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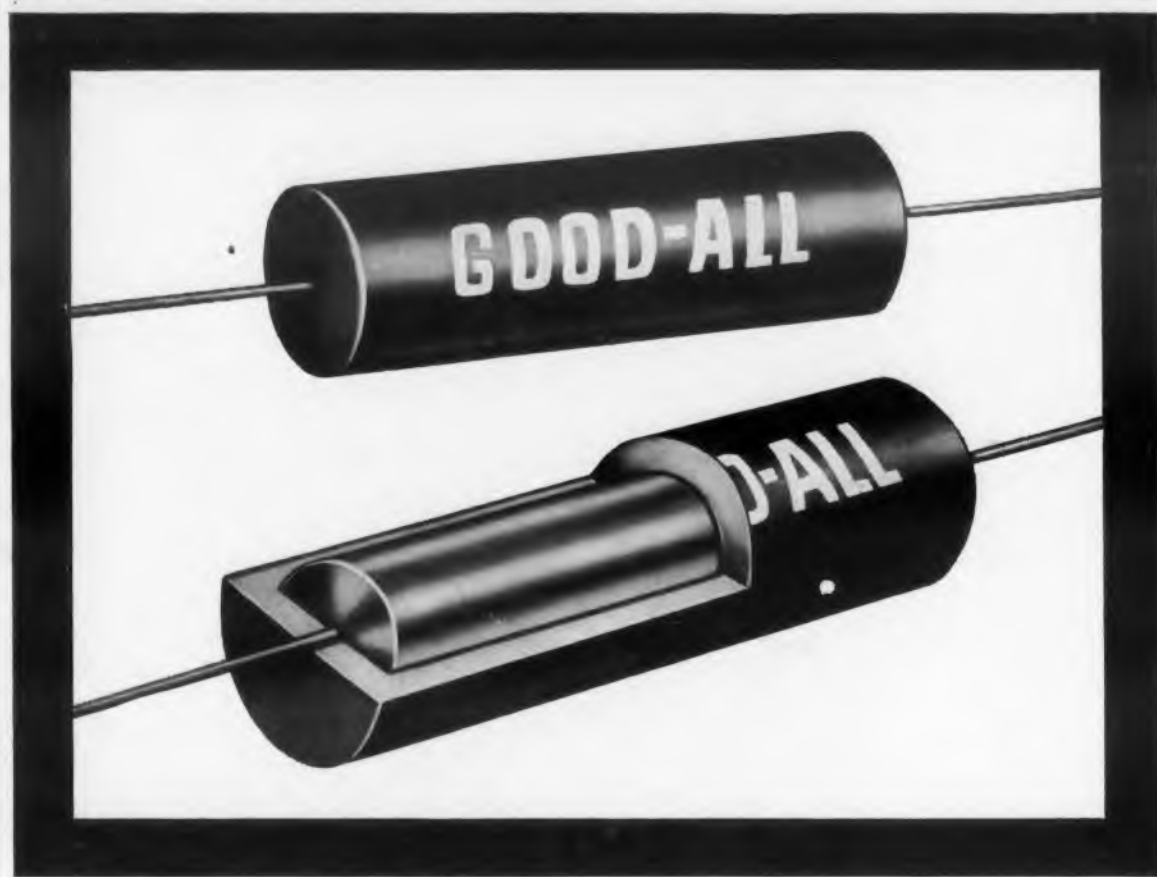
Vibration Resistant Balanced Potentiometer ... page 28

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EPON® RESIN does it!

Improved GOOD-ALL capacitors have low leakage, high stability—even in extremely humid climates



Here's how:

EPON RESIN is helping to set new standards of excellence in a line of 600 UE capacitors made by Good-All Electric Manufacturing Company, Ogallala, Nebraska.

Good-All reports that Epon resin offers superior moisture resistance . . . far better humidity protection than obtained with

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ferred because they offer an almost ideal combination of electrical and physical properties.

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CIRCLE 1 ON READER-SERVICE CARD



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EPA

NBP

BIG NEWS...IN SEALED

THERMOSTATS!

G-V's Series C8 is Undamaged By 150 G Shock, Vibration up to 2000 Cycles, Exposure to -100°F. and +300°F.

This new series of electrical thermostats is specially designed to meet the difficult operating conditions of electronic and aircraft applications. Operating points, regardless of setting, are not changed by exposure to temperatures from -100°F. to +300°F. Shocks up to 150 G for 3 milliseconds, vibration of 25 G up to 1000 cps, and vibration of 10 G up to 2000 cps do not damage these thermostats or change their setting.

Hermetically Sealed But Rapid in Response

Sealed in a metal shell which is also its sensing element, the G-V Series C8 Thermostat responds as rapidly as a laboratory thermometer. Temperature settings may be made at the factory or by the user. Contacts are rated at 5 amps. 115 volts AC, or 3 amps. 28 volts DC, non-inductive load. Differential is about 1°F. Insulation test is 1250 v. between circuit and shell, and insulation resistance is over 100 megohms. These thermostats are suitable for direct control of heaters and for over-temperature and under-temperature indication, alarm, or cut-off.

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Convenient Mounting Forms**

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for Bulletin with complete technical and application data.



G-V

G-V CONTROLS INC.

18 Hollywood Plaza • East Orange, N. J.



CIRCLE 2 ON READER-SERVICE CARD

Allied's New MHJ Relay Built for Shock and Vibration

10-55 cps at 0.125 inch double-amplitude • 55-2000 cps at 20g

Here are the facts:

Contact Ratings:

Low level up to 2 amperes non-inductive or 1 ampere inductive at 29 volts d-c or 115 volts a-c

Contact Arrangements:

MHJ-12D: 4 PDT
MHJ-18D: 6 PDT

Temperature:

Minus 65°C to plus 125°C

Vibration:

10-55 cps at 0.125 inch double-amplitude
55-2000 cps at 20g

Operating Shock: 100g

Altitude:

Sea level to 80,000 feet

Weight:

MHJ-12D: 3.0 ounces
MHJ-18D: 4.2 ounces

Insulation:

1000 megohms minimum

Dielectric Stress:

1000 volts rms at sea level;
450 volts rms at 70,000 feet

Initial Contact Resistance:

.03 ohms maximum at .01 to 2 amps

Operate Time:

15 milliseconds or less
at rated voltage at 25°C

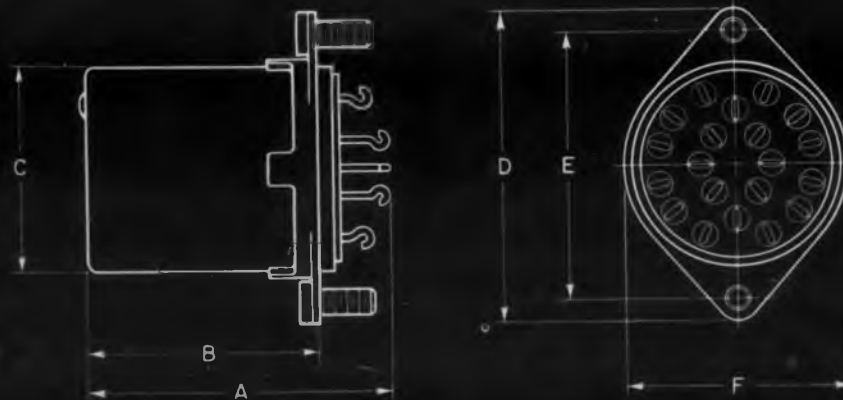
Release Time:

5 milliseconds or less
at rated voltage at 25°C

ACTUAL
SIZE



Type
MHJ



MOUNTING = 6-32 NC-2A THD. (2) STUDS

	A	B	C	D	E	F
MHJ-12D (4 Pole)	1 3/4 max.	1 3/16	1 3/4	1 2 1/32	1.406	1 1/8
MHJ-18D (6 Pole)	1 3/4 max.	1 3/16	1 3/16	1 1 1/16	1.562	1 1/4

Editorial

Sputnik Should Spark Translations

In March 1 of 1956 we ran an abridged translation of a Russian article on a telemetering system. Eighteen months and two Sputniks later we get an urgent plea for advice on how to get a complete translation. Although requests for information or full translations has stepped up recently, we can't report that our translator has been any busier.

Few people want to pay the necessary \$50 to \$100 to get a complete translation. The common excuse: "They couldn't possibly have anything important enough . . ."

Now that we can't ignore the competition, it's still easy to pass the buck to the Defense Department. But does all moral responsibility for assuring our fitness to protect the free world rest with the Government? We think every free man has an obligation.

We recommend a double front for keeping armored against ignorance.

1. A government translation program comparable to the USSR's.

2. The assuming of individual responsibility, to keep abreast of the best in engineering.

Unfortunately, our government does nothing comparable to the USSR in communicating technical information. It is no secret that the Soviet has a central translation agency set up to feed their technical personnel American reports. The numerous citations of U. S. articles and books in their technical articles prove they read us.

As we have reported, MIT will soon translate electronic journals with National Science Foundation financial aid. But plans for the future are not enough. We recommend a crash program now to survey all Soviet articles, books, and reports. If our experts are in the know, we're not aware of it. It seems unreasonable, let alone uncomfortable, to realize that our policy is reshaped only after Tass sends out news releases. *In the next issue we'll talk about individual responsibility.*

-J.A.L.

◀ CIRCLE 3 ON READER-SERVICE CARD



ALLIED CONTROL



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

Engineering Review

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

Photolithographic Transistor

A transistor small enough to fit in a hole drilled in a printed circuit board has been shown by the Diamond Ordnance Fuze Laboratory, Washington 25, D. C. This transistor, produced by use of photolithographic fabrication techniques, permits a transistor to become an integral part of a printed circuit.

Tests have shown that the transistor is relatively stable, and one experimental model was operated to an alpha cutoff of 15 mc.

In their paper, presented at the IRE-PGED conference, Washington, D. C., James R. Nall and Jay W. Lathrop, outlined the basic constructional methods employed in the production of this transistor.

Diffused germanium blanks 45 mils square and ten mils thick are coated with a photosensitive resist, masked, exposed to ultra-violet light and developed; leaving a bare rectangular

area of germanium. Aluminum emitter material is evaporated and deposited over the layer of resist. When the underlying resist is chemically stripped away, the aluminum remains only on the rectangular area. Resolution equivalent to mechanical masking can be achieved by this process. The aluminum emitter is alloyed to the germanium blank by annealing it in a high-temperature hydrogen atmosphere.

A base contact of similar shape is formed next to the emitter, by the same photolithographic process. However, in this case the contact is electrolytically deposited gold on the surface of the germanium, rather than on the resist. This gold contains a small percentage of antimony, and is deposited only on the clean germanium surface, and there is no necessity to strip the resist before alloying. The gold alloying takes place at a lower temperature than the

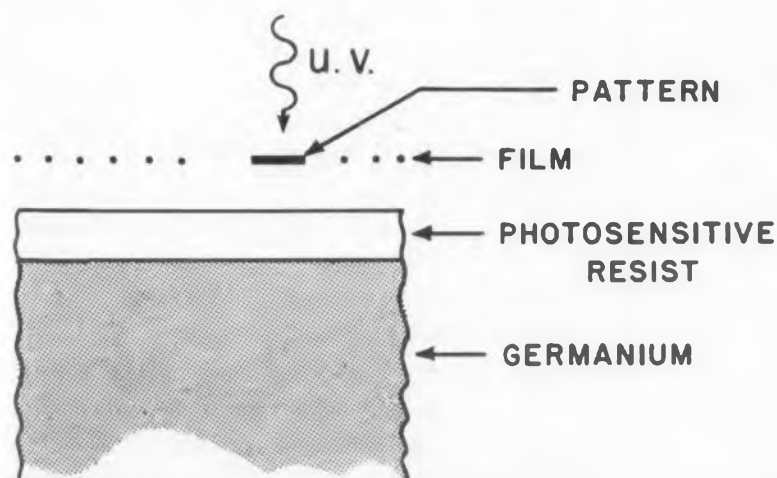
aluminum alloying, thus leaving the emitter undisturbed. The collector base junction is defined by etching away the germanium except in the vicinity of the emitter and base contacts. This provides a pedestal for the collector-base.

At this point it is possible to produce leads to the emitter and base by placing a coat of photoresist over the finished transistor leaving bare only the areas above the emitter and base contacts. In some cases additional gold is electrolytically deposited in these areas to insure good contact at these points.

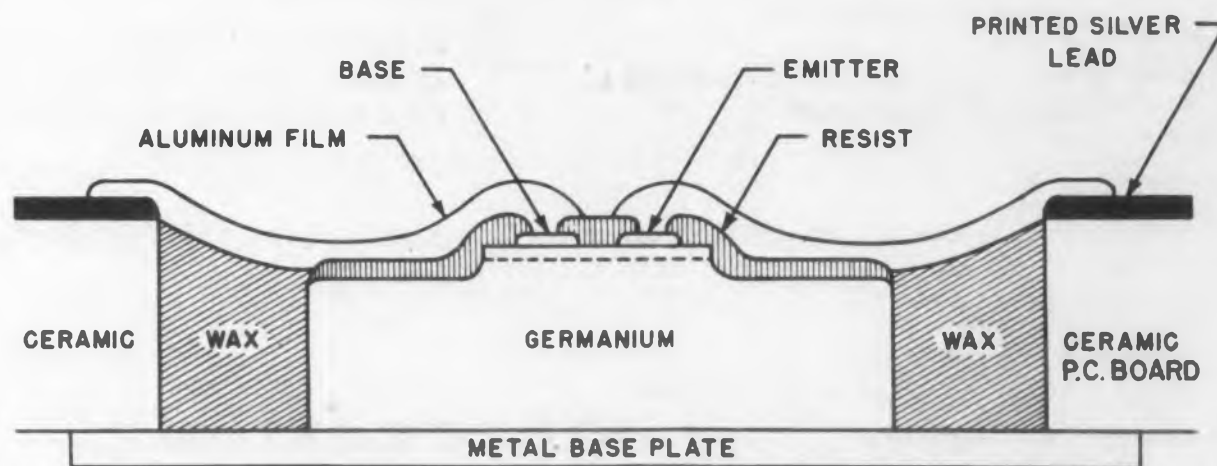
The transistor may then be soldered to a thin metal base plate and inserted into a hole in a ceramic printed circuit board. Any gap between the board and the transistor is filled with cement and this firmly attaches the transistor to the ceramic printed circuit board.

With relatively crude masking, aluminum leads are vacuum deposited to connect the printed wiring on the board with the contacts on the transistor pedestal. The leads which have

Arrow points to the transistor, shown actual size.



Photoresist is placed on the germanium surface, masked, exposed, and developed, leaving a bare rectangle of germanium.



A schematic diagram of the finished unit is shown. The aluminum leads a conductivity approximately equivalent to 0.0006 in. wire.



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Glass
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CIRCLE 4 ON READER-SERVICE CARD

Engineering Review

been used have a conductivity of approximately what might be found in half mil diameter wire.

Photoresist not only insulates the deposited leads from the germanium surface, but also protects the surface from contamination until the circuit or combination of circuits can be mounted and hermetically sealed.

A sample circuit shown to ED utilized these transistors in an audio amplifier. The device has operated for several weeks with excellent results and no deterioration could be detected.

A limitation of this particular transistor is the presence of lead capacitance. It is felt that the problem may be corrected by changes in the circuit design.

Photolithographic transistors can be produced in any shape. Transistor manufacturers might utilize the technique to produce complete circuits, as a single component.

The physical size of the device may permit the construction of devices in form requiring little space, replacing racks of equipment.

Polaris Missile Funds Tripled

Decision by the Navy to sharply increase development tempo on its high-priority fleet ballistic missile project, Polaris, was reflected today in the award of an expanded contract to the Lockheed Missiles, Sunnyvale, California.

Lockheed, missile system manager for the Polaris, has just been given a \$62.1 million contract extending the program work through fiscal year 1958. The new award more than triples the funding and considerably increases present Polaris program activity.

The Polaris—focal point of a new concept in U. S. defense strategy is being accelerated to bring it into the front line missile arsenal as rapidly as possible.

The Polaris, a weapon that will be virtually impossible to detect or destroy, will be the nation's first ballistic missile able to roam the world's oceans aboard specially equipped naval craft. The weapon's flexibility and mobility, unique to naval operations, will extend to great distances our defense perimeter and provide an important weapon as a deterrent to aggression. Because it is in ships at sea, an enemy's efforts to counter it will be drawn away from the continental U. S.



Rent-A-Radio: A unique two-way communications system, establishes the dispatch desk of the Dallas Hertz Rent-A-Car system as a radio message center for executives. Mobile radio equipment enables users of properly-equipped Hertz cars to keep in constant contact with their offices, homes, and friends. The Dallas system is described as a pilot installation and is the first of its kind in the nation. The equipment is licensed by the FCC in a radio band known as the Citizens' Radio Service.

If someone wishes to talk to the driver of a car, he dials the Hertz office telephone number and the Executive Service Operator relays the message to the vehicle by radio. If the driver wants to send a message, he merely picks up the handset in the car and calls the operator. A Hertz official said that all that is necessary to rent a car with two-way radio is the usual identification required for auto rentals.

Slide-Rule Correction!

Many readers have built the "do-it-yourself" slide-rule for filter design on page 43 of the October 1 issue and have expressed themselves as gratified at the results obtained.

Unfortunately, the example given contained inaccuracies. The paragraph entitled: "How to Read the Slide Rule" should have read:

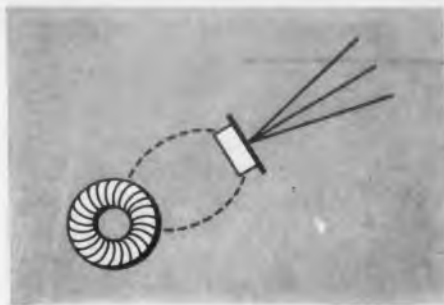
"For example, suppose a high-pass filter is needed in a 50-ohm system to reject all frequencies below 150 mc. On the high-pass face of the rule, set the arrow in the *Set Frequency* window to 150 mc. On the capacity (C) scale, opposite 50 ohms on the adjoining resistance scale, read capacitance as 10.8 μfd . On the inductance (L) scale, opposite 50 ohms on its adjoining resistance scale, read 0.0265 μh ."



PERKIN POWER SUPPLY Review

Announcing an Important Engineering Achievement!

Time—the reliability and efficiency of Magnetic Amplifiers are combined with the fast transient response and precise regulation of transistor circuitry in a completely new line of DC Power Supplies.



PERKIN HAS INCORPORATED the above features for completely new lines of transistorized B+ units, as well as low voltage power supplies. The following is the detailed description of the design features and performance characteristics of both lines.

B+ POWER SUPPLIES.



Model MTB 300-200

THESE PERKIN POWER SUPPLIES are designed to incorporate the latest magnetic amplifier, transistor assisted design circuitry which insures long, trouble-free, continuous-duty type service, with virtually no maintenance. This circuitry features the latest in reliability, since it contains no vibrating contacts and no vacuum tubes. Latest type Pointed Circuit techniques are employed.

The circuitry is based on AC transistor amplifiers; therefore, the effect of any changes in transistor parameters is greatly minimized. AC amplification is obtained by the use of modulators and detectors. The actual carrier frequency is approximately 80 Kc which, in effect, regulates steady state as well as attenuating the ripple.

Magnetic amplifiers are used in the circuitry for preregulation purposes, and the transistors used supply the final regulatory element. Provision is made within the circuitry to limit the transistor voltages—especially in the power output transistors—to a safe limit under all conditions of switching, line voltage transients, and short circuits to insure against any possible transistor failure.

SPECIFICATIONS AND RATINGS AVAILABLE:
 AC INPUT: 105-125 volts, single phase, 50-400 cps.
 RIPPLE: 6 millivolts peak to peak (2 millivolt).
 REGULATION:
 $\pm .1\%$ for line changes of 105-125 volts.
 $\pm .1\%$ for load changes of no load to full load.
 DYNAMIC IMPEDANCE: 1 ohm from 20 to 20,000 cycles.
 OUTPUT VOLTAGE ADJUSTMENT: Potentiometer controlled.
 METERS: Optional.
 CONSTRUCTION: Rack panel; panel dimensions 200 ratings: 5½"H x 19"W.
 1.5 A ratings: 10½"H x 19"W.

SPECIFIC MODELS AND RATINGS AVAILABLE:

MODEL NO.	OUTPUT VOLTAGE RANGE	LOAD CAPACITY
MTB 150-200	150 V $\pm 10\%$	200 MA
MTB 200-200	200 V $\pm 10\%$	200 MA
MTB 250-200	250 V $\pm 10\%$	200 MA
MTB 300-200	300 V $\pm 10\%$	200 MA
MTB 30150-200	30-150 V	200 MA
MTB 30200-200	30-200 V	200 MA
MTB 30250-200	30-250 V	200 MA
MTB 30300-200	30-300 V	200 MA
MTB 150-1500	150 V $\pm 10\%$	1.5 Amperes
MTB 200-1500	200 V $\pm 10\%$	1.5 Amperes
MTB 250-1500	250 V $\pm 10\%$	1.5 Amperes
MTB 300-1500	300 V $\pm 10\%$	1.5 Amperes
MTB 30150-1500	30-150 V	1.5 Amperes
MTB 30200-1500	30-200 V	1.5 Amperes
MTB 30250-1500	30-250 V	1.5 Amperes
MTB 30300-1500	30-300 V	1.5 Amperes

TRANSISTORIZED LOW VOLTAGE UNITS.



Model MTR 060-5

TYPICAL OF PERKIN'S NEW LINE of low voltage DC power supplies employing magnetic amplifier circuitry is Model MTR060-5 rated at 0-60 Volts, 0-5 amperes. Features include excellent transient response for both line and load changes, 1 millivolt ripple, regulation to 5 millivolts, continuously adjustable to 0 volts, wide AC line range, and remote sensing.

Applications for these units are transistor circuitry, relays, strain gauges, filament power and general laboratory testing.

DETAILED SPECIFICATIONS AND RATINGS:
 DC OUTPUT VOLTAGE RANGE: 0-60 volts DC.
 DC OUTPUT CURRENT: 0-5 amperes DC.
 AC INPUT: 95-135 volts, single phase, 60 cps.
 RIPPLE: 1 millivolt maximum.
 REGULATION:

Line

Static: Less than ± 5 millivolts for line changes from 95-135 volts AC.

Dynamic: Less than 10 millivolts for step changes of 20 volts, anywhere between 95 to 135 volts AC.

Load

Static: Less than 25 millivolts for changes from no load to full load.

Note: The regulation accuracies above are applicable for any output setting between 0-60 volts DC.

OUTPUT IMPEDANCE:

Less than 5 milliohms from 0 to 100 cps.
 Less than 25 milliohms from 100 cps to 2 KC.
 Less than 50 milliohms from 2 KC to 20 KC.

CONTROLS: Coarse control with resolution of 120 millivolts. Fine control with resolution of 5 millivolts.

PROTECTION: Unit will sustain short circuits without damage. Input and output fuses on front panel.

METERS:

Voltmeter, 0-75 volts DC, 4½" rectangular.
 Ammeter, 0-5 amperes DC, 4½" rectangular.

DIMENSIONS: Rack panel construction, 19"W x 14¾"D x 12¼"H. (Cabinet unit also available.)

OTHER MODELS AVAILABLE WITH SIMILAR SPECIFICATIONS ARE:

MODEL NO.	OUTPUT VOLTAGE RANGE	LOAD CAPACITY
TR 036-15	0-36 V	15A
MTR 036-30	0-36 V	30A
MTR 28-30	24-32 V	30A

Further engineering data and quotations available upon receipt of your letterhead inquiry.

PERKIN ENGINEERING CORPORATION

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 EAstgate 2-1375

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CIRCLE 5 ON READER-SERVICE CARD

Engineering Review



Mr. G. Kronacher of Bell Telephone Laboratories is holding a display board on which a disassembled vernier resolver is mounted. In back of display board is a set-up for checking the accuracy of the resolver.

Electro Magnetic Resolver

A high precision electromagnetic angle transducer called the vernier resolver has been developed by Bell Telephone Laboratories, 463 West Street, New York 14, New York, under an Air Force contract. The resolution of this transducer is better than ± 3 sec of arc. This is about the same angle as that subtended by a baseball at 3 miles.

Such a resolver has potentially wide applications for visual and automatic angle reading systems as required in the machine shop and military applications. At Bell Laboratories, it has been used in an "angle encoder" which converts a shaft angle to a numerical representation acceptable to a digital computer. The standard deviation of the error of this complete encoder is less than ten sec of arc.

The vernier resolver is a reluctance type, variable coupling transformer. In the present design, two output voltages are produced which vary in amplitude as the sine and cosine of 27 times the angle through which the rotor is turned. Thus, the equivalent of a standard resolver driven by a 27:1 gear train is obtained. Other ratios are also possible.

The unit is of small size and simple construction. All windings are on the stator, leaving the rotor free of sliding contacts.



The types pictured and charted on these pages possess the characteristics and the dependability to merit your specification and your confidence.

Type	Peak Inverse Volts	Forward Current (min.) at +1V mAdc	Average Rectified Current mAdc (25°C)	Reverse Current μ A at V
1N300	15	15	65	0.001 10
1N300A	15	30	88	0.001 10
1N432	40	10	55	0.005 10
1N432A	40	20	70	0.005 10
1N301	70	5	45	0.05 50
1N301A	70	18	65	0.05 50
1N460	90	5	45	0.1 75
1N460A	90	15	60	0.1 75
1N303	125	3	40	0.1 100
1N303A	125	12	55	0.1 100
1N433	145	3	40	0.1 125
1N433A	145	10	50	0.1 125
1N434	180	2	35	0.1 150
1N434A	180	7	45	0.1 150
1N302	225	1	30	0.2 200
1N302A	225	5	40	0.2 200
CK863	300	1	20	0.3 275
CK863A	300	3	30	0.3 275

Type	Peak Inverse Volts	Average Rectified Current (max.) mAdc	Reverse Current at -10V μ A
1N305	60	125	2
1N306	15	150	2
1N307	125	50	5

Type	Peak Inverse Volts	Average Rectified Current (max.) mAdc	Reverse Current μ A at V
1N66	60	50	800 -50
1N67	80	35	50 -50
1N68	100	35	625 -100
1N294	60	50	800 -50
1N297	80	35	100 -50
1N298	70	50	250 -40
VHF and UHF			
1N295	40	35	200 -10
CK715	40	35	

Type	Peak Inverse Volts	Average Rectified Current Amps. (125°C*)	Reverse Current (max.) at PIV mAdc
CK774	25	5	5
CK775	60	5	5
CK775-1	125	5	5
CK776	200	5	5
CK777	325	5	5

*Case Temperature



YOUR DESIGN IS BETTER
YOUR PRODUCT PERFORMS BETTER

CIRCLE 6 ON READER-SERVICE CARD

Objects in Motion Seen by Radar "Eye"

A radar eye that ignores stationary objects and speeds a surface-to-air missile instantly toward a threatening moving aerial target was made public as part of the Army Hawk air defense missile system, defender of American cities against aerial invaders flying at even the lowest altitude.

The Hawk's outstanding ability to seek out and destroy invaders even at tree top level, the Army said, is due to use of a radically advanced radar technique in the missile's guidance system.

Another aspect of the Hawk system is the extreme mobility of the ground support equipment which permits Hawk batteries to travel with the fast-moving assault forces of the Army and Marine Corps.

Raytheon Mfg. Co., Waltham, Mass., has complete weapon system responsibility for the Hawk program. Northrop is the major subcontractor for missile airframe components and system support equipment such as the mobile loader and the launcher.



A				B							
Type	Peak Inverse Volts	Average Rectified Current Amps. (150°C)	Reverse Current (max.) at PIV μ A	Type	Peak Inverse Volts	Average Rectified Current Amps. (135°C)	Reverse Current (max.) at PIV μ A	Type	Peak Inverse Volts	Average Rectified Current Amps. (150°C)	Reverse Current (max.) at PIV μ A
CK846	100	1.0	2	1N253	95	1.0	10	1N537	100	0.25	2
CK847	200	1.0	2	1N254	190	0.4	10	1N538	200	0.25	2
CK848	300	1.0	2	1N255	380	0.4	10	1N539	300	0.25	2
CK849	400	1.0	2	1N256	570	0.2	20	1N540	400	0.25	2
CK850	500	1.0	2					CK844	500	0.25	2
CK851	600	1.0	2					CK845	600	0.25	2



Traffic Light System Shows when Talos Can Go:

The Talos guided missile features a "traffic light" test system that tells when the weapon is ready for firing.

The Talos, manufactured by the Bendix Aviation Corporation for the Navy and being evaluated by the Army for incorporation into the continental air defense system, uses the automatic test equipment designed and built by the York (Pa.) division of the company to determine whether all of its systems are operating properly before it is launched.

The results are recorded by red and green lights, indicating which components have passed, or failed. A master green light on the system called Talos tactical test equipment (Tatte), will give the go-ahead, once all components have passed inspection. Bendix engineers said this automated test equipment reduces the technical training requirements of military personnel assigned to the missile.

RAYTHEON

Silicon and Germanium Diodes and Transistors • Silicon Rectifiers

Newton, Mass.: 55 Chapel St., Bigelow 4-7522
New York: 589 Fifth Ave., Plaza 9-3900
Chicago: 9501 Grand Ave., Franklin Park, TUXedo 9-5400
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CIRCLE 6 ON READER-SERVICE CARD

Engineering Review

AEC Broadens Fellowships for Nuclear Training

To meet the increasing demand for highly trained scientists and engineers in nuclear fields, the AEC has broadened one of its special fellowship programs to include study through the doctorate level. Fellowships have been established to provide a total of 150 fellowship grants on a one-year basis to first, second, and third year graduate students.

The fellowships carry basic stipends of \$1600, \$1800, and \$2000 respectively, with additional allowances for dependents, tuition, and travel. The original program, at that time called "AEC Special Fellowships in Nuclear Energy Technology," was announced on October 30, 1956, and supported one year of study at the first-year graduate level.

The revised program is the result of the increased demand for scientists and engineers with more advanced training in nuclear technology and provides the opportunity for a large number of graduate students to pursue, at certain universities, studies in the nuclear aspects of conventional scientific and engineering disciplines in addition to basic work in the reactor technology field.

Nuclear Studies on Ceramics

Advanced research studies of the nuclear effects on ceramics will be conducted by Gulton Industries, Inc., Metuchen, N.J., at the Brookhaven National Laboratory. Irradiated barium titanate and lead zirconate will be used for making fundamental investigations of the property changes of ferroelectrics. These nuclear studies on ceramics will concentrate chiefly on the electrical measurements of the ir-

CIRCLE 7 ON READER-SERVICE CARD ►



this is

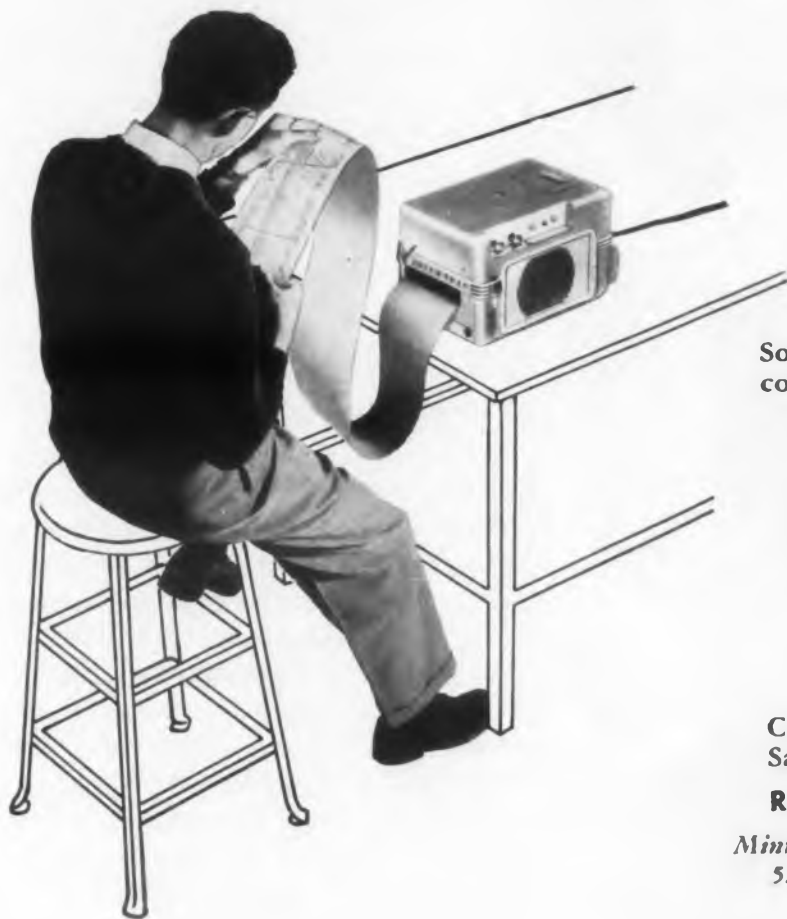


This Visicorder Oscillograph record* is a symbol of the leadership that is typical of Honeywell engineering. In laboratories all over the world the Visicorder's instantly-readable direct records are showing the way to new advances in rocketry, control, computing, product design and component test and in nuclear research.

*reproduced actual size, unretouched

The Model 906 Visicorder is years ahead of the trend. It is the first oscillograph that combines the convenience of direct recording with the high frequencies and sensitivities of photographic-type instruments. The Visicorder alone among oscillographs lets you monitor high-speed variables as they go on the record.

a record of leadership



Some of the general features which give the Visicorder leadership in the direct-recording field are:

- Frequencies from DC to 2000 cps without peaked amplifiers or other compensation
- Six channels plus 2 timing traces on 6" paper
- Deflection 6" peak to peak; traces may overlap
- Record speeds 0.2, 1, 5, and 25 inches per second, minute, or hour
- Records require no liquids, powders, vapors, or other processing

Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Reference Data: Write for Visicorder Bulletin

*Minneapolis-Honeywell Regulator Co., Heiland Division,
5200 East Evans Avenue, Denver 22, Colorado.*

MINNEAPOLIS
Honeywell



Heiland Division

radiated materials. It is hoped that by changing the structure of the ceramic materials, improved electrical characteristics will be effected. Gulton Industries, Inc., maintains a research staff at the Brookhaven National Laboratory, and was previously licensed by the AEC for the investigation of certain aspects of the use of ceramics in the nuclear field.

European Trade Show Exclusively American

The first United States trade show ever presented in Europe under private auspices has been scheduled for Hamburg, Germany, during October 3-12, 1958.

Called "1958 American Industrial Exposition of Electronics, Automation and Atomics," exhibits of American manufacturers will be accepted.

The exposition presents a new technique in advertising and sales promotion "packaging" designed for American manufacturers securing new markets for their products throughout Europe. It is the first opportunity American businessmen have had to actually sell their wares abroad in a trade exposition exclusively American. More than 40,000 buyers, government purchasing agents, manufacturers, franchise agents, engineers, and scientists are expected to attend.

The show, embracing 200,000 square feet, is sponsored by a group of Los Angeles businessmen in cooperation with the City of Hamburg and intensive support of the West German government has been assured.

A cost analysis for typical exhibit, based on special rate and transportation arrangements made by Intercontinental Trade Shows, 5746 Sunset Blvd., Los Angeles, Calif., makes it possible for a manufacturer to exhibit and demonstrate his products at Hamburg with his own sales representatives on the scene for \$2500.

The package is complete from United States plant to Germany and return, and Intercontinental Trade Shows, will handle all of the details.

◀ CIRCLE 7 ON READER-SERVICE CARD

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THIS IS WORK SAVING

READ THE *recti/riter*® AT A GLANCE!

RECTILINEAR GALVANOMETRIC RECORDERS

Old-fashioned curvilinear recordings are difficult to interpret—are highly subject to reading errors. The modern “recti/riters,” both SINGLE and DUAL, are read at a glance with a simple ruler.

Furthermore, *only* the “recti/riter” systems provide these *wide* ranges for recording electrical parameters:

- 10 millivolts to 1000 volts
- 500 microamperes to 1000 amperes
- Monitor standard frequencies—50, 60, 400 cps

You will also like the fast rise time, full scale accuracy, and high sensitivity inherent in this galvanometric system . . . the easy frontal access for all controls and routine operations . . . the fingertip control of 10 chart speeds . . . dependable closed inking system . . . AC, DC, spring, or external drives.

TI's efficient “recti/riters” are being used extensively in government projects, production control, medical instrumentation, weather studies, and numerous other applications. Very likely, *you* can greatly facilitate *your* specific project with a versatile “recti/riter.”

Write for complete detailed information
or a visit from the TI representative.



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CIRCLE 8 ON READER-SERVICE CARD



Engineering Review



Using the harmonic drive principle of motion transmission, a hermetically sealed means of controlling nuclear reactors is available. All rotating parts are exterior to the pressure vessel, and internally, there is but one moving part.

