

June 25, 1958

ELECTRONIC DESIGN

JULY 9, 1958

CONGRESS
SERIAL RECORD

JUL 9-1958

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TRANSISTORS

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basically they consist of high grade base phenolic sheet with IRC resistance material permanently bonded by carefully controlled heat processing.

Resistance strips can be supplied by IRC with either side or end termination or further processed to form particular shapes for individual requirements.

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MAN—Can you use us? IRC Resistance Strips and Concentric Disc Resistors des. pt. or full-time job in electronics, espec. in servomechanical, telemetering & UHF equipment fields. 10 yrs.' exp. Adaptable to special reqmts. Excellent ref. from electronic engrs. and designers.

International Resistance Co., 401 N. Broad St., Phila. 8, Pa., U.S.A. or phone WAlnut 2-2166 (Philadelphia). Qualifications and photo in Bulletin T-1A.

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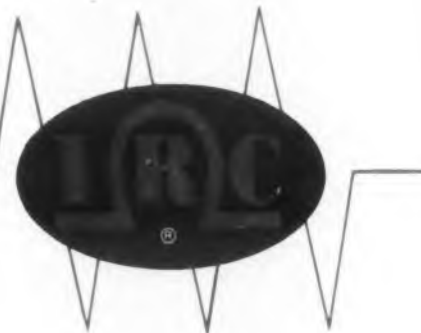
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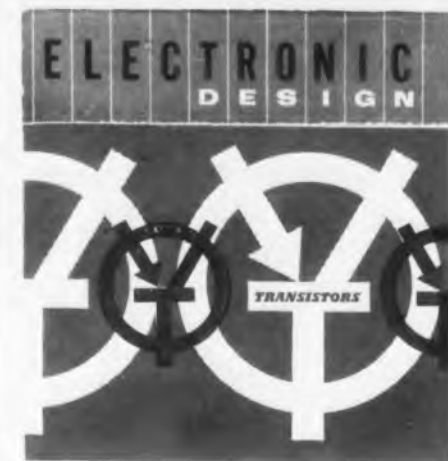
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HIGHLIGHTS OF ISSUE



Sixth Annual Transistor

Data Chart . . . following p 70

Over 600 transistors are tabulated according to manufacturer and type to provide the circuit designer with a single comprehensive transistor data chart. Included are pertinent parameters which determine the operating characteristics of each transistor.

Diffused Base Transistor . . . 12

With the development of the diffused base transistor the circuit designer has now at his disposal high frequency devices with alpha cut-off values in the 500 to 1000 mc range. Because of their many commercial and military application possibilities two typical diffused base transistors are discussed in terms of their operating characteristics.

Voltage Limiter 20

Here is a reliable voltage limiter that effectively protects transistorized equipment from overvoltage. It achieves this by a novel voltage limiting technique.

The PNN and NPP 106

These two interesting transistor devices can be assembled from ordinary junction type transistors. Soon available commercially, they can eliminate the need of an inverter in a push-pull transistor circuit.

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JEDEC-30 Type	Punch through Voltage min.	f_{ab} ave. Mc	H_{FE1} ave.	H_{FE2} ave.	I_{CO} at -12V $I_C = -1\text{mA}$ $V_{CE} = -6\text{V}$ μA	r_b' ohms	C_{ob} μf
			$I_B = 1\text{mA}$ $V_{CE} = -0.25\text{V}$	$I_B = 10\text{mA}$ $V_{CE} = -0.35\text{V}$			
2N658	-24	5	50	40	2.5	60	12
2N659	-20	10	70	55	2.5	65	12
2N660	-16	15	90	65	2.5	70	12
2N661	-12	20	120	75	2.5	75	12
2N662	-16	8	30 min	50	2.5	65	12

MEDIUM CURRENT, HIGH FREQUENCY, HIGH GAIN SWITCH

JEDEC-30 Type	V_{CE} max. volts	f_{ab} ave. Mc	H_{FE1} ave.	H_{FE2} ave.	Rise Time* max. μsec
			$I_B = 1\text{ma}$ $V_{CE} = -0.25\text{V}$	$I_B = 10\text{ma}$ $V_{CE} = -0.35\text{V}$	
2N404	-24	12	30 min.	-	-
2N425	-20	4	30	18	1.0
2N426	-18	6	40	24	0.55
2N427	-15	11	55	30	0.44
2N428	-12	17	80	40	0.33

* $I_C = 50\text{ma}$; $I_B = 5\text{ma}$; $R_L = 200\ \Omega$; $I_{B2} = 5\text{ma}$; Grounded Emitter Circuit

SUBMIN Type	V_{CE} max. volts	f_{ab} ave. Mc	H_{FE1} ave.	H_{FE2} ave.	Rise Time* max. μsec
			$I_B = 1\text{ma}$ $V_{CE} = -0.25\text{V}$	$I_B = 10\text{ma}$ $V_{CE} = -0.35\text{V}$	
CK25	-20	4	30	18	1.0
CK26	-18	6	40	24	0.55
CK27	-15	11	55	30	0.44
CK28	-12	17	80	40	0.33

Ratings at 25°C unless otherwise indicated. Illustrations actual size.
 Dissipation Coefficients: For 1 Amp types, in air $0.35^{\circ}\text{C}/\text{mW}$, infinite sink $0.18^{\circ}\text{C}/\text{mW}$.
 For med. current types, in air $0.40^{\circ}\text{C}/\text{mW}$, infinite sink $0.18^{\circ}\text{C}/\text{mW}$.
 For submin types, in air $0.75^{\circ}\text{C}/\text{mW}$, infinite sink $0.35^{\circ}\text{C}/\text{mW}$.

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CIRCLE 3 ON READER-SERVICE CARD

Decade of Transistor Progress

Alexander E. Takacs
Assistant Editor

PROGRESS over the past ten years in the transistor field has been feverish and exciting. The transistor chart in this issue which lists 619 units, indicates the growth of the transistor field. Our first transistor chart in 1953 listed 43 available types. From 1948, the year of the invention of the transistor, to 1958 when transistors provide the radio voice in our satellites, a few of the potentialities of the transistor realized were:

- Diffused base transistors now operate in the 1000 mc range;
- Rise, storage, and fall times of switching transistors in the order of 10 millimicrosec;
- Operating junction temperature over 100 C with silicon transistors;
- Germanium power transistors available with power gains of 35 db and collector currents of 13 amp.

In this report the highlights of transistor developments are discussed. We also take a look at the current and future status of transistors.

Areas of Application

Audio. One common type of junction transistors produced is the diffused alloy type. The procedure is basically melting indium dots into a wafer of germanium. However, diffused alloy transistors have their limitations by being only suited for medium power and audio frequency work. Because of the high capacitance between collector and base, the device does not perform effectively at high frequencies.

High Frequencies. The rate grown junction transistor is an improvement, being more stable at higher frequencies. The manner of construction is essentially different from the diffused alloy type. From a melt which has been doped with small amounts of antimony and gallium, a germanium bar is grown. The characteristics of the bar change from p type to n type according to temperature and rate of growing. This technique of fabrication has the advantage of avoiding non-uniform junctions which occur in ordinary junction-growing methods.

Over the past year the production of diffused base transistors increased greatly as manufacturers raced to exploit its advantages. By diffusing gaseous impuri-

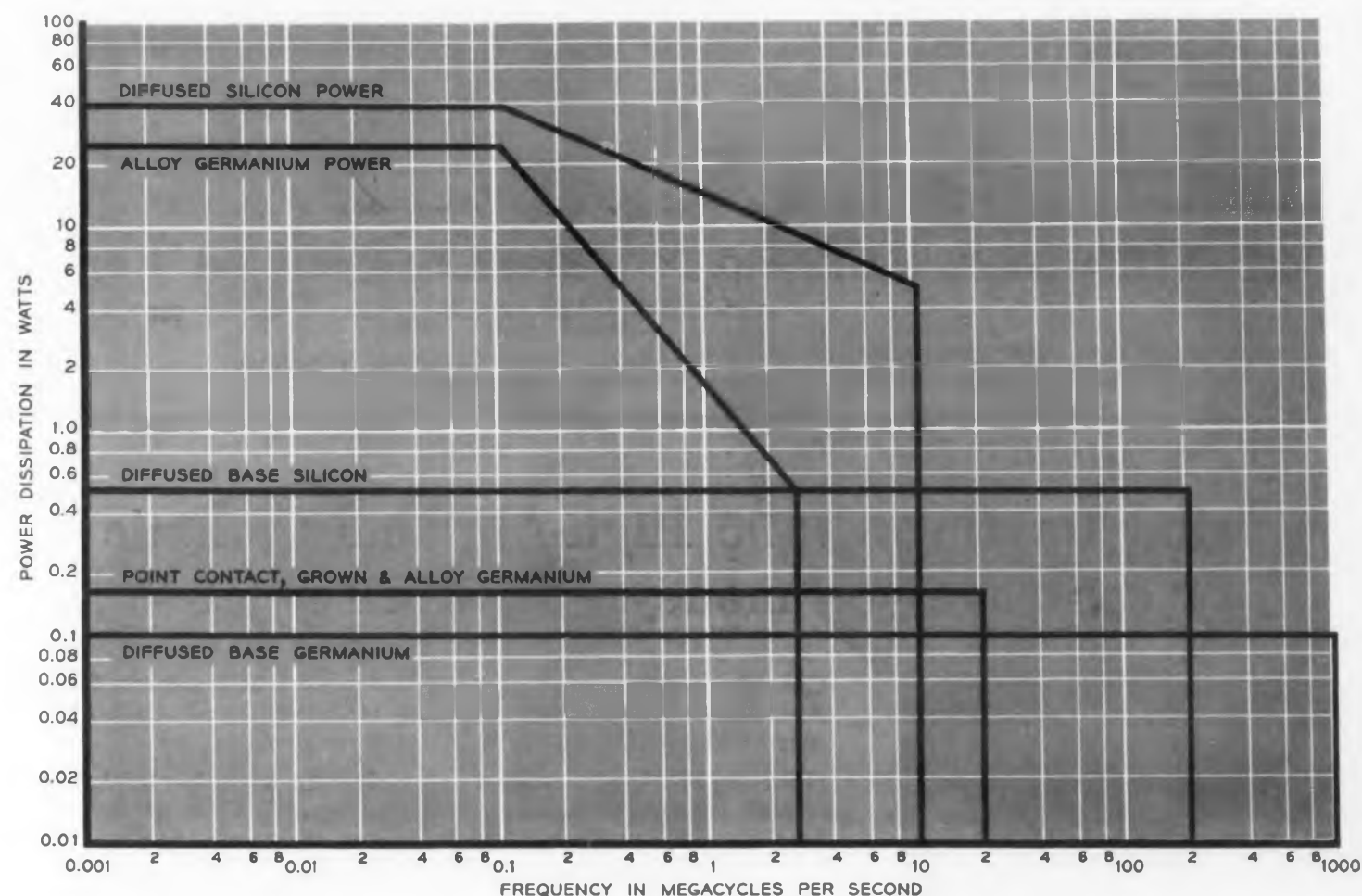


Fig. 1. Frequency vs power dissipation curves of various types of transistors.

ties into a semiconductor an incredibly small base width in the order of 1.5×10^{-4} cm is produced. The change in resistivity, from high conductivity near the emitter to almost intrinsic near the collector, reduces the transit time of the holes in a pnp type. The 1000 mc range could then be reached, which is 10 to 50 times higher than using alloy and grown junction types. It became suited for computer and switching circuits.

Diffused silicon types were also produced. A typical value for silicon base width is 3.8×10^{-4} cm. Though they operate at a lower frequency, they are useful for high temperature applications. Silicon diffused base

transistor can also be used as an electronic switch because of its high impedance when non-conducting. **Power.** The upper limit for germanium power transistors was 10 to 15 w several years ago, with maximum operating junction temperatures of 80 C. Today transistors are available as high as 55 w at 95 C maximum junction temperature. However, there is still a need for transistors operating at higher voltages.

Silicon power transistors proved useful because of their high ambient temperature range. With each passing year higher temperature materials associated with the fabrication of silicon transistors are developed.

Which ceramic characteristics do you need . . .

Characteristic	Material								
	Electrical Porcelain	Steatite	Fused Quartz	Magnesia	Cordierite	Glass Bonded Mica	Raytheon R-95 High Alumina	Forsterite	Zircon
Dielectric Constant (1 mc)	6-7	5.5-6.5	3.7	5.8	4-5	7-8	9	6.5	9
Power Factor (1 mc)	.009	.0008	.00035	.0008	.008	.002	.001	.0002	.0014
Loss Factor (1 mc)	.055	.004	.0013	.004	.03	.016	.009	.0014	.013
Water Absorption (%)	0-1.0	0-.01	0	16	3-8	0.5	0.0	0-0.01	0-0.01
Tensile Strength (p.s.i. x 10 ³)	2.6	13	8	2.8	3	8	25	10	10
Flexural Strength (p.s.i. x 10 ³)	11	20	—	6	7-10	18	45	12	18.5
Compressive Strength (p.s.i. x 10 ³)	30-65	65	200	48	50-95	25	250	80	80
Dielectric Strength (volts/mil)	100-200	250	200	65	200	245	450	250	200
Hardness, Moh's scale	7.5	7.5	5	6	7	—	9	7.5	8
Modulus of Elasticity (p.s.i. x 10 ⁶)	10	14	4	—	5	—	42	—	21
Specific Gravity	2.4	2.6	2.2	3.0	2.5	—	3.7	2.8	3.7
Linear Thermal Expansion 20-100°C (in./in./°C x 10 ⁻⁶)	3.6	6	.20	9.4	2.5-4	—	6.2	8.5	2.5-5
T _E Value (°C)*	—	450°-800°	—	—	750°	—	980°	990°	700°

*T_E is that temperature at which the volume resistivity reaches 1 Meg.

Approximate characteristics of "electronic" ceramic materials. Source: manufacturer sales literature

Reprinted from Electronic Design, November 1, 1956

How Raytheon R-95 High-Alumina Ceramic can save you money—do a better job



Consider well the unusual properties present in Raytheon R-95 High-Alumina Ceramic. If your needs are for a less specialized material, you may find a satisfactory performer at lower cost.

However, when you require a material with remarkably *high resistance to high temperature, shock and vibration; high dielectric strength and high electrical resistance at all temperatures; extreme hardness; high mechanical strength and positive sealing capability*—then you will surely want to be familiar with the ratings of Raytheon's R-95. Proper application of this superior material assures continuing design and assembly economy, particularly where ceramic seals are a factor.

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Table 2. Impedance Levels

Configuration	Power rating
Common emitter	low (under 100 mw, over half watt)
Common base	under 10 mw over half watt
Common collector	under 100 mw over half watt

Configuration	Input impedance
Common emitter	500-20,000 ohm 20-500 ohm
Common base	10-500 ohm 0.2-20 ohm
Common collector	10,000-0.5 meg 400-10,000 ohm

Configuration	Output
Common emitter	10,000-200,000 ohm 200-10,000 ohm
Common base	50,000-2 meg 1000-50,000 ohm
Common collector	10-500 ohm 0.2-20 ohm

Eventually silicon power transistors will be available with operating junction temperatures of 200-300 C. **Switching.** Transistors were readily adapted to switching applications: germanium alloy pnp transistors for low speed switching applications such as dc to dc converters; diffused base transistors for high speed switching where rise times in the order of a few millimicrosec are required; and power switching handling voltages up to 100 v and currents of 10 amp. Higher power transistors are required to operate in the range between 10 and 100 usec.

In the past year high speed germanium switching transistors became more available for commercial use. Typical switching applications are generation of rectangular and sawtooth waveforms, time delays, gating, amplifying and lengthening pulses.

Transistor Performance

Power Gain. The important feature of a power transistor is delivering useful gains at high current levels.

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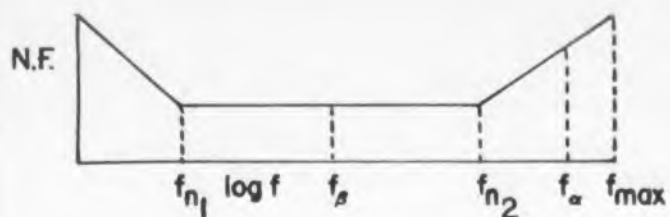


Fig. 2. Noise figure vs frequency curve.

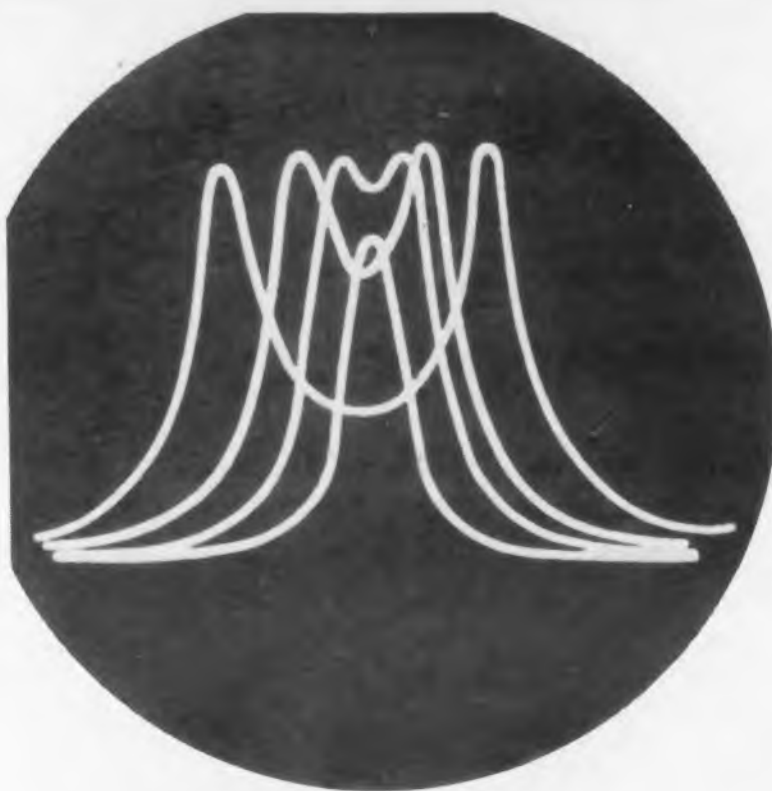
The power gain in a transistor is a result of the relatively small amount of current drawn by the base-emitter circuit in producing a current change in the emitter-collector circuit. The current change produced in the collector circuit is developed at high impedance. A typical high power audio transistor is the Sylvania type 2N173 which provides a power gain of 34 db and maximum collector current of 13 amp.

The amount of power gain in a transistor amplifier, like that in a tube amplifier, depends on the circuit configuration. The maximum gain, 40 to 50 db, is obtained with the input signal on the base and the output taken from the collector. Somewhat less gain, 30 db, is obtained when the input signal is introduced into the emitter and the output taken from the collector; and even less gain, about 20 db, with the input signal into the base and the output taken from the emitter.

Frequency Response. Limitations in the frequency response of transistors have been overcome by technological breakthroughs such as diffused base techniques. The principal parameters affecting frequency response are r_b' , g_f and C_{bc} and C_{cb} . Often preliminary design is based on the assumption (frequently the assumption is invalid) that the base spreading resistance r_b' may be neglected. If the input source impedance to the transistor is less than the reactance of the input capacitance, C_{bc} , then, for r_b negligible, a relatively uniform response may be obtained. Since the value of C_{bc} for a transistor depends on the uniformity of current flow across the base and on the thickness of the base, an increase in the allowable source impedance can be obtained only by the selection of a transistor having a smaller value of C_{bc} . This capacitance may be small as 100 μf or possibly less, and as large as 0.1 μf .

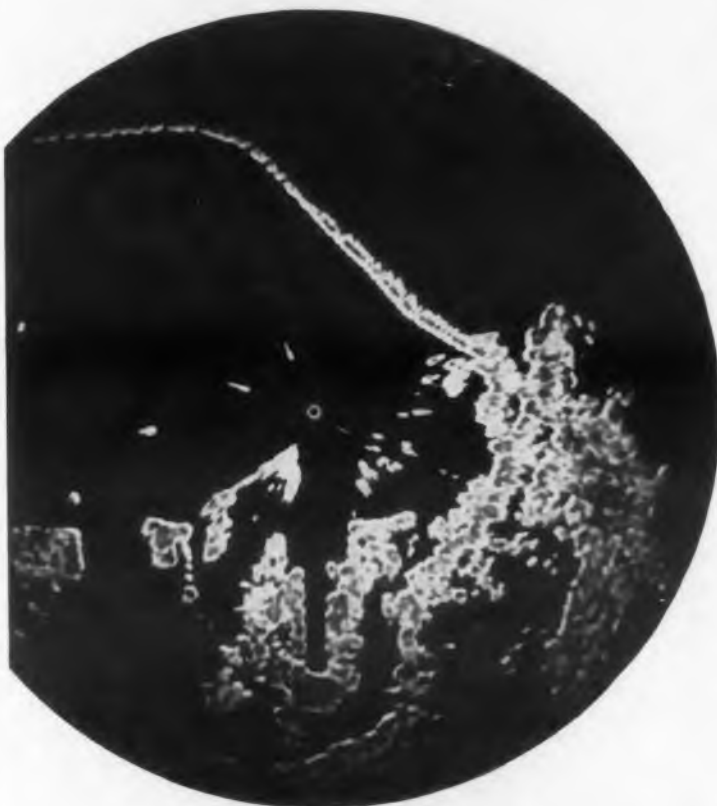
Frequency of operation is plotted in Fig. 1 as a function of power dissipation for various types of transistors presently available. Values of alpha cutoff frequencies are used. For oscillator applications, higher values of frequency are possible, while lower values would apply for broadband applications. Areas under the curves show the continuing trend of transistor device development toward the latest types of structures with wider ranges of operating characteristics.

As the power rating of a transistor is increased through enlarging the active areas of the emitter and collector, a corresponding increase in the value of C_{bc} is inevitable, reducing the operating frequency range. The use of diffusion techniques to produce a graded



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base or drift transistor extends the frequency range for any given power device. Typical limiting frequencies for standard type transistors are indicated in Table I.

Noise Figure. The noise figure of present-day transistors for the range of frequencies for which thermal noise is the predominant component may be as small as two to twelve db, depending on the processing and the circuit conditions under which the transistor is used. A typical noise figure vs frequency curve is shown in Fig. 2. The noise developed by the transistor depends on both the circuit and on the currents and voltages applied to it.

The deterioration of noise figure at a low frequency is usually attributed to semiconductor noise and surface recombination noise. The frequency f_{n1} at which the low frequency deterioration sets in varies from transistor to transistor, and may be as high as several megacycles. The deterioration above the switch limit frequency f_{n2} is caused primarily by the non-uniformity in the diffusion of the minority carriers through the base region.

Impedance Levels. The input and output impedances for the three circuit configurations differ substantially. The actual values depend on the characteristics of the transistor and also the values of the associated circuit components. The range of typical values is shown in Table 2.

Other Transistor Types

Field Effect Transistor. Typical junction type transistors depend upon both minority and majority carriers for operation. The unipolar field effect transistor, however, involves only the flow of one carrier, either holes or electrons. It is constructed by forming pn junctions on a bar of germanium. The bulk resistance is modulated by the application of an electric field. A change in the n-type material-depleted of carriers, is produced by a voltage change across the pn junction.

In the May 14 issue of ELECTRONIC DESIGN a field effect transistor was described using an electrolyte-semiconductor interface. Between the two ends of the semiconductor, oppositely biased with respect to an electrolyte, a neutral point exists which shifts back and forth with changing biasing grid voltage. The resistance changed accordingly and a current flowed following the driving frequency. This experimental amplifier operated at 1000 cps with 15 db gain.

However, the field effect transistor has not been investigated to the extent that typical junction transistors were. A question mark still hangs over the future role of the field effect transistor.

Intrinsic Barrier Transistor. The distinguishing characteristic of an pnp intrinsic barrier transistor is a layer of nearly intrinsic material next to the collector. This layer which in some respects compares to the grid of an electron tube, serves several functions. First, close control of the carriers is permitted. Second, separating the input from the output allows the device to operate at higher voltages. Last, lower collector ca-

Table 1. Limiting Transistor Frequencies

Type	Approx. f_{max}
Junction transistors High Power Low Power	100 kc to 10 mc 1 kc to 20 kc
Thin-base transistors	10 mc to 75 mc
Surface barrier transistors	10 mc to 200 mc
Double-base transistor	200 mc
Diffused base transistor Low Power High Power	50 mc to 1000 mc 20 kc to 10 mc

puitance is achieved. The device can operate with cutoff frequency of over 300 mc.

Tetrode. The tetrode is basically an npn grown-junction transistor with a double base connection. A potential drop is set up across the base. Electron flow is confined to a small region near to one base control, and a lower effective base resistivity results because of the shorter path. This permits the device to be designed with a higher cutoff frequency.

Point-Contact. Because of the advantages of junction type transistors, the point-contact transistor has almost been reduced to historical importance only. It was the first transistor to be developed. The distinctions are lower power capabilities, more noisy and lower collector impedance. It has been used mainly for switching applications.

Thyristor. The thyristor is a transistor that acts like a thyatron. It can be rigged "on" and "off" with low power and has a collector voltage drop of only about 0.5 v during conduction. It is almost a perfect switch having a collector current rise and fall time of less than 0.1 μ sec. The speed of switching is limited by the Thyristor design and the input and the output capacities. Since the high frequency response is good the rise and fall times below one tenth μ sec are easy to obtain. Ring counters, shift registers and similar type devices may be made by using the Thyristor collector current triggering characteristics.

Silicon Controlled Rectifier. This semiconductor switch combines both transistor and rectifier features for high power switching at μ sec speeds. This device operates at low power levels. Ratios of load power to control power of 100,000 to 1 have been obtained. The future of silicon controlled rectifier is promising. We expect to see many manufacturers producing this type device in the near future. A few of the devices it can replace are thyratrons, relays and typical rectifiers. It can replace the power transistor in servo motor amplifiers.

Transistor Art Today

Transistors are superior to electron tubes because of their long life, rugged construction and smaller size. But they were initially inferior in other ways. The inherent noise limited minimum signals. Internal capacitance limited maximum frequency. Internal heat-



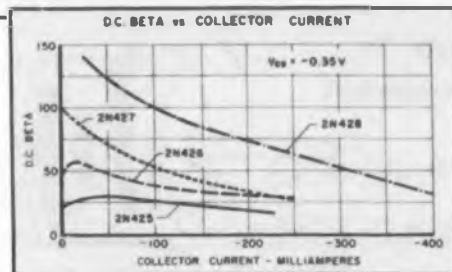
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TECHNICAL DATA

TYPE NUMBER	V_{CR} volts	V_{EB} volts	V_{CE} volts	f_{ab} min mc	h_{FE} typ.
2N425	-30	-20	-20	2.5	30
2N426	-30	-20	-18	3.0	40
2N427	-30	-20	-15	5.0	55
2N428	-30	-20	-12	10.0	80

Collector dissipation in free air, 150 mw
Derate 2.5 mw/°C above 25°C



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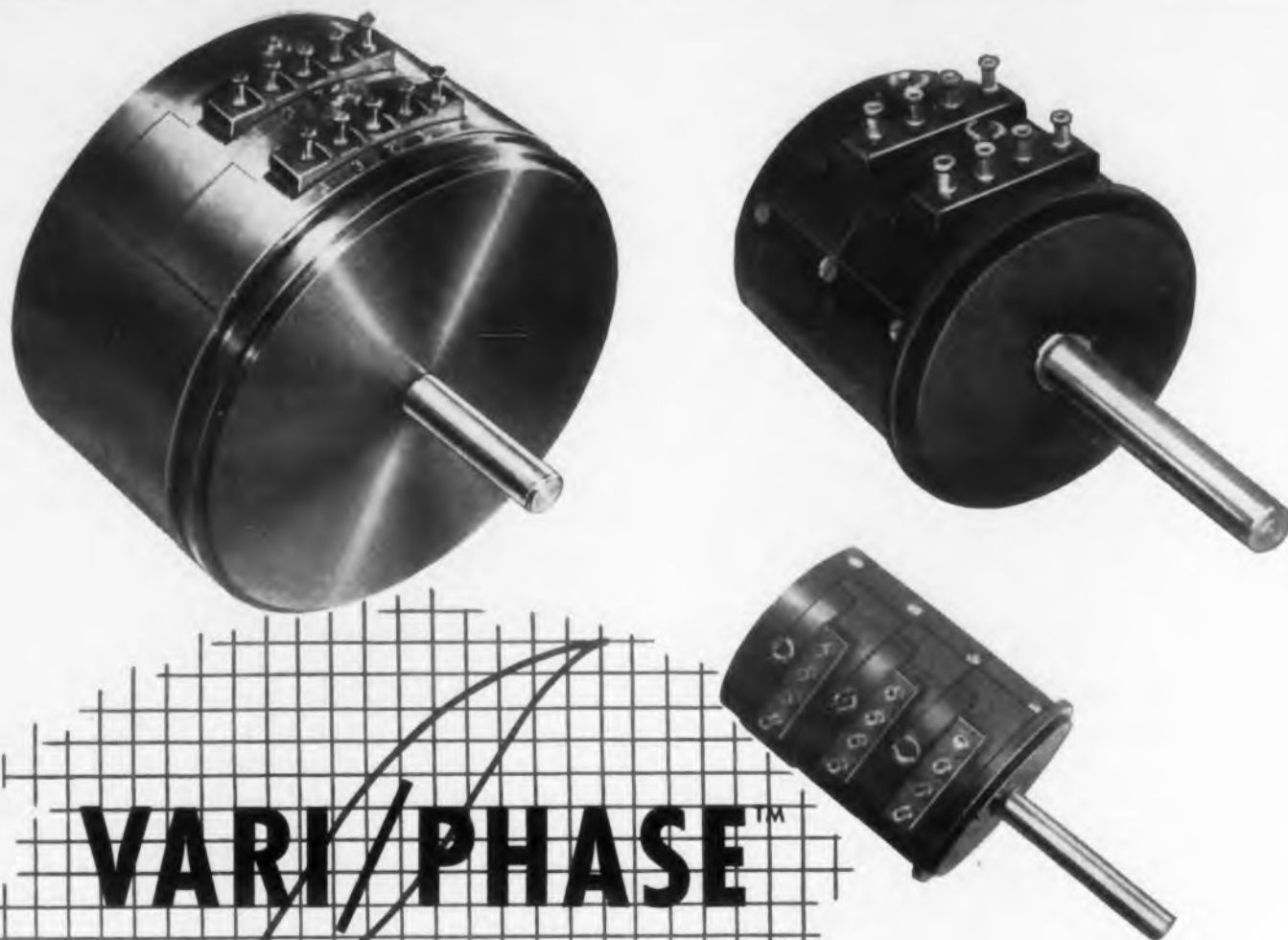
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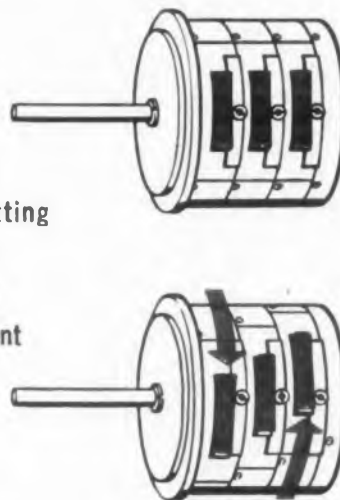
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ing and distortion limited maximum power. Large temperature coefficient limited ambient temperature range. However in recent years some of these limitations were overcome. Diffusion techniques shorter transit times of the carriers and higher frequency ranges were reached. The use of silicon permitted high ambient temperature range.

Today the transistor does not perform as many functions as the electron tube. But there is little doubt that in the future years transistor device research will make deep inroads on the earlier successes of the electron tube. This will be dependent on technological breakthroughs not only in device research but investigation of the bulk and surface properties of semiconductor materials.

There are many semiconductor materials other than silicon and germanium. Yet only these two have been exploited, germanium to a greater extent than silicon. There is a constant search for other suitable semiconductor materials that would make the transistor a more versatile device. A promising family of semiconducting material is the intermetallic semiconductor group. They have characteristics similar to germanium and silicon. In this group the indium phosphide and antimonide compounds are most promising.

Acknowledgment

Appreciation for contributing valuable transistor data to this issue is expressed to K. C. Pullen, Ballistic Research Lab., Aberdeen Proving Ground, Md.

CIRCUITS WANTED

The Bureau of Ships recently awarded a contract to Transistor Applications, Inc. to prepare a "Selected Semiconductor Circuits Handbook."

The Boston firm will invite companies, government organizations and individuals to submit reliable transistor and diode circuits and their descriptions for possible inclusion in the handbook. Among the many circuits to be covered will be amplifiers, oscillators, mixers and converters, switches, and power supplies.

All circuits will be reviewed by a committee of technical authorities, and all contributors will receive full credit.

The handbook, it is hoped, will encourage better engineering practice by transistor circuit engineers, in designing circuits for military electronic equipment.

We, at ELECTRONIC DESIGN, hope this project will lead to some standardization in semiconductor circuitry. Our readers can help by sending their contributions to the Research Director at Transistor Applications, Inc., 50 Broad St., Boston, Mass.

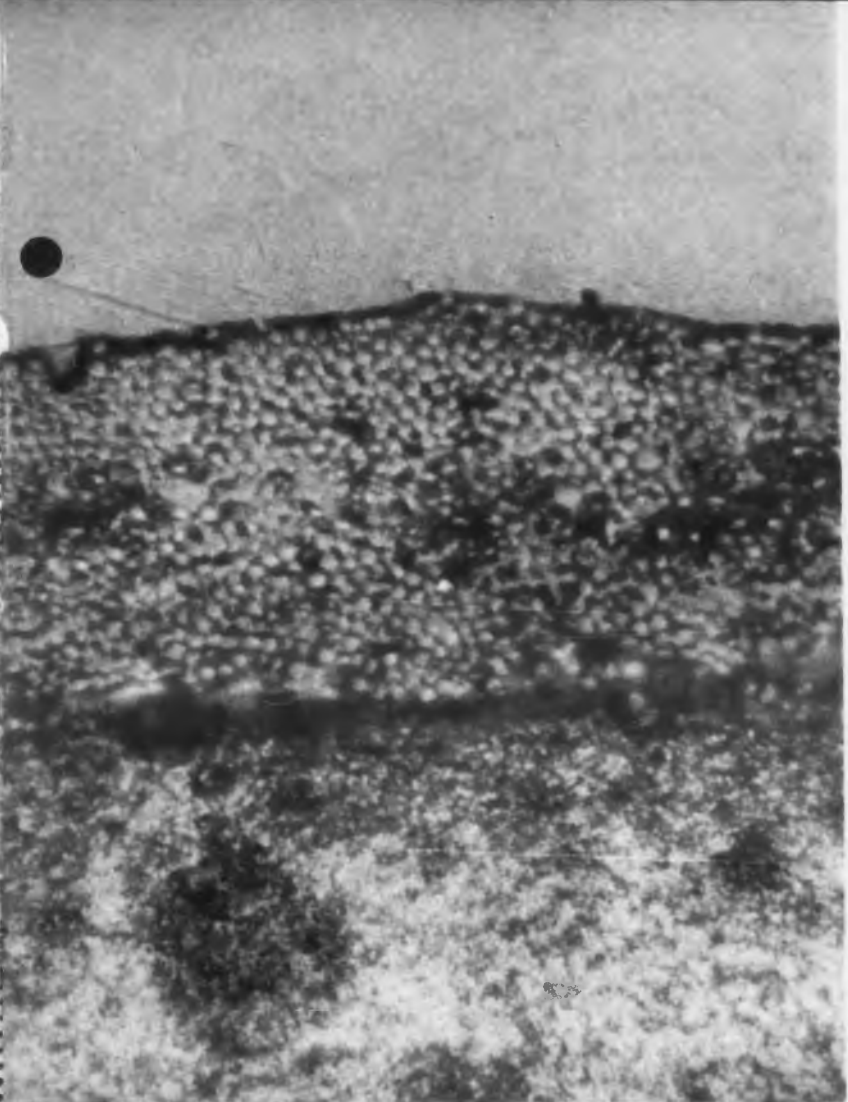
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VITROTEX, magnified approximately 400X. The lower layer is the copper wire; the upper layer, the glass insulation. The glass fiber-ends appear as small circles in the photograph. The sections between fibers are occupied by bonding varnish. Notice the fibers are close together, well distributed.



VITROTEX-D, magnified approximately 400X. The upper layer consists of glass fibers in fused Dacron*. Notice the even distribution which provides uniform insulation value—no large "islands" where fibers are missing.

*Reg. U. S. Pat. Off., Dupont

Let these Anaconda photomicrographs help you select high-temperature Magnet Wire with glass-type insulation

These two longitudinal sections of Anaconda magnet wires have been blown up 400 times—to show you the difference between Anaconda Vitrotex and Vitrotex-D (both 130°C—AIEE Class B).

Maximum high-temperature protection in glass-type insulation depends on the proportion of the glass fibers present. Maximum resistance to winding damage, however, can call for reducing the number of glass fibers and adding a "damage reducing" agent such as Dacron.

This is essentially the difference between Vitrotex and Vitrotex-D.

Anaconda provides both—in complete size ranges, in rounds, squares and rectangulars. You, the designer, must weigh the need for insulation and heat-resistance against those properties which affect windability.

Vitrotex, as the left-hand photograph shows, consists of all glass fibers—therefore, where winding damage is controllable, Vitrotex offers you greater insulation value.

Sometimes, however, the risk of winding damage cannot be avoided. For these situations, Anaconda offers Vitrotex-D. The

Dacron acts as a bonding agent—holds the fibers in place and protects them during winding.

The pictures above show more than the difference in glass-fiber content. They show how Anaconda engineering and manufacturing care provide uniform fiber distribution in both types . . . how each has been designed to do a different job—and do it well!

Ask the Man from Anaconda for additional details on (1) Vitrotex, (2) Vitrotex-D, (3) Silotext (180°C—AIEE Class H) and (4) Silotex-D†. See "Anaconda" in your phone book, in most principal cities, or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

†Reg. U. S. Pat. Off.

SEE THE MAN FROM **ANACONDA**[®] FOR **MAGNET WIRE**

For more details on the characteristics of Vitrotex and Vitrotex-D, please turn the page—

ANATHERM 155°C (AIEE Class F) high temperature resistance

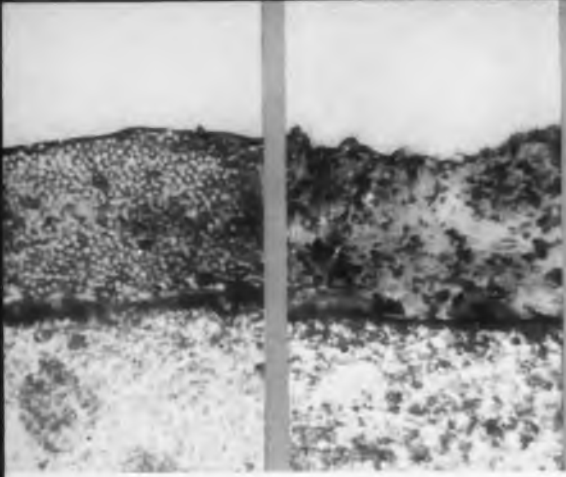
NYFORM 105°C (AIEE Class A) superior windability

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MAGNET WIRE DATA SHEET

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... about Anaconda Vitrotex 130°C (AIEE Class B) Magnet Wire

HIGH TEMPERATURE OVERLOAD PROTECTION. Even under severe overload conditions, Vitrotex provides protection. This exceptional high-temperature resistance is Vitrotex's outstanding advantage—and can be put to use even in totally enclosed applications.

REDUCTION IN FRAME SIZE. Because of the higher temperature stability, excellent space factor (compared with cotton), and the high heat conductivity of the glass fibers, Vitrotex-wound motors and generators can be produced in smaller frame sizes for equal rating or with increased ratings in comparable size frames.

TECHNICAL PROPERTIES

MECHANICAL PROPERTIES. Vitrotex has the necessary abrasion-resistance for most winding applications. It is suitable wherever controllable winding is possible. Vitrotex possesses remarkable space factor, especially when considering its ability to withstand high operating temperatures. Single Vitrotex has a space factor better than single cotton of equal gage. Double Vitrotex has a space factor better than double cotton of equal gage. Vitrotex has good "mesh" factor—windings expand no more than other insulations so that special precautions are unnecessary in design of windings.

ELECTRICAL PROPERTIES. Vitrotex is offered as a 130°C (AIEE Class B) magnet wire. Its high-grade organic bonding varnish plus the glass, give Vitrotex high electrical qualities. Vitrotex will retain sufficiently high dielectric strength to operate satisfactorily at temperatures above the destruction point of organic fiber insulation. At high relative humidity, Vitrotex retains its dielectric strength to a marked degree.

CHEMICAL PROPERTIES. Vitrotex is compatible with most Class B bonding varnishes and materials. Windings with Vitrotex can be baked after impregnation at temperatures that would destroy ordinary insulations. Windings can be impregnated with commercial varnishes or other compounds by standard methods. While the glass fibers themselves will not absorb liquids or compounds, the interspaces of the insulation will take up and retain the impregnant. Allows great latitude in design.

THERMAL PROPERTIES. Vitrotex is a 130°C (AIEE Class B) magnet wire by definition. However, the precise temperature at which Vitrotex wire can be operated will depend on the design of the apparatus. For example, Vitrotex is excellent for use in dry-type transformers under Group 2 NEMA classification for operation at 150°C hottest spot. Under severe overload conditions where all bond and varnish are destroyed, the inorganic glass remains to protect against shorting.

... about Anaconda Vitrotex-D 130°C (AIEE Class B) Magnet Wire

WINDABILITY. Vitrotex-D is a high-temperature AIEE Class B magnet wire with special abrasion-resistance properties. Where a controllable winding operation is not possible (making the use of all glass insulation impractical), Vitrotex-D is recommended.

PRECAUTION: Dacron is a polyester. Therefore the use of this wire is limited to ventilated equipment.

TECHNICAL PROPERTIES

MECHANICAL PROPERTIES. Vitrotex-D exhibits superior abrasion-resistance. It is ideally suited to those situations where a high-temperature Class B magnet wire is needed, but where the winding operations from the standpoint of abrasion, small bending radii or forming stresses are too severe to permit the use of all glass insulated wire. Use of Vitrotex-D on rectangular results in thinner insulation and thus improves space factor.

ELECTRICAL PROPERTIES. As in the case of Vitrotex, Vitrotex-D is offered as a 130°C (AIEE Class B) magnet wire. The same high-grade, organic bonding varnish is used in Vitrotex-D as in Vitrotex—giving this wire similar high electrical properties.

CHEMICAL PROPERTIES. The chemical properties of Vitrotex-D are similar to those of Vitrotex except, since Dacron is a polyester, care should be taken in the selection of the proper varnish.

THERMAL PROPERTIES. Vitrotex-D shows the same general thermal properties as Vitrotex—with excellent aging and heat-resistance. Since less glass is present in the covering, less protection is provided under severe overload conditions.

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TEAR OUT FOR YOUR FILE

EDITORIAL

Look for and Try for the Unexpected

Recognition of the 10th Anniversary of Transistors has produced so many words on the subject that this editor is reluctant to add more. No doubt, most every generalization and point of view worthwhile saying has been said. But in addition to being the Tenth birthday of transistors, it's our occasion for publishing the Sixth Annual Transistor Data Chart. We cannot forego saying a few words about it. Tedious as the compilation was, we enthuse and marvel over the picture of the industry it gives us. True there are no prices, no statement of the volume of business for the various types. Yet, every transistor listed represents a saleable item and every type will be sold. There are 619 transistors tabulated, the total different types listed are 535. The total number of transistors on the market by all USA manufacturers increased 38 per cent. The total number of different types increased 32 per cent. The difference is several manufacturers now make the same type. We begin to see a slight trend to settle on a few "standard" types.

That every manufacturer's transistor is not special is becoming more evident by the replacement or substitution guides put out by the manufacturers. Manufacturer A does have a type that can be used in place of Manufacturer B's device. We would have liked to publish such cross-reference guides but space would not permit. As a matter of fact, the tabulation has grown so that we have deferred until later issues many of our "how to apply" transistor design articles. We just didn't have the necessary space.

One can hardly appraise transistor developments without making comparison with tubes. We know practically everyone is investigating conversion from tubes to transistors. Despite this activity we suspect transistors are not being exploited as fully as they might. The reason: the designer has the wrong frame of reference. He approaches the problem "Can I use a transistor here more profitably than a tube?" This approach assumes tubes are the natural component. Transistors offer enough so that they ought to be the first consideration. The question should be "Is a tube better than a transistor in this application?" New concepts in thinking are needed.

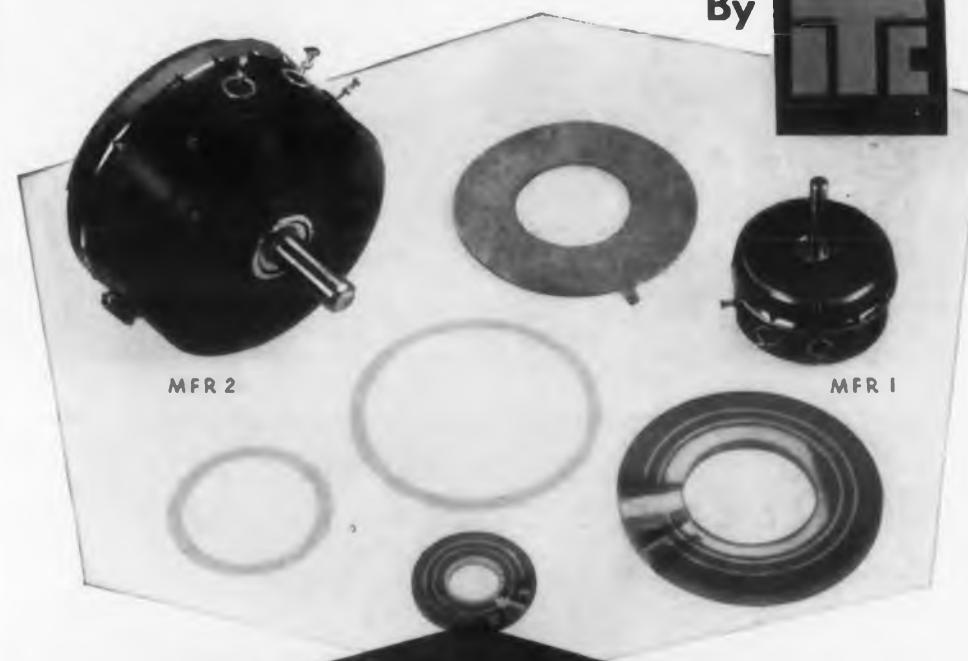
We are certain the future of transistors holds surprises that are not even hinted at today. Walter H. Brattain, speaking of research in the June Proceedings of the IRE, said ". . . while a well thought of experiment may always give good results, nevertheless the really important experiment is the one that leads to new and unexpected results regardless of the original reason or expectation that inspired it." Can not this alertness to the new and unusual give us new insights into circuit design? We think so.

James G. Kipp

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Fig. 1. Minute electrode structure of a diffused base transistor.

1000 mc range reached with Diffused Base Transistors

C. H. Knowles and E. A. Temple*

HIGH FREQUENCY characteristics, rugged construction and relative temperature insensitivity were the main reasons why diffused base transistors were used in the Vanguard and Explorer satellites. They have been designed to operate in the 1000 mc range and maintain good characteristics up to about 100 C. A diffused base germanium transistor, shown in Fig. 1, now serves many functions previously reserved because of temperature considerations for a silicon transistor. In this article high and low frequency characteristics are discussed, along with the power rating and fabrication techniques. Important parameters of two typical diffused base transistors are listed in Table 1.

High Frequency Characteristics

The most common figure of merit for high frequency transistors is the maximum frequency of oscillation 1:

$$f_{max} = \sqrt{\frac{f_{\alpha}}{8\pi r'_b C_c}} \quad (1)$$

where f_{α} is the frequency at which the grounded base short circuit current gain is 3 db down, r'_b is the high frequency base resistance, and C_c is the collector depletion layer capacitance.

Because of its high value of around 1000 mc f_{α} cannot be measured conveniently for the 2N509-2N537 series. Instead, the common emitter high

frequency short circuit current gain is measured. This is easier to measure and it is related to the common base characteristics in a calculable way. Fig. 2 shows a typical plot of common emitter short circuit current gain, h_{fe} , versus frequency. By measuring h_{fe} at a low frequency, say 100 mc, f_{α} can be extrapolated. Since f_{α} is about three-fourths f_{α} in this type of transistor, we have:

$$f_{\alpha} = h_{fe} \text{ (at 100 mc)} \times 100 \text{ mc} \times 4/3 \quad (2)$$

Using the data of Table 1 in Eqs. 1 and 2, a typical 2N537 is found to have an f_{max} of 1000 mc. The amplitude of h_{fe} at 100 mc is 6.3. This value rather than the corresponding 16 db in Table 1 is used in Eq. 2.

The high frequency characteristics of the 2N509 and the 2N537 are relatively insensitive to temperature. For example, h_{fe} at 100 mc falls less than 1 db from -200 C to room temperature and about 1 db more from room temperature to 100 C. Ohmic base resistance rises about 20% from -200 C to room temperature and somewhat less from room temperature to 100 C. Collector barrier capacitance has a very low temperature coefficient as in all germanium and silicon transistors.

Variations of high frequency parameters with bias voltage and bias current are similar to those in other transistors. For example, the collector barrier capacitance varies approximately as the

inverse square root of collector barrier voltage as in alloy transistors. This variation shows clearly that the collector barrier lies primarily in the p-type collector body.

At 100 mc h_{fe} increases with increasing emitter current. In this and the following figures parameters for the 2N509 and 2N537 are normalized to their respective values at $V_c = 10$ ma, $I_E = -10$ ma at room temperature. This variation may be understood from the dependence of h_{fe} on emitter current. This parameter is given at high frequencies by

$$h_{fe} \approx \frac{2\pi f_{\alpha}}{2\pi f} = \frac{1}{2\pi f \tau_{oe}} \approx \frac{1}{2\pi f(\tau_e + \tau_b + \tau_c + \tau_{x,2})} \quad (3)$$

Here τ_e is the emitter barrier charging time constant $C_e \times kT/qI_e$, τ_b is the carrier transit time across the base, τ_c is the collector barrier charging time constant, $-r'_c C_c$, and τ_x is the carrier transit time through the collector barrier.

Rough calculations show that these times for a 2N509 biased at 10 ma and -10 v are:

$$\tau_e \approx 0.5 \times 10^{-10} \text{ sec}$$

$$\tau_b \approx 1.2 \times 10^{-10}$$

$$\tau_c \approx 0.6 \times 10^{-10}$$

*C. H. Knowles is with Bell Telephone Lab., Inc., Murray Hill, N. J. and E. A. Temple is with Western Electric Co., Laureldale, Pa.

$$\tau_{z/2} \approx 0.25 \times 10^{-10}$$

$$\therefore \tau_{oe} \approx 2.60 \times 10^{-10}$$

$$f_{oe} \approx 615 \text{ mc}$$

The first of these terms, τ_e , accounts for a large part of the decrease in h_{fe} as emitter current is decreased.

Increase of collector voltage, while decreasing collector capacitance, increases h_{fe} and ohmic base resistance somewhat. The increase of h_{fe} results from a decrease in the base transit time associated with thinning of the base layer at higher voltages and from a reduction of τ_c . Increase of ohmic base resistance is caused by thinning of the base layer.

Low Frequency Characteristics

The collector reverse current, I_{co} , varies with temperature and voltage in the conventional fashion. It increases about 8 per cent per degree C, reaching 100 μa at 100 C. Breakdown voltages average around 40 v and I_{co} has essentially the low voltage value at 20 v.

Low frequency common base h-parameters change with temperature as shown in Fig. 3. The current gain defect $1 + h_{fb}$ decreases steadily with increasing temperature over the entire range. Although the basic physical cause of this variation is not understood, it is consistent with other observations on this parameter. The short circuit input impedance h_{ib} is nearly independent of temperature. It contains a term kT/qI_e which increases linearly with temperature and which apparently dominates at high temperatures.

Other variations are traceable to changes in $1 + h_{fb}$ and in r'_b . The open circuit voltage feedback ratio h_{rb} changes relatively little with temperature because its two major components have temperature coefficients of opposite sign. The space charge layer widening factor $kT/qw \delta\omega/\delta V_c$ increases linearly with temperature. Since the collector conductance h_{ob} decreases quite rapidly as temperature increases, its contribution to h_{rb} , $h_{ob}r'_b$, also decreases with rising temperature. The decrease of h_{ob} with increasing temperature results in part from the decrease of $1 + h_{fb}$ with increasing temperature and in part from a decrease of avalanche multiplication as temperature is increased.

In both the 2N509 and the 2N537, $1 + h_{fb}$ decreases steadily as emitter current is increased. This effect is connected to the temperature dependence of $1 + h_{fb}$ and is not yet fully explained. The decrease of h_{ib} with increase of emitter current results primarily from a reduction in the term kT/qI_e as in other transistors and in small part from the reduction of $1 + h_{fb}$ at high I_e . The rise of h_{ob} with emitter current is that ordinarily found in junction triodes. This rise ac-

TABLE 1. Diffused Base Transistor Parameters

Parameter	Bias I_E, V_C ma. v.	2N509		2N537	
		Median	Spec. Limit	Median	Spec. Limit
h_{re} (100 mc)—db	(10,-10)	16	>12	12	>10
r'_b —ohm	(10,-10)	70	<80		<30
C_c —mmf	(0,-10)	1.2	<1.5	1.2	<1.5
I_{co} — μa	(0,-20)	1.0	<5	1.0	<5
$1 + h_{fb}$ —	(10,-10)	.02	<.04	.07	<.10
h_{ib} —ohm	(10,-10)	5	<14	5	<10
h_{ob} — μmho	(10,-10)	9.0	<20	9.0	<20
h_{rb} —	(10,-10)	1.6×10^{-3}	< 3×10^{-3}	1.2×10^{-3}	< 3×10^{-3}

Fig. 2. h_{fe} vs frequency.

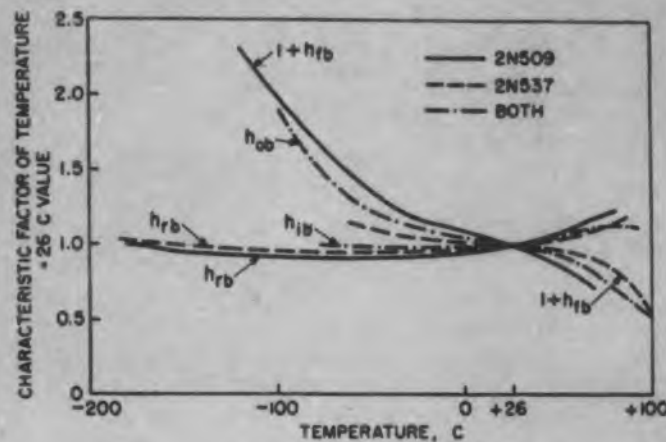
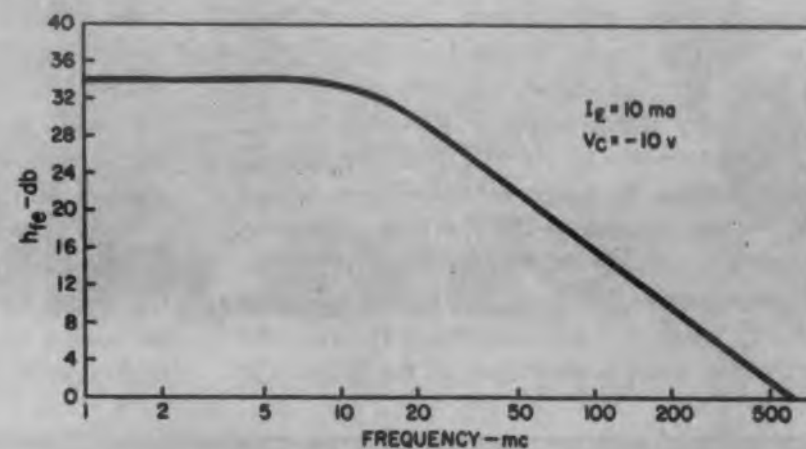
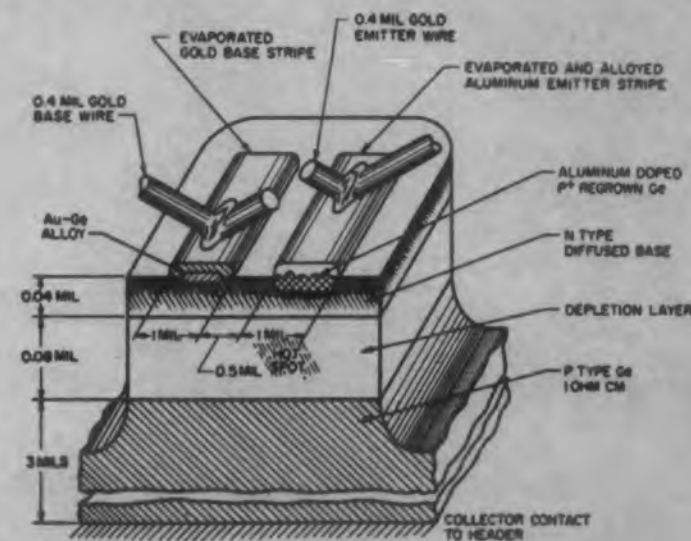


Fig. 3. How low frequency common base h-parameters change with temperature.

Fig. 4. Cutaway view of a germanium pnp diffused base transistor.



counts for the rapid increase of h_{rb} with emitter current, since $h_{ob}r'_b$ is the dominant term in h_{rb} .

Increase of collector voltage causes a monotonic decrease of $1 + h_{fb}$. At low voltages, the change of base layer thickness is largely responsible, but from about 12 v upward the increase of avalanche multiplication is responsible. The short circuit input impedance h_{ib} quite naturally reflects the decrease of $1 + h_{fb}$. The open circuit output admittance h_{ob} shows the effects of avalanche multiplication even at 8 to 10 v. The increase of $h_{ob}r'_b$ is, in turn, largely responsible for the rapid increase of h_{rb} at high voltages.

Power Rating

The 2N509 and the 2N537 can dissipate several hundred milliwatts when clamped to a cooling plate at room temperature. Power ratings have not been completely established and the values given here are conservative.

The tentative maximum junction temperature is 100 C. An increase to about 125 C is expected in a few months. B. Reich of the Evans Signal Laboratory has measured the thermal resistance from junction to can as 30 C per watt. M. A. Logan has measured 26 C per watt. Both workers used the I_{co} method for determining the rise. As shown in Fig. 4 the hottest spot in the transistor

is the collector junction immediately across the base from the emitter. Straightforward thermal calculations indicate that the temperature rise at this hot spot is probably four to five times greater than the rise determined by the I_{co} method. The I_{co} method inherently averages temperature over the entire region in which the reverse current is generated.

Structure and Manufacture

A cut-away view of the active region of a germanium pnp diffused base transistor² is shown in Fig. 4. As this sketch suggests, the production steps are: preparation of thin slabs (0.003 in.) of 1 ohm centimeter p-type germanium; diffusion of an n-type impurity layer 0.04 mils deep with an impurity concentration of about 10^{17} at the surface; evaporation and alloying of the aluminum emitter stripe; evaporation and alloying of the gold base contact; mounting of the wafer onto a header; masking with wax and chemical etching of the mesa; bonding of the gold wires to the emitter and base stripes; sealing it into the can.

This structure is inherently rugged. Its most fragile parts are the 0.4 mil gold wires. However, the wire lengths are such that centrifuge acceleration of more than 20,000 g may be applied in any direction without damage.

The most important structural features of the semiconductor crystals used in the 2N509 and the 2N537 are the very thin, heavily doped base layers and the location of the collector barrier layer largely on the collector side of the base-to-collector p-n transition. These features are essential to obtaining the short carrier transit times, low ohmic base resistances, low collector capacitances, and reasonable breakdown voltages required for good high frequency transistor performance. Transit times through the very thin base layers of these transistors are shortened significantly by the gradient of impurities inherently produced by diffusion^{3,4,5}. This gradient sets up an electric field in the base which speeds minority carriers through the base from emitter to collector.

The techniques of diffusion of impurities into semiconductors and the evaporation of electrodes onto semiconductors are highly controllable. They produce large numbers of transistors per square inch of semiconductor material used. Diffused base transistors are therefore very manufacturable.

We can summarize the advantages obtained from the thin base layers and proper location of the collector barrier in diffused base transistors and from the diffusion and evaporation-alloying

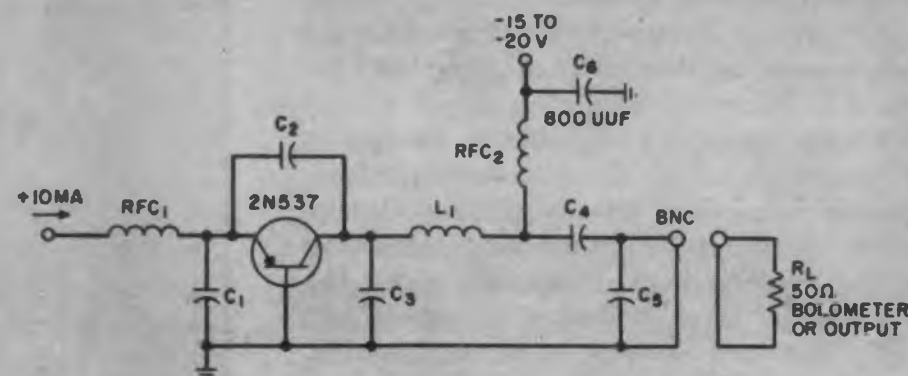
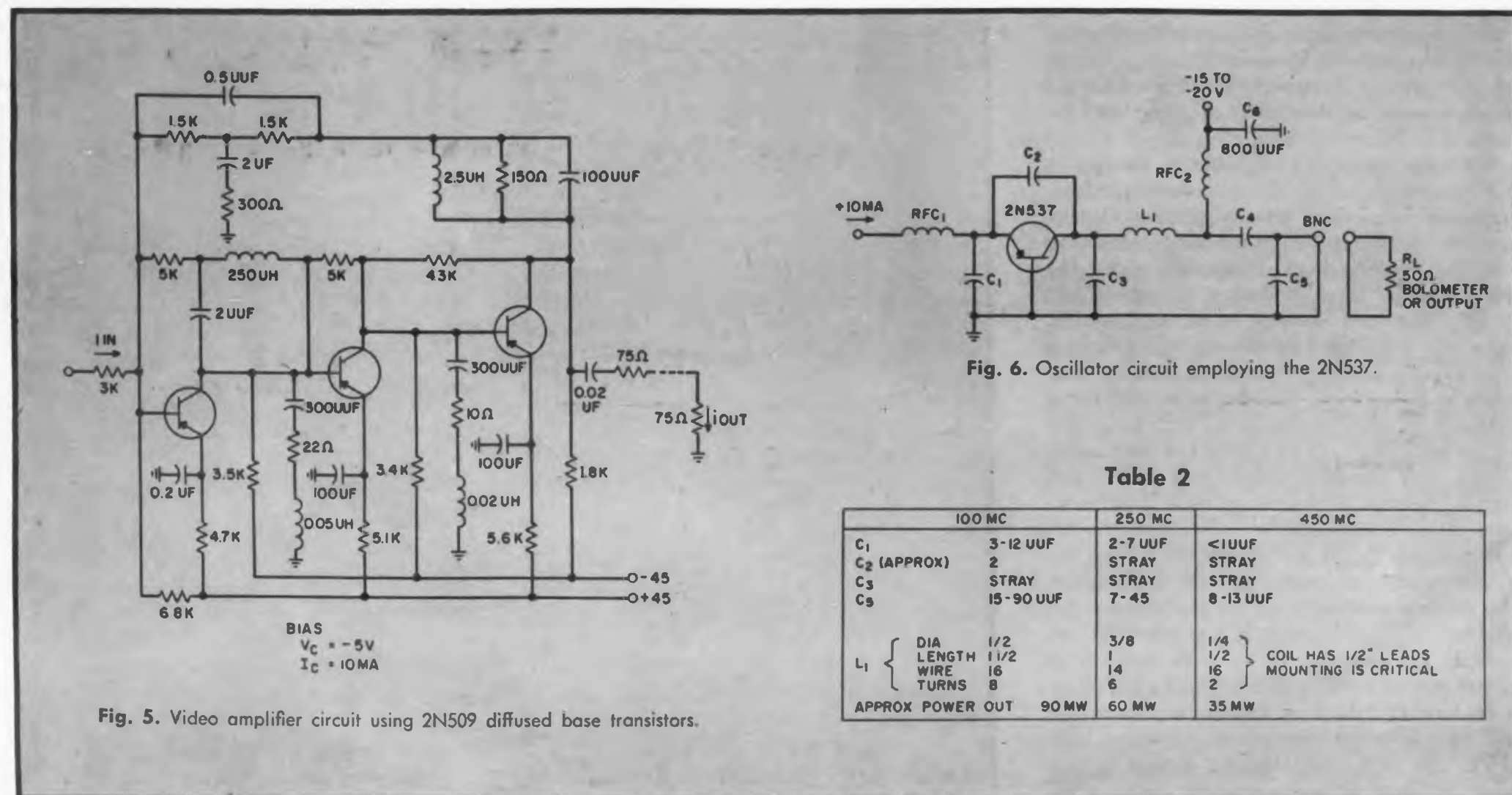


Table 2

	100 MC	250 MC	450 MC	
C ₁	3-12 UUF	2-7 UUF	<1 UUF	
C ₂ (APPROX)	2	STRAY	STRAY	
C ₃	STRAY	STRAY	STRAY	
C ₅	15-90 UUF	7-45	8-13 UUF	
L ₁	{ DIA 1/2 LENGTH 1 1/2 WIRE 16 TURNS 8	{ 3/8 1 14 6	{ 1/4 1/2 16 2	} COIL HAS 1/2" LEADS MOUNTING IS CRITICAL
APPROX POWER OUT	90 MW	60 MW	35 MW	

techniques as:

- Very high f_a (500-1500 mc);
- Low collector capacitance (0.3-1.5 mmf);
- Low base resistance (10-100 ohm);
- Relatively high voltage operation (in these types $BV_{BC} \sim 40-45$ v);
- Good manufacturability.

Typical Applications

The 2N509 is designed for moderate power video and uhf amplifier service. Fig. 5 shows a 50 mc video amplifier circuit designed by R. P. Abraham using 2N509's. This amplifier, designed to couple an fm discriminator to a 75 ohm line, has 35 db of current gain over its 50 mc band. The amplifier has 34 db of feedback. Reduction of the input resistor from 3000 ohm to 75 ohm would yield 35 db of stable power gain out to 50 mc with feedback of 28 db.

Median characteristics and specification limits of the 2N509 and the 2N537 are shown in Table I. Note that the principal differences are the high alpha in the 2N509 and the low ohmic base resistance r'_b in the 2N537.

The 2N537 is designed as a power oscillator for the vhf and low uhf range. Fig. 6 shows an oscillator circuit for the 2N537 designed by R. L. Lowell. The output powers shown in the Table 2 are for bias powers of 150 to 200 mw. Somewhat higher efficiencies are obtained at larger emitter currents. R. L. Lowell has designed a 1000 mc oscillator which radiates tens of milliwatts using selected 2N537's. This oscillator is to be displayed at the World Fair in Brussels this summer.

Summary

Two types of transistors, capable of operating in the 1000 mc range are now beyond the development stage and into production. These transistors are the 2N509, suitable for amplifier service, and the 2N537, intended for oscillator service.

The two transistors are intended for several hundred milliwatts of internal power dissipation, and operate in the hundreds of mc with high efficiency (10 to 45 per cent). These transistors maintain good characteristics up to about 100 C, hence will serve many functions previously reserved for silicon transistors.

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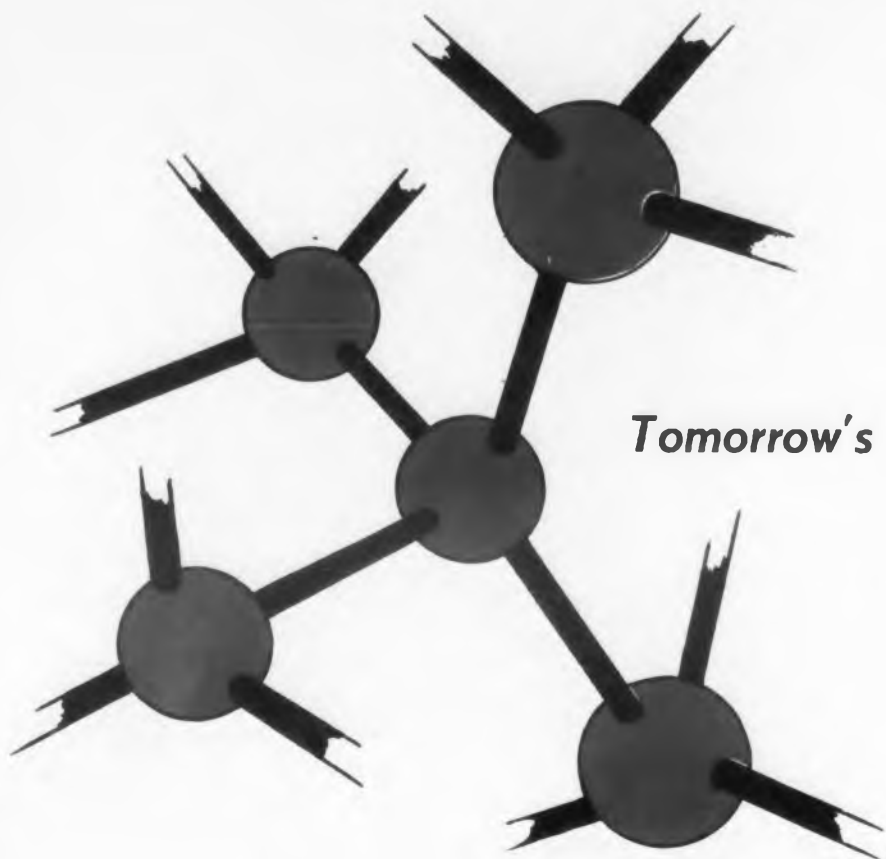
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Tomorrow's Transistors Depend on Better . . .

Semiconductor Bulk Properties

A. D. Kurtz, C. Gravel

Minneapolis-Honeywell Regulator Co.
Boston 35, Mass.

DEVELOPMENT of solid state devices depends upon the purity and perfection of semiconductor crystals. In designing the ideal transistor, crystal characteristics are often in contrariety. In the case of leakage current problems at high temperatures, a large energy gap is required. The reverse is true if greater mobility of holes and electrons is required. Therefore better semiconductor materials must be made available having wider ranges of energy gap, mobility, conductivity, and lifetime. This article after discussing these electrical properties, describes how the need for a higher degree

of crystal perfection is leading to improved devices and fabrication techniques. The magnitudes of the bulk properties (energy gap, mobility, conductivity, and lifetime) are listed in Table 1, along with the significant concentration of impurity.

The Need for Higher Energy Gaps

In germanium, with an energy gap of 0.7 electron-volt, the effects of leakage current are very serious at temperatures above 80 C. For many applications higher impedance pn junctions would be desirable at room temperature.

Silicon with an energy gap of 1.1 ev gives exceptionally high impedance junctions at room temperature and operates satisfactorily even above 200 C. Higher energy gaps are available in intermetallic compounds such as gallium arsenide (1.45 ev), indium phosphide (1.25 ev), and silicon carbide (3 ev). These materials will make possible the operation of semiconducting devices at temperatures in excess of 500 C.

Mobilities of Germanium and Silicon

For high frequency devices high mobility of holes or electrons is required. Germanium is

Table 1 Magnitudes of Important Bulk Properties

Property	Desirable Characteristics	Significant Impurity Concentration (atom fraction)
Energy Gap	0.7 electron-volt	10^{-4}
Mobility	$1000 \text{ cm}^2/\text{v sec}$	10^{-6}
Conductivity	Controlled magnitude, type, and geometry.	10^{-8}
Lifetime	10^{-5} sec	10^{-10}
Surface Properties	Stability	
Crystal Perfection	Highly perfect	10^{-3} dislocations/ cm^2

Table 2 Energy Gaps and Electron Mobilities

Semiconductor	Energy Gap (electron volts)	Electron Mobility ($\text{cm}^2/\text{volt sec.}$)
Ge	0.68	3800
Si	1.10	1700
Ge-Si Alloys	0.8-1.0	~3000
GaAs	1.45	~4000
InP	1.25	~3400
GaSb	0.77	~4000
InAs	0.35	~23,000
InSb	0.18	77,000
CuInSe ₂	0.9	~1000

superior in this respect to silicon since the mobility of charge carriers is about twice as great. However, certain of the intermetallic compounds with small energy gaps have extremely high mobilities, as much as a factor of 30 higher than that of germanium. Devices employing these compounds will be discussed subsequently. Table 2 lists the room temperature energy gaps and electron mobilities for germanium, silicon, and some of the intermetallic compounds.

Effects of Crystal Imperfections

Most semiconductor devices require adjacent regions of opposite conductive types (pn, np junctions), whose widths must be very accurately controlled. In high frequency transistors these regions may be as thin as 0.00005 in. In order to control junction geometry the semiconductor material must also have a high degree of crystal perfection including crystallographic orientation, low dislocation densities, and the absence of such gross imperfections as lineage and slip. Dislocations may be thought of as mistakes made in the ordinarily perfect arrangement of atoms in a crystal lattice. They arise from either accidents in the crystal growing process or the application of plastic deformation to the crystal. Since the dislocations are stress centers they will dissolve during alloying faster than the more perfect regions of lattice and thus make it difficult to control junction formation. In addition they tend to lower the junction breakdown voltage, increase reverse currents and limit the transfer of carriers. Thus the control and avoidance of these imperfections is fundamental to the production of semiconductor material suitable for device fabrication.

Lifetime Degrading Impurities

The lifetime, τ , of an injected carrier is the time constant describing the rate at which carriers of one type recombine with carriers of the opposite type. Preserving minority carrier lifetime places the most stringent requirements on purity and crystal perfection. Impurities such as nickel and copper in germanium and gold and iron in silicon of one part in ten billion are sufficient to markedly decrease the lifetime. Since the low level grounded emitter gain of a transistor, β , is given by:

$$\beta = \frac{2D \tau}{W_B^2}$$

where W_B is the base width of the transistor, the gain may be affected by the presence or absence of lifetime degrading impurities. Similarly dislocation densities must be less than 10^4 per cm^2 to insure high lifetime, and high gain as well as ease of fabrication.

(Continued on page 18)

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Resistance, ohms			
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+ or - Print solenoid	25.5	75.0	450.
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COIL DATA

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Resistance, ohms				
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+ Print solenoid	17.6	89.0	375.	125.
- Print solenoid	17.6	53.0	375.	125.
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Maximum on time, seconds (continuous printing)	.050	.050	.035	.050

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New Devices and Techniques

Processes. The diffusion of impurities from the vapor phase into the solid semiconductor promises an extremely reliable and controllable process for fabricating closely spaced, uniform junctions. The need for such junctions is one of the limitations on the frequency response of junction transistors. Units have been made by this technique which amplify and oscillate at frequencies well over 1000 mc with controlled impurity layers as thin as 0.00003 in. In addition, a given gradient of impurities in the diffused layers may be obtained by the proper choice of both diffusion temperatures and impurity vapor pressures.

Zone-refining has made it possible to prepare germanium and silicon with no more than one part per billion of electrically-active impurities. In zone-refining a molten zone is swept through an ingot of the semiconductor material, sweeping impurities to one end of the bar, taking advantage of the fact that the solubility of the impurities in the liquid is greater than in the solid material.

Since copper and nickel diffuse very rapidly into germanium, and gold and iron diffuse rapidly into silicon at the temperatures necessary for the fabrication of devices, efficient methods for removing these undesirable impurities must be found. Various techniques such as getting materials on the semiconductor surfaces, forming a metal semiconductor eutectic which leaches out the impurity, and annealing to precipitate the impurity, are being investigated.

The requirement for a higher degree of crystal perfection has led to improvements in the crystal growing process. Crystals of germanium and silicon can now be produced almost free from lattice defects.

Materials. The intermetallic compounds promise new and interesting devices. These may be divided into three classes: higher temperature and frequency transistor-like devices; infrared, ultraviolet and visible light sensing devices; and magnetic sensing devices. The first class of devices depends on the very large energy gap of certain of the intermetallics. For instance, use of silicon carbide as a semiconductor should permit transistor operation above 500 C. Furthermore the large carrier mobilities of the intermetallics makes possible the much higher attainment of frequency response than now possible (as large as a factor of ten greater than that of germanium).

Sensitivity to radiation of a particular wave length is also possible with these compounds because of their wide variation of energy gap. When these effects are better understood we have available photo-sensing devices set for fixed frequencies or bands of frequencies.

The electrical properties of these materials also show very large changes in the presence of magnetic fields. In indium antimonide very large magneto-resistance effects including resistance changes of as much as 20:1 are obtainable with convenient magnetic fields. This property can be used to make variable resistors without sliding contacts, such resistors being electronically controlled for use in servo-systems or current stabilizers.

New Devices. A whole family of devices stem from the use of the Hall effect. Devices for measuring magnetic field strength, an electric compass, a high sensitivity magneto-meter, clip on current ammeters for dc systems, multiplying elements in analog computers, a dc Hall amplifier are a few of the possibilities. The attractiveness of indium antimonide for these devices arises from its high power efficiency which is some 300 times higher than for germanium. The sharp conductivity change of indium antimonide when subjected to a magnetic field may also be adapted to a relay with no moving parts which can be switched from on to off with the application of a magnetic field.

Since work on the intermetallic semiconductors was started relatively recently their purity and crystal perfection does not equal that available for germanium and silicon and the carrier mobilities are still limited by impurities and imperfections. Further work is required to control their conductivity sufficiently for transistor applications.

The advent of new techniques and devices must be examined against a background of the economics concerned. Semiconductor progress in the beginning encountered great difficulties in manufacture with yields of usable devices as low as 15 to 20 per cent of starts. Much of this difficulty has been overcome with standard devices in mass production operations and a continual effort is directed towards increasing yields and in reclaiming as much waste material as possible.

Silicon has proved to be more difficult to process than germanium because of its extreme activity and high melting point. Uncontrolled impurity variations from lot to lot of the raw material are reflected in lower device yields and in higher unit costs. Silicon cannot be purified by ordinary zone melting techniques as can germanium, because the impurity element boron possesses a distribution coefficient in silicon of nearly unity and does not segregate on zone melting. In addition, quartz, the only crucible material found practical for melting silicon, contains sufficient boron so that repeated recrystallization in quartz results in the contamination of silicon by the quartz. Before silicon is competitive with germanium, the industry must reduce the cost of the basic material by overcoming these technological difficulties.

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2N378	-40	-20	50	30
2N379	-80	-40	50	30
2N380	-60	-30	70	50
2N459	-105	-60	50	30



IMPROVED SPECIFICATIONS OF TUNG-SOL COLD-WELDED HIGH POWER TRANSISTORS.

Collector Dissipation @ 25°C*...50 Watts
Collector Dissipation @ 55°C*...25 Watts
Thermal Resistance 1.2° C/Watt Max.
ICBO @ VCB = -25v T = 25°C...0.5 Ma Max.
ICBO @ VCB = -25v T = 85°C...7.5 Ma Max.
Storage Temperature -55 to +100°C

*Mounting base temperature



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Fig. 1. Model 66 voltage limiter.

Voltage Limiter

Protects Transistors

TRANSISTORIZED equipment is cleverly protected by this voltage limiter that both instantaneously clamps the dc voltage and removes input power from the power source. In many transistor applications, the briefest overvoltage causes the transistor to start over-heating and possibly race away to destruction. This can be very costly where a large amount of semiconductor equipment is undergoing life or heat tests. The voltage limiter described here has been developed to protect transistors from damaging overvoltages, particularly those overvoltages of a transient nature.

Effective Voltage Limiting

Model 66 voltage limiter manufactured by Electronic Measurement Co., Inc., combines the best features of typical voltage limiters. Upon overvoltage, the

dc voltage is instantaneously clamped, and while the clamp is holding the voltage, input power is quickly removed from the power source.

Operation of the voltage limiter shown in Fig. 1 is straightforward, requiring no special procedures. A glance at Fig. 2 is sufficient to determine the required connections. The cut-off point may be set to any value between 0 and 50 v by means of a continuously variable front panel control.

A semiconductor provides a clamp with an adjustable operating level. The return path for the clamp current is through the winding of relay K1. If the power supply voltage E_o exceeds the operating level at which the clamp is set, clamp current operates relay K1 which in turn short circuits the dc line and disconnects ac power. During the time required for the relay to operate,

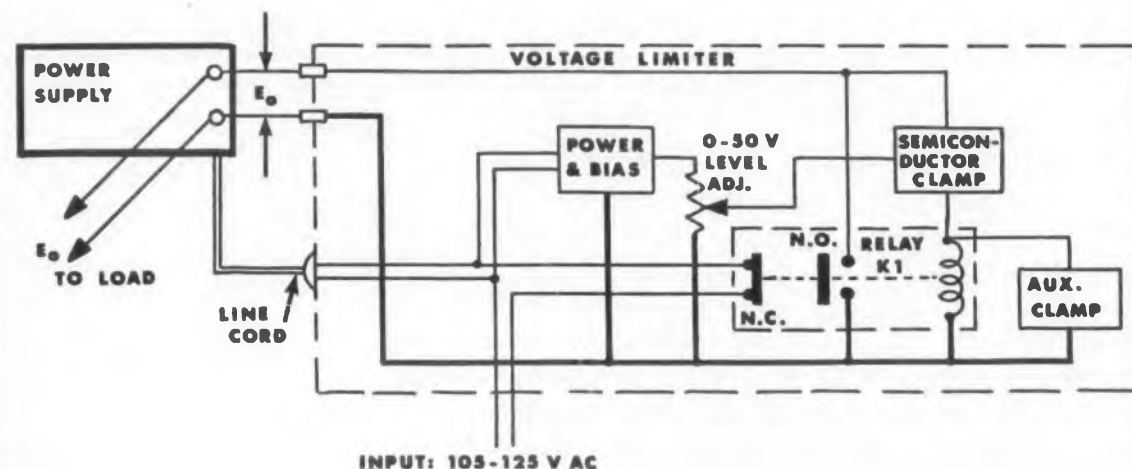


Fig. 2. Simplified functional diagram.

the clamp continues passing current, holding E_o within very narrow limits of its initial value.

Operating Characteristics

The curves in Fig. 3 show the behavior of the clamp at two different operating levels, namely 10 and 50 v. With the clamp set at 50 v, trip-out occurs at less than 50.8 v. The 50.8 v point corresponds to 130 ma. This is the minimum current required for relay trip-out. If the power supply is capable of furnishing more than 130 ma during the surge, the limiter will absorb the additional current. However, there will be a slight increment of voltage due to the additional current. For example, as shown in the graph, an available current of 1 amp during clamp operation will produce a voltage of about 1.1 v above the nominal setting. At 2 amp the rise is still very low, being about 1.5 v above nominal. These slight increments are well below the level of the voltage spikes generally responsible for damage.

The voltage increment plotted against limiter current for the 10 v curve is approximately the same as for the 50 v curve. Although this represents somewhat of an increase percentagewise over the 50 v curve, it is still a small increase compared to the nature of most damaging transients. Additional curves for other voltages can be extrapolated.

Limiting occurs at the very beginning of an overvoltage, however, as indicated in the graph, the relay will not operate until the clamp current reaches or exceeds 130 ma. Therefore, the power supply should be capable of furnishing at least 130 ma, the minimum required for relay trip-out.

For more information, turn to the Reader-Service card and circle 15.

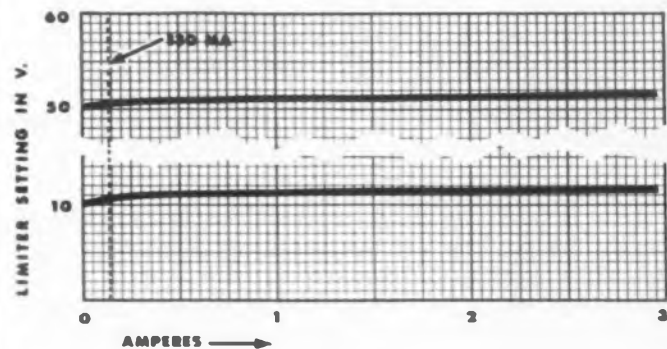


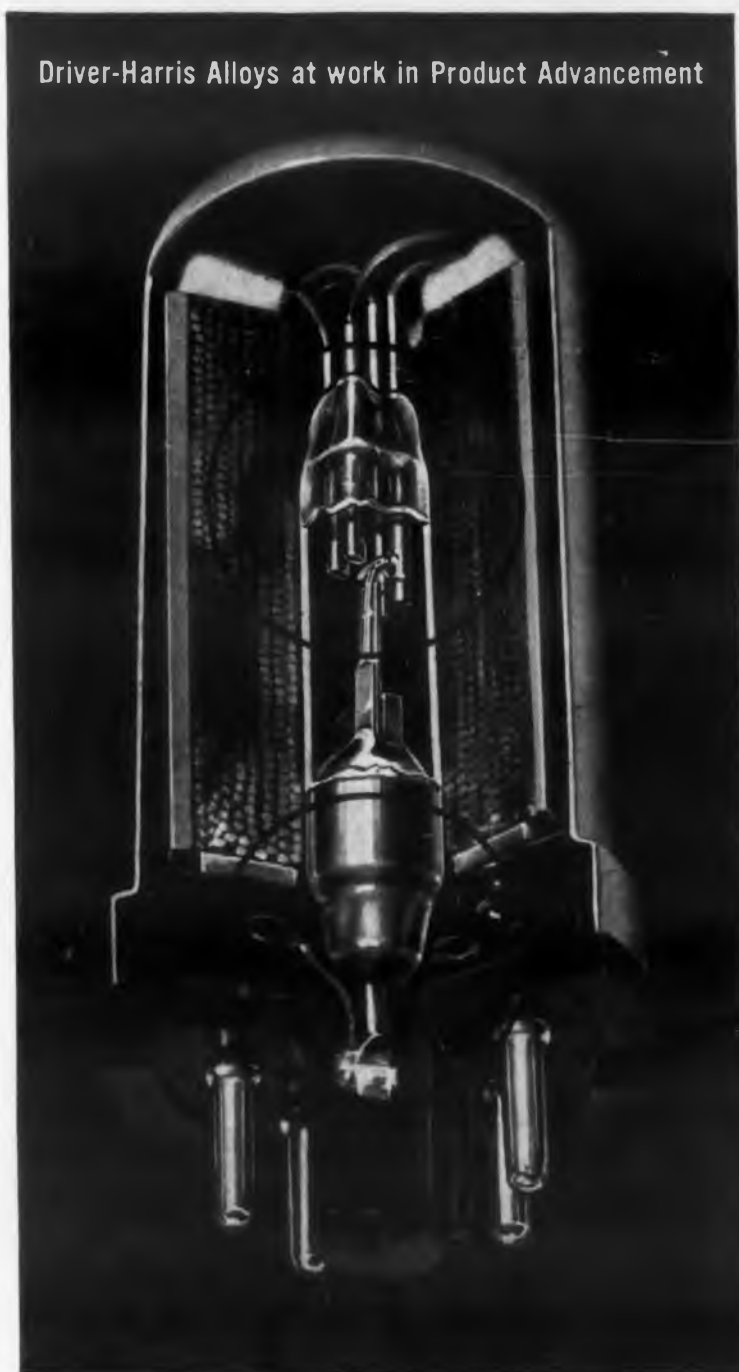
Fig. 3. Voltage increase above nominal limiter setting vs available current at time of limiter trip out.

