-reliability switching

Texas Instruments
2N705 Transistors
Available *Now* From
These Authorized TI Distributors:

EAST

BALTIMORE 30, Maryland
ELECTRONIC WHOLESALERS OF MARYLAND, INC.
3000 Washington Blvd./MI 4-7900

BOSTON 10, Massachusetts
LAFAYETTE RADIO
110 Federal Street/HU 2-7850

BUFFALO 16, New York
GENESEE RADIO & PARTS CO., INC.
2550 Delaware Avenue/DE 9661

CAMDEN 2, New Jersey
GENERAL RADIO SUPPLY COMPANY, INC.
600 Penn Street/WO 4-8560 WA 2-7037 (Phila.)

JAMAICA 33, New York
LAFAYETTE RADIO
165-08 Liberty Avenue/AX 1-7000

NEWARK 2, New Jersey
LAFAYETTE RADIO
24 Central Avenue/MA 2-1661

NEW YORK 6, New York
MILGRAY ELECTRONICS, INCORPORATED
136 Liberty Street/RE 2-4400

NEW YORK 13, New York
LAFAYETTE RADIO
100 Sixth Avenue/WO 6-5300

PITTSBURGH 5, Pennsylvania
RADIO PARTS COMPANY, INC.
6401 Penn Avenue/EM 1-4600

PLAINFIELD, New Jersey
LAFAYETTE RADIO
139 W. Second Street/PL 6-4718

ROCHESTER 5, New York
ROCHESTER RADIO SUPPLY CO., INC.
600 E. Main Street/LO 2-9900

SYRACUSE, New York
SYRACUSE RADIO SUPPLY CO.
620 S. Saline Street/GR 4-2927

WASHINGTON 1, D.C.
ELECTRONIC INDUSTRIAL SALES, INC.
2345 Sherman Ave., N.W./HU 3-5200

CENTRAL

CEDAR RAPIDS, Iowa
DEECO, INC.
618 First Street N.W./EM 4-2493

CHICAGO 80, Illinois
ALLIED RADIO CORPORATION
100 N. Western Avenue/HA 1-6800

CHICAGO 6, Illinois
NEWARK ELECTRIC CO.
223 W. Madison Street/ST 2-2944

CINCINNATI 10, Ohio
HERRLINGER DISTRIBUTING CO.
112 E. Liberty Street/GA 1-5282

CLEVELAND 15, Ohio
PIONEER ELECTRONIC SUPPLY CO.
2115 Prospect Avenue/SU 1-9410

DAYTON 4, Ohio
SREPCO, INCORPORATED
314 Leo Street/BA 4-3871

DETROIT 38, Michigan
FERGUSON ELECTRONIC SUPPLY CO.
2306 Puritan Avenue/UN 1-6700

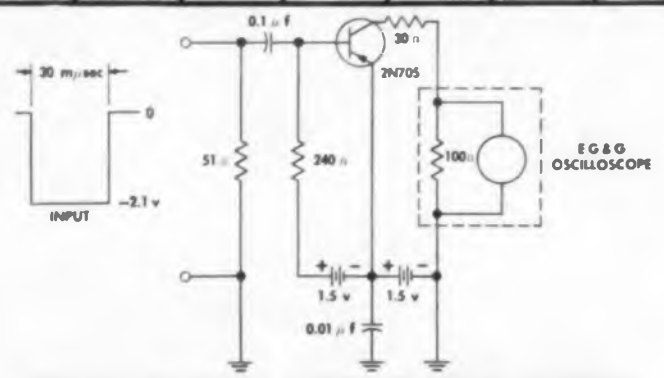
INDIANAPOLIS, Indiana
RADIO DISTRIBUTING COMPANY
1013 North Capitol Avenue/ME 5-8311

MINNEAPOLIS, Minnesota
STARK RADIO SUPPLY COMPANY
71 South 12th Street/FE 2-1325

APPLICATION NOTES

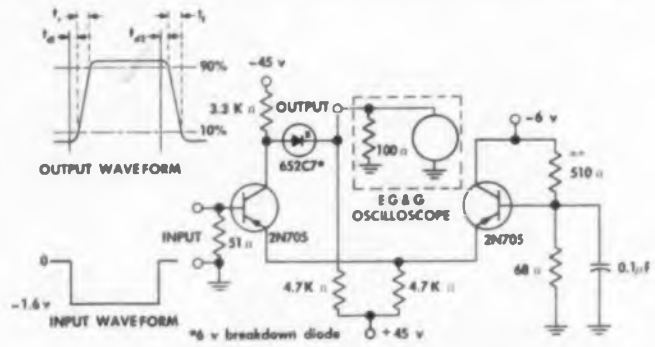
VOLTAGE SWITCHING CIRCUIT

t_d	t_r	t_s	t_f	$V_{BE(0)}$	$V_{BE(1)}$	$V_{BE(2)}$
5 mμsec	7 mμsec	7 mμsec	7.5 mμsec	1.5 v	−0.6 v	1.5 v



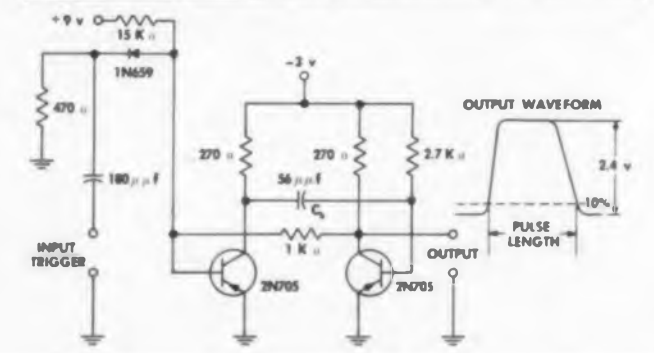
NON-SATURATING CURRENT MODE SWITCH

t_{d1}	t_r	t_{d2}	t_f
4 mμsec	3.6 mμsec	5.5 mμsec	10.4 m sec



MONOSTABLE MULTIVIBRATOR

t_r	t_f	Pulse length (depends on C_E)
20 mμsec	40 mμsec	120 mμsec



5 times actual size

Exact product uniformity and reproducibility is another benefit to you from TI's diffused-base production process. Maximum mechanical strength and high heat transfer characteristics are a direct result of mounting the wafer directly to the header.

Highest inherent reliability provided by diffused-base 'mesa' process

- Higher reliability because of lower operating junction temperature from the industry's highest dissipation germanium ultra-high speed switcher.
- Increased protection against surge voltages provided by diffused junction (rugged emitter-base junction) permits greater design freedom.
- Maximum resistance to shock and vibration is designed into all TI diffused-base products by fusing the semiconductor wafer directly to the header.

Actual Size

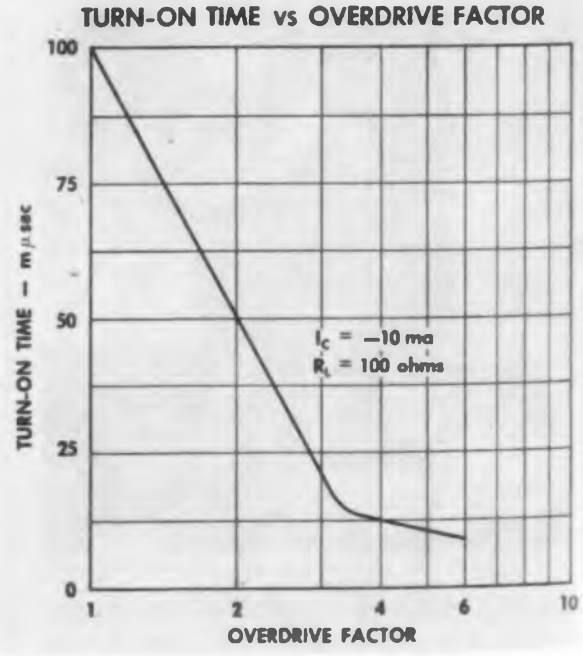
Now utilize the combination of *maximum* reliability and ultra-high speed switching furnished by TI 2N705's. Reliability is determined largely by device operating junction temperature. 2N705 *300-mw dissipation at 25°C case temperature and operation to 100°C junction temperature gives you three times greater power handling capacity* plus typical total switching times of 25 mμsec!

TRUE SWITCHING SPEED

A transistor's true switching speed in any circuit is dependent on the amount of over-drive designed in the circuit: Overdrive $= \frac{I_b h_{FE}}{I_{CS}}$

Below is the speed-up of 2N705's as a function of overdrive characteristics.

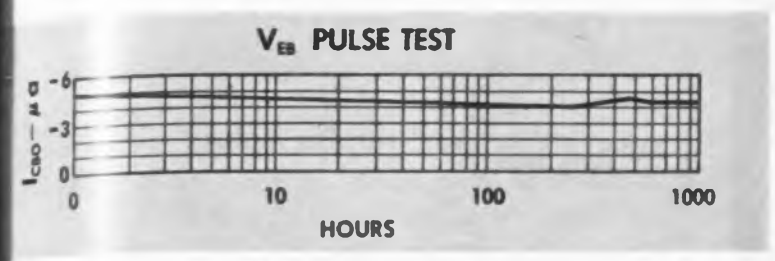
TURN-ON TIME vs OVERDRIVE FACTOR

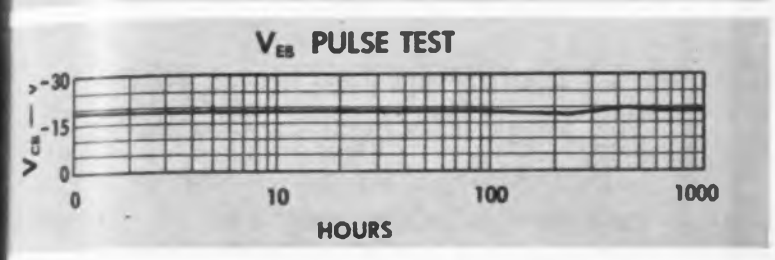


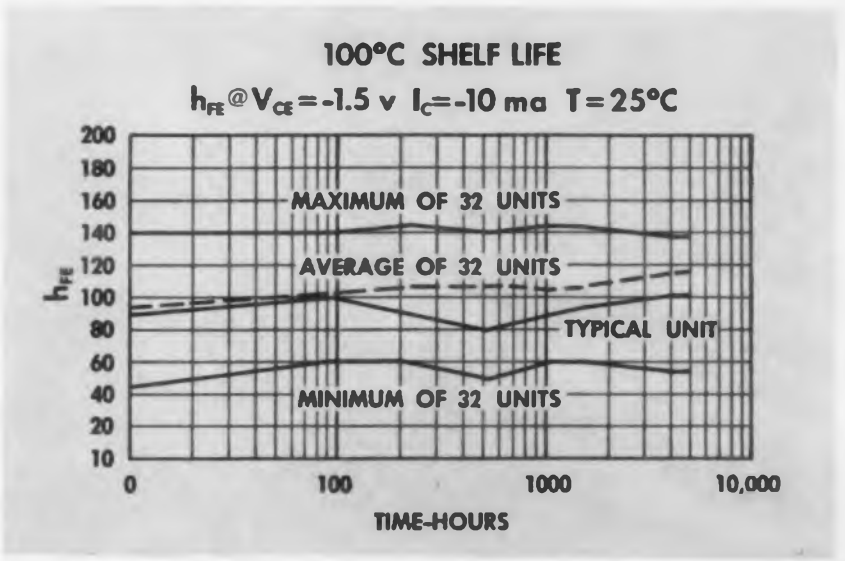
FROM THE WORLD'S LARGEST SEMICONDUCTOR PLANT

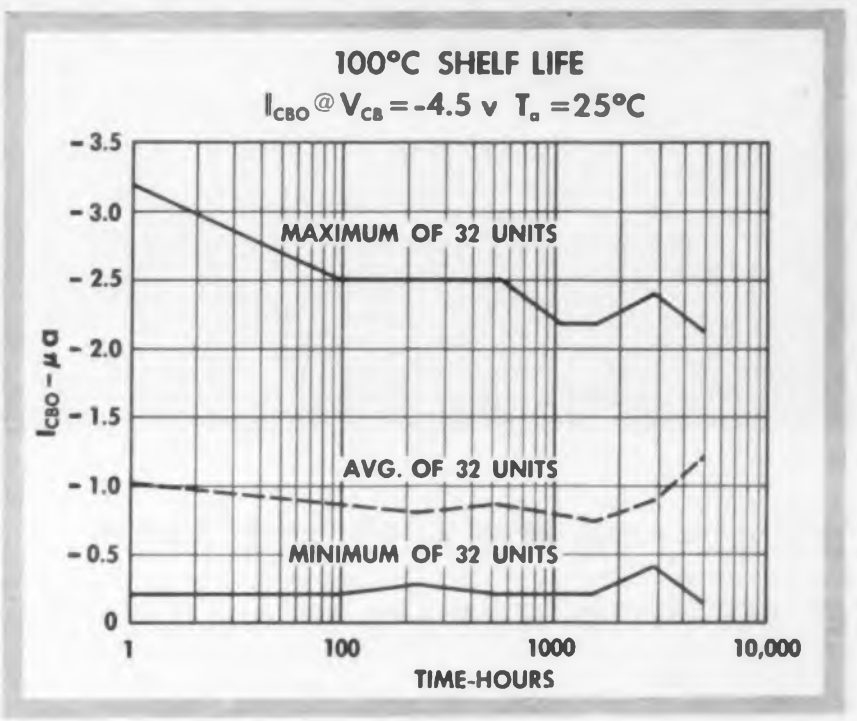
TEXAS

...TI 'mesa' transistors!









RELIABILITY INSURED BY RUGGED DESIGN, TEST

6000-hours life test data! Check the curves on the right for yourself and see how TI's 2N705 h_{FE} and I_{CBO} proved-performance characteristics apply to your high speed switching requirements. Also, for absolute assurance of conformance to specifications, all units are stabilized at 100°C for 100 hours and then 100% production tested!

Rugged Emitter-Base Junction

For an added design safety factor, consider the voltage surge tests shown above from which the graphic data on this page was obtained. In a circuit utilizing 2N705's a voltage pulse was applied to the emitter base diode in sufficient magnitude that it resulted in breakdown of the emitter base diode, causing flow of a 1, 5 and 10 ma current in each of three separated device groups. This test was continued for 1000 hours and all test data indicated that device characteristics I_{CBO}, h_{FE}, V_{EB}, and V_{CB} were *unaffected by this 1000 hour pulse test.*

Also remember, *every Texas Instruments semiconductor product is guaranteed for one full year to published min/max ratings!*

Absolute maximum ratings at 25°C case temperature (unless otherwise specified)

	2N705	2N710
Collector-Base Voltage	– 15 v	– 15 v
Emitter-Base Voltage	– 3.5 v	– 2.0 v
Collector-Emitter Voltage	– 15 v	– 15 v
Storage Temperature Range	–65 to +100°C	
Emitter Current	– 50 ma	– 50 ma
Collector Current	– 50 ma	– 50 ma
Collector Junction Temperature	+100°C	+100°C
Total Device Dissipation	300 mw*	300 mw*

* Derate at 4 mw/°C. This is equivalent to a maximum power rating of 300 mw at a case temperature of 25°C. The power rating in free air at 25°C is 150 mw.

Evaluate the data on these pages for your requirements and call your nearby TI sales office for complete price and delivery information . . . or contact your authorized TI distributor for off-the-shelf overnight delivery!

Write on your company letterhead describing your application for specific details on TI products.

INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
13500 N. CENTRAL EXPRESSWAY
POST OFFICE BOX 312 • DALLAS, TEXAS

CIRCLE 20 ON READER-SERVICE CARD

Texas Instruments
2N705 Transistors
Available *Now* From
These Authorized TI Distributors:

SOUTHWEST

ALBUQUERQUE, New Mexico
MIDLAND SPECIALTY COMPANY
1712 Lomas Blvd., N.E./Tel: 7-0236

DALLAS 35, Texas
ENGINEERING SUPPLY COMPANY
6000 Denton Drive/FL 7-6121

EL PASO, Texas
MIDLAND SPECIALTY COMPANY
500 W. Paisano Drive/KE 3-9555

HOUSTON 2, Texas
HARRISON EQUIPMENT COMPANY, INC.
1422 San Jacinto/CA 4-9131

TULSA 10, Oklahoma
ENGINEERING SUPPLY COMPANY
1124 East 4th Street/DI 3-8121

SOUTHEAST

ATLANTA 13, Georgia
ACK RADIO SUPPLY CO. OF GEORGIA
331 Luckie Street, N.W./JA 4-8477

BIRMINGHAM 5, Alabama
ACK RADIO SUPPLY COMPANY
3101 Fourth Avenue South/FA 2-0568

MELBOURNE, Florida
ELECTRONIC SUPPLY
909 Morningside Drive/PA 3-1441

MIAMI 32, Florida
ELECTRONIC SUPPLY
61 N.E. Ninth Street/FR 7-2511

ORLANDO, Florida
ELECTRONIC SUPPLY
GA 5-1717

ST. PETERSBURG, Florida
ELECTRONIC SUPPLY
OR 1-5171

WEST

DENVER 4, Colorado
DENVER ELECTRONIC SUPPLY COMPANY
1254 Arapahoe Street/AM 6-1671

GLENDALE 1, California
R. V. WEATHERFORD COMPANY
6921 San Fernando Road/VI 9-2471

LOS ANGELES 15, California
RADIO PRODUCTS SALES, INC.
1501 S. Hill Street/RI 9-7471

WEST LOS ANGELES 64, Calif.
CALIFORNIA ELECTRONICS SUPPLY, INC.
11801-11 W. Pico Blvd./BR 2-2124

OAKLAND 7, California
ELMAR ELECTRONICS
140 Eleventh Street/TE 4-3311

PHOENIX, Arizona
ADIO SPECIALTIES AND APPLIANCE CORP.
917 North 7th Street/AL 8-6121

SALT LAKE CITY 10, Utah
STANDARD SUPPLY COMPANY
225 East Sixth South Street/EL 5-2971

SAN DIEGO 1, California
RADIO PARTS COMPANY
2060 India Street/BE 9-9361

SEATTLE 9, Washington
WESTERN ELECTRONIC SUPPLY CO.
717 Dexter Avenue/AT 4-0200

TUCSON, Arizona
STANDARD RADIO PARTS, INC.
218 N. First Avenue/MR 3-2545

WASHINGTON REPORT

Ephraim Kahn

Ruling on Purchases Aiding Small Electronics Companies

The whip hand in government buying from small companies, including those in electronics, has been handed to the Small Business Administration by the Controller General. A recent decision says, in effect, that Congress puts the judgment of the Small Business Administration above that of the Defense Department when it comes to judging the qualifications of bidders for defense contracts.

The ruling by the Controller General came after the Assistant Secretary of the Army (Logistics) had inquired into the Army's rejection of a low bid on a procurement set aside for small companies. The Army had decided that the low bidder was not "responsible." It had based its decision on an opinion of the Signal Supply Agency's Contractor Evaluation Board that the company lacked "know-how" and that this had resulted in the past in deficient performance of military contracts.

The Controller General, after checking the laws, noted that the Small Business Act of 1958 directed those who bought for the government to accept "as conclusive" the Small Business Administration's certification of the "capacity and credit" of small companies bidding on government contracts.

Army Protest Rejected

In rebuttal, the Army said that the law also required military contracting officials to conduct their own evaluations of bidders and that some of the criteria to be employed included technical organization, size, experience and reputation. Extending the term "capacity" to cover "know-how," the Army protested, would require it to surrender its statutory duty. It would, the Army said, "impair the ability of the military departments to properly perform their mission of safeguarding the national security."

Then the Controller General's office went to work. It reviewed the legislative history of small-business legislation. And it arrived at the conclusion that Congress intended to let the Small Business Administration decide whether small compa-

nies ha the technical ability to do jobs for the governm nt.

Air Force Using Check List

In li with the tendency in Congress to be solicito of the welfare of small business, the Air Force is urging prime contractors for weapons systems (and their major subcontractors) to farm out more work to little companies. At present participation in the Air Force drive is voluntary. If the results are satisfactory, it is probable that no further steps will be taken.

So far the Air Force has tried to induce major contractors for prime systems to look more closely at the qualifications of small concerns in letting subcontracts. It does this by having all purchases of $10,000 or more checked against a "small business check list." On this document, the buying official must show whether small outfits were asked to bid on any contract or subcontract. The results of such requests must also be noted. If no effort to interest small companies was made, an explanation is in order.

Small Electronics Concerns Gain

Small electronics companies stand to benefit from this policy, according to some Pentagon officials. They believe that the check list will discourage in-house electronics work by some prime contractors and lead to wider competition.

They note, too, that an important function of the small-business check list is to alert the managements of big companies to the efforts being made in their own concerns to buy efficiently from a broad base of sources.

The data gathered in compliance with this voluntary Air Force program do not have to be turned back to the government. But quarterly reports of the success of the program are supposed to be available, on request, to Air Force or Small Business Administration personnel.

Command Urges Cooperation

With refreshing frankness, the Air Materiel Command called for cooperation in the small-business program by noting:

"It has been alleged that the Air Force's weapon system concept might have a drastic effect on the number of opportunities afforded small business, and that prime contractors who formerly gave out a large share of their work in subcontracts to small business now are tending to develop subsystems in their own plants or those of major subcontractors."

The command said it was "necessary" for contractors to modify their purchasing methods to encompass "certain procedures that the Air Force has proved to be mutually beneficial for itself and small business."

MEETINGS

Calendar of Events

August

4-6 Annual Convention of Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Calif.

9-12 ASME-AICE Heat Transfer Conference, University of Connecticut, Storrs, Conn.

17 National Ultrasonics Symposium (PGUE), Stanford University, Stanford, Calif.

18-21 WESCON Show and Convention, Cow Palace, San Francisco, Calif.*

23-26 AIEE, 6th Electrical Conference of the Petroleum Industry, Wilton Hotel, Long Beach, Calif.

31-2 Semiconductors Conference, Metallurgical Society of AIME, Statler Hotel, Boston, Mass.

September

1-2 Conference on Chemistry in Aerodynamic and Space Flight, Air Force Office of Scientific Research, General Electric Co., University of Pennsylvania, Philadelphia, Pa.

1-3 14th National Meeting, Association of Computing Machinery, MIT, Cambridge, Mass.*

7-10 6th Annual International Meeting, The Institute of Management Sciences, (TIMS), Paris, France.

17-18 Engineering Writing and Speed Symposia, IRE, Boston, Mass. and Los Angeles, Calif.*

18-19 3rd Technical Symposium, Cedar Rapids section IRE, Sheraton-Montrose Hotel, Cedar Rapids, Iowa.

18-20 8th Annual High Fidelity Show, International Sight and Sound Exposition, Inc., Palmer House, Chicago, Ill.

20-25 14th Annual Conference and Exhibit, Instrument Society of America, Chicago, Ill.

21-22 Standard Engineers Society 8th Annual Meeting, Boston Section, Hotel Somerset, Boston, Mass.

23-25 4th Annual Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers, AIEE, IRE, Shoreham Hotel, Washington, D.C.*

28-30 National Symposium on Telemetering, IRE, Civic Auditorium and Whitcomb Hotel, San Francisco, Calif.

30-1 Oct. Industrial Electronics Symposium, Mellon Institute, IRE, AIEE, Pittsburgh, Pa.

* Includes meetings described herewith.

WESCON Show and Convention, August 18-21

The show will feature numerous exhibits which will fill the Cow Palace in San Francisco. Complementing the product lines will be papers covering all phases of professional group interests. A "new look" in the technical program is being planned this year which will limit each of the usual 40 daytime sessions to three full-length papers in each. A second innovation will be the introduction of a "panel of peers," a group of experts in the field, invited to comment on the group of papers at the completion of each session. Registrants will be able to obtain and review all papers prior to their presentation through the Convention Record.

14th ACM National Conference, September 1-3

Conference of the Association of Computing Machinery will be held at the Massachusetts Institute of Technology, Cambridge, Mass. Technical papers to be presented will cover numerical analysis, data processing, automatic programming, language translation, digital and analog devices, and various applications of computers. Chairman of Local Arrangements is: Frank M. Verzuh, Computation Center, MIT, Cambridge, Mass.

Engineering Writing and Speech Symposia, September 17-18

To be held simultaneously on the East and West Coast, the IRE Symposia will be devoted to "More Effective Communication of Scientific and Engineering Information." The West Coast session will be held at the Ambassador Hotel, Los Angeles, Calif., and will feature motivations that make the engineer want to improve his writing ability, what he can do to improve himself and how to go about it, and educational steps for further improvement. The East Coast session will meet at the Sheraton-Plaza Hotel, Copley Square, Boston, Mass. Four sessions will cover: "Communication in Modern Society," "Problems in Communications Facing the Professional Man," "How To-Do-It Topics for Engineers and Scientists," and "Writing and Editing." National Symposia Chairman: T. T. Patterson, Jr., Radio Corporation of America, Bldg. 13-2, Camden, N.J.

4th Annual Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers, Sept. 23-25.

To be sponsored by the AIEE and IRE and will be held at the Shoreham Hotel, Washington, D.C. The technical program will consist of sessions devoted to the theory, design, and application of: (1) magnetic amplifiers and similar saturating core devices, (2) magnetic amplifiers and semiconductor devices in circuit combinations, (3) magnetic components for switching circuits and digital computers.

Paper Deadlines

August 15: Submit by this date four copies of a 100 word abstract and a 1000 word summary of papers on any phase of computing for the **1959 Eastern Joint Computer Conference.** The Conference will be held **December 1-3, 1959.** Forward abstracts to: *J. H. Felker, Chairman, EJCC Program Committee, Bell Telephone Laboratories, Mountain Ave., Murray Hill, N.J.*

NEW PRODUCT

Versatile High Speed Crimping Tool

The Omaton Division of the Burndy Corporation has available for the electronic industry its new, extremely versatile, semi-automatic, portable pneumatic crimping tool, type YD, which provides for controlled crimping in volume production work.

This magazine-fed tool automatically positions, feeds, and crimps contacts such as those used with BURNDY's MODULOK® and CRAB-LOK®, STAPIN® and HYFEN® lines of connectors. This simplifies contact installations, permitting highly reliable connections to be made at a high production rate.

The YD HYPRESS® crimps up to 1000 contacts per hour by advancing and positioning the contacts automatically. The YD accommodates up to 70 contacts per load.

Contacts to be installed with the YD are furnished pre-loaded in color coded plastic expendable carry strips carrying fourteen contacts per strip and packaged five strips to a magazine load. The plastic strips are automatically ejected from the tool after the contacts have been used.

The power unit of the YD HYPRESS is an air cylinder which is controlled pneumatically (no mechanical ratchets) to provide full cycling control which assures that each contact is properly crimped. The tool is factory set to operate at 80-100 psi line pressure and develops 2500 lbs. force when operated at 90 psi.

Burndy Corporation, Norwalk, Connect.

CIRCLE 24 ON READER-SERVICE CARD

EDITORIAL

U.S. Leads U.S.S.R. in Transistor Progress

Despite some fine theoretical work being done by the Soviet physicists in the field of semiconductors, Americans are way ahead in the production of transistors.

This is not to say the Soviets are not trying. Many of the articles being published in the U.S.S.R. and East Germany are devoted to transistor circuits. It is significant, however, that most of the references cited at the end of the articles are American.

Interesting is the fact that some of the articles on practical transistor circuits appearing in East German publications refer to Raytheon and Sylvania transistors with Philips getting some mention. Editorials in these same magazines call for greater production efforts and the opening of new plants make news items. No actual production figures are ever mentioned.

Nevertheless, the Soviets are exporting some semiconductors –38 types according to a listing supplied to us by International Rectifier Corporation. A total of 39 types are on display at the recently opened Soviet Exhibition, New York Coliseum. It is practically a pleasure to read their brief transistor data chart after studying our own rather lengthy one which includes some 816 types.

We find all types are apparently available from the U.S.S.R. except the mesa transistor. Germanium junction types for audio use include units rated at 10w. High frequency diffused base transistors for oscillator use are rated at 120 mc. Surface barrier types for 30 mc operation are also available. Only very few low-level silicon units are mentioned. Very little is given in the way of switching data. One power type capable of 100 w dissipation was included in the group displayed at the Soviet Exhibition.

Soviet magazines are describing some diodes listed for high frequency use. Switching speeds in the order of 0.5 microsecond are apparently considered good.

It is heartening to conclude that in the field of semiconductors, free enterprise is certainly out-producing state-controlled enterprise. Ironically our unfettered competitive system is so prolific that we almost create problems by having too many types. Fortunately, we have a free market place and intelligent selection by transistor circuit designers should strike a balance to keep us ahead of bureaucratically-controlled production.

James C. Kyprios

Understanding Transistor Voltage Breakdown

There is a plethora of misinformation on transistor voltage breakdown. Harry Schauwecker, Chief Engineer of Valor Instruments, and a lecturer at U. C. L. A., wrote this article to show how voltage breakdown takes place, its various forms, and its dependence on external circuit characteristics.

In a forthcoming issue of *ELECTRONIC DESIGN*, he will provide a similar enlightening treatment for leakage currents.

Harry E. Schauwecker
Valor Instruments, Inc.,
Gardena, California

PROBABLY more than 95 per cent of transistor failures are attributable to exceeding the allowable voltage breakdown. There are several breakdown voltages in the transistor which a circuit designer must be familiar with in choosing a transistor for a given circuit or in selecting the operating voltages.

Since the transistor may be represented as a combination of two diodes, the transistor will also be characterized by the breakdown voltage associated with the collector to base diode and that associated with the base to emitter diode. These two breakdown voltages associated with the diodes are commonly referred to as V_{CB} max. and V_{BE} max.

In addition to these two common types of voltage breakdown, a third type also exists which is not so well known or so well understood. This is generally referred to as the breakdown voltage—V_{CE} max. and results in a breakdown directly between collector and emitter under conditions of operation where physical resistance is inserted in the circuit between the base and emitter terminals of the transistor.

The breakdown voltage between collector and emitter is a function of the resistance inserted between the base and emitter leads. This may be seen by referring to the figure which shows a family of curves of collector characteristics versus base to emitter external resistance.

Almost all manufacturers state voltage breakdown in terms of V_{CB}. Only a few state breakdown voltage from collector to emitter. Before a standard method of specifying V_{CE} max. may be determined, all manufacturers must agree on standard values of resistance to use between the base and emitter terminal. Meanwhile, there are three V_{CE} ratings that are in common usage. They are:

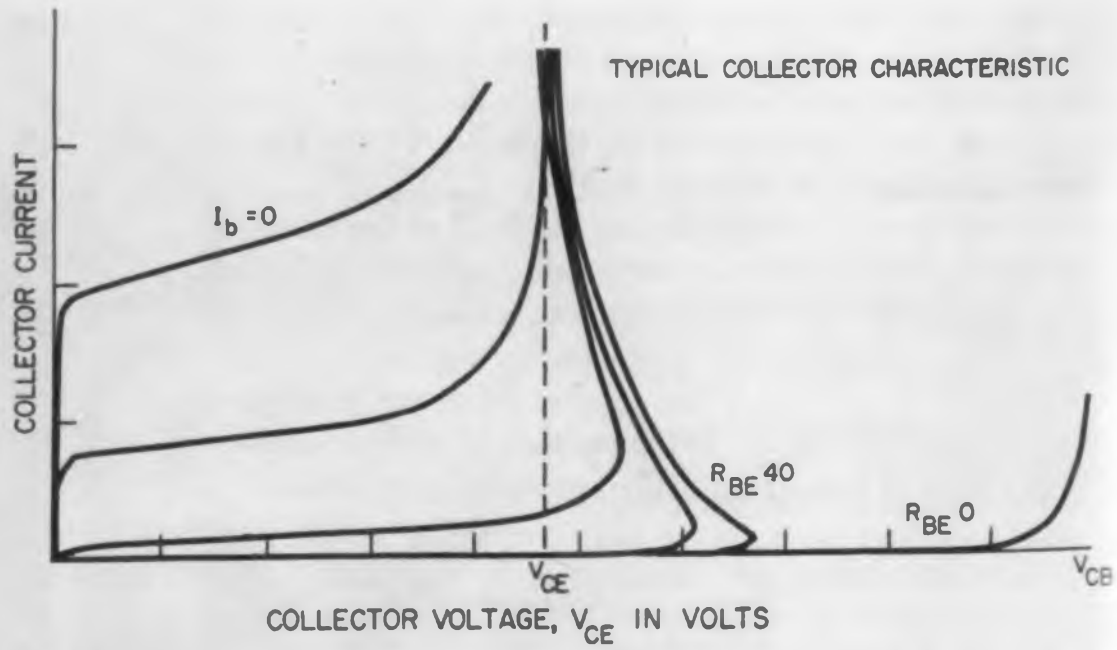
1. V_{CE}, $I_B = 0$, (R_{BE} = infinity)
2. V_{CE} max. (R_{BE} = 40 ohms)
3. V_{CE} max. ($R_{BE} = 0$)

Referring to the figure, the two distinct voltage breakdown points are those represented by the conditions where V_{CE} is measured with $I_B = 0$ and the V_{CB} measurement. Since the collector characteristic curves between these two breakdown voltages show a negative resistance characteristic, it is apparent that if the voltage on the transistor exceeds the maximum breakdown voltage on a surge, the transistor will remain broken down even after the surge has disappeared. Hence, caution should be exercised when using a transistor with a voltage supply greater than that limited by V_{CE} ratings.

Types of Voltage Breakdown

There are at least five types of voltage breakdown. Although these five types are not strictly independent, they may each be treated separately.

Avalanche Breakdown.—Avalanche breakdown is a voltage breakdown occurring in the collector



This family of curves shows how the collector to emitter breakdown voltage is a function of external base to emitter resistance.

base junction which is quite similar to the Townsend effect occurring in gas tubes. It is due to the high dielectric field which occurs across the collector-base junction as the collector voltage is increased. The high field accelerates the free charge carriers so that they collide with other atoms, knocking loose additional free charge carriers which in turn are accelerated and have further collisions.

This multiplication process occurs at an increasing rate as the collector voltage increases until at some voltage V_a, known as the avalanche voltage, the current suddenly goes to infinity.

The carrier multiplication factor, which indicates the rate of extra charge carrier generation, may be given the symbol m and a plot of m versus collector voltage would show a variation of m from unity to infinity with a very sharp break at V_a, the avalanche breakdown point. This type of breakdown characterizes the maximum V_{CB} rating on most germanium pnp transistors.

Alpha Multiplication.—This type of breakdown is very closely related to the avalanche effect. It is produced by the same physical phenomena that produces avalanche but is different only as regards the circuit configuration. Since the current flowing in the collector is:

$$I_c \cong \alpha I_e$$

and since the factor m which accounts for the multiplication of charge carriers can be considered as a multiplying factor on alpha, the collector current can actually be given as:

$$I_c \cong m \alpha I_e$$

In the common emitter configuration, then, beta is normally given as:

$$\beta = \frac{\alpha}{1 - \alpha}$$

Taking into account the alpha multiplication factor m, the common emitter equation becomes:

$$\beta = \frac{\alpha m}{1 - \alpha m} \text{ or } I_c \cong \frac{\alpha m}{I - \alpha m} I_b$$

Thus when the product αm becomes equal to unity, the denominator becomes zero and beta becomes infinite. This is known as alpha multiplication breakdown and, since beta becomes infinite, the collector current becomes infinite for collector voltages given by the condition where $m = 1/\alpha$. This voltage is always much lower than the avalanche breakdown voltage and generally accounts for the collector-emitter breakdown voltage with base current equal to zero.

Punch-Through.—The punch-through breakdown voltage is a voltage breakdown occurring between collector and emitter due to space charge layer widening of the collector-base junction with

increasing collector voltages. As the collector voltage is increased, the space charge region (collector junction width) gradually increases until it actually penetrates completely through the base region touching the emitter.

At this point the emitter and collector are effectively shorted. This type of breakdown occurs in some pnp junction units but generally the alpha multiplication breakdown occurs at a lower voltage than punch-through. Since breakdown occurs between collector and emitter, this type of breakdown is more serious in the common emitter or common collector configuration.

Thermal Runaway.—Thermal runaway involves the avalanche effect, and in addition is dependent upon the circuit stability factor, the ambient temperature and the transistor power dissipation.

Thermal runaway is a regenerative process where an increase in temperature causes an increase in the leakage current I_{co}, which results in an increased collector current which in turn causes an increased power dissipation. This raises the junction temperature causing a further increase in leakage current.

If the leakage current is high enough (caused by high temperature or high voltage) and if the circuit is not adequately stabilized to counteract increases in collector current due to increases in leakage currents, the process can regenerate to such a degree that the temperature of the transistor and the power dissipation rapidly increase, destroying the transistor.

This type of effect is most prominent in power transistors where the junction is normally operated at high temperatures and where high leakage currents are present due to the large junction areas.

Thermal runaway can be reduced and controlled by choosing circuits with a low stability factor, using transistors with low leakage currents and by maintaining the circuit at low ambient temperatures.

Miscellaneous Breakdown.—A discussion of voltage breakdown should also include the breakdown from base to emitter which occurs as a result of the base-emitter junction voltage. This type of breakdown is very important in switching application or, for that matter, any large signal applications where a large voltage swing may be expected at the emitter, particularly when the emitter is back-biased.

In multivibrators, for example, the entire output voltage swing may appear across the emitter in some part of the cycle. Since the factors relating to breakdown in the emitter-base junction are similar to those occurring in the collector-base junction, the same principles apply.

In the case of a symmetrical transistor, the voltage breakdown between base and emitter may be the same as that occurring from collector

base. However, in unsymmetrical transistors such as the drift transistors or silicon grown transistors, the voltage breakdown from base to emitter may be considerably lower due to the low resistivity material in the emitter region. Breakdown between base and emitter generally results in destruction of the base-emitter junction.

Effect of Voltage Breakdown

Results of these breakdowns manifest themselves in various ways on the transistor.

Avalanche breakdown generally results in destruction of the collector-base junction due to excessive currents. This generally results in an opening between collector and base.

Breakdown due to alpha multiplication and thermal runaway generally results in destruction of the transistor due to excessive heat dissipation. This shows up electrically as a short between collector and emitter with the collector diode open. This condition which is most common in transistors which have been ruined is not easily detected. Ohmmeter measurements may indicate a good transistor because of the sneak path through the collector to emitter short circuit and then through the emitter diode to the base.

On the other hand, if such a defective transistor is placed in a standard transistor tester, the short from collector to emitter may result in damage to the meter or, barring such a development, may result in an indicated alpha of unity which could give an erroneous indication of transistor condition.

Punch-through breakdown generally does not damage the transistor and is a self-healing type of breakdown. After the voltage is removed, the transistor is again in satisfactory operating condition.

Breakdown between emitter and base may result in either an open or short in the emitter to base diode.

Voltage Supplies for Transistors

Since most transistors should be operated with supply voltages considerably less than the V_{CB} which the manufacturers generally state, a voltage supply of less than 20 volts should be used for most common junction transistors. Voltage supplies of 30 volts or less are adequate for all but the highest voltage transistors.

The engineer should select his transistor for common emitter and common collector circuit applications on the basis of a V_{CE} rating rather than the V_{CB} rating commonly given. It also should be pointed out that there is not a unique relationship between the V_{CB} rating and the V_{CE} max. rating. In time, large scale usage of transistors will undoubtedly require that the manufacturer specify the V_{CE} rating to some prescribed standard. ■ ■

Let's Use a

High Frequency Figure of Merit

For Power Transistors

Richard E. Seifert knows the semiconductor business from both ends—sales and engineering. In this article, he proposes the use of a much-neglected figure of merit that can provide a simple indication of transistor performance at high frequencies.

Richard E. Seifert
Raytheon Co.
Semiconductor Div.
Needham Heights, Mass.

MOST HIGH frequency transistor applications involve *power* amplification. If *current* or *voltage* transformation alone were desired, other devices such as diodes or transformers would suffice. A high frequency figure of merit, then, should express the relationship of the transistor's maximum available power gain to operating frequency.

Neither "alpha cutoff" nor "beta cutoff" information alone can advise the designer of the power gain to be expected at a given frequency. Impedance or voltage relationships are not specified in these expressions. But with an understanding of the general power gain versus frequency relationship and a specification of power gain at some particular frequency, the engineer can readily evaluate a transistor for any bandpass amplifier application.

Power Gain Depends on Frequency

Fig. 1 illustrates the general relationship of maximum available power gain to operating frequency. Depicted on semilog paper, this frequency response clearly displays its two basic components —the "low" and "high" frequency power gain characteristics.

The point at which power gain has decreased three decibels from its low frequency value is known as "power gain cutoff" and is analogous to the current gain figure of merit "alpha cutoff." In fact, for a given transistor and circuit configuration, the power gain and current gain frequency response curves are congruent.

Observe the 6 db/octave slope of the high frequency characteristics in Fig. 1. This relationship postulates the so-called "unilateralized," or matched, neutralized transistor amplifier. The slope steepens with departure from this condition.

Should the transistor under test be of the grown-junction variety (e.g. most vhf tetrodes), the slope will be approximately 4.5 db/octave. The base lead impedance in such devices is intrinsic to the active base region and contains a capacitive component. The majority of high frequency transistors are of the alloy-junction "wafer" construction having base lead impedances extrinsic to the active base region. These impedances are essentially resistive.

Several Factors Control f_{max}.

It has been shown that the frequency of unity power gain, f_{max}, is directly proportional to the low frequency, common-base current gain alpha. It is also proportional to the frequency at which the common-base current gain has decreased three db from its low frequency value alpha cutoff. It is inversely proportional to the base lead impedance and the collector-to-base capacitance.

The term f_{max} is derived from the conclusion that, theoretically a transistor will oscillate up to a "maximum frequency" at which its maximum available power gain is unity. For a given transistor, this frequency may be calculated as

$$f_{max} = \left(\frac{\alpha_c f_\alpha}{8 \pi r_b' C_c (10)^{-6}} \right)^{\frac{1}{2}} \quad (1)$$

where f_{max} = Frequency of unity power gain (mc)

α = Low frequency common-base current gain (alpha),

f_α = Alpha cutoff frequency (mc),

r_b' = Base lead impedance (ohms),

C_c = Collector-to-base capacitance ($\mu\mu f$)

Having determined the unity power gain frequency, the design engineer can compute the maximum available power gain for any desired operating frequency along the high frequency characteristic curve of Fig. 1:

$$G_p = 10 \log \left(\frac{f_{max}}{f} \right)^2 \quad (2)$$

where G_p = Maximum available power gain (db)

f_{max} = Unity power gain frequency (mc).

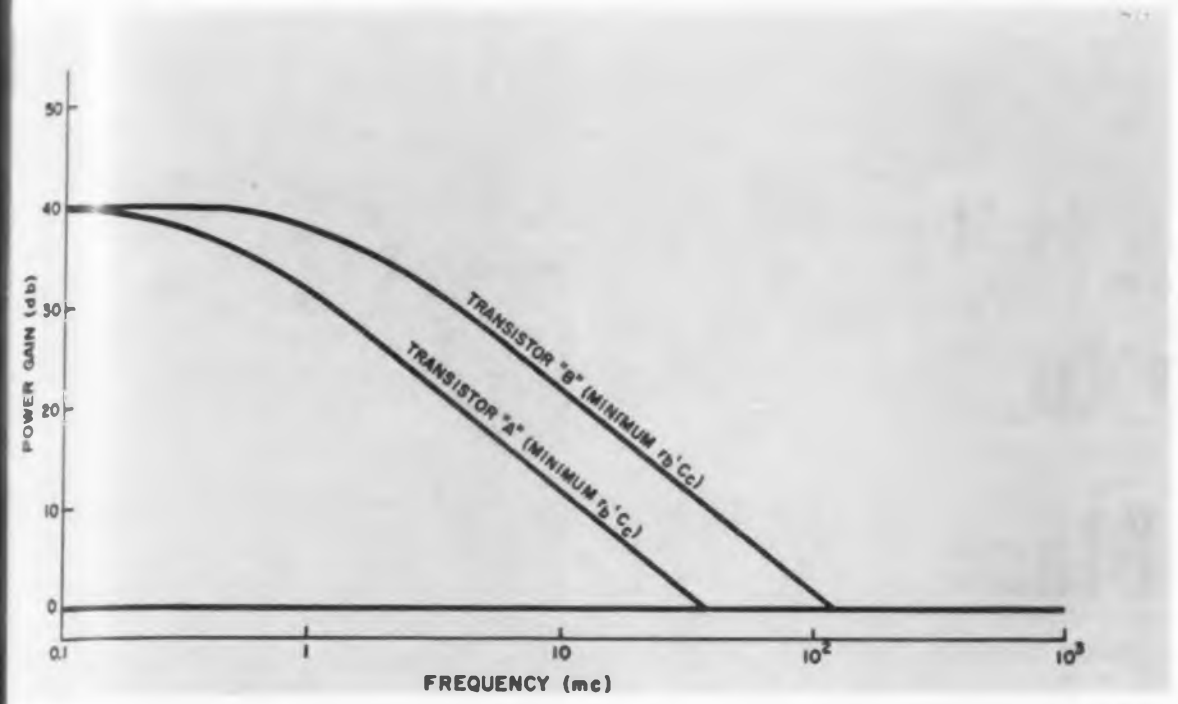


Fig. 1. Maximum available power gain vs frequency. This curve is for a typical vhf triode transistor in a unilateralized common emitter circuit.

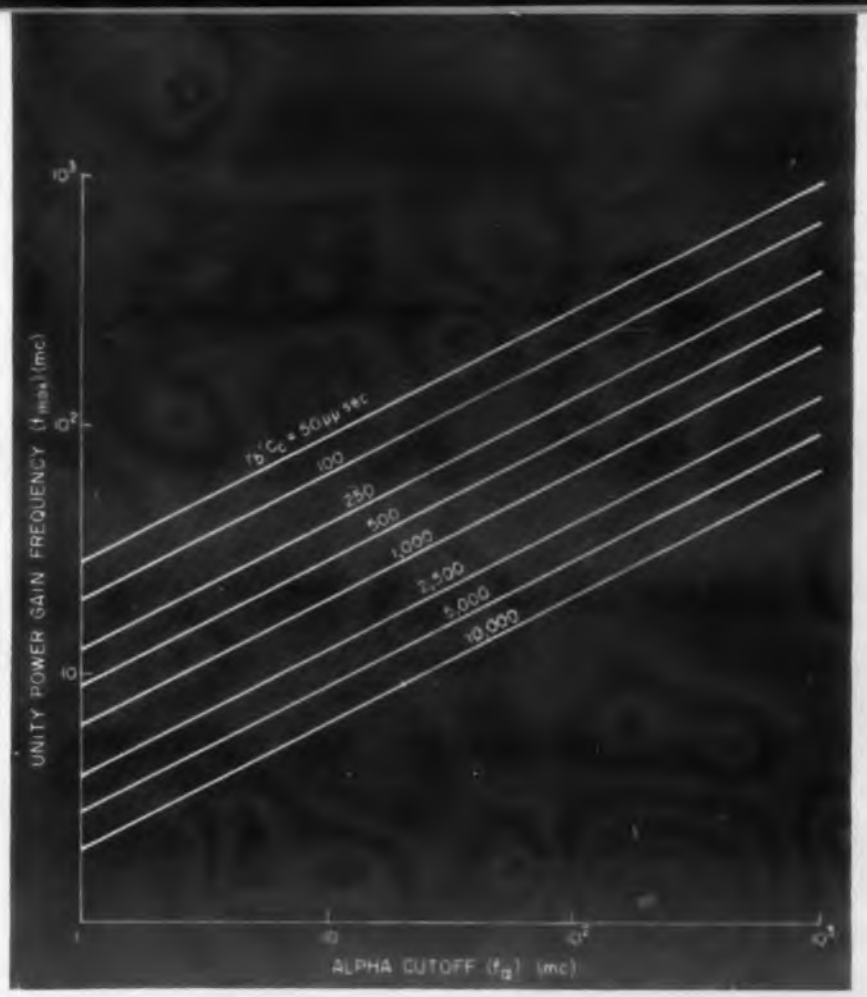


Fig. 3. (above) Unity power gain frequency vs alpha cutoff. This graph assumes an alpha of unity, and a constant $r_b'C_c$ product in each case.

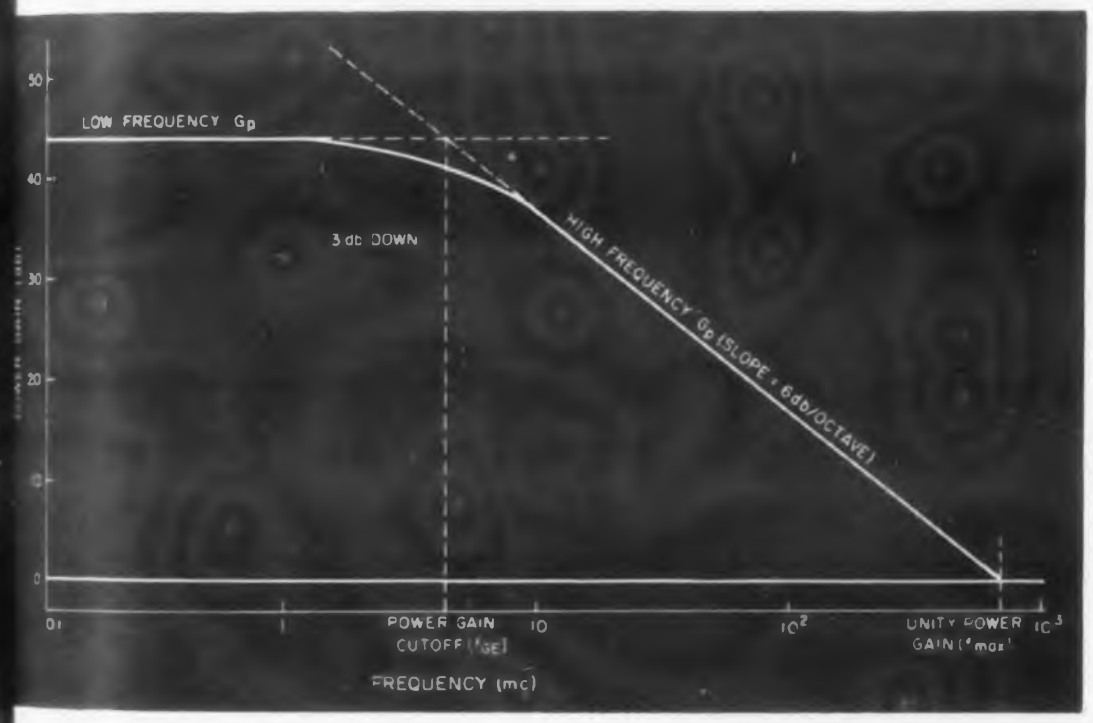


Fig. 2. (left) Effect of the $r_b'C_c$ product on power gain. The two transistors have selected $r_b'C_c$ products, but are otherwise identical with a 200 mc alpha cutoff.

f = Desired operating frequency (mc).

For the designer with a particular stage gain requirement at a given operating frequency, Eq. (2) may be rewritten:

$$f_{max} = f\ (log^{-1}\ 0.1\ G_p)^{\frac{1}{2}} \qquad (3)$$

This shows that obtaining appreciable power gain in a single-stage, high frequency amplifier depends on f_{max}-to-operating-frequency ratios of 10 or more. For every octave below the transistor's f_{max} that the operating frequency is moved, an additional 6 db of maximum available power gain is obtained. This gain-frequency exchange process continues till the power gain cutoff region is approached. There, the low frequency power gain-determining impedance factors dominate.

Therefore, whereas the power gain cutoff frequency is a function of circuit configuration, the transistor's f_{max} is substantially independent of configuration.

Eq. (1) shows that base lead impedance and collector-to-base capacitance are the significant determinants of f_{max} and consequently, of high frequency power gain. This assumes typical high frequency transistor alphas of 0.9 and higher. For any given transistor, unless the $r_b'C_c$ product is suitably low, poor high frequency power gain will result.

This is true even though the transistor may have an impressively high alpha cutoff, and is quite pronounced as shown in Fig. 2. Two transistors, each having an alpha cutoff of 200 mc and identical in every respect except that their $r_b'C_c$ products are at opposite ends of the normal distribution, differ in high frequency power gain characteristics by about 10 db.

Observe, incidentally, that neither unit is usable as an amplifier or oscillator at the alpha cutoff frequency.

Available high frequency transistors offer a wide range of $r_b'C_c$ products relative to their alpha cutoff frequencies. The f_{max} of these devices may be well above or below their alpha cutoff specifications.

A convenient display of the $f_{max} - f_{\alpha co}$ relationship for typical constant values of $r_b'C_c$ may be constructed as shown in the graphic treatment of Eq. (1) in Fig. 3. Thus equipped, the design engineer may readily select the transistors best suited to his high frequency amplifier and oscillator applications. ■ ■

Reference

Lloyd P. Hunter, Handbook Of Semiconductor Electronics, p. 12-19, McGraw-Hill Book Co., Inc., New York City, N. Y., 1956.

New Approach to Transistor DC Bias

J. Paul White
Leeds & Northrup Co.
Philadelphia, Pa.

STABILIZATION of single transistor amplifier stages can be accomplished simply and easily by a straightforward though unconventional approach which takes into account variations in β. Certain simplifying assumptions are made, e.g., the usual current and voltage stability factors are ignored. In their place the high and low limits of V_{CE} are used. The variation in collector current may be easily obtained once the collector to emitter voltage variation is specified, and the values of R_E and R_C known. It is assumed that the minimum value of collector cutoff current I_{CBO} is zero, a conservative assumption which changes the design only slightly when the expected temperature variation is 24 C or more.

Calculating The Required Resistances

The simplifying assumptions made are that $V_{BE} = 0$, and that $(\beta + 1)$ may be replaced by β. The following fundamental equations apply to the usually preferred circuit, Fig. 1.

$$I_C = (I_{CBO} + I_B) \tag{1}$$

$$I_B = \frac{V - V_E}{R} - \frac{V_E}{R_B} \tag{2}$$

$$V_E = R_E (I_C - I_{CBO}) \tag{3}$$

$$V_{CE} = V - V_E - R_C I_C \tag{4}$$

The highest value of V_{CE} will occur when I_{CBO} is minimum (zero used here) and β is also minimum. Similarly, the smallest collector to emitter voltage will occur when both I_{CBO} and β are maximum. Therefore, by eliminating I_C, I_B and V_E from the above equations, and substituting the values of I_{CBO} and β for the two conditions of maximum and minimum V_{CE}, two equations are obtained which may be solved simultaneously for two of the four resistances in the circuit. It will be found to be most convenient to solve for R_B and R in terms of the other resistances, the battery voltage, and the limiting values of the other parameters.

The initial selection of V and R_C on the basis of desirable voltage, current and transistor power dissipation considerations, etc., is usually no problem. The selection of R_E may not be so obvious a matter, especially if it is desired to keep R_E as small as possible. Shea, discussing this selection, says that R_E should be made large enough to swamp the dc resistance of the emitter-base diode.[1] This requirement may be readily observed by making R_E sufficiently large to insure that the voltage across it will be somewhat larger than the expected dc emitter base diode voltage of the transistor.

Using the following symbols, and solving for R_B and R:

$\underline{\beta}$ = Minimum possible value of β.
$\bar{\beta}$ = Maximum possible value of β.
$\bar{I}_{CBO}$ = Maximum possible value of I_{CBO}.
$\underline{V}_{CE}$ = Minimum allowable value of V_{CE}.
$\bar{V}_{CE}$ = Maximum allowable value of V_{CE}.
$m = R_C/R_E$.

$$U = \frac{V}{\bar{V}_{CE}} - 1.$$

$$L = \frac{V}{\underline{V}_{CE}} - 1.$$

$$k_1 = 1 + (U + 1)\, m.$$

$$k_2 = 1 + (L + 1)\, m.$$

$$R_B = \frac{R_E (1+m)\left[L - U - \dfrac{\bar{I}_{CBO} R_E (k_1 - 1)}{\underline{V}_{CE}}\right]}{\dfrac{U_{k_2}}{\underline{\beta}} - \dfrac{L_{k_1}}{\bar{\beta}} + \dfrac{\bar{I}_{CBO} R_E k_1}{\underline{V}_{CE}}\left[1 + m + \dfrac{U_m}{\underline{\beta} k_1}\right.} \tag{5}$$

$$R = k_1 R_E / U \left(\frac{1}{\underline{\beta}} + \frac{R_E}{R_B}\right) \tag{6}$$

For a grounded collector stage, $m = 0$; and for a phase splitter, $m \cong 1$.

If the resistor R is returned to the collector, Fig. 2, equations similar to (1) thru (4) may be written and similarly solved. In this case it is convenient to solve for R_E, since R_B may be more easily chosen than R_E (stage input impedance considerations). Solving for R_E and R after selecting values of R_B and R_C, etc., assuming that $I = I_B$

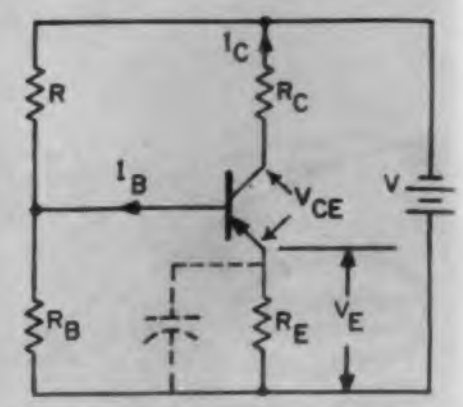


Fig. 1. Preferred circuit described by eqs. (5) and (6).

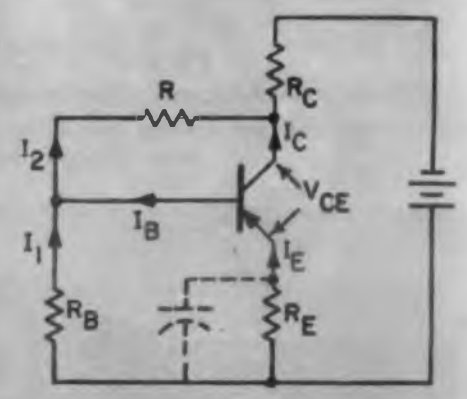


Fig. 2. Circuit described by eqs. (7) and (8). Resistor R is returned to the collector.

and that $I_2 \ll I_C$, we obtain:

$$I_C = \frac{R_B\left[\left(\frac{U}{\beta} - \frac{L}{\beta}\right) V_{CE} + \bar{I}_{CBO} R_C\right]}{V_{CE}(L - U) - \bar{I}_{CBO} R_B} \qquad (7)$$

If the values calculated by Eqs. (5) and (6) or (7) and (8) are not suitable, a reselection of the value of R_E or R_B (respectively) may be made that will usually provide an acceptable design on the next try. In this respect, it will be noted that R_E and R_B will increase or decrease together, R_B changing by a somewhat smaller percentage than R_E.

These equations may be useful to those desirous of being able to specify the limits of β, I_{CBO} and V_{CE}, and then proceed directly to the final circuit values required to stabilize the amplifier stage.

Designing a Low Level Amplifier

It is required to operate a low level amplifier at an emitter current of 0.1 ma. at 25 C, and to limit the collector to emitter voltage to the range of 1.5 to 3 vdc. The supply is 7.5 vdc, and beta may range from 30 to 200. The maximum collector cut-off current $\bar{I}_{CBO}$, will be 10 microamperes. It is desired to provide dc stabilization which just meets these specifications.

Selecting the voltage across R_E as a generous 1.8 v, $R_E = 1.8/0.1$ ma $= 18$ K. The maximum voltage from collector to ground will then be $1.8 + 3 = 4.8$ v. The voltage across R_C is therefore $7.5 - 4.8 = 2.7$ v and R_C is $2.7/0.1$ ma $= 27$ K. The constants for use in equations (5) and (6) may now be determined.

$$m = \frac{27}{18} = 1.5$$

$$U = \frac{7.5}{3} - 1 = 1.5$$

$$L = \frac{7.5}{1.5} - 1 = 4$$

$$k_1 = 1 + (1.5 + 1)\,1.5 = 4.75$$

$$k_2 = 1 + (4 + 1)\,1.5 = 8.5$$

From Eq. (5), $R_B = 52.2$ K.

From Eq. (6):

$$R = \frac{4.75 \times 18\ K}{\frac{1}{30} + \frac{18}{52.2} \times 1.5} = 151.0\ K$$

Note that in Eq. (5) $\bar{I}_{CBO}$ is in milliamperes, and V_{CE} is in millivolts. The use of the nearest 10 percent rma value will usually be satisfactory, so that the final design would have $R_B = 56$ K and $R = 150$ K. ■ ■

References

1. H. F. Shea, Ed., Transistor Circuit Engineering, John Wiley & Sons, New York, p. 57.

Transistor Types 1959

W. C. Hittinger
Assistant Director of Development
Bell Telephone Laboratories
Allentown, Pa.

TRANSISTORS have progressed, since their inception 11 years ago, from strictly low-power audio frequency devices to a family of components capable of operating in the microwave region and at wattages in excess of 100 w.

These advances are due to a steady increase in fundamental knowledge plus a continual development of fabricating techniques. The present situation is shown in Fig. 1 for germanium and silicon transistors either commercially available or in advanced laboratory development.

Fabricating Techniques

By first outlining each of the various fabrication processes, it is possible to establish a basic comparison of their salient features. From this, potentialities and limitations can be visualized for each type. Many generalizations will be necessary in making broad comparisons. A list of appropriate references is included for the reader interested in a more thorough analysis.

Point Contact

Pointed emitter and collector wires, spaced a few thousandths of an inch apart, are placed in contact with the semiconductor surface. Small junction regions are formed under each point by a combination of heat and pressure. The exact theory of the device is not well understood and very few transistors are being made, primarily because of limited performance range. However, many point contact diodes are still being produced, both as inexpensive, non-critical rectifiers and as microwave mixers and detectors.

Grown Junction

Emitter, base and collector regions are formed in a single crystal of germanium or silicon grown from the liquid. Individual transistor bars are cut from the crystal and leads are attached to each region. The theory of this and other junction devices to follow is quite well understood, thereby allowing for improved designability in comparison to the point-contact transistor. More recent variations of this technology are the grown-diffusion and melt-back. Both of these techniques make it possible to produce narrower base layers than obtainable by conventional growing, by using diffusion of impurities in the solid crystal to form the base layer. Since the frequency response of a transistor is inversely proportional to the square of base width, significant performance improvement is obtained. Many grown junction transistors are being produced for use in both entertainment and industrial-military applications. Grown junction diodes have never attained significant importance.

Alloy Junction

Emitter and collector regions are formed in a semiconductor wafer by alloying appropriate element or alloy pellets into opposite sides such that they penetrate to within approximately 0.001 in. of each other. The thin unpenetrated region serves as the base. This type represents the largest volume transistor being produced at the present time, being used in applications varying from low-power computers to high-power audio output amplifiers. The limited ability to control the depth of alloy penetration and hence base layer width limits the frequency response of this type. Many alloy diodes are being produced, ranging from small area gold bonded (alloyed) switches to large area power rectifiers.

Surface Barrier

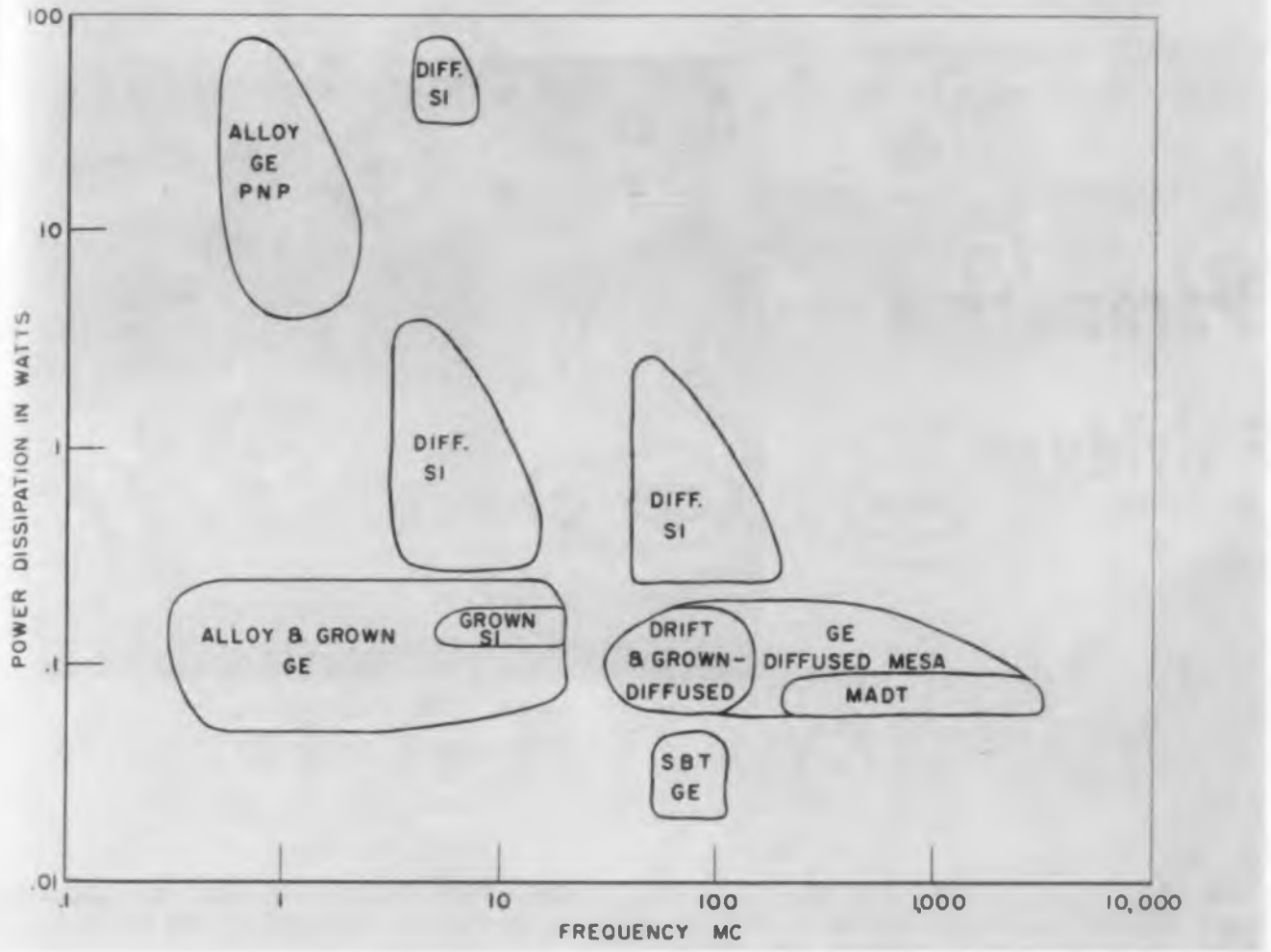
Two small jet streams of electrolyte are directed onto opposite sides of a germanium wafer. By appropriate electrical bias, pits are electrolytically etched such that they penetrate to within about 0.0005 in. of each other. The polarity is then reversed, so that small emitter and collector deposits are plated from the jet solution into the pits. As with the alloy types, the unetched web serves as the base. A variation of this technique involves shallow alloying of the plated deposits for improved device stability. Large quantities of these transistors have been produced for application in high speed circuitry. The thin base region and small emitter and collector contacts limit the power handling capabilities of this type.

Diffused Junction

The base layer is formed in both germanium and silicon transistors by diffusing an appropriate element from the vapor into the solid semiconductor. Dimensional control of penetration is about one order of magnitude better in this method of diffusion than by techniques mentioned above, so that base layers as thin as 0.00002 in. can be readily produced. Emitter regions are formed in some cases by alloying, in others by diffusion. Mesa types derive the name by virtue of the means used to minimize collector capacitance. The active portion of the device is contained in a localized, raised region of small area, while the remainder of the semiconductor is used as a rugged handle for mounting and power handling purposes. The drift transistor contains a diffused base layer and a region under the base of high resistivity semiconductor (intrinsic barrier) to reduce collector capacitance and increase breakdown voltage. The MADT transistor is

Table I. Comparison of Transistor Types
(Higher numbers signify better characteristics)

Type	Base Layer Thickness	Breakdown Voltage	Collector Capacitance	Saturation Resistance
Alloy	4	3	4	1
Grown	4	3	3	3
Surface barrier	3	4	2	2
Grown-diffused-melt back	2	2	3	3
Diffused	1	1	1	4



Power and frequency limits of currently available transistors.

essentially a surface barrier transistor with a diffused base layer and with emitter and collector contacts which are shallow alloyed. The diffused transistor possesses the highest frequency capability of any known type. The mesa structure combines high speed and high power capabilities. Production quantities of these types will constitute an ever increasing portion of the total market. Diffused diodes are in large scale production for a variety of applications varying from microwave varactor types to high power rectifiers.

Comparison of Techniques

Maximum limits for power and frequency of transistor types available are shown in Fig. 2.

A rough comparison of the transistor types considered to be of economic importance at the present time is shown in Table I. The parameters chosen as a basis for comparison have the following significance:

- Base-layer thickness control—the better the higher the frequency performance.
- Breakdown voltage—must be maximized for high power applications.
- Collector capacitance—must be minimized for high frequency performance.
- Saturation resistance—should be minimized for optimum switching performance.

Parameters are rated numerically from one to four with one signifying top position. ■ ■

References

J. Bardeen and W. H. Brattain, Nature of the Forward Current in Germanium Point Contacts, *Physical Review*, Vol. 74, pp 231, July 15, 1948.

W. Shockley, M. Sparks, and G. K. Teal, PN Junction Transistors, *Physical Review*, Vol. 83, pp 151-162, July 1, 1951.

B. Cornelison and W. A. Adcock, Transistors by Grown-Diffused Technique, *IRE WESCON Convention Record*, Vol. 1, Part 3, pp 22-27, 1957.

I. A. Lesk and R. C. Gonzalez, Germanium and Silicon Transistor Structures by the Diffused-Meltback Process Employing Two or Three Impurities, *IRE Trans. on Electron Devices*, July, 1958.

R. R. Law, C. W. Mueller, J. I. Pankove and C. D. Armstrong, A Developmental PNP Junction Transistor, *Proceedings IRE*, Vol. 40, p 1352, Nov. 1952.

J. S. Saby, Fused Impurity PNP Junction Transistors, *Proceedings IRE*, Vol. 40, pp 1358-1360, Nov. 1952.

W. E. Bradley, et al., Surface Barrier Transistor, *Proceedings IRE*, Vol. 41, pp 1702-1720, Dec. 1953.

Rittman, Messenger, Williams and Zimmerman, Micro-alloy Transistor, *IRE Trans. on Electron Devices*, Vol. ED-5 No. 2, p 49, April 1958.

C. A. Lee, A High-Frequency Diffused Germanium Transistor, *Bell System Technical Journal*, Vol. 35, Jan. 1956.

M. Tanenbaum and D. E. Thomas, Diffused Emitter and Base Silicon Transistors, *Bell System Technical Journal*, Vol. 35, Jan. 1956.

J. M. Early, PNIP and NPIN Junction Transistor Triodes, *Bell System Technical Journal*, Vol. 33, May 1954.

A. L. Kestenbaum and N. H. Detrick, Design, Construction, and High-Frequency Performance of Drift Transistors, *RCA Review*, p 12, March 1957.

C. G. Thornton, Technology of Micro-Alloy Diffused Transistors, *Proceedings IRE*, Vol. 46, p 1166, June 1958.

Measuring Transistor Parameters With Wayne Kerr RF Bridges

Dr. R. M. Scarlett
Assistant Professor
Stanford Electronics Labs.
Stanford Univ.
Stanford, Calif.

Wayne Kerr rf bridges used for measuring high frequency transistor parameters.

MEASUREMENT of transistor parameters can be made easily and accurately by using the Wayne Kerr rf bridges. These bridges are capable of measuring either two-terminal (driving-point) admittances or transfer admittances of a three-terminal network over a wide frequency range. The bridges have an extremely wide admittance range.

Theory of Bridge Operation

The Wayne Kerr B-601 and B-801 are transformer ratio-arm bridges with internal comparison standards, which cover the frequency ranges of 15 kc to 5 mc and 1 mc to 100 mc. Although the circuits differ somewhat in detail, Fig. 1 illustrates the essential principles involved.

An input transformer with closely coupled secondary windings applies equal and opposite potentials between the neutral point and the unknown and standard admittances Y_x and Y_s (see Fig. 1a). When Y_s is adjusted to be equal to Y_x, equal and opposite currents flow through them, hence the current in the detector transformer is zero, and a null is obtained. The secondary windings on the input transformer need not have a 1 to 1 ratio. Either Y_x or Y_s may be tapped down on the detector transformer to obtain different scale factors.

The condition for balance is zero net ampere-turns in the detector transformer primary, whose parts must be tightly coupled. Essentially the same principles are involved if source and detector are interchanged in Fig. 1.

An important advantage of a transformer ratio–arm bridge is that any impedance appearing directly between either side of the input transformer secondary and the neutral point has no effect on the balance, since an equal impedance is reflected into the other half of the transformer–provided that the impedance is large compared with the small leakage impedance between secondary halves. Similarly, impedance appearing directly from point to neutral is across the detector transformer, where it can affect only the bridge sensitivity.

