

ELECTRONIC DESIGN

JULY 22, 1959



DESIGN ENGINEER
SERIAL RECORD
JUL 23 1959
TRANSISTOR SELECTION CHART
1959

GIVE YOUR PRODUCTS MORE RELIABILITY AND BETTER PERFORMANCE WITH

FREED QUALITY

MINIATURE PULSE TRANSFORMERS



- Meets all requirements of MIL-T-27A
- Small size and weight
- Ideal for computer applications

CATALOG #	APPLICATION	TURNS RATIO
EPT-1		1:1
EPT-2	Impedance	2:1
EPT-3	Matching	3:1
EPT-4		4:1
EPT-5	and	4:1
EPT-6		5:1
EPT-7	Interstage	7:1:1
EPT-8	Coupling	5:1
EPT-9		3:1
EPT-11		1:1
EPT-12		1:1
EPT-13	Blocking	2:1
EPT-14	Oscillator	1:1.4
EPT-15	Memory core &	5.5:1:PP
EPT-16	Current driver	3.3:3.3:1:PP
EPT-17	Current driver	6:1
EPT-18	Current Transformer	11:1
EPT-19	Pulse Inversion	6:1:1

*Supplied both milled and cased.

MAGNETIC AMPLIFIERS

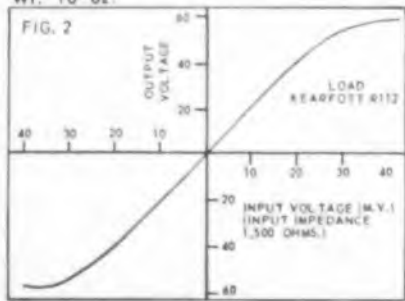
- Hermetically Sealed To MIL Specifications
- No Tubes
- Direct Operation from Line Voltage
- Fast Response
- Long Life Trouble Free Operation
- Phase Reversible Output

Power Gain 2×10^4



Transistor Preamp. MAT-1
Mag. Amp. MAF-5
Motor

Wt. 10 oz.



LOW FREQUENCY HIGH "Q" REACTORS Solve your low frequency selective problems by using FREED QGC REACTORS

- Available from stock
- Meets MIL-T-27A specifications
- Low hum pick-up
- Low voltage coefficient
- Low temperature coefficient
- High self resonant frequency

Inductors with maximum "Q" at very low frequencies can be supplied on special order.

CATALOG NO.	INDUCTANCE HY.	
QGC-1	100	
QGC-2	75	
QGC-3	50	
QGC-4	25	
QGC-5	10	
QGC-6	5	
QGC-7	1	
QGC-8	75	
QGC-9	50	
QGC-10	25	
QGC-11	10	
QGC-12	5	
QGC-13	1	
QGC-14	50	
QGC-15	25	
QGC-16	10	
QGC-17	5	
QGC-18	1	
QGC-19	10	
QGC-20	7.5	
QGC-21	5	
QGC-22	2.5	
QGC-23	1	
QGC-24	0.5	

FREED QUALITY INSTRUMENTS FOR PRECISION LABORATORY TESTING

NO. 1110-AB INCREMENTAL INDUCTANCE BRIDGE



- Inductance: 1 Millihenry to 1000 Henry
- Maximum Direct Current: 1 Ampere

NO. 1620 VARIABLE TEST VOLTAGE MEGOHMMETER



- Variable DC test voltage: 50 to 1000 volts
- Resistance range: .1 megohm to 4,000,000 megohms

NEW MINIATURE VARIABLE HIGH FREQUENCY INDUCTORS

- Continuous Inductance Variation
- Hermetically Sealed Constructions
- Frequency Range 20 KC to 500 KC
- High Q
- Exact Tuning Without Trimmers
- High Self Resonant Frequency



Cat. #	NOMINAL IND. MHY.		AVERAGE Q	SELF RES. FREQ. MC
	MIN.	MAX.		
VHI-1	1.1	1.75	95	2.2
VHI-2	1.7	2.5	95	1.9
VHI-3	2.3	3.7	95	1.6
VHI-4	3.	4.5	100	1.4
VHI-5	4.	5.7	100	1.3
VHI-6	5.5	7.5	100	1.
VHI-7	7.	10.5	100	.9
VHI-8	10.	15.	100	.85
VHI-9	14.5	20.5	100	.6
VHI-10	20.	30.	100	.55

NEW HERMETICALLY SEALED CONSTANT VOLTAGE TRANSFORMERS.

- Meets Military Specifications
- No Tubes
- No Moving Parts
- Accurate Regulations
- Fast Response
- Fully Automatic



Here at last is a hermetically sealed magnetic voltage regulator that will provide constant output voltage regardless of line and/or load changes.

CAT. #	SUPPLIED EITHER MIL. OR COMMERCIAL		LINE FREQ.	OUTPUT VOLT. VA.
	INPUT VOLT.	OUTPUT VOLT. VA.		
MCV-620L	95-130 v	60 cps.	115	20
MCV-670L	95-130 v	60 cps.	115	70
MCV-6130L	95-130 v	60 cps.	115	130
MCV-670F	95-130 v	60 cps.	6.4	70
MCV-6130F	95-130 v	60 cps.	6.4	130
MCV-420F	95-130 v	400 cps.	6.4	20

HIGHLIGHTS OF ISSUE

ELECTRONIC DESIGN



Transistor Data Chart (Cover) 49

The 1959 Seventh Annual Transistor Data Chart is tailor-made for the design engineer. Over 600 listed numbers have been separated into six categories—audio, high-frequency, power, low-level and high-level switching and special types. In each category the value of a key parameter determines the location of a particular type. Rapid selection of type numbers, with alternate sources of supply, is offered by this chart.

Flip-Flop Silicon Trigistor . . 74

New pnpn silicon device, designed for flip-flop circuits, can replace two transistors plus several components.

Self-Oscillating Beta Tester 76

An accurate measurement of the "ac small signal Beta" (h_{fe}) can be obtained using the transistor under test as the active element of an oscillator circuit.

Circulators' Size and Weight Reduced 78

The series CLL circulators are especially useful in radio astronomy, airborne and other critical applications where size and weight are important considerations.

Next Issue WESCON Products

Preview of new, previously unannounced products to be displayed at WESCON.

◀ CIRCLE 1 ON READER-SERVICE CARD

Send for NEW TRANSFORMER AND INSTRUMENT CATALOGS

FREED TRANSFORMER CO., INC.

1727 Weirfield Street Brooklyn (Ridgewood) 27, New York

NEWS

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EDITORIAL

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TRANSISTOR DATA CHART

Transistor types are separated into six categories—values of key parameters determine sequence of listing 49

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Self-Oscillating Beta Tester 76
Transistor tester uses the transistor being tested as the only active element

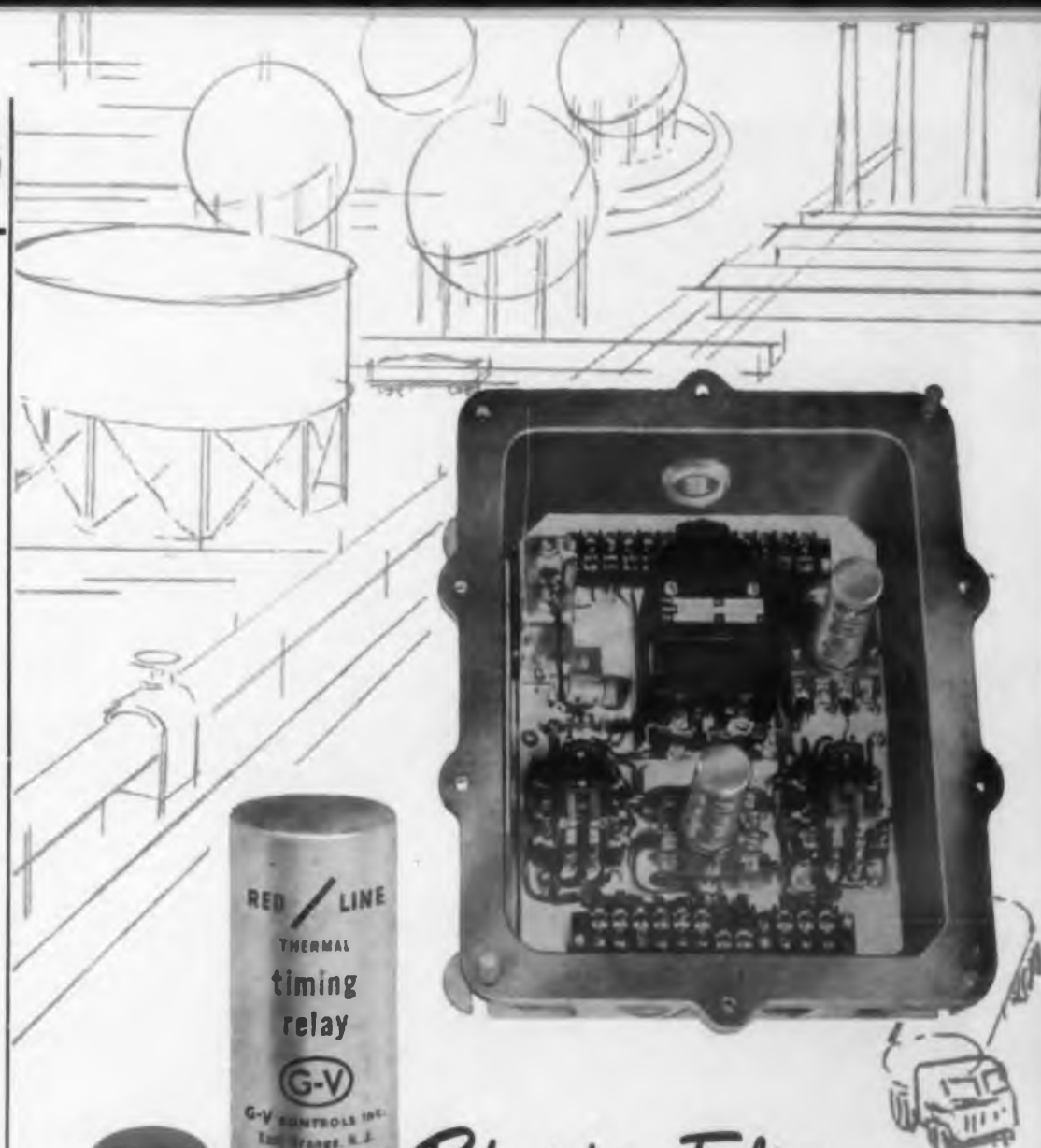
Circulators' Size and Weight Reduced 78
Series CLL circulators are especially useful where size and weight are important considerations

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CIRCLE 2 ON READER-SERVICE CARD >



Robertshaw-Fulton

G-V stands guard with Robertshaw to detect harmful vibration...

Abnormal and persistent vibration in rotating equipment usually means costly trouble. Robertshaw-Fulton's Vibraswitch Detectors and Model 651 control units detect vibration and shut down valuable equipment before damaging trouble develops.

Two G-V Red Line Thermal Time Delay Relays are used in each control unit. One blocks out the vibration detector while the protected equipment is starting up. The second times the duration of vibration and permits shut-down only if trouble persists.

Absolute reliability of every component is vital in a protective system of this sort. G-V Red Line Delay Relays meet this requirement for reliability ... at surprisingly low cost. Apply them in your equipment and be safe.

Write for Publication 131.

G-V CONTROLS INC.
LIVINGSTON, NEW JERSEY





TRANSISTOR applications

deserve **RAYTHEON**

RELIABILITY

Raytheon's reputation for transistor quality and reliability is based on the following unequalled record of achievement and experience:

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- First to insure reliable Transistor performance by developing the Raytheon Fusion Alloy process
- First to make low-noise Junction Transistors commercially available
- First to develop and introduce High Frequency Fusion-Alloy Transistors
- First to offer Fusion-Alloy Transistors specially designed, manufactured and tested for computer (switching) applications
- First to manufacture Computer Transistors meeting military specifications
- First to design and produce "Submin" Transistors
- First to produce PNP Silicon Transistors for standard industrial applications
- First to make available both PNP and NPN Silicon Transistors
- First to engineer and build automatic test equipments for quality control of Transistors and to use them on a full production scale

Many Raytheon Transistors meet requirements of MIL-T-19500A



RAYTHEON CIRCUIT-PAKS are compact, encapsulated, complete sub-assemblies of Transistors, Diodes, Rectifiers and other components for uses such as Phase Comparators, Bridges, Choppers, Flip-Flops, etc. They save space, speed assembly and assure Raytheon reliability.



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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 second-class matter for postage and 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

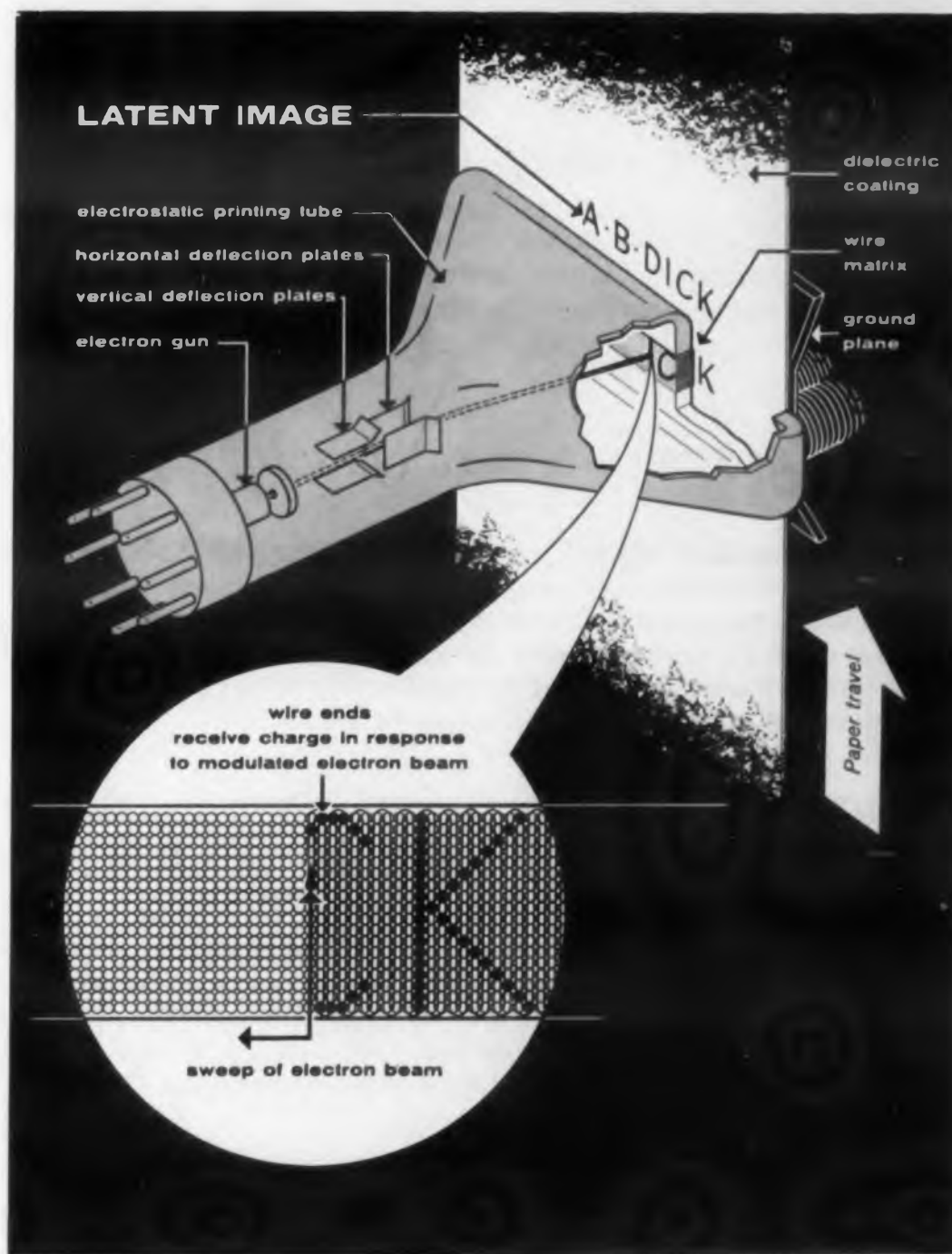
At the heart of the Videograph process is an electrostatic printing tube developed for A. B. Dick by the Stanford Research Institute at Menlo Park, Calif. This EPT is basically a cathode ray tube with a flared, rectangular faceplate. The glass faceplate supports a matrix of 250 stainless steel wires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

Q

What is an attenuator?



A

An attenuator is a resistive network, either fixed or variable, designed to reduce the power output of a signal system by a definite amount. Furthermore, it can keep the input impedance or output impedance, or both impedances, constant, depending on the type of network.

Q

What are the uses of attenuators?

A

- Volume controls in multi-channel mixers • Meter multiplier controls
- Equalizer controls • Sound level controls • Video and R. F. line controls
- Controls in transmission systems and transmission measuring equipment

Q

Why use a step-type attenuator?

A

A high degree of accuracy and repeatability is obtainable in a step-type, since the resistors are individually calibrated • The switch contact noise is practically eliminated by the use of precious metal contacts • Life of the unit is increased greatly over units in which the rotor arm makes contact with the resistor elements • Indexing by positive detent action is available for resetting of readings at an exact resistive position, or a position with a specific decibel loss.

Q

Where can complete information be obtained on the various types and designs of attenuators?

A

From the Daven Attenuator Catalog—the "BIBLE" of attenuator users. Daven has over 2,000 listed catalog types to solve your problem. Step-type Potentiometers, Ladder Networks, "T" Pads, Balanced "H" Units. Attenuators are available covering the audio, video or R. F. frequency ranges. Fixed pads . . . plus variable units with 10, 20, 30 and 45 steps are but some of the units covered.

Our Engineering Department will be glad to work with you on attenuators for specialized applications.



THE DAVEN CO. LIVINGSTON, NEW JERSEY

WORLD'S LARGEST MANUFACTURER OF ATTENUATORS
CIRCLE 4 ON READER-SERVICE CARD

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 infrared cells pictured in the June 10 issue of *ELECTRONIC DESIGN* should have been described as being of 0.25-in. diameter and able to cool to -213°C . The proposed maser cooler will chill to -271°C .

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 Talbot, of Boeing.

it's
for
the
BIRDS*

THE KERNEL

... A New Microminiaturized Toroidal Inductor

The new Burnell & Co. MT 34 and MT 35 microminiature Kernel toroidal inductors are made to order for the engineer who isn't content with outer husk solutions but gets right to the core of second generation missile communication problems.

MT 34 microminiature Kernels can be supplied with inductances up to 500 mhys and the Kernel MT 35 is available in inductances up to 200 mhys. MT 34 Kernels are recommended for frequencies to 30 kcs and the MT 35 is applicable to frequencies up to 200 kcs depending on inductance values. Q for the MT 34 is greater than 55 at 25 kc and for the MT 35 more than 60 at 100 kcs.

Size of the MT 34 is .437" OD x 9/32", spacing between leads .3" x 1" L with a weight of .06 ounces.

The new microminiature Burnell MT 34 and MT 35 Kernels provide maximum reliability as well as considerable economy in printed circuit use. Completely encapsulated, the Kernels will withstand unusually high acceleration, shock and vibration environments.

Write for special filter bulletin MTF to help solve your circuit problems.

*missiles

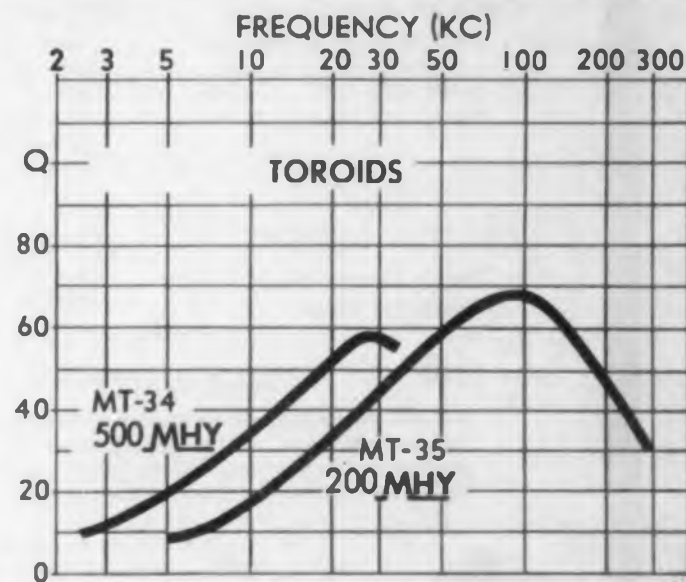
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CIRCLE 5 ON READER-SERVICE CARD

HIGH SPEED alphanumeric PRINTER with integrated storage and programming electronics

prints up to
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adaptable to all digital data sources

SOLID STATE DESIGN
MODEL 3260

A POTTER EXCLUSIVE
Stellite Type Fonts To Order

Check these features...

OPERATING SPEEDS

4 BIT DATA @ 20 lines/sec.
6 BIT DATA @ 10 lines/sec.
PAPER FEED TIME.....15 Ms
SERIAL LOADING RATE 20 kcs

RELIABILITY

Solid state storage, transistorized hammer drive and paper feed . . . troublesome contacts and wiper arms eliminated by reluctance pickup. Digital logic throughout.

CUSTOM DESIGNS

Designs to meet MIL or Commercial Specs.

COMPATIBILITY

4 or 6 bit input data in parallel or serial-parallel form and in any coding system.

FLEXIBILITY

Self-synchronized or random (slaved) operating modes
Tailored horizontal and/or vertical formats
Modular construction permits wide variation of characteristics
Accessible input/output command functions for maximum utility

Look to Potter for a complete line of magnetic and perforated tape handlers, associated equipment and system combinations.



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Potter has career opportunities for qualified engineers who like a challenge, and the freedom to meet it.

CIRCLE 6 ON READER-SERVICE CARD



NEWS

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 a 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.

PHILCO[®] Silicon Microwave Mixer Diodes

Offer Unequaled Performance and Sensitivity...at 16,000 mc and 24,000 mc



- Lowest Over-all Receiver Noise Figure
- Operating Temperature More Than Doubled
- Hermetic Seal for Maximum Reliability
- Burn-Out Rating Doubled

Performance Data

	1N26	1N26A	1N26B	
Conversion Loss	8.5	7.5	7.5	(db)
Noise Ratio	2.5	2.0	1.5	(times)
RF Impedance	—	1.6	1.5	(VSWR)
Over-all Receiver Noise	13.1	11.3	10.0	(db)

	1N78	1N78A	1N78B	1N78C	
Conversion Loss	7.5	7.0	6.5	6.0	(db)
Noise Ratio	2.5	1.5	1.3	1.3	(times)
RF Impedance	—	1.6	1.6	1.5	(VSWR)
Over-all Receiver Noise	11.8	9.8	8.8	8.3	(db)
Burn-Out	0.3	0.3	0.3	0.6	(ergs)

*Immediately available only from PHILCO

Write Special Components Dept. ED-759—Lansdale Tube Company Division, Philco Corporation, Lansdale, Pa.

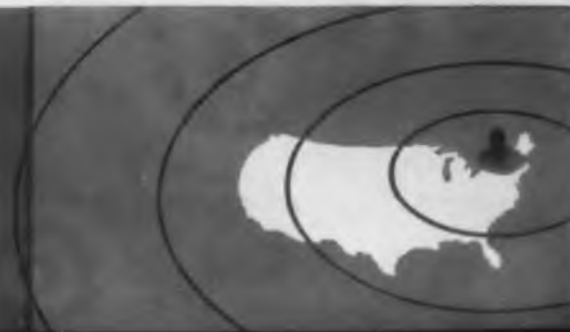
The result of extensive research and development by Philco, the two newest diodes in these families provide better performance, greater reliability and increased sensitivity in both the 16,000 mc and 24,000 mc regions. Operating temperatures of all diodes in both families are more than doubled . . . to 150° C. All Philco Diodes are packaged in hermetically sealed cases for extreme reliability under adverse environmental conditions. The newest diodes (1N26B, 1N78C) offer the lowest over-all noise figure in these series . . . immediately available only from Philco. If you are designing for maximum performance and sensitivity, to meet rigid specifications . . . write for detailed data and application information on these new Philco Silicon Microwave Diodes.

We offer complete production capability for classified millimeter crystals and invite your inquiry.

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LANSDALE, PENNSYLVANIA





12,000 Mc

directly displayed by a counter

Model 7580 Transfer Oscillator (bottom cabinet) with Model 7370 EPUT and Timer (top cabinet):

Frequency measuring range dc to 12 K Mc
Types of signals accommodated CW, AM, FM
pulsed r-f

Sensitivity 100 mv rms

Input impedance 50 ohms

Accuracy up to $\pm 3p$ in 10^7

Fundamental range of trans. osc 75 to 150 Mc &
7.5 to 15 Mc

Harmonics available Up thru 80th

Stability of fundamental0001%/min

Four-step operation:

1. Tune to two adjacent zero beats identified by built-in oscilloscope display.
2. Read harmonic number on calculator dial.
3. Set rotary switches to harmonic number.
4. Read frequency indication directly from counter.

Prices: Model 7580 Transfer Oscillator \$1650

Model 7370 10 Mc EPUT & Timer \$1975

Model 7360J 2 Mc EPUT & Timer (price \$1325) may also be used with the transfer oscillator.

Used in combination with the computing transfer oscillator in the cabinet beneath it, the 10 Mc EPUT® and Timer creates a *direct* decimal display of 12,243.15 megacycles generated by the small klystron at the right. How? The transfer oscillator contains a computing device which automatically calculates the harmonic number of a harmonic brought to zero beat with the frequency under test. Then, the gate time of the counter is multiplied by the harmonic number to produce a counter indication of actual klystron frequency. By eliminating all manual computations, the entire operation commonly takes less than one-fifth the time required using equipment previously available.

This assembly of two independent units, compatibly designed, offers an unprecedented combination of range, accuracy and convenience. The transfer oscillator can also be used with either of two other BECKMAN/Berkeley EPUT Meters currently in wide use.

Beckman

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For more information on this and other recent advances in digital frequency measuring techniques, write for the new Data File 111. Address department D-7.

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's defense systems department. Their paper, "Baseline Guidance Systems," surveyed guidance and tracking of space vehicles. One conclusion was that, in principle, "extremely long baselines stretching 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 μ sec 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 atmosphere.

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.



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CIRCLE 10 ON READER-SERVICE CARD

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

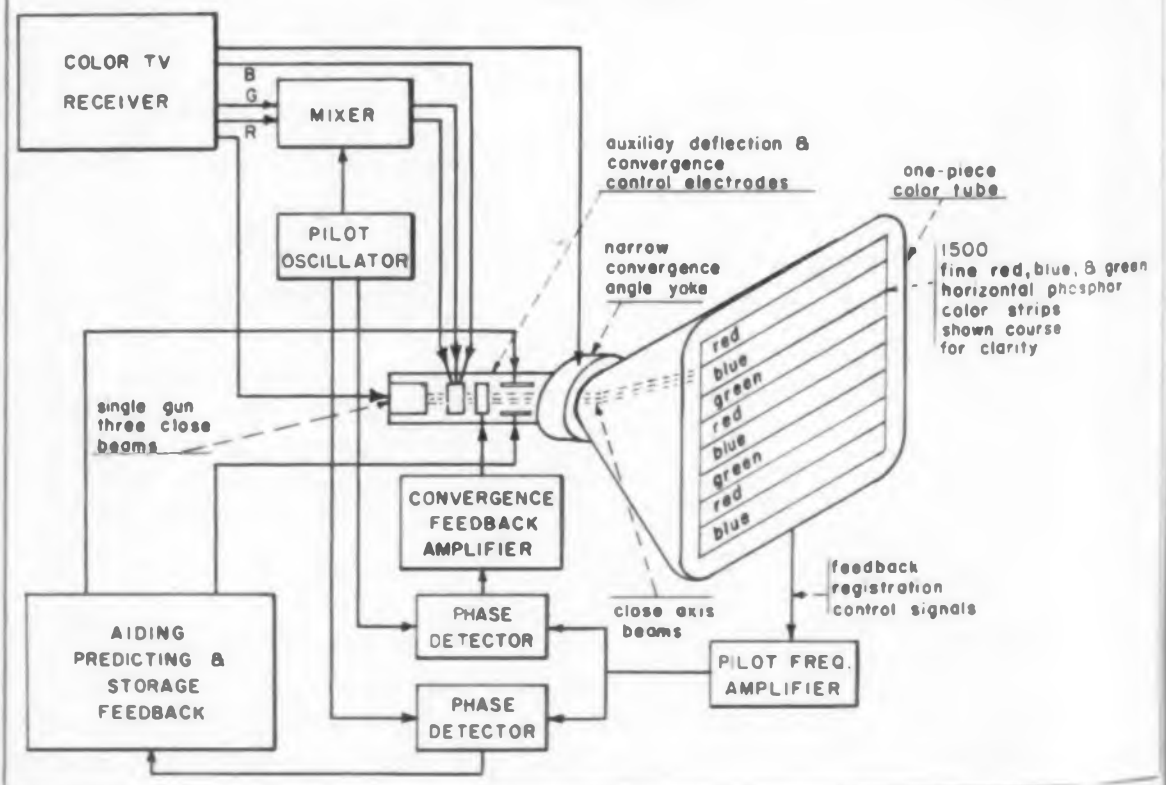
Aided feedback correction of color registration is claimed to be key principle of this color TV system. The aided feedback is said to permit use of horizontal color strips in a relatively inexpensive one-piece, single-gun tube.

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, Chromalox 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.

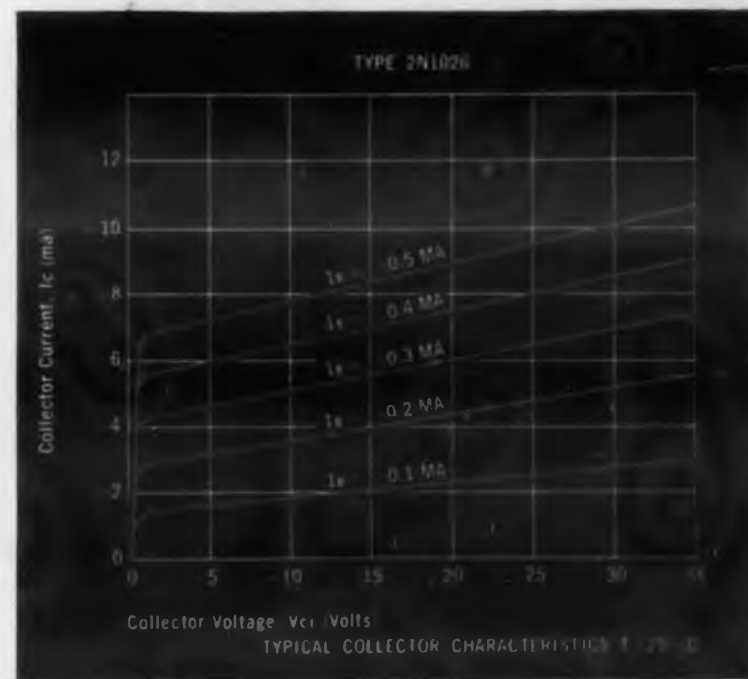
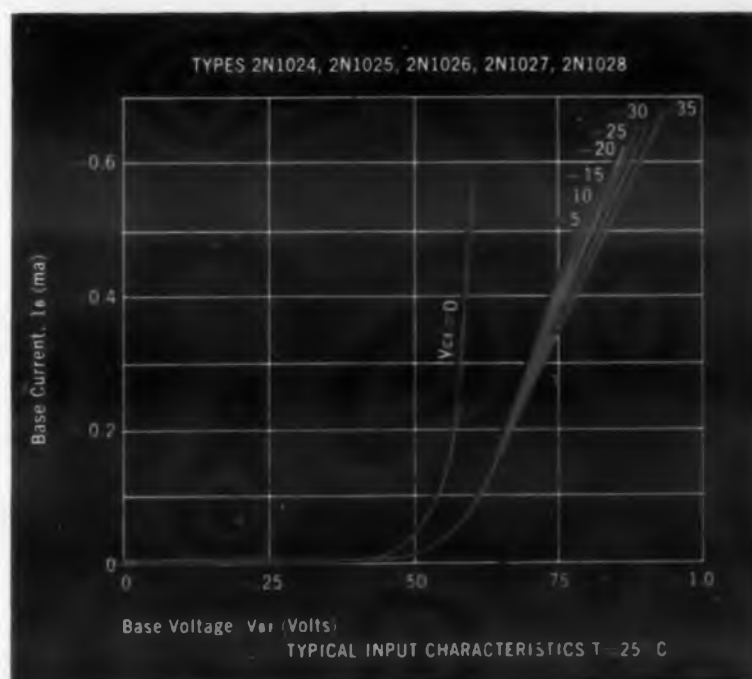
But with the eye evidently designed to see natural scenes, with random color distribution, its subtlety could easily be lost in any artificially filtered, fragmented, two-color viewing situation.

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

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SPECIFICATIONS

TYPE	COLLECTOR VOLTAGE	BETA (β_{DC})	f_{α}	APPLICATIONS
2N1024 2N1025 2N1026 2N1026A	15v 20v 15v 35v	3 min. 5-15 15-25 25-72	1mc min. 1mc min. 2mc min. 2mc min.	D.C. and audio amplifiers, voltage regulation, modulator and demodulator and switching circuits.
2N1027	15v	15 min.	5mc min.	Medium frequency—amplifier, oscillator and switching circuits.
2N1028	10v	5 min.	4mc min. 1.5 min.	High speed computer switching.

These Sperry silicon transistors, made by the alloy junction process, offer important advantages for general-purpose and switching circuits in missile and airborne applications.

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For complete electrical characteristics of these Sperry PNP transistors, write for data sheets.

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CIRCLE 12 ON READER-SERVICE CARD

NEWS



The universe, as a 60-foot high aluminum shell, dominates the Soviet exhibit and serves as a dramatic backdrop for three Soviet Sputniks. Sputnik 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, micrometer 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)

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of specific interest to engineers

Folio 59-5

REFERENCE
DATA FILE



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.

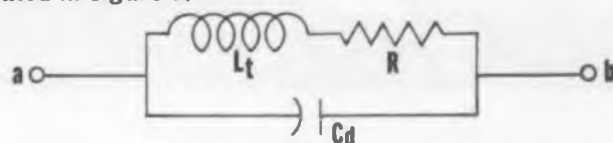


FIGURE 1

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.

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TYPE 521

SPECIFICATIONS

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CIRCLE 14 ON READER-SERVICE CARD

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.

ELECTRONIC DESIGN • July 22, 1959



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 350-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.



ACTUAL SIZE

incredible...but true. This is a new transistorized voltage controlled subcarrier oscillator, type TS-50. It is 1-3/8" high, 7/8" deep and 1-1/16" wide. The weight is only 1-3/4 oz. Due to excellent repeatability the unit does not have any adjustments and is completely encapsulated. Operational temperatures range from -55°C to +125°C.

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NEWS

Ceramic Circuit Takes 1300 F Temperatures



Heat of 1300 F can't damage this molybdenum 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 C. 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 neuron'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.

ARTICLE 17 ON READER-SERVICE CARD

AN IMPORTANT **NEW** VHF-UHF INSTRUMENT

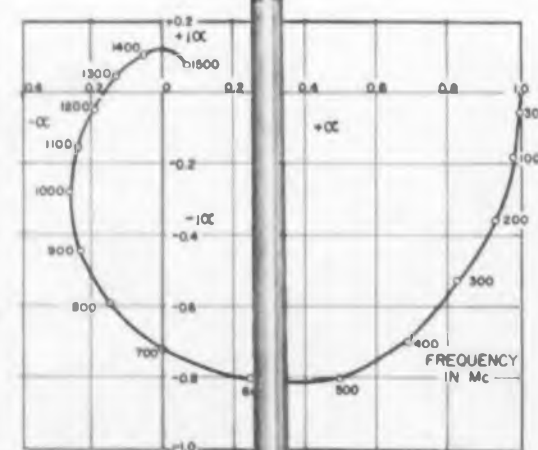
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Plot of Alpha versus frequency for an experimental high-frequency transistor... measured with the Type 1607-A.



Imittance Indicator for all impedance and admittance measurements.

Type 1607-A Transfer-Function and Imittance Bridge, \$1665.

Frequency Range: 25 to 1500 Mc.
Biasing Provisions: Built-in for use with external d-c sources.
Maximum current, 100 ma; maximum voltage, 400 volts.

Measurement Ranges:

FUNCTION	RANGE	ACCURACY
Voltage and current ratios (R)	0-30	$2.5 (1 + \sqrt{R}) \% + 0.025$
Transimpedance (Z_{21})	0-1500 ohms	$2.5 (1 + \sqrt{\frac{Z_{21}}{50}}) \% + 1.25$ ohms
Transadmittance (Y_{12})	0-600 mmhos	$2.5 (1 + \sqrt{\frac{Y_{12}}{20}}) \% + 0.5$ mmho
Impedance (Z_{11})	0-1000 ohms	$2.0 (1 + \sqrt{\frac{Z_{11}}{50}}) \% + 1.0$ ohm
Admittance (Y_{11})	0-400 mmhos	$2.0 (1 + \sqrt{\frac{Y_{11}}{20}}) \% + 0.4$ mmho



ACCESSORIES SUPPLIED:
Frequency-Range Extension Unit; Two Calibrated Transfer-Function and Imittance Indicators; Terminations; Standards; 10-db Attenuator; Air Lines, Patch Cords, and other Coaxial Elements.

Type 1607-P101 Transistor Mount

ACCESSORIES AVAILABLE:
Type 1607-P101 Transistor Mount for JETEC-30 0.200-in. pin-circle triode with grounded-base arrangement. \$60.
Type 1607-P102 Transistor Mount for JETEC-30 0.200-in. pin-circle triode with grounded-emitter arrangement. \$60.

Type 1607-P201 Tube Mount, 7-pin miniature, grounded cathode for 6AF4, 6AF4A, 6AN4, 6T4, and other tubes with the same pin connections \$75.

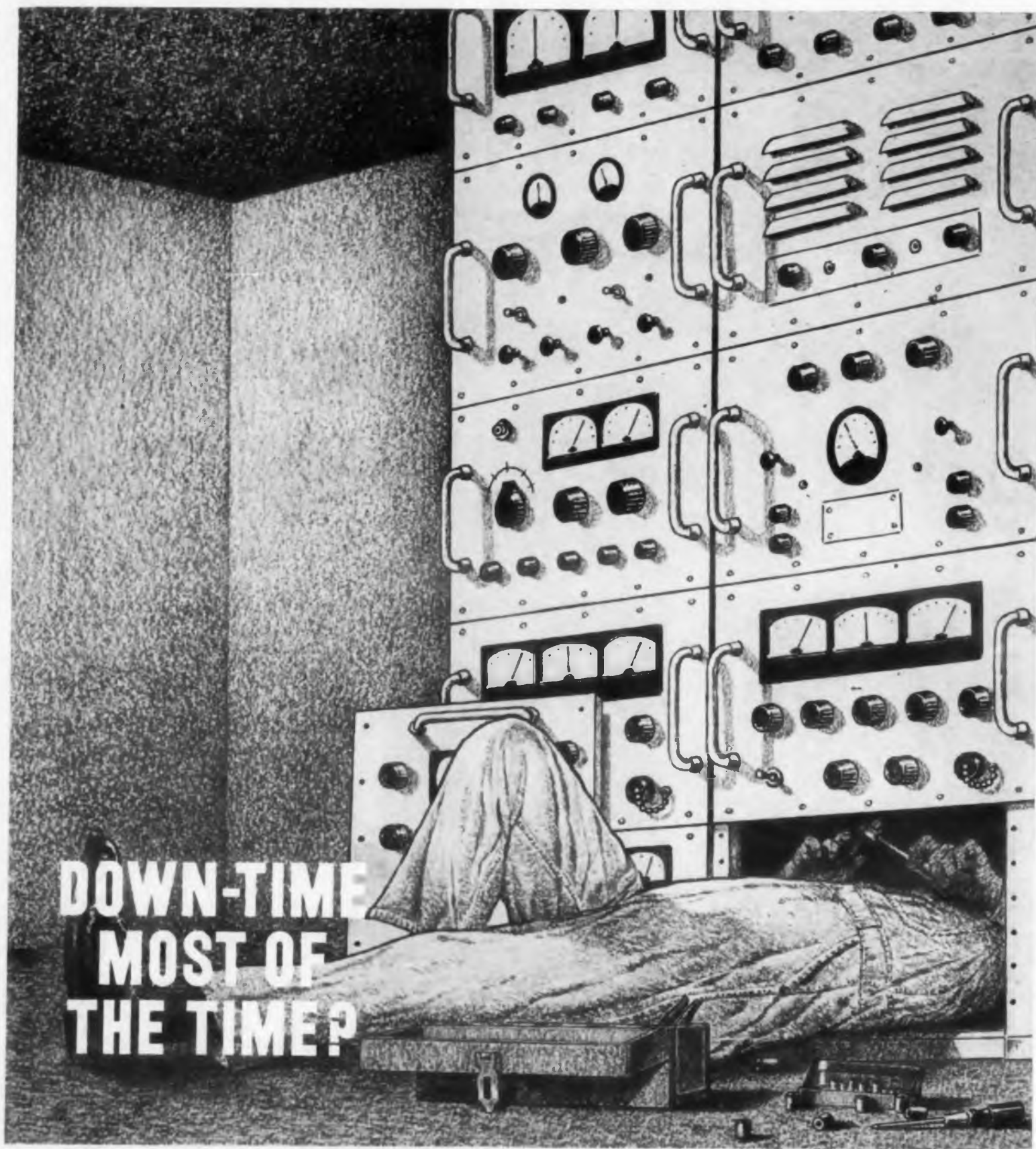
Other mounts for tetrodes, 0.100-in. pin-circle triodes, and ungrounded components are in development and will be announced soon.

Generator and Detector: G-R Unit Oscillators and Type DNT Detectors are recommended.

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CIRCLE 18 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 air 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.



A NEW 50 VOLT SUBMINIATURE PAPER CAPACITOR

meets requirements of MIL-C-25A K characteristic

FOR TRANSISTORIZED APPLICATIONS

Astron's new 50 volt hermetically sealed subminiature paper capacitors have the reliability required by specification MIL-C-25A.

These units operate at temperatures from -65°C to $+125^{\circ}\text{C}$ without derating. The capacitance variation is less than $\pm 3\%$ over the entire operating temperature range. High insulation resistance, low power factor, unusually low resonance loss are combined in this new light-weight subminiature unit.

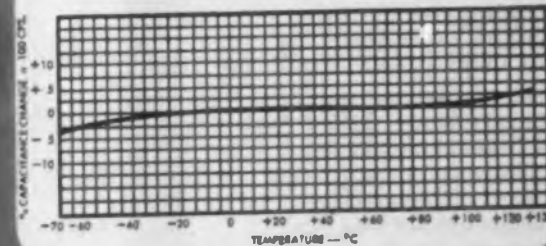
In response to a definite engineering need, Astron's new type AQF is compactly designed and offers superior performance characteristics for low voltage transistorized applications.

Write today for complete technical information.

PARTIAL LIST OF RATINGS AVAILABLE

CAP. MF	DIA. x LENGTH
0.027	.235 x 3/4
0.068	.312 x 7/8
0.1	.312 x 7/8
0.27	.400 x 1-3/8
0.47	.500 x 1-1/4
1.0	.562 x 1-5/8
2.0	.750 x 2-1/8

TYPICAL CAPACITANCE VS. TEMPERATURE



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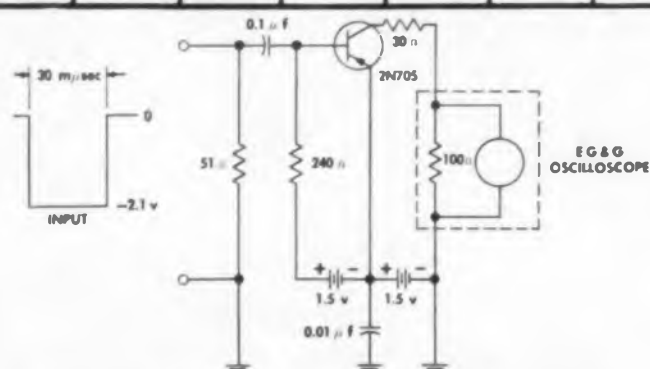
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71 South 12th Street/FE 2-1325



APPLICATION NOTES

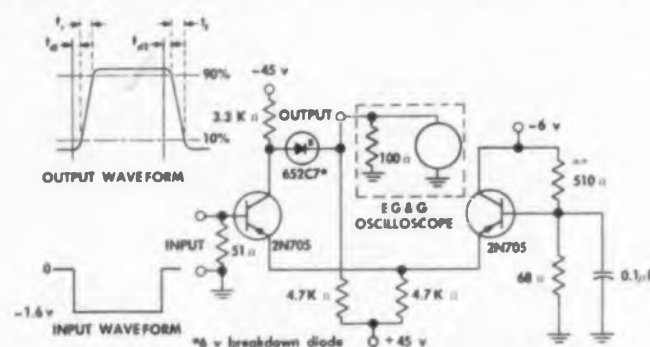
VOLTAGE SWITCHING CIRCUIT

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



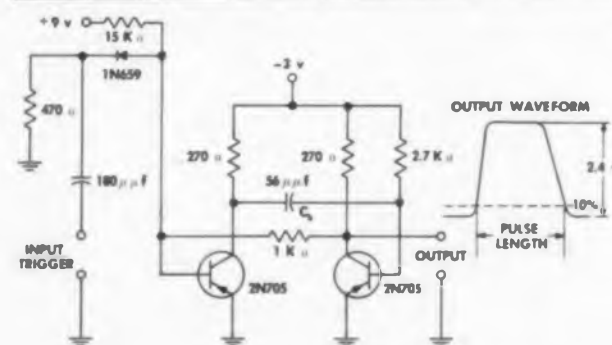
NON-SATURATING CURRENT MODE SWITCH

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



MONOSTABLE MULTIVIBRATOR

t_r	t_f	Pulse length (depends on C_2)
20 μ sec	40 μ sec	120 μ sec



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.



FROM THE WORLD'S LARGEST SEMICONDUCTOR PLANT

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.



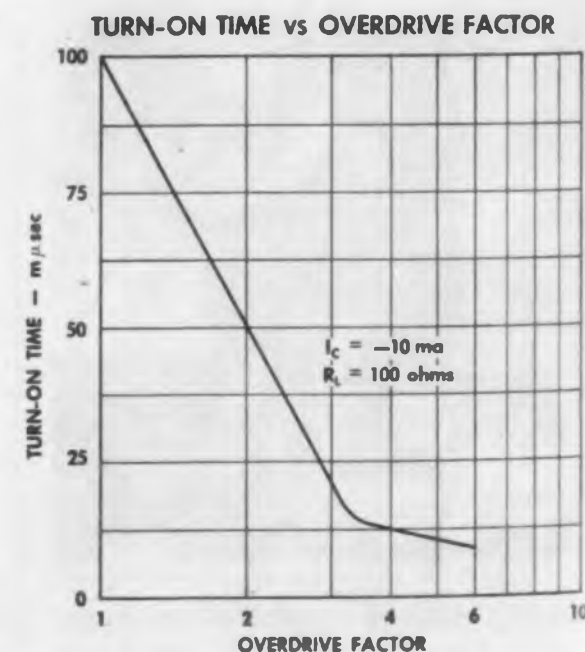
Actual Size

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 μ sec!

TRUE SWITCHING SPEED

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

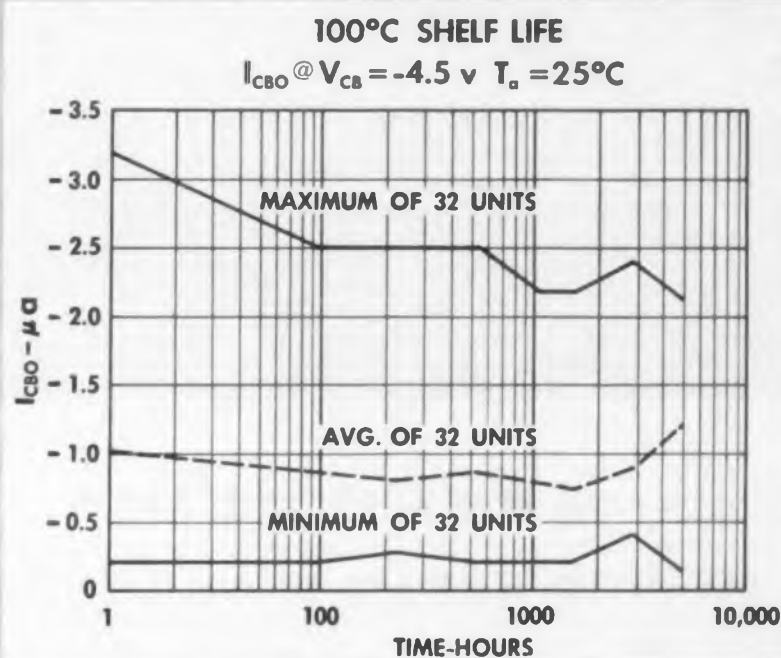
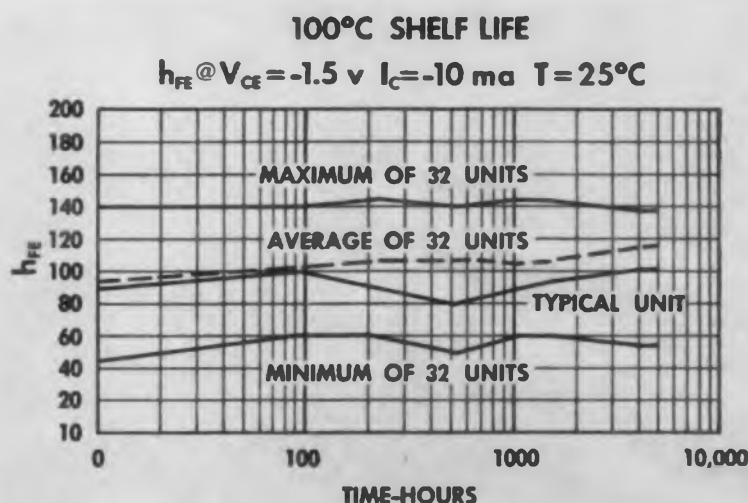
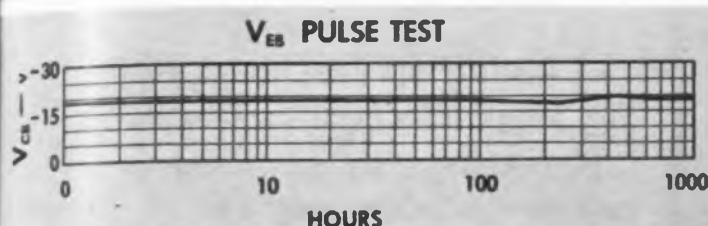
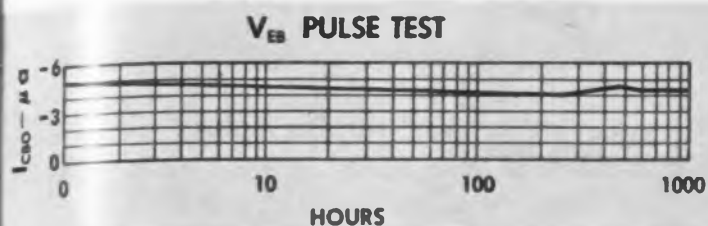
Below is the speed-up of 2N705's as a function of overdrive characteristics.



TEXAS



TI 'mesa' transistors!



RELIABILITY INSURED BY RUGGED DESIGN, TEST

5000-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 1 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.

CIRCLE 20 ON READER-SERVICE CARD

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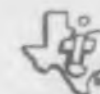
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WASHINGTON REPORT



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-

... the technical ability to do jobs for the government.

Air Force Using Check List

In line with the tendency in Congress to be solicitous 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 sub-systems 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."

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INSURE FAILURE-PROOF PERFORMANCE!

Only 1 Failure in 7,168,000 Unit-Hours for 0.1 MFD Capacitors*

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*Life tests have proved that El-Menco Mylar-Paper Dipped Capacitors — tested at 100°C with rated voltage applied — have yielded a failure rate of only 1 per 716,800 unit-hours for 1 MFD. Since the number of unit-hours of these capacitors is inversely proportional to the capacitance, 0.1 MFD El-Menco Mylar-Paper Dipped Capacitors will yield **ONLY 1 FAILURE IN 7,168,000 UNIT-HOURS.**

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• Five case sizes in working voltages and ranges:

200 WVDC —	.018 to .5 MFD
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600 WVDC —	.0018 to .25 MFD
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Write for Technical Brochure Giving Complete Information on the El-Menco Tubular Dur-Paper Line.

THESE CAPACITORS WILL EXCEED ALL THE ELECTRICAL REQUIREMENTS OF E.I.A. SPECIFICATION RS-164 AND MILITARY SPECIFICATIONS MIL-C-91A AND MIL-C-25A.

FOR FAILURE-PROOF PERFORMANCE... COUNT ON EL-MENCO MYLAR-PAPER DIPPED CAPACITORS... FROM MISSILE GUIDANCE SYSTEMS TO DATA PROCESSING EQUIPMENT!

*Registered Trade Mark of DuPont Co.

SPECIFICATIONS

- TOLERANCES: $\pm 10\%$ and $\pm 20\%$. Closer tolerances available on request.
- INSULATION: Durez phenolic resin impregnated.
- LEADS: No. 20 B & S (.032") annealed copper-weld crimped leads for printed circuit application.
- DIELECTRIC STRENGTH: 2 or $2\frac{1}{2}$ times rated voltage, depending upon working voltage.
- INSULATION RESISTANCE AT 25°C:
For .05MFD or less, 100,000 megohms minimum.
Greater than .05 MFD, 5000 megohm-microfarads.
- INSULATION RESISTANCE AT 100°C:
For .05MFD or less, 1400 megohms minimum.
Greater than .05MFD, 70 megohm-microfarads.
- POWER FACTOR AT 25°C:
1.0% maximum at 1 KC.



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- tubular paper • ceramic • silvered mica films • ceramic discs

CIRCLE 22 ON READER-SERVICE CARD

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.

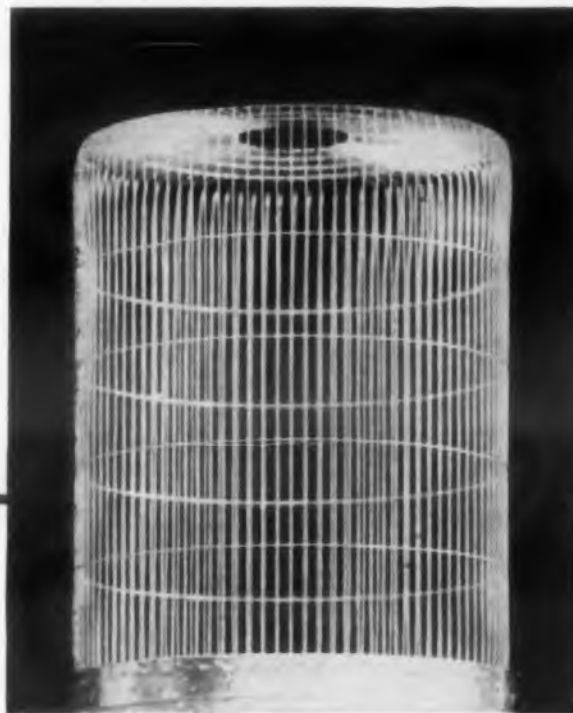
September

- 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 Telemetry, IRE, Civic Auditorium and Whitcomb Hotel, San Francisco, Calif.
 - 30-1 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.

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The Deoxo Catalytic Purifier is combined with an extremely efficient automatically operated drying unit to provide oxygen-free hydrogen that is ideally pure and dry. The combined units are identified as the Deoxo Dual Puridryer. It supplies hydrogen with less than one part oxygen per million — dried to a dew point of -100°F . No inert gas purging is needed. The Deoxo Dual Puridryer can also be used with other gases such as: Nitrogen, Argon, Helium and saturated hydrocarbons, with equally fine performance. Write for descriptive literature.

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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

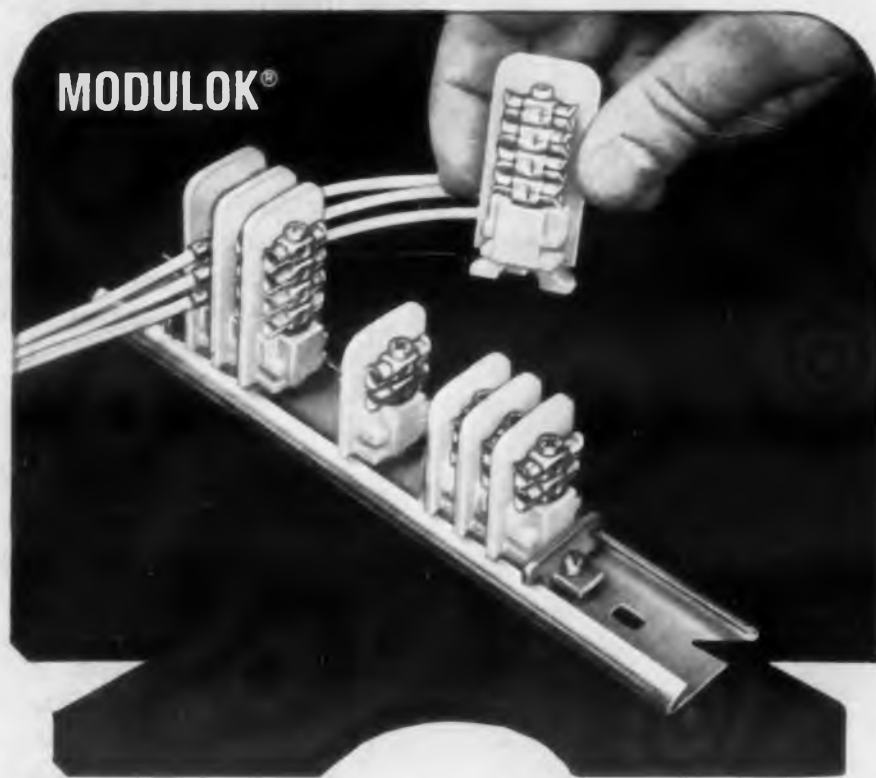
To be held simultaneously on the East and West Coast, the IRE Symposia will be devoted to "More Effective Communication of Scientific and Engineering Information." The West Coast session will be held at the Ambassador Hotel, Los Angeles, Calif., and will feature motivations that make the engineer want 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.*



Snap-in spring-loaded contacts for quick-disconnect or permanent connection. Modules—2 or 4 tier—snap together or apart for extreme flexibility. Contacts are solderless crimp-type. Up to 30 modules per foot of track.

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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 prepositions, feeds, and crimps contacts such as those used with BURNDY's MODULOK® and CRABLOK®, 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 (by 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 develop 2500 lb force when operated at 90 psi.

Burndy Corporation, Norwalk, Connecticut

CIRCLE 24 ON READER-SERVICE CARD
ELECTRONIC DESIGN • July 22, 1958

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 micro-second 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.

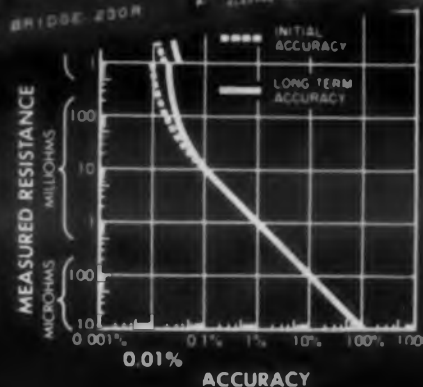
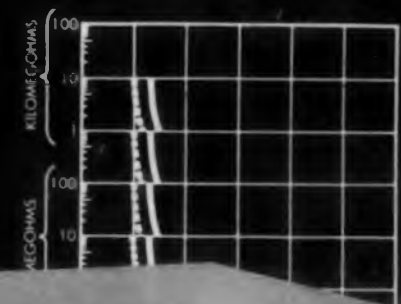
James G. Kipp

Precision

MODEL 230-R



Resistance BRIDGE



For precise resistor checking, temperature coefficient measurements, strain gauge calibration and other critical resistance measurements, the new Model 230-R Resistance Bridge gives an unsurpassed combination of accuracy, speed and convenience.

- Resolution of one part in a million.
- Accuracy of better than 0.02%.
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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:

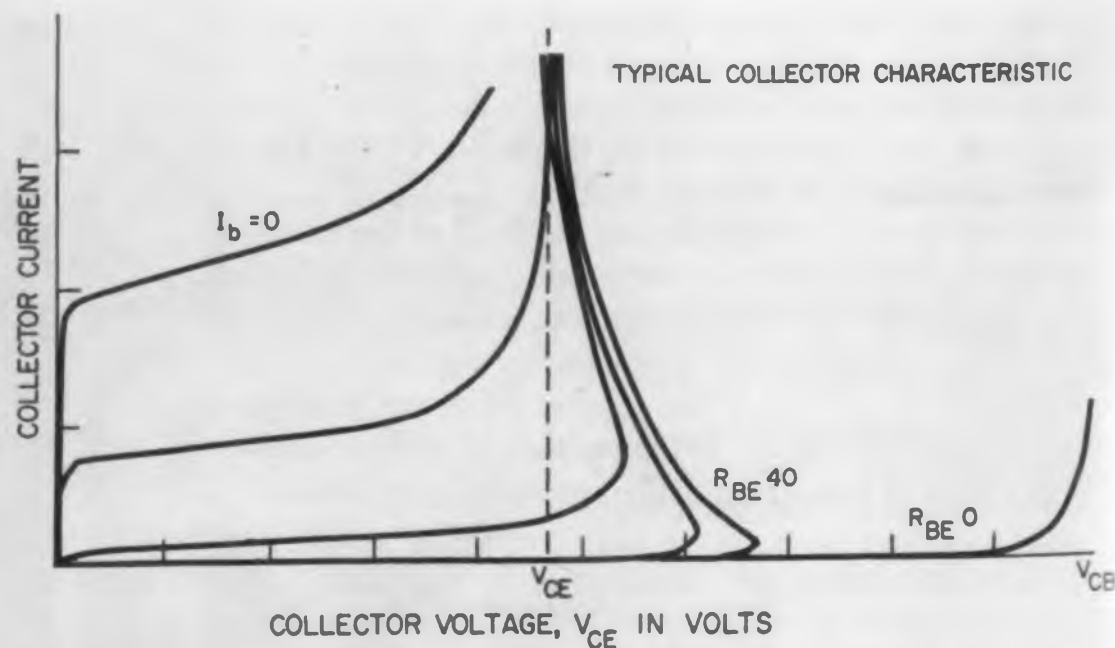
1. V_{CE} , $I_B = 0$, ($R_{BE} = \text{infinity}$)
2. V_{CE} max. ($R_{BE} = 40$ ohms)
3. V_{CE} max. ($R_{BE} = 0$)

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 charac-

teristic, 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} operating 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:

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

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 $\alpha m = 1$. 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

reads easily, at a glance . . .



This new General Electric Type KT time meter measures operating time of any electrical equipment, speeds routine checking with "**at-a-glance**" readability. Big numbers are more than twice the size of ordinary meter digits. New low cost, too—in square, round, portable and sealed models. Totally enclosed construction means extra years of dependable operation. Increased operating temperature range (minus 67F to plus 150F) extends meter life, reduces maintenance. What's more, a **new sixth digit**—standard on all G-E models—offers more accurate range of measurement at **no extra cost!** Pass on these important benefits to your customers with time meters from the complete KT line. Also, specify G.E.'s Type TSA interval or process timers for dependable service on your automatic time-control applications. New BIG LOOK panel meters are available, too! For the full story on any of these instruments, contact your nearby G-E Apparatus Sales Office; or, write to Section 593-306, General Electric Co., Schenectady 5, N. Y. In Canada, contact Canadian General Electric Company Limited, 940 Lansdowne Avenue, Toronto 4, Ontario.

Other General Electric Instruments for Original Equipment Manufacturers—Switchboard instruments; inking, inkless, switchboard and portable recorders; testing instruments; speed-measuring systems.

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WIDE BAND AMPLIFIERS



SERIES T-330

TRANSISTORIZED AMPLIFIER SERIES T-330

A new series of completely transistorized I-F amplifiers offered to fill the need for standardized, high quality units. These T-330 series amplifiers by I.F.I. are available in a variety of center frequencies and bandwidths. They also can be equipped with emitter follower, cathode detector or low noise tube input. All applicable military environmental specifications are met:

SPECIFICATIONS

Center Freq.	T-330A	30 mc
	T-330B	30 mc
Bandwidth	T-330A	10 mc
	T-330B	3 mc
Gain	T-330A	80 db min.
	T-330B	100 db min.
Output (max)	T-330A	+ 5 DBM
	T-330B	+10 DBM
Input Impedance	T-330A	50 ohm
	T-330B	50 ohm
Noise Figure	T-330A	10 db
	T-330B	8 db
Mean Stage Gain	T-330A	11.5 DB
	T-330B	14.0 DB



Standard Relay Rack Panel Mount 19" Wide x 3 1/2" High.

SERIES M500 AMPLIFIER

In combination, IFI amplifiers deliver a gain as high as 46 DB. With bandpass 200KC-220MC wide, you get power output of 3 watts. Pulses with rise time as short as 3 millimicroseconds can be measured. A Model 530, for instance, driving a Model 510, in turn connected to a Model 500 and fed with a signal of 120 millivolts (peak), will furnish an amplitude of 25 volts peak. Input pulse may be positive or negative with rise time of 2 or 3 millimicroseconds.

SPECIFICATIONS

	M-530	M-500A*	M-510
Band Pass	10 KC to 300MC	200KC to 220MC	200KC to 220 MC
Input Impedance	135 ohms	90 ohms	90 ohms
Output Impedance	150 ohms	185 ohms	185 ohms
Gain	18 DB	12 DB	16 DB (90 ohm load)
Rise Time	.002 sec.	.0025 μ sec	.0025 μ sec.
Average Power	0.08W	3 Watts CW	0.75W
Peak Pulse Power	—	300 Watts (Negative pulse into 185 ohm load)	—
RMS Voltage out—across rated load impedance	3.5 V	22 Volts	12 Volts
Peak to Peak Voltage—across rated load impedance	7V	62 Volts	33 Volts
Price including Power Supply	\$245	\$390*	\$325

*A modified version of the M-500A which operates only in the linear mode, is the M-500 which is available at a price of \$330.



SUPER VIDEO AMPLIFIER

RACK MOUNTED OR PORTABLE

GENERAL DESCRIPTION

Two new super video amplifiers, designated the M-630 and M-680 are now offered by Instruments For Industry.

Two M-630 or two M-680 amplifiers can be housed in a cabinet that includes a power supply and front panel connections (as illustrated). These two amplifier sections can be operated separately, in cascade, in parallel, or in push-pull operation.

For two channel purposes, each amplifier can be used as a separate amplifier with gain of 20 db (if M-680 sections are used) or 60 db (if M-630 sections are used.) The two sections can also be connected in push-pull operation and in this manner, it is possible to deflect most laboratory scopes a full inch (approximately 30V PP) when fed directly into the plates. Price \$495.00 as shown

SPECIFICATIONS

Bandpass	200 cps to 30 mc (M-630) 400 cps to 80 mc (M-680)
Gain	60 \pm 2 db (M-630) 20 \pm 1/2 db (M-680)
Input Impedance	90 Ω , VSWR less than 1.5
Output Impedance	90 Ω , VSWR less than 2.1
Max. undistorted output voltage—matched	2.0 VRMS
Max. Pulse Output (Matched Load)	3.0 volts peak (open circuit 7.0 volts peak—positive or negative)
Pulse Rise Time	10 millimicroseconds
Max. Pulse Duration (10% droop)	60 microseconds (M-630) 40 microseconds (M-680)
Pulse Delay Time	30 millimicrosec. (M-630) 12 millimicrosec. (M-680)
Recovery Time (100 times overload)	500 millimicroseconds
Noise Figure	Approximately 9 db
Gain Control Range	20 db
Linear Range at full gain	Approximately 60 db
M630 or M680	\$225.00 each

I-F AMPLIFIERS—SERIES M200



SPECIFICATIONS OF STANDARD UNITS

	M-260	*M-230	*M-235
Band center	60 mc	30 mc	30 mc
Band width	10 mc	2 mc	10 mc
Voltage gain	90 db	110 db	90 db
Input impedance	50 ohms	50 ohms	50 ohms
Input V.S.W.R. less than	1.3:1	1.3:1	1.3:1

*Variations of the above standard units are available as follows

M-2330 LN—Model M-230 modified for low noise figure input circuit (1.5 db).
M-230 A—Model M-230 modified and featuring a built-in detector and cathode follower. Video output of 2 VRMS (for 30% modulated signal) across 400 ohms approx. Video bandwidth 1 mc.

M-235A—Model M-235 modified and featuring a built-in detector and cathode follower. Video output of 2 VRMS (for 30% modulated signal) across 400 ohms approx. Video bandwidth 5 mc.

Prices of the above units remain same as standard M-200 Series amplifiers.

POWER SUPPLY REQUIREMENTS

Power supply requirements for the standard units are detailed below.

M-230	140 V at 90 Ma	6.3 V at 1.4A
M-235	140 V at 90 Ma	6.3 V at 1.4A
M-260	125 V at 90 Ma	6.3 V at 1.4A

POWER OUTPUT CAPABILITIES

Due to the high gain available in the IFI units, it is possible to saturate the final stage of the amplifier with a relatively small applied signal voltage at full gain. Saturation occurs at the following output powers and voltages. Beyond this output level the amplifier will not operate linearly.

	Output Power	Output Voltage
M-235	0.051 WATTS	1.6
M-230	0.096 WATTS	2.2
M-260	0.007 WATTS	0.6

CIRCLE 27 ON READER-SERVICE CARD

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 current 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

However, in unsymmetrical transistors such as 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.

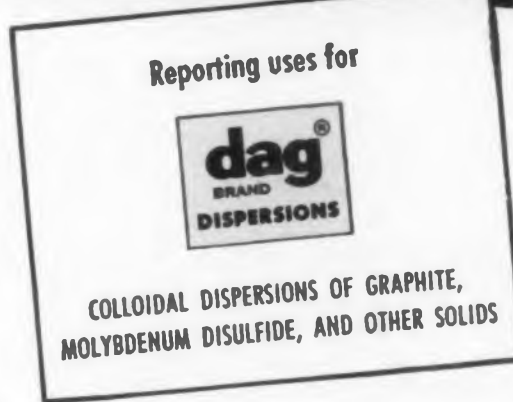
Punch-through breakdown generally does not damage the transistor and is a self-healing type of breakdown. After the voltage is removed, the transistor is again in satisfactory operating condition.

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

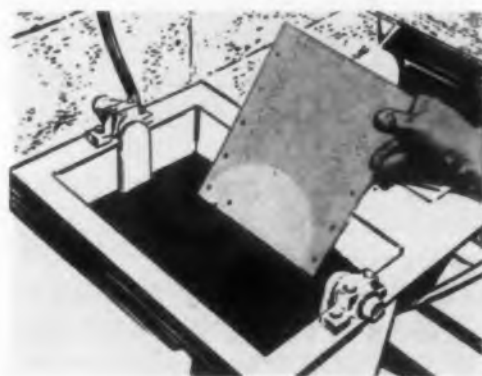
Voltage Supplies for Transistors

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. ■ ■



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Copper-clad laminated phenolic sheets are shown being dipped in a solution of 'dag' 154 and alcohol.

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are produced for the U. S. Air Force at the company's Kingston, New York plant. High reliability of the circuits in these printed wiring-boards is essential. Basically, the process involves piercing copper-clad phenolic laminates and sensitizing the pierced holes

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... Acheson colloidal dispersions are finding a variety of uses in the electrical and electronic industry. The unusual properties of 'dag' brand dispersions make them readily adaptable to a wide range of new design possibilities.

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'dag' dispersion solves an assembly problem at Marathon Electric

As one of the nation's largest producers of electric motors and generators, Marathon Electric Manufacturing Corporation must maintain high, uninterrupted production. Up until 2½ years ago, one of Marathon's chief problems came in the armature assembly of 37½ to 45 HP generators. Four wound pole pieces with a male dove-tail are fitted to the four sides of a laminated generator spider. Both the spider channel and dove-tail are lubricated and the pieces slid together with machine pressure. White lead was used as the lubricant.

According to Ray Waldringer, Machine Shop Supervisor at the company's main plant at Wausau, Wisconsin, five or six armatures were scrapped every day when the spider fins sheared under assembly pressure. Damage was traced to insufficient, uneven lubrication.

In 1956 Marathon began using Acheson 'dag' 210 — a dispersion of colloidal molybdenum disulfide in an isopropanol carrier. Since then neither a pole piece nor a spider has been scrapped because of a lubrication breakdown at this vital point in assembly!



'dag' 210, brushed on generator components before press-fit assembly, has eliminated rejects at Marathon Electric.

'dag' 210 is also used at Marathon in the assembly of electric motors. Applied to die-cast aluminum motor end brackets before press-fitting bronze sleeve bearings into them, this microscopically thin dry film lubricant has completely eliminated rejects caused by distortion of one or both of these pieces.

for plating. Actual printing is by applying a plating-resist to the copper sheet conforming to the circuit pattern.

The pierced sheets are first dipped in a solution of 'dag' 154 — colloidal graphite in alcohol. After rubber-rolling excess solution from the surface and oven drying, the graphite is automatically sanded off the surface of the sheet, leaving a graphite coating only

on the walls of the holes. Conductors are then plated through these holes. International Business Machines Corporation is one of many leading companies using Acheson dispersions profitably.

For additional information, call in your Acheson Service Engineer. Or write direct for Bulletin No. 433. Address Dept. ED-79.



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CIRCLE 28 ON READER-SERVICE CARD

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.
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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

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

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

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

f_a = Alpha cutoff frequency (mc),

r_b' = Base lead impedance (ohms),

C_c = Collector-to-base capacitance (pfd)

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)

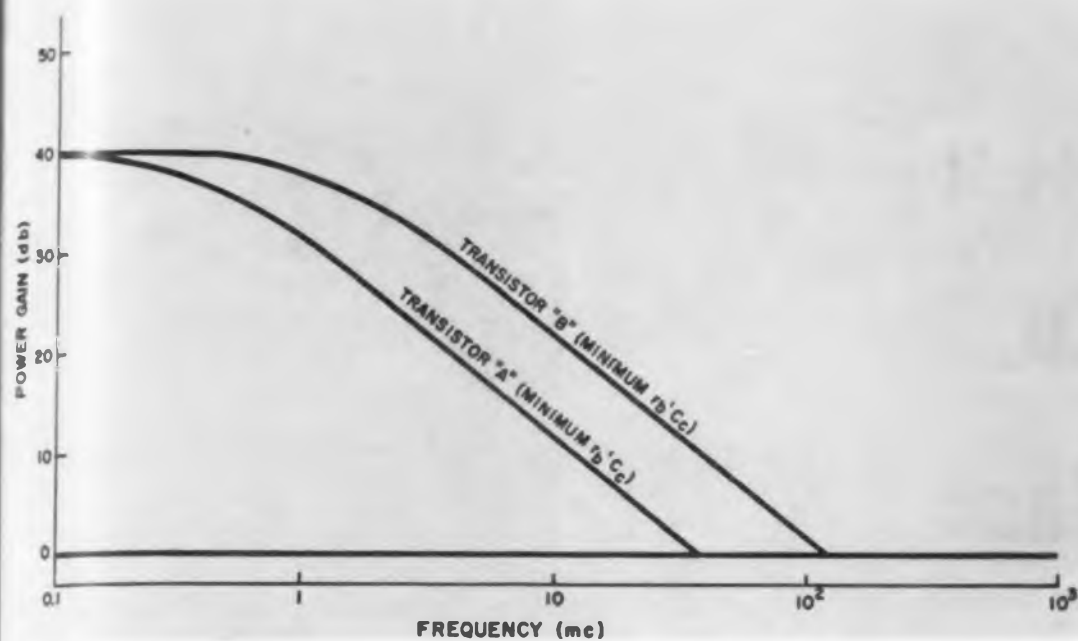


Fig. 1. Maximum available power gain vs frequency. This curve is for a typical vhf triode transistor in a unilateralized common emitter circuit.

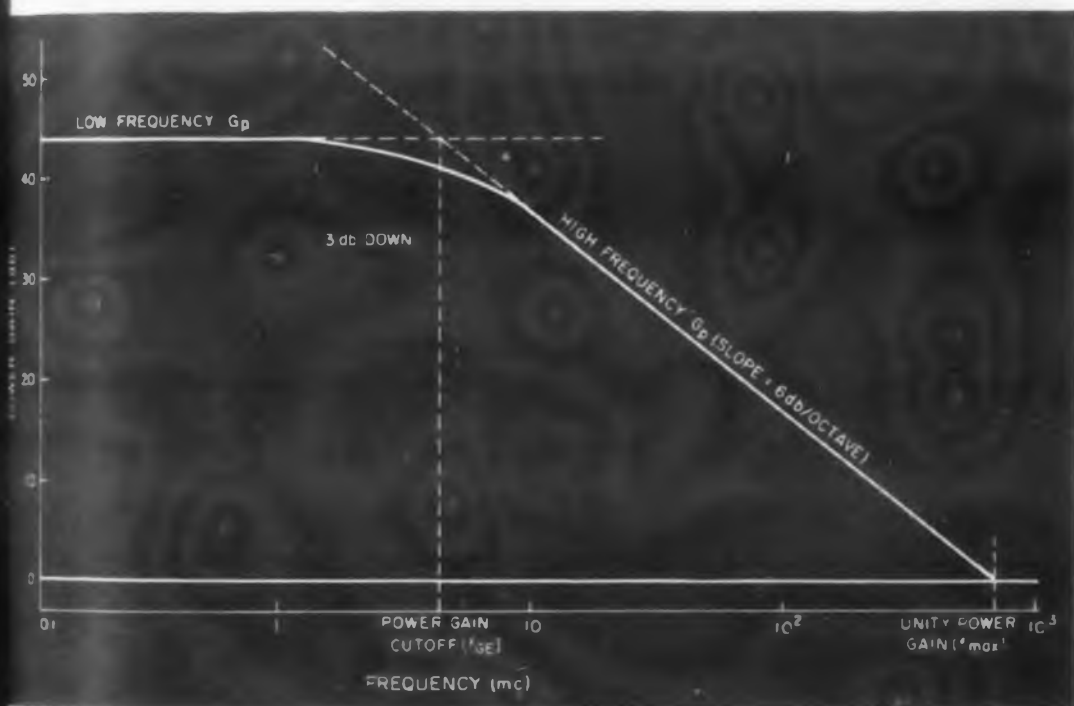


Fig. 2. (left) Effect of the $r_b'C_e$ product on power gain. The two transistors have selected $r_b'C_e$ products, but are otherwise identical with a 200 mc alpha cutoff.

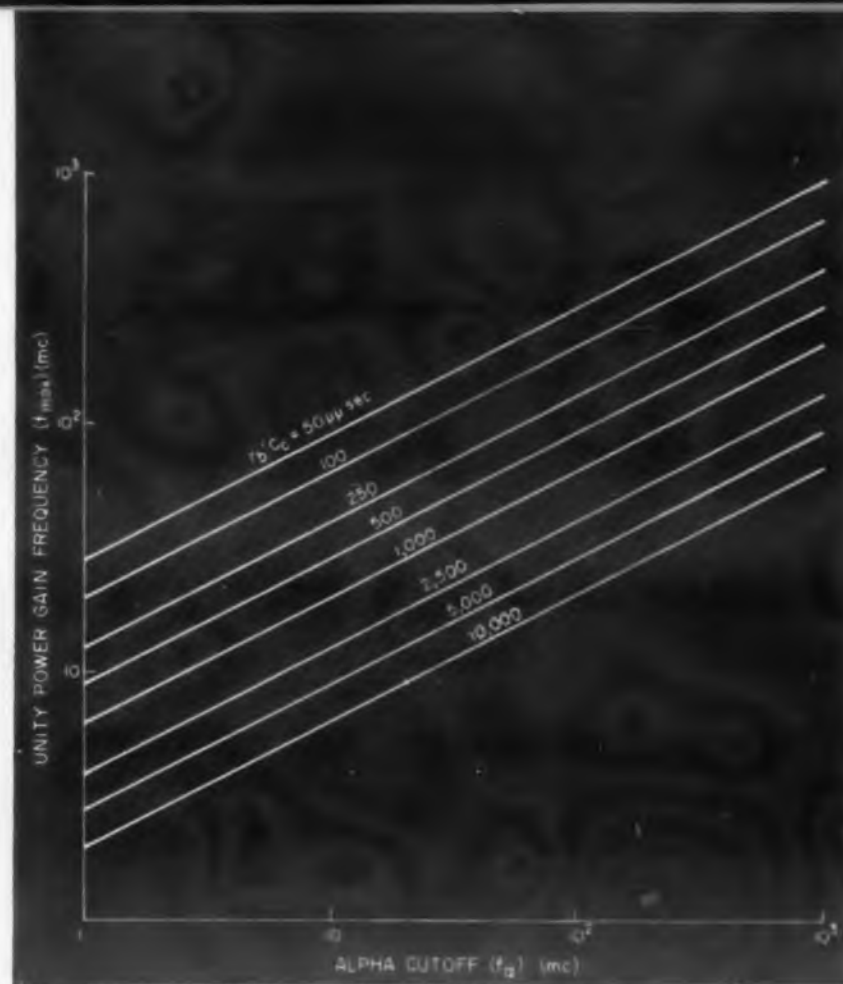


Fig. 3. (above) Unity power gain frequency vs alpha cutoff. This graph assumes an alpha of unity, and a constant $r_b'C_e$ product in each case.

