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TRANSISTORS

'57



NEW IRC®

Distributed Parameter Delay Lines

FEATURE UNIFORMITY, STABILITY AND LOW COST

IRC's extensive mass production experience and technique in the manufacture of continuous lengths of wire wound resistive elements have now been utilized to produce a uniform high-quality, low-cost, distributed-constant delay line. Simplicity of design permits close control of electrical characteristics even to providing, in many applications, unusual phase characteristics to meet customers' special requirements.

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TIME DELAY 0.2 to 1.0 microseconds
IMPEDANCE 500 to 2500 ohms standard; higher and lower are available on special request
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OPERATING TEMPERATURE 65°C

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 Toronto, Licensee

Send technical data and prices on the new IRC Distributed Parameter Delay Lines.

NAME _____
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CIRCLE 1 ON READER-SERVICE CARD FOR MORE INFORMATION

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*for an entirely
new range of
time delays*

Delay Intervals:

$\frac{1}{10}$ to 5
seconds

Recovery Rate:

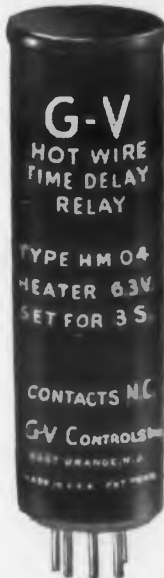
extremely
rapid

*specify
sturdy, dependable,
application-tested*



G-V Hot Wire Time Delay Relays

SERIES H



WRITE for Publication No.35—
complete engineering
data and drawings.

Designed for delay intervals which are longer than those produced by magnetic relays and shorter than can be produced by the usual types of thermal relays, these G-V Hot Wire Time Delay Relays make possible many simplified, lightened and improved designs.

How They Operate: G-V Series H Time Delay Relays employ a group of nickel-chromium alloy wires, 8 to 20 strands electrically in series and mechanically in parallel, as the actuating element. A mechanism holds these wires under tension and when the energizing current passes through these wires, heating them and causing elongation, the mechanism multiplies this and moves the contacts into or out of engagement.

Over two years of successful field service in electronic, aeronautical and industrial equipment prove these new G-V relays to be dependable, efficient and accurate.

ADJUSTABLE DELAY even though hermetically sealed
DC or AC of any frequency for energization

SMALL AND LIGHT. $\frac{3}{4}$ " diameter, $2\frac{3}{8}$ " length. Weight: 1 oz.

WIDE AMBIENT RANGE compensated from -70°C to 100°C or higher

CONTINUOUS ENERGIZATION without damage

AVAILABLE in 7-pin Plug-in and Flanged designs

G-V

G-V CONTROLS INC.

18 Hollywood Plaza, East Orange, New Jersey

CIRCLE 2 ON READER-SERVICE CARD FOR MORE INFORMATION

Now, your choice of SILICON RECTIFIERS

from one reliable source
(All available in production quantities)



Diffused junction STUD RECTIFIERS

Temperature Range, minus 65°C to plus 165°C

AVERAGE CHARACTERISTICS			
Type	Peak Inverse Volts*	Average Rectified Current** Amps.	Reverse Current (max.) at PIV mAdc at 25°C
CK846	100	1.0†	0.002
CK847	200	1.0†	0.002
CK848	300	1.0†	0.002
CK849	400	1.0†	0.002
CK850	500	1.0†	0.002
CK851	600	1.0†	0.002
1N253	95	1.0‡	0.010
1N254	190	0.4‡	0.010
1N255	380	0.4‡	0.010
1N256	570	0.2‡	0.020

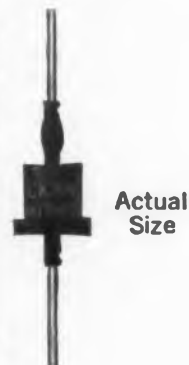
† Rated at 150°C ‡ Rated at 135°C



Diffused junction WIRE-IN RECTIFIERS

Temperature Range, minus 65°C to plus 165°C

AVERAGE CHARACTERISTICS				
Type	Peak Inverse Volts*	Average Rectified Current** Amps.		Reverse Current (max.) at PIV mAdc at 25°C
		150°C Ambient	100°C Ambient	
1N537 (CK840)	100	0.25	0.5	0.002
1N538 (CK841)	200	0.25	0.5	0.002
1N539 (CK842)	300	0.25	0.5	0.002
1N540 (CK843)	400	0.25	0.5	0.002
CK844	500	0.25	0.5	0.002
CK845	600	0.25	0.5	0.002



POWER RECTIFIERS

Temperature Range, minus 65°C to plus 165°C

MAXIMUM RATINGS					
Type	Peak Inverse Volts	125°C Case Temperature		25°C Case Temperature	
		Average Rectified Current** Amps.	Peak Current Amps.	Forward Voltage at 5 amps.	Reverse Current (max.) at PIV
CK774	25	5	15	1.5	5 mA
CK775	60	5	15	1.5	5
CK775-1	125	5	15	1.5	5
CK776	200	5	15	1.5	5
CK777	325	5	15	1.5	5

*PIV ratings apply from -65°C to +150°C **Average rectified current into inductive or resistive load



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CIRCLE 3 ON READER-SERVICE CARD FOR MORE INFORMATION

Editorial

Transistor Noise

Special issues generally run the risk of offering nothing of interest to a number of readers. Not so with transistors. All circuit and equipment designers are interested. The promise of unlimited life is a feature which can't be overlooked.

This is not to say transistors threaten the existence of vacuum tubes. Metal and ceramic tubes are available to operate at 500 to 800 C. The present target for top transistor operation is 500 C. By the time this is achieved, tubes will probably have exceeded 1000 C. Tubes are still well out front with regard to power, frequency response, high-temperature operation and tolerance to radiation. We expect transistors to catch up. According to Dr. Hebb of General Electric, there is every reason to expect improvements in the first three areas. Except for possible inherent limitations in radiation tolerance, Hebb finds no theoretical reason why transistors cannot match many types of tubes.

What seems to be needed is more competition. This may seem paradoxical in view of the fact that there are 430 different types in our fifth Transistor Data Chart, compared to 270 for last year. (These are types commercially available.) This impressive quantity belies the real situation. Only in a few cases do different manufacturers make the same or interchangeable types. (In only five cases are RETMA types made by more than one manufacturer.) Military designers in particular are reluctant, or may find it impossible, to specify transistors if there is only a single source available.

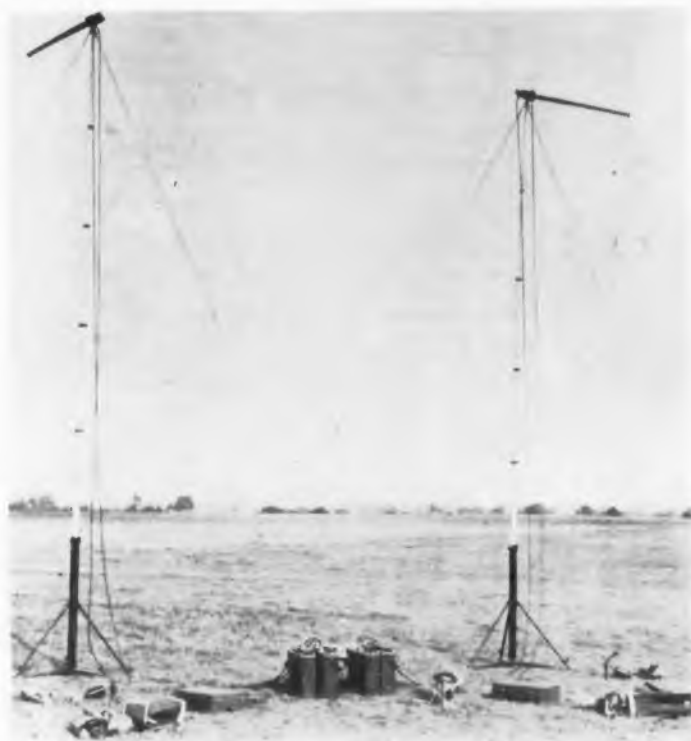
What may be needed is standardization of user demands. The perennial cry has been that manufacturers don't standardize. It will be a long time before there is or can be any standardization of manufacturing processes. Until that time, there will be few identical types. In the meantime, transistor manufacturers will put out many new types, more or less sampling the market. Those that look like they can be sold profitably will be manufactured. This means the designer's requirements and demands can influence what is made.

User criticisms about too many types but no similar types are worthless until there is an effort on the part of users to guide manufacturers intelligently. Tantalizing both users and manufacturers are valid accelerated life tests. Thwarting concentrated effort to take stock of what might be best for the future of the transistor industry is the celerity of manufacturers turning out better units and the frantic effort of users trying out all the new items. But such activity almost guarantees progress.—JAL

Next issue watch for the first of a two-part series on transistor network design.

Engineering Review

For more information on developments described in "Engineering Review," write directly to the address given in the individual item.



Two of the portable microwave stations are placed back to back to form a link. Each station can be broken down into individual units that can be carried on a man's back. The amount of time it takes to erect one of these stations is about five minutes.

Weighing less than 46 lbs per unit, a microwave communications system has been developed which should prove highly applicable to a multitude of military, emergency and industrial situations. Designed in Paris, France, by the Compagnie Generale de Telegraphie Sans Fil, the system is being marketed in this country by International Electronics Corp. of Mineola, Long Island, N.Y.

The purpose behind the design of the equipment was to furnish a system that could be carried piecemeal on men's backs and could be quickly and

easily installed. As it turned out, one link of the MX-641 microwave system can be erected in approximately five minutes. The equipment is also waterproofed to allow floating it across bodies of water.

One of the components which gives this system a somewhat distinct appearance is the cigar-shaped antenna. Consisting of a disc-loaded aluminum rod, with the discs slightly varying in diameter and spacing according to frequency demands, the antenna has considerable advantages over parabolic designs in being quite light in weight and in having less wind resistance. Capable of producing a gain of about 18 db, the antenna can be easily attached to whatever offers itself, such as trees, telephone poles and the like. For the ordinary situation, a pneumatic mast permits raising of the antenna to a height of 22 ft. The length of the antenna is not critical; however, by making it longer, it becomes more directional.

A 2000 mc band was chosen in preference to a higher frequency so that rather long feeders to the antenna could be used without a crippling loss of power. Thus antennas can be set at considerable heights to achieve the required line of sight.

A terminal station, consisting of eight units, can be transported in a jeep, small trunk or by three



The microwave antenna with the new look can also be attached to trees and telephone poles. Offering less wind resistance than the parabolic type, the disc-loaded aluminum rod has a gain of about 18 db.

men over terrain inaccessible to vehicles. Voltages from 105 to 240 ac v can be used for power. A switch permits selecting the proper transformer connection for the supplied voltage. A test meter for monitoring and adjusting all the important circuits in both the radio and pulse chassis is also included. Simply by juxtaposing two terminal stations, a relay station can be established. Links up to 180 miles are possible by means of such stations placed about 30 miles apart.



The Seagoing Air Force: In order to fill a missile tracking gap in the 5000 mile test range off the coast of Florida, the Air Force ARDC has taken to the water in ships obtained from no one other than the Army. Six cargo vessels were converted into telemetry ships, which will receive data from missile test flights over the Atlantic ocean and transmit this data back to Cape Canaveral, Florida.

Engineering Review

Color TV Studies Missile Takeoff

The color of flash and flame spurt-ing from a missile during and shortly after takeoff can disclose considerable information concerning the missile's flight characteristics. Closed-circuit color TV will make the recording of such information possible, an accomplish-ment which was almost impos-sible previously without such a sys-tem. Required safety precautions and the variations in the brightness of the flame made it extremely difficult to observe its color.

The closed-circuit TV is being pur-chased by the Army from General Electric Co. The contract calls for del-ivery this month, and the system will be put to use at the Army's Missile Test Center at Cape Canaveral, Fla.

Lots of Juice

In 1963, 450 billion kw-hrs of electrical power will be required by American industry, according to Westinghouse Vice President A. C. Monteith. The figure is 12-1/2% higher than the esti-mate made in 1954.

Doped Gold Transistors

The development of doped gold processes, utilizing group 3 and 5 elements, for use in germanium and silicon semiconductor applications, is expected to eliminate major short-comings of conventional materials by operating at room temperatures, and producing bright, uniformly distrib-uted gold deposits in required thick-nesses, directly from the bath. Doped with antimony or other elements, de-pending on the desired physical properties, the process is the result of work done by Precious Metals Divi-sion, Sel-Rex Corp., Nutley, New Jersey.

Although the electronics industry has taken advantage of gold's unique properties for years, gold processes containing small percentages of group 3 and 5 elements have not been reliable in proprietary salts or solutions, heretofore.

CIRCLE 4 ON READER-SERVICE CARD ►

SILICON DIODES

FEATURES

- Recovery times under .15 μ sec
- High voltage ratings
- Operation up to 200°C
- High Inverse Resistance
- Subminiature size

MILITARY AND HIGH CONDUCTANCE TYPES

RATINGS AT 150°C AMBIENT			
Type	Maximum Inverse Operating Voltage (volts)	Maximum Average Forward Current (ma)	Maximum Inverse Current (μ a) @ V
IN457*	60	25	5 @ 60
IN458*	125	25	5 @ 125
IN459*	175	25	5 @ 175
IN486A	225	50	25 @ 225
IN488A	380	50	25 @ 380

*JAN Types

HIGH FREQUENCY AND FAST SWITCHING TYPES

RATINGS AT 25°C			
Type	Maximum Inverse Operating Voltage (volts)	Maximum Average Forward Current (ma)	Inverse Recovery Time (μ sec)
IN251*	30	75	.15
IN252	20	100	.15
SG213	200	30	.3
SG223	200	55	.5
SG228	200	80	1

*JAN Types

Write for Bulletin TE1350

GERMANIUM DIODES

FEATURES

- Complete Reliability
- Superior Forward Conductance
- Higher Inverse Resistance
- More Uniform Characteristics
- Greater Ruggedness

SPECIFICATIONS AND RATINGS AT 25°C

Type	Forward Current at +IV (ma)	Inverse Current at Specified Voltage (μ a @ V)	Max. Oper. Voltage (volts)	Description
IN270	200	100 @ -50	80	
IN277	100	250 @ -50 75 @ -10 @ 75°C	100	
IN276	40	100 @ -50	70	JAN TYPES
IN281	40	500 @ -50 30 @ -10	60	
IN126	5	500 @ -50 30 @ -10	60	
IN127	5	300 @ -50 25 @ -10	100	
IN198	5	250 @ -50 75 @ -10 @ 75°C	50	
IN283	200	20 @ -10	20	COMPUTER TYPES
T16G	40	100 @ -50 20 @ -10	60	
IN278	20	125 @ -50 @ 75°C	50	HI-TEMPERATURE TYPES
T22G	40	20 @ -10 @ 75°C	15	
T9G	100	20 @ -50 2 @ -10	60	HI-RESISTANCE TYPES
IN67A	5	50 @ -50 5 @ -5	80	

Other JAN types: IN38A, IN69, IN70, IN81, IN128
Write for Bulletin TE1300 & TE1319



Trans

SILICON Power

FEATURES

- Reliability at High Temperature
- High Power Handling Ability
- High Efficiency
- Rugged Construction
- Hermetically Sealed

MINIATURE TYPES

RATINGS AT 150°C AMBIENT			
Type	Peak Recurrent Inverse Voltage (volts)	Maximum Average Forward Current (ma)	Maximum Inverse Current (ma)
TJ10A	100	200	.5
TJ25A	250	200	.5
TJ40A	400	200	.5

SILICON RECTIFIER STACKS

RATINGS AT 125°C AMBIENT			
Circuit	DC Output		Stack Designation
	Voltage (volts)	Current (amps)	
6 ϕ Star	150	30	TL6S1A1/TR352
3 ϕ Bridge	325	18	TL6F1A1/TR352
3 ϕ Halfwave	1120	1.2	TD12Y6B1A4
1 ϕ Bridge	748	1.2	TD12B4C1A3
1 ϕ Center Tap	250	3.0	TD12C4C3A2

SILICON VOLTAGE REGULATORS and REFERENCES

FEATURES

- Excellent long-term stability
- High current handling ability
- Operation to 150°C
- Extended operating current range
- Small size, easy mounting
- Hermetically sealed

Reference assemblies are available with temperature coefficients to .002%. They are also available with voltage tolerances to 1% from 10 to over 100 volts. The assemblies are encapsulated in a miniature axial lead package.

"Leadership in semiconductors"

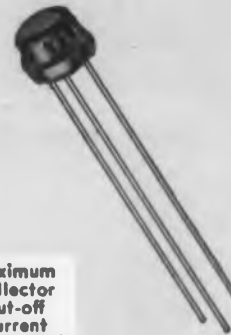
itron

SILICON TRANSISTORS

HIGH FREQUENCY TYPES

FEATURES

- Low I_{co} , typically under $.02 \mu a$
- Operation to $175^{\circ}C$
- Power Ratings of 200 mw
- High Frequency Operation
- Welded Hermetic Seal



Type	Minimum Common Emitter Current Gain β	Maximum Collector Voltage V_{ce} Peak (volts)	Typical Cut-off Frequency (mc)	Maximum Collector Cut-off Current @ $25^{\circ}C$ @ V_{ce} Max. (μa)
ST12	40	15	16	.5
ST32	40	30	16	.5
ST11	20	15	13	.5
ST31	20	30	13	.5
ST10	10	15	9	.5
ST30	10	30	9	.5

Write for Bulletin TB1353

RECTIFIERS

RATINGS AT $150^{\circ}C$ CASE TEMPERATURE			
Type	Peak Recurrent Inverse Voltage (volts)	Maximum Average Forward Current (ma)	Maximum Inverse Current (ma)
MILITARY TYPES			
IN253	95	1000	.1
IN254	190	400	.1
IN255	380	400	.15
IN256	570	200	.25
STUD MOUNTED TYPES			
TM47	400	3000	.5
TM64	600	1000	.5
MEDIUM POWER TYPES (amps)			
IN250A	200	20	5
TR301	300	10	5
TR402	400	20	5
HIGH POWER TYPES (amps)			
IN412A	100	35	5
TH402	400	35	5

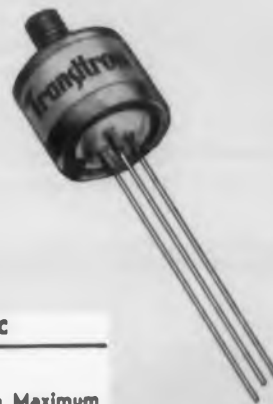
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GERMANIUM Power TRANSISTOR

FEATURES

- Operation to $85^{\circ}C$
- Linearity at High Currents
- Up to 10 watts Dissipation
- Low Thermal Resistance
- Small Size
- Hermetically Sealed



SPECIFICATIONS AND RATINGS AT $25^{\circ}C$

TYPE	Minimum DC Common Emitter Current Gain (β @ I_c)	Maximum Collector Voltage V_{ce} Peak (volts)	Maximum Collector Current (amps)	Maximum Power Dissipation (watts)
2N83A	8 @ 1.0A	60	3	10
2N83	8 @ .5A	60	2	10
2N84A	12 @ 1.0A	45	3	10
2N84	12 @ .5A	45	2	10

Write for Bulletin TB1320

Type	Voltage Range (volts)	Maximum Dynamic Resistance (ohms)	Maximum Current @ $25^{\circ}C$ (ma)	Maximum Current @ $125^{\circ}C$ (ma)
Subminiature				
SV-5	4.3- 5.4	55	50	10
SV-7	6.2- 8	8	30	6
SV-11	9.0-12.0	50	20	4
SV-15	13.5-18	120	14	3
SV-24	20 -27	300	10	2
Miniature				
SV-804	4.3- 5.4	55	150	30
SV-806	6.2- 8	8	90	18
SV-810	9 -12	50	60	12
SV-815	13.5-18	120	40	8
SV-824	20 -27	300	27	5
Power				
SV-904	4.3- 5.4	.5	2.0	500
SV-906	6.2- 8	.8	1.2	300
SV-910	9 -12	1.5	.8	200
SV-915	13.5-18.0	3	.6	150
SV-924	20 -27	8	.4	100

Write for Bulletin TB-1352
*Case temperature ratings

Modified Matador

The Matador ground-to-ground tactical missile designed by Martin Co. and presently in operational use is being replaced by an improved version. Designated the TM-61C, the missile incorporates an improved guidance system developed by the Martin Co. Range of the TM-61C Matador will be substantially increased over the original version, and traffic capabilities—the ability to control more than one missile in the air at the same time—will be greater, thus making the firepower of a missile squadron much stronger.

One of the most important improvements in the TM-61C guidance system is stated to be the high resistance to electronic countermeasures. As in other Matador missiles, the TM-61C can be launched from rough terrain through the use of mobile launching platforms. The TM-61C is 39.6 ft long, 54 in. in diam and has a wing span of 28.7 ft. Operating at speeds of more than 650 mph, the missile is capable of altitudes over 35,000 ft.

High Altitude Altimeter

A new type altimeter, accurate in the ranges of from 75,000 ft to 225,000 ft, is being produced by Hastings-Raydist, Inc. of Hampton, Virginia. The altimeter operates on 115 v ac is unaffected by ambient temperature changes, and provides continuous direct altitude reading or recording. The instrument measures altitude by means of a transducer, which consists of a noble metal thermopile. At the higher altitudes it becomes much more sensitive than the usual bellows or capsule types of pressure indicators. Maximum sensitivity is in the range of a few mm of mercury.

These thermopile elements are compensated for ambient temperature and change of temperature. The transducer elements are designed using only metal to glass and have been operated satisfactorily through a range of temperature extending from -300 to $+300$ F. The elements react very rapidly to changes in pressure and altitude, having a lag of only a few hundredths of a second.

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Transitron

electronic corporation

wakefield, massachusetts

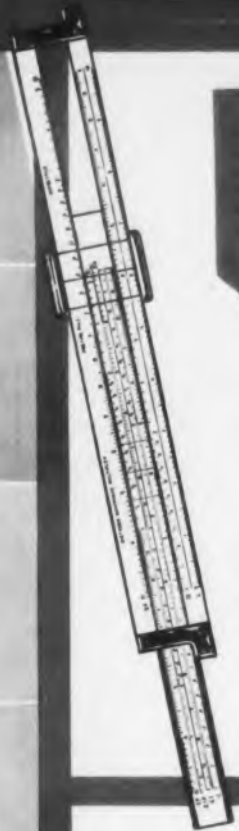
CRystal 9-4500



Here they are!
WESTERN GEAR answers to your
 electrical equipment problems...



Pictured above are only a few of Western Gear's complete miniature motor line, ranging from 1/500th to 4 HP. Choose from cycle ranges of 50 to 400 at any voltage required. Furthermore, if our basic designs do not meet your particular requirements, our engineers will be glad to work with you on your rotary electrical problems WITHOUT OBLIGATION!



LABORATORY-TYPE POWER SUPPLY— New from Western Gear, Electro Products Division, is this lab-type, voltage-regulated power supply, available in either cabinet or rack type mounting. Input voltage is 105 to 125 volts at 50 to 60 cycles per second. Three output voltages are available . . . continuously variable 0 to 300V DC at 150 MA; continuously variable 0 to negative 150V DC at 5 MA; and 6.3V AC at 8 amperes. For full information, use the coupon below.



STROSCOPE UNIT— Now available, a reasonably-priced, compact, true-color strooscope for viewing rotary, reciprocating or repetitive motion, as designed and manufactured by Western Gear's Electro Products Division. **SPECIFICATIONS:** Flash duration, 10 microseconds; light output, 5 Lumen seconds per flash; repetition rate, 0 to 100 pulses per second; dimensions, 6" wide, 5" high, 5 3/4" deep. For complete information, mail the coupon below.

TRANSISTORIZED VOLTAGE REGULATOR— Rugged conditions are made to order for this precision unit, especially where performance, space and weight are of extreme importance. The circuitry employs a shunt power transistor and a temperature-compensated Zener diode reference voltage. Input voltage is 31V DC plus or minus 4V. Output of the 7VR12 is 5V DC at 100 to 200 MA. Regulation less than plus or minus .1 per cent for combined variations of input voltage, load current, temperature, drift and vibration. Dimensions 2 x 2 x 2. Weight 8.5 ounces. For more of the story, check and mail the coupon below.



MULTIPLE CHANNEL STRAIN GAGE POWER SUPPLY— Model 7P01 single or multiple channel strain gage power supply, 115 V, 60 cycle input, 10V DC output, adjustable from 9-11V DC with a 10-turn potentiometer. Output voltage changes less than plus or minus .05% due to temperature change from 0 to 45°C; output voltage changes less than .1% due to 2% change in load current. Output ripple is less than 300 microvolts RMS, isolated from ground as follows: insulation resistance to ground, 10,000 megohms; AC pickup voltage to ground, 5 microvolts peak. (Six channel unit shown.) For complete information, mail coupon below.

CLIP AND SAVE

Lightweight Radio Relay for Military

In line with the new Marine concept of helicopter assault operation, a new lightweight radio communications relay set that can be carried on a man's back to otherwise inaccessible battlefield locations is now available. Developed by Raytheon Manufacturing Co., Waltham, Mass., the set operates in the super high frequency range making it possible to reduce the diameter of the antenna to 2-1/2 feet.

The radios have a point to point range up to 10 miles or they may be linked in chain fashion to transmit up to 40 miles. Eight messages may be sent or received simultaneously. The complete radio and all auxiliary parts can be carried by a team of five men, the heaviest unit weighing about 55 lbs. Total weight of the entire unit is about 250 lbs.

Science Faculty Fellowships

The National Science Foundation announced that applications will be accepted after June 10, 1957, for a second group of Science Faculty fellowship awards to be made in this calendar year. Closing date for receipt of applications is Sept. 3, 1957. The primary purpose of these awards is to provide an opportunity for college and university science teachers to enhance their effectiveness as teachers. Fellowships are offered for study in the mathematical, physical, medical, biological, engineering, and other sciences.

The foundation's awards will be adjusted so that the combined support—from the Foundation and other sources—will not exceed \$10,000 per annum. Selection will be based on letters of recommendation, academic records, and other appropriate evidences of professional activity and competence. Application materials may be obtained from the Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D. C. Completed materials must be received not later than September 3, 1957. Selections will be announced on October 18, 1957.

Glenn Malme • WESTERN GEAR CORPORATION • P.O. Box 182, Lynwood, California

Please send information checked:

- Motor Catalog No. 254-A
 Data sheet on Voltage Regulator

- Data sheet on Strain Gage Power Supply
 Data sheet on Lab-type Power Supply
 Data sheet on Stroboscope Unit

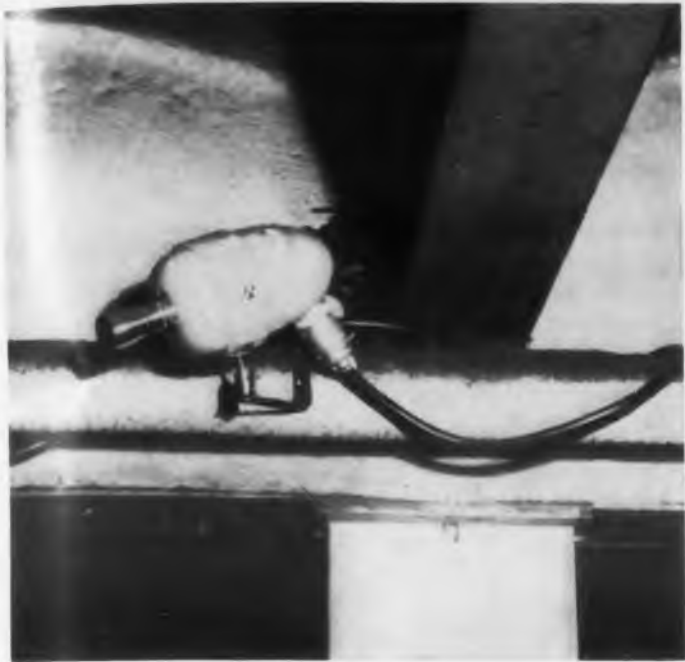
Name _____
 Title _____
 Company _____
 Address _____
 City _____ State _____



PLANTS AT STERLING, ILLINOIS AND SAN FRANCISCO, CALIFORNIA
 DISTRICTS AND BRANCHES — REPRESENTATIVES IN NUMEROUS CITIES

◀ CIRCLE 12 ON READER-SERVICE CARD

TUNG-SOL GOLD BONDED GERMANIUM COMPUTER DIODES



Policing Via TV: An experimental closed-circuit TV system is being used by the New York Transit Authority to study the possibilities of increased efficiency in subway operations. Installed by General Precision Lab., N.Y., a small camera is mounted on a ceiling beam and focused on subway exit gates to prevent riders without passes from entering. A picture of the area is transmitted by coaxial cable to a monitor screen located nearby. The use of television cameras to police entire subway platforms as a further deterrent to crime is also being considered.



More Powerful Radar: Turret-like radar antennae located behind the Terrier missiles aboard the cruiser USS Canberra will be used for long range missile guidance. Developed for the Navy by Sperry Gyroscope Company, of Great Neck, N. Y., the AN/SPQ-5 radar systems came into fleet use after several years of testing. The two systems aboard the Canberra combine several radar functions in each unit. Either system can control the missiles from a single launcher or battery, or both radars can track different target groups simultaneously. The systems include flexible modes of scanning and provide the advantage of early warning.

You
can
bend
the
leads
like
this,
without
cracking
the
glass!



Actual Size

Here's the answer to the problem of how to make computer diodes so the lead wires can be sharply bent close to the glass body without cracking the end seal. It's the "ring seal" design, an exclusive Tung-Sol construction feature embodying a metal collar fused into the end-seal. The collar absorbs the strain of lead wire bends, thereby preventing damage to the diode enclosure.

During its more than fifty years of lamp, electron tube and semiconductor manufacturing experience, Tung-Sol has had to overcome countless problems in glass to metal bonding. Almost every new product development and design improvement thru the years has presented new technological challenges. The resulting stockpile of experience in sealing glass to metal is one of the reasons for the

IT'S THE EXCLUSIVE TUNG-SOL "RING SEAL" CONSTRUCTION!



TYPICAL DIODE CHARACTERISTICS:

Peak Inverse Voltage 75 volts
Forward Current At 1.0 volt 75MA
Reverse Currents At -50.0 volts 50 Microamperes
Recovery Time Less Than 1.0 Microsecond

high quality standards enjoyed by Tung-Sol tubes and semiconductor products.

Tung-Sol Diodes with "ring seal" construction will be supplied in the standard RETMA or JAN types. The Tung-Sol junction-forming technique features an electronically-controlled bonding cycle. The result is a consistently accurate bond which assures maximum uniformity of electrical characteristics.

ADDRESS INQUIRIES TO:
SEMICONDUCTOR DIVISION, Tung-Sol Electric Inc.,
95 Eighth Avenue, Newark 4, New Jersey.

SALES OFFICES:
Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.;
Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington,
N.J.; Melrose Park, Ill.; Newark, N.J.; Seattle, Wash.

SPECIAL INFORMATION SERVICE:
Your name will be added to our Special Mailing List to automatically receive new data as it becomes available.

CIRCLE 6 ON READER-SERVICE CARD FOR MORE INFORMATION

Engineering Review

Bombed Again

The ARDC has just disclosed for immediate publication its Talking Bomb which, when parachuted above the heads of enemy troops, will successfully talk them into surrendering. Judging from the number of news releases received during the past year on this aerial brainwasher, it would seem that it is the century's answer to the atom bomb. Possibly, the ARDC is carrying on an intensive investigation of the effects of psychological warfare. Hearing the same thing over and over again does have its effects, and we are duly impressed by the success of these always new but identical releases from the ARDC in causing frenzied distraction among our ranks. But before we throw down our pencils and surrender, we offer this last resistance as token of our firm belief that words can still be fought with words, without recourse to swords, bombs or other devices.

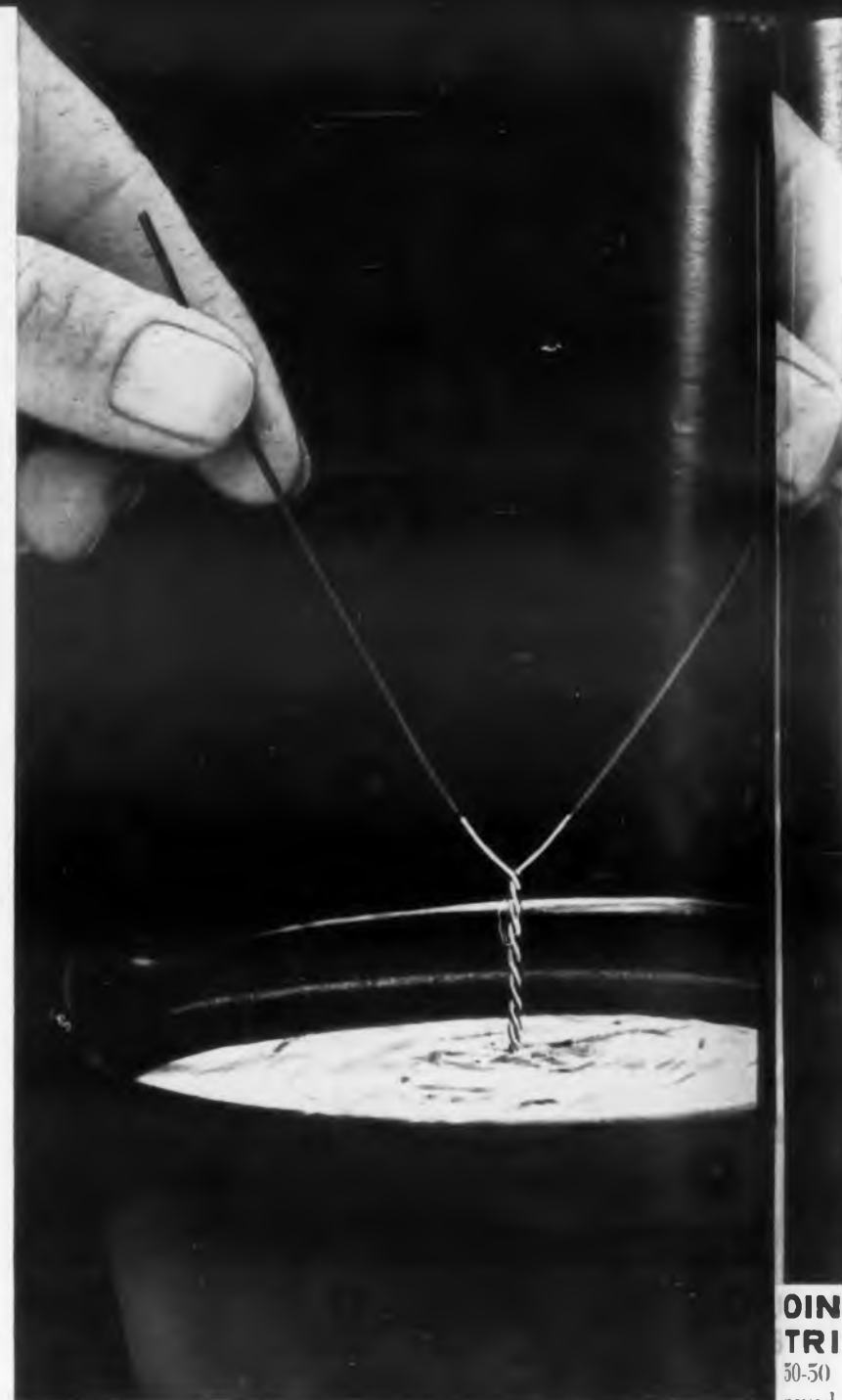
Resilient Mounts: a "Crutch"

When approaching the problems of vibration and isolation of airborne equipment, resilient mounts should be used if all other solutions have been investigated and appear impractical. According to a paper delivered at the AIEE Air Transportation Conference, isolation should always be regarded as a crutch, and all possible means should be used to obtain compatibility of equipment with environment without using resilient mounts.

The engineer was advised to proceed directly to the solution of resilient mounts only when the level of shock transmitted by the structure to the equipment supports is sufficiently greater than the fragility level, removing all doubt that no other means is practical. In short, this implies that a vibration specialist should be employed to translate environment level into terms comparable to fragility level. The engineer would then be able to consider the fragility factor in realistic terms, and therefore maintain better design control.



TWIST WIRES ...



DIP IN SOLDER ...

Anaconda announces Analac an improved sold

New Analac* film-insulated, solderable magnet wire can be used similarly to Formvar or Plain Enamel—except that it is solderable without stripping!

Soldering by dipping, iron or gun produces a perfect joint—in just one second in finer sizes—without prior removal of the insulation. Analac reduces labor, saves time and money wherever many soldered connections are made, or where small diameter wire makes other means of insulation removal hazardous to the insulation or wire.

Not only this, Analac has the excellent abrasion resistance and other good mechanical properties of the enamel wire you're now using. It handles readily, per-

forms well in high-speed winding.

Analac is colored a bright red with stable dye used many years for identical applications—making it highly visible even in finest sizes. This helps operators feel more secure, results in higher quality work. Distinctive color simplifies its identification, too, from nonsolderable wires.

Analac is available in an exceptionally large range of sizes. The Man from Anaconda will be glad to give you more information and help with a production run in your plant. See "Anaconda" in your phone book—in most principal cities—or write: Anaconda Wire & Cable Company, Magnet Wire Headquarters, Muskegon, Michigan.



JOINT IS COMPLETED WITHOUT TRIPPING WIRE with Analac wire dipped in 50-50 tin-lead solder at 360°C (680°F). The insulation is moved at the temperature of molten solder.



1. STRONG JOINTS—as strong as the same joints made in bare copper wire—are produced. Here in laboratory test, joint holds under high stress.



2. EXCELLENT ABRASION RESISTANCE of Analac is shown in this test. It has the same high windability normally associated with Formvar, Plain Enamel.



3. MOLDED-PLASTIC CASES — designed and developed by Anaconda—protect spools of Analac from damage during shipping. Result: no breaks due to bent spools.

ready-to-solder magnet wire

See the Man from
ANACONDA®
 for ready-to-solder
Analac
 magnet wire



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 Yours for the asking.
 Mail coupon
 for your copy.

ANACONDA WIRE & CABLE COMPANY
 Magnet Wire Headquarters,
 Muskegon, Michigan.
 Please send me catalog C-95A on
 Analac ready-to-solder magnet wire.

NAME & TITLE.....

COMPANY.....

ADDRESS.....

CITY, ZONE, STATE.....

Automatic Ferrite Memory Core Tester

An Automatic Ferrite Memory Core Tester, with the ability to test, select and reject cores according to the customer's specifications three times as fast as was formerly possible with most semi-automatic devices has been developed. Currently in operation at the RCA Components Division, Camden, N. J., the core tester couples a mechanical handling device with an electronic pulse program generator and electronic measuring and evaluating circuits. The device hopper-feeds 0.050 I.D. x 0.080 O.D. x 0.025 thick ferrite memory cores through the Tester. Each core is tested for its one output on a Go-No-Go basis. The Tester also examines each core for Disturbed Zero output, then classifies the test run into five groups according to value. In addition to its high-speed fully-automatic operation, it features the ability to segregate cores.

Retreat of Transistor Heat Barrier

Experimental use of new compound semi-conductors in place of germanium or silicon has led to laboratory types of transistors and diodes that can operate efficiently over a broad range of frequencies at temperatures as high as 850 deg F.

Describing recent work at RCA labs, Princeton, N. J., Dr. Dietrich Jenny noted that efforts to combine in a single material the best features of both germanium and silicon have now resulted in new experimental devices employing various compound materials, notably gallium arsenide. Germanium is most useful for its high frequency properties, silicon greater efficiency at higher temperatures.

Correction

In "Resistor Performance Levels," *ED*, June 15, 1957, the symbols for Composition Resistors and the New Pyrolytic General Purpose Resistors in the bar graph of Performance Characteristics (Fig. 6) were accidentally reversed. This leaves the erroneous impression that the performance of the new pyrolytic resistors was worst in the comparison, whereas—it was indeed the best.

◀ CIRCLE 7 ON READER-SERVICE CARD

Engineering Review

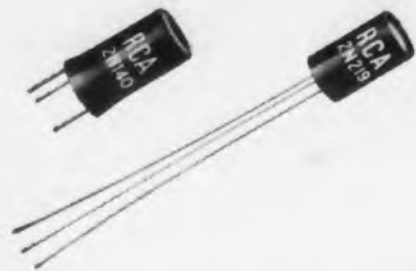
Large-scale military sponsorship of research during and since World War II has, besides accelerating the pace of industrial research, equalized the competitive position formerly held by companies. According to a recent address by Dr. E. W. Engstrom of RCA, the rapid growth of research and the increasing number of participants, together with shortening of the time cycle from research to product, is having a leveling effect on all of industry. Dr. Engstrom found the sharing of know-how in actual procedures and techniques on so wide a front and across competitive barriers to be a deeply significant change in the industrial research environment.

Referring to the past half century as the pioneering period for industrial research, the RCA executive said that the recent impetus of large-scale military sponsorship has brought about stability and maturity. Although the value of any one research result to the organization doing the work continues in intrinsic value, this value is diluted by the larger sum total of the research effort; and it is particularly diluted by the large amount of research sponsored by the government in the military area.

World's Largest Radio-Telescope

Now being readied to go into full use at Nancay, 93 miles from Paris, is the world's largest radio-telescope. The French Academy of Sciences expects it to reveal many new facts about the sun. For example, the sun sometimes shoots torrents of electrified particles into the atmosphere, seriously disturbing radio communications in the world. The radio-telescope, over 0.9 of a mile long, already has enabled a group of French scientists to discover that these radio-electric storms emanate not from the sun's surface, but from within the solar corona—perhaps 62,000 miles from the surface.

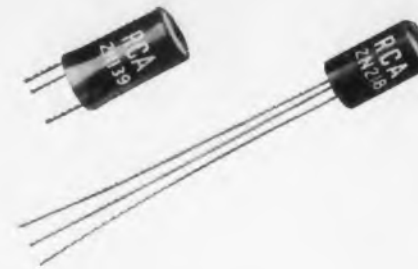
◀ CIRCLE 8 ON READER-SERVICE CARD



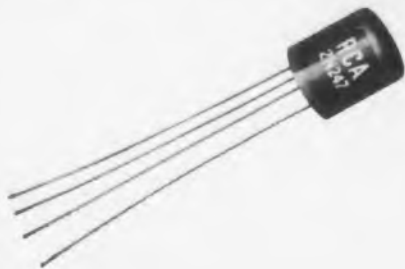
RCA-2N140—For converter and mixer-oscillator applications in standard-AM broadcast-band receivers. Linotetral 3-pin base. For flexible-lead version, specify **RCA-2N219**.



RCA-2N269—For low-level, medium speed, on-off, control applications as in flip-flop and gating circuits of electronic computers.



RCA-2N139—For 455-Kc IF amplifier applications in standard-AM broadcast-band receivers. Linotetral 3-pin base. For flexible-lead version, specify **RCA-2N218**.



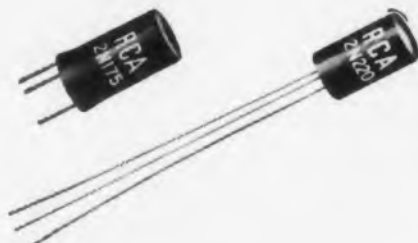
RCA-2N247—"Drift" Transistor for use as an RF amplifier in the AM broadcast-band and up into the short-wave bands.



RCA-2N109—For large-signal AF amplifier service. In class B push-pull, two RCA-2N109's can deliver max. signal power output of approximately 150 milliwatts. Linotetral 3-pin base. For flexible-lead version, specify **RCA-2N217**.



RCA-2N206—For moderate-power AF amplifier service. Meets military specification MIL-T-25380/4 USAF. (Max. collector dissipation, 75 mw. at ambient temp. of 25°C.)



RCA-2N175—Exceptionally low-noise type for pre-amplifier or input stages of transistorized audio amplifiers operating from extremely small input signals. Linotetral 3-pin base. For flexible-lead version, specify **RCA-2N220**.



RCA-2N301—For audio-power output stages of equipment requiring high output with low distortion at high power gain. In class A, one RCA-2N301 can deliver a max. signal power output of approximately 2.7 watts; a pair can deliver up to 12 watts in class B push-pull. For operation at peak collector voltages as high as 60 volts, specify **RCA-2N301-A**.



RCA-2N270—For large-signal AF amplifier service. In class A, one RCA-2N270 can deliver a max. signal power output of approximately 60 milliwatts; in class B push-pull, a pair can deliver up to 500 milliwatts.

When top performance is essential...

SPECIFY RCA TRANSISTORS

RCA offers a broad line of superior-quality p-n-p transistors for RF, IF, AF, and switching service in entertainment, industrial, military, and computer applications.

When you design equipment for mass production, uniformity of transistor characteristics is vital to good end-product. Special-purpose miniature apparatus requires transistors with the added feature of extreme stability. RCA's advanced manufacturing techniques combined with rigid quality controls assure "top performance" in commercial, military, and industrial applications. Described here are some of the outstanding transistors from RCA's broad line—now commercially available.

Contact your RCA Field Representative for a discussion of the many advantages offered your specific designs by RCA Transistors.

EAST Newark 2, N. J.
744 Broad Street
HUmboldt 5-3900

WEST Los Angeles, Calif.
6355 E. Washington Blvd.
RAYmond 3-8361

MIDWEST Chicago, Ill., Suite 1181,
Merchandise Mart Plaza
WHitehall 4-2900

GOVERNMENT Dayton, Ohio
224 N. Wilkinson Street
HEmlock 5585

Washington, D. C.
1625 "K" Street, N. W.
District 7-1260

For technical data on RCA Transistors, write to RCA Commercial Engineering, Sec. G18NN2, Somerville, N. J.



SEMICONDUCTOR DIVISION

Radio Corporation of America
Somerville, N. J.

Helicopters Fly Blind

The combination of an automatic navigator, a sonic altimeter, and a glide path indicator enables helicopter pilots to take off, fly to any spot inside a 100-mile area, make an instrument approach to within 10 ft of the ground and then land without looking outside the helicopter cabin.

The navigator system, developed originally by Decca Navigation Co. Ltd. of England, but being built for use in this country by Bendix-Pacific Corp., uses transmission of radio signals from three ground stations to receiving equipment in the aircraft. The airborne unit, which weighs 40 lb, can pinpoint the helicopter's location with 25-ft accuracy. The triangular arrangement of stations creates a pattern of precisely known and stable geographical positions.

Position information is computed and displayed by decometers or by plotting boards. Pilots can follow the navigation-position lines displayed on the board, deviating from one line or direction to another as necessary, similar to the way one follows a road map from one city to another. The sonic altimeter weighs 16 lb and measures absolute altitude from 0 to 150 ft, with an accuracy of less than 6 in.

3-D TV?

A television screen, developed by the Naval Research Lab., may lead to three-dimensional television. In its present state it offers a simplified approach to color TV. The basis for the new screen is a process for depositing phosphor on the face of the TV tube in the form of thin, transparent films, instead of the opaque white powders now in use. Films that create different colors may be deposited on top of each other and may be lighted separately or mixed by controlling the speed or the direction of the electrons in the tube. By using one film of each of the three primary colors, the complete color spectrum can be obtained by proper mixing. The process has been successfully demonstrated in a full range of colors.

CIRCLE 9 ON READER-SERVICE CARD >

how large is small?

DAVEN'S NEW MINIATURE WIRE WOUND RESISTORS PROVIDE AS MUCH AS 400K RESISTANCE IN

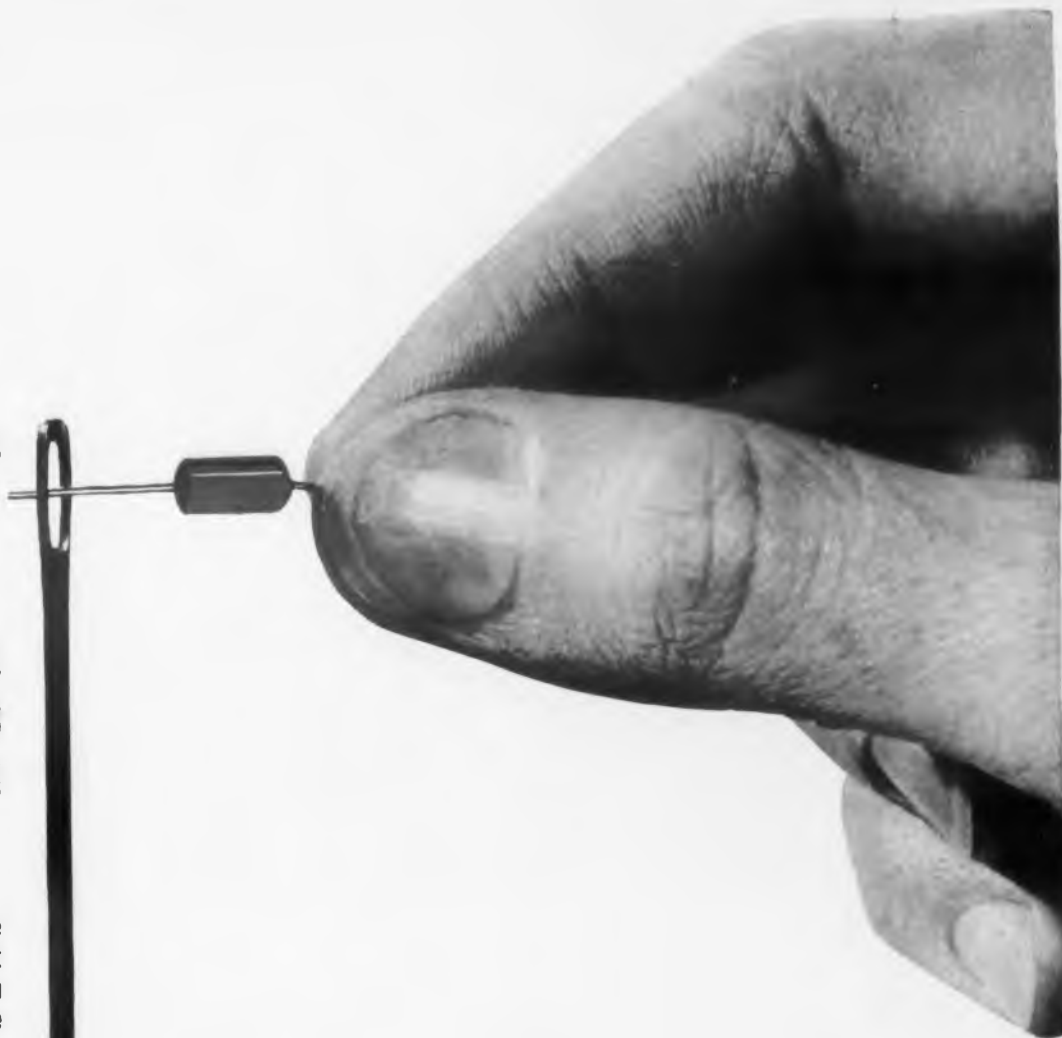
$\frac{1}{4}$ " X $\frac{5}{16}$ " SPACE

DAVEN's fully encapsulated, miniature, precision wire wound resistors offer the design and development engineer the solution to critical space limitation problems. DAVEN's advanced techniques provide the needed resistance value in a minimum of space, without sacrificing reliability. Where space conservation is a prime factor in your design, specify DAVEN miniature wire wounds.

Types and Specifications

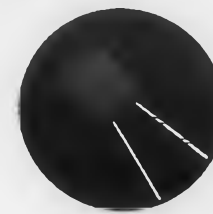
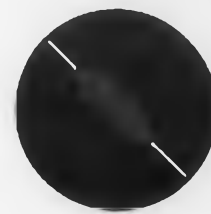
Type	Dia.	Length	Max. Ohms	Max. Watts
1274	3/16	3/8	100K	0.25
1273	1/4	5/16	400K	0.25
1283	1/4	5/16	400K	0.25
1284	1/4	27/64	.5 Meg.	0.25
1250	1/4	1/2	900K	0.33
1170A	7/16	1/2	1.2 Meg.	0.50
1170	1/2	1/2	1.8 Meg.	0.50

• Fully encapsulated • Meet and exceed all humidity, salt water immersion and cycling tests as specified in MIL-R-93A, Amendment 3 • Operate at 125°C continuous power without de-rating • Can be obtained in tolerances as close as $\pm 0.02\%$ • Standard temperature coefficient is $\pm 20\text{PPM}/^\circ\text{C}$.



THE **DAVEN** CO.

524 West Mt. Pleasant Ave.
Route 10, Livingston, N. J.



Special temperature coefficients can be supplied on request.

Write for our new resistor catalog.

Engineering Review

Sperry is Superclean and Ultraprecise

Ultraprecision machining to 25 millionths of an inch has been achieved on a production basis by Sperry Gyroscope Co. for "floating" integrating gyros used as "stable tables." Cleanliness is a major problem in manufacturing inertial navigation equipment, as specks of dust or bacterial organisms might cause errors of miles at the end of 5000-mile flights.

What is tolerable in the way of foreign particles and what constitutes a cleanliness hazard is not fully known. To be on the safe side, Sperry considers the assembly room the key to the problem. Sperry assemblers, that put floating integrating gyros and accelerometers together, work in what has been judged the cleanest place on earth. This pure environment is 5000 sq ft in size. Ceilings, walls and floors are vinyl covered. The skilled workers are carefully screened for desirable skin conditions, and are clad from head to toe in special nylon gowns, caps and boots (of different colors for psychological reasons). The uniforms prevent microscopic dust or lint from clothing from reaching the ultrasensitive elements put together under 45-power microscopes. No paper is allowed in these rooms—"blueprints" are plastic sheets.

Sperry's all-out effort to design and analyze inertial components of extreme accuracy has resulted in the development of new supersensitive test devices. Reaction torques less than 0.05 dyne-cm and output torques accurate to 1/10 dyne-cm can be measured. Heavy seismic blocks for testing are completely isolated from the building floor.

Fabrication of the high-precision gyros on a production basis with needed accuracy and ruggedness is considered a manufacturing breakthrough. In addition to machining and cutting gears to 25 millionths of an inch, special deburring processes are used. Relatively new electropolishing techniques and dental polishing tools are used. A leak detector can note 2/10,000 micron per cu ft per hr.

◀ CIRCLE 10 ON READER-SERVICE CARD

CIRCLE 11 ON READER-SERVICE CARD ▶



1,000,000,000

proofs a day...

that a VOM is electronics' most basic Test Instrument
Yes, over 1,000,000,000 measurements are made every day with Volt-Ohm-Milliammeters

and triplett model 630 leads all vom's

in design, quality, performance, operating simplicity, and value per dollar. The leader at only \$44.50
At leading electronic parts distributors everywhere.

TRIPLETT Model 630 VOM—the proof of 53 years' experience in test instruments.

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Triplet Electrical
Instrument Company
Bluffton, Ohio



631



630-NA



630-A



310



630-T



666-HH



625-NA



666-R



NEW

from **Beckman**[®]

Berkeley

Variable Time Base Universal EPUT[®] Meters
For Direct Digital Readout Without Conversion!



NEW MODELS 7351

(shown on preceding page) and 7361

With their variable preset "count down" time bases, Models 7351 (100 kc) and 7361 (1 mc) Preset Universal EPUT* Meters are unique multipurpose instruments. Regardless of transducer conversion factors, results may be read in direct digital form by merely selecting the proper time base. These instruments will measure time intervals of any number of periods from 1 to 10,000 over the frequency range 0 to 10 kc, totalize a selectable sequence of events, divide frequency, function as single preset counters, generate pulses of varying frequency.

Applications include precise measurement of velocity, pressure, flow, viscosity, low and high frequency, frequency ratio and period, and tachometry.





NEW MODEL 5230 PORTABLE UNIVERSAL EPUT* METER

Combines many features of the popular Beckman/Berkeley 7000 series in a new, light-weight portable instrument to perform the functions of a counter, timer, time interval meter, EPUT* meter, frequency, frequency ratio or period meter. Printed circuitry contributes to compact design, increased reliability and economical cost.

MODELS 7350 and 7360 UNIVERSAL EPUT* METERS

DESCRIPTION—These truly universal instruments combine high-speed electronic counting with a precision time base in multi-purpose circuitry. They function as counters, timers, time-interval meters, EPUT* meters, frequency, frequency ratio or period meters, or as secondary frequency standards.

All models have provision for standardization against WWV and may be coupled to external frequency standards. Connections are provided for driving Berkeley digital printers, data converters, or in-line remote readout units.

FEATURES

- 1 0.1 ν rms sensitivity
- 2 Step attenuators; trigger-adjusted noise discriminators
- 3 More stable frequency dividers
- 4 Electronic (not relay) reset
- 5 External frequency standard input connection
- 6 AC or DC coupling of all input circuits; 10 megohm input impedance
- 7 Multivoltage accessory socket to power photocells, etc.
- 8 Binary-coded output with direct connection to digital printers, data converters, inline readouts, etc.
- 9 Crystal-controlled time marker output
- 10 Unitized modular design
- 11 Larger, brighter readout numbers
- 12 Modern-styled all-aluminum cabinets



MODEL 1452 DIGITAL PRINTER

Automatically and permanently records information from any Berkeley 5571 or 7000 Series instrument, prints data in digital form on standard adding machine tape from printer and scanner in one compact unit. May be modified to print "Time" or "Code" information simultaneously with data. Rack or bench mounted; available in up to 8 digits. One printout every 0.85 seconds. Price (6-digit), \$950.00.



MODEL 5916 IN-LINE READOUT

Large, illuminated in-line IN-PLANE figures reduce fatigue and error. Ideal for remote observation of data. Connects directly to any Berkeley 5571 or 7000 Series instrument. Presentation rate up to 15 per second; accepts binary voltages. Price (six digit unit), \$775.00.

TRANSDUCERS

A large number of transducers especially designed for use with Berkeley counting, timing, and frequency measuring equipment are available. These include tachometer pickups, photocells, and light sources. Specifications and technical description on request.

SPECIFICATIONS & PRICES

NEW SPECIAL PRODUCTS SECTION SPEEDS SERVICE

A new department with complete specialized engineering, model shop and manufacturing facilities is ready to give prompt service on special modifications to standard Beckman/Berkeley instruments, or supply special equipment to your specifications.

BRIEF SPECIFICATIONS	Model 5230	Model 7350	Model 7351	Model 7360	Model 7361
RANGES-FREQUENCY	0 cps to 100 kc	0 cps to 100 kc	0 cps to 100 kc	0 cps to 1 mc	0 cps to 1 mc
TIME INTERVAL	100 μ sec to 10 ¹ sec	10 μ sec to 10 ¹ sec	10 μ sec to 10 ² sec	1 μ sec to 10 ¹ sec	10 μ sec to 10 ¹ sec
PERIOD	0 cps to 10 kc	0 cps to 100 kc	0 cps to 10 kc	0 cps to 1 mc	0 cps to 10 kc
TIME BASES	0.1 and 1 sec	10 μ sec to 10 sec	Time Interval* Generator	1 μ sec to 10 sec	Time Interval* Generator
CODED OUTPUT FOR DRIVING DIGITAL RECORDER, ETC.	\$30.00 extra	yes	yes	yes	yes
COUNT CAPACITY (READOUT)	4 digit	6 digit	5 digit	7 digit	6 digit
ACCURACY	± 1 count, \pm oscillator stability				
OSC. STABILITY	1 part in 10 ¹ per day	3 parts in 10 ⁶ per week	1 part in 10 ⁶ per day	3 parts in 10 ⁶ per week	1 part in 10 ⁶ per day
INPUT SENSITIVITY	0.25 v rms	0.1 volt rms**			
INPUT IMPEDANCE	1 megohm, direct	10 megohm, dc or ac coupled			
TRIGGER SLOPES	Positive or negative				
CABINET DIMENSIONS	12" H x 8" W x 14" D	10 ³ / ₄ " H x 20 ³ / ₄ " W x 16 ¹ / ₂ " D (Rack Panel - 8 ³ / ₄ " x 19")			
APPROX. SHIPPING WT. LBS.	30	60	50	60	50
PRICE: (F.O.B. FACTORY)	\$575.00	\$945.00	\$1295.00	\$1245.00	\$1445.00

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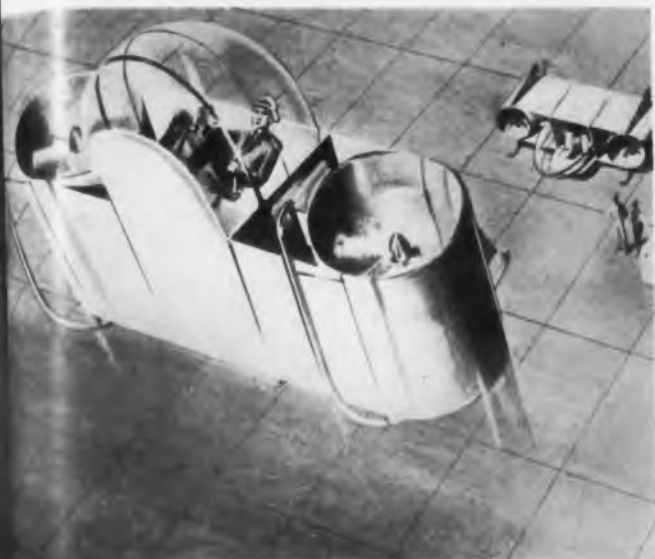
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Ceramic-vs-Glass Tubes

Electron tubes made of ceramics will prove of great value in atomic-powered and other high speed aircraft according to Electronic Products, Inc. In a paper delivered before the Boston Chapter of an IRE Group on Electron Devices, it was stated that ceramic materials can endure intense nuclear bombardment far better than the glass components of conventional tubes, making it possible to remove considerable shielding weight from the electronic systems of nuclear-powered planes. The construction of a stacked tube which uses ceramic parts extensively even for the envelope was described. The tube parts are stacked one upon the other in a radical departure from ordinary assembly methods. While possessing electrical characteristics comparable to conventional tubes, the ceramic stacked tubes are smaller than counterparts. The unusually stable life performance of stacked tubes under conditions of shock, vibration, and high ambient temperatures was pointed out. This performance was attributed to the resiliency of the ceramic material, the stacked construction, and the high-temperature outgassing that can be employed in the manufacturing process of the tubes.

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Washington Report

Herbert H. Rosen

Wilson Directives to Curtail Defense Spending

Now that we are into the Government's new fiscal year, some of the pressure on cost-saving in defense projects may be somewhat relieved. However, the effects of three recent Wilson directives on spending are expected to have far-reaching effects on the future of electronics. One directive concerns overtime work. It is merely a reaffirmation of existing ASPR regulations governing the authorization of overtime on defense contracts. The final decision on whether a project is of sufficient importance to warrant overtime engineering and labor will rest chiefly with the Government's project engineer. He has been given instructions that will help guide him to his decision.

Another order was designed to lop off some \$500 million from the Fiscal '57 spending budget just passed. But the order seems to have come a little too late to be wholly effective, as was hoped. The inertia of Government projects just does not allow a cut of this magnitude in so short a time.

The third order restricts the services from letting a contract for a project or program until all of the money required for their completion is in the "bank." This means the services cannot order 100 widgets, pay for 20, and hold up delivery on the remaining 80 for some later date when and if the money is made available.

In terms of the future, these directives mean that the defense effort, especially in electronics, is stretched out for an undetermined length of time. Sec'y of the Air Force Douglas estimates that the directives mean an ultimate cut of over \$3.5 billion from the AF's purchasing ability. Some programs that have been marginal for lack of conclusive data may now very well be discontinued until more money becomes available—if it ever will.

But of particular importance, the element of time is severely sacrificed. No one has been able to figure out just how bad a sacrifice this will eventually be. Another factor obviously overlooked is that much of the huge spending in '57 and '58—estimated at about \$42 billion—is the result of two or three year old programs coming into fruition. In all, some severe economies will have to be instituted by the electronic industries. From here on the cry will be for the same or better gear as before at a lower price. It will be up to the design engineer to give his company that equipment.

Is Automation Passe?

A meeting in Washington of the IRE Professional Group on Production Techniques seemed to prove one thing: There's reasonably little that's new in

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the field of automatic production. Further, that while the electronic industries are and will be to a greater extent responsible for automation in other industries, the "art" is a long way off for itself. True, mechanization may become more highly refined. But the day of automatic feedback loops and computer directed mechanization that will control the assembly of a piece of electronic gear is far off.

The meeting did demonstrate one important concept to the design engineer. The concept of standardization. From here on in there will be greater and greater emphasis on cost coupled with reliability. And it seems that the only way to achieve these two factors simultaneously is by standardization.

One step in this direction is RETMA standard RS-188. This lays down the recommendation that "dimensions which must be controlled for automatic purposes be multiples of 0.025 inch. . . ." The standard also represents an early attempt to bring about an era of mechanical standardization. It also means that if an end assembler hopes to mechanize any of his production capability, his design engineers may have to design the end equipment around these suggested standards.

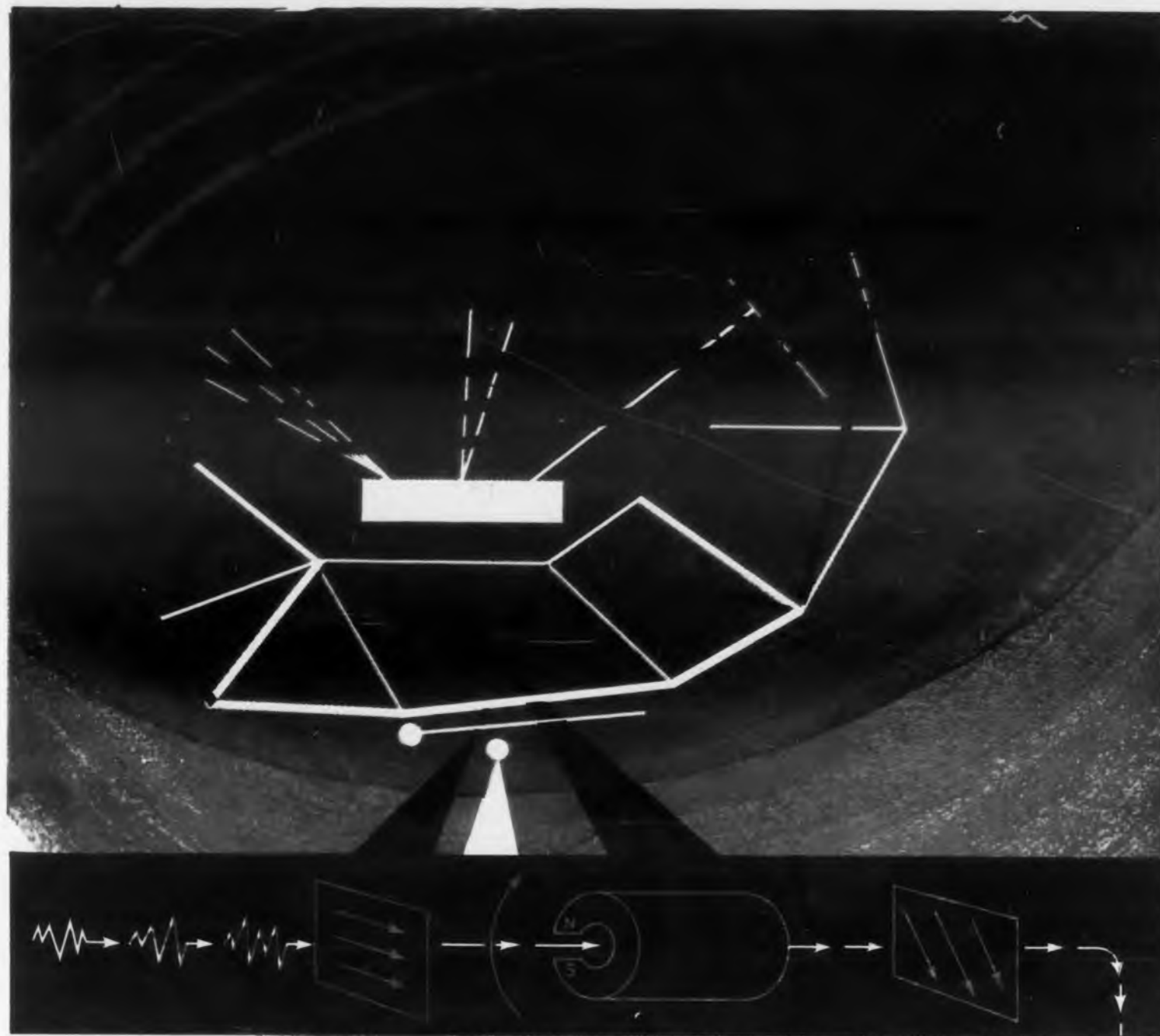
Another document disclosed at this meeting concerns itself with design requirements for printed wiring used in electronic equipment produced for the Signal Corps. It lays down suggested ground rules for circuit design, packaging, printed wiring boards, component mounting, modular dimensions.

Anticollision Study

Bendix Aviation has been awarded a small Air Force contract to help defray their costs for developing a device to give proximity warning and avoid collision of airplanes. The company has been working on the problem for about 2 years and have reached the point of proving their mathematical hypotheses. The Air Force has asked Bendix to study the problem, first, from the standpoint of defining the proximity and collision problems. Once this has been done, possible technical approaches to the solution of the defined problems are to be suggested. Finally, Bendix is to build a research model of the instrument that is supposed to do the job. Deadline for the project is March 1958.

Behind all of this activity is a minimum market worth \$10 million. This is the value set by the airlines industry on what they—as a combined group—would pay to equip their airliners.

And still in the realm of air safety and navigation, the Department of Defense has finally declassified four types of Doppler radar. Generally, these units are self-contained navigation aids and fit in ideally with the space and power limitations of a commercial airliner. By type numbers, the equipments released are AN/APN's 66, 78, 105, 79, and 67. A commercial version of the APN-66, called the RADAM, is supposed to be turned over to ATA by General Precision Laboratories via the Air Force.



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Printed Circuit Board Problems

Gentlemen:

I found your editorial appearing in the January 15th issue of *ELECTRONIC DESIGN* to be very timely. As of this date, we are experiencing considerable difficulty with one of our suppliers who builds a piece of airborne electronic equipment for us, due to printed circuit board problems. Certainly, your indication that evidence is accumulating showing that plated through holes on printed circuit boards are oft times troublesome is disturbing to us, since we plan a change to "plate-through" holes as a solution to some of our problems. Specific information that you may have concerning types and frequency of failures would be of immediate interest.

Noting that an association of manufacturers is now being set up to establish standards for printed circuits, I would appreciate being advised as to the membership of this group with the thought in mind of contributing our experience as well as requirements to assist in their undertaking.

W. E. Shannon
 Electrical Design Group
 Allison Division
 General Motors Corp.

▶ The technical problem seems to be with soldering plated-through holes. See article on p 40, April 15, *ELECTRONIC DESIGN* for an hourglass hole configuration which may be a solution. We have received many such letters from people expressing concern about the problem.

Our latest word is that the manufacturers association is not yet officially formed. According to RETMA, Committee 40C on Printed Circuits has recently been reorganized into subcommittees to more efficiently consider printed circuit problems. Subcommittees are: 40C2, Industrial Standards Survey; 40C3, Conductivity and Temperature Rise; 40C6, Arc and Flame Resistance; 40C7, Insulation Resistance; 40C8, Adhesion and Solderability; 40C9, Definition and Register; 40C10, Contamination; 40C13, Mechanical Consideration; and 40C14, Hardware.

Letters to the Editor

Russia Not First

Dear Sir:

The Russian translation starting on page 180 of your March 1st issue describes "A new photoconductive pickup tube of the Vidicon type. . . recently developed in Russia. . . ." employing Sb_2S_3 .

It may be of interest to recall here that an Sb_2S_3 Vidicon of very high sensitivity was rather extensively described back in September, 1951 in this country in the RCA REVIEW article "Properties of Some Photoconductors, Principally Antimony Trisulfide" by S. V. Forgue, R. R. Goodrich and A. D. Cope.

One of our modifications of Sb_2S_3 having good speed of response has been commercially available for several years in the RCA 6198 Vidicon.

Stanley V. Forgue
RCA Laboratories
Princeton, N.J.

► It's comforting to know the U.S.S.R. is five years behind, in this instance at least.

Correction

In the article, "Cooling Packaged Electronic Equipment," Part I, May 15, equation (2) should read:

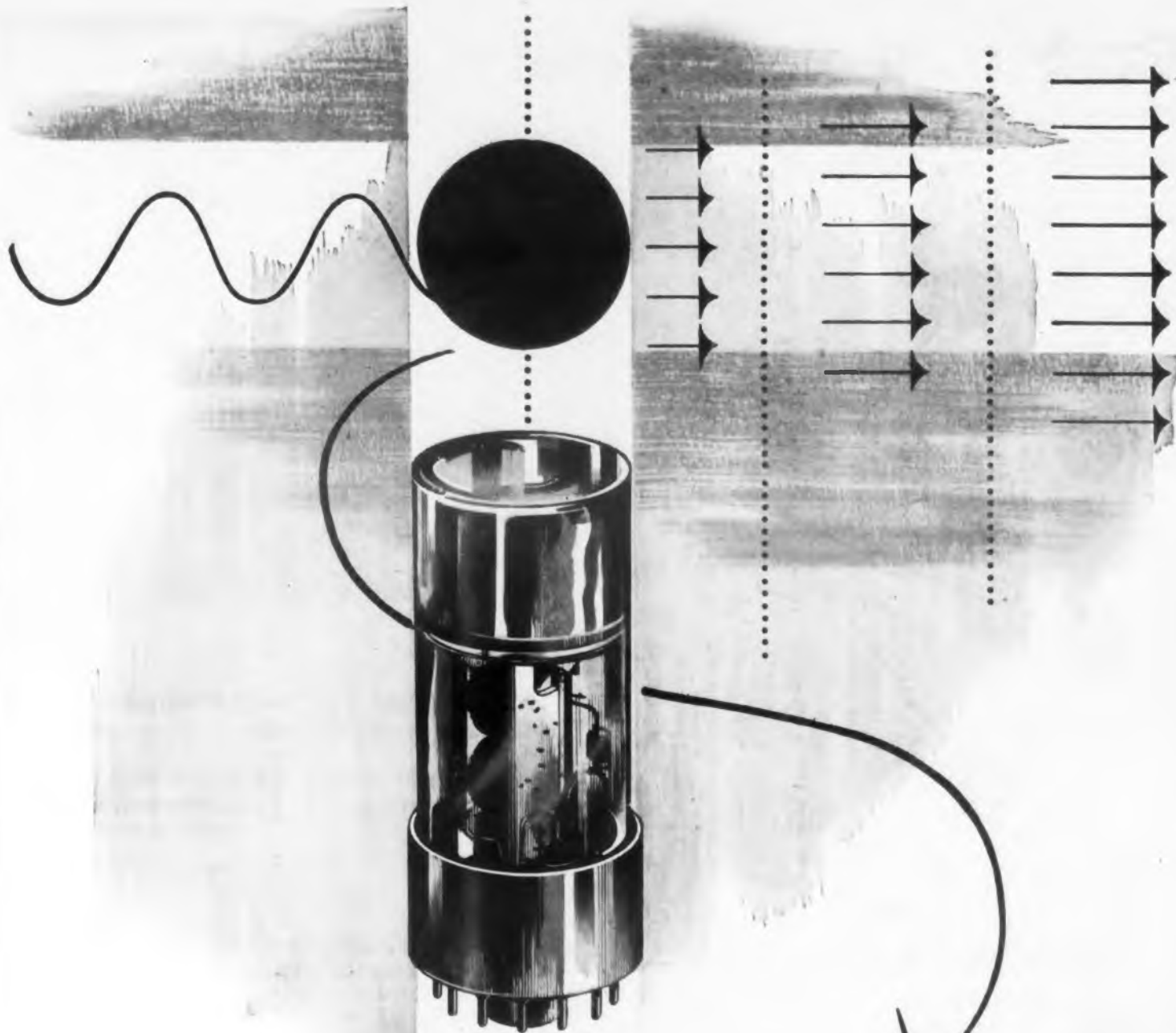
$$h_p = \frac{h_1}{[1 - e^{-(h/T)}]} \quad (2)$$

The expansion of the exponential should read:

$$e^{-(h/T)} = 1 - \frac{h_1}{T} + \frac{h_1^2}{2! T^2} - \frac{h_1^3}{3! T^3} + \dots$$

Correction Please!

Martin Berger of Minitran Corp., 5 Oliver St., Newark, N.J., was the unidentified author of "Transformer Design Nomograph-III" appearing on page 36 of the June 1st issue. Minitran Corp. manufactures miniaturized transformers. We regret that the by-line was omitted.

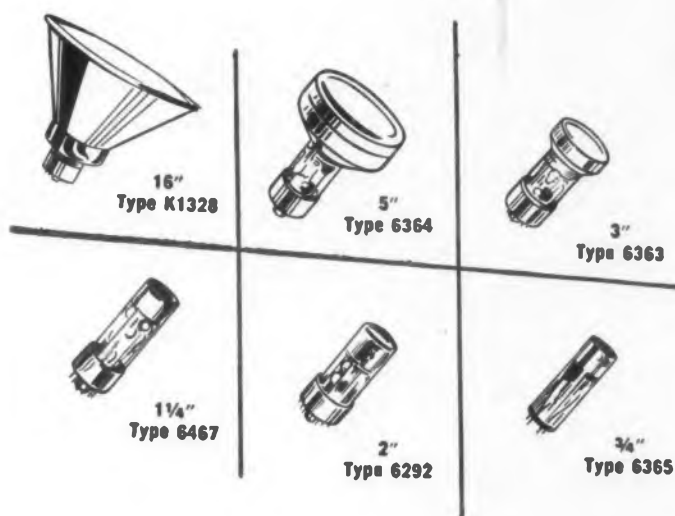


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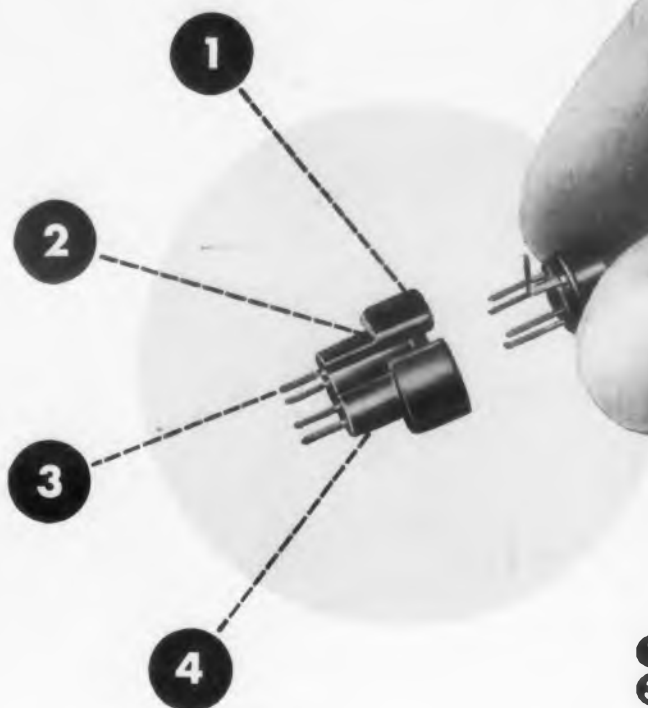


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Transistor sockets

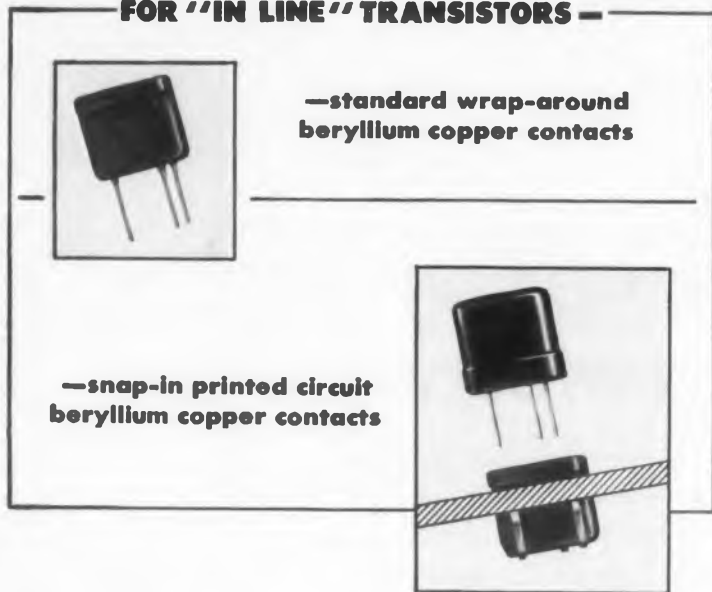
—from Sylvania



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designed to fit standard military 100-mil grid

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- ② ground strap provision
- ③ wrap-around beryllium copper contacts
- ④ mounts with standard retaining ring

FOR "IN LINE" TRANSISTORS —



—standard wrap-around
beryllium copper contacts

—snap-in printed circuit
beryllium copper contacts

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Sylvania sockets, including those for "in line" transistors, are molded in general purpose phenolic. Beryllium copper contacts are silver plated or silver plated and gold flashed.

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Meetings

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Albany Hotel, Denver, Colo. Sponsored by the Denver Research Institute Metallurgy Div. Twenty-three papers will be presented. For further details write to the Metallurgy Div., Denver Research Institute, Univ. of Denver, Denver 10, Colo.

Aug. 20-21: Third Biennial Electron Beam Symposium

General Electric Co. X-Ray Dept., Milwaukee, Wis. There will be reports on radiation equipment, applications of radiations, and economic evaluation of processes and methods. Chemical, plastic and petroleum applications are to be stressed. A conducted tour of GE facilities for fabricating electron beam generators and linear accelerators will be offered. More information may be obtained from J. J. Ludwig, General Electric Co., X-Ray Dept., 4855 Electric Ave., Milwaukee 1, Wis.

Aug. 20-23: Wescon (Western Electronic Show and Convention)

Cow Palace, San Francisco, Calif. Sponsored by the San Francisco and Los Angeles Sections representing the Seventh Region IRE and West Coast Electronic Manufacturers Association. For more information write to Don Larson, Business Manager, 342 N. LaBrea Ave., Los Angeles 36, Calif.

Aug. 29-30: Fourth Annual Symposium on Computers and Data Processing

Albany Hotel, Denver, Colo. Sponsored by the Denver Research Institute. Technical papers on components, devices, systems organization, analysis techniques, and design techniques will be presented. For further information write to J. Marshall Cavenah, Electronics Div., Denver Research Institute, University of Denver 10, Colo.

Sept. 4-6: Special Technical Conference on Magnetic Amplifiers

Penn Sheraton Hotel, Pittsburgh, Pa. Sponsored by the AIEE and the IRE. The program's four sessions will deal with New Circuits and Techniques, Analysis and Design, and Applications. For more information, write to D. Feldman, Bell Telephone Labs.

Sept. 8-13: Second Annual Course on Investment Castings

MIT Cambridge, Mass. Sponsored by the Investment Casting Institute. Lectures, laboratory exercises and demonstrations will be offered on investment materials; melting; gating, risering, solidification and heat transfer; metal and alloy systems; defects in castings; and consideration of new investment and allied processes. For further information, write Harry P. Dolan, Investment Casting Institute, 27 E. Monroe St., Chicago 3, Ill.

Sept. 9-13: Twelfth Annual Instrument-Automation Conference and Exhibit

Cleveland Auditorium, Cleveland, Ohio. Sponsored by the ISA. Organized under the unifying theme, "Instrumentation for Systems Control," the conference will open with formal sessions devoted to data handling and instrument terminology. Following these there will be individual workshop sessions in limited discussion groups covering such topics as aircraft and missiles (excluding propulsion), wind tunnels, flight propulsion systems, process industries, power generation and distribution, meteorological, nuclear, medical, geophysical exploration and general industrial laboratories. Some 100 papers will be presented at the technical sessions. There will be about 500 exhibits. For details of the technical program write to Herbert S. Kindler, Director of Technical Programs, ISA, 313 Sixth Ave., Pittsburgh, Pa.

Sept. 17-18: RETMA Symposium on Numerical Control Systems for Machine Tools

Ambassador Hotel, Los Angeles, Calif. For details write to RETMA, Room 650, 11 W. 42nd St., New York 36, N.Y.

Sept. 24-25: Sixth PGIE Symposium on Industrial Electronics

Morrison Hotel, Chicago, Ill. Sponsored by the IRE Professional Group on Industrial Electronics and AIEE. The main theme for the conference will be the characteristics, use and integration of transducers into complete systems to measure and control complete processes. For further details, write to J. N. Banky, 628 West 18th Street, Chicago, Ill.

Oct. 16-18: 1957 IRE Canadian Convention and Exposition

Automotive Building, Exhibition Park, Toronto, Canada. Sponsored by the Canadian Sections of the IRE. For information write to Grant Smedmor, IRE Canadian Convention, 745 Mt. Pleasant Rd., Toronto 7, Canada.

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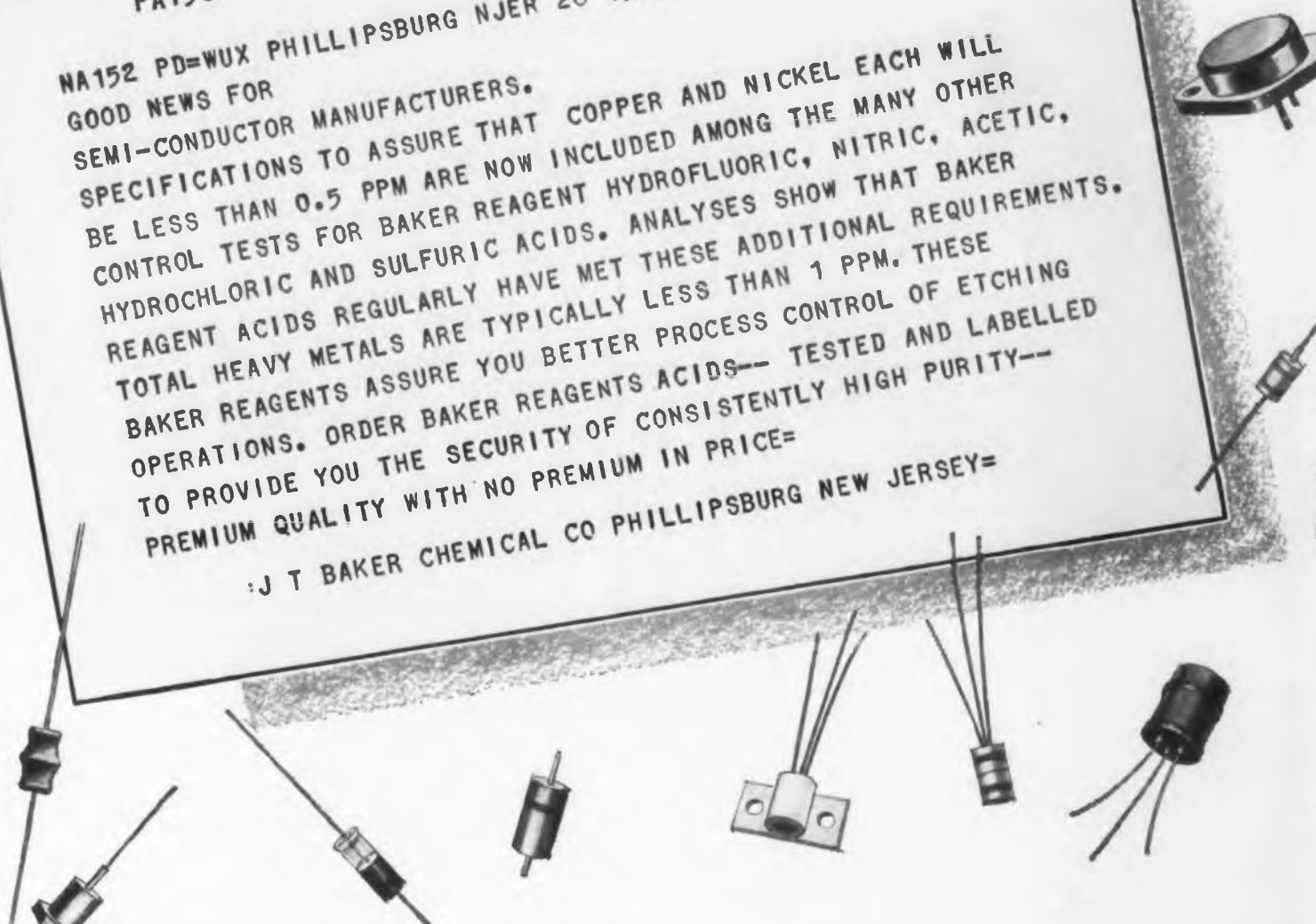
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Ammonium Phosphate	Magnesium Oxide
Antimony Trioxide	Manganous Carbonate
Barium Acetate	Methanol
Barium Carbonate	Nickelous Chloride
Barium Fluoride	Nickelous Nitrate
Barium Nitrate	Nickelous Sulfate
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Cadmium Chloride	Potass. Dichromate
Cadmium Nitrate	Potass. Hydroxide
Cadmium Sulfate	Radio Mixtures
Calcium Carbonate	Silicic Acid
Calcium Chloride	Sodium Chloride
Calcium Fluoride	Sod. Phos. Dibasic
Calcium Nitrate	Strontium Nitrate
Calcium Phosphate	Sulfuric Acid
Ether, Petroleum	Toluene
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Oct. 31-Nov. 1: Third Annual Technical Conference of the Professional Group on Electron Devices, IRE.

Shoreham Hotel, Washington, D.C. Those interested in submitting papers should check the paper deadlines at the end of this section. For more information, write W. M. Webster, RCA Semiconductor Div., Somerville, N.J.

Nov. 6-8: Tenth Annual Conference on Electronic Techniques in Medicine and Biology

Boston, Mass. Sponsored by ISA and AIEE. Further details and advance programs may be obtained from H. S. Kindler, Director of Technical Programs, Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

Nov. 6-8: Third Aero-Com Symposium

Hotel Utica, Utica, N.Y. Sponsored by the IRE Professional Group on Communications Systems. The conference will deal with systems, equipment design, techniques, antennas, spectrum conservation, air traffic control, management and other topics. For the presentation of confidential material, there will be a classified session on Nov. 8. For more information, write to R. C. Benoit, 138 River-view Pkwy., Rome, N.Y.

Nov. 11-13: Third Annual Instrumentation Conference

Biltmore Hotel, Atlanta, Ga. The theme of this conference will be "Instrumentation for Data Handling" with special symposiums on electronic instrumentation as applied to medicine and the sales and purchasing aspects of electronic instrumentation. Papers should be submitted to Lamar Whittle, Federal Telecommunications Lab., 1389 Peachtree St., N.E., Atlanta, Ga. For more information write B. J. Dasher, School of Electrical Engineering, Georgia Institute of Technology, Atlanta, Ga.

Nov. 13-14: Mid-America Electronics Convention

Municipal Auditorium and Hotel Muehlebach, Kansas City, Mo. Sponsored by the Kansas City Section of the IRE. There will be exhibits and twelve technical sessions. Approximately thirty papers will deal with medical electronics, airborne electronics, instrumentation, engineering management, electronics in nucleonics and a diversity of other subjects. Persons who want to submit papers should contact the Technical Papers Chairman, MAECON, 5109 Cherry St., Kansas City 10, Mo. The deadline for submissions is Aug. 15. For more information write Richard L. Clarke, 425 Volker Blvd., Kansas City 10, Mo.

Nov. 13-15: Eighth National Conference on Standards

St. Francis Hotel, San Francisco, Calif. Sponsored by the American Standards Association. Emphasis will be on standards as a key to progress and profits. Sessions will cover radiation exposure, electronics, industrial preparedness, motion pictures and television, purchasing, company standards, technical communications, government standards and safety. For more information, write to D. E. Denton, ASA, 70 E. 45th St., New York 17, N.Y.

Dec. 9-12: Seventh Eastern Joint Computer Conference and Exhibit

Sheraton-Park Hotel, Washington, D.C. Sponsored by the IRE, Association for Computing Machinery and AIEE. "Computers with Deadlines to Meet" will be the central theme. Papers will be presented on record keeping, materials handling, traffic, deadline data reduction, communication, flight simulation, and other computer deadline areas. For more details, write to Malcolm B. Catlin, Council for Economic and Industry Research, Inc., Arlington 2, Va.

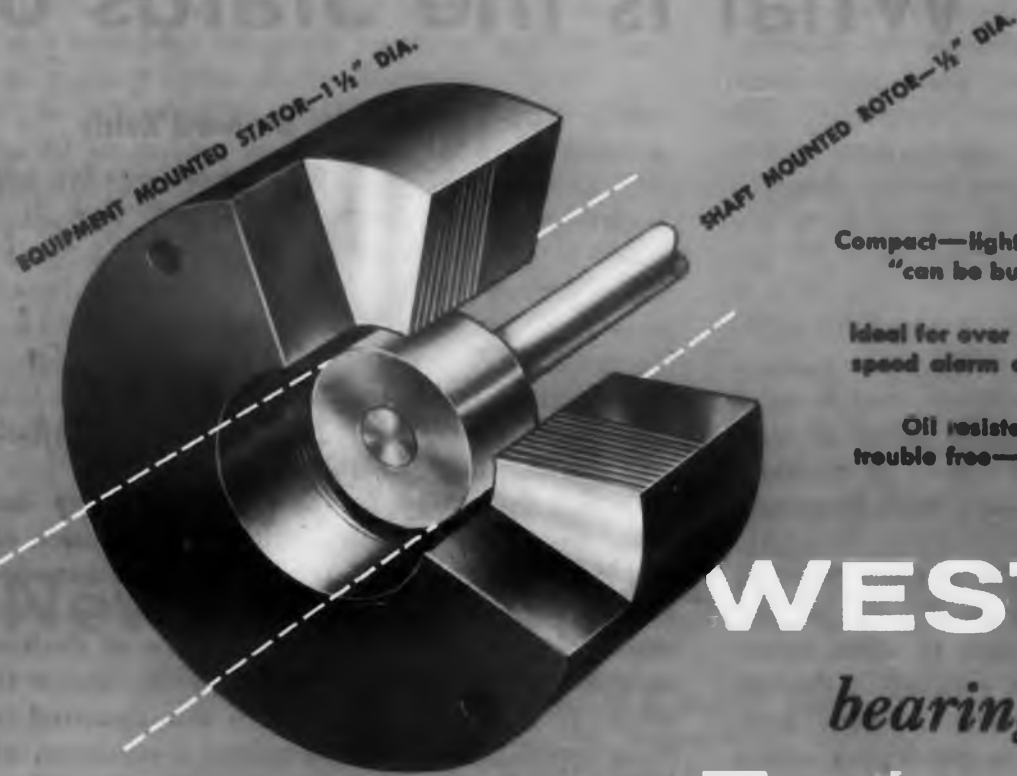
Jan. 6-8: Fourth National Symposium on Reliability and Quality Control

Hotel Statler, Washington, D.C. Sponsored by the IRE, ASQC and AIEE. Covering fields of reliability in the electronic industries, the symposium will encompass the following topics: reliability organization and management; theory and mathematical techniques; application of these techniques; design information; and education and training for reliability. For detailed information, contact Richard M. Jacobs, RCA Bldg. 108-2, Moorestown, N.J.

Paper Deadlines

Nov. 1: Deadline for papers to be presented at the 1958 IRE National Convention. The convention will be held March 24-27 at the Waldorf-Astoria and the New York Coliseum, New York, N.Y. Prospective authors should submit a 100-word abstract and a 500-word summary. Both must be in triplicate with the title of the paper and the name and address of the author. The technical field in which the paper falls must also be indicated. Only papers not published or presented prior to the convention will be considered. Military or company clearance must be obtained before submittal. Address all material to Dr. George L. Haller, Chairman, 1958 Technical Program Committee, IRE, 1 E. 79th St., New York 21, N.Y.

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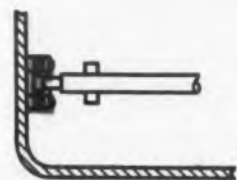


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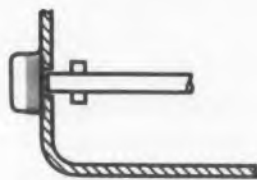
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WESTON INSTRUMENTS



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What is the Status of Transistors?

Bernard Reich

U. S. Army Signal Corps Eng. Labs.
Ft. Monmouth, N. J.

THIS report covers the current status of transistor development. Specific areas of transistor development are discussed; power, high frequency, and switching.

Over the last three years, the state of the transistor art has progressed quite rapidly. During this period new advances were made to allow operation at higher temperatures in germanium devices, and to remove existing frequency barriers; however, the designer interested in developing equipment utilizing transistors has the primary problem of securing devices which are available and reliable. Because of the nature of the industry, the availability and reliability of devices has not been defined. [The Transistor Data Chart section lists the types reported by manufacturers as being available.] This lack of definition regarding the current status of transistor development requires amplification. It is the purpose of this paper to clarify, as much as possible, the status of transistor developments and the extent of availability. The statements set forth are based on the experience of the writer in his contacts with the transistor industry.

Power Transistors

Two to three years ago the upper limit for germanium power transistors was 10 to 15 w. These ratings were attainable under the most optimum conditions and very limited numbers were available. Maximum operating junction temperatures of 80 C were quoted; however, the reliability of most devices at this temperature was not defined, or may not have been known. By the spring last year most power transistors were rated at 85 C operating junction temperature. Many manufacturers sold units meeting this specification; but often poor hermetic seals caused device failure during operation. Although the effects of moisture on junctions was well known at the time, apparently no short-term test was available to remove leaky devices. Experiments performed at these Laboratories indi-

cated a definite correlation between operating failures and non-moisture resistant transistors.

During the last year, the power transistor demand has increased many-fold by the inclusion of the devices in the audio output stages of automobile receivers. With this requirement on the transistor industry has come the fabrication of devices capable of operating at junction temperatures to 100 C. In some instances, devices manufactured to these specifications are guaranteed a minimum of 1000 hours of reliable operation. The transistors utilized in radio applications have collector-to-base or collector-to-emitter voltage ratings of the order of 40 v, and thermal resistances of 1 to 4 deg C per watt. There are approximately eight suppliers of this type of device, and most of the suppliers use the same type of package indicating semi-standardization in power transistors.

In limited instances, the above devices are suitable for military applications; however, provisions must be made for higher voltage operation. Units have been manufactured with the required voltage ratings by approximately six suppliers. Of the higher voltage units, one is presently covered by a Signal Corps specification.

Other units are available with thermal resistances of 1 deg C per watt or less; however, the number of manufacturers is limited to two or three.

The impetus of the automobile radio business, and the requirements for power transistors in power supplies have caused the number of power transistor suppliers to increase. Because of the competition involved, the yields in manufacture have increased, making available power transistors for other uses.

The discussion on power transistors thus far has been limited to germanium devices. Some applications require silicon because of the temperature limitations on germanium. Some power transistors (approximately one-watt devices) have been fabricated in silicon by grown-junction techniques.

Grown junction silicon transistors and some early development alloy silicon power transistors have been fabricated. One of the major problems is the alpha vs. I_c response of these devices leading to high output harmonic distortion in audio circuits. It appears that the upper operating junction temperature of silicon devices presently available is in the neighborhood of 150 C.

Future developments in silicon power devices will include fabrication by diffusion techniques. At this time, it is difficult to see whether any startling operational differences will be noted. This can be explained by the lack of information on the nature of the silicon material and associated surface conditions. In addition, high temperature materials associated with the fabrication of silicon devices must be developed. Eventually, silicon power devices will be available with operating junction temperatures of 200-300 C. Much research and development work is still necessary before the full benefits of silicon transistors will be realized.

Switching Transistors

The potentiality of transistors will be fully exploited in the switching applications area. Computers utilize many transistors and other semiconductor devices. Long life under mild operating conditions are requirements.

For low-speed switching applications such as dc to dc converters, many germanium audio devices in various power ranges exist. With the additional specification of the key-parameters requisite of a switching transistor, devices normally used as audio amplifiers can be employed. As with all audio devices fabricated by alloying techniques, p-n-p transistors are more available than the n-p-n variety. Some n-p-n germanium transistors fabricated by grown-junction techniques do exist; however, these devices bear the characteristics resulting from fabrication by this method. It appears, at present, that there are many different types of p-n-p devices for

low-speed switching applications. Some of these devices are covered by military specifications, while many others are commercially available. A few of the n-p-n units are comparable to the p-n-p counterparts.

In the low-power medium-speed switching range, many alloy germanium p-n-p devices exist. In general, the availability of this type of device is considered fair. There are some n-p-n switching devices in this area manufactured by three suppliers. The overall availability of these units is considered poor to fair, mainly because of fabrication problems.

Core switches developed for computer use also fall into this same general frequency area. Some limited operation core switches are available commercially. The Signal Corps, at present, is developing both germanium and silicon core drivers. A very limited number of feasibility samples have been evaluated. In coming months, state-of-the-art samples will become available. Approximately one year hence, pilot-line production quantities are expected. Summarizing the core switch situation, some commercial units are presently available; however, more units should appear in about one year.

New developments are occurring in the high-speed switching area where rise times in the order of a few millimicrosec are required. Already an extremely limited quantity of devices have been evaluated with rise, storage and fall times in the neighborhood of 10 millimicrosec. These devices are being fabricated by diffusion techniques. It is believed that in the next 18 months, many more units should be available for circuit evaluation, and limited numbers for equipment models.

High-Frequency Transistors

The development of high-frequency transistors will open new areas of application in communications equipment. A year ago, alloy or surface barrier homogeneous base transistors were being used. In addition to these triode devices, some tetrodes were and are still used in high-frequency applications. At that time, some devices were available for operation as radio-frequency and intermediate frequency amplifiers up to about 10 mc.

With the advent of the p-n-i-p and drift transistors, the limiting frequency barrier was lifted. The possibility of operating transistors to 3000-5000 mc is now feasible. It is known that many interested device manufacturers are utilizing the advantages of the p-n-i-p and drift structures.

At present, the supply of diffused-base high-frequency transistors is quite limited; however, it is expected that within the next 12 to 18 months more units will be available for advanced circuit design and development. At that time, 200 mc amplifiers and oscillators should be available.

Silicon Transistors

At present, for operating junction temperatures of over 100 C, it is necessary to use silicon transistors. Most silicon transistors available are of the grown type and are supplied mainly by two manufacturers. For high-power, high-current operation, silicon transistors are practically non-existent. [For a new type see *ED*, June 15, p 42.] Most silicon devices suffer from high saturation resistance and low current gains at higher current levels.

The operating temperature potential of silicon should be in the range of 200-300 C. At present, available devices are rated to about 150 C. The technology of preparing silicon is not understood as well as is necessary for the fabrication of better devices. Injection efficiencies of the emitter diode must be improved to improve current gain. Silicon surfaces require study in order to be understood. It is also difficult to predict when silicon transistors

will become as available as comparable performing germanium devices.

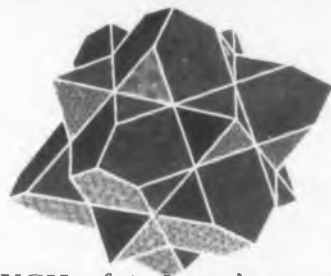
In summarizing, it can be stated that germanium audio devices of various power levels are available. One of the major problems in this area, which should be overcome within the next year, is standard packaging.

Low and medium-frequency p-n-p switching transistors are in fairly good supply. The n-p-n varieties, especially the alloy type, are not as available. High-speed switching devices are in extremely limited supply.

High-frequency p-n-i-p or drift types are, at present, in extremely limited supply. It is expected that this type will blossom within the next 12 to 18 months.

The advances to be made in silicon transistor fabrication are difficult to estimate because of the status of very basic material problems.

New Frontiers in Solid-State Physics



Dr. Malcolm H. Hebb

Manager, General Physics Research
General Electric Research Laboratory
Schenectady, N. Y.

MUCH of industry's interest in solid-state science is related to the importance of solid-state devices to automation. Those who have made the most careful studies of tomorrow's population trends and production requirements describe automation not as a problem of the future but rather as the only solution to a problem of the future. A key function of electronics in automation is control, and the key requirement for control elements is reliability. Solid-state devices give every promise of providing the ultimate in long life, low maintenance, and reliability that will be required if automation is to be a dependable servant instead of a sick relative requiring constant nursing and medication.

Included in control—whether control of a chemical process, control of a manufacturing operation, control of inventory or of distribution—are three functions: 1) sensing the actual state of affairs, 2) processing the information so obtained with such aids as computers and instructions stored in memory devices, and 3) finally the execution of the control. For all of these control tasks, and particularly for the first two, solid-state devices are being developed at an ever-increasing pace. For sensing elements there are tiny devices that see (photo detectors), hear (piezoelectric materials), feel (magnetic materials), and smell (leak detectors). A solid

that tastes is not known to the author, but it might be made if there were sufficient demand for it. There are many forms of solid-state substitutes for brain cells, although none thus far that could reproduce the complexity of the human brain in anything smaller than a warehouse packed with approximately ten billion transistors, ten billion transformers, ten billion solid-state memory cells, and more wire than anyone—even a machine—would want to think about. Solid-state devices can *talk* and they can *do*. And best of all, by performing these functions in solids, we can foresee the day when all of these devices can be built to last a lifetime, using very little power to operate them, and requiring no maintenance at all.

An example of how the transistor may turn up in some unexpected places in tomorrow's world is the report that automobile designers are working on a transistorized fuel-injection system. This appears to be an application never considered for the vacuum tube, however, most ideas for the use of transistors involve putting them in places now occupied by vacuum devices.

One can look forward to developments in another direction. Of particular interest are devices comprising more than one or two rectifying junctions. An example is a rectifier—somewhat like a hook



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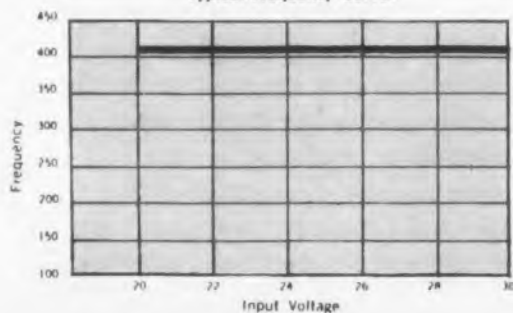
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transistor—that might “fire” over a controlled part of the electrical cycle in the manner of a thyatron.

Photoconductors

The previous mention of solid-state devices that “see” was a reference to a whole family of photo detectors—photoconductors, photo diodes, photo transistors. Because they are relatively inexpensive and have high output, the photoconductors are coming in for a large share of scientific attention. Recently RCA announced it is making a photo conductive cell for use in a headlight dimmer for automobiles. General Electric's X-ray Department uses photoconductor detectors in an x-ray system that “looks” through beer cans to ensure that they are completely full before they leave the brewery. This way is faster than detecting a light can by its weight. Improved photoconductors would also extend the usefulness of the vidicon, that is now limited mostly to industrial TV applications because of low sensitivity and speed of response.

Tiny germanium-junction photoelectric cells recently announced by Standard Telephones and Cables Limited in Great Britain are less than a tenth of an inch in diameter and are designed specifically for scanning operations in punched-card and perforated-tape machines. They speed operations by eliminating certain machined and other intermediate steps involved in storing information from punched-card systems.

Electroluminescence

Solid-state devices can be light-producing as well as light-sensitive. Electroluminescence—the well-publicized “wall of light” phenomenon to which important contributions have been announced recently by Sylvania and Westinghouse—is essentially the direct conversion of electrical energy into light energy in a solid phosphor film. There is no question but that—with improvements in efficiency—electroluminescence will have an important place in the lighting techniques of the future. We should not forget, however, that even if it can become an economically efficient producer of light, the “wall of light” has certain limitations. One of the author's associates, tongue in cheek, has suggested that if Edison had invented electroluminescence instead of the light bulb, every research laboratory would be knocking itself out trying to produce a different kind of electric light source, one that wouldn't take up the whole wall and could be put in some compact form—maybe even in a little glass sphere.