This property makes possible the measurement of the transfer admittances of three-terminal networks. Referring to Fig. 1b, the transfer admittance in question is defined as $Y_{21} = I_2/V_1$ with $V_2 = 0$. This last condition is met at balance, since the voltage across the detector transformer is necessarily zero. Since $V_1 = V_s$, despite the impedance presented by the network to V_1, and at balance $I_d = 0$, or $I_2 = -I_s$, the following equation is obtained,

$$Y_{21} = \frac{I_2}{V_1} = \frac{-I_s}{V_s} = -Y_s$$

Upon interchanging ends *1* and *2* of the network, the transfer admittance Y_{12} can be measured. It is important to note that the bridge measures transfer admittances with the sign reversed, which comes about simply because of the standard defi-

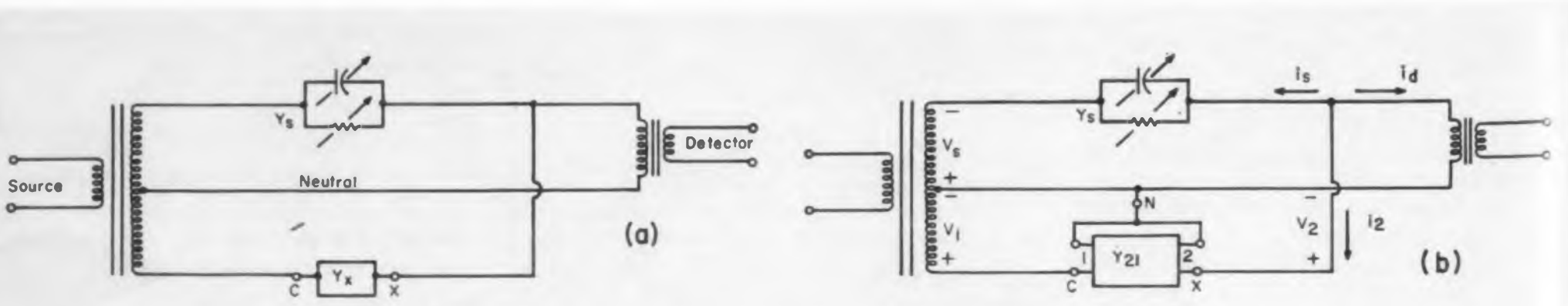
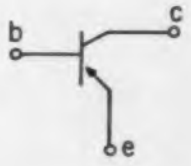


Fig. 1. Principles of operation of Wayne Kerr bridges. *(a)* Driving-point admittance. *(b)* Transfer admittance.



	b	e	c
b	Y_{bb} $Y_{11_e} = Y_{11_c}$	Y_{be} Y_{12_c}	Y_{bc} Y_{12_e}
e	Y_{eb} Y_{21_c}	Y_{ee} $Y_{11_b} = Y_{22_c}$	Y_{ec} Y_{12_b}
c	Y_{cb} Y_{21_e}	Y_{ce} Y_{21_b}	Y_{cc} $Y_{22_b} = Y_{22_e}$

Fig. 2. Indefinite admittance matrix.

nition of transfer admittance which is usual in network theory.

Measuring Admittance Parameters

There exist simple relations between the Y parameters of the three transistor orientations. These may all be calculated from any set of four independent measurements by making use of the scheme of Fig. 2, where the sum of any row or column is zero. A preferred set for ease of measurement and accuracy of the resulting calculations is Y_{11e}, Y_{11b}, Y_{22b} and Y_{12e}.

The only transfer quantity involved here is Y_{12e}, where a direct measurement is often desired since it gives the neutralizing impedance required for a common type of common-emitter bandpass amplifier. The connections to the bridge for this measurement (or any other transfer admittances) can be deduced by referring to Fig. 1b. The common terminal (emitter) is connected to neutral (N); Y_{12} is the transadmittance from output to input, so that the output terminal (collector) is connected to C and the input (base) to X.

It should be mentioned that Y_{12e} is usually a rather small admittance, and may be considerably influenced by stray capacitance between the transistor leads, and from the leads to the case. If the transistor is to be used common-emitter, the case should generally be connected to the emitter so that direct collector-to-case and base-to-case capacitance does not affect Y_{12e}.

Since this parameter is rather difficult to measure, it is sometimes better to measure current gain, alpha, and Y_{11} and calculate $Y_{21} = \text{alpha } Y_{11}$. This

gives the fourth parameter in the matrix. However, the resultant calculation of Y_{12}, if it is required, may lead to a serious loss of accuracy. One of the adaptors for the B-601 measures alpha directly and gives a further advantage, that the most important property of the transistor can be established directly over the frequency range.

Other Transistor Parameters

The open circuit impedance (Z) and hybrid (h) parameters which are sometimes used to characterize transistors can be calculated from the Y parameters[1] or driving-point quantities can, of course, be measured directly. There are two cases important enough to consider in detail.

The forward short-circuit current gain h_{21}, commonly denoted by, $\alpha = -h_{21b}$ or $\beta = h_{21e}$ may be calculated from the relationship

$$h_{21} = Y_{21} \; Y_{11}$$

Alternatively, a known resistor R may be placed in series with the input terminal. If R is much larger than the input impedance $h_{11} = 7/Y_{11}$, the forward transfer admittance of the combination is very nearly

$$y_{21'} = h_{21} \; R$$

Thus, for the common-base connection for example, the bridge reads

$$-Y_{21'b} = \alpha \; R$$

and the magnitude and phase angle of alpha is readily determined. A resistance of 10 K is generally large enough; its phase angle, which can be measured separately on the bridge, should be taken into account.

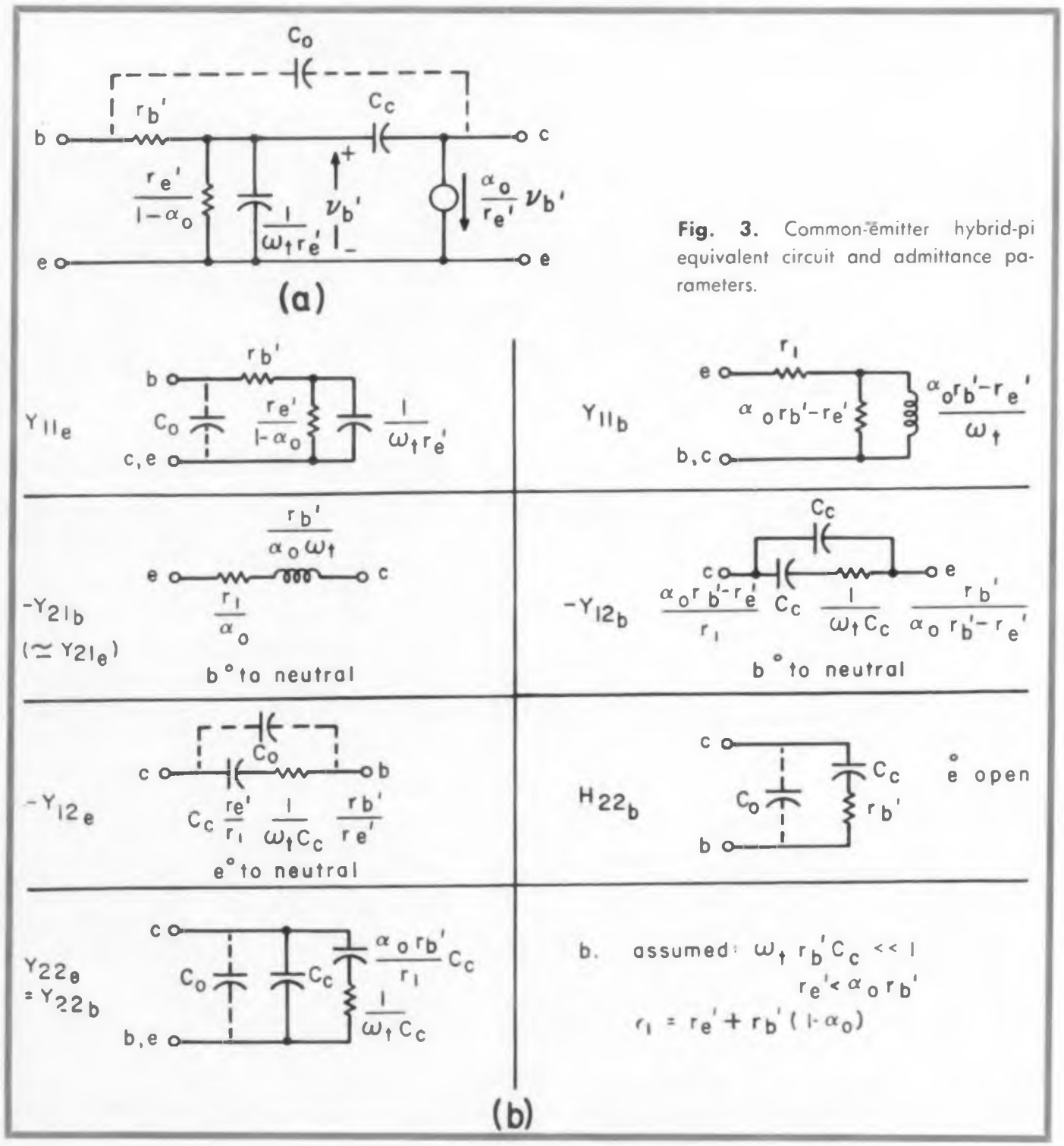


Fig. 3. Common-emitter hybrid-pi equivalent circuit and admittance parameters.

The open-circuit output impedance in the common-base connect $Z_{22b} = 1/h_{22b}$ is important since it consists chiefly of the space-change layer capacitance of the reverse-biased collector-base junction. This capacitance is sufficiently small in many high frequency transistors that interlead and lead to case stray capacity is of importance. If desired, the lead to case capacity can be eliminated from the measurement by connecting the case to the neutral terminal.

The emitter must be essentially open-circuited, the bias current being supplied through a low-capacitance resistor of sufficiently large resistance. For many transistors, nearly the same result will be obtained if the emitter is left open altogether. Measurements may be made on a transistor to determine the applicability and element values of a particular equivalent circuit.

As an example, consider the common-emitter hybrid-pi equivalent circuit shown in Fig. 3a, which is often used to represent a transistor at high frequencies. In this circuit $r_e \cong kT/qI_E$ dc. r'_b is the ohmic base resistance and f_t is the frequency at which $|\beta| = 1$, where β is the common-emitter current gain $h_{21e}1$. The cutoff frequency is given by $(1 - \alpha_0)$ ft.

According to this equivalent circuit model, the various admittances should have the forms which are shown by the individual networks in Fig. 3b. The common-collector transfer admittances are not included. In deriving these, the approximation $W_t r'_b C_c \ll 1$ has been used, and to this degree of approximation, $Y_{21c} = Y_{21b}$. In certain transistor structures, a relatively large direct capacitance is present from collector to base. This may be comparable or greater than C_c, and is denoted by C_o in Fig. 3a. Other direct terminal capacitances have been ignored for simplicity.

The admittances of Fig. 3b can all be measured conveniently on the Wayne Kerr bridges. A series of such measurements will indicate the degree to which the equivalent circuit model approximates to the transistor under test. In any case, these networks serve as a qualitative guide to the forms of the various admittances.

If one assumes the circuit of Fig. 3a to be a fair approximation, the element values are readily obtained. Measurement of Y_{11c} at two suitably chosen frequencies will enable r'_b, $r'_e/(1 - \alpha_o)$ and $1/w_t r'_e$ to be calculated approximately, if C_o is ignored. Measurement of h_{22b} gives $C_c + C_o$. The accurate separation of C_c and C_o is difficult; one method involves measurement of the common-base h_{12} (defined as V_1/V_2 when $I_1 = 0$) given by

$$h_{12b} = -Y_{12b}/Y_{11b}$$

From the circuit of Fig. 3a, this is approximately $j\omega r'_b C_c$. The current gain α_o or $\beta_o = \alpha_o/(1 -$) is most easily obtained by conventional low-frequency techniques. The Wayne Kerr Univer

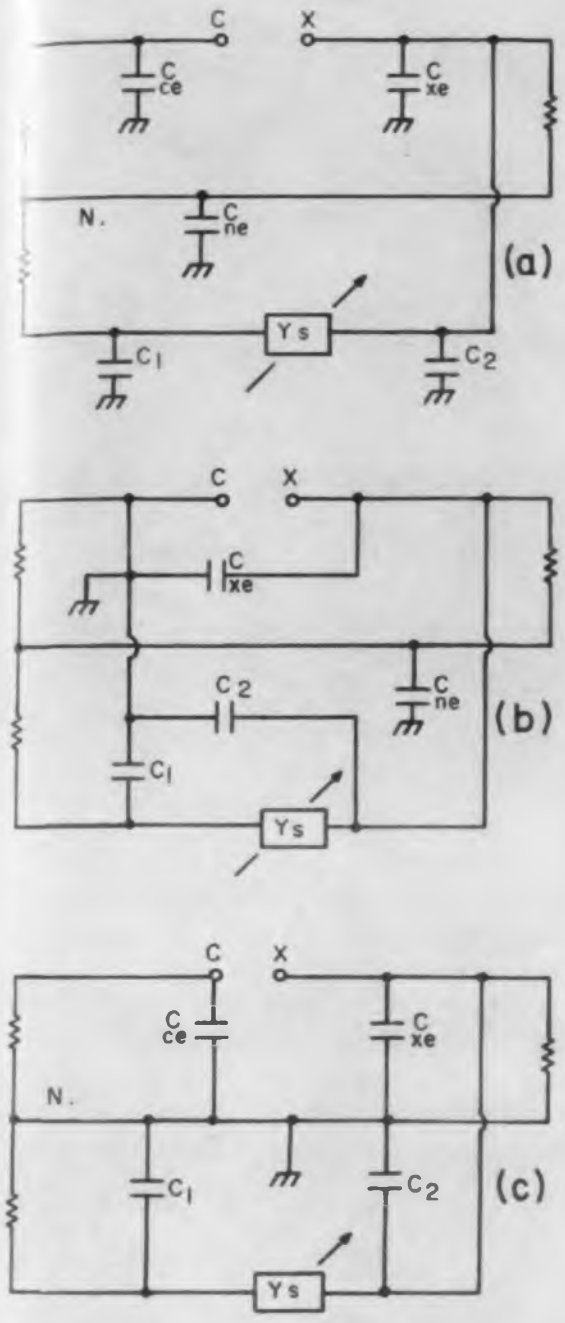


Fig. 4. Connection to bridge terminals to counteract stray capacitances. *(a)* Bridge stray capacitances. *(b)* If common is grounded, C_{XE}, C, and C_2 appear as shown. *(c)* If neutral is grounded, stray capacitances can be neglected.

Bridge B-221 can be used quite effectively for this measurement since its frequency range is 50 cps to 20 kc.

Transistor Adaptors

To connect a transistor to the bridge and provide it with dc bias, an adaptor is required. This will generally include a transistor socket and various bypass capacitors. Fig. 5 shows some circuits which have been found useful. In the physical construction of an adaptor, it must be remembered that the high-frequency performance of a transistor or any other component can be greatly affected by the arrangement of connecting leads. In bridges of this nature, which are essentially parallel substitution instruments, the capacitance of the adaptor leads and socket appearing across the bridge is balanced out if the adaptor is connected when the bridge is initially balanced. However, the series inductance of the leads and bypass capacitors will introduce errors in the final measurement.

In Fig. 5a is shown a suitable arrangement for measuring driving-point admittances on B-601 bridge. A transistor is shown connected for measurement of Y_{22b} (or h_{22b}) as an example, with a typical biasing circuit. Bias is fed to one electrode through the bridge, which provides a low-resistance dc path, and the remaining electrodes are connected to the other side of the bridge through capacitors.

Since extreme care must be exercised in the design and attachment of a transistor adaptor to these bridges to avoid serious errors, Wayne Kerr has developed a group of adaptors especially designed to fit the terminals of the rf bridge B-601. The form of these adaptors is such that they introduce minimum error (usually less than 1 per cent) over the full frequency range of the bridge.

This bridge uses the transformer ratio-arm technique and provides a three-terminal measuring facility in the frequency band 15 kc to 5 mc. It covers a very wide range of measurements of resistance (10 ohm to 10 megohm) and capacitance (0.01 pf to 0.02 μf). Inductances (0.5 μh to 0.05 h) are measured as equivalent negative capacitances.

The set of adaptors consists of a dc control unit and five adaptors providing the direct measurement of the input and output admittance and alpha in the ground-base configuration. The two other adaptors provide the measurement of the input and transfer admittance in the grounded-emitter configuration. ■ ■

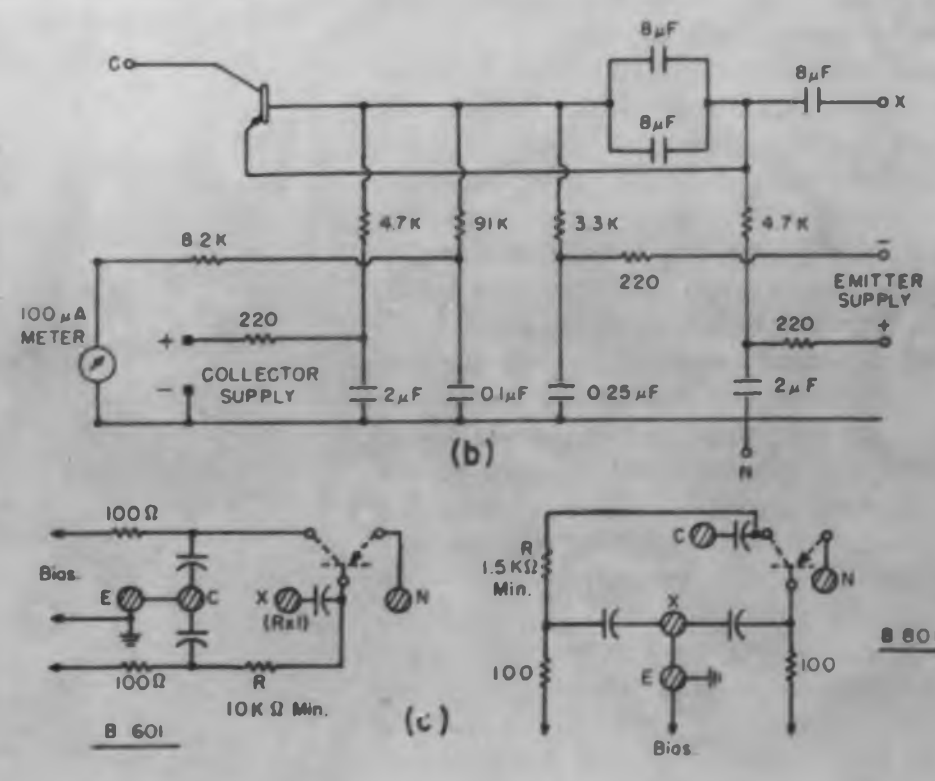


Fig. 5. Transistor adaptors. *(a)* Photograph of different adaptors used to connect the transistor to the bridge and provide it with dc bias. *(b)* Adaptor circuit for driving-point admittance shown for $Y_{22b} = Y_{22e}$ on B-601 Bridge. *(c)* Adaptor circuit for Y_{12e} transfer admittance.

Cathodic Envelope Energizer . . .

Energy in a Sandwich

LEAKPROOF, compact, lightweight construction, plus low cost per hour operation and high energy content are benefits offered by a new concept in carbon-zinc battery design. The guaranteed leakproof design eliminates the need for costly housings and the use of polarized plug and snap terminals obsolete the need for battery clips and holders.

Developed by the National Carbon Co., Division of Union Carbide Corp., the "Eveready Cathodic Envelope" energizers are particularly suited for transistorized equipment where size and weight must be at a minimum with operating life maintained as long as possible.

Cathodic Envelope Structure

The popular "Mini-Max" flat cell, placed on the market some twenty years ago, consists of a lamination of zinc, depolarizer mix, and other ingredients—similar to a sandwich with but "one slice of bread." High voltage B-supplies were obtained by stacking cells in series.

In the cathodic envelope construction, flat cakes of depolarizing mix are placed in contact with both sides of a zinc plate anode. Now, the sandwich has "two slices of bread." Completing the cell is a carbon-impregnated current-conducting film of flexible plastic and metal foil; this film encases the sandwich and is bonded to a plastic film wrapper which seals the cell; see Fig.1.

This arrangement effectively doubles the zinc anode area of each cell and reduces the current density in the mix; these factors provide higher electro-chemical efficiency with heavier current drains. To form a completed battery, groups of cells are connected and assembled into compact, rugged metal or plastic containers.

Performance Figures

In a typical application involving a 15 ma drain, the 9 v energizer (model 2762), yields 25 per cent longer service than 18 flashlight-type batteries and can deliver one year's service at a normal discharge schedule of four hours per day. The energizer occupies just about one-half the space required for the equivalent flashlight-type batteries.

With a 50 ma load, the 4.5 v energizer (model 2731) is compared, in Fig. 2, with a single series string of three "D"-size round cells and two parallel strings of "D" cells. As shown in Fig. 2, the cathodic envelope structure gives almost three times the service of two parallel strings of three "D" cells under a four hour per day discharge. Or, put in terms of special signaficance to portable equipment designers, the cathodic envelope battery occupies only one-third of the space required by "D" cells for equivalent service.

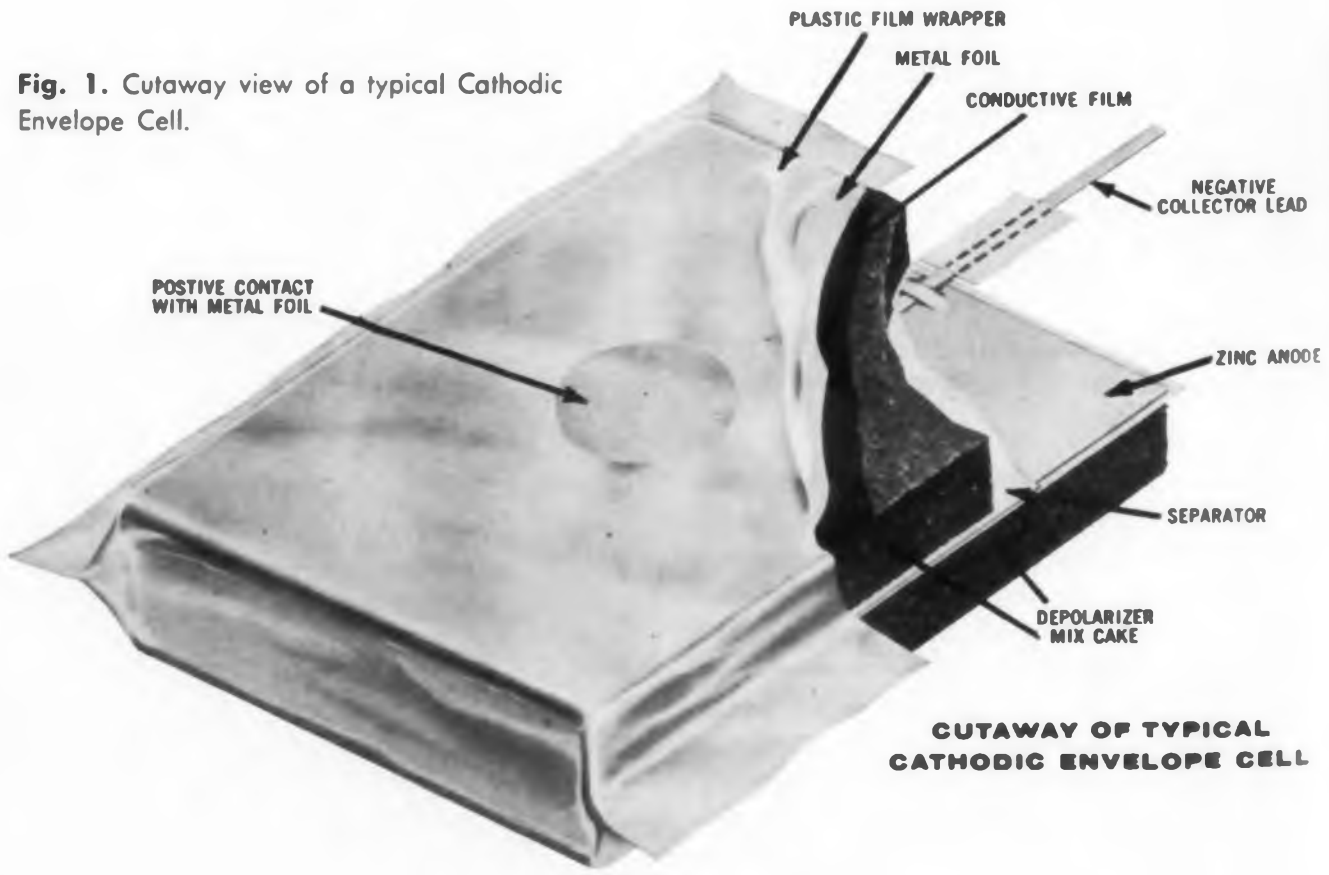
In Fig. 3, the same batteries are compared at 30 ma drain with a 24 hour per day schedule. Again, superior performance is shown for the cathodic design.

Consumer Benefits

Direct consumer appeal is provided by the use of terminals which can only be connected in the proper polarity; reversed polarity insertion damage is impossible.

The exceptionally long service life offered means fewer battery replacements and lower operating costs. In addition, the leakproof feature assures the consumer that equipment will not be ruined by corrosive chemical discharge. ■ ■ ■

Fig. 1. Cutaway view of a typical Cathodic Envelope Cell.



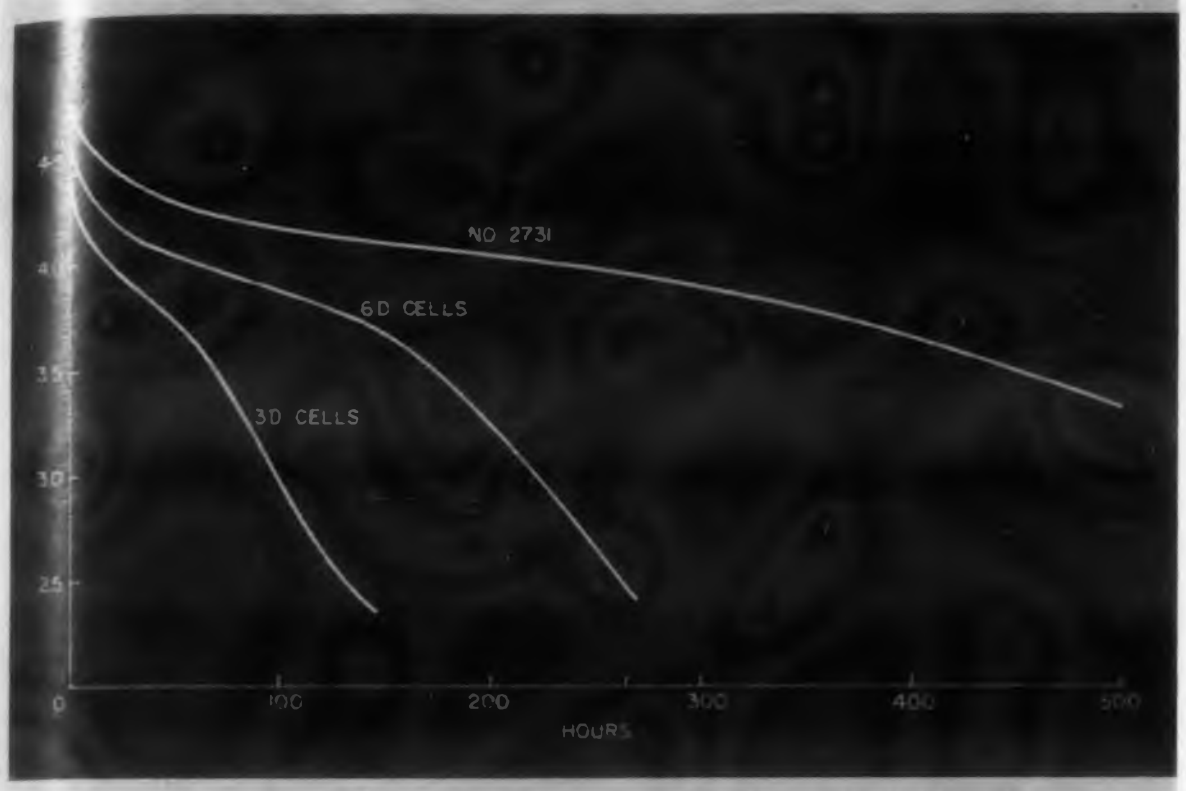


Fig. 2. Comparison between a 4.5 v type 2731 energizer, three "D" flashlight-type cells in series, and six "D" cells in series-parallel delivering 50 ma at a 4 hr/day discharge rate.

Data Chart—"Eveready" Cathodic Envelope Energizers

	2713	2714	2731	2732	2761	2762
Voltage	6	9	4-1/2	4-1/2	9	9
Weight (lb.)	1/4	7/16	3	1-9/16	1-1/2	3
Height (in.)	4-23/32	6-11/16	8-11/32	7-31/32	7-31/32	8-11/32
Length (in.)	1-13/32	1-13/32	2-13/16	2-9/32	2-9/32	2-13/16
Width (in.)	47/64	47/64	1-3/4	1-1/4	1-1/4	1-3/4

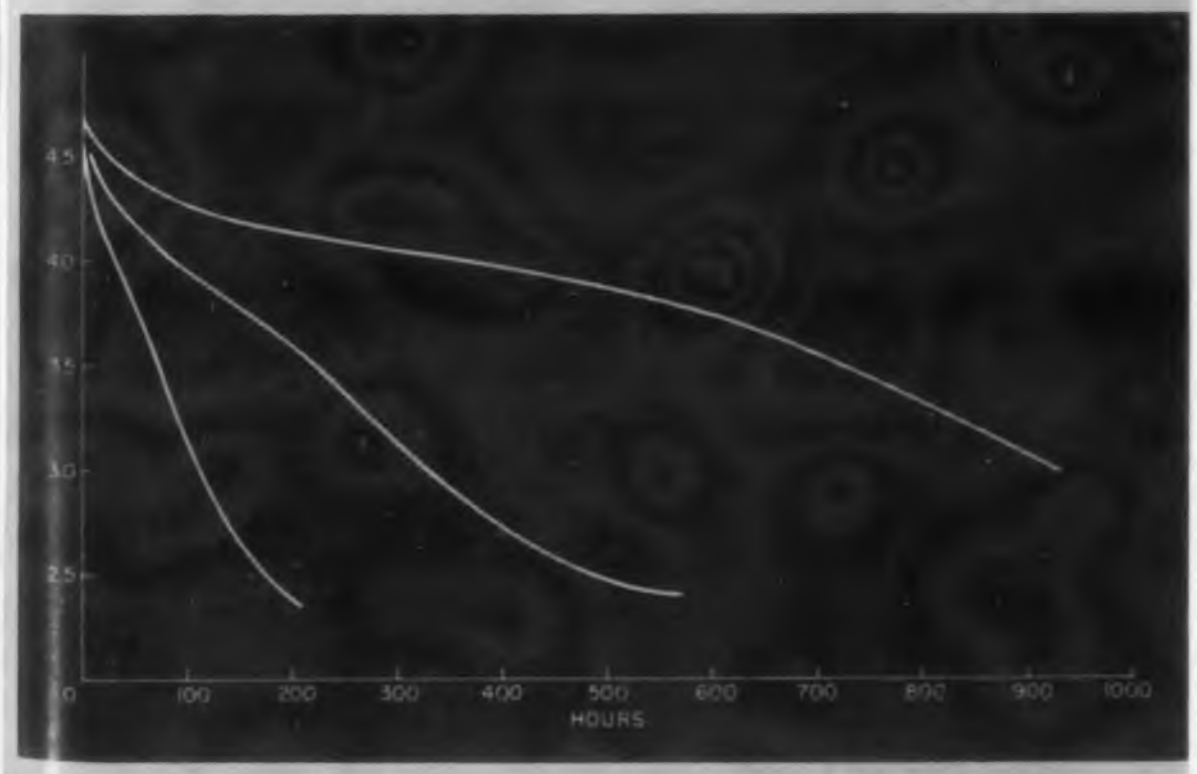


Fig. 3. Comparison between a type 2731 energizer, three "D" cells in series, and six "D" cells in series-parallel with a 30 ma continuous drain.

Three Selected Semiconductor Circuits

S. Schwartz
President
Transistor Applications, Inc.
Boston, Mass.

These three building-block type circuits have been chosen from "Selected Semiconductor Circuits Handbook" which will be completed this fall. The handbook, originally announced in *ED* (July 9, 1958 pg 10) was sponsored by the Bureau of Ships, prepared by Transistor Applications, Inc., with the hope of providing a handy reference of reliable circuits as well as to encourage the standardization of semiconductor circuit nomenclature and symbols.

Although the project is nearing completion, engineers engaged in transistor circuit design are invited to submit circuits with descriptive text for possible inclusion. Address material to Mr. S. Schwartz, Transistor Applications, Inc., 50 Broad St., Boston, Mass.

TRANSISTOR circuits engineers will find the following examples of well-designed contemporary circuitry useful for developing commercial and military electronic equipment:

- A flip-flop circuit, using 4-layer diodes, which provides high output voltage swing and operates over a wide voltage range.
- Conventional saturated and nonsaturated astable multivibrator, designed for reliability and simplicity.
- Regenerative frequency divider, capable of dividing by relatively large ratios with a small number of transistors.

Negative Resistance Diode Flip-Flop

A flip-flop using 4-layer pnpn diodes, is shown in Fig. 1. The circuit is capable of providing a high output voltage swing and operates over a wide range of voltage settings.

If $N\text{-}CR_2$, a negative resistance pnpn diode, is conducting initially, it receives a current from V_2 through CR_4 of 20 ma and an additional current from V_1. The other pnpn diode $N\text{-}CR_1$ is cut off, since V_1 and R_1 establish the operating point in the cut-off region. The voltage at point A is at V_1 and diode CR_3 is cut off.

The diodes CR_5 and CR_6 are steering diodes and are appropriately biased under the present circuit condition to allow an input pulse to turn $N\text{-}CR_1$ on. The diode CR_1 prevents the trigger from developing a total voltage across $N\text{-}CR_1$ sufficient to exceed the peak voltage. $N\text{-}CR_1$ turns on very rapidly, less than 0.1 μsec, and diverts the

current from $N\text{-}CR_2$.

In addition, when $N\text{-}CR_1$ turns on, capacitor C_1 causes the voltage fall to $N\text{-}CR_2$ and aids in reversing the current through $N\text{-}CR_2$. When $N\text{-}CR_2$ turns off, diode CR_4 is reverse-biased and point B is at a voltage level V_1. The steering diodes are biased so that the next input pulse will turn on $N\text{-}CR_2$.

For optimum circuit operation V_1, R_1 and R_2 should establish the operating point at cutoff with no intersection in the saturated region or the negative resistance region. This requires that V_1 be less than v_p where v_p is the peak voltage of the v-i characteristic of the pnpn diode.

Also,

$$\frac{V_1}{R_1} = \frac{V_1}{R_2} < i_h$$

where i_h is the holding current.

To provide adequate turn on, the currents from V_1 and V_2 must exceed the current i_h.

$$\frac{V_1}{R_1} + \frac{V_2}{R_3} > i_h$$

It is desirable, but not necessary, that

$$R_1, R_2 > 2\left(\frac{v_p - V_1}{V_2 - v_p}\right) R_3$$

and

$$V_2 > v_p$$

if these latter two conditions are not met, it is possible to have both $N\text{-}CR_1$ and $N\text{-}CR_2$ cut off until the trigger source is applied.

The flip-flop just described will operate with input pulses greater than 6 v. The turn-off time is about 7 μsec, while the turn-on is less than 0.1 μsec. The capacitor C_3 may be made smaller to reduce the turn-off time, but a higher input pulse will be required. V_2 may be varied from 30 to 150 v with V_1 at 30 v. With V_2 at 100 v, V_1 may be varied from 17 to 40 v.

Basic Astable Multivibrator

A conventional saturated and a nonsaturated astable multivibrator are shown in Figs. 2 and 3. To understand the operation of the circuit, assume that Q_1 has just switched on, driving the base of Q_2 to a positive voltage negative with respect to ground and C_2 is quickly charged to nearly V_{CC}. The collector of Q_1, the "on" transistor, is at nearly ground potential and C_1 is discharging toward V_{BB} with a time constant R_4C_1.

When the voltage at the base of Q_2 starts to go negative, Q_2 begins to conduct with the positive going waveform at the collector transferred to the base of Q_1 through C_2, turning Q_1 off and driving Q_2 on harder. Q_1 remains off until C_2 has discharged with a time constant R_2C_2 from V_{CC} to a slightly negative value at which time Q_1 turns on. Then the cycle repeats.

The time intervals of conduction are easily determined. Assume that

$$R_1 C_1 \ll R_2 C_2 \quad (1)$$

$$R_3 C_2 \ll R_4 C_1 \quad (2)$$

When Q_1 turns on, the base of Q_2 is reverse biased by $|V_{CC}|$. C_1 discharges toward V_{BB} with a time constant R_4C_1. Q_1 turns off when the voltage across the base of Q_2 becomes negative. Similar statements apply to the situation for Q_2 on.

$$T_1 = R_4 C_1 \ln \frac{V_{CC} + V_{BB_2}}{V_{BB_2}}$$

where T_1 is the time that Q_1 is in conduction and V_{BB_2} is the voltage to which R_4 is returned.

$$T_2 = R_2 C_2 \ln \frac{V_{CC} + V_{BB_1}}{V_{BB_1}}$$

where T_2 is the time that Q_2 is in conduction and V_{BB_1} is the voltage to which R_2 is returned.

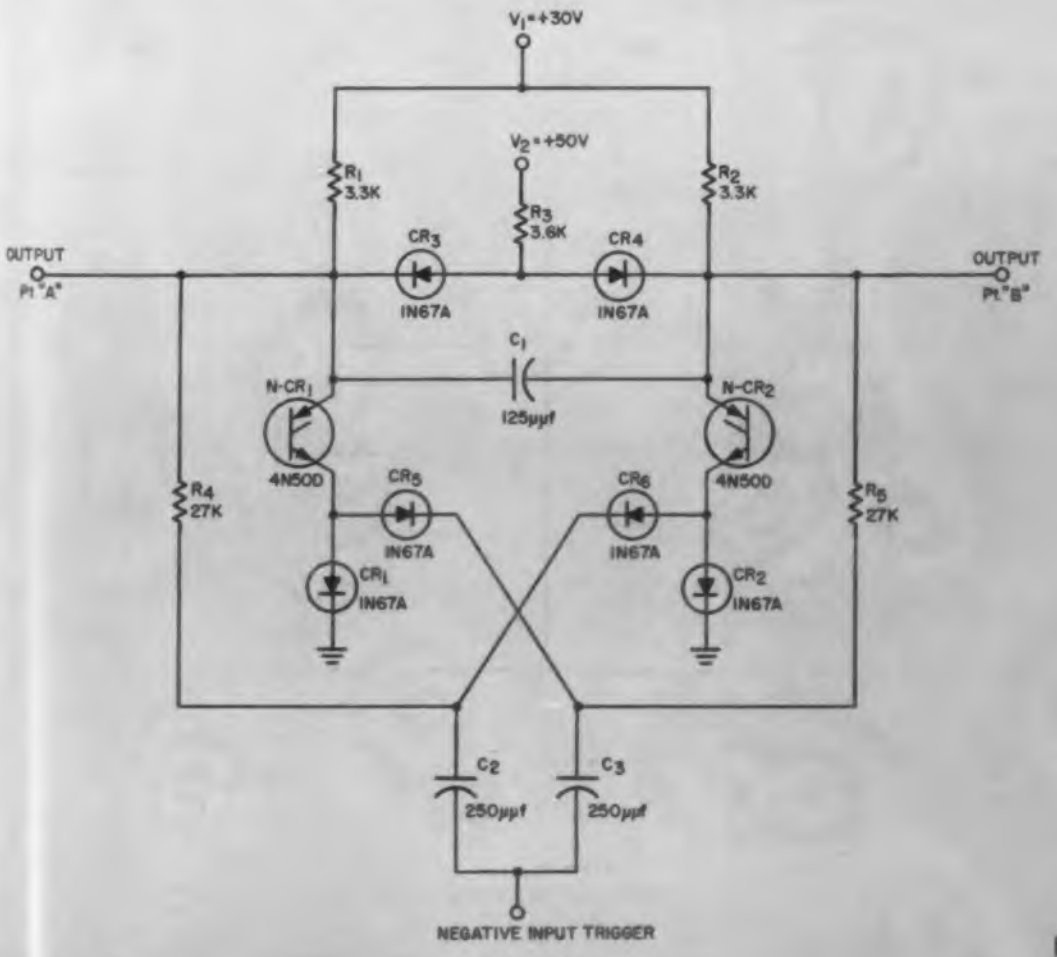
If the resistors R_2, R_4 are returned to V_{CC}, the expressions for the conduction times become

$$T_1 = 0.692\, R_4 C_1$$

and

$$T_2 = 0.692\, R_2 C_2$$

The repetition frequency is the reciprocal of the



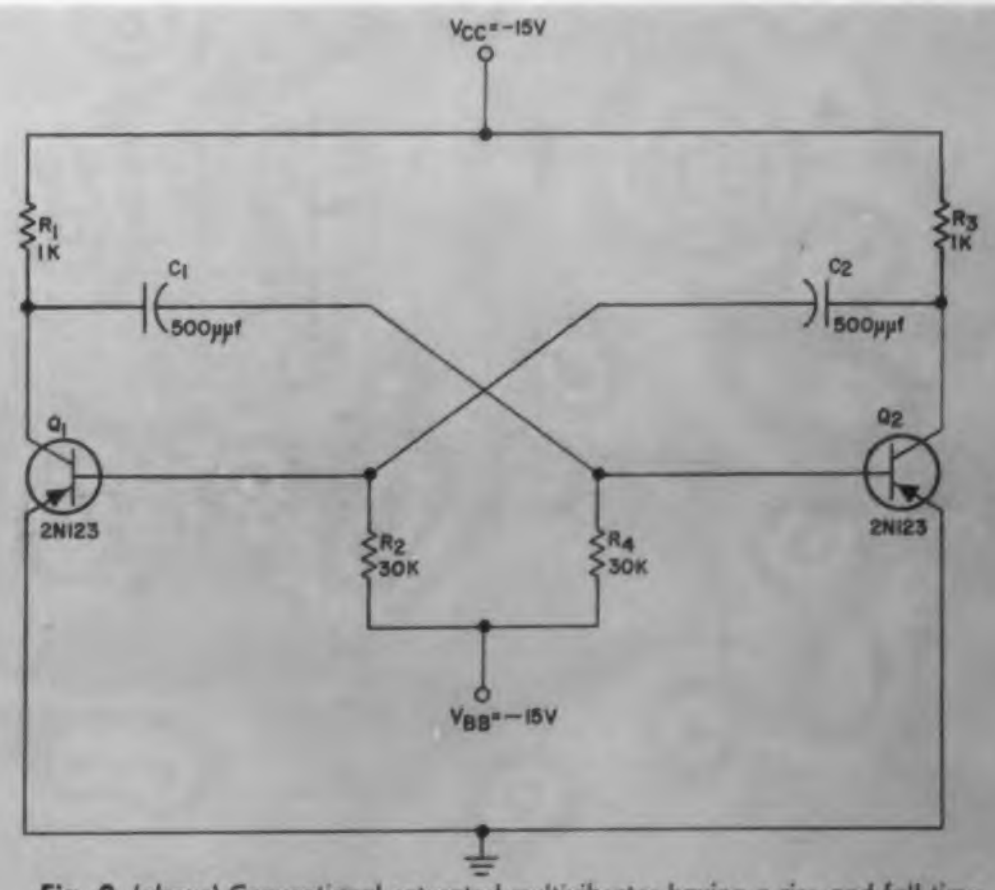


Fig. 2. (above) Conventional saturated multivibrator having a rise and fall time of less than one μsec.

Fig. 1. (left) Negative resistance flip-flop circuit uses four-layer diodes.

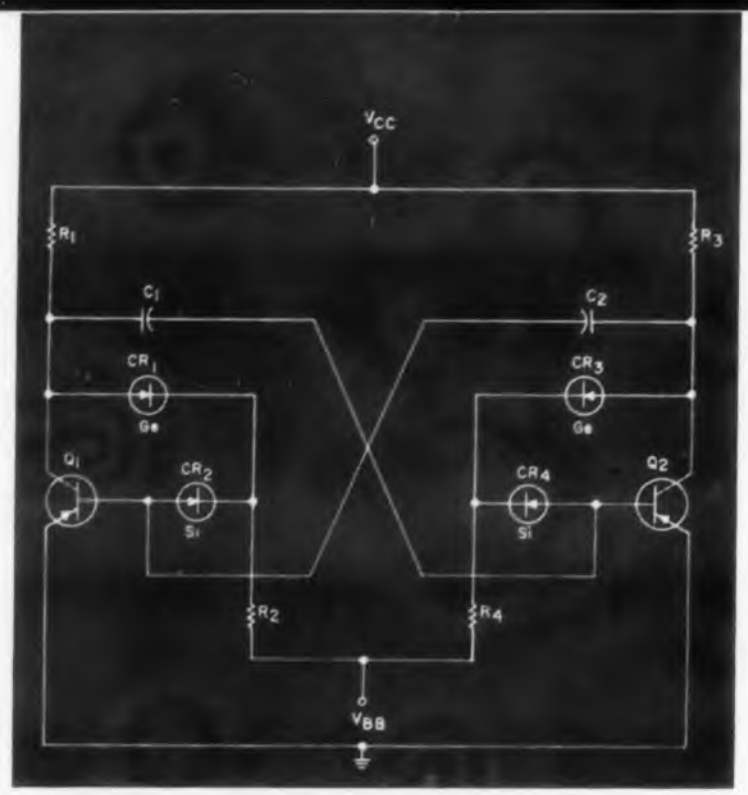


Fig. 3. The nonsaturated multivibrator may be operated at megacycle rates using high-frequency transistors.

sum of T_1 and T_2.

In Fig. 2 the resistors R_2 and R_4 are shown returned to a common voltage, but they may be returned to separate voltages.

It is not necessary that $T_1 = T_2$. The conduction times may be adjusted by variation of time constants and the base voltages. If the inequalities in Eqs. 1 and 2 are not met, the coupling capacitors do not charge to the supply voltage and the expressions for T_1 and T_2, as given above, do not apply.

The output voltage amplitude is approximately 15 v and has rise and fall times of less than 1 μsec. If capacitors C_1 and C_2 are 500 μμf, the multivibrator period is about 20 μsec. The circuit will utilize any recommended transistor type with a maximum voltage rating of over 15 v.

The basic multivibrator shown in Fig. 2 may be made nonsaturating by using a clamping method of Fig. 3. The nonsaturated multivibrator may be operated at megacycle rates with transistors having a sufficiently high frequency response.

The design relationships given for the saturated multivibrator hold for the nonsaturated type to the extent that the supply voltages are large compared to the voltage drops across the conducting clamp diodes. The silicon diodes may be replaced with two germanium diodes in series.

Regenerative Frequency Divider

The regenerative frequency divider, shown in Fig. 4, is of particular interest because it is capable of dividing by relatively large ratios with a small number of transistors. In spite of this, very high reliability can be obtained and the circuit, if properly designed, will have "fail safe" characteristics. This means a failure of the input voltage, or a radical component failure will decrease the output voltage to zero.

The relative simplicity and component economy of the divider can be appreciated when it is recognized that a circuit employing digital techniques would require seven transistors and ten diodes to accomplish the same result.

The divider is driven at a frequency of one megacycle and produces an output at 100 kc. The

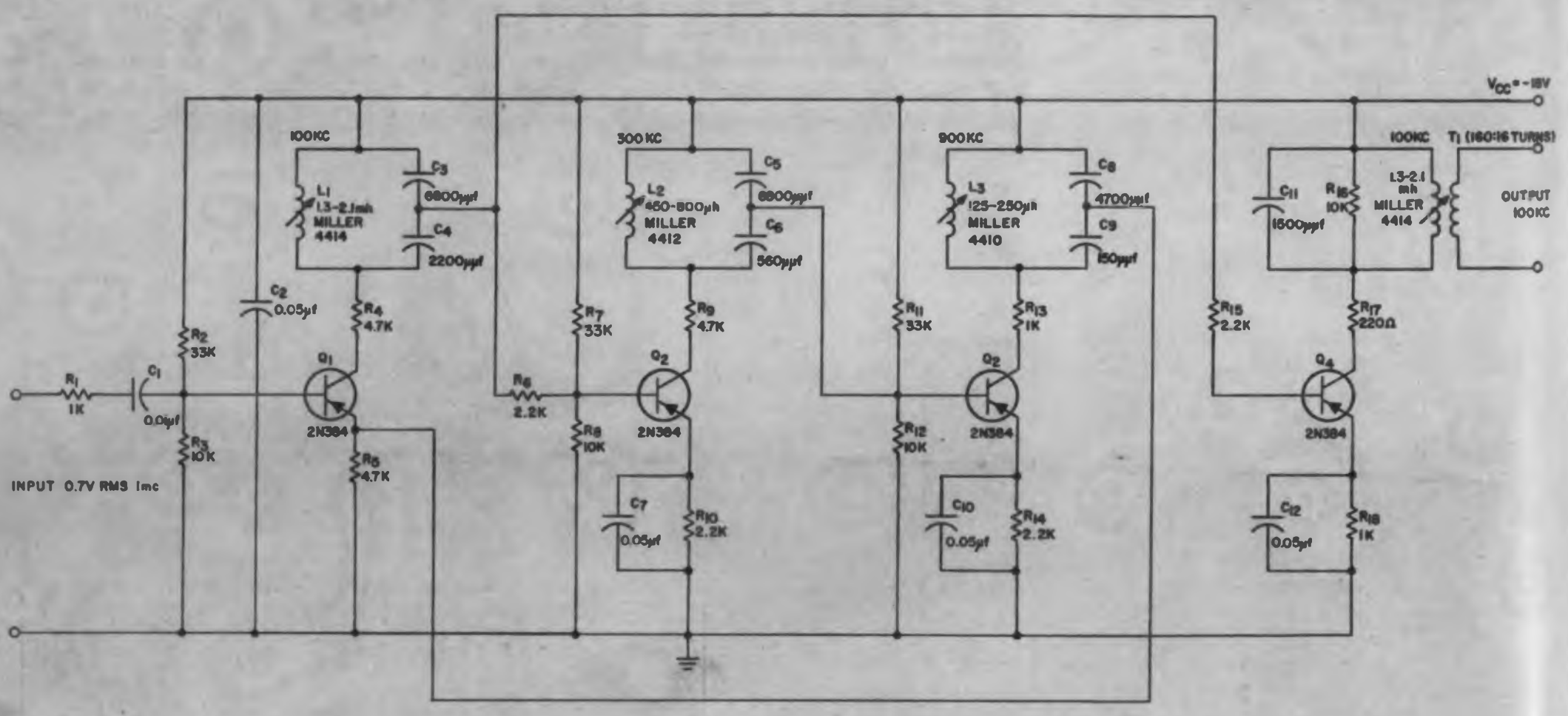


Fig. 4. High reliability, together with large ratio frequency-division, can be realized with this regenerative frequency divider.

circuit is stable and reliable, and, if properly adjusted, will not oscillate in the absence of an input. The phase stability is good and the operating bandwidth is such that excessively close tolerances in the tuned circuits need not be maintained.

Transistor Q_1 is a mixer that receives an input of 0.7 v rms at 1 mc from an external source. The output of the mixer is at 100 kc, is multiplied by three twice, once in Q_2 and again in Q_3 to produce 900 kc. This multiplier stage drives the emitter of Q_1 to produce a frequency difference of 100 kc, which is selected by means of a tapped tuned circuit.

The 4700 ohm resistor is connected in series with the collector of the transistor to suppress a form of negative resistance oscillation that is encountered with high frequency junction transistors when bottoming occurs. It also serves the very useful function of limiting the peak collector current to a satisfactory value.

The frequency multiplier, Q_2, is driven from a capacitive tap on the 100 kc tuned circuit through a series isolating resistor, R_6, which also helps to prevent vhf parasites.

The second frequency multiplier, Q_3, produces the 900 kc voltage required for the mixer. The output amplifier, Q_4, is driven by the mixer output, and has sufficient gain to deliver 20 mw to a 50 ohm load. The 10,000 ohm resistor R_{16} across the tuned circuit of Q_4 stabilizes the amplifier and also prevents an excessively high voltage from being developed at this point in the absence of a load. The frequency-multiplier stages and the output amplifier also contain series collector resistors for the reasons given above.

The alignment of the divider is best accomplished by driving the base of each transistor separately at the frequency of the collector tuned circuit. The tuned circuit is then adjusted for maximum response while the input is decreased if necessary, to avoid limiting. An input of 0.7 v rms at 1 mc should then be applied to Q_1. The system should oscillate and, as a final step, each tuned circuit should be adjusted to the center of the range where correct operation is obtained.

When properly adjusted the divider should work as the supply is varied from 5 to 40 v. Increasing the voltage beyond 40 v may cause transistor damage, and should not be attempted. The output should be zero in the absence of an input, except for a small amount of noise. The operating bandwidth should be at least ± 2 per cent at the middle of the supply-voltage range.

The divider is relatively insensitive to temperature and has been tested over the range from 0 to 60 C. The upper temperature limit is determined by the characteristics of the germanium transistors. The lower limit could be extended by the use of more stable tuned circuits such as those based upon powdered-iron toroids. ■ ■

PHILCO

Silicon Surface Alloy Transistors

For Reliable Performance at High Temperatures

These field proven Philco Silicon Transistors (SAT*) permit complete transistorization of military and commercial circuits that are subjected to high ambient temperatures . . . with excellent performance at junction temperatures ranging from −65° C to +140° C.

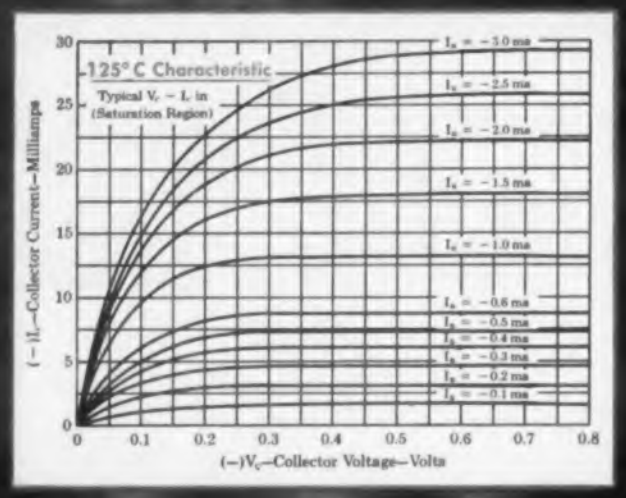
Type 2N495 is a general purpose silicon transistor designed for amplifier and oscillator applications at frequencies through 15 mc.

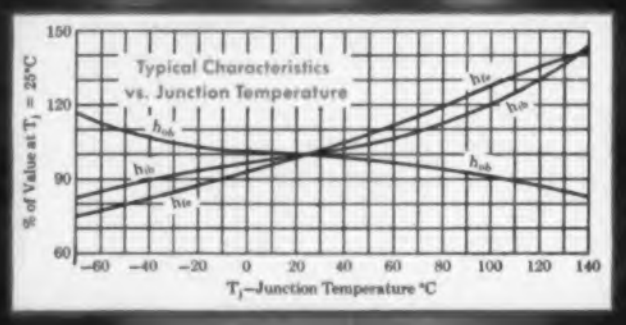
Type 2N496 is specifically engineered for high speed switching circuits. The frequency at which beta equals unity (f_t) is typically 18 mc. It gives the designer the advantages of low saturation resistance and low voltage operation, at high junction temperatures.

These units are environmentally tested in accordance with MIL-T-19500A.

Complete information will be supplied upon request. Write Lansdale Tube Company, Division of Philco Corporation, Lansdale, Pa., Dept. ED 759

**Trade Mark Philco Corp. for Surface Alloy Transistor*





CHARACTERISTICS OF TYPES 2N495 and 2N496

CHARACTERISTIC	CONDITION	TYPICAL VALUE 2N495	TYPICAL VALUE 2N496
Current Amplification Factor, h_{fe}	$V_{CE} = -6$ v, $I_E = 1$ ma	20	
Current Amplification Factor, h_{FE}	$V_{CE} = -0.5$ v, $I_C = -15$ ma		16
Output Capacitance, C_{ob}	$V_{CB} = -6$ v, $I_E = 1$ ma	7 μμf	7 μμf
Maximum Frequency of Oscillation, f_{os} max.	$V_{CB} = -6$ v, $I_E = 1$ ma	21 mc	
Frequency for Beta = 1, f_t*	$V_{CE} = -6$ v, $I_E = 1$ ma, $f = 4$ mc		18 mc
Cutoff Current, I_{CBO} or I_{EBO}	V_{CB} or $V_{EB} = -10$ v	.001 μa	.001 μa

Maximum Power Dissipation—150 mw

Maximum Collector Voltage 2N495—25 V
2N496—10 V

*f_t (the frequency at which beta is unity) is typically 85% of the alpha cutoff frequency.

Immediately available in quantities 1 to 99 from your Philco Industrial Semiconductor Distributor

PHILCO

LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.

Call Your Nearest Philco Industrial Semiconductor Distributor for Fast Service

EASTERN REGION

ACK RADIO SUPPLY CO.
Birmingham, Alabama
Atlanta, Georgia

CHEMCITY RADIO & ELECTRIC CO.
Knoxville, Tennessee
Charleston, West Virginia
Kingsport, Tennessee
Beckley, West Virginia
Johnson City, Tennessee

CRAMER ELECTRONICS, INC.
Boston, Massachusetts

ELECTRONIC SUPPLY CO.
Melbourne, Florida
Miami, Florida
St. Petersburg, Florida
Orlando, Florida
Tampa, Florida

ELECTRONIC WHOLESALERS, INC.
Washington, D.C.
Baltimore, Maryland

GENERAL RADIO SUPPLY CO.
Camden, New Jersey

LAFAYETTE RADIO CORPORATION
New York, New York
Jamaica, New York
Newark, New Jersey
Plainfield, New Jersey

MILGRAY ELECTRONICS, INC.
New York, New York

PHILADELPHIA ELECTRONICS, INC.
Philadelphia, Pennsylvania
Norristown, Pennsylvania

SUMMIT DISTRIBUTORS, INC.
Buffalo, New York

TERMINAL RADIO CORPORATION
New York, New York

MIDWEST REGION

ALLIED RADIO CORPORATION
Chicago, Illinois

NEWARK ELECTRIC COMPANY
Chicago, Illinois

PIONEER ELECTRONIC SUPPLY
Cleveland, Ohio

RADIO ELECTRONIC SUPPLY
Grand Rapids, Michigan

RISSI ELECTRONIC SUPPLY
Detroit, Michigan

SREPCO, INCORPORATED
Dayton, Ohio

STARK RADIO SUPPLY CO.
Minneapolis, Minnesota
LaCrosse, Wisconsin
St. Paul, Minnesota
Duluth, Minnesota

STEVENSON'S
St. Cloud, Minnesota

VAN SICKLE RADIO CO.
St. Louis, Missouri

SOUTHWEST REGION

CENTRAL ELECTRONICS
Dallas, Texas
Fort Worth, Texas

DENVER ELECTRONIC SUPPLY CO.
Denver, Colorado

RADIO SPECIALTIES, INC.
Phoenix, Arizona
Alamogordo, New Mexico
Flagstaff, Arizona
Albuquerque, New Mexico

STANDARD RADIO PARTS, INC.
Tucson, Arizona

STANDARD SUPPLY CO.
Salt Lake City, Utah

STERLING RADIO PRODUCTS, INC.
Houston, Texas

WESTERN REGION

C & G RADIO SUPPLY CO.
Tacoma, Washington
Bremerton, Washington
Olympia, Washington
Aberdeen, Washington
Centralia, Washington

ELMAR ELECTRONICS
Oakland, California

KIERULFF ELECTRONICS, INC.
Los Angeles, California

NEWARK ELECTRIC CO.
Inglewood, California

RADIO PRODUCTS SALES, INC.
Los Angeles, California

WESTERN RADIO & TELEVISION SUPPLY
San Diego, California

◄ CIRCLE 34 ON READER-SERVICE CARD

Transistor Data Chart

ELECTRONIC DESIGN's Seventh Annual Transistor Data Chart has been specially tailored to meet the specific needs of the design engineer.

Contrary to existing lists which group transistors by manufacturer or in numerical sequence (fine for salesmen, of limited use to engineers), the 1959 Data Chart has transistors organized into six application categories:

Audio units are mostly general purpose types, under one watt power rating. Types are listed in order of increasing forward-current transfer ratio.

High frequency units include those ranging up to and above the vhf range and are tabulated in order of increasing alpha-cutoff frequency.

Power devices include transistors that are rated at one watt and above and are listed in order of increasing collector power dissipation.

High-level switching devices include those intended for handling high currents and are listed in order of increasing alpha-cutoff frequency.

Low-level switching transistors are low power devices for switching signal circuits. They are tabulated in order of increasing alpha-cutoff frequency.

For both high- and low-level switching devices, rise, storage and fall time are given. Where spreads in characteristics were supplied by manufacturers, an average value has been used.

Special types such as phototransistors and unijunction units are included in this section.

By this system of listing transistors, the design engineer is offered a rapid method of selecting a particular type based on a parameter value. In addition, close substitutes are apparent and multiple sources of supply are listed when applicable.

For example, if a five watt power transistor is required, it is merely necessary to scan down the "W_c" columns in the "Power Transistor" group until "5 w" is found. Various units, together with significant characteristics and manufacturers, will be tabulated. Immediately several types are shown and final selection is up to the design engineer. Similar arrangement of the other groups by a key parameter grouping offers rapid selection and sufficient information for initial guidance to proper types.

Foreign types have not been included since they are currently unavailable in large quantities; signs point, however, to a mass deluge of imports during the coming year.

One word of caution is included. Quite a few similar number types, made by several companies, were submitted with different characteristics due to the non-conformity in test methods among manufacturers. It is thus advisable to use this listing as a guide to selection and then follow up with a detailed evaluation of specific test methods and data as outlined in each manufacturer's spec sheet.

A cross index is included to identify a type number with its listed category. The JEDEC type numbers are tabulated in numerical order and the category group is shown at its right.

For an additional copy of this chart, turn to the Reader's Service card and circle number 850.

AUDIO—Under one watt power rating.
Listed in order of increasing beta.

Type No.	Mfg	Type	h_{fe} or h_{FE}	Max. Ratings W_c (mw)	T_j (c)	mw/o_c	Characteristics V_c V	I_c ma	I_{co} μa	NF db	C_c μμf	$f_{\alpha e}$ mc	Remarks	Type No.
2N160	BO	npn,GJ,si	0.93	150	175	–	40	25	0.2	25	7	4		2N160
2N160A	BO	npn,GJ,si	0.93	150	175	–	40	25	9.2	25	7	4		2N160A
2N349	BO	npn,GJ,si	0.95	750	175	–	125	40	10	–	–	3		2N349
2N161	BO	npn,GJ,si	0.96	150	175	–	40	25	0.2	25	7	5		2N161
2N161A	BO	npn,GJ,si	0.96	150	175	–	40	25	0.2	25	7	5		2N161A
2N348	BO	npn,GJ,si	0.96	750	175	–	90	50	10	–	–	3		2N348
2N1096	BO	npn,GJ,si	0.96	500	175	–	90	30	6	–	–	3		2N1096
2N347	BO	npn,GJ,si	0.98	750	175	–	60	60	10	–	–	3		2N347
2N1095	BO	npn,GJ,si	0.98	500	175	–	60	40	5	–	–	3		2N1095
2N163	BO	npn,GJ,si	0.99	150	175	–	40	25	0.2	25	7	6		2N163
2N163A	BO	npn,GJ,si	0.99	150	175	–	40	25	0.2	25	7	6		2N163A
952	TI	npn,GJ,si	6	750	150	6	80	50	6	–	–	8	2N1155	952
951	TI	npn,DJ,si	9	750	150	6	50	60	5	–	–	8	2N1154	951
953	TI	npn,GJ,si	9	750	150	6	120	40	8	–	–	8	2N1156	953
2N45*	GT	pnp,AJ,ge	12	150	100	2	45	–	10	22	40	–	*MIL	2N45*
2N364	TI	npn,GJ,ge	14	150	85	2	30	50	1	–	4.5	2.5		2N364
GT327A	GT	pnp,AJ,si	14	150	150	1.2	50	—	0.1	18	70	0.5	2N327A	GT327A
2N284	AMP	pnp,AJ,ge	15	125	75	2.5	32	125	–	–	–	–		2N284
2N284A	AMP	pnp,AJ,ge	15	125	75	2.5	60	125	–	–	–	–		2N284A
903	TI	npn,GJ,si	15	150	175	1	45	25	2	25	–	4	2N1149	903
TR34	IND	pnp,AJ,ge	15	200	85	3	30	125	10	15	25	1		TR34
2N129	SPR	pnp,AJ,ge	20	30	85	–	3.0	5.0	–	–	–	30		2N129
2N243	TI	npn,GJ,si	20	0.75	150	6	60	60	1	–	–	7		2N243
2N1051	WE	npn,DD,si	20	600	150	.25	40	–	–	–	8	60	US, MIL only	2N1051
2N1249	TR	npn,GD,si	20	30	150	0.24	6	2.0	2.0	50	9	5	low noise	2N1249
ST1057	TR	npn,GD,si	20	30	150	0.24	6	–	2.0	50	9	5	low noise	ST1057
2N63	RA	pnp,FA,ge	22	100	85	–	22	10	6	25	–	–		2N63
TR722	IND	pnp,AJ,ge	22	200	85	3	45	200	10	15	25	1		TR722
CK64	RA	pnp,FA,ge	23	80	85	–	29	100	2	22	–	0.8		CK64
2N186A	GE	pnp,AJ,ge	24	200	85	4	25	200	16	–	40	0.8		2N186A
2N189	GE	pnp,AJ,ge	24	75	85	2	25	50	16	15	40	0.8		2N189
2N44	GE	pnp,AJ,ge	25	240	100	4	45	300	16	6	40	1	MIL, GT	2N44
2N204A	TI	npn,GJ,ge	25	150	85	2	60	50	1	11	4.5	2.5		2N204A
2N402	WH	pnp,FJ,ge	25	180	85	3.3	25	200	15	12	40	0.6	AF driver	2N402
2N460	TS	pnp,AJ,ge	25	200	100	33	45	400	15	–	–	–		2N460
2N564	IND	pnp,AJ,ge	25	200	85	3	30	300	3	12	30	0.8		2N564
2N592	GT	pnp,AJ,ge	25	150	100	.2	20	–	5	16	35	0.4	Bilateral	2N592
2N612	WH	pnp,FJ,ge	25	180	85	3.3	25	200	15	12	40	0.6	driver	2N612
GT328A	GT	pnp,AJ,si	25	150	150	1.2	50	–	0.1	18	20	1	2N328A	GT328A
2N130A	RA	pnp,FA,ge	26	100	85	–	40	100	6	22	–	0.7		2N130A
2N464	IND	pnp,AJ,ge	26	200	85	3	45	100	6	15	–	0.7	MO, RA	2N464
2N118	TI	npn,GR,si	29	150	175	1	45	25	2	20	–	5		2N118
2N279	AM	pnp,AJ,ge	30	25	75	2.5	20	10	110	10	–	0.15		2N279
2N524	GE	pnp,AJ,ge	30	225	100	4	45	500	10	6	25	2		2N524
2N594	GT	npn,AJ,ge	30	100	85	1.67	20	–	2	16	15	2	Bilateral	2N594
2N1248	TR	npn,DG,si	30	30	150	0.24	6	–	2.0	1.1	9	5	low noise	2N1248
904	TI	npn,GR,si	30	150	175	1	45	25	2	25	–	5	2N1150	904
OC65	AM	pnp,AJ,ge	30	50	75	1.7	5	10	–	9	–	0.15	hearing aid	OC 65
ST1050	TR	npn,GD,si	30	30	150	0.24	6	–	2.0	1.1	9	5	low noise	ST1050
2N319	GE	pnp,AJ,ge	34	225	85	4	20	200	16	–	25	2		2N319
2N365	TI	npn,GJ,ge	35	150	85	2	30	50	1	–	4.5	3		2N365
2N368	TI	pnp,AJ,ge	35	100	85	2	30	50	7	–	33	1		2N368
2N403	WH	pnp,FJ,ge	35	180	85	3.3	25	200	15	12	40	0.85	driver	2N403
2N406	RCA	pnp,AJ,ge	35	150	85	–	20	70	14	–	–	–		2N406
2N593	GT	pnp,AJ,ge	35	150	100	2	35	–	5	16	35	0.6	Bilateral	2N593
2N613	WH	pnp,FJ,ge	35	180	85	3.3	25	200	15	12	40	0.85	driver	2N613
2N680	TI	pnp,AJ,ge	35	150	85	2.5	25	150	8	–	–	1		2N680
2N1010	RCA	npn,AJ,ge	35	20	55	–	10	2	10	5	–	2		2N1010
2N1101	SY	npn,AJ,ge	35	180	75	3.6	20	100	100	–	–	0.01		2N1101
2N1102	SY	npn,AJ,ge	35	180	75	3.6	40	100	100	–	–	0.01		2N1102
OC53	AM	pnp,AJ.ge	35	10	55	0.7	3	5	0.1	10	–	0.01	Hearing Aid	OC53
2N187A	GE	pnp,AJ,ge	36	200	85	4	25	200	16	–	40	1		2N187A
2N190	GE	pnp,AJ,ge	36	75	85	2	25	50	16	15	40	1		2N190
2N381	TS	pnp,AJ,ge	36	200	85	3.3	25	200	10	–	–	–		2N381
2N405	SY	pnp,AJ,ge	40	150	85	2.5	20	35	250	–	–	0.25	RCA	2N405
2N650	IND	pnp,AJ,ge	40	200	85	3	45	250	1	10	20	2	MO	2N650
2N653	IND	pnp,AJ,ge	40	200	85	3	30	250	1	10	20	2	MO	2N653
2N1124	PH	pnp,AJ,ge	40	300	85	5.0	35	150	30	–	–	0.4		2N1124
2N1192	MO	pnp,AJ,ge	40	175	85	2.8	25	200	4	10	20	1.5		2N1192
2N43	GE	pnp,AJ,ge	42	240	100	4	45	300	16	6	40	1.3		2N43

The Coming Year

Prospects for the coming year in transistor technology include mesa transistors with alpha cutoff frequencies as high as 300 mc and switching speeds in the order of 100 μsec. Although the mesa device has been heralded quite prominently over the past year, production quantities have been rather limited; several manufacturers now promise consistent output within several months.

Some concern has been expressed by some companies on the subject of increased Japanese imports of general purpose, entertainment-type transistors. From 10,000 units shipped last year, close to 50,000 have been sent during the first quarter of this year. Over a half dozen new plants have been recently set up in Japan to fabricate enough transistors to meet their heavy domestic demands as well as the lucrative export market.

Initial response from users indicates that the quality of the imported transistors, used in such consumer products as radios and intercoms, equals that of domestic types; the low prices quoted point to strong competition for major U. S. manufacturers.

The coming year will find a rapid rise in imported semiconductors in U.S.-made products. The possible availability of cheap vhf transistors may open the door to inexpensive FM and TV receivers of transistorized design.

Index of Manufacturers

Abbrev.	Company	Location
AMP	Amperex Electronic Company	Hicksville, N.Y.
BE	Bendix Aviation Corporation	Long Branch, N.J.
BO	Bogue Electric Mfg. Company	Paterson, N.J.
CBS	CBS-Hytron, Semicon, Operations	Lowell, Mass.
CL	Clevite Transistor Products	Waltham, Mass.
DE	Delco, General Motors Corporation	Kokomo, Ind.
FA	Fairchild Semicond. Corp.	Palo Alto, Calif.
GE	General Electric Company	Syracuse, N.Y.
GT	General Transistor Corporation	Jamaica, N.Y.
HU	Hughes Products, Semicon. Div.	Los Angeles, Calif.
IND	Industro Transistor Corporation	L. I. C., N.Y.
MH	Minneapolis-Honeywell	Minneapolis, Minn.

MO	Motorola, Semiconductor Products Div.	Phoenix, Ariz.
PH	Philco Corporation	Lansdale, Pa.
PSI	Pacific Semiconductors, Inc.	Culver City, Calif.
RCA	Radio Corp. of America	Somerville, N.J.
RA	Raytheon Mfg. Company	Newton, Mass.
Rh	Rheem Mfg. Co.	Mountain View, Calif.
STC	Silicon Transistor Corporation	L. I. C., N.Y.
SSP	Solid State Products	Salem, Mass.
SSD	Sperry Semiconductor Div.	South Norwalk, Conn
SPR	Sprague Electric Company	North Adams, Mass.
SY	Sylvania Semiconductor Div.	Woburn, Mass.
TI	Texas Instruments, Inc.	Dallas, Texas
TR	Transitron Electronic Corporation	Wakefield, Mass.
TS	Tung-Sol Electric, Inc.	East Orange, N.J.
WE	Western Electric Company, Inc.	New York, N.Y.
WH	Westinghouse Electric Corp.	Youngwood, Pa.

Abbreviation of Terms

AJ	Alloyed Junction
DB	Diffused Base
DD	Double Diffused
DG	Grown Diffused
DJ	Diffused Junction
DM	Diffused Mesa
Dr	Drift
FA	Fused Alloy
FJ	Fused Junction
GD	Grown Diffused
GE	Germanium
GJ	Grown Junction
GR	Grown Rate
MB	Meltback
MD	MADT
MA	Micro Alloy
Ms	Mesa
RG	Rate Grown
SI	Silicon
SBT	Surface Barrier

C_{oe} = Collector to emitter capacitance measured across the output terminals with the input ac open-circuited.

F = Frequency at which the magnitude of the forward-current transfer ratio (small-signal) is 0.707 of its low frequency value.

h_{fe} = Common Emitter-Small signal forward current transfer ratio

h_{FE} = Common Emitter-Static value of short-circuited forward current ratio

I_{co} = Collector current when collector junction is reverse biased and emitter is dc open-circuited.

AUDIO—Under one watt power rating. Listed in order of increasing beta.