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

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

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 until 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 $r_b'C_e$ 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 $r_b'C_e$ 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 $r_b'C_e$ 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 $f_{max} - f_{\alpha}$ relationship for typical constant values of $r_b'C_e$ 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. ■ ■

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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.

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

$$I_B = \frac{V - V_E}{R} - \frac{V_E}{R_B} \quad (2)$$

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

$$V_{CE} = V - V_E - R_C I_C \quad (4)$$

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 :

β = Minimum possible value of β .

$\bar{\beta}$ = Maximum possible value of β .

\bar{I}_{CBO} = Maximum possible value of I_{CBO} .

\bar{V}_{CE} = Minimum allowable value of V_{CE} .

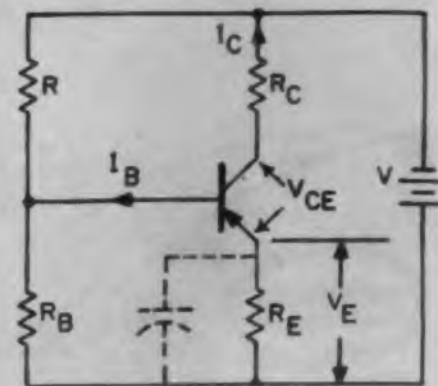


Fig. 1. Preferred circuit described by eqs. (5) and (6).

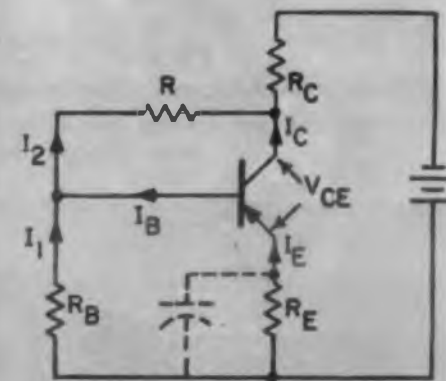


Fig. 2. Circuit described by eqs. (7) and (8). Resistor R is returned to the collector.

\bar{V}_{CE} = Maximum allowable value of V_{CE} .

$m = R_C/R_E$.

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

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

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

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

$$R_B = \frac{R_E (1+m) \left[L - U - \frac{\bar{I}_{CBO} R_E (k_1 - 1)}{\bar{V}_{CE}} \right]}{\frac{U k_2}{\beta} - \frac{L k_1}{\bar{\beta}} + \frac{\bar{I}_{CBO} R_E k_1}{V_{CE}} \left[1 + m + \frac{U}{\beta k_1} \right]} \quad (5)$$

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

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 $I = I_{CBO}$.

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

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

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, $R_E = 1.8/0.1 \text{ ma} = 18 \text{ K}$. The maximum voltage from collector to ground will then be $1.8 + 3 = 4.8 \text{ v}$. The voltage across R_C is therefore $7.5 - 4.8 = 2.7 \text{ v}$ and R_C is $2.7/0.1 \text{ ma} = 27 \text{ K}$. 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), $R_B = 52.2 \text{ K}$.

From Eq. (6):

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

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 $R_B = 56 \text{ K}$ and $R = 150 \text{ K}$. ■ ■

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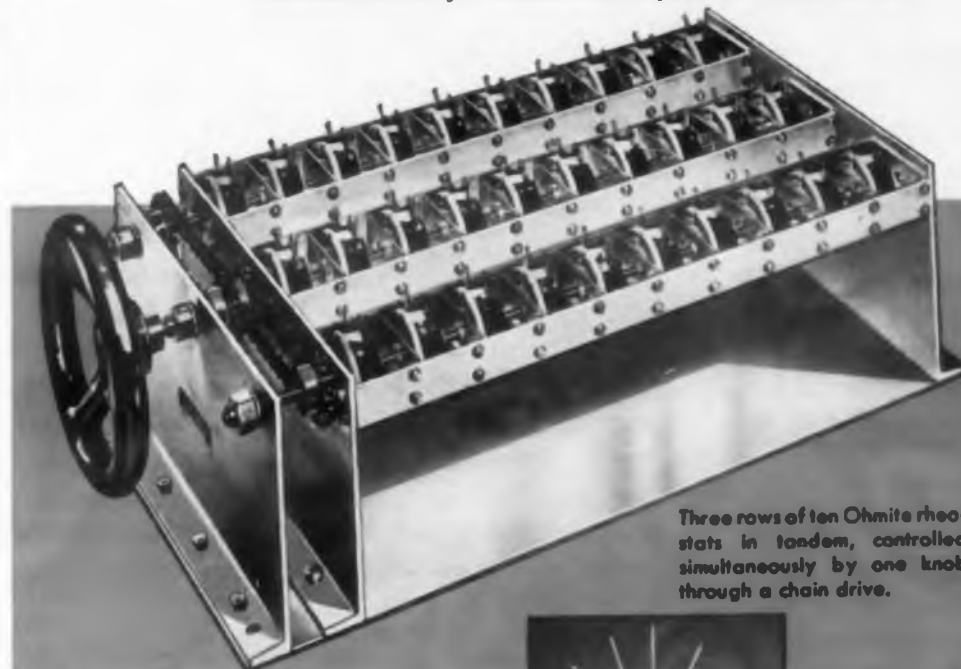
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Typical Ohmite motor-driven tandem rheostat assembly.

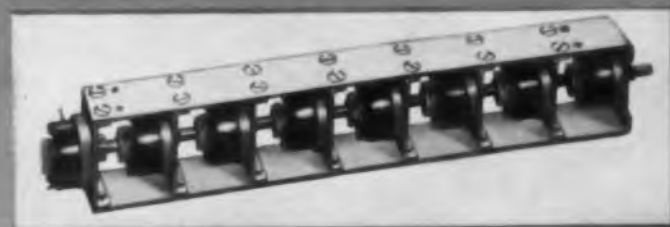


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CIRCLE 29 ON READER-SERVICE CARD

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

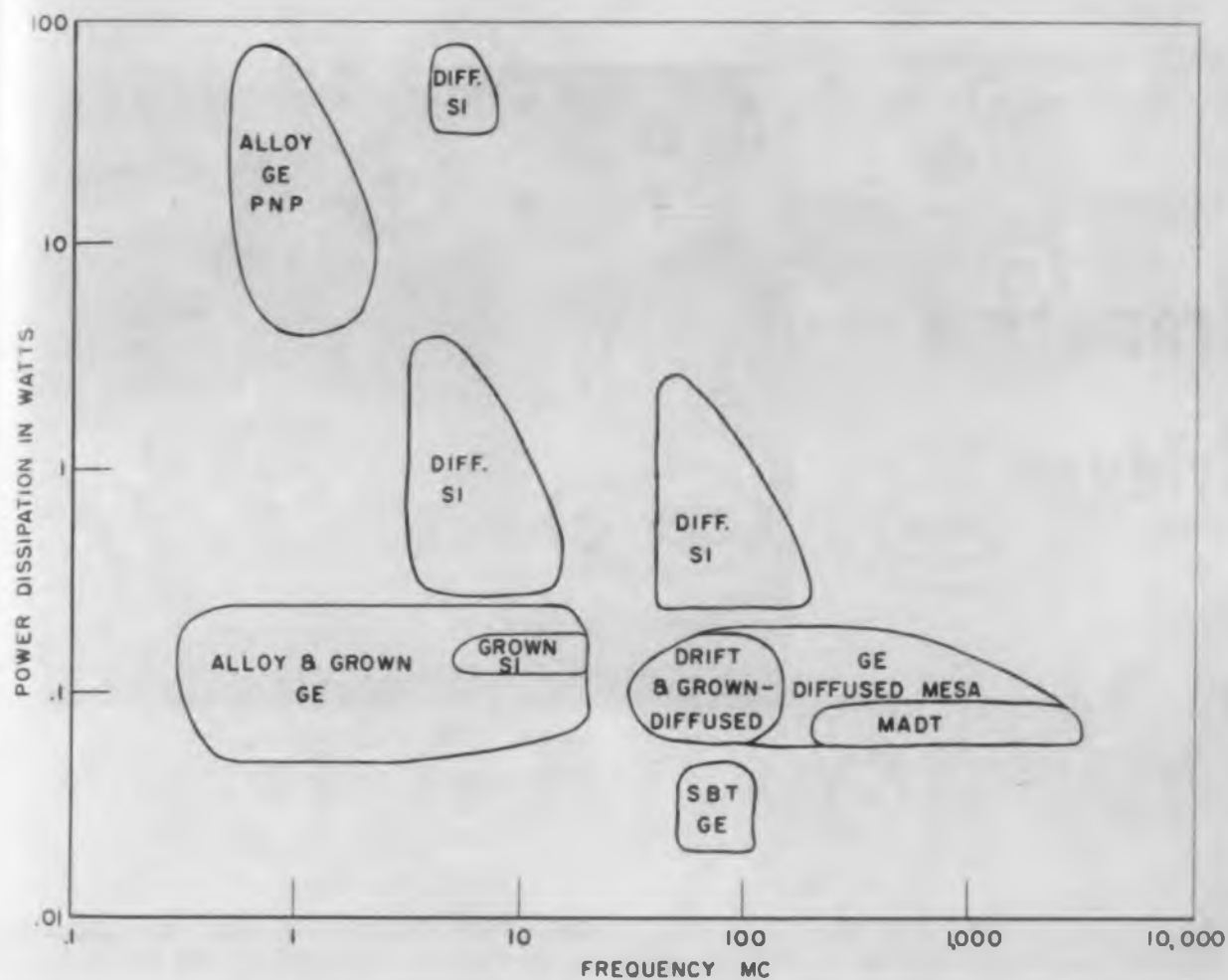
serves as the base. A variation of this technique involves shallow alloying of the plated deposits for improved device stability. Large quantities of these transistors have been produced for application in high speed circuitry. The thin base region and small emitter and collector contacts limit the power 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	Break-down 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. ■ ■

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CIRCLE 96 ON READER-SERVICE CARD

Measuring Transistor Parameters With Wayne Kerr RF Bridges

Dr. R. M. Scarlett

Assistant Professor
Stanford Electronics Labs.
Stanford Univ.
Stanford, Calif.

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

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



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,

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

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-

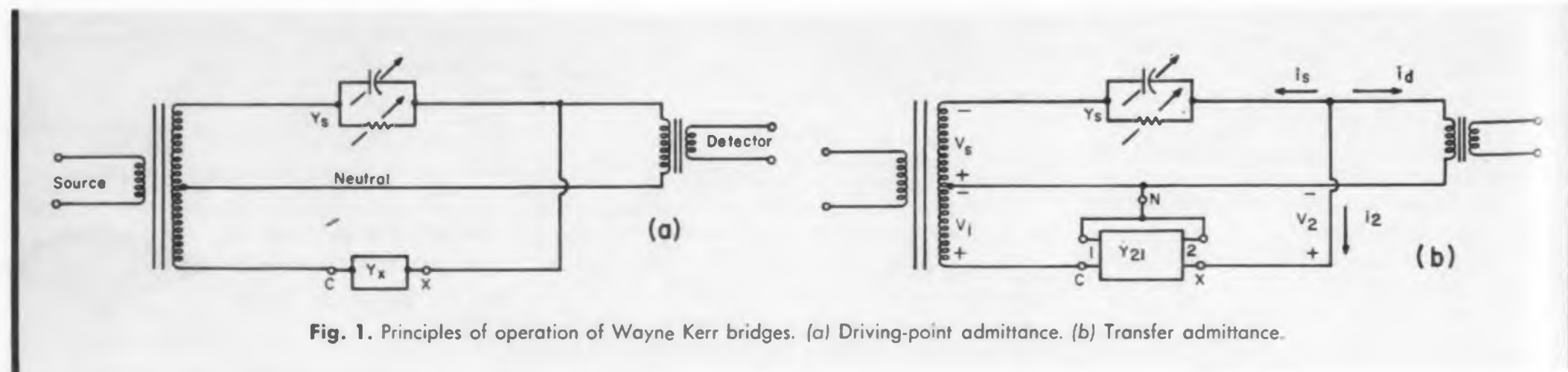
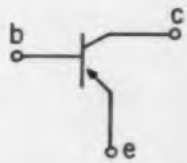


Fig. 1. Principles of operation of Wayne Kerr bridges. (a) Driving-point admittance. (b) Transfer admittance.



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

Fig. 2. Indefinite admittance matrix.

definition 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} .

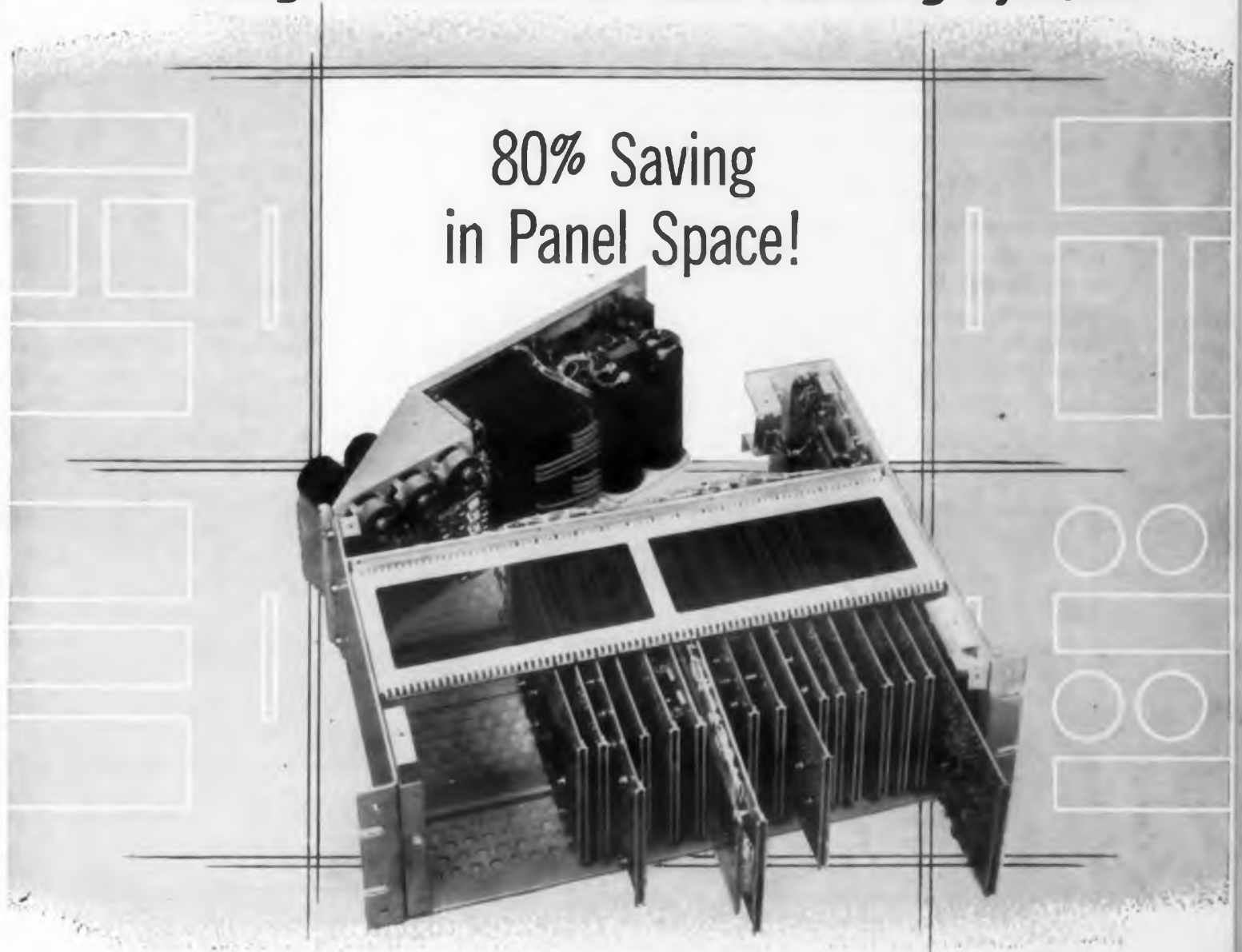
The only transfer quantity involved here is Y_{12e} , where a direct measurement is often desired since it gives the neutralizing impedance required for a common type of common-emitter bandpass amplifier. The connections to the bridge for this measurement (or any other transfer admittances) can be deduced 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, α , and Y_{11} and calculate $Y_{21} = \alpha Y_{11}$. This

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gives the fourth parameter in the matrix. However, the resultant calculation of Y_{12e} , 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 parameters¹ 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 $\beta = h_{21}$,

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 $h_{11} = 1/Y_{11}$, the forward transfer admittance of the combination is very nearly

$$h_{21}' = h_{21} R$$

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

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

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.

The open-circuit output impedance in the common-base connect $Z_{22b} = 1/h_{22b}$ is important since it consists chiefly of the space-charge 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 $(1 - \alpha_0) f_t$.

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 $\omega r_b' C_c \ll 1$ 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_{11e} at two suitably chosen frequencies will enable $r_b', r_e'/(1 - \alpha_0)$ and $1/\omega_f r_e'$ 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_0 or $\beta_0 = \alpha_0/(1 - \alpha_0)$ is most easily obtained by conventional low-frequency techniques. The Wayne Kerr Univer-

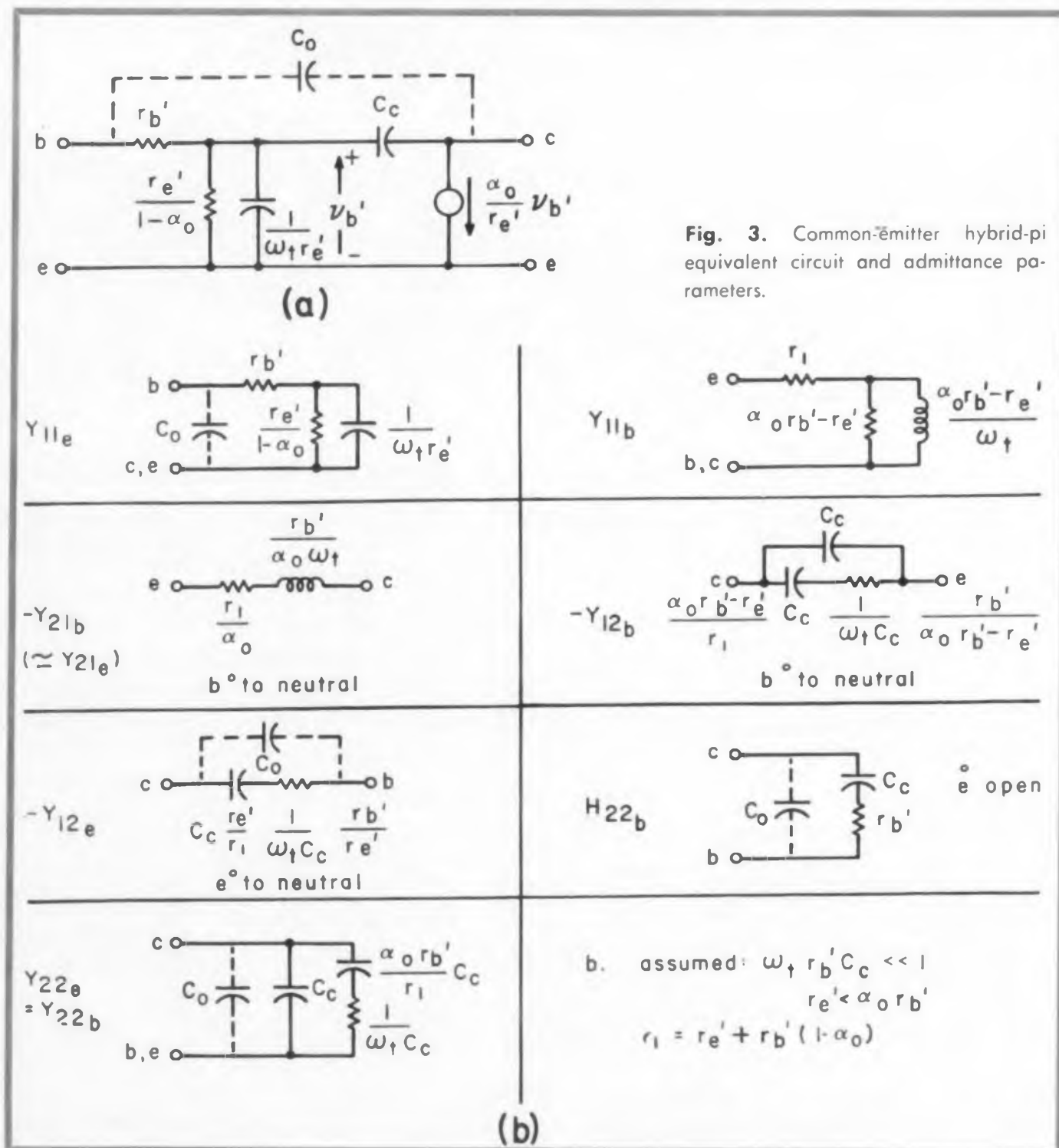


Fig. 3. Common-emitter hybrid-pi equivalent circuit and admittance parameters.

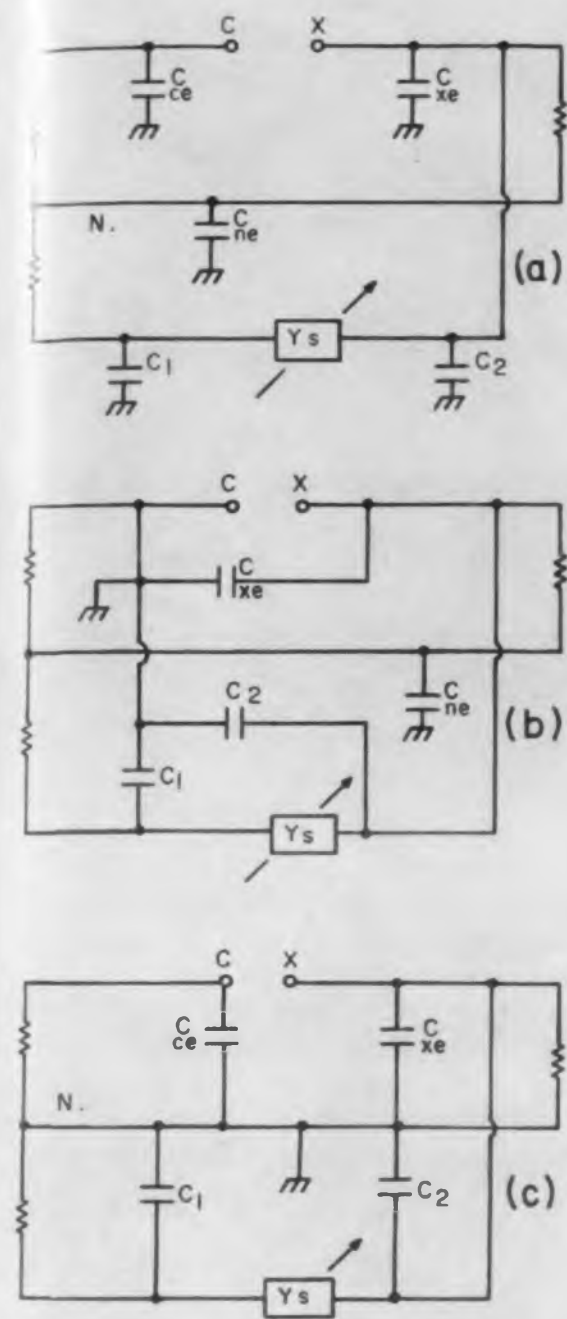


Fig. 4. Connection to bridge terminals to counteract stray capacitances. (a) Bridge stray capacitances. (b) If common is grounded, $C_{x\bar{e}}$, C_1 , and C_2 appear as shown. (c) If neutral is grounded, stray capacitances can be neglected.

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 μ f). Inductances (0.5 μ h 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. ■ ■

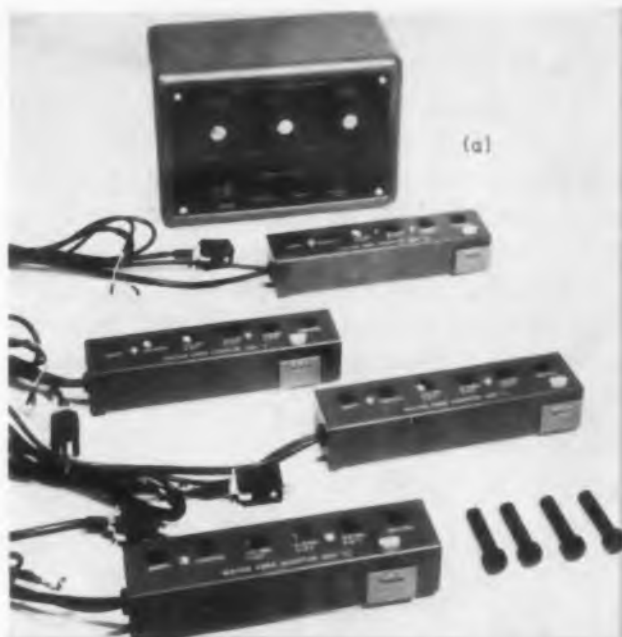
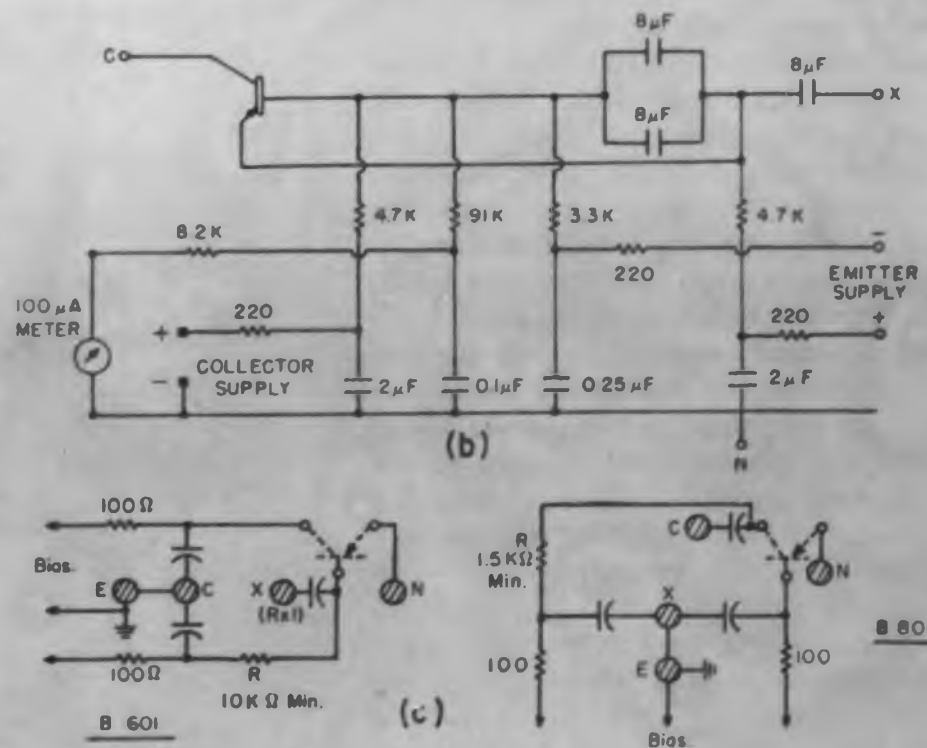


Fig. 5. Transistor adaptors. (a) Photograph of different adaptors used to connect the transistor to the bridge and provide it with dc bias. (b) Adaptor circuit for driving-point admittance shown for $Y_{22b} = Y_{22e}$ on B-601 Bridge. (c) Adaptor circuit for Y_{12o} transfer admittance.



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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.

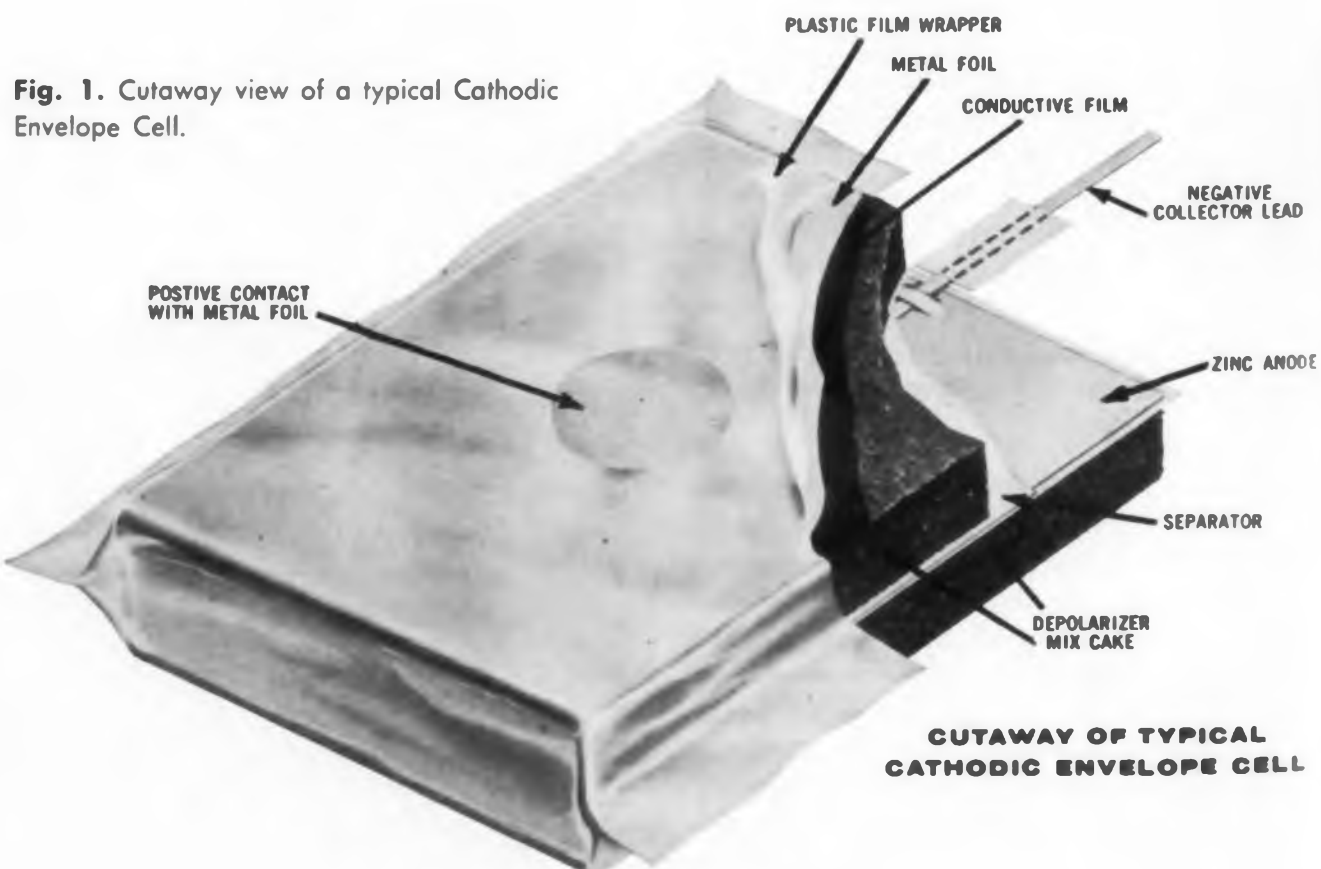
With a 50 ma load, the 4.5 v energizer (model 2731) is compared, in Fig. 2, with a single series string of three "D"-size round cells and two parallel strings of "D" cells. As shown in Fig. 2, the cathodic envelope structure gives almost three times the service of two parallel strings of three "D" cells under a four hour per day discharge. Or, put in terms of special significance 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. ■ ■ ■



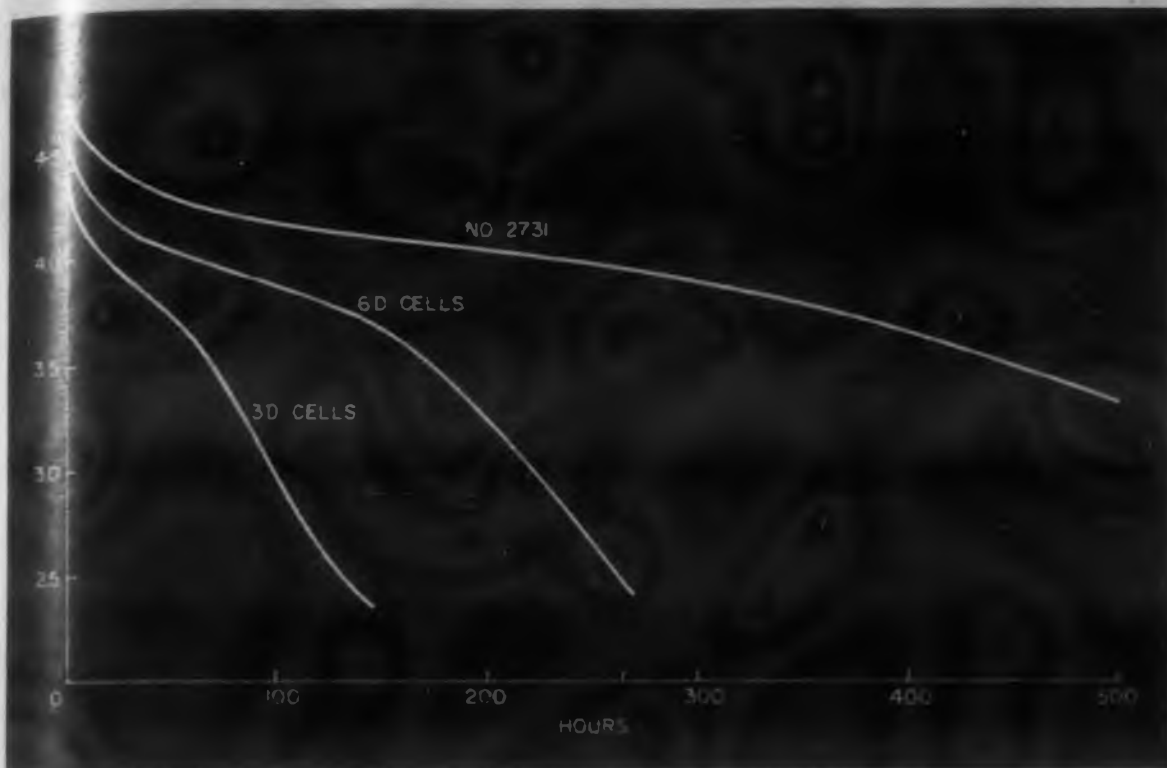


Fig. 2. Comparison between a 4.5 v type 2731 energizer, three "D" flashlight-type cells in series, and six "D" cells in series-parallel delivering 50 ma at a 4 hr/day discharge rate.

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

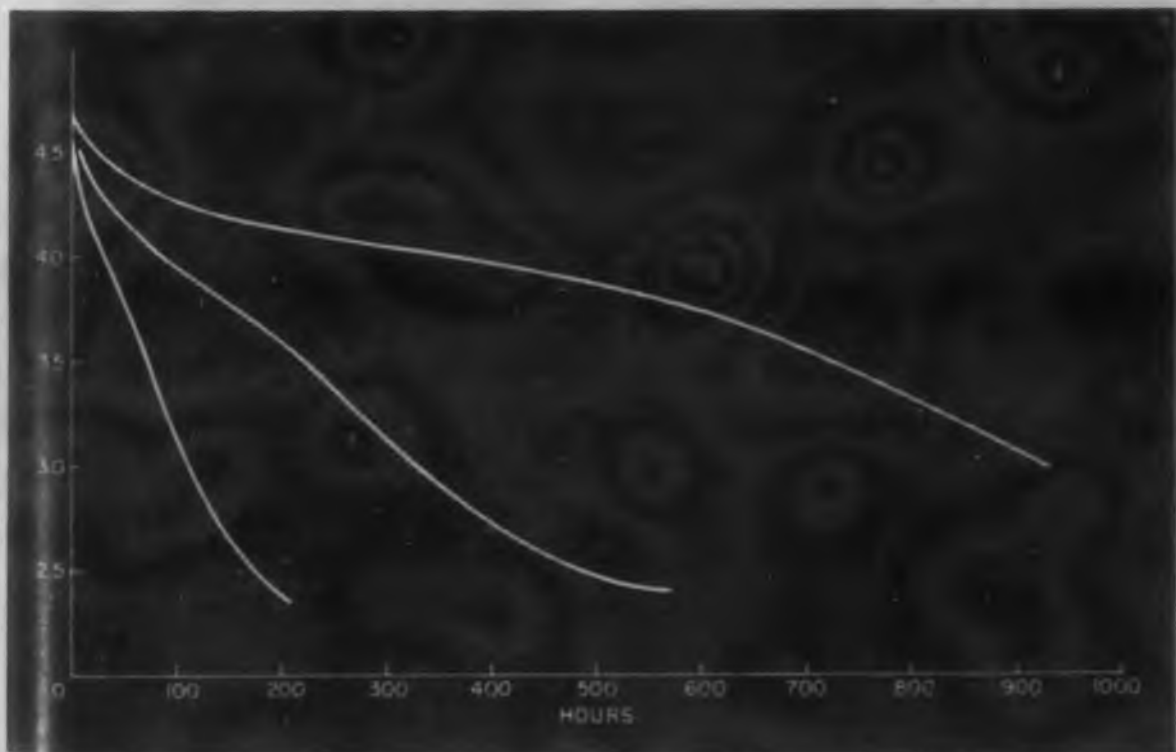


Fig. 3. Comparison between a type 2731 energizer, three "D" cells in series, and six "D" cells in series-parallel with a 30 ma continuous drain.

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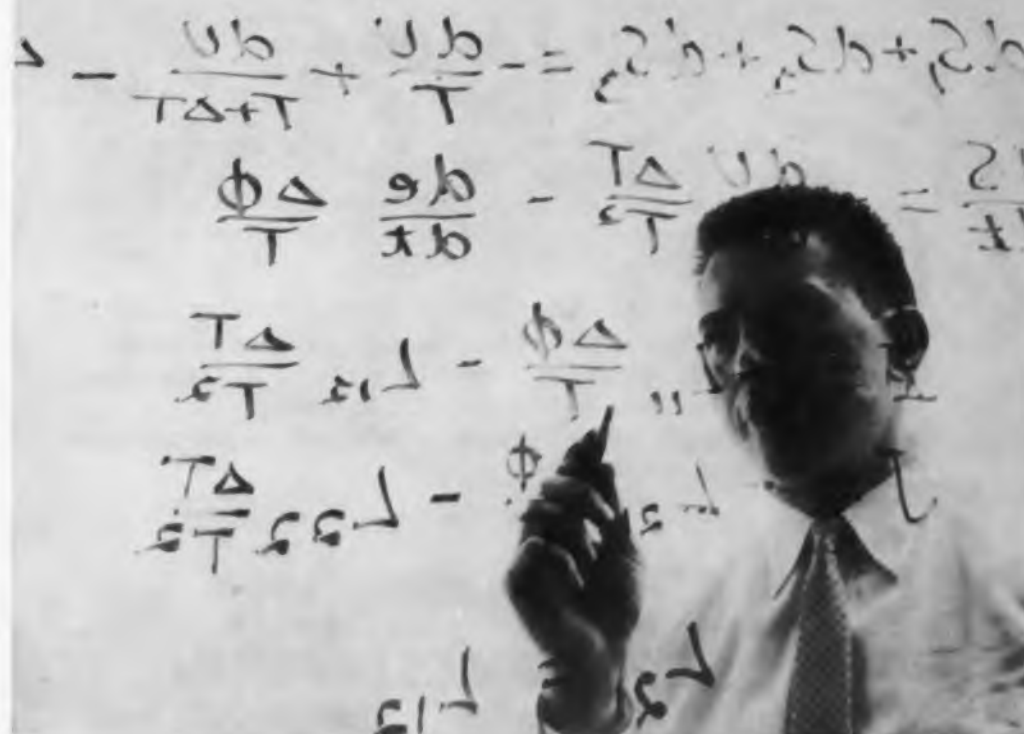
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Three Selected Semiconductor Circuits

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 $N-CR_2$, 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 $N-CR_1$ 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 $N-CR_1$ on. The diode CR_1 prevents the trigger from developing a total voltage across $N-CR_1$ sufficient to exceed the peak voltage. $N-CR_1$ turns on very rapidly, less than 0.1 μ sec, and diverts the

current from $N-CR_2$.

In addition, when $N-CR_1$ turns on, capacitor C_1 couples the voltage fall to $N-CR_2$ and aids in reversing the current through $N-CR_2$. When $N-CR_2$ 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 $N-CR_1$.

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 $N-CR_1$ and $N-CR_2$ 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 μ sec, while the turn-on is less than 0.1 μ sec. 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 $R_4 C_1$.

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 $R_2 C_2$ 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 $R_4 C_1$. 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.

$$T_1 = R_4 C_1 \ln \frac{V_{CC} + V_{BB2}}{V_{BB2}}$$

where T_1 is the time that Q_1 is in conduction and V_{BB2} is the voltage to which R_4 is returned.

$$T_2 = R_2 C_2 \ln \frac{V_{CC} + V_{BB1}}{V_{BB1}}$$

where T_2 is the time that Q_2 is in conduction and V_{BB1} 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

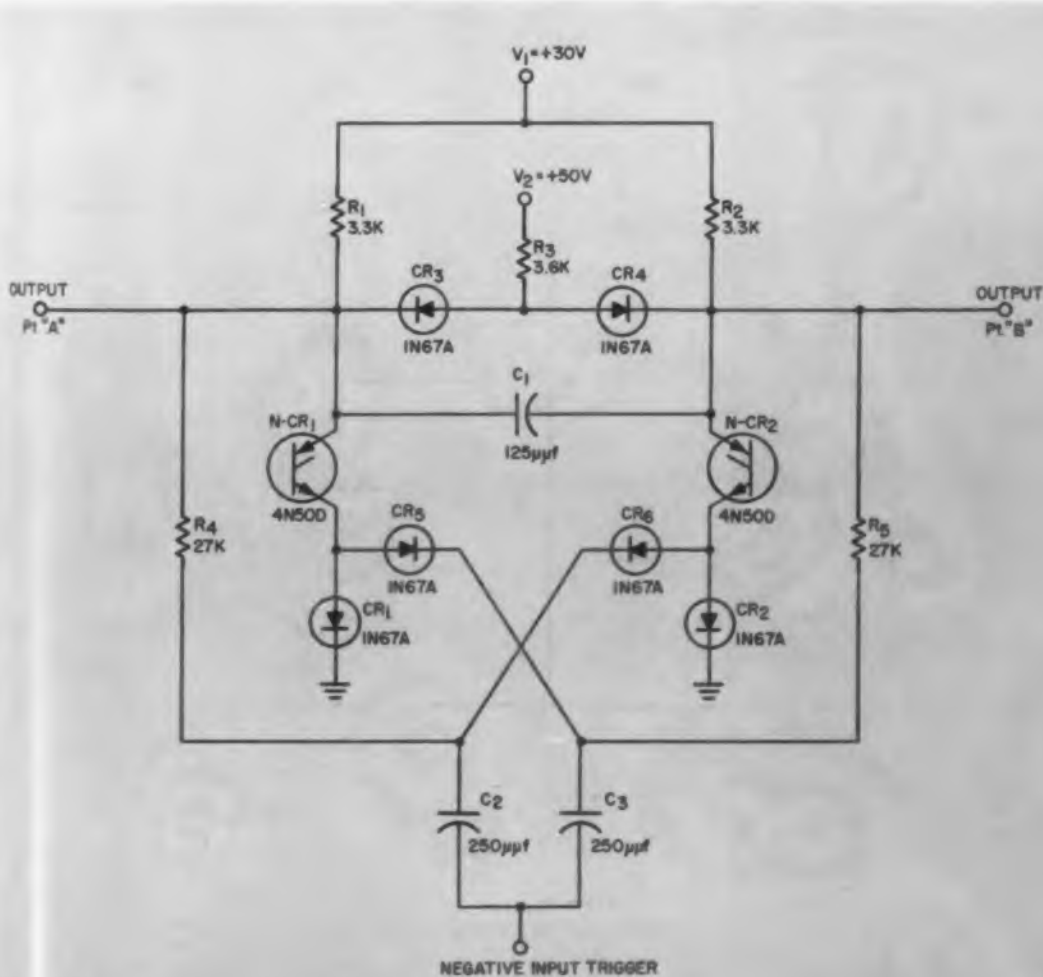


Fig. 1. (left) Negative resistance flip-flop circuit uses four-layer diodes.

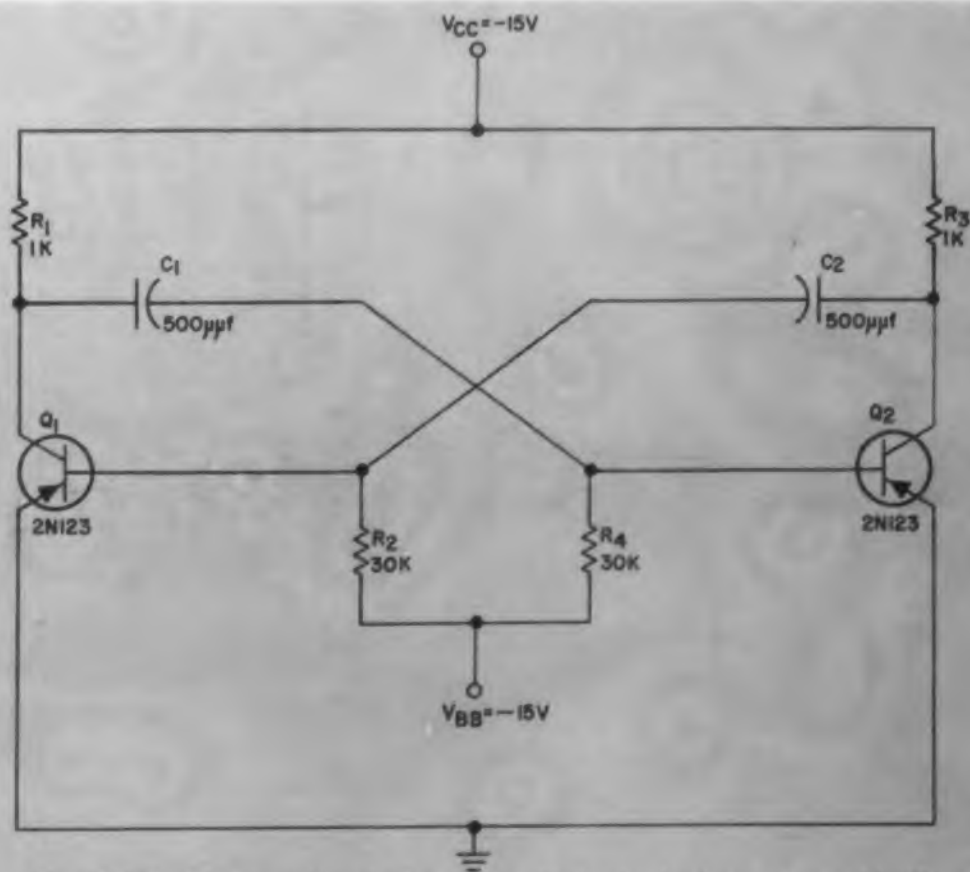


Fig. 2. (above) Conventional saturated multivibrator having a rise and fall time of less than one μ sec.

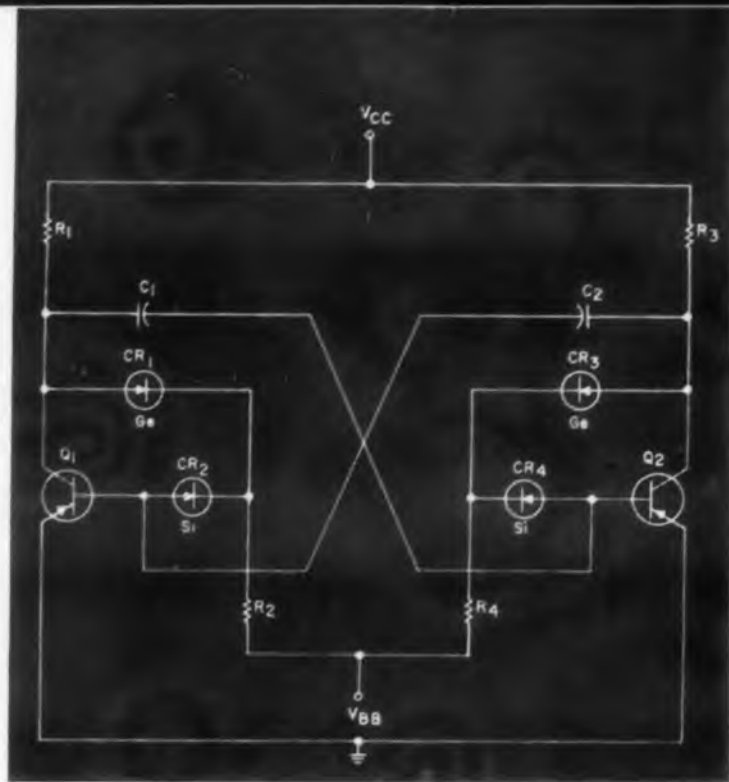


Fig. 3. The nonsaturated multivibrator may be operated at megacycle rates using high-frequency transistors.

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 μ sec. If capacitors C_1 and C_2 are 500 μ mf, the multivibrator period is about 20 μ sec. 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

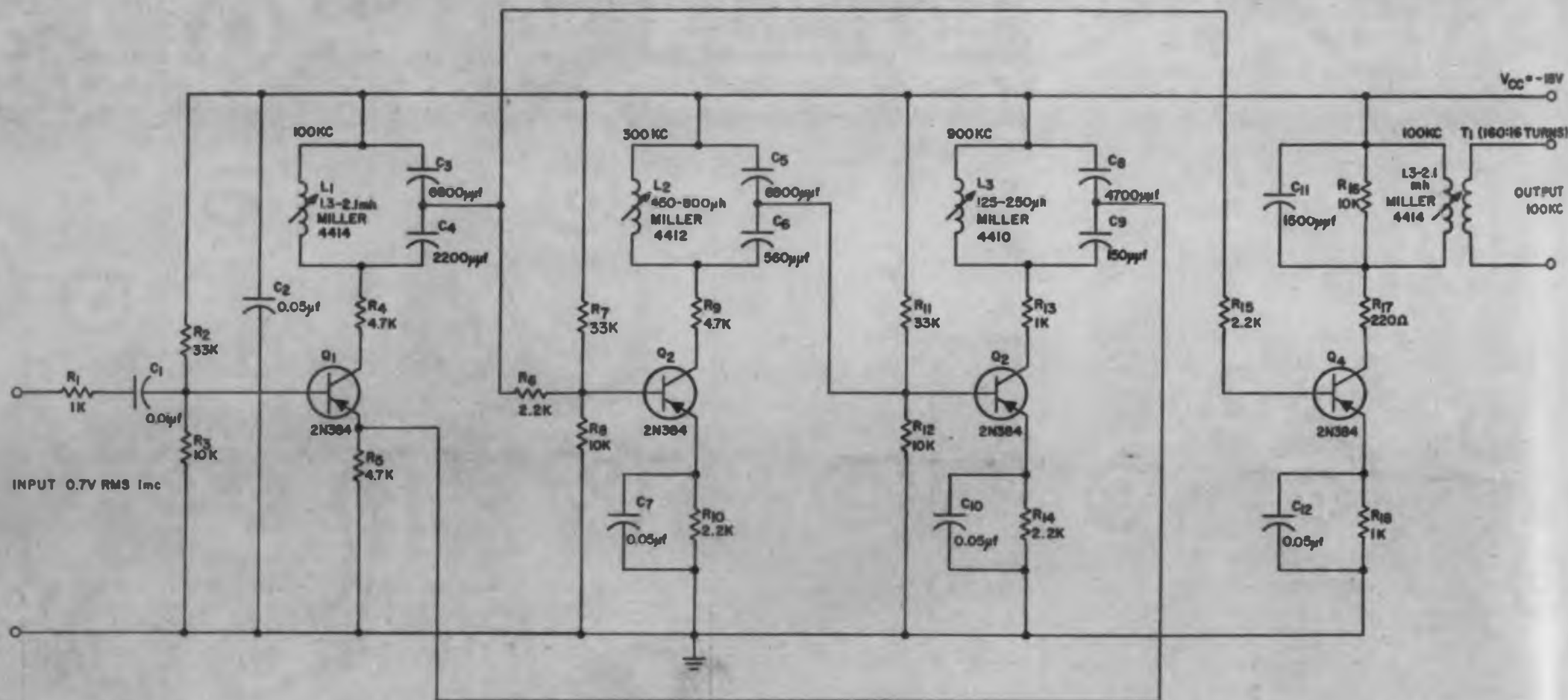


Fig. 4. High reliability, together with large ratio frequency-division, can be realized with this regenerative frequency divider.

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. ■ ■

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Code No.	Min. Fwd. DC Cur. @ +1V	Max. Rev. DC Cur. @ Test V.		Test Voltage	Max. Inv. Voltage	Min. Breakdown Voltage*	Avg. Fwd. DC Cur. (Max.)
		25° C.	150° C.				
1N457	20 mA	.025 μ A	5 μ A	60V	60V	70V	75 mA
1N458	7 mA	.025 μ A	5 μ A	125V	125V	150V	55 mA
1N459	3 mA	.025 μ A	5 μ A	175V	175V	200V	40 mA

*Reverse voltage at which a reverse current of 100 μ A flows.
All ratings and characteristics are at 25° C. unless otherwise noted.
Operating temperature range -80° C. to +200° C.

G

Semiconductor Division

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CIRCLE 33 ON READER-SERVICE CARD



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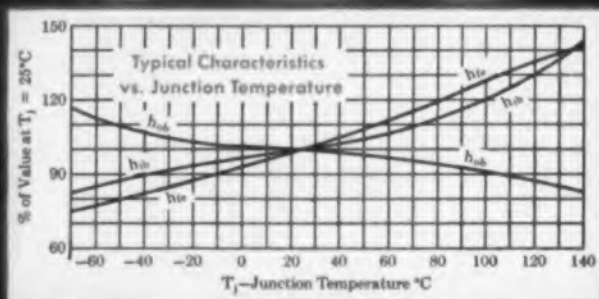
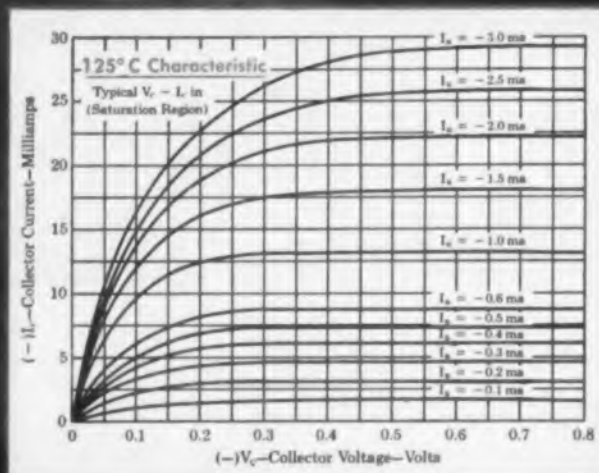
Type 2N495 is a general purpose silicon transistor designed for amplifier and oscillator applications at frequencies through 15 mc.

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.

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

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.

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◀ CIRCLE 34 ON READER-SERVICE CARD

Transistor Data Chart

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High Frequency page 54
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High-Level Switching page 62
Low-Level Switching page 66

Special page 70

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.**

1959 Transistor Data Chart

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 msec. 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.

Type No.	Mfg	Type	h _{fe} or h _{FE}	Max. Ratings				Characteristics					Remarks	Type No.
				W _c (mw)	T _j (c)	mw/o _c	V _c V	I _c ma	I _{co} μa	NF db	C _c μmf	f _{αe} mc		
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	pnnp,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	pnnp,AJ,si	14	150	150	1.2	50	—	0.1	18	70	0.5	2N327A	GT327A
2N284	AMP	pnnp,AJ,ge	15	125	75	2.5	32	125	—	—	—	—		2N284
2N284A	AMP	pnnp,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	pnnp,AJ,ge	15	200	85	3	30	125	10	15	25	1		TR34
2N129	SPR	pnnp,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	pnnp,FA,ge	22	100	85	—	22	10	6	25	—	—		2N63
TR722	IND	pnnp,AJ,ge	22	200	85	3	45	200	10	15	25	1		TR722
CK64	RA	pnnp,FA,ge	23	80	85	—	29	100	2	22	—	0.8		CK64
2N186A	GE	pnnp,AJ,ge	24	200	85	4	25	200	16	—	40	0.8		2N186A
2N189	GE	pnnp,AJ,ge	24	75	85	2	25	50	16	15	40	0.8		2N189
2N44	GE	pnnp,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	pnnp,FJ,ge	25	180	85	3.3	25	200	15	12	40	0.6	AF driver	2N402
2N460	TS	pnnp,AJ,ge	25	200	100	33	45	400	15	—	—	—		2N460
2N564	IND	pnnp,AJ,ge	25	200	85	3	30	300	3	12	30	0.8		2N564
2N592	GT	pnnp,AJ,ge	25	150	100	.2	20	—	5	16	35	0.4	Bilateral	2N592
2N612	WH	pnnp,FJ,ge	25	180	85	3.3	25	200	15	12	40	0.6	driver	2N612
GT328A	GT	pnnp,AJ,si	25	150	150	1.2	50	—	0.1	18	20	1	2N328A	GT328A
2N130A	RA	pnnp,FA,ge	26	100	85	—	40	100	6	22	—	0.7		2N130A
2N464	IND	pnnp,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	pnnp,AJ,ge	30	25	75	2.5	20	10	110	10	—	0.15		2N279
2N524	GE	pnnp,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		904
OC65	AM	pnnp,AJ,ge	30	50	75	1.7	5	10	—	9	—	0.15	hearing aid	OC65
ST1050	TR	npn,GD,si	30	30	150	0.24	6	—	2.0	1.1	9	5	low noise	ST1050
2N319	GE	pnnp,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	pnnp,AJ,ge	35	100	85	2	30	50	7	—	33	1		2N368
2N403	WH	pnnp,FJ,ge	35	180	85	3.3	25	200	15	12	40	0.85	driver	2N403
2N406	RCA	pnnp,AJ,ge	35	150	85	—	20	70	14	—	—	—		2N406
2N593	GT	pnnp,AJ,ge	35	150	100	2	35	—	5	16	35	0.6	Bilateral	2N593
2N613	WH	pnnp,FJ,ge	35	180	85	3.3	25	200	15	12	40	0.85	driver	2N613
2N680	TI	pnnp,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	pnnp,AJ,ge	35	10	55	0.7	3	5	0.1	10	—	0.01	Hearing Aid	OC53
2N187A	GE	pnnp,AJ,ge	36	200	85	4	25	200	16	—	40	1		2N187A
2N190	GE	pnnp,AJ,ge	36	75	85	2	25	50	16	15	40	1		2N190
2N381	TS	pnnp,AJ,ge	36	200	85	3.3	25	200	10	—	—	—		2N381
2N405	SY	pnnp,AJ,ge	40	150	85	2.5	20	35	250	—	—	0.25	RCA	2N405
2N650	IND	pnnp,AJ,ge	40	200	85	3	45	250	1	10	20	2	MO	2N650
2N653	IND	pnnp,AJ,ge	40	200	85	3	30	250	1	10	20	2	MO	2N653
2N1124	PH	pnnp,AJ,ge	40	300	85	5.0	35	150	30	—	—	0.4		2N1124
2N1192	MO	pnnp,AJ,ge	40	175	85	2.8	25	200	4	10	20	1.5		2N1192
2N43	GE	pnnp,AJ,ge	42	240	100	4	45	300	16	6	40	1.3		2N43

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 Semicon. 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.

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

Type No.	Mfg	Type	h_{fe} or h_{FE}	Max. Ratings					Characteristics					Remarks	Type No.
				W_c (mw)	T_i (c)	mw/o_c	V_c V	I_c ma	I_{co} μa	NF db	C_c $\mu\mu f$	f_{20} mc			
2N104	RCA	pn, AJ, ge	44	150	85	—	30	50	10	12	—	0.7		2N104	
2N215	RCA	pn, AJ, ge	44	150	85	—	30	50	10	12	—	0.7		2N215	
2N525	GE	pn, AJ, ge	44	225	100	4	45	500	10	6	25	2.5	SY	2N525	
2N64	RA	pn, fa, ge	45	100	85	—	15	10	6	22	—	—		2N64	
2N131A	RA	pn, FA, ge	45	100	85	—	30	100	6	22	—	0.8		2N131A	
2N238	TI	pn, AJ, ge	45	150	85	2.5	25	150	6	7.5	—	1.5		2N238	
2N291	TI	pn, AJ, ge	45	180	85	3	25	200	6	7.5	—	1.5		2N291	
2N322	GE	pn, AJ, ge	45	140	85	4	16	100	16	—	25	2.0	Driver	2N322	
2N465	IND	pn, 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	pn, AJ, ge	45	140	85	4	16	100	16	—	25	—	Driver	2N1098	
2N1145	GE	pn, AJ, ge	45	140	85	4	16	100	16	—	40	—	Driver	2N1145	
CK65	RA	pn, FA, ge	45	80	85	—	24	100	2	22	—	1		CK65	
TR721	IND	pn, AJ, ge	45	200	85	3	30	200	10	15	25	1		TR721	
2N280	AM	pn, AJ, ge	47	25	75	2.5	20	10	150	10	—	0.1		2N280	
OC66	AM	pn, AJ, ge	47	50	75	1.7	5	10	—	9	—	0.47	hearing-aid	OC66	
2N43A*	GT	pn, AJ, ge	48	155	100	—	45	—	8	10	40	2	MIL, GE	2N43A*	
2N61	WH	pn, FJ, ge	48	180	85	3.3	25	200	15	12	40	1		2N61	
2N611	WH	pn, FJ, ge	48	180	85	3.3	25	200	15	12	40	1		2N611	
TR320	IND	pn, AJ, ge	48	200	85	3	25	100	10	—	25	2.5	2N320	TR320	
2N133A	RA	pn, FA, ge	50	100	85	—	20	100	6	6.5	—	0.8		2N133A	
2N320	GE	pn, AJ, ge	50	225	85	4	20	200	16	—	25	2.5		2N320	
2N331	RCA	pn, AJ, ge	50	200	85	—	30	200	16	9	—	1.16	GT, BE	2N331	
2N363	IND	pn, AJ, ge	50	200	85	3	25	100	10	—	—	1	RA	2N363	
2N422	IND	pn, AJ, ge	50	200	85	3	35	100	6	6	—	0.8	RA	2N422	
2N461	TS	pn, AJ, ge	50	200	100	3.3	45	400	15	—	—	—		2N461	
TR381	IND	pn, AJ, ge	50	200	85	3	30	200	10	—	50	1.2	2N381	TR381	
2N188A	GE	pn, AJ, ge	54	200	85	4	25	200	16	—	40	1.2		2N188A	
2N191	GE	pn, AJ, ge	54	75	85	2	25	50	16	15	40	1.2	Driver	2N191	
2N382	TS	pn, AJ, ge	54	200	85	3.3	25	200	10	—	—	—		2N382	
2N105	RCA	pn, AJ, ge	55	60	85	—	25	15	7	16.5	—	0.75		2N105	
2N566	IND	pn, AJ, ge	55	200	85	3	30	300	3	12	30	1		2N566	
2N1097	GE	pn, AJ, ge	55	140	85	4	16	100	16	—	25	—	Driver	2N1097	
2N1144	GE	pn, 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	pn, AJ, ge	55	10	55	0.7	3	5	0.1	10	—	0.01	hearing aid	OC54	
2N226	PH	pn, 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	pn, 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	pn, AJ, ge	64	225	100	4	45	500	10	6	25	3		2N526	
2N175	RCA	pn, AJ, ge	65	50	85	—	10	2	12	6	—	0.85		2N175	
2N220	RCA	pn, AJ, ge	65	50	85	—	10	2	12	6	—	0.85		2N220	
2N407	RCA	pn, AJ, ge	65	150	85	—	20	70	14	—	—	—	SY	2N407	
2N408	RCA	pn, AJ, ge	65	150	85	—	20	70	14	—	—	—		2N408	
2N649	RCA	npn, AJ, ge	65	100	85	—	20	100	14	—	—	—		2N649	
OC56	AM	pn, AJ, ge	65	10	55	0.7	3	5	120	15	—	—	hearing aid	OC56	
2N323	GE	pn, AJ, ge	68	140	85	4	16	100	16	—	25	2.5	Driver	2N323	
2N361	IND	pn, AJ, ge	70	200	85	3	25	200	10	—	—	1	RA	2N361	
2N591	RCA	pn, 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	
5T1026	TR	npn, DG, si	70	30	150	0.24	6	—	0.8	—	9	5	Low-drift dc amp	5T1026	
2N383	TS	pn, AJ, ge	72	200	85	33	25	200	10	—	—	—		2N383	
2N241	GE	pn, AJ, ge	73	100	85	3	25	200	16	—	40	1.3		2N241	
2N241A	GE	pn, AJ, ge	73	200	85	4	25	200	16	—	40	1.3		2N241A	
2N34	SY	pn, 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	pn, FJ, ge	75	180	85	3.3	25	200	15	12	40	1.5		2N60	
2N109	RCA	pn, AJ, ge	75	150	85	—	25	70	14	—	—	—		2N109	
2N192	GE	pn, 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	pn, 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	pn, FJ, ge	75	180	85	3.3	25	200	15	12	40	1.1		2N610	
2N651	IND	pn, AJ, ge	75	200	85	3	45	250	1	10	20	2.5	MO	2N651	
2N654	IND	pn, 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	pn, AJ, ge	75	175	85	2.8	25	200	4	10	20	2		2N1193	

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_{ce} = Collector to emitter capacitance measured across the output terminals with the input ac open-circuited.
- $f_{0.7}$ = 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.

(Continued on p. 52)

PHILCO Transistors operate 51,614,343

SERVICE HOURS*



in High-Speed Computer Circuits
with only 8 Failures!†

Total Transistor Service Hours To Date	Total Transistors	Total Failures‡	Report
1,068,111	99	0	ELECTRONICS, Oct. 1, 1957, pg. 167
5,460,000	600	1	ELECTRONICS, Oct. 1, 1957, pg. 167
1,250,000	125	0	PHILCO REPORT, Feb. 10, 1959
16,000,000	—	2	WJCC REPORT, Feb. 1957
8,640,000	8,000	2	PHILCO REPORT, Feb. 12, 1959
19,196,232	18,601	3	PHILCO REPORT, Nov. 19, 1958

‡Failures due to all causes including human error.

Carefully documented reports now reveal that Philco electro-chemical transistors have amassed more than fifty-million hours of operation in six computers under actual field conditions. Here is proof of the outstanding performance and reliability that electronics engineers and designers have come to expect from Transistor Center, U.S.A. Of course, these transistors are still operating in their original high speed computer switching circuits . . . extending service life data on these transistors beyond the limits of any previously published information.

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*Documented service hours in these six computers only. Total transistors hours in similar circuits are many times this amount.

PHILCO
LANSDALE TUBE COMPANY DIVISION
LANSDALE, PENNSYLVANIA



CIRCLE 35 ON READER-SERVICE CARD

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_i (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 Growth
FJ	Fused Junction	SI	Silicon
GD	Grown Diffused	SBT	Surface Barrier

ed in order of increasing beta. (continued)

V _c V	Characteristics			Remarks	Type No.
	NF dB	C _c μf	f _{ae} mc		
25	-	25	1	2N382	TR81
25	-	50	1.5		TR382
25	6	35	-		GT74
25	16	35	-		GT81
150	6.5	-	2		2N185
20	-	25	3	hearing aid 2N321	2N321
3	10	-	0.01		OC55
30	-	25	3		TR321
45	6	25	3.3		2N527
16	-	25	3	Driver	2N324
12	20	-	-	MO, RA	2N65
20	22	-	1		2N132A
25	-	125	0.57		2N224
30	-	33	1.3		2N369
35	15	-	1		2N466
20	6.5	-	1.2		CK22
20	22	-	1.2		CK66
25	12	40	1.2		2N59
12	5	-	2		2N207
12	2	-	2		2N207A
12	2	-	2	2N207B	
25	-	-	1	RA	2N360
25	-	-	1	RA	2N362
30	-	4.5	3.5		2N366
26	5	-	2		2N535
20	2	-	2	RA	2N535A
20	2	-	2		2N535B
12	12	30	1.5		2N568
30	12	40	1.2		2N609
25	-	-	1		2N632
25	-	-	1		
25	-	90	1	2N1128	
25	-	50	1.8	2N383	
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	RA	2N120
25	-	-	1		2N359
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	MO, RA	2N1194
35	15	-	1.2		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.	OCF70

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.

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of the new
Westinghouse
Silicon



transistor!

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- It has astonishingly low saturation resistance—less than .5 ohms at 5 amperes and .75 ohms at 2 amperes, an achievement made possible through extensive research and development of hyper-pure Siemens-Westinghouse Silicon.
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- Series regulated power supplies
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- In class A amplifiers.

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 CIRCLE 36 ON READER-SERVICE CARD

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

h _{FE} or h _{FE}	Characteristics			Remarks	Type No.
	I _{co} μa	NF db	C _{Coe} μμf		
50	5	-	2.4		2N169A
28	0.2	39	7	GE, T1	2N333
-	5	-	12	GT, SY	2N358
-	6	-	12		2N447
150	1	12	14		2N521A
-	6	10	8	Reflex	2N616
20	0.1	25	7		ST904
150	0.1	20	7	USN	2N118
30	6	8	-	SY	2N140
-	6	-	-		2N219
75	0.2	19	7	GE	2N335
15	10	-	-	SY	2N411
48	10	-	-		2N412
75	2.0	4	-	IND.	2N416
15	10	-	12	GT, SY	2N440
80	-	-	-		2N440A
200	2	12	14		2N447A
-	0.01	20	7		2N473
-	0.01	20	7		2N474
-	0.01	20	7		2N475
-	3.0	-	-	IF	2N484
90	5	-	12	GE	2N635
20	2.0	4	-		CK16
80	0.1	25	7		ST905
200	0.1	25	7	JAN, T1	2N118A
50	0.1	20	7	USN	2N119
-	0.2	19	7	GE, T1	2N334
60	0.01	19	7		2N478
60	0.01	19	7		2N479
60	0.01	19	7		2N480
-	-	19	7		ST9
60	0.02	22	7		ST15
-	0.1	19	7		ST29
50	0.02	22	7	2N332	ST35
50	0.02	22	7	2N332	ST45
-	0.1	25	7		ST904A
60	0.1	20	7		ST910
140	3	-	12	RA. Converter	2N486
100	0.2	19	17	GE	2N336
20	0.001	-	7		2N495
15	0.01	19	7		2N541
50	0.01	19	7		2N542
-	0.01	19	7		2N543
130	20	-	-		2N624
20	5	-	12	GE	2N636
-	1	12	14		2N522A
200	2.0	4	-	IND.	2N417
140	3	14	4		2N602
-	2.0	4	-		CK17
200	1	12	14	IND.	2N523A
300	4	12	3		2N1065
-	16	-	-	SY	2N247
60	16	-	-		2N274
10	20	-	-	SY	2N370
10	20	-	-	SY	2N371
60	20	-	-	Mixer, SY	2N372
10	8	-	-	SY	2N373
10	8	-	-	Converter, SY	2N374
10	8	-	-	SY	2N544
10	5	-	2		2N1109
5	5	-	2		2N252
5	5	-	2		2N308
5	5	-	2		2N309
5	5	-	2		2N310
5	5	-	2		2N1108
25	5	-	2		2N1110
25	5	-	2		2N1111
25	5	-	2		2N1111A
25	5	-	2		2N1111B
5	3	14	3		2N603

(Continued on p. 56)

INDICATORS...LIGHTS...PUSH BUTTONS

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A first in the industry - a complete low signal indicator unit designed for direct mounting on printed circuit cards. Encapsulated unit includes neon indicator, transistor driver, circuitry and wire leads. For use where indication is required for maintenance only, it eliminates separate lamp holder, transistor, resistors and wiring costs. Mounts on 1/2" centers; height 1/4". May also be used to drive remote indicator on console or panel.

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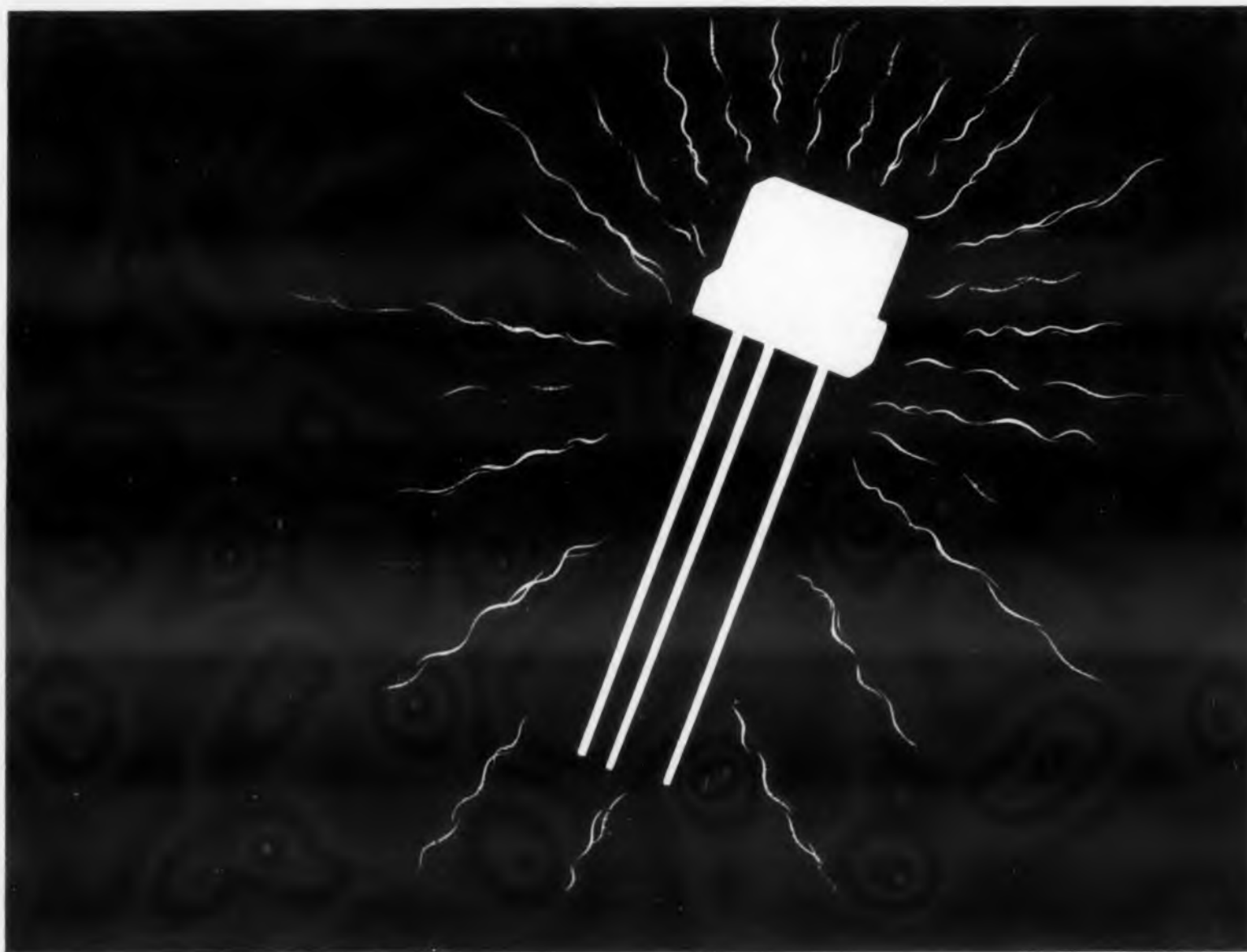


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CIRCLE 37 ON READER-SERVICE CARD



How to tame a "hot" transistor

Magnetic Materials Section reports on G-E thermistors . . . and how they may help you solve your temperature compensation problems

General Electric thermistors reduce their resistance substantially upon slight increases in temperature, making them especially suitable for temperature compensation of transistor circuits. Frequently, a thermistor or thermistor network is used in place of a base biasing resistor. Thermistors restrain transistors from running away at high temperatures, and often result in further economies.

For example, in some cases germanium transistors can be substituted for silicon transistors when thermistors are used. Or a higher gain in the circuit for given temperature variations may be achieved. Too, capacitors

and resistors with large temperature coefficients may be used. Thermistors compensate for all temperature effects in the circuit.

Because they are smaller and contain no moving parts, G-E thermistors are ideal for other temperature compensation applications, such as copper, magnetic amplifiers, and diodes. Other uses for thermistors include temperature measurement, time delay devices, voltage regulators, and current inrush suppressors.

Through new production facilities, General Electric can now design and manufacture thermistors to your specifications. For resistance values from 1 to 10,000,000 ohms, and with temperature coefficients of resistance from -1% to -5% at 25°C ., there is a G-E thermistor for you. For further information, write: *Magnetic Materials Section, 7820 N. Neff Road, Edmore, Michigan.*

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CIRCLE 38 ON READER-SERVICE CARD

1959 Transistor Data Chart

HIGH-FREQUENCY—Up to 750 mc.