Junction Light Sources

Solid-state research may have an answer to the need for more efficient light sources that also are compact. Some semiconductor junctions emit light when a current is passing through them. Although this phenomenon has been useful in clarifying cer-

tain theories of “breakdown” in transistors, it has not yet been evaluated as a useful source of light because of the extremely poor efficiency. Some of the solid-state theoreticians at G.E.'s Research Laboratory, however, have ventured that the junction light source just might be the key to getting closer to the theoretical 200 lumens from every watt of electricity instead of the approximately 20 lumens per watt produced by a good incandescent bulb and the 60 lumens per watt of fluorescent lamps.

“Light-carrier” Amplifier

An interesting combination of the two solid-state phenomena just discussed—light sensitivity and light production—is involved in a method of controlling electric currents in a manner that cannot be accomplished by ordinary relays or amplifiers. In this system, electrical energy is converted into light by a form of electroluminescence; the light therefrom falls on a light-sensitive photoconductor, producing an electrical current. This sounds like a complicated method of starting out and ending up with the same thing—electrical energy—but it offers certain opportunities for control that might not be possible by more straightforward methods.

New Light Amplifier

The converse of the above system would be to use light to control an electric current through a photoconductor and then convert the electric energy back into light by electroluminescence. A number of systems of this type have been developed under the general description of “light amplifiers.” G.E. has developed another method of light amplification that is unique because the amplification and conversion (in this case the conversion of one kind of light energy directly into another kind of light energy) all takes place in a single solid-state layer of phosphor. The most appealing application at the present time appears to be in x-ray fluoroscopy, where amplification and conversion in a simple, thin device would combine a brilliant image for the doctor and minimum exposure for the patient.

The Cryotron

The Cryotron appears to be the first practical application of the phenomenon superconductivity. Superconductive materials actually have no electrical resistance at all at extremely low temperatures—within a few degrees of absolute zero. The Cryotron is an amplifying device that makes use of the superconducting properties of tantalum when cooled in liquid helium. Because it is compact, simple, and inexpensive in construction—and consumes very little power apart from the modest power needed to create the very low temperatures—the Cryotron may play an important role in computers.

Masers

"Maser" stands for Microwave Amplifier by Stimulated Emission of Radiation. Not all of the Masers developed to date are solid-state devices, although the solid-state Masers appear—obviously—to have conspicuous advantages. Applications of the Maser are expected to be principally in the amplification of radar signals and in scatter communication.

Purity—Needed Breakthrough

Thus far devices, applications—even gadgets have been discussed. Now let us turn to one fundamental that is important to the future of solid-state physics—purity. Purity has one meaning to a preacher, another to a water commissioner, but to the solid-state scientist purity has a meaning that is difficult to visualize. Semiconductors demand the extreme in freedom from chemical impurity and freedom from structural imperfections such as misplaced atoms. Germanium and silicon are routinely prepared with no more than one part per billion of electrically-active impurities. They have been prepared with no more than one part per trillion. Some concept of this last number is given by noting that it is less than one counterfeit dollar in the national debt.

This critical need for purer materials seems somewhat paradoxical since almost all semiconductor devices require eventually that certain impurities be intentionally introduced. However, other impurities must still be vigorously excluded, and to improve practical devices we must have the understanding that comes from studying extremely pure materials.

Eventually these efforts may produce the materials or the knowledge that can lead not only to important devices for industry and defense but even to cheaper and better lighting, or to baby-sitting TV sets, or to electronic computers that do most of the household chores automatically. Everyday use of solid-state electronic helpers "at home" will demand low-cost devices, and learning how to make power materials is closely tied to making electronics less expensive.

To accomplish some of the new things mentioned it will be necessary to extend the technology now available for silicon and germanium to other materials. It will require the talent and cooperation of several scientific disciplines: physics, metallurgy, chemistry, and others.

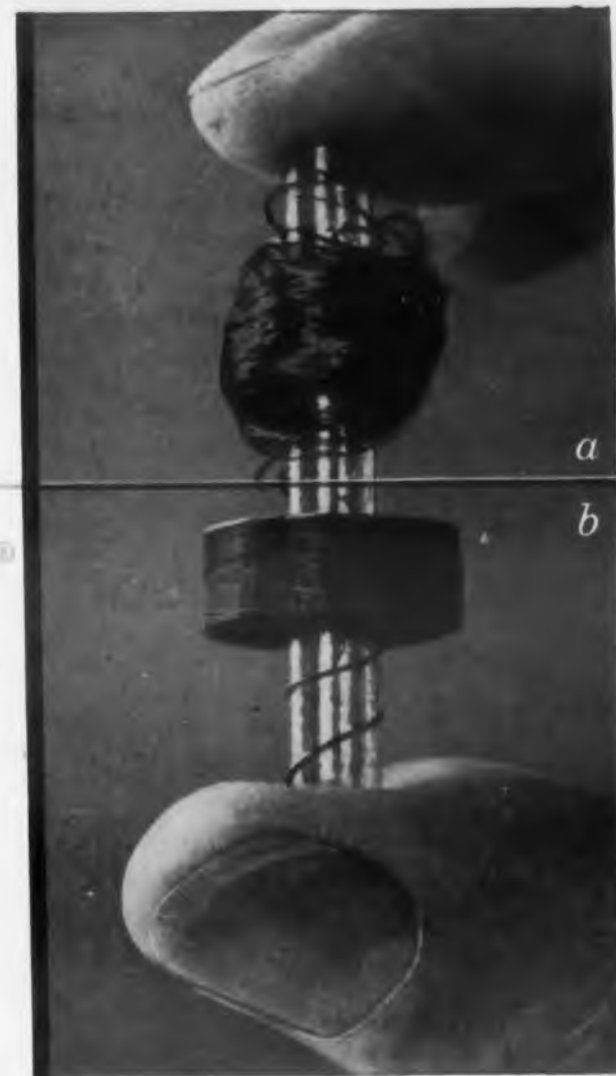
Keep an eye on the fundamental efforts to produce purer, cleaner materials for solid-state research. This is the "breakthrough" that is needed to produce many of the fantastic electronic devices that have been promised for the future.

Adapted from a talk at the 1957 IRE National Convention for use by ELECTRONIC DESIGN.

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Analysis of Nuclear Radiation Effects on Transistors

D. B. Kret

Defense Electronics Products
Radio Corporation of America
Camden, N. J.

CURRENTLY available silicon transistors seem to stand up under radiation better than audio frequency germanium devices but not as well as high-frequency germanium devices.

For most polycrystalline materials, thermal neutron capture or transmutation is more important as a cause of damage than fast neutrons. However, in transistors, where regular single crystal structure is essential for the proper operation of the device, fast neutrons are the chief cause of damage.

Gamma rays must also be considered. Low energy gamma rays generally cause photoelectric effect to which most semiconductors are relatively sensitive. However, except under prolonged or intense low energy gamma radiation, generated photo emf's are of secondary importance and not a cause of permanent damage.

Another important consideration is Compton effect or Compton scatter—a process in which a

gamma ray is captured with a subsequent release of a high energy electron. Thus, although electrons themselves are not capable of penetrating the case used for a transistor, they may be generated inside of the transistor package itself.

These particles are capable of causing crystal damage in the same manner as fast neutrons. All gamma ray with a certain minimum energy are capable of breaking chemical bonds in such a manner as to change the nature of the bombarded material. Silicone grease or oil may in this manner be vulcanized to rubber. Long chain type organic molecules decompose into smaller more stable compounds possibly with the evolution of Hydrogen gas. In transistors, this is very important, since at the surface of the crystal, various types of chemical bonds exist and various susceptible materials are used as fillers and capsulents.

The radiation effects on transistors can be recognized as primarily two discrete types, surface effects generally induced by gamma rays and damage to the crystal lattice primarily due to fast neutrons. Compton scatter electrons and thermal neutron capture may be regarded as second order sources of damage. The surface effects may be recognized by changes in surface recombination velocity, while bulk damage relates directly to decreases in minority carrier lifetime. The most sensitive design parameters relating these fundamental characteristics are:

beta(common emitter current gain)
 I_{co} (leakage and saturation current)

Typical gain curves are shown in Fig. 1 for transistors subjected to nuclear radiation. There are three modes of change. Curve A which indicates little change in gain hence, the most desirable characteristic occurred only on some of the highest frequency devices. This is due primarily to their much narrower base width as compared to lower frequency devices. Curve A on a somewhat different time base would take on the character of Curve C if the test had been continued for sufficient dura-

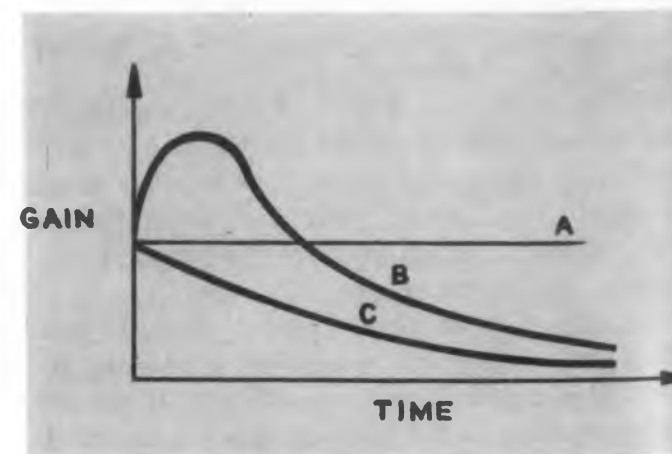


Fig. 1. Gain curves for transistors subjected to nuclear radiation. Curve A is that exhibited by most high-frequency transistors. Curve C is the usual curve for most transistors with a few following curve B as explained in the text.

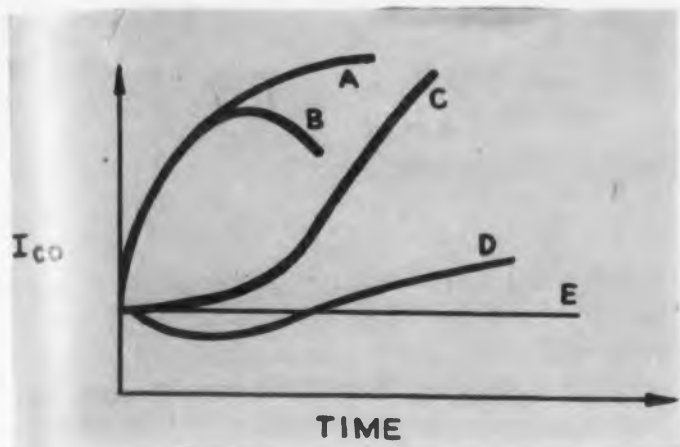


Fig. 2. Typical I_{co} vs Time curves for various transistors tested in presence of nuclear radiation. Most transistors followed curves A or C.

tion. While most transistors exhibit the predicted hyperbolic deterioration in gain as a function of time as depicted in Curve C, a fair number of them had the type of characteristic shown in Curve B. Most of these are p-n-p alloyed junction types in which the initial increases in gain are attributable to surface changes which tended to improve them by decreasing surface recombination velocity. The majority of units, however, show an initial deterioration of gain that might be expected due to bulk effects alone. Devices that initially have relatively low beta exhibit the same type of gain deterioration except that the percentage change is much less since they start so much lower down on the hyperbolic curves.

A composite of the variation I_{co} is shown in Fig. 2. Analysis is not as simple or straight forward as that for changes in gain. The initial I_{co} variations are primarily gamma induced surface changes while the long term increases are bulk induced, the former due to leakage current, the latter due to saturation current. Most transistors follow Curve A or C. Some of the units which exhibit the E characteristics had relatively high I_{co} initially. Units of a single type from one manufacturer produced in the same lot exhibited different types and amounts of I_{co} changes as a function of irradiation and time. This suggests an immediate expedient for obtaining reasonable radiation resistant devices for use in current equipment until more highly radiation resistant types are made by design. A simple screening process whereby all units required for an equipment design which would be exposed to a medium intensity gamma source for a relatively short period of time while the I_{co} changes are being monitored. All units exhibiting large I_{co} deterioration or instability would be eliminated and the balance could then be expected to be deteriorated as predicted by the bulk damage due to neutron flux only.

Most transistors recover or anneal to some extent after removal from radiation flux. Two distinct types



ANOTHER VARIAN FIRST - 2 kW SHF KLYSTRON



The VA-804D (4.85—5.0 kMc) mounted in its focusing magnet, the VA-1504.

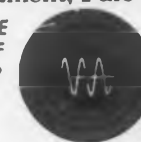
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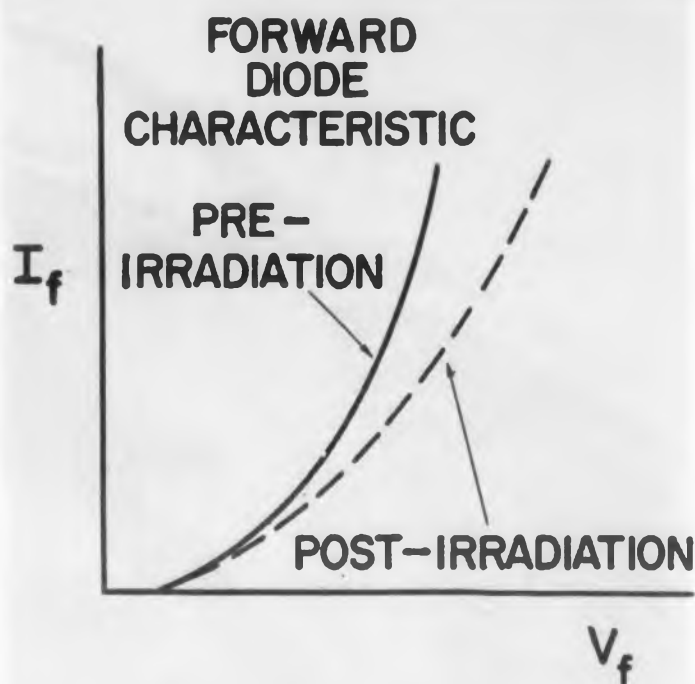


Fig. 3. Diode characteristic—before and after being subjected to nuclear radiation.

of annealing are important, bulk and surface. Both of these processes are temperature and time dependent. While bulk annealing of germanium at 25 C is negligible, it becomes appreciable and increases rapidly above 100 C. Hence, devices might be rejuvenated by a high temperature baking process. Complete recovery could not be achieved at temperatures which would not destroy currently available germanium transistors due to the temperature limitations of other materials employed in fabrication. Although currently available silicon transistors have an upper limit of 200 C, it is now conceivable that they could be made in a manner that would permit baking at temperatures in excess of 500 C.

Surface recovery is not as clearly understood as bulk annealing. We believe it is so however, to predict that an exact repetition of the manufacturer's surface preparation technique could remove all traces of radiation effects from the surface. Radiation induced surface changes may cause either improvement or deterioration of device characteristics. Annealing reverses this process such that in some instances slight deterioration was noticed after removal of the units from the radiation environment, and in one exceptional instance the characteristics after annealing were markedly better than before the radiation test by a ratio of about six to one. This was however a very poor device

initially and was rejectable on the basis of manufacturers specifications. Generally, most commercially available devices can be expected to deteriorate due to surface changes during irradiation and recovered partially as a function of time and temperature after removal.

Effects Noted

In Fig. 3 is shown a diode characteristic before and after irradiation. The input impedance and saturation resistance of diodes, which have a linear relationship with common base and common emitter transistor circuits, should increase as a function of bulk deterioration. These changes will generally be relatively slight.

The output characteristics of a transistor are shown in Fig. 4 with the collector voltage plotted against the collector current and with the base current as the independent variable. The solid lines are pre-irradiation, and the dotted lines are pre-irradiation. The changes predicted on the basis of the forward diode characteristic are clearly apparent. In addition, from this it can be seen that the output impedance will generally decrease. The change being attributable to surface effects. In rare cases the converse might be true.

Maximum breakdown voltage should generally be decreased due to surface effects. Breakdown voltage which is generally a function of resistivity will not be noticed before the device is virtually destroyed due to the deterioration of minority carrier lifetime except possibly for extremely narrow base width units.

Noise figure will increase as a function of surface deterioration. Discrete noise pulses due to incident particles and rays are insignificant except possibly in the presence of an intense cosmic shower. The probability of which is insignificantly small up to altitude in excess of 250 miles.

Improved silicon devices will show a greater sensitivity to nuclear radiation damage than equivalent germanium devices by a factor of two to five.



TRANSISTOR COLLECTOR CHARACTERISTIC

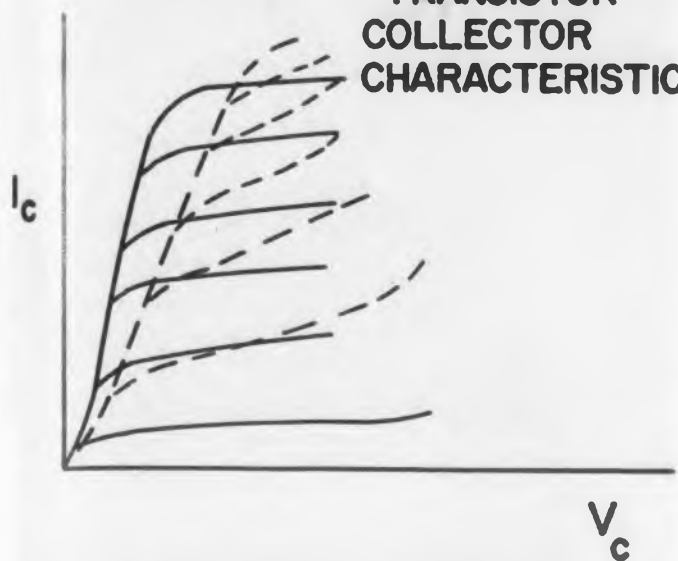


Fig. 4. Transistor output characteristics curves—before (solid) and after (dotted) subjection to radiation fields.

Information is currently available for the initiation of development of devices specifically intended for use in radiation environments. Much work has yet to be done in this area, surface preparation and capsulating materials which can readily be analyzed and tested might be a fruitful area for work. More radiation resistant surfaces could be manufactured by design, but in the interim (by the screening technique suggested previously) highly resistant devices can be selected to be satisfactory for most requirements.

All the tests that have been conducted so far have been with very intense radiations such as are found in the heart of a reactor or under extremely intense gamma sources. The transistors tested were capable of lasting specific lengths of time. Some gave indications of little or no deterioration under very intense gamma flux; others under the most severe atomic pile conditions gave appearances of useful life in the order of hundreds of hours. Under these conditions, human beings could not be expected to survive after a fraction of one percent of this time. Due to their single crystalline structure, transistors are somewhat more sensitive to radiation damage than other conventional components, with a few exceptions.

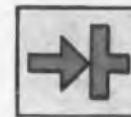
This article is based on a talk given by Mr. Kret at the Electronics Components Symposium in Chicago, May 1-3, 1957.

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		.1	50	.438 x 1-3/16
		.47	50	.562 x 1-15/16
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		.1	50	.281 x 15/16
		.47	50	.437 x 1-15/16
UPRIGHT MOUNTING 	613G . . . Mylar dielectric winding, extended foil construction, hermetically-sealed metal housing.	.01	50	.173 x 23/32
		.1	50	.313 x 27/32
		.47	50	.50 x 1-3/16
EPOXY COATED CERAMIC DISCS 	600RE . . . This novel design combines features of conventional tubular capacitors and upright mounting types. The mylar dielectric winding is completely encapsulated in Epoxy. In addition to its attractive glossy red appearance the Epoxy formulation developed by Good-All yields a tough, durable coating with excellent dielectric strength.	.01	50	.250 x 11/16
		.1	50	.375 x 15/16
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UPRIGHT MOUNTING 	600UPE . . . Mylar dielectric winding molded in dense, moisture-resisting Epoxy.	.01	50	.438 x 15/16
		.1	50	.562 x 1-3/16
		.47	50	.688 x 1-15/16
UPRIGHT MOUNTING 	620UPB . . . Mylar dielectric winding with molded bakelite housing and thermo-setting plastic end seal.	.01	50	.375 x 1
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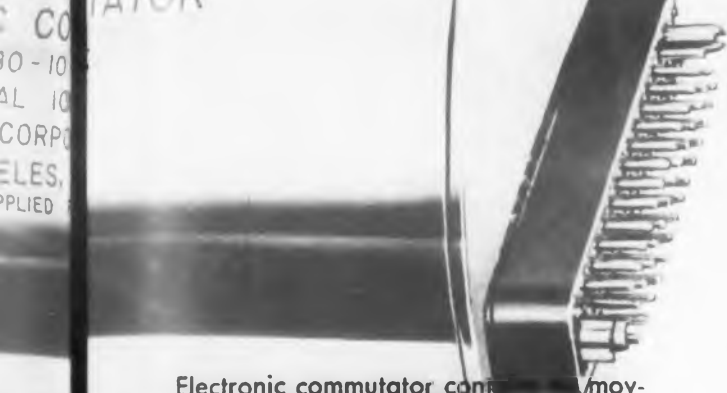
Airborne El Telemetry Co

USED FOR telemetering information in aircraft and missiles, this electronic commutator can be expected to have a life of 5000 hours. Twenty-eight data channels are switched without recourse to moving parts. The unit, consisting of a transistorized pulse generator, a silicon diode switching matrix and a sequential counter, is contained in a package 3 in. diam x 5 in. long and weighs 2 lb.

The commutator, manufactured by Arnoux Corp., 11924 W. Washington Blvd., Los Angeles 66, Calif., is designed to operate at fixed speeds from 2-1/2 to 30 cps and to handle input signals over the range 0 to 5 v with a 25 K source impedance. One of the 28 input channels is used for frame synchronizing purposes. With an input signal between 0 and 5 v applied to this channel, the device produces a frame synchronizing pulse in the output equal in width to three *on* periods and two *off* periods. Output amplitudes are from 5 to 7 v with a 5 v input, constant to ± 5 per cent.

ELECTRONIC DESIGN • July 15, 1957

TATOR



Electronic commutator containing no moving parts, consists of a transistorized pulse generator, silicon diode switching matrix and sequentia counter, is contained in a 47 cu in. volume.

Electronic Commutator

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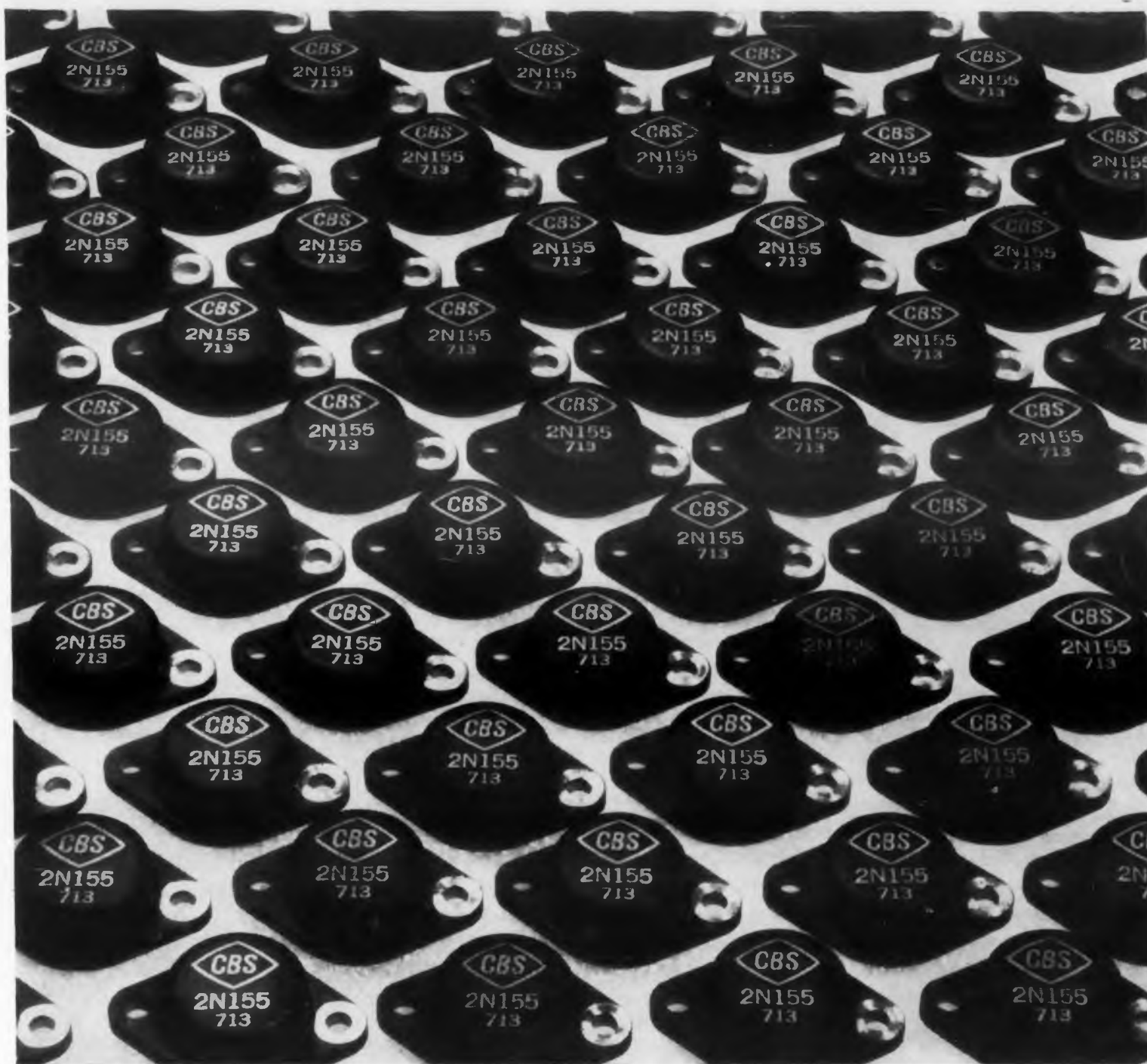
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The variation in output pulse level corresponding to inputs between 0 to 5 v is less than 10 per cent of the pulse width, while the peak-to-peak noise level on the output pulse train is less than half a per cent of the full scale range. Cross-talk between channels is less than 0.25 per cent of the full scale range. With equal inputs to all channels—0 to 5 v—the variation in pulse levels between channels is again plus or minus half a per cent of the full scale range.

Designed to operate from $+150 \pm 5$ v dc, the unit requires 2 w. It will operate between -65 and 185 F, sea level and 80 kilofeet.

The electronic commutator was developed to fulfill a need left by mechanical switches that wear relatively quickly when a common wiper makes contact with the data channel contacts at speeds from 150 to 1800 rpm.

For more information on this electronic commutator, turn to the Reader's Service Card and circle 33.



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Frequency Division with Semiconductor Devices

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FREQUENCY division may be accomplished in a number of ways with semiconductor devices. It is a process of deriving from a source frequency f a frequency of exactly f/n , where n is an integer. Frequency division is used in radar systems, radio navigation systems, computers, television transmitters, some fm transmitters, electronic clocks and in a host of other applications where it is necessary to obtain a frequency that is an exact integral sub-multiple of another frequency. It finds important application in frequency measurement equipment where a low frequency signal is obtained from a precision high frequency source.

Frequency division may be accomplished with semiconductor devices by use of:

- Blocking oscillators
- Multivibrators
- Devices showing negative resistance (double base diodes, point contact transistors, negative resistance diodes, avalanche transistors, combinations of junction transistors)
- Counter circuits (binary counters and ring counters)
- Regenerative frequency dividers
- Circuits in which increments of charge are added to a capacitor which is then discharged at a given count (an integrating type of counter)

A junction transistor blocking oscillator is shown in Fig. 1a. This circuit is similar to one often used with vacuum tubes. The operation of the circuit may be explained by assuming that a negative pulse has just driven the base negative, causing the col-

lector to conduct and the voltage at the collector to swing positive. The transformer secondary in the base circuit inverts the voltage across the primary in the collector circuit and drives the base more negative causing the transistor to conduct more heavily. This action is regenerative and rapidly drives the transistor to full conduction. The duration of the pulse is a function of the size of the coupling capacitor in the base circuit and the mutual inductance of the transformer, among other things.

When the voltage across the capacitor begins to change, and when the voltage across the transformer starts to drop, the voltage at the base begins to decrease, causing a decrease in collector current. This initiates regenerative action in the other direction and the transistor is rapidly turned off. Because of the charge placed on capacitor C during the conduction interval the base is now biased positively and the transistor will remain in the cut-off condition until the capacitor discharges to zero or a pulse drives the base negative.

The base wave form is shown in Fig. 1b. The capacitor discharges with a time constant determined mainly by C and R_1 in series with the parallel combination of R_1 and R_2 . When the transistor is turned off, the impedance looking into the base is very high. If the transistor did not conduct when the base voltage became negative the capacitor would discharge to $-V_{cc} R_2 / (R_1 + R_2)$.

Fig. 1b illustrates division by four. The negative pulses are too small to drive the base negative until

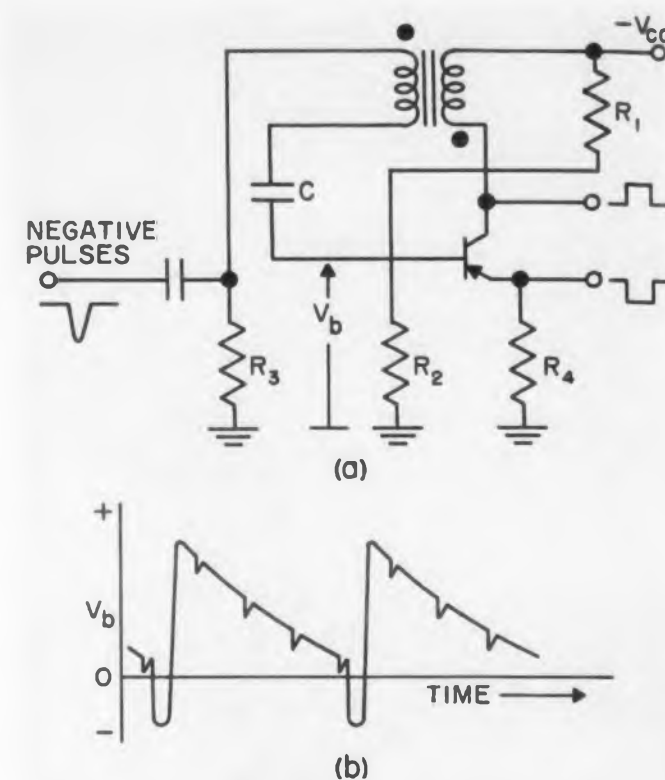


Fig. 1. a) A typical blocking oscillator b) Base voltage waveforms

base voltage has dropped to the point where the fourth pulse triggers the circuit. The free-running period of the circuit is longer than the triggered period. By placing R_1 in the emitter circuit a negative pulse is available to drive another similar dividing circuit. A positive pulse is available at the collector.

Blocking oscillator circuits take different forms. In Fig. 2a the RC circuit controlling the frequency is placed in the emitter circuit. A negative output is available from a transformer winding and a positive pulse is obtained at the collector. In Fig. 2b the transformer secondary and the RC circuit are in the emitter circuit, with a positive pulse available at the collector.

Multivibrators

A junction transistor multivibrator and the associated waveforms are shown in Fig. 3. The parameters R_{b1} , R_{b2} , and C_2 may be adjusted for the desired conduction periods. The circuit may be modified by returning R_{b1} and R_{b2} to voltages other than $-V_{cc}$. Every third pulse applied to the base of transistor 1 causes triggering in the example shown.

Negative Resistance Devices

Semiconductor devices capable of producing negative resistance characteristics include point contact transistors, double-base diodes, avalanche transistors and combinations of junction transistors. A typical negative resistance curve is shown in Fig. 4a. If a load resistance R_L is used with a

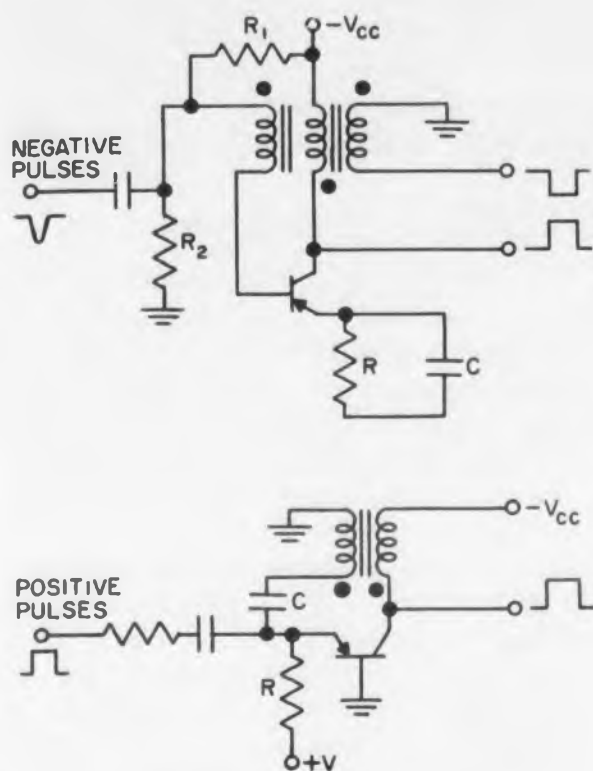


Fig. 2. Blocking oscillators using junction transistors

voltage V_s to bias the device in the negative resistance region and a capacitor is placed across the input as shown in Fig. 4b, relaxation oscillations will result. The voltage appearing across the capacitor is shown in Fig. 4c where division by three is shown. The path of the operating point is shown by arrows in Fig. 4a. Operation of the circuit may be explained by assuming that the device is initially in the cut-off region. The capacitor charges towards V_s through R_L until the peak point V_p of the negative resistance curve is reached.

Upon reaching the peak point voltage, the operating point switches rapidly to the conduction region where the capacitor is quickly discharged to the valley point voltage V_v at which point the device is turned off and the cycle repeats. By superposing small timing pulses as indicated in Fig. 4b and 4c frequency division may be accomplished.

The negative resistance curve of Fig. 4a is typical of the V-I characteristics obtainable with the devices mentioned above except that the location of the curve in the V-I plane may differ. All the devices mentioned are three terminal devices with the exception of the negative resistance diode. The diode is not available on the market but a great deal of research is being carried on, as indicated at a recent conference on semiconductor devices where one-third of the papers presented were on the subject of negative resistance diodes.

The negative resistance diode is capable of very high frequency operation. Relaxation oscillators at

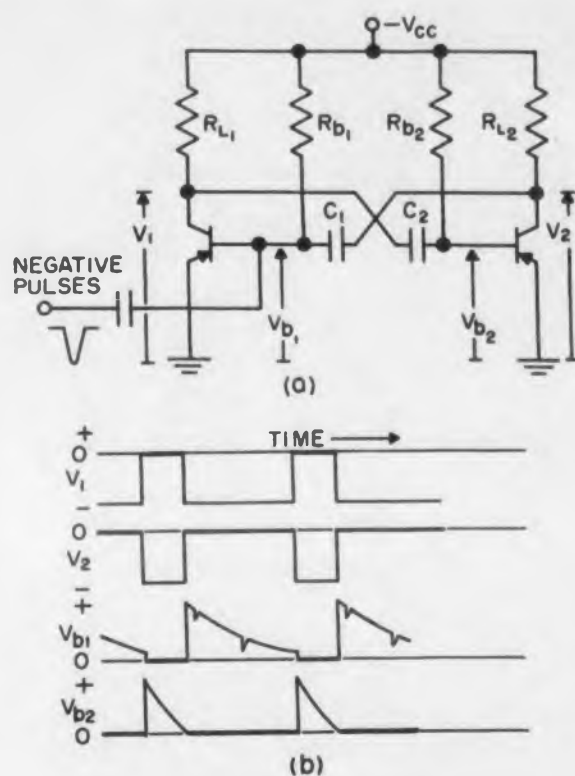


Fig. 3. A junction transistor multivibrator and the associated waveforms

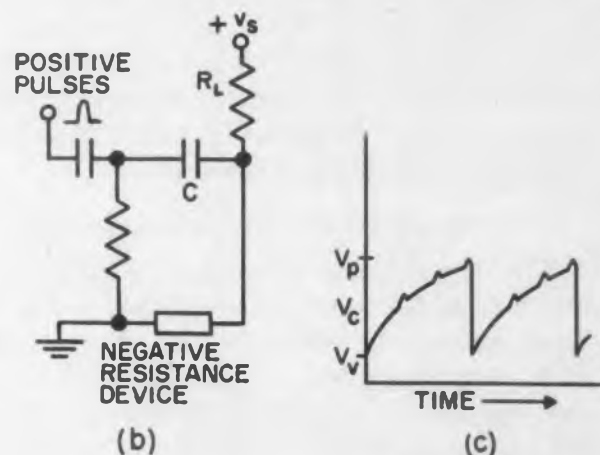
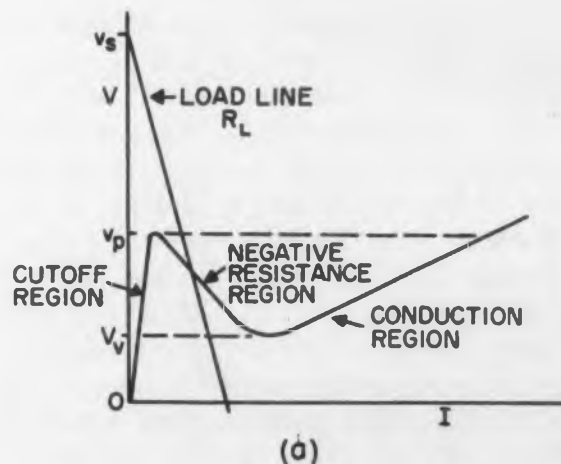


Fig. 4. a) A typical negative resistance curve b) A negative resistance frequency divider c) Voltage across the capacitor of Fig. 4b for division by three

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30 mc have been obtained. Fig. 4b gives a fair indication of the simplicity of a relaxation oscillator using a two-terminal negative resistance diode. For a three-terminal device, the block in Fig. 4b represents the two terminals across which negative resistance characteristics appear. In three-terminal devices, the third terminal may be used for a signal output.

Fig. 5 illustrates some other circuits having a negative resistance characteristic. The combination of a PNP and an NPN transistor as shown in Fig. 5d is equivalent to a point contact transistor except that the current gain is higher. The avalanche transistor is not shown but consists essentially of an ordinary junction transistor operated at higher than normal collector voltages where heavy conduction occurs due to avalanche multiplication at the collector. This "breakdown" current may be controlled by base current and the transistor may be used in circuits similar to those used with point contact transistors. The remarkable feature of the avalanche transistor is that a switching time of a fraction of a microsecond may be obtained with low frequency audio transistors.

Counters

Binary counters and ring counters may be used for frequency division. They differ from the frequency divider circuits previously mentioned in that they are not free-running and are not as sensitive to trigger pulse, supply voltage, or circuit parameter variations. They are, however, more

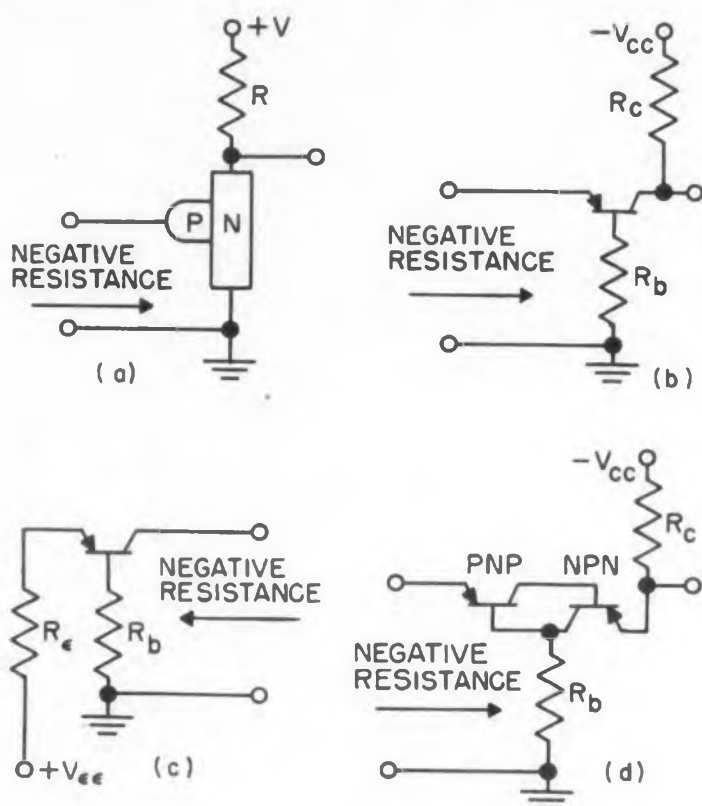


Fig. 5. Circuits having negative resistance characteristics a) Double base diode b) Point contact transistor c) Point contact transistor d) Combination of junction transistors

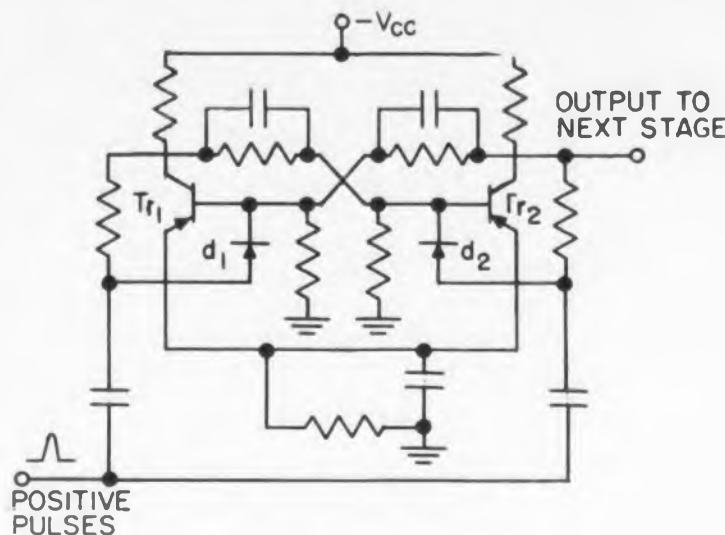


Fig. 6. A binary counter frequency divider

complicated than the free-running circuits. If the counter accepts n pulses before returning to its original state, it will produce an output pulse once for each n input pulses. The counter may be constructed with transistors of either the point contact or junction type and may be either a ring counter or a binary type made up of a number of binary flip-flops. Fig. 6 shows a typical binary counter stage using junction transistors.

Ring counters may be constructed to divide by any integer. Binary counters normally count in powers of two but may be used with feedback circuits to reset at the desired count and thus may also be used to divide by any integer. The binary counter of Fig. 6 operates as follows. If Tr_2 is 'on' a positive pulse applied to the flip-flop will pass through d_2 to the base of Tr_2 and turn it 'off' and at the same time turn Tr_1 'on', (diode d_1 is reverse-biased by the negative collector voltage of Tr_1).

The next positive pulse will turn Tr_1 'off' and Tr_2 'on' producing a positive going voltage at the collector of Tr_2 which may be applied to another binary stage for further division. Thus every other input pulse applied to the flip-flop returns it to the same state. In a ring counter an 'on' condition is transferred from one stage to the next at each input pulse with the frequency division determined by the number of stages in the counters.

Regenerative Frequency Dividers

The regenerative frequency divider shown in Fig. 7 is similar to the counter types in that it is not free-running, but differs in that it is essentially a sine wave circuit. Fig. 7a shows a block diagram of the regenerative frequency divider. To understand the operation of the circuit, assume the system is in operation with an input frequency f and an output frequency f/n . A signal of frequency f/n is applied to a harmonic generator tuned to the $(n-1)$ th harmonic of the f/n signal and thus has an output frequency of $(n-1)f/n$ which is applied to the mixer.

The mixer output circuit is tuned to the difference frequency of the two signals coming into the mixer, f and $(n-1)f/n$, this difference frequency being the desired output frequency, f/n . Fig. 7b illustrates how the circuit might be realized with junction transistors.

Integrators

Fig. 8a shows a counter in which an increment of charge is added to a capacitor each time a pulse is applied to the circuit. After a desired number of pulses the negative resistance circuit discharges the capacitor. In explaining the operation of the circuit, it will be assumed that the negative resistance device has a V-I characteristic similar to that in Fig. 4a. The transistor is normally 'off' and a negative pulse is assumed to drive the transistor fully 'on' so that the collector goes nearly to ground potential during the pulse. C_1 is much smaller than C_2 . Assume that the negative resistance device has just discharged C_2 at time t_0 . C_1 is charged to a voltage of nearly $-V_{cc}$ (the voltage at the collector when cut off). When a short negative pulse arrives it drives the transistor to full conduction, the collector approaches ground potential, and C_1 transfers most of its charge to C_2 through diode D_2 causing a positive step of voltage to appear across C_2 as shown in Fig. 8b. After the trigger pulse disappears, C_1 charges again to $-V_{cc}$ through R_L and diode D_1 . The next trigger pulse to arrive results in another transfer of charge from C_1 to C_2 and another jump in voltage across C_2 . The process continues until the

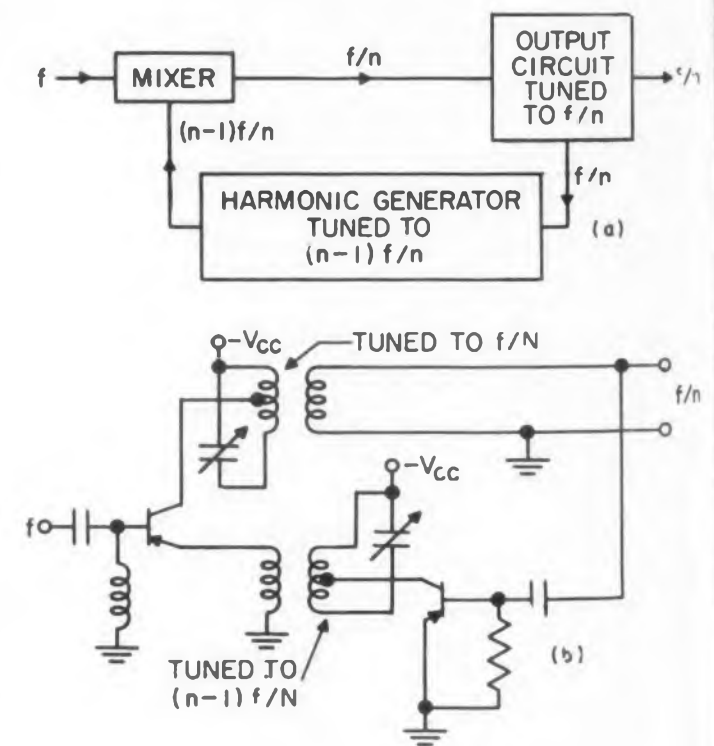


Fig. 7. a) Block diagram of a regenerative frequency divider b) Circuit of a regenerative frequency divider

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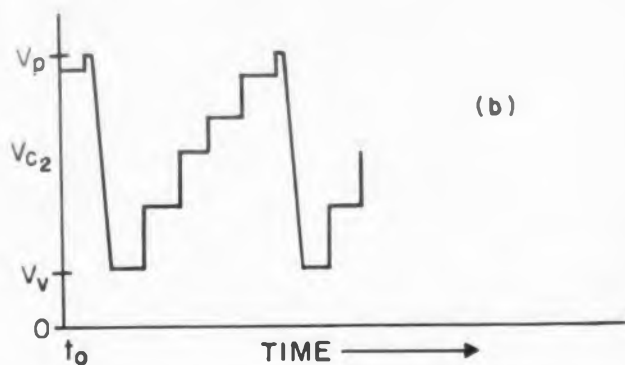
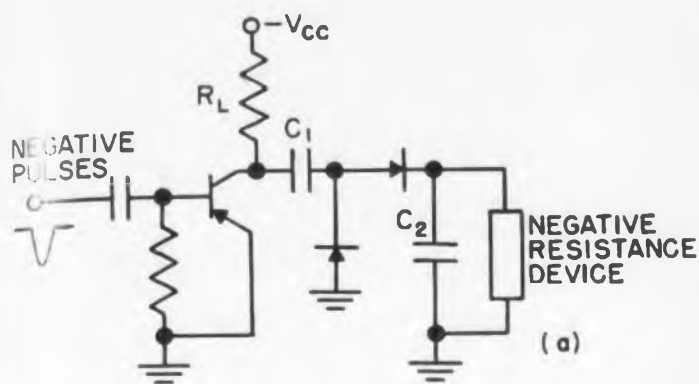


Fig. 8. a) An integrating type of frequency divider b) Associated waveform

voltage across C_2 reaches the peak point of the negative resistance device causing it to fire, at which time the cycle of events repeats. It is assumed that the back resistance of the diodes and the cut-off resistance of the negative resistance device is high enough so that C_2 does not discharge appreciably between trigger pulses. The negative going waveform appearing when C_2 is discharged could be used to operate another similar counter circuit. Fig. 8b shows frequency division by five.

Bibliography

Transistor Issue, *Proceedings of the IRE*, Nov. 1952.

Lo, et al, *Transistor Electronics*. Prentice Hall, Inc., Englewood Cliffs, 1955.

Transistors I, RCA Laboratories, March 1956.

Terman, *Radio Engineering*. McGraw-Hill, N. Y., 1947.

Suran and Keonjian, "A Semiconductor Diode Multivibrator," *Proceedings of the IRE*, July 1955.

"The Three Junction Diode," *AFCRC-TN-55-120*, Oct. 1955, Air Force Cambridge Research Center, Bedford, Mass.

J. J. Bowe and R. R. Rutherford, "Non-Thermal Negative Resistance Diodes," *AFCRC-TR-55-123*, Nov. 1955, Air Force Cambridge Research Center, Bedford, Mass.

Moll, Tanenbaum, Golden, and Holonyak, "PNPN Transistor Switches," *Proceedings of the IRE*, Sept. 1956.

Statz and Pucel, "The Spacistor, A New Class of High-Frequency Semiconductor Devices," *Proceedings of the IRE*, March 1957.

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Fig. 1. Stable 400 cycle multivibrator

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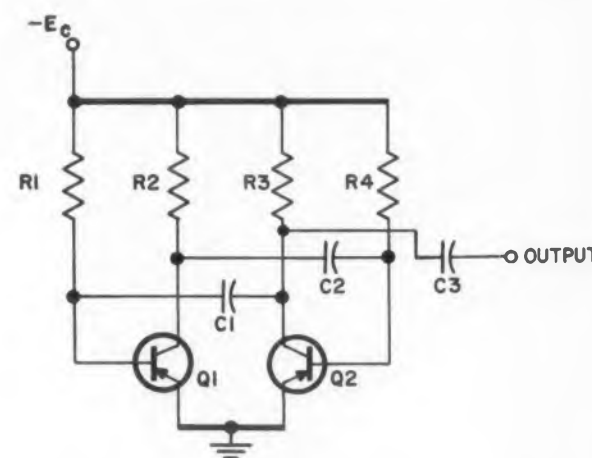


Fig. 2. Schematic of tiny 400 cycle multivibrator

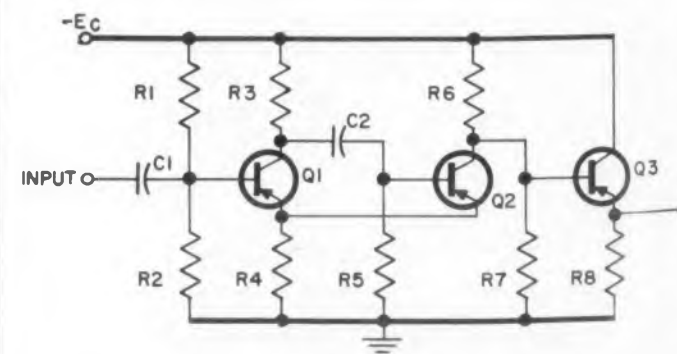


Fig. 3. Schematic of one-shot multivibrator which occupies less than one-fifth of a cubic inch

Tiny Transistor Assemblies

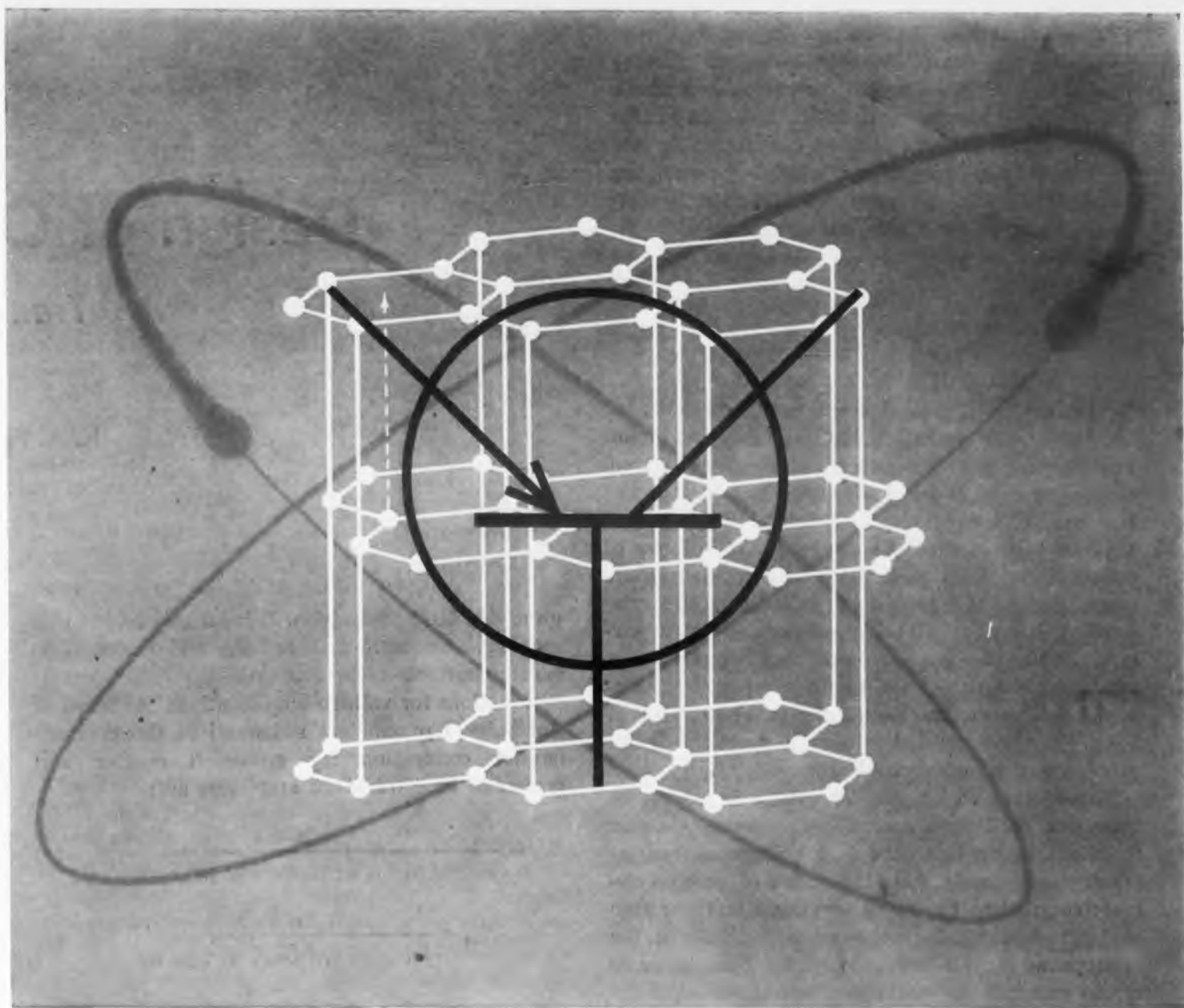
lications where reliability is of prime importance.

Circuit configurations currently available are a two-stage audio amplifier, three db down at 40 cps and 60 kc with a minimum voltage gain of 30 db; a 400 cycle multivibrator; a one-shot multi; a flip-flop which can be triggered at rates up to 20 kc; and a bootstrap sawtooth generator.

These minuscule assemblies are designed and manufactured with emphasis on reliability. The manufacturer, M F Electronics Co., 122 E. 25th St., New York 10, N.Y., includes testing as one of a major series of operations in their fabrication. The units are subjected to exhaustive tests, first at the mock-up stage, again prior to potting, then once again after the units have been potted and set for several days. In addition temperature runs are made on representative units to insure that the specified temperature requirements are met.

The 400-cycle multi, which may be used, typically, to drive a gate, act as a pulse source, or drive a counter, is shown in Fig. 1, and its schematic in Fig. 2. Critical components *RI*, *R4*, *C1*, and *C2* are chosen to be the most stable components available. 5 v peak to peak are available, using a 6 vdc supply providing 3 ma. Even more impressive from the viewpoint of space economy is the three-transistor one-shot multi whose schematic is shown in Fig. 3.

These Lilliputian circuits are encapsulated with epoxy resin in drawn nickel silver cases, offering complete protection from humidity—even operation under water. The container measures 0.75 in. h. x 0.717 in. w. x 0.312 in. t., and the complete assembly weighs less than one-third of an ounce. For more information about these tiny circuits, turn to the Reader's Service Card and circle 28.



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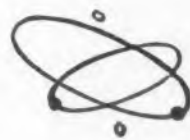
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CIRCLE 34 ON READER-SERVICE CARD FOR MORE INFORMATION

Editors Note: Use of conductance curves¹ for designing electronic circuits has been the subject of many articles by Mr. Pullen. In this article he points out some interesting conduction ratios which can be used in the design of oscillators. Part I, which appeared in the July 1 issue, discussed the design of vacuum tube oscillators using conductance values. Part II extends these techniques to a variety of transistor oscillators.

Design of Oscillators—II

Transistor

K. A. Pullen, Jr.

Ballistic Research Laboratories
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TRANSISTORS are excellent active elements for low-power oscillators. High stability and almost unbelievable economy can be attained when transistors are used in design of oscillators. In Part I of this article, the principals involved in design of vacuum tube oscillators were analyzed in terms of practical problems of design. Conductance values were used in the analysis to coordinate the tube (active element) with other components in the circuit. Design techniques were considered from a small signal point of view with emphasis on sinusoidal oscillators. The techniques developed in Part I will now be extended to include practical design problems of transistor oscillators.

The factors which are important in design of transistor oscillators are: (1) the active element functions best when used in a voltage control, or conductance mode. (2) Impedance of passive circuits coupled to the input terminals of the active element should satisfy the relation $gZ < 1$ at the appropriate port or terminal pair. (g is conductance of the active device, and Z source impedance of the passive circuit). (3) Loading of the feedback network should have a negligible effect on the output voltage of the active device. (4) Loop amplification should exceed unity for proper starting. (5) When good frequency stability is necessary, circuit feedback must be sufficiently small to prevent amplitude limiting as a result of clamping.

Each of these requirements are elaborated upon in the discussion which follows.

Operating Conditions

The first step in the practical design of transistor oscillators is establishment of operating conditions which will provide amplitude limiting. The high degree of current gain constancy in transistors prohibits the use of constant current conditions—starting is too hard to obtain in sinusoidal oscillator circuits. Amplitude control is readily obtained when the transistor is used in a conductance mode of operation (constant input voltage). Thermal stability requires that either base or emitter current be held approximately constant. Base current is held constant when a common emitter connection is used. Emitter current is held constant with a

grounded base connection. It is for this reason that starting base current is call I_{bo} and the starting emitter current I_{eo} in this article.

Equations for voltage amplifications* in terms of small-signal parameters measured at the common emitter connection for grounded emitter and grounded base transistor amplifiers are:

$$K_{ve} = \frac{-g_{fe} R_L}{1 + g_{ie} (R_i + r_b') + g_{oe} R_L + g_{ie} g_{ce} (R_i + r_b') R_L} \quad (1)$$

$$K_{vb} = \frac{g_{fe} R_L}{L + (g_{ie} + g_{fe}) (R_i + r_b) + g_{oe} R_L} \quad (2)$$

Two conclusions can be drawn from these equations: the first is that if R_i (or r_b') is sufficiently large, variations of K_v are difficult to obtain since R_L and R_i are constants; the second is that available values of amplification are relatively small.

Input admittance of a transistor is rather large compared to that for a tube. The reason is evident when the significance of g_{ie} is considered. The design technique used to compensate for capacitive charging current in the input circuit of a tube is to arrange the input circuit to provide the required

*Notations used in the equations are described in the transistor data chart.

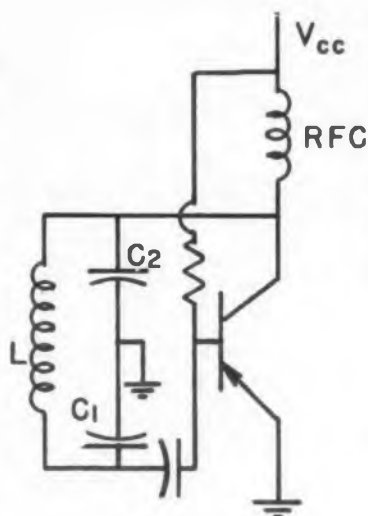


Fig. 1. Colpitts oscillator. An SB-100 transistor is used in 5 MC oscillator.

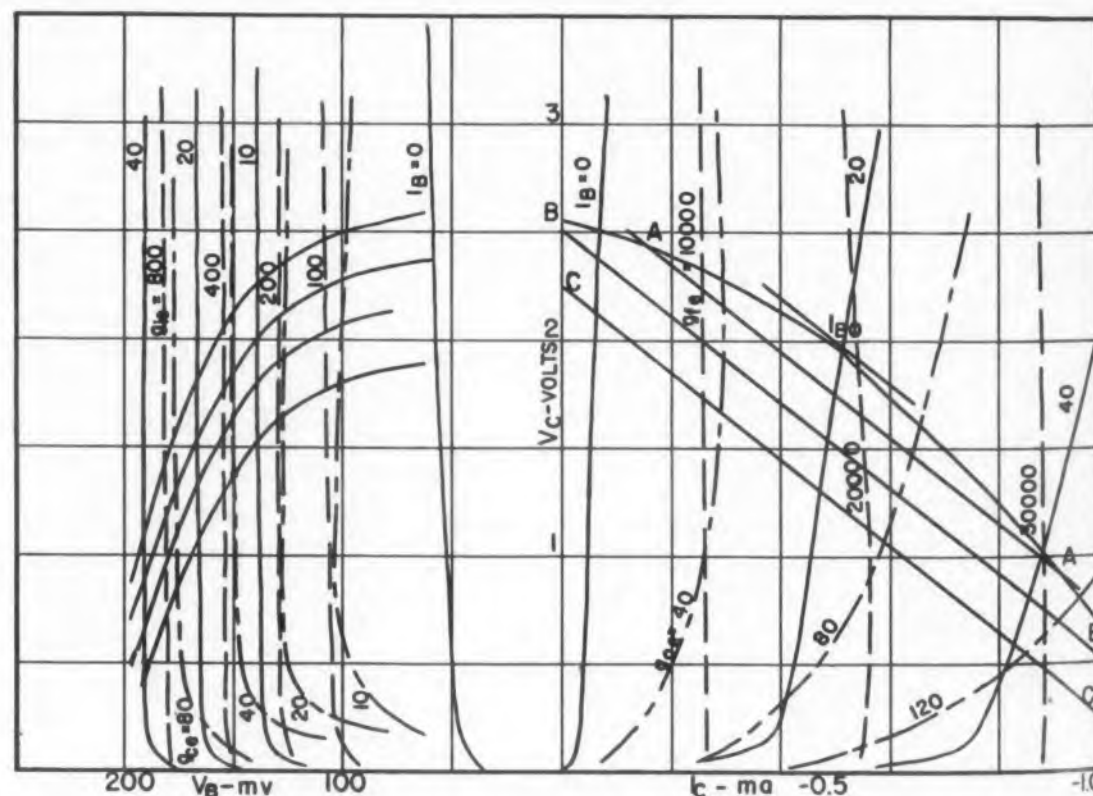


Fig. 2. Characteristic curves for SB-100 transistor with limit contours.

charging current without upsetting impedance relations. The same technique may be used with transistors.

Input conductance of a grounded emitter transistor is approximately equal to g_{ie} , and for a grounded base transistor it is approximately $(g_{ie} + g_{fe})$. Complete equations for input admittances of common emitter and degenerative emitter amplifiers are:

$$g_{in} = \frac{g_{ie} (1 + g_{ce} R_L)}{1 + g_{ie} (R_i + r_b') + g_{oe} R_L + g_{ie} g_{ce} (R_i + r_b') R_L} \quad (3)$$

$$g_{id} = \frac{g_{ie} [1 + g_{ce} (R_e + R_L)]}{1 + g_{ie} (R_i + r_b + R_e) + (g_{fe} + g_{oe}) R_e + g_{oe} R_L + g_{ie} g_{ce} [(R_i + r_b) + (R_e + R_L) + R_e R_L]} \quad (4)$$

Equation 4 is of particular importance in the design of phase-shift oscillators. Without emitter degeneration input admittance can not be made sufficiently small to function with the phase-shift network.

Colpitts Oscillator

Design procedures discussed in the first part of this article** will now be applied to a transistorized Colpitt's oscillator (Fig. 1). The following relations apply in a well-designed oscillator. For the output circuit:

$$g_{oe} Z_L < 1 \quad (5)$$

and the input circuit:

$$g_{ie} R_i = g_{ie} (C_2/C_1)^2 Z_L < 1 \quad (6)$$

**Design of Oscillators-I, Electronic Design pp. 52 to 55 July 1, 1957

Feedback gain is:

$$K_f = C_2/C_1 \quad (7)$$

and the loop gain is approximately:

$$K_L = K K_f = g_{fe} Z_L (C_2/C_1) \geq 1 \quad (8)$$

For oscillation to start, the terms in (8) should be selected so that the product is equal to at least 1.5.

A 5 mc transistor Colpitts oscillator will be designed to illustrate equations 5 through 8. The transistor selected is an SB-100 (Fig. 2). A trial collector supply voltage of $-2v$ with a collector current of 0.5 ma is used as starting point for design. Since g_{ie} has a value of 550 micromhos, $(C_2/C_1)^2 Z_L$ must have a value of about 1,000 to satisfy eq. 11. Taking $C_2/C_1 = 0.1$, gives value of Z_L in the neighborhood of 2500 ohms. Since the value of g_{fe} at the starting point is 0.018 mhos, a value of 0.05 for C_2/C_1 and 2000 ohms for Z_L gives a $K K_f$ of 1.8. The approximate impedance of the circuit which supplies the base is $(0.05)^2 \times 2000$, or five ohms. A typical value for g_{oe} is 60 micromhos. Substituting in eq. 5 gives $g_{oe} Z_L = 0.12$, indicating that the effect of collector loading can also be neglected.

Assuming a Q of 100 for the overall tuned circuit, the reactance of the collector circuit is 20 ohms, giving a capacitance C_2 of 1600 $\mu\mu\text{fd}$, and $C_1 = 3200 \mu\mu\text{fd}$. The required inductance L is 0.67 microhenries.

The next step is to plot limit contours on the transistor characteristic curves, Fig. 2, and locate the amplification limit conditions. Operating limits along any load line are determined by finding the set of points which will simultaneously give the same average base current as that chosen at the

starting point, and a positive excursion of the base voltage equal to the negative excursion, Fig. 3.

Two points are taken along the load contour drawn on the base family. The points represent equal changes of base voltage, one positive, ΔV_{bp} , and the other negative ΔV_{bn} .

$$\Delta V_{bp} + \Delta V_{bn} = 0$$

The base current is averaged by the equation:

$$I_{bn} = (I_{bp} + 2I_{bs} + I_{bn}) / 4 \quad (9)$$

where I_{bp} is the most positive base current, I_{bs} the base current at the intersection of the static and dynamic load lines, and I_{bn} the most negative base current. This equation is valid as long as the sum of I_{bp} and I_{bn} is approximately twice I_{bs} . If this condition does not exist, a more complex method of averaging is required. The current I_{bs} has a smaller magnitude than I_{bo} , the starting base current. Either I_{bp} or I_{bn} must be very large, otherwise the average will not limit to a value of I_{ba} equal to I_{bo} . Trial changes in base voltage amplitude are increased until the proper value of I_{ba} is obtained. The resulting points represent the positive and negative limits along the individual load contour. The calculation may be repeated along each load line.

When the limit contours have been located and plotted, loop amplifications at the static point and at the limit points can be calculated for each of the load contours. The average amplification, assuming that no sharp breaks in the plot of K as a function of e_b are encountered, is given by the equation:

$$K_a = (K_p + 2K_s + K_n) / 4 \quad (10)$$

and the loop gain by

$$K_a K_f = K_L \quad (11)$$

As always with oscillators, the load contour giving a value of unity for K_L is the one which represents the limit cycle.

The limit contours shown in Fig. 2 show that the operating point has not been properly selected (or the wrong load impedance has been selected), causing the transistor to cut off for part of the cycle. The average amplification for the load line at which the minimum base current reaches zero is 1.4, indicating that eq. 10 does not give accurate results. Linear operation can be obtained by changing the value of K_f from 0.05 to 0.033 or changing both K_f and Z_L to provide better characteristics.

Crystal Oscillator

An excellent crystal-controlled oscillator can be constructed using the SB-100 transistor. The circuit is shown in Fig. 4. The crystal is used in the series resonant mode and has the variable capacitor C_1 in series with it to trim the phase of the feedback. A coil in parallel with the crystal is used to tune out the shunt capacitance of the crystal and its holder.

When a transistor is used as a grounded base

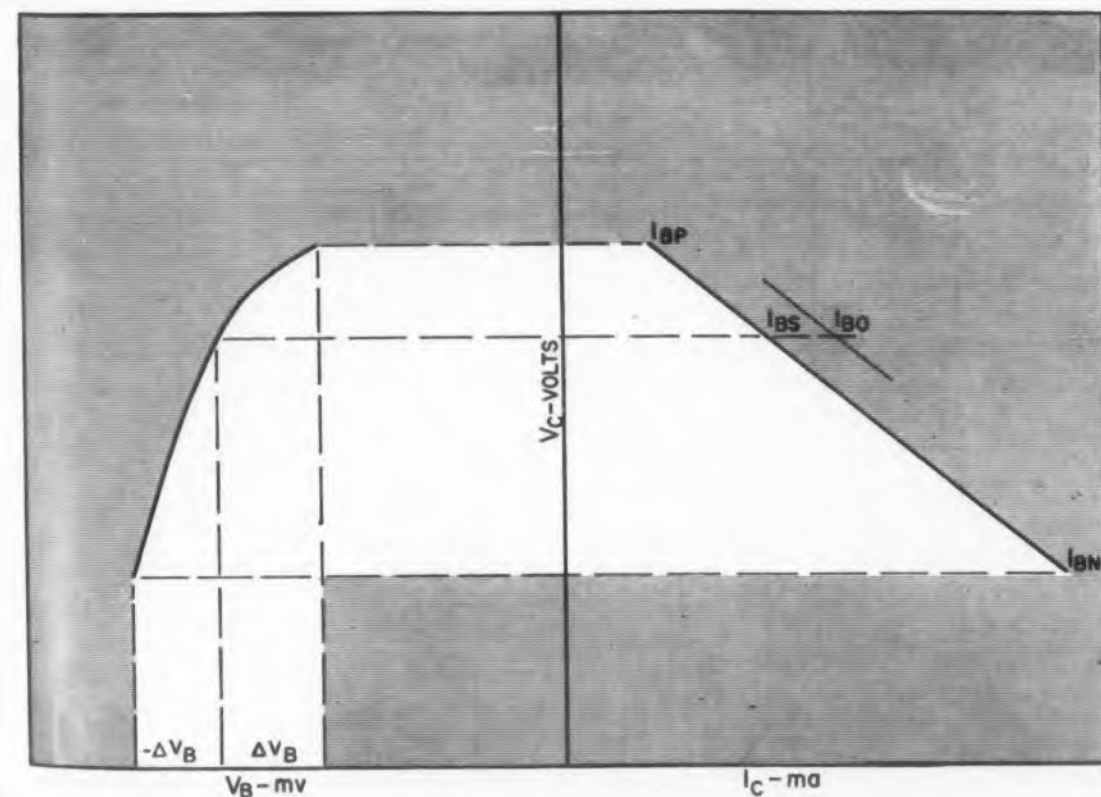


Fig. 3. Operating limits along the load line give the same average base current as that chosen at the starting point and equal positive and negative excursions of the base voltage.

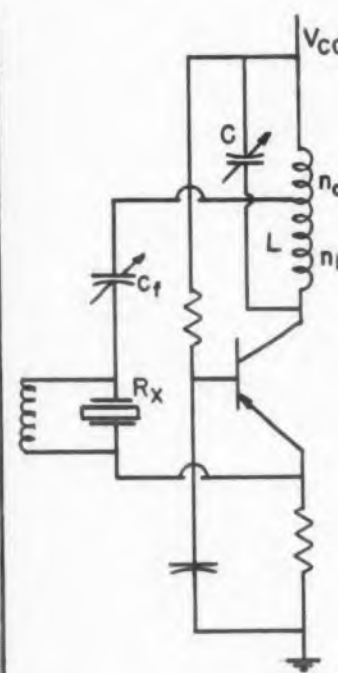


Fig. 4. Crystal oscillator. Operating in series resonant mode. Variable capacitor C_1 trims the phase of the feedback. A coil in parallel with the crystal is used to tune out the shunt capacitance of the crystal and its holder.

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oscillator, an impedance stepdown (current stepup) is required to provide the current gain needed to make the necessary emitter signal current available. The very low input impedance of the emitter also makes a voltage step-down necessary. Maximum turns ratio in the inductance L is given by:

$$n_i/n_o = g_{fe} Z_L / [1 + (g_{ie} + g_{fe}) R_x]^2 \quad (12)$$

where R_x is the series resistance of the crystal, n_i is the total number of turns in L , and n_o the number of turns from the collector supply to the feedback tap. A ratio value about half the maximum given by eq. 12 should be used to assure effective starting with average transistors. For a crystal having a series mode resistance of 100 ohms, a typical value for the complete denominator would be between ten and twenty, since $(g_{ie} + g_{fe})$ has a value between 0.02 and 0.03 mhos. The maximum value of the ratio n_i/n_o is between two and twenty, depending on the crystal used.

Current limiting in a grounded base oscillator is obtained in a manner similar to the method described for a Colpitts oscillator except that limiting is on the emitter current instead of the base cur-

rent. Exactly the same technique is used to average the emitter current, which is the sum of the base and the collector currents. The limit points are points having equal changes of base to emitter voltage with reference to the static voltage. (If the crystal impedance is very high, the emitter current changes will be equal rather than the voltages).

An oscillator can be built around the static conditions used for the Colpitts oscillator just discussed. With $Z_L = 2000$ ohms, and resistance of the crystal, 50 ohms, the feedback ratio should be approximately four. Use of a coil with several taps is desirable, since measurement of the series resonant resistance of the crystal is quite difficult with ordinary equipment.

Magnetic Coupled Oscillators

Transistorized oscillators using magnetic coupling in the feedback path are constructed with the tuned circuit in the collector rather than in the base circuit. Otherwise oscillator starting and frequency stability will be difficult to obtain. Impedance of the base coil, L_b in Fig. 5, is adjusted so that $g_{ie} X_b < 1$, where X_b is the reactance of the base coil L_b . Cou-

Fig. 5. Magnetic coupled oscillator: Coupling is adjusted to provide the required unity loop gain at the desired operation level.

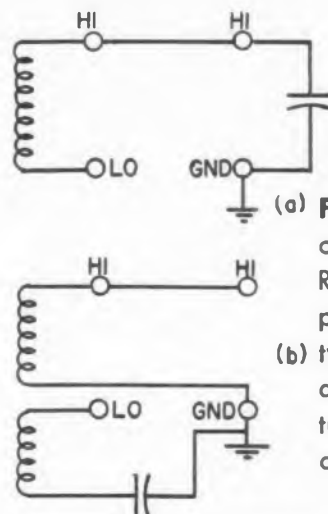
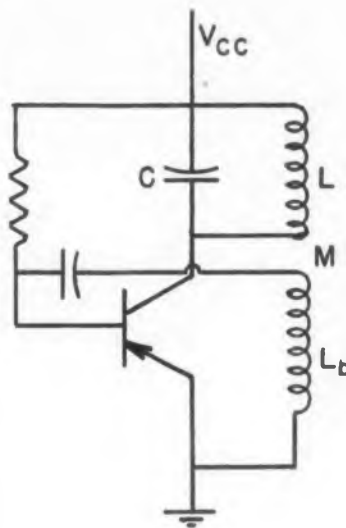


Fig. 6. Determination of coupling coefficient: (a) Required coupling capacitance is added between the "HI" terminal and ground. (b) After tuning the circuit is reconnected as shown.

Fig. 7. Four Section ladder decreases input and output loading problems.

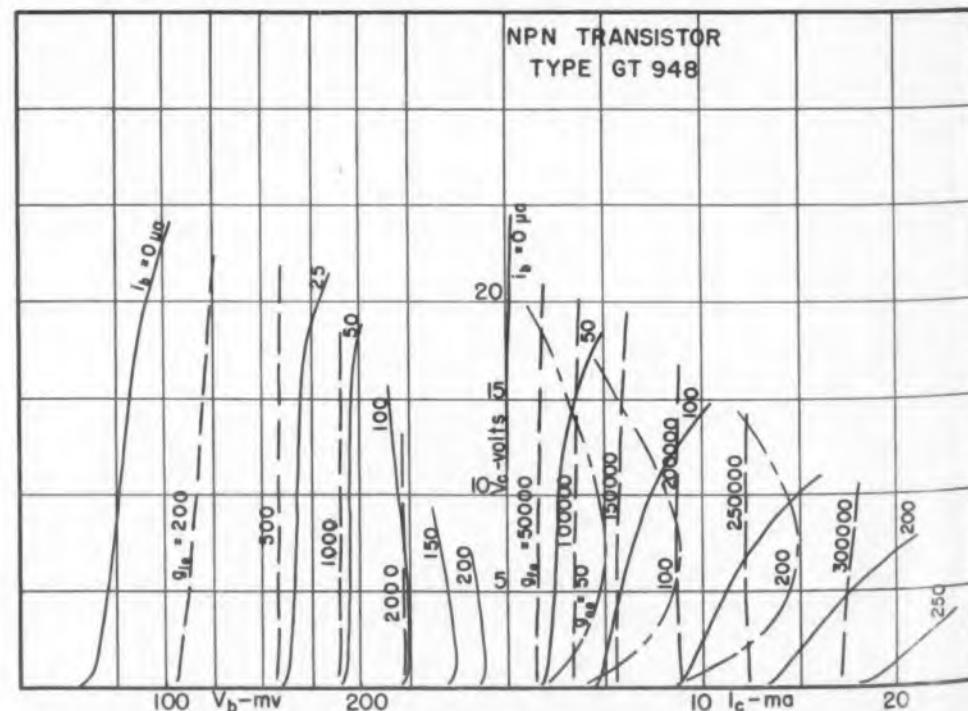
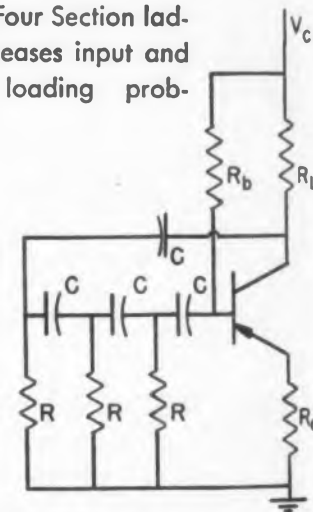


Fig. 8. Characteristic curves for a GT 948 transistor with limit contours.

pling is adjusted to provide the required unity loop gain at the desired operation level.

The main design advantage of a magnetic coupled oscillator is the additional degree of freedom—the coupling factor. The reactance in the base circuit is first adjusted to be small compared to the input conductance. Inductance of the base coil should also be low enough so that $\omega^2 L_b C_b < 0.2$, where ω is the angular frequency at which the oscillator operates, L_b is the inductance, and C_b is the capacitance of the base circuit, including, if necessary, the effective capacitance from base to collector.

The impedance level of the tuned circuit serving as the collector load impedance should be sufficiently small to permit stable operation. A practical value is 2000 ohms. The equation for this relation is written:

$$Z_L = Q X_c = 2000 \text{ ohms} \quad (13)$$

where X_c is the reactance of the capacitor C , and Q is the overall Q of the collector circuit.

Coupling Adjustment

Experimental adjustment of the coupling can be accomplished with a Q meter. First the collector inductance L is connected to the Q meter, Fig. 6a, and the required capacitance obtained by adding fixed mica capacitors between the "HI" terminal and ground to tune the circuit to the proper frequency. (At one megacycle a C of about 5600 μmfd is required). The Q of the combination is read, and the circuit reconnected as shown in Fig. 6b. The position of the coil L_b is adjusted until the new reading on the Q scale satisfies the relation:

$$K_f = Q_b/Q_c \quad (14)$$

where Q_b is the reading with L_b connected to the "HI" terminal (Fig. 6b), and Q_c the reading when the tuned circuit L-C is connected to the "HI" terminal, (Fig. 6a). If, after the adjustment is made, the transistor gain satisfies the relation

$$K_a = g_{fe} Z_L > 1/K_f \quad (15)$$

oscillation will result. (At very high frequencies g_{fe} may be reduced below the dc value, with the result that near cutoff frequency K_f may have to be larger than calculated).

Transistor R-C Oscillators

Transistor R-C oscillators are more difficult to design than their vacuum tube equivalents because of the relatively high values of g_{ie} characteristics of transistors. As a consequence, a design which may appear to be excellent on paper may not function properly even when loop gain and phase appear to be correct. A circuit, such as shown in Fig. 7, requires considerable emitter degeneration to function as an oscillator. Without the four-section ladder,

input and output loading become difficult to design problems.

Collector load impedance should not be greater than 1500 ohms with a GT-948 transistor operating at point A, Fig. 8. Since forward conductance of the transistor is 0.075 mhos at point A, the maximum permissible value of R_e is 82 ohms. Amplification is therefore about 15. Emitter resistance also increases the input impedance of the transistor through emitter degeneration.

The approximate input conductance for a degenerative transistor amplifier (g_{ie} and $g_{fe} \gg g_{oe}$ and g_{ce}) is:

$$g_{ia} = \frac{g_{ie} (1 + g_{ce} (R_e + R_L))}{1 + (g_{ie} + g_{fe}) R_e + g_{oe} R_L} \quad (16)$$

Since the forward amplification is

$$K = \frac{-g_{fe} R_L}{1 + (g_{ie} + g_{fe}) R_e + g_{oe} R_L} \quad (17)$$

the loop amplification, assuming proper termination on the ladder is:

$$K_L = \frac{g_{fe} R_L}{13 [1 + (g_{ie} + g_{fe}) R_e + g_{oe} R_L]} \quad (18)$$

As a result, the effective value of g_{fe} is reduced by 13 by the feedback net, lowering correspondingly the permitted value of g_{ie} ; A correspondingly larger value of beta is required in a transistor for a phase-shift oscillator.

The ladder network must simultaneously have negligible effect on the load impedance in the collector circuit, and an output impedance which is at most equal to the input impedance of the transistor. If input conductance of the transistor is used as the output shunt element of the ladder, the input resistance of network reduces the load impedance just enough to give a marginal operation with transistors having betas less than 100.

Design of oscillators using transistors is slightly more complicated than with vacuum tubes. For low power requirements the excellent results obtained are easily worth the effort. As was pointed out in the opening paragraph, transistors are highly stable elements and offer considerable savings in equipment cost.

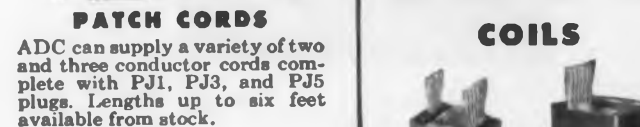
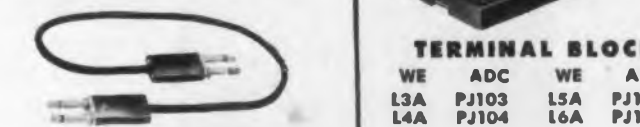
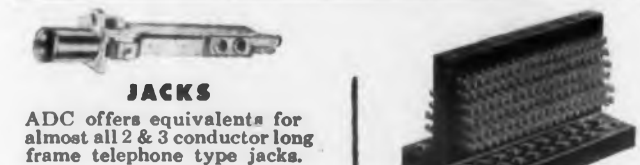
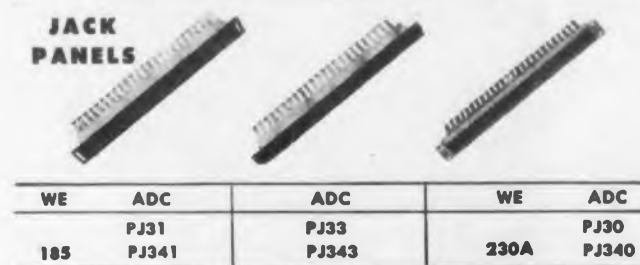
Reference

1. Design of Oscillators-Part I, K. A. Pullen, Jr. Electronic Design, July 1, 1957, pp. 52-55; Designing Cathode-Coupled Amplifiers with Conductance Curves, K. A. Pullen, Jr., Electronic Design, Jan. 15, 1956, pp. 24-27; Designing Cascode Amplifiers with g-Curves, K. A. Pullen, Jr., Electronic Design, May 1, 1956, pp. 26-27; Transistor Contour Curves, K. A. Pullen, Jr., Electronic Design July 1, 1956, pp. 40-43; Design Techniques Using Conductance Curves, Pentode Degenerative Amplifier and Cathode Follower, K. A. Pullen, Jr., Electronic Design, Oct. 1, 1956, pp. 32-35; Oscillator Design Techniques Using Conductance Curves, K. A. Pullen, Jr., Electronic Design, May 15, 1957, pp. 34-37.

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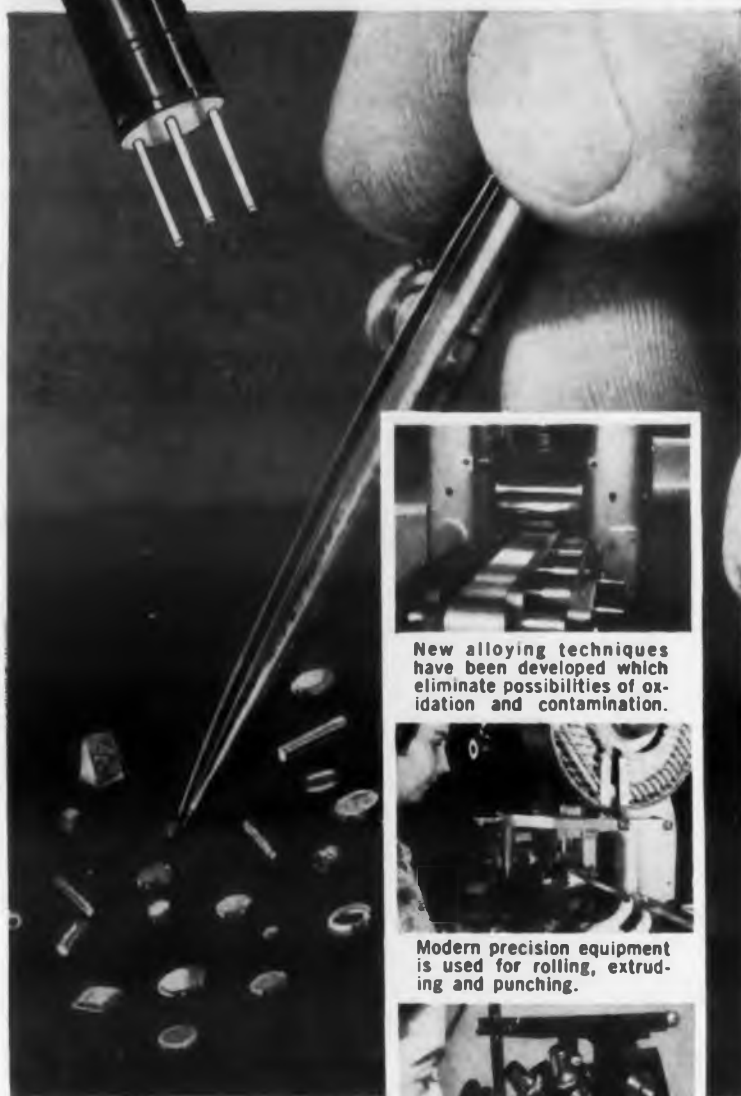


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High Speed

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MULTIPLICATION and division can be performed during conversion of information from analog-to-digital and digital-to-analog by the Multiverter. Speeds in excess of 15,000 per sec for analog-to-digital conversion and 300,000 per sec for digital-to-analog conversion are possible. Accuracies of better than 0.01 per cent can be obtained. In systems that require multiplication or division of analog and digital functions the converter will perform the operation directly, eliminating additional equipment.

The Multiverter, developed by Packard-Bell Computer Corp., Los Angeles, Calif., is the first commercially available high speed converter to be fully transistorized. The principles involved in design permits the construction of digital-to-analog converters which are about the size of a pack of cigarettes. At the electronic speeds with which the Multiverter operates—over 15,000 analog-to-digital conversions per sec and 300,000 digital-to-analog conversions per sec—the 0.01 per cent ac-

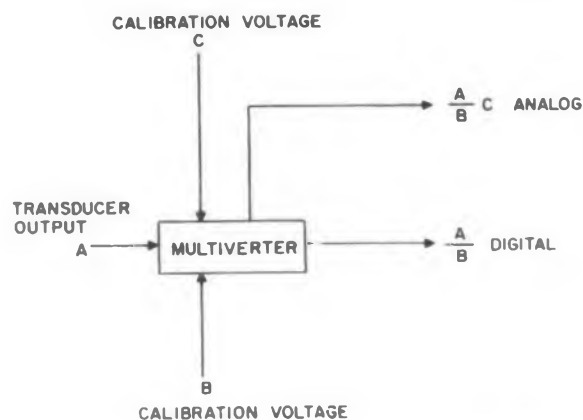


Fig. 1. Multiverter used for reading transducers. Calibration voltages B and C may represent temperature, barometric pressure or any other correction that must be applied to transducer output.

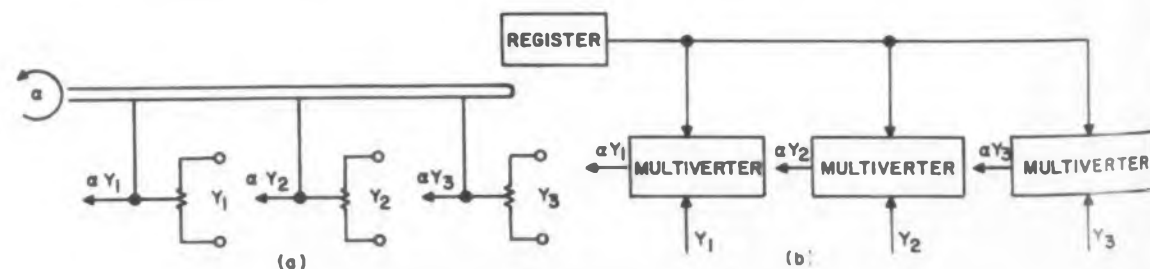


Fig. 2. Employment of Multiverter in a control system.

accuracy of the rack-mounted version is better than any previous converter. Greater accuracy has been obtained before, but only with relays or other electro-mechanical devices.

When used to convert a number n to a voltage, the product nx is formed simply by supplying the variable voltage x . When used to convert a voltage a to a digital number, the quotient a/v in digital form is effected by supplying the unit with a second voltage v . Multiverter are also available which will form aw/v as a voltage where w is a third variable voltage input.

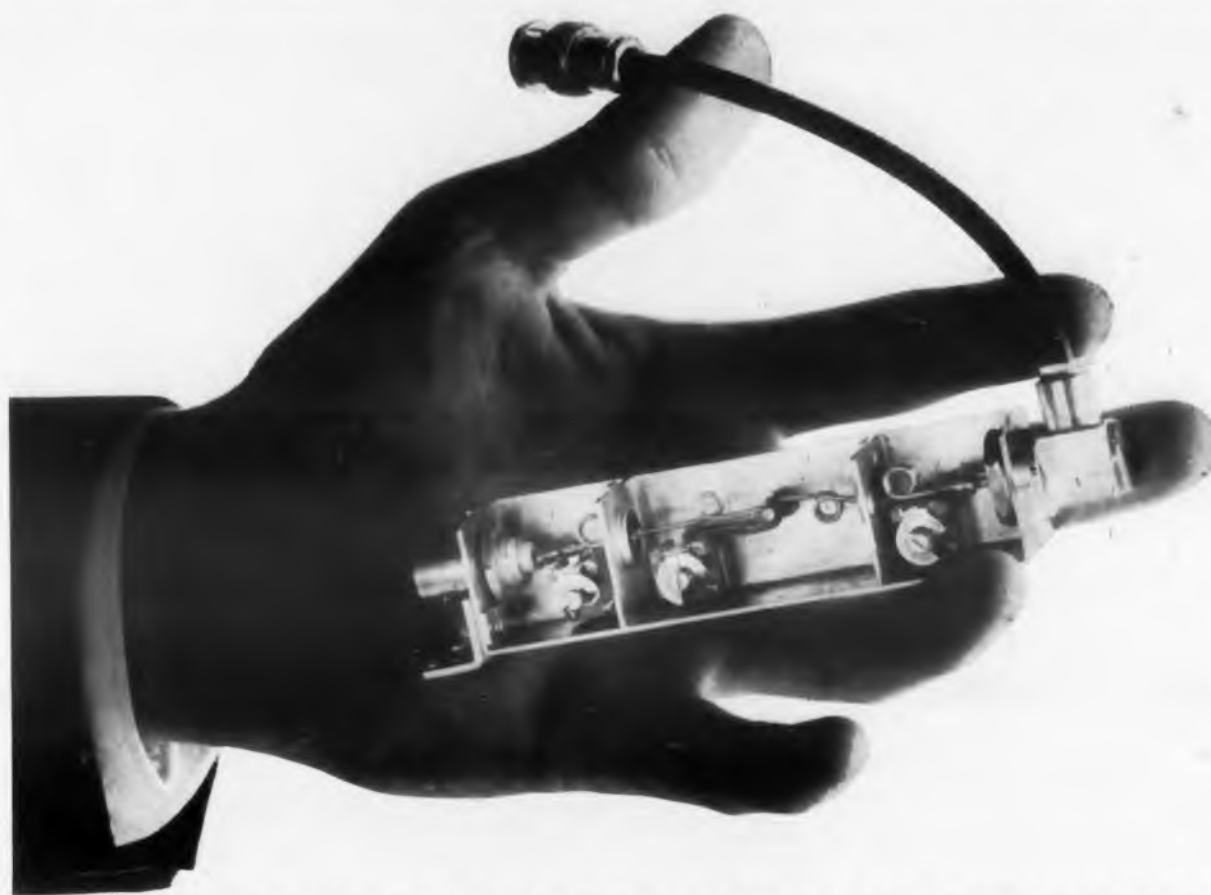
The importance of being able to perform multiplication and division in the process of conversion can be gauged by considering Fig. 1 & 2.

Fig. 1 is a configuration that occurs in the reading of transducers. B and C are calibration voltages. They may represent temperature, barometric pressure or any other correction that must be applied to the transducer output. An analogous situation—not shown—arises in employing an analog plotter for plotting digital information. The converter in this case can introduce scale changes and other corrections during the process of conversion.

Fig. 2 illustrates the employment of the Multiverter in a control system. Common practice in an analog control system is to produce some of the outputs as shaft rotations and to couple to each shaft several potentiometers to effect a series of multiplications Fig. 2 (a).

Often a digital computer is used to replace a portion of the control system. When multiplication is to be performed digitally and the result take the form of a control voltage, two conversions are necessary. A single conversion and an analog multiplier are required when the multiplication is performed analogwise. In addition to eliminating the difficulties involved in conversion and multiplication, the Multiverter permits a digital output and an analog voltage to be multiplied directly Fig. 2 (b).

Accuracy requirements of most computing systems vary inversely with the frequency content of the data. This is because the contribution of higher frequencies to the over-all operation is proportionally small in most physical systems. Since speed and accuracy can be interchanged in the Multiverter, it will adjust to varying speed and accuracy requirements. This is particularly important in incremental conversion. Speed can be increased by a factor of several hundred in those portions of a solution where only low accuracies are needed. Because the adjustment of accuracy to frequency can be automatic, it is possible to use a single converter for both high and low frequency regions without manual intervention. For further information on this converter, turn to the Reader's Service Card and circle 38.



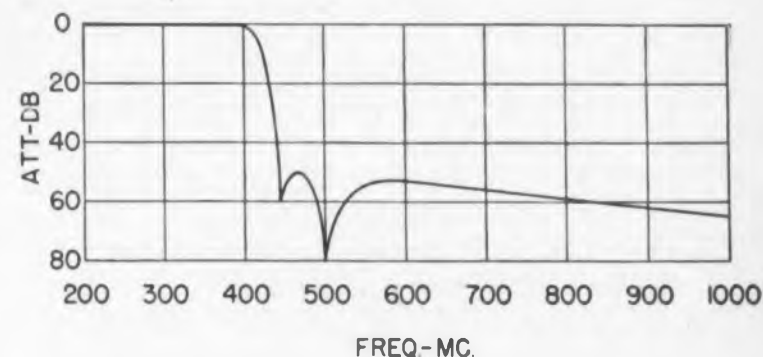
New low pass filter squeezes max. performance into min. space

It's not a short step from miniature r-f tuning devices to miniature r-f filters. But without R/C's quarter-century of tuning device experience, the low pass filter illustrated might never have been built. Low insertion loss from 200 to 400 mc is often combined with rapid attenuation above 400 mc . . . but rarely in a space measuring just under 4 cubic inches!

R/C low pass filters owe their small size to a unique capacitor, the Series 75 air dielectric trimmer recently introduced by Radio Condenser. Perhaps the smallest air trimmers ever made in the U.S., they're finding wide application wherever space is a problem. Outstanding insulation resistance, "Q", and thermal stability make miniaturization a much easier job, on filters, i-f transformers, printed wiring boards, and conventional chassis of every description.

Originally designed for defense effort use, this filter is now in quantity production at R/C . . . and modifications are available to meet special performance requirements as they arise.

Additional information on R/C low pass r-f filters is provided in Engineering Bulletin FL-462. Trimmers are covered in Bulletin TR-123. Both are available on request to Radio Condenser Company.



Electrical Specifications	
max. insertion loss, 200-400 mc	0.75 db
min. attenuation, 450 mc and above	45 db
min. attenuation, 1000 mc and above	60 db
max. rated power	1000 watts
pass band SWR	1.5 : 1
impedance, input and output	50 ohms

Physical Specifications	
size over-all	1"x1"x4" approx.
temperature range	-55 to +85 C



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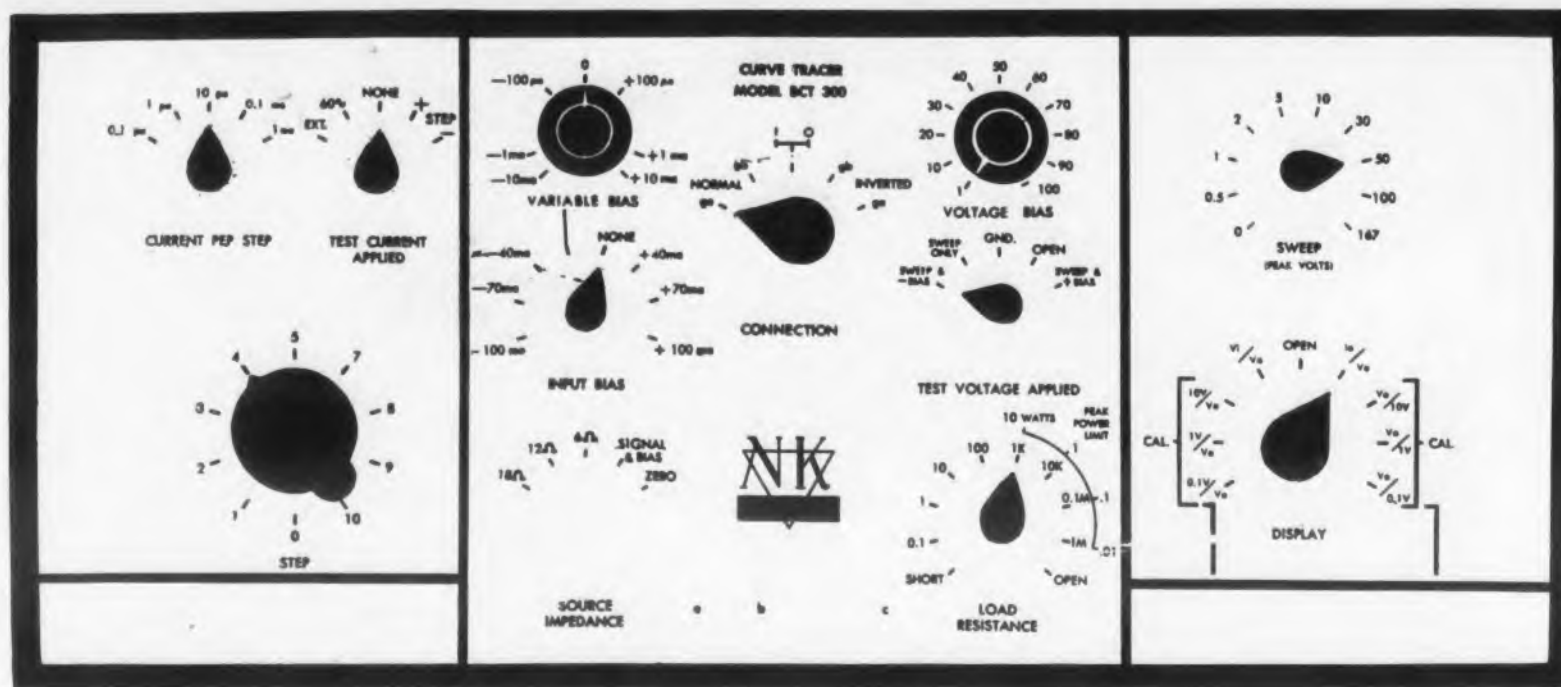


Fig. 1. A transistor analyzer showing the controls for biasings, etc. not found on a simple curve tracer.

Norman B. Saunders
Circuit Engineering Consultant
Weston, Mass.

Using A Curve Tracer for Transistor Circuit Design

A TRANSISTOR curve tracer supplies stepped input current and swept output voltage to the device under test. It uses an oscilloscope face to compare families of curves with a calibration grid. It is superior to other methods of measurement in that it checks transistors over the full range of their characteristics giving more data, more accurately, faster, and with less chance of damage to the transistor if the tracer is properly designed and used.

Good circuit design requires that biases applied to the transistor be no larger than necessary to handle the expected signals with adequate margins. But at small biases gain goes down, feedback goes up, and distortion is introduced. The biases to give a reasonable compromise are determined on the collector family plot of the curve tracer. The relations are expressed quantitatively. The collector family curves are also used in determining cutoff current variation with voltage and the constant and temperature dependent portions of this current. The exponential relation between junction voltage and current simplifies some of the measurements and makes others almost unnecessary. The small signal coefficients are read on the displayed curves by slopes or intercepts. Translation of the display facilitates this.

A transistor analyzer is a curve tracer with input and output biases also supplied. The controllable biases allow interpolation between the steps and

sweeps and permit direct reading of the small signal coefficients as on a meter. At frequencies high enough for reactive effects to be significant, the alternating current measurement is necessary for accuracy. The biases from the analyzer are also used to power a breadboard of the stage as designed for check of the design.

The data taken with the curve tracer is adapted to design by the method of successive approximations. In general, as the coefficients become difficult to measure they become unimportant in practical application. The complete consideration of the effect or reverse (feedback) voltage ratio is too extensive to be treated in this paper.

The manufacturer's published data on transistors has a limited number of coefficients given, usually at one bias or other parameter value. The range of the individual coefficients is seldom given. A transistor analyzer is generally the best instrument to supply the additional data necessary to design the individual transistor stage. A tracer having a full calibration grid is more accurate than the inexpensive transistor tester, and faster in a survey of the operating area than a precision small signal tester.

Setting Up the Curve Tracer

The full face of the oscilloscope should be checked for linearity and calibration by using the internal calibration circuits of the tracer. Check of

just two axes across the face of the oscilloscope is inadequate to show up some of the weird types of deflection found too often even in the best of oscilloscopes. The cathode ray tube acts as an interpolating surface and a transfer device between the transistor curves displayed and the calibration grid. The scopeface calibration need only be made once a day and takes only a few seconds. The check of the origin (no deflection voltage in either direction) should be made every few minutes because most all oscilloscope amplifiers show appreciable zero drift.

The tracer should be set to limit the power into the transistor that is to be tested to its rated or other safe value. This protects the transistor having unexpectedly high leakage current or current gain, and also that incapable of withstanding normal voltages. If the tracer is capable of supplying the large power needed to test some transistors, only the operator can be sure it is set so as to protect those with lesser capabilities.

The Small Signal RC Coupled Stage

It is possible to operate a transistor just at the bias values at which the manufacturer chooses to give its characteristics, but for small signal work this is seldom advisable. Power generally needs to be conserved to lengthen the life of the battery supply. Even with unlimited power available, lim-

iting the power into the stage to the amount required is good design procedure. It limits the heating within the transistor, and increases the range of temperatures over which the circuit will operate, the stability of the circuit, and the life of the transistor. The desirability of keeping the temperature low to minimize I_{CO} is adequately discussed elsewhere.

On the other hand, operation at miniscule powers is seldom advisable. At low currents the current gain of the transistor is quite small, and it is also small at low voltages. Note the region below 0.2 volts in Fig. 2. Furthermore, the high frequency performance suffers. In Fig. 3 the apparent alpha cutoff frequency is plotted against collector voltage at two current levels. The apparent alpha cutoff frequency is taken as the common emitter current gain multiplied by the frequency of its measurement where the frequency of measurement is so chosen that the current gain is greater than unity and less than half of its low frequency value. Such an estimate may be low by one part in ten. The collector capacitance also increases at low voltages thus reducing high frequency power gain. Fig. 4, which shows the collector susceptance, was made with an adapter for the BCT 300 which allows measurement of the high frequency small signal output and reverse transfer coefficients h_o and h_r .

The maximum peak signal excursion is an obvious limit to the reduction in bias that is permissible. In the RC coupled stage the greatest distortion is probably introduced where the signal is from a voltage source. The distortion arises because of the exponential characteristic of the input impedance of the transistor. For a signal of ten millivolts peak-to-peak the second harmonic at the output is one-fifth of the signal or 0.2 fractional and the third 0.08 fractional. The fraction of second harmonic decreases directly as the signal decreases, while that of the third decreases as the square of the signal.

The first purpose of the transistor curve tracer is to set forth the family of collector-current collector-voltage curves so that an operating region and bias point can be selected to give a reasonable compromise between these conflicting demands. As the preceding photographs show, the curve tracer allows one to pick an operating point such that any desired fraction of the possible current gain or other criterion is achieved. A more useful selection of the operating point is based upon an allowance for operating point or characteristic shift, say by a factor of two, in any direction. From the plots on the curve tracer the bias boundaries for the minimum performance of the stage are determined. The operating point is then chosen to differ from the bias at these boundary-of-performance points by the safety factor (see references 1 and 2).

The collector cutoff current I_{CBO} (see reference 3) is given by the curve of collector current versus collector voltage with the emitter open. This is

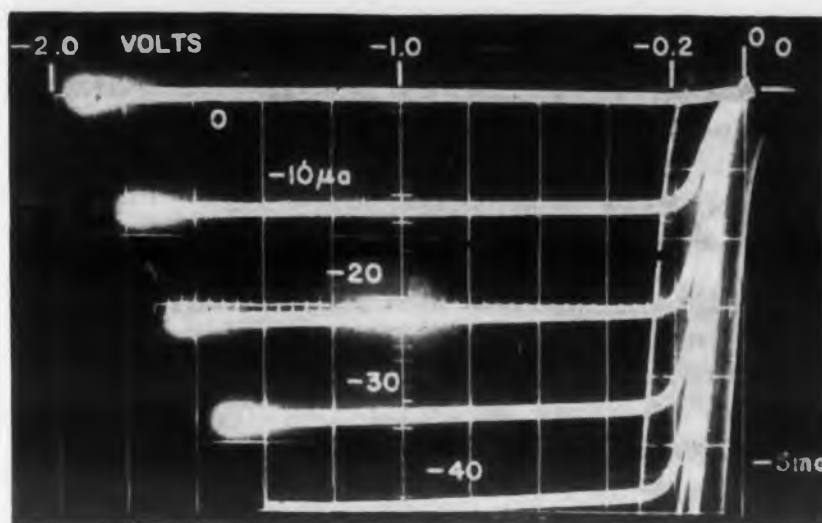


Fig. 2. Curve tracer display of collector current at 1 ma/cm as a function of collector voltage at 0.2 v/cm. Input current of 10 μ a per step to a GT 92 transistor with common emitter. Note how the current gain beta falls below 100 at voltages below 200 mv.