Type No.	Mfg	Type	h_{fe} or h_{FE}	Max. Ratings W_c (mw)	T_j (c)	mw/°c	Characteristics V_c V	I_c ma	I_{co} μa	NF db	C_c μμf	f_{ae} mc	Remarks	Type No.
2N104	RCA	pnp,AJ,ge	44	150	85	–	30	50	10	12	–	0.7		2N104
2N215	RCA	pnp,AJ,ge	44	150	85	–	30	50	10	12	–	0.7		2N215
2N525	GE	pnp,AJ,ge	44	225	100	4	45	500	10	6	25	2.5	SY	2N525
2N64	RA	pnp,fa, ge	45	100	85	–	15	10	6	22	–	–		2N64
2N131A	RA	pnp,FA,ge	45	100	85	–	30	100	6	22	–	0.8		2N131A
2N238	TI	pnp,AJ,ge	45	150	85	2.5	25	150	6	7.5	–	1.5		2N238
2N291	TI	pnp,AJ,ge	45	180	85	3	25	200	6	7.5	–	1.5		2N291
2N322	GE	pnp,AJ,ge	45	140	85	4	16	100	16	–	25	2.0	Driver	2N322
2N465	IND	pnp,AJ,ge	45	200	85	3	45	100	6	15	–	0.8	MO, RA	2N465
2N595	GT	npn,AJ,ge	45	100	85	1.65	20	–	2	16	15	4	Bilateral	2N595
2N1098	GE	pnp,AJ,ge	45	140	85	4	16	100	16	–	25	–	Driver	2N1098
2N1145	GE	pnp,AJ,ge	45	140	85	4	16	100	16	–	40	–	Driver	2N1145
CK65	RA	pnp,FA,ge	45	80	85	–	24	100	2	22	–	1		CK65
TR721	IND	pnp,AJ,ge	45	200	85	3	30	200	10	15	25	1		TR721
2N280	AM	pnp,AJ,ge	47	25	75	2.5	20	10	150	10	–	0.1		2N280
OC66	AM	pnp,AJ,ge	47	50	75	1.7	5	10	–	9	–	0.47	hearing-aid	OC66
2N43A*	GT	pnp,AJ,ge	48	155	100	–	45	–	8	10	40	2	MIL, GE	2N43A*
2N61	WH	pnp,FJ,ge	48	180	85	3.3	25	200	15	12	40	1		2N61
2N611	WH	pnp,FJ,ge	48	180	85	3.3	25	200	15	12	40	1		2N611
TR320	IND	pnp,AJ,ge	48	200	85	3	25	100	10	–	25	2.5	2N320	TR320
2N133A	RA	pnp,FA,ge	50	100	85	–	20	100	6	6.5	–	0.8		2N133A
2N320	GE	pnp,AJ,ge	50	225	85	4	20	200	16	–	25	2.5		2N320
2N331	RCA	pnp,AJ,ge	50	200	85	–	30	200	16	9	–	1.16	GT, BE	2N331
2N363	IND	pnp,AJ,ge	50	200	85	3	25	100	10	–	–	1	RA	2N363
2N422	IND	pnp,AJ,ge	50	200	85	3	35	100	6	6	–	0.8	Ra	2N422
2N461	TS	pnp,AJ,ge	50	200	100	3.3	45	400	15	–	–	–		2N461
TR381	IND	pnp,AJ,ge	50	200	85	3	30	200	10	–	50	1.2	2N381	TR381
2N188A	GE	pnp,AJ,ge	54	200	85	4	25	200	16	–	40	1.2		2N188A
2N191	GE	pnp,AJ,ge	54	75	85	2	25	50	16	15	40	1.2	Driver	2N191
2N382	TS	pnp,AJ,ge	54	200	85	3.3	25	200	10	–	–	–		2N382
2N105	RCA	pnp,AJ,ge	55	60	85	–	25	15	7	16.5	–	0.75		2N105
2N566	IND	pnp,AJ,ge	55	200	85	3	30	300	3	12	30	1		2N566
2N1097	GE	pnp,AJ,ge	55	140	85	4	16	100	16	–	25	–	Driver	2N1097
2N1144	GE	pnp,AJ,ge	55	140	85	4	16	100	16	–	40	–	Driver	2N1144
904A	TI	npn,GR,si	55	150	175	1	45	25	2	25	–	8		904A
OC54	AM	pnp,AJ,ge	55	10	55	0.7	3	5	0.1	10	–	0.01	hearing aid	OC54
2N226	PH	pnp,AJ,ge	60	250	75	5.0	30	150	8	–	140	0.4		2N226
2N244	TI	npn,GJ,si	60	0.75	150	6	60	60	1	–	–	0.08		2N244
2N596	GT	npn,AJ,ge	60	100	85	1.67	20	–	2	16	15	6	Bilateral	2N596
2N633	IND	pnp,AJ,ge	60	200	85	3	25	50	10	–	–	0.8	RA	2N633
905	TI	npn,GR,si	60	150	175	1	45	25	2	25	–	6	2N1152	905
2N526	GE	pnp,AJ,ge	64	225	100	4	45	500	10	6	25	3		2N526
2N175	RCA	pnp,AJ,ge	65	50	85	–	10	2	12	6	–	0.85		2N175
2N220	RCA	pnp,AJ,ge	65	50	85	–	10	2	12	6	–	0.85		2N220
2N407	RCA	pnp,AJ,ge	65	150	85	–	20	70	14	–	–	–	SY	2N407
2N408	RCA	pnp,AJ,ge	65	150	85	–	20	70	14	–	–	–		2N408
2N649	RCA	npn,AJ,ge	65	100	85	–	20	100	14	–	–	–		2N649
OC56	AM	pnp,AJ,ge	65	10	55	0.7	3	5	120	15	–	–	hearing aid	OC56
2N323	GE	pnp,AJ,ge	68	140	85	4	16	100	16	–	25	2.5	Driver	2N323
2N361	IND	pnp,AJ,ge	70	200	85	3	25	200	10	–	–	1	RA	2N361
2N591	RCA	pnp,AJ,ge	70	100	85	–	32	40	7	–	–	–	SY	2N591
2N647	RCA	npn,AJ,ge	70	100	85	–	25	100	14	–	–	–		2N647
2N1247	TR	npn,DG,si	70	30	150	0.24	6	–	0.8	–	9	5	Low-drift dc amp	2N1247
ST1026	TR	npn,DG,si	70	30	150	0.24	6	–	0.8	–	9	5	Low-drift dc amp	ST1026
2N383	TS	pnp,AJ,ge	72	200	85	33	25	200	10	–	–	–		2N383
2N241	GE	pnp,AJ,ge	73	100	85	3	25	200	16	–	40	1.3		2N241
2N241A	GE	pnp,AJ,ge	73	200	85	4	25	200	16	–	40	1.3		2N241A
2N34	SY	pnp,AJ,ge	75	150	75	3	40	100	100	–	–	0.01	Driver	2N34
2N35	SY	npn,AJ,ge	75	150	75	3	40	100	100	–	–	0.01	Driver	2N35
2N60	WH	pnp,FJ,ge	75	180	85	3.3	25	200	15	12	40	1.5		2N60
2N109	RCA	pnp,AJ,ge	75	150	85	–	25	70	14	–	–	–		2N109
2N192	GE	pnp,AJ,ge	75	75	85	2	25	50	16	15	40	1.5		2N192
2N214	SY	npn,AJ,ge	75	180	85	3	40	100	100	–	–	0.01	Matched	2N214
2N217	RCA	pnp,AJ,ge	75	150	85	–	25	70	14	–	–	–		2N217
2N228	SY	npn,AJ,ge	75	50	75	1	40	100	100	–	–	0.01		2N228
2N610	WH	pnp,FJ,ge	75	180	85	3.3	25	200	15	12	40	1.1		2N610
2N651	IND	pnp,AJ,ge	75	200	85	3	45	250	1	10	20	2.5	MO	2N651
2N654	IND	pnp,AJ,ge	75	200	85	3	30	250	1	10	20	2.5	MO	2N654
2N1059	SY	npn,AJ,ge	75	180	75	3.6	40	100	50	–	–	0.01		2N1059
2N1193	MO	pnp,AJ,ge	75	175	85	2.8	25	200	4	10	20	2		2N1193

(Continued on p. 52)

1959 Transistor Data Chart

AUDIO—Under one watt power rating.

Type No.	Mfg	Type	h_{fe} or h_{FE}	Max. Ratings W_c (mw)	T_j (c)	mw/a_c	V_c V
TR81	IND	pnp,AJ,ge	75	200	85	3	25
TR382	IND	pnp,AJ,ge	75	200	85	3	25
GT74	GT	pnp,AJ,ge	75	150	100	2	25
GT81	GT	pnp,AJ,ge	75	150	100	2	25
2N185	TI	pnp,AJ,ge	80	150	85	2.5	150
2N321	GE	pnp,AJ,ge	80	225	85	4	20
OC55	AM	pnp,AJ,ge	80	10	55	0.7	3
TR321	IND	pnp,AJ,ge	80	200	85	3	30
2N527	GE	pnp,AJ,ge	81	225	100	4	45
2N324	GE	pnp,AJ,ge	85	140	85	4	16
2N65	RA	pnp,FA,ge	90	100	85	–	12
2N132A	RA	pnp,FA,ge	90	100	85	–	20
2N224	PH	pnp,AJ,ge	90	250	75	5.0	25
2N369	TI	pnp,AJ,ge	90	100	85	2	30
2N466	IND	pnp,AJ,ge	90	200	85	3	35
CK22	RA	pnp,FA,ge	90	80	85	–	20
CK66	RA	pnp,FA,ge	90	80	85	–	20
2N59	WH	pnp,FJ,ge	100	180	85	3.3	25
2N207	PH	pnp,AJ,ge	100	50	65	1.25	12
2N207A	PH	pnp,AJ,ge	100	50	65	1.25	12
2N207B	PH	pnp,AJ,ge	100	50	65	1.25	12
2N360	IND	pnp,AJ,ge	100	200	85	3	25
2N362	IND	pnp,AJ,ge	100	200	8	3	25
2N366	TI	npn,GJ,ge	100	150	85	2	30
2N535	PH	pnp,AJ,ge	100	50	85	0.87	26
2N535A	PH	pnp,AJ,ge	100	50	85	0.87	20
2N535B	PH	pnp,AJ,ge	100	50	85	0.87	20
2N568	IND	pnp,AJ,ge	100	200	85	3	30
2N609	WH	pnp,FJ,ge	100	180	85	3.3	25
2N632	IND	pnp,AJ,ge	100	200	85	3	25
2N1128	PH	pnp,AJ,ge	100	150	85	2.5	25
TR383	IND	pnp,AJ,ge	100	200	85	3	25
2N223	PH	pnp,AJ,ge	110	250	75	5.0	18
2N265	GE	pnp,AJ,ge	110	75	85	2	25
GT109	GT	pnp,AJ,ge	110	150	100	2	25
2N508	GE	pnp,AJ,ge	112	140	85	4	16
2N120	TI	npn,GR,si	150	150	175	1	45
2N359	IND	pnp,AJ,ge	150	200	85	3	25
2N534	PH	pnp,AJ,ge	150	25	65	1.43	50
2N570	IND	pnp,AJ,ge	150	200	85	3	30
2N631	IND	pnp,AJ,ge	150	200	85	3	25
910	TI	npn,GR,si	150	150	175	1	45
2N652	IND	pnp,AJ,ge	160	200	85	3	45
2N655	IND	pnp,AJ,ge	160	200	85	3	30
2N1130	PH	pnp,AJ,ge	160	150	85	2.5	30
2N1194	MO	pnp,AJ,ge	160	175	85	2.8	25
2N467	IND	pnp,AJ,ge	180	200	85	3	35
CK67	RA	pnp,FA,ge	180	80	85	–	15
2N1129	PH	pnp,AJ,ge	190	150	85	2.5	25
2N572	IND	pnp,AJ,ge	200	200	85	3	30
2N213	SY	npn,AJ,ge	250	150	85	2.3	40
CK754	RA	pnp,FA,ge	300	100	85	–	10
GT1200	GT	npn,AJ,ge	–	120	85	2	90
OCP70	AM	pnp,AJ,ge	–	25	65	2.5	7.5

Abbreviation of Terms

AJ	Alloyed Junction	**GE**	Germanium
DB	Diffused Base	**GJ**	Grown Junction
DD	Double Diffused	**GR**	Grown Rate
DG	Grown Diffused	**MB**	Meltback
DJ	Diffused Junction	**MD**	MADT
DM	Diffused Mesa	**MA**	Micro Alloy
Dr	Drift	**Ms**	Mesa
FA	Fused Alloy	**RG**	Rate Grown
FJ	Fused Junction	**SI**	Silicon
GD	Grown Diffused	**SBT**	Surface Barrier

ed in order of increasing beta. *(continued)*

...gs V_c V	Characteristics NF dB	C_c μμf	$f_{\alpha e}$ mc	Remarks	Type No.
25	–	25	1		TR81
25	–	50	1.5	2N382	TR382
25	6	35	–		GT74
25	16	35	–		GT81
150	6.5	–	2		2N185
20	–	25	3		2N321
3	10	–	0.01	hearing aid	OC55
30	–	25	3	2N321	TR321
45	6	25	3.3		2N527
16	–	25	3	Driver	2N324
12	20	–	–		2N65
20	22	–	1		2N132A
25	–	125	0.57		2N224
30	–	33	1.3		2N369
35	15	–	1	MO, RA	2N466
20	6.5	–	1.2		CK22
20	22	–	1.2		CK66
25	12	40	1.2		2N59
5 12	5	–	2		2N207
5 12	2	–	2		2N207A
5 12	2	–	2		2N207B
25	–	–	1	RA	2N360
25	–	–	1	RA	2N362
30	–	4.5	3.5		2N366
7 26	5	–	2		2N535
7 20	2	–	2		2N535A
7 20	2	–	2		2N535B
30	12	30	1.5		2N568
25	12	40	1.2		2N609
25	–	–	1	RA	2N632
25	–	90	1		2N1128
25	–	50	1.8	2N383	TR383
18	–	90	0.6		2N223
25	15	40	1.5	Driver	2N265
25	16	35	–		GT109
16	–	25	3.5	Driver	2N508
45	20	–	7		2N120
25	–	–	1	RA	2N359
3 50	–	–	–		2N534
30	12	30	2		2N570
25	–	–	1.2	RA	2N631
45	20	–	7	2N1153	910
45	10	20	3	MO	2N652
30	10	20	3	MO	2N655
30	–	125	0.75		2N1130
25	10	20	2.5		2N1194
35	15	–	1.2	MO, RA	2N467
15	22	–	1.5		CK67
25	–	125	0.75		2N1129
30	12	30	3		2N572
40	–	–	0.01	Driver	2N213
10	–	–	1		CK754
90	20	–	–	Driver	GT1200
7.5	–	–	–	relay photo-tr.	OCP70

= Collector to emitter capacitance measured across the output terminals with the input ac open-circuited.
= Frequency at which the magnitude of the forward-current transfer ratio (small-signal) is 0.707 of its low frequency value.
= Common Emitter-Small signal forward current transfer ratio
= Common Emitter-Static value of short-circuited forward current ratio
= Collector current when collector junction is reverse biased and emitter is dc open-circuited.

HIGH-FREQUENCY—Up to 750 mc. Listed in order of increasing alpha cutoff frequency.

Type No.	Mfg	Type	$f_{\alpha e}$ MC	Max. Ratings					Characteristics				Remarks	Type No.
				W_c (mw)	T_j (c)	mw/o_c	V_c V	I_c ma	h_{fe} or h_{FE}	I_{co} μa	NF db	C_{Coe} $\mu\mu f$		
2N444	CBS	npn,AJ,ge	0.5	100	85	1.67	15	–	–	6	–	12		2N444
2N306	CBS	npn,AJ,ge	0.550	50	75	–	20	–	16	200	–	12		2N306
2N444A	GT	npn,AJ,ge	1	150	100	2	40	–	25	2	12	14		2N444A
2N1024	SSC	pnp,AJ,si	1	150	150	1.2	15	100	9	25	–	7		2N1024
2N1025	SSC	pnp,AJ,si	1	150	150	1.2	35	100	15	25	–	7		2N1025
2N94	SY	npn,AJ,ge	2	50	75	1	20	50	50	50	–	–		2N94
2N139	SY	pnp,AJ,ge	2	50	75	1	16	15	80	50	–	–	RCA	2N139
2N193	SY	npn,AJ,ge	2	0.05	75	1	18	50	9	50	–	–	Osc	2N193
2N194	SY	npn,AJ,ge	2	0.05	75	1	18	50	10	50	–	–	Mixer	2N194
2N194A	SY	npn,AJ,ge	2	0.05	75	1	18	50	10	50	–	–	Converter	2N194A
2N233A	SY	npn,AJ,ge	2	50	75	1	18	50	30	50	–	–		2N233A
2N413A	SY	pnp,AJ,ge	2	150	85	2.5	15	200	–	10	–	–		2N413A
2N515	SY	npn,AJ,ge	2	50	75	1	18	10	10	50	–	–		2N515
2N516	SY	npn,AJ,ge	2	50	75	1	18	10	10	50	–	–		2N516
2N517	SY	npn,AJ,ge	2	50	75	1	18	10	10	50	–	–		2N517
2N519A	GT	pnp,AJ,ge	2	150	100	2	25	–	25	1	12	14	IND.	2N519A
2N445	CBS	npn,AJ,ge	2	100	85	1.67	15	–	–	6	–	12		2N445
2N1026	SSC	pnp,AJ,si	2	150	150	1.2	35	100	25	25	–	7		2N1026
2N1026A	SSC	pnp,AJ,si	2	150	150	1.2	35	100	36	25	–	7		2N1026A
2N413	RA	pnp,FA,ge	2.5	150	85	–	18	200	30	2.0	7	–	IND.	2N413
CK13	RA	pnp,FA,ge	2.5	80	85	–	18	200	30	2.0	7	–		CK13
2N356	CBS	npn,AJ,ge	3	100	85	1.67	20	–	–	5	–	12	RCA, GT, SY	2N356
2N438	CBS	npn,AJ,ge	3	100	85	1.67	30	–	–	10	–	12	GT	2N438
2N438A	CBS	npn,AJ,ge	3	150	85	2.5	30	–	–	10	–	12		2N438A
2N445A	GT	npn,AJ,ge	3	150	100	2	30	–	70	2	12	14		2N445A
2N481	IND	pnp,AJ,ge	3	200	85	3	30	20	50	3	–	14	RA. Qscillator	2N481
2N614	WH	pnp,FJ,ge	3	125	85	2.1	20	150	4	6	10	8		2N614
2N1222	GT	pnp,AJ,si	3	150	150	1.2	30	100	10	0.05	16	9		2N1222
2N482	IND	pnp,AJ,ge	3.5	200	85	3	30	20	50	3	–	12	RA,IF	2N482
2N212	SY	npn,AJ,ge	4	0.05	75	1	18	50	20	50	–	–	Converter	2N212
2N385	CBS	npn,AJ,ge	4	150	100	2.0	25	–	–	35	–	4	SY	2N385
2N414A	SY	pnp,AJ,ge	4	150	85	2.5	15	200	–	10	–	–		2N414A
2N1027	SSC	pnp,AJ,si	4	150	150	1.2	15	100	18	25	–	7		2N1027
2N1058	SY	npn,AJ,ge	4	0.05	75	1	18	–	15	50	–	–	Converter	2N1058
GT495	GT	pnp,AJ,si	4	150	140	1.3	25	50	10	0.05	–	6		GT495
2N94A	SY	npn,AJ,ge	5	50	75	1	20	20	50	19	–	–		2N94A
2N292	GE	npn,RG,ge	5	65	85	1.1	15	20	25	5	–	2.4		2N292
2N439	CBS	npn,AJ,ge	5	100	85	1.67	30	–	–	10	–	12	GT, SY	2N439
2N439A	CBS	npn,AJ,ge	5	150	85	2.5	30	–	–	10	–	12		2N439A
2N446	CBS	npn,AJ,ge	5	100	85	1.67	15	–	–	6	–	12		2N446
2N448	GE	npn,RG,ge	5	65	85	1.1	15	20	25	5	–	2.4		2N448
2N520A	GT	pnp,AJ,ge	5	150	100	2	25	–	100	1	12	14	IND.	2N520A
2N615	WH	pnp,FJ,ge	5	125	85	2.1	20	150	8	6	10	8		2N615
2N634	CBS	npn,AJ,ge	5	150	85	2.5	20	–	–	5	–	12	GE	2N634
2N483	RA	pnp,FA,ge	5.5	150	85	–	12	20	60	3.0	–	–	IND	2N483
2N357	CBS	npn,AJ,ge	6	100	85	1.67	20	–	–	5	–	12	RCA, GT, SY	2N357
2N377	CBS	npn,AJ,ge	6	150	100	2.0	25	–	–	5	–	12	SY	2N377
2N446A	GT	npn,AJ,ge	6	150	100	2	30	–	120	2	12	14		2N446A
2N1221	GT	pnp,AJ,si	6	150	150	1.2	30	100	20	0.05	16	7		2N1221
2N218	RCA	pnp,AJ,ge	6.8	80	85	–	16	15	48	6	–	–		2N218
2N409	RCA	pnp,AJ,ge	6.8	80	85	–	13	15	48	10	–	–	SY	2N409
2N410	RCA	pnp,AJ,ge	6.8	80	85	–	13	15	75	10	–	–		2N410
2N332	TR	npn,GR,si	7	150	175	0.8	45	–	14	0.2	36	7	GE, BO	2N332
2N414	RA	pnp,FA,ge	7	150	85	–	15	200	60	2.0	6	–	IND.	2N414
2N617	WH	pnp,FJ,ge	7	125	85	2.1	15	150	14	6	10	8	Conv.	2N617
CK14	RA	pnp,FA,ge	7	80	85	–	15	200	60	2.0	6	–		CK14
GT496	GT	pnp,AJ,si	7	150	140	1.3	25	50	10	0.05	–	6		GT496
ST903	TR	npn,GR,si	7	150	150	1.0	30	–	16	0.1	25	7		ST903
2N485	IND	pnp,AJ,ge	7.5	200	85	3	30	20	50	3	–	12	Converter RA.	2N485
2N117	TR	npn,GR,si	8	150	175	0.8	30	–	15	0.1	20	7	USN TI	2N117
2N168A	GE	npn,RG,ge	8	65	85	1.1	15	20	40	5	–	2.4		2N168A
2N169	GE	npn,RG,ge	8	65	85	1.1	15	20	72	5	–	2.4		2N169
2N293	GE	npn,RG,ge	8	65	85	1.1	15	20	25	5	–	2.4		2N293
2N388	CBS	npn,AJ,ge	8	150	100	2.0	25	–	–	5	–	12	GT, SY	2N388
2N449	GE	npn,RG,ge	8	65	85	1.1	15	20	72	5	–	2.4		2N449
2N1086	GE	npn,RG,ge	8	65	85	1.1	9	20	40	3	–	2.4		2N1086
2N1086A	GE	npn,RG,ge	8	65	85	1.1	9	20	40	3	–	2.4		2N1086A
2N1087	GE	npn,RG,ge	8	65	85	1.1	9	20	40	3	–	2.4		2N1087
2N1121	GE	npn,RG,ge	8	65	85	1.1	15	20	72	5	–	2.4		2N1121
S500	SSC	pnp,AJ,si	8	150	150	1.2	25	100	9	25	–	7		S500

HIGH-FREQUENCY—Up to 750 mc.

Type No.	Mfg	Type	$f_{\alpha e}$ MC	Max. Ratings				
				W_c (mw)	T_j (c)	mw/o_c	V_c V	I_c ma
2N169A	GE	npn,RG,ge	9	65	85	1.1	25	20
2N333	TR	npn,GR,si	9	150	175	0.8	45	–
2N358	CBS	npn,AJ,ge	9	100	85	1.67	20	–
2N447	CBS	npn,AJ,ge	9	100	85	1.67	15	–
2N521A	GT	pnp,AJ,ge	9	150	100	2	25	–
2N616	WH	pnp,FJ,ge	9	125	85	2.1	15	150
ST904	TR	npn,GR,si	9	150	150	1.0	30	–
2N118	TR	npn,GR,si	10	150	175	0.8	30	–
2N140	RCA	pnp,AJ,ge	10	80	85	–	16	15
2N219	RCA	pnp,AJ,ge	10	80	85	–	16	15
2N335	TR	npn,GR,si	10	150	175	0.8	45	–
2N411	RCA	pnp,AJ,ge	10	80	85	–	13	15
2N412	RCA	pnp,AJ,ge	10	80	85	–	13	15
2N416	RA	pnp,FA,ge	10	150	85	–	12	200
2N440	CBS	npn,AJ,ge	10	100	85	1.67	30	–
2N440A	CBS	npn,AJ,ge	10	150	85	2.5	30	–
2N447A	GT	npn,AJ,ge	10	150	100	2	30	–
2N473	TR	npn,GR,si	10	200	200	1.1	15	–
2N474	TR	npn,GR,si	10	200	200	1.1	30	–
2N475	TR	npn,GR,si	10	200	200	1.1	45	–
2N484	RA	pnp,FA,ge	10	150	85	–	12	20
2N635	CBS	npn,AJ,ge	10	150	85	2.5	20	–
CK16	RA	pnp,FA,ge	10	80	85	–	12	200
ST905	TR	npn,GR,si	10	150	150	1.0	30	–
2N118A	TR	npn,GR,si	11	150	175	0.8	30	–
2N119	TR	npn,GR,si	11	150	175	0.8	30	–
2N334	TR	npn,GR,si	11	150	175	0.8	45	–
2N478	TR	npn,GR,si	11	200	200	1.1	15	–
2N479	TR	npn,GR,si	11	200	200	1.1	30	–
2N480	TR	npn,GR,si	11	200	200	1.1	45	–
ST9	TR	npn,GR,si	11	150	150	1.2	15	–
ST15	TR	npn,GR,si	11	200	200	1.1	15	–
ST29	TR	npn,GR,si	11	150	150	1.2	30	–
ST35	TR	npn,GR,si	11	200	200	1.1	30	–
ST45	TR	npn,GR,si	11	200	200	1.1	45	–
ST904A	TR	npn,GR,si	11	150	150	1.0	30	–
ST910	TR	npn,GR,si	11	150	150	1.0	30	–
2N486	IND	pnp,AJ,ge	12	–	85	3	30	20
2N336	TR	npn,GR,si	13	150	175	0.8	45	–
2N495	PH	pnp,SA,si	15	150	140	1.1	25	50
2N541	TR	npn,GR,si	15	200	200	1.1	15	–
2N542	TR	npn,GR,si	15	200	200	1.1	30	–
2N543	TR	npn,GR,si	15	200	200	1.1	45	–
2N624	SY	pnp,AJ,ge	15	100	100	1.3	20	–
2N636	CBS	npn,AJ,ge	15	150	85	2.5	20	–
2N522A	GT	pnp,AJ,ge	17	150	100	2	25	–
2N417	RA	pnp,FA,ge	20	150	85	–	10	200
2N602	GT	pnp,Dr,ge	20	120	85	2	20	–
CK17	RA	pnp,FA,ge	20	80	85	–	10	200
2N523A	GT	pnp,AJ,ge	23	150	100	2	20	–
2N1065	GT	pnp,Dr,ge	25	120	85	2	40	–
2N247	RCA	pnp,Dr,ge	30	80	85	–	35	10
2N274	RCA	pnp,Dr,ge	30	80	85	–	35	10
2N370	RCA	pnp,Dr,ge	30	80	85	–	20	10
2N371	RCA	pnp,Dr,ge	30	80	85	–	20	10
2N372	RCA	pnp,Dr,ge	30	80	85	–	20	10
2N373	RCA	pnp,Dr,ge	30	80	85	–	25	10
2N374	RCA	pnp,Dr,ge	30	80	85	–	25	10
2N544	RCA	pnp,Dr,ge	30	80	85	–	18	10
2N1109	TI	pnp,GD,ge	30	30	85	–	16	5
2N252	TI	pnp,GD,ge	35	30	55	–	16	5
2N308	TI	pnp,GD,ge	35	30	55	–	20	5
2N309	TI	pnp,GD,ge	35	30	55	–	20	5
2N310	TI	pnp,GD,ge	35	30	55	–	30	5
2N1108	TI	pnp,GD,ge	35	30	85	–	16	5
2N1110	TI	pnp,GD,ge	35	30	85	–	16	5
2N1111	TI	pnp,GD,ge	35	30	85	–	20	5
2N1111A	TI	pnp,GD,ge	35	30	85	–	20	5
2N1111B	TI	pnp,GD,ge	35	30	85	–	27	5
2N603	GT	pnp,Dr,ge	40	120	85	2	30	–

...ted in order of increasing alpha cutoff ...equency. *(continued)*

h_{fb} or h_{FE}	Characteristics I_{co} μa	NF db	C_{Coe} μμf	Remarks	Type No.
50	5	–	2.4		2N169A
28	0.2	39	7	GE, TI	2N333
–	5	–	12	GT, SY	2N358
–	6	–	12		2N447
150	1	12	14		2N521A
20	6	10	8	Reflex	2N616
31	0.1	25	7		ST904
30	0.1	20	7	USN	2N118
75	6	8	–	SY	2N140
75	6	–	–		2N219
60	0.2	19	7	GE	2N335
48	10	–	–	SY	2N411
75	10	–	–		2N412
80	2.0	4	–	IND.	2N416
–	10	–	12	GT, SY	2N440
–	10	–	12		2N440A
150	2	12	14		2N447A
30	0.01	20	7		2N473
30	0.01	20	7		2N474
30	0.01	20	7		2N475
90	3.0	–	–	IF	2N484
–	5	–	12	GE	2N635
80	2.0	4	–		CK16
65	0.1	25	7		ST905
50	0.1	25	7	JAN, TI	2N118A
60	0.1	20	7	USN	2N119
45	0.2	19	7	GE, TI	2N334
60	0.01	19	7		2N478
60	0.01	19	7		2N479
60	0.01	19	7		2N480
60	–	19	7		ST9
50	0.02	22	7		ST15
60	0.1	19	7		ST29
50	0.02	22	7	2N332	ST35
50	0.02	22	7	2N332	ST45
60	0.1	25	7		ST904A
140	0.1	20	7		ST910
100	3	–	12	RA. Converter	2N486
100	0.2	19	17	GE	2N336
15	0.001	–	7		2N495
130	0.01	19	7		2N541
130	0.01	19	7		2N542
130	0.01	19	7		2N543
20	20	–	–		2N624
–	5	–	12	GE	2N636
200	1	12	14		2N522A
140	2.0	4	–	IND.	2N417
–	3	14	4		2N602
140	2.0	4	–		CK17
300	1	12	14	IND.	2N523A
–	4	12	3		2N1065
60	16	–	–	SY	2N247
60	16	–	–		2N274
60	20	–	–	SY	2N370
60	20	–	–	SY	2N371
60	20	–	–	Mixer, SY	2N372
60	8	–	–	SY	2N373
60	8	–	–	Converter, SY	2N374
60	8	–	–	SY	2N544
20	5	–	2		2N1109
–	5	–	2		2N252
–	5	–	2		2N308
–	5	–	2		2N309
–	5	–	2		2N310
3[illegible]	5	–	2		2N1108
2[illegible]	5	–	2		2N1110
2[illegible]	5	–	2		2N1111
2[illegible]	5	–	2		2N1111A
2[illegible]	5	–	2		2N1111B
–	3	14	3		2N603

(Continued on p. 56)

HIGH-FREQUENCY—Up to 750 mc.

Type No.	Mfg	Type	f_{ae} MC	Max. Ratings W_c (mw)	T_j (c)	mw/°c	V_c V
2N1107	TI	pnp,GD,ge	40	30	85	–	16
2N640	RCA	pnp,Dr,ge	42	80	85	–	34
2N641	RCA	pnp,Dr,ge	42	80	85	–	34
2N642	RCA	pnp,Dr,ge	42	80	85	–	34
SB100	PH	pnp,SB,ge	45	10	55	0.67	4.5
2N248	TI	pnp,GD,ge	50	30	75	0.6	25
2N344	PH	pnp,SB,ge	50	20	55	1.33	5
2N345	PH	pnp,SA,ge	50	20	55	1.33	5
2N504	PH	pnp,MD,ge	50	30	85	0.75	25
2N604	GT	pnp,Dr,ge	50	120	85	2	30
3N36	GE	npn,MB,ge	50	30	85	0.5	6
2N1254	HU	pnp,DJ,si	55	–	160	–	15
2N1255	HU	pnp,DJ,si	55	–	160	–	15
2N1256	HU	pnp,DJ,si	55	–	160	–	30
2N1257	HU	pnp,DJ,si	55	–	160	–	30
2N1258	HU	pnp,DJ,si	55	–	160	–	50
2N1259	HU	pnp,DJ,si	55	–	160	–	50
2N128	PH	pnp,SB,ge	60	25	85	0.39	4.5
2N393	PH	pnp,MA,ge	60	25	85	0.63	6
OC170	AM	pnp,DJ,ge	70	60	75	2	20
2N346	PH	pnp,SB,ge	75	20	55	1.3	5
3N37	GE	npn,MB,ge	90	30	85	0.5	6
2N300	PH	pnp,SB,ge	95	20	85	0.5	5
2N384	RCA	pnp,Dr,ge	100	80	85	–	30
3N34	TI	npn,GD,se	100	125	150	1	30
OC171	AM	pnp,DJ,ge	100	60	75	2	20
2N299	PH	pnp,SBT,ge	110	20	85	0.5	4.5
3N35	TI	npn,GD,si	150	125	150	1	30
XT518	PSI	npn,DM,si	170	2.8	150	2.3	120
XT519	PSI	pnp,DM,si	170	2.8	150	2.3	120
XT520	PSI	npn,DM,si	170	2.8	150	2.3	120
3N25	TI	pnp,GD,ge	200	25	75	0.5	15
2N588	PH	pnp,MD,ge	250	30	85	0.75	15
2N503	PH	pnp,MD,ge	320	25	85	0.63	20
2N499	PH	pnp,MD,ge	330	30	85	0.75	18
2N502	PH	pnp,MD,ge	400	25	85	0.63	20
2N502A	PH	pnp,MD,ge	400	25	100	0.45	20
2N1143	TI	pnp,DB,ge	480	750	100	10	25
2N1142	TI	pnp,DB,ge	600	750	100	10	30
2N1141	TI	pnp,DB,ge	750	750	100	10	35
2N528	WE	pnp,DG,ge	750	100	100	5	40
2N537	WE	pnp,DG,ge	750	250	100	.3	30
2N1094	WE	pnp,DM,ge	750	250	100	0.3	30
2N1195	WE	pnp,DM,ge	750	250	100	0.3	30
2N312	CBS	npn,AJ,ge	–	75	85	–	15
2N695	MO	pnp,DM,Ms	–	75	100	1	12
2N700	MO	pnp,DM,Ms	–	75	100	1	25
2N701	MO	pnp,DM,Ms	–	75	85	–	20
XT515	PSI	npn,DM,si	–	2.8	150	2.3	120
XT516	PSI	npn,DM,si	–	2.8	150	2.3	120
XT517	PSI	npn,DM,si	–	2.8	150	2.3	120

Abbreviation of Terms

AJ	Alloyed Junction	**GE**	Germanium
DB	Diffused Base	**GJ**	Grown Junction
DD	Double Diffused	**GR**	Grown Rate
DG	Grown Diffused	**MB**	Meltback
DJ	Diffused Junction	**MD**	(MADT)
DM	Diffused Mesa	**MA**	Micro Alloy
Dr	Drift	**Ms**	Mesa
FA	Fused Alloy	**RG**	Rate Grown
FJ	Fused Junction	**SI**	Silicon
GD	Grown Diffused	**SBT**	Surface Barrier

Li ed in order of increasing alpha cutoff fr quency. *(continued)*

V_c V	Characteristics: h_{fe} or h_{FE}	I_{co} μa	NF db	C_{Coe} μμf	Remarks	Type No.
16						
34	34	5	–	2		2N1107
34	60	5	–	–		2N640
34	60	7	–	–		2N641
4.5	60	7	–	–		2N642
25	20	0.5	–	3.5		SB100
5	20	5	–	1.2		2N248
5	22	0.7	–	3	SPR	2N344
25	35	0.7	–	3	SPR	2N345
30	16	10	–	1.7		2N504
6	–	4	14	3		2N604
15	2.2	3	–	2	Tetrode	3N36
15	–	0.05	–	12		2N1254
30	–	0.05	–	12		2N1255
30	–	0.05	–	12		2N1256
50	–	0.05	–	12		2N1257
50	–	0.05	–	12		2N1258
4.5	–	0.05	–	12		2N1259
6	40	0.6	10	2.5	SPR	2N128
20	155	1.5	–	3.5	SPR	2N393
5	–	2	–	–		OC170
6	20	0.7	–	3	SPR	2N346
5	1.1	3	–	1.5	Tetrode	3N37
30	18	0.6	5	–		2N300
30	60	16	–	–		2N384
20	4	0.4	20	–	Tetrode	3N34
4.5	–	2	–	–		OC171
30	–	0.6	5	–		2N299
120	4	0.4	14	–	Tetrode	3N35
120	13	–	–	4	Power Amp	XT518
120	13	–	–	4	Power Amp	XT519
15	13	–	–	4	Power Amp	XT520
15	65	10	–	1.1	Tetrode	3N25
20	–	3	5	–		2N588
18	45	3	–	1.0		2N503
20	–	1.0	–	1.3		2N499
20	45	3	–	1.0		2N502
25	45	3	–	1.0		2N502A
30	8	10	–	1.5		2N1143
35	10	10	–	1.5		2N1142
40	12	5	–	1.5		2N1141
30	25	10	–	–	U.S., MIL only	2N528
30	10	5	–	2.8	U.S., MIL only	2N537
30	15.5	1.2	–	4	U.S., MIL only	2N1094
15	15.5	1.2	–	4	U.S., MIL only	2N1195
12	–	60	–	12	SY	2N312
25	–	0.8	–	4		2N695
20	8	1.0	–	1.2	UHF amp	2N700
120	25	1	–	1.2		2N701
120	–	–	–	4	Power Osc.	XT515
120	–	–	–	4	Power Osc.	XT516
	–	–	–	4	Power Osc.	XT517

C_{oe} = Collector to emitter capacitance measured across the output terminals with the input ac open-circuited.

F = Frequency at which the magntiude of the forward-current transfer ratio (small-signal) is 0.707 of its low frequency value.

h_{fe} = Common Emitter-Small signal forward current transfer ratio

h_{FE} = Common Emitter-Static value of short-circuited forward current ratio

I_{co} = Collector current when collector junction is reverse biased and emitter is dc open-circuited.

1959 Transistor Data Chart

POWER—Above one watt dissipation

Type No.	Mfg.	Type	W_c W	Max. Ratings: $W/^oC$	T_j °C	V_c V	I_c A
2N339	TR	npn,GR,si	1.0	0.008	150	55	–
2N340	TR	npn,GR,si	1.0	0.008	150	85	–
2N341	TR	npn,GR,si	1.0	0.008	150	125	–
2N342	TR	npn,GR,si	1.0	0.008	150	60	–
2N342A	TR	npn,GR,si	1.0	0.008	150	85	–
2N343	TR	npn,GR,si	1.0	0.008	150	60	–
2N1206	TR	npn,GR,si	1.2	0.01	200	60	–
2N1207	TR	npn,GR,si	1.2	–	200	60	–
2N1092	RCA	npn,DJ,si	2	0.286	175	60	0.5
2N1172	DE	pnp,AJ,ge	4	0.07	95	40	1.5
H3A	MH	pnp,AJ,ge	5	0.07	95	60	0.35
H4A	MH	pnp,AJ,ge	5	0.07	95	60	0.5
2N1067	RCA	npn,DJ,si	5	0.067	175	60	0.5
2N326	SY	npn,AJ,ge	7	0.11	85	35	2
2N255	BE	pnp,AJ,ge	8.5	0.3	85	15	3
2N256	BE	pnp,AJ,ge	8.5	0.3	85	30	3
2N122	TI	npn,GR,si	8.75	0.07	150	120	140
2N176	SY	pnp,AJ,ge	10	0.15	90	30	3
2N350	SY	pnp,AJ,ge	10	0.13	100	40	3
2N351	RCA	pnp,AJ,ge	10	1.0	90	40	3
2N376	RCA	pnp,AJ,ge	10	1.0	90	40	3
2N669	MO	pnp,AJ,ge	10	1.5	90	30	3
2N1068	RCA	npn,DJ,si	10	0.133	175	60	1.5
CTP1104	CL	pnp,AJ,ge	10	2.0	85	40	3
CTP1105	CL	pnp,AJ,ge	10	2.0	85	40	3
CTP1108	CL	pnp,AJ,ge	10	2.0	85	20	3
CTP1109	CL	pnp,AJ,ge	10	2.0	90	20	3
CTP1111	CL	pnp,AJ,ge	10	2.0	90	80	3
2N301A	RCA	pnp,AJ,ge	11	1.0	90	60	3
2N301	SY	pnp,AJ,ge	12	0.2	85	40	2
2N325	SY	pnp,AJ,ge	12	0.2	85	35	2
CTP1112	CL	pnp,AJ,ge	14	1.5	90	100	3
CTP1117	CL	pnp,AJ,ge	14	1.5	90	40	4
CTP1133	CL	pnp,AJ,ge	14	1.5	90	40	3
CTP1137	CL	pnp,AJ,ge	14	1.5	90	40	3
2N307	BE	pnp,AJ,ge	15	0.2	75	35	1.0
2N307A	SY	pnp,AJ,ge	17	0.34	75	35	2
2N155	CBS	pnp,AJ,ge	20	–	85	30	3
2N156	CBS	pnp,AJ,ge	20	0.33	85	30	3
2N157	CBS	pnp,AJ,ge	20	–	85	60	3
2N157A	CBS	pnp,AJ,ge	20	–	85	100	3
2N158	CBS	pnp,AJ,ge	20	–	85	60	3
2N158A	CBS	pnp,AJ,ge	20	–	85	80	3
2N255A	CBS	pnp,AJ,ge	20	–	85	15	3
2N256A	CBS	pnp,AJ,ge	20	–	85	25	3
2N401	BE	pnp,AJ,ge	20	0.5	90	40	3
LT-11	CBS	pnp,AJ,ge	20	–	85	80	3
LT-12	CBS	pnp,AJ,ge	20	–	85	100	3
LT-13	CBS	pnp,AJ,ge	20	–	85	120	3
LT-14	CBS	pnp,AJ,ge	20	–	85	150	3
LT-15	CBS	pnp,AJ,ge	20	–	85	200	3
LT5163	CBS	npn,AJ,ge	20	–	85	60	4
LT5164	CBS	npn,AJ,ge	20	–	85	80	4
LT5165	CBS	npn,AJ,ge	20	–	85	30	4
2N234A	BE	pnp,AJ,ge	25	0.5	90	30	3
2N235A	BE	pnp,AJ,ge	25	0.5	90	40	3
2N236A	BE	pnp,AJ,ge	25	0.5	95	40	3
2N242	SY	pnp,AJ,ge	25	0.33	100	45	1.0
2N250	TI	pnp,AJ,ge	25	0.42	85	30	3
2N251	TI	pnp,AJ,ge	25	0.42	85	60	3
2N285A	BE	pnp,AJ,ge	25	0.5	95	40	3
2N296	SY	pnp,AJ,ge	25	0.33	100	60	2
2N350A	MO	pnp,AJ,ge	25	1.5	100	40	3
2N351A	MO	pnp,AJ,ge	25	1.5	100	40	4
2N376A	MO	pnp,AJ,ge	25	1.5	100	40	5
2N399	BE	pnp,AJ,ge	25	0.5	90	40	3
2N400	BE	pnp,AJ,ge	25	0.5	95	40	3
2N419	BE	pnp,AJ,ge	25	0.5	95	45	3
2N1146	CL	pnp,AJ,ge	25	0.7	95	40	5
2N1146A	CL	pnp,AJ,ge	25	0.7	95	60	5

Liste | in order of increasing power dissipation.

Characteristics				Remarks	Type No.
I_{co} ma	f ae kc	Powr. Gain db	Powr. Out. W		
1.0	–	–	–	TI	2N339
1.0	–	–	–	TI	2N340
1.0	–	–	–	TI	2N341
1.0	–	–	–	TI	2N342
1.0	–	–	–	TI	2N342A
1.0	–	–	–	TI	2N343
0.001	–	–	–		2N1206
0.001	–	–	–		2N1207
1	–	–	–		2N1092
0.01	17	34	400	Driver	2N1172
0.03	–	–	–		H3A
0.03	200	–	–		H4A
0.5	–	–	–		2N1067
3	150	–	–		2N326
0.18	–	23	–	2N234A,CL	2N255
0.18	–	26	2	E1A2N234A,CL	2N256
0.01	1	28	–		2N122
0.3	–	35.5	–	RCA,MO,BE	2N176
–	5	32	–	MO	2N350
3	7	34	4	MO,SY	2N351
3	7	35	4	MO	2N376
0.3	5	40	2		2N669
0.5	–	–	–	Industrial	2N1068
2	4	28	1.2		CTP1104
2	5	30	1.2		CTP1105
2	4	27	0.6		CTP1108
2	6	35	0.6		CTP1109
5	4	29	1.2		CTP1111
3	5	33	5	BE,CL,CBS	2N301A
5	5	35	–	CL,RCA,BE,CBS	2N301
3	150	–	–		2N325
2	–	–	–		CTP1112
2	5	35	4		CTP1117
5	20	30	1.2		CTP1133
2.2	5	34	1.2		CTP1137
0.25	–	–	–	2N234A	2N307
–	0.005	33	–	BE	2N307A
2	5	–	2	CL	2N155
1	5	–	2		2N156
1	5	–	2		2N157
1	5	–	2		2N157A
1	5	–	2		2N158
1	5	–	2		2N158A
1.0	5	25	2		2N255A
1	5	25	2		2N256A
1.3	–	30	5		2N401
1	5	–	–		LT-11
1	5	–	–		LT-12
1	5	–	–		LT-13
1	5	–	–		LT-14
1	5	–	–		LT-15
0.3	–	–	–		LT5163
0.3	–	–	–		LT5164
0.3	–	–	–		LT5165
0.42	–	25	2	CBS	2N234A
0.42	6	36	2	CBS,CL	2N235A
0.76		35	4		2N236A
1.	–	36	–	CL,BE	2N242
–	–	30	–	CL	2N250
0.5	–	30	–		2N251
0.42	–	39	–		2N285A
2.	4	–	–		2N296
0.3	7	31	4		2N350A
0.3	7	33	4		2N351A
0.3	7	35	4		2N376A
1.5		33	8		2N399
1.3	–	35	6		2N400
0.5	–	–	5		2N419
25	4	–	–		2N1146
25	4	–	–		2N1146A

(Continued on p. 60)

1959 Transistor Data Chart

POWER—Above one watt dissipation.

Type No.	Mfg.	Type	W_c W	Max. Ratings				
				W/°C	T_j °C	V_c V	I_c A	h_{fe} or h_{FE}
2N1146B	CL	pnp, AJ, ge	25	0.7	95	80	15	–
2N1147	CL	pnp, AJ, ge	25	0.7	95	40	15	–
2N1147A	CL	pnp, AJ, ge	25	–	95	60	15	–
2N1147B	CL	pnp, AJ, ge	25	–	95	80	15	–
2N1147C	CL	pnp, AJ, ge	25	–	95	100	15	–
2N1245	CBS	pnp, AJ, ge	25	–	85	25	3	–
2N1246	CBS	pnp, AJ, ge	25	–	85	25	3	–
B-177	BE	pnp, AJ, ge	25	0.5	90	30	3	–
B-178	BE	pnp, AJ, ge	25	0.5	90	30	3	–
B-179	BE	pnp, AJ, ge	25	0.5	90	40	3	–
2N236B	CBS	pnp, AJ, ge	30	–	85	40	3	–
2N257	BE	pnp, AJ, ge	30	0.5	90	40	3	–
2N268	BE	pnp, AJ, ge	30	0.5	90	80	3	–
2N538	MH	pnp, AJ, ge	32	0.45	95	80	3	30
2N539	MH	pnp, AJ, ge	32	0.45	95	80	3	43
2N540	MH	pnp, AJ, ge	32	0.45	95	80	3	64
2N1202	MH	pnp, AJ, ge	32	0.45	95	80	3	86
2N1203	MH	pnp, AJ, ge	32	0.45	95	120	3	37
2N1261	MH	pnp, AJ, ge	32	0.45	95	60	3	30
2N1262	MH	pnp, AJ, ge	32	0.45	95	60	3	43
2N1263	MH	pnp, AJ, ge	32	0.45	95	60	3	64
H45	MH	pnp, AJ, ge	32	0.45	95	80	3	20
2N392	DE	pnp, AJ, ge	35	0.7	95	60	5	–
2N463	WE	pnp, AJ, ge	35	2	100	60	5	60
2N553	DE	pnp, AJ, ge	35	0.5	95	80	4	–
2N665	DE	pnp, AJ, ge	35	0.5	95	80	5	–
2N1168	DE	pnp, AJ, ge	35	0.7	95	50	5	–
2N1047	TI	npn, DJ, si	40	0.25	200	80	0.5	–
2N1048	TI	npn, DJ, si	40	0.25	200	120	0.5	–
2N1049	TI	npn, DJ, si	40	0.25	200	80	0.5	–
2N1050	TI	npn, DJ, si	40	0.25	200	120	0.5	–
2N173	DE	pnp, AJ, ge	50	1.0	95	60	15	–
2N277	DE	pnp, AJ, ge	50	1.0	95	40	15	–
2N278	DE	pnp, AJ, ge	50	1.0	95	50	15	–
2N441	DE	pnp, AJ, ge	50	1.0	95	40	15	–
2N442	DE	pnp, AJ, ge	50	1.0	95	50	15	–
2N443	DE	pnp, AJ, ge	50	1.0	95	60	15	–
2N561	REA	pnp, AJ, ge	50	1.0	100	80	10	75
2N627	MO	pnp, AJ, ge	50	0.8	90	30	10	18
2N628	MO	pnp, AJ, ge	50	0.8	90	45	10	18
2N629	MO	pnp, AJ, ge	50	0.8	90	60	10	18
2N630	MO	pnp, AJ, ge	50	0.8	90	80	10	18
2N1014	RCA	pnp, AJ, ge	50	1.0	100	100	10	75
2N1069	RCA	npn, DJ, si	50	1.0	175	60	4	20
2N1070	RCA	npn, DJ, si	50	1.0	175	60	4	20
2N1159	DC	pnp, AJ, ge	50	0.8	95	80	5	–
2N1160	DE	pnp, AJ, ge	50	0.8	95	80	7	–
2N1162	MO	pnp, AJ, ge	50	0.8	90	35	25	25
2N1163	MO	pnp, AJ, ge	50	0.8	90	35	25	25
2N1164	MO	pnp, AJ, ge	50	0.8	90	60	25	25
2N1165	MO	pnp, AJ, ge	50	0.8	90	60	25	25
2N1166	MO	pnp, AJ, ge	50	0.8	90	80	25	25
2N1167	MO	pnp, AJ, ge	50	0.8	90	80	25	25
H200	MH	pnp, AJ, ge	63	0.91	95	60	10	50
H201	MH	pnp, AJ, ge	63	0.91	95	60	10	40
2N174	DE	pnp, AJ, ge	70	0.8	95	80	12	–
2N1099	DE	pnp, AJ, ge	70	1.2	95	80	15	–
2N1100	DE	pnp, AJ, ge	70	1.2	95	100	15	–
2N574	MH	pnp, AJ, ge	100	1.43	95	60	15	14
2N574A	MH	pnp, AJ, ge	100	1.43	95	80	15	14
2N575	MH	pnp, AJ, ge	100	1.43	95	60	30	25
2N575A	MH	pnp, AJ, ge	100	1.43	95	80	30	25
2N1157	MH	pnp, AJ, ge	100	1.43	95	60	30	50
2N1157A	MH	pnp, AJ, ge	100	1.43	95	80	30	50

L ted in order of increasing power dissipation. *(continued)*

I_C A	h_{fe} or h_{FE}	Characteristics: I_{co} ma	f αe kc	Powr. Gain db	Powr. Out. W	Remarks	Type No.
15	–	25	4	–	–		2N1146B
15	–	25	4	–	–	Solder lugs	2N1147
15	–	25	4	–	–	Solder lugs	2N1147A
15	–	25	4	–	–	Solder lugs	2N1147B
15	–	25	4	–	–	Solder lugs	2N1147C
3	–	1	5	–	–		2N1245
3	–	1	5	–	–		2N1246
3	–	15	–	36	–		B-177
3	–	15	40	33	–		B-178
3	–	15	25	28	–		B-179
3	–	1.0	5	37	4	BE	2N236B
3	–	–	–	33	–	2N235A,CL	2N257
3	–	2	6.0	35	–	SY,CL	2N268
3	30	0.1	200	–	–		2N538
3	43	0.1	200	–	–		2N539
3	64	0.1	200	–	–		2N540
3	86	0.1	200	–	–		2N1202
3	37	0.1	200	–	–		2N1203
3	30	0.1	200	–	–		2N1261
3	43	0.1	200	–	–		2N1262
3	64	0.1	200	–	–		2N1263
3	20	0.1	200	–	–		H45
5	–	0.065	6	–	–		2N392
5	60	100	5	–	–		2N463
4	–	0.02	25	–	–		2N553
5	–	0.02	25	–	–		2N665
5	–	0.065	10	–	–		2N1168
5	–	0.015	–	–	–		2N1047
5	–	0.015	–	–	–		2N1048
5	–	0.95	–	–	–		2N1049
5	–	0.015	–	–	–		2N1050
5	–	0.1	10	–	20		2N173
5	–	0.1	10	–	20		2N277
5	–	0.1	10	–	20		2N278
5	–	0.1	10	–	20		2N441
5	–	0.1	10	–	20		2N442
5	–	0.1	10	–	20		2N443
0	75	0.1	–	26	30		2N561
0	18	0.3	8	38	–		2N627
0	18	0.3	8	38	–		2N628
0	18	0.5	8	38	–		2N629
0	18	0.5	8	38	–		2N630
0	75	0.1	–	26	30		2N1014
1	20	1	–	–	–	STC	2N1069
1	20	1	–	–	–	STC	2N1070
5	–	0.065	10	–	–		2N1159
–	–	0.065	10	–	–		2N1160
25	25	0.3	4	–	–		2N1162
25	25	0.3	4	–	–		2N1163
25	25	0.5	4	–	–		2N1164
25	25	0.5	4	–	–		2N1165
25	25	0.5	4	–	–		2N1166
25	25	0.5	4	–	–		2N1167
50	50	0.3	750	–	–		H200
40	40	0.3	375	–	–		H201
–	–	0.1	10	–	40	JAN,2N174A	2N174
–	–	0.1	10	–	40		2N1099
–	–	0.1	10	–	40		2N1100
14	14	0.9	200	–	–		2N574
14	14	0.9	200	–	–		2N574A
25	25	0.9	200	–	–		2N575
25	25	0.9	200	–	–		2N575A
50	50	0.9	200	–	–		2N1157
50	50	0.9	200	–	–		2N1157A

1959 Transistor Data Chart

HIGH-LEVEL SWITCHING—High current devices.

Type No.	Mfg	Type	$f_{\alpha e}$ KC	Max. Ratings W_C W	T_j °C	W/°C	V_C V	I_C A	h_{fe} or h_{FE}
2N1238	HU	pnp, FJ, si	0.8	1.0	200	–	15	0.2	14 to 0
2N1239	HU	pnp, FJ, si	0.8	1.0	200	–	15	0.2	32 to 0
2N1240	AU	pnp, FJ, si	1.0	1.0	200	–	35	0.2	14 to 0
2N1241	HU	pnp, FJ, si	1.0	1.0	200	–	35	0.2	24 to 0
2N1242	HU	pnp, FJ, si	1.0	1.0	200	–	65	0.2	14 to 0
2N1243	HU	pnp, FJ, si	1.0	1.0	200	–	65	0.2	24 to 0
2N1244	HU	pnp, FJ, si	1.2	1.0	200	–	40	0.2	14 to 0
GA52830	WE	pnp, AJ, ge	4	500	85	60	40	5	50
GA53242	WE	pnp, AJ, ge	4	500	85	60	40	5	50
GF45017	WE	pnp, AJ, ge	4	500	85	60	40	5	50
2N297	CL	pnp, AJ, ge	5	4	85	4.0	60	1	–
2N297A	CL	pnp, AJ, ge	5	12	95	2.0	60	1	–
2N618	CL	pnp, AJ, ge	5	14	90	1.5	80	1	–
2N268A	CL	pnp, AJ, ge	6	14	90	1.5	80	1	–
2N375	CL	pnp, AJ, ge	7	–	95	–	80	3	–
2N378	TS	pnp, AJ, ge	7	50	100	1.2	20	3	30
2N379	CL	pnp, AJ, ge	7	5	85	3	80	1	–
2N380	TS	pnp, AJ, ge	7	50	100	0.8	30	3	–
2N456	TI	pnp, AJ, ge	7	50	95	0.72	40	3	–
2N457	TI	pnp, AJ, ge	7	50	95	0.72	60	3	–
2N458	TI	pnp, AJ, ge	7	50	95	0.72	80	3	–
2N459	TS	pnp, AJ, ge	7	50	100	0.8	60	3	–
2N511	TI	pnp, AJ, ge	7	80	95	1.4	40	10	–
2N511A	TI	pnp, AJ, ge	7	80	95	1.4	60	10	–
2N511B	TI	pnp, AJ, ge	7	80	95	1.4	80	10	–
2N512	TI	pnp, AJ, ge	7	80	95	1.4	40	10	–
2N512A	TI	pnp, AJ, ge	7	80	95	1.4	60	10	–
2N512B	TI	pnp, AJ, ge	7	80	95	1.4	80	10	–
2N513	TI	pnp, AJ, ge	7	80	95	1.4	40	25	–
2N513A	TI	pnp, AJ, ge	7	80	95	1.4	60	25	–
2N513B	TI	pnp, AJ, ge	7	80	95	1.4	80	25	–
2N514	TI	pnp, AJ, ge	7	80	95	1.4	40	25	–
2N514A	TI	pnp, AJ, ge	7	80	95	1.4	60	25	–
2N514B	TI	pnp, AJ, ge	7	80	95	1.4	80	25	–
2N1021	TI	pnp, AJ, ge	7	50	95	0.72	100	3	–
2N1022	TI	pnp, AJ, ge	7	50	95	0.72	120	3	–
2N545	TR	npn, DJ, si	8	5	200	0.045	60	4	25 to 0
2N546	TR	npn, DJ, si	8	5	200	0.045	30	4	25 to 0
2N387	PH	pnp, AJ, ge	9	11.5	75	0.5	80	5	45
2N386	PH	pnp, AJ, ge	10	12.5	75	0.5	60	5	40 to 0
2N1046	TI	pnp, AJ, ge	12	15	65	0.37	80	5	–
WX1015	WH	npn, FJ, si	25	150	150	1.4	30	8	8 to 0
WX1015A	WH	npn, FJ, si	25	150	150	1.4	60	8	8 to 0
WX1015B	WH	npn, FJ, si	25	150	150	1.4	100	8	8 to 0
WX1015C	WH	npn, FJ, si	25	150	150	1.4	150	8	8 to 0
WX1015D	WH	npn, FJ, si	25	150	150	1.4	200	8	8 to 0
WX1015E	WH	npn, FJ, si	25	150	150	1.4	250	8	8 to 0
WX1015F	WH	npn, FJ, si	25	150	150	1.4	300	8	8 to 0
WX1016	WH	npn, FJ, si	25	150	150	1.4	30	8	8 to 0
WX1016A	WH	npn, FJ, si	25	150	150	1.4	60	8	8 to 0
WX1016B	WH	npn, FJ, si	25	150	150	1.4	100	8	8 to 0
WX1016C	WH	npn, FJ, si	25	150	150	1.4	150	8	8 to 0
WX1016D	WH	npn, FJ, si	25	150	150	1.4	200	8	8 to 0
WX1016E	WH	npn, FJ, si	25	150	150	1.4	250	8	8 to 0
WX1016F	WH	npn, FJ, si	25	150	150	1.4	300	8	8 to 0
2N1140	TR	npn, DJ, si	60	1	200	–	10	1	30 to 0
2N1072	WE	npn, DD, si	60	12	150	65	30	1	28 to 0
2N115	AMP	pnp, AJ, ge	200	50	75	1	32	10	–
2N418	BE	pnp, AJ, ge	400	25	100	0.5	30	3	–
2N420	BE	pnp, AJ, ge	400	25	100	0.5	45	3	–
2N420A	BE	pnp, AJ, ge	400	25	100	0.5	70	3	–
2N637	BE	pnp, AJ, ge	400	25	100	0.5	40	3	–
2N637A	BE	pnp, AJ, ge	400	25	100	0.5	70	3	–
2N637B	BE	pnp, AJ, ge	400	25	100	0.5	90	3	–

Listed in order of increasing alpha cutoff frequency.

Characteristics				Switching		Remarks	Type No.
hfe or hFE	co ma	Powr Gain db	Powr Out W	Rise Time μsec	Stor. Time μsec		
14	0.0001	–	–	–	–		2N1238
32	0.0001	–	–	–	–		2N1239
14	0.0001	–	–	–	–		2N1240
24	0.0001	–	–	–	–		2N1241
14	0.0001	–	–	–	–		2N1242
24	0.0001	–	–	–	–		2N1243
14	0.0001	–	–	–	–		2N1244
50	10	–	–	.5	1	US,MIL only	GA52830
50	10	–	–	.5	1	US,MIL only	GA53242
50	10	–	–	.5	1	US,MIL only	GF45017
–	3	–	–	–	–	BE	2N297
–	3	–	–	–	–	BE,DE	2N297A
–	3	–	–	–	–	MO	2N618
–	2	–	–	–	–	BE 2N639A	2N268A
–	3	–	–	–	–	MO	2N375
30	0.5	–	–	–	–		2N378
–	5	–	–	–	–		2N379
–	0.5	–	–	–	–		2N380
–	0.2	–	–	12	12.5		2N456
–	0.6	–	–	12	12.5	RCA	2N457
–	1	–	–	12	12.5	CL	2N458
–	0.5						2N459
–	0.2	–	–	11.2	2.5		2N511
–	0.2	–	–	11.2	2.5		2N511A
–	0.2	–	–	11.2	2.5		2N511B
–	0.2	–	–	11.2	2.5		2N512
–	0.2	–	–	11.2	2.5		2N512A
–	0.2	–	–	11.2	2.5		2N512B
–	0.2	–	–	10.8	2.0		2N513
–	0.2	–	–	10.8	2.0		2N513A
–	0.2	–	–	10.8	2.0		2N513B
–	0.2	–	–	10.3	2.0		2N514
–	0.2	–	–	10.3	2.0		2N514A
–	0.2	–	–	10.3	2.0		2N514B
–	0.85	–	–	12	12.5		2N1021
–	0.85	–	–	12	12.5		2N1022
25	0.07	–	–	0.3	0.1		2N545
25	0.05	–	–	0.3	0.1		2N546
45	1.0	33	5				2N387
40	0.8	33	5				2N386
–	0.2	–	–	0.7	1.2		2N1046
8	10	–	–	7	1		WX1015
8	10	–	–	7	1		WX1015A
8	10	–	–	7	1		WX1015B
8	10	–	–	7	1		WX1015C
8	10	–	–	7	1		WX1015D
8	10	–	–	7	1		WX1015E
8	10	–	–	7	1		WX1015F
8	10	–	–	7	1		WX1016
8	10	–	–	7	1		WX1016A
8	10	–	–	7	1		WX1016B
8	10	–	–	7	1		WX1016C
8	10	–	–	7	1		WX1016D
8	10	–	–	7	1		WX1016E
8	10	–	–	7	1		WX1016F
50	0.001	–	–	0.2	0.08		2N1140
98	.1	–	–	50	50		2N1072
–	–	–	–	–	–		2N115
	1.5	–		15	–		2N418
	0.5	–	–	15	–		2N420
–	1.5	–	–	15	–		2N420A
–	0.5	–	–	15	–		2N637
–	2	–	–	15	–		2N637A
–	2	–	–	15	–		2N637B

(Continued on p. 64)

1959 Transistor Data Chart

HIGH-LEVEL SWITCHING—High current devices

Type No.	Mfg	Type	$f_{\alpha e}$ KC	Max. Ratings W_o W	T_j °C	W/°C	V_c V
2N638	BE	pnp,AJ,ge	400	25	100	0.5	40
2N638A	BE	pnp,AJ,ge	400	25	100	0.5	70
2N638B	BE	pnp,AJ,ge	400	25	100	0.5	80
2N639	BE	pnp,AJ,ge	400	25	100	0.5	40
2N639A	BE	pnp,AJ,ge	400	25	100	0.5	70
2N639B	BE	pnp,AJ,ge	400	25	100	0.5	80
2N1011	BE	pnp,AJ,ge	400	35	95	1.2	–
2N1136	BE	pnp,AJ,ge	400	60	100	0.8	40
2N1031	BE	pnp,AJ,ge	400	50	100	1.0	30
2N1031A	BE	pnp,AJ,ge	400	50	100	1.0	40
2N1031B	BE	pnp,AJ,ge	400	50	100	1.0	70
2N1031C	BE	pnp,AJ,ge	400	50	100	1.0	80
2N1032	BE	pnp,AJ,ge	400	50	100	1.0	30
2N1032A	BE	pnp,AJ,ge	400	50	100	1.0	40
2N1032B	BE	pnp,AJ,ge	400	50	100	1.0	70
2N1032C	BE	pnp,AJ,ge	400	50	100	1.0	80
2N1120	BE	pnp,AJ,ge	400	45	95	1.0	–
2N1136A	BE	pnp,AJ,ge	400	60	100	0.8	70
2N1136B	BE	pnp,AJ,ge	400	60	100	0.8	80
2N1137	BE	pnp,AJ,ge	400	60	100	0.8	40
2N1137A	BE	pnp,AJ,ge	400	60	100	0.8	70
2N1137B	BE	pnp,AJ,ge	400	60	100	0.8	80
2N1138	BE	pnp,AJ,ge	400	60	100	0.8	40
2N1138A	BE	pnp,AJ,ge	400	60	100	0.8	70
2N1138B	BE	pnp,AJ,ge	400	60	100	0.8	80
2N1042	TI	pnp,AJ,ge	650	20	95	0.28	40
2N1043	TI	pnp,AJ,ge	650	20	95	0.28	60
2N1044	TI	pnp,AJ,ge	650	20	95	0.28	80
2N1045	TI	pnp,AJ,ge	650	20	95	0.28	100
2N1073	BE	pnp,AJ,ge	1500	35	100	0.8	40
2N1073A	BE	pnp,AJ,ge	1500	35	100	0.8	80
2N1073B	BE	pnp,AJ,ge	1500	35	100	0.8	120
2N547	TR	npn,DJ,si	6M	5	200	0.045	60
2N424	TR	npn,DJ,si	6M	85	200	0.27	80
2N497	TR	npn,DJ,si	6M	4	200	0.024	60
2N498	TR	npn,DJ,si	6M	4	200	0.024	100
2N548	TR	npn,DJ,si	6M	5	200	0.045	30
2N549	TR	npn,DJ,si	6M	5	200	0.045	60
2N550	TR	npn,DJ,si	6M	5	200	0.045	30
2N551	TR	npn,DJ,si	6M	5	200	0.045	60
2N552	TR	npn,DJ,si	6M	5	200	0.045	30
2N656	TR	npn,DJ,si	6M	4	200	0.024	60
2N657	TR	npn,DJ,si	6M	4	200	0.024	100
2N1116	TR	npn,DJ,si	6M	5	200	0.045	60
2N1117	TR	npn,DJ,si	6M	5	200	0.045	60
2N1250	TR	npn,DJ,si	6M	85	200	0.267	60
ST401	TR	npn,DJ,si	6M	85	200	0.27	45
ST402	TR	npn,DJ,si	6M	50	200	0.33	60
ST403	TR	npn,DJ,si	6M	50	200	0.33	45
2N389	TR	npn,DJ,si	8M	85	200	0.27	60
2N1212	TR	npn,DJ,si	10M	45	200	0.267	60
2N1208	TR	npn,DJ,si	12M	85	200	0.267	60
2N1209	TR	npn,DJ,si	12M	85	200	0.267	45

Abbreviation of Terms

AJ	Alloyed Junction	**GE**	Germanium
DB	Diffused Base	**GJ**	Grown Junction
DD	Double Diffused	**GR**	Grown Rate
DG	Grown Diffused	**MB**	Meltback
DJ	Diffused Junction	**MD**	MADT
DM	Diffused Mesa	**MA**	Micro Alloy
Dr	Drift	**Ms**	Mesa
FA	Fused Alloy	**RG**	Rate Grown
FJ	Fused Junction	**SI**	Silicon
GD	Grown Diffused	**SBT**	Surface Barrie

Liste in order of increasing alpha cutoff freq ency. *(continued)*

Charc eristics			Switching				
I_{cc} A	Powr Gain db	Powr Out W	Rise Time μsec	Stor. Time μsec	Remarks	Type No.
0.5	–	–	15	–		2N638
2	–	–	15	–		2N638A
2	–	–	15	–		2N638B
0.5	–	–	15	–		2N639
2.2	–	–	15	–		2N639A
2.2	–	–	15	–		2N639B
15	–	–	–	–		2N1011
0.5	–		15	–		2N1136
1.0	–	–	15	–		2N1031
1.0	–	–	15	–		2N1031A
1.0	–	–	15			2N1031B
2	–	–	15	–		2N1031C
–	–	–	15	–		2N1032
1	–	–	15	–		2N1032A
2	–		15	–		2N1032B
2	–	–	15	–		2N1032C
15	–	–	–	–		2N1120
2	–	–	15	–		2N1136A
2	–	–	15	–		2N1136B
0.5	–	–	15	–		2N1137
2	–	–	15	–		2N1137A
2	–	–	15	–		2N1137B
0.5	–	–	15	–		2N1138
2	–	–	15	–		2N1138A
2	–	–	15	–		2N1138B
0.05	–	–	5.0	2.0		2N1042
0.05	–	–	5.0	0.5		2N1043
0.05	–	–	5.0	2.0		2N1044
0.05	–	–	5.0	2.0		2N1045
1	–	–	5	–		2N1073
2	–	–	5	–		2N1073A
5	–	–	5	–		2N1073B
0.001	–	–	0.7	0.2		2N547
10	–	–	–	–	TI	2N424
0.2	–	–	–	–	TI	2N497
0.2	–	–	–	–	TI	2N498
0.001	–	–	0.7	0.2		2N548
0.0004	–	–	0.7	0.2		2N549
0.0004	–	–	0.7	0.2		2N550
0.001	–	–	1.2	0.3		2N551
0.001	–	–	1.2	0.3		2N552
0.2	–	–	–	–	TI	2N656
0.2	–	–	–	–	TI	2N657
0.001	–	–	0.7	0.2		2N1116
0.0004	–	–	0.7	0.2		2N1117
20	–	–	0.25	0.5		2N1250
20	–	–	0.25	0.5		ST401
20	–	–	0.25	0.5		ST402
20	–	–	0.25	0.5		ST403
–	–	–	–	–		2N389
10	–	–	0.25	0.5		2N1212
10	–	–	0.25	0.5		2N1208
20	–	–	0.25	0.5		2N1209

C_c = Collector to emitter capacitance measured across the output terminals with the input ac open-circuited.

f_s = Frequency at which the magnitude of the forward-current transfer ratio (small-signal) is 0.707 of its low frequency value.

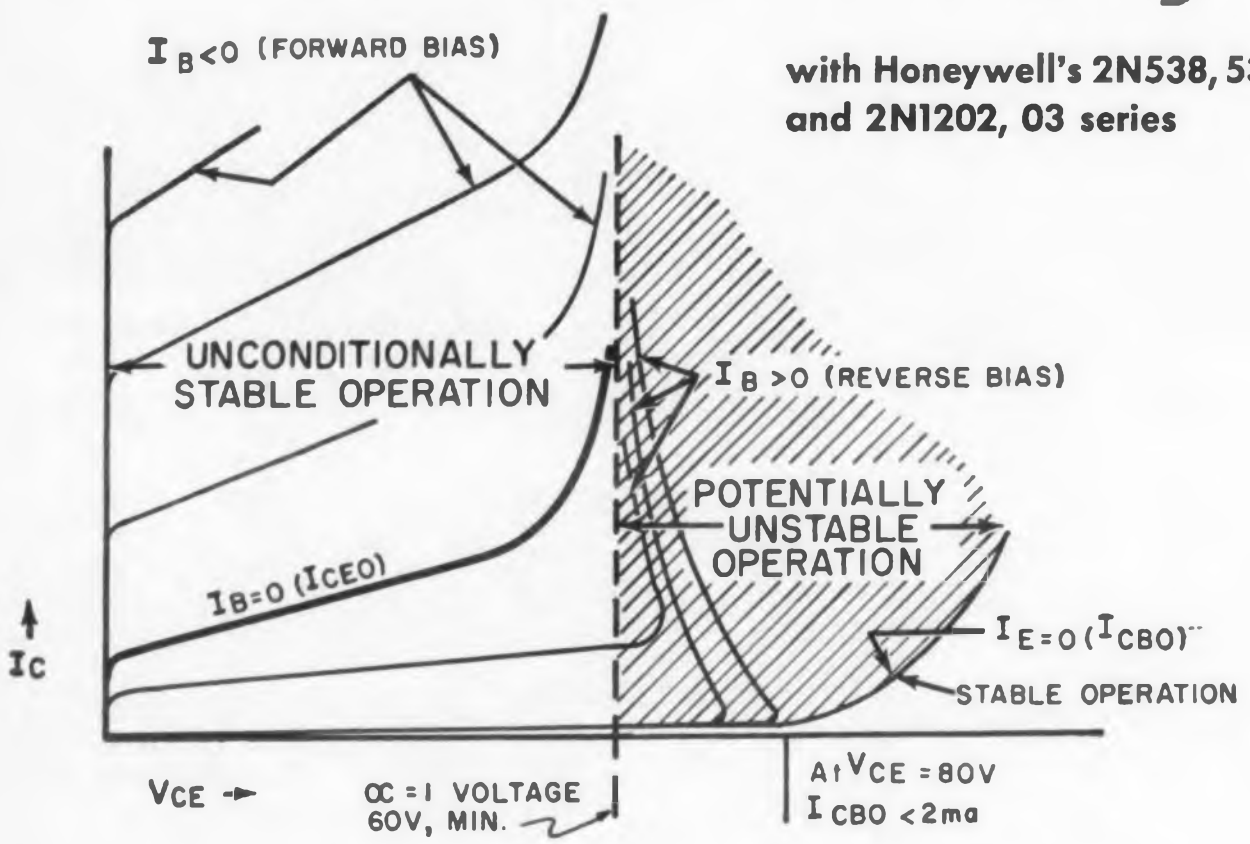
h_{fe} = Common Emitter-Small signal forward current transfer ratio

h_{FE} = Common Emitter-Static value of short-circuited forward current ratio

I_c = Collector current when collector junction is reverse biased and emitter is dc open-circuited.