Type No.	Mfg	Type	f _{oe} MC	Max. Ratings			
				W _c (mw)	T _j (c)	mw/o _c	V _c V
2N1107	TI	pnnp, GD, ge	40	30	85	—	16
2N640	RCA	pnnp, Dr, ge	42	80	85	—	34
2N641	RCA	pnnp, Dr, ge	42	80	85	—	34
2N642	RCA	pnnp, Dr, ge	42	80	85	—	34
5B100	PH	pnnp, SB, ge	45	10	55	0.67	4.5
2N248	TI	pnnp, GD, ge	50	30	75	0.6	25
2N344	PH	pnnp, SB, ge	50	20	55	1.33	5
2N345	PH	pnnp, SA, ge	50	20	55	1.33	5
2N504	PH	pnnp, MD, ge	50	30	85	0.75	25
2N604	GT	pnnp, Dr, ge	50	120	85	2	30
3N36	GE	npn, MB, ge	50	30	85	0.5	6
2N1254	HU	pnnp, DJ, si	55	—	160	—	15
2N1255	HU	pnnp, DJ, si	55	—	160	—	15
2N1256	HU	pnnp, DJ, si	55	—	160	—	30
2N1257	HU	pnnp, DJ, si	55	—	160	—	30
2N1258	HU	pnnp, DJ, si	55	—	160	—	50
2N1259	HU	pnnp, DJ, si	55	—	160	—	50
2N128	PH	pnnp, SB, ge	60	25	85	0.39	4.5
2N393	PH	pnnp, MA, ge	60	25	85	0.63	6
OC170	AM	pnnp, DJ, ge	70	60	75	2	20
2N346	PH	pnnp, SB, ge	75	20	55	1.3	5
3N37	GE	npn, MB, ge	90	30	85	0.5	6
2N300	PH	pnnp, SB, ge	95	20	85	0.5	5
2N384	RCA	pnnp, Dr, ge	100	80	85	—	30
3N34	TI	npn, GD, se	100	125	150	1	30
OC171	AM	pnnp, DJ, ge	100	60	75	2	20
2N299	PH	pnnp, SB, T, 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	pnnp, DM, si	170	2.8	150	2.3	120
XT520	PSI	npn, DM, si	170	2.8	150	2.3	120
3N25	TI	pnnp, GD, ge	200	25	75	0.5	15
2N588	PH	pnnp, MD, ge	250	30	85	0.75	15
2N503	PH	pnnp, MD, ge	320	25	85	0.63	20
2N499	PH	pnnp, MD, ge	330	30	85	0.75	18
2N502	PH	pnnp, MD, ge	400	25	85	0.63	20
2N502A	PH	pnnp, MD, ge	400	25	100	0.45	20
2N1143	TI	pnnp, DB, ge	480	750	100	10	25
2N1142	TI	pnnp, DB, ge	600	750	100	10	30
2N1141	TI	pnnp, DB, ge	750	750	100	10	35
2N528	WE	pnnp, DG, ge	750	100	100	5	40
2N537	WE	pnnp, DG, ge	750	250	100	.3	30
2N1094	WE	pnnp, DM, ge	750	250	100	0.3	30
2N1195	WE	pnnp, DM, ge	750	250	100	0.3	30
2N312	CBS	npn, A, J, ge	—	75	85	—	15
2N695	MO	pnnp, DM, Ms	—	75	100	1	12
2N700	MO	pnnp, DM, Ms	—	75	100	1	25
2N701	MO	pnnp, 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

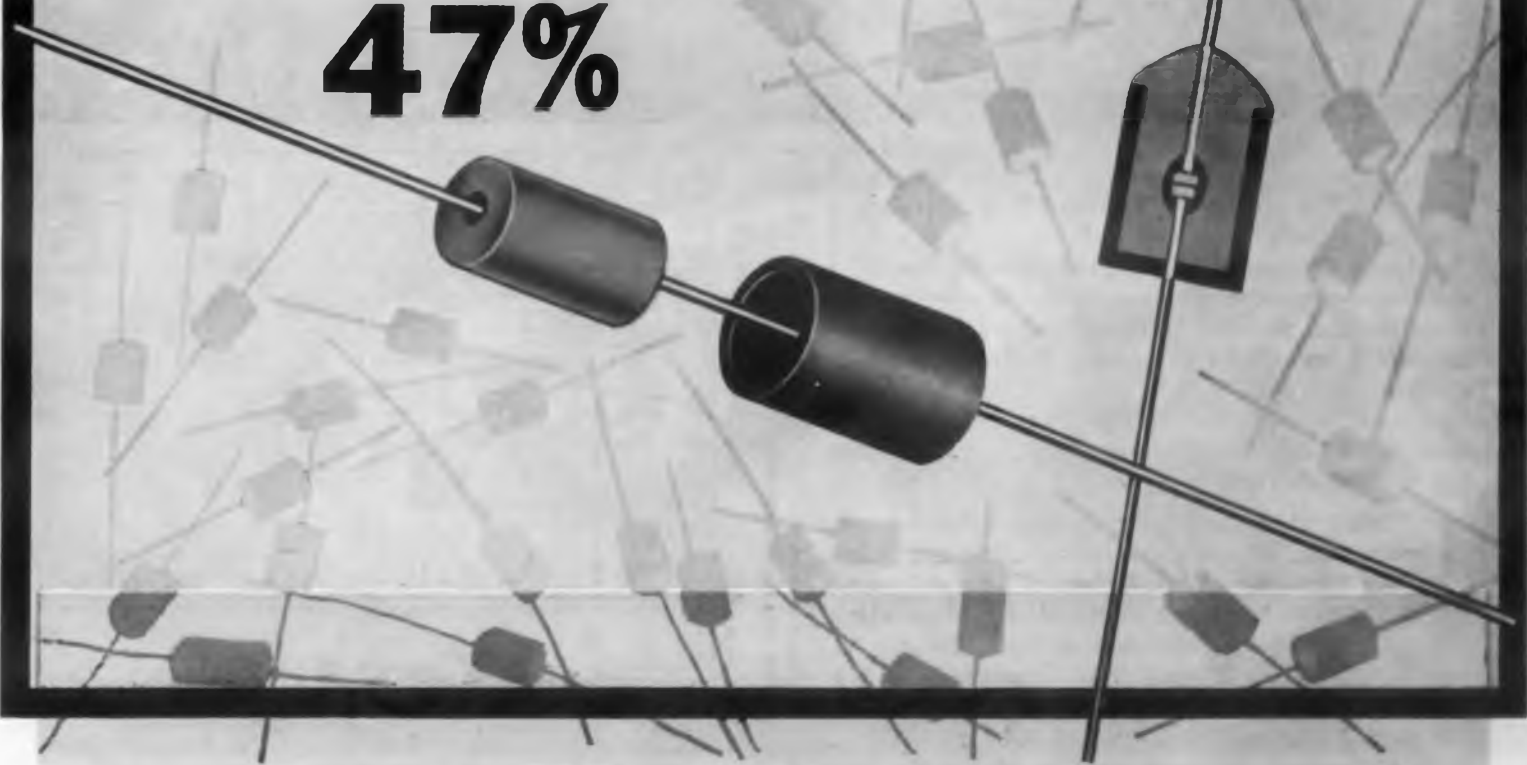
Abbreviation of Terms

AJ	Alloyed Junction	GE	Germanium
DB	Diffused Base	GJ	Grown Junction
DD	Double Diffused	GR	Grown Rate
DG	Grown Diffused	MB	Melback
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

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

V _c V	Characteristics				Remarks	Type No.
	f _α or f _{FE}	I _{co} μa	NF db	C _{Coe} μμf		
16	34	5	-	2		2N1107
34	60	5	-	-		2N640
34	60	7	-	-		2N641
4.5	60	7	-	-		2N642
25	20	0.5	-	3.5		5B100
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
4.5	-	0.05	-	12		2N1258
6	40	0.6	10	2.5	SPR	2N1259
20	155	1.5	-	3.5	SPR	2N128
5	-	2	-	-		2N393
6	20	0.7	-	3	SPR	OC170
5	1.1	3	-	1.5	Tetrode	2N346
30	18	0.6	5	-		3N37
30	60	16	-	-		2N300
20	4	0.4	20	-	Tetrode	2N384
4.5	-	2	-	-		3N34
30	-	0.6	5	-		OC171
120	4	0.4	14	-	Tetrode	2N299
120	13	-	-	4	Power Amp	3N35
120	13	-	-	4	Power Amp	XT518
15	13	-	-	4	Power Amp	XT519
15	65	10	-	1.1	Tetrode	XT520
20	-	3	5	-		3N25
18	45	3	-	1.0		2N588
20	-	1.0	-	1.3		2N503
20	45	3	-	1.0		2N499
25	45	3	-	1.0		2N502
30	8	10	-	1.5		2N502A
35	10	10	-	1.5		2N1143
40	12	5	-	1.5		2N1142
30	25	10	-	-	U.S., MIL only	2N1141
30	10	5	-	2.8	U.S., MIL only	2N528
30	15.5	1.2	-	4	U.S., MIL only	2N537
15	15.5	1.2	-	4	U.S., MIL only	2N1094
12	-	60	-	12	SY	2N1195
25	-	0.8	-	4		2N312
20	8	1.0	-	1.2	UHF amp	2N695
120	25	1	-	1.2		2N700
120	-	-	-	4	Power Osc.	2N701
120	-	-	-	4	Power Osc.	XT515
120	-	-	-	4	Power Osc.	XT516
120	-	-	-	4	Power Osc.	XT517

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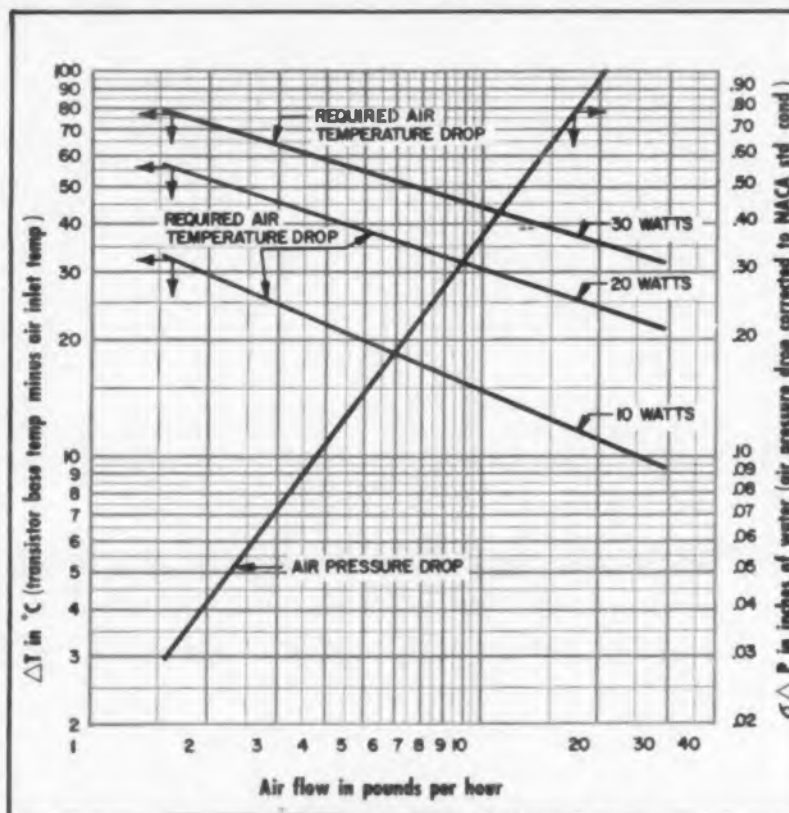
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*Joint Electronic Device Engineering Council

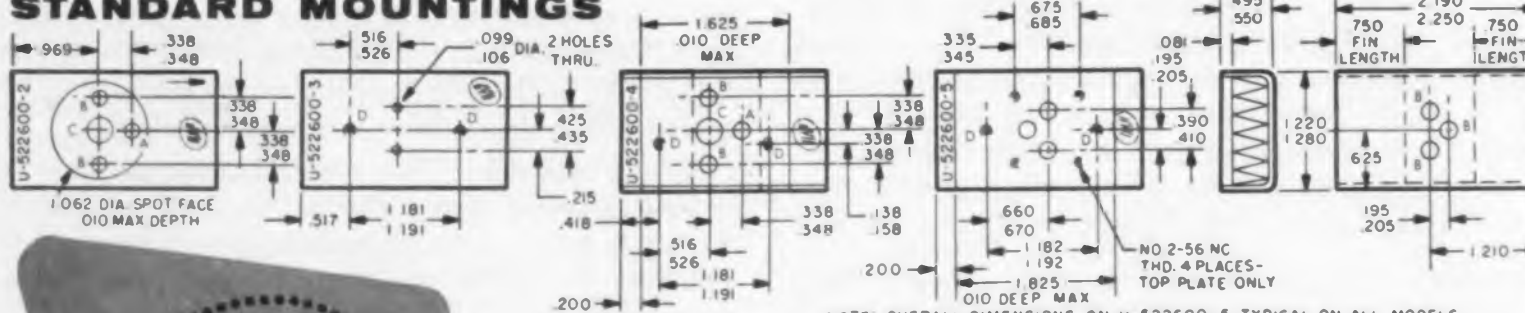
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CIRCLE 40 ON READER-SERVICE CARD

1959 Transistor Data Chart

POWER—Above one watt dissipation.

Type No.	Mfg.	Type	W _c W	Max. Rating:				I _c A	I _{co} ma
				W/°C	T _i °C	V _c V	I _c A		
2N339	TR	npn,GR,si	1.0	0.008	150	55	—	—	1.0
2N340	TR	npn,GR,si	1.0	0.008	150	85	—	—	1.0
2N341	TR	npn,GR,si	1.0	0.008	150	125	—	—	1.0
2N342	TR	npn,GR,si	1.0	0.008	150	60	—	—	1.0
2N342A	TR	npn,GR,si	1.0	0.008	150	85	—	—	1.0
2N343	TR	npn,GR,si	1.0	0.008	150	60	—	—	0.001
2N1206	TR	npn,GR,si	1.2	0.01	200	60	—	—	0.001
2N1207	TR	npn,GR,si	1.2	—	200	60	—	—	1
2N1092	RCA	npn,DJ,si	2	0.286	175	60	0.5	—	0.01
2N1172	DE	npn,AJ,ge	4	0.07	95	40	1.5	—	0.03
H3A	MH	npn,AJ,ge	5	0.07	95	60	0.35	—	0.03
H4A	MH	npn,AJ,ge	5	0.07	95	60	0.5	—	0.5
2N1067	RCA	npn,DJ,si	5	0.067	175	60	0.5	—	3
2N326	SY	npn,AJ,ge	7	0.11	85	35	2	—	0.18
2N255	BE	npn,AJ,ge	8.5	0.3	85	15	3	—	0.18
2N256	BE	npn,AJ,ge	8.5	0.3	85	30	3	—	0.01
2N122	TI	npn,GR,si	8.75	0.07	150	120	140	—	0.3
2N176	SY	npn,AJ,ge	10	0.15	90	30	3	—	—
2N350	SY	npn,AJ,ge	10	0.13	100	40	3	—	3
2N351	RCA	npn,AJ,ge	10	1.0	90	40	3	—	3
2N376	RCA	npn,AJ,ge	10	1.0	90	40	3	—	0.3
2N669	MO	npn,AJ,ge	10	1.5	90	30	3	—	0.5
2N1068	RCA	npn,DJ,si	10	0.133	175	60	1.5	—	2
CTP1104	CL	npn,AJ,ge	10	2.0	85	40	3	—	2
CTP1105	CL	npn,AJ,ge	10	2.0	85	40	3	—	2
CTP1108	CL	npn,AJ,ge	10	2.0	85	20	3	—	2
CTP1109	CL	npn,AJ,ge	10	2.0	90	20	3	—	5
CTP1111	CL	npn,AJ,ge	10	2.0	90	80	3	—	3
2N301A	RCA	npn,AJ,ge	11	1.0	90	60	3	—	5
2N301	SY	npn,AJ,ge	12	0.2	85	40	2	—	3
2N325	SY	npn,AJ,ge	12	0.2	85	35	2	—	2
CTP1112	CL	npn,AJ,ge	14	1.5	90	100	3	—	5
CTP1117	CL	npn,AJ,ge	14	1.5	90	40	4	—	2.2
CTP1133	CL	npn,AJ,ge	14	1.5	90	40	3	—	—
CTP1137	CL	npn,AJ,ge	14	1.5	90	40	3	—	0.25
2N307	BE	npn,AJ,ge	15	0.2	75	35	1.0	—	—
2N307A	SY	npn,AJ,ge	17	0.34	75	35	2	—	2
2N155	CBS	npn,AJ,ge	20	—	85	30	3	—	1
2N156	CBS	npn,AJ,ge	20	0.33	85	30	3	—	—
2N157	CBS	npn,AJ,ge	20	—	85	60	3	—	1
2N157A	CBS	npn,AJ,ge	20	—	85	100	3	—	1
2N158	CBS	npn,AJ,ge	20	—	85	60	3	—	1
2N158A	CBS	npn,AJ,ge	20	—	85	80	3	—	1.0
2N255A	CBS	npn,AJ,ge	20	—	85	15	3	—	1
2N256A	CBS	npn,AJ,ge	20	—	85	25	3	—	1.3
2N401	BE	npn,AJ,ge	20	0.5	90	40	3	—	1
LT-11	CBS	npn,AJ,ge	20	—	85	80	3	—	3
LT-12	CBS	npn,AJ,ge	20	—	85	100	3	—	3
LT-13	CBS	npn,AJ,ge	20	—	85	120	3	—	3
LT-14	CBS	npn,AJ,ge	20	—	85	150	3	—	3
LT-15	CBS	npn,AJ,ge	20	—	85	200	3	—	0.3
LT5163	CBS	npn,AJ,ge	20	—	85	60	4	—	0.3
LT5164	CBS	npn,AJ,ge	20	—	85	80	4	—	0.3
LT5165	CBS	npn,AJ,ge	20	—	85	30	4	—	0.42
2N234A	BE	npn,AJ,ge	25	0.5	90	30	3	—	0.42
2N235A	BE	npn,AJ,ge	25	0.5	90	40	3	—	0.76
2N236A	BE	npn,AJ,ge	25	0.5	95	40	3	—	1.
2N242	SY	npn,AJ,ge	25	0.33	100	45	1.0	—	—
2N250	TI	npn,AJ,ge	25	0.42	85	30	3	—	0.5
2N251	TI	npn,AJ,ge	25	0.42	85	60	3	—	0.42
2N285A	BE	npn,AJ,ge	25	0.5	95	40	3	—	2.
2N296	SY	npn,AJ,ge	25	0.33	100	60	2	—	0.3
2N350A	MO	npn,AJ,ge	25	1.5	100	40	3	—	0.3
2N351A	MO	npn,AJ,ge	25	1.5	100	40	4	—	0.3
2N376A	MO	npn,AJ,ge	25	1.5	100	40	5	—	1.5
2N399	BE	npn,AJ,ge	25	0.5	90	40	3	—	1.3
2N400	BE	npn,AJ,ge	25	0.5	95	40	3	—	0.5
2N419	BE	npn,AJ,ge	25	0.5	95	45	3	—	25
2N1146	CL	npn,AJ,ge	25	0.7	95	40	5	—	25
2N1146A	CL	npn,AJ,ge	25	0.7	95	60	5	—	—

Listed in order of increasing power dissipation.

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

(Continued on p. 60)

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- Current gain controls: 60-150 at 5 amperes.
- 100% test for resistance to transient burn out.
- Either standard pins or solder lugs.

TECHNICAL DATA

Typical Electrical Characteristics at 25°C

	2N1147 2N1146	2N1147A 2N1146A	2N1147B 2N1146B	2N1147C 2N1146C
2N1147 Series has solder lugs 2N1146 Series has standard pins				
Collector to Emitter Voltage Shorted Base (I _C = 1 amp)	30V (Min)	40V (Min)	60V (Min)	75V (Min)
Saturation Voltage (I _C = 15 amps)	1.0V (Max)	1.0V (Max)	1.0V (Max)	1.0V (Max)
DC Current Gain (I _C = 5 amps)	60-150	60-150	60-150	60-150
DC Current Gain (I _C = 15 amps)	35	35	35	35
Absolute Maximum Ratings				
Collector Current	15 amps	15 amps	15 amps	15 amps
Collector to Base Voltage	40V	60V	80V	100V
Collector to Emitter Voltage	40V	60V	80V	100V
Power Dissipation at 70°C Case Temperature	25W 95°C	25W 95°C	25W 95°C	25W 95°C
Junction Temperature	95°C	95°C	95°C	95°C

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(ACTUAL SIZE)

DIFFUSED ALLOY POWER TRANSISTORS

Features

Faster Switching Times 0.5-5 μ Sec
Switching Currents up to 10 amperes
Flatter Frequency Response 40 Kc
Higher Breakdown Voltage up to 120 Volts
Current Gain of 40 at 5 amperes
Standard Power Transistor Package
Lower Base Resistance, 2 ohms
Lower Saturation Resistance, 0.1 ohm

Uses

TV Horizontal Output
Hi-Fi Amplifiers
Core Drivers
High Current Switching
Power Converters
Ultrasonic Generators
Modulators

Because no other transistor offers this combination of features and uses, you will want to try out the DAP transistor in your circuits. Get full details now on new Bendix diffused alloy power transistors by writing SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY.

	Ratings		Typical Performance			
	Vdc	Pc (25°C)	B (Ic=5 Adc)	Vs (Ic=5 Adc)	f α	rbb'
2N1073	40	35 W	40	0.5 Vdc	1.5 mc	2 ohms
2N1073A	80	35 W	40	0.5 Vdc	1.5 mc	2 ohms
2N1073B	120	35 W	40	0.5 Vdc	1.5 mc	2 ohms

West Coast Sales: 117 E. Providencia Ave., Burbank, Calif.

Midwest Sales: 4104 N. Harlem Ave., Chicago 34, Ill.

New England Sales: 4 Lloyd Rd., Tewksbury, Mass.

Export Sales: Bendix International, 205 E. 42nd St., New York 17, N. Y.

Canadian Affiliate: Computing Devices of Canada, Ltd.,

P. O. Box 508, Ottawa 4, Ont.

Red Bank Division

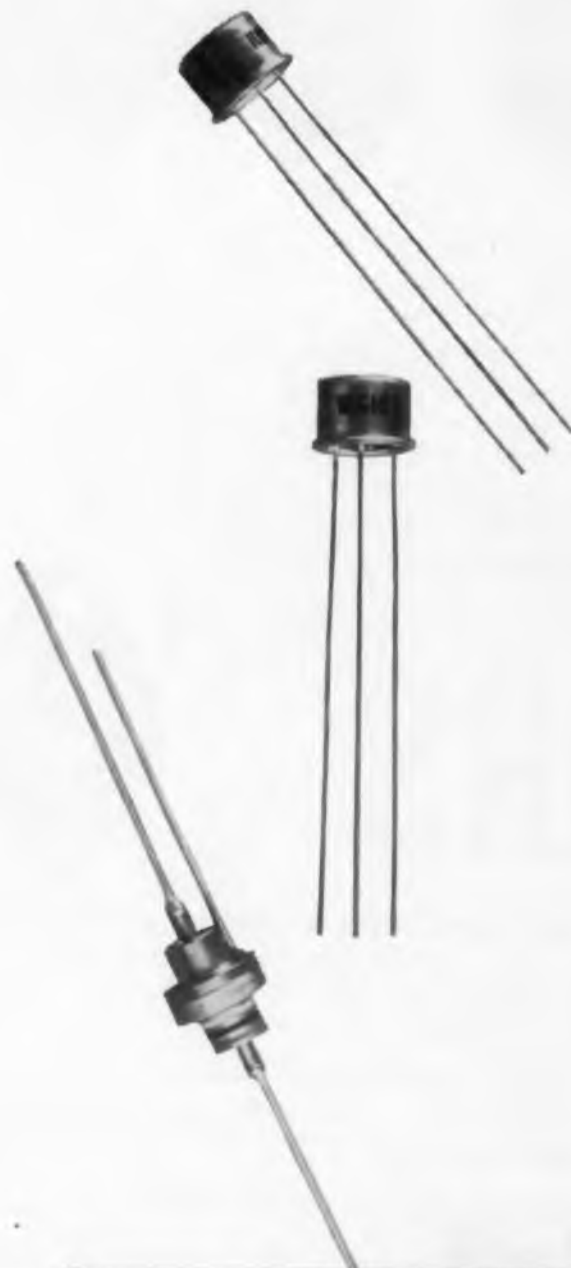


POWER—Above one watt dissipation.

Type No.	Mfg.	Type	W _c W	Max. Ratings					I _{co} ma
				W/°C	T _i °C	V _c V	I _c A	h _{fe} or h _{FE}	
2N1146B	CL	pn _p , AJ, ge	25	0.7	95	80	15	—	25
2N1147	CL	pn _p , AJ, ge	25	0.7	95	40	15	—	25
2N1147A	CL	pn _p , AJ, ge	25	—	95	60	15	—	25
2N1147B	CL	pn _p , AJ, ge	25	—	95	80	15	—	25
2N1147C	CL	pn _p , AJ, ge	25	—	95	100	15	—	25
2N1245	CBS	pn _p , AJ, ge	25	—	85	25	3	—	1
2N1246	CBS	pn _p , AJ, ge	25	—	85	25	3	—	1
B-177	RE	pn _p , AJ, ge	25	0.5	90	30	3	—	15
B-178	BE	pn _p , AJ, ge	25	0.5	90	30	3	—	15
B-179	BE	pn _p , AJ, ge	25	0.5	90	40	3	—	15
2N236B	CBS	pn _p , AJ, ge	30	—	85	40	3	—	1.0
2N257	BE	pn _p , AJ, ge	30	0.5	90	40	3	—	—
2N268	BE	pn _p , AJ, ge	30	0.5	90	80	3	—	2
2N538	MH	pn _p , AJ, ge	32	0.45	95	80	3	30	0.1
2N539	MH	pn _p , AJ, ge	32	0.45	95	80	3	43	0.1
2N540	MH	pn _p , AJ, ge	32	0.45	95	80	3	64	0.1
2N1202	MH	pn _p , AJ, ge	32	0.45	95	80	3	86	0.1
2N1203	MH	pn _p , AJ, ge	32	0.45	95	120	3	37	0.1
2N1261	MH	pn _p , AJ, ge	32	0.45	95	60	3	30	0.1
2N1262	MH	pn _p , AJ, ge	32	0.45	95	60	3	43	0.1
2N1263	MH	pn _p , AJ, ge	32	0.45	95	60	3	64	0.1
H45	MH	pn _p , AJ, ge	32	0.45	95	80	3	20	0.1
2N392	DE	pn _p , AJ, ge	35	0.7	95	60	5	—	0.065
2N463	WE	pn _p , AJ, ge	35	2	100	60	5	60	100
2N553	DE	pn _p , AJ, ge	35	0.5	95	80	4	—	0.02
2N665	DE	pn _p , AJ, ge	35	0.5	95	80	5	—	0.02
2N1168	DE	pn _p , AJ, ge	35	0.7	95	50	5	—	0.065
2N1047	TI	np _n , DJ, si	40	0.25	200	80	0.5	—	0.015
2N1048	TI	np _n , DJ, si	40	0.25	200	120	0.5	—	0.015
2N1049	TI	np _n , DJ, si	40	0.25	200	80	0.5	—	0.95
2N1050	TI	np _n , DJ, si	40	0.25	200	120	0.5	—	0.015
2N173	DE	pn _p , AJ, ge	50	1.0	95	60	15	—	0.1
2N277	DE	pn _p , AJ, ge	50	1.0	95	40	15	—	0.1
2N278	DE	pn _p , AJ, ge	50	1.0	95	50	15	—	0.1
2N441	DE	pn _p , AJ, ge	50	1.0	95	40	15	—	0.1
2N442	DE	pn _p , AJ, ge	50	1.0	95	50	15	—	0.1
2N443	DE	pn _p , AJ, ge	50	1.0	95	60	15	—	0.1
2N561	REA	pn _p , AJ, ge	50	1.0	100	80	10	75	0.1
2N627	MO	pn _p , AJ, ge	50	0.8	90	30	10	18	0.3
2N628	MO	pn _p , AJ, ge	50	0.8	90	45	10	18	0.3
2N629	MO	pn _p , AJ, ge	50	0.8	90	60	10	18	0.5
2N630	MO	pn _p , AJ, ge	50	0.8	90	80	10	18	0.5
2N1014	RCA	pn _p , AJ, ge	50	1.0	100	100	10	75	0.1
2N1069	RCA	np _n , DJ, si	50	1.0	175	60	4	20	1
2N1070	RCA	np _n , DJ, si	50	1.0	175	60	4	20	1
2N1159	DC	pn _p , AJ, ge	50	0.8	95	80	5	—	0.065
2N1160	DE	pn _p , AJ, ge	50	0.8	95	80	7	—	0.065
2N1162	MO	pn _p , AJ, ge	50	0.8	90	35	25	25	0.3
2N1163	MO	pn _p , AJ, ge	50	0.8	90	35	25	25	0.3
2N1164	MO	pn _p , AJ, ge	50	0.8	90	60	25	25	0.5
2N1165	MO	pn _p , AJ, ge	50	0.8	90	60	25	25	0.5
2N1166	MO	pn _p , AJ, ge	50	0.8	90	80	25	25	0.5
2N1167	MO	pn _p , AJ, ge	50	0.8	90	80	25	25	0.5
H200	MH	pn _p , AJ, ge	63	0.91	95	60	10	50	0.3
H201	MH	pn _p , AJ, ge	63	0.91	95	60	10	40	0.3
2N174	DE	pn _p , AJ, ge	70	0.8	95	80	12	—	0.1
2N1099	DE	pn _p , AJ, ge	70	1.2	95	80	15	—	0.1
2N1100	DE	pn _p , AJ, ge	70	1.2	95	100	15	—	0.1
2N574	MH	pn _p , AJ, ge	100	1.43	95	60	15	14	0.9
2N574A	MH	pn _p , AJ, ge	100	1.43	95	80	15	14	0.9
2N575	MH	pn _p , AJ, ge	100	1.43	95	60	30	25	0.9
2N575A	MH	pn _p , AJ, ge	100	1.43	95	80	30	25	0.9
2N1157	MH	pn _p , AJ, ge	100	1.43	95	60	30	50	0.9
2N1157A	MH	pn _p , AJ, ge	100	1.43	95	80	30	50	0.9

Listed in order of increasing power dissipation. (continued)

		Characteristics				Remarks	Type No.
I_C A	h_{fe} or h_{FE}	I_{CO} ma	f a e k c	Powr. Gain db	Powr. Out. W		
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
75	-	0.1	-	26	30		2N561
18	-	0.3	8	38	-		2N627
18	-	0.3	8	38	-		2N628
18	-	0.5	8	38	-		2N629
18	-	0.5	8	38	-		2N630
75	-	0.1	-	26	30		2N1014
20	-	1	-	-	-	STC	2N1069
20	-	1	-	-	-	STC	2N1070
-	-	0.065	10	-	-		2N1159
-	-	0.065	10	-	-		2N1160
25	-	0.3	4	-	-		2N1162
25	-	0.3	4	-	-		2N1163
25	-	0.5	4	-	-		2N1164
25	-	0.5	4	-	-		2N1165
25	-	0.5	4	-	-		2N1166
25	-	0.5	4	-	-		2N1167
50	-	0.3	750	-	-		H200
40	-	0.3	375	-	-		H201
-	-	0.1	10	-	40	JAN,2N174A	2N174
-	-	0.1	10	-	40		2N1099
-	-	0.1	10	-	40		2N1100
14	-	0.9	200	-	-		2N574
14	-	0.9	200	-	-		2N574A
25	-	0.9	200	-	-		2N575
25	-	0.9	200	-	-		2N575A
50	-	0.9	200	-	-		2N1157
50	-	0.9	200	-	-		2N1157A



How to get ultra-uniformity

in a Silicon

PNP fused alloy transistor

Through precise manufacturing techniques, Hughes PNP fused-junction silicon transistors give you uniformity of parameters by type. Result: Circuit interchangeability no longer is a problem.

Designed for switching and amplifying applications at low and medium current levels, these Hughes transistors offer you a number of advantages:

- useful Beta over a wide range of collector currents
- high punch-thru voltage (BV_{CBO} in excess of 100 volts in types 2N1244 and 2N1234)
- low collector cutoff current

These devices, now available in production quantities, are housed in TO-5 (single ended) and coaxial packages (double ended). Engineered for reliability, they meet MIL-T-19500A specifications.

	2N1238	2N1239	2N1240	2N1241	2N1242	2N1243	2N1244
Coaxial Package Type:	2N1228	2N1229	2N1230	2N1231	2N1232	2N1233	2N1234
TO-5 Package Type:*							
Breakdown Voltage @ 100 μ A: C_{EO} , C_{BO} , E_{BO}	15V	15V	35V	35V	65V	65V	110V
h_{fe} (Average)	22	32	14	25	14	25	14
Collector Cutoff Current	.01 μ Adc	.01 μ Adc	.01 μ Adc	.01 μ Adc	.01 μ Adc	.01 μ Adc	.01 μ Adc
V_{CB} (max.) ($I_C = 10$ mAdc, $I_B = 2$ mAdc)	0.2V		0.2V		0.2V		0.2V
V_{CB} (max.) ($I_C = 20$ mAdc, $I_B = 2$ mAdc)		0.4V		0.4V		0.4V	
Coaxial Package: Power dissipation . . . 1 watt in free air (derate 7.4 mw/ $^{\circ}$ C)							
	5 watts with heat sink (derate 37 mw/ $^{\circ}$ C)						
TO-5 Package: Power dissipation . . . 250 mw (derate 1.8 mw/ $^{\circ}$ C)							
Collector current limited by power dissipation. Operating and storage temperature range -65 $^{\circ}$ C to +160 $^{\circ}$ C							
* formerly JETEC-30							

Your inquiry regarding these transistors will be given prompt attention. Just write or call the Hughes sales office nearest you. They are located in Boston (phone WO 2-4824), Newark (phone MA 3-3520), San Francisco (phone DA 6-7780), Syracuse (phone GR 1-0163), Philadelphia (phone MO 4-8365), Chicago (phone NA 2-0283), and Los Angeles (phone OR 8-8125). Or write Marketing Department, SEMICONDUCTOR DIVISION, NEWPORT BEACH, CALIFORNIA

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

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CIRCLE 43 ON READER-SERVICE CARD

25 AMP 100 VOLT POWER TRANSISTORS

ANOTHER MOTOROLA FIRST



Motorola 2N1166 and 2N1167 PNP germanium transistors offer • more usable power output than any other transistor • low saturation resistance (0.012 ohms-typical) for lower dissipation • high current gain • welded hermetic seal • excellent Beta linearity.

These new high-power transistors can be used to reduce the size and weight of transmitters without sacrificing power output, to extend the life expectancy of DC-DC converters and for a wide number of other high current switching and audio applications. Both units are available from stock. For engineering quantities contact your authorized Motorola Semiconductor distributor.



MOTOROLA'S COMPLETE RANGE OF INDUSTRIAL POWER TRANSISTORS gives you power for every purpose. Three separately designed series, produced under individual specifications, enable you to select devices best suited for your specific application.

POWER TRANSISTOR	Maximum Ratings			Typical Electrical Characteristics	
	Type Number	BV _{CEO} volts	BV _{CEV} volts	h _{FE} @ I _C amps	
25 AMP TO 100 VOLTS	2N1167*	100	75	25	25
	2N1166	100	75	25	25
	2N1165*	80	60	25	25
	2N1164	80	60	25	25
	2N1163*	50	35	25	25
	2N1162	50	35	25	25
T _J = 90°C					
10 AMP TO 100 VOLTS	2N630*	100	75	18	10
	2N629*	80	60	18	10
	2N628*	60	45	18	10
	2N627*	40	30	18	10
T _J = 90°C					
3 AMP TO 80 VOLTS	2N375	80	60	22	3
	2N618	80	60	35	3
T _J = 95°C					



FOR COMPLETE TECHNICAL INFORMATION regarding Motorola power transistors contact your nearest Motorola Semiconductor regional office.

Regional Offices:

RIDGEFIELD, NEW JERSEY
540 Bergen Boulevard
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1741 Ivar Avenue
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IN FOREIGN COUNTRIES WRITE: **MOTOROLA INTERNATIONAL, S.A.**
4545 West Augusta Blvd.
Chicago, Illinois



MOTOROLA, INC., 5005 E. McDOWELL, PHOENIX, ARIZONA

HIGH-LEVEL SWITCHING—High current devices.

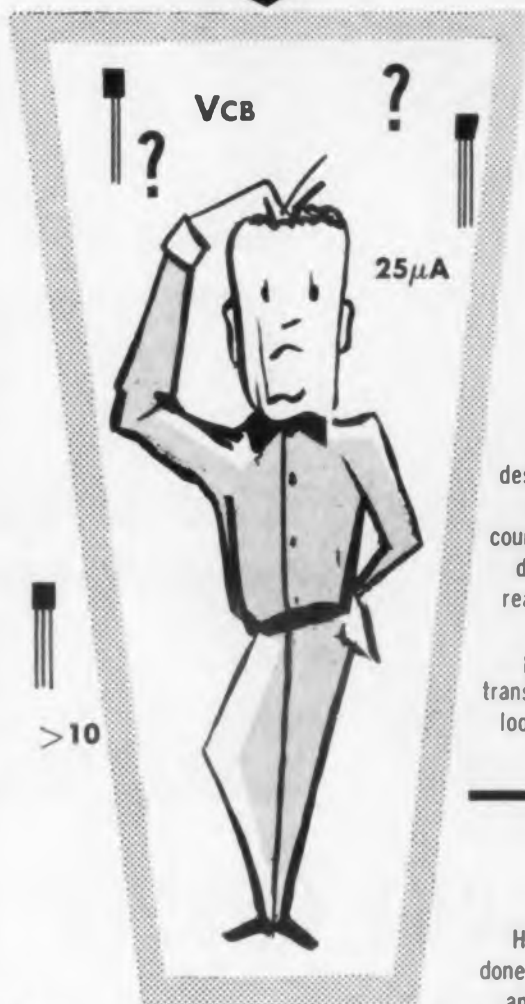
Type No.	Mfg	Type	f _{ae} KC	Max. Ratings			
				W _c W	T _i °C	W/°C	V _c V
2N1238	HU	pnp, FJ, si	0.8	1.0	200	—	15
2N1239	HU	pnp, FJ, si	0.8	1.0	200	—	15
2N1240	AU	pnp, FJ, si	1.0	1.0	200	—	35
2N1241	HU	pnp, FJ, si	1.0	1.0	200	—	35
2N1242	HU	pnp, FJ, si	1.0	1.0	200	—	65
2N1243	HU	pnp, FJ, si	1.0	1.0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

*Supplied in TO-3 package with solder terminals.

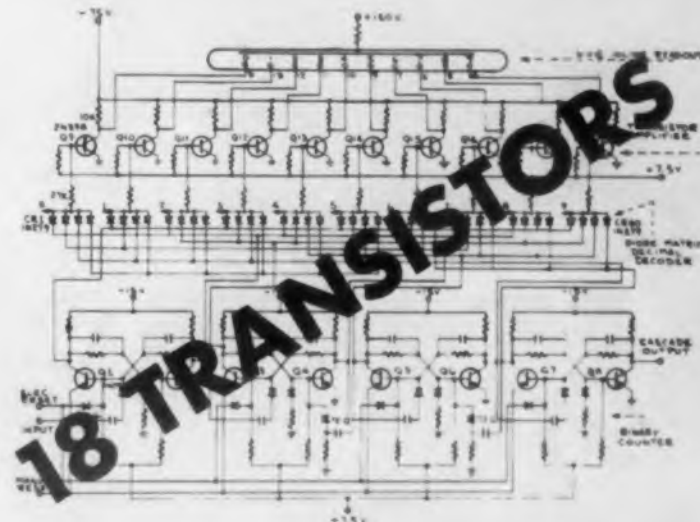
NOTE: all twelve of the above transistors have welded hermetic seals and are designed to meet or exceed mechanical and environmental requirements of MIL-T-19500A.

are you a victim of

Transistor
HYSTERISTOR?*

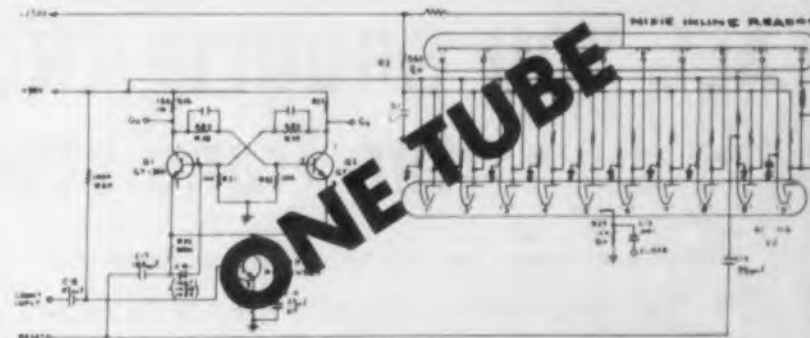


Transistor expert, Bill Binary, designed a high-speed decade counter requiring decimal in-line readout. He did the best job possible (with transistors) and it looked like this:



ALL TRANSISTOR DECADE COUNTER WITH NIXIE[®] TUBE READOUT

He could have done a better job and eliminated 90 components with one Miniature Beam Switching Tube, like this.



MINIATURE BEAM SWITCHING TUBE DECADE COUNTER WITH NIXIE TUBE READOUT



WRITE FOR COMPARISON CHART WHICH OUTLINES BEAM SWITCHING TUBE ADVANTAGES IN SIZE, WEIGHT, POWER, COST, TEMPERATURE, SHOCK, VIBRATION, LIFE AND RELIABILITY.

* Epidemic Symptoms:
Hysterical
Total Use of Transistors
Resulting in
Multi-Component
Unreliability

ANALYSIS: Transistors like ordinary tubes or cores are essentially binary devices.

REMEDY: Use a decimal component like Beam Switching Tubes to perform a decimal function.

LIVING PROOF:

By Actual count the all transistor circuit uses 146 components, while the Miniature Beam Switching Tube approach uses only 56 components.

YOU SHOULD KNOW ABOUT BEAM SWITCHING TUBES BECAUSE :

A single cathode controls an electron beam to any one of 10 constant current outputs each of which has individual bi-stable beam locking and high impedance switching.

You will find Beam Switching Tubes being used regularly to outperform other components wherever there is: distributing, switching, multiplexing, counting, sampling, coding, timing, gating, matrixing, memory, dividing, decoding, converting, or presetting.

ANOTHER ELECTRONIC CONTRIBUTION BY

Burroughs Corporation



ELECTRONIC TUBE DIVISION

Plainfield, New Jersey

Listed in order of increasing alpha cutoff frequency.

V _c V	I _c mA	Characteristics			Switching		Remarks	Type No.
		Power Gain db	Power Out W	Rise Time µsec	Stor. Time µsec			
15	14	0.0001	-	-	-	-		2N1238
15	32	0.0001	-	-	-	-		2N1239
35	14	0.0001	-	-	-	-		2N1240
35	24	0.0001	-	-	-	-		2N1241
65	14	0.0001	-	-	-	-		2N1242
65	24	0.0001	-	-	-	-		2N1243
40	14	0.0001	-	-	-	-		2N1244
40	50	10	-	.5	1		US,MIL only	GA52830
40	50	10	-	.5	1		US,MIL only	GA53242
40	50	10	-	.5	1		US,MIL only	GF45017
60	-	3	-	-	-	-	BE	2N297
60	-	3	-	-	-	-	BE,DE	2N297A
80	-	3	-	-	-	-	MO	2N618
80	-	2	-	-	-	-	BE 2N639A	2N268A
80	-	3	-	-	-	-	MO	2N375
20	30	0.5	-	-	-	-		2N378
80	-	5	-	-	-	-		2N379
30	-	0.5	-	-	-	-		2N380
40	-	0.2	-	-	12	12.5		2N456
60	-	0.6	-	-	12	12.5	RCA	2N457
80	-	1	-	-	12	12.5	CL	2N458
60	-	0.5	-	-	-	-		2N459
40	-	0.2	-	-	11.2	2.5		2N511
60	-	0.2	-	-	11.2	2.5		2N511A
80	-	0.2	-	-	11.2	2.5		2N511B
40	-	0.2	-	-	11.2	2.5		2N512
60	-	0.2	-	-	11.2	2.5		2N512A
80	-	0.2	-	-	11.2	2.5		2N512B
40	-	0.2	-	-	10.8	2.0		2N513
60	-	0.2	-	-	10.8	2.0		2N513A
80	-	0.2	-	-	10.8	2.0		2N513B
40	-	0.2	-	-	10.3	2.0		2N514
60	-	0.2	-	-	10.3	2.0		2N514A
80	-	0.2	-	-	10.3	2.0		2N514B
100	-	0.85	-	-	12	12.5		2N1021
120	-	0.85	-	-	12	12.5		2N1022
60	25	0.07	-	-	0.3	0.1		2N545
30	25	0.05	-	-	0.3	0.1		2N546
80	45	1.0	33	5	-	-		2N387
60	40	0.8	33	5	-	-		2N386
80	-	0.2	-	-	0.7	1.2		2N1046
30	10	-	-	-	7	1		WX1015
60	10	-	-	-	7	1		WX1015A
100	10	-	-	-	7	1		WX1015B
150	10	-	-	-	7	1		WX1015C
200	10	-	-	-	7	1		WX1015D
250	10	-	-	-	7	1		WX1015E
300	10	-	-	-	7	1		WX1015F
30	10	-	-	-	7	1		WX1016
60	10	-	-	-	7	1		WX1016A
100	10	-	-	-	7	1		WX1016B
150	10	-	-	-	7	1		WX1016C
200	10	-	-	-	7	1		WX1016D
250	10	-	-	-	7	1		WX1016E
100	10	-	-	-	7	1		WX1016F
10	50	0.001	-	-	0.2	0.08		2N1140
10	30	.1	-	-	50	50		2N1072
32	-	-	-	-	-	-		2N115
30	-	1.5	-	-	15	-		2N418
45	-	0.5	-	-	15	-		2N420
70	-	1.5	-	-	15	-		2N420A
40	-	0.5	-	-	15	-		2N637
70	-	2	-	-	15	-		2N637A
80	-	2	-	-	15	-		2N637B

(Continued on p. 64)

CIRCLE 45 ON READER-SERVICE CARD



NEW CATALOG contains :



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Here are some of the questions it answers:

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2. Can Ultra Pure graphite help cut costs? (answered on page 5)
3. Can more reliable transistors be made through the use of Ultra Pure graphite? (answered on page 4)
4. Does United guarantee "crash" deliveries? (answered on page 14)
5. Exactly how pure is United's Ultra Pure? (answered on page 5)
6. How is United set up to help with technical questions? (answered on pages 2-3)

7. What difference does it make whether a graphite fusion jig is molded or extruded? (answered on page 6)
8. What production help can a graphite producer offer a maker of transistors? (answered on pages 12-13)
9. Does United guarantee quality? (answered on page 15)

And these questions are but a few—a merest indication. For the whole story on United's services, and on Ultra Pure Graphite's role in improving semiconductor production, send for this new 20 page loose-leaf, stiff cover brochure. Fully illustrated . . . carefully compiled . . . sure to be a help to you. . . . Mail the coupon now.

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CIRCLE 46 ON READER-SERVICE CARD

1959 Transistor Data Chart

HIGH-LEVEL SWITCHING—High current devices.

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

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

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

C_{ce} = 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

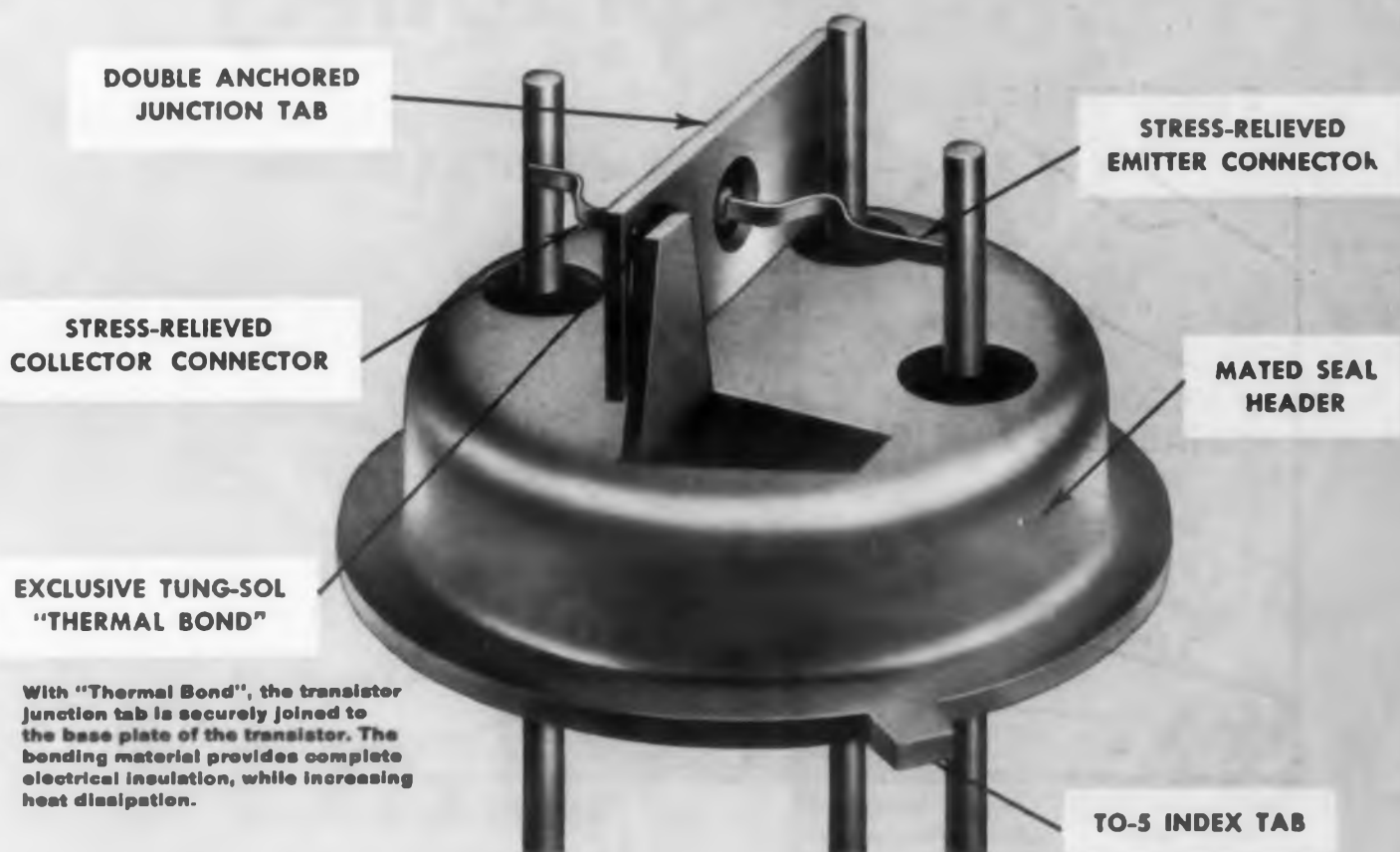
h_{FE} = Common Emitter-Static value of short-circuited forward current ratio

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

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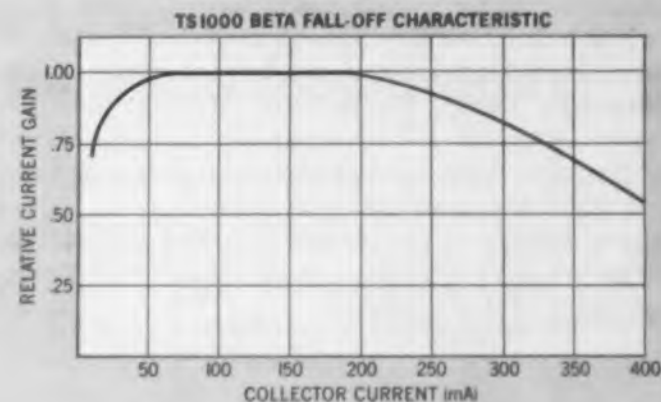
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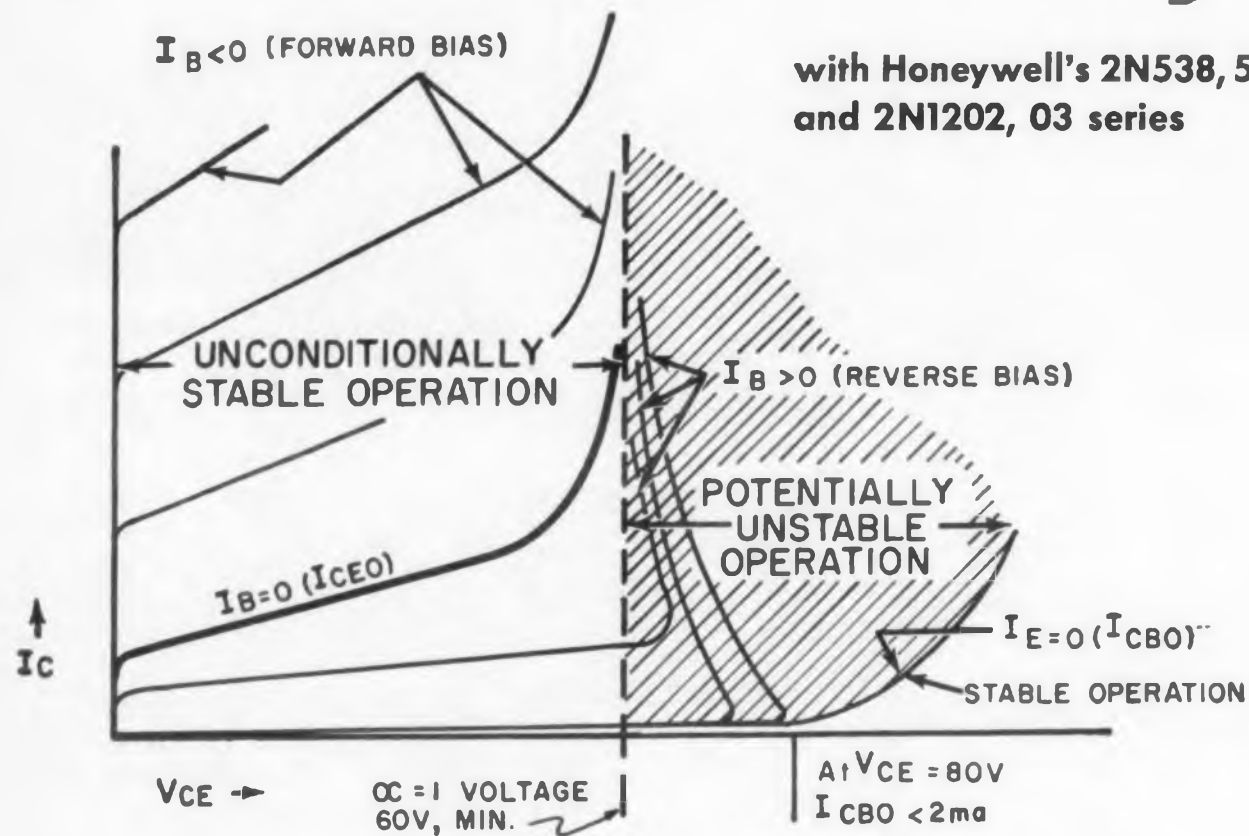
MAXIMUM RATINGS	TYPICAL CHARACTERISTICS (25°C)		
BV_{CBO}	-30V	f_{α}	12 Mc
BV_{EBO}	-20V	C_{ob}	12 μ f
BV_{CEX} ($V_{BE} = 0.1V$)	-20V	h_{FE} ($I_B = 1mA$)	60
BV_{CEO}	-12V	h_{FE} ($I_C = 400mA$)	40
I_C (continuous)	400mA	$(t_r + t_d)$ (rise plus delay)	0.45 μ sec
I_C (peak)	1.0 A	t_s (storage)	0.30 μ sec
T_j	-65°C to +85°C	t_f (fall)	0.20 μ sec
P_C	175mW	Thermal Resistance	0.350° C/mW
		I_{CBO} @ -12V	25°C 2.5 μ A
			65°C 25 μ A



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CIRCLE 47 ON READER-SERVICE CARD

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

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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_{ce} MC	Max. Ratings				Characteristics
				W_c (mw)	T_j °C	mw/o_c	V_c V	
2N1038	TI	pnp,AJ,ge	0.008	800	95	14	40	50
2N1039	TI	pnp,AJ,ge	0.008	800	95	14	60	50
2N1040	TI	pnp,AJ,ge	0.0085	800	95	14	80	50
2N1041	TI	pnp,AJ,ge	0.0085	800	95	14	100	50
2N327A	RA	pnnp,FA,si	0.2	385	160	—	40	5
2N619	RA	npn,FA,si	0.2	385	160	—	40	5
2N1034	RA	pnnp,FA,si	0.2	385	160	—	40	5
2N1074	RA	npn,FA,si	0.2	385	160	—	40	5
2N1037	RA	pnnp,FA,ge	0.25	385	160	—	35	5
2N328A	RA	pnnp,FA,si	0.3	385	160	—	35	5
2N620	RA	npn,FA,si	0.3	385	160	—	35	5
2N1035	RA	pnnp,FA,si	0.3	385	160	—	35	5
2N1075	RA	npn,FA,si	0.3	385	160	—	35	5
2N1077	RA	npn,FA,si	0.3	385	160	—	30	5
2N1036	RA	pnnp,FA,si	0.4	385	160	—	30	5
2N1126	PH	pnnp,AJ,ge	0.4	*1000	85	16.7	35	30
2N329A	RA	pnnp,FA,si	0.5	385	160	—	30	5
2N462	PH	pnnp,AJ,ge	0.5	150	75	3.0	40	7.0
2N621	RA	npn,FA,si	0.5	385	160	—	30	5
2N1057	GE	pnnp,AJ,ge	0.5	240	100	4	45	16
2N1076	RA	npn,FA,si	0.5	385	160	—	30	5
2N670	PH	pnnp,AJ,ge	0.7	300	85	5.0	40	20
2N671	PH	pnnp,AJ,ge	0.7	1000	85	16.7	40	20
2N1228	HU	pnnp,FJ,si	0.8	250	200	—	15	0.05
2N1229	HU	pnnp,FJ,si	0.8	250	200	—	15	0.05
2N1008	BE	pnnp,AJ,ge	1.0	400	85	150	20	5
2N1008A	BE	pnnp,AJ,ge	1.0	400	85	150	40	5
2N1008B	BE	pnnp,AJ,ge	1.0	400	85	150	60	7
2N331	BE	pnnp,AJ,ge	1	200	85	3	30	16
2N1056	GE	pnnp,AJ,ge	1	240	100	4	50	25
2N1125	PH	pnnp,AJ,ge	1.0	300	85	5	40	2.5
2N1127	PH	pnnp,AJ,ge	1	*1000	85	16.7	40	25
2N1176	BE	pnnp,AJ,ge	1	300	85	0.4	15	10
2N1176A	BE	pnnp,AJ,ge	1	300	85	0.4	40	12
2N1176B	BE	pnnp,AJ,ge	1	300	85	0.4	60	15
2N1230	HU	pnnp,FJ,si	1.0	250	200	—	35	0.05
2N1231	HU	pnnp,FJ,si	1.0	250	200	—	35	0.05
2N1232	HU	pnnp,FJ,si	1.0	250	200	—	65	0.05
2N1233	HU	pnnp,FJ,si	1.0	250	200	—	65	0.05
2N1234	HU	pnnp,FJ,si	1.2	250	200	—	110	0.05
2N558	SY	npn,AJ,ge	—	100	85	1.66	15	15
2N587	SY	npn,AJ,ge	—	150	85	2.5	25	50
2N312	SY	npn,AJ,ge	1.5	100	85	1.66	15	15
2N519	IND	pnnp,AJ,ge	1.5	200	85	3	15	2
2N519A	IND	pnnp,AJ,ge	1.5	200	85	3	20	1
2N536	PH	pnnp,AJ,ge	2.0	50	85	0.83	20	4
2N679	SY	npn,AJ,ge	2	150	85	2.5	20	25
2N1223	GT	pnnp,AJ,si	2	150	150	1.2	40	0.05
TR524	IND	pnnp,AJ,ge	2	200	85	3	45	5
TR525	IND	pnnp,AJ,ge	2.5	200	85	3	45	5
2N356	RCA	npn,AJ,ge	3	100	85	—	20	5
2N356A	GT	pnnp,AJ,ge	3	150	100	2	40	3
2N1220	GT	pnnp,AJ,si	3	150	150	1.2	30	0.05
TR526	IND	pnnp,AJ,ge	3	200	85	3	45	5
TR527	IND	pnnp,AJ,ge	3.3	200	85	3	45	5
2N425	MO	pnnp,AJ,ge	4	150	85	2.5	20	2.0
2N1028	SSC	pnnp,AJ,si	4	150	150	1.1	10	25
CK25	RA	pnnp,FA,ge	4	80	85	—	20	2
2N395	GE	pnnp,AJ,ge	4.5	200	100	3.3	15	6
2N520	IND	pnnp,AJ,ge	4.5	200	85	3	15	1
2N520A	IND	pnnp,AJ,ge	4.5	200	85	3	20	1
2N597	PH	pnnp,AJ,ge	4.5	250	100	3.3	40	1
2N1123	PH	pnnp,AJ,ge	4.5	750	100	10.0	40	5
2N315	GT	pnnp,AJ,ge	5	100	85	2	40	1
2N315A	GT	pnnp,AJ,ge	5	150	100	2	40	1
2N439	SY	npn,AJ,ge	5	100	85	1.66	20	1
2N450	GE	pnnp,AJ,ge	5	150	85	2.5	12	1
2N576	SY	npn,AJ,ge	5	200	100	2.6	20	2
2N578	RCA	pnnp,AJ,ge	5	120	85	—	20	2
2N585	RCA	npn,AJ,ge	5	120	85	—	25	1

Devices

Listed in order of increasing alpha cutoff frequency.

V _c V	I _c mA	Switching		Remarks	Type No.	
		Rise Time μsec	Stor. Time μsec			
40	50	100	5.0	2.0	GB	2N1038
60	50	100	5.0	2.0	GB	2N1039
80	50	100	5.0	2.0	GB	2N1040
100	50	100	5.0	2.0	GB	2N1041
40	5	70	-	-		2N327A
40	5	35	-	-		2N619
40	5	70	-	-		2N1034
40	5	35	-	-		2N1074
35	5	70	-	-		2N1037
35	5	70	-	-		2N328A
35	5	35	-	-		2N620
35	5	70	-	-		2N1035
35	5	35	-	-		2N1075
30	5	35	-	-		2N1077
30	5	70	-	-		2N1036
35	30	-	-	-	*with inf. heat sink	2N1126
30	5	70	-	-		2N329A
40	7.0	20	-	-		2N462
30	5	35	-	-		2N621
45	16	40	-	-		2N1057
30	5	35	-	-		2N1076
40	20	-	-	-	Pulse Amp	2N670
40	20	-	-	-	Pulse Amp	2N671
15	0.05	100	-	-		2N1228
15	0.05	100	-	-		2N1229
20	5	-	-	-		2N1008
40	5	-	-	-		2N1008A
60	7	-	-	-		2N1008B
30	16	-	-	-		2N331
50	25	40	-	-	Neon indicator	2N1056
40	2.5	-	-	-		2N1125
40	25	-	-	-	*with inf. heat sink	2N1127
15	10	-	-	-		2N1176
40	12	-	-	-		2N1176A
60	15	-	-	-		2N1176B
35	0.05	100	-	-		2N1230
35	0.05	100	-	-		2N1231
65	0.05	100	-	-		2N1232
65	0.05	100	-	-		2N1233
110	0.05	100	-	-		2N1234
15	15	-	3.5	2		2N558
25	50	-	2	2		2N587
15	15	-	1.5	2		2N312
15	2	14	-	-		2N519
20	1	14	1.3	0.7		2N519A
20	4	-	-	-		2N536
20	25	-	5	5		2N679
40	0.05	15	-	-		2N1223
45	5	25	-	-	2N524	TR524
45	5	25	-	-	2N525	TR525
20	5	-	1.0	0.3	GT, SY	2N356
40	3	14	1.5	0.3		2N356A
30	0.05	9	-	-		2N1220
45	5	25	-	-	2N526	TR526
45	5	25	-	-		TR527
20	2.0	14	1.0	0.3	TR,SY,RA,IND.	2N425
10	25	7	-	-		2N1028
20	2	14	0.5	0.3		CK25
15	6	12	0.55	0.5	TI	2N395
15	1	14	-	-		2N520
20	1	14	0.9	0.7		2N520A
40	5	18	-	-		2N597
40	5	18	-	-		2N1123
40	1	14	1	0.12	IND	2N315
40	1	14	0.9	0.4	IND.	2N315A
20	10	-	0.5	0.7		2N439
12	6	20	-	-		2N450
20	2	-	2	1		2N576
20	1	-	0.85	0.33	IND.	2N578
25	1	-	0.35	0.25		2N585

(Continued on p. 68)

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2 WATTS dissipation at 25° C—the combination of power with high frequency that is available only in double diffused silicon transistors.

In Fairchild's recent succession of new transistor announcements, each has offered some exceptional combination of characteristics previously unattainable. The 2N699 combines high collector voltage rating with high-frequency performance, medium power capabilities and low saturation resistance. Its applications range from low-current high-frequency I-F circuits to high-current, low-frequency relay drivers. Other products nearing production at Fairchild promise even greater advances in the state of the art.

2N699—ELECTRICAL CHARACTERISTICS (25° C)

Symbol	Characteristic	Min.	Typ.	Max.	Test Conditions
h_{FE}	D.C. pulse current gain	40		120	$I_C = 150\text{ma}$ $V_C = 10\text{v}$
$V_{BE(sat)}$	Base saturation voltage		1.0	1.3	$I_C = 150\text{ma}$ $I_B = 15\text{ma}$
$V_{CE(sat)}$	Collector saturation voltage			5v	$I_C = 150\text{ma}$ $I_B = 15\text{ma}$
h_{fe}	Small signal current gain at $f = 20$ mc	2.5	5.0		$I_C = 50\text{ma}$ $V_C = 10\text{v}$
C_{cb}	Collector capacitance		14 μmf	20 μmf	$I_E = 10\text{ma}$ $V_C = 10\text{v}$
I_{CBO}	Collector cutoff current			200 μa	$V_C = 60\text{v}$ $T = 25^\circ\text{C}$
					$V_C = 60\text{v}$ $T = 150^\circ\text{C}$

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1959 Transistor Data Chart LOW-LEVEL SWITCHING—Small signal devices

Type No.	Mfg	Type	$f_{\alpha e}$ MC	Max. Ratings				Characteristics
				W_c (mw)	T_j °C	mw/°C	V_c V	
2N658	RA	npn,FA,ge	5	150	85	—	16	2
2N1012	GT	npn,AJ,ge	5	150	100	2	40	5
2N1093	TI	npn,AJ,ge	5	150	100	2.0	30	2
2N357	RCA	npn,AJ,ge	6	100	85	2	20	5
2N357A	GT	npn,AJ,ge	6	150	100	2	40	3
2N377	SY	npn,AJ,ge	6	150	100	2	20	20
2N426	MO	npn,AJ,ge	6	150	85	2.5	20	2.0
CK26	RA	npn,FA,ge	6	80	85	—	18	2
2N1090	RCA	npn,AJ,ge	7	120	85	—	25	8
2N1114	SY	npn,AJ,ge	7	150	100	2	15	30
2N1219	GT	npn,AJ,si	7	150	150	1.2	30	0.0
GT123	GT	npn,AJ,ge	7	150	150	2	25	3
2N598	PH	npn,AJ,ge	7.5	250	100	3.3	20	5
2N600	PH	npn,AJ,ge	7.5	750	100	0.1	20	5
2N123	GE	npn,AJ,ge	8	150	85	2.5	15	6
2N388	GT	npn,AJ,ge	8	150	100	2	25	5
2N396	GE	npn,AJ,ge	8	200	100	3.3	20	6
2N505	IND	npn,AJ,ge	8	200	85	3	40	2
2N576A	SY	npn,AJ,ge	8	200	100	2.6	20	40
2N579	RCA	npn,AJ,ge	8	120	85	—	20	6
2N581	RCA	npn,AJ,ge	8	80	85	—	18	6
2N583	RCA	npn,AJ,ge	8	80	85	—	18	6
2N662	RA	npn,FA,ge	8	150	85	—	11	2.5
TR123	IND	npn,AJ,ge	8	200	85	3	20	2
TR396	IND	npn,AJ,ge	8	200	85	3	20	3
2N167*	GE	npn,GJ,ge	9	65	85	1.1	30	1.5
2N358	GT	npn,AJ,ge	9	100	85	2	30	3
2N358A	GT	npn,AJ,ge	9	150	100	2	40	3
2N394	GE	npn,AJ,ge	9	150	85	2.5	10	6
2N1198	GE	npn,RC,ge	9	65	85	1.1	25	1.5
2N332	GE	npn,GD,si	10	150	200	1.0	45	2
2N440	SY	npn,AJ,ge	10	100	85	1.66	15	10
2N518	GE	npn,AJ,ge	10	150	85	2.5	12	6
2N521	IND	npn,AJ,ge	10	200	85	3	15	1
2N521A	IND	npn,AJ,ge	10	200	85	3	20	1
2N659	RA	npn,FA,ge	10	150	85	—	14	2.5
2N427	GT	npn,AJ,ge	11	150	100	2	30	2
2N496	PH	npn,SB,si	11	150	140	1.1	10	0.00
CK27	RA	npn,FA,ge	11	80	85	—	15	2.0
2N269	RCA	npn,AJ,ge	12	120	85	—	25	5
2N316	GT	npn,AJ,ge	12	100	85	2	30	1
2N316A	GT	npn,AJ,ge	12	150	100	2	30	1
2N333	GE	npn,GD,si	12	150	200	1.0	45	2
2N397	GE	npn,AJ,ge	12	200	100	3.3	15	6
2N404	RCA	npn,AJ,ge	12	120	85	—	25	5
2N635	GE	npn,AJ,ge	12	150	85	2.5	20	5
TR269	IND	npn,AJ,ge	12	200	85	3	25	2
2N334	GE	npn,GD,si	13	150	200	1.0	45	8
2N1091	RCA	npn,AJ,ge	13	120	85	—	25	2
2N335	GE	npn,GD,si	14	150	200	1.0	45	2
2N336	GE	npn,GD,si	15	150	200	1.0	45	2
2N580	RCA	npn,AJ,ge	15	120	85	—	20	5
2N660	RA	npn,FA,ge	15	150	85	—	11	2.5
2N428	GT	npn,AJ,ge	17	150	100	2	30	2
2N636	GE	npn,AJ,ge	17	150	85	2.5	20	5
CK28	RA	npn,FA,ge	17	80	85	—	12	2.0
2N522	IND	npn,AJ,ge	18	200	85	3	15	1
2N522A	IND	npn,AJ,ge	18	200	85	3	20	1
2N582	RCA	npn,AJ,ge	18	120	85	—	25	5
2N584	RCA	npn,AJ,ge	18	120	85	—	25	5
2N599	PH	npn,AJ,ge	18	250	100	3.3	20	5
2N601	PH	npn,AJ,ge	18	750	100	0.1	20	5
2N317	GT	npn,AJ,ge	20	100	85	2	30	1
2N317A	GT	npn,AJ,ge	20	150	100	2	30	1
2N417	IND	npn,AJ,ge	20	200	85	3	30	2
2N661	RA	npn,FA,ge	20	150	85	—	9	2
2N1017	RA	npn,FA,ge	20	150	85	—	10	2
2N523	IND	npn,AJ,ge	24	200	85	3	15	1
2N523A	IND	npn,AJ,ge	24	200	85	3	15	1
2N1205	TR	npn,GR,si	27	150	150	—	30	0

ed in order of increasing alpha cutoff
d vices, quency) (continued)

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

(Continued on p. 70)

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Implemented and fully proven by Amperex, a unique manufacturing technique originating with Philips of the Netherlands now enables Amperex to provide you with production VHF transistors of unparalleled laboratory quality at truly reasonable prices.

The new Amperex "alloy-diffusion" P-N-P transistors combine the best qualities of both the alloy and the diffusion approaches to transistor construction. As a result of the special "self-jigging" techniques, a maximum degree of uniformity is achieved. Thus the necessity for "selection" is completely eliminated.

The Type OC170 is designed for use as a mixer oscillator in short wave receivers, as an IF amplifier in FM receivers, and as a broadband linear amplifier for instrumentation and industrial applications. The OC170 features a high cut-off frequency of 70 Mc and a low collector-to-base capacitance of 1.8 $\mu\mu\text{f}$.

The Type OC169 is designed for lower frequencies and gain.

The Type OC171 is designed for use as a local oscillator and preamplifier in FM receivers and has a cut-off frequency of 100 Mc.

MAXIMUM RATINGS	OC169	OC170	OC171
V_{ce}	20 V	20 V	20 V
I_c	10 mA	10 mA	5 mA
P_c at $T_{amb.} = 45^\circ\text{C}$	50 mW	60 mW	60 mW
TYPICAL CHARACTERISTICS			
Cut-off frequency f_{cb}	70 Mc	70 Mc	100 Mc
Power gain P_g at 0.45 Mc	35 db	57 db	—
P_g at 10.7 Mc	20 db	31 db	—
P_g at 100 Mc	—	—	23 db
Noise figure NF at 0.45 Mc	4 db	4 db	—
NF at 10.7 Mc	5 db	5 db	—
NF at 100 Mc	—	—	11 db



The Breakthrough...
How It Was Accomplished!

This VHF transistor breakthrough was made possible by a new alloy-diffusion process, a manufacturing method that combines the best features of the currently used alloy and diffusion processes, without their drawbacks.

The limitation of the alloy process is encountered when attempting to manufacture transistors with an average cut-off above 20 Mc. In this process the collector and emitter elements are fused (or alloyed) to the base. For this to be successfully accomplished the base must be relatively thick and the thickness very accurately controlled in order that during the fusion process the collector and emitter elements do not flow through the base and short the transistor. This relatively thick base increases the transit time, precluding any usable response above 20 Mc.

In the diffusion process the base is formed on the collector by gaseous diffusion in a high temperature oven. Very thin bases can be manufactured by this method with low transit time and very high cut-off frequencies. In this process the problem lies in attaching the emitter junction and base lead.

In the AMPEREX "alloy-diffusion" process, alloying and diffusion take place simultaneously. The transistor is built up on a piece of P-type germanium. Two small pellets are placed on the germanium. Pellet B, the base pellet, contains only an N-type impurity. Pellet E, the emitter pellet, contains a P-type and an N-type impurity.

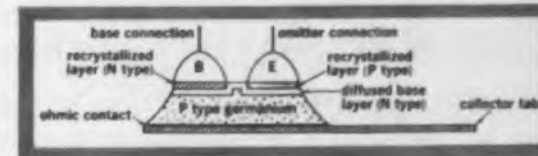
When this assembly is heated at a certain temperature, the germanium dissolves into the metal pellets until saturation is reached, and the pellet impurities diffuse into the solid germanium.

However, the P-type impurity in pellet E has such a low diffusion constant, that for practical purposes it does not penetrate into the germanium. The N-type impurity in pellets E and B has a much greater diffusion constant and readily penetrates into the solid germanium to form a diffused N-type layer underneath the pellets.

When the assembly is cooled down, a layer of germanium recrystallizes from the pellets as in the normal alloy technique. The recrystallized layer of pellet E contains many atoms of the P-type impurity and is, therefore, a P-type germanium layer. The germanium layer recrystallized from pellet B is, of course, the N-type because there are no other impurities in the pellet.

Connections are made to the germanium and the metal pellets and a P-N-P transistor is obtained. The original P-type germanium is the collector, pellet B the base, and pellet E the emitter.

This process makes it possible to mass produce transistors with a base layer of a few microns for very short transit time and high cut-off frequencies. The yield is also very high which enables AMPEREX to supply these transistors at low prices.



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- MEDIUM SPEED LINEAR AMPLIFIER

	2N1219	2N1220	2N1221	2N1222	2N1223
V _{ceo}	30 v	30 v	30 v	30 v	40 v
V _{ceo}	25 v	25 v	25 v	25 v	40 v
V _{ceo}	20 v	20 v	10 v	10 v	10 v
I _{co}	.1 μa max.	.1 μa max.	.1 μa max.	.1 μa max.	.1 μa max.
h _{FE}	18 min.	9 min.	—	—	—
f _{ab} (mc)	5 min.	2 min.	5 min.	2 min.	2 typ.
h _{FE}	—	—	18 min.	9 min.	6 min.

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CIRCLE 52 ON READER-SERVICE CARD

1959 Transistor Data Chart

LOW-LEVEL SWITCHING—Small signal devices.

Type No.	Mfg	Type	f _{3dB} MC	Max. Ratings			
				W _c (mw)	T _i °C	mw/°C	V _{ce} V
2N337	GE	npn,GO,si	30	125	200	1.0	45
2N643	RCA	pnnp,DR,ge	30*	120	85	—	30
2N1122	PH	pnnp,MA,ge	40	25	85	0.63	10
2N1122A	PH	pnnp,MA,ge	40	25	85	0.63	14
2N338	GE	npn,GO,si	45	125	200	1.0	45
2N644	RCA	pnnp,DR,ge	50*	120	85	—	30
2N560	WE	npn,DD,si	60	600	150	.25	60
2N240	PH	pnnp,SB,ge	60	30	85	0.5	6
2N398	RCA	pnnp,AJ,ge	60	100	85	—	105
2N586	RCA	pnnp,AJ,ge	60	250	85	—	45
2N645	RCA	pnnp,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	pnnp,MD,ge	180 MC	25	85	0.63	12
2N501A	PH	pnnp,MD,ge	180 MC	25	100	0.45	12
2N705	TI	pnnp,DJ,ge	250 MC	300	100	4	15
2N559	WE	pnnp,DG,ge	750 MC	150	100	5	15
2N311	IND	pnnp,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	pnnp,AJ,ge	—	300	85	5.0	25
2N673	PH	pnnp,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	pnnp,DM,si	—	2W	175	—	30
2N1132	FA	pnnp,DM,si	—	2W	175	—	30

SPECIAL

Type No.	Mfg	Type	Anode Volt V
3A30	SSP	pnnp	30
3A40	SSP	pnnp	60
3A100	SSP	pnnp	100
3A150	SSP	pnnp	150
3A200	SSP	pnnp	200
2N489 to 2N494	GE	pn,aj,si	P = 450 mW, T _i = 175°C, 0.4 mw/°C
2N469	GT	pnnp,AJ	P = 50 mW, h _{FE}
GT34N	GT	pnnp,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

Listed order of increasing alpha cutoff frequency. (continued)

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

SPECIAL UNIJUNCTION, control, and phototransistors.

Anode Volt V	Remarks
30	Diss. = 2.5 w @ 100C case
60	Diss. = 0.25 w @ 100C amb.
100	Anode Current = 1.0 A
150	Temp -65C to +150C
200	Time = 0.2 μ sec; Turn 1 μ sec
P = 450	Unijunction
$T_j = 175$	in three ranges of
0.4 mw	eff and two ranges of
	case resistance
P = 50 mW	$h_{fe} = 50$ Sens = 15 μ a/ft coil Photo
P = 125 mW	Neon light
P = 50 mW	Photo
P = 65 mW	Photo

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

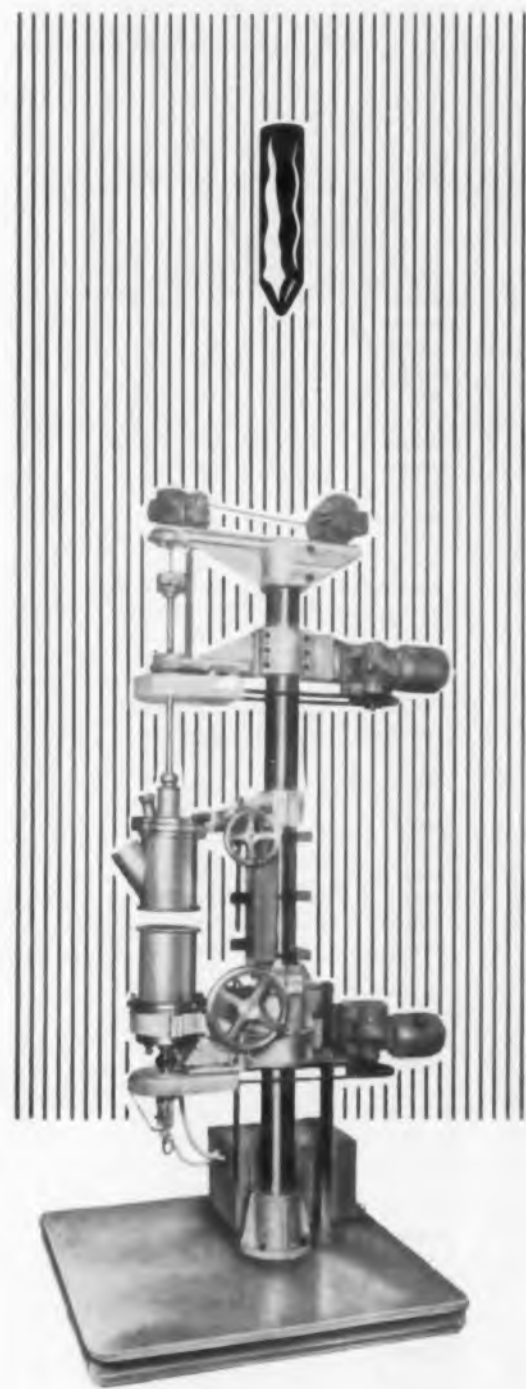
f_{oe} = Frequency at which the magnitude of the forward-current transfer ratio (small-signal) is 0.707 of its low frequency value.

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

α_{sc} = 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.