Harmonic Drive Principle Hermetically Seals Valves

Among the new devices developed by the Atomic Power Department of the United Shoe Machinery Corporation, Beverly, Mass., are examples of the “Harmonic Drive” principle. While not yet fully proved or in commercial use, the principle offers extremely interesting possibilities, particularly in the atomic power field.

“Harmonic drive” makes use of controlled waves of deflection to produce powerful rotary or linear forces. Deflection waves are produced in solid steel walls of vessels, pipes or other enclosures, so as to drive mechanisms within those walls. The principle eliminates the need for valve stems or other parts passing through the wall. Using this process a valve, for instance, can be truly hermetically sealed.

United's exhibit illustrates “harmonic drive” by means of a linear actuator which demonstrates the application of the principle to a control rod drive mechanism.

7511

Washington Report

Herbert H. Rosen

FCC Stirs up Another Pay-TV Furor

In recent weeks the Federal Communications Commission decided it had jurisdiction over toll television and announced a course of action. The Commission is planning to experiment with the system, and anyone who has the financial and technical know-how can participate. However, in making this decision, the FCC has incurred the wrath of the House Interstate and Foreign Commerce Committee and certain elements of the broadcasting industry. The decision has even caused concern among companies proposing pay-TV systems.

A two-day secret meeting preceding the announcement of the decision brought to five the number of toll TV systems now available to the public. For many years, Zenith's position has been well publicized. Allies in the issue are Skiatron, International Telemeter, Teleglobe, and Blonder-Tongue. Each offers different systems: some use wire; others, uhf transmission. One uses coding devices; another, a gas-meter type toll box; another ties reception in with the telephone bill; and still another lets you see the picture without the sound until the proper password is given.

Pay-TV has been a big center of controversy in the FCC for some time. It appears that the major industry opponents are the networks. Although they, as a body, have made no formal announcements, a spokesman did have some words. He was Harold E. Fellows, president of the National Association of Radio and Television Broadcasters. He made note of the fact that the FCC plans to honor no applications until March 1. "This will give Congress, which will then be in session, and its committees an opportunity to express their feelings on this action, including their responsibility on the public interest aspect."

The added confusion that shrouds the toll TV problem has given more ammunition to Sen. C. E. Potter (R-Mich.). He has introduced a Joint Resolution—Number 106—that proposes establishment of a national commission to study the extent of allocation of frequency space and the extent of utilization of the space. A companion resolution, Number 381, has been introduced in the House.

In making this decision, the FCC must have realized that opposition would have been forthcoming. The magnitude of it was probably a surprise. Therefore, there may be a tendency on the part of the Commission to hold back, to wait and see what kind of bricks will be thrown at it next January when Congress returns to Washington.

ENGINEERING REPORT

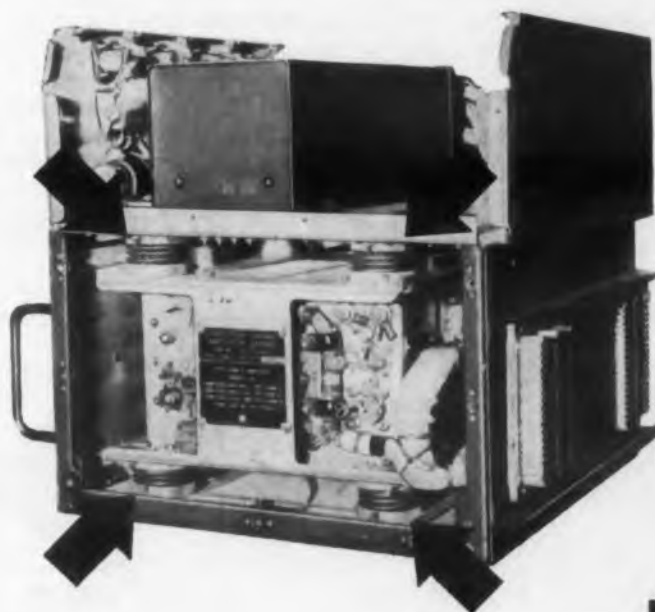
A Case History of Environmental Control

PROBLEM

VIBRATION • SHOCK AND COOLING

POWER TUBE FAILURE during environmental testing of the Servo-Amplifier in the flight stabilization system of Chance Vought's F8U-1 Crusader.

SOLUTION



ENGINEERED MOUNTING SYSTEM:

Robinson Model 1514 all-metal light-weight mounting system to protect entire Servo-Amplifier assembly. Highly damped Met-L-Flex resilient elements are incorporated in an opposed cushioning design. Resulting center-of-gravity suspension system assures all attitude protection for power tube and other electronic components.

The Servo-Amplifier assembly was isolated with no increase in over-all equipment dimensions.

SPECIAL FEATURE:

Range of environmental protection is extended by screened cooling apertures designed as part of the combined chassis and mounting.

PERFORMANCE:

Natural frequency of the mounting system is between 15-21 c.p.s. After 15 G drop tests on all six sides, there was no loss of isolation efficiency which remained as high as 90% at 55 c.p.s. with .060 inches excursion.

RESULT:

1. Increased operational reliability of Chance Vought's supersonic Crusader.
2. Another contribution to the weapons system reliability program pioneered by Chance Vought Aircraft, Inc. in cooperation with Robinson engineers.

ROBINSON

AVIATION, INC.

Teterboro, New Jersey

West Coast Engineering Office, Santa Monica, California

ROBINSON CONTROL IS RELIABILITY CONTROL

CIRCLE 9 ON READER-SERVICE CARD

For the record ...
it's IMMEDIATE-PRINT scope photos
with the DUMONT 302

- NOW, ULTRA-FAST TRANSPARENT POLAROID-LAND FILM FOR HIGH SPEED RECORDING!
- CONTACT AND PROJECTION PRINTS... NO IMAGE REVERSAL.
- EASY, INEXPENSIVE CONVERSION TO VARIETY OF STANDARD ROLL AND CUT FILMS.
- CLICK-STOP SLIDE PERMITS MULTIPLE EXPOSURES ON SINGLE FRAME FOR GREATER FILM ECONOMY AND EASY, DIRECT WAVEFORM COMPARISON.
- FULL BINOCULAR VIEWING SIMULTANEOUS WITH RECORDING.
- MOUNTS QUICKLY AND EASILY ON ANY STANDARD 5" SCOPE. NO ADDITIONAL SUPPORTS REQUIRED.
- EASY ACCESS FOR LENS AND SHUTTER ADJUSTMENT.
- BUILT-IN DATA RECORDING SYSTEM.



The Du Mont Type 302 Recording Camera provides the most convenient and flexible means for applying the many advantages of the immediate-print Polaroid-Land process to oscilloscope recording.

And now the utility of the Polaroid-Land process has been greatly extended with the development of the new Polaroid-Land projection film — a transparent base material with a specified emulsion speed of 1000 (ASA).

This new film not only permits contact and projection prints, and eliminates image reversal, but also enables use of the Polaroid-Land process in recording ultra-high-speed phenomena — even single transients.

Utility of the 302 is further broadened by the availability of adapter backs which permit the camera to use various standard roll and cut films. Write for full information...

SPECIFICATIONS

- Wollensak-Du Mont 75 mm f/2.8 three element lens, or 75 mm f/1.9 six element lens.
- Image reduction ratio 2.25:1.
- Alphax #2 shutter, bulb and 1/25 to 1/100 sec. with f/2.8 lens. Alphax #3 shutter, time, bulb and 1 sec. with f/1.9 lens.
- Writing rate dependent upon film used.
- Mounting clamp for use on any standard 5" scope bezel.

Type 302 with f/2.8 lens \$314.00
 Type 302 with f/1.9 lens 391.00

WHATEVER YOUR REQUIREMENTS... DU MONT HAS THE CAMERA



TYPE 352

High-speed, single frame 35 mm featuring automatic film advance. 8 frames/sec. automatically. Wollensak f/1.5 lens. \$648.00



TYPE 339

Immediate-print type utilizing Polaroid film. Special f/2.8 lens for distortion-free images. Binocular viewing of screen. \$246.00



TYPE 299

General-purpose camera accepting backs for roll-film, film-pack, or cut film. Converts to Type 302 for Polaroid recording. f/1.9 lens \$369.00, f/2.8 lens \$292.00



TYPE 296

Low-cost, general-purpose single-frame camera. Uses standard cassette wound 35 mm film. Corrected f/2.8 lens. Viewing port. \$164.50



TYPE 321-A

Permits either continuous or single-frame recording. Perforated or unperforated film or paper in 100 or 400 foot reels. Variable film drive speeds from 0.8 to 10,800 in./min. 321-A with f/1.5 lens \$1270.00. 321-A with f/2.8 lens \$1120.00. (50 cps models available)

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 CLIFTON, NEW JERSEY

CIRCLE 10 ON READER-SERVICE CARD

Engineering Review



The lower away signal is given for the grab and camera to start the 680 ft dive to the lake bottom.

TV for Salvage

For the first time in underwater salvage, a grappling iron fitted with an underwater television camera has been used to recover wreckage from a crashed aircraft at a depth of 680 ft. The operation was used to recover pieces of a Swiss DC3 which crashed into Lake Constance, Switzerland, with the loss of nine lives.

Following the loss of the aircraft, the Swiss government launched an inquiry to establish the cause of the crash. The approximate location of the wreck was established from eyewitness accounts. Later, the exact spot was located from a helicopter, when oil was sighted, and marked with buoys.

An underwater camera, supplied and operated by Pye Corp., Cambridge, England, was attached to a grapple, to permit observation and recovery of wreckage in one operation. The procedure adopted while searching with the television grapple allowed the crane operator to watch the television monitor for wreckage coming toward the arms of the grapple. As the

POCO TIEMPO IS SPECIAL!



Photograph of operator's viewing monitor, showing the arms of the grapple moving a few feet above the bed of the lake.

wreckage passed below, the grapple was dropped, and the arms were closed. Within minutes, the wreckage was hauled to the surface, and brought to shore.

Experts consider that the underwater television techniques employed during the search constitute a considerable advance in salvage operations. It is now possible for experts to be selective in the wreckage to be salvaged. The TV grapple also saves time as wreckage can be raised without necessitating the lowering of additional bulky equipment, which can not be accurately positioned.

Super Accurate Flight Reference

A new type basic flight reference has been developed which holds random drift rates to one quarter deg per hr in the horizontal or directional plane and to one tenth deg per min in the vertical axis. The lightweight equipment employs two perpendicular gyros rather than the usual combination of one vertical and one directional gyro. Heading information and all-altitude flight information are provided with unprecedented accuracies.

The fully maneuverable "table" was developed by Sperry Gyroscope Co., Great Neck, N.Y. as a central reference system for modern aircraft to replace a multiplicity of special purpose gyro equipment. It provides continuous data regardless of aircraft maneuver.

Suitable also as a back-up system for more elaborate inertial navigation equipment, the 18 lb Twin Gyro platform requires no warm up, is very rugged and simple to maintain.

Special group! With its own coil-winding, machining and assembly facilities.

Its own sales, engineering, purchasing, inspection and shipping activities. Its own everything

but red tape. **Special orders!** Potentiometers, in prototype quantities, with these

special modifications: resistance values, tolerances, linearities, taps, shafts, lids, bushings, ganged

assemblies, torque, bearings and rotation. Take your pick. **Special Delivery!** In 10 days

or less. **Special price?** No! Not one cent extra! *For your non-standard prototype pots,*

go fast, go first-class, go Poco Tiempo! Ask for it by name.

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CIRCLE 11 ON READER-SERVICE CARD

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the V I B R I S T O R

**A SELF-RESONANT, SEMICONDUCTOR INTERRUPTER
NO CONTACTS • NO MOVING PARTS • UNLIMITED LIFE**

Completely Transistorizes Existing Power Supplies

- UNPLUG VIBRATOR, PLUG-IN VIBRISTOR. NO WIRING CHANGES REQUIRED.
- RIPPLE AND NOISE ARE EFFECTIVELY ELIMINATED.
- OUTPUTS AND OVER-ALL PERFORMANCE ARE UNCHANGED.
- NO DAMAGE RESULTS FROM ACCIDENTAL SHORTS OR OVERLOADS.
- OPERATING LIFE OF POWER SUPPLY IS UNLIMITED.
- 100% STARTING AND OPERATING RELIABILITY.
- SYNCHRONOUS AND NON-SYNCHRONOUS MODELS AVAILABLE.

Revolutionizes New Equipment Design

- AVAILABLE FOR ANY FREQUENCY UP TO 100 KC.
- ALLOWS COMPLETE FREEDOM OF POWER TRANSFORMER DESIGN. ANY MAGNETIC MATERIAL MAY BE USED IN ANY CORE CONFIGURATION.
- MAGNETIC SATURATION OF POWER TRANSFORMER NOT REQUIRED.
- INVERTER FREQUENCY IS INDEPENDENT OF INPUT VOLTAGE.
- OPTIMUM PERFORMANCE OF SEMICONDUCTORS ASSURED.
- REDUCES NUMBER OF COMPONENTS — SIMPLIFIES MECHANICAL DESIGN.

MODEL NO.	TYPE	INPUT VOLTS	MAX. AVE. INPUT CURRENT (AMPS)	FREQ. (CPS)	MAX. DC OUTPUT VOLTS
VT603S	S	6	3	115	400
VT610N	N	6	10	115	—
VT123S	S	12	3	115	400
VT125S	S	12	5	115	400
VT241F	F	24	1.5	400	—
VT243F	F	24	3	400	—

S—Synchronous N—Non-synchronous F—Constant Frequency

MANY OTHER MODELS AVAILABLE. DATA ON REQUEST.

VRL, long a leader in the vibrator and vibrator power supply field, proudly announces a new and complete line of transistorized power supplies and associated equipment.

OTHER PRODUCTS

- DC-AC Inverters — 400 cps $\pm 1\%$ — up to 300 VA.
- DC-DC Converters — 6, 12, 24 volt input to any desired outputs, regulated or unregulated.
- DC and AC Voltage Regulators.

VRL has pioneered literally hundreds of power supply developments over the past decade and offers a complete design, engineering, and manufacturing service. Send us your power supply requirements for quotation.

VIBRATION RESEARCH LABORATORIES INC.

58 MARBLEDALE RD., TUCKAHOE, N. Y.

CIRCLE 14 ON READER-SERVICE CARD

Meetings

Dec. 9-13: Seventh Eastern Joint Computer Conference and Exhibit

Sheraton-Park Hotel, Washington, D.C. Sponsored by the IRE, the Association for Computing Machinery, and the AIEE. "Computers with Deadlines to Meet" will be the central theme.

Dec. 18-19: EIA Conference on Maintainability of Electronic Equipment

University of Southern California, Los Angeles, Calif. Sessions will cover military concepts and requirements for maintainability, ground environment equipment, missile maintainability, airborne equipment maintainability, and road blocks to maintainability. For additional information contact Engineering Office, Electronic Industries Association (formerly RETMA), Rm. 650, 11 W. 42nd St., New York 36, N.Y.

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.

Jan. 28-31: Fourteenth Annual National Technical Conference of the Society of Plastics Engineers

Sheraton-Cadillac Hotel, Detroit, Mich. The theme of the conference will be "Progress Through Plastics Engineering." Its sessions will deal with radiation and plastics, epoxy resins and embedment, extrusion, injection molding, education, packaging, plastic tooling, mold design, new materials, test methods, reinforced plastics, color and finishing, foams, compression molding, sheet forming, and research. For further details write to Lewis A. Bernhard, Society of Plastics Engineers, Inc., Suite 116-18, 34 E. Putnam Ave. Greenwich, Conn.

Feb. 3-4: Instrument Society of America National Conference on Progress and Trends in Chemical and Petroleum Instrumentation

Wilmington, Del. For information and advance programs write to H. S. Kindler, Director of Technical Programs, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Feb. 3-7: AIEE Winter General Meeting

Statler and Sheraton-McAlpin Hotels, New York City. The 96 sessions will encompass power generation and computing devices; data communications and telegraph systems; radio communication; television and aural broadcasting; telegraph systems and wire communications; industrial power rectifiers and systems; industrial control; feedback control; electric heating; nucleonics; basic sciences; dielectrics; electrical techniques in medicine and biology; magnetic amplifiers; metallic rectifiers; solid state devices; high frequency instruments; recording and controlling instruments; and a variety of other subjects. For additional information write the AIEE, 33 W. 39th St., New York, N.Y.

Feb. 4-6: Thirteenth Annual Technical and Management Conference of the Reinforced Plastics Division of the Society of the Plastics Industry, Inc.

Edgewater Beach Hotel, Chicago, Ill. The basic theme for the 18-session program will be the new and improved in materials, test results, quality controls and processing techniques. There will be papers on reinforced plastics tooling, industrial design, speed-temperature-radiation behavior of reinforced plastics, the development of reinforced plastic motors, filament winding, quality control of electrical applications, and other subjects. For complete information, write George L. Smead, Manager, Reinforcement Sales, L-O-F Glass Fiber Co., 1810 Madison Ave., Toledo, Ohio.

Feb. 20-21: 1958 Transistor and Solid State Circuits Conference

University of Pennsylvania and Sheraton Hotel, Philadelphia, Pa. Sponsored by the IRE, AIEE, and University of Pennsylvania. Papers will deal with high speed circuits, analytical techniques for system integration, device characterization, high and low power circuits, memory, magnetics, and related topics. For further information send to J. H. Milligan, Jr., Dept. of E. E., New York University, New York 53, N. Y.

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Enlarged cross section shows:
1. Bondeze and bonding action
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These successful uses of Bondeze suggest unlimited new redesign possibilities, often at overall savings.

COILS

Random-wound, layer, paper-section and solenoid coils for brakes and clutches, instruments, television, radio and other applications.

TRANSFORMERS

Paper-section, random-wound, oil-filled, air-cooled and high voltage for distribution, current, X-ray, television, radio and other applications.

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Windings for shaded pole, series fields, instruments, induction and others.

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

**FIRST FOR
LASTING QUALITY—
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INCA MANUFACTURING DIVISION
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CIRCLE 13 ON READER-SERVICE CARD

Sperry's combination radar test sets integrate all testing functions

Faster, simpler radar maintenance is the pay-off with the Sperry Combination Test Sets. One set does the job of three or more standard test units but requires one-quarter the space and weighs half as much! Here are the five functions each Sperry test set performs:

POWER METER: Directly measures average power of radar transmitter with accuracy of ± 1.0 db.

FREQUENCY METER: Indicates directly the frequency of both receiver and transmitter.

SPECTRUM ANALYZER: Accurately displays power vs. frequency spectrum of transmitter signals from single or multi-pulse systems. Display is stable at all pulse widths and repetition rates.

SYNCHROSCOPE: Simple general-purpose synchroscope functions as an "A" scope and displays radar video signals or similar wave forms—no need for auxiliary synchroscope.

SIGNAL GENERATOR: Accurately and directly calibrated output signal level is variable over complete range. Choice of pulse, frequency or external modulation.

With no additional equipment you can also measure transmitter peak power, repetition rate, transmitter pulse width, T.R. recovery time, duplexer losses, transmission line VSWR. Designed for tough operating conditions, these sets comply fully with military specification MIL-T-945A. Your nearest Sperry district office will gladly supply you with complete operating data.



MICROWAVE ELECTRONICS DIVISION

SPERRY GYROSCOPE COMPANY
Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION

Brooklyn • Cleveland • New Orleans • Los Angeles
San Francisco • Seattle. In Canada: Sperry Gyroscope Company of Canada, Ltd., Montreal, Quebec.

CIRCLE 15 ON READER-SERVICE CARD

Meetings

Feb. 20-24: 1958 EIA (formerly RETMA) Industrial Relations Conference

Town and Country Hotel, San Diego, Calif. Collective bargaining in the electronics industry, and technical manpower development and utilization are among the topics to be discussed. For information write to D. H. Stover, Industrial Relations Dept., Electronic Industries Assoc., 1721 De Sales St., N.W., Washington 6, D. C.

Mar. 11-13: Eighth Annual Conference on Instrumentation for the Iron and Steel Industry

Roosevelt Hotel, Pittsburgh, Pa. Sponsored by the Pittsburgh Section of the Instrument Society of America. For details write to Frank K. Briggs, Westinghouse Electric Corp., Atomic Power Div., Large, Pa.

Mar. 16-21: 1958 Nuclear Congress

Chicago Amphitheatre and Palmer House, Chicago, Ill. Sponsored by the AICE, AIEE, IRE, and many others. The congress will include five separate conferences: The Fourth Nuclear Engineering and Science Conference (Mar. 17-21), The Fourth International Atomic Exposition (Mar. 16-21), The Sixth Atomic Energy in Industry Conference (Mar. 17-19), The Sixth Hot Laboratories and Equipment Conference (Mar. 19-20), and The American Power Conference (Mar. 17-19). For more information write to the American Institute of Chemical Engineers, 25 W. 45th St., New York 36, N. Y.

Mar. 24-27: IRE National Convention

Coliseum and Waldorf-Astoria, New York City. For information write E. K. Gannett, IRE, 1 E. 79th St., New York, N. Y.

Mar. 27-29: Ninth Biennial Electrical Industry Show and Fifth Electrical Maintenance Conference

Shrine Exposition Hall, Los Angeles, Calif. Some of the topics to be discussed are maintenance to

prevent breakdown, maintenance of electrical and electronic equipment, and maintenance of lighting to assure peak output. For more details write Paul H. Henrichs, Southern California Edison Co., P.O. Box 351, Los Angeles, Calif.

Mar. 31-Apr. 2: Instruments and Regulators Conference

University of Delaware, Newark, Del. Sponsored by the IRE, ASME, AICHE, and ISA. For details send to E. M. Grabbe, P.O. Box 45067, Airport Station, Los Angeles 45, Calif.

Apr. 8-10: Sixth National Conference on Electromagnetic Relays

Oklahoma State University, Stillwater, Okla. Sponsored by the National Association of Relay Manufacturers. More information may be obtained from Charles F. Cameron, Dept. of Electrical Engineering, Oklahoma State University, Stillwater, Okla.

Apr. 10-12: IRE South West Regional Conference and Electronics Show

San Antonio Hotel and Municipal Auditorium, San Antonio, Tex. Write for details to J. O. Parr, Jr., 202 Janis Ave., San Antonio, Tex.

Apr. 14-16: Conference on Automatic Techniques

Statler Hotel, Detroit, Mich. Sponsored by the IRE, AIEE, and ASME. Information may be obtained by writing to J. E. Eiselein, Radio Corporation of America, Bldg. 10-7, Camden 2, N. J.

Apr. 22-24: 1958 Electronic Components Conference

Ambassador Hotel, Los Angeles, Calif. Sponsored by the IRE, AIEE, EIA, and WCEMA. With "Reliable Application of Component Parts" as its main theme, the conference has been planned to cover the following general topics: resistors, capacitors, and dielectrics; transistors and solid state devices; component reliability; electron tubes and their application; and progress with materials. For complete information write to David M. Knox, Packard-Bell Electronics Corp., 12333 W. Olympic Blvd., Los Angeles 64, Calif.

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PUSH PULL
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FOR SERVO
APPLICATIONS**



new all-magnetic

THYRATRON GRID DRIVE

in pre-engineered, packaged unit for power levels up to 15 kilowatts

For Complete Information, Write for Engineering Bulletins

FAIRFIELD ENGINEERING CORP. 934 HOPE STREET, DEPT. 122, SPRINGDALE, CONN.

New all-magnetic thyatron grid drive in pre-engineered, packaged unit for power levels up to 15 kilowatts . . . Another important advance from Fairfield! Designed especially for servo applications. Push pull, full wave medium gain thyatron grid drive, incorporating a fast response magnetic amplifier, provides a complete servo amplifier for power levels up to 15 kilowatts when used with appropriate thyatrons.

- Polarity reversible DC input signal controls two sets of two thyatrons each in full wave or back to back connection.
- Either set fires smoothly from off to full on, depending on polarity of input signal.
- Fast 6 millisecond response time for rapid reversing in high performance servo systems.
- External resistor provides complete adjustment of null point crossover.
- Compact packaging. Size: 2 $\frac{3}{8}$ " x 2 $\frac{3}{4}$ " x 3 $\frac{3}{4}$ ".

THESE EXCLUSIVE DRIVES FEATURE:

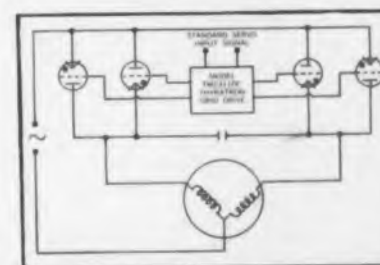
- Linear proportional control
- Essentially full 180° range of firing angles
- Inherent noise filtering
- Automatic compensation for line voltage variations
- Elimination of variations due to aging or tube replacement
- Maximum economy and reliability in carefully engineered and tested unit.

SOME PROVEN SERVO APPLICATIONS INCLUDE:

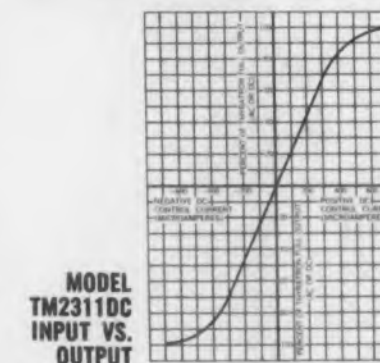
- High speed magnetic tape drives for computer memory units.
- Compact reversible motor drives for numerical control of machine tools.
- Electronic reversing of thyatron and Ward-Leonard systems for mills and other large horsepower applications.
- Electronic reversing of three phase induction motors.
- Accurate speed control of clutch and brake AC motor drives.

HERE ARE A FEW OF THE MANY MODELS AVAILABLE:

MODEL NO.	DESCRIPTION
TH1201AC	Fast response 1/2 wave magnetic amplifier with transistor preamplifier. 5 millivolt signal for full output.
TH2201AC	Full wave version of above for two thyatrons in full wave or back to back connection.
TM2301DC	Fast response full wave magnetic amplifier with DC control winding. 1 milliamper input signal controls two thyatrons in full wave or back to back connection.
TM3301DC	Three phase version of TM2301DC.
TM3311DC	Three phase push pull version of TM2301DC.
TM6311DC	Six phase push pull magnetic amplifier with DC control winding. 2 millisecond response time provides ultra high speed servo power amplifier.



TYPICAL APPLICATION: Polarity of DC input signal controls direction of two phase AC servo motor.



CIRCLE 16 ON READER-SERVICE CARD

This is an approach to proving that a given equipment has the necessary reliability to do the job. One practical concern of the design engineer is the production of a piece of electronic gear that is not over-reliabilized. Extra quality costs extra money, though it shortens the testing time required to meet buyer's specs. The problem of the designer is to find the point where the derivative is zero, between testing time and added reliability.

Here are two sides of the same coin. Statistical techniques are applied by the buyer to insure that the equipment he gets will fulfill the requirements. The same techniques are used to show the designer how long a testing time will be required for acceptance, given a numerical reliability attributed to his equipment.

are you ready to pay for

Proving Reliability?

Larry D. Smith, Lt., USAF

Wright Air Development Center

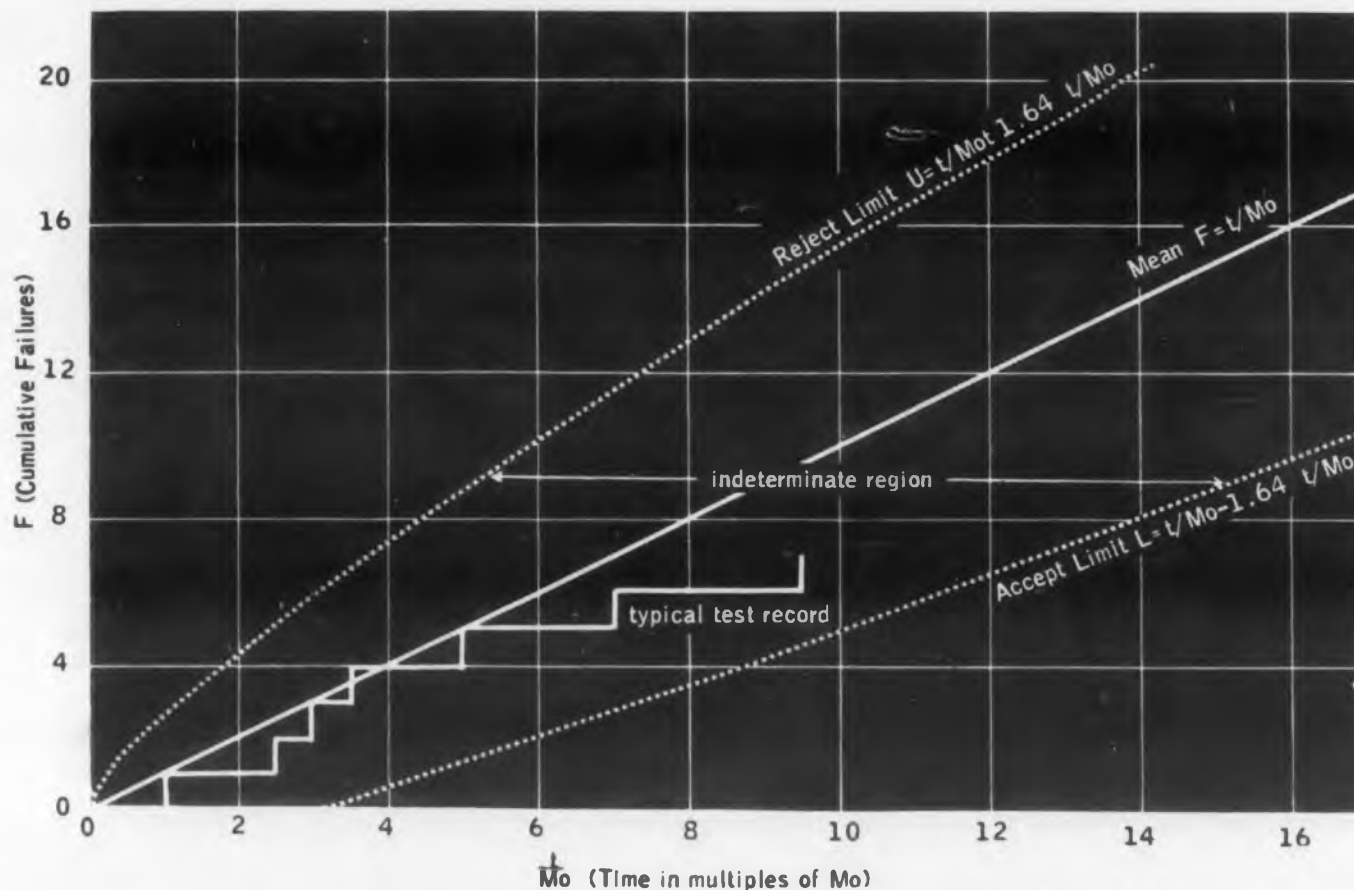


Fig. 1. Typical test record chart for 95 per cent confidence.

OBTAINING proof of an equipment's reliability can be expensive and time consuming. The buyer must be willing to pay for proof that he is getting the reliability that he needs.

Two basic assumptions are made in the demonstration of the accuracy of these statements:

The reliability of the equipment to be tested can be described by $R = e^{-T/M_0}$

where R is the minimum acceptable reliability,
 T is the required time of failure-free continuous operation with reliability R ,
 M_0 is the mean time between failures,
 e is 2.718.

The times between successive failures for the equipment show an approximately normal distribution about M_0 . This allows the use of standard statistical methods in making predictions about the behavior of groups of data.

According to the first assumption it can be seen that when T is fixed, M_0 gives a useful measure of reliability and it is M_0 that must actually be measured in any test program.

Let us suppose, then, that the buyer has written the following statement into the contract for a radio transmitter: *The vendor shall demonstrate that the mean time between failures of the transmitter is 95 per cent certain to be greater than a minimum of 50 hr under the test conditions specified.* The key to this statement lies in the two words greater than. It would be statistically impossible to prove that the equipment has an M_0 of exactly 50 hr but the difficulty of proving that it is greater than 50 hr depends on just how much greater it is. A 95 per cent confidence level has been chosen because this allows only a 5 per cent or a 1 in 20 chance of making an error. This arbitrary level is subject to argument, but it is the author's belief that it is better to lower the requirement for mean time between failures than to take a greater than 5 or 10 per cent chance of accepting an inadequate design.

A typical test record chart is shown in Fig. 1 where the cumulative number of failures, F , is plotted against elapsed test time. The line $F = t/M_0$ divides the chart into regions of reliable and unreliable operation. The existence of the indeterminate region is explained by the knowledge that there is a certain statistical doubt in data obtained from a finite number of observations. The indeterminate region effectively prevents the making of a decision until enough data has been gathered to give the required 95 per cent confidence in any decision made.

The test record chart was developed as follows:

If an equipment actually has a mean time between failures of M_0 , a line $F = t/M_0$ can be drawn such that one half of the failures plotted will fall on one side of the line and one half will fall on the other side of the line.

The farther one gets from the line, the less the density of data points. Thus, the points fall into a

distribution about the mean, $F = t/M_o$. For small F the distribution is best found by evaluating Poisson's Exponential Binomial Limit but when F is greater than 5 the limits are given sufficiently accurately by

$$U = t/M_o + 1.64 \sqrt{t/M_o},$$

$$L = t/M_o - 1.64 \sqrt{t/M_o},$$

where U and L are the upper and lower limits, respectively, and are expressed in terms of failures.

For an example of the accuracy of the above approximation, take the point on the line $F = t/M_o$ where F is 5. The limits are

$$U = 5 + 1.64 \sqrt{5} = 8.67,$$

$$L = 5 - 1.64 \sqrt{5} = 1.33,$$

and although statistical tables were used to draw Fig. 1, this simple approximation gives good accuracy as can be seen.

Fig. 1, then, can represent the buyer's requirement. An equipment put on test would not be accepted unless the plot of failures against time passed through the lower limit line. If a newly designed transmitter of unknown reliability is now run to obtain a plot of cumulative failures *vs* time the following can be determined:

- If the plot goes above the upper limit line, we know that there is a 5 per cent chance that the transmitter meets the requirement, or, in other words, we are 95 per cent sure that the transmitter fails to meet the requirement.

- If the plot goes below the lower limit line, we know that there is a 5 per cent chance that the equipment fails to meet the requirement or we are 95 per cent sure that it does meet the requirement of having a mean time between failures of more than 50 hr.

- If the plot stays between the limit lines, we have less than the required 95 per cent confidence that the equipment has either a greater or lesser than 50 hr mean time between failures; therefore, according to the rules that have been set up, no decision can be made.

It has been noted before that the better the vendor makes the transmitter the sooner it will be accepted; however, it costs extra money to build in extra quality and the vendor is interested in being able to balance the cost of extra quality against the cost of extra testing time.

Before answering his question of *How much better?* the following three questions must be answered:

1. How sure does the vendor want to be of being accepted in a given amount of time? More assurance means more test time and/or more extra quality as a result.

2. How much time can be devoted by the vendor to testing?

3. How many transmitters can the vendors afford

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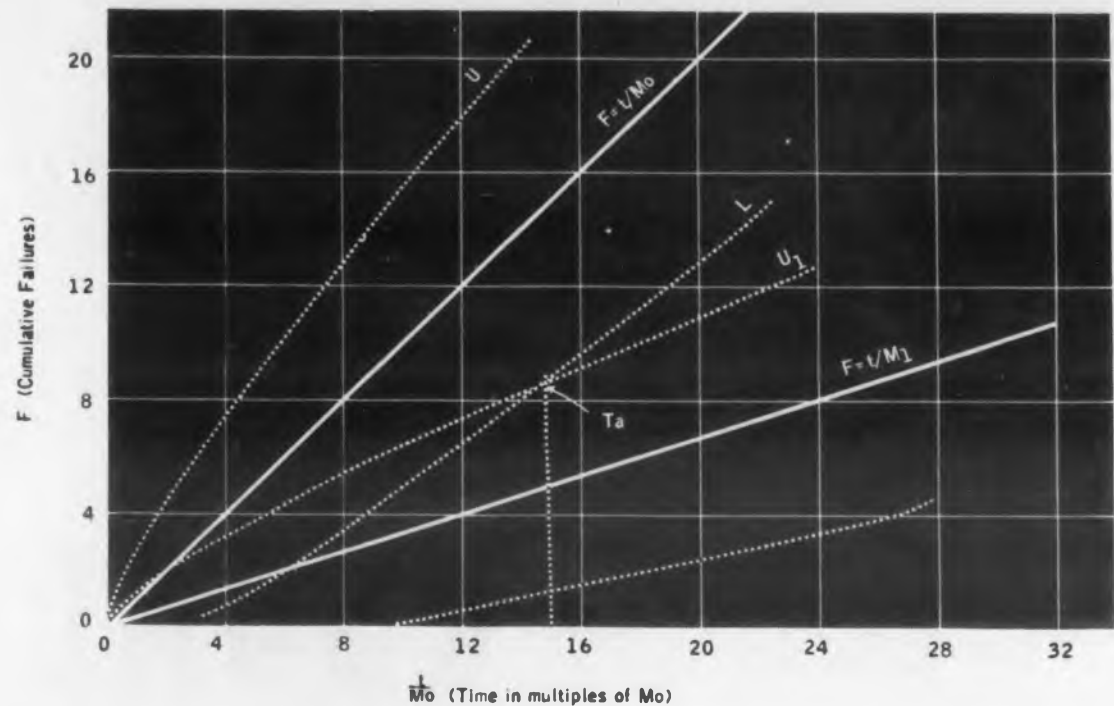


Fig. 2. Determination of time for 95 per cent assurance of acceptance when M_1 is greater than M_0 .