New Honeywell formula for power transistor reliability

with Honeywell's 2N538, 539, 540 and 2N1202, 03 series



NOW THESE Honeywell Power Transistors guarantee minimum α=1 voltage to insure stable operation under all bias conditions up to 60 volts. This rating permits operation of *both* class A and class B transformer-coupled output power amplifiers from a 28VDC source. Proper back bias extends safe operating voltage up to the collector diode design limit of 80 volts.

Contributing to the reliability of Honeywell Power Transistors is a built-in stability through improved design and processing methods, *plus* significant dynamic testing.

Honeywell's 2N538, 539 and 540, 2N1202 (characterized at ½ amp) and 2N1203 (120 volt collector diode) Power Transistor Series are rugged, hermetically sealed germanium PNP transistors suited to servo amplifier, power conversion, voltage regulation and switching applications.

The 2N539 can be supplied in accordance with the requirements of MIL-T-19500A/38.

These new improved Honeywell Power Transistors give you two other bonuses—new lower prices, plus 1 year warranty. For complete data on these transistors, or for a copy of Honeywell's new Technical Booklet "Fundamental Voltage Limitations of a Transistor," contact one of the following offices:

- UNION, NEW JERSEY.....(MUrdock 8-9000)
- BOSTON, MASSACHUSETTS.....(ALgonquin 4-8730)
- CHICAGO, ILLINOIS.....(IRving 8-9266)
- LOS ANGELES, CALIFORNIA.....(RAymond 3-6611 or PArkview 8-7311)
- ATLANTA, GEORGIA.....(TRinity 4-9776)

Or write Minneapolis-Honeywell, Dept. ED-7-82, Minneapolis 8, Minnesota.

Honeywell

First in Control

CIRCLE 48 ON READER-SERVICE CARD

1959 Transistor Data Chart

LOW-LEVEL SWITCHING—Small signal devices

Type No.	Mfg	Type	$f_{\alpha e}$ MC	Max. Ratings W_c (mw)	T_j °C	mw/°C	V_c V
2N1038	TI	pnp,AJ,ge	0.008	800	95	14	40
2N1039	TI	pnp,AJ,ge	0.008	800	95	14	60
2N1040	TI	pnp,AJ,ge	0.0085	800	95	14	80
2N1041	TI	pnp,AJ,ge	0.0085	800	95	14	100
2N327A	RA	pnp,FA,si	0.2	385	160	–	40
2N619	RA	npn,FA,si	0.2	385	160	–	40
2N1034	RA	pnp,FA,si	0.2	385	160	–	40
2N1074	RA	npn,FA,si	0.2	385	160	–	40
2N1037	RA	pnp,FA,ge	0.25	385	160	–	35
2N328A	RA	pnp,FA,si	0.3	385	160	–	35
2N620	RA	npn,FA,si	0.3	385	160	–	35
2N1035	RA	pnp,FA,si	0.3	385	160	–	35
2N1075	RA	npn,FA,si	0.3	385	160	–	35
2N1077	RA	npn,FA,si	0.3	385	160	–	30
2N1036	RA	pnp,FA,si	0.4	385	160	–	30
2N1126	PH	pnp,AJ,ge	0.4	*1000	85	16.7	35
2N329A	RA	pnp,FA,si	0.5	385	160	–	30
2N462	PH	pnp,AJ,ge	0.5	150	75	3.0	40
2N621	RA	npn,FA,si	0.5	385	160	–	30
2N1057	GE	pnp,AJ,ge	0.5	240	100	4	45
2N1076	RA	npn,FA,si	0.5	385	160	–	30
2N670	PH	pnp,AJ,ge	0.7	300	85	5.0	40
2N671	PH	pnp,AJ,ge	0.7	1000	85	16.7	40
2N1228	HU	pnp,FJ,si	0.8	250	200	–	15
2N1229	HU	pnp,FJ,si	0.8	250	200	–	15
2N1008	BE	pnp,AJ,ge	1.0	400	85	150	20
2N1008A	BE	pnp,AJ,ge	1.0	400	85	150	40
2N1008B	BE	pnp,AJ,ge	1.0	400	85	150	60
2N331	BE	pnp,AJ,ge	1	200	85	3	30
2N1056	GE	pnp,AJ,ge	1	240	100	4	50
2N1125	PH	pnp,AJ,ge	1.0	300	85	5	40
2N1127	PH	pnp,AJ,ge	1	*1000	85	16.7	40
2N1176	BE	pnp,AJ,ge	1	300	85	0.4	15
2N1176A	BE	pnp,AJ,ge	1	300	85	0.4	40
2N1176B	BE	pnp,AJ,ge	1	300	85	0.4	60
2N1230	HU	pnp,FJ,si	1.0	250	200	–	35
2N1231	HU	pnp,FJ,si	1.0	250	200	–	35
2N1232	HU	pnp,FJ,si	1.0	250	200	–	65
2N1233	HU	pnp,FJ,si	1.0	250	200	–	65
2N1234	HU	pnp,FJ,si	1.2	250	200	–	110
2N558	SY	npn,AJ,ge	–	100	85	1.66	15
2N587	SY	npn,AJ,ge	–	150	85	2.5	25
2N312	SY	npn,AJ,ge	1.5	100	85	1.66	15
2N519	IND	pnp,AJ,ge	1.5	200	85	3	15
2N519A	IND	pnp,AJ,ge	1.5	200	85	3	20
2N536	PH	pnp,AJ,ge	2.0	50	85	0.83	20
2N679	SY	npn,AJ,ge	2	150	85	2.5	20
2N1223	GT	pnp,AJ,si	2	150	150	1.2	40
TR524	IND	pnp,AJ,ge	2	200	85	3	45
TR525	IND	pnp,AJ,ge	2.5	200	85	3	45
2N356	RCA	npn,AJ,ge	3	100	85	–	20
2N356A	GT	npn,AJ,ge	3	150	100	2	40
2N1220	GT	pnp,AJ,si	3	150	150	1.2	30
TR526	IND	pnp,AJ,ge	3	200	85	3	45
TR527	IND	pnp,AJ,ge	3.3	200	85	3	45
2N425	MO	pnp,AJ,ge	4	150	85	2.5	20
2N1028	SSC	pnp,AJ,si	4	150	150	1.1	10
CK25	RA	pnp,FA,ge	4	80	85	–	20
2N395	GE	pnp,AJ,ge	4.5	200	100	3.3	15
2N520	IND	pnp,AJ,ge	4.5	200	85	3	15
2N520A	IND	pnp,AJ,ge	4.5	200	85	3	20
2N597	PH	pnp,AJ,ge	4.5	250	100	3.3	40
2N1123	PH	pnp,AJ,ge	4.5	750	100	10.0	40
2N315	GT	pnp,AJ,ge	5	100	85	2	40
2N315A	GT	pnp,AJ,ge	5	150	100	2	40
2N439	SY	npn,AJ,ge	5	100	85	1.66	20
2N450	GE	pnp,AJ,ge	5	150	85	2.5	12
2N576	SY	npn,AJ,ge	5	200	100	2.6	20
2N578	RCA	pnp,AJ,ge	5	120	85	–	20
2N585	RCA	npn,AJ,ge	5	120	85	–	25

Liste in order of increasing alpha cutoff freq ency.

Characte tics		Switching			
I_{co} μa	C_{coe} μμf	Rise Time μsec	Stor. Time μsec	Remarks	Type No.
50	100	5.0	2.0	GB	2N1038
50	100	5.0	2.0	GB	2N1039
50	100	5.0	2.0	GB	2N1040
50	100	5.0	2.0	GB	2N1041
5	70	–	–		2N327A
5	35	–	–		2N619
5	70	–	–		2N1034
5	35	–	–		2N1074
5	70	–	–		2N1037
5	70	–	–		2N328A
5	35	–	–		2N620
5	70	–	–		2N1035
5	35	–	–		2N1075
5	35	–	–		2N1077
5	70	–	–		2N1036
30	–	–	–	*with inf. heat sink	2N1126
5	70	–	–		2N329A
7.0	20	–	–		2N462
5	35	–	–		2N621
16	40	–	–		2N1057
5	35	–	–		2N1076
20	–	–	–	Pulse Amp	2N670
20	–	–	–	Pulse Amp	2N671
0.05	100	–	–		2N1228
0.05	100	–	–		2N1229
5	–	–	–		2N1008
5	–	–	–		2N1008A
7	–	–	–		2N1008B
16	–	–	–		2N331
25	40	–	–	Neon indicator	2N1056
2.5	–	–	–		2N1125
25	–	–	–	*with inf. heat sink	2N1127
10	–	–	–		2N1176
12	–	–	–		2N1176A
15	–	–	–		2N1176B
0.05	100	–	–		2N1230
0.05	100	–	–		2N1231
0.05	100	–	–		2N1232
0.05	100	–	–		2N1233
0.05	100	–	–		2N1234
15	–	3.5	2		2N558
50	–	2	2		2N587
15	–	1.5	2		2N312
2	14	–	–		2N519
1	14	1.3	0.7		2N519A
4	–	–	–		2N536
25	–	5	5		2N679
0.05	15	–	–		2N1223
5	25	–	–	2N524	TR524
5	25	–	–	2N525	TR525
5	–	1.0	0.3	GT, SY	2N356
3	14	1.5	0.3		2N356A
0.05	9	–	–		2N1220
5	25	–	–	2N526	TR526
5	25	–	–		TR527
2.0	14	1.0	0.3	TR,SY,RA,IND.	2N425
25	7	–	–		2N1028
2	14	0.5	0.3		CK25
6	12	0.55	0.5	TI	2N395
1	14	–	–		2N520
1	14	0.9	0.7		2N520A
5	18	–	–		2N597
5	18	–	–		2N1123
1	14	1	0.12	IND	2N315
1	14	0.9	0.4	IND.	2N315A
10	–	0.5	0.7		2N439
6	20	–	–		2N450
2	–	2	1		2N576
1	–	0.85	0.33	IND.	2N578
1	–	0.35	0.25		2N585

(Continued on p. 68)

1959 Transistor Data Chart

LOW-LEVEL SWITCHING—Small signal devices

Type No.	Mfg	Type	$f_{\alpha e}$ MC	Max. Ratings W_c (mw)	T_j °C	mw/°C	V_c V	I_c
2N658	RA	pnp,FA,ge	5	150	85	–	16	10
2N1012	GT	npn,AJ,ge	5	150	100	2	40	
2N1093	TI	pnp,AJ,ge	5	150	100	2.0	30	
2N357	RCA	npn,AJ,ge	6	100	85	2	20	5
2N357A	GT	npn,AJ,ge	6	150	100	2	40	5
2N377	SY	npn,AJ,ge	6	150	100	2	20	
2N426	MO	pnp,AJ,ge	.6	150	85	2.5	20	
CK26	RA	pnp,FA,ge	6	80	85	–	18	
2N1090	RCA	npn,AJ,ge	7	120	85	–	25	5
2N1114	SY	npn,AJ,ge	7	150	100	2	15	
2N1219	GT	pnp,AJ,si	7	150	150	1.2	30	10
GT123	GT	pnp,AJ,ge	7	150	150	2	25	
2N598	PH	pnp,AJ,ge	7.5	250	100	3.3	20	
2N600	PH	pnp,AJ,ge	7.5	750	100	0.1	20	
2N123	GE	pnp,AJ,ge	8	150	85	2.5	15	10
2N388	GT	npn,AJ,ge	8	150	100	2	25	
2N396	GE	pnp,AJ,ge	8	200	100	3.3	20	
2N505	IND	pnp,AJ,ge	8	200	85	3	40	
2N576A	SY	npn,AJ,ge	8	200	100	2.6	20	
2N579	RCA	pnp,AJ,ge	8	120	85	–	20	5
2N581	RCA	pnp,AJ,ge	8	80	85	–	18	10
2N583	RCA	pnp,AJ,ge	8	80	85	–	18	10
2N662	RA	pnp,FA,ge	8	150	85	–	11	10
TR123	IND	pnp,AJ,ge	8	200	85	3	20	1
TR396	IND	pnp,AJ,ge	8	200	85	3	20	2
2N167*	GE	npn,GJ,ge	9	65	85	1.1	30	
2N358	GT	npn,AJ,ge	9	100	85	2	30	5
2N358A	GT	npn,AJ,ge	9	150	100	2	40	5
2N394	GE	pnp,AJ,ge	9	150	85	2.5	10	2
2N1198	GE	npn,RG,ge	9	65	85	1.1	25	1
2N332	GE	npn,GD,si	10	150	200	1.0	45	
2N440	SY	npn,AJ,ge	10	100	85	1.66	15	
2N518	GE	pnp,AJ,ge	10	150	85	2.5	12	1
2N521	IND	pnp,AJ,ge	10	200	85	3	15	1
2N521A	IND	pnp,AJ,ge	10	200	85	3	20	1
2N659	RA	pnp,FA,ge	10	150	85	–	14	10
2N427	GT	pnp,AJ,ge	11	150	100	2	30	
2N496	PH	pnp,SB,si	11	150	140	1.1	10	
CK27	RA	pnp,FA,ge	11	80	85	–	15	
2N269	RCA	pnp,AJ,ge	12	120	85	–	25	1
2N316	GT	pnp,AJ,ge	12	100	85	2	30	5
2N316A	GT	pnp,AJ,ge	12	150	100	2	30	5
2N333	GE	npn,GD,si	12	150	200	1.0	45	
2N397	GE	pnp,AJ,ge	12	200	100	3.3	15	2
2N404	RCA	pnp,AJ,ge	12	120	85	–	25	1
2N635	GE	npn,AJ,ge	12	150	85	2.5	20	3
TR269	IND	pnp,AJ,ge	12	200	85	3	25	1
2N334	GE	npn,GD,si	13	150	200	1.0	45	
2N1091	RCA	npn,AJ,ge	13	120	85	–	25	4
2N335	GE	npn,GD,si	14	150	200	1.0	45	
2N336	GE	npn,GD,si	15	150	200	1.0	45	
2N580	RCA	pnp,AJ,ge	15	120	85	–	20	4
2N660	RA	pnp,FA,ge	15	150	85	–	11	10
2N428	GT	pnp,AJ,ge	17	150	100	2	30	
2N636	GE	npn,AJ,ge	17	150	85	2.5	20	3
CK28	RA	pnp,FA,ge	17	80	85	–	12	4
2N522	IND	pnp,AJ,ge	18	200	85	3	15	1
2N522A	IND	pnp,AJ,ge	18	200	85	3	20	1
2N582	RCA	pnp,AJ,ge	18	120	85	–	25	1
2N584	RCA	pnp,AJ,ge	18	120	85	–	25	1
2N599	PH	pnp,AJ,ge	18	250	100	3.3	30	4
2N601	PH	pnp,AJ,ge	18	750	100	0.1	20	4
2N317	GT	pnp,AJ,ge	20	100	85	2	10	5
2N317A	GT	pnp,AJ,ge	20	150	100	2	10	5
2N417	IND	pnp,AJ,ge	20	200	85	3	10	2
2N661	RA	pnp,FA,ge	20	150	85	–	9	10
2N1017	RA	pnp,FA,ge	20	150	85	–	10	4
2N523	IND	pnp,AJ,ge	24	200	85	3	5	1
2N523A	IND	pnp,AJ,ge	24	200	85	3	5	1
2N1205	TR	npn,GR,si	27	150	150	–	0	

...ed in ...der of increasing alpha cutoff frequency *(continued)*

Characteristics			Switching		Remarks	Type No.
...fe ...FE	I_c ...	C_{coe} $\mu\mu f$	Rise Time μsec	Stor. Time μsec		
	2...	12	–	–		2N658
	5	10	0.1	0.1		2N1012
	2	–	0.3	0.4		2N1093
	5	–	0.6	0.3	GT, SY	2N357
	3	14	0.5	0.5		2N357A
	20	–	2.5	0.7		2N377
	2.0	14	1.0	0.3	IND, TRA, SY, TR	2N426
	2	14	0.5	0.3		CK26
	8	–	0.25	0.20		2N1090
	30	–	–	–		2N1114
	0.05	7	–	–		2N1219
	3	15	0.9	0.5		GT123
	5	18	–	–		2N598
	5	18	–	–		2N600
	6	15	0.45	0.90	SY	2N123
	5	10	0.6	0.4	SY	2N388
	6	12	0.4	0.6	TI, GT	2N396
	2	14	0.1	0.05		2N505
	40	–	2	1		2N576A
	6	–	0.36	0.33	IND.	2N579
	6	–	0.20	0.20		2N581
	6	–	0.20	0.20		2N583
	2.5	12	–	–		2N662
	2	10	0.7	0.5		TR123
	3	12	–	–	2N396	TR396
	1.5	2.5	0.4	0.7	USAF 2N167 MIL	2N167*
	3	14	0.4	0.5	SY	2N358
	3	14	0.4	0.4		2N358A
	6	12	–	–		2N394
	1.5	2.5	0.4	0.7		2N1198
	2	7	0.65	0.4	BO	2N332
	10	–	0.3	0.7		2N440
	6	12	0.8	0.9		2N518
	1	14	–	–		2N521
	1	14	0.2	0.5		2N521A
	2.5	12	–	–		2N659
	2	14	0.43	0.3	TR,MO,IND,RA	2N427
	0.001	7.0	–	–		2N496
	2.0	14	0.4	0.3		CK27
	5	–	0.17	0.20		2N269
	1	14	0.4	0.4	IND.	2N316
	1	14	0.4	0.4	IND	2N316A
	2	7	0.55	0.75	TI	2N333
	6	12	0.3	0.7	TI	2N397
	5	–	0.17	0.20	GE,RA,GT,SY,Ind.	2N404
	5	–	–	–		2N635
	2	–	–	0.15	2N269	TR269
	2	7	0.55	0.8	TI	2N334
	8	–	0.20	0.17		2N1091
	2	7	0.5	0.9		2N335
	2	7	0.4	1.4		2N336
	5	–	0.16	0.29	IND.	2N580
	2.5	12	–	–		2N660
	2	14	0.43	0.3	SY,TR,MO,RA,IND	2N428
	5	–	–	–		2N636
	2.0	14	0.4	0.3		CK28
	1	14	–	–		2N522
	1	14	0.2	0.5		2N522A
	5	–	0.15	0.17		2N582
	5	–	0.15	0.17		2N584
	5	18	–	–		2N599
	5	18	–	–		2N601
	1	14	0.3	0.4		2N317
	1	14	0.3	0.4	IND	2N317A
	2	12	–	–		2N417
	2.5	12	–	–		2N661
	2	12	–	–		2N1017
	1	14	–	–		2N523
	1	14	0.1	0.4		2N523A
	0.05	3.0	–	–		2N1205

(Continued on p. 70)

LOW-LEVEL SWITCHING—Small signal devices.

Type No.	Mfg	Type	f_{ae} MC	Max. Ratings W_c (mw)	T_j °C	mw/°C	V_c V
2N337	GE	npn,GO,si	30	125	200	1.0	45
2N643	RCA	pnp,DR,ge	30 *	120	85	–	30
2N1122	PH	pnp,MA,ge	40	25	85	0.63	10
2N1122A	PH	pnp,MA,ge	40	25	85	0.63	14
2N338	GE	npn,GO,si	45	125	200	1.0	45
2N644	RCA	pnp,DR,ge	50 *	120	85	–	30
2N560	WE	npn,DD,si	60	600	150	.25	60
2N240	PH	pnp,SB,ge	60	30	85	0.5	6
2N398	RCA	pnp,AJ,ge	60	100	85	–	105
2N586	RCA	pnp,AJ,ge	60	250	85	–	45
2N645	RCA	pnp,DR,ge	70 MC *	120	85	–	30
2N702	TI	npn,DJ,si	100 MC	150	175	2	20
2N1139	TR	npn,GR,si	140 MC	500	175	–	15
2N501	PH	pnp,MD,ge	180 MC	25	85	0.63	12
2N501A	PH	pnp,MD,ge	180 MC	25	100	0.45	12
2N705	TI	pnp,DJ,ge	250MC	300	100	4	15
2N559	WE	pnp,DG,ge	750MC	150	100	5	15
2N311	IND	pnp,AJ,ge	–	200	85	3	15
2N556	SY	npn,AJ,ge	–	100	85	1.66	20
2N557	SY	npn,AJ,ge	–	100	85	1.66	20
2N672	PH	pnp,AJ,ge	–	300	85	5.0	25
2N673	PH	pnp,AJ,ge	–	1000	85	16.7	25
2N696	FA	npn,DM,si	–	2W	175	–	40
2N697	FA	npn,DM,si	–	2W	175	–	40
2N1131	FA	pnp,DM,si	–	2W	175	–	30
2N1132	FA	pnp,DM,si	–	2W	175	–	30

SPECIAL UNIJUNC

Type No.	Mfg	Type	Anode Volt V
3A30	SSP	pnpn	30
3A60	SSP	pnpn	60
3A100	SSP	pnpn	100
3A150	SSP	pnpn	150
3A200	SSP	pnpn	200
2N489 to 2N494	GE	pn,aj,si	P = 450 mw, T_j = 175°C, 0.4 mw/°C
2N469	GT	pnp,AJ	P = 50 mw
GT34N	GT	pnp,AJ	P = 125 mw
1N85	WE	pn,GJ	P = 50 mw
800	TI	npn,GR	P = 65 mw

Abbreviation of Terms

AJ	Alloyed Junction	GE	Germanium
DB	Diffused Base	GJ	Grown Junction
DD	Double Diffused	GR	Grown Rate
DG	Grown Diffused	MB	Meltback
DJ	Diffused Junction	MD	MADT
DM	Diffused Mesa	MA	Micro Alloy
Dr	Drift	Ms	Mesa
FA	Fused Alloy	RG	Rate Grown
FJ	Fused Junction	SI	Silicon
GD	Grown Diffused	SBT	Surface Barrier

devices.

Listed order of increasing alpha cutoff frequency. *(continued)*

Characteristics			Switching		Remarks	Type No.
	I_{co} μa	C_{coe} μμf	Rise Time μsec	Stor. Time μsec		
	1	1.4	0.02	0.02	TR,TI	2N337
	10	–	0.03	0.006	*gain bandwidth prod.	2N643
	5.0	0.6	–	–	SPR	2N1122
	5.0	0.6	–	–	SPR	2N1122A
	1	1.4	0.06	0.02	TI,TR	2N338
	10	–	0.015	0.004	*gain bandwidth prod.	2N644
	.1	8	60	50	US,MIL only	2N560
	0.7	2.9	–	–	SPR	2N240
	14	–	–	–		2N398
	16	–	–	–		2N586
	10	–	0.01	0.002	*gain bandwidth prod.	2N645
	0.5	–	–	–		2N702
	1.0	9.0	0.1	0.05		2N1139
	1.0	1.5	0.013	0.007	SPR	2N501
	1.0	1.5	0.013	0.007	SPR	2N501A
	5	–	0.30	0.075		2N705
	3	–	–	–	US,MTL only	2N559
	50	–	1	1		2N311
	25	–	3.5	2	t_r = 3.5 μS Max t_o = 2.0 μS Max	2N556
	25	–	6.5	2.5	t_r = 6.5 μS Max t_o = 2.5 μS Max	2N557
	25	–	0.5	0.4	Pulse Amp	2N672
	25	–	0.5	0.4	Pulse Amp	2N673
	0.01	20	0.08	0.03		2N696
	0.0	20	0.08	0.03		2N697
	0.01	35	0.08	0.03		2N1131
	0.01	35	0.08	0.03		2N1132

SPECIAL UNIJUNCTION, control, and phototransistors.

Anode Volt V		Remarks	
30	P_{diss} = 2.5 w @ 100C case		Silicon Controlled Switch
60	P_{diss} = 0.25 w @ 100C amb.		
100	Anode Current = 1.0 A		
150	Temp -65C to +150C		
200	Time = 0.2 μsec; Turn		
	μsec		
P = 450	ed in three ranges of		Unijunction
T_j = 175	self and two ranges of		
0.4 mw	ase resistance		
P = 50 m	h_{fe} = 50	Sens = 15 ua/ft coil	Photo
P = 125 m	----	----	Neon light
P = 50 m	----	----	Photo
P = 65 m	----	----	Photo

C_{ob} = Collector to emitter capacitance measured across the output terminals with the input ac open-circuited.

f_α = Frequency at which the magnitude of the forward-current transfer ratio (small-signal) is 0.707 of its low frequency value.

h_{fe} = Common Emitter-Small signal forward current transfer ratio

h_{FE} = Common Emitter-Static value of short-circuited forward current ratio

I_{co} = Collector current when collector junction is reverse biased and emitter is dc open-circuited.

Cross Index

A=Audio
LL=Low-Level Switching
HL=High-Level Switching
HF=High Frequency
P=Power
Sp=Special

1N85	Sp	2N207	A	2N309	HF	2N375	HL	2N447A	HF	2N526	A	2N612	A	2N1042	HL	905	A
2N34	A	2N207A	A	2N310	HF	2N376	P	2N448	HF	2N527	A	2N613	A	2N1043	HL	910	A
2N35	A	2N207B	A	2N311	LL	2N376A	P	2N449	HF	2N528	HF	2N614	HF	2N1044	HL	951	A
2N43	A	2N212	HF	2N312	HF, LL	2N377	LL, HF	2N450	LL	2N534	A	2N615	HF	2N1045	HL	952	A
2N43A	A	2N213	A	2N315	LL	2N378	HL	2N456	HL	2N535	A	2N616	HF	2N1046	HL	953	A
2N44	A	2N214	A	2N315A	LL	2N379	HL	2N457	HL	2N535A	A	2N617	HF	2N1047	P	B177	P
2N45	A	2N215	A	2N316	LL	2N380	HL	2N458	HL	2N535B	A	2N618	HL	2N1048	P	B178	P
2N59	A	2N217	A	2N316A	LL	2N381	A	2N459	HL	2N536	LL	2N619	LL	2N1049	P	B179	A
2N60	A	2N218	HF	2N317	LL	2N382	A	2N460	A	2N537	HF, LL	2N620	LL	2N1050	P	CK13	HF
2N61	A	2N219	HF	2N317A	LL	2N383	A	2N461	A	2N538	P	2N621	LL	2N1056	LL	CK14	HF
2N63	A	2N220	A	2N319	A	2N384	HF	2N462	LL	2N539	P	2N624	HF	2N1057	LL	CK16	HF
2N64	A	2N223	A	2N320	A	2N385	HF	2N463	P	2N540	P	2N627	P	2N1058	HF	CK17	HF
2N65	A	2N224	A	2N321	A	2N388	LL, HF	2N464	A	2N541	HF	2N628	P	2N1059	A	CK22	A
2N94	HF	2N226	A	2N322	A	2N389	HL	2N465	A	2N542	LL	2N629	P	2N1065	HF	CK25	LL
2N94A	HF	2N228	A	2N323	A	2N392	P	2N466	A	2N543	HF	2N630	P	2N1067	P	CK26	LL
2N104	A	2N233A	HF	2N324	A	2N393	HF	2N467	A	2N545	HL	2N631	A	2N1068	P	CK27	LL
2N105	A	2N234A	P	2N325	P	2N394	LL	2N469	Sp	2N546	HL	2N632	A	2N1069	P	CK28	LL
2N109	A	2N235A	P	2N326	P	2N395	LL	2N473	HF	2N547	HL	2N633	A	2N1070	P	CK64	A
2N115	HL	2N236A	P	2N327A	LL	2N396	LL	2N474	HF	2N548	HL	2N634	HF	2N1072	HL	CK65	A
2N117	HF	2N236B	P	2N328A	LL	2N397	LL	2N475	HF	2N549	HL	2N635	HF, LL	2N1073	HL	CK66	A
2N118	HF	2N238	A	2N329A	LL	2N398	LL	2N476	LL	2N550	HL	2N636	HF, LL	2N1073A	HL	CK67	A
2N118A	HF	2N240	LL	2N331	LL	2N399	P	2N478	HF	2N551	HL	2N637	HL	2N1073B	HL	CK754	A
2N119	HF	2N241	A	2N332	LL, HF	2N400	P	2N479	HF	2N552	HL	2N637A	HL	2N1074	LL	CTP	P
2N120	A	2N241A	A	2N333	LL, HF	2N401	P	2N480	HF	2N556	LL	2N637B	HL	2N1075	LL	CTP	P
2N122	P	2N242	P	2N334	HF, LL	2N402	A	2N481	HF	2N557	LL	2N638	HL	2N1076	LL	CTP1111	P
2N123	LL	2N243	A	2N335	HF, LL	2N403	A	2N482	HF	2N558	LL	2N638A	HL	2N1077	LL	CTP1112	P
2N128	HF	2N244	A	2N336	LL, HF	2N404	LL	2N483	HF	2N559	LL	2N638B	HL	2N1092	P	CTP1117	P
2N129	A	2N247	HF	2N337	LL	2N405	A	2N484	HF	2N560	LL	2N639	HL	2N1095	A	CTP1133	P
2N130A	A	2N248	HF	2N338	LL	2N406	A	2N485	HF	2N561	P	2N639A	HL	2N1096	A	CTP1137	P
2N131A	A	2N250	P	2N339	P	2N407	A	2N486	HF	2N564	A	2N639B	HL	2N1099	P	GA52830	HL
2N132A	A	2N251	P	2N340	P	2N408	A	2N489	Sp	2N566	A	2N640	HF	2N1100	P	GA53242	HL
2N133A	A	2N252	HF	2N341	P	2N409	HF	2N490	Sp	2N568	A	2N641	HF	2N1101	A	GF45017	HL
2N139	HF	2N253	P	2N342	P	2N410	HF	2N491	Sp	2N570	A	2N642	HF	2N1102	A	GT34N	Sp
2N140	HF	2N255	P	2N342A	P	2N411	HF	2N492	Sp	2N572	A	2N643	LL	2N1107	HF	GT74	A
2N155	P	2N255A	P	2N343	P	2N412	HF	2N493	Sp	2N574	P	2N644	LL	2N1108	HF	GT81	A
2N156	P	2N256	P	2N344	HF	2N413	HF	2N494	Sp	2N574A	P	2N645	LL	2N1109	HF	GT109	A
2N157	P	2N256A	P	2N345	HF	2N413A	HF	2N495	HF	2N575	P	2N647	A	2N1110	HF	GT123	LL
2N157A	P	2N257	P	2N346	HF	2N414	HF	2N496	LL, HF	2N575A	P	2N649A	A	2N1111	HF	GT495	HF
2N158	P	2N265	A	2N347	A	2N414A	HF	2N497	HL	2N576	LL	2N650	A	2N1111A	HF	GT496	HF
2N158A	P	2N268	P	2N348	A	2N416	HF	2N498	HL	2N576A	LL	2N651	A	2N1111B	HF	GT1200	A
2N160	A	2N268A	HL	2N349	A	2N417	LL, HF	2N499	HF	2N578	LL	2N652	A	2N1114	LL	H3A	P
2N160A	A	2N269	LL	2N350	P	2N418	HL	2N501	LL	2N579	LL	2N653	A	2N1116	HL	H4A	P
2N161	A	2N270	HF	2N350A	P	2N419	P	2N501A	LL	2N580	LL	2N654	A	2N1117	HL	H45	P
2N161A	A	2N271	LL	2N351	P	2N420	HL	2N502	HF	2N581	LL	2N655	A	2N1122	LL	H200E	P
2N163	A	2N274	HF	2N351A	P	2N422	A	2N502A	HF, LL	2N582	LL	2N656	HL	2N1122A	LL	LT11	P
2N163A	A	2N277	P	2N356	LL, HF	2N424	HL	2N503	HF	2N583	LL	2N657	HL	2N1123	LL	LT12	P
2N167	LL	2N278	P	2N356A	LL	2N425	LL	2N504	HF	2N584	LL	2N658	LL	2N1124	A	LT13	P
2N168A	HF	2N279	A	2N357	LL, HF	2N426	LL	2N505	LL	2N585	LL	2N659	LL	2N1125	LL	LT14	P
2N169	HF	2N280	A	2N357A	LL	2N427	LL	2N508	A	2N586	LL	2N660	LL	2N1126	LL	LT5164	P
2N169A	HF	2N284	A	2N358	LL, HF	2N428	LL	2N515	HF	2N587	LL	2N661	LL	2N1127	LL	LT5165	P
2N173	P	2N284A	A	2N358A	LL	2N438	HF	2N516	HF	2N588	HF	2N662	LL	2N1128	A	OC65	A
2N174	P	2N285A	P	2N359	A	2N438A	HF	2N517	HF	2N591	A	2N669	P	2N1129	A	OC66	A
2N175	A	2N291	A	2N360	A	2N439	LL, HF	2N518	LL	2N592	A	2N670	LL	2N1130	A	OC171	HF
2N176	P	2N292	HF	2N361	A	2N439A	HF	XT519	HF	2N593	A	2N672	LL	2N1131	LL	SB100	HF
2N185	A	2N293	HF	2N362	A	2N440	LL	XT520	HF	2N594	A	2N673	LL	2N1132	LL	ST401	HL
2N186A	A	2N296	P	2N363	A	2N440A	HF	2N519	LL	2N595	A	2N680	A	2N1136	HL	ST402	HL
2N187A	A	2N297	HL	2N364	A	2N441	P	2N519A	LL	2N596	A	2N696	LL	2N1136A	HL	ST403	HL
2N188A	A	2N297A	HL	2N365	A	2N442	P	2N520	LL	2N598	LL	2N697	LL	261136B	HL	ST903	HF
2N189	A	2N299	HF	2N366	A	2N443	P	2N520A	HF	2N599	LL	2N700	HF	2N1137	HL	ST904	HF
2N190	A	2N300	HF	2N368	A	2N444	HF	2N521	LL	2N600	LL	2N701	HF	2N1137A	HL	ST904A	HF
2N191	A	2N301	P	2N369	A	2N444A	HF	2N521A	LL, HF	2N601	LL	2N702	LL	2N1137B	HL	ST905	HF
2N192	A	2N301A	P	2N370	HF	2N445	HF	2N522	LL	2N602	HF	2N705	LL	2N1138	HL	ST910	HF
2N193	HF	2N306	HF	2N371	HF	2N445A	HF	2N522A	LL	2N603	HF	2N1008	LL	2N1138A	HL	ST1026	A
2N194	HF	2N307	P	2N372	HF	2N446	HF	2N523	LL	2N604	HF	2N1008A	LL	2N1138B	HL	ST1050	A
2N194A	HF	2N307A	P	2N373	HF	2N446A	HF	2N523A	LL, HF	2N609	A	2N1008B	LL	2N1141	HF	ST1051	A
2N204A	A	2N308	HF	2N374	HF	2N447	HF	2N524	A	2N610	A	2N1010	A	2N1142	HF	TR34	A
								2N525	A	2N611	A	2N1011	HL	2N1143	HF	TR81	A
												2N1012	LL	2N1146	P	TR123	LL
												2N1014	P	2N1146A	P	TR269	LL
												2N1017	LL	2N1146B	P	TR320	A
												2N1021	HL	2N1146C	P	TR321	A
												2N1022	HL	2N1147	P	TR381	A
												2N1024	HF	2N1147A	P	TR382	A
												2N1025	HF	2N1147B	P	TR383	A
												2N1026	HF	2N1147C	P	TR396	LL
												2N1026A	HF	2N1247	A	TR526	LL
												2N1027	HF	2N1248	A	TR527	LL
												2N1028	LL	2N1249	A	TR721	A
												2N1031	HL	3A30	SP	TR722	A
												2N1031A	HL	3A60	Sp	WX1015	HL
												2N1031B	HL	3A100	Sp	WX1016	HL
												2N1031C	HL	3A150	Sp	WX1016A	HL
												2N1032C	HL	3A200	Sp	WX1016B	HL
												2N1034	LL	3N25	HF	WX1016C	HL
												2N1035	LL	3N34	HF	WX1016D	HL
												2N1036	LL	3N35	HF	WX1016E	HL
												2N1037	LL	3N36	HF	WX1016F	HL
												2N1038	LL	3N37	A	XT515	HF
												2N1039	LL	800	Sp	XT516	HF
												2N1040	LL	903	A	XT517	HF
												2N1041	LL	904A	A	XT518	HF

—READER SERVICE INFORMATION—

CANNON PLUGS

Schweber

FOR IMMEDIATE LARGE QUANTITY DELIVERY AT FACTORY PRICES

2500

Yes! You can now order up to 2500 each of such popular Cannon Connector types as Miniature D, KO, DPD, DPA, DPX, etc. Immediate shipment at factory prices.

Schweber ELECTRONICS

60 HERRICKS ROAD, MINEOLA, L.I., N.Y.
PIONEER 6-6520 TWX G-CY-NY-580

CIRCLE 55 ON READER-SERVICE CARD

Increased Production Facilities for Cannon MS Series Plugs

MODERN PRODUCTION FACILITIES — The new modern Cannon factory building in Santa Ana has over 110,000 square feet of floor space, equipped with the latest automatic and semi-automatic processes. This increased production capability has been organized especially for the production of the Cannon MS line of plugs.

QUALITY CONTROL — The Santa Ana Division utilizes the most modern methods of quality control to insure conformance to MIL-Q-5923, MIL-C-5015, and related specifications as presented in the latest QPL Lists.

SPECIAL ENGINEERING
A complete engineering staff is maintained at Santa Ana to handle all special modification requirements on the MS Series, and to serve customers with unusual needs.

FASTER DELIVERY — This new facility further increases the ability of Cannon Electric Company to provide fast deliveries of Cannon Plugs, without sacrificing quality or reliability.

STOCKED BY DISTRIBUTORS — Cannon Distributors, located throughout the country, stock the standard types of MS Plugs and can arrange for immediate shipment.

NEW MS-R SERIES
All Cannon MS Series Plugs conform to Military Specification MIL-C-5015D (ASG)

CLASS R — environmental resisting (Lightweight) Cannon Plugs are a new addition to the MS Line. Class R Plugs are intended for use where the plug will be subject to heavy condensation, rapid changes in temperature or pressure, and to high vibrations.

Cannon is the only qualified source for the complete line of the new Class MS-R Plugs. MIL-C-5015D specifies that Class R Plugs shall have the "wire sealing grommets in firm contact against the rear face of the insert." This requirement, now written into the specification, has always been a Cannon design criterion for all MS environmental resistant designs.

MS — MS-A, MS-B, MS-E

■ 260 Shell Styles ■ Lightweight ■ 1 to 100 Contacts ■ 15 different Diameters

All Cannon MS Plugs Conform to Military Specification MIL-C-5015D (ASG)

OTHER MS PLUGS AVAILABLE FROM CANNON

MINIATURES • POWER • RACK/PANEL • BATTERY • PRINTED CIRCUIT • MS ACCESSORIES • MS MODIFICATIONS TO MEET SPECIAL NEEDS

For further information write for the new MS-R Catalog, MS Nomenclature Guide, and Catalog on MS Insert Arrangements to:

CANNON ELECTRIC COMPANY —
3208 Humbolt Street, Los Angeles, California · Please refer to Dept. 138

LARGEST FACILITIES IN THE WORLD FOR RESEARCH-DEVELOPMENT-MANUFACTURE

CANNON PLUGS

Factories in Los Angeles, Santa Ana, Salem, Toronto, London, Paris, Melbourne and Tokyo. Distributors and Representatives in the principal cities of the world.

CIRCLE 56 ON READER-SERVICE CARD

TWO TRANSISTORS plus associated components of a flip-flop or bistable multivibrator circuit can be replaced by a single "Trigistor." Significant miniaturization along with higher reliability can be realized as a direct result of circuit simplification.

Silicon PNPN Device

The Trigistor is the first commercially available "circuit equivalent" component for many switching applications which are based on bistable multivibrator.

Developed by Solid State Products, Inc. of Salem, Mass., the Trigistor is a silicon pnpn device with the unique property of triggered turn off, as well as triggered turn on, control at its base. The Trigistor will turn on with the application of a low-level positive trigger pulse to its base. Once on, it will remain on without the need for sustaining base current. A negative trigger pulse applied to the base turns it off. It will then remain off until triggered on again.

Circuit Comparison

Far fewer components are required with Trigistor circuitry as compared with transistors or other switching elements. Thus significant miniaturization along with higher reliability can be achieved as a direct result of the circuit simplification. Usually, a single Trigistor will perform the same function as two transistors plus several associated capacitors and resistors.

Fig. 1 shows a basic Trigistor flip-flop circuit in comparison with a conventional transistor flip-flop and illustrates the inherent simplicity of Trigistor bistable circuits. The 3C series Trigistors which are now commercially available are designed for operation in the range of 2 to 8 ma collector current with collector voltage ratings to 60 v. Maximum operating temperature is 125 C. Turn off times of 0.5 μsec are typical with circuit repetition

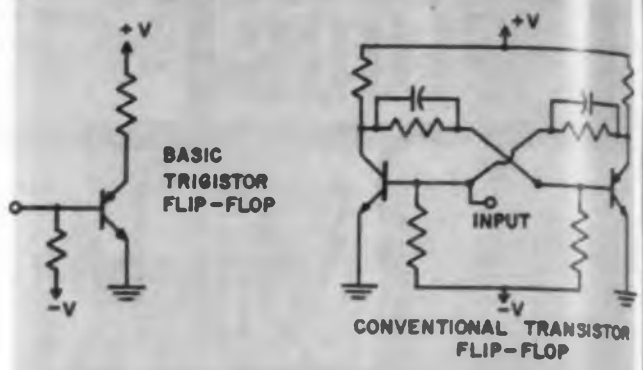


Fig. 1. Comparison between Trigistor and conventional transistor flip-flop circuit.

Fig. 2. Analogy between two transistors, a pnp and an npn, and a single Trigistor. Trigistor's three leads correspond to terminals A, B, and C of the two-transistor circuit.

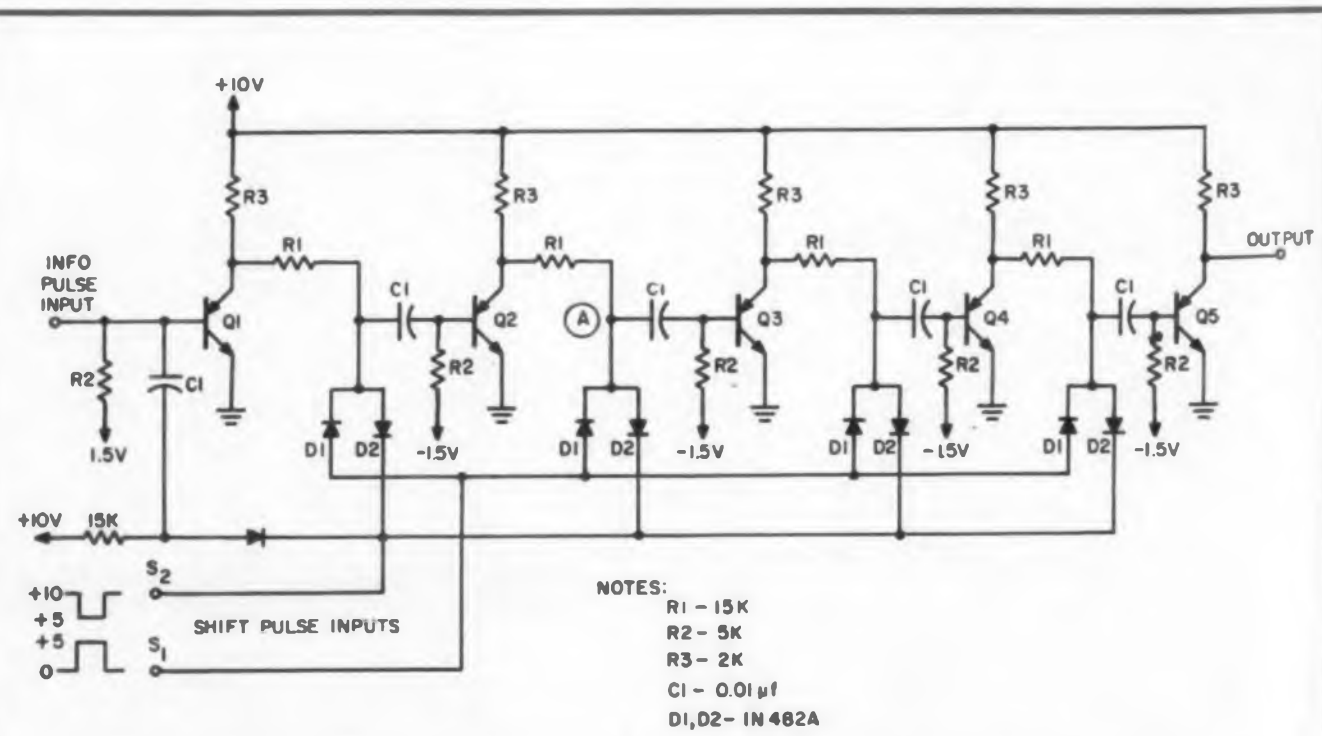


Fig. 3. Five-bit shift register using one Trigistor per bit. The individual basic Trigistor flip-flops are coupled through a simple gating network which provides the proper polarity shift pulse to each stage.

rates to 100 kc. The Trigistors are packaged in the JEDEC Standard TO-9 case.

Operation

The Trigistor's operation can be best understood by considering the analogy of two silicon transistors, an npn and a pnp connected as shown in Fig. 2. The collector of the npn drives the base of the pnp and the collector of the pnp drives the base of the npn. This positive feedback loop has a gain equal to B_1B_2, the product of the current gains of the two transistors. The circuit is stable as long as B_1B_2 is less than unity, but becomes self-regenerative when the loop gain reaches unity.

With a small negative current applied to terminal C, the npn transistor is biased off and the loop gain is less than unity. The only current that can flow between output terminals A and B is the cutoff collector current of the two transistors. Consequently, the impedance between A and B is very high.

When a positive current is applied to terminal C, the npn transistor is biased on, causing its collector current to rise. Since the current gain, B_1, of the npn increases with increased collector current, a point is reached where the loop gain equals unity and the circuit becomes self-regenerative. Collector currents of the two transistors rapidly increase to a value limited only by the external circuit. Both transistors are driven into saturation and the impedance between A and B is very low. The positive current applied to terminal C which served to trigger the self-regenerative action is no longer required since the collector of the pnp transistor supplies more than enough current to drive the base of the npn.

The circuit will remain in this "on" state until it is triggered off. Turnoff is accomplished by a negative current pulse at terminal C which diverts the collector current of the pnp from the base of the npn. Regenerative action is no longer sustained and the two transistors return to their stable cutoff condition.

In the Trigistor, the functions of the two transistors are combined into a single pnpn diffused silicon device. The Trigistor's three leads correspond to terminals A, B, and C of the circuit analogy.

The inherent simplicity of bistable circuits using the Trigistor make it attractive for a wide variety of applications. The Trigistor is particularly suited to memory, counter, gating, logic timing and related pulse circuits. These functions are readily performed by the addition of appropriate coupling networks to the basic bistable flip-flop shown in Fig. 1. A five-bit shift register using one Trigistor per bit is shown in Fig. 3.

For more information on the Trigistor, turn to the Reader-Service Card and circle **101**.

Self-Oscillating Beta Tester

BY USING the transistor under test as the only "active" element in a simple oscillator circuit, a very accurate test can be made of "ac small-signal Beta"

$$\left(h_{fe} = \frac{i_c}{i_b}\right).$$

The circuit may be added to any conventional transistor test instrument or test jig, or it may be operated directly from batteries or an external circuit impedance, or the type and rating of the transistor tested.

Fig. 1 shows the simple oscillator circuit employed in the T-345 Beta check made by Armour Electronics Div., Cardinal Instrumentation Co., 4201 Redwood Ave., Los Angeles, Calif. Heart of the circuit is the tuned phase-shift network which couples the collector to the base to permit oscillation. Any of several simple passive network configurations may be used provided that:

- There is negligible dc resistance in the network circuit paths from terminals *1* to *2*, and from terminals *3* to *4*.
- There is no appreciable conductive path from the *1-2* circuit to the *3-4* circuit.
- Network phase-shift at the desired frequency of oscillation is 180 deg, 540 deg, etc. (some odd multiple of π radians).
- Network attenuation at the desired frequency of oscillation is less than the minimum value of Beta to be tested.
- Input impedance of the network, at the desired frequency of oscillation is high . . . preferably, it should "peak" at that frequency.

Fig. 2 shows these desired network characteristics graphically.

If all the requirements are met, the circuit will oscillate over a wide range of value of R. By calibrating the "set" indicator appropriately, "R" may be calibrated directly and linearly in terms of Beta.

The circuit equations which follow assume that $R \gg Z_{34} + h_{ie}$, a condition easily achieved in practice.

$$e_f = -i_c Z_{12} A \qquad (1)$$

$$i_b = \frac{e_f}{R} \qquad (2)$$

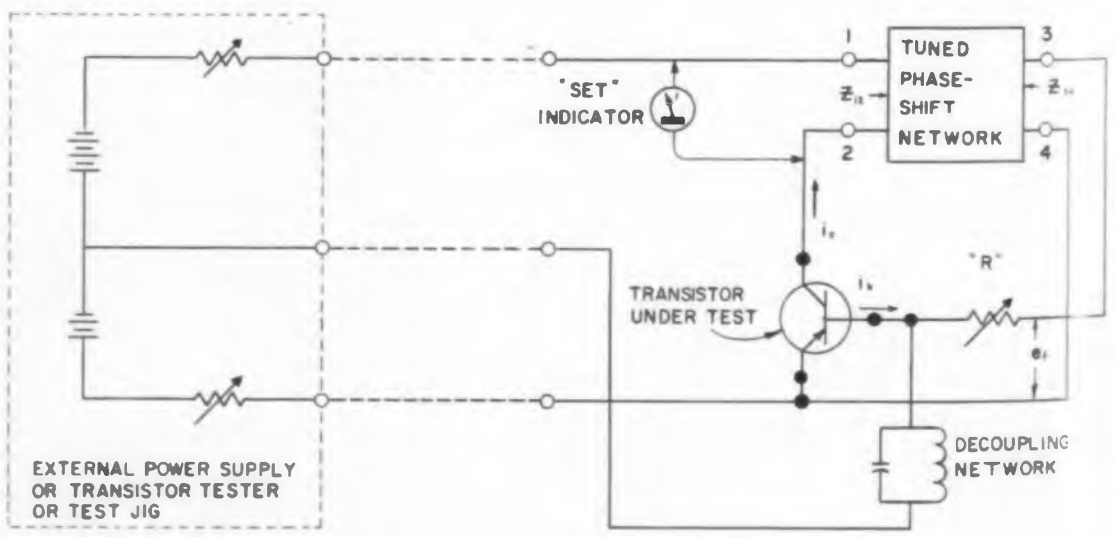


Fig. 1. Circuit of Armour's self-oscillating transistor beta tester.

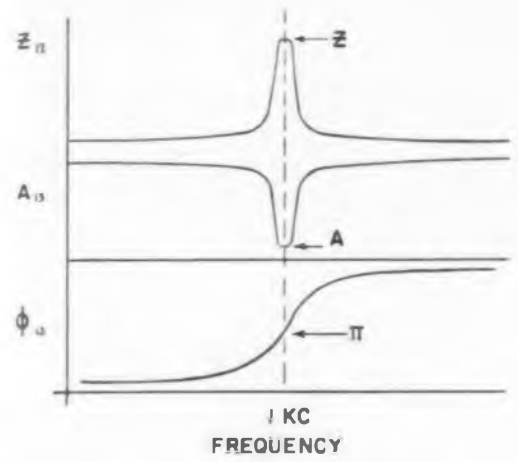


Fig. 2. Network characteristics necessary to permit oscillation of the circuit of Fig. 1.

combining Eqs. (1) and (2).

$$i_b = \frac{-i_c Z_{12} A}{R}$$

$$\frac{-i_c}{i_b} = h_{fe} = \frac{R}{Z_{12} A}$$

Since Z_{12} and A are constant, for a given network and frequency, then beta is directly proportional to R.

In use, one simply adjusts R (a helical potentiometer is convenient) until the "set indicator" voltmeter reads to a pre-calibrated mark; beta is then read directly off a scale on "R" (a digital dial scale is convenient).

Accuracy improves as R becomes larger with respect to Z_{34} and h_{ie}; thus the higher values of beta are more accurately proportional to R than the very low values.

The frequency employed in the Model T-345 is 1 KC, the recommended MIL test frequency for most transistors.

For more information, turn to the Reader-Service Card and circle **102**.

Fig. 3. How the "Beta-Check" may be used in conjunction with a conventional transistor tester.

FIELD-PROVED HONEYWELL COMPONENTS

for measuring, balancing and positioning applications

CONVERTERS

These synchronously driven choppers handle d-c signals as small as 10^{-8} volt. Sensitive, stable performance. Available with special features such as fungus proofing, grounded housing, mica-filled base, various contact percentages. Weight: 10 oz. Prices from $39.

ELECTRICAL CHARACTERISTICS

Part No.	354210-2	354210-3	354210-1	354210-4	355081
Modulation Frequency	20-30 cycles	40-45 cycles	50-65 cycles	50-65 cycles	360-440 cycles
Switching Action (SPDT)	(Make-before-break) Each contact closed 55% of each cycle (± 2%) Other actions as specified			(Break-before-make). Each contact closed 47% of each cycle	Each contact closed 57% of each cycle (± 7%)
Driving Coil Requirements	6.3 v, 60 ma at rated frequency				18 v, 94 ma at rated frequency
Contact Rating	100 microwatts at 5 v max., 1 0 ma max.				
Electrostatic Stray Pickup	2×10^{-5} volts per ohm of input circuit impedance				2×10^{-10}
Electromagnetic Stray Pickup	Less than 2×10^{-6} volts, constant to within 2×10^{-7}				2×10^{-5} volts constant to 2×10^{-6}
Phase Shift	Output voltage lags driving phase by 17° ± 5°				Lags driving phase by 45° to 50°
Symmetry	Within 2%				Within 7%
Shielding	Frame and coil shield, grounded through pin No. 2				Shell and coil shield, grounded through pin No. 2
Load Characteristics	Resistive or Inductive				
Vibration Resistance	Output voltage varies less than 2% with rates of vibration from 0 to 10g				

MOTORS

Designed for chart drives, servos and balancing circuits, these motors are available in three general types: Stack type, with easily maintained sectional housing; self-lubricated, oil-sealed type; and fungus-proofed, oil-sealed military motors. Prices from $40.

Nominal No Load R.P.M.*	R.P.M.*	Gear Ratio	Intermittent Rated Load (oz.—in.)	Max. Starting Torque (oz.—in.)	Pull-In Torque Min. (oz.—in.)	Continuous Torque (oz—in.)	Power (Watts) Loaded	Current (amps.) Loaded	Temp. Rise °F
Two Phase Induction Motor									
330		44:1	4	10			11.5	0.11†	70
144		10:1	5	20			11.5	0.11†	70
48		30:1	15	60			11.5	0.11†	70
23		60:1	30	110			11.5	0.11†	70
Synchronous									
	180	10:1			12	12	24	0.21	100
	180	10:1			2.0	2.0	11.5	0.11	65
	90	20:1			14	12	11.5	0.11	65
	60	30:1			21	18	11.5	0.11	65
	30	60:1			42	36	11.5	0.11	65

*1/6 less at 50 cycles †Field winding 11.0 watts, balance in amplifier winding
Note: Some speeds available at 25 cycles
All motors are available in two phase and synchronous models

AMPLIFIERS

They amplify a d-c or a-c microvolt input signal sufficiently to drive one field of a two-phase balancing motor. Three stages of voltage amplification are followed by the power-output phase discriminator stage, which supplies power for the motor. Extremely low stray pickup . . . adjustable sensitivity . . . fast response. Priced from $110 to $250.

Gain	Sensitivity (Microvolts)	Nominal Input Impedance (Ohms)
10^6	4.0	400, 2,200, 50,000
4×10^6	1.0	400, 7,000, 50,000
12×10^6	0.4	400, 2,200, 7,000
40×10^6	0.1	2,200

POWER SUPPLY—115 v., 60 cycles (fused power line)
OUTPUT—2 to 18 ma. into 12,000 ohm load
SENSITIVITY—Continuously variable screwdriver adjustment. Recessed slot protects setting
MOUNTING—Operation unaffected by mounting position
OPTIONAL FEATURES—(a) thermocouple burnout protection, (b) without desensitizing adjustment, (c) parallel T feedback, (d) velocity damping, (e) special connecting cables and plugs, (f) without tubes, shields, and converter, (g) for 25 cycles.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Aves., Phila. 44, Pa.

Honeywell

First in Control

CIRCLE 60 ON READER-SERVICE CARD

Circulator's Size and W

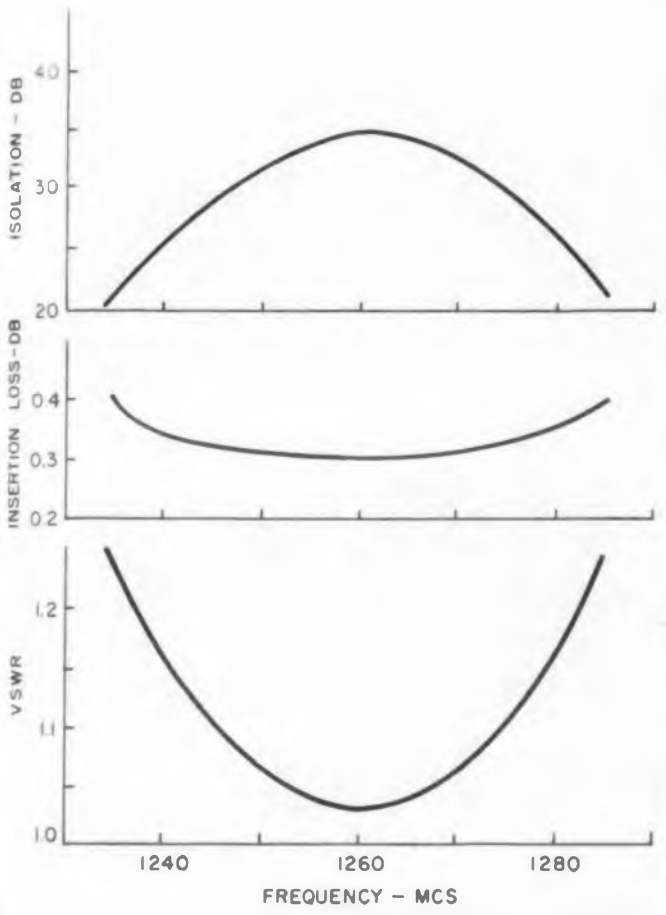
Operating in the L-band, these circulators are are especialy useful for airborne and other applications where weight must be kept at a minimum.

LOW IN WEIGHT, small in size—these characteristics make the series CLL circulators especially useful in radio-astronomy, airborne and other critical applications. Weighing a maximum 9 lb and having a 7.5 in. diam, the circulators were designed down from a weight of 125 lb and a length of about 8 ft.

Operating in the L-band, the units are suited for maser and parameteric amplifier work because of their low insertion loss. They are made by the Raytheon Co., Special Microwave Devices, 103 River St., Waltham 54, Mass.

The units are three-port devices (instead of four-port, with one arm loaded) and have type N coaxial connections. They combine a typical insertion loss of 0.3 db with 25 db isolation and a vswr of less than 1.1 centered at any frequency

Weight Reduced



Typical performance characteristics for the model CLL1 circulator.

from 900 to 1600 mc.

With a permanent magnet, as shown in the photograph, the insertion loss is 0.4 db max, the isolation is 20 db min, and the vswr is 1.2 over any 50 mc band. With an electromagnet, a circulator may be tuned over a 100 mc bandwidth maintaining the same performance. Units having electromagnets can be designed to meet specific requirements.

All circulators can handle an average power of 5 w. The standard models available and their operating frequencies, in megacycles, are: CLL1, 1260 ±25; CLL2, 1400 ±25; CLL3, 1280 ±25; CLL4, 1315 ±25; CLL5, 1420 ±25; CLL8, 960 ±25.

For more information on these circulators, turn to the Reader-Service card and circle 103.

Tetrode Transistor Drives Rotary Solenoids

WE HAD to activate two Ledex rotary solenoid switches simultaneously at five second intervals. The solenoid coils required 2.5 amp each at 28 v dc, applied for at least 0.25 sec to insure reliable switching. One side of each coil had to be grounded.

The only power available was +28 v dc, and the circuit had to be capable of continuous operation over the temperature range of −40 to +85 C.

The system we designed is a bootstrap oscillator circuit. When the supply voltage is first applied, capacitor *C1* charges through *R1* −*R2* and the Ledex coils until the base to emitter voltage of *T1* is sufficient to turn this transistor on. The resulting collector current flow in *T1* causes current to start flowing through *T2* and starts voltage buildup across the Ledex coils.

As this voltage increases, *C1* starts to charge through *R2*, and the charging current flows into the base of *T1*, saturating this transistor. It, in turn, saturates *T3* and applies nearly the full 28 v across the solenoid coils.

Five amperes then flow through the coils and continue to do so until *C1* is nearly fully charged and the charging current into the base of *T1* is no longer sufficient to keep both transistors saturated.

At this time the voltage across the coils starts to decrease and, in so doing, swings the base of *T1* negative through *C1* and *R1* which cuts the whole system off. The circuit remains in the off condition until the charge on *C1* has leaked off through *R1*, and the base to emitter voltage of *T1* is sufficiently positive to allow the cycle to repeat.

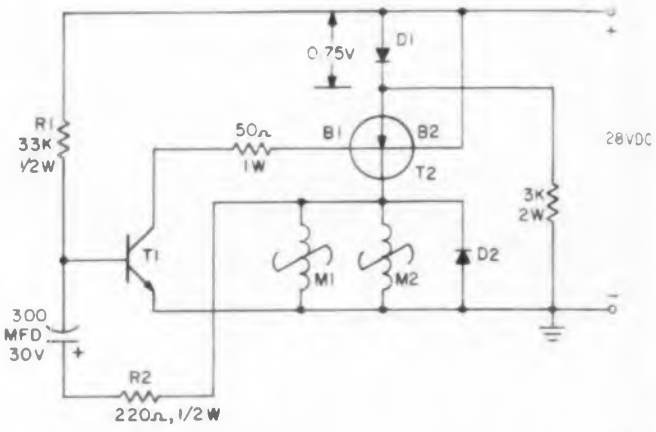
The transitions from off to on are speeded up by the bootstrap effect, so the voltage impressed across the coils is essentially rectangular in shape. Diode *D2* absorbs the inductive kickback voltage across the relay coils when the circuit switches off.

A tetrode power transistor was used here because of its greatly improved leakage characteristics at high temperatures when used in the common emitter configuration. Diode *D1* supplies 0.75 v of emitter bias when the circuit is in the off condition. The 3K resistor insures that sufficient current flows through the diode to maintain this bias. The diode can be left out if operation is confied to temperatures below 40 C.

With the component values shown, the off-time of the system is 5 sec and the on time 0.35 sec. Changing the values of *R1*, *R2*, and *C1* enables the timing of the system to be varied over wide limits, but care should be taken to insure that *R2* never becomes low enough to allow excessive base current to flow in *T1* while the circuit is pulling itself on. Changes in the load impedance will also vary the timing to some degree.

The circuit behaves quite well between −50 and +95 C, with no appreciable variation in timing or efficiency.

J. Wisnia, Engineer, Comstock & Wescott, Inc., Cambridge, Mass.



Driver for two Ledex rotary solenoids. Both diodes are Tarzian LF. *T1* is a TI 2N497, *T2* is a Honeywell H200 E tetrode transistor, and M1 and M2 are Ledex rotary solenoid switches.

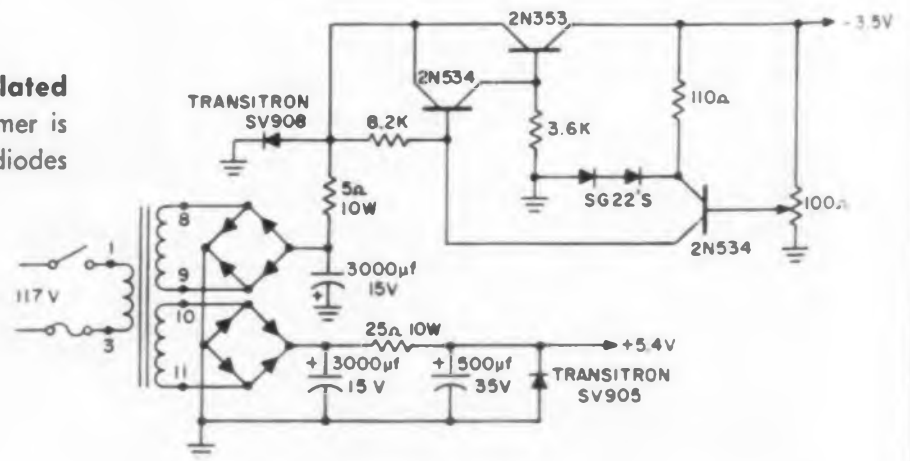
Transistor Power Supply

Uses Low-Cost, Noncritical Components

THE TRANSISTOR regulated power supply, shown here, provides the voltage and current requirement of many transistor circuits. It is simply designed and uses inexpensive, readily-available components.

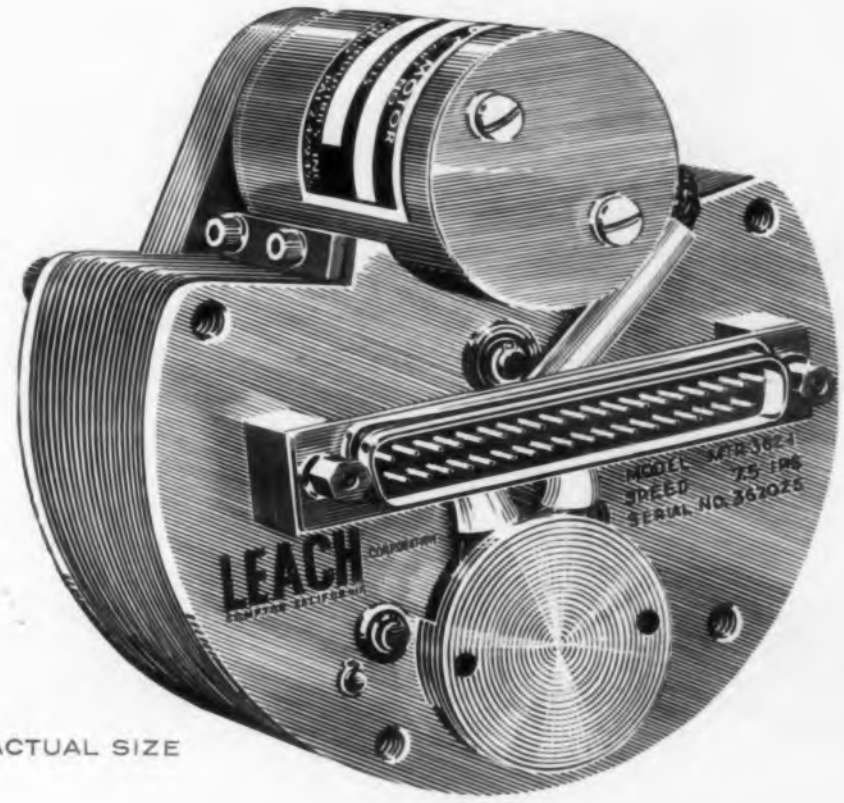
The diodes and surface barrier transistors do not have critical specifications. The output voltages are approximate. They depend on the Zener diode used.

Donald A. Purland, Test Equipment Engineer, Philco Corp., Phila. 44, Pa.



Low cost transistor-regulated power supply. The transformer is a Stancor RT201. Bridge diodes are Federal type 1017.

built to take it
...designed to tell
the whole story
with impact!



ACTUAL SIZE

MINIATURE TAPE RECORDER

Testing under severe environments . . . in extremely limited space? Inet's rugged Miniature Magnetic Tape Recorder simultaneously records data on 1 to 14 in-line channels, never loses a record because it's built to survive high impacts.

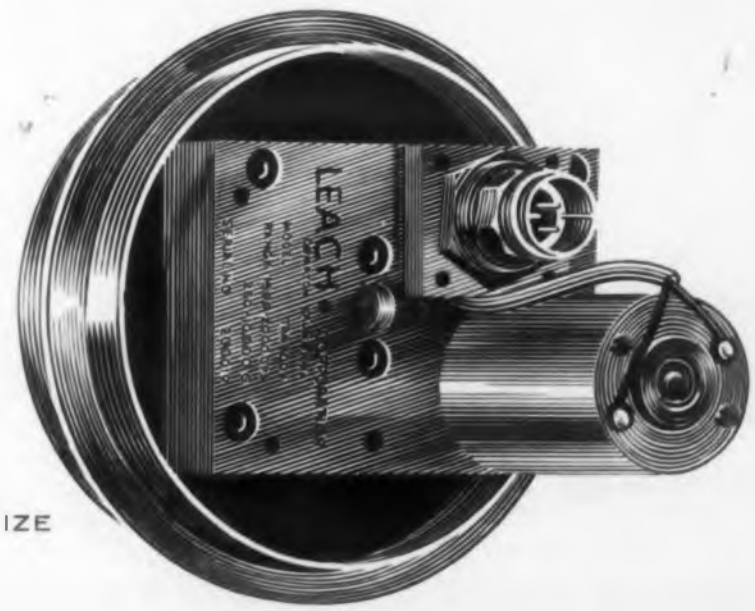
Weighs just 24 ounces and operates at tape speeds of from ¼ to 15 inches per second in a temperature range of −50°F to +200°F. Among its features: precision in-line recording head; adjustable motor speed and tape tension; and molded rubber pressure roller and drive wheels.

APPLICATIONS: in-flight and static tests; atmospheric, blast, explosion and wind tunnel studies; and acceleration and actuation tests.

Write for complete specifications.

LEACH MINIATURES

newest
new products
from Leach/Inet



ACTUAL SIZE

TRIAXIAL RECORDING ACCELEROMETER

The compact, self-contained unit shown above is Inet's 6-ounce Triaxial Recording Accelerometer... attached to a 1½-inch-radius missile nose section.

This rugged unit has three sensing elements—reeds—that directly sense and record data on structures and components subjected to high-acceleration loads. It operates on 6 volts in a temperature range of −50°F. to +160°F., requires no connections to external devices except a power source. The unit records data on acceleration-time history along each of three mutually perpendicular axes. Among its applications: water-entry shock studies; ground impact, blast, and explosion studies; and various other tests, including rocket motor, target impact, sled, and switch actuation tests.

Write for complete specifications.

RELIABILITY

LOOK TO LEACH

INET DIVISION . . . LEACH CORPORATION

18435 SUSANA ROAD, COMPTON, CALIFORNIA

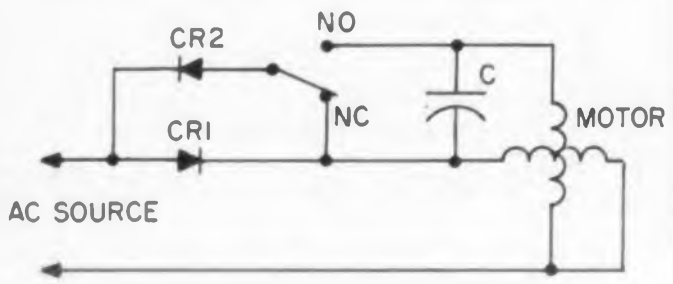
DISTRICT OFFICES AND FIELD REPRESENTATIVES IN PRINCIPAL CITIES OF U.S. AND CANADA • EXPORT: LEACH CORP., INTERNATIONAL DIVISION

CIRCLE 62 ON READER-SERVICE CARD

Fast Brake For Small Motors

To minimize coasting or over-travel, it is often necessary to brake gear reduction motors. The method shown in the diagram can be used for almost instantaneous braking.

In the normally closed position of the switch, ac power is supplied to the motor to develop full rated torque. When braking is required, the switch is thrown to the normally open position.



Diode arrangement allows capacitor gear reduction motor to be braked almost instantly.

The positive half cycle is then supplied to the motor through rectifier *CR1*, generating a torque in the normally running direction. On the negative half cycle, current flows through *CR2*, through the motor but to the opposite side of capacitor *C*. This creates torque in the reverse direction. The net effect is a locked rotor.

This method allows a large inertia rotor to be used where a low inertia rotor (longer and narrower) would be necessary to get effective braking through ordinary means.

Richard Ceier, American Optical Co., Buffalo, N. Y.

Tune Servo Motors With Unequal Phase Impedances

Frank Hagen's article of March 4th, "How to Use Motor Impedance Data in Designing Servo Mechanisms" was very interesting. Since series 90 deg phase leading is widely used, I was curious as to what capacitance would be required to tune motors of unequal phase impedances such as those encountered for transistor servo drives. The following is the result for maximum starting torque.

$$X_c = X_f + \frac{R_v}{X_v} R_f$$

X_c is the fixed phase series capacitive reactance. X_f, X_v are the fixed and "variable" inductive reactances at stall. R_f, R_v are the fixed and variable effective resistance at stall.

W. Merel, Chief Systems Engineer, Airborne Accessories Corp., Hillside, N.J.

Relay Surgery Makes High Voltage Buzzer

Occasionally, a buzzer is required for operation on 220 v or 440 v, 60 cycle lines. These buzzers are not catalog items. The usual solution is to use a minimum size step down transformer (25 va) and a low voltage buzzer. At best, the result is bulky and relatively expensive.

A five second solution consists of using any 60 cycle relay with the proper voltage coil and cutting the one or two single-turn copper shading coils imbedded in the working face of the relay magnet.