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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
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2N44	A	2N214	A	2N315A	LL	2N379	HL	2N457	HL	2N535A	A	2N617	HF	2N1047	P	B177	A
2N45	A	2N215	A	2N316	LL	2N380	HL	2N458	HL	2N535B	A	2N618	HL	2N1048	P	B178	A
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	A
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	A
2N120	A	2N241A	A	2N333	LL, HF	2N401	P	2N480	HF	2N555	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	HF
2N123	LL	2N243	A	2N335	HF, LL	2N403	A	2N482	HF	2N558	LL	2N638A	HL	2N1077	LL	CTP1112	HF
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	A
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	HL	2N639B	HL	2N1099	P	GA52830	A
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	A	2N490	Sp	2N568	HL	2N641	HF	2N1101	A	GF45017	HL
2N139	HF	2N253	P	2N342	P	2N410	HF	2N491	Sp	2N570	HL	2N642	HF	2N1102	A	GT34N	Sp
2N140	HF	2N255	P	2N342A	P	2N411	HF	2N492	Sp	2N572	HL	2N643	LL	2N1107	HF	GT74	A
2N155	P	2N255A	P	2N343	P	2N412	HF	2N493	Sp	2N574	HL	2N644	LL	2N1108	HF	GT81	A
2N156	P	2N256	P	2N344	HF	2N413	HF	2N494	Sp	2N574A	HL	2N645	LL	2N1109	HF	GT109	A
2N157	P	2N256A	P	2N345	HF	2N413A	HF	2N495	Sp	2N575	HL	2N647	A	2N1110	HF	GT123	LL
2N157A	P	2N257	P	2N346	HF	2N414	HF	2N496	Sp	2N575A	HL	2N647A	A	2N1111	HF	GT495	HF
2N158	P	2N265	A	2N347	A	2N414A	HF	2N497	Sp	2N576	HL	2N650	A	2N1111A	HF	GT496	HF
2N158A	P	2N268	P	2N348	A	2N416	HF	2N498	Sp	2N576A	HL	2N651	A	2N1111B	HF	GT1200	A
2N160	A	2N268A	HL	2N349	A	2N417	HF	2N499	Sp	2N578	HL	2N652	A	2N1114	LL	H3A	P
2N160A	A	2N269	LL	2N350	P	2N418	HL	2N501	Sp	2N579	HL	2N653	A	2N1116	HL	H4A	P
2N161	A	2N270	HF	2N350A	P	2N419	P	2N501A	Sp	2N580	HL	2N654	A	2N1117	HL	H45	P
2N161A	A	2N271	LL	2N351	P	2N420	HL	2N502	Sp	2N581	HL	2N655	A	2N1122	LL	H200E	P
2N163	A	2N274	HF	2N351A	P	2N422	A	2N502A	Sp	2N582	HL	2N656	A	2N1122A	LL	LT11	P
2N163A	A	2N277	P	2N356	LL, HF	2N424	HL	2N503	Sp	2N583	HL	2N657	HL	2N1123	LL	LT12	P
2N167	LL	2N278	P	2N356A	LL, HF	2N425	LL	2N504	Sp	2N584	HL	2N658	LL	2N1124	LL	LT13	P
2N168A	HF	2N279	A	2N357	LL, HF	2N426	LL	2N505	Sp	2N586	HL	2N659	LL	2N1125	LL	LT14	P
2N169	HF	2N280	A	2N357A	LL, HF	2N427	LL	2N508	Sp	2N588	HL	2N660	LL	2N1126	LL	LT5164	P
2N169A	HF	2N284	A	2N358	LL, HF	2N428	LL	2N515	Sp	2N591	HL	2N661	LL	2N1127	LL	LT5165	P
2N173	P	2N284A	A	2N358A	LL	2N438	HF	2N516	Sp	2N592	HL	2N662	LL	2N1128	A	OC65	A
2N174	P	2N285A	P	2N359	A	2N438A	HF	2N517	Sp	2N593	HL	2N669	P	2N1129	A	OC66	A
2N175	A	2N291	A	2N360	A	2N439	LL, HF	2N518	Sp	2N594	HL	2N670	LL	2N1130	A	OC171	HF
2N176	P	2N292	HF	2N361	A	2N439A	HF	2N519	Sp	2N595	HL	2N672	LL	2N1131	LL	SB100	HF
2N185	A	2N293	HF	2N362	A	2N440	LL	2N520	Sp	2N596	HL	2N673	LL	2N1132	LL	ST401	HL
2N186A	A	2N296	P	2N363	A	2N440A	HF	2N519A	Sp	2N598	HL	2N680	A	2N1136	HL	ST402	HL
2N187A	A	2N297	HL	2N364	A	2N441	P	2N520A	Sp	2N599	HL	2N696	LL	2N1136A	HL	ST403	HL
2N188A	A	2N297A	HL	2N365	A	2N442	P	2N521	Sp	2N600	HL	2N697	LL	261136B	HL	ST903	HF
2N189	A	2N299	HF	2N366	A	2N443	P	2N521A	Sp	2N601	HL	2N700	HF	2N1137	HL	ST904	HF
2N190	A	2N300	HF	2N368	A	2N444	HF	2N522	Sp	2N603	HL	2N701	HF	2N1137A	HL	ST904A	HF
2N191	A	2N301	P	2N369	A	2N444A	HF	2N522A	Sp	2N604	HL	2N702	LL	2N1137B	HL	ST905	HF
2N192	A	2N301A	P	2N370	HF	2N445	HF	2N523	Sp	2N609	HL	2N705	LL	2N1138	HL	ST910	HF
2N193	HF	2N306	HF	2N371	HF	2N445A	HF	2N523A	Sp	2N611	HL	2N1008	LL	2N1138A	HL	ST1026	A
2N194	HF	2N307	P	2N372	HF	2N446	HF	2N524	Sp		HL	2N1008A	LL	2N1138B	HL	ST1050	A
2N194A	HF	2N307A	P	2N373	HF	2N446A	HF	2N525	Sp		HL	2N1008B	LL	2N1141	HF	ST1051	A
2N204A	A	2N308	HF	2N374	HF	2N447	HF		Sp		HL	2N1010	A	2N1142	HF	TR34	A

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- 15 different Diameters

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

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**CANNON
PLUGS**





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 PNP 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 Tristors 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 μ sec are typical with circuit repetition

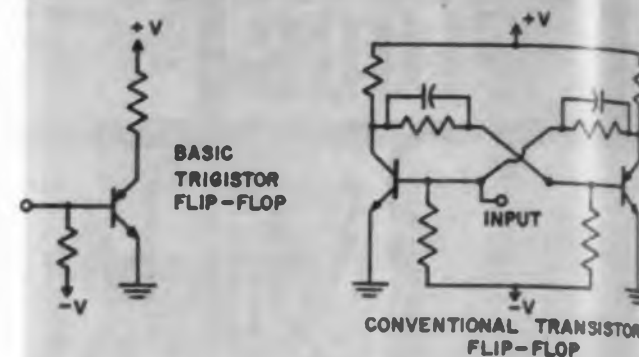


Fig. 1. Comparison between Trigistor and conventional transistor flip-flop circuit.



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.

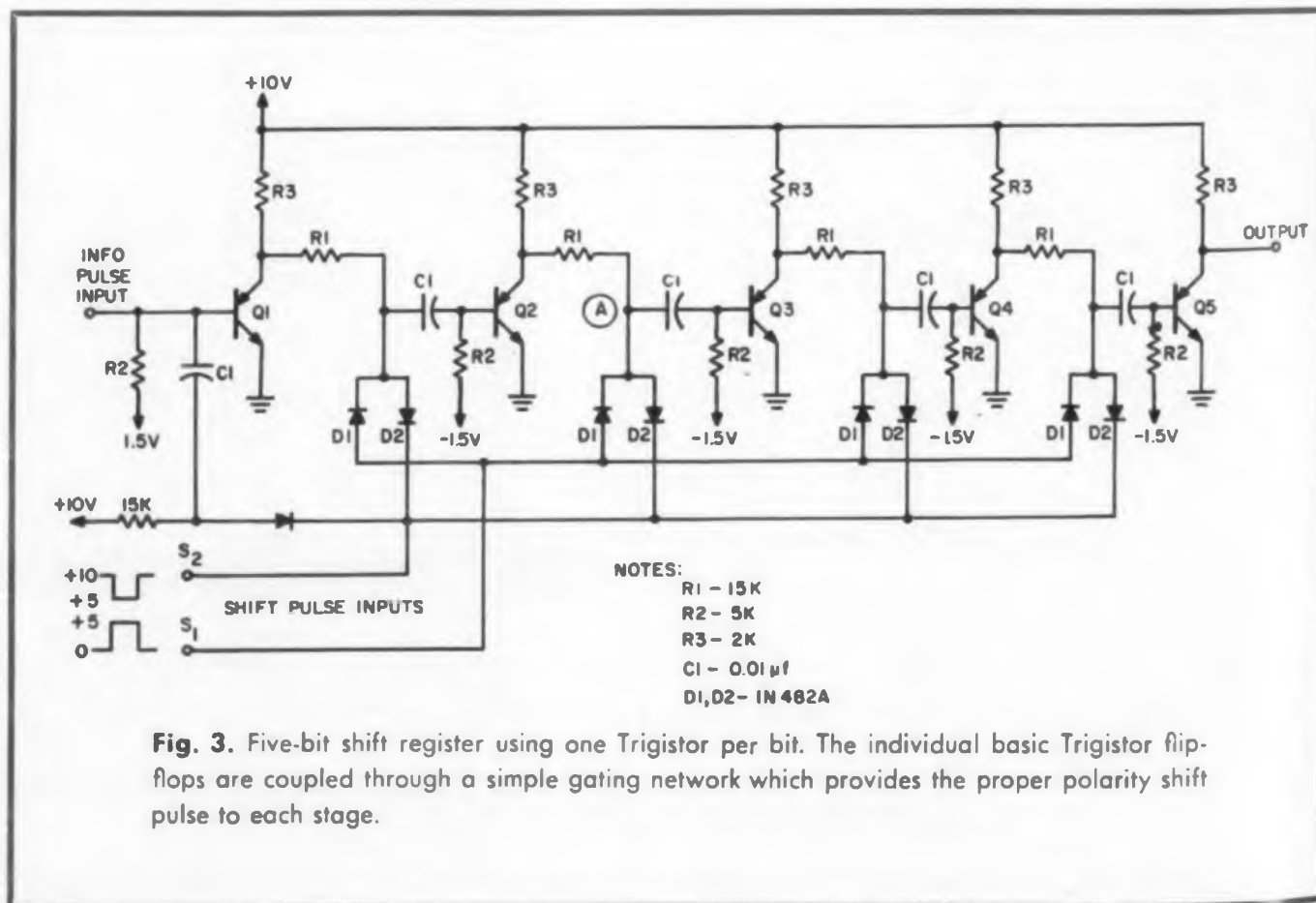


Fig. 3. Five-bit shift register using one Trigistor per bit. The individual basic Trigistor flip-flops are coupled through a simple gating network which provides the proper polarity shift pulse to each stage.

rates 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 Reader-Service Card and circle 101.

AMP

3 CIRCUITS

6 CIRCUITS

9 CIRCUITS

12 CIRCUITS

THE NEW LOOK IN AMP-lok

Now . . . connect 3, 6, 9 or 12 circuits simultaneously with the AMP-lok multiple connector and a simple push of the fingers.

All units are self-anchoring and require no supplementary mounting parts in through panel multiple connector applications.

AMP-lok can be used as a safe, free-hanging multiple connector also.

AMP-lok obsoletes all it replaces because of the following design features:

- contacts are identical . . . self cleaning . . . recessed for safety
- finger grip engagement and disengagement
- polarized to eliminate circuit error
- wide panel thickness accommodation—one simple mounting hole required
- color coding available

Additional literature and samples available on request.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A MP products and engineering assistance are available through wholly owned subsidiaries in Canada • England • France • Holland • Japan

CIRCLE 57 ON READER-SERVICE CARD



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Over 340 models with 1300 designs give the aircraft designer the flexibility of custom fans with the economy of standard fans. Horsepowers as low as 1/500th, fan efficiencies as high as 86%, and pressures up to 70" WG are available.

Joy Axivane Fans meet most applicable government specifications being used by a majority of airframe and missile manufacturers, including Boeing, Lockheed, Martin, Douglas and North American. Joy Axivane Fans have only three basic parts, and motors are flange mounted inside the fans to permit mounting in ducts. This simplicity of design makes the fans lightweight and compact, yet vibration and shock resistant.

Special designs to meet unusual requirements also can be furnished to your specifications. Whatever your air movement problems, Joy can provide the solution. **Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.** In Canada: *Joy Manufacturing Company (Canada) Limited; Galt, Ontario.*



Write For Free Twelve Page Catalog 266-57

JOY

WORLD'S LARGEST MANUFACTURER OF VANEAXIAL TYPE FANS

WSW 1 7302-266

CIRCLE 58 ON READER-SERVICE CARD

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.

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

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

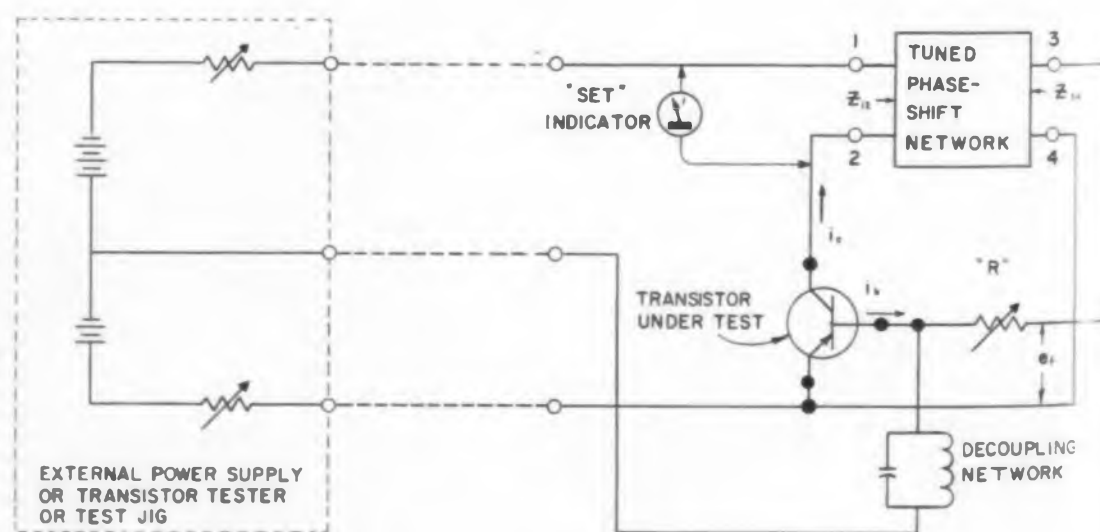


Fig. 1. Circuit of Armour's self-oscillating transistor beta tester.

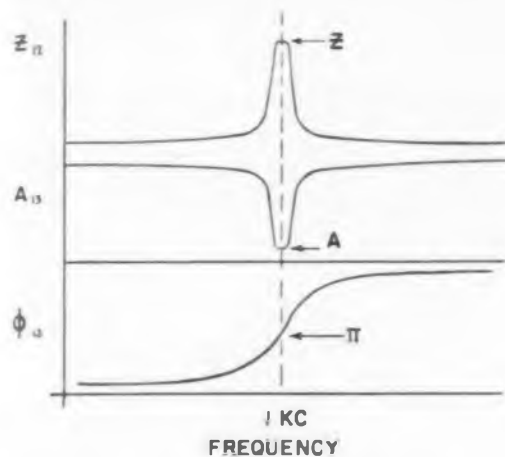


Fig. 2. Network characteristics necessary to permit oscillation of the circuit of Fig. 1.

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.

have you checked this
*Remote Actuator for jobs
under Shock and Vibration?*

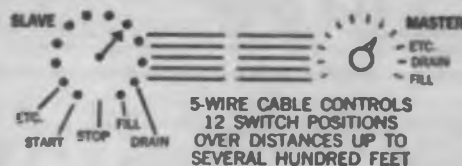
...OAK ROTARY SOLENOIDS

(Mfd. under license from G. H. LELAND, INC.)

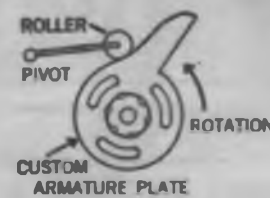
MODEL 5E
SHOWN ACTUAL SIZE



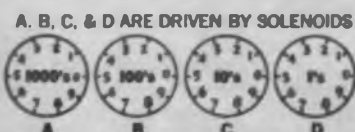
CUSTOM-BUILT FOR—



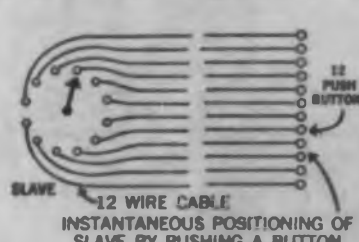
MASTER-SLAVE DEVICES
(Incremental Positioning)



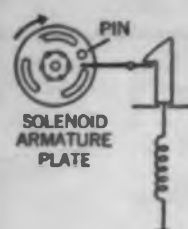
CAM LIFTS



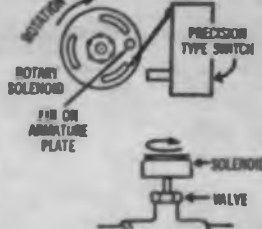
PRESETTABLE COUNTING DEVICES



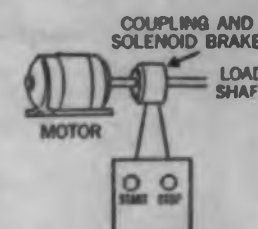
AUTOMATIC SWITCHING



TRIPPING DEVICES

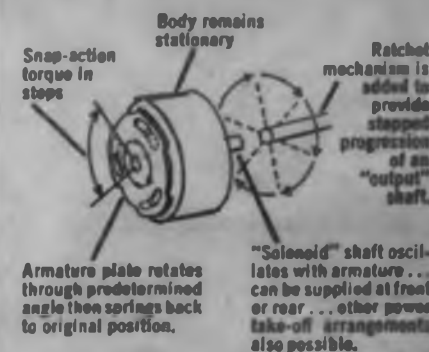


ACTUATORS

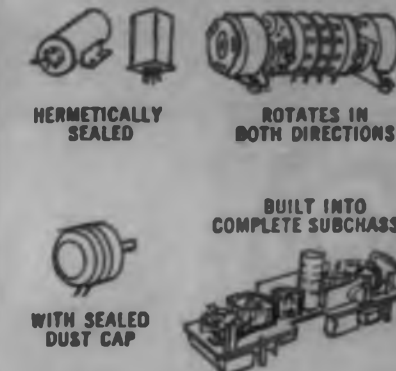


CLUTCHES and BRAKES
(When Modified for Straight Pull)

OPERATES IN ANY POSITION



EXTREMELY ADAPTABLE



stepping torques from 6.4 to 64 inch-ounces

If you've been searching for an actuator that meets such specs as MIL-S-4040A, and is remarkably small for the amount of work it can do, investigate Oak Rotary Solenoids. They operate on DC and are designed for intermittent service. Standard models give steps of 25°, 35°, 45°, 67.5°, or 95° in either a left or right-hand direction. Self-stepping or externally pulsed units are also built. Oak Rotary Solenoids find wide use in both commercial and military equipment. Why not evaluate their unusual capabilities for your next project. We will be glad to help you engineer the job. Just send us a short description and sketch.

CIRCLE 59 ON READER-SERVICE CARD

OAK MFG. CO.

1260 Clyburn Ave., Dept. D, Chicago 10, Illinois
Phone: MOhawk 4-2222

SWITCHES • ROTARY SOLENOIDS • CHOPPERS
VIBRATORS • TUNERS
SUBASSEMBLIES

FIELD-PROVED HONEYWELL COMPONENTS

for measuring, balancing and positioning applications

CONVERTERS



These synchronously driven choppers handle d-c signals as small as 10^{-6} 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 ($\pm 2\%$) Other actions, as specified			(Break-before-make). Each contact closed 47% of each cycle	Each contact closed 57% of each cycle ($\pm 7\%$)
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; 10 ma max.				
Electrostatic Stray Pickup	2×10^{-6} 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^{-3} volts constant to 2×10^{-6}
Phase Shift	Output voltage lags driving phase by $17^\circ \pm 5^\circ$				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



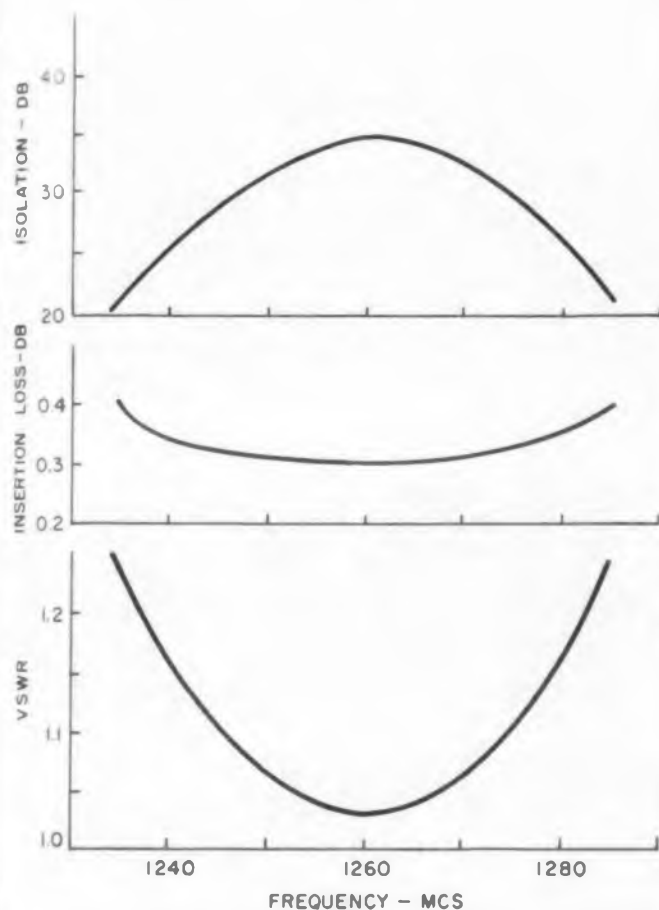
Operating in the L-band, these circulators are especially useful for airborne and other applications where weight must be kept at a minimum.

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 parametric 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 \pm 25; CLL2, 1400 \pm 25; CLL3, 1280 \pm 25; CLL4, 1315 \pm 25; CLL5, 1420 \pm 25; CLL8, 960 \pm 25.

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

New!

Centralab Printed Circuit Switches

Cutting costs of
Switch Installation...
your job...and Centralab's

the greatest advance
in switch design
in decades

The CENTRALAB Series 20 Printed Circuit Switch provides these cost-saving advantages:

- 1 Elimination of switch wiring errors.
- 2 Simultaneous connection of all switching leads during dip soldering of etched circuit boards.
- 3 No hardware is required for rigid anchoring of switch to the board.

SPECIFICATIONS:

Construction: 1 3/4" high x 2" wide laminated phenolic sections. Bolted construction multiple sections and staked single or dual section assemblies.

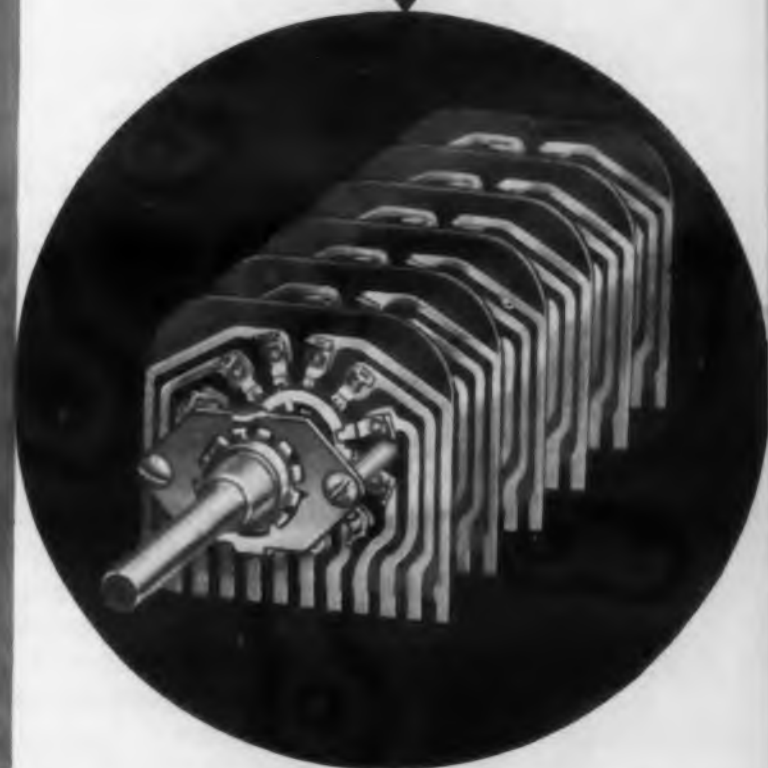
Switching Combinations: 1 pole—12 positions through 6 pole—2 positions. Also available with dual concentric shafts for A.C. line switch or 1/2 watt variable resistor, equipped with printed circuit terminals.

Rating: 2 amperes at 15 volts D.C., 150 ma. at 110 volts A.C. (make and break, resistive load).

Insulation: Laminated phenolic type PBE per specification MIL-P-3115. Voltage breakdown 1000 volts RMS.

Rotational Life: 10,000 cycles minimum.

For complete physical and electrical specifications on CENTRALAB Printed Circuit Switches ask for Bulletin EP-757.



Centralab

A Division of Globe-Union Inc.
960G E. KEEFE AVE. • MILWAUKEE 1, WIS.
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VARIABLE RESISTORS • ELECTRONIC SWITCHES • PACKAGED ELECTRONIC CIRCUITS • CERAMIC CAPACITORS • ENGINEERED CERAMICS
CIRCLE 61 ON READER-SERVICE CARD

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.

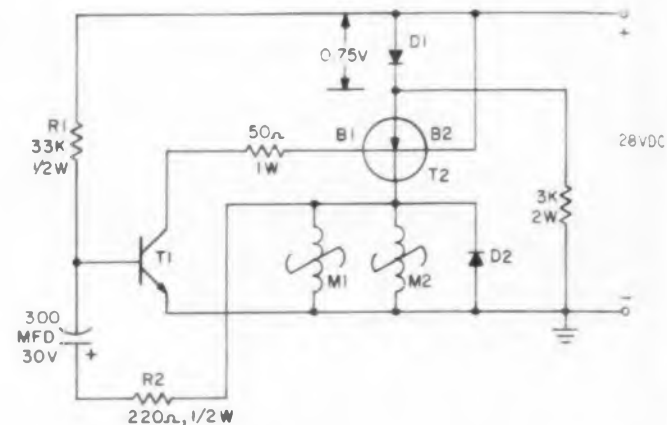
A tetrode power transistor was used here because of its greatly improved leakage characteristics at high temperatures when used in the common emitter configuration. Diode *D1* supplies 0.75 v of emitter bias when the circuit is in the off condition. The 3K resistor insures that sufficient current flows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

this bias. The diode can be left out if operation is confined 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

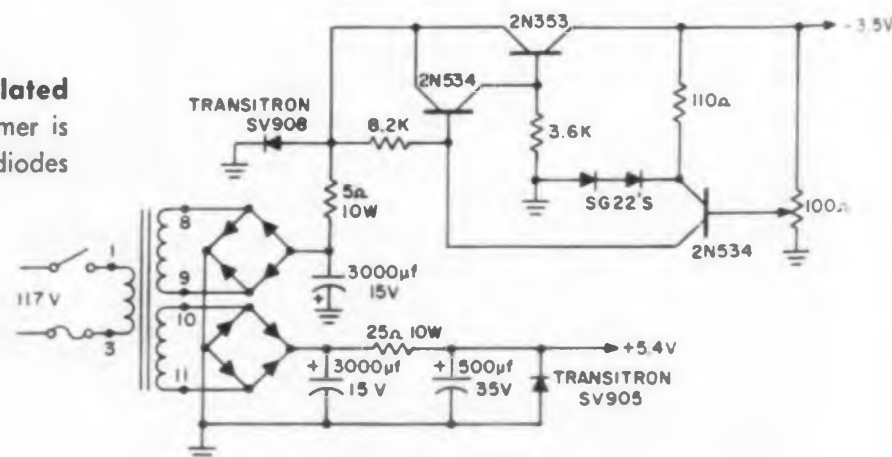
Uses Low-Cost, Noncritical Components

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!



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.

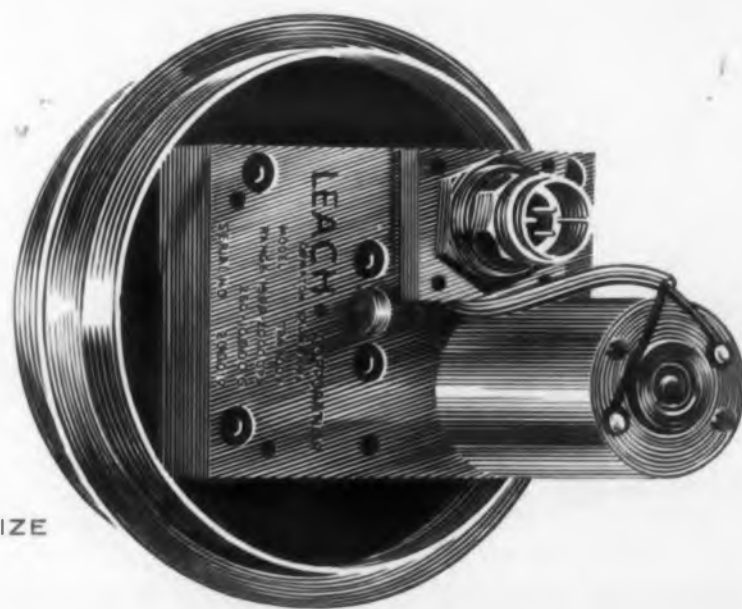
Weighs just 24 ounces and operates at tape speeds of from 1/4 to 15 inches per second in a temperature range of -50°F to +200°F. Among its features: precision in-line recording head; adjustable motor speed and tape tension; and molded rubber pressure roller and drive wheels.

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



TRIAXIAL RECORDING ACCELEROMETER

The compact, self-contained unit shown above is Inet's 6-ounce Triaxial Recording Accelerometer . . . attached to a 1 1/2-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

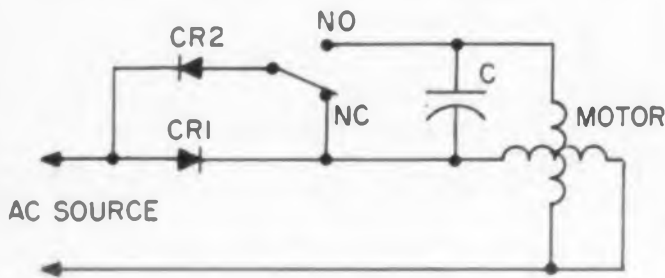
DISTRICT OFFICES AND FIELD REPRESENTATIVES IN PRINCIPAL CITIES OF U.S. AND CANADA • EXPORT: LEACH CORP., INTERNATIONAL DIVISION
 CIRCLE 62 ON READER-SERVICE CARD

IDEAS FOR DESIGN

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.

5 EXCITING NEW SILICON TRANSISTOR

1. HI-POWER STUD-MOUNTED SILICON TRANSISTOR



Type	V _{cb} Max. Volts	I _c max. Amps	B Typical	R _{cs} Typical (Ohms)
2N1208	60	5	35	1.5
2N1209	45	5	40	1.5
2N1212	60	5	25	2.5

APPLICATIONS Regulated Power Supplies ... High Current Switching ... High Frequency Power Amplifiers

Send for Bulletin No. 1355M

2. CORE SWITCH



Type	V _{cb} Max. Volts	(B) Min.	Typ. Input Voltage (Volts)	Typ. Saturation Resistance (Ohms)	Switching Characteristics (μsec)
ST4100	60	15	2.5	10	t _r .2 t _s .2 t _f .2

APPLICATIONS ... magnetic core memory ... high level multivibrators ... buffer amplifiers ... clock source

Send for bulletin 1355X

3. 150mc VERY HIGH FREQUENCY TRANSISTOR



TYPE
2N1139

	Min.	Typical	Max.	Test Conditions
D.C. Current Gain	h _{FE}	20	40	I _C = 10ma, V _{CE} = 6V
D.C. Collector Saturation Voltage	V _{CE}	.5	0.7V	I _C = 10ma, I _B = 1ma
Collector Cutoff Current	I _{CO}	—	2	5 μa, V _{CB} = Rating
Output Capacitance	C _{ob}	—	8	12 μmf, V _{CB} = 6V, I _E = 0 mA
High Frequency Current Gain	h _{fe}	5	7.5	F = 20mc, V _{CE} = 6V, I _E = 10 mA
Delay Time	t _d	—	6	mμsec.
Rise Time	t _r	—	12	mμsec.
Fall Time	t _f	—	10	mμsec.

Send for bulletin TE1355 B2

4. UNIVERSAL 50mc LOGIC TRANSISTOR



Type	Typ. Alpha Cutoff (Mc)	Beta Typical	C ₀ (Typical) (μmf)	Max. (Volts)	Typ. Saturation Resistance (ohms)
ST3031	70	50	2	20	40

APPLICATIONS ... flip-flops ... IF and video amplifiers ... transistor logic ... pulse amplifiers

Send for bulletin 1353X

5. STABISTOR COUPLED LOGIC TRANSISTOR



Type	Beta Typical	V _c max. (Volts)	Typical Saturation Resistance (ohms)	Typ. Alpha Cutoff (Mc)	Switching Characteristics (μsec)
ST3030	12	15	40	50	t _r .05 t _s .20 t _f .10














APPLICATIONS ... designed specifically for SCTL and DCTL circuits (write for descriptive paper on SCTL)

Send for Bulletin 1353Y

DEVELOPMENTS FROM TRANSITRON...added to

**THE INDUSTRY'S
MOST COMPLETE
LINE**

SILICON TRANSISTORS

JAN TRANSISTOR		Minimum Current Gain (β)	Maximum Collector Voltage (Volts)	Typical Cut-off Frequency (Mc)	Maximum I _{co} @ 25°C and V _c Max. (μa)	FEATURES	
	JAN-2N118	10	30	10	1	• Only Jan Silicon Transistor	
SMALL SIGNAL		Minimum Current Gain (β)	Maximum Collector Voltage (Volts)	Typical Cut-off Frequency (Mc)	Maximum I _{co} @ 25°C and V _c Max. (μa)	FEATURES	
	2N333	18	45	7	50	• Low I _{co} • Operation to 175°C • 200 mw Power Dissipation	
	2N335	37	45	10	50		
	2N480	40	45	11	.5		
	2N543	80	45	15	.5		
	ST905	36	30	10	10		
HIGH SPEED SWITCHING		Typical Cut-off Freq. (Mc)	Maximum Collector Voltage (Volts)	Maximum Collection Saturation Resistance (ohms)	Max. Power Dissipation @ 100°C ambient (mw)	FEATURES	
	ST3030	50	15	60	50	• High Frequency Operation • Low Saturation Resistance • Low I _{co}	
	ST3031	70	20	65	50		
	2N1139	150	15	70	500		
	2N337	20	45	150	50		
	2N338	30	45	150	50		
MEDIUM POWER		Max. Power Dissipation @ 25°C Case (Watts)	Maximum Collector Voltage (Volts)	Minimum DC Current Gain (β)	Typical Rise Time (μsec)	Typical Storage and Fall Time (μsec)	FEATURES
	ST4100	5	60	15	.2	.4	• Fast Switching • High V _c • Rugged Construction
	2N545	5	60	15	.3	.5	
	2N547	5	60	20			
	2N498	4	100	12			
	2N551	5	60	20			
	2N1140	1	40	20	.2	.2	
HIGH POWER		Maximum Power Dissipation @ 25°C Case (Watts)	Minimum DC Current Gain (β)	Typical Collector Saturation Resistance (Ohms)	Maximum Collector Voltage (Volts)	FEATURES	
	ST400	85	15 @ 2 Amps	1.5	60	• High Current Handling Ability • Low Saturation Resistance • Rugged Construction	
	2N389	85	12 @ 1 Amp.	3.5	60		
	2N424	85	12 @ 1 Amp.	6.0	80		
	2N1208	85	15 @ 2 Amps	1.5	60		
	2N1209	85	20 @ 2 Amps	1.5	45		
	2N1212	85	12 @ 1 Amp.	2.5	60		

Write for Bulletins: TE-1353 and TE-1355

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.

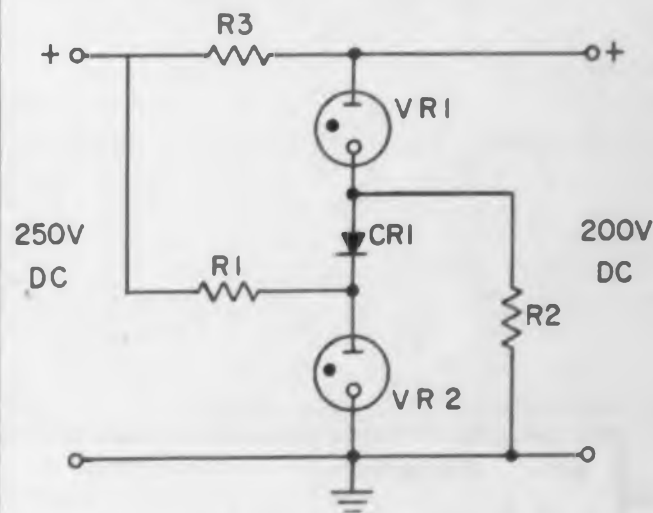
This removes the shading coil from the circuit and, in turn, removes the out-of-phase component of the current. When energized, the relay acts as a buzzer. Mounting the unit on a metal pan, which serves as a sounding board amplifier, provides a loud enough buzz for most applications.

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.*

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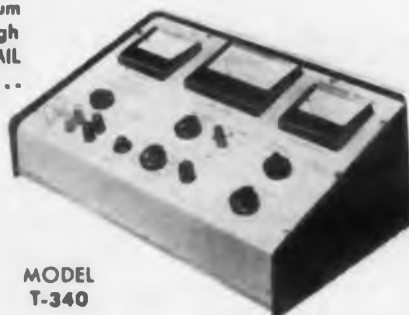
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solid-state
art . . .
NO. 1

Test Transistors .. completely!

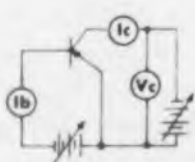
Check All Five
Basic "Quality-Control"
Parameters Rapidly, Easily
Accurately, Quantitatively!

You can save the price of these precision testers in weeks, speed production and testing and guarantee greater product reliability by rejecting out-of-limit transistors before they are assembled into your circuits. Statistics prove it!

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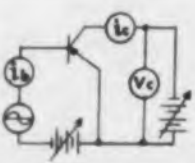


DC Beta— $H_{fe} = \frac{I_c}{I_b}$
the static ratio of
the collector cur-
rent to base cur-
rent.

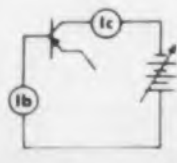


MODEL
T-340

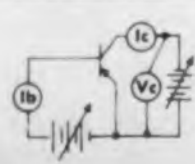
AC Beta— $h_{fe} = \frac{I_c}{I_b}$
the dynamic ratio
of small-signal col-
lector current to
base current



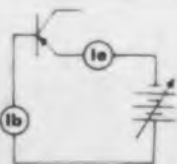
I_{co} —
the collector - to-
base current with
the emitter open



I_{cbo} —
the base current
required to reduce
the collector cur-
rent to zero



I_{eo} —
the emitter-to-base
current with the
collector open



MODEL	DESCRIPTION	FEATURES	PRICE
T-301	Utility T.T.	DC Beta, I_{cbo} , I_{co} , signal level	\$138.00
T-340	Professional T.T.	DC Beta, I_{cbo} , I_{co} , I_{eo} , wide range	\$395.00
T-345	AC Beta Adapter	Adds AC Beta check to T-340	\$140.00
T-350	Advanced T.T.	AC Beta, DC Beta, I_{cbo} , I_{co} , I_{eo} , voltage reg'n, wide range	\$585.00
T-375	Power T.T.	Test power transistors under Pulse Conditions	Available in August



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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, *Carnegie 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

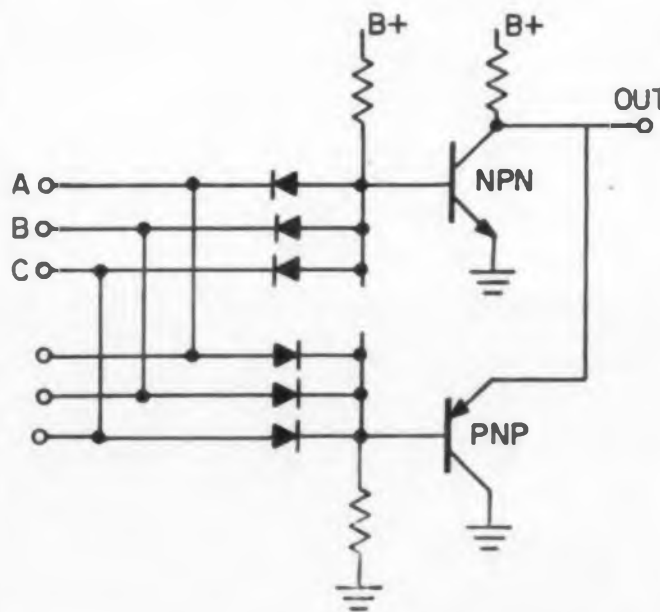
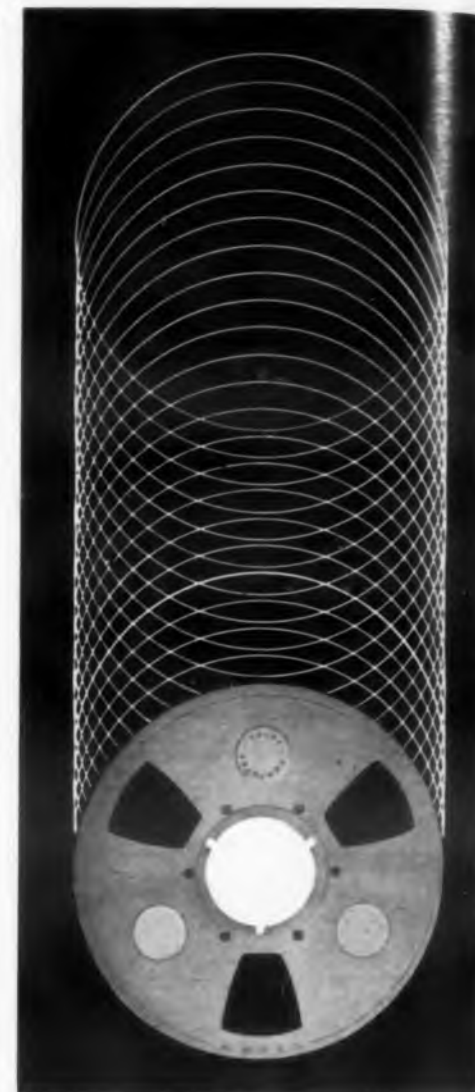


Fig. 1. "Exclusive OR" with high output when some inputs are high, some low. Output is low when A, B and C are all either low or high.



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AMPEX MAGNETIC TAPE

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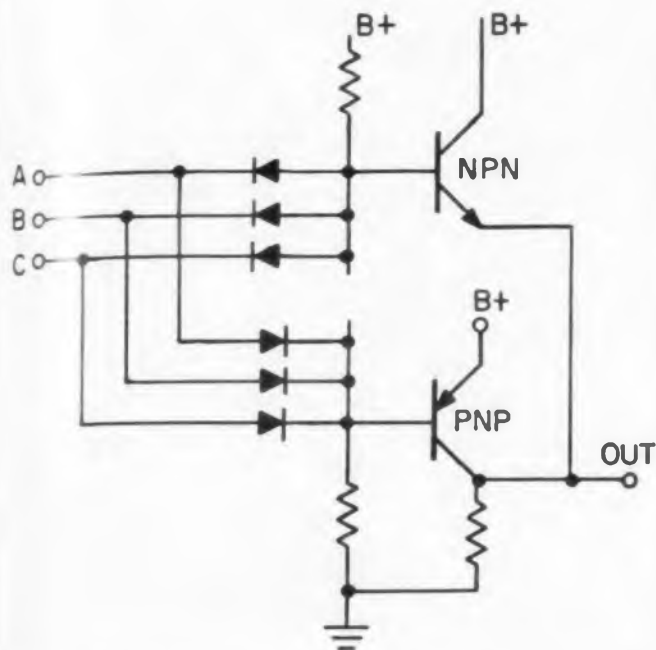


Fig. 2. "Exclusive OR" with low output when some inputs are high, some low. Output is high when A, B and C are all either low or high.

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

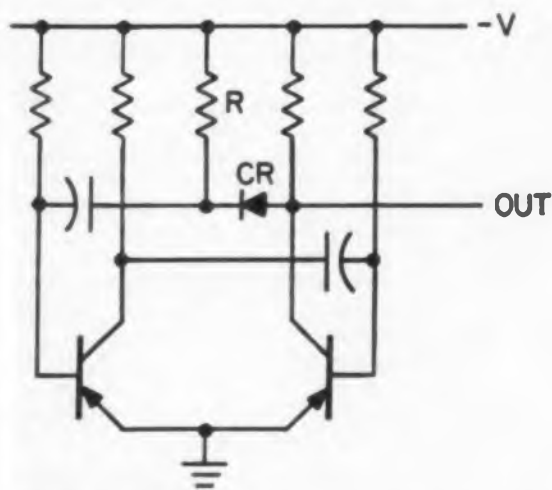
Stanley Maki, Senior Electronics Engineer, Convair Astronautics, San Diego, Calif.

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.

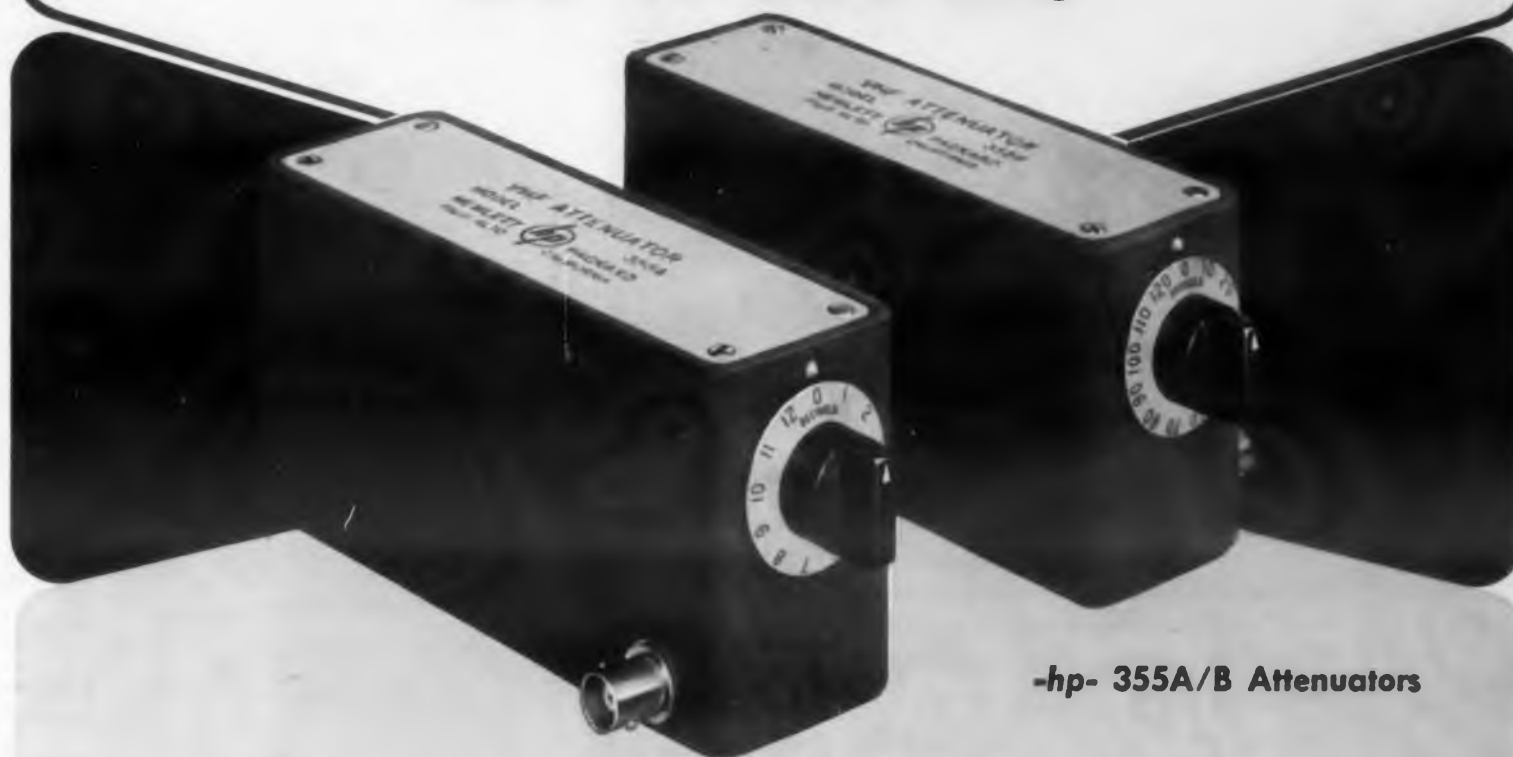
The addition of a resistor and a diode will permit the multi to deliver excellent square waves with fast rise and fall times. The capacitor is isolated during the recharge cycle so it does not prevent the output collector from recovering rapidly.

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.

New design 50 ohm attenuator 0 to 132 db in 1 db steps— DC to 500 MC



-hp- 355A/B Attenuators

$\frac{1}{4}$ db accuracy full range for low attenuation values. Maximum error at full attenuation 2 db. "One-knob" control. Super compact design—size approximately $2\frac{1}{2}$ " x $2\frac{1}{2}$ " x 6".

These are characteristics of the new, rugged, simple -hp- 355A/B attenuators.

-hp- 355A provides 0 to 12 db in 1 db steps. -hp- 355B provides 0 to 120 db in decade steps. Together, 132 db of attenuation from DC to 500 MC is available, with simplest possible controls, pre-

mium accuracy, and no complex setup. A solid-shield 50 ohm connector may be used to interconnect the two attenuators.

These new -hp- attenuators have balanced capacities and completely shielded sections. They are enclosed in a sturdy metal case, yet weigh only $1\frac{1}{2}$ pounds.

Ask your -hp- representative to show you these practical, minimum-space attenuators this week.

SPECIFICATIONS

Attenuation: -hp- 355A, 12 db in 1 db steps. -hp- 355B, 120 db in 10 db steps

Frequency Range: DC to 500 MC

Overall Accuracy: -hp- 355A, ± 0.25 db, DC to 500 MC. -hp- 355B, ± 1 db, DC to 250 MC, ± 2 db, 250 to 500 MC

Nominal Impedance: 50 ohms

Maximum SWR: 1.2 to 250 MC, 1.5 to 500 MC

Max. Insertion Loss: 0 at DC, 0.4 db at 60 MC, 1 db at 250 MC, 1.5 db at 500 MC

Power Dissipation: 0.5 watt average; 350 v peak

Connectors: BNC

Size: $2\text{-}\frac{3}{16}$ " wide, $2\text{-}\frac{5}{8}$ " high, 6" long. Net weight $1\frac{1}{2}$ pounds

Price: -hp- 355A, \$125.00. -hp- 355B, \$125.00

Data subject to change without notice. Prices f.o.b. factory

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MODEL 440-A

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In basic electronic instruments for lab or test work, less than the best may be a dangerously bad bargain. Unexpected limitations — of reliability, range, precision — can throw out weeks of work on today's jobs, and can make tomorrow's tougher jobs untouchable.

The best instrument of its type is probably a bit more expensive, but it's worth buying . . . because you can believe in it today, and will rely on it tomorrow. An example is the Krohn-Hite Model 440-A wide range push-button oscillator. Here are some facts about it.

FREQUENCY RANGE: 0.001 cps to 100 kc, continuous coverage.

CALIBRATION ACCURACY: $\pm 1\%$ from 1 cps to 10 kc, $\pm 3\%$ from 0.01 to 1 cps and from 10 kc to 100 kc.

RESETABILITY: exact for push-button resetting, subject only to drift of less than 0.05% per hour.

SINE WAVE OUTPUT: 10 volts rms open circuit, 100 milliwatts into 1000 ohms; amplitude constant within ± 0.25 db from 0.1 cps to 10 kc.

SINE WAVE DISTORTION: less than 0.1% from 1 cps to 10 kc, less than 1% from 0.01 to 1 cps and from 10 kc to 100 kc.

SQUARE WAVE OUTPUT: 10 volts peak to peak open circuit, 5 volts peak to peak across 1500 ohms; amplitude constant within $\pm 1\%$ at any frequency; rise time less than 0.5 microsecond.

There's a lot more you should know about the 440-A . . . and about the other Krohn-Hite oscillators, tunable electronic filters, power supplies and amplifiers. In all of them, you'll find the same far-ahead engineering, design and construction. Because K-H instruments are good enough even for tomorrow's most critical work, they are increasingly chosen today where reliability and precision are needed.

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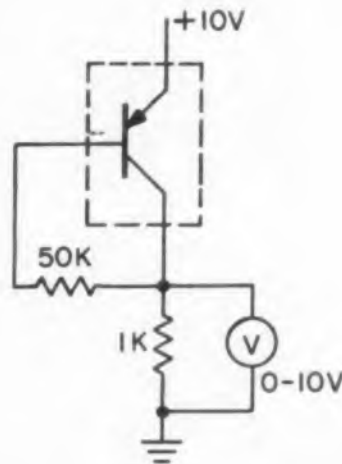
CIRCLE 67 ON READER-SERVICE CARD

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	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



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

E. J. Sallier, Digital Devices Co., Box 9146, San Diego, 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.

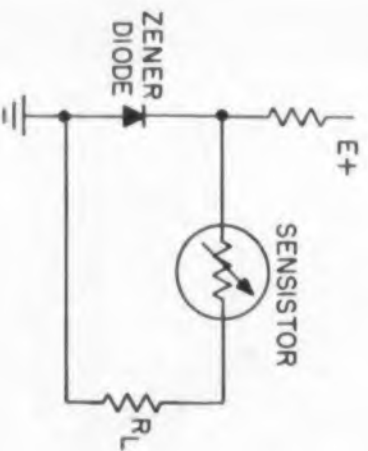
R. Purdy, Electronics Engineer, Waldorf Electronics, Huntington Station, L. I.

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.

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Neon Indicators
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Blocking Oscillators
Level Shapers
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- Easy-Access Test Points

SPECIFICATIONS

Frequency Ranges . . . up to 400 KC
Switching Times
Diode Logic 0.7 μ sec max
Transistor Logic 1.5 μ sec max
Signal Voltage Levels
 ± 18 volts, ± 6 volts
Temperature Range
-55°C to +75°C

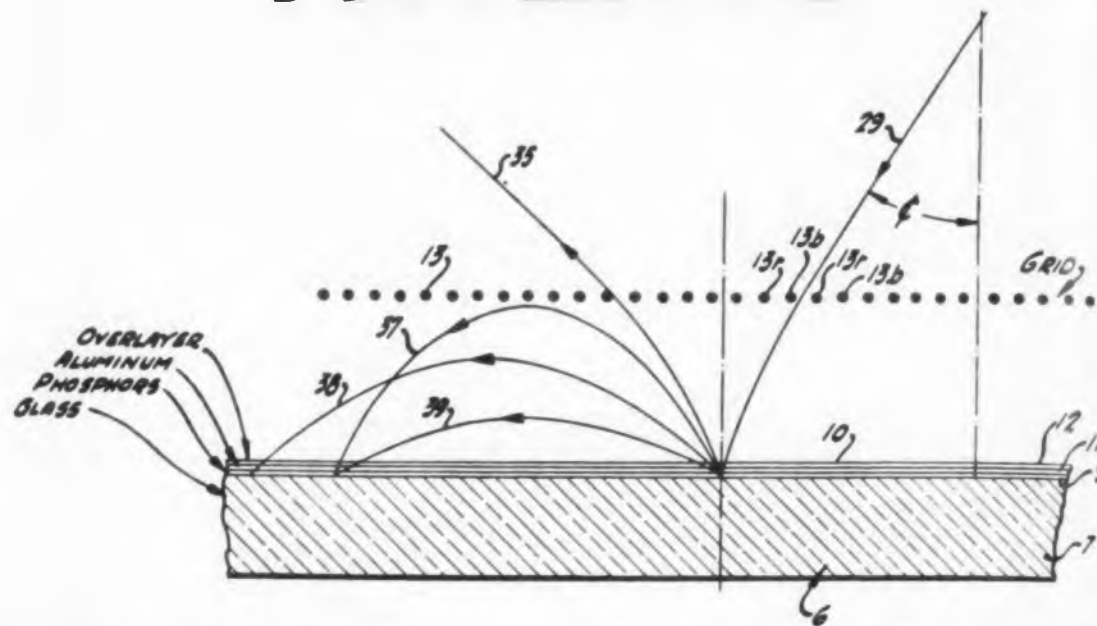
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PATENTS



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-

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

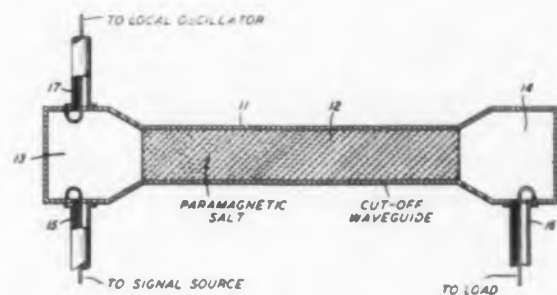
In the illustration, electron beam 29 strikes the phosphor and electrons would escape to the walls of the tube along path 35 in the absence of grid 13. However, the grid retards the electrons which return along paths 37, 38, and 39. By applying a low atomic number overlayer such as boron carbide, the 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 crystal-line 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.

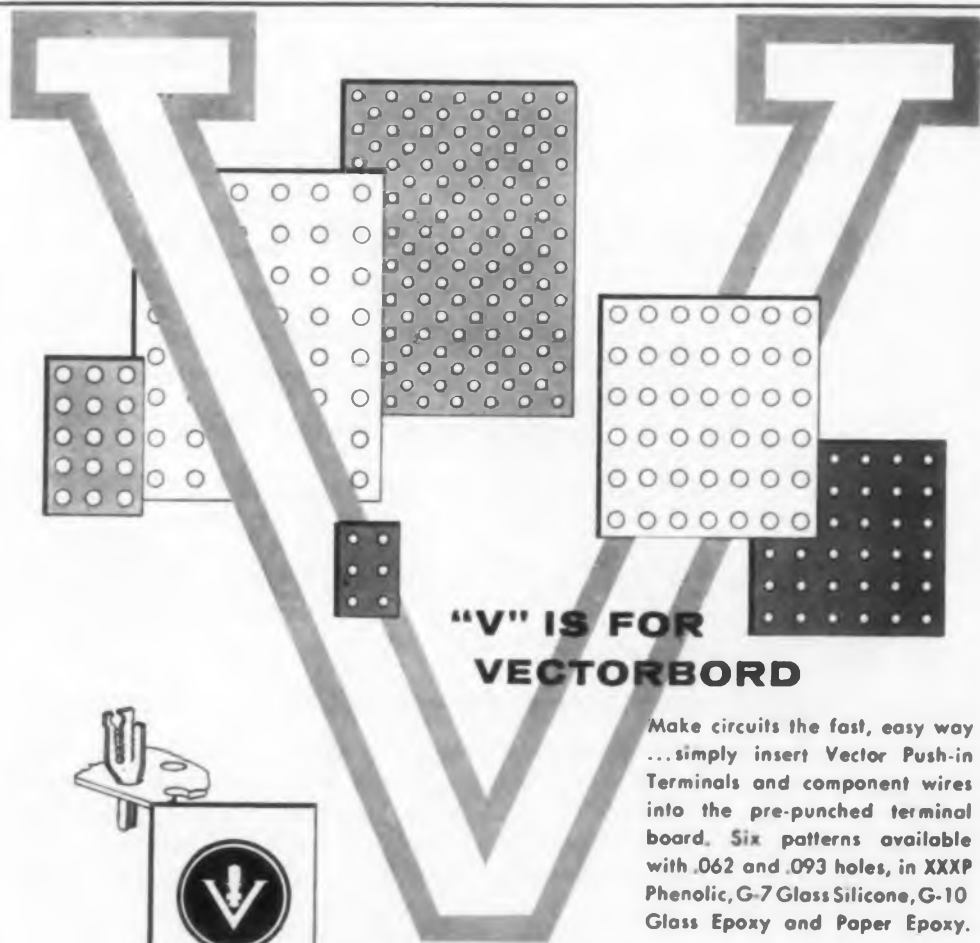
The wave guide is superior to the reso-



nant 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 paramagnetic 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.



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features



- Long life • High input impedance • Wide voltage range
- Large easy to read meter with overlap • High accuracy at any point on the scale • Light, compact, rugged

SPECIFICATIONS

VOLTAGE RANGE: 1 millivolt to 1000 volts rms. in 6 decade ranges (.01, .1, 1, 10, 100 and 1000 volts full scale).

FREQUENCY RANGE: 10 to 250,000 cps.

ACCURACY: 2% throughout voltage and frequency ranges and at all points on the meter scale.

INPUT IMPEDANCE: 2 megohms shunted by 15 μ f except 25 μ f on lowest range.

DECIBEL RANGE: -60 to +60 decibels referred to 1 volt.

STABILITY: Less than 1/2% change with power supply voltage variation from 105 to 125 volts.

SCALES: Logarithmic voltage scale reading from 1 to 10 with 10% overlap at both ends; auxiliary linear scale in decibels from 0 to 20.

AMPLIFIER CHARACTERISTICS: Maximum voltage gain of 60-DB; maximum output 10 volts; output impedance is 300 ohms. Frequency response flat within 1 DB from 10 to 250,000 cps.

POWER SUPPLY: 115/230 volts, 50-420 cps, 35 watts approx.

Write for catalog for complete information.



BALLANTINE LABORATORIES, INC.
Boonton, New Jersey

CIRCLE 73 ON READER-SERVICE CARD



... now wind 19,000 times!

If you're dedicated to the cause of high resolution, you could wind your own pots and be sure. Allow yourself plenty of time, though — because the secret's in the number of turns per inch, and the spacing between 'em. Pack those turns right in there *closely and accurately*, and you *might* have a pot you'll be proud of!

But if you want to eliminate all bother, but not the high resolution, call on Ace! We've designed and built our own special winding equipment; we use premium, close tolerance resistance wire — and really leave no winding unturned to produce pots with the highest resolution in the industry. All AIA sizes, all mounting styles, specials and standards. So get your resolution the easy way — get Acepots! See your ACErep at once!



Here's highest resolution in a standard sub-miniature pot: The 500 Acepot® ½" size, ±0.3% independent linearity. Special prototype section insures prompt delivery on the Acepot® — ½" to 6" AIA sizes.

ACE ELECTRONICS ASSOCIATES, INC.
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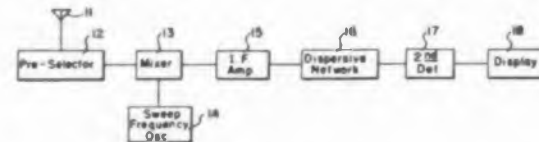
Acepot® Acotrim® Acosot® Aceohm® *Reg. Appl. for
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PATENTS

Electronic Circuits

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

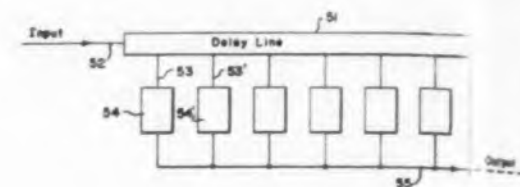
Resolution in a panoramic receiver increases when the output of a relatively narrow band amplifier is passed through a dispersive network. This network characterized by time delay depending upon frequency, will convert the broad amplified output pulse to a very narrow pulse.



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 55 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 Uhler, 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-

NEW "STANDARD" with SPECIAL CAPABILITIES



- Rugged Anodized Aluminum Housing
- Operation Up to 150°C
- 5.5 watts @ 85°C (derated to 0 @ 150°C)
- Resistance Range from 250 ohms to 300K ohms

Those are just a few of the important performance features you get with the new Gamewell RVG-14-MT10 multi-turn potentiometer. It fully meets applicable sections of MIL-E-5272A and NAS-710 — and much more. It gives you extras that often save you the cost of a "special."

Available in 10, 5, or 3 turns, with tap locations limited only by physical spacing. Write for detailed specifications and catalog of other stand-

ard Gamewell potentiometers. Special pots supplied whenever necessary. Bring all your pot problems to THE GAMEWELL COMPANY, Dept. 14B, Newton Upper Falls 64, Mass.

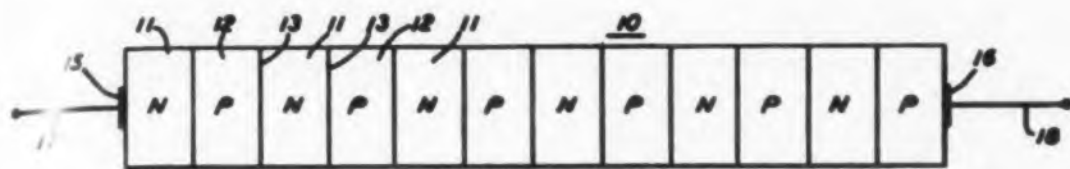
Gamewell

PRECISION POTENTIOMETERS

"Integrals of High Performance"

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ELECTRONIC DESIGN • July 22, 1959



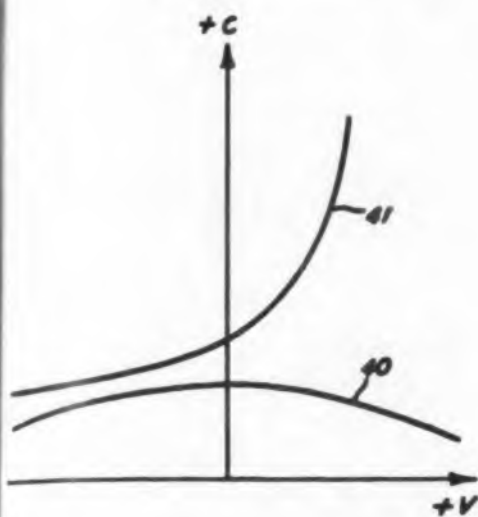
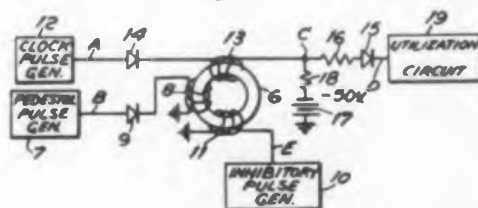
the high impedance device varies non-linearly with voltage as shown.

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 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,



KAY Vari-Sweep

10-BAND, 15-470 MC SWEEPING OSCILLATOR
MODEL 400

SPECIFICATIONS

Freq. Range (for Sweeping or as Continuously Tuned CW Signal Source): Fund. freq., 15-470 mc, cont. variable in 10 switched overlapping bands. Direct-reading freq. dial.
Sweep Width: 60% of center freq. to 50 mc; at least 30 mc max, 50-400 mc, approx. 20 mc max above 400 mc.
Sweep Rate: Cont. variable, 10-40 cps; locks to line frequency.
RF Output: 1.0 V rms (metered) into nom 70 ohms (50 ohms on request to 220 mc; 0.5 V rms to

470 mc. AGC'd flat throughout to ± 0.5 db.
Attenuators: Switched 20, 20, 10, 6 & 3 db plus cont. variable 6 db.
Sweep Output: Reg. sawtooth in sync with oscillator. Approx. 7.0 V amplitude.
Power Supply: Input approx. 100 watts, 117 V ($\pm 10\%$), 50-60 cps. 8+ electronically regulated.
Dim. & Weight: 9 1/2" x 19 1/2" x 13", 34 lbs
Price: \$795.00, f.o.b. factory.



KAY DRD Attenuators (ROTARY SWITCHABLE)

1-119 db Attenuation in 1-db Steps

SPECIFICATIONS

Impedance In & Out: Choice of 50, 70, or 90 ohms; others on special order.
DB Switched: 119 db in 1-db steps.
Attenuation Steps: 10 db & 1 db.
Insertion Loss: Zero at low freq; approx. 0.1 db at 250 mc, 0.2 db at 500 mc.
Max. Total Error (incl. above): 1.0 db at 250 mc; 2.0 db, 250-500 mc; better at lower freq. and/or lower attenuation.

Freq. Range: DC-500 mc; useful to 1000 mc.
SWR: 1.2:1 to 250 mc; 1.4:1 max, 250-500 mc.
Max. Power: 1/2 watt.
Switches: Silver contacts set in teflon.
Resistors: 1% Carbon Film.
Dim. & Weight: 5" dia. x 2 1/4", 4 1/4 lbs.
Price: \$195.00, f.o.b. factory.

SEE US AT WESCON SHOW, BOOTHS 3114 & 3116

Write for 1959-A Catalog
KAY ELECTRIC COMPANY
Dept. ED-B • Maple Ave. • Pine Brook, N. J. • Capital 6-4000

CIRCLE 76 ON READER-SERVICE CARD

imc

SERVO MOTOR-GENERATORS FOR INSTANT ERROR-SIGNAL RESPONSE

A significant result of Induction Motors' creative engineering program in recent years is the growing series of precision servo motor-generators . . . Sizes 8, 11, 18 (shown above) plus sizes 10, 15, and 20.

These units constructed to meet the latest applicable MIL specifications covering extreme environmental conditions incorporate the design objectives of light weight, high performance, and reliability at reasonable cost.

The high torque-to-inertia characteristic of these servo motor-generators offers high acceleration and immediate accurate response to error signals.

GENERATOR CHARACTERISTICS
Input: 18V 400 cps, 1.65 watts
Voltage gradient per 1000 RPM: 0.27V
Temperature range: -55°C . to $+150^{\circ}\text{C}$.
Null Voltage (max): 0.015V rms
Phase shift: within 10° of Reference

SIZE 8
O.D. = 0.750
L = 2-1/32
J = 0.75 gm cm²
Wt. = 2.86 oz.

MOTOR CHARACTERISTICS
Input: 18V 400 cps 4.7 watts per phase
Torque at Stall: 0.42 oz. in.
No Load Speed: 6200 rpm
Power Factor: 0.875
Theoretical Acceleration at Stall: 39000 rad/sec²

Design characteristics of IMC's Size 8 to Size 20 series of servo motors and servo motor-generators, as well as full technical data on IMC DC motors and dynamotors; axial, vaneaxial, and centrifugal blowers; hysteresis and torque motors; synchros and solenoids, can be obtained by writing on company letterhead to IMC's Sales Engineering Dept. All IMC components can be designed to your particular requirements with the same precision and accuracy.

imc Magnetics Corp.
Formerly Induction Motors Corp.

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CIRCLE 77 ON READER-SERVICE CARD

SYSTEMS ENGINEERS

...to work
in advance
areas of
Systems
Planning,
Development
and Design for
Missile Detection
on a Global Scale



These positions are with the Missile Detection Systems Section of General Electric and require high technical and creative capacities. All assignments offer fruitful opportunities to make state-of-the-art advances with an organization that encourages and rewards the individual contributor. The ability to function both through individual action and team leadership is highly valued. Current openings are in these areas:

ADVANCED RADAR SYSTEMS PLANNING

Work in this area calls for engineers able to visualize and define future defense and space problems and conceive advanced radar systems to solve them.

RADAR SYSTEMS ANALYSIS & DEVELOPMENT

An advanced degree and/or strong background in systems analysis and design is essential for such assignments as:

... analyze and define requirements for advance detection systems and determine broader parameters for such systems; establish their feasibility.

... analyze long range missile detection systems and specify optimum configuration on the basis of utility, performance, cost and delivery.

SPECIALISTS IN ELECTRO-MAGNETIC PROPAGATION

PhD or MS is required in this area. Scientists will carry out analysis of propagation phenomena, as related to long range missile detection. Plan detailed investigations and illustrate practicability of results. Ability to assume responsibility essential.

OPPORTUNITIES IN D & D OF RECONNAISSANCE RECEIVER DESIGN & SYSTEMS EQUIPMENT

Assignments require specialized background in one or more of these areas: VHF and UHF frequency spectra (P & L bands) • ECM • Microwave; wave guide components, Duplexers, switches, hybrids; VHF and UHF transmitters.

ALSO POSITIONS IN COMPUTER APPLICATIONS

(Knowledge of large business or special purpose computers needed) and COMPUTER PROGRAMMING (experience with IBM 704 & 709 needed.)

Write in confidence to: Mr. James P. Kinsella, Div. 76-SMC

Missile Detection Systems Section
HEAVY MILITARY ELECTRONICS DEPT.

GENERAL  ELECTRIC

Court Street, Syracuse, New York

CIRCLE 900 ON CAREER INQUIRY FORM

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)

Top Management Openings for **ELECTRONIC ENGINEERS AND SCIENTISTS**

at
**ELECTRONIC SYSTEMS DEVELOPMENT CORP.
IN VENTURA, CALIFORNIA**

Electronic Systems is a wholly owned subsidiary of Solar Aircraft Company, important in air and space developments since 1927. Electronic Systems has been closely associated with the instrumentation of the U. S. NAMTC at Point Mugu, and is expanding rapidly in the development and manufacture of electronic systems and components for commercial and military use. The right men joining now will gain top positions in their fields of interest. Living conditions are ideal in Ventura, a noted California seaside resort community. Act at once.

MANAGER—SCIENTIFIC STAFF

Must have proven record of outstanding technical accomplishments in electronic systems analysis and have made significant contributions in advancing the state of the art. The responsibility of this position includes active participation in the preparation of study proposals, the establishment of advanced concepts, extensive high level theoretical investigations and systems analysis in electromagnetic navigation and tracking systems, guidance and control systems, servo-mechanisms, information handling systems, and solid state electronic circuitry. MS or PHD degree in Electronics or Physics is required.

MANAGER—DIGITAL SYSTEMS DEPARTMENT

Must have proven record of outstanding technical and manufacturing achievements in directing the development of digital systems and circuits. The responsibility of this position includes active participation in the development of ground-based and airborne special digital computers, digital converters and analyzers, digital data handling and recording equipment, format convert-

ers, digital servos, etc. Advanced degree in Electronics or Physics is preferred.

SUPERVISOR—ELECTRONICS PACKAGING DESIGN ENGINEERING

Must have extensive experience in the package design of analogue and digital modules and assemblies with emphasis on transistor circuits and be thoroughly familiar with etched circuitry, encapsulating, MIL specs, etc. Working knowledge of heat transfer and structural analysis pertaining to strength, shock, and vibration required. Must have practical and theoretical experience in miniaturization and sub-miniaturization. Degree in Mechanical or Electrical Engineering is preferred.

ELECTRONIC ENGINEERS AND SENIOR ELECTRONIC ENGINEERS

Must have experience in the development and design of semi-conductor circuitry, analogue or digital components and sub-systems and/or data handling, conversion and processing equipment. Detailed knowledge of many of the following modules is required: modulators, demodulators, choppers, inverters, converters, power supplies, DC and AC amplifiers, flip-flops, multivibrators, squarers, pulse amplifiers, gates, etc. Degree or advanced degree in Electronics is preferred.

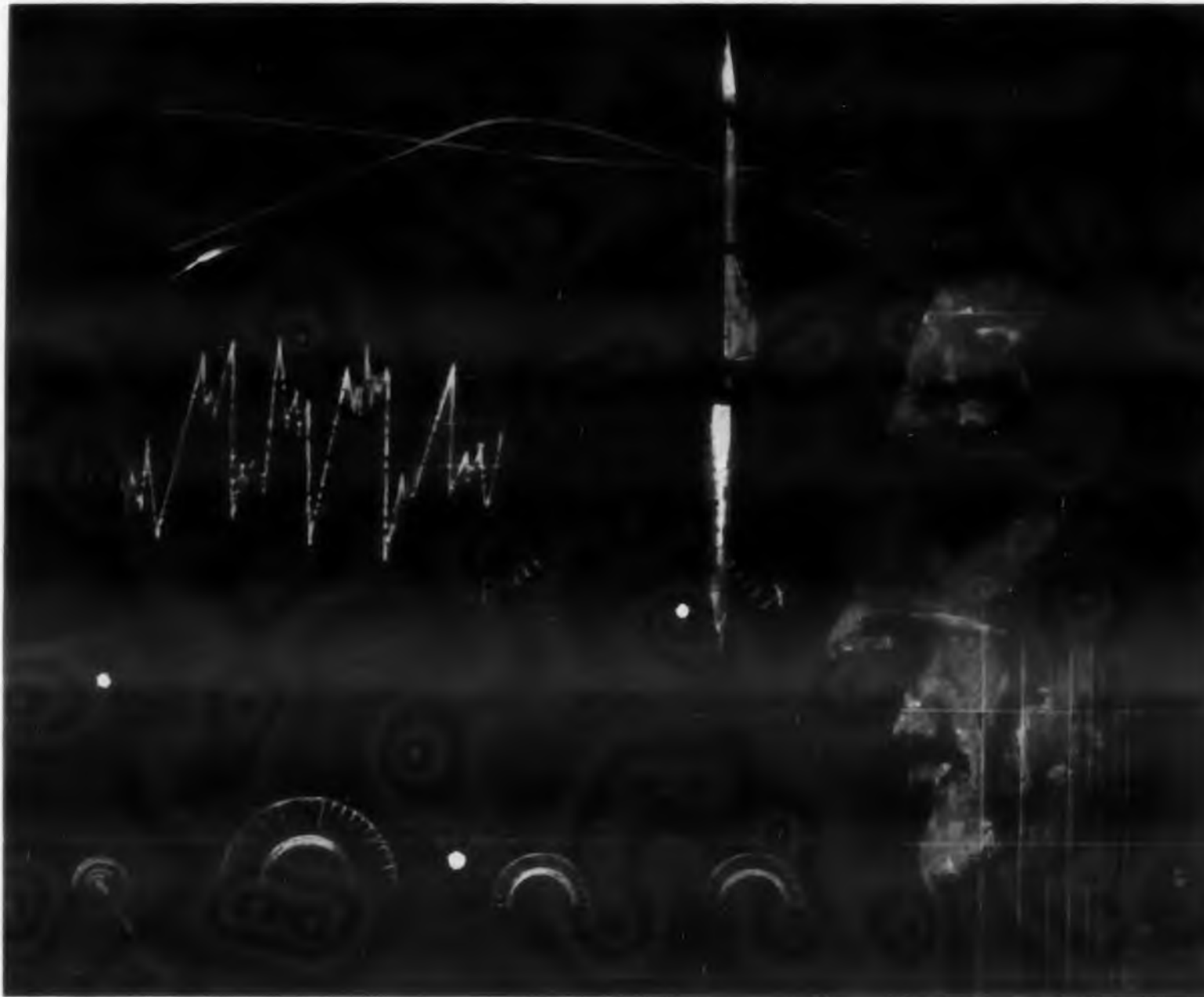
SEND YOUR RESUME

Please send resume of your qualifications at the earliest opportunity to E. E. Binger, Corporate Director of Industrial Relations, Dept. ED-1, Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, California.

SOLAR  **SAN DIEGO
DES MOINES**

AIRCRAFT COMPANY

CIRCLE 901 ON CAREER INQUIRY FORM



WE MAKE THE SYSTEMS WORK

Almost unique in the world of the electronics industry, Federal Electric Corporation serves as a complete engineering service organization for the government, for industry and for its parent organization, International Telephone and Telegraph Corporation. A central engineering department, at Paramus, provides a professional staff for systems and application engineering, layout and installation planning, equipment and systems evaluation — and publications services.

Our job is "making the systems work". After complex electronic equipment or systems are designed and built, they must be installed by experts, properly aligned, tuned and tested to assure operation at peak performance. Then they must be continuously maintained to assure dependability. In some cases teams must be provided to operate the equipment, or to train

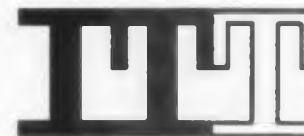
the user to operate it. All this we do — exercising complete management responsibility.

Prime examples of Federal projects are the DEW Line of radar stations across Canada and Alaska and the White Alice communication system in Alaska. In many parts of the world FEC has installed and tested TACAN and ILS systems for military and commercial use. Today Federal is also engaged in engineering operations connected with missile test ranges in Florida and California. From the Arctic Circle to Spain Federal Electric is keeping systems working.

For further information regarding positions in our Systems Engineering staff, at Paramus, and field engineering assignments in the U.S. and abroad, write W. F. Duffy, Professional Placement.

FEDERAL ELECTRIC CORPORATION

An Associate of International Telephone and Telegraph Corporation
Paramus Industrial Park, Paramus, New Jersey



CIRCLE 902 ON CAREER INQUIRY FORM

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 much 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." ■ ■

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.)

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.

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 _____

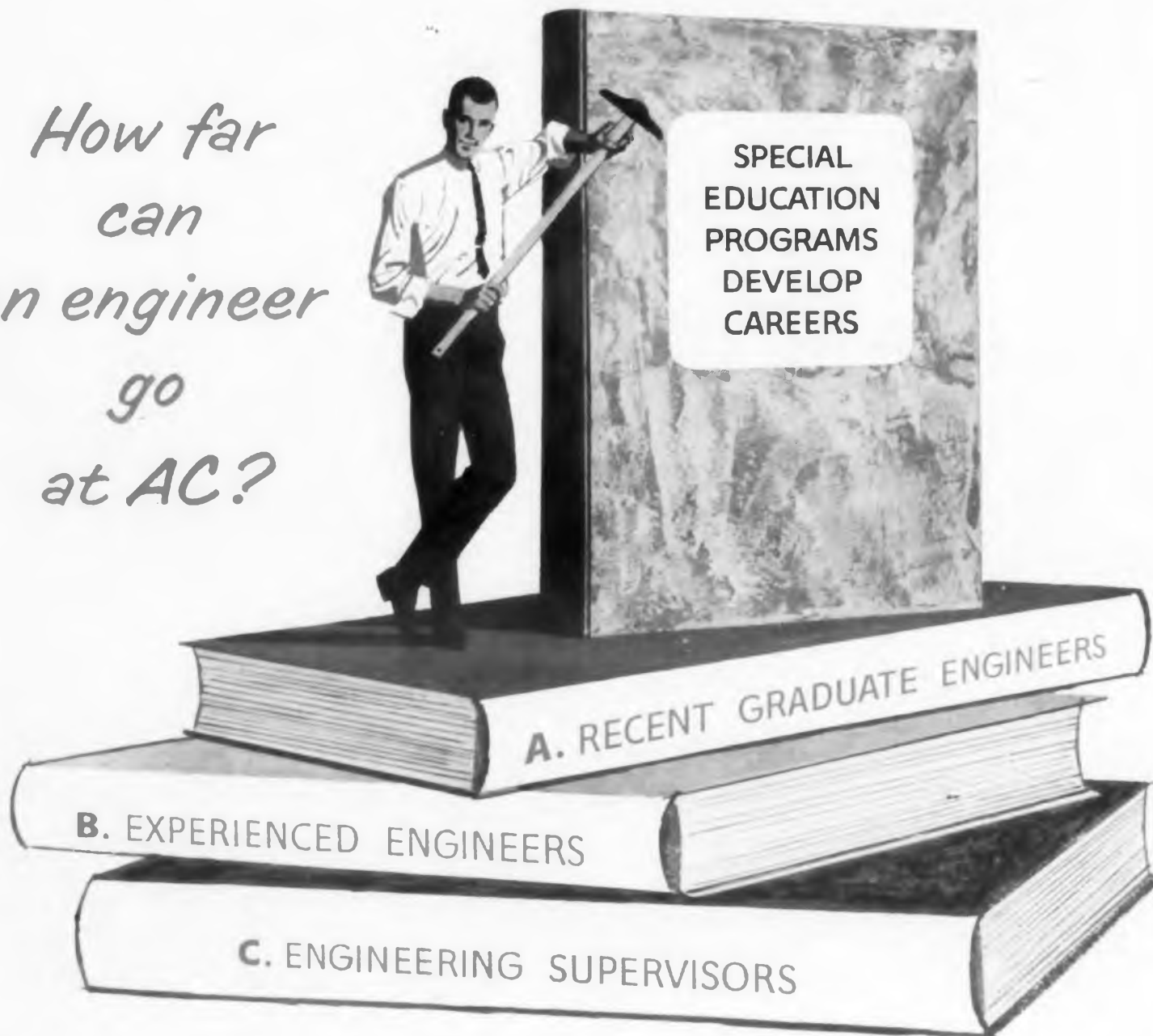
Minimum Salary Requirements (Optional) _____

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

*How far
can
an engineer
go
at AC?*



Finest "in house" programs anywhere

When you work in AC's instrumentation business, AC offers free comprehensive training programs that will help you grow professionally and enhance your status. Just look at these opportunities . . .