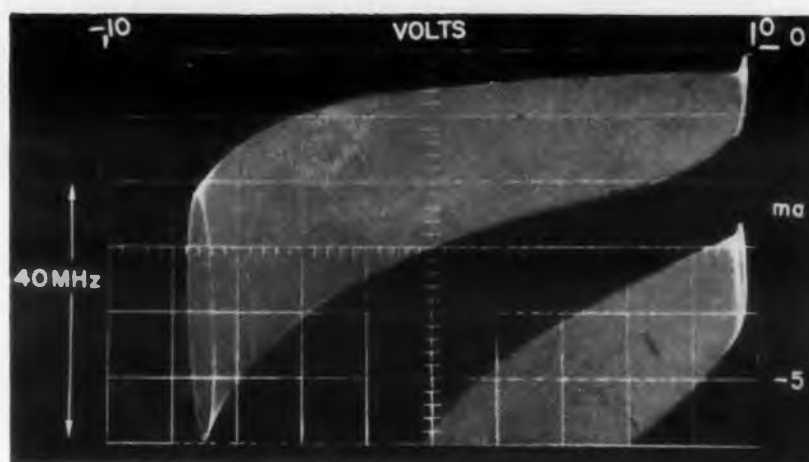


Fig. 3. Collector current at 1 ma/cm and collector voltage at 1 v/cm. A GT 764 with 100 μ a peak to peak at 1 mc per second applied to base superimposed on two fixed input biases and collector voltage sweep. Emitter is common. The indicated frequency of alpha cutoff at 8 v is approximately 40 MHz.

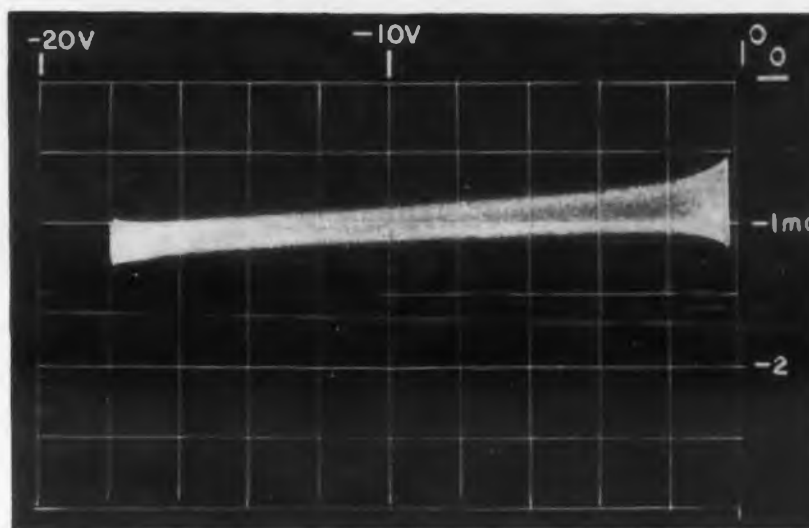


Fig. 4. Collector family for GT 222 with 1 v p-p of 1 MHz applied to the collector. Common emitter. 500 μ a/cm and 2 v/cm.

shown in Fig. 5 together with the saturation current, I_{CBS} , and the common emitter cutoff current I_{CEO} . The scale for the latter is ten times that of the others. Note that I_{CBO} consists of a constant portion plus a portion increasing linearly with voltage plus a portion increasing almost exponentially with voltage. The constant portion I_{CBO0} may be measured at small voltages, is the current that should theoretically flow, and is the component that doubles every nine Celsius degrees. The proportional current I_L is measurable by the slope on the display of the curve tracer and varies but little with temperature. This is the leakage current. The curve tracer allows these components of I_{CBO} (I_{CO}) to be determined separately so that its value at any temperature and voltage can be forecast by the equation $I_{CBO} = I_L \times V_C + I_{CBO0} \exp(C^\circ/9)$.

When the collector cutoff current is too small to measure with the oscilloscope or meter at hand, it can be measured indirectly. The transistor is put into the common emitter connection and reverse base current applied and increased until the collector current no longer decreases at the voltage of interest. The collector current and base current are now each very nearly equal to the collector cutoff current. The value is read from the dials setting the input current to the transistor under test. With silicon transistors, and a few germanium units, the constant portion may be found more easily by calculating it from the saturation current. $I_{CBO0} = I_{CBS} (1 - h_{FO} h_{RFO})$. The saturation current, if not measurable directly, is determined from the fact that it increases tenfold for each input bias voltage increase of roughly 60 millivolts. With the Norden-Ketay BCT 300, thermally compensated resistors to set multiples of this voltage into the base are available. The transistor is measured in the inverted connection to put the applied bias across the collector junction. Ten or 100 milliamperes of nominal input current are applied to the resistor to produce the junction voltage giving the appropriate multiple of collector current. The output current is read, with its decimal shifted appropriately, as the saturation current I_{CBS} . This method is a last resort; as it becomes most useful it also becomes most sensitive to voltage bias errors. The exponential relationship between junction voltage and current that makes this method of measurement possible also causes the error sensitivity.

The exponential relation also determines the large and small signal input impedances. The input bias voltage is proportional to the logarithm of the ratio of the operating emitter current to the emitter diode saturation current. The input bias voltage at the operating current is read with the curve tracer by switching to the display of input voltage.

With the curve tracers having a floating sweep voltage power supply, proper termination for the hybrid coefficients h_o and h_r will generally exist. Proper termination for measurement of h_i and h_r

requires a collector load resistance that is small. The load resistance is satisfactory when (for full display of the collector characteristics) the sensitivity of the oscilloscope for the current axis is one hundred times as great as for the voltage axis.

Small Signal Coefficients

Next the small signal coefficients are determined in the vicinity of the chosen operating or bias point. The forward current gain is determined directly from its definition as the increment in collector current for a unit increment of base current at a constant collector voltage. At the voltage under consideration, the increment in collector current is read directly on the face of the oscilloscope. If the deflection system of the oscilloscope is uniform and linear, the pattern may be offset for convenience in reading. This is shown in Fig. 6. Restore the no-signal display point to the zero-zero scale point immediately after reading.

Reading of the small signal current gain at a given operating point can be made more simply or more accurately by the use of an analyzer. See Fig. 1. With this, the stepped and swept biases are removed and potentiometers used to set in biases to the chosen operating point. A smaller increment of stepped input current can now be superimposed, or a power frequency sine wave, or an alternating current wave of most any form at the frequencies of interest (superimposed from an external oscillator). High gain ac coupled amplifiers may now be used in the indicating oscilloscope or voltmeter. The alternating current is calibrated by switching it directly into the precision load resistor instead of through the transistor. The gain of the system is adjusted to give unit indication. A flick of the switch and the transistor is inserted into the circuit between the voltage dropping resistor and the load resistor, so that the meter now reads the current gain. These alternating current techniques are necessary where the heating of the transistor at its operating point causes drifts that would invalidate the curve-to-curve measurements, and also where the frequency of interest is high enough so that the transistor's coefficients differ from their low frequency and direct current values.

Cascaded RC Coupled Stages

In cascaded RC coupled stages the overall current gain is but little less than the product of the current gains of the individual stages. The amount by which the current gain of each cascaded stage falls short of the transistor current gain can be expressed by a correction factor, F , multiplying the current gain, B , of the transistor. The overall current gain of a four stage amplifier is then $B_1F_1B_2F_2B_3F_3B_4F_4$. Other loading effects and losses can be similarly accounted for. This is the method of successive approximations. The first approximation to the gain of the amplifier is the product of

the current gains of the individual transistors. For the interstage coupling the second approximation correction factor is factored into that existing because the collector load resistors are only finitely larger than the input impedance of the following stage and that existing because of effects contributing still smaller losses. The third approximation is in the assumption that the output impedance of the transistor is large relative to the load resistor, R_L , and the input impedance in the same interstage network. The correction for this approximation is often unnecessary and the correction for the residual losses is usually unnecessary. It is easier to calculate the corrections separately and insert them if they are large enough to warrant than it is to solve the complete network equations. The factor F_2 in the above example is then made up of

$$F_{2a} \times F_{2b} \times F_{2c} = \frac{(1/h_i)}{(1/R_L) + (1/h_i)} \times \frac{h_o}{(1/R_L) + (1/h_i) + h_o} \times F_{2c}$$

Input Impedance

At low frequencies the input impedance of a transistor is most easily found by calculation. For either base or emitter input the resistance is given by the thermal voltage divided by the input current. (proof supplied on request). The thermal voltage V_θ is defined as kT/q and is about 25 millivolts at room temperature. In the common emitter connection the collector cutoff current is part of the input current to be used in this calculation, and must be added to the external input current. The input current is best found by dividing the collector current by the current gain. The transistor input resistance is then given by; $h_i = V_\theta h_r / I_c$. The curve tracer is used to check this value by setting the display to show the transistor input voltage V_i and stepping the input current. The input voltage increment for unit input current increment at constant output voltage is by definition the input resistance, h_i . This may be difficult to read on the face of the oscilloscope or may be wanted at a frequency at which it is different from the dc value. The methods used for h_r apply here with the substitution of input voltage for output current. The analyzer is particularly useful if a measured value of h_i or h_o is desired.

Output Impedance

The correction for the output impedance being less than infinite requires the measurement of it. Re-stated in terms of the hybrid coefficients, "the correction for the output admittance being greater than zero." The small signal output admittance is the increment in output current for a unit increment in output voltage with the input current held constant. The measurement is made on the family of collector current as a function of collector voltage curves.

The measurement is made along the tangent to the curve of constant base current passing through the point of interest. See Fig. 6. The portion of the curve intercepted by a unit increment of collector voltage is noted and the increase of collector current from one end of this segment to the other is the output conductance h_o . One saving factor for the curve tracer is that as this measurement becomes more difficult to make because of the small size of it, the need for accuracy in the measurement de-

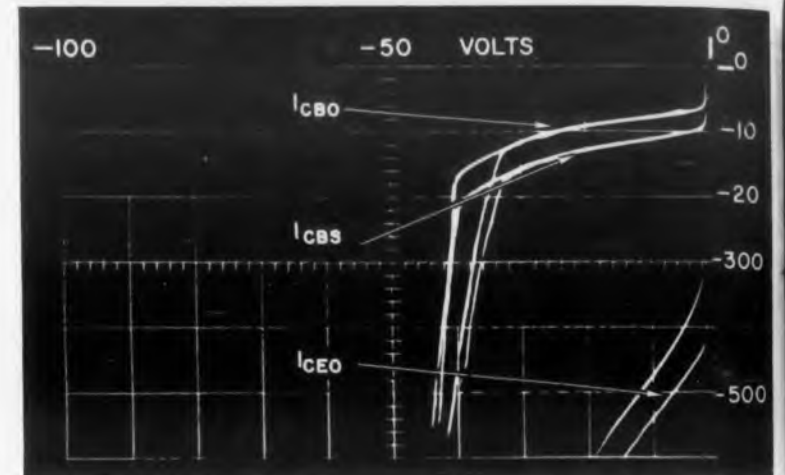


Fig. 5. Collector family GT 222 with 10 μ A/cm for I_{CBO} and I_{CBS} but 100 μ A/cm for I_{CEO} . For all, 10 v/cm. Collector cutoff current is the smallest of these three. Subtract 1 μ A/10 v from all curves to allow for the input conductance of the oscilloscope.

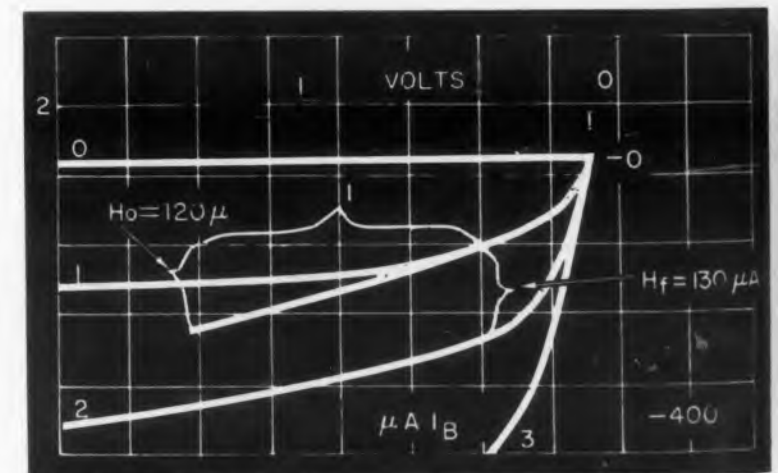


Fig. 6. Offset of the zero point for ease in reading small signal values by increments.

creases. The correction factor for it approaches unity. If a measurement is essential in any case, the analyzer allows it to be made by applying steady input and output biases to put the transistor at the operating point. A small sweep voltage is superimposed on the collector bias voltage and the collector current that results observed.

Observing the input voltage under these conditions gives the reverse voltage transfer ratio h_r . The foregoing design procedure has assumed that the ef-

fect of this reverse voltage transfer is negligible. This is often the case. If it must be considered the first approximation is to add a correction factor which is close to but may be greater or less than unity. A plot of h_r as a function of collector voltage at intermediate frequency is shown in Fig. 7. The considerations in the incorporation of this correction supply material enough for two or more articles.

If the stage gain arrived at in this fashion is too large either local or overall feedback may be used to reduce it. Alternatively and if it is too small, the transistor type can be changed.

The final circuit design is then haywired and connected to use the analyzer current and voltage power supplies to power it. A selection of transistors at the limits of the manufacturers' range of production can then be plugged in to check the adequacy of the margins set up.

When the engineering model of the circuit has been built, the tracer is very convenient for checking transistors suspected of damage. The curve tracer has the advantage of quickly showing all of the transistor's useful operating region. Damage to a transistor may render it unfit for use in a particular circuit but still not show up on a beta checker. An example is shown in Fig. 8. The transistor shown is a GT 949 rated at 30 volts and 100 milliwatts. A bit more than double the rated power applied momentarily reduced the sustaining voltage to twenty volts (as shown) with no apparent change in the characteristics at lower voltages, where most single point testers operate. The curve tracer has the further advantages that the average power applied is only one-fourth to one half of the peak power and of showing momentary variation in the transistor's characteristics. An example of such a variation is failure of the retrace to fall on top of the sweep. An upward drift of current is caused by continuous heating. A smooth gross deviation repeating each sweep occurs when the transistor is overheated in each single sweep. A jittery and irregular lack of superposition is indicative of an improperly processed or subsequently damaged transistor. Such a transistor is likely to soon show excessive noise, leakage current, and short life.

Having designed the circuits of commercial wide band, precision small signal, and inexpensive testers, the author's preference is for a circuit analyzer due to its versatility. As a curve tracer it has the highest information rate for characteristics from transistor to operator.

References:

1. Norman B. Saunders, "Designing Reliable Transistor Circuits" *Electronic Design*, Vol. 3, No. 3, March 1955, pp. 24-27 and No. 4, April 1955, pp. 36-39.
2. Keats A. Pullen, "Using Contour Curves in Transistor Circuit Design", *Electronic Design*, Vol. 3, No. 7, July 1955, pp. 22-25.
3. "IRE Standards on Letter Symbols for Semiconductor Devices, 1956" *Proc. IRE*, Vol. 44, No. 7, July 1956, pp. 934-7.

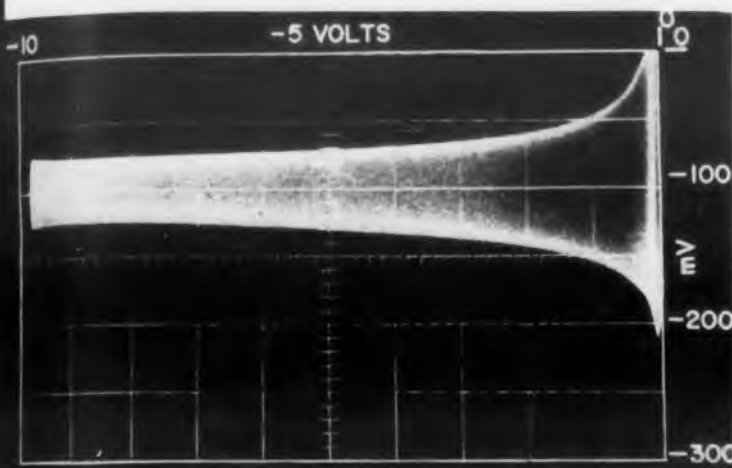


Fig. 7. A plot of input voltage at 50 mv/cm as a function of output voltage at 1 v/cm for a GT 222 with 1 v p-p of 1 MHz applied to the collector and base common.

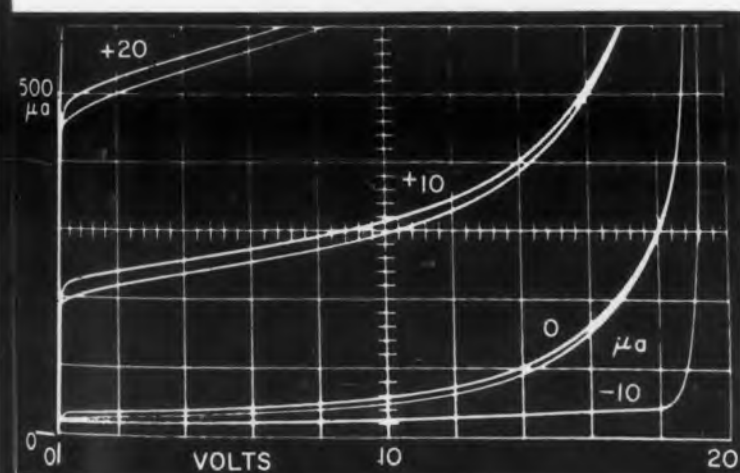


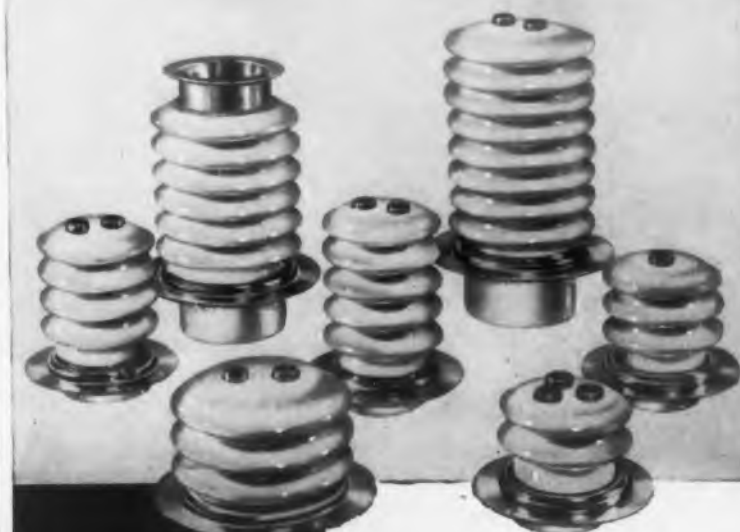
Fig. 8. Collector family 100 $\mu\text{a}/\text{cm}$ and 2 v/cm for damaged GT 949 in common emitter with -10, 0, 10, 20 and 30 μA applied to the base. Overheating has reduced the saturation voltage to 18 v but the characteristics below 10 v are little changed.

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Recent advances in the semiconductor field have resulted in the commercial availability of transistors designed specifically to handle large amounts of power. These "power transistors" are capable of dissipating up to several watts and are particularly suitable for use in audio-frequency power amplifiers. Circuit-design considerations for the application of pnp alloy junction power transistors to audio-frequency power output stages are presented, along with a discussion of the effects of source and load impedances on distortion. Methods of obtaining a desired degree of bias stability with temperature variations are also outlined. Although a specific application is described in this article, sufficiently general remarks are made which are applicable to a wide variety of transistor power amplifiers.

Class A Transistor Power Amplifier Design

Robert Minton

Semiconductor Div.
Radio Corp. of America

THE CHOICE of class A or class B push-pull operation depends upon several factors, including the amount of power output and power efficiency required. The object is to obtain as much power output as possible with a minimum distortion. A single power transistor can be used in a class A circuit for moderate output. The output is developed such that collector current flows continuously throughout the cycle. Because maximum power is dissipated in the transistor at zero input signal, the maximum possible output power is one-half the maximum rated dc power dissipation, $P_{max}(dc)$.

In audio power amplifier design, the most important consideration is of course the power-dissipation capability of the transistor. The maximum power that can be dissipated before "thermal runaway" occurs depends heavily on how well the heat generated within the transistor is removed. When it is removed by conduction, the ability to do so is measured by the thermal resistance. The lower this figure, the greater the power-handling capability. Other factors which determine the maximum power-dissipation capability are the *collector-voltage rating*, *reverse collector saturation current*, *circuit stability factor*, and *maximum ambient temperature*. The maximum permissible dissipation, P_{max} , of a germanium transistor is given by:

$$P_{max} = \frac{12.5}{\Theta} \times \ln \left[\frac{12.5}{\Theta s_f V_{ce} I_{cs}} - \frac{(T_a - T_{25})}{\Theta} \right] \quad (1)$$

Where Θ is the total thermal resistance of the transistor and chassis in deg C per w,

V_{ce} is the collector-to-emitter voltage in volts,

I_{cs} is the reverse collector saturation current at 25 C,

s_f is the circuit stability factor, and

T_a is the maximum operating ambient temperature in deg C^{1,2}.

In circuits having low values of $s_f V_{ce}$, P_{max} as computed may be greater than the power which can be obtained in practical circuits. The actual power dissipation possible in a practical circuit design is limited by the maximum safe collector-junction temperature at which the power transistor can be operated without appreciable alteration in its electrical characteristics or a decrease in its life expectancy. For most germanium transistors this is below 100 C. The maximum power-dissipation capability can be expressed in terms of the allowable junction temperature as follows:

$$P_{max} = \frac{T_j - T_a}{\Theta} \quad (2)$$

Where T_j is the maximum allowable junction temperature in deg C, T_a is the ambient temperature in deg C and Θ is the total thermal resistance of chassis and transistor in deg C per w.³ The two equations for P_{max} can be used together to obtain power-rating curves for a given transistor provided that

- when the allowable power dissipation obtained from eq (1) is greater than that calculated from eq (2), the maximum allowable collector-junction temperature rise is the limiting condition for dissipation; and

- if the allowable power dissipation calculated from equation (1) is less than that found by equation (2), then thermal runaway is the limiting factor.

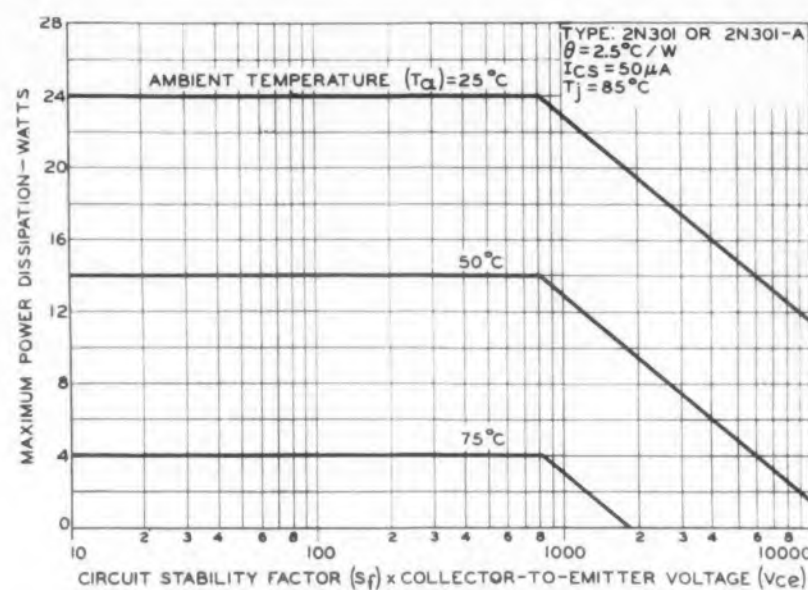


Fig. 1. Maximum power dissipation curves for the type 2N301 or 2N301-A transistor. "Thermal Runaway" occurs at any point above the sloping lines.

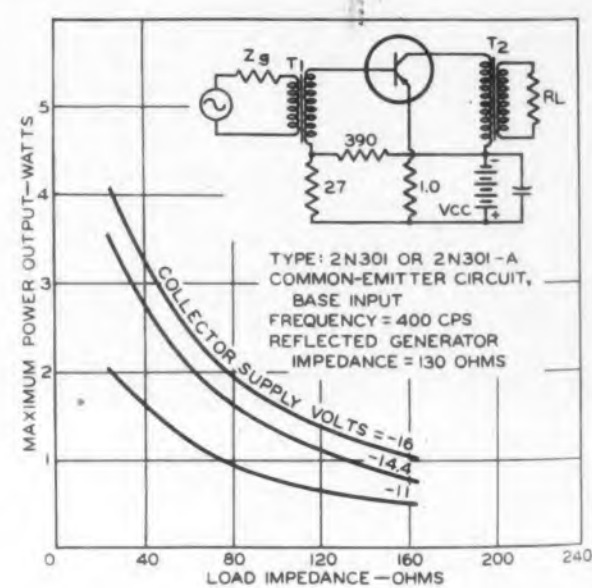


Fig. 2. Class A audio frequency power amplifier. Curves represent maximum power output as a function of collector load impedance.

Fig. 1 shows a set of maximum power-dissipation curves for the 2N301 or 2N301-A power transistor. The horizontal lines represent the maximum power dissipation for various ambient temperatures when the limiting factor is maximum collector-junction temperature rise. The sloping portion of the curves represents the maximum power dissipation before runaway occurs. The maximum power dissipation can be obtained for any value of S/V_{ce} .

Class A Power Amplifiers

Fig. 2 shows a typical class A audio-frequency power amplifier for use in an automobile receiver output stage, together with curves of maximum power output as a function of collector load impedance. For the supply voltages shown, the load impedance must be kept low if large amounts of power output are to be obtained. Consequently, the possibility of impedance matching for maximum power transfer is eliminated; distortion becomes the limiting factor in selecting the output load value. In the case of output stages for automobile receivers, a maximum value of 10 per cent total harmonic distortion is usually acceptable, which the curves shown in Fig. 2 represent.

The power gain of a junction-transistor class A amplifier is a function of input resistance, load impedance, and ac large-signal current transfer ratio, and can be expressed as follows for the common-emitter circuit:

$$\text{Power Gain} = \alpha_{cb}^2 \frac{R_1}{R_{in}} \quad (3)$$

Where α_{cb} is the ac large-signal current transfer ratio,

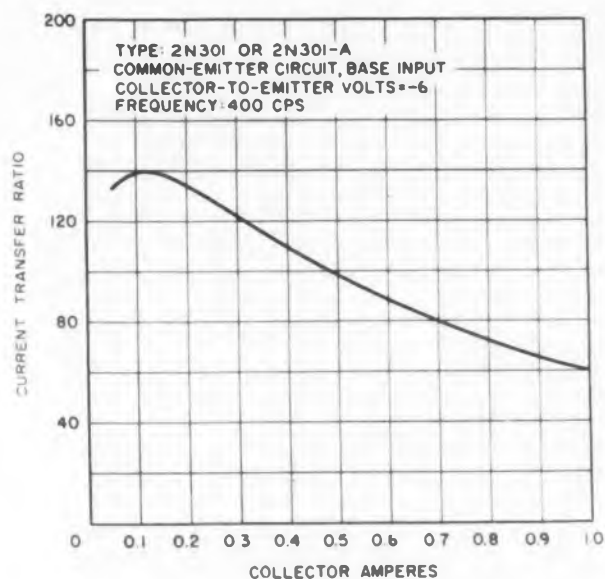
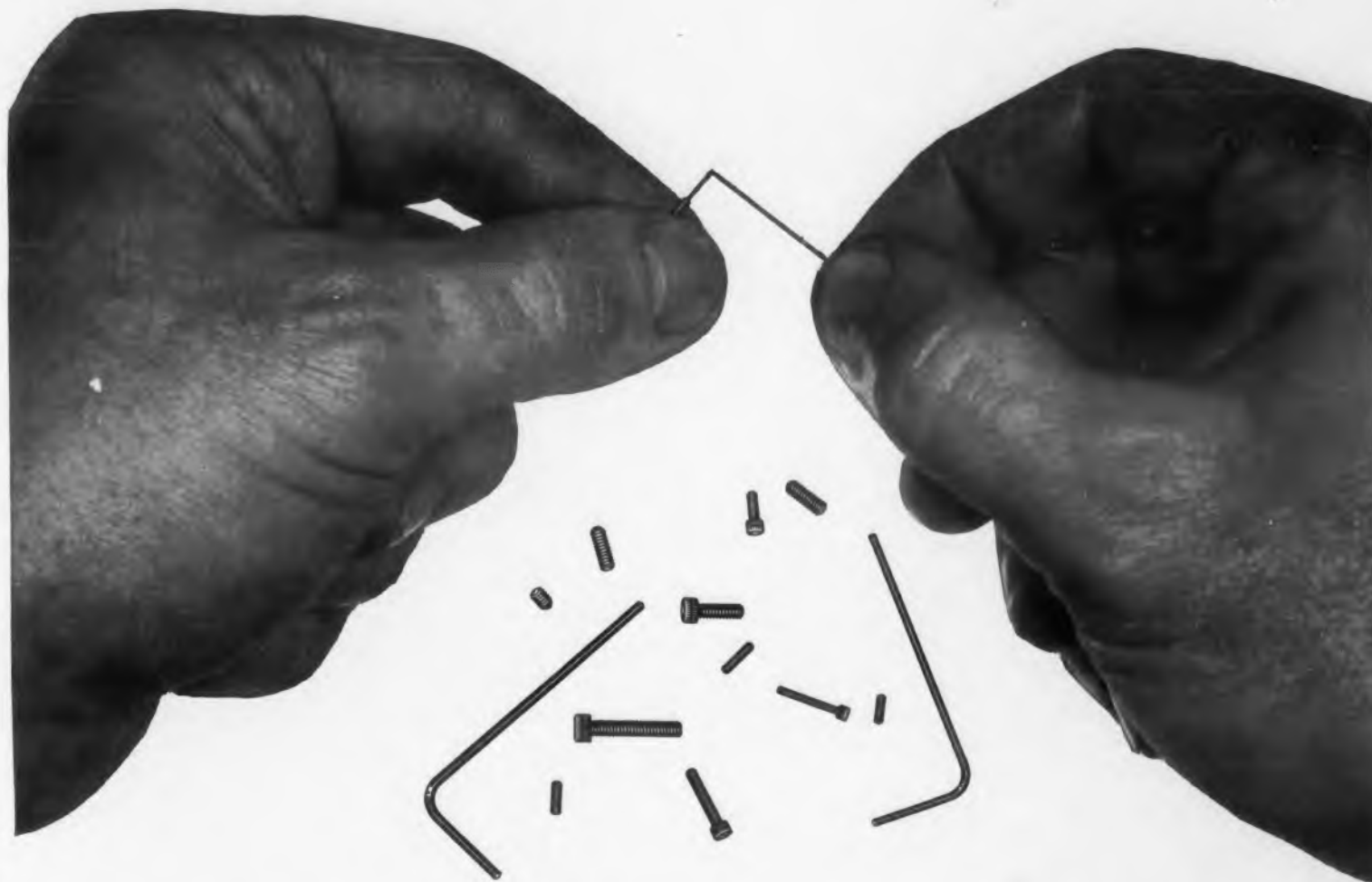


Fig. 3. Reduction of current transfer ratio (α_{cb}) with dc collector current.



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R_L is the collector load impedance in ohms, and R_{in} is the ac input resistance of the transistor in ohms, i.e., r_{bb} plus the product of α_{cb} and the external emitter resistance.

At the high values of emitter current, the resistance of the emitter junction is very low and the input resistance of the transistor is approximately equal to the resistance r_{bb} . When an unbypassed external emitter resistor is used, the resultant input resistance of the transistor is approximately equal to r_{bb}' plus the product of the current transfer ratio (α_{cb}) and the emitter resistor. If this resistance is greater than the load impedance, the power gain of the class A stage will again be low unless the transistor has a high α_{cb} . Fig. 3 shows the reduction of α_{cb} with dc collector current.

Efficiency of Class A

The efficiency of a class A transistor power amplifier is defined as the ratio of the power output that can be developed with only moderate distortion to the dc power supplied to the collector circuit. A class A power amplifier has a maximum theoretical efficiency of 50 per cent. In practice, the over-all efficiency depends upon the efficiency of the output transformer and the amount of power lost in the bias network. The collector-circuit efficiency is greatest at full rated power output and decreases as the power output is reduced.

Distortion is principally a function of supply voltage, power output, nonlinearity in transfer

characteristics, and source impedance. When the input (base) current is sinusoidal, the nonlinearity in the current transfer characteristic is small at low signal levels. The output current is fairly linear and low in harmonics. As the signal level increases, the input current traverses a greater portion of the nonlinear region of the transfer characteristic and the harmonic content of the output current increases considerably. Fig. 4 shows the total harmonic distortion as a function of power output for different supply voltages. The increase in distortion with increasing power output is due primarily to the nonlinearity in the base-to-collector current transfer characteristic. Clipping is the cause of the rapid change in slope of the distortion curve.

Source Impedance Distortion

The source impedance presented to the input of a class A stage which uses an interstage transformer depends on the type of driving device used and the impedance transfer ratio of the driver transformer⁴. When the transferred driver output impedance is much less than the input resistance of the transistor, the class A stage is considered to be operated from a constant-voltage source. When the reflected driver output impedance is much greater than the input resistance of the transistor, the stage is considered to be operated from a constant-current source. Fig. 5 shows the variation in total harmonic distortion as a function of the ratio of reflected source impedance (Z_g) to the input resistance

of the transistor. The total harmonic distortion increases appreciably as the ratio Z_g/R_{in} is increased, partly because of the higher degree of nonlinearity in the current transfer characteristic. The lowest feasible value of source impedance should be used in a class A power amplifier to minimize distortion.

In some applications, it may be necessary to use negative feedback to reduce the total harmonic distortion. One method of obtaining degenerative feedback is by the insertion of resistance in the emitter lead. The amount of emitter resistance that can be used is normally limited by the power-gain requirements of the output stage.

Temperature Considerations

The effects of temperature changes on transistor behavior are due primarily to changes in reverse collector current, I_{co} , and the dc input conductance. These parameters are highly sensitive to temperature changes, and may cause a shift in operating point. In a class A circuit having low dc load resistance, the collector voltage is relatively constant, but the collector current will increase with temperature due to variations in I_{co} and dc input conductance. The resulting increase in dissipation may cause operation beyond the maximum power ratings of the transistor. For satisfactory operation over a wide range of temperatures, some form of stabilization must be used.^{5,6,7}

The transfer characteristic curves shown in Fig. 6 illustrate the effects of temperature upon the

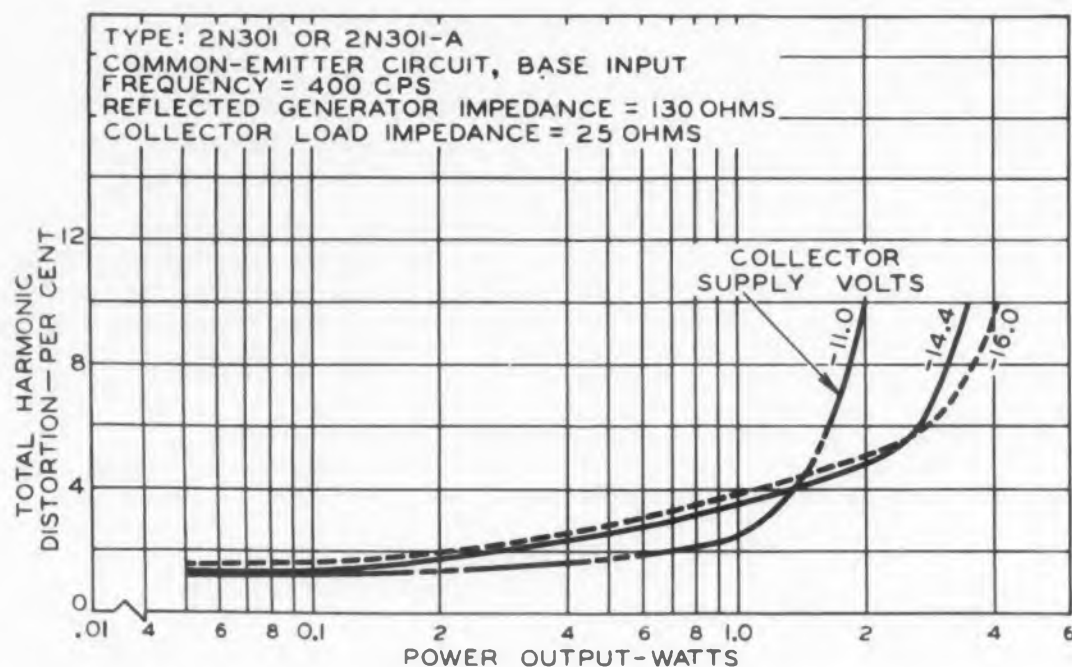


Fig. 4. Total harmonic distortion as a function of power output for different supply voltages.

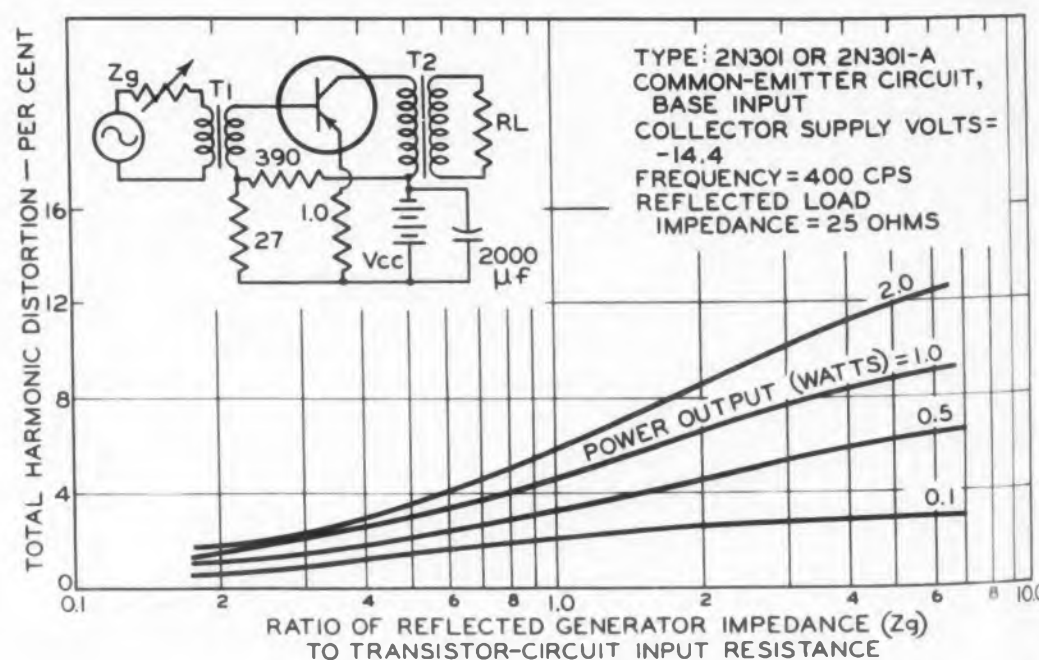


Fig. 5. Variation in total harmonic distortion as a function of the ratio of the reflected source impedance (Z_g) to the transistor-circuit input resistance.

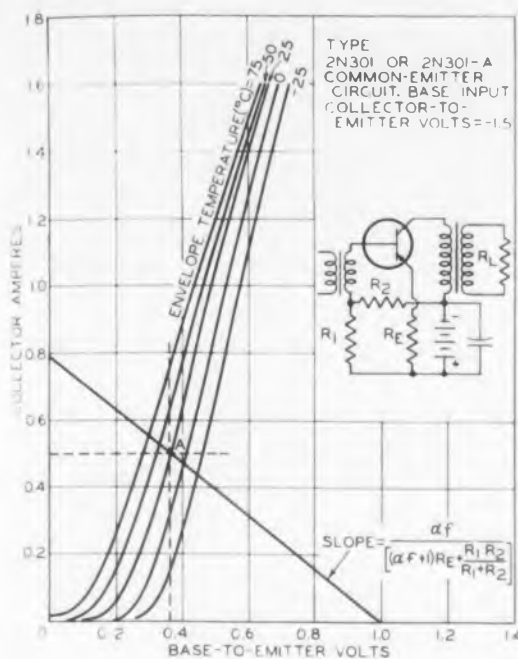


Fig. 6. Effects of temperature in a stabilized common emitter class A circuit.

transistor in a stabilized common-emitter class A circuit. The operating point is designated by point A on the 25 C curve. If this common-emitter circuit were operated with a constant base-to-emitter bias voltage, an increase in temperature would cause an appreciable increase in quiescent collector current and a consequent increase in power dissipation. In the circuit shown, however, the bias voltage is determined by the voltage drops across the emitter resistor, R_E and the parallel combination of R_1 and R_2 . The voltage drop across the emitter resistor is essentially proportional to the collector current, and tends to stabilize the collector current by applying a reverse bias to the transistor. For a given value of emitter resistance, therefore, the stability of the operating point is largely dependent on the resistance of the parallel combination of R_1 and R_2 . Decreasing the resistance of the parallel combination of R_1 and R_2 results in an increase in stabilization.

This is the first of a series of two articles on circuit considerations for audio-output stages using power transistors. The second article will deal with class B push-pull power amplifiers.

References

1. "A 20 Watt Transistor Audio Amplifier" by H. C. Lin, Transistor I, RCA Laboratories, pp 536-537, March 1956.
2. "Private Communications" by C. F. Wheatley, April 1956.
3. "Some Aspects of the Design of Power Transistors" by N. H. Fletcher, Proceedings IRE, Vol. 43 pp 558-559, May 1955.
4. "Design Principles for Junction Transistor Audio Power Amplifiers" by D. R. Fewer, IRE Transactions on Audio, Nov-Dec 1955.
5. "Temperature Effects in Circuits Using Junction Transistors" by H. C. Lin, Transistor I, RCA Laboratories, pp 309-402, March 1956.
6. "Power Transistors for Audio Circuits" by L. T. Giacometto, Electronics Vol 27 pp 144, January 1954.
7. "Bias Stabilization" by R. F. Shea, Principles of Transistor Circuits, John Wiley & Sons, Inc. pp 102-108.

TECHNIQUES and DEVELOPMENTS in oscillographic recording

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DESIGN PRINCIPLES AND SOME APPLICATIONS OF A PREAMPLIFIER FOR LOGARITHMIC MEASUREMENTS

THE Model 150-1400 Log Audio Preamplifier (Figure 1), one of eleven plug-in "front ends" now available for 150 Series systems, permits measurements involving logarithmic or exponential functions. The "Log Diode" circuit (shaded portion of circuit block diagram in Fig. 2) is the heart of this instrument, and is based on the logarithmic relationship between the voltage across a thermionic diode and the cur-



Fig. 1

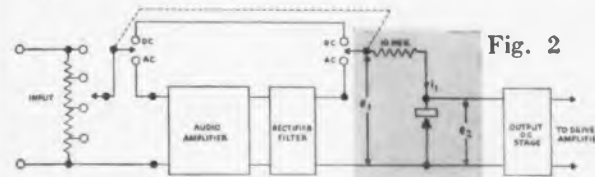


Fig. 2

rent through it. If R is large, the current through the diode i_1 becomes proportional to the voltage e_1 , and the logarithmic relationship of e_2 and i_1 is transformed into a logarithmic relationship between e_2 and e_1 . Circuit constants for this Preamplifier were chosen to provide an accurately logarithmic relationship between e_2 and e_1 , over the range of 200 to .63 volts for e_1 . This is a 50 db spread, and the gain of the DC output amplifier (fed by e_2) is arranged so that a 50 db variation in e_1 produces a 50 mm stylus deflection.

In audio or AC measurements, e_1 is derived from a peak reading type rectifier-filter circuit, which

follows a high quality 20 cycle—20 KC audio amplifier. With an input of 100 mv RMS, this amplifier will produce a 200 volt output from the rectifier. The 50 db chart, therefore, corresponds to a variation in AC input voltage of 0.316 to 100 mv.

In DC measurements, the audio amplifier is bypassed and the input applied to the diode circuit. Since the diode itself is a rectifier, used in the forward direction with its cathode near ground, the DC input must be polarized with the high side positive.

One broad area of application for the Log Audio preamplifier is audio level recording. For example, room reverberation time can be measured by recording sound level decay after the sound source is suddenly turned off, the reverberation time considered the period required for a 60 db decay to occur. Another example of audio signal recording is the plotting of frequency response curves of audio equipment such as microphones, filters, loudspeakers, etc. A multi-channel recording system with appropriate filters also makes possible audio spectrum analysis.

A second major type of application of this Preamplifier is the recording of DC voltages on a db basis. If the signals are small, a chopper can be used to convert DC to AC, thus taking advantage of the Preamplifier's audio amplifier. With an impedance matching transformer added to such an arrangement, the system becomes a logarithmic DC millivoltmeter or logarithmic DC microammeter of extreme sensitivity. Such a device could be used for plotting the volt-ampere characteristic of a germanium diode, which might be very helpful in selecting matched pairs of diodes. Another possibility is plotting the output of a fixed gain radio receiver and linear detector to a db scale, to rapidly record antenna performance data.

A comprehensive discussion of the design and these applications of the Log Audio Preamplifier is contained in an article by Dr. Arthur Miller, Chief Electrical Engineer of Sanborn Company, published in the Sanborn RIGHT ANGLE. Copies are available on request.

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Extension and Adapter Sleeves



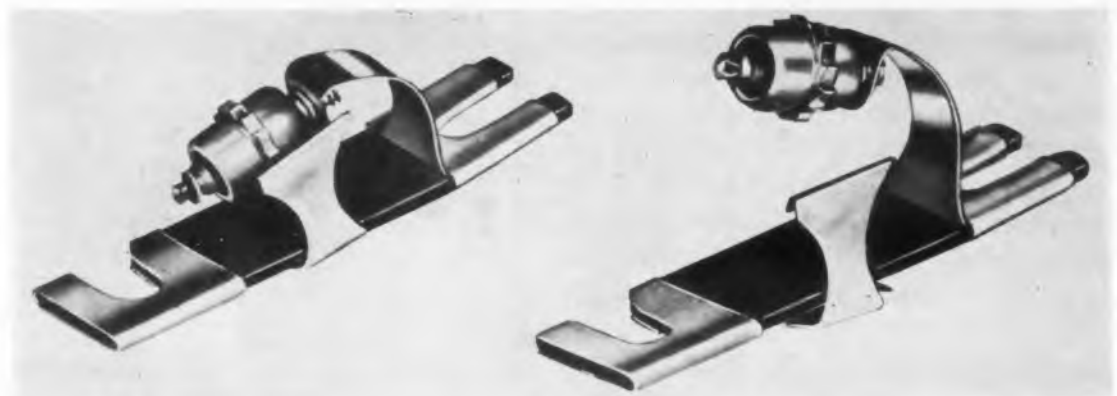
EXTENSION and adapter sleeves, which provide more enclosed space in the backshell area of connectors, and which permit the use of proper AN clamps with any given size cable and connector, increase the reliability of the electrical circuits to which they are attached.

Enclosure of wires in the standard backshell is, in many cases, possible only by crowding the wires, wherein strain and insulation damage may result. The extension sleeve replaces the standard backshell increasing the space for wire terminations at the connectors.

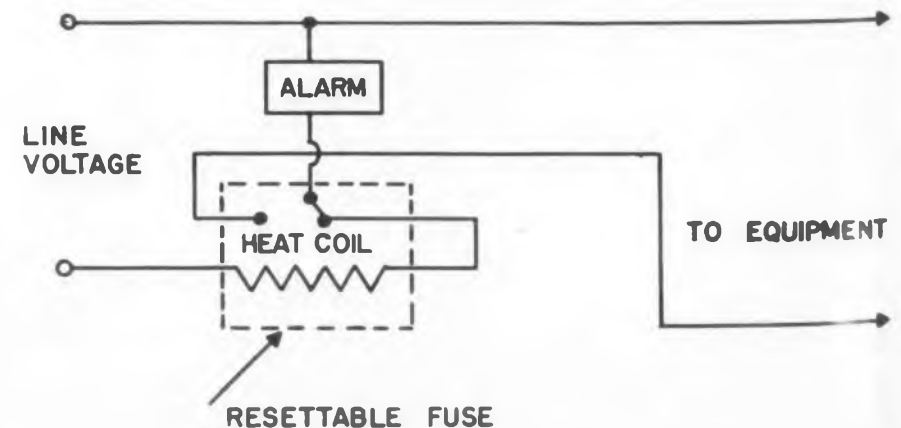
There is only one clamp to fit a given size connector and very often it is too large or too small to fit the cable. The adapter has provisions for stepping up or stepping down the thread size for attaching the clamp. The adapter mates with the connector and permits the use of any of the AN clamps with a given connector.

Developed by Pacific Automation Products, Inc., Glendale 1, Calif., the devices are threaded and fabricated of aluminum with an anodized finish. For more information on these extension sleeves fill out the Reader's Card and circle 44.

Resettable Grasshopper Fuse



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How the circuit is protected. A revolvable ratchet when subjected to more than rated current releases the ground and alarm spring.

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Heat coils are manufactured to a range of ratings, notably a three hour current carrying capacity of from 0.1 amp to a 0.055 amp. The fuse will operate in 210 sec, when there is a current of 0.18 amp in the coil rated at 0.1 amp, and a current of 0.11 amp in the 0.055 amp rated coil. The grasshopper fuse bases are made to accommodate varied mountings and screw sizes. The fuses were developed by Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill.

These grasshopper fuses are ideal for actuating alarm circuits or grounding out stray or excessive currents. For additional information about this resettable grasshopper fuse, fill out the enclosed Reader's Service Card and circle 45.

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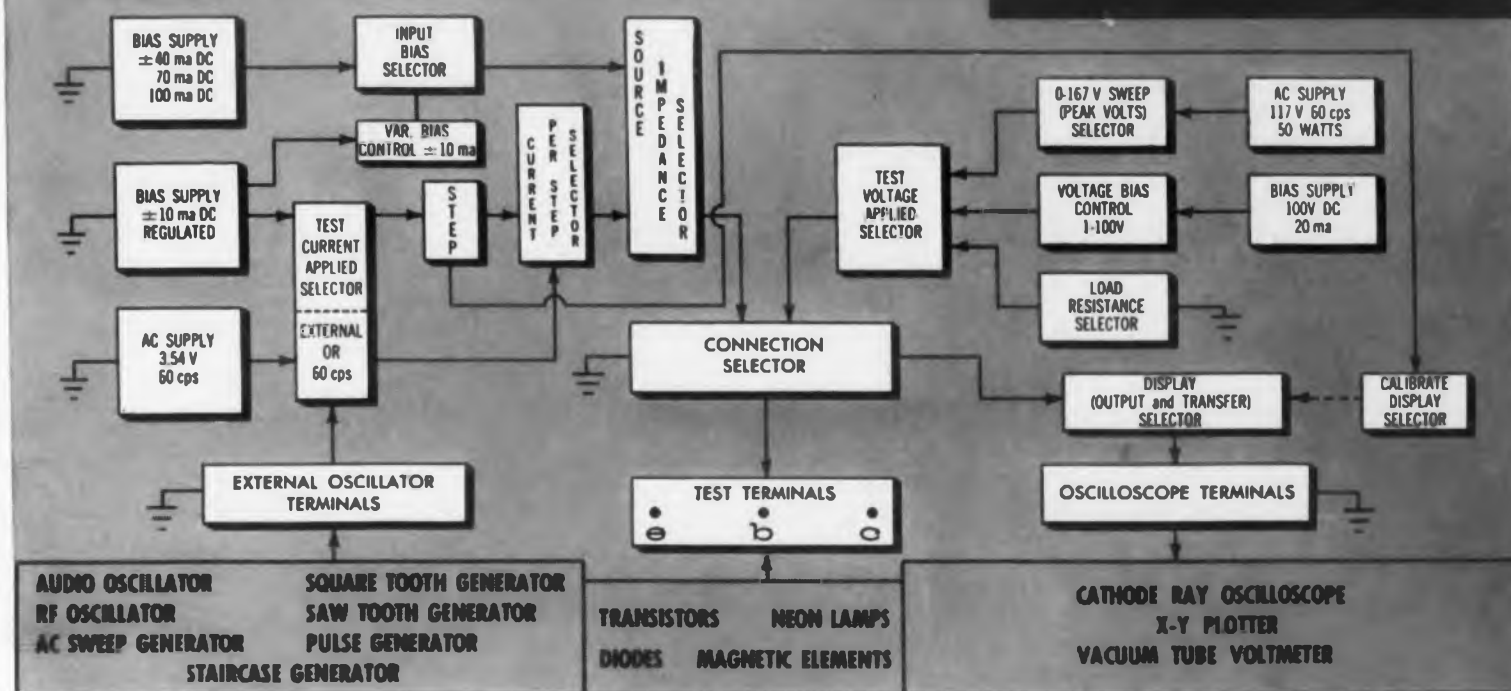


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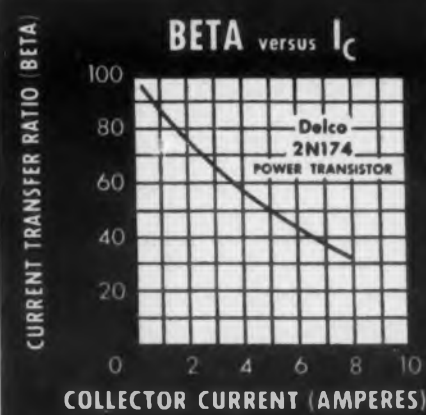
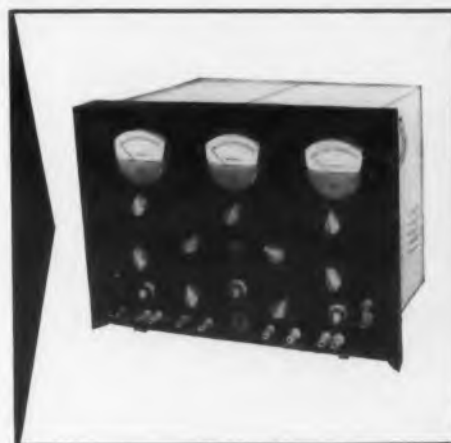
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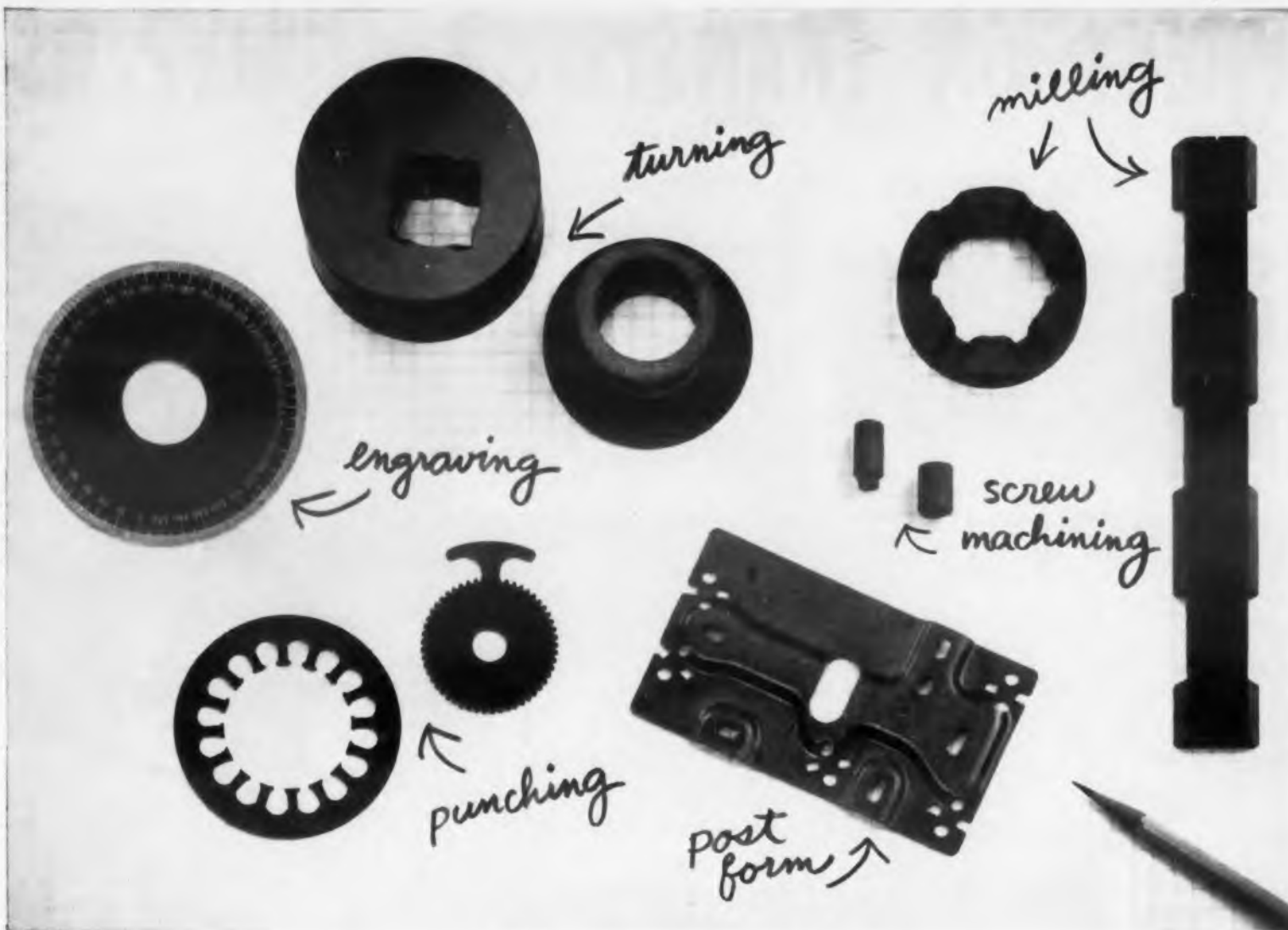
The curve shown above on the 55 watt Delco 2N174 was obtained with Norden-Ketay BTS-400 Test Set.

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CIRCLE 47 ON READER-SERVICE CARD FOR MORE INFORMATION

A Voltage Gain Nomogram for Transistor Circuit Design

AS AN aid to rapid design and application of transistor circuitry to electronic systems, these two nomograms can be used to determine gain variations when changes are made in various circuit values.

The Transistor Voltage Gain Nomogram described will enable gain variations to be easily determined. It also permits the rapid design of common-base and common-emitter amplifiers for any desired gain. Any adjustment of either the load impedance (R_L) or the external emitter resistance (R_E) will automatically plot the course that the voltage gain (VG) will take. By the same token, if any two of the values are known, the other may be found.

The nomograms are based upon the approximation formula:

$$VG \cong \frac{\alpha R_L}{R_E + r_e + r_b(1-\alpha)} \quad (1)$$

Which assumes:

$$\begin{aligned} R_L &\ll r_c \\ R_E + r_e + r_b &\ll r_c \end{aligned}$$

The approximation is for all practical purposes correct if $R_L \ll r_c$ by two or more orders of magnitude. In general, $r_c \cong 1$ megohm for junction transistors.

$$r_c = \frac{V_{CB}}{I_{ce}} \quad (2)$$

As R_L increases and approaches r_c , the inaccuracy of equation (1) and of the nomograms increases. Generally, however, R_L remains lower than $(0.01)r_c$. An error of 1 per cent may be expected if $R_L = (.001)r_c$; and approximately 10 per cent as R_L approaches $(.01)r_c$.

Rudolph Wellsand
Convair
Guided Missile Division
Pomona, Calif.

For strict applications, and particularly where tight tolerances, great accuracy, and higher load impedances than $R_L = (0.01)rc$ are to be used, the exact expressions for VG should be used.

Nomogram Operation

Nomogram II functions with a denominator resistance R_D , where:

$$R_D = R_E + re + rb(1-\alpha) \quad (3)$$

Parameters re and rb may be found in the specifications for a particular transistor. As an aid, Nomogram I lists the transistor's alpha with its $(1-\alpha)$. A straightedge from $(1-\alpha)$ to the rb scale will quickly determine the $rb(1-\alpha)$ read from the center scale.

Adding $re + rb(1-\alpha)$ mentally, one gets the value of R_D .

$$R_D = re + rb(1-\alpha) \quad (4)$$

However, if in grounded-emitter orientation an external emitter resistor, R_E , is further added, then the combined total becomes R_D , as in equation (3).

When $re + rb(1-\alpha) \ll R_E$, in example by approximately two orders of magnitude, then:

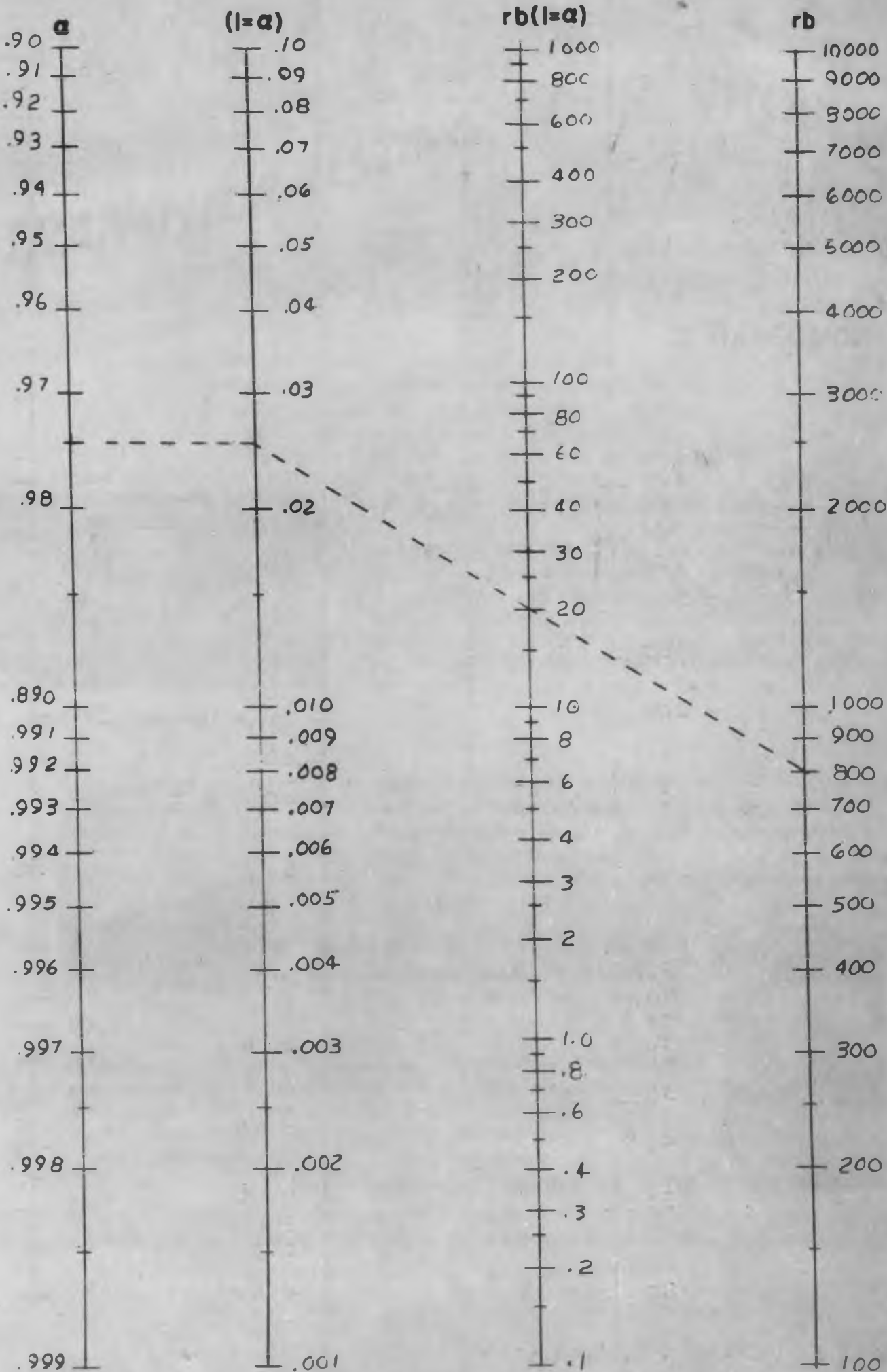
$$R_D \cong R_E \quad (5)$$

$$VG \cong \alpha \frac{R_L}{R_D} \quad (6)$$

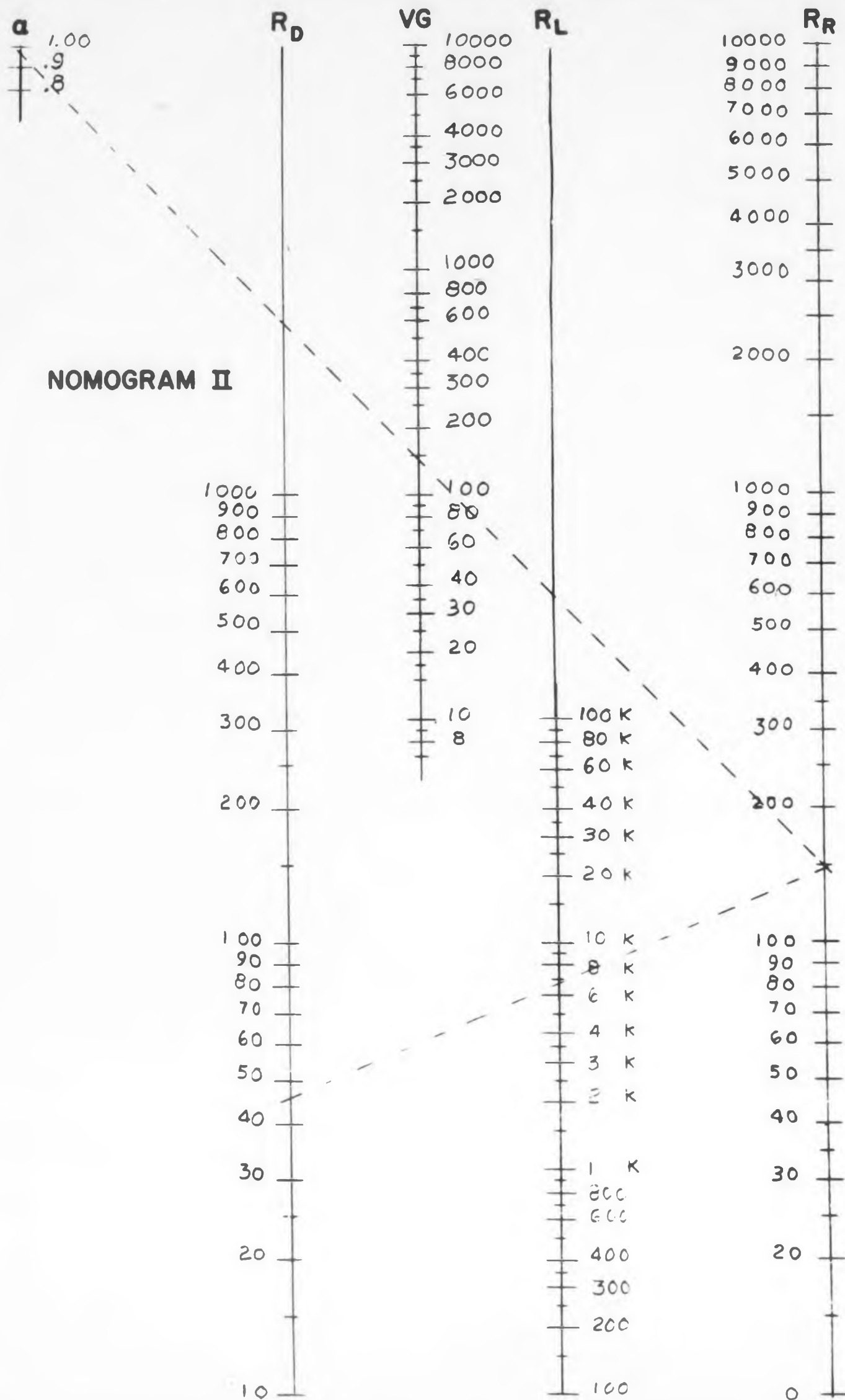
Where the resistance ratio $R_R = \frac{R_L}{R_D}$ (7)

Then: $VG \cong \alpha R_R$ (8)

Set a straightedge on Nomogram II, from the value of denominator resistance on the R_D scale to the value of load impedance on the R_L scale, and note the value of the resistance ratio on the R_R scale. Now set the straightedge from the R_R value to the known alpha on the α scale and read the voltage gain direct on the VG scale.



NOMOGRAM I



The reverse procedure may also be used, by setting the straightedge from α to the desired value of V_G and noting the R_R obtained. If R_L is known, then R_D may be found. Knowing the value of the parameters, r_e and r_b , from the specifications previously employed, these parameters may be subtracted from R_D , the result being the value of the external emitter resistance, R_E , which should be placed in the emitter leg.

Sample Problem

(Using a 2N35-n-p-n in grounded-emitter)

- List the values of r_e , r_b , r_c and α from the specifications:
 - $r_e = 26$ ohms
 - $r_b = 800$ ohms
 - $r_c = 2$ megohms
 - $\alpha = 0.975$

- Find the value of $r_b(1 - \alpha)$ from Nomogram I.
 $r_b(1 - \alpha) = 20$ ohms

- Substitute the value of r_e and $r_b(1 - \alpha)$ into Equation (4):

$$R_D = r_e + r_b(1 - \alpha) \quad (4)$$

$$= 26 + 20$$

$$= 46$$

- Note the value of R_E to be used, and compare with Equation (4):
 $R_E \gg r_e + r_b(1 - \alpha)$ by approximately 100 times.

- If the comparison above is true, then substitute R_E into equation (5):

$$R_D \cong R_E \quad (5)$$

If not true, then substitute R_E into equation (3):

$$R_D = R_E + r_e + r_b(1 - \alpha) \quad (3)$$

- If no R_E is used, then continue using equation (4):

$$R_D = r_e + r_b(1 - \alpha) \quad (4)$$

- Assuming that an external emitter is used, resistance of $R_E = 500$ ohms, then the comparison of $R_E \gg r_e + r_b(1 - \alpha)$ would be true:
 $R_E \gg 46$ by approximately 100 times.
 Substituting into equation (5):

$$R_D \cong R_E$$

$$R_D \cong 500 \text{ ohms}$$

- Note the value of R_L to be used and substitute into Equation (7): (Let R_L be 6000 ohms)

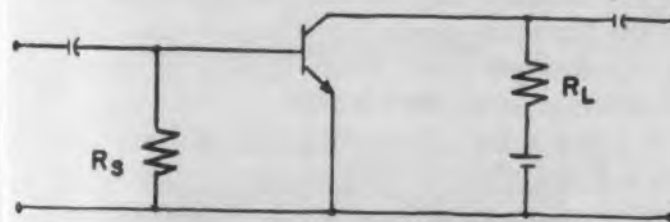
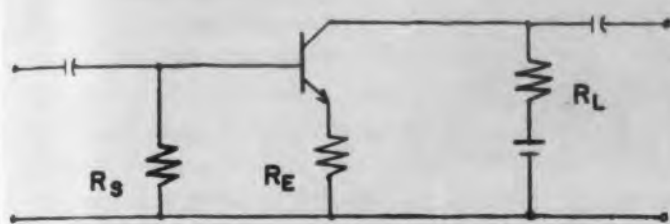
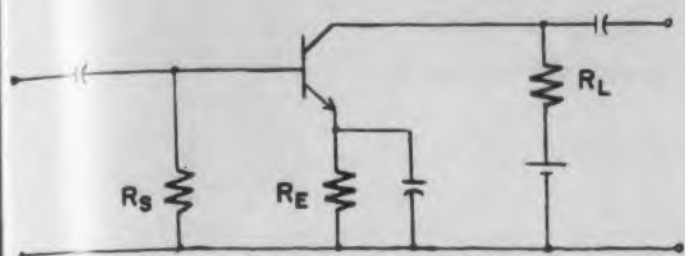
$$R_R = \frac{R_L}{R_D} \quad (7)$$

- Since $R_L \ll r_c$ ($6500 \ll 2$ megohms), less than 10 per cent error may be expected by use of the Nomogram.

- Find the value of R_R from Nomogram II and substitute into equation (8):

$$\begin{aligned} VG &\cong \alpha R_R \\ VG &\cong \alpha(13) \end{aligned} \quad (8)$$

General circuits to which the nomograms are applicable.



10. Lastly, knowing the value of alpha and R_R , find V_G on Nomogram II.

$$V_G \cong 12.7$$

Had no emitter resistance been used, R_R would have been 140 and V_G equal to 136.

For a reprint of this article, turn to Reader Service Card and circle 499.

References

F. R. Stansel: Transistor Equations: ELECTRONIC DESIGN: March 1953: page 156.

Nomogram for Some Transistor Parameters, H. Lefkowitz, ELECTRONIC DESIGN, 15 Oct. 1956, p. 62.

Principles of Transistor Circuits, R. F. Shea, John Wiley and Sons, Inc., 1953.

BAIRD  ATOMIC

IS TRANSISTOR-TESTING YOUR PROBLEM? LOOK TO Baird-Atomic FOR THE ANSWER

Complete, accurate testing requires test equipment especially designed for the job — not modifications of standard apparatus. B-A has developed a complete line of transistor test equipment. The features of some of B-A's Transistor Test Equipment are listed below:



Model GP4 — TRANSISTOR TEST SET

TRANSISTOR TEST SET — The transistor tester that is rapidly becoming the standard of the industry... for 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 . Test frequency from 100 cps to 1 mc.



Model KP-1 —
MEDIUM POWER TRANSISTOR TESTER

MEDIUM POWER TRANSISTOR TESTER — Measures all h parameters... provisions for measuring transistor reverse characteristics and external measurement of I_{co} . Wide range of test conditions — I_c and I_e , variable from 1.0 to 300 ma; V_c , 0 to 100 volts; frequency 100 cps to 200 KC.

BETA, h_{11} , I_{co} TESTER — Light weight... portable — completely self-contained... utilizes transistorized, printed-circuit construction. Contains 1 KC oscillator and long-life mercury-cell power supply. Provision for collector waveform observation... meter overload protection.

Model KT1 — BETA, h_{11} , I_{co} TESTER



Complete technical data available on these and other B-A Transistor Test Equipment. Engineering representatives throughout United States and abroad.

BAIRD  ATOMIC

Baird-Atomic, Inc.

33 UNIVERSITY ROAD, CAMBRIDGE 38, MASS.

CIRCLE 48 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Transistor Transformers Seven Types



Seven additional types of ultra-miniature DO-T transistor transformers are available. These units weigh one-tenth ounce and are fully hermetically sealed. Included in this group are a number of 500 mw units designed for pushpull transistor to 600 ohm line, a chopper input transformer, transistor interstage transformer, and a line to line matching transformer.

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

CIRCLE 49 ON READER-SERVICE CARD FOR MORE INFORMATION

Spectrum Analyzer 10 Cps Resolution



Designed for applications requiring extremely high resolution, such as investigation of side bands caused by low modulating frequencies, single side-band transmissions, teletype, etc. The SB-12 Panalyzer can be used to observe signals anywhere in the spectrum up to 1000 mc by means of an external signal generator and an internal aperiodic mixer which translate the spectrum segment to be analyzed down to the 450 to 550 kc input band of the

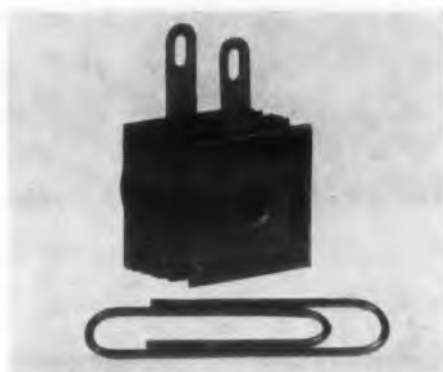
Panalyzer. Offering the advantages of wide scan spectrum presentation, the SB-12 at the same time permits examination of signals so closely adjacent in frequency that their corresponding deflections normally tend to merge together or completely mask one another in wide scan displays. Maximum sweepwidth is 100 kc continuously reducible to 0 kc. Scan rate is adjustable in steps of 30, 5, 1 and 0.1 cps. Resolution ranges from 3.2 kc to 10 cps. Afc is provided for narrow sweepwidths.

The unit can be used to investigate pulsed rf signals, analyze am and fm transmitters, spot spurious oscillations and modulation, monitor communications bands, test industrial rf equipment, diathermy and electrosurgical instruments, and is applicable to other laboratory and production test problems.

Panoramic Radio Products Inc., Dept. ED, 10 S. 2nd St., Mount Vernon, N.Y.

CIRCLE 50 ON READER-SERVICE CARD FOR MORE INFORMATION

Selenium Rectifier 65 Mil



Designated Type 1263-A for standard mounting, and 1262-B for bracket mounting, this 65 mil selenium rectifier is for use in small electronic equipment. The rectifier has the following characteristics for single phase capacitive loads: Max rms input v of 130 v; max peak inverse v of 380 v; max peak current of 650 ma; max rms current of 175 ma; max dc current of 65 ma; approx rectifier voltage drop of 7 v; min series resistance of 22 ohms, and the max plate operating temp is 85 C.

Federal Telephone and Radio Co., Dept. ED, 100 Kingsland Rd., Clifton, N.J.

CIRCLE 51 ON READER-SERVICE CARD FOR MORE INFORMATION



Rotary Solenoid Withstands 500 F Ambient

This rotary solenoid is claimed to have a life expectancy of 300,000 snap-action operations at 500 F. It is able to operate with high wattage inputs to produce higher torques. Eight basic sizes are available, ranging from 1 to 3-3/8 in. diam. Starting torques for 45 deg. stroke range from 0.2 to 54.0 lb-in. Special magnet wire and coil insulation, lubrication, bearing and return spring materials were developed for the product. Operation is identical with the standard rotary solenoid. Magnetic action moves the armature along the solenoid axis. This action is converted into a rotary motion by means of ball bearings on inclined races.

G. H. Leland, Inc., Dept. ED, 123 Webster St., Dayton 2, Ohio.

CIRCLE 52 ON READER-SERVICE CARD FOR MORE INFORMATION

5 Mc Crystal High Stability



Type BG61A-5 is a glass mounted, optically polished, gold plated quartz crystal operating on the 3rd overtone mode at 5 mc. The temperature coefficient of the unit is less than 0.1 ppm over a 1 C range at the preferred operating temperature (75 C or 85 C). When used with temperature control adequate to maintain ± 0.01 C, the resultant crystal stability is 1 part per billion at 5 mc.

Bliley Electric Co., Dept. ED, Union Station Bldg., Erie, Pa.

CIRCLE 53 ON READER-SERVICE CARD FOR MORE INFORMATION



Dish Antenna Simplified Mounting

A one-piece, four-foot dish antenna designed for tubular mast mounting is secured to 4 in. IPS tubular masting by two heavy-duty clamps. The clamps are designed to produce an even, tight connection assuring positive orientation under extreme wind loads.

This model is constructed on a ring principle. The basic ring is a circular heavy-weight aluminum disc supporting cantilever aluminum arms, which extend to the perimeter. The parabolic surface is covered with expanded aluminum mesh, inert arc-welded to the supporting arms. The antenna is designed to operate in the range of 1000 through 4000 mc. Standard drivers are of the dipole and horn type.

Technical Appliance Corp., Dept. ED, Sherburne, N.Y.

CIRCLE 55 ON READER-SERVICE CARD FOR MORE INFORMATION

Insulation Tester High Speed



This instrument will detect, totalize, and record insulation faults in material travelling at 400 ft. per min. with 1-in. long electrode. It will detect pinhole invisible to the naked eye at this speed.

The tester will detect and register every fault, since it does not have the inherent limitations of 60 cps testers and fault relays which do not register faults if they occur too close together in time.

Testing is non-destructive. It will not burn insulation, nor mark it in any way. The output is non-lethal. At 10 kv dc the maximum short circuit current is 4 ma.

Peschel Electronics, Inc., Dept., ED, 13 Garden St., New Rochelle, N.Y.

CIRCLE 56 ON READER-SERVICE CARD FOR MORE INFORMATION

surface barrier transistors from SPRAGUE

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	—



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

IN VOLUME PRODUCTION

Now!

For general high frequency applications, and for high speed computer switching circuits, design around Sprague surface barrier transistors. They are available now in production quantities from a completely new, scrupulously clean plant, built from the ground up especially to make high quality semi-conductor products.

The four transistor types shown are the most popular. Orders for these units are shipped promptly. What's more, surface barrier transistors are reasonably priced. High quality and excellent electrical characteristics make them an economical solution to many difficult circuit requirements.

Sprague surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type number are manufactured to the same specifications and are fully interchangeable. You have *two* sources of supply when you use surface barrier transistors!



WRITE FOR COMPLETE ENGINEERING DATA SHEETS ON THE TYPES IN WHICH YOU ARE INTERESTED. ADDRESS REQUEST TO THE TECHNICAL LITERATURE SECTION, SPRAGUE ELECTRIC CO., 347 MARSHALL ST., NORTH ADAMS, MASS.

TRANSISTORS • RESISTORS • MAGNETIC COMPONENTS
CAPACITORS • INTERFERENCE FILTERS • PULSE NETWORKS
HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS

CIRCLE 57 ON READER-SERVICE CARD FOR MORE INFORMATION

SPRAGUE[®]
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NEW Simpson

WIDE-VUE panel instruments



3 1/2"



4 1/2"



2 1/2"

a new concept

In styling and visibility

The clean, graceful lines of these "Wide-Vue" panel instruments add two plus values to your equipment. First, style—ultramodern beauty that blends with the advanced design of today's panels. Second, functionalism—longer scales together with wide-angle readability. The 2 1/2" size, for example, has the same scale length as a conventional 3 1/2" panel instrument. The durable, plastic cover is formed in one piece, and can be supplied with black or color finishes. Custom-built in 2 1/2", 3 1/2", and 4 1/2" sizes. External magnet type movement or self shielded core magnet meter movement.



Simpson
ELECTRIC COMPANY
5200 W. Kinzie St., Chicago 44, Illinois
Phone: EStebrook 9-1121
In Canada: Bach-Simpson Ltd., London, Ontario

INSTRUMENTS THAT STAY ACCURATE

New Products

1500 F Insulating Fabrics

Also Used for Leak Detections

Two types of high temperature insulating fabrics for service up to 1500 F have been announced. Made of fiberfrax ceramic fiber, these fabrics are available in various widths or thickness for positive high temperature insulation. In addition, they are also supplied as instrumentation tapes for both insulation and leak detection. The high temperature tapes consist of two stranded Chromel wires covered with reinforced ceramic fiber. When wrapped around pipes carrying metallic or radioactive fluids, the tape both insulates and quickly causes an alarm-sounding short circuit in the event of a leak. This tape is designed to withstand 1500 F for 1500 hr, and is flexible enough to be wrapped in spiral form around pipe of 1/2 in. diam. The fabrics can be treated with silicone rubbers, epoxy resins or can be impregnated with phenolic resin and molded into various shapes. If desired, they can be woven in tubular form.

The Russell Mfg. Co., Dept. ED, 255 E. Main St., Middletown, Conn.

CIRCLE 58 ON READER-SERVICE CARD

Arc Resistance Tester

Quality Control for Plastics

An arc resistance tester has been designed to evaluate the arc and track resistance of plastic materials. The Model 126 is employed in measuring the resistance of insulating materials to high voltage-low current arcs. The instrument has a built-in timer to indicate arc resistance time and a specimen holder which automatically levels and sets the correct electrode pressure. The electrode enclosure permits visibility and prevents drafts from disturbing the arc during the test.

Delsen Corp., Dept. ED, 719 W. Broadway, Glendale 4, Calif.

CIRCLE 59 ON READER-SERVICE CARD

◀ CIRCLE 60 ON READER-SERVICE CARD

Stock Drawing Forms

Meet Military Specifications

A range of stock drawing forms are available for immediate delivery in small or large quantities. Drawing forms in stock are: A size—8-1/2 x 11 in., B size—11 x 17 in., C size—17 x 22 in., and D size—22 x 34 in.

PIC Design Corp., Dept. ED, 477 Atlantic Ave., East Rockaway, N.Y.

CIRCLE 62 ON READER-SERVICE CARD

Stagnation Temperature Probe

For Flight Applications

The WCRC temperature probe provides stable measurement of stagnation air temperature. The probe has a high degree of internal, thermal equilibrium in dynamic measurement of total temperature. Heat transfer between probe and mounting is stabilized for wide temperature differentials. The aerodynamic design provides for steady-state readings from subsonic to supersonic speeds. Recovery factor is relatively insensitive to speed. Sensing is accomplished by a resistance element, a thermocouple, or a thermistor, depending on specified input impedance.

West Coast Research Corp., Dept. ED, 2371-1/2 Westwood Blvd., Los Angeles, Calif.

CIRCLE 63 ON READER-SERVICE CARD

Thyratron

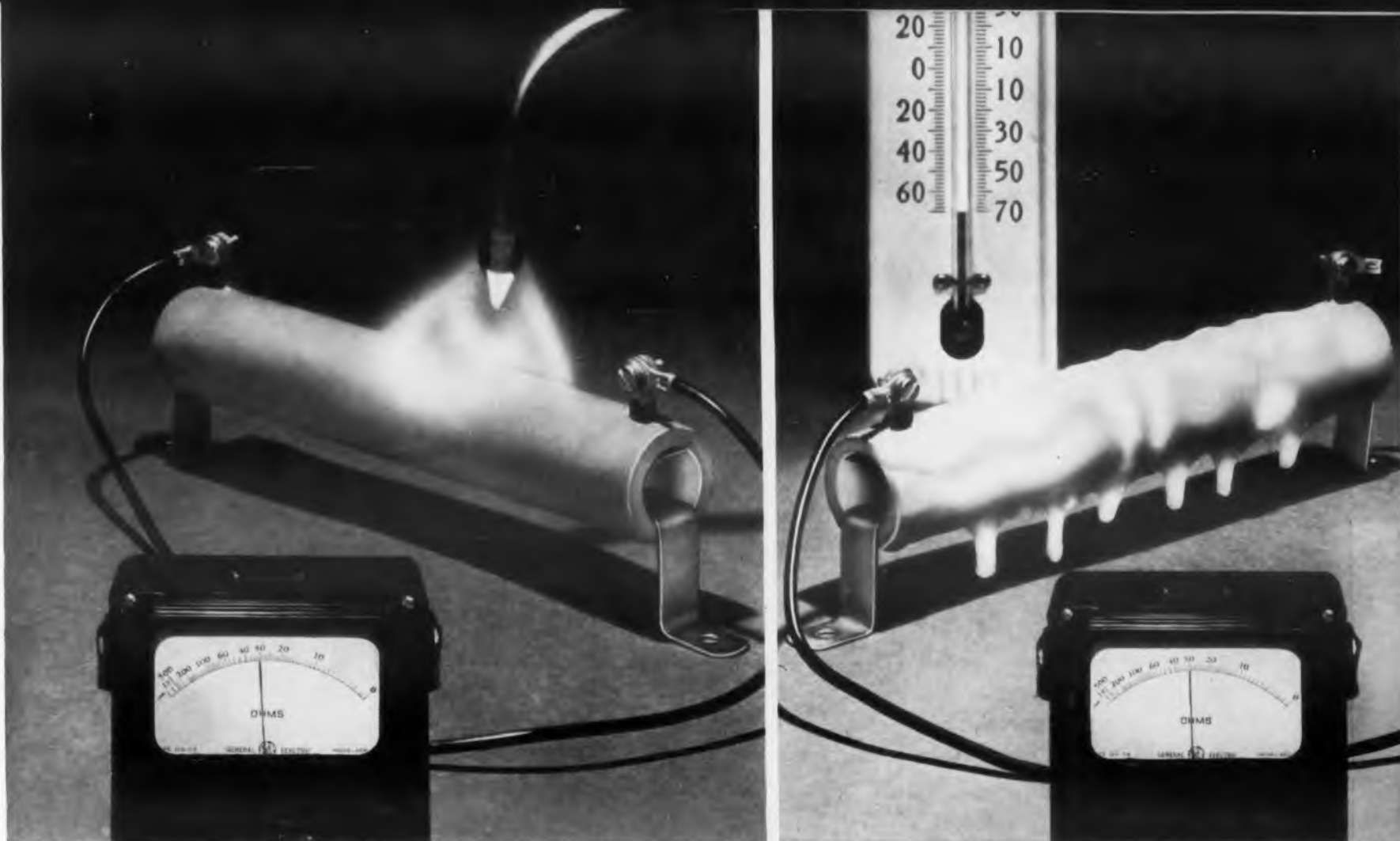
Average Rating of 1 Amp.

The Xenon-filled XR-764, 3-1/2 in. high, has an octal base and top cap and a 10 v drop in use. Filament voltage and current is 5 v and 3 amp respectively, with a heating time of 120 sec. Peak forward and inverse voltages are 500 v dc, start (plus 3 v grid) is 25 v, with 25 v emission at 30 amps. De-ionization time is 200 μ sec or less. The tube is claimed to be unusually rugged.

Continental Electric Co., Dept. ED, 6 N. Michigan Ave., Chicago 2, Ill.

CIRCLE 64 ON READER-SERVICE CARD

CIRCLE 65 ON READER-SERVICE CARD ▶



TESTS ON NEW GENERAL ELECTRIC RESISTORS PROVE . . .

Stable operation from +700° to -70° F

Under searing heat or sub-zero cold, General Electric resistors maintain their rated ohmic values. Actual laboratory tests have proved that these vitreous-enamelled resistors hold their rated resistance under ambient temperatures from +700 F to -70 F.

These General Electric resistors are available in over 1400 combinations of ratings (5 to 200 watts), types, and mountings. Stable operation is but one of their outstanding qualities: They have sufficient terminal strength to hold up to 21 pounds of right-angle pull, and special terminals are available to hold up to 34 pounds. Their vitreous-enamel coating provides resistance to adverse atmospheric conditions.

Like to know more? Ask your General Electric salesman for a free set of sample resistors and test them yourself! And mail this coupon today for the new 36-

page catalog containing complete information on ratings, dimensions and ordering directions.

Industry Control Department, Roanoke, Virginia.

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Section B784-8

General Electric Co., Schenectady, N. Y.

Please send a copy of GEA-6592, G-E Resistor Catalog.

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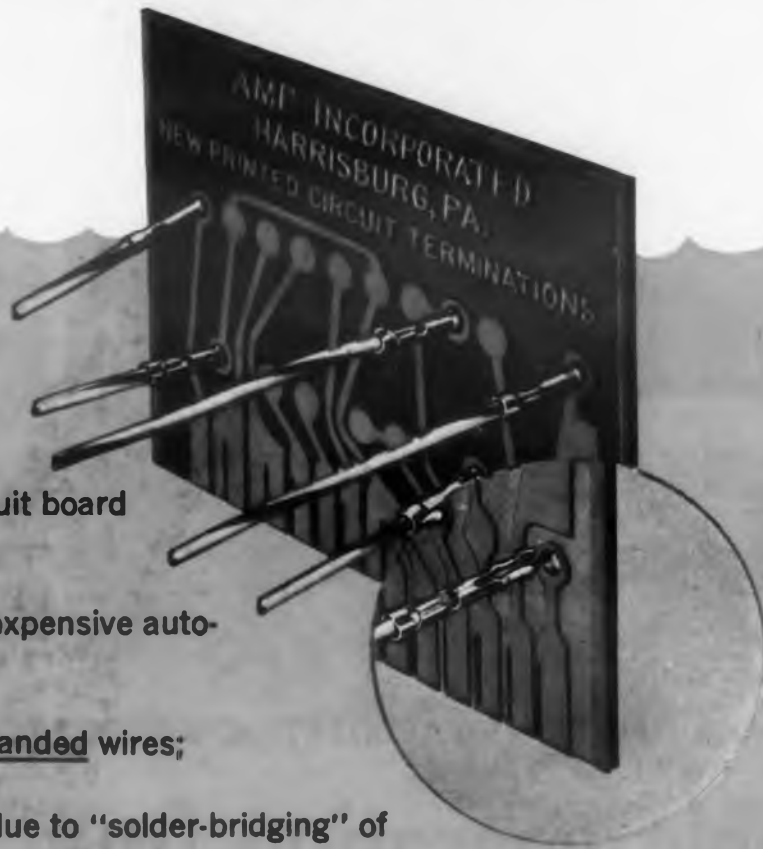
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WELL I'LL BE DIPPED...better
...because the NEW **AMP** SNAPIN



- Gets leads to the printed circuit board in one assembly operation;
- Eliminates an investment in expensive automation equipment;
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- Eliminates danger of shorts due to "solder-bridging" of insecure leads;
- Has construction details that promote good capillary flow of solder during the dipping process;
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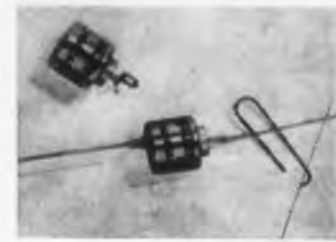
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Distributor in Japan: Oriental Terminal Products Co., Ltd., Tokyo, Japan

AMP

CIRCLE 66 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



Miniature Tantalum Capacitors

175°C

Miniature tantalum electrolytic capacitors are available for operation over a temperature range from -55 to 175 C. Known as the X T M line, they are being manufactured in six capacities, from 4 to 40 mfd, at nominal working ratings from 40 to 360 v. The body diameter of the metal case (all capacitors) is 5/8 in. with case lengths from 9/16 to 1-25/32 in. All capacities employ a metal-to-glass hermetic seal and offer a choice of 2-1/4 in. axial leads or solder-tab terminals.

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

CIRCLE 67 ON READER-SERVICE CARD FOR MORE INFORMATION

Frequency-Period Counter

0 cps-1 mc

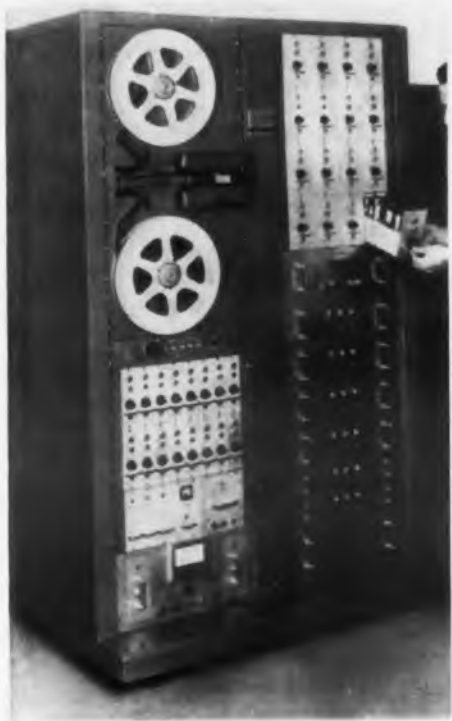


This frequency-period counter, model 203A, offers 0 cps to 1 mc direct reading operation for frequency and period (1 freq.) measurement. The counter also serves to measure pressure, temperature, velocity, acceleration, flow, rps, rpm, and displacement with the use of suitable transducers. The instrument may also be used as a secondary frequency standard. It features a continuously adjustable trigger level control which permits full rated sensitivity at any voltage level between -300 and +300 v. Small voltage increments ordinarily masked by attenuators are easily selected. Simplified color-coded controls and direct read-out in kc, mc, sec, or μ sec, with automatic decimal point indication are incorporated. Oscilloscope marker signal facilities trigger level adjustment for amplitude discrimination in frequency or period measurement. The counter has a time base range of 10 μ sec to 10 sec in decade steps (frequency), 1 and 10 cycles (period).

Computer-Measurements Corp., Dept. ED, 5528 Vineland Ave., No. Hollywood, Calif.

CIRCLE 68 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Tape Recorder
300 KC Bandwidth



Series 3000 Multi-Channel Magnetic Tape Recording System features a 300 kc Band Width. The system accommodates reel sizes up to 14 in. as standard equipment and has a single switch on the front panel which selects any of the six standard speeds up to 60 in. per sec. Module housings provide plug-in facilities for amplifiers, permitting instant selection of direct fm or PDM recording or playback in any combination.

American Electronics, Inc., Dept. ED, 655 W. Washington Blvd., Los Angeles 15, Calif.

CIRCLE 69 ON READER-SERVICE CARD FOR MORE INFORMATION

Ultrasonic Cleaning
50-250 W output



A series of ultrasonic cleaning units ranging in capacity from two quarts upward is available.

Power output ranges from 50 to 250 w. Designed for continuous commercial use, the generator supplies the rated output of electrical energy to a barium titanate transducer. Generators are designed to permit use of two cleaning transducers alternately. One tank may be used for removal of excessive amounts of contamination, and the other tank for final cleaning.

Alcar Instruments Inc., Dept. ED, 17 Industrial Ave., Little Ferry, N.J.

CIRCLE 70 ON READER-SERVICE CARD FOR MORE INFORMATION

**“top
hat
design”**

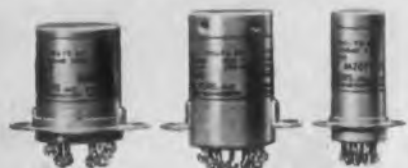
**for Air-borne Power Supplies
and Other Military and Industrial Applications**



Hoffman

CIRCLE 71 ON READER-SERVICE CARD FOR MORE INFORMATION

BURTON BROWNE/New York



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ONLY PRECISION MACHINED ROTARY RELAY

NO STAMPED PARTS IN THE MOTOR. MACHINED PARTS—ONLY ONE OF THE ADDITIONAL QUALITY CONTROL STEPS TAKEN BY FILTORS IN THE MANUFACTURE OF HERMETICALLY SEALED SUB-MINIATURE RELAYS . . . YOUR ASSURANCE OF GREATEST RELIABILITY.

WRITE FOR CATALOG, FILTORS, INC., PORT WASHINGTON, LONG ISLAND, NEW YORK, PORT WASHINGTON 7-3850

New Products

Flying Spot Scanner For Test Equipment

A 5 in. flying spot scanner tube for use in television receiver test equipment has been developed. Designated type 5BNP16, the tube employs low voltage electrostatic focus, an aluminized screen of very short persistence, and operates without ion trap for simplified installation. Compared to other tube types designed for studio flying spot scanning pickup equipment, the 5BNP16 is less expensive, approximately 4 in. shorter in over-all length, and operates at lower anode voltages.

Sylvania Electric Products, Inc., Dept. ED, 1740 Broadway, New York 19, N.Y.

CIRCLE 106 ON READER-SERVICE CARD

Cap Nuts

Made of Nylon

A line of cap nuts fabricated from black Nylon comes either knurled or slotted, and may be used with rods or screws or serve as knobs. Nylon fabrication makes the nuts particularly useful where dielectric strength and resistance to corrosion are important. A range of sizes with American Standard threads includes 6-32, 8-32, 10-32 and 1/4-20.

Weckesser Co., Dept. ED, 5701 Northwest Highway, Chicago 30, Ill.

CIRCLE 107 ON READER-SERVICE CARD

Wide-Field Magnifier

For Parts Inspection

A magnifier has been developed that allows the small parts inspector to use both eyes and thus maintain a high degree of efficiency. The wide-field magnifier consists of a large oil-filled, plastic-cased lens. The lens is very clear and free of distortion from edge to edge. It will not discolor or become cloudy with age. The magnifier permits an inspector to sit comfortably while the item to be inspected is passed beneath the lens.

Curry & Paxton, Inc., Dept. ED, 866 Willis Ave., Albertston, Long Island, N.Y.

CIRCLE 108 ON READER-SERVICE CARD

◀ CIRCLE 109 ON READER-SERVICE CARD

Precision Fine Wire

0.004 In. Diam.

Through new methods developed using a centerless grinder, wire can be ground as fine as 0.004 in. diam eliminating the problem of lateral die marks which are present in most drawn wire. This is extremely important for electronic tube elements, instrument movements, and similar applications.

The TB-12 centerless grinder used for the process will production grind tungsten carbide, titanium, glass, wood, hard rubber, ceramics, cork, and other materials.

Royal Master Inc., Dept. ED, State Highway No. 23, Riverdale, N.J.

CIRCLE 110 ON READER-SERVICE CARD

Brazing Alloys

High Purity

Vacuum-tube grade silver and gold brazing alloys have been designed specifically for brazing electronic components in which the concentrates of metallic impurities must be kept to an absolute minimum. The alloys are carbon-free and meet all applicable industry specifications on maximum content of cadmium, zinc and other volatile elements not allowable for vacuum-tube work. They are supplied in wire, strip and sheet form in all the usual gages.

Handy & Harman, Dept. ED, 82 Fulton St., New York 38, N.Y.

CIRCLE 111 ON READER-SERVICE CARD

Reinforced Plastic Sheet

Flexible

A flexible grade of reinforced plastic sheet, 1/32 in. thick, with characteristics which make it suitable for such application as transformer layer insulation, is in production. Known as Grade EEF, this insulating material is expected to have use in other components besides transformers. Bulletin No. 101 containing product characteristics is available.

Reinforced Plastics Div., Dept. ED, Hays Mfg. Co., Erie, Pa.

CIRCLE 112 ON READER-SERVICE CARD

CIRCLE 113 ON READER-SERVICE CARD

OHMITE

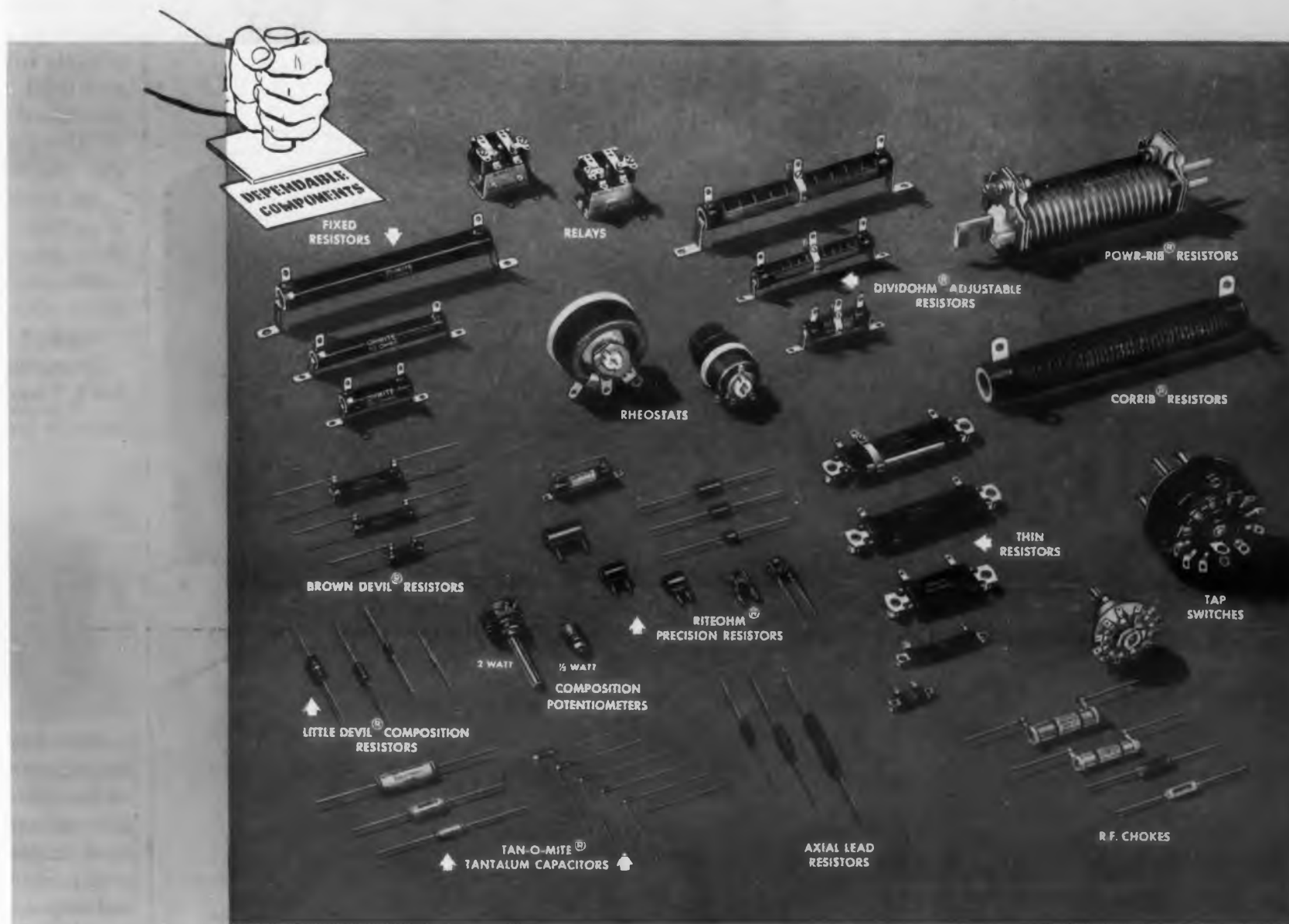
the complete

line of

industry-preferred

COMPONENTS

Long life and dependability are synonymous with the name Ohmite. When you specify Ohmite components . . . you build reliability into your product. This reliability is backed by Ohmite's continuing research programs which explore new product ideas, improve present products, and develop more efficient manufacturing processes. All this plus the fact that Ohmite is the world's leading specialist in the manufacture of power-type resistance components —high quality rheostats and wire-wound resistors in the most complete range of sizes and types available in industry. Reliability is also characteristic of Ohmite tap switches, precision wire-wound resistors, molded composition resistors and potentiometers, general-purpose relays, subminiature tantalum capacitors, and R. F. chokes. Write on company letterhead for the complete Ohmite Catalog and Engineering Manual.