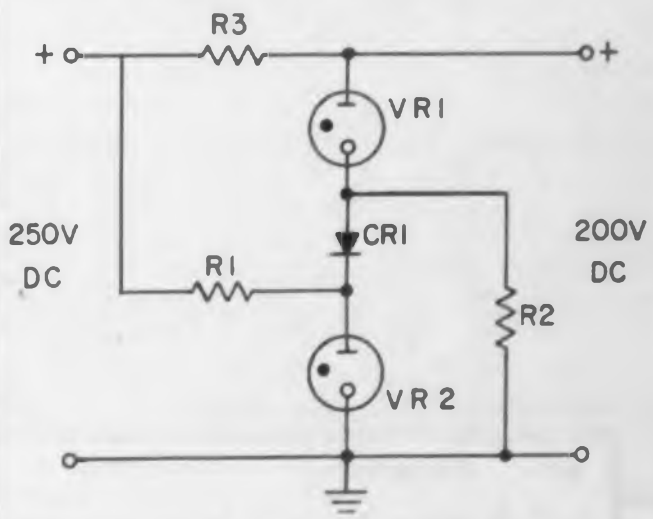
This removes the shading coil from the circuit and, in turn, removes the out-of-phase component of the current. When energized, the relay acts as a buzzer. Mounting the unit on a metal pan, which serves as a sounding board amplifier, provides a loud enough buzz for most applications.

The buzzer may be converted back to a relay by resoldering the shading coils.

M. K. Kessie, Senior Design Engineer, Atomics International, Canoga Park, Calif.

Fire VR's in Parallel Operate in Series

Approximately 145 v are needed to ignite a 100 v regulator tube such as the CK5787. Our problem was to use two such VR tubes in series for a 200 v reference, but we had only 250 v dc available, instead of at least 290.



One diode and two resistors help this regulator operate with "inadequate" firing voltage.

We solved the problem by using a diode and two resistors as shown in the figure. *R1* and *R2* supply just enough current to bias off the diode and start the VR tubes. Once both tubes are fired, the diode is switched on. Thus, both tubes are fired in parallel and operated in series.

Teague N. Leiboff, Senior Development Engineer, Magnetic Amplifiers, Inc., El Segundo, Calif.

IDEAS FOR DESIGN

I-f can houses fm tuner. The circuit for this one-tube fm tuner is packed inside a shield can about the size of a standard i-f transformer. The circuit comprises a neutralized triode rf amplifier and a pentode oscillator-mixer. The tuner is made by the French firm Visodion.

Dr. A. V. J. Martin, Cornegie Institute of Technology, Pittsburgh, Pa.

Two Transistor "n" Input "Exclusive OR"

The circuits of Figs. 1 and 2 perform the "Exclusive OR" function for two or more inputs (n) with only two transistors and $2n$ diodes. Fig. 1

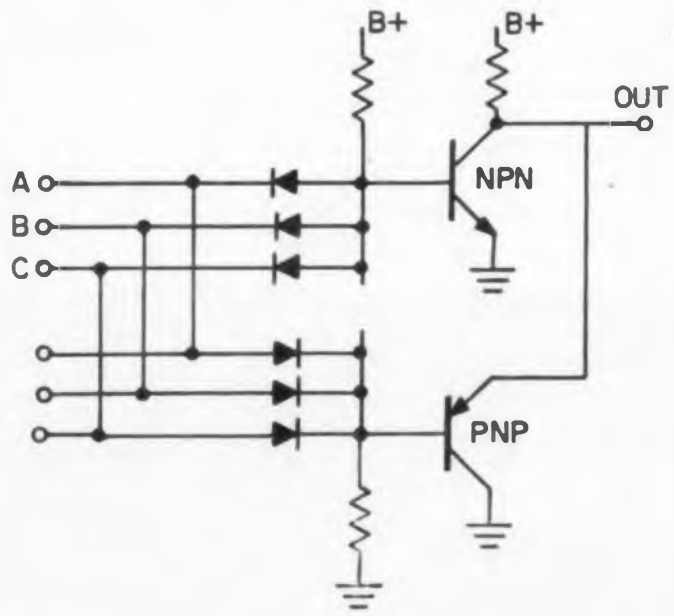


Fig. 1. "Exclusive OR" with *high* output when some inputs are high, some low. Output is low when *A*, *B* and C are all either low or high.

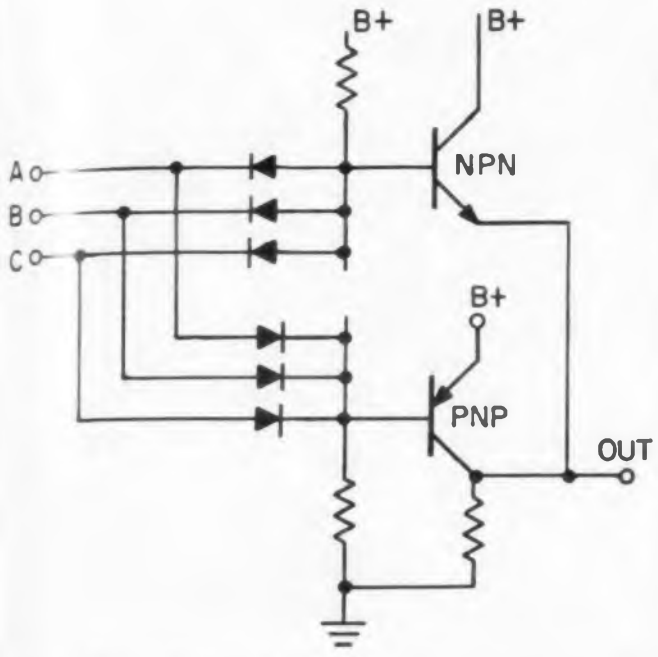


Fig. 2. "Exclusive OR" with *low* output when some inputs are high, some low. Output is high when *A*, *B* and *C* are all either low or high.

satisfies the function with a high output, Fig. 2 with a low output.

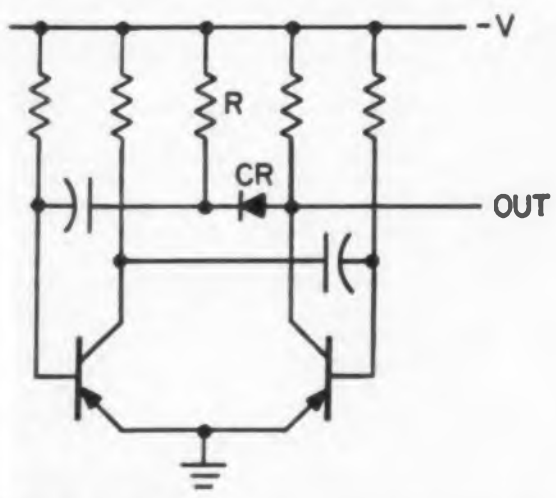
Stanley Maki, Senior Electronics Engineer, Convair Astronautics, San Diego, Calif.

Transistorized Multi With Fast Fall Time

Transistorized multivibrators make very good square wave generators except for the fact that they stretch the trailing edge of the wave. This is due to recharging the cross-coupling capacitor.

The addition of a resistor and a diode will permit the multi to deliver excellent square waves with fast rise and fall times. The capacitor is isolated during the recharge cycle so it does not prevent the output collector from recovering rapidly.

Roy P. Foerster, Baltimore, Md.



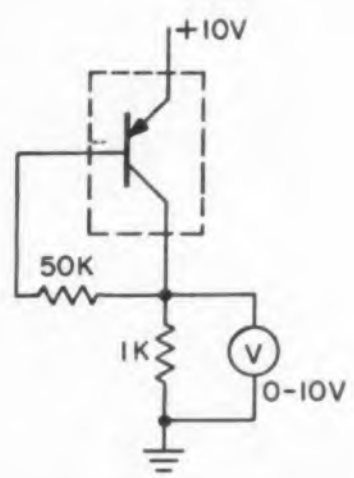
Addition of diode (CR) and resistor (R) helps the output collector recover rapidly. This gives the multivibrator a fast fall time.

IDEAS FOR DESIGN

Small, Simplified Pnp Beta Tester

This simplified beta tester measures the value of dc beta. It is taken at a current level of 10 ma and is a good measure of ac beta too. The accompanying beta chart, which gives beta from a voltage reading, is calculated from $\beta = 50\ V/(10 - V)$.

V	β		
0.5	2.6	5.0	50
1.0	5.5	5.5	61
1.5	8.8	6.0	75
2.0	12.5	6.5	93
2.5	17	7.0	116
3.0	21	7.5	150
3.5	27	8.0	200
4.0	33	8.5	283
4.5	41	9.0	450
		9.5	950



This simple dc beta tester should take almost no time to build.

Benjamin H. Rose, Eatontown, N.J.

Human Engineered Breadboard

One thing about this breadboard, made with thumbtacks and a pine board, is that it is obviously a breadboard and you waste no time trying to make it look pretty. It boasts the usual advantage claimed for breadboards; when it comes to easily salvaging parts, it is superior to most.

Materials required in addition to electronic parts are nickel plated thumbtacks, soft pine board, 10 in. wide and as long as you choose, bus wire, paper and pencil.

Construction involves only these simple six steps. 1. Draw schematic of circuit on paper. 2. Put paper on board. 3. Put thumbtacks at ends of buses on the schematic. 4. Solder bus wire between thumbtacks to provide an electrical bus over the symbolic bus on the diagram. 5. Put

thumbtacks at all major circuit intersections except crossing the buses. 6. Connect parts (solder) between thumbtacks and directly over their representation on the schematic.

E. J. Sadler, Digital Devices Co., Box 9146, San Diego 7, Calif.

Encapsulate in Silicone Rubber Molds

One of the less desirable steps in encapsulating small components in epoxy resin is that of releasing the component from the mold after the cure is completed. When preparing to encapsulate a few small bobbin core pulse transformers, we found we were "fresh out" of release agent.

What we did find was an old test cure of silicone rubber potting compound about 2 in. in diam and 1 in. thick. By drilling a few 3/8 in. holes in it, we had a mold to which epoxy would not adhere.

When the curing was complete, the transformers were simply "popped out" of the rubber. This method has proved very convenient in the lab for encapsulating prototype designs.

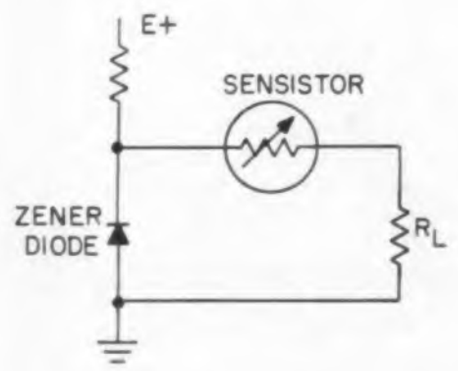
R. Purdy, Electronics Engineer, Waldorf Electronics, Huntington Station, L. I.

Sensistor Compensates Zener Regulator

Zener diodes make excellent voltage regulation elements but, unfortunately, their breakdown voltage shifts with temperature. As shown in the figure, the addition of a Sensistor, a positive temperature coefficient resistor, solves the problem neatly.

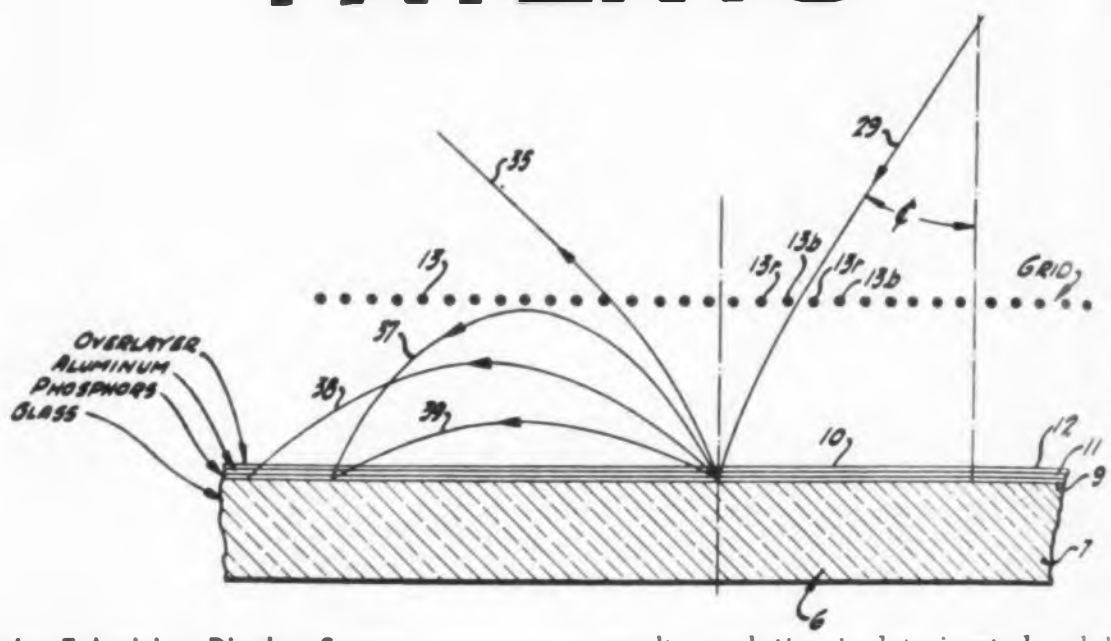
This simple method is effective where the input voltage may vary widely but the load remains constant.

Andrew S. Bishore, Engineer, United Electrodynamics, Pasadena, Calif.



The sensistor helps keep load voltage constant despite effects of temperature variations on the Zener diode.

PATENTS



Color Television Display Screen

Patent No. 2,878,411. Luis W. Alvarez. (Assigned to Chromatic Television Labs., Inc.)

Color television tubes employing a retarding grid are subject to halo formations due to back-scattered electrons which strike adjacent color sources. As a result, resolution is deteriorated and the colors are diluted.

However, the number of back-scattered electrons is proportional to the atomic number of the scattering material. Hence, halo formation is reduced by depositing low atomic number materials over the light reflecting aluminum screen. The combined thickness of all layers pro-

hibits the escape of back-scattered electrons which now dissipate their energies to produce useful light output or heat.

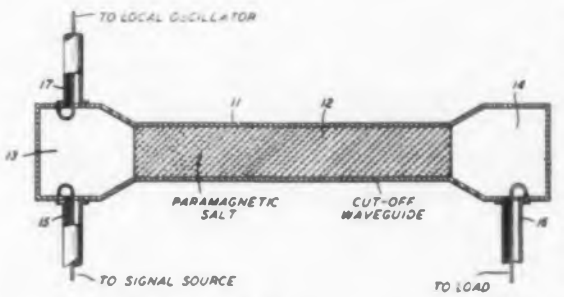
In the illustration, electron beam *29* strikes the phosphor and electrons would escape to the walls of the tube along path *35* in the absence of grid *13*. However, the grid retards the electrons which return along paths *37*, *38*, and *39*. By applying a low atomic number overlayer such as boron carbide, the electrons are unable to back-scatter from the screen and halo is eliminated.

Microwave Amplifier

Patent No. 2,883,481. Ping K. Tien. (Assigned to Bell Telephone Labs., Inc.)

The amplifier is a three level maser using a wave guide containing a crystalline paramagnetic salt uniformly distributed along its length. Using nickel Tutton salt, a 30 kmc signal is amplified when pumping power is delivered at 74 kmc. With appropriate matching, the signal power propagates along the slow wave circuit interacting with the negative temperature medium and thereby increases the efficiency of interaction.

The wave guide is superior to the resonant cavity since the latter has narrow bandwidth, degrades the low noise quality of the maser and is inconvenient for coupling microwave power.



In the illustration, transformers *13* and *14* are short-circuited stubs free of the parametric salt and the stub has a lower cut off frequency than the wave guide. Connection is made by the inductive loops as shown. In addition guide *11* and the transformers are resonant at pumping power frequency to reduce the required pumping power.

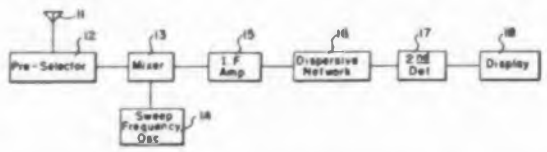
Guide *11* cuts off at higher than signal frequency. When filled with the paramagnetic salt, the group velocity of signal power is small so that the guide acts as a distributed reactive circuit with a high unloaded Q. Large magnetic fields are produced with low driving power and increases the magnitude of radiation.

PATENTS

Electronic Circuits

Patent No. 2,882,395. Warren D. White. (Assigned to Cutler-Hammer, Inc.)

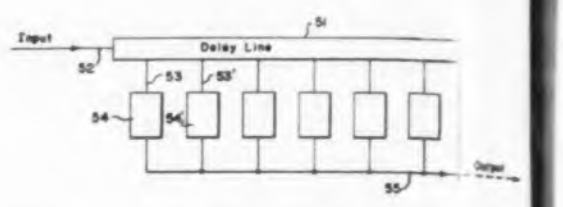
Resolution in a panoramic receiver increases when the output of a relatively narrow band amplifier is passed through a dispersive network. This network characterized by time delay depending upon frequency, will convert the broad amplified output pulse to a very narrow pulse.



This pulse can then be distinguished from closely adjacent pulses.

A dispersive network designed to match the scan rate will allow the scan rate to increase directly as the network compression ratio. Resolution remains the same, although the spectrum is analyzed more rapidly. Since the amplifier bandwidth is unchanged, the receiver noise figure does not deteriorate.

A typical arrangement of a receiver and dispersive network is shown. The network is a delay line tapped at successive

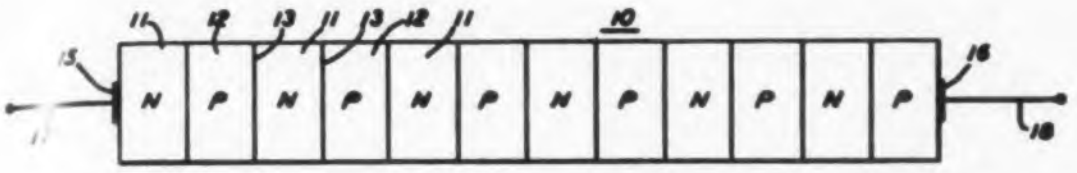


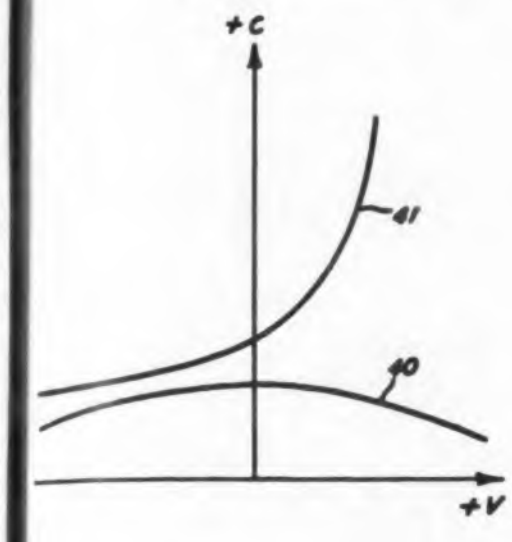
points corresponding to length of delay. The outputs of selective filters *54* and *54'* turned to pass adjacent narrow frequency bands, are connected to the output line. To delay low frequencies more than high frequencies, filter *54* passes the highest frequencies in the band and successive filters pass successively higher frequencies. For uniformly varying time delay, many taps in the line are provided.

Semiconductor Nonlinear Capacitance Diode

Patent No. 2,884,607. Arthur Uhlir, Jr. (Assigned to Bell Telephone Labs, Inc.)

A nonlinear change of capacitance with voltage is obtained when alternate graded np and step pn junctions are connected in cascade. The capacitance diode may be formed in a single crystalline body by controlling the concentration of impurities. This device, when placed across a waveguide with the planes of the junctions parallel to the direction of transmis-





sion, can switch moderate microwave power.

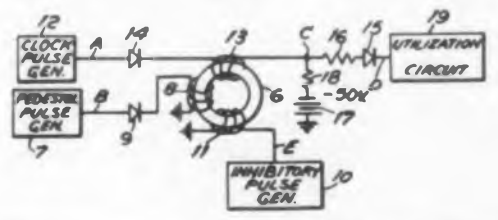
The capacitance diode shown consists of 12 regions with 13 alternate graded and abrupt junctions. With applied bias, the depletion layer of the abrupt junction is less than the widening of the depletion layer of the graded junction. As a result, the high impedance device varies nonlinearly with voltage as shown.

Magnetic Switching Circuit

Patent No. 2,881,331. Ben Alexander. (Assigned to International Telephone & Telegraph Corp.)

A ferrite rectangular hysteresis core wound with gating and signal coils provides effectively infinite signal-to-noise ratio.

With core *6* set at maximum positive residual flux, simultaneous clock and pedestal pulses will overcome the bias of battery *17* to couple the output to utilization circuit *19*. However, inhibitory pulse generator *10* will set the residual flux at maximum negative value so that no signal couples to the output.



Can An Employment Agency Help You Find The Right Job?

WHATEVER your reason for seeking a new engineering job, private employment agencies can offer excellent help. Why? Let Al Davis and Bob Duffy, executives of two large agencies specializing in the placement of electronic engineers tell you.

Davis, vice president in charge of Edwards Employment's executive-engineering division at 16 West 46th St., New York, N.Y., and Duffy, placement specialist of Engineering Employment Service, 217 Broadway, New York City, answered the following questions in an interview arranged exclusively for the readers of ELECTRONIC DESIGN.

Do you have a large number of job orders for electronic engineers?

Both men reported approximately 12 to 15,000 open orders for electronics men. They also noted a definite increase in the number of orders flowing into their agencies—"several thousand more vacancies to be filled than at this time last year; new orders coming in every day."

The greatest demand was for men in the following areas (ranked in volume of requests):

1. designing and developing components
2. planning and designing of systems
3. designing circuits

What types of companies send you these job orders?

There was general agreement that the majority of requests came from blue chip companies in the missile, space, and communications systems fields. Davis and Duffy also emphasized the national, rather than local demand for men.

Davis: "We receive orders from companies in all parts of the United States . . . operate on a coast-to-coast basis. About 25 per cent of our placements are made outside of the New York metropolitan area."

Duffy: "There is a nation-wide need for electronics men. As high as 40 per cent of our placements are made in locations outside of the immediate New York City area."

Do agencies reveal their clients and tell you to whom they will send your resumes?

No, both executives agreed. If you do not want to apply to certain companies, name them and tell the agency to bypass them.

How about the small manufacturer—supposing an applicant wants a small

"white chip" company instead of a major "blue chip" manufacturer. Can you help him?

A strong affirmative from both men

Davis: "We have orders from numerous small companies—so-called 'white chips'—who are vying with the big fellows for good men. Within the past few months we placed several very fine men with smaller outfits—one at $8400, another at $11,000."

Duffy: "Close to 50 per cent of our placements are made with small to medium-sized companies. For example, we just placed a man who had been with a giant company. He came to us asking for a smaller company in a similar field. We found him a swell spot at $12,000—and he's very happy."

Do your job orders have a wide range in terms of duties, salaries, etc.—that is, from the beginner to the top senior and executive openings?

An "across-the-board" need for juniors to top men was quoted by both men. Salaries offered ranged from $5200 to $30,000 a year. As to the area of greatest demand (salary-wise and experience) . . .

Davis: "The greatest demand is for $7 to $10,000 a year men with a couple of years experience."

Duffy: "Greatest demand in the whole country is for men with 2 to 5 years of experience."

What suggestions do you have for the electronics engineer who seeks your services to help him find a better job?

Both Davis and Duffy agreed right down the line on the following points:

- The applicant must have made up his mind on where he wants to locate.
- He must have a good idea of what he can do best—and be willing to utilize his strong points.
- He must be realistic about his *true worth* in the labor market. "Too many men are walking in the clouds when they appraise their value to an employer."
- He must have a sufficient supply of clean, neat resumes.
- He shouldn't work with more than three good agencies who specialize in his field.
- He shouldn't flood the market with resumes in his own mailing or promotion campaigns.

Davis used the following example to stress the importance of not flooding the market with resumes: "A man looking for a new job, let's call him Mr. A., will often send out resumes on a scattershot basis to many potential employers. He crosses his fingers and hopes that some of his resumes will be on target.

"Well, now, let's say that Company B, one of A's targets, receives one of A's resumes. Company B's personnel man scans A's resume, realizes he has no current openings that fit A's qualifications. Thus he puts A's resume aside, forgets about him for the time being.

"Then A comes to us for help. He doesn't know it but Company B is one of our clients and when B places an order with us for a man with A's qualifications, we send A's resume to B's personnel man.

"Now what happens. B's personnel man looks at A's resume, remembers it vaguely, and says to us 'we think we've seen that fellow before—let's see someone else.'

"You'd be surprised how often a situation like this occurs—understandable though when a personnel man is swamped with resumes."

Duffy emphasized the desirability of an applicant working closely with his agent: "The closer a man works with us, the more we can do for him. By letting us know the results of his interviews, we can guide him better on future referrals."

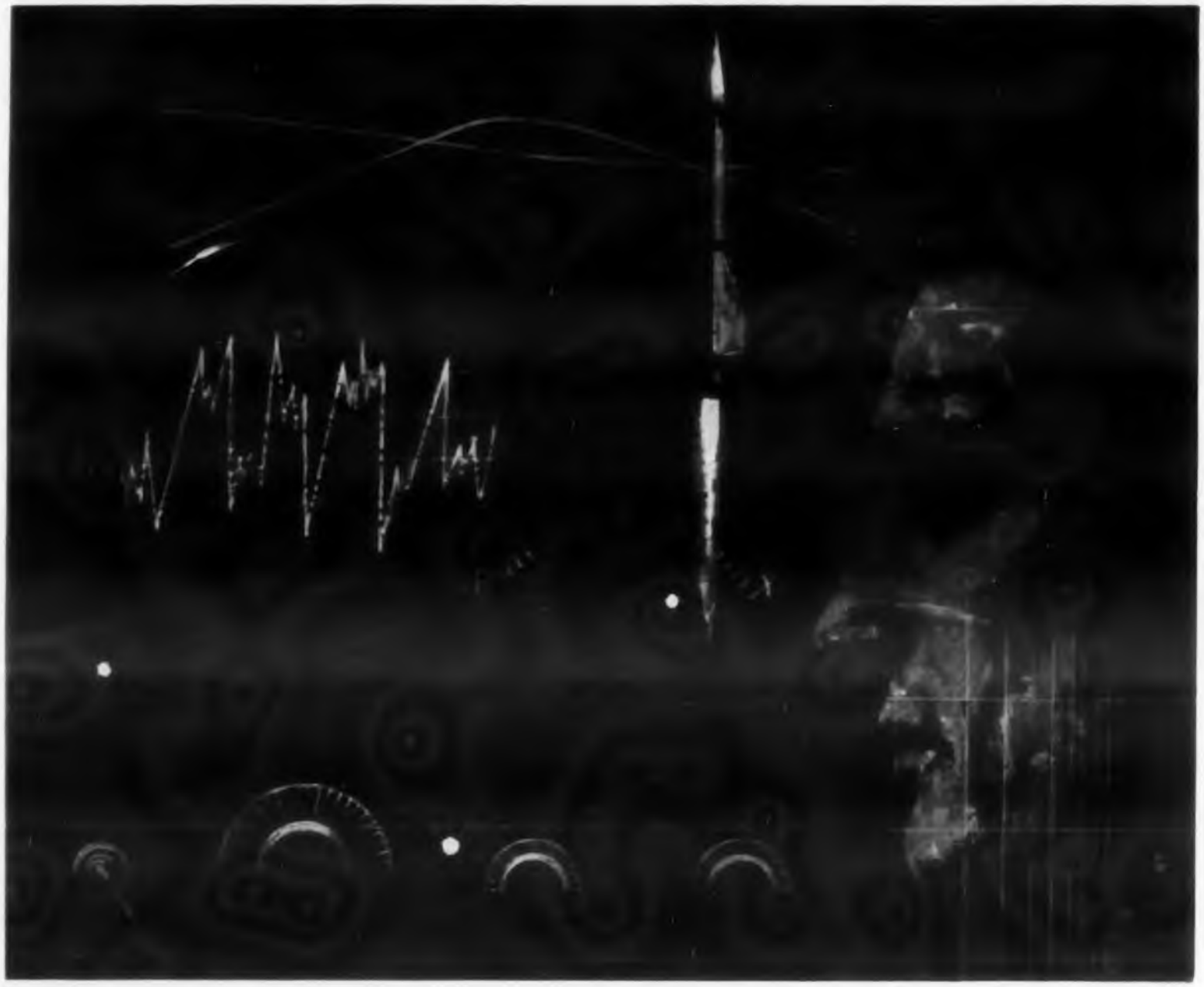
Speaking of resumes, do you have any suggestions on the type of resume a man should have. If he doesn't have a resume can you help him prepare one?

Davis and Duffy were in accord on brevity being the soul of a good resume as long as it was complete and wholly accurate—no employment gaps left unexplained, no half-truths that could be tumbled by a careful reference check.

Davis: "A resume should be short, sweet, and right to the point . . . never more than two pages . . . always typed. If a man doesn't have a resume and needs help in writing one, we have a 'specimen' we give him to use as a guide."

Duffy: "We, as well as most employers, like the chronological type resume rather than the functional one. An employer partially judges a man on the companies he has worked for before and sometimes the functional resumes won't carry that information. Also, the functional resume tends to be more fancy than it is factual."

(*Continued on following page*)



DESIGNING YOUR FUTURE

About how long, on the average, does it take you to find a spot for an applicant?

The time varies in accordance with the salary level, location, and specific type of work and company a man is seeking, according to Davis and Duffy.

Davis: "If a man is *qualified* and will take a job in this area, we can frequently place him within 48 hours. If he wants an out-of-town spot, necessitating transmission of resumes, correspondence, scheduling of several interviews, etc., it may take weeks. Also, of course, it takes longer to place five-figure men than it does men at $7000 to $8000.

Duffy: "Placement is must faster in the electronic than any other field, today. But, if a man has specific requirements, if he insists on a particular location, a particular type of industry, and a particularly high salary—a dream job tailor-made to his own personal wishes—often the best help we can give him is to try to bring him down to earth."

●

And now for the all-important "how much?" What does it cost a man for your services?

Davis: "98 per cent of our present electronic openings are fee paid—transportation and re-location expenses are also covered."

Duffy: "It's the very rare company in the electronics field that will not pay the applicant's fee."

●

Summing up, what would you say are the chief advantages an agency can offer electronic engineering job applicants?

An agent has a broad and current knowledge of the market. He offers a confidential service. He can give realistic advice on salaries and comparative opportunities in various companies. He can save a job hunter hours of time, leg work, and shoe leather.

On top of these advantages, Davis added: "don't forget that an applicant benefits by the confidence that an employer places in our judgment. Going into an interview with an agent's solid recommendation is a big help to a man." And Duffy closed with the important thought that "an employment agent provides an applicant with an approach to the right source—the right man to see." ■ ■

Advancement Your Goal? New Form Speeds Action

ELECTRONIC DESIGN's new Career Inquiry Service form is designed to help engineers advertise themselves. This new service will speed applicants to the jobs they seek. It is the first such service offered in the electronics field.

To present your qualifications immediately to the personnel managers of companies that interest you, simply fill in the attached standardized short resume.

Study the employment opportunity ads in this section, and circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN's Reader Service Department will make photocopies of your standardized resume and send it to all companies you select . . . *the same day the resume is received.* (ELECTRONIC DESIGN will detach the circle number portion of the form, so that no company will know how many numbers you circled.)

The standardized resume will permit personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you directly. In the past much time has been lost through personnel-manager requests for resumes from applicants who proved ineligible.

Readers who desire only company brochures should use the regular Reader Service card.

Mail Career Inquiry Service form to Reader Service, ELECTRONIC DESIGN, 830 Third Ave., New York 22, N. Y.

ELECTRONIC DESIGN CAREER INQUIRY SERVICE

USE BEFORE SEPT. 2, 1959

After completing, mail career form to *ELECTRONIC DESIGN*, 830 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below. (15)

(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.

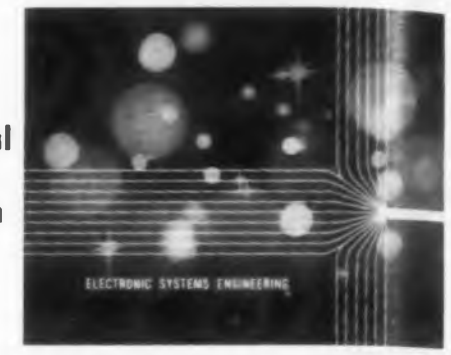
Circle Career Inquiry numbers of companies that interest you

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

CAREER OPPORTUNITIES BROCHURES

International Electric Corporation



Attractive color folder highlights opportunities for engineering assignments with the company. An organizational chart for systems engineering is featured and each activity is described briefly. Company benefits and community facilities are outlined along with a map showing company location. A concise outline of engineering facilities and interests is presented.

International Electric Corp., an associate of International Telephone and Telegraph Corp., Dept. ED, Route 17 and Garden State Parkway, Paramus, N.J.

CIRCLE 880 ON READER-SERVICE CARD

Sperry Gyroscope Company

"Don't Let Chance Decide Your Career" is an eight-page, illustrated brochure describing the work of Sperry—development and production of instrumentation and control systems—and the kind of engineering position relating to each specific system. A "flow diagram" compares areas covered by Sperry and the skills required for each position. These are listed under four general categories: study and research, development of experimental systems, pre-production models and production program. Plant locations, advanced educational opportunities, and other benefits of the company are discussed. A brief summary of career opportunity at Sperry concludes this concise pamphlet.

Mr. John Whitton, Technical Employment Supervisor, Sperry Gyroscope Co., Division of Sperry Rand Corp., Dept. ED, Great Neck, N.Y.

CIRCLE 881 ON READER-SERVICE CARD

YOUR CAREER

NEWS, NOTES, NOTIONS

A promotion isn't a one-way ticket for a gravy train. After the first exhilaration wears off, headaches and anxieties can appear. And they need not be related directly to the technical demands of the job. Listen to a job consultant, Lon D. Barton, president of Cadillac Associates, Inc., of Chicago:

"The first few days after you are promoted will be the most critical in your career. Unless your seniority is clearly established and your duties are well-defined, you immediately become the bull's-eye for every rival who wanted the promotion. This is particularly true if you have been brought in from the outside. It is a time of real peril."

The trouble, Mr. Barton explains, is that newly promoted men often aren't aware of this. They begin to act differently, to discard all the characteristics that won them the promotion in the first place, and they become fair game for the sharpshooters.

"The newly promoted man has to walk a fine chalk line between stepping on people and allowing them to step on him," Mr. Barton warns.

It is a rough time for every executive who has been promoted. It is particularly crucial for the man making his first move to supervisory responsibilities. For the novice executive, Mr. Barton suggests an intensive review of personnel management fundamentals. This involves getting to know subordinates and superiors and obtaining their complete cooperation.

Whether you've been promoted from within or hired from without, Mr. Barton has found it wise to let the dust settle, to wait for the phrase "new boss" to start dying. This is an excellent time to take inventory of yourself and the job—to find out why you were promoted, what your superiors expect of you and the mood of your subordinates.

"While you're catching your breath and probably for a considerable time after it," Mr. Barton says, "you can confidently expect to be the loneliest man in your company. Your old cronies will be suspicious of your new eminence and try to trade on past friendships. The men on your new level will be equally suspicious of the new man, how he got there, how he got a key to the washroom and what it means for them."

The loneliness may never leave. It sometimes is part of the price of executive advancement. An antidote, Mr. Barton has found, is to develop new interests, hobbies, friendships outside your company. Closer family ties can help, too.

For those beset by executive anxiety, Mr. Barton has a final word of comfort:

"Cheer up, the more you advance, the more the symptoms are magnified. The greater the re-

sponsibility, the greater the reaction—until finally you realize all this comes with advancement and are able to live with it. Some men actually are forced to resign with a complete nervous breakdown but most men make the grade, and you probably will, too, if you remain calm. Cheer up. It could have been worse. You could have been fired.

But **suppose you have** yet to advance. You may be considering a switch to another company. What should you find out about a new job before taking it? In a recent newspaper ad, General Electric advised prospective engineers for its Light Military Electronics Dept. at Utica, N.Y., to ask about these essentials in the preliminary interview:

- Company sales record and size of staff. Inquire whether there have been wide fluctuations in staff size or steady growth.
- Projects under way. Determine if the technical challenge meets your requirements.
- Salary scale. Ask how technical and administrative pay compare.
- Size of company and how management is organized. Find out who makes decisions.

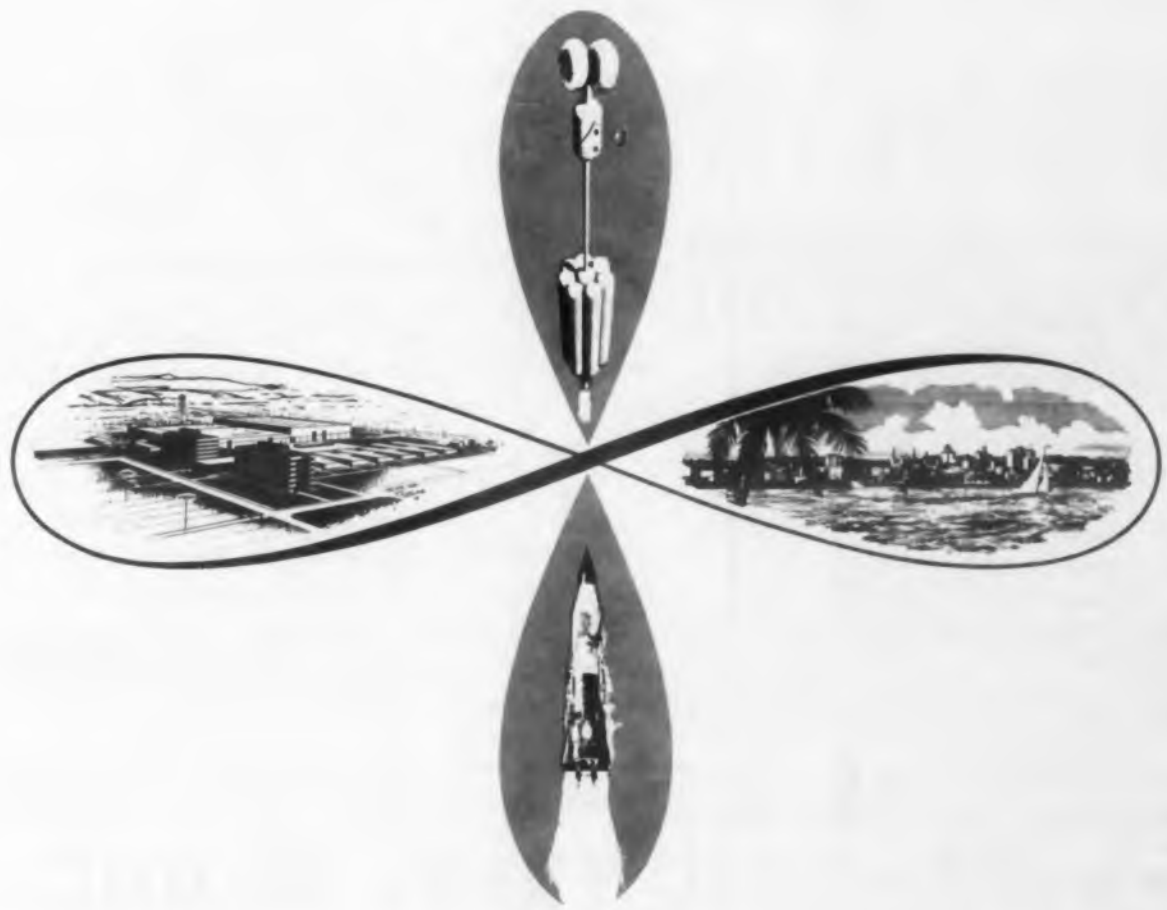
Later, at the in-plant interview, GE's ad continued, you should be seeking the answers to these questions, among others:

- What will your first assignment be? This will help you gage your interest in the new job.
- What advancement opportunities lie immediately ahead? Ask about the size of the group you will work with, and try to estimate how many men will have to move up before you can be promoted. Consider whether company growth will create new lateral positions.
- How much project responsibility will you receive as a development or design engineer?
- What company aids are offered for professional growth? Find out if there are in-plant courses, a technical library, financial aid for graduate study, encouragement to publish technical papers.
- What technical facilities are available? Remember to note such side factors as noise in the plant, the amount of privacy and space allotted to each engineer.
- Is the company situated near a desirable residential community? You have a private life to live, too.

If a **small company** is your goal, CGS Labs, Inc., of 391 Ludlow St., Stamford, Conn., suggests in a booklet, "Getting an Engineering Job," that you put these questions to the interviewer:

- Who owns the company? If it is a "closely held" concern, you will want to investigate the personal reputation of the owner or owners.
- Who really controls the company? The person with control is the one who formulates policy.

(Continued on following page)



Three important openings exist within our new

Electronics Applied Research Laboratories for Space Systems

—a company sponsored facility

COMPONENTS

• Molecular and Atomic Electronics • Thin Films • Vacuum Deposition • Solid State and Surface Physics • Solar and Thermionic Energy Converters • Electroluminescence

SYSTEM TECHNIQUES

• Threshold Reduction • Bandwidth Compression • Sampling and Quantization • Long-Range Tracking and Communication • Data Handling and Processing • Automation • Information Enhancing and Interpretation • Infrared Space Filtering • Application of Statistical Theory of Noise and Information Theory

INSTRUMENTATION

• Attitude Stabilization • Biotechnical Transducers • Reconnaissance Surveillance • Geo-Astrophysical Transducers for Space Probes

Advanced degrees, while highly desirable, are not requisite if adequate experience is apparent. We invite your inquiry. Address T. W. Wills, Engineering Personnel Administrator, Dept. 130-90

CONVAIR / ASTRONAUTICS CONVAIR DIVISION OF **GENERAL DYNAMICS**

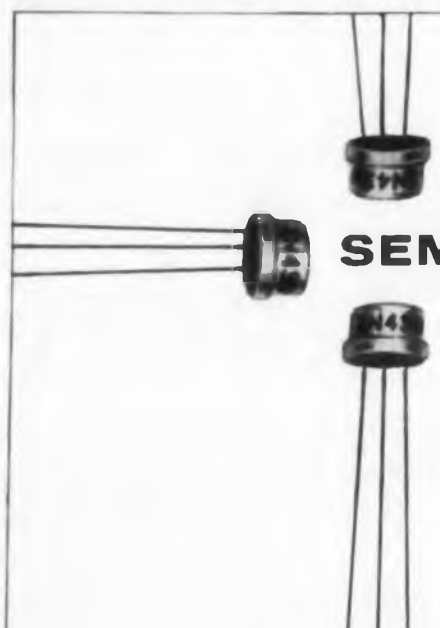
5811 KEARNY VILLA ROAD, SAN DIEGO, CALIFORNIA

CIRCLE 907 ON CAREER INQUIRY FORM

CAREER NEWS, NOTES, NOTIONS

- How are salaries and increases in salaries determined? Explore whether merit or formula is the rule.
- What are the salaries of the company's highest and lowest-paid engineers who have been out of school, say, five years? If the bracket is narrow, a yardstick other than merit is being used, or the company is unusual in its ability to hire equally qualified and industrious persons.
- Will the company let me select several of its employes at random and talk to them alone before accepting the job? A good way to find out about a company is to sample the attitudes of the men who work there.
- If I make a worthwhile invention for the company, how do I share in it?
- Are the profits of the company growing steadily? Ask to see copies of annual statements for the last few years.

"Assuming that you select a small company that is progressive and growing," CGS says, "there are a number of possible advantages in working for a small company. By the very nature of the operation of such a small business, management finds it necessary to put responsibility on younger men without the luxury of many years of training such as is sometimes provided in larger corporations."



SEMICONDUCTOR ENGINEERS

JOIN OUR FIVE MILLION DOLLAR EXPANSION PROGRAM

If you have experience as:

PRODUCTION MANAGER ENGINEERING MANAGER
DIODE ENGINEERS APPLICATIONS ENGINEERS PILOT LINE ENGINEERS
TRANSISTOR ENGINEERS DEVICE DEVELOPMENT ENGINEERS PHYSICISTS
PRODUCTION ENGINEERS RECEIVING TUBE DEVELOPMENT ENGINEERS
RESEARCH AND DEVELOPMENT ENGINEERS

You are invited to become part of CBS Electronics new expansion program. CBS Electronics, with research, development, and semiconductor manufacturing facilities in Lowell, Massachusetts . . . situated along the scenic North Shore . . . now offers ground floor opportunities to qualified personnel. At CBS Electronics, you become associated with some of the finest scientific minds in the fields of solid state semiconductors.

1959 college graduates in the fields of electronics, chemical and mechanical engineering are also invited to apply.

Call collect or write Mr. Robert D. Harding, Personnel Supervisor and send resume . . .

ELECTRON TUBES
CBS
SEMICONDUCTORS

CBS ELECTRONICS
900 Chelmsford Street
Lowell, Massachusetts
GLenview 4-0446

(CBS Electronics — A Division of Columbia Broadcasting System, Inc.)

CIRCLE 913 ON CAREER INQUIRY FORM

PHILCO

FAMOUS FOR QUALITY THE WORLD OVER

has immediate opportunities for Electronic Engineers & Scientists

IN PHILADELPHIA, PA.

COMMUNICATIONS SYSTEMS
Systems Analysis, UHF & VHF Development, Receivers & Transmitters
Transistorization, Microwave Development, Telemetering
Pulse Circuit Techniques, IF & Video Circuitry, Miniaturization

WEAPONS SYSTEMS & RADAR
Advanced Systems, Systems Analysis, Guidance & Navigation
Radar Development, Data Transmission, Display Development
Missile Fuzing, Aerodynamics, Applied Mechanics

ELECTRONIC DATA PROCESSING
Product Planning, Systems Analysis, Memory Development
Input and Output, Test & Evaluation, Production Engineering
Programming, Field Service Engineers, Instructors & Writers

Send Confidential Resume to Mr. J. R. Barr, Engineering Employment Manager

PHILCO Government and Industrial Division
4780 Wissahickon Avenue, Philadelphia 44, Pa.

CIRCLE 914 ON CAREER INQUIRY FORM

Sales Engineers

Openings In:
BOSTON, SYRACUSE, ST. PAUL, LOS ANGELES, SAN DIEGO, PHOENIX

Exceptional opportunities in field sales are available to individuals with electrical or electronic engineering background.

Due to our rapid expansion program, we are opening field sales offices in Boston, San Diego and Phoenix. We also need men for our offices in Syracuse, Los Angeles and St. Paul. The positions will involve technical and purchasing contact with equipment manufacturers.

Our products are exclusively semiconductor components, including transistors, rectifiers and diodes. As one of the largest manufacturers in this young and rapidly growing field, there are unlimited opportunities for professional growth. Salaries are attractive; vacation, insurance, and retirement benefits are liberal.

A letter or call to our Director of Technical Placement will be held in strict confidence.

Transitron electronic corporation
Wakefield, Mass. CRystal 9-4500

CIRCLE 915 ON CAREER INQUIRY FORM

Engineers and scientists return to the midwest

. . . where there's time and opportunity to enjoy yourself while climbing to the top in the field you like best.

The fish are biting in Minnesota. One of our fellows in the infra-red lab caught a 8¾-pound walleye opening day—on the Lake of the Woods. He used a minnow and June bug spinner. His little boy pulled in 10 crappies. Some of our fellows take their families camping nearly every weekend—up along the north shore of Lake Superior. Great country, this Minnesota. You should be here—with your wife and children—and you can be . . .

The Research and Engineering Laboratories at the Mechanical Division of General Mills—in Minneapolis—need senior level staff members for creative design, research and development work in the following fields:

- Electronic Circuit Design
- Micro-wave Development
- Atmospheric Physics
- Digital Computer Logic
- Field Engineering
- Advanced Digital Computer Systems Design
- Advanced Digital Computer Circuit Development
- Advanced Pulse and Video Circuit Development
- Advanced Inertial Navigational System Development
- Applied Mechanics
- Optical and Infra-Red Equipment Engineering
- Research Physics

Positions available are for purely technical and technical-supervisory work—job titles and salary provide equal opportunity for advancement in both. Our people enjoy their associates, liberal company benefits and non-routine projects, as evidenced by our extremely low turnover rate.

If you have from three to five years experience in any of the above fields we'd like to tell you more about opportunities at General Mills. Send today for all the facts. We'll keep your inquiry in strict confidence.

GMI • GMI • GMI • GMI • GMI • GMI • GMI • GMI • GMI • GMI • GMI • GMI • GMI • GMI • GMI

MECHANICAL DIVISION General Mills

G. P. Lambert, Manager
Professional Employment
Personnel Department

2003 E. Hennepin, Minneapolis 13, Minnesota

CIRCLE 916 ON CAREER INQUIRY FORM

Systems
Electronic / *Engineers*
Mechanical

NEWS OF ENGINEERING OPPORTUNITIES

OPEN ON MOST "TALKED ABOUT"

MISSILE OF THEM ALL

POLARIS

...and other diverse and complex weapons projects at General Electric's Ordnance Department in the Berkshires*

When the first operational Polaris missiles are installed in the "George Washington" —first atomic submarine specifically designed as floating platform for the Navy's undersea-launched IRBM s—it will be a day of great moment for the engineers and scientists at General Electric's Ordnance Department, who are now pouring their energies, imagination and technical skills into the development, design and production of Polaris Fire Control and Inertial Guidance Systems.

A day of celebration—but also one that ushers in new and other challenging problems—for the push to develop the next generation of long-range underwater ballistic missiles and kindred advanced weapons and weapon systems will be on.

There are openings now for engineers (*EEs or MEs*) with two to seven years' experience in these areas:

SYSTEMS DEVELOPMENT / SYSTEMS DESIGN OR EVALUATION
FIRE CONTROL ENGINEERING / INERTIAL COMPONENT DESIGN / COMPUTER DEVELOPMENT
ELECTRONIC CIRCUIT DEVELOPMENT / STRUCTURAL DESIGN AND VIBRATIONS
FIELD SERVICE & EVALUATION / QUALITY ASSURANCE & RELIABILITY ENGINEERING
ELECTRO-MECHANICAL DESIGN / ADVANCED PRODUCTION ENGINEERING
ELECTRICAL DISTRIBUTION SYSTEMS ENGINEERING / PLANT FACILITIES ENGINEERING
PRODUCT SERVICE INSTRUCTION / PRODUCT PLANNING / SALES ENGINEERING
CONTRACT ADMINISTRATION / TECHNICAL WRITING

Field Test Engineering (Florida, California and several naval stations in continental U.S.)
Also technician openings for graduates with missile experience

Write in strict confidence to: Mr. R. O'Brien, Dept. 76-SMC
Ordnance Department of the Defense Electronics Division

GENERAL ELECTRIC

100 Plastics Avenue, Pittsfield, Mass.

* **Additional Projects Under Investigation at the Ordnance Department.** Urgent, vital and engrossing as the Department's share in the Fleet Ballistic Missile Program is, it is just one of the diverse activities here that today offer engineers a progression of challenging assignments on: **Atlas Guidance Equipment • Talos Handling and Launching Equipment • Advanced Torpedo Development • Tartar Fire Control**

CIRCLE 917 ON CAREER INQUIRY FORM

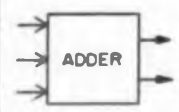
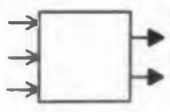
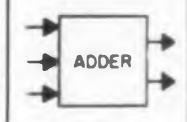
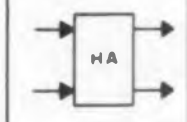
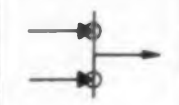
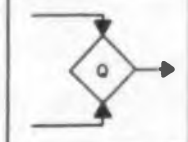
BOOKS

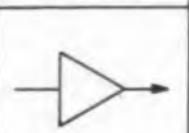
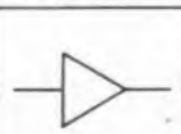
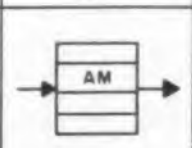
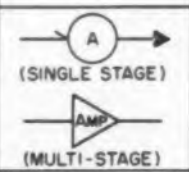
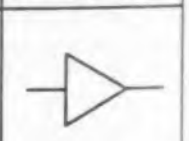
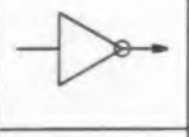
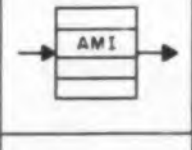
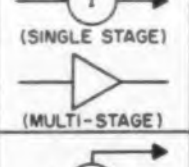
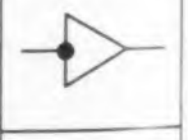
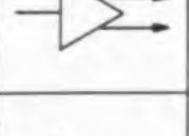
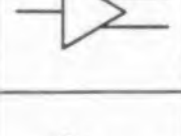
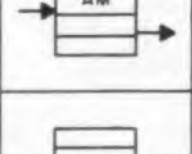
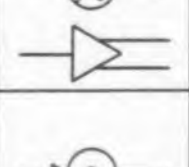
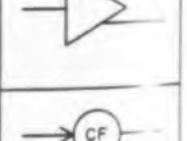
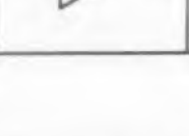
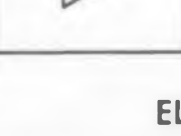
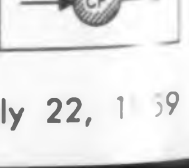
The Language and Symbology of Digital Computer Systems

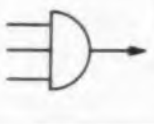
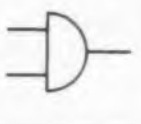
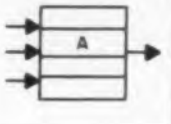
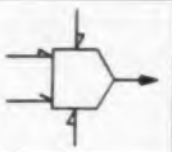
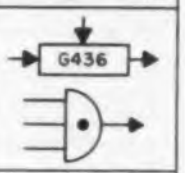
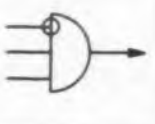
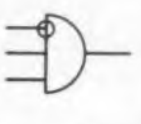
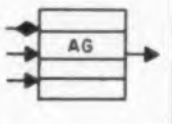
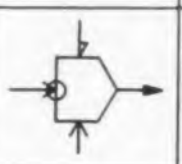
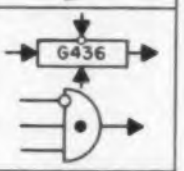
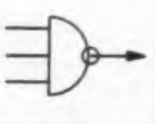
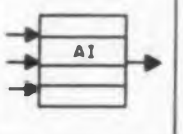
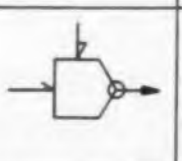
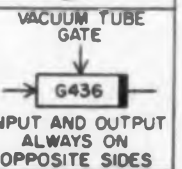
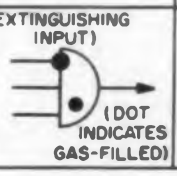
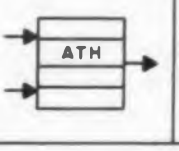
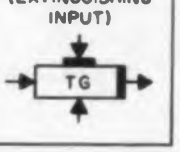
RCA Service Company, Government Service Department, (Bldg. 210) Camden 8, N.J. 114 pp, $2.00.

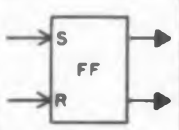
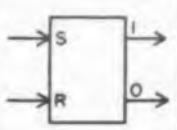
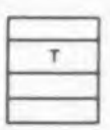
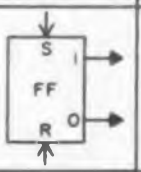
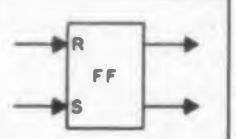
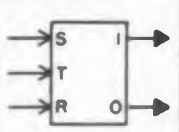
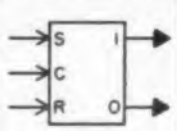
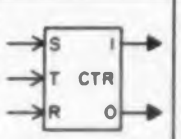
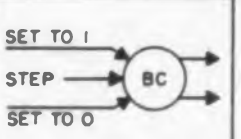
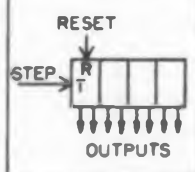
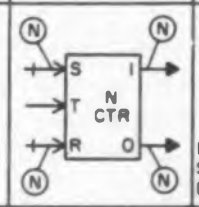
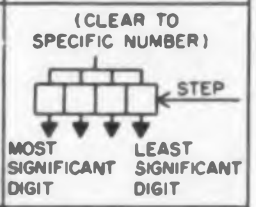
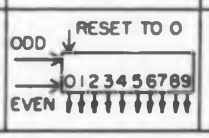
This textbook on the basic principles, language and characteristics of electronic computers is a convenient reference for engineering, administrative and training personnel in industry and the military. Explaining many of the basic characteristics of computers, the book discusses Boolean algebra in practical terms, and contains a cross reference of logic diagrams and symbols used by various computer manufacturers and a dictionary of computer terminology.

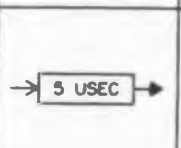
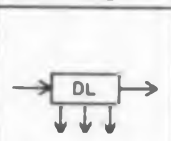
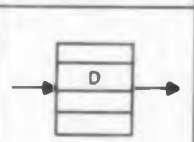
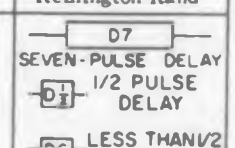
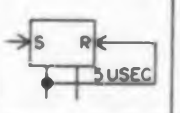
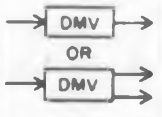
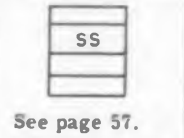
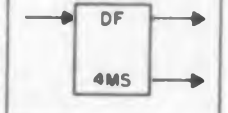
Pages 35-42 of the cross reference charts are reproduced here through permission of the publishers.

	Preferred	Burroughs	IBM	RCA	Remington Rand
	See Detailed Notes, Pages 26 to 34.	See Detailed Notes, Pages 44 to 48.	See Detailed Notes, Pages 49 to 58.	See Detailed Notes, Pages 58 to 66.	See Detailed Notes, Pages 66 to 71.
Adder					
Adder, Half					
Adder, Quarter (Exclusive OR) (AND-NOT)					

	Preferred	Burroughs	IBM	RCA	Remington Rand
Amplifier (No inversion)					
Amplifier, With inverted output					
Amplifier, With multiple outputs					
Cathode Follower					

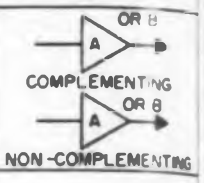
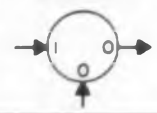
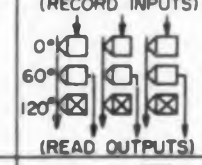
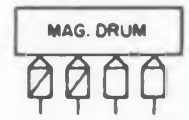
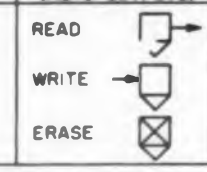
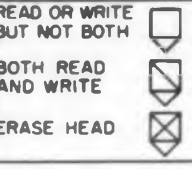
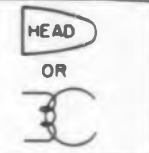
	Preferred	Burroughs	IBM	RCA	Remington Rand
AND Gate					
AND Gate, With inhibiting input					
AND Gate, With inverted output					
AND Thyratron					

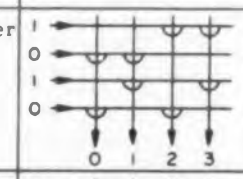
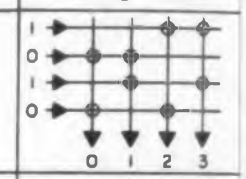
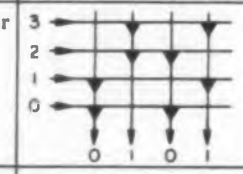
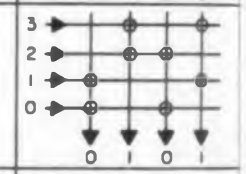
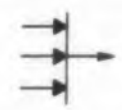
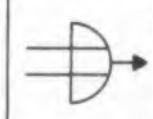
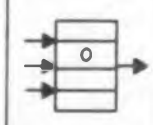
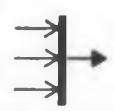
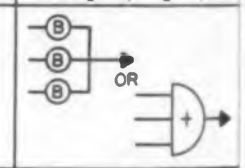
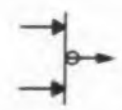
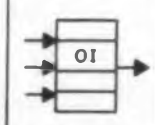
	Preferred	Burroughs	IBM	RCA	Remington Rand
Binary (Flip-Flop) (Toggle)					
Counter, Binary					
Counter, Binary Multistage					
Counter, Multiposition					

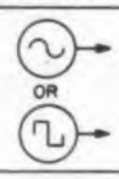
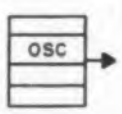
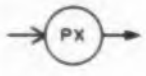
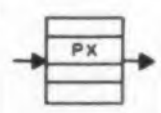
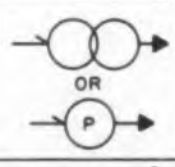
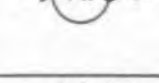
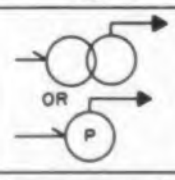
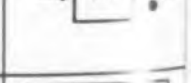
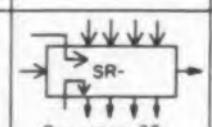
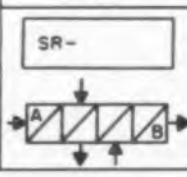
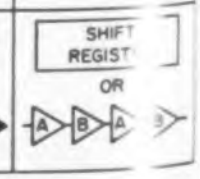
	Preferred	Burroughs	IBM	RCA	Remington Rand
Delay Line					
Delay, Flip-Flop					
Delay, Logical					
Inverter					

(Continued on following page)

BOOKS

	Preferred	Burroughs	IBM	RCA	Remington Rand
Magnetic Amplifier	 See page 29 for details.				
Magnetic Core, Binary	 See page 29 for details.	See pages 46 and 47. 			
Magnetic Drum					
Magnetic Head					

	Preferred	Burroughs	IBM	RCA	Remington Rand
Matrix, Decoder					
Matrix, Encoder					
OR Circuit					
OR Circuit, With inverted output					

	Preferred	Burroughs	IBM	RCA	Remington Rand
Oscillator					
Pulse Transformer (Without inversion)					
Pulse Transformer (With inversion)					
Shift Register	 See page 33 for details.				

Feedback Control Systems

J-C[illegible]ille, M. J. Pelegrin, P. Decaulne, McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y., 793 pp, $16.50.

Written by three French engineer-scientists, this book provides a synthesis of the most important servo problems by uniting in a single book the overall theory (linear and nonlinear) and the components of servo systems. It explains in a progressive and coherent manner how a servo system can be systematically designed.

Although the subject matter is presented in a coherent sequence, it can be roughly divided into two categories: material constituting a consistent textbook in the basic theory of servomechanisms; and material constituting additional data and particular or more advanced methods. The chapters which fall into the first category are essentially concerned with frequency-response methods for linear systems and describing-function analysis for nonlinear systems. The remainder of the book deals with other problems and approaches.

In the part of the book devoted to theory an attempt is made to tie together the different methods available, to show the relations that exist between them and to discuss their respective advantages. In dealing with components an attempt is made to consider them systematically as components of a whole system and to discuss their properties from the influence they have on the overall system performance.

Recent French and Soviet materials are used extensively in the detailed study of nonlinear servo problems. Two of the most important recent advances which appear in English for the first time in this work are: the rigorous method for determining the self-oscillations and forced oscillations of an on-off servo; and an original method which will enable the designer to meet the specifications more closely than before when choosing a servo-motor.

Other special topics, many of which are also appearing in English for the first time in this work include: structural stability; transient response of servo with any nonlinear system on the verge of instability; forced oscillations of nonlinear servos; Liapunov's direct method; and describing function with statistical input.

A distinguished feature of this work is that the philosophy and technique of presentation are European rather than American. More than average attention is given to the pure and applied mathematics underlying modern automatic-control theory and to the physical limitations of their use. A large number of illustrative problems are included as well as a five-language glossary of automatic control terms with lucid notes explaining German and Russian concepts.

The critical bibliography at the end of the volume is arranged according to subject matter and lists many European references not known to the American public. Every book or article mentioned as a reference is followed by a few lines which summarize the general approach and the most important subjects covered.

Analytical Transients

T. C. Gordon Wagner, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 202 pp, $8.75.

This book represents the means of acquiring the more advanced mathematical knowledge necessary for a greater understanding of network analysis, Fourier series, and the Laplace transformation. An elementary acquaintance with all these subjects is presumed.

Network analysis is presented in a general manner, then studied in detail. Much of the discussion in the book is devoted to the Laplace transformation in order to provide a substantial idea of the subject as a whole, and to convey the sense of balance needed to perceive the limitations and applications of this calculus. The treatment of Fourier series and integrals establishes a logical basis for the Laplace transformation; a thorough consideration is given to the convergence of the series, the sampling theorems, and Gibbs phenomenon.

An especially significant chapter concerns the behavior of linear systems of differential equations and the influence of discontinuous driving functions upon their solutions. In the section on stability, a general application of Sturm's and Routh's theorems is supplied. Prof. Wagner has included some applications of the Laplace transform to the solutions of the partial differential equations of transmission lines.

The V-Shaped Inclined Antenna

ALL HIGH-efficiency in-phase and rhombic antennas used for short wave transmission require high towers. These are rather difficult to construct. If simplicity and mobility of the antenna become decisive factors, it is necessary to use the less efficient Vee antenna, which needs only one high tower for mounting.

Such an antenna is shown in Fig. 1. For convenience, it will be designated in the form $VH(L/H)2\phi_0$ where L is the length of the antenna in meters, H the height of the tower in meters, and $2\phi_0$ is the angle between the projections of the wires on the horizontal plane (aperture angle).

Such an antenna radiates (and accordingly, receives) both a normally (horizontally) polarized field, and a parallel (vertical) polarized field. Assuming ideal ground conductivity, the equation for the horizontal directivity pattern of a Vee antenna with normal polarization is

$$E_h(\Delta, \phi) = -\frac{30 I_0}{R}\cos\psi' e^{-i\alpha R} \times \left\{\sin(\phi-\phi_0)\left[\frac{e^{-i\alpha\delta_1 L}-1}{\delta_1} - \frac{e^{-i\alpha\delta_2 L}-1}{\delta_2}e^{-2i\alpha H\sin\Delta}\right] - \sin(\phi+\phi_0)\left[\frac{e^{-i\alpha\delta_3 L}-1}{\delta_3} - \frac{e^{-i\alpha\delta_4 L}-1}{\delta_4}e^{-2i\alpha H\sin\Delta}\right]\right\}. \quad (1)$$

where α is the wave number, I_0 the amplitude of the current in the wire, ϕ the azimuth angle, measured from the bisectrix of the aperture angle, Δ the elevation angle, Ψ the angle between the horizontal plane and the plane of the wires, Ψ' the angle between an antenna wire and the horizontal plane, and

$$\delta_1 = 1 - \cos\Delta\cos\psi\cos(\phi-\phi_0) - \sin\Delta\sin\psi,$$
$$\delta_2 = 1 - \cos\Delta\cos\psi\cos(\phi-\phi_0) + \sin\Delta\sin\psi,$$
$$\delta_3 = 1 - \cos\Delta\cos\psi\cos(\phi+\phi_0) - \sin\Delta\sin\psi,$$
$$\delta_4 = 1 - \cos\Delta\cos\psi\cos(\phi+\phi_0) + \sin\Delta\sin\psi. \quad (2)$$

The directivity pattern in a vertical plane passing through the bisectrix of the angle between the antenna wires ($\phi = 0$) can be found by simplifying eq (1) as follows

$$E_v(\Delta, \phi) = -\frac{120 I_0}{R}\cos\psi'\sin\phi_0 e^{-i\alpha R} \times \sqrt{\frac{\sin^2\frac{\alpha\delta_1}{2}L}{\delta_1^2} - 2\frac{\sin\frac{\alpha\delta_1}{2}}{\delta_1}\frac{\sin\frac{\alpha\delta_2}{2}L}{\delta_2}}$$

$$\cos(\alpha H\sin\Delta) + \frac{\sin^2\frac{\alpha\delta_2}{2}L}{\delta_2^2}. \quad (3)$$

Fig. 1. The Vee antenna. W represents the wave impedance.

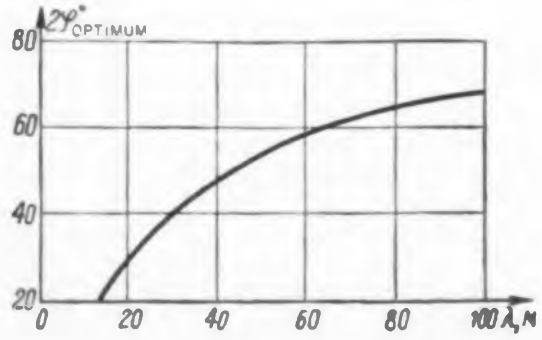


Fig. 2. The optimum aperture angle varies with wavelength.

The formula for the directivity pattern of the parallel (vertical) component of the field is

$$E_v(\Delta, \phi) = -\frac{30 I_0}{R}e^{-i\alpha R}\left\{p_1\frac{e^{-i\alpha\delta_1 L}-1}{\delta_1} - p_3\frac{e^{-i\alpha\delta_3 L}-1}{\delta_3} + R_\beta e^{-2i\alpha H\sin\Delta}\left[p_2\frac{e^{-i\alpha\delta_2 L}-1}{\delta_2} - p_4\frac{e^{-i\alpha\delta_4 L}-1}{\delta_4}\right]\right\}, \quad (4)$$

where

$$p_1 = \cos\Delta\sin\psi' + \sin\Delta\cos\psi'\cos(\phi-\phi_0),$$
$$p_2 = \cos\Delta\sin\psi' - \sin\Delta\cos\psi'\cos(\phi-\phi_0),$$
$$p_3 = \cos\Delta\sin\psi' + \sin\Delta\cos\psi'\cos(\phi+\phi_0),$$
$$p_4 = \cos\Delta\sin\psi' - \sin\Delta\cos\psi'\cos(\phi+\phi_0), \quad (5)$$

Eq (1) to (4) show that, at low elevation angles, the antenna will essentially radiate a horizontally polarized field. At large elevation angles, the intensity of radiation (or reception) will be of the same order of magnitude for both polarizations.

The gain of such an antenna relative to a half wave dipole in free space is given by the formula

$$\epsilon = 0.365\cos^2\psi'\sin^2\phi_0 e^{-\beta L} \times \left[\frac{\sin^2\frac{\alpha\delta_1}{2}L}{\delta_1^2} - 2\frac{\sin\frac{\alpha\delta_1}{2}L}{\delta_1}\frac{\sin\frac{\alpha\delta_2}{2}L}{\delta_3} \cos(\alpha H\sin\Delta) + \frac{\sin^2\frac{\alpha\delta_2}{2}L}{\delta_2^2}\right]_{\Delta=\Delta'}. \quad (6)$$

where Δ' is the elevation angle of the direction of

the maximum field strength, and

$$\beta L = \frac{R\Sigma}{2W}, \tag{7}$$

accounts for the attenuation in the antenna current through radiation. ($R\Sigma$ is the radiation resistance of the wire and W the wave resistance of the antenna beam). Neglecting the effect of the earth and the mutual coupling between the wires, we can write

$$R\Sigma = 60\,(\ln 2\alpha l - \mathrm{ci}\,2\alpha l + \frac{\sin 2\alpha l}{2\alpha l} - 0.423). \tag{8}$$

and W can be assumed to be 400 ohms. The efficiency of the antenna then becomes

$$\eta = 1 - e^{-2\beta L}, \tag{9}$$

and the directivity coefficient becomes

$$D = \frac{1.64\,\epsilon}{\eta}. \tag{10}$$

An examination of eq (6) shows that a certain optimum angle exists for each wavelength. This is illustrated by Fig. 2. In view of the great range of variation in the angle (by almost a factor of four) no one antenna can cover the entire short wave range and retain a high gain.

It is therefore necessary to use several antennas, arranged as shown in Fig. 3. Fig. 4 shows the directivity pattern of a *VH*(200/20) 20 antenna in the range from 12 to 75 meters for the normal component of the field in the vertical plane (φ=0) and over a conical surface (Δ = 10 deg).

Fig. 5 shows the data for the antenna *VH* (200/20) 40 (aperture angle doubled). Fig. 6 shows the gain obtained at the longer waves by using a *VH* (200/20) 60 antenna. The gains of these three antennas are shown in Fig. 7.

It is readily seen that the efficiency of an antenna increases with the height of the tower and with the length of the wire. In practice it is difficult to use towers higher than 20 meters and wires longer than 200 meters.

To cover the entire short-wave range from 12 to 100 meters it becomes necessary to use compound antennas of the type shown in Fig. 3. In this case the gain of the antenna approaches the optimum, shown dotted in Fig. 7. Theoretical and experimental investigations have shown that the individual wires of a compound antenna interfere little with each other.

Abstracted from "V-Shaped Inclined Antenna" by V. G. Yampol'skiy, which appeared in Elektrosvyaz (Electrical Communications), No. 4, April 1959.

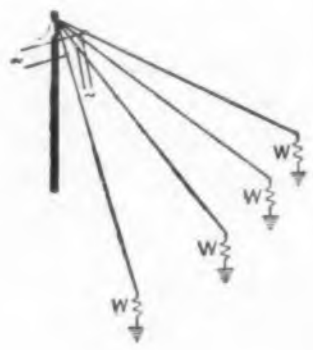


Fig. 3. An array of several antennas can cover the entire short wave range.