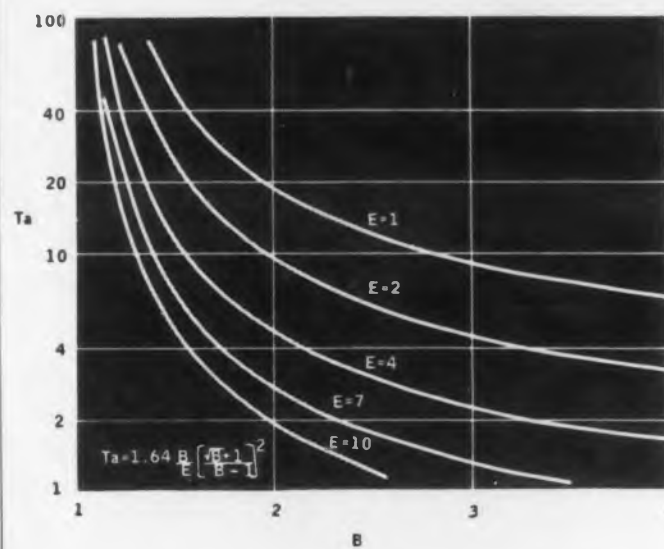


Fig. 3. Test time (in multiples of M_0) for 95 per cent assurance for the vendor and the buyer when $M_1 = BM_0$, and E is the number of units on test.

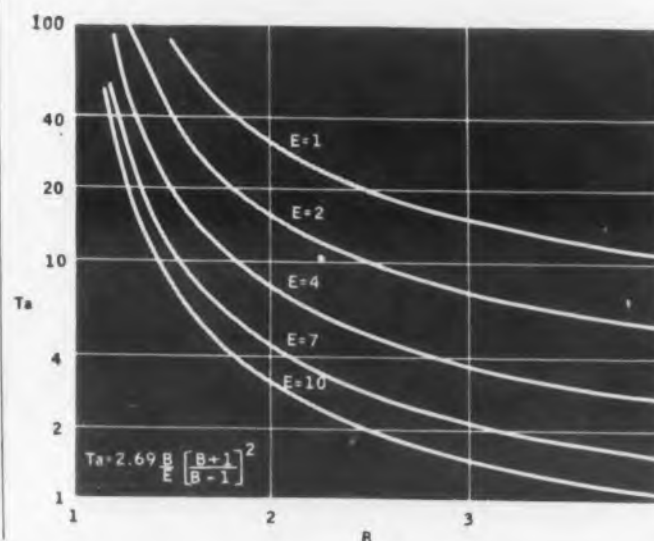


Fig. 4. Test time (in multiples of M_0) for 90 per cent assurance for both vendor and buyer when $M_1 = BM_0$ and E is the number of units on test.

to build for the purpose of testing?

Let us assume that the vendor wants to be as sure of having a good design accepted as the buyer wants to be sure of rejecting an inadequate design—95 per cent sure. Assume, also, that the vendor has actually designed a transmitter with a mean time between failures, M_1 , greater than M_0 (50 hr). We can then draw lines on a graph representing $F_1 = t/M_1$ and its limits as shown in Fig. 2. $F = t/M_0$ and its limits are also shown.

The intersection of the upper limit of the production with the lower requirement limit gives the time for 95 per cent assurance of acceptance; this time has been designated T_a . If the contractor wants to be 95 per cent sure that his design will be accepted by time T_a , he will have to make it with a mean time between failures that is greater than 50 hr by a factor, B , which can be calculated.

The lower limit of the requirement is the acceptance line, L , and is given by

$$L = t/M_0 - 1.64 \sqrt{t/M_0} \quad (L > 0)$$

while the upper limit of the vendor's production is

given by $U_1 = t/M_1 + 1.64 \sqrt{t/M_1}$

If we then let $M_1 = BM_0$, we find that

$$U_1 = t/BM_0 + 1.64 \sqrt{t/BM_0}$$

When $L = U_1$, the time for 95 per cent assurance of acceptance is determined:

$$L = U_1$$

$$t/M_0 - 1.64 \sqrt{t/M_0} = t/BM_0 + 1.64 \sqrt{t/BM_0}$$

$$T_a = t/M_0 = 2.69 B \left[\frac{\sqrt{B+1}}{B-1} \right]^2$$

If more than one equipment is placed on test at the same time, the equations are modified like this:

$$L = Et/M_0 - 1.64 \sqrt{Et/M_0}$$

$$U_1 = Et/BM_0 + 1.64 \sqrt{Et/BM_0}$$

$$T_a = t/M_0 = 2.69 \frac{B}{E} \left[\frac{\sqrt{B+1}}{B-1} \right]^2$$

This last relationship for T_a is plotted in Fig. 3 for 95 per cent assurance on the parts of both the vendor and the buyer. Fig. 4 shows what happens to T_a when 90 per cent assurance on the parts of both the vendor and the buyer is desired.

For an example, let us suppose that a contractor has been asked to bid on a radio receiver that is to have a 95 per cent assurance of a 40 hr mean time between failures with 10 receivers to be built for reliability testing. From past experience and a reliability analysis, the contractor might determine that he can build an equipment with a 60 hr mean time between failures. We can then calculate that

$$B = M_1/M_0 = 60/40 = 1.5$$

From Fig. 3, where $B = 1.5$ and $E = 10$ it is seen that $T_a = 8$. The contractor can then estimate the test time for 95 per cent assurance of acceptance as

$$t = T_a M_0 = 8 \times 40 = 320 \text{ hr per receiver.}$$

or a total of 3200 hr since 10 receivers are on test.

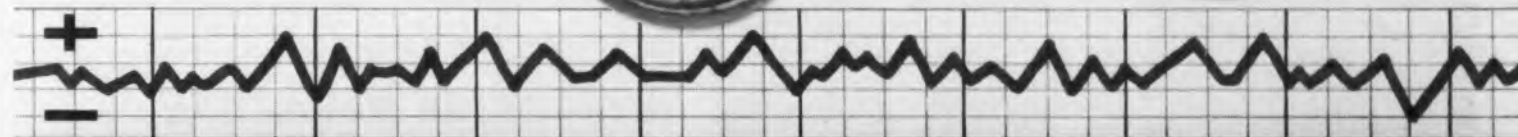
If both the buyer and the contractor are willing to accept 90 per cent assurance, T_a is reduced to 5, as determined from Fig. 4:

$$t = T_a M_0 = 5 \times 40 = 200 \text{ hr per receiver.}$$

The contractor now has the necessary information for estimating the cost of proving that he has met the buyer's requirement.

Statistical acceptance testing for equipment will be expensive as far as the initial cost of the equipment is concerned, but it will be far cheaper than redesigning the equipment after field usage has shown it to have inadequate reliability; in addition, the savings in maintenance costs should more than pay for the cost of the testing since maintenance costs have often been estimated at ten times the original cost of the equipments.

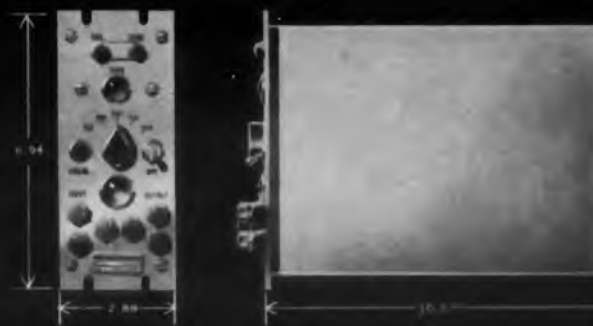
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CIRCLE 20 ON READER-SERVICE CARD

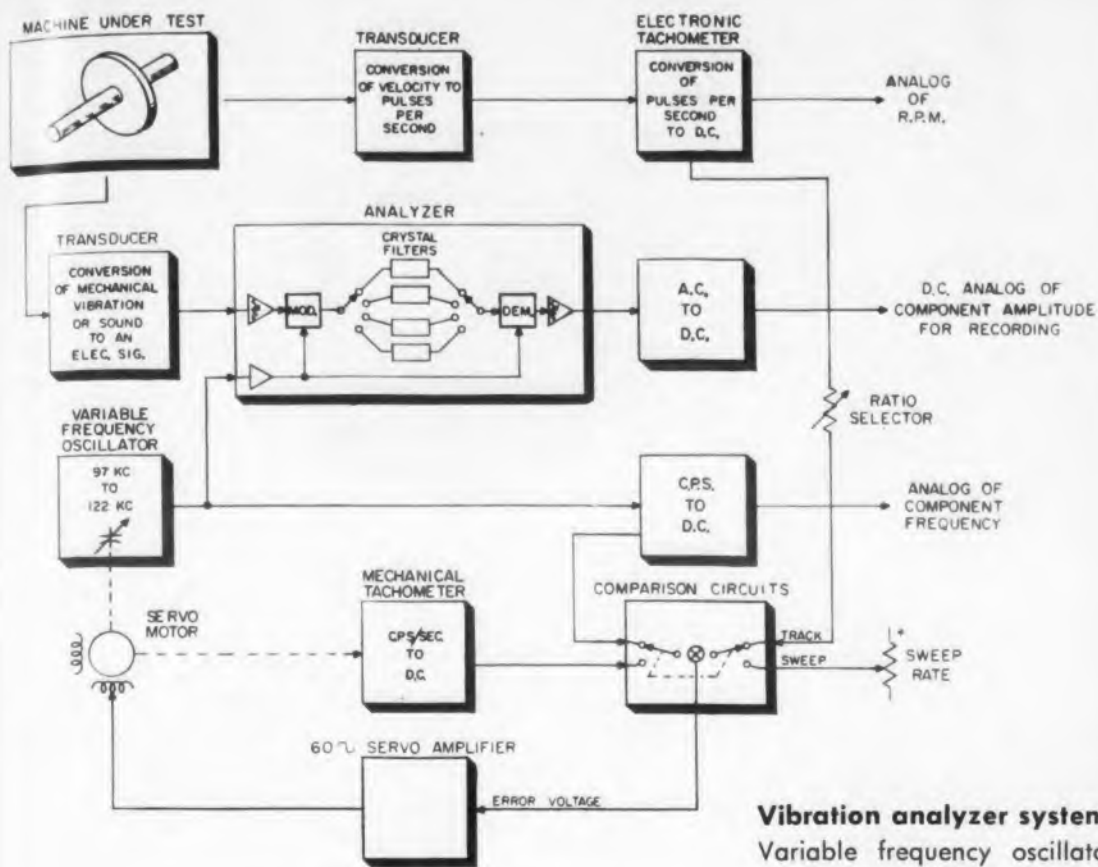
Wave Analyzer Tracks Automatically



Automatic tracking vibration analyzer is used as a design and production tool to investigate the power density spectrum of rotating machinery vibrations.

THE ADDITION of automatic tracking to this frequency analyzer permits the inspection of the vibration power and amplitude spectrum of rotating machinery while the equipment is accelerating. Transient harmonics can be tracked and investigated as the device under inspection passes through any point of velocity. Developed by Technical Products Co., 6670 Lexington Ave., Los Angeles, Calif., the system operation is illustrated. The frequency of one signal is related, through suitable transducers, to the instantaneous velocity of the machinery under test; the other signal represents the complex vibrations present at some point of interest on or near the machine.

The vibration signal is applied to the analyzer, where it is modulated by the variable frequency



Vibration analyzer system.

Variable frequency oscillator is made to tune over its 97 to 122 kc range in proportion to the rotational velocity of the machinery under test. In this way the behavior of any vibrational harmonic can be tracked over the full velocity range of the machine.

oscillator and applied to a narrow band crystal lattice filter centered at 97 kc. The oscillator is tunable from 97 to 122 kc. As it is tuned through this band, the spectrum of the vibrations represented by the inferior sideband out of the modulator is shifted, allowing the filter to pass different portions of the spectrum. The output of the filter is then demodulated to restore the original frequencies. This signal is detected to produce a dc analog for recording or visualization.

Signals whose repetition rate is proportional to velocity are applied to an electronic tachometer which generates a dc analog of the velocity with an accuracy of 0.1 per cent. This voltage is compared with a dc analog of the oscillator frequency. The error voltage is applied to a servo amplifier, which drives a motor ganged to the tuning element in the oscillator. In this way the frequency output of the oscillator is made to follow the velocity of the machinery under analysis. A ratio selector can be employed to adjust the scale factor of one of the analogs of frequency, for harmonic tracking.

In addition to automatic tracking, the analyzer can be manually tuned or made to scan at frequencies up to 500 cycles. Scanning is accomplished by using tachometer feedback with an adjustable sweep rate reference level in a velocity servo loop.

Control panels for the wave analyzer may be obtained in two frequency ranges: two to 250 cy and 150 to 25,000 cy.

For further information on this automatic tracking wave analyzer turn to the Readers Service Card and circle 21.



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CIRCLE 23 ON READER-SERVICE CARD



Fig. 2. Preamplifier increases microphone output level to a value easily measured with a VTVM. Low frequency cutoffs are provided at 50, 250, and 1250 cps, to improve signal to noise ratio.

Fig. 1. Microphone measures high forces caused by sound waves.

High Intensity Sound . . .

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FREE field sound pressure intensities over a 10 cps to 50 kc frequency range are accurately transformed into equivalent electrical voltages. The voltage is waveform essentially the same as the sound pressure wave. Instantaneous amplitude of the voltage waveform is a measure of the instantaneous sound pressure at the microphone location. Measurements are accurate to ± 0.5 db

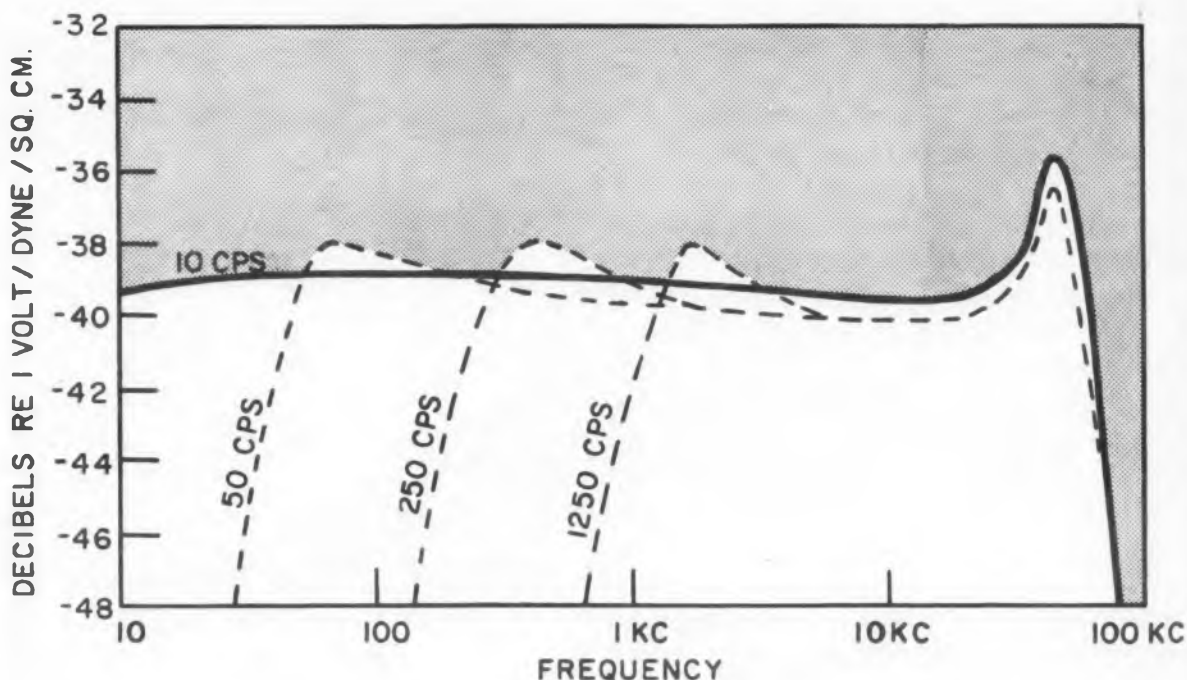


Fig. 3. Microphone response is accurately calibrated to within ± 0.5 db from 10 cps to 50 kc. Disc construction and heavy walled aluminum diaphragm give microphone high calibration stability.

throughout the frequency range. The microphone is constructed for operation in any gaseous or fluid medium up to pressures of 30 psi. It has an extremely wide dynamic range and is unaffected by temperature changes between 0 C and 110 C. Knowing the frequency and magnitude of ambient sound, an engineer can design components to meet stress requirements.

Developed by Electro-Voice, Inc., Buchanan, Mich., the instrument consists of a transducer-cathode follower probe assembly with removable shock mount (Fig. 1), and a preamplifier-power supply assembly (Fig. 2). Four barium titanate generating discs incorporated in a thickness mode vibrating system give an extremely rugged assembly. The discs are polarized in manufacture so that a voltage is generated between the electrodes when the disc is either compressed radially inward, or stressed radially outward. The four elements are equally spaced and cemented to the inside surface of a split cylindrical diaphragm of aluminum tubing. Damping material is placed between the ceramic discs to support the interconnecting wires so that unwanted resonances are eliminated. Since the ceramic elements are displacement devices, that is, the generated voltage is directly proportional to the displacement of its matter, and since the transducer is stiffness controlled below its resonance of 50 kc, a constant output voltage versus actuating pressure results for all frequencies. Ceramics disc construction and a heavy walled aluminum diaphragm give the microphone high calibration stability.

Preamplifier and Power Supply

The preamplifier and power supply unit increase the level from the microphone to a value which is easily measured with a vacuum tube voltmeter. Sound pressure in dynes/cm² or intensity level in db re 0.0002 dynes/cm² can be determined from the nomograph provided with the preamplifier. Incorporated in the preamplifier are three low frequency cut-off filters of 18 db/octave slope which may be inserted in the signal channel to eliminate low frequency rumble or extraneous noise components which may be present during high frequency measurements. The filters can be selected to become effective below 50 cps, 250 cps, or 1250 cps. A 10 cps position is provided on the switch for full range measurements (Fig. 3).

Threshold sensitivity of the microphone is 0.5 dynes/cm² on the 10 cps range and greatly improves when using the low frequency cut-offs. It is omnidirectional up to 20 kc with a directional marker provided for operation above 20 kc. Maximum sound pressure is 140 db re 0.0002 dynes/cm², and can be increased to 200 db with an input attenuator for the preamplifier.

For further information on the microphone turn to Reader Service Card and circle 24.

New Sperry Reflex Oscillator Klystron

COVERS FULL X BAND

Low-Voltage Test Oscillator
Spans 21% of Center Frequency

Featuring complete coverage of the frequency range from 8.5 to 10.5 kmc, the new SRX-92 reflex oscillator klystron is designed for use as a local oscillator in microwave receivers and spectrum analyzers, as a signal source in radar test equipment, or as a low-power bench oscillator.

Low-voltage operation, low hysteresis and high thermal stability are other important advantages of this new klystron, which delivers a minimum output power of 20 mw over a minimum bandwidth of 35 mc. In addition, it offers single-screw tuning over the entire frequency range, with integral cavity and tuner.

Sperry has packaged all these key features in a klystron that combines low cost and small size—it weighs only 4½ ounces. For detailed information on the SRX-92 and other Sperry klystron tubes, write or phone the nearest Sperry district office.



SRX-92 Specifications

Frequency Range	8.5 to 10.5 kmc
Output Power (VSWR 1:1)	20 mw (min)
Electronic Tuning Bandwidth	35 mc (min)
Beam Voltage (maximum value)	300 v
Reflector Voltage (maximum value)	800 - 900 v

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Vibration Resistant Balanced Potentiometer

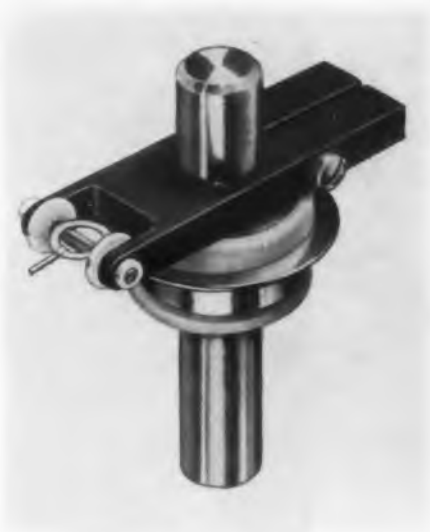


Fig. 2. Balanced contact assembly is insulated from the arm and is mounted in jeweled pivots.

Dynamically balanced arm and contact assembly give continuous operation under 2000 cycle vibration at 30 g's.

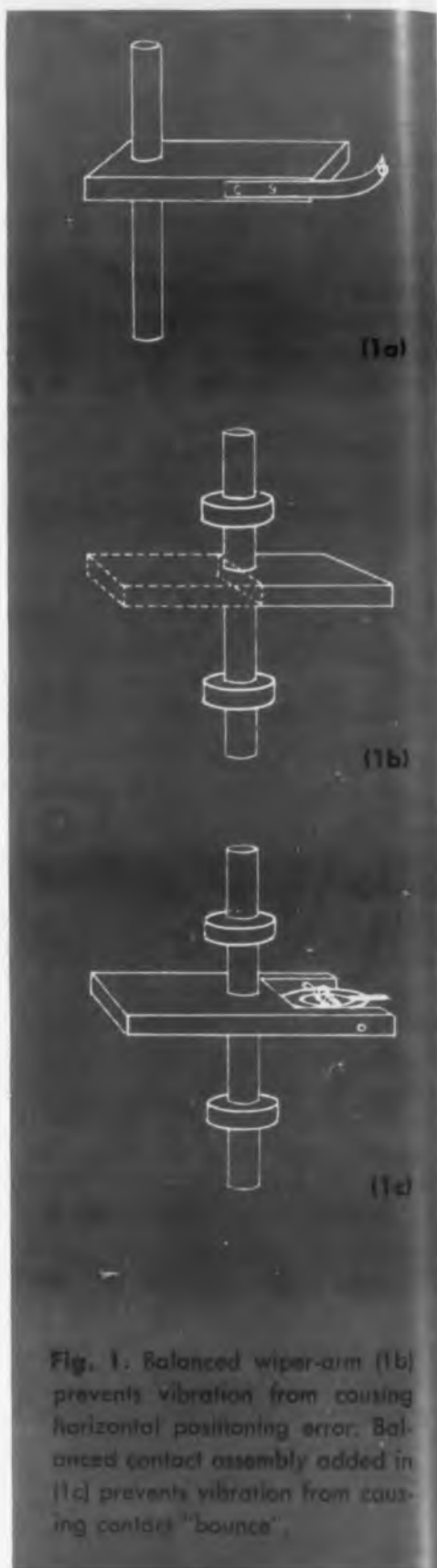


Fig. 1. Balanced wiper-arm (1b) prevents vibration from causing horizontal positioning error. Balanced contact assembly added in (1c) prevents vibration from causing contact "bounce".

Waldes Truarc Rings speed assembly, facilitate maintenance, improve performance of new automatic calculator

A DYNAMICALLY balanced wiper arm guarantees constant contact in this potentiometer. Accuracy and continuity are thereby assured, regardless of system vibration or operating speed. The resulting low wear gives the potentiometer a 5 million cycle life.

The new potentiometer, developed by the Kintronic Division, Chicago Aerial Industries, 10265 Franklin Avenue, Franklin Park, Illinois, matches mechanical performance to electronic precision. Previous potentiometer design used a cantilevered spring to provide contact with the wire, Fig. 1a. When subjected to vibration the unbalanced mass of the arm and spring caused it to rotate and give a positioning error. In applications requiring the wiper to rotate at high speeds, centrifugal force increases pressure on the winding causing excessive wear.

Dynamic Balance

When the mass of the wiper arm is equally balanced on both sides of the shaft, Fig. 1b, vibration or shock will not result in a rotational force on the arm, and therefore accuracy is not affected.

Extending the concept of dynamic balance to the contact, Fig. 1c, allows it to follow the winding under all conditions. The balanced contact assembly, Fig. 2, is mounted in jewel pivots at the end of the arm. As in the case of the arm, vibrations will not cause it to rotate or "bounce." To insure good electrical operation, a small spring loads the contact with a minimum force.

Standard linearity for these dynamically balanced potentiometers is .1 per cent. The units will give continuous operation with a minimum of noise when subjected to vibrations up to 2000 cycles at a force of 30 g's. Maximum speeds range from 1000 to 3425 rpm depending on the size of the potentiometer. Starting torques are as low as .1 in. oz for the smaller sizes.

The 1000 series is produced in six sizes: 7/8, 1-1/16, 1-7/16, 1-3/4, 2, and 3 inches. All six can be ordered with either linear or functional windings. Mechanical rotation is 360 degrees continuous, but phaseable stops are available. Electrical rotation of 358 deg is standard. Careful material selection gives the pots excellent high temperature characteristics. Operation up to 225 C is available and 165 C is standard. Housings are all metal, and only ceramic and Teflon are used in interior construction. The winding card is made of stable silicone glass laminate.

For further information on the Dynamic Balanced Potentiometer turn to Reader Service Card and circle 27.

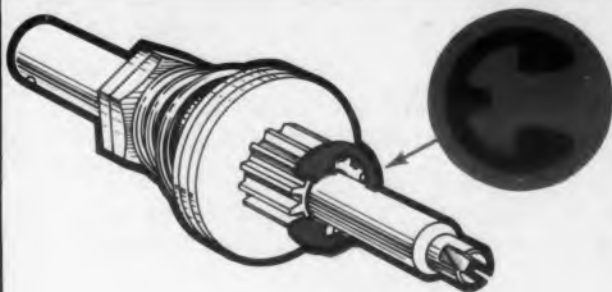


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automatic-decimals calculator made by Marchant Calculators, Inc., Oakland, California.

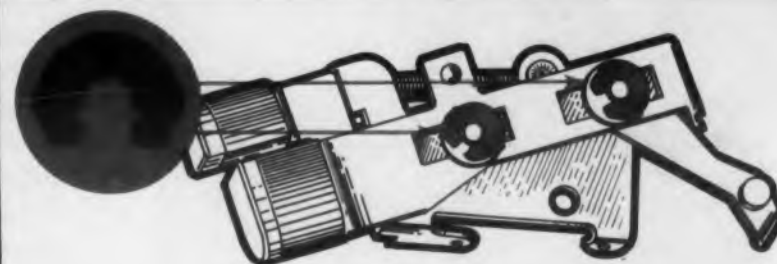


CRESCENT RING SPEEDS ASSEMBLY, DISASSEMBLY

Main clutch utilizes radially-installed series 5103 crescent ring for rapid assembly and disassembly. Ring's low protruding shoulder provides necessary clearance between ring and the two studs. The main clutch operates each time a Deci-Magic control key is depressed.



E-RING SECURES PARTS AGAINST SPRING THRUST. Slip clutch assembly uses Truarc series 5133 E-ring to hold parts on shaft. Functioning of the assembly is dependent upon the ring's ability to withstand thrust exerted by the heavy barrel spring.



LOCKING PRONG RINGS PERMIT SIMPLE DESIGN. Shift slide assembly uses two Truarc series 5139 bowed locking prong rings to lock the parts together in a sliding fit. Precise amount of spring tension prevents objectionable wobble and noise, permits the key to slide smoothly in operation. Easy radial assembly and disassembly of rings facilitates field maintenance and repair. Alternative construction would have required cut washer, spring washer and hairpin-type spring clip on each stud.

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CIRCLE 30 ON READER-SERVICE CARD

Shielded Cable Grounding Techniques

Michael D. Lazar

Senior Engineer
Burndy Corp.

IN ORDER to protect and isolate the signal, maintain correct impedance and prevent reflection, braided shield must be properly grounded. There are a number of ways to do the job. All are listed in the Table, each with its description, advantages and disadvantages. Depending on the needs of the individual product or production line, the guide will help in selecting the proper technique. One important factor must be kept in mind, however—protection of the inner conductor.

If the ground wire is soldered to the shield, the destruction of the insulation of the inner conductor by overheating must be avoided. If the choice is the crimp-type ferrule—either the one or two piece type—the right size ferrules for the cable must be designated. This can be done by trial and error using available sample kits, or—preferably—referring a sample piece of cable to the connector manufacturer for installation and size recommendation. A cutaway drawing of a one-piece ferrule is shown in Fig. 1. A simple way to check for a good joint is to see if the installation slides over the inner conductor when subjected to light hand pressure, after

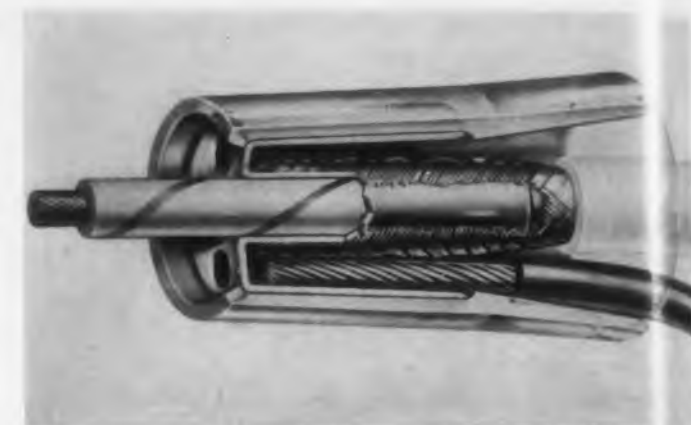


Fig. 1. Cutaway view of single-unit ferrule. Inner shell of ferrule is slit under the cable braid; outer shell and ground lead are crimped to braid to provide good contact.

the outer insulation has been removed in the case of jacketed cable. If it slides, the inner conductor is undamaged. If it does not, the size may be incorrect or the connector-tool combination may be improperly designed.

In systems using more than one cable, the ground leads may be connected from ferrule to ferrule in parallel. The inner conductors are then attached to a multi-contact disconnect plug; the ground lead is brought into a socket used to carry it to ground.

If a multicable system demands individual grounding of each shield, a slightly different technique is used. A pigtail is joined to the shield, and a disconnectable socket is attached to the free end of the pigtail as well as the inner conductor, as in Fig. 3. At final assembly, all that is necessary is to plug in both sockets. This permits maximum pre-wiring in the wiring shop, where the best efficiency is usually achieved.

The one- and two-piece ferrules illustrated are manufactured by the Burndy Corp., Norwalk, Conn. A two-piece ferrule is produced by Thomas and Betts, Elizabeth, N. J.

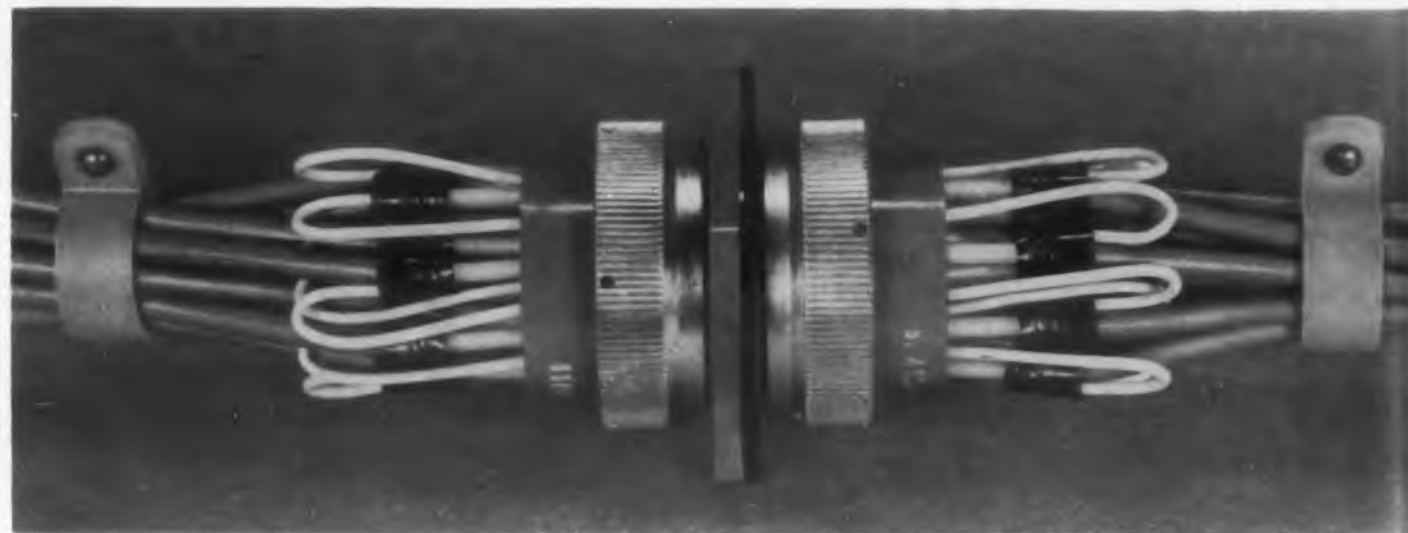


Fig. 3. Ground leads as well as inner conductors are attached individually to the disconnectable sockets shown here.







(a)

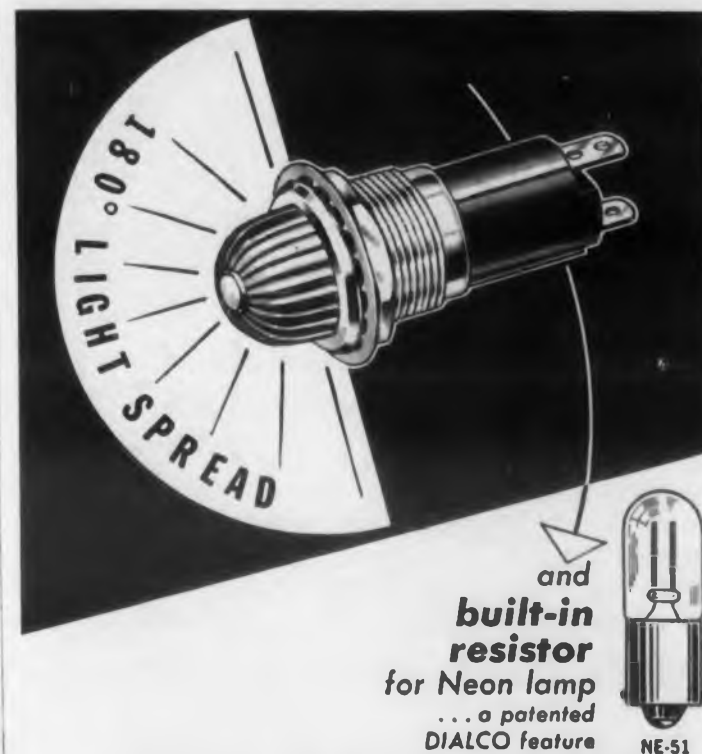


(b)

Fig. 2. Jacket insulation may be used with all grounding techniques in Table. Shown here are examples of (a) braided cable used as ground and (b) one-piece ferrule, which comes with insulation already provided. Ferrule—plus—insulation is crimped in normal fashion, as shown.

Tabulation of Various Grounding Methods

	Description	Advantage	Disadvantage
Braid as Ground Lead. 	Braid is either unravelled and twisted together, or the inner conductor is pulled through a space forced in the braid.	Requires no soldering, connectors or crimping tools. Unskilled operators can perform operation.	Slow, especially on tight braid. Often results in bulky job. Difficult to insulate ground lead and exposed braid, and to terminate ground lead.
Ground Lead Soldered to Braid. 	Solid wire is wrapped around braid and soldered. A variation of this method employs an eyelet under the braid to protect inner conductor insulation.	Ground lead easily terminated. No connectors or crimping tools required.	Good connection to braid difficult due to oxidation. Heat from soldering iron may melt inner conductor insulation. Skilled operator required. Bulky result. Poor reliability due to frequent cold joints; assembly of separate sleeve necessary to insulate.
Two-Piece Crimped Ferrules. 	Inner ferrule slides under braid, outer ferrule over braid; assembly crimped with standard tool.	Fast operation with good reliability due to controllable process. Inner conductor insulation protected from damage by brass ferrule. Outer ferrule may be pre-insulated ground lead easily terminated.	Crimping tool required. Frayed edges of braid protruding beyond ferrule may require trimming. The size of ferrule must be specified.
One-Piece Crimped Ferrules. 	One-piece combined inner and outer ring. Inner ring slides under the braid as tap wire is held between braid and outer ring.	Fastest method. Reliable, no skill required for operation. Inner conductor protected by inner element. May be pre-insulated; no trimming of braid necessary. The ground lead easily terminated.	Crimping tool required. The size of ferrule must be specified.