OHMITE

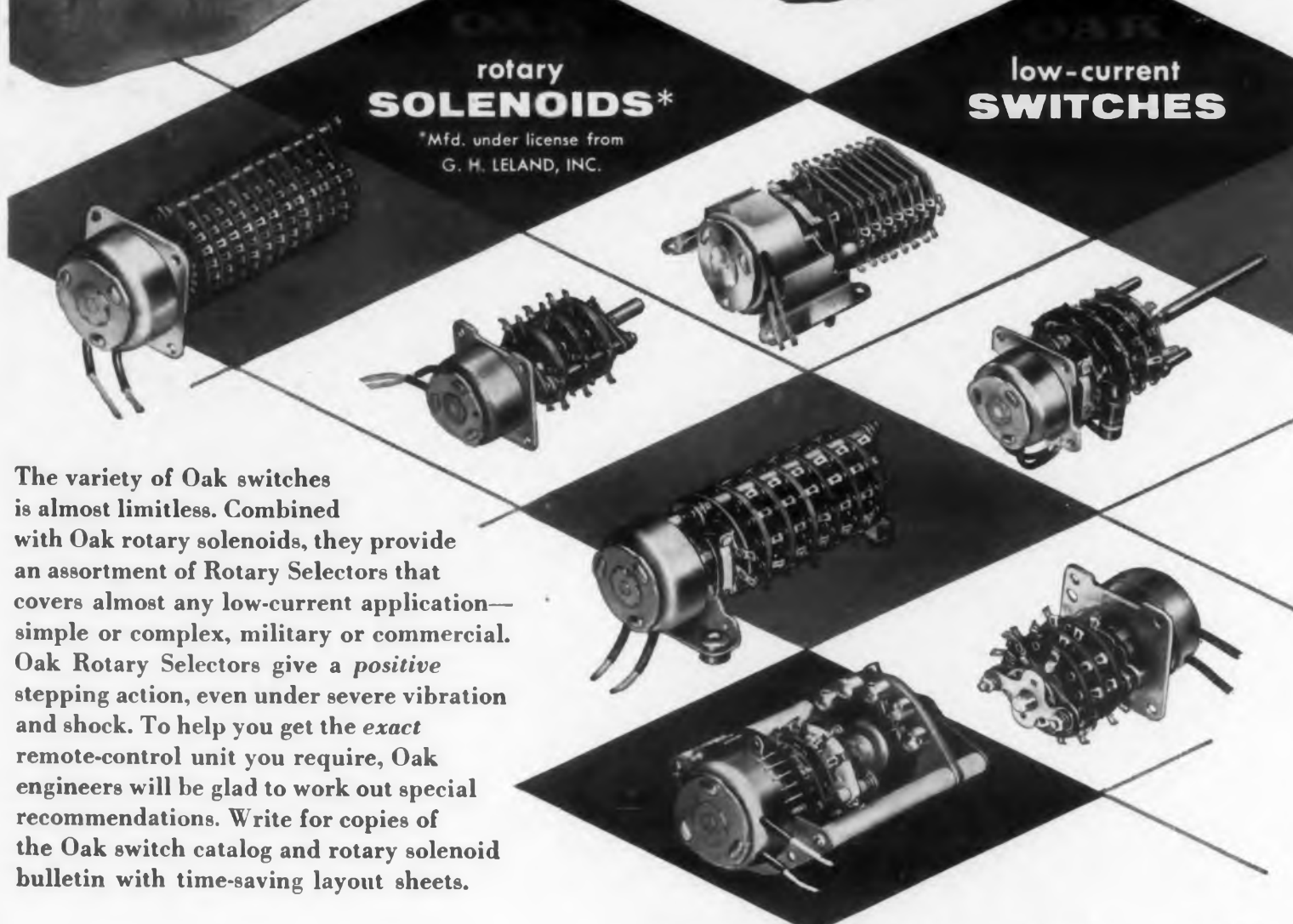
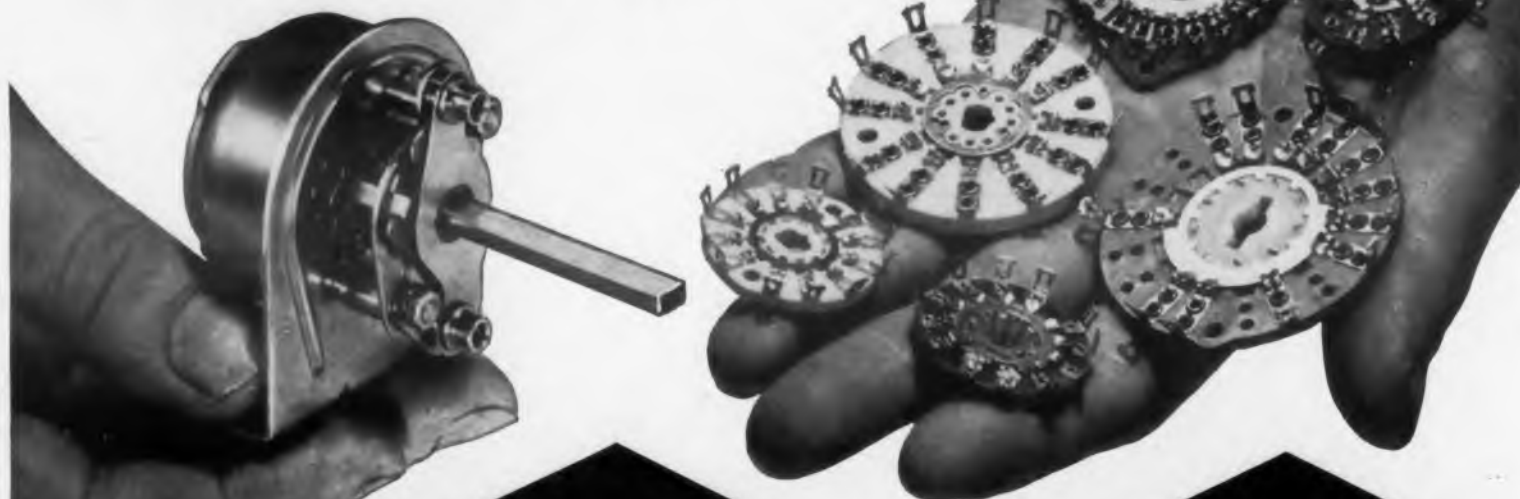
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REMOTE CONTROL SWITCHING



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SOLENOIDS*

*Mfd. under license from
G. H. LELAND, INC.

low-current
SWITCHES

The variety of Oak switches is almost limitless. Combined with Oak rotary solenoids, they provide an assortment of Rotary Selectors that covers almost any low-current application—simple or complex, military or commercial. Oak Rotary Selectors give a *positive* stepping action, even under severe vibration and shock. To help you get the *exact* remote-control unit you require, Oak engineers will be glad to work out special recommendations. Write for copies of the Oak switch catalog and rotary solenoid bulletin with time-saving layout sheets.

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Phone: MOhawk 4-2222

CIRCLE 78 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Remote Size and Position Indicator Accuracy of 1 Per Cent



Remote indication of position, size, tension, strain, thickness, and other quantities which can be related to minute displacement of a feeler probe, is accomplished with the Model 100 displacement transmitter used with the Model 300 displacement indicator. The system offers accuracy of 1 per cent of scale with three calibrated ranges of ± 0.1 , 0.01, and 0.001 in. full scale. Drift errors are virtually eliminated by a constant current excitation system, stabilized amplifier circuitry, and integral zero and gain checking features.

An auxiliary electrical output is available which is suitable for direct operation of standard strip chart recorders. A wheel attachment is available for continuous thickness measurements of moving material. Operating temperature range is -65 to $+200$ F.

Daytronic Corp., Dept. ED, 216 S. Main St., Dayton 2, Ohio.

CIRCLE 79 ON READER-SERVICE CARD FOR MORE INFORMATION



Voltage Regulator 400 Cycle, Single Phase

This automatic voltage regulator for 400 cycle, single phase service gives instantaneous correction of line voltage variations with 0.25 v bandwidth for line voltage variations and 0.35 v bandwidth for load current and load power factor changes. The unit is designed for an input of 95-130 v for nominal output voltage of 115 v, adjustable from 110-120 v and a load of 1.0 kva. It has a waveform distortion of 3.5 per cent max at 400 cycles. The power factor rating is from 0.7 lagging to 1.0. The size of the regulators is 7-3/4 x 5 x 14-3/8 in. including front panel handles.

The Superior Electric Co., Dept. ED, 83 Laurel St., Bristol, Conn.

CIRCLE 80 ON READER-SERVICE CARD FOR MORE INFORMATION

Step Input Unit

Plots Bar Graphs



Data plotting at any number of pre-set increments up to 999 steps along one axis is possible with the model 51 Step Input Unit. The unit provides means for producing bar-type graphs to any scale on standard or non-standard graph paper and visually displays by means of illuminated numbers the content of the mechanism at any point in a test series thus facilitating start and stop operations without losing track of position at any time. Calibration to any scale factor is possible by adjusting both size and number of steps to conform to the data being plotted. Zero may be set at any point.

F. L. Moseley Co, Dept. ED, 409 N. Fair Oaks Ave., Pasadena, Calif.

CIRCLE 81 ON READER-SERVICE CARD FOR MORE INFORMATION



Coaxial Turret Attenuators

30 db


Three new coaxial turret attenuators, Models 705, 706, and 707 offer twelve steps of attenuation in the uhf range from dc to 1500 mc. A single unit can give a maximum of 30 db. Two units can also be used in series to permit a wide range of control in small steps. Designed for either bench use without further mounting, or for mounting into a test equipment package, the turret attenuators are housed in a cast case which is provided with tapped mounting holes. All models use type BNC connectors and have twelve snap-in attenuator pads in a convenient turret arrangement. The units have a zero insertion loss position for use in applications where it is necessary to obtain the full output of the signal source into the load. This zero insertion loss position also provides a convenient point for calibration without physically removing the attenuator. A spring-loaded detent assures alignment of the pad selected. An engraved dial indicates the attenuation values.

Narda Corp., Dept. ED, 160 Herricks Rd., Mineola, N.Y.

CIRCLE 82 ON READER-SERVICE CARD FOR MORE INFORMATION

Cannon Electric reduces laminate rejections by 54%

Cannon Electric engineers tested many XXX-P laminates before they chose G-E Textolite 11570 for the insulators in their LK-A53 connectors. By using this laminate the percentage of rejections was reduced from approximately 55% to 1%. This insulator is the most difficult punching part at Cannon. The dimensions—1.998" in diameter, 1/8" thick, 49 holes .067" diameter and 4 holes .128 diameter. The report is superior punching with no cracking between holes, no delamination around holes, and no dimensional change in parts.

 **Textolite**[®]

11570

COLD PUNCH LAMINATE

General Electric Textolite 11570 is a XXX-P, high IR paper-base laminate that can be punched clean in a temperature range of 80° F. to 130° F. This cold fabricating quality, plus outstanding product uniformity, eliminates dimensional variations from piece to piece . . . permitting the use of automatic assembly techniques. The superior electrical and mechanical properties of G-E Textolite 11570 offer many design opportunities to both electrical and electronic manufacturers.

General Electric Co.
Laminated Products Dept.
Sec. EDL-77, Coshocton, Ohio

Please send me details of the Cannon Electric Company tests of G-E Textolite[®] 11570 laminate.

Please have your representative call.

Name _____

Title _____

Firm _____

Street _____

City _____ Zone _____ State _____

CIRCLE 83 ON READER-SERVICE CARD FOR MORE INFORMATION



Progress Is Our Most Important Product

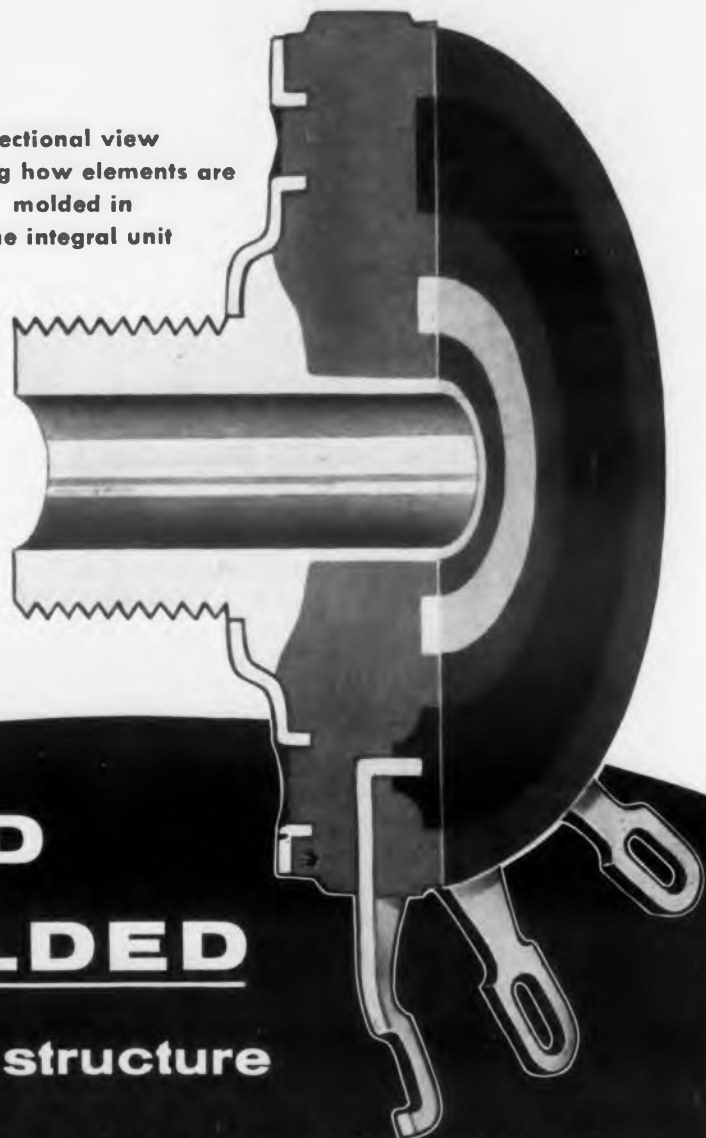
GENERAL  **ELECTRIC**

ALLEN-BRADLEY

QUALITY variable resistors

When successful circuit operation depends upon a variable resistor that is not affected by moisture, heat, cold, or age . . . the Allen-Bradley units are the answer. The solid "one piece" hot-molded structure has insulation, terminals, faceplate, and threaded bushing imbedded in the plastic body. With the resistance element as an integral part of the mold—not an added film or paint—it can be made to satisfy any resistance-rotation curve. Write for full details, today.

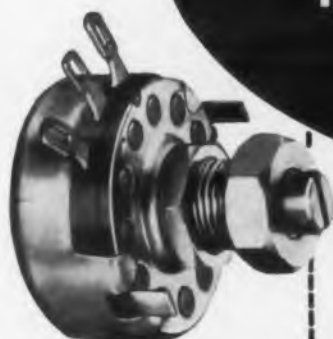
Sectional view
showing how elements are
molded in
one integral unit



**SOLID
HOT-MOLDED**

in one integral structure

for long life and low noise level



TYPE J—rated 2 watts at 70C ambient. Total resistance values from 50 ohms to 5 megohms. Available in single, dual, and triple units with various types of adjusting shafts, and with built-in line switch.



TYPE H—rated 5 watts at 40C ambient. Total resistance values from 50 ohms to 2.5 megohms. Good for over 100,000 cycles with no appreciable resistance change. Max. voltage 750 v, d-c.

TYPE T—rated 1/2 watt at 70C ambient. Plastic cover serves as actuator, making unit extremely flat. Total resistances from 100 ohms to 5 megohms.



TYPE F—rated 1/4 watt at 70C ambient. Diameter 1/2". Standard tapers. Slotted shaft. Designed for printed circuits.



TYPE G—rated 1/2 watt at 70C ambient. Diameter 1/2". Plain or lock-type bushings; plain or slotted shaft. Available with line switch (right).



Allen-Bradley Co., 1344 S. Second St.
Milwaukee 4, Wis.
In Canada:
Allen-Bradley Canada Ltd., Galt, Ont.

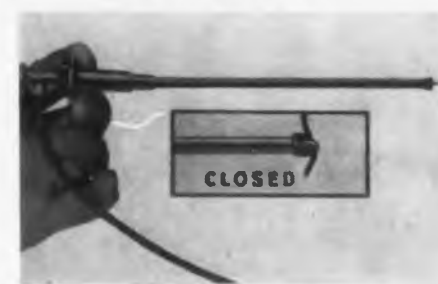
ALLEN-BRADLEY
RADIO, ELECTRONIC, AND TELEVISION COMPONENTS

QUALITY

CIRCLE 84 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Test Probe Grips Wires



The Gripprobe is a test probe of durable plastic for gripping terminals, tube sockets, lugs, and wires thus freeing the hands of the operator to handle other tools or test equipment. It features an interior spring mechanism which by pressing the thumb, opens the hook-shaped metal probe and, by removing the thumb, closes it in a self-lock grip.

Standard Electronics, Inc., Dept. ED, 5523 Satsuma Ave., Burbank, Calif.

CIRCLE 85 ON READER-SERVICE CARD FOR MORE INFORMATION

Brushless Converter 1 KVA - 10 KVA



Nobrush, a 40-pole, brushless, 400 cycle converter operates from standard 60 cycle supply. The unit employs a generator, direct coupled to 1200 rpm, 60-cycle synchronous motor. The generator is direct mounted on motor, making the unit two-bearing. With input variation up to 15 per cent, output for steady load, without regulator, will remain within 1 per cent. Any standard voltage, single or three phase, can be supplied. Three phase machines can be loaded asymmetrically, without impairment of performance. For unity power factor, voltage will depart no more than 2-1/2 per cent from slated value for any load within rating of machine. With correction of power factor to high leading value, voltage will hold within better than plus or minus 1 per cent. For other load conditions, or for closer regulation, regulator can be supplied, holding voltage within 1/2 per cent for all conditions of load. Units from 1 KVA to 10 KVA are available.

Georator Corp., Dept. ED, Manassas, Va.

CIRCLE 86 ON READER-SERVICE CARD FOR MORE INFORMATION

THE NATIONAL SCENE

Aircraft Safety Device

Monitors Critical
Temperatures

Model CTI-10D is powered and operated entirely by magnetic amplifier circuitry, monitoring up to 10 channels of temperature, simultaneously. Balance and sensitivity adjustment enable each channel to be set for any desired critical temperature range and trip point. This point may be set accurately to within 1 per cent of the operating range established. Units comprising a complete temperature-monitoring system are: indicator panel, for mounting in a convenient location clearly visible to pilot or flight engineer; balance and power unit; temperature probes; and interconnecting cabling. Power requirements are 105-125 v, 380-420 cps, 25 w. System accuracy is ± 1 per cent under specified environmental conditions. The warning panel measures 5-3/4 x 3 x 3 in.; the balance and power unit, 5-1/8 x 9-1/4 x 19 in.; the total system weighs 15 lbs. The device meets MIL-E-5272 for temperature, acceleration, vibration, altitude and humidity.

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

CIRCLE 87 ON READER-SERVICE CARD FOR MORE INFORMATION

Thyratron Xenon Filled

A Xenon filled, 18 amp dc thyatron provides quick starting and wide temperature limits. It is especially designed for motor speed control, resistance welder control, and incandenscent light control. Designated as the NL-5665/C16J, its ratings are: filament volts, 2.5; filament current, 31 amp; maximum peak inverse volts, 1250; maximum peak forward volts, 1000; average anode current, 18 amp; peak anode amp, 100 amp; anode current averaging time 4.5 sec; and filament heating time, 60 sec.

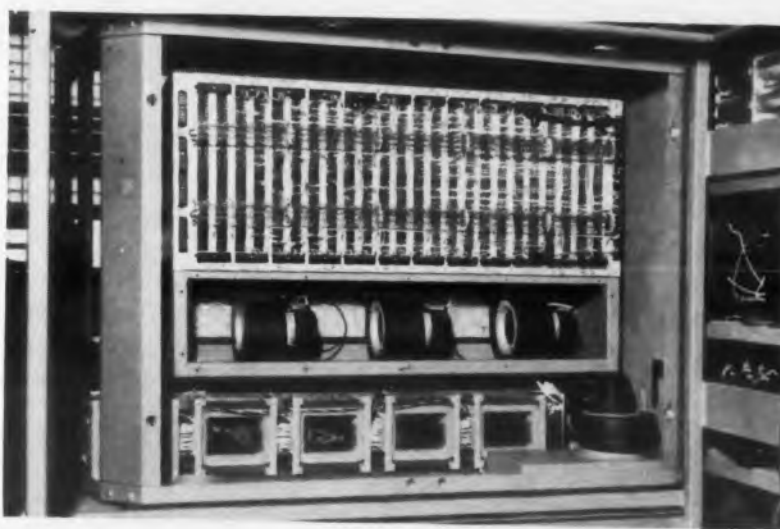
National Electronics Inc., Dept. ED, Geneva, Ill.

CIRCLE 88 ON READER-SERVICE CARD FOR MORE INFORMATION



KEEPING "ELECTRONIC BRAINS" FROM LOSS OF MEMORY. One of science's greater marvels is IBM's 705 Electronic Data Processing Machine—which makes intricate calculations and logical decisions in millionths of a second. Heart of this electronic "wizard" is its main magnetic core memory. Designed for use with the machine's high-speed printer is the IBM 760 Control and

Storage Unit containing its own core memory of 1,000 positions which allows central processing to continue in the 705 while other data are being printed. Helping the 760 remember what information is to be printed is a job for PHENOLITE® Laminated Plastic. PHENOLITE's unique combination of properties makes it ideal for this application.

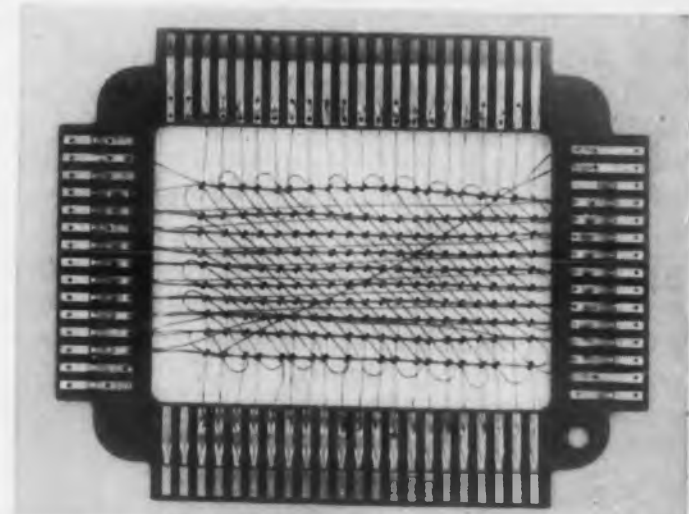


MOST ADVANCED FORM OF ELECTRONIC STORAGE. The 1,000-position core memory for the IBM 760 Control and Storage Unit—a portion of which is shown here—consists of pinhead size cores strung on copper-wired frames of PHENOLITE. Electrical impulses, passing through wires, alter the magnetic state of cores so that a group of them stands for a word or figure. Reversing the process recalls information from storage. PHENOLITE frames safeguard the circuit and permit stacking of core planes as shown.

NATIONAL CAN HELP YOU reduce unit product cost or improve product performance at no added cost. Here's why . . . You can select the "one best material" from over 100 grades of PHENOLITE, Vulcanized Fibre and National Nylon—without compromise in properties or cost. You can simplify production and purchasing with the timed delivery of 100% usable parts—from a single reliable source. You gain competitively with National's new materials and grades—the direct result of programmed materials-research.

You benefit by calling National first. Check Sweet's PD File 2b/Na, the Telephone Directory Yellow Pages, or write Wilmington 99, Delaware. Dept. E-7.

CIRCLE 89 ON READER-SERVICE CARD FOR MORE INFORMATION



PHENOLITE MEETS CRITICAL STANDARDS. Core frames like the one shown are punched out of laminated PHENOLITE by IBM. Each frame has printed circuit type terminal strips and soldered connections. PHENOLITE proves an ideal material for this application because it is mechanically strong and stiff, punches cleanly, etches well, remains flat, has high dielectric properties and withstands the heat of dip soldering.

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VULCANIZED FIBRE CO
WILMINGTON 99, DELAWARE

In Canada:
NATIONAL FIBRE CO. OF CANADA, LTD., Toronto 3, Ont.

New Products



Hexagon Nut Drivers
Miniature Sizes

Starting where normal size nut drives leave off and going down to the no. 00 hexagon nut, this set of nut drivers is available in sizes, measuring across the flats, of 5/64, 3/32, 7/32, 1/8, 5/32 and 3/16 in. Approximate overall length of the nut driver is 2-1/2 in. Drivers are available in sets containing their individual permanent plastic handles, and also in replaceable sets with a swivel type jewelers handle.

Hunter Tool, Dept. ED, Box 564, Whittier, Calif.

CIRCLE 90 ON READER-SERVICE CARD FOR MORE INFORMATION



Signal Generator
900-2100 Mc

The SHF Signal Generator (Model SG-161) operates over a frequency band from 900 to 2100 mc, with an accuracy of better than 1 per cent, providing signals for a variety of measurements on radar and communications receivers. It can be used to energize slotted lines for vswr measurements and to measure conversion gains of receiver front ends, while its low residual rf leakage makes possible overall receiver gain measurements at fractional microvolt levels. Either cw or pulse modulated output may be obtained and the output continuously varied between 0.2 and 200,000 mv into a 50 ohm load. The signal generator provides for a choice of either internally or externally generated pulses for modulation of Klystron oscillator tube. Circuits and controls are included for adjusting the repetition rates and width of pulsed rf signals when such signals are derived from the internal modulator. The internal modulator may be operated either free running or synchronized with pulse or sine wave signals from an external source. In addition to the rf output signal, the SG-161 also provides two separate output synchronizing signals for external use in synchronizing pulsed rf signals with external equipment.

Transitron, Inc. Div. of Van Norman Indus., Dept. ED, 186 Granite St., Manchester, N.H.

CIRCLE 91 ON READER-SERVICE CARD FOR MORE INFORMATION

MICROWAVE PROGRESS

At this time, in place of our usually scheduled scientific discussions, we'd like to introduce our specially skilled field representatives to you. These men are highly qualified engineers, capable and willing to sit down with you to discuss any microwave equipment problems you may have. They'll see to it that your problems are answered promptly and completely.

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3215 Western Avenue
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Murdock 8313

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Roseland, New Jersey
Digby 4-2997

835 Glenside Avenue
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Rocky Mountains

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Loveland, Colorado
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Twinbrook 3-1400

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Granite 1-7870

174 Grayton Road
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Atwater 5095

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PRD West Coast Sales Office

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We've expanded our production runs to fill the increasing demand for our catalog products. Delivery on these items can now be made within 30 days (at the outside) from receipt of order.

The listing on the opposite page is a partial rundown of the PRD items in stock and available for immediate delivery.

If you don't see the product you want, contact our Engineering Representative nearest you (see Microwave Progress column), or write directly to us.

P.S. We will always maintain the same high standards of product quality that started this increasing demand in the first place.

Be sure your name's on our mailing list for:

- PRD Catalog . . . complete descriptions and specifications on PRD's microwave equipment. NEW CATALOG COMING SOON!
- PRD Reports . . . internationally famous, authoritative professional papers that give practical information on virtually every aspect of microwave research and engineering.

CIRCLE 92 ON READER-SERVICE CARD FOR MORE INFORMATION

PRD MICROWAVE TEST EQUIPMENT READY FOR IMMEDIATE DELIVERY!



PRODUCT	PRD TYPE #	FREQUENCY RANGE (kmc/sec)
Waveguide Termination	116-A	8.2 to 12.4
Fixed Coaxial Attenuator	130 Series	2.0 to 10
Fixed Coaxial Attenuator	1100 Series	DC to 4.0
Coaxial Termination	145-A	0 to 4.0
Precision Dial-Gauge Attenuator	185-B	7.0 to 10.0
Precision Dial-Gauge Attenuator	192-A	26.5 to 40.0
Precision Dial-Gauge Attenuator	195-B	8.2 to 12.4
Shielded Uncalibrated Variable Attenuator	154-A	8.2 to 12.4
Precision Dial Attenuator	196-C	8.2 to 12.4
Precision Dial Attenuator	196-D	8.5 to 9.6
Variable Cutoff Attenuator	180-A	8.2 to 10
Precision Coaxial Slotted Section	200-C	1.0 to 4.0
Precision Coaxial Slotted Section	205-A	4.0 to 10.0
Precision Waveguide Slotted Section	201-A	3.95 to 5.85
Precision Waveguide Slotted Section	203-E	8.20 to 12.4
Precision Waveguide Slotted Section	212-A	26.5 to 40.0
Rotary Standing Wave Detector	219	100 to 1,000 mc/s
Broadband Probe	250-A	1.00 to 12.4
Standing Wave Amplifier	277	350 to 2500 cycles
Waveguide Slide Screw Tuners	303-A	8.2 to 12.4
Double Stub Tuner	306-A	2.0 to 10.0
E-H Tuner	313-A	18.0 to 26.5
Waveguide-to-Coaxial Adapter	354-B	8.2 to 12.4
Waveguide-to-Coaxial Adapter	356-A	5.4 to 8.2
Directional Coupler	401	7.05 to 10.0
Directional Coupler	402	8.5 to 9.6
E-Plane Bend	462	8.2 to 12.4
H-Plane Bend	463	8.2 to 12.4
Frequency Standard Multiplier	500	3.25 to 10,000 mc/s
Heterodyne Frequency Meter	504	100 to 10,000 mc/s
Precision Direct Reading Frequency Meter	559 Series	8.20 to 10.0
Precision Direct Reading Frequency Meter	570 Series	26.5 to 32.0
Calibrated Precision Frequency Meter	560-S1	2.7 to 3.7
Calibrated Precision Frequency Meter	583-D	2.4 to 3.7
Direct Reading Frequency Meter	585 Series	8.2 to 10.0
Tunable Crystal and Bolometer Mount	621-A	18.0 to 26.5
Bolometer	610-A	0 to 12.4
Coaxial Tunable Crystal and Bolometer Mount	612-A	1 to 10
Broadband Coaxial Bolometer Mount	627-A	0.5 to 10
Broadband Coaxial Bolometer Mount	628-A	0.5 to 10
Broadband Bolometer	631 Series	0.5 to 10
Waveguide Thermistor Mount	643-A	8.2 to 12.4
Waveguide Thermistor Mount	646	5.4 to 8.2
Universal Power Bridge	650-B	---
Shielded Tube Mount	702	8.50 to 9.66
Universal Klystron Power Supply	801-A	---
Klystron Power Supply	809	---
VHF-UHF Noise Generator	904	30 to 1000 mc/s

Polytechnic Research & Development Co., Inc.

202 Tillary Street • Brooklyn 1, N. Y. • Tel: UL 2-6800

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CIRCLE 92 ON READER-SERVICE CARD FOR MORE INFORMATION



Subminiature Relay
High Contact Rating

This subminiature relay has full 1/8 in. silver or palladium contacts, which handle 3 amps resistive load standard and 4 amp intermittent. The basic design incorporates a permanent magnet in an electro-magnetic circuit of high efficiency and performance. This arrangement provides the extra armature torques necessary to overcome high contact pressures and actuate large contacts. Relay is constructed with a balanced armature having no pivots, hinges or bearings.

Three types are available. Model M-1000A is a dc spdt relay with standard pull-in 1/2 w. Vibration resistance is 10 g to 2000 cps. Greater sensitivity can be achieved by derating the vibration resistance to 500 cps. The standard coil for 24 v operation has a 550 ohm resistance, with special coils available up to 10,000 ohms. Model M-1000AA has identical characteristics except that pull-in power is 2/3 w, and vibration resistance is 30 g to 500 cps and 20 g to 2000 cps. Model M-1000P is a two-position dc polarized relay for use as a versatile control element. This relay provides sensitivities from 15 mw to 500 mw, and 2 to 3 amp contact rating. Vibration resistance is 10 g's to 2000 cps with 500 mw models and 10 g to 500 cps with the more sensitive models. Coils are available to 10,000 ohms.

Luther Mfg. Co., Dept. ED, 7312 Varna Ave., No. Hollywood, Calif.

CIRCLE 93 ON READER-SERVICE CARD FOR MORE INFORMATION



Precision Gears
For Servo Systems

Spur, spring and clutch gears, and bevel and miter gears are among the types available, especially for servomechanism use. Presently in stock for immediate delivery are 48- and 64-pitch spur gears, in tooth multiples of 8 and 10, with 14-1/2 deg pressure angle, and minimum and maximum pitch diameters of 9/16 in. and 4 in. respectively. Stock gears have clump hubs with 1/4 in. bores.

Helipot Corp., Dept. ED, Newport Beach, Calif.

CIRCLE 94 ON READER-SERVICE CARD FOR MORE INFORMATION

**For high-quality
vacuum-tight seals at low
or high temperatures...**



**...specify Centralab
Metallized Ceramics**

Centralab offers you unmatched facilities and experience to produce fired or pressed-on metallized components for all your mechanical and electrical uses.

Steatite bodies with low-temperature seals or High Alumina components with special high-temperature alloy seals are available.

Properly matched metal-ceramic combinations facilitate brazing . . . prevent bake-out. And integrally formed metals and ceramics minimize destructive motion and vibration, maintain close tolerance, and provide excellent electrical characteristics.

Centralab offers you modern facilities and the services of ceramics specialists to help improve your product's efficiency.

Send your inquiry to Centralab today. And ask for Bulletin 42-221 showing complete facilities.

X-2658

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Discuss your special requirements with your Centralab representative

CIRCLE 95 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Floated Integrating Gyros Measuring 1 In. Diam



Known as series 101G, these gyros retain all of the precision construction of the larger series of the company's floated gyros, the 2-in. 201G and the 3-1/2-in. HIG-5. Measuring 1 in. in diam, the new gyros are fully floated to keep friction and uncertainty torques to low levels and to give the unit resistance to vibrational shock. Trimmed drift rates as low as 0.1 milliradians/sec can be expected. Both signal generator and torque generator are provided for use in closed-loop operation, and a range of impedances and sensitivities are available to meet specific requirements.

The unit is arranged in a flanged housing for easy mounting, with the input axis located by a notch in the flange. Power requirement is less than 1/3 w. Connections are made through 11 pin plugs at each end of the gyro. Total weight exclusive of connectors is 3-3/4 oz.

Reeves Instrument Corp., Dept. ED, 215 E. 91st St., New York 28, N.Y.

CIRCLE 96 ON READER-SERVICE CARD FOR MORE INFORMATION



Potentiometer Miniaturized Wirewound

Measuring 3/4 in. diam x 3/4 in. long, this 2 w precision wirewound potentiometer is composed of a one piece anodized aluminum housing securing a low loss phenolic terminal board and winding assembly. Shaft torque is 0.05 oz-in. standard, 0.02 oz-in. on special request. Independent linearity of 1 per cent is standard, better linearity can be provided. The precision potentiometer is available in a servo mounting, 75-M27, or threaded bushing, 75-M7, with a selection of shaft lengths.

Maurey Instrument Corp., Dept. ED, 7924 S. Exchange Ave., Chicago 17, Ill.

CIRCLE 97 ON READER-SERVICE CARD FOR MORE INFORMATION

GREATER VERSATILITY IN SUMMING ANGULAR POSITIONS. The Hollow Shaft design reduces bread-board and production costs by eliminating the need for stocking custom shaft lengths. Can be installed or removed without disassembly of differential or instrument. Small size, low inertia, high accuracy. Write for complete specifications.

Hollow Shaft Differential



Librascope Mechanical Computer Components



Sine-Cosine Mechanism

INSTANTANEOUS, ACCURATE ANGLE RESOLVER FOR ANALOG COMPUTERS. The Sine-Cosine Mechanism is a precision device that permits the conversion of angular motion into a linear displacement. This displacement is proportional to the sine or cosine of the angle of input rotation. It is designed to solve range, bearing and vector resolution computations. Its features include low friction, high accuracy, and simplicity of installation. Write for complete specifications.



LIBRASCOPE

Librascope, Inc.
808 Western Ave.
Glendale, Calif.

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CIRCLE 98 ON READER-SERVICE CARD
CIRCLE 99 ON READER-SERVICE CARD



PRINTED *Circuitry*

HOW PRINTED CIRCUITRY BECAME A MAJOR PRODUCT AT CRONAME

A few short years ago circuitry was confined to our research laboratories. NOW, EVERY DAY thousands and thousands of etched and plated circuits are produced at CRONAME for America's leading radio, television, electronic, instrument, automotive and appliance manufacturers. For over 50 years CRONAME has been accepted by industry as a superior source for decorative metal and glass parts, nameplates, grilles, control panels, bezels, escutcheons, jack covers, TV masks and assemblies. With the advent of Printed Circuitry, CRONAME'S vast experience in precision etching, plating, silk screening and lithographing on metal was called upon to lead the way for a new electronic era.

This experience has met the challenge. Our precision quality and service in the infant Printed Circuitry industry has brought an acceptance of our circuits exceeding many of our older products. Our new Printed Circuitry Division geared for volume production will share a major portion of our new facilities now under construction. Your acceptance of our products has made this expansion inevitable. We would like to help you improve your product now. Write for literature.



CRONAME
INCORPORATED

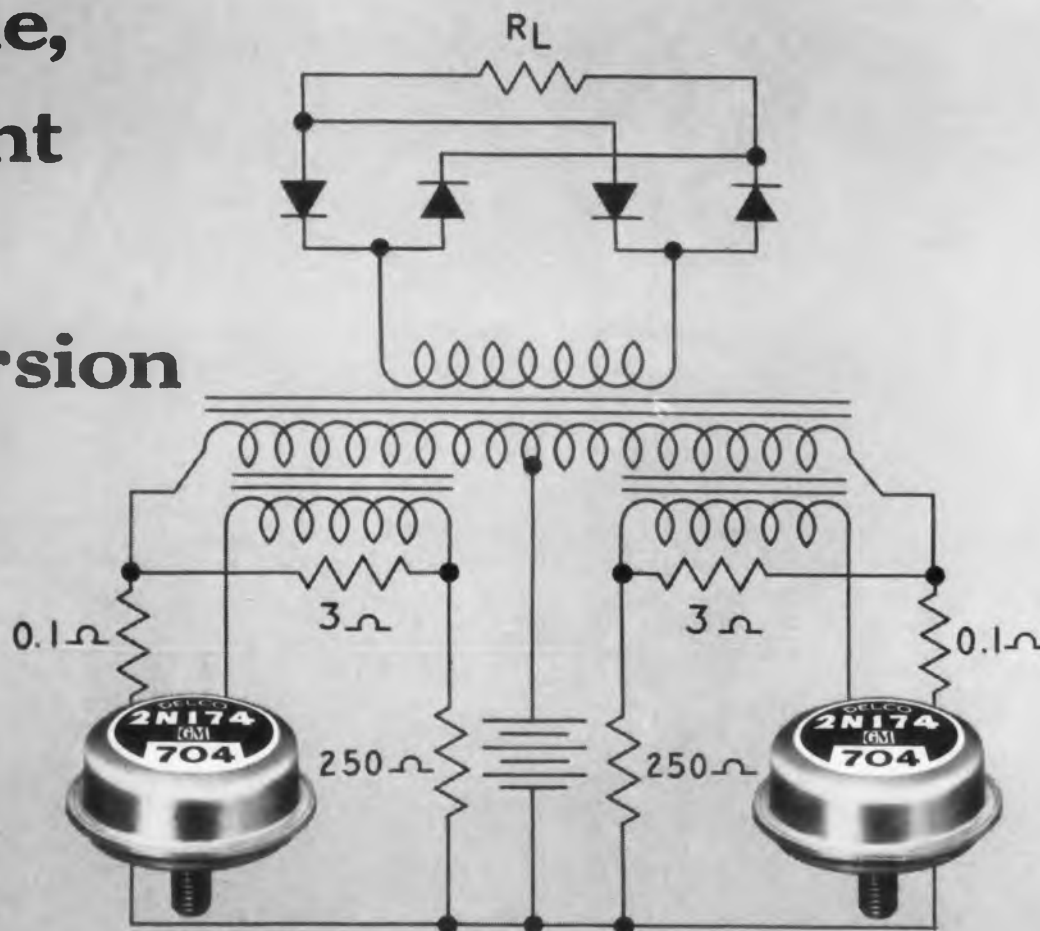
1741 GRACE STREET
CHICAGO 13, ILLINOIS



SEND FOR NEW PRINTED CIRCUITRY
TOLERANCE DATA SHEETS

Clip this to your Letterhead

Reliable, Efficient DC Conversion



Industry's Highest Power Transistors

Low saturation voltage of Delco Radio 2N173 and 2N174 opens new opportunities for converter economy, efficiency and reliability

The excellent electrical characteristics of Delco High Power transistors permit the conversion of *low* DC voltage to *higher* DC voltage—with a high degree of efficiency—in a wide range of applications. This proved performance offers greater reliability than will be found in corresponding vibrator circuits.

The low saturation voltage of Delco 2N173 and 2N174 transistors also reduces their internal power dissipation in conversion applications to an insignificant degree so that little self-heating is apparent. The result is an overall economy which permits converters of smaller size . . . important in many applications.

TYPICAL CHARACTERISTICS		
	2N173	2N174
Properties (25°C)	12 Volts	28 Volts
Maximum current	12	12
Maximum collector voltage	60	80
Saturation voltage (12 amp.)	0.7	0.7
Power gain (Class A, 10 watts)	38	38
Alpha cutoff frequency	0.4	0.4
Power dissipation	55	55
Thermal gradient from junction to mounting base	1.2°	1.2°
Distortion (Class A, 10 watts)	5%	5%

DELCO RADIO

DIVISION OF GENERAL MOTORS
KOKOMO, INDIANA

CIRCLE 100 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Explosion-Proof Cases For Airborne Equipment



This line of explosion-proof cases, to house airborne electronic equipment, is designed for use in an environment of explosive atmosphere. Flame and explosion arresting characteristics meet test procedure 2 of Military Specification MIL-E-5272A. Weighing about 10 per cent more than standard MIL-C-172B cases, these units fit shock mounting racks listed on military standard sheet MS91405 of the same specification. Thirteen case volumes are available.

Churchill Lighting Corp., Dept. ED, 344 Franklin St., Melrose 76, Mass.

CIRCLE 101 ON READER-SERVICE CARD FOR MORE INFORMATION



Oscillogram Reader For Data Reduction

This Oscillogram Reader reads opaque or translucent oscillograms, automatically correcting for nonlinearity in the record, and prepares data for recording by plotting, type-writing, tap-perforating, or card-punching devices. Either linear or non-linear calibration is possible without overlays. Curves may be quickly and accurately traced. Editing, notating, and reading are all possible over the entire area of the exposed record. X and Y motions are separately inhibitable. This equipment is incorporated into a desk-type console 54 in. wide and 59 in. high and constructed of walnut and formica panels on a metal frame. The 12 x 14 in. exposed reading area accommodates records 13 in. wide with a roll diam of 6 in. Other specifications include a 40-400 count per inch resolution, total travel \pm 999 counts, and accuracy calibrated to \pm 0.010.

Telecomputing Corp., Dept. ED, 16217 Lindbergh St., Van Nuys, Calif.

CIRCLE 102 ON READER-SERVICE CARD FOR MORE INFORMATION



Wire-Wound Resistors
Vitreous Enamel

These wire-wound axial-lead resistors offer compact size and are designed to withstand high temperatures. A vitreous enamel coating affords environmental protection. Standard tolerances are ± 5 per cent for 50 ohms and higher and ± 10 per cent for below 50 ohms. Power ratings are based on temperature rise of 300 C in free air with ambient temperature of 40 C. Available in 3, 5 and 10 w ratings for up to 50 K.

Hardwick Hindle Inc., Dept. ED, 40 Hermon St., Newark 5, N.J.

CIRCLE 103 ON READER-SERVICE CARD FOR MORE INFORMATION



Coaxial Switch
Direct Scope Measurements

This coaxial switch transforms an ordinary oscilloscope into an instrument that takes accurate, quantitative measurements, offering the simultaneous display of two channels or voltages on an oscilloscope. The high-speed switch unit utilizes two Clare "Mercury-Wetted" switch elements mounted in a coaxial circuit. The switching unit has a maximum current rating of 5 amp at 500 v and can be supplied for either 50 or 75 ohms with a vswr of less than 1.08 from 0 to 250 mc. The switching functions are controllable by circuitry at a 30, 15, or 10 cps rate, locked with the 60 cycle line. A phase reverse switch and a phasing control are provided for adjusting the phase in respect to the line. By switching rf energy up to 250 mc, it is possible to use one detector for the reference circuit, as well as for the unit being tested. This avoids the possibility of error caused by non-identical detectors. Suggested applications for the unit are: measurement of attenuation—0 to 250 mc; measurement of amplifier gain—0 to 250 mc; measurement of return loss (vswr); comparison of production unit with standard—up to 250 mc; general purpose oscilloscope switch; display of diode or transistor characteristics; square wave generator.

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

CIRCLE 104 ON READER-SERVICE CARD FOR MORE INFORMATION

MANY FACTORS CONTRIBUTE TO LOW INSTALLED COST OF SOUTHCO DRIVE RIVETS...

ECONOMICS OF FASTENING
COVERS FULL CYCLE
FROM INVENTORY
REQUIREMENTS TO
FINISHED PRODUCT

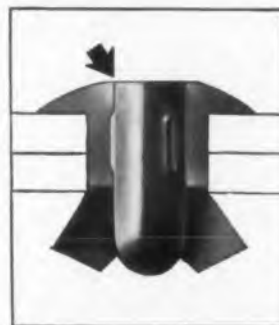
Designers who specify fasteners realize the many considerations that enter into cost determination. While ease of installation is often the most important feature, other factors affect costs. It may be difficult to put a dollar value on availability, for example, but serious financial losses do occur when production is held up or shipping dates are missed because of a slow fastener delivery. Being able to ship from stock, as Southco does, helps avoid production delays.

ELIMINATION OF SPECIAL TOOLS



Down time due to special tool failure and maintenance of special fastening tools are two fastening costs which are eliminated by Southco Drive Rivets. The only tool required is a hammer... any kind of a hammer... claw or ball, and size is not important. The number of men on a Southco riveting job is never limited by the number of special tools on hand and in working order.

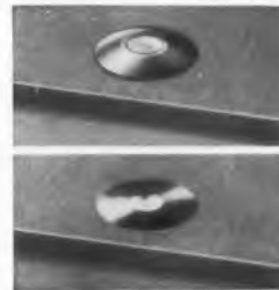
QUICKLY SET



To install, Southco Rivets are placed in drilled hole. The pin is then driven with a hammer. Installation is complete. No bucking is required.

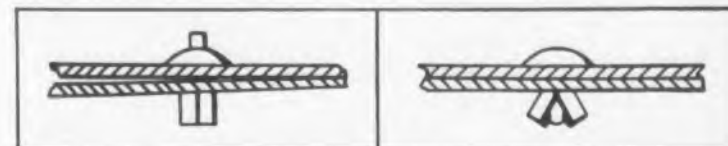
Expanded prongs force parts together. Pin is locked securely into rivet by displaced metal filling unique grooves. Compression forces are utilized for greater strength.

NO FINISHING OFF, NO WASTE



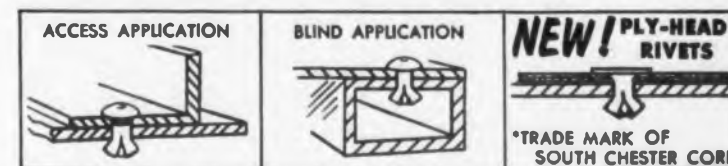
Impact of hammer seals pin neatly in rivet. No part of the rivet is cut off and discarded. No time-consuming filing, grinding or polishing is necessary. No scrap to clean up.

AUTOMATIC "PULL-UP" ACTION ASSURES TIGHT JOINT



Even when adjacent surfaces are separated, parts are forced together by Southco Rivet action, then held tightly in compression.

WIDE RANGE OF APPLICATION



Southco Drive Rivets are used to secure metal to metal or metal to wood. They are equally adaptable to blind or open applications. In each, they are quickly set and grip tightly. New PLY-HEAD* rivet permits higher loading of "soft" materials such as plywood, plastics and composition.

AVAILABLE IN ALUMINUM OR STEEL

Southco Rivets are supplied in aluminum or cadmium plated steel. The aluminum rivets have either cadmium plated or stainless steel grooved pins. The steel rivets have cadmium plated steel grooved pins.

Standard head designs are Universal or Countersunk. Full Brazier heads are available in popular sizes. New PLY-HEAD rivet rounds out line.

ALUMINUM

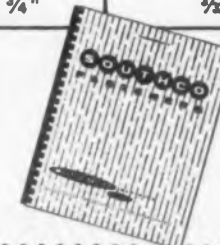
DIAMETERS	LENGTHS	NOMINAL GRIPS
1/8"	1/8" to 1/2"	1/2" to 1 1/2"
3/16"	3/16" to 3/4"	1/4" to 3/8"
1/4"	1/4" to 3/4"	1/2" to 3/8"
5/16"	5/16" to 3/4"	1/4" to 3/8"

STEEL

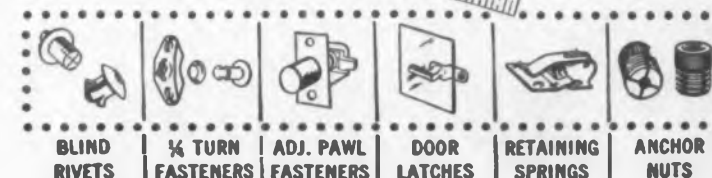
DIAMETERS	LENGTHS	NOMINAL GRIPS
1/8"	1/8" to 1/2"	1/2" to 1 1/2"
3/16"	1/4" to 3/4"	3/2" to 3/8"
1/4"	1/4" to 3/4"	3/2" to 3/8"

FREE FASTENER HANDBOOK... Send for your free copy of Fastener Handbook No. 7, just released. Gives complete engineering data on these and many other specialty fasteners. 52 pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 235 Industrial Highway, Lester, Pa.



SOUTHCO FASTENERS
©1957
LION



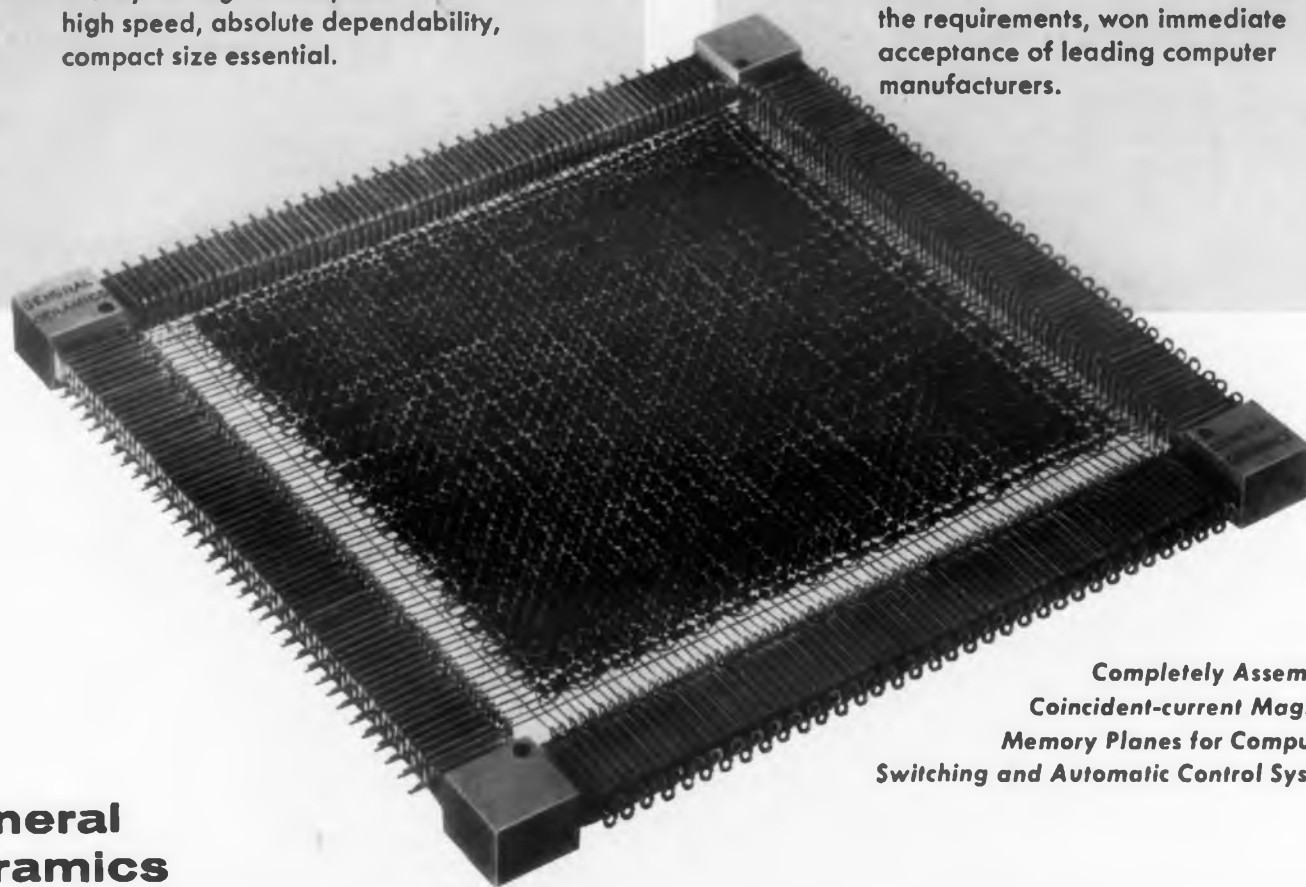
CIRCLE 105 ON READER-SERVICE CARD FOR MORE INFORMATION

PROBLEM:

Provide a reliable memory storage facility for digital computers . . . high speed, absolute dependability, compact size essential.

SOLUTION:

Magnetic Core Memory Planes by General Ceramics . . . far exceeded the requirements, won immediate acceptance of leading computer manufacturers.



Completely Assembled
Coincident-current Magnetic
Memory Planes for Computers,
Switching and Automatic Control Systems

**General
Ceramics**

FERRAMIC[®] MAGNETIC MEMORY PLANES

Utilizing Ferramic Magnetic Memories resulted in important increases in reliability, speed and accuracy in actual operation. In addition, designers found space requirements sharply reduced. Lower power consumption, lighter weight, elimination of heat dissipating devices and *greatly reduced* maintenance were other significant improvements.

General Ceramics Magnetic Memories offer a solution to similar problems in automatic control systems for conveyors, elevators, telephony, production machines, processing equipment and signalling. For further details, write General Ceramics Corporation, Keasbey, New Jersey. Please address inquiries to Dept. ED.

GENERAL CERAMICS

Industrial Ceramics for Industrial Progress... Since 1906



FERRAMIC CORES



FERRAMIC
MAGNETIC CORES



PRECISION STEATITES

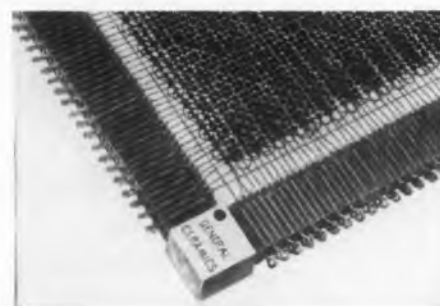


"ADVAC" HIGH
TEMPERATURE SEALS



SOLDERSEAL TERMINALS

CIRCLE 72 ON READER-SERVICE CARD FOR MORE INFORMATION



Completely assembled standard type memory frames available from stock. Memory Frames of special design can be produced to your specifications.

New Products

Digital Clock Time Source



This digital clock is a multiple output unit designed to serve as a time source for data loggers, data handling systems, computers, digital time displays and other applications where a digital representation of time is required. It also functions as a twenty-four hour program controller, providing a contact closure for every minute of the day. The output is a parallel, decimal contact closure pattern, based upon twenty-four hour time, i.e., 2:26 PM is represented as 14:26. As many as three completely independent parallel outputs can be supplied in one unit. Designed for 19 in. wide relay rack mounting, the digital clock requires 3 1/2 in. of panel height. The depth behind the panel is 12 in. Top and bottom covers are removable, permitting full access to all components. The clock utilizes printed circuit techniques for the digital circuitry; no stepping switches are used.

Supply voltage is 110-120 v, 60 cycle, as standard; other voltages and frequencies are available. Power consumption is 6 w continuous with peak power requirements of 200 w. Average power is about 7 w.

Chrono-Log Corp., Dept. ED, P.O. Box 4587, Philadelphia 31, Pa.

CIRCLE 73 ON READER-SERVICE CARD FOR MORE INFORMATION



Battery Eliminators 6 v or 12 v

The model "A" Battery Eliminator is designed for use with transistor or vibrator operated auto radio sets. It provides 6 v or 12 v dc output operation at negligible ripple current, featuring 8 position voltage control voltmeter, ammeter, and completely automatic operation.

American Television & Radio Co, Dept. ED, 300 E. 4th St., St. Paul, Minn.

CIRCLE 74 ON READER-SERVICE CARD FOR MORE INFORMATION



Delay Line
100 μ sec Delay

The model F-186 delay line has a delay of 100 μ sec with low attenuation and is tapped every 2 μ sec. At the full delay of 100 μ sec, the risetime is 5.5 μ sec and the attenuation is 1.4 db. The characteristic impedance is 2000 ohms. The unit comes in a hermetically sealed box with dimensions of 10-1/2 long x 4 wide and 6-3/8 in. high. Twenty-five tap terminals are brought out on each of the 10-1/2 x 6-3/8 in. sides for total of 50 taps. The delay line can be cascaded with additional units to provide longer delays. Four such units will provide a delay of 400 μ sec with a risetime of 17 μ sec and an attenuation of 6 db. The unit is provided with studs for mounting.

Control Electronics Co., Inc., Dept. ED, 1925 New York Ave., Huntington Station, N.Y.

CIRCLE 75 ON READER-SERVICE CARD FOR MORE INFORMATION



Phase Angle VTVM
Measures Phase and Magnitude

This VTVM includes a phase sensitive rectifier which can measure both magnitude and phase of a signal as well as perform other test functions. It permits measurement of 400 cps signal phase angles, $E \cos \theta$, $E \sin \theta$ and vector sum. Measurements are unaffected by quadrature. Total harmonic rejection can be obtained by optional filters in signal and/or reference channels. Factory modifications adapt the instrument to 60, 1000 cps and other frequencies. Major applications are phase sensitive null indication, testing synchros, servo-mechanisms, magnetic amplifier carrier amplifiers, notch networks and transducers.

As a conventional VTVM, measurements are 1 mv to 300 v full scale at frequencies of from 10 cps to 50 kc.

North Atlantic Indus., Dept. ED, Instrumentation Div., 603 Main St., Westbury, L.I., N.Y.

CIRCLE 76 ON READER-SERVICE CARD FOR MORE INFORMATION

Now! Simplify pulse-forming circuits with new Westinghouse **WL-6954**

Designed for:



Guided Missiles



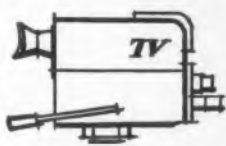
Airborne Communications



Radar

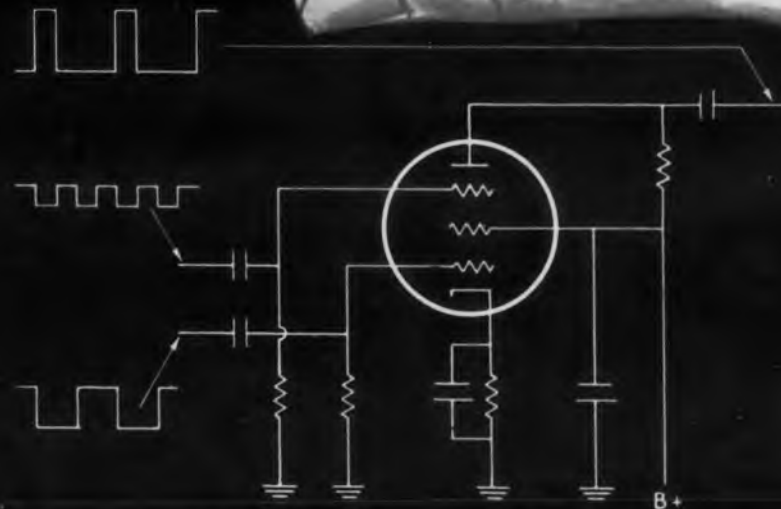


Test Equipment



Closed Circuit TV

GATING CIRCUIT
WITH TYPE WL-6954



NEW SHARP CUT-OFF DUAL-CONTROL PENTODE OFFERS EXCEPTIONALLY HIGH TRANSCONDUCTANCE

The new Westinghouse WL-6954 is a 7-pin miniature pentode designed for application in Military and Industrial equipment as a gating, coincidence, mixing or delay tube.

Built to high standards of reliability, it meets MIL-E-1C vibration test specifications. It permits simplification of pulse-forming circuits and has the advantage of high transconductance from Grid 3 to Plate.

The WL-6954 is available in production quantities

YOU CAN BE SURE...IF IT'S

Westinghouse

ELECTRONIC TUBE DIVISION • ELMIRA, N. Y.

CIRCLE 77 ON READER-SERVICE CARD FOR MORE INFORMATION

for immediate delivery. It's one more reason why—when you want highest quality tubes for Military or Industrial purposes—you'll find it wise to check Westinghouse.

SAMPLE ORDERS INVITED! IMMEDIATE DELIVERY.

CLIP AND MAIL COUPON

Commercial Eng. Dept., Electronic Tube Div.
Westinghouse Electric Corp., Elmira, N. Y.

Please send me complete data on your new
WL-6954 pentode.

NAME _____

COMPANY _____

ADDRESS _____

ED-5-1

new and unique!



**Eliminate
Breadboard Layout!
SPEED DESIGN OF TRANSISTOR CIRCUITS
With the SPRAGUE TRANSIMULATOR**

Bring transistor circuits to life in a matter of minutes with the Sprague LF-1 Transimulator. This new instrument lets you simulate any amplifier stage, a-c or direct-coupled, short of high power audio output; also multivibrator, switching, phasing, push-pull, Class A and B, and many others using cross-coupled Transimulators . . . whether the circuit is common or grounded emitter, base, or collector . . . whether the transistors are PNP, NPN, or Surface Barrier. You can simulate circuits stage-by-stage for cascade operation . . . or use a separate Transimulator for each stage to get simultaneous multi-stage operation.

Bring Circuit Diagrams To Life In Minutes

Everything you need for RC amplifier circuits is built right into the LF-1, including coupling capacitors . . . bias and load resistors . . . battery voltage supplies . . . Base Collector—Voltage Divider stabilization circuits . . . 5-way binding posts for transformer coupling and metering.

Whether you're designing audio circuits or switching circuits, you'll get a true picture of operating parameters minutes after you've drawn the circuit diagram . . . without wasting valuable time with breadboard and soldering gun.

Pays For Itself In A Matter Of Weeks

An ideal laboratory instrument, Transimulators are inexpensive enough to justify several on every bench. You can even use the LF-1 to test transistors *in the circuit* . . . the only real proof of design parameters. And a complete step-by-step instruction manual makes operation fast, simple, and easy.

CIRCLE 114 ON READER-SERVICE CARD FOR MORE INFORMATION

FEATURES OF THE LF-1 TRANSIMULATOR

- TRANSISTORS—PNP and NPN Junction, and Surface Barrier.
- CIRCUITS—Common or Grounded Emitter, Base, Collector.
- RANGE—Audio, up to 100 kc.
- TRANSISTOR POWER—Through medium power audio output.
- BATTERY SUPPLY—Separate bias and load. 1.5, 3, 4.5, 6 volts d-c. Polarity Reversing Switch.
- COUPLING—2 μ f and 20 μ f Direct, and Ext. C. posts, on both Input and Output.
- BIAS RESISTANCE—Up to 555,000 ohms continuously variable.
- LOAD RESISTANCE—Up to 277,500 ohms continuously variable.
- EMITTER RESISTANCE—Up to 2,500 ohms variable. Series resistor and bypass capacitor can be added.
- BASE COLLECTOR STABILITY—Up to 250,000 ohms variable. Series resistor and bypass capacitor can be added.
- VOLTAGE DIVIDER STABILITY—Up to 50,000 ohms variable.
- 5-WAY BINDING POSTS—For meters, transformer coupling, external supply voltage, degeneration, bypass, coupling, signal input and output, almost any connection required.

only **\$79.50**
NET

SPRAGUE[®]

SPRAGUE PRODUCTS COMPANY, NORTH ADAMS, MASSACHUSETTS

New Products

**Slide-Back VTVM
0.05 Per Cent Accuracy**



The TS-E6 is a slide-back VTVM which measures dc voltages in two ranges. The first range from 0.01 to 110 v, and the second range from 110 to 1100 v. An accuracy of 0.05 per cent is maintained on both ranges. The equipment operates equally well on 60 cps and 400 cps at 110 v ac. The maintenance and cycling time on the TS-E6 is held to a minimum because the meter contains a built-in standard cell for instant on-the-spot calibration. This unit contains no motor or stepper-switches that can burn out and complicate maintenance problems.

Accuracy of measurements is in no way dependent upon the deflection sensitivity of the meter movement, since it is a zero current operated device; the meter is used strictly as a null indicator.

George Vincent McMahon, Dept. ED, 381 W. 7th St., San Pedro, Calif.

CIRCLE 115 ON READER-SERVICE CARD FOR MORE INFORMATION



**Digital Tachometer
Accurate to 0.001 RPM**

Accuracy of this instrument is only limited by read-out method employed, and can be better than 0.001 rpm, with a scale of zero to 10,000 rpm. Output can be by sharp pulse or sine wave with signal set 1 to 100 per revolution. The tachometer is available with either single-ended or feed-through shafts, for mounting on drive pads.

Nacimco Products, Inc., Dept. ED, 2300 National Ave., National City, Calif.

CIRCLE 116 ON READER-SERVICE CARD FOR MORE INFORMATION

Video and Pulse Switch

Up to 4.5 Mc



This rotary switch, No. 5583, is designed for use at frequencies up to 4.5 mc, and is intended for video and pulse switching. The electrical characteristics of this switch call for DPDT operation of 10 separate circuits with very strict isolation requirements. The 10 rear decks of this switch are all completely isolated from each other by the use of sectional shielding and rf grounding fingers. Each of these 10 decks is also designed to eliminate capacitive or inductive coupling effects within each deck. The three front decks of this unit are used for switching filament voltages, line voltages and B plus voltages, etc. The entire switch is silver plated; all contacts and wipers are of coin-silver to minimize contact resistances. Overall dimensions are 4 1/2 x 3 x 22 in.

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

CIRCLE 117 ON READER-SERVICE CARD FOR MORE INFORMATION

Programmer Counter

Control of Test Limits



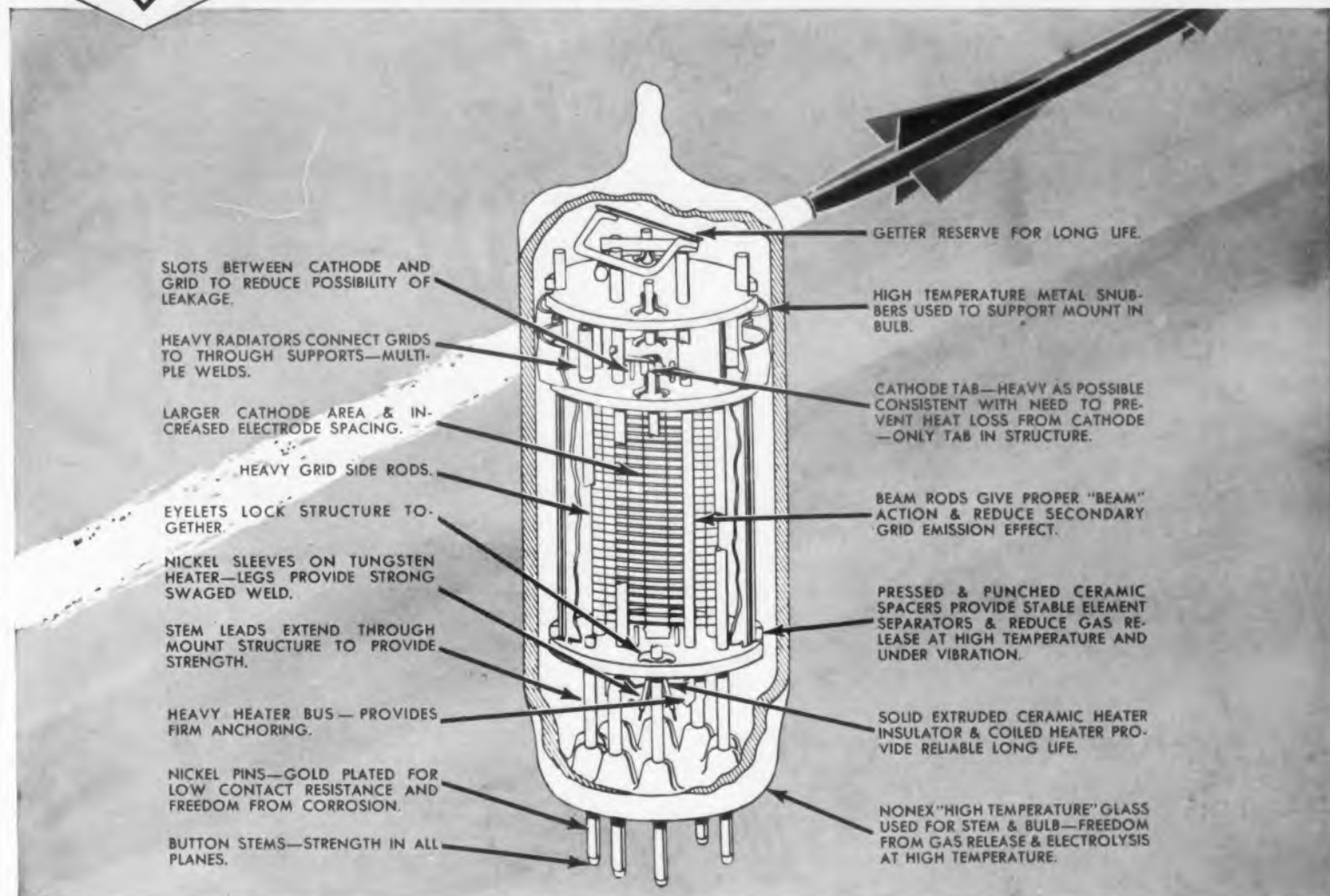
The Programmer Counter is used to turn on and off test apparatus whose limits are sensed by strain gages, thermocouples or any other transducers that have a maximum output not exceeding 100 mv dc. The unit eliminates the need for manual control of test cycling and simplifies the setting up of equipment each time a test is to be made. It is a precision, millivolt electronic relay having adjustable energizing and release thresholds and DPDT 15 amp contacts. Its two adjustable, stable thresholds provide for precise selection of upper and lower operating limits and a counter, which may be of the preset type, registers each cycle. The instrument operates on 110 v ac. Other models provide up to 5 sets of adjustable limits with automatic switching by preset counters. A signal of a flashing light or ringing bell can be supplied to indicate when the counter is registering.

Spar Eng. & Devel. Inc., Dept. ED, Wyncote, Pa.

CIRCLE 118 ON READER-SERVICE CARD FOR MORE INFORMATION



ELECTRON TUBES FOR SURVIVAL

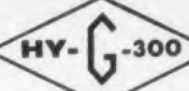


WHY BENDIX* HY-G-300 ELECTRON TUBES ARE BEST FOR EXTREME SHOCK, VIBRATION AND TEMPERATURES!

From the standpoint of design features (see above), these reliable hard glass tubes offer the superior quality needed to survive today's severe environmental demands. Specifically, Bendix HY-G-300's are designed to withstand the following environmental conditions—bulb temperatures up to 300° C; vibration up to 20G's over the range of 5-2000 cycles; and shock of 200G's having 20-millisecond duration.

For full information about the HY-G-300 line . . . the surest answer to electron tube applications in jet aircraft, missiles and rockets . . . write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY. *TRADEMARK

West Coast Sales and Service: 117 E. Providencia, Burbank, Calif. • Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. • Canadian Affiliate: Aviation Electric, Ltd., P. O. Box 6102, Montreal, Que.



TUBES ARE AVAILABLE FROM STOCK

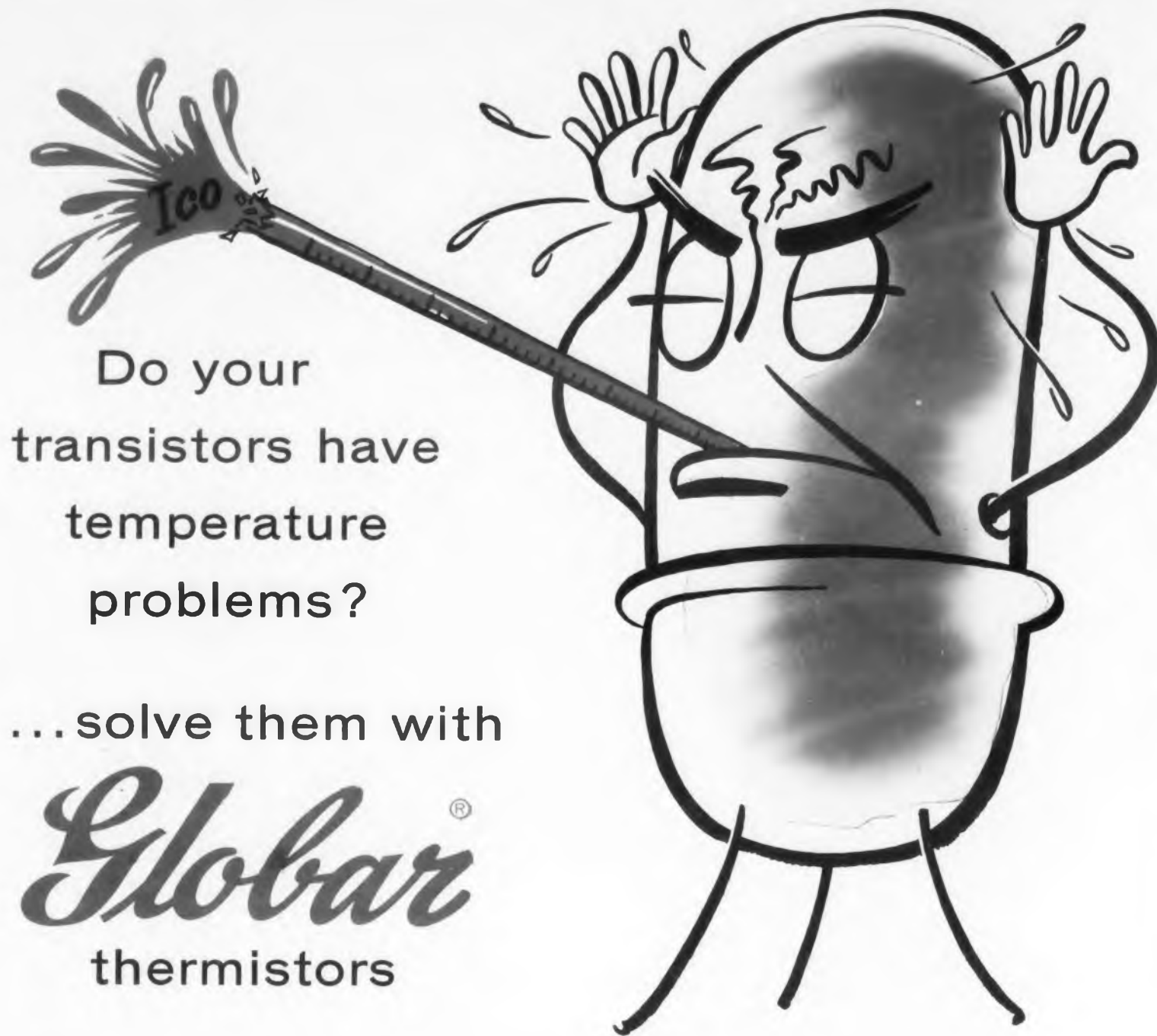
Bulb Size	DbI. Triodes Volt Amp.	R. F. Pentodes	Gate Pentodes	Rectifiers FullWave	Beam Power	Power Triodes Passing
T-12	—	—	—	—	—	6080WB 6082A
T-11	—	—	—	—	6384 6889	—
T-9	—	—	—	6853	—	—
T-6½	6851 6854 6900	6582A	6486A	6754	6094	6877 6900

Retma Type No.	Retrofit For	Generic Type	E _f	I _f	Bulb	Bendix Type No.
6080WB	6080 6080WA	6080	6.3	2.5	T-12	TE-46
6094	—	6A05- 6005	6.3	0.6	T-6½	TE-18
6853	6106 5Y3	5Y3	5.0	1.7	T-9	TE-45
6384	6AR6 6098	6AR6	6.3	1.2	T-11	TE-27
6854	6385	2C51 5670	6.3	0.5	T-6½	TE-47
6486A	6486	6AS6	6.3	0.25	T-6½	TE-43
6582A	6582	6AK5	6.3	0.25	T-6½	TE-44
6754	412A	—	6.3	1.0	T-6½	TE-36
6851	5751	—	6.3	0.5	T-6½	TE-42
6877	—	Half of 6080	6.3	0.8	T-6½	TE-48
6900	5687	5687	6.3	0.9	T-6½	TE-54
6889	—	—	6.3	1.2	T-11	TE-52
6082A	6082	6082	26.5	0.6	T-12	TE-55

Red Bank Division



CIRCLE 119 ON READER-SERVICE CARD FOR MORE INFORMATION



Do your
transistors have
temperature
problems?
...solve them with

Globar[®]
thermistors



Minimize Ico variation and prevent thermal runaway by using Globar thermistors. They are available in a wide range of resistance values and temperature coefficients to meet most transistor circuit requirements.

Globar Thermistor Test Kits are available for general evaluation in transistor circuits. If you have a specific transistor temperature problem, submit details to GLOBAR Division, The CARBORUNDUM Company, Dept. ED 87-711, Niagara Falls, New York. Ask for Technical Bulletin GR-3...describes physical and electrical characteristics of GLOBAR Thermistors.

Globar[®]

Ceramic Resistors

by **CARBORUNDUM**
REGISTERED TRADE MARK

Over 30 years' experience in the field of special ceramic resistance devices

CIRCLE 120 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Variable Power Supply 0.01 Voltage Variation



Model 700-A 1.5 amp power supply, features less than 500 mv ripple, less than 0.01 output voltage variation from no load to full load, and uses 5-1/4 in. of rack height. Voltage across the series tubes is kept constant by a secondary feedback loop, while the primary feedback loop controls the output voltage. Varying the line voltage, changing the load, or manually varying the output voltage does not affect the average series tube dissipation. As a result, the regulator does not lose regulation with a full 1.0 amp step change in load.

Harrison Labs. Inc., Dept. ED, Berkely Heights, N.J.

CIRCLE 121 ON READER-SERVICE CARD FOR MORE INFORMATION



Salt Spray Test Chamber

Lucite Construction

An All-Lucite test chamber is used for determining salt fog corrosion resistance of materials and components. The chamber, when connected to a low pressure air supply produces fine mist, and reaches test conditions within 15 min. Specimens to be tested are then suspended from Lucite hanger rods which are supplied with the chamber. Bulkier components can be placed on the bottom of the chamber supported by rods to avoid contact with the salt solution. The Lucite construction assures complete visibility from all angles of the test in progress. The unit is equipped with temperature controllers and indicators for both the chamber and the air saturation tower. Dimensions of the chamber are 20 x 20 x 20 in.

Assoc. Testing Labs., Dept. ED, 412 Clinton Road, Caldwell, N.J.

CIRCLE 122 ON READER-SERVICE CARD FOR MORE INFORMATION



Waveguide Switches Rotary Channel Type

This miniature waveguide switch provides switching of signals from any one of three positions to either of the remaining two and will not change to another position upon failure of its power supply. The characteristics of the 1 x 0.5 in. OD size switch include a frequency range of 8500 to 9600 mc with a maximum vswr of 1.10 and a minimum isolation of 40 db. The maximum switching time is 0.25 sec. for 240 deg operation and 0.15 sec. for 120 deg operation. It operates at 3 amp maximum at 28 v dc nominal and employs 20 lb of pressurization throughout. Available in Xs and X_L band series, Airtron switches are of the rotary channel type using a circular bend in the rotor and a broadband internal choke design. Other frequency bands and special designs can be supplied. The three position switch can be designed with the circular bends in the H plane on special order.

Airtron, Inc., Dept. ED, Linden, N.J.

CIRCLE 123 ON READER-SERVICE CARD FOR MORE INFORMATION

Packaged Filter & Blower Reduced Size



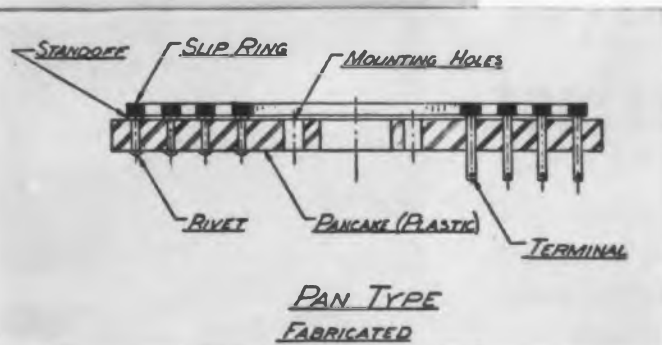
Packaged blowers are available in several sizes to utilize the minimum of valuable panel height in an electronic rack by designing the filter and blower section to protrude into the normally unused base section of the rack. The blower is normally the bottom component on a relay rack. Models 2P408 and 2Q408 require 5 1/4 in. of panel height but have the performance of Model 2E408 blower which is 7 in. high throughout, and will dissipate at 1.5 kw heat load with an air temperature rise of 10 C. A total of 25 models are available.

McLean Engineering Labs., Dept. ED, 70 Washington Rd., Princeton, N.J.

CIRCLE 124 ON READER-SERVICE CARD FOR MORE INFORMATION

NO. 1 of a Series of Data Sheets

General Purpose Slip Ring Assemblies are those which are used in relay, lighting and power supply circuits. These circuits are characterized by lack of sensitivity to external electrical influence induced by electro static or electro magnetic fields from other circuits. Another usual characteristic of these assemblies is their limited power-handling require-



ments. For higher current and power requirements, the rings are usually classified as power rings.

Design techniques have been developed for small size and light weight. These are drum type, pan type, and electro formed assemblies.

The drum type are brushed on the surface bounded by the outside diameter. Another drum type ring is brushed on the flat surface. In this instance the brushes project between the ring surfaces.

Pan type construction consists of a concentric, nested set of rings on one plane.

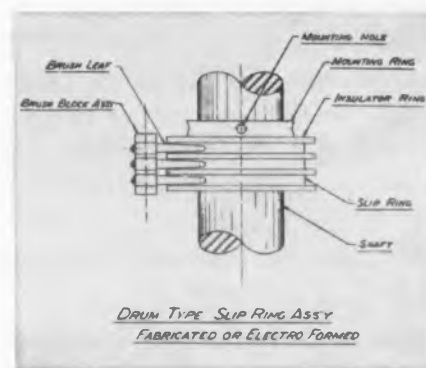
It is relatively easy to make electro formed rings of the first mentioned drum type and the pan type, and they perform well as general purpose rings. However, choice of materials is limited.

The fabricated type construction will be superior and will surpass all the usual requirements of general purpose rings over the electro formed construction for universal applications.

Fabricated ring stacks are metal rings separated by plastic laminate insulators. The plastic laminate should be treated with an insulating varnish to seal the machined edges against the entrance of moisture. The rings may be continuous and machined from plate stock or stamped from sheet. The standard hardness for the rings is 125 BHN minimum.

Brush contact materials for slip rings are usually sintered silver-graphite; the silver provides the low contact and brush resistance, and the graphite provides lubrication for long wear.

As the brush moves with respect to the ring, and with current flowing from brush to ring



(or vice versa), there are variations in current flow resulting from the imperfect contact between the moving elements of the circuit. Even for general purpose slip ring applications, this current variation is kept to a minimum by proper selection of compatible materials. The resistance variation seldom exceeds .005 ohms for double contacts on a ring. This is equivalent to about 1 ft. of #16 AWG copper wire.



General purpose rings are usually limited to slow rotating speeds, not more than 1,000 rpm or less than 1,000 feet/minute. If this speed is exceeded, the assembly is no longer considered a general purpose ring assembly, because special brush materials or even air cooling may become necessary.

Additional considerations for this type slip ring assembly come under the other type assemblies to be discussed at a future time.

MAKEPEACE complete staff of specialized design engineers are available to discuss your slip ring problems.

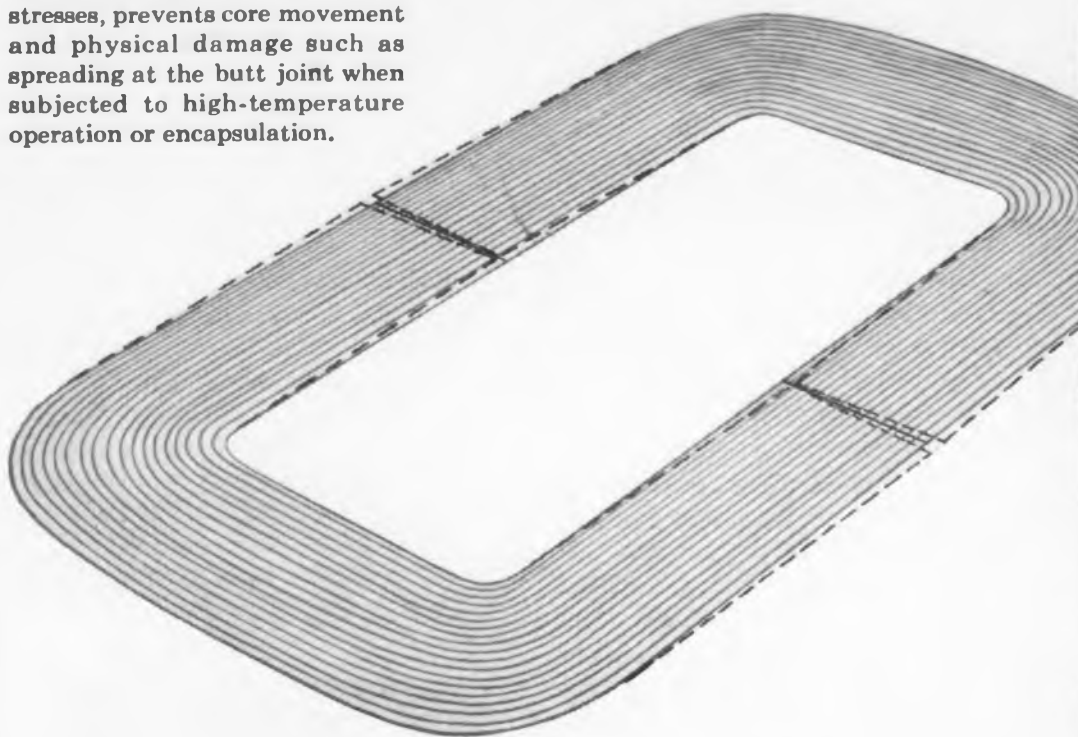
Makepeace SLIP RINGS

D. E. MAKEPEACE COMPANY Attleboro, Mass.

ENGELHARD INDUSTRIES

CIRCLE 125 ON READER-SERVICE CARD FOR MORE INFORMATION

"Normalizing" relieves internal stresses, prevents core movement and physical damage such as spreading at the butt joint when subjected to high-temperature operation or encapsulation.



"Normalizing" Hipersil® Cores holds magnetic values constant

Westinghouse has licked the bugaboo of heat in transformer treatment and operation. "Normalizing," a process exclusive with Hipersil cores, relieves internal stresses in the core structure.

Both exciting current and inductance "stay put" when a transformer is built around a "normalized" Hipersil core. Thus, magnetic values remain constant (within practical limits) even when the transformer is cast or encapsulated in high-temperature resin, or operated at high temperatures.

Electronics industry demands are ideally met with Hipersil cores. Smaller, lighter transformers result from such revolutionary core properties as oriented grain direction, with 100% coincidental flux; lowest possible core volume for high-temperature transformers; highest permeability, lowest loss; and 100% flux-carrying activity. These values, plus the extra magnetic stability added by "normalizing" make Hipersil the preferred core for more efficient, compact transformers . . . at lower cost.

Also available from Westinghouse: a complete line of both Hipermag* and Hipersil* cores for every electronic application.

For extra profits from your production, send for the *Type "C" Hipersil Core Design and Application Manual*. Write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. *Trade-Mark J-70799

YOU CAN BE SURE...IF IT'S
Westinghouse



CIRCLE 126 ON READER-SERVICE CARD FOR MORE INFORMATION



Both "normalized" and un-"normalized" cores record the same exciting current before encapsulation in high-temperature resin.



"Normalized" Hipersil core shows exciting current unchanged after encapsulation.



Un-"normalized" core, with the same applied voltage, records considerably higher exciting current after encapsulation.

New Products



Wiring Duct
Snap Slot

This plastic wiring duct, which requires no special fasteners, features a snap-in open slot design allowing wires to be installed in the duct with lugs already attached. The snap-in design eliminates operation of threading wire through duct holes. To insert a wire, the plastic finger separating the slots is pulled out, laid in the duct, and the finger released. A duct cover is snapped in place on the duct after wires are laid. The duct is also available in an overlapping closed-slot design which allows wire insertion over full length of the duct with no dead spots. Duct and cover are non-flammable dark grey vinyl plastic meeting J.I.C. specifications. Cutting is easily accomplished with snips or ordinary wood cutting tools.

Panduit Co. Dept. ED, 10132 S. Washtenaw Ave. Chicago 43, Ill.

CIRCLE 127 ON READER-SERVICE CARD FOR MORE INFORMATION



Miniature Magnetic Pickup
No Physical Contact

A magnetic pickup, Model 3055, provides minimum weight and size with a maximum voltage output. Weighing about 4 grams, the pickup is a sensitive transducer which translates the movement of ferrous objects, without physical contact, into measurable ac voltage. The output, proportionate to the rate of the object's movement, can indicate motion, torque, rpm and vibrations.

Heart of the pickup is an Alnico magnet which energizes a pole device surrounded by a coil of wire. The pickup creates an external magnetic field, which when interrupted or distorted by the movement of an external ferrous metal object, generates the ac voltage. Operable in temperatures up to 250 deg F., the pickup has a 7/8 in. overall length and 1/4 in. diam. Six inch output leads are provided. The mounting end of the pickup has been threaded to screw into a 1/4 in.-40 NFS tapped hole.

Electro Products Labs., Inc., Dept. ED, 4501 N. Ravenswood Ave., Chicago 40, Ill.

CIRCLE 128 ON READER-SERVICE CARD FOR MORE INFORMATION



Magnetic Potentiometer
0.5 Per Cent Linearity

A magnetic potentiometer for transmitter and/or receiver in servo systems. Directly interchangeable with many models of synchros for increased reliability, and offering infinite resolution. No electrical contacts, slip rings, etc. Output is linear with shaft rotation to better than 0.5 per cent. One to ten turn models are available in standard servo mountings from 0.937 in. and larger.

Instron Inc., Dept. ED, 722E, Gutierrez St., Santa Barbara, Calif.

CIRCLE 168 ON READER-SERVICE CARD FOR MORE INFORMATION



Sub-Miniature Terminals
Direct Assembly to Panels

The terminals, measuring 0.17 in. diam x 1/4 in. outside height x 1/16 in. inside height, have a Teflon coated outer insulator, and are available in either feed-through or turret head styles. They can be assembled directly to the panel, thereby allowing unlimited patterns and eliminating the necessity of soldering in headers.

Sphere Co. Inc., Dept. ED, Eagle Rock Bldg., 25 Amity St., Little Falls, N.J.

CIRCLE 169 ON READER-SERVICE CARD FOR MORE INFORMATION



Analog to Digital Converter
70 Counts per Sec

Model 100A has an accuracy of ± 1 count and readings as high as 70 per sec. Input is 0 to 130 v. Unit supplies power for external scale changing amplifier. It can be used as a counter, timer or an events per unit time instrument. Contains decimal point locator and both decimal and binary coded output. Four digit 0.01 per cent accuracy models are also available.

Electronic Computer Co., Dept. ED, 6191 Ridge Ave., Philadelphia 28, Pa.

CIRCLE 170 ON READER-SERVICE CARD FOR MORE INFORMATION

Regulated dc power supplies

with unique features that simplify and speed research

model 3-150B



FITS INTO SMALL AREA OF RELAY RACK

Size: 5 1/4" x 19" panel—9" depth.

Output: 0-300 V.D.C. continuously variable without switching. Current: 0-150 MA.

Regulation: 105-125 V. line: 0.15%; NL to FL: 100 MV change.

bulletin 1020

model 1K-500B



WIDE RANGE, HIGH PERFORMANCE

Output: 3-1000 V.D.C. continuously variable without switching.

Current: 0-500 MA.

Output current needs no derating throughout full range.

Regulation: 105-125 V. line: 400 MV change; NL to FL: 800 MV change.

bulletin 1021

model D3-300E



MANY POWER SUPPLIES IN A COMPACT PACKAGE

Outputs: 0-300 V.D.C. at 0-300 MA; 0-300 V.D.C. at 0-150 MA—both continuously variable without switching. Bias voltage 0 to -145/155 V.D.C. at 0-5 MA. Low ripple on D.C. outputs. 0-10 V.A.C.—controlled by Powerstat.

Size: 8 3/4" x 19" panel—17" depth.

bulletin 1022

model 5-300XA



150W... SMALL SIZE, WIDELY ADJUSTABLE

Output: 500 V.D.C. at 300 MA—adjustable by simple internal changes.

Regulation: 105-125 V. line: 0.5%; NL to FL:

Ripple: 0.1% change below 10 MV RMS for any rated voltage or load.

Size: W: 5"; L: 12 1/2"; H: 5 3/8" above deck.

bulletin 1017

model .6-1MB



FOR TRANSISTOR AND STRAIN GAUGE CIRCUITRY

Output: 0-60 V.D.C.; current: 0-1 amp. Provides full output current throughout entire range with no derating.

Regulation: 105-125 V. line: 0.1%; NL to FL: 20 MV change.

Recovery: NL to FL: 0.5 millisecond; FL to NL: 0.25 millisecond.

bulletin 1024

model .28-5MXR



28-V.D.C.—5 AMPS—REGULATED BY MAG. AMPL

You get the dependability and long life of a magnetic amplifier in this unit. Regulation— for 105-125 V. line: $\pm .25V$; NL to FL: $\pm 0.5V$. Size: 4" wide, 12 1/2" long, 7" high.

bulletin 1019

Each unit features simplified design, highest quality components, easy-to-trace wiring, and ample working room under the chassis. Components are derated to run cool and last longer. Write for literature on any or all models.

dressen-barnes

DRESSEN-BARNES CORP.
250 N. Vinado Avenue, Pasadena, Calif.

CIRCLE 171 ON READER-SERVICE CARD FOR MORE INFORMATION

Important News!... FROM TRANSISTOR CENTER, U.S.A.

NOW...a full selection of PHILCO Transistors

For Reliable Performance... Stability of Operation... Long Life!



ACTUAL
SIZE

MINIATURE LOW LEVEL AUDIO TRANSISTORS (25 mw)	
2N207	general purpose micro-miniature low level transistor, typical beta of 100, 15 db maximum noise figure
2N207A	10 db maximum noise figure version of 2N207
2N207B	5 db maximum noise figure version of 2N207
T0031	50 volt version of 2N207
Special versions of the 2N207 to selected beta ranges are available.	



ACTUAL
SIZE

HIGH FREQUENCY, HIGH GAIN (MICRO ALLOY) TRANSISTOR	
T1166	combines high frequency response with high gain for general purpose high frequency applications and switching circuits, typical f_{max} 60 mc
HIGH FREQUENCY SILICON TRANSISTORS (150 mw)	
T1025	general purpose, 10 mc silicon transistor
T1159	high speed silicon switch for speeds up to 5 mc characterized by extremely low switch resistance

HIGH FREQUENCY SURFACE BARRIER TRANSISTORS	
SB100	general purpose, minimum $f_{max} = 30$ mc, beta over 10.5
2N344/ SB101	general purpose, good beta control (11-33)
2N345/ SB102	general purpose, higher beta (25-110)
2N346/ SB103	general purpose, higher minimum f_{max} (60 mc)
2N128	general purpose, with military specifications, beta 19-66, minimum f_{max} 45 mc
2N129	general purpose, with military specifications, beta over 11.5
2N240	switching transistor, $f_{\alpha b} > 30$ mc
2N299	for tuned amplifiers, military specifications, 20 db minimum power gain at 10 mc, minimum f_{max} 90 mc
2N300	for video amplifiers, 50 mc minimum current gain bandwidth product, f_{max} over 85 mc
T1050	high frequency transistor for 50 mc oscillator mixers and 10-15 mc bandpass amplifiers, 22 db typical power gain at 10 mc Other types with special parameter controls are available.



ACTUAL
SIZE

MEDIUM POWER ALLOY JUNCTION AUDIO TRANSISTORS (100 mw)	
2N223	39-120 beta driver transistor
T1000	45-85 beta version of 2N223
T1001	70-120 beta version of 2N223
2N224	high gain output transistor, 2N225 is a matched pair
2N226	medium gain version of 2N224, 2N227 is a matched pair
Versions of the 2N224 with various beta ranges and higher betas are available singly or in matched pairs.	



AUDIO POWER TRANSISTORS	
T1040	40 volt, 7 watt power transistor, thermal drop 3°C/w maximum
T1041	40 volt, 10 watt power transistor, thermal drop 2.5°C/w maximum
T1167	60 volt, 12.5 watt power transistor
T1168	80 volt, 12.5 watt power transistor

Proven performance of Philco Hermetically Sealed Transistors has made them the basis for design in commercial and military applications where reliability is the major consideration. Philco transistors range from the world's smallest germanium transistors now in production to silicon transistors with excellent performance at temperatures from -60°C to $+150^{\circ}\text{C}$.

Philco produces a wide range of transistors designed for special applications in accordance with customer requirements. The Philco Micro-Alloy Transistor is in production. Specifications and design quantities are available. New and exciting transistor types, such as the Philco Micro-Alloy Graded Base Transistor, are now in development. In keeping with our policy, specifications will be made available as soon as these units reach pilot production and are available in design quantities.

Make Philco your prime source for complete transistor application information... write to Lansdale Tube Company, Dept. 1-2, Lansdale, Penna.

Regional offices—Merchandise Mart Plaza, Chicago 54, Ill.—10589 Santa Monica Blvd., Los Angeles 25, Calif.

New Products

Twin Triode Oscillator

470 to 890 Mc Use

The 3AF4-A is a medium-mu twin triode of the seven-pin miniature type designed especially for use as an oscillator in tuners of uhf television receivers, covering the frequency range from 470 to 890 mc. It is like the popular 6AF4-A but utilizes a 3.2 v/450 ma heater having controlled warm-up time. The 3AF4-A features a small mount structure with small elements to provide low interelectrode capacitances; short internal leads to reduce lead inductance and resistance; silver-plated base pins to minimize losses caused by skin effect at the ultra-high frequencies; and double base-pin connections for both plate and grid. The double connections are arranged so as to facilitate use of the 3AF4-A with either series of parallel resonant lines.

Radio Corporation of America, Dept. ED, Electron Tube Div., Harrison, N.J.

CIRCLE 132 ON READER-SERVICE CARD

Strain Gage Bridge

Operates Off Line Voltage

Indicators and recorders available in the 10 mv range work in well with the B-1 bridge without the need for further amplification. Because the B-1 operates off the line rather than batteries, there is power to drive higher resistance gages fully and thereby get increased sensitivity. The bridge handles SR-4 strain gages and similar transducers, and drives indicators, recorders, and oscilloscopes. Dc power on the bridge is regulated. One feature of the B-1 is the use of higher resistance internal bridge arms. These go in series with the external gages on the two arm connection, and thereby give practically double the output for the same gage current that would be obtained with the internal arm equal to the resistance of the external arm.

Ellis Associates, Dept. ED, Box 77, Pelham, N.Y.

CIRCLE 133 ON READER-SERVICE CARD

◀ CIRCLE 134 ON READER-SERVICE CARD

PHILCO CORPORATION

LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA

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Transistor Data Chart

REVISED 1967

General Purpose, Low Frequency

Manufacturer and Type	Class and Application	Maximum Ratings					β or α
		W_c (mw)	T_i (C)	(a)mw/C (b)C/mw	V_c (volts)	I_c (ma)	
Amperex Electronic Corp., Hicksville, N. Y.							
2N284	p-n-p, alloy, hi-current switch	167 ¹	75		32	250	45
2N284A	p-n-p, alloy, hi-current switch	167 ¹	75		60	250	45
OC63	p-n-p, alloy, hearing aid	50		1.54(a)	10	10	30
OC66	p-n-p, alloy, hearing aid	50		1.54(a)	10	10	47
2N109/2N217	p-n-p, alloy, audio driver, out.	125		2.5(a)	32	70	70
2N279	p-n-p, alloy, audio pre-amp.			2.5(a)	30	10	40
2N280	p-n-p, alloy, audio driver			2.5(a)	30	10	75
2N281/2N282 ²	p-n-p, alloy, audio output	167		3.33(a)	32	125	70
2N283	p-n-p, alloy, audio			2.5(a)	32	10	55
British Thomson-Houston Export Co., Ltd.							
Rugby, Warwickshire, England							
GT1	p-n-p, alloy	50	65 ⁴	1.25(a)	-9	-10	
GT2	p-n-p, alloy	50		1.25(a)			
GT3	p-n-p, alloy	50		1.25(a)			
GT11	p-n-p, alloy	25		0.75(a)			
GT12	p-n-p, alloy	25		0.75(a)			
GT13	p-n-p, alloy	25		0.75(a)			
CBS-Hytron, Lowell, Mass.							
2N180	p-n-p, alloy, gen. purp.	250 ⁵	75	3(a)	-30		60
2N181	p-n-p, alloy, gen. purp.	250	75	5(a)	-30		60
Fretco Inc., Pittsburgh, Pa.							
2N34	p-n-p, fused, lo-pwr., lo-freq.	50	30		-25	+8	0.98
2N35	n-p-n, fused, lo-pwr., lo-freq.				+25	-8	0.98
2N36	p-n-p, fused, lo-pwr., lo-freq.				-25	+8	45
2N37	p-n-p, fused, lo-pwr., lo-freq.						30
2N38	p-n-p, fused, lo-pwr., lo-freq.						15
General Electric Co., Syracuse, N. Y.							
2N43	p-n-p, fused, audio	150	100	2(a)	-20	50	50
2N43A	p-n-p, fused, audio						50
2N44	p-n-p, fused, audio						22
2N45	p-n-p, fused, audio						12
2N186	p-n-p, fused, audio out.	75	85	1.25(a)	-25	200	24
2N186A ⁶	p-n-p, fused, audio output	180	85	3(a)	-25	200	24
2N187 ⁶	p-n-p, fused, audio output	75		1.25(a)			36
2N187A ⁶	p-n-p, fused, audio output	180		3(a)			36
2N188 ⁶	p-n-p, fused, audio output	75		1.25(a)			54
2N188A ⁶	p-n-p, fused, audio output	180		3(a)			54
2N189	p-n-p, fused, audio driver	75	85	1.25(a)	-25	50	24
2N190	p-n-p, fused, audio driver						36
2N191	p-n-p, fused, audio driver						54
2N192	p-n-p, fused, audio driver						75
2N241	p-n-p, audio	100		3(a)		200	73
2N241A	p-n-p, audio	180	85	3(a)	-25	200	73
2N265	p-n-p, alloy, audio	75		1.25(a)	-25	50	110
2N319	p-n-p, audio	200			-20	200	36
2N320	p-n-p, audio	200	85		-20	200	54
2N321	p-n-p, audio	200	85		-20	200	73
2N322	p-n-p, audio	75	85		-16	50	36
2N323	p-n-p, audio	75			-16		54
4JD1A17	p-n-p, fused, audio	150			-20		40
2N324	p-n-p, audio	75			-16		75
General Electric Co., Ltd.,							
London, England							
GET3	p-n-p, alloy, audio	150 ⁸	55	5(a)	-12	-50	50
GET4	p-n-p, alloy, audio				-30		
GET6	p-n-p, alloy, audio				-12		
GET5	p-n-p, alloy, audio	200			-30	350	40
GET10	p-n-p, alloy, switch	250			-40	500	15
GET15	p-n-p, alloy, audio	200			-15	350	40

A Survey of Transistor Characteristics

Characteristics

I_{co} (μa)	NF (db)	C_c ($\mu\mu f$)	f_{co} (Mc)
4.5	15		0.35
4.5	15		0.35
5	9		0.45
5	9		0.47
4.5	15		0.35
5	10		0.3
4.5	8		0.3
4.5	15		0.35
2	4		0.5
-5	12		0.8 ³
	12		0.9
	12		1
			4
			6
			9
10	12	25	0.6
10	12	25	0.6
-12	50		0.27kc
	50		
	40		
15	22	40	1.0
	10		
	22		
	22		
16	15	35	0.8
16	15	35	0.8
	10	35	1.0
	10	35	1.0
	10	25	1.2
		35	1.2
16	15	35	0.8
			1.0
			1.2
			1.5
			1.3
16		35	1.3
			1.3
			3
16		35	3
16		35	3
16		35	3
16		35	3
		40	1
		35	3
67	9	60	1.5
	9		
	6		
		42	1.3
		65	1.0

IN THE past eight years since the discovery of transistors at the Bell Telephone Laboratories, great strides have been made in raw material handling and transistor production techniques. This survey of the present state of junction transistor technology is a digest of many reports present in the literature.

Available Gain Per Stage

The amplification from a transistor depends upon the configuration in which it is operated. The transistor may be used as a voltage gain device (grounded base), as a current gain device (grounded collector), or as a power gain device (grounded emitter). These gains per stage, neglecting interstage loss, are approximately as follows:

grounded base	30 db
grounded collector	20 db
grounded emitter	40 db

The grounded base configuration is essentially a voltage gain device; the grounded collector configuration is a current gain device; while the grounded emitter configuration must be considered a power gain device.

The input and output impedance of the three configurations are radically different and may therefore be used for impedance matching. The order of magnitude of these impedances are listed in Fig. 1.

These impedances vary with the termination at the other end and may be varied over approximately an order of magnitude. The impedance levels may also be adjusted with the proper use of feedback.¹ An unbypassed emitter resistor in the grounded emitter configuration will increase both input and output impedances. A feedback path from collector to base in this configuration will de-

¹Riddle, R. L., "Hybrid Parameters for Grounded Emitter Amplifiers with Feedback," Electronic Design, April 1, 1956.

1. With heat sink at 25 C.
2. Matched pair of 2N281's.
3. Grounded base.
4. Storage.
5. With heat sink.
6. Matching not required for class B push-pull.
7. At $V_c = 6$ v.
8. At 25 C.

General Purpose, Low Frequency (cont.)

R. L. Riddle

Haller, Raymond and Brown, Inc.
State College, Penn.

crease both input and output impedances. A combination of these forms of feedback may be used for impedance stabilization.

Frequency Response

There are two effects in a transistor which tend to limit the upper frequency response. They are the transit time of minority carriers across the base region, and the capacity of the collector junction. The capacity of the collector junction is similar to the plate capacity of vacuum tubes and may be compensated for to a certain extent by external circuitry. The transit time for minority carriers across the base region is similar to the transit time for electrons from cathode to plate in a vacuum tube. External circuitry can do little to help the situation and a different design of the transistor is required to improve the frequency response.

There are many designs which tend to extend the upper frequency at which amplification may occur. These are listed below with their approximate upper cutoff frequencies, f_{cb} .

Conventional n-p-n or p-n-p:	5 to 10 mc
N-p-n or p-n-p with very thin base regions:	50 mc
Surface barrier transistor:	200 mc
Double base transistor:	200 mc
Diffused base transistor:	1000 mc

Power and frequency response seem to be inversely related. Plotting frequency versus power handling (see Fig. 2) reveals approximately a straight line relationship. The low frequency re-

1. Maximum.
2. Matched pair of 2N224's.
3. Matched pair of 2N226's.
4. C_{cb}
5. Maximum at 12 v, 2N223 at 9 v.
6. $V_{cb} = 30$ v, $T_j = 30$ C.
7. Junction to case.
8. Matched pair.
9. Sensitivity 0.3 A/lumen.
10. Grounded base.
11. $V_c = 4.5$ v.
12. Same type, flexible leads.
13. Military type.
14. Current transfer ratio, common emitter.
15. Large signal.
16. At -12 V_{cb} , common emitter.
17. C_{bc}
18. Common base.
19. At -25 V_{cb} .
20. Common base circuit.
21. All data referred to common emitter circuit.