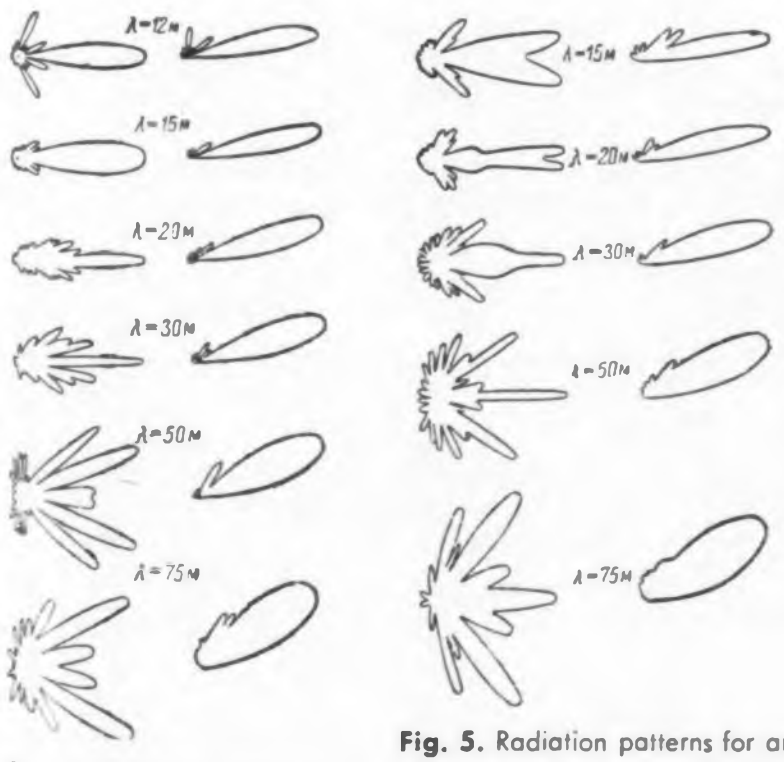


Fig. 4. Radiation patterns for a *VH*(200/20)20 antenna operating at wavelengths from 12 to 75 meters.

Fig. 5. Radiation patterns for an antenna like the one used for Fig. 4, except that the aperture angle is doubled. The antenna is a *VH*(200/20)40.

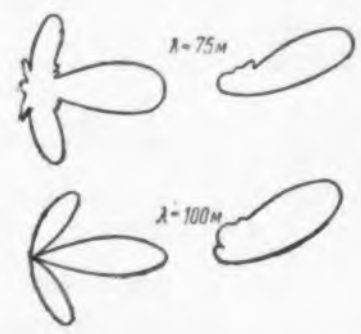


Fig. 6. Radiation patterns for a *VH*(200/20)60 at the longer wavelengths.

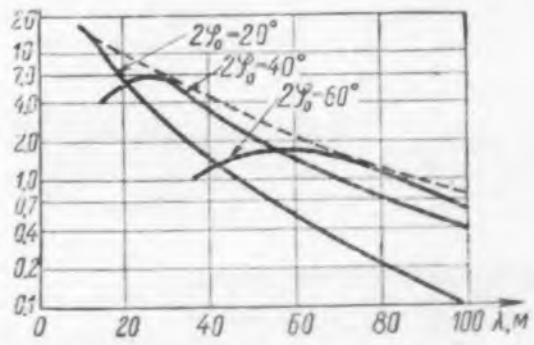


Fig. 7. Gains of antennas with different aperture angles.

GERMAN ABSTRACTS

E. Brenner

Shot Noise in VHF Tubes

CONSIDERABLE differences between measured and theoretical shot noises are occasionally observed in vhf triodes. Experimental investigation reveals that the noise in such tubes consists of two components, one of which is frequency dependent and the other frequency independent. The frequency independent contribution to the noise is the component which corresponds to the space charge reduced shot noise current while the frequency dependent component is attributed to flicker noise.

The mean-squared space charge reduced short circuit shot noise current in a triode is given by

$$I^2_a = F^2\, 2e\, I_a\, \Delta\, F \qquad (1)$$

where the space charge reduction factor F^2 is independent of the bandwidth and is given by Rack's formula[1]

$$F^2_a = 6(1 - \pi/4)(KTS)/e\sigma I_a) \qquad (2)$$

For ideal space charge limited triodes, the mutual conductance S is proportional to the cube root of the plate current.

The conclusions stated above were deduced from two sets of measurements, one at 420 kc, the other at 94.4 mc, so that transit time effects were

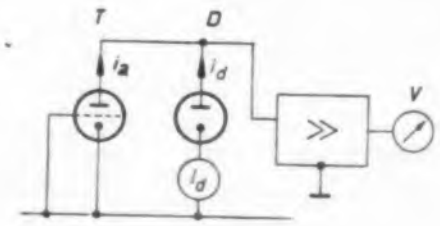


Fig. 1. Measurement scheme

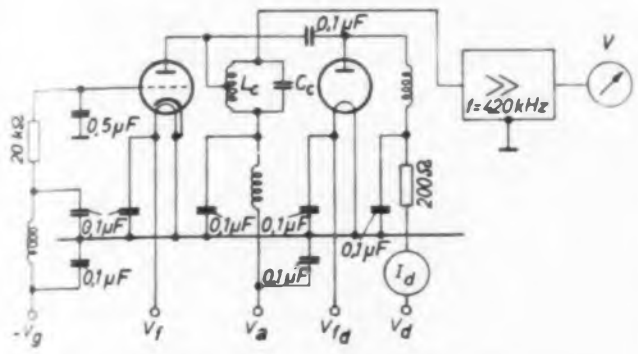


Fig. 2. Amplifier input circuit for the 420 kc tests

negligible. In the experiment, tube T (see Fig. 1) with grid at rf ground, is connected in parallel with a noise diode D, across the input of a linear amplifier-square law detector-voltmeter cascade. The amplifier noise is calibrated out and the equivalent diode noise current I_d, which corresponds to the noise of T, is measured. Since $I_d = F^2$, it is independent of amplifier bandwidth. The circuit details for the two frequencies are shown in Figs. 2 and 3.

From the experiments, it is concluded that for some tube types $I_d = I_{d1} + I_{d2}$ where I_{d1} is frequency independent and increases as the (1/2.6) power of the tube current while I_{d2} decreases with increasing frequency. Since I_{d2} is approximately proportional to the square of the tube current, it is attributed to the flicker effect.

Abstracted from an article by R. Thielert, Nachrichtentechnische Zeitschrift, *Vol. 12, No. 4, April 1959, pp 201-203.*

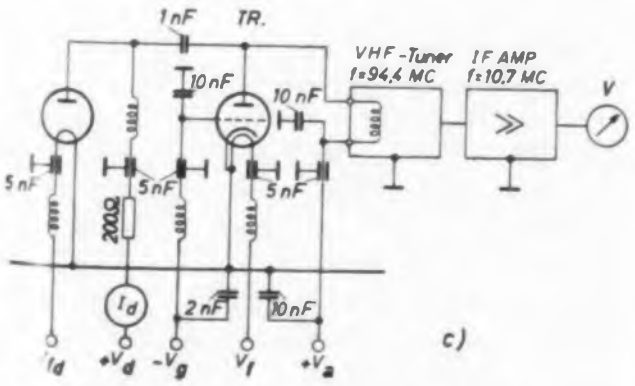


Fig. 3. Amplifier input for the 94.4 Mc tests.

1. Bell Syst. Tech., Journal 17, 1938, p 592.

GERMAN ABSTRACTS

E. Brenner

Shot Noise in VHF Tubes

CONSIDERABLE differences between measured and theoretical shot noises are occasionally observed in vhf triodes. Experimental investigation reveals that the noise in such tubes consists of two components, one of which is frequency dependent and the other frequency independent. The frequency independent contribution to the noise is the component which corresponds to the space charge reduced shot noise current while the frequency dependent component is attributed to flicker noise.

The mean-squared space charge reduced short circuit shot noise current in a triode is given by

$$I^2_a = F^2\, 2e\, I_a\, \Delta\, F \qquad (1)$$

where the space charge reduction factor F^2 is independent of the bandwidth and is given by Rack's formula[1]

$$F^2_a = 6(1 - \pi/4)(KTS)/e\sigma I_a) \qquad (2)$$

For ideal space charge limited triodes, the mutual conductance S is proportional to the cube root of the plate current.

The conclusions stated above were deduced from two sets of measurements, one at 420 kc, the other at 94.4 mc, so that transit time effects were

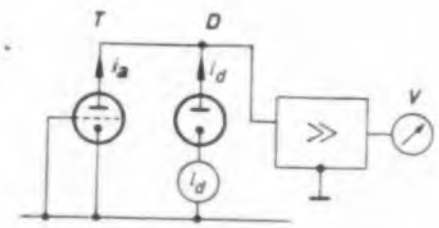


Fig. 1. Measurement scheme

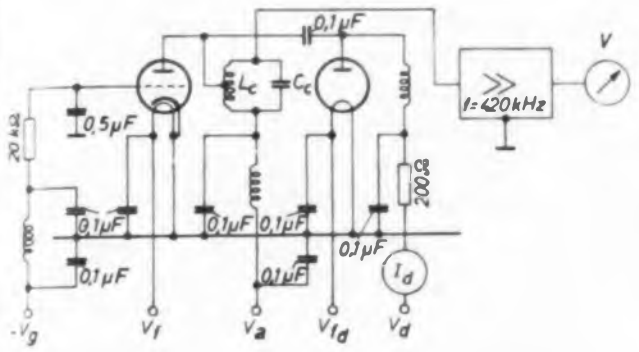


Fig. 2. Amplifier input circuit for the 420 kc tests

negligible. In the experiment, tube T (see Fig. 1) with grid at rf ground, is connected in parallel with a noise diode D, across the input of a linear amplifier-square law detector-voltmeter cascade. The amplifier noise is calibrated out and the equivalent diode noise current I_d, which corresponds to the noise of T, is measured. Since $I_d = F^2$, it is independent of amplifier bandwidth. The circuit details for the two frequencies are shown in Figs. 2 and 3.

From the experiments, it is concluded that for some tube types $I_d = I_{d1} + I_{d2}$ where I_{d1} is frequency independent and increases as the (1/2.6) power of the tube current while I_{d2} decreases with increasing frequency. Since I_{d2} is approximately proportional to the square of the tube current, it is attributed to the flicker effect.

Abstracted from an article by R. Thielert, Nachrichtentechnische Zeitschrift, *Vol. 12, No. 4, April 1959, pp 201-203.*

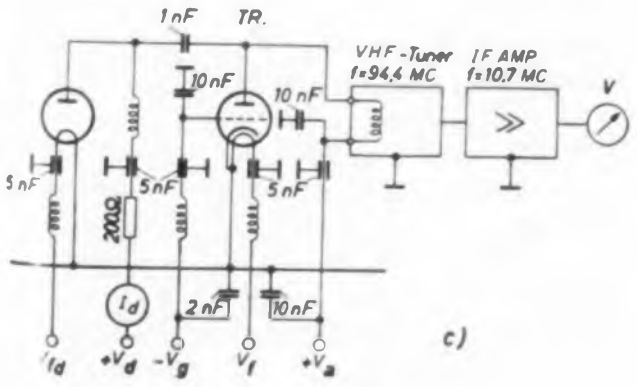


Fig. 3. Amplifier input for the 94.4 Mc tests.

1 Bell Syst. Tech., Journal 17, 1938, p 592.

REPORT BRIEFS

Standards And Test Procedures For Printed Circuits

This report describes a program of research and development which facilitated the preparation of military specifications for multiple-contact printed circuit connectors. In addition, the initial phases of a similar program on printed circuit component-lead-terminations are described; this program was subsequently cancelled. Comprehensive questionnaires concerning the field performance of printed circuit connectors and terminations and laboratory techniques for testing them were distributed nationally to commercial firms. Results from these questionnaires were used in planning the laboratory phases of the program. Samples of multiple-contact connectors suitable for incorporation in printed circuit assemblies were purchased from representative manufacturers. These were evaluated in the laboratory and specification limits were derived from their performance. In turn, these limits were incorporated into two tentative military specifications for printed circuit connectors. Where existing methods of testing connectors were not adequate to fully evaluate printed circuit connectors—which are unique in some respects—new, more suitable, test procedures were developed. The properties most important for printed circuit connectors used in military equipment were established. The specifications prepared contain a test procedure and a quality assurance limit for each such property. *Preparation Of Standards And Test Procedures For Printed Circuits, C. A. Dodge, S. E. Graf, and W. W. Hansen, Stanford Research Institute, Menlo Park, Calif., Oct. 1958, 119 pp, $2.50. Order PB 131983S from OTS, Department of Commerce, Washington 25, D. C.*

Broad Band Traveling Wave Tube

The basic design objectives and the related technical problems are outlined. Three tube design approaches, designated as types A, B, and C, were studied to determine the best compromise in design toward meeting the objectives. Type A design favors flat gain and broad band characteristics more than low noise; type C design emphasizes low noise characteristics; and type B is a compromise between those two designs. The design features and the measured performance characteristics of all three tube types are given. *Development Of Low Noise, Broad Band Traveling Wave Tube, Leslie D. Kovach, Radio Corporation of America, Harrison, N.J., June 1954, Jan. 1957, 55 pp, Microfilm $3.60, Photocopy $9.30. Order PB 136480 from Library of Congress, Washington 25, D. C.*

Electronic Equipment Failures

Forty-two published reports of the Evaluation Branch were examined, and the failures reported therein were statistically analyzed. The equipment covered a wide range of function, and included radar sets, radio receivers and transmitters, sonar equipment, IFF coders, oscilloscopes, and power supplies. The relative frequency of occurrence of 28 common categories of failure was plotted as a bar graph. The largest category encountered consisted of instances of inadequate electronic design which were easily detectable with a minimum of instrumentation, and should have been corrected prior to submission of the equipment for evaluation. A second large category was poor design of operating controls, indicating a need for human engineering in the design of electronic equipment. *Statistical Analysis Of Electronic Equipment Failures and Evaluation, R. J. Steelman, Navy Electronics Laboratory, San Diego, Calif., Feb. 21, 1955, 20 pp, Microfilm $2.40, Photocopy $3.30. Order from PB 139043 from Library of Congress, Washington 25, D. C.*

Field Emission Cathodes

Improved stability of operation of the field emission cathode is essential before this electron source can be effectively utilized in practical devices. Methods are described for greatly improving stability by avoiding changes in surface electric field and work function. Experimental testing of fixed voltage operation of a cold tungsten emitter has been extended beyond 3000 hr. In other cases, current drift rates less than 5 per cent per hr of operation have been observed over several hundred hours at currents of the order of 10^{-4} amp. Comparable improvement during repetitive, microsecond, pulsed operation at pulse currents up to 0.1 amp has been demonstrated. Techniques have included careful vacuum practice, envelope material nearly impervious to atmospheric gases, and thoroughly degassed refractory metal anodes shaped to minimize impingement of secondary electrons on tube envelopes. A second field of study has been the electrochemical behavior of refractory metals applied to the fabrication of field emitters. Formation and dissolution of oxide layers are believed to have a major influence on surface smoothness and emitter geometry. Useful results of this study are an automatically controlled method of emitter shaping and a means of removing material uniformly from small parts such as miniaturized cathode structures. *Research On Field Emission Cathodes, E. E. Martin, H. W. Pitman, Linfield Research Inst., McMinnville, Oreg., Sept. 1956-1957, 69 pp, $1.75. Order PB 151552 from OTS, Washington, D. C.*

Transistor Heat Dissipators

International Electronic Research Corporation

Burbank, Calif.—Transistors which generate heat must be applied so that the heat which they generate is dissipated to an ultimate heat sink. This heat must be dissipated at a rate fast enough so that the junction temperature is not exceeded.

Since there are no exceptions to this requirement it is necessary to consider, in the initial equipment design stages, a method for dissipating the heat from the transistor.

Dissipators which operate on the radiation and convection cooling principle require an amount of area depending on the power being dissipated by the transistor.

There are also no exceptions to this requirement. However, the area necessary to dissipate the heat being generated can take many forms other than a flat metal plate. Because of the small size of power transistors, it is desirable to have its dissipator as small and compact as possible.

After one and one-half years of research and development, IERC has developed dissipators for power transistors which are efficient and most compatible in size and shape to conform with packaging requirements.

The first series of dissipators which have been thermally evaluated, and now available, are designed to fit any power transistor in a TO-3 case. These dissipators are in the form of vertical fins and are available in various heights. A TO-3 germanium type transistor with a maximum junction temperature of 90°C can be operated at only 2½ watts when no means of dissipating its heat is provided. This same transistor can be operated at 10 watts when using a 3" dissipator mounted to a small 2" x 2" aluminum plate.

IERC test report #114 is available upon request. This report contains 12 sets of curves relating junction temperature to wattage while the transistor is mounted to various size dissipators. Tests are under way on other types of transistors and other types of heat dissipators. Test reports on these will be available upon completion of tests.

(Advertisement)

REPORT BRIEFS

SHF-Band Traveling Wave Tube

This report describes the development of a 100 w, S-band traveling wave amplifier operating over the 2000 mc to 4000 mc frequency band. The tube utilizes a lightweight periodic permanent magnet for electron beam focusing and is therefore, suitable for airborne applications. The design of the helix, coaxial line-to-helix couplers, electron gun, attenuator, and periodic magnet is presented. The mechanical construction and processing of the tube is also described. *Development of 100 Watt SHF-Band Traveling Wave Tube, Weislaw W. Siekanowicz and George Novak. Radio Corporation of America, Harrison, N.J., Apr. 1958, 79 pp, Microfilm $4.50, Photocopy $12.30. Order PB 137201 from Library of Congress, Washington 25, D. C.*

High-Level Single-Sideband Generation

A transmitter has been constructed which incorporates the latest work on the high-level system and includes completely automatic tuning. The principal aims in constructing this transmitter have been those of improving the performance of the system and simplifying its design and operation. *Advanced Engineering Research Study Of Methods And Equipment For High-Level Single-Sideband Generation, J. F. Honey, D. K. Reynolds, and D. K. Weaver, Jr., Stanford Research Inst., Calif, June 1950, July 1951, 198 pp, Microfilm $8.70, Photocopy $30.30. Order PB 137200 from Library of Congress, Washington 25, D. C.*

Frequency Limitations of Distributed Amplifiers

The prescription of the series inductance together with a practical coefficient of coupling, limits the negative mutual inductance which can be reflected into the grid and plate leads. This paper shows that an optimum compromise in the interest of bandwidth exists between the ideas of a small series inductance and a substantial mutual inductance. An additional complication in the conventional circuit is that the minimum physical spacing between tubes determines a minimum practical series inductance for the lines. *Some Useful Techniques For Overcoming The Frequency Limitations Of Conventional Distributed Amplifiers, P. H. Rogers, University of Michigan, Ann Arbor, Nov. 1956, 27 pp, Microfilm $2.70, Photocopy $4.80. Order PB 136292 from Library of Congress, Washington 25, D. C.*

Tapped Delay-Line Filters

A method of synthesizing a matched filter is developed through the use of the sampling theorem. This method makes use of tapped ideal delay lines together with lowpass filters and adding circuits to form both the matched filter and the matched signal generator. Theoretically this method permits the use of any finite bandwidth and finite time duration signal as the matched signal. The selection of matched signals is discussed in terms of the requirements on the matched signal itself. *Experimental Study Of Tapped Delay-Line Filters, D. W. Lytle, Stanford Electronics Laboratories, Stanford University, Calif., July 30, 1956, 84 pp, Microfilm $4.80, Photocopy $13.80. Order PB 138269 from Library of Congress, Washington 25, D. C.*

Feedback Amplifier Design

It is shown that by introduction of unilateral forward equivalent circuit representations the analysis of feedback amplifiers is greatly simplified. Typical shunt-, series-, and shunt-series-feedback circuits are investigated, with examples from vacuum tube narrow band amplifiers and transistor video amplifiers. Furthermore it is shown that by introduction of reciprocal forward equivalent circuit representations, a direct synthesis procedure of active networks is made possible. This procedure is not restricted by frequency dependence of the active element or network configuration. *Feedback Amplifier Design By Forward Equivalent Circuits, L. M. Vallese, Microwave Research Inst., Polytechnic Institute of Brooklyn, N.Y., Sept. 5, 1957, 47 pp, Microfilm $3.30, Photocopy $7.80. Order from PB 136276 from Library of Congress, Washington 25, D. C.*

Effects of Noise On Range Tracking Systems

A mathematical analysis has been made on a radar tracking system, with position memory, to determine the deterioration in the operation when noise is present in the system. Mathematical equations have been developed relating the probability of not losing the target in the presence of noise and the various parameters of the tracking unit. These equations were developed for two cases: (1) when the signal is completely faded and the target is stationary, (2) when the signal is completely faded and the target is moving with some constant velocity. *Effects Of Noise On Range Tracking Systems, Jack Ruina, Microwave Research Inst., Polytechnic Inst. of Brooklyn, N. Y. June 13, 1951, 26 pp, Microfilm $2.70, Photocopy $4.80. Order PB 137043 from Library of Congress, Washington 25, D. C.*

REPORT BRIEFS

Silicon Transistor

Objectives attained within the work scope of the contract have made possible the solving of many of the technical problems involved in the development of silicon semiconductor devices. This has confirmed the assumption that these devices can be produced eventually in production quantities at a consistently high quality level. A summary of work carried on in the areas of theory, research and development is presented. *Silicon Transistor, S. Barnes, M. Becker and others, Hughes Aircraft Co., Culver City, Calif., Sept.-Oct. 1953, 172 pp, Microfilm $8.10, Photocopy $21.30. Order PB 137354 from Library of Congress, Washington 25, D. C.*

Miniature Power Transformers

This report covers investigations of certain capabilities and limitations of miniature power transformers designed for 1000 hr minimum life at 200 C ambient temperature. This contract extension explores the extreme potentials of these transformers, the maximum life expectancy at 200 C ambient temperature, the maximum ambient temperature that could be employed without sacrifice of a 1000-hr life, and the capability of operating at altitudes up to 70,000 ft instead of 10,000 ft. *Miniature Power Transformers Having Wide Temperature Range, L. W. Kirkwood, Bell Telephone Laboratories, Inc., New York, Sept. 1957, 153 pp, Microfilm $7.50, Photocopy $24.30. Order PB 136722 from Library of Congress, Washington 25, D.C.*

X-Band Traveling-Wave Tubes

This is the final report under Contract AF 33 (600)-8375. It summarizes the program of research, study, and development of broadband traveling-wave amplifier tubes in the frequency range from 7500 to 11,300 mc. The basic objective of this contract has been the extension of the frequency range and the increase of the power output which may be obtained from tubes in this band. The report summarizes the various steps through which the development has progressed in arriving at final production type designs for four different X-band traveling-wave tubes. *Development of X-Band Traveling-Wave Tubes, J. N. Lenker, J. L. Peck, and F. Astorino, Federal Telecommunication Laboratories, Nutley, N.J., Jan. 1958, 156 pp, Microfilm $7.50, Photocopy $24.30. Order PB 136473 from Library of Congress, Washington 25, D.C.*

Voltage-Sensitive Elements

Research was conducted to determine the effects of hf and lf vibration, mechanical shock, and constant-acceleration forces on the physical and electrical properties of fixed and variable resistors, thermistors, and voltage-sensitive elements. The effects of the applied forces were evaluated in terms of the changes occurring in the specimens' mechanical and electrical properties. Forces of lf vibration, mechanical shock, and constant acceleration caused no physical failures and produced only minor changes in the mechanical and electrical properties of all the specimens. Hf-vibration forces caused mechanical failures in four of the six specimen categories. The most detrimental frequency in the range from 55 to 2000 cps was that at which the specimen resonated with the maximum amplitude of motion; the condition usually occurred at the lowest resonant frequency. For the variable resistors, transient electrical-resistance changes were observed during mechanical resonance. *Component Evaluation and Specification Engineering: Task XXV, High and Low and Voltage-Sensitive Elements, E. G. Lebre and P. G. Perry, Battelle Memorial Institute, Columbus, Ohio, Sept. 1955, 82 pp, Microfilm $4.80, Photocopy $13.80. Order PB 136294 from Library of Congress, Washington 25, D.C.*

Folded Loop Antenna

A study is being conducted to find a means for tuning the antenna by flexing or telescoping the loop in addition to varying the gap capacitance, in order to maintain a wide bandwidth as the center frequency is changed. *Experimental Folded Loop Antenna, J. F. Cline, G. H. Robinson, University of Michigan, Ann Arbor, Nov. 1956, 26 pp, Microfilm $2.70, Photocopy $4.80. Order PB 135358 from Library of Congress, Washington 25, D. C.*

Military Color Television

The need for a good practical military color television system is emphasized and discussed. The technical possibilities and limitations of color television systems, in general, are discussed. The more important types of color systems are outlined, with emphasis on motion-detection limitation. A superior color television system for general military application is outlined, which is suitable for use with or without optical amplification. *Military Color Television System Usable With Optical Application, R. D. H. Gebel, Aeronautical Research Laboratory, Wright Air Development Center, Wright-Patterson AFB, Ohio, Apr. 1958, 12 pp, $0.50. Order PB 151586 from OTS, Washington 25, D.C.*

REPORT BRIEFS

C-Band Klystron

A series of experimental C-band klystron oscillator tubes, resonator test apparatus, and an electron-gun tester were designed, manufactured, and tested. Fourteen tube models were designed according to floating-drift-tube-klystron theory, and nine tubes were completed to the point of producing useful rf output power. The characteristics and electrical performance of all tubes manufactured during the development program are reported in detail, and cross-sectional drawings of the various models are included. A new and original principle of klystron operation was devised and employed in one experimental model known as the reflex floating-drift-tube klystron. The resonator test apparatus provided a means of investigating the resonant frequency of the floating-drift-tube resonator and a number of other important characteristics, including the figure of merit. The gun tester provided accurate information regarding the beams produced by convergent-flow electron guns. Several of the tubes developed during the reported program fulfilled a portion of the objective performance specifications, and the work described by this report indicates that further development of the floating-drift-tube klystron will result in a tube that will fulfill all objective specifications with the exception of efficiency. *Development of C-Band Klystron, W. H. Thon, Electronic Defense Lab., Inc., Mountain View, Calif., Sept. 1958, 90 pp, $2.25. Order PB 151332 from OTS, Department of Commerce, Washington 25, D.C.*

Sinuate Antenna

The purpose of the work described here was to conduct a theoretical and experimental investigation of the far zone radiation patterns of a planar, sinuate, filamentary antenna mounted parallel to and one quarter wavelength away from a ground plane. Free space wavelength is measured at a frequency of 9.0 kmc. Theoretical computations were made of the far zone radiation vector components of the two basic elements of the antenna, a one-half wavelength dipole and a semicircular bend of two wavelength circumference. The calculations were based on the assumptions of an unattenuated standing wave current distribution and a phase velocity along the filament equal to the velocity of light. *Sinuate Antenna, H. K. Macomber, Electronics Research Lab., University of California, Berkeley, Sept. 1957, 37 pp, Microfilm $3.00, Photocopy $6.30. Order PB 136273 from Library of Congress, Washington 25, D.C.*

Phase Delay in a Radome Wall

The purpose of the report is to describe the development of an instrument suitable for accurate measurements of relative changes in electrical thickness. The theory of operation as developed shows that the electrical thickness and effective dielectric constant are functions of the reflected phase and amplitude of a radome. The automation of the device and the prescribed calibration and measurement procedure permit use of the instrument as specified, while the technique developed and information gained provide the basis for the use of the reflection measurements for quality control of production radomes. *Instrumentation For The Determination of Phase Delay In A Radome Wall, B. Carpe, Dalco Victor Co., Belmont, Calif., Oct. 1958, 31 pp, $1.00. Order PB 151549 from OTS, Department of Commerce, Washington 25, D.C.*

Secondary Emission Pulse Circuit

A regenerative pulse circuit is described which uses a single EPF 60 thermionic secondary emission tube (made by Phillips in Holland) that can generate pulses with a 6 mμsec rise time and a continuously variable width from 25 mμsec to 12 μsec. A circuit analysis wherein expressions are derived for pulse width and resolving time is followed by various practical circuit realizations which include a millimicrosecond pulse generator and a fast-pulse-height discriminator. The analysis showed that the ratio between the saturation current and the product of total capacitance times the grid-voltage interval between saturation and cutoff represent a figure of merit for how well a vacuum tube will perform in a switching circuit. The analysis suggested that the loop gain equals unity at the points from which jumps take place. *Secondary Emission Pulse Circuit, Its Analysis and Application, J. A. Narud, Cruft Lab., Harvard U., Cambridge, Mass., Apr. 1957, 43 pp, Microfilm $3.30, Photocopy $7.80. Order PB 136042 from Library of Congress, Washington 25, D.C.*

Impulse Noise Generator

The development of an impulse noise generator, capable of being used as a standard for noise figure measurements of system, more specifically radar receivers, is discussed. The complete system is outlined in block diagram form. The component parts are considered in detail and evaluated, and finally, results are presented and recommendations made. *Impulse Noise Generator, Empire Devices, Inc., Bayside, N.Y., Apr. 1954-June 1956, Microfilm $3.00, Photocopy $6.30. Order PB 136232 from Library of Congress, Washington 25, D.C.*

SERVICES FOR DESIGNERS

Custom Coated Products

A custom fabricator of pressure-sensitive adhesive coatings and coated products, New Rochelle Coating Corporation specializes in formulating special coatings, and designing and producing coated products, to meet customer job specifications.

With the installation of a pressure-sensitive coating machine capable of handling a web of material over 5 ft wide, the company is equipped to offer a full range of custom fabrication services to the trade.

In a single continuous operation, the company's new 80-ft machine, applies an adhesive coating, then dries, laminates, slits and winds the web. Its 62-in. web width permits continuous production runs of extremely large pieces. Among the materials the machine can process in volume quantities are vinyl, acetate, oilcloth, oilsilk, Mylar, polyurethane foam and film, metal foil and paper.

For R & D work and formulation of new coatings and products, the company maintains complete lab facilities. For pilot or limited production, the company has a small coating machine accommodating a 10-in. material web. For volume production needs, the large new machine is available.

New Rochelle Coating Corp., Dept. ED, 15 River St., New Rochelle, N.Y.

CIRCLE 119 ON READER-SERVICE CARD

Ultrasonic Machining

Ultrasonic grinding and machining of production quantities of hard and brittle materials such as glass, quartz and carbides, is being offered by Precision Glass Products Co. Since the method of machining is non-thermal, non-electrical, and non-chemical, there is no change in the chemical, metallurgical or physical properties of the material during or after machining. The method assures maximum uniformity in production quantities of a component containing a complex or intricate shape. Some of the operations performed include: drilling—blind, through or tapered and as small as 0.006 in. diam; multiple drilling of holes in one operation even with different diameters; precision, multiple slicing of material into wafers as little as 0.015 in. thick with little material waste; machining to tolerances of as little as 0.0005 in. or better and surface finishing to 10 micro in.

Bulletin UG559 describing products machined by this method and type of savings resulting is available upon request.

Precision Glass Products Co., Dept. ED, 6138-40 Beechwood St., Philadelphia 38, Pa.

CIRCLE 120 ON READER-SERVICE CARD

Electron Tube News
—from SYLVANIA

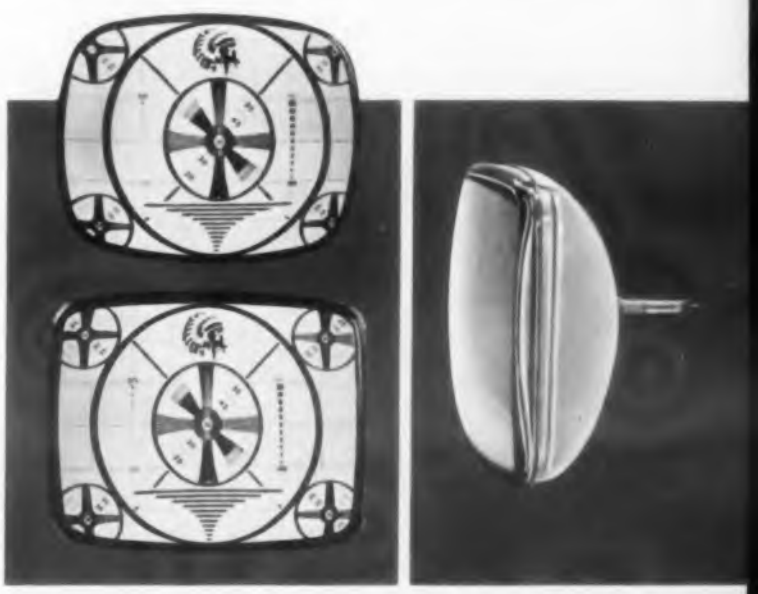
Designing for extra reliability—everywhere in Electronics

TELEVISION...

New bonded-shield picture tube squares away the TV screen, increases viewing area, reduces reflection, improves light output and picture clarity

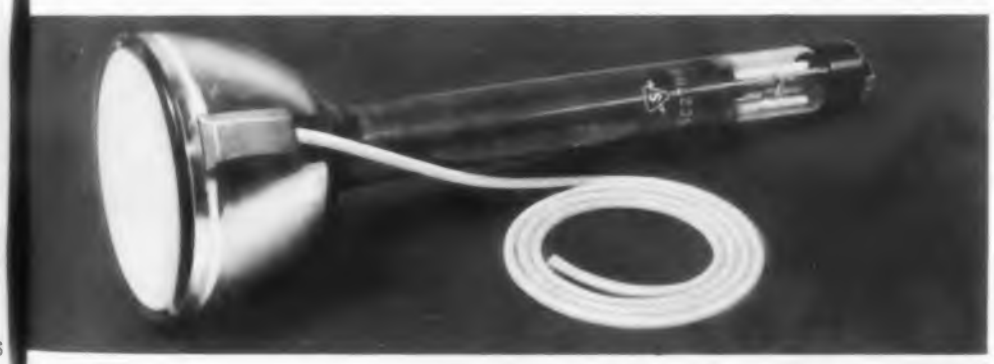
TV design engineers can now take advantage of one of the first major improvements in television faceplate design since the rectangular screen ... the Sylvania bonded-shield picture tube. It incorporates a built-on panel of safety glass that makes the traditional separate safety glass unnecessary and opens the way to exciting new possibilities in TV cabinet design. It allows substantial reductions in both cabinet dimensions and cost. And because it reduces reflection, increased light output and clearer TV pictures result.

The squared away corners of the new bonded-shield picture tubes add approximately 20 square inches to the viewing area of a 21-inch screen. The 23-inch tube presents more of the picture as the camera sees it. The new bonded-shield picture tubes are available in 18″ and 23″ sizes (diagonal measurement) with conventional or Sylvania tripotential focus electron guns.



New Sylvania bonded-shield picture tube shows more picture than the conventional 21″ tube

INDUSTRIAL & MILITARY CATHODE-RAY TUBES...



New Sylvania high resolution CRT, type SC2782

Sylvania develops ultrahigh definition CRT for photo video recording in aerial reconnaissance and other applications where high resolution is necessary

All of the precision qualities of specialized fine spot CRT's are now available to design engineers in a new 5-inch CRT with a definition range of 3,000 lines. Through rigid selection techniques, greater accuracy controls, new fine grain phosphors and optical quality faceplate, Sylvania CRT engineers have been able to achieve this extremely fine definition using standard CRT auxiliary components and design. The new tube has an operating voltage of 20 to 25 KV. It incorporates an anode lead that is potted on the side of the tube to prevent corona and permit high-altitude applications. The tube has standard basing and a 6.3 V standard heater. It is available now for sampling through your Sylvania equipment representative or government office.

Sylvania is actively engineering CRT's with even greater resolutions —up to 6,000 lines—to meet the ever increasing needs of the armed forces and industry. We will welcome the opportunity to discuss your specific applications problems with you and to explore custom design possibilities to meet your needs. Contact your Sylvania representative or the factory directly today.

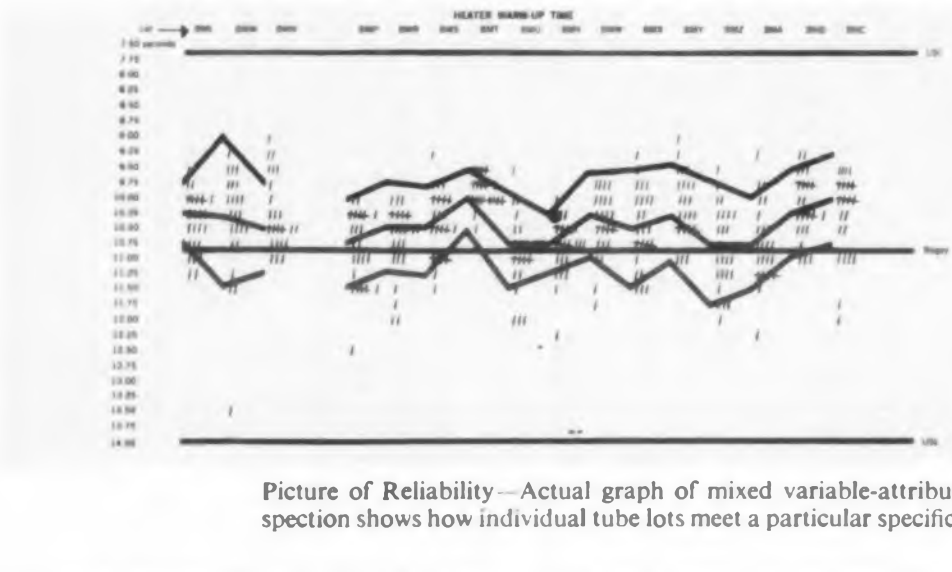
New design of standard 3-inch oscilloscope tube

Improved Sylvania oscilloscope CRT, type 3ASP1

Oscilloscope designers can obtain all the advantages of present 3-inch oscilloscope CRT's plus these added features with the new 3ASP1:

- **Improved faceplate—**
  Flat pressed type gives greater clarity —less distortion.
- **Better Insulation—**
  Anode connection located on side to prevent possible arcing.
- **Conventional basing—**
  Standard CRT stem and base is used.

Sylvania sets a new GOLD



Picture of Reliability—Actual graph of mixed variable-attribute inspection shows how individual tube lots meet a particular specification

New variables inspection procedure gives a quantitative picture of the reliability of each important characteristic in Gold Brand Tubes

A new measure of reliability is being extended to Sylvania Gold Brand Tubes. Developed by the Sylvania quality control department, it provides the design engineer with a true, measurable profile of the operating dependability of individual tube lots.

The new testing procedure—known as Mixed Variables—Attributes Inspection involves the recording of each characteristic reading, as opposed to ordinary go no-go testing by attributes. If the readings fall within the closely established acceptance limits, the tube passes the new testing procedure, otherwise it is rejected.

The new procedure not only provides Sylvania tube-design engineers with invaluable data for product improvement but allows Sylvania to provide the design engineer with tubes that more exactly fit his application needs.

Sylvania develops new specifications for Gold Brand Industrial and Commercial Types to meet the specialized needs of jet airliners, commercial prop-driven aircraft, executive aircraft, mobile radio, marine radio and industrial control equipment

Now designers of electronic equipment for commercial and industrial applications can specify tubes that are tailored to meet their specific requirements. Sylvania has developed a line of 47 commercial industrial Gold Brand types, that are identified with a GB prefix. This is the mark of a Gold Brand tube specifically designed to meet commercial and industrial application requirements. Specialized specifications are already written for more than half of the GB line and eventually all 47 will be covered. These new GB specifications tailor military standards to the individualized requirements of commercial and industrial equipment. In many cases, the GB specifications exceed previously known requirements.

In every case, specification of Gold Brand Types provides the very highest degree of reliability and performance.

For example, type GB5751, a high mu double triode (9 pin miniature) meets a tougher AC Gain Test than the comparable military type. While the military type is tested to a 100 V supply, the supply for GB5751 is only 65 V. This provides extra assurance that the tube will operate effectively with a low voltage supply such as is used in fuel gauge circuits—the GB5751 also meets life test conditions that are more severe than the military.

Another example of a Gold Brand Industrial and Commercial type with specifications that exceed comparable military requirements is type GB5749. This semi-remote cutoff pentode (7-pin miniature) can withstand a 165°C maximum bulb temperature and is tested to lower grid emission minimums. This again is extra assurance the tube will perform reliably under high temperature conditions that may exist in today's high speed industrial and commercial electronic equipment.

Jet Age Choice—Sylvania Gold Brand tubes—Over 27 Sylvania types are in use in Pan American Boeing 707 Jet Airliners

GOLD BRAND standard

Sylvania Gold Brand Industrial and Commercial tubes have become one of the fastest growing tube lines in the electronics industry. Today every major airline uses Sylvania Gold Brand tubes. And in the new jet airliners, where the demand for top performance and reliability is more than ever a critical necessity, Sylvania Gold Brand types are becoming the leading choice. On Pan American's Boeing Jet 707 Airliners over 27 Sylvania types are in daily use.

Here are some of the tests that every Gold Brand tube must pass: Multiple Life Tests ranging from 500 to 1000 hours, Impact Shock Tests of up to 500 G, Fatigue Tests of 96 hours at 2.5 G, Vibration Tests, Glass Strain Tests, Variable Control Tests and Special Interface Control Tests are underway. And Gold Brand tubes must meet stringent electrical test requirements. Shorts and continuity are controlled to a 0.4% AQL and major electrical characteristics are controlled to a 0.65% AQL.

GOLD BRAND Guided Missile Types— Reliability in the Atomic Age

The electronic equipment in today's missiles, drones and aircraft must have the capability to withstand some degree of nuclear radiation if it is to meet realistic military operational requirements. Preliminary tests have already indicated Sylvania Gold Brand Guided Missile tubes have an immunity to radiation that solid-state devices tested do not exhibit.

The reliability of Sylvania's Gold Brand Guided Missile Line is outstanding because of the way it is manufactured and tested. The entire line undergoes Sylvania's exclusive White Noise Test which subjects each type to a vibrational spectrum covering the frequency band of 100 to 5,000 cps. The rms G-level is 2-3 G's per octave with peak G-level of 15 G's. The tubes are also tested for rms and peak vibrational output and limits are established on each.

SYLVANIA GOLD BRAND
Reliable Commercial and Industrial Types

Type	Description	Use
GB-OA2WA	Cold cathode diode	Voltage regulator
GB-OB2WA	Cold cathode diode	Voltage regulator
GB-5Y3WGTA	Double diode	Rectifier
GB-6AU6WB	Sharp cutoff pentode	Amplifier
GB-6J4WA	Hi mu triode	Grounded grid amplifier
GB-6SJ7WGT	Sharp cutoff pentode	Amplifier
GB-6SL7WGT	Hi mu double triode	Amplifier
GB-6SN7WGT	Medium mu double triode	Amplifier
GB-6X4WA	Double diode	Rectifier
GB-6X5WGT	Double diode	Rectifier
GB-7AK7	Dual control pentode	Computer
GB-7F8W	High mu double triode	Amplifier
GB-28D7W	Double beam pentode	Power amplifier
GB-407A	Medium mu double triode	Amplifier
GB-408A	Sharp cutoff pentode	Amplifier
GB-1216	Medium mu double triode	Computer
GB-1217	Dual control pentode	Computer
GB-5654	Sharp cutoff pentode	Amplifier
GB-5670	Medium mu double triode	Amplifier
GB-5725	Dual control pentode	Gated amplifier, converter
GB-5726	Double diode	Detector
GB-5727	Tetrode thyratron	Relay, grid controlled rectifier
GB-5749	Semi-remote cutoff pentode	Amplifier
GB-5750	Dual control heptode	Gated amplifier converter
GB-5751	High mu double triode	Amplifier
GB-5814A	Medium mu double triode	Amplifier
GB-5930	Low mu triode	Power amplifier
GB-5931	Double diode	Rectifier
GB-5932	Beam pentode	Power amplifier
GB-5933	Beam pentode	Power amplifier
GB-5963	Medium mu double triode	Computer
GB-5964	Medium mu double triode	Computer
GB-5965	Medium mu double triode	Computer
GB-6005	Beam Pentode	Power amplifier
GB-6101	Medium mu double triode	Oscillator-amplifier
GB-6135	Medium mu triode	Oscillator-amplifier
GB-6145	Dual control pentode	Computer
GB-6186	Sharp cutoff pentode	Amplifier
GB-6189	Medium mu double triode	Oscillator-amplifier
GB-6201	High mu double triode	Amplifier
GB-6211	Medium mu double triode	Computer
GB-6350	Medium mu double triode	Computer
GB-6814	Triode	Computer
GB-6888 (Mil)	Dual control pentode	Computer
GB-7044	Medium mu double triode	Computer
GB-7137	Medium mu triode	Grounded grid amplifier
GB-7327	Medium mu double triode	Pulse Applications

The Sylvania Gold Brand Guided Missile Line

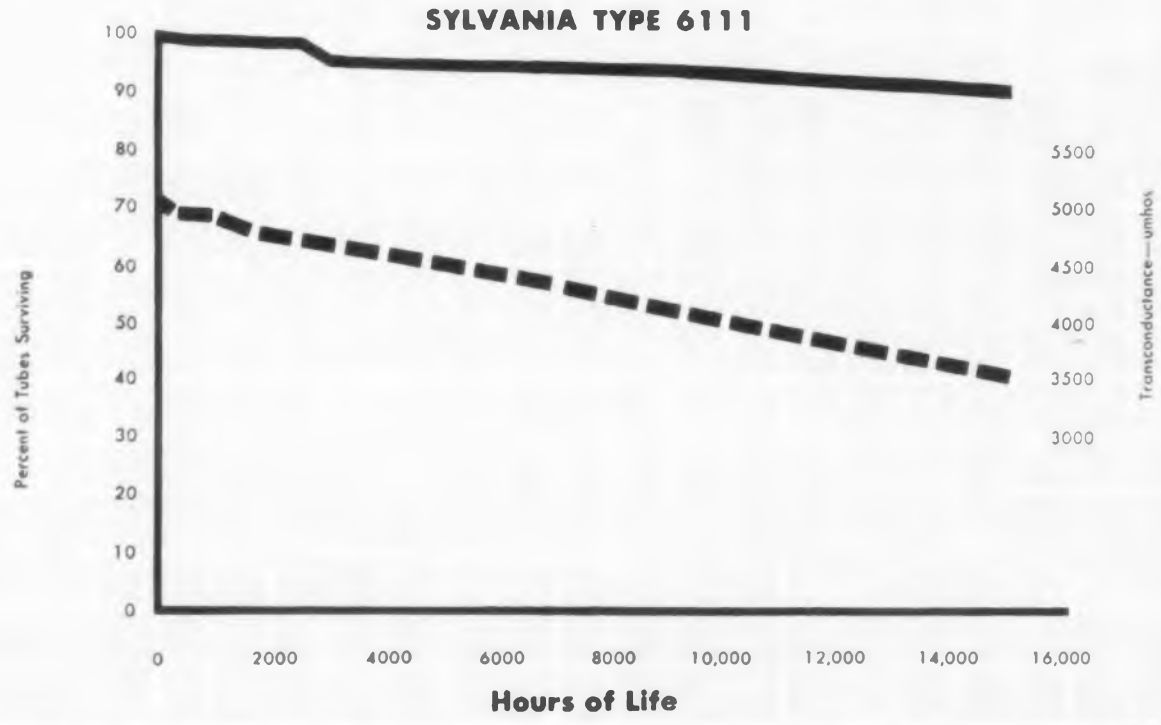
Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 2833 Sec. 34.9 P.L.&R., Buffalo 9, N.Y.

SYLVANIA ELECTRIC PRODUCTS INC.
1100 Main St.
Buffalo 9, N.Y.



New test results show the outstanding capability of premium Gold Brand subminiature tubes

SYLVANIA TYPE 6111
Observed Survival Curve For Inoperatives Thru 15,000 Hours
Median For Transconductance Thru 15,000 Hours

GOLD BRAND Subminiatures—Reliability Plus

Life tests on Gold Brand premium subminiature tubes set new records of reliability

Unprecedented testimonial to the reliability of Sylvania Gold Brand Subminiatures is indicated by the results of new life tests on the tubes. They exhibit a mean time between inoperative failure of 133,000 hours. Life tests conducted for 15,000 hours on twenty lots of tubes show an average decline in Gm of only 2.4% per 1,000 hours. Inoperatives in these life tests exhibited a failure rate of 0.66% per 1,000 hours during the first 3,000 hours of operation and 0.75% per 1,000 hours during the following 12,000 hours.

SYLVANIA
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
P. O. Box 1190, Station "O," Montreal 9

Please send additional information on the items checked below:

- ☐ New Bonded Shield Picture Tube
- New Industrial & Military CRT's:
- ☐ Type SC2782
- ☐ Type 3ASP1
- ☐ Gold Brand Industrial and Commercial Types
- ☐ Gold Brand Guided Missile Types
- ☐ Gold Brand Premium Subminiatures

Name_____

Address_____

Company_____

Use this handy business reply card to request additional information on these important new Sylvania developments

A TYPICAL BEKEY CUSTOM MOTOR DESIGN PROJECT

BEKEY Custom 120-pole hyspersyn® motor drives new Genisco precision centrifuge

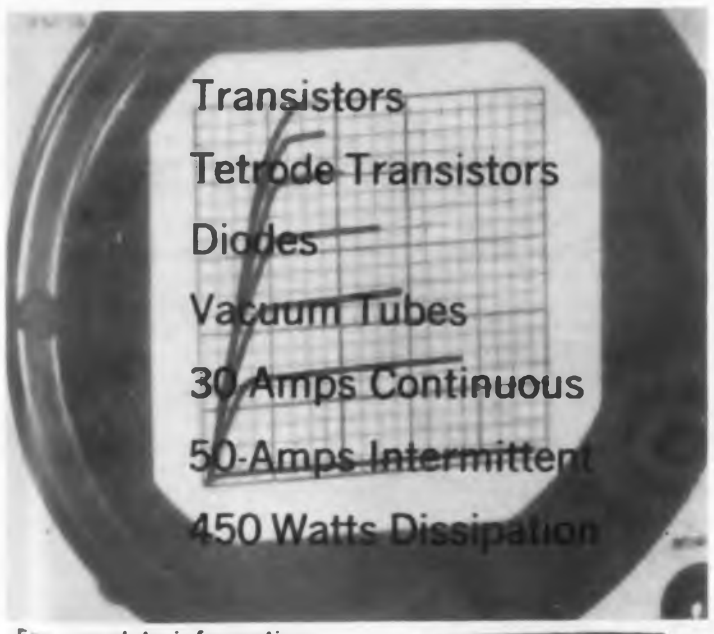
To attain desired accuracies, angular velocity of the Genisco A931 Centrifuge must be constant to 1 part in 50,000. To get this constancy, Genisco uses a Bekey 120-pole, three phase, *hys*teresis motor with induction start and *per*manent magnet excitation for *syn*chronous operation.

Bekey specializes in highly efficient, custom rotating equipment. Motors and generators can be designed to operate on any frequency, voltage or speed; in any ambient; and can be built in any shape. No requirement too specialized or small. Custom *Hyspersyn* motors, 75% to 90% efficient, can be delivered in 60 days with *no charge for tooling!* Inquire today!

BEKEY CUSTOM MOTORS
Bekey Division Genisco, Inc.
2233 Federal Avenue
Los Angeles 64, Calif.

CIRCLE 123 ON READER-SERVICE CARD

NEW CURVE TRACER with Tube Adapter



For complete information write for bulletin #TT108.

Baird Atomic

Baird-Atomic, Inc.
33 UNIVERSITY RD
CAMBRIDGE 38, MASS

Visit B/A booth at WESCON, Aug. 18-21

CIRCLE 124 ON READER-SERVICE CARD

Miniature P-W Boards Offered

Miniature printed wiring boards that have the characteristics of a reliable plated-through hole are being offered by the Photocircuits Corp.

Using a plating technique that allows sufficient copper in the holes without land pattern on either side, the minifying technique produces these characteristics:

- Minimum .0015 fine-grained ductile copper.
- Reliable interface plating on both sides.
- Thermal and mechanical shock resistance (MIL-E-5272A).
- Good "wicking" action during dip soldering.

The major advantages of the process is that the barrels of holes are used for solder joints, and therefore, with no pads to take up space, lines can be moved closer together. This results in substantial increase in component density.

Photocircuits is now quoting pilot quantities and filling prototype requirements.

Photocircuits Corp., Dept. ED, 31 Sea Cliff Ave., Glen Cove, N.Y.

CIRCLE 125 ON READER-SERVICE CARD

Waveguide Bends, Twists and Transitons

Manufacturers of microwave components and assemblies may use Intaspace Corporation as a source for the production of waveguide bends, twists, and transitions. This new corporation is manned by specialists who will devote their energies exclusively to waveguide bending and forming. Modern techniques and facilities are available. All machines have been especially designed to produce waveguide bends and twists to meet the most exacting mechanical and electrical tests.

Intaspace Corp., Dept. ED, 135 Orange St., Bloomfield, N.J.

CIRCLE 126 ON READER-SERVICE CARD

Systems Research

A new systems research activity has been announced by the Defense and Technical Products Div. of Rheem Mfg. Co. One principal approach to be used by the activity is applied research in the mathematical phase of complex problems. The new group is planning to eliminate this error of human perception through the use of digital computer techniques in association with special analog circuits. These approaches will be proved on a general purpose computer installation prior to building special equipments.

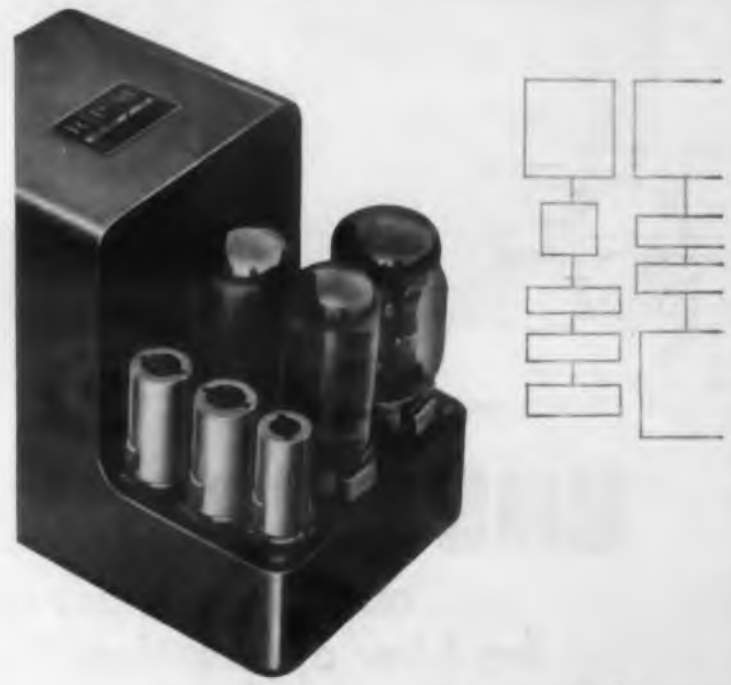
Defense and Technical Products Div., Rheem Mfg. Co., Dept. ED, La Jolla, Calif.

CIRCLE 127 ON READER-SERVICE CARD

here's a complete element of your block diagram... now readily available

R|P|M*

*REGULATED POWER MODULE



All design, development and production work has been completed for you in these RPM power modules. Buy them as catalog items, and get these advantages:

Wide choice of overlapping adjustable voltage and current ranges—125 to 425 volts...50 to 400 milliamps.

Excellent regulation—0.05% NL to FL, or 10% line change.

Compactness—RPM units are custom designed and built with our own transformers for most efficient use of space.

Super-rugged construction includes one-piece, cast aluminum housings and JAN hardware. RPM modules can be mounted in **any** position.

High reliability—achieved by use of top quality components throughout, and rigid inspection during production.

Request ACDC Bulletin 400.

ACDC **ELECTRONICS, INC.**
2979 N. Ontario St., Burbank, Calif.
Formerly NYT ELECTRONICS, INC.

CIRCLE 128 ON READER-SERVICE CARD

NEW LITERATURE

Capacitors 130

Wet-electrolyte sintered-anode tantalum capacitors are described in bulletin 3710A, eight pages. Included are the catalog numbering system, standard ratings, dimensional data, characteristic curves, and performance information. The "cup" type 131D and 132D units, covered in the bulletin, replace the older type 104D design. Sprague Electric Co., 347 Marshall St., North Adams, Mass.

Subminiature Switches

Subminiature switches that meet military specifications for a wide variety of uses are described in catalog 159, 16 pages. Data is provided on high temperature switches and metal enclosed, environment-free switches as well as popular types of phenolic-cased, push-button, toggle and integral-actuator subminiature switches. *Write to The W. L. Maxson Corp., Unimax Switch Div., Dept. ED, Ives Rd., Wallingford, Conn.*

Microwave Data 131

Bulletin PT-29, four pages, lists the essential characteristics and typical performance data of the firm's unclassified microwave power tubes, both developmental and commercially available. Included are traveling-wave tubes, lighthouse-planar types, klystrons and packaged voltage-tunable magnetrons. General Electric Co., Power Tube Dept., Schenectady 5, N.Y.

Toroidal Inductors 132

Bulletin TL-102, four pages, covers the firm's toroidal inductors. Included in the publication are 4 "Q" curve graphs for various cores, 3 graphs illustrating the effects of ac and dc on inductance, 3 graphs devoted to the self-resonant frequencies for a group of cores, a comprehensive chart on the preferred inductance values, data on temperature coefficients and other material. PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif.

Transistor Heat Dissipator

Technical report No. 414, 22 pages, covers the subject of cooling transistors for improved performance and reliability by using transistor heat dissipators. The effectiveness of the TO-3 heat dissipators is presented with descriptions of test techniques, tabulated data, heat dissipator and transistor assembly methods, curve plots and illustrations for engineering reference. *Write on company letterhead to: International Electronic Research Corp., Engineering Dept., Dept. ED, 145 W. Magnolia Blvd., Burbank, Calif.*

Pulse Transformers 134

This four-page brochure describes and illustrates the firm's standard line of low power pulse transformers and electronic test instruments. Physical and electrical specifications are given on the transformers along with some technical application notes. Among the instruments are a cathode ray indicator, a variable pulser, a VFO, and a power amplifier. Technitrol Engineering Co., 1952 E. Allegheny Ave., Philadelphia 34, Pa.

Diode Catalog 135

This four-page catalog, form 1895, covers silicon glass diodes. The catalog lists some high-reliability-general-purpose and switching diodes and includes curves, charts and other pertinent data. Silicon Transistor Corp., Carle Place, L.I., N.Y.

Selection of Cathodes 136

How to select the best cathode for an electron tube is covered in this reprinted article. Two types of cathodes are described: plain metal sleeve cathodes and disc cathodes. Four forms of sleeves and four forms of disc cathodes are illustrated and described. Superior Tube Co., 1521 Germantown Ave., Norristown, Pa.

Environmental Test Chambers 137

Catalog 59, 12 pages, covers the firm's environmental test chambers. Included are pictures, dimensional data, and general specifications. Walk-in as well as smaller units are described. American Research Corp., Farmington, Conn.

NEW LITERATURE

Industrial Glassware

Information on Vycor brand, 96 per cent silica glass which withstands high temperatures and thermal shock is given in this bulletin. The eight-page, illustrated brochure details physical properties on the glass, which may be used in delay line coilforms. *Write for bulletin B-91 on company letterhead to Corning Glass Works, Technical Products Div., Dept. ED, Corning, N.Y.*

Snap-Action Switches 141

Catalog ES-59, 52 pages, contains photos, dimension drawings, specifications and modification information on electrical switches and actuators, including sub-subminiature switches, hermetically sealed switches, die cast enclosed switches and custom designs for special applications. Basic design types, operating methods, and environment application data are provided. Electrosnap Corp., Switch Div., 4218 W. Lake St., Chicago 24, Ill.

Miniaturized Power Packs 142

Catalog No. 116, one page, describes high voltage miniaturized solid state power packs having current ratings of 0-100 ma, voltage ranges 150-300 v dc. Catalog No. 117, one page, describes short circuit proof miniaturized power packs providing outputs in the range 5-50 v dc, with current ratings up to 200 ma. Electronic Research Assoc., Inc., 67 Factory Place, Cedar Grove, N.J.

Instruments 143

Bulletin 301 provides performance and application data on the firm's broadband phase angle voltmeter which has been designed for direct reading of phase angles, nulls, total, in-phase and quadrature volts. Bulletin 401 describes a precision ac to dc phase sensitive converter which permits use of dc instrumentation for measurement of ac signals. North Atlantic Industries, Instrumentation Div., 603 Main St., Westbury, N.Y.

Control Transformers 145

Miniature synchro control transformers are described in data sheet No. 801-CT4. Information includes dimensional drawings, photos, and tables of electrical and mechanical specifications. Daystrom Inc., Daystrom Transcoil Div., Worcester, Montgomery County, Pa.

Magnetic Heads 146

Eight-page illustrated brochure, "Magnetic Heads," describes precision tape and drum heads, ranging from one to sixty-four channels. Included are typical specifications and graphs of performance characteristics. J. B. Rea Co., Electronics Div., 2202 Broadway, Santa Monica, Calif.

Missiles, Electrical Connectors 147

This 12-page brochure contains photographs and engineering drawings of the firm's principal connector types. Featured are illustrations of America's spacecraft and missiles. Burndy Corp., Norwalk, Conn.

Inductive Potentiometers 148

Data sheet 801-LP4 gives dimensioned and schematic drawings, photos, and tables of electrical and mechanical specifications of the firm's size eight inductive potentiometer line. Daystrom, Inc., Daystrom Transicoil Div., Worcester, Montgomery County, Pa.

Analog-to-Digital Recorder 149

Catalog 35-1541, eight pages, describes a shaft-input device that converts and records analog values in digital binary-decimal punched tape form and provides digital values in electrical form for telemetering. Fischer & Porter Co., 151 Jacksonville Rd., Hatboro, Pa.

Clamps, Wire Strippers 150

Electrical and mechanical products, including plastic clamps or clips in nylon, ethyl cellulose and saran, hand-type wire strippers and wire connectors are described in this 32-page catalog, No. 100. Holub Industries, Inc., Sycamore, Ill.

NEW LITERATURE

Shock Testing 154

Type 15575 shock test machine is described in bulletin 57-06B. Features, pictures, dimensional data and a general description of the unit are covered. Barry Controls Inc., P. O. Box 215, 700 Pleasant St., Watertown 2, Mass.

Tables and Formulas

Booklet B-36779, 120 pages, contains convenient tables, formulas, and graphical symbols summarizing electrical data, properties of materials, heat transfer, measurements and other subjects. *Write to: Westinghouse Electric Corp., Dept. ED, Box 2099, Pittsburgh 30, Pa.*

Potentiometers 155

This four-page brochure is designed to simplify the selection of Bourns potentiometers. Construction features, specifications and photographs of the Trimpot and Trimit are included. Schweber Electronics, 60 Herricks Rd., Mineola, L.I., N.Y.

Amplifiers 156

Catalog 95, 16 pages, provides data on if, rf, and twt amplifiers for radar and missile use. It contains information on electrical characteristics, mechanical construction, and general applications. Several new transistorized units are described, including a hybrid strip combining tubes and transistors for minimum noise figure and power consumption. LEL, Inc., 380 Oak St., Copiague, N.Y.

Clamps

Engineering design manual TA210G includes descriptions on a line of standard clamps, line supports and brackets in a wide variety of shapes and sizes. Also covered are installation techniques for electronic harnessing applications. Information on standard extreme and high and low temperature insulating materials and data on chemical resistance are provided, along with over 400 illustrations. *Write to: TA Mfg. Corp., Dept. ED, 4607 Alger St., Los Angeles 39, Calif.*

Insulation 158

This data sheet describes glass yarns coated with Teflon. The material may be used for insulation purposes such as covering wire. In addition to the yarn's properties a tabulation of approximate yarn diameter and average yards per pound is given. Chemo Products, Inc., West Warwick, R.I.

Design Notes 159

Formulae for designing transformers for use in transistorized power supplies are given in bulletin E-285. It offers a guide to selecting the proper transistors, choosing operating frequencies, and determining the values of biasing resistors. CBS-Hytron, Parker St., Newburyport, Mass.

Silicone Products 160

Catalog CDS-129A, eight pages, provides data on silicone products and their uses. Among the electronic uses described are insulation and rubber products. Pictures and tabular technical information are included. General Electric Co., Silicone Products Dept., Waterford, N.Y.

Multiplier-Divider Data Sheet 161

This technical data sheet describes model K5-M multiplier-divider. Contained in the sheet are general specifications, and a description of the unit, application notes and pictorial information. George A. Philbrick Researches, Inc., 285 Columbus Ave., Boston 16, Mass.

Toggle Switch 162

This one-page data sheet No. 158, describes an ultra-small toggel switch for use on aircraft panels, transistorized devices and other areas where space and weight are at a premium. Minneapolis-Honeywell Regulator Co., Micro Switch Div., Freeport, Ill.

Fastening Devices 163

This 12-page brochure illustrates the firm's line of precision brass nuts. Included are engineering specifications on machine screw nuts, hexagon nuts, cap and open cap nuts, volume control and potentiometer nuts. Cornell Manufacturing Co., Inc., 21B Saw Mill River Rd., Yonkers, N.Y.

NEW LITERATURE

Vibration Pickup 167

Type 4-120 vibration pickup is described and illustrated in Bulletin 1575. Included are specifications, applications and a nomograph of this calibrated standard. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Terminals 168

Standoff and feedthrough terminals are described in this eight-page brochure. Drawings, dimensional data in tabular form, and installation information are included. Taurus Corp., 8 Coryell St., Lambertville, N.J.

Coaxial Terminations 169

Specifications on the firm's model 535 coaxial terminations are given in this two-page bulletin, No. 46. Two-color graphs show typical vswr vs frequency for each type of connector. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md.

Capacitors 170

Bulletin 3701, eight pages, covers tubular sintered-anode tantalum electrolytic capacitors. The catalog numbering system, standard ratings, a general description, and performance characteristics are included. Sprague Electric Co., 347 Marshall St., North Adams, Mass.

Silicone Rubber 171

Selector Chart CDS-145 is a specification guide on silicone rubber. It permits selection of the proper type of silicone rubber and contains data on applications, typical properties, primary classes and standard industry and military specifications. General Electric Co., Silicone Products Dept., Waterford, N.Y.

Magnetic Lamination 172

Bulletin TB 104, two pages, describes transformer laminations, magnetic head laminations, servo motor rotors and stators and special shape laminations. Characteristics are provided. G-L Electronics, 2921 Admiral Wilson Blvd., Camden 5, N.J.

Terminal Blocks

Various types of terminal blocks are covered in this 20-page catalog. It illustrates and describes applications and specifications of heavy-duty, medium-duty and sectional type terminal blocks and shows typical list prices for them. *Write on company letterhead to Marathon Special Products Corp., Dept. ED, 12th and Cranberry Streets, P.O. Box 1220, Erie, Pa.*

Transistors 174

Design limits, performance specifications and typical characteristics for germanium power transistors 2N538, 2N538A, 2N539, 2N539A, 2N540, 2N540A, 2N1202, 2N1203 are given in these separate two-page brochures. Booklet 79-9200, seven-pages, "Fundamental Voltage Limitations of a Transistor" summarizes basic transistor voltage breakdown mechanisms and their relationship to the actual modes of breakdown observed in typical alloyed junction germanium power transistor applications. Minneapolis-Honeywell Regulator Co., 2747 Fourth Ave. S., Minneapolis 8, Minn.

Motor Shields 175

Data sheet 146 illustrates and describes use of Co-Netic Netic magnetic shields for shaded pole motors. Perfection Mica Co., Magnetic Shield Div., 1322 N. Elston Ave., Chicago 22, Ill.

Recorder/Reproducer 176

Type 5-781 continuous-loop recorder/reproducer, designed for data analysis, is described in bulletin 1614, four pages. A general description of the unit, pictures and diagrams and electrical specifications are included. Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.

Encapsulation 177

The bulletin "Improved Casting Techniques for Void-Free Encapsulation in Epoxy Resin" describes the three principal methods of encapsulating coils, transformers and other electrical components. Automatic Process Control, 1170 Morris Ave., Union, N.J.

PRODUCTION PRODUCTS

Tap Welder

Has built-in audible ohmmeter

The Flash-Flow potentiometer tap welder puts taps on one turn of windings made from wire 0.0003 to 0.008 in. in diameter. It handles most of the commonly used precious and nonprecious winding alloys. The unit has a built-in audible ohmmeter to indicate the correct turn to which a weld is to be made.

Ewald Instruments, Dept. ED, Box 124, Kent, Conn.

CIRCLE 180 ON READER-SERVICE CARD

Inserting Machine

Automatic

The Sertomat automatic inserting machine has interchangeable tooling that permits a wide range of applications in the handling of terminals, connectors, pins, studs, and many types of fasteners. It inserts up to 3000 pieces an hour and can simultaneously feed and insert two-piece Teflon bushings and feedthrough terminals for electronic circuit boards.

Hill Machine Co., Dept. ED, 1301 Eddy Ave., Rockford, Ill.

CIRCLE 181 ON READER-SERVICE CARD

.. silicones assure dependable components

Silastic Protects Against Corona, Humidity

This klystron tube for airborne radar utilizes Silastic®, the Dow Corning silicone rubber, to maintain frequency stability. Silastic moldings cover the tube's connections and lead wires, keeping out moisture and preventing corona. An excellent insulator, Silastic is unaffected by temperature extremes and ozone. Silastic retains its properties . . . can be relied upon to protect electronic gear in widely diverse and adverse environments.

In addition to its usefulness as a dielectric material, Silastic is often employed for purely physical reasons. Available in sponged or solid form, it protects delicate parts against shock and vibration. Silastic stays resilient from —90 to 260 C (—130 to 500 F), and resists the effects of extended storage, weathering, and corrosive atmospheres.

PHOTO COURTESY VARIAN ASSOCIATES

CIRCLE 601 ON READER-SERVICE CARD

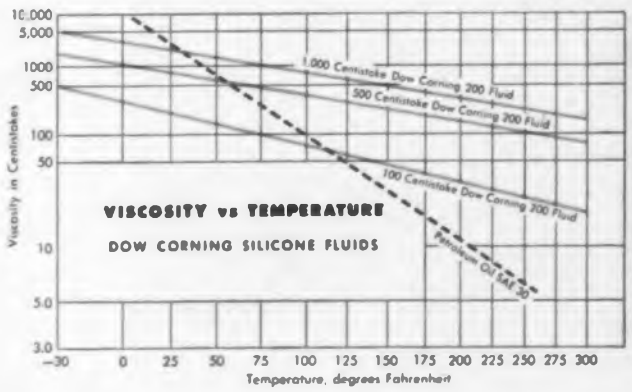
Grease-Like Silicones Boost Transistor Dependability... Dow Corning silicone compound is ideal for potting transistors. It seals out moisture and conducts heat away rapidly. In addition, it reduces rejection rates by preventing metal splatter from reaching the transistor wafers when caps are welded in place. These silicone compounds don't melt, don't thicken, and retain their excellent dielectric properties from —40 to 210 C. Industro Transistor Corporation, manufacturer of the units illustrated, finds the grease-like silicone materials help build a new degree of reliability into their product.

Actually, transistor potting is but one of the many jobs performed by Dow Corning silicone compounds. They seal out moisture at joints, on terminals, and in many other applications . . . preventing arcs, shorts, flashovers, corrosion, and contamination . . . assuring the performance of electronic units.

CIRCLE 602 ON READER-SERVICE CARD

Cooling Fluid with Reliable Flow Rate

Because of their thermal stability and relatively flat viscosity-temperature curves, Dow Corning silicone fluids make excellent heat exchange media. Silicone fluids maintain consistency over a range of —65 to 250 C. They can be pumped at high speed without suffering breakdown due to shear, have good lubricity, and will not oxidize or act as corrosives, despite contact with metals at high temperatures. In sum, they allow heat exchange units to operate uniformly and almost indefinitely, as far as the coolant is concerned.



Recognizing these factors, the Hallicrafters Company utilizes Dow Corning silicone fluid as the cooling medium in their new heat exchangers for electronic equipment. Specifically designed to cool airborne, shipboard, and ground support electronic equipment, the Hallicrafters units have ratings up to 7,000 watts dissipation, meet MIL specs.

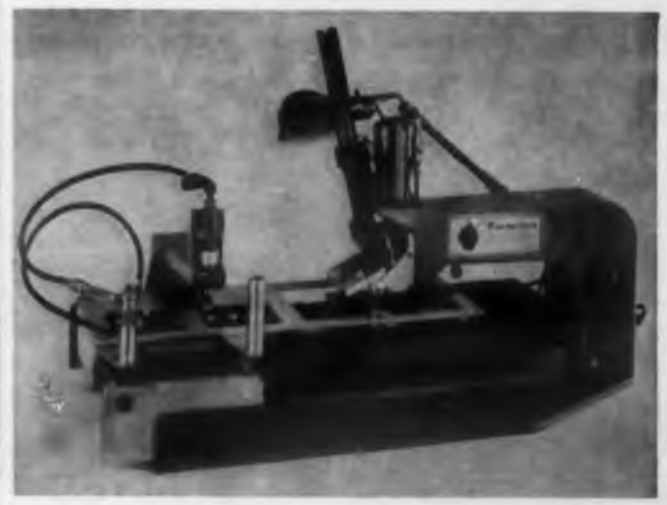
CIRCLE 603 ON READER-SERVICE CARD

Your nearest Dow Corning office is your number one source for latest information and technical service on silicones.

main office: MIDLAND, MICHIGAN / branches: ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

Printed Circuit Assembly Machine

Inserts 30 components a minute



The Panto-Sert printed circuit assembly machine inserts components all over a board in one pass. With a template and a pantograph type attachment, it can install 30 components a minute. Power requirements are 30 w, 110 v, 60 cps.

Design Tool Corp., Electro-Machinery Div., Dept. ED, 772 Bergen St., Brooklyn 38, N.Y.

CIRCLE 182 ON READER-SERVICE CARD

Flag Wrapper

Labels 650 parts an hour

Working as an attachment on the company's AWM-2 automatic marking machine, the Flagmatic automatically applies a pressure-sensitive flag around small wires, components, and products. It can bundle small parts together and will accept 28 gage wire and parts with up to 1/8 in. OD. The unit flags 650 1/16 in. diameter parts in an hour.

W. H. Brady Co., Dept. ED, 727 W. Glendale Ave., Milwaukee 9, Wis.

CIRCLE 183 ON READER-SERVICE CARD

Electron Beam Welder

Joins reactive and refractory metals

Equipped with a gun that is fully protected from gaseous discharges in the weld area, the model 2770 electron beam welder joins reactive and refractory metals in a high vacuum. The welding chamber contains a work table that can be rotated or moved laterally or longitudinally without breaking vacuum. Pump and gun ports are set into the tank, and three other ports allow for the addition of extension chambers. Beam current is 0 to 100 ma at 0 to 10 or 0 to 20 kv, depending on the rating of the gun.