Improved Metal-To-Glass Alloy Holds Seals Tight Against Hydrogen at 250 Pounds Pressure

Development of Clare[†] Mercury-Wetted Contact Relays aided by special gas-free Driver-Harris #152 Alloy



Driver-Harris Alloys at work in Product Advancement



For all kinds of high-speed switching machines and devices which demand accuracy and dependability of the highest order, this new Clare Type HG Relay offers a combination of high speed, high current-and-voltage capacity with remarkably uniform long-life performance. It has a conservative life expectancy of more than a *billion operations* when operated within its ratings and can be driven at speeds up to *100 operations per second*.

In this cutaway view ($2\frac{3}{4} \times$) a magnetic switch, hermetically sealed in a high-pressure hydrogen filled glass capsule, and a coil, are enclosed in a steel vacuum tube type envelope. The switch forms the core of the coil which provides the magnetomotive force for operating it.

The glass enclosed switch is very compact and small ($5/16''$ diameter x 2" long) yet its handling capacities of 5 amperes and 500 volts maximum are truly remarkable.

These features of its construction make this possible. In the switch segment, the platinum contact surfaces are wetted and protected from electrical and mechanical erosion with mercury by means of a capillary connection to a mercury reservoir below the contacts. In addition, the high hydrogen pressure enables the contact gap to withstand a high voltage gradient without breakdown.

Keeping the gas from leaking posed a production problem. The specifications for the lead wires at the top of the switch and the tubular vacuum stem at the bottom were stiff. 1. Gas-tight seal against hydrogen at 250 PSI. This was difficult. 2. Perfect match to thermal expansion characteristics of the glass. 3. Good ferromagnetic properties. 4. Exceptional surface bonding properties since the permissible maximum 5 ampere 500 volt limits are dictated rather by factors relating to heating of the metal-to-glass seal than the current handling capacities of the contacts.

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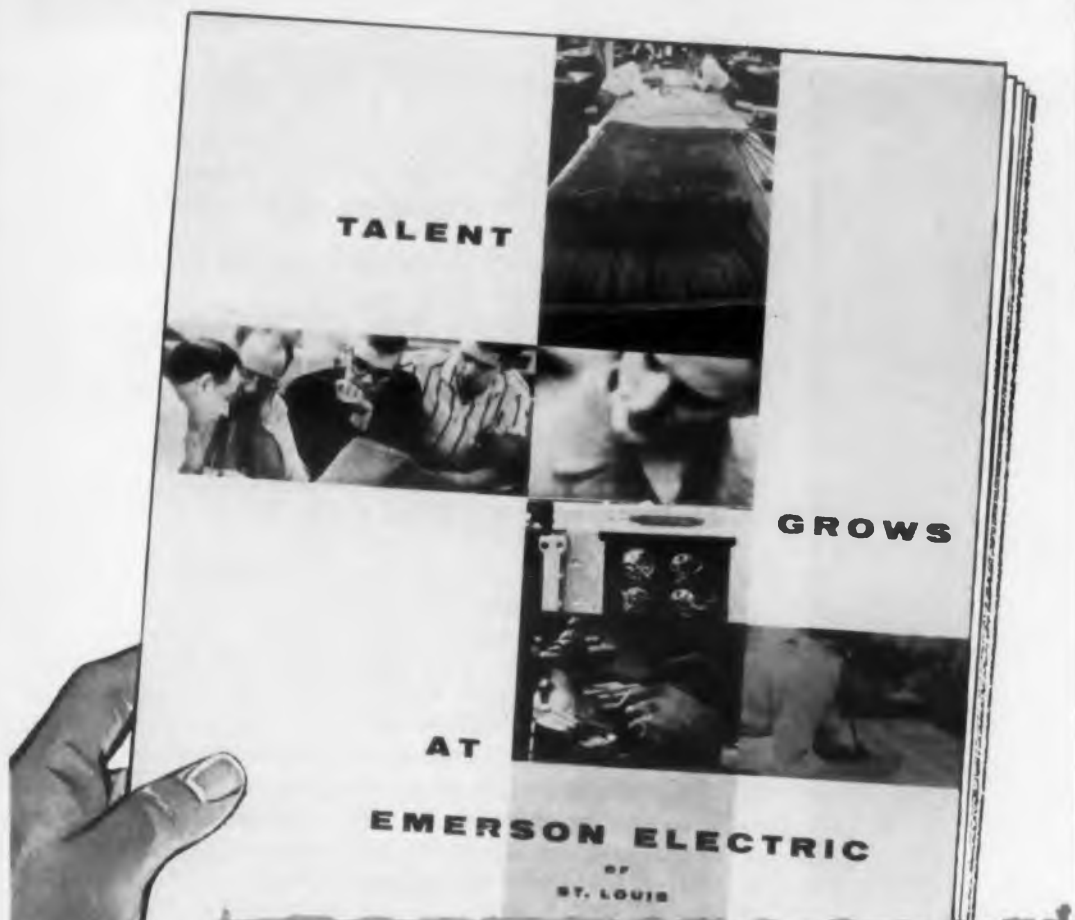


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Variations Of Transistor Parameters With Temperature

W. J. Maloney

General Electric Co.
Semiconductor Products Dept.
Syracuse, N. Y.

TRANSISTOR parameters variations with small changes in temperature may be greater than suspected by the designer. The magnitude of variation of important transistor parameters are shown in Figs. 2-6. Ambient temperature for testing range from 25 to 45 C (77 to 113 F). The following parameters were considered:

- Grounded emitter power gain, G_e , at 455 kc
- Reverse voltage feedback, h_{rb} , at 1 ma grounded base
- Collector current with base open, I_{CEO}
- DC beta, h_{FE} , with a constant base current

The parameters investigated are those directly affecting small signal radio frequency amplifier. All tests were performed at $V_c = 5$ v and $I_E = 1$ ma except where other conditions are noted. The power gain was measured in the circuit shown in Fig. 1. The gain figures are in decibels and represent the circuit gain rather than the transistor gain. [Ozalid copies of other test circuits for various parameters may be obtained by writing to the editors.]

In addition to the difficult application problem, classification of the units presents an associated

(Continued on page 25)



W. J. Maloney joined the Semiconductor Division of GE three years ago. Prior to obtaining his degree in electrical engineering from Lehigh University, he served six years in the navy as an electronic technician. His main area of effort is the evaluation of specification on products and specific applications encompassing instrumentation, parametric variations, and product stability, as they affect both the product and its application. The author is shown demonstrating the importance of transistors to the younger members of his family.

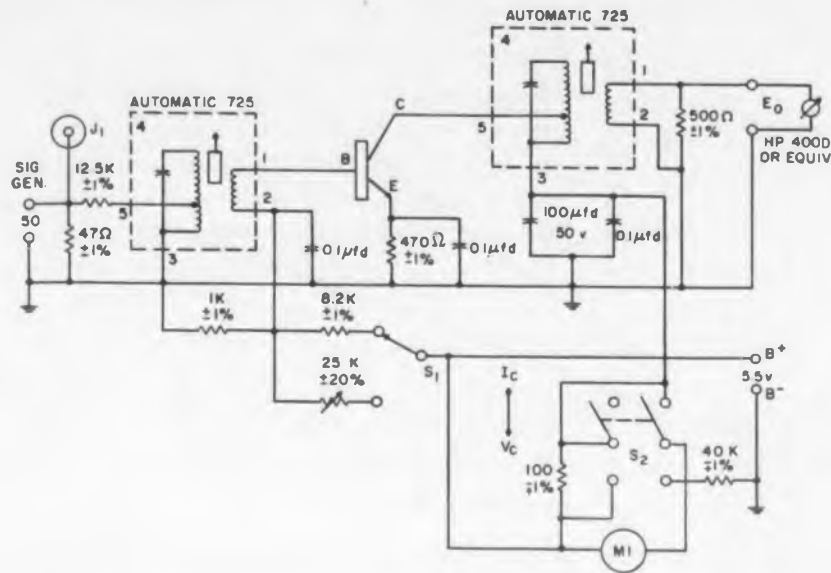


Fig. 1. Test circuit used to measure the effects of temperature on transistor parameters. 100 Ge, npn, rate grown transistors, types 2N168A, 2N292, 2N169 and 2N193, were tested. Figs. 2-6 show the changes in specific transistor parameters with temperature, assuming negligible effects of circuit parameters.

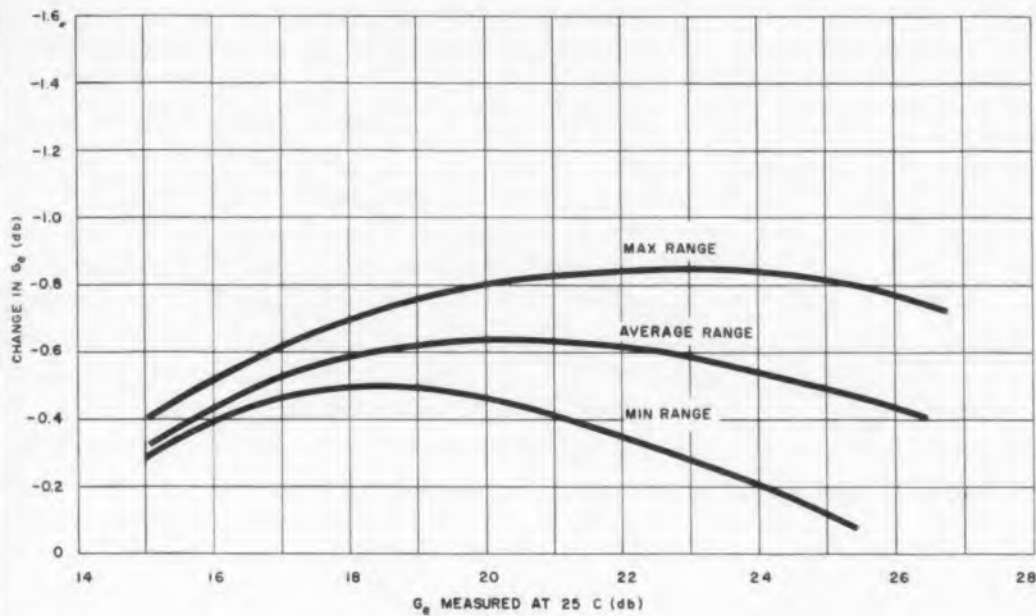


Fig. 2. The curves show the minimum, average and maximum changes in power gain, G_p , caused by increasing ambient transistor temperature from 25 to 35 C.

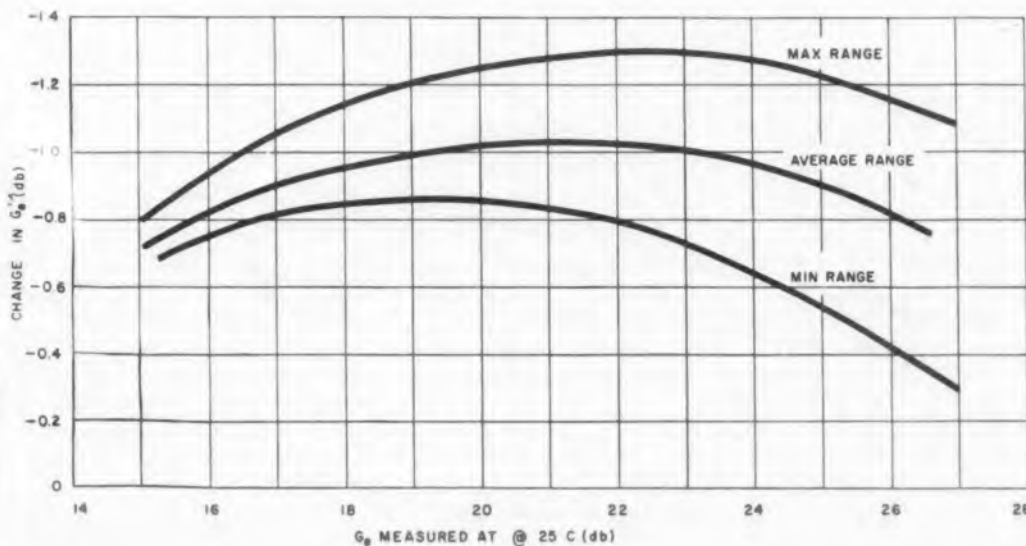


Fig. 3. Change in G_p caused by increasing ambient temperature from 25 to 45 C.

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Nominal power required: 2C, 1.0 watts nominal (appr.); 6C, 3.0 watts nominal (appr.).
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Contact arrangement: Available in form A, B, C, D, or E, up to a maximum of 6 Poles.

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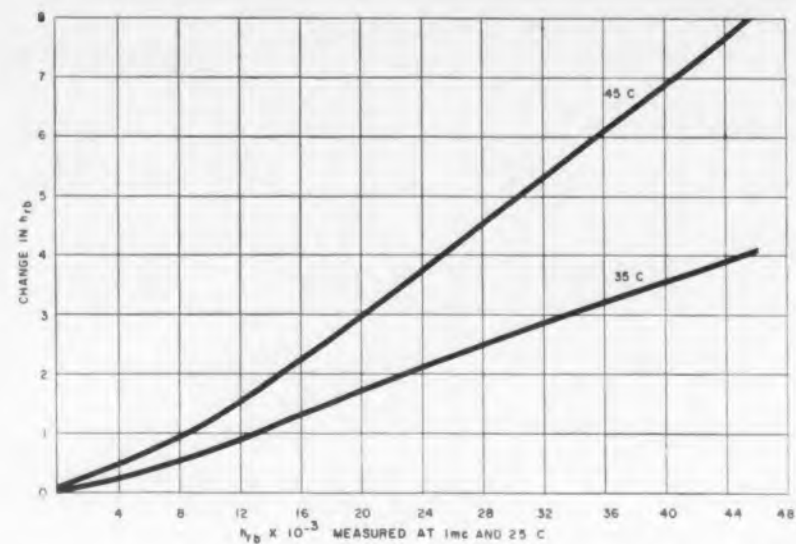


Fig. 4. Change in reverse voltage feedback ratio, h_{rb} , with increase in temperature.

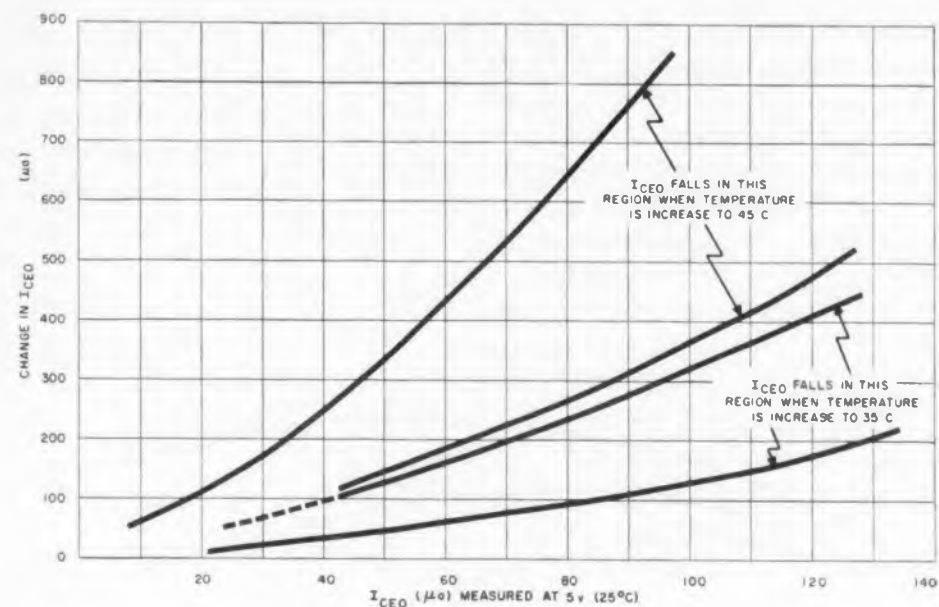


Fig. 5. Change in I_{CEO} for changes in transistor ambient temperature.

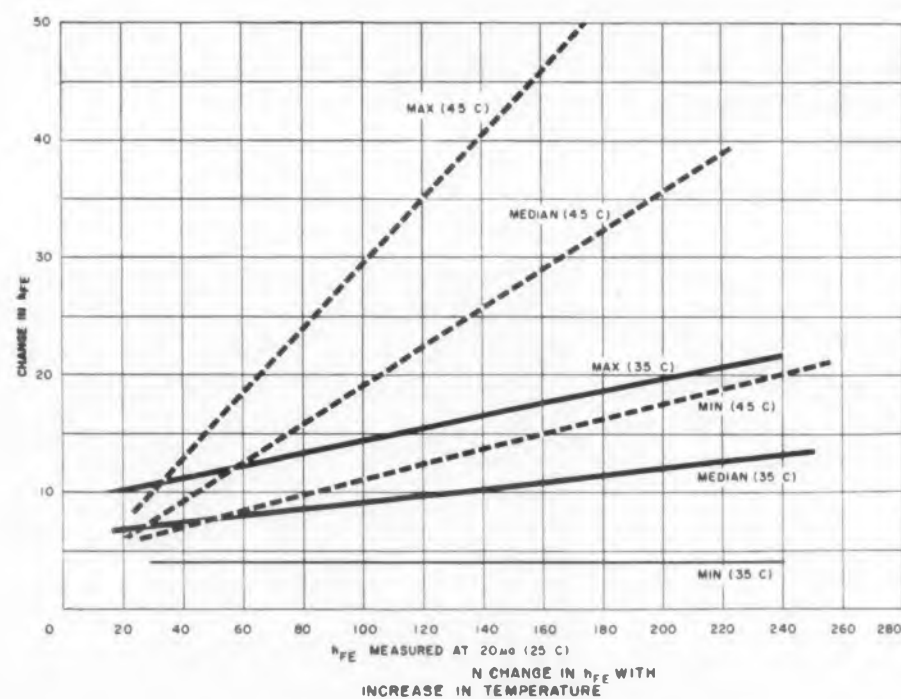


Fig. 6. Change in h_{FE} with increase in temperature.

problem where the value of any parameter will change with ambient temperature. This can be associated either with a manufacturer's production and quality control testing or with a customer's incoming inspection testing. The temperature of 25 to 45 C are typical ambient values encountered in production testing.

Parameters

Power gain, G_e , decreases with an increase in ambient temperature, as shown in Figs. 2 and 3. The magnitude of decrease is dependent on the original reading at room temperature and the temperature rise.

The change in reverse voltage feedback, h_{rb} , increases at a nearly linear rate with respect to the 25 C reading. See Fig. 4. The slope is dependent upon the new ambient temperature. The collector capacity increased. The change was essentially a constant equal to 0.25 μf increase when the ambient was raised to 35 C and 0.4 μf increase for an ambient of 45 C. Alpha cut-off frequency decreased. Again the change was constant amounting to 0.3 mc change when ambient temperature was raised to 35 C and 0.5 mc change for 45 C.

The breakdown voltage with the base open is constant with temperature. However the inherent current level increases with temperature. Fig. 5 shown a plot of I_{CEO} , the current level, at 5 v for various temperature conditions. Obviously I_{CEO} increases with temperature and when testing V_{CEO} or V_{CER} to a specified current level, the test may indicate a decrease in V_{CEO} or V_{CER} depending on the current level. The results will be influenced by I_{co} , h_{FE} and the specified current level as well as the temperature. Hence, specific conclusions must take these into account.

DC beta, h_{FE} , increases with temperature. See Fig. 6. Correlation to any readily available parameter is not apparent.

Conclusions

Changes in transistor parameters are large enough to cause major problems even with small changes in ambient temperature. Tolerances on inspection specifications must take this into account. In some cases, such as dc beta, the problem is compounded since the variations are large and erratic and not readily related to a simple measurement technique. These changes can cause major problems where large quantities of transistors are tested unless the ambient temperature is controlled.

Reference

High Frequency Power Gain of Junction Transistors, R. L. Pritchard, Proceedings of IRE, Vol. 43, pp 1075, Sept., 1955.

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Transistor Impedance Nomogram

T. R. Nisbet
Alto Scientific Co.
Palo Alto, Calif.

MATCHING transistors to circuits and vice versa is made simpler with these nomograms. In each of the four nomograms, the key shows the method of operation. Where a curve is used, the traversing straightedge should be laid tangent to the curve. Certain scales can be multiplied by any factor, provided certain other scales are also multiplied. To make the arrangement easy to use, one point on each of the relative scales has been labeled with one alternative value. Scales bearing the same type of label (e.g. outlined by a single or double line) must be dealt with in the same way.

Because of the nature of the equations various amounts must be added to or subtracted from the data before or after using the nomograms. In many calculations, however, these amounts are negligible. Details are shown in a note on each nomogram.

Common Emitter Examples

A transistor with $r_b = 500$ ohms, $r_c = 50$ ohms, $r_e = 2$ megohms, $\alpha = 0.96$, is used in the following situations:

Ex. 1. Load resistance 20 K; find input resistance. Nomogram shows $R'_i = 960$. Add $r_e + r_b$. Input resistance = 1510 ohms.

Ex. 2. If input resistance is to be 5000 ohms, and load resistance is 20 K, find the series resistance to be added in emitter circuit. $R'_i = 5000 - r_e - r_b = 4450$ ohms. Nomogram shows emitter resistance to be 230 ohms. Subtract r_e . Required additional resistance = 180 ohms.

Ex. 3. Generator resistance is 400 ohms. Find output resistance. $R_o = 400 + r_e + r_b = 950$ ohms. Nomogram shows $R_o = 181$ K.

Common Collector Examples

Ex. 4. Assume the same transistor characteristics as listed for common emitter examples. Load resistance, 160 K; find input resistance. Using multiplier on nomogram scales, $R_i = 1.33$ megohms.

Ex. 5. Output resistance, 15.5 K; find generator resistance. Nomogram shows this to be 480 K.

A useful scale for converting between α and β is available on the *input vs load resistance, common collector* nomogram. (Continued on page 28)

ELECTRONIC
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Engineering Data

Transistor Impedance Nomograms—1

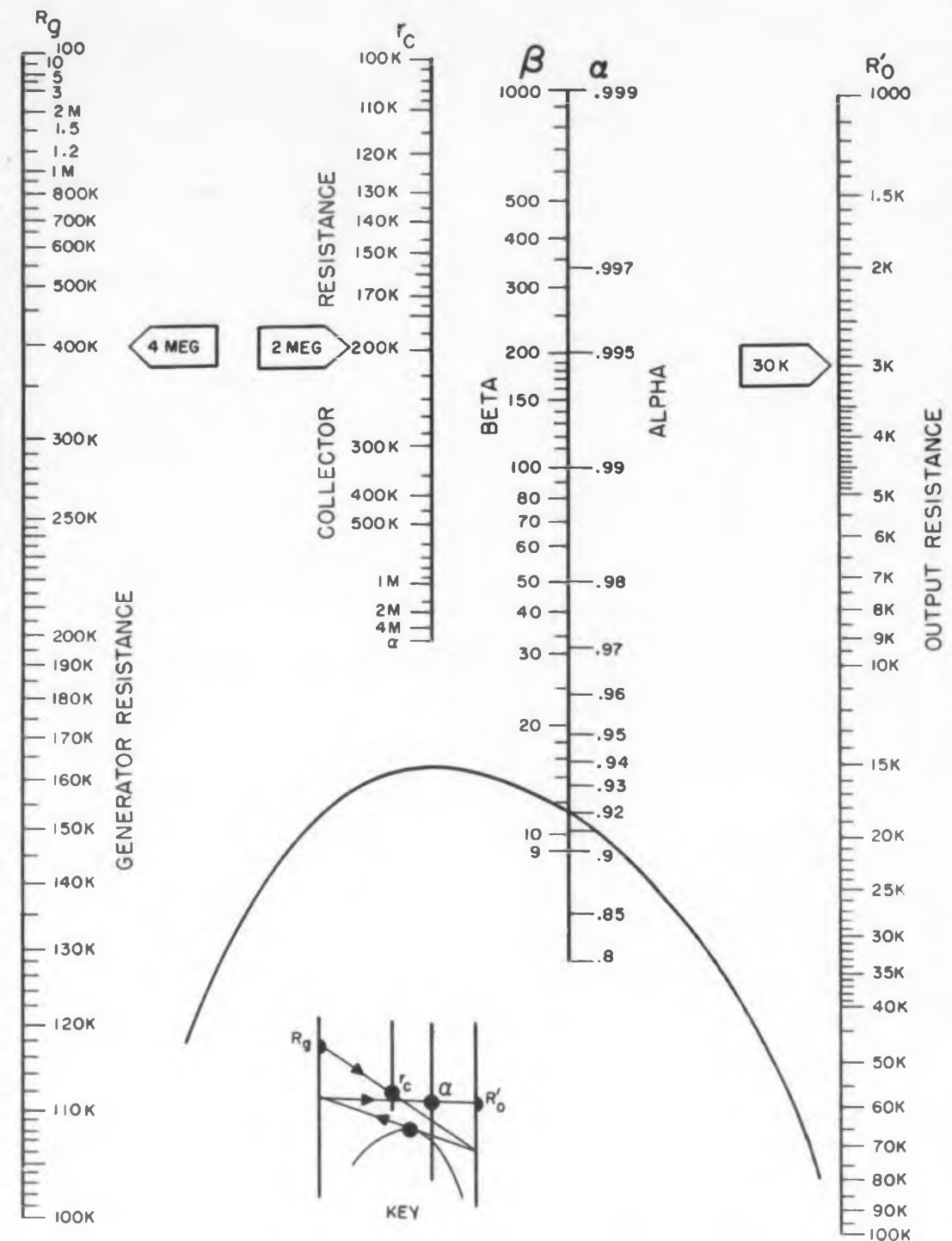


Fig. 1. Generator resistance vs output resistance, common collector. Note: nomogram uses R'_o as equal to the output resistance. True output resistance is $R_o = R_o + r_e$.

Transistor Impedance Nomograms—2

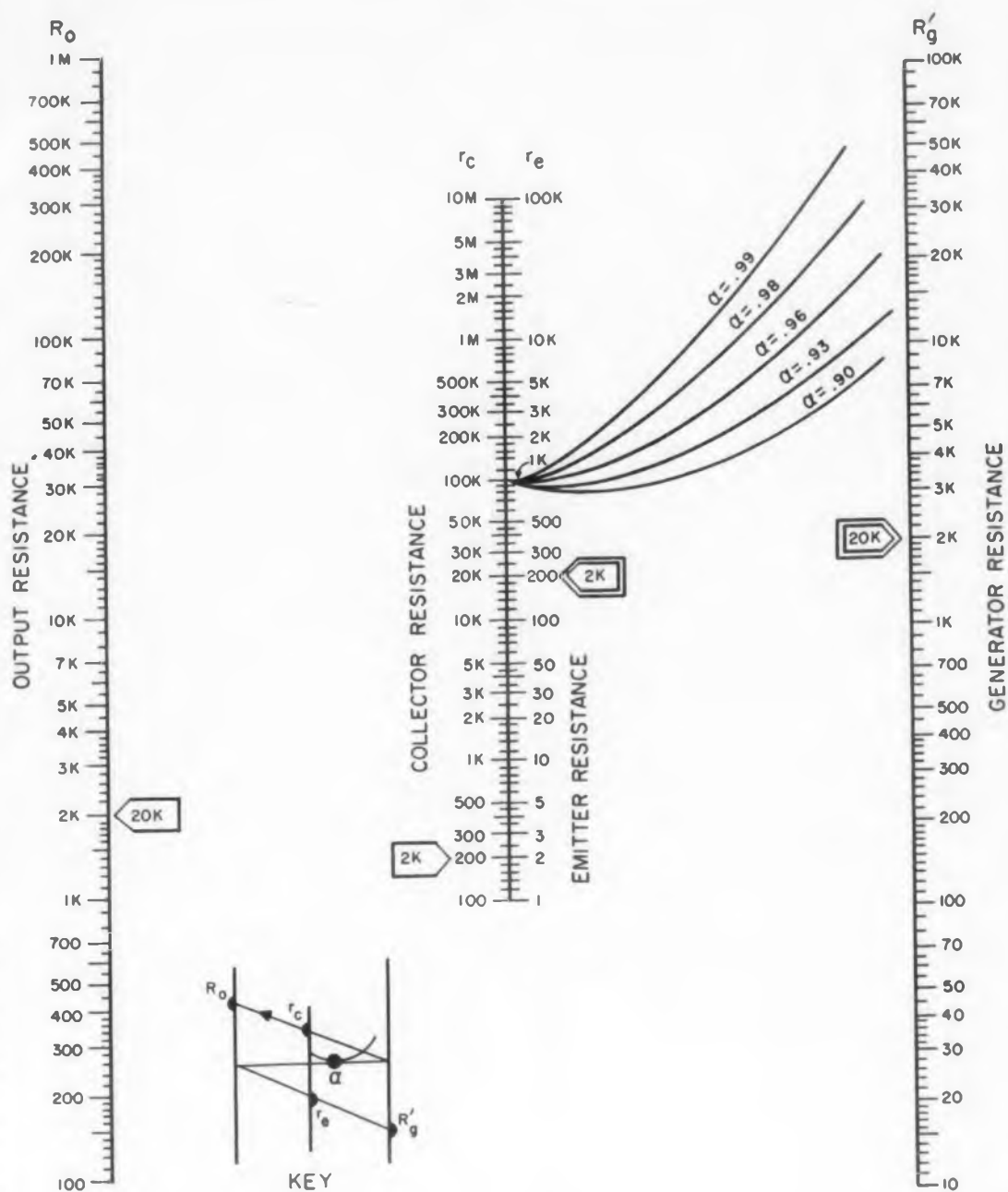


Fig. 2. Generator resistance vs output resistance, common emitter. Note that the nomogram uses R'_g as equal to the generator resistance, though true generator resistance is $R_g = R'_g - r_e - r_c$.

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STARTING VOLTAGE RANGE is reduced in the NE-81 from the ± 15 volts of the earlier NE-2 to a ± 8 volts—a cut of nearly 50%.

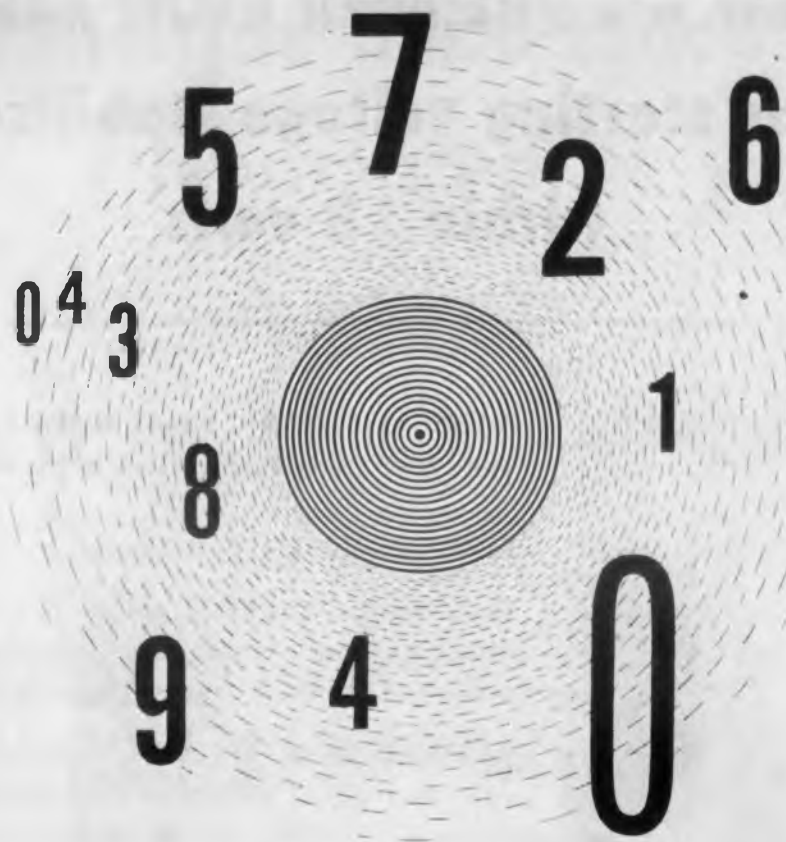
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Transistor Impedance Nomograms—3

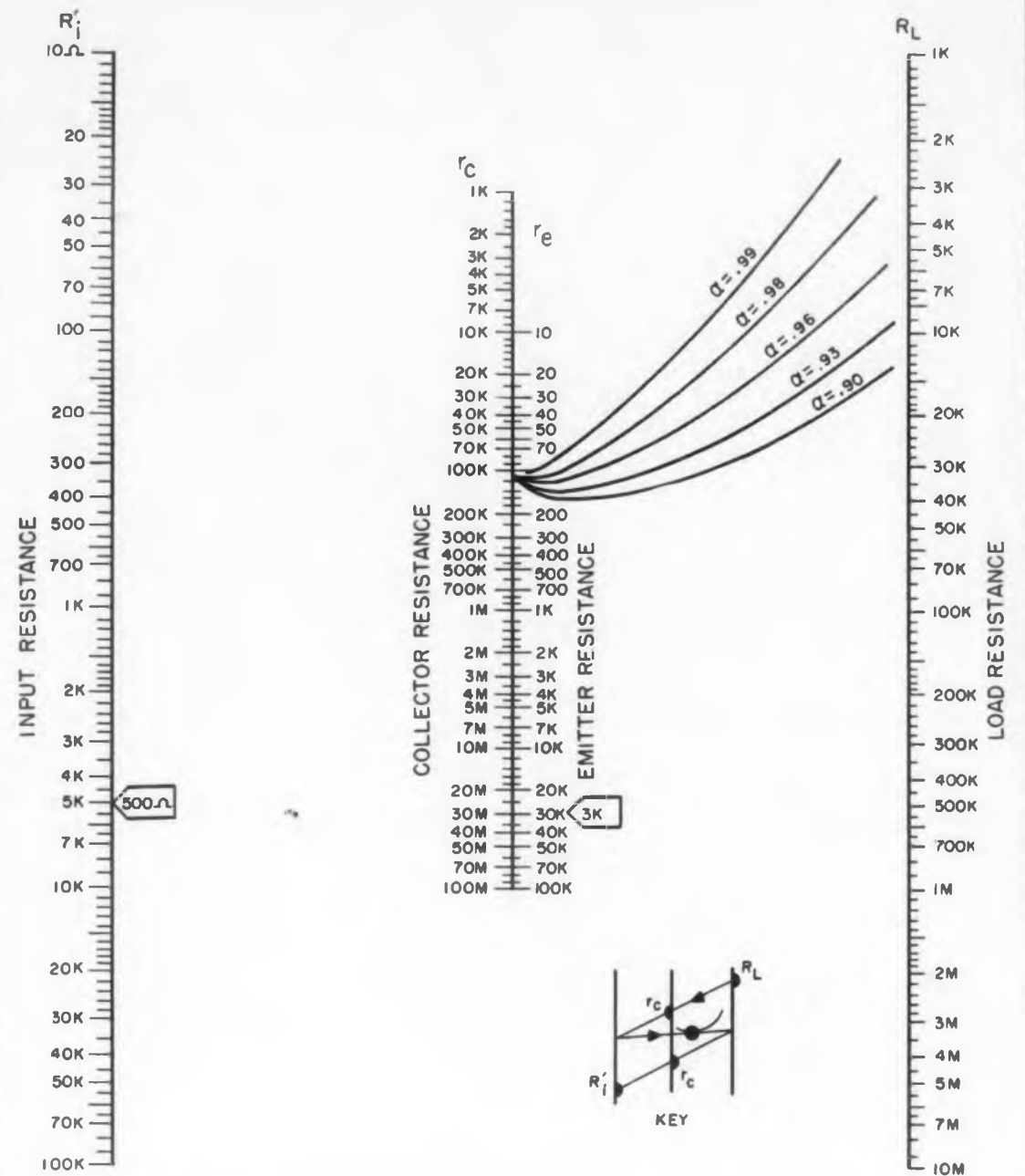


Fig. 3. Input resistance vs load resistance, common emitter. The nomogram uses R'_i equal to the input resistance. True input resistance is $R_i = R'_i + r_b + r_e$.

The equations from which these four nomograms have been developed are as follows:

Common emitter.

$$R_i = r_b + r_e \left[\frac{r_c + R_L}{r_c (1 - \alpha) + R_L} \right]. \text{ No assumptions.}$$

$$R_o = r_c (1 - \alpha) + r_e \left(\frac{\alpha r_c + R_g}{r_c + r_b + R_g} \right), \text{ assuming}$$

Transistor Impedance Nomograms—4

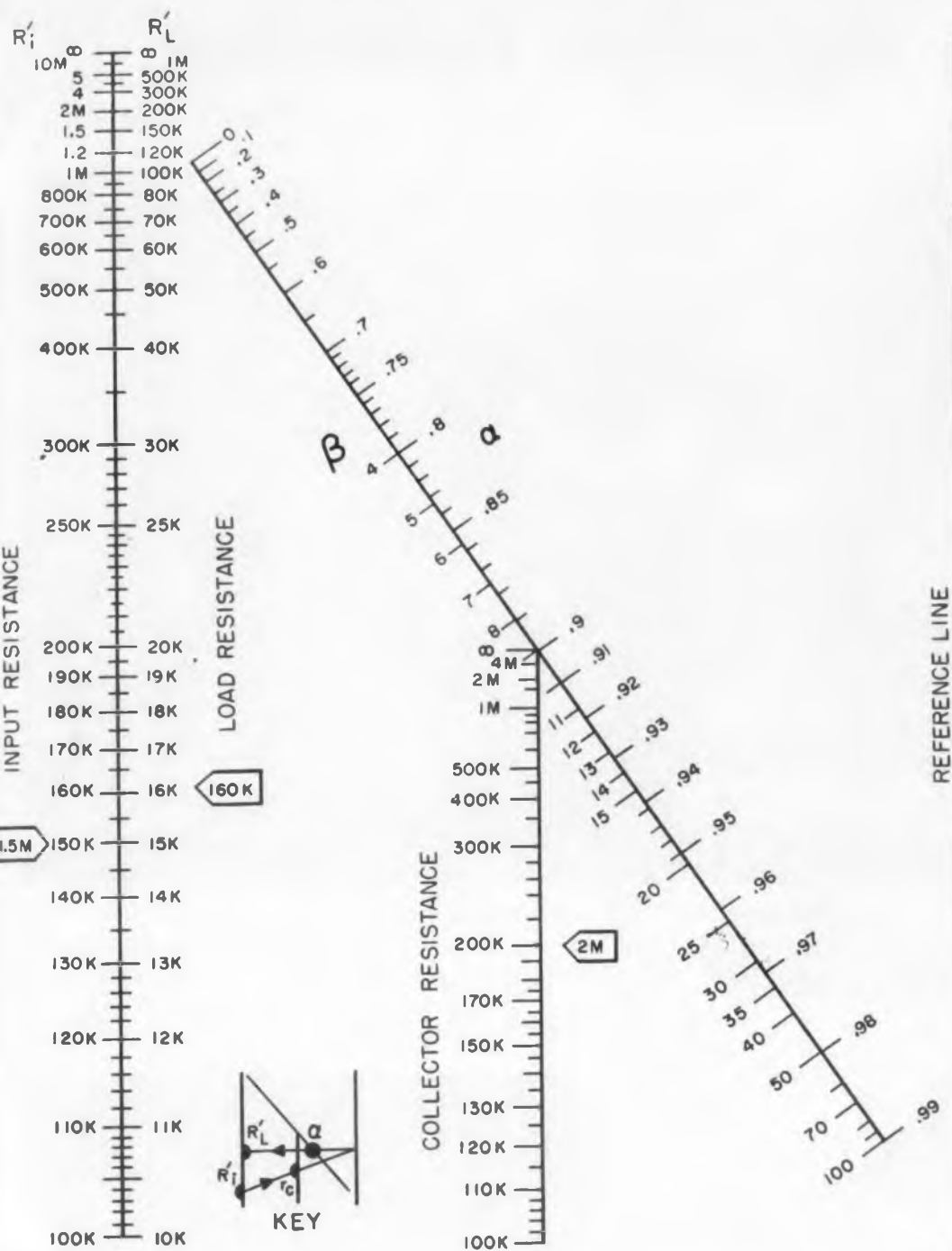


Fig. 4. Input resistance vs load resistance, common collector. In this nomogram R'_i = input resistance and R'_L = load resistance. True equations for these are $R_i = R'_i + r_b$; $R_L = R'_L + r_e$.

that $\alpha r_c \gg r_e + r_b$ and $R_o \gg r_e$.

Common collector.

$$R_i = r_b + r_c \left(1 - \frac{r_c - \alpha r_e}{r_c + \alpha r_e + r_e + R_L} \right). \text{ No}$$

assumptions. Assuming that $r_c \gg r_b$, then

$$R_i = r_e + r_c - \alpha r_c - [(r_c - \alpha r_c) r_c / (r_b + r_c + R_o)].$$



NEW REFINEMENT

MAKES OLD DOG GOOD

FOR LOW LEVEL WORK

This particular little friend of man (left, above) has been on the Sigma payroll now for about ten years, which explains why he can be called "old." Over the years he's been sent out on a variety of switching assignments, where neither space nor available power would permit using a St. Bernard. Although he's earned a reputation for being pretty dependable when there's a lot of shaking and tail wagging going on, lately certain people at Sigma have been hard at work to give him more "class." They figure that with his background, he might be able to show up a lot of late-model poodles in cases where loads hover around 0.0000001 watt, or in the native vernacular, "dry circuit" applications.

It looks now as if the Brink of Success has been reached: 98 out of 100 of these refined types consistently pass our special low level tests, switching 10 microamperes at 10 millivolts 5,000 times, with all operations monitored. This is 100% production testing on this type, and the 2% that don't pass are sent to a horrible end (in our plant, not in yours). As a matter of interest, the contacts in these new types for low level work use 24 karat gold.



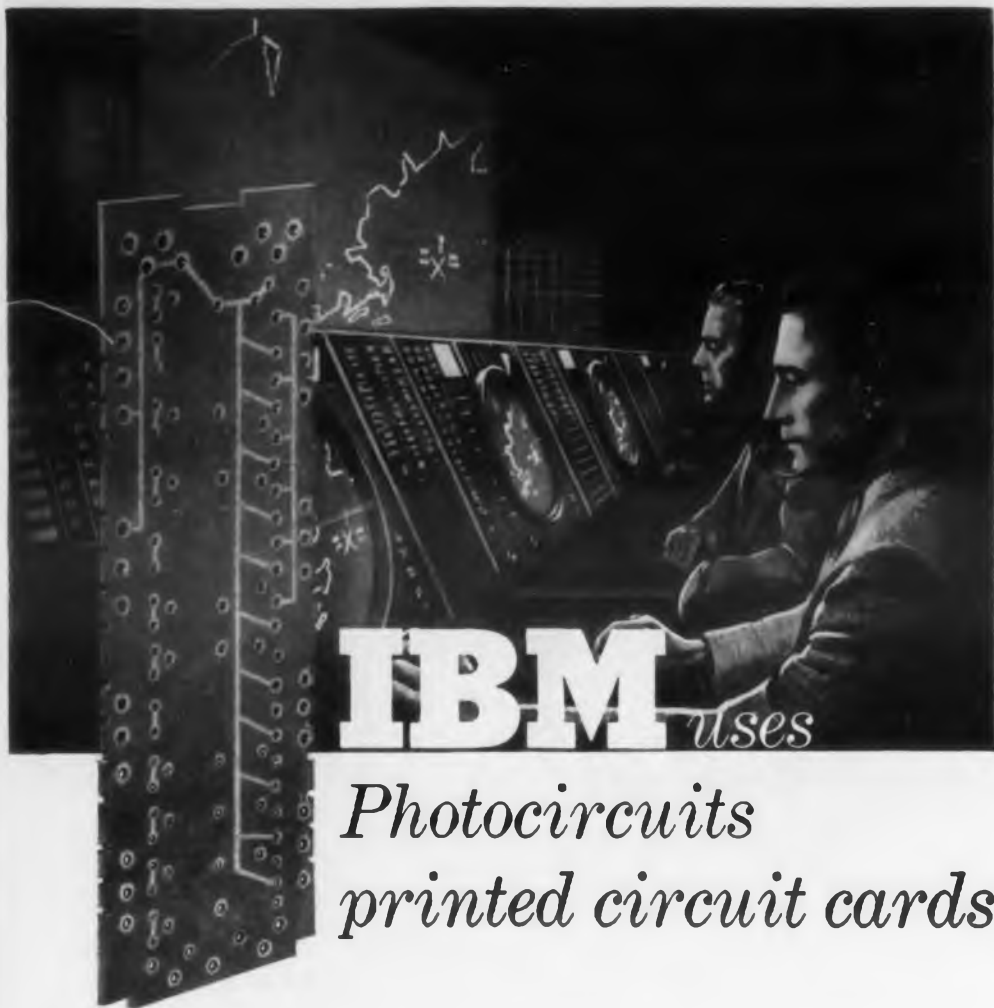
In case your circuit is considerably more moist, but still calls for long, dependable switching that's immune to high shock and vibration levels, old faithful can also be ordered with silver, palladium or gold alloy contacts. The silver contacts are rated up to 2 amp. (resistive load at 120VAC or 28VDC), the palladium and gold alloy types, 0.5 amp. Latest facts are available in a Sigma bulletin entitled "Series 22 Relay", a straight presentation with no animal pictures.

SIGMA

SIGMA INSTRUMENTS, INC.

91 Pearl Street, So. Braintree 85, Massachusetts

CIRCLE 23 ON READER-SERVICE CARD



IBM *uses* Photocircuits printed circuit cards

Vital Component in Sage Air Defense Computers

The Sage System, vital to our nation's security, relies on IBM-built computers to display accurate pictures of hostile and friendly aerial action.

IBM uses printed circuit cards with *plated-thru holes* by PHOTOCIRCUITS to help do the job. IBM experience indicates that through-circuitry—using both sides of a printed card—saves space and costly assembly time.

Printed circuit cards by PHOTOCIRCUITS have *plated-thru holes* that help eliminate troublesome intermittents caused by vibration and temperature changes...increase solderability, too.

PHOTOCIRCUITS produces *reliable* printed circuit cards...builds them with strength to spare for all applications.

"Bonus" copper, on the right-size hole wall, is just one of the reasons you can depend on PHOTOCIRCUITS printed circuit cards. Proper design, precision production, and advanced quality control techniques are others. All add up to outstanding reliability...often at lower cost.

Check the advantages of printed circuit cards with *plated-thru holes* by PHOTOCIRCUITS...the largest and most experienced manufacturer in Printed Circuitry. For full information, write our Engineering Department PS-1 today.

PHONES
GLEN COVE 4-8000
FLUSHING 7-8100
CABLE
PHOCIRCO



CIRCLE 24 ON READER-SERVICE CARD

Guaranteed Performance Limits And New Core Protection



Seen for the first time: complete core protection.



Tough glass polyester cap allows complete freedom of handling and using tape wound and bobbin cores, and helps lower production costs.

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card

S **G**UARANTEED core performance limits will be a boon to designers of computer drive circuits, switching matrices, shift registers, core-diode memory systems and pulse transformers. Engineers can now buy bobbin cores with tight maximum and minimum limits on open circuit characteristics, core flux, and squareness.

By defining and guaranteeing performance limits, Magnetics, Inc. has taken the first step towards placing cores on the same catalog basis as vacuum tubes and resistors. The Butler, Pa. firm also guarantees performance limits on B_m , B_r/B_m , H_1 , and gain for tape wound cores.

New Core Protection

Protections are now available for tape wound and bobbin cores. A tough glass polyester cap completely protects cores during handling and use, while a new finish for aluminum tape wound core boxes guarantees a minimum voltage breakdown of 1000 v at 60 cps.

Tough Core Caps

The "Poly Cap" cores are available for both stainless steel and ceramic bobbins. The rigid structure of the new cap does not distort with wide temperature changes, and thus, allows freedom of handling, and assures against damage or changes in core characteristics.

The permanent protection of these caps (unbreakable in normal use), not only lowers production costs, and assures performance stability, even after potting, but actually allows for smaller cores because the cap fits over the top of the flanges rather than requiring encapsulation.

Guaranteed Voltage Breakdown

The new finish for the aluminum boxes for tape wound cores insulates the windings from the box without taping—and over a temperature range from -70 to $+450$ F. By eliminating the need to tape the core box, cost and production time are knocked down. This GVB finish is compatible with any standard potting compound, and allows vacuum impregnation down to 20 mm of mercury.

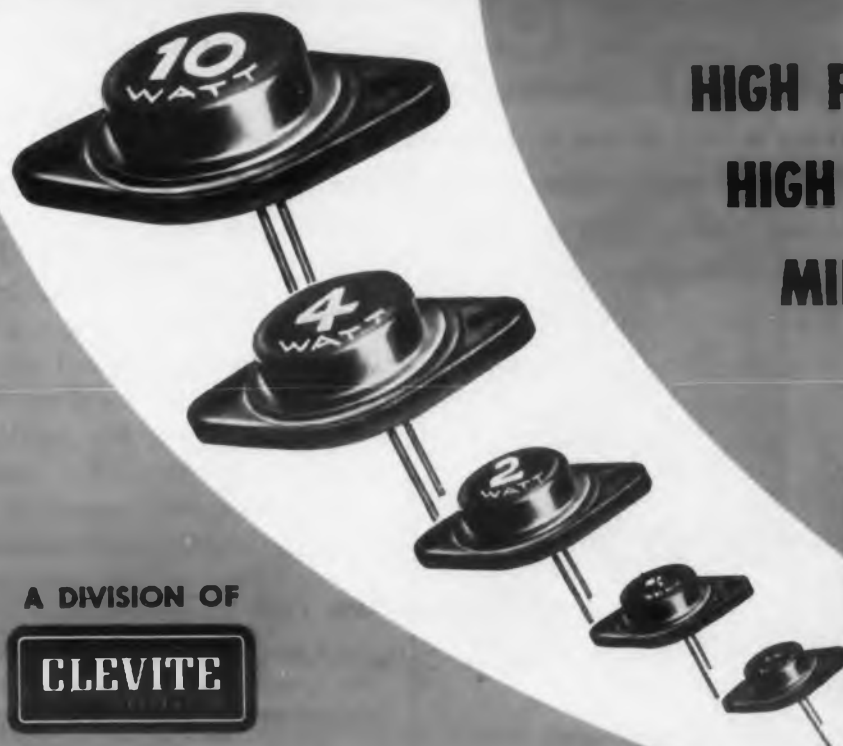
For more information on these new developments, turn to the Reader Service card and circle 25.

from **CLEVITE ...**
with **PROVEN RELIABILITY...**



SILICON JUNCTION
SILICON-GERMANIUM ALLOY
GOLD BONDED GERMANIUM

GLASS DIODES and **POWER TRANSISTORS**



A DIVISION OF

CLEVITE

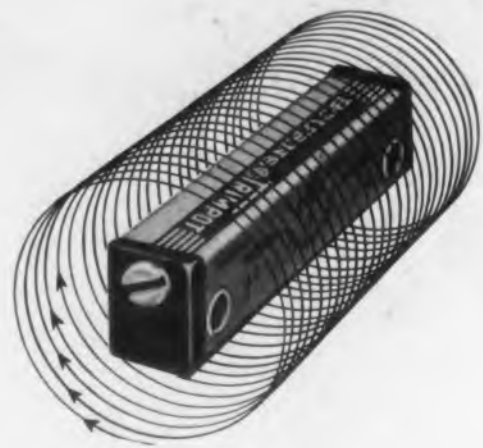
HIGH FREQUENCY AUDIO
HIGH SPEED SWITCHING
MIL-T-12679 A/32 (Sig C)
10 WATT & 4 WATT

CLEVITE
TRANSISTOR PRODUCTS

241 Crescent St., Waltham 54, Mass.
Twinbrook 4-9330

OTHER CLEVITE DIVISIONS: Cleveland Graphite Bronze • Brush Instruments • Clevite Electronic Components
Clevite Harris Products • Clevite Ltd. • Clevite Ordnance • Clevite Research Center • Intermetall G. m. b. H.

CIRCLE 26 ON READER-SERVICE CARD



YOU GET **33 TIMES** THE ADJUSTABILITY
WITH BOURNS POTENTIOMETERS!

Compared with the conventional single-turn rotary potentiometer, the adjustability of Bourns potentiometers is a 33:1 improvement.

Providing 9000° of rotation instead of 270°, Bourns potentiometers simplify and speed up the adjustment or balancing of circuits. You can repeat any setting quickly and easily.

Settings are virtually immune to shock, vibration and acceleration. Translatory action of wiper provides inherent stability. The rigidly mounted wiper is driven by a threaded stainless steel shaft, which is actuated by your screwdriver. No need to recheck settings after a lock-nut is tightened. There *isn't* any lock-nut.

Available with printed circuit pins, solder lugs, or stranded insulated leads.



write for TRIMPOT
Model Summary Brochure

BOURNS
Laboratories, Inc.

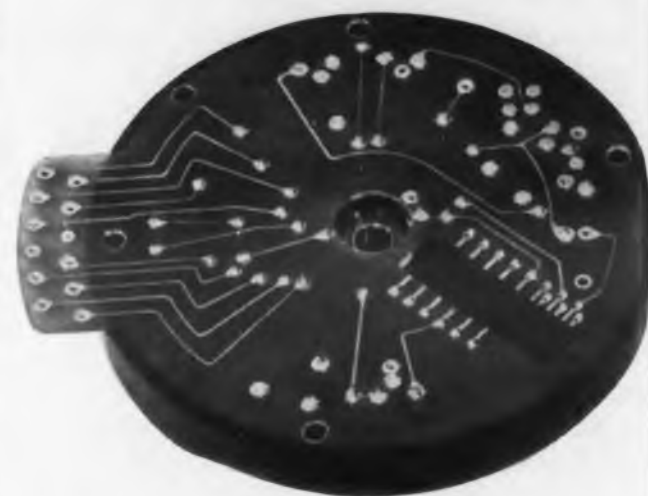
P. O. Box 2112-B • Riverside, California

ORIGINATORS OF TRIMPOT® AND TRIMIT®
PIONEERS IN POTENTIOMETER TRANSDUCERS FOR POSITION, PRESSURE AND ACCELERATION

Protected by U. S. Patents 2,706,230; 2,777,926 Other Patents Pending

CIRCLE 27 ON READER-SERVICE CARD

Error-Free



Analog/Digital



Converter

Unbuttoned A/D converter shows staggered segments on 3-1/2 in. disc. Ten bit resolution and no ambiguity for "on the fly" reading is obtained in this way, with an unusual internal switching network.

ELECTRONIC DESIGN • July 9, 1958

DISC ROTATION—

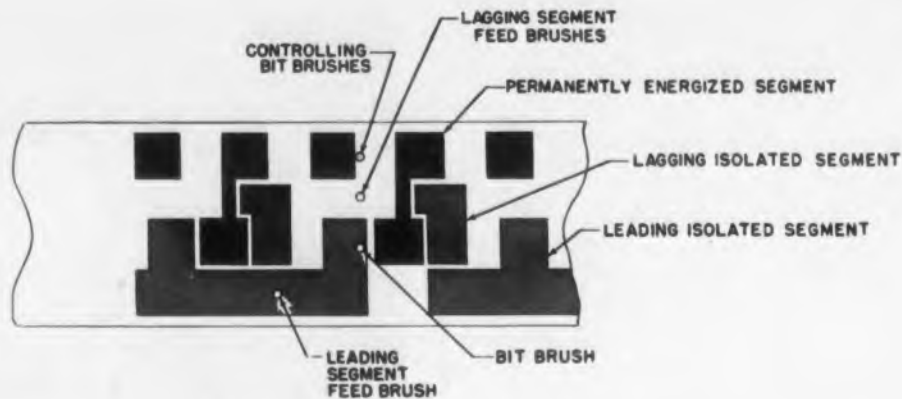


Fig. 1. Staggered pattern of disc. Black areas are permanently energized, shaded areas are the leading and lagging portions of the segments. The electrical status of the bit brush is a function of a logic circuit formed by feed brushes and conducting segments. Control of the logic circuit is by the controlling bit brushes.

UNAMBIGUOUS ten bit resolution on a 3-1/2 in. disc results from staggering bits on two concentric tracks in this new analog to digital converter. Ambiguity is controlled by preventing the transition of any of the nine most significant bits—except when they coincide with the least significant bit. An unusual combination of bit tracks and transistorized logic circuits provides the 10 bit resolution.

Designed by Librascope, Inc., Glendale, Calif., the converter uses 17 brushes—one readout brush per digit, six feed brushes, and one common brush. The disc pattern shown in Fig. 1 is designed so each normally-conducting segment has an electrically isolated leading and lagging portion (shaded areas).

The unique brush arrangement coupled with the transistor logic eliminates ambiguous outputs due to time differences in bit transition. The transition of a single brush depends on the simultaneous transition of the controlling bit.

Ambiguity in earlier disc converters usually resulted from disc misalignment. Miscounts and noise resulted. To dodge this problem, some computers operate only on information received when the converter's input shaft has been stopped and locked. This eliminates ambiguity, all right, but decreases the amount of data available to the computer during any interval.

Other converters use either special numerical codes—requiring that only one digit change at a time—or some combi-

nation of electrical and mechanical techniques to prevent errors. With these, a translator is needed for the output. The computer usually accepts only binary or binary coded decimal systems.

A double brush system, formerly used by Librascope, required that two brushes be used on the more significant track, instead of one. The angular distance between each of the double brushes and the single, least significant brush was half the angular length of the least significant segment. A switching circuit, controlled by the signal from the single brush, eliminated the transition between conductive and nonconductive segments. Need for this switching made the system more complex.

The new A/D converter can be used with conventional data logging equipment, and as a source of digital information in computer facilities. It can be used in a host of applications. Typical ones include supplying integration information for aircraft engine thrust measurements; and in recent computer work, finding the convolution integral, given a weighting function and an independent function.

In the latter application the independent function is represented by the input shaft position as a function of time, and the weighting function is approximated by adjusting the computer's sampling rate.

For further information on this error-free A/D converter, turn to the Reader-Service Card and Circle 28.

NEW

General Purpose Transistor Test Set — KP-2

with Semiconductor Regulated Power Supplies for ease of operation



For
LABORATORY
research
and quality
control
applications

- Common Base or Common Emitter
- Current Range — 100 μ a to 1 amp. (special models to 2 amp.)
- Collector Voltage Range — 0 to 100 v.
- Frequency Range — 100 cps to 200 kc
- Direct measurement of h parameters plus α and β cutoff
- Meter indication of DC parameters, I_{CO} , I_{EO} , BV_{CER} , V_{EBF}

Designers of custom test equipment for specific applications (e.g., automatic and production test sets). B-A transistor test sets are designed by transistor circuit engineers.

Other Baird-Atomic Transistor Test Equipment Available:



TRANSISTOR TEST SET — GP-4

The transistor tester that measures: h parameters and equivalent T coefficients . . . NPN and PNP junction and surface-barrier transistors . . . grounded-base or emitter circuits . . . alpha and beta cut-off . . . I_{CO} . . . and C_c . Measurement frequency from 100 c.p.s. to 1 mc.



TRANSISTOR BETA h_{ie} TESTER — KT-1

Portable, lightweight transistor tester measures Beta h_{ie} and I_{CO} . Completely self-contained with a transistorized 1 kc oscillator and batteries, featuring printed-circuit construction and meter overload protection.

Two transistor sockets — one standard socket for in-line or JETEC cases, plus easy insertion socket for long lead transistors.

ALSO:

Minority Carrier Lifetime Test Set

Semiconductor Resistivity Test Set

For specific applications, modified versions of standard instruments are available.

Write for complete technical information.

Baird-Atomic, Inc.
33 UNIVERSITY RD., CAMBRIDGE 38, MASS.



Instrumentation
for
Better Analysis

CIRCLE 29 ON READER-SERVICE CARD

NEW PRODUCTS

To provide a complete coverage of ALL new products generally specified when designing electronic original equipment, the New Product section has been extended. To include the largest number of items, products which are best suited to a brief description have been noted at the end of the section.

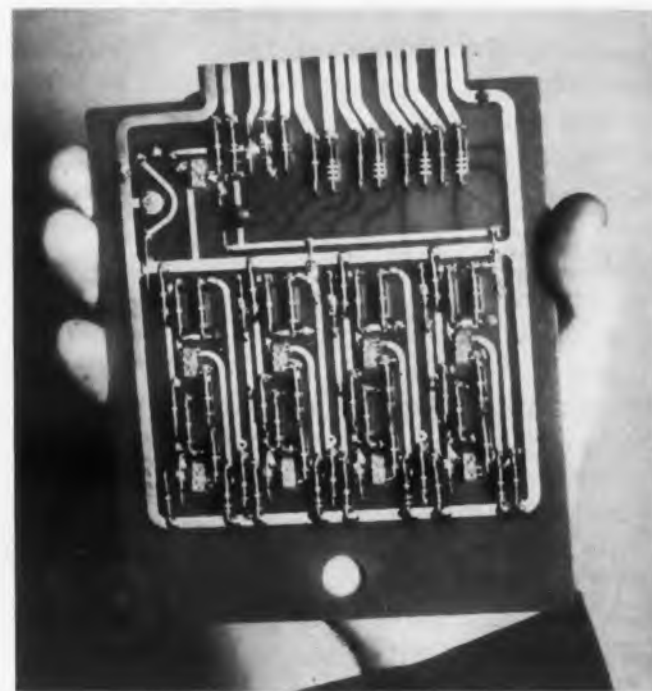


APR CAMERA

Up to 24 channels of low frequency data are stored on 16 mm film by the automatic processing and recording camera. The record is automatically developed and fixed internally by conventional processing methods. Processing is completed within 5 to 10 minutes depending upon film speed. Utilizing precision galvanometers, the APR camera has a resolution of 20 cps for a film speed of 3 cm per min, and a linearity of better than ± 1 percent.

The Geotechnical Corp., Dept. ED, 3712 Haggard Dr., Dallas 9, Tex.

CIRCLE 30 ON READER-SERVICE CARD



DECIMAL COUNTER

Providing a four line 1-2-4-8 code, with 4 ma drive available directly from each of these lines, this transistorized counter has the output amperage necessary for a variety of recording purposes. The counter is designed to operate from negative pulses of approximately 2 v amplitude and 1 to 2 μ sec in duration, and at operating speeds from 0 to 150 kc.

Navigation Computer Corp., Dept. ED, 1621 Snyder Ave., Philadelphia 45, Pa.

CIRCLE 31 ON READER-SERVICE CARD



VARIABLE CAPACITOR

The **Semicap**, a silicon variable capacitor, has a ratio of over 1000 at 1 mc, with a 10 to 1 capacity ratio well within its piv rating of -200 v dc. Applications are in automatic frequency control, frequency modulation oscillators, and bandpass and filter networks where precision capacitance control is needed.

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

CIRCLE 32 ON READER-SERVICE CARD



TOROIDAL INDUCTORS

Large inductance values, despite a relatively small size, are featured in series 781 toroidal inductors. Inductances range from 1 mh to 7 h, in a useful frequency range of 100 cps to 80 kc. Maximum Q for a typical 50 mh inductor operating at 11 kc is 130. The line is designed for printed circuit boards, or stacking on a single screw for chassis mounting.

Arnold Magnetics Corp., Dept. ED, 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

CIRCLE 33 ON READER-SERVICE CARD

New!



1" SQUARE PULSE GENERATOR!

ESC's Low Cost, Portable Modupulser®

Now generate any fixed or variable pulse repetition rate without tying up larger pulse generating equipment. ESC's new 1" square fixed Modupulser is factory-set at the specified pulse rate—you just plug it in to operate. The Modupulser is so inexpensive and convenient, you can stock several (with various pulse rates already fixed)

for quick insertion at any time—or a Modupulser with a variable repetition rate. Also supplied for external triggering. Manufactured for commercial and military applications, Modupulsers are available from stock or custom-built to your specifications. Write for complete technical data today!

SPECIFICATIONS FOR FIXED MODUPULSER

Pulse Width Range: 1.0 μ sec to 8 μ sec
PRF Range: 400 cps to 15,000 cps
Rise Time: 0.2 μ sec min.
Output: 6 volts positive and 6 volts negative when operated from a 6 volt DC source
Supply Voltage: -6 volts
Supply Current: Dependent on pulse width and PRF

Tolerance (on pulse width and PRF):
 $\pm 20\%$ * change in performance from nominal (@25°C): when operated over a wide operating temperature range:
 10%

Minimum Output Load: 75,000 ohms (lower output load values available with reduced amplitude)

Volume: 1" x 1" x 1"

Available with miniature 7-pin plugs, 1/10" grid pins for printed circuit boards, or to your specifications.

*This tolerance can be reduced if specified



electronic components division

ESC®

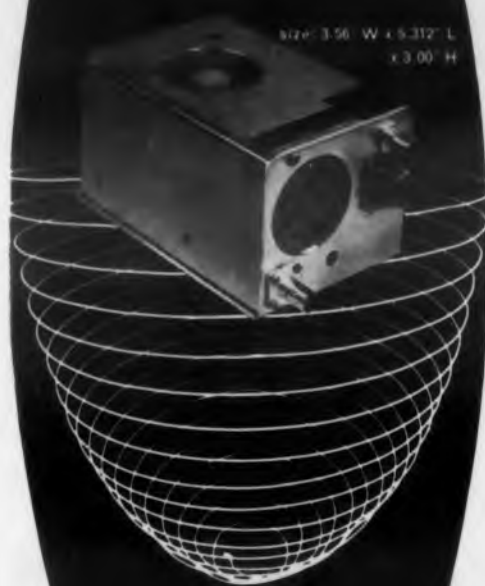
CORPORATION • 534 BERGEN BOULEVARD • PALISADES PARK, NEW JERSEY

exceptional employment opportunities for engineers experienced in pulse techniques

Pulse transformers • Medium and low-power transformers • Filters of all types • Pulse forming networks • Miniature plug-in encapsulated circuit assemblies

CIRCLE 34 ON READER-SERVICE CARD

INCREASED SIGNAL POWER



*in the 215 mc
to 260 mc
telemetry band*

The Model REL-10 R-F Power Amplifier is a high-output unit for airborne applications. With power outputs from 10 to 100 watts, it dramatically increases the range of missile and aircraft telemetry systems... teams up with presently available FM transmitters... meets missile environmental requirements.

*For full specs, write for
Data File ED-500-1*

RHEEM MANUFACTURING COMPANY ELECTRONICS DIVISION

7777 Industry Avenue, Rivera, Calif.
phone: RAYmond 3-8971



CIRCLE 422 ON READER-SERVICE CARD

MISSILE- PROVED RELIABILITY



*in the 235 mc
to 245 mc
telemetry band*

The Model REL-09-HF is a ruggedized miniature R-F power amplifier. With a solid history of reliability in current missile systems, the unit has proved capable of withstanding the most rigorous airborne applications. The 5-inch, 1-pound amplifier delivers an 8-watt output to a 52-ohm load with a 1.4-watt input drive.

*For full specs, write for
Data File ED-504-1*

RHEEM MANUFACTURING COMPANY ELECTRONICS DIVISION

7777 Industry Avenue, Rivera, Calif.
phone: RAYmond 3-8971



CIRCLE 423 ON READER-SERVICE CARD

100 MILLION MEGOhm INPUT IMPEDANCE



*measures current
without adding resistance:
0.001 μ a full scale reading*

The Model REL-500 Precision Universal Meter is so versatile and broad-ranged that it performs as a voltage stability meter, a millivoltmeter, a micromicroammeter, a megohmmeter, a capacity meter, a pH meter, and as an electrostatic voltmeter.

It is so accurate that it performs all these functions with greater precision than most specialized single-purpose meters.

*For full specs, write for
Data File ED-503-1*

RHEEM MANUFACTURING COMPANY ELECTRONICS DIVISION

7777 Industry Avenue, Rivera, Calif.
phone: RAYmond 3-8971



CIRCLE 424 ON READER-SERVICE CARD

NEW PRODUCTS

Radar Test Set Combination X and C band



A combination X and C band radar test set has been designed into one compact unit. Model W 909-1C-A has all four master functions of spectrum analyzer, power monitor, signal generator and direct reading frequency meter. Identical in function with standard single band models, the unit has a stacking arrangement that permits a dual performance check.

Kearfott Company, Inc., Microwave Dept., Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

CIRCLE 35 ON READER-SERVICE CARD

Phase Measuring Units

Accuracy of $\pm 2-1/2$ per cent



Type 410 phase meter features: no tubes, battery, or power supply; no error due to harmonic or noise content; no amplitude adjustment, zeroing; direct reading in degrees; no drift, warm-up period required; and accuracy of $\pm 2-1/2$ per cent. Type 206 microsecond indicator measures: phase angle between two pulse modulated sine waves; time interval between any two points of an irregular pulse; time delay of a four-terminal network; and time interval between an incident and its reflected pulse through a medium.

Ad-Yu Electronics Lab., Inc., Dept. ED, 2 Terhune Ave., Passaic, N.J.

CIRCLE 36 ON READER-SERVICE CARD

Synchronous Motor

Delivers 12 oz-in. torque



This hysteresis synchronous motor, size 10 with a maximum length of 1-3/16 in., will operate directly from 115 v line, 400 cps, single or three phase, delivering 12 oz-in. at 1000 rpm pull out torque. The unit can be supplied with a gearhead with a maximum length of 2-1/8 in. up to a ratio of 200:1 and with a maximum length of 2-3/8 in. up to 10,500:1.

Servomechanisms, Inc., Mechanical Div., Dept. ED, 1200 Prospect Ave., Westbury, N.Y.

CIRCLE 37 ON READER-SERVICE CARD

Filament Transformer

For transmitting tubes



Type P-6463 filament transformer has been designed especially for use with the Eimac 4CX1000A transmitting tube. The unit provides center-tapped secondaries of 6.5 or 7 v, at 13 amp. Primary is 27 v, 60 cps. The P-6463 is designed to withstand 2000 v rms.

Chicago Standard Transformer Corp., Dept. ED, 3501 Addison St., Chicago 18, Ill.

CIRCLE 38 ON READER-SERVICE CARD
CIRCLE 39 ON READER-SERVICE CARD

Transitron

*Now...
The widest
POWER RANGE
in the
industry!*

SILICON TRANSISTORS

New high power transistors have just been added to the Transitron line, increasing power ratings to 85 watts. Now, whatever the application, you can choose from the broadest power range in the industry... with Transitron reliability built into every transistor.

Visit us at WESCON, Booth 1567-68

HIGH POWER

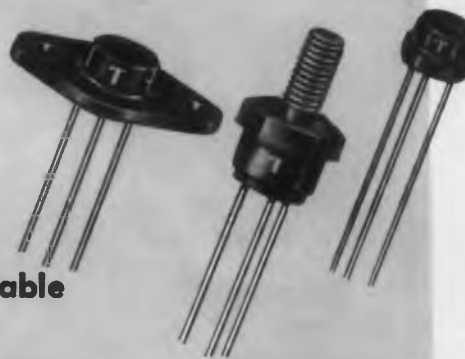
- Ratings to 85 watts
- Operation to 5 amps
- Low Rcs, 1.5 ohms typical
- Voltage Ratings to 60V
- High Current Gain
- High Speed Switching



Type	Maximum Power Dissipation at 25°C case (watts)	Minimum D.C. Common Emitter Current Gain B	Typical Collector Saturation Resistance (ohms)	Maximum Collector Voltage Vc (volts)
ST400	85	15@2 amps	1.5@2 amps	60
ST401	85	20@2 amps	1.5@2 amps	45
ST402	50	15@2 amps	3.0@2 amps	60
ST403	50	15@2 amps	2.5@2 amps	45

MEDIUM POWER

- Operation to 500 ma
- Ratings to 5 watts
- Low Rcs, 6 ohms typical
- High Speed Core Driving
- Heat Sink Mountings available

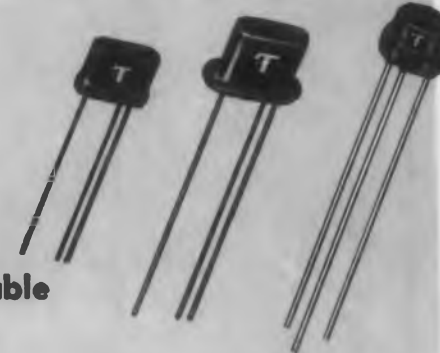


Type	Maximum Power Dissipation at 100°C case (watts)	Maximum Collector Voltage VcMax (volts)	Minimum D.C. Common Emitter Current Gain B	Typical Collector Saturation Voltage (volts)
2N545*	5	60	15@500 ma	3V@500 ma
2N547	5	60	20@500 ma	3V@500 ma
2N498	2.5	100	12@200 ma	4V@200 ma
2N497	2.5	60	12@200 ma	4V@200 ma
2N551	5	60	20@50 ma	1V@50 ma

*FAST SWITCHING TYPE

SMALL SIGNAL

- Operation to 175°C
- Low Ico at Rated Vc max.
- High Current Gain
- Three package sizes available



Type	Minimum Common Emitter Gain, β	Maximum Collector Voltage Vcc Peak (Volts)	Typical Cut-off Frequency (MC)	Maximum Collector Cut-off Current at 25°C (μa)
2N543	80	45	15	.5
2N480	40	45	11	.5
2N475	20	45	10	.5
2N336	78	45	13	50
2N334	18	45	11	50
2N118	18	30	4	10
2N119	36	30	4	10
ST904	18	30	4	10
ST905	36	30	4	10
2N337*	20	40	20	50
2N338*	45	40	30	50

*FAST SWITCHING TYPE

WRITE FOR BULLETIN TE 1353

Transitron

electronic corporation • wakefield, massachusetts



Transistors

Diodes Regulators

Rectifiers



STEMCO THERMOSTATS

for precise, sensitive temperature control



STEVENS manufacturing company, inc.
P.O. Box 1007, Mansfield, Ohio

STEMCO

THERMOSTATS

1, 2, TYPE C semi-enclosed (1), hermetically sealed (2). Small, positive acting with electrically independent bimetal strip for operation from -10° to 300°F. Rated at approximately 3 amps, depending on application. Hermetically sealed type can be furnished as double thermostat "alarm" type. Various terminals and mountings. Bulletin 5000.

3, 4, TYPE M semi-enclosed (3), hermetically sealed (4). Electrically independent bimetal disc types for appliance and electronic applications from -20° to 300°F. Rating: 8 amps at 115 VAC, 4 amps at 230 VAC and 28 VDC. Semi-enclosed with virtually any type terminal; hermetically sealed with pin or solder terminals, wire leads, various mounting brackets. Bulletin 6000.

5, 6, TYPE MX semi-enclosed (5), hermetically sealed (6). Snap acting miniature units to open on temperature rise for missile, avionic, electronic and similar uses. 2° to 6° differentials available. Rated at 3 amps to 1 amp, depending on duty cycle, at 115 VAC and 28 VDC for 250,000 cycles. Semi-enclosed types with metal or ceramic bases; hermetically sealed in circular or CR7 cans. Various terminals, mountings, brackets, etc. Bulletin 6100.

7, 8, TYPE S* adjustable (7), non-adjustable (8). Positive acting with single stud or nozzle mounting. Operation to 600°F. Rated at 15 amps at 115 VAC, 7 amps at 230 VAC. Spade, screw or elevated terminals, various adjusting stems, etc. Bulletin 1000.

9, TYPE SA* adjustable (9) or non-adjustable. Snap acting with electrically independent bimetal. Also single-pole, double-throw. Single stud or nozzle mounting. Non-inductive-load rating: 15 amps at 115 VAC, 10 amps at 230 VAC. Spade or screw terminals. Bulletin 2000.

10, TYPE SM* manual reset (10). Electrically same as Type SA (above) except for manual reset feature. Bulletin 2000.

11, TYPE B adjustable (11) or non-adjustable. For uses where heat generated by passage of current through bimetal strip is desirable. Various terminals, single stud or nozzle mounting. Operation to 400°F. Nominal rating: 5½ amps at 115 VAC of 40 cycles and higher. Bulletin 9000.

12, 13, 14, TYPE A* semi-enclosed (12, 13), hermetically sealed (14). Insulated, electrically independent bimetal disc gives fast response and quick, snap action control for appliance, electronic and apparatus applications from -20° to 300°F, or higher on special order. Rating: 3 to 4 amps, depending on duty cycle, at 115 VAC, 2 amps at 230 VAC and 28 VDC. Various enclosures and mountings, including brackets. Bulletin 3000.

15, TYPE R* sealed adjustable (15), sealed non-adjustable. Positive acting for operation to 600°F. Rated at 15 amps at 115 VAC, 4 amps at 230 VAC. Screw terminals. Bulletin 7000.

16, TYPE W* adjustable (16), or non-adjustable. Snap action bimetal strip type for operation to 300°F. Rated at 5 amps at 115 VAC, 3 amps at 230 VAC. Screw or nozzle mountings; spade, solder or screw terminals. Bulletin 4000.

17, TYPE H† adjustable. Positive acting for fry pans, skillets, sauce pans, etc. Fail-safe, open in low to 500°F in high. Rated at 1650 watts at 115 VAC. Bulletin 10,000.

18, TYPE D* automatic (18), or manual reset. For laundry dryers or other surface and warm air applications. Snap acting disc type U.L. approved for operation to 350°F. Open or enclosed styles. Rated at 25 and 40 amps at 120-240 VAC. Screw or spade terminals. Bulletin 8000.

Illustrations, for general information only, do not necessarily show size comparisons. Fully dimensioned and certified prints on request. Manufacturer reserves right to alter specifications without notice. AA-7250

*Refer to Guide 400ED for U.L. or C.S.A. approved ratings.
†Patent Applied For.

NEW PRODUCTS

Recorder Calibrator

Checks airborne tape recorders



A recorder calibrator, designed for checkout and calibration of airborne analog tape recorders has been developed. Voltage can be supplied to all recorder circuits from a single 28-v dc source. Voltages to supply bias current and motor drive are available. A signal current is supplied in various steps as desired to within 0.1 per cent through a Ledex type of switch. Any normal bridge type of end instrument may be calibrated.

Aerophysics Development Corp., Div. Curtiss-Wright Corp., Dept. ED, P.O. Box 689, Santa Barbara, Calif.

CIRCLE 42 ON READER-SERVICE CARD

Pressure Transducer

Has high sensitivity



Performance characteristics of pressure transducer model 22005 are: resolution 0.0002 or less, hysteresis better than ± 0.3 per cent, repeatability better than 0.3 per cent, high temperature operation, low vibration, and steady state acceleration error.

Technology Instrument Corp. of California, Dept. ED, 7229 Atoll Ave., North Hollywood, Calif.

CIRCLE 43 ON READER-SERVICE CARD

◀ CIRCLE 41 ON READER-SERVICE CARD

Radar Transmitters

Available in several operating frequencies



Operating frequency of the X-band radar transmitter model is 8500-9600 mc (tunable). In other models frequency ranges are: 3030-3110 mc (fixed); 5360-5400 mc (fixed); 16,400-16,600 mc (fixed); 23,800-24,270 mc (fixed). Repetition rate can vary over the range 300 to 10,000 pps and pulse length over the range 0.25 to 2.5 μ sec, within maximum duty cycle ratio (repetition rate times pulse length) of 0.001.

Resdel Engineering Corp., Dept. ED, 330 S. Fair Oaks Ave., Pasadena, Calif.

CIRCLE 44 ON READER-SERVICE CARD

Energizer

Has sandwich construction



A cut-away model of the cathodic envelope energizer construction shows the various layers of the sandwich making up this long-life high-energy battery designed specifically for transistorized equipment. Type of construction allows wide range of shapes and sizes.

National Carbon Co., Div. Union Carbide Corp., Dept. ED, 30 East 2nd St., New York 17, N.Y.

CIRCLE 45 ON READER-SERVICE CARD

CIRCLE 46 ON READER-SERVICE CARD



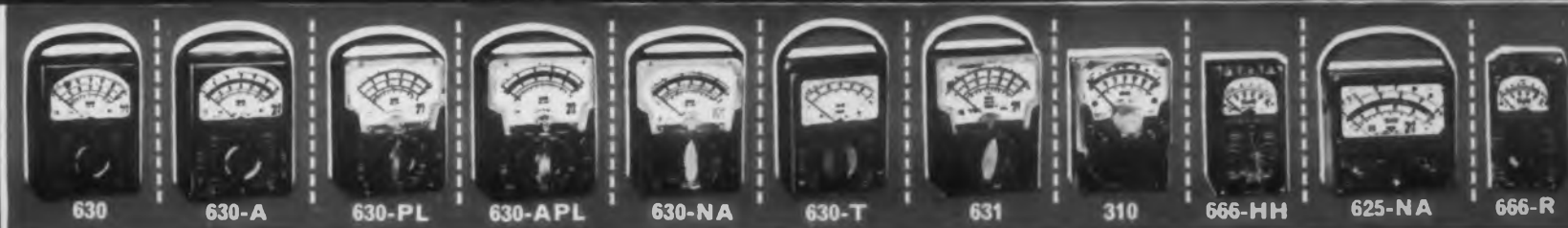
new... most easy to read



- Clear, unbreakable, shadowless front for instant wide vision.
- 5 to 500,000 cps on A.C.
- Continuous resistance reading from 0.1 ohms to 100 megohms.
- Polarity reversing switch.
- Only one (king-sized) switch selects both circuit and range—minimizes wrong settings, burnouts.

Only Triplet affords you such a wide choice of VOMs. Whatever your application—broad or limited—there is a Triplet VOM particularly suited for it.

the mighty nine + two



TRIPLET ELECTRICAL INSTRUMENT COMPANY • BLUFFTON, OHIO



extremely pure, 'Baker Analyzed' REAGENT

HYDROFLUORIC ACID

in your choice of

3 CONTAINER SIZES

6½ GALLON POLYETHYLENE CARBOYS

10-LB. or 1-LB. POLYETHYLENE BOTTLES



... functional,
labor-saving packaging
for your

SAFETY • CONVENIENCE • ECONOMY

HYDROFLUORIC ACID is a key processing chemical.

To meet the sharply rising demand for Hydrofluoric Acid manufactured to J. T. Baker's exceptional standards of quality, Baker has once more expanded production facilities. In addition to dependable, on-time deliveries, Baker offers you:

YOUR CHOICE OF CONTAINER SIZES: 6½ gallon polyethylene carboys, 10-lb. and 1-lb. polyethylene bottles.

SAFE, CONVENIENT, LABOR-SAVING PACKAGING: Carboys and 10-lb. bottles expedite convenient handling of large quantities of acid. The Baker 1-lb. bottle makes possible more rapid pouring

than competitive 1-lb. containers and with an added safety factor: There's no diaphragm to puncture—no danger of "acid-spurt."

PURITY: Baker manufactures in conformance with extremely high standards of purity. Specifications assure that copper and nickel each will not exceed ½ part per million.

ACTUAL LOT ANALYSIS: Each container is labeled with the actual lot analysis defining copper, nickel and eight other significant impurities.

ACTUAL LOT ASSAY: You'll appreciate this "J. T. Baker extra" especially important for your use.

FULL AVAILABILITY AND FAST SERVICE—from expanded production facilities.

FOR PRICES AND ADDITIONAL INFORMATION, WRITE OR PHONE



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

NEW PRODUCTS

Chargeable Dry Cell

Can be stored indefinitely



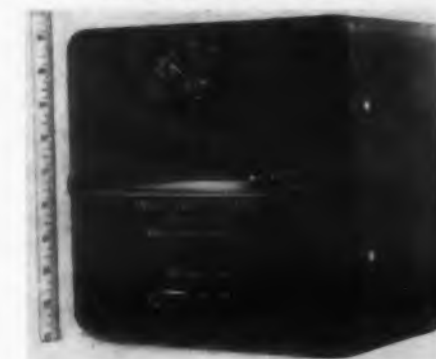
Manufactured in the uncharged state, this dry cell can be stored indefinitely at any temperature likely to be encountered, and charged when ready to use. Nominal output is 0.9 v, and average capacity is 1500 ma-hr. Using an alkaline lead oxide-silver system, the cell is available in experimental production quantities.

P. R. Mallory & Company, Inc.
Dept. ED, 28 S. Gray St., Indianapolis 6, Ind.

CIRCLE 48 ON READER-SERVICE CARD

Decade Inductors

High Q, low frequency



Designed for use in analog computers, network design, and general laboratory applications, these decade inductors have maximum values of Q in excess of 300 and micrometer adjustment for precise settings. Models LP 121, LP 131 and LP 141 are available in three decades (0.01 to 0.1 h; 0.1 to 1.0 h and 1 h to 10 h) which may be combined to permit switching in any value of inductance from 0.01 to 11.1 h in 0.01 h steps. Low level inductance is within 0.1 per cent of nominal value at 100 cps.