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CA 650	20" w by 17" d by 22" h	100° to 650°F
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Design Forum

Dual Function npn-pnp

TWO TRANSISTORS, an npn and a pnp, are used together in a versatile flip-flop configuration that finds a double application in a Transistor Curve Tracer manufactured by Cubic Corp. in San Diego, Calif. In one case the flip-flop is used as a regenerative switch to produce a sawtooth signal at the rate of 500 cps. The same flip-flop design is also used to provide bi-stable multivibrators in a three-stage binary counter.

Astable Multivibrator

Figs. 1 and 2 indicate the similarity between the pnp-npn flip-flops when used as oscillators or bi-stable multivibrators. In both cases, the transistors are in the common emitter configuration, because of bias considerations. The "switch" is turned "on" by a positive pulse to the base of the npn transistor, and "off" by a positive pulse at its emitter.

Fig. 1 shows the transistor switch as used in a sawtooth sweep generator. Here, in conjunction with two additional transistors, it provides the transistor equivalent of a bootstrap generator. The transistors Q_1 and Q_2 act as a regenerative switch and provide a charging source for C_1 . When the potential of C_1 approaches the battery

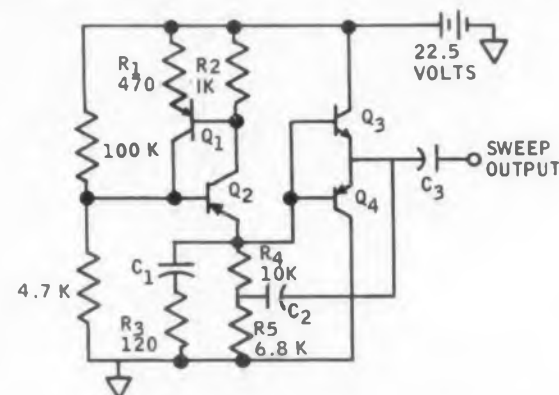


Fig. 1. Transistor switch used in a sawtooth sweep generator. With two additional transistors it provides the equivalent of a bootstrap generator.

supply voltage, the current through Q_2 decreases. This causes the regenerative switch to open. C_1 then discharges through R_4 . During the discharge time, the output current of Q_4 is coupled through C_2 to the junction of R_4 and R_5 in order to keep a constant voltage across R_4 . The result is a linearly decreasing voltage at the output terminal. Q_3 supplies the current through C_2 to the R_4 - R_5 junction during the charge time of C_1 .

The repetition rate for the sawtooth signal is approximately 500 cps. In the Cubic curve tracer, the same sweep generator is also used to provide 10- μ sec positive pulses to the binary counter. These pulses, with amplitudes of 4 to 5 v, are taken from the negative side of C_1 and coincide with the positive peaks of the sawtooth signal.

Bi-Stable Multivibrator

Fig. 2 indicates how the pnp-npn switch is used as a bi-stable multivibrator. In this case, three multivibrators form a binary counter to produce a stair-step voltage. This is used in turn to provide a varying base drive for the transistor under test.

The binary counter is designed so that positive pulses from the sweep generator serve to trigger the first multivibrator either "on" or "off." If it is tripped "on" (but not "off"), the first multivibrator produces a pulse that in turn trips the second multivibrator, controls the third multivibrator in the same fashion. Assuming that all three stages are "off," the first pulse from the sweep generator serves to turn all three "on." The second pulse turns the first stage "off," but does not affect the second and third stages. The third pulse turns the first stage "on," and this switches the second stage "off." At the end of the eighth pulse, all three switches are "off."

The outputs of the three counting stages are summed on the base of a phase inverter. Summing resistors are arranged so that the third stage has an output of approximately 4 v, the

Flip-Flop



second stage 2 v, the first stage 1 v. The result is a stair-step signal varying between 7 v and 0. The repetition rate is approximately 30 per second.

An examination of Fig. 2 indicates that a positive pulse at the input terminal passes through both CR1 and CR2 and through C5. The pulse arrives, therefore, coincidentally, at both the base and emitter terminals of Q6. However, the value of parallel resistances R10 and R12 is less than that of R11, and this lowers the voltage at the Q6 emitter. The resulting bias permits current to flow from collector to emitter through Q6.

This results in a 20-v pulse at the Q6 emitter. The pulse passes through C6 to trip the next stage. It also causes a drop in the base voltage of Q5. The resulting emitter-to-base bias promotes a current flow through the Q5 collector. This raises the voltage on the base of Q6 and keeps the flip-flop "on," with steady power available at output 1.

A second positive pulse at the input terminal is blocked at CR1 by the high potential on the base of Q6. The pulse passes through CR2, however, and is transmitted through C5. The pulse stops the current flow through the Q6 emitter, which raises the voltage on the Q5 base and thus

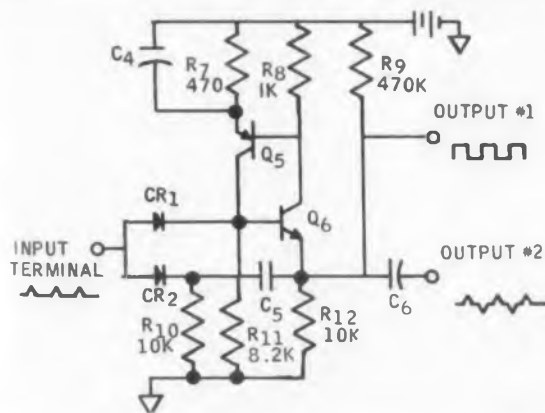


Fig. 2. The pnp-npn switch used as a bistable multivibrator. Three multivibrators form a binary counter to produce a stair-step voltage.

trips the flip-flop to the "off" condition.

The abrupt drop in voltage at the Q6 emitter puts a negative pulse through C6, but the bias requirements of the input diodes of the next flip-flop stage prevent the pulse from affecting its "on" or "off" condition.

The signal at output 1 is a square wave with a repetition rate half that of the positive pulses received at the input terminal. The amplitude of the signal is determined by the ratio between resistances R12 and R9, for the lower limit, and between R12 and the combination of R9 and R8 plus the collector-emitter resistance for Q6 for the upper limit.

Experience has indicated that the ac response of the switch can be improved through the use of a capacitor, C4, between the emitter of Q5 and the positive supply voltage. The certainty with which the switch trips "on" with a positive pulse at the base of Q6 depends on the speed with which Q5 reacts to the lowered voltage on its base. C4 allows this response to be virtually instantaneous. And once current is flowing from emitter to collector of Q5, the proper bias on the Q5 base is assured by the action of Q6 in conjunction with the values of resistors R7, R8, R11 and R12. R7 and R8 are selected to provide a steady negative bias to Q5, R11 and R12 give a positive bias to Q6.

Stability in the "off" position is provided by resistor R9. The ratio of this resistance to R12 puts a reverse bias on the emitter of Q6. This bias must be overcome by a positive pulse on the base of Q6 before the switch will be tripped "on." A low value of R9 will assure protection against unwanted transient pulses on the Q6 transistor base.

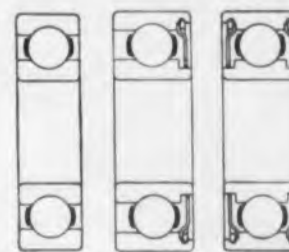
Thus by suitable selection of resistances and capacitances, the pnp-npn flip-flop can be made either bi-stable or self-oscillating. Moreover, in the bi-stable configuration, the minimum pulse that will trip the switch can be predicted and controlled with great accuracy.

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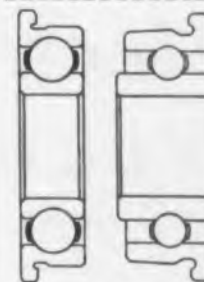
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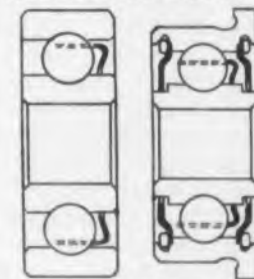
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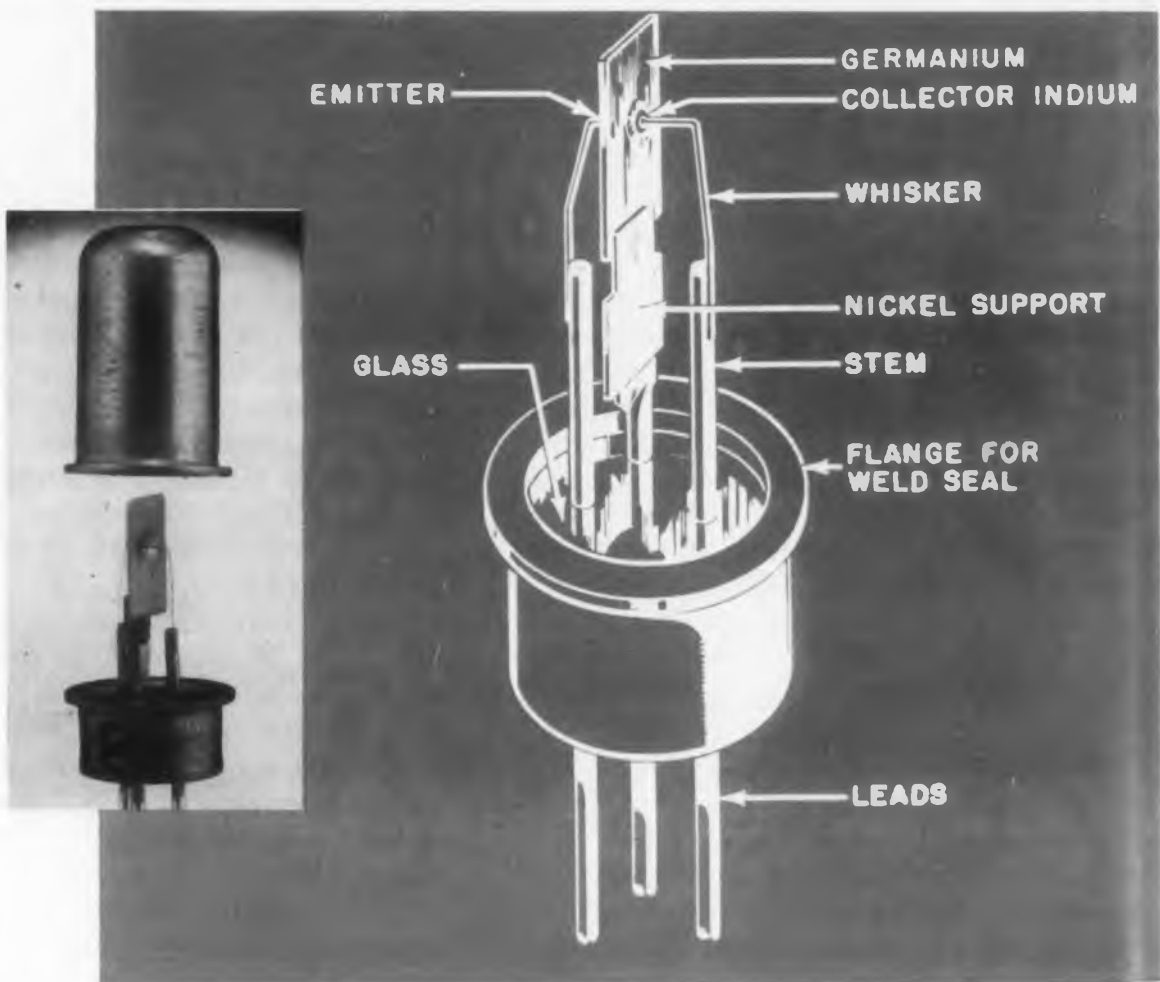
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CIRCLE 35 ON READER-SERVICE CARD

Highest Frequency Transistors Covers Entire VHF Spectrum

A NEW class of "field accelerated" transistors with maximum frequency cutoff of 100 Mc is made possible by the Micro Alloy Diffused-base Transistor (MADT) process. The MADT's constitute a new family of transistors which enable the transistorization of high-gain, high frequency amplifiers; high speed computers; high gain wideband video amplifiers; and other critical high-frequency circuitry.

Made by the Philco Corp., Lansdale Tube Co., Div., Lansdale, Pa., the MADT's are available to various voltage and frequency specifications for the design of transistorized equipment through the entire VHF and part of the UHF spectrum.



High frequency micro alloy diffused base transistor. With electrochemical techniques the collector can be placed on the edge of the graded field region, permitting high-speed operation at very low voltages.

Transistor Spectrum

The transistors have a maximum frequency from 250 mc to as high as 1000 mc. MADT gains are typically 10 db at 200 mc and greater than 16 db at 100 mc. A low cost general purpose unit is available which will deliver typically 18 db at 50 mc and 32 db at 10 mc.

A logical outgrowth of the MADT is the development of a super high speed switch. If switching time is discussed in light feet instead of millimicroseconds, a typical transistor will switch "on" or "off" in ten light feet, requiring special oscilloscopes for measurement.

The MADT is a field accelerated transistor owing its high frequency response to a grading of the resistivity throughout the entire base from the emitter to the collector with no intrinsic region. The ultra high frequency properties of the transistor are a result of the fact that the current carriers move much more rapidly from the emitter to the collector than in conventional transistors. The MADT is made from the basic structure of an electro-chemically machined surface barrier and micro-alloyed transistor with a built-in electric field added. This speeds the carrier flow from emitter to collector and overcomes much of the random diffusion effect found in conventional units.

The electrochemical technique has another advantage in that the electrodes can be precisely positioned in the graded field resulting in controlled electrode capacities, break-down voltages and switching properties. In producing a transistor for tuned amplifiers, for example, the collector is placed on a relatively high resistivity portion of the grading and the emitter on a very low resistivity portion near the surface. This results in a very low collector capacity and base required for high frequency performance.

In the design of a switching transistor, the collector is placed on a lower resistivity portion of the grading and emitter on a higher resistivity portion than in the amplifier case, so as to obtain the high gain, small rise time, and storage values desired for this application. Using electrochemical techniques, the collector can be placed directly in the edge of the graded region, so that the high speed operation of the transistor is maintained down to very low voltages.



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RATINGS

Maximum inverse working voltage: 100V.
Average forward current: 200 mA.
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CIRCLE 36 ON READER-SERVICE CARD

Selection and Application of Travelling Wave Tubes—II

This is the concluding part of an article begun in the Nov. 1 issue of ELECTRONIC DESIGN. It deals with the design of solenoids and power supplies associated with travelling wave tubes.

Part I presented the procedures in selecting proper operating performance of a TWT and the most suitable circuit design, together with a discussion of the practical problems associated with designing and packaging a travelling wave amplifier.

AFTER THE operating parameters have been established, the design of the power supplies and associated circuitry can be effected. Necessarily the first consideration, because of its proximity, is the focusing field. This field may be produced by permanent magnet assemblies usually in a form called periodic focusing. Since this type of a structure is not generally available, only electromagnetic focusing will be discussed. This field is very critical as to alignment, but not very critical as to magnitude. The tube design used at FTL demands that the gun structure be free of magnetic fields. The tube is constructed with "barriers" which are disks of magnetic material at each end of the helix to assure parallel flux lines in the helix region. These requirements lead to an electromagnet in the long solenoid form wound on a non-magnetic tube with an enclosing magnetic shield. A picture of a miniaturized TWT and solenoid is shown in Fig. 9. The end plates have holes dimensioned to accept the TWT in a Class 4 fit in order to prevent flux fringing at this joint. In some cases, the most careful dimensioning and quality control practice does not allow this type of construction to be dependable in the alignment of the helix and magnetic field. This condition arises both in low noise tubes and in high power tubes. For this reason, it is sometimes

necessary to rotate the tube for minimum helix current or to construct the solenoid so the twt may be tilted a small amount to effect this alignment.

The cooling of the TWT is simple except in the case of high power TWT's in which the collector dissipates several hundred watts. In this case the TWT collector has fins attached and is cooled by air.

The electrical connections of the tube are usually made by flying leads to the filament cathode and grid. Since the accelerating anode helix and collector are all at about the same potential, we find that the easiest method of connecting these is to ground them through the barrier end plate joint, and to connect the collector to a separate lead if it is necessary to add a bias to avoid secondary emission. The solenoid mass does cause a shock problem and must be securely fastened, as heavy transformers must be, in military equipment.

The selection of the solenoid material is based on the relative importance of size, weight, power dissipation, and ease of cooling. Decisions involving compromises of the optimum materials and sizes must be made. To do this, we can derive an equation for power from the fundamental single turn solenoid which is:

$$P = \frac{8.7}{K} B^2 L \left(\frac{r+1}{r-1} \right) \times 10^{-6} \text{ watts}$$

where B is the flux density

L is the length in inches

r is the OD to ID ratio

K is a constant which includes the packing factor and relative resistance. If this function is plotted for a fixed gauss and length, we obtain the curve of Fig. 10.

Note that the power asymptotically approaches infinity at $r = 1$. By inspecting the equation, we can see that if the OD were fixed due to size limitations that the ID should be made as small as possible, and hence, the winding should be as close to the electron beam as possible. Hence, we see a marked advantage of the new small diameter tubes over the older types. The curve shows the advantage of working with OD to ID ratios of 2 or greater.

The winding material will determine the factor K in the equation. We find practical values of K to be as listed:

	Copper	Aluminum
Foil	0.85	0.53
Wire	0.70	0.45

If the smallest size were desired, which goes hand in hand with the most efficient material, we would use copper foil. If a light inefficient solenoid were required, aluminum foil is most likely. The most



Fig. 9. A miniaturized TWT with its solenoid.

N. Hansen and A. Nielsen
Federal Telecommunication Labs.
A Division of I. T. & T.
Nutley, N. J.

inexpensive and also the easiest to design is copper wire. If the solenoid dissipation is relatively small and if the cooling problem is not difficult, as is the case in equipment shown later, an air cooled wire-wound solenoid is the best choice. In military equipment designed for aircraft, for example, the choice is usually a liquid cooled copper foil solenoid. It is important to note that in foil solenoids the heat is readily conducted in an axial direction, this being the reason for cooling the end plates on foil solenoids.

At this point the material can be decided upon. Knowing the size limitations, the power required at room temperature can be found from the equation mentioned before, and then the maximum power at the highest temperature expected. The maximum temperature the insulation will allow could be used as the maximum average winding temperature. At this temperature, of course, is the highest voltage drop, since the current must be determined only by the flux density. Voltage is dictated by the solenoid supply. Because of the type of power supply this is 80 v. If the winding is designed for this voltage at 120 C, or 80 C above a 40 C ambient, as indicated by Class B insulation, it will be 40 v at -55 C. Therefore, the solenoid supply must be designed for a 40 to 80-v range. Since the power and voltage are known, the current is also known. The design is completed by selecting the number of turns to produce the required gauss with the known current, and then determining the wire size by means of trial calculations.

The solenoid can then be wound. In case it is wire-wound and air cooled (as is the one in the equipment shown), the end plates and shell are machined from soft iron and, after winding on a

spool formed by the core and end plates, the shell is fastened to the end plates serving as the means of holding the assembly together.

Power Supplies

The TWT solenoid requires a constant current to maintain the field. In general, the field can vary as much as ± 5 per cent without degrading performance. In searching for a small efficient supply we find that the recent advances in core material permit the use of magnetic amplifiers, and ideal component around which to build the solenoid supplies. A circuit well suited here is commonly called the "self-saturating bridge magnetic amplifier" (Fig. 11). The regulation is accomplished as shown in the control characteristics (Fig. 12). The load ampere turns (supplying negative feedback) are bucked out by the reference current ampere turns; the net ampere turns determine the output.

The diodes are usually germanium or silicon since they are more efficient than other types and are small. The saturable reactor is a two-core device using toroidal tape wound cores of grain oriented 50 per cent nickel iron alloy called Delta-max, Orthonal, and other tradenames. The design of the reactor is relatively simple, using much the same formulae as transformer design. A design procedure is covered in the "Reference Data for Radio Engineers," Fourth Edition, published by I. T. & T. Available cores should be selected from those with ID to OD ratios of approximately two-thirds to three-fourths.

The actual core size is selected on the basis of its hold-off volt-amperes. The hold-off voltage is usually 85 to 90 v to take care of the 20-v minimum specified in the section on solenoids. This deter-

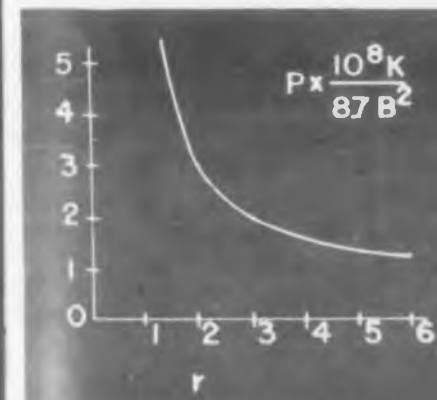


Fig. 10. Solenoid power as a function of OD to ID ratio with field strength and length kept constant.

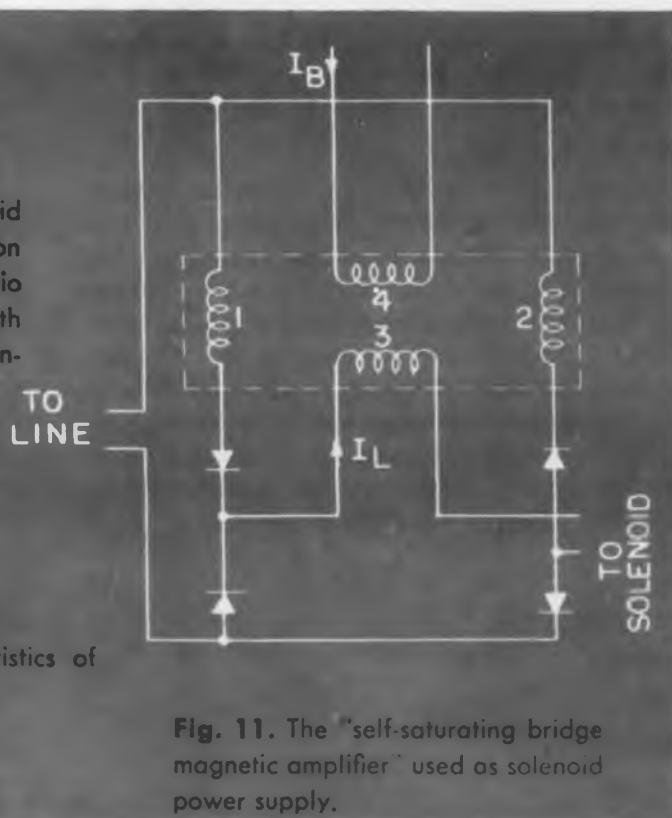


Fig. 11. The "self-saturating bridge magnetic amplifier" used as solenoid power supply.

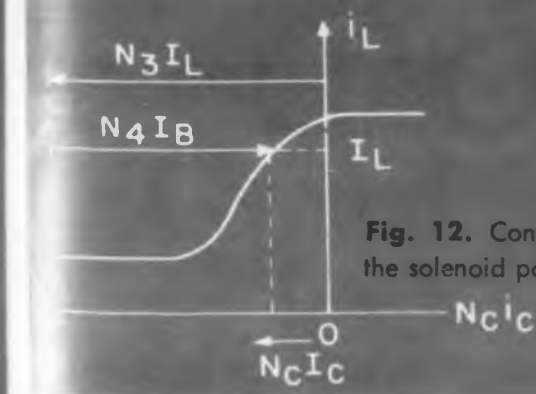


Fig. 12. Control characteristics of the solenoid power supply.

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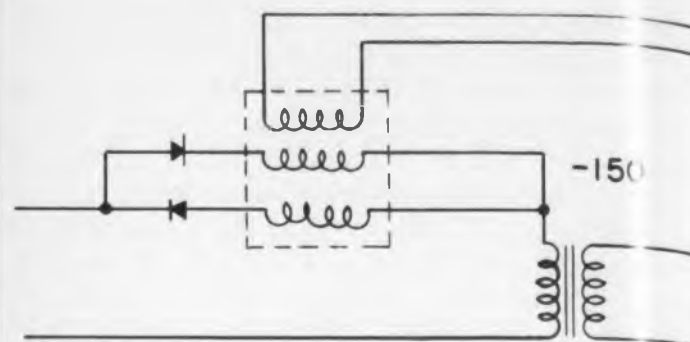


Fig. 13. A 10 kv accelerating power supply using

magn...
mines the load winding turns. The wire size is determined by the allowable temperature rise. A figure of 1000 circular mils per amp is usually adequate for Class B insulation in 65 C ambients. The other windings are determined from the regulation requirements. Usually 30-ampere turns on the feedback and on the reference winding are sufficient. Then the windings should be checked to see if they will fit on the selected core.

In the packaged amplifier, the next consideration is that of the accelerating voltages, ranging from 500 to 15000 v. The 500-v supplies can readily be regulated using standard vacuum tube circuitry. However, a 15000-v, 25-ma supply using vacuum tube regulation is nearly out of the question because of its size and inefficiency. It would appear that, sacrificing only response time, a magnetic amplifier would be a good component to use in this case also. The magnetic amplifier can be used as a replacement for the series tube as in the circuit of Fig. 13. Here the magnetic amplifier is connected so that it varies the ac reaching the rectifiers and is controlled by a dc coupled feedback amplifier.

The string of gas tubes in Fig. 14 is used to furnish dc coupling to the low impedance control winding without the loss that would be entailed with resistors, thus allowing us to utilize the gain of the magnetic amplifier. The supply holds the voltage to ± 2 per cent with line voltage changes from 105 to 125 v and is adjustable from 500 to 650 v.

In addition to the major supplies, other voltages

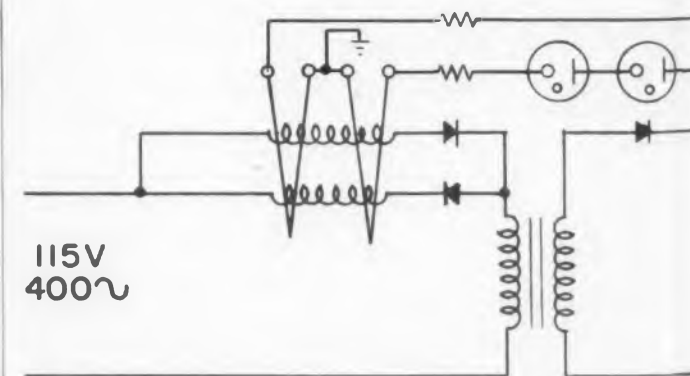
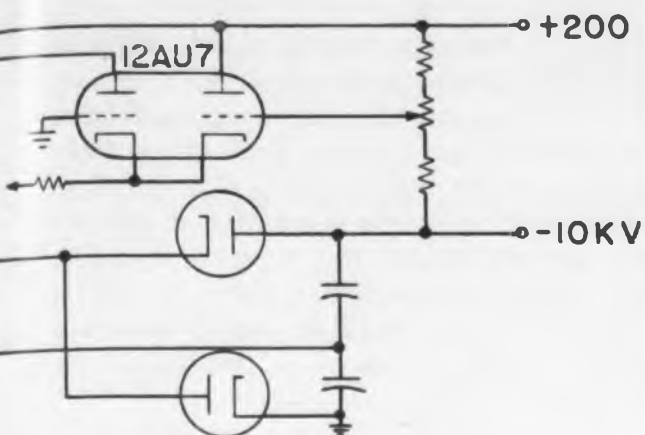


Fig. 14. A power supply with series gas tubes to



using a magnetic amplifier as a series control element.

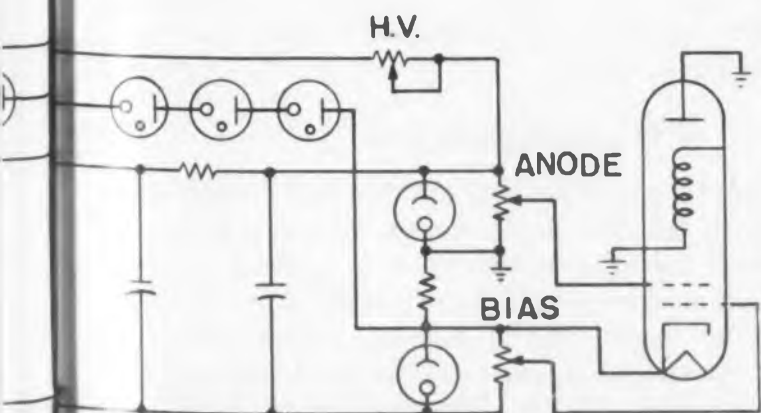
must be applied to the grids and/or focusing electrodes of the TWT. This is in the same nature as the bias on a triode and the same techniques such as cathode bias can be used with TWT's. Some means of adjusting the bias and focusing should be made. These requirements were met by using glow discharge regulator tubes in series with the power supply in the packaged TWT amplifier mentioned previously. Sometimes it is necessary to operate the collector positive with respect to the helix to prevent secondary emission of the collector from reaching the helix. This can be done since some positive voltage is usually available in equipment of this type.

Also required in the packaged TWT amplifier are access points to the grid to allow pulsing or modulating the TWT. The TWT may be considered as a low mu triode in applying pulses or modulation. Means for measuring the cathode, and helix current should be included.

Alignment of the tube involves setting the parameters to those specified on the data sheets and adjusting the solenoid current and bias for minimum helix current and then setting the high voltage for maximum output. These parameters are interdependent, but no difficulty in this sort of alignment is found.

Acknowledgement

The packaged travelling wave tube amplifier discussed in this paper is credited to Mr. L. V. Kollmar of Federal Telecommunications Labs. The TWT displayed was developed under U.S.A.F. funds and is gratefully acknowledged.



to furnish dc coupling to the control winding.

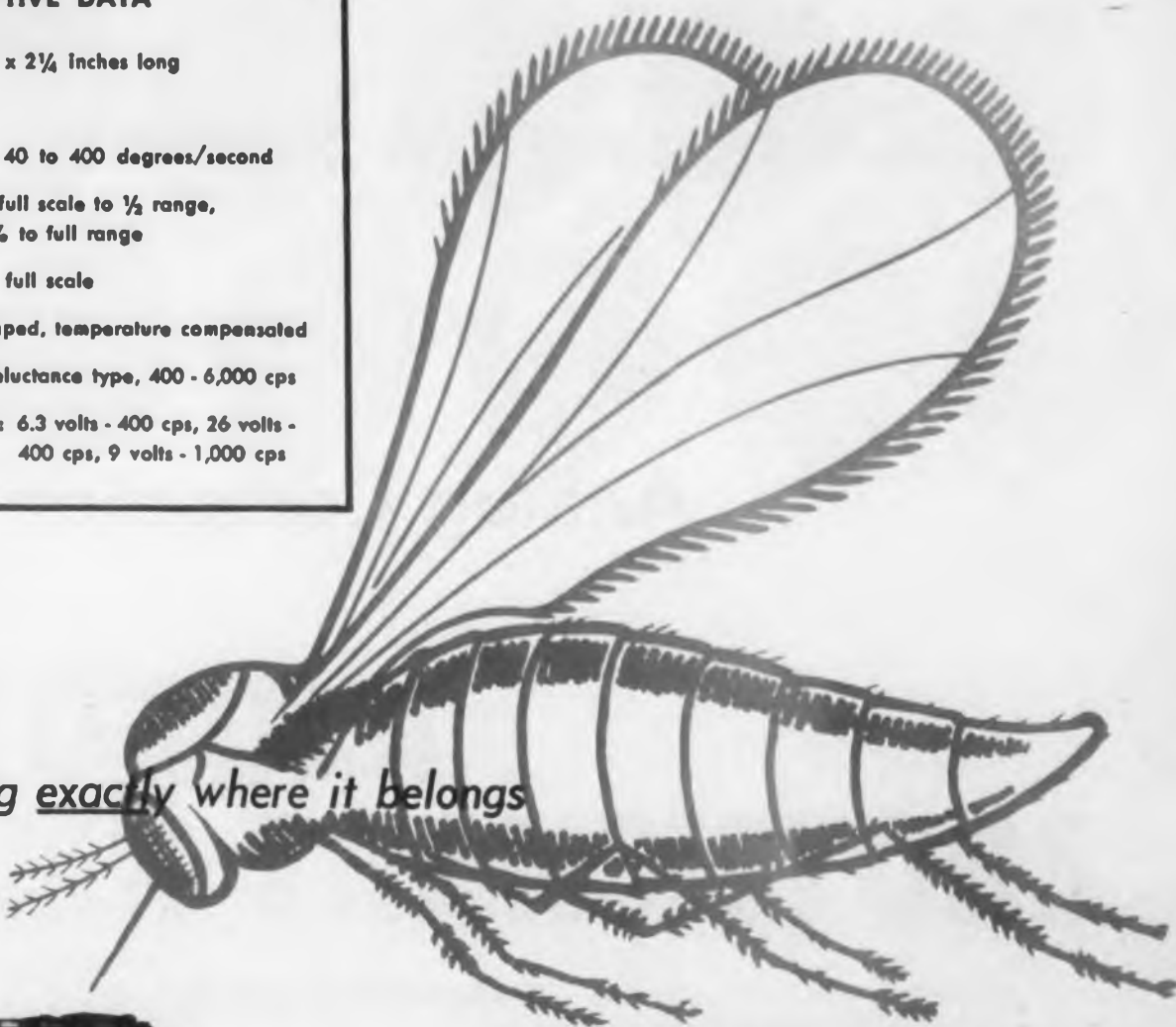
DESCRIPTIVE DATA

- SIZE: 1 inch diameter x 2¼ inches long
- WEIGHT: 3.8 ozs.
- FULL SCALE RANGE: 40 to 400 degrees/second
- LINEARITY: 0.1% of full scale to ½ range, within 2% to full range
- RESOLUTION: 0.01% full scale
- DAMPING: Fluid damped, temperature compensated
- PICKOFF: Variable Reluctance type, 400 - 6,000 cps
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CIRCLE 39 ON READER-SERVICE CARD

Designing FM Systems with an Analog Computer

Henry A. Musk
Electronics Division
Westinghouse Electric Corp.
Baltimore, Md.

Background of Problem

High power transmitters in the vlf band have a special antenna problem not found at the higher frequencies. The antenna circuit is equivalent to a series resonant circuit with a Q of the order of 700. Since the time constant of build-up or decay is $Q/\pi f_0$, amplitude modulation keying speeds are limited to about 20 words per min with a typical 90 per cent rise time of 30 msec.

It was demonstrated in 1948 at the Westinghouse laboratories that this keying speed limitation could be overcome by using a newly developed principle of frequency modulation transmission through synchronously tuned antenna networks. In the fm system the transmitter master oscillator is frequency shift keyed. The antenna circuit resonant frequency, in addition, is maintained in synchronism with the oscillator instantaneous frequency by keying a saturable reactor in the antenna circuit. Under these conditions the fm signal is transmitted without distortion or power loss. A 500 kw installation using this system has been made and described.¹ In 1949 a patent application was made by the author which described a system of this type adapted for use with a fixed frequency source such as a crystal oscillator or an Alexander-son alternator installation. Since the driving oscillator cannot be frequency modulated directly, fm may still be obtained under certain conditions by merely keying the antenna. This system is both experimentally and analytically more complicated and was investigated with a specially constructed analog computer. The results of this investigation are the subject of this article.

AN ANALOG computer can be used to compute variable frequency network problems, or variable parameters in general, eliminating the tedium of direct analytic computation. This article illustrates how a specially-constructed analog computer was used to analyze synchronously tuned antenna networks for transmitter frequency modulation. The equivalent circuit studied is shown in Fig. 1. The fundamental characteristics and quantitative calculations for the circuit were determined by the computer.

The Problem

In Fig. 1, the current in the antenna, $I(t) = A(t)e^{j\theta(t)}$, is to be determined by the analog computer.

The required computer outputs are:

1. $A(t) =$ amplitude
2. $\omega(t) = d\theta/dt =$ instantaneous frequency

The frequency modulation investigated for the vlf band is 15 to 30 kc.

The inductance of the loading coil is varied at the keying frequency f_m by an amount, K , which is of the order of 1 per cent. The antenna is represented by the capacity, C , and the total radiation and circuit losses, r . The transmitter input is $Ee^{j\omega_0 t}$. The fundamental characteristics of the circuit to be determined are the conditions under which the above system produces frequency modulation, not phase modulation, of the radiating current, $I(t)$.

The fundamental characteristic demonstrated is that frequency modulation will be produced by the keying system of Fig. 1 subject to certain conditions:

1. K is much less than 0.1.
2. The two resonant frequencies of the circuit f_1 , and f_2 , corresponding to the switch open and closed, are symmetrically below and above the carrier frequency, f_0 , with an error less than half the half-power bandwidth of the circuit, $f_0/2Q$.
3. The circuit Q is high enough so that the time constant $Q/\pi f_0$ is greater than the modulating period $1/f_m$ at which the switch is operated. This condition sets a lower limit on f_m for a given Q and f_0 requiring that a sub-carrier frequency be used to frequency modulate the antenna.