NRC Equipment Corp., Dept. ED, 160 Charlemont St., Newton 61, Mass.

CIRCLE 184 ON READER-SERVICE CARD

PRODUCTION PRODUCTS

Potentiometer Marker
Imprints tops and sides

For potentiometers and large semiconductor power rectifiers, the model U-1009 machine marks tops and sides in a single operation, with each print in register with the terminals. It handles 30 pieces per min. The side and top markers may be used independently, and the side printer marks single or double unit potentiometers without adjustment.

Markem Machine Co., Dept. ED, Keene 53, N.H.

CIRCLE 186 ON READER-SERVICE CARD

Vacuum Metallizing Unit
For production and research

Model 3144 bell-jar metallizing unit is designed for developmental work or limited volume deposition of one or more materials under vacuum. It can be used for production of semiconductors, precision resistors and capacitors, printed circuits, waveguides, computer elements and other components. The vacuum chamber is formed by a 30-1/2 in. high bell jar and a 28 in. diameter precision ground baseplate. The bell jar may be an 18 in. diameter pyrex unit with perforated metal shields or a 24 in. diameter mild or stainless steel type with two eye level sight glasses. The baseplate,

which can be either stainless or nickel plated mild steel, has one central 6 in. diameter vacuum pumping port and seventeen 1 in. diameter holes for feedthroughs.

NRC Equipment Corp., Dept. ED, 160 Charlemont St., Newton, Mass.

CIRCLE 189 ON READER-SERVICE CARD

Set Screw Feeder-Driver

Automatic

Handling up to 2000 units an hour, these portable, automatic, gun type machines receive and drive standard socket set screws 15 ft away. Three models handle screw diameters No. 4 to 8, No. 10 to 5/16 in., and 3/8 to 1/2 in. Change-over from one size to another takes about 20 min.

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

CIRCLE 190 ON READER-SERVICE CARD

Glass Diode Case Machine

Dual purpose

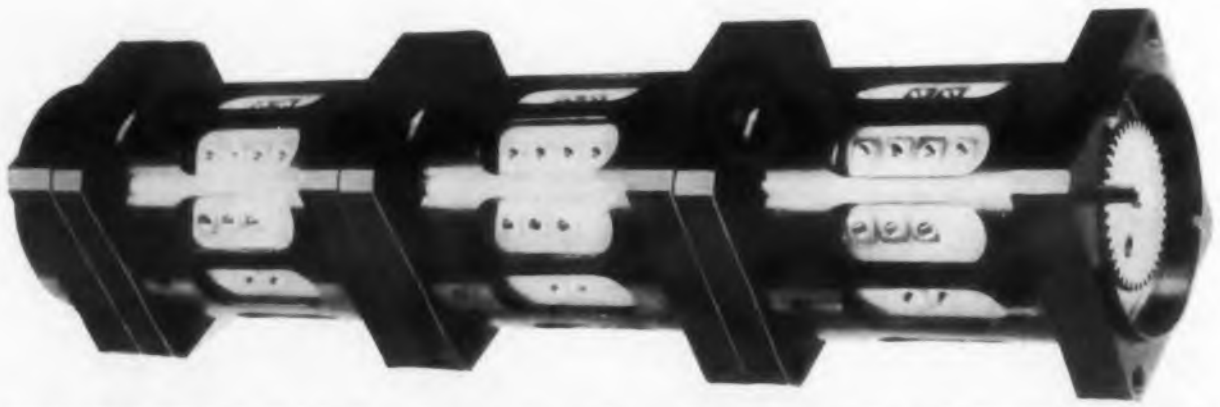
The 3187 diode body case machine automatically produces a beaded lead wire and seals a glass body sleeve over it. The machine handles up to 1500 units an hour.

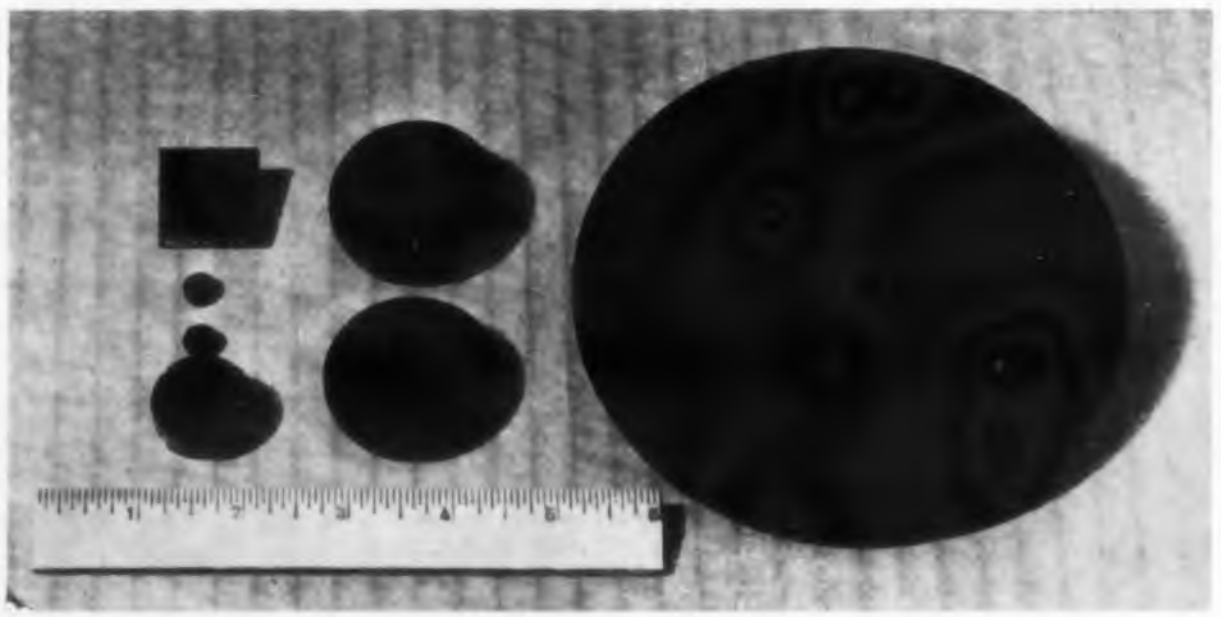
Kahle Engineering Co., Dept. ED, 3322 Hudson Ave., Union City, N.J.

CIRCLE 191 ON READER-SERVICE CARD

NEW PRODUCTS

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





Near Infrared Filters Operate at 100 C

Capable of operating from −40 to +100 C with little shift in the cut-off wavelength, these near infrared, interference type filters use evaporated films of silicon. They are essentially long pass filters and begin to transmit at wavelengths up to 1.2 microns. They are available in diameters up to 6 in.

Metavac, Inc., Dept. ED, 45-68 162nd St., Flushing 58, N.Y.

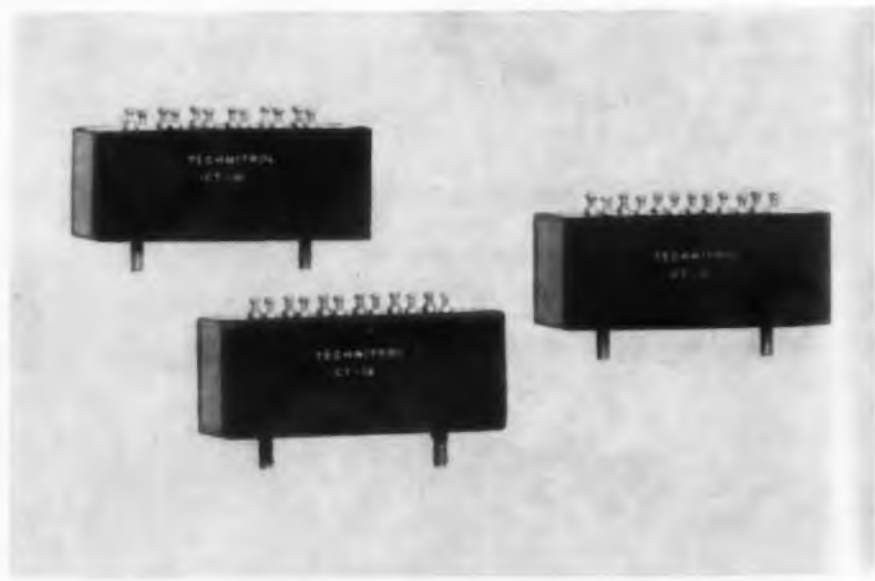
CIRCLE 194 ON READER-SERVICE CARD

Shaft Encoder Pulses Computer Directly

This shaft to digital converter pulses data processing equipment directly without an intermediate relay matrix. Designated model AP-124, the unit has a heavy current output that eliminates the need for relays. The unit has two outputs: 500 ma for card punch and similar equipment; 0.5 to 1 ma for neon lamps or other displays. Maximum slewing speed is 1500 rpm; each revolution provides 10 counts.

United Precisioneers, Inc., Dept. ED, 23916 Craftsman Rd., Calabasas, Calif.

CIRCLE 193 ON READER-SERVICE CARD



Delay Line Provides 10 Increments of 0.05 μsec

Type CT-18 lumped constant delay line has 10 separate taps of 0.05 μsec each. Impedance of the unit is 550 ohms and it has a maximum rise time of 0.1 μsec. Attenuation is 1 db max, and temperature range is from −25 to +85 C. It measures 2.5 x 1 x 1.5 in.

Technitrol Engineering Co., Dept. ED, 1952 E. Allegheny Ave., Philadelphia, Pa.

CIRCLE 195 ON READER-SERVICE CARD

Voltage Standard has 0.000001% Regulation

A dc reference voltage with a regulation of 0.000001% for any change in input voltage from 90 to 150 v is provided by this unit, called Voltaloc. Its temperature coefficient is 5 to 20 ppm per C from −65 to +125 C. Having military uses, the unit is available with any output voltage up to 5 v for 60 or 400 cps inputs of any wave shape.

Jackson Electronic & Mfg Co., Dept. ED, 695 Johnston St., Akron 6, Ohio.

CIRCLE 196 ON READER-SERVICE CARD

Switch Cuts Installation Costs

Series 20 printed circuit switch cuts installation costs because: switch wiring errors are eliminated; all leads are connected during dip soldering; and no hardware is required to securely hold the switch to the board. It is available with combinations from one-pole 12 positions, through six-pole 2 positions. Its ratings are 2 amp at 15 v dc, and 150 ma at 110 v ac (make and break, resistive load).

Centralab, A Division of Globe-Union Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

CIRCLE 197 ON READER-SERVICE CARD

NEW PRODUCTS

High Potential and Insulation Tester

Nondestructive

This high potential and insulation tester checks products at high voltage without damaging them. The unit weighs 22 lb, measures 7 x 19 x 7 in., and requires no additional safety cabinets. Standard ranges are 0 to 3500 v dc and 0 to 2500 v ac, 60 cps.

Arizona Instrument Corp., Dept. ED, 2342 E. Broadway, Phoenix, Ariz.

CIRCLE 199 ON READER-SERVICE CARD

Power Meter

Temperature compensated

The model B831A temperature compensated power meter uses the company's series 218 thermistor head to provide virtually drift free operation. It has ±5% accuracy and six direct reading ranges from 10 μw to 3 mw, full scale.

FXR, Inc., Dept. ED, 26-12 Borough Place, Woodside 77, N.Y.

CIRCLE 200 ON READER-SERVICE CARD

Automatic Circuit Analyzer

Measures three-terminal complex impedance

The SPACE Mark II automatic circuit analyzer measures two or three-terminal complex impedance, insulation resistance, and diode forward voltage drop and reverse resistance. It handles a minimum of two tests per sec.

Brooks Research, Inc., Dept. ED. P.O. Box 3867, Rochester 10, N.Y.

CIRCLE 201 ON READER-SERVICE CARD
CIRCLE 202 ON READER-SERVICE CARD

Terminals

Teflon insulated

Securely seated in Teflon, double turret type 1945, 1946, and 1947 solder terminals are suited for high humidity conditions. They are about 3/8 in. in diameter and have externally threaded, rivet type, or internally threaded mounting studs.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

CIRCLE 203 ON READER-SERVICE CARD

DC Power Supply

Delivers 200 ma at 25 kv

For nuclear research and experimental or industrial use, the model PS 25-200-1 dc power supply delivers 200 ma at 25 kv. It is designed to operate on a 208 v, three-phase, 60 cps line voltage delivered by a three-phase variable transformer. Multiplier resistors are provided so that the output voltage can be measured by a 100 μa full scale meter. The unit is 21 x 17-1/2 x 18 in.

Del Electronics Corp., Dept. ED, 521 Homestead Ave., Mt. Vernon, N.Y.

CIRCLE 204 ON READER-SERVICE CARD

Digital Logic Circuits

Plug-in

This plug-in digital logic circuit series includes AND gates, OR gates, inverters, and emitter followers. All units are available with either single or dual circuits and come in npn, pnp, or complementary symmetry types. The single units are 1-9/16 in. high; the dual units are 2-1/16 in. high. Both are 9-pin devices 7/8 in. in diameter. The circuits can also be provided in 0.5 cu in., 1 oz cartridge form.

The Walkirt Co., Dept. ED, 141 W. Hazel St., Inglewood 3, Calif.

CIRCLE 205 ON READER-SERVICE CARD

CIRCLE 206 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Airborne Tape Recorder

Seven track

Airborne magnetic tape recorder model AR-200 is a complete seven track system with two units that occupy a total of 1.6 cu ft and weigh 90.5 lb. It operates up to 100,000 ft at temperatures from −54 to +95 C and withstands shocks to 15 g. The recorder provides for all standard recording techniques and has an accessory remote control unit. It handles up to 14 analog tracks, 32 digital tracks, or a combination of 7 analog and 16 digital tracks on a single magnetic tape 1 in. wide.

Ampex Corp., Instrumentation Div., Dept. ED, 934 Charter St., Redwood City, Calif.

CIRCLE 208 ON READER-SERVICE CARD

Frequency Meter

Needs no phones or calibration curves

Model 700 standard frequency meter is capable of measuring and continuously monitoring without use of head phones, transfer oscillator, or calibration curves. Its basic frequency range is 25 to 50 mc; when used with model 710 range selector it will measure frequencies up to 1000 mc. This direct-reading meter measures to within ±20 cps, when referenced to a prime standard.

Measurements, A McGraw-Edison Div., Dept. ED, Intervale Rd., Boonton, N. J.

CIRCLE 209 ON READER-SERVICE CARD

Switch-Stop

Is infinitely adjustable

Model LS302 infinitely adjustable limit stop-switch has a single exterior range adjustment screw which permits rapid adjustment to any angular rotation from 0 to 25 turns. It is actuated at either end of shaft travel prior to contact with non-locking stops. It has a 0.937 in. diam and its length is 2 in.; shaft diameter is 0.125 in.

Precision Mechanisms Corp., Dept. ED 577 New Bridge Ave., East Meadow, N.Y.

CIRCLE 210 ON READER-SERVICE CARD

AC Motor

Has explosion proof construction

A three-phase, 400 cps, 200 v ac motor, the model D-2260 is rated 0.38 hp at 1500 rpm, continuous duty. For use in aircraft, missile, and industrial equipment, the unit is designed to MIL-M-7969B and MIL-E-5272A and is supplied with a mounting pad that meets AND-20000. It is explosionproof, operates to 65,000 ft, and has an integral cooling fan. Dimensions are 7.625 x 5.19 x 3.875 in.; weight is 6.2 lb.

Hoover Electric Co., Dept. ED, Hanger Two, Port Columbus Airport, Columbus 19, Ohio.

CIRCLE 211 ON READER-SERVICE CARD

Frequency and Deviation Meter

±0.0001% accurate

Portable model T-1020A all-band frequency and deviation meter measures and generates variable signals from 20 to 1000 mc with calibrated ±0.0001% accuracy. For deviation measurements, it has a dual range meter with 7.5 and 15 kc deviation scales. The 40 lb unit measures 15 x 12-1/2 x 13 in. and requires 75 w at 115 v ac.

Motorola Inc., Communications and Industrial Electronics Div., Dept. ED, 4501 W. Augusta Blvd., Chicago 51, Ill.

CIRCLE 212 ON READER-SERVICE CARD

Computer Register Elements

Operating temperature range is −35 to +55 C

Model CTR-400 magnetic shift register element's output signal has a 50:1 One/Zero ratio and a peak voltage drop on the shift line of 0.4 v for a One. It uses a 12 v supply and requires a maximum of 16 ma average current at 400 kc repetition rate with all One's. Model CTD-400 shaper-driver element is designed to shift up to 12 register stage at 400 kc. Standard units have an operating temperature range of −35 to +55 C, and function with any rise time on the shift pulse for a pulse width of 1/4 to 1 μsec.

Di-An Controls, Inc., Dept. ED, 40 Leon St., Boston 15, Mass.

CIRCLE 213 ON READER-SERVICE CARD

NEW PRODUCTS

DECADE SCALER.—Low cost model N-220 uses three in-line decades and a four digit electromechanical register. Time resolution is 1 μsec; preset count is 10, 100, 1000; and discriminator range is −50 to +100 v.

Hamner Eelectronics Co., Inc., Dept. ED, Princeton, N.J.

CIRCLE 217 ON READER-SERVICE CARD

AC VOLTAGE REGULATOR.—This solid state, 500 va, 3-phase unit is designed to operate in subsonic and supersonic conditions. Input is 100 to 130 v ac; output, 115 v ac ±1%; frequency range, 380 to 420 cps. Dimensions are 3-1/2 x 4 x 6 in. and weight is about 6 lb.

Ratigan Electronics Inc., Dept. ED, 425 W. Cypress St., Glendale 4, Calif.

CIRCLE 218 ON READER-SERVICE CARD

TRANSISTORIZED AUDIO TONE EQUIPMENT.—Type KA equipment provides multiple telegraphic type channels for operating on leased or private wire lines, radio circuits, or coaxial cable. On one pair of wires or any single voice frequency channel, the equipment will give up to 18 channels for telemetering, control, data transmission, and other functions. Six flip-out panels and a power panel fit into one frame 19 in. wide.

Westinghouse Electric Corp., Dept. ED, P.O. Box 2099, Pittsburgh 30, Pa.

CIRCLE 219 ON READER-SERVICE CARD

INDICATING TEMPERATURE CONTROL.—Type E36N is a low cost, sensitive, remote bulb unit that controls and indicates gas, liquid, and hotplate temperatures over a variety of ranges between −100 and +600 F. Suited for centrifuges and ovens, it provides easy reference between setting and controlling temperatures by using one dial with two pointers.

United Electric Controls Co., Dept. ED, 79 School St., Watertown 72, Mass.

CIRCLE 220 ON READER-SERVICE CARD

NYLON CABLE CLAMPS.—Fully adjustable. Lok-Straps incorporate a miniature quick-release tab which holds the clamp band securely around the wires. The ties accommodate wire harnesses from 1/8 in. in diameter and can be used from −65 to +350 F.

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

CIRCLE 221 ON READER-SERVICE CARD

ULTRASONIC CLEANING EQUIPMENT.—Model GW-8 consists of a 30 x 12 x 12 in. cleaning tank and a separately housed generator 25 x 25 x 33 in. In continuous operation it will not overheat low boiling, low flash, flammable or toxic solvents and can be used with solvents at temperatures to 400 F.

Blackstone Corp., Dept. ED, Jamestown, N.Y.

CIRCLE 222 ON READER-SERVICE CARD

Crystal Socket Assembly

Miniature

A miniature HC-18/U crystal with 0.04 in. diameter pins can be quickly inserted in, or extracted from, this socket assembly without removal or adjustment of latches and screws. Severe vibration will not shake the crystal loose once it is installed. The assembly is available with antirotate tabs.

Augat Bros., Inc., Dept. ED, 33 Perry Ave., Attleboro, Mass.

CIRCLE 223 ON READER-SERVICE CARD

Lighted Pushbutton Devices

Modular

Series 2 modular lighted indicator and pushbutton switch devices can be combined to perform almost any switching and indicating function in control equipment. A variety of types and colors afford more than 34,000 possible combinations.

Micro Switch, Div. of Minneapolis-Honeywell Regulator Co., Dept. ED, Freeport, Ill.

CIRCLE 224 ON READER-SERVICE CARD

Turns Counting Dial

Graduated in hundredths of a turn

Made of lightweight plastic, the VerniDial H5850 turns counting dial fits the shafts of potentiometers, capacitors, valves, and other equipment where micrometer setting is required. The inner dial is graduated in hundredths of a turn and the outer dial keeps count of up to 20 turns. The unit is available in a variety of colors.

Howell Instrument Co., Dept. ED, 3101 Trinity St., Fort Worth 7, Tex.

CIRCLE 225 ON READER-SERVICE CARD

CIRCLE 226 ON READER-SERVICE CARD ➤

NEW PRODUCTS

HIGH VOLTAGE RECTIFIER.—For use in power supplies for rf heaters, radio broadcasting transmitters, or sonar transmitters, the WL-575A mercury-vapor tube is rated at 15 kv inverse voltage and 1.5 amp.

Westinghouse Electric Corp., Electronic Tube Div., Dept. ED, P.O. Box 284, Elmira, N.Y.

CIRCLE 228 ON READER-SERVICE CARD

VIDEO CRYSTAL DETECTOR MOUNTS.—Tangential sensitivities to —63 dbm may be obtained with these mounts. They are available in the spectrum from 50 to 12,000 mc and can be built narrow or broad band with or without dc return. Detectors and rf filters can be supplied as matched units.

American Electronic Labs, Inc., Dept. ED, 121 N. Seventh St., Philadelphia 6, Pa.

CIRCLE 229 ON READER-SERVICE CARD

TRANSISTORIZED TACHOMETERS.—The Electro-Tach models 7101, 7102 and 7103 measure speed without physical loading. They have a Weston indicating dc milliammeter calibrated in rpm with 1 ma 250 deg scale movement. Accuracy of rpm indication is within 1% of full scale deflection. Respectively, the units measure 0 to 2000, 5000, and 10,000 rpm.

Electro Products Labs, Dept. ED, 4501 N. Ravenswood Ave., Chicago 40, Ill.

CIRCLE 230 ON READER-SERVICE CARD

POTTING COMPOUND.—Formula P-20 has an average linear coefficient of thermal expansion of 14×10^{-6} in. per in. per deg F. First developed for gyroscopic applications, it permits the encapsulation of metallic components with a rigid, dimensionally stable material that is resistant to thermal shock. It has a 1 hr pot life at 200 F and does not shrink on curing.

Bacon Industries, Inc., Dept. ED, 192 Pleasant St., Watertown 72, Mass.

CIRCLE 231 ON READER-SERVICE CARD

TRANSISTORIZED DC POWER SUPPLY.—Model 851H develops any voltage from 12 to 1200 v dc at 100 w output power from 28 v dc input. Output regulation is ±1.5% for 5 v dc input changes and ±2% half load to full load.

Arnold Magnetics Corp., Dept. ED, 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

CIRCLE 232 ON READER-SERVICE CARD

SYNTHETIC SAPPHIRE WINDOWS.—For infrared, ultraviolet, and microwave applications, these windows can now be produced in diameters to 5 in. and in large, contoured shapes.

Linde Co., Div. of Union Carbide Corp., Dept. ED, 30 E. 42nd St., New York 17, N.Y.

CIRCLE 233 ON READER-SERVICE CARD

Noise Loading Test Sets

For broadband radio systems

These portable noise loading test sets measure intermodulation distortion and idle channel noise in broadband radio systems. Model 5204A, used at the transmitter, furnishes either a 50 to 500 kc band of noise to simulate 120-channel system loading, or a 50 to 1100 kc band to simulate 240 channel loading. The 5204A, used at the receiver with a vtvm, permits noise measurement in a 3 kc band centered at 26 kc, a 3 kc band at 550 kc, or a 6 kc band at 1200 kc.

Lenkurt Electric Co., Dept. ED, San Carlos, Calif.

CIRCLE 234 ON READER-SERVICE CARD

Coil Wound Foils

Permit variety of cooling methods

These foil wound wafer coils can be assembled in multiples so that air, oil, water, or gas cooling methods can be used. Tube appendages can pass directly through the windings. The units are suited for use with twt's, klystron electromagnets, maser devices, and beamed deflection magnets.

Sylvania Electric Products Inc., Sylvania Lighting Products, Dept. ED, Salem, Mass.

CIRCLE 235 ON READER-SERVICE CARD

Altitude-Temperature Test Chamber

Simulates up to 100,000 ft

Designed to simulate actual conditions encountered at altitudes to 100,000 ft, this altitude-temperature test chamber provides true vertical air flow. It has a range of −100 F to +350 F and a free test space of 4 x 4 x 7-1/2 ft. A small reach-in door makes it possible to check test pieces without opening the large door.

American Research Corp., Dept. ED. Farmington, Conn.

CIRCLE 236 ON READER-SERVICE CARD

CIRCLE 237 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Silicon Rectifier

250 amp

Rated at 250 amp dc and 50 to 400 piv, Y series silicon rectifiers have a thermal drop of less than 10 deg C, junction to base, and a junction temperature rise of about 60 C. Either positive or negative base polarity is available. The units are designed for welding, electroplating, or any application that requires 1000 or more dc amperes.

Sarkes Tarzian, Inc., Rectifier Div., Dept. ED, 415 N. College Ave., Bloomington, Ind.

CIRCLE 238 ON READER-SERVICE CARD

Pressure Transducers

Have ± 2% overall accuracy

Designed to measure gage or absolute pressures from 100 to 10,000 psi, model TPH-175 transducers provide linear or nonlinear outputs. Their overall accuracy, including linearity, friction, and hysteresis, is ±2%. Resolution may be as low as 0.25%. The units can withstand 10 g, 55 to 500 cps vibration with less than 1% error and 25 g, 2000 cps without permanent calibration shift. They also withstand 25 g shock and acceleration. A differential version, the TPH-176, measures pressures in the 100 to 5000 psi range with case pressures to 5000 psi.

Fairchild Controls Corp., Components Div., Dept. ED, 225 Park Ave., Hicksville, N.Y.

CIRCLE 239 ON READER-SERVICE CARD

3M FLUOROCHEMICAL FC-75 has a pour point of —150°F., giving it a useful liquid range of —150°F. to 212°F. at atmospheric pressure. In addition, it offers these other useful properties: High dielectric strength in both liquid and vapor state (37 KV @ 0.1″ gap for liquid) . . . self-healing in high voltage electrical equipment after repeated arcing . . . excellent wetting power on all types of surfaces . . . compatible with materials commonly used in the construction of high temperature equipment . . . thermally stable to temperatures in excess of 750°F. and, even under extreme use conditions does not form sludge or corrosive products. Heat capacities in both liquid and vapor state are approximately equal.

COSTS!

See what 3M Chemicals can do for you! For free literature, write on your company letterhead, specifying product interest, to 3M Chemical Division, Dept. KAP-79, St. Paul 6, Minnesota.

3M CHEMICAL DIVISION, MANUFACTURERS OF:
Acids • Resins • Elastomers • Plastics • Oils, Waxes and Greases • Dispersion Coatings • Functional Fluorochemicals • Surfactants and Inert Liquids

DUAL ELECTRONIC TACHOMETER.—Model 6602A contains two complete indicators with overspeed sensing and protective circuits in a single package. It measures 0 to 60,000 rpm with ±3% full scale accuracy and operates from a 28 v ac source. It is 3.23 in. in diameter and 6.5 in. long, weighs under 2 lb, and withstands —55 to +50 C.

Varo Mfg. Co., Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

CIRCLE 241 ON READER-SERVICE CARD

ADHESIVE COLOR DOTS.—Precut 1/4 in. diameter Quik-Dots replace paint markings or tagging in inspection and quality control work. Quickly applied, they can show the nature of part defects. They are useful for identification.

W. H. Brady Co., Dept. ED, 727 W. Glendale Ave., Milwaukee 9, Wis.

CIRCLE 242 ON READER-SERVICE CARD

FREQUENCY METER.—Expanded scale, direct reading meter with a square 4-1/2 in. face, 0.25% accuracy, and a range from 380 to 420 cps. The separate sensor unit is potted, occupies about 10 cu in., and weighs 2 lb.

American Machine & Foundry Co., Alexandria Div., Dept. ED, 1025 N. Royal St., Alexandria, Va.

CIRCLE 243 ON READER-SERVICE CARD

PLASTIC INSULATOR.—Mechanically tough, Prolene has a melting point of 166 C, a dielectric constant of 2, and a specific gravity of 0.9. It is resistant to solvents, greases, oils, and many common acids and chemicals. A complete range of colors is available.

Phalo Plastics Corp., Dept. ED, Shrewsbury, Mass.

CIRCLE 244 ON READER-SERVICE CARD

MINIATURE TWIN TRIODE.—Medium mu, 9-pin type 7044 is designed for use in pulse amplifier, inverter, frequency divider, cathode follower, and multivibrator circuits in computers and other equipment. It has separate terminals for each cathode and a mid-tapped heater to permit operation from a 6.3 or 12.6 v supply.

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

CIRCLE 245 ON READER-SERVICE CARD

HIGH SPEED SOLDERING TOOLS.—These tools combine threaded heating units and the company's thread-on Mini-Tips. They provide fast heat recovery in high speed repetitive soldering. Available heating units are the 4037, which delivers 850 to 900 deg at 47-1/2 w, and the 1237, which delivers 750 to 800 deg at 37-1/2 w. The Mini-Tips are 3/4 in. long and available in pencil or chisel types, both plated or unplated.

Ungar Electric Tools, Inc., Dept. ED, 4101 Redwood Ave., Los Angeles 66, Calif.

CIRCLE 246 ON READER-SERVICE CARD

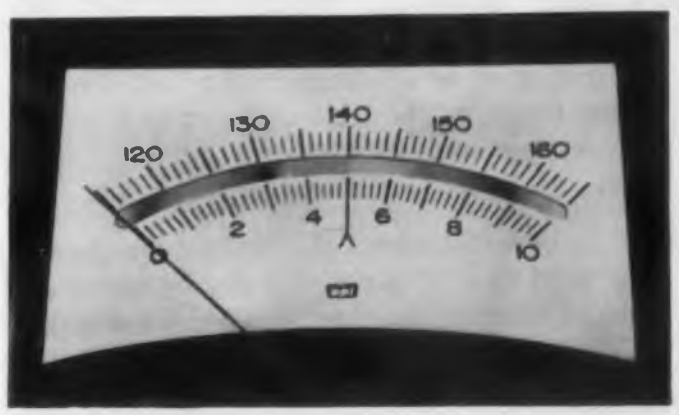
NEW . . . FROM api THE PANEL METER WITH THE BUILT-IN

NATURAL READING ANGLE

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

Installation is easier done than said. The 5″ x 2⅞″ case frame is self-trimming, requires a simple panel cutout—no holes to drill, no stud alignment troubles. A window in the meter case provides for dial illumination; you can save a bit of work (and panel space) by using the dial light as a pilot.

For the man who needs a smaller meter, there's the Model 361, an identical but diminutive companion to the Model 561. It measures just 3½″ x 2″. Both models are molded of satin-finish Bakelite, and both can be had in ranges of 0-5 microamperes to 0-50 amperes or 0-5 millivolts to 0-500 volts.



MORE INFORMATION? SEND FOR DATA SHEET 10-A

ASSEMBLY PRODUCTS, INC.
Chesterland 17, Ohio

CIRCLE 247 ON READER-SERVICE CARD

NEW PRODUCTS

Mechanical Convection Ovens

Have 8 cu ft capacity

Batch type Stabil-Therm mechanical convection ovens provide 8 cu ft of heated volume for electronic component processing, plastic heat treating, and other processes. The low cost, bench type units have ranges of 100 to 300 and 100 to 500 F. They are available for 115 v, single-phase, 60 cps; 230 v, single or three-phase, 60 cps; or 440 v, three-phase, 60 cps operation. Inside dimensions are 24 x 25 x 24 in.; outside dimensions 37 x 32 x 44 in.

Blue M Electric Co., Dept. ED, 138th and Chatham Sts., Blue Island, Ill.

CIRCLE 248 ON READER-SERVICE CARD

High Voltage Power Supply

3-3/4 x 3-3/16 x 5 in.

Variable from 0 to 5 kv at 5 ma this power supply is hermetically sealed in an oil filled CP70 container 3-3/4 x 3-3/16 x 5 in. Connections are made to screw type solder seal terminals. Suited for use in oscilloscopes, it has 1% maximum ripple and 7.5 ma maximum output current.

Film Capacitors, Inc., Dept. ED, 3400 Park Ave., New York, N.Y.

CIRCLE 249 ON READER-SERVICE CARD

DC Power Supply

Variable

Variable dc power supply model 630B is a precision laboratory unit that provides 300 ma at any voltage between 0 and 600 v with 0.1% line and load regulation and 1 mv ripple. A variable bias of 0 to 250 v and a 6.3 v, 6 amp filament supply are also available.

Lawn Electronics Co., Inc., Dept. ED, Woodward Rd., Englishtown, N.J.

CIRCLE 250 ON READER-SERVICE CARD

CIRCLE 251 ON READER-SERVICE CARD

Miniature Two-Position Toggle Switch

Operates from −65 to +200 F

Rated 7 amp, resistive at sea level and 75,000 ft, the model 2TM1-T two position, dpdt toggle switch is 1.2 in. square at the base and weighs 4.5 g. It operates from −65 to +200 F and is suitable for aircraft panels, portable communication gear, and printed circuit and transistorized devices. The unit has integral terminals, gold plated stationary contacts, and low circuit resistance. A threaded bushing with a keyway slot affords single hole mounting.

Micro Switch Div. of Minneapolis-Honeywell Regulator Co., Dept. ED, Freeport, Ill.

CIRCLE 252 ON READER-SERVICE CARD

Spectrum Analyzer

3 to 30 mc range

For measuring emissions from 3 to 30 mc, the model S.510 spectrum analyzer has a dual persistence screen that affords trace repetition rates from 0.1 to 30 sec. It can measure signal components in a 60 db range with bandwidths up to 30 kc. Available with the unit is the type S.520 frequency changer which extends its range below 3 mc.

Furzehill Labs Ltd., Dept. ED, 475 Fifth Ave., New York 36, N.Y.

CIRCLE 253 ON READER-SERVICE CARD

Audio Phase Shift Network

Has ±1.5 deg accuracy

The model 350, type 2Q4 phase shift network splits any 300 to 3000 cps audio signal into two equal amplitude components that are 90 deg out of phase with each other. It has ±1.5 deg accuracy and may be used in receiving and transmitting circuits in ssb suppressed carrier radio-telephony equipment. The unit plugs into a standard octal socket and requires no adjustments.

Barker & Williamson, Inc., Dept. ED, Bristol, Pa.

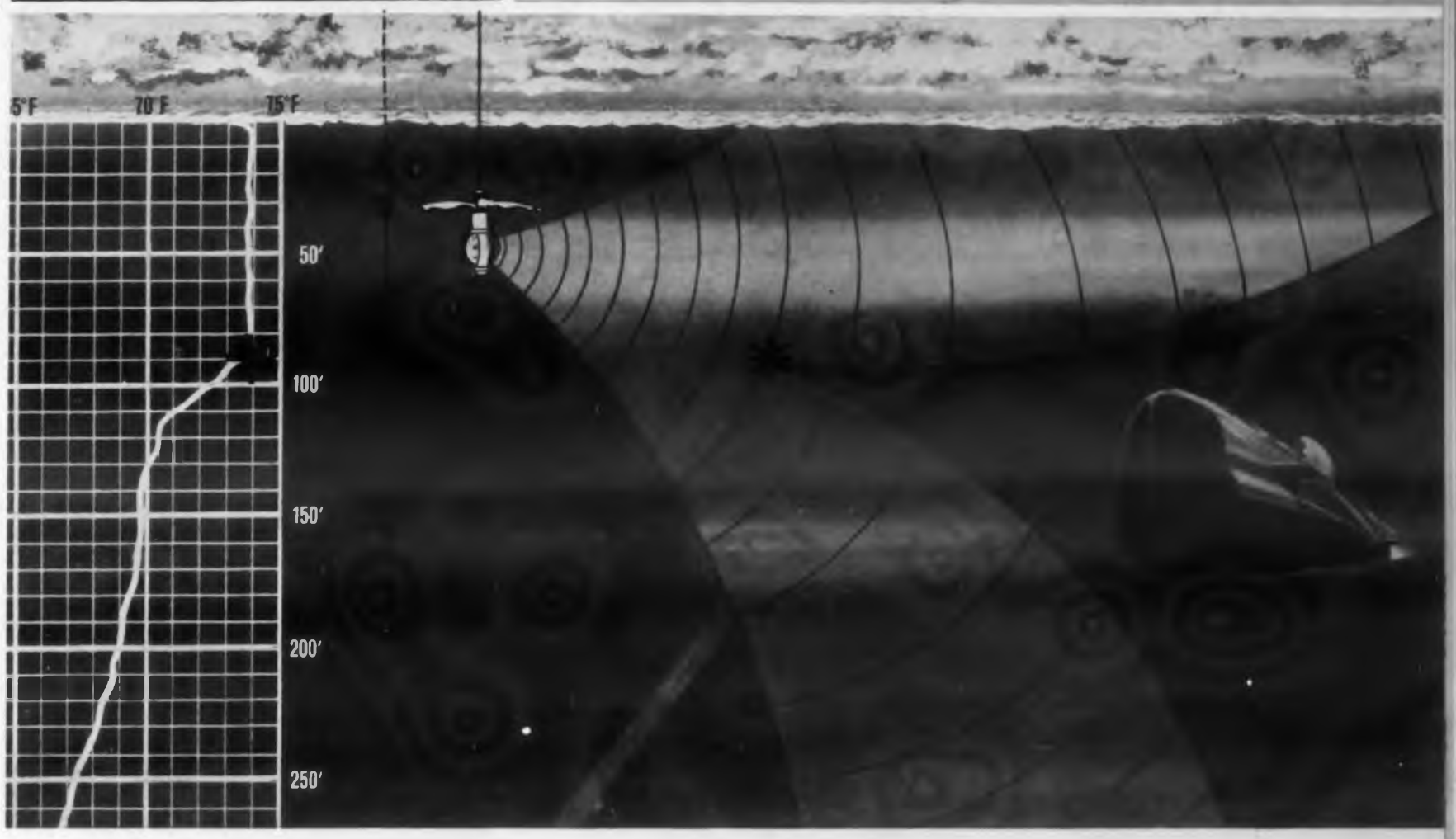
CIRCLE 254 ON READER-SERVICE CARD

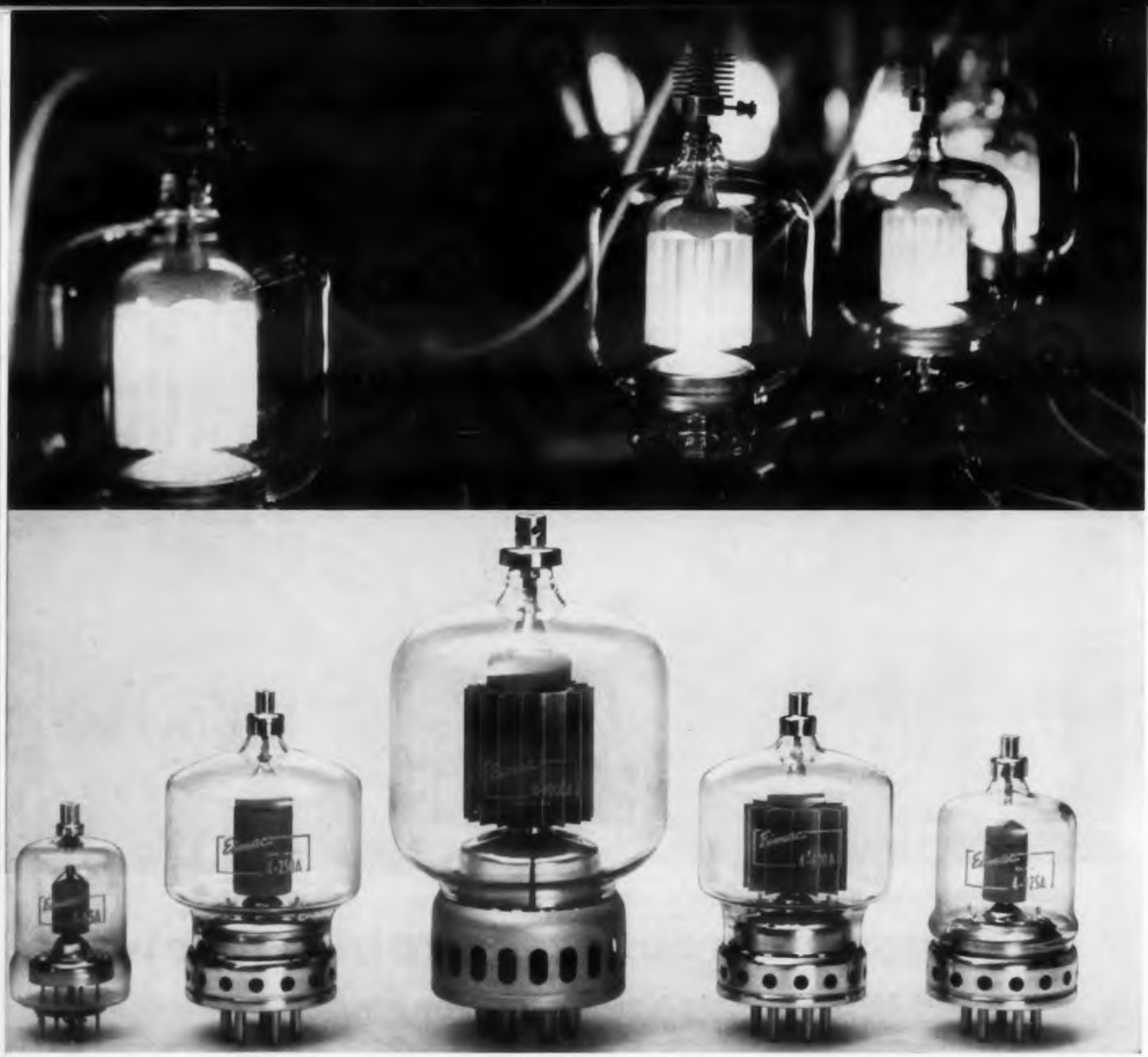
CIRCLE 918 ON CAREER FORM PAGE 95 ➤

idea:

Submarines can hide within range of helicopter-borne sonar by "riding the thermocline"—a water temperature change that casts shadows in sonar-search patterns. Precise temperature-vs.-depth records allow the operator to spot thermoclines and change his search pattern to look into the shadows. Existing gear "worked", but it took too long and could not define the shadow zones very accurately. TI engineers created an automatic recorder, the **bathythermograph,** more accurate than a laboratory thermometer, that gives results instantly where they were needed—in the helicopter. Small as a portable typewriter, it easily fits with the sonar into the space available.

RESULT: Same sonar—fewer missed submarines.





NEW PRODUCTS

EIR Meter

Portable

Low cost, portable model 457 EIR meter covers 0 to 1200 v ac in six ranges, 0 to 1200 v dc in six ranges, and 0 to 100 meg in four ranges. It has center scale ranges of 5, 500, 5000, and 500,000 ohms; current ranges of 50 μa, 1 ma, 10 ma, 100 ma, 1000 ma, and 10 amp; and five db ranges from −18 to +57. The unit has 20 K per v dc and 1 K per v ac sensitivity, a 5 in. meter, and a single function-range control. Test leads are included.

Hickok Electrical Instrument Co., Dept. ED, 10525 Dupont Ave., Cleveland 8, Ohio.

CIRCLE 255 ON READER-SERVICE CARD

Count and Time Scaler

Has 1 μsec resolving time

A combination decimal count scaler and electronic time scaler, the model 49-33 provides preset time to 1000 sec or preset count to 10 million. Resolving time is 1 μsec. The unit has positive or negative input and includes a full range discriminator, a precision fixed mercury pulse generator, and a four digit register.

Radiation Instrument Development Lab, Inc., Dept. ED, 5737 S. Halsted St., Chicago 21, Ill.

CIRCLE 256 ON READER-SERVICE CARD

Power Transistors

Have 100 v BV_{cbo}

Power transistor types 2N1166 and 2N1167 are rated 25 amp I_c and 100 v BV_{cbo}. The 2N1166 has a standard TO-3 package with 0.052 in. pins, while the 2N1167 is equipped with solder terminals welded to the pins. Both are germanium pnp alloy junction types with collector common to case. They provide a minimum current gain of 15 at 25 amp.

Motorola Inc., Semiconductor Products Div., Dept. ED, 5005 E. McDowell Rd., Phoenix, Ariz.

CIRCLE 257 ON READER-SERVICE CARD

◀ CIRCLE 258 ON READER-SERVICE CARD

Voltage Dividers

Both ac and dc

Model 1001 and 1002 voltage dividers are combined ac and dc ratio standards that provide six place resolution and ac ratios up to 1.11111. The dc sections are the same in both units. In the 1001, the ac ratio transformer section operates from 50 cps to 10 kc with 0.35 cps, 350 v maximum input voltage. In the 1002, the ac RatioTran section operates from 30 cps to 1 kc with a 2.5 cps, 350 v maximum input. The ac sections of the 1001 and 1002 are available by themselves as models 1003 and 1004, respectively.

Gertsch Products, Inc., Dept. ED, 3211 S. La Cienega Blvd., Los Angeles 16, Calif.

CIRCLE 259 ON READER-SERVICE CARD

Receiving Tubes

Miniature

These miniature receiving tubes are designed for TV, tuner, and auto radio use. Type 6AF3 single diode is for horizontal frequency damper service in TV receivers; type 6DT8 and 12DT8 duo triodes can be used as combined rf amplifiers and oscillator-mixers in fm tuners; type 6ES5 diode triode is for use as a TV rf amplifier; and type 12DY8 tetrode, sharp cutoff triode is for auto radios.

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

CIRCLE 260 ON READER-SERVICE CARD

Shock Indicators

Show shipping damage

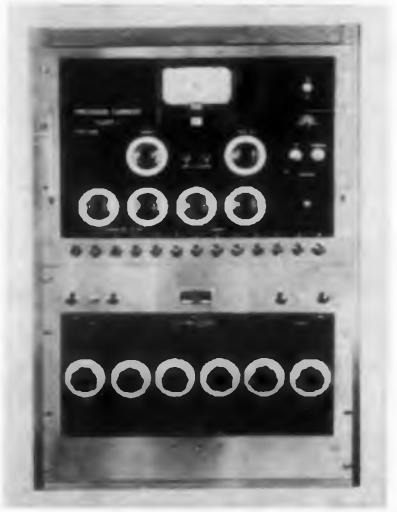
Designed to show when shock to an instrument has passed permissible limits, V-Dot indicators are available from 5 to 75 g in standard models. They have complete spherical sensitivity, and are also available with one or two plane sensitivity. Resettable and reusable, the units are accurate to within 5% of the preset value and last about 5 years.

Inertia Switch, Inc., Dept. ED, 511 W. 43rd St., New York 36, N.Y.

CIRCLE 261 ON READER-SERVICE CARD

CIRCLE 262 ON READER-SERVICE CARD ➤

NEW PRODUCTS



Voltage-Current Potentiometer

Primary standard

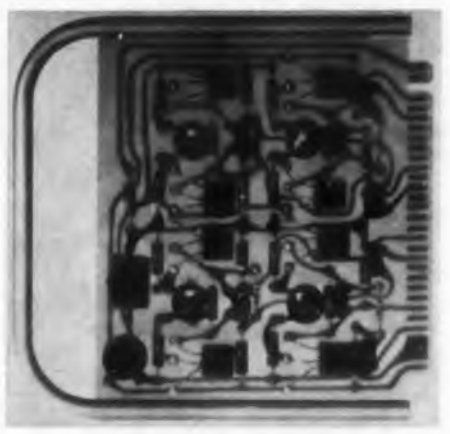
Voltage-current potentiometer model PVC-504 is composed of a primary standard, absolute voltage reference with 0.0002% absolute accuracy and stability; a primary standard, six-decade voltage divider with 100 K overall resistance and 0.0001% divider accuracy; and a stable, constant current generator that provides up to 40 ma in four ranges, each continuously adjustable in 1 million direct reading increments from zero to maximum. As a potentiometer, it provides 0.0015% accuracy on its 1 and 4 v ranges and 0.003% accuracy on its 1, 4, 10, and 40 ma ranges. As a current or voltage generator, it is 0.003% accurate. The unit fits a standard 19 in. relay rack.

Julie Research Labs, Inc., Dept. ED, 556 W. 168th St., New York 32, N.Y.

CIRCLE 264 ON READER-SERVICE CARD

Thyratron Driver

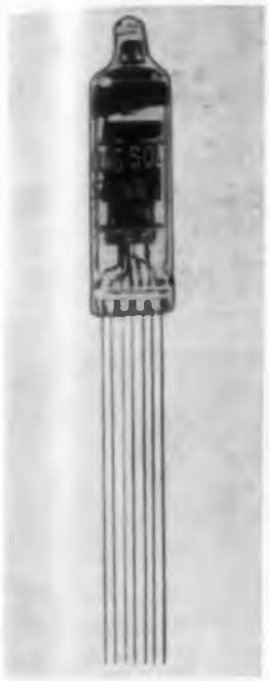
Has 75 μsec pulse duration



Thyratron driver model TO-10 is designed for triggering thyratrons or other circuits which cannot be directly operated from the company's T-Pac model LE-10. Output amplitude is 14 v positive, output pulse duration, 50 μsec min and 75 μsec nominal; output impedance, 3.9 K.

Computer Control Co., Inc., Dept. ED, 92 Broad St., Wellesley 57, Mass.

CIRCLE 265 ON READER-SERVICE CARD



Subminiature Tubes

MIL-STD-200D preferred

These rugged, subminiature 6.3 v tubes appear on the MIL-STD-200D preferred list. The 5702WA is a 400 mc, sharp cutoff pentode with low interelectrode capacitances and high input resistance at ultra high frequencies; the 5718 is a 500 mc, medium-mu triode for use as a uhf oscillator; the 5719 is an af, high-mu triode; the 5896 is a 400 mc, double diode for the uhf band; and the 6111 is a uhf medium-mu twin triode. All units withstand severe shock and vibration.

Tung-Sol Electric Inc., Dept. ED, 95 Eighth Ave., Newark 4, N.J.

CIRCLE 266 ON READER-SERVICE CARD

AC Null Detector

Covers 20 cps to 200 kc

Designed for bridges, the model 51-A ac null detector is a sensitive tuned detector that covers the 20 cps to 200 kc range. Its input impedance is 1 meg shunted by 100 μμf, and its sensitivity is such that a 10 μv input will produce a deflection of 1/4 in. on the 2 in. cathode ray indicator or 0.1 ma on an external meter. Discrimination against the second harmonic of the tuned frequency is 40 db over most of the range. The unit may be calibrated for use as a tuned peak-to-peak voltmeter or as a wave analyzer.

Boonton Electronics Corp., Dept. ED, 738 Speedwell Ave., Morris Plains, N.J.

CIRCLE 267 ON READER-SERVICE CARD

NEW PRODUCTS

AVC AUDIO COMPRESSORS.—These units may be connected in the microphone line of any high impedance audio equipment, holding the input to equipment within 6 db regardless of input to the microphone. They may also be connected in the speaker line of receivers to prevent blasting. Model AFC-1, 3 x 3 x 5 in., requires an external power source for B+ and filaments and contains a built-in 90 to 3500 cps audio filter. Model AFC-2, 5 x 5 x 7 in., has a built-in power supply and a switchable audio filter.

P&H Electronics Inc., Dept. ED, 424 Columbia, Lafayette, Ind.

CIRCLE 269 ON READER-SERVICE CARD

VHF AMPLIFIER.—Type VAC-1 provides 40 db minimum gain on any TV channel in the 54 to 88 mc range. At channel 6, noise figure is 3 db. The unit weighs 12 lb and has 10,000 hr tubes.

Adler Electronics, Inc., Dept. ED, 1 LeFevre Lane, New Rochelle, N.Y.

CIRCLE 270 ON READER-SERVICE CARD

VARIABLE TRANSFORMERS.—Series 10B transformers have a brush designed for long life and an improved terminal design for soldered connections or push-on connectors. Series 126-226 units have constant current load ratings up to 12.5 amp and constant impedance ratings up to 18 amp.

Superior Electric Co., Dept. ED, Bristol, Conn.

CIRCLE 271 ON READER-SERVICE CARD

PANCAKE SYNCHRO.—For inertial platforms, this precision size 20 synchro is 3/8 in. wide. It has 6 ft spread accuracy and is designed for use with 26 v, 400 cps or 115 v, 2000 cps. It is insensitive to clamping pressures on either rotor or stator.

Clifton Precision Products Co., Inc., Dept. ED, 9014 W. Chester Pike, Upper Darby, Pa.

CIRCLE 272 ON READER-SERVICE CARD

MINIATURE TRANSISTOR TRANSFORMERS.—These seven units are available hermetically sealed, in a MIL-AF case, in a round hermetic case, or in epoxy molded construction. They occupy less than 1 cu in. and weigh about 1 oz.

Microtran Co., Inc., Dept. ED, 145 E. Mineola Ave., Valley Stream, N.Y.

CIRCLE 273 ON READER-SERVICE CARD

KNOCKOUT PUNCH.—Model 734-D quickly cuts double-D holes for electrical receptacles. Operated with an ordinary wrench, it makes a finished receptacle 1-1/8 in. in diameter across the parallel sides 1-3/8 in. in diameter across the rounded ends. Holes are made in a few minutes without filing or other hand finishing operations.

Greenlee Tool Co., Dept. ED, Rockford, Ill.

CIRCLE 274 ON READER-SERVICE CARD

NEW PRODUCTS

RF Detectors

Have low vswr

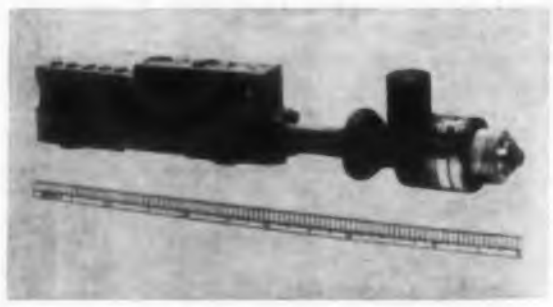
Designed to rectify rf test signals in laboratory and production-line testing and tuning, these crystal diode detectors have a low vswr and cover the 1 to 2000 mc range. The series includes half wave, two-polarity half wave, voltage doubler, and balanced circuits with termination impedances ranging from 50 to 300 ohms. Two detectors in the line are the XD-3 and XD-8. The first is a half wave rectifier covering 1 to 1000 mc with a vswr of 1.1 to 1 below 500 mc and 1.2 to 1 above. The second is a voltage doubler circuit with a 1 to 250 mc range and a 1.1 to 1 vswr.

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

CIRCLE 281 ON READER-SERVICE CARD

Video Detector Mount

Filter and crystal



This filter and crystal video detector mount, mechanically and electrically a single unit, has a pass band of 2.6 to 3.25 kmc and an insertion loss of under 1.4 db within this band. It has a tangential sensitivity of —57 dbm measured with a 2 mc video bandwidth using an MA40SB crystal. Input is matched to a 50 ohm line and Microdot miniature coaxial connectors are used at both input and output. The entire combination weighs about 3 oz.

American Electronic Labs, Inc., Dept. ED, 216 N. Seventh St., Philadelphia 6, Pa.

CIRCLE 282 ON READER-SERVICE CARD

Radar Pulse Modulator

Has 500 kw peak power

For testing antenna systems or other radar devices, this laboratory pulse modulator has up to 500 kw peak power and up to 4000 pps repetition rates. It can be furnished with a pulse amplifier and generator or arranged to operate from external pulse sources. Provisions are made for the incorporation of various pulse forming networks from 0.5 to 2 μsec. Designed to operate into a 50 ohm output impedance, the unit has a 50 ohm pulse cable.

Dormitzer Electric & Mfg Co., Inc., Dept. ED, 5 Hadley St., Cambridge 40, Mass.

CIRCLE 283 ON READER-SERVICE CARD

Transfer Function Bridge

Measures impedance and admittance

Over a 60 to 1 frequency range from 25 to 1500 mc, the type 1607-A bridge measures all complex transfer functions of electron tubes, amplifiers, attenuators, filters and transistors in common base or common emitter connection. It directly measures input and output impedances and admittances of two, three, and four terminal devices and networks. Ranges are: voltage and current ratios, 0 to 30; transimpedance, 0 to 1500 ohms; transadmittance, 0 to 600 millimhos; impedance, 0 to 1 K; admittance, 0 to 400 millimhos. The unit has terminals for introducing dc bias from external sources. Maximum bias current is 100 ma; maximum bias voltage, 400.

General Radio Co., Dept. ED, West Concord, Mass.

CIRCLE 284 ON READER-SERVICE CARD

NEW PRODUCTS

LIGHTED PANELS.—Custom constructed Lampanels have colors, lettering, lights, sockets, resistors, and circuits inside the panel thickness. Gas type bulbs last 3000 to 6000 hr, emit light which is transmitted laterally through an acrylic layer in the plastic board. Light is reflected through front surface in even orange or red color. Lampanels conform with MIL-P-7788A, operate on 110 v ac, 60 cps or on dc with less intensity.

Miller Dial & Name Plate Co., Dept ED, 4400 N. Temple City Blvd., El Monte, Calif.

CIRCLE 287 ON READER-SERVICE CARD

AC PANEL VTVM.—Model 332 has 2-1/2 in. meter, 0 to 100 mv rms basic range, 20 cps to 20 kc ±2% frequency response, ±3% full scale accuracy. Input impedance is 1 meg paralleled by 10 μμf. Barrel is 2 in. in diameter and under 4-3/4 in. long. Provided with any voltage range to 300 v rms.

Metronix, Inc., Dept. ED, Chesterland, Ohio.

CIRCLE 288 ON READER-SERVICE CARD

LOW LEVEL DC AMPLIFIERS.—Typical of this line is model MA-1-5 which has power gain of over 1 million and delivers full output of 5 v into 1 K with 1 mv input signal. Input impedance, 50 ohms min; response time, 0.5 sec; power requirements, 28 v dc ±5%; linearity, ±2% of full scale. Unit is hermetically sealed, occupies under 16 cu. in., features common mode rejection.

Micromag Instrument Corp., Dept. ED, 115 Halleck St., Roxbury, Mass.

CIRCLE 289 ON READER-SERVICE CARD

TEMPERATURE TEST CHAMBER.—This chamber has a −100 to +1000 F range and features liquid CO_2 refrigeration. It can dissipate 5000 Btu per hr at −100 F and cools from ambient to this temperature in under 3 min. An optional multipane window gives a full view of the 18 cu in. interior.

Associated Testing Labs, Inc., Mfg. Div., Dept. ED, Clinton Rd., Caldwell, N.J.

CIRCLE 290 ON READER-SERVICE CARD

RADAR DISPLAY TUBES.—Model 10K[illegible]B is 10 in., long persistence unit of round glass construction with metal backed screen, gray glass faceplate, magnetic focus and deflection. Model 10W[illegible]7A has aluminized screen, no-ion-trap gun, electrostatic focus, magnetic deflection. Model 12ABP7A is 12 in. round unit with metal backed screen, gray filter glass faceplate, magnetic deflection, and low voltage electrostatic focus gun with high definition.

Westinghouse Electric Corp., Electronic Tube Div., Dept. ED, P.O. Box 284, Elmira, N.Y.

CIRCLE 292 ON READER-SERVICE CARD

MULTICONTACT METER READOUT UNIT.—Model DT-12 digitizer is for applications where dc current readout is required at 1 to 10 quantitative predetermined values. It can also be used for conversion of current transients into operative or multiple alarm points. The unit has ten independent output channels, 0 to 1 ma dc input, and ±0.02 ma accuracy.

Atomation, Inc., Dept. ED, 5959 S. Hoover St., Los Angeles 44, Calif.

CIRCLE 293 ON READER-SERVICE CARD

FOCUSING LIGHT SOURCE.—Model LS-2 extends working range of company's photoelectric scanning systems. Focus adjustment provides sharply defined light spot at any distance from 1 ft to 5 in., allowing precise control by rapidly moving objects. Source is contained in cast aluminum housing 1-1/4 x 1-1/4 x 2-1/16 in. with focusing system extending 1-13/16 to 2-1/8 in. beyond, depending on focus.

Farmer Electric Products Co., Inc., Dept. ED, 2300 Washington St., Newton Lower Falls, Mass.

CIRCLE 294 ON READER-SERVICE CARD

TRACING PAPER.—V-600 Vindure is impervious to buckling, resists ghosting when used with hard pencils, retains writing quality after many pencil or ink erasures, can be dipped in water, does not yellow with age. Available in rolls 30, 36, and 42 in. wide; in cut sheets plain or printed with title block and border line; and with cross section ruling of 4 x 4, 5 x 5, 8 x 8, and 10 x 10 to inch.

George Vincent, Inc., Dept. ED, 95 Industrial Ave., E., Clifton, N.J.

CIRCLE 295 ON READER-SERVICE CARD

NEW PRODUCTS

Rack-Mounted Power Supplies

Have continuously variable 0 to 32 v dc output

W series rack-mounted laboratory power supplies give 0.5% regulation from no-load to full-load; Z series give 0.01% regulation. Both series operate with ac inputs from 105 to 125 v, 60 to 400 cps, have continuously variable outputs from 0 to 32 v dc, and are available with 2, 5, 10 or 15 amp maximum output.

Consolidated Avionics Corp., Dept. ED, 800 Shames Dr., Westbury, N.Y.

CIRCLE 299 ON READER-SERVICE CARD

Motor Tachometer Generator

Temperature compensated

Type 6280-05 is a size 15, temperature compensated motor tachometer generator incorporating a 4-pole, 115 v, fixed phase motor with a 36 v, control phase, center tapped winding suitable for transistorized operation. Stall torque is 1.5 oz-in.; no load speed, 9500 rpm; output voltage gradient, 2.2 v per 1000 rpm; linearity, 0.05% to 4200 rpm. Maximum variation in output voltage is ±0.2% from −10 to +95 C. The unit is 3.315 in. long, meets MIL-E-5272, and weighs 12.5 oz.

John Oster Mfg. Co., Avionic Div., Dept. ED, 1 Main St., Racine, Wis.

CIRCLE 300 ON READER-SERVICE CARD

Overload Circuit Breakers

Provides 1/8 to 1 cycle fault current removal

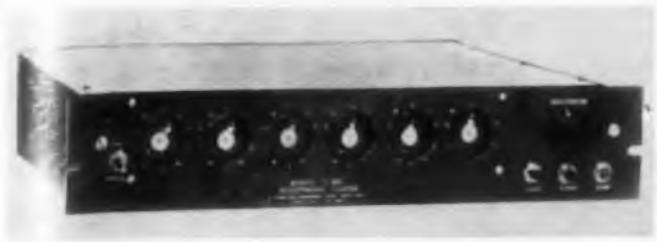
Superfast vacuum switch circuit breaker provides positive interruption at first current zero in ac circuits to limit arc time to less than 8 msec. This, combined with mechanical operating times of less than 2 msec, results in 1/8 to 1 cycle fault current removal. It is available with interrupting capabilities up to 115 kv and 4000 amp and continuous current rating up to 600 amp rms.

Jennings Radio Mfg. Corp., Dept. ED, P.O. Box 1278, San Jose, Calif.

CIRCLE 301 ON READER-SERVICE CARD

Electronic Timer

Presets for ½ to 10,000 sec



Electronic timer model N-801 is a glow-tube type unit that can be preset for 1/2 to 10,000 sec in steps of 1/2, 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, and 10,000 sec. It also has provisions for elapsed time measurements to 1000 or 10,000 sec. The unit has remote control electronic gating and a timing accuracy of 0.1% per day. Suited for X-ray counting, the unit may be used with the company's model N-270 printer scaler or separately.

Hamner Electronics Co., Inc., Dept. ED, Princeton, N.J.

CIRCLE 302 ON READER-SERVICE CARD

Hall Effect Device

Has −65 to +125 C temperature range

The type HR-31 Halltron device has high gauss sensitivity and a temperature range of −65 to +125 C. Temperature sensitivity of the Hall effect is 0.1% per deg C or less. The unit has a control current of 500 ma maximum and 300 ma nominal, a Hall circuit power of 50 mw maximum, and a typical Hall output voltage of 0.35 at 500 ma. Featuring low noise and high resolution with no hysteresis, it is suited for flux measuring equipment, analog multipliers, power meters, and a variety of other equipment.

Ohio Semiconductors, Inc., Dept. ED, 1035 W. Third Ave., Columbus 8, Ohio.

CIRCLE 303 ON READER-SERVICE CARD

Modular Plotter

Has one, two, or four active bridge arms

Model 222 modular plotter is a multi-channel instrument for scanning and plotting strain vs. load data. It has one, two, or four active bridge arms, 24 channel modules and is available with 4 or 24 factor controls and 4 or 24 range selectors. This model has individual graphs and three zero positions for each channel, automatic zero and gage factor adjustments, individual range selection, and gage factors for each channel.

Gilmore Industries, Inc., Dept. ED, 13015 Woodland Ave., Cleveland 20, Ohio.

CIRCLE 304 ON READER-SERVICE CARD

NEW PRODUCTS

MINIATURE ADJUSTABLE THERMOSTATS.—Models M-1 and M-2 for communication, aircraft, missile, and other electronic use. Temperature range, preset at 50 C, is 40 to 90 C; electrical rating, 0.75 amp, 28 v ac, noninductive. M-1 is 1 in. long with temperature differential of 0.5 C at thermostat; M-2 is 3/4 in. long with 1 C temperature differential. Both units weigh 3 g, have 1/4 in. diameter.

Ramco Products, Dept. ED, P.O. Box 1381, Erie, Pa.

CIRCLE 307 ON READER-SERVICE CARD

NYLON CABLE TIES.—For strapping, clamping, or fastening wire bundles to supporting structure, Ty-Raps withstand —65 to +350 F, replace 14 AN type clamb sizes for 1/16 to 1-3/4 in. diameter bundles. Available in tool installed and self-clinching styles, variety of colors.

Thomas & Betts Co., Dept. ED, 36 Butler St., Elizabeth, N.J.

CIRCLE 308 ON READER-SERVICE CARD

MINIATURE TRANSIENT PEAK RELAY.—Solid state type MLA-800 absorbs or grounds transient peaks and surges without imposing power load on system or unbalancing output impedance. Leakage values: at 250 v, infinitesimal; 500 v, 2.1 μa; 800 v, 4.1 μa; 1200 v, 6.6 μa. Unit has 5/8 in. diameter, is 3/4 in. long, closes at about 1460 v, opens again at 1400 v.

Clark Electronic Labs, Research Products Div., Dept. ED, Box 165, Palm Springs, Calif.

CIRCLE 309 ON READER-SERVICE CARD

THERMOCOUPLE CONNECTOR.—Two-post model F-2 operates to 1000 F, is removable and reusable. Unit mounts on thermocouple shaft end with brass compression fitting, needs no welding, provides direct contact between thermocouple and thermocouple lead wires. Four-post model also available.

Aero Research Instrument Co., Dept. ED, 315 N. Aberdeen St., Chicago 7, Ill.

CIRCLE 310 ON READER-SERVICE CARD

LINEAR AMPLIFIER.—Model P develops full electrical output in under 0.1 sec, is fully compatible with inputs from thermocouples, radiation pyrometers, thermal converters, and dc strain gages. Unit develops effective outputs from input signals down to 0.2 mv, provides measurement accuracy of ±0.25% of input range for 5 mv and up. Available in multiple fixed and adjustable ranges, with or without adjustable zero suppression, for rack or wall mounting. Uses include dc preamplification, temperature measurement and control, telemetering, stress measurement, and automation.

Hagan Chemicals & Controls, Inc., Controls Div., Dept. ED, P.O. Box 1346, Pittsburgh 30, Pa.

CIRCLE 312 ON READER-SERVICE CARD

CAPACITORS.—Computer grade Alumalytics in 3 in. diameter, 5-5/8 in. high case with microfarad values 23 to 275% above previous models at all voltage ratings. Capacitance of 3 v unit is 150,000 μf.

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

CIRCLE 313 ON READER-SERVICE CARD

DIGITAL MULTIMETER.—Model M-24 volt-ohm-ratiometer now provides 100 μv and 0.1 ohm sensitivity. Unit automatically measures and displays ±0.9999 to ±999.9 v dc; 0.9999 to 999.9 K; dc voltage ratios to 0.9999. Range multiplier accuracy for dc voltages, 0.01% of reading; resistance measurement accuracy, 0.05% of full scale plus one digit; linearity for dc range and voltage ratio measurements, 0.01% of full scale. Range and polarity changes are automatic.

Non-Linear Systems, Inc., Dept. ED, Del Mar, Calif.

CIRCLE 314 ON READER-SERVICE CARD

BOLOMETER PREAMPLIFIER.—Model BA-1C measures rf power ratios to 30 db between 20 mc and 90 kmc at maximum rf level of 200 μw without switching of attenuators or change of amplifier gain. Unit has fine coarse gain controls, can be used with barretters or video crystals. Regulated self-contained barretter bias circuit replaces battery supply.

Weinschel Engineering, Dept. ED, 10503 Metropolitan Ave., Kensington, Md.

CIRCLE 315 ON READER-SERVICE CARD

NEW PRODUCTS

PHOTOELECTRIC RELAY.—Low cost unit for limit switch type applications. Draws full operating power of 57.5 v directly from transformer which supplies power to light source. Performs 200 operations per min at minimum illumination level of 25 ft-c; mounts in any position. Output relay lasts for 1 million operations with 1 amp, 115 v ac resistive load and mechanical life is 100 million operations.

General Electric Co., Specialty Control Dept., Dept. ED, Waynesboro, Va.

CIRCLE 319 ON READER-SERVICE CARD

DUAL BLOWERS.—For electronic cooling. Models 2NB300 and 2NB408 produce 160 and 320 cfm, respectively, have shaded pole, fan cooled motors with Class A insulation good to 105 C. Shafts are stainless steel; ball bearings are permanently sealed and lubricated per MIL-C-3278; motors meet CC-M-636A.

McLean Engineering Labs, Dept. ED, P. O. Box 228, Princeton, N.J.

CIRCLE 320 ON READER-SERVICE CARD

BISTABLE MAGNETIC AMPLIFIER.—For use as sensitive static relay in regulating and indicating systems. Units combine magnetic with transistor bistable amplifier, have four control inputs and 0 or 5 w output at 24 v dc. Sensitivity, 0.05 μw; average response time, 20 msec; input impedance range, 1 ohm to 1 meg; shock and vibration resistance, per MIL-E-5272; dimensions, 3 x 5 x 7 in.

Westinghouse Electric Corp., Dept. ED, 256 Collins Ave., Pittsburgh 6, Pa.

CIRCLE 321 ON READER-SERVICE CARD

P-C DRAFTING TAPES AND SHAPES.—Pressure sensitive strips and close tolerance shapes for printed circuit layouts in B-225 transparent red or B-150 black tape. More than 150 shapes include terminal circles, fillets, elbows, universal circles, teardrops, and tees.

W. H. Brady Co., Dept. ED, 727 W. Glendale Ave., Milwaukee 9, Wis.

CIRCLE 322 ON READER-SERVICE CARD

UNIVERSAL IMPEDANCE BRIDGE.—Portable model 250-DA with accuracy of 0.1% for resistance, 0.2% for capacitance, and 0.3% for inductance. Equipped with the company's Dekadial which provides over 12,000 dial divisions for each of seven ranges. One dial division represents 0.1 μμf, 0.1 milliohm, and 0.1 μh on lowest ranges. Values to 1200 μf, 12 meg, and 1200 h can be measured on highest ranges. Supplied ready to operate with ac and dc generators and detectors.

Electro-Measurements, Inc., Dept. ED, 7524 S.W. Macadam Ave., Portland 1, Ore.

CIRCLE 324 ON READER-SERVICE CARD

LAMINATED PLASTIC.—Type FF-60 glass melamine laminated plastic has good fire and arc resistance, retains 70% of dielectric strength after two weeks in water at 50 C. Insulation resistance is 20,000 meg after 96 hr exposure to 90% relative humidity.

Formica Corp., Dept. ED, 4532 Spring Grove Ave., Cincinnati 32, Ohio.

CIRCLE 325 ON READER-SERVICE CARD

SILICON POWER TRANSISTORS.—Type 2N1067, 2N1068, 2N1069, 2N1070, and 2N1092 npn diffused junction mesa transistors for use in multivibrator, converter, inverter, and relay and solenoid actuating circuits. Also for use in oscillators, class A and B push-pull amplifiers, and dc amplifiers. Cases are JEDEC TO-3, TO-5, or TO-8. Units have good beta stability over full −65 to +175 C operating range. Peak collector-to-emitter voltages, 50 and 60 v; peak collector currents, 0.5 to 4 amp; dissipation, 1 to 25 w.

Radio Corporation of America, Semiconductor and Materials Div., Dept. ED, Somerville, N.J.

CIRCLE 326 ON READER-SERVICE CARD

INSULATING MATERIAL.—Glass-Teflon Duroid 5870 for use as high temperature circuit base stock, missile antenna dielectric, and microwave strip insulation. Available in rods, tubes, sheets, and copper clad sheets.

Rogers Corp., Dept. ED, Rogers, Conn.

CIRCLE 327 ON READER-SERVICE CARD

NEW PRODUCTS

MINIATURIZED CONTROLS.—Panel mounted units with ac or dc meter relays, self-contained power supplies. Round units have 2-1/2 in. meter relay, 2 in. barrel diameter, 2 to 5 in. length. Rectangular units have nonindicating meter relay, measure about 2 x 2-1/4 x 2-3/4 in. With simple limit circuits, any sensitivity from 0 to 5 μa or 0 to 5 mv may be specified. For automatic circuits, sensitivity begins at 200 μa.

Assembly Products, Inc., Dept. ED, Chesterland, Ohio.

CIRCLE 331 ON READER-SERVICE CARD

SILICON RECTIFIERS.—Style 30 units have 11/16 in. hex stud base, 1-7/16 in. maximum height, weight 1/2 oz. Rated 10 amp average at 150 C ambient and available from 50 to 400 piv in 50 v steps. Outer case is nickel plated to withstand severe service.