Computer Engineering Associates, Inc., Dept. ED, 350 N. Hollywood Ave., Pasadena, Calif.

CIRCLE 49 ON READER-SERVICE CARD
◀ CIRCLE 47 ON READER-SERVICE CARD

Relay Sockets

For use with 6, 4 and 2 pole double throw relays



This Hi-Reli series of relay sockets features gold plated over silver plate, free floating screw machine contacts in a molded body of MIL-M-4E type insulation. Contacts are available with solder cup, turret or eyelet terminations. Units are for use with 6 pole, 4 pole and 2 pole double throw relays.

Armel Electronics, Inc., Dept. ED, 840 5th Ave., Brooklyn 32, N.Y.

CIRCLE 50 ON READER-SERVICE CARD



Cooling System

Employs water boil-off method

This system, known as model RS-50, type 100, was designed to protect electronic equipment by maintaining a safe temperature within the close confines of a pressurized pod. Cooling is accomplished by circulating refrigerated air over the hot electronic components and transferring this heat to a vapor-cycle refrigeration system. This heat, plus that generated by the refrigeration compressor motor and other motors in the system, is disposed through the condenser where water carried for this purpose is boiled and exhausted overboard. Its capacity is 2500 w, with power requirements of 200 v, 400 cycle, three-phase and 28 v dc.

Eastern Industries, Inc., Dept. ED, 100 Skiff St., Hamden, Conn.

CIRCLE 51 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 9, 1958

CLOSES SWITCH WITH **ONE PUSH** **NEXT PUSH** OPENS SWITCH

NEW PUSH-PUSH SWITCH CONTROLS

. . . take the waiting out of warm-up time!



TURN
SHAFT FOR VARIABLE RESISTANCE CONTROL

Here's real operating convenience and added sales appeal for TV and radio receivers, phonographs and instruments!

Three new Stackpole controls combine pushbutton switching with rotary control of volume, tone, contrast or similar functions. "Waiting for the warm-up" before making final adjustments is a thing of the past. Just one push and the circuit is "on" and adjusted to the last selected setting of the variable resistor.

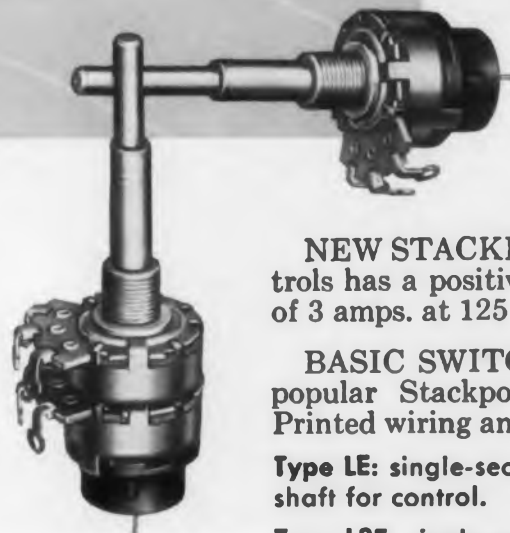
NEW STACKPOLE TYPE "E" SWITCH used on these controls has a positive, SP-ST snap-action. It carries a UL rating of 3 amps. at 125 volts ac-dc or 1 amp. at 240 volts ac-dc.

BASIC SWITCH/CONTROL COMBINATIONS using the popular Stackpole L-type control are available as follows. Printed wiring and wire-wrap terminals obtainable on each:

Type LE: single-section, single-shaft. Push shaft for switch, turn same shaft for control.

Type L3E: single-section, dual-shaft. Push inner shaft for switch, turn outer shaft for control.

Type LXE: dual-section, dual-shaft. Push inner shaft for switch, turn inner shaft for rear control, turn outer shaft for front control.



NEW DATA SHEET

Containing complete specifications and dimensions sent on request.

STACKPOLE VARIABLE COMPOSITION RESISTORS



Electronic Components Division

STACKPOLE CARBON COMPANY, St. Marys, Pa.

Iron cores • Coldite 70+® fixed composition resistors • Snap and Slide Switches • Ceramag® ferromagnetic cores
Ceremagnet® ceramic magnets • Fixed composition capacitors • Brushes for all rotating electrical equipment
Electrical contacts • Hundreds of related carbon, graphite and metal powder products.

CIRCLE 52 ON READER-SERVICE CARD

NEW PRODUCTS

Calorimeter Bridge

Measures 10 kw full scale



For use with any water load, this calorimeter bridge measures 10 kw full scale. Water flow is 4 gallons per minute. Accuracy of the ac wattmeter is 1 per cent. The instrument contains an ac standard load, a balancing thermopile, a galvanometer, a Variac and an ac wattmeter.

Electro Impulse Labs., Dept. ED, 208 River St., Red Bank, N.J.

CIRCLE 53 ON READER-SERVICE CARD

High Voltage Supply

0 to 90 kv regulated



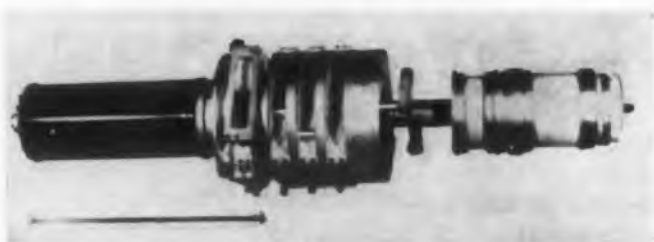
Model LAB-90 dc power supply provides voltages continuously variable from 0 to 90 kv. Output current is 1 ma at 80 kv; and 2 ma from 40 kv down. Voltage regulations are better than 1 per cent throughout the range.

Spellman Television Co., Dept. ED, 3029 Webster Ave., New York 67, N.Y.

CIRCLE 54 ON READER-SERVICE CARD

Klystron

1700 to 2400 mc range

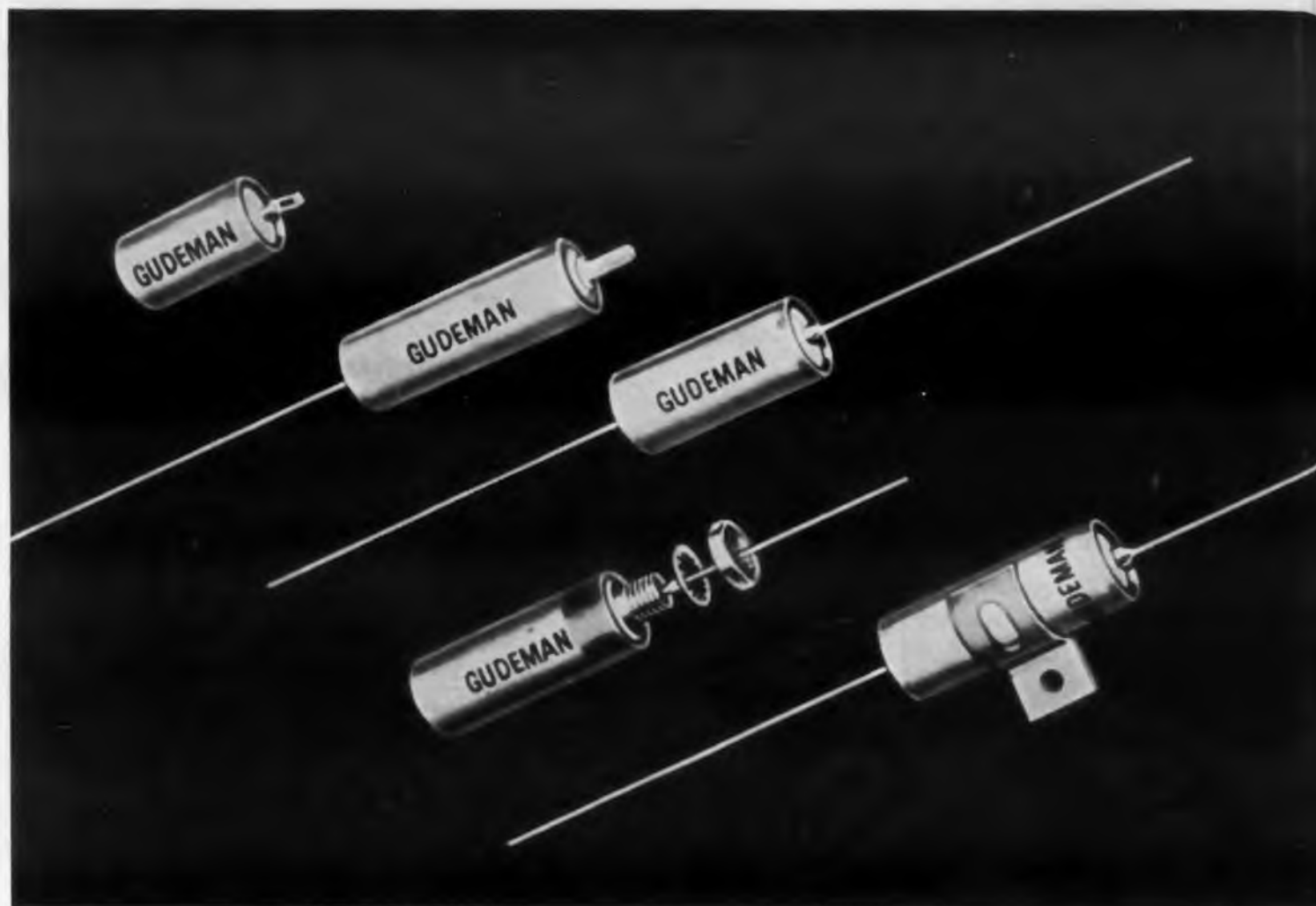


The 4KM50, 000SG external-cavity power amplifier klystron covers the 1700 to 2400 mc range. It is rated at 10 kw cw power output with less than 1 w drive. The unit incorporates a modulat-

Design better products with D

DOW CORNING 200 FLUIDS

... ASSURE ADDED RELIABILITY AT EXTREME TEMPERATURES



These miniature capacitors made by Gudeman Company for filter, by-pass and blocking service, are impregnated with silicone fluids to decrease electrical losses and increase permissible operating temperatures. Designed to meet all specifications of characteristic "K" MIL-C-25A, they have an operating temperature range of -55 to 125 C.

TYPICAL DIELECTRIC PROPERTIES
OF 200 FLUID, 100 CSTK.

Property	Temperature		
	-55 C	23 C	200 C
Dielectric Constant,			
1.0 kcs.	3.1	2.7	2.3
0.1 mcs.	3.1	2.7	2.3
Dissipation Factor,			
1.0 kcs.	0.0005	0.00004	0.001
0.1 mcs.	0.0002	0.00001	0.0003
Resistivity, ohm-cm.	10×10^{14}	2.0×10^{14}	1.0×10^{13}
Electric Strength,			
dc, 20 mil gap			
v/mil	700	650	550

As a liquid dielectric and coolant for electronic components and assemblies, Dow Corning 200 Fluid aids miniaturization and makes higher temperature operation possible. For example, paper capacitors impregnated with 200 Fluid have almost constant capacitance over an extremely wide temperature range... help assure reliable equipment performance. Heat stable electrical grade Dow Corning 200 Fluids show little change in electrical and physical properties over a wide range of frequencies and environmental conditions. Available in 20, 50, 100, 500 and 1000 centistokes viscosity grades, they are finding growing use as a means of increasing the reliability of capacitors, transformers, filter networks and other electronic devices.



Dow Corning CORPORATION
MIDLAND, MICHIGAN

Dow Corning Silicone Dielectrics



Electronic "Package" on B-58 by Emerson Electric.

SILASTIC PROTECTS ELECTRONIC "PACKAGES"

Silastic® the Dow Corning silicone rubber, remains resilient from -70 to 250 C, has excellent dielectric strength and offers superior resistance to moisture, ozone, corona and corrosive atmospheres. Available in many forms, including molded parts, extrusions, tapes, sheets and pastes, Silastic is ideal for insulating, sealing and cushioning delicate electrical and electronic equipment.

ing anode which allows simple, continuously variable control of power applied to the tube.

Eitel-McCullough, Inc., Dept. ED, San Bruno, Calif.

CIRCLE 56 ON READER-SERVICE CARD

Temperature Probe

-200 to $+250$ Range

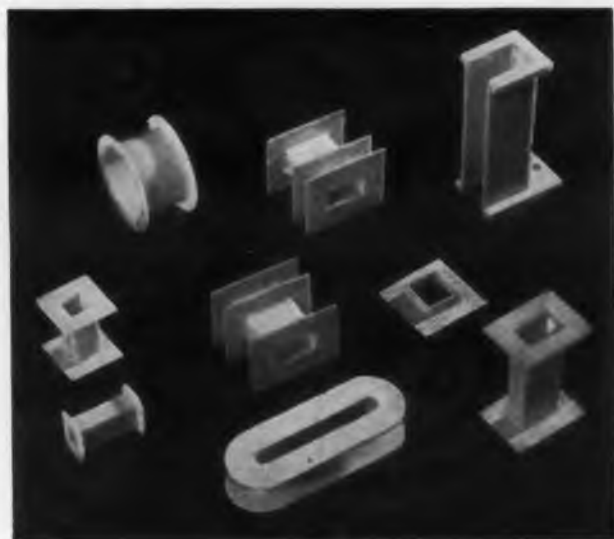


Model 134 temperature probe has a temperature range from -200 C or lower to $+250$ C or higher. The probe provides 100 ohm variation in the range from -270 to -300 F, which corresponds to pure platinum wire having a resistance of 1380 ohms at 0 C. The high impedance level together with a capability for large power dissipation permits large voltage variations to be developed for telemetering purposes. Calibration stability is such that after 50 cycles from boiling water to LN_2 , R_0 resistance drift is less than 0.1 ohm.

Rosemont Engineering Co., Dept. ED, 9424 Lyndale Ave., S., Minneapolis 20, Minn.

CIRCLE 57 ON READER-SERVICE CARD

SILICONE GLASS LAMINATES HAVE HIGH ARC RESISTANCE, STRENGTH



Silicone-glass laminates are easily molded into one-piece core and flange structures. Strong even at flange joints, they are lightweight and moisture-resistant, retain excellent physical and dielectric properties at 250 C. Finished shapes are available from leading laminators.

SILICONE VARNISH MAKES MOTORS TOUGHER, MORE DEPENDABLE

Dipped or impregnated with Dow Corning 997 Varnish, the insulating components of motors, servos, generators, transformers and other assemblies are bonded into an integrated moisture resistant insulation system with high dielectric strength. This silicone varnish combined with other silicone components permits operating temperatures up to 250 C . . . protects against moisture, many chemicals and corrosive atmospheres.



AiResearch miniature motors for B-52A Bomber.

Phase-Lock Demodulator

Boosts telemetry receiver sensitivity



Model 8-100 receiver phase-lock demodulator offers a gain in telemetry receiver sensitivity by lowering the improvement threshold by at least 6 db. This is a minimum figure realized when all rdb subcarriers are received. When fewer channels are used, the threshold is lowered even more. The demodulator is specifically designed for use with standard 1400 series receivers but may be modified for use with other models. It is installed by a simple plug-in connection and no modification to the receiver is required.

Radiation, Inc., Dept. ED, P.O. Box 37, Melbourne, Fla.

CIRCLE 391 ON READER-SERVICE CARD

For further information on these products, write Dept. 167
CIRCLE 55 ON READER-SERVICE CARD

thousands of "SPECIALS" without DELAY!

THESE 22 SERIES
OF STANDARD SWITCHES
WILL HANDLE ALMOST
ANY **LOW-CURRENT**
APPLICATION

ROTARY



MINIATURE: 8, 10, and 12 positions; up to 18 contacts per wafer.

Series A



SMALL: Up to 12 positions in phenolic, Mycalex, or steatite insulation.

Series F



ADAPTABLE: 8, 10, 12, and 14 positions; many variations; economical.

Series J, K, N



GENERAL PURPOSE: Up to 12 positions; 30°, 45°, 60° throw.

Series H



LOW COST: Up to 12 positions; staked or strut screw construction.

Series QH



18-POSITION: Single or double eyelet fastening of clips.

Series L



24-POSITION: 15° throw handles complex circuits.

Series MF



LOW COST: 2 to 5 positions; fits in limited space.

Series 50, 53



SIMPLE SWITCHING: Up to 5 positions combined with AC switch.

Series 52, 54



SIMPLE SWITCHING: Up to 4 positions; numerous variations.

Series 20



LEVER OPERATED: 2 to 5 positions; numerous versions using std. wafers.

Series 185



CONCENTRIC SHAFTS: Dual and triple shafts with many wafer types.

FOR PRINTED CIRCUITS: Special lug designs for direct insertions.

CUSTOM-MADE
TO YOUR EXACT
SPECIFICATIONS
FROM
STANDING TOOLS



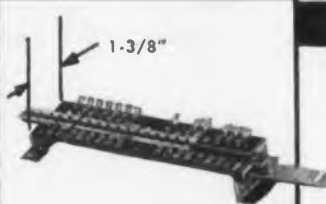
SOLENOID SWITCH: Oak wafers with G. H. Leland type of Rotary Solenoid.

SLIDE



2-POSITION: Shorting type with floating slider.

Series 70



COMPLICATED SWITCHING: 2 to 4 positions; up to 20 poles; very thin.

Series 150

ROTARY SLIDE



COMPACT—2 to 4 positions; max. switching in min. space.

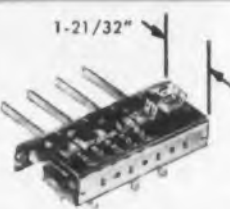
Series 160

PUSHBUTTON



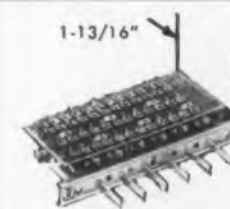
SINGLE BUTTON—1 to 4 poles; spring return and push-push.

Series 170, 175



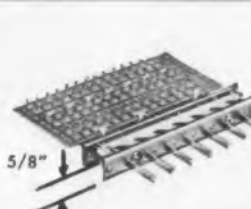
SIMPLER CIRCUITS: 3 to 12 buttons; very adaptable unit.

Series 80



COMPLICATED CIRCUITS: 1 to 18 buttons, up to 32 contacts each.

Series 130



ULTRATHIN: 1 to 12 buttons; up to 14 contacts per button.

Series 131

EACH SWITCH
IS PRETOOLED
IN NUMEROUS
VARIATIONS.
DETAILS
ON ANY SERIES
ARE AVAILABLE
ON REQUEST

For Recommendations on Unusual Applications, send us a sketch and short description.

OAK MFG. CO.

1260 Clybourn Ave., Dept. D, Chicago 10, Illinois

Phone: MOhawk 4-2222



SWITCHES



ROTARY SOLENOIDS



CHOPPERS



VIBRATORS



SPECIAL ASSEMBLIES

CIRCLE 58 ON READER-SERVICE CARD

NEW PRODUCTS

Amplifier Voltage gain of 1000



Model M-10 transistorized amplifier has the following characteristics: input impedance greater than 150 K; voltage gain of 1000; power gain of 85 db and maximum output of 150 m rms into 350 ohm.

M F Electronics Co., Dept. ED, 122 E. 25th St., New York 10, N.Y.

CIRCLE 59 ON READER-SERVICE CARD



Wide-Band Sweep Generators

Range of 4 mc to 225 mc

Two rugged, portable, wide-band sweep generators to test and align radio frequency circuits in the range from 4 mc to 225 mc are available. Models 601 and 602 have an all-electronic sweep circuit, of the saturable reactor type, with a continuously variable sweep range from a minimum of a nominal 1 per cent of center frequency to a maximum frequency deviation of approximately 5 to 1. Agc circuitry holds fundamental frequency output constant throughout the operating range.

The 601 has a frequency range of 12 mc to 225 mc divided into 11 switchable bands. Output voltage is 1 v rms with a variation at maximum sweep widths of ± 0.5 db. The 602 has a frequency range of 4 to 112 mc, also divided into 11 overlapping bands. A voltage output of 2.5 v rms is maintained across any band to within ± 0.5 db.

Jerrold Electronics Corp., Dept. ED, 23rd and Chestnut Sts., Philadelphia 3, Pa.

CIRCLE 60 ON READER-SERVICE CARD

Pulse Event Recorder

Recoverable type



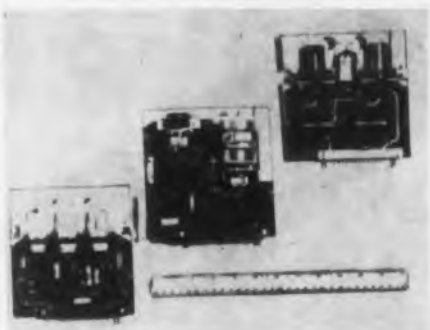
This recoverable pulse event recorder monitors accurately whether or not an event occurs in missile, guided and other applications. Designed to withstand high impact forces, the recorder has a self-contained electrical system. Weight is one pound.

Aerophysics Development Corp., Div. Curtiss-Wright Corp., Dept. ED, P.O. Box 689, Santa Barbara, Calif.

CIRCLE 61 ON READER-SERVICE CARD

Logic Units

Thirty types available



Thirty types of plug-in printed circuits in modular form are currently offered as stock items. The various types of bales currently available include: multi-vibrators, high speed binary and decimal electronic counters, stepping switches, operational amplifiers, storage devices, for both short and long-term applications; pulse-shaping circuits, timing and delay circuits, diode logic, "and," "or," and "not" circuits, gating circuits and transmission gates, relay and switching circuits, voltage regulators, pulse generators, clocks and gated oscillators, and analog to digital conversion systems and vice versa.

Skiatron Electronics & Television Corp., Dept. ED, 180 Varick St., New York 14, N.Y.

CIRCLE 62 ON READER-SERVICE CARD

CIRCLE 63 ON READER-SERVICE CARD

faced with a tough design problem?

Rugged

ALSiMAG[®]

ALUMINA CERAMICS

may be the answer!

For exacting applications, your chances are better with ALSiMag because more special-characteristic Aluminas are available here than from any other source. You benefit from extra "know-how" . . . years of experience in producing simple and complicated Alumina parts in a broad range of shapes and sizes . . . plus equipment for rapid delivery in any quantity. Precision tolerances. Prototypes before tooling, if you like.

Advantages like these give you greater freedom: Tensile strengths up to 25,000 lbs./sq. in. Compressive strengths up to 420,000 lbs./sq. in. Flexural strengths up to 62,000 lbs./sq. in. Superior electrical characteristics. Safe operation at continuous temperatures up to 2952° F. Loss factors as low as .0074 at 10,000 MC.

Not all applications need such advanced properties. A standard ALSiMag material—from the industry's widest selection—may meet your specifications. Let us help match your requirements to the ALSiMag material that will do the job at lowest cost. Premium ALSiMag Aluminas will be suggested only where superior performance is needed. Send blueprint or sketch with details of operating conditions.

A Subsidiary of
Minnesota Mining and
Manufacturing Company

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
57TH YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Atlanta, Ga. • Boston: Newton Center, Mass. • Buffalo, N. Y. • Chicago: Bedford Park, Ill. • Cincinnati, O. • Cleveland, O. • Dallas, Texas • Detroit, Mich. • High Point, N. C. • Los Angeles, Cal. • New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash. Canada: Minnesota Mining & Manufacturing of Canada, Ltd., P. O. Box 757, London, Ontario. All other export: Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

NEW PRODUCTS

Microsyn 3/4 in. in size



The unit shown is the T 813 microsyn, 3/4 in. in size, used with frequency from 400 to 1600 cps. The signal generator T 813 S 1 has a sensitivity of 0.3 mv/milliradian/ma excitation of 400 cps. The range is ± 10 deg and the resolution is 15 sec of arc. Maximum torque of 3000 dyne-cm rated continuous torque 50 dyne-cm is a feature of the T 813 T 1 torquer. The unit has a transfer function 0.005 dyne-cm/ma².

Sterling Precision Corp., Instrument Div., Dept. ED, 17 Matinecock Ave., Port Washington, N.Y.

CIRCLE 64 ON READER-SERVICE CARD

Cathode Ray Indicator Tube

7-1/2 in. long



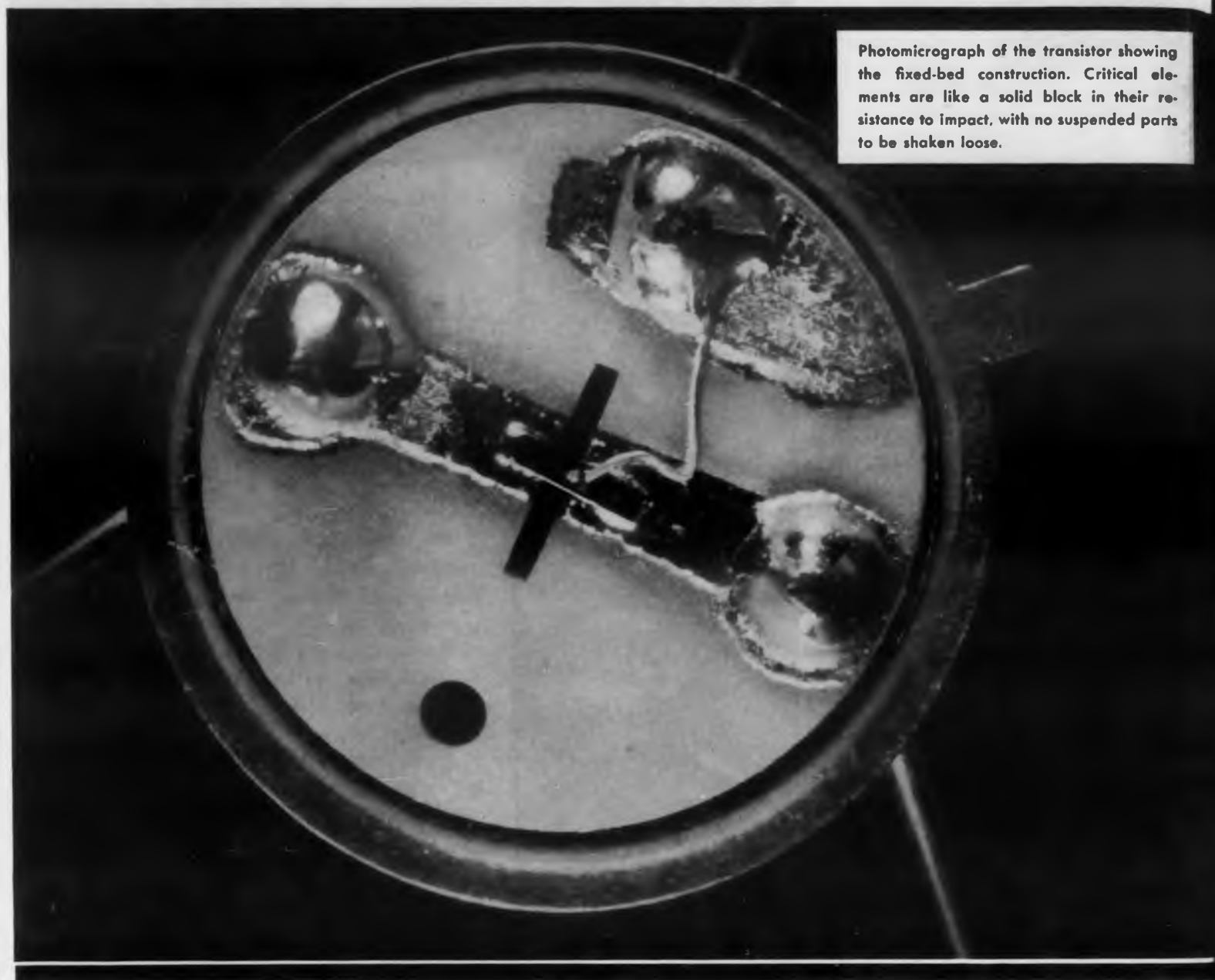
Operating conditions of cathode ray indicator tube model VTP-P1XP-11 are heater voltage of 6.3 v, heater current of 0.400 to 0.500 a, anode #1 from 400 to 500 v dc, anode #2 of 2000 v dc, anode #3 of 4000 v dc and grid #1 of -35 to -70 v. The undeflected spot position is within 1/8 in. radius circle with deflection factors: $D_1 D_2$ of 255 to 325 v per in. and $D_3 D_4$ of 143 to 175 v per in. Ratio of anode #3 voltage to anode #2 voltage is a maximum of 3 with optimum conditions obtained when the ratio is less than 1.5.

Vacuum Tube Products Co., Inc., Dept. ED, 2020 Short St., Oceanside, Calif.

CIRCLE 65 ON READER-SERVICE CARD

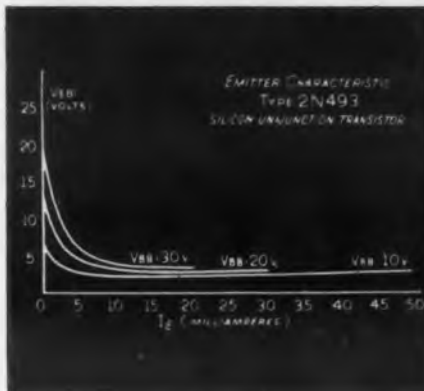
General Electric Semiconductor News

New fixed-bed mounting withstands



Photomicrograph of the transistor showing the fixed-bed construction. Critical elements are like a solid block in their resistance to impact, with no suspended parts to be shaken loose.

New data on the silicon Unijunction transistor



SPECIFICATIONS OF THE SIX SILICON UNIJUNCTION TYPES	
Absolute maximum ratings (25°C)	
RMS power dissipation	350 mw
RMS emitter current	50 ma
Peak emitter current	2 amps
Emitter reverse voltage	60 volts
Operating temperature range	-65°C to 150°C
Storage temperature range	-65°C to 200°C

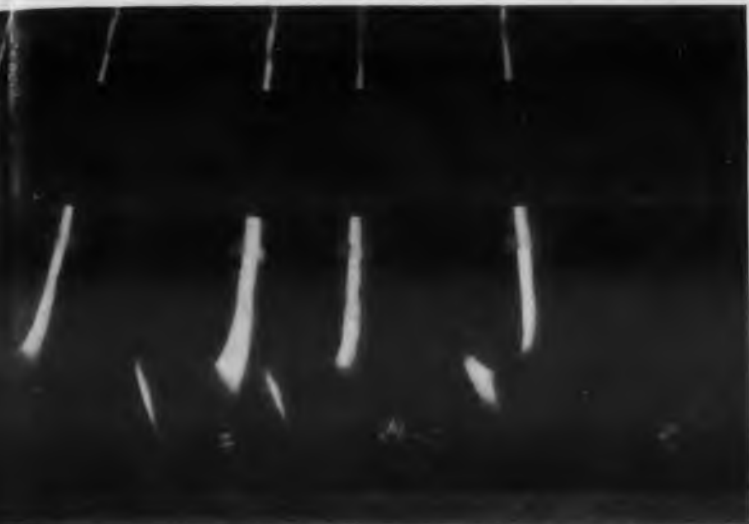
The unijunction features open-circuit-stable negative resistance characteristics. In switching and oscillator applications, one unijunction not only does the work of two transistors with less circuitry, but the circuit is also more stable over a wide temperature range.

To help you in your use of the unijunction, a new series of curves has been developed as shown. It points up emitter characteristics at different base-to-base voltages. The unijunction is also the first G-E transistor to be converted to the new impact-resistant Fixed-Bed Mounting process as described above.

Please send for complete data on the six unijunction types — sample circuits, theory and specifications.

YOUR G-E SEMICONDUCTOR SALES REPRESENTATIVE will be glad to give you further information and specifications on General Electric transistors and rectifiers. Spec sheets, bulletins, and other data can also be obtained by writing Section S-2388 Semiconductor Products Dept., General Electric Company, Electronics Park, Syracuse, N. Y.

tremendous impact and vibration



"GOLF CLUB TEST" General Electric transistors with Fixed-Bed Mounting have been struck full force with a No. 2 Iron. After traveling forty yards, tests showed they still worked perfectly.



"JACKHAMMER TEST" Another G-E transistor with Fixed-Bed Mounting was taped to a pneumatic drill, which was then operated for ten minutes. When the transistor was removed, tests showed it still worked perfectly.

Ceramic disk guards against major causes of transistor failure

In General Electric's new Fixed-Bed Mounting, critical elements of the transistor are welded flat on a disk of ceramic. Thus any impact must be great enough to damage the disk itself before transistor failure can occur. In conventional methods of manufacture, impact need only penetrate the transistor's metal case in order to damage the standard upright header.

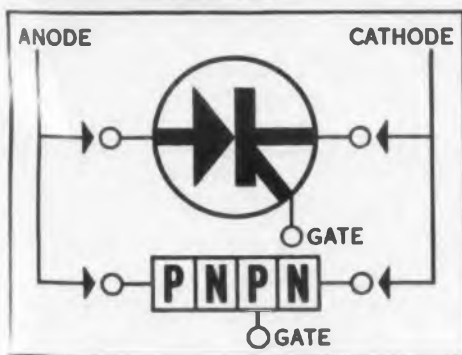
Because of their many suspended parts, standard upright headers are also subject to inertial stress at a number of points. General Electric's Fixed-Bed Mounting eliminated *all but one* of those parts—the suspended aluminum emitter lead. And this is provided with enough slack to absorb inertial stress, with connection points so securely welded that the unit withstands far more than the military centrifuge test of 20,000 G's.

To eliminate thermal stress, the coefficient of expansion of G.E.'s ceramic disk has been made equal to that of the semiconductor metal. Previously, enough "play" had to be allowed to absorb alternate expansions and contractions, thereby reducing the strength and stability of the unit.

The Fixed-Bed Mounting's electrical elements lie flat, in close contact to the transistor case, providing greater heat conduction out through the case. Therefore, the fixed-bed construction cuts down junction temperature, making it possible to double the power dissipation of the same transistor made with upright-header construction.

Fixed-Bed Mounted units have exceeded all standard shock, centrifuge and temperature-cycling tests. General Electric's unijunction transistor (see below) now has this feature.

New G-E Controlled Rectifier rectifies and controls current up to 5 amperes at 300 v.



The controlled rectifier is a four-layer silicon device with a "gate" to which a signal can be applied to control forward current. It can handle more than one kw of power.

NEED A FEW SEMICONDUCTORS IN A HURRY? Check your local G-E distributor first. You'll find his delivery, service facilities and prices are hard to beat.

General Electric's new silicon controlled rectifier acts like a thyatron. In the reverse direction, it's a standard rectifier. But it will also block forward current until either a critical breakover voltage is exceeded or a signal is applied to the third lead. Then it switches to a conducting state and acts as a forward-biased silicon rectifier.

The controlled rectifier can be actuated by a little as 15 mw. Breakdown occurs at speeds approaching a microsecond, after which voltage across the device is so low that current is determined by the load. This enables the user to control a large anode-to-cathode current with an extremely small amount of power, or to switch power from high impedance to low impedance in microseconds.

Applications include replacement of relays, thyatrons, magnetic amplifiers, power transistors and conventional rectifiers. Sample quantities of the controlled rectifier are now available. Prices will be sent on request.

GENERAL  ELECTRIC

CIRCLE 66 ON READER-SERVICE CARD

Converter

Operates over 100 c



This transistorized high temperature dc to dc converter features: input from 12 to 30 v; output from 6 to 300 v; regulation line and load ± 1 per cent; and temperature line and load ± 5 per cent.

Jordan Electronics, Dept. ED, 3025 W. Mission Rd., Alhambra, Calif.

CIRCLE 67 ON READER-SERVICE CARD



Power Supply

0.03 ohm internal impedance

Model 104 transistorized has a low internal impedance of less than 0.03 ohms, dc to 10 kc. Overload protection is provided for the current meter, with automatic reset. Coarse and fine voltage controls facilitate precision settings.

Quan-Tech Lab., Dept. ED, Morristown, N.J.

CIRCLE 68 ON READER-SERVICE CARD



Illumination Control

Light level actuates relay

A new version of an illumination control instrument which monitors light levels and signals a relay to switch lights on or off automatically has been announced. Model 1099 Luminaire features operation without regard to temperature, or weather conditions.

Weston Instruments, Division of Daystrom Inc., Dept. ED, Newark 12, N.J.

CIRCLE 69 ON READER-SERVICE CARD

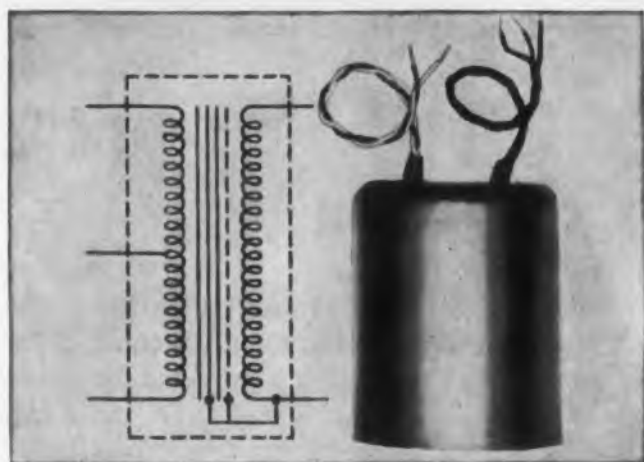
Use high-quality, dependable
BROWN COMPONENTS
 in your measuring circuits and servo loops



CONVERTERS—Handle d-c signals as small as 10^{-8} volt. SPDT switching action. Sensitive, stable performance. Ideal for computers, servomechanisms, balancing circuits. Available with special features such as fungus proofing, grounded housing, mica-filled base, various contact percentages. Weight: 10 ounces. Driving coils in 60, 40 and 25 cycle converters are energized by 6.3 volt a-c. 400 cycle uses 18 volts. Other coil ratings as follows:

Converter Type	Impedance	D-C Resistance	Power Consumption	Current Drain
60 cycle	125 ohm	110 ohm	.3 watts	.05 amps
25 and 40 cycle types	.65 ohm	55 ohm	.60 watts	.10 amps
400 cycle	191 ohm	110 ohm	1.7 watts	.094 amps

Write for Specification S900-2.



INPUT TRANSFORMERS—Handle low-frequency a-c, or chopper-modulated d-c signals from .005 to 200 millivolts, such as generated by thermocouples or other transducers. Designed with highly efficient shielding. Measure $1\frac{5}{8}$ " in diameter, $2\frac{3}{32}$ " high.

Choose from three models		355567-1	356326	35567-2
Primary (center-tapped)	turns (1/2 primary)	600	1,094	3,400
	Resistance (approx.)	30 ohms	450 ohms	750 ohms
	60 cps impedance	1,300 ohms	7,500 ohms	30,000 ohms
	Impedance, full pri.	5,200 ohms	30,000 ohms	120,000 ohms
Secondary	turns	9,600	17,500	12,000
	Resistance (approx.)	2,500 ohms	5,800 ohms	3,400 ohms
	Capacity to tune to 60 cycles	.015 mfd.	.001 mfd.	.003 mfd.
Weight		5.7 oz.	7.1 oz.	6 oz.

Write for Specification S900-1.



ELECTR-O-VANE CONTROL UNIT—A torque of 2 gram-inches or less actuates this precision switch. Use it as a limit switch to operate valves, lights or hopper openings, in response to motion of weighing beams or other members. Use it to sense other mechanical movements—to operate protective devices when a diaphragm is bulged or near rupture, for example.

SPECIFICATIONS

Torque to move vane . 2 gram-inches max.
 Vane motion for snap action . . . 0.003 in.
 Precision within 0.002 in.
 Switch action . SPDT, when vane center-line approx. 41° left of vertical
 Load relay rating . 115 volts, 6 amp. a-c, non-inductive load
 Operating power . 115 volts, 50-60 cycles; also 230 volt model

Write for Specification S800-1.

Honeywell



First in Controls

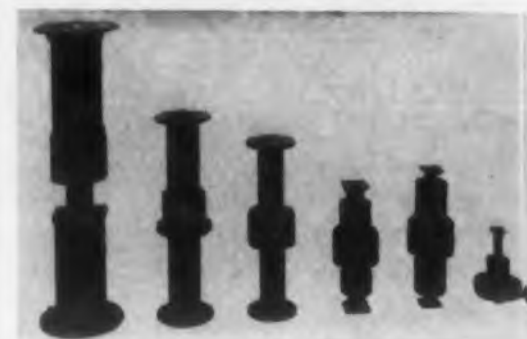
CIRCLE 70 ON READER-SERVICE CARD

For additional details, call your nearby Honeywell sales engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR Co., Industrial Division, Wayne and Windrim Avenues, Philadelphia 44, Pa.

NEW PRODUCTS

Rotary Joints
 High speed, broadband



These waveguide rotary joints are of the line type and feature broadband operation at high speeds. The joints employ novel transducers from rectangular to loaded circular waveguide producing a pure circularly symmetric TM mode. Because of the purity of the mode, no dissipation mode suppressors are required so that insertion loss is held to a minimum, and there is no phase shift with mechanical rotation. The joints cover frequencies from 2.6 to 26.5 kmc. Average power handling ranges from 3 kw to 1/2 kw. Vsw less than 1.5 to 1. Insertion loss is less than 0.1 db.

Diamond Antenna & Microwave Corp., Dept. ED, 7 North Avenue, Wakefield, Mass.

CIRCLE 71 ON READER-SERVICE CARD

Spectrum Analyzers
 2400 to 9600 mc



Series 860 spectrum analyzers have a wide range of performance that makes them valuable for precise spectrum measurements, such as evaluation of high vswr, leakage, and loss; and analysis of radar, radio relay, and other signals. Featuring simplicity of operation and lower price, they offer a choice of frequency ranges from 2400 to 9600 mc and have an accuracy of ± 0.08 per cent, or ± 1 mc. The instruments are based on the improved power supply and indicator of type 860-I.

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

CIRCLE 72 ON READER-SERVICE CARD

ENGINEERS

... cross new frontiers in system electronics at THE GARRETT CORPORATION

Increased activity in the design and production of system electronics has created openings for engineers in the following areas:

ELECTRONIC AND AIR DATA SYSTEMS Required are men of project engineering capabilities. Also required are development and design engineers with specialized experience in servo-mechanisms, circuit and analog computer design utilizing vacuum tubes, transistors, and magnetic amplifiers.

SERVO-MECHANISMS AND ELECTRO-MAGNETICS Complete working knowledge of electro-magnetic theory and familiarity with materials and methods employed in the design of magnetic amplifiers is required.

FLIGHT INSTRUMENTS AND TRANSDUCER DEVELOPMENT Requires engineers capable of analyzing performance during preliminary design and able to prepare proposals and reports.

FLIGHT INSTRUMENTS DESIGN Requires engineers skilled with the drafting and design of light mechanisms for production in which low friction, freedom from vibration effects and compensation of thermo expansion are important.

HIGH FREQUENCY MOTORS, GENERATORS, CONTROLS Requires electrical design engineers with BSEE or equivalent interested in high frequency motors, generators and associated controls.

Send resume of education and experience today to:
Mr. G. D. Bradley

THE GARRETT CORPORATION

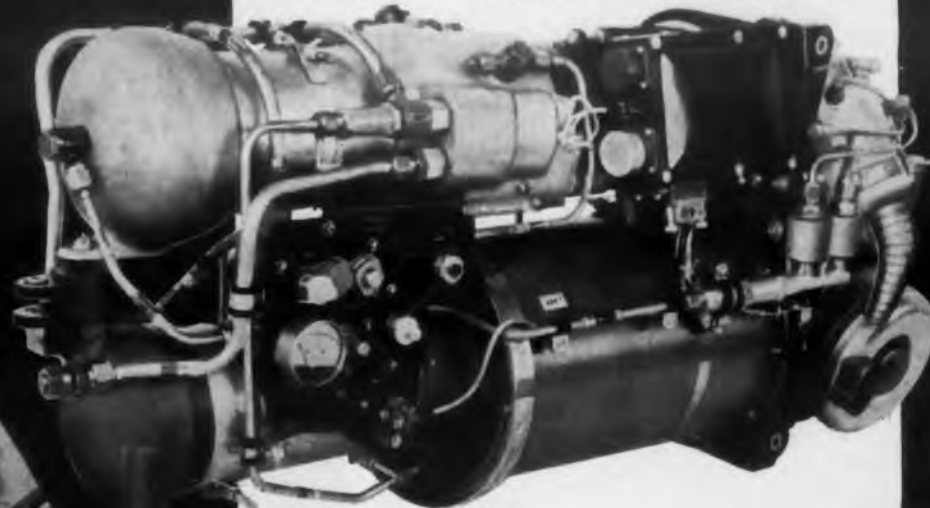
9851 S. Sepulveda Blvd.
Los Angeles 45, Calif.

DIVISIONS:

AiResearch Manufacturing
Los Angeles
AiResearch Manufacturing
Phoenix
AiResearch Industrial
Rex - Aero Engineering
Airsupply - Air Cruisero
AiResearch Aviation
Service

AUXILIARY POWER for the U.S. Army's deadly NIKE HERCULES

AiResearch units power the controls of America's most potent defense weapons



Key defense and population centers are now being ringed with batteries of Army Nike Hercules missiles to deter or destroy aggressors. Supplying power for flight controls is the AiResearch auxiliary power unit pictured above, now in production.

As a member of the Army-industry team producing the Nike Hercules (Army Ordnance, Western Electric-Bell Telephone Laboratories and Douglas Aircraft), AiResearch was chosen to design, develop and manufacture this vital accessory power source for the missile because of nearly two decades of experience in light-weight turbomachinery.

This experience includes applications utilizing solid propellants, liquid mono-propellants, bi-propellants, atomic power, cryogenic gases as well as gasoline and air. AiResearch's ability for high capacity production as well as in research and development, made it the logical choice.

Garrett's AiResearch divisions have also designed systems and components for 18 other missiles and rockets in the U.S. defense arsenal. We invite your inquiries.

THE GARRETT CORPORATION

ENGINEERING REPRESENTATIVES: AIRSUPPLY AND AERO ENGINEERING, OFFICES IN MAJOR CITIES

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

CIRCLE 392 ON READER-SERVICE CARD

CIRCLE 551 ON READER-SERVICE CARD

NEW PRODUCTS

Kilomegacycle Generator

Stability Of 1 part In 10^8



Model RD-170 generates both sinusoidal frequencies of 100 mc and 1000 mc and harmonic signals covering a major portion of the microwave spectrum. Output frequency stability is governed by the stability of a 1 mc reference signal. The unit is intended for use as a precise but low cost source for reference, monitoring or calibrating purposes. Employing crystal synthesizer design techniques, the instrument essentially consists of a free running 100 mc oscillator, which is phase-locked to the 1 mc reference, and multiplier stages which raise the frequency to 1000 mc. A pencil tube in a coaxial cavity forms the final output state. Power delivered is 100 mw across 50 ohms.

Manson Laboratories, Inc., Dept. ED, 207 Greenwich Ave., Stamford, Conn.

CIRCLE 73 ON READER-SERVICE CARD



Pulse Modulator

Delivers 21 kw

USN-3D21B pulse modulator is a beam power tube capable of delivering 21 kw in 10 μ sec pulses. It features an open-type plate of large area for high thermal dissipation, a non-warping cathode, and gold-plated special alloy grids with heavy side rods and oversize heat radiators. The tube is rated to withstand a plate pulse voltage of 5 kv.

CBS-Hytron Div. Columbia Broadcasting System, Inc., Dept. ED, 100 Endicott St., Danvers, Mass.

CIRCLE 74 ON READER-SERVICE CARD

THE SKY IS N



NO LONGER THE LIMIT

Under the water . . . on the water . . . on land . . . in the air . . . and out into space . . . in all these areas Hughes advanced technology is being applied to vital military and commercial electronics projects.

In the space satellite field, for example, Hughes is active in the preliminary design of guidance and control systems, communication and telemetry systems, and sensing devices using infrared, optical and radar techniques.

Responsible for guiding and formulating the advanced systems concepts that make this new product diversification possible is the Systems Analyst. His creative thinking has motivated such new Hughes projects as advanced ballistic missile guidance, space vehicle systems, and tactical missile systems. Other new programs initiated by Hughes Systems Analysts include advanced radar systems for all areas of military and civilian applications, including AICBM, missile

guidance, early warning, air traffic control; and integrated electronics systems for undersea warfare.

Currently the Hughes Research and Development Laboratories are engaged in the greatest expansion in their history. Professional opportunities have never been more promising, especially in the more senior areas such as Systems Analysis.

Other Hughes activities are also participating in the expansion. Hughes in Fullerton is developing and producing advanced three-dimensional radar systems. Hughes Products, the commercial activity of Hughes, is producing an electronics system which automates a complete line of machine tools.

Today Hughes offers Engineers and Physicists the opportunity of locating with an established firm and working in advanced new technical fields.



The wide range of activity at the Hughes Fullerton facility extends from basic data processing and surveillance radar research through final design and packaging.



Ferromagnetic studies conducted by the Hughes Research Laboratories include fundamental research in the physics and chemistry of ferrites, synthesis of ferrite materials and development of ferromagnetic devices.

New commercial and military contracts have created an immediate need for engineers in the following areas:

Circuit Design	Aerodynamics
Reliability	Vacuum Tubes
Communications	Crystal Filters
Microwaves	Systems Analysis
Nuclear Electronics	Computer Engineering

Write in confidence to Mr. Phil N. Scheid,
Hughes General Offices, Bldg. 6-M, Culver City, California.

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Creating a new world with **ELECTRONICS**

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo,
Fullerton and Los Angeles, California
Tucson, Arizona

CIRCLE 552 ON READER-SERVICE CARD

Time Delay Relays

Transistorized series



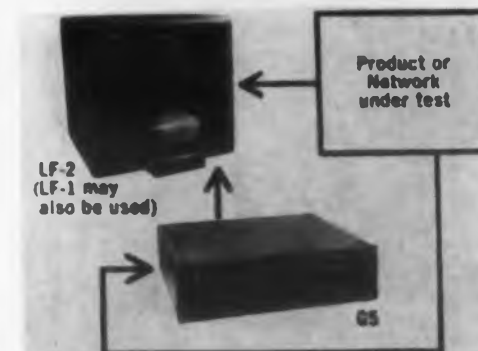
This line of time delay relays offers high temperature operation, high vibration, light weight and very short time delays. A transistorized RC time constant network is used. Two series are currently offered with time delays ranging from 50 msec to 60 sec. Operating voltage for either type will be 18 to 30-v dc, although operation on ac voltages can be offered. The 31200 series can be provided with contact arrangements up to 4 pdt. Weight is approximately 6 oz, length 2-1/4 in., and the unit will withstand vibrations up to 500 cps. The 31300 miniature series can be supplied with contact arrangements up to dpdt. This unit can withstand vibrations up to 2000 cps at 10 g. Weight of this style is approximately 3 oz.

A. W. Haydon Co., Dept. ED, Waterbury 20, Conn.

CIRCLE 75 ON READER-SERVICE CARD

Response Indicator

Range from 0.5 to 2250 cps



Model G-5 analyzes frequency response characteristics of servo amplifiers, filters, acoustic reproducers, transformers and shaker tables in the low frequency range from 0.5 to 2250 cps. It is helpful in locating resonant frequencies in mechanical structures and testing networks and devices which tend to produce distortion products, where hum and noise are present, and where measurements through large dynamic ranges are necessary.

Panoramic Radio Products, Inc., Dept. ED, 520 S. Fulton Ave., Mt. Vernon, N.Y.

CIRCLE 76 ON READER-SERVICE CARD

NEW PRODUCTS

Voltage Regulator

400 cps use



Type TM7101 voltage regulator is designed for 115 v, 400 cps ± 5 per cent, single phase duty with a rating of 1 kva. The input voltage range is 95-130 v and the output voltage is adjustable from 110 to 120 v. Output voltage accuracy is constant to within a 1 v bandwidth for line voltage variations.

Superior Electric Co., Dept. ED, Bristol, Conn.
CIRCLE 77 ON READER-SERVICE CARD

Pulse Height Analyzer

Improved 256-channel unit



The improved 256-Channel Pulse Height Analyzer, Model 20609, has these advantages: 27 hours pre-set time during which background may be counted and automatically subtracted from original run data; logarithmic readout on flat-faced cathode ray tube and strip chart recorder; dual-function high voltage supply; and interpolation lights to aid in setting zero point and instrument maintenance. All channels are printed out in less than one minute.

Radiation Counter Laboratories, Inc., Dept. ED, Skokie, Ill.

CIRCLE 78 ON READER-SERVICE CARD



THE MISSILE MEN

From the earliest Assyrian "artillery missile"—with the flint-tipped warhead and hawk feathers for a guidance system—the fate of nations has been in the hands of the missile men.

Today, our strength in military missilery may hold the key to survival.

Martin based its long-range planning on that probability in 1946 with the development of one of this nation's first successfully operational guided missiles. The result is the *total missile* concept.

Under this concept, far more is involved in missile system contracting than the design and production of hardware:

The testing, packaging, delivery, maintenance, launching, operation, field training and contractor service requirements make up the *total* story of missile performance...in the air, and operated by the military personnel.

The heavy demands of our country's greatly accelerated missile and space development programs now emphasize the importance of Martin's total capabilities as a major resource for the military and astroscientific branches of the government.

Among those capabilities are three plant facilities which include the newest and most advanced missile development centers in the world.

Also part of these Martin capabilities is one of the great U. S. resources in manpower: More than 3,000 specialist engineers, trained and teamed in the *total missile* concept.

This is one of the few systematically organized companies of genuine Missile Men in the country.

MARTIN
BALTIMORE · DENVER · ORLANDO

Packaged Amplifier

High flexibility



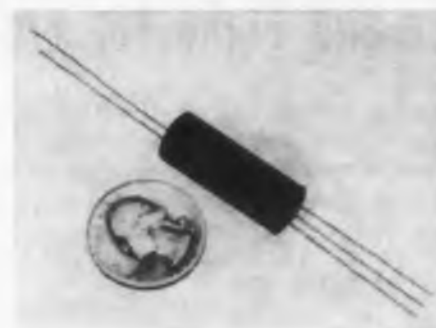
This flexible packaged amplifier, the Model UPA-2, can drive a 12,000 ohm load to 100 v in either direction, and will tolerate large values of cable capacitance. Typical operations which can be performed separately or in combination include: straight amplification and inversions; slaving or transducing voltages into currents and vice-versa; integrating and differentiating; adding and subtracting; and oscillating, bounding, clipping, multivibrating, and other nonlinear functions. For standard 3-1/2 in. rack mounting, the unit can be removed from the rack adaptor and used as a bench-top amplifier or plug-in sub-assembly.

George A. Philbrick Researches, Inc., Dept. ED, 230 Congress St., Boston, Mass.

CIRCLE 79 ON READER-SERVICE CARD

Chopper

Nonmechanical type



This transistorized chopper, Model 50, is a solidly encapsulated unit which can be used either as a modulator or demodulator. Unlike mechanical choppers, the Model 50 can be driven from dc to hundreds of kilocycles. The switching circuitry used operates the transistors in a manner which provides stability and freedom from drift. The unit withstands shocks of 500 g for 11 msec, vibrations of 30 g up to 2000 cps, and acceleration of 700 g.

Solid State Electronics Co., Dept. ED, 8158 Orion Ave., Van Nuys, Calif.

CIRCLE 80 ON READER-SERVICE CARD

Fischer



"Special" is our middle name! We make millions of odd-size brass and aluminum nuts for all types of equipment. Unique high-speed machinery turns all Fischer nuts to exacting specifications. Extreme uniformity, competitive prices and prompt delivery assure you of substantial savings in cost and time.

Next time you need "special" brass or aluminum nuts, contact Fischer for fast action . . . premium quality.



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Please send your new 20-page CATALOG FS-1000 containing complete specifications on brass and aluminum nuts.

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8048-FS

CIRCLE 401 ON READER-SERVICE CARD

SILVER



Handy & Harman Silver Powder and Flake for Electronic Applications



Among the many forms of silver and silver alloys manufactured by Handy & Harman are:

Fine silver (wire, strip and foil) • Silver anodes and grain for plating • Silver contact alloys • Silver powders • Silver flake, paints and paste • Silver brazing alloys • Silver electronic solders • Silver sintered metals • Solder-flushed silver alloys • Silver chloride and oxide • Coin silver (wire and strip) • Silver bi-metals

The increased acceptance of silver powder and flake in electronic circuitry and components has created a demand for a source that can supply these materials at a consistently high level of quality.

Handy & Harman manufactures silver powder and flake in all types and forms, for use in formulations on printed circuitry and wiring, resistors, condensers, thermistors, printed terminal strips on glass, ceramics or plastic laminates, etc.

If you are working on conductive or resistive coatings where you require excellent electrical conductivity, Handy & Harman will welcome the opportunity to assist you in the choice — or discussion of *any* silver product that may interest you. Write for Technical Bulletin A-4 on Silver Conductive Coatings and Bulletin A-5 on Silver Powder and Flake.

Our technical service and field application experience are at your disposal... we welcome inquiries on products and product problems involving any form of silver.

Your NO. 1 Source of Supply and Authority on Silver Alloys



HANDY & HARMAN

General Offices: 82 Fulton St., New York 38, N. Y.

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TORONTO, CANADA
MONTREAL, CANADA

CIRCLE 81 ON READER-SERVICE CARD

NEW PRODUCTS

Potentiometer For dc analog computation



Developed initially for accurate conversion of slant range to ground range and altitude in dc analog computation, model PT315 trigonometric potentiometer enables accurate triangle solution over a range of angles commonly encountered in navigational problems. These 15-turn units embody the sine or cosine function over a 100-degree range of function. Conformity is 0.02 per cent for sine or cosine less than 0.707, and 0.04 per cent for sine or cosine greater than 0.707.

Analogue Controls, Inc., Dept. ED, 39 Roselle St., Mineola, N.Y.

CIRCLE 82 ON READER-SERVICE CARD

Aircraft Blower Delivers 175 cfm of air



The MSA 7861 aircraft blower unit delivers 175 cfm of air against an operating pressure of 16 in. of water and can be used in a temperature range from -75 to 160 F. The totally enclosed, explosion-proof 1.2 hp aircraft motor furnished with the unit operates with a 4-pin-type connector on a 200-v, 400-cps system and at speeds up to 11,000 rpm. The MSA 7861 unit weighs 8 lb and occupies a space of less than 8 x 8 x 9 in.

Torrington Manufacturing Co., Air Impeller Div., Dept. ED, Torrington, Conn.

CIRCLE 83 ON READER-SERVICE CARD

Delay Lines

Feature compactness



A standard series of delay lines features compactness and meets MIL-C-15305A, Grade 1, Class B requirements. The 1 μ sec, 1000-ohm line has a delay-bandwidth product of over 7.5 per cu in. Molded in epoxy resin, units are square or tubular for printed circuit use or for stacking on common mounting screws. They can be stacked in series to give higher delays, or tap-off points can be used to give lower delays. Impedances range from 500 to 2000 ohms, with delays up to 1 μ sec. Operating temperature range is -55 to $+125$ C. Rise times are short—0.15 μ sec maximum for the longest delay.

NYT Electronics, Inc., Dept. ED, 2979 N. Ontario St., Burbank, Calif.

CIRCLE 84 ON READER-SERVICE CARD

Curve Tracer

Plots transistor characteristics



Model 341 power transistor characteristics plotter is a compact, general purpose curve tracer, designed for use with both point-contact and junction transistors. Its uses include supplying design information for transistor circuits, observing transistor anomalies, examining transistors for changes or deterioration, checking tolerance of transistors and matching or comparing transistors. Design permits circuit simplification similar to that of one-curve tracers, yet yields information equivalent to that from far more complex plotters.

Dunn Engineering Assoc., Inc., Dept. ED, 225 Brian Hwy., Cambridge 41, Mass.

CIRCLE 85 ON READER-SERVICE CARD



40 TAPS
IN 320
DEGREES

DeJUR FIELD INSERTABLE POTENTIOMETER TAP

MEETS ALL
EXISTING
SPECIFICATIONS
AND VIBRATION
TESTS!



ENLARGED VIEW

You're
always
sure
with

DeJUR

ELECTRONIC SALES DIVISION

Now you can meet most potentiometer function requirements with one new Insertable Tap* and a basic group of DeJUR potentiometers. With this rugged, easily installed tap, DeJUR potentiometers accept up to 40 taps in 320 degrees. In normal applications, taps can be placed as close as 5 degrees apart, in 2" diameter potentiometers.

All DeJUR potentiometers are made by exclusive bonding and cleaning methods that result in high precision and long life. These methods rule out loose turns and changes in wire contour and winding resistance. Since no drilling is necessary, the new tap can be inserted without sacrificing optimum reliability. Write for complete details on the new DeJUR Field Insertable Tap and DeJUR potentiometers.

WIDE-RANGE APPLICATION

In order to give you the widest range of application, DeJUR can also supply special configurations for unusual design functions, where less than 5 degrees separation between taps is desirable. Illustrated to the left are two of the new Field Insertable Taps set zero degrees apart.

ELECTRONIC SALES DIVISION
DeJUR-AMSCO CORPORATION
48-01 NORTHERN BLVD.
LONG ISLAND CITY 1, N. Y.

manufacturers of
precision potentiometers
for over 30 years

CIRCLE 86 ON READER-SERVICE CARD

*PAT. PENDING

PRODUCT-DESIGN MEMOS FROM DUREZ

Insulative molding compounds

Phenolics for a relay

New idea for control panels

But what if it rains?

From time immemorial, weather has upset the military plans of men. In Colonial days, wet gunpowder could lose a skirmish. Today, one moisture-affected part can nullify months of costly labor on a new missile.

This helps to explain the increasing pressure on moisture-resistant insulations for electronic parts that must not fail. It explains, too, the growing interest in a relatively new Durez molding material, *diallyl phthalate*.

This is the *only* plastic that retains its high insulation values over extended periods at relative humidities above 90%.

Its arc resistance, as measured by ASTM D495 (Method A or B) can be consistently reproduced.

It does not corrode metal contact points. Because it is a thermosetting material, it provides virtual freedom from cold flow and creep.

You can get this material from us as an orlon-filled granular blue or green molding compound with plasticity values of 10, 12, or 16 by ASTM D731. It is designed to meet the requirements of Mil-M-18794, Type SDI-5.



Official U. S. Navy photo

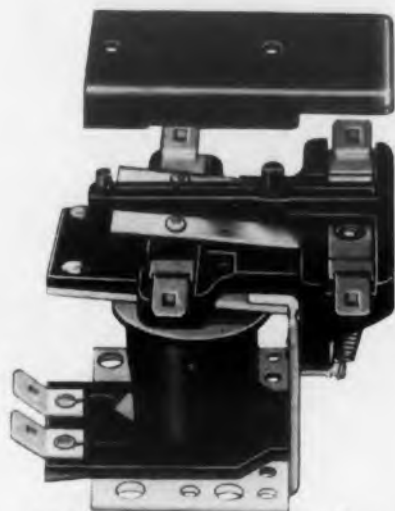
For a data sheet detailing properties of the compound and of molded material, check the coupon.

Right for a relay

Are you taking full advantage of the versatility of today's phenolics?

Consider the example of this new power relay produced by R-B-M Division, Essex Wire Corporation—a natural application for phenolic.

Designers wanted this relay to be *low in cost*, since it is intended for use in appliances. A unique feature, hammer-blow action on the contacts, calls for a specific degree of *mechanical strength* in the parts. Other requirements include high *dielectric*



R-B-M Control Division, Essex Wire Corporation

strength, stability on exposure to high humidity, and glossy finish.

A Durez medium-impact phenolic satisfies all these musts; helps R-B-M to offer a rugged, trouble-free product at a low price.

When you're designing electrical parts or components, remember that you're most likely to find the exact balance of properties you need—electrical, mechanical, and chemical—in one of the more than 150 Durez phenolic molding compounds.

Your molder can put Durez versatility to work for you. Why not call him in early on your next job?

New duct cuts wiring cost

You can save up to 30% of the cost of wiring control panels with this new per-

forated material, called "Channel-Duct."

Easily installed by means of clips, it takes the place of harnesses and solid-wire layouts, at a substantial reduction in cost. It also simplifies wire-tracing and replacement, and prevents trouble from vibration.

Assembly consists of two side members punched with 1/2" holes, and a solid snap-on cover strip. Strips may be sheared to any length.

Made of HETRON® polyester resin, reinforced with fibrous glass, the duct combines high degrees of flame retardance, impact strength, heat and moisture stability, and superior arc resistance.



The Glastic Corp.

For information on "Channel-Duct," write the manufacturer, The Glastic Corp., 4321 Glenridge Road, Cleveland 21, Ohio.

This is just one example of how product designers are using Hetron's unique properties. If you have a product (or just an idea) calling for a strong, lightweight material with inherent fire retardance, you may find some help in a complete Hetron data file which we'll be glad to send you. Just check the coupon.

For more information on Durez materials mentioned above, check here:

- Diallyl phthalate, 16694
- Phenolic molding compounds—descriptive bulletin
- Hetron resins—technical data file

Clip and mail to us with your name, title, company address. (When requesting samples, please use business letterhead.)



PLASTICS DIVISION
HOOKER CHEMICAL CORPORATION

2207 Walck Road, North Tonawanda, N. Y.

CIRCLE 87 ON READER-SERVICE CARD

NEW PRODUCTS

Phase Meter and Phase Shifters

0.1 deg accuracy



Model 340 phase meter and phase shifter as shown provides phase measurements and a phase source having an accuracy of 0.1 deg. The phase angle is continuously adjustable from 0 to 400.0 deg. Model 440 phase shifter has an accuracy of better than 0.1 deg. The input impedance is 200 K and the output impedance is 500 ohm.

Dytronics Co., Dept. ED, P.O. Box 3676, Columbus 14, Ohio.

CIRCLE 88 ON READER-SERVICE CARD



Clutch

Has torque of 140-oz-in.

Model HCS-500 clutch has 140 oz-in. torque rating. Torque may be controlled from zero up to the maximum rating of the unit, relatively independent of slip speed characteristics, according to the clutch control current setting. The unit employs a stationary coil, eliminating frequently objectionable characteristics of slip rings.

Magtrol, Inc., Dept. ED, 240 Seneca St., Buffalo 5, N.Y.

CIRCLE 89 ON READER-SERVICE CARD

Low Pass Filters

Feature low insertion loss

Type A2 low pass filters have low insertion loss, are very compact in size and have rugged construction. Six models are available with cut-offs from 125 to 1000 cps. Specifications include an insertion loss of 0.2 to 0.5 db ripple in the

pass band; vswr of 1.5 max; power handling of 5 w, and weight of less than 3 oz.

Maury & Assoc. Electronic Research & Development, Dept. ED, 10373 Mills Ave., Pomona, Calif.

CIRCLE 90 ON READER-SERVICE CARD

Servo Amplifier

Has variable damping or feedback control



Operating from -55 to $+125$ C, this transistorized servo amplifier with variable damping or feedback control, has an output power of up to 10 w. Type AMP-9616 can be designed to drive a servo motor-generator with standard 115/57.5 v control phase or 40/20 v control phase without the need of an output transformer. Open loop power gain is up to 90 db.

John Oster Manufacturing Co., Avionic Div., Dept. ED, 1 Main St., Racine, Wis.

CIRCLE 91 ON READER-SERVICE CARD

Timers

Intervals from 50 msec to several hours



This series of transistorized RC timers has time intervals ranging from 50 μ sec to several hours and eliminates use of motor-driven and thermal elements. Voltage ranges are 14 to 32 v dc or 24 to 220 v ac. They measure as small as 3 cu in. and weigh a minimum of 3 oz. Temperature range from -55 to $+71$ C or -55 to $+125$ C.

Jordan Electronics Div. of The Victoreen Instrument Co., Dept. ED, 3025 W. Mission Rd., Alhambra, Calif.

CIRCLE 92 ON READER-SERVICE CARD



MICRO SWITCH Precision Switches



We've Miniaturized the Subminiature!

WEIGHT: 1 gram... 28 switches to the ounce... over 430 to the pound. SIZE: .500" long, .200" wide, .350" high. CUBIC CONTENT: .035 cubic inches. ELECTRICAL RATING: 5 amps-250 vac, 30 vdc. SPDT.

After a long period of laboratory development, MICRO SWITCH announces this new, highly miniaturized precision snap-action switch and a complementary line of actuators.

We call it the "Sub-subminiature!"

This new "SX" basic switch represents an entirely new set of answers to the space-weight problems in dependable precision switching. It combines new small size with more than ample capacity for wide usefulness, meeting the pressing demand for miniaturization combined with reliability.

In its exacting development, many prob-

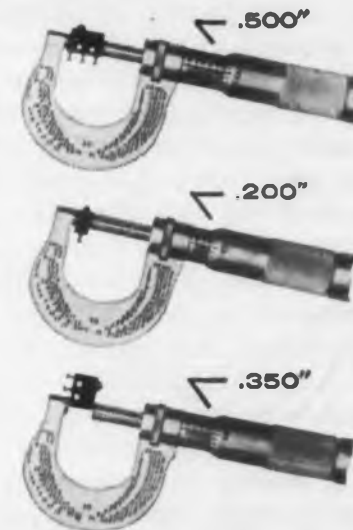
lems of design, testing and quality control presented themselves. However, 23 years of experience proved of immense value. As a result, a new standard has thus been set by which all precision switches must be measured.

This broad experience can prove of equal value to you. Send for more information about this new switch. Request Data Sheet No. 148.

MICRO SWITCH...FREEPORT, ILL.

A division of Honeywell

In Canada: Honeywell Controls, Ltd., Toronto 17, Ontario



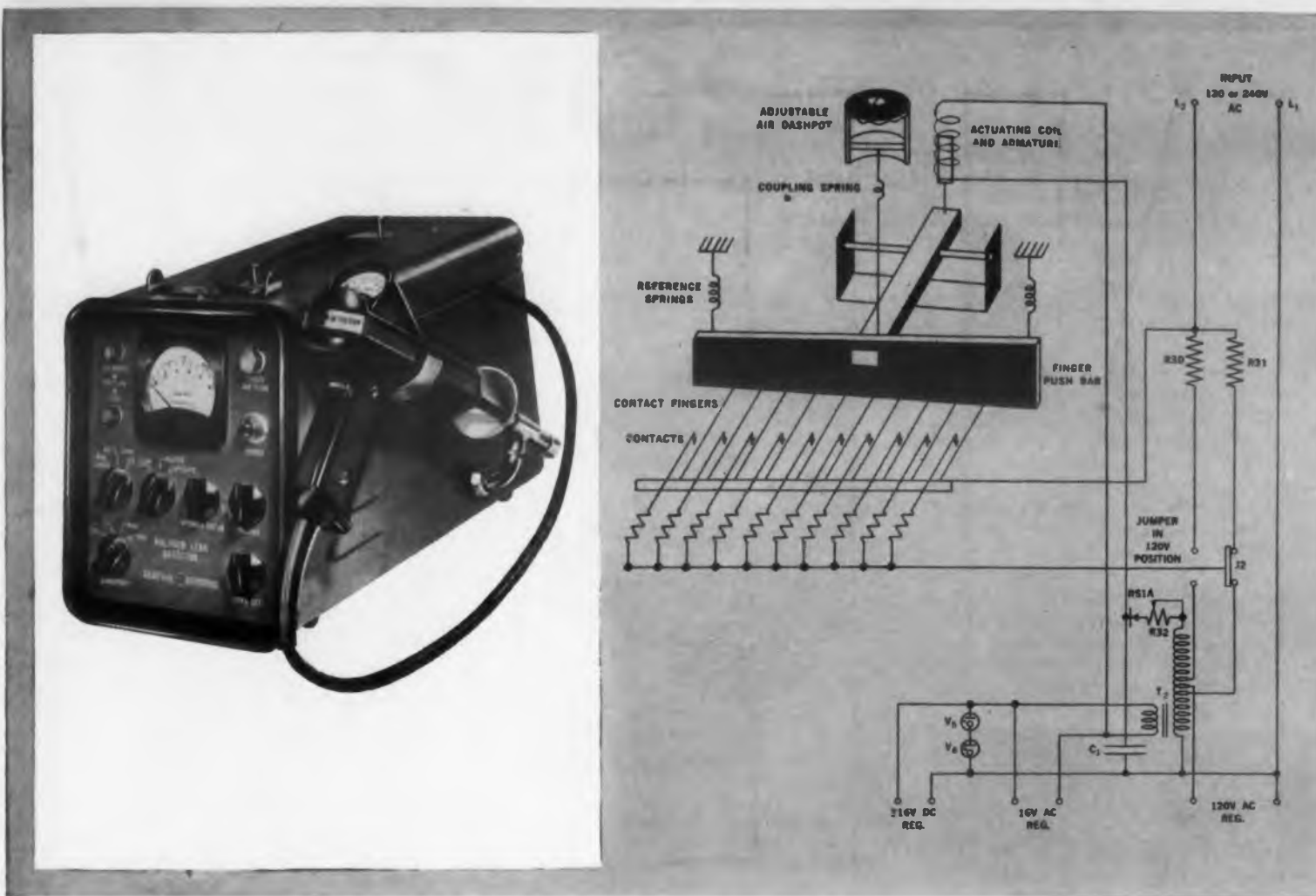
Honeywell

MICRO SWITCH PRECISION SWITCHES

CIRCLE 93 ON READER-SERVICE CARD

The two-word name MICRO SWITCH is NOT a generic term. It is the name of a division of Honeywell.

REGOHM SOLVES Another Electronics Control Problem



REGOHM CONTROL HELPS MAINTAIN 0.01 oz/year SENSITIVITY IN NEW HALOGEN LEAK DETECTORS

The General Electric Company uses a REGOHM to control the input voltage to the power supply transformer of its Type H Halogen Leak Detectors. The REGOHM was installed because the high sensitivity requirements of these instruments call for rigid control of the voltages on the amplifier tubes and the sensing element. REGOHM's small size and light weight were other factors in this application. Furnished with extremely stable gain by the REGOHM, the Leak Detector provides a quick, clean, and reliable method of locating leaks as small as 0.01 ounce a year in pressurized or evacuated enclosures.

In operation, the REGOHM senses any change in the voltage across the secondary of the power supply transformer and instantly modifies the transformer primary input to restore the secondary voltage to normal. In this way, both AC and DC output voltages are regulated to better than $\pm 1\%$, with input voltages of 120 or 240 VAC $\pm 8\%$ at frequencies from 48 to 480 CPS.

Where close control is required in electronic or electrical equipment, designers choose REGOHM, because of its exceptional sensitivity; stability, wide range of control resistance, long life, permanence of adjustment, rugged design, and low cost.

Electric Regulator Corporation produces many other control devices — MAGOHM magnetic voltage regulators, REGOHM-MAGASET exciter field regulators, voltage and frequency monitors, line-load regulators, airborne magnetic amplifiers, filament regulators, speed controls, GOVOHM diesel governors, and servomotor controls.

Our engineers will be glad to help you select a control that can solve your problem, both performance-wise and cost-wise. Quite likely, it has already been solved by an established application of an Electric Regulator control device. Call, wire, or write Electric Regulator Corporation, Norwalk, Connecticut.

CIRCLE 94 ON READER-SERVICE CARD



Please write for design data and performance specs on REGOHM multi-stage regulators in applications similar to this.



ELECTRIC REGULATOR CORPORATION
NORWALK CONNECTICUT

NEW PRODUCTS

Gear-Head Motor Withstands very high shock



Model P5B827P75 is stated to be designed to withstand 7500 g. It operates on 28.5 to 31.5 v dc developing 1000 oz-in. of torque at -65°C . The gear box is a six-stage, planetary design with a reduction ratio of 13,840:1, giving the output shaft a rotation speed of 1.3 rpm.

Western Gear Corp., Dept. ED, P.O. Box 182, Lynwood, Calif.

CIRCLE 95 ON READER-SERVICE CARD



Gas Noise Source Tube

Generates random noise of 16 ± 1 db

Designed for use with the standard RG-52/U waveguide assembly, this gas noise source tube type 6357 will generate random noise at a noise level of 16 ± 1 db above 290 K at frequencies in the 2.4 to 3.6 cm waveband. The use of an inert gas makes the noise output independent of the operating temperature.

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

CIRCLE 96 ON READER-SERVICE CARD

Magnetic Shift Register

Speeds to 500 kc

A two-cores-per-bit shift register operates at speeds up to 500 kc. The maximum shifting rate of the DK 107 is above one megacycle. All components including two cores and four gold-

bonded germanium diodes are encapsulated in epoxy. Units are provided with solder lug headers, plug in bases, and solder pins for printed circuitry.

Airtronics, Inc., Dept. ED, Bethesda, Md.
CIRCLE 97 ON READER-SERVICE CARD

Converter

Features three section tuner



Model 99R all-channel uhf converter features a three-section tuner with a dual input section. Additional features are simplified single-knob tuning of channels 14 through 83, drift-free performance, double-tuned rf section and precise 300 ohm impedance match. The unit operates on 117 v at 60 cps. It weighs 3-1/2 lb and measures 6-3/4 x 5 x 4-3/4 in.

Blonder-Tongue Labs., Inc., Dept. ED, 9-25 Alling St., Newark 2, N.J.

CIRCLE 98 ON READER-SERVICE CARD

Transistor Tester

Measures transistor characteristics



Model TT-205 transistor tester measures small signal beta, collector leakage current, and collector resistance on all npn, pnp, surface barrier, grown or diffused junction transistors. Eleven operating points are provided with one selector switch. The instrument employs three transistors, one as a stable local oscillator having a nominal frequency of 1000 cps, the other two as a special purpose, low level, synchronous linear detector.

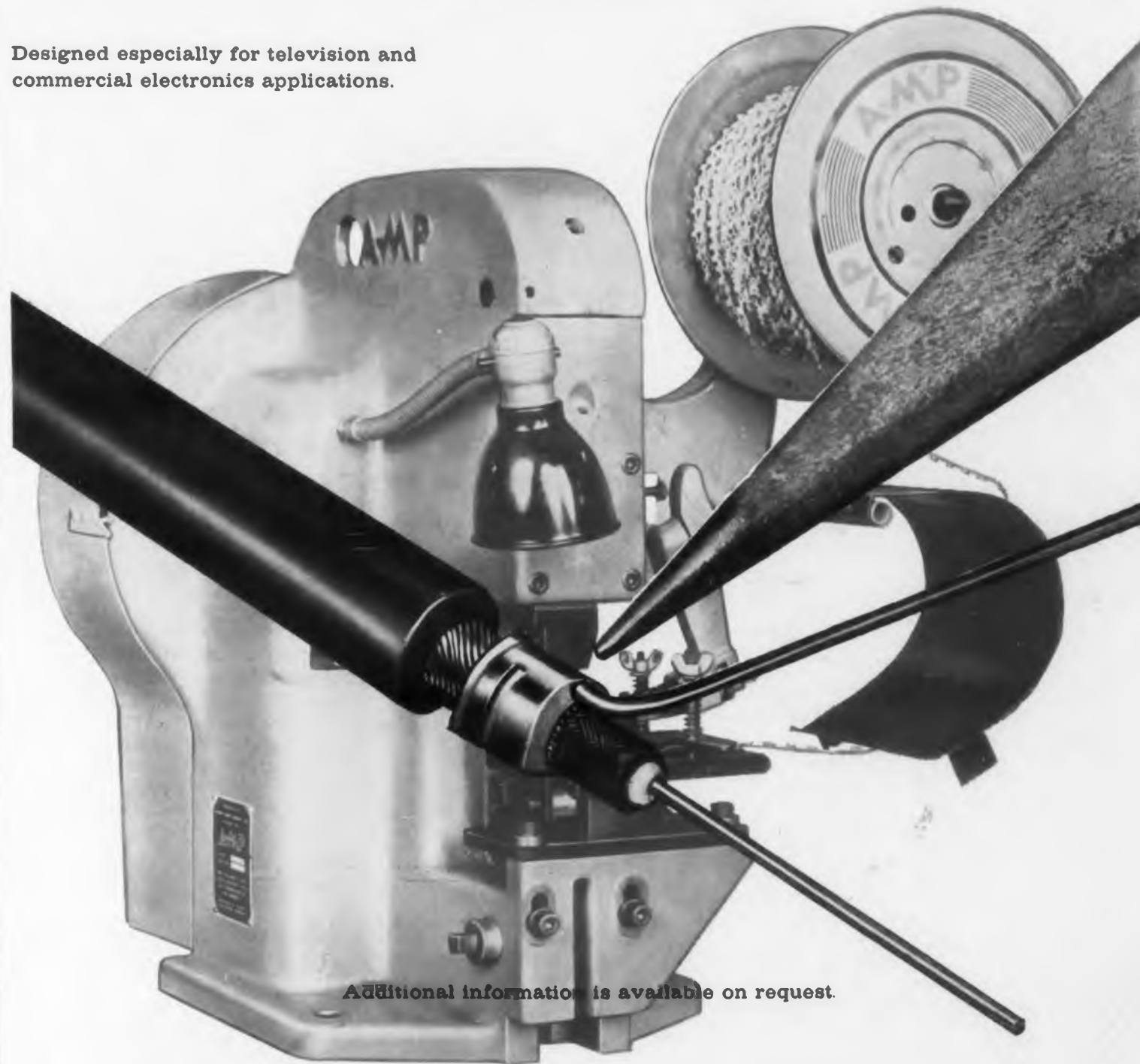
Sonex, Inc., Dept. ED, 73 S. State Rd., Upper Darby, Pa.

CIRCLE 99 ON READER-SERVICE CARD

NOW... AUTOMATED PIGTAILING ... AT 75% LESS COST - with the NEW **AMP** Automachine Shielded Wire Ferrule

- machine-fed ferrules and pigtail wire • controlled compression termination, with AMP automachine technique • dual applicator permits termination of two leads or double-ended jumper, simultaneously
- pigtails cut to desired length, automatically!

Designed especially for television and commercial electronics applications.



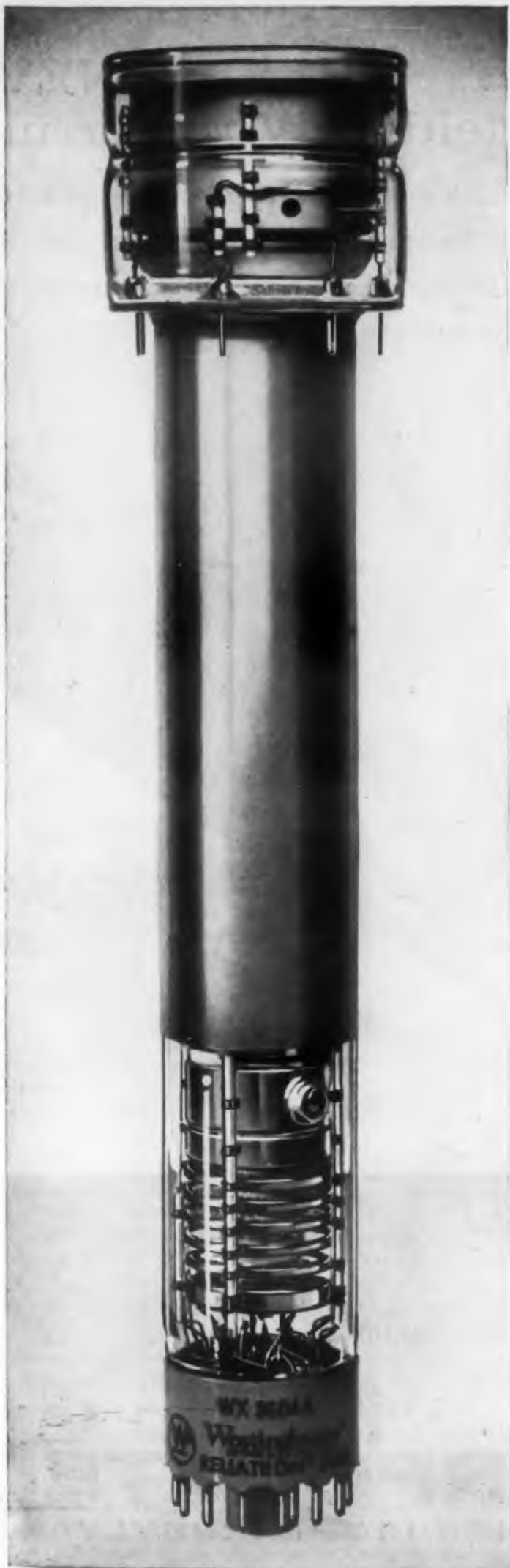
Additional information is available on request.

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 104 ON READER-SERVICE CARD



New Ruggedized Westinghouse Image Orthicon!

**DURABLE NEW WL-7198
WITHSTANDS SEVERE
ENVIRONMENTAL CONDITIONS,
SHOWS NO DEGRADATION
AFTER 30 G'S!**

Now Westinghouse has developed an image orthicon tube that's rugged enough to withstand 30 g's . . . yet sensitive enough to perform efficiently at low light levels. The new WL-7198 is ideal for military, industrial and scientific applications subject to extreme environmental conditions.

TYPICAL CHARACTERISTICS OF THE WL-7198 ARE:

- Vibration: (1) Operable throughout MIL-E-5272A Procedure I (10 g's from 50 to 500 cps)
(2) 350 lines horizontal resolution at 5 g's from 50 to 500 cps with 3×10^{-2} foot-candles on photocathode.

Shock: No degradation after 30 g's.

Low light level performance: 250 lines minimum resolution 3×10^{-4} foot-candles on photocathode.

Sample quantities of the WL-7198 are available for immediate delivery.

WESTINGHOUSE ENGINEERS WILL HELP YOU SOLVE YOUR IMAGE ORTHICON PROBLEMS UPON YOUR REQUEST.

YOU CAN BE SURE...IF IT'S

Westinghouse

Electronic Tube Div. Elmira, New York

CIRCLE 105 ON READER-SERVICE CARD

NEW PRODUCTS



Patchcord System
Modular contact strips

This patchcord programming system provides an uncomplicated method of programming that is both compact and flexible. Its flexibility results from the modular arrangement of contact strips and the use of either single or multiple patchcords. By altering the size of the framework any reasonable number of contacts can be provided. The compactness of the system is such that 44 contacts are contained in an area $8\text{-}3/32$ in. wide by $4\text{-}1/2$ in. high.