Program A—for recent graduate engineers—gives you a solid foundation in the theory and application of inertial guidance systems and servomechanisms. You attend classes three hours per day for four months, all on company time.

Program B—for experienced engineers—consists of upgrading studies in inertial guidance, servomechanisms, environmental problems, engineering math and physics, plus advanced state-of-the-art courses. Time—during working hours or evenings.

Program C—for all engineering supervisors—involves management training developed by a team of AC executives and University of Chicago industrial relations

experts. Sixty one-half-hour sessions give you a solid grounding in management techniques.

These thoroughly practical courses—taught by university professors or recognized AC specialists—constitute AC educational "extras." AC offers them in addition to their educational assistance programs for men who wish to study for degrees in nearby universities.

You may be eligible for training

If you are a graduate engineer in the electronics, electrical or mechanical fields, or if you have an advanced degree in mathematics or physics, you may be able to participate in these programs while you work on AC's famous AChiever inertial guidance system or a wide variety of other electromechanical, optical and infra-red devices.

For more details, just write the Director of Scientific and Professional Employment: Mr. Robert Allen, Oak Creek Plant, Dept. G, Box 746, South Milwaukee, Wisconsin.

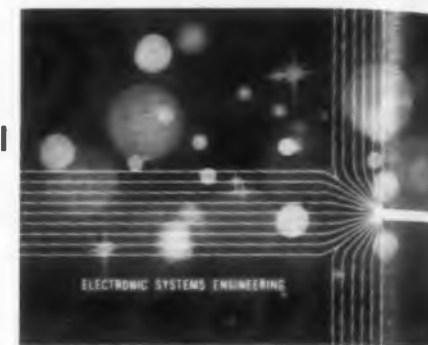
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SPARK PLUG THE ELECTRONICS DIVISION OF GENERAL MOTORS
CIRCLE 903 ON CAREER INQUIRY FORM

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

Don't Let Chance
DECIDE YOUR CAREER



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
ELECTRONIC DESIGN • July 22, 1959

engineers
 What kind of
 professional
 climate
 is essential
 to you
 as a
 creative man?

The "right" Professional Climate doesn't just happen. It has to be created — painstakingly, with careful planning, foresight and creative inspiration.

If you would like to know how General Electric's Advanced Electronics Center at Cornell University has built an ideal creative environment—and the many opportunities and rewards that await you as an engineer or scientist at the Center—please clip and return the coupon below for your free copy of the brochure entitled "Professional Climate."

GENERAL  ELECTRIC



Mr. James R. Colgin, Div. 76-SM-Y
 Advanced Electronics Center at Cornell University
 General Electric Company
 Ithaca, New York

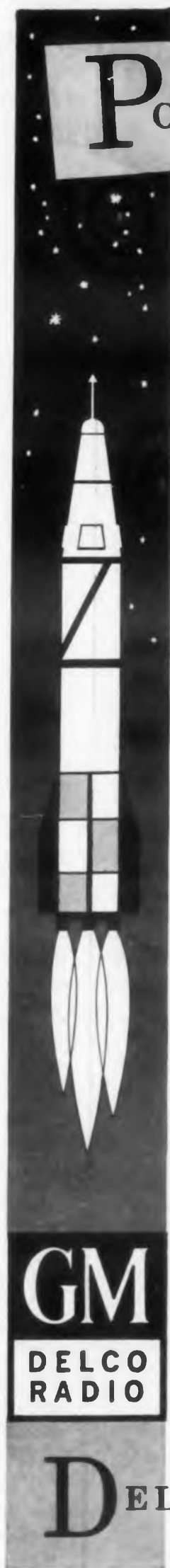
Please send me a free copy of the brochure
 "Professional Climate."

NAME _____

ADDRESS _____

CITY & STATE _____ DEGREE(S) _____

My field of interest is (please check) Data handling Radar Human
 Engineering Infrared Electronic Systems Communications Vehicle
 Guidance Engineering Data & Publications Engineering Physics Servo
 Systems Advanced Circuit Design Countermeasures.



Power Through Solid State Physics

Delco Radio is a world leader in automotive radio engineering and production. And, since our beginning in 1936, we have grown steadily, keeping pace with the rapidly expanding electronics industry.

Today, with this world of experience and knowledge accumulated through the years, it's only natural that Delco would become deeply involved in the important missiles and allied fields.

NOW Delco Is Offering Engineers and Scientists Opportunities in Space Age Devices:

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- **STATIC INVERTERS**
- **THERMOELECTRIC GENERATORS**
- **POWER SUPPLIES**

We have immediate requirements for:

ELECTRONIC ENGINEERS to design transistor circuits . . . communication circuits . . . radio circuits . . . servo-systems . . . antennas . . . or to do component and material specifications.

COMPUTER ENGINEERS for development of control type, special, or general purpose units. Experience in digital to analog and analog to digital converter design. Or magnetic core or drum type memory. Mechanical engineers for package design. Electronic engineers for test design, servo-analysis, and circuit design.

PROCESS ENGINEERS—Electronic and Mechanical for transistor and electronic production planning and follow-up.

SEMI-CONDUCTOR SALES ENGINEERS—Also customer assistance engineers. Prefer semi-conductor applications or similar experiences.

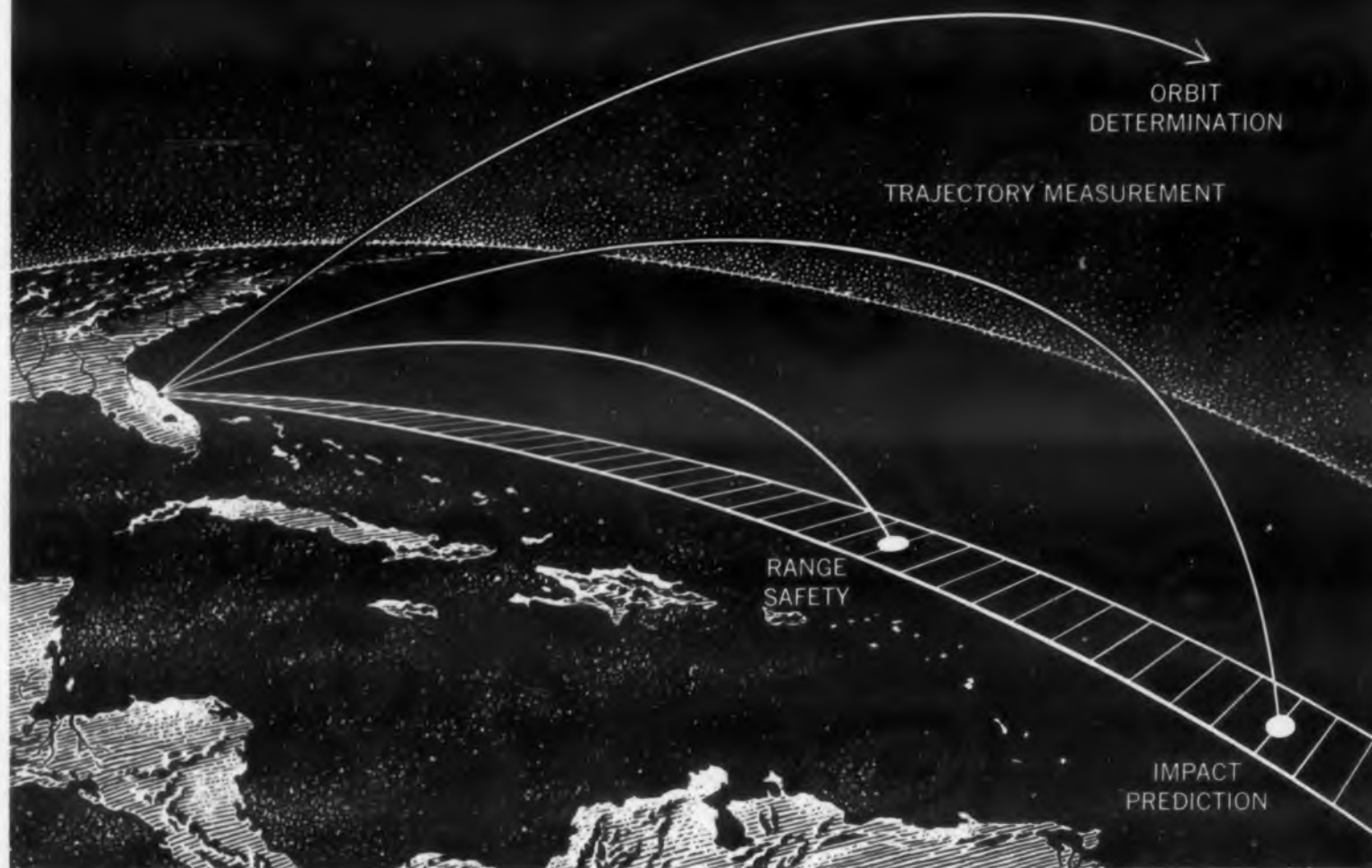
DRAFTSMAN—Minimum of 3 years experience in making complicated, detailed drawings and minor layouts.

If you are interested in becoming a part of this newly-established GM team of specialists, send your resumé today to the attention of Mr. Carl Longshore, Supervisor—Salaried Employment.

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DELCO RADIO DIVISION OF GENERAL MOTORS
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AZUSA



NOTE: ELECTRONIC ENGINEERS

AZUSA is a precision, automatic missile and space vehicle tracking system that supplies continuous, non-ambiguous trajectory data in real time, consisting of slant range and two-direction cosines for impact or orbit prediction.

Long used on ballistic missiles fired from Cape Canaveral, predesign and development is now under way to extend basic AZUSA techniques for use on advanced systems. When utilized for vehicle commands, telemetry, data transmission, space probe tracking and communications, these systems will perform guidance functions, supply navigational information, and determine space probe orbits.

Contracts for this development work have been received. Immediate positions, providing technical challenge and long-range advancement opportunity are open for senior

engineers with BS or MS degrees in EE, and a minimum of 3 years applicable experience. Specific needs are in:

- CIRCUIT DESIGN (phase comparison circuitry)
- ULTRA-STABLE OSCILLATORS
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- MICROWAVE AND ANTENNA DESIGN
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- MISSILE-BORNE ELECTRONIC EQUIPMENT DESIGN
- TECHNICAL SUB-CONTRACT LIAISON

If you feel qualified in one of these specialties, please write at once, giving full details of your background and education, to Mr. G. N. McMillan, Engineering Personnel Administrator, Department 130-90

CONVAIR-ASTRONAUTICS

Convair Division of

GENERAL DYNAMICS

5527 Kearny Villa Road, San Diego, California

CIRCLE 906 ON CAREER INQUIRY FORM

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-

responsibility, 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 gauge 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.

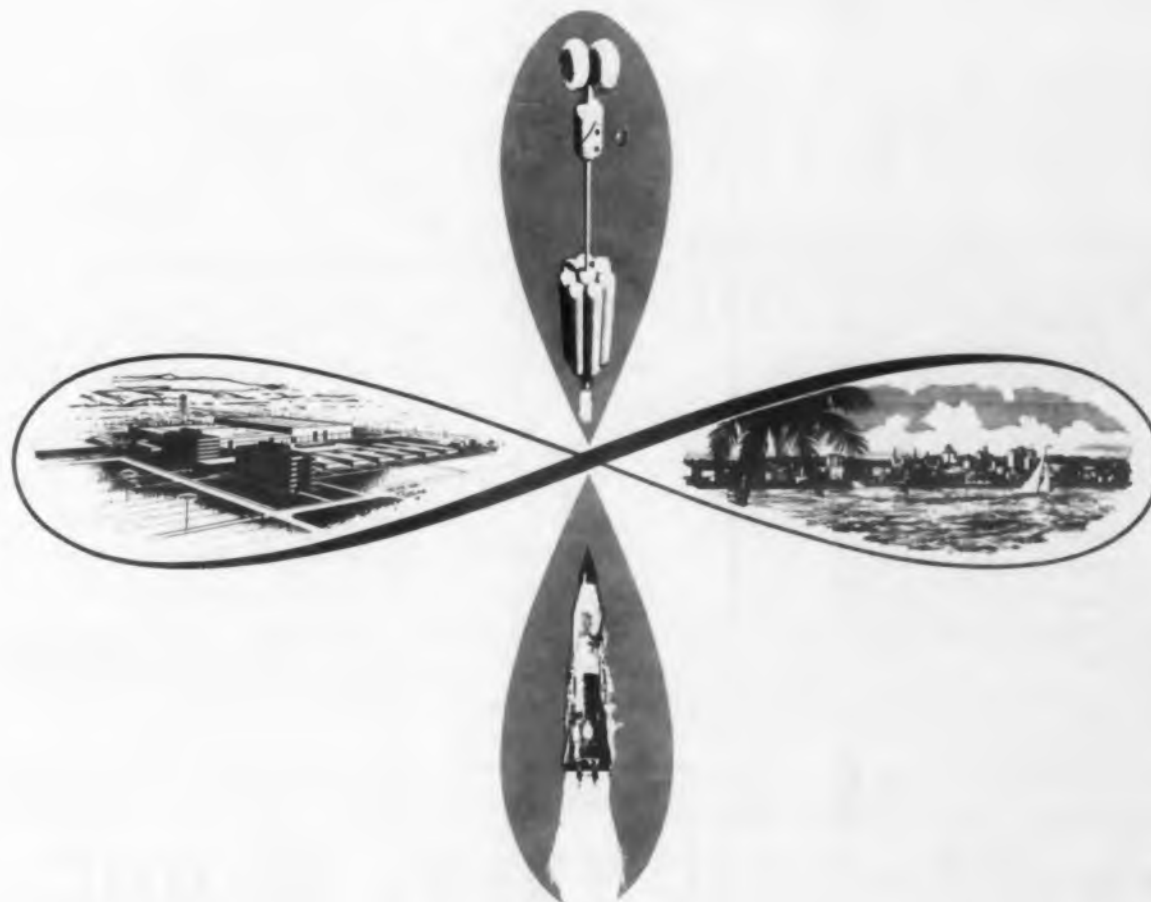
- Is the company situated near a desirable residential community? You have a private life to live, too.

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*

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• 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

SENIOR ENGINEERS AND PHYSICISTS FOR SEMICONDUCTOR R & D

Expansion of advanced research and development activity at the Semiconductor Division of Hughes Products (Hughes Aircraft Co.) has created several openings for senior men capable of assuming the direction of important new programs. Openings include:

DEVICE DEVELOPMENT PHYSICIST—to work on new device programs with responsibility for fabrication processes, device theory and analysis or device testing and evaluation. He must have an M.S. or Ph.D. in Physics and several years experience in the development of semiconductor devices.

EXPERIMENTAL DEVICE STUDY PHYSICIST—to do theoretical and/or experimental research on advanced exploratory solids for the devices on a long range study basis. He will work on his own project or in conjunction with other physicists on basic device study, leading to the first model of a new device. Position requires an M.S. or Ph.D. in Physics and several years experience in the experimental research on advanced semiconductor devices.

Recently completed ultramodern facilities of the Semiconductor Division are located in Newport Beach, California—just south of Los Angeles. Here you will find choice suburban living in the heart of Western electronics.

If you meet the requirements for the above positions, or if you are a senior engineer or physicist with experience in the field of semiconductors, we invite your inquiry. Please contact:

Mr. C. L. M. Blocher
Scientific Staff Representative
HUGHES SEMICONDUCTOR DIV.
500 Superior Avenue
Newport Beach 3, California

HUGHES PRODUCTS

SEMICONDUCTOR DIVISION
HUGHES AIRCRAFT COMPANY

CIRCLE 908 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."

FREE—\$1,000

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because you are an electronics engineer

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Electronics Division
Cadillac Associates, Inc.

29 East Madison Building—
Dept. E-2
Chicago 2, Ill.

CIRCLE 909 ON CAREER INQUIRY FORM

PROFESSIONAL GROWTH
IN A NEW FIELD:



DATA SYSTEMS IN UNDERWATER RESEARCH

Work is expanding at IBM on the design of new information-handling techniques required to explore the depths of the ocean. These investigations in oceanography are expected to have far-reaching scientific and military implications. They will require major contributions from many fields. Original and basic work will be needed in acoustics, information theory, advanced network theory, delay lines and cross-correlation techniques. The work will include systems design, real-time data processing, analysis of experimental equipment, and hybrid analog-digital techniques in unique data processing configurations. All phases of these varied projects will provide excellent career opportunities for qualified Systems Engineers.

SYSTEMS ENGINEERS

Qualifications: M.S. or Ph.D. in E.E. Navy experience in one or more of these specialties is desired: sonar, fire control, ASW, navigational systems or in applying information theory concepts to signal processing. Experience desirable in signal cross-correlation techniques, statistical data processing, sampled-data control theory, analog-digital data processing techniques, signal propagation and beam formation.

You will enjoy unusual professional freedom and the support of a wealth of systems knowledge. Comprehensive education programs are available—plus the assistance of specialists of many disciplines. Working independently or with a small team, your individual contributions are quickly recognized and rewarded.

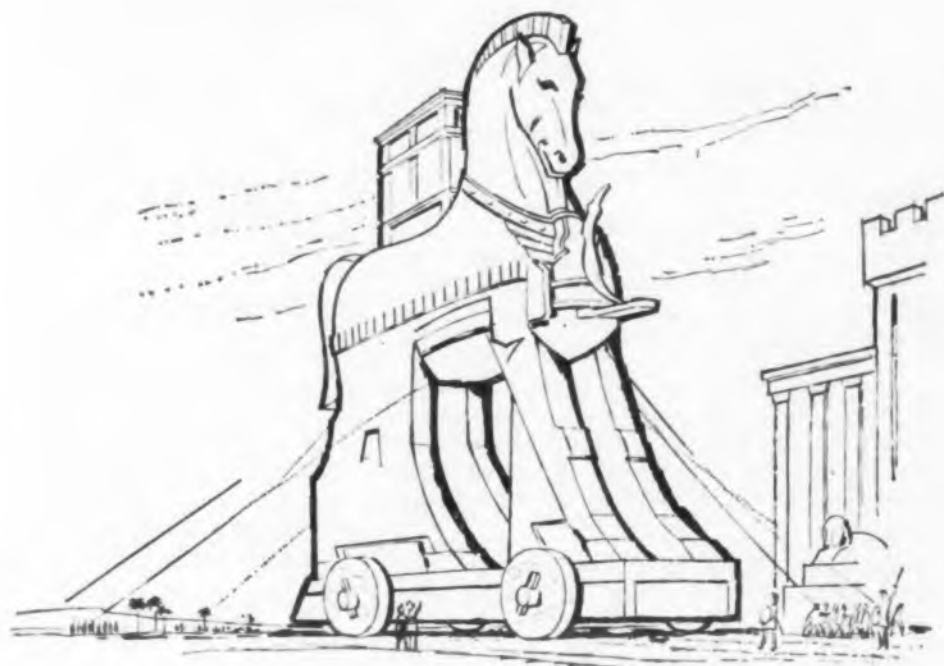
Write, outlining your qualifications and experience, to:

Mr. R. L. Lang, Dept. 55564
IBM Corporation
Owego, New York

IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION

CIRCLE 910 ON CAREER INQUIRY FORM
ELECTRONIC DESIGN • July 22, 1959



ECM . . . today's TROJAN HORSE

One of the many absorbing areas of investigation available to gifted engineers at Melpar is the Research and Development aspect of ECM systems.

The mature engineer's capacity to reach deeply into provocative lines of inquiry is particularly valued and encouraged at Melpar. Your own intellectual dimensions govern remuneration and assignments.

Opportunities are now available at Melpar in the following areas:

Reconnaissance Systems	Detection & Identification Systems
Airborne Equipment	Antenna & Radiation Systems
Ground Data Handling Equipment	Chemistry Laboratory
Ground Support Equipment	Applied Physics Laboratory
Simulation & Training Systems	Production Engineering
Communication & Navigation Systems	Quality Control

INTERVIEWS ARRANGED IN YOUR LOCALE

For Details
Wire Collect or Write to:
Professional
Employment Supervisor

MELPAR  **INC**

A SUBSIDIARY OF WESTINGHOUSE AIR BRAKE COMPANY

3307 Arlington Boulevard, Falls Church, Virginia
10 miles from Washington, D.C.

CIRCLE 911 ON CAREER INQUIRY FORM

ELECTRONIC DESIGN • July 22, 1959

SUBURBAN* NEW YORK CITY PLANT

(20 minutes from Times Square)

ENGINEERS PHYSICISTS

NEW PRODUCT DEVELOPMENT

ON LONG RANGE
COMMERCIAL PROJECTS

Must have proven record
of Product Development.

GROWTH POTENTIAL WITH
PERMANENT ENGINEERING STAFF

ELECTRONIC PROJECT ENGINEERS

Extensive Transistor and Vacuum Tube
Circuitry experience in the following:

- VIDEO and PULSE CIRCUITRY
- HIGH GAIN D.C. AMPLIFIERS
- REGULATED POWER SUPPLIES
- DIGITAL and SWITCHING CIRCUITRY

MAGNETIC COMPONENTS and POWER SUPPLY ENGINEERS

with extensive design and application
experience in the following:

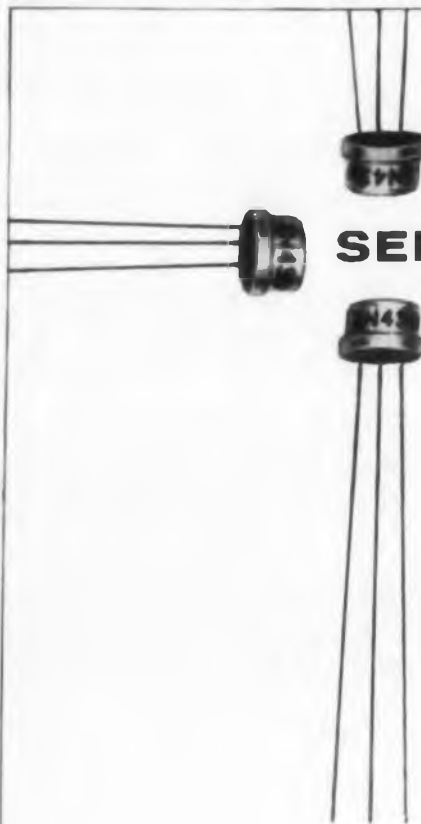
- SMALL ELECTRONIC TRANSFORMERS
- TOROIDAL COILS and TRANSFORMERS,
including ADJUSTABLE AUTOTRANSFORMERS
- A.C. SATURABLE VOLTAGE STABILIZERS
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LIMITING DEVICES
- LOW VOLTAGE, HEAVY CURRENT
PLATING RECTIFIERS
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SATURABLE REACTORS

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SALARY COMMENSURATE WITH EXPERIENCE
ALL REPLIES HELD IN STRICTEST CONFIDENCE

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Pleasant travel on non-congested roads, ample
parking facilities.

CIRCLE 912 ON CAREER INQUIRY FORM



SEMICONDUCTOR ENGINEERS

JOIN OUR FIVE MILLION DOLLAR EXPANSION PROGRAM

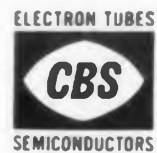
If you have experience as:

PRODUCTION MANAGER ENGINEERING MANAGER
 DIODE ENGINEERS APPLICATIONS ENGINEERS PILOT LINE ENGINEERS
 TRANSISTOR ENGINEERS DEVICE DEVELOPMENT ENGINEERS PHYSICISTS
 PRODUCTION ENGINEERS RECEIVING TUBE DEVELOPMENT ENGINEERS
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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 . . .*



CBS ELECTRONICS

900 Chelmsford Street
 Lowell, Massachusetts
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(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, Telemetry
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WEAPONS SYSTEMS & RADAR

Advanced Systems, Systems Analysis, Guidance & Navigation
 Radar Development, Data Transmission, Display Development
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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

ELECTRONIC DESIGN • July 22, 1959

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 8 $\frac{3}{4}$ -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.

MECHANICAL DIVISION



**G. P. Lambert, Manager
Professional Employment
Personnel Department**

2003 E. Hennepin, Minneapolis 13,
Minnesota

CIRCLE 916 ON CAREER INQUIRY FORM

ELECTRONIC DESIGN • July 22, 1959

Systems
Electronic
Mechanical

Engineers

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 IRBMs—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 • Tales Handling and Launching Equipment • Advanced Torpedo Development • Tartar Fire Control

CIRCLE 917 ON CAREER INQUIRY FORM

NEW



MINIATURE TRANSFORMERS

FOR
Transistor

AND PRINTED
CIRCUIT APPLICATIONS

Custom transformers for printed circuits are now available from ADC in five standard case sizes with terminals and inserts on 0.1" grid multiples. Audio, power, and ultrasonic transformers and inductors with maximum electrical performance for each size are being custom designed for transistor and vacuum tube circuitry. Raised mountings prevent moisture from being trapped. Available in Mumetal cases. They meet MIL-T-27-A Grade 5 Class R or S Life X, and can be designed to meet 500 and 2,000 cps vibration.

TYPICAL RATINGS

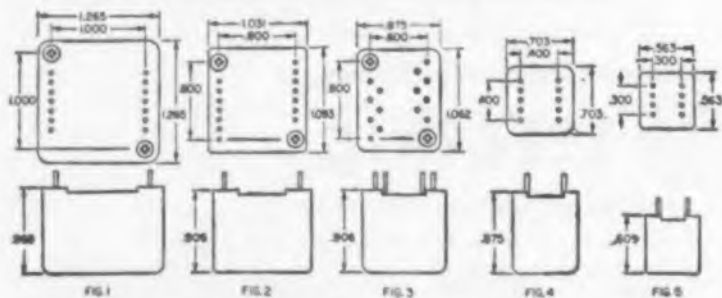
Fig.	Description	Primary	Secondary	Maximum Level	Response (CPS)
1	Output	P P collectors 100 ohms CT	600/150 ohms	+33 dbm (2w)	±2db 250-10,000 cps
2	Output	5000 ohms 5ma DC	50/250/600 ohms	+10 dbm (10mw)	±1db 100-10,000 cps
3	Output	P P collectors 1000 ohms CT	4/8/16 ohms	+25 dbm (300mw)	±1db 250-10,000 cps
3	Interstage	Collector, 5000 ohms 1ma DC	P P bases 3000 ohms CT	+5 dbm	±1db 250-5,000 cps
4	Input	50/250/600 ohms	50,000 ohms	+2 dbm	±1db 250-10,000 cps
5	Output	P P collectors 500 ohms CT	4/8/16 ohms	+20 dbm (100mw)	±1db 250-10,000 cps
5	Interstage	Collector 7500 ohms 1ma DC	P P bases 5000 ohms CT	0 dbm	±1db 250-10,000 cps

Fig.	Description	Rating
3	Audio	200 hys 1v 1000 cps 0 DC
5	Power	500 mhys 1v 400 cps 10ma DC

Fig.	Description	Rating
3	Low pass	600 ohms input 600 ohms output +10dbm f cutoff 50kc Attenuation 18db per octave
3	High pass	10,000 ohms input 10,000 ohms output +10dbm f cutoff 2kc Attenuation 18 db per octave

Fig.	Description	Primary	Secondary	VA	Regulation
4	Filament	115v 380-420 cps	6.3v .6a	4.0	10%
5	Dual filament	26v 380-420 cps	(1) 6v 5ma (2) 6v 5ma	.2	2%

Note: Other combinations are available with 400 cps max. volt ampere ratings up to 15 for Fig. 1, 10 for Fig. 2, 6 for Fig. 3, 4 for Fig. 4, and 1 for Fig. 5.



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CIRCLE 79 ON READER-SERVICE CARD



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					VACUUM TUBE GATE INPUT AND OUTPUT ALWAYS ON OPPOSITE SIDES
AND Thyatron (EXTINGUISHING INPUT)	 (DOT INDICATES GAS-FILLED)				(EXTINGUISHING INPUT)

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Counter, Binary					
Counter, Binary Multistage					(CLEAR TO SPECIFIC NUMBER)
Counter, Multiposition					

	Preferred	Burroughs	IBM	RCA	Remington Rand
Delay Line					 SEVEN-PULSE DELAY 1/2 PULSE DELAY LESS THAN 1/2 PULSE DELAY
Delay, Flip-Flop				See page 64. 	
Delay, Logical					
Inverter					

(Continued on following page)



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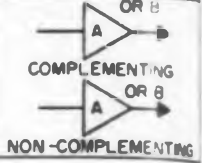
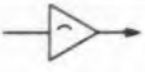
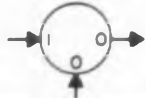
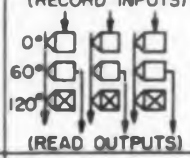







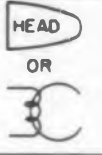
Electronics and Avionics Division

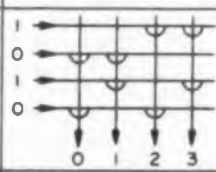
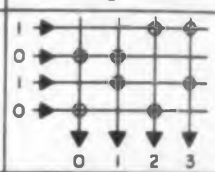
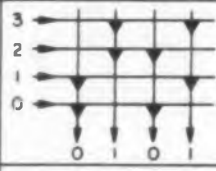
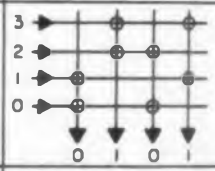

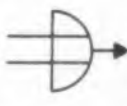
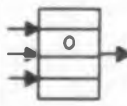

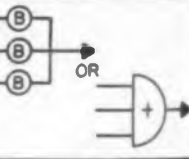
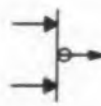
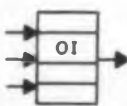
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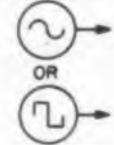

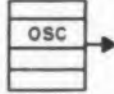



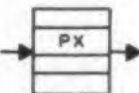
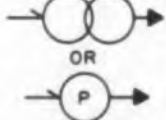


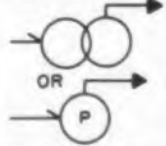

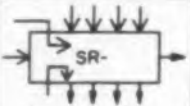
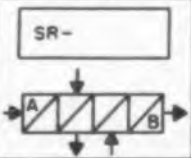
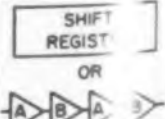
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BOOKS

	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	(RECORD INPUTS)  (READ OUTPUTS)				
Magnetic Head	READ  WRITE  ERASE 			READ OR WRITE BUT NOT BOTH  BOTH READ AND WRITE  ERASE 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	 OR 				
Pulse Transformer (Without inversion)					
Pulse Transformer (With inversion)					
Shift Register	 See page 33 for details.				



Feedback Control Systems

J. C. Ville, 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.

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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

$$E_A(\Delta, \phi) = -\frac{30 I_0}{R} \cos \psi' e^{-1 \alpha R} \times \left\{ \begin{aligned} &\sin(\phi - \phi_0) \left[\frac{e^{-i \alpha \delta_1 L} - 1}{\delta_1} - \frac{e^{-i \alpha \delta_2 L} - 1}{\delta_2} e^{-2 i \alpha H \sin \Delta} \right] \\ &- \sin(\phi + \phi_0) \left[\frac{e^{-i \alpha \delta_3 L} - 1}{\delta_3} - \frac{e^{-i \alpha \delta_4 L} - 1}{\delta_4} e^{-2 i \alpha H \sin \Delta} \right] \end{aligned} \right\}. \quad (1)$$

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

$$\begin{aligned} \delta_1 &= 1 - \cos \Delta \cos \psi \cos(\phi - \phi_0) - \sin \Delta \sin \psi, \\ \delta_2 &= 1 - \cos \Delta \cos \psi \cos(\phi - \phi_0) + \sin \Delta \sin \psi, \end{aligned}$$

$$\begin{aligned} \delta_3 &= 1 - \cos \Delta \cos \psi \cos(\phi + \phi_0) - \sin \Delta \sin \psi, \\ \delta_4 &= 1 - \cos \Delta \cos \psi \cos(\phi + \phi_0) + \sin \Delta \sin \psi. \end{aligned} \quad (2)$$

The directivity pattern in a vertical plane passing through the bisectrix of the angle between the antenna wires ($\varphi = 0$) can be found by simplifying eq (1) as follows

$$E_v(\Delta, \phi) = -\frac{120 I_0}{R} \cos \psi' \sin \phi_0 e^{-i \alpha R} \times \sqrt{\frac{\sin^2 \frac{\alpha \delta_1}{2} L}{\delta_1^2} - 2 \frac{\sin \frac{\alpha \delta_1}{2} L}{\delta_1} \frac{\sin \frac{\alpha \delta_2}{2} L}{\delta_2}}$$



Fig. 1. The Vee antenna. W represents the wave impedance.

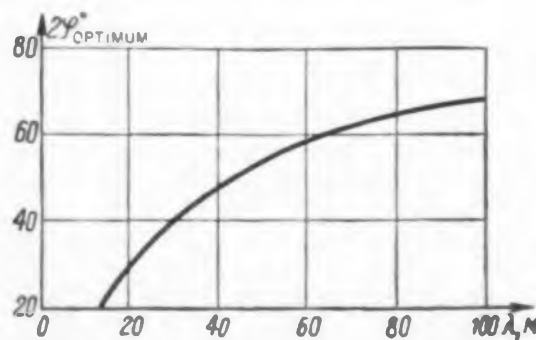


Fig. 2. The optimum aperture angle varies with wavelength.

$$\cos(\alpha H \sin \Delta) + \frac{\sin^2 \frac{\alpha \delta_2}{2} L}{\delta_2^2}. \quad (3)$$

The formula for the directivity pattern of the parallel (vertical) component of the field is

$$E_v(\Delta, \phi) = -\frac{30 I_0}{R} e^{-i \alpha R} \left\{ p_1 \frac{e^{-i \alpha \delta_1 L} - 1}{\delta_1} - p_3 \frac{e^{-i \alpha \delta_3 L} - 1}{\delta_3} + R_\beta e^{-2 i \alpha H \sin \Delta} \left[p_2 \frac{e^{-i \alpha \delta_2 L} - 1}{\delta_2} - p_4 \frac{e^{-i \alpha \delta_4 L} - 1}{\delta_4} \right] \right\}, \quad (4)$$

where

$$\begin{aligned} p_1 &= \cos \Delta \sin \psi' + \sin \Delta \cos \psi' \cos(\phi - \phi_0), \\ p_2 &= \cos \Delta \sin \psi' - \sin \Delta \cos \psi' \cos(\phi - \phi_0), \\ p_3 &= \cos \Delta \sin \psi' + \sin \Delta \cos \psi' \cos(\phi + \phi_0), \\ p_4 &= \cos \Delta \sin \psi' - \sin \Delta \cos \psi' \cos(\phi + \phi_0), \end{aligned} \quad (5)$$

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

$$\begin{aligned} \epsilon &= 0.365 \cos^2 \psi' \sin^2 \phi_0 e^{-\alpha L} \\ &\times \left[\frac{\sin^2 \frac{\alpha \delta_1}{2} L}{\delta_1^2} - 2 \frac{\sin \frac{\alpha \delta_1}{2} L}{\delta_1} \frac{\sin \frac{\alpha \delta_2}{2} L}{\delta_2} \right. \\ &\left. \cos(\alpha H \sin \Delta) + \frac{\sin^2 \frac{\alpha \delta_2}{2} L}{\delta_2^2} \right]_{\Delta = \Delta'} \quad (6) \end{aligned}$$

where Δ' is the elevation angle of the direction of

the maximum field strength, and

$$\beta L = \frac{R_{\Sigma}}{2W} \quad (7)$$

accounts for the attenuation in the antenna current through radiation. (R_{Σ} 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

$$R_{\Sigma} = 60 (\ln 2\alpha l - ci 2\alpha l + \frac{\sin 2\alpha l}{2\alpha l} - 0.423). \quad (8)$$

and W can be assumed to be 400 ohms. The efficiency of the antenna then becomes

$$\eta = 1 - e^{-2\beta L} \quad (9)$$

and the directivity coefficient becomes

$$D = \frac{1.64 \epsilon}{\eta} \quad (10)$$

An examination of eq (6) shows that a certain

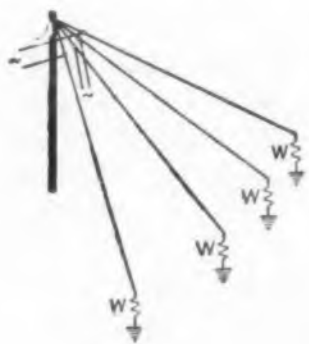


Fig. 3. An array of several antennas can cover the entire short wave range.

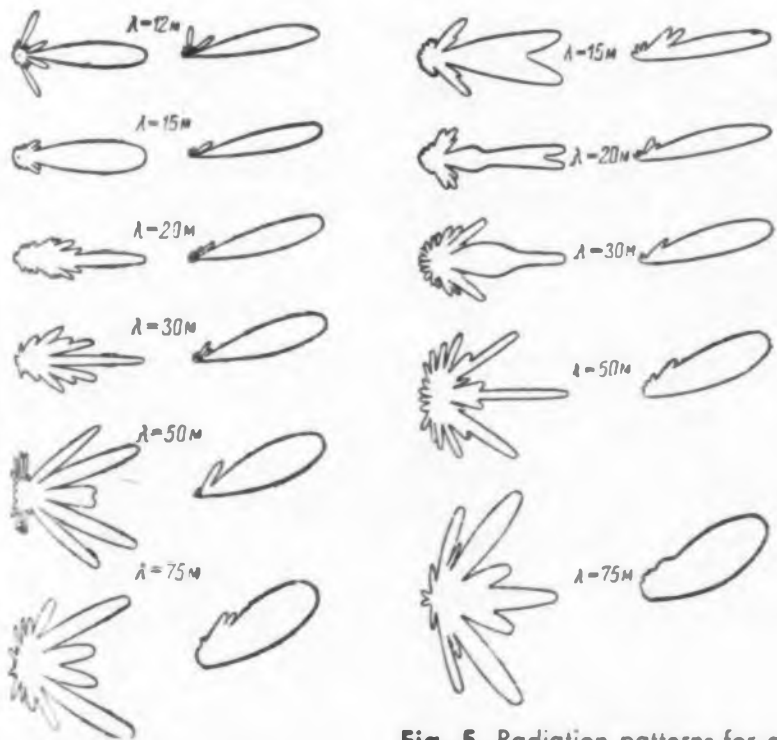


Fig. 4. Radiation patterns for a VH(200/20)20 antenna operating at wavelengths from 12 to 75 meters.

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.

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 ($\varphi=0$) and over a conical surface ($\Delta = 10$ 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.

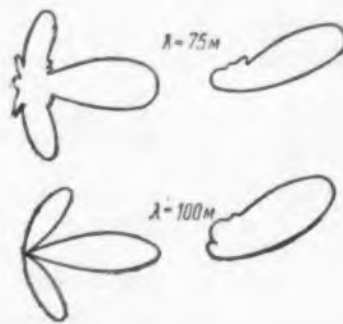


Fig. 6. Radiation patterns for a VH(200/20)60 at the longer wavelengths.

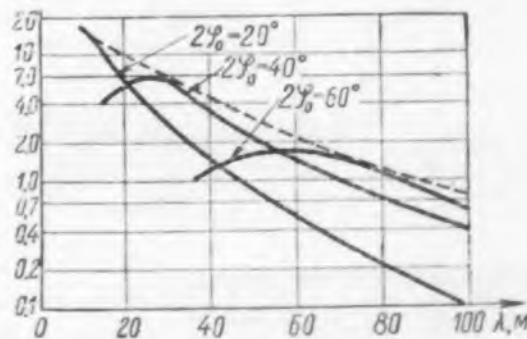


Fig. 7. Gains of antennas with different aperture angles.

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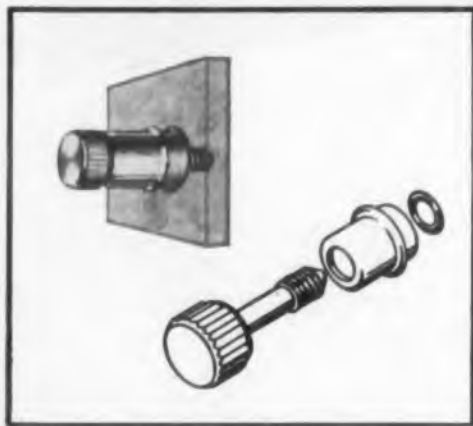
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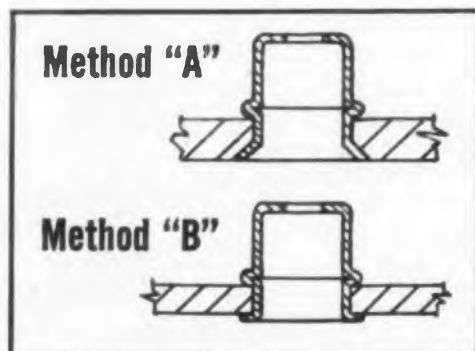
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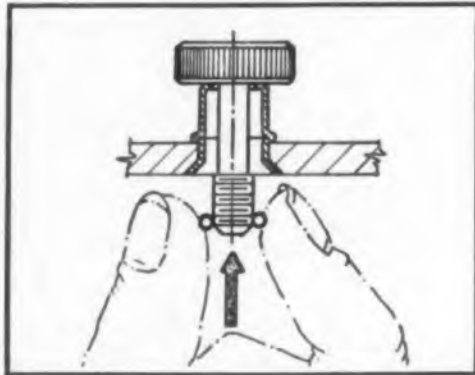


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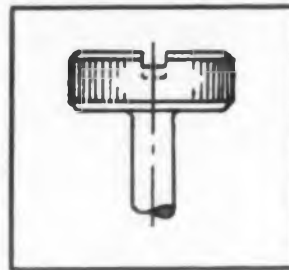
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MINIATURE TO LARGE SIZE HEADS IN FIVE TYPES

HEAD DIAMETER	$\frac{3}{4}$ "	$\frac{9}{16}$ "	$\frac{9}{16}$ "	$\frac{7}{16}$ "	$\frac{7}{16}$ "
THREAD SIZE	1/4-20	1/4-20	12-24	10-24	10-32



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GERMAN ABSTRACTS

E. Brenner

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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.

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$$I_a^2 = F^2 2e I_a \Delta F \quad (1)$$

where the space charge reduction factor F^2 is independent of the bandwidth and is given by Rack's formula¹

$$F^2 = 6(1 - \pi/4)(KTS)/e\sigma I_a \quad (2)$$

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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

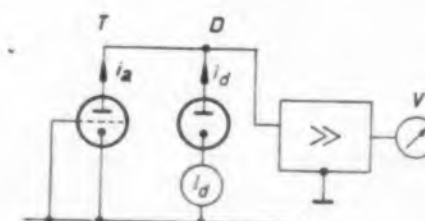


Fig. 1. Measurement scheme

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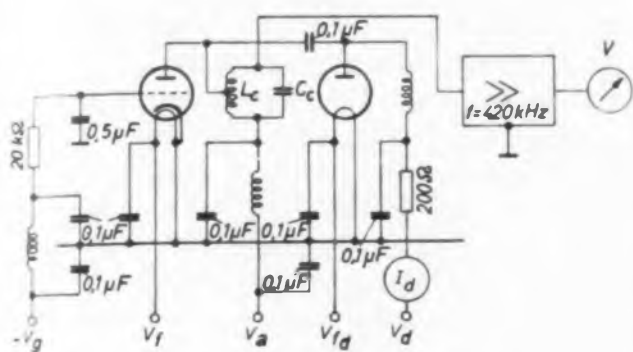


Fig. 2. Amplifier input circuit for the 420 kc tests

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.

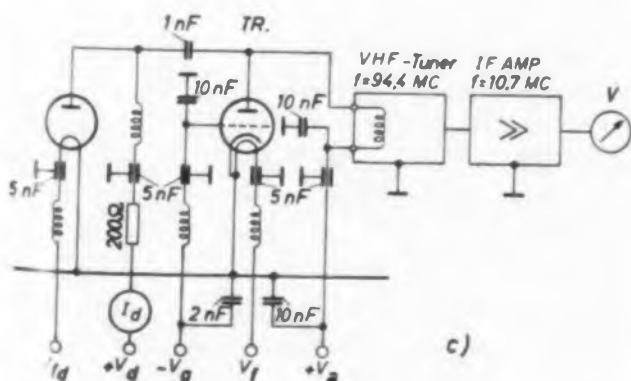


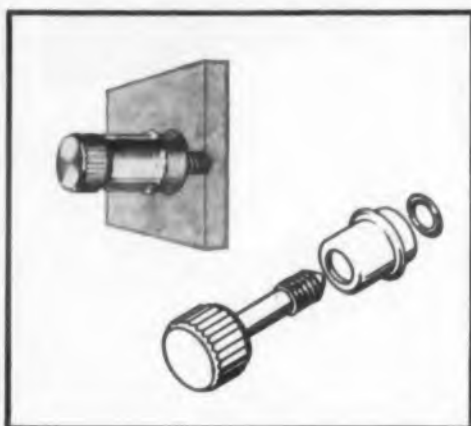
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1. Bell Syst. Tech., Journal 17, 1938, p 592.

Compact Captive Panel Screws:

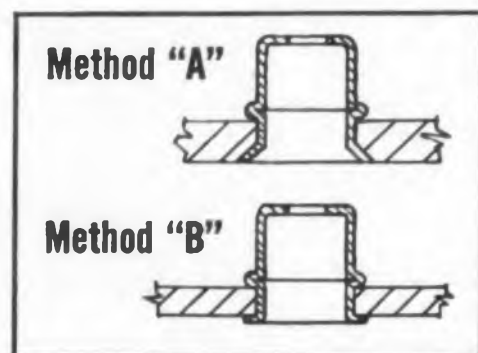
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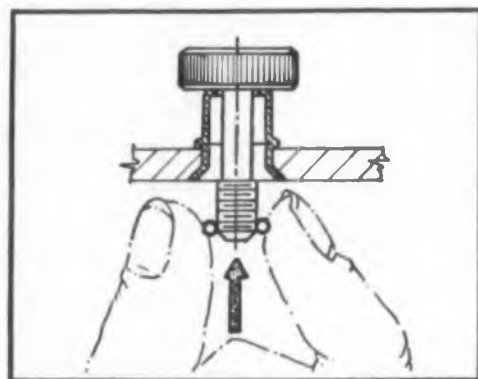


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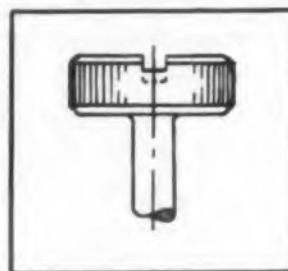
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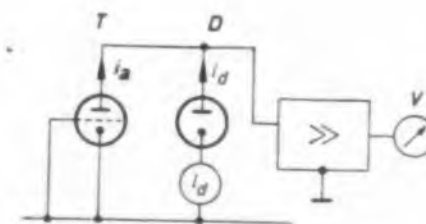


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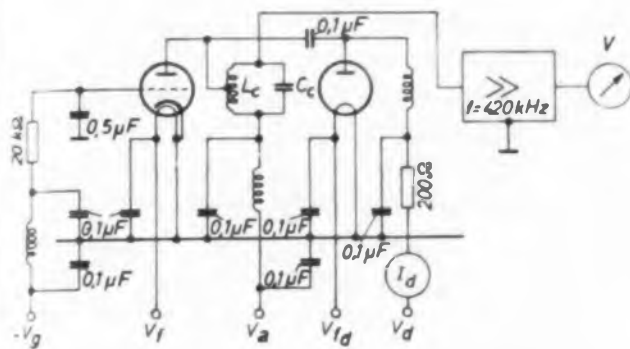


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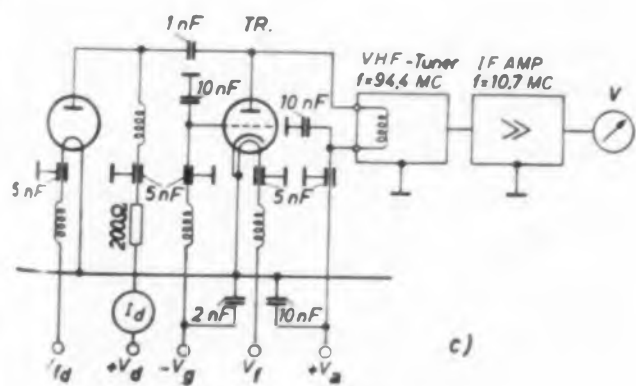


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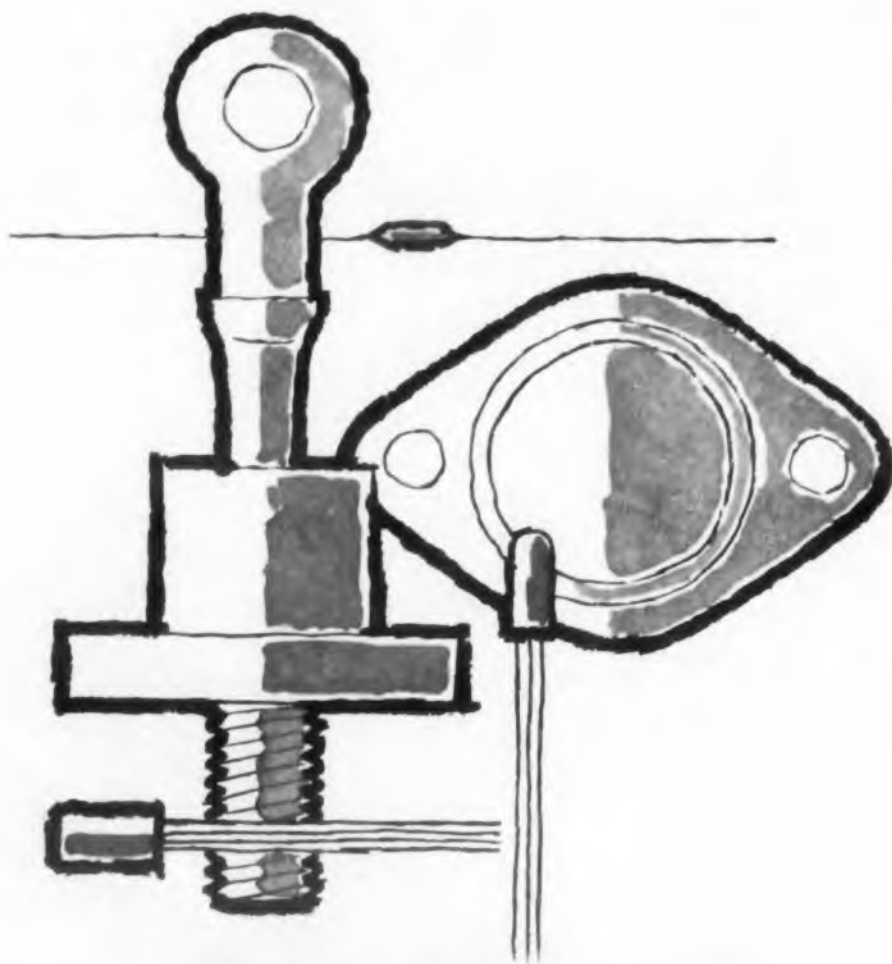


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REPORT BRIEFS

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

For two published reports of the Evaluation Branch were examined, and the failures reported thereon 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 $2\frac{1}{2}$ 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.

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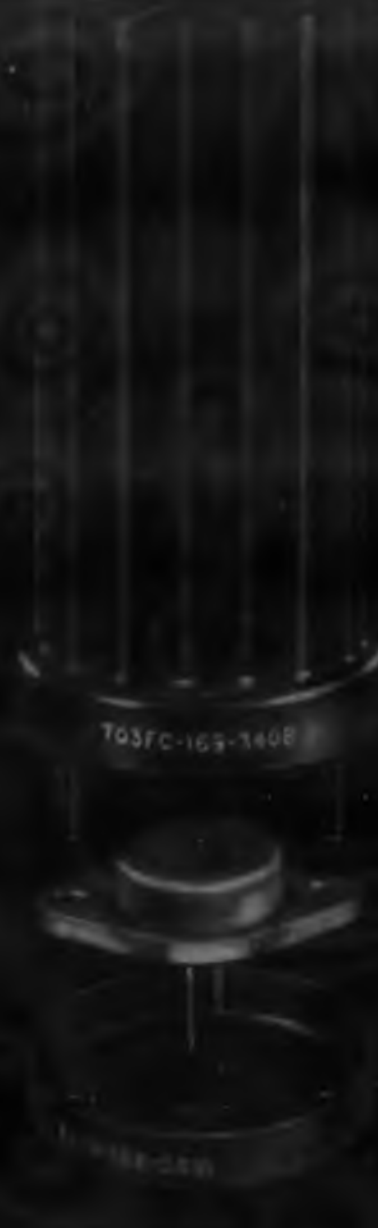
do you know...

that proper heat dissipation of a TO-3 type transistor operating at 12 watts would require a $\frac{1}{4}$ " thick aluminum heat sink the size of this $4\frac{1}{2}$ x 10 ad?

IERC TRANSISTOR HEAT DISSIPATORS

of the type shown here full size, are the thermal equivalent when mounted to a heat sink 60% smaller!

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New Pyramid Tantalum slug capacitors have cylindrical cases and contain a non-corrosive electrolyte. Due to the special construction of materials used in the manufacture of Pyramid Tantalum slug capacitors, these units are both seep and vibration proof. In addition, this type of capacitor assures long service life and corrosion resistance—made to meet MIL-C-3965 Specifications.

Commercially available immediately, these new Pyramid Tantalum capacitor units have an operating range between -55°C to 100°C for most units without any de-rating at the higher temperature.

PYRAMID MYLAR...
 -30°C to $+125^{\circ}\text{C}$...
SMALLEST FILM CAPACITORS MADE!

Pyramid new Mylar capacitors have extremely high insulation resistance, high dielectric strength and resistance to moisture penetration.

Commercially available immediately, Pyramid Mylar capacitors have an operating range between -30°C to $+125^{\circ}\text{C}$ with voltage de-ratings above $+85^{\circ}\text{C}$. Pyramid wrapped Mylar capacitors—Series Nos.: 101, 103, 106 and 107 have the following characteristics:

Construction Styles:	Basic No.	Type Winding	Shape
	101	Inserted Tabs	Flat
	103	Extended Foil	Flat
	106	Inserted Tabs	Round
	107	Extended Foil	Round

Tolerance: The standard capacitance tolerance is $\pm 20\%$. Closer tolerances can be specified.

Electrical Characteristics: Operating range for Mylar capacitors—from -55°C to $+85^{\circ}\text{C}$ and to $+125^{\circ}\text{C}$ with voltage de-rating.

Dissipation Factor: The dissipation factor is less than 1% when measured at 25°C and 1000 CPS or referred to 1000 CPS.

Insulation Resistance:	Temperature	1R x mfd	Maximum IR Requirements
	25°C	50,000	15,000 megohms
	85°C	1,000	6,000 "
	125°C	50	300 "

Pyramid Mylar capacitors are subject to the following tests:

Test Voltage—Mylar capacitors shall withstand 200% of rated D.C. voltage for 1 minute at 25°C .

Life Test—Mylar capacitors shall withstand an accelerated life test of 250 hours with 140% of the voltage rating for the test temperature. 1 failure out of 12 is permitted.

Humidity Test—Mylar capacitors shall meet the humidity requirements of MIL-C-91A specifications.

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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.

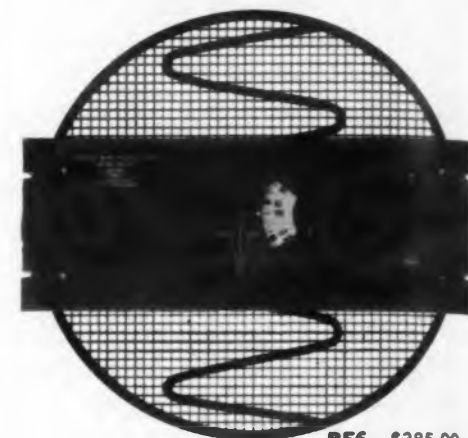
Frequency Limitations of Distributed Amplifiers

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.

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**BAND
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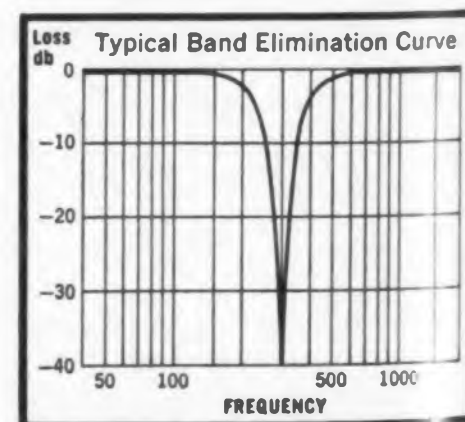
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The Allison Model BE6 Band Elimination Filter is a passive network filter with a direct reading dial, continuously tunable over full audio frequency range from 20 cps to 20,000 cps. It will transmit all frequencies from DC to more than 100 kcps, except for the reject band to which the filter is tuned.

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More than 40 db attenuation at one frequency. Passive network—no power supply. No vacuum tubes. Impedance (in and out), 600 ohms. Reject band less than 1 octave wide. Loss in pass bands, $\frac{1}{2}$ db. Single dial control. Direct reading frequency dial. Maximum input for minimum distortion, 5 V. Size of portable units, excluding knobs and handle, 17" long, 5 $\frac{1}{4}$ " deep, 8" high. Rack models are mounted on 7" rack panel.



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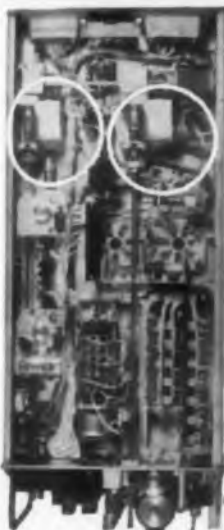
ELECTRONIC DESIGN • July 22, 1959

Electro-Mechanical CLUTCH and BRAKE ASSEMBLY



Precision Built by
Forbes and Wagner for

Aeronautical Communications Equipment Inc.



Aerocom Transmitter

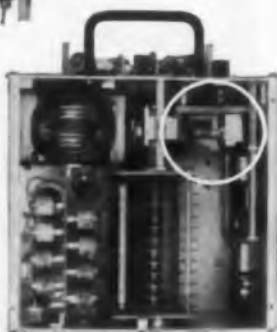
Uses two F & W drives as circled. When frequency is selected motor is actuated and first clutch engages driving crystal drum to proper crystal. Clutch releases and brake holds setting.

Second clutch engages, driving tuning unit to proper tuning point. Clutch is then deactivated and brake holds entire mechanism.

Motor coasts to a stop.

Aerocom Tuner

Uses one F & W drive. Frequency selection starts motor drive through clutch to variometer and variable condenser. When point of resonance is reached, clutch disengages and brake holds setting.



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ELECTRONIC DESIGN • July 22, 1959

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.

RF BROADBAND PREAMPLIFIERS



HRB Model 530 Preamplifier with power supply in relay rack mounting enclosure.

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PREAMPLIFIER PERFORMANCE DATA

FREQUENCY BAND	NOISE FIGURE	MODEL NO.	GAIN db	MODEL NO.	GAIN db	MODEL NO.	GAIN db
50-100	2-4	510	30	—	—	—	—
50-150	3-5	515	22	515NK	44	515NS	66
50-300	5-7	530	15	530NK	30	530NS	45
125-250	5-7	1225	22	1225NK	44	1225NS	66
140-280	5-7	1428	22	1428NK	44	1428NS	66
150-300	5-7	1530	22	1530NK	44	1530NS	66
250-500	6-8	2550	14	2550NK	28	2550NS	42
300-600	7-9	3060	11	3060NK	22	3060NS	33
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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.

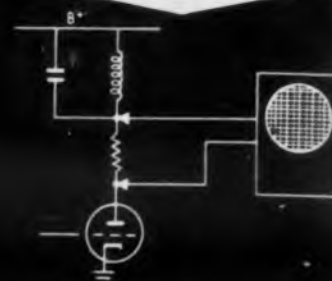
Miniature Power Transformers

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.

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(1) power line current flows in scope and circuit—only 60 cycles show; (2) triode is loaded by shunt capacitance to ground . . . and gain changes.

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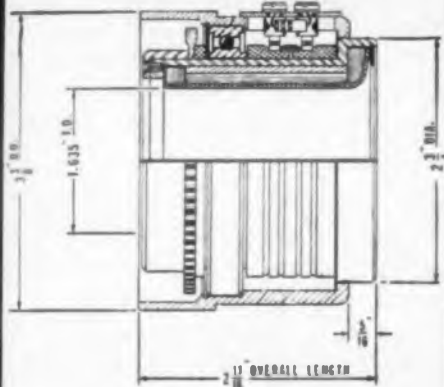
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Voltage-Sensitive Elements

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.*

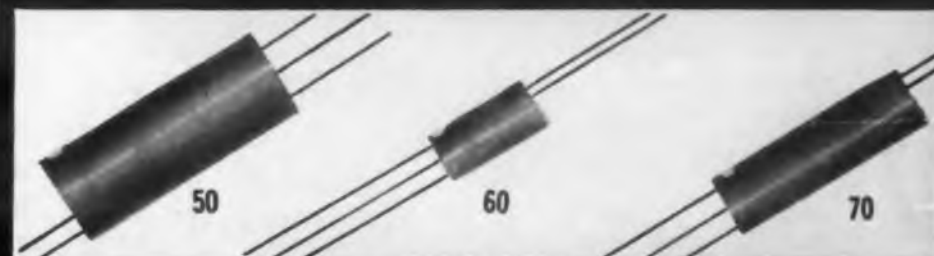
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LOW POWER
LOW LEVEL

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LINEAR
HIGH SPEED
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ACTUAL SIZE

Model: Type:	50 Germanium	60 Germanium	70 Silicon
Temperature Range:	-55° C, to +85° C	-55° C to +90° C	-55° C to +130° C
Sq. Wave Drive Volt.:	1 to 10v. p-p	1 to 15 v. p-p	5 to 20 v. p-p
DC Input Voltage:	to 12 v	to 15 v	to 20 v
Chopping Freq.:	DC to 100 kcps	DC to 100 kcps	DC to 200 kcps
Alpha Cutoff Freq.:	900 kilocycles	One megacycle	5 megacycles
Temperature Drift:	.04% per °C	.02% per °C	.03% per °C
Random Noise:	25uv rms	10uv rms	50uv rms
Weight:	3 grams	1 gram	2 grams

DESCRIPTION

The transistor chopper (or modulator) is a solidly encapsulated unit designed to alternately connect and disconnect a load from a signal source. It may also be used as a demodulator to convert an a.c. signal to d.c. It is capable of linearly switching or chopping voltages over a wide dynamic range which extends down to a fraction of a millivolt and up to 10 volts. Unlike mechanical choppers which can only be designed to operate over a narrow and comparatively low frequency range due to mechanical limitations, this transistorized chopper is an inertialess device that can be driven from d.c. to hundreds of kilocycles.

The switching circuitry used operates the transistors in a manner which provides stability and freedom from drift over a wide temperature range. Only carefully selected transistors are utilized.

The noise figure of the transistor chopper is competitive with mechanical choppers for many uses. Furthermore, the noise level will not increase with usage.

This unit is practically immune to the effects of shock and vibration making it ideal for military, missile, and portable applications; or where power conservation, miniaturization and elimination or maintenance are a necessity. The transistor chopper has an inherently long life and is not subject to contact bounce, wear, pitting or burning.

TYPICAL APPLICATIONS

Chopper (modulator).
Demodulator.

Low, medium level switching.

D.C. amplifier stabilization.

High speed servomechanisms.

Replace less sensitive diode modulators.

Thermocouple instrumentation.

Low, medium level D.C. instruments.

Low level commutators for telemetering.

Carrier for lower frequency signals.

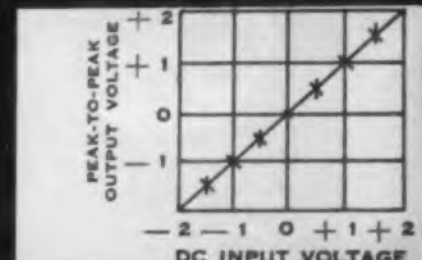
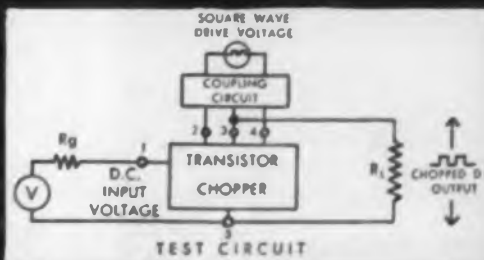
Digital meters.

Portable equipment.

Low power source equipment.

Minimum maintenance equipment.

Multiplex switching equipment.



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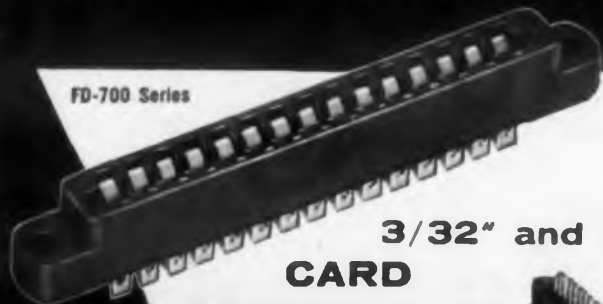
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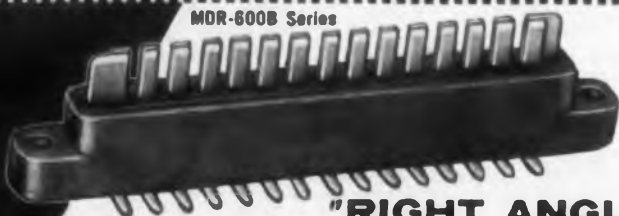
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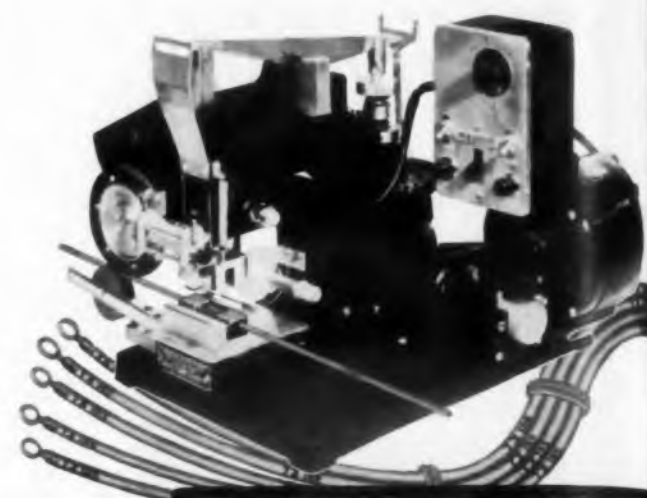
REPORT BRIEFS

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.*



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ELECTRONIC DESIGN • July 22, 1959

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 μ sec rise time and a continuously variable width from 25 μ sec to 12 μ sec. 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

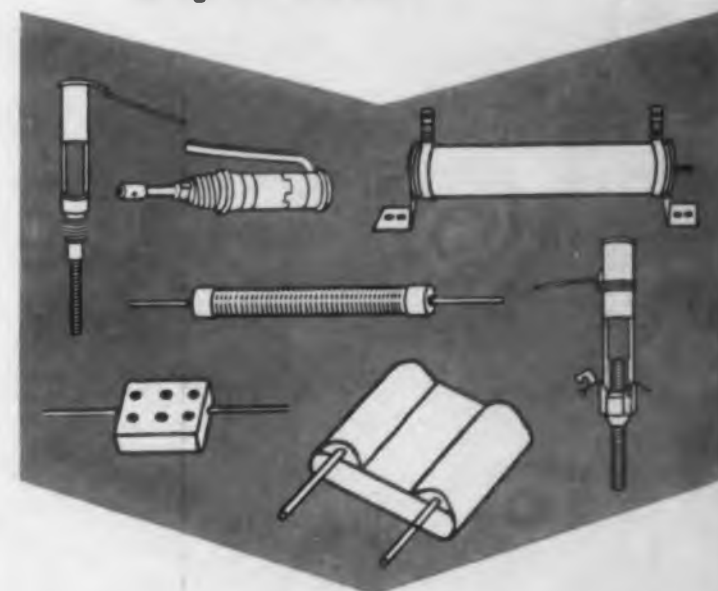
The development of an impulse noise generator, capable of being used as a standard for noise figure measurements of system, more specifically radar receivers, is discussed. The complete system is outlined in block diagram form. The component parts are considered in detail and evaluated, and finally, 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.

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- Model 29-104—Molded phenolic insulating washers.

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Time resolutions of minutes, tenths of minutes or seconds.

Available with one parallel, binary-coded-decimal electrical output or up to three parallel, decimal electrical outputs.

Flexible control features permit use of Chrono-log Digital Clocks and Digital Calendars in all logging, computing and programming systems.

CHRONO-LOG CORPORATION
Box 4587 Philadelphia 31, Penna.

CIRCLE 121 ON READER-SERVICE CARD

NEW Universal IMPEDANCE BRIDGE

Replaces the Famous Type 650-A

COMPLETELY TRANSISTORIZED
GREATLY INCREASED RANGES

FEATURES

- New Orthonull* Balancing Mechanism eliminates sliding null effect; simplifies rapid balancing; avoids false nulls.
- RANGES: R: 1 milliohm to 10 megohms
C: 1 $\mu\mu\text{f}$ to 1,000 μf
L: 1 μh to 1,000 h
D: 0.001 to 50 at 1 kc
Q: 0.02 to 1,000 at 1 kc
- ACCURACY: R, L and C $\pm 1\%$
D and $\frac{1}{Q} \pm 5\%$
- POWER SUPPLY: 4 D-type batteries for d-c and 1 kc oscillator a-c measurements. Panel meter null indicator for BCT d-c and a-c.



Type 1650-A
IMPEDANCE BRIDGE:
\$440

Write for the Universal Impedance Bridge Bulletin

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

Broad Avenue at Linden, Ridgefield, N. J. NEW YORK AREA 1000 N. Seward St. NEW YORK, N. Y.
8055 13th St., Silver Spring, Md. WASHINGTON, D. C. 1150 York Road, Abington, Pa.
1182 Los Altos Ave., Los Altos, Calif. SAN FRANCISCO 6605 W. North Ave., Oak Park, Ill.
In CANADA: 99 Floral Parkway, TORONTO 15

CIRCLE 122 ON READER-SERVICE CARD

CIRCLE 467 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, in-

creased 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

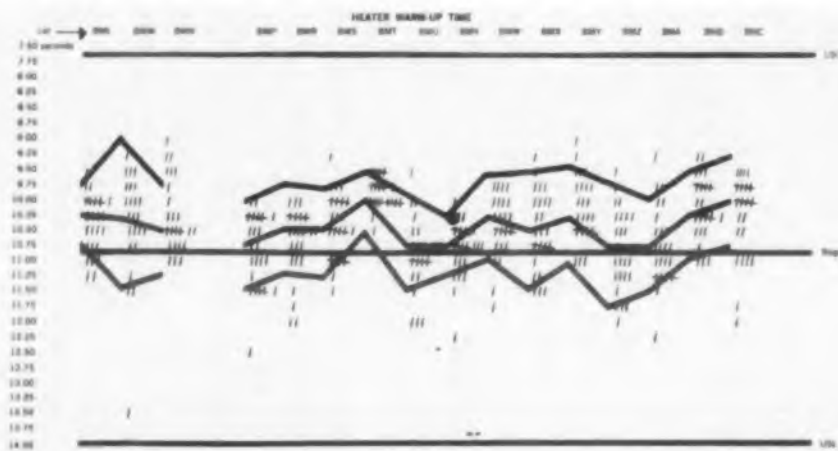


Improved Sylvania oscilloscope CRT, type 3ASPI

Oscilloscope designers can obtain all the advantages of present 3-inch oscilloscope CRT's plus these added features with the new 3ASPI:

- **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



Picture of Reliability—Actual graph of mixed variable-attribute inspection shows how individual tube lots meet a particular specification

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

New variables inspection procedure gives a quantitative picture of the reliability of each important characteristic in Gold Brand Tubes

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 cut-off 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.



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Jet Age Choice—Sylvania Gold Brand tubes—Over 27 Sylvania types are in use in Pan American Boeing 707 Jet Airliners

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 thyatron	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

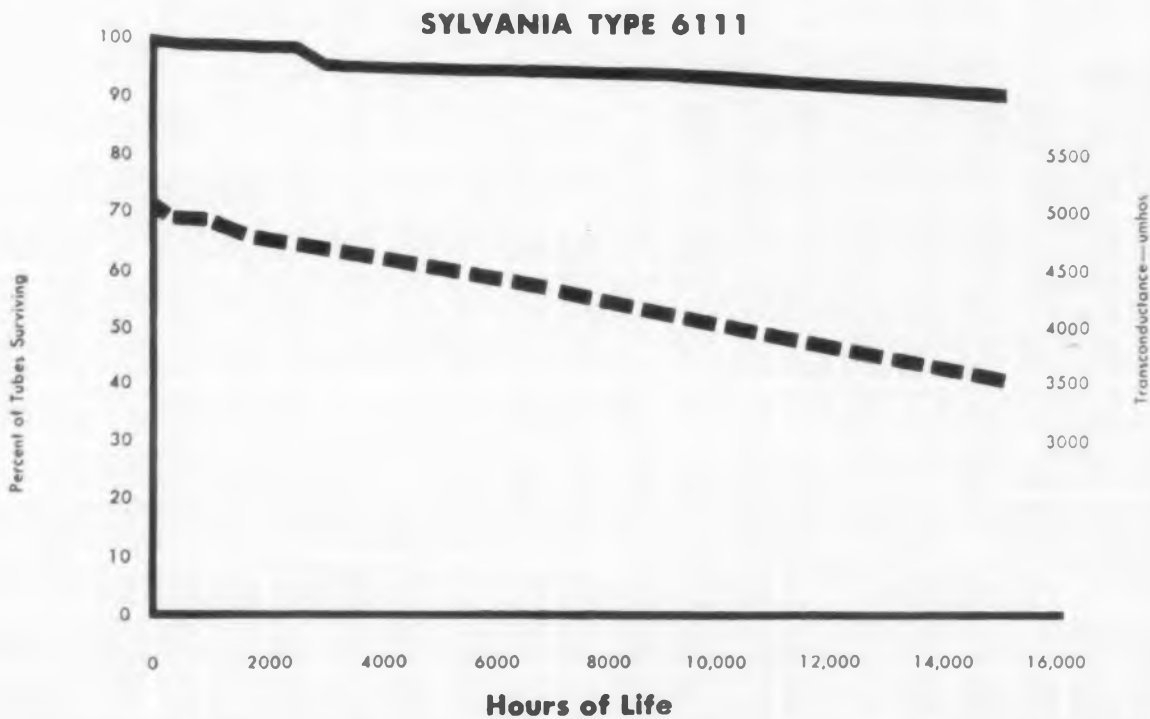
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1100 Main St.
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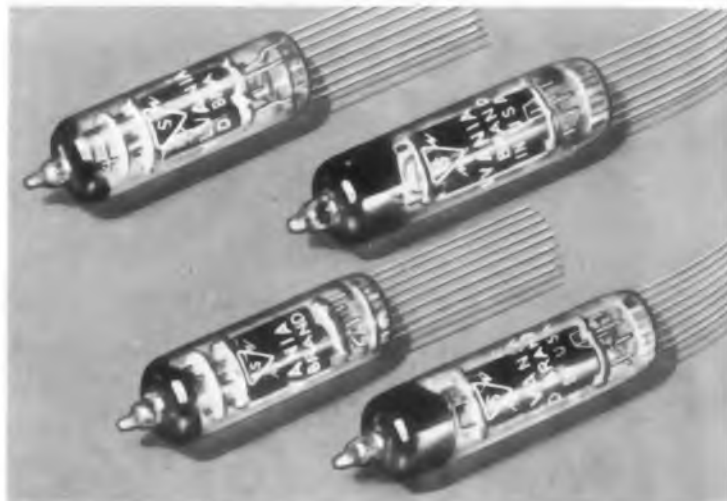
New test results show the outstanding capability of premium Gold Brand subminiature tubes

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:

- | | |
|-----------------------------------------------------------|---------------------------------------------------------------------|
| <input type="checkbox"/> New Bonded Shield Picture Tube | <input type="checkbox"/> Gold Brand Industrial and Commercial Types |
| <input type="checkbox"/> New Industrial & Military CRT's: | <input type="checkbox"/> Gold Brand Guided Missile Types |
| <input type="checkbox"/> Type SC2782 | <input type="checkbox"/> Gold Brand Premium Subminiatures |
| <input type="checkbox"/> Type 3ASP1 | |

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Use this handy business reply card to request additional information on these important new Sylvania developments

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A TYPICAL BEKEY CUSTOM MOTOR DESIGN PROJECT

BEKEY Custom 120-pole hypersyn[®] 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, hysteresis motor with induction start and permanent magnet excitation for synchronous operation.

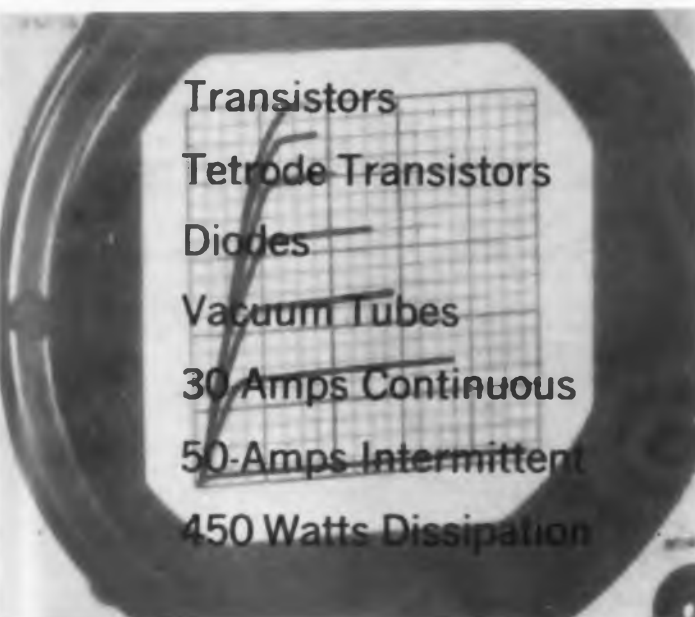
Bekey specializes in highly efficient, custom rotating equipment. Motors and generators can be designed to operate on any frequency, voltage or speed; in any ambient; and can be built in any shape. No requirement too specialized or small. Custom Hypersyn motors, 75% to 90% efficient, can be delivered in 60 days with no charge for tooling! Inquire today!

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Genisco, Inc.
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CIRCLE 123 ON READER-SERVICE CARD

NEW CURVE TRACER with Tube Adapter



For complete information
write for bulletin #TT108.

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33 UNIVERSITY RD
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Visit B/A booth at
WESCON, Aug. 18-21



CIRCLE 124 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1959

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 miniifying 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 Transitions

Manufacturers of microwave components and assemblies may use Intospace 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.

Intospace Corp., Dept. ED, 135 Orange St., Bloomfield, N.J.

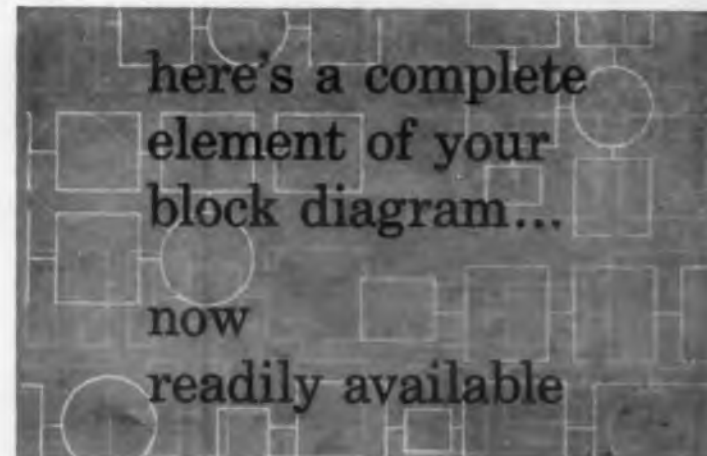
CIRCLE 126 ON READER-SERVICE CARD

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.

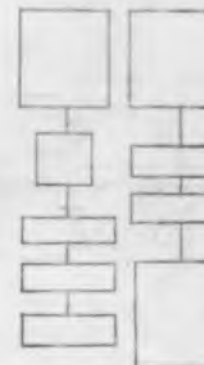
Defense and Technical Products Div., Rheem Mfg. Co., Dept. ED, La Jolla, Calif.