Quantitative calculations demonstrate the above conditions and also circuit action when these conditions are not fulfilled.

The Analog Computer

Special equipment was built to derive the output $\omega = d\theta/dt$ since this data cannot be obtained from a standard analog computer. This equipment can be used to analyze any frequency modulation network problem. The system diagram for the computer is shown in Fig. 2. A crystal-controlled carrier is generated from a Hewlett Packard 522-B electronic counter at the analog frequency of 1 cps,

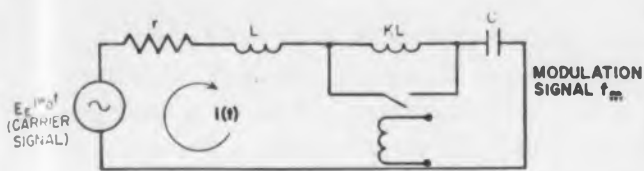


Fig. 1. The equivalent circuit of the antenna system.

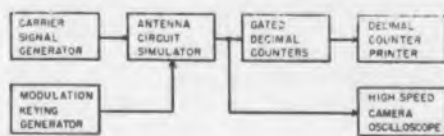


Fig. 2. Block diagram of the analog computer system.

which corresponds to the actual frequency of 15,000 cps. The antenna circuit simulator is composed of four operational amplifiers as shown in Fig. 3. The output, $I(t)$, is fed to a novel, digital-type fm detector composed of five gated decimal counters, Hewlett Packard type AC-4A. The counters receive 100 kc pulses which are gated at the instant $I(t)$ goes through zero so that the time for a period of $I(t)$ is measured. During the next cycle of $I(t)$ this number is printed by a decimal counter printer so that every cycle of $I(t)$ is measured. The decimal counter printer is the Berkeley model 1452. The amplitude is continuously recorded by a Fairchild camera oscilloscope. The keying signal for the modulation relay is generated by a Hewlett-Packard 202A function generator at about 0.02 cps, corresponding to the actual frequency of 300 cps.

Because of the low frequency keying limit for this problem, f_m would have to be a subcarrier for teletype modulation of alternator transmission. Teletype keying variations are at a rate of only 2 to 23 CY. This subcarrier would be turned on and off by the teletype signal. Data recorded here is in terms of the subcarrier only, since no information is gained from keying the subcarrier. However, in all cases the carrier amplitude is allowed to stabilize before turning on the subcarrier.

The frequency shift is 1 per cent; the fm detector output is in terms of carrier period rather than fre-

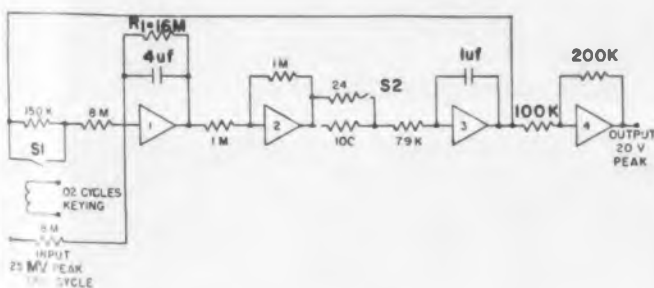


Fig. 3. The antenna circuit simulator. Standard $1.0 \mu\text{f}$ integrators with 30 K feedback pots were not used. The Q is set with R_1 ; 16 megohms gives a Q of 800. The switch, S_1 , across the 150 K resistor is used to stabilize the carrier amplitude prior to starting the symmetric keying. The output is the analog of E_c rather than $I(t)$. The $I(t)$ can be obtained from amplifier 2.



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MN25 (2N351 Reserved)	-40	-30	60	34	4	7
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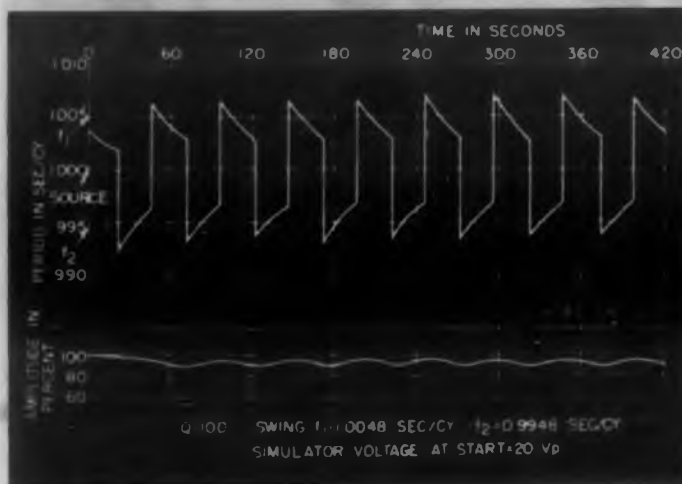
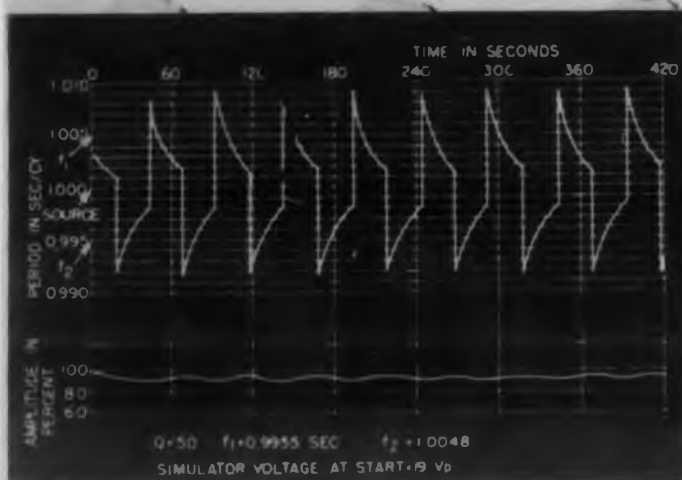


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CIRCLE 40 ON READER-SERVICE CARD



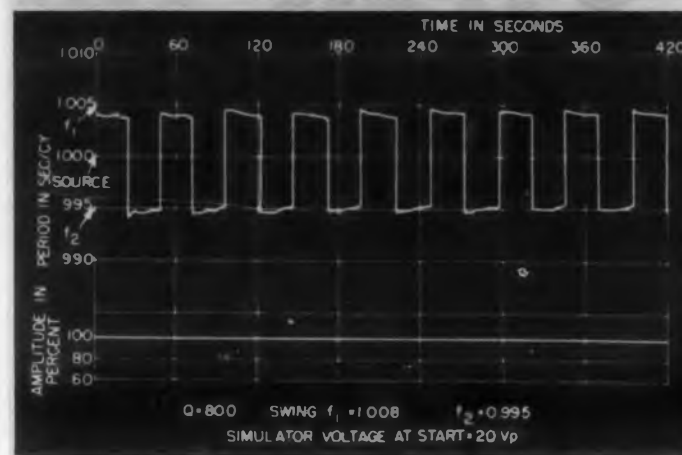
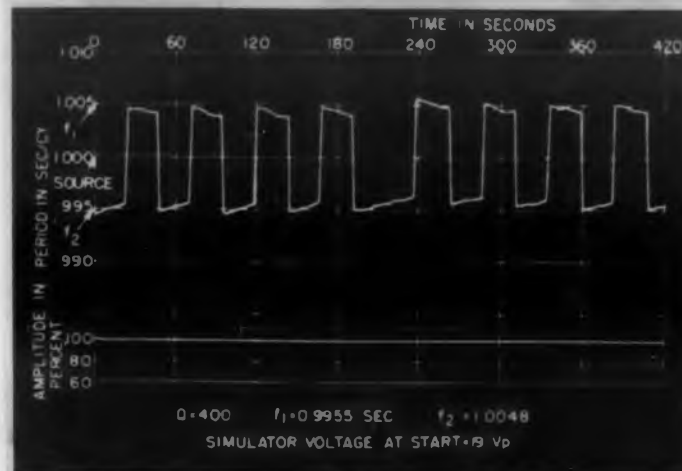
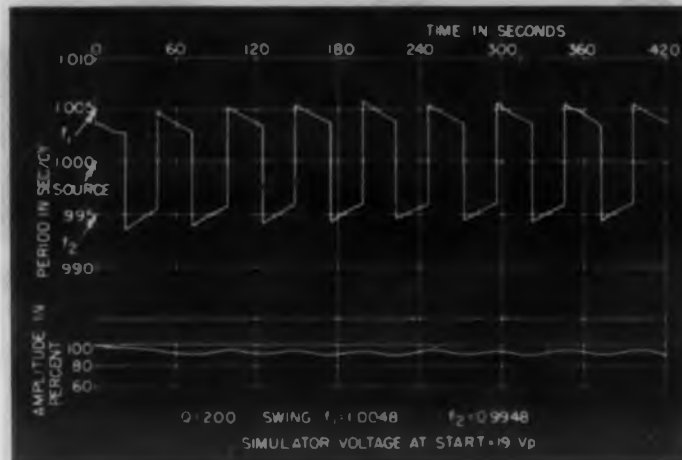
Curves of Period (sec/cy) and Amplitude (per cent) with respect to time for various values of Q . Curves 1 through 5 are plotted for symmetric frequency shift. Curves 6 through 9 are for asymmetric frequency shift. Subcarrier rate is 50 sec/cy; source period is 1 sec/cy.

quency. However, since the shift is 1 per cent, no appreciable linearity error occurs from plotting the reciprocal of frequency.

The antenna Q values are 800, 400, 200, 100, and 50. Curves of amplitude envelope and instantaneous carrier period are shown for two cases, symmetric shift and asymmetric shift.

Adjustment of the analog system to prescribed values can be accomplished quite accurately with the equipment mentioned above and is described in the Appendix.

Symmetric Frequency Shift. Curves 1 through 5 show the events per time of each modulation cycle for the various circuit Q 's. At low values of Q , transition to phase modulation can be observed. Note that with symmetric shift no appreciable keying transient is observed. The carrier has been allowed to stabilize prior to time equals zero as previously mentioned. For $Q = 800$, no amplitude change can be measured and the output frequency



is almost a square wave. Hence, for a typical antenna, 300 cps is a reasonable subcarrier frequency.

Asymmetric Frequency Shift. Several interesting differences can be seen in curves 6 through 9 as compared to symmetric shift. For $Q = 50$, even though the source is shifting from 1.000 to 1.008 (0.8 per cent), the output frequency shifts symmetrically about the source frequency after a short keying transient.

The most typical fm curve is for $Q = 200$, curve 8. Here the output shift again becomes symmetric after a long keying transient, but the amplitude has dropped to 50 per cent.

Under these conditions the alternator would be unloaded and the system would not work. It is assumed that if the amplitude remains constant then the alternator load is constant and no reduction in alternator power output will result.

The data for curves 9 $Q = 400$, and for $Q = 800$ (not shown) were slightly erratic, but the phenom-

ena would appear to represent an oscillatory keying transient both in frequency and amplitude analogous to a sine wave applied to a series resonant circuit, perhaps 20 db down from resonance in the steady state.

Note that curve 9 shows the results of a slightly asymmetric shift. The keying transient is not objectionable.

High Speed Problem

Operational tests over long distances on high speed keying showed that standard teletype conversion equipment gave more errors in the presence of impulse noise (static) than reception by ear at lower speeds. Noise discriminating circuits can be developed at the receiver to eliminate these errors.

Conclusion

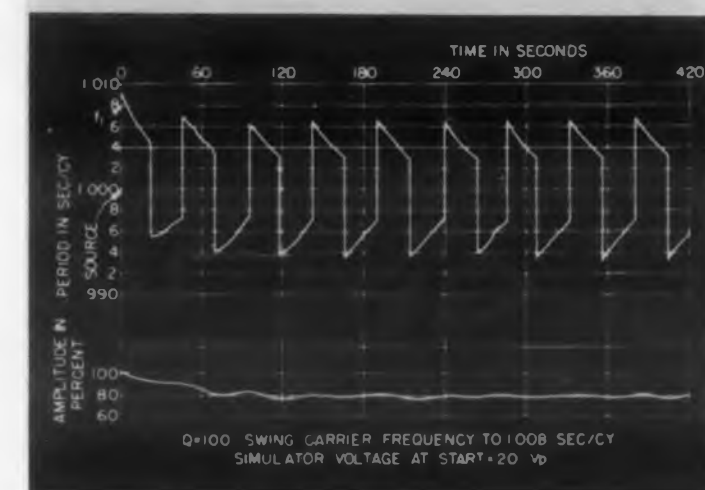
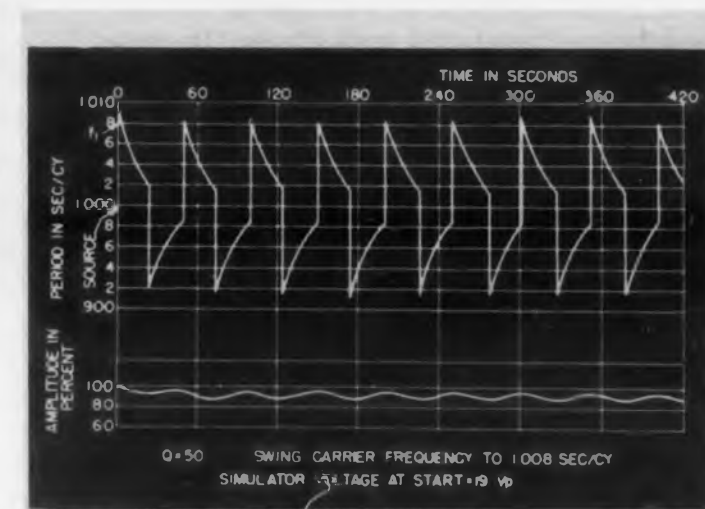
The conditions under which frequency modulation transmission is possible in the vlf band from a fixed frequency source can be determined using analog computer techniques.

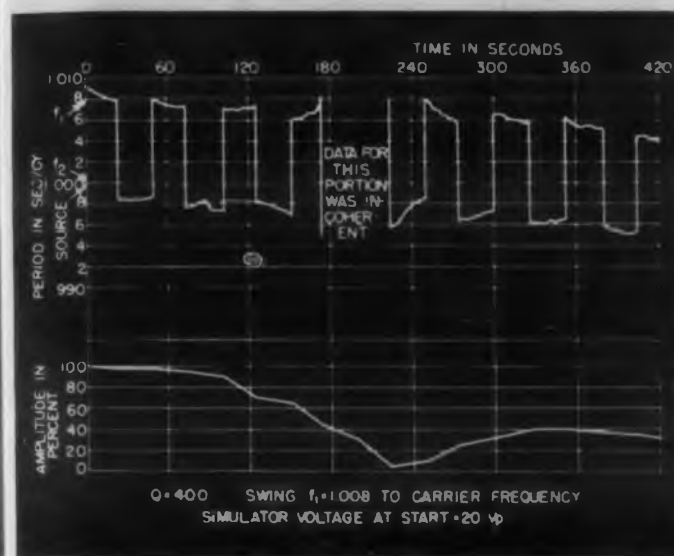
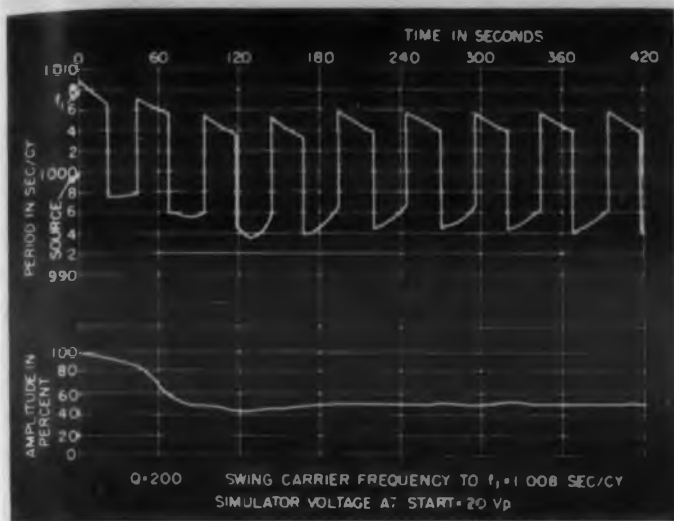
The analog computer technique described is applicable to any fm circuit analysis problem.

Appendix

Operational Procedures

The self resonant frequencies of the series circuit can be measured (to four figures) by applying a battery to the input and reading the time on the printer. The source





frequency is measured similarly by connecting it directly to the fm detector.

The Q can be measured by applying a battery to the input and counting the number of cycles, n , for the envelope on the Fairchild camera photograph to drop to $0.368 = 1/e$. For high Q's it is more convenient to remove the counter reset and watch the amplitude drop on the oscilloscope. At 0.368 the counter will read $n/2$. At this point $Q = n\pi$.

Transient response at and near resonance was checked for an applied sine wave with the Fairchild camera.

It is inconvenient to make a one cycle sine wave, hence, a rectangular wave was actually applied to the input. The Q of the circuit eliminates harmonics, however.

References

I. I. Jacob, H. N. Brauch, "Keying VLF Transmitters at High Speed", *Electronics*, Vol. 27, No. 12, pp. 148-151, Dec. 1954.

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Standard
rectifier

hcd* RADIO RECEPTOR Petti-Sel SELENIUM RECTIFIERS are revolutionizing the field!

* high current density

- ▶ 100,000 hours estimated life
- ▶ Lower voltage drop
- ▶ Higher current density
- ▶ Less reverse leakage
- ▶ Smaller size

Both rectifiers are rated at 26V, 8 amps,
but notice the significant space saving in the
compact Petti-Sel unit.

RRco. Petti-Sel
rectifier

compare the size ...

compare the specs ...

STANDARD SELENIUM RECTIFIERS								
NOMINAL CELL SIZE (INCHES)		RRco. CELL CODE	Continuous DC Amperes at 35° C Ambient					
Vert.	Horiz.		SINGLE PHASE		THREE PHASE			
			Half Wave	Center Tap	Bridge	Half Wave	Center Tap	Bridge
1.0	1.0	M	.11	.22	.22	.29	.40	.33
1 1/8	1 1/8	P	.23	.45	.45	.60	.81	.67
1.5	1.5	Q	.45	.90	.90	1.2	1.6	1.3
2	2	S	.70	1.4	1.4	1.8	2.5	2.1
3	3	U	1.6	3.2	3.2	4.2	5.8	4.8
3 3/8	3 3/8	V	2.0	4.0	4.0	5.3	7.2	6.0
4	4	W	3.0	6.0	6.0	8.0	10.8	9.0
4.5	5	G	3.75	7.5	7.5	10.0	13.5	11.2
4 1/4	6	T	4.2	8.5	8.5	11.0	15.0	12.5
5	6	H	5.0	10.0	10.0	13.3	18.0	15.0
6	7 1/4	L	7.5	15.0	15.0	20.0	27.0	22.5

RRco. PETTI-SEL SELENIUM RECTIFIERS								
NOMINAL CELL SIZE (INCHES)		RRco. CELL CODE	Continuous DC Amperes at 35° C Ambient					
Vert.	Horiz.		SINGLE PHASE		THREE PHASE			
			Half Wave	Center Tap	Bridge	Half Wave	Center Tap	Bridge
1.0	1.0	6	0.2	0.4	0.4	0.6	1.0	0.6
1.3	1.3	11	0.5	1.0	1.0	1.5	2.5	1.5
1.6	1.6	16	0.75	1.5	1.5	2.25	3.75	2.25
2	2	25	1.25	2.5	2.5	3.75	6.25	3.75
2.6	2.6	44	2.25	4.5	4.5	6.75	11.25	6.75
4	4	100	4	8	8	12	20	12
4	8	200	8	16	16	24	40	24
4	12	300	12	24	24	36	60	36
8	8	402	16	32	32	48	80	48
8	12	600	22.5	45.0	45.0	67.5	112.5	67.5
8	16	800	30.0	60.0	60.0	90	150	90

In case you haven't noticed, the yellow and gray areas denote actual comparative sizes of the two rectifier types.

and compare the prices! HCD Petti-Sel rectifiers, developed in Western Germany by Siemens and now made in the U.S. by Radio Receptor, offer many important electrical advantages over standard types plus economic advantages.

See for yourself — We'll be glad to send you further information on this remarkable new rectifier line. Submit your requirements to Section D-12R

Radio and
Electronic Products
Since 1922



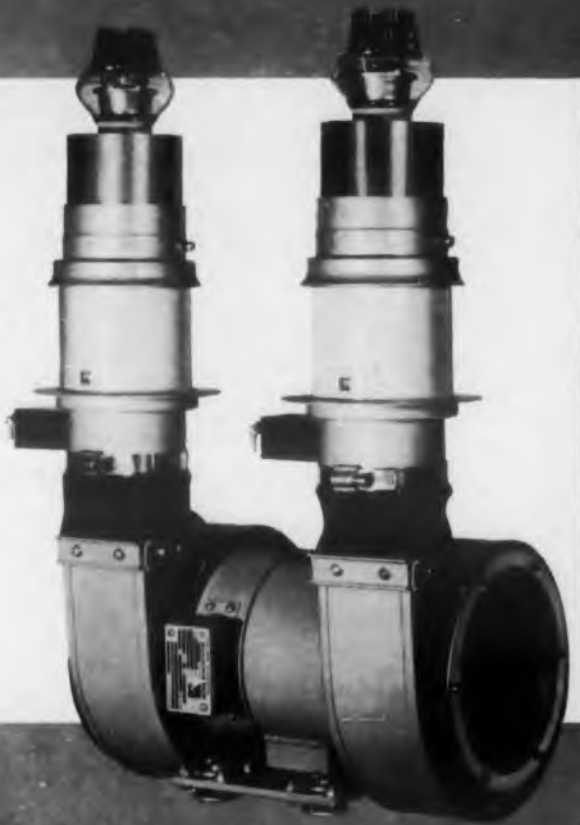
Semiconductor Division
RADIO RECEPTOR COMPANY, INC.
Subsidiary of General Instrument Corporation

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Radio Receptor products for Industry and Government:
Germanium and Silicon Diodes, Selenium Rectifiers, Thermatron Dielectric
Heating Generators and Presses, Communications, Radar and Navigation Equipment

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•
**Special Air
 Performance
 curves to suit
 electronic tube
 applications**



•
***Model A simplex-duplex
 “communication” quality blowers***

➤
 New Catalog section #40101-1 describes **60 DIFFERENT
 TYPES** covering almost any conceivable requirement in
 TV-Broadcasting and Radio Communication.

Driven by Rotron's new "L" Frame Induction Motors
 1/6 HP to 5 HP
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EXTREME RELIABILITY



ROTRON



MANUFACTURING CO., INC.

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CIRCLE 42 ON READER-SERVICE CARD

Compact Digital Voltmeter

FLEXIBILITY and compactness are the outstanding features of this newly developed digital voltmeter. The use of a magnetic amplifier together with miniature and subminiature parts assured a compact design. Two-unit construction lends flexibility and allows convenient application as a component of other equipment. Through a carefully planned layout, neither accuracy nor accessibility have been sacrificed at all.

The instrument may be used as a digital voltmeter or digital ratiometer which features compact design, good resolution, high accuracy, high input impedance, and rugged construction. Full scale response is about four seconds. It covers ranges from 0-1 vdc to 0-1000 vdc with accuracy and reading resolution of 0.1 per cent.

It was designed by John H. Klopp of The Martin Co., Baltimore, Maryland to provide automatic measurement with a high degree of accuracy. It is now used as a standard component of electronic test equipment.

The two units (Fig. 1) are a digital read-out section which can be panel mounted

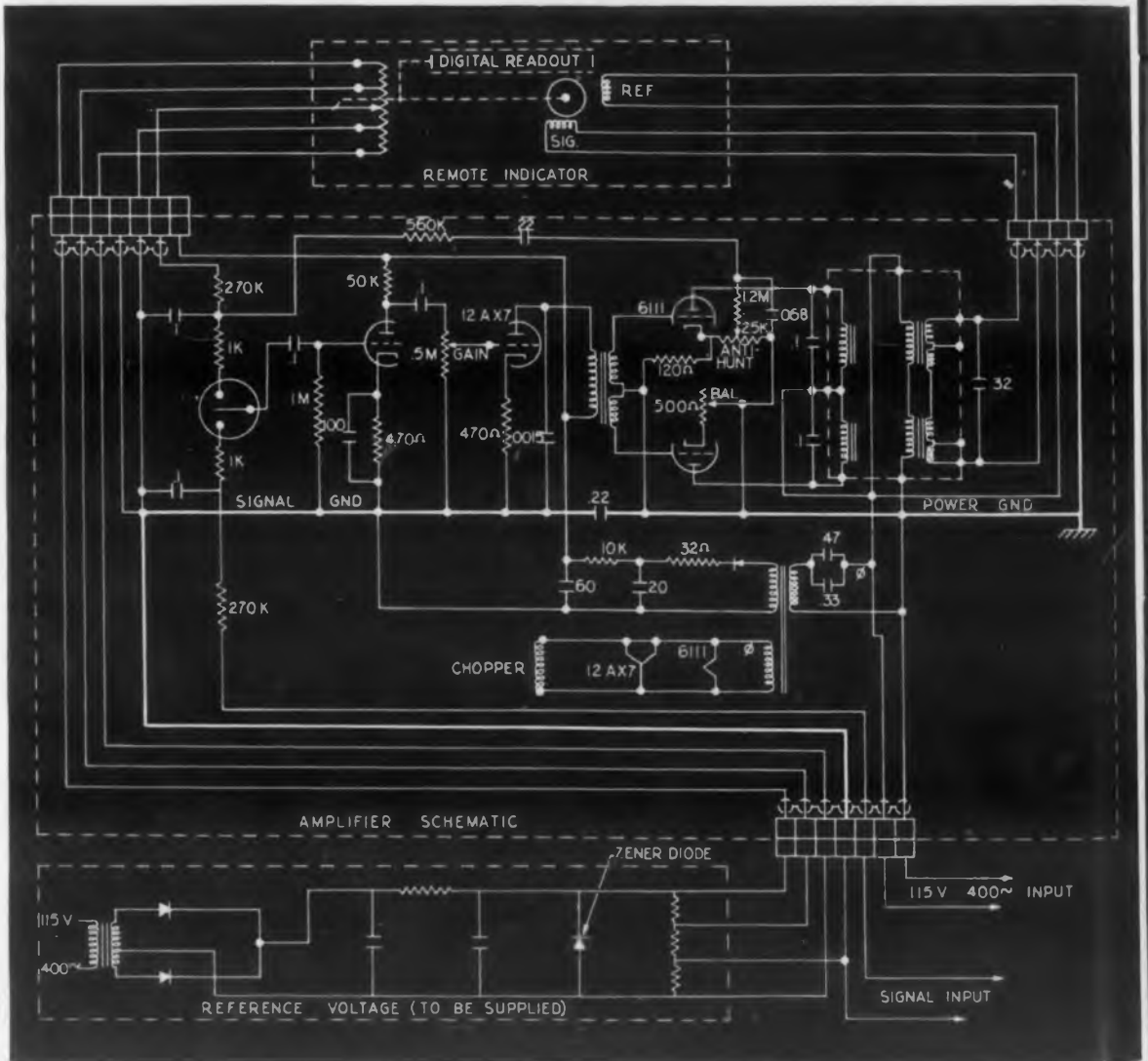


Fig. 2. Digital voltmeter schematic. Two tubes, a chopper, and a magnetic amplifier are the heart of the amplifier.



Fig. 1. Unusual flexibility and compactness are provided in this digital voltmeter.

in a standard 3-1/2 in. hole, and an amplifier, 5 in. high by 4 in. square, which mounts on a separate chassis.

The amplifier (Fig. 2), is a plug-in type, receiving input power and reference voltage from the equipment with which it is used. Scale switching is done on the equipment, obviating the need for selector switches on the meter. The amplifier consists of a chopper input, vacuum tube ac preamp, and a magnetic amplifier which serves as a phase demodulator and driver for the servo motor. Very high gain is incorporated to provide good resolution. A feedback arrangement prevents hunting while a gain control makes the overall response more uniform when different reference voltages are employed. The unit employs a balance potentiometer to compensate for inherent electrical unbalance.

A 1 v reference is used when the instru-

ment is to measure on the 0-1 v range. On all other ranges a 10 v reference is required, together with appropriate input attenuators.

The digital readout section (Fig. 3), consists of three components—a gearhead servo motor, an 11 turn Helipot, and a 10 turn digital dial assembly. These are direct, in line coupled, and housed in an aluminum tubular case. The Helipot provides for five per cent overtravel on both ends of all ranges before engaging the mechanical stops. This permits full utilization of all ranges and makes it possible to read slightly negative going voltages without having to switch polarity.

The accuracy of the system is a function of the accuracy of the Helipot and the reference voltage. Using a Helipot with 0.025 per cent linearity and zener diode regulation in the reference supply, an overall accuracy of 0.1 per cent is easy to get.

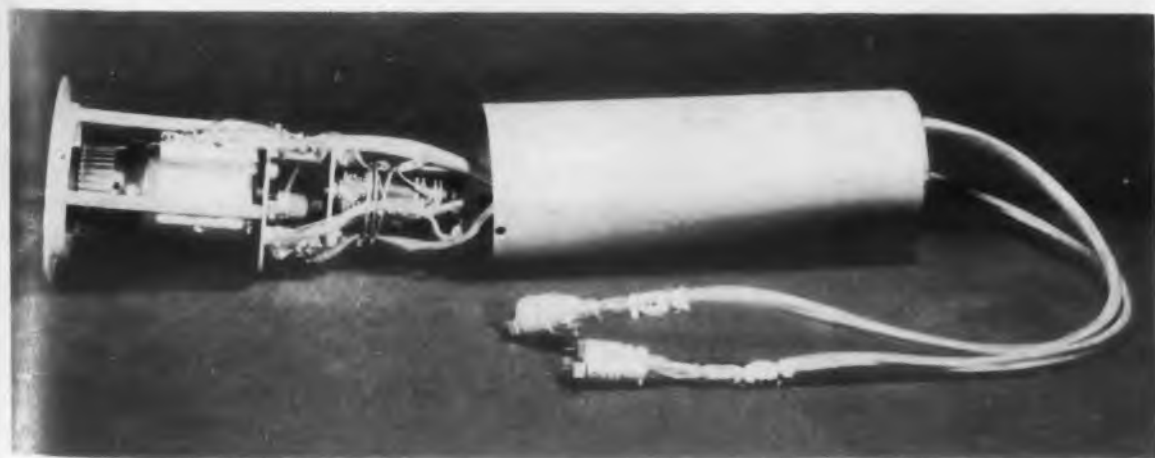


Fig. 3. Digital readout section. Only three components are in this easy to get at, reliable unit.



DRAW YOUR OWN CURVE this overload relay is now tailored...to your equipment

NEVER BEFORE has any practical overload protector offered such close-tolerance specifications.

In most ratings, the Heinemann Silic-O-Netic Overload Relay may now be specified to trip on overloads as small as 15%. Time-delay characteristics can be selected which will permit starting inrush yet give high-speed tripping at critical load points.

Operating on the hydraulic-magnetic principle, this relay will always carry its full rated load despite ambient temperatures. It establishes a new and fully dependable close-tolerance between "must-hold" and "must-trip" current values.

Now, Silic-O-Netic Relays are available with tailored response characteristics. Within limitations, you specify the current value and the tripping time. Here is the ideal means of protection . . . an overload protector precisely rated in current and time delay to your specific equipment.



The full facts about tailored overload protection are given in Bulletin 5102. Send for your copy.

HEINEMANN

ELECTRIC COMPANY

Plum Street

Trenton 2, N. J.



CIRCLE 43 ON READER-SERVICE CARD

New Products

Teflon Terminals Installed in One Step

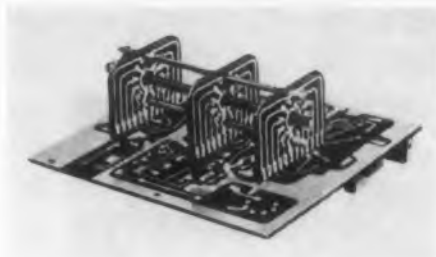


Specifically designed for quick insertion in amplifiers and other miniature chassis, these Trinsel terminals require one swift motion for permanent installation and sealing. The Teflon terminal gives during insertion, then expands to hold permanently in place. Because of the material used, more severe shock, electrical and temperature conditions can be withstood.

Tri-Point Plastics, Inc., Dept. ED, 175 I. U. Willets Rd., Albertson, L.I., N.Y.

CIRCLE 44 ON READER-SERVICE CARD

PC Rotary Switches Dip Soldered Connection



Designed for plug-in installation on printed circuit boards, these rotary switches are suited for any circuit requiring multiple switching. Consisting of a standard rotor and phenolic wafers, the switches differ from conventional rotary switches in that they eliminate manual wiring and soldering to each individual contact terminal.

This is achieved by using etched foil on the wafers to connect the contacts to terminal prongs on the base of each wafer. Dip soldering of the printed circuit board establishes all switch connections in one process. Other advantages include the elimination of solder drip, no temper loss in the contacts, no torque problem with ganged assemblies, and elimination of wiring errors. The switches can be supplied in either 8 or 12 position types, in single or ganged assemblies to meet specific requirements.

Knight Electronics Corp., Dept. ED, 210 S. Desplaines St., Chicago 6, Ill.

CIRCLE 45 ON READER-SERVICE CARD

Taper-Pin Connections Simplify Circuit Changes



This taper-pin panel assembly was developed for equipment which requires a high degree of flexibility in connections, and thus is particularly useful for circuit testing and development. Versatility is achieved with an aluminum frame in which shielded panels are snapped and locked. While a frame will accommodate as many as five or eight panels, no more need be used than each application requires. Insertion of Stapin-terminated wires into the panel is performed easily with an insertion tool, and they can be removed with needle-nose pliers.

Burndy Corp., Dept. ED, Norwalk, Conn.

CIRCLE 46 ON READER-SERVICE CARD



Shields for Power Supplies Cut Transformer Radiation

This Netic magnetic shield is designed for isolating the substantially increased transformer radiation in transistorized power supplies. The Netic shield meets this requirement by effectively attenuating both high and low frequencies, and thus preventing magnetic radiation or hum at the source. In addition, the shield simplifies filtering problems associated with this type of supply, is not retentive, not shock sensitive and does not require periodic annealing.

Perfection Mica Co., Magnetic Shield Div., Dept. ED, 1322 N. Elston Ave., Chicago 22, Ill.

CIRCLE 47 ON READER-SERVICE CARD



Microphones Miniature Size

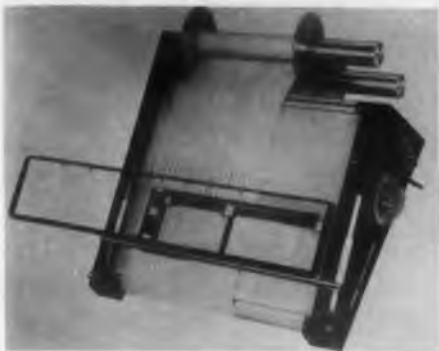
Measuring 1/2 in. sq and about 1/4 in. thick, the MC30 microphone was designed for use by manufacturers of hearing aids, tape recorders and dictating equipment. It weighs less than 1/6 oz and is of the controlled magnetic type. Response rating is from 400 to 4200 cps; output is -76 db at 1000 cps, and impedance is 2000 ohms at 1 kc.

Shure Brothers, Inc., Dept. ED, 222 Hartrey Ave., Evanston, Ill.

CIRCLE 48 ON READER-SERVICE CARD

Oscillogram Reader

Handles Non-Linear Channels



The Model R-1 oscillogram reader is capable of handling a large number of linear or non-linear channels, correcting for linear or non-linear scale factors, as well as automatically correcting for the zero line location of each channel. Tracking, record damage and record tension problems have been virtually eliminated. Features include film widths of 0-16 in.; expendable rolls which can be loaded in the darkroom; design for both reading and scanning; forward and reverse operation; and a vertical variable scale to count cycles, read frequencies, or space stations directly.

Gerber Scientific Instrument Co., Dept. ED, 162 State St., Hartford 3, Conn.