Virginia Electronics Co. Inc., Dept ED, River Rd. and B. & O. Railroad, Washington 16, D.C.

CIRCLE 106 ON READER-SERVICE CARD

Sampling Switch

45 channels



This solid state commutator has 45 non-short-circuiting channels, sampled 20 times per second. It accepts signals ranging from 0 to +5 v dc and produces a train of noise-free pam waveforms with rise and fall times not exceeding 0.5 per cent of full scale pulse. "On" time is continuously adjustable from 100 to 0 per cent of duty cycle. Preselected repetition rates are selected by proper wiring to mating plugs. The unit weighs less than $2\text{-}1/4$ lb, and requires less than 3 w of 28 v dc. With source impedances as low as 5 k conversion accuracy is ± 0.5 per cent of full scale.

General Devices, Inc., Dept. ED, Princeton, N.J.

CIRCLE 107 ON READER-SERVICE CARD

Relay

For high vibration use



Type 2SM two-pole relay is available on special order to those who need vibration immunity to two or three times the normal limitation of 20 g at 2000 cps. The relay will withstand temperatures to 125 C, standard, and to 200 C, special. Contacts are rated to 5 amp resistive, and for dry circuit application.

Hj-G, Inc., Dept. ED, Bradley Field, Windsor Locks, Conn.

CIRCLE 108 ON READER-SERVICE CARD

Tape Monitor

Multi-channel



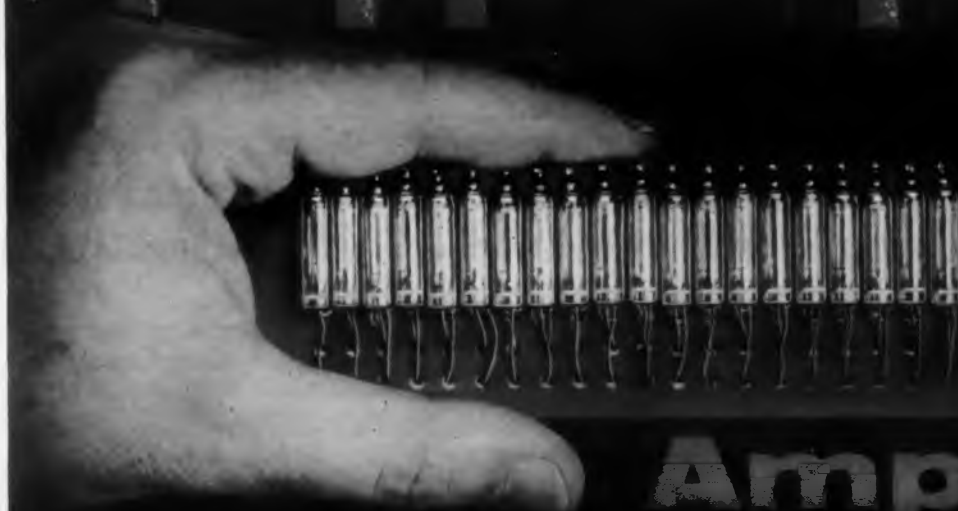
Model P-106-B Systemat multi-channel tape monitor has applications in telemetering, jet engine testing and many other similar jobs. The unit includes six Panelscopes, power supply, and sweep generator for up to 14 monitors. A system of lamps is used to indicate under or over modulation. The model P-106-B is designed to indicate full scale vertically or horizontally with an input of 1 v rms with a response of dc to 300 kc within 3 db.

Waterman Products Co., Inc., Dept. ED, 2445 Emerald St., Philadelphia 25, Pa.

CIRCLE 109 ON READER-SERVICE CARD
CIRCLE 393 ON READER-SERVICE CARD



*The tube that makes
present computer
indicator system designs
obsolete...*

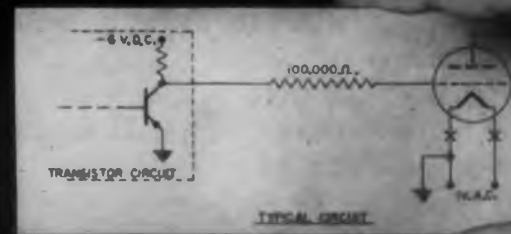


Amperex 6977
subminiature indicator tube

Monitors Transistorized Circuits

- with higher information density
- with simpler associated circuitry
- without ionization- and deionization-time problems
- with increased circuit protection
- with lower power requirements
- with lower cost per unit
- with ultra-compact assembly on printed circuit boards

The AMPEREX 6977 is a high-vacuum filamentary subminiature indicator triode which gives a bright blue-green indication when the control grid is at zero potential. It has been developed specifically for transistorized computers, where its high input impedance and small signal requirements enable it to monitor the transistor circuits without loading them and affecting their operation. It replaces the conventional and much more expensive high-voltage transistor and neon lamp combination so far used in transistor computers for the same purpose. Since its high input impedance permits the use of a series grid resistor, it will not short out the transistor circuit if it should ever fail. Manufactured with special computer tube techniques, the 6977 is designed for 20,000 hours life.



Heater voltage is only 1 volt, 30 ma, AC or DC. The anode will draw only 0.5 ma from a 50 volt DC supply during the zero-bias "on" condition. A 3.0 volt DC voltage is sufficient to cut-off plate current and light. Write for data sheet to Semiconductor and Special Purpose Tube Division, Amperex Electronic Corp., 230 Duffy Avenue, Hicksville, L.I., N.Y.

about products and services for the computer industry

AMPEREX ELECTRONIC CORP., 230 DUFFY AVENUE, HICKSVILLE, LONG ISLAND, N. Y.
In Canada: Rogers Electronic Tubes & Components, 11-19 Brentcliffe Road, Leaside, Toronto 17

NEW PRODUCTS

Punched Card Buffer

Card-to-tape compatibility



This magnetic core memory unit, type 80-CB-7, stores up to 80 alpha-numeric characters to accommodate the full contents of a standard card. Additional applications include transfer of card data to electronic computers, digital control systems, and remote transmission equipment.

Telemeter Magnetics, Inc., Dept. ED, 2245 Pontius Ave., Los Angeles 64, Calif.

CIRCLE 394 ON READER-SERVICE CARD

Tuning Forks

Accuracies to 0.01 per cent



Series 6250 tuning forks cover a range of 300-4000 cps at accuracies to 0.01 per cent. Configurations available include thermistors for external circuit temperature compensation and heaters for extreme temperature ranges.

Varo Manufacturing Co., Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

CIRCLE 395 ON READER-SERVICE CARD

Power Supply

Dual transistorized unit



Model TQ-36 is a twin transistorized dc power supply, with each output rated at 4-36 v, 0-1 amp. Regulation of 0.1 per cent for line or load is

WESTINGHOUSE TAKES A GIANT STEP

Through major improvements in silicon purification and transistor fabrication, Westinghouse has broken down the previous limitations of Silicon Power Transistors. The result is a new series of Westinghouse Power Transistors which can operate at high efficiencies in the "true power range."



LIFE-SIZE DRAWING shows how Westinghouse Silicon Power Transistor is designed for attachment to heat sink with a screw stud. All leads are in the base.

THESE are the first members of an entirely new family of Westinghouse Silicon Power Transistors, which have the advantages associated with silicon (high voltages and high operating temperature) without the disadvantages (high losses). As you can see from the chart on the right-hand page, these units possess exceptionally low saturation resistance—less than one half ohm. This low saturation resistance which results in low internal dissipation, coupled with high power handling capacity, makes possible silicon transistors which can efficiently handle 1000 or 1500 watts. For example, as a DC switch, handling 1.5 kw (300 volts at 5 amperes) the internal dissipation of the units is about 12.5 watts with a resulting efficiency of better than 99%. Typical reverse leakages are 3 milliamperes.

Like other silicon devices, these transistors can operate in ambient temperatures up to and exceeding 150°C while germanium units are limited to 85°C. Thus, where the higher power rating is not required these units may be used for their high temperature capabilities. It also follows that wherever germanium power units are presently employed, a switch to silicon transistors will result in higher reliability of operation, because of the greater margin of safety with respect to operating temperature.

There are a great many circuits for which this new type of silicon power transistor is made to order. It will find use in inverters or converters (AC to AC, AC to DC, DC to AC, DC to DC), to control frequencies for data processing, servo output, and other aircraft information applications. It will serve as a low frequency switch, as mentioned above; it will operate efficiently with low power supply voltages; and it will find a number of uses in class A amplifiers. There are also many additional applications—too numerous to list here.

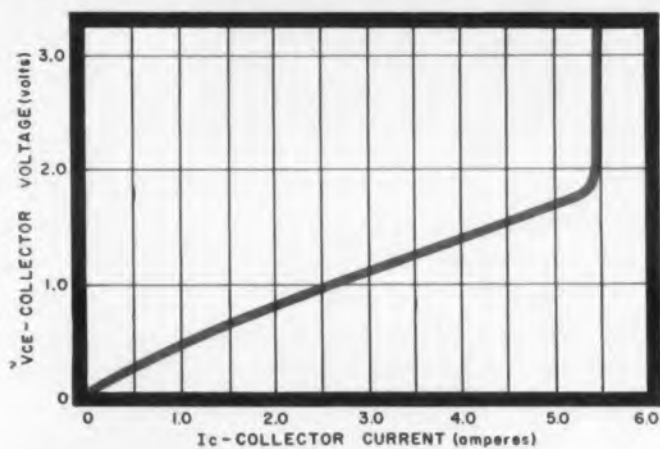
These Westinghouse Silicon Power Transistors are available in sample quantities for your testing and immediate application. Call your Westinghouse representative or write directly to Westinghouse Electric Corporation, Semiconductor Dept., Youngwood, Pennsylvania.



WESTINGHOUSE SILICON POWER TRANSISTORS

	current rating	V _{CBO}	V _{CE} (V _{EB} =0)	R _s
X 107-2	2 amperes	30-300V	30-300V	0.5 ohms Typical
X 107-5	5 amperes	30-300V	30-300V	0.4 ohms Typical

Thermal resistance—Junction to case, 0.7°C/watt typical. Current ratings based on the current at which current gain is equal to or greater than 10. It is possible to switch higher collector currents with some sacrifice in gain.



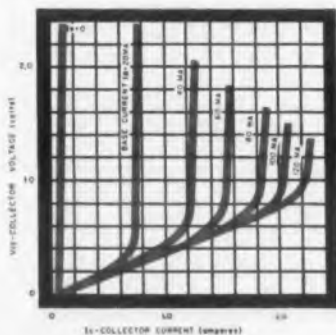
LOW SATURATION RESISTANCE

is exhibited in this graph showing values for a typical Westinghouse Silicon Power Transistor driven to 5 amperes. The values are fractions of those observed in other silicon transistors.



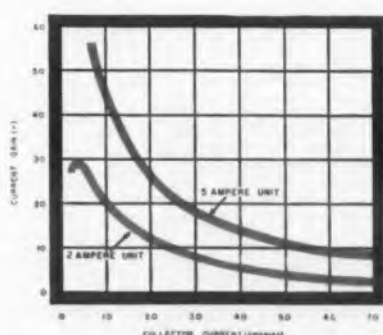
VOLTAGE CHARACTERISTICS

of a 300-volt unit are shown here. High emitter-base voltage may be important in some circuits. In this illustration emitter-base reaches 100 volts.



COMMON EMITTER OUTPUT CHARACTERISTICS

are charted here for the lower current outputs. The characteristics saturate sharply.



DC CURRENT GAINS

are presented as functions of collector-emitter current in the 2 ampere- and 5 ampere-rated units.

CIRCLE 396 ON READER-SERVICE CARD

YOU CAN BE SURE...IF IT'S

Westinghouse

afforded by a Zener diode reference. Output impedance is 0.01 ohm, dc. Typical transient response is 50 μsec and ripple is less than 3 mv.

Universal Electronics Co., Dept. ED, 1720 22nd St., Santa Monica, Calif.

CIRCLE 397 ON READER-SERVICE CARD

Constant Speed Drive

16 in.-oz at 1000 rpm



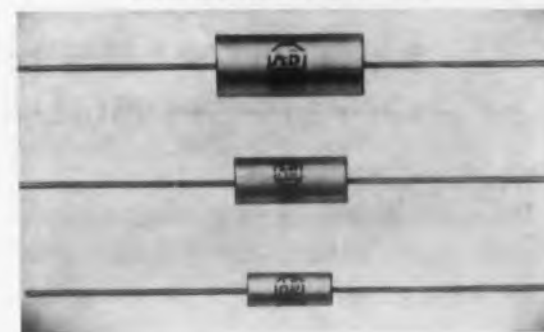
Designed for computer and control system applications, this constant speed power drive supplies 16 in.-oz at 1000 rpm. Tolerance on speed is in the order of ±0.1 per cent with an input voltage variation of ±20 per cent and an input speed of 1100 rpm ±15 per cent. A typical unit, type 041-9902, measures 4-1/4 x 2 x 2 in. and weighs in the order of 1 lb. This unit utilizes a timing motor requiring 28 v dc at 3 w.

M. Ten Bosch, Inc., Dept. ED, Pleasantville, N.Y.

CIRCLE 398 ON READER-SERVICE CARD

Resistors

Grid resistance Element



Using a specially designed metal alloy grid resistance element, these resistors are available in three types: the CAH, 0.25 w; the EAH, 0.50 w; and the GAH, 1.0 w, with full ratings at 100 C ambient. The resistors exceed Mil specifications for wirewound and metal film type precision resistors. The resistors employ a noninductive resistance element for excellent high frequency characteristics. The metal alloy grid results in a noise level comparable to that of wirewound resistors.

Allen-Bradley Co., Dept. ED, 136 W. Greenfield Ave., Milwaukee 4, Wis.

CIRCLE 399 ON READER-SERVICE CARD



Weston offers a broad new line of long-scale instruments

250° SCALES MEAN GREATER READABILITY FROM EACH SQUARE INCH OF PANEL SPACE

Weston's new series of Long-Scale Instruments now fills the requirements of a wide variety of special applications. Rugged, spring-backed-jewel mechanisms are self-shielded for immunity to the effects of stray magnetic fields. The instruments may be mounted without concern for panel thickness or material. Thus, exceptional stability (both mechanical and electrical) teams up with unequalled readability for a new high in panel instrument value. Accuracies are within $\pm 1\%$ of full-scale range.

Weston Long-Scale Instruments are available in Aircraft and Standard Flanged cases for a wide range of current, voltage, tachometric and temperature indications. Consult your local Weston representative for complete details on Long-Scale Instruments . . . or write for Catalog A-50. Address: Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.

Take advantage of Weston's unusually fast prototype service!

WESTON

Instruments

CIRCLE 110 ON READER-SERVICE CARD



NEW PRODUCTS



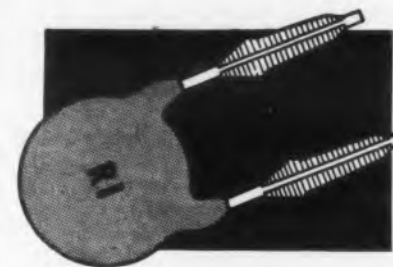
Terminals

High temperature ceramic-to-metal

These ceramic-to-metal lead-through terminals, which provide vacuum seals around conductor lead-throughs, are designed for high temperatures and high altitudes. The terminals are for use with soft solders at temperatures up to 450 F and with hard or silver solders at temperatures to 1400 F.

Thermo Materials, Inc., Dept. ED, 4040 Campbell Ave., Menlo Park, Calif.

CIRCLE 111 ON READER-SERVICE CARD



Capacitor Leads

Lock-in

Available on RI-cap printed circuit capacitors, Swedge leads lock firmly into circuit boards and prevent falling out or tipping over. A special shoulder stop keeps the leads from being pushed through the board and prevents durez parts from interfering with soldering. The leads insert easily into various size holes.

Radio Industries, Inc., Dept. ED, 5225 N. Ravenswood Ave., Chicago 40, Ill.

CIRCLE 112 ON READER-SERVICE CARD

Components

For 26 v and 115 v, 400 cps operation



This series of synchros, resolvers and line transformers for indication and control is designed for 26 v and 115 v, 400 cps operation.

Stainless steel construction with high nickel laminations provides for good corrosion resistance. Operating temperatures are from -50 to $+125$ C. In addition to position indicating on valves, computer shafts, and missile components, the units achieve accuracy as sensing elements and in servo mechanisms.

Induction Motors of California, Dept. ED, 6058 Walker Ave., Maywood, Calif.

CIRCLE 113 ON READER-SERVICE CARD

Cooling System

Takes large heat loads



The U-520878-1 hydraulic and electronic system has such performance characteristics as: max heat loads of 2500 w (hydraulic) and 5150 w (electronic); required air flow of only 75 lb per min; max pressure drop of 6 in. H_2O at 122 lb per min, and an operative altitude range to 70,000 ft.

United Aircraft Products, Inc., Dept. ED, 1116 Bolander Ave., Dayton, Ohio.

CIRCLE 114 ON READER-SERVICE CARD

Silicon Diodes

Rated to 500 v piv



These diodes provide dc forward currents up to 45 a with a maximum peak inverse voltage to 500 v. They are capable of operation at a junction temperature of 200 C.

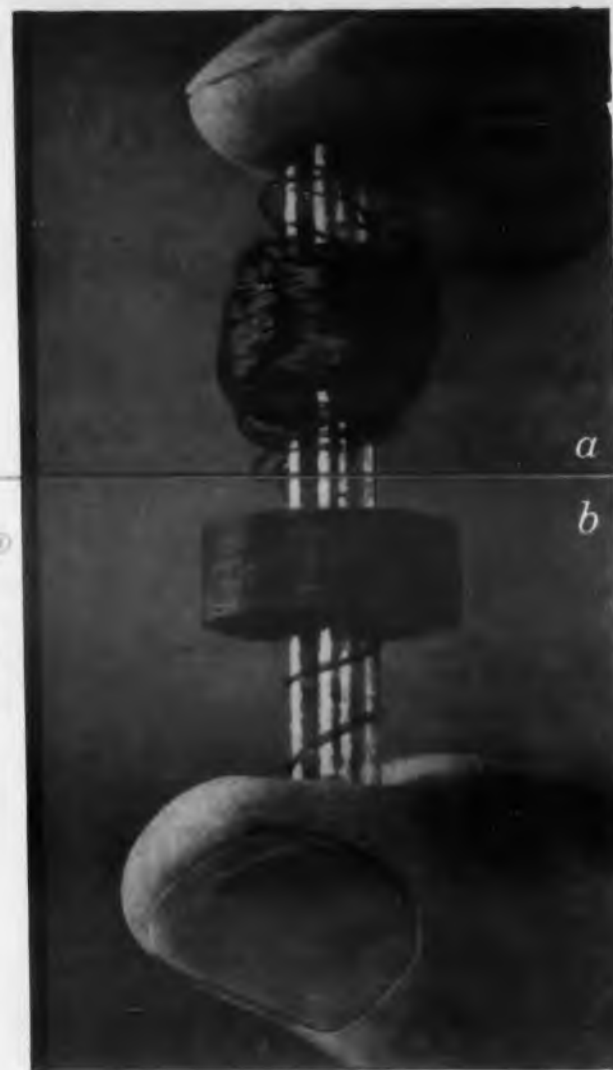
International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

CIRCLE 115 ON READER-SERVICE CARD

If you have this problem, investigate

GRIP-EZE®

—an example of Phelps Dodge's realistic approach to Magnet Wire research



THE PROBLEM: To develop a solderable film-coated wire without fabric for winding universal lattice-wound coils without adhesive application.

THE SOLUTION: Phelps Dodge Grip-eze—a solderable film wire with controlled surface friction for lattice-wound coils that provides mechanical gripping between turns and keeps wire in place.

EXAMPLE: Coils wound with (a) conventional film wire; (b) Grip-eze. Note clean pattern of Grip-eze as compared to fall-down of conventional film wire.

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

FIRST FOR
LASTING QUALITY
—FROM MINE
TO MARKET!



**PHELPS DODGE COPPER PRODUCTS
CORPORATION**

INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA

CIRCLE 400 ON READER-SERVICE CARD

Narda SonBlasters offer the most complete line of lowest-cost mass-produced ultrasonic cleaners!

Narda's mass-production techniques assure you the most complete line of ultrasonic cleaners at the lowest prices in the industry! From the smallest 35-watt to the amazing 2500-watt unit with a tank capacity of 75 gallons, Narda's SonBlasters are available now—off-the-shelf—for immediate delivery. And with a full 2-year warranty besides!

What do you want to clean? Transistors, semi-conductors, other electronic, automotive, missile and avionic components, instruments, timing mechanisms—Narda's SonBlasters clean

'most any mechanical, electrical or horological part or assembly you can think of—and clean faster, better and cheaper.

No matter what you need in ultrasonic cleaning equipment, you'll find Narda's complete line of production-size units have the quality, power, performance, capacity and appearance of cleaners selling up to three times their price! Write for more details now and we'll include a free questionnaire to help determine the precise model you need. Address: Dept. ED-16E.



Generator G-202 35 watts Transducerized Tank NT-202 Capacity: 3/8 gallon

An amazingly efficient, yet inexpensive, ultrasonic cleaner. Duty cycle timer permits operator to turn the unit on, set it, and leave; the SonBlaster will turn off automatically at the end of the cycle. Four choices of timers—from 0-15 min. to 0-120 min. Also available without timer at slightly lower cost (G-201).

\$220



Generator G-601 60 watts Transducerized Tank NT-602 Capacity: 1 gallon

A more powerful production-type unit, with a special circuit and selector switch permitting operator to alternate between two tanks, when items being cleaned require different solutions or a two-step process.

\$350



Transducerized Tank NT-1505 Capacity: 5 gallons Generator G-1501 200 watts

The lowest price in the industry for a tank of this capacity and activity. Generator also will operate 2, 3 or 4 submersible transducers at one time, with just a turn of the load selector switch on the front panel.

\$695



Transducerized Tank NT-5001 Capacity: 10 gallons

Generator G-5001 500 watts

Generator features standby switch for longer life and load selector switch on the front panel to operate up to 8 submersible transducers or 8 NT-602 or 2 NT-1505 transducerized tanks at one time. Larger tanks available on special order.

\$1325



Submersible Transducer NT-605

Heli arc welded stainless case, hermetically sealed for safe, leak-proof immersion. Radiating face: 27 sq. in. Effective plane of radiation: 40-50 sq. in. (approximately 10" x 5"). Effective cavitation of volumes up to 1200 cu. in. at 24 in. tank height (5 gal.) and 2400 cu. in. at 48 in. tank height (10 gal.). Bulkhead electrical fitting on back allows all wiring connections to be made on outside of tank. For use in any arrangement or location in any shape tank you desire to use. Also available—model NT-604, identical with NT-605, except for pipe thread instead of bulkhead fitting, permitting electrical connections inside of tank.

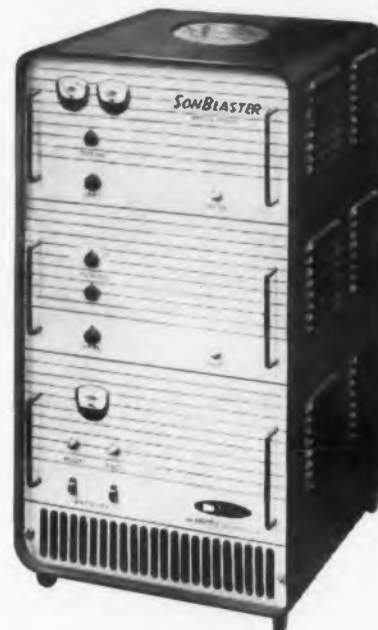
\$130

Consult with Narda for all your ultrasonic requirements. The SonBlaster catalog line of ultrasonic cleaning equipment ranges from 35 watts to 2.5 KW, and includes transducerized tanks as well as immersible transducers which can be adapted to any size or shape tank you may now be using. If ultrasonics can be applied to help improve your process, Narda will recommend the finest, most dependable equipment available—and at the lowest price in the industry!

Generator G-25001 2500 watts

Powerful unit drives the largest mass-produced industrial-size transducerized ultrasonic cleaning tank made! (Tank NT-25001; capacity: 75 gallons.) G-25001 generator also energizes up to 40 submersible transducers.

\$4360



For custom-designed installation and unique electro-acoustic applications, including cleaning, soldering, welding, drilling and non-destructive testing, consult our subsidiary, Alcar Instruments Inc., at the address below.

NEW PRODUCTS

Frequency Measurement

Range from 2000 to 4000 mc



Developed for the exact determination of frequencies of transmitted signals, this instrument is basically a frequency marker generator covering the range from 2000 to 4000 mc. Applications include use in counter-measures, communication systems, and telemetering.

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

CIRCLE 117 ON READER-SERVICE CARD

Video Attenuator

Flat response to 10 mc



Model V256 video attenuator is available in 45 steps of 0.1 db per step. The attenuator has a flat frequency response from dc to 10 mc and has either a standard lug type terminal board, or UG-185/U connectors.

The Daven Co., Dept. ED, Livingston, N.J.

CIRCLE 118 ON READER-SERVICE CARD

Low-Noise Potentiometer

Operates from -85 to +185 F



Capable of handling up to 3 w, the model 101 low-noise precision potentiometer operates



the narda ultrasonics corporation

118-160 HERRICKS ROAD, MINEOLA, L. I., N. Y.
Subsidiary of The Narda Microwave Corporation

CIRCLE 116 ON READER-SERVICE CARD

over a temperature range from -85 to +185 F. It stands 5 g of vibration between 20 and 2000 cps and up to 30 g of shock in six directions. This 10-turn potentiometer is available in eight standard resistance values between 500 and 100,000 ohms. Standard linearity tolerance is ± 0.5 per cent. Other resistance values can be provided with linearity up to ± 0.05 per cent.

Hub-Pot, Inc., Dept. ED, 1242 E. Transit Ave., Pomona, Calif.

CIRCLE 119 ON READER-SERVICE CARD

Waveguide Bending

Process provides smooth interior



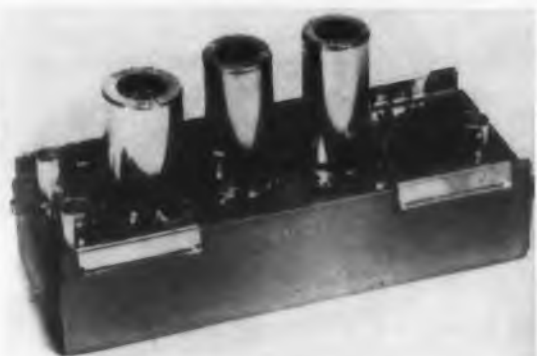
This forming process, for bending and twisting wave guides, produces a uniformly smooth interior devoid of energy absorbing hot-spots. Draw marks, creases, burrs and ripples are eliminated by the process, which is called Micro-smooth. The method allows closer tolerances to be held on inner dimensions while bends in any plane can be combined with twists and sharp radii.

Uniwave, Inc., Dept. ED, Farmingdale, N.Y.

CIRCLE 120 ON READER-SERVICE CARD

I-F Preamplifier

20 db gain over 10 mc band



Model P205 preamplifier is designed to be fed from a crystal mixer having a 200 to 300 ohm balanced output. A variation of the P205, model P205A, is available for 200 ohm unbalanced mixers. The unit provides a gain of 20 db with a bandwidth of 10 mc. Noise figure is 2 db. Output impedance is 50 ohms, and input is either 200 to 300 ohms balanced or 200 ohms unbalanced.

Instruments For Industry, Inc., Dept. ED, 150 Glen Cove Rd., Mineola, N.Y.

CIRCLE 121 ON READER-SERVICE CARD

2 Giant Waldes Truarc Beveled Rings Cut Costs \$500, Save 76½ Hours Machining-Assembly Time on X-Ray Unit

TRIPLETT & BARTON TRI-IND-X PORTABLE X-RAY UNIT

OLD MODEL

NEW MODEL



	OLD SPECIFICATIONS	NEW SPECIFICATIONS
Weight	107 lbs.	65 lbs.
Diameter	15 inches	11 inches
Machining and Assembly Time	78 hours	1½ hours
Service Time	4½ hours	5 minutes
Parts	27 bolts	2 Truarc Rings

Prior to adoption in their new bantam-weight TRI-IND-X, Tripllett & Barton, Inc., Burbank, Calif., subjected Waldes Truarc Retaining Rings to severe tests and rigid inspections. Although the TRI-IND-X operates at a normal pressure of 50 psi, Truarc Rings were subjected to pressure tests in excess of 500 psi, proving their high performance.

TUBE END ASSEMBLY



OLD



NEW

ONE 10" BEVELED RING REPLACES 12 BOLTS—Machining and assembly time formerly required 78 hours . . . now reduced to 1½ hours! Service operations for dismantling or tube change formerly required 4½ hours . . . now reduced to 5 minutes! In addition to savings on materials, costs have been reduced approximately \$500 per unit.

END BELL ASSEMBLY



OLD



NEW

ONE 9" BEVELED RING REPLACES 15 BOLTS—In addition to functioning as mechanical fasteners, the Truarc Beveled rings serve as pressure vessel closures, providing leak-proof seals. The wedge action of the ring compensates for wear, provides a constant tight seal.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get

Statistically Controlled Quality from engineering and raw materials to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available

quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today . . . let our Truarc engineers help you solve design, assembly and production problems . . . without obligation.



WALDES

TRUARC[®]
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y.

Consult the Yellow Pages of Your Telephone Directory for Name of Local Truarc Factory Representative and Authorized Distributor. Look under "Retaining Rings" or "Rings, Retaining."

CIRCLE 122 ON READER-SERVICE CARD

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N. Y.
Please send new, descriptive catalog showing all types of Truarc rings and representative case history applications.

(Please print)

Name _____

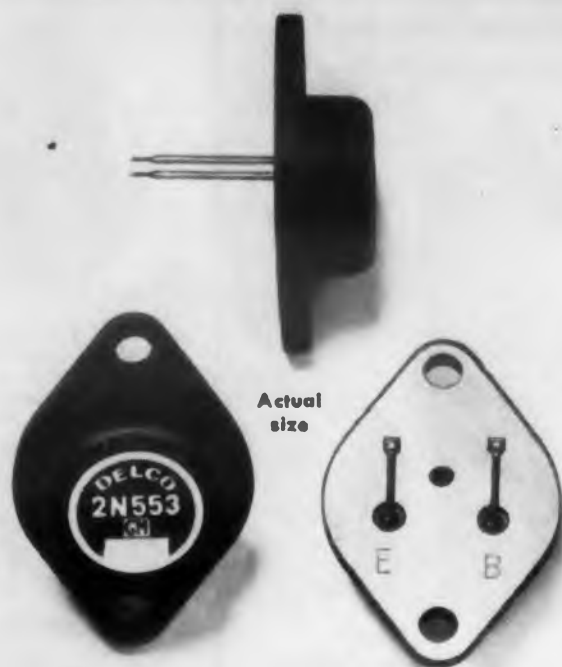
Title _____

Company _____

Business Address _____

City _____ Zone _____ State _____

ED070



ANNOUNCING...

the newest addition to the Delco family of PNP germanium transistors! It's ideally suited for high-speed switching circuits and should find wide use in regulated power supplies, square wave oscillators, servo amplifiers, and core-driver circuits of high-speed computers. It's the 2N553!

NEW HIGH-FREQUENCY POWER TRANSISTOR BY DELCO

No other transistor offers so desirable a combination of characteristics for applications requiring reliability and consistency of parameters.

TYPICAL CHARACTERISTICS $T = 25^{\circ}\text{C}$ unless otherwise specified

Collector diode voltage V_{CB} ($V_{EB} = -1.5$ volts)	80 volts maximum
Emitter diode voltage V_{EB} ($V_{CB} = -1.5$ volts)	40 volts maximum
Collector current	4 amps. maximum
Base Current	1 amp. maximum
Maximum junction temperature	95°C
Minimum junction temperature	-65°C

Collector diode current I_{CO} ($V_{CB} = 2$ volts)	12 μa
Collector diode current I_{CO} ($V_{CB} = -60$ volts)	0.5 ma
Collector diode current I_{CO} ($V_{CB} = -30$ volts, 75°C)	0.5 ma
Current gain ($V_{CE} = -2$ volts, $I_C = 0.5$ amp.)	55
Current gain ($V_{CE} = 2$ volts, $I_C = 2$ amps.)	25
Saturation voltage V_{EC} ($I_B = 220$ ma, $I_C = 3$ amps.)	0.3
Common emitter current amplification cutoff frequency ($I_C = 2$ amps, $V_{EC} = 12$ volts)	25 kc
Thermal resistance (junction to mounting base)	1°C/watt

BRANCH OFFICES

Newark, New Jersey
1180 Raymond Boulevard
Tel: Mitchell 2-6165

Santa Monica, California
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

DELCO RADIO

Division of General Motors
Kokomo, Indiana

CIRCLE 123 ON READER-SERVICE CARD

NEW PRODUCTS

Ignition Primer

For high altitudes



Model 1029A high-altitude ignition primer is a hermetically-sealed part designed for the ignition of propellants and powders at altitudes in excess of 100,000 ft. The unit is a standard screw-in construction having a 3/8-24 class 2A thread and a 7/16 in. hex.

Holex, Inc., Dept. ED, P.O. Box 148, Hollister, Calif.

CIRCLE 125 ON READER-SERVICE CARD

Potentiometer

2.5 w at 200 c



Designed for high temperature service, this potentiometer is for use up to 250°C , with 2.5 w rating at 200°C . Sample and pilot quantities are available in linear tapers from 10 to 20,000 ohms, and in standard tolerance of ± 5 per cent.

P. R. Mallory & Co. Inc., Dept. ED, Indianapolis 6, Ind.

CIRCLE 124 ON READER-SERVICE CARD

Frequency Standard

Temperature shifts less than 0.01 C



The LA90 5-mc frequency standard offers long term stability to better than one-part in one billion.

ELECTRONIC DESIGN • July 9, 1958

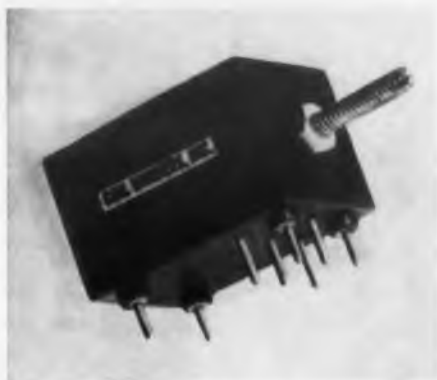
tion. Long term operation results in temperature shifts of less than 0.01 C. The environmental temperature range is 0 to 50 C. When the unit is in operation a high coefficient crystal acts as a very sensitive high Q control device which equalizes the power in the oven.

Lavoie Laboratories, Inc., Dept. ED, Matawan-Freehold Rd., Morganville, N.J.

CIRCLE 126 ON READER-SERVICE CARD

Tuneable Transformers

Plug-in PC units



This series of sealed miniature tuneable transformers and reactors for printed circuit use are plug-in types with provision for assuring clearance of body of unit from printed circuit board. This type of construction is available with 2 to 8 functional terminals. Characteristics include a frequency range of up to 70 mc, inductance to 30 mh, and Q value to 125.

Coil Winders, Inc., Dept. ED, New York Ave., Westbury, N.Y.

CIRCLE 127 ON READER-SERVICE CARD

Power Supply

For strain gages



Model 2-200 transistorized strain-gage power supply provides 0-15 v at 0-5 amp with less than 1 mv drift over a 24-hr period at constant temperature, and less than 0.001 per cent per deg F change with temperature variations. A 10 per cent change in line voltage will produce a change of less than 2 mv in output, while a 1 amp change in load current will produce less than 1 mv change in output. Ripple is less than 1 mv peak to peak under all conditions of load.

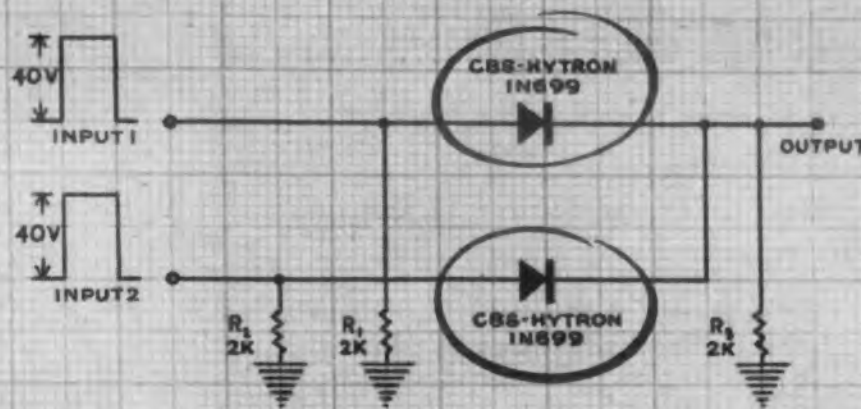
Neff Instrument Corp., Dept. ED, 2211 E. Foothill Blvd., Pasadena, Calif.

CIRCLE 128 ON READER-SERVICE CARD

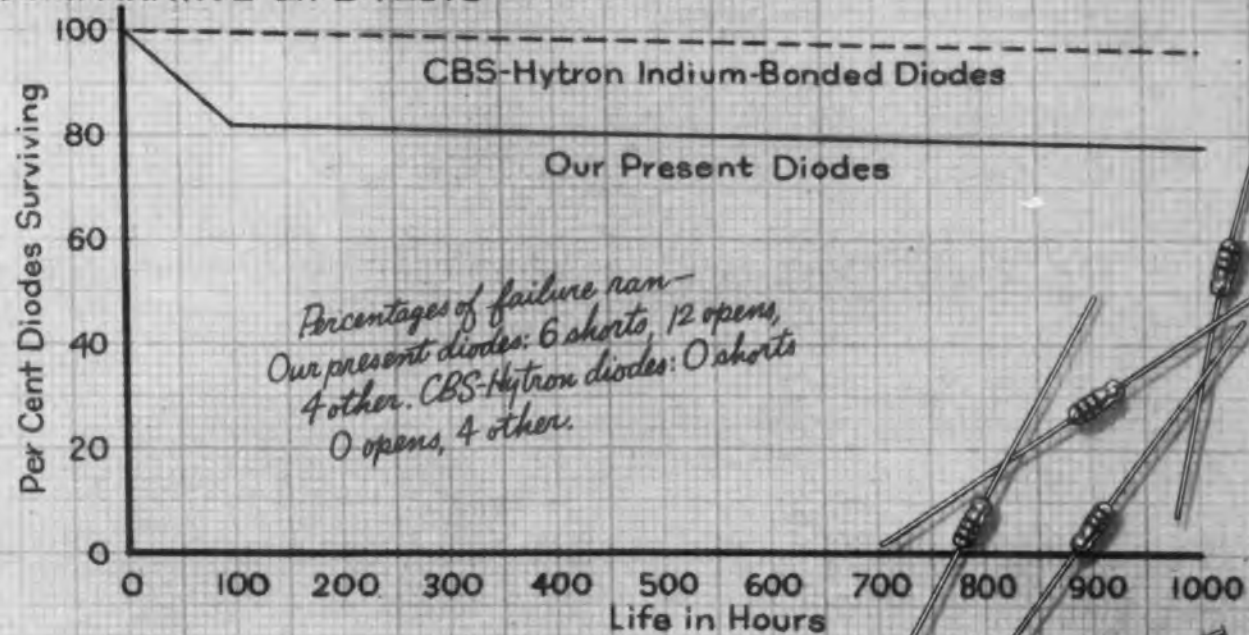
COMPUTER DIODE REPORT ET-757

Diode survival during vibration portion of life tests of XA-25-725-A computer. Test conditions: free vibration at 3600 impulses p.m. at amplitude of 0.080 inch.

TEST CIRCUIT 17



COMPARATIVE LIFE TESTS



J.D.H.:
New CBS-Hytron indium-bonded diodes avoid catastrophic failures on production line. Recommend we use them. For data, see CBS-Hytron Bulletin E-286.

F.G.



CBS-HYTRON Semiconductor Operations, Lowell, Massachusetts. A Division of Columbia Broadcasting System, Inc. Sales Offices: Newark, N.J.; Melrose Park, Ill.; Los Angeles, Calif.

CIRCLE 129 ON READER-SERVICE CARD

PHILCO

Silicon Transistors

2N495 - 2N496

For outstanding performance
at high junction temperatures

- Excellent performance at Temperatures from -65°C to $+140^{\circ}\text{C}$
- Collector Saturation Voltage of 0.1 Volt or Under
- Maximum Frequency of Oscillation in the 15 Megacycle Range

These new Philco PNP Surface Alloy Silicon Transistors permit transistorization of circuits where high ambient temperatures are encountered.

Type 2N495 is a general purpose silicon transistor, with excellent performance and reliability in amplifier and oscillator applications at frequencies through 15 mc. Units are rated at 150 mw total dissipation with a collector voltage rating of 25v.

Type 2N496 is specifically designed for high speed switching circuits . . . f_{ab} typically over 17 mc. This unit gives the designer the advantages of low saturation, low voltage operation and minimum load impedance even at junction temperatures as high as 140°C .

Make Philco your prime source for information and prices on silicon transistors.
Write Dept. ED 758

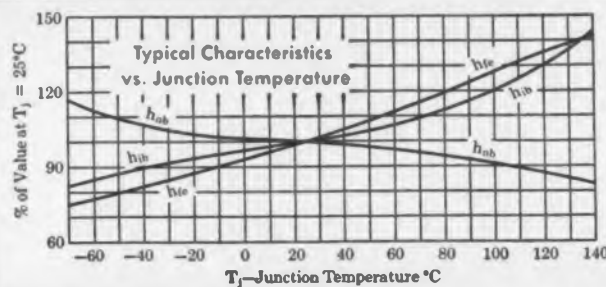
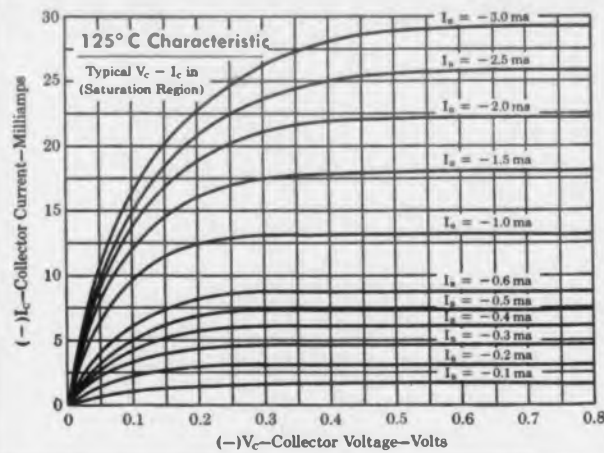
PHILCO CORPORATION

LANSDALE TUBE COMPANY DIVISION
LANSDALE, PENNSYLVANIA

CHARACTERISTICS OF TYPES 2N495 and 2N496

CHARACTERISTIC	CONDITION	TYPICAL VALUE	
		2N495	2N496
Current Amplification Factor, h_{fe}	$V_{CB} = -6\text{ v}$ $I_E = 1\text{ ma}$	18	
Current Amplification Factor, h_{FE}	$V_{CB} = -0.5\text{ v}$ $I_C = -15\text{ ma}$		12
Output Capacitance, C_{ob}	$V_{CB} = -6\text{ v}$ $I_E = 1\text{ ma}$	7 μf	7 μf
Maximum Frequency of Oscillation, $f_{\alpha\text{ max}}$	$V_{CB} = -6\text{ v}$ $I_E = 1\text{ ma}$	15 mc	
Frequency for Beta = 1, f_t^*	$V_{CB} = -6\text{ v}$ $I_E = 1\text{ ma}$ $f = 4\text{ mc}$		15 mc
Cutoff Current, I_{CBO} or I_{EBO}	V_{CB} or $V_{EB} = -10\text{ v}$.001 μa	.001 μa

Maximum Power Dissipation—150 mw
Maximum Collector Voltage 2N495—25 V
2N496—10 V
* f_t (the frequency at which beta is unity) is typically 85% of the alpha cutoff frequency.



NEW PRODUCTS

Tape-Programmed Tester Improved flexibility



The new model Robotester, type LA-302, permits random selection throughout any two of 250 circuit points for measurement of resistance, polarized dc or ac voltage or insulation resistance. This improvement in flexibility increases user savings over that obtained with the original model. The unit is adaptable to automated production running 60-100 tests per minute and is able to signal wiring or assembly errors with a flashing light indicator. The range of voltage measurement is from 0.5 to 500 v and hi-pot is accomplished at 500 v dc with a theoretical 10,000 meg upper limit. The resistance range of the Robotester is from one ohm to 9.99 meg.

Lavoie Laboratories, Inc., Dept. ED, Matawan-Freehold Rd., Morganville, N.J.

CIRCLE 131 ON READER-SERVICE CARD

Relay

Switches radio frequencies

This relay for switching radio frequencies has applications such as antenna change-over on mobile radio. A special contact spring construction is designed to provide the lowest possible capacitance between springs. Operating voltages 6 to 110 v dc spst or spdt contacts rated 2 amp at 24 v dc or 115 v ac non-inductive load.

Magnecraft Electric Co., Dept. ED, 33500 W. Grand Ave., Chicago 51, Ill.

CIRCLE 132 ON READER-SERVICE CARD

◀ CIRCLE 130 ON READER-SERVICE CARD



1958 Transistor Data Chart

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Audio and High Frequency Transistors

Manufacturer and Type	Class and Application	Maximum Ratings					Characteristics					r'_b
		W_c (mw)	T_j (C)	(a) mW/C (b) C/mW	V_c (volts)	I_c (ma)	h_{fe} or h_{fb}	I_{co} (μa)	NF (db)	C_c ($\mu\mu f$)	f_{co} (Mc)	
Ampere Electronic Corp., Hicksville, N. Y.												
2N279	p-n-p, alloy, audio pre-amp.	125	75	2.5(a)	-30	10	40	5 ²	10		0.3 ³	
2N280	p-n-p, alloy, audio driver			2.5(a)	-30	10	75	4.5	10		0.3	
2N283	p-n-p, alloy, audio gen. pur.			2.5(a)	-32	10	55	3.5	10		0.5	
2N284	p-n-p, alloy, audio output	167 ¹		3.33(a)	-32	250	45	4.5	10		0.35	
OC65	p-n-p, alloy, hear aid, pre-amp.	50 ¹	65	1.54(a)	-10	10	30	5 ²	9		0.15 ³	
OC66	p-n-p, alloy, hear aid, out.			1.54(a)	-10	10	47	5 ²	9		0.1 ³	
Bendix Aviation Corp., Long Branch, N. J.												
B159	p-n-p, AJ, audio	500	95	0.20(b)	40	300	100					10 kc
Begue Electric Mfg. Co., Paterson, N. J.												
2N97	n-p-n, grown, audio, if	50	75	2.0(a)	30	10	0.93	2 ¹	15	14	1.0	
2N161	n-p-n, grown, Si, comp. servo	150	175	1.0(a)	40	25	30	0.5	25	10	5	
2N163A	n-p-n, grown, Si, comp. servo						50	0.5			6	
2N160	n-p-n, grown, Si, comp. servo						15	0.5			4	
2N163	n-p-n, grown, Si, comp. servo						50	0.5			6	
2N162A	n-p-n, grown, Si, comp. servo						35	0.5			8	
RD316	n-p-n, grown, Si, comp. servo	100 ⁵	175	1.0(a)	20	20	10	0.2 ⁴	25	10	0.2	
2N347	n-p-n, grown, Si, servo, sw.	750		3.0(a)	60	60	20		24			
2N348	n-p-n, grown, Si, servo, sw.			3.0(a)	90	50	20					
2N349	n-p-n, grown, Si, servo, sw.			3.0(a)	125	40	20					
2N332	n-p-n, grown, Si, gen. purpose	150		1.16(b)	45	25	0.925	4	20	7	4	
2N333	n-p-n, grown, Si, gen. purpose	150	175	1.16(b)	45	25	0.960	4	20	7	5	
2N334	n-p-n, grown, Si, gen. purpose						0.975				8	
2N335	n-p-n, grown, Si, gen. purpose						0.980				6	
General Electric Co., Syracuse, N. Y.												
3N36	n-p-n, Meltback, amp.	30	85	0.5(a)	7	20		3			50	50
3N37	n-p-n, Meltback, amp.										90	
2N44A	p-n-p, AJ	155	100	0.25(b)	-45		30	-5	6	40	1	
2N524	p-n-p, AJ	225		0.27(b)		-500				25	2	
2N525	p-n-p, AJ						44				2.5	
2N526	p-n-p, AJ						64				3	
2N527	p-n-p, AJ						81				3.3	
General Transistor Corp., Jamaica, N. Y.												
GT14	p-n-p, AJ, audio	125	85	2.0(a)	-25		20-34	<10	16			
GT20	p-n-p, AJ, audio	125		2.0(a)	-25		35-49	<10	16			
GT34	p-n-p, AJ, audio						10-19					
GT74	p-n-p, AJ, audio						50-99		<12			
GT75	p-n-p, AJ, audio	125	85	2.0(a)	-25		100-199	<10	<12			
GT81	p-n-p, AJ, audio						50-99		16			
GT81HS	p-n-p, AJ, audio	150					50-99					
GT82	p-n-p, AJ, audio	125					100-999					
GT87	p-n-p, AJ	125	85	2.0(a)	-25		20-34	<15	<24	<50	>0.5	
GT88	p-n-p, AJ						>50	<10	16		>1.0	
GT109	p-n-p, AJ, audio						80-140		<29			
GT122	p-n-p, AJ						>50	<10			>1.5	
GT229	n-p-n, AJ, amateur	100		1.67(a)			>10	<20			>3	
GT34HV	p-n-p, AJ, hi-volt	125	85	2.0(a)	-50		10-34					
GT759R	p-n-p, AJ, rf-if	90	75	1.8(a)	-10		>15	6		16	0.5	90
GT760R	p-n-p, AJ, rf-if						>20				3.0	110
GT83	p-n-p, AJ	125	85	2.0(a)	-25		35-49	<10		<50	>0.7	
GT357	p-n-p, AJ	100		1.67(a)			20-80	<25				

Sixth Annual

Transistor Data Chart

THIS YEAR'S data chart has been designed as a quick and comprehensive reference for the transistor circuit designer. Only the most significant characteristics have been tabulated in an effort to keep the chart within reasonable proportions. Each transistor's operating characteristics depends on a particular circuit used, the frequency of operation, the temperature and other conditions so that the operating characteristics given are typical ones, usually for the grounded emitter circuit.

Four Data Charts

Transistors are grouped into four categories according to principal use.

Audio and high frequency types—these are the most part general purpose types.

Low level switching types—low power devices for signal circuits are included here. Currents of 1 amp or better are included under Power type. Switching characteristics such as rise time, fall time and storage time in addition to other factors which are important to switching are tabulated.

Power types—devices having a collector dissipation of one watt or greater are included here. Transistors for switching substantial currents are included in this section. Thus the compilation contains audio output, servo, and switch devices.

Special types—photo transistors, unijunction units, etc. are found in this section. Not included are controlled switching rectifiers. As three terminal devices they might be considered transistors but since operating characteristics do not fall into our chart conveniently, they are not tabulated.

Transistors made by a single manufacturer are grouped together within the main categories. The type number is generally used to classify transistors within each manufacturer's grouping. However, this did not always seem the best arrangement and if a grouping by similar fabrication type, power, or rating seemed better, this scheme was followed.

A total of about 612 different types of transistors are available this year as compared to about 430 last

Contents

Introduction to Data Chart
Symbology for Transistors
Typical Amplifier Equations
Audio and High Frequency Transistors
Switching Transistors
Power Transistors
Special Transistors
Transistor Cross Index
Choosing the Proper Transistor Circuit Battery

year. One important development of the year has been the further trend toward coordination of types between manufacturers. Probably this trend will continue in the coming years as designs become stabilized.

We have not included foreign types this year. To date, sales of foreign transistors has been negligible. U.S.A. types are generally better for the price. (Japanese transistors are not available to American buyers.)

Footnotes are used throughout to add pertinent information or distinctions that might be of interest. Unless otherwise described, the transistor is a germanium type and classed according to the following abbreviations:

AJ = alloy junction	SBT = surface base
GJ = grown junction	PC = point contact
DJ = diffused	MAJ = micro-alloy junction
FJ = fused	Si = silicon

Not all explanatory notes are included as the chart would become too unwieldy. Manufacturers data should be consulted before selecting transistors.

Ratings depend on testing conditions. Because there are few or no standards in the industry, the reader must not assume that he can accurately compare one manufacturer's transistors with another's on the basis of published data.

For an additional copy of this chart, turn to the Reader-Service card and circle 100.

- | | |
|-----------------------------------|--------------------------------------|
| 1. Collector Dissipation at 25 C | 11. with heat sink 0.15 c/mw |
| 2. at I_{cbo} | 12. grounded base |
| 3. at F_{cos} | 13. same type flexible leads |
| 4. μa at 25 C ($V_c = 5$ v) | a. collector to base volts —12 |
| 5. Mw's at 25 C | b. collector to base volts —25 |
| 6. Symmetry pairs (npn) | c. collector to base volts —30 |
| 7. also 2N35 | d. 2 transistor push-pull |
| 8. Military | 14. matched pair |
| 9. at 270 cps | 15. push-pull |
| 10. with heat sink 0.18 c/mw | 16. maximum frequency of oscillation |

Audio and High Frequency Transistors (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings				Characteristics						
		W_c (mw)	T_j (C)	(a) mw/C (b) C/mw(volts)	V_c	I_c (ma)	h_{fe} or h_{fb}	I_{co} (μa)	NF (db)	C_c (μmf)	f_{co} (Mc)	r'_{fb}
General Transistor Corp., (cont.)												
GT222	p-n-p, AJ, audio	125	85	2.0(a)			>10	<20	30			0
GT761R	p-n-p, AJ, rf-if	90	75	1.8(a)	-10		>30	6		14	>7.0	15
GT762R	p-n-p, AJ, rf-if						>60				>15	
GT792R	n-p-n, AJ, rf-if										5-7	130
GT948R	n-p-n, AJ, rf-if										3-5	120
2N43												
2N43	p-n-p, AJ, audio	150	100	2.0(a)	-45		>32	1-15	11-33	30-50	0.5-2.5	
2N43A ¹	p-n-p, AJ, Ind.						30-66	<10	20	<50	>0.75	
2N44	p-n-p, AJ, audio						16-32	1-15	11-33	30-50	0.5-2.5	
2N45	p-n-p, AJ, audio						9-16	1-15	11-33	30-50	0.5-2.5	
2N529⁶												
2N529 ⁶	p-n-p, AJ, comp.	100	85	2.0(a)	-15			<5	14	14	2.5	
2N530	p-n-p, AJ, comp.										3.0	
2N531												
2N531	p-n-p, AJ, comp.	100	85	2.0(a)	-15			<5	14	14	3.5	
2N532	p-n-p, AJ, comp.										4.0	
2N533	p-n-p, AJ, comp.										4.5	
2N563												
2N563	p-n-p, AJ, audio	150		2.5(a)	-30		25		16	30		
2N564												
2N564	p-n-p, AJ, audio	120		2.0(a)								
2N565												
2N565	p-n-p, AJ, audio	150	85	2.5(a)	-30		55	<5	16	30		
2N566												
2N566	p-n-p, AJ, audio	120		2.0(a)								
2N567												
2N567	p-n-p, AJ, audio	150		2.5(a)			100					
2N568												
2N568	p-n-p, AJ, audio	120		2.0(a)								
2N569												
2N569	p-n-p, AJ, audio	150		2.5(a)			150					
2N570												
2N570	p-n-p, AJ, audio	120	85	2.0(a)	-30		150	<5	16	30		
2N571												
2N571	p-n-p, AJ, audio	150		2.5(a)			200					
2N572												
2N572	p-n-p, AJ, audio	120		2.0(a)								
2N605												
2N605	p-n-p, drift, amp. osc., conv.	120	85	2.0(a)	-15		40	<10	16	<7		150
2N606												
2N606	p-n-p, drift, amp. osc., conv.						60					160
2N607												
2N607	p-n-p, drift, amp. osc., conv.				-15		80	<10	16	<7		180
2N608												
2N608	p-n-p, drift, amp. osc., conv.						120					200
Hughes Aircraft Co., Los Angeles 45, Calif.												
HA5011												
HA5011	n-p-n, AJ, amp.	400	70	9.0(a)	40		50	6	15	15	1	200
HA5016												
HA5016	n-p-n, AJ, amp.				30		40	4			0.5	
HA5002												
HA5002	n-p-n, AJ, amp.				20			6	16			
HA5003												
HA5003	n-p-n, AJ, amp.				30		50		15		1	
HA5005												
HA5005	n-p-n, AJ, amp.				10		20	7		20	0.5	
Industro Transistor Corp., Long Island City 6, N. Y.												
2N359												
2N359	p-n-p, AJ, audio radio	150	85	0.36 ¹¹ (b)	-20	150	150 ⁹	5	12			
2N360												
2N360	p-n-p, AJ, audio radio			0.35 ¹¹ (b)			100 ⁹					
2N361												
2N361	p-n-p, AJ, audio radio			0.36 ¹¹ (b)	-30		70 ⁹					
2N362												
2N362	p-n-p, AJ, audio radio				-20		120 ⁹					
2N363												
2N363	p-n-p, AJ, audio radio				-40		50 ⁹					
TR764												
TR764	p-n-p, AJ, hf gen pur	150	85	0.4 ¹⁰ (b)	-20	150	200 ⁹	5		14	25	
2N413												
2N413	p-n-p, AJ, hf gen pur				-18		25 ⁹	5		14	2.5	
2N414												
2N414	p-n-p, AJ, hf gen pur				-15		40 ⁹	2		14	7	
2N416												
2N416	p-n-p, AJ, hf gen pur				-12		60 ⁹	2		14	10	
2N417												
2N417	p-n-p, AJ, hf gen pur				-10		80 ⁹	2		14	20	
2N422												
2N422	p-n-p, AJ, audio	150	85	0.36(b)	-20	150	90	5	12			
2N464												
2N464	p-n-p, AJ, audio			"	-30		22					
2N465												
2N465	p-n-p, AJ, audio						45					
2N466												
2N466	p-n-p, AJ, audio				-20		90					
2N467												
2N467	p-n-p, AJ, audio				-15		180					

Audio and High Frequency (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings					Characteristics					
		W_c (mw)	T_j (C)	(a) mw/C (b) C/mw(volts)	V_c (volts)	I_c (ma)	h_{ie} or h_{fb}	I_{co} (μ a)	NF (db)	C_{co} (μ mf)	f_{co} (Mc)	r'_{b}
Industro Transistor Corp. (cont.)												
Long Island City, N. Y.												
2N481	p-n-p, AJ, rf radio	150	85	0.4 ¹⁰ (b)	-12	150	2		12	2.5		
2N482	p-n-p, AJ, rf radio									4		
2N483	p-n-p, AJ, rf radio									4		
2N485	p-n-p, AJ, rf radio									8		
2N486	p-n-p, AJ, rf radio									8		
2N519	p-n-p, AJ, hf gen pur	150	85		-15	150	25	5	14	0.5		
2N520	p-n-p, AJ, hf gen pur				-12		40			0.3		
2N521	p-n-p, AJ, hf gen pur				-10		70			0.8		
2N522	p-n-p, AJ, hf gen pur				-8		120			15		
2N523	p-n-p, AJ, hf gen pur				-6		200			21		
TR81	p-n-p, AJ, audio	150	85	0.36 ¹¹ (b)	-22	150	200	5	12			
TR722	p-n-p, AJ, audio				-25		22					
Motorola, Inc., Semiconductor Prod. Div., Phoenix, Arizona												
2N464	p-n-p, AJ, audio	150	85	2.5(a)	-45	100	26 ¹²	6	22	20	700kc	
2N465	p-n-p, AJ, audio						15				800kc	
2N466	p-n-p, AJ, audio				-35		90				1	
2N467	p-n-p, AJ, audio						180				1.2	
2N650	p-n-p, AJ, audio	200	100	2.8(a)	-45	250	40	15	10		2	
2N651	p-n-p, AJ, audio	200	100	2.8(a)	-45	250	75	15	10	20	2.5	
2N652	p-n-p, AJ, audio				-45		160				3	
2N653	p-n-p, AJ, audio				-30		40				2	
2N654	p-n-p, AJ, audio						75				2.5	
2N655	p-n-p, AJ, audio						160				3	
Philco Corp., Lansdale, Pa.												
2N207	p-n-p, AJ, aud. amp.	50	65	0.8(b)	12	20	100	15			2	
2N207A	p-n-p, AJ, aud. amp.							10				
2N207B	p-n-p, AJ, aud. amp.							10				
2N535	p-n-p, AJ, amp.		85		20			10				
2N223	p-n-p, AJ, audio driver	200	65	0.2(b)	18	150	95	20		90		
2N224 ¹⁴	p-n-p, AJ, audio out.	250	75		25			25		125	0.5	
2N226 ¹⁴	p-n-p, AJ, aud. out.	250	75	0.2(b)	30	150		25		140	0.4	
2N128	p-n-p, Sbt, rf, if video	25	85	0.75(b)	10	5	35	0.7	9	3	65 ¹⁶	
2N499	p-n-p, Madt, rf, osc amp.	75	85	0.8(b)	30	50		15	5	1.3	320 ¹⁶	
2N500	p-n-p, Madt, uhf osc.				20			25		1		
2N502	p-n-p, Madt, vhf amp.	60		1(b)					5		500 ¹⁶	
2N344	p-n-p, Sbt, hf	20	55	0.75(b)	5	5	22	3		3	50 ¹⁶	
2N345	p-n-p, Sbt, hf	20	55	0.75(b)	5	5	35	3		3	50 ¹⁶	
2N346	p-n-p, Sbt, hf						30	0.7			75 ¹⁶	
2N299	p-n-p, Sbt, hf tuned amp.	40	85		7	20			8		105 ¹⁶	
2N300	p-n-p, Sbt, Video amp.						16					
2N503	p-n-p, Madt, vhf amp.	60		1(b)	20	50		10	5	1		
2N504	p-n-p, Madt, if amp.	50	85		35	50	16	10		1.7	50 ¹⁶	
2N588	p-n-p, Madt, osc., vhf amp.	80			20	18		15	15		200	
RCA, Somerville, N. J.												
2N104,215 ¹³	p-n-p, AJ, amp.	150	85		-30	-50	41	-10 ^{13a}	6.5	22.8	0.7	290
2N105	p-n-p, AJ, amp.	60			-25	-15	55	-7 ^{13a}	7.5	12.4	0.75	250
2N109,217 ¹³	p-n-p, AJ, lge. sig. amp.	150				-70	75	-14 ^{13b}				
2N175,220 ¹³	p-n-p, AJ, amp.	50			-10	-2	65	-12 ^{13b}	6	25	0.85	190
2N206	p-n-p, AJ, amp.	75	50		-30	-50	47	-10 ^{13c}	9		0.78	200
2N270	p-n-p, AJ, lge. sig. amp.	250	85		-25	-150	70	-16				
2N405,406 ¹³	p-n-p, AJ, driv., amp.	150			-12	-70	35	-14 ^{13a}			0.65	
2N407,408 ¹³	p-n-p, AJ, lge. sig. amp.				-20		65	^{13a}				

Symbology of Transistors

K. A. Puller, Jr.

THE BASIC Symbols for transistor electrical quantities comprise a combination of lower-case and capital letters. For example, instantaneous signal values use lower-case symbols and lower-case subscripts, whereas the instantaneous total values use lower-case symbols and capital subscripts. Likewise, rms, limit, or effective varying component values may be identified by capitalized symbols with lower-case subscripts, and the average or dc value by capitalized symbols and subscripts.

Values at specified limiting conditions take the symbols for the corresponding rms value and add an extra subscript to identify the specific condition. For example, the negative-limit value for the base voltage is written as V_{bn} . Tables for the significant transistor voltages are included in Table I, and currents in Table II.

The symbols for the electrical parameters are made up in a somewhat similar fashion. The recognized families of parameter symbols include the hybrid, or h symbols, the admittance, or y symbols, the current gain, or α (*alpha*) symbols, and the equivalent *tee*, or R symbols. In accordance with electrical engineering practice, both the z and y parameters may be taken as phasor quantities according to the equations:

$$z = r + jx$$

$$y = g + jb$$

Because of these standard and accepted forms for impedance and admittance components, the selection of g to represent the inverse h parameters appears to be contrary to good usage. Reasons for not using g symbols to represent inverse h parameters include the use, for many years, of g parameters on transistor data sheets, notably by RCA, for conductance components, and the general use of the g symbol for conductance with such active devices as tubes.

The subscripts which indicate the specific relation, input, forward, reverse, or output immittance (an immittance may be an impedance, an admittance, or a numerical ratio of two impedances or admittances) have been changed by the IRE from the 11, 21, 12, and 22 subscripts commonly used in physics for many years to the more descriptive i , f , r , and o , respectively. These

Transistors

Audio and High Frequency Transistors (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings				Characteristics					r'_{ib}	
		W_c (mw)	T_j (C)	(a) mw/C (b) C/mw	V_c (volts)	I_c (ma)	h_{fe} or h_{fb}	I_{co} (μ a)	NF (db)	C_c ($\mu\mu$ f)		f_{co} (Mc)
RCA, Somerville, N. J. (cont.)												
2N139,218 ¹³	p-n-p, AJ, if amp.	80			-16	-15	48	-6 ^{13a}			6.8	
2N140,219 ¹³	p-n-p, AJ, conv.						75		13 ^a		10	
2N409,410 ¹³	p-n-p, AJ, if amp.	80			-12	-15	48	-10 ^{13a}			31	
2N411,412 ¹³	p-n-p, AJ, conv.				-13		75		13 ^a		32	
2N247	p-n-p, AJ, Drift	80	85				60	-20 ¹			30	
2N274	p-n-p, AJ, Drift, rf amp.	80	85		-35	-10	60	-20 ¹			30	
2N370	p-n-p, AJ, Drift, rf amp.				-20							
2N371	p-n-p, AJ, Drift, rf osc.											
2N372	p-n-p, AJ, Drift, Mixer	80	85		-20	-10	60	-20			30	
2N384	p-n-p, AJ, Drift, rf amp.	120			-30			-16			100	
2N544	p-n-p, AJ, Drift	80			-18	-10	60	-4 ¹			30	
Raytheon Mfg. Co., Newton, Mass.												
2N359	p-n-p, AJ, audio	165	85	0.36(b)	-45	-200	150	-10				
2N360	p-n-p, AJ, audio						100					
2N361	p-n-p, AJ, audio						70					
CK13	p-n-p, AJ, rf amp.	80	85	0.75(b)	-30		30	-2	7	12	2.5	
CK14	p-n-p, AJ, rf amp.						60		6		7	
CK16	p-n-p, AJ, rf amp.	80	85	0.75(b)	-30	-200	80	-2	4	12	10	
CK17	p-n-p, AJ, rf amp.						140				18	
CK64	p-n-p, AJ, audio				-35	-100	22.5		22		800 kc	
CK65	p-n-p, AJ, audio						45				1000 kc	
CK66	p-n-p, AJ, audio						90				1200 kc	
CK67	p-n-p, AJ, audio	80	85	0.75(b)	-35	-100	180	-2	22		1500 kc	
CK22	p-n-p, AJ, audio preamp.						190		6.5		1200 kc	
2N330A	p-n-p, AJ, Si, lo noise	380	160	0.35(b)	-50	-50	25	0.005	8	70	500 kc	
2N622	p-n-p, AJ, Si, lo noise						25					
2N362	p-n-p, AJ, audio	165	85	0.36(b)	-20	-100	100	-10				
2N363	p-n-p, AJ, audio	165	85	0.36(b)	-40	-100	50	-10				
2N481	p-n-p, AJ, portable radio	150		0.4 (b)	-12	-20		10 max		10-14	3.5	
2N482	p-n-p, AJ, portable radio						50				5.5	
2N483	p-n-p, AJ, portable radio						60				10	
2N484	p-n-p, AJ, portable radio						90				7.5	
2N485	p-n-p, AJ, portable radio					-10	50			12		
2N486	p-n-p, AJ, radio ckts.	15	85	0.4(b)	-12	-10	100	-3		12	12	
2N487	p-n-p, AJ, radio ckts.							-3			10	
2N631	p-n-p, AJ, audio	165		0.36(b)	-25	-50	150	-10			1.2	
2N632	p-n-p, AJ,AJ, audio				-30		100				1	
2N633	p-n-p, AJ, audio				-35		60				0.8	
Sprague Electric Co., North Adams, Mass.												
2N345	p-n-p, Sbt, hf	20	55	0.75(b)	-5	5	35	3		3	50	
2N346	p-n-p, Sbt, hf						30	0.7			75	
2N128	p-n-p, Sbt, rf-if video	25	85		-10		35	0.7	9	3	65	
2N344	p-n-p, Sbt, hf	20	55		-5		22	3		3	50	
Sylvania Electric Products, Inc., Woburn, Mass.												
2N233A	n-p-n, AJ, if amp.	50	75	1.0(a)	18		5	50		12	2	1250
2N515	n-p-n, AJ, hf	50	75		18	10	7.5	2.5		11	3	1250
2N516	n-p-n, AJ, hf											
2N517	n-p-n, AJ, hf											
2N214	n-p-n, AJ, audio out.	180		3.6(a)	25	100		50			10 kc	

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symbols are simpler than the old number symbols, and have proven to be entirely satisfactory. One additional specific relation is often convenient, since it helps in the removal of the differencing of two products. It is represented by the subscript c , and is defined by the relation:

$$y_i y_c = y_i y_o - y_f y_r$$

As a result, a simple relation exists between one of the h parameters and the y_c parameter:

$$h_o = y_c$$

The subscripts associated with small-signal parameters always use lower-case letters. The first letter indicates the specific immittance relation, and the second letter, if used, indicates the circuit configuration under which the parameter should be measured. In this application, an e subscript indicates that the grounded emitter configuration is used for measurement, b —the grounded base, and c —the grounded collector. The relations between these various parameters are indicated in the conversion tables in the list of parameter relations.

The number subscripts, 11, 12, 21, and 22, still may be used for the designation of immittances, but the use of the i , f , r , o , and c symbols is more practical since they convey the same information and require writing fewer symbols. In either case, a configuration subscript symbol may be required after the specific immittance symbol or symbols to make the equations clear.

Considerable confusion has arisen in the field of transistor parameters as a result of the failure to designate the configuration used for the measurement. Since the trend for several years has justifiably been toward the use of the common emitter configuration as a reference, it is suggested that the configuration symbol be omitted when the data are measured for a grounded emitter circuit, and included when the measurements are for either grounded base or grounded emitter circuits.

The following three tables show the suggested symbols for use by design engineers for voltage, current, and immittance symbols. They conform with IRE symbols insofar as possible, but provide additional symbols which have proven use-

Audio and High Frequency (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings				Characteristics					r'_{b}
		W_c (mw)	T_j (C)	(a) mw/C (b) C/mw(volts)	V_c (ma)	h_{fe} or h_{fb}	I_{co} (μ a)	NF (db)	C_c (μ mf)	f_{co} (Mc)	
Sylvania Elec. Prod., Woburn, Mass.											
2N228	n-p-n, AJ, audio out.	50	75	1(a)	40	70	50			600	
2N94	n-p-n, AJ, if amp.				20	7.5		11	2	1250	
2N94A	n-p-n, AJ, hf				20	25			5	2000	
2N193	n-p-n, AJ, osc.				18	7.5			2	1250	
2N229	n-p-n, AJ, gen. pur.				6	15	100				
2N306	n-p-n, AJ, audio dr.	50	75	1(a)	15	75	50			600 kc	
2N34	p-n-p, AJ, audio dr.	150		3(a)	-25	100				10 kc	
2N35	n-p-n, AJ, audio dr.				25						
2N213	n-p-n, AJ, audio dr.		85	2.5(a)	25	300					
2N194	n-p-n, AJ, mixer	50	75	1(a)	18	8		11		2000	
2N211	n-p-n, AJ, osc.	50	75	1(a)	12	10	20	10		1250	
2N212	n-p-n, AJ, conv.				18	20	50				
2N216	n-p-n, AJ, if amp.				10	7.5		11			
2N233	n-p-n, AJ, hf				10	4.5				1200	
2N370	p-n-p, Drift, hi-freq.	80	85		-35	90	15	2.5		100 ohm	
2N372	p-n-p, Drift, hi-freq.				-20	100					
2N247	p-n-p, Drift, hi-freq.				-35	60	25	3.0			
2N544	p-n-p, Drift, hi-freq.				-18	90	4	2.5			
2N624	p-n-p, DJ, hi-freq.	100	100	1.3(a)	-30	25	30	3		50 ohm	
Texas Instruments, Inc., Dallas, Texas											
2N185	p-n-p, AJ, audio amp.	150	75		-20	70	8				
2N238	p-n-p, AJ, audio amp.	50				55					
2N291	p-n-p, AJ, audio amp.	180	85	0.25(b)	-25	45	10				
2N368	p-n-p, AJ, gen. pur.	150	75	0.33(b)	-30	36	7	8	33	1.0	
2N369	p-n-p, AJ, gen. pur.					55	7	7			
2N680	p-n-p, AJ, audio amp.	150	75	0.33(b)	-20	35	8				
2N117	n-p-n, grown, Si, gen. pur.		175		45	0.925	2	20	7	4	
2N118	n-p-n, grown, Si, gen. pur.					0.96				5	
2N118A	n-p-n, grown, Si, gen. pur.					0.975				8	
2N119	n-p-n, grown, Si, gen. pur.	150	175		45	0.98	2	20	7	6	
2N120	n-p-n, grown, Si, gen. pur.					0.99				7	
2N248	p-n-p, Diff., hi-freq.	30	85		-25	20	5		1.2	50	
3N25	p-n-p, Diff., hi-freq.	25	75		-15	65	10		1.1	200	
2N145	n-p-n, grown, 455 kc if	65	75	0.7(b)	20	15	0.2		6		
2N146	n-p-n, grown, 455 kc if										
2N147	n-p-n, grown, 455 kc if										
2N253	n-p-n, grown, 455 kc if										
2N254	n-p-n, grown, 455 kc if										
2N172	n-p-n, grown, radio conv.	65	75	0.7(b)	16	15	0.2		6		
2N252	p-n-p, grown, radio conv.	30			-16	20	5		6		
2N308	p-n-p, grown, 455 kc if				-20						
2N309	p-n-p, grown, 455 kc if										
2N310	p-n-p, grown, radio refl.				-30						
Transitron Electronic Corp., Wakefield, Mass.											
2N117	n-p-n, Diffused, Si	150	175		30	15	0.1	20	7	8	
2N118	n-p-n, Diffused, Si		150		30	30		20		10	
2N118A	n-p-n, Diffused, Si					50		25		11	
2N119	n-p-n, Diffused, Si					60		20			
ST903	n-p-n, Diffused, Si					16	0.1	25			
ST904	n-p-n, Diffused, Si					31					
2N332	n-p-n, Diffused, Si ²		175		45	14	0.2	22		7	
2N333	n-p-n, Diffused, Si	150	175		45	28	0.2	20	7	9	
2N334	n-p-n, Diffused, Si					45		19		11	
2N335	n-p-n, Diffused, Si					60				10	
2N336	n-p-n, Diffused, Si					100				13	

ful to the writer. The third table may be converted from admittance to hybrid parameters by the substitution of an h for the corresponding y values.

Table I. Voltages

Conditions	Base	Collector	Emitter	In	Out
Instant. total	V_B	V_C	V_E	V_S	V_o
No signal dc	V_B	V_C	V_E	V_S	V_o
Instant. signal	v_b	v_c	v_e	v_s	v_o
Maximum value varying component	V_{BM}	V_{CM}	V_{EM}	V_{SM}	V_{oM}
Rms value	V_b	V_c	V_e	V_s	V_o
Value at peak positive bias	V_{bp}	V_{cp}	V_{ep}	V_{sp}	V_{op}
Value at peak negative bias	V_{bn}	V_{cn}	V_{en}	V_{sn}	V_{on}
Value at cutoff bias	V_{bz}	V_{cz}	V_{ez}	V_{sz}	V_{oz}
Average value	V_{ba}	V_{ca}	V_{ea}	V_{sa}	V_{oa}
Total change	ΔV_b	ΔV_c	ΔV_e	ΔV_s	ΔV_o
Max. dissipation	V_{bm}	V_{cm}	V_{em}		
Supply voltage	V_{BB}	V_{CC}	V_{EE}	V_{SS}	V_o

TABLE II. Currents

Conditions	Base	Collector	Emitter	In	Out
Instant. total	i_B	i_C	i_E	i_S	i_o
No signal dc	I_B	I_C	I_E	I_S	I_o
Instant. signal	i_b	i_c	i_e	i_s	i_o
Maximum value varying component	I_{BM}	I_{CM}	I_{EM}	I_{SM}	I_{oM}
Rms value	I_b	I_c	I_e	I_s	I_o
Value at peak positive bias	I_{bp}	I_{cp}	I_{ep}	I_{sp}	I_{op}
Value at peak negative bias	I_{bn}	I_{cn}	I_{en}	I_{sn}	I_{on}
Value at cutoff bias	I_{bz}	I_{cz}	I_{ez}	I_{sz}	I_{oz}
Average value	I_{ba}	I_{ca}	I_{ea}	I_{sa}	I_{oa}
Total change	ΔI_b	ΔI_c	ΔI_e	ΔI_s	ΔI_o
Max. dissipation	I_{bm}	I_{cm}	I_{em}		

TABLE III. Conductance

Conditions	Input	Forward	Output	Modified Output	Amplification
Instant. value*	g_i	g_f	g_o	g_c	K
Static value	g_{is}	g_{fs}	g_{os}	g_{cs}	K_s
Value at peak positive bias	g_{ip}	g_{fp}	g_{op}	g_{cp}	K_p
Value at peak negative bias	g_{in}	g_{fn}	g_{on}	g_{cn}	K_n
Average value	g_{ia}	g_{fa}	g_{oa}	g_{ca}	K_a
Total change	Δg_i	Δg_f	Δg_o	Δg_c	ΔK
Conversion gain	$\Delta g_i/4$	$\Delta g_f/4$	$\Delta g_o/4$	$\Delta g_c/4$	$\Delta K/4$

* g_r = reverse

The following list is a compilation of symbols and definitions extracted from the IRE Standard 56 THE 28.S1. In each definition, only the basic symbol, without a configuration subscript, is listed. Where a second symbol is required to identify an electrode which is inactive or connected in some specified manner, the electrode is identified by the symbol μ . Where several possible symbols can be used for the same parameter, only one of the group is included, since the other forms may be found by consulting the reference.

List of Terms

C_i (added symbol) = diffusion (or input) capacitance from base to emitter; the output is short-circuited to ac.

C_o = capacitance measured across the output terminals with the input open-circuited to ac.

f_a = frequency at which the magnitude of the forward-current transfer ratio (small-signal) under low impedance output is 0.707 of its low frequency value.

h_F = static value of the forward-current transfer ratio under low-impedance output conditions.

h_f = small-signal value of the forward-current transfer ratio under low-impedance output conditions.

h_i = static value of the input impedance under low-impedance output conditions.

h_i = small-signal value of the input impedance under low-impedance output conditions.

h_o = static value of the output impedance under open-circuit input conditions.

h_o = small-signal value of the output impedance under open-circuit input conditions.

(Continued on following page)

CIRCLE 380 ON READER-SERVICE CARD

First From PHILCO...

OUTSTANDING TRANSISTOR PERFORMANCE for VHF Amplifiers and Oscillators

Philco MADT* Transistors Assure Reliable Operation for Circuits With Collector Current Ratings As High As 50 ma ... Power Dissipation Up To 100 mw ... Collector Voltages to 35 V!

- ◆ Low r_b' ◆ Low c_c
- ◆ High f_{ab} ◆ High f_{max}

Philco's family of MADT transistors offers the designer a new dimension in very high frequency amplification and oscillation. These new transistors will provide amplification as high as 1500 megacycles. MADT transistors have been successfully operated through the entire VHF military electronics spectrum. The accompanying circuit diagrams show typical 100 mc and 200 mc amplifier layouts.

Due to their low $r_b' c_c$ product, Philco MADT transistors will oscillate at frequencies far in excess of f_{ab} . The 2N499 produces a specified minimum of 25 mw output at 100 mc. The 2N500 will deliver 20 mw output at 200 mc.

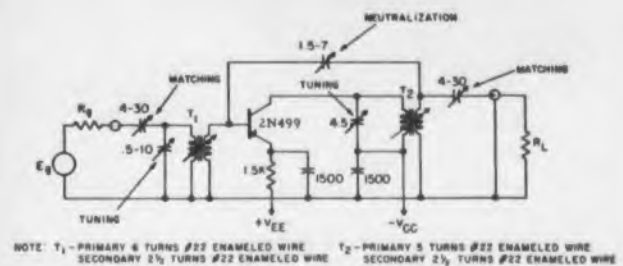
Mass production of these very unique transistors is possible through Philco's exclusive electrochemical etching process. Due to the outstanding precision of this process, certain of these graded base transistors are manufactured with no intrinsic base region. This results in much lower power dissipation of the transistors in critical circuitry. A typical 100 mc-200 mc oscillator circuit is shown.

Make Philco your prime source of information for high frequency transistor applications.

Write to Lansdale Tube Company, Division of Philco Corporation, Lansdale, Pa., Dept. ED758

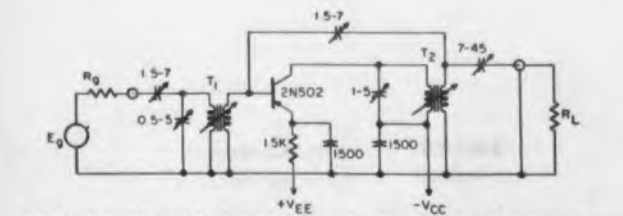
PHILCO CORPORATION
LANSDALE TUBE COMPANY DIVISION
LANSDALE, PENNSYLVANIA

100 MC POWER AMPLIFIER



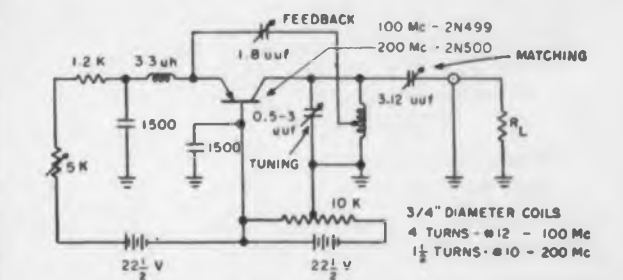
NOTE: T₁ - PRIMARY 4 TURNS #22 ENAMELED WIRE SECONDARY 2 1/2 TURNS #22 ENAMELED WIRE T₂ - PRIMARY 5 TURNS #22 ENAMELED WIRE SECONDARY 2 1/2 TURNS #22 ENAMELED WIRE

200 MC POWER AMPLIFIER



NOTE: T₁ - PRIMARY 3 TURNS #18 ENAMELED WIRE SECONDARY 1 TURN #20 ENAMELED WIRE T₂ - PRIMARY 2 1/2 TURNS #18 ENAMELED WIRE SECONDARY 1 TURN #20 ENAMELED WIRE

100 MC-200 MC OSCILLATOR



MADT FAMILY APPLICATIONS DATA

TYPE*	f_{max}	Power Gain	Oscillator Efficiency	Class of Use
2N499	250 mcs (min)	10 db at 100 mcs	25% at 100 mcs (min)	oscillator and amplifier to 100 mcs
2N500			25% at 200 mcs (min)	oscillator to 400 mcs
2N501	Ultra high-speed switch typical $t_r = 12$ msec; (18 max.); $t_f = 7$ msec; (12 max.); $t_r = 4$ msec; (10 max.). In circuit with current gain of 10 and voltage turnoff.			
2N502†	500 mcs	10 db at 200 mcs		amplifier to 250 mcs
2N503†		12 db at 100 mcs		amplifier to 100 mcs
2N504	50 mcs	46 db at 455 KC		high gain IF amplifier
2N588	200 mcs (min)	13 db at 50 mcs		oscillator and amplifier to 50 mcs

*Available in voltage ratings up to 35 V and dissipation ratings to 100 mw. †In JETEC TO-9 Case (widely known as JETEC 30 Case).