Syntron Co., Dept. ED, Lexington Ave., Homer City, Pa.

CIRCLE 332 ON READER-SERVICE CARD

ENVIRONMENTAL TEST CHAMBER.—Walk-in model WD-420 has −100 to +500 F range, can be furnished with humidity control range of 20 to 98% from 35 F dew point to +185 F. Options include programming recording controllers with calibrated accuracy of 0.25% of scale, rain simulation equipment for 1 or 4 in. per hr. Full front end opening door is power operated for recessing into pit below floor level. Unit is also equipped with personnel door, front and wide viewing windows.

Conrad, Inc., Dept. ED, Conrad Sq., Holland, Mich.

CIRCLE 333 ON READER-SERVICE CARD

FERRITE ISOLATORS.—Radar system and laboratory units for 6575 to 6875 mc use. Isolation loss, 40 db; insertion loss, 1 db; vswr, 1.2. Unit is 5 in. long, weighs 2 lb, operates to 160 F.

Motorola Inc., Military Electronics Div., Dept. ED, 8201 E. McDonell Rd., Phoenix, Ariz.

CIRCLE 334 ON READER-SERVICE CARD

DIGITAL CLOCK.—Model DC-112 has telephone type relays and stepping switches, provides digital output in form of contact closures representing hours, minutes, and seconds. Output can be decimal, binary, or binary coded decimal. With suitable external programming circuitry, unit will operate card punches, electric typewriters or printers, other readout devices. Clock operates from unregulated, 115 v, 60 cps power supply, has in-line readout, individual time set pushbuttons, and zero reset button. Mounted on standard 7 x 19 in. relay panel.

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

CIRCLE 336 ON READER-SERVICE CARD

MECHANICAL TIMER.—Model No. TMC-50 fits into 1 cu. in. space; weighs under 4 oz.; withstands —65 to +250 F temperature, 300 g, 20 msec shock, 25 g, 2000 cps vibration. Available over 1 to 20 sec time range with ±5% accuracy.

Timech Corp., Dept. ED, 13866 Saticoy St., Van Nuys, Calif.

CIRCLE 337 ON READER-SERVICE CARD

PULSE GENERATOR.—Precision Tullamore model PPG-1 for calibration of single and multichannel pulse height analyzers. Unit has two pulse outputs, with low level pulse obtained from built-in attenuator which reduces high level pulse by factors of 1, 10, 100, or 1000. Amplitude control is in 10 v steps to 90 v, 1 v steps to 9 v; 10-turn continuous control covers 0 to 1 v range. Rise time is continuously variable from 50 mμsec to 1 μsec; decay time constants are 1, 2, 10, and 100 μsec. Unit is 5-1/4 in. high, weighs 18 lb, fits 19 in. rack.

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

CIRCLE 338 ON READER-SERVICE CARD

METAL FILM RESISTORS.—Model 9850 1-w and 9849 2-w Vamistors have 25 and 50 ppm temperature coefficients; 1, 15, 0.25, and 0.1% tolerances. One unit with 20 meg can dissipate up to 16 w.

Weston Instruments, Div. of Daystrom, Inc., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N.J.

CIRCLE 339 ON READER-SERVICE CARD

NEW PRODUCTS

Tubeless DC Power Supplies

Heavy duty

Tubeless, heavy duty E-line dc power supplies are available in 32 combinations which can be selected from eight basic units. Output ranges are between 0 to 32 and 0 to 160 v, and between 0 to 4 and 0 to 20 amp. All units operate from 115 v, 60 cps, single phase power. They may have ±2 or ±5% load regulation and ±0.5% or no input regulation.

NJE Corp., Dept. ED, 345 Carnegie Ave., Kenilworth, N.J.

CIRCLE 343 ON READER-SERVICE CARD

Motor Drive Amplifier

Provides precise 60 cps power

Series MDA motor drive amplifiers provide extreme frequency regulation of power source and are used to produce precise 60 cps power for tape recorder motors. Motor drive amplifiers are available for operation from either 24 to 28 v dc or 105 to 125 v ac, 48 to 62 cps. Output is 100 w with frequency regulation ±0.02%. Unit weighs 35 lb and measures 7-1/2 x 15-1/2 x 8-5/8 in.

Precision Instrument Co., Dept. ED, San Carlos, Calif.

CIRCLE 344 ON READER-SERVICE CARD

Zener Diodes

Zener voltage is less than 10 v

These diodes have nominal Zener voltages of 6.8, 7.5, 8.2 and 9.1 v with 1, 1.5, 10 and 50 w power ratings. They are available with tolerances of ±20%, ±10% and ±5%. Applications for these low voltage units include power regulation of vacuum tube filaments, protection of transistors against voltage surges, and precise voltage regulation of transistorized equipment.

Motorola Inc., Semiconductor Products Div., Dept. ED, 5005 E. McDowell Rd., Phoenix, Ariz.

CIRCLE 345 ON READER-SERVICE CARD

Flash Tube

Has 3500 candlepower light output

Flash tube FX-6A has a peak light output of 3500 horizontal candlepower at a flash duration of 3 μsec. Under maximum power input the tube has half-light output expectancy of 20 million flashes. It is 7/8 in. in length and diam, and has a standard 9 pin socket. Its operating range is 400 to 1200 v and is triggered by a low-current, high-voltage pulse of between 4 to 7 kv.

Edgerton, Germeshausen & Grier, Inc., Dept. ED, 160 Brookline Ave., Boston, Mass.

CIRCLE 346 ON READER-SERVICE CARD

DPDT Relay

Takes 20 g to 2000 cps vibration

The ESS series hermetically sealed relay can take vibrations of 20 g to 2000 cps with a sensitivity of 80 mw in a dpdt unit. The contacts are rated at 2 amp resistive and coil resistances as high as 36 K are available. The relay enclosure is 1 x 1 x 1-1/2 in.

Hi-G, Inc., Dept. ED, Bradley Field, Windsor Locks, Conn.

CIRCLE 347 ON READER-SERVICE CARD

Counting Rate Meters

Accept signals from radiation detectors

The CRM series count rate meters are available in various combinations having linear, logarithmic and different indications of counting rate. Model CRM–2, linear with meter has 10 ranges, counting rate up to 3 x 10^6 cpm. Type CRM-3 provides logarithmic coverage of counting rates over a six-decade range from 10 to 10^7 cpm. Type CRM-4 is a dual unit simultaneously providing linear and log indications on two meters. Models 2CRM-2 and 2CRM-3 are dual count rate meters and incorporate two linear or two log circuits. Models 2CRM-2D and 2CRM-3D are log dual-differential count rate meters.

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

CIRCLE 348 ON READER-SERVICE CARD

NEW PRODUCTS

WALK-IN TEST CHAMBERS.—Series TC-110 modular environmental chambers are light, weatherproof, need no special foundations. Doors, windows, other openings can be cut anywhere; roofs support 30 lb per sq ft snow load; complete structures withstand 120 mph winds. Heating available by steam or electric elements; cooling by liquid CO_2, block dry ice, or mechanical refrigeration. Suitable for high and low temperature, humidity, salt spray, other environments.

Wyle Mfg. Corp., Dept. ED, El Segundo, Calif.

CIRCLE 351 ON READER-SERVICE CARD

RECORDING HEAD.—All metal, universal unit records 20 audio or digital information channels on 1 in. tape; incorporates precision lapped gap and full shielding between channels.

General Transistor Western Corp., Dept. ED, 6110 Venice Blvd., Los Angeles 34, Calif.

CIRCLE 352 ON READER-SERVICE CARD

DUMMY ANTENNAS.—Series RBN, RBK, and RD for tuning, checking, and measuring transmitter power output. Cover 0 to 30, 30 to 200, 0 to 600 mc and transmitter outputs from 50 w to 20 kw. Type RBN units ensure character of an exponential line over full operating frequency range; RBK units are designed according to long lossy line principle; RD types consist of ladder networks.

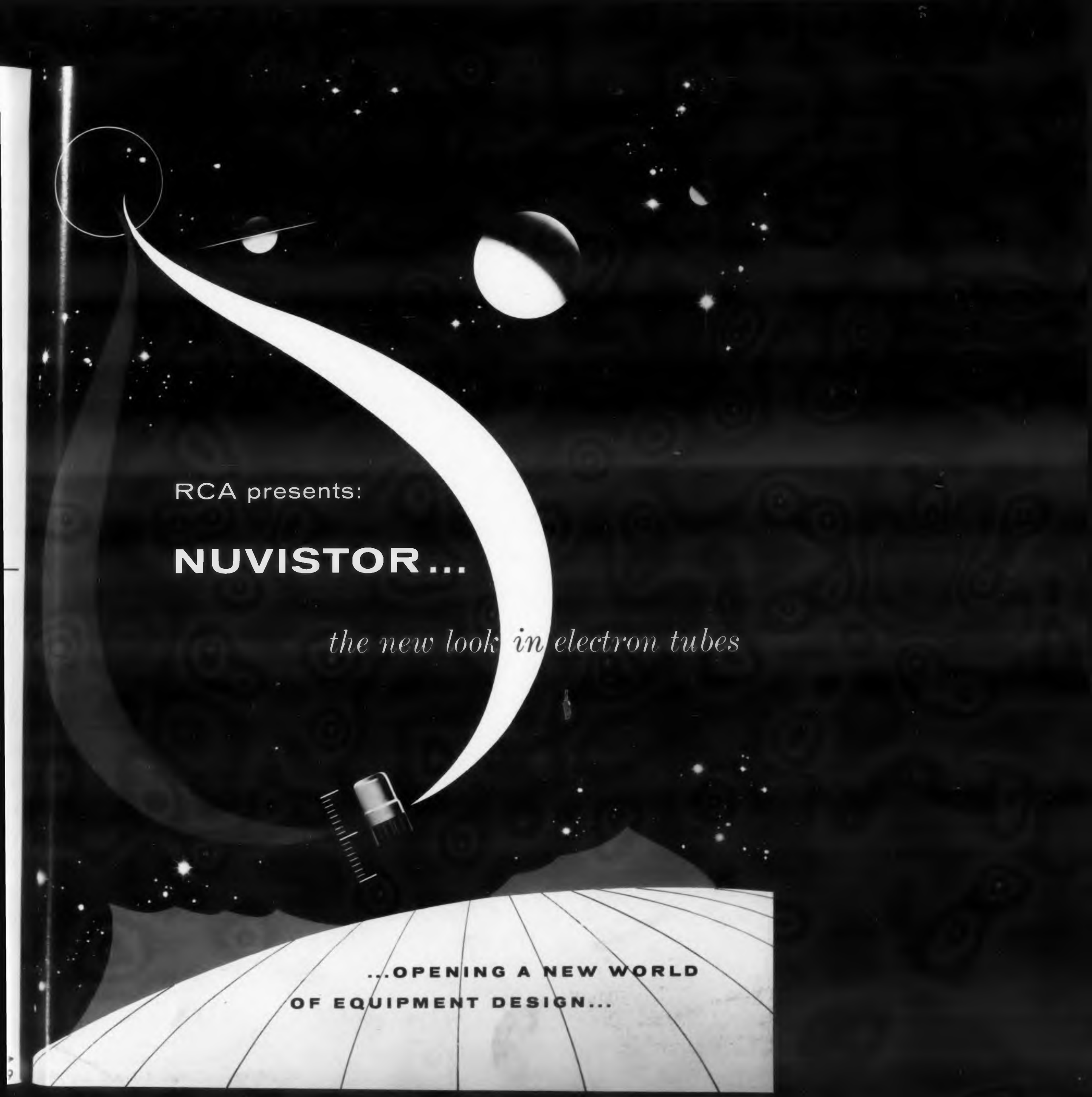
Rohde & Schwarz Sales Co., Inc., Dept. ED, P.O. Box 275, Passaic, N.J.

CIRCLE 353 ON READER-SERVICE CARD

PHOTOVOLTAIC TRANSDUCER.—Miniature, precision Celab Fotoducer reads directly on millivoltmeters, microammeters, or ohmmeters without amplification; maintains accuracy and repeatability over wide temperature range and in vibration environments. Available as load cell, accelerometer, or potentiometer. Width, 1-1/4 in.; height, 1-1/2 in.; weight, 55 g. Most models use 1.5 or 3 v supply.

Clark Electronic Labs, Research Products Div., Dept. ED, Box 165, Palm Springs, Calif.

CIRCLE 354 ON READER-SERVICE CARD


RCA presents:
NUVISTOR...
the new look in electron tubes
...OPENING A NEW WORLD
OF EQUIPMENT DESIGN...

OUT OF THE PAST

Man's knowledge and skills increase with every moment. Theory becomes reality. Principle becomes practice. These are the dynamics of this era. And, in this quest for new knowledge, for a finer way of life, Electronics has become one of man's most important tools. RCA has contributed steadily to the advancement of Electronics... has constantly endeavored to remove the limitations imposed by accepted materials, processes, and techniques.

A BRIGHT PROMISE FOR THE YEARS AHEAD

RCA now presents an entirely new concept in electron tubes... a concept that promises to be one of the most exciting advancements in electron-tube design.

NUVISTOR

...the new look in electron tubes that drastically reduces size, weight, mass, and power drain!

...the new design in electron tubes that promises dramatic improvements in quality, performance, and reliability!

NUVISTOR... *a new era in electron tubes!*

The **NUVISTOR** *concept promises tube structures that are truly rugged.*

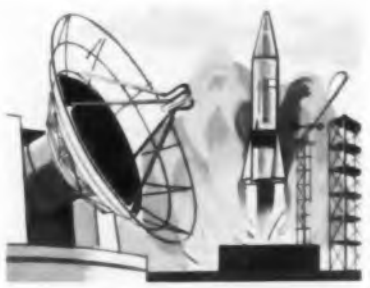
Each tube electrode is brazed to its supporting member, an open-ended conical structure. The platform for the structure is a strong ceramic base-wafer. Electrodes are extraordinarily small, lightweight cylinders. Neither mica nor glass is used. Spot welding is eliminated. This combination of strong structural assembly, brazed joints, all ceramic-metal construction, small size, extra low mass, and high-temperature processing has resulted in a tube design in a small envelope that holds promise of fine performance under thermal or mechanical shock and continuous vibration. For example, NUVISTOR triodes have been subjected to more than 1000 blows each of 850 g's for 0.75 millisecond. After such tests, no shorts were indicated...either permanent or temporary.

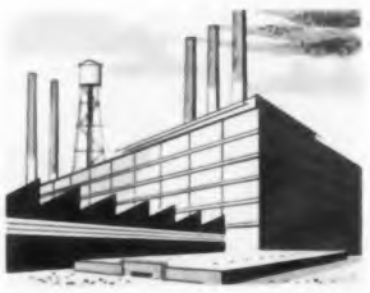
NUVISTOR *is given its start in a brazing furnace.*

Ceramics and strong metals such as steel, molybdenum, and tungsten—processed at high temperatures in brazing and vacuum exhaust furnaces—form the basic structure of the tube. Such high-temperature processing eliminates many of the gases and impurities that cannot be eliminated when tubes of conventional design are processed at temperatures limited by glass and mica. This new processing technique significantly reduces the residual gases that might contaminate the tube as the elements heat and age. And, because the tubes have been outgassed at high temperatures, they offer promise of operating at ambient temperatures considerably higher than conventional tubes can withstand. NUVISTOR tubes have been subjected to temperatures of 660°F...and continued to function. At normal operating temperatures, therefore, reliable operation over long periods of time can be anticipated.

NUVISTOR *can withstand the test of freezing cold.*

In several tests, NUVISTOR tubes continued to function when immersed in liquid nitrogen at a temperature of -320°F.





what **NUVISTOR** *will mean to defense electronics*

NUVISTOR seems destined to have significant impact upon equipment designed for military applications. NUVISTOR promises an extremely high level of performance and reliability never before anticipated from electron tubes produced in large quantities. Under unusual conditions of environment, the reliability of NUVISTOR promises to make radical improvements in "mean-time-to-failure hours". NUVISTOR tubes offer miniaturization capabilities that can significantly increase payload capacities of military vehicles. The electrical characteristics of NUVISTOR tubes make them suitable for many different services...hold out the prospect of designing a large number of circuits "around" just a few tube types. These NUVISTOR features can reduce requirements for replacement equipment and service personnel, can increase mobility of the equipped "arm".

what **NUVISTOR** *will mean to industrial electronics and entertainment products*

The high-performance capability of NUVISTOR and its inherent ability to function under difficult environmental conditions seem certain to stimulate new equipment designs for industry. Automation, electronic computers and business machines, closed-circuit television—in fact, the entire range of industrial electronics applications will be given a new platform from which to climb higher. In electronic equipment for home entertainment, more compact, more reliable, more attractive products are in store. New levels of performance can be expected in lightweight AM and FM radios, phonographs, hi-fi, and TV sets.

NUVISTOR small-signal TRIODE

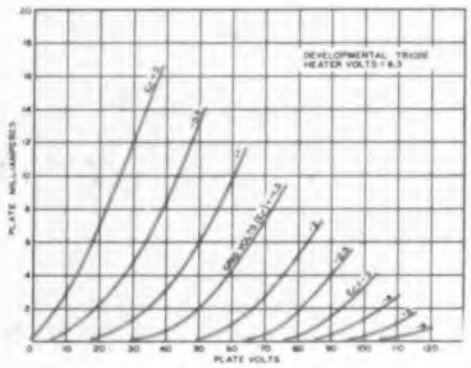
Ready now...on a limited sampling basis...for new equipment designs. First Nuvistor type to be sampled.

High-frequency amplifier performance...

The NUVISTOR triode has shown its mettle as a radio-frequency amplifier in experimental TV-tuner tests. Compared to miniature types 6BQ7-A and 6BN4-A in cascode and neutralized-triode VHF amplifiers, Nuvistor has provided improved gain and at least 1 db less noise measured at television channel 13. In addition, Nuvistor has indicated greatly reduced B+ power drain—about ⅓ the voltage and ½ the current used for the miniature types. Experimental cascode-type tuners using Nuvistors have demonstrated substantially higher performance than commercial tuners, even those using the latest commercial types of receiving tubes...and they required less heater power and only about one watt of B+ power input, as compared to about 7 watts for commercial cascode-type tuners.

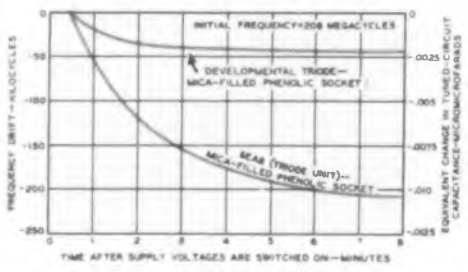
Oscillator performance...

The Nuvistor is a remarkably stable and efficient tube for local oscillator service. Oscillations are obtainable at more than 1000 megacycles with the Nuvistor triode in conventional molded-type sockets. Oscillator efficiency is essentially independent of frequency up to about 450 megacycles, and typical circuits start oscillating with 7 volts or less at the plate of the tube. The low power input needed for the oscillator, as well as amplifier and mixer circuits, helps reduce temperature rise and consequent frequency drift of tuned circuits. The tube itself is particularly stable. Note the accompanying graph which shows the warm-up drift of a 200-megacycle oscillator compared to type 6EA8, a notably good VHF tuner tube by present standards. Each type produces the same output voltage in a conventional circuit from which other causes of drift were removed—yet Nuvistor triode has less than ¼ the warm-up frequency drift of 6EA8.



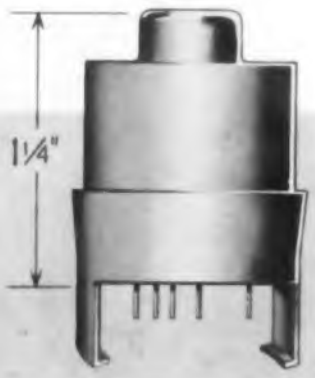
◀ TYPICAL PLATE CHARACTERISTICS

OSCILLATOR FREQUENCY STABILITY CURVE ▼



TYPICAL DATA

ELECTRICAL:		
Heater, for Unipotential Cathode:		
Voltage (AC or DC)		6.3 volts
Current		0.14 amp
CHARACTERISTICS, CLASS A_1 AMPLIFIER:		
Plate Voltage	40	75 volts
Grid Resistor	1	— megohm
Grid Voltage	—	−1.35 volts
Amplification Factor	31	31
Plate Resistance (approx.)	—	2600 ohms
Transconductance	12000	12500 μmhos
Plate Current	8.5	12.5 ma
Grid Voltage (approx.) for plate current of 10 μa	—	−6.5 volts
MAXIMUM RATINGS, DESIGN-MAXIMUM VALUES:		
PLATE VOLTAGE		110 max. volts
GRID VOLTAGE		−55 max. volts
PEAK POSITIVE GRID VOLTAGE		2 max. volts
PLATE DISSIPATION		1.2 max. watts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode		100 max. volts
Heater positive with respect to cathode		100 max. volts



NUVISTOR BEAM POWER TUBE

Now being developed...plate dissipation objective in the order of 30 watts; intended for beam-power applications in the entertainment, industrial and military fields.

NUVISTOR small-signal TETRODE

Ready soon for limited sampling... an amplifier tube for new equipment designs in entertainment, industrial, and military applications.

what NUVISTOR will mean to you...the designer of electronic equipment

Remember way back when all tubes were "radio tubes", and they earned the name "bottle". They were big, fragile, and relatively inefficient. Miniaturization was a vague dream. Rugged tubes were nonexistent. Portability really meant transportability. Design possibilities were limited. But, new developments in tube designs brought smaller envelopes, sturdier structures, the octal socket, the 7-pin and 9-pin miniatures...new techniques and new processes...electrical uniformity, reliability and efficiency! So, NUVISTOR takes its place in the progressive advancement of the electronics industry with new criteria for electron-tube efficiency and reliability. And you, the design engineer, will participate importantly as NUVISTOR ELECTRON TUBES open a new world of unlimited possibilities in equipment design.

For more details on NUVISTORS and for information on how you may obtain developmental samples of NUVISTOR small-signal TRIODE, call your RCA Field Representative at the Field Office nearest you.

ENTERTAINMENT SALES
- Newark 2, N. J., 744 Broad Street, HUmboldt 5-3900
- Detroit 2, Mich., 714 New Center Bldg., TRinity 5-5600
- Chicago 54, Ill., Suite 1154, Merchandise Mart Plaza, WHitehall 4-2900
- Los Angeles 22, Calif., 6355 E. Washington Blvd., RAymond 3-8361

INDUSTRIAL SALES
- Newark 2, N. J., 744 Broad Street, HUmboldt 5-3900
- Detroit 2, Mich., 714 New Center Bldg., TRinity 5-5600
- Chicago 54 Ill., Suite 1154, Merchandise Mart Plaza, WHitehall 4-2900
- Los Angeles 22, Calif., 6355 E. Washington Blvd., RAymond 3-8361

GOVERNMENT SALES
- Newark 2, N. J., 744 Broad Street, HUmboldt 5-3900
- Dayton 2, Ohio, 224 N. Wilkinson St., BAldwin 6-2366
- Washington 6, D. C., 1625 "K" St., N.W., District 7-1260

RADIO CORPORATION OF AMERICA

Electron Tube Division — *Harrison, N. J.*

PLASTIC PROTECTED MARKINGS.—May be used for both exterior or interior applications. Duralar, a polyester film layer laminated over the markings, makes these signs completely permanent.

Duralith Corp., Dept. ED, 1025 Race St., Philadelphia 7, Pa.

CIRCLE 356 ON READER-SERVICE CARD

UHF TRANSMITTER.—Model 28 1 kw uhf transmitter, 225 to 400 mc, is self-contained and needs a primary power source of 380 to 1200 cps for operation. It can handle 1750 channels, weighs less than 200 lb and is 15 x 30 x 27 in.

Electronic Communications, Inc., Dept. ED. St. Petersburg, Fla.

CIRCLE 357 ON READER-SERVICE CARD

BONDING SOLUTION.—Fluorobond solution is used to make fluorocarbons bondable. Materials such as Teflon or Kel-F can be treated in a maximum of 15 sec by either dipping, brushing or spraying.

Joclin Manufacturing Co., Dept. ED, Lufbery Ave., Wallingford, Conn.

CIRCLE 358 ON READER-SERVICE CARD

FIBERGLASS TUBING.—Polytube is class B polyester varnished fiberglass tubing with high flexibility. It is resistant to acids, alkalis, and moisture, and is unaffected by hot or cold transformer oils.

L. Frank Markel & Sons, Dept. ED, Norristown, Pa.

CIRCLE 359 ON READER-SERVICE CARD

SNAP CLAMP.—Snaps into closed position instantly, and can be adjusted to apply up to 800 lb of clamping force. The clamp accommodates any size work piece, and is used for welding operations and holding electronic chassis assembly.

Wilton Tool Mfg. Co., Inc., Dept. ED, Schiller Park, Ill.

CIRCLE 360 ON READER-SERVICE CARD

NEW PRODUCTS

MINIATURE FEEDTHROUGH INSULATOR.—Compression mounted type CF-408-X87 has a Teflon body and a lengthwise hole for rapid wire insertion and soldering. The insulator is self-fastening and requires no additional hardware.

Fluorocarbon Products Inc., Dept. ED, Camden 1, N.J.

CIRCLE 365 ON READER-SERVICE CARD

MECHANICAL LIMIT STOP.—Infinitely adjustable, this unit comes in two sizes with 10.5 and 42 maximum turns. Starting torque is 0.1 oz-in. maximum and moment of inertia is 0.005 oz-in^2. Torque capacity is 60 oz-in. Energy storage at the limits to reduce shock in gear trains is 0.5 oz-in. Housing diameter is 0.937 in. and shaft diameter is 0.1873 in. Lengths are 1-1/4 and 2-1/4. without the shaft.

Gap Instrument Corp., Dept. ED, 116 E. Merrick Rd., Freeport, N.Y.

CIRCLE 366 ON READER-SERVICE CARD

SELF-ADHESIVE LABELS.—In many different colors mounted on sheets, Polka Dot labels have diameters from 7/16 to 2 in. They are useful for color coding and as temporary flags for wires, harnesses, or cables.

Pee Cee Tape & Label Co., Dept. ED, 521 N. LaBrea, Los Angeles 36, Calif.

CIRCLE 367 ON READER-SERVICE CARD

CIRCUIT BREAKER—Series 2300 heavy duty circuit breaker weighs 2-1/2 oz, has push-pull button action, and protects circuits up to 5000 amp, 120 v, 60 cps. It is shock resistant and precision calibrated.

Wood Electric Co., Dept. ED, 244 Broad St., Lynn, Mass.

CIRCLE 368 ON READER-SERVICE CARD

INSULATION ANALYZER.—The D-K analyzer has been adapted as a gage for nonmetallic thickness measurements. Readings may be taken instantly from one side of an insulating sheet by a dial adjustment. The portable unit is 12-1/2 x 9-1/2 x 10-1/2 in. and weights about 15 lb.

Delsen Corp., Dept. ED, 719 W. Broadway, Glendale 4, Calif.

CIRCLE 369 ON READER-SERVICE CARD

PANCAKE RESOLVES.—For direct gimbal mounting, these resolvers have accuracies of ±4 ft, perpendicularities of ±3 ft, and nulls of 1 mv per v of output or less. They were developed for use in cascaded, amplifierless resolver systems and are trimmed for 10 K input impedance, 0 deg phase shift, and a constant transformation ratio, with temperature, at 900 cps.

Clifton Precision Products Co., Inc., Dept. ED, 9014 W. Chester Pike, Upper Darby, Pa.

CIRCLE 370 ON READER-SERVICE CARD

Terminal Blocks

Stud type

Available in various sizes accommodating from one to 26 stud posts, these molded barrier terminal blocks have milliampere to 90 amp current handling ratings. Commercial units are made from Bakelite; military types are made from CFG, MFE, MAI-60, MME, and MDG plastics to meet MIL-M-14.

Kulka Electric Corp., Dept. ED, 633-643 S. Fulton Ave., Mt. Vernon, N.Y.

CIRCLE 372 ON READER-SERVICE CARD

Chart Recorder

Provides full month's record

Four-inch strip chart recorder and recorder controller, Mark III, has a modified inking system that provides a full month's record without refill. It provides a 14 hr visible chart record, flip switch for reversing controller action from air to open to air to close, and built-in damping of pneumatic input signals.

Fischer & Porter Co., Dept. ED, 143 Jacksonville Rd., Hatboro, Pa.

CIRCLE 373 ON READER-SERVICE CARD

Miniature Fan

Weighs 4 oz

Designed to cool tightly packaged airborne black boxes, the 4 oz Aximax 1 fan has a 1.5 in. diam and 1.5 in. long. At 22,500 rpm it provides 23 cfm free delivery or 19 cfm at 1 in. static pressure. Available motor designs include 115 or 200 v ac, single or three-phase for pressurized or nonpressurized applications.

Rotron Mfg. Co., Dept. ED, Woodstock, N.Y.

CIRCLE 374 ON READER-SERVICE CARD

NEW PRODUCTS

Wire Wrap Terminals

Standoff and Feedthrough

Made with a self-locking nylon body, Pushlo wire wrap terminals align and lock when th are pushed into place with an arbor press, a dr press, or a hand tool. Available in standoff an feedthrough types, they are suited for aircra missile, and automation equipment where sho and vibration are extreme. They are also sui able for printed circuitry. The units maintain uniform holding power under exposure to oi common solvents, and −65 to +300 deg te peratures.

Whitso, Inc., Dept. ED, 9330 Byron S Schiller Park, Ill.

CIRCLE 377 ON READER-SERVICE CARD

Shock Tester

Performs test cycle every minute

Hyge-6500 production-line shock tester repea either of a choice of two widely specified sho pulses in rapid succession, performing a comple test cycle every minute. Waveform may b changed by means of external adjustment. tests specimens ranging in weight from a fracti of 1 oz to 150 lb, and is 13 x 13 x 30 in.

Consolidated Electrodynamics Corp., Roche ter Div., Dept. ED, Rochester 3, N.Y.

CIRCLE 378 ON READER-SERVICE CARD

Signal Conditioning System

Airborne

For airborne telemetry and tape appli ation the SCAMP miniature signal conditioning syste

accepts millivolt inputs and produces 0 to 5 v to drive voltage controlled oscillators or record amplifiers. It features transistorized dc, ac, or carrier amplifiers and operates on unregulated 28 v dc power. The six-channel modular case accepts any combination of solid state amplifiers, each with separate controls, which can be operated independently. The ac amplifier output is biased at +2.5 v above ground, with the output signal swinging from 0 to +5 v.

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

CIRCLE 379 ON READER-SERVICE CARD

EIR Meter

Available in kit-form or completely wired

Model WV-38A volt-ohm-miliammeter is offered in kit-form and as a factory-wired and calibrated instrument. Each kit contains step-by-step instructions, laminated circuit board construction and oversized drawings. This instrument contains a new 1 v scale and a 0.25 v scale for transistor circuit measurements. Input resistance is 20 K per v for dc, and 5 K per v for ac measurements. It has 8 ranges for 0 to 5000 v dc, 6 ranges for 0 to 5000 v ac, 6 ranges for 50 μa to 10 amp full scale, and 3 ranges for 0 to 20 megohms.

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

CIRCLE 380 ON READER-SERVICE CARD

Capacitor Standard Kit

Contains 32 plug-in units

Kit model SS 32 contains 32 miniaturized, plug-in capacitor standards with values from 0.0001 to 0.05 μf. It can be supplied with a four position adapter which provides, with the appropriate capacitors, capacitance values accurate to four significant figures with ±0.1% tolerance.

Arco Electronics Inc., Dept. ED, 64 White St., New York 13, N.Y.

CIRCLE 381 ON READER-SERVICE CARD

NEW PRODUCTS

Crystal Detector Mount

Weighs less than 1.2 oz

Aluminum broadband coaxial crystal video detector mount weighs less than 1.2 oz. It is made with a choice of type N or TNC male input connectors and either TNC or miniature female video connectors. This mount covers the band from 1 to 11 kmc with tangential sensitivities better than —50 dbm over the entire band.

American Electronic Labs., Inc., Dept. ED, 116 N. Seventh St., Philadelphia 6, Pa.

CIRCLE 383 ON READER-SERVICE CARD

Power Transformers

Are used with silicon rectifiers

These three power transformers, for use with silicon rectifiers, provide output voltages of 40 v, center tap, 20 v, center tap, and 10 v. Current rating of type F-90X is 100 ma, type F-91X is 300 ma, type F-92A is 1 amp. They are used to supply the dc voltages for transistors through a full wave bridge or bridge rectifier from 115 v 60 cycle source.

Triad Transformer Corp., Dept. ED, 4055 Redwood Ave., Venice, Calif.

CIRCLE 384 ON READER-SERVICE CARD

Encoder Assembly

Resolves shaft positions to 1 part in 100,000

Model CG-703 geared encoder assembly uses two shaft position encoders and a gear box. The encoder used on the input shaft provides 1000 positions of the least significant digit per 360 deg rotation. This assembly can resolve shaft positions to 1 part in 100,000. It is 3 in. in diam, 3 in. long, exculsive of shaft, and weighs 19 oz.

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

CIRCLE 385 ON READER-SERVICE CARD

CRT GUN SUPPORT RODS.—Made of Formula M10 glass, these rods are free of air entrapments and provide tight tolerances in finished gun structure. Available in all standard shapes and in all lengths.

Mansol Ceramics Co., Dept. ED, 140 Little St., Belleville, N.J.

CIRCLE 388 ON READER-SERVICE CARD

MULTISPEED CHART DRIVES.—These chart drives can be field mounted on any of the company's standard Dynamaster strip chart recorders. They allow instant dialing of any of six different chart speeds without the need of stopping the chart. Two standard models with overall ratios to 16 to 1 and 32 to 1 are available for every different chart drive gear train used in the standard Dynamaster recorder.

Insco Co., Div. of Barry Controls Inc., Dept. ED, Groton, Mass.

CIRCLE 389 ON READER-SERVICE CARD

GANGED STANDOFF TERMINALS.—Model 409 TT miniature blocks are one-piece, ready-to-install units with standoff turrets. They take up to 21 turret terminals with barriers between. Fastening holes can be supplied to clear 2-56 fillister head mounting screws, tapped for 4-36 screws, or provided with a brass bushing threaded 0.80. A choice of plastic materials and metal platings is available.

Kulka Electric Corp., Dept. ED, 633-643 S. Fulton Ave., Mt. Vernon, N.Y.

CIRCLE 390 ON READER-SERVICE CARD

ORDER WIRE AND ALARM ASSEMBLIES.—Series 53A/44A assemblies provide conveniently packaged service channels with a variety of control and alarm circuit combinations for remote operation and maintenance. Previously custom engineered, this equipment is now offered in standard assemblies providing up to 35 tone channels for either wire-line or radio transmission.

Lenkurt Electric Co., Dept. ED, San Carlos, Calif.

CIRCLE 391 ON READER-SERVICE CARD

SEMIAUTOMATIC TURNTABLE DEGAUSSER.—Model A-937 has a predetermined 20 sec timed cycle. The pushbutton controlled, motor driven turntable insures fast, complete bulk erasure and eliminates noise patterns generated by irregular rotational motion. The unit accommodates all sizes of instrumentation tapes and magnetic films.

Magnasync Mfg. Co., Ltd., Dept. ED, 5546 Satsuma Ave., North Hollywood, Calif.

CIRCLE 392 ON READER-SERVICE CARD

AC AND DC POWER SUPPLY.—The Varicell adjustable supply provides either an ac or dc voltage from ac power lines.

Superior Electric Co., Dept. ED, Bristol, Conn.

CIRCLE 393 ON READER-SERVICE CARD

NEW PRODUCTS

HIGH TEMPERATURE TAPE.—Temp-R-Tape GV, for the construction and repair of electrical equipment, has a thermal curing, pressure sensitive silicone polymer adhesive which, once cured, will withstand operating temperatures to 500 F. The tape meets MIL-1-19166 and is 0.007 ±0.001 in. thick with adhesive. Available in 36 yd rolls 1/2, 3/4, 1, 1-1/2, and 2 in. wide.

Connecticut Hard Rubber Co., Dept. ED, 407 East St., New Haven 9, Conn.

CIRCLE 396 ON READER-SERVICE CARD

COMPUTER MAGNETIC TAPE UNITS.—Transistorized models 729 II and 729 IV are capable of reading and writing at either their former density of 200 characters per in. or at 555 characters per in. Input and output speeds with the latter density are 41,667 and 62,500 characters per sec, respectively, as compared with 15,000 and 22,500 with the former.

International Business Machines Corp., Data Processing Div., Dept. ED, 112 E. Post Rd., White Plains, N.Y.

CIRCLE 397 ON READER-SERVICE CARD

HIGH ALTITUDE TEST CHAMBER.—Model FHV-27-5-5 Chemosphere chamber is designed for testing in the Centigrade range between 100,000 and 260,000 ft. Standard temperature range is +300 to −100 F. The unit combines altitude with temperature and vibration, permitting the vibration machine to be coupled through a bellows arrangement so that test items can be bolted directly to the vibration table.

Conrad, Inc., Dept. ED, Conrad Square, Holland, Mich.

CIRCLE 398 ON READER-SERVICE CARD

DC POWER SUPPLY.—Transistorized, transient free model M-1360 uses magnetic amplifier and transistor regulation, eliminating overshoots. Line regulation is less than ±0.05 v for step change of 10 v in the ac input of 115 v, 60 cps, while load regulation is less than ±0.2 v no load to full load. The unit provides 6 to 15 v at 0 to 5 amp and meets MIL-P-6457A, MIL-G-008512, and MIL-E-4970 specifications.

Perkin Engineering Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

CIRCLE 399 ON READER-SERVICE CARD

PANEL INDICATOR LIGHTS.—Series L5900, L5910, and L5200 placard twin-lamp indicator lights have 1-3/8 x 9/16 in. plastic lenses which can be engraved with words or phrases to denote circuit function. The lenses, easily removed for lamp replacement, are captive to the cases so that they cannot be replaced on the wrong case. Forty units will fit in a 9 x 5 in. space.

Hetherington Inc., Dept. ED, Folcroft, Pa.

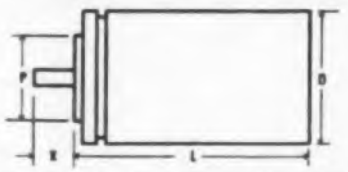
CIRCLE 400 ON READER-SERVICE CARD

SPECIAL REPORT ON STEP-SERVO MOTORS:

Induction Motors of California Offers Step-Servo Motor Line

A full line of step-servo motors, sizes 5, 8, 11, 15 and 23, designed for digital-to-analog conversion in 45° increments up to 120 pulses per second, are manufactured by Induction Motors of California. The motors are available with impedance of 15 to 300 OHMS and voltage range of 20 to 50 VDC. Motors operate over a range of −55°C to +125°C and meet environmental requirements of MIL-E-5272B and MIL-E-5400. Stainless steel construction is used, and no mechanical detents are employed.

GENERAL SPECIFICATIONS FOR STEP-SERVO MOTORS



I.M.C. P/N	Dim. in Inches D	L	P	X	Rotor Inertia (Oz-in-Sec²)	Min. Holding Torq. Oz.-in.	Max. Watts Per ϕ
005-801	.500	1.20	.375	13/32	0.50	0.5	8
9708-024	.750	1.09	.500	11/32	0.65	0.8	10
011-859	1.062	1.36	.625	3/8	0.65	1.4	15
9711-007	1.062	1.76	.625	3/8	2.5	1.4	15
9711-050	1.062	1.78	.625	3/8	2.5	1.2	15
9711-053	1.062	1.36	.625	3/8	2.5	1.0	15
9715-001	1.437	1.75	.875	3/8	2.5	1.8	25
023-801	2.250	1.75	2.00	5/8	5.0	3.0	50

Information on cost, delivery, or additional technical information, as well as information on synchro components and solenoids, is available when requested on your company letterhead.

Induction Motors of California

DIVISION OF
INDUCTION MOTORS CORPORATION, N.Y.
6060 Walker Avenue, Maywood, California
LUdlow 3-4785
Representatives in principal cities

CIRCLE 402 ON READER-SERVICE CARD

Transistor Transformers

Weigh 2 oz

Available in MIL-AG cases, in round YY hermetic cases with glass bead headers, or in molded construction, these transistor transformers weigh about 2 oz. They are slightly over 1 cu in.

Microtran Co., Inc., Dept. ED, 145 E. Mineola Ave., Valley Stream, N.Y.

CIRCLE 403 ON READER-SERVICE CARD

Temperature Chamber

Plugs into any 115 v source

High and low temperature chamber model FT1-100X350 is a low cost unit that plugs into any 115 v power source. It has a working space of 1 cu ft, outside dimensions of 35 x 24 x 45 in., and an accuracy of ±3 F over its full −100 to +350 F range.

Missimers Inc., Dept. ED, 3737 San Fernando Rd., Glendale 4, Calif.

CIRCLE 404 ON READER-SERVICE CARD

Miniature Plastic Switches

Have operating force as low as 2.5 g

Series 5200 snap-acting switches have electrical terminals molded in place for maximum rigidity. Ten models, with actuating button in center position, cover an operating force range of 3 to 20 oz; the remaining nine switches, with actuating button in off-center position, cover an operating force range of 2.5 to 60 g.

Haydon Switch Co., Dept. ED, Waterbury 20, Conn.

CIRCLE 405 ON READER-SERVICE CARD

NEW PRODUCTS

LINEAR DETECTOR.—Model 404, for use with distortion meters, incorporates a vacuum tube rectifier for rf detection and a bridging transformer. It meets FCC requirements and operates on a 20 to 30 v rf carrier. Frequency range is 400 kc to 30 mc. When operated as a bridging transformer, input impedance of the detector is 6 K and insertion loss is 1 db. Frequency response is flat from 20 cps to 50 kc.

Barker & Williamson, Inc., Dept. ED, Bristol, Pa.

CIRCLE 410 ON READER-SERVICE CARD

COLORED POTTING COMPOUNDS.—Type PA-407 silicone rubber compounds are available in white and a variety of colors to permit positive identification of encapsulated and potted materials. The material is supplied in premetered kits which contain 3 oz of color mixed compound and a catalyst. Quick setting and shrink resistant, it cures to a rubber after 25 min at room temperature.

Plastic Associates, Dept. ED, 185 Mountain Rd., Laguna Beach, Calif.

CIRCLE 411 ON READER-SERVICE CARD

HIGH TEMPERATURE SNAP ACTION SWITCH.—Miniature spdt type USM4 is designed for continued use at temperatures to 400 F. Ratings are 2.5 amp, 30 v dc, inductive; 5 amp, 30 v dc, resistive; and 5 amp, 125 or 250 v ac. The unit is 25/32 x 1/4 x 1/2 in. and may be gang mounted four to the inch for multiple circuit control.

The W. L. Maxson Corp., Unimax Switch Div., Dept. ED, Ives Rd., Wallingford, Conn.

CIRCLE 412 ON READER-SERVICE CARD

AUDIO-POWER AMPLIFIERS.—Designed to be used as variable frequency power sources and as power supplier for vibration testing systems, ultrasonics, sonar development, and audio-sonic testing, these units have a useful frequency range of 5 to 5000 cps and a power input of 440 v, three phase, 60 cps. Each of the 5, 10, 30, 70, and 200 kw amplifiers is housed in a single steel cubicle.

Westinghouse Electric Corp., Industrial Electronics Dept., Dept. ED, P.O. 416, Baltimore 3, Md.

CIRCLE 413 ON READER-SERVICE CARD

COMMERCIAL PROGRAMMERS.—Series 41900 programmers can be used for automation controls, industrial programming, and other predetermined electrical switching applications. The units have from one to eight spdt snap action switches and a wide range of cycling times from 30 sec to 24 hr per cycle. Timing program is set up during manufacture to provide programming functions required for each application.

The A. W. Haydon Co., Dept. ED, Waterbury, Conn.

CIRCLE 414 ON READER-SERVICE CARD

Magnetic Tape Transports

For computers

Model 3269 digital magnetic tape loop transports are computer components that perform data format conversions, data rate changes, and serial-to-parallel or parallel-to-serial conversions. They can also be used for fixed or variable time delay, sorting, and correlations analysis input. The units have one tape drive plate or two independent tape drive plates. Each plate may contain one or more capstans with independent speeds and directions.

Potter Instrument Co., Inc., Dept. ED, Sunnyside Blvd., Plainview, N.Y.

CIRCLE 415 ON READER-SERVICE CARD

Relay

1 in. long, 1/4 in. in diameter

Less than 1 in long and 1/4 in. in diameter, the Unimite spdt relay has a 1 msec operating time and a 3 msec release time. Rated 1 amp at 28 v dc, it requires 240 mw and can be cycled at 10,000 operations per min.

General Electric Co., Specialty Control Dept., Dept. ED, Waynesboro, Va.

CIRCLE 416 ON READER-SERVICE CARD

Sinusoidal Transformers

Have ±1% regulation

Available in nine output ratings from 60 to 7500 va, these sinusoidal transformers automatically regulate to within ±1% for ±15% line voltage variations. They provide an output with less than 3% total rms harmonic content and have an average response time of 1.5 cy. The static-magnetic units are protected against shorts on the load circuit and require no maintenance or manual adjustments. They are available in step-up and step-down ratios allowing substitution for conventional, nonregulating transformers.

Sola Electric Co., Dept. ED, 4633 W. 16th St., Chicago 50, Ill.

CIRCLE 417 ON READER-SERVICE CARD

CIRCLE 418 ON READER-SERVICE CARD ➤

NEW PRODUCTS

TEMPERATURE CONTROLLER.—Designed for single point control, model 535 uses transistor circuitry and thermistor sensors to cover a range of 0 to 600 F. The thermistor sensing elements may be mounted hundreds of feet from the controller itself and connections may be uncompensated standard electric wiring. The unit has 2 deg F setting accuracy within a 0 to 125 deg ambient range. Contact capacity is 5 amp, 155 v ac, spdt.

Fenwal Inc., Dept. ED, Pleasant St., Ashland, Mass.

CIRCLE 421 ON READER-SERVICE CARD

SIZE 18 SERVO MOTORS.—Built to BuOrd specifications for continuous operation at 250 C. Weight, 14 oz; power input, 12.5 w; no load speed, 3000 rpm; stall torque, 2.5 in.-oz per min.

American Electronics, Inc., Dept. ED, 1025 W. Seventh St., Los Angeles 17, Calif.

CIRCLE 422 ON READER-SERVICE CARD

MAGNESIUM CONTAINERS.—Deep-drawn boxes and covers made to military specifications. Over 40 stock sizes.

Zero Mfg. Co., Dept. ED, 1121 Chestnut St., Burbank, Calif.

CIRCLE 423 ON READER-SERVICE CARD

BENCH MOUNTED TORQUE TOOLS.—Indicate correct torque during assembly of electrical and instrumentation units. Models available to measure in.-g, in.-lb, and in.-oz fractions.

Apco Mossberg Co., Dept. ED, 1004 Lamb St., Attleboro, Mass.

CIRCLE 424 ON READER-SERVICE CARD

INSULATED WIRE AND CABLE.—Teflon FEP fluorocarbon insulation permits use of this wire and cable from −90 to +200 C. Tinned copper can be used for conductors, and extended lengths can be supplied.

Tensolite Insulated Wire Co., Inc., Dept. ED, W. Main St., Tarrytown, N.Y.

CIRCLE 425 ON READER-SERVICE CARD

HIGH VACUUM HEAT-TREATING FURNACE.—Laboratory model 300 has 1 in. diameter, 3 in. high hot zone for 2500 C operation.

Richard D. Brew and Co., Inc., Vacuum Furnace Div., Dept. ED, 90 Airport Rd., Concord, N.H.

CIRCLE 426 ON READER-SERVICE CARD

SHAFT CUTTER.—Shaft-Kut Tool is accurate to 1/64 in., cuts control and switch shafts in a few seconds.

Centralab, Div. of Globe-Union Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

CIRCLE 427 ON READER-SERVICE CARD

Wirewound Potentiometer

Rated 1.5 w at 25 C

A single turn, wirewound precision potentiometer, model 12 is rated 1.5 w at 25 C and derates to 0 w at 130 C. It rotates 360 deg and can be provided with stops for any angle. Resistance values are from 0.45 to 555 ohms per deg; linearity is to 0.05%; and resolution is from 0.13 to 67 ohms per turn. The unit is moisture resistant and withstands severe vibration.

Handley Corp., Dept. ED, 14758 Keswick, Van Nuys, Calif.

CIRCLE 430 ON READER-SERVICE CARD

Digital Transducer

Uses mechanical amplifier

Series 400 digital transducers measure process variables and provide digital encoding for flow, liquid level, pressure or temperature. They use a mechanical force amplifier to position the shaft of a precision encoder. Available in vacuum and pressure ranges to 10,000 psi, and temperature ranges to 600 F, they are housed in all-weather meter cases.

American Meter Co., Mechanical Components Dept., Dept. ED, P.O. Box 309, Garland, Texas.

CIRCLE 431 ON READER-SERVICE CARD

Right Angle Coax Receptacle

Used for printed wiring boards

Type 3008 right-angle coax receptacle for printed-wiring boards is made of hex stock with four milled studs of rectangular cross sections. The receptacle is attached to the wiring board by dip soldering The main insulator follows the contact around the 90 deg bend, providing a uniform dielectric thickness on all sides of the contact.

Sealectro Corp., Dept., ED, 610 Fayette Ave., Mamaroneck, N.Y.

CIRCLE 432 ON READER-SERVICE CARD

IDEAS FOR DESIGN—*ENTRY BLANK*

To the *Ideas-For-Design* Editor of ELECTRONIC DESIGN —
830 3rd Ave., New York 22, N.Y. • PLaza 1-5530

Here is my design idea for possible publications in your *Ideas For Design* department. I can expect $10 for this idea if accepted for publication.

(Ideas suitable include: *1.* new circuits or circuit modifications, *2.* new design techniques, *3.* designs for new production methods, *4.* clever use of new materials or new components in design, *5.* design or drafting aids, *6.* new methods of packaging, *7.* design short cuts, or *8.* cost saving tips)

STATEMENT OF THE PROBLEM—

MY SOLUTION. AND WHY— (Please be explicit. Include sketches or photos that will help the idea across)

Name_____

Title_____

Company_____

Address_____

(Place illustrations on separate sheet if necessary)

NEW PRODUCTS

Transistorized Analog Computer

15 x 17 x 24 in.

The low cost PACE TR-10 analog computer is fully transistorized, measures 15 x 17 x 24 in. and weighs 80 lb without accessories. The unit can perform 95% of the mathematical operations encountered in design calculations.

Electronic Associates, Inc., Dept. ED, Long Branch, N.J.

CIRCLE 435 ON READER-SERVICE CARD

Gas Density Switch

Weighs 2 oz

Type SN-88 sub-miniature gas density switch signals when the density of surrounding inert gases approaches a critical value. This value remains constant as pressure changes with temperature. It actuates along any temperature-pressure line from 0.028 to 0.041 psia per deg Rankine. The accuracy of the actuation point is ±0.8 psi over the temperature range of −85 F to +200 F. It weighs 2 oz, is 2-1/32 in. long and 1-5/32 in. in diam, and meets MIL-E-5272.

Newark Controls Co., Dept. ED, 15 Ward St., Bloomfield, N.J.

CIRCLE 436 ON READER-SERVICE CARD

Amplifier Module

For non-return-to-zero data handling

Model 139A-NRZ contains ten low-level amplifiers for obtaining 20 v pulses from the low level outputs of magnetic tape, memory cores, and small photo cells. Signals as low as 10 mv into 5.6 K input impedance and as slow as 100 μsec in duration will produce negative pulses of 20 v and 15 μsec. Module is 2-1/4 x 10-3/4 x 7 in.

Navigation Computer Corp., Dept. ED, 1621 Snyder Ave., Philadelphia 45, Pa.

CIRCLE 437 ON READER-SERVICE CARD

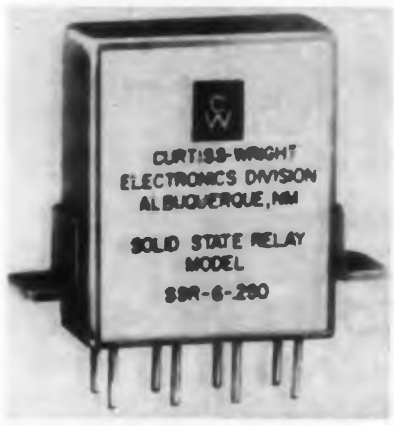
Hinged Control Panel

Permits easy wiring

Relays are mounted on the top surface of these modular control panels, while the control wires are contained in built-in compartments beneath. Each module swings out so that the wires can be snapped into place behind flexible vinyl retaining fingers. The units are built for both horizontal and vertical wiring.

Wyr-Way, Inc., Dept. ED, 250 Mt. Hope Ave., Rochester 3, N.Y.

CIRCLE 438 ON READER-SERVICE CARD



Solid State Relay

Withstands 1000 g shock

For aircraft, missile, and other dc power switching applications, the model SSR-6-.250 is a 6 v, 0.25 amp, spst solid state relay that can withstand 1000 g shock. It has a 2 μsec pickup time and a 5 μsec drop-out time and may be used as a current limiting device to protect power sources from overloads.

Curtiss-Wright Corp., Inter Mountain Instruments Div., P.O. Box 8324, Albuquerque, N. Mex.

CIRCLE 439 ON READER-SERVICE CARD

CLUTCH ASSEMBLY AND ACTUATOR.—Model CK-1 for intermittent unidirectional control of airborne rotating components over wide environmental extremes. Actuate time, 3 msec at 60 rpm; release time, 2 msec at 60 rpm; total weight, 4 oz.

Abrams Instrument Corp., Dept. ED, 606 E. Shiawassee St., Lansing 1, Mich.

CIRCLE 442 ON READER-SERVICE CARD

DESOLDERING TIPLETS.—The Triangle tiplet melts solder from leads which are in a triangular pattern; the 1/8 in. diameter Offset Slotted tiplet straightens leads and tube tabs, melts and removes excess solder on wire connections; and the Cube tiplet melts solder and removes center pins of tube sockets and harness leads.

Ungar Electric Tools, Inc., Dept. ED, 4101 Redwood Ave., Los Angeles 66, Calif.

CIRCLE 443 ON READER-SERVICE CARD

CONTROL AND POWER CABLE SUPPORTS.—Aluminum or steel series 2SB supports have 9-11 gage expanded mesh bottom made to any width. Mesh permits easy handling and inspection, reduces electrical losses.

Chalfant Products Co., Inc., Dept. ED, 11525 Madison Ave., Cleveland 2, Ohio.

CIRCLE 444 ON READER-SERVICE CARD

EXPANDED SCALE FREQUENCY METER.—Rugged military field unit with 397 to 403 cps range, 0.1% accuracy. Occupies about 10 cu. in.

American Machine & Foundry Co., Alexandria Div., Dept. ED, 1025 N. Royal St., Alexandria, Va.

CIRCLE 445 ON READER-SERVICE CARD

PRESSURE CONTROL.—Type AP-153 is 4-1/8 x 3-1/8 x 2-7/8 in., weighs 1-3/4 lb. Range, adjustable from 1 to 20 psig; contact rating, 4 amp, 115 v or 2 amp, 230 v. For applications involving air or gases.

The Mercoid Corp., Dept. ED, 4201 Belmont Ave., Chicago 41, Ill.

CIRCLE 446 ON READER-SERVICE CARD

UHF HORN.—High power dual frequency primary feed for radio telescope antennas. Operates at 400 and 650 mc; has 75 ohm input impedance. Can be oriented at 0, 45, and 90 deg.

The Gabriel Co., Gabriel Electronics Div., Dept. ED, 135 Crescent Rd., Needham Heights, Mass.

CIRCLE 447 ON READER-SERVICE CARD

PRESSURIZATION PACKAGES.—Complete dry-air systems incorporating compressor, accumulator, dryer, manifolding, and instrumentation. For military use.

Trinity Equipment Corp., Dept. ED, Cortland, N.Y.

CIRCLE 448 ON READER-SERVICE CARD

LETTERS

Diode Kudos

Dear Sir:

Congratulations on your special report on diodes in the June 10 issue. It is truly a confusing problem, but we thought you might be interested in one approach we use to find our way through the maze.

As we do considerable design work for commercial applications as well as military, *price* is an important factor with us. We have found price often to be the best starting point in diode selection, starting with the cheapest diodes and working our way up, evaluating each as to whether or not they will meet the technical requirements. This is the reverse of the usual procedure, where unfortunately engineers are told not to worry about such mundane matters and leave that to the purchasing department.

To avoid the time and expense of getting quotations from those manufacturers too coy to publish their prices, we simply use an Allied Radio catalog as our reference, and ask for quotations only when we have narrowed down the selection.

We wonder if the dollar sign isn't being overlooked as a good yardstick?

R. W. Johnson, Chief Engineer
The R. W. Johnson Co.
Anaheim, Calif.

Dear Sir:

I certainly agree with the comments you have made in your letter of June 11th, relating to the problem of nonstandardization of diode types. The staff report on diodes in the June 10th issue of ELECTRONIC DESIGN has certainly emphasized the complexity of the problem.

The EIA Standards Laboratory and the JEDEC activity are both turning their attention to the matter of standardizing test characteristics and tightening requirements for registering diode types. I hope that this activity will result in the elimination of many of the diodes currently on the market. Because of the nature of the support that EIA enjoys, it may be difficult for EIA to exercise direct veto power in this activity. It may be necessary for the Government to take the initiative of standardizing a very small number of diodes and rectifiers.

The need for standardization is obvious, and we

have seen it done in many other component fields. You are to be commended for this initiative. I hope these efforts prove to be fruitful.

Charles Weyl, President
International Resistance Co.
Philadelphia, Pa.

Missing Credit

Dear Sir:

We have read with great interest the article, "How to Get Ahead, The Do's and Don't" in your June 10th issue of ELECTRONIC DESIGN. We have found a close resemblance in ideas, format and in fact sentence structure between Mr. Kaufman's paper and "The Unwritten Laws of Engineering," written by W. J. King and copyrighted by the American Society of Mechanical Engineers in 1944.

We feel there should be an explanation. Please give credit where credit is due.

R. E. Schulz
F. W. Vortmeier
St. Louis, Mo.

A credit line was missing from Mr. E. N. Kaufman's article, "How To Get Ahead, The Do's and Don't" (ED, p 76, June 10), which indicated that the material was adopted from Mr. W. J. King's, "The Unwritten Laws of Engineering." This inadvertent omission is indeed unfortunate since one of Mr. King's points was that credit should always be given to the originator of ideas.

IR Detector Developed by NRL

Dear Sir:

We appreciate your efforts in bringing your readers the latest available information on products. They must certainly consider it a valuable service.

In your coverage of the new infrared detector (*ED* May 13, p. 229), now available from Perkin-Elmer, it was unfortunate that mention of the Naval Research Laboratories was excluded.

The Naval Research Laboratory invented the detector, and did the primary development of it before we get involved in the manufacturing side of the device. The new detector represents a significant advance in infrared instrumentation, and as such NRL very much deserves the credit for it. Further, the illustrations which accompanied the release were provided us by NRL.

I hope it will be possible for you to call attention to this credit in a subsequent issue of ELECTRONIC DESIGN.

Charles C. Dayton
Public Relations Manager
The Perkin-Elmer Corp.
Norwalk, Conn.

LETTERS

Did We Do That?

Gentlemen, gentlemen!

I appreciate your consideration for my suggestion, as exhibited by your willingness to sign a ten dollar check and to publish the idea in your Ideas for Design Department. I rather suspect, however, that those of my acquaintance who happen across this item in your February eighteenth issue will not come away with an elevated opinion of my coherence.

As you have printed my words, they have been rearranged so as to intermix the note of hope (". . . can be simplified."), the cry of doom re the other circuit ". . . the output will be a step—not a pulse") and the description of the operation of the circuit I suggested. The confusion is heightened further by your reference to my circuit (Fig. 3) in the midst of the section explaining why the *other* circuit (Fig. 1) will not work.

M. L. Aitel
Radio Corporation of America
Defense Electronic Products
Moorestown, N. J.

Idea for Design is Good, But Not New

Dear Sir:

Mr. A. M. Goldschmidt, in his Idea for Design, "Pentode Cathode Follower for Low-C Probe," in the May 13, 1959 issue, is not new.

We have been making a low input capacity cathode follower (called the Bridger), using this philosophy, for about ten years. It has been widely used for audio circuit and component research, and in test equipment for certain types of analogue computers. We have attained a voltage ratio of 0.996, which allows an input capacity of 1 μμf (all strays). Frequency range is 2 cps to 1 mc.

In one respect we have added an improvement: the same philosophy may be used to reduce the effective capacity of an input cable. Thus we are able to enjoy a cable input capacitance of little over 1 μμf at the tip of a three foot cable; adding the follower capacitance to the cable's produces an overall total of little more than 2 μμf.

C. J. LeBel
Audio Instrument Co., Inc.
New York City, N.Y.

Communication Centers Proposed

Dear Sir:

Keeping up with the latest technological and scientific advances is a difficult feat for most engineers and technicians today. The latest progress in the industry is reported by numerous trade

journals, but important changes are not conveyed immediately to those most directly concerned. Lack of immediate communication of technical news is in evidence partly because engineers have little time to read all that is required and tend to read only those journals pertaining specifically to their field of specialization. More importantly, management has failed to realize the importance of a good communications program. The solution suggested is the establishment of "Specialized Information Centers" which would offer a newsletter digest of the latest technological and scientific advances to engineers and technicians on a weekly, bi-weekly or monthly basis. Newsletter services are in existence but most of them are directed to management, not specifically to the engineer.

While the federal government has a translation and publications programs pertaining to technical literature, the engineer must rely on the daily supply of trade journals for the most current technical data as against assistance in conducting research work. To meet the need of rapid communication, management can adopt several plans. One idea is the establishment of technical libraries with the job of publishing newsletters. Another method would be to allow one day per week for engineers to read magazines, but this seems highly impractical. An alternative method would be to assign an engineer within a different group each week with the full time task of reviewing current journals and abstracting items of general interest, compiling the items into a newsletter and distributing it to members of the group. This method may be inexpensive and particularly suitable to highly specialized groups.

However, the author believes that "Specialized Information Centers" offer maximum advantages, as experienced by a West Coast industry some time ago. A monthly publication was issued to approximately 1800 engineers and technicians. One engineer-editor worked full-time and utilized a clerk-typist assistant part-time. The editor screened more than 40 trade journals per month, abstracting the latest and most pertinent facts, and supervised publication and distribution. In the interim, he maintained close departmental coordination which enabled him to be on the lookout for any special items that an engineer or technician might find useful in answering a research problem. The program was very well received by the engineers receiving the company publications.

Richard Paulson, Consultant
La Jolla, Calif.

▶ We would like to hear if any of our readers have been helped by similar services.

LETTERS

How Toxic Are Teflon Fumes?

Dear Sir:

In the April 15, 1959 issue of ELECTRONIC DESIGN there is an article "Blow Out Old Solder" that could cause injury should the method be used.

The article describes the removal of solder from solder terminals by heating the terminal, placing one end of a short length of Teflon tubing at the terminal and blowing through the other end.

This method is excellent as long as the Teflon is not elevated in temperature. When Teflon is heated above 400 deg F, toxic fumes are produced and the volume of fumes produced increases with increasing temperature.

Soft solder has a melting range of 200 to 600 F while intermediate solder has a melting range of 600 to 1100 deg F. Therefore, it is highly possible that toxic fumes could be produced.

W. G. Funke
Sperry Microwave Electronics Co.
Clearwater, Fla.

Dear Sir:

You may not have noticed giving dangerous advice in your Idea for Design "Blow Out Old Solder." The author recommends ". . . After heating terminals with a soldering iron, place one end of a length of Teflon tubing at the terminal and blow through the other."

Perhaps you should warn your readers of this procedure. Cleaning terminals by blowing the molten solder away is a good old practice. But beware of using Teflon tubing for this purpose.

In the present application, it is not at all necessary to introduce this hazard.

Klaus H. Jaensch
Stromberg-Carlson Co.
Rochester, N.Y.

▶ We thought it was quite safe to "Blow Out Old Solder." But just to make certain, we asked the people at DuPont. They know quite a bit about Teflon. Here is their reply.

Dear Sir:

Thank you very much for the opportunity of commenting on "Blow Out Old Solder" in Ideas For Design. The idea certainly is a cute trick for accomplishing what I, for one, have found to be an exasperating and messy job.

Regarding the safety aspect, it does not appear that there is any real hazard here at all. Since this is a practical problem, we have to be practical in assessing the situation and consider all relevant factors. Some of these are the temperature and amount of heated "Teflon" and the length of exposure to fumes.

Let's consider a typical practical case and suppose that we have a length of 22 gauge spaghetti tubing, preferably about three feet long (if you do not want your nose in the wiring every time you use it). Suppose, when you blow out solder, a length of one inch of the tubing is heated to 700 F and remains at this temperature for 30 seconds on each application.

Among the Teflons, Teflon 6 resin, at 700 F, has the relatively high weight loss of 0.032 per cent per hour. A foot of this tubing weighs about 0.75 gram so our hot one inch length weighs about 0.06 gram and the quantity of vapor released per application is 0.06 (gram) x 0.032 (%/hour) x 30 (sec)/3600 (sec/hr) = 1.6×10^{-7} gram/application.

Now, let us assume that these vapors are dissipated into one cubic foot of air or about 0.028 cubic meter. The concentration of decomposition products in the air is then 1.6×10^{-7} (gram)/0.028 (cu meter = 0.006 milligram/cubic meter.

This concentration is decidedly insignificant in the light of a considerable amount of experimental evidence which shows that in short time exposures (15 to 60 minutes) to Teflon heated to temperatures of 350 C and higher, test animals are not affected until the concentration of decomposition products exceeds about 700 milligrams/cubic meter.

This is more than 100,000 times the concentration we calculated for blowing out the solder. Calculations are, I feel, made on extremely conservative assumptions, especially the assumption of the 700 F temperature of one inch of spaghetti. I think, however, these serve to demonstrate that this is not a hazardous practice.

A word about the use of Teflon generally: the DuPont Company furnishes literature on safe handling of Teflon TFE-fluorocarbon resins primarily for the guidance of processors who daily handle large quantities of Teflon at temperatures of 650 to 735 F. These operations require proper ventilation precautions as with handling other plastics, elastomers, paints, etc.

Safe handling of Teflon in fabrication has been effectively demonstrated by the fact that in the twenty-year history of the product there has never been an injury attributed to the products evolved from heated Teflon.

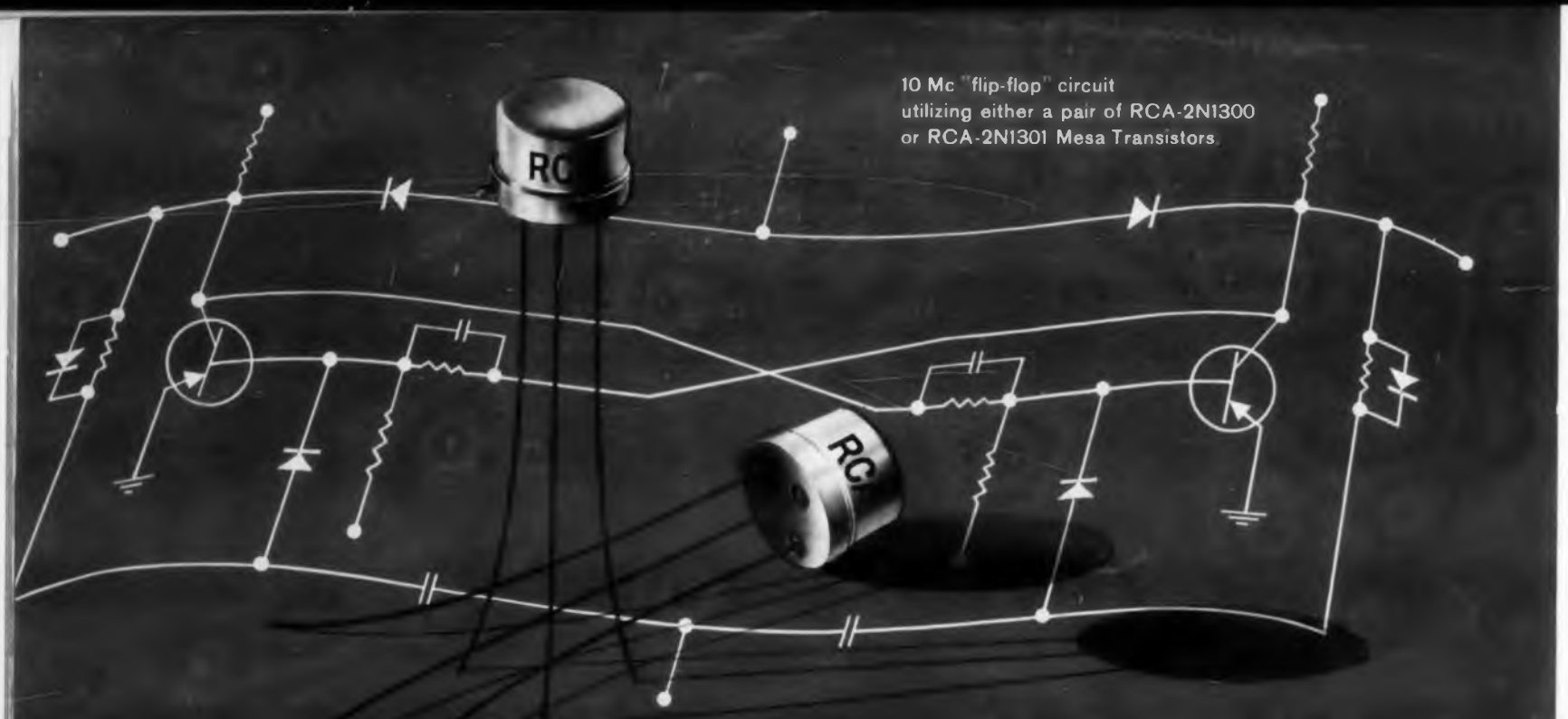
In normal end-use applications rarely are special safety precautions required. This is because the quantity and temperature of the resin, in combination, are rarely toxicologically significant. In special end uses where it is necessary to use TFE resins continuously above their 500 F upper service temperature some ventilation may be advisable.

G. R. Snelling
Polychemicals Dept.
E. I. DuPont de Nemours & Co.
Wilmington, Del.

ADVERTISERS' INDEX
July 22, 1959

◀ CIRCLE 463 ON READER-SERVICE CARD

ELECTRONIC DESIGN
HAYDEN PUBLISHING COMPANY, INC.
830 Third Avenue, New York 22, N.Y.



10 Mc "flip-flop" circuit
utilizing either a pair of RCA-2N1300
or RCA-2N1301 Mesa Transistors.

RCA-2N1300 and 2N1301

LOW-COST MESA COMPUTER TRANSISTORS

Now in quantity production . . . and available!

RCA-2N1300 and 2N1301 Germanium Mesa Transistors offer these 10 major benefits to designers of switching circuits. And they're ready for you now!

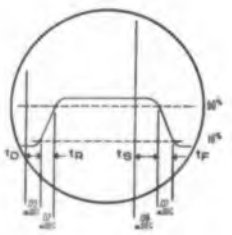
- rugged Mesa structure—permits extremely small base width to insure top performance at high frequencies
- fast switching times with low values of base input current—made possible by high frequency response and low total stored charge
- high current gain—permits high fan-out ratios (number of paralleled similar circuits per driver-stage output)
- high breakdown voltage and punch-through voltage ratings—the result of the diffusion process
- high power dissipation—150 milliwatts at 25°C—aids in the design of reliable circuits
- high current ratings—improve overall system speed
- rugged overall design—units have unusual capabilities to withstand severe drop tests and electrical overloads
- electrical uniformity—a result of the diffused-junction process used by RCA in the manufacture of Mesa Transistors
- especially well suited for use at pulse repetition rates up to 20 Mc
- exceptionally well suited to applications in saturation-type switching circuits

Information on RCA-2N1300 and 2N1301 Low-Cost Mesa Transistors is available from your RCA Field Representative. For technical data, write RCA Commercial Engineering, Section G-18-NN2.

RCA TYPE	Maximum Ratings* Absolute-Maximum Values						Characteristics: Common-Emitter Circuit, Base Input Ambient Temperature of 25° C		
	Collector-to-Base Volts	Emitter-to-Base Volts	Collector Milli-amperes	Transistor Dissipation—mw			Minimum DC Current Gain		Gain Bandwidth Product• Mc
				at 25°C	at 55°C	at 71°C	at collector ma = −10	at collector ma = −40	
2N1300	−13	−1	−100	150	75	35	30	–	40
2N1301	−13	−4	−100	150	75	35	30	40	60

*Maximum collector-to-emitter voltage rating = −12 volts

• For collector ma = −10 and collector-to-emitter volts = −3.



Oscilloscope wave form shows typical delay, rise, storage, and fall times achieved with 10-ma inverter circuit utilizing the RCA-2N1301 MESA TRANSISTOR.

RCA FIELD OFFICES:

- Newark 2, N. J., 744 Broad Street HUmboldt 5-3900
- Chicago 54, Ill., Suite 1154 Merchandise Mart Plaza WHitehall 4-2900
- Los Angeles 22, Calif. 6355 E. Washington Blvd. RAymond 3-8361
- Detroit 2, Mich., 714 New Center Bldg. TRinity 5-5600
- Needham Heights 94, Mass., 64 "A" St. HIllcrest 4-7200

GOVERNMENT SALES

- Newark 2, N. J., 744 Broad Street HUmboldt 5-3900
- Dayton 2, Ohio, 224 N. Wilkinson St. BAldwin 6-2366
- Washington 6, D.C., 1625 "K" St., N.W. DIstrict 7-1260

ALSO AVAILABLE THROUGH YOUR LOCAL RCA SEMICONDUCTOR DISTRIBUTOR.

RADIO CORPORATION OF AMERICA

SEMICONDUCTOR AND MATERIALS DIVISION • SOMERVILLE, N. J.