CIRCLE 127 ON READER-SERVICE CARD



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.



ELECTRONICS, INC.

2979 N. Ontario St., Burbank, Calif.
Formerly NYT ELECTRONICS, INC.

CIRCLE 128 ON READER-SERVICE CARD



UNDECIDED...

about which pot cores are best for filter applications?

Leading makers of high quality filters for sharp cut-off and multiplexing applications specify professional quality . . . low loss pot cores made by Ferroxcube — the only U. S. producer supplying winding bobbins . . . mounting hardware and adjusting devices to complement its product. Ferroxcube pot cores are adjusted, measured and grouped to provide effective permeabilities within $\pm 3\%$, $\pm 2\%$ or $\pm 1\%$ of mean values. Available from $\frac{5}{8}$ " to $1\frac{1}{4}$ " diameter. Complete technical and sample kit information supplied on request.

Say
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when you
need ferrite.



FERROXCUBE

CORPORATION OF AMERICA

50 East Bridge Street, Saugerties, New York

CIRCLE 129 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, light-house-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.

Machlett ML-7351

A New High Sensitivity Vidicon



Machlett Laboratories offers the designer a new, small, high sensitivity television camera tube designed primarily for low light level viewing of subjects with limited motion in industrial CCTV and other applications where some signal integration is desirable. Its radiant sensitivity at .08 μA dark current is .25 $\mu\text{A}/\mu\text{W}$.

Using a photoconductive layer as its light sensitive element, the ML-7351 permits televising scenes with about 0.1 foot-candles illumination on the faceplate of the tube, which may be contrasted to approximately 5 foot-candles scene illumination required when using an f/2 lens. Its resolution capability is about 500 line.

Applications include observation of low contrast, slow moving phenomena, visualization of radar patterns and other instances where increased image retention and sensitivity are desired. Spectral response includes the region from about 5000-8400 angstrom with a peak at 6400. At this point the tube is about ten times as sensitive and its image persistence roughly twice that of the 6198.

Pertinent tube characteristics include:

Deflection and Focusing	Magnetic
Signal-Electrode Voltage	10 to 25 volts
Grid No. 4 (Decelerator) & Grid No. 3 (Beam Focus) Voltage	250 to 300 volts
Grid No. 2 (Accelerator) Voltage	300 volts
Grid No. 1 Voltage (For picture cutoff)	-45 to -100 volts
Highlight Signal-Output Current	0.2 to 0.4 μamps
Maximum Dark Current	0.08 μamp

Uniform 2870°K Tungsten Illumination on Tube Face to Produce	
Signal-Output Current of 0.1 to 0.2 μamp	0.1 to 0.3 ft-c
"Gamma" of Transfer Characteristic	0.6 to 0.7

For full technical data on this or any other Machlett tube type, write:

Machlett Laboratories, Inc., 1063 Hope Street, Springdale, Connecticut

CIRCLE 133 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1959

Transistor Heat Dissipator

131
The 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

132
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.

THERE'S NO EXCUSE!



. . . for inaccurate resistance measurements: Millivac's Direct-Reading Ohmmeter has an accuracy of 1%!

All at once, the majority of direct-reading resistance meters seem old-fashioned. In one giant stride, Millivac has advanced Direct-Reading Ohmmeters many years by the creation of an instrument with an heretofore unheard of accuracy: 0.25% full scale . . . 1% part scale (absolute), over 11 measuring ranges, from 1 ohm to 1 megohm. Outstanding among the many new ideas introduced in Millivac's new Model MV-279A Direct-Reading Ohmmeter is the use of constant current as a power source for measurements . . . and a linear scale that enhances accuracy by several orders of magnitude. Write today for full details.

tomorrow
is our
yesterday

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CIRCLE 139 ON READER-SERVICE CARD

NEW NEW

MULTIMEGAWATT SWITCHES for radar applications



AMCI
Type 1038-HV
for 6 1/8" lines
Type 1136-HV
for 3 1/8" lines

For use in Rigid Coaxial
Transmission-Line
Systems at VHF and UHF

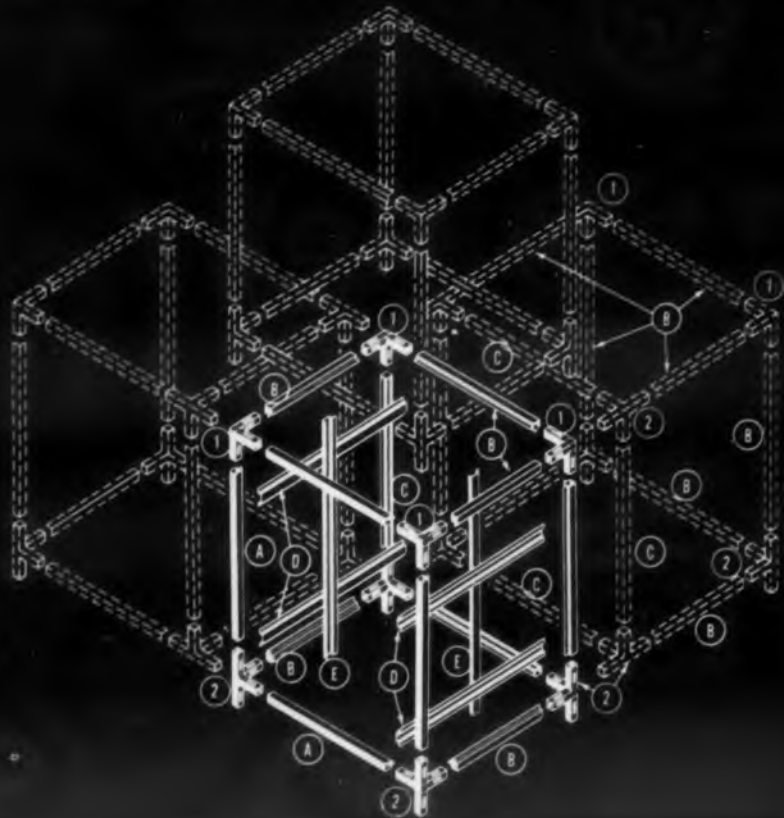
CW rating is approximately that of the mating transmission lines. Switches available in either motor-driven or manually operated models.

Write for
complete information
on AMCI
Coaxial Switches



CIRCLE 138 ON READER-SERVICE CARD

MODULAR ALUMINUM INSTRUMENT ENCLOSURES



Any size from 7" to 20' is standard



The newest idea from AMCO is a system of aluminum frames! The big advantages are outstanding convenience and versatility!

Another example of Amco's concern with customer requirements is this latest addition to the Amco Modular Instrument Enclosure Systems. It's a uniquely flexible modular aluminum frame that can be assembled to any desired height, width or depth from 7" to 20' from standard units. No tools required for assembly. Within minutes, you can assemble most any size frame from only 7 stocked parts.

Amco aluminum castings serve as corners, tie frame box extrusions together by means of ears which slip into the extrusions, lock there with locking clips. Corners are permanent-mold cast of #356-T6 aluminum alloy. Extrusions are made from #6061-T6 aluminum alloy.

Extrusions are available in full 20-foot lengths, or pre-cut and mitered to any specified length. Extrusions are flanged on one, two and three sides, supplied with or without holes for panel mounting. These, to-

gether with both vertical and horizontal channel extrusions give complete mounting versatility, make it possible to recess panels to any depth, or flush-mount panels of any thickness. 3-ear corners for single cabinet construction and 4-ear corners for multiple cabinets are supplied with all needed locking clips. That's all you need to stock—five extrusions and two types of corners—and you can count on getting them *fast* with Amco's realistic 3 week delivery! Panels can also be ordered from Amco, or made from sheet aluminum purchased locally.

WRITE FOR
SUPPLEMENT-A
TO CATALOG 201



AMCO ENGINEERING CO.
7333 W. Ainslie St., Chicago 31, Illinois



Factory-trained representatives in all principal U.S. cities and Canada
CIRCLE 140 ON READER-SERVICE CARD

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-miniature 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.

NEW Transistorized Relay Combines Fine-Sensitivity with Heavy-Duty Construction

Cutler-Hammer has developed a heavy-duty transistorized A-c relay which will respond to either an A-c or D-c signal between .0028 and .025 amperes. The heart of this compact relay is the plug-in type signal-amplifying module which contains all the electronic parts. This tough module is practically indestructible, and the plug-in design simplifies maintenance... cuts downtime to a minimum. The Bulletin 13535 transistorized relay requires no warm up time and it is exceptionally quick in operation. 600 volt model offers a wide selection of contact arrangements... rated 15 amperes. 110 volt model rated 10 amperes. Prices unusually low. Cutler-Hammer also offers conductive liquid level probes, and photo-cell units for use with the transistorized relay.



Write today for
Bulletin 13535-N217
CUTLER-HAMMER Inc.,
Milwaukee 1, Wisconsin



CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wis. • Division Airborne Instruments Laboratory • Subsidiary Cutler-Hammer International, C. A.
Associated: Canadian Cutler-Hammer Ltd., Cutler-Hammer Mexicana, S. A., Intercontinental Electronics Corporation

CIRCLE 144 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1959

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 Transcoil Div., Worcester, Montgomery County, Pa.

Analog-to-Digital Recorder 149

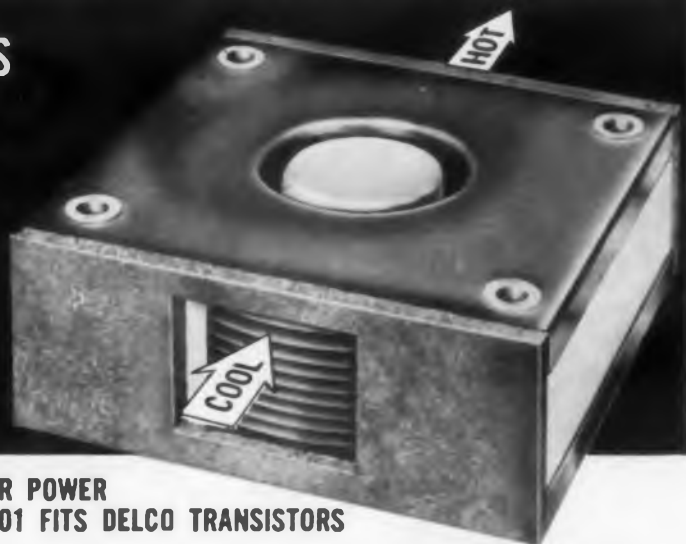
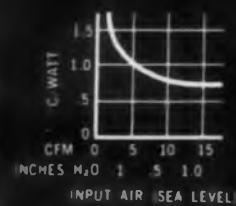
Catalog 35-1541, eight pages, describes a shaft-input device that converts and records analog values in digital binary-decimal punched tape form and provides digital values in electrical form for telemetering. Fischer & Porter Co., 151 Jacksonville Rd., Hatboro, Pa.

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-COOLS TRANSISTORS

GETS 46 WATTS
AT ROOM
TEMPERATURE



NEW HEAT EXCHANGER FOR POWER TRANSISTORS, MODEL LF-101 FITS DELCO TRANSISTORS

46 watts at room temperature are obtained under these conditions: 95°C junction temperature; thermal impedance of .8°C/W from junction to stud root, and .7°C/W between stud root and input air caused by the LF-101 (see above graph).

Send for complete data and informative paper, "Temperature Control in Electronic Equipment."

Gasket manufacturing company, inc.
DEPT. E 319 W. 17TH STREET, LOS ANGELES 15, CALIF.

This product featured in May 27, 1959 issue, pg. 122.

CIRCLE 151 ON READER-SERVICE CARD



"Congratulations, Doctor, that was a remarkable operation..."



"Thank you... but I'm not really a doctor... I'm a microwave engineer."



"Oh? And do you think everyone should be a microwave engineer?"



"No... I think people should decide for themselves... But I do think all microwave engineers should use..."

MICROWAVE ASSOCIATES WINDOWS

... they insure mechanical ruggedness, reliable, low-loss hermetic sealing, resistance to wide cycling of temperature and pressure. Typical applications:

COMMON CARRIER (4000 Mc) Mica pressure windows built on a standard flange. Ready to install in any system.

MICROWAVE RELAY LINK (6000 Mc) Mica pressure seals. All-weather protection for systems from Texas to the Arctic. Built on a standard flange.

INVAR REFERENCE CAVITIES — Glass-Kovar pressure windows especially designed using *Flexframe** construction to resist breakage.

A complete line of windows, including designs for these specific areas is described in our new bulletin 59W. Included are mechanical and electrical characteristics and improved testing procedures.

We will design and deliver microwave windows to your specifications. Please write or call:

*MA's new shock-resistant window-mount.

MICROWAVE ASSOCIATES INC.

BURLINGTON, MASSACHUSETTS BROWNING 2-3000



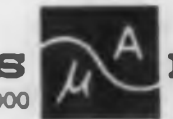
MA-1474



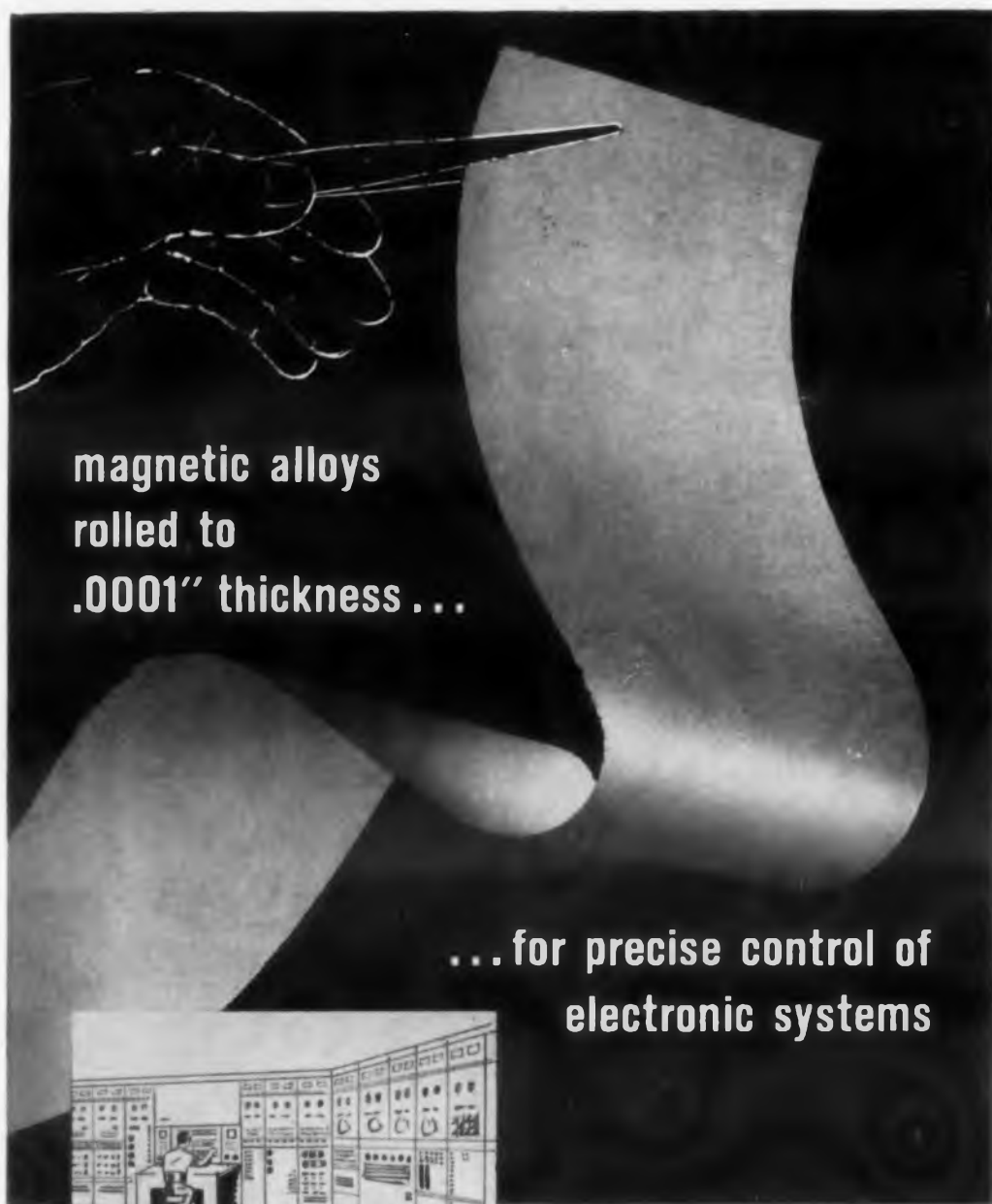
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MA-904

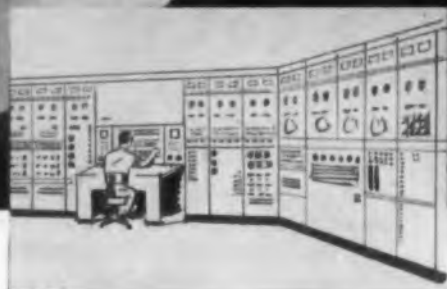


CIRCLE 152 ON READER-SERVICE CARD



magnetic alloys
rolled to
.0001" thickness...

...for precise control of
electronic systems



Now you can obtain high magnetic permeability alloys such as 4-79 Moly Permalloy, Alfenol, and HyMu "80" in cold rolled strip and foil in production quantities! The unique and newly expanded facilities of Precision Metals Division are geared to produce ultra-thin metal strip and foil in any quantity and in virtually any alloy.

Precision Metals strip and foil for development and production offer these special advantages:

uniform magnetic properties
thicknesses from .010" to .0001"
dimensional uniformity

extremely close tolerances
excellent surface characteristics

For specific requirements, Precision Metals can also furnish custom alloys to your own specification in the form you need. Write today for fully illustrated facilities booklet, ED-7.



HAMILTON

WATCH COMPANY / Precision Metals Division

Lancaster, Pennsylvania
CIRCLE 153 ON READER-SERVICE CARD

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

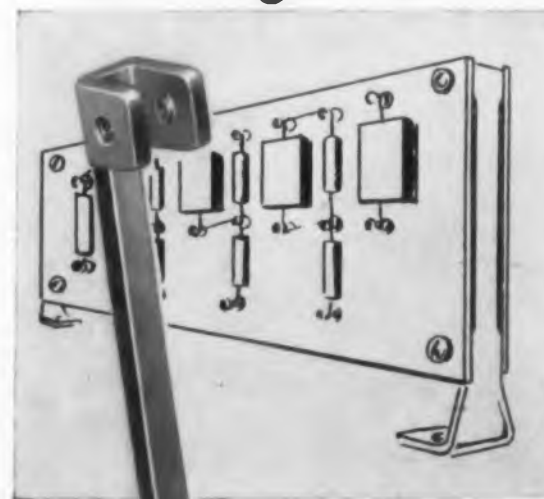
156

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.

New Augat Panel Mounting Brackets



offer unique
extruded-thread
feature

Newest addition to the Augat line, these panel mounting brackets provide rigid support for vertically-mounted component boards under shock and vibration. The special feature of this bracket is five extruded

holes to provide four full threads, meeting military specs.

Brackets mount either single or double boards and are available in different heights to mount various size panels. Fabricated from cold rolled steel, cadmium plated.

Write today for additional information and samples.

AUGAT BROS. INC.

31 PERRY AVENUE • ATTLEBORO, MASS.
CIRCLE 157 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 195

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

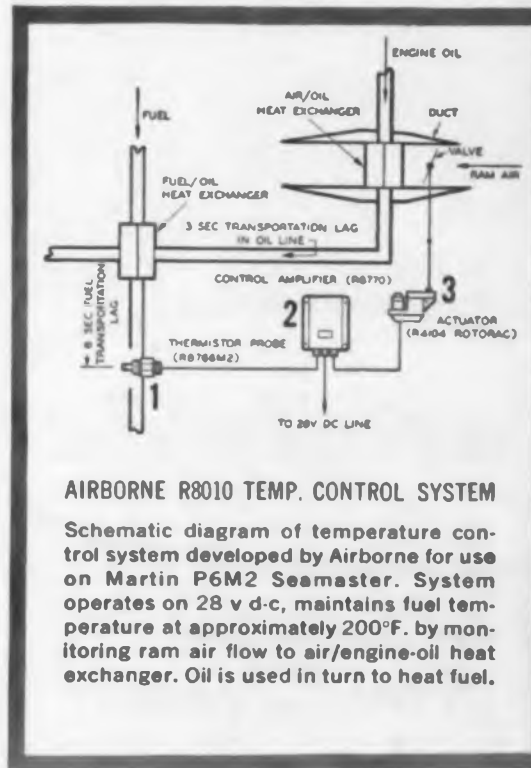
This technical data sheet describes model K5-M multiplier-divider. Contained in the sheet are general specifications, and a description of the unit, application notes and pictorial information. George A. Philbrick Researches, Inc., 285 Columbus Ave., Boston 16, Mass.

Toggle Switch 162

This one-page data sheet No. 158, describes an ultra-small toggle 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.



AIRBORNE R8010 TEMP. CONTROL SYSTEM

Schematic diagram of temperature control system developed by Airborne for use on Martin P6M2 Seamaster. System operates on 28 v d-c, maintains fuel temperature at approximately 200°F. by monitoring ram air flow to air/engine-oil heat exchanger. Oil is used in turn to heat fuel.

Airborne electromechanical system regulates jet fuel temperature

An integral part of each main engine installation on the Martin P6M2 Seamaster is an Airborne R-8010 custom-engineered temperature control system. By regulating air flow through a heat exchanger, this system maintains supply line fuel at 180-220°F.

As developed for the P6M2, the R-8010 system consists of a thermistor probe, a control amplifier and a rotary actuator. The probe (mounted in an MS10057-12 fitting) is in direct contact with the temperature-regulated fuel and presents to the control box a resistance which is proportional to fuel temperature. In response, the control box energizes the actuator to change the setting of a ram air intake valve, thus regulating volume of air flow through an air/fuel heat exchanger. This sensing and response continues until prescribed fuel temperature

is attained, at which point the system reaches a state of electrical balance.

A fail-safe feature is also provided. In the event of power failure, a magnetic clutch in the actuator is released, permitting the air valve to be pushed open by the force of the ram air.

This application* on the P6M2 illustrates only one of many possible adaptations of the Airborne R-8010 system for temperature control functions on aircraft, missiles and related equipment—cabin temperature control, engine temperature control, temperature regulation of fuel, oil, electronic cooling packages, etc. If you have requirements in these areas, we will be happy to make a proposal. Contact any of our offices.

*Described in detail in new Bulletin PS-4A, available on request.

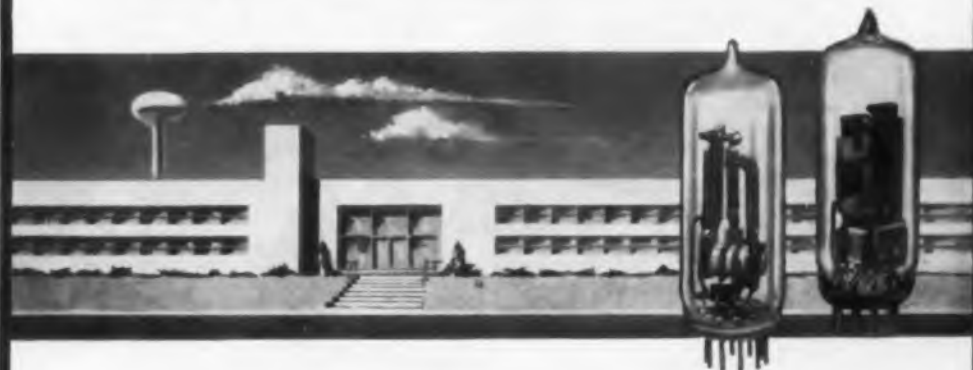


Engineered Equipment for Aircraft and Industry

AIRBORNE ACCESSORIES CORPORATION

HILLSIDE 5, NEW JERSEY • Offices in Los Angeles and Dallas
CIRCLE 165 ON READER-SERVICE CARD

MINIATURE TIME DELAY RELAYS



Low-cost for commercial applications

Curtiss-Wright offers a reliable and inexpensive thermal time delay relay in the "G" and "K" Series—miniature size hermetically sealed in glass.

The Components Department also manufactures digital (stepping) motors, ultrasonic delay lines, and other units for electronic systems.

WRITE FOR COMPLETE COMPONENTS CATALOG 159

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • WEST CALDWELL, N. J.

CIRCLE 164 ON READER-SERVICE CARD



now available

at new low prices — same high quality

Thanks to advanced production techniques, these space-saving modern meters are now offered at prices that are competitive with old-fashioned meters.



* MODEL 1145

side indicators



* MODEL 1135



MODEL 1120



Save space on crowded, complex panels without sacrificing readability or accuracy. Model 1145 provides accuracy and scale length of conventional 4½" meters with ½ the panel area and far less weight . . . Model 1135 compares with conventional 3½" meters. For horizontal or vertical mounting. Feature dust-proof cases with clear plastic covers. Center, top or bottom zero position and other variations so pointer movement will conform with "human engineering" principles. Side indicator panel meters are an original International Instruments development, and *only* International offers you a complete line with scale lengths of 2.7", 2.1" and 1.2"! Supplied in a wide variety of standard and special ranges.

**VISIT OUR BOOTH NO. 2813
AT THE "WESCON" SHOW**

WRITE NOW FOR ENGINEERING DATA SHEETS
... on Side Indicators and also on our 1½" Ruggedized Meters, 1" and 1½" Panel Meters, VU, DB and Illuminated Meters, and Miniature Multitesters. Sub-miniature Rotary and Lever Switches. P.O. Box 2954, New Haven 15, Connecticut. Cable: "INTERINST"

*PATENTED

MINIATURIZATION HEADQUARTERS



international instruments inc.

CIRCLE 166 ON READER-SERVICE CARD

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.

Precision-Produced MATERIALS for TRANSISTORS and DIODES

Specialists in the Unusual

GOLD doped with N-type or P-type elements — supplied in the form of wire, sheet or ribbon and cut or stamped pieces.

INDIUM electroplated base or precious metal wires.

WELDED RIBBONS — Dissimilar metal ribbons of the same width can be continuously welded together, within close overlap tolerances.

Write for List of Products

SIGMUND COHN CORP.
121 SOUTH COLUMBUS AVE., MOUNT VERNON, N. Y.

CIRCLE 173 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1969

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

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

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.

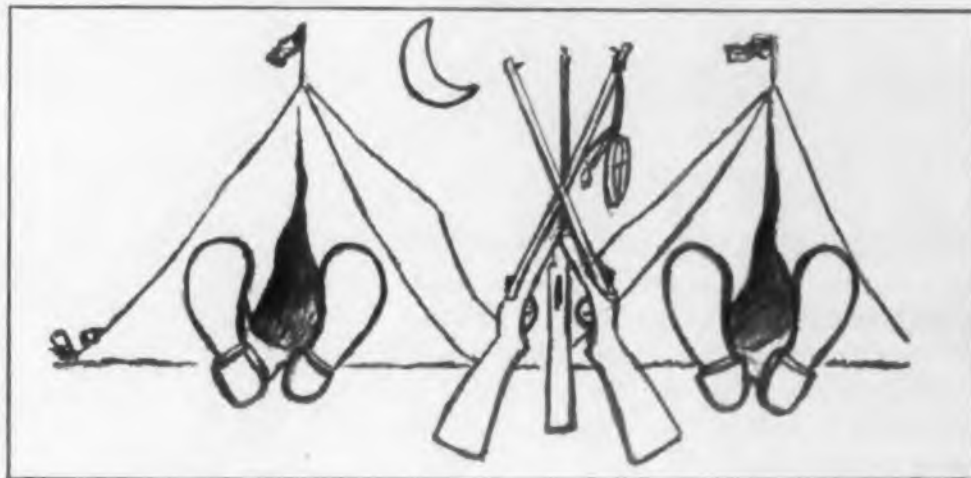
Recorder/Reproducer

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 Electro-dynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.

Encapsulation

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.

SIGMA RELAY FOR MILITARY EQUIPMENT NOW TWICE AS SENSITIVE; DESIGNERS GET TWO WEEKS OFF

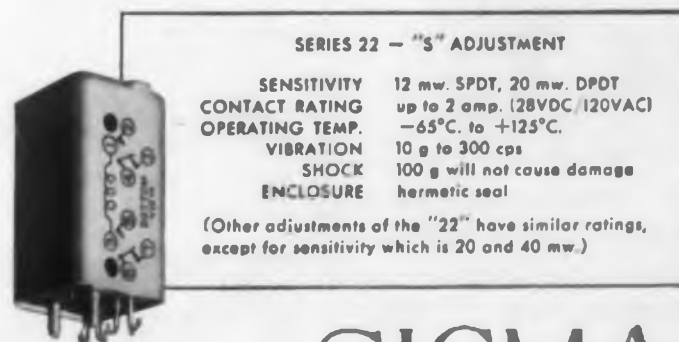


Sensitive relays* have very little company these days, as they continue to do the same job they always have, but on less and less take-home power. There was a time when you could say a relay was sensitive if it would operate around 50 milliwatts or so; now, it has to do the same work on about half as much coil power. Alas, the price of Progress she comes high...

With this philosophy firmly implanted, our Chief Sensitivity Engineers took a perfectly good "military" Sigma relay of fairly wide application success and attempted to make it more sensitive, without impairing any of its other characteristics. The fruits of their labors is a new adjustment which is twice as sensitive as the original relay, since the required operate power is only half as much as the old style which is also still available if you've got double the number of milliwatts to play with as anyone else currently building military gear.

With the sensitivity question all straightened out, these two Chiefs were given their just reward and flown by privately chartered aircraft to a secluded spot for the vacation they so richly deserved. Found among the papers they left behind were the following additional facts, which may be of interest to anyone who has to squeeze an SPDT or DPDT relay into 1.75 cubic inches and have it work on next to nothing, in airborne and similar environments.

*(unlike other people)



SERIES 22 - "S" ADJUSTMENT

SENSITIVITY	12 mw. SPDT, 20 mw. DPDT
CONTACT RATING	up to 2 amp. (28VDC/120VAC)
OPERATING TEMP.	-65°C. to +125°C.
VIBRATION	10 g to 300 cps
SHOCK	100 g will not cause damage
ENCLOSURE	hermetic seal

(Other adjustments of the "22" have similar ratings, except for sensitivity which is 20 and 40 mw.)

Series 22 bulletin on request, but you may have to wait a little while until everyone gets back to work—annual plant shut-down takes place the first two weeks of July.

SIGMA

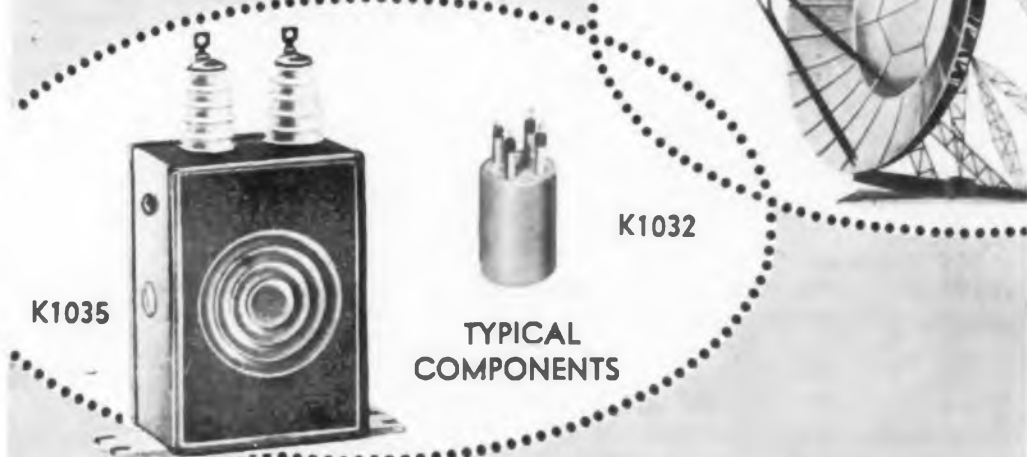
SIGMA INSTRUMENTS, INC.
91 Pearl Street, So. Braintree 85, Mass.

AN AFFILIATE OF THE FISHER-PIERCE CO. (Incorporated)

CIRCLE 179 ON READER-SERVICE CARD

129

LINEAR PULSE TRANSFORMERS for COMPUTER-RADAR and VIDEO circuits



K1035

TYPICAL
COMPONENTS

K1032

K1035 Pulse Impedance matching transformer 0.1 - 1.0 usec.; 1320 p.p.s.; 75/1000. ohms.

K1032 Pulse Charging Reactor 3.5hy/75ma; 200 - 1000 p.p.s.; 7kv.pk.

keystone PRODUCTS COMPANY
SPECIALISTS IN PRECISION MAGNETIC COMPONENTS

904-6 TWENTY-THIRD STREET UNION CITY, NEW JERSEY
UNION 6-5400

CIRCLE 178 ON READER-SERVICE CARD

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

Toward Greater Reliability



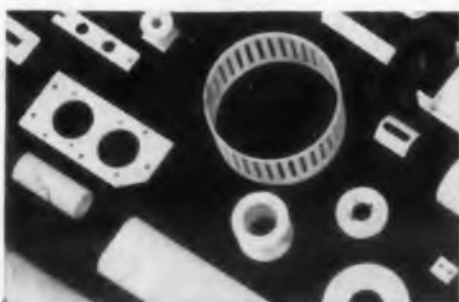
Silicone-Glass Laminate Proves More Dependable in Rough Environments

Schlumberger Well Surveying Corporation, makers and operators of geophysical well-logging instruments, found terminal boards of silicone-glass laminate more reliable in service and easier to fabricate. The instrument shown has a working range up to 194 C amid high humidity environments. In Schlumberger's evaluation tests, here's how a laminate based on Dow Corning silicone resins stacked up against other materials.

Silicone vs. phenolic: Silicone laminate had superior and more uniform dielectric properties at high environmental temperatures. Silicone laminate had lower moisture absorption: approximately 0.02% as compared with 2% for phenolic. Silicone laminate had much better dimensional stability than phenolic laminates.

Silicone vs. bonded mica sheeting: Once again, silicone-glass was chosen for its satisfactory dielectric characteristics. Silicone laminate also proved easier and less expensive to fabricate and install than mica because of mica's fragility.

Other plus properties of silicone-glass laminates include stability at 250 C, low loss factor, good physical strength, ease of fabrication, light weight, resistance to arcing, ozone and corona, and permissibility of adjacent soldering.



TYPICAL SILICONE LAMINATE PARTS

What all these add up to is greater reliability. If you are faced with the problem of engineering an electronic unit that will remain failure-free in difficult environments, investigate silicone-glass laminates. Manufacturers of quadradar sets, rotary switches, test chambers, and radio transmitters, to name but a few, have found these laminates meet or exceed their needs.

CIRCLE 600 ON READER-SERVICE CARD

Here are some sample data:

Properties of Silicone-Glass Laminates

Property	Range
Flexural Strength, flatwise, psi, 1/8-inch thickness	
Lengthwise	20,000 - 40,000
Crosswise	18,000 - 33,000
Izod impact strength, edgewise, ft-lb per inch notch	
Lengthwise	6.5 - 17.0
Crosswise	5.5 - 14.0
Bonding strength, lbs., 1/2" thickness	
Condition A	650 - 1100
Condition D-48/50	550 - 950
Dielectric breakdown parallel to laminations, step-by-step test, kv.	
Condition A	32 - 50
Condition D-48/50	15 - 35
Dielectric constant at 1 megacycle, 1/8-inch thickness	
Condition A	3.90 - 4.20
Condition D-24/23	3.95 - 4.20
Dissipation factor at 1 megacycle, 1/8-inch thickness	
Condition A	.0015 - .003
Condition D-24/23	.008 - .022
Arc resistance, seconds	
Condition A	180 - 292
Condition D-48/50	180 - 248
Volume resistivity, meg-cm.	
Condition C-96/35/90	1 x 10 ¹¹ - 4 x 10 ¹²
Surface resistivity, megohms	
Condition C-96/35/90	10 - 10,000



Dow Corning
CORPORATION
MIDLAND, MICHIGAN

...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.

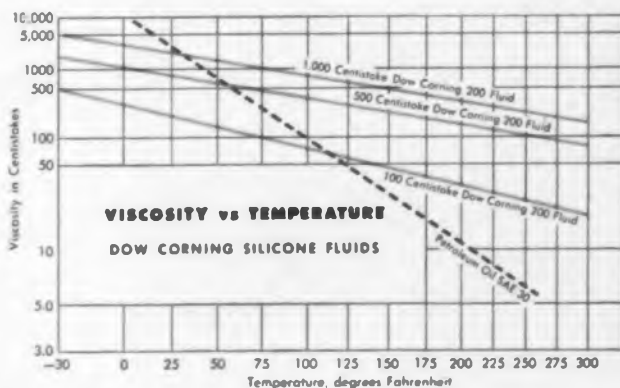
PHOTO COURTESY VARIAN ASSOCIATES

CIRCLE 601 ON READER-SERVICE CARD

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.



Grease-Like Silicones Boost Transistor Dependability...

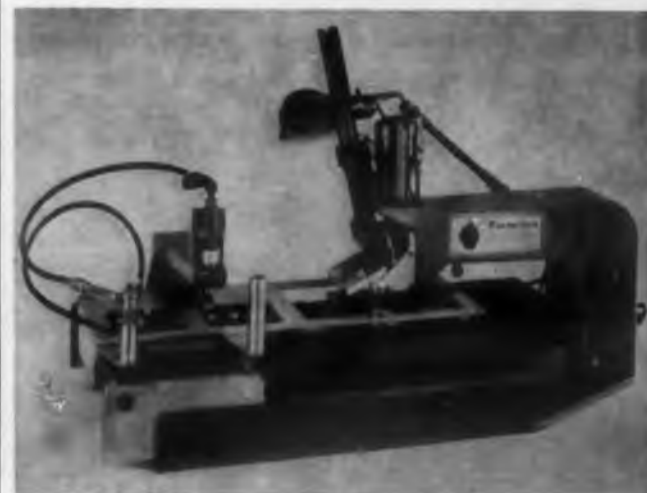
Dow Corning silicone compound is ideal for potting transistors. It seals out moisture and conducts heat away rapidly. In addition, it reduces rejection rates by preventing metal splatter from reaching the transistor wafers when caps are welded in place. These silicone compounds don't melt, don't thicken, 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

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 Flag-matic 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.

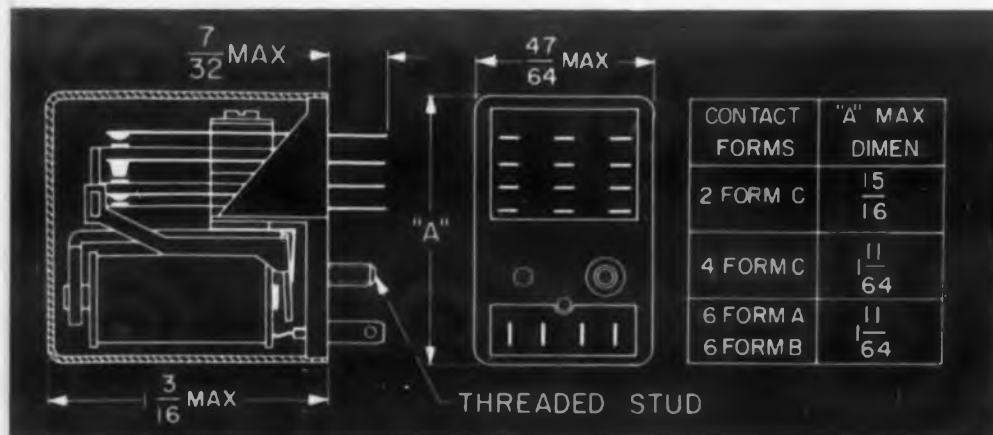
CIRCLE 184 ON READER-SERVICE CARD

MINIMUM SIZE Maximum Dependability LOW COST



ACTUAL SIZE

The new T-154 relay is now being manufactured by Allied Control at Plantsville, Conn.



General Features:

Operate Sensitivity:

From 90 milliwatts for 1.3 ohm coil to 160 milliwatts for 15,000 ohm coil up to 2 Form C

From 200 milliwatts for 1.3 ohm coil to 400 milliwatts for 15,000 ohm coil up to 6 Form A

Coil Resistance: Up to 15,000 ohms

Coil Voltage: Up to 140 volts d-c

Contact Rating:

Low Level to 1 ampere 29 volts d-c or 115 volts a-c resistive. 5 ampere contacts are available

Contact Arrangement: Up to 6 Form A, B and 4 Form C

Operate and Release Time: 7 milliseconds max. at 1 watt

Shock: 10 g's

Vibration: 10 to 55 cps at .062" double amplitude

Enclosure: Dust proof and hermetically sealed

For complete information write for Bulletin T154

ALLIED CONTROL

ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N. Y.

AL 183

CIRCLE 185 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,

TELL YOUR PERSONNEL MANAGER ABOUT ELECTRONIC DESIGN'S "CAREER'S SECTION"

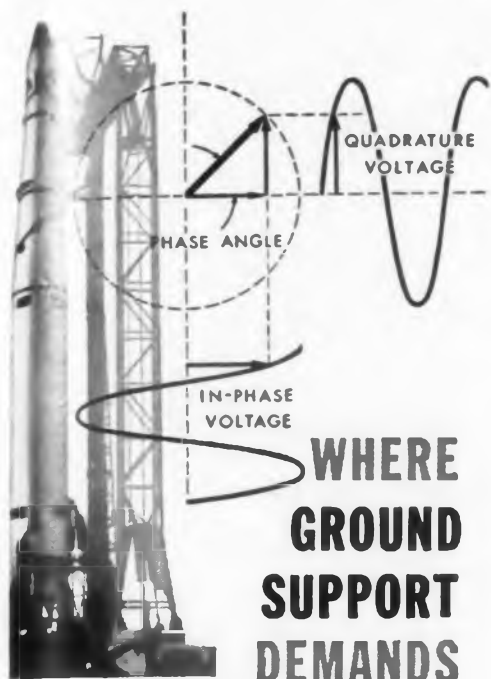
If your company is trying to attract skilled electronic design, development or research engineers, tell your Personnel Manager about ELECTRONIC DESIGN. Here is a concentrated audience of 27,000 engineers ready to read about the advantages offered by your plant.

Remember, more than 5,500 ELECTRONIC DESIGN readers inquire every issue —many of them will be interested in your job opportunities.

You can efficiently reach them in ELECTRONIC DESIGN'S "Career's Section."

CIRCLE 187 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1969



**WHERE
GROUND
SUPPORT
DEMANDS**

**DIRECT READING OF
PHASE, NULL, VOLTS**

FOR FLIGHT LINE,
PRE-LAUNCH, MAINTENANCE

**NORTH ATLANTIC
PHASE ANGLE VOLTMETER**

in one portable package, provides direct reading of in-phase volts, quadrature volts, phase angle, nulls—without accessory equipment. Compact, rugged and unaffected by harmonics—it simplifies support systems, reduces human error in test, adjustment, analysis of complex electronics.

Its accuracy and versatility (1 mv to 300 v, 0—360°) have been demonstrated in the Atlas, Polaris, Pershing and F-105 programs. It can be supplied for single frequency or broadband measurements, for dolly or console mounting, or as a module for complete checkout systems. For full specs, write for Bulletin 201.



Model 202BR,
used with Sperry SP30 Flight Director
5 1/2" by 19" x 7 1/2"

**NORTH ATLANTIC
industries, inc.**
603 Main Street, Westbury, N.Y.
EDgewood 4-1122

CIRCLE 188 ON READER-SERVICE CARD
ELECTRONIC DESIGN • July 22, 1959

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 Charle-
mont St., Newton, Mass.

CIRCLE 189 ON READER-SERVICE CARD

**Set Screw Feeder-Driver
Automatic**

Handling up to 2000 units an hour, these port-
able, 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 automati-
cally 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 Hud-
son Ave., Union City, N.J.

CIRCLE 191 ON READER-SERVICE CARD



designed
for
MICRO-
MINIATURE
SOLDERING

... the T-12-XF
by **American Beauty**

The T-12-XF Transformer Type Electric Soldering Iron is a scientifically
designed, finely engineered tool that is especially intended to do just the
kind of soldering job you see being accomplished above.

Proven best-by-test on many similar applications . . . affords extreme
flexibility . . . assures a high degree of protection to delicate, expensive
electronic components because its hypersil type transformer provides
complete line-voltage isolation.

The cord with which the T-12-XF is equipped is ultra-flexible . . .
impervious to oil, water and grit.

Tips—elements are Armco ingot iron brazed to stainless steel casings
. . . 1/8" (shown), 1/16", 1/8" and 1/4"
tip diameters, all same casing
diameters.

The featherweight, pencil type
handle minimizes operator fatigue
. . . is always comfortably cool.

AMERICAN BEAUTY Electric
Soldering Irons Are Made In ONE
Quality Only . . . The Best . . . And
Only The BEST Gives You The
MOST!



YOU CAN'T BEAT A SOLDERED CONNECTION

WRITE FOR 28-PAGE ILLUSTRATED CATALOG CONTAINING FULL INFORMATION ON OUR
COMPLETE LINE OF ELECTRIC SOLDERING IRONS—INCLUDING THEIR USE AND CARE.

202-B

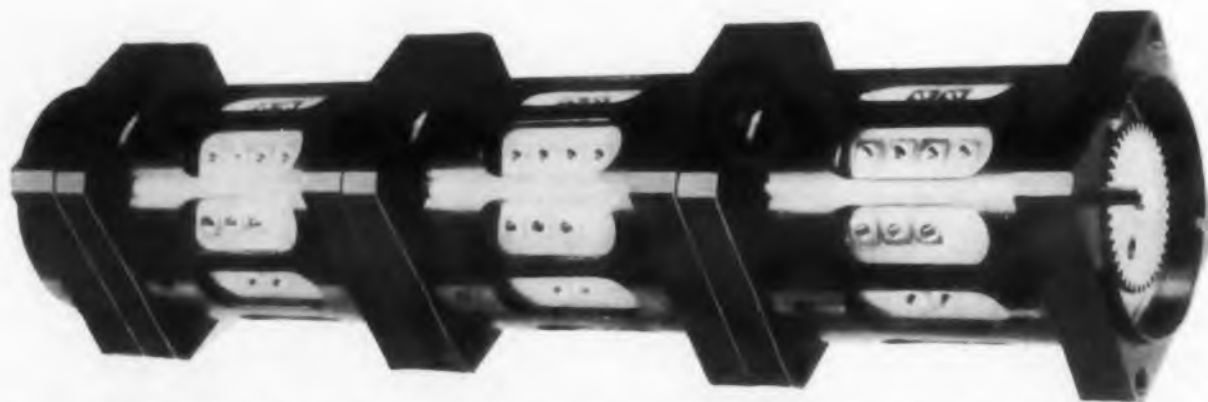
AMERICAN ELECTRICAL HEATER COMPANY

DETROIT 7, MICHIGAN

CIRCLE 192 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.

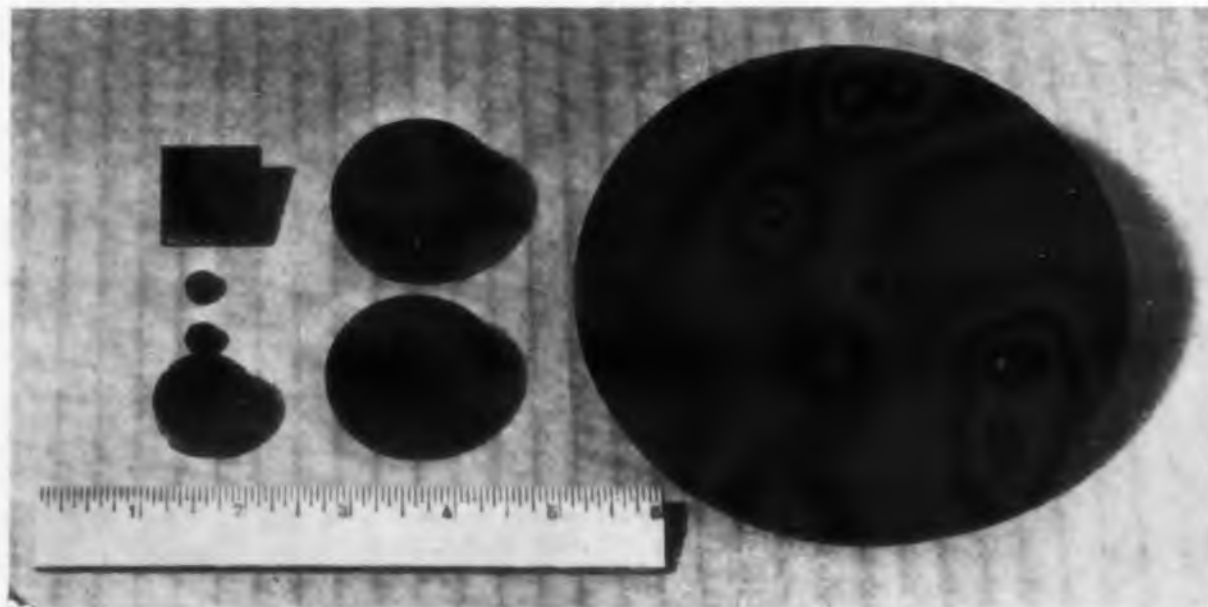


Shaft Encoder Pulses Computer Directly

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 Precisioners, Inc., Dept. ED, 23916 Craftsman Rd., Calabasas, Calif.

CIRCLE 193 ON READER-SERVICE CARD

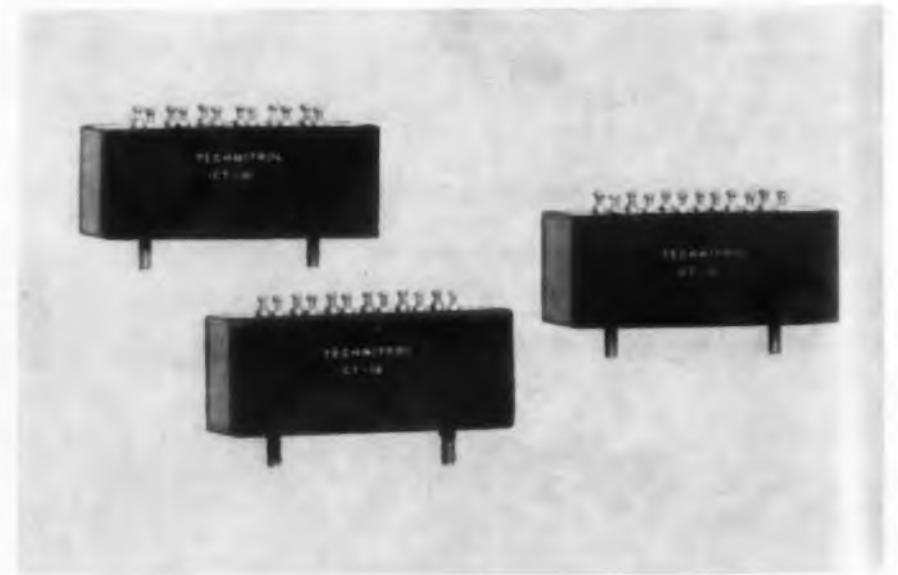


Near Infrared Filters Operate at 100 C

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



Delay Line Provides 10 Increments of $0.05 \mu\text{sec}$

Type CT-18 lumped constant delay line has 10 separate taps of $0.05 \mu\text{sec}$ each. Impedance of the unit is 550 ohms and it has a maximum rise time of $0.1 \mu\text{sec}$. Attenuation is 1 db max, and temperature range is from -25 to $+85$ C. It measures $2.5 \times 1 \times 1.5$ 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 Volta-loc. 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

*first in
Performance
Reliability
and Quality*

Kepeco

TRANSISTORIZED V.R.P.S.*

*VOLTAGE
REGULATED
POWER
SUPPLIES



Model SC-32-2.5

0.01% REGULATION STABILITY

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.
SC-32-0.5	0-32	0-0.5
SC-32-1	0-32	0-1
SC-32-1.5	0-32	0-1.5
2SC-32-1.5	0-32	0-1.5
DUAL OUTPUT	0-32	0-1.5
SC-32-2.5	0-32	0-2.5
SC-32-5	0-32	0-5
SC-32-10	0-32	0-10
SC-32-15	0-32	0-15
SC-60-2	0-60	0-2
SC-60-5	0-60	0-5
2SC-100-0.2	0-100	0-0.2
DUAL OUTPUT	0-100	0-0.2
SC-150-1	0-150	0-1
SC-300-1	0-300	0-1



Model SC-18-2M

0.1% REGULATION STABILITY

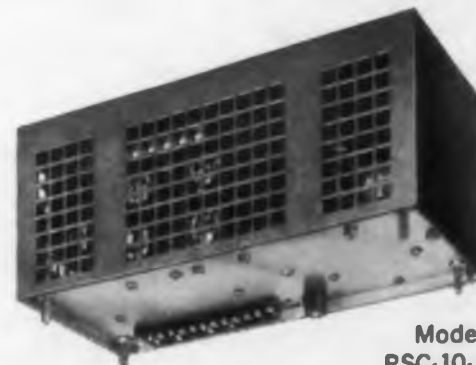
MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.
SC-18-0.5	0-18	0-0.5
SC-18-1	0-18	0-1
SC-18-2	0-18	0-2
SC-18-4	0-18	0-4
SC-36-0.5	0-36	0-0.5
SC-36-1	0-36	0-1
SC-36-2	0-36	0-2
SC-3672-0.5	36-72	0-0.5
SC-3672-1	36-72	0-1

the most
complete
line of
POWER
SUPPLIES

0.02% REGULATION STABILITY

COMPACT PACKAGE TYPE

MODEL	DC OUTPUT VOLTS	DC OUTPUT AMPS.
PSC- 5-2	0-7.5	2
PSC-10-2	7.5-12.5	2
PSC-15-2	12.5-17.5	2
PSC-20-2	17.5-22.5	2
PSC-28-1	22.5-32.5	1
PSC-38-1	32.5-42.5	1



Model PSC-10-2

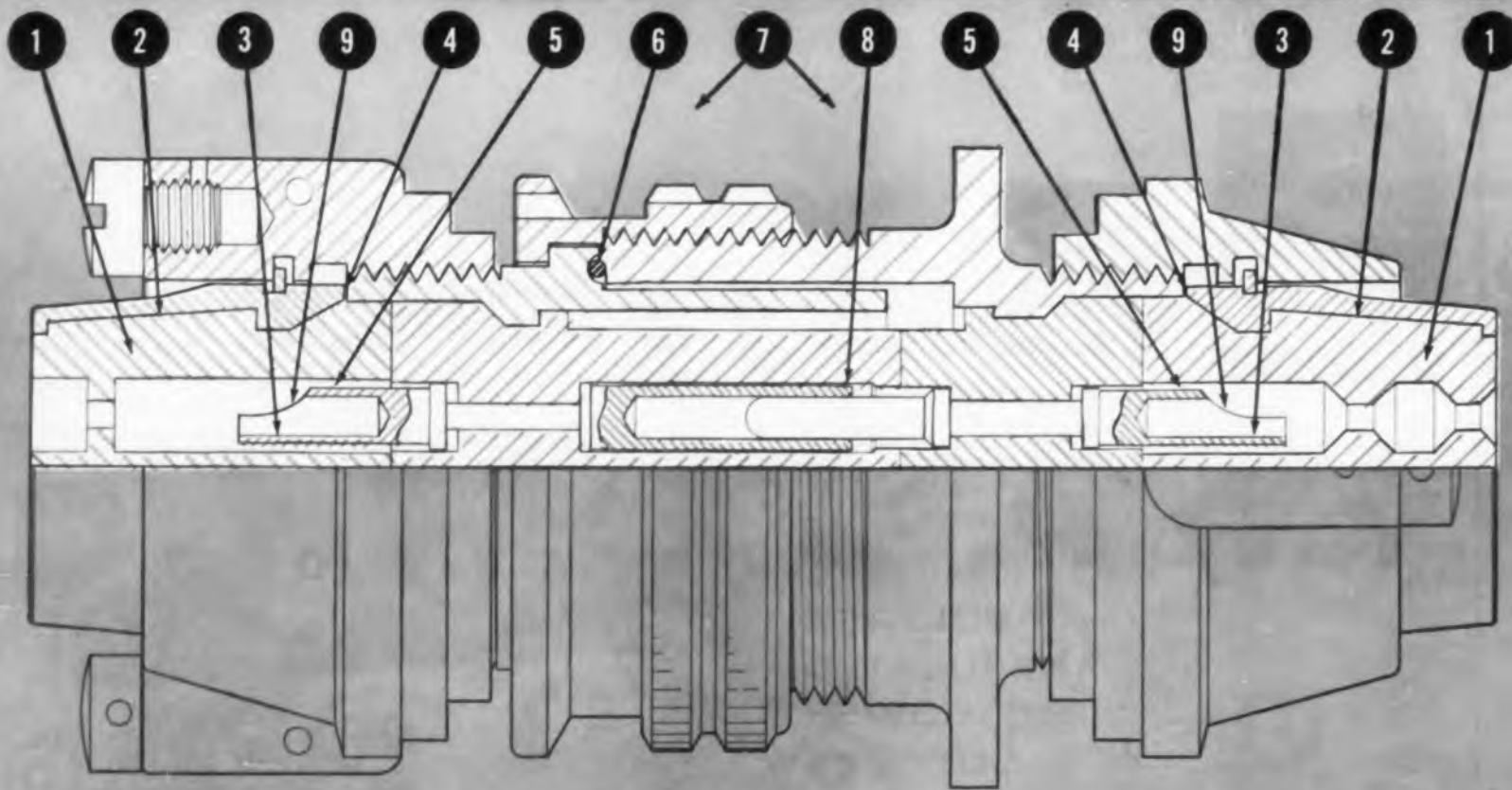
Kepeco
offers more than
120 standard voltage
regulated power supplies
covering a wide range
of transistor, tube
and magnetic types.

For complete specifications,
write for Brochure B-591



Kepeco INC.

131-38 SANFORD AVENUE • FLUSHING 55, N.Y. • INDEPENDENCE 1-7000
CIRCLE 198 ON READER-SERVICE CARD



SECTION OF MATED MS 3100R & MS 3106R

STUB^ER

Check the PLUS features of the NEW Amphenol "R"!

Stub R is the newest member of AMPHENOL's family of fully approved MIL-C-5015D environmentally resistant connectors. The "R" construction is a recent addition to this Specification and is described as "environment resistant—light weight". Like AMPHENOL's superior Stub E, the Stub R offers plus features above and beyond the minimums established by the Specification. Together, these connectors provide users with a complete selection of the shortest, lightest, finest environmentally resistant AN/MS connectors available to MIL-C-5015D. AMPHENOL Stub R connectors offer the following plus features:

- 1 **Slippery Grommet Material** A special neoprene material that allows easy slippage over wires. A cost-saving advantage that speeds up assembly.
- 2 **Unitized Rear Grommet** Grommet, clamp nut, clamp shell and retainer ring form a single sub-assembly, making assembly and disassembly easier and quicker than with any other "E" or "R" connector.
- 3 **Uniformly Tinned Solder Pockets** Uniform and complete distribution of solder tinning on the inside of the solder pockets, assuring the user of producing the best electrical and mechanical connection.
- 4 **Metal-to-Metal Bottoming** The unitized rear grommet provides metal-to-metal bottoming to the front shell when the grommet is fully engaged, assuring pre-determined, controlled sealing and minimizing the possibility of compression "set".

- 5 **Ease of Soldering** Solder pockets are exposed for easy wiring and soldering, providing fast, low cost and high quality assembly.
- 6 **"O" Ring** The Stub R incorporates an "O" ring on the shoulder of the MS 3106 plug for additional sealing protection.
- 7 **Shorter Length, Lighter Weight** Both Stub E and Stub R are the shortest and lightest types available, allowing for more compact equipment that saves money where weight = money, as in aircraft.
- 8 **Closed Entry Socket Contacts** Resistant to test prod damage, female contacts are machined of a copper alloy and provided with a closed entry.
- 9 **Positioned Contact Pockets** All solder pockets face in the same direction, accelerating wiring and substantially reducing assembly costs.



AMPHENOL CONNECTOR DIVISION 1830 S. 54th Ave., Chicago 50, Illinois
Amphenol-Borg Electronics Corporation

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 $\pm 5\%$ accuracy and six direct reading ranges from 10 μ w 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 μ a 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.

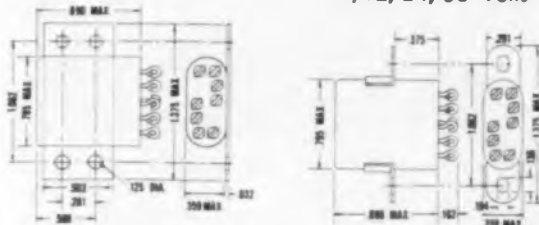
CIRCLE 205 ON READER-SERVICE CARD

CIRCLE 206 ON READER-SERVICE CARD



SC11D
6, 12, 24, 36 Volts

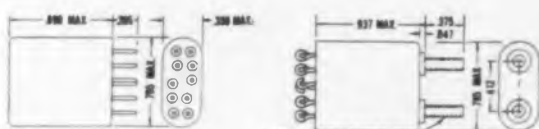
SC11DK
6, 12, 24, 36 Volts



SC11DB
6, 12, 24, 36 Volts

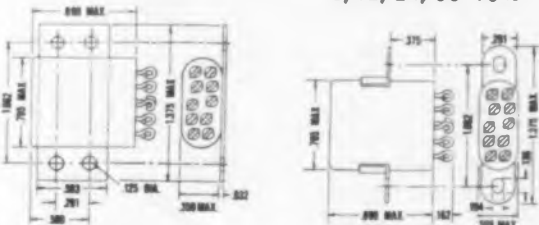
SC11DA
6, 12, 24, 36 Volts

2 TYPES • 4 MOUNTINGS • 4 VOLTAGES



SL11D
6, 12, 24, 36 Volts

SL11DK
6, 12, 24, 36 Volts



SL11DB
6, 12, 24, 36 Volts

SL11DA
6, 12, 24, 36 Volts

SC

SL



Off the shelf delivery FROM YOUR P & B DISTRIBUTOR

32 STANDARD P & B CRYSTAL CASE RELAYS

Prototype or small-production-run quantities of P & B's micro-miniature relays are now available from your local electronic parts distributor. Choose from 2 types, 4 mountings, 4 coil voltages—32 models in all.

P & B's dual coil, permanent magnet, crystal case relays remain operative under 100g shock, 30g to 2000 cps vibration. Modern White Room production facilities assure

highest possible reliability.

The SC conforms to standard dimensions and circuitry, and can replace ordinary relays of the same size.

The SL, a latching relay, utilizes the dual-coil, permanent magnet principle to provide a highly efficient, tenacious latch, assuring high contact pressure.

Order today from your local electronics parts distributor.

SC and SL SPECIFICATIONS:

Shock: 100g for 11 millise.

Vibration: 30g from 55 to 2000 cps
.195" max. excursions from 10 to 55 cps

Ambient Temperature Range:
-65°C. to +125°C.

Contact Arrangement: dpdt

Contact Load: 2 amps at 30 vdc
1 amp at 115 vac, 60 cycle

Sensitivity:

SL—230 milliwatts at 25°C. with
630 ohm coil

SC—260 milliwatts at 25°C. with
550 ohm coil



POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

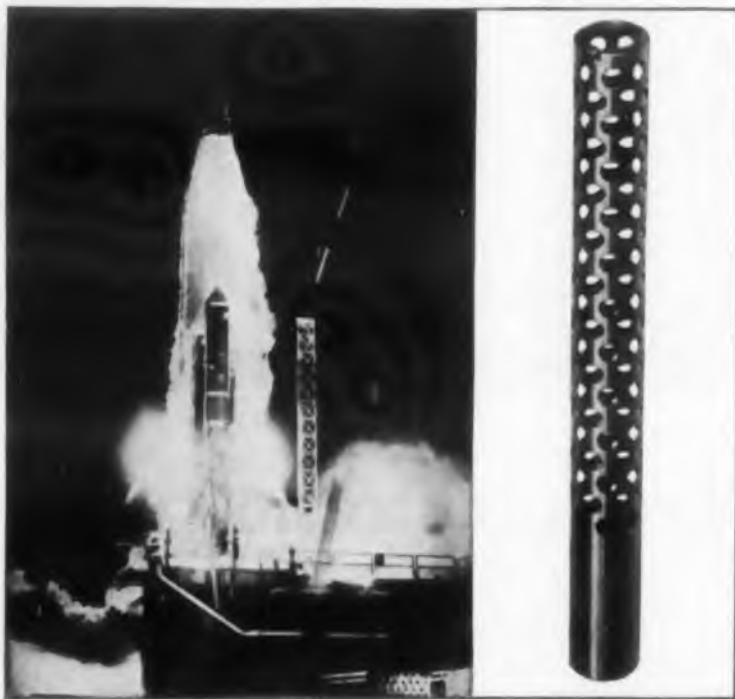
IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO



BISHOP QUICK SERVICE TEAM SOLVES STICKLER IN ATLAS PROGRAM

Telemetry bulb part (illustrated)—originally of 304 seamless tubing—cracked during fabrication. BISHOP specialists were called in—304L seamless, $\frac{1}{2}$ hard was recommended and supplied (against a tough deadline). *Results:* The 304L part met all requirements, including critical resistance to vibration fatigue within a temperature range of -80° to $+380^{\circ}$ F in inert helium, and gave completely satisfactory performance in the Atlas program. More information on 304L—or any BISHOP tubular products? Use the coupon.

CIRCLE 797 ON READER-SERVICE CARD



BIMETALLICS NOW AVAILABLE IN MANY DIFFERENT FORMS, METALS

Bimetallics—the new family of composite metal products—is solving problem after problem these days. BISHOP capabilities in producing bimetallics are almost endless. Both base and precious metals are available in wire, sheet, and tubing form. *Typical example of popular bimetallic for glass sealing applications:* nickel-iron alloys over copper wire in sizes from .004 to .125 in. diameter . . . advantages: low electrical resistivity, good thermal conductivity. Look into the possibilities of improving your products . . . use the coupon.**

CIRCLE 798 ON READER-SERVICE CARD

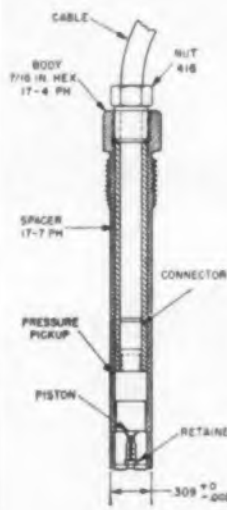


17-7 PH* TUBING BEING DRAWN TO HYPODERMIC SIZE

Small diameter 17-7 PH tubing, welded and seamless, is available from BISHOP now on standard order in sizes down to .375 in. OD X .035 in. wall—on special order to .020 in. OD X .006 in. wall. Accompanying illustration shows a piezoelectric transducer used for measuring pressures up to 100,000 psi in ballistics and hypersonic research work. Use of welded 17-7 PH spacer in transducer permitted finish machining of the part before heat treating. Want more data on BISHOP's 17-7 PH products or other super alloys? Use the coupon.

*Trademark of Armco Steel Corporation

CIRCLE 799 ON READER-SERVICE CARD



J. BISHOP & CO.

platinum works

FOR HELPFUL DATA USE THIS HANDY COUPON

- Check information you'd like and mail to
J. BISHOP & CO.,
55 King St., Malvern, Penna.
- Bimetallics,
Data Sheet PA-1
- 17-7 PH alloy,
Data Sheet TA-2A
- 304L alloy,
Data Sheet TA-2
- Tubular Products,
Bulletin No. 12
- Platinum Metals
Products,
Catalog No. 3
- Name _____
Position _____
Company _____
Address _____
City _____ Zone _____ State _____

Tubular Products Division

55 KING STREET, MALVERN, PENNA.

NIagara 4-3100

THIS IS THE BISHOP LINE:

Products of all the Platinum Metals...

Small diameter Stainless Steel,

nickel and special alloy tubing

CIRCLE 207 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

.005 μsec. to 5,000 μsec.

ESC DELAY LINES TAKE GIANT STEPS!



From the smallest to the largest - .005 μsec. to 5,000 μsec. - ESC's research staff has custom-designed delay lines for virtually every military and commercial application! And with every delay line prototype comes a comprehensive laboratory report, which includes submitted electrical requirements, photo-oscillograms (which indicate input and output pulse shape and output rise-time), the test equipment used, and an evalu-

ation of the electrical characteristics of the prototype.

In addition, an extensive factory rep organization spans the nation, ready to provide on-the-spot assistance in specification and installation.

For complete technical data, write to ESC - America's leading manufacturer devoted to the design, development and production of custom-built and stock delay lines!



ESC

WRITE TODAY FOR COMPLETE TECHNICAL DATA.

exceptional employment opportunities for engineers experienced in computer components... excellent profit-sharing plan.

CORPORATION 534 Bergen Boulevard, Palisades Park, New Jersey

Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Pushbutton decade delay lines • Shift registers • Pulse transformers • Medium and low power transformers • Filters of all types • Pulse forming networks • Miniature plug-in encapsulated circuit assemblies

CIRCLE 214 ON READER-SERVICE CARD

HIGH TEMPERATURE CAPACITORS BY BENDIX

DESIGN FEATURES

Temperature Range . . . -55° to $+315^{\circ}\text{C}$. Capacitance . . . 0.05 to 4.0 uf at 600 VDC. Voltage Range . . . 600 V to 3000 V per section. No Voltage Derating, Low Capacitance and Power Factor Variation, Environmental Resistant, Hermetically Sealed, Rugged Construction, Nonstrategic Materials, Minimum Size and Weight, High Altitude Operation.

The E-315 capacitor offers proven stability of operation over the temperature range of -55° to $+315^{\circ}$ Centigrade* with no voltage derating and low capacitance variation. Of rugged hermetically sealed construction and nonstrategic materials, this capacitor is built for high altitude and severe environmental operation.

This nonpolarized capacitor is available in a variety of sizes in a capacity range of from 0.05 to 4.0 microfarads at 600 VDC. It is also available in higher voltage ratings. Performance data and operating characteristics are given in Technical Bulletin SL-61 which is supplied upon request.

*Confirmed by qualification test of 1000 hours at 100% rated voltage over ambient temperature range of -55° to $+315^{\circ}\text{C}$.

Now Available
in Production Quantity

E-315



Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec.
Export Sales and Service: Bendix International Division, 205 East 42nd St., New York 17, N.Y.



Scintilla Division

Sidney, New York

CIRCLE 215 ON READER-SERVICE CARD

Hotpack CONTROLLED ENVIRONMENTAL CHAMBERS ENGINEERED FOR ELECTRONIC TESTING AND DEVELOPMENT

CONSTANT TEMPERATURE and HUMIDITY CHAMBER



Full view window, temperature ranges from 35°C to 100°C ; 0°C to 100°C (Refrigerated) Temperature constancy within $\pm 0.5^{\circ}\text{C}$. Controlled humidity from 20% to 98% R.H. (5% R.H.) Designed for rapid, accurate testing and conditioning of semiconductors, printed circuits, filters and many other components. Engineered to meet requirements of JAN, ASTM and numerous test methods of MIL-STD 202 A. Through wall connectors, test leads built into unit on request. Sizes from 2 to 30 cu. ft.

Write to Dept. 601
for complete details
and Brochure

PORTABLE ENVIRONMENTAL ASSEMBLY ROOM



HEATED
REFRIGERATED
HUMIDIFIED
DEHUMIDIFIED

Completely portable environmental room used for assembling electronic components

and systems requiring controlled environmental conditions. Specially designed filter and air purifier provide dust free atmosphere for assembly operations. Double glass type windows for effective dust, air and moisture seal. Temperature ranges to 40°C or 125°C . Temperature controlled within $\pm 0.5^{\circ}\text{C}$ at control point. Higher temperature range allows room to double as test chamber. Humidity closely regulated from 20% to 98% R.H. within 5% R.H. Sectionalized prefabricated design permits assembly or disassembly of the entire room in a few hours. No blueprints needed for installation. Standard rooms may be equipped for recessed mounting. Room size easily expanded by insertion of center sections. Readily adaptable as computer housing facility. Write for list of sizes.

THE ELECTRIC *Hotpack* COMPANY, INC.
COTTMAN AND MELROSE STREETS, PHILADELPHIA 35, PENNA.

CIRCLE 216 ON READER-SERVICE CARD

VACUUM CHAMBER

Newly designed, temperature ranges to 200°C and 300°C within $\pm 0.5^{\circ}\text{C}$. Vacuum evacuation to 1 micron. Provides improved production testing and processing of transistors, capacitors, relays, and hundreds of sensitive components and systems. Standard units equipped to accommodate through wall connections or double door arrangement for use on production lines.

WIDE
RANGE
OF
SIZES



CONSULT OUR
ENGINEERING DEPT.
ON YOUR
SPECIAL
REQUIREMENTS

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 Electronics 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 $\pm 1\%$; 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 tele-metering, 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.

Hawell Instrument Co., Dept. ED, 3101 Trinity St., Fort Worth 7, Tex.

CIRCLE 225 ON READER-SERVICE CARD

CIRCLE 226 ON READER-SERVICE CARD



An important message to manufacturers of

semi-conductors electronic tubes thermistors ferrites

J. T. BAKER ELECTRONIC CHEMICALS

Acetic Acid, Glacial	Cobalt Carbonate	Nickelous Nitrate
Acetone	Cobalt Oxide	Nickelous Sulfate
Aluminum Nitrate	Cobalt Nitrate	Nitric Acid
Aluminum Sulfate	Ether, Anhydrous	Petroleum Ether
Ammonium Carbonate	Hydrochloric Acid	Potassium Dichromate
Ammonium Chloride	Hydrofluoric Acid	Potassium Hydroxide
Ammonium Hydroxide	Hydrogen Peroxide,	iso-Propyl Alcohol
Ammonium Phosphate	30% and 3% Solution	Radio Mixture No. 3
Antimony Trioxide	Lithium Carbonate	Silicic Acid
Barium Acetate	Lithium Chloride	Sodium Carbonate
Barium Carbonate	Lithium Nitrate	Sodium Chloride
Barium Fluoride	Lithium Sulfate	Sodium Hydroxide
Barium Nitrate	Magnesium Carbonate	Sodium Phosphate Dibasic
Benzene	Magnesium Chloride	Strontium Carbonate
Boric Acid	Magnesium Oxide	Strontium Nitrate
Cadmium Chloride	Manganese Dioxide	Sulfuric Acid
Cadmium Nitrate	Manganese Nitrate	Toluene
Cadmium Sulfate	Manganese Sesquioxide	Trichloroethylene
Calcium Carbonate	Manganous Carbonate	Triple Carbonate
Calcium Chloride	Methanol	Xylene
Calcium Fluoride	Nickel Carbonate	Zinc Chloride
Calcium Nitrate	Nickel Oxide, Black	Zinc Nitrate
Calcium Phosphate	Nickel Oxide, Green	Zinc Oxide
Carbon Tetrachloride	Nickelous Chloride	

You can reduce your production costs with 'Baker Analyzed' Reagents because (1) they are manufactured to exceedingly high standards of purity at no price premium to you, (2) they are consistently pure, consistently uniform, lot after lot, (3) Baker reagent purity regularly offers you the quality-plus demanded by the specialized processes and products of your industry, (4) the regular 'Baker Analyzed' Label defines a degree of purity so high that special "electronic grade" labeling is unnecessary.

As the electronics industry is able to define its needs more precisely, Baker will continue to provide material meeting the required specifications.

Listed at the left are some of the J. T. Baker high purity chemicals of particular importance to electronic manufacturers.

J.T. Baker

CHEMICAL

J. T. Baker Chemical Co.
Phillipsburg, New Jersey

major advance in miniaturization:
SUPRAMICA® 555
commutator plates



360 rectangular contact
 2-pole commutator plate of
 SUPRAMICA 555 ceramoplastic

on a 3 inch precision-molded plate
 ... up to **540 rectangular contacts!**

Since 1948 . . . when Mycalex Electronics Corporation pioneered the first *precision-molded* MYCALEX® 410 glass-bonded mica, 180-contact commutator plate . . . MYCALEX switches have introduced a degree of accuracy and dependability never before approached in mechanical switching.

And now, Mycalex offers a *new* ceramoplastic commutator plate design destined to set *even higher* standards for long-life, low-noise-level multiplexing.

Typical of these new plates is the CP 427. Its specifications call for *precision-molded* SUPRAMICA 555 ceramoplastic which delivers total dimensional stability as well as superb thermal endurance (700°F.). The individual contacts of this plate have an exclusive *rectangular* form and embody tolerances within the .0005" range. They are permanently fixed in place.

An exclusive brush-holder design permits *lower pressures* on the wipers . . . gives *lower contact resistance* with a noise level of *less than 10 microvolts*. Brush bounce is eliminated and life greatly extended. MYCALEX switches using this type of design have been tested satisfactorily for over 1000 hours at 600 RPM without maintenance.

Information on complete MYCALEX switches or matched brush assemblies and plates is available.

General Offices and Plant: 121-E Clifton Blvd., Clifton, N.J.
 Executive Offices: 30 Rockefeller Plaza, New York 20, N.Y.

EXCLUSIVE LICENSEE OF MYCALEX CORPORATION OF AMERICA
 CIRCLE 227 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 $\pm 1.5\%$ for 5 v dc input changes and $\pm 2\%$ 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

SYNTHETIC MICA
 MYCALEX
 SUPRAMICA
MYCALEX
 ELECTRONICS CORPORATION

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 $4 \times 4 \times 7\text{-}1/2$ 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 in looks, new in efficiency, and forerunner of a great new line of MB vibration exciters...that's the new Model C125.

Once again leading the way, MB has achieved a radical step-up in magnetic circuit efficiency. This new shaker, barely larger than its predecessor, develops 10,000 pounds force output...a 43% gain! Conversely, it calls for less amplifier power than any other electrodynamic shaker of comparable force.

Leading companies in missiles, aircraft and electronics look first to MB for progress in complete vibration test systems. It has been that way for almost 15 years. Our "encyclopedia" of vibration experience is yours to draw on...as is the largest, national, field service staff of specialists. Send for full data.

MB ELECTRONICS

A DIVISION OF TEXTRON ELECTRONICS, INC., 1058 State Street, New Haven 11, Conn.



*New breakthrough in
vibration exciter
performance!*



**43% more
force output...
More efficient
utilization of
power amplifier**

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 $\pm 2\%$ 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 $\pm 2\%$. 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



THE RAW MATERIALS OF PROGRESS



FC-75 DAMPS DANGER, CUTS C

Non-flammable, non-explosive 3M inert liquids now allow high voltage transformers to be vapor-cooled with complete safety. And that means they can be located right next to the load.

The result: big savings in installation and maintenance costs. Power loss is reduced! And fluorochemically cooled V/g transformers can be installed in residential areas, crowded downtown areas . . . even indoors . . . without firewalls, drainage pits, sprinkler systems or other fire prevention equipment.

That's why Westinghouse Electric Corporation has chosen

3M Brand Fluorochemical Inert Liquid FC-75 for its V/g transformers.

Their report — greater safety, reduced installation costs. More quiet operation (with fluorochemicals, transformers are self-cooled at 100% load), no maintenance required for the coolant or the core and coils!

Fluorochemicals are outstanding for practical use as evaporative coolants and insulators. They're also non-explosive, non-corrosive, non-toxic, non-flammable and they're odorless. Investigate the remarkable properties of 3M fluorochemical inert liquids in terms of your own product design and performance problems.

CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

... WHERE RESEARCH IS THE KEY TO TOMORROW



CIRCLE 240 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1979



3M FLUORO-CHEMICAL 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.

TS COSTS!

5 for its

on costs. Transformers required.

use as also non-able and peries of our own

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 over-speed sensing and protective circuits in a single package. It measures 0 to 60,000 rpm with $\pm 3\%$ 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, Pro-lene 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



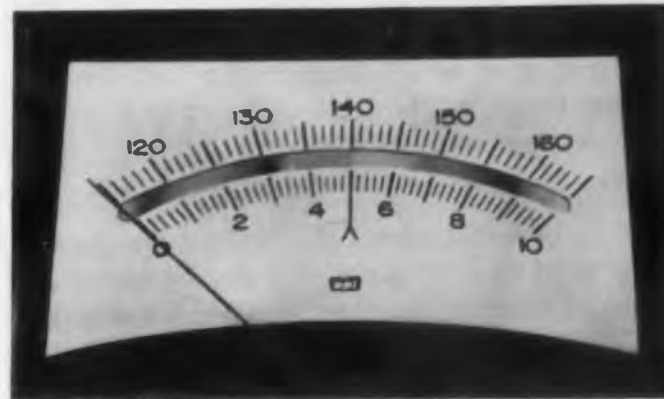
NATURAL READING ANGLE



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 2 7/8" 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 3 1/2" 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

Are you a victim of SPECIPHOBIA?*



* That martyred, hands-tied feeling you get when your specification is loaded.

Did your contract specify that you use unproved devices instead of tubes? For a reason? Or just because something "new" was available? (Which meant derating your whole circuit just to get the performance you *know* tubes will give!) Well, mister designer, you are a victim of speciphobia!