Audio and High Frequency (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings				Characteristics					r'_b
		W_c (mw)	T_j (C)	(a) mw/C (b) C/mw(volts)	V_c (ma)	h_{fe} or h_{fb}	I_{co} (μa)	NF (db)	C_c ($\mu\mu f$)	f_{co} (Mc)	
Transitron Electronic Corp., (cont.)											
Wakefield, Mass.											
2N480	n-p-n, Diffused, Si ²	200	200	45		60	0.2	19	7	11	
2N473	n-p-n, Diffused, Si			15		30		20		10	
2N474	n-p-n, Diffused, Si			30							
2N475	n-p-n, Diffused, Si			45							
2N470	n-p-n, Diffused, Si			15		16		22		8	
2N541	n-p-n, Diffused, Si	200	200	15		130	0.02	19	7	15	
2N542	n-p-n, Diffused, Si			30							
2N543	n-p-n, Diffused, Si			45							
2N478	n-p-n, Diffused, Si			15		60				11	
2N479	n-p-n, Diffused, Si			30							
2N549	n-p-n, Diffused, Si	5w	200	60			0.04		130	4	
Tung-Sol Electric Inc., East Orange, N. J.											
2N381	p-n-p, AJ, audio out.	200	85	0.2(b)	-25	200	50	10	50	1.2	
2N382	p-n-p, AJ, audio out.						75			1.5	
2N383	p-n-p, AJ, audio out.						100			1.8	
2N460	p-n-p, AJ, audio		100		-45	400	0.960	15	9	1.2	
2N461 ¹	p-n-p, AJ, audio						0.980		9		
2N413	p-n-p, AJ, rf amp.	120		0.4(b)	-30	200	30	5	7	12	3
2N414	p-n-p, AJ, rf amp.						60		6		5
2N416	p-n-p, AJ, rf amp.	120	85			200	80	5	4	12	10
2N417	p-n-p, AJ, rf amp.						140		5		20
T5627	p-n-p, AJ, driver amp.	150	85	0.33(b)	-25	200	80	20			1.5
T5628	p-n-p, AJ, low-noise					100	0.992	10	9		1.2
T5629	p-n-p, AJ, driver amp.						0.985	15			
Western Electric,³											
New York, N. Y.											
2N509	p-n-p, Diffused, amp.	250	100	0.35(b)	-30	40	15.5	1.2	2.5	750	55
GA53194	p-n-p, Diffused, osc.					30	14	2.5		600	80
Westinghouse Electric Corp.,											
Youngwood, Pa.											
2N59	p-n-p, Fused, Class B audio	180	85	0.003(a)	-25	200	95	10			1.8
2N60	p-n-p, Fused, Class B audio						65				1.5
2N61	p-n-p, Fused, Class B audio						50				1.1
2N402	p-n-p, Fused, Class A audio driver						20				0.6
2N403	p-n-p, Fused, Class A audio out.						30				0.85
2N609	p-n-p, Fused, Class B audio out.	180	85	0.003(a)	-25	200	95	20			1.8
2N610	p-n-p, Fused, Class B audio out.						65				1.5
2N611	p-n-p, Fused, Class B audio out.						50				1.1
2N612	p-n-p, Fused, Class A audio driver					150	20				0.6
2N613	p-n-p, Fused, Class A audio out.					200	30				0.85
2N614	p-n-p, Fused, if amp.	150	85	0.0025(a)	-25	100	.97	-3	6	3.5	
2N615	p-n-p, Fused, if amp.						.98			7	
2N616	p-n-p, Fused, reflex amp.						.985			8	
2N617	p-n-p, Fused, conv. amp.						.987			9	

1. Collector Dissipation at 25 C
2. at I_{cbo}
3. at F_{co}
4. μa at 25 C ($V_c = 5$ v)
5. Mw's at 25 C
6. Symmetry pairs (n-p-n)
7. also 2N35

8. Military
9. at 270 cps
10. with heat sink 0.18 c/mw
11. with heat sink 0.15 c/mw
12. grounded base
13. same type flexible leads
- a. collector to base volts -12

13. b. collector to base volts -25
- c. collector to base volts -30
- d. 2 transistor push-pull
14. matched pair
15. push-pull
16. maximum frequency of oscillation

h_R = static value of the reverse voltage transfer ratio for open-circuit input conditions.

h_r = small-signal value of the reverse voltage transfer ratio for open-circuit input conditions.

$I_{b\mu_0}$ = base current when the base is biased in the high-impedance direction with respect to the given reference electrode; the remaining electrode μ is open-circuited with respect to dc.

$I_{b\mu_s}$ = base current when the base is biased in the high-impedance direction with respect to the given reference electrode; the remaining electrode μ is short-circuited with respect to dc.

$I_{c\mu_0}$ = collector current when collector is biased in the high-impedance direction with respect to the given reference electrode; the remaining electrode μ is open-circuited with respect to dc.

$I_{c\mu_s}$ = collector current when collector is biased in the high-impedance direction with respect to the given reference electrode; the remaining electrode μ is short-circuited with respect to dc.

$I_{e\mu_0}$ = emitter current when emitter is biased in the high-impedance direction with respect to the given reference electrode; the remaining electrode μ is open-circuited with respect to dc.

$I_{e\mu_s}$ = emitter current when emitter is biased in the high-impedance direction with respect to the given reference electrode; the remaining electrode μ is short-circuited with respect to dc.

r'_b = base spreading resistance—resistance between the external connection and the active area of the base region.

t_d = ohmic delay time—time interval between the rise of a pulse applied at the input terminals and the rise of the output pulse generated by minority carriers.

t_s = storage time—time interval between the start of the decay of a pulse applied at the input terminals and the start of the decay of the output pulse generated by the minority carriers.

$V_{B\mu F}$ = floating potential; open-circuit direct voltage between base and reference electrode when the electrode μ is biased in the high-impedance direction.

$V_{C\mu F}$ = floating potential; open-circuit direct voltage between the collector and reference electrode when the electrode μ is biased in the high-impedance direction.

$V_{E\mu F}$ = floating potential; open-circuit dc voltage between emitter and reference

electrode when the electrode μ is biased in high-impedance direction.

$BV_{\mu o}$ = breakdown voltage between the base and reference electrode.

$BV_{c\mu o}$ = breakdown voltage between the collector and the reference electrode.

$BV_{e\mu o}$ = breakdown voltage between the emitter and the reference electrode.

y_c = modified output admittance with high input impedance.

y_f = forward transfer admittance with low output impedance.

y_i = input admittance with low output impedance.

y_o = output admittance with low input impedance.

y_r = reverse transfer admittance, low input impedance.

z_f = forward transfer impedance with high output impedance.

z_i = input impedance with high output impedance.

z_o = output impedance with high input impedance.

z_r = reverse transfer impedance with high input impedance.

The g components of y parameters are frequently used rather than the y parameters, since often the susceptance component may be neglected. In that case, y_c , y_f , y_i , y_o and y_r are replaced with g_c , g_f , g_i , g_o , and g_r respectively.

Parameter Conversion Tables

Literature over the years in the transistor field has been written in a mixture of early network parameters and later IRE designations. The problem is further complicated by the use of impedance, admittance, and hybrid parameters. The following tables are included in this issue to facilitate easy conversion from one system to another. See figs. 1-5.

Any of these symbols may carry an additional e , b , or c subscript to designate the configuration in which the transistor is operated. The only exceptions are h_{fb} and h_{fe} , which already have the additional subscripts.

Admittance parameters may be represented by conductance parameters at low frequencies.

All h and y parameters are grounded emitters unless otherwise noted.

The primed conductances are those which would be observed at the active region in the transistor after correction for base spreading resistance.

In all the above tables, y_i , y_f , y_c , and y_o , may be replaced by the corresponding g functions, g_i , g_f , g_c , and g_o , respectively except when capacitance effects are important.

Additional parameter relations may be found for h , z , and r parameters in the 1957 Data Chart.

(Continued on page XIII)

More power for its size than any other transistor

Honeywell Power Transistors

More rugged, more compact, more flexible—specifically designed for the following applications:

- **D. C. Power Converters**—(shown at right)
- **Amplifier for Servo Motors**—for control motors or indicator motors
- **Voltage Regulation**

WHERE miniaturization is vital, yet high power is still required, Honeywell's complete line of power transistors is your best answer.

Honeywell *stud-mounted* transistors combine smaller size per power output with greater flexibility and interchangeability. *Stud mounting* is ideal for printed circuit techniques.

They offer a *narrow* span of characteristics—along with superior electrical performance and high uniform power gain over a wide range of collector current values.

For complete information on these and other Honeywell Transistors, contact your nearest Honeywell Representative below, or Minneapolis-Honeywell Semiconductor Products Division, Dept. ED-7-114, Minneapolis 8, Minnesota.

UNION, N. J.
MURdock 8-9000

CHICAGO
IRving 8-9266

BOSTON
ALgonquin 4-8730

LOS ANGELES
RAYmond 3-6611 or
PARKview 8-7311



Honeywell *stud-mounted* 2N539 transistors make this 48-watt, 14 ounce D. C. Power Converter more compact than any other.

EXCERPTS FROM 2N540 SPECIFICATIONS

Symbol	Conditions	Min.	Typ.	Max.	Unit
HFE	$I_C = -2a, V_{CE} = -2V$	45	64	113	
V_{BE}	$I_C = -2a, V_{CE} = -2V$	-0.75	-1.3	-1.88	Volt
θ			1.7	2.2	$^{\circ}C/W$
T	(Thermal time response)	10	30		Ms
I_{CBO}	$I_E = 0, V_{CB} = -2V$		-0.04	-0.1	Ma
	-28V		-0.1	-1.0	
	-60V		-0.3	-2.0	
	-80V		-0.6	-10	
V_{EBF}	$R_{EB} = 10K, V_{CB} = -60V$		-0.1	-0.3	Volt
	-80V		-0.4	-1.5	
V_S	$I_C = -2a, I_B = -200ma$		-0.15	-0.6	Volt

Complete specifications available on request for 2N538, 2N538A (formerly H5), 2N539, 2N539A (formerly H6), 2N540 and 2N540A (formerly H7); also specifications for the largest transistors made, the 2N574, 2N574A, 2N575 and 2N575A

Honeywell

H First in Control

CIRCLE 381 ON READER-SERVICE CARD

Switching Transistors, Low Level

Manufacturer and Type	Class and Application	Maximum Ratings				Characteristics					Switching						Manufacturer and Type
		W_c (mw)	T_j (C)	(am)w/C (b) C/mw(volts)	V_c (ma)	h_{fe} or h_{fb}	I_{co} (μ a)	NF (db)	C_c (μ mf)	f_{co} (Mc)	r'_{fb}	Rise Time (μ s)	Storage Time (μ s)	Fall Time (μ s)	Sat. Volt (V)	Leak Cur. (μ a)	
CBS Hytron, Lowell, Mass.																	
2N438	n-p-n, AJ	100	85	2.0 (a)	30	25	1.5	10	4	180	0.7	0.8	0.5	0.15	40	25(a)	2N438
2N439	n-p-n, AJ					35			8	220	0.5	0.7	0.3		60	40(a)	2N439
2N440	n-p-n, AJ					65			12	300	0.3	0.6	0.2		100	70(a)	2N440
2N356	n-p-n, AJ				20v	500	3	14	3		1	0.3	1	0.18		30(a)	2N356
2N357	n-p-n, AJ								6		0.6		0.6				2N357
2N358	n-p-n, AJ	100	85	2.0 (a)	20v	500	3	14	9		0.4	0.5	0.6	0.18		30(a)	2N358
2N377	n-p-n, AJ	150	100		25v	200	6	15	5		1.2	0.4	0.6			30(a)	2N377
2N385	n-p-n, AJ								6							40(a)	2N385
2N388	n-p-n, AJ							15	8		0.6	0.4	0.4			80(a)	2N388
General Electric Co., Syracuse, N. Y.																	
2N394	p-n-p, AJ, sw.	150	100	2.5(a)	-10	-200	-6	12	5.5	150	0.9	0.35	0.35	-0.1	2	20(a)	2N394
2N395	p-n-p, AJ, sw.				-15				7	130		0.28	0.28			25(a)	2N395
2N396	p-n-p, AJ, sw.				-20					140		0.35	0.25	-0.09		30(a)	2N396
2N397	p-n-p, AJ, sw.				-10	-250			10	160				-0.085		(a)	2N397
2N450	p-n-p, AJ, sw.		85		-20	-125			7					-0.2		(a)	2N450
2N518	p-n-p, AJ, sw.	150	85	2.5(a)	-45	-125	-6	12	10		0.8	0.9	0.5	-0.150		60(a)	2N518
2N332	n-p-n, GJ ³ , amp, Si, sw.		200	1(a)		25	15	.04	28	7	0.4	0.4	.14	0.4	.04	15(a)	2N332
2N333	n-p-n, GJ ³ , amp, Si, sw.						35		23		.35	.15	.16			35(a)	2N333
2N335	n-p-n, GJ ³ , amp, Si, sw.						50		20		.33	.25	.17			50(a)	2N335
2N452	n-p-n, DJ, Si, sw.	85	150		65	5	50			400 kc						8(a)	2N452
2N634	n-p-n, AJ, sw.	150	85	2.5(a)	20	300	5		8							15(a)	2N634
2N635	n-p-n, AJ, sw.								12							25(a)	2N635
2N636	n-p-n, AJ, sw.								17							35(a)	2N636
General Transistor Corp., Jamaica, N. Y.																	
2N311	p-n-p, AJ, lo-speed sw.	100	85	1.67(a)	15		<60				<1.5	<1.5	<1.5			25-75(b)	2N311
2N312	n-p-n, AJ, lo-speed sw.															(b)	2N312
2N315	p-n-p, AJ, comp. sw.				20		<2	14	5		<1.5	<0.4	<0.8			15-30(a)	2N315
2N316	p-n-p, AJ, comp. sw.								12		<0.8	<0.8	<1.0			20-50(a)	2N316
2N317	p-n-p, AJ, comp. sw.								20		<0.6		<0.8			20-60(a)	2N317
2N356	n-p-n, AJ, comp. sw.	100	85	2(a)	20	30	<5	14	3		<2.0	<0.7	<2			20-50(a)	2N356
2N357	n-p-n, AJ, comp. sw.					45			6		<1.2		<1.2			(a)	2N357
2N358	n-p-n, AJ, comp. sw.								9		<0.8	<1.0	<1.2			(a)	2N358
2N444	n-p-n, AJ, comp. sw.			1.67(a)	15		<6	16	13	>0.5						>10 (b)	2N444
2N445	n-p-n, AJ, comp. sw.								>2	150						>20 (b)	2N445
2N446	n-p-n, AJ, comp. sw.	100	85	1.67(a)	15		<6	16	13	>5						>30 (b)	2N446
2N447	n-p-n, AJ, comp. sw.								>9	220						>50 (b)	2N447
2N519	p-n-p, AJ, comp. sw.						<2	14	>0.5	75						>15 (b)	2N519
2N520	p-n-p, AJ, comp. sw.								>3	100						>20 (b)	2N520
2N521	p-n-p, AJ, comp. sw.								>8	150						>35 (b)	2N521
2N522	p-n-p, AJ, comp. sw.	100	85	1.67(a)	15		<2	16	14	>15						>60 (b)	2N522
2N523	p-n-p, AJ, comp. sw.								>21	275						>80 (b)	2N523
2N592	p-n-p, AJ, bi-lateral, sw.	125		2 (a)	20		<5	35	0.4							>20 (a) ⁶	2N592
2N593	p-n-p, AJ, bi-lateral, sw.			(a)	30				0.6							>50 (a) ⁶	2N593
2N594	n-p-n, AJ, bi-lateral, sw.	100		1.67(a)	20			15	>1.5							>20 (a) ⁶	2N594
2N595	n-p-n, AJ, bi-lateral, sw.	100	85	1.67(a)	15		<5	16	15	>3.0						>35 (a) ⁶	2N595
2N596	n-p-n, AJ, bi-lateral, sw.				10				>5.0							>50 (a) ⁶	2N596
GT345	p-n-p, AJ, bi-directional	125		2 (a)	40		<15	24								10-19(b)	GT345
GT123	p-n-p, AJ, sw.	100		1.67(a)	20		<6	15	>5		0.5	0.5	0.5			30-150(a) ⁶	GT123
GT153	p-n-p, AJ, sw.				30		<5	<15								>20 (a)	GT153
2N602	p-n-p, Drift, sw. comp.	120		2.0(a)	20		3	16	<7						0.1	20-80(a)	2N602
2N603	p-n-p, Drift, sw. comp.			2.0(a)	30		3	16	<5						0.12	30-100(a)	2N603
2N604	p-n-p, Drift, sw. comp.			2.0(a)	30		4	16	<5						0.15	40-140(a)	2N604

Switching Transistors, Low Level (cont.)

Switching

Manufacturer and Type	Class and Application	Maximum Ratings				Characteristics						Switching					Manufacturer and Type	
		W_c (mw)	T_j (C)	(a) mw/C (b) C/mw(volts)	V_c (ma)	h_{fe} or h_{fb}	I_{co} (μ a)	NF (db)	C_{coo} (μ mf)	f_{co} (Mc)	r'_{fb}	Rise Time (μ s)	Storage Time (μ s)	Fall Time (μ s)	Sat. Volt (V)	Leak Cur. (μ a)		Beta (a) h_{FE} (b) h_{fe}
General Transistor Corp. (cont.)																		
GT792	n-p-n, AJ, sw.	100	85	1.67(a)	20		<6		>4.8							37-160(b)	GT792	
GT903	n-p-n, AJ, sw.						<25		<20								GT903	
GT904	n-p-n, AJ, sw.								>4								GT904	
GT905	n-p-n, AJ, sw.								<20								GT905	
GT947	n-p-n, AJ, sw.				15				<30								GT947	
GT167	n-p-n, AJ, sw.	100	85	1.67(a)	25		<10		<15						>25(b)		GT167	
GT269	p-n-p, AJ, sw.						<2.5		>4						>35(a)		GT269	
GT758	p-n-p, AJ, sw.						<2		16						>10(b)		GT758	
GT759	p-n-p, AJ, sw.								16						>15(b)		GT759	
GT760	p-n-p, AJ, sw.														>20(b)		GT760	
GT761	p-n-p, AJ, sw.	100	85	1.67(a)	-20		<2		16						>30(b)		GT761	
GT762	p-n-p, AJ, sw.			(a)											>60(a)		GT762	
GT763	p-n-p, AJ, sw.							16	14						>80(b)		GT763	
Hughes Aircraft Co., Culver City, Calif.																		
HA7501	p-n-p, FJ, Si, med. pwr.	0.5w	150	4 (a)	-60	.880	-0.1			0.5				-2	-0.1		HA7501	
HA5014	n-p-n, AJ, sw.	400	70	9 (a)	40						0.9	0.7	0.8	0.15	8	80(a)	HA5014	
HA5020	n-p-n, AJ, sw.	300		6.7(a)	20						0.9	0.7	0.8	0.25	5	70(a)	HA5020	
HA5021	n-p-n, AJ, sw.			6.7(a)							0.6	0.5	0.4	0.30	5	70(a)	HA5021	
HA5001	n-p-n, AJ, sw.	400		9 (a)	30						0.9	0.7	0.8	0.20	5		HA5001	
HA5009	n-p-n, AJ, sw.	400	70	9 (a)	10					2	0.9	0.7	0.8	0.35	7	15(a)	HA5009	
HA7502	p-n-p, FJ, Si, med. pwr.	0.5w	150	4 (a)	-60	.950	-0.1			0.5				-2	-0.1		HA7502	
HA7506	p-n-p, FJ, Si, med. pwr.				-35	.930	-0.5								-0.5		HA7506	
HA7507	p-n-p, FJ, Si, med. pwr.				-20	.930	-0.1			1.5					-0.1		HA7507	
HA7510	p-n-p, FJ, Si, med. pwr.				-35	.960	-0.5			0.5					-0.5		HA7510	
Industro Transistor Corp., Long Island City, N. Y.																		
2N315	p-n-p, AJ, comp.	150	85		-15	400			14	5	1	0.5	0.5			20(a)	2N315	
2N316	p-n-p, AJ, comp.				-10					12						30(a)	2N316	
2N317	p-n-p, AJ, comp.				-6					20						40(a)	2N317	
2N425	p-n-p, AJ, comp.				-20					4						30(a)	2N425	
2N426	p-n-p, AJ, comp.				-16					6						40(a)	2N426	
2N427	p-n-p, AJ, comp.	150	85		-15	400			14	15	0.4	0.3	0.3			60(a)	2N427	
2N428	p-n-p, AJ, comp.				-12					20						80(a)	2N428	
Motorola, Inc., Phoenix, Ariz.																		
2N425	p-n-p, AJ, sw.	150	85	2.5(a)	-30	400		2	14	4	50	0.5	0.3	.45	0.22	2	30(a)	2N425
2N426	p-n-p, AJ, sw.									6	55			.35			40(a)	2N426
2N427	p-n-p, AJ, sw.									11	60	0.4		.35			55(a)	2N427
2N428	p-n-p, AJ, sw.									17	70			0.3			80(a)	2N428
Philco Corp., Lansdale, Pa.																		
2N597	p-n-p, AJ	250	100		-30	400		25	18	4.5				.085		40(a)	2N597	
2N598	p-n-p, AJ									7.5						90(a)	2N598	
2N599	p-n-p, AJ									15						100(a)	2N599	
2N462	p-n-p, AJ, bi-lateral	150	75		-40	200		35	20	0.5				.085		45	2N462	
2N670	p-n-p, AJ, pulse amp.	300	85			2 amp.		75						0.35		40-250	2N670	
2N671	p-n-p, AJ, pulse amp.	1w ⁴															2N671	
2N240	p-n-p, Sbt	30	85	0.75(b)	-6	15	30	0.7	3	50 ⁹							2N240	
2N501	p-n-p, Madt	50	85		-15	50		0.8	2		12	7	4	0.15		50(a)	2N501	
2N393	p-n-p, MAJ, hf amp., osc.	25	85		-6	50	155	1.5	3.5	60				0.07		95(a)	2N393	
2N534	p-n-p, AJ, amp.	25	65	0.7(b)	-50	25	150	15									2N534	
2N536	p-n-p, AJ	50	85		-20	30				2				0.07	5	100	2N536	
2N495	p-n-p, AJ, Si, amp.	150	140	0.77(b)	-25	50	18	1	7	15							2N495	
2N496	p-n-p, AJ, Si			0.77(b)	-10			1	7	11 ⁹				0.08	5	10(a)	2N496	
General Trans. (cont.)																		

Switching Transistors, Low Level (cont.)

Switching

Manufacturer and Type	Class and Application	Maximum Ratings				Characteristics						Switching					Manufacture and Type
		W_c (mw)	T_j (a) (C) (b) C/mw(volts)	V_c (volts)	I_c (ma)	h_{fe} or h_{fb}	I_{co} (μ a)	NF (db)	C_{cob} (μ mf)	f_{co} (Mc)	r'_{b}	Rise Time (μ s)	Storage Time (μ s)	Fall Time (μ s)	Sat. Volt (V)	Leak Cur. (μ a)	
RCA, Somerville, N. J.																	
2N269	p-n-p, AJ, med. sp., sw.	120	85	—20	—100	40	—2.5 ⁷			12						40(a)	RCA 2N269
2N356	n-p-n, AJ, hi-current sw.	100		20	500	30	5 ^{7a}			3		0.3				30(a)	RCA 2N356
2N357	n-p-n, AJ, hi-current sw.									6			0.6				RCA 2N357
2N358	n-p-n, AJ, hi-current sw.									9			0.6				RCA 2N358
2N398	p-n-p, AJ, hi-volt sw.	50		—105	—100	60	—14 ⁷									60(a)	RCA 2N398
2N404	p-n-p, AJ, med. sp., sw.	120	85	—25	—100	40	—5 ^{7c}			12						40(a)	RCA 2N404
2N578	p-n-p, AJ, hi-current sw.			—20	—400	15				5		0.6				15(a)	RCA 2N578
2N579	p-n-p, AJ, hi-current sw.					30				8			0.5			30(a)	RCA 2N579
2N580	p-n-p, AJ, hi-current sw.					45				15			0.4			45(a)	RCA 2N580
2N581	p-n-p, AJ, med. sp., sw.	80		—18	—100	30	—6 ^{7b}			8						30(a)	RCA 2N581
2N582	p-n-p, AJ, hi-speed sw.		85			60	—5 ^{7c}			18						60(a)	RCA 2N582
2N583	p-n-p, AJ, med-speed sw.					30	—6 ^{7b}			8						30(a)	RCA 2N583
2N584	p-n-p, AJ, hi-speed sw.					60	—5 ^{7c}			18						60(a)	RCA 2N584
2N585	n-p-n, AJ, med. sp. sw.					40	8 ^{7d}			5		1.5		0.8		40(a)	RCA 2N585
2N586	p-n-p, AJ					60	—16 ^{7e}									60(a)	RCA 2N586
Raytheon Mfg. Co., Newton, Mass.																	
2N464	p-n-p, AJ, audio low-freq.	150	85	0.4 (b)	—45	—100	26	—6	22	12	0.7					30(a)	Raytheon 2N464
2N425	p-n-p, AJ, comp. sw., ckts.				—30	—400		—2		14	2					40(a)	Raytheon 2N425
2N426	p-n-p, AJ, sw., comp.										3					55(a)	Raytheon 2N426
2N427	p-n-p, AJ, sw., comp.										5					80(a)	Raytheon 2N427
2N428	p-n-p, AJ, sw., comp.										10						Raytheon 2N428
2N404	p-n-p, AJ, sw., comp.	120	85		—25	—100		—2		12	4						Raytheon 2N404
2N658	p-n-p, AJ, sw., comp.	170		0.35(b)		—1 amp		—2.5			5					50(a)	Raytheon 2N658
2N661	p-n-p, AJ, sw., comp.							—10			20					120(a)	Raytheon 2N661
2N662	p-n-p, AJ, sw., comp.										8					60(a)	Raytheon 2N662
CK25	p-n-p, AJ, sw., comp.	80		0.75(b)	—30	—400		—2		14	4					30(a)	Raytheon CK25
CK26	p-n-p, AJ, sw., comp.	80	85	0.75(b)	—30	—400		—2		14	6					40(a)	Raytheon CK26
CK27	p-n-p, AJ, sw., comp.										11					55(a)	Raytheon CK27
2N413	p-n-p, AJ, rf, video, sw., ckts.	150		0.4 (b)		—200	30		7	12	2.5						Raytheon 2N413
2N414	p-n-p, AJ, rf, video, sw., ckts.						60		6		7						Raytheon 2N414
2N416	p-n-p, AJ, rf, video, sw., ckts.						80		4		10						Raytheon 2N416
2N417	p-n-p, AJ, rf, video, sw., ckts.	150	85	0.4 (b)	—30	—200	140	—2.6	4	12	20						Raytheon 2N417
CK28	p-n-p, AJ, comp., sw.	80		0.75(b)		—400		—2		14	17					80(a)	Raytheon CK28
2N327A	p-n-p, FJ, Si, audio, dc amp.	380	160	0.35(b)	—50	—50	14	0.005	18	70	200			0.1		11(a)	Raytheon 2N327A
2N328A	p-n-p, FJ, Si, audio, dc amp.						28				300			0.2		18(a)	Raytheon 2N328A
2N329A	p-n-p, FJ, Si, audio, dc amp.						60				500			0.2		26(a)	Raytheon 2N329A
2N619	n-p-n, FJ, Si, audio, dc amp.	380	160	0.35(b)	—50	—50	14	0.005	18	70	200					15(a)	Raytheon 2N619
2N620	n-p-n, FJ, Si, audio, dc amp.						28				300					30(a)	Raytheon 2N620
2N621	n-p-n, FJ, Si, audio, dc amp.						60				500					60(a)	Raytheon 2N621
2N659	p-n-p, FJ, comp.	170	85		—25	—1 amp		—2.5		12	10					70(a)	Raytheon 2N659
2N660	p-n-p, FJ, comp.										15					90(a)	Raytheon 2N660
Sprague Electric Co., North Adams, Mass.																	
2N393	p-n-p, Maj, hf amp., osc.	25	85		—6	50	155	1.5		3.5	60			0.07		95(a)	Sprague Electric 2N393
2N240	p-n-p, Sbt.	30	85	0.75(b)	—6	15	30	0.7		3	50 ⁹						Sprague Electric 2N240
Sylvania Electric Prod., Inc., Weburn, Mass.																	
2N356	n-p-n, AJ, sw.	100	85	0.6(b)	20	100		20		14	3	1	0.3	1	0.18	30(a)	Sylvania Electric 2N356
2N357	n-p-n, AJ, sw.					200					6	0.6		0.6			Sylvania Electric 2N357
2N358	n-p-n, AJ, sw.					300					9	0.4	0.5				Sylvania Electric 2N358
2N377	n-p-n, AJ, sw.	150	100	2 (a)	20	200	40	200 ¹¹		15	6	2.5	0.7	1.0			Sylvania Electric 2N377
2N385	n-p-n, AJ, sw.				25		70	400 ¹¹			4						Sylvania Electric 2N385
2N388	n-p-n, AJ, sw.	150	100	2 (a)	20	200	120	50		15	8	1.0	0.7	0.7			Sylvania Electric 2N388
2N625	n-p-n, AJ, sw.	2.5w		3.3(a)	40		500	100		60		0.5	0.5	0.5			Sylvania Electric 2N625

Switching Transistors, Low Level (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings				Characteristics					Switching						Manufacturer and Type
		W_c (mw)	T_j (C)	(a) mw/C (b) C/mw(volts)	V_c (ma)	h_{fe} or h_{fb}	I_{co} (μ a)	NF (db)	C_{co} (μ mf)	f_{co} (Mc)	r'_b	Rise Time (μ s)	Storage Time (μ s)	Fall Time (μ s)	Sat. Volt (V)	Leak Cur. (μ a)	
Sylvania Elec. (cont.)																	
2N679	n-p-n, AJ, sw.	150	85	2.5(a)	25	20	25										Sylvania (cont.) 2N679
2N312	n-p-n, AJ, sw.	100	85	1.7(b)	15	200					1.0	1.5	1.5	0.075v	15	50(a)	2N312
2N576A	n-p-n, AJ, sw.	200	100	2.7(a)	40	400			15	5	1.5	0.7	0.7	0.4			2N576A
2N587	n-p-n, AJ, sw.	150	85	2.5(a)		200	25	15	25			15					2N587
Texas Instruments Inc., Dallas, Texas																	
2N364	n-p-n, grown, hi-freq.	150	85	0.5(b)	30	50	12	1	4.5	2.5							Texas Instruments 2N364
2N365	n-p-n, grown, hi-freq.						26			3							2N365
2N366	n-p-n, grown, hi-freq.						65			3.5							2N366
204A	n-p-n, grown, hi-freq.				60		19			2.5							204A
2N623	n-p-n, DJ, hi-freq.			1 (b)	30		35		3.5	90	75 ohm	12	12 ¹⁰	1		35(a)	2N623
Tung-Sol Electric Inc., East Orange, N. J.																	
2N579	p-n-p, AJ, comp.	120	85	0.4(b)	-20	400		5	14	8	0.4	0.3	0.25	-0.2	5	30(a)	Tung-Sol Electric 2N579
2N580	p-n-p, AJ, comp.	120	85	0.4(b)	-20	400		5	14	15	0.2	0.2	0.2	-0.2	5	45(a)	2N580
2N581	p-n-p, AJ, comp.				-18	100				8				-0.2	5	30(a)	2N581
2N404	p-n-p, AJ, comp.			0.28(b)	-25					12				-0.1	5	30(a)	2N404
2N582	p-n-p, AJ, comp.			0.4 (b)						18				-0.2	5	60(a)	2N582
2N425	p-n-p, AJ, comp.				-30	400				4	50	0.5	0.3	0.45	5	30(a)	2N425
2N426	p-n-p, AJ, comp.	120	85	0.4(b)	-30	400		5	14	6	55	0.5	0.3	0.35	5	40(a)	2N426
2N427	p-n-p, AJ, comp.									11	60	0.4				55(a)	2N427
2N428	p-n-p, AJ, comp.									17	70		0.3			80(a)	2N428
2N578	p-n-p, AJ, comp.									5		0.9		-0.2		15(a)	2N578
Western Electric¹⁰, New York, N. Y.																	
2N29	n-p-n, GJ, trans.	100	85	0.5(b)	35	0.480	15		17	2							Western Electric 2N29
2N110	pc	200		0.3	50	50	3.2	1.3		5	0.09		1.7				2N110
GA52829	p-n-p, AJ	100		0.5	-30		0.985	1.8	11	3.3							GA52829
GA53104	p-n-p, AJ				-10		0.980			2.9							GA53104
GA53149	p-n-p, AJ				-35		0.09			3.3							GA53149
2N560	n-p-n, Diffused, Si		175	0.25(b)	60	0.98	0.1	35		50	0.075		0.05	0.50		68(a)	2N560
GA53242	p-n-p, AJ	500	85					5		4	0.37	0.080	0.28	0.25		20(a)	GA53242

1. Collector Dissipation at 25 C
2. at 70 C mounting base
3. at 2.0 amp.

4. at 0.5
5. diffused base
6. also h_{fe}

7. collector to base $V = -2.5$
a. collector to base $V = 5$
b. collector to base $V = -6$

7. c. collector to base $V = -12$
d. collector to base $V = 12$
e. collector to base $V = -25$

7. f. mounts flange temp of 80 C
g. 2 transistor push-pull
8. heat sink

9. f_t = frequency for beta = 1
10. Military
11. Maximum I_{cer} shown with $R_{BE} = I_k$ and VCE max.

(continued from page IX)

Grounded Emitter Amplifier

$$K = \frac{-g_f R_L}{1 + g_i R_s + g_o R_L + g_i g_c R_s R_L} \text{ (voltage)}$$

$$K_i = \frac{-g_f R_s}{1 + g_i R_s + g_o R_L + g_i g_c R_s R_L} \text{ (current)}$$

Degenerative Emitter Amplifier (Voltage)

$$K = \frac{-(g_f - g_i g_c R_e) R_L}{1 + g_i R_s + (g_i + g_f + g_o) R_e + g_o R_L + g_i g_c [R_s (R_e + R_L) + R_e R_L]}$$

(continued on page XIV)

Typical Amplifier Equations

Grounded Base Amplifier

$$K_b = (g_f + g_o) R_L / [1 + (g_i + g_f + g_o) R_s + g_o R_L + g_i g_c (R_s + R_L) R_e]$$

Grounded Collector Amplifier

$$K_c = \frac{(g_i + g_f - g_i g_c R_e) R_e}{1 + g_i R_s + (g_i + g_f + g_o) R_e + g_i g_c R_s R_e}$$

Grounded Collector Amplifier Complex

The normal R_e is replaced with a transistor T_1 having its collector connected to the emitter of the grounded emitter amplifier T_2 , and with its emitter connected to the emitter return through a new R_e . The base current is fixed for the load transistor T_1 .

$$K = \frac{1}{1 + \frac{g_{o2} + G_L}{g_{i2} + g_{f2}} + \frac{g_{o1} + g_{i1} g_{c1} R_e}{(g_{i2} + g_{f2}) [1 + (g_{i1} + g_{f1} + g_{o1}) R_e]}}$$

where the "1" refers to a value of T_1 , the "2" to a value for T_2 , and G_L is the load conductance.

Input and Output Conductances

Grounded Emitter

In the following equations R_s is the source resistance, R_e the emitter resistance, and R_L the collector load resistance.

$$G_{ie} = \frac{1 + g_c R_L}{1 + g_i R_s + g_o R_L + g_i g_c R_s R_L}$$

$$G_{oe} = \frac{g_o + g_i g_c R_s}{1 + g_i R_s + g_o R_L + g_i g_c R_s R_L}$$

Degenerative Emitter

$$G_{id} = \frac{g_i [1 + g_c (R_e + R_L)]}{1 + g_i R_s + (g_i + g_f + g_o) R_e + g_o R_L + g_i g_c [R_s (R_e + R_L) + R_e R_L]}$$

$$G_{od} = \frac{g_o + g_i g_c (R_e + R_s)}{1 + g_i R_s + (g_i + g_f + g_o) R_e + g_o R_L + g_i g_c [R_s (R_e + R_L) + R_e R_L]}$$

Grounded Base

$$G_{ib} = \frac{(g_i + g_f + g_i g_c R_L)}{1 + (g_i + g_f) R_s + g_o R_L + g_i g_c R_s (R_s + R_L)}$$

$$G_{ob} = \frac{(g_i g_c R_s + g_o)}{1 + (g_i + g_f) R_s + g_o R_L + g_i g_c R_s (R_s + R_L)}$$

Grounded Collector

$$G_{ic} = \frac{g_i (1 + g_c R_e)}{1 + g_i R_s + (g_i + g_f + g_o) R_e + g_i g_c R_s R_e}$$

$$G_{oc} = \frac{(g_i + g_f)}{1 + g_i (R_s + R_e) + g_f R_s}$$

These equations may be changed to the hybrid parameter form by dividing numerators and denominators both by $g_i R_s$, and substituting

$$h_i = \frac{1}{g_i}; \quad h_f = \frac{g_f}{g_i}; \quad h_o = g_c; \quad h_c = h_o - \frac{h_f h_r}{h_i} = g_o$$

Table I. From Network to IRE Parameters

Hybrid	Admittance	Impedance	Conductance
$h_{11} = h_i$	$y_{11} = y_i$	$z_{11} = z_i$	$g_{11} = g_i$
$h_{21} = h_r$	$y_{21} = y_r$	$z_{21} = z_r$	$g_{21} = g_r$
$h_{12} = h_o$	$y_{12} = y_o$	$z_{12} = z_o$	$g_{12} = g_o$
$h_{22} = h_{rb}$	$y_{22} = y_{rb}$	$z_{22} = z_{rb}$	$g_{22} = g_{rb}$
$\alpha = h_{rb}$	$\beta = h_{fe}$		

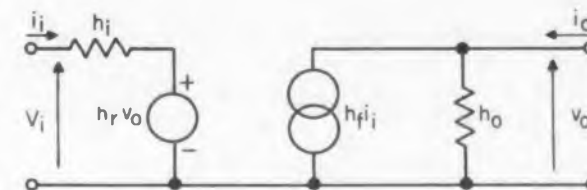


Fig. 1. Grounded base equivalent circuit using h parameters.

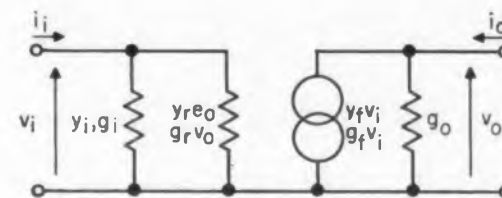


Fig. 2. Equivalent circuit using either y or g parameters.

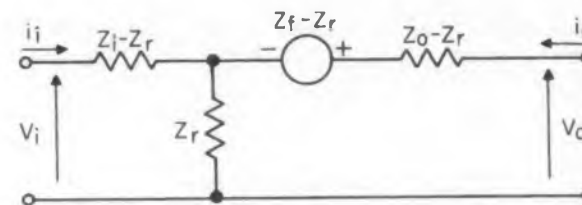


Fig. 3. Open circuit impedance equivalent circuit with one generator.

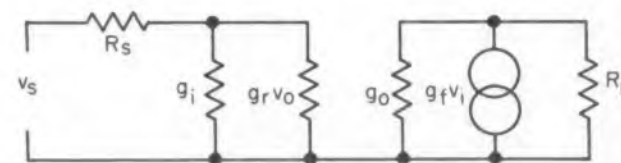


Fig. 4. Basic amplifier circuit.

Table II. Between y and z Parameters

z to y	y to z
$z_1 = y_o / y_1 y_c$	$y_1 = z_o / D(z)$
$z_r = -y_b / y_1 y_c$	$y_r = -z_r / D(z)$
$z_f = -y_r / y_1 y_c$ $= (y_c - y_o) / y_f y_c$	$y_f = -z_f / D(z)$
$z_o = I / y_c$	$y_o = z_1 / D(z)$
$D(z) = z_1 z_o - z_f z_r$	$y_c = I / z_o$
	$D(y) = y_1 y_c$

Table III. Between h, y, and z Parameters

$h_i = I / y_1 = D(z) / z_o$	$h_r = (y_c - y_o) / y_f = z_r / z_o$
$h_f = y_f / y_1 = -z_f / z_o$	$h_o = y_c = I / z_o$
$D(h) = h_1 h_o - h_f h_r$	

Table IV. Relations for Tee Parameters

$r_d = I / y_c = I / h_o$	$r_m = -y_r / y_1 y_c = -h_r / h_o$
$r_b = y_o / y_1 y_c = D(h) / h_o$	$r_e = [(y_o / y_c) - I] / y_f = -h_r / h_o$
$r_c = (y_1 + y_r) / y_1 y_c = (I + h_r) / h_o$	

Table V. Miscellaneous Relations

$\alpha = y_f / (y_1 + y_r) = h_{rb}$	$\beta = y_r / y_1 = h_r$
$g_i' = g_i / (I - g_i r_b')$	$g_r' = g_r / (I - g_i r_b')$

Table VI. RCA Parameters

$g_{be}' = g_i \approx y_1$	$g_m = y_f - y_r \approx y_f \approx g_r'$
$g_{ce} g_o$	$g_{bc}' \approx (g_c - g_o) g_i / g_r$
$r_b = r_{bb} = \text{base spreading resistance}$	

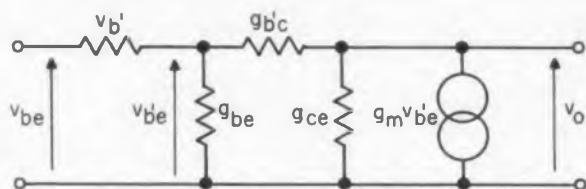


Fig. 5. RCA π circuit.

Table VII. Between y Parameters for Different Configurations

Parameters	CE	CB	CC
Input	y_1	$y_1 + y_r + y_o$	y_1
Forward	y_f	$-y_r - y_o$	$-y_1 - y_r$
Reverse	y_r	$y_r + y_o$	$y_1 + y_r$
Output	y_o	y_o	$y_1 + y_r + y_o$
Modified Output	y_c	$y_1 y_c / (y_1 + y_r)$	$y_1 + y_r + y_o$

Table VIII. Between h Parameters for Different Configurations

Parameter	CE	CB	CC
Forward	h_i	$h_i / [I + h_r - h_r + D(h)]$	h_i
Input	h_r	$(-h_r - D(h)) / [I + h_r - h_r + D(h)]$	$-(I + h_r)$
Reverse	h_r	$[D(h) - h_r] / [I + h_r - h_r + D(h)]$	$(I - h_r)$
Output	h_o	$h_o / [I + h_r - h_r + D(h)]$	h_o



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2N602			10-30 mc		2N605	20-25 db
2N603		25-100	30-50		2N606	25-30 db
2N604			50-70		2N607	30-35 db
					2N608	35-40 db

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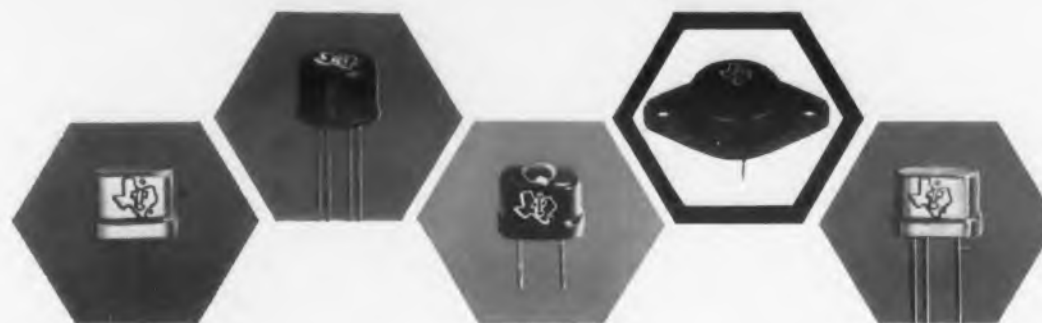
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	Type	Former Designation	Dissipation at 25°C mW	Collector Voltage-V (max.)	Collector Current mA (max.)	Beta (min.) (max.)	Conversion Gain db (min.) (max.)	IF Gain db (min.) (max.)	Audio Gain db (min.) (max.)	RF Gain db (min.) (max.)	Alpha Cutoff Frequency mc (avg.)	Bulletin Number
VHF tetrode	3N25	501	25	-15	-2	65 (Avg.)				10 @ 100mc	200	DL-S 659
high frequency	2N623		40	-30		35 (typ)				15db Avg @ 43mc	90	DL-S 904
	2N248		30	-25	-5	20 (Avg.)				10 @ 18mc	50	DL-S 661
radio converter and IF	2N253		65	12	5			28 32 at 455 kc				DL-S 648
	2N254		65	20	5			32 36 at 455 kc				DL-S 648
	2N145		65	20	5			30 33 at 455 kc				DL-S 568
	2N146		65	20	5			33 36 at 455 kc				DL-S 568
	2N147		65	20	5			36 39 at 455 kc				DL-S 568
	2N252		30	-16	-5		30 34 Avg					DL-S 660
	2N308	375	30	-20	-5			39 42 at 455 kc				DL-S 709
	2N309	376	30	-20	-5			41 44 at 455 kc				DL-S 709
	2N310	377	30	-30	-5			37 Avg at 455 kc	28† Avg			DL-S 710
audio output	2N185	352	150	-20	-150	35 (55 Avg)			39/26††			DL-S 610
	2N238	310	50	-20					37 42			DL-S 638
	2N291	357	300	-25	-200	30 (45 Avg)			31/22††			DL-S 672
general purpose	2N364	200A	150	30	50	9 19					2.5	DL-S 862
	2N365	201A	150	30	50	19 49					3	DL-S 862
	2N366	202A	150	30	50	49 142					3.5	DL-S 862
	204A		150	60	50	9 49					2.5	DL-S 862
	2N368	301	150	-30	-50	19 49					1	DL-S 873
	2N369	302	150	-30	-50	49 142					1.3	DL-S 873
power	2N250	356	25W	-30	-3A	30	Class B Power Output: 10W		30			DL-S 726
	2N251	356A	25W	-60	-3A	30	Class B Power Output: 40W		30			DL-S 727
	2N456		50W	-40	-5A	130 Avg						DL-S 909
	2N457		50W	-60	-5A	130 Avg						DL-S 909
	2N458		50W	-80	-5A	130 Avg						DL-S 909
phototransistor	800		65	20	5							DL-S 810

E Out
† Audio voltage gain = $\frac{E_{Out}}{E_{In}}$ —in recommended circuit.

†† Min. audio power — Class A/Class B.

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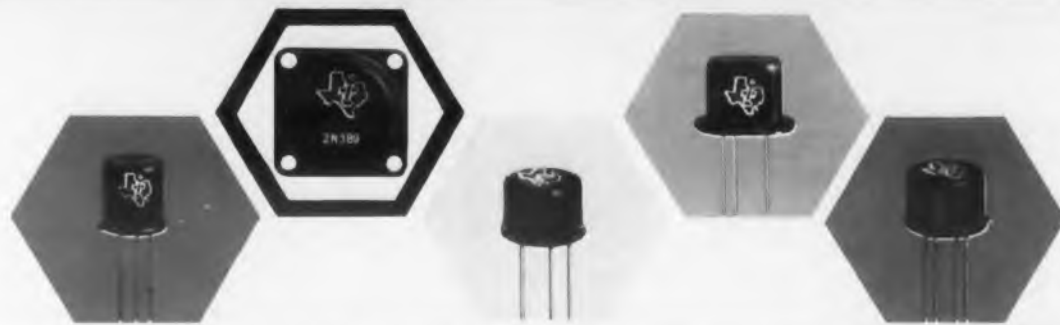
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small signal	903	0.150	9 20	25		30	300	1	DL-S 818	
	904	0.150	18 40	25		30	300	2	DL-S 819	
	904A	0.150	18 90	25		30	300	8	DL-S 820	
	905	0.150	36 90	25		30	300	2	DL-S 821	
	910	0.150	76 333	25		30	300	7 (typ)	DL-S 822	
	2N117	0.150	9 20	25		45	200	1	DL-S 896	
	USN2N117*	0.150	9 20	25		45	200	1		
	2N118	0.150	18 40	25		45	200	2	DL-S 897	
	USN2N118*	0.150	18 40	25		45	200	2		
	2N118A	0.150	18 90	25		45	200	8	DL-S 898	
	2N119	0.150	36 90	25		45	200	2	DL-S 899	
	USN2N119*	0.150	36 90	25		45	200	2		
	2N120	0.150	76 333	25		45	200	7 (typ)	DL-S 900	
	2N332	0.150	9 20	25		45	200	1	DL-S 891	
	2N333	0.150	18 40	25		45	200	2	DL-S 892	
	2N334	0.150	18 90	25		45	200	8	DL-S 893	
	2N335	0.150	36 90	25		45	200	2	DL-S 894	
	2N336	0.150	76 333	25		45	200	7 (typ)	DL-S 895	
switching	2N337	0.125	19	20	20 55	40	300	10	DL-S 811	
	2N338	0.125	39	20	45 150	40	300	20	DL-S 812	
high frequency	3N32	0.125		10	Power Gain: 20db (min.) at 4.3 mc	30	300		DL-S 730	
	3N33	0.125		10	Power Gain: 18db (min.) at 12.5 mc	30	300		DL-S 730	
	3N34	0.125		10	Power Gain: 16db (min.) at 30 mc	30	300		DL-S 730	
	3N35	0.125	8 (typ)	10	Power Gain: 25db (typ.) at 70 mc	30	300	100 (typ)	DL-S 784	
	medium power	951	0.750	9	60		50	300		DL-S 563
952		0.750	9	50		80	350		DL-S 564	
953		0.750	9	40		120	400		DL-S 565	
2N243		0.750	9 32	60		60	350		DL-S 639	
2N244		0.750	28 90	60		60	350		DL-S 640	
2N339		1	9 90	60		55	300		DL-S 908	
2N340		1	9 90	50		85	350		DL-S 908	
2N341		1	9 90	40		125	400		DL-S 908	
2N342		1	9 32	60		60	350		DL-S 908	
2N343		1	28 90	60		60	350		DL-S 908	
2N497		4	20 (large signal typ)	200	12 36		60	10 (typ) 30 (max.)		DL-S 840
2N498		4	20 (large signal typ)	200	12 36		100	14 (typ) 30 (max.)		DL-S 840
2N656		4	20 (large signal typ)	200	30 90		60	10 (typ) 30 (max.)		DL-T 121
2N657		4	20 (large signal typ)	200	30 90		100	14 (typ) 30 (max.)		DL-T 121
power		970	8.75		140	3	120	200		DL-S 673
	high power	2N389	85 at 25°C 45 at 100°C	10 (large signal typ)	2A	10 60	60	5		
2N424		85 at 25°C 45 at 100°C	10 (large signal typ)	2A	10 60	80	10			

* Units supplied with more rigid values for BV_{CBO} and R_{CS} than required by USN specs.

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Quarterly Listing of Transistor Types

Derivation and Tabulation Associates, Inc. publishes quarterly, a list of available transistor types. Complete cross indexes make the tabulation easy to use. Characteristics described are very similar to those contained in the ELECTRONIC DESIGN Data Chart. The principal difference is that D.A.T.A.'s charts are organized by increasing maximum collector dissipation. Major subdivisions are general junction transistors and power transistors. For more information on this service write to Derivation and Tabulation Associates, Inc., 67 Lawrence Ave., West Orange, N.J.

Power Transistors (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings					Characteristics					Switching					Manufacturer and Type	
		W_c (w)	T_j (C)	(a) W/C (b) C/W	V_c (volts)	I_c (ma)	h_{fe} or h_{fb}	I_{co} (μa)	F_{co} (Mc)	Pwr. Gain (db)	Pwr. Out. (W)	Rise Time (μs)	Storage Time (μs)	Fall Time (μs)	Sat. Volt (V)	Leak Cur. (μa)		Beta (h_{FE}) (a) h_{FE} (b) h_{fb}
Amperex Electronic Corp., Hicksville, N. Y.																		
2N284A	p-n-p, alloy, hi-volt	167w ²	75	3.33(a)	-60	250	45	4.5	0.35					0.4	200	30(a)	Amperex Electronic 2N284A	
2N115 ¹	p-n-p, alloy, audio out., dc conv.	50 ²	75	1(a)	-32	3	56	20	5.5kc		2.5		0.4	0.6	22(b)	2N115		
OC16-G ¹	p-n-p, alloy, audio out., dc conv.	50 ²	75		-30	2	45	20	5.5kc		2.5		0.4	0.6	22(b)	OC16-G		
OC16-E	p-n-p, alloy, audio out., dc conv.	50 ²	75		-30	2	40	20	5.5kc		2.5		0.4	0.6	22(b)	OC16-E		
OC16-D	p-n-p, alloy, audio out., dc conv.	50 ²	75		-13	2	22	20	5.5kc		2.2		0.4	0.6	22(b)	OC16-D		
OC30 ¹	p-n-p, alloy, audio output	6.67 ²	75		-32	1.4	36	12	9kc		1.0		0.25	0.4	28(b)	OC30		
Bendix Aviation Corp., Long Branch, N. J.																		
2N234A	p-n-p, AJ, audio	25w	90	2.2 (b)	-30	3	25	1	7 kc	-30	2						Bendix Aviation 2N234A	
2N235A	p-n-p, AJ, audio				-40		40	0.5		-33							2N235A	
2N235B	p-n-p, AJ, audio		95				60			-36							2N235B	
2N236A	p-n-p, AJ, audio			2.0 (b)			40			-33	4						2N236A	
2N236B	p-n-p, AJ, audio						60			-36							2N236B	
2N155	p-n-p, AJ, audio	25w	90	2.2 (b)	-40	3	40	0.5	7 kc	-33	2						2N155	
2N176	p-n-p, AJ, audio						45			-34							2N176	
2N242	p-n-p, AJ, audio		100				40			-33							2N242	
2N255	p-n-p, AJ, audio		90		-30		30	1	6 kc	-30							2N255	
2N256	p-n-p, AJ, audio	25w	90	2.2 (b)	-30	3	30	1.0	6 kc	-30	2						2N256	
2N257	p-n-p, AJ, audio	37w			-40		40	0.5	7 kc	-33	2.5						2N257	
2N285A	p-n-p, AJ, audio	25w	95			3	150		8 kc	-39	2						2N285A	
2N399	p-n-p, AJ, audio ¹⁵		90				40			-33	5 ^a						2N399	
2N400	p-n-p, AJ, audio		95				50			-36	6						2N400	
2N268A	p-n-p, AJ	25w	100	2.2 (b)	-80	5				-31	5	15	1	30	2.0	2	25(a)	2N268A
2N418	p-n-p, AJ																2N418	
2N401	p-n-p, AJ, audio ¹⁵	25w	90	2.2	-40	3	40	0.5	8 kc	-30	8 ^a						2N401	
2N301	p-n-p, AJ, audio	25w	90	2.2 (b)	-40	3	40	0.5	7 kc								2N301	
2N307	p-n-p, AJ, audio				-35		25	1.0	6 kc								2N307	
B177	p-n-p, AJ, audio				-30		150	0.5	7 kc	-38	2						B177	
B178	p-n-p, AJ, audio						40			-33							B178	
B179	p-n-p, AJ, audio				-40		25			-28							B179	
2N297	p-n-p, AJ	25w	100	2.0 (b)	-70	5		0.5				15	1	30	2	2	25(a)	2N297
2N301A	p-n-p, AJ	25w	100	2.2 (b)	-60	2	40	0.5	7 kc									2N301A
B113	p-n-p, AJ	25w	100	2.0 (b)	-40	5						25	2	40	1.5	2.0	40(a)	B113
2N268	p-n-p, AJ	25w	100	2.2 (b)	-80	5			7 kc			15	1	30	2.0	2	25(a)	2N268
2N419	p-n-p, AJ	25w	95	2.2 (b)	-45	3						25	2	50	0.8	1.0		2N419
2N420	p-n-p, AJ		100		-40	5									1.5	0.5	50(a)	2N420
2N420A	p-n-p, AJ				-70													2N420A
2N421	p-n-p, AJ				-40													2N421
2N637	p-n-p, AJ			2								15	1	30	0.5	0.5	45(a)	2N637
2N637A	p-n-p, AJ	25w	100	2 (b)	-70	5						15	1	30	0.5	0.5	45(a)	2N637A
2N637B	p-n-p, AJ				-80													2N637B
2N638	p-n-p, AJ				-40										0.7		30(a)	2N638
2N638A	p-n-p, AJ				-70										2			2N638A
2N638B	p-n-p, AJ				-80													2N638B
2N639	p-n-p, AJ	25w	100	2 (b)	-40	5						15	1	30	1.1	0.5	25(a)	2N639
2N639A	p-n-p, AJ				-70													2N639A
2N639B	p-n-p, AJ				-80													2N639B
2N677	p-n-p, AJ	50w		1.5 (b)	-30	15									0.5	1	40(a)	2N677
2N677A	p-n-p, AJ				-40													2N677A
2N677B	p-n-p, AJ	50w	100	1.5	-70	15									0.5	2	40(a)	2N677B
2N677C	p-n-p, AJ				-80										1			2N677C
2N678	p-n-p, AJ				-30													2N678
2N678A	p-n-p, AJ				-40													2N678A
2N678B	p-n-p, AJ				-70										2			2N678B
2N678C	p-n-p, AJ	50	100	1.5	-80	15									0.5	2	65(a)	2N678C

Power Transistors (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings					Characteristics					Switching					Manufacturer and Type	
		W_c (w)	T_j (C)	(a) W/C (b) C/W	V_c (volts)	I_c (amp)	h_{fe} or h_{fb}	I_{co} (μa)	F_{co} (Mc)	Pwr. Gain (db)	Pwr. Out. (W)	Rise Time (μs)	Storage Time (μs)	Fall Time (μs)	Sat. Volt (V)	Leak Cur. (μa)		Beta (a) h_{FE} (b) h_{fe}
Minneapolis-Honeywell, Minneapolis, Minn. cont.																		
2N539	p-n-p, AJ, dc conv., servo	10w ^s	95	2.2(a)	-80	3.5	43	100	7	31	12	40	70	0.6	2	23	Minneapolis-Honeywell	
2N539A	p-n-p, AJ, dc conv., servo															2N539A		
2N540	p-n-p, AJ, dc conv., servo						66		6	34		45	90			48		2N540
H3A	p-n-p, AJ, servo	15w	95	14(b)	-60	0.35	20	10		21	2			0.15	15(b)	H3A		
H4A	p-n-p, AJ, servo					0.5	30			23	3				22(b)		H4A	
H45	p-n-p, AJ, servo	10w		2.2	-80	3.5	20	100	8.5 kc	25	12	35	60	0.6	2.0		20(b)	H45
2N539 ^d	p-n-p, AJ, servo						43		7	31		40	70			32(b)	2N539	
H200E	p-n-p, AJ	22w		1.1	-60	10	40	200	13	30	30			0.5	3.0	(b)	H200E	
Motorola Inc., Phoenix, Ariz.																		
2N178	p-n-p, AJ, 2 w pwr.	40w	90	1.6(a)	-40	3	25	1 ma	9 kc	30	2						Motorola	
2N176	p-n-p, AJ, 2 w pwr.						45		7	35								2N176
2N669	p-n-p, AJ, 2 w pwr.						100		5	40								2N669
2N350	p-n-p, AJ, 4 w pwr.						30		8	31	4						2N350	
2N351	p-n-p, AJ, 4 w pwr.						45		7	33							2N351	
2N376	p-n-p, AJ, 4 w pwr.	40w	90	1.6(a)	-40		60	1 ma	6 kc	35	4						2N376	
2N554	p-n-p, AJ, pwr.				-30		30-100	3		27	2							2N554
2N555	p-n-p, AJ, pwr.				-40				8 kc									2N555
2N375	p-n-p, AJ, hv. pwr. sw.			1.5 (b)	-80	3			10 kc			10	5	50	0.6	1 ma	65(a)	2N375
2N627	p-n-p, AJ, hi-current sw.	50w	90	1.2(b)	-40	10			7.5 kc	38				0.4	1 ma	60(a)	2N627	
2N628	p-n-p, AJ, hi-current sw.				-60											(a)	2N628	
2N629	p-n-p, AJ, hi-v, hi-cur. sw.				-80											(a)	2N629	
2N630	p-n-p, AJ, hi-v, hi-cur. sw.				-100											(a)	2N630	
Nucleonic Prod. Co., Los Angeles 55, Calif.																		
2N155	power	13.5w		2.5(b)	-30	-3	-150									33(a)	Nucleonic Prod. 2N155	
Philco Corp., Lansdale, Pa.																		
2N352	p-n-p, AJ, audio out.	25w ¹	100	3 (b)	40	2	3			0.016				0.4		65	Philco Corp. 2N352	
2N353	p-n-p, AJ, audio out.	30w		2.5 (b)	40	2	3			.016				0.4		90(a)		2N353
2N386	p-n-p, AJ, audio out.	37.5w		2 (b)	60	3	5			.007				0.7		20(a)		2N386
2N387	p-n-p, AJ, audio out.	37.5w	100	2 (b)	80	3	5			.006				0.7		20(a)	2N387	
2N589	p-n-p, AJ, audio out.				100					.006						(a)	2N589	
RCA, Somerville, N. J.																		
2N301	p-n-p, AJ, pwr. amp.	11w	91 ^{7f}	1(a)	-40	-3	70	-220 ^{7c}		33	12 ^{7g}						RCA 2N301	
2N301A	p-n-p, AJ, pwr. amp.				-60													2N301A
Sylvania Elec. Prod., Woburn, Mass.																		
2N301	p-n-p, AJ	12w	85	2.5(b)	-40	2A		1 ma		35	2.5						Sylvania Electric 2N301	
2N301A	p-n-p, AJ				-60													2N301A
2N307A	p-n-p, AJ		75	3.0(b)	-35			5 ma	3.5 kc	25								2N307A
2N350	p-n-p, AJ	10w	90		-30	3a	40	2 ma	5 kc	31.5	4						2N350	
2N351	p-n-p, AJ					3A	55			33.5							2N351	
Texas Instruments Inc., Dallas, Texas																		
2N456	p-n-p, AJ, pwr.	50w	95	1.1(b)	-40	-5a	130	0.2 ma				26	80	0.24		30(a)	Texas Instruments 2N456	
2N457	p-n-p, AJ, pwr.				-60			0.6										2N457
2N458	p-n-p, AJ, pwr.				-80			1.0										2N458
2N250	p-n-p, AJ, pwr.	25w	85		-30	-3a	90	0.3	8 kc	34							2N250	
2N251	p-n-p, AJ, pwr.				-60			0.5									2N251	

Power Transistors (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings					Characteristics					Switching					Manufacturer and Type		
		W_c (w)	T_j (C)	(a) W/C (b) C/W	V_c (volts)	I_c (amp)	h_{fe} or h_{fb}	I_{co} (μa)	F_{co} (Mc)	Pwr. Gain (db)	Pwr. Out. (W)	Rise Time (μs)	Storage Time (μs)	Fall Time (μs)	Sat. Volt (V)	Leak Cur. (μa)		Beta (a) h_{FE} (b) h_{FE}	
CBS Hytron, Lowell, Mass.																			
2N155	p-n-p, AJ ⁷	8.5w	85	0.14(a)	-30	-3	40	180	145 kc	33	2	3	8	7.5	0.5	-200	23	CBS Hytron	
2N156	p-n-p, AJ					-3												2N155	
2N157	p-n-p, AJ				-60		41	140		37					-300	20		2N156	
2N157A	p-n-p, AJ				-90													2N157	
2N158	p-n-p, AJ				-60													2N157A	
2N158A	p-n-p, AJ	8.5w	85	0.14(a)	-80	-3	41	140	145 kc	37	2	3	8	7.5	0.5	-300	20	2N158	
2N255	p-n-p, AJ						30	180		25	1				-200			2N158A	
2N256	p-n-p, AJ									27	2							2N255	
Clevite Transistor Prod., Waltham 54, Mass.																			
2N257	p-n-p, AJ, 12 v audio	14w	90	1.5(b)	-40	3	50	<2	7 kc	33	2.5			0.5	<2	50(a)		Clevite Transistor	
CTP1137	p-n-p, AJ, 12 v audio						75			36						75(a)		2N257	
CTP1117	p-n-p, AJ, 12 v audio					6	100			36	5.0					100(a)		CTP1137	
2N268	p-n-p, AJ, 24 v audio				-80	3	50			31	2.5							CTP1117	
2N297 ³	p-n-p, AJ				-60									0.5	<3	50		2N268	
CTP1512	p-n-p, AJ	20w		1.0(b)	-100	13								0.5	<15	90		2N297 ³	
CTP1133	p-n-p, AJ, 12 v audio	14w	90	1.5(b)	-40	30		<2	30 kc		30 kc							CTP1512	
2N268A	p-n-p, AJ, 24 V sw.	14w ²	90		-80	4								0.5	<2	40(a) ³		CTP1133	
CTP1112	p-n-p, AJ, 30 V sw.														<3	(a) ³		2N268A	
CTP1135	p-n-p, AJ, 12 V sw.				-40	3						4	4	6	0.8	<2	50(a) ⁴		CTP1112
CTP1503	p-n-p, AJ, sw.	20w		1.0(b)	-80	13								0.5	<15	35(a) ⁴		CTP1135	
Delco Radio, Kokomo, Ind.																			
2N173	p-n-p, AJ, pwr.	72w	95	1.0(b)	-60	13	150	10 kc	40			20		20	8 ma			Delco Radio	
2N174	p-n-p, AJ, pwr.				-80				38						12 ma			2N173	
2N174A	p-n-p, AJ, pwr.						120							0.5	15 ma			2N174	
2N277	p-n-p, AJ, pwr.	52w			-40		150		40						8 ma			2N174A	
2N278	p-n-p, AJ, pwr.				-50													2N277	
2N441	p-n-p, AJ, pwr.	52w	95	1.2(a)	-40	13	150	10 kc	38			20		20	8 ma			2N278	
2N442	p-n-p, AJ, pwr.				-50													2N441	
2N443	p-n-p, AJ, pwr.				-60													2N442	
2N553	p-n-p, AJ, med. pwr.	35w	100	2.0(a)	-80	4	10	20 kc	32			5	5	0.5				2N443	
DT80	p-n-p, AJ, pwr.	72w	95	1.0(a)		13	150	10 kc	40			20	20	0.5	12 ma			2N553	
DT100	p-n-p, AJ, pwr.		95	1.0(a)	-100	13	150	10 kc	38			20	20		12			DT80	
General Electric Co., Syracuse, N. Y.																			
2N451	n-p-n, DJ, Si, amp.	85w	150	1.5(b)	65	5	20	400 kc								10(a)		General Electric Co.	
2N453	n-p-n, DJ, Si, amp.				30	2	20											2N451	
2N454	n-p-n, DJ, Si, amp.				65		20											2N453	
Minneapolis-Honeywell																			
Minneapolis, Minn.																			
H5SCL	p-n-p, AJ, dc conv., servo	10w	95	2.2(a)	-70	3.5	26	100	8.5 kc	28	12	35		60	0.6	4	23	Minneapolis-Honeywell	
H6SCL	p-n-p, AJ, dc conv., servo						41		7 kc	31		40		70			32	H5SCL	
H7SCL	p-n-p, AJ, dc conv., servo						60		6 kc	34		45		90			48	H6SCL	
SCL18 ⁴	p-n-p, AJ, dc conv., servo	25w		0.8(a)	-60	10	14	700		19	60	15		27	1.0	7	12	H7SCL	
SCL19 ⁴	p-n-p, AJ, audio dc conv., servo						28		5 kc	22		12		30			10	SCL18 ⁴	
2N540A	p-n-p, AJ, dc conv., servo	10 ⁵ w	95	2.2(a)	-80	3.5	66	100	6 kc	34	12	45		90	0.6	2	48	SCL19 ⁴	
2N574	p-n-p, AJ, dv conv., servo	25w		0.7(a)	-60	15	14	700		19	60	15		27	0.5	7	12	2N540A	
2N574A	p-n-p, AJ, dc conv., servo				-80													2N574	
2N575	p-n-p, AJ, dc conv., servo				-60	30	25		5 kc	22		12		30			10	2N574A	
2N575A	p-n-p, AJ, dc conv., servo				-80													2N575	
2N538	p-n-p, AJ, dc conv., servo	10w ⁵	95	2.2(a)	-80	3.5	30	100	8.5 kc	28	12	35		60	0.6	2	23	2N575A	
2N538A	p-n-p, AJ, dc conv., servo																	2N538	

Power Transistors (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings					Characteristics					Switching						Manufacturer and Type
		W_c (w)	T_j (C)	(a) W/C (b) C/W (volts)	V_c (amp)	I_c	h_{fe} or h_{fb}	I_{co} (μa)	F_{co} (MC)	Pwr. Gain (db)	Pwr. Out. (W)	Rise Time (μs)	Storage Time (μs)	Fall Time (μs)	Sat. Volt (V)	Leak Cur. (μa)	Beta (h_{FE}) (a) h_{FE} (b) h_{ie}	
Texas Instruments Inc., Dallas, Texas																	Texas Instrument	
2N389	n-p-n, Diff., Si, pwr.	85w	200	2(b)	60	2				15	1.5	0.1	2.5	5	10 ma	10-60(a)	2N389	
2N424	n-p-n, Diff., Si, pwr.				80												2N424	
2N497	n-p-n, Diff., Si, med. pwr.	4w		22.8(a)	60		12-36	10			1.0	0.5	1.0	2		12-36	2N497	
2N498	n-p-n, Diff., Si, med. pwr.				100												2N498	
2N656	n-p-n, Diff., Si, med. pwr.				60		30-90									30-90	2N656	
2N657	n-p-n, Diff., Si, med. pwr. ²	4w	200	22.8	100		30-90	10			1.0	0.5	1.0	2	10	30-90	2N657	
Transistor Electronic Corp., Wakefield, Mass.																	Transistor Electronics	
ST400	n-p-n, Diffused, Si	85w	175		60		20 ma	6						1.5		40	ST400	
ST401	n-p-n, Diffused, Si				30											50	ST401	
ST402	n-p-n, Diffused, Si	50w			60									4.0		40	ST402	
ST403	n-p-n, Diffused, Si				30									3.0			ST403	
2N309	n-p-n, Diffused, Si	85w			60		10 ma										2N309	
2N497	n-p-n, Diffused, Si	4w			60		0.2	4						3		20	2N497	
2N498	n-p-n, Diffused, Si				100												2N498	
2N550	n-p-n, Diffused, Si ²	5w	200		30		0.4				0.7	0.2	1.0	1.5		35	2N550	
2N551	n-p-n, Diffused, Si				60		1.2				0.12	0.3	1.3	.9		30	2N551	
2N552	n-p-n, Diffused, Si				30						0.12	0.3	1.3				2N552	
2N545	n-p-n, Diffused, Si	5w	200		60		1.2	4			0.3	0.1	0.5	3		25	2N545	
2N546	n-p-n, Diffused, Si				30									2			2N546	
2N547	n-p-n, Diffused, Si				60						0.7	0.2	1	3		35	2N547	
2N548	n-p-n, Diffused, Si				30		0.5							2			2N548	
Tung-Sol Electric Inc., East Orange, N. J.																	Tung-Sol Electric, Inc.	
2N242	p-n-p, AJ, audio out.	15w		3 (c/w)	-45	2 amp.	50	0.3	5 kc								2N242	
2N378	p-n-p, AJ, pwr.	50w	85	1.2 c/w	-40	3 amp.		0.5	7		25		40		50(a)	2N378		
2N379	p-n-p, AJ, pwr.				-80						25					2N379		
2N380	p-n-p, AJ, pwr.				-60										70(a)	2N380		
2N459	p-n-p, AJ, pwr.				-105						25		40		50(a)	2N459		
Western Electric,³ New York, N. Y.																	Western Electric	
2N436	p-n-p, AJ	35w	100	2 c/w	-60	5	83	59	5.5 kc		0.37	0.80	0.28	0.25		20(a)	2N436	

Special

These 6 types are specified in three ranges of stand-off ratio (.56, .62, .68) and two ranges of interbase resistance (5.6 and 7.5 K).

General Electric Co., Syracuse, N. Y.

2N489-94 Unijunction, Si 250mw 150 2 (a)

General Transistor Corp., Jamaica 35, N. Y.

2N318 p-n-p, AJ, sideview, photo 50 85 0.001(a) <15 0.75
 2N469 p-n-p, AJ, endview, photo 75 0.001 -6 <15 1.0
 GT34N p-n-p, AJ, neon light 125 85 0.002 -100

Texas Instrumental, Inc., Dallas, Texas

800 n-p-n, Grown, photo 65 75 -20 5

Western Electric, New York, N. Y.

1N85 p-n-p, GJ, photo 50 85 -90 1

Power Transistor

Footnotes:

1. Matched pairs for Class B push-pull
2. Collection dissipation at 25 C
3. Military
4. Also under 7002
5. sink at 70 C
6. 2 transistor push-pull
7. sink at 25 C
8. Class B push-pull output

Cross-index to transistor types at the end of this section.



2N128
General Purpose
(MIL-T-12679A)

	Min.	Typ.	Max.
h_{fe}	19	32	66
f_{max}	45	65	—

2N344/SB101
for Medium Gain
Amplifiers

	Min.	Typ.	Max.
h_{fe}	11	23	83
f_{max}	30	45	—

2N345/SB102
for High Gain
Amplifiers

	Min.	Typ.	Max.
h_{fe}	25	40	110
f_{max}	30	45	—

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2N346/SB103
for High Frequency
Oscillators

	Min.	Typ.	Max.
h_{fe}	10	—	—
f_{max}	60	90	—

2N240/SB5122
for Computer
Switching

	Min.	Max.
h_{fe}	16	—
f_{max}	30	—
T_s	—	80



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Choosing the Proper Transistor Circuit Battery

DESIGNING a power supply for portable transistorized equipment requires the proper choice of batteries. The basic criteria must be long periods of uniform sustained voltage and low drain under proper loads. Some of the questions that must be asked when determining the proper transistor circuit battery are:

- How do environmental factors affect the operation of the battery?
- What are the discharge characteristics under loads?
- What are the relative advantages and disadvantages of different battery constructions?

These and other useful questions will be answered as to how to make the operation of the transistor circuit battery more efficient and more reliable. A designers' check list is furnished in Table 1, enumerating the points that must be considered before the electronic circuit and physical package are finalized. A cross reference chart relating the types of batteries available is presented in Table 2.

The Effects of Temperature

Temperature is the most serious of the environmental factors that affect the life and operation of a battery. Batteries operate very efficiently at a temperature range of 60 to 90 F. But for typical batteries higher temperatures are apt to be detrimental when the batteries are stored for months at these higher temperatures. Three months at 115 F reduces the capacity of the battery from 10 to 50 per cent. It also produces occasional duds. Much higher temperatures can be withstood for shorter periods, but temperatures above 160 F are very damaging even for short periods. The chemical action which takes place on discharge within a dry cell

Vital information on the factors affecting the choice and operation of transistor batteries were obtained in an interview with J. J. Coleman, Vice President, Engineering, and R. C. Clock, Battery Design Chief, Burgess Battery Co. The article concludes with a handy designer's check list and with a cross reference chart.

is improved by higher temperatures. So long as something serious such as a blown seal does not develop, the higher the temperature, the greater the power and energy output.

On the other hand, the lower the storage temperature, the better. The shelf life of batteries is greatly prolonged at storage temperatures near 0 F. The life of even very tiny batteries can be extended by many years at temperatures of -40 F. The performance of the battery is greatly reduced at near 0 F unless special low temperature batteries are employed. In the latter case, one can get some performance down to -40 F. Below this temperature, little or no performance can be obtained.

Batteries are not much affected even by extremes of humidity. If moisture condenses, leakage currents can develop, as in the case of any electrical device. At extremely low humidities, there may be an increased tendency for batteries to dry out. The water contained in dry batteries is very vital to their operation.

Discharge Characteristics Under Load

Dry batteries ordinarily have a quick drop in their potential at the start of the discharge period. Then they discharge at a rather uniform potential down to 1 v per cell. See Fig. 1. Higher end points such as 1.2 v per cell are very common but they mean a substantial loss of performance. At end points much higher than 1.2 v per cell, the performance is likely to be inadequate. There is no sudden drop off in potential and the life is steadily increased as the end point is decreased beyond 1 v per cell. Frequently this gradual decrease is beneficial since it warns the user that a new battery is required long before the point is reached at which no operation of the

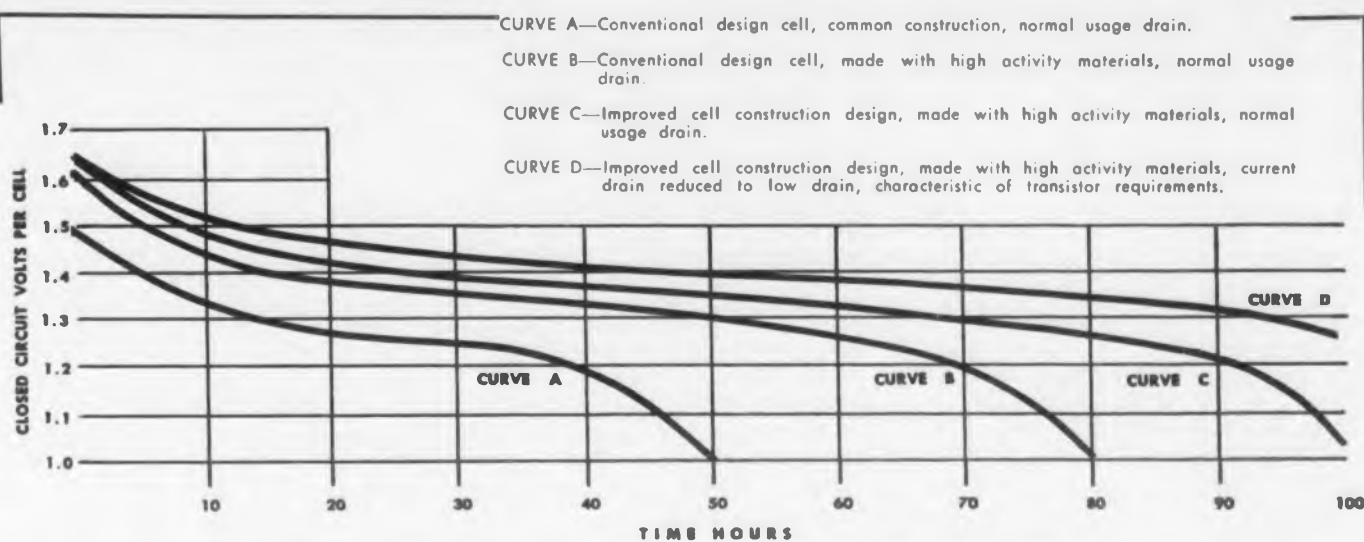


Fig. 1. Various types of cells showing voltage vs time characteristics.

Table 1. Designer's Check List

BATTERY VOLTAGE—(Nominal)

This is normally dictated by the using equipment. The equipment will frequently operate satisfactorily over a moderately wide volt range. The designer should keep this in mind and select a standard battery if possible.

BATTERY END VOLTAGE

This again is governed by the using equipment. For best battery efficiency the circuit should be designed to allow the widest possible range between nominal battery voltage (1-1/2 volts per cell) and end voltage.

BATTERY SIZE

Normally batteries of the same voltage are available in several different physical sizes. Most economical service will usually be obtained by selecting the largest battery size that can be tolerated.

BATTERY COMPARTMENT

This should be free from all sharp projections that might puncture the battery or ground to a metal battery case. Some batteries are made with rounded corners or with corners beveled at 45 deg. Where space permits, it is desirable to leave the battery compartment so that it could accommodate the full rectangular cross section without the round or beveled corners. This allows later increase in battery service by design change to utilize these corners.

The battery should fit freely into the compartment with allowance for minor size variations. This can frequently be accomplished by sponge rubber pads or light leaf springs. These also serve to prevent the battery from moving.

TERMINALS

The using equipment should be provided with proper connections such as plugs or snap fasteners to mate with the battery terminals. Battery terminals are made to conform to RMA standards. The mating terminal should also conform to these standards. The location should be such that neither the battery nor the equipment will be damaged in the process of connecting or disconnecting the battery.

BATTERY LOCATION IN EQUIPMENT

Battery should be located away from any sources of excessive heat. Ideal battery operating temperature is in the range of 60-90 deg. F. Weight balance is frequently a factor. Battery location should be considered with this in mind.

BATTERY DISCONNECT SWITCH

This should provide a positive means for disconnecting the battery when the equipment is idle. An indicator to show "Off" and "On" positions is desirable to prevent the power being left on accidentally when the equipment is put away. In many instances a battery is blamed for giving poor service when in fact the power switch has been left "On" while the equipment was idle.



SO COMPACT that it occupies less than half a cubic foot of bench space, the H-Lab Model 800A Power Supply is fully transistorized to provide these advanced features: twin, continuously variable, 2-36 volt 1 ampere, outputs, that may be series-connected to deliver a single 4-72 volt, 1 ampere, output . . . less than 500 microvolts ripple . . . less than .01 ohms source impedance . . . constant regulation over full voltage and current range . . . automatic short-circuit and overload protection. For full information on H-Lab Power Supplies, transistorized and vacuum tube, write to: **HARRISON LABORATORIES, INC.** 45 Industrial Road, Berkeley Heights, New Jersey

CIRCLE 387 ON READER-SERVICE CARD

device is possible. Decreasing the load on a dry battery greatly increases not only the life in hours but also the life in ampere hours. A simple formula gives a fair approximation of the increase to be expected:

$$\log \text{ of output (ma-hr)} = \text{constant} - \log \text{ of load current (ma)}$$

As an example of the application of this formula, reducing the load to one-half increases the output 20 per cent, an increase in life by a factor of 2.40.

Different Types of Construction

Commercial dry batteries are differentiated by the following characteristics: their chemical components; form; and envelope. There has been a growing use of more active chemical components. The increased activity has sometimes led to unreliable performance. Hence there has been a great deal of work done toward the control of the new materials. An example is manganese dioxide. A crystal structure which is suitable for some types of dry batteries is not at all suitable for other types.

Most multi-cell batteries are now made with cells of a rectangular shape which efficiently use the space available. The early B batteries were simply flashlight cells soldered in series. Their cylindrical shape resulted in a waste of space. One approach to the problem has been a return to something like the original voltaic pile. A duplex electrode is employed. Zinc plates are coated with carbon paint and they are assembled with other components into units which are not individual cells but which, when stacked one on another, form a pile of cells connected in series. Ordinarily the unit is enclosed in a plastic sheath or envelope. This method employs the space efficiently but presents other problems.

Since individual cells are not made, the 100 per cent testing and inspection of individual cells is no longer possible. The lower potential

Table 2. Cross Reference Chart

Burgess	NEDA	General Dry	Mercury	National Carbon	RCA	Ray-O-Vac
2N6	1602	178	—	246	VS305	1602
D6	1603	88	—	276	VS306	1603
D6S	1608	—	—	2761	—	—
D6PI	1601	89	—	2506	VS301	1601
C6X	—	86	—	2356	—	—
P6M	1600	—	—	226	VS300	1600
2U6	1604	—	—	216	—	1604
XX9	1900	177	—	239	VS304	1900
NE	910	913	G401	W468	VS073	716
930	—	—	G502	1015E	—	—
130	—	—	—	635	—	—
230	—	—	—	A100	—	—
4D4	1400	—	—	274	—	—
A4	—	—	—	—	—	—

of a weak cell is masked by the other cells in a series assembly. It is likely to escape detection in the inspection process. Moreover, these units are not themselves sealed against loss of moisture. It is only the finished stack of cells which is sealed by dipping in wax.

The wafer cell meets both of these problems. It has a complete cell, sealed against moisture loss, which can be individually tested. The cell is so strong that a stack of cells can be molded into a smooth form, leaving no wasted voids of space. One of the problems of forming such a stack of cells has always been that of making an electrical connection. This problem led to the use of duplex electrodes in the older type of dry battery.

One of the electrodes in the wafer cell is a thin sheet of plastic made conductive by loading it with graphite. It is not possible to solder to such a material nor to make any of the usual mechanical connections. A conductive wax has been developed which is rendered conductive by silver plated copper particles. This material is extremely conductive and at the same time has the soft adhesive properties of wax. Two small buttons of this wax serve as the terminals on the wafer cell.

When these cells are piled one on the other, a strong electrical bond is formed from terminal to terminal, which is very resistant to vibration because of the lack of rigidity. Each wafer cell is sealed in a plastic envelope which has a low moisture vapor permeability. The entire stack is wrapped once again with a sheet of mylar to which another plastic has been bonded to form an additional moisture vapor barrier. Finally the entire assembly is dipped in a special type of wax solution.

Cost Considerations

The following factors increase cost unnecessarily. Some types of sockets need to extend down into the battery a great distance. This not only wastes space that could be better used but also requires considerable padding. While the cost of this is not large, it is sometimes entirely unnecessary. The voltage of dry batteries declines when discharged and for efficient use a rather wide variation is required. When cost is extremely important, the batteries should be contained in simple, rectangular paper boxes. Metal containers are quite common. Both aluminum and steel are used. They can improve the quality of the battery—for example, making it more rugged and greatly enhancing its appearance. When these containers are used, the batteries usually have rounded corners. However, when possible the designers should provide a rectangular compartment for the battery so that the battery manufacturer can use this shape if he finds it desirable.



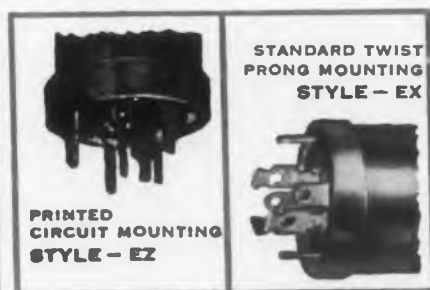
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of **tiny** electrolytic capacitors
for every requirement in entertainment electronics . . .
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recorders, auto receivers



LITTL-LYTIC* CAPACITORS

Sprague's new Type 30D hermetically-sealed aluminum-encased capacitors are the *tiniest* electrolytic capacitors made to date . . . and their performance is better than ever. Their remarkable reliability is the result of a new manufacturing technique in which *all the terminal connections are welded. No pressure joints . . . no "open circuits" with the passage of time.* And check this for ultra-low leakage current: for a 2 μ f, 6 volt capacitor . . . only 1.0 μ a max.; for a 300 μ f, 6 volt capacitor . . . 3.5 μ a max.! Engineering Bulletin No. 3110 gives the complete story. 85°C standard.

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FOR ENGINEERING BULLETINS on the industry's first complete line of subminiature aluminum electrolytic capacitors, write Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.

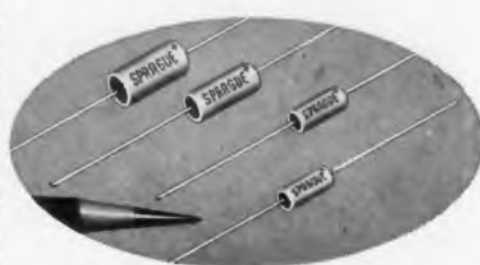
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VERTI-LYTIC* CAPACITORS

These space-saving Type 89D 'lytics are designed for easy manual upright mounting on printed wiring boards. Keyed terminals assure fast mounting and correct polarity. No reworking on the assembly line. Sturdy pre-molded phenolic shell with resin end-fill gives excellent protection against drying-out of the electrolyte or the entry of external moisture. The phenolic case eliminates the necessity for additional insulation. Reasonably priced for mass production receivers. Engineering Bulletin No. 3060 lists standard ratings with performance data.



Cera-lytic* CAPACITORS

The ideal capacitor for applications where low cost is the primary consideration is Sprague's new Type 31D. Capacitor sections are housed in a dense steatite tube with resin end-fill to provide protection against mechanical damage and atmospheric humidity. This construction results in excellent capacitor performance for all miniature electronic circuits. Size for size, they're the smallest the industry has produced in a ceramic-cased aluminum electrolytic. Engineering Bulletin No. 3010 details standard ratings and gives performance data.