Manufacturer and Type	Class and Application	Maximum Ratings					Characteristics			
		W_c (mw)	T_j (C)	(a)mw/C (b)C/mw	V_c (volts)	I_c (ma)	β or α	f_{co} (μ a)	NF (db)	C_c (μ mf)
General Transistor Corp., Jamaica, N. Y.										
GT14	p-n-p, alloy, audio	125	85		25	100	28 ²¹	6	16	
GT20	p-n-p, alloy, audio						42 ²¹		16	
GT34	p-n-p, alloy, audio						15 ²¹		16	
GT74	p-n-p, alloy, audio						75 ²¹		<12	
GT75	p-n-p, alloy, audio						150 ²¹		<12	
GT81	p-n-p, alloy, audio	125	85		25	100	75 ²¹	6	16	
GT81HS	p-n-p, alloy, audio	150					120 ²¹			
GT82	p-n-p, alloy, audio	125					150 ²¹			
GT109	p-n-p, alloy, audio						120 ²¹			
GT222	p-n-p, alloy, audio				12		120 ²¹		30	
GT14H	p-n-p, alloy, hearing aid	90	75		12	50	28 ²¹	6	12	
GT20H	p-n-p, alloy, hearing aid						42 ²¹	6	12	
GT81H	p-n-p, alloy, hearing aid						80 ²¹	6	12	
GT210H	p-n-p, alloy, hearing aid						250 ²¹	<25	>29	
GT35	n-p-n, alloy, audio	100	75		25	100	40 ²¹	12	16	
2N43A ¹³	p-n-p, alloy	150	85		45	50	65 ²¹	10	<20	>0.4
2N44 ¹³	p-n-p, alloy	150	85		45	50	32 ²¹	15	<33	>0.4
Intelelex Systems Inc., New York, N. Y.										
TS1	p-n-p, alloy, low freq.	50			1.5	2	>10	10	15	0.5
TS2	p-n-p, alloy, low freq.						>30			
TS3	p-n-p, alloy, low freq.						>50			
TJ1	p-n-p, alloy, low freq.	200					10		25	
TJ2	p-n-p, alloy, low freq.						>30		25	
TJ3	p-n-p, alloy, low freq.									
Lansdale Tube Co., Div. Philco Corp., Lansdale, Pa.										
2N207	p-n-p, alloy, low pwr. audio	50	65	0.8(b)	-12	-20	100	15 ¹	5	2
2N207A	p-n-p, alloy, low pwr. audio							10 ¹	2	
2N207B	p-n-p, alloy, low pwr. audio							10 ¹		
2N223	p-n-p, alloy, audio driver	100	65	0.12(b)	-18	-150	95	20 ⁵	10	90 ⁴ 0.8
2N224, 2N225 ²	p-n-p, alloy, audio output	150	75		-25			25 ⁵		125 ⁴ 0.5
2N226, 2N227 ³	p-n-p, alloy, audio output	100	65		-25			25 ⁵		140 ⁴ 0.4
Motorola, Inc., Semiconductor Product Div., Phoenix, Arizona										
MN13A	p-n-p, fused, aud. driv., sw.	350	90	14.3(a) ⁷	40	150	15	30 ⁴	32	0.01
MN13B	p-n-p, fused, aud. driv., sw.									
MN13C	p-n-p, fused, aud. driv., sw.									
Mullard (International Electronic Corp.), New York, N. Y.										
OC70	p-n-p, alloy, audio	25	45	0.4(b)	10	10	30	5	10	10
OC71	p-n-p, alloy, audio	25	45	0.4(b)	10	10	50	4.5	10	10
OC72 ¹	p-n-p, alloy, audio	100	75	0.3(b)	16	125	55	4.5	15	12
OC73	p-n-p, alloy, audio	25	65	0.4(b)	30	10	40	4.5	10	10
OC76	p-n-p, alloy, converters	50	65		30	125				
OCP71	p-n-p, alloy, photo ⁹	25	55		25	10				
Pye Indust. Electronics, Ltd., Newmarket, England										
V10/15A	p-n-p, alloy, audio	100	75	2(a)	-10	-30	20	10 ¹¹	16	0.6 ¹⁰
V10/30A	p-n-p, alloy, audio						40			0.7 ¹⁰
V10/50B	p-n-p, alloy, audio						75			1.2 ¹⁰
RCA, Somerville, N. J.										
2N77	p-n-p, alloy, audio	35	85		-25	-15	55 ¹⁴	-10 ¹⁶	6.5	40 ¹⁷ 0.7 ²⁰
2N104/2N215 ¹²	p-n-p, alloy, audio			2.5(a)	-30	-50	44 ¹⁴	-10 ¹⁶	12	36 ¹⁷ 0.7 ²⁰
2N105	p-n-p, alloy, audio				-25	-15	55 ¹⁴	-5 ¹⁶	16.5	27 ¹⁷ 0.75 ²⁰
2N109/2N217 ¹²	p-n-p, alloy, lge. sig. audio	50			-25	-70	70 ^{14, 15}	-10 ¹⁶		
2N175/2N220	p-n-p, alloy, class A, low noise	20			-10	-2		-12 ¹⁹	6	36 ¹⁷ 0.85 ²⁰
2N206 ¹³	p-n-p, alloy, class A	75		3.3(a)	-30	-50		-10 ¹⁶	9	35 ¹⁷ 0.78 ²⁰
2N270	p-n-p, alloy, lge. sig. audio	150			-25	-150	70 ^{14, 15}	-10 ¹⁶		

General Purpose, Low Frequency (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings					Characteristics				
		W_c (mw)	T_j (C)	(a)mw/C (b)C/mw	V_c (volts)	I_c (ma)	β or α	I_{co} (μa)	NF (db)	C_c ($\mu\mu f$)	f_{co} (Mc)
Raytheon Mfg. Co., Newton, Mass.											
2N63	p-n-p, fused, audio, low rf.	100	85		-22	-10	22	6	15		
2N64	p-n-p, fused, audio, low rf.				-15		45		13		
2N65	p-n-p, fused, audio, low rf.				-12		90		11		
2N106	p-n-p, fused, audio, low rf.				-6		45		4.5		
2N130	p-n-p, fused, audio, rf.	120			-22		22		15		
2N131	p-n-p, fused, audio, rf.	120	85		-15	-10	45	6	13		
2N132	p-n-p, fused, audio, rf.				-12		90		11		
2N133	p-n-p, fused, audio, low-noise				-15		45		4.5		
2N130A	p-n-p, fused, audio, rf.	100			-22		22		15		
2N131A	p-n-p, fused, audio, rf.	100			-15		45		13		
2N132A	p-n-p, fused, audio, rf.	100	85		-12	-10	90	6	11		
2N133A	p-n-p, fused, audio, low-noise	100			-15		45		4.5		
2N138A	p-n-p, fused, audio output	130			-12	-100	140				
CK751	p-n-p, fused, audio output	240 ²			-12	-100	140				
2N272	p-n-p, fused, audio, rf.	150			-20	-100	90		12		
2N273	p-n-p, fused, audio output	150			-12	-100	140				
CK870	p-n-p, fused, audio, sw.	130	85		-25	-100	10	6		0.4	
CK871	p-n-p, fused, audio, sw.	130	85		-20	-100	15	6		0.5	
2N327	p-n-p, fused, Si, audio, sw.	150	160		-50	-50	14	0.005	18	60 ¹	
2N328	p-n-p, fused, Si, audio, sw.				-35		24			0.35	
2N329	p-n-p, fused, Si, audio, sw.				-30		50			0.6	
2N330	p-n-p, fused, Si, low-noise				-45		30		12	0.5	
Sprague Electric Co., North Adams, Mass.											
10A	p-n-p, alloy, audio driver	180	70	4.5(a)	50	100	33	5000	20	35	1.2
10B	p-n-p, alloy, audio driver						53	5000			
10C	p-n-p, alloy, audio driver						>53	5000			
8F	p-n-p, alloy, audio	100	80	2(a)	-45	-50	15	16	20	28	0.7
8E	p-n-p, alloy, audio						30				
8D	p-n-p, alloy, audio						99				
8G	p-n-p, alloy, audio						>100				
Sylvania Elec. Products Inc., Woburn, Mass.											
2N229	n-p-n, alloy, gen. purpose	50	75	1(a)	-10 ³	40	0.96	200			0.55 ⁴
2N306	n-p-n, alloy, low freq.				-20 ³		0.96				
2N34	p-n-p, alloy, low freq.				-40 ³	100	0.975			15	0.3 ⁴
2N35	n-p-n, alloy, low freq.				40 ³		0.975			18	0.6 ⁴
2N213	n-p-n, alloy, audio driver						150				
2N214	n-p-n, alloy, audio output	125		2.5(a)	25		70			15	0.6
2N228	n-p-n, alloy, audio output	50		1(a)	25		7.5			15	0.6
Texas Instruments Inc., Dallas, Texas											
2N185	p-n-p, alloy, audio amp.	150	50		-20	150	35	8			
2N238	p-n-p, alloy, audio amp.	50	60		-20			8			
2N291	p-n-p, alloy, audio amp.	180	50	0.25(b)	-25	200	30	10			
Tung-Sol Electric Inc., East Orange, N. J.											
TS616	p-n-p, alloy, med. pwr. audio	200	85	0.2(b)	-25	200	36 ⁵	8			
TS617	p-n-p, alloy, med. pwr. audio						54 ⁵				
TS618	p-n-p, alloy, med. pwr. audio						72 ⁵				
TS620	p-n-p, alloy, low-noise	100		0.35(b)		50	0.98		8	50	1.0
TS621	p-n-p, alloy, low-noise	100		0.35(b)		50	0.99		8	50	1.0
SN63T	p-n-p, alloy, audio	100	85	0.35(b)	-25	25	0.96	8	25	50	0.6
2N64	p-n-p, alloy, audio						0.98		22		0.8
2N65	p-n-p, alloy, audio						0.99		20		1.2
2619	p-n-p, alloy, driver amp.					50					
S615T	p-n-p, alloy, hi-volt, amp.				-45	50	0.98		22		1.0
Western Electric Co., New York, N. Y.											
1N85 ⁶	p-n, grown, photo, coding	50	85		-90	-1		6 ⁷		5	0.1
2N29 ⁶	n-p-n, grown, linear audio	120	85	2.0(a)	35	100		4	15	8.5	2.0
GA52829 ⁶	p-n-p, alloy, gen. purpose	120	85	2.0(a)	-65	50	0.98	4.5	<10	17	3.0
GA53149 ⁶	p-n-p, alloy, gen. purpose	120	85	2.0(a)	-65	-50		4.5	10	22	3.0
GA53270 ⁶	n-p-n, alloy, gen. purpose	120	85		30	30		3		20	3.0

response of transistor amplifiers depends upon passive elements in the circuit and therefore may be controlled at the designer's discretion.

Power

The maximum power dissipation of a commercially available transistor is about 25 watts. Experimental transistors have been constructed which dissipate over a hundred watts. Power handling capabilities of typical transistors are presented in Figs. 2 and 3. It is noticed that f_{α} (Fig. 2) decreases with increasing power handling capabilities and that h_{fe} (grounded emitter current transfer function) decreases in a somewhat similar manner (Fig. 3).

The main drawback to large power handling capabilities is the internal temperature rise within the transistor. When a junction temperature of about 100 C is reached, a germanium transistor will not operate correctly (see section on temperature). Silicon is slightly better in this respect. A junction temperature between 150 and 200 C may be achieved.

Transistors are usually de-rated linearly in power as the temperature increases such as,

$$P_T = P_r [1 - K(T - T_r)]$$

where

- P_T = power dissipation at temperature T,
- P_r = power dissipation at room temperature,
- T_r = room temperature, 25 C,
- K = de-rating constant.

The higher current density across the emitter to base junction affects the emitter efficiency, thereby reducing the parameter alpha, which in turn reduces the gain of the device. Therefore, power transistors usually have lower gain capabilities than transistors of other types (see Fig. 3).

Noise

Although noise is a drawback of point contact and early types of junction units, the noise figure of present junction transistors is as low as 4.5 db measured for a one-cycle bandwidth at 1 kc. Typical commercial units specify 10 to 12 db maximum noise figure.

Impedance	grounded base	grounded emitter	grounded collector
Input	100 ohms	1500 ohms	30,000 ohms
Output	100,000 ohms	20,000 ohms	100 ohms

Fig. 1

1. Maximum.
2. With heat sink.
3. V_{cb}
4. Alpha, minimum.
5. $I_c = 150$ ma.
6. Military Type.
7. Dark current. Sensitivity—0.35 $\mu a/mw$.

F-l-a-s-h!...from Transistor Center, U.S.A.



Announcing a new transistor class... The PHILCO Micro-Alloy Transistor (MAT)*

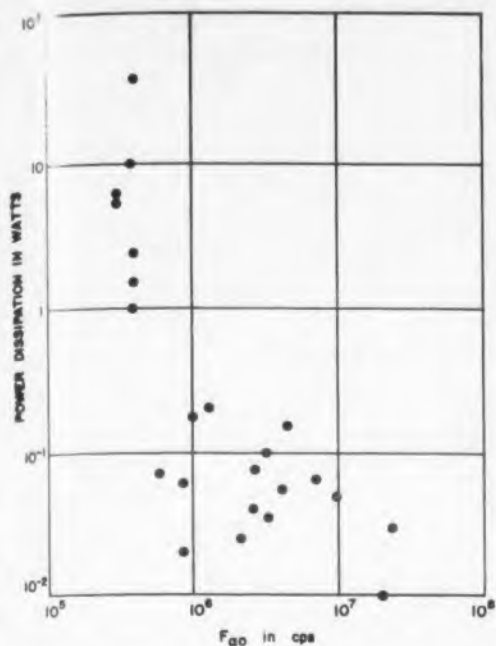


Fig. 2. Average f_{ao} vs. power dissipation for commercially available transistors.

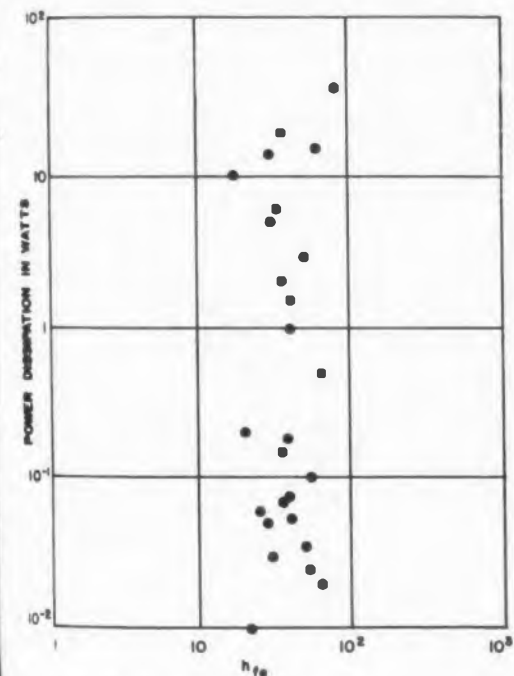


Fig. 3. Average h_{re} vs. power dissipation for commercially available transistors.



CHECK THESE UNEQUALLED FEATURES

- Excellent High Speed Switching characteristics.
- Low Saturation Voltage (low impedance)
- Excellent high frequency amplification.
- Excellent low-level amplifier over entire frequency range from D.C. to Megacycles.
- Exceptionally Long Life (hermetically sealed)
- Permits high speed computer design with Fewer Stages.

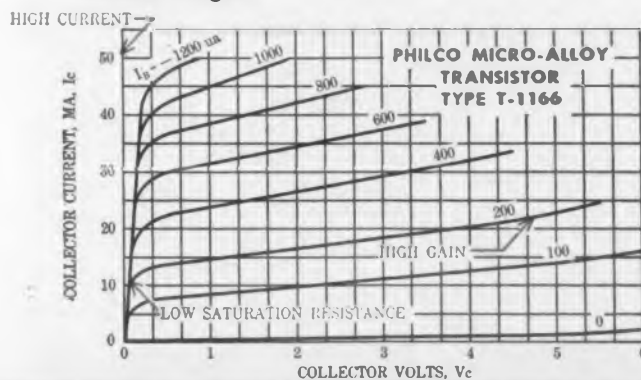


Fig. 4. Typical noise factor versus frequency curve for transistors.

...world's first production transistor with exceptionally high frequency and high gain... plus low saturation resistance!

This newest development from Philco Transistor Center features the characteristic high frequency response obtainable with extremely precise base width control. Designed for low voltage operation, the new MAT transistor is especially well suited for high speed applications where low saturation resistance (reduced power consumption) is necessary.

To combine high gain at high currents with high frequency response, the new MAT transistor employs a gallium doped alloy junction for the emitter electrode.

A special short-alloying cycle, combined with precise electro-chemical production techniques (pioneered and developed at Philco Transistor Center for production of SBT), results in the micro-alloy contact for exceptionally high injection efficiency. This new process assures higher gain, and permits operation at higher current. Beta linearity is excellent over the entire range of operating currents... up to 50 milliamperes.

● Write for complete information and specifications. Make Philco your prime source of information for high frequency transistor applications.

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PHILCO CORPORATION
LANSDALE TUBE COMPANY DIVISION
LANSDALE, PENNSYLVANIA

General Purpose, Low Frequency (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings					Characteristics				
		W_c (mw)	T_j (C)	(a)mw / C (b)C / mw	V_c (volts)	I_c (ma)	β or α	I_{c0} (μ a)	NF (db)	C_c ($\mu\mu$ f)	f_{c0} (Mc)
Westinghouse Electric Corp., Youngwood, Pa.											
XD5081/XD5082	p-n-p, fused, switch, amp.		85		-35		48 ¹				0.01
2N59	p-n-p, fused, class B audio out.	150		3.25(a)	-25	-150	80	10 ma	15	40	1.0
2N60	p-n-p, fused, class B audio out.						66				
2N61	p-n-p, fused, class B audio out.						45				
2N403	p-n-p, fused, class A audio out.						50				
2N402	p-n-p, fused, audio driver					50	50				
Bogus Elec. Mfg. Co., Paterson, N. J.											
2N347	n-p-n, grown, Si, audio, servo, sw.	750	175	3.0(a)	60	60	20		24	10	0.2
2N348	n-p-n, grown, Si, audio, servo, sw.				90	50					
2N349	n-p-n, grown, Si, audio, servo, sw.				125	40					

High Frequency, Switching

Amperex Electronic Corp., Hicksville, N. Y.											
OC44	p-n-p, alloy, rf conv.	100	75	2.0(a)	15	10	100	0.5		40	15
OC45	p-n-p, alloy, if amp.	100	75	2.0(a)	15	10	40	0.5			6
Bogus Elec. Mfg. Co., Paterson, N. J.											
RD316	n-p-n, grown, Si, audio, comp. servo	100	175	1.0(a)	20 ²	20	10	0.5	25	10	2
2N160/2N160A³	n-p-n, grown, Si, audio, comp. servo	150			40 ²	25	15				4
2N161/2N161A³	n-p-n, grown, Si, audio, comp. servo						30				5
2N162/2N162A³	n-p-n, grown, Si, audio, comp. servo						35				8
2N163/2N163A³	n-p-n, grown, Si, audio, comp. servo						50				6
2N97	n-p-n, grown, audio, if, osc. comp.	50	75	2.0(a)	30	10	0.93	2	15	14	1.0
2N98	n-p-n, grown, audio, if, osc. comp.				40		0.975			10	2.5
2N99	n-p-n, grown, audio, if, osc. comp.				40		0.975				3.5
2N103	n-p-n, grown, audio, if, osc. comp.				35		0.80	5			0.75
CBS-Hytron, Lowell, Mass.											
2N182	n-p-n, alloy, switch	100	75	2.0(a)	25		25	3		10	5
2N183	n-p-n, alloy, switch						40				10
2N184	n-p-n, alloy, switch						60				>10
Fretco Inc., Pittsburgh, Pa.											
2N32	pt. contact, pulse, osc., sw.	50	30		-40	-8	2.2	-12	40		50
2N33	pt. contact, pulse, osc., sw.	30	30		-85	-7		-12	40		50
General Electric Co., Syracuse, N. Y.											
2N78	n-p-n, grown, hi-gain rf-if	65	85	1.1(a)	15	20	40	5	12	2.4	8
2N123	p-n-p, alloy, hi-fi switch	100		1.67(a)	-15	125	50			15	8
2N164A	n-p-n, grown, mix.-osc., if	65		1.1(a)	15	20	40	5		2.4	8
2N165	n-p-n, grown, if	55	75		15	20	72	5		2.4	4
2N167	n-p-n, switch	65	85		30	75	36	1.5	8	4	8
2N168A	n-p-n, grown, if	65	85	1.1(a)	15	20	40	5		2.4	8
2N169	n-p-n, grown, if	55	75		15		72				4
2N169A	n-p-n, grown, if	55	75		25		72				5
2N292	n-p-n, grown, if	65	85		15		25				5
2N293	n-p-n, grown, if	65	85		15		25				8
2N313	n-p-n, grown, if	65	85	1.1(a)	15	20	25	5		2.4	5
2N314	n-p-n, grown, if	65		1.1(a)	15	20	25	5		2.4	8
4JD1B3	p-n-p, switch	200			-30	1000	15	20		45	0.8
4JD1B4	p-n-p, switch	200			-30	1000	20	20		45	0.8
4JD4A2	n-p-n, Si, hf	150	150	1.0(a)	15	20	14	0.15		14	25
4JD4A3	n-p-n, Si, low-level sw.	150	150	1.0(a)	10	20		0.15		14	25
4JD4A4	n-p-n, Si, hf amp.			1.0(a)	15		15				
4JD4A5	n-p-n, Si, hf, amp.			1.0(a)	15		40				
4JD5A1	n-p-n, Si, unijunction	250			45 ⁴	50 ⁴		50 ⁴			
3N29	n-p-n, tetrode	50	85		7 ⁵	20		25		4.2	40
3N30	n-p-n, tetrode									5	80
3N31	n-p-n, tetrode									3.1	20

The typical noise figure characteristic (see Fig. 4) of a transistor has a $1/f$ characteristic at low frequency; is flat over the intermediate range; and increases at the higher frequency. The $1/f$ noise at low frequency is predominantly semiconductor and surface recombination noise. The middle range is thermal noise, and the increase in noise figure at high frequencies is due to the decrease in amplification of the device.

Reliability

When transistors were first produced in any quantity their reliability was very questionable. The effects of humidity and temperature were very disheartening. However, today with hermetically-sealed units the effects of humidity have been eliminated.

The most recent reports on reliability indicate that for transistors operating in computers and hearing aids, the number of unit-hours per failure is of the order of 10^5 to 10^6 . If this rate of failure continued, the average life of a transistor would be from 10 to 100 years. This sounds slightly fantastic but is not impossible.

The effects of vibration and shock on transistors are almost negligible. They will hold up as well as passive circuit elements.

Temperature

Temperature, however, still has a detrimental effect upon transistor operation. At the present time the upper operating temperature limit on germanium devices is approximately 85 C. The devices must be de-rated as mentioned earlier. Silicon transistors have an upper operating temperature limit of approximately 150 C. The factor controlling the upper temperature limit is the width of the forbidden region in the energy band structure of the material from which the transistor is fabricated. The reason silicon is better is because it has an energy gap of 1.1 volt as compared to germanium with 0.7 volt. An inter-metallic compound, e.g., Gallium Arsenide, has a larger energy gap than either germanium or silicon and thus should work at higher temperatures, if and when suitable single crystals are made.

With proper circuit design the effect of temperature upon I_{c0} may be swamped out. That is, if the current flowing in the collector is large with respect to any expected I_{c0} change, the operating point will not change appreciably.



1. $I_c = 1.5$ A, $V_{ce} = 2$ v.
2. 1 v emitter voltage.
3. Same as basic type, but emitter voltage 5 v.
4. V_{bb} , I_e , I_{c0}
5. V_{cb}

Irradiation Effects

Another environment besides high temperature that is detrimental to transistor operation is that of a gamma or neutron flux field.

Neutrons react on transistors by producing imperfections in the crystal structure of germanium or silicon from which the transistor is fabricated. These imperfections appear as p-type impurity centers in germanium. After prolonged irradiation n-type germanium has been converted to p-type; p-type germanium remains p-type. The imperfections produced reduce the mobility and lifetime of the carriers in either type of material. In silicon the defects produced appear at an energy level in the center of the forbidden region. This material thus tends to become intrinsic under irradiation. The effects on mobility and lifetime are also present.

The general figure reported to date for the amount of integrated flux that a transistor will withstand is in the order of 10^{12} to 10^{13} nvt. This is the region in which the parameters of the transistors start to deteriorate. With the aid of feedback the useful range on a transistor amplifier might be extended an order of magnitude higher in integrated flux.

There is some evidence that indicates that it is the fast neutrons that do the majority of the above damage. Thermal neutrons are thought to produce substitutional impurities by K capture and beta emission. For the isotope $^{32}\text{Ge}^{70}$, this process is: $^{32}\text{Ge}^{70}$ plus thermal neutron transmutes to $^{31}\text{Ga}^{71}$ by K capture. For the case of the germanium isotope $^{32}\text{Ge}^{74}$, the process is: $^{32}\text{Ge}^{74}$ plus thermal neutron transmutes to $^{33}\text{As}^{75}$. The half-life of $^{32}\text{Ge}^{71}$ is 11.4 days, and for $^{32}\text{Ge}^{75}$ the half-life is 82 minutes.

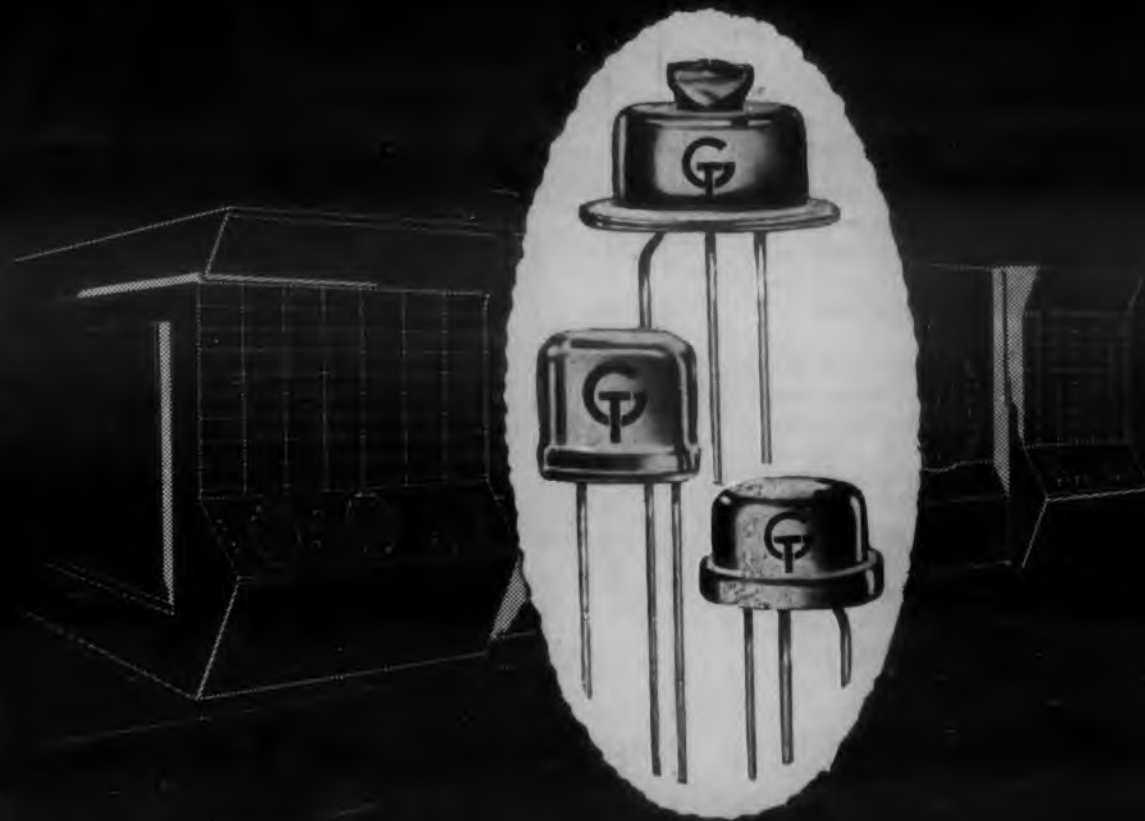
This would indicate a gradual degradation in characteristics after irradiation, which does not seem to be present. In fact, improvement in the parameters after irradiation is stopped is more often noticed. This is explained by an annealing process which can occur even at room temperature. The annealing process results in removal of interstitials or other lattice defects by thermal vibration.

Gamma irradiation produces interstitial defects as well as ionized atoms within the crystal structure. The ionization appears as an increased temperature with its resulting degradation in transistor performance.

Transistors have now taken their place alongside vacuum tubes as a useful tool for designers of electronic equipment. With careful design based upon the known limitations of transistors, reliable operation of transistor circuitry may be obtained.

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- Low level modulation



GENERAL TRANSISTOR CORPORATION

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CIRCLE 502 ON READER-SERVICE CARD FOR MORE INFORMATION

High Frequency, Switching (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings				
		W_c (mw)	T_j (C)	(a)mw/C (b)C/mw	V_c (volts)	I_c (ma)
General Transistor Corp., Jamaica, N. Y.						
GT759R	p-n-p, alloy, rf-if	90	75		12	100
GT760R	p-n-p, alloy, rf-if				10	
GT761R	p-n-p, alloy, rf-if				10	
GT762R	p-n-p, alloy, rf-if				6	
GT83	p-n-p, alloy, lo-speed comp.	125	85		25	200
GT87	p-n-p, alloy, lo-speed comp.					
GT88	p-n-p, alloy, lo-speed comp.					
GT122	p-n-p, alloy, lo-speed comp.					
2N311	p-n-p, alloy, lo-speed comp.	100			15	
GT758	p-n-p, alloy, lo-speed comp.	100	85		>20	200
GT123	p-n-p, alloy, hi-speed comp.				>20	
GT153	p-n-p, alloy, hi-speed comp.				>30	
GT269	p-n-p, alloy, hi-speed comp.				25	
GT759	p-n-p, alloy, hi-speed comp.				>20	
GT760	p-n-p, alloy, hi-speed comp.	100	85		15	50
GT761	p-n-p, alloy, hi-speed comp.				15	50
2N356	n-p-n, alloy, switch, comp.				>30	200
2N357	n-p-n, alloy, switch, comp.					
2N358	n-p-n, alloy, switch, comp.					
2N312	n-p-n, alloy, switch, comp.	100	85		15	200
GT792	n-p-n, alloy, switch, comp.				20	100
GT903	n-p-n, alloy, switch, comp.					200
GT904	n-p-n, alloy, switch, comp.		75			
GT905	n-p-n, alloy, switch, comp.		85			
GT947	n-p-n, alloy, switch, comp.	100	85		15	200
GT948	n-p-n, alloy, switch, comp.				20	
GT949	n-p-n, alloy, switch, comp.				30	
GT762	p-n-p, alloy, hi-speed comp.				6	50
GT763	p-n-p, alloy, hi-speed comp.				6	50
GT764	p-n-p, alloy, hi-speed comp.	100	85		>20	200
2N315	p-n-p, alloy, switch, comp.				20	
2N316	p-n-p, alloy, switch, comp.					
2N317	p-n-p, alloy, switch, comp.					
GT167	n-p-n, alloy, switch, comp.				25	
GT229	n-p-n, alloy, experimental	100	85		>10	200
GT345	p-n-p, alloy, bi-directional	125			40	
GT34N	p-n-p, alloy, neon light	125			100	
GT34HV	p-n-p, alloy, hi-voltage	150			50	
2N318	p-n-p, alloy, photo ¹	50			12	20
Intelex Systems Inc., New York, N. Y.						
TP1	n, point contact, switch	150			-30	30
TP2	n, point contact, amp., osc.	150			-30	30
Lansdale Tube Co., Div. of Philco Corp. Lansdale, Pa.						
T0031	p-n-p, alloy, Ne ind., rel. driv.	25	65		-50	-10
T0033	p-n-p, alloy, f switch	50	85	0.8(b)	-20	-20
2N128 ²	p-n-p, sbt, rf, video	30		0.75(b)	-10	-5
2N129 ²	p-n-p, sbt, rf, if	30			-10	-5
2N299 ²	p-n-p, sbt, rf tuned amp. ⁷	40			-7	-20
2N300 ²	p-n-p, sbt, video amp. ⁷	40			-7	-20
2N344/SB101	p-n-p, sbt, hf	20	55	0.75(b)	-5°	-5
2N345/SB102	p-n-p, sbt, hf					
2N346/SB103	p-n-p, sbt, hf					
2N240	p-n-p, sbt, hf switch	10			-6°	-15
2N393/T1166	p-n-p, microalloy, hf, switch	50	85		-6°	-50
2N354/T1025	p-n-p, alloy, Si, hf amp.	150	140	0.77(b)	-25°	
2N355/T1159	p-n-p, alloy, Si, hf switch	150	140	0.77(b)	-10°	
T1164	p-n-p, alloy, sym. switch					

Characteristics
 β or α I_{co} NF C_c f_{co}
 (μa) (db) ($\mu\mu f$) (Mc)

*	*	*	*
25	6		2.5
40			5
70			11
120			17
49	10	16	<0.7
38			0.5
80			
80			1.5
	<60		
15	<5	16	<0.5
150	<6		>5
>20	<5		
>20	<4		>4
>20	<5	16	3
40	1.0	16	5
75	1.0	16	10
	<5		3
			6
			9
	<60		
	6		4.8
	<25		>4
	<25		>4
	<20		>0.7
100	1	16	20
120	1	16	30
200	<5	16	>25
	1.0		5
	1.0		12
	1.0		20
>25	<10		>5
>10	<10	30	
15	15	24	
18	<450		
10	10	16	
100	10	20	
>2	1 ma		
5	2 ma		2
	15		
100	10	5	2
35	3 ³	9	65 ³
25		9	60 ³
		8 ⁴	105 ³
0.94		8 ⁴	105 ³
22	3	4 ⁴	50 ³
35			50 ³
30			75 ³
32			55 ³
155	5	3.5 ⁴	60 ³
18	0.1		15 ³
18	0.1		25 ³
			20
			0.8

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*All characteristic data for General Transistor Corp. is referred to CE operation.
 1. Sensitivity 0.16 v/ft candle.
 2. Military type.
 Max. freq. of oscillation.
 4. Cob
 5. Max. at $V_c = -5$ v.
 6. At 10 MC.
 7. Characteristic data given for GB circuit.
 8. At 1 MC.
 9. V_{ce}

High Frequency, Switching (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings				
		W_c (mw)	T_i (C)	(a)mw/C (b)C/mw	V_c (volts)	I_c (ma)
Mullard (International) Electronic Corp., New York, N. Y.						
OC44	p-n-p, rf conv.	100	75	2.0(a)	15	10
OC45	p-n-p, alloy, if amp.	100	75	2.0(a)	15	10
Pye Industrial Electronics, Ltd., Newmarket, England						
V6/R2	p-n-p, alloy, if amp.	25	75	0.5(a)	-6	-12
V6/R4	p-n-p, alloy, if, osc.-mix.					
V6/R8	p-n-p, alloy, if, osc.-mix.					
RCA, Somerville, N. J.						
2N139/2N218 ¹	p-n-p, alloy, 455 kc if amp.	35	85		-16	-15
2N140/2N219 ¹	p-n-p, alloy, 540-1640 kc conv.				-16	-15
2N247	p-n-p, alloy drift, class A rf				-35	-10
2N269	p-n-p, alloy, lo-level switch				-20	-100
Raytheon Mfg. Co., Newton, Mass.						
2N111	p-n-p, fused, if-rf	150	85		-30	-200
2N111A	p-n-p, fused, if					
2N112	p-n-p, fused, if-rf					
2N112A	p-n-p, fused, if					
2N113	p-n-p, fused, rf, switch					
2N114	p-n-p, fused, rf, switch					
2N271	p-n-p, fused, mix.-conv. bdcst.					
2N271A	p-n-p, fused, if					
CK768	p-n-p, fused, if-rf	150				-100
Sprague Electric Co., North Adams, Mass.						
2N159	n, point contact, pulse, sw. ⁵	100	80	2.0(a)	-50	-40
PC6	n, point contact, comp. sw. ⁵	150	80	3.0(a)	-80	-60
SB101	p-n-p, sbt, if-rf osc., amp.	10	85	0.18(a)	-5	-5
SB102	p-n-p, sbt, if-rf osc., amp.			0.18(a)		
SB103	p-n-p, sbt, if-rf osc., amp.			0.18(a)		
SB5122	p-n-p, sbt, hi-speed switch		65	0.28(a)	-6	-15
Sylvania Electric Products, Inc., Woburn, Mass.						
2N94	n-p-n, alloy, hf	50	75	1.0(a)	20	50
2N94A	n-p-n, alloy, hf, switch				20	
2N193	n-p-n, alloy, hf osc.				15	
2N194	n-p-n, alloy, hf mixer				25	
2N211	n-p-n, alloy, hf osc.				10	
2N212	n-p-n, alloy, hf mixer	50	75	1.0(a)	10	50
2N216	n-p-n, alloy, if amp.				15	
2N233	n-p-n, alloy, hf				10	
2N377	n-p-n, alloy, hf, switch	150	85	2.5(a)	20	200
2N385	n-p-n, alloy, hf, switch				25	
2N388	n-p-n, alloy, hf, switch					
Texas Instruments Inc., Dallas, Texas						
2N332 ⁹	n-p-n, grown, Si, gen. purpose	150	175	0.116(b)	45	25
2N333 ⁹	n-p-n, grown, Si, gen. purpose					
2N334 ⁹	n-p-n, grown, Si, gen. purpose					
2N335 ⁹	n-p-n, grown, Si, gen. purpose					
2N336 ⁹	n-p-n, grown, Si, gen. purpose					
903 ⁹	n-p-n, grown, Si, gen. purpose	150	175	0.116(b)	30	25
904 ⁹	n-p-n, grown, Si, gen. purpose					
904A ⁹	n-p-n, grown, Si, gen. purpose					
905 ⁹	n-p-n, grown, Si, gen. purpose					
910 ⁹	n-p-n, grown, Si, gen. purpose					
2N263 ⁹	n-p-n, grown, Si, switch	125	150	0.166(b)	40	20
2N337 ⁹	n-p-n, grown, Si, switch					
2N338 ⁹	n-p-n, grown, Si, switch					
925 ⁹	n-p-n, grown, Si, hi-freq.				30	10
926 ⁹	n-p-n, grown, Si, hi-freq.					
3N32 ⁹	n-p-n, grown, Si, hi-freq.					
3N33 ⁹	n-p-n, grown, Si, video, rf					
3N34 ⁹	n-p-n, grown, Si, video, rf					

Transistor Parameter

E. K. Novak

Characteristics

β or α	I_{co} (μa)	NF (db)	C_c ($\mu\mu f$)	f_{co} (Mc)
---------------------	-------------------------	------------	-------------------------	------------------

100	0.5		40	15
40	0.5			6

25	1.0		35	3
50				5.5
80				10

48 ²	-6	4.5	9.5 ³	4.7 ⁴
48 ²	-6		9.5 ³	7 ⁴
60 ²	-16		1.7 ³	30 ⁴
	2.5			4 ⁴

25	1.0	10	12	3
25				3
30		10		5
30				5
45		10		10
75		10		20
45				10
45				10
20			15	2.5

3	0.5 ma	43	0.5	5
5	1.0 ma	43	0.5	5
23	500	20	3.5	45
40				45
>6	1000			60

0.97 ⁶	50 ⁷		10	2
0.98 ⁶	50 ⁷		10	5
7.5 ⁶	40 ⁷		11	2
8.0 ⁶	40 ⁷		11	
10 ⁶	20 ⁷		10	
10 ⁶	20 ⁷		10	4
7.5 ⁶	40 ⁷		11	2
4.5 ⁶	150 ⁷			
30 ⁸	20 ⁷		15	4
60 ⁸	35 ⁷		15	4
80 ⁸	20 ⁷		15	8

0.925	4	20	7 ¹⁰	4
0.960				5
0.975				8
0.980				6
0.990				7
0.925	0.1	25	7 ¹⁰	4
0.960		34		5
0.975		25		8
0.980		25		6
0.990		20		7

0.975	1.0		3	30
0.950	1.0			20
0.975	1.0			30
	0.2		1.8	12.5
			1.8	30
				4.3
				12.5
				30.0

TRANSISTOR characteristics are usually now given by most manufacturers in h parameters. Occasionally however, characteristics are available only in r parameters. Also, in some transistor circuit design problems, a more familiar physical representation of the transistor is permitted if the small signal parameters of the transistor are expressed as resistances. Both systems of representation are useful and a typical design problem usually requires the application of both h and r parameters. The time required to perform these conversions may be considerably reduced by application of these tables. All equations given are in the exact form and are derived from the basic equivalent circuits given in Fig. 1. The r parameters are given for the common base, common emitter and common collector connections; the z and h parameters are given in their general form and will represent the CB, CE or CC connection when the subscripts b , e or c , respectively, are added to each parameter. For example, the input impedance in the general four terminal network h parameters form is h_{11} ; h_{11b} is the input impedance for the common base connection, h_{11e} is the input impedance for the common emitter connection, h_{11c} for the common collector.

The h parameters are given by manufacturers in either of the two following forms:

For common base:

h_{11b} = input impedance	= h_{11}
h_{12b} = reverse transfer, or feedback voltage ratio	= h_{12}
h_{21b} = forward, or current transfer ratio	= h_{21}
h_{22b} = output admittance	= h_{22}

Since the majority of the literature is written in the nomenclature of the left hand column it is used in these tables.

Use of the tables is illustrated by the following simple example.

The characteristics of a Type 903 grown junction

1. Has flexible leads.
2. Current transfer ratio, common emitter circuit.
3. $C_{b,c}$
4. CB circuit.
5. All characteristic data for Grounded Base circuit.
6. h_{fe} —small signal current gain.
7. Maximum, emitter open.
8. h_{fe} —dc current gain.
9. All characteristics given for design center, grounded base.
10. 1[MC design center.

Conversion Tables

silicon transistor are given in the manufacturer's data sheet as follows:

$$\begin{aligned} h_{11b} &= 42 \text{ ohms} \\ h_{12b} &= 120 \times 10^{-6} \\ h_{21b} &= -0.925 \\ h_{22b} &= 0.4 \times 10^{-6} \text{ mhos} \end{aligned}$$

Since these parameters are given for the common base connection, calculation of the characteristics of a common emitter amplifier, for example such as in Figure 1c, requires conversion of the given values to their common emitter equivalent. Using Table I:

$$h_{11e} = \frac{h_{11b}}{(1 + h_{21b})(1 - h_{12b}) + h_{11b} h_{22b}} = 560 \text{ ohms}$$

similarly:

$$\begin{aligned} h_{12e} &= 104 \times 10^{-6} \\ h_{21e} &= 12.3 \\ h_{22e} &= 5.33 \times 10^{-6} \text{ mho} \end{aligned}$$

Also from Table I, the common collector h parameters are:

$$\begin{aligned} h_{11c} &= 560 \text{ ohms} \\ h_{12c} &= 1.0 \\ h_{21c} &= 13.3 \\ h_{22c} &= 5.33 \times 10^{-6} \text{ ohms} \end{aligned}$$

When calculations in terms of r parameters are required, Table II and the above results give:

$$\begin{aligned} r_b &= 300 \text{ ohms} \\ r_c &= 2.5 \text{ megohms} \\ r_d &= 0.187 \text{ megohms} \\ r_e &= 19.5 \text{ ohms} \\ r_m &= 2.3 \text{ megohms} \end{aligned}$$

Other conversions are carried out similarly.

For the transformation of g parameters, the following relations can be used in conjunction with the tables:

$$h_{11} = \frac{1}{g_{11}}, h_{21} = \frac{g_{21}}{g_{11}}$$

$$h_{12} = \frac{-g_{12}}{g_{11}} = \frac{(g_c - g_{22})}{g_{21}}$$

$$h_{22} = g_c = \frac{1}{r_{22}}$$

Continued on page 12

now...

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Clevite Research Center

CIRCLE 505 ON READER-SERVICE CARD FOR MORE INFORMATION

High Frequency, Switching (cont.)

Manufacturer and Type	Class and Application	Maximum Ratings				
		W_c (mw)	T_j (C)	(a)mw/C (b)C/mw	V_c (volts)	I_c (ma)
Texas Instruments Inc. (cont.)						
2N232	p-n-p, grown diff., conv.	30	55		16	5
2N308	p-n-p, grown diff., if amp.				20	
2N309	p-n-p, grown diff., if amp.				20	
2N310	p-n-p, grown diff., if reflex				30	
2N172	n-p-n, grown, conv.	65	75	0.7(b)	16	5
2N143	n-p-n, grown, 455 kc if				20	
2N146	n-p-n, grown, 455 kc if					
2N147	n-p-n, grown, 455 kc if					
2N148	n-p-n, grown, 262 kc if				32	
2N149	n-p-n, grown, 262 kc if	65	75		32	5
2N130	n-p-n, grown, 262 kc if				32	
2N253	n-p-n, grown, 455 kc if				12	
2N254	n-p-n, grown, 455 kc if				20	
Transitron Electronics Corp., Melrose, Mass.						
ST10	n-p-n, grown, Si, gen. purpose	200	175		15	
ST30	n-p-n, grown, Si, gen. purpose				30	
ST40	n-p-n, grown, Si, gen. purpose				45	
ST11	n-p-n, grown, Si, med. gain				15	
ST31	n-p-n, grown, Si, med. gain				30	
ST41	n-p-n, grown, Si, med. gain				45	
ST12	n-p-n, grown, Si, hi gain	200	175		15	
ST32	n-p-n, grown, Si, hi gain				30	
ST42	n-p-n, grown, Si, hi gain				45	
ST13	n-p-n, grown, Si, hf				15	
ST33	n-p-n, grown, Si, hf				30	
Western Electric Co., New York, N. Y.						
2N67 ³	point contact, switch	100			-50	-50
2N110 ³	point contact, switch	200		3.3(a)	-50	-50
3N22 ³	n-p-n, grown, video amp.	30			10	3
GA52829 ³	p-n-p, alloy, gen. purpose	120	85	2.0(a)	-65	-50
GA52830 ³	p-n-p, alloy, core-driver	500	80		-40	-500
GA53080 ³	point contact, switch	250			-100	-50
GA53242 ³	p-n-p, alloy, switch	500	80		-40	-500
GA53149 ³	p-n-p, alloy, gen. purpose	120	85	2.0(a)	-65	-50
GA53233 ³	p-n-p, diffused, vhf osc.	200		5.0(a)	-35	-30
GA53270 ³	n-p-n, alloy, gen. purpose	120			30	30

Power Transistors

Manufacturer and Type	Class and Application	Maximum Ratings				
		W_c (W)	T_j (C)	(a)W/C (b)C/W	V_c (volts)	I_c (amp.)
Bendix Aviation Corp., Red Bank Div., Long Branch, N. J.						
2N235A	p-n-p, alloy, audio pwr.	25 ⁴	90	2(a)	-40	3
2N234A	p-n-p, alloy, pwr.		90		-30	3
2N285A	p-n-p, alloy, hi-gain audio		95		40	3
B-114	p-n-p, alloy, audio pwr.		100		40	3
X-140	p-n-p, alloy, audio pwr.		95		40	3
X-119	p-n-p, alloy, class B audio		90		40	3
X-145	p-n-p, alloy, class B audio		90		40	3
X113	p-n-p, alloy, hi-current sw.		100		70	4
X133	p-n-p, alloy, hi-current sw.				80	5
X134	p-n-p, alloy, hi-current sw.	50 ⁴		1.5(a)	40	12
X137	p-n-p, alloy, hi-current sw.	50 ⁴		1.5(a)	80	12

Basic Equivalent Circuits

(Small Signal Parameters)

Characteristics

β or α	I_{co} (μa)	NF (db)	C_c ($\mu\mu f$)	f_{co} (Mc)
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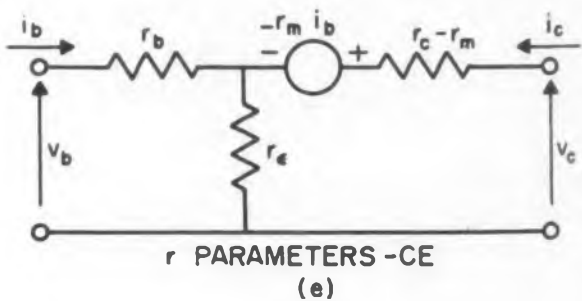
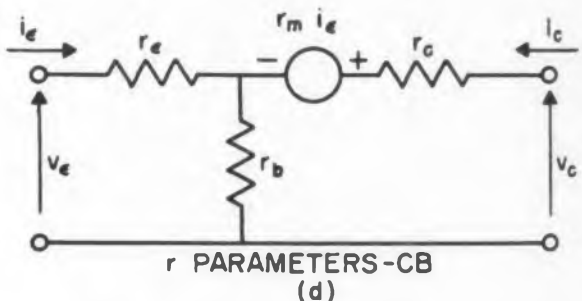
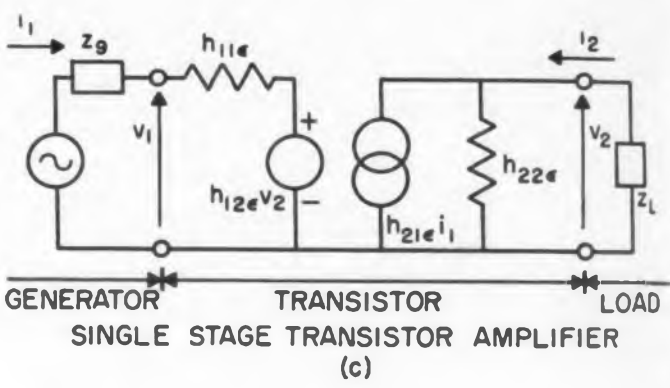
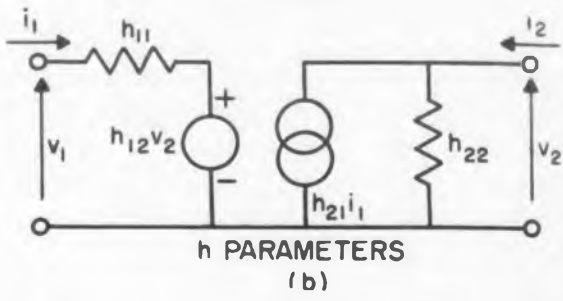
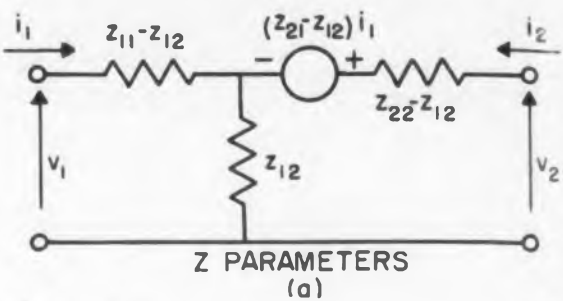
10			6 ¹	
3				
25	0.005 ²	22	7	9
45		20		13
45		20		13
45		20		13
40	0.005 ²	19	7	16
60			10	17
60			10	17

0.98	4.5	<10	17	3
	10		40	4
	1000			15
	10		40	4
	4.5	10	22	3
	13	4.5	4	500
	3		20	3

Characteristics

β or α	I_{co} (ma)	f_{co} (Mc)	pwr. gain (db)	pwr. out. (W)
---------------------	------------------	------------------	-------------------	------------------

60	1.0	0.007	35	2
30			30	2
100			38	2
50			34	5
100			34	6
50		0.008	25	9 ⁶
40		0.008	27	5 ⁶
40 ⁵				
40 ⁵				
15 ⁵				
15 ⁵				



Continued on page 15



1. C_{oe} design center.
2. At 6 v, 25 C.
3. Military Type.
4. With heat sink.
5. h_{fe} dc Beta.
6. Two units.

Typical Switching Operation

Manufacturer and Type	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}
Bendix Aviation Corp.						
Long Branch, N. J.						
X110 pwr.	100		200	2	1000	40(a)
X113 pwr.				2	8000	40(a)
X133 pwr.					2000	40(a)
X134 pwr.					4000	15(a)
X137 pwr.					4000	15(a)
Bogue Elec. Mfg. Co.						
Paterson, N. J.						
RD316				2.5		10(a)
2N160	0.3		0.4	1.25		15(a)
2N161	0.3		0.4			30(a)
2N162	0.2		0.3			35(a)
2N163	0.25		0.35			50(a)
X30A pwr.						12(a)
X31A pwr.						
X32A pwr.						
CBS-Hytron						
Lowell, Mass.						
2N182	0.7	0.8	0.5	0.15	7.5	25(b)
2N183	0.5	0.7	0.3		120	50(b)
2N184	0.3	0.6	0.2		180	100(b)
Clevite Transistor Prod.						
Waltham, Mass.						
2N257 pwr.					2000	100(a)
2N268 pwr.					2000	100(a)
2N297 pwr.				1.0	3000	100(a)
CTP117 pwr.					2000	60(a)
Delco Radio						
Kokomo, Ind.						
2N278 pwr.	50		80	0.6	15ma	80(b)
2N277 pwr.	50		80	0.6	15ma	80(b)
2N174 pwr.	60		100	0.6	15ma	50(b)
2N173 pwr.	50		80	0.6	15ma	80(b)
General Electric Co. Ltd.						
London, England						
GET10	1	3.5	4.5	40	6	40(a)
Lensdale Tube Co. (Philco)						
Lensdale, Pa.						
2N352 pwr.				0.47		65(a)
2N353 pwr.		0.5				90(a)
2N386 pwr.						85(a)
2N387 pwr.						85(a)
2N224			0.29	0.25		75(a)
2N226			0.36	0.25		55(a)
2N240 h.f.				0.06		65(a)
2N393 h.f.				0.05		93(a)
2N355 h.f.	0.038		0.09	0.08		50(a)
T1164	9					20(a)
Minneapolis-Honeywell						
Minneapolis, Minn.						
H5 pwr.	4	3	1	0.36	-500	30(a)
H6 pwr.						42(a)
H7 pwr.						60(a)
H3A pwr.					150	12(a)
H4A pwr.					150	22(a)
H10 pwr.				0.5	1000	20(a)

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		100ma	200ma	25°C	150°C		25°C	150°C
PS 606	80	1.1		.250	30	-70	125	50
PS 611	80		1.0	.025	5	-70	200	100
PS 618	200	1.1		.250	30	-180	125	50
PS 623	200		1.0	.025	5	-180	200	100
PS 630	330	1.1		.250	50	-300	125	50
PS 633	330		1.0	.100	25	-300	200	100
PS 634	420	1.1		.250	50	-380	125	50
PS 637	420		1.0	.100	25	-380	200	100

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Power Transistors (Cont.)

Manufacturer and Type	Class and Application	Maximum Ratings				
		W_c (W)	T_j (C)	(a)W/C (b)C/W	V_c (volts)	I_c (amp.)
Bogus Electric Mfg. Co., Paterson, N. J.						
X30A	n-p-n, grown, Si, audio, servo	8 ¹	175	0.1(a)	40	0.20
X31A	n-p-n, grown, Si, audio, servo	10 ¹			80	0.16
X32A	n-p-n, grown, Si, audio, servo	10 ¹			125	0.14
CBS-Hytron, Lowell, Mass.						
2N155	p-n-p, alloy, pwr.	8.5 ¹	85	0.14(a)	-30	-3
2N156	p-n-p, alloy, pwr.	8.5 ¹		0.14(a)	-30	
2N158	p-n-p, alloy, pwr.	8.5 ¹		0.14(a)	-60	
2N255	p-n-p, alloy, pwr.	6.25 ¹		0.10(a)	-15	
2N256	p-n-p, alloy, pwr.	6.25 ¹		0.10(a)	-30	
Clevite Transistor Products, Waltham, Mass.						
2N257	p-n-p, alloy, pwr. amp., sw.	37 ¹	90	0.5(a)	40	3
2N268	p-n-p, alloy, pwr. amp., sw.	37 ¹	90	0.5(a)	80	3
2N297 ²	p-n-p, alloy, pwr. amp., sw.	15 ¹	85	0.25(a)	60	3
CTP1117	p-n-p, alloy, pwr. amp., sw.	43 ¹	90	0.67(a)	40	6
Delco Radio, Kokomo, Ind.						
2N278	p-n-p, alloy, pwr.	70 ¹	95	1(b)	50	13
2N277	p-n-p, alloy, pwr.				40	
2N174	p-n-p, alloy, pwr.				80	
2N173	p-n-p, alloy, pwr.				60	
General Electric Co. Ltd., London, England						
GET7	p-n-p, alloy, dc conv.	14 ¹	75	1.5(b)	-15	8
GET8	p-n-p, alloy, audio output				-30	
GET9	p-n-p, alloy, volt. reg.				-60	
Lansdale Tube Co., Div. of Philco Corp., Lansdale, Pa.						
2N352/T1040	p-n-p, alloy, audio out., sw.	7 ¹	100	3(b)	-40	-2
2N353/T1041	p-n-p, alloy, audio out., sw.	10 ¹	100	2.5(b)	-40	-2
2N386/T1167	p-n-p, alloy, servo, pwr. sw.	12.5 ¹	100	2(b)	-60	-3
2N387/T1168	p-n-p, alloy, servo, pwr. sw.	12.5 ¹	100	2(b)	-80	-3
Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.						
H5 ¹	p-n-p, alloy, servo, dc conv.	20 ⁶	95	2.2(b)	-80	-3
H6 ¹	p-n-p, alloy, servo, dc conv.	20 ⁶		2.2(b)	-80	-3
H7 ¹	p-n-p, alloy, servo, dc conv.	20 ⁶		2.2(b)	-80	-3
H3A ¹	p-n-p, alloy, servo amp.	3 ⁶		14(b)	-60	-3.5
H4A ¹	p-n-p, alloy, servo amp.	3 ⁶		14(b)	-60	-0.5
H10	p-n-p, alloy, dc conv.	55 ⁶		0.8(b)	-60	-1.5
Motorola Inc., Semiconductor Product Div., Phoenix, Arizona						
2N176	p-n-p, fused, audio pwr.	10	90	1(a)	40	3
MN21	p-n-p, fused, high-volt.				80	
MN24	p-n-p, fused, audio pwr.				40	
MN25	p-n-p, fused, audio pwr.				40	
MN26	p-n-p, fused, audio pwr.				40	
MN28	p-n-p, fused, audio pwr., sw.				30	
MN29	p-n-p, fused, audio pwr., sw.				40	
Nucleonic Products Co., Los Angeles, Calif.						
2N350	p-n-p, alloy, audio pwr.	10	90	1(a)	-40	3
2N155	power	13.5		2.5(b)	-30	-3

Typical Switching Operation (cont.)

Characteristics					Manufacturer and Type	Storage						
β or α	I_{co} (ma)	f_{co} (Mc)	pwr. gain (db)	pwr. out. (W)		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}	
15			32	2	Motorola Inc. Phoenix, Ariz.							
					2N176	pwr.	50	10	80	0.6	1000	75(a)
					MN13A		7	2	9	0.2	30	25(a)
					MN13B				12			40(a)
					MN13C				12			80(a)
					MN21	pwr.	50	10	80	0.6	1500	55(a)
40	0.42	0.145	33	2	MN24	pwr.				1000	40(a)	
40	0.26	0.180	33	2	MN25	pwr.					60(a)	
41	0.26	0.180	37	2	MN26	pwr.					80(a)	
30		0.145	19-26	1	MN28	pwr.					2000	70(a)
30		0.145	22-29	2	MN29	pwr.					2000	70(a)
					RCA Somerville, N. J.					0.15	-4	
	2	0.3 ³	33	2.5	2N269							
	2		31	2.5								
	3				Raytheon Mfg. Co. Newton, Mass.							
	2		33	5.0	2N113	h.f.	0.1		0.15			
					2N114	h.f.	0.05		0.15			
		0.3 ⁴	40		Sprague Elec. Co. North Adams, Mass.							
		0.3 ⁴	40		2N159		0.12	1.5	0.5			
		0.15 ⁴	38		PC6		0.05	1.0	0.5			
		0.3 ⁴	40		SB5122		0.015	0.065	0.015	-0.1	-200	12(b)
20	.062	0.25	46	20	Sylvania Elec. Prod. Weburn, Mass.							
					2N34		1.0	2.0	2.0			
					2N35		1.0	1.5	2.0			
					2N94A	h.f.	0.3	0.4	0.6			49(b)
					2N377	h.f.	1	1	1	0.75		30(a)
					2N385	h.f.				0.75		60(a)
	3	0.016 ⁵	36		2N388	h.f.	0.6	0.6	0.6	0.75		80(a)
	3		36		2N325	pwr.	5	10	5	0.6		
	5		33		Texas Instruments Inc. Dallas, Texas							
	5		33		2N263		0.06	0.02	0.14			80(a)
					2N337		0.05		0.08			20(a)
					2N338		0.06		0.14			80(a)
50 ⁹	-0.5	>0.008	31	10	Tung-Sol Elec. Inc. East Orange, N. J.							
75 ⁹	-0.5	>0.007	34	10	TS612	pwr.	25		40	1.0		35(a)
140 ⁹	-0.5	>0.006	37	10	TS613	pwr.						30(a)
12 ⁹	0.15 ¹⁰		21	2	TS614							60(a)
15 ⁹	0.15 ¹⁰		23	3								
					Western Electric Co. New York, N. Y.							
					2N110		90		1.7			
45	<1	0.007	34	2	GA52830		0.45	1.1	0.6			
65	1.5		37	5	GA53242		0.45	1.1	0.6			
40	<1		31	4								
60	<1		33	4								
80	<1		35	4								
60	2		31	2								
60	2		33	2								
60	3	0.006	33									
50	0.3											

1. With heat sink.
2. Military Type.
3. Common base circuit.
4. Grounded base.
5. β_{co} , grounded emitter.
6. At a mounting base temp. of 50 C.
7. Two units, class B push-pull, common emitter.
8. DC beta.
9. I_{co} at 60 v.

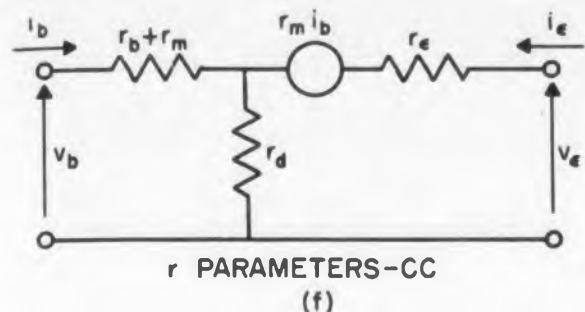


TABLE I h Parameters CB-CE-CC

	CE	CC
CB	$h_{11e} = \frac{h_{11b}}{(1+h_{21b})(1-h_{12b})+h_{11b}h_{22b}}$	$h_{11o} = \frac{h_{11b}}{(1+h_{21b})(1-h_{12b})+h_{11b}h_{22b}}$
	$h_{12e} = \frac{h_{11b}h_{22b}-(1+h_{21b})h_{12b}}{D_{eb}}$	$h_{12o} = \frac{1+h_{21b}}{D_{eb}}$
	$h_{21e} = \frac{-h_{11b}h_{22b}-h_{21b}(1-h_{12b})}{D_{eb}}$	$h_{21o} = \frac{-(1-h_{12b})}{D_{eb}}$
	$h_{22e} = \frac{h_{22b}}{D_{eb}}$	$h_{22o} = \frac{h_{22b}}{D_{eb}}$

	CB	CC
CE	$h_{11b} = \frac{h_{11e}}{(1+h_{21e})(1-h_{12e})+h_{11e}h_{22e}}$	$h_{11o} = h_{11e}$
	$h_{12b} = \frac{h_{11e}h_{22e}-(1+h_{21e})h_{12e}}{D_{be}}$	$h_{12o} = (1-h_{12e})$
	$h_{21b} = \frac{-h_{11e}h_{22e}-(1-h_{12e})h_{21e}}{D_{be}}$	$h_{21o} = -(1+h_{21e})$
	$h_{22b} = \frac{h_{22e}}{D_{be}}$	$h_{22o} = h_{22e}$

	CB	CE
CC	$h_{11b} = \frac{h_{11e}}{h_{11e}h_{22e}-h_{12e}h_{21e}}$	$h_{11o} = h_{11e}$
	$h_{12b} = \frac{h_{11e}h_{22e}+h_{21e}(1-h_{12e})}{D_{be}}$	$h_{12o} = (1-h_{12e})$
	$h_{21b} = \frac{h_{12e}(1+h_{21e})-h_{11e}h_{22e}}{D_{be}}$	$h_{21o} = -(1+h_{21e})$
	$h_{22b} = \frac{h_{22e}}{D_{be}}$	$h_{22o} = h_{22e}$

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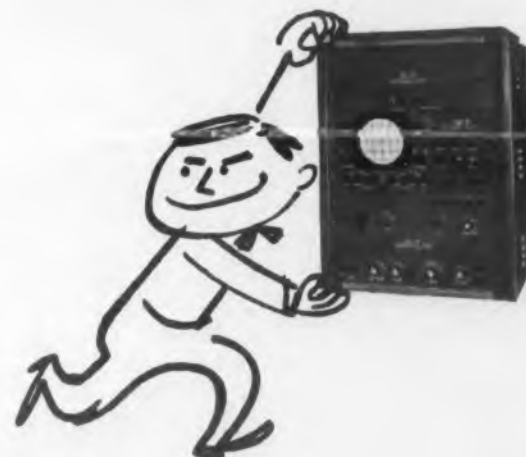
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Power Transistors (Cont.)

Manufacturer and Type	Class and Application	Maximum Ratings				
		W_c (W)	T_j (C)	(a) W/C (b) C/W	V_c (volts)	I_c (amp.)
Pye Industrial Electronics, Ltd., Newmarket, England						
V15/10P	p-n-p, alloy, pwr., 6v dc conv.	10 ²	75	0.2(a)	-15	-3
V15/20P	p-n-p, alloy, pwr., 6v dc conv.				-15	
V15/30P	p-n-p, alloy, pwr., 6v dc conv.				-15	
V30/10P	p-n-p, alloy, pwr., 12v dc conv.				-30	
V30/20P	p-n-p, alloy, pwr., 12v dc conv.				-30	
V30/30P	p-n-p, alloy, pwr., 12v dc conv.				-30	
RCA, Somerville, N. J.						
2N301 ⁴	p-n-p, alloy, lge. sig. audio pwr.	12 ²	85		-40	-2
2N301A ⁴	p-n-p, alloy, lge. sig. audio pwr.	12 ²	85		-60	-2
Sylvania Electric Products Co., Woburn, Mass.						
2N68	p-n-p, alloy, pwr.	4 ²	75	0.08(a)	-30	1.5
2N95	n-p-n, alloy, pwr.					
2N101	p-n-p, alloy, pwr.					
2N102	n-p-n, alloy, pwr.					
2N141	p-n-p, alloy, pwr.				-60	0.8
2N142	n-p-n, alloy, pwr.				60	
2N143	p-n-p, alloy, pwr.				-60	
2N144	n-p-n, alloy, pwr.				60	
2N155	p-n-p, alloy, pwr.	8.5 ²	85	0.14(a)		3
2N176	p-n-p, alloy, pwr.	10 ²	90	1(a)		3
2N235A	p-n-p, alloy, pwr.	5 ²	85	0.5(a)	-40	2
2N242	p-n-p, alloy, pwr.	25 ²	100	0.33(a)	-45	
2N250	p-n-p, alloy, pwr.	12 ²	80	0.22(a)	-30	
2N257	p-n-p, alloy, pwr.	25 ²	85	0.41(a)	-40	
2N296	p-n-p, alloy, pwr.	25 ²	100	0.33(a)	-60	2
2N307	p-n-p, alloy, gen. purp. pwr.	15 ²	75	0.3(a)	-35	1
2N325 ⁴	p-n-p, alloy, pwr.	12 ²	85	0.2(a)	-35	2
2N326 ⁴	n-p-n, alloy, pwr.	7 ²	85	0.12(a)	35	2
Texas Instruments Inc., Dallas, Texas						
951 ¹⁰	n-p-n, grown, Si, med. pwr.	0.75 ²	150	116(b)	50	.060
952 ¹⁰	n-p-n, grown, Si, med. pwr.				80	.050
953 ¹⁰	n-p-n, grown, Si, med. pwr.				120	.040
2N243 ¹⁰	n-p-n, grown, Si, med. pwr.				60	.060
2N244 ¹⁰	n-p-n, grown, Si, med. pwr.				60	.060
2N339 ¹⁰	n-p-n, grown, Si, med. pwr.	1.0			55	.060
2N340 ¹⁰	n-p-n, grown, Si, med. pwr.	1.0			85	.050
2N341 ¹⁰	n-p-n, grown, Si, med. pwr.	1.0	150	116(b)	125	.040
2N342 ¹⁰	n-p-n, grown, Si, med. pwr.				60	.060
2N343 ¹⁰	n-p-n, grown, Si, med. pwr.				60	.060
970 ¹⁰	n-p-n, grown, Si, power	8.75		166(b)	120	.140
2N389 ¹⁰	n-p-n, grown, Si, power	37.5		166(b)	60	
2N250	p-n-p, alloy, audio amp.	25	85	1.1(b)	-30	3.0
2N251	p-n-p, alloy, audio amp.	25	85	1.1(b)	-60	3.0
Transitron Electronic Corp., Melrose, Mass.						
2N83	p-n-p, pwr. amp.	10	85	0.16(a)	-66	2
2N83A	p-n-p, pwr. amp.				-66	3
2N84	p-n-p, pwr. amp.				-50	2
2N84A	p-n-p, pwr. amp.				-50	3
Tung-Sol Electric, Inc., East Orange, N. J.						
TS176	p-n-p, alloy, audio pwr.	10 ²	85	3(b)	-30	2
TS612	p-n-p, alloy, pwr. sw.	15 ²			-40	3
TS613	p-n-p, alloy, pwr. sw.	15 ²			-80	3
TS614	p-n-p, alloy, pwr. sw.	15 ²			-60	3
2N307	p-n-p, alloy, audio pwr.			5(b)	-35	1
Western Electric Co., New York, N. Y.						
2N66 ⁴	p-n-p, alloy, pwr. amp.	5 ²	80	0.5(a)	-60	-0.8

TABLE II h Parameters to r Parameters

	CB	CE	CC
r_e	$\frac{h_{11b} h_{22b} - h_{12b}(h_{21b} + 1)}{h_{22b}}$	$\frac{h_{12e}}{h_{22e}}$	$\frac{1 - h_{12e}}{h_{22e}}$
r_b	$\frac{h_{12b}}{h_{22b}}$	$\frac{h_{11e} h_{21e} - h_{12e}(h_{21e} + 1)}{h_{22e}}$	$\frac{h_{11e} h_{22e} + h_{21e}(1 - h_{12e})}{h_{22e}}$
r_c	$\frac{1 - h_{12b}}{h_{22b}}$	$\frac{1 + h_{21e}}{h_{22e}}$	$\frac{-h_{21e}}{h_{22e}}$
r_d	$\frac{1 + h_{21b}}{h_{22b}}$	$\frac{1 - h_{12e}}{h_{22e}}$	$\frac{h_{12e}}{h_{22e}}$
r_m	$-\left[\frac{h_{12b} + h_{21b}}{h_{22b}}\right]$	$\frac{h_{12e} + h_{21e}}{h_{22e}}$	$-\left[\frac{h_{12e} + h_{21e}}{h_{22e}}\right]$

TABLE IV z Parameters CB-CE-CC

	CE	CC
CB	$Z_{11e} = Z_{11b}$	$Z_{11e} = Z_{22b}$
	$Z_{12e} = Z_{11b} - Z_{12b}$	$Z_{12e} = Z_{22b} - Z_{21b}$
	$Z_{21e} = Z_{11b} - Z_{21b}$	$Z_{21e} = Z_{22b} - Z_{12b}$
	$Z_{22e} = Z_{11b} - Z_{21b} + Z_{22b}$	$Z_{22e} = Z_{11b} - Z_{12b} - Z_{21b} + Z_{22b}$

	CB	CC
CE	$Z_{11b} = Z_{11e}$	$Z_{11e} = Z_{11e} - Z_{12e} - Z_{21e} + Z_{22e}$
	$Z_{12b} = Z_{11e} - Z_{12e}$	$Z_{12e} = Z_{22e} - Z_{12e}$
	$Z_{21b} = Z_{11e} - Z_{21e}$	$Z_{21e} = Z_{22e} - Z_{21e}$
	$Z_{22b} = Z_{22e} - Z_{21e}$	$Z_{22e} = Z_{22e}$

	CB	CE
CC	$Z_{11b} = Z_{11e} - Z_{12e} - Z_{21e} + Z_{22e}$	$Z_{11e} = Z_{11e} - Z_{12e} - Z_{21e} + Z_{22e}$
	$Z_{12b} = Z_{11e} - Z_{12e}$	$Z_{12e} = Z_{22e} - Z_{12e}$
	$Z_{21b} = Z_{11e} - Z_{12e}$	$Z_{21e} = Z_{22e} - Z_{21e}$
	$Z_{22b} = Z_{11e}$	$Z_{22e} = Z_{22e}$



1. Push-pull class B on heat sink.
2. With heat sink.
3. Large signal current transfer ratio.
4. All characteristics for CE operation.
5. Two transistors class B push-pull.
6. h_{fe} current gain.
7. h_{fe}
8. Military Type.
9. Push-pull.
10. All characteristics for grounded base.
11. Alpha design center.
12. DC beta (min.)
13. Common emitter, 1 w. out at 100 C.
14. Design center.
15. Switch.

Characteristics

β or α	I_{co} (ma)	f_{co} (Mc)	pwr. gain (db)	pwr. out. (W)
18	0.03	0.1		12 ¹
24				
38				
18				
24				
38				
70 ³	-0.22		30 ⁵	12 ⁵
70 ³	-0.2		30 ⁵	12 ⁵
40 ⁶	5	0.4	23	0.6
			26	
	1	0.145	33	2
60 ⁷	3.0	0.01	32	3
60 ⁷	2	0.007	35	2
	5	0.005	35	2.5
60 ⁷	1	0.006	33	1.5
	2	0.007	30	
27 ⁶	0.2	0.004		
25 ⁷	15	0.003		
40 ⁶	0.5	0.15	28	3 ⁹
40 ⁶	0.5	0.15	28	3 ⁹
0.94 ¹¹	.005		30	
	.006			
	.008			
	.001			
0.97 ¹¹	.001			
0.94 ¹¹	.001			
0.94 ¹¹	.001			
0.94 ¹¹	.001		30	
0.94 ¹¹				
0.97 ¹¹				
3 ¹²	.01		28 ¹³	
10 ¹²	.01			
30	0.3	.012 ¹⁴	31	1.5
30	0.3	.012 ¹⁴	31	1.5
18	0.1	0.35		
17	0.08	0.4		
21	0.11	0.4		
20	0.09	0.45		
50	0.3	0.009	32	2.5
			24 ¹	26 ¹⁵
			23 ¹⁵	52 ¹⁵
			29 ¹⁵	54 ¹⁵
<20	15			
	0.07	0.2		

TABLE III r Parameters to h Parameters

	CB	CE	CC
h_{11}	$h_{11b} = r_e + r_b \left[\frac{r_o - r_m}{r_o + r_b} \right]$	$h_{11e} = r_b + r_e \left[\frac{r_d + r_m}{r_d + r_e} \right]$	$h_{11c} = r_b + \left[\frac{r_o r_e}{r_d + r_e} \right]$
h_{12}	$h_{12b} = \frac{r_b}{r_o + r_b}$	$h_{12e} = \frac{r_e}{r_d + r_e}$	$h_{12c} = \frac{r_d}{r_d + r_e}$
h_{21}	$h_{21b} = - \left[\frac{r_m + r_b}{r_o + r_b} \right]$	$h_{21e} = \frac{r_m - r_e}{r_d + r_e}$	$h_{21c} = - \left[\frac{r_e}{r_d + r_e} \right]$
h_{22}	$h_{22b} = \frac{1}{r_e + r_b}$	$h_{22e} = \frac{1}{r_d + r_e}$	$h_{22c} = \frac{1}{r_d + r_e}$

TABLE V r Parameters to z Parameters

	CB	CE	CC
z_{11}	$r_b + r_e$	$r_b + r_e$	$r_e + r_b$
z_{12}	r_b	r_e	r_d
z_{21}	$r_m + r_b$	$r_e - r_m$	r_e
z_{22}	$r_e + r_b$	$r_e + r_d$	$r_e + r_d$

TABLE VI h to z Conversion

$h_{11} = \frac{z_{11} z_{22} - z_{12} z_{21}}{z_{22}}$
$h_{12} = \frac{z_{12}}{z_{22}}$
$h_{21} = \frac{-z_{21}}{z_{22}}$
$h_{22} = \frac{1}{z_{22}}$

TABLE VII z to h Conversion

$z_{11} = \frac{h_{11} h_{22} - h_{12} h_{21}}{h_{22}}$
$z_{12} = \frac{h_{12}}{h_{22}}$
$z_{21} = \frac{-h_{21}}{h_{22}}$
$z_{22} = \frac{1}{h_{22}}$

TABLE VIII z Parameters to r Parameters

	CB	CE	CC
r_e	$z_{11b} - z_{12b}$	z_{12e}	$z_{22c} - z_{12c}$
r_b	z_{12b}	$z_{11e} - z_{12e}$	$z_{11c} - z_{21c}$
r_c	$z_{22b} - z_{12b}$	$z_{22e} - z_{21e}$	z_{21c}
r_d	$z_{22b} - z_{21b}$	$z_{22e} - z_{12e}$	z_{12c}
r_m	$z_{21b} - z_{12b}$	$z_{12e} - z_{21e}$	$z_{21c} - z_{12c}$



Types: IN536 thru IN540, IN1095



Types: IN456 thru IN459, IN461 thru IN464, IN482 thru IN488, A and B



Types: IN137A, IN138A, IN200 thru IN222, IN431, IN465 thru IN470, ZA8 thru ZA125. Double anode types IN471 thru IN475, IN225 thru IN235. (Silicon Junction Diodes will also be available in axial glass package)



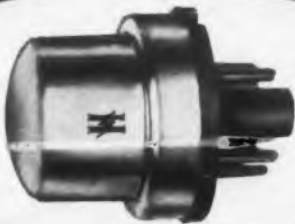
Type: IN429



Types: IN430, IN430A, IN430B



Types: HMP1 thru HMP5 and 1A thru 5A; HDMP4 thru HDMP10 and 4A thru 10A



Types: HFWR1 thru HFWR3



Types: HZPR in Zener Voltage, voltages between 10 and 100 volts



CIRCLE 508 ON READER-SERVICE CARD FOR MORE INFORMATION

Curve Tracers

Manufacturer and Model	Maximum Base Current	Max. Collector Sweep Current and Frequency	Max. Coll. Sweep Power	Min. Load Resistance	Max. Sweep Volts	Auxiliary Equip. Needed	Characteristics Displayed	Internal Calib.	Accuracy	Price and Delivery	Size and Weight
American Electronic Lab.											
121 North Seventh Street Philadelphia 6, Pennsylvania											
126H	600 ma	3 a 60 cps	30 w	—	150 v	Scope	Output, Input	Yes	—	\$1,090.00 4 weeks	19" x 21" x 32" 150 pounds
126R	600 ma	15 a 60 cps	200 w	—	200 v	Scope	Output, Input	Yes	—	\$1,250.00 10 weeks (Oscilloscope \$425 extra)	19" x 21" x 32" 170 pounds
Cubic Corporation											
5575 Kearney Villa Road San Diego, 11 California											
504	.7 ma	1/30 a 600 cps	1/2 w	—	18 v	Scope	Output	No	—	\$325.00 30 days	2" x 3" x 8" 1 pound
Dunn Engineering Associates, Inc.											
186 Massachusetts Avenue Cambridge 39, Massachusetts											
331	1 ma	250 cps or 25 cps Triangular Waveform	—	1,300 ohm	50 v	Scope	Output, Transfer	Yes	3%	\$750.00 1 week	21" x 11" x 14" 65 pounds
Fairchild Guided Missiles Div.											
Wyandanch, L. I., New York											
103A	10 ma	1/4 a 60 cps	2.5 w	—	100 v	Scope	Output, Transfer	Yes	5%	\$650.00 30 days	19" x 13" x 10" 35 pounds
Magnetic Amplifiers											
632 Tinton Avenue New York 55, New York											
200A	10 ma	1/10 a 60 cps	2 w	100 ohm	100 v	Scope	Output, Transfer	Yes	2 1/2%	\$685.00 10 days	16" x 10" x 8" 18 pounds !
300A	200 ma	2 a 60 cps	5 w	1 ohm	100 v	Scope	Output, Transfer	Yes	2 1/2%	\$785.00 45 days	16" x 10" x 13" 28 pounds
Norden-Ketay Corporation											
Instrument and Systems Division Wiley Street Milford, Connecticut											
BC T-300	110 ma	8 a 60 cps	20 w	1/10 ohm	267 v	Scope	Output, Transfer	Yes	2%	\$795.00 30 days	19" x 9" x 14" 35 pounds
Polyphase Instrument Company											
East Fourth Street Bridgeport, Pennsylvania											
TA-3A	1.2 ma	1/10 a 120 cps	10 w	—	150 v	Scope	Output, Input	Yes	—	\$645.00 6 weeks	19" x 19" x 10" 50 pounds (approx.)
TA-13	450 ma	10 a 60 cps	1,560 w	Less than 1 ohm	150 v	Scope	Output, Input, Transfer	Yes	—	\$3,600.00	19" x 60" x 15" 250 pounds (approx.)
TA-11		20 a	3000 w	—	150 v	Scope	Output, Transfer	Yes	—	\$1,450.00	—
R. C. A.											
Harrison, New Jersey											
811C-1	1,000 ma	1 a, 60 cps 1/2 wave	300 w	—	1,000 v	None	Output, Transfer	Yes	—	\$6,500.00 10 months	19" x 21" x 32" 140 pounds (approx.)
Tektronix											
Portland 7, Oregon											
575	2,400 ma	10 a 60 cps	200 w	1 ohm	200 v	None	Output, Input, Transfer	Yes	3%	\$925.00 6 months	13" x 17" x 24" 70 pounds
Senex, Incorporated											
73 S. State Road Upper Darby, Pennsylvania											
CT-103	0.5 ma	15 ma 60 cps	1.5 w	—	100 v	Scope	Output	Yes	5%	\$135.00 immediate	10" x 8" x 8" 13 pounds

Transistor Test Equipment Survey

Soren C. Ibsen
Norden-Ketay Corp.
Milford, Conn.

THE TRANSISTOR test equipment field is keeping abreast of the dynamic semi-conductor growth by providing a large variety of instruments. The equipment power handling capabilities have a spread of 1/2 watt to 1560 watts; whereas, the weight of the instruments have extremes of 1 pound to 250 pounds. The units vary in price from \$125.00 to \$6,500.00. This variety has been dictated by the exponential growth of transistors themselves. Point contact types have been replaced with junctions and other transistors. Power transistors with dissipation ratings above 50 watts have outclassed their predecessors.

This power handling capability is the strongest underlying trend in Transistor Test Equipment for 1957. This high power need is met by some manufacturers by offering two separate models while others have upgraded their equipment to cover the entire span.

The 33 commercially available models built by 21 manufacturers tend to align themselves into four general categories: Curve Tracers, Parameter-Analyzers, Portable Test Sets, and Miscellaneous types. In each category, many performance differences are found among the instruments and they should be compared as to their individual merits.

Curve Tracers usually employ 60 cycle sweep power to produce the transistor characteristic curves for oscilloscope display. Sweep power varies greatly among units. If large power is available in the sweep circuit, then small transistor load resistance is necessary for the proper hybrid impedance termination. On the other hand, high sweep voltage is vital for transistor breakdown measurements and a transistor collector voltage of above 250 volts may be required. The accuracy specification should be evaluated with the oscilloscope tolerance included.

Parameter-Analyzers generally operate by small signal measuring techniques. Metered input and output bias supplies provide the transistor dc operating point under consideration. The transistor is connected in either the grounded base or grounding emitter configuration, with bias appropriate for pnp or npn types. A small internal audio test signal is properly applied to the transistor, detected, and converted to

HIGH QUALITY DIODES AND TRANSISTORS MUST HAVE CONSISTENTLY HIGH QUALITY WELDS

*Raytheon subminiature
precision welding systems
provide extremely uniform
production—from the 1st to
the 1,000,000th unit.*

The four difficult welds shown here are being performed with Raytheon precision welding equipment at the rate of 25,000 units a day by the diode division of a major electronics manufacturer.* In addition to joining the components of these diodes, the welding also seals them hermetically. Statistical sampling of production runs consistently meets JETEC specifications for high quality welds.

Raytheon AC and DC power supplies, controls, welding heads and transformers have been proved in applications where high speed, low cost, precision welding is required. Millions of tubes, transistors, diodes, relays, instruments, capacitors and resistors have been produced with Raytheon welders—designed and produced by *electronic* engineers for use in electronic manufacture.

Learn how Raytheon can help you solve your production problems; have your own samples processed in our Welding Application Laboratory. Write Dept. 6120ED.

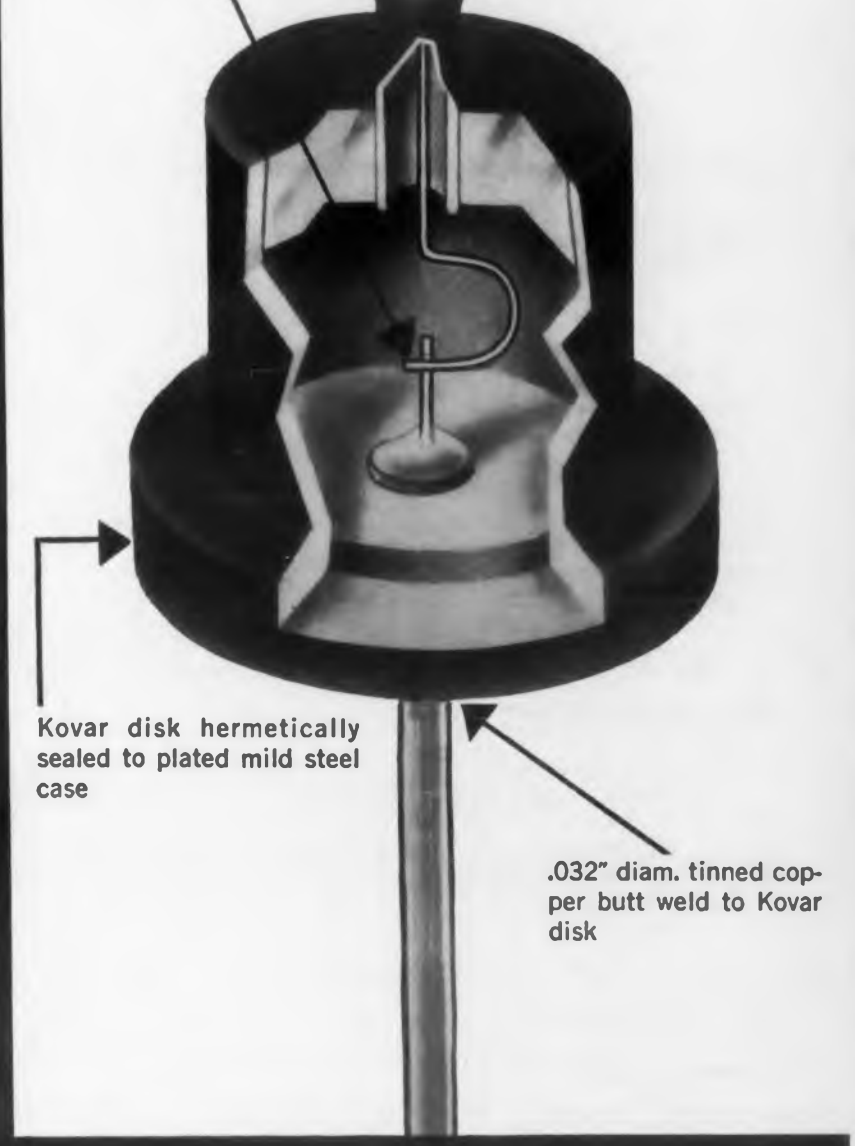
*Name on request

Raytheon production equipment for the electronic industry—AC and DC welding equipment • Automatic welding systems • Magnetizers • Ultrasonic Impact Grinders
CIRCLE 509 ON READER-SERVICE CARD FOR MORE INFORMATION

TYPICAL DIODE
ASSEMBLY —
four welds performed
with Raytheon precision
welding equipment

.010" diam. soft annealed
nickel wire to tungsten
spike

Pinch-off weld joining
.010" diam. annealed
nickel wire, .032" diam.
tinned copper wire and
hermetically sealing
both in Kovar tube



Kovar disk hermetically
sealed to plated mild steel
case

.032" diam. tinned cop-
per butt weld to Kovar
disk

RAYTHEON MANUFACTURING COMPANY

Commercial Equipment Division

Waltham 54, Mass.

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hybrid parameters for meter readout. Microampere test signals and true hybrid ac termination are mandatory for precision measurements with accuracy of better than ± 5 percent.

Analyzers vary in that some require external signal generators and vtvm detection while others are self-contained. The dc bias capability is an important variation when high power transistors are to be measured. The range of parameter measurement is vital if

the instrument is to test all transistors commercially available. One instrument has combined the parameter analyzing with that of curve tracing to provide a highly versatile Transistor Test Set.

Portable test sets are generally simplified parameter-analyzers in that the units provide only one or two parameters with the primary function of go-no-go testing. Some units are only dc static test instruments. The input bias current is limited and collector volt-

age is low. Battery operation is standard. The accuracy is normally not better than ± 5 percent.

How should a transistor be evaluated? The actual transistor user is the best judge as to what transistor characteristics are vital to his particular applications. He must further compromise as to whether a curve display is superior to a meter reading. Then questions as to instrument range, accuracy, flexibility, completeness and price become deciding factors.

Portable Test Sets

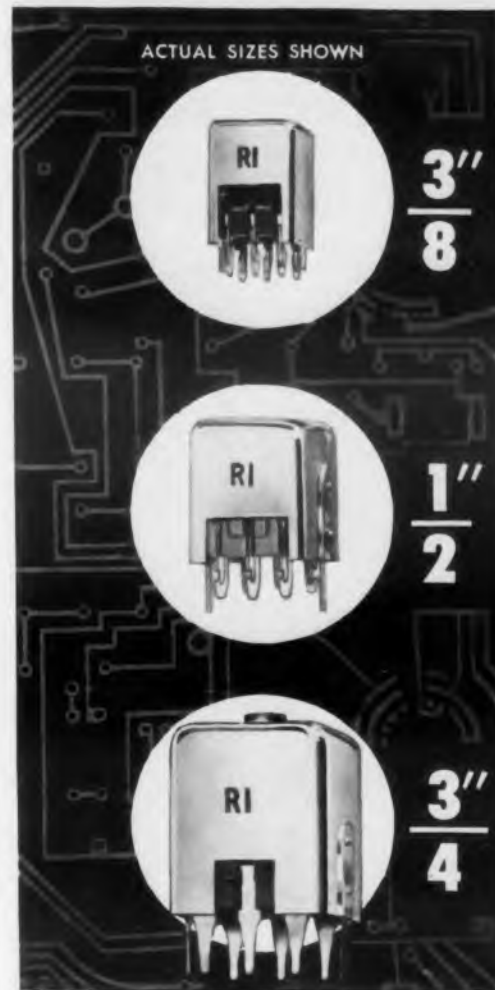
Manufacturer Model No.	Maximum DC Base Current	Maximum DC Collector Voltage	Test Frequency	Characteristics Displayed	Maximum Beta Range	Accuracy	Battery Operated	Size and Weight	Price and Delivery
Baird Atomic, Incorporated Cambridge, Massachusetts KT-1	10 ma	7½ v	1 kc	Beta, H_{11} , I_{co}	200	3%	Yes	6" x 5" x 11"	\$175.00 30 days
C. G. Electronics 305 Dallas Street Albuquerque, New Mexico TR-2	10 ma	12 v	1 kc	Alpha, Beta, I_{co}	1 000	—	Yes	4" x 4" x 8" 3 pounds	\$124.50 15 days
Electronic Research Associates, Inc. 67 East Centre Street Nutley, New Jersey AT-10	10 ma	100 v	240 cps (External Oscillator to 5 mc)	Alpha, Beta	100	5%	No	8" x 11" x 8" 17 pounds	\$385.00 60 days
Davenco, Incorporated 150 Broadway New York 38, New York TT-1	—	4½ v	270 cps	Beta	100	—	Yes	9" x 6" x 6" 9 pounds	\$125.00 8 weeks
Measurements Corporation Boonton, New Jersey 505	70 ma	12 v	DC	I_{co} , Beta, G_m , H_{11}	200	—	Yes	10" x 14" x 7" 9 pounds	—
Metronic, Incorporated Mill Lane Waterford, Connecticut 545	100 ma	5.2 v External to 25 v	1 kc	Beta, I_{co}	250	3%	Yes	7" x 11" x 7" 8 pounds	\$210.00 4 weeks
Sonex, Incorporated 73 S. State Road Upper Darby, Pennsylvania TT-205	2 ma	20 v	1 kc (External Osc. 0.25 to 5 kc)	Beta, I_{co} , R_c	150 (Larger as calibrated)	5%	Yes	14" x 8" x 8" 19 pounds	\$155.00 immediate
Quantum Electronics, Incorporated 1921 Virginia Street Albuquerque, New Mexico Mod. V	100 ma	5.36 v	2 kc	I_{co} , Beta	1,000	5%	Yes	5" x 7" x 10" 5½ pounds	\$295.00 90 days
Durson Company 10416 National Blvd. Los Angeles 34, Calif. 201	10 ma	5 v	—	Beta, I_{co}	500	—	Yes	10" x 7" x 5" 10 pounds	\$190.00

CROSS INDEX

Amperex	Am	Minneapolis-	
Bendix	Be	Honeywell	MH
Bogue	Bo	Motorola	Mo
British Thomson-		Mullard	Mu
Houston	BTH	Nucleonic	Nu
CBS-Hytron	CBS	PYE Electronics	PYE
Clevite	C	Raytheon	Ra
Delco		Sprague	Sp
Fretco		Sylvania	Sy
General Electric	GE	Texas Instrument	TI
General Electric		Transitron	Tr
Co. Ltd.	GL	Tung-Sol	TS
General Transistor	GT	Western Electric	WE
Intel Systems	IS	Westinghouse	Wh
Lansdale Tube			
(Philco)	LT		

1N85	WE	2N123	GE
2N29	WE	2N128	LT
2N32	Fr	2N129	LT
2N33	Fr	2N130	Ra
2N34	Fr, Sy	2N130A	Ra
2N35	Fr, Sy	2N131	Ra
2N36	Fr	2N131A	Ra
2N37	Fr	2N132	Ra
2N38	Fr	2N132A	Ra
2N43	GE	2N133	Ra
2N43A	GT, GE	2N133A	Ra
2N44	GT, GE	2N138A	Ra
2N45	GE	2N139	RCA
2N59	Wh	2N140	RCA
2N60	Wh	2N141	Sy
2N61	Wh	2N142	Sy
2N63	Ra, TS	2N143	Sy
2N64	Ra, TS	2N144	Sy
2N65	Ra, TS	2N145	TI
2N66	WE	2N146	TI
2N67	WE	2N147	TI
2N68	Sy	2N148	TI
2N77	RCA	2N149	TI
2N78	GE	2N150	TI
2N83	Tr	2N155	CBS, Nu, Sy
2N83A	Tr	2N156	CBS
2N84	Tr	2N158	CBS
2N84A	Tr	2N159/5A	Sp
2N94	Sy	2N160	Bo
2N94A	Sy	2N160A	Bo
2N95	Sy	2N161	Bo
2N97	Bo	2N161A	Bo
2N98	Bo	2N162	Bo
2N99	Bo	2N162A	Bo
2N101	Sy	2N163	Bo
2N102	Sy	2N163A	Bo
2N103	Bo	2N164A	GE
2N104	RCA	2N165	GE
2N105	RCA	2N167	GE
2N106	Ra	2N168A	GE
2N109/2N217	Am, RCA	2N169	GE
2N110	WE	2N169A	GE
2N111	Ra	2N172	TI
2N111A	Ra	2N173	De
2N112	Ra	2N174	De
2N112A	Ra	2N175	RCA
2N113	Ra	2N176	Sy, Mo
2N114	Ra	2N180	CBS

for your transistorized circuits . . .

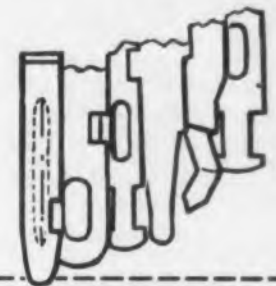


RI I. F. TRANSFORMERS

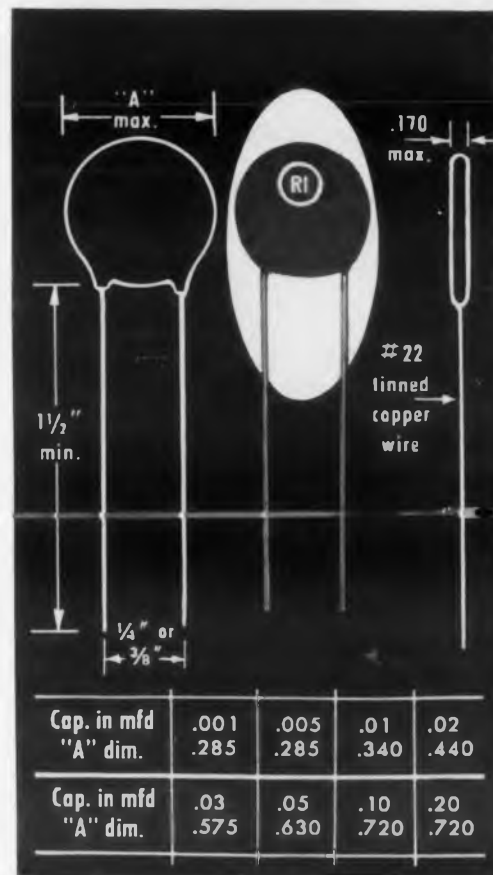
custom-built to the Q you require with the low cost advantages of mass production . . . in 3/8", 1/2" and 3/4" sizes

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 . . .



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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.

5225 no. ravenwood ave. • chicago 40, illinois
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CIRCLE 510 ON READER-SERVICE CARD FOR MORE INFORMATION

Parameter Analyzers

Manufacturer and Model	Max. DC Base Current	Max. DC Collector Power	Max. DC Collector Voltage Current	Parameters Measured (gb and ge, NPN and PNP)	Range of Measurement	Transistor Bias Terminations (Output)	Maximum Frequency Range	Accuracy	External Equipment Required	Size and Weight	Battery Operated	Price and Delivery
Baird Associates 73 University Road Cambridge, Massachusetts GP-4	5 ma	1/2 w	45 v 5 ma	H ₁₁ , H ₁₂ , H ₂₁ , H ₂₂ , I _{co}	H ₁₁ to 3K ohm H ₂₁ to 1,000	—	(ge) - 200 kc (gb) - 1 mc	5%	Osc. VTVM	22" x 10" x 13" 70 pounds	Yes	\$475.00 30 days
KP-1	200 ma	30 w	100 v 300 ma	H ₁₁ , H ₁₂ , H ₂₁ , H ₂₂ , I _{co}	H ₁₁ to 3K ohm H ₂₁ to 1,000	—	200 kc	5%	Osc. VTVM	22" x 22" x 15" 100 pounds	No	\$795.00 90 days
Quantum Electronics 1921 Virginia Avenue Albuquerque, New Mexico PTA #3	1,500 ma	75 w (Regulated)	32 v 15 a	H ₂₁ , (ge only)	H ₂₁ to 1,000	—	DC Tests	—	None	47" x 21" x 24" 200 pounds	No	\$3,475.00 120 days
Norden-Ketay Corporation Instrument & Systems Division Wiley Street Milford, Connecticut BCT-300 (See Curve Tracer)	10 ma	2 w	100 v 20 ma	H ₂₁ , H ₁₁	H ₁₁ to 10K ohms H ₂₁ to 1,000	100 ohm	1 mc ge or gb	3%	Osc. VTVM	19" x 8" x 14" 35 pounds	No	\$795.00 30 days
BTS-400	1,000 ma	60 w	150 v 6 a	H ₁₁ , H ₁₂ , H ₂₁ , H ₂₂ (Real and Imaginary) I _{co} , I _{ceor} , I _{ces}	H ₁₁ to 100K ohms H ₂₁ to 1,000	1 ohm	2 mc with external Oscillator, ge or gb	2%	None	19" x 14" x 15" 80 pounds	No	\$2,495.00 6 months
Owens Laboratories 55 Beacon Place Pasadena, California 210	7 1/2 ma	—	75 v	H ₁₁ , H ₁₂ , H ₂₂ , H ₂₁ , I _{co}	H ₁₁ to 1K H ₂₁ to 1,000	5 ohms	1 mc with external Oscillator, VTVM	5%	None	15" x 13" x 4" 18 pounds	No	\$475.00 30 days

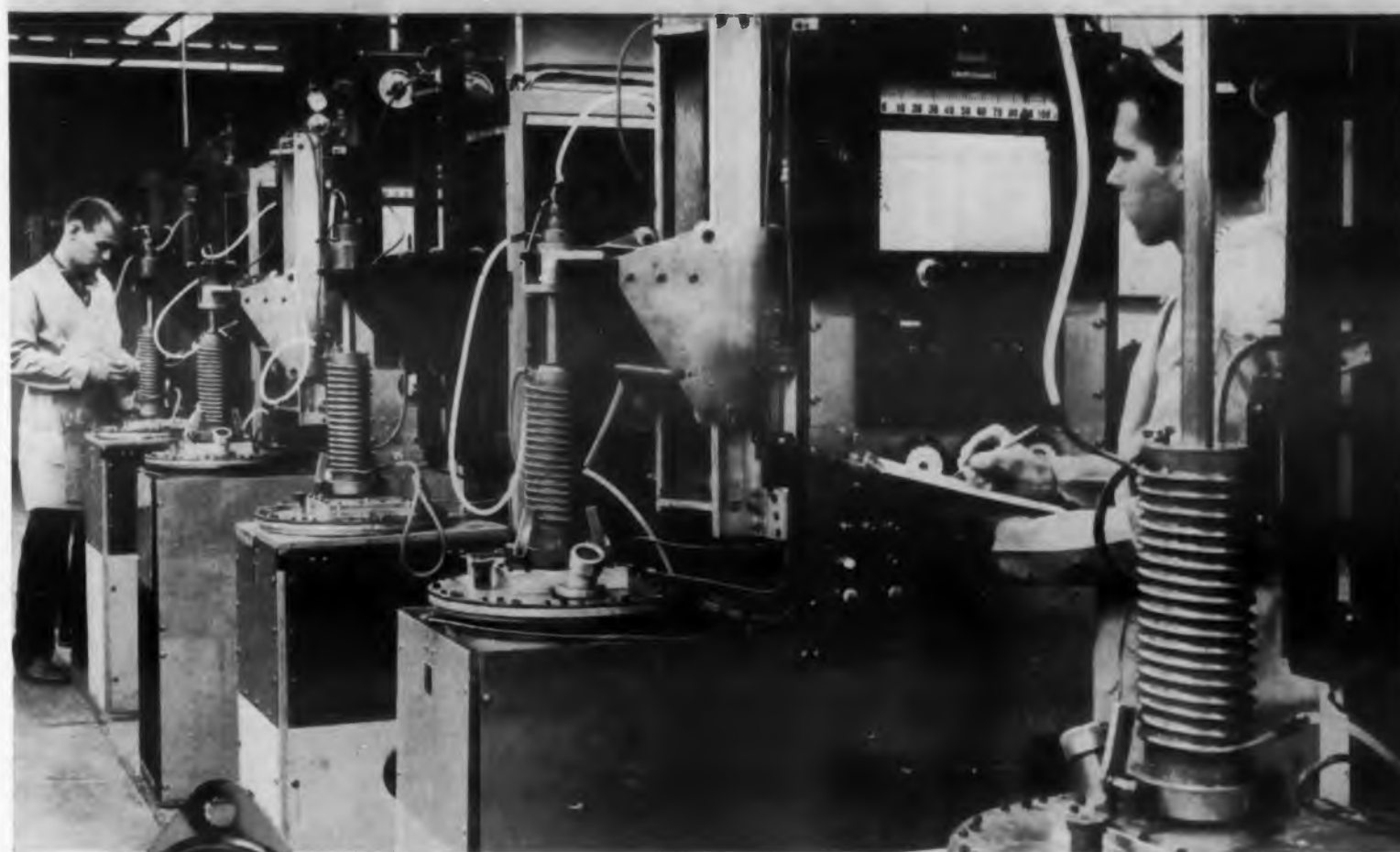
Miscellaneous Test Equipment

Manufacturer Model	Description	Test Performed	Price and Delivery
Electronic Measurements Lewis Street Eatontown, New Jersey 200 Series	Power Pack for Transistors.	Provides voltage to 100 v and 3000 ma regulated to 1/10 ohm output impedance. Input modulations jacks available for coefficient measurements.	—
Electronic Research Assoc. Incorporated 69 East Center Street Nutley, New Jersey NET	Transistor Noise figure meter.	Range of 60 db at 1000 cps with 1 cycle band-width. DC input bias to 10 ma.	\$775.00 4 weeks
Key Electric Maple Avenue Pine Brook, New Jersey 970A	Alpha versus frequency Curve Tracer. Combine bias controls with "Mega-Sweep" generator (50 mc).	DC input bias to 10 ma. Output bias 25 ma and 50 volts. Auxiliary Oscilloscope required.	\$1,595.00 60 days
Polyphase East Fourth Street Bridgeport, Pennsylvania TA-1B	Alpha and Beta versus input current Curve Tracer. Metered Beta, Alpha and I _{co} .	DC input bias to 15 ma. Output bias to 30 ma and 100 v.	\$1,225.00 4 weeks
TA-10	Unijunction transistor or diode curve tracer; power supply.	Interbase or power pack, 0-100 v, 0-100 ma. Emitter to 150 v. Scope required.	\$395.00

INDEX (Cont.)

2N181	CBS	2N218	RCA
2N182	CBS	2N219	RCA
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2N186	GE	2N225	LT
2N186A	GE	2N226	LT
2N187	GE	2N227	LT
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2N212	Sy	2N250	Sy, TI
2N213	Sy	2N251	TI
2N214	Sy	2N252	TI
2N215	RCA	2N253	TI
2N216	Sy	2N254	TI
2N217	RCA	2N255	CBS

VOLUME PRODUCTION OF SUPERIOR CRYSTALS



improves quality...lowers cost of MOTOROLA TRANSISTORS

This battery of mechanized furnaces, developed by Motorola, produces crystals of extreme quality . . . in quantities necessary for Motorola's mass production of transistors. Crystals are outstanding in uniformity of structure and characteristics—contributing to exceptional transistor performance.

PRODUCTIONEERED

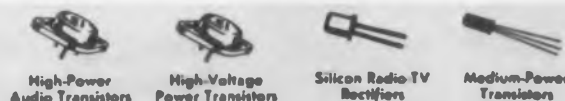
A unique combination of solid-state knowledge and production skill enables Motorola to "productioneer" transistors and other semiconductor devices for extreme *quality* . . . in *quantity*. This assures you a dependable supply of finest quality units . . . at the most competitive prices.

Advanced crystal growing techniques are only one example of Motorola's excellence in semiconductor research, development and production. For complete data concerning Motorola semiconductors . . . or for applications information, write, wire or phone Motorola, Inc., 5005 E. McDowell Road, Phoenix, Arizona. BRidge 5-4411

CHALLENGING PROFESSIONAL CAREER OPPORTUNITIES ARE AVAILABLE

. . . for experienced engineers and scientists with Motorola's rapidly expanding semiconductor team in the Valley of the Sun. For complete information write in confidence to Mr. V. Sorenson, Dept. 10, 5005 E. McDowell, Phoenix, Arizona.