CIRCLE 49 ON READER-SERVICE CARD



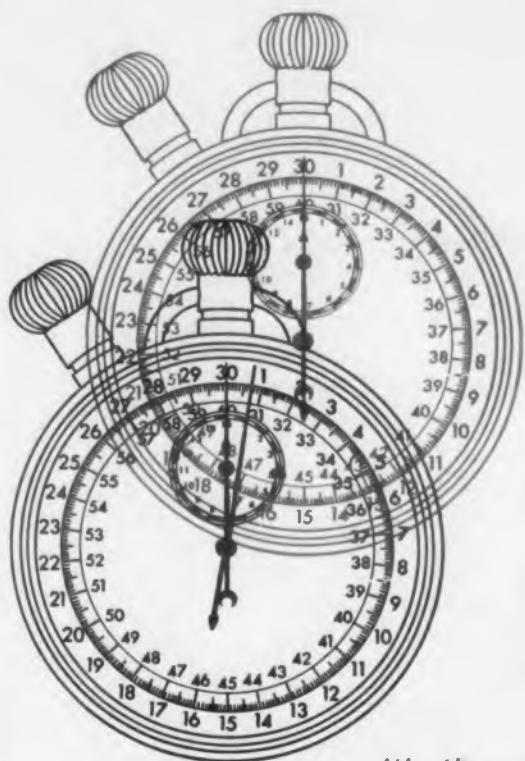
Sensitive Relay

Requires 2 μ w Power

Transistorized relay type 160 features sensitivity down to 2 μ w. Designed for dc applications, these relays can pick-up as low as 20 μ a at 100 mv. Contact combination is from spst through 4 pnt. Power source for the transistor may be either external or internal. The internal source is battery powered using mercury batteries packaged within the relay enclosure. Incorporating wiping action, the contacts have a capacity of 1 amp inductive or 3 amp resistive at 115 v ac or 29 v dc. Available coil resistance is up to 30,000 ohms. The relays are available either with hermetically sealed dust cover or open. Headers are either plug-in, solder lugs, or other variations.

General Automatic Corp., Dept. ED, 12 Carlton Ave., Mountain View, N.J.

CIRCLE 50 ON READER-SERVICE CARD



INSTANTLY...

measure and supply DC voltages to 0.02%

with the new KIN TEL DC voltage standard and null voltmeter

LABORATORY ACCURACY. The Model 301 is an extremely compact and accurate variable DC power supply and calibrated null voltmeter. It employs KIN TEL's proved chopper circuit to constantly compare the output voltage against an internal standard cell. As a DC voltage standard, it combines the stability and accuracy of the standard cell with the current capabilities and excellent dynamic characteristics of the finest electronically regulated power supplies. The self-contained null voltmeter indicates the voltage difference between the supply in the 301 and the DC source being measured, affording simple and rapid measurement of DC voltages to an accuracy of 0.02%.

PRODUCTION LINE SPEED. DC voltage measurements can be made as fast as changing ranges on a VTVM. Merely set the direct reading calibrated dials on the 301 to exactly null out the unknown DC input voltage. The reading on the dials then indicates the value of the unknown input voltage to within 0.02%. As a variable DC standard or power supply, the calibrated dials provide instant voltage selection to an accuracy normally attained only with standard cells.

VERSATILITY. The KIN TEL Model 301 is ideal for rapid and accurate production calibration of precision measuring instruments and DC power supplies... design of DC amplifiers and complex electronic circuitry... computer reference... versatile precision reference for calibration and measurement laboratories.

0.01% stability

0.02% accuracy

1 to 501 volts at 20 ma

4 accurate null ranges

0.002% regulation

Less than 100 μ v ripple



IMPORTANT SPECIFICATIONS

Output Voltage & Current 1 to 501 volts at up to 20 ma
Full Scale Meter Ranges (Zero Center)

DC Output Range \pm 500, 50 volts

DC Input Range \pm 500, 50 volts

DC Null Meter Range .. \pm 50, 5, 0.5, 0.05 volts

Long Time Stability \pm 100 parts per million

Output Voltage Calibration \pm 0.02% or 2 mv

Output Hum and Noise Less than 100 μ v RMS

Line and Load Regulation 0.002%

DC Output Impedance Less than 0.01 ohm

Response Time 0.2 millisecond

Model 301 Price \$625.

Representatives in all major cities. Write today for demonstration or descriptive literature.
5725 Kearny Villa Road, San Diego 11, Calif., BRowning 7-6700

KINTEL

(KAY LAB)

CIRCLE 51 ON READER-SERVICE CARD

50 CPS

SO WIDE IN RANGE...

8.0 MC

SO SMALL



IN SIZE

ESC WIDE BAND VIDEO TRANSFORMERS have been engineered and developed to offer . . . subminiature units of unusually wide bandwidth (50 CPS to 8.0 MC). They are used to replace bulkier and more costly components, thereby creating greater economy, and increasing equipment efficiency.

ESC ELECTRONIC COMPONENTS DIVISION specializes

in the design and development of Wide Band Video Transformers to meet your particular applications. Each transformer prototype is accompanied by a comprehensive laboratory report, which includes submitted electrical requirements, photo-oscillograms (which indicate input and output pulse shape and output rise-time), the test equipment used, and evaluation of the electrical characteristics of the prototype.

WIDE BAND VIDEO TRANSFORMERS

ESC PART NUMBER	URNS RATIO	PRIMARY IMPEDANCE (OHMS)	SECONDARY IMPEDANCE (OHMS)	BANDWIDTH at 1 db POINTS	APPROXIMATE PHYSICAL DIMENSIONS
4001	1:1	600	600	50 CPS to 8.0 MC	1-5/8" OD x 1/2"
		3500	3500	1 KC to 1.5 MC	
		10,000	10,000	1.6 KC to 800 KC	
4002	4:1	1600	100	100 CPS to 320 KC	1-1/8" OD x 3/8"

Transformers Are Supplied With Solder Terminals

Meet All Applicable Mil-Specs

Complete catalog data on request



electronic components division

ESC

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exceptional employment opportunities for engineers experienced in pulse techniques

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

New Products

High Voltage Connectors

Rated at 30 Kv

Included in a line of hermetically sealed high voltage lead-through bushings, is this series of connectors that use Teflon as the insulating material. Gases, conventional insulating oils, silicone oils and their vapors cannot penetrate through these connectors when they are cycled repeatedly over a temperature range from -100 to +350 F. Features include ratings to 30 kv, operation at sea level to 60,000 ft, operation at 100 per cent relative humidity, a hermetic seal tested to 40 psig, and a press-fit or screw-in construction.

Joclin Mfg. Co., Dept. ED, Lufbery Ave., Wallingford, Conn.

CIRCLE 52 ON READER-SERVICE CARD

Delay Lines

Continuously Variable



These delay lines feature infinite resolution, no sliding contacts and a calibrated delay accuracy of better than 1 per cent. The temperature coefficient is approximately 0.005 per cent per deg C over a range of -40 to +85 C. The lines are externally terminated in characteristic impedance. Internal termination is optional. The unit is readily adaptable to servo systems and automatic tracking devices, and can be combined, as required, with belt or gear drive.

Standard models offer a range of from 0.06-0.1 μ sec (for the 1R-1-1000 model) to 3.3-5 μ sec (for the 1R-5-1000 model). The impedance level of these models is 1000 ohms. Elements of 500 ohms and 2000 ohms are available. Rise times are 0.02 μ sec and 0.4 μ sec.

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

CIRCLE 53 ON READER-SERVICE CARD

◀ CIRCLE 54 ON READER-SERVICE CARD

Right Angle Drive For Low Torque Devices



This right angle drive is intended primarily for remote operation of low torque units such as tuning capacitors or potentiometers. It may be used for continuous operation at low speeds with loads up to 50 in.-oz., and will tolerate intermittent 500 rpm operation with loads to 100 in.-oz. Backlash is less than 1-1/2 deg. Unloaded running torque is less than 2-1/2 in.-oz. Gears are brass and shafts and bushings are stainless steel. It measures 4-9/16 in. long by 6-1/64 in. wide.

National Co., Inc., Dept. ED, 61 Sherman St., Malden 48, Mass.

CIRCLE 55 ON READER-SERVICE CARD

Coaxial Connectors High Voltage



These high-voltage coaxial connectors have a rated corona level exceeding 15 kv ac. All electrical connections are accomplished by molded-on pig-tails in varying lengths to suit assembly requirements. Thus, no soldering cup is required. Another cost-saving factor is the elimination of the potting operation. The connectors have higher voltage efficiency than potted types, and noise radiation has been reduced to a minimum. The connectors will function without impairment at -55 C, under humidity and salt spray conditions and under vibration and shock conditions. The dielectric breakdown level exceeds 50,000 v.

H. H. Buggie, Inc., Dept. ED, Box 817, Toledo 1, Ohio.

CIRCLE 56 ON READER-SERVICE CARD

CIRCLE 57 ON READER-SERVICE CARD



Now—the first 155°C (Class F) polyester film-coated magnet wire designed to meet new AIEE requirements

Another Anaconda first! Anatherm—a new polyester film-coated magnet wire—fully tested for use at “hottest-spot” temperatures up to 155°C. With this new higher level of thermal stability, Anaconda Anatherm is the first film-coated wire to meet the newly adopted AIEE 155°C (Class F) rating!

Greater thermal stability—plus excellent abrasion-resistance characteristics, chemical stability and dielectric strength—makes Anatherm ideally suited for manufacturers seeking maximum performance and reliability from smaller and smaller equipment operating at higher and higher temperatures.

As a polyester magnet wire, Anatherm can be used equally successfully at any hottest-spot temperature over the range of 105°C to 155°C.

Available in single and heavy film thickness in AWG sizes from 15 through 25.



FREE TECHNICAL BULLETIN on Anatherm Magnet Wire is available. Simply write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York. 67374



ASK THE MAN FROM **ANACONDA**[®]
ABOUT **ANATHERM** MAGNET WIRE



HF to VHF

*your best
choice is*

RCA DRIFT TRANSISTORS

RCA offers a line of "DRIFT" TRANSISTORS specifically designed and controlled for operation in mass-produced electronic equipment at operating frequencies up into the VHF band.

New horizons in the design of mass-produced equipment operating well into the VHF band are now practical with the commercial availability of RCA p-n-p "Drift" transistors. These transistors offer many excellent features to equipment designers. Some of these features are: low base resistance, low feedback capacitance, high alpha-cutoff frequency, controlled input and output impedances, and controlled power gain characteristics to insure unit-to-unit interchangeability. Design benefits are: high input-circuit efficiency, excellent high-frequency operating stability, good signal-to-noise ratio, good automatic-gain-control capabilities, and wide range of input signal levels. Additional features include high power dissipation and rugged mechanical construction.

For superior-quality semiconductor devices, your best choice is always RCA. For sales information on these and other RCA TRANSISTORS, contact the RCA field Office nearest you. For technical data on specific RCA "Drift" transistor types, write RCA Commercial Engineering, Section L-18-NN-1, Somerville, N. J.



**SEMICONDUCTOR DIVISION
RADIO CORPORATION OF AMERICA**
Somerville, New Jersey

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New Products

**Lightning Arrestor
For Aircraft Antennas**



The AMC-127 aircraft antenna lightning arrestor is designed to provide protection for radio and associated gear in operational aircraft, and is especially designed to adapt to the company's high altitude, high voltage antenna mast AML-53. Arc over voltage in the lightning arrestor is 10,000 v peak at an altitude of 30,000 ft above sea level for the first stroke. Weighing 3.75 lb, the lightning arrestor is mounted at the base of the antenna mast by the mast mounting flange.

Dale Products, Inc., Dept. ED, Columbus, Neb.

CIRCLE 58 ON READER-SERVICE CARD

**Bearingless Differential
Backlash of 30 Min.**



This bearingless differential has a backlash of approximately 30 minutes of arc. Constructed of stainless steel spider and bronze bevel gears, both 48 and 72 diametrical pitch, the bearingless variety tumbles within 1 in. plus 1/32 in., and any standard stock precision hubless gear may be assembled to it.

Dynamic Gear Co., Inc., Dept. ED, 20 Merrick Rd., Amityville, N. Y.

CIRCLE 59 ON READER-SERVICE CARD

◀ CIRCLE 471 ON READER-SERVICE CARD

Hi-Shear Alignment

Aligns Honeycomb Panels



This light-weight alignment bolt is designed to re-align, through normal installation, any misalignment existing between wing panel skins, access doors and heavy stainless steel honeycomb panels. The bolts are manufactured in titanium, type 431 stainless steel and other materials. The fastener is designed for repeated installation and removals.

Hi-Shear Rivet Tool Co., Dept. ED,
2600 W. 247th St., Torrance, Calif.

CIRCLE 61 ON READER-SERVICE CARD

Circuit Breaker

For High Altitudes



Type C6758 high altitude, manual reset, aircraft circuit breaker is designed to indicate when trip-outs occur. Ratings are from 50 to 105 amp for 30 v dc and many 110-220 v ac circuits. The C6758 features high rupture capacity and a sealed and explosion-proof construction in compliance with MIL-E5272.

Metals & Controls Corp., Dept. ED,
Attleboro, Mass.

CIRCLE 62 ON READER-SERVICE CARD

Correction: On page 49 of the October 15th issue, there appears a new product description of a crystal filter manufactured by Bulova Watch Co. The accompanying illustration, however, is of a magnetic amplifier instead of a crystal filter, and belongs to Dynamics Research Associates.

CIRCLE 63 ON READER-SERVICE CARD >



TESTS ON NEW GENERAL ELECTRIC RESISTORS PROVE . . .

Terminals withstand 21-lb pull

Resistor terminals are often subjected to considerable stress. That's why General Electric has built extra strength into the terminals of these new vitreous-enameled resistors . . . strength to hold up to 21 pounds of right-angle pull. For exceptionally heavy-duty applications, there's a special G-E terminal that holds up to 34 pounds of pull.

General Electric resistors are available in over 1400 combinations of ratings (5 to 200 watts), types, and mountings. They will hold standard rated tolerance even under extreme temperature conditions (-70 F to +700 F). Their vitreous-enamel coating provides resistance to moisture, acids, solvents, and alkalis.

Want to see for yourself? Ask your General Electric salesman for a free set of sample resistors and conduct

your own tests. 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.

SEND TODAY FOR FREE RESISTOR CATALOG

Section E784-6

General Electric Company, Schenectady, N. Y.

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

Name _____

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Progress Is Our Most Important Product

GENERAL  ELECTRIC

New MAT
for
CONTROL
AREAS



REMOVES EVERY TRACE OF
DUST & DIRT *on contact!*

Developed for laboratories and production areas demanding absolute dust control at entrances. As shoe soles and truck wheels pass over the CLEAN TREAD mat, dust and dirt are removed *without rubbing*. Damp mopping renews surface. Tested by well known labs. 2" tapered metal edging holds 500 lb. truck. 4' x 4' x 3/4", 80 lb. mat is \$94 F.O.B. Boston. All sizes available. Immediate shipment of wire, phone or mail orders. CLEAN TREAD DIV., Merit Paper and Chemical Corp., 135 Regent St., Cambridge 40, Mass. Phone: TR 6-6122.

CIRCLE 64 ON READER-SERVICE CARD

where
COSTS
count...

price
\$65

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PHOTO-ELECTRIC CONTROL
counts best!

Count, inspect, control traffic with low-cost miniaturized precision control. Swivel-mounted for easy installation. Counts up to 600 operations a minute. Fast response, trouble-free. Ideal for automatic control of hundreds of processes in any plant. Brochure on request.

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INSTRUMENT CORPORATION
657 BROADWAY, NEW YORK

CIRCLE 65 ON READER-SERVICE CARD



Two Ideas Provide
Constant Temperature in this
CRYSTAL OVEN

BY UTILIZING the principle of both the latent heat of fusion and proportional heat control, this crystal oven achieves an extremely constant temperature. Other ovens have used the volume change of a material at its change-of-state temperature to operate a switch controlling a heater element. While this is satisfactory in maintaining average heat input, the cyclic action produces a temperature fluctuation. This crystal oven, available from Robertshaw-Fulton Co., Aeronautical Div., Anaheim, Calif., successfully eliminates the cyclic action.

The distinguishing feature of the crystal oven lies in its use of the volume change of a material to control the pressure on a carbon pile. Instead of a separate heater winding being controlled by the resistance of the pile, the required heat is dissipated by the carbon itself, acting as a heater.

Under conditions of a steady 24 C ambient temperature, the crystal oven will maintain a temperature accuracy of 70.6 ± 0.005 C. Under ambient conditions ranging from -20 to $+50$ C, the temperature of the oven is maintained steady within ± 0.5 C. The oven has a stabilization time of approximately 20 min. to within 0.5 deg of the mean from -20 C.

Heater voltage required by the unit is 5 v ac or dc, regulated to ± 2 per cent, and the power required amounts to 1.6 w at an ambient of 24 C, and 3.5 w at an ambient of -20 C. The unit is packaged in an octal-plug container measuring 2-in. od by 4-in. length.

For further information turn to the Reader Service Card and circle 66.

Variable Frequency Oscillator
Has Digital Selector



The output frequency of Model 110 variable oscillator is determined by positioning five digital selector switches located on the front panel. These switches provide for the selection of any frequency in this range to one part in five significant figures. Continuously adjustable from 100 cps to 100 kc, the instrument offers an accuracy of ± 5 counts or 0.005, whichever is greater.

Digital Instrument Labs., Dept. ED, 152 S. Atlantic Blvd., Los Angeles 22, Calif.

CIRCLE 292 ON READER-SERVICE CARD

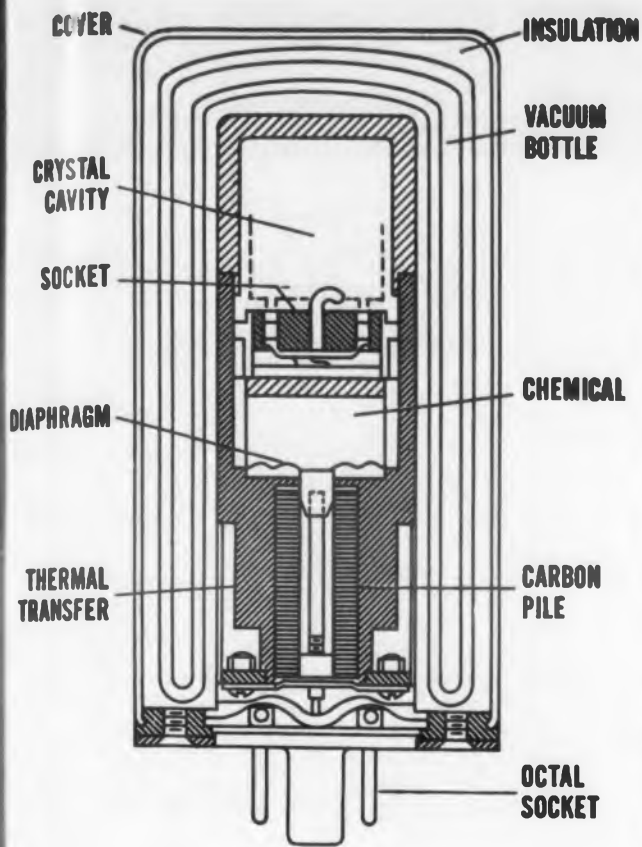
Trimming Potentiometer
High Resistance in Small Unit



Model 025 trimming potentiometer is available in resistances ranging from 1 to 125,000 ohms in a cylindrical case measuring 1/4 in. in diameter and 1-1/4 in. in length. A mechanical range of 45 turns affords high resolution. Power rating of the standard model 025 is 0.4 w at 50 C, derating to zero at 105 C. All the features of the cylindrical model 025 also are available in the rectangular model 037. Both models are available in resistances up to 1 meg with carbon elements.

Con-Elco, Dept. ED, P. O. Box 307, 1711 S. Mountain Ave., Monrovia, Calif.

CIRCLE 293 ON READER-SERVICE CARD



A cross-section of the crystal oven shows the thermal operation. As the solid-liquid ratio of the chemical increases, the resulting change of volume causes pressure to be applied to the carbon pile. The increased current flow through the pile causes a proportional amount of heat to be dissipated. The chemical remains at a constant temperature of 70.6 C as long as a solid-liquid ratio exists. Accuracy is within 0.005 C for a fixed ambient and within 0.5 C for a -20 to +50 C ambient range.

Transformers

Mount on PC Boards



Designed especially for mounting on printed wiring boards, these miniaturized transformers handle a wide range of audio and carrier frequencies. Core structures are nickel-iron lamination for audio units, and ferrite for carrier frequency ranges. Cases are made of injection-molded phenolic in two sizes, 1-1/16 x 3/4 x 3/4 in., and 1-1/16 x 15/16 x 1-1/8 in. After assembly the units are filled with an epoxy casting resin.

Telecommunication Div., Stromberg-Carlson, Dept. ED, Rochester 3, N.Y.

CIRCLE 294 ON READER-SERVICE CARD

A.C. Ratiometer

...accurate to five parts per million!

REFERENCED TO UNITY RATIO

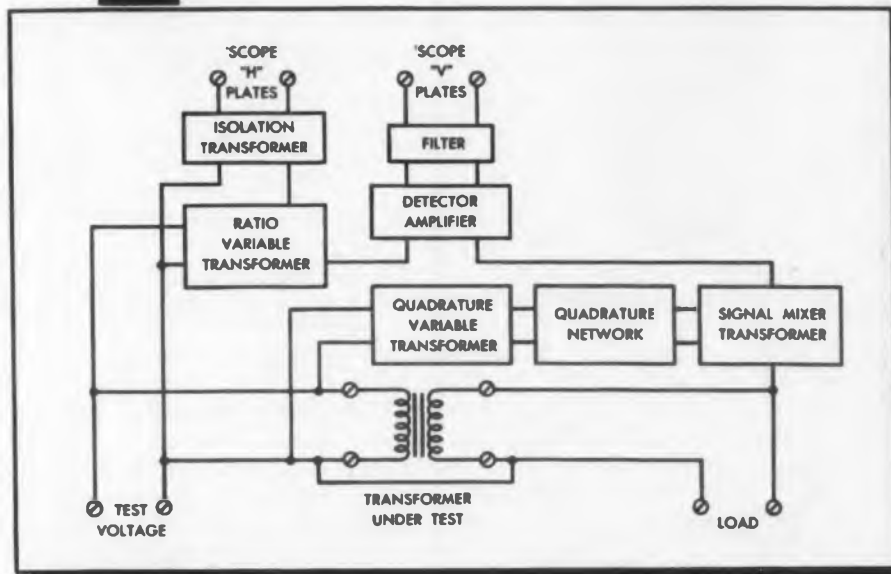


The Transformers, Inc. Ratiometer is a precision instrument to measure any voltage ratio from 0.000001 to 1.111111. Transformer ratios can be accurately measured at "no load" and under full load. Two models are available:

MODEL 204 is designed for use between 200 cps and 2,000 cps. It is supplied with plug-in units for 400 cps operation.

MODEL 206 is designed for use between 40 cps and 1,000 cps. It is supplied with plug-in units for 60 cps operation.

Plug-in units for any other frequency are supplied to order.



The Ratiometer consists of two precision variable transformers, a calibrated quadrature injector, a filter, and a pre-amplifier. Block diagram indicates connections of the various components within the instrument.

For additional information, ask for Bulletin #204

TRANSFORMERS, INCORPORATED

200 Stage Road, Vestal, N.Y.

CIRCLE 67 ON READER-SERVICE CARD

ACCURACY

Five parts per million referenced to unity ratio.

MAXIMUM VOLTAGE

Model 204	120 V	200 cps
	180 V	300 cps
	240 V	400 cps and over
Model 206	80 V	40 cps
	120 V	60 cps
	240 V	120 cps and over

PRICE

Model 204 Ratiometer, complete with 400 cps plug-in filter and quadrature units	\$865
Model 206 Ratiometer, complete with 60 cps plug-in filter and quadrature units	\$1235

New Products

Concentric Differential Simplifies Computer Design



Model T-750 concentric shaft differential is designed for high precision servo and computer applications. Instead of the conventional method of having the two inputs at opposite ends of the spider, the output and inputs extend concentrically from one end of a servo-mounted case. This permits mounting of this differential like standard servo components, thus resulting in a single line gear train.

Sterling Precision Corp., Dept. ED, 34-17 Lawrence St., Flushing 54, N.Y.

CIRCLE 69 ON READER-SERVICE CARD



VHF Drift Transistor Frequency of 250 Mc

The 2N384 is a hermetically sealed drift transistor of the germanium pnp type. It is designed primarily for use as an oscillator up to 250 mc or as an rf amplifier in mobile communications equipment. The 2N384 also has application as an i-f and low-level video amplifier, and as a pulse amplifier and high-speed switching device.

The 2N384 features a frequency of 250 mc for unity power amplification, an alpha cutoff frequency of 100 mc, a collector transition capacitance of 1.3 μf , a base resistance of 50 ohms, and a dissipation rating of 120 my at 25 C and 35 my at 71 C. In a unilateralized common-emitter circuit, this transistor can provide a power gain of 15 db at 50 mc and 30 db at 10.7 mc.

Radio Corporation of America, Semiconductor Div., Dept. ED, Somerville, New Jersey.

CIRCLE 70 ON READER-SERVICE CARD



MICRO SWITCH Precision

... FIRST IN PRECISION SWITCHING

Here are 5 NEW Series of Precision Switches by MICRO SWITCH...

Designed to meet modern electrical control requirements

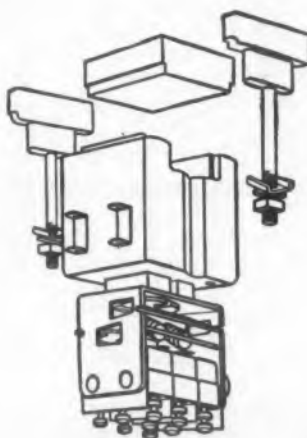
MICRO SWITCH pioneered the development of precision switches... It has been first in precision switching for two decades... These new switches are typical of MICRO SWITCH's continuing leadership.

NEW!

LIGHTED PUSHBUTTON SWITCHES



Typical switch module
(a 3-circuit design)



Exploded view Series 100 PB
switch showing button and
mounting means.

ANOTHER FIRST BY MICRO SWITCH

A typical compact assembly of switches in panel slot. Indicates choice of button color and number of circuits.



- LARGE, EASILY ENGRAVED BUTTONS ... EASILY INSTALLED IN COMPACT ASSEMBLY
- THREE TYPES OF ILLUMINATED SIGNAL
- WIDE CHOICE OF CIRCUITRY

MICRO SWITCH Series 100PB Lighted Pushbutton Switches provide a neat, good looking panel. Their compact mounting allows more switches per panel.

Because separate terminals are provided for each lamp and for each element of the contact structure, these switches permit intermixing of voltages, a-c or d-c current and even combinations of opposing polarities.

Three types of illuminated signals are provided: (1) one-color buttons, (2) two colors (lighted singly or in

combination) and (3) choice of either of two colors—neither of which is visible when button is not lighted.

Buttons are large enough to allow two lines of clearly legible engraving. The switch assemblies are easily mounted, either individually or in strips, by cutting a single slot in the panel.

Matching indicating lamp assemblies are available with the same button and lamp combinations and same means of mounting as the complete 100PB switch assembly.

(Send for Data Sheet 143)

CIRCLE 68 ON READER-SERVICE CARD

Switches have uses unlimited



NEW!

MICRO SWITCH
"Rocket Switch"—
a rugged, sealed small
switch for indicating
and lockout devices

Developed for use on rocket launchers, this MICRO SWITCH 21AS2 assembly fits the needs of many industrial designs.

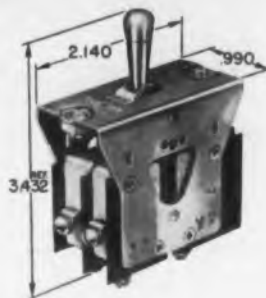
The assembly consists of one SPDT Type-EN switch attached to a rugged cam-type actuator. The assembly is environment-proof and withstands the highly-corrosive effects of rocket propulsion gases. The assembly will withstand heavy impact hammer blows on the actuator.

(Send for Data Sheet 120)

SWITCH CHARACTERISTICS

Operating force—6 to 12 lbs. Full overtravel force—10 lbs. min.; Release force—4 lbs. min.

Electrical Data: 28 vdc rating; inductive, 3 amps. at sea level and 2 amps. at 50,000 feet; resistive, 4 amps. at sea level and 50,000 feet; inrush, 24 amps. at sea level and 50,000 feet. Motor, 4 amps. at sea level and 50,000 feet; inrush, 24 amps. at sea level and 50,000 feet. (Altitude ratings established with seal deliberately broken.)



NEW!

MICRO SWITCH
three-position
toggle switch—4 SPDT circuits with
a single lever

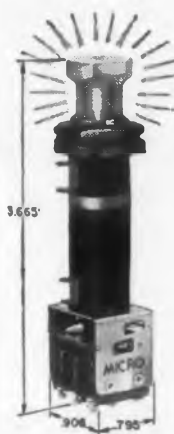
MICRO SWITCH 115AT Series of toggle switches uses four SPDT switching units. Two units are actuated in each extreme toggle lever position. None are actuated when lever is in center position.

Many different combinations, however, may be obtained, including the make and break of circuits in all three lever positions.

Outstanding features of this series include the compact design, positively-driven switch actuators and sturdy construction. A safety catch guards against accidental movement of toggle lever. (Send for Data Sheet 134)

SWITCH CHARACTERISTICS

Electrical rating at 30 vdc: inductive—10 amps. at sea level, 6 amps. at 50,000 ft.; resistive—10 amps.; motor—6 amps. Basic units listed by Underwriters' Laboratories for: 10 amps. 125 or 250 vac; ¼ amp. 125 vdc; ¼ amp. 250 vdc.



NEW!

MICRO SWITCH Magnetic
Hold-in Lighted Pushbutton
Provides Three Functions

MICRO SWITCH lighted pushbutton switch combines the functions of a three-pole double-throw pushbutton switch, indicating light, and holding

relay into one compact unit which panel mounts on one-inch centers, both horizontally and vertically. Thus, the cost, wiring, maintenance and added space of these separate components are eliminated. . . . A 28-volt dc solenoid is incorporated into the switch shaft. After the button is manually operated, the solenoid holds the switches in the operated position until electrically released. This feature gives the designer complete freedom in panel layout by eliminating the restrictions found in conventional mechanical release designs. (Send for Data Sheet 128)

SWITCH CHARACTERISTICS:

Operating force—35 oz. max. Pretravel—.050 in. approx. Total travel—.090 in. max. Three subminiature switches are SPDT.



NEW!

MICRO SWITCH
"typewriter" pushbutton
switch for manual
keyboard control

MICRO SWITCH 1PB81-T2 switch is ideal for one-finger rapid-repeat operation such as is required for the type of keyboard control found in electric typewriters, adding machines, etc. The repeat action is as rapid as the fastest operator can push the button.

This switch uses a SPDT MICRO SWITCH subminiature switch for snap-action reliability. The contoured button and unique overtravel spring combine to reduce operator fatigue. Operating "feel," however, is sufficient to avoid mistakes and false actuations.

Removable ½ in. dia. plastic button is available in red, green, off-white or black. It is keyed to prevent rotation. (Send for Data Sheet 125)

SWITCH CHARACTERISTICS

Electrical rating at 30 vdc: inductive—3 amps. at sea level and 50,000 ft.; maximum inrush—15 amps. Basic subminiature switch is listed by Underwriters' Laboratories at 5 amps. 125 or 250 vac.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS



CIRCLE 68 ON READER-SERVICE CARD



Silicon Zener Diodes
Low Zener Impedance

Low temperature coefficient and zener impedance over the voltage range are features in these zener diode types. The S series of pigtail type construction, is rated at 1 w over a voltage range 3.9 to 30 v, in 10 per cent voltage steps. The T series is stud mounted, and is rated at 3.5 w over the same range. Full calibration data is supplied with each diode, showing a plot of the zener voltage and zener impedance. Temperature range is from -55 to 150 C.

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

CIRCLE 71 ON READER-SERVICE CARD

G-Line Transmission System
Range Extended to 1700-9000 Mc



The G-Line, a single-wire surface wave transmission line, now covers the microwave range from 1700 to 9000 mc. Featuring ease of installation, the system includes a transmission line terminated at both ends by identical rf field transformers (launcher and collector) to provide efficient transition from a conventional feed line to the surface wave wire and back again at the antenna input end. Typical operating loss at 2000 mc is held down to 0.5 db per field transformer plus 0.8 db per 100 ft of surface wire transmission line.

Prodelin Inc., Dept. ED, 307 Bergen Ave., Kearney, N.J.

CIRCLE 72 ON READER-SERVICE CARD

New Products



Miniature Thermostat
Has 3/16 In. Diameter

Model WP thermostat features a 3/16 in. diam and 0.690 in. body length. The unit incorporates bimetal actuated contact, reliable performance, and fast thermal sensing. The thermostat is rated at 1/2 amp for 6-28 v ac or dc and 115 v ac circuits. Externally adjustable temperature range is -65 to +150 C.

Chatham Controls Corp., Dept. ED, 33 River Rd., Chatham, N.J.

CIRCLE 74 ON READER-SERVICE CARD



Magnetic Amplifiers
With Variable Gain

Model MA 41 and MA 101 magnetic amplifiers feature variable gain to allow full output for a wide range of low-level input signals. Feedback parameters determine overall gain and may be arranged so that either the load current or load voltage is independent of changes in the load value. Stability is maintained by a current or voltage negative feedback which is external to the amplifier.

Cylindrically shaped model MA 41, with a maximum power rating of 62 mw, has an output of 10 v dc max across a 10,000 ohm load and 18 ma dc through a 200 ohm load, and a time constant approximately equal to the voltage gain divided by 1500 (in seconds). Model MA 101 has a maximum power rating of 160 mw, an output of 12 v dc max across a 10,000 ohm load and 28 ma dc through a 200 ohm load, and a time constant approximately equal to the voltage gain divided by 3750 (in seconds).

Dynamics Research Associates, Dept. ED, P.O. Box 5841, St. Louis 21, Mo.

CIRCLE 75 ON READER-SERVICE CARD



G-E Unijunction Silicon Transistor

**NOW FULLY CHARACTERIZED AND PROVED
FOR USE IN SIMPLIFYING CIRCUITRY**

The unique advantage of the unijunction transistor lies in its open-circuit-stable negative resistance characteristics. The unijunction is the nearest solid state equivalent to the grid-controlled thyatron and is very sensitive to voltage levels. It is primarily useful in switching and oscillator applications. Not only will one unijunction do the job of two transistors (and with less circuitry) but the circuit will be more stable over a wide temperature range.

Technical data and application ideas are available to help you in studying the unijunction—the first device other than the transistor itself to reach commercial success. The six unijunction types can be obtained from most G-E Distributors, or write *General Electric Company, Semiconductor Products Dept., Section S23127, Electronics Park, Syracuse, New York.*

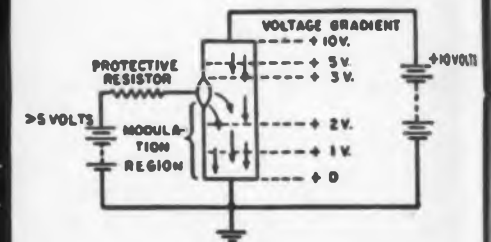
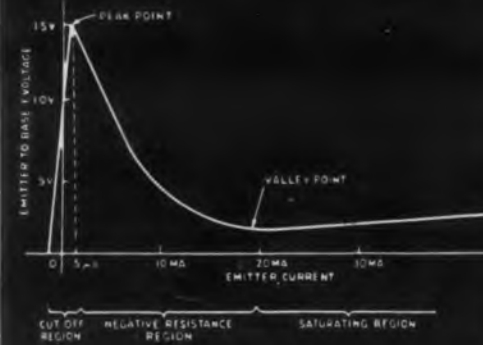
SPECIFICATIONS OF THE SIX SILICON UNIUNCTION TYPES

Absolute maximum ratings (25°C)

RMS power dissipation	250 mw
RMS Emitter current	50 ma
Peak emitter current	2 amps
Emitter reverse voltage	60 volts
Operating temperature range	-65°C to 150°C.
Storage temperature range	-65°C to 200°C.

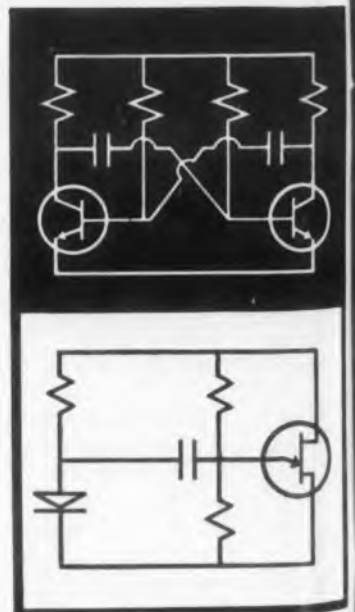
Major electrical characteristics (nominal)

	2N489	490	491	492	493	494
Interbase resistance at 25°C junction temp.	5.6	7.5	5.6	7.5	7.5	5.6
Intrinsic standoff ratio	.56	.56	.62	.62	.68	.68
Modulated interbase current	12	12	12	12	12	12
Emitter reverse current (T _J =25°C)	.07	.07	.07	.07	.07	.07
(T _J =150°C)	28	28	28	28	28	28



The unijunction consists of an "N" type silicon bar mounted between two ohmic base contacts, with a "P" type emitter near base 2. When the emitter is forward biased, emitter current flows, lowering the resistivity of the bar between emitter and base. Inherent regeneration results in a negative emitter to base impedance. As the emitter current increases past the valley of the curve, the conditions for inherent regeneration cease to exist. The peak point of the curve shows the beginning of the negative resistance region.