Don't feel bad. Lots of circuit designers are in the same quandary. But why not *do* something about it? Summon your manly courage, and go ask this specifier whether he wants novelty (at an awful price), or:

...known performance, known reliability, safe design, good logistics, systems flexibility, and economy (all of which you can prove). In short... a design that doesn't apologize!

Then, when he innocently asks "... Why of course. How can you get this?", just tell him to get out of orbit and specify tubes. As a matter of fact, *General Electric 5-Star Receiving Tubes*. And tell him that you'll apply them with all your up-to-date know how on how to care for an electronic circuit.

If he's still skeptical, just ask him to come see us. We've got some data we'd be glad to show, and match with anything he's got. And while we're at it, don't forget to have us show him the tubes we're working on for the circuits you'll be designing next. Want *small size*? Well, you ain't seen nothin' yet! Receiving Tube Dept., Owensboro, Ky.

Progress Is Our Most Important Product

GENERAL  ELECTRIC
2-411-102

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 ssh suppressed carrier radio-telephony equipment. The unit plugs into a standard octal socket and requires no adjustments.

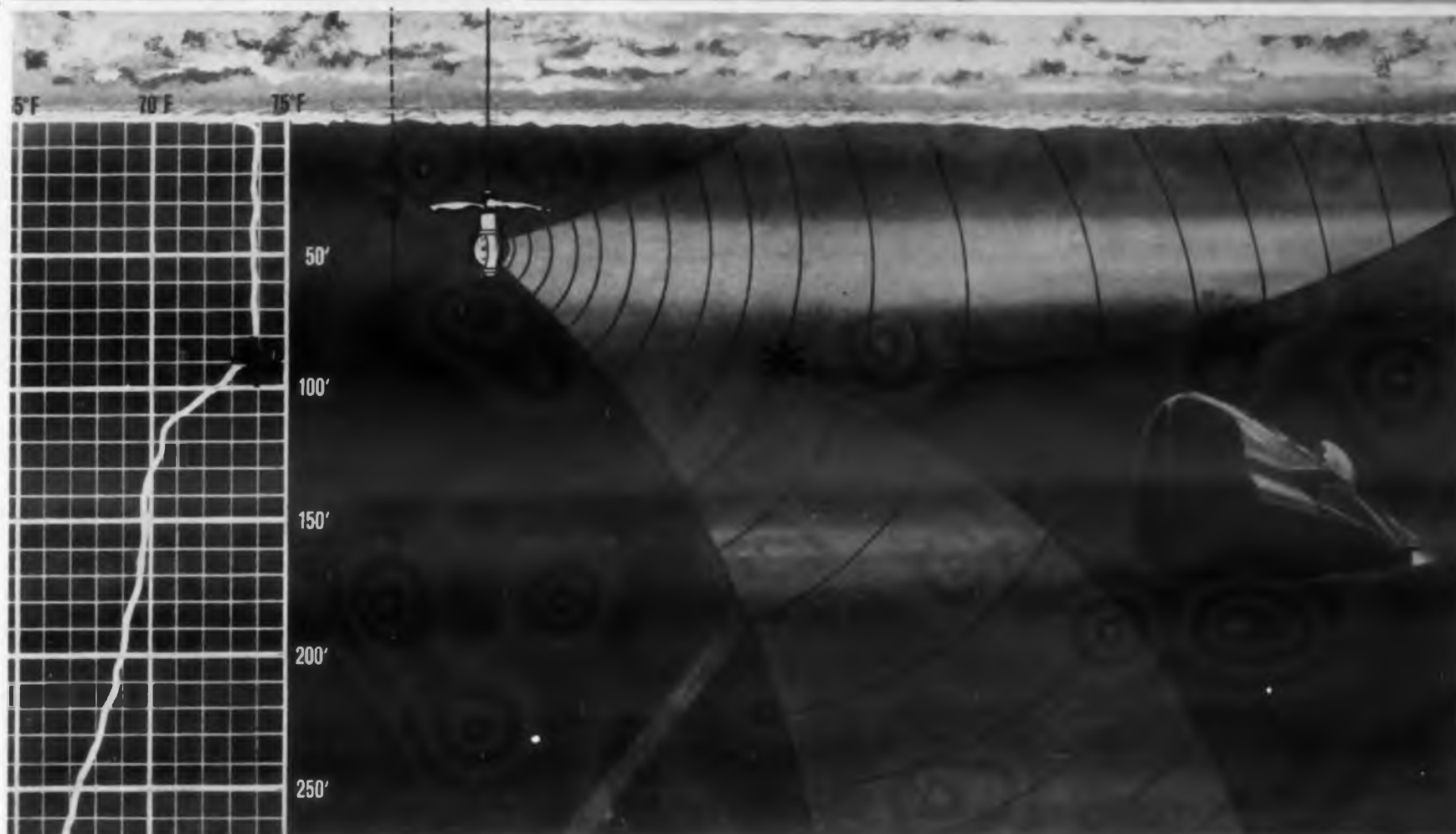
Barker & Williamson, Inc., Dept. ED, Bristol, Pa.

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.



design, manufacturing and quality engineers—3-10 years experience

high-gain careers for problem-solvers

YOUR SPECIAL TOUCH with unsolved problems buys you a solid future in any of Texas Instruments major military programs—Antisubmarine Warfare, Heavy Surface Radar, Missile Systems, or Electronic Surveillance. For example, you can try your hand at solving the Navy's clearly stated ASW requirement: Build *something* that will detect and classify a fast-moving submerged submarine at depths of 1500 feet, more than 50 miles from your aircraft.

Your experience in one of the following technologies may find immediate application in one of our four major programs:

radar • sonar • infrared • magnetic anomaly detection • passive detectors • servos • navigational systems • special-purpose computers • timers • programmers • microwave • telemetering • data link • optics • video mappers • visual displays • intercom

We require a steady influx of exceptionally-qualified men in these technologies. To learn more about us and how we can fit into your career plan, write for a copy of "We can tell you this much about Apparatus division" to:

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ME's:

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INDUSTRIAL ENGINEERS:

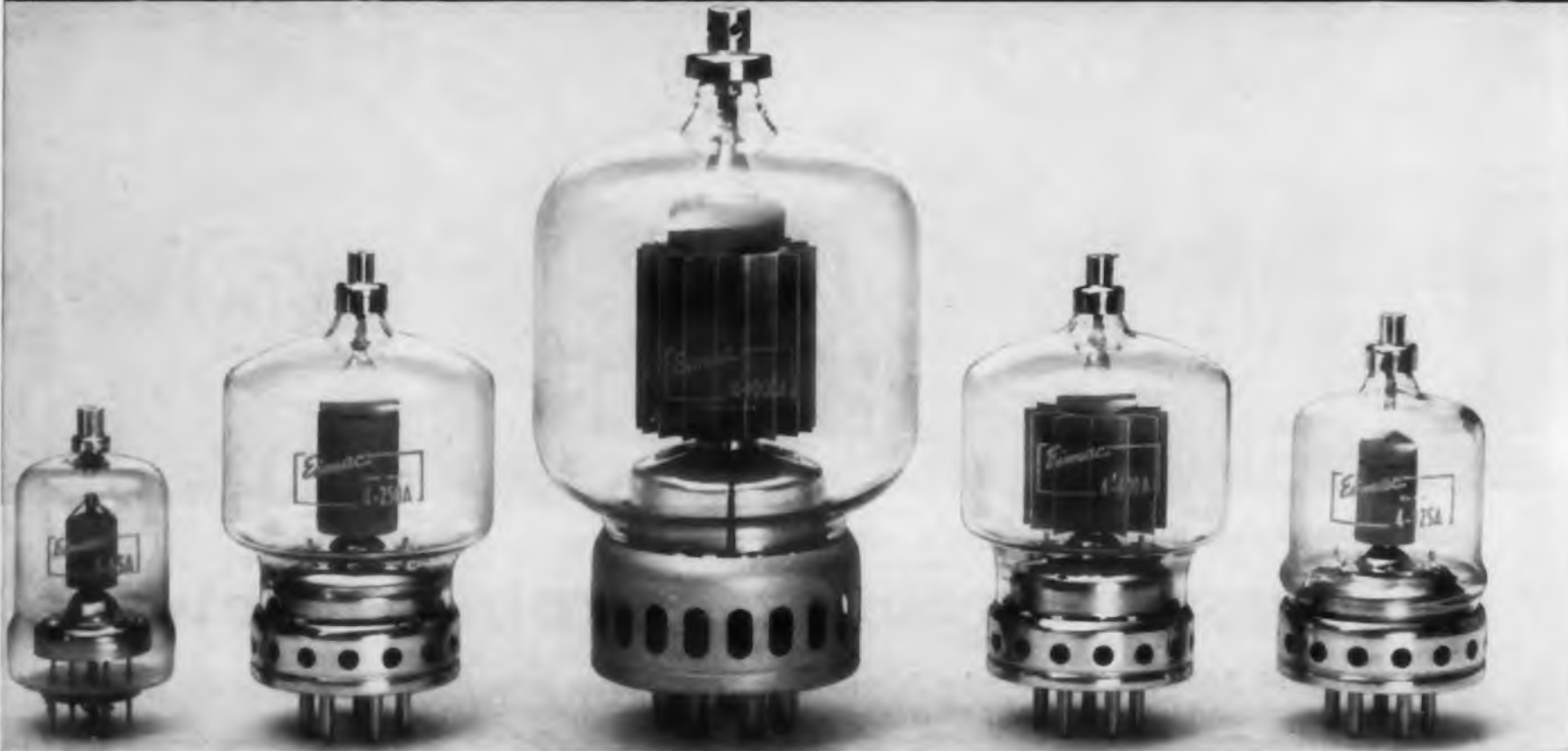
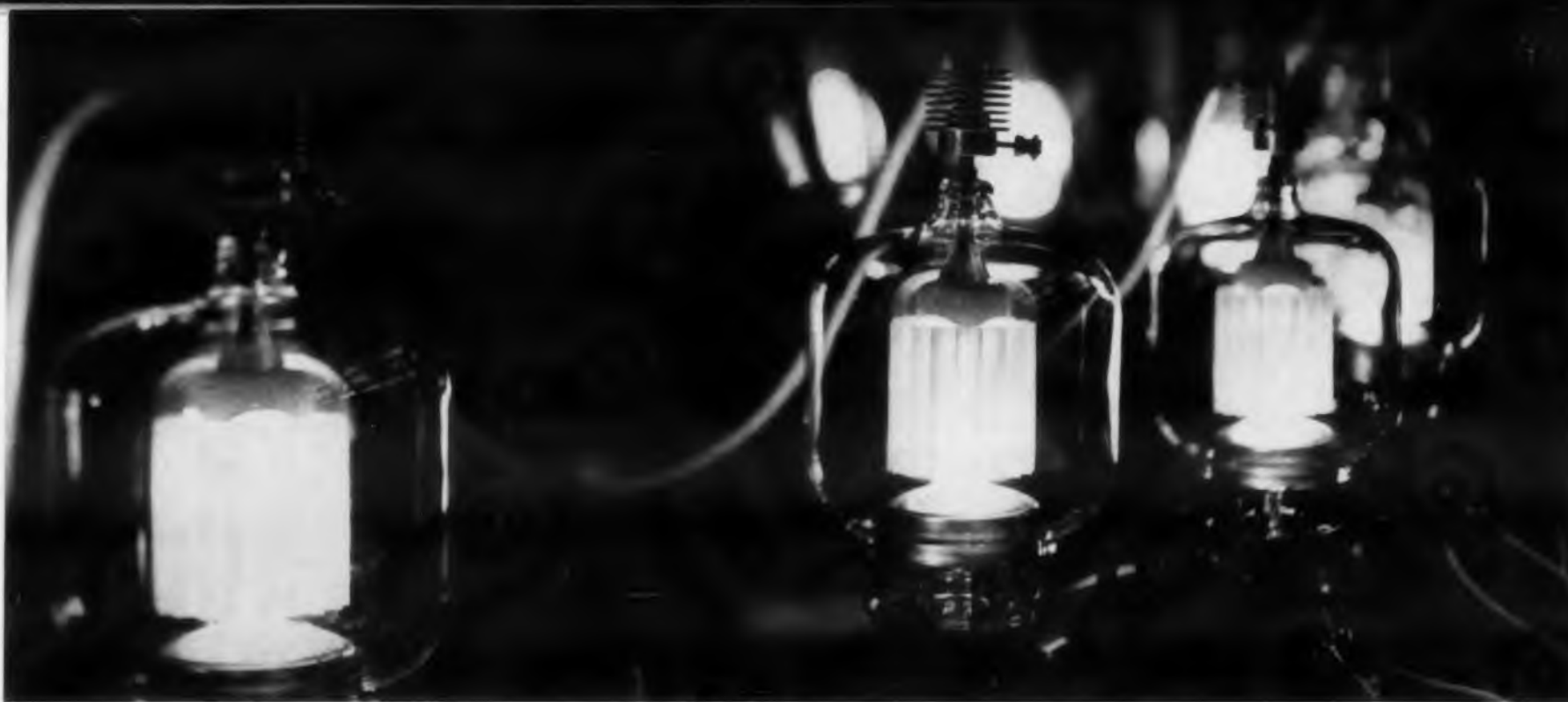
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EIMAC PIONEERED INTERNAL-ANODE TETRODES— PERFORMANCE LEADERS FOR OVER A DECADE

Developed and introduced to the industry in the mid 1940's, Eimac's line of internal-anode radial-beam tetrodes immediately received widespread and enthusiastic acceptance. Well over a million have been sold since that time. These tubes, quality leaders from the very start, still maintain that position through advanced processing techniques, inherently sound design and continuing concern with production refinements.

Clean electrode design, for example, and the exceptionally hard vacuums achieved on Eimac-developed rotary

vacuum pumps, result in consistently reliable tubes with an exceptional ability to withstand high momentary overloads and peak powers. Rugged filament design with high reserve emission contributes greatly to their reliability and long life.

Stable operation at high frequencies is assured by low inter-electrode capacitances and low lead inductances. Driver requirements and associated circuitry are simplified by the high power gain and low driving power requirements of these tube types.

These features, plus other Eimac

design innovations such as the Pyrovac* plate and non-emitting grids make Eimac internal-anode tetrodes your logical choice for new equipment designs, as well as tube replacements, when exceptional performance and reliability are required. Most types available for immediate delivery.

*Registered Trademark

EITEL-McCULLOUGH, INC.



San Carlos, California

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 μ a, 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 μ sec 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 μ sec. 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

Models 1001 and 1002 voltage dividers are combined ac and dc ratio standards that provide six decade 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

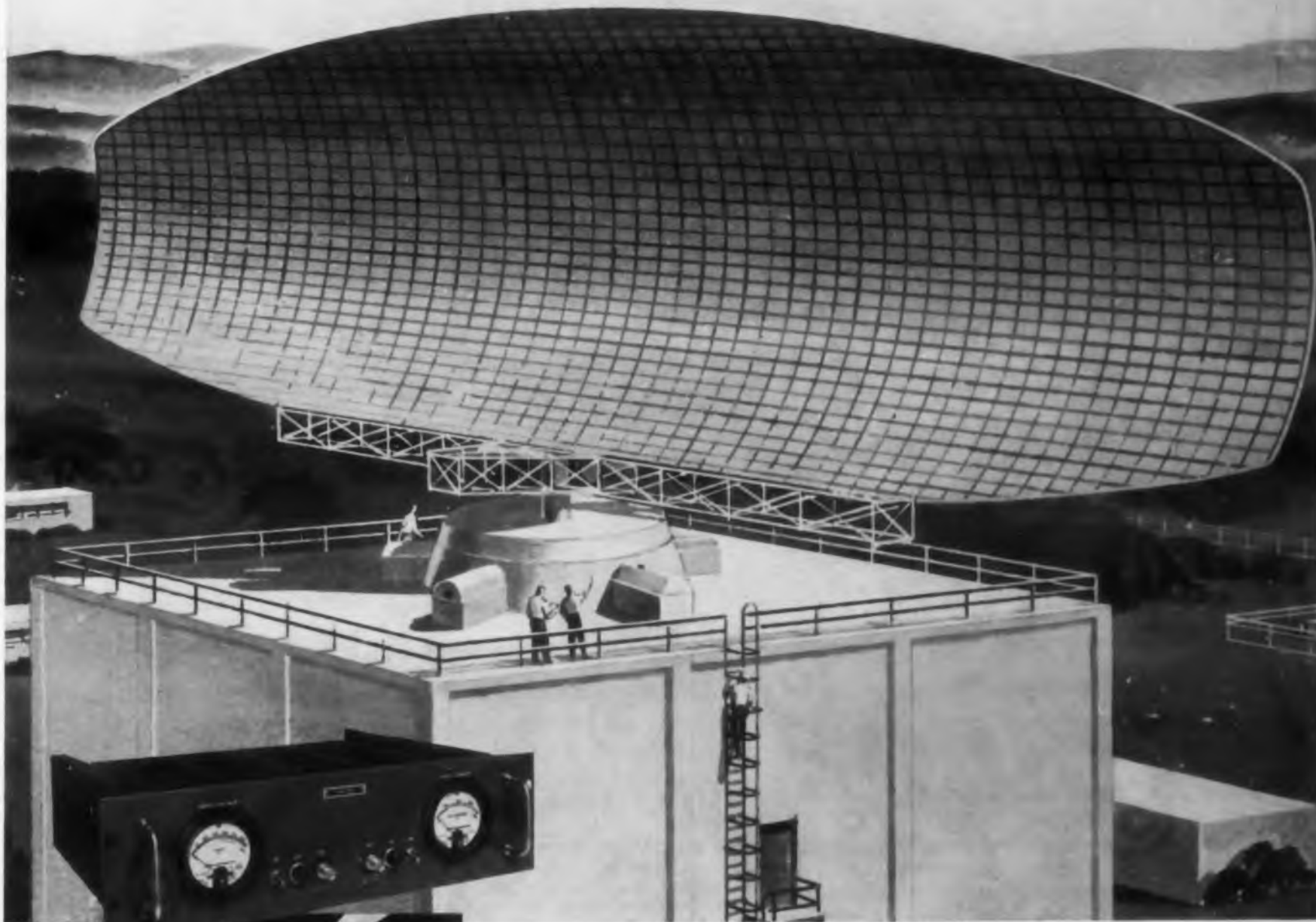
Designed to show when shock to an instrument has passed permissible limits, V-Dot indicators are available from 5 to 75 g in standard models. They have complete spherical sensitivity, and are also available with one or two plane sensitivity. Resettable and reusable, the units are accurate to within 5% of the preset value and last about 5 years.

Inertia Switch, Inc., Dept. ED, 311 W. 43rd St., New York 36, N.Y.

CIRCLE 261 ON READER-SERVICE CARD

CIRCLE 262 ON READER-SERVICE CARD

Lambda Power Supplies specified for newest radar installation



"Off-the-shelf" Lambda power supplies—modified only with special panels, MIL meters and tubes—will be part of the complex radar equipment housed in the 85-foot tower at Thomasville, Alabama, one of four identical installations.

Meet MIL-E 4158 environmental test requirements

Sperry Gyroscope Co., operating under the technical guidance of the Rome (N.Y.) Air Development Center, is producing the new SAGE radar equipment (AN/FPS-35). The power supplies employed to power transmitters and receivers must be able to pass stringent tests.

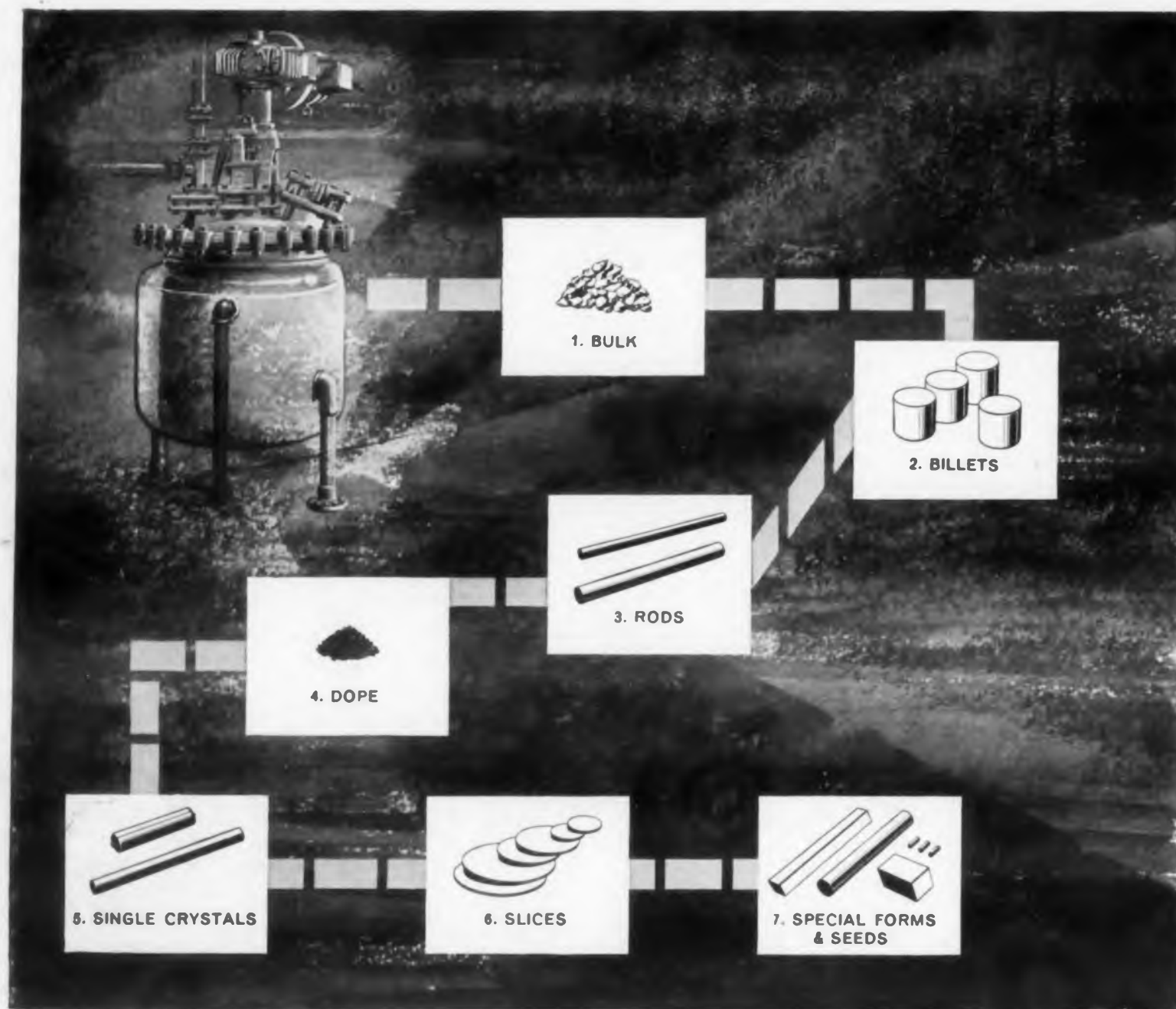
Sperry's choice: Lambda's COM-PAK, already widely used as a component in many rocket and missile programs.

All Lambda stock industrial power supplies are made to MIL quality and guaranteed for five years. They are pictured and described in a new 32-page catalog. Write for your copy.

LAMBDA ELECTRONICS CORP.

11-11 131 STREET • COLLEGE POINT 56, NEW YORK

INDEPENDENCE 1-800 CABLE ADDRESS: LAMBDA-TON, NEW YORK



SILICON...any way you want it!

Is there any good reason why you shouldn't obtain all forms of silicon you want from a *single* source?

Up to now the answer to that question was simple: No one firm offered a complete silicon supply facility.

But that is no longer true because from Allegheny you can now obtain silicon in every form. Here are the facts:

1. BULK — The bulk polycrystalline silicon you get from Allegheny comes in four grades, three semiconductor, one solar. Each requires a minimum of doping, exhibits a high degree of uniformity and shows a significantly low boron level.

2. CAST BILLETS — Cut to charge size for Czochralski furnaces and in standard sizes up to 2" in diameter.

3. CAST RODS. — For float zoning, you get uniformly dense cast rods in standard sizes up to 1", with lengths entirely dependent on your requirements.

4. MASTER DOPING ALLOYS — These are made from extremely pure silicon, using 99.999% or better elemental dope. They are alloyed in different ranges, and in homogeneous lots of sufficient size to allow for long term standardization in your production doping procedures.

5. SINGLE CRYSTALS — Custom processing of single crystals is a basic service from Allegheny. We will dope to your specifications and grow in Czochralski or float zone furnaces, again depending on application.

6. SLICES — You can get slices to meet any surface requirement since Allegheny has both the know-how and facilities for slicing, lapping, and finishing. And 100% testing is your assurance that the slices completely meet your specifications.

7. SEEDS & SPECIAL FORMS — You tell us your mounting and other physical requirements and we will provide the shapes and forms, cut ultrasonically. All seeds are oriented optically to $\frac{1}{2}^\circ$ (or better) to the (111), (110), or (100) plane.

Analyze your current silicon supply arrangements. Consider that *only* Allegheny provides every form of silicon you need. Doesn't it look like now is a good time for you to get all the facts from the people at Allegheny? Write, wire, or phone.

*producers of semiconducting materials
for the electronics industry*

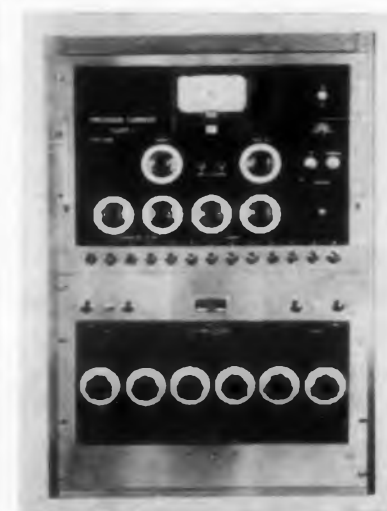
ALLEGHENY

ELECTRONIC CHEMICALS CO.

207 HOOKER-FULTON BLDG., BRADFORD, PA.
252 NORTH LEMON STREET, ANAHEIM, CAL.

CIRCLE 263 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 μ sec 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 μ sec min and 75 μ sec 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 μ f, and its sensitivity is such that a 10 μ v 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.

Bronton Electronics Corp., Dept. ED, 738 Speedwell Ave., Morris Plains, N.J.

CIRCLE 267 ON READER-SERVICE CARD

BIG-METER PRECISION IN MICRO-MINIATURE SIZE

Now you can stop worrying about meter weight and size limitations in missiles, aircraft, computers, communication and other electronic equipment. DeJUR precision panel instruments give you big-meter sensitivity and accuracy in rugged, sealed units in extremely small sizes. For example, check these features on the new Series SC-030 —ACCURACY: $\pm 5\%$ of full scale. RANGES: 100-800 UA, DC; 1-800 MA, DC; 1-800 V, DC; 50 MV basic movements for DC Ammeters with external multipliers. CALIBRATION: Magnetic or

non-magnetic. Internal Zero Adjuster. (Note: This meter is available with optional face plate and hex nut for front mounting...see illustrations.)

And like all DeJUR panel instruments, the micro-miniature series uses gasket sealed scale window and terminals, miniaturized external pivot D'Arsonval movement and high flux density Alnico magnet. Look into DeJUR's meter line today by writing for complete specs on standard and special units for commercial and military applications.

Manufacturers of precision electrical indicating instruments for over 20 years.



MODEL 100. 1" round Meets MIL-M-3823 watertight specs External pivot. D'Arsonval movement. Wide range of resistances and scales available

MODEL 131. 1 1/2" ruggedized. Withstands shock, vibration and temperature extremes. Meets MIL-M-10304 specs. Square case.

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sure with
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ELECTRONIC COMPONENTS

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LONG ISLAND CITY 1, N. Y.



ELAPSED TIME INDICATORS. 1 1/2", 2 1/4", 3 1/4" Registers 1/10 minute or 1/10 hour increments to 9999.9. Hour steps to 99999. Self-starting. 110-125VAC, 60 cycles.

MULTIMETER. 3 1/4" AN type for data link or analog application. Hermetically sealed and gas filled. Four simultaneous readouts.

CIRCLE 268 ON READER-SERVICE CARD

Microwave Component News



from SYLVANIA



NEW Sylvania Micro-Min Diodes

Sylvania opens the way to advanced miniaturization concepts in microwave and radar design with new smaller Silicon Microwave Diodes



Major step in the trend to ever smaller radar and microwave equipment to meet today's military and commercial demands is represented by Sylvania's new line of subminiature Micro-Min diodes. The new diodes meet the electrical performance of their larger counterparts and are equivalent in ruggedness and reliability. They combine in one unit Sylvania's unmatched experience in diode packaging and proven technical excellence in microwave diode design.

The subminiature metal-to-glass package opens the way to new possibilities in strip-line and slab-line transmission designs. Included among the new types are Detector Diodes ranging in frequencies from 100 mc to 9,000 mc and Mixer Diodes in frequencies from 3,000 mc to 9,000 mc. Contact your Sylvania representative for full information on the new subminiature microwave diodes—or write Sylvania directly.

NEW SYLVANIA MICRO-MIN DIODES

IN830 (D 4050)—UHF Detector | IN832 (D 4065)—X Band Mixer
IN831 (D 4064)—S Band Mixer | IN833 (D 4063)—X Band Video Detector

SYLVANIA

Subsidiary of
GENERAL TELEPHONE & ELECTRONICS



SYLVANIA ELECTRIC PRODUCTS INC.
Semiconductor Division
100 Sylvan Road, Woburn, Mass.

CIRCLE 465 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 the microphone 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

STRAPLOCK[®] CABLE CLAMPS

- SAVE TIME
- REDUCE INSTALLATION COSTS
- SIMPLIFY ASSEMBLY



Just push Straplocks into place and you're ready to lay cables or wires immediately—without time-consuming bundling or lacing. Straplocks require only a mounting hole for fast, easy manual installation, eliminate "blindspot" problems, quickly adjust to various sizes and align perfectly. They provide an ideal vibration-proof clamp for fastening cables or wires to cabinets, panels or sheet metal surfaces.



Typical Straplock application. Auto lighting cable is anchored quickly and economically. Straplocks resist engine heat, oil, grease and battery acid.

Molded from tough Nylon, Straplocks resist oils, greases, common solvents and severe temperatures from -65° to +300°F. Absence of any metal in their construction and mounting requirements assures complete insulation. They are especially suited for aircraft, missile, automotive and heavy appliance applications.

Request literature giving complete information and technical data.

INTRODUCTORY OFFER SPECIAL STRAPLOCK KIT

Prove to yourself how Straplocks save time, reduce installation costs. Special introductory kit containing 200 W-1 Straplock Cable Clamps and handy installation tool costs only \$4.50. Order today!

 **WHITSO, INC.**
9326 Byron Street, Schiller Park, Illinois
(Chicago Suburb)

CIRCLE 275 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1959

MORE

OF EVERYTHING
YOU WANT IN A
**TRANSISTOR
CHECKER**



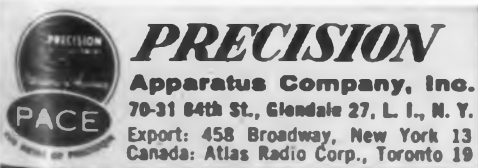
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\$89.00

THE PRECISION MODEL 960

- **Direct Icbo Readings** in terms of true collector current.
- **Five Icbo Ranges** cover all types of transistors — low, medium and high power . . . n-p-n and p-n-p types.
- **17 D.C. Collector Voltages:** .5 volts DC to 100 volts DC in 17 steps.
- **Direct-Reading Gain Ranges:** 5 separate injection currents.
- **Leakage:** Reliable check of emitter to collector leakage current provides basis for accurate gain tests.
- **Crystal Diode Tests:** Separate tests for both forward and reverse currents.
- **Transistor Test Settings** listed on high speed roller chart.
- **Patchcord Selector System** and universal adapter provide for future semiconductor releases.
- **Wide-Angle, 5 1/2", 100 microampere** sensitivity PACE meter.
- **Free Transistor Test Data Subscription Service** for one full year.

MODEL 960: Complete with portable carrying case and comprehensive technical manual. **Net Price: \$89.00**

- ▶ Available and on display at leading electronic parts distributors. Write for complete **PRECISION** catalog.
- ▶ **PRECISION** Test Equipment carries a full year warranty!



CIRCLE 276 ON READER-SERVICE CARD

Resistors Aluminum finned



Series CH power resistors are encapsulated in a finned anodized aluminum case and require no lugs or mounting brackets. CH25 units are rated 25 w at 25 C ambient and have resistances from 0.1 ohm to 16 K. CH50 models are rated at 50 w with resistances from 0.3 ohm to 175 K. Both series derate to 0% at 275 C ambient. Standard tolerances are 1% and others from 0.05 to 3% are available. Temperature coefficient is 20 ppm per deg C.

Pacific Resistor & Cable Co., Dept. ED, 2186 Colorado Ave., Santa Monica, Calif.

CIRCLE 277 ON READER-SERVICE CARD

DC Potentiometric Voltmeter

Has $\pm 0.025\% + 3 \mu\text{v}$ accuracy



This potentiometric voltmeter has a 0 to 10 v dc range of either polarity and an accuracy of $\pm 0.025\% + 3 \mu\text{v}$. It has a readout facility of six decade switch dials with $\pm 10 \mu\text{v}$ resolution. Using the panel galvanometer, the resolution can be extended to the submicrovolt region. The reference supply stability is 0.005% for line voltages varying from 107 to 127 v ac. Especially suited for transducer calibration, the unit may also be used as a null or quasi-deflection potentiometer, and its galvanometer may be disconnected and used separately. Designed to be carried or mounted in a rack, the instrument is 19 x 8-3/4 x 11 in.

Siegler Corp., Hallamore Div., Dept. ED, Anaheim, Calif.

CIRCLE 278 ON READER-SERVICE CARD

NEW EECO

Transistorized

for extremely
reliable operation
in the 0 to 250 kcs range

DECADES



ONE-THIRD ACTUAL SIZE



APPLICATIONS

New EECO N-Series Transistorized Decades are miniaturized plug-in units designed for reliable pulse counting and frequency division in the frequency range of 0 to 250,000 pulses per second.

FEATURES

- Small, compact size.
- Simple power supply requirements (for example, Models N-101 and N-102 require only -12 volts).
- Low power consumption.
- Compatible with EECO T-Series circuits.
- Auxiliary 9-step staircase output available.
- Plug into standard 9-pin miniature socket. (Some models require special 13-pin socket, furnished with each such unit.)
- Pin connections arranged for in-line wiring of power and grounds.
- Extreme reliability, due to saturation techniques and consistent derating of component tolerances.

WIDE SELECTION

EECO N-Series plug-in Decades are available in the following standard models:

MODEL	DESCRIPTION
N-101	No readout.
N-102	Incandescent readout.
N-104	Incandescent readout (remote). Typically a projection readout module.
N-105	Nixie readout. (Can be cabled to remote Nixie.)
N-106	Nixie readout with preset control switch. (Can be cabled to remote Nixie.)
N-107	Incandescent readout with inputs for external preset control.
N-108	Incandescent readout (remote) with inputs for external preset control.

Additional information on N-Series Transistorized Decades and other EECO products available on request.

TYPICAL SPECIFICATIONS

The N-102 Transistorized Decade which includes visual readout numerals 0 through 9 displays vertically and illuminated by incandescent lamps, is identical electrically with Model N-10. Abbreviated specifications are as follows:

INPUT

Minimum Trigger Input: (0-10 kcs): 7 volts pos. pulse or step at 0.5 μsec . rise time. (100 k to 250 kcs): 7 volts pos. pulse or step at 0.2 μsec . rise time
Max. Operating Frequency: 250 kcs.

Input Impedance: 470 μmfd . capacitance, max.

DC Reset input is provided (normally supplied by EECO T-129 DC Reset Generator).

OUTPUT (No Load)

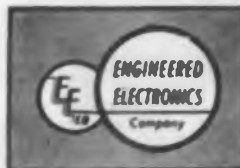
Amplitude: 8 volts, peak to peak
Output Levels: (N/10) and (N/10) —11 volts DC and —3 volts DC, nom. Staircase: —11 volts DC to —3 volts DC in 9 steps
Rise Time: (N/10): 0.5 μsec (N/10): 0.5 μsec .

Load: Typical, one N-Series Decade or one T-Series flip flop. (Load information available on request.)

OPERATING TEMPERATURE

RANGE: —45°C to +65°C.

SIZE: 1-5/32" wide x 2-3/32" deep x 3-7/8" seated height (including handle). Dimensions are exclusive of external presenda found on external preset and Nixie models.)



ENGINEERED ELECTRONICS COMPANY
(a subsidiary of Electronic Engineering Company of California)

506 East First Street • Santa Ana, California

CIRCLE 279 ON READER-SERVICE CARD



MICRO SWITCH Precision Switches



Need pushbutton switches?

Here is a sampling of a very wide choice

These assemblies are typical of many different series of MICRO SWITCH pushbutton switches. Each series offers many variations of electrical and operating characteristics.

Operational characteristics include: momentary action, lock-down, alternate action, two-position alternate action, and magnetically held. Direct control of up to fourteen double-throw circuits is offered. Short and long button strokes can be provided. Sealed switches are available when protection is required from oil, water, sand, or salt spray. Special shock and vibration-resistant features are built into switches for

rugged duty service. Switches with illuminated pushbutton display are available. These include switch devices with interchangeable modular indicator and pushbutton units.

Experienced engineering assistance to help you select the pushbutton switch best suited to your requirements is as near as your MICRO SWITCH branch. There is no obligation.

MICRO SWITCH... FREEPORT, ILLINOIS

A division of Honeywell

In Canada: Honeywell Controls Limited, Toronto 17, Ontario



Honeywell

MICRO SWITCH Precision Switches

CIRCLE 280 ON READER-SERVICE CARD

NEW PRODUCTS

RF Detectors

Have low vswr



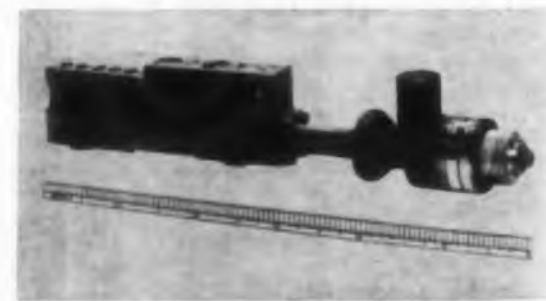
Designed to rectify rf test signals in laboratory and production-line testing and tuning, these crystal diode detectors have a low vswr and cover the 1 to 2000 mc range. The series includes half wave, two-polarity half wave, voltage doubler, and balanced circuits with termination impedances ranging from 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, 116 N. Seventh St., Philadelphia 6, Pa.

CIRCLE 282 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1959



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 μ sec. 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

Low cost, versatile DIGITAL SYSTEMS

for automatic testing of
transistors  resistors  diodes 
and capacitors 



Small E-I automatic digital systems provide many advantages. First, they cost less. This is primarily the result of large-quantity manufacture of modules which make up the E-I system. Cost is almost a linear function of performance capabilities desired in the system.

Second, they are exceptionally versatile. The E-I system can be expanded simply by adding appropriate modules. Typical systems presently in use measure resistance, capacitance, DC and AC voltages, DC/DC ratios, AC/DC ratios, AC/AC ratios and combinations of these. Measurements to four or five digits can be vis-

ually displayed and printed out at rates up to five readings per second. Operation can be semi- or totally automatic with go/no go comparison of values and programmed readout at periodic intervals. Scanners can be provided for scanning thousands of single and multi-wire input channels. In brief, the E-I system has an extensive scope of operating capability.

Third, E-I systems provide unmatched reliability. Where practicable, circuits are totally transistorized. The use of etched, plug-in circuit boards, and modular internal construction make maintenance checks and in-plant repairs easy.

Typical E-I system for evaluating components—includes 100 channel input signal scanner. Can digitize DC voltage, resistance, AC voltage and DC/DC voltage ratio analogs. Digital equivalents are recorded on strip printer for "quick look" data and on punch paper tape for additional data reduction by digital computer.

Lower cost, maximum versatility and greater reliability—if you want these advantages in your component test system, contact your nearest E-I representative. He can give you complete information or answer any specific questions you may have.



Electro Instruments, Inc.

E I 3540 AERO COURT
SAN DIEGO 11, CALIF.

CIRCLE 285 ON READER-SERVICE CARD

protect your
circuits

REPLACE FUSES WITH A
Thermocal switch

PYRISTOR®...protects your
equipment circuitry...precisely

NEW miniature, hermetically sealed, single-shot, current-sensitive switch for positive overload protection and for current operated triggering devices.

RELIABILITY in critical environments
...from -100° F. to $+1000^{\circ}$ F. continuous.
...closing time 1 millisecond to 5 seconds.

Write for new
Brochure containing
complete specifications:
advanced concepts of
precision specialty
switches for maximum protection

thermocal

1631 COLORADO AVENUE
SANTA MONICA, CALIFORNIA

CIRCLE 286 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 $\pm 2\%$ frequency response, $\pm 3\%$ full scale accuracy. Input impedance is 1 meg paralleled by 10 μ f. 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-15 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 $\pm 5\%$; linearity, $\pm 2\%$ 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

MANUFACTURERS of MESA TRANSISTORS NEED PRECISION in EVAPORATION MASKS

BMC is the **MAJOR PRODUCER**
for the **PRECISE** answer to your need

* Buckbee Mears Company also manufactures etched forms and electroforms of unusual accuracy—items used in electronic tubes, shaver heads, numerical indicator tubes, color television masks. Perhaps a component for your product could be made better and more economically by this process. We will gladly quote from your specifications.

For complete information call or write...

BUCKBEE • MEARS CO.

Toni Building • St. Paul 1, Minn.
CA 7-6371

CIRCLE 291 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1969

RALPH DISPLAY TUBES.—Model 10K B is 10 in., long persistence unit of round glass construction with metal backed screen, gray glass faceplate, magnetic focus and deflection. Model 10W 7A has aluminized screen, non-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 READ-OUT 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



photo courtesy of Emerson Research Laboratories

WELDMATIC PRECISION WELDING IMPROVES COMPONENT RELIABILITY FOR EMERSON

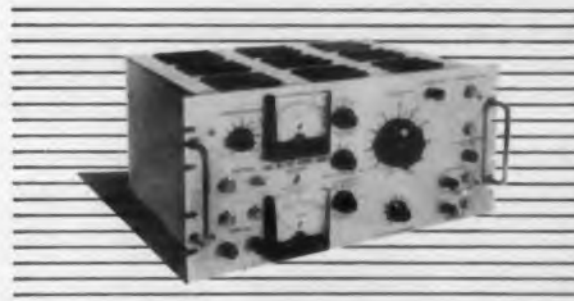
Joining lead wires to magnetic amplifiers was a problem at Emerson Research Laboratories. However, using a Weldmatic Model 1012 welder, they found they could join materials like #40 nickel iron resistance wire and #24 tinned copper both quickly and easily. Resulting joints proved *reliable*—able to withstand severe vibration, acceleration and high temperature. With Weldmatic welders you can simplify miniaturization, speed production. Write for technical data on the Weldmatic line.

WELDMATIC DIVISION OF UNITEK CORPORATION
260 North Halstead Avenue • Pasadena, California

SALES ENGINEERING REPRESENTATIVES IN PRINCIPAL CITIES
CIRCLE 296 ON READER-SERVICE CARD

NEW IDEAS IN PACKAGED POWER

for lab, production test, test maintenance, or as a component or subsystem in your own products



Series 1000.

Easy-to-use compact Beta Series 1000 high voltage supplies come in 13 different models, providing voltages up to 60kv dc and currents as high as 500 ma. Adjustable output voltage (0 to max. rating with coarse and fine controls); extremely low ripple; easy, rapid polarity reversal and full metering are a few outstanding features.

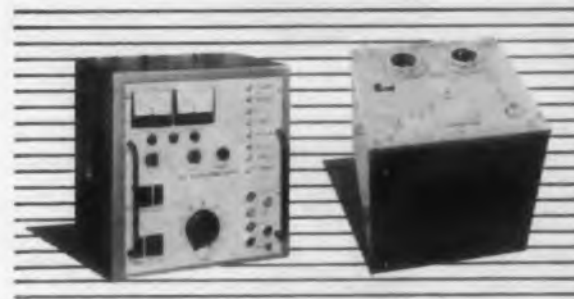
Single-unit, rack-mounting supplies to 60 KV

Available ranges and current capacities:

Output (DC KV)	Current (Max. MA)
0-1	500
0-3	200
0-5	10 or 100
0-10	2, 10, or 50
0-15	5, or 10
0-30	2, 5, or 10
0-60	5 @ 50 KV 1 @ 60 KV

Inputs: 117 vac, 60 cps, single phase

HV DC TO 250KV WITH MAXIMUM CONVENIENCE, SAFETY



Series 2000 — control section (left).

Series 2000 — high-voltage section (right).

Simple to operate, conservatively rated to insure long, optimum performance with maximum safety, Beta Series 2000 supplies come in thirteen different models, with maximum voltages ranging from 1 to 250kv dc. Output voltage continuously adjustable from 0 to maximum. Two-unit design allows optional remote operation of high voltage circuits. For maximum voltages less than 30 kv, the high-voltage unit is air-insulated; for higher voltages, oil-insulated (shipped dry). Every precaution is taken to insure personnel and equipment safety.

Two section supplies to 250KV

Available ratings:

Output (KV DC)	Current (Max. MA continuous)
0-1	3000
0-3	1000
0-6	500
0-10	200
0-20	150
0-30	30
0-30	100
0-50	10, 50
0-120	5
0-120	25
0-150	5
0-250	10

Inputs: 117 vac, 60 cps, single phase

Sorensen markets the widest line of controlled power equipment available today, including: Regulated a-c and d-c supplies, unregulated power supplies, frequency changers, inverters, and converters, SAMES electrostatic generators for regulated voltages up to 600 kv dc, voltage reference sources, high-voltage d-c overpotential testers and high-potential test equipment.

An exceptionally wide selection of standard models is available and experienced Sorensen engineers are always glad to discuss your special needs.



SORENSEN & COMPANY, INC.

Richards Avenue, South Norwalk, Connecticut

WIDEST LINE OF CONTROLLED-POWER EQUIPMENT FOR RESEARCH AND INDUSTRY

IN EUROPE, contact Sorensen-Ardag, Zurich, Switzerland. IN WESTERN CANADA, ARVA. IN EASTERN CANADA, Bayly Engineering, Ltd. IN MEXICO, Electro Labs, S. A., Mexico City.

CIRCLE 297 ON READER-SERVICE CARD



PRECISION GYROS

A Proven Kearfott Capability. The increasing use of Kearfott gyros and gyro platforms in today's missile programs, underscores the company's leadership in gyro design and production. Such missile projects as the Atlas, Bomarc, Polaris, Snark, Subroc and Talos rely on Kearfott gyros or gyro platforms, as do the majority of manned aircraft now in service.

FLOATED RATE INTEGRATING GYROS. High accuracy miniature gyros specifically designed for missile use. The performance characteristics of these gyros are superior to any comparably-sized units available today. Hermetically sealed within a thermal jacket and ruggedly designed for adaptability to production methods. These gyros operate efficiently at unlimited altitudes. More precise performance characteristics can be provided in the same dimensions.

VERTICAL GYROS. Provide accurate vertical reference in the form of two 400 cps synchro signals proportional to the sine of gimbals' displacement about pitch and roll axes. Gravity-sensitive vertical reference device provides electrical signals directly to torque motors which maintain gyro spin axis perpendicular to earth's surface. Hermetically sealed, they are unaffected by sand, dust, sun, rain, salt spray, humidity or fungus conditions as specified in MIL-E-5272A.

FREE GYROS. Provide extremely accurate reference in the form of electrical output signals proportional to displacements about outer axes. With 360° of freedom about outer axes (inner axis freedom depends on the unit involved), these gyros may be mounted to give output signals of either pitch, roll or yaw. Shock and vibration resistant, they are equipped with quick-starting motors for applications in high performance missiles and aircraft.

SPRING RESTRAINED RATE GYROS. Almost universally applicable in missile and aircraft designs demanding precise angular rate measurements in environments of extreme shock and vibration. Fluid filling provides added immunity to shock and vibration, reduces bearing friction in AC types and potentiometer wiper friction in DC types. Kearfott design advances permit 30 second warm-up, overcome fluid viscosity variations resulting from ambient temperature change. These gyros are single-degree-of-freedom, viscous damped, spring restrained, with gimbals supported by precision bearings. Compensatory damping mechanisms eliminate need for accessory heaters.

Engineers: Kearfott offers challenging opportunities in advanced component and system development



Roll Stabilized Directional Gyro



3 Gyro-4 Gimbal Gyro Reference



25 Pound Inertial Platform

CIRCLE 298 ON READER-SERVICE CARD



TYPICAL CHARACTERISTICS

Mass Unbalance: Along Input Axis: 1.0°/hr maximum untrimmed	Damping: Ratio of input angle to output angle is 0.2
Standard Deviation (short term): Azimuth Position: 0.05°/hr Vertical Position: 0.03°/hr	Characteristic Time: .0035 seconds or less.
Drift Rate Due to Anisotropy: Steady Acceleration: .015°/hr./g ² maximum	Weight: 0.7 lbs.
Vibratory Acceleration: .008°/hr./g ² maximum	Warm-up Time: 10 minutes from -60°F
	Life: 1000 hours minimum



TYPICAL CHARACTERISTICS

Repeatability to Established Vertical: To within a cone of half angle equal to 15 minutes of arc (± 8 minutes typical).

Free Drift Rate in 5 minutes Time: 2.5° maximum at room temperature. 3.75° at -54°C and +71°C.

Erection Rate: 2.5°/Min.

Initial Erection: The gyro will erect to within $\pm 1^\circ$ of established vertical in 60 seconds time after application of power at room temperature.

Vibration and Shock: The gyro will meet above characteristics after vibration of 0.060" total excursion cycling between 10 CPS and 55 CPS for 4.5 hours. Shock test in accordance with MIL-E-5272A Procedure 2. Operating Life: 1000 hours minimum.



TYPICAL CHARACTERISTICS

Free Drift Rate: Within 0.5° in one minute time.

Shock: The gyro operates satisfactorily without damage after 60g shock of .015 seconds duration.

Hermetically Sealed: These instruments are hermetically sealed and are not affected by sand, dust, sunshine, rain, humidity or fungus conditions.

Operating Temperature Range: Gyros operate in ambient temperatures below -20°C to +100°C. A maximum of 3 minutes of operation at 400°F will not damage these gyros nor impair their accuracy.

Weight: 5.5 lbs. approximately.



TYPICAL CHARACTERISTICS

Maximum Rate (°/sec.): 45-1000

Natural Undamped Frequency (cps) ($\pm 10\%$): 16

Damping Ratio (of critical) over Temperature Range: .35 to .80

Operating Temperature Range (°F): -65 to +185

Vibration: 12 g's @ 20-2,000 cps

Shock (Motor Running): 60 g's for 6.5 milliseconds

Warmup Time (Sec.): 30

Weight (lbs.) (max): 1.5

Gyro Time Constant (Sec.): .012

Kearfott

A
GENERAL
PRECISION
COMPANY

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.
A subsidiary of General Precision Equipment Corporation

Sales and Engineering Offices: 1500 Main Ave., Clifton, N. J.
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South Central Office: 6211 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinado Avenue, Pasadena, Calif.

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 $\pm 0.2\%$ 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 1/2 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

vital electronic equipment is "soft mounted" on F-105



Critical electronic units on the Air Force's Mach 2 F-105 Thunderchief fighter-bomber are "soft mounted" on LORD vibration control systems. Operational reliability is thus assured for a toss bomb computer, sight amplifier and two integrated electronics chassis.

Use of resilient suspension systems—custom designed—provides positive protection against the extreme disturbances of the advanced jet environment. By working with LORD, F-105 contractors obtained the lightest, most economical suspensions in the shortest time.

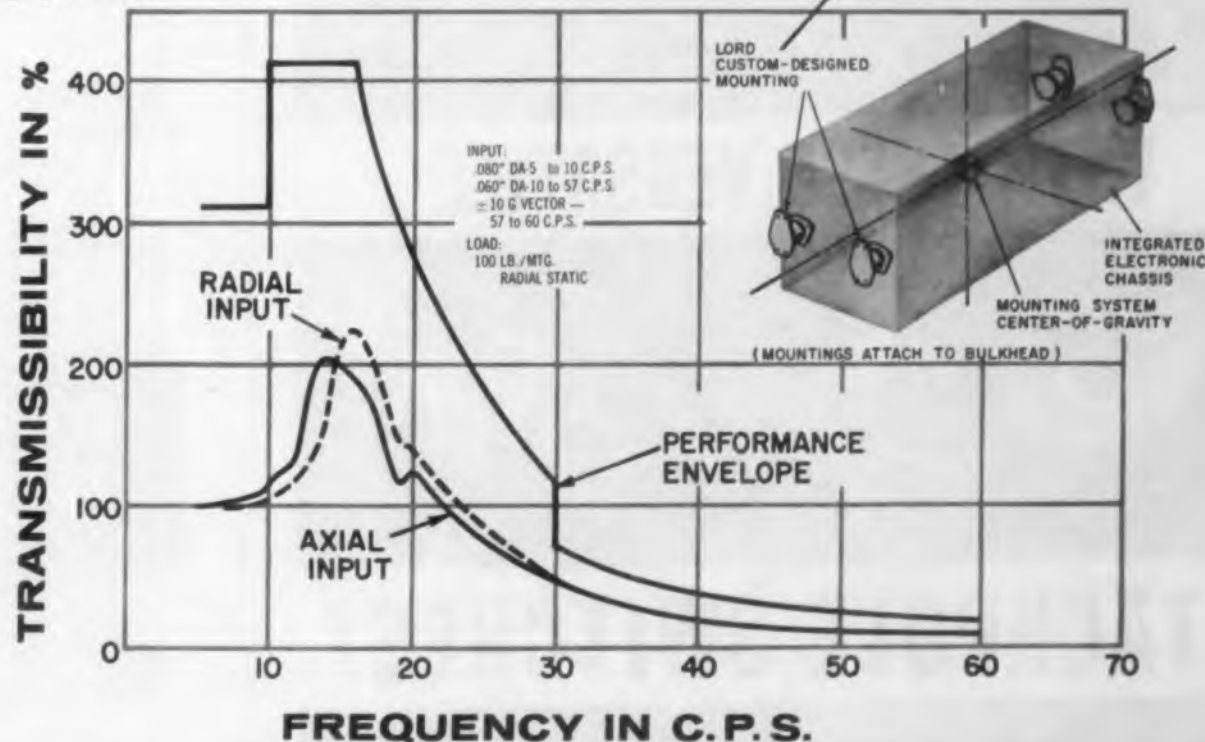
If you have a problem in the protection of sensitive equipment, LORD offers you a broad background of vibration/shock/noise control experience in air, space, marine and ground environments. Your inquiry will be welcomed. Contact your nearest LORD Field Office or the Home Office, Erie, Pa.



Vibration/shock/noise control—Two integrated electronics chassis on Republic F-105 jet fighter are mounted on special Lord high-performance isolators. Severe environment includes vibration, superimposed sustained accelerations to 9 G and 30 G shock loads throughout temperature range from -65° to +200° F.

In final design shown, four isolators weighing less than 1.5 pounds each support chassis weighing between 266 and 400 pounds. Use of Lord BTR (Broad Temperature Range) elastomer assures excellent damping plus constant performance over wide temperature range.

Transmissibility curve shows how efficient vibration isolation keeps equipment well inside fragility envelope.



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"In Canada—Railway & Power Engineering Corporation Limited"

LORD MANUFACTURING COMPANY • ERIE, PA.

CIRCLE 305 ON READER-SERVICE CARD





SS-5
DP-DT spring return
0.5-amp. @ 125v ac-dc
U.L. Inspected.

SS-15
SP-ST pushbutton, momentary
contact, 1-amp. @ 125v ac
U.L. Inspected.

SS-16
2-position special
0.5-amp. @ 125v ac-dc

UNIQUE ELECTRICAL PRODUCT



SS-31
2-Position, 3-amps
@ 125v ac
U.L. Inspected.

SS-32
SP-DT, 1-amp.
@ 125v ac-dc
U.L. Inspected.

SS-33
DP-DT, 1-amps
@ 125v ac
U.L. Inspected.

DESIGN IDEAS OFTEN BEGIN



SS-50
DP-DT miniature
0.5-amp. @ 125v ac-dc
U.L. Inspected.

SS-8
JP-DT, optional
detent, 1-amp. @ 125v ac

SS-27
SP-DT spring return
1-amps @ 125v ac
U.L. Inspected.

WITH THESE VERSATILE



SS-26-1
SP-DT, 3-amps
@ 125v ac
U.L. Inspected.

SS-9
SP-DT spring return
3-amps @ 125v ac
U.L. Inspected.

SS-18
2-position special
0.5-amp. @ 125v ac
100-1000 cycles

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Ask for 8-page Switch Bulletin RC-110
World's largest slide switch line—over 12 low cost
standard types—dozens of economical adapta-
tions. NEW colored knobs. Special conventional and
miniaturized switches designed and produced for
large quantity users. Electronic Components Division,
STACKPOLE CARBON COMPANY, St. Marys, Pa.



CIRCLE 306 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 μ a; 800 v, 4.1 μ a; 1200 v, 6.6 μ a. 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

Engineers! Designers!
**THERE IS NO SUBSTITUTE
FOR RELIABILITY!**

Specify—
**PERFORMANCE
PROVEN "MAG MOD"**

MAGNETIC MODULATORS

Actual
Size



For complete
specifications and
application data on "Mag Mod"
Miniature and Standard
Components, call or write.

Miniaturized design permits engineers to employ these new components in transistorized printed circuit assemblies and wafer type structures. All models offer maximum reliability, fully ruggedized construction and conform to MIL-T-27A specifications.

- COMPLETE RELIABILITY
- INFINITE LIFE
- FASTER RESPONSE TIME
- NEGLIGIBLE HYSTERESIS
- EXTREME STABILITY
(Ambient Temp. Range from -75° to +135°C)
- COMPACT SIZE
- LIGHTWEIGHT

Typical circuit applications for Magnetic Modulators are algebraic addition, subtraction, multiplying, raising to a power, controlling amplifier gains, mechanical chopper replacement in DC to fundamental frequency conversion, filtering and low signal level amplification.

GENERAL MAGNETICS • INC

135 BLOOMFIELD AVENUE
BLOOMFIELD, NEW JERSEY
Telephone: Pilgrim 8-2400

CIRCLE 311 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1959

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 $\pm 0.25\%$ 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 Alumalox 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 μ f.

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 μ v 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.

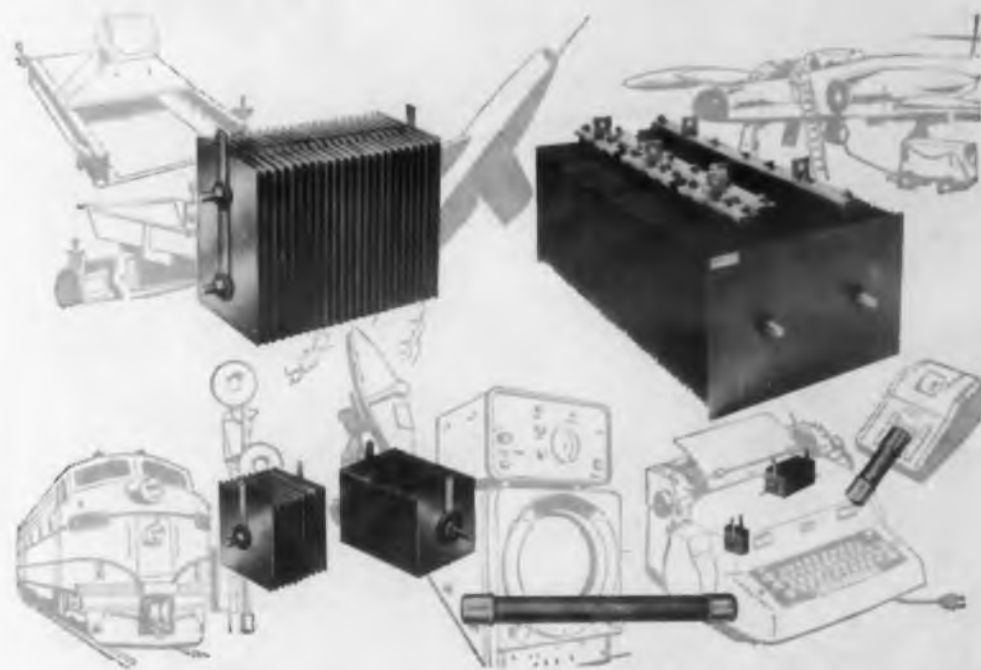
CIRCLE 314 ON READER-SERVICE CARD

BOLOMETER PREAMPLIFIER.—Model BA-1C measures rf power ratios to 30 db between 20 mc and 90 kmc at maximum rf level of 200 μ w 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

SYNTRON SELENIUM RECTIFIERS



provide greater d-c output per
dollar for given a-c input

SYNTRON'S unique vapor deposit process and rigid quality control yield more efficient Selenium Rectifier cells. Cells noted for their low forward voltage, long life, uniformity, high temperature and voltage ratings—Cell voltage ratings from 15 to 52 volts RMS are available. Offering the widest range of cell sizes in the industry—from .280 inch diameter to 12 x 16 inch—permitting single stack assemblies from a few watts to many kilowatts. SYNTRON Selenium Rectifiers offer—versatility, dependability, long life, performance stability for all your d-c power applications.

Write for complete information and specification catalog—FREE

SYNTRON COMPANY

283 Lexington Avenue

Homer City, Penna.

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deep drawn aluminum boxes and covers

**11,600
Standard
Sizes
and
Shapes**

WITH NO TOOLING COST!



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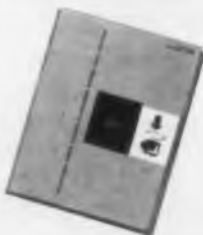
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NEW PRODUCTS

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 μ w; 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, tear-drops, and tees.

W. H. Brady Co., Dept. ED, 727 W. Glendale Ave., Milwaukee 9, Wis.

CIRCLE 322 ON READER-SERVICE CARD

ILLINOIS CAPACITORS KNOWN THE WORLD OVER for their TIME TESTED QUALITY!

there is an Illinois Electrolytic Capacitor for every Electronic Requirement!

Single Anode SMT Dual Anode or Cathode SMT Tubular SMT

PE Octal Plug-in

UMP Twist Prong

UMS Molded Terminal

UMC Energy Storage and Photo Flash

LN Flexible Lead Types, Screw Neck Mounting

IHC Replacement Types

UMT Clamp Mount

IHT Tubular Pigtailed

Illini "300" Bantam and "300"

ITC Ceramic Cased Paper

BT Electrolytic and Paper

More than a quarter century of research and development is backed by the production facilities of four factories to produce electrolytic capacitors of any and every type to meet your requirements. Whether you need a small quantity of highly specialized types . . . or, large production quantities, you will find that we can offer you better service, PLUS many other advantages worthy of your consideration.

Catalog Literature Upon Request

ILLINOIS CONDENSER COMPANY

616 N. Throop Street • Chicago 22, Illinois • phone: Everglade 4-1300 • TWX: CG3149

CIRCLE 323 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 195

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 1 μ f, 0.1 milliohm, and 0.1 μ h on lowest ranges. Values to 1200 μ f, 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, LOW FREQUENCY RELIABILITY IN GLASS-ENCLOSED CRYSTAL

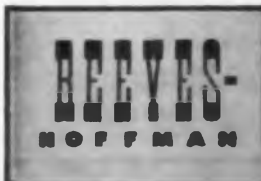


Precision components of the new RHG-DP crystals are enclosed and hermetically sealed in glass holders to assure maximum internal cleanliness and most reliable evacuation. The result is a series of sturdy, miniature, low frequency units having excellent long-term stability and higher Q.

TYPICAL VALUES FOR 2 KC UNIT*

Frequency range	1 to 15 kc
Holder	T5 1/2 glass bulb —Noval Base
Temperature range	-55 to $+100^{\circ}$ C
Frequency tolerance	$\pm 0.15\%$
Effective resistance	75,000 ohms max.
Aging 8 hours— 100° C	$\pm 0.01\%$ max.
Meets MIL specifications for vibration stability	

*Reeves-Hoffman manufactures a broad line of crystals in the range from 1 to 1000 kc.



WRITE FOR BULLETIN RHG-DP

DIVISION OF
DYNAMICS CORPORATION OF AMERICA
CARLISLE, PENNSYLVANIA

CIRCLE 328 ON READER-SERVICE CARD



MODEL AVS 320
Fixed voltage regulator. Four fixed voltages between 1 volt and 300 volts at all frequencies 35 cycles to 20 KC. Will make any power amplifier. A precision voltage supply.

MODEL AVS 321
Precision AC Power Supply
1 volt to 1000 volts AC
35 cycles to 10 KC
Digital set voltage to $\pm 0.1\%$



PRECISION A.C. VOLTAGE INSTRUMENTATION



MODEL 30 Power Amplifier
30 Watts 0.1% Distortion
Output 1 to 300 volts AC
35 cycles to 20 KC

MODEL AVA 500 Power Amplifier
500 Watts 2% Distortion
Output 115 - 230 volts
300 cycles to 2 KC



MODEL AO .1 Audio Oscillator
20 cycles to 20 KC
1 volt RMS Output with short term stability of 0.05%
frequency stability $\pm 1\%$
Distortion 0.1%
The ideal oscillator for A.C. voltage measurements

Complete details and specifications on HOLT Precision AC Voltage Instrumentation are yours upon request . . . Write Today.

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CIRCLE 329 ON READER-SERVICE CARD



VOLTRON now offers —a portable wattmeter for refined, low-power measurements of gyros, synchros and servomotors

- Rugged Taut Band Suspension
- Full-Scale Range: 0-1.2 Watt
- Low Power Factor
- Voltage drop across current coil as low as 0.2% of input voltage, permitting accurate measurements without the need for correction factor.

SPECIFICATIONS:

CONSTRUCTION	Meter consists of d'Arsonval type D.C. milliammeter and one A.C. power to D.C. current transducer for each phase. Taut band suspension eliminates the static friction and the delicacy of conventional jewels and pivots. Solid state circuit components are used in the transducer.		
INPUT VOLTAGE	26/115 ± 10%		
WATTAGE RANGE	26 volt input — 1.2/3/12/30 115 volt input — 1.2/3/12/30/120		
FREQUENCY RANGE	Flat from 50 to 2000 cycles		
ACCURACY	1.0% of full scale watts		
PHASE	1, 2, or 3 phase. The 3-phase meter is suitable for 3-phase, 3-wire, or 3-phase 4-wire measurements.		
POWER FACTOR	0.1 to 1.0 Lag or Lead.		
WAVE FORM FACTOR	Calibrated for use with both sine and square wave. For distorted waveforms, the error will be less than 2% for 5% harmonic distortion.		
ERROR DUE TO POWER CONSUMED IN:	VOLTAGE CIRCUIT:	0%	
	CURRENT CIRCUIT:	Max. Error (% watts indicated)	P.F.
		0.2 2.0	1.0 0.1
	linear between these values		
OVERLOAD	VOLTAGE CIRCUIT: 100% continuous overload without damage CURRENT CIRCUIT: 25% at 0.1 PF continuous without damage		
SIZE	8 1/2" x 12" x 4"		
WEIGHT	15 lbs.		
ORDERING INFORMATION	Model No.	PW-1	PW-2
	PHASE	1	1/2
	PRICE	\$385.00	\$485.00
			PW-3 1/2/3 \$585.00

DELIVERY: From stock subject to prior sale.

TERMS: Net 30, FOB: South Pasadena, Calif.

VOLTRON Products

1010 Mission St., South Pasadena, California

CIRCLE 330 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.

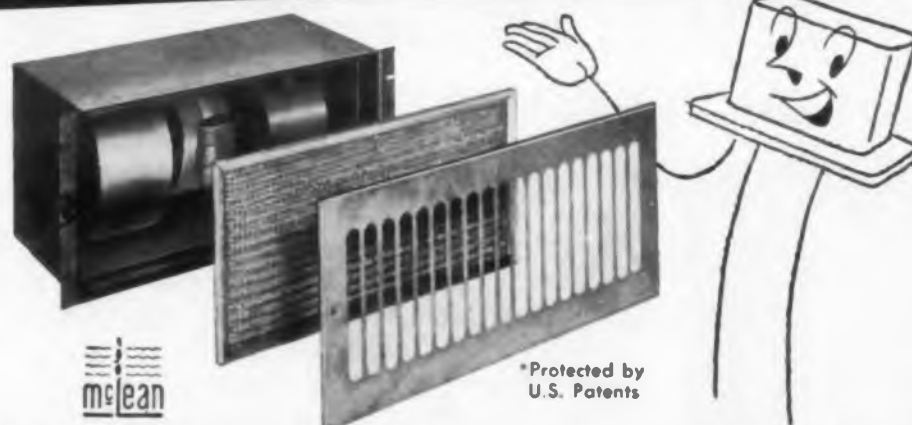
CIRCLE 333 ON READER-SERVICE CARD

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

TRANSISTORS NEED COOLING TOO!



McLean Fans and Blowers* Save Sensitive Components

Semi-conductors like tubes, require uniform temperatures for top efficiency. Excessive heat causes thermal runaway . . . destroys physical properties and calibration. A McLean fan or blower will extend component life and prevents system failure or inaccuracies. McLean's full line of packaged cooling units are smart, compact, easy-to-install and have a multitude of mounting possibilities. Many models in various panel heights and CFM's available. Mil. Spec. equipment for packaged cooling also available.

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World Leader in Packaged Cooling
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FREE TECHNICAL DATA

- 24 Page Catalog
- 12 Page Article Forced Convection Cooling
- Specification Sheet on Reversible Fans

See us at the Wescon Show, Booth No. 1818-1820

CIRCLE 335 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1957

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 typewriter 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 $\pm 5\%$ 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 msec to 1 μ sec; decay time constants are 1, 2, 10, and 100 μ sec. 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

SINGLE SIDE BAND FREQUENCY STANDARD

In flight for the U. S. Military
In production at James Knights



TIME PROVEN MODEL JKTO-P1A

Frequency Range: 1 to 5 mc

Stability: 1×10^{-7} /Day

Output: 1 volt into 5,000 ohms

Power: Operates from 24 to 28V D.C.

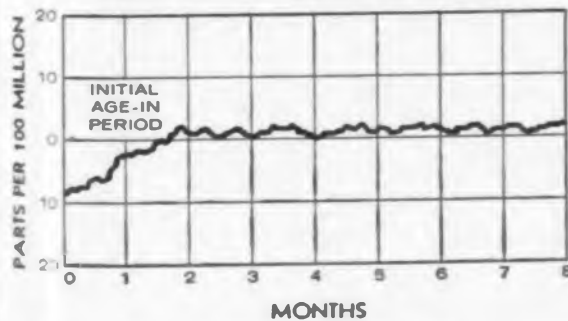
Oven: Long life; booster and control thermostats hermetically sealed.

Dimensions: 1.8" x 2 x 3 1/4". Wt. 10 oz. max.

Environmental: Hermetically sealed; meets applicable aircraft equipment specifications with maximum frequency deviation of 4×10^{-7} .

Write for literature, stating your specific requirements.

LONG TERM STABILITY OF JKTO-P1A



CIRCLE 340 ON READER-SERVICE CARD



**THE JAMES KNIGHTS
COMPANY**
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ELECTRONIC DESIGN • July 22, 1959



Low in cost...
easiest to program and operate...
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Operating from any convenient wall outlet, the LGP-30 helps you increase your productivity by taking the tedium out of mathematical analyses. It facilitates the optimum design of electronic tubes and circuitry, servo systems, radar and antennae... is an important Research and Development tool in magnetic field applications, microwave and semi-conductor studies.

The lowest-priced complete computer your company can buy, the LGP-30 gives you memory (4096 words) and capacity comparable to computers many times its size and cost — yet it is by far the easiest to program in basic machine language. What's more, you operate the LGP-30 yourself. Solutions are printed out in any desired alpha-numeric format — require no deciphering. Auxiliary high-speed input-output equipment is available for system expansion.

No expensive installation or air-conditioning. Sales and service available coast-to-coast. Customer training is free. An extensive library of programs and sub-routines is available—as well as membership in an active users organization.

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CIRCLE 341 ON READER-SERVICE CARD

All-new transistor power source engineered for modern, compact circuits



EVEREADY **ENERGIZER NO. 2713**

One of a family of new "Eveready" Energizers
with exclusive cathodic envelope construction

Designed especially for Transistor Service . . . Now equipment designers are offered greater flexibility in a power source than ever before. The new "Eveready" Energizer No. 2713 with unique cathodic envelope construction will service all requirements of the newest, most advanced battery-operated pocket radios . . . and many other transistorized devices.

Longer service . . . lower cost per hour. One Energizer No. 2713 battery gives *twice* the length of service

FREE! For Complete Engineering Data, write . . . Manager, Battery Engineering Department.

of *four* penlite batteries. More energy per unit volume than any other carbon-zinc battery! Polarized terminals prevent incorrect installation by users. No need for clips or cell-holders. Quick — easy installation the first time.

Guaranteed Leakproof. Like the entire line of "Eveready" Cathodic Envelope Energizers, this custom-designed battery is leakproof with a guarantee against corrosion damage. Ideal for all battery-operated transistorized devices.

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 $\pm 5\%$ load regulation and $\pm 0.5\%$ 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 $\pm 0.02\%$. 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 $\pm 20\%$, $\pm 10\%$ and $\pm 5\%$. 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

ELECTRONIC DESIGN • July 22, 1967



"Eveready" and "Union Carbide" are registered trade-marks of Union Carbide Corporation

NATIONAL CARBON COMPANY • Division of Union Carbide Corporation • 30 East 42nd Street, New York 17, N. Y.
OFFICES: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco • CANADA: Union Carbide Canada Limited, Toronto

CIRCLE 342 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 μ sec. 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

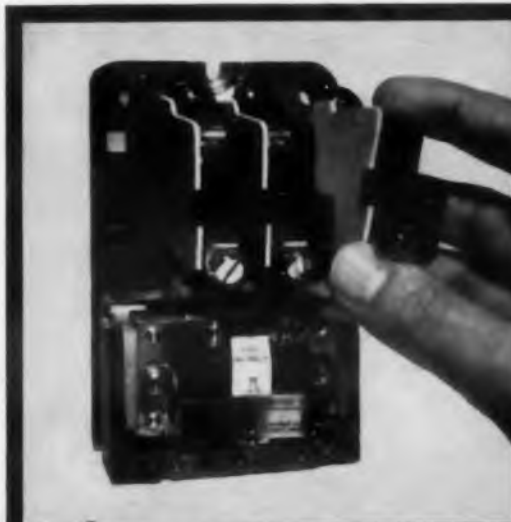
Counting Rate Meters

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 3×10^6 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



"Unitized" poles protect contacts



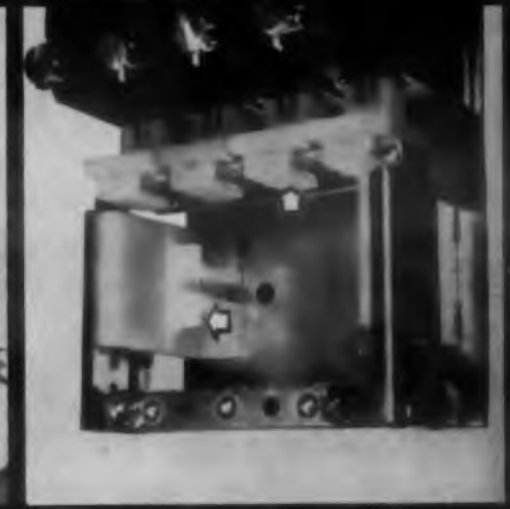
double-break, silver-to-silver contacts are self-cleaning, self-aligning



rugged steel base plates



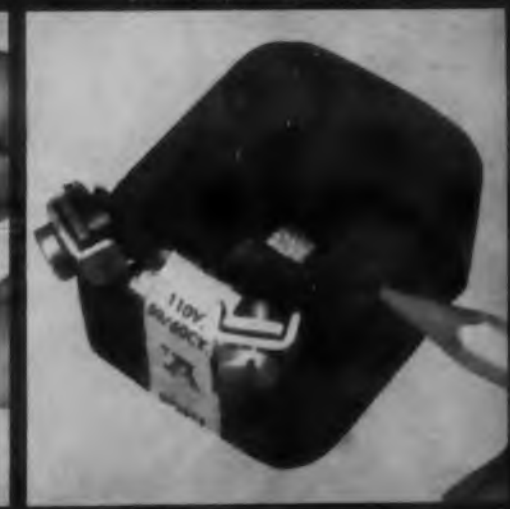
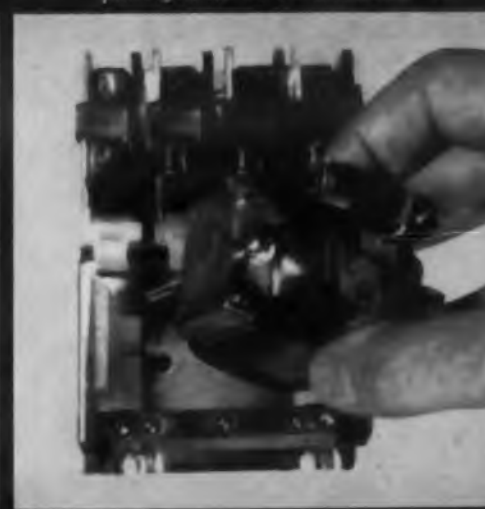
powerful AC or DC solenoids



friction-free nylon parts



simple, fast, easy installation speeds assembly into your equipment



molded coils minimize "burnouts"

every aspect of Ward Leonard bulletin "HR" relays is designed for maximum reliability . . . these are components you can buy, install and then forget

Ward Leonard "HR" relays are engineered for industrial and electronic applications requiring: ultra-long life, high speed, high reliability, compactness and versatility.

Consider the powerful solenoids, just one of the features shown above. Every HR relay, AC or DC, is equipped with a powerful solenoid to assure fast, consistent, long-life operation so essential in the circuitry of any high reliability relay. The "E-I" laminated magnet ar-

mature is free-floating and self-aligning to minimize noise level. DC solenoids feature exceptionally fast operation. Nylon armature guides minimize operational friction. All AC and DC power plants are readily interchangeable.

2 to 8 pole "HR" relays are but one of five W/L lines of industrial power relays . . . all designed with emphasis on reliability. Write for bulletin 4470. Ward Leonard Electric Co., 77 South Street, Mount Vernon, N.Y. D. 1

CIRCLE 349 ON READER-SERVICE CARD

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ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

LIVE BETTER...Electrically

Result-Engineered Controls Since 1892





NOW!

Certified

PRECISION STOCK GEARS

**STOCK GEARS 32 TO 120 PITCH
A.G.M.A. PRECISION #3...
IMMEDIATE DELIVERY**

Tens of thousands of gears of all types . . . 32, 48, 64, 72, 96 and 120 diametral pitches of 14½° and 20° pressure angles. APPCO offers them all for quick delivery. Each one "Certified" to meet or surpass A.G.M.A. specifications. APPCO Certified Precision Stock Gears offer 7 finishing options on aluminum gears at no extra cost . . . compatible bore tolerances for accurate fitting of gears, shafts and bearings. Each gear is completely sealed on shipping tray with plastic cover . . . always "factory fresh" and free of dust, corrosion and scratches.

APPCO Precision Gears are engineered and manufactured to allow for accurate assembly of precision units . . . held to tolerances that assure precise fits to standard instrument bearings, shafting, etc., according to accepted industry practice and A.G.M.A. specifications. For complete technical data and catalog write to Atlas Precision Products Co., Castor and Kensington Aves, Phila. 24, Pa.



Division of
PRUDENTIAL INDUSTRIES INC.

CIRCLE 350 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 CO₂, 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.

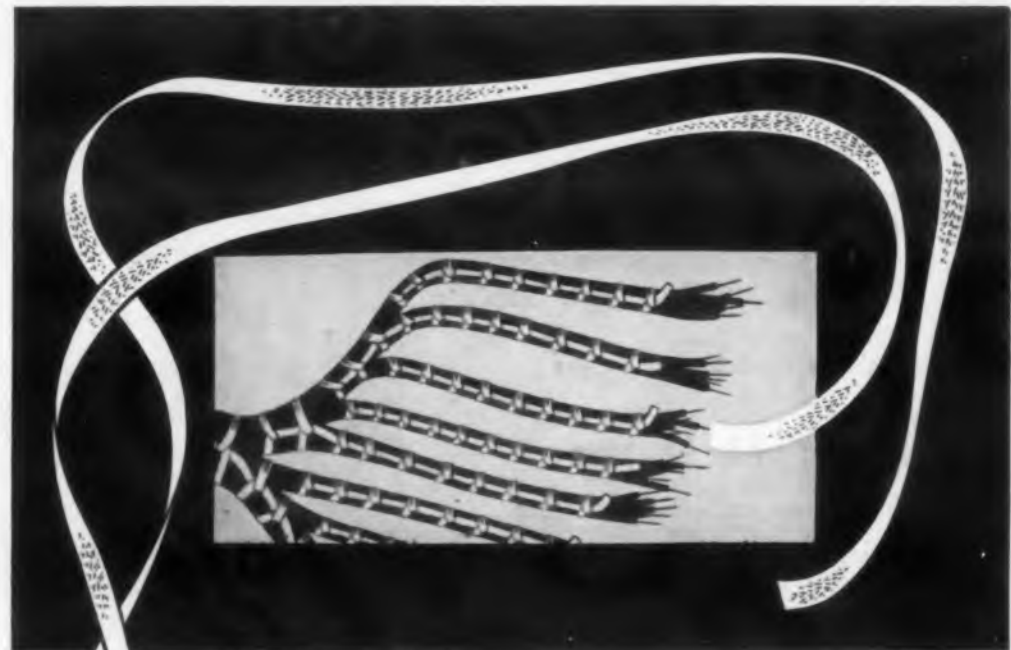
Rohde & Schwarz Sales Co., Inc., Dept. ED, P.O. Box 275, Passaic, N.J.