Motorola
Quality Products
Include:



CIRCLE 511 ON READER-SERVICE CARD FOR MORE INFORMATION

2N256	CBS	2N348	Bo
2N257	C, Sy	2N349	Bo
2N263	TI	2N350	Nu
2N265	GE	2N352/T1040	LT
2N268	C	2N353/T1041	LT
2N269	RCA	2N354/T1025	LT
2N270	RCA	2N355/T1159	LT
2N271	Ra	2N356	GT
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2N272	Ra	2N358	GT
2N273	Ra	2N377	Sy
2N277	De	2N385	Sy
2N278	De	2N386/T1167	LT
2N279	Am	2N387/T1168	LT
2N280	Am	2N388	Sy
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2N282	Am	2N393/T1166	LT
2N283	Am	2N402	Wh
2N284	Am	2N403	Wh
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2N292	GE	3N31	GE
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2N309	TI	4JD5A1	GE
2N310	TI	8D/2N43	Sp
2N311	GT	8E/2N44	Sp
2N312	GT	8F/2N45	Sp
2N313	GE	8G	Sp
2N314	GE	903/2N117, 2N332	TI
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2N317	GT	2N334	TI
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2N319	GE	910/2N336	TI
2N320	GE	925/3N26	TI
2N321	GE	926/3N27	TI
2N322	GE	951/2N339	TI
2N323	GE	952/2N340	TI
2N324	GE	953/2N341	TI
2N325	Sy	970	TI
2N326	Sy	10A	Sp
2N327	Ra	10B	Sp
2N328	Ra	10C	Sp
2N329	Ra	B114	Be
2N330	Ra	CK751	Ra
2N332	TI	CK768	Ra
2N333	TI	CK870	Ra
2N334	TI	CK871	Ra
2N335	TI	CTP1117	C
2N336	TI	GA52829	WE
2N337	TI	GA52830	WE
2N338	TI	GA53080	WE
2N339	TI	GA53242	WE
2N340	TI	GA53149	WE
2N341	TI	GA53233	WE
2N342	TI	GA53270	WE
2N343	TI	GET3	GL
2N344/SB101	LT	GET4	GL
2N345/SB102	LT	GET5	GL
2N346/SB103	LT	GET6	GL
2N347	Bo	GET7	GL

More power for its size than any other transistor

Honeywell Weld-Seal 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 Weld-Seal Transistors is your best answer.

Honeywell Weld-Seal Transistors combine smaller size per power output with greatest flexibility and interchangeability.

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.

Honeywell Weld-Seal Transistors are hermetically sealed by *welding*—so you can build new ruggedness and durability into your equipment. You get long life along with outstanding performance.

For complete information on the Honeywell transistor line, write or phone your nearest Honeywell representative:

UNION, N. J.
MURdock 8-9000
P.O. Box 161

CHICAGO
IRving 8-9266
7350 N. Lincoln Ave.

BOSTON
ALgonquin 4-8730
1230 Soldier Field Rd.

MINNEAPOLIS
FEderal 2-5225
2749 4th Ave. So.

LOS ANGELES
RAmond 3-6611 or
PArkview 8-7311
6620 Telegraph Rd.



Honeywell Weld-Seal H6 Transistors make this 48-watt, 14 ounce D. C. Power Converter more compact than any other.

Note these new specifications—developed with
the design engineer in mind

	H5	H6	H7
Input Resistance	24—48 ohms	27— 54 ohms	30— 60 ohms
Power Conductance	17.5—52 mhos	35—105 mhos	71—213 mhos
Current Gain, Median	30	40	60

(At a collector current of 2 amps.)

The H6 and H7 Transistors are available for immediate delivery.

Honeywell

H First in Controls

CIRCLE 512 ON READER-SERVICE CARD FOR MORE INFORMATION

INDEX (Cont.)

GET8	GL	OC45/2N140	Mu, Am
GET9	GL	OC65/2N130	Am
GET10	GL	OC66/2N131	Am
GET15	GL	OC70	Mu
GT1	BTH	OC71	Mu
GT2	BTH	OC72	Mu
GT3	BTH	OC73	Mu
GT11	BTH	OC76	Mu
GT12	BTH	OCP71	Mu
GT13	BTH	PC6	Sp
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GT81	GT	ST33	Tr
GT81HS	GT	ST40	Tr
GT82	GT	ST41	Tr
GT83	GT	ST42	Tr
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GT88	GT	T0033	LT
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GT122	GT	TJ1	IS
GT123	GT	TJ2	IS
GT153	GT	TJ3	IS
GT167	GT	TP1	IS
GT210H	GT	TP2	IS
GT222	GT	TS1	IS
GT229	GT	TS2	IS
GT269	GT	TS3	IS
GT758	GT	TS176/2N242	TS
GT759	GT	TS612/2N378	TS
GT759R	GT	TS613/2N379	TS
GT760	GT	TS614/2N380	TS
GT760R	GT	TS615/2N44	TS
GT761	GT	TS616/2N381	TS
GT761R	GT	TS617/2N382	TS
GT762R	GT	TS618/2N383	TS
GT762	GT	TS619	TS
GT763	GT	TS620/2N64	TS
GT764	GT	TS621/2N65	TS
GT792	GT	V6-R2	PYE
GT903	GT	V6-R4	PYE
GT904	GT	V6-R8	PYE
GT905	GT	V10-15A	PYE
GT947	GT	V10-30	PYE
GT948	GT	V10-50B	PYE
GT949	GT	V15-10P	PYE
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H4A	MH	V15-30P	PYE
H5	MH	V30-10P	PYE
H6	MH	V30-20P	PYE
H7	MH	V30-30P	PYE
H10	MH	X30A	Bo
MN13A	Mo	X31A	Bo
MN13B	Mo	X32A	Bo
MN13C	Mo	X110	Be
MN21	Mo	X113	Be
MN24	Mo	X119	Be
MN25	Mo	X133	Be
MN26	Mo	X134	Be
MN28	Mo	X137	Be
MN29	Mo	X140	Be
OC44/2N139	Mu, Am	X145	Be
		XD5081/XD5082	Wh

Color Drafting Pencils

Draw Permanent or Temporary Lines

The first of these pencils is called the Non-Print. Its translucent, colored lead makes a line that drops out when a translucent original or master is reproduced by processes such as blueprint, brownprint, and Ozalid. The pencil provides freedom to sketch and make notes on drawings without having to worry about cleaning up before the drawings are reproduced. The pencil has a fine point and supplies a contrasting color that will not fade or smear. The function of another model, called the Lumochrom, is entirely different. The Lumochrom comes in 24 colors, including white, and all of its colors reproduce perfectly. Because of this it enables draftsmen to distinguish quickly between numerous different elements shown on their masters by means of their color contrast.

J. S. Staedtler, Inc., Dept. ED, Hackensack, N.J.

CIRCLE 136 ON READER-SERVICE CARD

Pen-Size Oiler

For Exact Lubrication

Designed like a fountain pen, this oiler delivers exact amounts of oil as small as a fraction of a drop. It operates in holes up to 7/8 in. in depth and other out-of-the-way places ordinarily difficult to reach. The oiler can be used either vertically or horizontally for both holes and surface application. The oil supply is clearly visible in the transparent reservoir, and one filling provides a supply for long periods. In operation, the spring controlled steel point of the unit is pressed against the spot to be oiled, then released. A fraction of a drop is thus automatically ejected, and if more is required, repeated pressing will deliver the exact amount.

Dill Mfg. Co., Dept. ED, 700 E. 82nd St., Cleveland, Ohio.

CIRCLE 137 ON READER-SERVICE CARD

CIRCLE 138 ON READER-SERVICE CARD ➤

INSURING RF SIGNAL RECEPTION AND TRANSMISSION IN THE LOCKHEED X-17 TEST MISSILE

The Rheem REL-09 Miniature RF Power Amplifier has been used in the X-17 test missile since the inception of the project.

The REL-09 provides power amplification over the 215-235 mc telemetering band. With 1.4 watts input drive, it will deliver an 11-watt output to a 52-ohm load. Grid and plate tuning controls are accessible from the front plate. Automatic protection is provided against damage resulting from loss of drive or plate power. Power leads contain 84-db attenuation filters. No cooling or shock mounting is required.

For further information, write direct to Rheem or contact your area sales representative:

North Central

Sam Robbins, Inc.
230 East 1st Street, Flint 2, Michigan

Florida

Arthur H. Lynch & Associates
P.O. Box 466, Fort Myers, Florida

New England and New York State

Electronics Associates, Inc.
200 5th Street, Stamford, Conn.

Central East Coast

F. R. Jodon, Inc.
8510 Beech Tree Road, Washington 14, D.C.

Southwest, Rockies and State of Washington

George E. Harris & Co., Inc.
3241 East Douglas, Wichita 8, Kansas



**ELECTRONICS DIVISION
RHEEM MANUFACTURING COMPANY**



THE LOCKHEED X-17 TEST MISSILE

The X-17 provides information on the problems which arise when the war-head of a ballistic missile re-enters the earth's atmosphere at high speed.



7777 Industry Avenue, Rivera, California

NO MORE EXTERNAL BOOSTER AMPLIFIERS...



with the new combination resolver-booster by *Reeves* INSTRUMENT CORPORATION

specifications

Transformation ratio: $1.000 \pm .001$
Phase shift: $0^\circ \pm 3'$
Functional accuracy: 0.1%
Input impedance: over 8 megohms
Frequency: 400 c.p.s. $\pm 5\%$
Max. amplitude: 14 V. r.m.s.
Temp. range: $-55^\circ \text{C. to } 80^\circ \text{C.}$
Power requirements:
30 V. d.c. @ 6 ma. per amplifier

An outstanding advance in MINIATURIZATION without sacrifice of performance or precision.

Shown FULL SIZE in the illustration above, this latest Reeves achievement in miniaturization for airborne applications takes up a fraction of the space occupied by a conventional resolver with external boosters. Yet performance, accuracy and dependability are in every way equivalent or better.

The new Reeves Combination Resolver-Booster consists of the time-proven R151 Precision Resolver with two PLUG-IN TRANSISTORIZED BOOSTER AMPLIFIERS built into it as shown. The amplifiers provide standardization for transformation ratio and phase shift over a wide range of temperatures. Specifications given are maintained for production units without culling. Additional data on request.

REEVES CONTINUOUS RESOLVER CHECKER



Provides continuous 360° check on resolver functional accuracy, and yields permanent record of results.



REEVES INSTRUMENT CORPORATION

A SUBSIDIARY OF DYNAMICS CORP. OF AMERICA, 223 EAST 91st ST., NEW YORK 28, N. Y.

CIRCLE 140 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

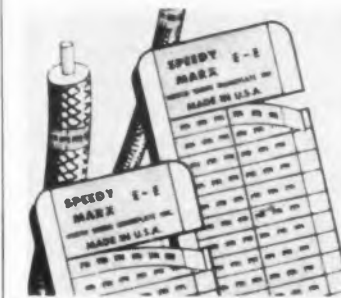


Thermocouple
Higher Voltage Output

The Super-Clad thermocouple is said to generate greater electrical output than standard thermocouples. The unit, which is interchangeable on all standard pilots, is designed to eliminate service calls caused by pilot outages and to insure positive holding action. Improved thermo-electric alloys are used to gain increased voltage output. The plating protects the copper from heat and prevents oxidation. The unit has 24 cooling fins to create a greater temperature differential. Tin plating on the contact end provides good electrical conduction.

Robertshaw-Fulton Controls Co., Dept. ED, Grayson Controls Div., Long Beach 5, Calif.

CIRCLE 141 ON READER-SERVICE CARD FOR MORE INFORMATION



Wire Markers
Aluminum Foil

Speedy Marx, aluminum foil wire markers, are furnished on quick-release dispensing cards which have been pre-cut for easy handling, and can be applied instantly without tools. Flexible aluminum markers offer users double sticking action. A thermosetting adhesive retains its bonding action up to temperatures of 350 F, and the mechanical action of the aluminum as it wraps around wiring will remain unaffected by solvents, grease or coolants. Large diameter wire and cable, or pipe and tube, can be coded with aluminum markers. A transparent plastic coating is applied to marker surfaces after imprinting to protect symbols against abrasions, water or dirt. Two sizes are available: 1-1/2 in. markers for wires over 1/4 in. OD, 3/4 in. markers for wires under 1/4 in. OD. Special sizes, shapes and colors can also be furnished.

North Shore Nameplate, Inc., Dept. 214-27 Northern Blvd., Bayside 61, N.Y.

CIRCLE 142 ON READER-SERVICE CARD FOR MORE INFORMATION



Pulling Elbow
For Corner Wiring

The Pulling Elbow permits easy wiring. Wires are slipped straight through conduit and out one hub. A big loop of wires is made and again pushed through hub and conduit. The wires are pulled out from the other end of system. The cover attaches quickly with big screws and will open easily. The Elbow is made of top quality malleable iron with heavy cadmium plated finish. Full neoprene gaskets and large cover screws designed to fit snugly in opposed corners without protruding inside. In addition, the cover is domed for greater rigidity and provides more wire area inside elbow. Smooth ground surfaces provide better cover and gasket seal. Hubs have precision tapered pipe threads and are positioned exactly 90 deg from center. The smooth inside surfaces eliminate the possibility of skinning insulation on wire when it is pulled through electrical system.

Ideal-Simplet Fittings, Inc., Dept. ED, 5098 Park Ave., Sycamore, Ill.

CIRCLE 144 ON READER-SERVICE CARD FOR MORE INFORMATION

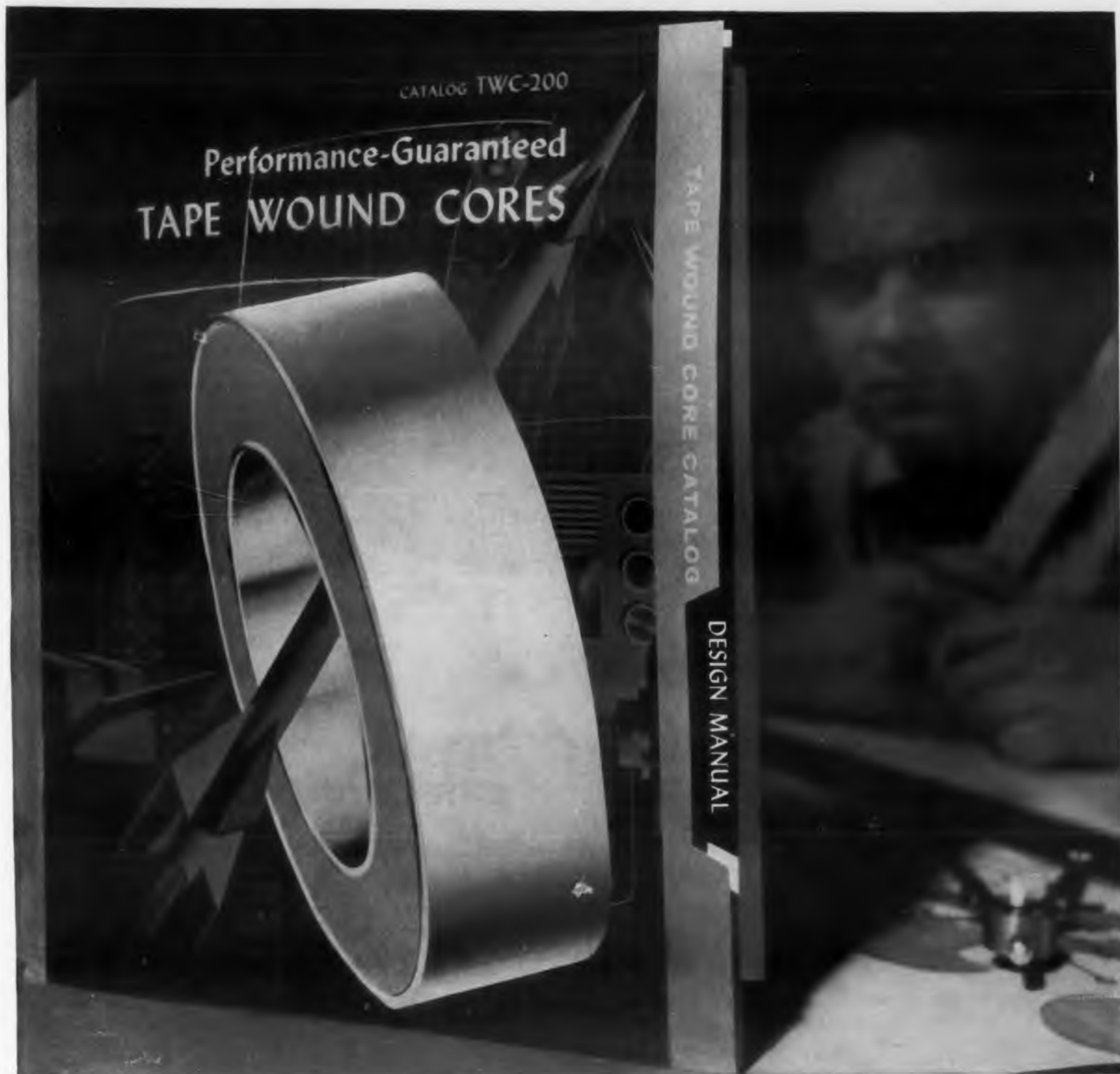
Sweeping Oscillator
Sweeps I-F's to 280 Mc



A broadband sweeping oscillator with six switched bands, the Rada-Sweep Sr. has 24 precise crystal markers set at customer specified frequencies. Center frequencies are from 1 to 260 mc. The instrument is designed and built for sweeping radar i-f units up to 280 mc. Rf output: 0.5 v rms into nominal 70 or 50 ohms. Higher for lower frequency units. Output held constant to within ± 0.5 db over widest sweep by agc circuit. Attenuators: switched 20 db, 10 db, 2 db plus continuously variable 6 db. A true zero base line produced on the oscilloscope during retrace time. Sweep output: sawtooth synchronized with sweeping oscillator.

Kay Electric Co., Dept. ED, 14 Maple Ave., Pine Brook, N.J.

CIRCLE 145 ON READER-SERVICE CARD FOR MORE INFORMATION



Here's the first design manual for your work with tape wound cores

Because engineers have expanded high permeability magnetics into a host of new uses, Magnetics, Inc. has combined its new tape wound core catalog with the industry's first design manual. If you and your staff need a working familiarity with magnetic equations, characteristics and terminology, this 28-page book will be of unusual value.

This design manual has been compiled under the direction of our laboratories. It contains basic units and conversion factors, methods of testing (dynamic, EI loop and d-c), properties and magnetic values of nickel-iron alloys, and many pages of curves showing the variation of magnetic properties with temperature and of core loss with frequency.

This fact-packed catalog and design manual also describes in detail the tape wound cores and bobbin cores which we manufacture. It will enable you to design around and specify the industry's only Performance-Guaranteed Tape Wound Cores. Should your engineering departments feel that more than one copy would be of value, please write for TWC-200 on company letterhead, giving full names and titles. *Magnetics, Inc., Dept. ED-40, Butler, Pa.*

MAGNETICS inc.

CIRCLE 146 ON READER-SERVICE CARD FOR MORE INFORMATION

FOR ELECTRONICS...

a new order of
chemical purity...



HF M. W. 20.01

Meets A.C.S. Specifications

Assay (HF) 49.00±0.25%

Maximum Limits of Impurities

Fluosilicic Acid (H ₂ SiF ₆)	0.05	%
Residue after Ignition	0.001	%
Chloride (Cl)	0.0005	%
Phosphate (PO ₄)	0.0003	%
Sulfate (SO ₄)	0.0005	%
Sulfite (SO ₃)	0.001	%
Arsenic (As)	0.000005	%
Copper (Cu)	0.00005	%
Heavy Metals (as Pb)	0.0001	%
Iron (Fe)	0.0001	%
Nickel (Ni)	0.00005	%

NOW! B&A OFFERS "ELECTRONIC GRADE" CHEMICALS

...with metallic and other impurities
held to lower limits than ever before!

Typical of B&A's special line of extremely pure "Electronic Grade" chemicals is its Hydrofluoric Acid. Note the specifications above . . . the carefully controlled assay, within plus or minus 0.25% . . . and the remarkably low limits on metallic and other undesirable impurities.

With products such as this, Baker & Adamson serves the needs of the electronic industry for chemicals of a new order of purity. And as the country's leading producer of laboratory and scientific chemicals, it is geared to work closely with the industry's engineers and chemists in developing other

products to meet their most stringent requirements.

Now available are the following B&A "Electronic Grade" chemicals:

For semiconductors (small packages):
Acetone
Acid Hydrofluoric, 48%
Alcohol Methyl, Absolute (Methanol)
Acetone Free
Alcohol Propyl, Iso
Carbon Tetrachloride
Ether, Anhydrous
Hydrogen Peroxide, 3%
Hydrogen Peroxide, 30%
Hydrogen Peroxide, 30% "Stabilized"
Sodium Carbonate, Monohydrate
Trichloroethylene

For radio receiving, black and white TV tubes (available in bulk):

Aluminum Nitrate, Crystal and Basic
Barium Acetate
Barium Nitrate
Calcium Nitrate, Tetrahydrate
Strontium Nitrate

Other special purity chemicals can be custom-made to meet your needs.

Write for free folder! Contains information on electronic chemicals for semiconductors, tubes, printed circuits; sulfur hexafluoride for gaseous insulation; selenium metals and selenides; metallic compounds for ferrite production. Lists exact specifications for "Electronic Grade" small package chemicals. Write for your copy today!

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CIRCLE 148 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Subminiature Capacitors

High Temperature



Deltaply 165 subminiature capacitors operate reliably over the temperature range -65 C to + 165 C. As an example of the size, a 1.0 mfd., 200 v unit requires 3.8 cubic inches. The same unit in teflon requires 6.4 cubic inches. Capacitance change over the full temperature range will amount to less than 9 per cent. Insulation resistance in megohms x microfarads varies from 200,000 at 250 C. The self-healing, metallized, plastic film provides unusually long life at 165 C with no voltage derating. Capacitance values from .001 to 10.0 mfd., may be obtained in hermetically sealed metal tubes or double-lock seal tubular cans. The smaller sizes are also available uncased. Standard voltage ratings are 200, 400 and 600.

Dearborn Electronics Labs., Dept. ED, 1421 N. Wells St., Chicago 10, Ill.

CIRCLE 149 ON READER-SERVICE CARD FOR MORE INFORMATION



Inductor Timing Motor

30 Oz.-In. at 1 Rpm

A permanent-magnet synchronous motor with guaranteed torque of 30 oz.-in. at 1 rpm and 60 cps is designed for a variety of timing applications. Basic features include: total enclosure to seal out dust, dirt and other breakdown materials; a controlled lubrication system; and the ability to operate in any position. Rotor speed of 450 rpm makes it possible to reduce the gear train and insure quieter operation and durability. The inductor motor is available with output shaft speeds from 1 to 60 rpm, for 120 and 240 v operation at 50 and 60 cps. Models for either clockwise or counter-clockwise rotation can be supplied.

Haydon Mfg. Co., Dept. ED, 245 E. Elm St., Torrington, Conn.

CIRCLE 150 ON READER-SERVICE CARD FOR MORE INFORMATION



1 KVA Voltage Regulator
Magnetic Type

Type TM7101 has an accuracy of 1 v band for line voltage variations and/or load magnitude or power factor changes. Load is rated at 1 kva. Input is 95 to 135 v, single phase, 60 cps, and output is 115 v nominal, adjustable from 110 to 120 v. It is suited for applications where little or no attention is possible, such as microwave relay stations and remote installations, where a tube or transistor malfunction and replacement can be costly or not immediately possible.

Cabinet model is a self-contained portable assembly that can be carried to laboratory test apparatus or factory operation.

The Superior Electric Co., Dept. ED, 83 Laurel St., Bristol, Conn.

CIRCLE 152 ON READER-SERVICE CARD FOR MORE INFORMATION



Speed/Torque Unit
1-6 Output Speeds

The new Servo-Speed/Torque-Unit, an experimental gear set, may be used with the manufacturer's Servo-Kit and other servo equipment. A complete set of change gears is supplied which enables the user to select any one of six output speed and torque values. There are two models, one for each of the two Barcol motors which are supplied with the Servo-Kit. Provision is made for mounting a 3/8 in. bushing mount potentiometer, coupled directly to the output shaft. Mounting adapters can be furnished so that the units may be used with any of the other popular makes and types of servo motors and transducers.

Servo Systems Co., Dept. ED, 55 Meeker Ave., Newark 12, N.J.

CIRCLE 153 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • July 15, 1957



TRANSISTORIZED REGULATED POWER SUPPLIES

WITH ZERO LINE TRANSIENT

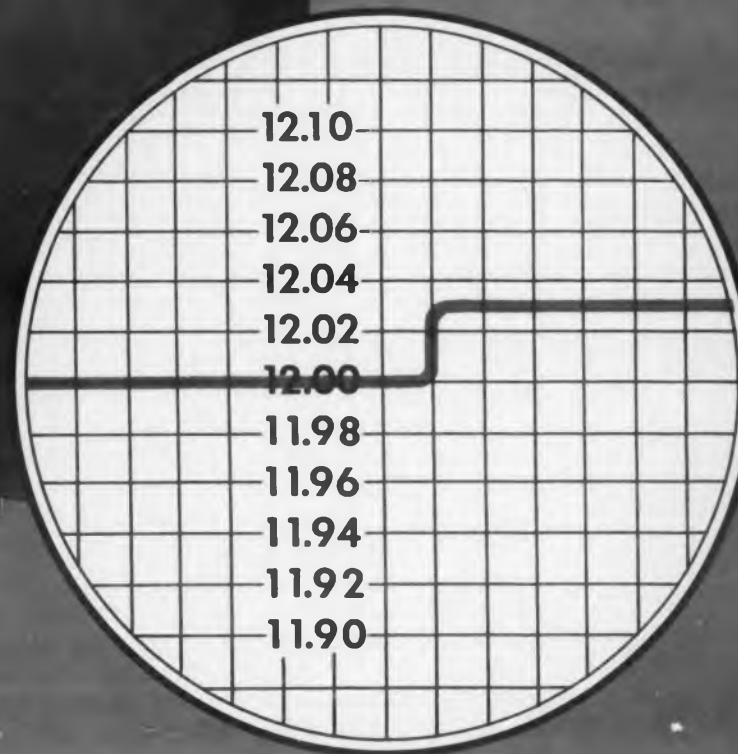
Transistor Devices, Inc brings to the design engineers a line of high performance, fully transistorized regulated power supplies. Units are all hermetically sealed and are available FROM STOCK in 0 to 30 volts range. These TDI power supplies also offer instantaneous and non-microphonic operation.

The scope trace as shown indicates a 12V unit taken from stock and checked before shipping — the result as in all previous tests showed a zero line transient.

If you need compact reliable regulated power supplies — call on TDI for high performance at quantity production prices.

Compare these specifications

Model 12E200
Input 115 V $\pm 10\%$ 60 cycles
Output 12 V D.C adjustable $\pm 10\%$
Load regulation 0 to .2 amps $\pm 0.1\%$
Line regulation 103.5 to 126.5 V $\pm 0.2\%$
Output impedance 1 ohm, 20 cycles to 10 KC.
Ripple less than 1 millivolt
Transient for 50% load step 0.4%
Load transient recovery time 200 microseconds
Transient for 10% line step 0.0%!!!
Instant operation
Non microphonic
Hermetically sealed
Only 2 7/8 x 3 x 6 3/4 inches
Available models for other outputs
For informative literature write



TRANSISTOR DEVICES, INC.

730 BOULEVARD, KENILWORTH, NEW JERSEY

CIRCLE 154 ON READER-SERVICE CARD FOR MORE INFORMATION

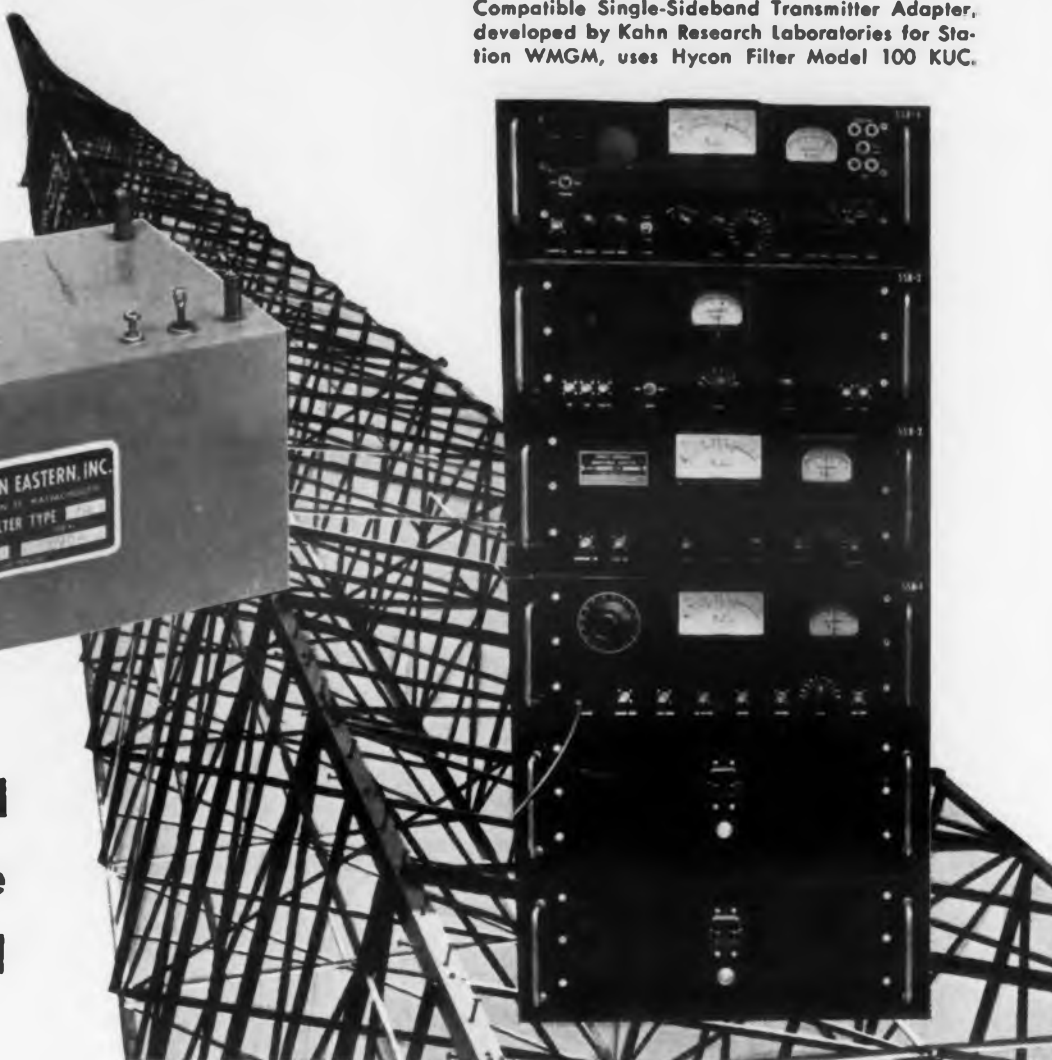
Compatible Single-Sideband Transmitter Adapter, developed by Kahn Research Laboratories for Station WMGM, uses Hycon Filter Model 100 KUC.

Hycon Filter Model 100 KUC
Shown 1/2 size



Accurate phase and frequency response for Single-Sideband Transmission . . .

Radio Tower of Broadcast Station WMGM (50,000 watts)



another problem solved by HYCON FILTERS

The first domestic broadcast installation of the Compatible Single-Sideband Modulation Method has recently been completed by Broadcast Station WMGM of New York City on an experimental basis. Advantages of this system are improved fidelity, improved range in the presence of co-channel interference, resistance

ELECTRICAL SPECIFICATIONS (Model 100 KUC)
Carrier Frequency: 100 KC
Attenuation at carrier +300 cps: 2 db maximum
Attenuation at carrier +6000 cps: 2 db maximum
Attenuation at carrier -300 cps: 60 db minimum
Insertion Loss: 10 db maximum
Passband Response Variation: $\pm 1/2$ db
Impedance: 8200 ohms
Dimensions: $5\frac{3}{8}$ " x 3" x $2\frac{3}{8}$ "

ALSO AVAILABLE: Model 100 KLC—Lower Sideband
Model 100 KPA—Carrier Selection

to fading and reduction in spectrum space. Because of their ability to meet the stringent requirements for the SSB frequency selective networks, Hycon Filters were chosen for this installation by Kahn Research Laboratories, designers of the CSSB Transmitter Adapter.

Whether your selectivity problems are in transmission or reception, AM or FM, mobile or fixed equipment, Hycon quartz crystal Filters offer you these advantages: **LOW COST**—standard models; **LOW DISTORTION**—passband uniformity within $\pm 1/2$ db; **HIGH STABILITY**—inherent in crystal resonators, also freedom from microphonic behavior; **ZERO MAINTENANCE**—hermetically sealed, requiring no realignment or readjustment. Hycon Eastern, Inc. can assist you in the selection of filter characteristics best suited to your needs. Write for *Crystal Filter Bulletin*.

"Bridging the Gap Between Science and Technology through Electronics"



HYCON EASTERN, INC.

75 Cambridge Parkway Dept. F-7 Cambridge 42, Mass.

Affiliated with HYCON MFG. COMPANY, Pasadena, California

Manufacturers of: Crystal Filters, Ultra Stable Oscillators, and Magnetic Tape Indexing and Search Units

CIRCLE 156 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



Equipment Mount
Temperature Resistant

This mounting features load capacitance above 60 lb, temperature resistance from -80 to $+250$ F, vibration isolation in severe operating conditions. The Temproof mounting is designed to meet the requirement of MIL-C-172B and is self damping in its resonant range. Mountings support loads in either the upward or downward direction.

Lord Manufacturing Co., Dept. ED, Erie, Pa.

CIRCLE 157 ON READER-SERVICE CARD FOR MORE INFORMATION



Resolver
1.062 In. Diam

Measuring 1.062 in. diam, size 11 resolvers are offered with a functional accuracy of better than 0.1 per cent. Compensated units are provided for use in systems performing over a wide temperature range. Both compensated and uncompensated resolvers are available in a range of 400 to 16 cps models.

Reeves Instrument Corp., Dept. ED, 207 E. 91st St., New York 28, N.Y.

CIRCLE 158 ON READER-SERVICE CARD FOR MORE INFORMATION



Transistor Clip
Beryllium Copper

This transistor clip is designed to retain all popularly used transistors under conditions of severe acceleration, deceleration, shock and vibration. Made from tempered beryllium copper, the transistor clip performs a dual function of retention and heat dissipation. Offered in a choice of cadmium, black ebanol or silver plate, clips are available in many sizes and modifications.

The Birtcher Corp., Dept. ED, 4371 Valley Blvd., Los Angeles 32, Calif.

CIRCLE 159 ON READER-SERVICE CARD FOR MORE INFORMATION



**Bolometers and
Thermistors**
Broadband Disc Type

Two broadband disc bolometers for coaxial detectors, Models N603 and N603-4.5, covering the frequency range of from 500 to 10,000 mc, and a broadband disc thermistor, Model N335, covering the same frequency range, have been developed. The Model 603 bolometers consist of two 100-ohm Wollaston wire bolometer elements mounted on a mica disc. The mica discs incorporate the rf bypass capacitor for the ungrounded end of the bolometer as well as a blocking capacitor at the central junction between the 100-ohm elements. This provides rf contact to the transmission line center conductor while blocking the bias current. The elements are in series to present a 200-ohm resistance to the external dc or af bias circuits and are arranged to be in parallel in the rf transmission line, thus acting as a 50-ohm termination.

The Model N335 thermistor is specifically designed for use with the Model 561 coaxial bolometer mount for microwave power measurements. The thermistor is used with microwave power meters capable of supplying the necessary 12 to 15 ma bias to measure power levels from 0.01 to 10 mw. Because of the long time constant, approximately 1 sec, the thermistor is particularly suited to measurement of pulsed signals. It is not susceptible to burnout, but in any case is readily replaceable and does not require tuning.

The Narda Corp., Dept. ED, 160 Herricks Rd., Mineola, N.Y.

CIRCLE 160 ON READER-SERVICE CARD FOR MORE INFORMATION



RF Preamplifier
35 and 50 Db Gain

Model 1 provides a gain of 35 db at band center and Model 2 provides 50 db, both with a maximum noise figure of 3.5 db. Frequency response is within 3 db over the band of 215-247 mc. The unit occupies a volume of 1/3 cu ft and weighs less than 3-1/2 lb.

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

CIRCLE 161 ON READER-SERVICE CARD FOR MORE INFORMATION

Servo Motors For Transistorized Operations

- Meets MIL-E-5272
- -65°C to +125°C temperature range.

	SIZE 8	SIZE 10	SIZE 11	SIZE 15	SIZE 18
Oster Type	8-5001-00	10-5052-00	11-5101-00	15-5153-00	18-5201-00
Electrical Characteristics					
Frequency (cps)	400	400	400	400	400
Torque at Stall (oz. in.)	.15	.30	.63	1.45	2.35
No Load Speed (rpm)	6500	6500	6500	5200	5200
Speed at Half Torque (rpm)	4000	4000	4000	3200	3200
Time Constant (sec.)	0.03	0.015	0.016	0.017	0.013
Reversing Time (sec.)	0.051	0.025	0.028	0.030	0.022
Theo. Acceleration at Stall (rad sec ²)	22500	45000	41500	31000	40000
Operating Temp. Range (°C)	-54 to +125	-54 to +125	-54 to +125	-54 to +125	-54 to +125
Slot Effect	1.6v/26v	1.0v/36v	1.0v/40v	1.0v/40v	1.0v/40v
Duty Cycle	Cont.	Cont.	Cont.	Cont.	Cont.
Fixed Phase					
Voltage	26	115	115	115	115
R (Stall) Ohms	196	1270	1250	490	280
X (Stall) Ohms	183	1560	1780	890	570
Z (Stall) Ohms	268	2210	2175	1030	640
P F (Stall)	0.73	0.57	0.58	0.49	0.45
Effective R (Stall) Ohms	366	3840	3800	2160	1460
Parallel Tuning cond. for unity P F (Stall) Mfd	1.0	0.13	0.15	0.33	0.55
Control Phase					
Voltage	40/20	40/20	40/20	40/20	40/20
*R (Stall) Ohms	480	124	145	58	39
*X (Stall) Ohms	445	215	204	103	77
*Z (Stall) Ohms	660	248	250	118	86
*P F (Stall)	0.73	0.50	0.58	0.49	0.45
*Effective R (Stall) Ohms	910	495	430	240	190
*Parallel Tuning cond. for unity P F (Stall) Mfd	0.4	1.4	1.3	2.9	4.1
Mechanical Characteristics					
Rotor Inertia (gm. cm ²)	.47	.47	1.07	3.3	4.0
Weight (oz.)	1.2	2	4.5	8	14
Mounting Type	Synchro	Synchro	Synchro	Synchro	Synchro
Motor Length	.863	.672	1.703	1.625	2.03
Type Shaft	Pinion	Pinion	Plain	Plain	Plain
Shaft Extension	.375	.218	.437	.540	.540
Outside Diameter	.750	.937	1.062	1.437	1.750
Type Connection	Leads	Terminals	Terminals	Terminals	Terminals

*For 40v connection

This complete line can be varied by Oster specialists to your precise requirement. Write today for further information, enclosing detailed data on your needs.

Other products include motor-gear-trains, synchros, AC drive motors, DC motors, servo mechanism assemblies, motor tachs, servo torque units, reference and tachometer generators, actuators, motor driven blower and fan assemblies and fast response resolvers.

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Avlonic Division
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Engineers For Advanced Projects:

Interesting, varied work on designing transistor circuits and servo mechanisms. Contact Mr. Zelazo, Director of Research, in confidence.

CIRCLE 162 ON READER-SERVICE CARD FOR MORE INFORMATION

Oster



Size 8



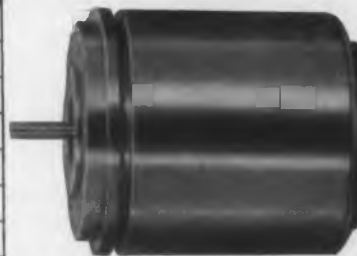
Size 10



Size 11



Size 15



Size 18



Sylvania...your only source for both semiconductor materials

IF YOU NEED MATERIALS for transistors, diodes, or other semiconductor devices... Sylvania is your only dependable source of both germanium and silicon.

The following forms of Sylvania germanium products are available; spectrographically pure germanium dioxide; polycrystalline as-reduced ingots; polycrystalline purified ingots; and undoped single crystals. All Sylvania germanium is n-type, and—in the purified ingot or single crystal form—has a resistivity greater than 40 ohm cm.

Diode and transistor manufacturers report that Sylvania germanium makes it possible for them to use the same doping schedule from shipment to shipment. They report higher yield in the growth of doped single crystals.

For growing doped crystals horizontally, Sylvania germanium ingots are purified in five standard shapes, or to your specification. Cut pieces, which require no further cutting or etching, are supplied to fit your crucible for vertical crystal growing.

Sylvania silicon is available in the form of polycrystalline stalagmitic rod; average density is 2.2 g/cc. The standard diameter for stalagmitic rod is 1½ in., and it is available in pieces or crucible charges to your specification.

If you have special requirements, our engineering department will gladly consult with you. Send for technical literature on Sylvania germanium and silicon. Write to:

SYLVANIA ELECTRIC PRODUCTS INC.
Tungsten and Chemical Div., Towanda, Penn.

TUNGSTEN • MOLYBDENUM • CHEMICALS • PHOSPHORS • SEMICONDUCTORS

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LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

CIRCLE 164 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Electromechanical Counter 300 Million Counts



A life of 300 million counts, count rate up to 60 per sec, either electrical reset or manual reset by a single-stroke push bar, and switch readout circuitry are features of an electro-mechanical counter. The unit adds, subtracts, and totalizes. If add and subtract pulses are received simultaneously, a zero count results. It is not necessary to have any specific sequence of add or subtract impulses, nor will the counter jam from an incomplete pulse. The totalizer will operate best with a counting-pulse ratio of 50 per cent on, 50 per cent off. While a square wave pattern for the pulse shapes is best, the totalizer will handle a wide variety of pulse shapes providing the leading edge of the wave is reasonably steep.

Autron Engineering, Dept. ED, 1254 W. Sixth St., Los Angeles 17, Calif.

CIRCLE 165 ON READER-SERVICE CARD FOR MORE INFORMATION



Sampling Switch High Speed

A precision switch having radial terminals designed for military and commercial applications is available with one or two poles and up to 120 shorting channels or 60 non-shorting channels per pole. The switch is easily adapted to a variety of motor drives. It is equipped with a precision machined ball bearing output shaft, constant force permanent brushes and lifetime semi-molded contact plates for long service free life. Approximate dimensions are 2.620 in. diam x 1.332 in. length plus hub extension 3/4 in. diam by 1/2 in. length and shaft 1/4 in. diam by 3/4 in. length. Applications include special oscilloscope displays, error indicating systems, and multichannels data systems.

General Devices, Inc., Dept. ED, P. O. Box 253, Princeton, N.J.

CIRCLE 166 ON READER-SERVICE CARD FOR MORE INFORMATION

VHF Directional Antenna

Gain of 23 Db



For 100 to 500 mc use, this directional antenna has a low vswr at any frequency in the band, accomplished through a rear adjusting balun and reflector assembly. The model CF-121M is a 12 ft. diam. antenna and utilizes a dipole exciter. Gain is 23 db or better at 500 mc, with minimum side lobes and cross polarization of 20 db or better. The antenna is of lightweight, all-aluminum mesh construction, fully weatherized and corrosive resistant. It is available in both the 12 ft. diam model CF-121M, and a 14 ft. diam model CF-141M.

Ainslie Corp., Dept. ED, 312 Quincy Ave., Quincy, Mass.

CIRCLE 129 ON READER-SERVICE CARD FOR MORE INFORMATION



X-Band Stabilization System
High Short-Term Stability

In combination with the VA-201B Klystron, the BA-1280B Stalo Cavity achieves a short term frequency stability of better than one part in a billion. The stabilization factor of the cavity is completely independent of the oscillator fluctuations or external disturbances. According to the manufacturer, this feature provides an advantage over stabilization systems utilizing the feedback principle. The elimination of all electronic components except the klystron oscillator provides reliability and longer life. The cavity tunes over the range of 8200 to 10,000 mc, depending on the klystron used. A method is utilized to suppress all undesired modes within this range.

Varian Assoc., Dept. ED, 611 Hansen Way, Palo Alto, Calif.

CIRCLE 120 ON READER-SERVICE CARD FOR MORE INFORMATION

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 $1\frac{1}{8}$ " in diameter, $2\frac{3}{8}$ " 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.

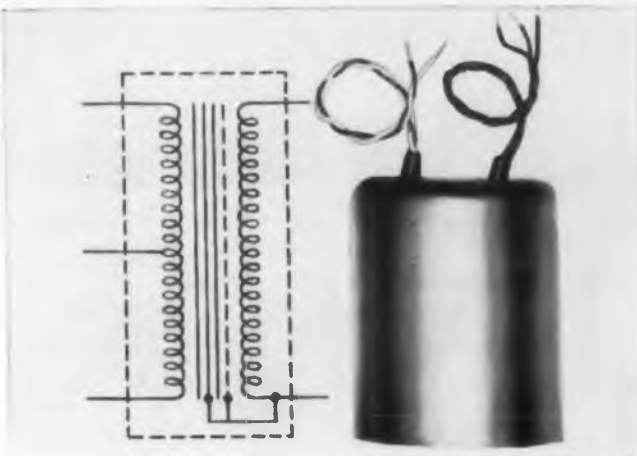
Write for Specification S900-1.

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.



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

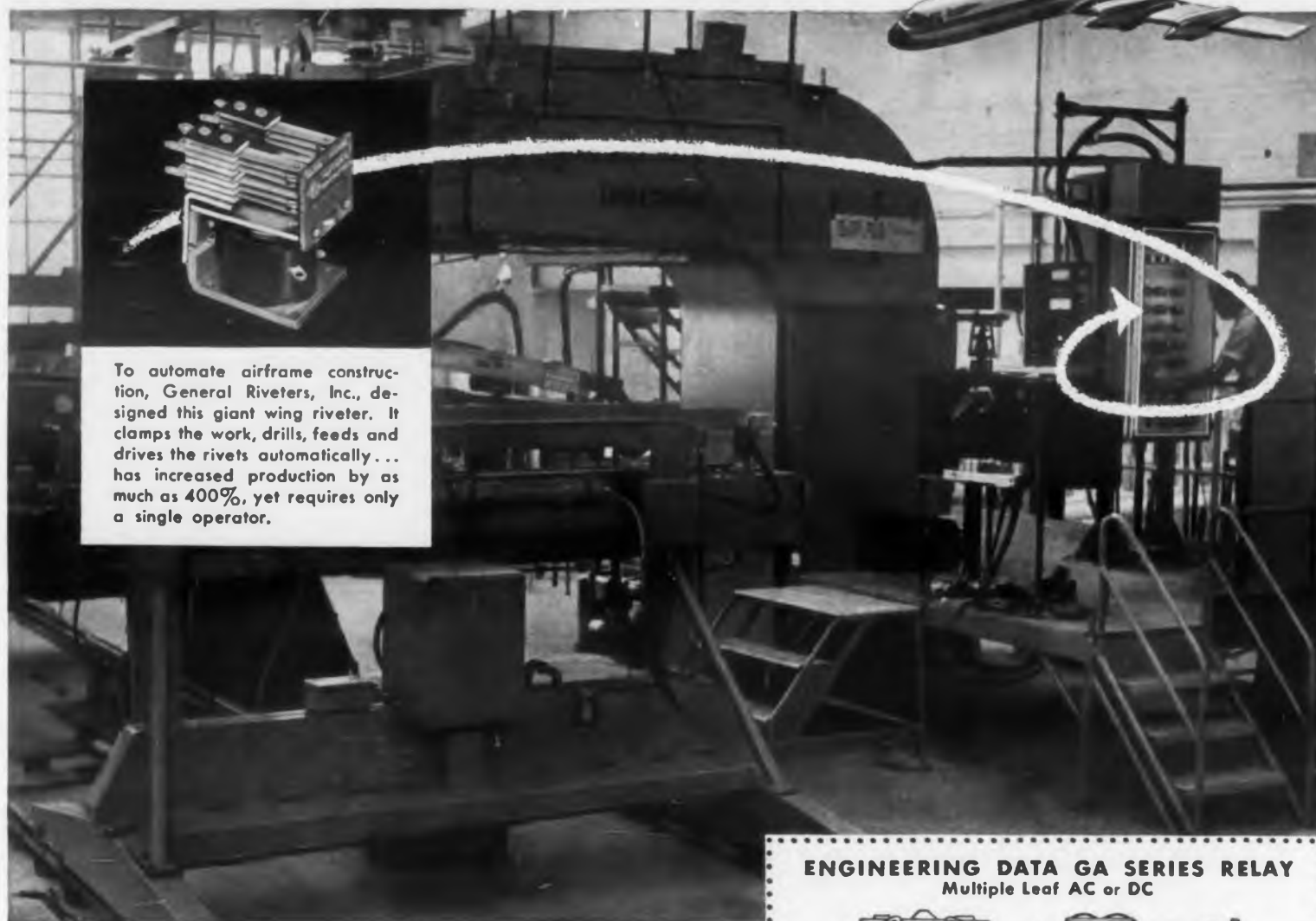
MINNEAPOLIS-HONEYWELL REGULATOR Co., Industrial Division, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

Honeywell



First in Controls

Potter & Brumfield engineering is in this picture



To automate airframe construction, General Riveters, Inc., designed this giant wing riveter. It clamps the work, drills, feeds and drives the rivets automatically... has increased production by as much as 400%, yet requires only a single operator.

P&B RELAYS AUTOMATE THIS GIANT RIVETER *for new Lockheed Electra Wings*

This new automatic riveter will be used to make wings for the new Lockheed Electra, a prop-jet luxury liner, as well as many other modern aircraft. The heart of this riveter is a relay circuit that "takes orders" from a pattern of holes punched in 35 mm film strips.

General Riveters, Inc. selected the GA Series P&B relay for the control circuits of this riveter because of its unusual dependability and versatility. In adapting this relay to a specific application, P&B's engineers again demonstrated how 25 years of creative engineering can pay off by providing a standard type or completely new relay to solve your particular problem. Write today for new compact catalog or engineering consultation.

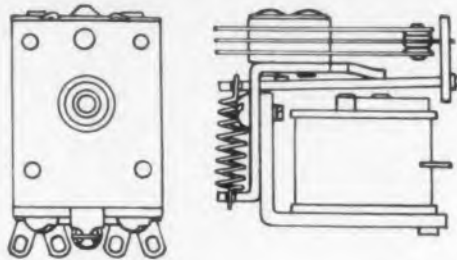
P&B Standard Relays are available at your local electronic, electrical and refrigeration distributors

Potter & Brumfield, inc.

PRINCETON, INDIANA Subsidiary of AMERICAN MACHINE & FOUNDRY COMPANY
Manufacturing Divisions also in Franklin, Ky. and Laconia, N. H.

CIRCLE 172 ON READER-SERVICE CARD FOR MORE INFORMATION

ENGINEERING DATA GA SERIES RELAY Multiple Leaf AC or DC



CONTACTS

Material: $\frac{3}{16}$ " fine silver (other contact materials can be furnished for specific applications)

Rating: 5 amp. 115 V. 60c non-inductive load

Arrangements: 4 Form C Max., AC; 6 Form C Max., DC

Breakdown: 1000 V. RMS between all elements

COIL

Resistance: 30,000 ohms max.

Power req'd: 6 W. max., 2 W. min. DC at 25° C. ambient
V range: DC to 110 V.; AC to 230 V.

DIMENSIONS, MAX.

$1\frac{3}{32}$ " L. x $1\frac{1}{16}$ " W. x $1\frac{25}{32}$ " H.

MOUNTING DATA

4 tapped #6-32 holes, .750" x .875" o.c. 1 tapped #8-32 core

ENCLOSURES

Hermetically sealed, octal plug: $2\frac{1}{32}$ " x $1\frac{25}{32}$ " x $1\frac{25}{32}$ "
Multiple solder header and miniature plug-in: $2\frac{15}{32}$ " x $1\frac{25}{32}$ " x $1\frac{25}{32}$ "

Special container required for 6 Form C

TERMINALS

Contacts: two #16 AWG wires

Coil: two #20 AWG wires

See our catalog in Sweet's Product Design File



New Products



Air Dielectric Cable Low Capacitance

This Teflon-air dielectric coaxial cable has a nominal overall diameter of 0.22 in. The conductor is No. 30 AWG, 7/38 silver plated copperweld. A choice of outer jackets include Teflon, lacquered nylon braid, and Teflon or silicone impregnated glass braid. The low attenuation of the 10 μ f cable makes it useful for high frequency, low level applications and as a low capacitance probe. Capacitance values of less than 10 μ f, with somewhat larger overall diameters are also available on request.

Flexibility is one of the features of the coaxial cable. Among the other characteristics are solderability, light weight, small size, and ready adaptation to a variety of connectors.

Tensolite Insulated Wire Co., Inc., Dept. ED, 198 Main St., Tarrytown, N.Y.

CIRCLE 173 ON READER-SERVICE CARD FOR MORE INFORMATION



DC Power Supply 200 to 325 v, 0 to 100 ma

Continuously variable output from 200 to 325 v dc for load currents of 0 to 100 ma can be obtained from the Model 3. Regulation is better than 1 per cent for loads of 0 to 100 ma and line voltage variations from 105 to 125 v. Ripple is less than 10 mv rms. Both positive and negative sides of the output are isolated from ground. Either side may be grounded or the output may be left floating. An isolated output of 6.3 volts ac at 3 amp is available at the output terminal connections. Net weight is approximately 20 lb, and it measures 5 wide, 7 high, and 16 in. deep.

Associated Specialties Co., Dept. ED, 1751 Main St., Orefield, Pa.

CIRCLE 174 ON READER-SERVICE CARD FOR MORE INFORMATION



**Snap-In Vise
For Connectors**

Round connectors are securely held during soldering operations by the Model V-3 Snap-in Vise. A spring loaded jaw provides the necessary pressure to hold the connector. Adjustment of the vise for any desired diameter may be done quickly. Once this adjustment is made, slight pressure on a lever engages or disengages the connector from the vise. This feature is especially useful in production assembly where repetitive operations are carried out. Jaws are covered with a tough non-skid cork and synthetic rubber compound which protects threaded portions from damage. The vise can be adjusted anywhere within an arc of 180 deg. Connectors up to 2 in. in diam. are tightly held in the vise. Screws are provided for easy mounting on a work bench or plywood base.

Western Electronic Prod. Co., Dept. ED, 655 Colman St., Altadena, Calif.

CIRCLE 176 ON READER-SERVICE CARD FOR MORE INFORMATION



**Standard and Null
Meter
Model 301**

This variable DC standard and null meter, Model 301, utilizes a chopper stabilized circuit which constantly compares the output with an internal standard cell to provide stability and accuracy. Direct-reading, calibrated dials provide instant voltage selection. Power supply output voltage is 1 to 501 v at up to 20 ma. It has 4 decades null meter ranges from 50 v to 501 mv full scale. The meter can also be used to read input voltage or the output voltage of the supply. The unit features 0.01 per cent stability, 0.2 per cent accuracy, 0.022 per cent line and load regulation, less than 100 mv ripple, 0.2 msec response time, and less than 0.01 output impedance.

Kin Tel, Dept. ED, 5725 Kearny Villa Rd, San Diego, Calif.

CIRCLE 177 ON READER-SERVICE CARD FOR MORE INFORMATION



DESIGN ENGINEERS! ELECTRICAL ENGINEERS! REPAIR SHOP FOREMEN!

LOOKING FOR A LINE OF U. S. NAVY-APPROVED INSULATING OR FUNGICIDAL VARNISHES?

HERE IT IS!

A Complete Westinghouse Leadership Line of Military-Approved Insulating and Fungicidal Varnishes for Original Equipment Manufacturers and Repair Shops.

MIL-V-1137A—INSULATING

GRADE	TYPE	MILITARY DESIGNATION
B-161	Clear Baking	Grade CB, Type M
B-163-N	Clear Baking	Grade CB, Type M*
B-166-1	Clear Baking	Grade CB, Type M
B-222-N	Clear Air Drying	Grade CA, Type M*
B-340-N	Black Baking	Grade BB, Type M*
B-451-N	Black Air Drying	Grade BA, Type M

*Also approved for Type AN

MIL-V-173A—FUNGICIDAL

B-219-F	Clear Air Drying	Type II
B-220-F	Clear Air Drying	Type I

YOU CAN BE SURE...IF IT'S

Westinghouse



Whether you're designing, manufacturing, or repairing military electrical apparatus, or whether you simply need quality insulating or fungicidal varnishes or enamels for critical applications, you can't do better than the Westinghouse Leadership Line of insulation materials, field proven in over 100 million applications!

The chart at left shows some of these remarkable products, approved by the U. S. Navy. For complete information, call your nearest Westinghouse branch or write for your free copy of the 8-page Leadership Line Catalog of insulating materials. Just fill out the coupon below.

J-06659

ED-7-57

Westinghouse Electric Corporation
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Manor, Pennsylvania

Please send free copy of Leadership Line Catalog.

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CIRCLE 178 ON READER-SERVICE CARD FOR MORE INFORMATION

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-11 — 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



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 180 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



**Rate Gyroscope
Miniature**

Known as the Golden Gnat Rate Gyro, Type GN has the following features: size of 1 in. diam, 2-1/4 in. length; weight of 3.8 oz; range of full scale rates up to 600 deg per sec; threshold and resolution of 0.01 deg per sec; inertia ratio of 0.00045 sec (ratio of gimbal inertia to angular momentum); temperature-compensated viscous damping for controlled dynamic performance; variable reluctance pickoff for high signal-to-noise ratio with infinite pickoff resolution; linearity of 0.1 per cent of full scale to 1/2 range, within 2 per cent to full range; ambient temperature range of -55 to +85 C; linear vibration of 10 g peak, 0 to 2000 cps; linear acceleration up to 100 g depending upon range; and shock up to 100 g depending upon range.

Minneapolis-Honeywell Regulator Co., Dept. ED, Boston Div., 1400 Soldiers Field Rd., Boston 35, Mass.

CIRCLE 181 ON READER-SERVICE CARD FOR MORE INFORMATION



**Ceramicite
For Hermetic Seals**

Ceramicite is a leak-tight ceramic hermetic seal used in relay bases, transformer bases, transistor bases, diode closures and other such component in continuous operation at temperatures up to 700 F. The heating required by the sealing process causes changes in the linear expansion properties of the materials resulting in a common coefficient permitting crystalline migration between interfaces of the materials involved during the cooling cycle. Thus an actual molecular bond exists between the metal and the Ceramicite. Ceramicite is available in two forms: as pre-formed pieces, ready for firing by the user in fabrication of seal components and as completed seal components, such as single and multiple pin terminals and headers.

Consolidated Electrodynamics Corp., Dept. ED, 300 N. Sierra Madre Villa, Pasadena, Calif.

CIRCLE 182 ON READER-SERVICE CARD FOR MORE INFORMATION



Punched Card Sensor
Multiple Switching
Device

This static reader for punched cards, a multiple switching device that simultaneously senses the entire card, is adaptable to any combination of 540 switching operations. The card reader accepts a standard punched-card with 540 holes, arranged 12 wide by 45 high, which is read or sensed when the handle is closed. In each hole position is a spring-loaded pin and a corresponding normally closed switch with each side isolated. The pin remains static where there is a hole in the card. Where there is not a hole in the card the pin moves forward and opens the corresponding switch. The card reader measures approximately 6-1/4 x 10-1/4 x 9 in., and weighs 18 lb. It may be installed in any circuitry by means of standard connectors.

Metron Corp., Dept. ED, Union and Elm Sts., Lambertville, N.J.

CIRCLE 184 ON READER-SERVICE CARD FOR MORE INFORMATION

Variable Delay Line
Model 502



This continuously variable delay line, Model 502, is designed for use as a component or as test equipment in advanced computer and radar systems. The entire delay range, from zero to maximum delay, is covered by a single control shaft, in ten turns. The unit may be locked at the desired delay by a locking device which is available from the manufacturer. It can then be used as a component in equipment with a fixed delay, or as a continuously variable test unit. Attenuation in the new unit is 1.2 db. Resolution is better than 1/1000 of maximum delay. Termination is external. Maximum delay is 2.0 μ sec. Maximum rise time is 0.38 μ sec. Impedance is 470 ohms. Outside dimensions are 7 1/4 x 1 x 1 5/8 in. Four other variable delay lines which feature maximum delays from 0.9 to 15.0 μ sec., Maximum rise times from 0.18 to 2.8 μ sec., and impedance from 56 to 1000 ohms are available.

ESC Corp., Dept. ED, 534 Bergen Blvd. Palisades Park, N.J.

CIRCLE 185 ON READER-SERVICE CARD FOR MORE INFORMATION



FROM SPECS TO PROTOTYPES---FAST

Globe Industries makes to special order all of the miniature motorized devices shown on this page. But so do a lot of other companies. The difference lies in your design freedom.

At Globe you can set the specs and get prototypes in a few weeks. Our special order department builds these under the direction of the engineering department. And production orders are delivered in a few months because Globe maintains enormous inventories around which most custom designs are based.

Globe's broad base of standard parts has helped earn a reputation for earliest prototype delivery, fast production, reasonable price, aircraft standards, and repeat-business quality. Parts for your servo, timing, control, power, or air moving systems may be in Globe's inventory now. MIL specs and special development (including temperatures to +500° F.) are routine at Globe Industries.

Catalog sent to qualified firms; please request it on your letterhead. Inquire now about products which interest you. Get a Globe proposal on your next design.

1. GEAR REDUCED MOTORS

6 basic AC and DC motors, 2 basic gear types with 112 odd and even ratios, as well as various brakes, clutches, shafts, governors, windings and mountings. Above unit powered by SS motor. Inventoried parts for SS motors can be combined in 6x10¹⁷ different ways.

2. RATE GYROS

5-10 cps. is natural frequency. Provides adjustable damping and control contacts, withstands 60Gs for 11 milliseconds repeatedly. Above unit powered by MM motor. Inventoried parts for MM motors can be combined in 10¹⁰ different ways.

3. TIMERS

AC or DC operated timing cycles to order, from a few seconds to many minutes, adjustable or non-adjustable. Multiple switching actions. Can be powered by any motor, such as the LL. Inventoried parts for LL motors can be combined in 8x10¹⁷ different ways.

4. CENTRIFUGAL BLOWERS

Many standard models with typical air delivery of 22 cfm. at 1" back pressure. Unit above is SC. Inventoried parts for SC motors can be combined in 10⁵ different ways.

5. AXIAL BLOWERS

Many standard models with typical air delivery to 58 cfm. in above configuration and over 300 cfm. with open axial fan. Above unit powered by MC motor. Inventoried parts for MC motors can be combined in 12x10⁴ different ways.

6. ACTUATORS

3 standard models around which custom units are designed, with intermittent torques up to 2500 oz. in. Above unit powered by FC motor. Inventoried parts for FC motors can be combined in 10⁵ different ways.



GLOBE INDUSTRIES, INC.
Dayton 4, Ohio • Phone: HEmlock 3741

CIRCLE 186 ON READER-SERVICE CARD FOR MORE INFORMATION

Dearborn

polystyrene capacitors

worth their weight
in GOLD!

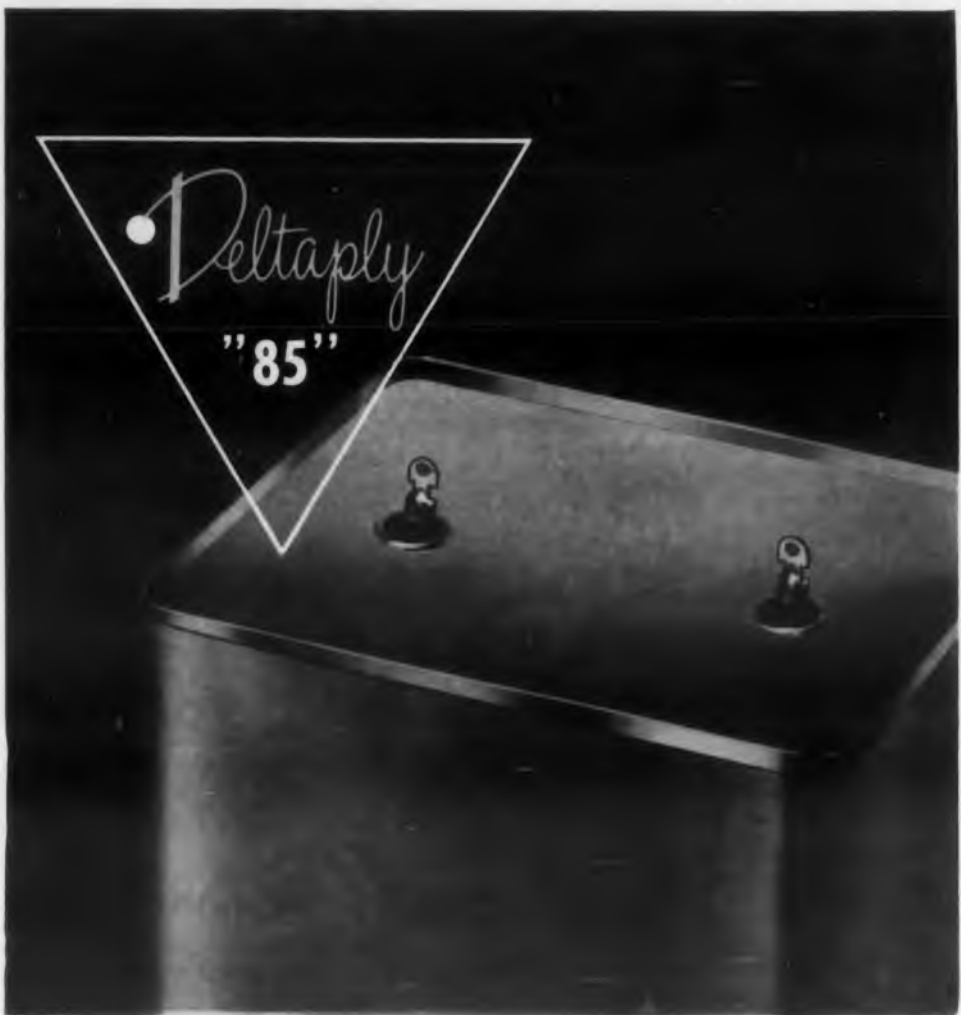
You'll find Deltaply "85" capacitors ideal for applications involving such critical factors as small uniform capacitance change with temperature . . . high Q . . . very high insulation resistance . . . very low dielectric absorption . . . and high stability. The "85" offers exceptional electrical properties in temperature range -55°C to $+85^{\circ}\text{C}$. Temperature-capacitance co-efficient is -120 PPM/ $^{\circ}\text{C}$ and is very nearly linear. Insulation resistance in megohms x mfd. varies from 10 million at 25°C to 200,000 at 85°C .

Capacitance values from .0001 to 10.0 mfd. are available in hermetically sealed metal tubes or CP-70 cans in six standard voltage ratings from 50 to 1000 volts.

WRITE FOR BULLETIN RL-1

DEARBORN ELECTRONIC LABORATORIES

1421 NORTH WELLS STREET • CHICAGO 10, ILLINOIS



CIRCLE 188 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products



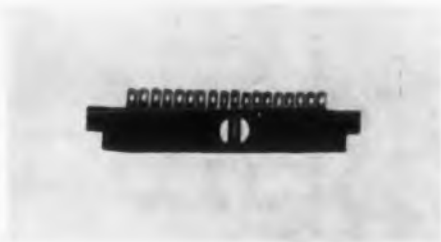
Packaged Power Supply
Hermetically Sealed

These hermetically sealed high voltage power supplies are convenient means of supplying high voltage to devices such as cathode ray tubes, oscilloscopes, TV equipment, and precipitators. The units are made by hermetically sealing all components in a metal can with suitable insulating oil. The advantages of this unitized power supply are greater reliability, long use life, more compactness and greater convenience. Different models give output voltages of 2 kv at 2 ma, 5 kv at 5 ma, 10 kv at 1 ma, 15 kv at 1 ma, 30 kv at 1 ma, and 50 kv at 1 ma.

Laboratory for Electronics, Inc., Dept. ED, 75 Pitts St., Boston 14, Mass.

CIRCLE 189 ON READER-SERVICE CARD FOR MORE INFORMATION

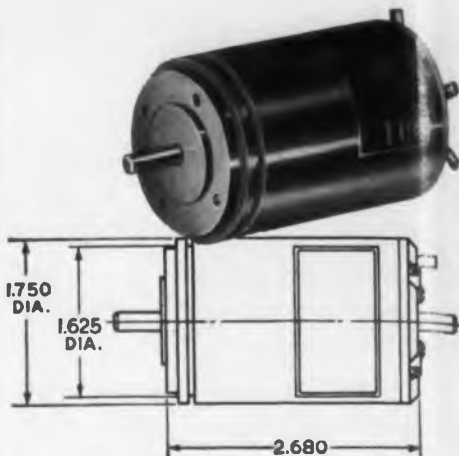
Printed Circuit Connectors Eight Sizes



These printed circuit connectors are available in eight different sizes, 6, 8, 10, 12, 15, 18, 22 and 38 and feature .058 wide coined beryllium copper contacts, heat treated to retain contact force after hundreds of insertions. Wide contact pads insure minimum abrasion under maximum contact force. Excessive contact mass insures lower heat rise at rated loads. Barriers between terminals insure high voltage break down ratings exceeding 2500 v rms at sea level and 700 v rms at 60,000 ft. Present models are available for printed circuit board thicknesses from .061 to .071. Polarizing pins may be located in any slot desired. Materials and construction match requirements called out in MIL-C-8384.

Gorn Electric Co., Inc., Dept. ED, Gorn Electronics Div., 845 Main St., Stamford, Conn.

CIRCLE 190 ON READER-SERVICE CARD FOR MORE INFORMATION



FOUR NEW VERNISTAT POTENTIOMETERS

**WITH HIGH LINEARITY
LOW PHASE SHIFT
LOW OUTPUT IMPEDANCE**

There is a Vernistat a. c. potentiometer to meet your requirements. Uniquely combining the functions of an auto-transformer with an interpolating resistance, the Vernistat potentiometer offers low output impedance and precise linearity plus long term stability.

The Model 2B Vernistat potentiometer is available in five versions. Check these specifications:

Model 2B

Output impedance (max) - 130 ohms
Linearity - $\pm 0.04\%$
Max. input voltage - 130
Output quadrature (max) - 0.50mV/V

Model 2B1

Output impedance (max) - 470 ohms
Linearity - $\pm 0.03\%$
Max. input voltage - 130
Output quadrature (max) - 0.13mV/V

Model 2B2

Output impedance (max) - 45 ohms
Linearity - $\pm 0.05\%$
Max. input voltage - 65
Output quadrature (max) - 0.47mV/V

Model 2B3

Output impedance (max) - 130 ohms
Linearity - $\pm 0.03\%$
Max. input voltage - 65
Output quadrature (max) - 0.16mV/V

Model 2B4

Output impedance (max) - 470 ohms
Linearity - $\pm 0.02\%$
Max. input voltage - 65
Output quadrature (max) - 0.06mV/V

For additional information write:

vernistat®

division

PERKIN-ELMER CORPORATION
Norwalk, Connecticut

CIRCLE 191 ON READER-SERVICE CARD

Protective Coating

Dip Applied

A strip-off plastisol coating for the protection of metal parts and products can be applied by heating the parts and dipping them in the plastisol. The plastisol can be peeled off readily by hand and serves as a protective coating for any metal parts which are subject to rust, corrosion, dirt or damage while in storage or transport. The coating provides resilient cushioning which reduces shock and breakage, and is a defense against nearly all chemicals including most acids, alkalis and solvents. It also has high thermal and electrical insulating qualities and is completely unaffected by extreme cold or hot weather. It resists mold, mildew, salt air and water and is not deteriorated by time or exposure.

Auburn Button Works, Inc., Dept. ED, Chemical Div., Auburn, N.Y.

CIRCLE 193 ON READER-SERVICE CARD

Teflon Film

Thin Film Laminate

Type CSC cast Teflon film is a cured, semicured film or Teflon in its sintered and partially sintered forms. It is comprised of a composite laminate of a minimum 2 mils of fully-cured cast Teflon superimposed by a 0.25-mil layer of semicured Teflon in particulate form bonded together to resist normal handling. Final insulation thickness is maintained after fusion because of the use of fully-cured Teflon. It is also offered in a 1.25-mil thickness. Suggested applications may include high-temperature wire insulation or the construction of thin-wall flexible Teflon tubing. Available in continuous roll lengths of 100 and 500 ft, in widths from 1/4 to 1 in. in increments of 1/16 in. Packaged on 3-in. ID cores.

Dilectrix Corp., Dept. ED, Allen Blvd. and Grand Ave., Farmingdale, N.Y.

CIRCLE 194 ON READER-SERVICE CARD

CIRCLE 195 ON READER-SERVICE CARD >

TRANSISTORIZED



ILLUSTRATED: MODEL SS-1503

Input: 105-125V, 60-500 cps, approximately 3A.

Output: 100-150V, 0-1.5A.

Ripple: ONE MILLIVOLT RMS.

Regulation: Line, 0.1%, 105-125V. Load, 0.1%, NL-FL.

Transient Response: ZERO-LAGGED for $\pm 10\%$ line transient or $\pm 25\%$ load transient.

Output Impedance: 0.06 ohms at dc. Less than 0.5 ohms, DC-500KC.

Meters: 0-150 volts, 0-2 amperes, 4 1/2" rectangular, 2%.

Size: Standard 19" panel, 5 1/4" high, 14 3/4" deep behind panel.

Duty: Continuous, between -20°F and 110°F , 100% humidity, 0 to 10,000 feet.

Polarity: Reversible and floatable to 500V peak from chassis ground.

Price: \$465. f.o.b. Kenilworth, New Jersey. Generous quantity discounts. Delivery 15 days.



SOLID STATE POWER SUPPLIES

have Everything!

ULTRA COMPACT—More power supply per inch of panel height than ever before!

COOL—Throws less heat into the cabinet than any other type of supply . . . 1/10th the heat generated by vacuum-tube equivalents.

FULLY TRANSISTORIZED—Semi-conductor rectifiers, zener-diode reference standards, transistor series regulators, transistor loop amplifiers.

HIGH STABILITY—Improved high-gain balanced PNP amplifier—prestabilized zener reference.

LOWER PRICE—As much as 30% less than inferior vacuum-tube equipment.

TEN MODELS—Covering 0-300V at 0-1.5 amperes for every plate, bias, and clamp application.

Write for our Solid State Catalog.

NJE corporation

Electronic Development & Manufacturing

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Competent Engineering Representation Everywhere

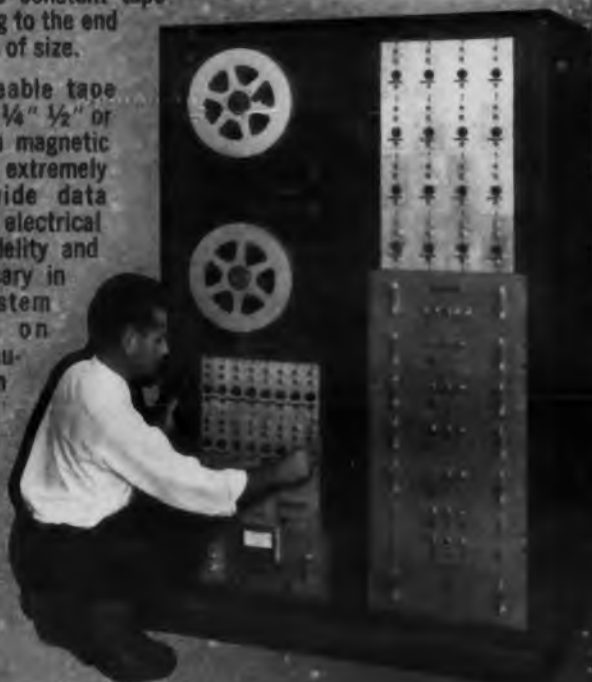
N J E L E A D S . T H E P O W E R S U P P L Y F I E L D

What's going on up there? 

American Electronic's new 300 KC Band Width
RECORDATA magnetic recording system
gives an accurate, permanent record.

Specifically designed for recording data from satellites, missiles or other projects where extreme accuracy is required, RECORDATA offers a new concept in reliability and versatility. This sixteen channel system with its modular construction offers many unique features. For example, the six standard tape speeds of 1 $\frac{1}{4}$, 3 $\frac{3}{4}$, 7 $\frac{1}{2}$, 15, 30 and 60 inches per second can be instantly selected with a single switch without changing belts or pulleys. Special speeds to 240 inches per second are also available. Automatic controls assure constant tape tension from beginning to the end of the reel, regardless of size.

Quickly interchangeable tape guides accommodate $\frac{1}{4}$ " $\frac{1}{2}$ " or 1" tapes. The plug-in magnetic head assemblies are extremely accurate and provide data tracks with the best electrical uniformity. Where fidelity and reliability are necessary in a data recording system you can depend on RECORDATA... manufactured by American Electronics whose Concertone Hi-Fi tape recorders have been famous as quality leaders. Write to Dept. Jy34 for complete technical information.



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ELECTRONICS
INC.** 655 W. Washington Blvd.
Los Angeles 15, California

Have you heard about the wonderful Engineering opportunities at AMERICAN?

CIRCLE 197 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Power Rectifier Junctions

330 Amp



This 330 amp germanium power rectifier junction is one of a series of six rated at 330 amps rectified output current with voltage ratings from 20 to 66 v rms. These low current density high capacity junctions have corrosion and moisture resistant cast-aluminum housings with airfoil type cooling fins for maximum heat dissipation. The unit size is $4 \frac{3}{32} \times 3 \times 3 \frac{1}{4}$ in. Six 330 amp germanium junctions connected in a three-phase bridge circuit will deliver 85 kw. (1,000 amps @ 85 v) while occupying $\frac{1}{2}$ cu ft of space. Its efficiency rating is to 98.5 per cent.

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

CIRCLE 198 ON READER-SERVICE CARD FOR MORE INFORMATION



Double Stub Tuner
Locking Collets

This double stub tuner, Model DS-1-12, has an impedance of 50 ohms and a frequency range of 1000 to 12,000 mc. A pair of collets locks the tuner securely in any pre-set position. The device employs silver plated contact springs, rugged stub junction construction and smooth acting, non-slip tuning elements. The tuning elements can be furnished with or without collet-type locking caps. The hex shaped body of the tuner facilitates holding or mounting in any position.

Uniwave, Inc., Dept. ED, 2 Marine St., Farmingdale, N.Y.

CIRCLE 199 ON READER-SERVICE CARD FOR MORE INFORMATION



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AND DESIGNERS OF:**

CAVITIES

**MIXERS • DETECTOR MOUNTS
DUPLEXERS • MULTIPLIERS
ROTARY JOINTS • BENDS
TWISTS • OTHER COMPLEX
COMPONENTS & ASSEMBLIES**

Application-engineered microwave parts and complex assemblies are our specialized field. We'll manufacture components to your prints ... or we will design and integrate them into your application.

You can depend on J-V-M for close coordination, guaranteed electrical performance and "know how" that is attested by innumerable assemblies ranging from dc. to 40,000 mc. now in industrial and military use.

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1. Variable vane directional coupler ... sliding vane type ... high directivity-low VSWR.



2. Pre-selector-mixer ... S band ... 50 ohm input impedance ... high Q double-tuned ganged cavities ... detector output ... frequency stable from -55° to $+85^{\circ}$ C.

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MICROWAVE

PARTS

J-V-M

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COMPANY**

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(Chicago Suburb)

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to solve
"insoluble"
problems . . .

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the unique properties of
PRECIOUS METALS

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TECHNIC BIBLIOGRAPHY

"Electroplated Gold"; "Precious Metal Electroplating Data: Gold, Rhodium, Palladium, Platinum, Silver, Nickel"; "Electroplated Platinum"; "Electroplated Palladium"; "Electroplated Rhodium"; "Analysis of Gold & Gold Alloy Solutions".

Write for authoritative Technic publications, many containing data assembled nowhere else. We serve as consultants on experimental projects as well as on regularized operations. Consult us without obligation.



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THE LARGEST ENTERPRISE OF ITS KIND IN THE WORLD

CIRCLE 202 ON READER-SERVICE CARD



Phasemeter
60 Cps-20 Kc

The PM-1B Phasemeter offers accurate measurement and calibration of phase relationships in complete systems and in electronic instrumentation at audible and supersonic frequencies. Featuring a passive system utilizing neither tubes nor semiconductors, the PM-1B phasemeter will retain its calibration accuracy of better than $\pm 1/2$ deg for very extended periods. The meter is available in two models: a single frequency unit which can be provided for any single frequency between 60 cps and 20 kc; and a three frequency unit which can be provided for any three selected frequencies between 60 cps and 20 kc. Continuous measurement of the phase angle from 0 to 360 deg may be obtained, while lead and lag angles may be measured directly from any reference desired. High impedance input with low impedance output; a large direct reading dial with adjustable zeroing and a constant amplitude output are other features.

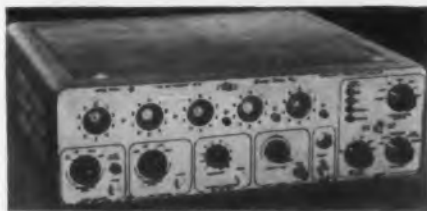
The size of the unit is 7 x 7 x 7 1/2 in. and it weighs approximately 6 lbs.

Statham Development Corp., Dept. ED, 12411 W. Olympic Blvd., Los Angeles 64, Calif.

CIRCLE 203 ON READER-SERVICE CARD FOR MORE INFORMATION

Frequency Interval Meter

Period and Time



Model 7550B features only one glow transfer counting tube per decade for both counting and indication, 200 mv input sensitivity, a self-test function switch for checking internal time base and counter decades, measuring capacities from 0.1 to 100 kc and 10 μ s to 1.5 days, and a counter tube life expectancy of over 10,000 hours. Applications include flow measurement, filter characteristic determination, oscillator calibration, rpm monitoring, and timing of physical events.

Electro-Pulse, Inc., Dept. ED, 11861 Teale St., Culver City, Calif.

CIRCLE 204 ON READER-SERVICE CARD FOR MORE INFORMATION

ANNOUNCING RADIFLO

... a revolutionary system
for detecting leaks
in transistors, diodes
and other sealed units
for pennies each!

RADIFLO offers a vast improvement over present leak detection methods because it measures the leak after the final sealing operation is completed. RADIFLO eliminates most of the expensive labor cost... yet gives the same or greater accuracy in a fraction of the time!

Here is how RADIFLO works. One or many parts are immersed under pressure in an inert, non-toxic radioactive gas. After air washing, the parts are passed over a scintillation counter which measures the molecular leakage to a normal sensitivity of one cc per 500 years.

Tests have shown that transistors can be checked at a cost as low as two cents each with corresponding savings on other types of parts. RADIFLO can also be easily set up on an assembly line for automatic parts inspection.

Even the initial cost of RADIFLO is low. Why not write today for complete technical information to Dept. No. 734Jy.



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Electronic Designers:

OVER 240 MODELS OF JOY FANS...

**... Designed especially for
your applications**

LIGHTWEIGHT because they are made of aluminum or magnesium castings produced in Joy's own foundries.

COMPACT design—with motor mounted inside the fan—permits installation anywhere . . . even inside a duct.

EFFICIENT vaneaxial design provides more air per given size than any other type fan.

AVAILABLE on a production line basis . . . Joy has over 250 standard models with 1300 designs available to your specs . . . from 1/500th horsepower up.

RUGGED because of simple design . . . the outer casing, the vanes and motor mounts are cast in one piece . . . vibration free.

Get more information from the world's largest manufacturer and supplier of vaneaxial fans to companies like G.E., Hallicrafters, Lear, R.C.A., Motorola, Raytheon, Sylvania.

Write to *Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.* In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*



Write for **FREE**
Bulletin 135-57

WSW 16348-135

CIRCLE 207 ON READER-SERVICE CARD FOR MORE INFORMATION

JOY

**WORLD'S LARGEST MANUFACTURER
OF VANEAXIAL-TYPE FANS**

New Products



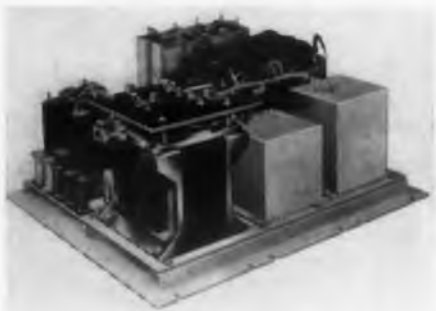
Concentric Dial Assembly Separate or Geared Inputs

This low inertia concentric dial assembly may be mounted so that the dial face is either parallel or perpendicular to the mounting surface. Input can be made perpendicular to the axis of rotation of the dial by the incorporation of a pair of miniature spiral mitre gears. Separate inputs to the two dials are provided permitting the comparison of two separate readings. Gears used are AGMA Class II. A hair-line indicator ensures accurate dial reading. The dial assembly is a two-speed indicator, with standard ratios of 10:1 or 36:1 available. Other ratios are available on special order.

Reeves Instrument Corp., Dept. ED, 207 E. 91st St., New York 28, N.Y.

CIRCLE 208 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Voltage Regulator 5 KVA



The 5 kva automatic voltage regulator type TM7105 is designed for an input of 95-135 v, and an output of 115 v nominal, adjustable from 110-112 v. The accuracy of the unit is 1 v band for line voltage variations and/or load magnitude and power factor changes. It has a waveform distortion of 4 per cent maximum and a response time of less than 1/2 sec for ordinary line and/or load changes. The size is 21-9/16 x 19 x 12-3/16 in., weighing 215 lbs. Both input and output connections are made to the terminal board inside the cabinet.

Superior Elec. Co., Dept. ED, 83 Laurel St., Bristol, Conn.

CIRCLE 209 ON READER-SERVICE CARD FOR MORE INFORMATION

HIGH VOLTAGE BREAKDOWN TEST

*... proves
Johnson tube sockets
are built to take it!*

**Eliminate special set-up charges!
Pick the tube socket you need from
Johnson's 3 basic grades...**

STANDARD—These are commercial grade sockets for general requirements. Bayonet Sockets equipped with porcelain bases, glazed top and sides. Phosphor bronze contacts .0002 cadmium plated. Nickel-plated hardware. Bayonet shells are etched aluminum. Wafer Sockets equipped with glazed steatite base—DC200 treated. Contacts are plated brass with steel springs. Shielded types equipped with etched aluminum shields.

INDUSTRIAL—Superior in quality to "Standard" types, equipped with glazed steatite bases, DC200 treated. Phosphor bronze or beryllium copper contacts and springs, .0005 silver-plated. Fungus resistant cushion washers under contacts. Aluminum bayonet shells and shields for wafer types, Iridite No. 14 treated.

MILITARY—Top quality for military requirements. Glazed L4 steatite bases, DC200 treated. Bayonet Sockets equipped with beryllium copper contacts .0005 silver-plated. Hot tin-dipped solder terminals—brass bayonet shells, .0003 nickel-plated. Threaded hardware .0002 nickel-plated—unthreaded hardware .0003. With fungus resistant cushion washers under contacts. Wafer Sockets equipped with phosphor bronze contacts and beryllium copper springs, silver-plated .001. Hot tin-dipped solder terminals. Fungus resistant, glass base melamine cushion washers under contacts. Aluminum shields on shielded types, No. 14 Iridite treated. Entire socket protected for 200 hour salt spray test.

Complete specifications ...
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Socket Standardization
Booklet 536, today!



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End the bottleneck on your assembly line by precision application of fasteners. Southern Quality fasteners are precision made for precision production. Sharp pointed, threaded to start fast, hold tight. They speed assembly, lower rejects. Give your product Permanence and Quality with Southern Screws!

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CIRCLE 212 ON READER-SERVICE CARD



Low Voltage Power Supply
Regulation ± 0.2 Per Cent

These telemeter and strain gauge power supplies are designed for 400 cps operation, but are also available for 60 cps circuits. Hermetically sealed, the supplies have no moving parts and are self-protected for shorted output. Characteristics include a regulation of ± 0.2 per cent, ripple of 1 per cent rms, recovery time of 0.5 sec, and a variety of outputs. Gulton Industries, Inc., Dept. ED, Engineered Magnetics Div., Metuchen, N.J.

CIRCLE 213 ON READER-SERVICE CARD



Modulators and Demodulators
For Tape Systems

FM-1A Modulators and FD-1A Demodulators are available for use with the modulator tape recording systems. The modulator produces an fm carrier suitable for magnetic tape recording and data transmission from a low-frequency signal. Each unit requires less than 6 ma at 180 v dc and 0.6 a at 12 v dc. Carrier output level is 100 v across 100,000 ohms; demodulator output level is 1 v across 20 K.

Electrodynamic Instrument Corp., Dept. ED, 2508 Tanglewood Rd., Houston 5, Texas.

CIRCLE 214 ON READER-SERVICE CARD



High Voltage Terminals
15 Kv to 50 Kv

Terminals in the 15 kv to 50 kv range have been developed. In addition to standard items, complete facilities to build custom terminals are in operation. The terminals are all twist-free, gasket type, and feature oil-filled design. Emphasis has been placed on raising the corona threshold.

Sphere Co. Inc., Dept. ED, Eagle Rock Bldg., 25 Amity St., Little Falls, N.J.

CIRCLE 215 ON READER-SERVICE CARD



1460 series

MOTOR OPERATED

Available SP2T thru SP6T—also DPDT and DP transfer. Frequencies thru 11,000 MC. AC or DC operation.



M1460 series

MANUALLY OPERATED

—same contact arrangement and R F head as the 1460 Series. For chassis or panel mounting.

TRANSKO

COAXIAL SWITCHES



11000 series

SOLENOID OPERATED

Miniature - SPDT

HN or Type N connectors. Frequencies thru 11,000 MC. AC or DC operation. Weight 6 oz.



—they simplify design of R F systems

With TRANSKO switches, you can cut down the number of components in a system—one switch handles up to 6 circuits. TRANSKO switches are small, and light in weight. Each is supplied in a choice of configurations to simplify installation.

Adds versatility to a system. All channels on a TRANSKO can be operated independently, and there's a wide variety of make-and-break arrangements available. TRANSKO switches operate through 11,000 MC—a standardization which cuts your stocking requirements to only one switch for this entire R F band width

High-efficiency switching is due to minimum insertion loss, low VSWR, and high isolation between channels. TRANSKO units are qualified to applicable military specifications. Performance has been fully confirmed in the field, where thousands of units are giving dependable service.

Technical data on any unit or the complete line sent on request. Send us your coaxial switching problems.

PROJECT ENGINEER OPENING FOR R. & D. ELECTRONICS

Engineer on Microwave Antenna Systems with Southern California leader in Avionics. Excellent company benefits. Address inquiries to Personnel Director.

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The Finest in R F System Components
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WHERE SPECS CALL FOR

MIL-I-7444A(2)

U.S.A.F.



Specify....

Resinite EP-93
VINYL INSULATION SLEEVING

For aircraft, airborne components, missiles and guidance systems – wherever specs call for MIL-I-7444A(2), or for any application where a dependable low temperature vinyl insulation sleeving is required, specify Resinite EP-93.

Not only does this outstanding material remain flexible at -90° F, it withstands 185° F continuously, an unusually wide operating range. It also offers exceptional flame, fungus and corrosion resistance. Available in all 3 size ranges.

EP-93 is just one of many fine insulation materials that have made Resinite the leading supplier of specification sleeving to the aircraft and electronics industries.

Write us your requirements and we'll submit samples and performance data on appropriate sleeveings, tapes or lacing cords.

Resinite

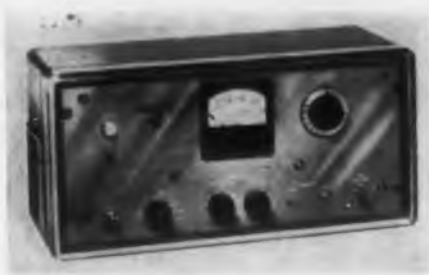


Resinite Department **THE BORDEN COMPANY** Chemical Division
Box 1589, Santa Barbara, California

SPECIALISTS IN VINYL SLEEVING AND TUBING FOR THE AIRCRAFT, ELECTRONICS, ELECTRICAL AND PHARMACEUTICAL FIELDS
CIRCLE 217 ON READER-SERVICE CARD FOR MORE INFORMATION

New Products

Logarithmic Counter 5 Decades



This logarithmic count rate meter, based on the Cooke-Yarborough circuit, is a wide-range instrument for use with all types of radiation detectors. Typical applications include gamma monitoring with scintillation counter, beta-gamma monitoring with Geiger counter, and gamma ray spectrometry. It incorporates a Schmidt trigger circuit for discrimination. The meter eliminates the necessity of manual or electro-mechanical switching as is required in linear-type rate meters. The meter circuit consists of a series of diode pump circuits where the signal is fed into a coupling condenser which charges through one diode and discharges through another into an integrating capacitor once each cycle. Range is from 10 to 1 million counts per min. in 5 decades on a single scale. Accuracy is within ± 2 per cent over the entire decade and is better than 1 per cent in the vicinity of the calibration point. Drift is less than 1 per cent in 24 hours. The unit operates on 150 v, 60 cycles and draws 135 w. Relay rack panel is 8-3/4 x 19 in. and shipping weight is 60 lb.

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

CIRCLE 218 ON READER-SERVICE CARD FOR MORE INFORMATION



Utility Oscillator 4.5 to 220 Mc Range

Incorporating self-contained attenuators, power supply and output meter, the Utilator provides a high level rf output age controlled for ± 0.5 db flatness over the 4.5 to 220 mc range. A direct reading frequency dial is accurate to ± 1 per cent. Rf output is 0.7 v rms into nominal 75 ohms. Attenuation is produced by switched steps of 20, 10 and 6 db, plus continuously variable 6 db. The instrument weighs 19 lb.

Kay Electric Co., Dept. ED, 14 Maple Ave., Pine Brook, N.J.

CIRCLE 219 ON READER-SERVICE CARD FOR MORE INFORMATION



in a Nutshell...

You may never build a circuit on or in a nutshell, but you—and a lot of other manufacturers—do have miniature and sub-miniature designs to contend with as a part of the modern electronic trend.

Mallory sub-miniature components help make these tiny circuits possible. Mallory, for example, pioneered the Mercury Battery—known 'round the world for its ability to perform... for its tiny size... and for its constant-voltage discharge rate, ideal for transistor circuitry.

Mallory manufactures four distinct lines of sub-miniature capacitors—from premium grades for performance under the most exacting conditions—to the newest TT series, low-cost aluminum-cased electrolytics, ideal for commercial applications. The new tiny TNT Capacitors measure .145" dia. by only $\frac{3}{16}$ " long!

When your problems are "small"—in physical size, look to Mallory for sub-miniature components. Ask the Mallory application engineers for capacitor specifications and assistance.

P. R. MALLORY & CO. INC.
Indianapolis 6, Indiana

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MALLORY

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Now ready!

The book you

need

for actual

circuit

designing . . .



TRANSISTOR CIRCUIT ENGINEERING

Edited by RICHARD F. SHEA.
Eight co-authors, all of the
General Electric Company.

Provides you with the necessary tools to do actual circuit designs, and develop usable circuits in all potential fields of application. It shows you how to build successful audio amplifiers, radio frequency amplifiers, etc. using available transistors—and how to combine these elements into radio receivers, television sets, and high fidelity audio systems.

Written by a team already famous as pioneers in the field of transistor electronics, the work contains a great deal of brand new material, plus up-to-date information on recently-introduced devices and their applications in ever-widening fields. Greatest emphasis is placed on the practical engineering aspects of the subject.

Chapter headings:

Characteristics and Characteristic Curves—Equivalent Circuits—Bias and Its Stabilization—Audio Amplifiers—DC Amplifiers and Their Applications—Tuned Amplifiers—Video Amplifiers—Oscillators—Modulation, Mixing and Detection—Transient Response and Pulse Circuits—Systems—Special Circuits.

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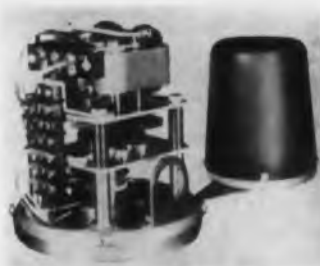
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Control Gearmotor Built-In Potentiometer

Shaftrol, shaft mounted gear motor includes a built-in potentiometer that provides remote control for valves, variable speed drives, gates, jacks, and variable displacement pumps. The potentiometer may also serve in bridge circuits of automatic control systems. Control may be by dial control, by push button or it may be automatic from limit switches, controllers or proportioning devices. The mounts on shafts from 1/4 to 1 in. in diam. A wide range of operating speeds and torques can be had by specifying the desired ratio of the 3 or 4 stage reduction gearing. A variety of potentiometer gear ratios may also be had so that full scale deflection of the calibrated meter may be obtained for rotation of the driven shaft from 1/6 revolution to 40 or more. Limit switches, which are optional, may be set to limit travel to any desired amount. Shaftrols can be furnished with built-in single or multi-turn precision potentiometers having a wide range of specifications. When the potentiometer is used as a part of a bridge circuit, the standard Shaftrol provides follow-up accuracies of plus or minus 1/5 per cent of full scale. With precision multi-turn potentiometers accuracies of 1/25 of 1 per cent can be had with counter read out if preferred. Shaftrols are available for use on single or 3 phase circuits with drip proof, totally enclosed or explosion proof enclosures.

Jordan Co., Inc., Dept. ED, 3235 W. Hampton Ave., Milwaukee 9, Wis.

CIRCLE 223 ON READER-SERVICE CARD FOR MORE INFORMATION



Spin-Lock Nuts Will Not Loosen

Spin-lock nuts combine the function of nut and lock washer in one piece. Available in sizes ranging from no. 8 to 1/2 in., the nut provides a ratchet-like structure on its base which bites into the bearing surface of the metal to be joined, resisting any tendency to loosen. The teeth provide excellent contact for electric equipment. The nuts are hardened to make them capable of carrying heavy loads, and the teeth are not deformed by use.

Russell, Burdsall & Ward Bolt and Nut Co., Dept. ED, Port Chester, N.Y.

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AN OPPORTUNITY AND A CHALLENGE
FOR COMPONENT AND SYSTEMS DESIGNERS

SIMPLIFY AND INCREASE SYSTEM RELIABILITY

BY DESIGNING TO CHARACTERISTICS OF LOW IMPEDANCE A-C DIFFERENTIAL TRANSFORMERS

*infinite resolution • no sliding contact nor bearings
frictionless • unlimited life, nothing to wear out
temperature stable • high signal to noise ratio
small, compact, lightweight*

Recommended for hydraulic servo valve feedback, rate gyros, accelerometers, hydraulic servo motors, pressure, flow, position and level detectors, Atcotran Differential Transformers are setting the pace for improved reliability of components in existing systems by replacement of sliding contact pickups.

New systems designs incorporating the full advantage of inherent characteristics of these transducers promise outstanding benefits:

- 1) The low impedance characteristics of differential transformers can reduce or eliminate the need for filter circuits.
- 2) Ratio winding techniques and simple interconnection for algebraic functions frequently can be accomplished without intermediate components.
- 3) The reliability and precision of differential transformers makes possible a new order of performance.

EXPERIMENTAL KIT



To enable designers to familiarize themselves with the application of differential transformers in the laboratory, the Atcotran Differential Transformer Experimental Kit has been made available. It contains seven standard coils of various characteristics, a flexure plate and clamp, a demodulator and a 32-page HANDBOOK containing theory and application data on differential transformers.

A \$324.00 value specially priced at only \$189.50 for lab investigation.

Start exploring this new opportunity now. Order your kit today.



THE WORLD'S LEADING
DESIGNERS AND MANUFACTURERS
OF LOW IMPEDANCE
DIFFERENTIAL TRANSFORMERS

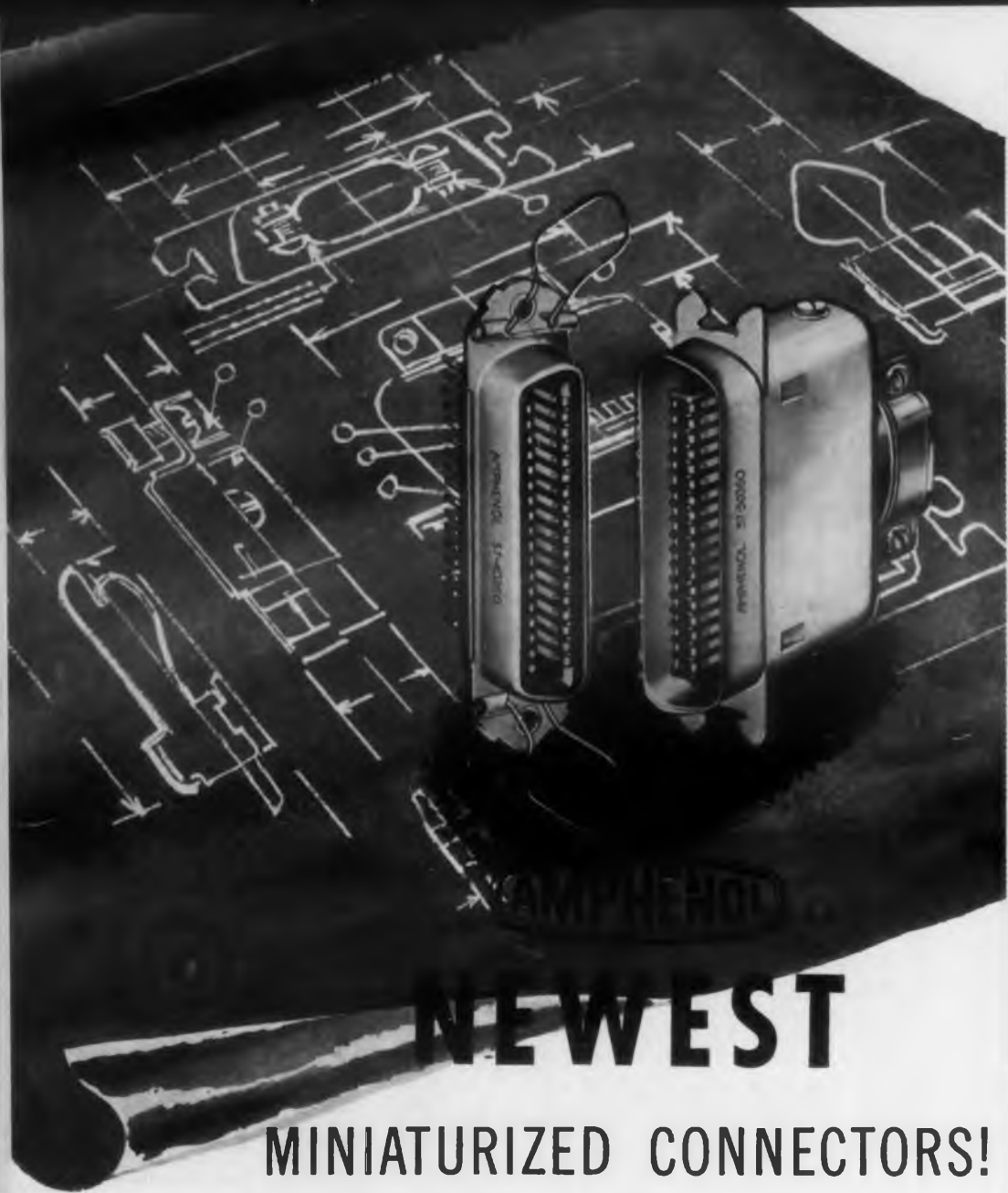
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NEWEST

MINIATURIZED CONNECTORS!

AMPHENOL's super-reliable Micro-Ribbons are now available in cable-to-chassis mountings. Providing all of the remarkable Micro-Ribbon advantages for this needed application, these new types feature cadmium-plated brass shells with clear chromate treatment, gold-over-silver plated contacts, diallyl phthalate dielectrics.

If you are cramped for space, here is how these connectors work for you. The *largest* cable-to-chassis pair contain 50 contacts—yet, mated, measure only 3.8 square inches!

At 5 amps Micro-Ribbon connectors are rated at 700 Volts D. C. at Sea Level, 200 Volts D. C. at 70,000 feet. They are available in 14, 24, 36 and 50 contacts.



AMPHENOL ELECTRONICS CORPORATION
chicago 50, illinois

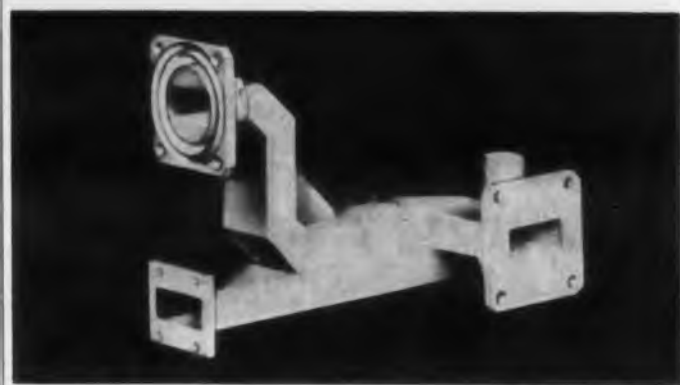
"BUILDING TO THE FUTURE OF ELECTRONICS"

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Services for Designers

Flux-Dip Brazing of Aluminum Assemblies

Flux-dip brazing, a new technique for joining complex, multi-joint aluminum assemblies in one operation, is now available through Waveline, Inc., of Caldwell, New Jersey. This revolutionary process eliminates the many drawbacks of hand brazing, and assures unmatched high volume, low cost production. The major benefits of flux-dip brazing are: Mechanical accuracy, due to controlled uniform heating, warp and distortion of the assembly are eliminated; close tolerances are maintained; high strength, quality finish, and economy. Flux-dip brazing has proven ideal for brazing waveguides, antennas, chassis and microwave assemblies. It also has found application in the aviation, missile and instrument industries. Additional information may be obtained by writing to Mr. John Morris, Production Engineer in charge of development, Waveline, Inc., Caldwell, N.J.



Typical complex multi-joint aluminum assembly flux-dip brazed in one operation.

Research and Development Laboratory

A new laboratory which offers research and development services on a contract basis has been established in Madison, Wisconsin by Trionics Corporation, P.O. Box 548. The services of the laboratory are available to both industrial and government sponsors. It will employ more than 30 persons at the Madison laboratory and plans call for an increase in staff to more than 70 persons.

The research program of the new laboratory is primarily designed to develop new and improved materials to meet the requirements of specific technological advances. Special fields in which the laboratory will be active include high and low temperature resistant materials, magnetic materials, ceramics, coatings and surface treatments, plastics, electronic component materials, high strength-low weight materials, packaging materials, corrosion inhibition, metallurgy, radiochemistry, and microwave physics.

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PIONEERS
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Gudebrod flat braided lacing tapes hold harness securely—no bite-through or slip, yet are easy on the hands. Some resist high temperature, some are color-coded . . . and they come wax-coated or wax-free . . . rubber-coated . . . or with special coating. Gudebrod makes many tapes for many purposes, including defense work. Send us your lacing problems or your specifications . . . we can supply the answer to both.

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CIRCLE 228 ON READER-SERVICE CARD

ON THE SHELF!

SINGLE SPIDER GEAR DIFFERENTIALS



by FORD INSTRUMENT

AVAILABLE IN FOUR SIZES:
 $\frac{1}{8}$ " , $\frac{3}{16}$ " , $\frac{1}{4}$ " , and $\frac{5}{16}$ " Shaft Diameters

NOTE! Prices of $\frac{1}{8}$ " units have been drastically reduced.

GUARANTEED SHIPMENT WITHIN:

(WITHOUT END GEARS)		TYPE
1 WEEK	for units with set shaft lengths*	A
3 WEEKS	for units with shaft lengths to customer specs	B
(WITH END GEARS)		
4 WEEKS	for units with stock end gears	C
8 WEEKS	for units with end gears to customer specs	D

(SUBJECT TO PRIOR SALE)

*Note: $\frac{3}{16}$ " units are not stocked with set shaft lengths.

Ford Instrument produces single spider gear differentials to highest military and commercial standards, for extreme accuracy in addition and subtraction, and in servo loop applications. Seven ways superior. Call or wire W. Mohr, Component Sales Division (Stillwell 4-9000) for prices, or check and mail coupon below, stating quantity. Data bulletin with performance curves and characteristics will be sent with the prices.



Component Sales Division ED

FORD INSTRUMENT COMPANY

DIVISION OF SPERRY RAND CORPORATION
 31-10 Thomson Avenue, Long Island City 1, N. Y.