Among the many simplified circuits possible with the unijunction (cutting transistor requirements in half) are a frequency divider, matrix switching circuit, low level d-c current-sensing circuit, temperature control element, phase and/or amplitude sensitive switch. The conventional multivibrator circuit (above right) requires even more circuitry than is shown if it is to be as stable as the comparable unijunction circuit shown below. A relaxation oscillator usually takes 4 resistors, 2 transistors and a capacitor. A single unijunction, a resistor and capacitor will do the equivalent job.



*Progress Is Our
Most Important Product*



**GENERAL
ELECTRIC**

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BURTON BROWNE/New York

NEW LATCHING SUB-MINIATURE RELAYS



**SMALLEST —
LIGHTEST**

EXCLUSIVE

*By Filtors,
smallest and lightest
hermetically sealed latching
sub-miniature relays,
magnetically held—
no power drain—
and electrically reset.
2PDT, 4PDT and 6PDT*

*High shock and vibration
resistance.*

*All made to
MIL-R-25018 (USAF)
and MIL-R-5757C.*

Dry circuit relays available

Write for catalog

*Leading manufacturers of
hermetically sealed
sub-miniature relays.*

FILTORS, INC.

*Port Washington,
Long Island, New York
Port Washington 7-3850*

Radar Interference Blanker Eliminates Main Bang



This radar interference blanker, model RB-128, eliminates main bang interference occurring in groups of normal and MTI radar sets or reduces it to a negligible value. In operation, the interfering signal is bracketed with a negative blanking gate to eliminate it from the protected radar's display. Since the PRR of the protected radar and that of the interfering radar are usually not synchronized, any loss of displayer information is unimportant.

The system is designed to protect two normal video channels and one MTI video channel. The blanker is self-contained and may be added to existing radar installations without appreciable modification of operating equipment. The use of instantaneous agc circuits and very low time constants in grid circuits reduces the guard-band receiver's susceptibility to jamming well below that of the radar being protected.

Empire Devices Products Corp., Dept. ED,
Amsterdam, N.Y.

CIRCLE 77 ON READER-SERVICE CARD

DC Power Supply 25 Amp, 0-32 V



Model M60V has a voltage range of 0-32 v with load capacity of 25 amp. The regulation accuracy is ± 1 per cent at 28 v and ripple is 1 per cent rms. The unit is furnished in a cabinet measuring 20-1/4 x 16-5/8 x 13-3/4 in.

Perkins Engineering Corp., Dept. ED, 345
Kansas Street, El Segundo, Calif.

CIRCLE 78 ON READER-SERVICE CARD

◀ CIRCLE 73 ON READER-SERVICE CARD

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 79 ON READER-SERVICE CARD

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 \$79⁵⁰
NET**

SPRAGUE®

SPRAGUE PRODUCTS COMPANY, NORTH ADAMS, MASSACHUSETTS

New Products

**Oscillograph Processor
Gives Immediate Records**



Called the 5-036 Datarite magazine, this unit attaches to standard oscillographs and provides developed and dried photographic records as fast as the instrument records data. The direct-writing magazine chemically develops an oscillogram at rates up to 25 in. per sec and permits instant access to the record. It is completely interchangeable with the 5-119 recording oscillograph's standard magazine without modification.

Consolidated Electrodynamics Corp., Dept. ED, 300 N. Sierra Madre Villa, Pasadena, Calif.

CIRCLE 80 ON READER-SERVICE CARD

**Printed Circuit Connector
Polarizing Screwlock**



Featuring polarizing screwlocks, series 683, right angle precision connectors are designed for printed board or printed cable applications, and meet airframe requirements for vibration and high altitude. Contact spacing is based on the 0.1 grid in accordance with EIA printed circuit specifications. Available in 11 or 33 contacts, standard molding compound is mineral filled melamine. In addition to the regular solder cup receptacles can be supplied with taper pin termination for solderless wiring.

DeJur-Amsco Corp., Dept. ED, 45-10 Northern Blvd., L.I. City 1, N.Y.

CIRCLE 81 ON READER-SERVICE CARD



Insulation Analyzer Rapid Quality Check

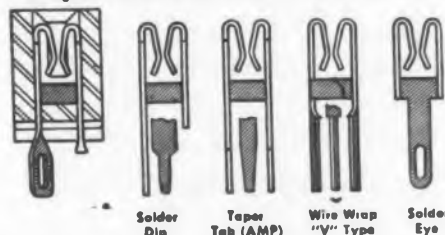
The D-K analyzer is a portable, non-destructive, direct reading instrument which measures the dissipation factor and dielectric constant of insulating materials. The instrument can be used to investigate the effects of variables such as hardeners, filters, and cure conditions in dielectric systems, to detect non-uniformities in electrical properties, and to inspect incoming material such as etched circuit board stock to insure conformance to standards. Measurements are made quickly and access to a system need only be from one side.

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

CIRCLE 82 ON READER-SERVICE CARD

Printed Circuit Connectors Prevent Board to Contact Damage

Swingflex contact terminations for printed circuit connectors



A contact design for printed circuit connectors to eliminate possibility of damage to either contact or printed circuit board during assembly or multiple-insertion has been announced. Called Swingflex, the contacts have high flexing strength combined with positive area contact for use with boards 1/16 and 3/22 in. thick, for either single- or double-sided board connection.

The contacts are made of pretempered beryllium copper in four standard types of terminations: solder eye, taper tab, solder dip and wire wrap. Solder dip types of connectors are available either in straight or right angle terminations for board thicknesses of 1/16, 1/8, or 1/4 in. Wire wrap terminations are in lengths up to 21/32 in. to accommodate three wrapped wires. Taper tab and wire wrap terminations are solderless types.

H. H. Buggie, Inc., Dept. ED, Box 817, Toledo 1, Ohio

CIRCLE 83 ON READER-SERVICE CARD

For Who Require PRECISE VOLTAGE CONTROL

STABILINE®

Automatic Voltage Regulators



TYPE IE (Instantaneous Electronic)
Completely electronic with no moving parts. Provides fast, close control. Rated from 0.25 KVA to 10.0 KVA.



TYPE EM (Electro Mechanical)
Corrects faster than most regulators and operates without waveform distortion. Rated from 2.0 KVA to 100 KVA.



TYPE TM (Tubeless Magnetic)
Without moving parts... tubes... transistors. Ideal for unattended or critical uses. Rated from 1.0 KVA to 5.0 KVA.

**Rely on
SUPERIOR
ELECTRIC
the Complete Line of
Voltage Control Equipment**

POWERSTAT®

Variable Transformers



MANUAL and MOTOR OPERATED
These variable autotransformers provide excellent regulation with high efficiency and zero waveform distortion. Standard models in ratings from 150 VA to 217 KVA.



HIGH FREQUENCY
units are one-third the weight . . . one-half the size of 60 cycle units. For 400/800 cycle use.

HEAVY DUTY
requirements are met by POWERSTATS in gangs of 6, 8, 9, 12, 16, 18 or more which provide precise adjustments to fractions of a volt.



UNUSUAL CONDITIONS
are met by standard POWERSTAT units that are explosion-proof . . . oil-cooled.



Other Products

in Superior Electric's Complete Line



POWERSTAT Line Correctors correct line voltage variations to maintain a constant output voltage. Can also be used to handle large amounts of current in supplying a limited output voltage range from stable A-C power sources. Rated from 6.0 KVA to 100 KVA.

VARICELL® D-C Power Supplies provide a variable range of stabilized and regulated D-C voltages from an A-C source.

VOLTBOX® A-C Power Supplies consist of a variable transformer, voltmeter and connection leads in one housing.

SUPERIOR 5-WAY Binding Posts — Offered in 5 colors to enhance product appearance and provide circuit identification. Provide 5 methods of connection. Current capacity 30 amperes. Working voltage 1000 volts.

USE THIS COUPON

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**SUPERIOR ELECTRIC
COMPANY**

1712 Bradley Ave., Bristol, Conn.

Please send following bulletins

- STABILINE** — General Bulletin S657
- POWERSTAT** — General Bulletin P357G
- POWERSTAT** — High Frequency Bulletin P257H
- VARICELL** — Bulletin V1051
- VOLTBOX** — Bulletin P357G
- 5-WAY BINDING POSTS** — Bulletin BP656

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How to make a Magnetic Core that's really SMALL?

use **AL**

PERMENDUR



Write for
your copy

"MAGNETIC MATERIALS"

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free on request.

ADDRESS DEPT. ED-96

When the conditions of service make it imperative for you to hold the size and weight of magnetic cores at an absolute minimum, that's the place to use Permendur. With it you can push the flux density up to 20 kilogausses, and practically eliminate weight as a consideration.

Along with its suitability for cores wherever the premium is laid on compactness, Permendur is just the thing for sonar magnetostriction applications, too. We maintain proper annealing facilities for this

alloy. Write for technical data on it, and let our engineers help you to cash in on its possibilities.

In addition to Permendur, we offer a range of high-permeability alloys, oriented silicon steels and other electrical alloys that is unmatched in its completeness. Our services also include the most modern facilities for lamination fabrication and heat treatment.

Let us supply your requirements. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

STEELMAKERS to the Electrical Industry

Allegheny Ludlum

WSW 8119



CIRCLE 85 ON READER-SERVICE CARD

New Products

Adjustable Audio Oscillator For Telemetry Purposes



These adjustable audio oscillators can be used as a stable tone modulator for energizing frequency sensitive relays in remote locations. Additional applications include use as a remote frequency audio decoder. The oscillators are can-mounted for plug-in construction and are available in frequency ranges from 200 to 1000 cps. Characteristics included short period drift of 0.1 cps and less than 0.5 per cent drift over a temperature range of 0 to 150 F. Other characteristics are: distortion, less than 5 per cent; rms output, 0 to 30 v and voltage drift tolerance of 0.1 per cent.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N. J.

CIRCLE 86 ON READER-SERVICE CARD

Balancing Potentiometers 25-Turn Screw Adjust



The Trimit line of balancing potentiometers features miniature size, 25-turn self-locking screwdriver adjustment, and a rectangular shape for compact assemblies. They can be obtained with flexible leads, solder lugs, or printed circuit pins, and may be mounted either individually or in stacked assemblies. The line is available with wirewound resistance elements from 100 ohms to 10K, or with carbon elements from 20K to 1 meg.

Bourns Laboratories, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

CIRCLE 87 ON READER-SERVICE CARD



**Stud Assemblies
For 1/4 Turn Fasteners**

These bail handle stud assemblies are designed for quarter-turn quick operating fasteners. The bail handle of the 26S22 and 40S47 series can be located firmly in one of three notched positions: vertical, horizontal left, and horizontal right. In these positions, the handle can not be jarred loose due to effects of gravity or vibration.

Camloc Fastener Corp., Dept. ED, 22 Spring Valley Rd., Paramus, N.J.

CIRCLE 88 ON READER-SERVICE CARD

Sound Spectrograph

Aids Communications Systems Design



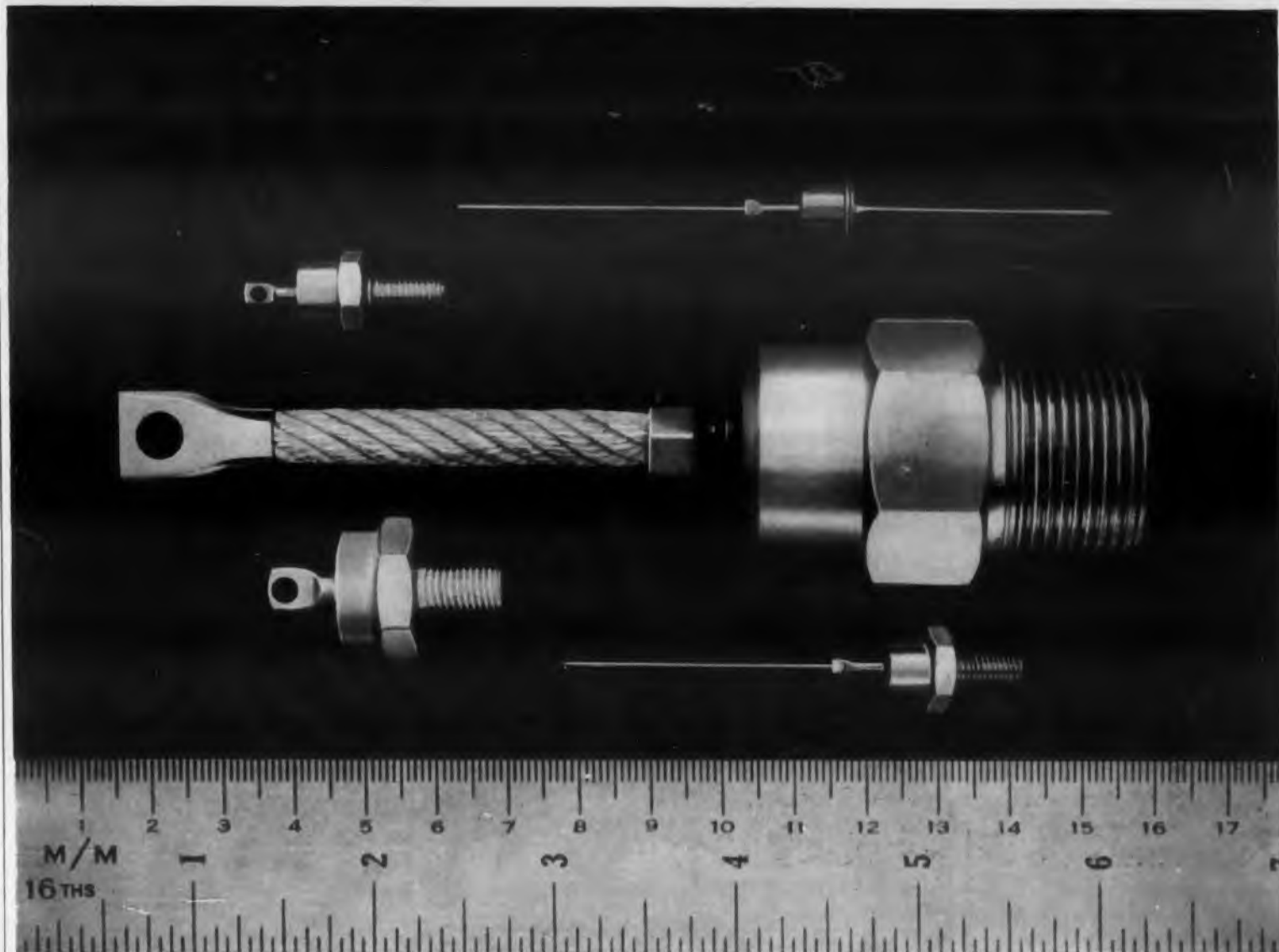
The Sono-Graph recorder is a sound spectrograph that makes a permanent, storable aural record in addition to three visual analyses of any audio vibrations in the 85-12,000 cps range. In communications systems work, the recorder can establish the basic frequency content of intelligence in order to determine the frequency bandwidth for adequate transmission. In addition, the effects on intelligibility of superimposed noise and distortion may be examined visually. The display graphs are made in two switched bands, the first from 85 cps to 6 kc, and the second from 6 to 12 kc.

The recording medium is a flexible magnetic disc 12-in. in diameter and approximately 3 mils thick. The first of the permanent graph display, the Sonagram, relates frequency and intensity to time; the second, the Section, relates intensity (over a wider dynamic range than the first) to frequency at any selected time. These two graphs may be made either on the same sheet or on separate sheets. The third display employs an amplitude display unit as an accessory to visually record in db the amplitude/time characteristic of an overall sample.

Kay Electric Co., Dept. ED, Maple Ave., Pine Brook, N. J.

CIRCLE 89 ON READER-SERVICE CARD

Boost DC power efficiency, cut costs with Westinghouse Silicon Rectifiers!



Whether you *use* or *manufacture* DC power equipment for low or high-power applications, Westinghouse Silicon Rectifiers offer you a way to step up power output efficiency yet save space, weight—and costs!

Manufacturing economies through tremendous volume and engineering know-how permit Westinghouse to bring you a product that is unsurpassed for quality at the lowest prices in the industry. All Westinghouse Silicon Rectifiers meet Military Environmental Tests and are ruggedly designed to withstand a wide range of operating conditions.

Westinghouse Silicon Rectifiers are ready for immediate delivery. Why not find out how they can cut DC power costs for you? Call your local Westinghouse Representative or mail the coupon now.

**YOU CAN BE SURE... IF IT'S
Westinghouse**

CIRCLE 90 ON READER-SERVICE CARD

WESTINGHOUSE SILICON RECTIFIERS

HIGH & MEDIUM POWER

Number	PIV (Max.)	Peak Reverse Current (Max.)	Maximum Current at 150°C Case	Thermal Drop Junction to Case
302	50-600 V	20 Ma	35 Amps.	1°C Per Watt
303	50-600 V	10 Ma	18 Amps.	1.5°C Per Watt
304	50-600 V	10 Ma	12 Amps.	2°C Per Watt
322	50-500 V	40 Ma	110 Amps.	.3°C Per Watt

LOW POWER

305	50-800 V	1.5 Ma	1.6 Amps.	5°C Per Watt
320	50-800 V	1.5 Ma	1.6 Amps.	5°C Per Watt

Mail Coupon Now

Westinghouse Electric Corp.
P. O. Box 868
Pittsburgh 30, Penna.

Will you please send me full information on Westinghouse Silicon Rectifiers No.(s) _____

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

New Products

Permanent-Magnet Motors

One Inch Diameter



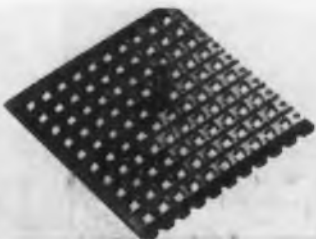
Although slightly over 1 in. in diam, these permanent-magnet motors feature a rotatable brush holder which is adjustable for best commutation and power output. Motors designed for operation from 6, 12, and 27.5 v are carried in stock. Other windings or modifications are available.

Servo-Tek Products Co., Dept. ED,
1086 Goffe Rd., Hawthorne, N.J.

CIRCLE 91 ON READER-SERVICE CARD

Diode and Matrix

Triggering Device



Originally designed for use in an automatic credit checking device, this pluggable diode cartridge assembly consists of a HD-2122 diode or HD-2290 diode. The diode is inserted into the two-sided etched wiring matrix to bring one way current from a vertical busbar on the bottom side of the panel through the diode and deliver to a horizontal busbar on the top side of the matrix. The cartridge, which is attached or removed by a twist, provides a triggering device which can be inserted at any desired intersecting co-ordinates in the matrix to provide yes-no answers. A matrix employing 10,000 individual positions can be made up in an area of approximately 26 x 26 in.

Methode Mfg. Corp., Dept. ED,
7447 W. Wilson Ave., Chicago 31, Ill.

CIRCLE 92 ON READER-SERVICE CARD

CIRCLE 93 ON READER-SERVICE CARD >

P&B PROGRESS

HIGH SHOCK CRYSTAL-CASE RELAYS



2 NEW RELAYS

Crystal-Case Size! Permanent Magnet Design.

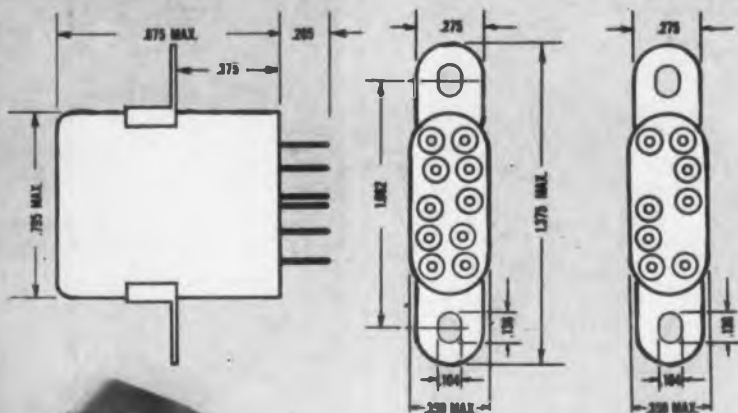
No Contact Openings. Shock: 100g. Vibration: 30g 55 to 2000 cps.

SC NON-LATCHING TYPE—This micro-miniature relay sets new standards—in design, in performance, in reliability. Yet the SC conforms to standard dimensions and circuitry and may be used to replace ordinary crystal-case relays. A permanent magnet in the structure provides *at least twice the contact pressure found in relays of comparable size*. This extra force accounts for the extremely high shock and vibration resistance shown in the specifications.

SL LATCHING TYPE—Unique magnetic latch assures positioning of armature and exceptional pressure. A 1 watt, 3 ms. pulse to either coil transfers contacts. Transfer time is only 0.5 ms. Coils are designed for continuous duty. Has the same exceptional shock and vibration characteristics as the SC.

POTTER & BRUMFIELD, INC., PRINCETON, INDIANA/SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY





SL—dual coil latching relay. Operates on a 1 watt, 3 ms. pulse at nominal voltage. Permanent magnet latch locks the armature in either position.

SC—non-latching relay with series-connected dual coils. Operates on approximately 1 watt at nominal voltage. Coils must remain energized to hold the armature in the operate position.

SC and SL Series Engineering Data

GENERAL: Insulation Resistance: 10,000 megohms, min.

Breakdown Voltage: 1,000 V. RMS.

Shock: 100g.

Vibration: 30g 55 to 2000 cps.; 0.195" max. excursions from 10-55 cps.

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

Weight: 17.5 grams (5/8 oz.).

Operate Time: 3 MS. max. with 550 ohm coil @ 24 V. DC. (SL: 630 ohm coil at 24 V. DC).

Transfer Time: 0.5 MS max.

Terminals: (1) Plug-in for microminiature receptacle of printed circuit board.

(2) Hook end solder for one #20 AWG wire.

Enclosure: Hermetically sealed.

CONTACTS: Arrangement: 2 Form C.

Material: Gold flashed palladium.

Load: 2 amps @ 28 V. DC, resistive; 1 amp @ 115 V. AC, resistive.

Pressure: SC—13 grams min.; SL—16 grams min.

COIL: Power: Approx. 1.0 watt at Nominal Voltage.

Resistance: SL—40 to 1400 ohms; SC—35 to 1250 ohms.

Duty: Continuous.

MOUNTINGS: Bracket, stud and plug-in.

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.

Mail coupon below for further engineering data on P&B's new SC and SL Series relays plus new compact catalog of standard type relays.

If you need answers to a specific application problem, write in detail.

Potter & Brumfield, Inc., Princeton, Indiana

Attn: T. B. White, Brig. Gen. USMC (Ret.)

Special Projects Engineer

Please send me complete data on the new SC and SL Series relays, plus the new compact catalog of P&B standard relays.

Name _____

Company _____ Dept. No. _____

Address _____

City _____ Zone _____ State _____

See our catalog in Sweet's Product Design File

CIRCLE 93 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 1, 1957

Galvanometer Assembly

3 Units in Standard Rack



Model 204AR-3 assembly contains three 204A galvanometers and may be mounted in standard 19-in. racks. The galvanometers in this unit are combination dc null detectors, linear deflection indicators, microvoltmeters, micro-microammeters, and low-level dc amplifiers. Each unit has seven decaded ranges which cover dc voltages from 10 μ v to 10 v full scale or currents from 0.001 μ a to 1 ma full scale. The sensitivity control functions as an attenuator and is calibrated in attenuation. Input resistance is a constant 10,000 ohms and there are no restrictions on source resistance. A high degree of isolation is provided between ac line, chassis, and the amplifier circuit. The unit also features a floating input.

Kintel, Dept. ED, 5725 Kearny Villa Rd., San Diego, Calif.

CIRCLE 94 ON READER-SERVICE CARD

Frequency and Counter Meter

Small Size, Accurate



This counter unit, Model WE-810, uses glow transfer decade tubes in the counting chain as well as in the crystal controlled time base dividing chain. This provides a small size 7 x 19 in. panel, 7 in. deep, in addition to a low power consumption. As a frequency meter, time bases of 0.01, 0.1, 1.0 and 10 sec are provided. The frequency range covered is 10 cps to 100 kc, with a minimum sensitivity of 100 mv. An external trigger may be used to initiate the counting cycle. The time interval time base frequencies are 100 kc, 10 kc and 1 kc, with an accuracy of ± 1 count, and crystal stability of $\pm .001$ per cent.

Westport Electric, Dept. ED, 149 Lomita St., El Segundo, Calif.

CIRCLE 95 ON READER-SERVICE CARD

HIGH RELIABILITY



DC/AC CHOPPERS

- ADVANCED DESIGN
- HIGH STABILITY
- LONG-LIFE

New and advanced designs by Collins Electronics Manufacturing Corporation now make possible a series of precision miniature choppers unique in reliability, stability of operating characteristics and long service life.

This new series of choppers is manufactured in S.P.D.T. types in both break-before-make and make-before-break models. Make-before-break models are unique in that the force developed by the vibrating element is exerted to hold the working contacts closed rather than to hold the non-working contacts open as in conventional designs. This results in firm contact closure, high contact pressure and imperviousness to disturbances caused by shock and vibration.

Write today for detailed brochure listing all types available with applicable technical information.

COLLINS

ELECTRONICS

MANUFACTURING CORP.

Stevensville, Maryland

CIRCLE 296 ON READER-SERVICE CARD

BIG-POT PERFORMANCE in Miniature-pot size

Waters PRECISION MINIATURE POTENTIOMETERS

are built, tested, and certified* to such rigid specifications as AIA, RETMA, JAN-R-19, MIL-E-5272A, and other applicable military specifications. *This new line* of single-turn pots packs Waters traditional performance into tight spots.

NOW! A complete single-turn-pot line
from Waters

*Complete test data on request.

•CHECK THESE SPECIFICATIONS

Model	Resistance Range (ohms)	Standard Linearity†	Case Dia. (inches)	Standard Shaft Dia. (inches)
WP 1/2	1/2 to 250K	1.0%	1/2	1/8
WP 7/8	1/2 to 250K	0.5%	7/8	1/8 or 1/4
WP 1 1/16	1/2 to 350K	0.5%	1 1/16	1/8
WP 1 1/8	1/2 to 350K	0.5%	1 1/8	1/4
WP 1 5/8	1/2 to 500K	0.5%	1 5/8	1/4

† For best possible linearity submit detailed specifications.
Servo mount standard, three hole and bushing mounting available.

A micro-miniature potentiometer that meets the requirements of today and tomorrow for high performance, while retaining the rugged dependability of the approved Waters design.

TYPE WP 1/2

Proved reliable in thousands of military and commercial installations. Available in dual unit with Waters new concentric shaft construction.



TYPE WP 7/8

Offers Waters reliability in the AIA nominal one-inch diameter. Available as servo or bushing-mounted unit, it gives high precision in a miniature size.



TYPE WP 1-1/16

Provides higher resistance values with better resolution and linearity, yet is a miniature unit in every sense. Available as dual unit with concentric shafts.



TYPE WP 1-1/8

Reliability and precision equal to many 2-inch or larger potentiometers results from Waters proved miniature design and assembly techniques.



TYPE WP 1-5/8

Write for catalog of the Waters complete single-turn-pot line; *precision, trimmer, low torque, miniature.*

Waters
MANUFACTURING, inc.

APPLICATION ENGINEERING OFFICES
IN PRINCIPAL CITIES

Wayland, Massachusetts



CIRCLE 96 ON READER-SERVICE CARD

New Products

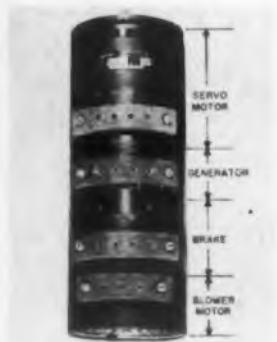


**Logarithmic
Translator**
Flat Response

The model 6700 logarithmic translator finds applications in audio and acoustic research and development, in measuring wide ranges of levels with maximum low level accuracy and in plotting frequency response characteristics of various components. The output voltage varies in average value proportionately to the logarithm of the input amplitude, and can be fed directly to any averaging type indicator or oscillograph. Decibel range is 0-40 db; voltage range is 1 mv to 100 v. Frequency response is 25 cps to 40,000 cps \pm 1 db. Linearity is \pm 0.5 db. Output average value varies 0.05 v per db from 2 to 4 v. Input impedance is 500 k and response speed is practically instantaneous.

Electro-Voice, Inc. Dept. ED, Buchanan, Mich.

CIRCLE 97 ON READER-SERVICE CARD



**Servo Motor
Combination**
Contains Brake and
Blower

Type 23-MTG-6327-01 is a single unit combining a size 23 1/15th hp at 6000 rpm servo motor; a damping tach generator with an output of 1.5 v per 1000 rpm nominal, null voltage of 0.15, and linearity of \pm 2 per cent up to 6000 rpm; a 28 v dc brake; and a blower capable of cooling the entire unit. The unit is available in any desired combination of its components. Designed for driving antennas and other self-cooled drive motor applications. Overall dimensions are 8.1 in. long max x 2.88 in. diam.

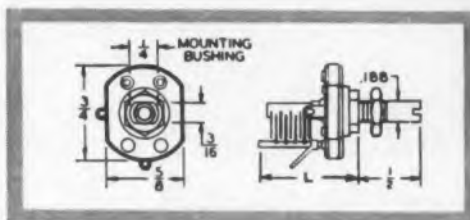
John Oster Mfg. Co., Avionic Div., Dept. ED, 1 Main St., Racine, Wis.

CIRCLE 98 ON READER-SERVICE CARD



Perfect for compact RF equipment . . .

These tiny variable capacitors provide the ideal solution to compact design problems. Requires just $\frac{5}{8}$ " x $\frac{3}{4}$ " panel area—the longest model extends only 1 17/64" behind panel. Soldered plate construction, oversized bearings, and heavily anchored stator supports provide extreme rigidity—torque is steady—rotor stays "put" where set! Bridge-type stator terminal provides extremely low inductance path to BOTH stator supports. Nickel-plated rotor contact—steatite end frames DC-200 treated. Single section, butterfly, and differential types available.



SPECIALS—Johnson Miniature Air Variables are available in production quantities with the following features: 1. Locking bearing. 2. 180° stop. 3. Various shaft extensions. 4. High torque. 5. Silver or other platings.

For complete information on these miniature capacitors or other Johnson electronic components—write for your free copy of our newest components catalog.

Free
Catalog

Contains complete specifications on all Johnson electronic components.



E. F. Johnson Company

3419 Second Ave. S.W. • Waseca, Minnesota

CIRCLE 99 ON READER-SERVICE CARD

Miniature Pentode

For Minimum Hum and Noise

The EF86/6267 nine-pin miniature pentode is designed for preamplifier and input stages having stringent requirements with regard to minimum hum, noise, and microphonics. It is a direct plug-in replacement for the older Z729. The low-frequency noise generated by the Amperex EF86/6267 is equivalent to a voltage of $2 \mu\text{v}$ on the control grid in the bandwidth from 25 to 10000 cps. Hum is kept to a minimum by winding the heater as a double helical wire with mutually cancelling magnetic fields. Effective internal screening reduces the internal tube capacitances through which hum can be transferred to the output.

Amperex Electronic Corp., Dept. ED, 230 Duffy Ave., Hicksville, N.Y.

CIRCLE 100 ON READER-SERVICE CARD

TV Camera Assemblies

Designed for Military Use



Four TV camera units make up this miniaturized chain designed to military specifications. Illustrated are a camera head unit, 5-in. high, which houses a vidicon pick-up tube and its associated circuits; a picture monitor unit, 7-7/8 in. high, which uses an 8-in. aluminized rectangular crt; a camera control unit, and a power supply unit. The system offers a resolution of 100 per cent modulation at 600 lines, is capable of reproducing the ten shades of gray on the retina test chart, and the sweep non-linearity is rated at 2 per cent max.

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

CIRCLE 101 ON READER-SERVICE CARD

CIRCLE 102 ON READER SERVICE CARD ➤

General Electric 5-Star Tubes

MADE LIKE A FINE WATCH FOR UNIFORM RELIABILITY!

HEATER. Wire is too critical in fineness to measure other than by weight... 4.5 mg per 200 mm. Maximum allowable weight variation is $\pm 1\%$.

CATHODE. Diameter .03 in, precision-held to $\pm .0005$ in. Coating is restricted to a weight variation of $\pm .25$ mg per sq cm.

GRID WIRE. Diameter .001 in, controlled by weight to ± 15 millionths of an inch. Grid No. 1, silver-plated tungsten—No. 2, gold-plated tungsten—No. 3, molybdenum.

GRID TOLERANCES (across minor axis):
No. 1, $\pm .0007$ in. No. 2, $\pm .0007$ in. No. 3, $\pm .002$ in.

GRID SIDE RODS. Held to $\pm .00015$ in.

MICA CATHODE-HOLE DIAMETER. Held to $\pm .00025$ in.

MICA GRID-HOLE DIAMETER. Held to $\pm .0005$ in.

MICA HOLE SPACING. Cathode-to-grid aperture spacing is held to a max variation of $\pm .00025$ in.

GENERAL ELECTRIC 5-Star Tubes are specially built to the industry's highest standards of craftsmanship and precision. Micro-measurements of a representative type, 5654—a few of which are given above—show the extreme accuracy of manufacture that sets these fine tubes apart from others. 5-Star Tubes are the most reliable you can specify...and the most uniform in their dependability, tube-to-tube.

A wide range of 5-star high-precision, high-reliability types—miniatures and subminiatures—is available for critical military and industrial sockets. Contact the nearest office of the Receiving Tube Department, at right!

ABOVE: greatly enlarged sectional view of a General Electric 5-Star high-reliability 5654. This tube was taken from current production.

EASTERN REGION

200 Main Ave., Clifton, N. J.

Phones:

(Clifton) GRegory 3-6387

(N.Y.C.) WI. 7-4065, 6, 7, 8

WESTERN REGION

11840 West Olympic Blvd.

Los Angeles 64, Calif.

Phones: GRanite 9-7765

BRadshaw 2-8566

CENTRAL REGION

3800 North Milwaukee Ave., Chicago 41, Illinois

Phone: SPring 7-1600

Progress Is Our Most Important Product

GENERAL ELECTRIC



Contact points able to survive this brutal shear test stay on forever

STANDARDS THAT DETERMINE RELAY QUALITY/

contact points that stay on for keeps

Superior attachment technique guards against insecure welds.

When you find a relay that sheds its contacts, you usually have a relay that's suffering from "cold welds"; this means that when the contact spring was made, the contact and the spring did not really weld together. When that happens, the contact is likely to fall off at any time.

We prevent that, here at Automatic Electric, by making contacts from a continuous length of precious-metal wire. In one combined oper-

ation, we weld the end of this wire to the spring blank (using very accurate control of time and voltage), pinch it off so as to provide exactly the right amount of material for the contact, and finally form it into a dome of the contact metal. Result: a contact with a polished surface, welded to the spring for the life of the relay. This is one more reason why Automatic Electric relays set performance records of 200 to 400 million operations without a failure!

This superior method is typical of the painstaking care that goes into every relay we make.

AUTOMATIC ELECTRIC

A member of the General Telephone System
One of America's great communications systems



CIRCLE 103 ON READER-SERVICE CARD

New Products

Frequency Converter 2400 Cps Source for Mag Amps



This transistorized frequency converter is primarily designed for application in autopilot systems, guidance systems and in telemetering functions, as a source of high frequency power for magnetic amplifiers. Producing a 1200 or 2400 cps output, the frequency converter weighs approximately 2-1/2 lb. Full load efficiency is better than 85 per cent. Synchronizing power is obtained by frequency multiplication of the 400 cps 3 phase input. Regulation is 3 per cent from no load to full load.

Robertshaw-Fulton Controls Co., Aeronautical Div., Dept. ED, 401 N. Manchester, Anaheim, Calif.

CIRCLE 104 ON READER-SERVICE CARD

Angular Divider For Synchros and Pots.



Model D-3 angular divider positions shafts of rotating components to an accuracy of 20 sec of arc. Flexible couplings are avoided by using the synchro shaft to locate the center of rotation of the synchro housing. Unskilled operators can handle this mechanism since colleting is automatic and readings are direct. Adaptation to all housing and shaft sizes can be accomplished easily. Specifications include: weight of 30 lb; diameter, 12 in.; height, 5-3/4 in.

Theta Instrument Corp., Dept. ED, 48 Pine St., E. Paterson, N.J.

CIRCLE 105 ON READER-SERVICE CARD



Class "A" Relay—for use when low first cost is important. Write today for Circular 1702. Automatic Electric Sales Corporation, Northlake, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. Offices in principal cities.