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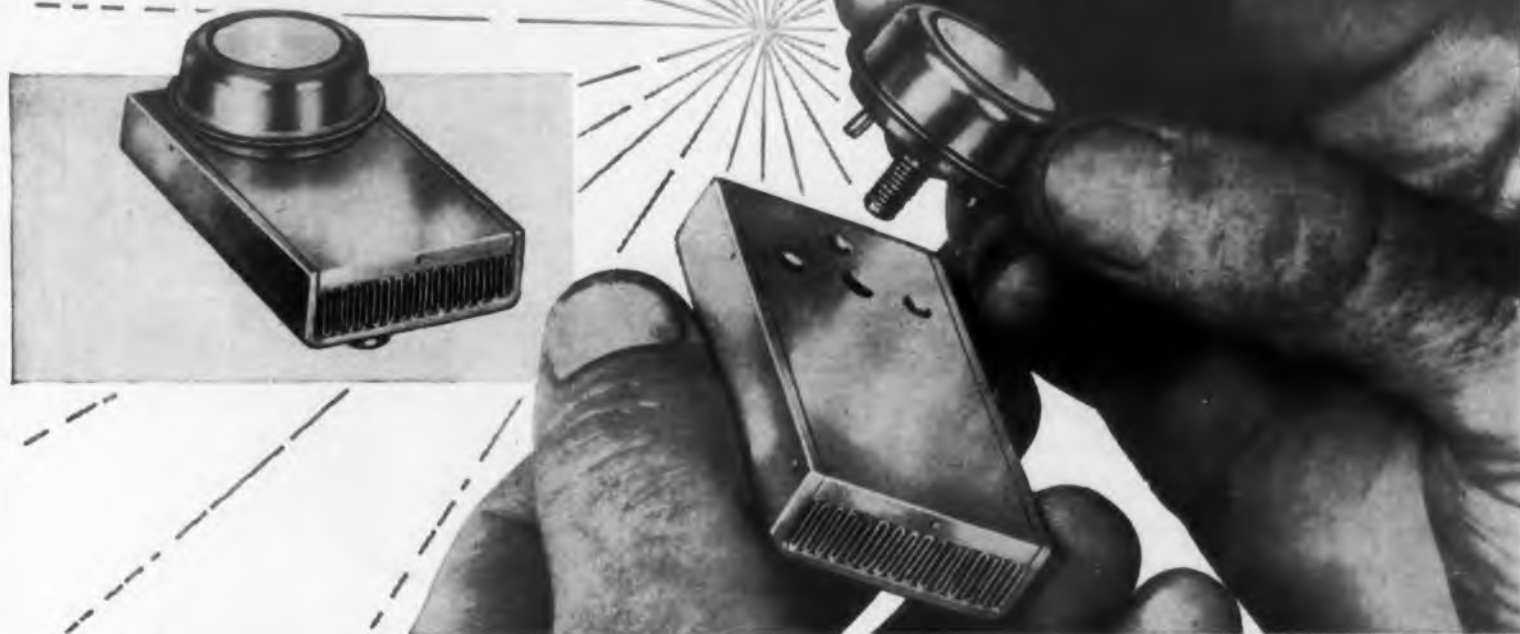
CROSS INDEX

Amperex	Am	Motorola	Mc
Bendix	Be	Nucleonics	Nu
Bogue	Bo	Philco	Ph
CBS-Hytron	CBS	RCA	RC
Clevite	C	Raytheon	Ra
Delco	De	Sprague	Sp
General Electric	GE	Sylvania	Sy
General Transistor	GT	Texas Instruments	TI
Hughes	Hu	Transitron	Tr
Industro-Transistor	Ind	Tung-Sol	TS
Minneapolis-Honeywell	MH	Western Electric	WE
		Westinghouse	Wh

1N85	WE	2N223	Ph
2N29	WE	2N224	Ph
2N34	Sy	2N226	Ph
2N35	Sy	2N228	Sy
2N43	GT	2N229	Sy
2N43A	GT	2N233	Sy
2N44	GT	2N233A	Sy
2N44A	GE	2N234A	Be
2N45	GT	2N235A	Be
2N59	Wh	2N235B	Be
2N60	Wh	2N236A	Be
2N61	Wh	2N236B	Be
2N94	Sy	2N238	TI
2N94A	Sy	2N240	Ph, Sp
2N97	Bo	2N242	Be, TS
2N104	RCA	2N247	RCA, Sy
2N105	RCA	2N248	TI
2N109	RCA	2N250	TI
2N110	WE	2N251	TI
2N115	Am	2N252	TI
2N117	TI, Tr	2N253	TI
2N118	TI, Tr	2N254	TI
2N118A	TI, Tr	2N255	Be, CBS
2N119	TI, Tr	2N256	Be, CBS
2N120	TI	2N257	Be, C
2N128	Ph, Sp	2N268	Be, C
2N129	Sp	2N268A	Be, C
2N139	RCA	2N269	RCA
2N140	RCA	2N270	RCA
2N145	TI	2N274	RCA
2N146	TI	2N277	De
2N147	TI	2N278	De
2N155	Be, CBS, Nu	2N279	Am
2N156	CBS	2N280	Am
2N157	CBS	2N283	Am
2N157A	CBS	2N284	Am
2N158	CBS	2N284A	Am
2N158A	CBS	2N285A	Be
2N160	Bo	2N291	TI
2N160A	Bo	2N297	Be, C
2N161	Bo	2N299	Ph
2N161A	Bo	2N300	Ph
2N162	Bo	2N301	Be, RCA, Sy
2N162A	Bo	2N301A	Be, RCA, Sy
2N163	Bo	2N306	Sy
2N163A	Bo	2N307	Be
2N172	TI	2N307A	Sy
2N173	De	2N308	TI
2N174	De	2N309	TI, Tr
2N174A	De	2N310	TI
2N175	RCA	2N311	GT
2N176	Be, Mo	2N312	GT, Sy
2N178	Mo	2N313	GT
2N185	TI	2N315	GT, Ind
2N193	Sy	2N316	GT, Ind
2N194	Sy	2N317	GT, Ind
2N206	RCA	2N327A	Ra
2N207	Ph	2N328A	Ra
2N207A	Ph	2N329A	Ra
2N207B	Ph	2N330A	Ra
2N211	Sy	2N332	Bo, GE, Tr
2N212	Sy	2N333	Bo, GE, Tr
2N213	Sy	2N334	Bo, Tr
2N214	Sy	2N335	Bo, GE, Tr
2N215	RCA	2N336	Tr
2N216	Sy	2N344	Ph, Sp
2N217	RCA	2N345	Ph, Sp
2N218	RCA	2N346	Ph, Sp
2N219	RCA	2N347	Bo
2N220	RCA	2N348	Bo

2N349	Bo	2N460	TS
2N350	Mo, Sy	2N461	TS
2N351	Mo, Sy	2N462	Ph
2N352	Ph	2N463	WE
2N353	Ph	2N464	Ind, Mo, Ra
2N356	CBS, GT, RCA, Sy	2N465	Ind, Mo, Ra
2N357	CBS, GT, RCA, Sy	2N466	Ind, Mo
2N358	CBS, GT, RCA, Sy	2N467	Ind, Mo
2N359	Ind, RCA	2N469	GT
2N360	Ind, RCA	2N470	Tr
2N361	Ind, RCA	2N471	Tr
2N362	Ind, RCA	2N472	Tr
2N363	Ind, RCA	2N473	Tr
2N364	TI	2N474	Tr
2N365	TI	2N475	Tr
2N366	TI	2N476	Tr
2N368	TI	2N477	Tr
2N369	TI	2N478	Tr
2N370	RCA, Sy	2N479	Tr
2N371	RCA	2N480	Tr
2N372	RCA, Sy	2N481	Ind, Ra
2N373	Mo	2N482	Ind, Ra
2N376	Mo	2N483	Ind, Ra
2N377	CBS, Sy	2N484	Ra
2N378	TS	2N485	Ind, Ra
2N379	TS	2N486	Ind, Ra
2N380	TS	2N487	Ra
2N381	TS	2N493	Ph
2N382	TS	2N496	Ph
2N383	TS	2N497	TI, Tr
2N384	RCA	2N498	TI, Tr
2N385	CBS, Sy	2N499	Ph
2N386	Ph	2N500	Ph
2N387	Ph	2N501	Ph
2N388	CBS, Sy	2N502	Ph
2N389	TI	2N503	Ph
2N393	Ph, Sp	2N504	Ph
2N394	GE	2N508	GE
2N395	GE	2N509	WE
2N396	GE	2N513	Sy
2N397	GE	2N516	Sy
2N398	RCA	2N517	Sy
2N399	Be	2N518	GE
2N400	Be	2N519	GT, Ind
2N401	Be	2N520	GT, Ind
2N402	Wh	2N521	GT, Ind
2N403	Wh	2N522	GT, Ind
2N404	RCA, Ra, TS	2N523	GT, Ind
2N405	RCA	2N524	GE
2N406	RCA	2N525	GE
2N407	RCA	2N526	GE
2N408	RCA	2N527	GE
2N409	RCA	2N529	GT
2N410	RCA	2N530	GT
2N411	RCA	2N531	GT
2N412	RCA	2N532	GT
2N413	Ind, Ra, TS	2N533	GT
2N414	Ind, Ra, TS	2N534	Ph
2N416	Ind, Ra, TS	2N535	Ph
2N417	Ind, Ra, TS	2N536	Ph
2N418	Be	2N538	MH
2N419	Be	2N538A	MH
2N420	Be	2N539	MH
2N420A	Be	2N539A	MH
2N421	Be	2N540	MH
2N422	Ind	2N540A	MH
2N424	TI	2N541	Tr
2N425	Ind, Mo, Ra, TS	2N542	Tr
2N426	Ind, Mo, Ra, TS	2N543	Tr
2N427	Ind, Mo, Ra, TS	2N544	RCA, Sy
2N428	Ind, Mo, Ra, TS	2N545	Tr
2N438	CBS	2N546	Tr
2N439	CBS	2N547	Tr
2N440	CBS	2N548	Tr
2N441	De	2N549	Tr
2N442	De	2N550	Tr
2N443	De	2N551	Tr
2N444	GT	2N552	Tr
2N445	GT	2N553	De
2N446	GT	2N554	Mo
2N447	GT	2N555	Mo
2N450	GE	2N560	We
2N451	GE	2N563	GT
2N452	GE	2N564	GT
2N453	GE	2N565	GT
2N454	GE	2N566	GT
2N456	TI	2N567	GT
2N457	TI	2N568	GT
2N458	TI	2N569	GT
2N459	TS	2N570	GT

UAP COLD PLATE controls TRANSISTOR junction temperature!



minimizes transistor derating for thermal conditions . . .

UAP cold plate U-521330, designed for Collins Radio Company, dissipates heat generated by power transistors used in ground and airborne electronic circuits. The heat is transferred across a pressure thermal contact to cooling air. The cold plate controls the transistor junction temperature within operating limits compatible with the installation. Therefore, transistor derating is minimized.

The cooling air, which is forced through the cold plate, can be ducted from an air cycle refrigeration system; a ram air supply; an air manifold within

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The aluminum cold plates are bonded by UAP's dip braze method which produces extremely lightweight assemblies with maximum heat transfer area within the core. Cold plates can be used individually or assembled in manifolded banks.

DESIGN PERFORMANCE CHARACTERISTICS OF U-521330 COLD PLATE

Air flow: 7 lbs. per hr.
 Air pressure drop: 0.25" H₂O corrected to .0765 density
 Temperature drop in cold plate: 1.5°C per watt dissipated
 Weight: Approximately 1 oz.
 Performance characteristics can be modified to requirements.

For complete information call the nearest UAP Contractual Engineering Office

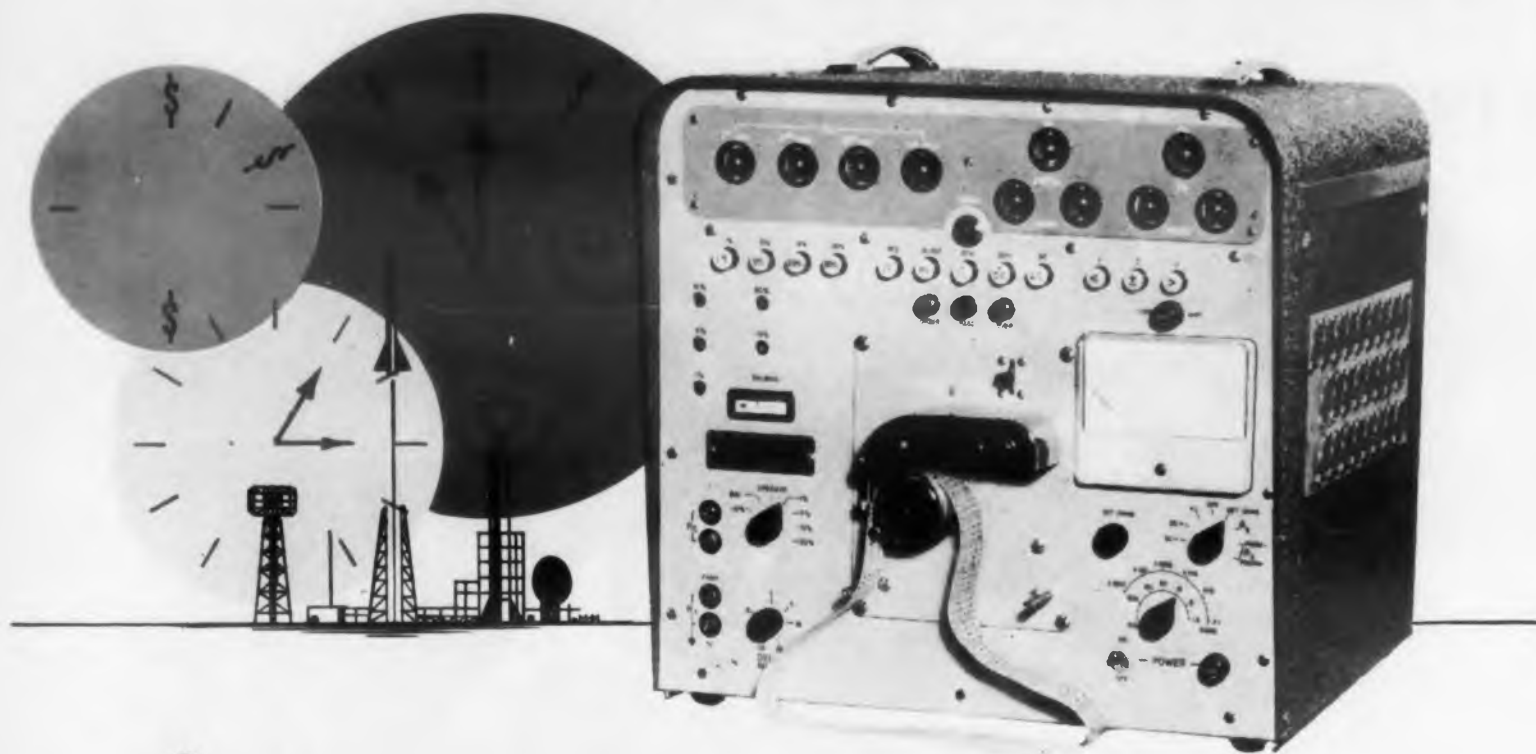
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In design, production, maintenance*

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MORGANVILLE, NEW JERSEY

DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT
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CROSS INDEX cont.

Amperex	Am	Motorola	Mo
Bendix	Be	Nucleonics	Nu
Bogue	Bo	Philco	Ph
CBS-Hytron	CBS	RCA	RC
Clevite	C	Raytheon	Ra
Delco	De	Sprague	Sp
General Electric	GE	Sylvania	Sy
General Transistor	GT	Texas Instruments	TI
Hughes	Hu	Transitron	Tr
Industro-Transistor	Ind	Tung-Sol	TS
Minneapolis-Honeywell	MH	Western Electric	WE
		Westinghouse	WI

2N571	GT	2N652	Mo	GT83	GT
2N572	GT	2N653	Mo	GT87	GT
2N574	MH	2N654	Mo	GT88	GT
2N574A	MH	2N655	Mo	GT109	GT
2N575	MH	2N656	TI	GT122	GT
2N575A	MH	2N657	TI	GT123	GT
2N576A	Sy	2N658	Ra	GT153	GT
2N578	RCA, TS	2N659	Ra	GT167	GT
2N579	RCA, TS	2N660	Ra	GT222	GT
2N580	RCA, TS	2N661	Ra	GT229	GT
2N581	RCA, TS	2N662	Ra	GT269	GT
2N582	RCA, TS	2N669	Mo	GT758	GT
2N583	RCA	2N670	Ph	GT759	GT
2N584	RCA	2N671	Ph	GT759R	GT
2N585	RCA	2N677	Be	GT760	GT
2N586	RCA	2N677A	Be	GT760R	GT
2N587	Sy	2N677B	Be	GT761	GT
2N588	Ph	2N677C	Be	GT761R	GT
2N589	Ph	2N678	Be	GT762	GT
2N592	GT	2N678A	Be	GT762R	GT
2N593	GT	2N678B	Be	GT763	GT
2N594	GT	2N678C	Be	GT792	GT
2N595	GT	2N679	Sy	GT792R	GT
2N596	GT	2N680	TI	GT903	GT
2N597	Ph	3N25	TI	GT904	GT
2N598	Ph	3N36	GE	GT905	GT
2N599	Ph	3N37	GE	GT947	GT
2N602	GT	204A	TI	GT948R	GT
2N603	GT	800	TI	H3A	MH
2N604	GT	B113	Be	H4A	MH
2N605	GT	B159	Be	H5SCL	MH
2N606	GT	B177	Be	H6SCL	MH
2N607	GT	B178	Be	H7SCL	MH
2N608	GT	B179	Be	H45	MH
2N609	Wh	CK13	Ra	H200E	MH
2N610	Wh	CK14	Ra	HA3001	Hu
2N611	Wh	CK16	Ra	HA5002	Hu
2N612	Wh	CK17	Ra	HA5003	Hu
2N613	Wh	CK22	Ra	HA5005	Hu
2N614	Wh	CK25	Ra	HA5009	Hu
2N615	Wh	CK26	Ra	HA5011	Hu
2N616	Wh	CK27	Ra	HA5014	Hu
2N617	Wh	CK28	Ra	HA5016	Hu
2N618	Mo	CK64	Ra	HA5020	Hu
2N619	Ra	CK65	Ra	HA5021	Hu
2N620	Ra	CK66	Ra	HA7501	Hu
2N621	Ra	CK67	Ra	HA7502	Hu
2N622	Ra	CTP1112	C	HA7506	Hu
2N623	TI	CTP1117	C	HA7507	Hu
2N624	Sy	CTP1135	C	HA7510	Hu
2N625	Sy	CTP1137	C	MIL-T19 500	M
2N627	Mo	CTP1503	C	OC16D	Am
2N628	Mo	CTP1512	C	OC16E	Am
2N629	Mo	DT80	De	OC16G	Am
2N630	Mo	DT100	De	OC30	Am
2N631	Ra	GA52829	WE	OC65	Am
2N632	Ra	GA53104	WE	OC66	Am
2N633	Ra	GA53149	WE	RD316	Bo
2N634	GE	GA53194	WE	SCL7002/18	M
2N635	GE	GA53242	WE	SCL7002/19	M
2N636	GE	GT14	GT	ST400	Tr
2N637	Be	GT20	GT	ST401	Tr
2N637A	Be	GT34	GT	ST402	Tr
2N637B	Be	GT34HV	GT	ST403	Tr
2N638	Be	GT34N	GT	ST903	Tr
2N638A	Be	GT34S	GT	ST904	Tr
2N639	Be	GT35/2N35	GT	TR81	Ind
2N639A	Be	GT74	GT	TR722	Ind
2N639B	Be	GT75	GT	TR764	Ind
2N650	Mo	GT81	GT	TS627	TS
2N651	Mo	GT81HS	GT	TS628	TS
		GT82	GT	TS629	TS

Core Plane Tester

Programmed outputs



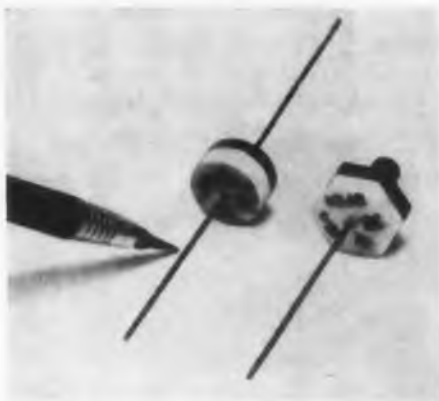
This unit is a transistorized core tester that can be used for automatic core plane testing. It is also useful for magnetic research or individual core testing. The current outputs can be programmed to give various combinations of full or half currents. The currents are adjustable from zero to 1.5 amp. Rise time adjustments from 3 μ sec to 1 μ sec are provided. Current widths are also controllable. Accurate current control is provided and maximum reliability is achieved with the use of transistors and printed circuit assemblies throughout.

Transistor Applications, Inc., Dept. ED, 50 Broad St., Boston, Mass.

CIRCLE 402 ON READER-SERVICE CARD

Silicon Rectifiers

1250 w of rectified power



Peak inverse voltage ratings for the series J silicon rectifiers are 100, 200, 300, and 400 v. The 100 v units are rated at 1.5 amp dc at a temperature of 100 C. They feature low forward drop, low current density, and axial leads. Type J-2 rectifiers are rated at 10 amp dc to 100 C. They require a cooling fin or heat sink to limit temperature rise. Mounting is by means of a #10-32 stud.

Sarkes Tarzian, Inc., Rectifier Div., Dept. ED, 115 N. College Ave., Bloomington, Ind.

CIRCLE 403 ON READER-SERVICE CARD



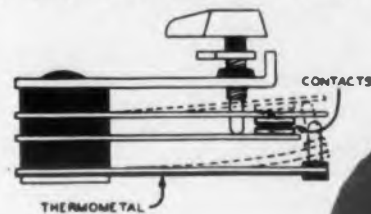
AMERICAN
PLATINUM
& SILVER
DIVISION

FOR A MIRROR BRIGHT FINISH

"SILVA-BRITE" SILVER PLATING PROCESS . . . Provides hard, bright, highly-ductile finish in stable deposits from flash to heavy. Water-clear solution enables plater to watch process; parts falling into tank may be recovered without contamination. Uniformly good results with current densities from 10 to 40 amperes per square foot; operation and control are non-critical, economical. Filtration through activated carbon removes organic contaminants; no purification downtime. Excellent throwing power, less tendency toward bath decomposition or fumes. Write for technical bulletin.

American Platinum & Silver Division, 231 New Jersey Railroad Avenue, Newark 5, N. J.

CIRCLE 101 ON READER-SERVICE CARD



H. A. WILSON
DIVISION



FOR CONTROLLING TEMPERATURE

THERMOMETAL® . . . for use in electrical appliances, thermal cutouts, heating controls . . . in any application involving the indication and accurate control of temperatures, electrical currents, voltages, etc. Supplied in strip form, rolled and slit to close tolerances and tempered to meet specifications. Also supplied as elements and sub-assemblies, with or without contacts attached, fabricated in accordance with specifications.

H. A. Wilson Division, U. S. Highway No. 22, Union, N. J.

CIRCLE 102 ON READER-SERVICE CARD



CHEMICAL
DIVISION



FOR PURIFYING AND PURIDRYING

DEOXO® PURIFIER . . . provides low-cost catalytic purification of hydrogen and other gases to the extent of less than one part oxygen per million. Requires no operating expense, no maintenance, no reactivation, no auxiliary heating, no water cooler. DEOXO® DUAL PURIDRYER . . . combines continuously-operating, dual tower, automatically-run drying unit with the features of Deoxo Purifier—catalytically produces pure, dry hydrogen, so pure it contains less than one part oxygen per million, so dry that it has a dew point of better than -100° F.

Chemical Division, 113 Astor Street, Newark 2, N. J.

CIRCLE 103 ON READER-SERVICE CARD

ENGELHARD INDUSTRIES, INC.

113 ASTOR STREET
NEWARK 2, NEW JERSEY

Varian Strip Chart Recorders

POTENTIOMETER PERFORMANCE* AT MODERATE COST



Varian G-10 — Portable for laboratory or bench use where chart accessibility is of prime importance. Base price \$340.

Varian G-11A — For panel, rack or portable use; designed for OEM, lab or field for long-term monitoring. Base price \$450.

* The servo-balance potentiometer method has long been used in expensive recorders to achieve superior stability, sensitivity, ruggedness and high input impedance. Use of servo balancing systems assures full realization of these inherent advantages by providing ample power independent of the source being measured. Now Varian offers you recorders of moderate cost using this time-proven principle.

VARIAN SPECIFICATIONS:

- Spans as low as 10 mv
- Limit of error 1%
- Maximum source resistance 50K ohms or higher
- Balancing times: 1 second or 2.5 seconds on G-10; 1 second on G-11

WRITE TODAY FOR COMPLETE SPECIFICATIONS

Varian recorders are sold and serviced throughout the free world by representatives in principal cities.



PALO ALTO 21, CALIFORNIA

Varian Associates manufactures Klystrons, Traveling Wave Tubes, Backward Wave Oscillators, Linear Accelerators, Microwave System Components, R. F. Spectrometers, Magnets, Magnetometers, Stalos, Power Amplifiers and Graphic Recorders and offers research and development services.

CIRCLE 133 ON READER-SERVICE CARD

NEW PRODUCTS

Transformers

Wide band



Designed for operation from 100 kc to 100 mc with minimum insertion loss, type 1210 transformers may be used for step-up or step-down. The impedance ratio is 600 ohms; 75 ohms. Good balance, low cross talk, and minimum capacitance coupling are achieved.

North Hills Electric Co., Inc., Dept. E Mineola, N.Y.

CIRCLE 134 ON READER-SERVICE CARD

Three-Phase Oscillator

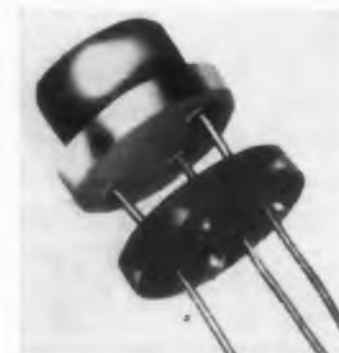
Facilitates component testing



Model 603 three-phase oscillator provides wide range, variable-frequency three-phase signal source. Coupled with three amplifiers, it can be used for variable speed-control of synchronous or induction motors; the testing of systems or components required to operate over a range of frequencies varying from the normal; and for testing gyros.

Genisco, Inc., Dept. ED, 2233 Federal Ave Los Angeles 64, Calif.

CIRCLE 135 ON READER-SERVICE CARD



Transistor Mounting

For P-C boards

The Transipad, a glass filled Diallyl Phthalate wafer with three holes and three hemispherical

...et, permits easier installation and more reliable mounting for transistors on printed circuit boards. Designed especially for Jetec 30 transistors, the device eliminates the need to use leads as supports and permits lower, more stable mounting with positive insulation between the transistor case and the printed circuit conductors. The Transipad is approved under MIL-M-18794 SDG.

Milton Ross Metals Co., Dept. ED, Davisville Rd., Bucks County, Southampton, Pa.

CIRCLE 136 ON READER-SERVICE CARD



Recorder
Sensitivity of
2 mv/mm

For recording electrical data from dc to 100 cps, the ER-20 direct-writing strip chart recorder features direct-coupled amplifiers which give a sensitivity of 2 mv/mm. Stylus deflection on each channel is 40 mm, with an accuracy of 2 per cent.

Mandrel Industrial Instruments, Dept. ED, 5134 Glenmont Dr., Houston, Tex.

CIRCLE 137 ON READER-SERVICE CARD

Decade Delay Line
High Impedance Output



This lumped-constant decade delay line features high impedance output. The following inputs are available: 500 ohms, 1000 ohms, 2000 ohms. Variable from 0 to 11 μ sec, in increments of 0.1 μ sec, with rise times of 0.25 microsecond. Units are provided with coaxial input and output connectors.

Epsco Inc., Components Div., Dept. ED, Cum-
mington St., Boston, Mass.

CIRCLE 138 ON READER-SERVICE CARD

RELIABILITY

is
the
word



El-Menco

Dur-Micas

are
the
CAPACITORS

with
BUILT-IN RELIABILITY

the finest of materials...

superior engineering know-how... combine to build in El-Menco Dur-Mica Capacitors the highest reliability... to give long, ever-ready, powerful service in electronic equipment — from lightning-fast giant brains to tiny transistor receivers.

* unique features in

El-Menco *Dur-Micas*

● Specially-selected, highest-grade India Ruby mica films... pre-tested to have highest insulation resistance... greatest dielectric strength... lowest dissipation factor. Specially developed dipped coating retains the superior properties of India Ruby mica.

● Debugging — the removal of early failures by subjecting mica capacitors to short life tests at elevated voltages and temperatures... THE SCORE... DM30, 10,000 MMF, "Debugged" El-Menco Dur-Mica Capacitors... subjected to 257,000 hours of life at 85°C with 100% of the rated DC voltage applied... turned in a record computed reliability performance — APPROX. 0.6% CUMULATIVE FAILURES OR ONLY 1 FAILURE PER 43 MILLION UNIT-HOURS.

El Menco "Dur-Micas"

have proved their tremendous power and ability under accelerated conditions of 1 1/2 times rated voltage at ambient temperatures of 125°C and 150°C, winning out over all others in longest life, most powerful performance, smallest size, greater stability.

DM15, DM16, DM19, DM20, DM30, DM40, DM42, DM43... perfect for extreme miniaturization; ideal for new miniaturized designs and printed wiring circuits. New "hairpin" parallel leads insure easy applications in radio, television, guided missiles. El-Menco Dur-Micas meet all humidity, temperature and electronic requirements, including military specs.

47 ± 5%

Avoid Costly Breakdowns... with Two-Way Built In Rugged Reliability.

DM15

390 ± 10%

DM20

63400 ± 1%

El-Menco

DM42

ACTUAL SIZE



Write for FREE sample and catalog on your firm's letterhead.

El-Menco
Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors

WILLIMANTIC

CONNECTICUT

- molded mica
- mica trimmer
- dipped paper
- tubular paper
- ceramic feed-thrus
- silvered mica films
- ceramic discs

Arco Electronics, Inc., 64 White St., New York 13, N. Y.

Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

CIRCLE 139 ON READER-SERVICE CARD



The 33 megawatt hydrogen thyatron shown above is just one of the many special purpose electronic tubes manufactured by Chatham Electronics, a Division of Tung-Sol Electric, Inc. The precision glass components shown in both photos are typical of those supplied by F & P for use in thyatrons and other tube products manufactured by Chatham.



New precision in glass:

precision glass puts giant thyatron on target

Here's a job in precision glass fabricating that wasn't easy — not even for the experienced production staff of Chatham Electronics, Division of Tung-Sol Electric, Inc.

This giant hydrogen thyatron just had to have its anode stem precisely centered at the top of the tube. The slightest lack of uniformity in the glass components used to make up the stem assembly would throw the anode off-center, resulting in spurious discharges, arcs, and misfires. Such behavior could hardly be tolerated in the high power radar pulse modulator service for which the tube was designed. Glass components made to conventional tolerances were not good enough!

That's when F & P was called in. Recommended by 20 years of experience in the field of precision glass forming and fabricating, F & P was the company chosen most likely to meet the strict ID-wall thickness-concentricity requirements of this critical application. F & P not only succeeded in furnishing components to the required tolerances, but also worked with Chatham in solving related glass design and fabricating problems. How's that for service?

This is just a sample of what F & P can do for you in precision glass. F & P has met tolerances as low as $\pm .0001$ in. . . . in special types of glass tube enclosures, glass switch components, miniature glass battery enclosures, and precision molds.

If you would like to explore the possibilities of using precision glass in your designs, contact the Glass Products Division, Fischer & Porter Company, 5778 County Line Rd., Hatboro, Penna.



FISCHER & PORTER CO.
Glass Products Division

CIRCLE 140 ON READER-SERVICE CARD

NEW PRODUCTS

Trimmer

2 w at 85 C



The RVG-8T trimmer potentiometers are stocked in resistance ranges of 20 to 50,000 ohms and are available to 100,000 ohms. The standard unit has a rating of 2 w at 85 C derated to zero at 150 C. Resistance tolerance of ± 5 and linearity of ± 3 are produced with windings on both cards and mandrels.

Gamewell Co., Dept. ED, Newton Upper Falls, Mass.

CIRCLE 141 ON READER-SERVICE CARD

Retaining Rings

Easily identified



A complete series of retaining rings are available for instrument use. Ring size is engraved on each piece for size identification. The rings are available stacked on rods for automatic assembly operations.

Rotor Clip Co., Dept. ED, 114 Allen Blvd., Farmingdale, N.Y.

CIRCLE 142 ON READER-SERVICE CARD

I-F Amplifier

With detector and cathode follower



This modified version of the M-200 Series of

ELECTRONIC DESIGN • July 9, 1958

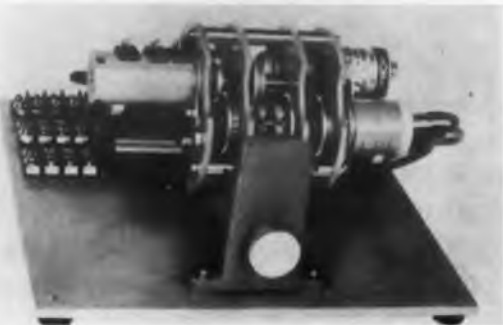
amplifiers includes two models which are known as the M-230A and M-235A. A built-in detector and cathode follower is featured. Center frequency for both units is 30 mc. Bandwidths are 2 mc and 10 mc respectively.

Instruments for Industry, Inc., Dept. ED, 150 Glen Cove Rd., Mineola, N.Y.

CIRCLE 143 ON READER-SERVICE CARD

Servo Breadboard

Provides accurate test results



This apparatus consists of stocked components which may be assembled quickly into a variety of 2-7/8 in. diam mechanisms. As many as six synchro style components of any pilot diameter may be mounted. Standard gear ratios range from 1:1 to 78,125:1. Ant backlash gearing is available in all ratios. The fixed gear center mechanisms provide test results which truly represent the behavior of a correctly designed production unit.

Precision Mechanisms Corp., Dept. ED, 577 Newbridge Ave., East Meadow, N.Y.

CIRCLE 144 ON READER-SERVICE CARD

Power Supplies

Short-circuit proof



These transistorized power supplies feature three-way short circuit protection, including a high-speed circuit breaker. Regulation is 0.1 or 0.01 v for extremes of line and load. Ripple is less than 0.001 v. Wide range models start at 0 to 36 v up to 0 to 36 v. Current ratings are up to 5 amp.

Electronic Measurements Co., Inc., Dept. ED, Paterson, N.J.

CIRCLE 145 ON READER-SERVICE CARD

MINIATURIZED military type CAPACITORS



FOR YOUR
MOST
CRITICAL
APPLICATIONS

SANGAMO TYPE S CAPACITORS

HERMETICALLY SEALED PAPER TUBULARS

These high reliability subminiature capacitors are encased in brass tubular metal cases, hermetically sealed with Sangamo's exclusive "INNERSEAL" glass-to-metal terminal that gives utmost protection against leakage under severe operating conditions.

Sangamo Type S Capacitors meet the performance requirements of MIL-C-25A, MIL-C-14157A, and MIL-C-26244USAF. For design convenience, several choices are available with regard to tolerances, circuit assembly, lead styles, mounting brackets, insulating sleeve, and inductive or non-inductive sections. Engineering Catalog No. 2421 gives complete information. Popular styles and ratings are available from stock.

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

CIRCLE 146 ON READER-SERVICE CARD

SC58-4



FOTOCERAM circuit board blanks are made photographically. All holes and shapes are produced by simple exposure to light, heat, and an etching operation.

This is a FOTOCERAM printed circuit ... an unusual new type of printed circuit board

Reliable through-plate holes • The good adhesion of the circuit runs applies also to the through-plate holes because both are produced with one plating operation.

Excellent resolderability • We have removed and resoldered components over twenty times on a FOTOCERAM board without damage to circuit runs or through-plate holes. And this is *without* using adhesives to bond the copper to the board.

Dimensional stability • Rigid structure of FOTOCERAM prevents unusual design

considerations—eliminates problem of warp and twist.

Good adhesion • It takes 12-25 pounds to peel a one-inch copper strip from a FOTOCERAM board.

Exceptional pull strength • 1400 pounds per square inch.

No water absorption • FOTOCERAM's nonporous—zero water absorption.

Non-flammable

No blisters • FOTOCERAM never blisters. We put it through repeated 15-second

cycles of copper metallizing at 500°F. and could not find a single blister or sign of peeling or failure.

Other properties:

Dissipation factor		
	1mc @ 20°C.	0.006
	@ 200°C.	0.014
Dielectric constant		
	1 mc @ 20°C.	5.6
	@ 200°C.	6.3
Loss factor	1mc @ 20°C.	0.034
	@ 200°C.	0.088

For more information, write for our Data Sheet on FOTOCERAM.

Corning means research in Glass



CORNING GLASS WORKS, Bradford, Pa.

Electronic Components Sales Department

CIRCLE 147 ON READER-SERVICE CARD

NEW PRODUCTS

Toroidal Transformers

For dc to dc converters



A standard line of toroidal transformers for dc to dc or ac transistorized converter applications is available. Dual purpose transformers for switching power transistors and supplying various output voltages have power ratings to 100 w, inputs of 6, 12, and 24 v dc, and outputs to 60 v. Basic power transistor switching transformers for use with other multiple tap power transformers are available for use with transistors of different power ratings. Units are uncased, encapsulated, or hermetically sealed.

Polyphase Instrument Co., Dept. ED, E. 4th St., Bridgeport, Pa.

CIRCLE 148 ON READER-SERVICE CARD

Force Transducer

1.68 v output



A differential transformer type force transducer, the model 9-1 features a high output of 1.68 v full scale with input of 115 v ac at 60 cps into a 5000 ohm resistive load. An efficient magnetic circuit makes the output possible. Temperature drift and sensitivity at zero are maximum of 2 per cent at full scale per 100 F. Units have 75-lb or 240-lb capacity with a ring element design. Maximum linearity is 0.5 per cent, and hysteresis does not exceed 0.09 per cent. Units meet or exceed MIL-E-005272B environmental requirements.

Edcliff Instruments, Dept. ED, P.O. Box 500, Monrovia, Calif.

CIRCLE 149 ON READER-SERVICE CARD

Shock Tester

Provides 77 g on 400 lb units



Model 30 K drop test machine provides shock forces in excess of 77 g on specimens weighing up to 400 lb. The machine consists of a piston type platform on which the equipment to be tested is mounted. The platform is then subjected to a free fall into a cylinder of air pressure. The advantages offered are repeatability of acceleration waveforms and simplicity of operation.

Aeroflex Corp., Aeroflex Laboratories Div., Dept. ED, 34-06 Skillman Ave., Long Island City, N.Y.

CIRCLE 150 ON READER-SERVICE CARD

Dual-Beam Oscilloscope

DC to 25 mc



Type 551 is a dc-to-25 mc dual-beam oscilloscope with the company's plug-in feature. All type 53/54 plug-in units can be used in both vertical channels, providing a high degree of signal-handling versatility. Risetime of the two main vertical amplifiers is 0.012 μ sec, and both have 2- μ sec signal-delay networks. The type 551 sweep is common to both beams. Twenty-two calibrated direct-reading sweep rates from 0.1 sec/cm to 5 sec/cm are provided, with a vernier (uncalibrated) control for continuous adjustment from 0.1 μ sec/cm to 12 sec/cm.

Tektronix, Inc., Dept. ED, P.O. Box 831, Portland 7, Ore.

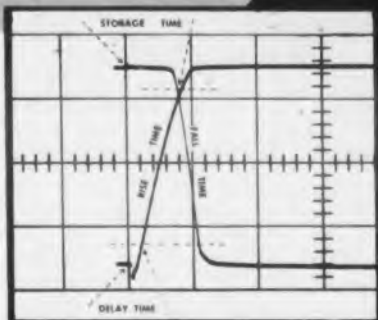
CIRCLE 407 ON READER-SERVICE CARD

NEW PLUG-IN UNIT



for Measuring Transistor High-Frequency Characteristics by the Pulse-Response Method

The Type 53/54R Unit can trigger the Oscilloscope sweep either on the start of the test pulse only, or on both the start and finish to display delay, rise, storage, and fall times simultaneously.



The Type 53/54R Unit and your Tektronix Oscilloscope with the Plug-In Feature equip you to measure transistor delay, rise, storage, and fall times. No other equipment is needed. Just plug in the Type 53/54R Unit and you're ready to go.

C H A R A C T E R I S T I C S

Collector Supply

1 to 15 v continuously variable, positive or negative. Current Capability, 400 ma.

Mercury-Switch Pulse Generator

Risetime less than 0.005 μ sec. Overall risetimes with the oscilloscopes are as follows:

Types 541, 543, 545—0.012 μ sec

Type 551—0.014 μ sec

Type 533—0.023 sec

Types 531, 535, 536—0.035 μ sec

Type 532—0.07 μ sec (The Type 532 and Type 536 have an additional limitation in the lack of signal delay in the main vertical amplifier).

Amplitude—0.02 v to 10 v, continuously adjustable, across 50 ohms. Eight calibrated steps—0.05, 0.1, 0.2, 0.5, 1, 2, 5, and 10 v.

Bias Supply

—0.5 v to +0.5 v and —5 v to +5 v, continuously variable. Current Capability— \pm 100 ma.

Calibrated Vertical Deflection

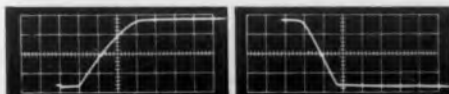
0.5, 1, 2, 5, 10, 20, 50, and 100 ma/cm collector current.

Price—\$300 f.o.b. factory

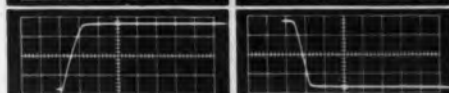
High-frequency characteristics of a transistor under five different conditions of drive. In each pair, the photograph at left shows delay time and rise time, the start of the driving pulse coinciding with the 2-cm graticule line. The second photograph of each pair shows storage time and fall time, the end of the pulse coinciding with the 2-cm line. The Type 53/54R Unit plugged into a Tektronix Type 543 Oscilloscope—3.5-v collector supply, 500-ohm collector load, 2-ma div vertical calibration, 0.5- μ sec div sweep rate. Driving conditions at left of each pair.

Low-frequency characteristics of the same transistor under driving conditions paralleling those of the first three pairs at left. Family of curves photographed on a Tektronix Type 575 Transistor-Curve Tracer—0.5-v/div horizontal calibration, 1-ma div vertical calibration, 500-ohm load line. Driving conditions at right of each photograph.

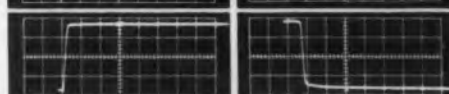
Drive voltage:
10 v through
20 kilohms.



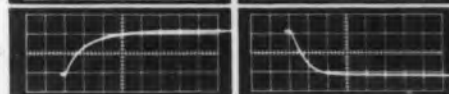
Drive voltage:
2 v through
1 kilohm.



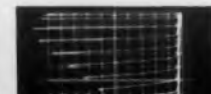
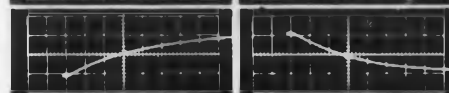
Drive voltage:
0.5 v through
50 ohms.



Class A drive:
0.05 v through
50 ohms.



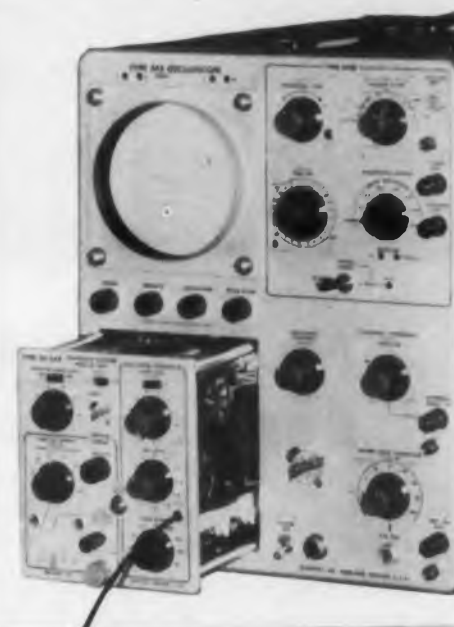
Class A drive:
0.1 v through
1 kilohm.



Drive voltage:
0.2 v/step
through
20 kilohms.

Drive voltage:
0.05 v/step
through
1 kilohm.

Drive voltage:
0.02 v/step
through
50 ohms.



Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon

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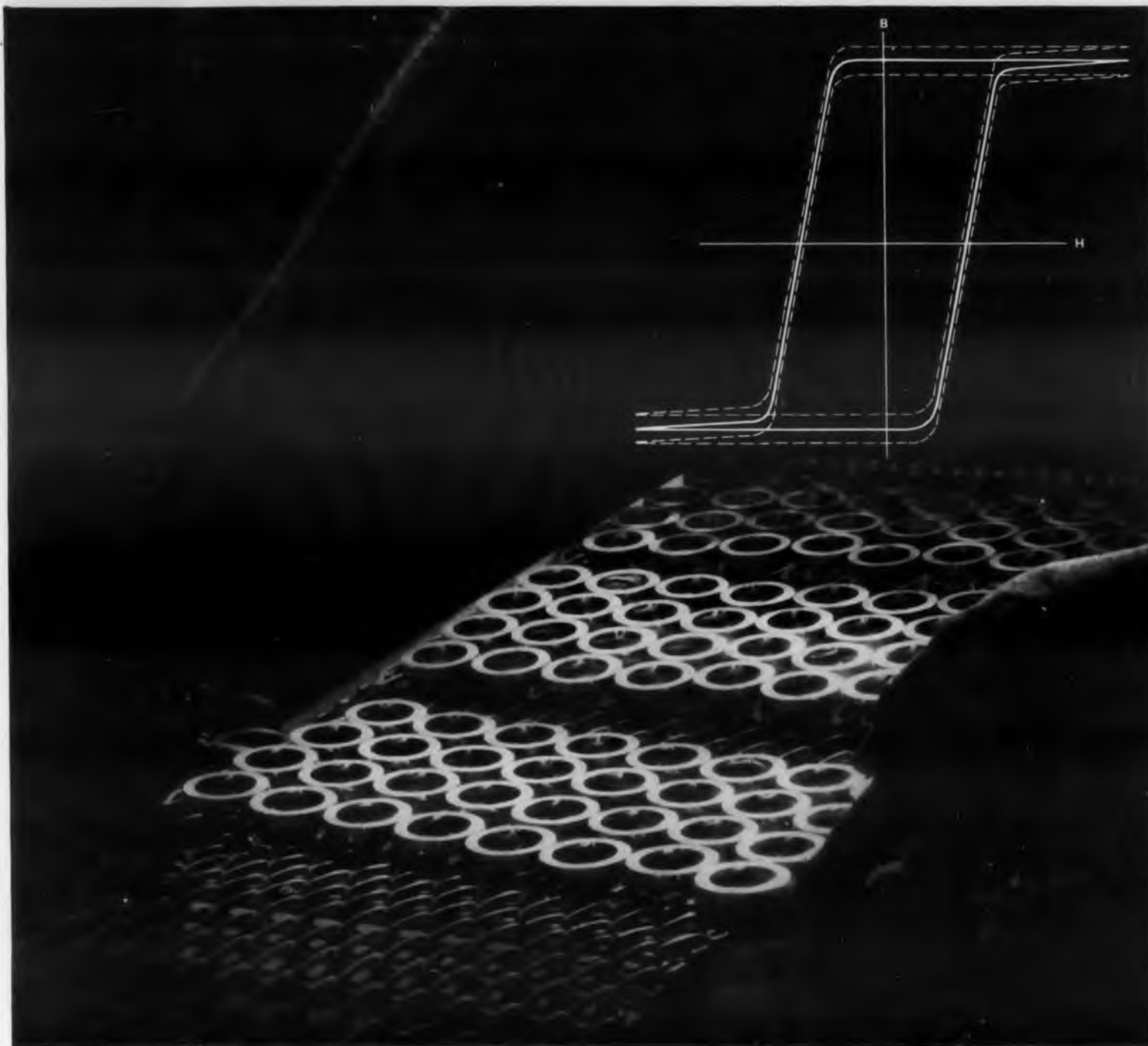
TEKTRONIX ENGINEERING REPRESENTATIVES: Arthur Lynch & Assoc., Ft. Myers, Fla.; Gainesville, Fla.; Bivins & Caldwell, Atlanta, Ga.; High Point, N. C.; Hawthorne Electronics, Portland, Ore.; Seattle, Wash.; Hytronic Measurements, Denver, Colo.

Tektronix is represented in 20 overseas countries by qualified engineering organizations.

Please call your Tektronix Field Engineer or Representative for complete specifications and, if desired, to arrange for a demonstration at your convenience.

ENGINEERS—interested in furthering the advancement of the oscilloscope? We have openings for men with creative design ability. Please write Richard Ropiequet, Vice President, Engineering.

CIRCLE 408 ON READER-SERVICE CARD



Now—guaranteed maximum and minimum performance limits for tape wound cores!

For the first time you can order tape wound cores with guaranteed performance to published limits.

All tape wound cores coming from the hydrogen atmosphere annealing furnaces at Magnetics, Inc. are tested by flux reset as proposed by the AIEE Working Group on Core Matching and Grading*. Thus, standard cores are given a standard test to give engineer-designers a standard component whose performance is guaranteed within fixed limits.

Magnetics, Inc. has established the limits to provide maximum, minimum and nominal B_m , B_r/B_m , H_1 and gain performance data. It is published for one, two, four and six mil tape thickness for Orthonol® and Hy Mu 80.

Now it is possible for you to select and order cores specifically suited to your design (just as with any other standardized

CIRCLE 151 ON READER-SERVICE CARD

component). You'll save many hours of experimenting, and because the reliability of the data is guaranteed, you'll be sure at every stage of design and production.

The published limits for Magnetics, Inc. tape wound core performance are ready now. Write for your copy: Dept. ED-45, Magnetics, Inc., Butler, Pennsylvania.

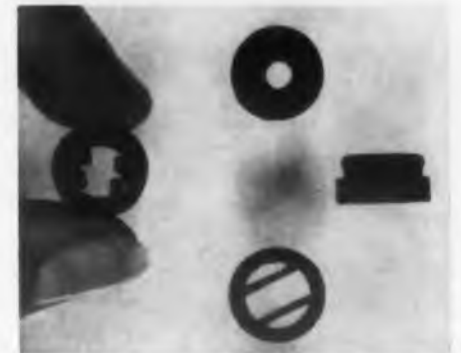


*Paper No. TWC-45, Winter General Meeting, AIEE, February, 1958. Flux Reset Test is one of two tests proposed for standardization.

NEW PRODUCTS

Transistor Mounts

Shock, vibration resistant



These transistor mounts provide standardized mounting for all transistors regardless of size or shape. They offer shock resistance and prevent movement under severe vibration. Temperature range is from -60 to $+99$ C. The mounts have a low dissipation factor, low conductivity, and low dielectric constant.

Delbert Blinn Co., Dept. ED, P.O. Box 750, Pomona, Calif.

CIRCLE 152 ON READER-SERVICE CARD

Headers

One-piece construction

Square and rectangular headers of one-piece construction eliminate assembly operations. They are available in nearly every standard size and include moat, square flange, and insert type constructions.

Glasseal Products Co. Inc., Dept. ED, 1111 Elizabeth Ave., Linden, N.J.

CIRCLE 153 ON READER-SERVICE CARD

Frequency Indicator

Meter and converter in one package



Model FR 305 frequency indicator combines an indicating meter with the manufacturer's transistorized frequency-to-voltage converter in a single package. Accurate indication of frequency, rate, frequency or rpm is provided.

Waugh Engineering Co., Dept. ED, 78 Burnet Ave., Van Nuys, Calif.

CIRCLE 406 ON READER-SERVICE CARD

Diode Function Generator

Punched card memory



The Model 100 may be used to generate either linear functions of an independent input stage, or of any parameter which may be connected to a voltage, or it may be used to generate non-linear functions of time by using either internal or an external time base. A complete library of non-linear functions may be created for future use.

Electrol, Inc., Dept. ED, P.O. Box 1152, Beverly Hills, Calif.

CIRCLE 154 ON READER-SERVICE CARD

Phase Meter

10 cps to 50 kc range

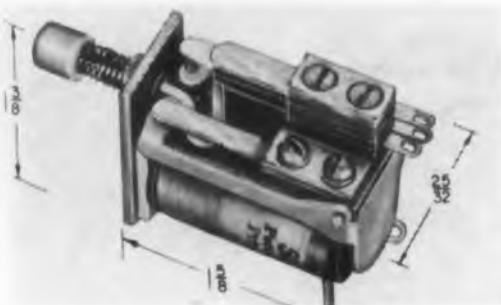
Type 328-A transistorized phase meter measures the phase angle in degrees between two sinusoidal or non-sinusoidal voltages within a frequency range from 10 cps to 50 kc. It is a direct reading electronic instrument which features broad frequency coverage, wide input dynamic range, accuracy and excellent stability.

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

CIRCLE 155 ON READER-SERVICE CARD

Relay

With reset lever



Model MA telephone-type relay has a push-to-release reset lever. The relay operates on 2.4 w, 1/2 msec pulses and has contact arrangements up to 4 p.d.t. When the relay operates, a latch lever locks the armature in position so that the contacts remain transferred when power is removed from the coil.

Potter & Brumfield, Inc., Dept. ED, Princeton, N.J.

CIRCLE 156 ON READER-SERVICE CARD

Now...major components for weapons testing and control systems come as reusable, universally adaptable modules

It's called MATE—Modular Automatic Testing Equipment—for go no-go readout, the first significant step in eliminating obsolescence in automatic testing systems.

After extensive surveys, AMF has found that all automatic systems, regardless of type or complexity, can be reduced to the same, basic, pack-ageable components.

WIDE RANGE AVAILABLE

AMF has already designed and produced 19 of these modules—each one a self-sufficient package with a distinct responsibility. Available to you on an "off-the-shelf" basis now, are programming and control modules, signal translator modules, comparator-evaluator modules and display devices.*

UNIVERSALLY ADAPTABLE

These modules can be put together to implement any automatic testing program. Or, any of them can be integrated with existing equipment of other manufacture.

OBSCOLESCENCE ELIMINATED

After serving their purpose for the system under test, MATE modules can be reintegrated into other systems requiring the same functions. The result: complete flexibility in the most complex systems; low-cost components available on short delivery, pre-designed to accomplish many dif-

ferent tasks; modules that retain their usefulness and validity after weapons systems modification. The resulting economies to prime contractors and the military are enormous.

MAJOR ASPECTS OF MATE

The response of all types of weapons hardware can be evaluated with MATE, including electrical, mechanical, and hydraulic. Signal Simulators and Transducers are not part of the MATE line, but the system is designed to match most currently-available transducer elements. From transducer to display device, MATE modules take over.

Control—the test sequence is achieved through sequential programming equipment...punched tape, sequential stepping switch or a combination of both.

Signal Evaluation—A key feature of MATE is the use of either analog or digital comparators which evaluate data without conversion. Analog comparators operate from 5 to 20 vdc with a nominal operating level of 10.000 vdc. Analog translators are available to convert sinusoidal and other complex data for the analog comparator.

Reference—Because the entire system is normalized to operate at 10 vdc, just one reference supply of 10.000 vdc, accurate to $\pm 0.02\%$ is required. Methods are provided for re-

motely establishing pre-set tolerance limits. Several different display devices are also provided.*

Your inquiries invited—Write to Associated Missiles Products Co. (a division of AMF), 2709 North Garey Avenue, Pomona, California...or to AMF, Government Products Office, Washington, D. C. or Dayton, Ohio; or Los Angeles, Cal.

*MATE MODULES AVAILABLE

PROGRAMMING & CONTROL

Program Sequencer Control Panel
Channel Selector Data Selector
Translator Selector

SIGNAL TRANSLATORS

AC to DC Translator
Frequency to DC Translator
IBM Translator

COMPARATOR-EVALUATORS

LO-GO-HI Comparator (2 modules)
Differential Error-Detector
Analog Comparator
Digital Comparator-Evaluator
(4 modules)
Quasi-Digitizer

DISPLAY DEVICES & POWER SUPPLY

LO-GO-HI Display Panel
LO-GO-HI Meter Display
Quasi-Digital Light Display Panel
28vdc Power Supply
Analog Reference Standard
Analog Reference Supply
Static Pressure Generator

It's called MATE...It's from AMF

(Modular Automatic Testing Equipment)



GOVERNMENT
PRODUCTS

Government Products Group

AMERICAN MACHINE & FOUNDRY COMPANY

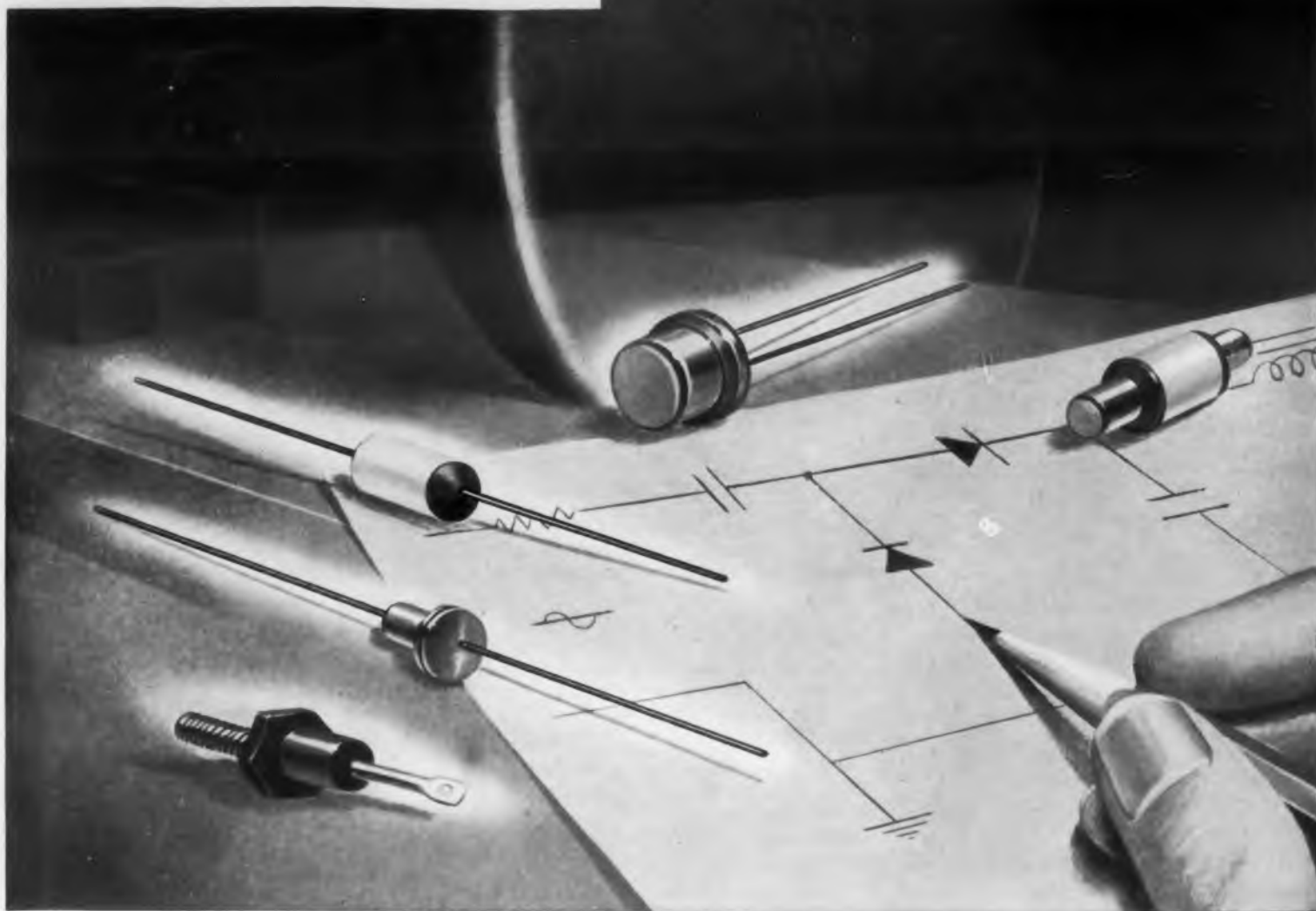
1101 North Royal Street, Alexandria, Va.

CIRCLE 405 ON READER-SERVICE CARD



WRITE for this brochure listing features, method of operation and applications of MATE Modules.

NEWS ABOUT SILICON DEVICES



Reverse current: 10^{-7} amp. Rectification ratio: 10,000,000:1

Now... new efficiency for TV power supplies with dependable diodes of Du Pont Hyperpure Silicon

More efficient power supplies... savings in space and weight... important reasons why TV manufacturers are replacing conventional rectifying systems with silicon diodes. Today, several types of silicon diodes and rectifiers are readily available for TV circuits. TV manufacturers have tested silicon rectifiers and report no noticeable change in output voltage under continuous load conditions over long periods of time. Sili-

con components can operate in ambients from -65° to 150° C. They maintain excellent electrical stability and resist aging.

Silicon components have high shock and vibration limits. They are up to 99% efficient in units operated at 60 cps, and require little maintenance. Silicon cells permit a rectification ratio as high as 10 million to 1—almost negligible reverse conductance. Silicon bridges are

available with ratings from 1 to 1,000 amperes and more than 600 volts rms.

Note to device manufacturers: You can produce silicon transistors, rectifiers and diodes of the highest quality with Du Pont Hyperpure Silicon. It's now available in three grades for maximum efficiency and ease of use... with a purity range of 3 to 11 atoms of boron per billion. Technical information on crystal growing is available from Du Pont... pioneer producer of semiconductor-grade silicon.



NEW BOOKLET ON DU PONT HYPERPURE SILICON

You'll find our new, illustrated booklet about Hyperpure Silicon helpful and interesting—it describes the manufacture, properties and uses of Du Pont Hyperpure Silicon. Just drop us a card for your copy. E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Silicon Development Group, Wilmington 98, Delaware. (This offer limited to United States and Canada.)

CIRCLE 157 ON READER-SERVICE CARD

PIGMENTS DEPARTMENT



BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY

NEW PRODUCTS

Heater Element

Total thickness of 0.02 in.



This metal film resistance element is sandwiched between rubber, fiberglass or other insulator as the particular application requires, for a total thickness of 0.02 in. This insures rapid transfer of heat and maximum efficiency. The unit is capable of continuous operation at 500 F, with power densities as high as 60 w per sq in.

Thermatic Co., Dept. ED, P.O. Box 585, Great Neck, N.Y.

CIRCLE 158 ON READER-SERVICE CARD

Switchable Tuning Unit

Requires one subcarrier discriminator

Requiring only one subcarrier discriminator, this switchable tuning unit provides regular data reduction quality on all standard telemetry channels. It incorporates the company's bandpass and low pass output filters and provides a single installation available with 8, 16, or 24 channels.

Data-Control Systems, Inc., Dept. ED, Danbury, Conn.

CIRCLE 159 ON READER-SERVICE CARD

Isolator

Frequency range of 3.5 to 9.6 kmc



Model W668-1A-2-0 transverse field isolator has a frequency range of 8.5 to 9.6 kmc with isolation at 10 db min and insertion loss of 0.5 db.

ELECTRONIC DESIGN • July 9, 1958

max. Other features include an input vswr 1.10 max with peak power at 300 kw nominal and ambient temperature of -65 to +125 C. Kearfott Co., Microwave Div., Dept. ED, 844 Oxnard St., Van Nuys, Calif.

CIRCLE 160 ON READER-SERVICE CARD

Spectrum Analyzers

100 and 30 channel types



This 100-channel analyzer model 100 analyzes cps bandwidths in the 50-10,500 cps range in three bands. The 30 channel analyzer model 30 plates a single amplitude to frequency, making instant graphic display of complex audio waveforms. It is a heterodyne-type analyzer which separates 4-kc wide bandwidths up to 20 into 29 equal frequency bands. A 30th channel is provided for reference.

Kay Electric Co., Dept. ED, Maple Ave., Pine Brook, N.J.

CIRCLE 161 ON READER-SERVICE CARD



Waveguide Switch

Range from 4.7 to 11.0 kmc

Technical characteristics of double ridged waveguide switch model H14A2AA are: frequency range from 4.7 to 11.0 kmc; vswr under 1.5 to 1; insertion loss of 0.5 db max; crosstalk -40 db; 1P2T positions; actuator operating voltage from 18 to 30 v dc; switching time of 1.5 sec max; and life of 100,000 actuations.

Thompson Products, Inc., Electronics Div., Dept. ED, 2196 Clarkwood Rd., Cleveland 3, Ohio.

CIRCLE 162 ON READER-SERVICE CARD

INTREWW



NEW TYPE 6 SERVO MOTORS

Here's one of the smallest precision servo motor series currently available. The new Daystrom Transicoil Type 6 Motors are wound for 26-, 33-, and 52-volt operation. Control phase is center tapped for operation with transistor drive. These Motors develop .125 oz-in. min. stall torque and 6200 RPM free speed. Each unit weighs only .9 oz. and is less than 1 1/4" overall.



NEW TYPE 8 INDUCTIVE POTENTIOMETER

This Inductive Potentiometer is an infinite resolution a-c potentiometer whose output voltage is linear rather than sinusoidal with the angle. Output voltage phase is dependent upon the direction of shaft displacement from null. When operated into load resistors not less than those specified, output is linear within .25% through an angular rotation of +85° through null to -85°.



NEW TYPE 8 SYNCHROS

The new Daystrom Transicoil Type 8 Synchro Line consists of transmitters, control transformers, differentials and repeaters. Dimensions equal to BuOrd Size 8. Operation: 115V 400 cycles or 26V 400 cycles. Accuracy of ± 10 minutes is standard. Other accuracies are available upon request. Corrosion resistant construction throughout. Conforms to MIL-E-5272-A. Operating temperature range is -54C to +125C. Higher temperature units also available.



NEW TYPE 11 INERTIAL DAMPED MOTOR

Here's inertial damping with no reduction in no-load speed! This new Type 11 Motor (BuOrd size 11) provides acceleration or deceleration damping in high-speed and high-gain servo systems. In non-critical applications, this motor can be used as a low-cost substitute for damping motor generators.

DATA SHEETS AVAILABLE Write for complete specifications, mechanical data, dimensions and characteristics. Be sure to ask about our New 24 HOUR SERVICE for servo motors and motor generators.



DAYSTROM TRANSICOIL CORP.

A Subsidiary of Daystrom, Inc.

WORCESTER, MONTGOMERY COUNTY, PA. • PHONE: JUNO 4-2421

CIRCLE 404 ON READER-SERVICE CARD

IN CANADA:

Daystrom, Ltd., 840 Caledonia Rd., Toronto 19, Ont.

FOREIGN:

Daystrom International Div., 100 Empire St., Newark 12, N. J.



What do these latest aircraft and missiles have in common?

All are equipped with Genisco flight control or instrumentation accelerometers.

What better proof of reliability?

With component reliability getting increased attention from missile and aircraft designers, it is significant to note the number of supersonic weapon systems equipped with Genisco accelerometers.

A complete list reads like a roll call of tactical and strategic missiles and aircraft now in the nation's arsenal. Included are such weapons as the *Atlas, Thor, Nike Ajax, Nike Hercules, Bomarc, LaCrosse, Bull Pup, Talos, Dart, Matador, Corporal* and *Territor* missiles; and the *F100D Super Sabre, F101 Voodoo, F106A*, and Canada's *CF105* aircraft. What better proof of the reliability of Genisco instruments than this acceptance by designers of these weapons?

Combining product reliability with guaranteed delivery schedules and competitive pricing has made Genisco the free world's largest producer of potentiometer-type flight and fire control accelerometers. More than 40,000 have been delivered to date.

Send for technical data sheets on all Genisco Accelerometers.

CIRCLE 163 ON READER-SERVICE CARD

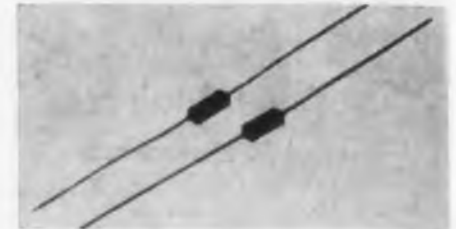


2233 FEDERAL AVENUE • LOS ANGELES 64 • CALIFORNIA

NEW PRODUCTS

Encapsulated Resistors

Operate at 125 C



These encapsulated axial or lug-type wire wound resistors operate effectively at 125 C full rated load, derated to 0 at 145 C. Standard miniature in size, they have maximum resistance values and a low inductance factor. The units are shock and humidity resistant.

General Resistance, Inc., Dept. ED, 577 E. 156th St., New York 55, N.Y.

CIRCLE 164 ON READER-SERVICE CARD

Filter

Highpass-lowpass

A dual unit, this direct coupled highpass/lowpass filter is an addition to the company's line of analog filters. Model LH-24D has two individual filter units which are identical and may be converted from highpass to lowpass by a selector switch.

Spectrum Instruments, Inc., Dept. ED, Box 10, Steinway Station, L.I.C., N.Y.

CIRCLE 165 ON READER-SERVICE CARD

Decade Amplifier

Low phase shift



Model 12-D decade amplifier features precision gain and low phase-shift. Gain is down less than 3 db at 3 cps and 500 kc. Phase shift is nominally zero, and less than 10 deg at 20 cps. There is less than 3 per cent change in gain from 50 F to 120 F. Input impedance is greater than 100,000 ohm.

Microdynamics Div., Plas-Kem Electronics Corp., Dept. ED, 100 W. Alameda Ave., Berkeley, Calif.

CIRCLE 166 ON READER-SERVICE CARD

Switch

Designed for high voltage use



This hermetically sealed rotary selector switch is rated at 1650 v dc and 20 ma. Other characteristics are: 28 v dc operating voltage; 2.3 amp coil current at rated voltage; hi-pot rating of 2000 v with maximum leakage of 1 μ a.
G. H. Leland, Inc., Dept. ED, 123 Webster Dayton 2, Ohio.

CIRCLE 167 ON READER-SERVICE CARD

Precision Potentiometer

Linearity of 0.015 per cent

Model MST-150 single turn potentiometer is a precision unit with linearities to 0.015 and resolution compatible with linearity. Dissipation at 100 C is 8 w. Temperature range is 125 C continuous and 160 C short periods.
Analog Controls, Inc., Dept. ED, 39 Roselle Mineola, N.Y.

CIRCLE 168 ON READER-SERVICE CARD

Radar Picture Tube

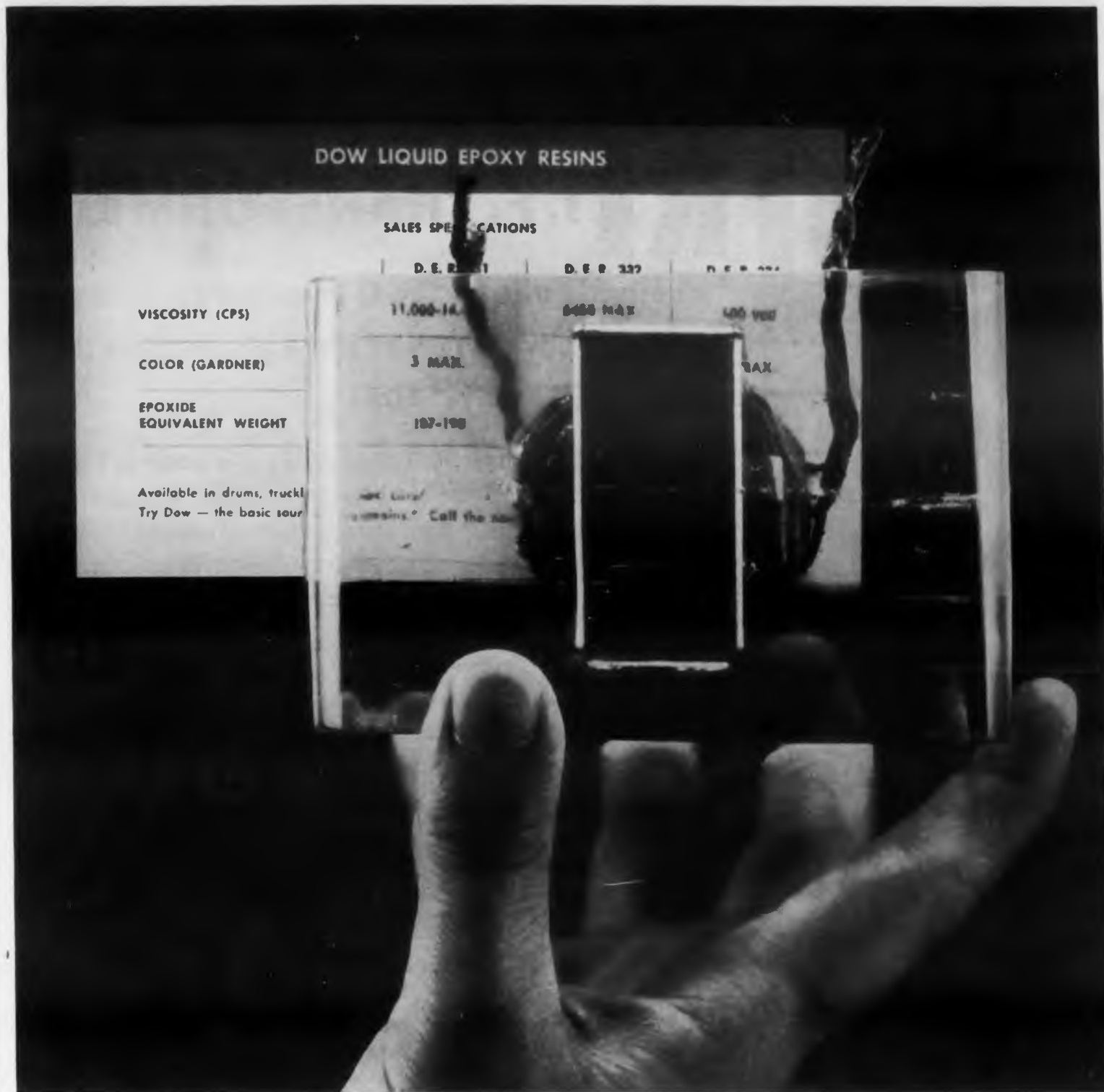
High resolution



The WX3751 high resolution radar picture tube produces 667 lines to the inch or a scanning line 0.0015 in. wide across the 5-in. faceplate. The faceplate is gray glass to increase contrast. The tube has a modified P-11 phosphor and a metal-backed screen to obtain maximum light output. An electrostatic deflection type, the tube is 13 in.

Westinghouse Electric Corp., Electronic Tube Dept., Dept. ED, P.O. Box 284, Elmira, N.Y.

CIRCLE 169 ON READER-SERVICE CARD



This hand-poured casting was not evacuated to remove bubbles.

See for yourself the clarity of new Dow Epoxy!

This unretouched photo demonstrates how easy it is to see through several inches of Dow Epoxy Resin 332—and thus how easy it is to visually inspect parts which are encapsulated in D. E. R. 332.

But a perfect inspection "window" is not the only advantage you get when you use D. E. R. 332 for encapsulation. Compared to ordinary epoxies, the high purity of D. E. R. 332 makes possible more uniformity, lower viscosity, longer pot life and greater heat resistance. Of special interest also for electrical applications, D. E. R. 332 and D. E. R. 331 are very low in total and hydrolyzable chlorides.

D. E. R. 331 is a standard unmodified resin designed for customary applications and D. E. R. 334 is a modified low-viscosity resin especially suited for laminating.

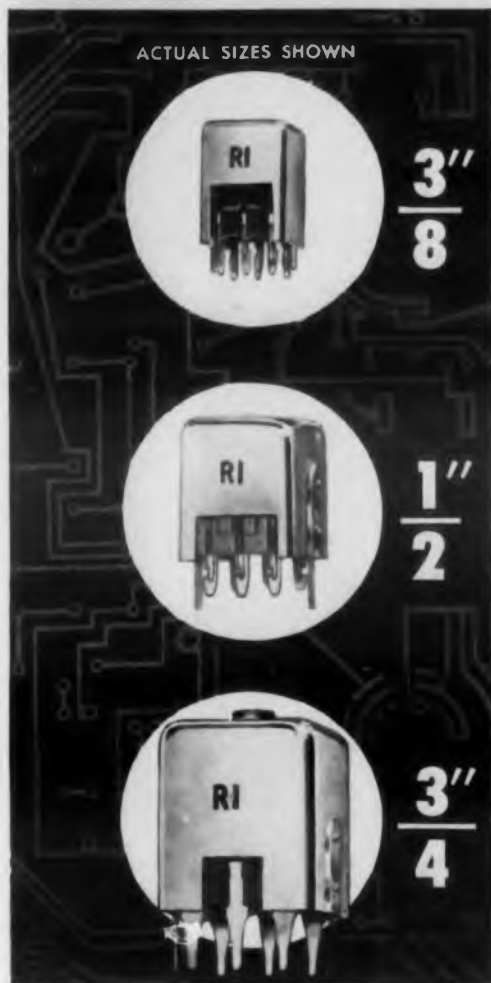
All three of these Dow Liquid Epoxy Resins are available for prompt delivery to you in drums, truck or tank car lots. For complete information on Dow liquid and solid epoxies and epoxy novolaks, call your nearest Dow sales office. Or write THE DOW CHEMICAL COMPANY, Midland, Michigan, Coatings Sales Dept. 2262P.

YOU CAN DEPEND ON

CIRCLE 170 ON READER-SERVICE CARD



for your transistorized circuits . . .



RI I.F. TRANSFORMERS

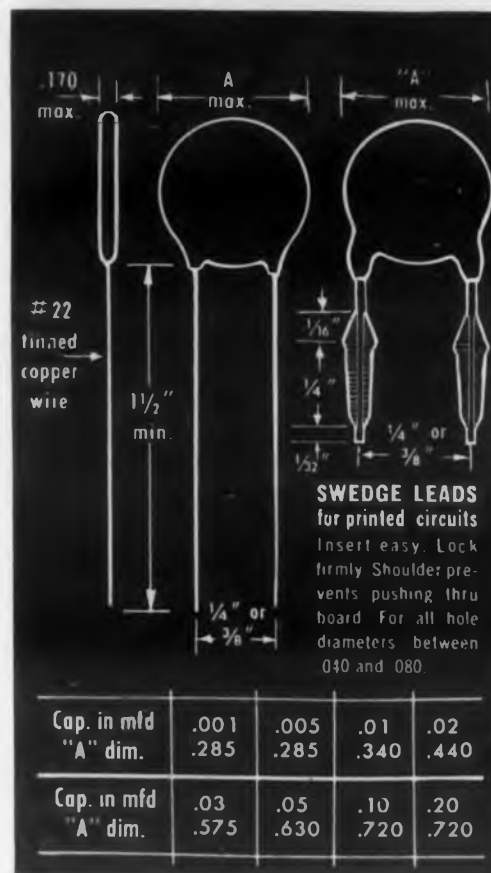
custom-built to the Q you require with the low cost advantages of mass production . . . in 3/8", 1/2" and 3/4" sizes

Whether your circuit requires a high Q for performance or a low Q for greater stability, Radio Industries will engineer and manufacture I.F. transformers to meet any specific level you require, up to 200 for the 3/4" and 1/2" and up to 140 for the 3/8". RI transformers have the shunt capacitors built in to meet your requirements.

Available in a variety of terminal styles for wired and printed circuits.



for your transistorized circuits . . .



RI ceramic DISC CAPACITORS

unique copper plating process lowers production costs

The Radio Industries patented Kemetal copper plating process provides copper electrodes that assure greater adhesion and freedom from migration. Another special RI process makes possible the unusual thinness of these capacitors, to meet the need for increased capacitance in a smaller size.

With a power factor of 3% maximum at 1 KC, RI-caps have a working voltage of 30 volts DC with a minimum I.R. of 1000 megohms contingent upon capacity values. Capacitance tolerances are available in +100% -20%, ±20%, ±10%.

Write for complete description and details



RADIO INDUSTRIES, INC.

666 Garland Place • Des Plaines, Illinois

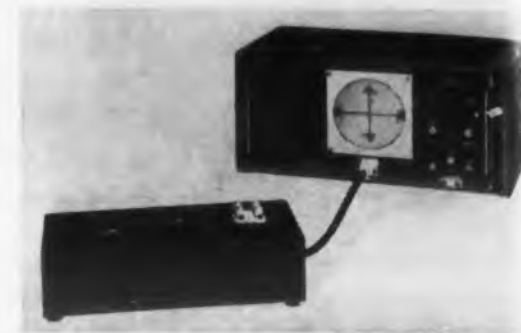
3 modern plants: Chicago, Des Plaines, and Marshall, Ill.

CIRCLE 171 ON READER-SERVICE CARD

NEW PRODUCTS

Comparator

Permits fast production testing



Type 265-A Q is available for fast production testing of coils, capacitors, and resistors. The comparator provides comparison measurements of relative Q, inductance and capacitance with ease and accuracy. No operator tuning or adjustment is necessary. Measurement is by means of a dot in the center of the crt. Any dot which does not appear at the center of the crt indicates that the component under test is different than the standard. Deviation along the vertical axis shows a change in Q, and deviation along the horizontal axis shows a change in L or C.

Boonton Radio Corp., Dept. ED, Boonton, N.J.

CIRCLE 172 ON READER-SERVICE CARD

Linear Actuator

860-lb normal load



Adaptable for a wide range of aircraft, missile ordnance, and industrial applications, the Model D-1890 linear actuator operates under a normal load of 860 lb at a rate of 0.28 ips. The maximum operating load is 1800 lb. The basic stroke is 2.50 in. can be lengthened or shortened to suit requirements. The unit features a radio noise filter, adjustable travel limit switches, integral thermal overload protection, an electromechanical clutch brake for low overtravel and inoperability, and positive nonjamming mechanical stops.

Hoover Electric Co., Dept. ED, 2100 S. Stoneman Ave., Los Angeles 25, Calif.

CIRCLE 173 ON READER-SERVICE CARD

Miniature Relay

Weighs less than 1/2 oz.

Measuring less than 1 in. long and weighing less than 1/2 oz, type S-M relay is designed for continuous use in a -65 to +125 C temperature range. Life expectancy is 100,000 operations minimum, at rated load. Specifications include: nominal coil voltage 26.5 v dc; contact arrangement, 2 pdt; contact rating, 2 amp at 28 v dc reverse; maximum operate time 4 msec; maximum release time 3 msec; maximum contact bounce 1 msec operating shock 50 g for 11 msec; vibration, 20 g to 2000 cps. The unit meets MIL-R-18 and MIL-R-5757C.

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

CIRCLE 174 ON READER-SERVICE CARD

Pulse Transformers

Plug-in types with four windings



Types PT-82 and PT-91 pulse transformers are designed to plug into standard noval sockets. The units may be used for isolation, coupling or blocking oscillator circuits. The four windings may be connected in various ways for impedance matching.

Berkshire Laboratories, Dept. ED, 964 Bank St., Greenville, N.H.

CIRCLE 175 ON READER-SERVICE CARD

Resistance Averaging Unit

Independent of number of resistors

This system for averaging resistors in parallel is designed for applications where it is necessary to continue averaging as individual resistors are in or out of the circuit (e.g. resistance thermometers). The basic principle of operation is base angle measurement and the unit does not incorporate any relays or other moving parts. Accuracies obtained are within ± 3 when as many as 50 of the resistors are cut out of the circuit. Several designs have been developed whereby other magnetic amplifiers, vacuum tubes, or resistors are utilized.

The B.G. Corporation, Dept. ED, 321 Broad St., Bridgfield, N.J.

CIRCLE 176 ON READER-SERVICE CARD



Sylvania develops cast germanium and silicon discs for more efficient infrared detection systems

GERMANIUM AND SILICON LENSES, ground from optical blanks cast by Sylvania, are finding wider application in the infrared detection systems in today's missiles and aircraft. These semiconductor materials are transparent to wave lengths above 7 microns where other materials, such as quartz, are opaque.

Sylvania's Chemical & Metallurgical Division now offers cast discs of polycrystalline germanium in sizes as large as 8 1/2 inches in diameter and 6 inches thick. Even larger sizes are being developed to meet the needs of detection system manufacturers. Cast sili-

con discs, too, are available for infrared use. Silicon, which weighs less than germanium, is finding growing acceptance in airborne systems. Other factors, such as the maintenance of infrared transmission characteristics at higher temperatures are of particular interest.

Through constant research and close cooperation with industry, Sylvania is continually improving its products to meet the needs of all areas of electronics. This is a basic reason why Sylvania has become a leading source for both silicon and germanium for all applications.