Please send me prices on the following:

Circle size of unit desired:

$\frac{1}{8}$ " $\frac{3}{16}$ " $\frac{1}{4}$ " $\frac{5}{16}$ "

Circle category for type of units needed:
 (Check two if both apply)

A B C D

I want _____ (number) units:

Name _____

Position _____

Company _____

Street _____

City _____ State _____

CIRCLE 232 ON READER-SERVICE CARD

Physics Research and Consulting Service

A privately-financed organization to offer full-scale physics research and consulting service based on use of a Van de Graaff particle accelerator has completed installation of its "atom smasher." The new company, Texas Nuclear Corp., Austin, is initially using its 2-million-volt positive-ion accelerator in programs dealing with elastic and inelastic scattering of neutrons.

The company is now staffed and equipped to provide complete coverage in such programs as analysis of compounds by nuclear methods, neutron activation cross section studies, investigation of radiation damage, study of radiation damage by electrons, electron sterilization and well-logging research. A 3600 square-foot facility has been constructed to house the Van de Graaff accelerator, and auxiliary equipment including a multichannel analyzer and related specialized counting and recording devices.

Plastic Coating Operation

The Polymer Corporation, Reading, Pa., announces the establishment of a plant at 3030 Oak Street, Santa Ana, California, to perform custom coating by the new Whirlclad coating process. The process is a new coating technique which primarily involves dipping preheated articles into a bed of finely divided dry powders which are fluidized by ascending currents of gas or air. The powders heat fuse to form the coating.

The process permits use of a wide range of plastic materials such as nylon, polyethylene, cellulose, epoxies and polyethers to be applied to metals and other base materials. Materials such as nylon and polyethylene, can be utilized. The single dip technique applies coatings for chemical and corrosion resistance, wear resistance, electrical insulation and decorative purposes. The new Santa Ana operation is expected to provide new availability of coatings to the aircraft, electronics, and other West Coast industries.



Preheated metal parts being dipped into a tank containing fluidized coating powders.

What makes a relay RELIABLE?

BASIC DESIGN

UNION engineers have been designing relays noted for highest reliability for more than 75 years. This experience has been applied to miniature relay design with outstanding success.



MANUFACTURING TECHNIQUES

To obtain reliable performance in every relay, UNION has developed excellent techniques for precision manufacture on a high-volume basis. Workers are provided with ingenious tools, jigs and fixtures for consistent accuracy. Special processes such as high-temperature baking and hermetic seal by welding of steel cases assure top relay performance.



QUALITY CONTROL

Scientific quality control practices and 100% testing to critical Military Specification requirements, including a hermetic seal test by mass spectrometer, assure standard quality in every relay.

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Wescon Show, Booths 810-811**

UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18, PENNSYLVANIA

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REX

K-F WIRES

OFFER A NEW STANDARD OF
QUALITY IN HOOK-UP WIRES
FOR 1,000 VOLT SERVICE AT
OPERATING TEMPERATURES
FROM -65°C to 175°C .

To MIL-W-12349 Specifications
Insulated with Kel-F*

MECHANICAL CHARACTERISTICS

- Good abrasion resistance
- Excellent resistance to cold flow
- Extremely flexible
- Smaller O.D. than wires of comparable values

ELECTRICAL PROPERTIES

- Dielectric constant between 2.5 and 3.0
- Good arc resistance
- Zero moisture absorption
- Resists wetting and high humidity

Available from stock in 17 solid colors — AWG sizes 10 through 30, also in 1, 2 or 3 stripes in any combination of 10 colors for almost unlimited color coding. Can also be supplied with braided shielding for special requirements.

Complete facilities for twisting single, insulated conductors in pairs, triplex or quads, cabling 808 conductors into a single core, and, for layer or sector type cabling are available. Application of braided shielding or spiral tape shielding over the core before jacketing a specialty. Jacketing done in polyethylene, vinyl, nylon, or Kel-F.

EFFECTS OF HEAT AGING ON WIRE INSULATED WITH "KEL-F" 500 RESIN	
TEMPERATURE AND PERIOD	RMS VOLTAGE BREAKDOWN
Initial Value	13,500
150°C (302°F)	
1 Week	13,000
2 Weeks	14,600
5 Months	12,100
175°C (347°F)	
1 Week	13,500
2 Weeks	14,500
5 Months	5,200
190°C (374°F)	
2 Weeks	9,600

R E X - K F	
Operating Temperature	175°C to -65°C
Continuous Operating Voltage	1000 volts RMS
Spark Test	7500 volts RMS
Dielectric Strength	5000 volts RMS
Power Factor	.001-.011
Dielectric Constant	2.4-2.8
Insulation Resistance	< 5000meg/1000'
Moisture Absorption	Nil
Flammability	Non flammable
Solvent Resistance	Impervious to corrosive chemicals

Send for complete technical data

*T.M. M. W. Kellogg Co.

ELECTRONICS DIVISION

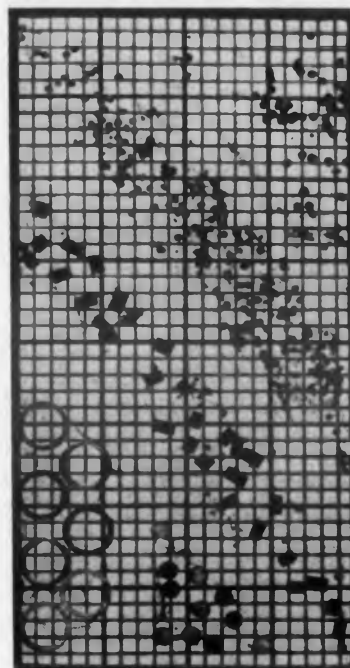


THE REX CORPORATION

210 Hayward Road
West Acton, Massachusetts



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Microforms for Semiconductors

Herbert Drapkin
Anchor Metal Co., Inc.

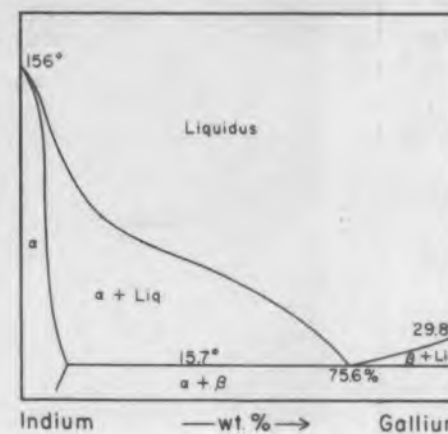
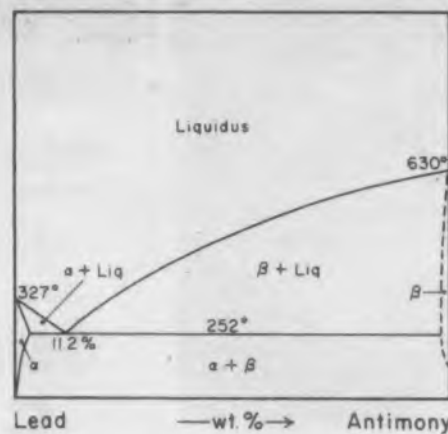
THE CHOICE in semiconductor devices at present are germanium for its high frequency properties, and silicon for its greater efficiency at higher temperatures. Experimentally other compounds show the high frequency properties of germanium at the temperatures where silicon devices work best, but for the purpose of description these two basic elements are used as examples.

Microforms of pure germanium and silicon are cut from single long crystals grown from zone-purified metals. The crystals are first started as seeds and pulled from their melts at about 1 mm per min. Purified germanium, or silicon, must be inoculated during crystal growth with precise amounts of doping elements, which either donate electrons to cross-sections of the growing crystal or take electrons out.

Donor dopes include antimony, arsenic, bismuth, phosphorus. Acceptors include boron, gallium, indium.

Junctions of types p or n are created in the crystal by letting pellets or spheres of the appropriate inoculant slide down a tube into the melt intermittently. Microforms cut from such doped germanium or silicon crystals grown by this method have either n or p, or both, junctions grown into them.

Other devices use microformed wafers of pure germanium or silicon to which the impurity is fused. For example, a pellet of indium is placed on a wafer of n-type germanium. The unit is slowly heated. At 156 C, the indium melts into a tiny blob. As the temperature continues to rise the spot of germanium on which the indium rests begins to melt and dissolve



Typical equilibrium diagrams show the proportional weight of each element of a binary alloy as it passes from the liquid to the solid phase.

up into the molten indium, making an indium-germanium alloy. At 500 C, heating is stopped and the unit allowed to cool slowly. The germanium settles out of the alloy and grows back into its original n-type crystal base. But the regrown spot of germanium is now p-type because it is contaminated with some atoms of indium, and the whole germanium wafer includes a p-n junction. The re-solidified indium blob on top makes an excellent connection to the junction.

Microforms used to alloy, solder, seal and otherwise serve in semiconductor devices must be extremely precise in the quantities of elements of which they are made. Most must be so small that they can be manipulated only under magnifying glasses. A few of the shapes in demand are discs, pellets, spheres, washers. These measure from 0.001 in. to 0.04 in. in thickness, from 0.1 in. up in diameter. In, say, antimony-doped germanium an impurity diffusion layer can be created 1.5×10^{-4} cm thick.

In addition to the simple elements many alloys heretofore scarcely known and still incompletely understood are being used in research, engineering and development. Such alloys, to list only a few binary ones, include indium with gallium, tin, lead, germanium, gold, silver, zinc and cadmium; lead with arsenic and antimony; aluminum with gallium, and indium; tin with gallium, lead, bismuth, antimony, gold, silver and arsenic; silver with arsenic and copper; gold with arsenic, antimony and gallium.

To produce the alloy prescribed for a particular use the metallurgist must know the proportions of the elements at the temperatures where their mixtures solidify out of the melts. This data has been recorded as precisely as possible for many binary, ternary and quaternary alloys, and charted as equilibrium diagrams.

Equilibrium diagrams for the systems lead-antimony and indium-gallium are shown. At 327 C lead starts to settle out of the Pb-Sb liquidus (melt). This is the alpha phase of the solidifying alloy. Antimony, as shown at the other side of the diagram, has already been settling out of the liquidus as it cooled below 630 C. This is the beta phase. At 252 C the alloy is all solid. It is a homogeneous mixture containing 11.2 per cent lead with 88.8 per cent antimony. Similarly, the In-Ga system solidifies at 15.7 C with 75.6 per cent gallium. Such equilibrium diagrams are considered guides to the engineer in calculating the quantities of the elements in the microform that he requires in the design of his semiconductor devices.

G U D E M A N

Capacitors



Bathtub Type Military Capacitors

MIL-C-25 Types
CP53, CP54, CP55 Case Styles
Temperature Ranges:
-55°C to +85°C
-55°C to +125°C



"XC" Plastic Film Dielectric Capacitors

The development of the Gudeman "XC" capacitors provides high temperature capacitors that have exceptionally high insulation resistance, low power factor and low dielectric absorption. No voltage derating is required when used within a temperature range from -65°C to +165°C. Bathtub and rectangular case styles also are available.



Miniature Feed-Through Capacitors

The Gudeman Feed-Thru Capacitor, Types 271 and 272 is a three-terminal component designed to be used for R. F. Interference suppression in a manner similar to a low pass filter. The typical insertion loss characteristics for these Feed-Thru Capacitors when measured in a 50 ohm line are in accordance with MIL-Standard 220.



Military Capacitors

MIL-C-25 Types
CP70 Case Styles
Temperature Ranges:
-55°C to +85°C
-55°C to +125°C



Tubular Laminated Cardboard Capacitors

The 633 series gives extra protection in extremely high humidity applications.
Paper Dielectric: Wax or Oil Impregnated Resin End Seals
Temperature Range: -40°C to +85°C



Dry Electrolytic Capacitors


ME and Printed Circuit Types
High Purity (99.99%) Aluminum Foil
Low Leakage
Temperature Range:
-30°C to +85°C

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Illustrated is Type R-75, 75 watts



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America's TOP Line

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TRU-OHM POWER RHEOSTATS are available singly or in a tremendous variety of tandem rheostat assemblies.

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"INDIUM"

prepared to your specifications . . .

Indium or indium alloys in ingots, sheets, wire, powder, ribbon, and pellets (disc or spherical) are supplied by us to leading U.S. manufacturers of electronic equipment. These and other forms prepared to your own requirements are available in two grades:

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As one of the world's leading primary producers of indium, we apply the services of our Research and Development Division to assist our customers in obtaining the full benefits of this most versatile metal.

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Zinc - 99.9995% Lead - 99.9998%
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New Materials

Ferroelectric Material

Permits Low Voltage Switching

Exploration in the field of ferroelectrics has resulted in the discovery of a new ferroelectric material at Bell Telephone Laboratories. Known as triglycine sulphate, the material has a rectangular voltage hysteresis loop and other desirable properties which make it promising for switching circuits and memory devices.

The most popular ferroelectric crystal previously investigated was barium titanate. Triglycine sulphate is superior in that it has a much lower coercive field, 220 v per cm, thus permitting switching with a lower voltage. Its polarization results in a lower output pulse when switched, but the size of the pulse can be increased by increasing the area of the switching electrodes.

Triglycine sulphate is stable chemically and does not decompose when exposed to moisture or to the atmosphere. It has adequate mechanical strength to permit handling in thin sheets. Large single crystals can be grown quite easily, and a number of large-area slices can be cut from each crystal.

Repeated switching does not cause any fatigue, and a given area will retain a given polarization indefinitely without deterioration. Although heating beyond the Curie point causes the material to lose its ferroelectric properties, these properties are regained in full when it is cooled.

The Curie point of the material is about 47 C. However, by replacing some of the hydrogen atoms with deuterium, easily accomplished when the crystal is grown, the Curie point can be raised to 60 C. Switching time is of the order of 1 to 2 μ sec. Electrodes can be applied to a slice cut from a single crystal by evaporating thin strips of metal on each side of the slice, the strips on one side



Triglycine sulphate, a new ferroelectric, provides a low switching voltage level as well as other qualities favorable for use in switching circuits.

being perpendicular to those on the other. Using this technique, thirty or more strips per inch can be applied, resulting in a memory or switching device capable of storing 900 or more bits of information on a square inch of crystal.

Custom-Shaped Sapphire

Melting Point of 2040 C

Advances in synthetic sapphire growing techniques have produced large single crystals competitive in price with sintered aluminas and quartz. A wide variety in sizes and shapes of rods, disks, tubes, domes and balls of sapphire are now available.

Properties include extreme hardness (next to diamond); resistance to acids and alkalis even at elevated temperatures; excellent electrical insulation; strength at high heats; melting point of 2040 C; excellent transmission characteristics of ultra-violet and infra-red wave lengths. These properties, together with the variety of shapes and sizes, allow such uses as windows and domes for infra-red systems and spacers and supports for electron gun structures.

Linde Air Prod. Co., Dept. ED, Div. Union Carbide, 30 E. 42nd St., New York 17, N.Y.

CIRCLE 244 ON READER-SERVICE CARD FOR MORE INFORMATION

Zirconium

Uses and Properties

Some sources of information pertaining to the applications and the electrical, chemical and nuclear properties of zirconium and its alloys have been collected for those who may be considering the use of zirconium. Comprehensive sources of information are the following books and pamphlets:

American Society for Metals, *Zirconium and Zirconium Alloys*, Cleveland, Ohio, 1953.

U. S. Atomic Energy Commission, *Zirconium, A Bibliography of Unclassified Report Literature* (TID. 3304), Oak Ridge, Tenn., 1956.

H. K. Adenstedt, *Physical, Thermal, and Electrical Properties of Hafnium and High Purity Zirconium*, Trans. A.S.M., 44, 949, 1952.

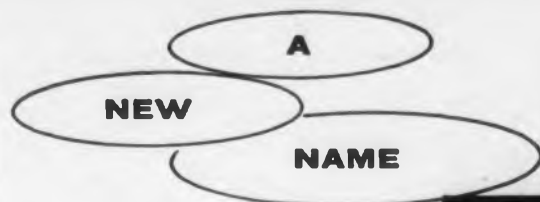
George A. Espersen, *Zirconium for Electron Tubes*, Foote Prints 18 (1), 3-7, 1946.

L. B. Golden, *The Corrosion Resistance of Zirconium and Zirconium Alloys*, A.S.M. Symposium on Zirconium and Zirconium Alloys, 305-326, 1953.

W. J. Kroll and H. L. Gilbert, *Melting and Casting Zirconium Metal*, Journal of Electrochemical Society, 96, 156, 1949.

C. F. Squire, and A. R. Kaufman, *The Magnetic Susceptibility of Titanium and Zirconium*, J. Chem. Phys., 9, 673, 1941.

Courtesy of Columbia-National Corp., 70 Memorial Drive, Cambridge 42, Mass., from whose bibliography on zirconium the above list was selected.



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The same company, the same engineering and manufacturing facilities, the same world-wide staff of field engineers, but a new name more descriptive of the Company and its products.

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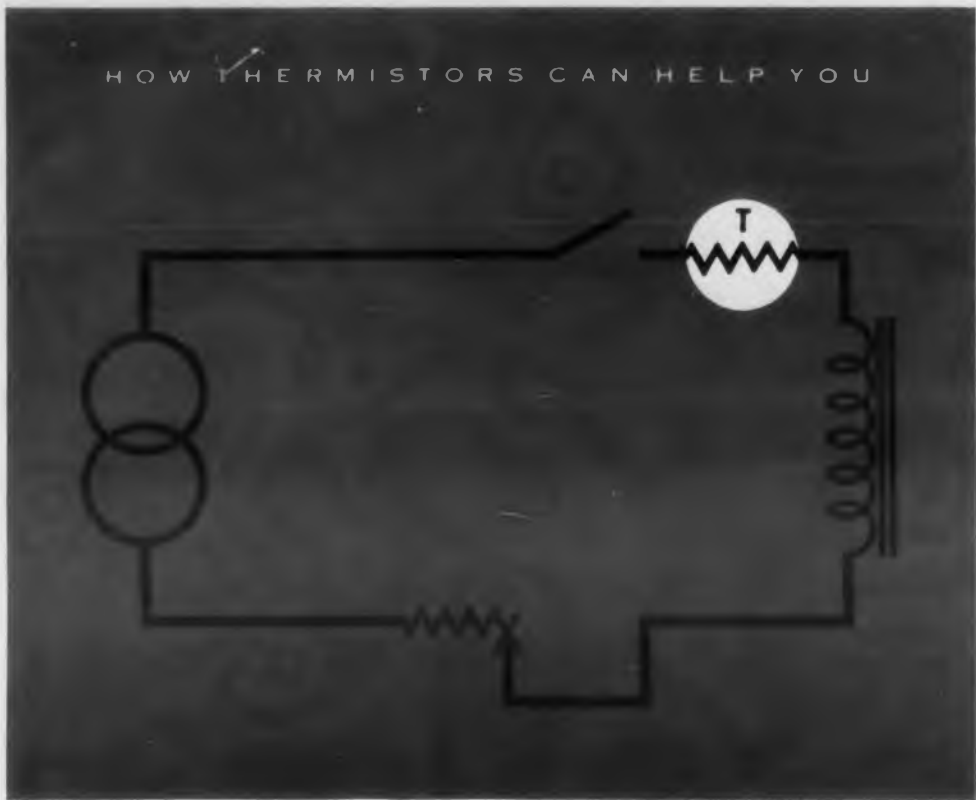
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CIRCLE 245 ON READER-SERVICE CARD FOR MORE INFORMATION



Effecting Time Delay with GLENNITE® Thermistors

An extremely effective time delay can be accomplished using Glennite Thermistors. This method shows distinct advantages over conventional time delay methods because of Glennite Thermistors' small size, long life, ruggedness and the elimination of moving parts.

The Glennite Rod Thermistor in the above schematic regulates current flow resulting in variable or fixed delay due to resistance change in the thermistor. Variable time delay can be obtained from a fraction of a second to several minutes.

Glennite Thermistors are available in bead, probe and wafer units, too — with some units offering temperature coefficients up to 7% per °C.

*Complete technical specifications
and typical applications are in the
Brochure T-100 . . . write for your copy.*



FROM RAW MATERIALS TO COMPLETE SYSTEMS . . .

Thermistor Division
Gulston Industries, Inc.

METUCHEN, NEW JERSEY



CIRCLE 248 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Electromagnetic Controls 249

Various types of electromagnetic controls are discussed in a series of seven catalogs recently released.

The booklets cover the following items: complete information on automatic transfer switches (mechanically or magnetically held) (Catalog 57-S1); remote control switches which are used to control power and lighting circuits (Catalog 57-S2); magnetically held contactors available for all normally open and closed classes of load (Catalog 57-S3); relays (Catalog 57-S4); AC and DC Solenoids (Catalog 57-S5); electric plant controls. Material includes complete systems, paralleling, changeover

and alternating panels, load demand controls, battery chargers and adapter units (Catalog 57-S6); and Catalog 57-S is the complete electromagnetic control catalog, which combines the information on Catalogs 57-S1 through 57-S6. Automatic Switch Co., Florham Park, N.J.

Electrolytic Capacitors 250

Catalog 1165 presents 12 pages of data on electrolytic capacitors. It also describes a long life capacitor which eliminates the excessive leakage current and rapid shelf aging problems of conventional electrolytic units. Industrial Condenser Corp., 3243-65 N. California Ave., Chicago 18, Ill.

Design for RELIABILITY in SERVICE with Alden Components for PLUG-IN UNIT CONSTRUCTION



New free Alden Handbook simplifies plug-in unit design. Presents complete line of basic components of tremendous flexibility for adapting your equipment to plug-in construction.

Request free "ALDEN HANDBOOK"

1. Utilize your circuitry in compact vertical planes using Alden Terminal Card Mounting System.



Eliminates wiring for common circuits. You can use Alden Terminal Mounting Card with Alden Miniature Terminals, Jumper Strip and Sockets staked to accommodate any circuitry—making complete units ready for housing. Components snap into unique Alden Terminals, are held ready for soldering.

YOUR COMPLETED CIRCUITS FOR PLUG-IN PACKAGE OR CHASSIS

2. Mount this compact vertical circuitry in neat accessible ALDEN PLUG-IN PACKAGE OR CHASSIS



Alden components provide standard plug-in or slide-in housings—with spares, your circuits become units replaceable in 30 seconds.

3. Use ALDEN BACK CONNECTORS and SERVE-A-UNIT LOCK for 100% circuit accessibility and 30-second chassis removal.



4. Assign to each unit tiny tell-tale ALDEN SENSING ELEMENTS — to spot trouble instantly:



7139 N. MAIN ST., BROCKTON 64, MASS.
ALDEN PRODUCTS CO.

From Alden's Line of Ready-made Components for Unitized Plug-in Unit Construction.

CIRCLE 251 ON READER-SERVICE CARD FOR MORE INFORMATION

Screw-Lock Inserts

258

Specifications on a complete line of screw-lock inserts, including miniature size 4-40 inserts are listed in Bulletin 738. The eight-page booklet contains screw-lock selection tables with thread sizes, insert numbers and sizes, and complete information on drilling, tapping, gaging and installation. Line drawings and photographs illustrate proper installation of the inserts in both blind and through holes. Also presented are basic engineering design data, military specifications, classes of fit, and assembly proportions. A variety of cost-cutting applications are cited. Heli-Coil Corp., Danbury, Conn.

Precision Ball

260

Catalog that serves as guide to quick and simple selection of precision balls for practically any requirement and material specification has been released. Included is comprehensive data on such items as balls of aluminum, brass and bronze, carbon steel etc., as well as information on balls of special materials.

It also includes material characteristics, type analysis, mechanical properties, temperature characteristics, corrosion resistance factors, machinability, finish, hardness, accuracy, size, weight, and quantities per pound and per shipping container.

A special feature is the Quick Ball Selector Chart that provides a comparative reference for all ball types. Hartford Steel Ball Co., 12 Jefferson Ave., W. Hartford, Conn.

Servomotor-Rate Generator

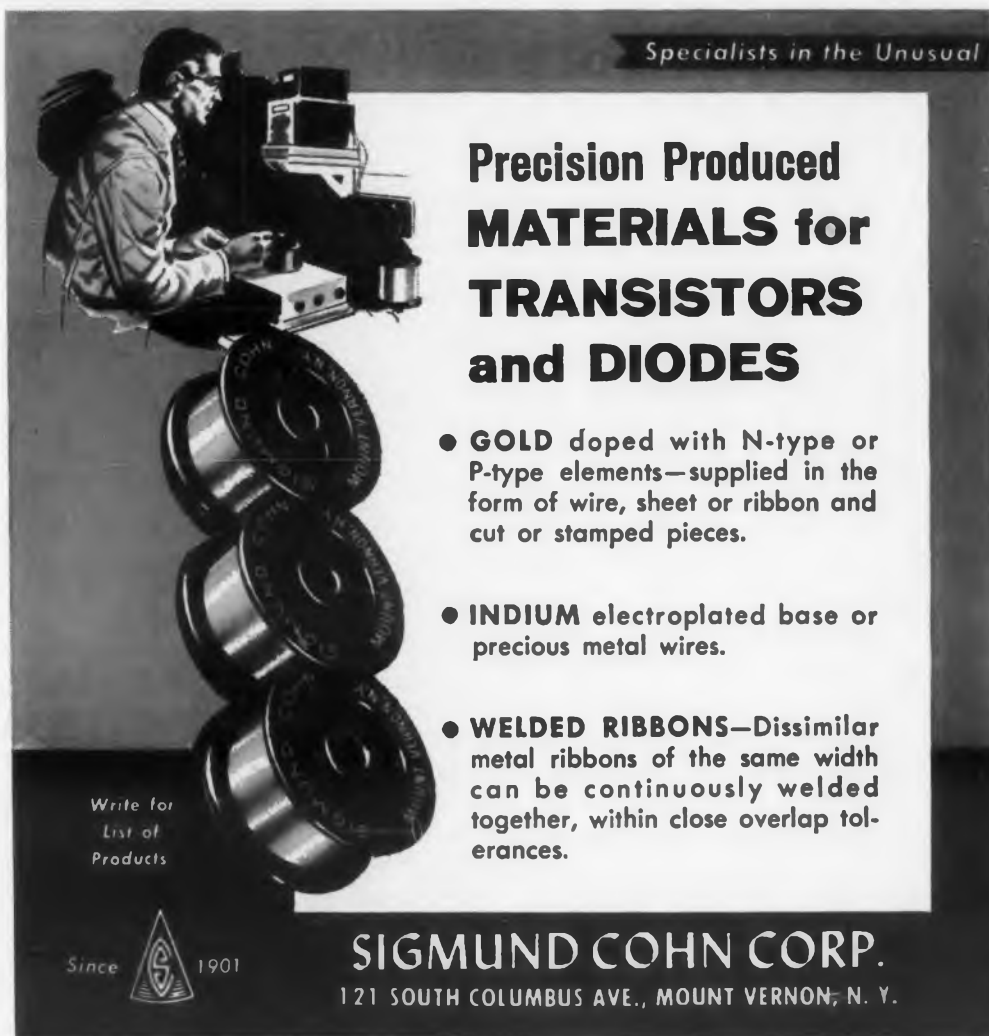
259

Data Sheet 866 covers details of the model 18 MG 690/660, a 60-cy, 115-v size 18 servomotor-rate generator. The sheet contains specifications, characteristics and other design information. It is illustrated with dimensional drawings, a schematic and a torque-speed curve. Beckman/Helipot Corp., Newport Beach, Calif.

Slip Ring Assemblies

261

Custom built slip ring assemblies are the topic of Bulletin S-2056. The four-page illustrated text describes complete ring assemblies, brush holder assemblies and brush contacts. Superior Carbon Products, Inc., 9115 George Ave., Cleveland 5, Ohio.




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Precision Produced MATERIALS for TRANSISTORS and DIODES

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- **INDIUM** electroplated base or precious metal wires.
- **WELDED RIBBONS**—Dissimilar metal ribbons of the same width can be continuously welded together, within close overlap tolerances.

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One of a kind

Among the many requirements for heat elements in industry today are those demanding virtually one-of-a-kind design.

Since such requirements normally cannot be met by loom weaving, Safeway technicians fabricate odd-shaped elements individually. Circles, half circles, cutouts, tapers and compound shapes are just a few of the elements fabricated in this fashion and produced in quantity.

Insulation, too, must provide for the characteristics of specialized applications. Safeway produces a wide variety of elements insulated with neoprene rubber, silicone rubber or reinforced plastics.

If you have a problem that requires heat, let Safeway engineers study your requirements and—without obligation to you—submit an appropriate recommendation.

For your copy of a fact-filled folder, write to:

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ELEMENTS
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CIRCLE 263 ON READER-SERVICE CARD FOR MORE INFORMATION

FANSTEEL

S.T.A. Capacitors

SOLID TANTALUM

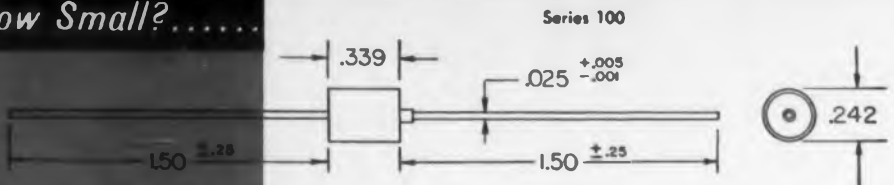


Small*

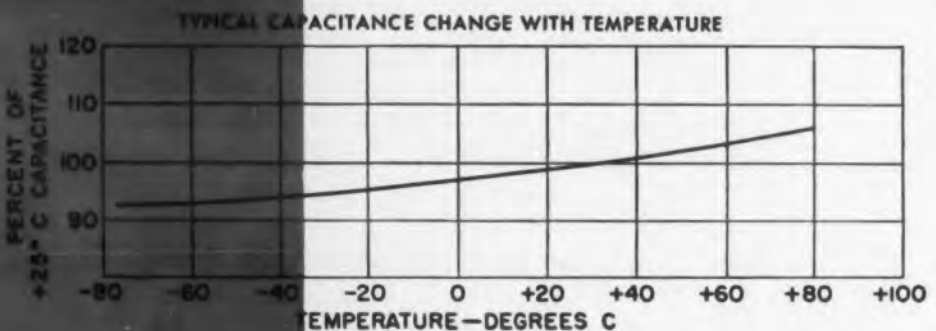
Stable**

Large Capacity***

*How Small?.....



**How Stable?.....



***How Large?.....

Series 100	1 mfd at 35 volts
Series 200	5 mfd at 35 volts
Series 300	20 mfd at 35 volts

Now Available in Production Quantities
(Write for bulletin 6.112)

FANSTEEL METALLURGICAL CORPORATION
North Chicago, Illinois, U. S. A.

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CS/5A

CIRCLE 268 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Rectifiers and Capacitors

269

ReCap, a new bimonthly journal of information on rectifiers and capacitors is now available, free, to interested engineers. The first issue, a four pager, featured an article on types and characteristics of silicon rectifiers and contained other interesting material on capacitors and rectifiers. Rectifier-Capacitor Div., Fansteel Metallurgical Corp., North Chicago, Ill.

Aluminum Bus Conductor Handbook

270

"Alcoa Aluminum Bus Conductor Handbook," a comprehensive work of 280 pages, presents facts and figures relative to the engineering and maintenance of bus installations. It contains 69 graphs, tables and photographs and presents essential information. There is comparatively little text. Introductory material traces the development of aluminum's use and its properties as a conductor. Subsequent chapters deal with conductor shapes, design, reactance, capacities, deflections, joints and short-circuit conditions, and the final sections explain important fundamentals of installation. A comprehensive bibliography refers the user to technical articles on related subjects. Copies of the handbook may be obtained by writing on company letterhead to Aluminum Co. of America, 793 Alcoa Bldg., Pittsburgh 19, Pa.

Data Sheets for Motors & Timers

271

To assist customers in ordering special timers or motors, two bulletins have been released.

Bulletin MS101-Applications data sheet for motors and elapsed time indicators and Bulletin MS102-Applications data sheet for repeat cycle timers and time delay relays. These bulletins are designed to aid customers in organizing their thinking when ordering or requesting information on any special units. All pertinent information is itemized with ample space to insert required values of current, voltage or life. In many cases these bulletins can be used to replace lengthy problem statements.

These bulletins will help considerably in saving time and money for the customers, since much correspondence can be eliminated by averting the omission of important details in the initial description of a timer.

The bulletin sheets are clearly blocked out with readable size type and check-off blocks and charts for laying out timing programs. A. W. Haydon Co., Waterbury, Conn.



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depend upon

Automatic
coaxial
SWITCHES and RELAYS



**Custom engineered
to your specifications**

Unsurpassed accuracy and dependability, based on over 15 years experience in producing precision parts for the Army, Navy, Air Force, and Atomic Energy Commission.

AUTOMATIC'S Coaxial Switches and Relays are available in the following types:

SPDT, DPDT, Crossover, Resistor Terminated, Multiple Position, and Rotary—both continuous and index type.

All switches available for both manual and relay operation, and may be ordered with all standard and sub-miniature fittings.

AUTOMATIC'S Switches and Relays are small in size...light in weight...low in cost...and have excellent electrical characteristics.

Our engineers are always ready to discuss your special requirements.

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CIRCLE 272 ON READER-SERVICE CARD

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for measurement and control of

- **TEMPERATURE**
-400F to +2000F
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0.5 to 0-5000 psi

to meet strictest requirements of

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OPEN TEMPERATURE PICKUPS



The illustrated OPEN TEMPERATURE PICKUPS are precision platinum resistance thermometers capable of high-speed temperature measurement of gases and non-corrosive fluids. Resistance winding, supported on ceramic-insulated posts or on card, is in direct contact with environment to be measured, and can have time constants as fast as 50 milliseconds. Full-scale output voltages of 5 volts can be delivered directly to telemetry commutation circuits. Units operate over selected ranges from -320F to +750F (-200C to +400C), with accuracy better than $\pm 1\%$ of full scale and repeatability of $\pm 0.2\%$. Calibration Certificate giving precise 5-point calibration supplied with each unit. Stainless steel case and rugged construction withstand 1500 psia pressures, ± 25 g vibration, and 60 g shocks under MIL-E-5272A. Send for Technical Bulletins 1182 and 1350.

TRANS-SONICS INCORPORATED

BURLINGTON, MASSACHUSETTS

CIRCLE 278 ON READER-SERVICE CARD

Industrial Materials

279

This new industrial materials selection chart lists application and descriptive data on adhesives, coatings and sealers. The chart, divided into six sections, includes reclaim rubber, synthetic rubber, latices, plastics, epoxy resins, and caulking. Miracle Adhesives Corporation, P.O. Box 466, New Philadelphia, Ohio.

High Density Felts

280

High density felts called Feutron "63," are discussed in Technical Data Sheet No. 19—a 2-page comprehensive presentation now available.

The data sheet describes the general characteristic of the new high density felts and diagrams their physical properties. Feutron "63" line felts provide an opportunity for technological advances in a wide range of applications, particularly where severe mechanical operating conditions are encountered.

Among the general characteristics of the new high density felts are high tensile strength, exceptional abrasion resistance and isotropic structure.

The bulletin declares that "special chemical and heat resistant properties are identified with the particular synthetic fiber of which the felt is composed.

A table in the data sheet refers specifically to the physical properties and performance characteristics of four representative samples included in the bulletin, which are illustrative of this class of mechanically interlocked and chemically shrunk materials. American Felt Co., Eng. & Research Labs., Glenville, Conn.

SRI Journal

The Stanford Research Institute has announced the first issue of its quarterly SRI Journal. The new publication will present scientific and economic subjects in comparatively nontechnical language. It is designed primarily for research directors and key executives in business, industry and government. Editor of the new magazine is Charles Scarlott, manager of the Institute's Publication Department. The Journal will feature articles by staff members and guest contributors. It will contain selected papers presented at SRI-sponsored meetings. Interpretive summaries of research projects will also be offered. The first issue contains illustrated articles on guided missile research; techniques for machine reading of Arabic characters printed in magnetic ink; the problem of X-ray crystal analyses and a new computer to shorten computation time; and other subjects. The Journal may be obtained for \$1.00 a copy or \$4.00 a year from the Editor, SRI Journal, Stanford Research Institute, Menlo Park, Calif.

FANSTEEL SILICON RECTIFIERS

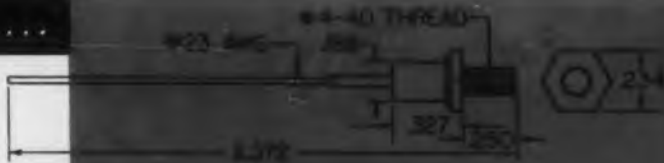


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Wide Range**

High Performance***

**How Small?.....*



***How Wide?.....*

Available in peak
inverse voltage ratings from
50 through 350 volts

****How High?.....*

Rated at 500 milliamperes
without heat sink



12764

Tell Me About Your Requirements

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CIRCLE 281 ON READER-SERVICE CARD FOR MORE INFORMATION

BULOVA

FAMED FOR PRECISION SINCE 1875



NEW AM-100



"MULTI-PURPOSE" OVEN

Now Bulova pioneers an entirely new, ultra-simplified means of temperature compensation...the "multi-purpose" AM-100 oven.

The AM-100 is designed to yield exacting temperature control of more than just crystals. Now entire circuits, components and/or complete sub-assemblies can be housed in one, low cost unit...the highly stable AM-100.

By eliminating costlier, less dependable, heavier and more complex temperature compensating factors, hundreds of design hours can be saved...circuits can be simplified and more dependable, and have a far wider operating range.

THE AM-100 FEATURES: Rugged lightweight construction (less than 7½ oz.); Long life expectancy due to triple insulation on heater winding; High stability $\pm .1^{\circ}\text{C}$.; Standard octal plug-in (stud mounting available); The unit draws 20 watts on initial warm-up, with average dissipation of less than 5 watts after warm-up; Meets vibration tests per MIL-E-5272; Overall 3" diameter x 5" high - cylindrical cavity 1¼" diameter x 2¼" high.

A complete line of precision Bulova ovens are available in quantity, with custom designed units available on request.



BULOVA

w a t c h c o m p a n y

Electronics Division
Woodside 77, N. Y.

Write Dept. A-765
Full Information
and Prices on Ovens

CIRCLE 288 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Zinc Brightener

289

The advantages of a zinc brightener used in plating parts by the barrel method are discussed in data sheet released recently.

The new brightener makes zinc barrel plating more dependable and reduces cost by eliminating subsequent bright dipping. Smoothex, Inc., 10705 Briggs Rd., Cleveland 11, Ohio.

Angle Meters

290

Various 250 deg. arc angle meters are discussed in a 6-page folder, Form 250 now available. The illustrated folder describes meters which feature scale lengths up to 2-1/2 times as long as conventional meters and are accurate up to one per cent of full scale deflection. The meters are available from 2-1/2 in. up in ruggedized, shockproof and sealed cases. Long scale aircraft and special purpose meters are also illustrated. Hickok Electrical Instrument Co., 10525 Dupont Ave., Cleveland 8, Ohio.

Battery Connectors

291

GB6 is a catalog with 32 pages of information on battery connectors, power connectors, and heavy-duty connectors for industrial and allied applications. Several series for aircraft, sound equipment, television and other uses are described. Individual units are listed with short specifications, dimensional drawings and photographs. The booklet also contains explicit ordering information. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

Special Transformers

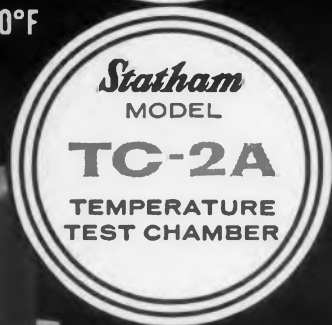
292

In a 4-page brochure, a line of military and special commercial transformers is described. High power pulse, hermetically sealed military and open type military, subminiature binary and toroids are some of the types discussed and illustrated. Manufacturing facilities are also outlined. Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass.

the most versatile
temperature test chamber
for laboratory or production line...

for testing from -65°F to $+350^{\circ}\text{F}$

\$550.00 f.o.b. Los Angeles



The Statham Model TC-2A portable Temperature Test Chamber has proven its versatility and value for years in such fields as the Aircraft, Electrical, Electronic, Automotive, and Chemical industries. Its wide operating range—from -65°F to $+350^{\circ}\text{F}$ —makes this unit the ideal solution for ambient temperature tests in the Laboratory or on the Production Line. Accurate and adjustable temperature control, wide temperature range, and a product capacity of 600 cubic inches provide the most versatile test chamber available for your testing needs. Interchangeable extra trays may be ordered for greater convenience and elimination of loading delays.

Write for descriptive literature on this and other models, or wire or call for prompt reply on your application.

Statham

DEVELOPMENT CORPORATION
12411 West Olympic Boulevard,
Los Angeles 64, California
GRanite 7-9157.

CIRCLE 293 ON READER-SERVICE CARD FOR MORE INFORMATION

Electronic Counters

298

A four-page illustrated brochure shows a line of electronic counters. Described are a decade scaler with a counting speed of 10 mc and a binary scaler with a counting speed of 20 mc. Other decade scalers covered have counting speeds of 20 kc, 40 kc, 100 kc and 1 mc. Three preset scalers of 20 kc, 40 kc and 100 kc counting speeds are also presented. Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass.

Miniature Lighting Assemblies

299

Miniature lighting assemblies, lamp-holders and components are covered in 16-page catalog just released. The catalog gives full application and dimensional data on the numerous units and parts, with detailed illustrations and full information on special variations and modifications of standard assemblies.

In addition, a general discussion of the purposes and construction of the component parts of assemblies is included, in order to facilitate the selection of the right unit for a given application. Drake Mfg. Co., 1713 W. Hubbard St., Chicago 22, Ill.

Regulated Power Supplies

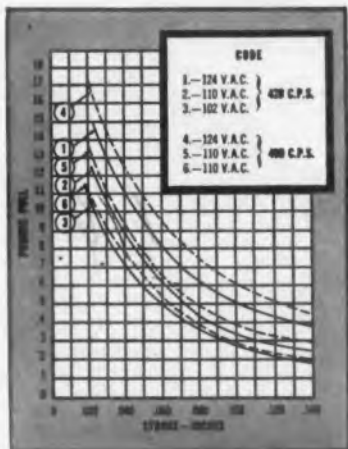
300

Magnetically regulated power supplies are the topic of a recent catalog. The four-page folder describes and illustrates filament power supplies, telemetering and strain gage power supplies, computer power supplies, and miniature magnetic amplifier power supplies. Also discussed is a transistorized line which includes dc voltage regulators and inverters. Gulton Industries, Engineered Magnetics Div., 212 Durham Ave., Metuchen, N.J.

Tiny Tantalytic Capacitors

301

GEA-6065C is a 4-page booklet on micro-miniature tantalytic capacitors for low-voltage, dc applications where high capacitance is needed. It contains a discussion of the units' features, construction, uses and specifications. A table shows ratings and dimensions. Photographs and dimensional diagrams provide illustration. The brochure also contains photographs and short descriptions of other capacitor types together with the numbers of bulletins where they are more fully treated. General Electric Co., Schenectady, N.Y.



A WesCo special: 400 cycle HI-TEMP solenoid!

WesCo's specially designed 400 cycle solenoid may help you solve your problem. Proven on latest military aircraft and other selective high temperature applications. Model shown is continuous duty, weighs 1 pound, tested to 600°F. Mounting furnished to meet your needs. Remember, when you need a solenoid, think of WesCo.

AC Industrial Solenoids—full line. Write for brochure.
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The trademark on
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since 1927



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CIRCLE 302 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW MODULAR DESIGN PRECISION POTENTIOMETER

PVR-09



STANDARD PARTS

Variables:

1. Case Depth
2. No. of Taps
3. Types of Terminals
4. Ganging (Up to 15)
5. Mounting
 - Servo
 - Tapped Hole
 - Threaded Bushing
6. Phasing

+ COMBINATION
OF
THE VARIABLES
AS REQUIRED

= CUSTOMIZED
POTENTIOMETERS

MODULAR
DESIGN

FEATURES OF CUSTOMIZED STANDARD POTS

- ▶ High Temperature Operation . . . to 145 deg C
- ▶ Independent Linearity of $\pm 0.25\%$
- ▶ Non-linear Functions

The newly developed TIC Type PVR-09 incorporates modular design for choice of cup depth, mounting, and number of taps. Modular design, a new concept in manufacturing, makes available all mounting types—servo, tapped hole, and threaded bushing . . . and, in addition provides extreme flexibility in customizing the standard PVR-09 design to the individual application.

Ganging up to 15 cups, without external clamps, and each individually phased at the factory also provided by the modular design technique. Up to 9 taps are available in a standard unit — others on special order. Ball bearing construction provides low torque.

With our new plant facilities and unique modular design techniques you now can get customized design without delay. Complete spec's on request.

PERTINENT CHARACTERISTICS:

- STANDARD RESISTANCES: 100 ohms to 150K
- ACCURACY OF TOTAL RESISTANCE: $\pm 5\%$ on standard, to $\pm 1\%$ on special linear functions
- INDEPENDENT LINEARITY: $\pm 0.5\%$ of total R above 5K standard, $\pm 0.25\%$ on special
- POWER RATING: 1.25 watts at 85°C
- RESISTANCE FUNCTIONS: Can be provided with a variety of non-linear functions
- TAPS: Up to 9 taps . . . with 10 deg
- TEMPERATURE RANGE: -55 to +145 deg C
- MILITARY SPECIFICATIONS: Tested to MIL-E-5272A

TIC TECHNOLOGY INSTRUMENT CORP.

555 MAIN STREET, ACTON, MASS.

P.O. BOX 3941, NORTH HOLLYWOOD, CALIF.

CIRCLE 303 ON READER-SERVICE CARD FOR MORE INFORMATION



a new measure



in Celco



precision

TOROIDAL COMPONENTS



Whether it's a complex 10 winding magnetic amplifier or a simple choke . . . at Celco each toroid is precision-made. New core materials are used in Toroidal magnetic amplifiers, reactors and transformers to achieve maximum performance.

At Celco, the proper matching of cores, winding, handling, impregnation, encapsulation and electrical history of the final assembly is carefully controlled to maintain the original design characteristics.

Our years of design, development, and production know-how are available for application to your specific TOROIDAL problems.

* For immediate attention,
call DAVIS 7-1123
— or write today.

Celco

Constantine Engineering Laboratories Co.
MAHWAH, NEW JERSEY

CIRCLE 308 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Network Components 309

Manufacturers of communications networks components recently established a regular monthly periodical entitled the Burnell Bulletin. The bulletin will contain, in addition to information about its progress, background material on the development and application of their products. Burnell & Co., Yonkers, N.Y.

Part Winding Starters 310

Bulletin GEA-6606 is a 4-page discussion of part winding starters. It points out the advantages of two-thirds part-winding starting and gives application data and part-winding characteristics of a typical motor. It also gives nomenclature and price information on the CR7050 starter designed for either one-half or two-thirds part-winding starting of standard motors or special part-winding motors for reduced kva inrush. The booklet is illustrated with connection diagrams and photographs. General Electric Co., Schenectady 5, N.Y.

Metal Instrument Cases 311

Deep-drawn and fabricated metal instrument cases, boxes and military cases are listed in a 62-page catalog. Photographs, specifications and descriptions are provided for a line encompassing more than 1400 stock sizes and shapes. The catalog has a section detailing plant facilities, among them product design, tooling, hydraulic presses, heliarc and spot welding, metal finishing, stamping and assembly. Zero Mfg. Co., 1121 Chestnut St., Burbank, Calif.

Control Cables

Publication of a brochure on supervisory and station control cables is announced. The illustrated literature introduces applications and gives complete technical information and engineering specifications. It comes in a loose-leaf cover binder to which supplemental data can be added. For copies write on company letterhead to Ansonia Wire & Cable Co., 111 Martin St., Ashton, R.I.

Looking for

PLUGS OR JACKS



You can rely on the man from Insuline to meet your specific requirements for plugs or jacks. Insuline's volume-produced standard or special design components are known for their quality workmanship. Orders filled promptly.

Ask the man from
insuline
CORPORATION OF AMERICA



186 Granite St. Manchester, N. H. (Van Norman Industries, Inc.)

CIRCLE 312 ON READER-SERVICE CARD FOR MORE INFORMATION

Slow Worm Motor

318

A one-page sheet is devoted to a slow-motion worm motor. Standard specifications on speed, rotation, shaft length, and type of application (continuous or intermittent) are listed. The sheet is illustrated with a photograph and a dimensional drawing. Brevet Products Corp., 601 W. 26th St., New York 1, N.Y.

VHF Transmitter

319

The Type T-20 building block 20-channel vhf transmitter is described in Brochure ARC BR-T20-1. The unit is designed to operate with either the ARC Type R-15 (108 to 135 mc) or ARC Type R-19 (118 to 145 mc) receiver to provide a 2-way vhf radio set. Aircraft Radio Corp., Boonton, N.J.

Industrial Heating

320

Bulletin 1331, a reprint of article entitled "How To Braze Stainless" by H. M. Weber, is now available. It discusses filler metals, wetting, fixtures, distortion, protective atmospheres, and other aspects of furnace brazing on stainless steels. General Electric Co., Schenectady 5, N.Y.

Pulse Burst Generators

321

The operation, specifications and uses of the Models 2130A and 2150A pulse burst generators are comprehensively treated in a bulletin of two pages. The text is illustrated with a diagram and a photograph. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.

Epiradiator

322

An epiradiator for remote evaporating and drying for infrared radiation is described in folder just released.

The folder gives complete description of the model as well as specifications and characteristics of the item. Quartz Products Corp., P.O. Box 628, Plainfield, N.J.

Ballast Heating

323

Basic heat problems and what causes overheating in fluorescent lamp ballasts are discussed in Bulletin 3328 entitled "Let's Talk About Ballast Heating" now available.

The 8-page two-color booklet tells what happens to an overheated ballast and gives steps to avoid ballast overheating and associated problems. General Electric Co., Schenectady 5, N.Y.



TYPE 751

Fairchild miniature precision potentiometers meet applicable portions of MIL-E-5272A. These units, in $\frac{7}{8}$ " and $1\frac{1}{8}$ " diameters, are available in standard or high temperature versions rated to 150° C. They are miniaturized without sacrificing performance—meeting the same requirements for accuracy and reliability as most standard precision units up to 2" in diameter.

MINIATURE PRECISION POTENTIOMETERS linear and nonlinear

Precision in linear and nonlinear functions is assured with each of these Fairchild miniature potentiometers. 0.5% standard accuracy, 0.25% special accuracy available. Type 751 ($\frac{7}{8}$ " dia.—weight .57 oz.) has a resistance range up to 75K ohms in mandrel, and 100K ohms in card-type windings. Type 741 ($1\frac{1}{8}$ " dia.—weight .77 oz.) has a resistance range up to 100K ohms in mandrel and 150 ohms in card-type windings. New external flush clamp bands, increasing the coupling strength of ganged units by 200% over previous designs, permit ganging up to six standard units without increasing the overall diameter.

Write for complete specifications.
Dept. 140-83N, Fairchild Controls
Corporation, Components Division:

EAST COAST
225 Park Avenue
Hicksville, L.I., N.Y.

WEST COAST
6111 E. Washington Blvd.
Los Angeles, Calif.



TYPE 741

FAIRCHILD
PRECISION POTENTIOMETERS
and COMPONENTS

CIRCLE 324 ON READER-SERVICE CARD FOR MORE INFORMATION



**1
WIRE
WITH
400 LIVES**

New "High Strength" wire with
400% longer "flex-life"

25% greater "tensile strength"

THE PROBLEM: Stranded hook-up wire users are experiencing excessive, costly and often dangerous conductor breakage, especially in the smaller, more susceptible conductor sizes (32 AWG to 24 AWG).

THE SOLUTION: A brand new mechanically improved, non-magnetic conductor, called "High-Strength" wire, has been developed by Hitemp Wires, Inc. Exhaustive tests of the new wire, which meets the requirements of MIL-W-16878, show tremendous improvement over conventional stranded wire... a truly amazing average of 400% longer "flex-life" and 25% greater "tensile strength." Another giant step by Hitemp to meet the growing needs of America's industrial and defense requirements.

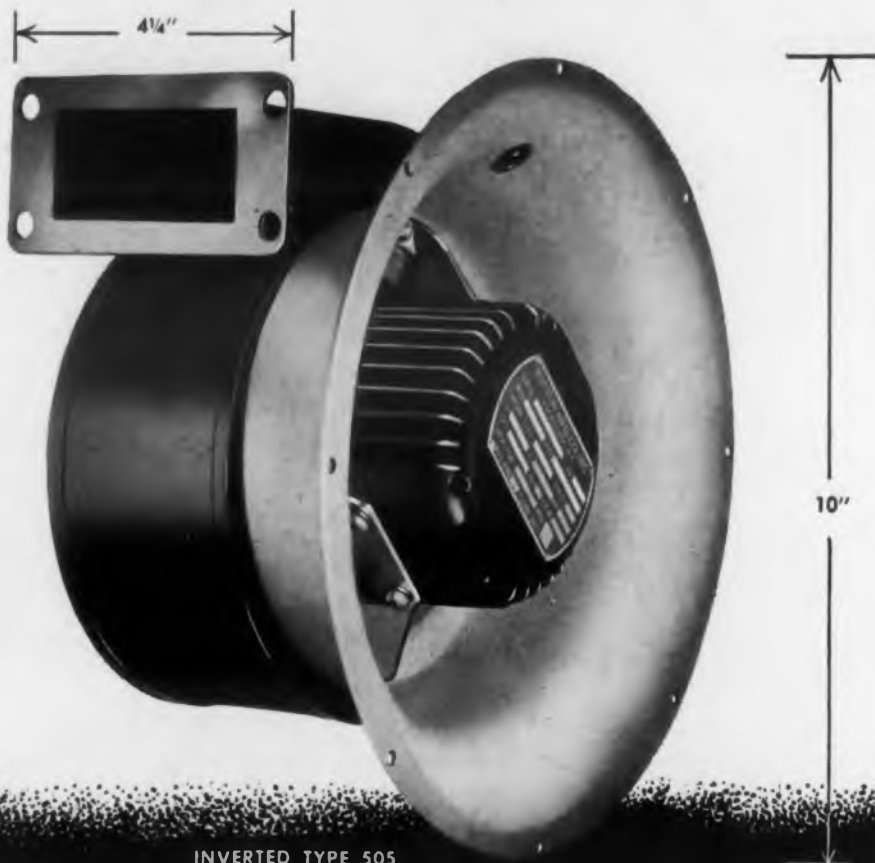
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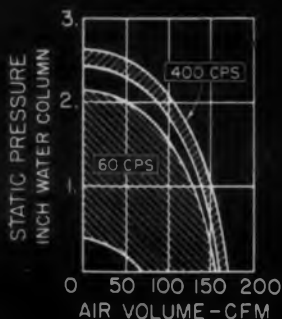
HITEMP WIRES, INC.
26 Windsor Avenue, Mineola, New York

CIRCLE 325 ON READER-SERVICE CARD FOR MORE INFORMATION

Cool Magnetrons and Power Tubes with Model D Blowers



INVERTED TYPE 505



Shown is one of a family of high-pressure blowers designed for turbulent cooling in Commercial and Military Electronic applications where space is at a premium and long trouble-free life is mandatory.

OPTIONAL AIR INLET & OUTLET ADAPTORS & MOUNTING SURFACES

SEE Catalog Sheets:
40102-31
40102-32
30102-3



ROTRON

MANUFACTURING CO., INC.
WOODSTOCK • NEW YORK

CIRCLE 328 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Erasing Machine

329

Superior electric erasing machine developed for the engineer and draftsman for faster erasing with minimum fatigue is described in data sheet now available.

This new machine "Sovereign," operates cool under heavy work conditions, has minimum torque and automatic stall control to protect drawings against damage from too heavy pressure. The machine is lightweight and easy to handle according to the data sheet. Frederick Post Co., 3650 N. Avondale Ave., Chicago 18, Ill.

Components and Test Equipment

330

In Short Form Catalog 57-BG, all company products are listed: pulsed and CW magnetrons, TR and ATR duplexing tubes, microwave silicon diodes, silicon power rectifiers, flange-mounted and solderable waveguide pressure windows, waveguide components, and test equipment. Operating characteristics are tabulated for a majority of the products. Microwave Associates, Burlington, Mass.

Reversible Geared Motors

331

Four pages of details on type TYAZ-CE reversible geared motors are available in Catalog GR2. Attention is given to construction, mounting, base motors and duty cycles. Standard gear reductions and control circuits are also considered. Tables show the performance characteristics of individual units. Photographs illustrate the motors and drawings show dimensions and circuits. Barber-Colman Co., Small Motors Div., 1400 Rock St., Rockford, Ill.

Miniature DC Solenoids

332

Reference material on representative miniature and subminiature dc solenoids is available. It is designed to aid in solenoid selection by type, size, voltage range, temperature range, force, weight and similar characteristics. The illustrated reference sheets give detailed data on nine units for data processing and memory units, computers, avionics and other applications. PSP Engineering Co., 6058 Walker Ave., Maywood, Calif.

REGATRON
SUPER-REGULATED

**TRANSISTOR
POWER PACKS**

Simplify D-C Power Requirements



MODEL 212A . . . 0 to 100 V dc, 100 ma. Regulation 0.1% or 0.02 volt over entire range of load and input voltage. Weight 14 lbs. 3 1/2" H x 19" W x 9 1/4" D. Price \$129.00 unmetred. Other models up to 3 amps.

In the laboratory, on the production line, as part of original equipment . . . wherever regulated d-c power is required . . . tough, versatile REGATRONs give customized performance.

With a minimum of adjustment, REGATRONs will deliver the precise power your equipment requires. Here are the features that make it possible:

- Full current capability at all voltage settings up to 100 volts
- Voltages up to 275 V at reduced currents (Curves available on request)
- Positive ground, negative ground or ungrounded output
- All control knobs readily accessible from front of instrument
- Output connections either front or rear (optional)
- Provisions for remote voltage adjustment
- Vernier as well as main voltage control
- Easily read panel designations
- No tricky controls
- Standard 19-inch rack or table mounting
- Low cost

AND . . . REGATRONs ARE REMOTELY PROGRAMMABLE . . . the only remotely programmable power packs available.



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Registered U.S. Patent Office.
Patents Pending.

CIRCLE 333 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • July 15, 1957

Precision Potentiometers 338

Recent modifications in specifications for the series AN and CN multi-turn potentiometers are noted in Data Sheet 54-12. Issued to supersede Data Sheet 54-11, the 2-page leaflet presents detailed technical information and illustrations to show dimensions and construction. Helipot Corp., Newport Beach, Calif.

μsec Coaxial Cables 339

1957 catalog describing line of micro-miniature coaxial cables and connectors is available. The 32-page catalog gives specifications and applications of the items included in the catalog. Microdot, Inc., 220 Pasadena Ave., So. Pasadena, Calif.

Coaxial Terminations 340

The Model 369 Series of high power coaxial terminations are the subject of a one-page data sheet. The leaflet presents photographs, power ratings, specifications, special features and prices. The Narda Corp., 160 Herricks Rd., Mineola, N.Y.

Shaft Angle Converters 341

Shaft angle converters for binary decimal coding are the topic of a four-page folder. The instruments' features are discussed with special attention to code drums, brush blocks, and drive systems. Also provided are application suggestions, detailed performance data, and a table showing specific characteristics of available models. The folder is illustrated with photographs and dimensional drawings. Instrument Development Labs., Inc., 67 Mechanic St., Attleboro, Mass.

Lubricant Testing Machines 342

Operating information on Model LFW-1 Lubricant-Friction-Wear testing machine are included in revised bulletin 106 now available.

Included in the bulletin is a more complete description of the machine's operation as well as a revised list of specifications in the English and Metric systems.

The details of the specimen holder and lubricant reservoir are shown in photograph. Alpha Molykote Corp., 65 Harvard Ave., Stamford, Conn.



*custom
instrument
cases*

NO TOOLING COSTS!

using Zero stock deep drawn aluminum components



6 basic sizes — each available in a wide range of depths

Many of today's finest instruments are housed in ZERO precision deep drawn aluminum cases. Smart buyers who check costs, design and quality choose ZERO. Custom designed and engineered boxes at comparable low cost—send your prints or contact your local ZERO representative.



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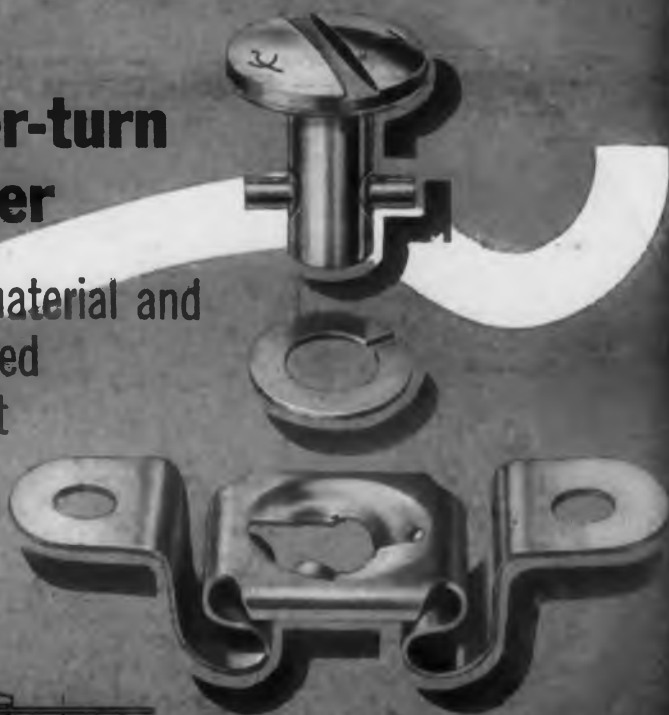
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CIRCLE 343 ON READER-SERVICE CARD FOR MORE INFORMATION

**a
quarter-turn
fastener**

**for thin material and
miniaturized
equipment**



CAMLOC *low cost/light weight*

5F series

Camloc's new small, lightweight 5F Series features high strength-weight ratio plus the quick-operating advantages of a $\frac{1}{4}$ -turn fastener... in a size and weight that offers new design possibilities to original equipment manufacturers! Particularly adaptable to thin materials and miniaturized equipment like airborne electronics, small electro-mechanical and computing devices and communications components. Ideal for attaching lightweight components in "packaged" equipment or for holding access panels on everything from washing machines to radar units.

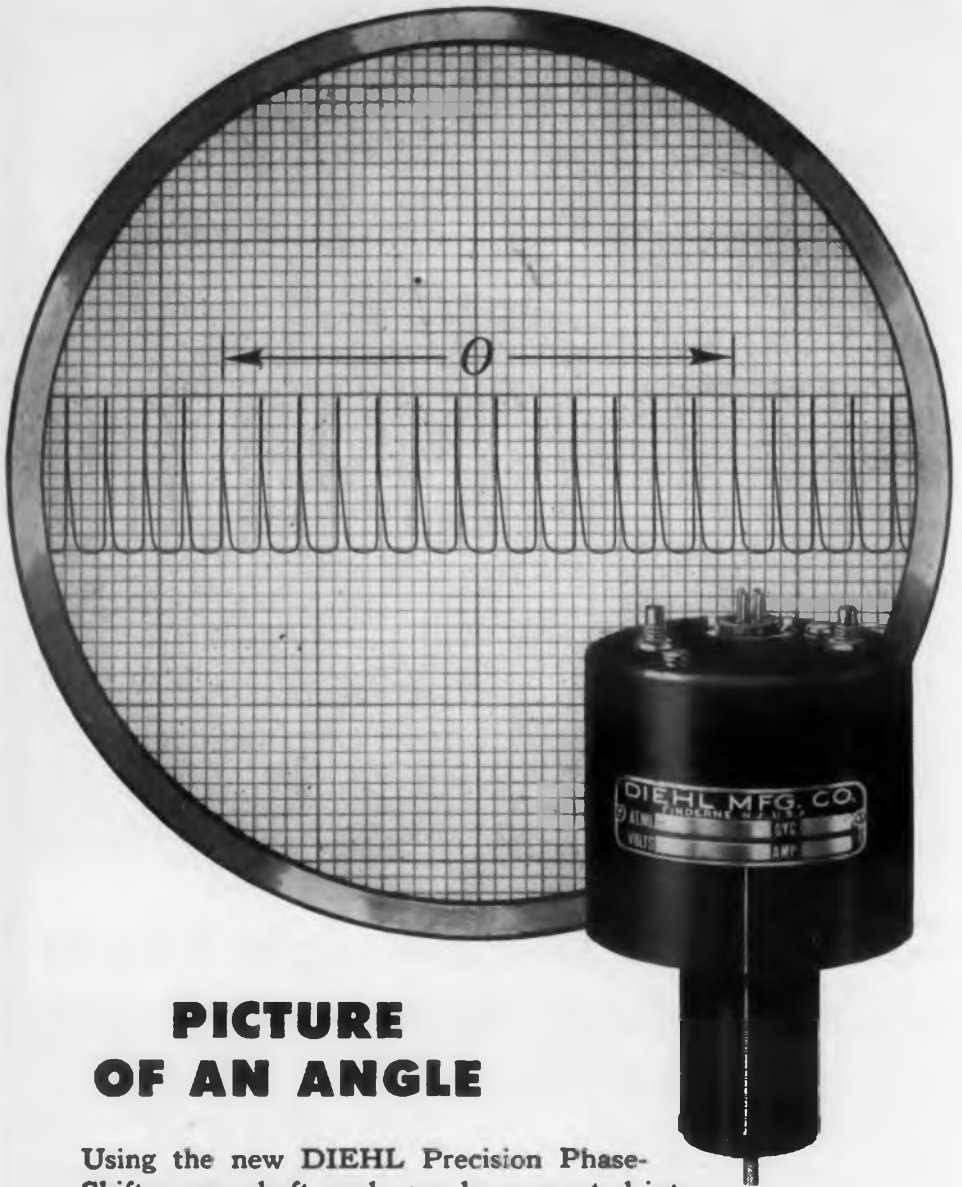
Offered in many different head styles. Complete specifications will be sent to you on request.



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61 Spring Valley Road, Paramus, N. J.

WEST COAST OFFICE: 5410 WILSHIRE BLVD., LOS ANGELES, CAL.
FORT WORTH OFFICE: 2809 W. BERRY ST., FORT WORTH, TEXAS

CIRCLE 344 ON READER-SERVICE CARD FOR MORE INFORMATION



PICTURE OF AN ANGLE

Using the new DIEHL Precision Phase-Shifter, any shaft angle can be converted into an accurate *digital* presentation like the pulse train shown above. In such use, a separate high frequency counting signal is triggered by the reference wave and shut off by the phase-shifted wave, thus identifying a shaft angle with a finite number of pulses. Small size and simplicity make this Phase-Shifter ideal for use as an Analog-to-Digital Converter component.

This is only one of many applications for the DIEHL Precision Phase-Shifter which can now be provided for any fixed frequency between 60 cps and 4 megacycles.

By combining the very accurate DIEHL Size 11 Resolver with the appropriate circuitry, accuracies of better than $\frac{1}{4}$ of a degree have been attained at frequencies up to 100 Kc. Phase shift is continuous through 360° and variation of output amplitude is held to a minimum.

To insure that the accuracy of the Phase-Shifter is not influenced by external loading, a cathode follower circuit is incorporated in the network to isolate the unit.



Send for additional engineering data.

DIEHL MANUFACTURING COMPANY

Electrical Division of THE SINGER MANUFACTURING COMPANY

Finderne Plant, SOMERVILLE, N. J.

other available components

- AC SERVOMOTORS
- AC SERVOMOTORS WITH AC TACHOMETERS
- DC SERVO SETS
- AC SERVOMOTORS WITH DC TACHOMETERS
- AC AND DC TACHOMETERS
- RESOLVERS

BOOTH 1303-1957 WESCON, SAN FRANCISCO, AUGUST 20-23

CIRCLE 348 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Transfer Storage Counter 349

"The Counter with a Difference" is a 6-page booklet about the Model TS-204 transfer storage counter and two of its accessories. The text explains what the counter can do and how it operates. The accessories described are the RR-40 relay readout and the TS-204P power supply. The booklet is illustrated with photographs and a block diagram. A list of specifications is provided for all three units. Burroughs Corp., Electronic Tube Div., Plainfield, N.J.

Ferrites 350

The magnetic properties of three ferrite materials, Ferramic O-2, Ferramic Q and Ferramic H, are discussed in separate 2-page catalog sheets. The ferrites are used as component parts in radio and TV sets, computers, automatic controls and related electronic equipment. Pertinent information is presented in tables and graphs. Photographs are provided for illustration. General Ceramics Corp., Keasbey, N.J.

Systems Manufacture 351

Facilities for systems manufacture are outlined in an illustrated brochure of eight pages. The booklet stresses the importance of systems to technological progress and names some areas where they have contributed immeasurably. It also cites a number of specific systems that the company has pioneered and supplied. McGraw-Edison Co., Thomas A. Edison Instrument Div., West Orange, N.J.

Vacuum Tube Test 352

A 16-page technical brochure deals with a quality test used in the production of power vacuum tubes. Entitled "A Positive Grid Voltage-Space Current Division Test for Power Vacuum Tubes," the paper was originally delivered by James A. Jolly at the 1957 IRE Convention. Existing test techniques and their limitations are discussed along with the new one. The description of the subject method is supported with sample data. Eitel-McCullough, Inc., San Bruno, Calif.

the DYNAMIC DIODE TESTER by TECHNITROL



This moderate-price instrument provides an invaluable means for the rapid, accurate checking of semiconductor diodes for instability and irregularities. The dynamic curve, far more revealing than static testing, is quickly apparent on a scope screen, and is readily adapted to volume testing. In addition, the easy portability of this 16-pound instrument makes

it ideal for field work as well as bench or rack installation.

Designed for use with a D.C.-coupled oscilloscope, the Technitrol Diode Tester provides for a variety of back and forward voltages, as well as independently-controlled ranges for back and forward currents.

CALIBRATED RANGES:

- Forward voltage 0-5 v.
- Back voltage 0-100 v.
- Forward current 0-50 ma.
- Reverse current 0-1 ma.



Write today to:

CIRCLE 353 ON READER-SERVICE CARD FOR MORE INFORMATION

Wire Twister

358

A 1957 catalog and price list for the M-80 wire twister is now available. The catalog is fully illustrated and contains complete specifications. The patented action of the wire twister is shown by a motion-picture-like sequence of 9 photographs. Ralph C. Robinson Co., 2516 Crosby Way, N. Sacramento 15, Calif.

Quick Reference Catalog

359

A 16-page, 3-color Quick Reference Catalog which summarizes electrical and physical data is now available. It gives this information in a handy tabulated form for each line of triodes, tetrodes, pentodes, diodes, thyristors, heat dissipating connectors and others. Eitel-McCullough, Inc., San Bruno, Calif.

Multi-Turn Potentiometers

360

Two series of multi-turn precision potentiometers with linearity tolerances of ± 0.01 per cent are specified in Data Sheet 54-23. The 2-page treatment is illustrated with a photograph, dimensional diagrams and a labeled cutaway. Helipot Corp., Newport Beach, Calif.

Pulse Generator

361

The Model 2125B pulse generator is featured in a revised two-page bulletin. Illustrated with photographs and lock diagrams, the text provides design and construction data and detailed specifications. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.

Thermostats

362

Two thermostats, the Model D1 for ac systems and the D10 for dc systems, are featured in Bulletin RT-803. Illustrated with photographs and diagrams, the four-page folder contains application and installation information. Robertshaw-Fulton Controls Co., 110 E. Otterman St., Greensburg, Pa.

Plastics: Fibre and Thermosetting

363

Various parts used in a wide range of industries are included in a folder entitled "Applications for Wear" now available.

The illustrated pamphlet gives a complete description of the parts, such as retainers, washers, bearings and rubbing blocks and bushings. Spaulding Fibre Co. Inc., Tonawanda, N.Y.



CINTEL MUTUAL and SELF INDUCTANCE BRIDGE



Coverage:

0.001 μ H to 30mH in 12 ranges
100 μ Ω to 3000 Ω

Accuracy:

$\pm 1\%$ of full scale on all ranges

Frequency:

1592 cps ($\omega = 10,000$)

Price:

\$625.00 f.o.b. N.Y.C.

Features:

- Direct reading of either mutual or self inductance.
- All measurements in form of 4-terminal network.
- Also measures very low resistance.
- Maintains accuracy at low values.
- L & R balances are independent.
- Built-in oscillator and visual detector.



MODEL 1852

CINTEL bridges simplify intricate measurements and all have wide range and high accuracy. Watch for future ads. Detailed specification on request.

Exclusive Sales and Service in U.S.A.

MARCONI Instruments 44 New Street • New York 4

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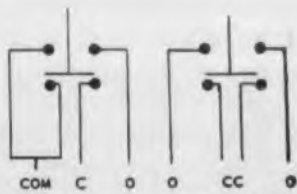
ACRO SUBMINIATURE SWITCH

Your Choice of 5 New Actuators



ACTUAL SIZE

CIRCUIT ARRANGEMENTS



DOUBLE THROW DOUBLE CIRCUIT



LEAF



FORMED LEAF



ROLLER LEAF



PLUNGER



TOGGLE

With its small size, high capacity, and newly-designed actuators, the Acro Subminiature Switch meets an exceptionally wide range of design requirements . . . provides many new development possibilities for subminiature assemblies.

The electrical rating of this precision Acro Snap-Action Switch—10 amperes at 125 or 250 volts A.C. or 28 volts D.C.—is over four times that of most switches this size. It will operate within a temperature range of from +350° to -80°F., and its terminal arrangement permits wiring double circuits.

Switching mechanism is enclosed in a durable plastic case which can also be adapted to various types of present actuators and mountings not shown.

Write for literature, engineering data!



Robertshaw-Fulton

CONTROLS COMPANY

ACRO DIVISION

Columbus 16, Ohio

In Canada: Robertshaw-Fulton Controls (Canada) Ltd., Toronto
CIRCLE 365 ON READER-SERVICE CARD FOR MORE INFORMATION

0 CPS to 1 MC!
DIRECT READING



new
Computer-Measurements Model 226A

UNIVERSAL COUNTER-TIMER

OUTSTANDING FEATURES:

- ★ Three independent, adjustable trigger level controls permitting full rated sensitivity at any voltage level between 300 and -300 volts.
- ★ Small voltage increments ordinarily masked by attenuators are easily selected.
- ★ Simplified color-coded controls and direct read-out in kc, mc, sec, or millisec, with automatic decimal point indication.
- ★ Oscilloscope marker signals facilitate start and stop trigger level adjustment for time interval measurement of complex waveforms.

A brand new, multi-purpose instrument provides precision measurement of frequency, frequency ratio, period (1 frequency) and time interval. Pressure, velocity, acceleration displacement, flow, RPS, RPM, etc., may also be measured with suitable transducers. The 226A may be used as a secondary frequency standard.

price: **\$1,100.00**

Long Term: 3 parts per million per week
Display Time: Automatic: Continuously variable 0.1 to 10 seconds
 Manual: Until reset
Input Impedance: 1 megohm and 50 mmf
Trigger Level: Continuously adjustable from -300 to +300 volts
Accuracy: ± 1 count ± stability
Secondary Frequency Standard: 1 mc; 100, 10, 1 kc; 100, 10, and 1 cps
Dimensions: 17" W x 8¾" H x 13½" D approx.
Weight: 50 lbs. approx.



MODEL 225A 0 cps-100 kc
UNIVERSAL COUNTER-TIMER

Similar to the 226A in design. Featuring Oscilloscope Trigger Level Marker Signals; Three Direct-Coupled Inputs of 70 mv sensitivity; Direct Reading, Automatic Illuminated Decimal Point. Easily portable. Price: **\$840.00**

Data Subject to Change Without Notice - Prices F.O.B. Factory

Write for complete specifications on the new 226A and the 225A models and the complete CMC line of electronic counting and controlling equipment.

Computer-Measurements Corporation

5528 Vineland Avenue, North Hollywood, Calif. Dept. 76-G

CIRCLE 368 ON READER-SERVICE CARD FOR MORE INFORMATION

FREQUENCY

SPECIFICATIONS:

FREQUENCY MEASUREMENT

Frequency Range: 0-1,000,000 cycles per second
Input Sensitivity: 0.2 volt rms. Direct-coupled input
Time Bases: 0.00001, 0.0001, 0.001, 0.01, 0.1, 1 and 10 seconds. Also can use external 0-1 mc standard

PERIOD MEASUREMENT

Period Range: 10 microseconds to 1,000,000 seconds
Frequency Range: 0.000001 cps to 100 kc
Input Sensitivity: 0.2 volts rms. Direct-coupled input

Gate Times: 1 and 10 cycles of unknown frequency
Standard Frequency Counted: 1 mc; 100, 10, 1 kc; 100, 10, 1 cps; external 0-1 mc.

TIME INTERVAL MEASUREMENT

Range: 3 microseconds to 1,000,000 seconds
Start and Stop: Two independent or common channels Positive or negative slope
Input Sensitivity: 0.2 volts rms. Direct-coupled input
Standard Frequency Counted: 1 mc; 100, 10, 1 kc; 100, 10, 1 cps; external 0-1 mc.

GENERAL

Stability: Short Term: 1 part in 1,000,000 (temperature-regulated crystal)

FREQUENCY • PERIOD • TIME INTERVAL • FREQUENCY

PERIOD • TIME INTERVAL • FREQUENCY • PERIOD • TIME INTERVAL • FREQUENCY



CC-30

New Literature

Aluminum Foil Wire Markers 369

A line of aluminum foil wire markers are shown in a two-page, three color bulletin now available. The bulletin illustrates two sizes of foil markers furnished on quick-release dispenser cards: 1-1/2 in. markers for wire over 1/4 in. O.D. 3/4 in. markers for wire under 1/4 in. O.D.

Special properties of instant-sticking aluminum wire markers are listed: resists temperatures to 350 F; precut, fits and sticks to any wire diameter; resistant to soil, grease and water; protected by transparent coating against rubbing and abrasion, and no tools required.

Although any size, shape, color or symbols can be specified, a large stock of items for immediate delivery are listed. These include solid numbers, letters, symbols and machine tool control symbols; consecutive numbers or letters; or consecutive numbers or symbols repeated in sequence.

The catalog also contains ordering information, list of prices and delivery time. North Shore Nameplate Inc., 214-27 Northern Blvd., Bayside 61, N.Y.

Multi-Channel Oscilloscopes 370

A 28 page catalog describing complete line of standard 2- and 4-channel oscilloscopes, strainalyzers and related dc amplifiers has been issued.

A number of new items are featured including a 2-channel scope with a vertical frequency range from dc to 15 Mc, and a 4-channel recording oscilloscope and master strainalyzer for which input information may be either differential or single-ended.

A portion of the catalog is devoted to explaining the advantages of multi-channel oscillography in which non-recurring events may be triggered and the resulting operational phenomena recorded simultaneously from different points. In addition to the 2- and 4-channel units described in the catalog, other types including oscilloscopes providing up to 8 channels or beams on a single-tube face are described. The catalog lists multi-gun cathode ray tubes in 2-, 3-, 4-, 5-, 6-, 8- and 10-gun types. DC power supply units are likewise included. Electronic Tube Corp., 1200 E. Mermaid Lane Philadelphia, Pa.



SNAP ACTION


IN EVERY CONTROL PHASE

with the Curtiss-Wright "SNAPPER" Thermal Time Delay Relay


Computers, broadcast equipment, motors, lighting systems, missiles, industrial controls — for electrical circuit applications involving time delay that demand unflinching action in every control phase, more and more design engineers specify "SNAPPER" Relays by Curtiss-Wright. These reliable relays eliminate chatter with positive snap action, have single-pole double throw contacts and a wide temperature range (-65° $+100^{\circ}\text{C}$). Preset time delays from 3 seconds to 3 minutes are now available in metal envelope and from 5 to 60 seconds in glass envelope. Write for our new detailed data sheet with complete application information.

Component
Sales
Department






"SNAPPER" GLASS RELAYS
—for commercial applications, single-pole double throw snap action.



MAGNETIC AMPLIFIERS
—custom-designed to fit complex requirements for control systems.



"MEMORY" RELAYS
—thermally operated bi-stable time delay relays with two separate heater circuits.

CIRCLE 371 ON READER-SERVICE CARD FOR MORE INFORMATION

Expansion Joints

378

Rubber, neoprene and Teflon-lined expansion joints, their construction, sizes and uses are fully explained in Bulletin AD-137 now available. The bulletin describes the characteristics and limitations of seven styles of expansion joints and flexible couplings; 1 spool-type expansion joints; 2 rectangular-type expansion joints; 3 U-type joints; 4 all-Teflon expansion joints; 5 all-Teflon flexible couplings; 6 full-faced Teflon lined rubber expansion joints; 7 expansion joints for use on piping and flanges.

It also explains that rubber expansion joints are suitable for handling hot or cold water, mild acids, mild caustic solutions, brine, air or exhaust steams, at temperatures to 180 F.

Rectangular type expansion joints as described in the bulletin are available for application in pressure and vacuum lines. These joints are frequently used as a flexible connection between a turbine and a condenser.

Metal retaining rings made of galvanized steel to be placed behind and directly

against the inner face of each of the rubber flanges at the ends of the joints, as well as Teflon expansion joints and flexible couplings for fluid process piping handling strong acids, caustics, foods and halogenated solvents are outlined in the bulletin. Garlock Packing Co., 408 Main St., Palmyra, N.Y.

Aircraft Thermocouples

379

MC-153 is a four-page brochure on thermocouples for aircraft gas turbines and related aviation applications. It describes and illustrates the four basic junction tips—exposed junction, twisted-exposed junction, stagnation tip and sampling tip—which provide the starting point for hundreds of model variations. Performance data and accuracy limits for the thermocouple wire material at temperatures up to 2000 F are listed. Also illustrated are the various design features which assure the reliability and accuracy of the thermocouple series in aviation service. Fenwal Inc., Aviation Products Div., Ashland, Mass.

new...

trio

**low-level BUILD-IN AC VTVM
with BUILT-IN ISOLATION**



*when ordinary instruments are
too big or inadequate...*

trio

*... the leader in panel-mounting
electronic instruments*

CIRCLE 380 ON READER-SERVICE CARD FOR MORE INFORMATION

Designed especially for panel-mounting, new model

109-1 reads down to

20 microvolts on its 1 MV

range with 2% full-scale

accuracy, 10 megs input

impedance, response

20-80,000 cps... features

signal & power circuits

and mounting

panel all isolated from each

other... extreme stability

— wide line variations do not affect

accuracy... calibration of gain

and frequency response without

removal from panel...

feedback and printed circuitry for

exceptional reliability and

simple maintenance...

size 5¼" h x 9½" w x 9¾" d —

panel fits standard modular-type

consoles. Price \$199.50

Write for FREE "how-to"

ENGINEERING GUIDE on Trio's complete

line to Dept. ED-7, Trio Laboratories, Inc.,

Seaford, N. Y.

Between Concept and Configuration

...Save Time and Money with

PHILBRICK PLUG-IN DC AMPLIFIERS



For a wide variety of instrumentation and control problems, you can facilitate rapid set-up with either one or both of these octal-based, plug-in Philbrick Amplifiers. Operational Amplifier, Model K2-W, features balanced differential inputs for minimum drift and maximum utility. In conventional applications, overall amplifier characteristics are affected solely by the feed-back networks, since the two inputs can be maintained at nearly equal potential with appropriate feed-back circuitry.

For more critical applications where long term drift must be reduced to sub-millivolt levels, Stabilizing Amplifier, Model K2-P, is paired with Model K2-W. Write for free 28 page Plug-In Amplifier Applications Manual-13.

MODEL K2-W

GAIN: 15,000 dc, Open Loop
POWER REQUIREMENTS: 4.5ma @ ± 300
vdc, 0.6 amps. @ 6.3v
OUTPUT RANGE: +50v. to -50v. at 1 ma
RESPONSE: 2 Microseconds rise time, 100
Kc with unity feed-back
PRICE: \$24.00 Postpaid

MODEL K2-P

GAIN: 1,000 dc
POWER REQUIREMENTS: 2.4 ma @ +300
vdc, 0.45 amps. @ 6.3 vac, 60 cps
INPUT IMPEDANCE: 1 Megohm
STABILITY: Below 100 Microvolts
PRICE: \$60.00 Postpaid

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RESEARCHES, INC.

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CIRCLE 381 ON READER-SERVICE CARD FOR MORE INFORMATION



New!

Acetrim* sub-miniature
precision **TRIMMERS**
for **PRINTED CIRCUITS**

Here is another new development from Ace . . . sub-miniature precision wire-wound trimmers especially for printed circuits. Designed and produced to meet your tightest specifications, the new Acetrim has flat or round tabs to facilitate production assembly. Just plug into printed circuit board, secure, and dip solder.

Ace delivers reliability

Modern mass production techniques assure delivery to meet your schedules . . . rigid quality controls assure highest standards of performance-reliability.

Acetrim — write for *Technical Data Unit #563*.

Acepot — 1/2" sub-miniature precision wire-wound linear potentiometers from 10 ohms to 250K. $\pm 3\%$ standard. Write for *Technical Data Unit #564*.

Nonlinear Acepot — precision wire-wound nonlinear potentiometers for

Featuring

- 1/2" size
- 10 ohms to 150 K
- weight 1/4 ounce
- power 2 w. @ 60° C. max.
- temperature to 125° C.
- sealed, moistureproofed, anti-fungus treated
- withstands severe shock, vibration, acceleration
- meets applicable Military specs

sine-cosine and square-law functions and other applications. High resolution, close conformity. Write for *Technical Data Unit #572*.

X-500 Acepot — 1/2" sub-miniature precision potentiometers for extreme temperatures of -55° C. to 150° C. 10 ohms to 250K. Write for *Technical Data Unit #571*.

*trademarks applied for

ACEPOT*
ACETRIM*

ACE ELECTRONICS ASSOCIATES, INC.

Dept. ED, 101 Dover St. • Somerville 44, Massachusetts
Telephone: 50merset 6-5130 • *Engineering Representatives in Principal Cities*

C.R.CLE 388 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Plastic Molding Presses

389

The redesigned 741 series of fully automatic compression presses for plastic molding is described in the 12 pages of Catalog 200. Complete specifications are given for the series' four models of 50, 75, 125, and 200 tons capacity. Photographs illustrate the 741 presses and a variety of other equipment. F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.

Antenna Systems

390

Engineering improvements to existing antenna systems equipment are noted in a 32-page new product supplement. Illustrated and described are a 9-in. uhf transmission line, a 3 1/8-in. uhf coaxial switch and an expanded line of microwave and communication antennas. Full specifications are given for all items. The booklet also contains ordering information and a price list for all available products. Andrew Corp., 363 E. 75th St., Chicago 19, Ill.

Bimetal Thermostats

Snap-acting Type M bimetal thermostats are the subject of Bulletin 6000. Hermetically sealed and semienclosed types for use in appliances, fire alarms, television receivers and communications equipment are described. The 2-page bulletin covers principles of operation, construction features and ratings. It is illustrated with photographs showing different types of available terminal arrangements and closures. Stevens Mfg. Co., Inc., Lexington, Ohio.

Electric Brake

An electric brake for ac motors is extensively discussed in a folder of 4 pages. Advantages, operation, performance, specifications and uses are covered. Typical performance curves and a labeled photograph showing construction are among the illustrations. American Rectifier Company Selenibrake Div., 95 Lafayette St., New York 13, N.Y.



BIRTCHER TRANSISTOR CLIPS

MATERIAL
Beryllium #25

FINISH
Choice of Cadmium,
black Ebanol or
Silver plated

SIZES
Available in sizes and
modifications to
retain all popularly
used transistors.

Birtcher TRANSISTOR CLIPS perform the dual functions of retention and heat reduction. Being made of tempered beryllium copper they grip the transistor securely and hold it in place even under severe conditions of shock and vibration. In addition they provide an excellent heat path to drain off heat into chassis or heat sink.

Write for catalog

THE BIRTCHER CORPORATION

**INDUSTRIAL
DIVISION**

4371 Valley Blvd.,
Los Angeles 32, Calif.

CIRCLE 393 ON READER-SERVICE CARD FOR MORE INFORMATION

DC Timing Motors 398

Bulletin AWH MO 805, a 2-page insert for a current catalog, contains information on the function of the three basic dc timing motors. The construction of the 5300, 6300 and 7600 series motors are analyzed in detail. Featured is a cutaway view of the motor which shows the rotor construction and self-contained gear train. The A. W. Haydon Co., Waterbury, Conn.

Chopper Circuit Residual Noise 399

Availability of a four-page technical paper, "Measurement of Residual Noise in Chopper Circuitry," is announced. The article covers the theoretical as well as the practical evaluation of residual noise in a wide variety of chopper circuitry. Included are graphs and information helpful to design engineers. James Vibrapowr Co., 4050 N. Rockwell St., Chicago 18, Ill.

Design Services 400

Electronic research and development, equipment and systems designing, production engineering, and pilot model building

are among the services announced in Bulletin 571. The four illustrated pages also give details on facilities and on completed projects. Strand Engineering Co., 1354 N. Main St., Ann Arbor, Mich.

Magnetic Tape Recorders 401

An entire line of professional magnetic tape recorders is listed in a catalog of 15 pages. Complete specifications and pertinent information are presented for all models. Also described with specifications are a variety of accessories and modification kits. Photographs are provided for illustration. Magnecord, Inc., 1101 S. Kilbourn Ave., Chicago 24, Ill.

Centerless Grinder 402

The TG-12 centerless grinder is the subject of a 4-page illustrated brochure. To a detailed description of mechanical features is added a complete specifications table which gives data on capacity, equipment and accessories. Various types of grinds are illustrated. Royal Master, Inc., State Highway No. 23, Riverdale 1, N.J.

one
source
for all
timers!

for military and industrial applications. Illustrated are some of these units . . . any can be modified to meet your specific requirements if the basic design is not adequate.

the
A. W. HAYDON COMPANY offers a
**COMPLETE LINE of STANDARD and CUSTOM
DESIGNED TIMING MOTORS and DEVICES!**



Shown below is the new catalog of the A. W. Haydon Company describing all of the basic types of units available and many of the "specials". Included in this 25-page catalog are 60 photographs of timers, 30 dimensional drawings, and 50 charts and diagrams. This complete catalog will be supplied on request.



- Long a pioneer in the timing field, The A. W. Haydon Company is prepared to assist you in solving your timing and control problems.
- When a solution to your problem has been reached, The A. W. Haydon Company is prepared to follow through with production geared to meet your requirements whether a basic timing unit or a highly specialized device is required.

the **A. W. HAYDON COMPANY**

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WATERBURY 20, CONNECTICUT

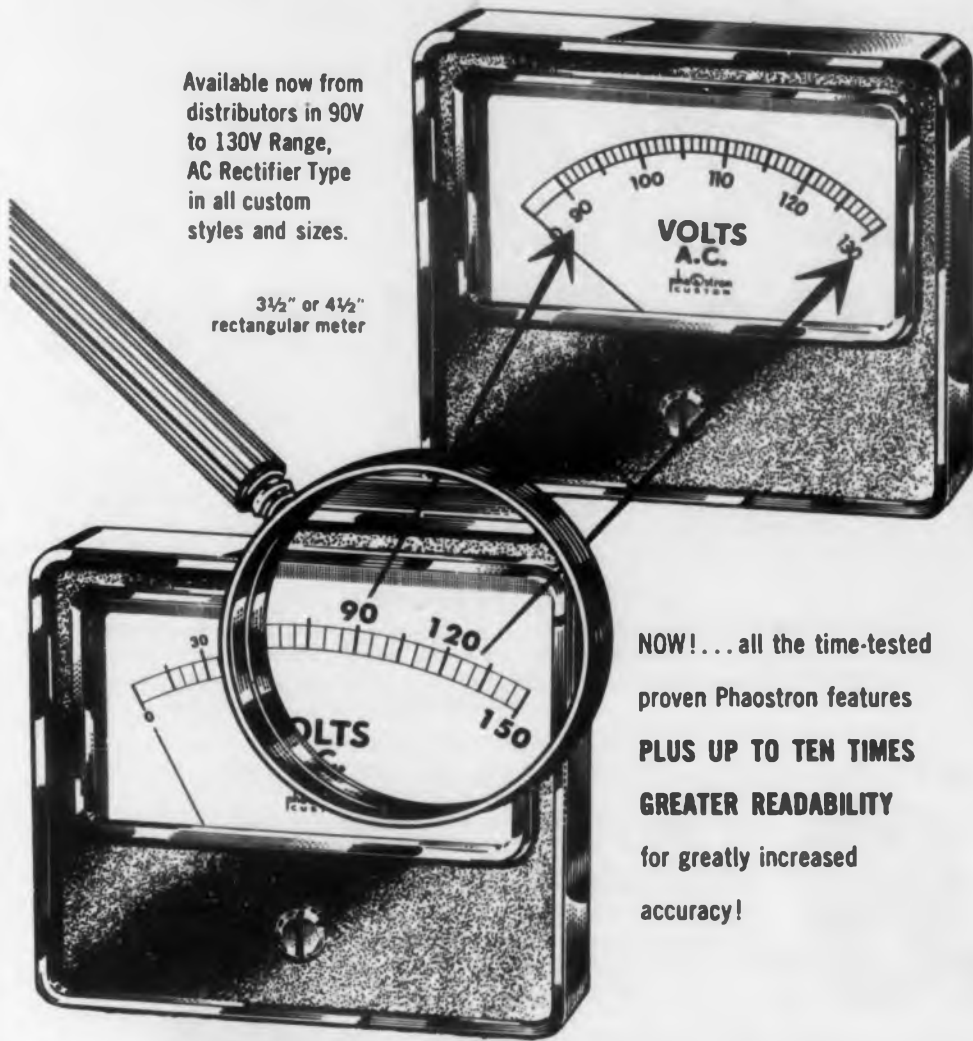
Design and Manufacture of Electro-Mechanical Timing Devices

CIRCLE 403 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW PHAOSTRON EXPANDED SCALE AC Voltmeter

Available now from distributors in 90V to 130V Range, AC Rectifier Type in all custom styles and sizes.

3½" or 4½" rectangular meter



NOW!... all the time-tested proven Phaostron features **PLUS UP TO TEN TIMES GREATER READABILITY** for greatly increased accuracy!

2½" or 3½" square meter



Phaostron has squeezed down that under 90V portion of the scale, where you don't need it, and expanded the section where you need it most—between 90 and 130V. Precisely calibrated 1 volt scale increments provide greater reading accuracy. Wide frequency range—linearity—true rms reading and Phaostron craftsman construction.

6" rectangular meter



Phaostron Custom Panel Meters, with expanded scale, 90V to 130V AC rms, are available in nine types at your Parts Distributor. For special requirements for AC or DC expanded scale meters, write to Product Development Dept. for practical recommendations.



2½" or 3½" round meter

All meters available with illuminated dial on special order

PHAOSTRON

PHAOSTRON INSTRUMENT & ELECTRONIC CO., 151 PASADENA AVE., SOUTH PASADENA, CALIF.
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when
reliability
counts

RCA RELAYS

RCA Relays . . . for outstanding performance in high-speed, high-altitude missile and airborne applications, and critical requirements in industry.

Miniaturized . . . hermetically sealed . . . RCA Relays are highly reliable under the most severe operating conditions. RCA Relays meet and exceed the electrical and mechanical requirements of MIL-5757C and MIL-R-25018 (USAF).

GENERAL FEATURES

- Rated for operation up to 80,000 feet.
- Insulation resistance better than 1,000 megohms after life test.
- Balanced rotary motors for utmost stability.
- **EXCLUSIVE**—Specially crimped mounting flanges provide positive contact at four points on the mounting surface!

Use the coupon for more information about RCA Relays.



RCA Type 203W2—A 6 PDT miniaturized DC relay weighing less than 4¼ ounces. Withstands 50g deceleration shock for 11 milliseconds, and 10g vibration shock from 5 to 2,000 cps. 26.5 volts DC coil. Contact rating 2 amperes. Life 100,000 cycles plus! Contact resistance less than .050 ohm. Contact Bounce less than 300 microseconds. R.F. Capacitance less than 3 µmf. Temperature Range -55° C to +85° C.

RCA Type 204W1—Same as the 203W2 except: Temperature Range -65° C to +125° C. Uses a "getter" which absorbs organic vapors and keeps contact clean—contact resistance will be lower after life test than before life test.



RCA Type 206W1—A 2 PDT miniaturized DC relay weighing less than 0.9 ounces. Temperature Range -65° C to +125° C. Like the 204W1 uses a "getter" to keep contacts clean. All other characteristics the same as the 203W2 except resistance to vibration shock from 5 to 2,000 cps is 15g.

ILLUSTRATIONS ARE TWO-THIRDS ACTUAL SIZE.



RADIO CORPORATION of AMERICA

COMPONENTS DIVISION

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MAIL NOW FOR RCA RELAY DATA

RCA Components Division, Sect. E-84-PP, Camden, N.J.

Bulletin 203W2 Bulletin 204W1 Bulletin 206W1 Have RCA Rep call

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

CIRCLE 408 ON READER-SERVICE CARD FOR MORE INFORMATION

New Literature

Hardener for Epoxy Potting 409

An epoxy hardener, for potting and encapsulation of electrical and electronic components, that gives good heat distortion temperature, excellent toughness, and long pot life is described in bulletin No. 13.

The physical properties of Sonite No. 41 and the physical and electrical properties of epoxy resins cured with this material are discussed.

Bulletin No. 13 gives detailed aspects of the properties, handling, mixing, pot life, and curing procedures when using Sonite 41. In addition physical properties of the cured castings, such as flexural strength, tensile strength, and resistance to impact, and electrical properties at various temperatures, such as surface resistance and volume resistivity. The physical data concerned with using Sonite 41 in glass cloth laminate systems are also included. Smooth-On Mfg. Co., 572 Communipaw Ave., Jersey City 4, N.J.

AC Output Accelerometer

Technical Data Sheet No. 20 provides engineering data, illustrations and information on special design and operational features of the Model GAL ac output accelerometer. The four-page bulletin also describes a modified version of the instrument, designated the Model GHL, which contains an internal thermostatically-operated heater for extremely close damping control. Genisco, Inc., 2233 Federal Ave. Los Angeles 64, Calif.

Electronic Parts Catalog

A 1957 electronic parts catalog has been released. Prepared by Electronic Publishing Co., Inc., the catalog contains 224 pages listing components, equipment and other electronic products for industrial and service use. Warren Radio Co., 1002 Adams Toledo, Ohio.



For exacting, high-temperature applications...

CERAMASEAL LEAK-TIGHT TERMINALS

Assuring you savings in installation and operation, these Ceramaseal high-temperature terminals are 100% leak-tested and guaranteed leak-tight when shipped.

High-alumina ceramic and metal parts of Ceramaseal terminals are joined by an exclusive process to form a high-strength, long-life molecular seal.

Brazing, welding or soldering techniques can be used for installation, without resulting damage to the seal, thus eliminating costly rework or replacement.

For brochure and spec sheets, or complete information on special high-temperature terminals, write: Ceramaseal, Inc., Box 25, New Lebanon Center, New York.

Supplying High-temperature, Quality Terminals for Five Years

CERAMASEAL, Inc.

CIRCLE 412 ON READER-SERVICE CARD FOR MORE INFORMATION

Load Calculating Nomograph 418

A load calculating nomograph has been developed to help figure cooling requirements for electronic equipment mounted in trailers, vans, consoles or stationary structures. When the type and size of a structure, the internal load, operating temperature and occupancy are selected, this nomograph will provide the required cooling load in BTU's per hour, and select the correct capacity for air conditioning equipment designed to meet rigid military specifications. The nomograph is printed on paper easily copied by any reproduction machine. Ellis and Watts Products, Inc., Monroe at Spencer, Cincinnati 36, Ohio.

Custom Molded Plastics 419

"Custom Molded Plastics for Industry" is a 12-page booklet with illustrated sections on molding facilities, finishing and assembly of components, research and development, and quality control. Chapters on injection molding, compression molding and transfer molding list examples of automatic equipment used in molding of thermoplastic and thermosetting materials. Sylva Electric Products Inc., Warren, Pa.

Electronics—Key to Control 420

Applications of electronic temperature controls for the heating, ventilating and air conditioning field are described in colored four page bulletin, F-2287-4 now available. It explains all the features, functions and advantages of an electronic system which provide efficient and economical control for any type of heating and air conditioning equipment. All components and accessories, used in the various types of electronic systems, are illustrated and specific applications of each are discussed. Barber-Colman Co., Temperature Controls, 1400 Rock St., Rockford, Ill.

Current Limiting Fuses 421

The eight pages of Bulletin GEA-6319B describe a line of CLF current limiting fuses capable of interrupting short circuit currents up to 200,000 rms symmetrical amperes. The operation and application of the fuses are outlined and dimensions and ratings are given. The booklet is illustrated with photographs and also graphs showing current characteristics. General Electric Co., Schenectady 5, N.Y.

for ACCURATE MEASUREMENT of FREQUENCY, PERIOD, or TIME INTERVAL

Electro-Pulse
presents the new

MODEL 7550B

- 5¼" x 17" Panel Size
- Crystal Accuracy
- Measures 0.1 CPS—100 KC
- Measures 10 μ s—1.2 days



Featuring glow transfer tube counting techniques and printed wiring throughout, Model 7550B/ED offers optimum reliability, economy, and accuracy for general purpose use in frequency and time measurement.

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CIRCLE 422 ON READER-SERVICE CARD FOR MORE INFORMATION

A New Broad Band **Kearfott**



FERRITE ISOLATOR

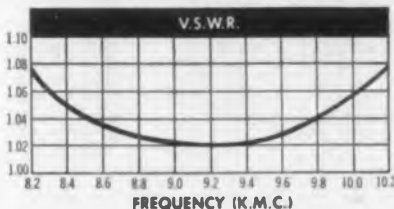
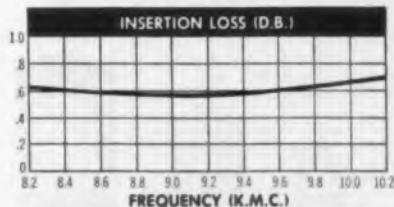
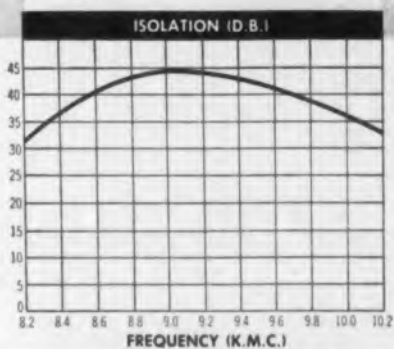
for Laboratory Test Bench Use

Use this Ferrite Isolator in your microwave setup for maximum frequency stability.



Model W177-2C-1

Typical Performance Curves



CHECK THESE FEATURES:

- Broad Band**—Usable from 8.2 to 10.2 KMC
- High Isolation**—A minimum of 25 db over the band
- Insertion Loss**—Less than 1 db
- Small & Compact**—Only 2½ inches long—weighs only 1½ lbs.
- Flanges**—Cover type. Mates with UG39/U flanges. Will absorb up to 10 watts reflected power
- Price**—\$135.00 each f.o.b., Van Nuys, Calif.

Delivery—From stock

Order—Model W177-2C-1

For custom-made isolators for specific radar & microwave application, you can depend on the skill of the Kearfott organization.

Kearfott, Western Division, has complete facilities for waveguide production, with qualified experts to assist in solving your problems. Let us help you.



For detailed information, ask for bulletins on new Ferrite Isolators and Radar Test sets.

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performance tested...

for long life...up to temperatures of 200°C!



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teflon film capacitors

 You can always depend on U. S. Edcor for the rigid quality control that guarantees complete and lasting reliability. For extra long service where the going is rough — under adverse conditions of vibration, widely varying ambient temperatures, extreme altitudes . . . or where requirements are critical — as in high performance missiles . . . specify U. S. Edcor Teflon Film Capacitors!



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Our field Engineering Representatives welcome the opportunity to consult with you on standard or special capacitor requirements. For address of office nearest you — or for complete technical data — WRITE TODAY to Sales Engineering Dept., U. S. Electronics Development Corporation, 1323 Airway, Glendale 1, California.

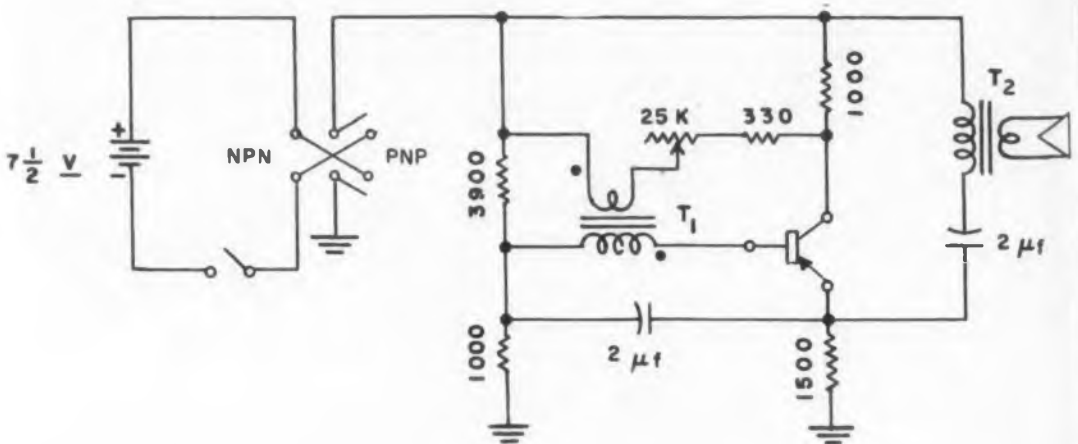
CIRCLE 428 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistor Beta Tester

A simple, inexpensive instrument for measuring the β of a wide variety of transistors has been developed by the National Bureau of Standards. The device measures the common-emitter short-circuit current gain of pnp or npn transistors at low audio frequency. In operation, the transistor is plugged into the instrument and a dial is adjusted to the point where a tone is heard from a loudspeaker. The β is then read directly from the dial. Properly calibrated, the instrument can measure β accurately over a range of 10 to 170.

The circuit is similar in principle to one used for measuring vacuum tube transconductance. In such a tube circuit, part of the plate voltage is fed back into the grid through resistor and transformer coupling to cause oscillation. Similarly, with the circuit for measuring transistor gain, the output is fed back into the input through a variable resistor and a transformer; when the resistor is properly adjusted, the circuit begins to oscillate at an audio frequency. The dial on the variable resistor can be calibrated through a substitution method.

To reduce the number of controls to a minimum, circuit parameters are chosen so that the transistor will adjust itself to a specified dc operating point. The resistors in the circuit were selected to fix this



T_1 - 200-10,000 ohms (N = 7)

T_2 - 500 - 3.2 ohms

Circuit diagram of transistor β tester. When the 25K pot is properly adjusted for a given transistor, the circuit oscillates at an audio frequency. Tone can be heard from loudspeaker.

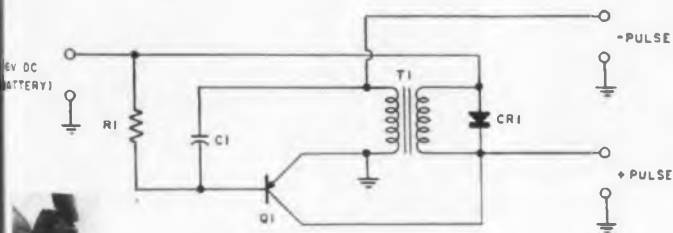
Get \$10.00 plus a by-line for the time it takes you to jot down your clever design idea. Payment is made when the idea is accepted for publication. Full information and an "entry blank" can be obtained by circling 548 on the Reader's Service Card.

point at about 5 v collector potential and 1 ma collector current. For any transistor whose β falls within the measuring range of the instrument, these dc values will be closely approximated when the transistor is plugged in.

The frequency at which oscillations begin depends upon the characteristics of the transformer and the phase shift of β . The current ratio of the audio transformer has a broad maximum centered at 1 or 2 kc, and if the phase shift of the transistor is sufficiently small, oscillation begins at a frequency near this maximum. However, the transistor gain required to produce oscillation for a given dial setting is not a particularly sensitive function of frequency. Measurements accurate to within a few per cent of full scale can be expected.