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



for every lacing need . . .

BEN-HAR LACING TAPES

BEN-HAR "TEFLON® GLASS"—fibers are Teflon coated before braiding for unique non-slip action. Knots hold. No heat shrinkage. Chemically inert. Flame-proof. Non-absorbent. Color fast. Practically indestructible.

BEN-HAR DACRON®—excellent dimensional stability and heat resistance. Available plain, waxed, or synthetic rubber treated.

BEN-HAR NYLON—meets Gov. Specs. MIL-T-713A. Flat braided nylon available in same finishes as above.

BENTLEY, HARRIS

WRITE FOR SAMPLES AND PRICES

Flexible INSULATIONS

Bentley, Harris Manufacturing Co., 700 Barclay St., Conshohocken 3, Pa.

CIRCLE 355 ON READER-SERVICE CARD CIRCLE 468 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1959

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.

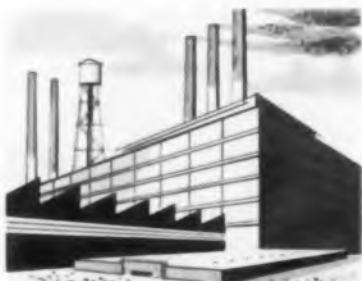
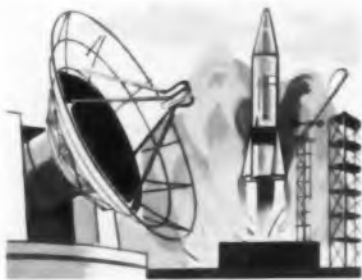
***NUVISTOR** is given its start in a brazing furnace.*

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.

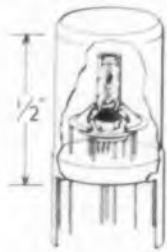


*what **NUVISTOR** will mean to defense electronics*

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

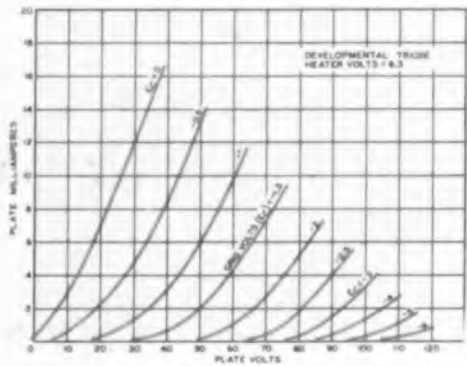
Ready now...on a limited sampling basis...for new equipment designs. First Nuvistor type to be sampled.

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 1/3 the voltage and 1/2 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.

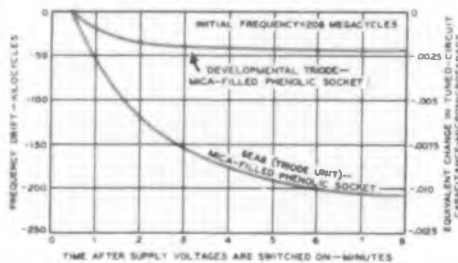
Oscillator performance...

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 1/4 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) _____
Current _____

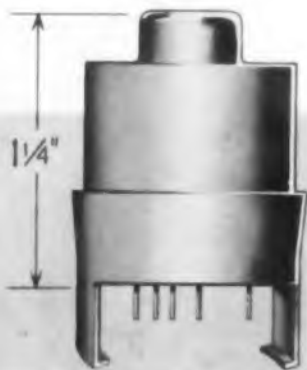
6.3 volts
0.14 amp

CHARACTERISTICS, CLASS A₁ 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 μ mhos
Plate Current	8.5	12.5 ma
Grid Voltage (approx.) for plate current of 10 μ a	—	-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 partici-

pate 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.

Joelin 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



**ONLY
\$3.25**

ELECTRONIC DESIGN BINDER

... KEEPS YOUR BACK COPIES FOR HANDY REFERENCE

These strong, 12 $\frac{3}{4}$, 12 $\frac{1}{4}$ x 5" binders offer an easy means of filing your back copies of *Electronic Design*. Each binder holds 13 normal size issues, and permits substitution of magazines if desired. Cost to *Electronic Design* subscribers is only \$3.25.

CIRCLE 466 ON READER-SERVICE CARD

NEW... handy guide to TRANSISTOR COOLER selection!



- * Forced air-flow models
- * NEW natural convection models

Modine now offers transistor coolers in two types, seven models... all available from stock. These pre-engineered, compact, brazed aluminum units are pre-drilled for the five standard transistor configurations. Choice of two finishes: MIL-C-5541 CHROMATE or MIL-A-8625 BLACK ANODIZED. New Bulletin ID-159 has comprehensive selection data. For your copy write direct.



Modine Manufacturing Company

1608 DeKoven Ave., Racine, Wisconsin

T-1402

CIRCLE 361 ON READER-SERVICE CARD



NEW... DIRECT-READING TRANSISTOR TEST SET MEASURES

- β in ranges of 0 to 30/100/300
- h_{11} } 0.5 to 20 K at 1 KC
- h_{1e} }
- I_{co} 0 to 50 microamperes
- I_e 0 to 3/10/30 milliamperes

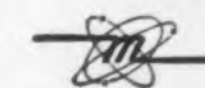
Quickly and accurately the new Metronix Model 545-B Transistor Test Set measures all the essential parameters of transistor performance and gives a direct presentation of the test data.

This versatile instrument can be operated either on its own 5.2-volt collector voltage supply or on any externally supplied potential up to 50 volts DC... can accommodate a wide test frequency range of from 200 cps to 50 kc... has an output jack to permit oscilloscope display of AC collector waveforms. And it's fully protected against meter overload.

Price \$225.00, f.o.b. factory.

Call or write for Specification Sheet No. 545-B

Metronix INC



A SUBSIDIARY OF
ASSEMBLY PRODUCTS, INC.
Chesterland 17, Ohio



S.A. 2098

CIRCLE 362 ON READER-SERVICE CARD

"O" SERIES
CARRIED IN STOCK FOR
IMMEDIATE DELIVERY

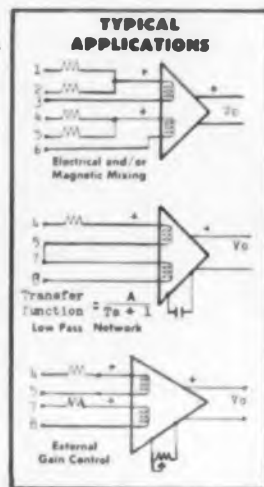


- O.D.—1.5 in.
- Length—3.0 in.
- 11-pin plug with locating key



TOROTEL MAGNETIC AMPLIFIER

The O2-type magnetic amplifier is a lightweight D.C. amplifier operating from a 115V, 400-cps source. The linear, gain stability and null characteristics of the amplifier make it very adaptable to use in Analog Computer and instrumentation.



TOROTEL, INC.
5512 EAST 110th STREET KANSAS CITY, MO.

CIRCLE 363 ON READER-SERVICE CARD

NOW!

MINIATURE AGASTAT®

time/delay/relay

MEASURES ONLY
4" x 1½" x 1½"



The Miniature Agastat time delay relay is a space-saving answer to aircraft, missile and computer problems. You get all these valuable features in one small package:

- Easily adjusted timing ranges as short as .030 seconds.
- Repeat accuracy of $\pm 5\%$.
- Time delay on energizing or de-energizing.
- For DC or AC operation.
- Hermetically sealed or dust-proof housings.

Write today for the full details on the new miniature Agastat. Dept. A36-724.

AGA ELASTIC STOP NUT CORPORATION OF AMERICA
1027 Newark Avenue, Elizabeth, N. J.

Gasaccumulator Co., (Canada) Ltd., 12 Gower Street, Toronto 16, Ontario
CIRCLE 364 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-in². 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.

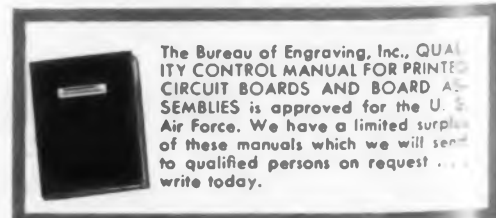
CIRCLE 370 ON READER-SERVICE CARD



Printed Circuit
Reliability
through Quality
Control

If your printed circuit is vital to the flight of a guided missile it must not fail. It may even undergo a 100% inspection at every stage of manufacture.

Bureau quality control is more than a method of inspection. It is also a check on the causes of rejects to weed them out. Our production techniques eliminate even "acceptable" flaws because we are striving to produce perfect boards. This is why Bureau circuits, whether tested 100% or on a scientific-sample basis, are consistently better than statistics predict. To put reliable circuits into your product, investigate the Industrial Division of the Bureau of Engraving, Inc.



The Bureau of Engraving, Inc. QUALITY CONTROL MANUAL FOR PRINTED CIRCUIT BOARDS AND BOARD ASSEMBLIES is approved for the U. S. Air Force. We have a limited surplus of these manuals which we will send to qualified persons on request. Write today.

Member of the Institute of Printed Circuits

BUREAU OF ENGRAVING, Inc.

Industrial Division

502 South 4th St.

Minneapolis 15, Minn.

Telephone Federal 9-8721



CIRCLE 371 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1979

Terminal Blocks

Stud type



Available in various sizes accommodating from one to 26 stud posts, these molded barrier terminal blocks have milliamperes 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

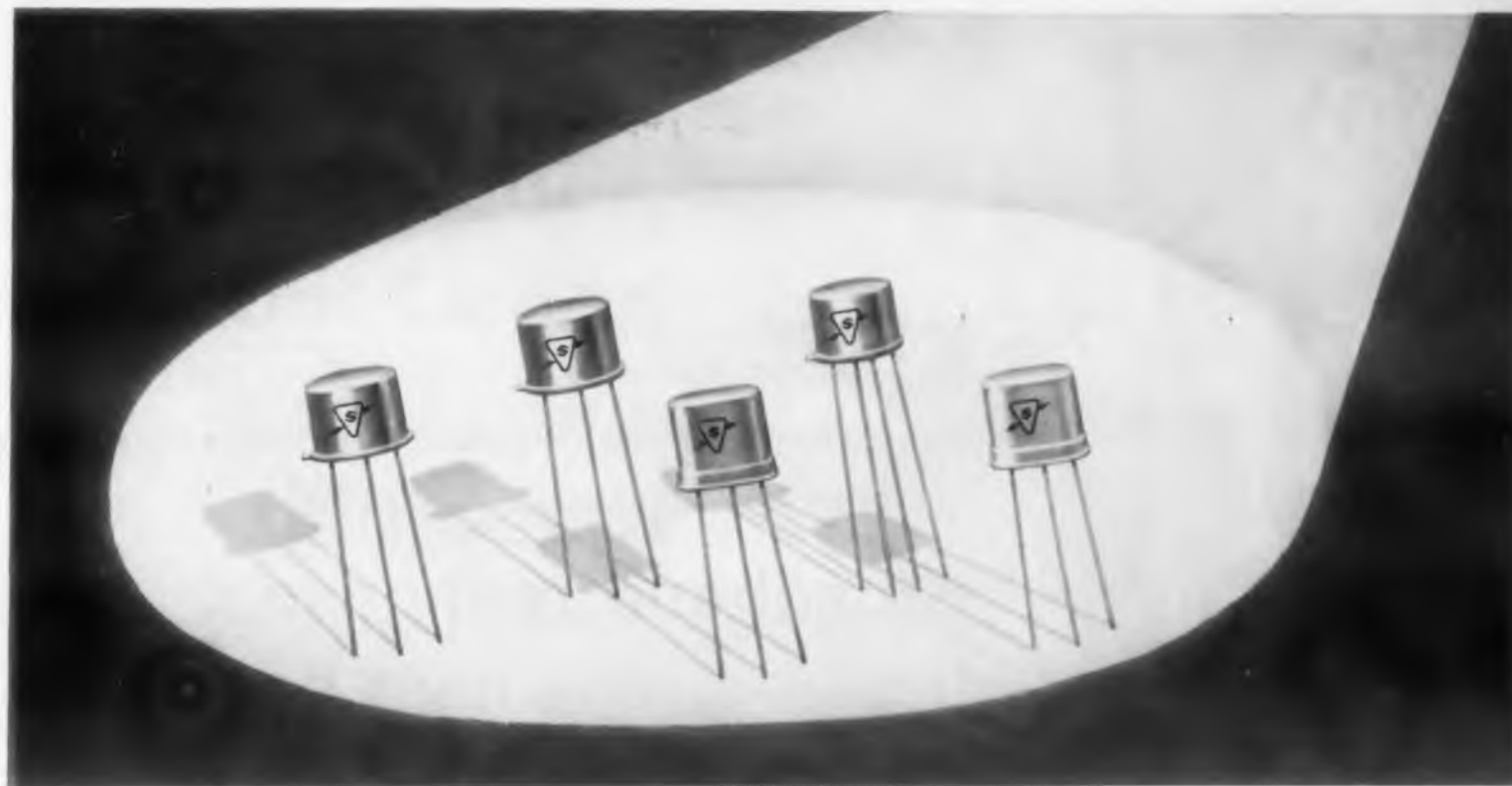
Weights 4 oz



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 non-pressurized applications.

Botron Mfg. Co., Dept. ED, Woodstock, N.Y.

CIRCLE 374 ON READER-SERVICE CARD



60 Choices—NPN AND PNP

Sylvania Entertainment Transistors



...star performers for every role

For any consumer product application—portable radio, toys, organs, intercoms, shortwave radio, auto radio, Hi-Fi—there's a Sylvania entertainment type to fill the bill

Sylvania's broad entertainment transistor line is one of the most complete in the industry. It offers the creative design engineer a full range of types from one source to meet his most selective needs. Twenty new types have been added, bringing the total number to over 60 top-quality types including PNP, NPN, PNP (Drift), Medium Power and Low Power

transistors. The entire line incorporates hermetic seal construction for maximum protection against humidity and other environmental conditions that can affect performance.

These Sylvania quality transistors are available now in production quantities to meet your new product manufacturing schedules—and at prices competitive with any comparable types in the industry.

Call your Sylvania representative now for a full rundown on the Sylvania entertainment line—or contact the factory directly at the address below.



Sylvania Electric Products Inc.
Semiconductor Division
100 Sylvan Rd., Woburn, Mass.

POPULAR SYLVANIA ENTERTAINMENT TRANSISTORS

PNP				NPN				(Drift) PNP	
Type	Description	Type	Description	Type	Description	Type	Description	Type	Description
2N34	GP Audio	2N412	HF, IF Conv	2N35	GP Audio	2N216	HF IF Amp	2N1102	GP Audio
2N109	GP Audio	2N591	Med Power, Audio	2N94	RF Amp	2N228	GP Audio	Syl 1279	Ent
2N217	GP Audio			2N193	HF Osc	2N229	GP Audio	Syl 1310	HF Conv
2N405	GP Audio	Syl 1430	Ent	2N194	HF Conv	2N233	HF RF Amp	Syl 1311	HF Conv
2N406	GP Audio	Syl 1536	Ent	2N194A	HF Conv	2N233A	HF RF Amp	Syl 1312	HF Conv
2N407	GP Audio	Syl 1537	Ent	2N211	HF Osc	2N515	HF RF-IF Amp	Syl 1313	RF Amp
2N408	GP Audio	Syl 1549	Ent	2N212	HF Conv	2N516	HF RF-IF Amp	Syl 1329	Ent
2N409	HF, IF Amp	Syl 1604	Ent	2N213	GP Audio	2N517	HF RF-IF Amp	Syl 1524	Ent
2N410	HF, IF Amp	Syl 1608	Ent	2N213A	GP Audio	2N1058	HF Mixer	Syl 1538	Ent
2N411	HF, IF Conv	Syl 1621	Ent	2N214	Matched Pair (single)	2N1059	GP Audio	Syl 1539	Ent
						2N1101	GP Audio	Syl 1547	Ent
								Syl 1583	Ent

CIRCLE 375 ON READER-SERVICE CARD

First multi-million watt klystrons were produced at SPERRY



Today — Sperry produces electronic tubes for every purpose — ranging in power from 20 milliwatts to over 5 megawatts.

NOW AVAILABLE

New X-Band TWT Amplifiers

from Sperry... for missile guidance, air navigation systems, and other CW applications... combining

**Broadband response...
high power...high gain...
rugged long life construction**

These two new Sperry Traveling Wave Tubes offer a unique combination of features which make them first choice for many applications in missile guidance, navigation and communications — whether airborne, ground or shipboard based. Both offer the fourfold advantages of high power, high gain, broadband response, and extra-rugged design for high altitude and severe environment performance. Minimum peak output power is 100 watts, with 150 watts averaged over the frequency ranges of the two tubes. The characteristics of the STX-105 curves shown below are duplicated in the corresponding frequency range of the STX-104. For complete data on the advantages of these new Sperry tubes for your current projects, write Sperry today.



STX-104

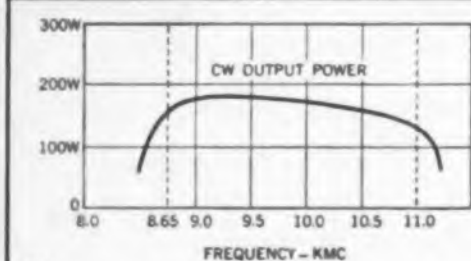
STX-105

SPECIFICATIONS

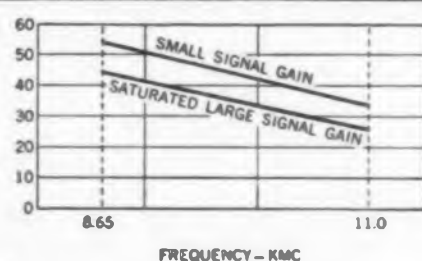
Frequency Ranges:.....STX-104, 7.00-8.75 kmc; STX-105, 8.65-11.0 kmc
Small Signal Gain:.....40 db nom
Output Power CW:.....100 w min, 150 w min avg over frequency range
Gain at Rated Output Power:.....30 db nom
Input Power at Rated Output Power:.....630 mw max
MAXIMUM RATINGS: Beam Voltage, 8 kv; Body Current, 100 ma; Collector Voltage, 2668 v min (with respect to cathode); Operating Temp., 150°C



(1) Loaded waveguide structure and tough metal envelope of STX-104 and 105 provide high vibration and shock resistance, as substantiated by this and many other environmental tests conducted in Sperry labs. Quality components and integral input-output connections contribute to high performance reliability and long life. (2) Output Power vs. Frequency (3) Small and large Signal Gain vs. Frequency.



(2)



(3)

SPERRY

ELECTRONIC TUBE DIVISION, SPERRY GYROSCOPE COMPANY, GREAT NECK, NEW YORK, DIVISION OF SPERRY RAND CORPORATION
Address all inquiries to Great Neck or Sperry offices in Brooklyn, Boston, Philadelphia, Los Angeles and Montreal. Export Dept., Great Neck, New York

CIRCLE 376 ON READER-SERVICE CARD

NEW PRODUCTS

Wire Wrap Terminals

Standoff and Feedthrough



Made with a self-locking nylon body, Pushlock wire wrap terminals align and lock when they are pushed into place with an arbor press, a die press, or a hand tool. Available in standoff and feedthrough types, they are suited for aircraft, missile, and automation equipment where shock and vibration are extreme. They are also suitable for printed circuitry. The units maintain uniform holding power under exposure to common solvents, and -65 to +300 deg temperatures.

Whitso, Inc., Dept. ED, 9330 Byron Schiller Park, Ill.

CIRCLE 377 ON READER-SERVICE CARD

Shock Tester

Performs test cycle every minute

Hyge-6500 production-line shock tester repeats either of a choice of two widely specified shock pulses in rapid succession, performing a complete test cycle every minute. Waveform may be changed by means of external adjustment. tests specimens ranging in weight from a fraction of 1 oz to 150 lb, and is 13 x 13 x 30 in.

Consolidated Electrodynamics Corp., Rochester Div., Dept. ED, Rochester 3, N.Y.

CIRCLE 378 ON READER-SERVICE CARD

Signal Conditioning System

Airborne



For airborne telemetry and tape applications the SCAMP miniature signal conditioning system

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.

Nelf 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 μ a 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



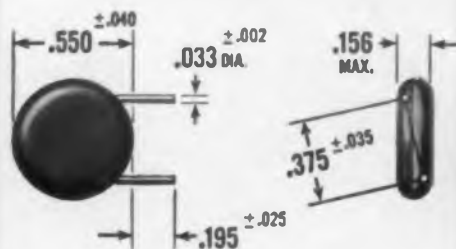
Kit model SS 32 contains 32 miniaturized, plug-in capacitor standards with values from 0.0001 to 0.05 μ f. It can be supplied with a four position adapter which provides, with the appropriate capacitors, capacitance values accurate to four significant figures with $\pm 0.1\%$ tolerance.

Arco Electronics Inc., Dept. ED, 64 White St., New York 13, N.Y.

CIRCLE 381 ON READER-SERVICE CARD

The beauty of this Capacitor is more than skin deep!

ACTUAL SIZE TYPE A CAPACITORS



Allen-Bradley Type A capacitors are available in the most frequently used types and capacitance values.

General Purpose Type in capacitance values from 10 mmf to .01 mmf.

Stable Type in capacitance values from 10 mmf to 0.1 mmf.

Temperature Compensating Type in characteristics from N4700 to P100, and in capacitance values from 10 mmf to 510 mmf.

N1500

AB

100
5%

N750

AB

A-B
QUALITY

560

10%

AB

Type A Capacitor...

One size for all values...

Designed for high speed assembly

Compare the attractive Allen-Bradley Type A ceramic capacitors with all the rest... you'll see instantly why more and more engineers are specifying them and will not accept substitutes—because there aren't any! The exclusive "Auto-Coat" process makes possible—for the first time—a capacitor of real beauty, precise physical uniformity, plus consistent and reliable quality and performance.

The smooth, tough insulating coating and the inherent mechanical uniformity of Type A capacitors permit easy hand or accurate automatic insertion on printed boards. Also, the "Auto-Coat" process prevents rundown on leads—costly wire cleaning and crimping to prevent soldering failures are unnecessary.

For full information on the superior physical and electrical properties of A-B Type A capacitors, send for Technical Bulletin 5401.

ALLEN-BRADLEY Quality Electronic Components

Allen-Bradley Co., 1344 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

CIRCLE 382 ON READER-SERVICE CARD

NEW PRODUCTS



Crystal Detector Mount

Weights 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, exclusive of shaft, and weighs 19 oz.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 385 ON READER-SERVICE CARD

product of the pioneer

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REQUIRE FAST SURVEILLANCE**



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Du Mont Ultra-Fast-Sweep Radar Read-Out

Remove the speed limitations of magnetic deflection from radar read-out—extend capabilities through ultra-fast Du Mont electrostatically deflected and focused radar tubes for accurate, complete surveillance of fast-moving orbital, guided or manned objects. These new Du Mont radar tubes offer jump-sweep capabilities in larger screen sizes to meet all modern radar read-out requirements, including high-resolution, deflection uniformity and reduced deflection defocusing.

Investigate Du Mont electrostatic radar tubes—write for complete technical details...

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NEEDED SIZE**

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Diameters

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and electrical requirements.

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Booths 421 & 423.**

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INTERNATIONAL DIVISION • 515 MADISON AVENUE, NEW YORK 22, N. Y. • CABLES: ALBEEDU, NEW YORK

CIRCLE 386 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1959

product of the pioneer

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OSCILLOSCOPES

Type 401-A for general precision investigations in the low-frequency range, Type 403 for extremely sensitive (1 mv full-scale) studies in the low frequency range, Type 410 for any high-frequency phenomena from dc to 50 mc, and the Type 411 true dual-beam oscilloscope for simultaneous related studies. A scope for any requirement.



High-Frequency
Oscilloscope
Type 410



True Dual-Beam
Oscilloscope
Type 411



General Purpose
Oscilloscope
Type 401-A



High Sensitivity
Oscilloscope
Type 403



VACUUM-TUBE VOLTMETER

Type 405. A compact, efficient and highly stable unit for measurements to 700 mc; from 0.002 volt dc and 0.01 volt ac up to 1000 volts dc or 300 rms volts ac. Permits off-ground measurements. Includes probe storage compartment.



PULSE GENERATOR

Type 404 provides high-quality, rectangular pulses at 50 ohms impedance. Pulse widths 0.05 usec to 100 usec with repetition rates to 100 kc. Pulse amplitude attenuation variable in precise 1/2-db steps over 60 db range from 50 volt level.

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INTERNATIONAL DIVISION • 515 MADISON AVENUE, NEW YORK 22, N. Y. • CABLES: ALBEEDU, NEW YORK

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ELECTRONIC DESIGN • July 22, 1959

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.

Inso 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

SEMI-AUTOMATIC 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



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PROPERTY VALUES
FOR FINER PRODUCTS

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- Chemical Inertness
- Outstanding Electrical Properties
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SEMICONDUCTORS**

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CIRCLE 395 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 \pm 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



how to see
high impedance
ac signals

The Keithley Model 102B Amplifier combines a 400-megohm input with high gain and low noise. It sharply reduces circuit loading errors when measuring outputs from accelerometers and other piezo-electric devices. It also has many uses in studies on hearing aids, phonograph pick-ups, and microphones.

Features of the Model 102B are: decade gains from 0.1 to 1000, selectable bandwidths of 2 cps to 150 kc and 2 cps to 1.7 mc, and a 5-volt, 50-ohm output for scopes and recorders. Other features include:

- **input impedance** of 400 megohms, shunted by 3 μ f.
- **low noise level**, below 10 μ v from 10 cps to 150 kc at maximum gain.
- **gain accuracy** of 1% at midband for all gain settings.
- **rise time** of 0.3 μ sec at highest gain.
- **two accessory** low capacitance probes available.
- **Price** — \$325.00

Write today for Catalog B, containing detailed information on the Model 102B.

**KEITHLEY
INSTRUMENTS, INC.**

12415 Euclid Ave., Cleveland 6, Ohio

CIRCLE 401 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1969

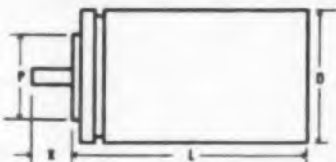
SPECIAL REPORT ON STEP-SERVO MOTORS:



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				Rotor Inertia GM-CM ²	Min. Hold- ing Torq. (Gz.-in.)	Max. Watts Per
	D	L	P	X			
005-801	.500	1.20	.375	3/8	0.50	0.5	8
9708-024	.750	1.09	.500	1/2	0.65	0.8	10
011-859	1.062	1.36	.625	3/4	0.65	1.4	15
9711-007	1.062	1.76	.625	3/4	2.5	1.4	15
9711-050	1.062	1.78	.625	3/4	2.5	1.2	15
9711-053	1.062	1.36	.625	3/4	2.5	1.0	15
9715-001	1.437	1.75	.875	3/4	2.5	1.8	25
023-801	2.250	1.75	2.00	3/4	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
LUdow 3-4785

Representatives in principal cities

CIRCLE 402 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1959

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

LEFT: STUD 7/16-11/16

CENTER: AXIAL LEAD TOP HAT

RIGHT: STUD INSULATED

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DOUBLE DIFFUSED SILICON RECTIFIERS
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silicon power rectifiers UP TO 35 AMPS.
JEDEC types exceeding MIL specifications.

NEW

SINGLE unit VERY HIGH
VOLTAGE silicon rectifiers ex-
hibiting these desirable char-
acteristics...

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VOLTAGE
up to 2000 PIV

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FORWARD DROP
1.5 Volts, DC

EXTREMELY
LOW LEAKAGE
1 μA

FORWARD
CURRENT
up to 20 Amps.

NEW

INSULATED STUD silicon recti-
fiers offering these quality
features...

- Simplify mounting
- Save assembly parts & costs
- Obtain efficient heat transfer
- Give greater design flexibility

AVAILABLE UP TO 10 AMPS
PER UNIT AND UP TO 2000
VOLTS PIV.

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CIRCLE 406 ON READER-SERVICE CARD

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for SEMICONDUCTOR and other uses

ANTIMONY suitable for intermetallic compounds — with zinc and tellurium each less than 0.01 ppm.
BISMUTH total impurity content of less than 1 ppm.
CADMIUM total impurity content of less than 1 ppm.
INDIUM no single impurity in excess of 0.1 ppm also other grades with a wide range of preform shapes and sizes.

LEAD total impurity content of less than 1 ppm.
SILVER total impurity content of less than 1 ppm.
TIN no single impurity in excess of 1 ppm.
ZINC total impurity content of less than 2 ppm.
INDIUM ANTIMONIDE highest commercial purity



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Metal Sales Division: 215 St. James Street W., Montreal 1, Quebec, Canada — Phone AVenue 8-3103

CIRCLE 407 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 premeasured 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

ELECTRONIC DESIGN • July 22, 1959

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CATALOG**

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Computer Measurements Company • A Division of Pacific Industries, Inc.
5528 Vineland Ave., North Hollywood, Calif.

CIRCLE 408 ON READER-SERVICE CARD

**NEW
GENISCO
MINIATURE
ACCELEROMETER**

The new Model GMA Accelerometer is a fluid damped, potentiometer output instrument, particularly suited for flight and fire control and telemetering applications. Now in production.

Weights only 3 ounces; measures just 1 1/16" x 1" x 1 1/8"!

Brief Specifications

Range: ±0.5 g to ±100 g's
 Natural Frequency: 12 cps to 75 cps
 Linearity: ±1% of full scale
 Damping: Nominally 0.7 of critical at 75°F.
 Temperature: Operates to specifications between -20°F and +185°F.
 Vibration: 10 g's, 10-20,000 cps, any axis
 Shock: 50 g's for 7 ms, any axis

MODEL GMA

Send for complete specifications to the Instrument Division:

Genisco INCORPORATED

2233 Federal Avenue, Los Angeles 64, California

CIRCLE 409 ON READER-SERVICE CARD

Magnetic Tape Transports

For computers

Model 3269 digital magnetic tape 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 $\pm 1\%$ regulation

Available in nine output ratings from 60 to 7500 va, these sinusoidal transformers automatically regulate to within $\pm 1\%$ for $\pm 15\%$ 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



MAIN PLANT—ELKHART, INDIANA • Manufacturers of variable resistors, precision wire fixed resistors, tube heaters, switches and other special components for radio, television, commercial and military electronic equipment.



CANADIAN SUBSIDIARY—C. C. Meredith & Company, Ltd., Streetsville, Ontario, Canada • Manufacturers of variable resistors and associated switches, industrial rectifiers (selenium, silicon, tube, regulated—mechanical and static control, non-regulated), emergency/normal motor generator sets, diesel driven generators, 500 cycle motor generators, control panels, switchboards, and photo-electric street lighting controls.



EXPANDS

BURTON BROWNE ADVERTISING



WEST COAST SUBSIDIARY—Chicago Telephone of California, Inc., 105 Pasadena Avenue, South Pasadena, California • Manufacturers of variable resistors and associated switches, custom moldings, transformers, foot switches, ignition coils and solenoid coils.



MIDWEST SUBSIDIARY—CTS, Inc., Berne, Indiana • Manufacturers of wirewound variable resistors, buzz and balance rheostats and special electronic components.



SOUTHEASTERN SUBSIDIARY—CTS of Asheville, Inc., Mill Gap Road, Skyland, North Carolina • Manufacturers of variable resistors and associated switches.

YESTERDAY

Since 1896, CTS has had a reputation for product excellence . . . becoming the world's largest variable resistor manufacturer. Most radio & TV sets throughout the world have dependable CTS controls.

TODAY

Now . . . in 5 plants . . . with over 1600 highly skilled technical personnel . . . in 436,000 sq. ft. plant area . . . CTS expands and diversifies . . . adding many other products . . . manufactured to these same high reliability standards.

FOR YOUR TOMORROW

CTS research and development with its established reputation will continue to anticipate your needs.

NEW NATION-WIDE SALES ORGANIZATION

It's easy to get the CTS product you desire. There's a CTS plant, office or representative near you.

PACIFIC AREA LOS ANGELES BRANCH OFFICE

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So. Pasadena, California
LOS ANGELES OFFICE
International Resistance Co.
1136 N. La Brea Blvd.
Hollywood, California
SAN FRANCISCO,
Logan & Stone Company
1485 Bayshore Boulevard
PORTLAND 9, OREGON
Richard Legg Company
1633 N.W. 21st Avenue

NEW JERSEY BRANCH OFFICE

Chicago Telephone Supply Corp.
5 Haddon Avenue
Haddonfield, New Jersey

NORTH CAROLINA BRANCH OFFICE

CTS of Asheville, Inc.
Mills Gap Road
Skyland, No. Carolina

NEW YORK CITY OFFICE

International Resistance Co.
165 Broadway—Room 2024
New York City 6, New York

EASTERN AREA

PHILADELPHIA OFFICE
International Resistance Co.
401 North Broad Street
Philadelphia 8, Pennsylvania

SYRACUSE OFFICE
International Resistance Co.
112 Montgomery Street
Syracuse, New York

**LEXINGTON 73,
MASSACHUSETTS**
Richard Purinton, Inc.
11 Muzzey Street

**PITTSBURGH 34,
PENNSYLVANIA**
Tanner & Covert
300 Mt. Lebanon Blvd.

CLEVELAND 7, OHIO
Baehr, Greenleaf & Assoc.
14700 Detroit Avenue

**NORTH MIAMI BEACH 62,
FLORIDA**
Benz Sales Company
P.O. Box 178

MOUNTAIN AREA

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Electronic Components Sales, Inc.
645 So. Broadway

SCOTTSDALE, ARIZONA

Carl Hower
369 N. Craftsman's Court

MIDWESTERN AREA

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International Resistance Co.
5243 W. Diversey Avenue
Chicago 39, Illinois

MINNEAPOLIS 16, MINNESOTA

Robert W. Marshall
6106 Excelsior Boulevard

INDIANAPOLIS 26, INDIANA
Macnabb, Schroeder & Loomis
820 East 64th Street, P.O. Box 1

KANSAS CITY, MISSOURI

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in instrument
design**MEDALIST* null indicators**

READABLE... WIDE RANGE SENSITIVITY

Modern MEDALIST design provides for greater readability and modern styling in minimum space. Unique core and magnet structure provides $\frac{1}{2}$ ua/mm sensitivity at null point with sharp square law attenuation to 100 ua at end of scale in Type A. Internal resistance is 2000 ohms. Other sensitivities available. ASA/MIL 2 $\frac{1}{2}$ mounting. Standard and special colors. Bulletin on request. Marion Instrument Division, Minneapolis-Honeywell Regulator Company, Manchester, N. H., U. S. A.

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WHERE ELECTRONICS MEETS THE EYE
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CIRCLE 419 ON READER-SERVICE CARD

**LOWER COST
MAGNETIC SHIELDING**

Co-Netic & Netic Foils Permit Max. Miniaturization, Improved Performance... Extremely Versatile—Readily Cut to Any Shape, Wrap Like Tape

How Co-Netic & Netic foils lower your magnetic shielding costs: 1) You use less shielding material because (a) foils are only .004" thick and (b) foils cut easily to exact shape required, minimizing waste. 2) Permit simple shielding of odd shapes and hard-to-get-at components, saving valuable time and eliminating polishing costs and inflexibility of rigid metals. These advantages make possible much smaller and less costly systems, as components may be positioned in close proximity without interference from damaging magnetic fields.



These foils are non-shock sensitive, non-retentive, require no periodic annealing. They effectively shield electrostatic and magnetic fields over a wide range of intensities. Both foils available from stock in any desired length in various widths.

Co-Netic & Netic foils are successfully solving many types of magnetic shielding problems in numerous critical satellite, missile, magnetic tape and other military, airborne, electronic and laboratory applications. These foils can help you solve your magnetic shielding problems.

MAGNETIC SHIELD DIVISION PERFECTION MICA CO.
1322 No. Elston Avenue • Chicago 22, Illinois
Originators of Permanently Effective Netic Co-Netic Magnetic Shielding

CIRCLE 420 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

check
the spec
on this **GORN**

**PRINTED CIRCUIT
CONNECTOR**

No. of contacts—6, 8, 10, 12, 15, 18, 22, 38.

Material: Body—molded plastic per spec. MIL-P-14
Type MME, contacts and polarizing pin—phosphor
bronze or beryllium copper.

Contacts and polarizing pin—silver plate .0002 plus
gold plate .00003 min.

Wire size: No. 16 or 17. AWG.

Breakdown voltage between contacts, at sea level,
mated with printed board 1200 volts DC.

Polarizing pin may be located in any slot desired.

Contacts will mate with printed circuit boards from
.061 to .071 thick

For further information, write:



CIRCLE 428 ON READER-SERVICE CARD

You may not need eyes
to line things up any more



Wherever the human eye is used for precise alignment work, there's a good chance we can lay lead sulfide down on glass in the precise pattern that will let you do the job electrically. Making such Kodak Ektron Detectors in precise configurations and complex arrays, and duplicating them in quantity, is a specialty of ours.

Spectral response of these photoresistors extends over a broad range. They are particularly sensitive in the infrared. This lets you use cool-running light sources where heat might affect accuracy of measurement. Signal-to-noise ratio is high. Units are rugged, unaffected by vibration.

You find out more by writing to Special Products Sales and asking for the new pamphlet, "Kodak Ektron Detectors."

EASTMAN KODAK COMPANY

Rochester 4, N. Y.

Kodak
TRADE MARKCIRCLE 429 ON READER SERVICE CARD
ELECTRONIC DESIGN • July 22, 1959

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)

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**BLACK NYLON
SCREWS
and
NUTS**

**Acid resistant ...
Need no insulation ...
Can't rust ...
Can't corrode ...**

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Show
San Francisco

CUT ASSEMBLY TIME

2-56, 4-40, 6-32, 8-32, 10-32 and 1/4-20 in stock. Actual production samples will give you the whole story. Write on your letterhead.

WECKESSER COMPANY
5703-05 Northwest Hwy. • Chicago 46, Ill.

CIRCLE 433 ON READER-SERVICE CARD



SPECTROL PRECISION POTENTIOMETERS

**Meet the SPECTROL
METAL
MULTI-TURN**



**New type
construction
provides
150°C.
OPERATION**

The Spectrol Model 590 ten-turn precision potentiometer features all metal construction of machined aluminum with the helical coil placed directly against the case for maximum heat dissipation. Aluminum case provides excellent dimensional stability, is non-hygroscopic and will operate in a relative humidity of 95%. The 1" diameter 590 is available in ranges from 25 to 120,000 ohms with a standard linearity tolerance of $\pm 0.3\%$. Tolerances to $\pm 0.025\%$ on special order.

For complete technical information call your local Spectrol representative or write directly to the factory. Please address Dept. 197-A

SPECTROL

**ELECTRONICS
CORPORATION**

"precision electronic components"

1704 South Del Mar Avenue, San Gabriel, Calif.

CIRCLE 434 ON READER-SERVICE CARD

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

Weights 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

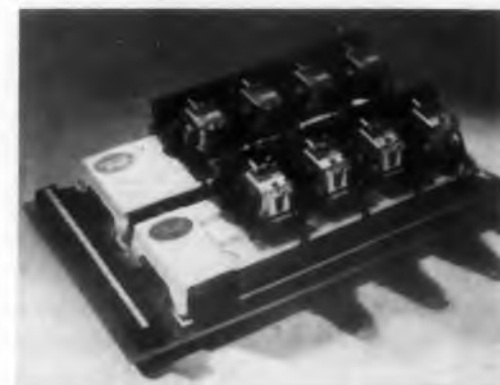
outputs of magnetic tape, memory cores, and small photo cells. Signals as low as 10 mv into 5.6 K input impedance and as slow as 100 μ sec in duration will produce negative pulses of 20 v and 15 μ sec. Module is 2-1/4 x 10-3/4 x 7 in.

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 0 v, 0.25 amp, spst solid state relay that can withstand 1000 g shock. It has a 2 μ sec pickup time and a 5 μ sec 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



AVAILABLE AT
AUTHORIZED DISTRIBUTORS
 throughout the country.



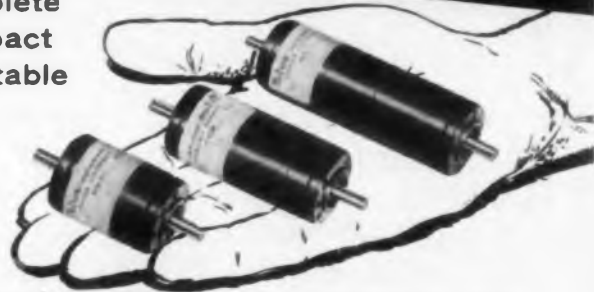
GOOD-ALL ELECTRIC MFG. CO.
 OGALLALA, NEBRASKA
 —IN CANADA, 700 WESTON RD., TORONTO

CIRCLE 440 ON READER-SERVICE CARD

New Metron Miniature Speed Changers

... Ready-to-go
 in your product

- Complete
- Compact
- Adaptable



Save design, production, and assembly costs

... USE METRON SPEED CHANGERS AS COMPONENTS IN YOUR PRODUCT

- Over 400 different standard ratios! 10:9 to 531,441:1
- Small! 1.062" diameter. Overall lengths: Class A, 2-11/16"; Class B, 3-1/2"; Class C, 4-5/16"
- Transmit power either way to 100:1 ratios
- All aluminum housing
- Servo or foot mounted
- Concentric ball-bearing input and output shafts
- Hardened steel spur gears
- Permanent lubrication
- Prompt delivery on production or experimental models

ONE WEEK DELIVERY

Write for Bulletin 97

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INSTRUMENT COMPANY

460 Lincoln St., Denver 3, Colo.

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 LOS ANGELES • CLEVELAND •

CIRCLE 441 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1959

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. Shiassee St., Lansing 1, Mich.

CIRCLE 442 ON READER-SERVICE CARD

DESOLDERING TIPPLETS.—The Triangle triplet melts solder from leads which are in a triangular pattern; the 1/8 in. diameter Offset Slotted triplet straightens leads and tube tabs, melts and removes excess solder on wire connections; and the Cube triplet 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, manifold, and instrumentation. For military use.

Trinity Equipment Corp., Dept. ED, Cortland, N.Y.

CIRCLE 448 ON READER-SERVICE CARD

TRANSISTOR CIRCUITRY ENGINEERING "KNOW HOW" AND PRODUCTION



• How to get the optimum performance and reliability from an electronic component is often directly related to research and engineering "know-how" of transistor circuitry.

The Acme Electric research and engineering staff have a wealth of experience to develop assemblies in this specialized field of manufacturing. A letter outlining your problem will have our prompt attention.

ACME ELECTRIC CORPORATION
 907 WATER ST. CUBA, N. Y.
 West Coast: 12822 Yukon Avenue • Hawthorne, Calif.

Acme Electric

CIRCLE 449 ON READER-SERVICE CARD

USE ELECTRONIC COUNTERS AS DIGITAL VOLTMETERS

with SYSTRON'S NEW MODEL 1230 VOLTAGE to TIME CONVERTER

FEATURES:

- All-Electronic System
- 10 Millisecond Conversion
- .05% Accuracy

PROVIDES:

- Automatic Polarity
- Microvolts to 1000 Volts
- 1 Megohm Input Impedance

The development of Systron's new Model 1230 now makes it possible to convert any existing period or time counter into a precision high speed digital voltmeter. Connects directly to Systron Models 1010, 1040, 1043 and 1031 to provide an IN-LINE readout ($\pm 10,000$) of DC voltages.

Systron manufactures IN-LINE Counters for laboratory, military and industrial applications, as well as complete Data Processing and Control Systems tailored to meet individual specifications.

Write today for complete specifications of Model 1230 and your free copy of our new Short Form Catalog . . .



SPECIFICATIONS MODEL 1230

Input Voltage Ranges	Errors
0 to -1 -10 and -100v DC	Conversion - 0.05% of full scale
Option A - 10 and -100 millivolts full scale	Input Impedance - 1 Megohm (standard ranges)
Option B - 1000 volts	Option A - 100 000 ohms
Indication NIXIE IN- LINE, -10,000 on Model 1031	Polarity Automatic polarity sensing
Conversion Time .010 seconds Time between pulses	Price
Option C 100 seconds (100KC counters)	Model 1230 \$1095 00
	Option A 895 00
	Option B 180 00
	Option C 100 00



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CIRCLE 450 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

ELECTRONIC DESIGN • July 22, 1959

HI-POWER EFFICIENCY



RIGHT ANGLE ADAPTER, 350-5000 MCS.



CABLE CONNECTOR, 350-5000 MCS.



WAVEGUIDE TO COAX ADAPTER, 2350-3600 MCS.



S-BAND SCIMITAR ANTENNA, 2350-5000 MCS.



COAX SLOTTED LINE, 1500-5000 MCS.



LT TO "W" TYPE TRANSITION, 350-5000 MCS.

These operational configurations comprise a representative selection of Tamar "hardware" designed and tested to meet all military and industrial specifications.



TAMAR ELECTRONICS, INC.
2339 COTNER AVENUE • LOS ANGELES 64, CALIFORNIA
CIRCLE 451 ON READER-SERVICE CARD

Here Is The Answer To Every COIL FORM REQUIREMENT

Complete Coil Form
Service

Arbor List
of Over
2000 Sizes



High dielectric kraft, fish paper, cellulose acetate, DuPont Nylon, Resinite and combination tubes for any electrical/electronic application.

Any shape—round, square, oval, rectangular, triangular or special. Any I.D., O.D. or length. All promptly available.

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Request Arbor List and Bulletin today. Send
specifications for free samples.



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Plant No. 2: 1 Flower Street, Hartford, Conn.
REPRESENTATIVES THROUGHOUT UNITED STATES AND CANADA
CIRCLE 452 ON READER-SERVICE CARD

has 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.

DEUTSCH DM SERIES MINIATURE CONNECTORS MEET * NEW MIL-C-26482

For complete technical information, contact your Deutsch Representative or write us for data file C-71



See us at WESCON, Booth 611-613

The Deutsch Company
7000 Avalon Boulevard • Los Angeles 3, California

CIRCLE 453 ON READER-SERVICE CARD

Bulletin: DM is MS...

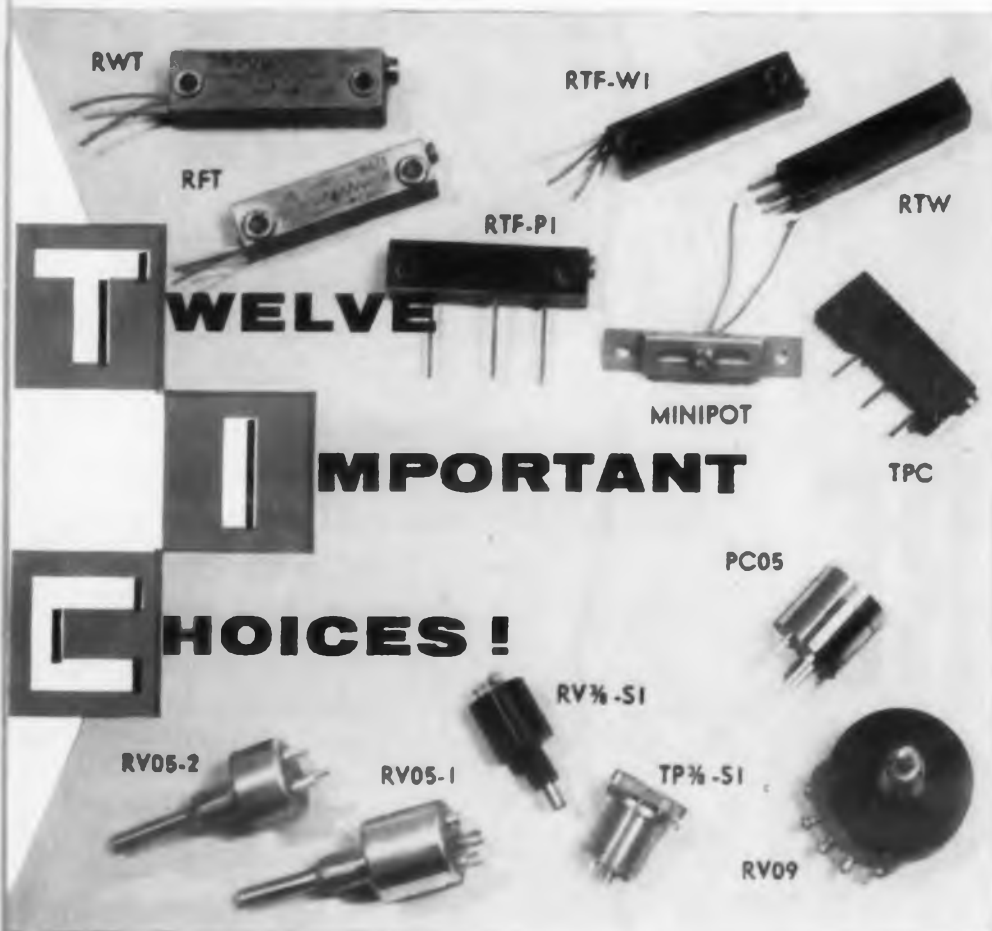
Now you can freely design these advanced push-pull miniatures into your application because the Deutsch DM Series is built to meet this new miniature connector Mil Spec.

Loaded with special Deutsch-developed features, these environmental miniatures have been proved under the punishing conditions of more than one hundred major electronic systems for military and commercial use.



- quick disconnect
- environmental
- unique ball-lock coupling
- moisture sealed
- vibration dampened
- continuous dielectric separation without voids
- positive lock without safety wiring
- operation to 250°F.

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PRECISION TRIMMER POTENTIOMETERS by TIC are standard in twelve different styles and each in a wide range of resistance values. The extensive use of trimmers in such applications as airborne, shipborne and ground based military electronic equipment for navigation, flight control, fuel control, radio transmission and reception, telemetering, computers, fire control and many others demands reliability and stable operation under severe environmental conditions. TIC quality-control procedures and environmental testing assure the user of the ultimate in dependable trimmer potentiometers.

TWELVE IMPORTANT CHOICES — six box type and six rotary type multiturn and single turn with wirewound or metallic film resistance elements, high temperature-resistant construction, varied mounting methods, and

sizes ranging from micro-miniature to the size of a quarter in diameter, permit the design engineer optimum freedom to select the unit best suited to his application. Special designs may be readily accommodated by TIC engineers.



For new catalog of the trimmers illustrated above write, wire or call

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ACTON, MASS.

CIRCLE 454 ON READER-SERVICE CARD

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 μf (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 μf 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 μf .

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



Temperature Control Within $\pm 0.3\text{C}$

Using the meniscus as his guide, an operator at Shockley Semi-Conductor Laboratories pulls a silicon crystal for use in the development of a four-layer diode while L&N's Speedomax G C.A.T. control system holds temperature of the melt within ± 0.3 degree!

Precise and completely dependable, this control system continuously regulates the output of an induction generator through a magnetic amplifier and saturable core reactor... and, if desired, can be used with an external program unit.

This system is helping not only Shockley Laboratories but also many other investigators, suppliers and producers of electronic equipment to grow crystals of consistently high quality.

Process Data Sheet 660(1) will bring you more information on L&N's temperature control for crystal growing. But no matter what your instrument needs—when quality counts, it'll pay you to see your L&N field engineer. Write your nearest L&N office or 4908 Stenton Ave., Phila. 44, Pa.

LEEDS NORTHROP
Instruments Automatic Controls • Furnaces

CIRCLE 455 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1959

Expanding the Frontiers
of Space Technology in

ELECTRO- MECHANICAL DESIGN

■ Lockheed Missiles and Space Division has complete capability in more than 40 areas of science and technology. As systems manager for such projects as the Navy POLARIS FBM; DISCOVERER Satellite; Army KINGFISHER; Air Force Q-5, X-7 and X-17, the Division is heavily engaged in all phases of design and packaging.

ENGINEERS AND SCIENTISTS

If you are experienced in electro-mechanical design or packaging with specific knowledge of electronic packaging; wiring design; harness assembly; ignition and separation systems design or auxiliary power systems design, we invite your inquiry.

Write: Research and Development Staff, Dept. G2-21, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed

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Navy POLARIS FBM;
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Please write direct to advertiser
mentioning ELECTRONIC DESIGN

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.

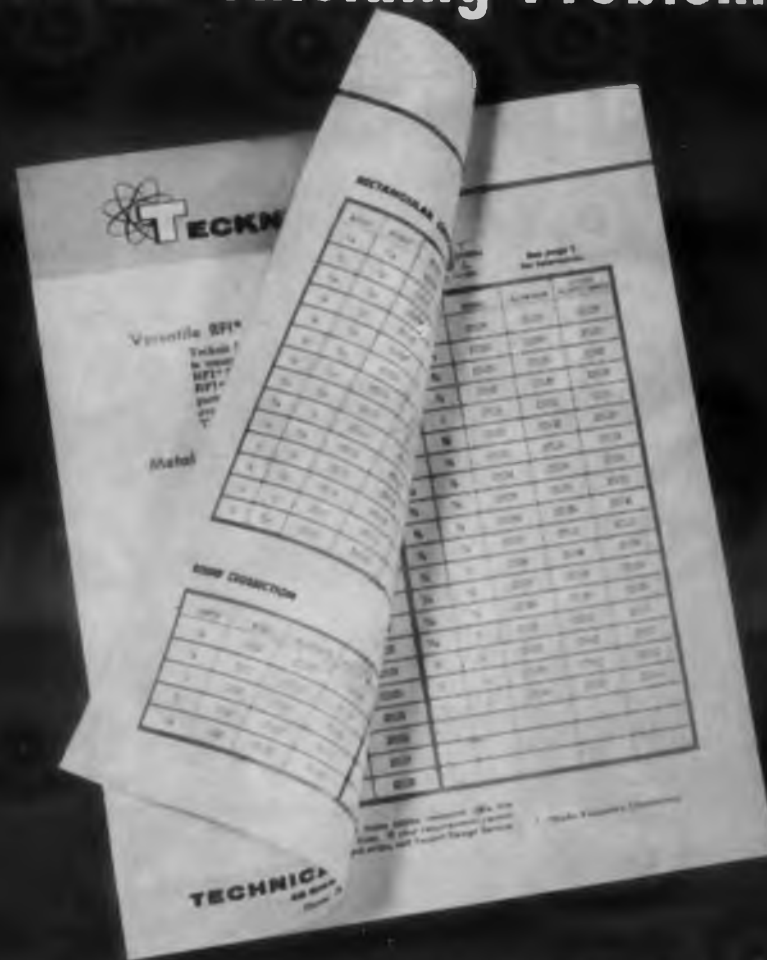
While the federal government has a translation and publications programs pertaining to technical literature, the engineer must rely on the daily supply of trade journals for the most current technical data as against assistance in conducting research work. To meet the need of rapid communication, management 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.

330 ANSWERS To RFI* Shielding Problems—



Tecknit Standard RFI* Strips

* Radio Frequency Interference

Solve over 80% of your RFI gasketing problems with this new Tecknit folder that lists 330 Standard RFI Strips of different sizes, shapes and materials. And—you'll save time, trouble and money by choosing the right standard strip from this wide selection to fit the application—not by changing your design to fit the strip.

If your requirements cannot be met by standard strips, call on Tecknit's exclusive Technical Design Service for engineering help with special problems. The services of RFI specialists are available to you without cost or obligation!

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PG-703

Technical Wire Products, Inc.
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- Please send me the complete Data File for Designs, including NEW tabulated folder.
 I have Data File, just send folder.

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DEPARTMENT _____
COMPANY _____
CITY _____ ZONE _____ STATE _____

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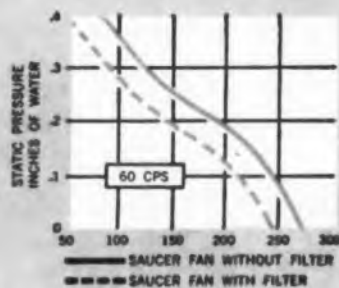
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**FILTERED
COOLING**

in electronic equipments

No need to spend valuable time and money in procuring filters and designing filter boxes to cool your electronic equipment. Now...from Rotron, a high performance combination of a Saucer Fan and matched filter box that delivers 240 CFM at free delivery. Filter box utilizes a media P96A high velocity, high efficiency viscous impingement filter incorporating RF shielding. Metallic and permanent, filter is completely washable. Frame and filter are one piece assemblies for quick removal and cleaning.

The Saucer Fan's pressure performance is tailored to filter requirements with suitable pressure building capacity to overcome impedance of filter and back pressure associated with packaged equipment. The Saucer Fan measures only 1-11/16" in depth and is designed for operation at 115 VAC, 50-60 CPS, 1 ϕ , and will meet all applicable military specifications.



Write for detailed information on
Saucer Fan/Filter Box to...



ROTRON mfg. co., inc.

WOODSTOCK, NEW YORK

ORIOLE 9-2401

In Canada: The Hoover Co., Ltd., Hamilton, Ont.

CIRCLE 457 ON READER-SERVICE CARD

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.

NATIONAL'S EXCLUSIVE "FLUSH MOUNT" CAPTIVE NUTS



Flush fit on both sides of aluminum sheet to provide permanent tapped holes.

Available in Five sizes for use in metal thickness from 1/16" up — in thread sizes from 2/56 up. No special tooling required. Drilled or Punched round hole — .002 only requirement.

MATERIAL: Stainless steel 303 as per MIL S-853A.

FINISH: Passivated as per MIL P-12011.

Four additional types also available, including one type which provides a permanent thread in thin aluminum that meets MIL SPECS P-11268, E-5400 and E-16400. A complete line of CAPTIVE STUDS is also available.

Write, wire or phone for complete specifications.

NATIONAL COMPANY, INC.

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SINCE 1914



Malden 48, Mass

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HIGH FREQUENCY
INDUCTION
HEATING
UNITS

Lepel induction heating equipment represents the most advanced thought in the field of electronics. The most practical and efficient source of heat developed for numerous industrial applications. You are invited to send samples of work with specifications. Our engineers will process and return the completed job with full data and recommendations without cost or obligations.

FLOATING ZONE UNIT FOR METAL REFINING AND CRYSTAL GROWING

A new floating zone fixture for the production of ultra-high purity metals and semi-conductor materials. Purification or crystal growing is achieved by traversing a narrow molten zone along the length of the process bar while it is being supported vertically in vacuum or inert gas. Designed primarily for production purposes, Model HCP also provides great flexibility for laboratory studies.

Model HCP



Features

- A smooth, positive mechanical drive system with continuously variable up, down and rotational speeds, all independently controlled.
- An arrangement to rapidly center the process bar within a straight walled quartz tube supported between gas-tight, water-cooled end plates. Placement of the quartz tube is rather simple and adapters can be used to accommodate larger diameter tubes for larger process bars.
- Continuous water cooling for the outside of the quartz tube during operation.
- Assembly and dis-assembly of this system including removal of the completed process bar is simple and rapid.

Electronic Tube Generators from 1 kw to 100 kw.
Spark Gap Converters from 2 kw to 30 kw.

WRITE FOR THE NEW LEPAL CATALOG

LEPEL HIGH FREQUENCY LABORATORIES, INC.

100 STREET and 27th AVENUE WOODSIDE, N. Y.

CIRCLE 459 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 22, 1959

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 $0.06 \text{ (gram)} \times 0.032 \text{ (\%/hour)} \times 30 \text{ (sec)}/3600 \text{ (sec/hr)} = 1.6 \times 10^{-7} \text{ gram/application}$.

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 $1.6 \times 10^{-7} \text{ (gram)}/0.028 \text{ (cu meter)} = 0.006 \text{ milligram/cubic meter}$.

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.

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Here are four representative units, each of which invites your trial and the beginning... or continuation... of a lifelong, rewarding association with the Lavoie standard of quality.



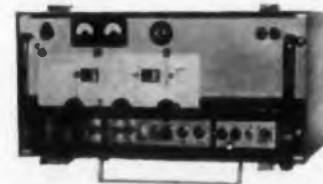
LA-302 ROBOTESTER

Provides the immediate profits of the automated approach to volume testing as well as for unique individualized test programs. High-speed sampling, go/no-go indication, with digital readout of fault isolation.



LA-20W SPECTRUM ANALYZER

Features 1 to 44 Kmc range in one instrument, selection of square law, linear or log detection, 10-KC resolution at 3 db points, regulated filament and plate supplies. Unit illustrated is only one of a full line of spectrum analyzers.



LA-70A FREQUENCY METER

Frequency measurements from 20 mc to 3000 mc with .0001% accuracy. Oven-controlled crystal oscillators, direct dial reading and light in weight for ease in portability. Ideally qualified to accommodate stringent FCC communications requirements.



LA-90 FREQUENCY STANDARD

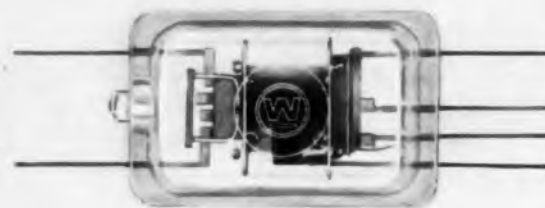
New design approach to crystal oven thermal regulation permits frequency stability of 1 part per 10⁶ per day at low cost, in small package. Oven temperature stability of 0.01%. Output frequency (basic LA-90 unit): 1 mc, 5 mc, 100 kc, 10 kc, 1 kc.

Technical literature describing these units in detail is available on request. Detailed technical data may also be supplied on a selection of Pulse Generators, WWV Receivers and Crystal Ovens and a diversified line of quality test equipment for laboratory and plant.

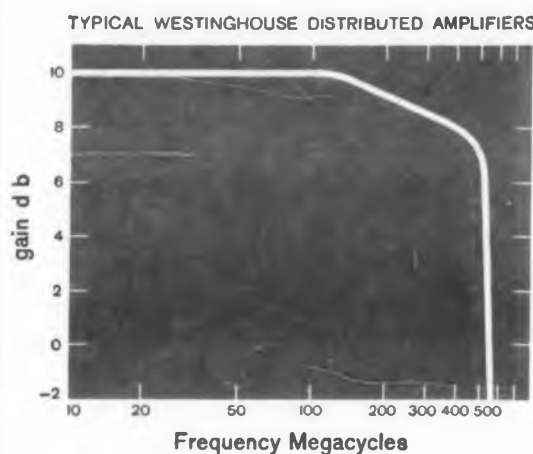
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Westinghouse tube engineering...
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with Westinghouse distributed amplifiers

The new Westinghouse Match Box Tubes provide distributed amplifiers with response to 550 MC.

Match Box tubes surpass conventional tubes in high frequency performance and resistance to vibration. Tubes lie flat . . . no height problem . . . eliminates sockets, fits printed circuits.

Westinghouse Distributed Amplifiers can be designed with various frequency pass bands. They're especially suited for electronic coun-

ter-measure circuits and for high-speed, high-frequency oscilloscopes. We'd welcome the opportunity to design and build your Distributed Amplifiers.

CHARACTERISTICS WX3683

Heater 6.3 Volts	0.2 amperes
Plate current	8 milliamperes
Transconductance	5100 micromhos
Plate Voltage	180 volts

Write for complete information.

YOU CAN BE **SURE**...IF IT'S **Westinghouse**

Electronic Tube Division Elmira, N. Y.

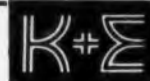
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Some Ideas

for your file of practical information on drafting and reproduction



from
KEUFFEL & ESSER CO.

One of the ways to judge a skilled craftsman is by the tools he uses. They're invariably the best he can find — chosen to lighten his work, sharpen his skills. And if the craftsman is a draftsman, they are, more often than not, products of K&E.

It may be that some of these products have escaped your attention (after all, we offer something over 8000 items). That's why we suggest you pay a visit to your K&E dealer whenever you can. It's a liberal education on what's new — as well as what's tried and true — in drafting equipment.

You'll find many products like these which can be highly useful in your work...

K&E "Quick Set" Bow Compass

The most remarkable feature of this compass is the speed and ease with which you can change settings—from diameters of 12 inches to 1/16 inch. With one hand, you can increase or decrease radii instantly and exactly. To go from small to larger radius, just press a spring release, and the legs will

leg pencil compass, and the N1070 combination with interchangeable pen and pencil inserts. Both come with a box containing leads and spare needles. And with the N1070, a pen handle is provided for the pen insert which permits its use as a ruling pen. The compass can also be used as a divider by substituting one of the spare needle points for the lead in the pencil insert.



Marathon® Ruling Pens

K&E Marathon Long Line and Wide Line Ruling Pens (1092) hold an extra large

ink supply — draw lines up to eight times longer than ordinary ruling pens. And because they are pre-set, line widths are always uniform, easy to match with complete accuracy. Ink flow is regular and even, lines are always sharp and clean edged.

An important feature of K&E Marathon Ruling Pens is that they will *not leak*. They can be laid on the work surface without risk of ink flowing out. That means you can fill several pens of different widths, use them as freely as you'd use pencils. They're easy to clean, too.

K&E Marathon Long Line Ruling Pens are available individually in line widths of .006, .009, .013, .020 inch — or in sets of three pens in line widths of .009, .013, .020 inch in a Leatherite case. Marathon *Wide Line Ruling Pens* come in line widths of .030 and .060 inch.

Leroy® Height and Slant Control Scriber

A versatile new Leroy scriber is now available which greatly expands the variety of lettering possible from a standard Leroy template.

Now, with the new Height and Slant Control Scriber (3237-12), you can form characters from vertical to slanting at any angle up to 45° forward. You can vary height from 60% to 150% of the size of letters on the template used. The width of letters remains the same.



Combinations of height and slant can be set quickly and easily. You just loosen the knob, move the scriber arm to the desired combination of height and slant, and tighten. That's all there is to it.

Stop in to see your nearest K&E dealer and ask to see these three products—small, perhaps, but mighty handy in the drafting room. Or drop us a line by mailing the coupon below...



expand automatically. Stop approximately where you want, and make precise adjustments with a micrometer screw. To go from large to small, simply squeeze the legs of the compass together, then adjust precisely.

The K&E Quick Set combines the rigidity and precise adjustment of a standard bow compass, the simplicity and speed of a friction type compass, plus the finger tip control of K&E's unique design. You have to try the Quick Set to appreciate it fully. Two types are available. The N1071 fixed

KEUFFEL & ESSER CO., Dept. ED-7, Hoboken, N. J.

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- K&E Quick Set Compass Leroy Height and Slant Control Scriber
 Marathon Ruling Pens
 Please send me the name and address of my nearest K&E Dealer.

Name & Title _____

Company & Address _____

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The Landing of the Puritans

On the banks of Gitchie Goomie,
Lake the white men call Atlantic
Heap big redskins going frantic,
Radar got no Bomac tubes!*

See the Pilgrims land on rock there!
See them cross the sky blue water!
Redskins know they hadn't oughter,
But radar got no Bomac tubes!

Beat the drum, call heap big powow,
Call the braves from heap big teepee,
Get um chief to put on toupee —
Radar got no Bomac tubes!

Fixum Cavity, Bald Eagle!
Get um faulty Klystron going!
Heap big white men come a-rowin
And radar got no Bomac tubes!

Storm Cloud, get those fingers flying!
Mend with rawhide, patch with sticks
Too late now to get um "fix" . . .
Radar got no Bomac tubes!

Redskin radar rests in ashes,
White men use um wood for fire, now.
Price of real estate is higher now . . .
Radar had no Bomac tubes!

On the banks of Gitchie Goomie
Different people now are living,
Every year they give Thanksgiving
Radar had no Bomac tubes!

No. 15 of a series . . . BOMAC LOOKS AT RADAR THROUGH THE AGES



* Today, Bomac makes the finest microwave tubes
and components since the Pilgrims landed

Bomac

B

Leaders in the design, development and manufacture of TR, ATR, Pre-TR tubes; shutters; reference cavities; crystal protectors; silicon diodes; magnetrons; klystrons; duplexers; pressurizing windows; noise source tubes; high frequency triode oscillators; surge protectors.

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DO-T₁ & DI-T₁ SERIES

Revolutionary transistor transformers

hermetically sealed to MIL-T-27A Specifications

DO-T₁ 2000 CT

DI-T₁ 2500 CT

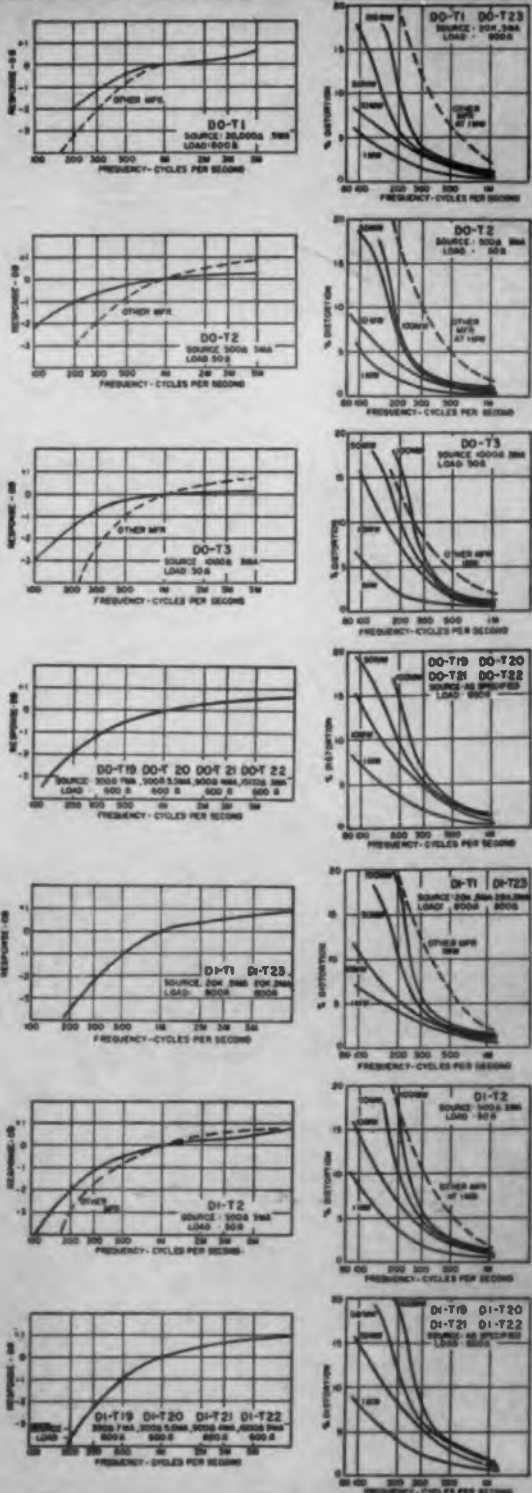


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High efficiency...
Rugged...
Balanced loads...
Push pull...

1-1/2" Dia. x 1-1/2" H. 1000 CT 1000 CT 1-1/2" Dia. x 1-1/2" H.

These DO-T and DI-T transformer-transistors provide...
...hermetically sealed to MIL-T-27A Specifications...
...push pull...

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DO-T No.	MIL Type	Application	Pri. Imp.	D.C. Ma. † in Pri.	Sec. Imp.	Pri. Res. DO-T	Pri. Res. DI-T	Level Mw.	DI-T No.
DO-T1	TF4RX13YY	Interstage	20,000 30,000	.5 .5	800 1200	850	815	50	DI-T1
DO-T2	TF4RX17YY	Output	500 600	3 3	50 60	60	65	100	DI-T2
DO-T3	TF4RX13YY	Output	1000 1200	3 3	50 60	115	110	100	DI-T3
DO-T4	TF4RX17YY	Output	600	3	3.2	60		100	
DO-T5	TF4RX13YY	Output	1200	2	3.2	115	110	100	DI-T5
DO-T6	TF4RX13YY	Output	10,000	1	3.2	790		100	
DO-T7	TF4RX16YY	Input	200,000	0	1000	8500		25	
DO-T8	TF4RX20YY	Reactor 3.5 Hys. @ 2 Ma. DC, 1 Hy. @ 5 Ma. DC				630			
DO-T9	TF4RX20YY	Reactor 2.5 Hys. @ 2 Ma. DC, .9 Hy. @ 4 Ma. DC				630			DI-T8
DO-T9	TF4RX13YY	Output or driver	10,000 12,000	1 1	500 CT 600 CT	800	870	100	DI-T9
DO-T10	TF4RX13YY	Driver	10,000 12,000	1 1	1200 CT 1500 CT	800	870	100	DI-T10
DO-T11	TF4RX13YY	Driver	10,000 12,000	1 1	2000 CT 2500 CT	800	870	100	DI-T11
DO-T12	TF4RX17YY	Single or PP output	150 CT 200 CT	10 10	12 16	11		500	
DO-T13	TF4RX17YY	Single or PP output	300 CT 400 CT	7 7	12 16	20		500	
DO-T14	TF4RX17YY	Single or PP output	600 CT 800 CT	5 5	12 16	43		500	
DO-T15	TF4RX17YY	Single or PP output	800 CT 1070 CT	4 4	12 16	51		500	
DO-T16	TF4RX13YY	Single or PP output	1000 CT 1330 CT	3.5 3.5	12 16	71		500	
DO-T17	TF4RX13YY	Single or PP output	1500 CT 2000 CT	3 3	12 16	108		500	
DO-T18	TF4RX13YY	Single or PP output	7500 CT 10,000 CT	1 1	12 16	505		500	
DO-T19	TF4RX17YY	Output to line	300 CT	7	600	19	20	500	DI-T19
DO-T20	TF4RX17YY	Output or line to line	500 CT	5.5	600	31	32	500	DI-T20
DO-T21	TF4RX17YY	Output to line	900 CT	4	600	53	53	500	DI-T21
DO-T22	TF4RX13YY	Output to line	1500 CT	3	600	86	87	500	DI-T22
DO-T23	TF4RX13YY	Interstage	20,000 CT 30,000 CT	5 5	800 CT 1200 CT	850	815	100	DI-T23
DO-T24	TF4RX16YY	Input (usable for chopper service)	200,000 CT	0	1000 CT	8500		25	
DO-T25	TF4RX13YY	Interstage	10,000 CT 12,000 CT	1 1	1500 CT 1800 CT	800	870	100	DI-T25
DO-T26	TF4RX20YY	Reactor 6 Hy. @ 2 Ma. DC, 1.5 Hy. @ 5 Ma. DC				2100			
DO-T26	TF4RX20YY	Reactor 4.5 Hy. @ 2 Ma. DC, 1.2 Hy. @ 4 Ma. DC				2300			DI-T26
DO-T27	TF4RX20YY	Reactor 1.25 Hy. @ 2 Ma. DC, .5 Hy. @ 11 Ma. DC				100			
DO-T27	TF4RX20YY	Reactor .9 Hy. @ 2 Ma. DC, .5 Hy. @ 6 Ma. DC				105			DI-T27
DO-T28	TF4RX20YY	Reactor .3 Hy. @ 4 Ma. DC, .15 Hy. @ 20 Ma. DC				25			
DO-T28	TF4RX20YY	Reactor .1 Hy. @ 4 Ma. DC, .08 Hy. @ 10 Ma. DC				25			DI-T28
DO-T29	TF4RX17YY	Single or PP output	120 CT 150 CT	10 10	3.2 4	10		500	
DO-T30	TF4RX17YY	Single or PP output	320 CT 400 CT	7 7	3.2 4	20		500	
DO-T31	TF4RX17YY	Single or PP output	640 CT 800 CT	5 5	3.2 4	43		500	
DO-T32	TF4RX17YY	Single or PP output	800 CT 1,000 CT	4 4	3.2 4	51		500	
DO-T33	TF4RX13YY	Single or PP output	1,060 CT 1,330 CT	3.5 3.5	3.2 4	71		500	
DO-T34	TF4RX13YY	Single or PP output	1,600 CT 2,000 CT	3 3	3.2 4	109		500	
DO-T35	TF4RX13YY	Single or PP output	8,000 CT 10,000 CT	1 1	3.2 4	505		500	
DO-T36	TF4RX13YY	Isol. or Interstage	10,000 CT	1	10000 CT	950	970	500	DI-T36

†DCMA shown is for single ended usage (under 5% distortion—100MW—1KC) . . . for push pull, DCMA can be any balanced value taken by .5W transistors (under 5% distortion—500MW—1KC)
*DO-T units have been designed for transistor application only . . . not for vacuum tube service. Pats. Pend.

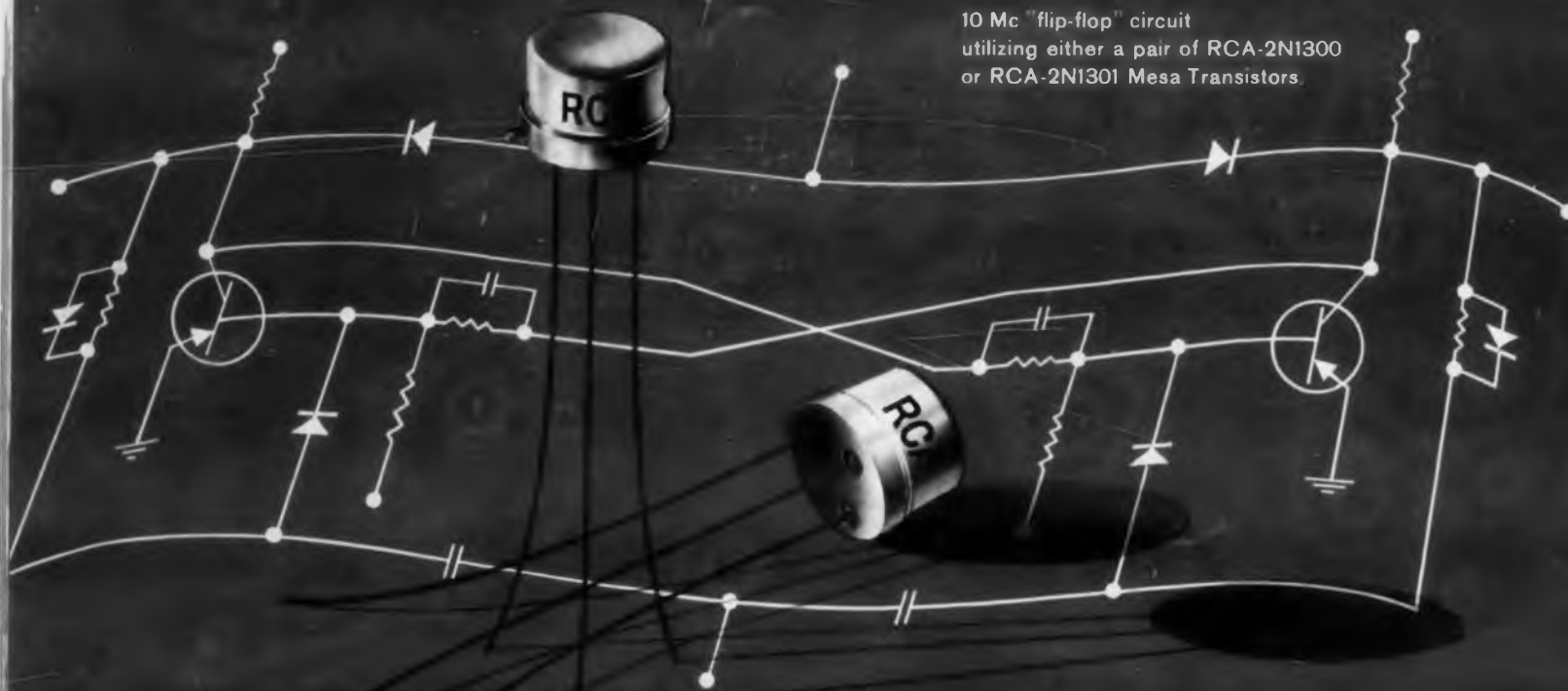
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Now in quantity production... and available!

RCA-2N1300 and 2N1301 Germanium Mesa Transistors offer these 10 major benefits to designers of switching circuits. And they're ready for you now!

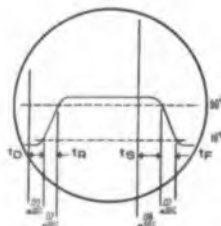
- rugged Mesa structure—permits extremely small base width to insure top performance at high frequencies
- fast switching times with low values of base input current—made possible by high frequency response and low total stored charge
- high current gain—permits high fan-out ratios (number of paralleled 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, Attention G-18-NN2.

RCA TYPE	Maximum Ratings ^a 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 ^b Mc
				at 25°C	at 55°C	at 71°C	at collector $i_{c} = -10$	at collector $i_{c} = -40$	
2N1300	-13	-1	-100	150	75	35	30	—	40
2N1301	-13	-4	-100	150	75	35	30	40	60

^aMaximum collector-to-emitter voltage rating = -12 volts

^bFor collector $i_{c} = -10$ 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.

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