TUNGSTEN • MOLYBDENUM • CHEMICALS • PHOSPHORS • SEMICONDUCTORS

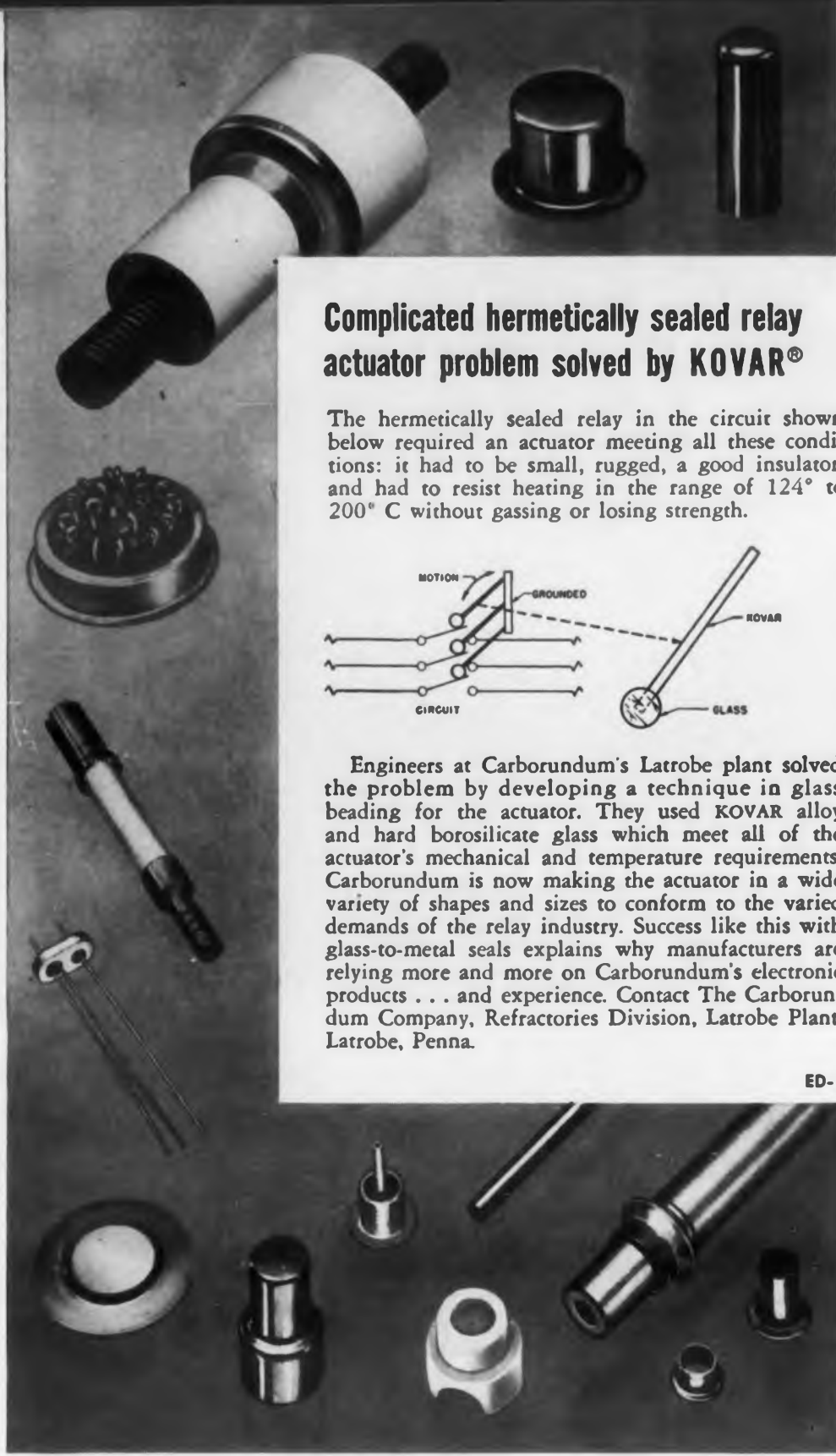


SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
Chemical & Metallurgical Div.
Towanda, Penna.

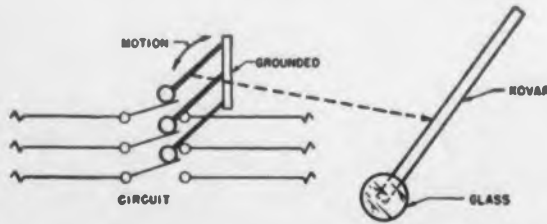
LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • CHEMISTRY-METALLURGY

CIRCLE 177 ON READER-SERVICE CARD



Complicated hermetically sealed relay actuator problem solved by KOVAR®

The hermetically sealed relay in the circuit shown below required an actuator meeting all these conditions: it had to be small, rugged, a good insulator, and had to resist heating in the range of 124° to 200° C without gassing or losing strength.



Engineers at Carborundum's Latrobe plant solved the problem by developing a technique in glass beading for the actuator. They used KOVAR alloy and hard borosilicate glass which meet all of the actuator's mechanical and temperature requirements. Carborundum is now making the actuator in a wide variety of shapes and sizes to conform to the varied demands of the relay industry. Success like this with glass-to-metal seals explains why manufacturers are relying more and more on Carborundum's electronic products . . . and experience. Contact The Carborundum Company, Refractories Division, Latrobe Plant, Latrobe, Penna.

ED-1

Precision Engineered Electronic Products

CARBORUNDUM

Registered Trade Mark



CERAMIC RESISTORS

VARISTORS

THERMISTORS

CIRCLE 178 ON READER-SERVICE CARD

NEW PRODUCTS

DC Voltage Regulator

Provides 20 v dc power



Model PR-10 is a completely transistorized dual dc voltage regulator capable of operation under extremes of shock and vibration. It is designed to provide a stable positive and negative 20 v dc power source for as many as 30 TSO-200B voltage-controlled sub-carrier oscillators. The unit is sealed against fungus and humidity.

United Electrodynamics, Dept. ED, 1200 S. Marengo Ave., Pasadena, Calif.

CIRCLE 179 ON READER-SERVICE CARD

Voltmeters

Accuracy ± 3 per cent



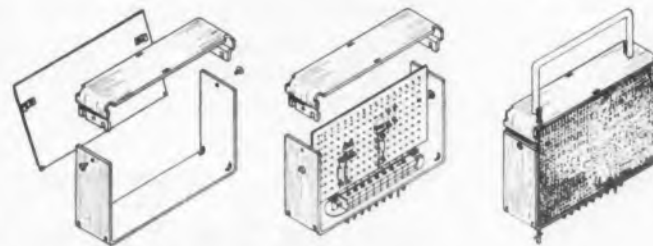
The dc voltmeters offer seven discrete voltage ranges from 1 to 1000 v. Accuracy is ± 3 per cent. The ac voltmeter has broad frequency response, from 20 cps to 100 kc. Full-scale ranges are provided in 10 db steps from 10 mv to 300 v.

Metronix, Inc., Dept. ED, Chesterland, Ohio.

CIRCLE 180 ON READER-SERVICE CARD

Plug-in Case

Metal enclosure simplifies design



A small metal enclosure, called a Frame-Loc, has recently been made available. All sides are flush and the case is provided with snap-out side



to .001

NESOR offers a complete range of fine wire in all Ferrous, Non-Ferrous, and Precious Metals. We are specialists in the fabrication of special wires for the stringent requirements of *Semi-Conductors* (Transistors, Diodes, etc.).

Other specialties are: High purity aluminum—99.999% for *silicon rectifiers*. Tinned and bare wire supplied; wire also cut to precision sizes for leads.

Metals and Alloys in Stock:

- Aluminum and Alloys
- Brass and Alloys
- Phosphor Bronze
- Copper: Bare, Tinned, Silver Plated.
- Lead and Solder Alloys
- Monel, Monel-Nickel, Nickel
- Steels: Copper Coated, High and Low Carbon, and Stainless

ELECTRO-PLATING SERVICE:

Ultra-modern plating facilities for wire, ribbon, and component parts. Tin, copper, nickel, indium, and precious metals can be plated over base metals to your specifications.

The
**NESOR
ALLOY
PRODUCTS CO.**

Mfr. of Fine Wire and Ribbon,
Braid and Strand
286 Halsey St., Newark 2, N. J.
Telephone: Mitchell 2-1682, 3, 4
In NYC Phone: Dlgby 4-9890

CIRCLE 181 ON READER-SERVICE CARD

making the case particularly suitable for resistor circuitry in small pluggable units. The is made in a wide variety of sizes and finishes. Internal terminal structures may be printed on suit panels or the company's wall, decks, or metal posts can be supplied. Where ventilation is essential, the side panels can be omitted, or perforations can be used. A variety of plug types are optional.

Victor Electronic Co., Dept. ED, 1100 Flower Glendale 1, Calif.

CIRCLE 182 ON READER-SERVICE CARD

Multicoder

Accepts up to 88 mv inputs



This transistorized pulse duration multicoder accepts up to 88 ten mv full scale differential inputs. The unit, termed model MC-G90X10, provides any of the standard PDM frame and computation rates of 30 x 30, 45 x 20, or 90 x 10 at the turn of a selector switch. Input full scale ranges of 10, 20, 50, 100, and 500 mv are selectable by means of a front panel switch.

Laake & Co., Dept. ED, 1632 Pico Blvd., Santa Monica, Calif.

CIRCLE 183 ON READER-SERVICE CARD

Magnetic Tape Transport

Speeds of 7.5 and 3.75 in. per sec



Equipped for automatic or manual operation, magnetic tape transport is designed for forward and reverse operation at speeds of 7.5 and 3.75 in. per sec. The Series 610 is provided with forward and rewind speeds of 2400 ft in two

American Electronics, Inc., Data-Tronics Div., Dept. ED, 655 W. Washington Blvd., Los Angeles 15, Calif.

CIRCLE 184 ON READER-SERVICE CARD

GLOBE BASIC A.C. MOTOR PACKAGES

TYPE SC
60- 400- or variable frequency
1. 2 or 3 phase
2. 4 or 6 pole
induction or hysteresis synchronous

49 standard gear ratios from 2.56:1 to 36,873:1
clutches, brakes and clutch brakes available

TYPE MC
60- 400- or variable frequency
1. 2 or 3 phase
2 or 4 pole
induction or hysteresis synchronous

129 standard gear ratios from 2.56:1 to 46,656:1
clutches, brakes and clutch brakes available

TYPE FC
60- 400- or variable frequency
1. 2 or 3 phase
2. 4 or 6 pole
induction or hysteresis synchronous

102 standard gear ratios from 4:1 to 3,000,000:1
right angle gear units
clutches, brakes and clutch brakes available

GLOBE A.C. MOTORS / GEAR REDUCERS / PACKAGES

In precision miniature motors, gear reducers, and small-package devices using clutches, brakes, and other components, Globe Industries has the hardware to meet your requirement. From a single source you can get fast 2 to 4 week prototype delivery of standard units. Modular design, interchangeable precision parts, and an efficient special order department are specific, unique reasons why you get what you need before your design grows cold.

Three basic A.C. motors are shown above. With their integral gear reducers they reliably span the torque range to more than 2000 in. oz. Custom modifications are a specialty.

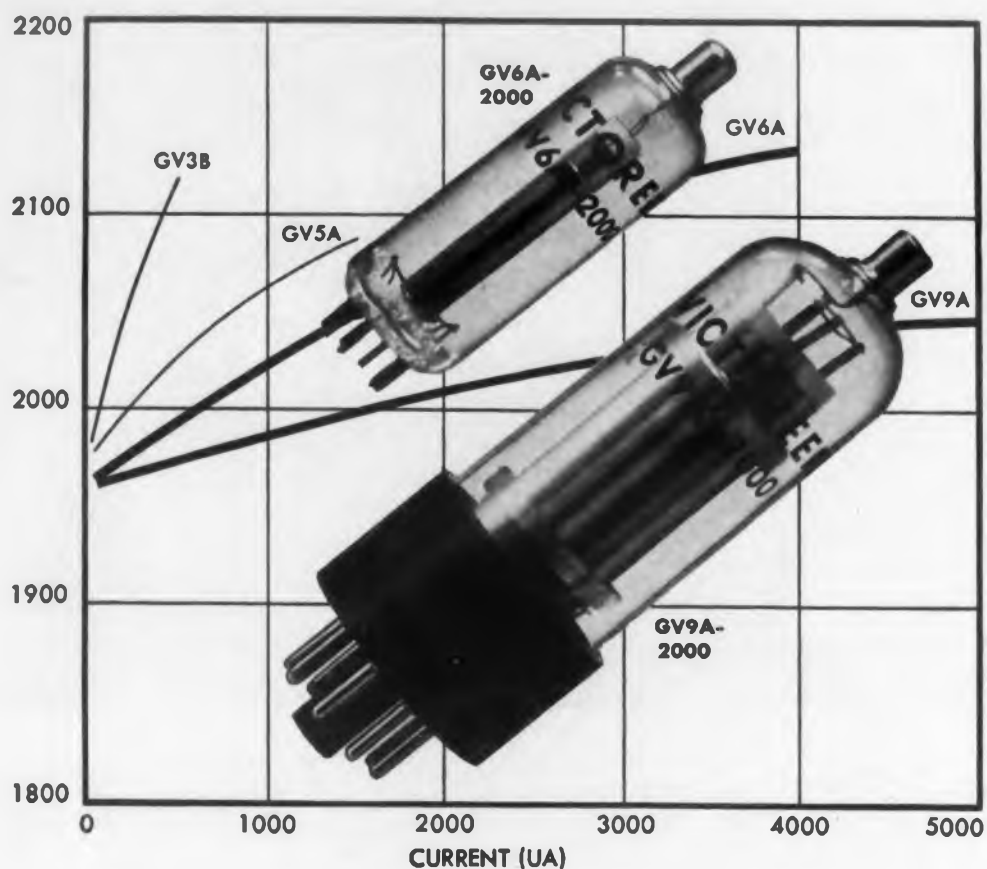
Globe motor packages were chosen for the Army's Jupiter C, and as you read this, at least one such package is circling the earth. Ask the largest precision miniature motor manufacturer first. Request the Globe A.C. Motor Catalog now. GLOBE INDUSTRIES, INC., 1784 Stanley Avenue, Dayton 4, Ohio. Baldwin 2-3741.

CIRCLE 185 ON READER-SERVICE CARD



NOW... from Victoreen

CORONA TYPE HIGH VOLTAGE REGULATORS WITH CURRENT CAPABILITIES AND SLOPES NEVER BEFORE OBTAINABLE



- Maximum currents to 4 ma
- Peak currents to 9 ma
- Regulation to 1.5%/ma
- Voltages from 400 to 3000
- 9 pin and octal base tubes
- In use by the military

Make Victoreen your headquarters for high voltage regulation. Send for Form 2022A and Form 2023A describing the GV6A and GV9A line of corona type voltage regulators.

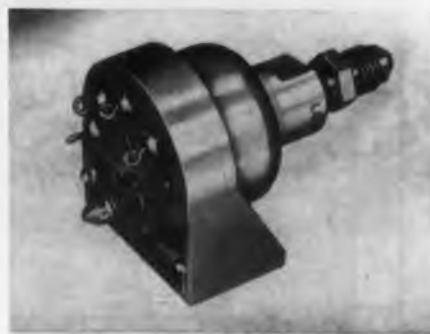


See us at WESCON, Booth 1542
The Victoreen Instrument Company

Components Division
5806 Hough Avenue • Cleveland 3, Ohio
CIRCLE 186 ON READER-SERVICE CARD

NEW PRODUCTS

Bourdon-Tube Transducer High resolution



With the Model 461227 Bourdon-tube pressure transducer resolution of up to 400 wires is obtained. Covering pressure ranges from 200 to 10,000 psi, the unit is suitable for measuring noncorrosive liquid or gas pressure in airborne applications.

G. M. Giannini & Co., Inc., Dept. ED, 918 E. Green St., Pasadena 1, Calif.

CIRCLE 187 ON READER-SERVICE CARD

Relay Meter

Controlled by true rms



Model 1094 Sensitrol relay deflects in proportion to the true rms of the impressed current or voltage. Offered with either one or two preset contacts and in current or voltage ranges, the unit is designed for applications in over and/or under current or voltage control and alarm.

Weston Instruments Div., Daystrom, Inc., Dept. ED, Newark 12, N.J.

CIRCLE 188 ON READER-SERVICE CARD

Pulse Sorter

Controls random inputs



Although the reversible counting of the model 111A binary counter is automatic, the feedback

WHO IS BORG

George W. Borg, who founded the George W. Borg Corporation, is the "Mr. Clutch" who started with Borg & Beck. He helped organize the Borg-Warner Corporation of which he became president. Later he served as a member of the board until he resigned to devote his full attention to the George W. Borg Corporation.

THE GEORGE W. BORG CORPORATION

BORG PRODUCTS DIVISION

BORG FABRICS DIVISION

BORG EQUIPMENT DIVISION

The George W. Borg Corporation is comprised of three divisions

- **Borg Products Division**
Manufactures automotive clutches
- **Borg Fabrics Division**
Manufactures deep-pile fabrics, the best known of this line is the fashionable "Borgana" fabric
- **Borg Equipment Division**
Manufactures Micropots (precision potentiometers), Microdials (precision turn-counting instruments), motor standards, aircraft navigation instruments and component systems.



HOW BORG EQUIPMENT DIVISION CAN HELP YOU...

Borg's background of experience can save you time and money by helping you solve design and production problems of electronic components. Whether you are faced with a special problem or interested in a standard component, call Borg Equipment Division for an economically sound solution. Write today for catalog BED-A90.



BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

CIRCLE 189 ON READER-SERVICE CARD

BORG 205 SERIES MICROPOTS...



OFFER DEPENDABLE, LIFETIME PRECISION!

Borg 205 Series MICROPOTS have given themselves exceptionally rugged and dependable. They have ten years of service in many different mobile and stationary applications for both military and commercial uses. They're readily available, too, as Borg's modern production facilities assure prompt delivery in any quantity. Write for the name of your nearest Borg Jobber or "Tech-Rep". It will help you to know him.

Check These Advantages...

- Fine resolution because of $43\frac{1}{2}$ " Kohlrausch winding in the helical element!
- Accurate setting and resetting due to anti-backlash spring in contact guide!
- Permanent accuracy because resistance wire is moulded integrally with housing!
- Long life because slider-contact is the only moving member that touches the resistance element.

Write for Catalog
BED-A90



BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

CIRCLE 190 ON READER-SERVICE CARD

pulses may occur at random or coincidental with the command pulses. The pulse sorter 136A is the answer to this problem. It is connected in series with both the forward and reverse inputs to the counter and blanks both pulses, should they occur within 5 μ sec of each other.

Navigation Computer Corp., Dept. ED, 1621 Snyder Ave., Philadelphia 45, Pa.

CIRCLE 191 ON READER-SERVICE CARD

Power Supply

For strain gage excitation



Model SR-200A power supply is designed especially for strain gage excitation. The unit features floating output, less than 10 μ v of noise from the dc output to ground when used with a grounded strain gage, and 0.1 per cent regulation for line voltage changes from 95 to 135 v. The dc output is continuously variable from 5 to 12. Maximum output current is 200 ma.

Video Instruments Co., Inc., Dept. ED, 3002 Pennsylvania Ave., Santa Monica, Calif.

CIRCLE 192 ON READER-SERVICE CARD

Delay Line

High delay-rise time ratio



Model 1D1 lumped constant ferrite delay line provides a high ratio of delay/rise time/number of sections through elimination of the leakage flux linkages in the cup cores. Whereas formerly a twelve section line had a delay/rise time ratio of 8, the new line has a ratio of 9.3 for twelve sections. Temperature coefficient is 25 ppm per deg C. Normal production tolerances on delay are 1 and 2 per cent on characteristic impedance.

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

CIRCLE 193 ON READER-SERVICE CARD

WAVE GUIDE COMPONENTS

by Kennedy



All Kennedy wave guide components for microwave applications are precision engineered to attain the highest level of performance, with highest transmitted power, lowest standing wave ratio. They are fully tested for trouble-free operation.

- **COMPLETE FEED SYSTEMS** designed and installed. For any antenna, anywhere.
- **HORNS** — both single and dual polarization. Exceptional low VSWR.
- **TRANSITIONS** — better bandwidth and lower VSWR.
- **DUPLEXERS** — rejection ratios better than 100 db
- **STRAIGHT SECTIONS** — Length 3" to 20'
- **BENDS** — E-plane or H-plane
- **COMPLETE HARDWARE** and accessories

For the most efficient use of your antenna, let Kennedy engineers design your feed system. Complete, detailed specification data is yours for the asking. Write today for your free copy of the handy file size Kennedy Antenna Equipment folder.



CIRCLE 194 ON READER-SERVICE CARD

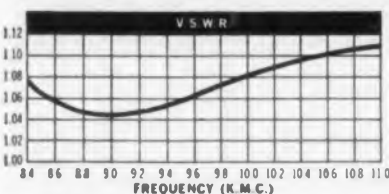
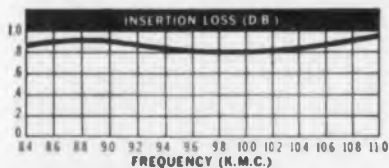
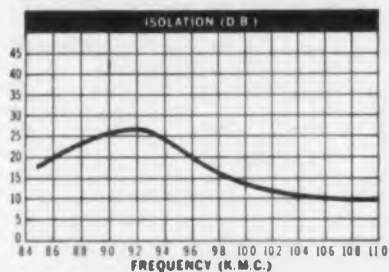
REDUCE INSERTION LOSS!!
INCREASE USABLE POWER!!

NEW

Kearfott
MIDGET
FERRITE
ISOLATOR



Typical Performance Curves



Kearfott



KEARFOTT COMPANY, INC.
MICROWAVE DIVISION
DEPT. 10E, 14844 OXNARD ST.
VAN NUYS, CALIF.

CIRCLE 195 ON READER-SERVICE CARD

**MAXIMUM FREQUENCY STABILITY
WHERE SPACE IS LIMITED...**

A high power unit of exceptionally small size and weight, this newest Kearfott product is the answer to microwave circuitry applications where space is limited.

IMPORTANT FEATURES:

BROAD FREQUENCY RANGE—from 8.5 to 9.6 KMC

HIGH ISOLATION—Minimum of 15 DB

INSERTION LOSS—Only 1.0 DB Maximum

SMALL SIZE—1.000" deep x 2.100" high x 2.400" high

POWER—Average 200 Watts

TEMPERATURE-AMB—150°C

PRICE—\$135.00 each f.o.b., Van Nuys, Calif.

Quantity prices on request

DELIVERY—from stock

OTHER STANDARD Ferrite Isolators and Duplexers in a wide range of sizes and band widths are available plus facilities to produce special configurations if desired. Our sales engineers can help you.

SALES OFFICES:

Eastern Office:
1378 Main Avenue
Clifton N.J.

Midwest Office:
23 W. Calendar Avenue
La Grange, Ill.

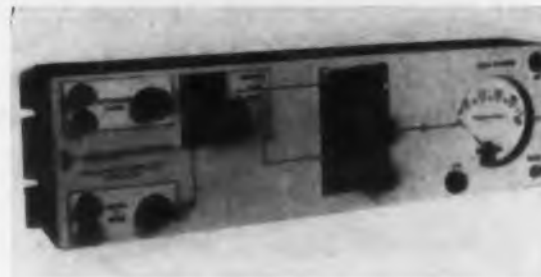
South Central Office:
6211 Denton Drive
Dallas, Texas

Northwest Area Office:
530 University Avenue
Palo Alto, California

NEW PRODUCTS

Signal-Noise Correlator

Takes dynamic measurements



Model I-101 signal-noise correlator can be used to make dynamic signal-to-noise measurements at the outputs of various types of communications equipment such as receivers, amplifiers, magnetic tape systems, etc. The signal-to-noise ratio can be measured without removing either the signal or the noise.

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

CIRCLE 196 ON READER-SERVICE CARD

Encapsulation Cups

For cores and laminations



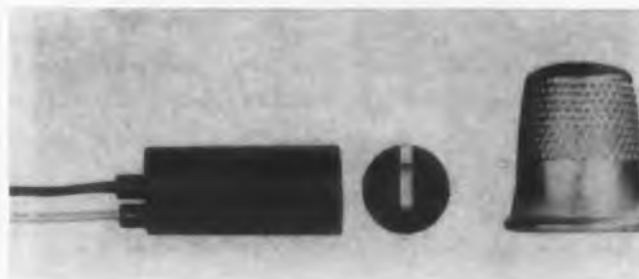
Designed to fit standard cores and laminations, these encapsulation cups permit the component to be placed closer to the container wall due to their arc resistance. The cups are made of glass-filled diallyl phthalate.

Electronic Production & Development, Inc., Dept. ED, 138 Nevada St., El Segundo, Calif.

CIRCLE 197 ON READER-SERVICE CARD

Moving Coil Indicator

Measures 7/16 in. diameter



Model HCM 7/16 core magnet moving coil indicator measures 7/16 in., permitting it to be in-

NOW...1 to 80
polaroid exposures
in ONE loading
with the newest
**BEATTIE
OSCILLOTRON!**



LABORATORY recording of oscilloscope traces is far more efficient with this new camera.

Key to the versatility of the new Beattie Oscilloscope camera with a polaroid back is the feather-touch Multiple Exposure Positioning Bar. Now you can get one-to-one presentation or up to 10 exposures on a



single frame—by a simple adjustment. Other features: f/1.9 lens, shutter speeds from 1 sec. to 1/100 sec., time, and bulb.

This new Oscilloscope camera fits the same periscope to which all other Beattie Oscilloscope cameras are attached.

Multiple Exposure Positioning Bar

for more information write to

**B BEATTIE-
C COLEMAN**

1000 N. Olive St., Anaheim, California

CIRCLE 416 ON READER-SERVICE CARD

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THE
CARAVAN!**



Ontario
in SOUTHERN CALIFORNIA

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INDUSTRIAL PARK**

... a part of the forward move to the
... planned-with-a-future 2000 acre industri-
... park in the very heart of ever-expanding
... Southern California. Ready now for
... occupation is plenty of zoned, low-cost
... industrial land with development care-
... fully guided by an extensive plan of
... ample 88' and 100' roadways, railroad
... mill tracks to major railways, ample
... sewage and complete utilities services.
... bounded on two sides by four-lane super
... state highways, the acreage is 1 1/2%
... uniform sloping land with 3000 pound
... bearing pressure per square inch. Cen-
... tralized location puts you minutes away
... from Metropolitan Los Angeles and all
... outboard points.

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... a promised future

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... ASSOCIATION OF COMMERCE AND INDUSTRY, INC.
... 106 West "B" Street, Ontario, California

NAME.....
TITLE.....
BUSINESS.....
ADDRESS.....

CIRCLE 417 ON READER-SERVICE CARD

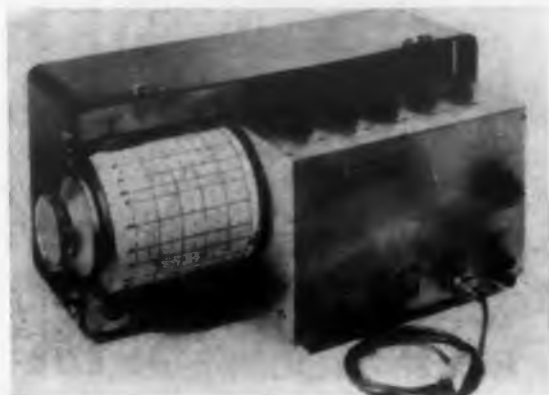
corporated within other meters to indicate such information as alarm, position, or malfunction. Hermetically sealed, the indicator is available with either flag or pointer display, and in a variety of electrical sensitivities and functions.

Marion Electrical Instrument Co., Dept. ED, Grenier Field, Manchester, N.H.

CIRCLE 418 ON READER-SERVICE CARD

Audio Response Plotter

Direct-reading indication



The ARP-1 audio response plotter gives immediate visual proof of performance of any audio system or component, by indicating whether the system provides equal amount of acoustical energy per octave. Records are plotted on a 40 db-range logarithmic chart by a high-torque, dry-writing, servo-controlled pen.

Southwestern Industrial Electronics, Dept. ED, 2831 S. Post Oak Rd., Houston, Tex.

CIRCLE 419 ON READER-SERVICE CARD

DC Digital Voltmeter

Includes 5 digit display



Model DVA-500 dc digital voltmeter consists of a DVX-500 switch module and a DXA-000 power module. The power module is transistorized and features internal modular construction. Specifications of the new instrument include a 5 digit display, automatic ranging and polarity, 0.0001-999.99 range and 0.01 per cent accuracy, ± one digit. Stability is better than 0.01 per cent.

Electro Instruments, Inc., Dept. ED, 3540 Aero Court, San Diego 11, Calif.

CIRCLE 420 ON READER-SERVICE CARD



**Engineers who don't know
"It Can't be Done that Way!"**

General Electric's Jet Engine Dept. at Cincinnati now conceives and designs its own Jet Engine controls, accessories, and components, also designs its own test instruments and instrumentation systems. This has created many new positions to be filled, and we have immediate openings for graduate engineers with experience in any of the following fields:

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| INSTRUMENTATION SYSTEMS | ACTUATION DEVICES |
| ELECTRONIC CIRCUITRY | RELAY CIRCUITS |
| INSTRUMENT DESIGN | HYDRAULIC COMPONENTS |
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| AERODYNAMICS | SERVO MECHANISMS |
| ELECTRONIC PACKAGING | FUEL CONTROLS |
| MAGNETIC AMPLIFIERS | LUBE SYSTEMS |
| AIRCRAFT SURFACE CONTROLS | |

These are career jobs and they pay well for engineers willing and able to work on brand new problems and come up with new answers. Actually, you'll be finding answers that will appear in Tomorrow's textbooks!

If you like the challenge of new problems . . . if you like to work where Engineers don't know "it can't be done that way" . . . fill out the coupon below and mail to

J. A. McGovern, Jet Engine Dept. ED-79
General Electric Co., Cincinnati 15, Ohio

Gentlemen: I am interested in the possibility of an association with the Jet Engine Dept. of General Electric.

Name _____

Address _____

City _____ Zone _____ State _____ Phone _____

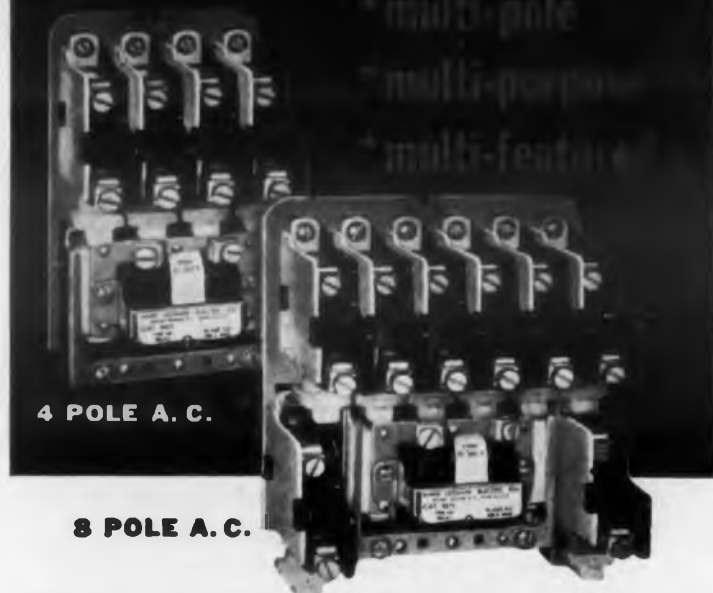
Degrees _____ College _____ Date _____

My field of interest is: _____

ED-79

GENERAL ELECTRIC
JET ENGINE DEPARTMENT CINCINNATI 15, OHIO
CIRCLE 559 ON READER-SERVICE CARD

new HIGH-RELIABILITY RELAYS



4 POLE A. C.

8 POLE A. C.

Brand new, Type HR solenoid relays are Result-Engineered to function as the "heart" of any control system. The Type HR is designed as a multi-pole relay for piloting machine and process control components where ultra-long life and hi-speed operation are mandatory.

Wiping action contacts insure high electrical reliability; nylon movable contact carriers and armature guides minimize operating friction.

Simple, fast, easy installation speeds assembly into your equipment, saves time, cuts cost. Accessible front connected coil and contact terminals equipped with pressure connectors . . . no lead lugging needed!

Four basic models, up to eight *unitized* poles, convertible N.O. or N.C. contacts, completely enclosed, make the HR an unusually versatile relay line.

Write for Ward Leonard Bulletin 4470. Ward Leonard Electric Co., 77 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada Ltd., Toronto.)

ENGINEERING DATA

CONTACT RATINGS: A.C.—10 amps., 600 V. max.; D.C.—6 amps., 115 V., 1 amp., 230 V.

COILS: A.C. 110, 208-220, 440, or 550 V., 50-60 cps. D.C. for 115 or 230 V. Others on special order.

POLES: 2 to 8, in all combinations of N.O. and N.C. Contacts convertible from N.O. to N.C. and vice versa.

DIMENSIONS: Maximum, 4 pole—3 $\frac{3}{8}$ "W, 5 $\frac{3}{4}$ "H, 3 $\frac{3}{32}$ "D. 8 pole—5 $\frac{1}{8}$ "W, 5 $\frac{3}{4}$ "H, 3 $\frac{3}{32}$ "D. Mounting centers for all models identical.

LIVE BETTER...Electrically

WARD LEONARD ELECTRIC CO.

Result-Engineered Controls Since 1892

RESISTORS • RHEOSTATS • RELAYS • CONTROLS • DIMMERS



CIRCLE 198 ON READER-SERVICE CARD

NEW PRODUCTS

Piston Potentiometer

Noise-free at 40 g vibration



This self-aligning linear motion potentiometer is capable of noise-free operation at 40 g, 10-2000 cps. The floating shaft of Model 157 permits free lateral movement of an actuator without side-load effect on the instrument. Error is less than 1/2 per cent when tested under the above vibration.

Bourns Laboratories, Inc., Dept. ED, Riverside, Calif.

CIRCLE 199 ON READER-SERVICE CARD

Modulator Monitor

Frequency range from 20 to 100 mc



Modulation monitor model 257B. measures total deviation of the carrier of fm transmitters when modulated by multiple sub-carrier oscillators. Frequency range is 20 to 100 mc and deviation measurements can be made from 0 to 1000 kc. The audio frequency range is flat within ± 1.0 db from 50 cps to 200 kc.

New London Instrument Co., Inc., Dept. ED, 82 Union St., New London, Conn.

CIRCLE 200 ON READER-SERVICE CARD

Flange Feed

Adjustable through 360 degrees



With 360 deg adjustable flange feed, this mounting flange adjusts polarization during in-

SODECO'S NEW Predetermining Impulse Counter

Compact

Measures only 3 $\frac{1}{4}$ " x 1 $\frac{1}{4}$ " x 3 $\frac{3}{8}$ "
Suitable for flush mounting



CONVENIENT PRESET —

Easily accessible setting wheels

FAST RESET — Manual, or electric for repeat cycling

S.P.D.T. PREDETERMINING SWITCH —

Less than 50 ms switching time

LOW POWER REQUIREMENT —

Counting at 10 i.p.s.—3.8 W; at 25 i.p.s.—5.1 W
Reset—7.6 W, all at 110 V. DC.

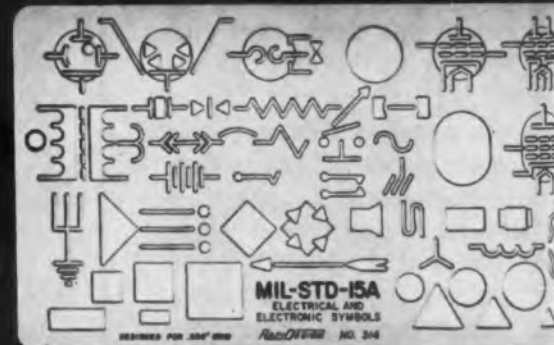
Write today for your
copy of Sodeco
Bulletin E-25 which
gives full technical
information.

LANDIS & GYR,

45 West 45th Street, New York

CIRCLE 201 ON READER-SERVICE CARD

MIL STD 15-A TEMPLATES



NO. 314 — 7" x 4" — .200 GR

NO. 315 — 8 $\frac{3}{4}$ " x 5" — .250 GR

\$4.00 AT YOUR LOCAL DEALER

Two of the more than 100
Rapidesign Templates—all of
which are better made and
more useful and lesser priced.

CATALOGUE NO. 60 AVAILABLE UPON REQUEST

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P. O. BOX 429, BURBANK, CALIFORNIA

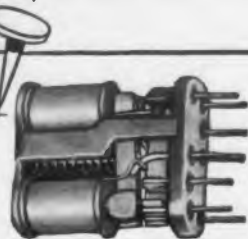
CIRCLE 202 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 9, 1967

EVERYTHING
UNDER CONTROL

GUARDIAN *Leadership*

in electromagnetic control began more than twenty-six years ago when Guardian became dedicated to the control of maximum power in minimum space. Here you see preferred standards of micro-miniature, sub-miniature and miniature control of today's aircraft, missiles and electrical industries.

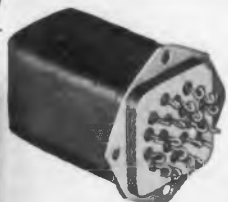


Series 1005 Micro-Miniature Control

L. 2 1/2" W. 2 1/2" D. 1 1/2"
(maximum)

3 Amp Double Pole, Double Throw. Meets or surpasses requirements for all specifications of MIL-R-25018 and MIL-R-5757C. No exceptions. Contact Rating: 3 Amps at 125° C. per MIL-R-25018; 2 Amps at 125° C. per MIL-R-25018 and MIL-R-5757C. Hermetically sealed. Specify plug-in or solder hooks.

\$5.90 each in lots of one thousand units
f.o.b. Chicago, Ill.



Series 2005 Sub-Miniature Control

L. 2 1/4" W. 1 1/2" D. 1 1/2"
(maximum)

5 Amp 6 Pole, Double Throw. Meets or exceeds MIL-R-6106B and MIL-R-5757C. Built to withstand 100 G shock. Vibration resistance is 10 G minimum from 75 to 2000 c.p.s. in all mounting planes. All contacts rated at 5 Amps 24 to 30 v. D.C., resistive load. Operates with voltage variations as low as 16 v. at 25° C., ambient.



Series 3205 Miniature Control

L. 2 1/2" W. 1 1/2" D. 1 1/4"
(maximum)

10 Amp 4 Pole, Double Throw aircraft and missile relay uses same size envelope as AN 3304 (4 P.D.T. 3 Amp relay) and is approximately the same weight. Designed to meet and exceed test requirements of MIL-R-6106B, Class B. Meets minimum current requirements of military specifications.

Write for circulars giving complete specifications

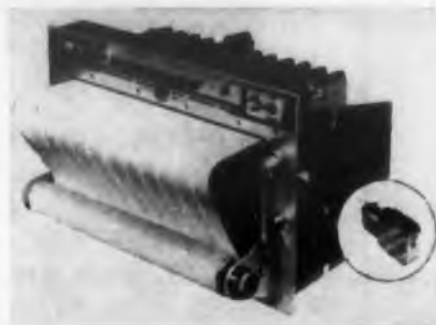
GUARDIAN ELECTRIC
MANUFACTURING COMPANY
1622-N W. WALNUT STREET, CHICAGO 12, ILLINOIS
CIRCLE 203 ON READER-SERVICE CARD

stallation or for alignment of center-fed, 7000 mc, Series B parabolic antennas. Insertable from the rear, it fits standard GED feed mounting bolts. The unit can be adjusted without removing nuts or bolts. Close tolerances permit accurate seating and positive clamping action, and there is no loss in rigidity over standard mounting flanges.

Gabriel Electronics Div., Dept. ED, Needham Heights, Mass.

CIRCLE 204 ON READER-SERVICE CARD

Rectilinear Recorder 12-channel



True rectilinear motion and good transient response are features of this 12-channel rectilinear recorder. Free of resonant peaks, overshoot, and ringing, the Model RE-12 has a frequency range from dc to 200 cps. Push button selection permits 18 chart speeds from 1/2 cm/hr to 200 mm/sec.

Massa Labs., Inc., Dept. ED, 5 Fottler Rd., Hingham, Mass.

CIRCLE 205 ON READER-SERVICE CARD

Memory Amplifier

Low standby current



Type 19 memory amplifier consists of an amplifier and bistable circuit. A relay load or any other may be connected from the output to ground. Upon application of a 50 mv trigger, full supply is applied to the load. The power continues to be applied until a reset pulse is connected to the reset line, when the power is removed from the load. A very low standby current allows the device to be connected for relatively long periods of time.

MF Electronics Co., Dept. ED, 122 E. 25 St., New York 10, N.Y.

CIRCLE 206 ON READER-SERVICE CARD

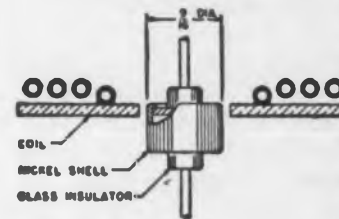
Lepel
HIGH FREQUENCY
INDUCTION
HEATING
UNITS

The Lepel line of induction heating equipment represents the most advanced thought in the field of electronics as well as the most practical and efficient source of heat yet developed for industrial heating.

If you are interested in induction heating you are invited to send samples of the work with specifications. Our engineers will process and return the completed job with full data and recommendations without any cost or obligations.

TYPICAL INDUCTION HEATING APPLICATIONS IN THE MANUFACTURE OF TRANSISTORS

SOLDERING TRANSISTOR ASSEMBLIES BY INDUCTION HEATING



Concentrator-type coil creates high intensity, restricted heating at joint of nickel shell and tinned glass, thus causing solder to flow for permanent seal.

SINGLE CRYSTAL PULLER



General arrangement for pulling single crystals. Induction heating coil is shown surrounding quartz tube containing crucible with molten germanium in suitable atmosphere.

MULTIPLE ZONE REFINING



Induction heating apparatus used in zone refining. The six coils shown provide simultaneous molten zones in the ingot as it passes through the tube containing the protective atmosphere.

Electronic Tube Generators from 1 kw to 100 kw.
Spark Gap Converters from 2 kw to 30 kw.

WRITE FOR THE NEW LEPEL CATALOG . . . 36 illustrated pages,
packed with valuable information.



All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission.

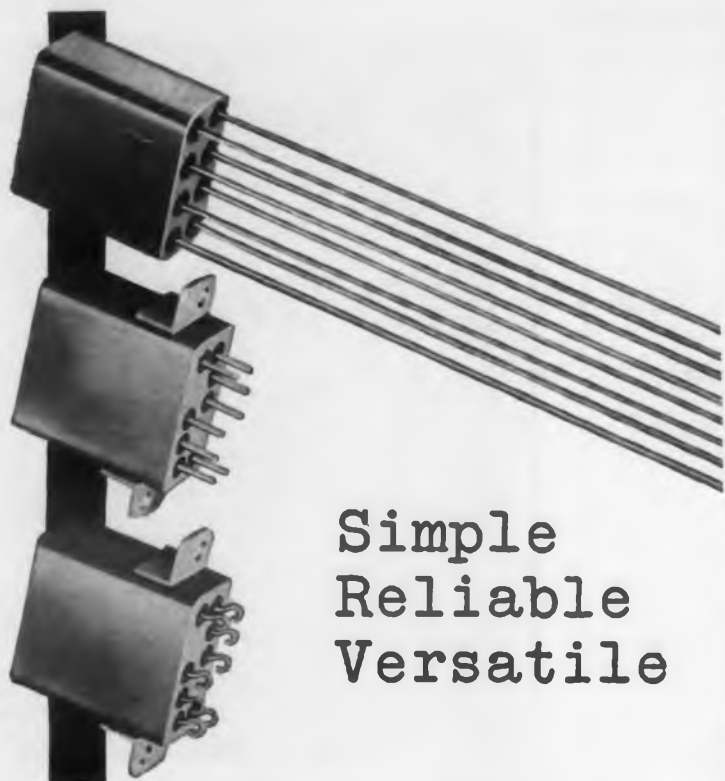
LEPEL HIGH FREQUENCY LABORATORIES, INC.

330 STREET 88th AVENUE WOODSIDE 77 NEW YORK CITY, N. Y.

CIRCLE 207 ON READER-SERVICE CARD

**NEW
LIGHT-
WEIGHT**

**Micro-
miniature
Relay**



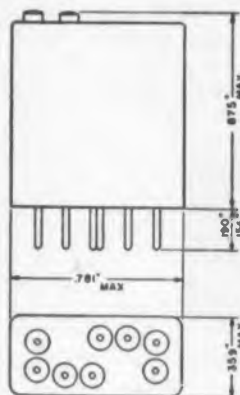
**Simple
Reliable
Versatile**

HUSKY STYLE 6

Price Electric's new Style 6 micro-miniature relay is a lightweight, crystal can style relay designed to give superior performance in miniaturized assemblies.

Weighing only 0.5 ounce, the Husky Style 6 is engineered for the utmost simplicity—a simplicity that allows for mass production of a high quality, reliable relay that is as versatile as it is dependable. Termination can be provided to meet most requirements. Style 6 meets the applicable requirements of military specifications and will perform continuously in ambients of -65C to $+125\text{C}$. This tiny Husky Relay will give excellent performance in guided missiles, computers, control systems, and other critical applications.

For further details write for Bulletin Number 10.



For Further
details write for
BULLETIN
NUMBER 10

Price Electric
CORPORATION

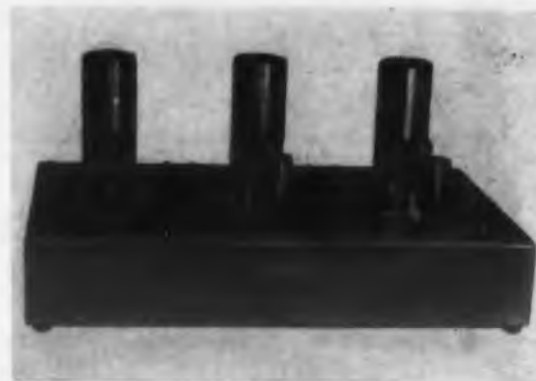
1500 Church St., Frederick, Maryland

CIRCLE 208 ON READER-SERVICE CARD

NEW PRODUCTS

Frequency Standards

Have cathode follower output



This line of frequency standards features a cathode follower output for long-term stability. Modules are available for any set frequency from 240 to 4000 cps, with accuracies up to ± 0.001 per cent. Output is 5 v rms, variable from 0 to 5 rms with external control.

The Gyrex Corp., 3003 Pennsylvania St., Dept. ED, Santa Monica, Calif.

CIRCLE 209 ON READER-SERVICE CARD

FERRITE ISOLATOR.—Model IXL10, for the frequency range of 9 to 10 kmc, is added to a line of X-band isolators. Length is 1.04 in.

Raytheon Mfg. Co., Dept. ED, Waltham 54, Mass.

CIRCLE 210 ON READER-SERVICE CARD

AC ACCELEROMETER.—The model GAH ac accelerometer is available in ranges from ± 0.1 to ± 20 g. Output is as high as 3 v per volt input.

Genisco, Inc., Dept. ED, 2233 Federal Ave., Los Angeles 64, Calif.

CIRCLE 211 ON READER-SERVICE CARD

ANCHOIC TEST CHAMBER.—A portable test chamber used for determining acoustical characteristics of miniature radio and audio equipment.

Industrial Acoustics Co., Inc., Dept. ED, 341 Jackson Ave., New York 54, N.Y.

CIRCLE 212 ON READER-SERVICE CARD

POSITION LIGHT FLASHER.—Model AFS-125 is designed to replace the C-2 flasher.

P. R. Mallory & Co., Inc., Dept. ED, 28 S. Gray St., Indianapolis 6, Ind.

CIRCLE 213 ON READER-SERVICE CARD

COAXIAL ATTENUATORS.—Models are available for 1000 to 11,000 mc, at 3, 6, and 10 db attenuation. 20 db models are available for 2000 to 11,000 mc. All have an impedance of 50 ohm.

Narda Corp., Dept. ED, Mineola, N.Y.

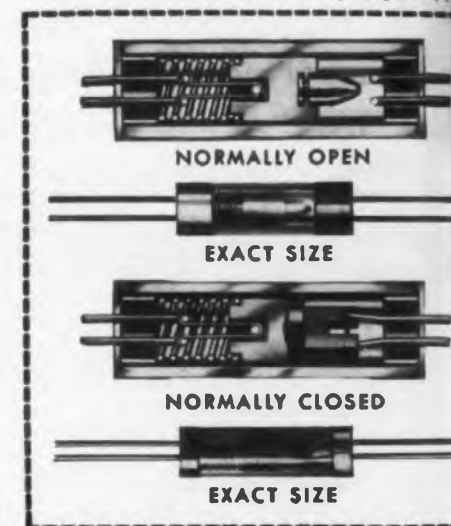
CIRCLE 214 ON READER-SERVICE CARD

MINIATURE THERMAL RELAYS

with
**99.99% Plus
Reliability**

**SERVICE-FITTED
SERVICE-TESTED
SERVICE-APPROVED**

*Our complete
environmental
testing laboratory
samples and certifies
daily production.*



New NORMALLY CLOSED RELAYS NOW AVAILABLE. They both meet or exceed requirements for guided missiles and complex electronic gear.

They are hermetically sealed by bonding headers to high thermal, shock resistant housings.

They open or close a circuit positively in 1/2 second or other delay times.

They can also be safely used as a "squib" timing mechanism.

Typical Characteristics

Temperature: -100°F. to $+450^{\circ}\text{F.}$
Vibration: 20-3000 CPS at 40 G's
Shock: 250 G's

Brochure containing complete characteristics and specifications available upon request.

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CORPORATION**

14806 OXNARD ST., VAN NUYS, CALIF.

Original designs for highest reliability in glass housed miniature Relays and Resistors for all purposes.

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**Crafted with Precision
for Reliability**



For critical military and industrial applications.

Hermetically sealed by bonding glass-kovar headers to high thermal, shock resistant glass housings. 100% humidity-proof.

NETWORKS' new, truly accurate, precision Resistors are available in 1/4, 1/2, 1 and 2 watt ratings at 105°C ±0.1 to 1%. Units for 125°C available on special order. Lug types or flexible leads. Test results prove substantial improvement over MIL specs. They combine remarkable stability, under load and on the shelf, with exceptionally low temperature coefficient.

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**Reliability
Conservative Ratings
Stable Characteristics**



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Sorensen & Co., Inc., Dept. ED, Richards Ave., S. Norwalk, Conn.

CIRCLE 217 ON READER-SERVICE CARD

SNAP ACTION SWITCH.—Has exact repeatability and stability in temperature and humidity conditions. Conforms to dimensional requirements of MS 25026.

Meletron Corp., Dept. ED, 950 N. Highland Ave., Los Angeles 38, Calif.

CIRCLE 218 ON READER-SERVICE CARD

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American Silver Co., Inc., Dept. ED, 36-07 Prince St, Flushing 54, N.Y.

CIRCLE 219 ON READER-SERVICE CARD

50-WATT TOROIDAL TRANSFORMER.—Input voltage is 115 v, 400 cps, single phase. Output voltage can be any from 1 to 1000 v. Standard units supplied for filament use, for synchro drive, isolation voltage, and plate voltage. Temperature is from -55 to +100 C.

Arnold Magnetics Corp., Dept. ED, 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

CIRCLE 409 ON READER-SERVICE CARD

SERVOMOTOR.—Size 8 model 8 SM 420 has rotor inertia of 0.1 gm cm² and stall torque of 0.25 oz in. to offer acceleration at stall of 170,000 rad/sec².

Helipot Corp., Dept. ED, Newport Beach, Calif.

CIRCLE 410 ON READER-SERVICE CARD

DIRECT-READING MICRODIALS.—1300 series has 3, 4, and 5 digit dials for 10-, 100-, and 1000-turn applications.

The George W. Borg Equipment Div., Dept. ED, 120 S. Main St., Janesville, Wisc.

CIRCLE 411 ON READER-SERVICE CARD

TRANSISTORIZED COUNTING PACKAGE.—Added to model C, the Count-Pak series now has model N-1 which counts at speeds up to 30,000 counts per min for more than 1 billion counts.

Veeder-Root Inc., Dept. ED, 70 Sargeant St., Hartford 2, Conn.

CIRCLE 412 ON READER-SERVICE CARD

RECYCLING TIMERS AND TIMING KITS.—In single, double, and three gang assemblies. Speeds vary from 50 cps to 1 cy per hr.

Herbach & Rademan, Inc., Dept. ED, 1204 Arch St., Philadelphia 7, Pa.

CIRCLE 413 ON READER-SERVICE CARD

TRANSISTORIZED POWER INVERTER.—Model PS-3001 provides 115 v ac at 400 cps and up to 750 ma load current. Input is 26 v dc ± 5 per cent.

Power Sources, Inc., Dept. ED, Burlington, Mass.

CIRCLE 414 ON READER-SERVICE CARD



EMCOR'S®

**VERSATILE, FUNCTIONAL
AND STRUCTURAL DESIGN**



Catalog 105 AVAILABLE
UPON YOUR REQUEST

EMCOR Modular Enclosure Cabinets house load banks used to simulate loads in testing generators at Jack & Heintz, Inc., Cleveland, Ohio.

EMCOR units are relied upon by leading instrument and electronic equipment manufacturers for their design and construction which comply to universally accepted engineering standards of structural strength, serviceability and flexibility. Engineering "know-how" and alertness to the demands of these industries has developed a proven confidence in the EMCOR Modular Enclosure System.

As specialists in the electronic enclosures field, EMCOR engineers are closely oriented to the needs of control and instrumentation designers. Highly trained EMCOR Sales Engineering Representatives located in all major industrial areas are available to help in planning specific applications of EMCOR equipment. Discover how EMCOR Engineering Skill can work for you, write for the name of the EMCOR Sales Engineer nearest you. *Registered Trademark of Elgin Metalformers Corporation.

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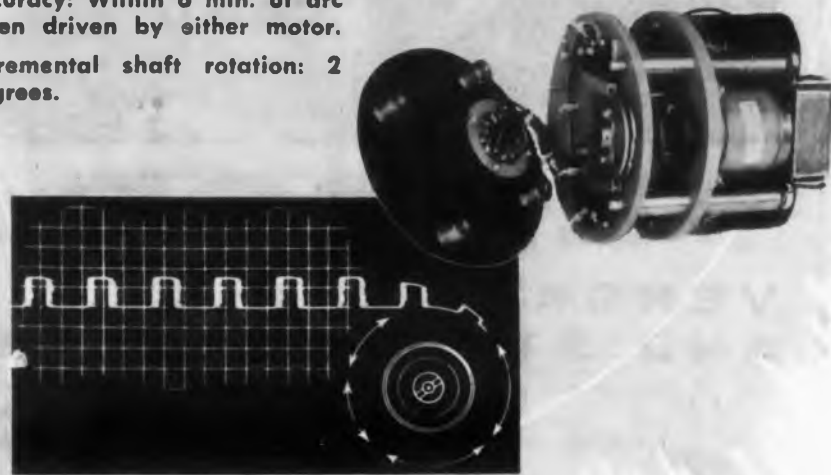
CIRCLE 415 ON READER-SERVICE CARD



STEPPER SYNCHRO POSITIONER

Accuracy: Within 6 min. of arc when driven by either motor.

Incremental shaft rotation: 2 degrees.



This is one of the many applications for the Stepper Motor — a device for translating electrical pulses into accurate, bi-directional, incremental shaft displacements.

The Synchro Positioner uses two Stepping Motors, an Autosyn differential, and a built-in pulse generator. One motor positions the Autosyn Shaft in coarse increments in either direction, while the other motor, using a different gear ratio, positions the same shaft in vernier increments in either direction. As the reset command signal is of steady-state type, the built-in pulse generator permits use of the driving motors for the reset function.

STEPPER MOTORS CORPORATION

Subsidiary of California Eastern Aviation, Inc.

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CIRCLE 220 ON READER-SERVICE CARD

NEW LITERATURE

Pressure Comparator 221

Catalog Sheet 32CA110 explains operation and construction of a pressure comparator. Unit gives precise service as high as 300 psi and 300 F, has about 50 times the life expectancy of other commercially-available pressure switches. Fischer & Porter Co., 496 Jacksonville Rd., Hatboro, Pa.

Special Metal Stampings 222

Services in the fabrication and production of stampings from rare and specialized metals are discussed in a 4-page illustrated folder. A quick reference chart lists the properties and typical uses of 20 types of rare or special metals. These metals include beryllium copper, K-Monel, molybdenum, tantalum, phosphor bronze, rodar, titanium, and silicon bronze. The Staver Co., 47 N. Saxon Ave., Bay Shore, N.Y.

Hermetic Seals 223

A brochure discusses the services offered by this manufacturer of hermetic seals and terminals. A consulting engineering service provides engineers for visiting customer plants to develop required components on the spot. A method for testing and inspecting finished parts is described which duplicates the testing procedures used by the customer. Glass-Tite Industries, Inc., 88 Spectacle St., Cranston 10, R.I.

Temperature Instruments 224

Having nearly 70 photographs, a 30-page booklet outlines facilities for the design and manufacture of temperature controls, detectors, and indicators. The brochure covers research, engineering, production, quality control, products, affiliated companies, and customer services. Fenwal Inc., Ashland, Mass.

VECO THERMISTORS, VARISTORS

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BY INDEPENDENT LABORATORIES

What's behind this quality? — it's VECO's ever-constant research, development and engineering program, designed to keep abreast of today's fast-changing industry. Backed by one of the country's largest and finest equipped plants, VECO works hand-in-hand with customers to improve existing products and develop new applications utilizing Thermistors and Varistors.

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Descriptive literature covering each item available on request



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CIRCLE 225 ON READER-SERVICE CARD

Regulators 226

A 4-page illustrated brochure furnishes complete technical data on magnetic voltage regulators and also serves as a technical manual. It covers detailed product description, principles of operation, operating instructions, and maintenance. Illustrated with dimensional diagrams, response curves, schematics, and vector diagrams, the brochure answers most questions about their operating capabilities. Sorensen & Co., Inc., Richards Ave., S. Norwalk, Conn.

Creativity

Deutsch and Shea, Inc., technical manpower consultants, have compiled a bibliography on creativity and its role in technology, industry, and business. The references include books, articles, and studies encompassing science, engineering, business, and other fields. The bibliography is intended as a help to better understanding of techniques for stimulating and developing creative abilities. Copies are \$2.00 and may be obtained from *Industrial Relations News*, Dept. ED, 230 W. 41st St., New York 36, N.Y.

Delay Lines 227

A 4-page catalog describes special and standard lumped constant delay lines. It lists over 275 different units covering standard impedance ranges from 50 to 10,000 ohms and delays from 0.25 to 5000 μ sec. Control Electronics Co., Inc., Huntington Station, N.Y.

Connectors 228

Catalog MS-E-3, containing 16 illustrated pages, covers all type E plugs. These plugs conform to the provisions of Military Standard MIL-C-5015. Also available is bulletin EX-1, describing the company's four basic EX types. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

Society of Plastics 229

This society prospectus summarizes all the activities and benefits of the organization. It contains 16 illustrated pages and includes instructions on how to join the organization. Society of Plastics Engineers, Inc., 34 E. Putnam Ave., Greenwich, Conn.

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To improve electronic component reliability

Sel-Rex Bright Gold is used on a variety of electronic parts at Federal because, to quote Mr. William F. Boyle, Chief Metallurgist, the deposits are "... fine grained and dense, giving exact duplication of the surface plated... (it) eliminates galling in sliding electrical contacts" and has "effected a tremendous saving" over previous materials and methods.

The Federal Telephone story, other case histories and technical data FREE on request.



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Manufacturers of Exclusive Precious Metals Processes, Metallic Power Rectifiers, Airborne Power Equipment, Liquid Clarification Filters, Metal Finishing Equipment and Supplies.

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NEW CONCEPTS IN TR TUBES...



MA338 is typical of these new tubes. It is a significant advance over the conventional 6334.

Microwave Associates now offers guaranteed crystal protection for entire life of tube . . . even under full power and elevated temperatures.

Out of Microwave's Switching Devices Laboratory, directed by Dr. Lawrence Gould, comes an important advance in duplexer tubes.

NEW KEEP-ALIVE DESIGN with new ruggedized windows and new stable gas fill maintains spike and flat leakage powers within specified limits over a wide temperature range.

Duplexer loss *plus* interaction *plus* noise generation from keep alive are controlled within tight limits as specified by the system overall noise figure requirement.

RETROFIT IS EASY . . . single and dual tubes are physically interchangeable with conventional tubes, or tubes can be shortened if desired.

Each half of a dual tube is tested individually to provide guaranteed performance. Tubes for applications requiring high repetition rate and short recovery time are available.

FOR COMPLETE DATA about these new TR tubes and other advanced tubes for switching high powers with guaranteed crystal protection at any frequency, write or phone for specific information.

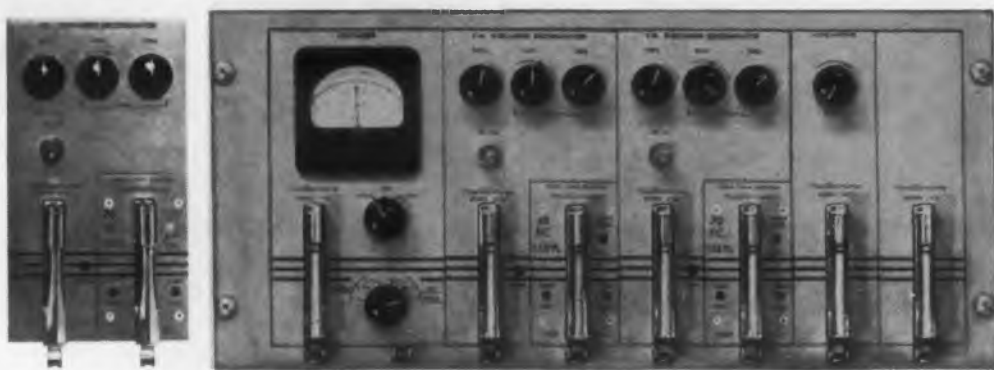


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CIRCLE 232 ON READER-SERVICE CARD



Forerunner in System Development

NEW LITERATURE

Connector Soldering 233

A 10-page report giving a step by step procedure for the soldering of miniature electrical connectors is available. The illustrated report is entitled "Electrical Connector Soldering Techniques." Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.

Conductive Gasketing 234

A data sheet which describes a company's electrically conductive gasketing is available. The company also provides samples with each data sheet. Connecticut Hard Rubber Co., 407 East St., New Haven, Conn.

RF Connectors 235

Rf connectors are covered in an 84-page loose-leaf catalog. The catalog contains illustrated descriptions, charts, cross indexes, assembly instructions, and technical data. Kings Electronics Co., Inc., 40 Marbledale Rd., Tuckahoe, N.Y.

Filter Capacitors 236

Bulletin GEA-6819, six pages, describes dc aluminum electrolytic filter capacitors for computer circuits. It discusses the materials and construction of the units and also their operation and uses. Specifications cover case sizes, ratings, performance, and characteristics. Pictures, charts, dimensional drawings, and tables fill out the text. General Electric Co., Schenectady 5, N.Y.

Switching Reactors 237

Catalog S-10 shows a complete line of standard switching reactors for one-step, low-cost static control. Adaptable for ac or dc use, the units perform all logic functions and are applicable to switching and sequencing installations. The 16-page catalog describes the units, their applications and dimensions. It contains tables of electrical characteristics and several typical application circuits. Control, Div. of Magnetics, Inc., Butler, Pa.

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SUB-MINIATURE Coaxial RatioTrans*

DESIGNED TO MEET MIL SPECS



Model CRT-3
5 PLACE RESOLUTION

DecaTran*

Model CRT-4
6 PLACE RESOLUTION

CRT-3 shown approx. half size

The CRT-3 and CRT-4 are sub-miniature RatioTrans* designed particularly for those applications where small panel mounting area, minimum depth behind panel and the need for meeting military specifications are of prime importance.

In spite of their small size, the CRT-3 and CRT-4 have the standard Gertsch accuracy of .001% and all other inherent RatioTran* characteristics. All components and materials used meet military specifications and are designed to operate under severe service conditions.

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CIRCLE 238 ON READER-SERVICE CARD

Instrument Bearings 239

Details on a miniature line of instrument bearings, including dimensions, tolerances, torque values, static and dynamic capacities and limiting speeds are covered in a 6-page catalog supplement M1. The illustrated catalog has fold-out pages. Barden Corp., Danbury, Conn.

Conduit Fittings 240

A 28-page color catalog illustrates and describes a full line of conduit fittings and accessories. The units are for rigid conduit, electric metallic tubing, armored cable flexible metallic tubing, and non-metallic cable. Conduit Fittings Corp., 6400 W. 66th St., Chicago 38, Ill.

Control Reactors 241

A catalog containing graphs and specifications for 48 standard control reactors covers 15 to 450 w type. Four series covering sensitivity range from 1.5 to 3 amp-turns. The series meets all MIL-T-27-81 specifications and stands 2000 G shock tests. Four standard wind-

ings are provided or units can be delivered with any number of windings up to eight to specifications. Chicago Magnetic Control, 1616 N. Damen Ave, Chicago 47, Ill.

Delay Lines 242

Bulletin 510 outlines performance characteristics and design considerations for ultrasonic delay lines. The 4-page data bulletin covers such subjects as: delay medium material, transducers, bonding medium, casing and packaging. Three pages are devoted to the performance characteristics of five different ultrasonic delay lines. Bliley Electric Co., Union Station, Erie, Pa.

Egghead Manual 243

An invaluable guide to aspiring eggheads is now in its second printing. Entitled "On Being An Egghead, or Engineering for the Shell of It," it contains a complete set of rules for egghead behavior. The booklet is fully illustrated. Benson-Lehner Corp., 11930 W. Olympic Blvd., Los Angeles 64, Calif.



- Output: 35KV • 25KVA continuous duty
- Corona-free • Vacuum—oil filled
- Equipped with special brackets for pole mounting

The outdoor potential transformer, a new member of the well-known family of NWL custom-built Transformers, is made to fit the particular needs of the user. Each Nothelfer transformer is individually tested for core loss, polarity, voltage, corona, insulation breakdown and aging characteristics and must meet all customer's requirements before shipment. We shall be glad to receive your specifications and quote you accordingly.



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NEW! RVG-8T

1/2" TRIMMER POT



Linearity $\pm 3\%$ and
Power Rating 2w @
85°C derated to 0
at 150° standard —
200°C intermittent
operation available

RVG-8T Specifications 1/2" Trimmer Pot

Rating (watts)	2
Torque (oz.-in.) Max.	1.
special high torque available	
Weight (ounces)	1/3
Resistance Range $\pm 5\%$	
20 Ω to 50K*	
Electrical Function Angle	320°
Voltage, Max. (insulation)	1000 DC
Linearity, Standard (%)	± 3

*100K available
Notes: Shaft lock nut is supplied.

High Performance and Low Cost

Improve performance of your electrical and electronic circuitry with this new RVG-8T 1/2" Trimmer Potentiometer.

Excellent performance characteristics for its type and size. Windings are on cards or mandrels, usually with wire temperature coefficient of 20 ppm. Body is one-piece phosphor bronze, nickel plated; terminals are gold plated; stop pins and shaft are of stainless steel; precious metal contacts are

used throughout. Insulation is designed to withstand 1000 volts DC.

Available now! RVG-8T is stocked in standard resistance ranges. 100 ohms to 50K ohms — up to 100K ohms available. Can be supplied with precision potentiometer tolerances, servo-mount, or for 200°C intermittent operation. Write for prices and catalog sheet today.

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GAB-5

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FREQUENCY CONTROL

NEW

CRYSTAL UNITS

MEET VIBRATION

UP TO 2000 cps. AT

5G. AND 100G. SHOCK

IN RANGE

4kc. TO 125mc.



**BLILEY
ELECTRIC CO.**
UNION STATION BUILDING
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This new series of Bliley crystals units answers a definite need for "ruggedized" frequency control in the field of airborne and missile-borne equipment. These units meet or exceed the electrical and mechanical requirements of MIL-C-3098B. Request Bulletin #512.

CIRCLE 247 ON READER-SERVICE CARD

NEW LITERATURE

Computer Design Techniques 248

New design techniques to accomplish substantial savings throughout engineering development programs for electronic digital computers are described in a booklet just published.

The well-illustrated booklet describes use of a family of general-purpose digital building blocks. It also explains the application of advanced computer-aided design methods, beginning with the checking of logical equations for systems definition through to the preparation of component lists and wiring tabulations. Control Data Corp., 501 Park Ave., Minneapolis, Minn.

High Speed Switching 249

"High Speed Zener Switching Circuits," an application bulletin giving detailed information on high speed electronic switching necessary for missile computers, ground control computers and industrial computers has been published. The bulletin describes the operation of silicon junction diodes about the zener or avalanche breakdown region. This permits diode switching at speeds of many magnitudes greater than those obtainable with zero bias point switching. The high speed limitation can be circumvented in this way to permit a reversal time, theoretically as short as one one-billionth of a second. Hoffman Electronics Corp., Semiconductor Div., 930 Pinner Ave., Evanston, Ill.

Data Display Indicators 250

Catalog 1015 has 12 pages of technical data on plug-in indicators for data display, storage, and transfer. It describes the construction, operation, specifications, and typical applications of the units. Union Switch & Signal, Div. of Westinghouse Air Brake Co., Pittsburgh 18, Pa.

Platinum-Clad Metals 251

Bulletin PLA-5 is a 2-page, illustrated discussion of platinum-clad metals as a low-cost substitute for solid platinum. A table lists the physical properties of platinum-group metals, while the text points out their advantages and applications. Metals & Controls Corp., General Plate Div., Attleboro, Mass.

Photoelectric Catalog 252

With pictures and descriptions, Catalog 58 lists 24 pages of photoelectric and other electronic controls. It covers high speed, ultra sensitive, and impulse actuated photoelectric timing controls; a complete series of light sources; normal, small, and miniature phototube and light source heads; electronic timers; and controls operated by current surge and impact. Autotron, Inc., Box 722 HA, Danville, Ill.

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Tiny Variable Vacuum Capacitors



Actual Size

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ENVELOPES

Especially suited for the needs of telemetering and other miniaturized electronic equipment, these new UNITED vacuum variable capacitors represent the latest and most effective solution to many complex problems.

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Capacitance range	2 to 10 uuf
Max. peak RF voltage	3000 volts
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Maximum temperature	500° C
Shaft revolutions	5 turns
Net weight	4/10 oz.
Nominal overall dimensions less connector lugs	Length: 1 1/16" Diameter: 5/8"

For dielectric stability and maintenance of precise setting of capacitance in high altitude, high temperature environment, there is no other class of capacitor that can equal these new vacuum variables. Capacitance variation control is straight line.

Your inquiries are cordially invited.



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CIRCLE 253 ON READER-SERVICE CARD

We insist on the Philbrick amplifier for our new package" says Philbrick
HERE'S PHILBRICK ON PHILBRICK
 We use only the finest components in our products. That's why we insisted on Philbrick's new USA-3 Operational Amplifier as a sub-assembly for our new Analog Package, the UPA-2. We have found it (the USA-3) nifty and thrifty. We recommend it without reservation. And that goes for the UPA-2 — too."

PHILBRICK OPERATIONAL AMPLIFIER ... USA-3
 More performance per dollar than any other amplifier. Highly reliable — no electrolytic capacitors or glow tubes. Designed to prevent self-destruction even when the output is grounded. Drift, noise, offset under 100 microvolts. Output ± 116 VDC. Wide frequency range—DC to 100kc (attenuation less than 3db) when connected as a gain-of-ten amplifier. 7" x 2½" printed circuit board mounts by several convenient methods. Price \$95.



PHILBRICK UTILITY PACKAGED AMPLIFIER ... UPA-2
 Combines new level of flexibility and convenience. Performance characteristics same as the USA-3 amplifier, the heart of this package. Can drive 12,000 ohm load to 100 volts in either direction. Designed for 3½" rack mounting but can be used equally well as a bench amplifier, or plug-in assembly without modification. Use it for analog computing, measurement and control, continuous data reduction. Price \$149. and many other feedback operations.

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 THE ANALOG WAY IS THE MODEL WAY
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Relays 255

Six subminiature relays for critical airborne applications are described in this product engineering bulletin. Characteristics and detail specifications for the DC 31, 32, and 33-AC, 34, and 36 subminiatures are furnished along with circuit diagrams and detail drawings of each. Features and technical data involving the production of these subminiature relays are included. The bulletin contains 4 pages plus a panel fold-in. Phillips Control Corp., 59 W. Washington St., Joliet, Ill.

Thermistor Probes 256

Nine specially designed thermistor probe assemblies are described in detail in a 4-page brochure. Each assembly is identified by its most common application, and has complete dimensions and mounting arrangements. Applications of the probes include air, oil, and fuel temperature measurement; surface temperature measurement; and liquid level indication and control. The probes are widely used in missile telemetering circuits and other places where precise and accurate control is demanded. Fenwal Electronics, Inc., Mellen St., Framingham, Mass.

Waveguide Components 426

Duplexers, horns, bends, straight sections, and other components for large size waveguides are described in a short form catalog. The components are especially suited to frequencies favored for tropospheric scatter propagation. D. S. Kennedy & Co., Cohasset, Mass.

Pulse Height Analyzer 257

This literature is an 8-page pamphlet listing specifications and operating characteristics of a company's 256-channel pulse height analyzer, model 20609. The pamphlet also describes quality control tests which finished instruments undergo before shipment. Radiation Counter Laboratories, Inc., 5121 W. Grove St., Skokie, Ill.

Power Supplies 258

Catalog No. E-58 illustrates and describes a line of dc power supplies, ac line regulators, and static inverters. The catalog contains six illustrated pages. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

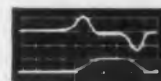
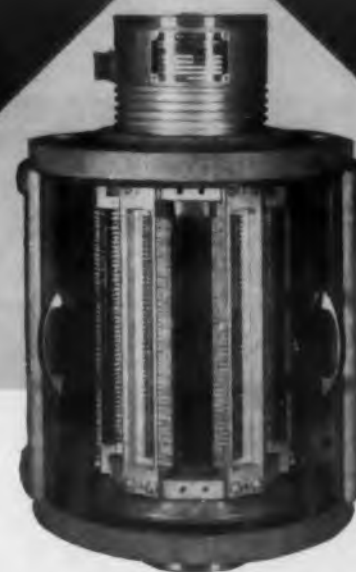
Wire and Cable 259

A six page illustrated brochure, TWC 57, presents descriptive information, including operating specifications for a wire and cable line. A special section of the brochure outlines the various multiconductor cables now offered by the company. William Brand & Co., Inc., Willimantic, Conn.

Now you can order from stock...

the new BRYANT MAGNETIC STORAGE DRUM

Unequaled for precision, versatility, and low cost



The new 512A Bryant general purpose magnetic storage drum meets the exacting demands of all permanent storage problems, yet is versatile enough to be used as a laboratory instrument. These 5" dia. x 12" long drums are stocked for immediate shipment at a price that is far below the cost of customer-designed drums.

Features: Guaranteed accuracy of drum run-out, .00010" T.I.R. or less; Integral motor drive; Capacities to 625,000 bits; Speeds up to 12,000 R.P.M.; 500 kilocycle drum operation possible; Accommodates up to 240 magnetic read/record heads; For re-circulating registers as well as general storage.

Special Models: If your storage requirements cannot be handled by standard units, Bryant will assist you in the design and manufacture of custom-made drums. Speeds from 60 to 120,000 R.P.M. can be attained, with frequencies from 20 C.P.S. to 5 M.C. Sizes can range from 2" to 20" diameter, with storage up to 6,000,000 bits. Units include Bryant-built integral motors with ball or air bearings. Write for Model 512A booklet, or for special information.



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NEW LITERATURE

Teflon Terminals

261

Dimensions and performance data on over 200 types of subminiature Teflon terminals are given in an 8-page catalog. The illustrated booklet describes subminiature stand-offs, feed-through plugs, jacks, and special terminal fabrications. Straight-pin, hollow, and threaded pin terminals are included. Data is also given on tin, gold, silver, and other pin platings available for reflow-to-solder use. Trinseel, Inc., Div. of Tri-Poly Plastics, Inc., 177 I.U. Willets Rd., Albertson, N.Y.

Magnetic Core Testing

262

Bulletin 57-G describes a modular magnetic core tester which delivers programmed pulse chains in a periodically repeated, basic 8-step pattern. The 4-page illustrated folder discusses the features of the instrument and the versatility of pulse programming through the repetition of any one or more steps or step-pairs. It also has a detailed explanation of the programming method, a block diagram, complete specifications, and brief descriptions of optional equipment. Res Engineering, Inc., 731 Arch St., Philadelphia, Pa.

Microwave Test Equipment

263

An 86-page catalog has been released to describe a full line of precision microwave test equipment. Charts illustrate the complete technical data, and photographs show all instruments. There are tables covering measurement formulas, waveguides, and waveguide connectors. The catalog also contains technical reports. Two of them are "Noise Measurement Techniques" and "Summary of Design for Aluminum Flux-Dip Brazing." Waveline, Inc., Caldwell, N.J.

Epoxy Resin Systems

264

This brochure outlines the physical and electrical properties of a company's epoxy resin systems. It covers twenty-five of the systems offered. Included in the brochure are room-temperature, moderate-temperature, and moderate-high-temperature curing systems. For each system available, a chart gives the average pot life, viscosity in centipoises, recommended cure conditions, flexural deformation temperature, and maximum exothermic temperature. Also listed in each chart are physical properties of cured samples of the systems, heat resistance, thermal shock, volume resistivity, dielectric constant, and dissipation factors. The brochure also contains a list of definitions of terms used in connection with epoxy resin systems. Permacel-Lepage's, Inc., New Brunswick, N.J.

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Waveguide Bends

267

A 12-page Catalog No. C-158 just released, provides an up-to-date guide for the selection of precision cast bends and formed waveguide bends. The catalog covers the wide variety of bends offered and provides simplified ordering information. Microwave Development Labs., Inc., 92 Broad St., Babson Park 57, Wellesley, Mass.

Precision Springs

268

Catalog No. 10 covers compression springs, flat springs, strip springs, contact rings, contact strips, and screw machine products. The catalog includes complete engineering data on the greatly expanded line of standard products and describes design engineering service available, tool making facilities, and lists various finishes available. Instrument Specialties Co., Inc., 244 Bergen Blvd., West Paterson, N.J.

Rotary Electrical Equipment

269

Bulletin 258 contains information on a company that produces miniature motors, generators, hand driven generators, and rotary converters. The company specializes in design and development work required in the electrical rotary field for specialized applications. Heinz Mueller Engineering Co., Inc., 1906 N. Cicero Ave., Chicago 39, Ill.

Pulse Generators

270

Model 3450B two megacycle pulse generator is covered in a 3-page booklet. Specifications, large instrument photo, and typical applications, are provided. Also available is a similar description of the model 3460A megacycle double pulse generator. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.

Thermistors and Varistors

271

Over 250 standard thermistors and varistors are listed with pertinent engineering data in a recent catalog. The applications and characteristics of the units are noted, and curves and drawings are used for illustration. Other products mentioned include experimenters' kits, gas analysis equipment, and hypsometers. Victory Engineering Corp., 519 Springfield Rd., Union, N.J.

Hardware

272

Catalog 30, 24 pages, features complete lines of molded and standard terminals, diode clips, taper pins, plubs and receptacles, handles, quint-lock nuts, terminal boards, swaging tools, and other hardware. Among the items new to the catalog is a snap-lock teflon-insulated terminal line. Facilities for custom design and manufacture are described. Lerco Electronics, Inc., 501 S. Varney St., Burbank, Calif.



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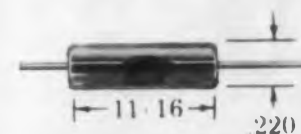
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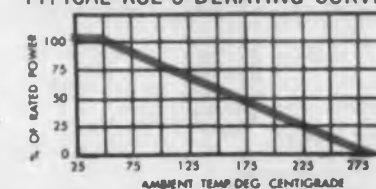
- Operating temperature range: -65° C. to 275° C.
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Harmonic Generation

282

"PRD Reports," Vol. 5, No. 4, discusses the frequency resolution obtainable from a noise-jittered harmonic generation system. The case analyzed in the 4-page is that of a noiseless oscillator whose frequency is to be adjusted to zero beat with some harmonic of a frequency standard which is likewise immersed in noise. Polytechnic Research & Development Company, Inc., 202 Tillary St., Brooklyn, N.Y.

Multicoder

283

A company's G series multicoder and associated commutator sampling switches for low-level data acquisition are described in this set of three catalog bulletin sheets. The bulletin sheets give features and specifications of console units which operate directly from strain gages, thermocouples and similar transducers which provide outputs in the low millivolt range. Applied Science Corporation of Princeton, P.O. Box 44, Princeton, N.J.

Metal Strip

284

"Electronics Precision Strip Selector" is a pamphlet to help engineers pick the right precision-rolled metal strip for miniature applications. The strips are rolled as thin as 0.0005 in. with tolerances as close as ± 0.0001 in. The pamphlet lists electronic parts and components alphabetically, showing the precision-rolled metals used in the manufacture of each. Applications are given for rarer metals such as niobium, zirconium, tantalum, and titanium. American Silver Co., 36-07 Prince St., Flushing 54, N.Y.

Heat Dissipating Shields

285

"Heat-Dissipating Electron Tube Shields and Their Relation to Tube Life and Equipment Reliability" is available in a new 28-page edition illustrated with charts, graphs, photographs, and cutaway drawings. The text is a speech that Harvey Riggs read to the U. K. Inter-Services Committee for the Coordination of Valve Development in London. International Electronic Research Corp., 145 W. Magnolia Blvd., Burbank, Calif.

Russian Research Contents

With May, 1958, a monthly guide to current Soviet research begins. Each issue will contain English titles of all papers being translated into English from 39 Soviet journals. Called "Express Contents of Soviet Journals," the guide will give the contents of Soviet periodicals two months after they are published and two to six months before translations are ready. An annual subscription is \$25.00 and may be ordered from Consultants Bureau, Inc., 227 W. 17th St., New York 11, N.Y.



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MULTI-ELECTRODE devices of npp or pnn configurations can be built that are capable of handling 10 w with good frequency response. They are built up from typical npn and pnp transistors, each selected for its individual characteristics. Essentially, the operation is based upon the stable properties of a hook connection. In this article the important design features are presented along with a simplified procedure of assigning symbols. An interesting circuit application of these devices is included where they are coupled with high-powered pnp or npn transistors in push-pull circuits.

Designing PNN and NPP Devices

In the past, pnpn structures have been built and used in a variety of ways. Many designers took advantage of the positive feedback properties a hook connection exhibits. However, no commercial units have been designed to be used in the stable configuration. One reason for this is that the floating region should have good collector characteristics and at the same time be a good base. A compromise has to be made between the two with the result that the frequency

response and power handling capabilities of the device are limited when used as a pnn or npp.

By using available npn and pnp transistors, each selected for its individual properties, practical pnn or npp devices can be made. A typical pnn connection is shown in Fig. 1. Units have been built that are capable of handling 10 w with good frequency response and α° 's of 5×10^4 . Here the current gain of the npp or pnn transistor has been designated α° . This is approximately equal to α of a common base stage times β of the transistor used as the output stage when directly coupled. Fig. 2 is typical characteristic curve of one such pnn device. Block and schematic diagrams of the junction structure of a conventional transistor and the hook collector junction transistor are shown in Figs. 3 and 4.

The assignment of symbols differs with conventional methods. Current distribution in the npn or pnp device is related to transistor action, and standard transistor terminology has been derived from consideration of this action in devices which have been available hitherto. In the standard transistor the base lead, which carries the control signal only, is connected to the base re-

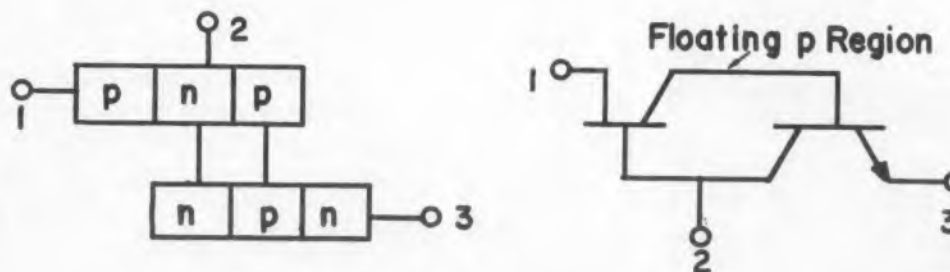


Fig. 1. A typical pnn connection built up from pnp and npn units.

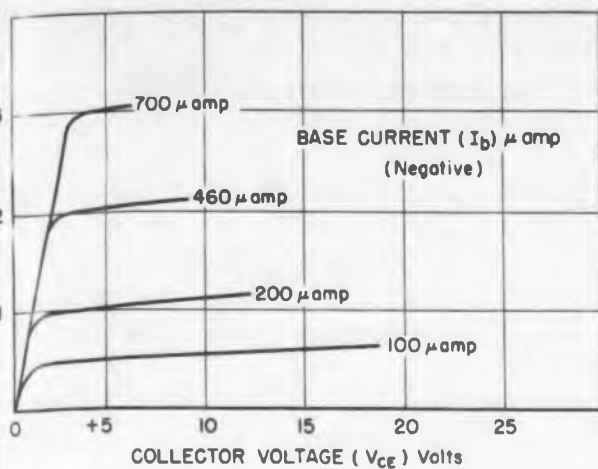


Fig. 2. Collector characteristics of pnn type transistor.

on, which is physically situated between the
er regions and hence is common to both junc-
ns. In the more complicated hook connection
th one additional junction the control current
ws through the region attached to one end of
e array, and the connection attached to the
ntrol or base region carries both signal and out-
t currents. In the standard texts describing the
ok connection, the leads are still designated by
pp. e regions to which they connect, so the base
sistor connection carries both the control and output
s, prac currents and the emitter connection carries only
ypical control current.

This terminology appears to be particularly
fortunate from the point of view of the circuit
x 10³ designer who is only interested in the perform-

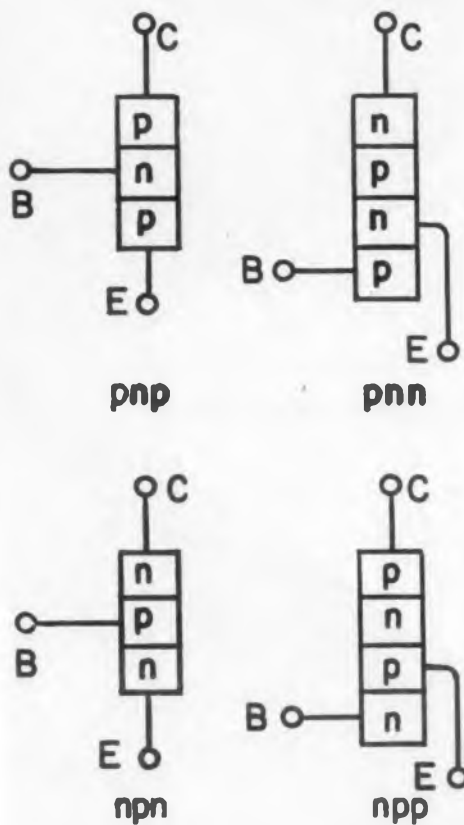


Fig. 3. Block diagrams of conventional and the hook collector junction transistors.