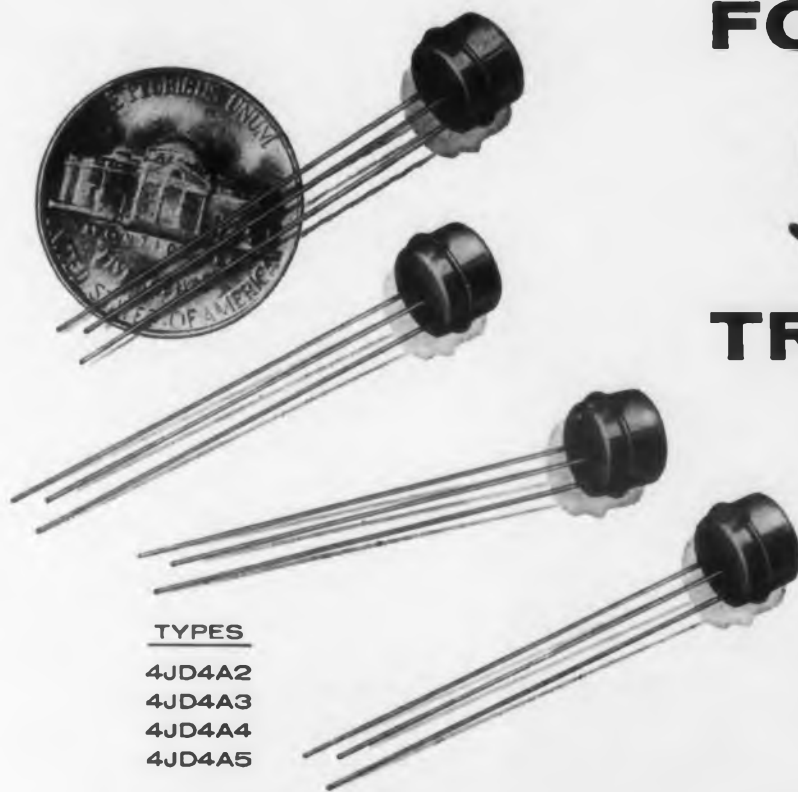
Encapsulated Blocking Oscillator

Encapsulated with epoxy resin within a 3/4 in. cube shown is a complete blocking oscillator circuit which includes a subminiature pulse transformer, transistor, capacitor, resistor and crystal diode. The circuitry shown produces triggering electronic



pulses identical to those obtained from larger, more expensive pulse generators.

Designed by engineers of Allen B. DuMont Labs. Inc., a pulse of 3 μ sec duration with a rise time of 0.06 μ sec is obtained. The repetition rate is 25 kc. Power requirements are furnished by a miniature 6 v mercury cell which lasts approximately 1000 hours. Amplitude of pulse is from +6 to -3 v peak. The "pulse cube" can be obtained from DuMont with a fixed repetition rate of 1 kc if desired, or a variable repetition rate from 400 cps to 24 kc. It can also be obtained as a free-running blocking oscillator or for external triggering. Operating temperature range is from -55 to 60 C.



TYPES

4JD4A2
4JD4A3
4JD4A4
4JD4A5

FOUR NEW G-E Silicon TRANSISTORS

- Operation below zero and up to 150°C
- 25 mc alpha cutoff
- Low leakage current
- Easy automatic insertion in printed circuit board

DESIGN FEATURES

High Temperature Performance . . . for maximum ambient operating temperature 150°C, storage temperature up to 200°C

New Package Design . . . for automatic insertion in printed circuit boards

Package Hermetically Sealed . . . no moisture seepage from outside air

Package Seams Are Welded . . . for great strength, long wear

Long Life and Stable Performance . . . when used within specified ratings

Small Size . . . extremely compact design provides added flexibility for most applications

Here are just a few typical applications for the NPN silicon triode transistors: wide band and d-c amplifiers, oscillator circuits, computer switching.

And now *all* General Electric transistors are a better buy than ever. Because of mechanized production lines, G-E transistors are made in less time and at a lower cost than before. Thus you benefit from lower prices. Besides, machine methods used on the General Electric production lines promote the strictest adherence to top quality stand-

ards. As a result, characteristics are controlled and narrow limits are built into the production transistor for a more uniform product. Therefore, General Electric is able to give a one-year written warranty.

For specifications and application engineering assistance, call your G-E Semiconductor District Sales Manager, your G-E Semiconductor distributor, or write the General Electric Company, Semiconductor Products, Section S2377, Electronics Park, Syracuse, N. Y.

Progress Is Our Most Important Product

GENERAL  ELECTRIC



ECE-226

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GYROS

for every application

The Kearfott miniature 4 Gimbal 3 Gyro, stable platform, provides precise azimuth, pitch and roll information—irrespective of the airframe attitude. It is hermetically sealed for environmental protection. Because of its rapid warmup characteristic, this unit is fully operational in less than five minutes. This platform provides the features of a magnetic slaved or a latitude corrected directional gyro for heading reference. Dependable, accurate single purpose Kearfott Gyros also available.



ALL ATTITUDE 3 GYRO STABLE PLATFORM

Suitable for use in both missile and aircraft, random drift rate 1° per hour in azimuth and 3° per hour in vertical. Measures only 8" Diam. x $8\frac{3}{4}$ " High, weighs but 23 lbs.



**VERTICAL
GYROS**



RATE GYROS



FREE GYROS



**FLOATED RATE
INTEGRATING GYROS**

Send for bulletin giving data of components of interest to you.

KEARFOTT COMPONENTS INCLUDE:

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KEARFOTT SYSTEMS INCLUDE:

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CIRCLE 430 ON READER-SERVICE CARD FOR MORE INFORMATION

Ideas for Design

Quick-Release Fastener

The clamp design shown eliminates or minimizes the tedious and time-consuming manual manipulations of the available non-standard component clamps and at low cost.

The clamp is a powdered metal casting of stainless steel with a core of plastic partially threaded. When assembled with a screw, the remainder of the thread is cut making a tight-fitting casting on the screw threads.

This captive sub-assembly is screwed into its mounting hole until it bottoms, and it is then backed off until the flat is opposite the diameter as shown. After three clamps are set, the component is mounted with the clamps in the open position, shown in the sketch. With a screw driver, the screw is turned until the clamp is in the locked position. The integral shoulder (1) stops the clamp in its strongest holding position.

Further tightening of the screw does not turn the clamp, but it is pulled down to its clamping position. In allowing the screw to continue to turn, while the clamp is stationary, the plastic permits the unit



Device held by "Synclamps". Below center, clamp is in unclamped position; at right, in clamped position; left, a side view. A half-turn with a screwdriver "does the trick."



No waveform distortion

from G-E Inductrol* Voltage Regulators

Unlike many other types of voltage regulators, General Electric Inductrols introduce no waveform distortion.

Featuring drift-free controls, Inductrols maintain the a-c or d-c voltage powering electronic circuits within $\pm 1\%$; are small and light.

They have long life and require little maintenance because *they use no brushes!*

For more information, write Section 425-6, General Electric Co., Schenectady 5, N. Y., or contact your G-E sales office or agent.

*General Electric Trade Mark for Induction Voltage Regulators.

Progress Is Our Most Important Product

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Do you
think about
angular
acceleration?



CONVAIR

Division of General Dynamics Corporation

does...

and uses *Statham*
Angular Accelerometers
to test...



*B-58 Hustler... the first
supersonic bomber for the
United States Air Force.*

Statham liquid rotor angular accelerometers are rugged and reliable. They may be ordered with either an unbonded strain gage or inductive pickoff and are available in ranges from ± 1.5 to $\pm 3,000$ rad/sec².

Please request our
Accelerometer Catalog and
Instrument Notes No. 26
"Some Design Considerations
For Liquid Rotor
Angular Accelerometers"

Statham

LABORATORIES
LOS ANGELES 64, CALIFORNIA

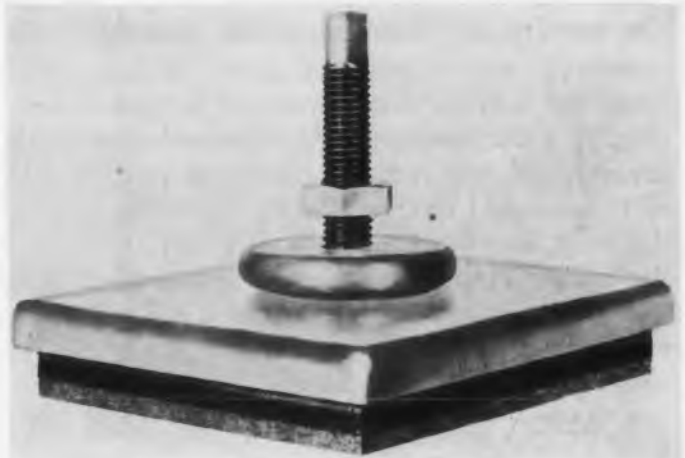
CIRCLE 432 ON READER-SERVICE CARD

to phase itself to the pilot diameter and its own tapped hole. Seemingly, by this action, the plastic thread is stripped. However, with just a half-turn the clamp is lifted up and around to the open position, being stopped by the flat (2).

The tight fit of the plastic on the screw threads is unchanged by the "stripping" action, and may be operated indefinitely. This tight fit also gives a stop-nut action by making the screw and clamp act as a unit. It is prevented from turning by the friction at the clamping point, giving a longer moment of arm. Timber-Top Inc., P.O. Box 14, Freeport, New York.

Shock Mount Provides Mobility

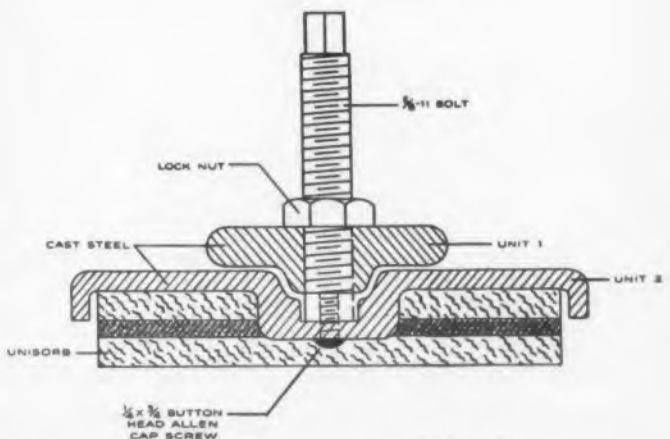
Through the use of a vibration dampener pad under a heavy steel plate, as shown, the Felters Co. of Boston has produced an equipment mount that permits ready mobility. At the same time, the equipment will remain firmly in position under vibration.



As illustrated in the cross-sectional view, leveling is readily accomplished by rotating *unit 1*, then locking in position with the *lock nut*. *Unit 2* is a steel base plate which rests on the "cushion" of *Unisorb*.

Mounts of this type are standard for loads from 800 to 7500 lb per mount, and in sizes from 4 to 10 in. square.

The *Unisorb* cushion will reduce transmitted vibration by as much as 85 per cent and is impervious to cutting fluids and cleaning compounds.



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Ideas for Design

Regulated Radio-Interference Free Generator

Described here is a generator of radio-interference-free design which produces a conventional voltage regulated output without requiring brushes, slip rings or commutator. As a result of the design, there are no sliding or arching contacts to initiate radio interference. The unique feature is the manner in which regulated excitation is supplied to the rotating field.

Brushless generators are not new. However, a machine was required which was suitable for all normal power and lighting applications and which produced a well-regulated 60 cps voltage supply. This requirement made it necessary for the generator to have a regulated dc field.

A standard engine generator set was modified for brushless, voltage regulated operation. The generator was a 30 kw., 0.8 power factor, 60 cps, 120/208/416 v, 1200 rpm diesel generator. The generator was a common type with a static armature, rotating field, and overhung dc exciter (Fig. 1). Voltage control was obtained by taking the commutated output of the exciter off through a set of brushes and feeding the dc excitation through slip rings into the main generator field. Control of the exciter output was exercised through the ex-

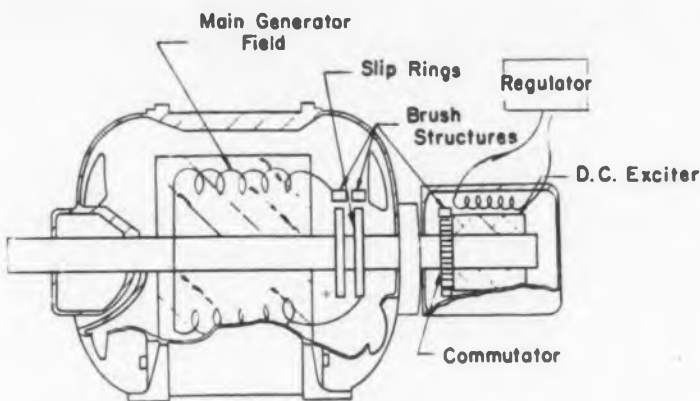


Fig. 1. Generator before modification.

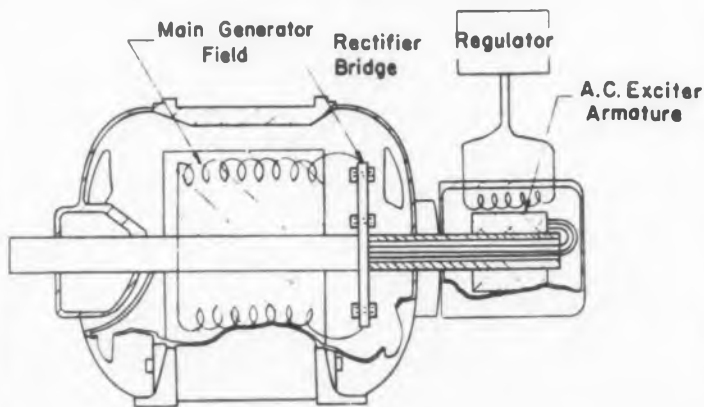


Fig. 2. Generator after modification to brushless type.

DUAL PURPOSE

TRANSISTORIZED ELECTROMETER

combined preamplifier and dc vtvm has 10^{14} ohms input, 1 mv sensitivity

HIGH input impedance is only part of the story with the new Keithley Model 220. As a sensitive dc vtvm, it's especially convenient when measuring voltages of transistors, dc amplifiers and computers, as well as many electrochemical and biological tests. In its alternate role as a dc pre-amplifier, the 220 has gains of 0.05 to 167 with suitable outputs. Uses include recording the variations in piezo-electric and pH voltages; currents in photocells, vacuum tube grids and ion chambers; and other long-term monitoring functions.



KEITHLEY
MODEL 220
DC VTVM

LINE-OPERATED, the 220 has 8 voltage ranges from 30 millivolts to 100 volts full scale. With added accessories, the instrument measures voltages from 1 mv to 20 kv, currents from 10^{-3} to 5×10^{-14} ampere, resistances from 10^4 to 10^{16} ohms.

USEFUL FEATURES include a 5-volt unbalanced output for amplifiers and oscilloscopes, and a one-milliampere output for sensitive recorders; a polarity reversing switch; and zero drift below 3 mv/hr.

DETAILS about the Model 220 are given in Keithley Engineering Notes, Vol. 5 No. 2. A request on your company letterhead will bring a copy promptly.

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- **TACHOMETER MODELS** Other models available with tachometer control to maintain speed within 1%.
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citer field. The modification made on the generator consisted of eliminating the two sets of brushes, the commutator, and the slip rings, and arranging to feed controlled dc excitation to the rotating main generator field. A sketch of the modified generator is shown in (Fig. 2).

The exciter armature, rectifier bridge, and main generator field are all rotating on the same shaft. Three phase ac exciter output is rectified in the bridge and delivered to the main field without brushes, commutators or slip rings. Thus all sources of electrical sparking and resulting radio interference have been eliminated from the generator and exciter. Control is exercised through the static exciter field which governs the exciter output, which in turn varies the main generator field to give regulated voltage output at the generator terminals.

The key development which has made this arrangement possible is the perfecting of the silicon rectifier. The relatively small size per unit of power and the more desirable temperature characteristics of the silicon rectifiers makes their use in this application very advantageous. The space required by selenium or copper oxide rectifiers would make it impracticable to mount them on the shaft of the generator. These small rectifiers will handle about one kw each. Their mass is about 1 per cent that of the old selenium or copper oxide type.

Voltage Regulation

A static type voltage regulator is used which senses the voltage output of the main generator terminals. This voltage is impressed upon two impedance type circuits in the regulator, which are in effect a voltage standard. A signal proportional to the difference between the generated voltage and the regulator voltage standard is delivered to a magnetic-amplifier control winding, and the magnetic-amplifier output is fed to the exciter field through rectifiers in such an amount as to bring the generator terminal voltage in balance with the regulating standard.

The regulating voltage standard is developed by placing across the generator terminals a linear and a non-linear circuit. There is one voltage at which the currents drawn by these circuits are equal. Above this voltage they deliver a different current to a control magnetic-amplifier in such a way as to

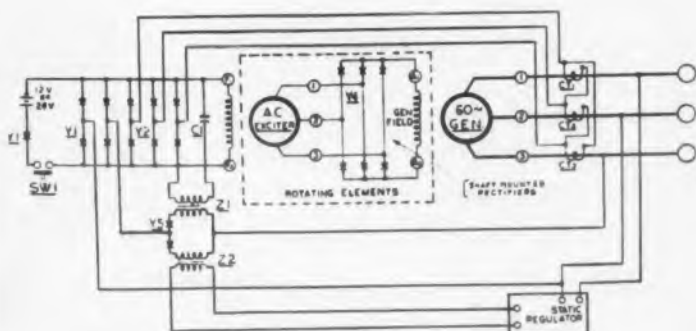


Fig. 3. Schematic of Brushless Generator.

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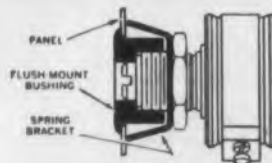
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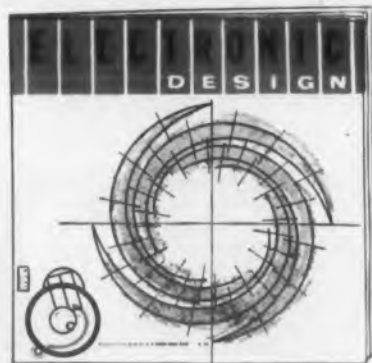
CIRCLE 437 ON READER-SERVICE CARD FOR MORE INFORMATION



W E S C O N 1957

An all time high, both in papers presented, and in number of exhibits, has been reported by the management of this year's WESCON. Once again (August 1 issue) *Electronic Design* will cover design progress at WESCON from the standpoint of the practical, working engineer.

If you would like an opportunity to publish your own practical design ideas, achievements, etc., not to a few, but to all of your 25,000 fellow engineer subscribers, be sure to look for us at the show. Our editors will be on hand to meet and talk to you.



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Ideas for Design

decrease generator excitation. Below this voltage they deliver a difference current which increases excitation. The magnetic-amplifier receives its power from the 60-cycle output of the main generator and delivers its rectified output to the stationary field of the exciter. The regulator is frequency compensated to hold voltage within ± 2 per cent with engine speed changes of ± 5 per cent.

In order to provide fast response and ample excitation current for motor starting loads and for short-circuit relay tripping conditions, the excitation system is strengthened by using current transformers in the output of the main generator. When load or fault current flows from the main generator the current back through a three phase rectified bridge directly to the stationary field winding of the ac exciter. Thus on motor starting loads or under fault conditions, which are low power factor demands, the current transformers maintain excitation at a value which will sustain the generator voltage. This arrangement insures that there will be sufficient current flow under fault conditions to trip the circuit breakers. A schematic wiring diagram of the generator and regulating system is shown in Fig. 3. A. M. Brown, U.S. Naval Civil Engineering Research and Evaluation Lab., Construction Battalion Center, Port Hueneme, Calif.

New Shock Mounting

Robinson Aviation, Inc. of Teterboro, manufacturers of all-metal vibration and shock mounting systems, recently developed a Met-L-Flex center-of-gravity mounting for a pressure ratio transmitter unit developed by Minneapolis-Honeywell for airborne applications.



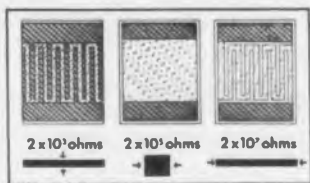
ELECTRONIC DESIGN • July 15, 1957

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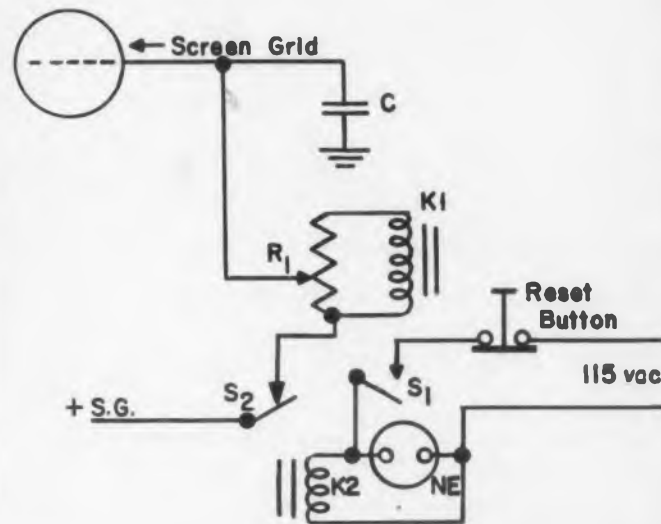
This specialized mounting system shown incorporates pressure and electrical connectors as part of the supporting structure of the mounting. It provides for ease of installation and in effect combines the equipment and mounting into an integral package.

Constructed of aluminum and steel throughout, the lightweight mounting system is a permanent type mounting unaffected by adverse operating conditions. The incorporation of Met-L-Flex resilient elements, located in the plane of the center-of-gravity, provides Model 1323 with environmental tolerance from vibration and shock, thereby insuring equipment reliability.

The high percentage of inherent damping displayed by the mounting system results in the reduction of resonant peaks and the quick dissipation of transient forces. The natural frequency of Model 1323 is between 6 to 11 cps while the amount of vibration provided is approximately 90 per cent at 40 cps. Designed in accordance with military specifications MIL-E-5272A, MIL-C-5541 and QQ-P-416, this mounting system is readily adaptable to military applications.

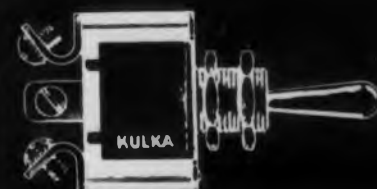
Tube Protection Scheme

A solution is given here to the problem of finding a reliable method of protecting the screen grids of high-power beam tetrodes and pentodes in event of bias, excitation or plate supply failure.



A very sensitive relay (k_1) of 10,000 ohms is used. When I_{sg} exceeds a predetermined value, the voltage drop across R_1 pulls in the relay K_1 . S_2 closes, energizing K_2 , which opens S_2 . K_2 has a holding contact which prevents reapplication of screen voltage until the reset button is pushed, again closing S_2 . The neon lamp across the coil of K_2 gives visual indication of the overload. Stephen J. Goch, Director Research, G & G Electronics Labs., 1062 Virginia Ave., Bronx 72, N.Y.

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Report Briefs

Traveling Wave Tubes

Two-helix and three-helix backward-wave amplifiers of the cascade type were studied, and the latter found to have a higher gain-bandwidth product. An experimental model of a two-helix mixer in which one helix is a backward-wave amplifier and the other a backward-wave oscillator gave conversion efficiencies up to 0.57, and it is believed that the design could now be improved. Interaction between several space harmonics, originally believed to be orthogonal, was observed on the multi-helix tubes, and several studies were conducted to determine the source of the interaction. A velocity and current analyzer for the backward-wave tubes was also designed. Several studies in crossed-field tubes are described, including measurements on a forward-wave amplifier using a zig-zag slow-wave structure, and the design of a two-circuit backward-wave crossed-field tube. Several gun studies, especially on guns of the shielded type, were made. Electrostatic focusing of electron beams was studied analytically and experimentally, and attempts were made to combine rf interaction with an electrostatically focused beam. Analyses of the noise problem and the large-signal problem are discussed. Experiments were made on several novel high-density emitters, including a metallic arc, a Phillips ion gage discharge, and a shielded field emitter. *PB 123983 Traveling Wave Tubes and Related Studies, David H. Sloan, John R. Whinnery and John R. Woodyard, California Univ. Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C. Dec. 1955, 26 pp. Microfilm \$2.70. photocopy \$4.80.*

Low Frequency Propagation

Study of Loran signals showed that E-layer fading rates are not always the same as those in the D-layer. Wide band multichannel equipment for the study of various kinds of atmospheric was designed and constructed. An improved intervalometer was constructed. From whistler data obtained in Seattle and Stanford during 1951 and 1952, it was found that approximately 22 per cent of the whistlers that occurred at either location were received at both locations. This result provides support for Storey's theory of whistlers. Simultaneous whistler observations made at Stanford and on the U.S.S. Atka of the Navy Antarctic Expedition in Dec. 1954 were analyzed. *PB 122359 Low Frequency Propagation Studies, Robert A. Helliwell, Stanford University, Radio Propagation Lab., Stanford, Calif., Library of Congress, Washington 25, D.C. Sept 1955, 61 pp. Microfilm \$3.90, photostat \$10.80.*



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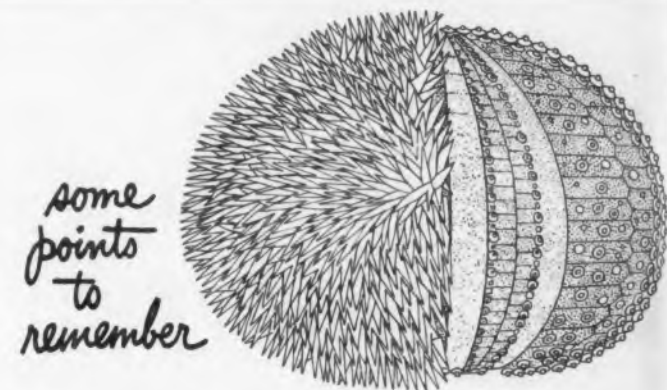
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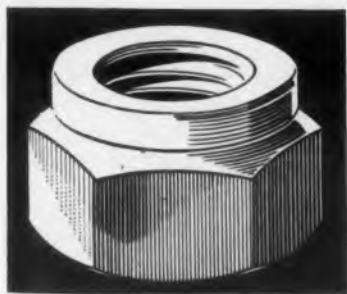
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FLEXLOC LOCKNUT DIVISION

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Anisotropic Particle Lattice

The dielectric properties of lattices composed of identical metallic or dielectric elements of various geometries, such as spheres, discs and strips have been investigated from a molecular point of view. The main objective of this note is to extend the treatment to general uniform lattice structures made of identically shaped and oriented particles of general constitutive characteristics. Thus, it includes the most general case of a uniform lattice with structural anisotropy and both element isotropy and anisotropy at the lattice points. *PB 124171 Dielectric Properties of a Lattice of Anisotropic Particles, Zohrab A. Kaprielian, California Institute of Technology, Electrical Engineering Dept., Library of Congress, Washington 25, D.C. June 1955, 29 pp. Microfilm \$2.70, photostat \$4.80.*

Radome Design

This report presents a general discussion of the design information which has been gathered by investigators and fabricators in developing various sizes and modular configurations of rigid radomes. The design information which is included pertains to the aerodynamic, structural, and thermodynamic analyses. Test data are given concerning climatic studies, wind-simulated loading tests, transmission tests, and installation tests. A discussion is also included on the parameters and problems involved in material selection and fabrication procedures. The applicability of the collected design and test data to Air Force requirements is discussed and conclusions and recommendations are presented. *PB 123976 Design Considerations for Rigid Radomes, J. R. O'Donnell, U. S. Air Force, Air Research and Development Command, Rome Air Development Center, Griffiss Air Force Base, Rome, N.Y., Library of Congress, Washington 25, D.C. June 1956, 73 pp. Microfilm \$4.50, photostat \$12.30.*

Low-Power Pulse Transformers

Analysis and design procedures are derived for application to low-power pulse transformers including, in particular, the types expected to be employed in many circuits of the electronic digital computer of Project Whirlwind. Pulse lengths considered are between a twentieth and a quarter μ sec. Although optimum reproduction of pulse shape is assumed to be a leading requirement, the procedures given are presumably general enough to be extended to applications for which faithful reproduction of input voltage or current waveform is not necessary. *PB 124199 Low-Power Pulse Transformer, Thomas F. Wimett, Mass. Institute of Technology, Servomechanisms Lab., Cambridge, Mass., Library of Congress, Washington 25, D.C. Dec 1947, 114 pp. Microfilm \$6.00, photostat \$18.30.*

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Complete details in Brochures L-156 A and L-157.

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Report Briefs

Snow Measurement

Intensities of the snow echoes obtained by a zenith-pointing radar from 180 different contributing regions are compared with suitably chosen thresholds. The probability of the intensities exceeding such a threshold and the frequency with which two intensities separated in time straddle it, are used to deduce the autocorrelation coefficients of the signals. The autocorrelation coefficient, after correction for receiver noise, is shown to be the product of three partial coefficients due to the differential settling of the particles, to a uniform wind driving the particles across the beam, and to turbulence. To the extent that differential settling and cross-wind are known, turbulence can be deducted from the measured coefficient of the signal. Considerations based on the theory developed suggest that measurements of turbulence in rain or snow in the horizontal beam of a high-resolution radar at close range should be feasible. Appendix 1: Correlation coefficients of the signal intensity, and of the amplitude components; the Wiener-Khinchine theorem. Appendix 2: Auto correlation coefficients are "multiplicative." PB 124560 *Measurement and Calculation of Fluctuations in Radar Echoes from Snow*, Walter Hitschfeld and Arnett S. Dennis, McGill University, MacDonald Physics Lab., "Stormy Weather" Research Group, Montreal, Canada, Library of Congress, Washington 25, D.C. 53 pp. Microfilm \$3.60, photostat \$9.30.

M Type BWO

A field theory of electron beams focused by crossed electric and magnetic fields is given. The theory is basic to the understanding of the small signal behavior of crossed field electron devices. It is applied to explain the slipping stream, or diocotron, effects as a coupling of two surface waves of the electron beam, and to derive the start-oscillation conditions of the M-type backward wave oscillator. It is found that the slipping stream effect can reduce the starting current by an appreciable factor. The results are compared with the thin beam theory which neglects space charge effects. An analysis of a loaded strip transmission line is given, from which a method of representing space harmonic slow wave circuits by a surface admittance boundary condition is obtained. Forward and backward space harmonic interaction may be treated equally well. PB 123973 *Field Analysis of the M Type Backward Wave Oscillators*, Roy W. Gould, Calif. Institute of Technology, Electron Tube and Microwave Lab., Pasadena, Calif., Library of Congress, Washington 25, D.C. Sept 1955, 108 pp. Microfilm \$5.70, photostat \$16.80.

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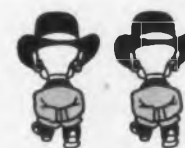
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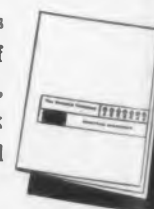


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Magnetic Amplifiers with Feedback

Tests made on magnetic amplifiers excited by a sine-wave carrier were conducted to determine if the figure of merit could be improved by means of feedback techniques. The results are presented schematically and mathematically. In general, the investigations reveal that the power gain of the magnetic-amplifier device can be increased to an unlimited point, but that with this increase a finite rise time remains. Under these conditions the figure of merit, as it is ordinarily defined, becomes meaningless. However, investigations reveal that even under conditions in which feedback techniques are employed, the voltage-gain to magnetic-amplifier rise time ratio remains essentially constant and results in a useful figure of merit. *PB 123403 Investigations of Magnetic Amplifiers with Feedback, Remington Rand Univac, Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D.C. Mar. 1956, 20 pp. Microfilm \$2.40, photocopy \$3.30.*

RFI in Communication

A simple method for measuring densitization of receivers caused by radio interference is presented. The use of this method for obtaining true signal to noise ratio measurements at the output of a receiver is discussed. A standard speech test signal is suggested for intelligibility evaluation by means of the concept of articulation index. *PB 123076 Evaluation of Interference Effects on Speech Communications, Arthur Gottfried and Kurt Ikrath, U. S. Signal Corps Engineering Labs., Fort Monmouth, N.J., Library of Congress, Washington 25, D.C. Mar 1956, 18 pp. Microfilm \$2.40, photostat \$3.30.*

Traveling-wave Tube Theory

Propagation constants have been calculated for a lossy traveling-wave tube by means of a field theory. These results have been applied to the prediction of an attenuator power loss of the order of 2 or 3 db. compared to attenuatorless operation. It is shown that the gain of the higher order modes is negligible. Admittance matching by means of radial admittance transformation is the underlying method used throughout. The Pierce-Fletcher theory in common use at this time is examined in some detail to determine its range of validity. The effects of space charge bunching on saturation has been treated. Criteria have been set for determining whether bunching is important or not in determining saturation. *PB 123173 Field theory of traveling-wave tubes with application to the study of attenuator saturation effects, William Buchman, California Institute of Technology, Electron Tube and Microwave Laboratory, Pasadena, Calif. LC. Washington 25, D.C. 136 pp. \$21.30.*



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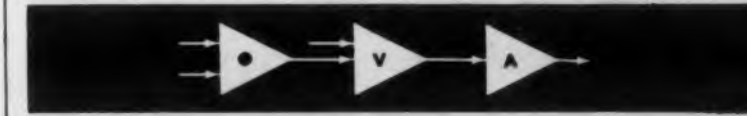
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low-voltage range	1.2	0.35	1.3
middle range	2.1	0.55	2.0
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Patents

Phase-Shift Oscillator

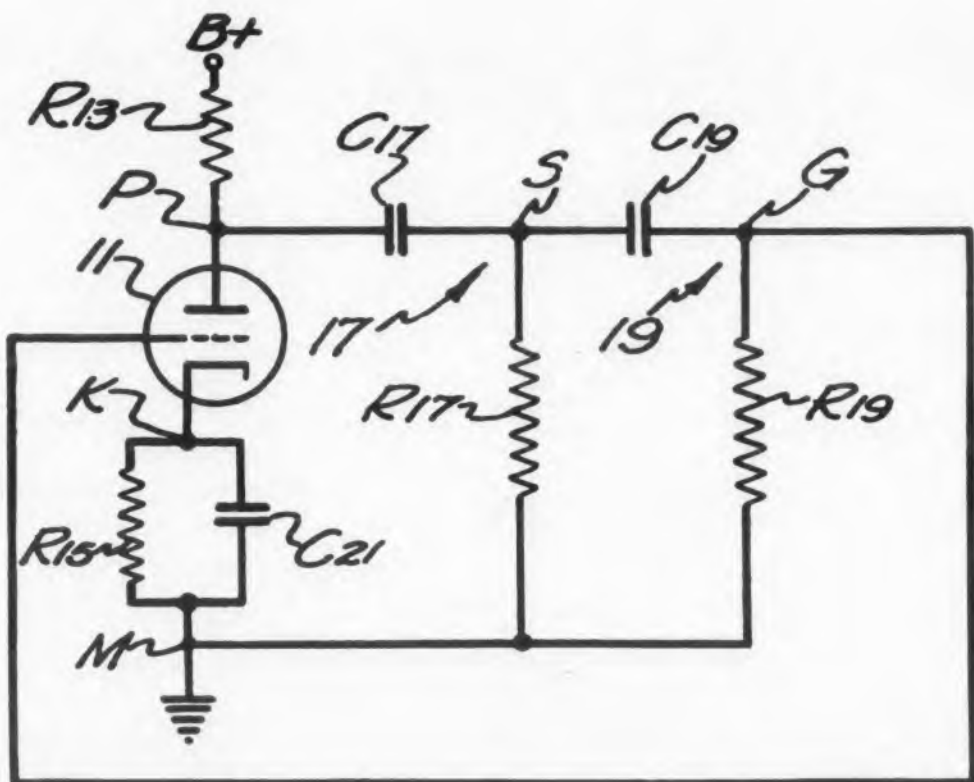
Patent No. 2,777,952 B. F. Spencer (Assigned to Sperry Rand Corporation)

Phase-shift oscillators as heretofore designed have required more than two phase-shift networks in the plate circuit of the oscillator tube in order to secure the 180 deg phase-shift necessary for sustained oscillations. Oscillators must have enough gain to overcome circuit losses for sustained oscillations. In the usual phase-shift oscillator, the cathode circuit includes a resistor and a condenser of large value in shunt with the resistor with the result that the phase-shift achieved in the cathode circuit is negligible. As a consequence an additional phase-shift network is required in the grid plate circuit to secure the necessary 180 deg phase-shift.

In the phase-shift oscillator shown in the figure, oscillations are secured with two phase-shift networks 17 and 19 in the plate to grid connection. The networks shown are of the L type using capacitors C17 and C19 in series between plate and grid. These

two networks secure a phase-shift of substantially less than 180 deg. The additional phase-shift necessary to achieve 180 degrees of phase-shift is secured from the reactance network K in the cathode to ground circuit. The shunting capacitor C21 has a value that provides sufficient phase-shift to achieve the 180 deg phase-shift for maintaining sustained oscillations.

It will be noted, therefore, that the phase-shift network in the plate-grid circuit provides substantially less than 180 deg phase-shift and that the additional phase-shift required is provided by the cathode network. As a consequence, a reduction in the number of phase-shift networks necessary to secure sustained oscillations is secured. In addition, the gain of the circuit for securing sustained oscillations is reduced to a minimum since circuit losses are less. The circuit described and illustrated has good stability. The patentee illustrates two other forms of the phase-shift oscillator circuit with results comparable to the results secured with the circuit illustrated.



Semi-Conductor Network

Patent No. 2,780,752 R. W. Aldrich et al
(Assigned to General Electric Company)

The network has a semi-conductor provided with spaced electrodes which are predominantly bilaterally conducting. A junction electrode having unilateral conducting properties contacts the semi-conductor in a region which is influenced by potential applied between the spaced bilaterally conducting electrodes. A potential of proper value is applied between these spaced electrodes. A capacitor connects the junction electrode with one of the bilaterally conducting electrodes, and an impedance connects the other of the spaced electrodes and the junction electrode.

Self-Saturating Reactor Circuits

Patent No. 2,780,772 B. Lee (Assigned to Vickers Incorporated)

The magnetic amplifier has the usual input and output circuits. A saturable reactor has its reactance winding in series with a half-wave rectifier between the input and output circuits for self-saturation. A second reactor winding connects with a source of

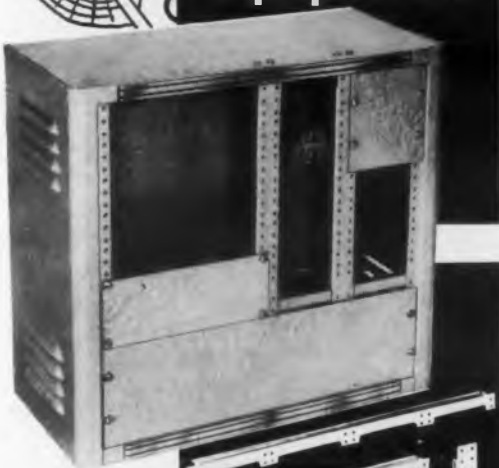
alternating control current. A shunt circuit is provided across the second winding. The circuit includes a second half-wave rectifier so that induced current flow in the second winding flows in a direction to generate magnetic effects in the reactor which are oppositely related to the magnetic effects produced by current flow through the first rectifier.

UHF Signal Generation

Patent No. 2,777,062. R. J. Hannon. (Assigned to Standard Coil Products Co., Inc.)

The high frequency oscillator of the patent uses an electron tube having a plurality of electrodes. The effective inductance of certain of the leads to the electrodes is resonated by means connected between the plate and the grid terminals of the tube in order to establish the frequency of oscillation. Compensation is provided for the effective inductance of the other electrode leads, as well as a parallel non-resonant LC circuit in series with the compensating circuit element for providing a high frequency output signal. This series circuit is between the plate terminal of the tube and ground.

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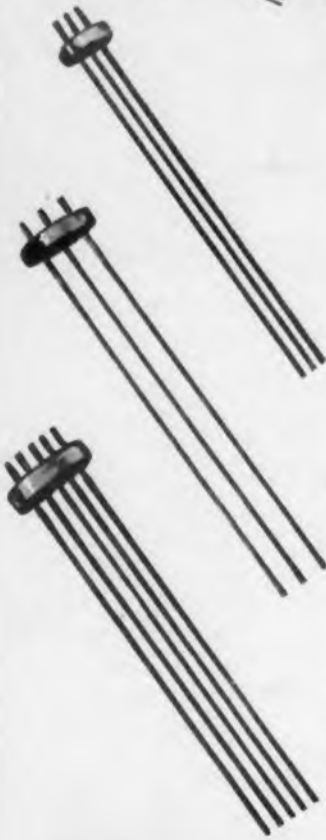


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Patents

Switching System

Patent No. 2,782,303 E. A. Goldberg (Assigned to Radio Corporation of America)

Electronic switching circuits employing semi-conductor materials are coming into increasing use since they require no filament supply and the overall circuit is simplified. The semiconductor materials are particularly desirable when there is no need for amplification of the switched signals. Switching circuits, as presently designed, are subject to two difficulties in particular. One difficulty is that of maintaining the level of the signal being switched because of losses arising in overcoming a blocking bias. Another difficulty is that occasioned by the capacity of the wiring which prevents rapid transmission of the switched signal required with electronic equipment.

The circuit in its simplest form is illustrated in the figure. The positive signal to be switched is applied to the input terminal EA and a negative signal is applied to the input terminal EB. The positive signal passes through the diode 30 and resistor 38 under the control of a switching signal which is applied through the diode 50.

Upon the application of a positive switching control signal through the diode 50, the cathode 32 of the diode 30 is biased to non-conduction and consequently the input signal is not transmitted. A negative control signal applied through the diode 50 will render the diode 30 conducting and the signal will be transmitted. In similar manner, a positive or negative control switching signal applied through the diode 80 biases the diode 60 to non-conduction or conduction so that the negative signal is blocked or transmitted.

Biasing of the diode 30 so that it becomes conducting affects the current flow through the resistor 92 and diode 40 so that the input signal appears at the output terminal 90. Similarly a signal conducted through the diode 60 affects the current flow through the resistor 92 and diode 70 and results in the negative signal appearing at the output terminal 90. With the circuit illustrated, the diode power losses in diode 30 and 40 are equal and opposite so that the two losses compensate for each other. The output signal appearing at the terminal 90 is of the same value as the input signal being

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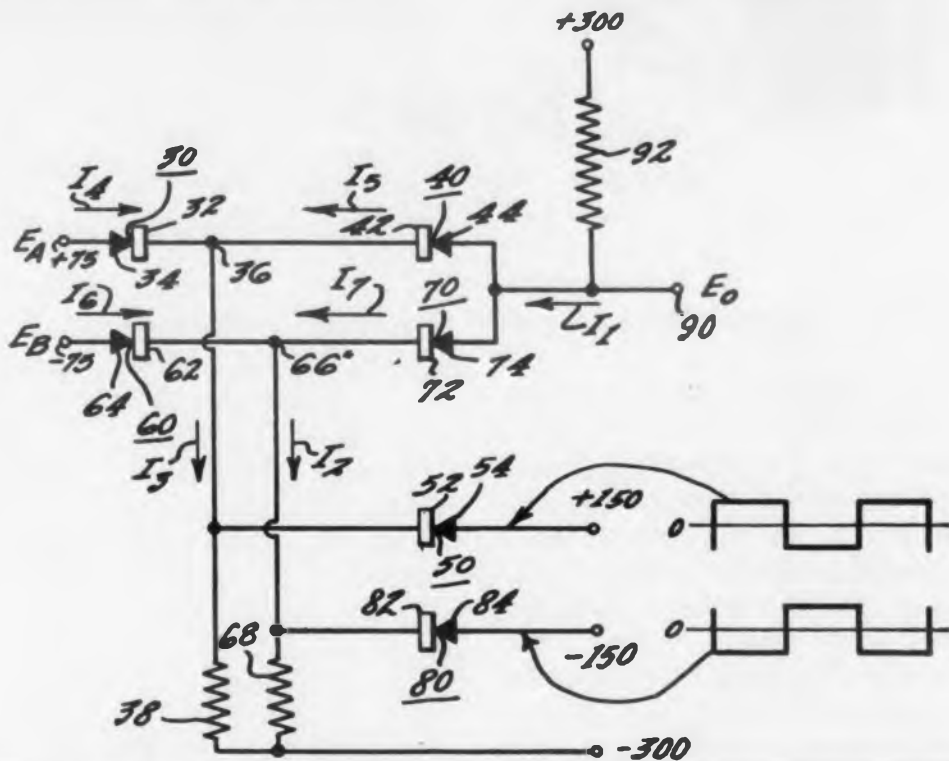
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switched or transmitted. The connection of the diodes through resistors 38 and 68 with a negative source of potential permits any potentials occurring as a consequence of capacitive effect of the connections to leak off and enables a high speed switching operation to be secured with the circuit.

There are two other forms of the circuit illustrated and described in the patent. In one circuit the resistor 92 is replaced by a vacuum tube and the resistors 38 and 68 also may be replaced by vacuum tubes. The other modified circuit is a refinement of the circuit illustrated herein.



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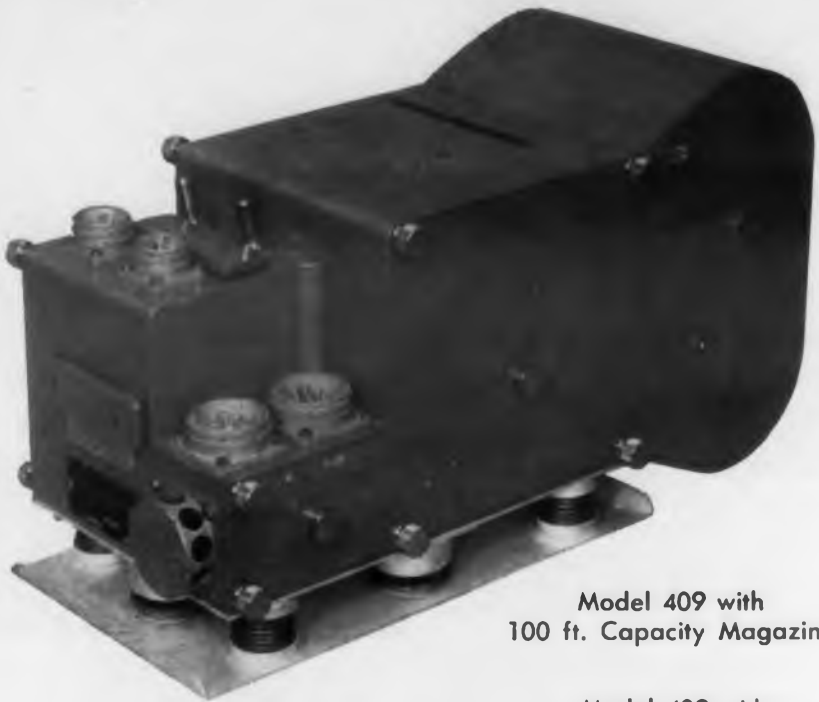
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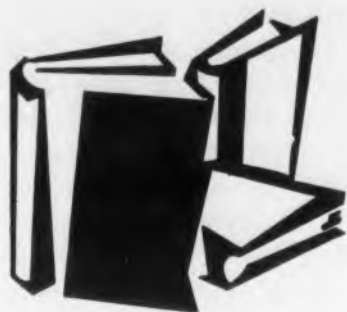
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Write for Bulletin CGC-303 and CGC-301

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Books

Annual Report 1956, National Bureau of Standards.

U. S. Dept. of Commerce, Washington 25, D.C., 15 pages, \$.60.

The National Bureau of Standards Annual Report on its research and development activities in the physical sciences contains brief descriptions of the accomplishments in each area of the Bureau's responsibilities. Such subjects as the maintenance of basic standards, determination of physical constants and properties of matter, development of methods and instruments of measurement, and the provision of calibration, testing and scientific advisory services are covered.

During the past year, significant results were achieved in programs dealing with electronic computers, electronic instrumentation and the properties of matter and materials. Development work was successfully completed on a micro-image data storage and retrieval device which provides rapid access to any one of 10,000 micro-filmed images located on a 10 in. square sheet of film.

The Bureau also developed a technique for capturing and storing large numbers of free radicals—highly reactive molecular fragments—at temperatures near absolute zero. In the field of optics and metrology, the Bureau completed a comprehensive dictionary of color names, which lists some 7500 individual color names and defines them in simple accurate terms easily understood by workers in different fields. A study of the effect of crystal orientation of fatigue crack initiation in metal was also completed.

Engineers in foreign countries ordering the publication must send remittances in U. S. exchange and should include an additional 1/4 of the publication price to cover mailing costs.

Semiconductor Abstracts

Battelle Memorial Institute, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 322 pages, \$10.00.

As with previous issues, the principal source of information for this volume is abstract journals. Some original articles, however, have been reviewed in cases where they add to the completeness of coverage. Numerical results are included in many of the abstracts.

The engineer working in the field of semi-conductors will find these abstracts an excellent directory of the literature released during the past year. They will give him an "even chance" of keeping up with the contributions from the many branches of science which are encompassed by activities in the semiconductor field.

Television Engineering Principles and Practice

Vol. 3—Waveform Generation, S. W. Amos & D. C. Birkinshaw Philosophical Library, 15 East 40 St., New York, N.Y., 226 pages, \$15.00.

A comprehensive survey of modern television principles and practice is compiled in this third volume of the four volume series. The application in television of sinusoidal, rectangular, sawtooth and parabolic waves and the mathematical relationship between them, is described. The text is devoted to the fundamental principles of the circuits commonly used to generate such signals. Treatment of the subject is primarily descriptive and considerably less mathematical than that of the previous volume. Although written primarily for the television engineer the book should prove useful to engineers interested in refreshing their knowledge on the fundamentals of pulse circuitry.

Digital Computer Programming

D. D. McCracken, John Wiley & Sons, Inc.
440 Fourth Ave., New York 16, N. Y. 253
page, \$7.75.

Digital programming is discussed on a practical level. Details involved in actually working with digital computers are presented in a lucid, comprehensive treatment. Many of the problems which are specially troublesome to beginners are discussed in a presentation of basic programming fundamentals.

Coverage is more comprehensive than that provided by instruction manuals for specific computers, yet it is on a more practical level than broad treatments written primarily for non-users of computers. To implement his approach Mr. McCracken has devised a mythical computer combining elements from a number of different models currently on the market. This approach makes the book suitable for study even though a computer might not be available for practice or demonstration. When a specific machine is available, the applicable parts of the book can be read with profit, along with the large portion of text material that is relevant to any machine.

Mr. McCracken's book should prove val-

uable for people with no previous knowledge of computing who want to know how to prepare detailed "instructions" for a computer, as well as for people whose work is so closely related to computer applications that they need to know what is involved in programming.

Transistor Circuits and Applications

John M. Carroll, McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N.Y., 283 pages, \$7.50.

Articles on transistors and transistor applications have been edited and compiled by Mr. Carroll into a somewhat textbook form. Many of the articles contain typical circuits with component values. The design engineer will find this information useful as background material and for comparison with his own designs and techniques. Military, industrial and home-entertainment transistor circuits are covered in the various articles. Typical transistor operating characteristics, important circuit parameters, transistor types, problems of temperature and gain stabilization, and a large number of typical transistor circuits are also included.

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Russian Transistors

J. George Adashko

Construction features and electrical properties of Russian semiconductor devices are presented in "Parameters and Construction of Russian Transistors" by A. V. Krasilov, (8 pp, 9 figs, 3 tables). The article appeared in *Radiotekhnika i Elektronika*, No. 8, 1956, whose contents were reviewed in *ED*, May 15, 1957. These features are abstracted here in picture caption form. Also presented in the article

are three tables giving the salient parameters of Russian point-contact and junction transistors.

The columns marked "80% limits" of Tables 1 and 2 show the limits, in which up to 80 per cent of the transistors of the corresponding types have been issued. The current amplification coefficient, α , is measured at audio frequency. The indices 0.5, 1.5, 5, and 10 in Table 1 indicate that the measurements

were carried out respectively at 0.5, 1.5, 5, and 10 mc. I_c limit of Table 3 indicates the minimum collector current at which the gain, $\beta = \alpha / 1 - \alpha$ still exceeds 2 for a given type of transistor.

The tables show that the spread in transistor parameters is quite large. The article claims that one of the reasons for this is the inhomogeneity of the presently used germanium.

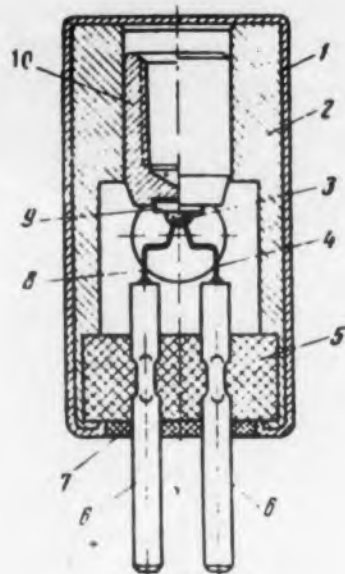


Fig. 1 Construction of point-contact transistor (types C1 and C2). 1—nickel envelope, 2—brass shell, 3—lacquer, 4—emitter, 5—plastic insulator, 6—nickel pin, 7—potting lacquer, 8—collector, 9—germanium base, 10—crystal holder.

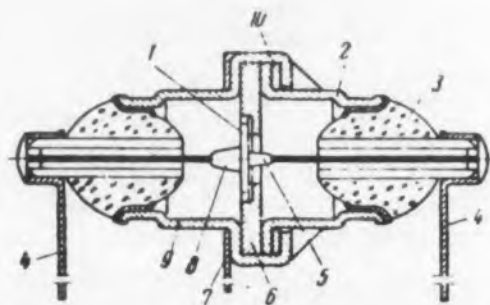


Fig. 3 Construction of junction-type transistor (types P1 and P2). 1—germanium base, 2—shell, 3—glass insulator, 4—terminal, 5—emitter, 6—crystal holder, 7—terminal, 8—collector, 9—shell, 10—lead lining.

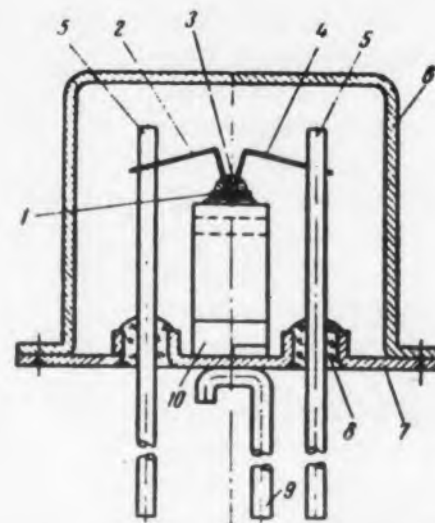


Fig. 2 Construction of hermetic point-contact transistor. 1—germanium base, 2—emitter, 3—lacquer, 4—collector, 5—pin, 6—shell, 7—mount, 8—glass insulator, 9—pin, 10—crystal holder.

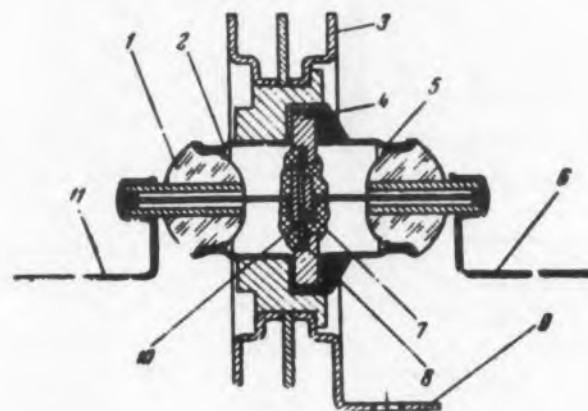


Fig. 5 Construction of P3 junction-type transistor. 1—insulator, 2—shell, 3—radiator, 4—crystal holder, 5—shell, 6—emitter terminal, 7—emitter electrode, 8—germanium crystal, 9—base terminal, 10—collector electrode, 11—collector terminal.

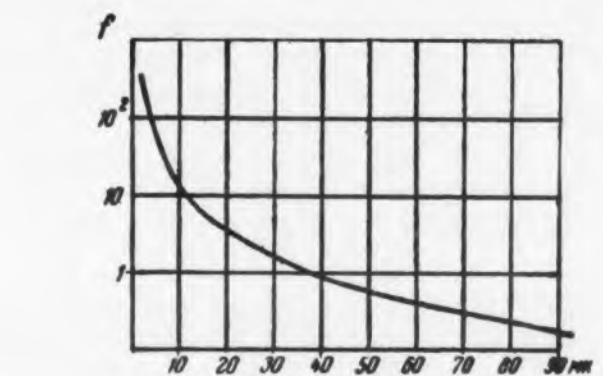


Fig. 4 Dependence of limiting frequency f of a junction-type transistor on distance between the emitter and collector.

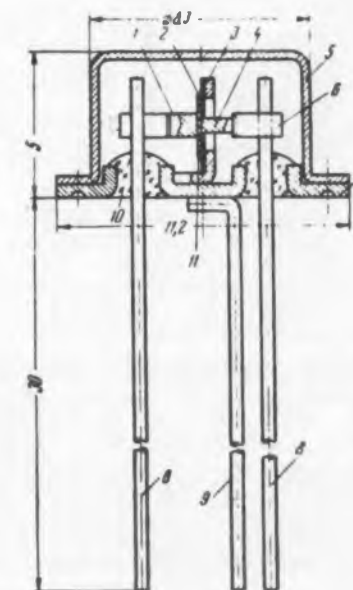


Fig. 6 New construction of P1 transistor. 1—collector, 2—tin ring, 3—nickel crystal holder, 4—emitter, 5—shell, 6—nickel lug, 7—mount, 8, 9—terminals, 10—glass insulator, 11—germanium base.

Table 1 Summary table of parameters of point-contact transistors

Type	Parameters (grounded-base circuit with $t = \pm 20 \pm 5 \text{ deg C}$)																				Measurement Conditions		Peak Values									
	R_{11}		R_{12}		R_{22}		α		$\alpha_{0.5}$		$\alpha_{1.5}$		α_1		α_{10}		K_V		K_m (power gain) $R_2 = 500 \text{ ohm}$, $R_{load} = 10 \text{ kilohm}$		I_e ma.	U_e v.	I_c ma.	I_c ma.	U_c v.	P_c mw.						
	Ohm		Ohm		Kilohm												Norm															
	norm	80% limits	norm	80% limits	norm	80% limits	norm	80% limits	norm	80% limits	norm	80% limits	norm	80% limits	norm	80% limits	norm	80% limits	min.	max.	max.	max.	max.	max.								
S1A	750	300	550	200	30	90	7	10	20	1,2	1,5	2,5	1,0	1,3	2,1	—	—	—	—	—	—	15	19	0,3	20	+10	-10	-40	100			
S1B	750	300	500	200	30	150	7	10	25	1,5	1,8	3	1,2	1,3	2,1	—	—	—	—	—	50	75	150	18	22	0,3	20	+10	-6	-40	50	
S1V	750	350	500	200	60	120	7	10	20	1,5	1,8	2,5	—	—	—	1,2	1,3	2,1	—	—	—	—	—	—	—	—	—	—	—	—		
S1G	750	300	500	200	30	120	7	10	20	1,5	2	3,5	—	—	—	1,2	1,5	3	—	—	—	50	100	150	18	22	0,3	20	+10	-6	-40	50
S1D	750	350	500	200	60	180	7	10	20	1,5	2	3,5	—	—	—	1,2	1,5	3	—	—	—	30	50	125	15	22	0,3	20	+10	-6	-40	50
S1E	750	—	—	200	—	—	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
S2A	1500	300	600	1000	50	200	7	10	25	1,5	1,8	4,5	1,2	1,5	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
S2B	1500	450	800	700	150	300	7	10	25	1,8	2	3,5	—	—	—	1,5	1,5	3	—	—	—	—	—	—	—	—	—	—	—	—		
S2V	1500	450	900	1000	150	400	7	10	25	1,8	1,8	3	—	—	—	1,5	1,5	3,5	—	—	—	—	—	—	—	—	—	—	—	—		
S2G	1500	—	—	1000	—	—	7	—	—	1,6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		

Table 2 Parameters of low-power junction transistors

Type	PARAMETERS																				Conditions of K_m Measurement				Permissible Limits							
	α		R_b ohm		R_c ohm		K_m (power gain) db		f_{lim} kc		P_n (noise power) db		C_{uuf}		$(U_{c=10v})$		I_e	U_c	R_{gen}	R_{load}	I_c	U_c peak	P_c									
	Specified Norm	80% limits	Spec. Norm	80% limits	Spec. Norm	80% limits	Spec. Norm	80% limits	Spec. Norm	80% limits	Spec. Norm	80% limits	Spec. Norm	80% limits	Spec. Norm	80% limits	ma	v.	ohm	kilohm	ma	v.	mw									
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.								
P1A	0,9	0,93	0,9	0,93	—	30	200	—	—	300	3000	30	—	30	40	100	—	15	40	—	20	35	5	25	1	-10	600	30	5	20	50	
P1B	0,93	0,97	0,93	0,97	—	400	100	250	500	1200	500	1200	33	—	35	42	100	—	15	40	—	20	35	5	20	1	-10	600	30	5	20	50
P1V	0,93	0,97	0,93	0,97	—	400	100	250	1000	—	1200	4500	37	—	38	45	100	—	15	40	—	20	35	5	15	1	-10	600	30	5	20	50
P1G	0,96	—	0,96	0,99	—	600	100	400	500	—	700	4500	37	—	38	45	100	—	15	40	—	20	35	5	20	1	-10	600	30	5	20	50
P1D	0,94	—	0,94	0,99	—	100	350	500	—	1200	4500	33	—	35	45	100	—	7	14	—	20	35	5	15	1	-10	600	30	5	20	50	
P1E	0,94	—	0,94	0,99	—	1000	150	350	300	—	300	4500	—	—	33	45	465	—	15	40	40	20	35	5	25	1	-10	600	30	5	20	50
P1Zb	0,96	—	0,96	0,99	—	1500	250	1500	300	—	300	4500	—	—	35	45	1000	—	15	40	40	20	35	5	20	1	-10	600	30	5	20	50
P1I	0,96	—	0,96	0,99	—	1500	—	500	—	—	—	—	35	—	—	1800	—	—	—	—	—	—	—	—	20	1	-10	600	30	5	20	50

Table 3 Parameters of high-power junction transistors

Type	P_{out} Watts min.	K_m (power gain) db	I_c lim. (8-2) ma	I_{c0}		Test Conditions					Limiting Values		
				ma.	ma.	I_c ma	U_c v.	R_{gen} ohm	R_{load} ohm	f cps	I_c ma	U_c v.	$P_{diss.}$ w.
P2A	0,1	> 17	—	0,03	0,2	5	50	100	10000	1000	10	100	0,250
P2B	0,1	> 17	—	0,03	0,2	10	25	25	4000	1000	15	50	0,250
P3A	1	17-20	150	—	—	130	25	5	220	1000	150	50	3,5
P3B	1	20-25	250	0,25	5	130	25	5	220	1000	250	50	3,5
P3V	1	25-30	450	0,25	3	130	25	5	220	1000	450	50	3,5
P4	10	13-20	1500	0,5	—	1000	28	3	85	1000	2000	55	30

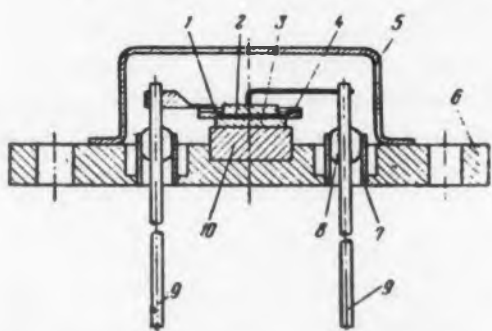


Fig. 7 New construction of P3 transistor. 1—germanium base, 2—emitter, 3—collector, 4—base, 5—shell, 6—mount, 7—cover sleeve, 8—glass insulator, 9—terminal, 10—copper disc.

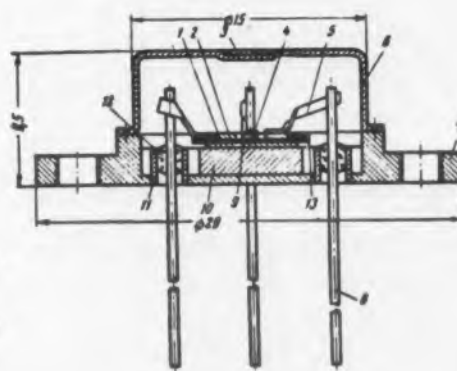


Fig. 8. New construction of P2 transistor. 1—germanium base, 2—emitter, 3—sealing (hermetic) lining, 4—central base, 5—nickel lug, 6—shell, 7—mount, 8—terminal, 9—collector, 10—copper disc, 11—cover sleeve, 12—glass insulator, 13—annular base.

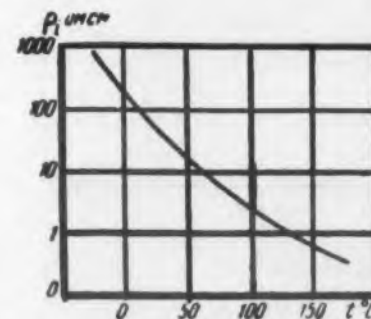


Fig. 9. Dependence of the value of the intrinsic resistance of germanium on the temperature, calculated from the equation

What the Russians Are Writing

J. George Adashko

RADIO ENGINEERING AND ELECTRONICS

(Contents of Radiotekhnika i Elektronika No. 11, 1956)

TRANSISTOR CIRCUITS

HF Transistor RC Oscillator, L. N. Kaptsov, (6 pp, 5 figs, 2 tables).

A grounded-base point-contact transistor amplifier with greater than unity gain may have negative input and output resistances and may serve as a relaxation or harmonic oscillator. Such a circuit, (essentially a multivibrator,) is analyzed in this article on the basis of the equivalent circuit of Fig. 2 over a range of frequencies comparable with the critical current-gain frequency. Fig. 3 shows the frequency and amplitude dependence on emitter current for several transistors.

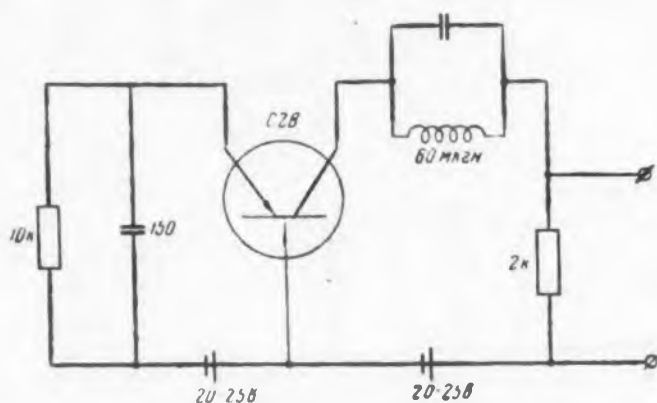


Fig. 1. Practical circuit of RC-oscillator using a type C2B transistor.

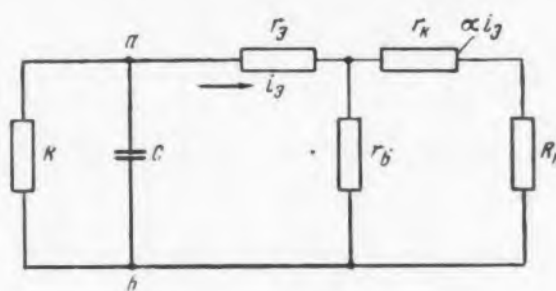


Fig. 2. Equivalent circuit of RC-oscillator.

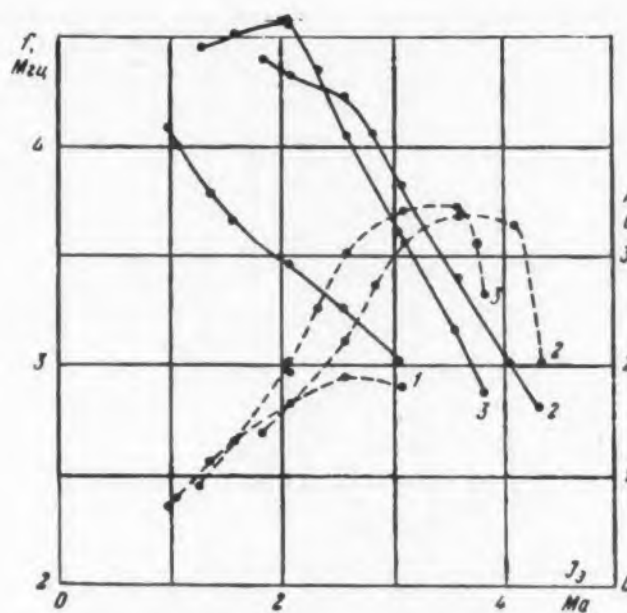


Fig. 3. Plots of frequency (solid) and output amplitude (dotted) vs. emitter current. Curves 1 and 2 are for two C2B transistors, Curve 3 is for the non-standard No. 577 transistor.

Voltage Gain of Tuned Point-Contact Transistor Amplifiers, E. F. Vorob'eva, (12 pp, 9 figs, 2 tables).

This is a simple approximate calculation applicable to common-base transistors, taking into consideration the effect of the frequency dependence of the transistor parameters and of the internal feedback on the resonant voltage gain. The analysis of the equivalent circuit leads to a set of gain vs. frequency curves for various degrees of mismatch at the input. Experimental verification of the analytical results is cited.

Study of Transients of a Triggering Circuit Using Point-Contact Transistors and Shaping of Pulses from a Sinusoidal Voltage, V. A. Kuz'min, (7 pp, 8 figs).

The study begins with the computation of the duration of the leading edge of the output pulse in response to an arbitrary input voltage. This is followed by computation of the part of the trailing edge of the output pulse that corresponds to the transition through the active region under the influence of the negative voltage drop. Shaping of sinusoidal voltages into pulses with the proposed trigger system is then studied. The amplitude, duty cycle, and duration of the forward front of the output pulses are calculated, and the circuit parameters are evaluated. The analysis is checked experimentally. Refers to A. W. Lo, "Transistor Trigger Circuits," Proc. IRE, 1952, 40, 11, 1531, and Lebow and Baker, "The Transient Response of Transistor Trigger Circuits," Proc. IRE, 1954, 42m 6, 938.

T W OSCILLATORS

Generation of Electromagnetic Oscillations by Traveling Wave Tubes with Double-Spiral Coaxial Lines, V. S. Mikhalevski, A. G. Dolganov, V. D. Ivanova, 11 pp, 13 figs).

A theoretical treatment of the dispersion properties of the double-spiral coaxial line was reported by V. S. Mikhalevski in the October 1956 issue of *Radiotekhnika i Elektronika* (ED June 15, 1956). The present article gives extensive experimental results on the effects of the geometry, winding direction, winding connections, and operating modes on the performance of the traveling-wave tube as an oscillator.

MEASUREMENT

Waveguide Methods for High-Temperature Measurement of Dielectric Properties of Materials, V. I. Aksenov, M. Ia. Borodin (9 pp, 6 figs).

The open-circuit method is used to determine the dielectric properties of materials at a wavelength of 3.2 cm in the 20–200° range. Equations are derived for ϵ' and ϵ'' ($\epsilon^\circ = \epsilon' - j\epsilon''$) and the temperature dependence of ϵ' and $\tan \delta$ of several polymers is obtained from the measurements and these equations.

Fig. 4 shows the block diagram of the test setup, while Fig. 5 shows a waveguide section used in the measurement.

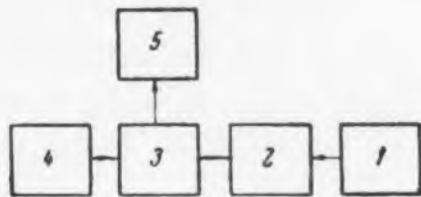


Fig. 4. Block diagram of test setup. 1—oscillator, 2—decoupling attenuator, 3—slotted line, 4—electrically-heated waveguide section, 5—amplifier.

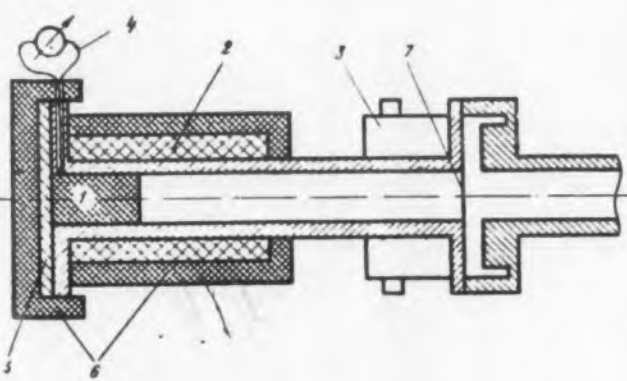


Fig. 5. Waveguide section. 1—specimen of dielectric, 2—electric heating coil, 3—cooling jacket, 4—thermocouple, 5—short-circuiting plate, 6—thermal insulation, 7—styroflex film.



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Russian Translations

RADIO ENGINEERING AND ELECTRONICS, Cont.

New Measurement Method for the Parameters of Magnetized Ferrites at Centimeter Waves, V. N. Vasil'ev, (17 pp, 14 figs).

A ferrite specimen in the form of a slab is inserted in the center section of a rectangular cavity. The mode and direction of the constant magnetic field are varied to make the resonant frequency and the Q of the cavity depend only on one or two unknown parameters (such as the complex dielectric constant or the permeability tensor), which are then calculated from the changes in the frequency in the resonator Q.

The method is applicable in the 0.8–20 cm range. The necessary equations are derived and experimental results are given for several ferrites. The real components of the permeability tensor and of the dielectric constant are obtained with an accuracy of 3 per cent. The accuracy of the imaginary components depends on the losses and ranges from 7 to 30 per cent (the accuracy increases with the losses.)

MISCELLANEOUS

Systems with Centrifugal-Electrostatic Electron-Beam Focusing, Z. S. Chernov (7 pp, 11 figs).

Describes a new electrostatic electron-beam shaping and focusing system, with the electrons moving in a spiral orbit within the beam. The new system eliminates many of the shortcomings of the usually-employed solenoids or permanent magnets such as high power consumption, heavy and cumbersome magnetic systems, the need for precise tuning, and short life.

Based on the stable motion of electrons in the field of cylindrical capacitor, the Institute of Radio Engineering and Electronics of the USSR Academy of Sciences developed new travelling-wave or double-helix tubes (called "spiratrons") employing this new system and requiring no magnetic focusing.

Figs. 6 and 7 show two types of electron guns to produce a spiralling electron beam. In Fig. 6 the electron beam is shaped into a ribbon and enters the space between two coaxial cylinders at an angle. The inner cylinder is at a higher potential than the outer one. The electrons leave the cathode with both axial and tangential velocity components, and when the centrifugal force is balanced by the electrostatic field strength, they move in spiral trajectories.

In Fig. 7 an annular cathode is contained between cylindrical focusing electrodes, and a cylindrical anode is placed in front of the cathode. Since all

electrodes have spiral cross sections, the electrons leaving the cathode acquire an initial angular momentum and form a solid tubular beam with spiral trajectories upon entering the field of the cylindrical capacitor.

Two spiratron prototypes are illustrated in Figs. 8 and 9. Experimental data are given on their focusing properties and on their high-frequency behavior.

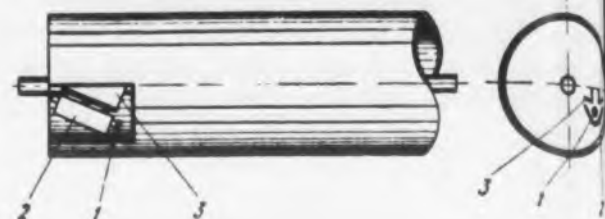


Fig. 6. Centrifugal electrostatic focusing system with flat gun 1—cathode, 2—focusing electrode, 3—anode.

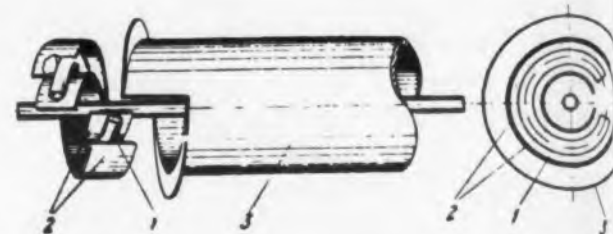


Fig. 7. Centrifugal electrostatic focusing system with spiral gun 1—cathode, 2—focusing electrode, 3—anode.

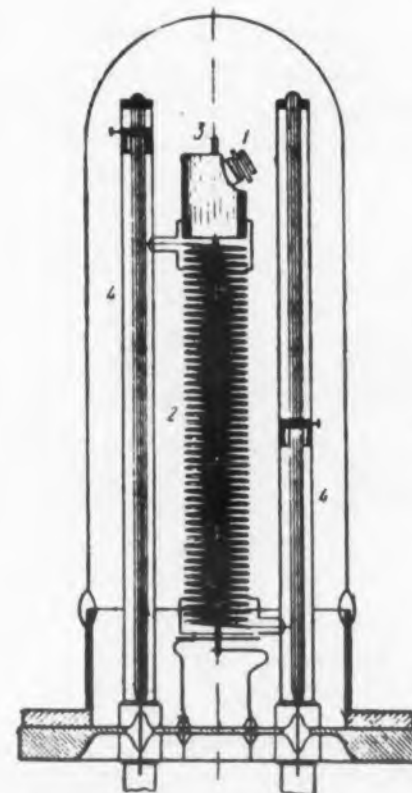


Fig. 8. Demountable construction of travelling wave type spiratron (100-300 mc) 1—electron gun, 2—helix, 3—focusing rod, 4—coaxial lines.

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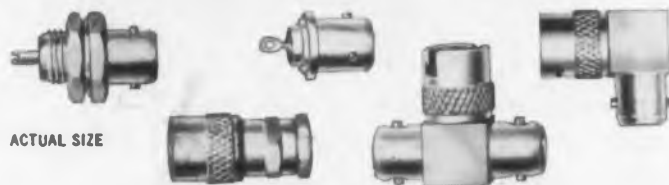
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Fig. 9. Construction of double spiral spiratron (tested at 100-300 mc). 1—electron gun, 2—entrance spiral, 3—exit spiral, 4—drift tube, 5—focusing rod.

Reception of Pulses of Arbitrary Waveform with Super-regenerative Receiver, L. R. Lavich, (9 pp, 9 figs).

The principle of superregeneration has been in use for more than 30 years, yet many of its theoretical aspects still remain to be explained. This pertains in particular to non-stationary processes which have lately come into prominence by virtue of the use of superregeneration for pulse reception. The author uses the slowly-varying amplitude method to analyze reception of pulses of any waveform with a superregenerative receiver having a separate heterodyne. It is shown that the pulse area can serve as a criterion of the effectiveness of pulses of different waveforms and durations.

ELECTRICAL COMMUNICATIONS

(Contents of *Elektrosviaz'* No. 11, 1956)

RADIO RELAY

Type FN-675 Radio Relay Apparatus, N. N. Kamenki, (10 pp, 5 figs).

Description of a French (CSFR) system, capable of handling up to 6 trunks, each accommodating 600 telephone channels or one TV (video plus audio) channel over distances up to 2000-3000 km.

Choice of Standby System of Radio Relay Lines, V. V. Petrov, M. V. Brodski, V. D. Shoshenkov, (9 pp, 4 figs).

Probability-theory aspects of square channels and of automatic switching.

NEGATIVE FEEDBACK

Modulation Negative Feedback in Radio Transmitter Installations, V. A. Khatskelevich, L. M. Shur, (10 pp, 5 figs).

A thorough discussion of the factors that limit the amount of feedback that can be used in transmitter circuits. The rigorous treatment is based on Bode's theories.

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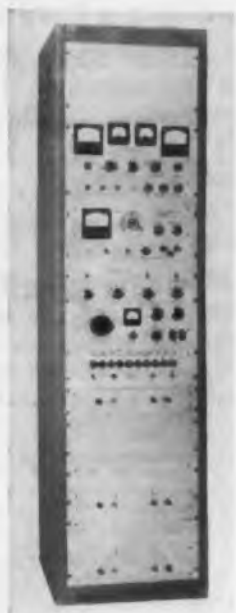
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Russian Translations

Electrical Communications (continued)

PULSE SYSTEMS

On the Theory of Linear Pulse Systems with Variable Parameters, G. P. Tartakovski, (12 pp, 2 figs).

Introduces the concept of a time-dependent transfer function of a pulse system with variable parameters. Shows, in analogy with the constant-parameter case, that this function yields the response of the system to any pulse sequence. Treats variable parameters of the linear portion of the system, variable sequence periods, and variable pulse durations. Gives examples of communication systems and elements normally subjected to pulse sequences. Refers to Zadeh's "Frequency Analysis of Variable Networks," Proc. IRE 38, No. 3, 1950, and "Time-Dependent Heaviside Operators," J. Math. & Phys. vol. 30, No. 2, 1951.

INTERFERENCE

Prevention of Interference in Steel Conductors from Other Steel Conductors or from Toll Lines, P. K. Akul'shin, (8 pp, 1 fig).

Continuation of work by the same author, reported in the January and April 1956 issues of *Elektrosviaz'* (*ED* May 15, and November 1, 1956).

MISCELLANEOUS

"Calculation of Errors Introduced by Speed Differences in Telegraph Start-Stop Apparatus," N. B. Zeliger, (13 pp, 8 figs, 1 table).

"Conditions under which Communication Aerial and Cable Lines can Parallel High-Voltage DC Transmission Lines," M. I. Mikhailov, K. K. Nikol'ski, (11 pp, 10 figs). (The Russians are planning power transmission at 400-800 kvdc. The inductive interference of the dc ripple with low frequency communication lines is therefore of more than theoretical interest.)

"Concerning the Mechanism of Communication-Line Loss under Icing Conditions," I. M. Metter, (2 pp, 2 tables).

AUTOMATION AND TELEMCHANICS

(Contents of *Avtomatika i Telemekhanika* No. 12, 1956)

SERVO SYSTEMS

Investigation of the Steady State of Pulse Servo Systems, Ia. Z. Tsyppkin, (13 pp, 10 figs).

Pulse servo systems are frequently used to convert discrete (digital) data into a continuous (analog)



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function, i.e., to interpolate between adjacent discrete values. To minimize the steady-state error it is necessary to improve on the customary straight-line interpolation, using suitable interpolating functions or polynomials (see Porter, Stoneman, and Lowden, "A New Approach to the Design of Pulse-Monitored Servosystems," Proc. IRE, part II, vol 97, 1950). The author gives an analytic expression for the steady-state error and discusses the transfer functions of a simple suitable system.

On the Theory of Nonlinear Solution Elements Employing Piecewise-Linear Approximation, B. Ia. Kogan, (11 pp, 7 figs).

Diode functional converters, described in an article by Talantsev in the February 1956 issue of *Avtomatika i Telemekhanika* (ED August 1, 1956) are used in conjunction with a solution (operational) amplifier to approximate a variety of nonlinear functions. The article derives some fundamental relationships for a solution amplifier employing stepwise-linearized nonlinear conductances. The relationships obtained between the slope of the original non-linear function and the slopes of the current curves of diode networks connected both in the amplifier input and in the external feedback loop. Several methods of synthesizing functional converters employing diodes are given.

The methods given make it possible to reduce the errors inherent in the functional converter and make it possible to reproduce a greater variety of functions. The article also shows how the current characteristics of the diode circuits can be plotted.

MEASUREMENT

Regenerative Measuring Transmitters, L. L. Dekabrun, (9 pp, 12 figs, 1 table).

Regenerative transmitters are vacuum-tube oscillators used to measure, say, small variations in conductivity of semiconductors by determining the change such a semiconductor introduces in the Q of the oscillator tuned circuit. A theoretical analysis of such a circuit is given, and some experimental installations are described. Reference is made to work by Trott (*Journal of Scientific Instruments*, No. 7, 1952) and Malling (*Electronics*, April 1953).

Other Articles In This Issue

"Electronic Flow Meter," D. A. Agaikin, A. A. Desova (4 pp, 7 figs). (Description of two types of electromagnetic flow meters for conducting liquids. Refers to several American designs.)

"Coding of Remote-Control Signals by Using Pulse Identification," M. A. Gavrillov, (22 pp, 18 figs). (Abstract switching theory.)

"Investigation of a Turbine-Drilled Well as an Object of Regulation," Ia. B. Kadymov, (11 pp, 8 figs).

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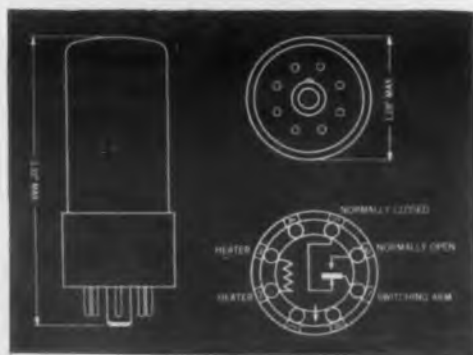
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German Abstract

Feedback

THE ADVANTAGES of feedback which are realized with vacuum tube circuits are also achieved in transistor circuits; i.e. stability and flexibility of input and output impedance values are possible. A systematic analysis of four basic resistance-feedback arrangements yield general results which can be of value to the designer.

In Fig. 1, four basic feedback circuits are shown. The calculations are particularly simple if the circuit description of the transistor is selected to suit each type of connection.

For Fig. 1a choose

$$v_1 = r_{11}i_1 + r_{12}i_2$$

$$v_2 = r_{21}i_1 + r_{22}i_2$$

For Fig. 1b choose

$$i_1 = y_{11}v_1 + y_{12}v_2$$

$$i_2 = y_{21}v_1 + y_{22}v_2$$

For Fig. 1c choose

$$v_1 = h_{11}i_1 + h_{12}v_2$$

$$i_2 = h_{21}i_1 + h_{22}v_2$$

For Fig. 1d choose

$$i_1 = g_{11}v_1 + g_{12}i_2$$

$$v_2 = g_{21}v_1 + g_{22}i_2$$

The quantities of interest are the voltage gain, β ;

the current gain α ; the input resistance R_e ; and the output resistance R_a . In addition, assuming that the input terminals are fed from a source of resistance R_Q and the load resistance is R_L , optimum values of input and output resistance are defined as those values which match source and load resistance respectively. (These optimum values result in maximum power gain.)

The results of the analysis are summarized in Table I. The notation used in this tabulation uses the superscript zero with reference to a quantity with feedback. In addition

R_{ek} = input resistance with shorted output terminals

R_{ak} = output resistance with shorted input

α_k = current gain with shorted output

R_{a1} = output resistance with open input

$r_0 = r_{11} + r_{22} - r_{12} - r_{21}$, other zero subscripts have analogous meaning.

Graphically these results are presented (qualitatively) in Fig. 2. The various significant ratios of characteristic value with feedback to value without feedback are shown (not on a linear scale) for the emitter connection. (Abstracted from an article by W. Glaser, *Nachrichtentechnik*, Vol. 7, No. 4, April 1957, pp. 159-162.)

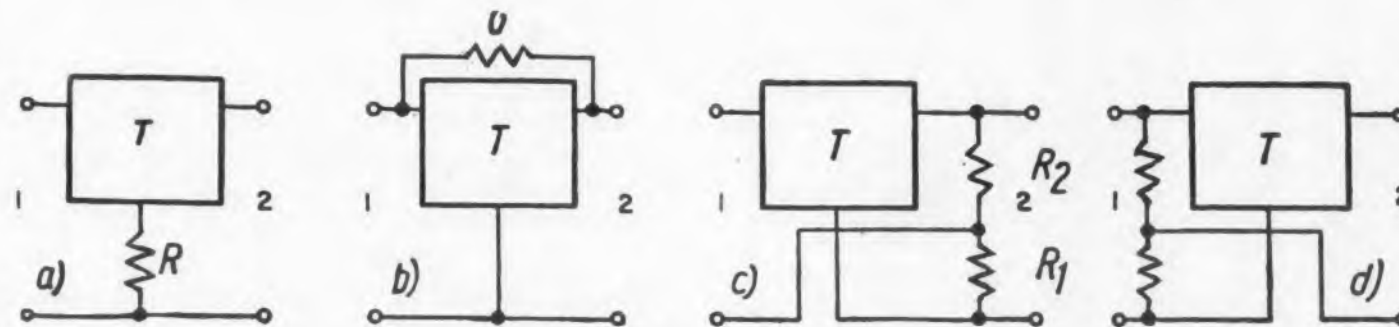


Fig. 1. Four basic feedback circuits: a) Series feedback b) Parallel feedback ($G = 1/R$) c) Series-Parallel feedback [$R_1 = k(R_1 + R_2)$] d) Parallel-Series feedback.

Transistor Circuits

E. Brenner

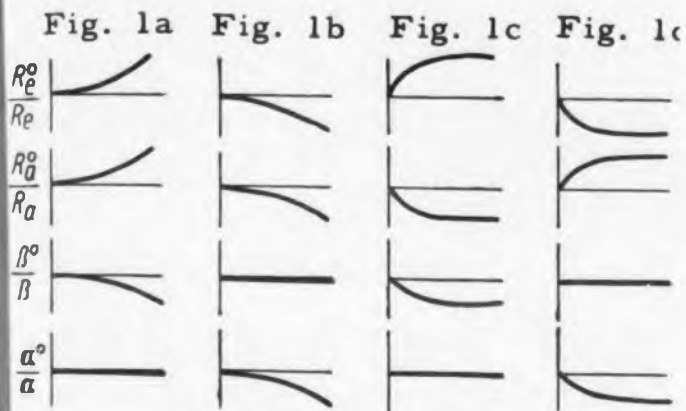


Fig. 2. Variation of parameters for the different connections.

Table 1. Characteristic values of the four types of transistor feedback circuits.

	Fig. 1a	Fig. 1b	Fig. 1c	Fig. 1d
a^0	$\frac{a_k R_{al} - R}{R_L + R_{al} + R}$	$\frac{a}{R_{ek}} - G$ $\frac{1}{R_{ek} + G + R_L \left(\frac{1}{R_{ek} R_{al}} + y_0 G \right)}$	$\frac{a_k + k}{1 + \frac{R_L}{R_{al}} + \frac{R_L}{R}}$	$\frac{a_k \frac{R_{ak}}{R_{ek}} + k}{\left(\frac{1}{R_{el}} + \frac{1}{R} \right) R_L + \frac{R_{ak}}{R_{ek}} + k y_0}$
β^0	$\frac{R_L (a_k R_{al} - R)}{R_L (R_{el} + R) + R_{ek} R_{al} + r_0 R}$	$\frac{R_L \left(\frac{a_k}{R_{ek}} - G \right)}{1 + R_L \left(\frac{1}{R_{ak}} + G \right)}$	$\frac{R_L (a_k + k)}{R_{ek} + R(k - k^2) + R_L \left(\frac{R_{ek}}{R_{ak}} + k h_0 \right)}$	$\frac{R_L \left(a_k \frac{R_{ak}}{R_{ek}} + k \right)}{R_L + R_{ak} + R(k - k^2)}$
R_e^0	$\frac{R_L (R_{el} + R) + R_{ek} R_{al} + r_0 R}{R_L + R_{al} + R}$	$\frac{1 + R_L \left(\frac{1}{R_{ak}} + G \right)}{\frac{1}{R_{ek}} + G + R_L \left(\frac{1}{R_{ek} R_{al}} + y_0 G \right)}$	$\frac{R_{ek} + R(k - k^2) + R_L \left(\frac{R_{ek}}{R_{ak}} + k h_0 \right)}{1 + \frac{R_L}{R_{al}} + \frac{R_L}{R}}$	$\frac{R_L + R_{ak} + R(k - k^2)}{\left(\frac{1}{R_{el}} + \frac{1}{R} \right) R_L + \frac{R_{ak}}{R_{ek}} + k y_0}$
$R_e^{0 \text{ opt}}$	$\frac{R_{el} + R}{R_{al} + R} (R_{ek} R_{al} + r_0 R)$	$\frac{\frac{1}{R_{ak}} + G}{\frac{1}{R_{ek}} + G} \frac{1}{R_{ek} R_{al} + y_0 G}$	$\frac{R_{ek} + R(k - k^2) \left(\frac{R_{ek}}{R_{ak}} + k h_0 \right)}{\frac{1}{R_{al}} + \frac{1}{R}}$	$\frac{R_{ak} + R(k - k^2)}{\frac{1}{R_{el}} + \frac{1}{R}} \frac{1}{\frac{R_{ak}}{R_{ek}} + k y_0}$
R_Q^0	$\frac{R_Q (R_{al} + R) + R_{ek} R_{al} + r_0 R}{R_L + R_{el} + R}$	$\frac{1 + R_Q \left(\frac{1}{R_{ek}} + G \right)}{\frac{1}{R_{ak}} + G + R_Q \left(\frac{1}{R_{ek} R_{al}} + y_0 G \right)}$	$\frac{R_{ek} + R(k - k^2) + R_Q}{\frac{R_{ek}}{R_{ak}} + k h_0 + R_Q \left(\frac{1}{R_{el}} + \frac{1}{R} \right)}$	$\frac{R_{ak} + R(k - k^2) + R_Q \left(\frac{R_{ak}}{R_{ek}} + k y_0 \right)}{1 + R_Q \left(\frac{1}{R_{el}} + \frac{1}{R} \right)}$
$R_{a \text{ opt}}^0$	$\frac{R_{al} + R}{R_{el} + R} (R_{ek} R_{al} + r_0 R)$	$\frac{\frac{1}{R_{ek}} + G}{\frac{1}{R_{ak}} + G} \frac{1}{R_{ek} R_{al} + y_0 G}$	$\frac{R_{ek} + R(k - k^2)}{\frac{1}{R_{al}} + \frac{1}{R}} \frac{1}{\frac{R_{ek}}{R_{ak}} + k h_0}$	$\frac{R_{ak} + R(k - k^2) \left(\frac{R_{ak}}{R_{ek}} + k y_0 \right)}{\frac{1}{R_{el}} + \frac{1}{R}}$

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Standards and Specs

Sherman H. Hubelbank

Connectors

MIL-C-3989, CONNECTORS, COAXIAL, RADIO FREQUENCY, AND ASSOCIATED FITTINGS, SERIES C, 14 MARCH 1957

This spec covers weatherproof series C connectors, having a nominal impedance of 50 ohms, and associated fittings. Qualification inspection is not required. Supplement 1 references the following connectors which are part of this spec: Plug UG-709A/U; Receptacle UG-704/U; Plug UG-707A/U; Right-Angle Plug UG-710A/U; Plug UG-711A/U; Plug UG-708A/U; Bulkhead Receptacle UG-706/U; Bulkhead Adapter UG-701/U; and Bulkhead Receptacle UG-705/U.

IEC PUBLICATION 83, STANDARDS FOR PLUGS AND SOCKET OUTLETS FOR DOMESTIC AND SIMILAR GENERAL USE

This 32-page publication gives the dimensions of plugs and outlets for three electrical systems throughout the world. These three systems are: standards approved by ASA and used in Canada and the United States; standards of the British Standards Institution and used in India and the United Kingdom; and standards of the International Commission on the Rules for the Approval of Electrical Equipment and used in Belgium, Denmark, France, Germany, Italy, Japan, The Netherlands, Norway, and Sweden. Copies of this publication may be obtained for \$2.40 from ASA, 70 East 45 Street, New York 17, N.Y.

Resistors

MIL-R-19A, RESISTORS, VARIABLE, WIREBOUND (LOW OPERATING TEMPERATURE), GENERAL SPECIFICATION FOR, 9 NOVEMBER 1956

Style RA10 has been added. It is a miniature type with a body diameter of 3/4 inch and is rated at 1 watt. Style RA25 has been deleted. The three styles, RA10, RA20, and RA30 are specified on detailed Military Specification Sheets MIL-R-19/1, 2, 3 respectively. Resistance tolerance of ±5% has been deleted, and only a tolerance of ±10% is now specified. Round shafts have been deleted. The number of flatted-shaft lengths has been reduced to one-2 1/2 inches. A moisture resistance test has been added to replace the humidity test. Low-temperature operation, low-temperature storage, acceleration, shock, and high-frequency vibration tests have been added. This spec supersedes JAN-R-19 and Amendment 7 thereto.

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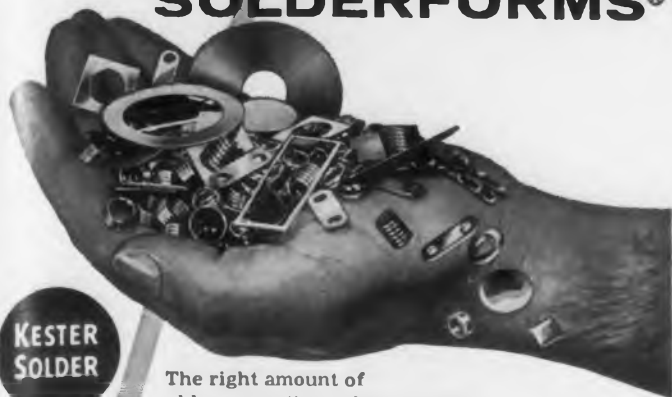
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American Standards

American Standards Association has announced that the following standards have been recently released or approved:

ELECTRICAL TERMS, DEFINITIONS OF, GROUP 35, TRANSMISSION AND DISTRIBUTION, C42.35-1957

ELECTRICAL TERMS, DEFINITIONS OF, GROUP 65, COMMUNICATIONS, C42.65-1957

METHODS OF MEASUREMENT OF PULSE QUANTITIES, C16.28-1956

COLOR CODING FOR NUMERICAL VALUES OF COMPONENTS FOR ELECTRONIC EQUIPMENT, C83.1-1956

NOMENCLATURE AND DIMENSIONS FOR PANEL MOUNTING RACKS, PANELS, AND ASSOCIATED EQUIPMENT, C83.9-1956

REQUIREMENTS FOR RECTANGULAR WAVEGUIDES, C83.10-1956

REQUIREMENTS FOR METAL-ENCASED FIXED PAPER DIELECTRIC CAPACITORS FOR D-C APPLICATION, C83.11-1956

REQUIREMENTS FOR CABLE CONNECTORS FOR AUDIO FACILITIES FOR RADIO BROADCASTING, C83.12-1956

REQUIREMENTS FOR WIRE-WOUND POWER-TYPE RHEOSTATS, C83.13-1956

REQUIREMENTS FOR RIGID COAXIAL TRANSMISSION LINES—50 OHMS, C83.14-1956

REQUIREMENTS FOR ELECTROLYTIC CAPACITORS (FOR USE PRIMARILY IN TRANSMITTERS AND ELECTRONIC INSTRUMENTS), C83.15-1956

Indicators

MIL-L-3661, LAMP HOLDERS AND LIGHTS, INDICATOR; BAYONET BASE, MINIATURE AND CANDELABRA, AMENDMENT 2, 19 MARCH 1957

The type designation letter for jewel lens D now designates plain, polaroid dimmer. A new letter designation M has been added to cover the plain, shutter dimmer type. Requirements for solder-lug wiring terminals have been added. Additional requirements have been established for packaging and metal parts. Three MS sheets have been revised.

RETMA Standards Proposals

The following Standards Proposals are being circulated by RETMA for standardization approval:
S.P. 537, MICROWAVE TOWERS
S.P. 538, MECHANICAL CHARACTERISTICS FOR MICROWAVE ANTENNAS AND PASSIVE REFLECTORS
S.P. 539, RECOMMENDED PRACTICE FOR PREPARATION OF OUTLINE DRAWINGS OF ELECTRON TUBES AND BASES (REVISION TO RETMA ET-102-B)
S.P. 540, DESIGNATION SYSTEM FOR CATHODE RAY TUBES (REVISION TO RETMA ET-111-A)

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SO. NORWALK, CONN.

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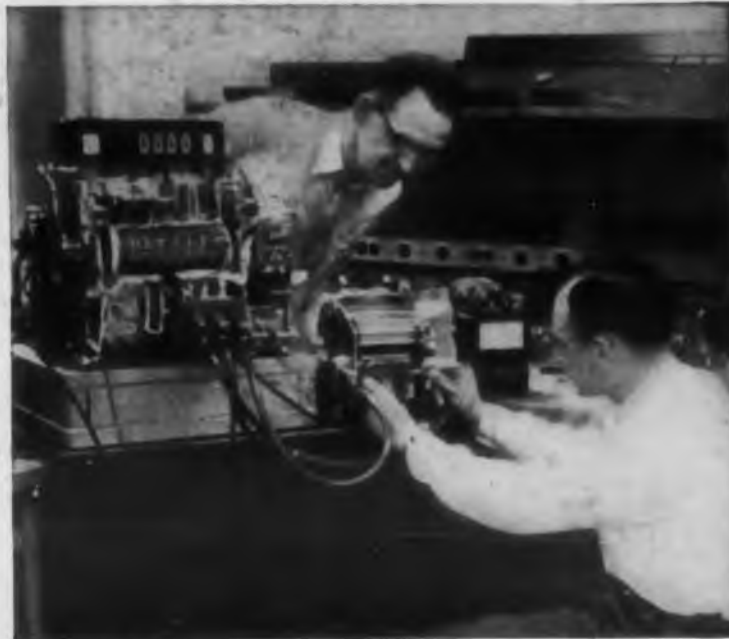
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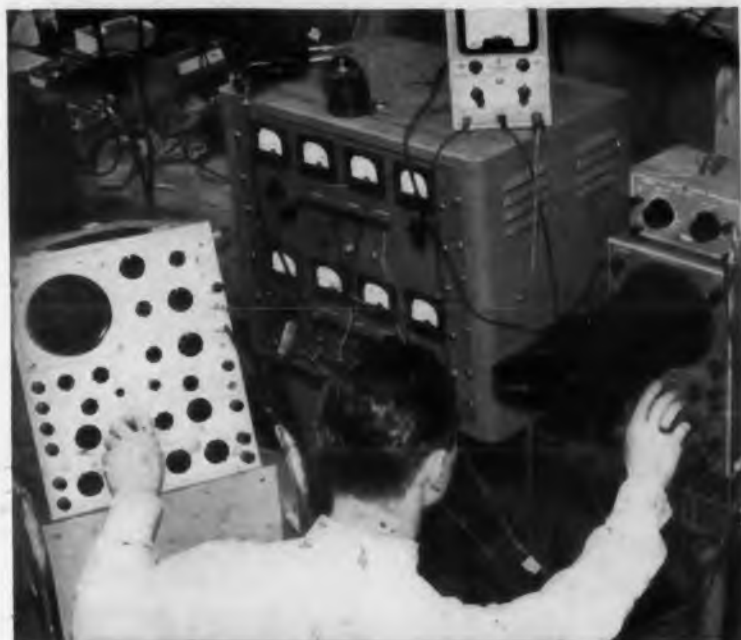
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MECHANICAL ENGINEERS are using their skills in the design and development of new mechanisms required for business machines and for those mechanical products which are associated with electronic data processing equipment.



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ELECTRONIC DESIGN • July 15, 1957

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Ryan needs all types of Electronics Engineers, Designers, Analysts, Specialists. Invest in your future—act now—write to James Kerns, Engineering Division — Ryan Aeronautical Company, 2708 Harbor Drive, San Diego 12, California.



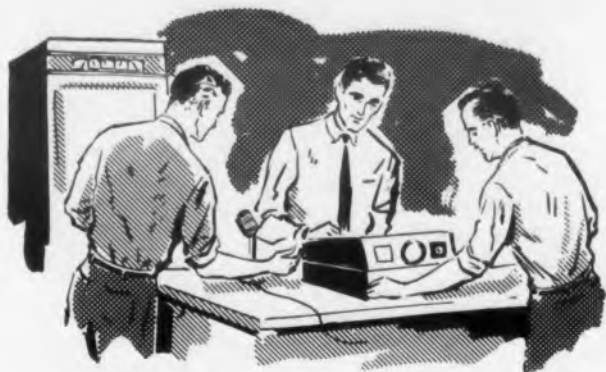
RYAN AERONAUTICAL COMPANY

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ELEC

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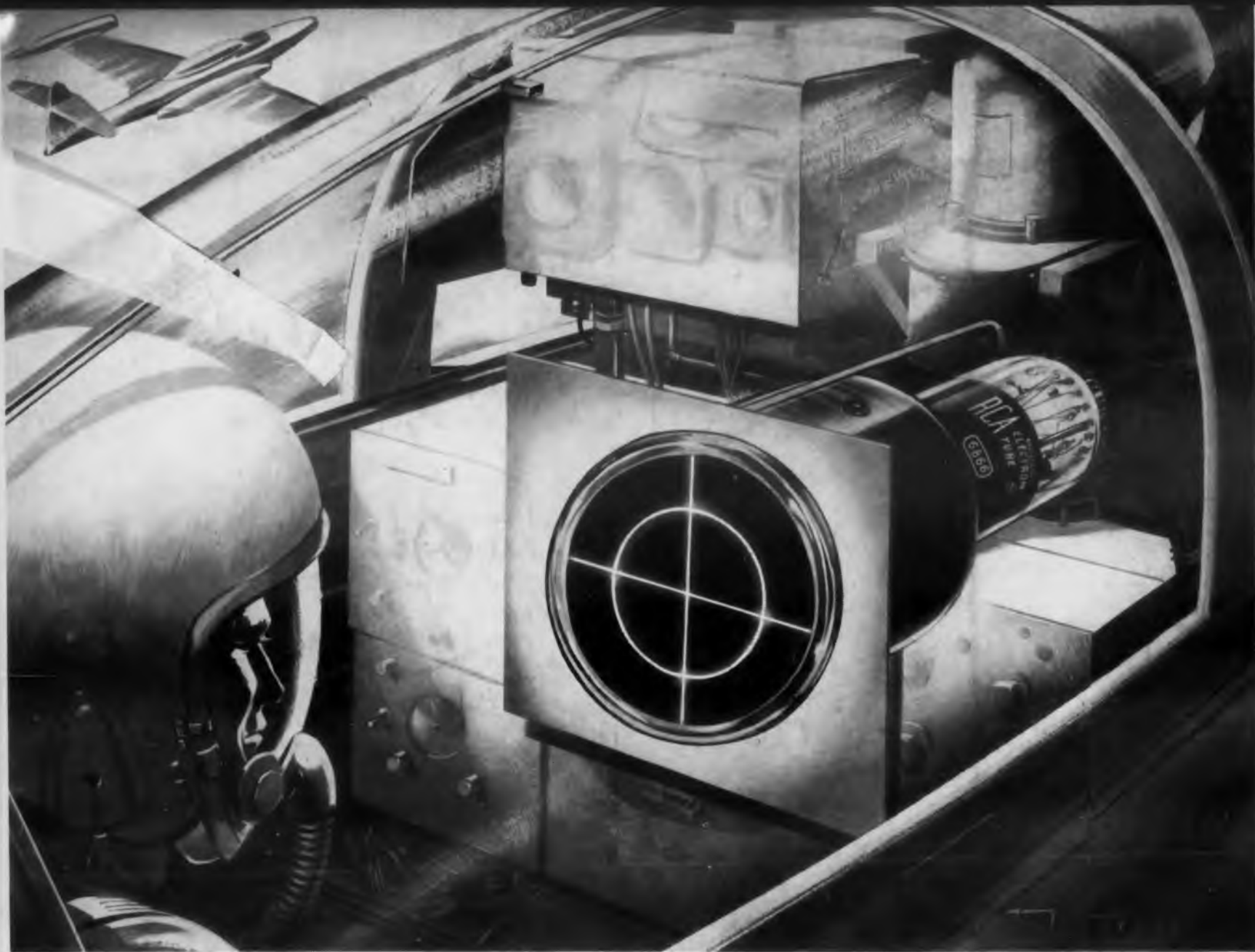
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- 6 7 Voltage or Current Ranges
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Model 204A Price \$325.00

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He "reads" his radar data...

IN BRIGHT DAYLIGHT

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For technical bulletin on the 6866, write RCA, Commercial Engineering, Section G-18 Q-2, Harrison, N. J. For sales information on this and on other RCA display storage tubes now in development...contact the RCA Field Office nearest you.

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