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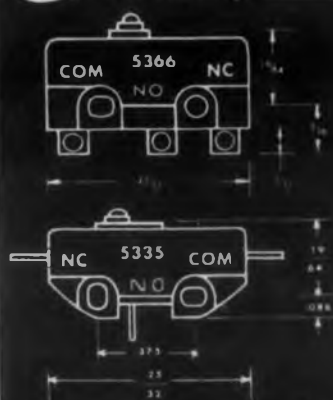
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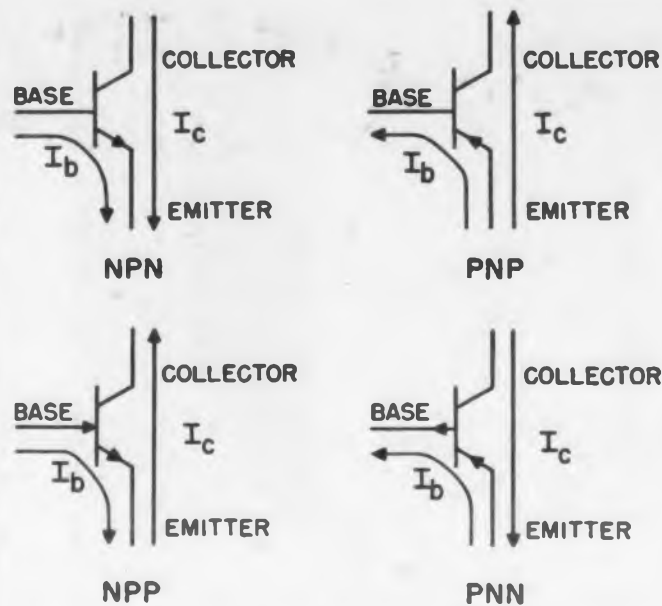


Fig. 4. Schematic diagrams of conventional and the hook collector junction transistors.

ance of the transistor as a black box.

Practical terminology of transistors will be adhered to, namely that the base connection is that which carries the control signal, the emitter connection is that which carries both control and output currents. The only adverse result of this convention is that as the control and output currents are of opposite sign, the actual emitter current is less than the actual collector current. If leads are connected to the semiconductor sections that are to be used in the circuit, one section floats. By naming the device for the sections connected, we have an npp or a pnp transistor. In Fig. 4, the four units are shown with the direction and distribution of currents.

Push-Pull Circuit Applications

One of the most interesting circuit applications of these devices is when they are coupled with existing high-powered pnp or npn transistors in

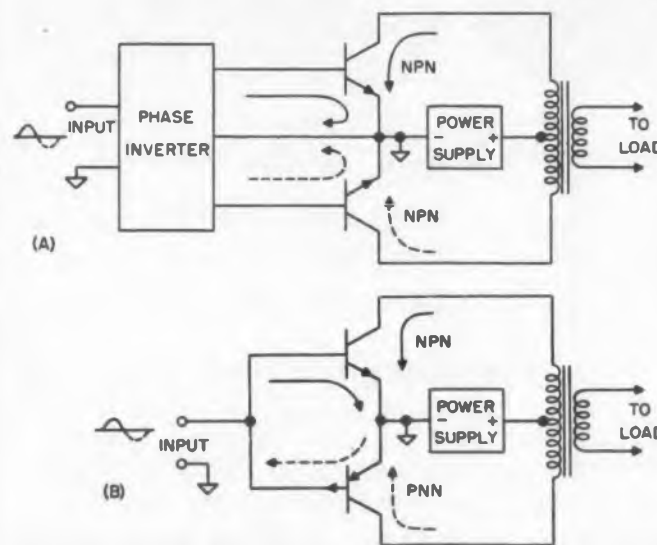


Fig. 5. (a) Typical push-pull amplifier circuit. (b) Replacing one of the npn's eliminates the need for a phase inverter.

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push-pull circuits. Consider the usual push-pull amplifier circuit shown in Fig. 5a. When using two npn transistors in a push-pull amplifier, the need for a phase inverter at the input arises in order to cancel the phase inversion in one of the npn's. If one of the npn's is replaced with a pnp, a phase inverter is no longer needed, as shown in Fig. 5b.

In addition to push-pull applications, there are many other circuits in which these devices will provide greater efficiency. When composite units such as the npp and pnn are available to the design engineer, much of the detail circuit design can be eliminated.

Henri H. Hoge, General Manager, Semiconductor Div., Advanced Research Associates, Inc., Kensington, Maryland.

Identifying Scope Displays

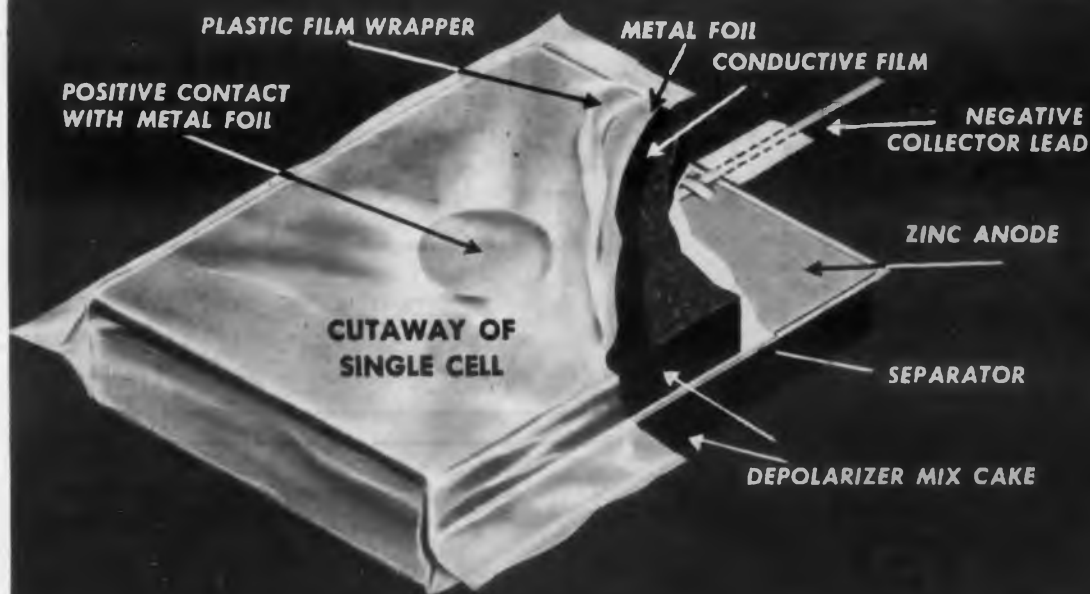
Especially when using a transistor curve tracer with a scope, it's handy to be able to identify the variables on the scope screen. An easy way to do this is to rough out a small area on the back surface of the plastic coordinate screen near the edge of the viewing area. A small piece of emery paper does this quickly. Then, one can apply decal letters on the front surface of the coordinate screen. (Decals with transparent backing are commercially available.)

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Keats A. Pullen, Jr., Ballistic Research Labs., Aberdeen Proving Ground, Md.

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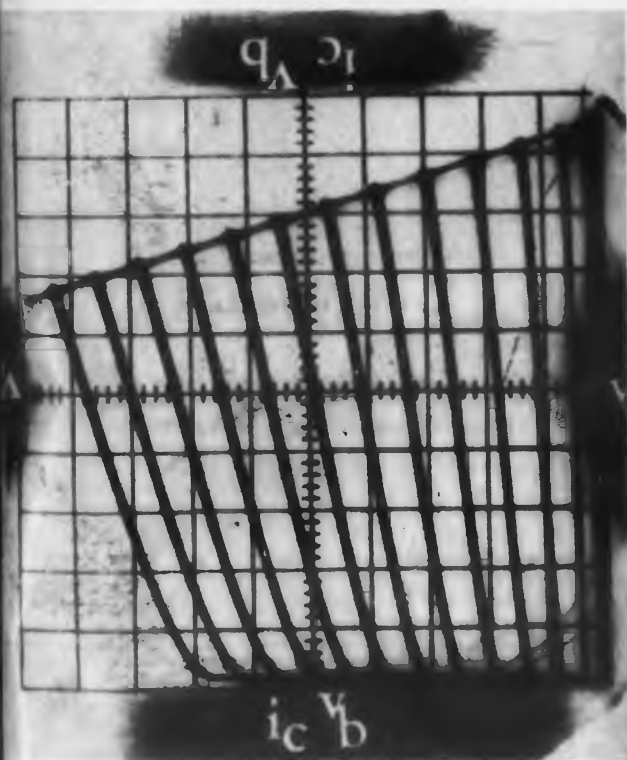
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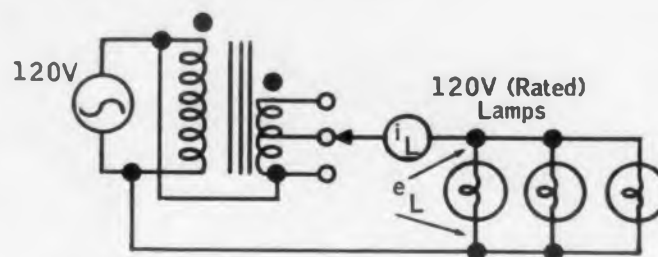
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High intensity lighting is often required for printed-wiring exposure techniques. It is desirable to avoid arc lamps and photo-floods.

Ordinary 120 v light bulbs can be used if they are operated with higher voltage across them. They can burn much brighter and still last for many hours. For example, with 180 v across them they burn three times as bright, and can be used for many hours.

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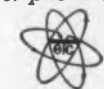
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Elliptical Spot Smothers TV Line Structure

Visible scanning lines on TV viewing screens are undesirable, particularly on large screens and studio monitors. The latter are usually viewed at close range. Most schemes to reduce the visibility of these lines added a small amplitude high frequency signal. Thus the sweep trace was changed from a line

to a wiggly pattern.

This scheme requires many more components and adds an rf interference problem.

The ideal solution would use a scanning spot whose horizontal dimension is minimized, but whose vertical size is equal to the distance between adjacent sweeps. An approximation is easily achieved by introducing astigmatism.

By distorting the beam focus field, an elliptical spot can be made whose major axis is in the vertical plane. Though this is a compromise with picture definition, it can reduce the visibility of the line structure.

It is an attractive solution because it can be incorporated into the electron gun design on new tubes, or added to older tubes by proper placement of external magnets.

E. R. Gunny, Hughes Aircraft Co., Culver City, Calif.



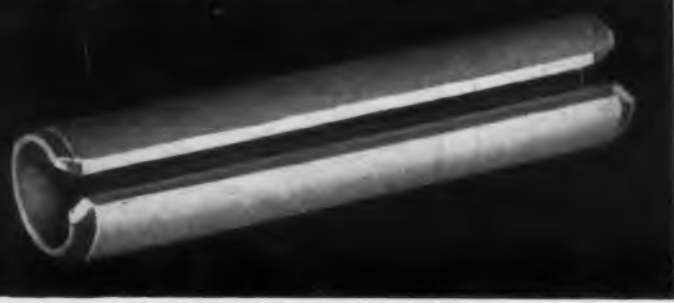
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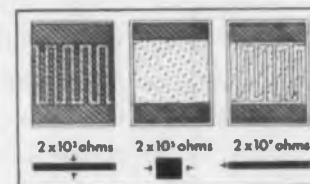
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REPORT BRIEFS

Backward-Wave Amplifier

This study was undertaken in an effort to explain gains which were measured in some early two-helix traveling-wave tubes when they were operated with one helix on the fundamental and other helix on the minus one space harmonic. A series of measurements and calculations was carried out to determine whether asymmetries in the tube could be a cause of this apparent coupling between the two space harmonics. In the study of a circumferential non-uniformity, measurements were made using a tube with a shuttered electron gun so that a portion of the electron beam could be removed. Also gain expressions were derived and calculations were made for a tube with a portion of the beam removed. On the basis of these measurements and calculations, it is concluded that the interspace harmonic gains measured in these earlier tubes were principally due to a small misalignment of the electron beam and the helix. It was found that a misalignment of one or two thousandths of an in. in a tube with helices of one-half in. diameter, could produce positive gains because of the resultant coupling between the forward and backward space harmonics. *Study of the Effect Produced by Asymmetries in the Two-Helix Backward-Wave Amplifier, Wilbur H. Watson, Calif. University, Div. of Electrical Engineering, Electronics Research Lab., Berkeley, Calif. July 1957, 50 pp, photos, drawings, diagrams, graphs, \$1.25. Order PB 131412 from Office of Technical Service, U. S. Department of Commerce, Washington 25, D.C.*

New Endfire Antenna

A new endfire element, the dielectric plate, has been experimentally investigated. Endfire arrays of these plates have been found to yield gains and beamwidths otherwise unattainable in a given volume as well as a measure of sidelobe control. The plate arrays have the property that whatever the broadside aperture available it may be used to advantage. In this respect they combine the characteristics of endfire and of aperture antennas. Beamwidths have, in fact, been empirically related to the volume occupied by the array. Patterns calculated by conventional means have shown good agreement with the experimental data. *Dielectric Plate Array, A New Endfire Antenna, by J. O. Pullman, U.S. Naval Research Lab., Jan. 1958, 22 pp, photos, diagrams, graphs, \$0.75. Order PB 131473 from OTS, U.S. Department of Commerce, Washington 25, D.C.*

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Epoxy cast. Resists environmental extremes, for plug-in printed circuits, .040 pins. $\frac{1}{4}'' \times 1\frac{1}{2}'' \times \frac{1}{8}''$ H. Wt. $1\frac{1}{4}$ oz.

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Electron Tubes in Military Equipment

This technical report presents tube information primarily from the point of view of the electronic designer as a guide in the application of electron tubes. In Part I tube properties are discussed. These are grouped according to ratings, characteristics essential in circuit operation, and properties detrimental to circuit operation. Part II discusses the tube properties in relation to circuit design. It includes a check list for use of the circuit designer to insure coverage of all important design factors. Part III contains numerical data and special design considerations for specific tube types. Part IV presents product distribution curves derived from life test records where available. The concepts of specification control, operation within ratings, and tolerance of characteristics are emphasized throughout. Supersedes earlier editions (PB 111644 and PB 111644 r). *Techniques for Application of Electron Tubes in Military Equipment*, Rex S. Whitlock, U. S. Air Force, Air Research and Development Command, Wright Air Development Center, Electronic Components Lab., Wright-Patterson Air Force Base, Dayton, Ohio. Oct. 1957, 558 pp, drawings, diagrams, graphs, tables, \$7.00. Order PB 111644r2 from Office of Technical Service, U. S. Department of Commerce, Washington 25, D.C.

New Approaches to Printed Circuitry

Operative capacitors, resistors, and connective circuit patterns have been made by vacuum evaporation. Improvement of the elements by various changes in techniques and materials has constituted the principal effort. Mechanical and temperature characteristics of electroplated ceramic circuit patterns have been studied. Samples withstood severe abrasion, temperatures as high as 500 C and high electric currents without detriment other than normal oxidation. All metal screen type stencils were formed by a hot dip process and subsequent selective etching. Results show that a stencil of long life, high temperature resistance, and special versatility suitable for printing electronic circuits can be made. Trials of usual xerographic techniques in the direct formation of metal patterns were unsuccessful. An investigation of special surface films produced by chemical treatment was begun. *Performing Research on New Approaches to Printed Circuitry. Scientific Report No. 2*, by John H. Dessauer, Frederick A. Schwertz and others, Haloid Co., Rochester, N.Y. Sept. 1956, 32 pp, photos, graphs, tables, microfilm \$3.00, photocopy \$6.30. Order PB 126412 from Library of Congress, Washington 25, D.C.



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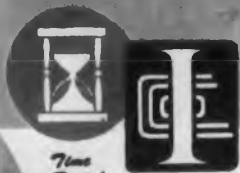
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REPORT BRIEFS

New Microwave Receiver

A new receiver has been investigated and described in some detail in this report. The principal advantage is the elimination of the I-f noise which is generated by the input tubes of a video amplifier at low modulation frequencies. With these same modulation demands, which are essentially aimed at pulse fidelity in microwave pulse reception, the new receiver should give a 12 db increase in sensitivity over a crystal video type. An important step toward receiver miniaturization has been indicated, and additional work leading to the design of an optimum r-f system is contemplated. *Some Aspects of Crystal Performance in a New Microwave Receiver*, George E. Hambleton, U. S. Signal Corps Engineering Labs., Fort Monmouth, N.J. June 1956, 37 pp, photos, diagrams, graphs, table, \$1.00. Order PB 131335 from Office of Technical Service, U. S. Department of Commerce, Washington 25, D.C.

Calibrations at Microwave Frequencies

Discusses receiver noise factor, principles employed in noise source calibrations, critical parameters and errors, and hot-body noise sources and their use as standards. *Fundamentals in Noise Source Calibrations at Microwave Frequencies* by J. Edwin Sees, U. S. Naval Research Lab., Jan 1958, 24 pp, diagrams, graphs, \$0.75. Order PB 131367 from OTS, U. S. Dept. of Commerce, Washington 25, D. C.

Electromagnetic Waves

Preliminary, and promising, results are given on a new, smaller bolometer made from 10 μ in. wire in .022 x .045 guide. The three-dimensional physical calculation of diffraction from an echelette grating is presented, the result at present being exact but difficult to apply. Further results are also given for the calculations being done on a UNIVAC of the optical constants of simple crystals. A new method for determining the complex index of refraction of solids is also included. For 1st-5th reports under this Contract see PB 116645, 116990, 117767, 119237, 123401. *Study of the Generation and Detection of Electromagnetic Waves in the Millimeter Wave Region*, Scientific Report No. 6 by J. H. Rohrbaugh, New York University, Washington Square College of Arts and Science, Physics Dept., Dec. 1956, 26 pp, microfilm \$2.70, photocopy \$4.80. Order PB 126373 from Library of Congress, Washington 25, D.C.

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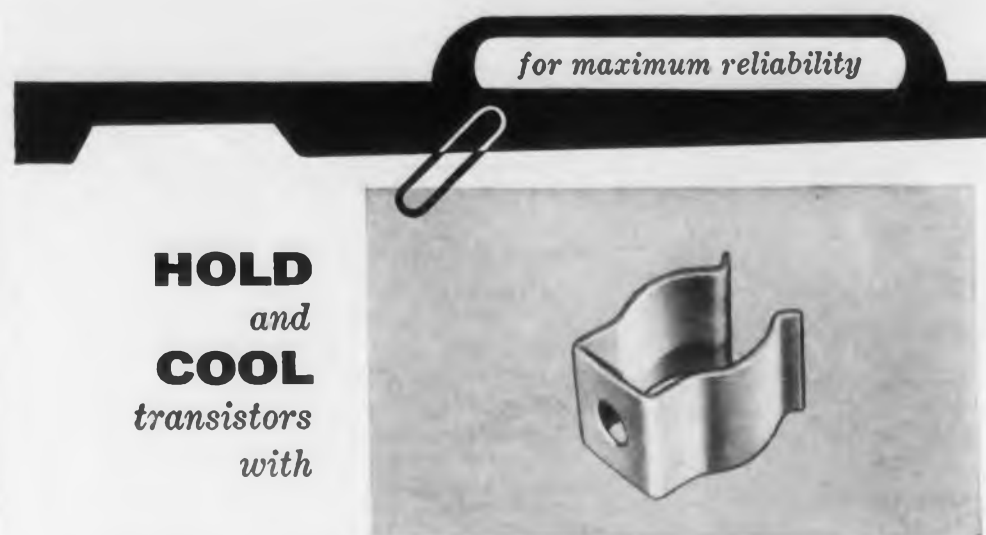
This approach to network synthesis offers a relatively simple geometric situation in which synthesis is accomplished by arranging points on a plane. The two main techniques to be developed are: the explicit visual handling on the complex frequency plane of poles and zeroes of the network transfer function; and the application of this visualization to network synthesis through mappings of function theory, in conjunction with a striking potential analogy. This method is applied to a class of bandpass amplifier interstage networks. *Maximally Flat Amplifiers of Arbitrary Bandwidth and Coupling* by De-Forest L. Trautman, Stanford University, Electronics Research Lab., Stanford, Calif. Feb. 1952, 145 pp, diagrams, graphs, table, microfilm \$7.20, photocopy \$22.80. Order PB 126300 from Library of Congress, Washington 25, D.C.

Grounded-Grid Amplifier Transfer Function

Contents: I—Introduction; II—The analysis of grounded-grid amplifiers; III—The synthesis of grounded-grid amplifier transfer functions; IV—Design equations and alignment procedure; V—The design and performance of a grounded-grid amplifier; VI—Conclusions. *Analysis and Synthesis of Grounded-Grid Amplifier Transfer Functions* by Warren A. Christopherson, Stanford University, Electronics Research Lab., Stanford, Calif. May 1952, 135 pp, diagrams, graphs, tables, microfilm \$6.90, photocopy \$21.30. Order PB 126343 from Library of Congress, Washington 25, D.C.

Radioactive Energy

Newly developed techniques of preparation of relatively large area electrode couple sheets from the point of view of cleaning the stainless steel base, anodizing, and evaporating magnesium on one side are described. The advantages of couples made in this manner over welded couples are given and a comparison of CPD measurements on both types is presented and analyzed. A new program of investigating promising insulators is discussed in detail. The importance of this program is reinforced by experimental evidence that the high voltage terminal of battery models must be potted. *Investigations on Utilization of Radioactive Energy as A Source of Battery Power*, by Alexander Thomas, Tracerlab, Inc., Boston, Mass. October 1954, 41 pp, photos, graphs, tables, microfilm \$3.30, photocopy \$7.80. Order PB 130243 from Library of Congress, Washington 25, D.C.



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FREQUENCY DISTORTION	3% Maximum At Full Load			
LOAD POWER FACTOR	+0.5 to -0.5 Maximum			
MILITARY SPECS.	MIL-E-5400A & MIL-E-5272A			
AMBIENT TEMPERATURE	-55°C to +71°C when mounted to heat sink			
VIBRATION	20G 10 to 2000 CPS			
UNIT DIMENSIONS	15" D 2 7/8" H 2 13/16"	18" D 2 7/8" H 2 13/16"	110" D 4 1/2" H 2 13/16"	
WEIGHT (Approx.)	2 lbs.	3.5 lbs.	5 lbs.	



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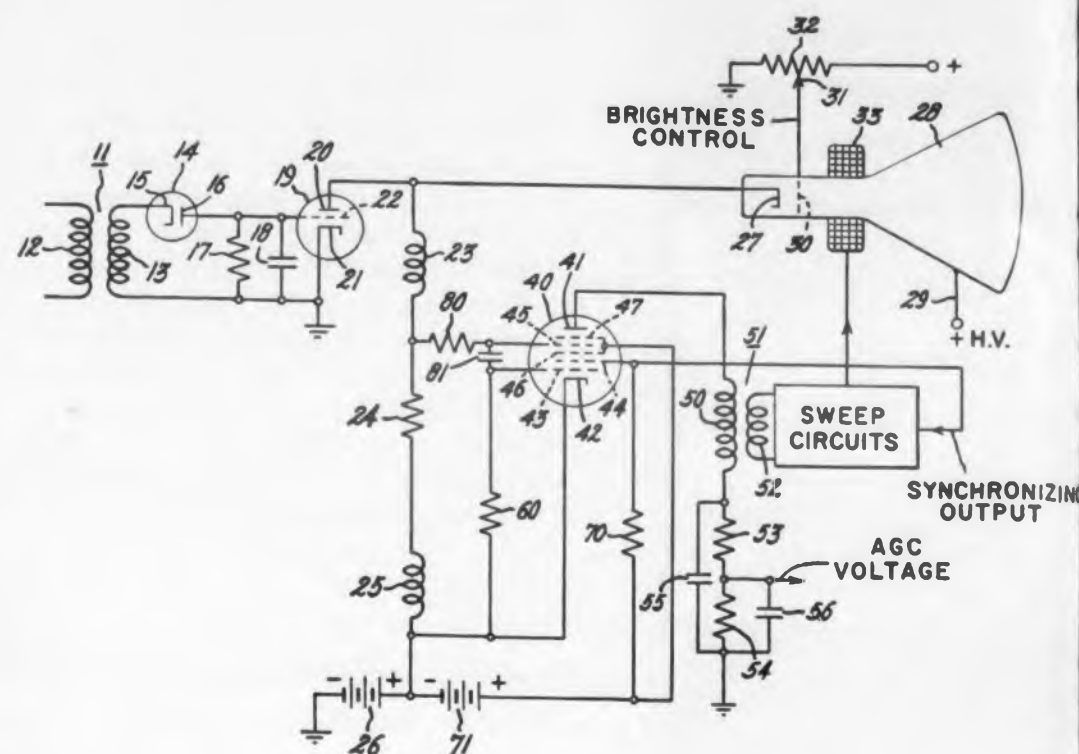
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PATENTS



Combined Automatic Gain Control and Synchronizing Signal Separation Circuits

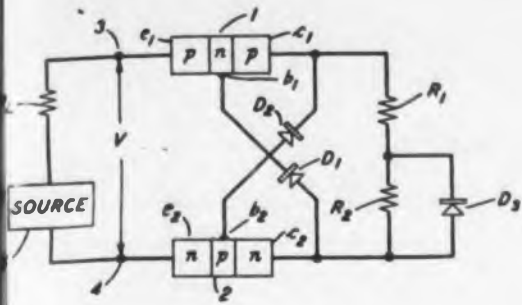
Patent No. 2,810,783. W. J. Gruen. (Assigned to General Electric Company)

A circuit for securing both automatic gain control and separation of the synchronizing signal from the composite signal is shown. Circuits commonly used for performing these functions have been subject to interference from noise transients. The circuit described makes use of this form of keyed A.G.C. systems having substantially greater immunity from noise. The coupling transformer 11 feeds the input signal, as from the if stage of a television receiver, to the circuit. Diode 14 detects the signal. The synchronizing signal developed across resistor 17 and condenser 18 is negative, requiring phase inversion so that the blanking pulse applied to the cathode 27 of the picture tube 28 is a positive signal which will black out the tube. The triode 19 is used for this purpose.

Substantially the entire signal of amplifier 19 will appear across resistor 24 and inductor 25. This signal is coupled to a second control grid 45 of tube 40 through a resistor 80 which provides a dc connection. Condenser 81 offers ac coupling of the amplifier signal to control grid 43 of tube 40. To obtain a keyed

signal pulses are applied to the anode as from the sweep circuit generator which is coupled into the plate circuit through transformer 51. A low pass filter is provided in series with secondary winding 50 of transformer 51 for generating a negative agc voltage across resistor 54 and condenser 56. This signal is fed to a stage which controls amplification through the receiver circuit. The signal applied to control grid 45 generates a current through the plate circuit the magnitude of which is fixed by the peak value of the video signal. The tube normally is in a non-conducting condition until the signal on the second control grid approximates the potential of the positive source 26. This potential is above the cut-off potential of amplifier 40. Conduction through the tube generates a control voltage which is sufficient to provide the agc potential.

By proper selection of resistor 60 in the circuit of control grid 43 the triode is formed by the cathode, first control grid and second grid 44 serves as a clipper since it transmits the synch pulse only. The second grid 44 which is connected with potential source 71 functions as an anode for the triode. The clipped synchronizing pulse of the input signal appears across the resistor 70 and is fed to the sweep circuit generator.



Negative Impedance Bistable Signal-Operated Switch

Patent No. 2,820,155. John G. Linvill. (Assigned to Bell Telephone Labs., Inc.)

The two terminal signal-operated apparatus is designed to connect the signal source, or a related source, and a load or signals in excess of a specified threshold. When the signal source is connected to the load, the circuit includes negative impedance adjusted to be less than the positive resistance of the associated circuit so that the switch and its load together are stable when the switch is closed. At the same time the switch furnishes a substantial amount of effective gain thereby reducing the amount of gain which might otherwise be required. Negative impedance converters using vacuum tubes are known to the art and prior patents have developed the theory of transistorized negative converters.

As shown, the source 5 connects to the load R_L through n-type transistor 1 and p-type transistor 2 interconnected through "Zener" diodes D_1 and D_2 , poled in opposite senses with respect to the transistor electrodes. The operation of the circuit is as follows:

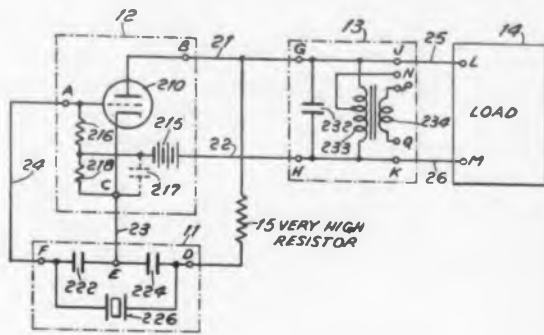
For small applied voltages, the input resistance is very high. The transistors are prevented from carrying current because each of them has in series with it a breakdown diode biased in its reverse direction. When the threshold voltage, equal to the sum of the breakdown voltages of diodes D_1 and D_2 , is exceeded, the diodes D_1 and D_2 breakdown and negligible resistance is present in the cross-coupling paths. The transistors and the low impedance cross-coupling constitute a negative impedance converter. The magnitude of the negative impedance is a direct function of the magnitude of resistances R_1 and R_2 in series. One resistor R_2 is shorted out when diode D_3 breaks down and the transient response and stability of the switch improves.

Oscillator

Patent No. 2,829,256. Joseph Kalish. (Assigned to International Telephone & Telegraph Corp.)

A triode produces ac at useful power level by means of a miniature crystal in an oscillating circuit, which is independent of variations in the other circuit elements, supply voltages and output characteristics.

In the circuit are shown amplifier tube 210 connected to the Colpitts-type oscillatory circuit 11 through the very high resistor 11. Crystal 226 operating in the



parallel mode forms the inductive branch in shunt with condensers 222 and 224 connected in series.

By using a special cut, the crystal is made miniature in size at low frequency. Typical circuit parameters are given for use in conjunction with one half of a type 5670 tube. The crystal dissipation is about 30 μ w and the output may be 200 v peak-to-peak operating into a load of 100,000 ohms.

Frequency Multiplier

Patent No. 2,816,277. Alwin Hahnel. (Assigned to the United States of America)

The frequency multiplier may also be termed a spectrum generator. The multiplier uses a vacuum tube having in its grid circuit an rf generator. There are two discrete resonant networks in circuit with the plate of the tube and one of these resonant networks is tuned to the fundamental frequency. The other resonant network is tuned to a prescribed multiple of the fundamental frequency so that there are produced respective simultaneous self-excited oscillations at the fundamental frequency and at the multiple frequency. The initial cycle of each of the periodic multiple frequency oscillations has the same relative phase.

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06-154 18-154	1.5	.005	3.7	1.9MC	45	40	250
06-224 18-224	2.2	.005	5.4	1.6MC	45	40	250
06-334 18-334	3.3	.005	7.8	1.3MC	36	40	250
06-474 18-474	4.7	.01	12	1.1MC	26	40	250
06-684 18-684	6.8	.01	16	920KC	20	40	250
06-105 18-105	10	.01	11	800KC	13.5	40	250
06-155 18-155	15	.01	14	660KC	11	40	79
06-225 18-225	22	.05	17	550KC	10	40	79
06-335 18-335	33	.05	50	470KC	6.6	40	79
06-475 18-475	47	.05	62	390KC	3.5	40	79
06-685 18-685	68	.05	76	330KC	2.3	40	79
06-106 18-106	100	.05	90	280KC	2.2	40	79
06-156 18-156	150	.10	115	230KC	2.2	40	50
06-226 18-226	220	.10	140	200KC	1.9	40	50
06-336 18-336	330	.10	170	160KC	1.9	40	40
06-476 18-476	470	.5	210	140KC	1.6	40	30
06-686 18-686	680	.5	250	120KC	.9	38	30
06-107 18-107	1000	.5	310	95KC	.6	35	20

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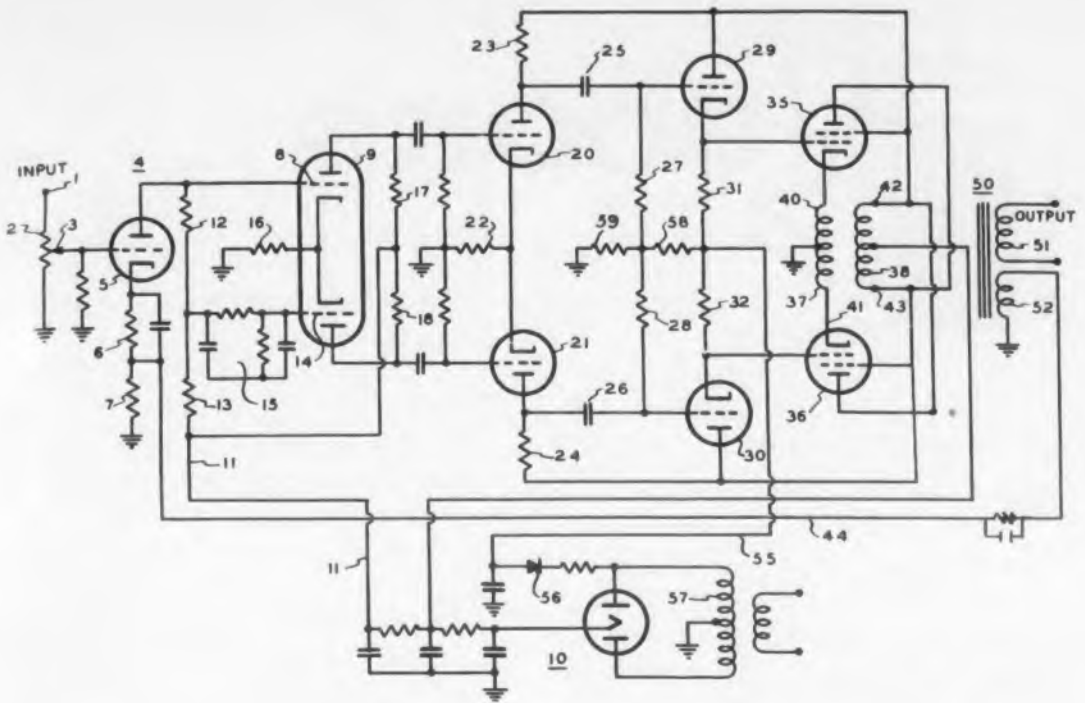
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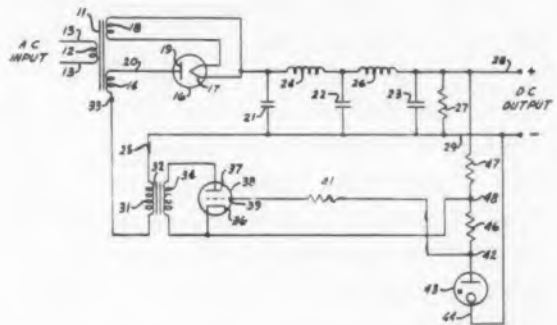


electrodes as the cathodes of the output stage. The circuit is incorporated into the Model MC-60 Power Amplifier which is currently manufactured by the Laboratory. The McIntosh amplifier has negligible distortion even at the higher audio frequencies since unity coupling in the bifilar windings reduces the leakage reactance of the output transformer. Consequently the transient voltage is negligible when the current shifts from one of the push-pull output tubes to the other.

The most significant features of the amplifier described are the separate bifilar windings 51-52 and 37-38, and cross-connection of the plates in the output stage and the cathode follower driver stage, tubes 29 and 30. These tubes have the same ac voltages in the plate circuits as the cathodes of the output stage. The latter feature reduces the necessary power capacity of the driver stage since the power requirement is compensated for by the resulting counter balancing of the ac voltage on the cathode of the output stage. In this manner, the power dissipation in the driver stage is maintained at a more reasonable value.

the rectifier. Compared to the series tube control circuit, this method is preferred since the design is not limited by the range of conductance or power capacity of the tube. However, the control range using a saturable reactor is severely restricted unless a condenser input filter is used.

A typical circuit is illustrated. The half wave rectifier 16 is connected to condenser 21 which returns back to the



rectifier through secondary winding 31. The amount of current flow in primary winding 34 is determined by the voltage at terminal 48 since the grid voltage of tube 38 is held constant by regulator 43. When the voltage at terminal 48 changes due to a change in load, the current in winding 34 changes in phase and magnitude. This change is sufficient to change the inductance of winding 31 to compensate for the change in output voltage. Since the transformer is step-down from winding 34 to winding 31, triode plate resistance if divided by the transformer ratio is effectively inserted in series with the ac supply to the rectifier. The rectifier current changes and, as a result, the output voltage is stabilized.

Voltage Regulated Power Supply

Patent No. 2,830,250. Arden H. Frederick, Alfred S. Gano. (Assigned to General Precision Laboratory)

Voltage regulation of a dc power supply is obtained using a saturable reactor connected in series with the ac supply to

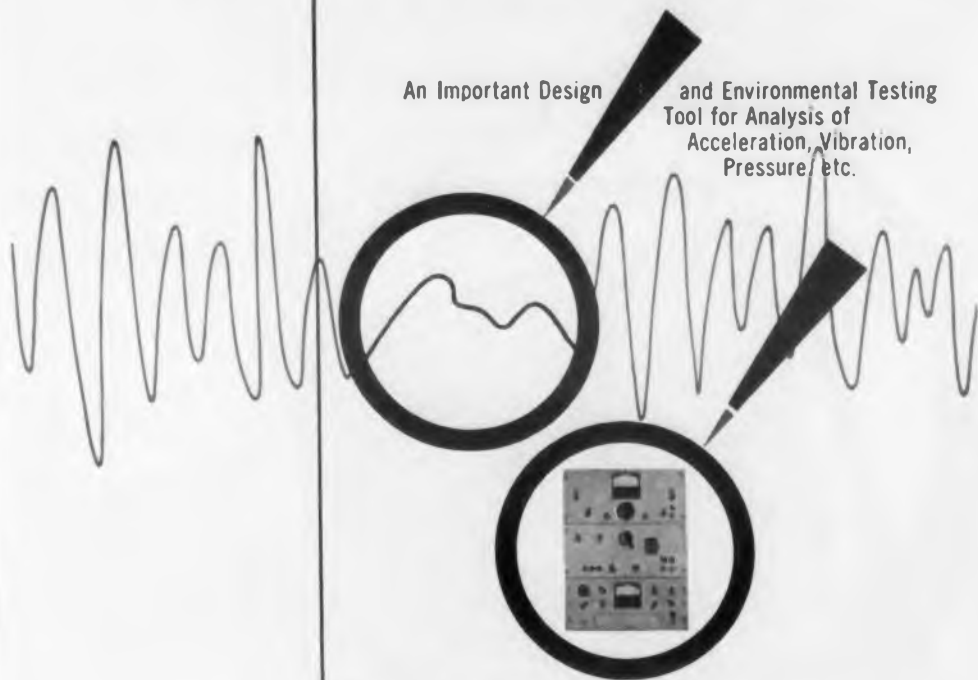
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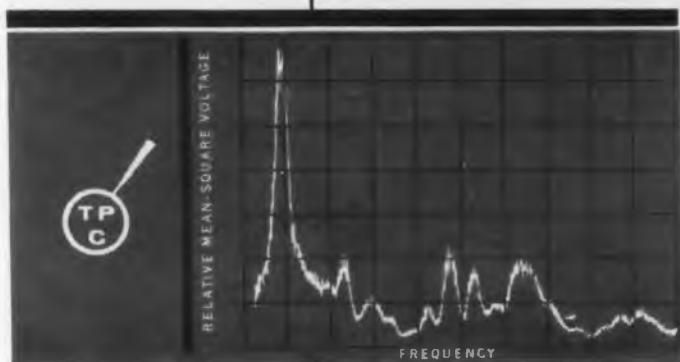
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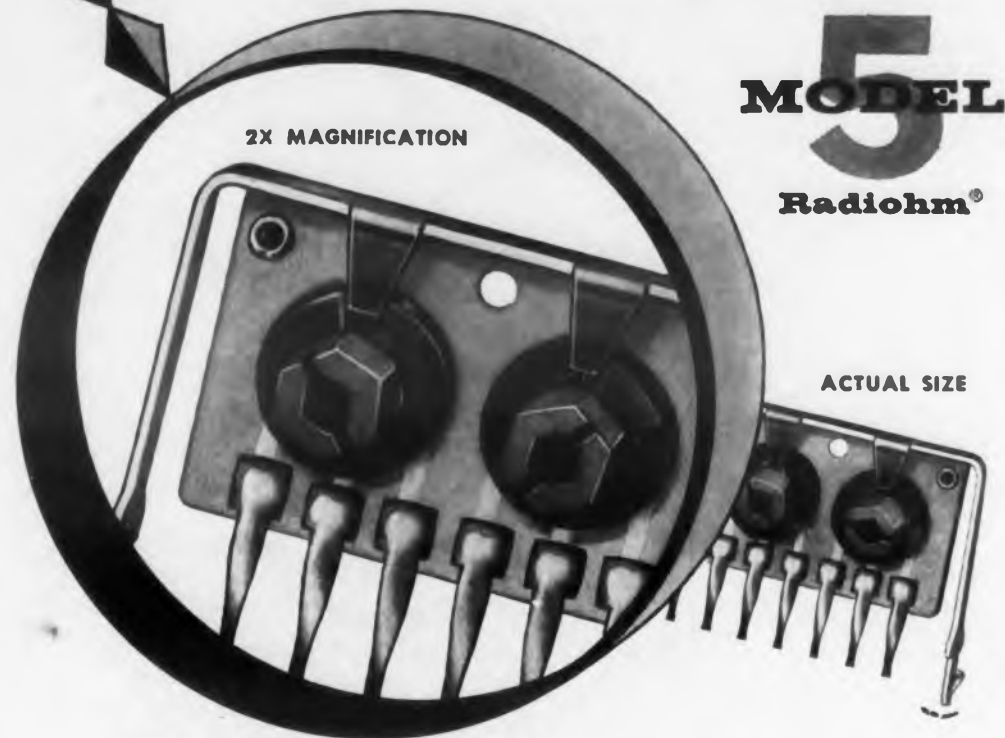
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Resistance Range: 1000 ohms to 5 megohms, $\pm 35\%$, linear taper

Wattage Rating: $\frac{1}{4}$ watt at 70° C. ambient

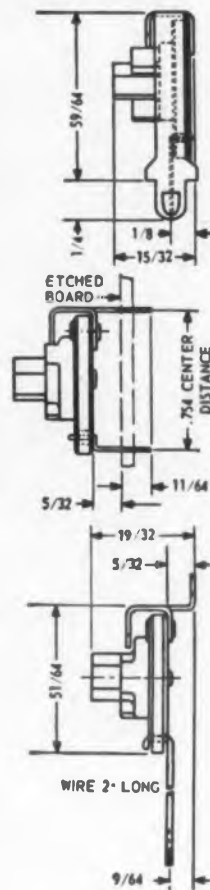
Breakdown Voltage: 1250 Volts RMS, between adjacent sections and to bracket

Minimum End Resistance: Less than 1%

Rotational Life: 5% change after 250 rotations

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BOOKS

Electronic Semiconductors

Eberhard Spenke, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N.Y., 375 pp, \$11.00.

A translation of the second edition of *Elektronische Halbleiter*, this book develops the subject of semiconductor physics in a logical and consistent manner from simple concepts. The reader is familiarized with the fundamentals of semiconductor devices such as rectifiers and the various transistor types.

The book specifically features treatments of the acceleration of electrons and the Zener effects. A chapter covers statistics and kinetics of electrons as modified by electrostatic potentials.

The first part describes basic theoretical concepts of semiconductors leading up to a detailed description of the operation of crystal rectifiers and the physics of crystal amplifiers.

Quantum mechanics of the hydrogen molecule, the band model, Fermi statistics of electrons in a crystal, imperfection equilibria, and boundary layers in semiconductors are considered in the second part. The translators have added a section on junction capacitance and separate problems for each chapter.

High-Speed Data Processing

C. C. Gotlieb, McGraw-Hill Book Co., 330 West 42nd St., New York, N.Y. 305 pp, \$9.50.

Important principles and general techniques of processing data at high speeds, particularly for business purposes, are thoroughly outlined in this new book. A wide range of subjects, from the method of representing information in a processor to advances in automatic programming, is covered. This volume shows precisely how data processors work, how they are used, and what their advantages are.

The book does not confine itself to any particular machine but covers data proc-

essors of all types from all manufacturers. To focus attention on the fundamental operational principles of all high-speed data processors, a hypothetical machine is used as a model. This model is a synthesis of several existing machines and has the full complexity of a real machine.

With scores of tables and illustrations, the book gives a detailed study of coding and programing, and provides several helpful examples showing typical applications of high-speed data processing in the major fields.

The Theory of Networks in Electrical Communication and Other Fields

F. E. Rogers, D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. 560 pp, \$11.50.

In this comprehensive volume the author makes a clear and thorough analysis of the subject. The principles covered in Chapters 1 through 7 are general. They provide the background for the special approaches associated with the transmission lines and communication networks, which are developed in Chapters 8 through 11; and also for the survey of light-current measurements presented in Chapter 12.

The Laplace Transform and matrices are omitted, but the treatments in Chapters 2 and 3, which include the Fourier integral and the generalization of network solutions respectively, should lead smoothly into such specialized studies; and suitable references are given.

Conductance Curve Design Manual

Keats A. Pullen, John F. Rider Publisher, Inc., 116 West 14th St., New York 11, N. Y. 128 pp, \$4.25.

Dr. Pullen is a familiar figure to ELECTRONIC DESIGN readers. He has presented many articles here which describe the design of specific circuits using conductance curves. His contributions in this

area have been expanded with the recent publication of the Conductance Curve Design Manual. This authoritative book explains the use of these curves in circuit design and provides more than 70 of the most representative curves used in all services. With the aid of these two-colored, full-page, clearly drawn graphs, design using small signals parameters can be used to predict large signal performance. A set of tables useful in making tube substitutions, and tables to simplify the selection of tubes for given applications have also been included.

Proceedings of the 1958 Electronic Components Conference

Engineering Publishers, Div. of the AC Book Co., Inc., GPO Box 1151, New York 1, N.Y. 222 pp, \$6.00.

Contained within this hard cover volume are the papers presented at the 1958 Electronic Components Conference. The technology advanced represents generally the designs, developments, production, and applications of electronic component parts in evidence today. Included for discussion are the latest developments in resistors, capacitors, and dielectrics; transistors and solid-state devices; electron tubes and their applications; economic aspects of component reliability; application aspects of component reliability, and progress with materials.

The book was published prior to the actual conference representing the 25 papers chosen by the Program Committee.

The theme for this conference was "Reliable Application of Component Parts." The material presented shows evidence where reliability is actually being applied as a prime design consideration in component part specification, application, and ultimate use.

Motion and Time Study

Ralph M. Barnes, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 665 pp, \$9.25.

In this revised edition, the basic principles that underlie the successful application of motion and time study are presented. Each is supplemented with illustrations and practical examples. Five new chapters deal with: motion study,

mechanization, and automation; mechanized time study and electronic data processing; systems of motion-time data; work sampling; evaluating and controlling factors other than labor; and multi-factor wage incentive plans.

The book includes new material on developments in the industrial use of pulse rate as an index of physical activity. All known systems of motion data are outlined and four of these systems are described in detail, including complete tables of motion-time data for each.

Introduction to Electromagnetic Engineering

Roger F. Harrington, McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N.Y., 312 pp, \$8.00.

Fields theory is introduced as an extension of circuit theory, with Maxwell's equations obtained early in the text. These equations are then specialized to the static case, and considerable time is spent on static field theory. An introduction to the study of time-varying field theory is given in the last chapter. The theory of vector analysis is developed as needed. The mks systems of units is employed throughout. An analytical approach to the theory has been emphasized. This text was designed for the introductory study of electromagnetic theory at the junior, senior, or first-year graduate level.

Zone Melting

William G. Pfann, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 236 pp, \$7.50.

This first book on the subject includes all the information needed to plan a zone melting process or to decide whether one is feasible. It covers both theory and practice and spells out potentialities of crystallization as yet unexploited.

Among the features: a comprehensive description of how to build and operate zone refineries; a complete set of computed zone-refining curves showing impurity concentrations throughout an ingot as a function of the number of passes; a discussion of the largely unexploited continuous multistage techniques; extensive coverage of solidification methods for growing and controlling properties of semiconducting crystals.

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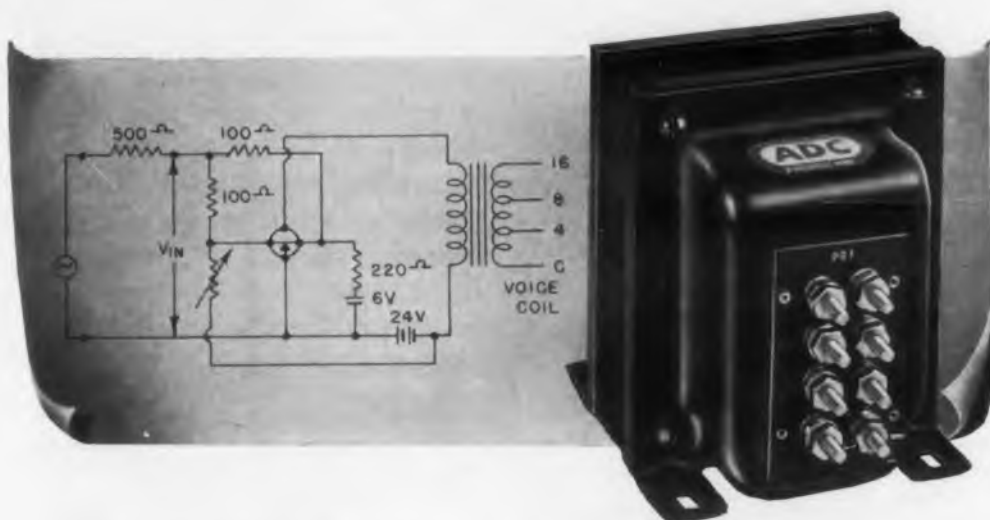
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What The Russians Are Writing

J. George Adashko



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INFORMATION THEORY

On the Probability of n-Coincidences by A. R. Livshitz. REE 8/57, pp 947-950, 3 figs.

Statistical discussion of the problem of determining the probability of coincidence of pulses in n-pulse random sequences. Equations are derived for the probability of coincidence and for the average duration of coincidence for equal and different duration of pulses contained in the pulse sequences. Reference is made to "Theoretical Aspects of Asynchronous Multiplexing" by W. D. White, *Proceedings IRE*, Vol. 38, No. 3, pp 270-275.

Estimate of the Parameters of the Distribution of a Random Function at Limited a Priori Data by Yu. P. Leonov and L. A. Tel'ksnis. AT 11/57, pp 984-998, 6 figs.

The authors show that reducing the a priori data concerning the parameters whose estimate is being sought can be effected if one can verify the correctness of certain hypotheses concerning these parameters. Reference is made to a large number of standard American works on prediction and statistical approaches to information theory.

From Mechanical Relays to Synchronous Static Detectors by A. A. Pirogov. EC 11/57, pp 6-16, 2 figs.

Although this is essentially devoted to the development of information theory in the U.S.S.R., it does have a detailed description of Kotelnikov's maximum interference-immunity theory. This has received a lot of publicity in recent times. The article also discusses efforts of Soviet scientists to overcome certain substantial informational defects of present-day communication systems.

Correlation Function and Energy Spectrum of Speech Signals that are Strongly Limited in Amplitude by Yu. G. Rostovtsev. EC 12/57, pp 45-49, 5 figs.

The author calculates the correlation function and the energy spectrum of speech signals that are limited (above 40-50 db) so as to have the signal acquire

rectangular form. The jumps take place at the instant when the values of the speech signal are zero. The sensible information is carried by the zero points of the signal.

Principal Problems in the Theory of Signals and Tasks in Its Further Development on the Basis of a New Stochastic Model by N. A. Zheleznov. RE 11/57, pp 3-12, 1 fig.

Assuming the spectrum is limited, in the analysis of a basic model for a modern theory of signals, leads to a complete statistical breakdown of the signal and leads to the impossibility of forming these signals in physically realizable systems. The limited nature of the signal concept excludes all types of radio signals. A new stochastic model, which retains the principal properties of real signals, is proposed. Refers to the standard articles by Shannon, Paley, Wiener and Middleton.

Optimum Regulation of Parameters of a Radio Line by S. I. Samoylenko. EC 12/57, pp 3-8, 2 figs.

To increase the amount of information transmitted per unit time under varying transmission conditions, it is possible to employ optimum regulation of the parameters of the radio line, the optimum depending on the transmission conditions. A procedure is examined for constructing optimum-regulation systems in the case of continuous and binary-coded signals. The method is illustrated by an example of optimum regulation of the amplitude threshold level in the transmission of communication coded with a binary code. Reference is made to an article by R. A. Silverman, *Transactions IRE*, IT-1, No. 3, 1955.

CIRCUITS

Procedure for Calculating the Optimum Parameters of DC Bridge Measuring Circuits by E. A. Yakubaytis. Izvestiya (Bulletin), Academy of Sciences, Latvian SSR, 6/57, pp 95-109.

A procedure is given for choosing the optimum parameters of a measurement dc bridge circuit operating with an input from an amplifier having a control

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RUSSIAN TRANSLATIONS

winding (magnetic dynamoelectric, carbon pile, etc.) The nonlinear bridge elements used in this article are barreters, but the procedure described can be readily extended to include other bridge circuits with nonlinear elements, whose characteristics lend themselves to piecewise-linear approximation.

Synthesis of Networks with Lumped Elements, Which Reproduce the Properties of Networks with Distributed Constants by N. S. Kochanov. RE 11/57, pp 72-78, 6 figs.

Considers the problem of representing several irrational and transcendental functions, and expressing the input impedance of a long line, with the aid of continuous fractions. It is shown possible to synthesize two and four-terminal networks with lumped elements, simulating the properties of long lines both with respect to the input impedance and the propagation constant.

Certain Problems in the Theory of Microwave Tetrode Oscillators by V. S. Mikhaylov. RE 12/57, pp 3-9, 6 figs.

The author considers the electronic phenomena that take place in the screen grid-anode region of a planar tetrode. He derives formulas for the efficiency of the microwave tetrode oscillator used either for power amplification or for frequency multiplication. Equations are derived for the motion of the electrons and for the coefficient of energy utilization of a single electron.

Simplified Design Method for a Transistor Amplifier Stage by A. A. Sokolov. AT 12/57, pp 1139-1141, 1 fig, 3 tables.

In this simplified procedure the transistor equivalent circuit is taken to be an active four-terminal network, thus leading to rather simple design equations.

KEY

The sources of the Russian articles and their dates of issue follow the authors' names. Here is the key to the names of the journals in which the articles originally appeared.

- AT** Automation and Telemechanics (*Avtomatika i Telemekhanika*)
- CJ** Communications Journal (*Vestnik Svyazi*)
- EC** Electrical Communications (*Elektrosvyaz'*)
- IET** Instruments and Experimental Techniques (*Pribori i Tekhnika Eksperimenta*)
- R** Radio
- RE** Radio Engineering (*Radiotekhnika*)
- REE** Radio Engineering and Electronics (*Radiotekhnika i Elektronika*)

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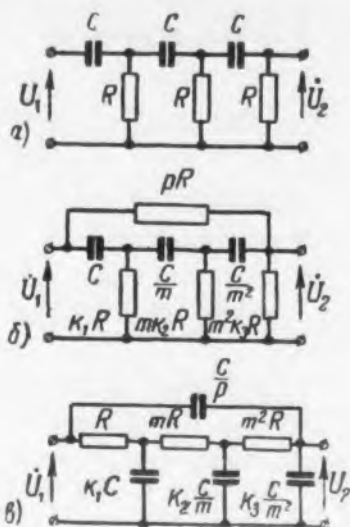


Fig. 1. Typical ladder networks used frequently in vacuum tube oscillators for feedback.

Improving the Parameters of RC Ladder Networks by I. A. Zakhariya. RE 11/57, pp 66-71, 7 figs.

This article analyzes improvement in the properties of ladder RC circuits by bridging. Comparative graphs are given for a three-element and four-element network with parallel resistances. Formulas are derived for the characteristics of the three-element RC circuit for changes in individual resistance and progressive changes in the circuit elements. The basic networks are shown in Fig. 1.

Increasing the Useful Power of a Tuned Semiconductor Amplifier by Increasing Its Efficiency. Part I by L. S. Berman. RE 11/57, pp 62-65, 3 figs, 2 tables.

Since there are no practical limitations to the emission current in transistors, the useful power is limited principally by the maximum heat dissipation. By increasing the efficiency of a tuned semiconductor amplifier with an additional tuned circuit to filter the third harmonic, it is possible to double the useful power compared with the usual circuit, using equal dissipation in both cases.

TRANSLATIONS AVAILABLE

ELECTRONIC DESIGN is gratified to learn of the growing availability of full translations of important Russian electronics journals.

Consultants Bureau, Inc. of 227 W. 17th St., New York 11, N.Y. translates *Automation and Telemechanics* regularly.

Pergamon Press of 122 E. 55th St., New York 22, N.Y. is preparing translations of *Radio Engineering*, *Radio Engineering and Electronics*, and *Electrical Communications*.

Readers interested in specific Russian journals can obtain more information by writing directly to one of these publishers.



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Insertion Loss	10 db			zero db at low freq.; approx. 0.1 db at 250 mc			approx. 0.2 db. 250-500 mc		
DB Switched	41 db in 6 steps						101 db in 9 steps		
Steps	20 db, 10 db, 5 db, 3 db, 2 db, 1 db						20 db, 20 db, 20 db, 20 db, 10 db, 5 db, 3 db, 2 db, 1 db		
Frequency Range	DC to 500 mc (useful to 1000 mc)								
Accuracy of Attenuation	1.0 db max at 500 mc 0.5 db max at 250 mc Better accuracy at lower frequencies						1.5 db max at 500 mc 0.75 db max at 250 mc		
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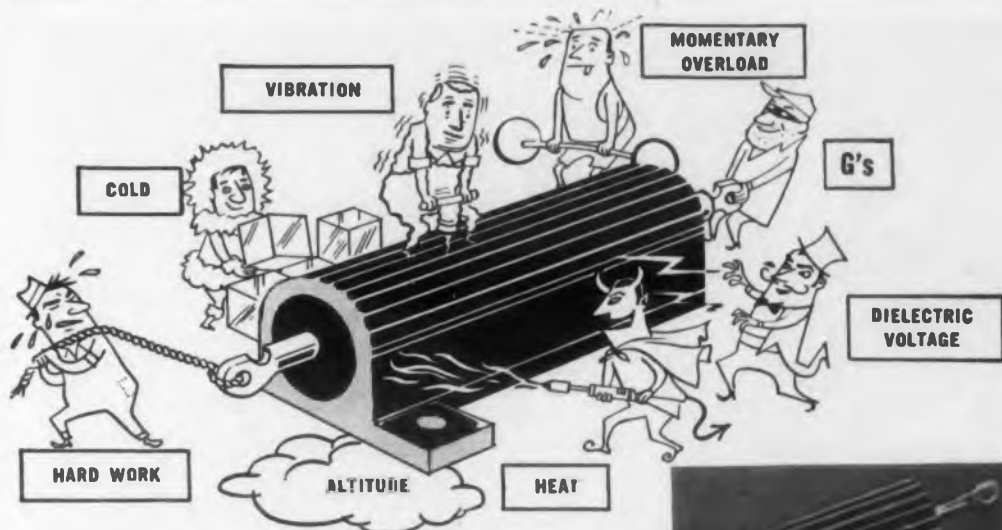
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HC	.002-2.0	1,000-20,000 800-15,000V Pulse	-60°C to +75°C	Pulse Forming Networks, RF Coupling & Bypass, Pulse Coupling & Despiking
TE	.002-5	4,000VDC-18KV 3,500V Pulse-15KV Pulse	-60°C to +200°C	Pulse Forming Networks, RF Coupling & Bypass, Pulse Coupling & Despiking
TC	.002-5	7,500-30,000	-60°C to +200°C	DC Filter



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RUSSIAN TRANSLATIONS

Calculations for Grounded Grid Oscillators by Ye. P. Korchagina and G. M. Utkin. RE 11/57, pp 29-38, 14 figs.

Discusses the choice of the optimum operating modes for amplifiers and frequency multipliers with grounded grids. If the resonant impedance of the tank circuit is limited, the energy relations in the plate circuit must take into account the power consumed by the preceding state of the transmitter. Recommendations are given concerning the choice of the cutoff angle and the amplitude of the plate-current pulse in amplifiers and frequency multipliers with allowance for the power gain of the stage.

Transients in a High Frequency Amplifier-Detector System by L. S. Gutkin and O. S. Chentsova. RE 11/57, pp 50-61, 19 figs.

A preceding article by the same authors (Radiotekhnika, April 1957) showed that the analysis of transients in a system comprising a high frequency amplifier and a strong signal diode detector is carried out more simply and obviously by using a low-frequency equivalent. In this article the method proposed is applied to the analysis of transients in the most widely used detector circuits (tuned resonant circuit, untuned resonant circuit, two coupled circuits).

Square-Law Detection with Aid of a Semiconductor by O. V. Sorokin. REE 10/57, pp 1293-1294, 3 figs.

This is a continuation of the subject discussed by the author previously in the May 1957 issue of Radiotekhnika i Elektronika, p 664.

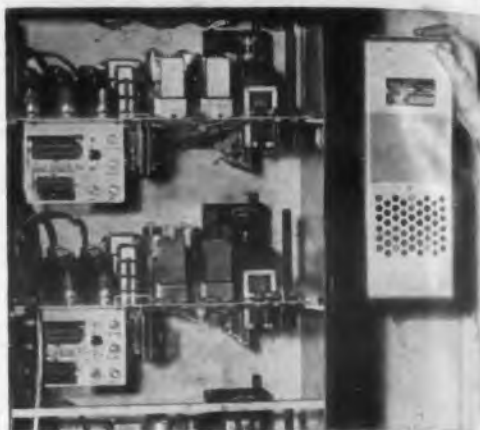
Use of Nonlinear Feedback to Eliminate Saturation of Transistors in Pulse Circuits by B. N. Kononov. REE 10/57, pp 1253-1260, 9 figs.

A method is proposed to eliminate saturation in junction transistors and the associated delays in the pulse circuits with nonlinear feedback. Two ways to design these circuits are shown. In addition to eliminating delay, nonlinear feedback extends the limits of permissible dispersion of transistor current gain. This makes it possible to use transistors whose gain ranges from a certain minimum to infinity without a change in circuit parameters. Refers to work by Ebers & Moll (*Proceedings IRE*, 1954, Vol. 42, Page 1761), Moll (*Proceedings IRE*, 1954, Vol. 42, Page 1773), Cooke-Yarborough (*Journal of Electronics*, 1956, Vol. 1, Page 539), Bothwell & Booth (*Transactions IRE*, 1956, EC-5, Page 132) and Prom & Crosby (*Transactions IRE*, 1956, EC-5, 4, Page 192).

Semiconductor DC Transformer by G. S. Tsykin. RE 12/57, pp 56-62, 8 figs.

The article discusses several methods for trans-

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forming dc at one voltage into dc at another voltage, at power ratings which can supply vacuum tube equipment. A semiconductor keying power amplifier is proposed, controlled by a master oscillator. The fundamental properties of the design are given. See Figs. 2-5.

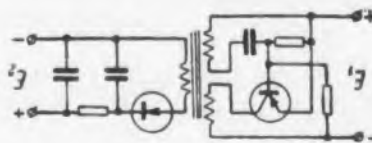


Fig. 2. Basic dc to dc transformer using a transistor to generate nearly rectangular pulses and diodes to rectify them.

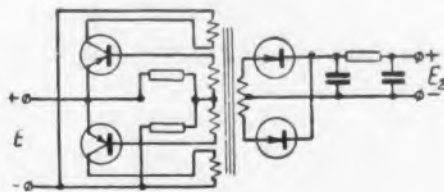


Рис 2

Fig. 3. Full wave version of the same scheme.

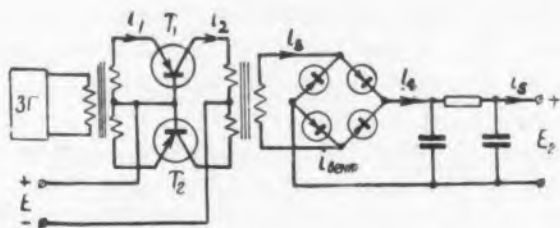


Fig. 4. The circuits of Figs. 2 and 3 have the shortcoming that the frequency and waveform of the self-excited oscillations vary with the load and with the supply voltage. A better semiconductor dc transformer would be the one shown here. It includes a master oscillator with rectangular waveform, a power amplifier, a semiconductor rectifier, a filter, the load, and the dc power source whose voltage is to be transformed. Theoretically its efficiency may reach 90 to 95 per cent.

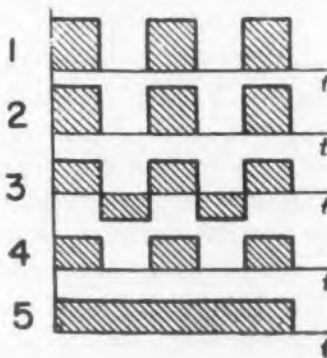


Fig. 5. Waveforms in the circuit of Fig. 4. 1—emitter current, 2—collector current, 3—input to rectifier, 4—current to filter, 6—output current.

(continued on following page)

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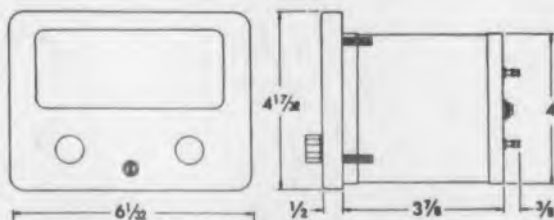
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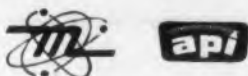
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RUSSIAN TRANSLATIONS

Scheme for Switching Radio Broadcast Programs by P. A. Palladin. CJ 1/58, p 12.

Brief description of a circuit permitting automatic selection of programs and checking the correctness of the switching in a central broadcast studio.

Auxiliary Multi-Channel Transistorized Amplifier by K. P. Yegorov and I. V. Sukhodoyev. EC 12/57, pp 58-64.

The authors discuss the possibility of designing a group amplifier for multi-channel communication using pnp transistors, and describes methods for reducing the noise.

SPUTNIK

Second Soviet Artificial Earth Satellite. R 12/57, pp 24-29, 5 figs.

Reprint of description, unsigned, of the Soviet second Sputnik, originally printed in "Pravda" November 13, 1957. The arrangement and the description of some of the electronic and cosmic-ray apparatus are described.

Exact Determination of the Velocity of a Satellite by S. Khaykin. R 12/57, pp 5-7.

Outlines the fundamental principles, in a popular manner, of how the speed of a moving satellite can be determined by its frequency shift.

Preliminary data on Propagation of Radio Waves by A. Kazantsev. R 12/57, pp 7-8.

Relates briefly how signals from the satellite can throw new light on the various ionized layers around the atmosphere.

COMPONENTS

Single Cycle Switching Circuits with Intermediate LC Network Employing Ferrites with Rectangular Hysteresis Loop by Ya. G. Koblents and D. A. Yakovenko. EC 11/57, pp 101-112, 12 figs.

Description of a contactless magnetic switching element developed by the authors, intended for automatic control equipment in automatic telephone stations and for long-distance apparatus.

Germanium Rectifiers by B. A. Piontkovskiy. CJ 11/57, pp 5-7, 4 figs.

Most rectifiers used for power supply for communications apparatus contain selenium rectifiers. Recently the Russian industry has developed new semiconducting germanium rectifiers, whose electrical parameters and properties are considered in this article.

Estimate of Nonlinear Properties of Junction Transistors by A. I. Borisov. EC 12/57, pp 37-44, 8 figs.

The author introduces coefficients that charac-

Using Thermistors

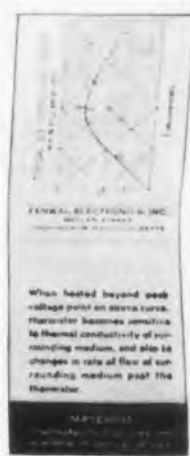
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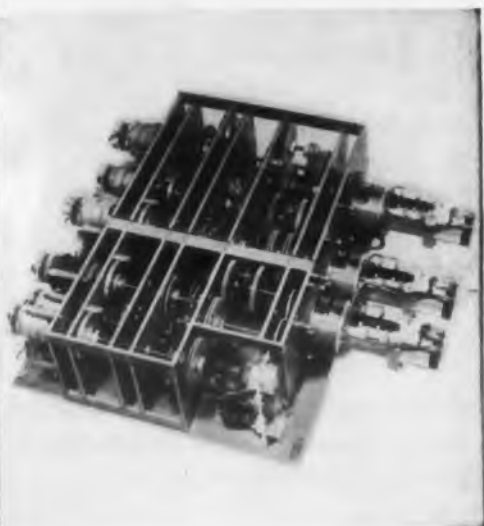
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terize the fundamental nonlinear properties of junction transistors. He shows that the nonlinear distortion introduced by the transistor is due to electric processes originating in the emitter and collector p-n junctions in the base region and he recommends a method for selecting transistors with least pronounced nonlinear properties. Reference is made to an article by W. M. Webster, *Proceedings IRE*, Vol. 42, Page 914-920, 1954.

RGM-500, an Oscillator Triode with Continuous Vacuum Pumping by A. L. Mints, M. I. Basalayev, N. I. Oganov, and Ye. V. Rudnev. *REE* 10/57, pp 1240-1252, 10 figs, 2 tables.

Describes the construction of a dismountable oscillator triode with continuous vacuum pumping, having a useful power of 500 kw. The tube has several features that distinguish it from previous models. The article contains an extensive description of the mechanical and electrical parameters of the tube, as well as some test results.

Effect of Impurity Distribution in the Base of Drift Transistors on Frequency Characteristics by Ya. A. Fedotov. *REE* 10/57, pp 1261-1270, 4 figs, 1 table.

The distribution of impurities in the base due to diffusion, determines certain properties of a transistor. In particular, this diffusion produces an internal accelerating field, which affects the process of the charge transport from the emitter to the collector. This article considers the frequency characteristics of such drift transistors, and discusses the diffusion of impurities in germanium, the connection between the collector voltage, thickness of the junction, and the capacitance of the junction, and also the influence of uneven distribution of the impurities in the base region on the motion of the carriers from the emitter to the collector. The maximum power gain frequency is also determined.

RADIO ASTRONOMY

New Radio Telescope (Preliminary Communication) by V. V. Vitkevich and V. A. Udal'tsov. *REE* 12/57, pp 1548-1549, 1 fig.

Short report on the new large radio telescopes, installed in July 1957 at the Crimean Scientific Station of the Physics Institute of the Academy of Sciences, USSR. The dish has a diameter of 31 meters and was used to study radio waves from the sun and from the Crab nebula at 50 and 10 cm, and from the sun at 3 cm.

A more detailed report on this article appears in *Soviet Bloc International Geophysical Year Information* published by the U.S. Department of Commerce, Office of Technical Services, Washington 25, D.C.

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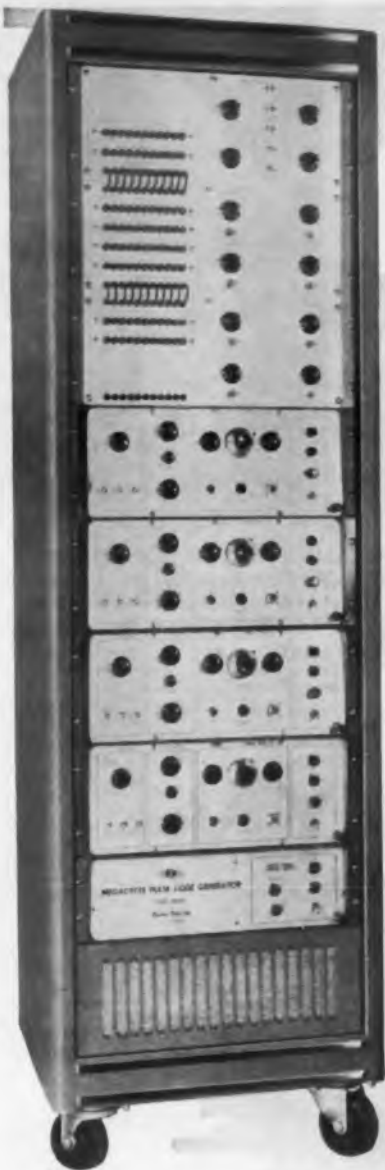
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E. Brenner

Temperature Stabilization Of Transistors

BOTH LINEAR and non-linear circuitry can be used for temperature compensation. The use of non-linear elements can, in principle, completely compensate for changes in quiescent collector current, collector voltage or gain.

If the collector current is maintained constant an experimental curve relating

emitter-base voltage to temperature can be obtained. For an OC811 transistor this curve is a straight line with slope -2.7 mv/deg C. In general the temperature dependence of emitter-base voltage (V_{EB}) with temperature (θ) gives values of $\Delta V_{EB}/\Delta \theta$ between -2 and -3 mv/deg C.

A temperature dependent resistor (semiconductor) can be used, as illustrated, to compensate for the transistor characteristics. For a limited temperature range such elements are described by the equation

$$R = R_0 e^{-c\Delta\theta}$$

where c depends on the temperature but is treated as constant over small ranges. For the circuit shown one sets

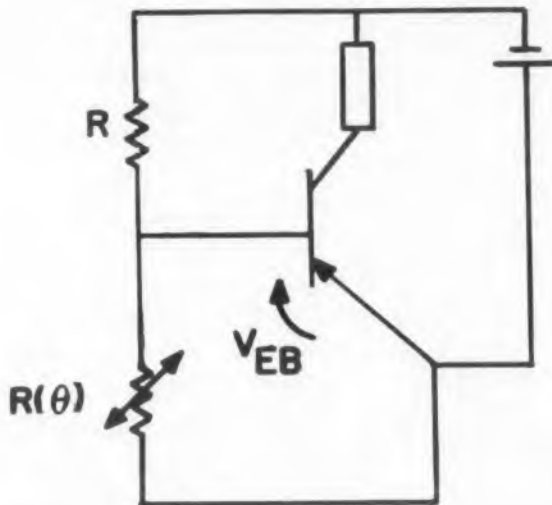
$$\frac{V_{EB}}{\Delta\theta} = \frac{d}{d\theta} \left(\frac{E \cdot R(\theta)}{R + R(\theta)} \right) \approx \frac{E}{R} \frac{dR(\theta)}{d\theta}$$

Because the parameter c is actually temperature dependent, compensation is achieved only over a limited range of temperatures.

The range can be extended by linearization, i.e. by connecting a linear resistor in series or in parallel with the temperature dependent semiconductor. This requires, of course, that the non-linear element have greater temperature sensitivity.

The original paper includes a review of the basic temperature/transistor characteristics relationships and a discussion of various linear compensation schemes.

Abstracted from an article by R. Lunze, Nachrichtentechnik, Vol. 8, No. 3, March 1958, pp 98-108.



Transistor compensation using a temperature dependent resistor, $R(\theta)$, in a voltage divider.

Transistor Oscillators

LINEAR analysis of the block diagram shown in Fig. 1 indicates that two types of transistor oscillators can be built. In one case the conditions for oscillation depend on the parameters of the transistor; in the second the frequency of the oscillation is independent of the transistor and depends only on the frequency selective feedback network.

If the ideal transformer with turns ratio a is considered part of the transistor four pole, as shown in Fig. 2, then the Barkhausen criterion for oscillation becomes

$$a(-\alpha + h_{11}) \geq \frac{a^2(1-\delta)A_{12}}{Z_{2s}} + Z_{1s}A_{21} + a^2A_{22}\frac{Z_{1s}}{Z_{2s}} + A_{11}$$

where α is the short circuit current gain; h_{12} is the feedback voltage gain (generally negligible compared to α); Z_{1s} and Z_{12} are the short circuit input and output impedances respectively; the A_{ij} 's are the elements of the cascade matrix (general circuit parameters ABCD) of the coupling four-pole. The parameter is the "short circuit stability" defined as $Y_{21}Y_{12}Y_{22}Y_{11}$ where Y_{ij} represents the elements of the open circuit admittance matrix of the transistor without the transformer.

The ideal transformer is introduced into the calculations for convenience. In the physical realization of the coupling network it is often possible to "absorb" this element by using unsymmetrical four-poles. If the coupling network is assumed to be a symmetrical lattice with reactance X_1 in the series arm and reactance X_2 in the cross-arm, then the conditions for oscillations are described by the following relationships:

To satisfy the amplitude condition, i.e., "magnitude of gain"

$$(-\alpha + h_{12})_{min} = 2 \frac{X_1 + X_2}{X_2 - X_1} \left(\frac{Z_{1s}}{Z_{2s}} \right)^{\frac{1}{2}}$$

where a^2 is chosen as the ratio Z_{2s}/Z_{1s} .

To uniquely specify the frequency of

oscillation

$$-a^2(1-\delta)X_1X_2 + Z_{1s}Z_{2s} = 0$$

This last equation can be satisfied if

$$X_1X_2 = Z_{1s}Z_{2s}/a^2(1-\delta)$$

or if the product X_1X_2 is indeterminate in the sense that X_1 has a zero when X_2 has a pole or vice versa. In the latter case the frequency of oscillation is independent of the transistor parameters. These parameters appear in the last equation through the quantity δ .

In the original paper several realizations of each type of oscillator without ideal transformer are discussed: the problem of losses; the possibility of not meeting exactly the requirement for zero (or pole) in X_1 when a pole (or zero) is required in X_2 . In either case the frequency of oscillation differs slightly from the value calculated from the last equation.

Abstracted from an article by J. Paul, Nachrichtentechnik, Vol. 8, No. 3, March 1958, pp 109-116.

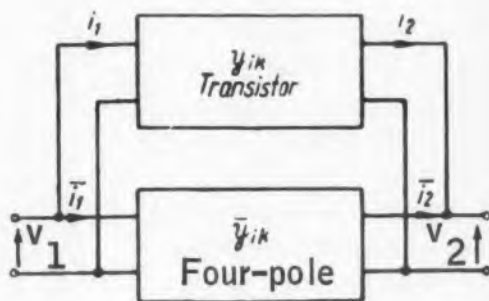


Fig. 1. Block diagram of the oscillator.

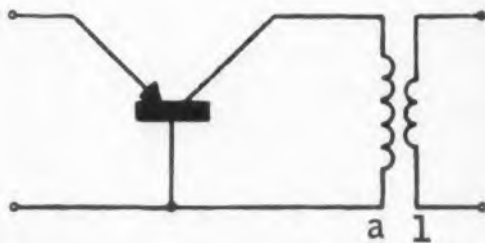


Fig. 2. Transistor with ideal transformer. The transformer is introduced to facilitate computations. The use of unsymmetrical four-poles often eliminates the transformer.

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MEETINGS

July 24-25: 5th Annual Symposium on Computers and Data Processing

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Aug. 6-8: Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers

Hotel Statler, Los Angeles, Calif. Sponsored by AIEE. The four technical sessions will include: technological and theoretical aspects of non-linear magnetics and magnetic amplifiers; computer applications; special purpose devices and applications; "new frontiers" in the field. Exhibits will be displayed by 40 manufacturers selected for their contributions to the industry. For more information about the conference, write AIEE, 33 West 39th St., New York 18, N.Y.

Aug. 13-15: Conference on Electronic Standards and Measurements

NBS Boulder Labs., Boulder Colo. Sponsored by the Professional Group on Instrumentation of IRE, Electronic and High-Frequency Instruments Committee of AIEE, and the Radio Standards Lab. of the National Bureau of Standards. Six technical sessions will cover the following subjects: The Relationship of Standards to Physical Constants; Frequency and Time Interval Standards; Direct-Current and Low-Frequency Standards; Radio-Frequency Standards (Measurement of voltage, current, power, impedance, attenuation, phase shift, field strength); Microwave Standards (Measurement of power, impedance, attenuation, noise); and The Organization and Operation of Standards Laboratories. Write James F. Brockman, National Bureau of Standards, Boulder Labs., Boulder, Colo.

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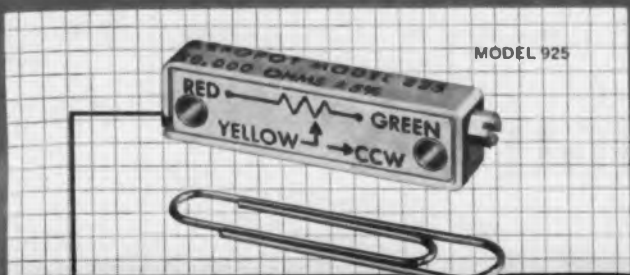
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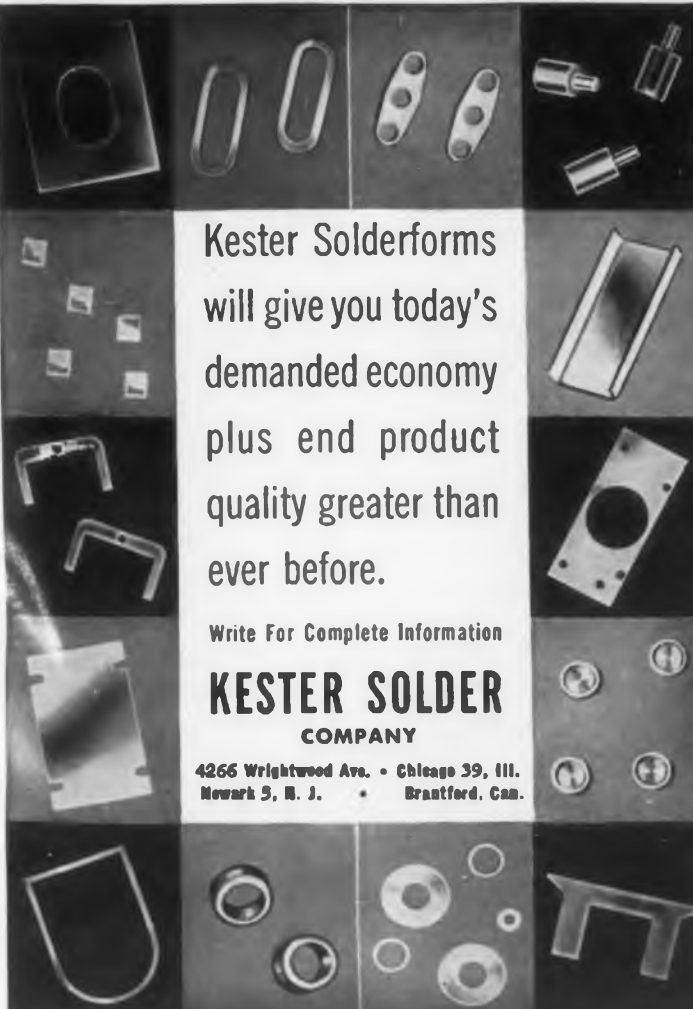
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Rackham Memorial Auditorium, Detroit, Mich. Co-sponsored by PGIE and AIEE. Address queries to William R. Thurston, General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

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Simple operation, widest usefulness, high regulation, broad voltage range, rugged dependability—these characteristics have made -hp- Power Supplies basic experimental, testing and production tools in America's laboratories and factories. The many jobs these precision instruments perform daily include powering low level amplifiers, constant frequency oscillators, pulse circuits with heavy instantaneous current demands, oscillators, small transmitters, klystrons and "bread board" arrangements from the most simple to the most complex. Brief data on -hp- power supplies appear in the table at right. For complete details on -hp- supplies meeting your power needs, call your -hp- representative for demonstration on your bench. Or, write direct.



Model	Characteristics	Regulation	Current	Voltage Range	Hum & Noise Level	Price
710B	General purpose dc/ac supply	$\pm 1\%$, 0 to 75 ma	100 ma	100 to 360 v dc; 6.3 v ac	Less than 0.0005 v	\$110.00†
711A	Similar to 710B wider voltage range	Less than $\pm 0.5\%$ or 0.1 v, no load to full load	100 ma	0 to 500 v dc; 6.3 v ac	Ripple less than 0.1 mv	225.00†
712B	Heavy duty, 4 outputs, 0-1 msec response	Less than 50 mv no load to full load	200 ma (pos. dc)	0 to 500 v dc; -300 v dc fixed bias; 0 to -150 v dc variable bias; 6.3 v ac	Ripple less than 500 uv	365.00†
715A	Klystron supply; square wave, external modulation	Less than 1%, no load to full load	50 ma (at 400 v)	250 to 400 v dc beam; 0 to 900 v dc reflector; 6.3 v ac	Ripple less than 7 mv	300.00

† Rack mount available at slight additional charge.

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



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- ✓ 150 ma output 0 to 30 v dc, continuously variable
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- ✓ Ripple less than 150 μ v rms
- ✓ Metered output and current limiter prevent damage to transistors under test
- ✓ Compact transistorized construction

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New  200 KC oscilloscope, \$435.00.

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RCA also announces the addition of three types to its expanding line of POWER OUTPUT TRANSISTORS: 2N176, 2N351, 2N376. For additional information on these types and the complete line of RCA transistors, contact your RCA field representative at the field office nearest you. For technical data on RCA POWER TRANSISTORS listed above, write RCA Commercial Engineering, Section G-18-NN-1, Somerville, N. J.

Type	MAXIMUM RATINGS			TYPICAL OPERATION*		
	Collector ^a Dissipation Watts	Peak Collector-to Base Volts	Peak Collector Current Amperes	Class A Service		Class B Service
				Max.-Sig. Power Output Watts	Power Gain db	Max.-Sig. Power Output (2 transistors) Watts
2N301	11	-40	-3	5	33 at 5 watts	12
2N301-A	11	-60	-3	5	33 at 5 watts	12
2N176	10	-40	-3	2	35.5	—
2N351	10	-40	-3	4	33.5	—
2N376	10	-40	-3	4	35	—

*At mounting-flange temperature of 80 °C



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