Percentage Recycling Timer

With 12 Time Cycles

The series PC is a re-cycling timer with a dial calibrated in terms of per cent. Its function is to close any electrical circuit for any desired part or percentage of a fixed time cycle. The PC series includes units in the following time cycles: 15, 30, 60 sec; 3, 5, 15, 30, 60 min; 3, 5, 12, 24 hr.

Industrial Timer Corp., Dept. ED, 1407 McCarter Hwy., Newark 4, N.J.

CIRCLE 106 ON READER-SERVICE CARD

High-Mu Twin Triodes

FM Tuner and TV Use

The 6DT8 and 12DT8 are high-mu twin triodes of the 9-pin miniature type. They are intended for use as combined oscillator-mixer and rf amplifier tubes in cathode-drive or grid-drive circuits of fm tuners, and may also be used in a variety of applications in television receivers. The two units of each type are effectively isolated from each other. The two cathodes in each type have separate base-pin terminals to provide greater flexibility.

Radio Corporation of America, Electron Tube Div., Dept. ED, Harrison, N.J.

CIRCLE 107 ON READER-SERVICE CARD



Pitch-Yaw Indicator

Accuracy of 0.1 Deg

Model 4-1 pitch-yaw indicator consists of a free-swiveling aerodynamic head providing potentiometer output linear with angles of pitch and yaw. High temperature components used throughout the instrument permits operation at high mach numbers. Model 4-1 is available in ranges up to 27-1/2 deg, with an indicating accuracy of 0.1 deg. Overall length is 4 in.

Edcliff Instruments, Dept. ED, P.O. Box 307, 1711 S. Mountain Ave., Monrovia, Calif.

CIRCLE 108 ON READER-SERVICE CARD



THE NEW GENISCO

ANGULAR OSCILLATING TABLE

Generates a precise sinusoidal function accurate to within 0.1% at excursions up to $\pm 2^\circ$, 0.5% up to $\pm 10^\circ$, and 1% up to $\pm 15^\circ$.

This newest Genisco machine utilizes a unique conical crank mechanism to generate an angular oscillation which closely corresponds to a theoretical sinusoidal waveform. A precision sine-cosine resolver coupled to the crankshaft can be used to bring a test instrument output signal and the oscillating table output signal into coincidence for direct reading of phase lag angle.

The extreme accuracy of the Model B386 Oscillating Table makes it particularly suited for evaluating the damping and response characteristics of angular accelerometers and rate gyros. The Model B386 can also be used for calibrating peak angular velocities and peak accelerations to the accuracy of the known angular excursion and frequency. Within its range, the machine can double as an environmental angular shake table.

For complete information and performance specifications, write to—

Genisco
NEW YORK, N.Y.

CIRCLE 109 ON READER-SERVICE CARD

Brief specifications

Angular Excursion: Infinitely adjustable from zero to $\pm 15^\circ$.

Frequency Range: Continuously variable from 0.02 to 3 cps in the low range; 0.2 to 30 cps in the high range.

Accuracy:

Angular Excursion — within 10 minutes of arc.
Frequency Indication — within 1% with tachometer; within 0.1% with stroboscope.

Payload Capacity: 100 lb. deadweight; 750 lb.-in. under dynamic conditions. Protected against dynamic overload by replaceable shear pins.

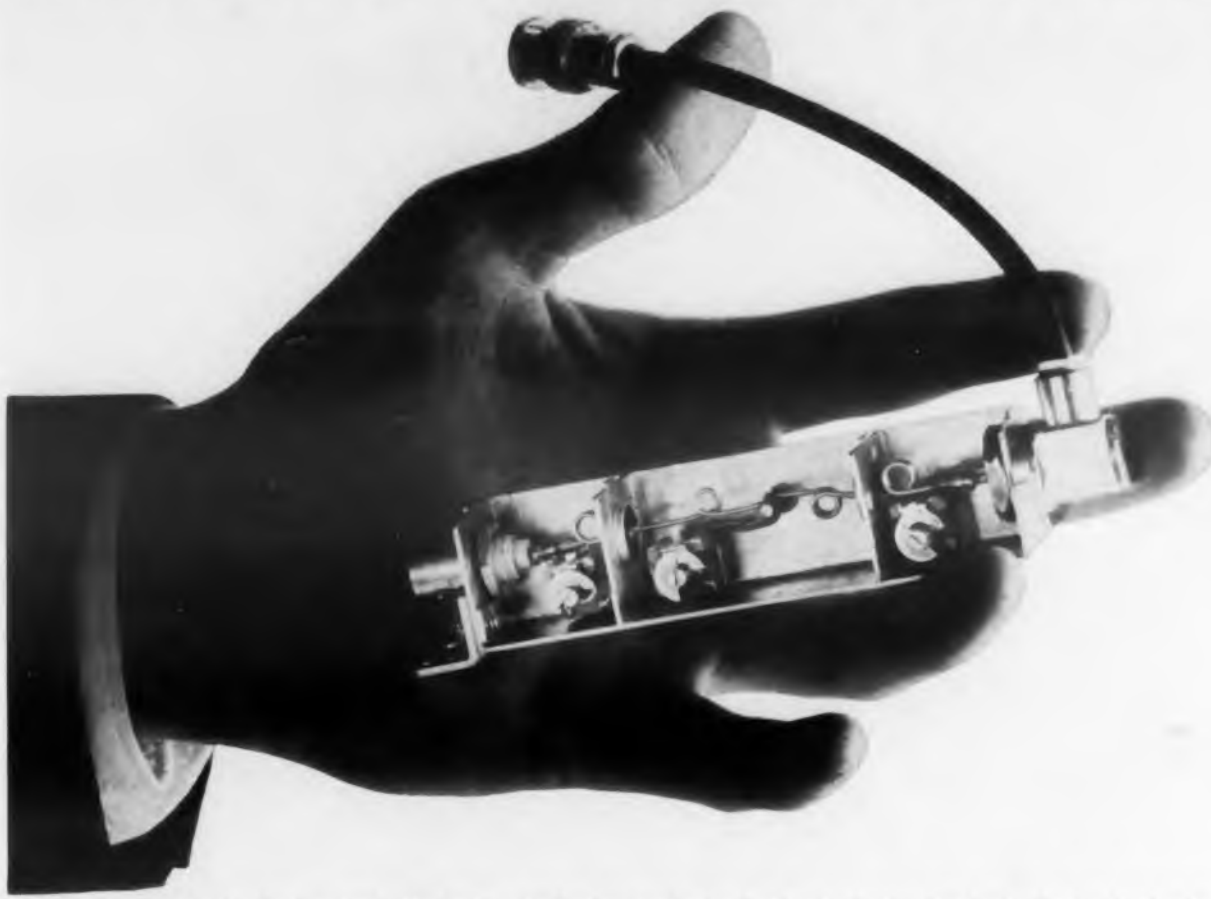
Vibration Isolation:

Vertical Displacement — 0.003" max. at any frequency
Lateral Displacement — 0.001" max. at any frequency.

Platform Diameter: 8".

Approx. Weight: 400 lb.

2233 FEDERAL AVE., LOS ANGELES 64, CALIFORNIA



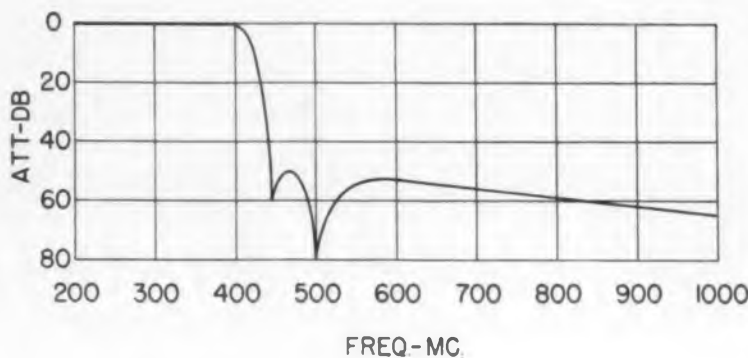
New  low pass filter squeezes max. performance into min. space

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	100 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



RADIO CONDENSER CO.

Davis & Copewood Streets • Camden 3, New Jersey
 EXPORT: Radio Condenser Co., International Div., 15 Moore St., N.Y. 4, N.Y.
 CABLE: MINTHORNE
 CANADA: Radio Condenser Co. Ltd. 6 Bermondsey Road, Toronto, Ontario

CIRCLE 110 ON READER-SERVICE CARD

New Products

AC Ratiometer
 Accuracy to 5 PPM

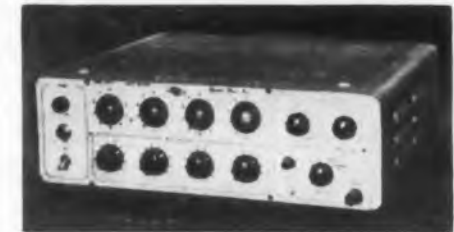


Capable of measuring ac voltage ratios between 0.000001 and 1.111111 with high accuracy and at any load, this ratiometer is particularly suited for testing precision transformers, resistors, capacitors, and inductors. Models 204 and 206 cover the frequency range from 40 to 2000 cps. and have an accuracy of 5 ppm at unity ratio, or 500 ppm at a ratio of 100 to 1. By following a simple calibration procedure, an accuracy of 5 ppm can be attained for any specific ratio within the range of the ratiometer.

Transformers, Inc., Dept. ED, 200 Stage Rd. Vestal, N. Y.

CIRCLE 111 ON READER-SERVICE CARD

Preset Counter
 and Digital Frequency Divider



Model 7240B preset counter and digital frequency divider is a four decade instrument with fast recycle for such applications as batching and frequency division. Switches, photocells, pressure or magnetic pickups, and strain gages are typical transducers used. Outputs upon reaching the preset count include a coincidence pulse for triggering other equipment, an adjustable width gate for actuating external equipment, and dpdt relay. Preset counting capacity is 1 to 9999 input events with absolute accuracy.

Electro-Pulse, Inc., Dept. ED, 11861 Teale St. Culver City, Calif.

CIRCLE 112 ON READER-SERVICE CARD

Power Resistor Decade Unit Reads Actual Resistance Values



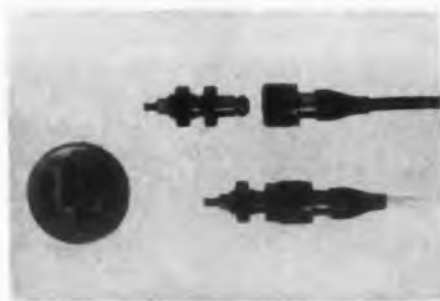
When accurate and predetermined steps of resistance value are desired, such as in calibrating or testing operations in working circuits, the power resistor decade box provides a means of obtaining the desired resistance value under actual load conditions. The unit is rated at 225 w at 1000 v maximum. It provides for any required ohmage from 1 to 999,999 ohms in increments of 1 ohm. Either known or unknown resistance value is dialed and then read directly from the six decade dials.

Clarostat Mfg. Co., Inc., Dept. ED, Dover, N. H.

CIRCLE 113 ON READER-SERVICE CARD

Coaxial Connectors

Positive Snap-Lock Action



Featuring a snap-lock design for easy connection in limited-access spaces, these connectors withstand shock and vibration without signal loss, loosening, or mechanical damage. A typical unit weighs 0.1 oz and measures 3/4 x 1/4 in. Snap-lock action is made possible by a spring-loaded retainer ring that engages in the groove of the receptacle. Frequency range of the connectors is 0-12 kmc and impedance values are 50, 75, and 95 ohms. Voltage breakdown is 1500 v rms min and temperature range is -70 to +550 F.

Electro-Physics Labs., Dept. ED, 2065 Huntington Dr., San Marino, Calif.

CIRCLE 114 ON READER-SERVICE CARD



... to meter-relay dependability



The only truly dependable meter-relays are those built with locking contacts. For lasting, reliable contact action, meter-relay contacts *must* make firmly and break cleanly, every time.

An indicating meter with a couple of contacts stuck somewhere inside just won't do. Such an instrument may be excruciatingly accurate as an indicator, but it will fail miserably in a control application.

LET'S CLEAR THE AIR

We make these statements because there seems to be some misunderstanding about how contact meter-relays should be built and what they will do. Since they are the very

PRIMER STUFF, BUT PERTINENT

Any meter-relay which makes and breaks contacts by depending on the tiny forces inherent in a meter movement has been manufactured by whistlers-in-the-dark. Make and break must come from an auxiliary device. Without it, you'll get, at best, only a halting, exploratory type of contact. On the break, you'll get fluttering and arcing and probably sticking . . . at a point maybe 50% behind where the contact should have separated.

HERE'S HOW LOCKING PAYS OFF

Properly used, locking coil contacts will operate reliably 10 to 20 million times. Non-locking contacts will do well to make it through 100,000 cycles, and this at greatly reduced contact current.

GET YOUR MONEY'S WORTH

Meter-relays are used to do hundreds of jobs because they are extremely sensitive, indicating and adjustable. If you've never tried them, we wish you would. If you've tried them



Locking
Coil
Action



Spring
action

heart of our business, we have the greatest concern for their reputation.

Indeed, we think everyone who has anything to do with meter-relays will benefit from a better understanding of them.



Trouble is, a meter
movement alone won't
do what it should

We use a locking coil to grab and hold the contacts. When they touch, there is no fooling . . . they close. The locking coil develops thousands of times as much press-together torque as the meter movement alone can generate. For positive separation, our meter-relays have a spring that loads when the contacts lock. When separation is desired, this spring unloads, flicking the contacts apart.



Operates 10,000,000
to 20,000,000 times

It is true that the need to unlock contacts sometimes presents circuit problems. But think of the problems if a meter-relay's contacts won't work at all! Then you don't have a meter-relay—simply a mighty expensive indicator.

and didn't make out so well, we'd like to have you try again.

In particular, try our locking coil types so you give meter-relays a fair shake—and do yourself a good turn in the bargain.

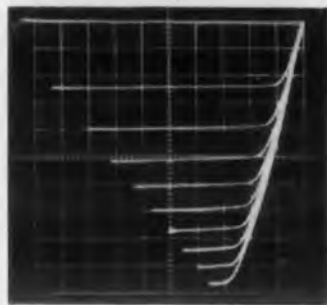


ASSEMBLY PRODUCTS, INC., 75 Wilson Mills Road, Chesterland 17, Ohio

Telephone: (Cleveland, O.) HAmilton 3-4436 • TWX: Gates Mills, Ohio 25-U

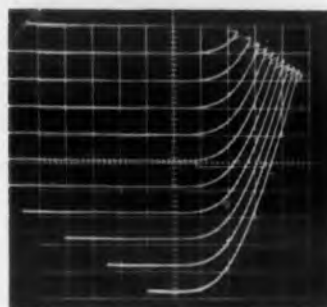
CIRCLE 115 ON READER-SERVICE CARD

NEW TRANSISTOR-CURVE TRACER



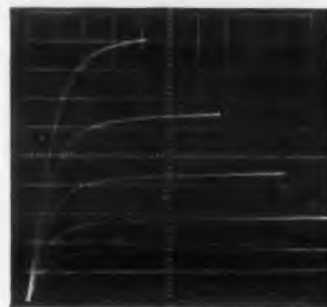
HIGH COLLECTOR CURRENT

PNP transistor, collector current vs collector voltage with constant-current base steps. Collector sweep is 0 to 5 v with a 0.25-ohm load, base current is 50 ma/step. Vertical deflection is 1000 ma/div, horizontal 0.5 v/div.



HIGH INPUT CURRENT

PNP transistor, collector current vs collector voltage with base grounded and constant-current emitter steps. Collector sweep is 0 to 1.5 v, emitter current 200 ma/step. Vertical deflection is 200 ma/div, horizontal 0.1 v/div. Zero voltage is at center scale.



LOW INPUT CURRENT

NPN transistor, collector current vs collector voltage with constant-current base steps. Collector sweep is 0 to 1.5 v, base current 1 microamp/step. Vertical deflection is 10 microamp/div, horizontal 0.1 v/div.

First shipments against a sizeable backlog occurred early in November. Please check with your Tektronix Field Engineer or Representative for current Type 575 shipping schedule.

ENGINEERS—interested in furthering the advancement of the oscilloscope? We have openings for men with creative design ability. Please write Richard Ropiequet, Vice President, Engineering.

**has 10-AMPERE COLLECTOR SUPPLY
2.4-AMPERE BASE SUPPLY**

**Displays 4 to 12 curves per family
with input current from
1 MICROAMP/STEP
to 200 MILLIAMPS/STEP**



The Tektronix Type 575 traces characteristic curves for both PNP and NPN transistors on the face of a cathode-ray tube. Seven different types of curves can be plotted. Vertical deflection is calibrated in collector current, base voltage, base current and base source voltage. Horizontal deflection is calibrated in collector voltage, base voltage, base current and base source voltage. Collector current supply is capable of 10 amperes from 0 to 20 v, 1 ampere from 0 to 200 v. Constant current or constant voltage step supply to either base or emitter is calibrated in 17 values from 1 microamp/step to 200 milliamps/step, and in 5 values from 0.01 v/step to 0.2 v/step with 24 values of driving resistance from 1 ohm to 22 kilohms. Input steps are adjustable from 4 to 12 per family, with repetitive or single-family display.

TYPE 575 TRANSISTOR-CURVE TRACER . . . \$925

f.o.b. Portland, Oregon

Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon

Phone CYPRESS 2-2611 • TWX-PD 311 • Cable: TEKTRONIX

CIRCLE 116 ON READER-SERVICE CARD

Engineering Review

AC-DC Voltmeter

1 Mv Full Scale, 10 Meg Input

Model D-31 ac-dc voltmeter is transistorized and rack mounted, and will measure either ac or dc with a full scale sensitivity of 1 mv. Power is supplied either from a 60 cps source or a rechargeable battery for low noise measurements. While the 60 cps source is being used the battery is recharged. Either balanced or unbalanced measurements can be made. Specifications include an ac input impedance of 10 meg, frequency response (unbalanced) of 10 cps to 1 mc, and an accuracy of ± 3 per cent full scale to 50 kc. Dc specifications include an input impedance of 5 meg, and an accuracy of ± 3 per cent full scale. Meter calibration is rms for ac, and direct reading for dc. The instrument measures 19 in. wide x 3-1/2 in. high x 4-3/4 in. deep.

Alto Scientific Co., Dept. ED, 855 Commercial St., Palo Alto, Calif.

CIRCLE 117 ON READER-SERVICE CARD

Carbon Film Pot. Tester

Rapidly Checks Non-Linear Pots.



Rapid accurate testing of carbon film precision potentiometers with non-linear output is possible with this system. The instrument makes a typical test plot of error every 3 deg of potentiometer angle to a system accuracy of one part in 50,000. A rigidly positioned, quick-acting rack is mounted on a compound slide system, permitting fine continuous indexing by micrometer advance with a reading accuracy of 1/2 min of arc. The null indicator used is chopper-stabilized and has a sensitivity of 20 μ v per in.

Computer Instruments Corp., Dept. ED, Hempstead, N.Y.

CIRCLE 118 ON READER-SERVICE CARD



Teflon Capacitors

High Insulation
Resistance

This line of Teflon capacitors has a minimum insulation resistance of one million megohm-microfarads at 25 C and 1000 at 200 C. Capacitance change over the entire temperature range is less than 4 per cent. Dissipation factor reaches a maximum of about 0.2 per cent at 200 C. Capacitance values from 0.001 to 10 mfd are available in hermetically sealed metal tubes or drawn rectangular cans. Standard voltages are 200, 400, and 600.

Dearborn Electronic Labs, Dept. ED, 1421 North Wells Street, Chicago 10, Ill.

CIRCLE 119 ON READER-SERVICE CARD



Magnetic Amplifier

Linear Reversible
Output

The Type MA-61 operational magnetic amplifier is a stable dc type operating from a 60 cps 115 v line. It features a linear, reversible output and is suitable for amplifying low level signals. The amplifier is stabilized by external feedback, and gain, which is determined by feedback parameters, may be varied over a wide range. The amplifier has a power rating of 25 mw. It is especially useful for mixing two or more input signals and for providing a buffer between a high impedance signal source and a low impedance load.

Characteristics include a zero drift of less than 0.2 per cent of full scale output for a range of 0 to 170 F. Fluctuations in supply voltage and frequency of 10 per cent give a zero error of less than 1 per cent of full scale output. Power gains up to 3×10^6 are obtainable. The linearity of the output, in terms of input signal, is less than 2 μ or 0.3 mv over 1/10 the maximum output.

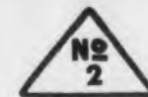
Dynamics Research Associates, Div. Universal Match Corp., Dept. ED, P.O. Box 5841, Ferguson 21, Mo.

CIRCLE 120 ON READER-SERVICE CARD

Nickelonic News



DEVELOPMENTS IN NICKEL AND NICKEL ALLOYS AND THEIR APPLICATIONS



New ultrasonic welder solves heat problem in thin gauge welding



Purity of Inco Nickel helps Raytheon stabilize emission characteristics in magnetron

The vitality of a radar set is centered in its magnetron oscillator. This is why Raytheon chose their RK2J42 fixed-frequency magnetron to pulse their Mariners Pathfinder Radar Model 1500. This tube is designed for long-life operation at 7kw and 1500 pps.

One reason for the tube's top performance is the use of Electronic Grade "A" Nickel in the cathode. This commercially pure, wrought nickel is non-contaminating, and thus helps maintain optimum emission characteristics.

Raytheon engineers also report that it stands up against high ambient temperatures, and has good machinability.

Magnetostrictive "A" Nickel transducer provides the vibratory energy

A new welding process has caught the ear of the electronics industry: "Sonoweld", developed by Aeroprojects, Inc., West Chester, Pa. By means of high-frequency mechanical

vibrations, it produces a metallurgically sound weld — and *without the application of heat.*

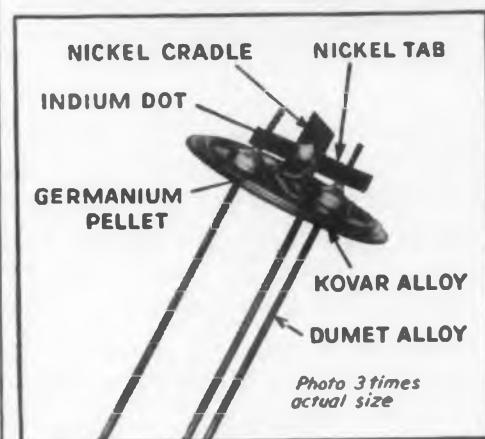
Thin gauge forms of metals like copper and aluminum are now being welded ultrasonically without melting and with little deformation. Photo shows "Sonoweld" unit being used to weld aluminum and copper foil conductors in American Machine & Foundry Co.'s wafer transformer project.

To maintain its high power levels, "Sonoweld" relies on a laminated stack transducer made from Electronic Grade "A" Nickel, a rugged magnetostrictive material. In a periodic electro-magnetic field, nickel undergoes alternating length-changes to vibrate at the field's frequency.

This magnetostrictive effect of "A" Nickel is relatively large, and is useful over a wide frequency range. "A" Nickel also has high resistance to fatigue, heat and corrosion, and is easily fabricated.



G. E. builds rugged PNP triode for computer use



Even the testing treatment (being shot out of mortars) doesn't harm the 2N123 transistor. G. E. (Syracuse) engineers build it with rugged, 99% + pure nickel.

Non-contaminating, corrosion resistant Electronic Grade "A" Nickel has the strength to withstand shock and vibration. It also holds its shape at processing temperatures, and forms, welds and solders easily.

For sure glass-to-metal seals, G. E. uses the special purpose alloys Kovar® (29% Ni) and Dumet (42% Ni).

®Trademark, Westinghouse Electric Corp.

Reprints of useful booklet on "Inco Nickel Alloys for Electronic Uses" now available

This booklet describes the compositions and special properties of the various grades and alloys of nickel which are widely used in the industry. It also lists many important electronic applications of the Inco Nickel Alloys. For your copy, fill out the Reader Service Card, or write to The International Nickel Company, Inc., 67 Wall St., New York 5, N. Y.



THE INTERNATIONAL NICKEL COMPANY, INC. • 67 Wall Street • New York 5, N. Y.

For more information on nickel alloys for electronic uses, send reader service card or write.

CIRCLE 121 ON READER-SERVICE CARD





CHEMELEC...

THE QUALITY LINE OF TEFLON INSULATED COMPONENTS

► **STAND-OFF AND FEED-THRU
INSULATORS**

Metal base and compression mounting miniatures. Hermetic solder-seal and gasket types. Metal body type.

► **SEPARATORS**

Stud and screw mounting types.

► **CONNECTORS**

Multiple-pin, molded Teflon* base type. Multiple-pin, aluminum base type. Individual connectors and test points, compression mounting type.

► **MINIATURE TUBE SOCKETS**

7 and 9 Pin shielded base, and saddle types.

► **CRYSTAL SOCKETS**

► **TRIMMERS**

► **TEFLON SPAGHETTI TUBING**

Thin, standard and heavy wall grades, and tubing treated for potting.

► **COPPER CLAD TEFLON**

for printed circuits and cable strips.

Write for Catalog No. EC-757

Fluorocarbon Products, Inc.

Division of

United States Gasket Company,
Camden 1, N. J.

*du Pont Trademark

Sold in U.S.A. by Erie Resistor Corp. parts distributors.

Fluorocarbon Products Inc.

CIRCLE 122 ON READER-SERVICE CARD

Engineering Review

Pulse Delay Unit

Three 2.5-50 μ sec Delays



This pulse delay unit of the 100 series of transistorized pulse programming equipment is available as a three-in-one unit. Each section provides pulse standardization, pulse delay adjustable from 2.5 to 50 μ sec, and square wave output adjustable over the same range. All of these functions may be utilized simultaneously.

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

CIRCLE 123 ON READER-SERVICE CARD

Power Supply

5 Amp, 0-60 V



Having transistorized magnetic amplifier type circuitry, this precisely regulated supply takes an ac input of 95 to 135 v at 60 cps, and has an output of 0 to 60 v at 5 amps. Ripple component is 1 mv rms maximum. The unit's line regulation is 5 mv static regulation, and less than 5 mv dynamic regulation; the load regulation is less than 25 mv static and dynamic combined. Especially suited for precision laboratory testing, instrumentation work and transistor circuit testing.

Perkin Engineering Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

CIRCLE 124 ON READER-SERVICE CARD

Need
a
Deep
Draw?



Somers

has
an Ace
in
Unigrain[®]

To provide deep drawing thinstrip brass with increased tensile strength and elongation Somers installed the first high speed continuous annealer in the non-ferrous industry. This produces a much finer grain size than batch annealing with the result that only a single color buff is needed for a polished finish: heavy buffing and orange peel effect are eliminated, an additional saving in production time.

Whatever your problems in thinstrip brass, nickel, copper and alloys, Somers will be glad to solve them for you without cost or obligation.

Write for Confidential Data Blank.



Somers Brass Company, Inc.
116 BALDWIN AVE. WATERBURY, CONN

CIRCLE 125 ON READER-SERVICE CARD

Flexibility for Designers



Adjust-A-Volt **500BU** VARIABLE AUTO-TRANSFORMER



2-GANG 500BU
(Also available in 3-gang)

Designed for back-of-panel mounting, the versatile 500BU Adjust-A-Volt variable auto-transformer offers the dependability and flexibility you have been looking for.

Shaft can be adjusted without disturbing rotor and commutator alignment. Terminal board connections allow for either clockwise or counter-clockwise rotation, as well as over-voltage or line-voltage operation.

Ganged units are available to provide increased current output, increased voltages, or for polyphase operation.

Specifications of the 500BU type—input voltage, 115 V; load rating, 1.0 KVA; output—0 to 135 V; output amps max. 7.5 A; driving torque in oz., 20-40. For more data, send for the catalog on the complete Adjust-A-Volt line.

STANDARD
ELECTRICAL PRODUCTS CO.
2240 E. THIRD ST., DAYTON, OHIO

CIRCLE 128 ON READER-SERVICE CARD



36-Channel Oscillograph Direct Recording

Model 1012 Visicorder produces oscillograph records that are immediately visible and useable, recording directly on paper that requires no processing. Having 36 channels, the Visicorder incorporates grid lines which may be recorded simultaneously with time lines and galvanometer traces. All speeds are changed by push-button control. The instrument features five speeds in each of three ranges, from 0.1 to 160 in. per sec. Frequency response is 3000 cps, achieved without peaked amplifiers. Writing speed is up to 20,000 in. per sec, using 12-in. paper.

Minneapolis-Honeywell Regulator Co., Heiland Div., Dept. ED, 5200 E. Evans Ave., Denver, Colo.

CIRCLE 126 ON READER-SERVICE CARD

Crystal Oscillators

Stability of ± 0.015 Per Cent



These crystal-controlled oscillators are available over a frequency range of 4 kc to 250 kc. and are transistorized for compactness. Length (seated) is 5-1/4 in.; diameter, 1-3/8 in. Output power is 600 mw. Frequency stability is ± 0.015 per cent over an ambient temperature range of from -40 to $+60$ C. Over the same range of operating temperature, output level stability is ± 2 db from the 25 C level. The oscillators are mounted in a plug-in octal base.

Dynamics Corp. of America, Reeves-Hoffman Div., Dept. ED, Carlisle, Pa.

CIRCLE 127 ON READER-SERVICE CARD

FOR MISSILE AND AIRCRAFT SERVO APPLICATIONS

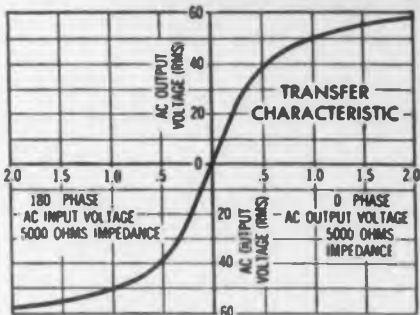
TRANSI-MAG

3.5 - 6 - 10 - 16 WATT

SERVO AMPLIFIER

Completely self-contained, this "minimum space" unit requires no external power supply, demodulator or preamplifier. High performance servo loop is obtained without added amplifying elements and achieved by use of stabilized silicon transistor pre-amplifier with a high speed, fast response miniaturized magnetic amplifier output stage. Send for complete data, Bulletin 100-106.

- Transistor-Magnetic
- High Gain
- 1/2 Cycle Response
- Miniaturized
- -55° to plus 100° C



MODEL NUMBER	TMA-40501-KX	TMA-40601-KX	TMA-41001-KX	TMA-41601-KX
MAXIMUM OUTPUT POWER	3.5	6	10	16
TYPICAL MOTOR LOAD	BuOrd Mk. 14 Kearfott R119	BuOrd Mk. 7 Kearfott R110	BuOrd Mk. 8 Kearfott R111	Kearfott R112
REFERENCE SUPPLY	115 volts, 400 cps, single phase			
SENSITIVITY RESPONSE	See transfer characteristics 0.0013 seconds			
AMBIENT TEMPERATURE	-55° C to +100° C			
WEIGHT - OZ.	10	14	20	30



MAGNETIC AMPLIFIERS INC.

632 TINTON AVENUE • NEW YORK 55, N. Y. • CYPRESS 2-6610
West Coast Division
136 WASHINGTON ST. • EL SEGUNDO, CAL. • OREGON 8-2665

CIRCLE 275 ON READER-SERVICE CARD



**for your
measurement
problems...in
the laboratory
or on the
production line**

you need

■ **THE GRAPHIC PRESENTATION...**

■ **THE WIDE INPUT
VOLTAGE RANGE...**

■ **THE CONTINUOUSLY
VARIABLE LINEAR
SCANNING WIDTH...**

■ **THE CONTINUOUSLY ADJUSTABLE RESOLUTION**



A scanning heterodyne receiver which automatically measures the frequency and amplitude of ultrasonic signals . . . tunes repetitively 6.7 times per second through a 200 kc range in any part of the 1 kc to 300 kc band covered.

Critically designed for laboratory operations on the research and development levels, the instrument provides driftless displays, constant linearity, and stabilized scanning widths yet the graphic display is easily readable by production line personnel. Both linear and log amplitude scales are provided, making it possible to compare simultaneously signals having amplitude ratios as high as 100:1. Detailed examination of signals separated by as little as 100 cps may be made due to the highly selective special control features of the instrument.

The SB-7aZ provides a unique and rapid method of analyzing ultrasonic vibrations . . . for checking the effects of load changes, component variations, shock, humidity and thermal changes upon frequency stability . . . for monitoring communications carrier systems for off-frequency transmissions, interference due to spillover, spurious modulation, parasitic oscillations, etc. . . . for Fourier analyses of complex ultrasonic waveforms.

of
**PANORAMIC'S
ULTRA-SONIC
(WAVEFORM)
ANALYZER
SB-7aZ**

The speed, accuracy and versatility of the SB-7aZ is further magnified with Panoramc accessory equipment:

Panoramc's Ultrasonic Response Indicator Model G-3 converts the SB-7aZ into a single line response curve tracer . . . discriminates against noise and hum . . . shows response to fundamental frequency only . . . assures accurate frequency response measurement.

Panoramc's Triangular Wave Generator TW-1 generates a continuously variable linear bidirectional swept frequency enabling the establishment of the proper rate of scan to insure the presentation of true response.

Panoramc's Signal Alternator SW-1 presents two signals to the Analyzer at alternate intervals making possible comparison of signal being analyzed with a standard. Variations are instantly visible.

Write, wire, phone TODAY for more information. There is a Panoramc Spectrum Analyzer to cover frequency ranges from Subsonic through Microwave.

Send for our new CATALOG DIGEST and ask to be put on our regular mailing list for the PANORAMIC ANALYZER featuring application data.



Panoramc Radio Products, Inc., 524 South Fulton Ave., Mount Vernon, New York
Phone: Owens 9-4600. Cables: Panoramc, Mt. Vernon, New York State

CIRCLE 130 ON READER-SERVICE CARD

Engineering Review



TV Tube Heater
Controlled Current
and Warm-Up

This 450 ma, 6.3 v television picture tube heater incorporates control of both warm-up time and current. Wound from a straight piece of tungsten, the heater is a double helical coil which makes possible the same cathode coating temperature achieved in 600 ma, 6.3 volt television picture tubes. The heater features a rigid mechanical structure with little tendency to sag away from the cathode cap. Heater warmup time is controlled to approximately 11 sec. Heater current is regulated to a tolerance of $\pm 5\%$.

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

CIRCLE 131 ON READER-SERVICE CARD



Instrument Rectifiers
Resist Temperature
and Vibration

Advantages cited for the CX1A4F and CX5A4F series of instrument rectifiers are negligible error with temperature variations, long life, retention of electrical characteristics under vibration and high resistance to momentary overload. Designed for general meter and instrument application, the series also meets the specifications for VU meters. Units consist of four cells in a full-wave bridge circuit, Rated up to 2 ma dc and 6 v ac input.

Bradley Labs., Dept. ED, 168 Columbus Ave., New Haven 11, Conn.

CIRCLE 132 ON READER-SERVICE CARD

**CRITICAL
POT SPECS*
are met at CIC**

Equipment designers who demand more than "shelf item" specifications, rely on CIC for dependable delivery of ultra-precise potentiometers.

The result of CIC research, carbon film potentiometers are setting new standards of accuracy, life at higher speeds and performance reliability.

CIC has assisted many firms in a wide variety of industrial instrumentation, military fire control and flight guidance equipment.

Why not discuss your specific requirements with us?

*New carbon film techniques assure virtually infinite resolution; linearity to .01%, sine-cosine to .025%; compact ganging; precision ball bearing servo construction.

"For Precision Performance...specify CIC"

Detailed Technical Data Sheets available on request.

COMPUTER INSTRUMENTS CORPORATION

92 Madison Ave. • Hempstead, Long Island, N.Y.

CIRCLE 133 ON READER-SERVICE CARD

**Fractional HP Motor
Two-Speed Reversible**



This two speed reversible sub-fractional hp motor, designated RBC-2514, is available with basic speeds of 1800 rpm to 3600 rpm. Standard gear reductions are from 3/1 to 3600/1. Basic torque ratings at 115 v, 60 cps, 3600 rpm synchronous, range from 0.15 to 0.5 oz-in., with induction ratings approximately 100 per cent higher.

Holtzer-Cabot Motor Div., National Pneumatic Co., Inc., Dept. ED, 125 Amory St., Boston 19, Mass.

CIRCLE 134 ON READER-SERVICE CARD

**Coolant Pump
For Airborne Equipment**



Model 1733-HBU-249 coolant pump is a self-priming, positive displacement pump, featuring an externally adjustable pressure regulating valve. It is qualified to military specifications which require 1 gpm at 100 psi of ethylene glycol and water. The unit permits the design of airborne electronic cooling systems, utilizing the advantages of this type of coolant. The assembly is flange mounted so that the motor can be inserted directly into the cooling air duct, using this airflow to cool the motor and therefore reduce weight and size. The assembly measures 3 x 3 x 7-3/16 in., and weighs 3 lb 9 oz.

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

CIRCLE 135 ON READER-SERVICE CARD

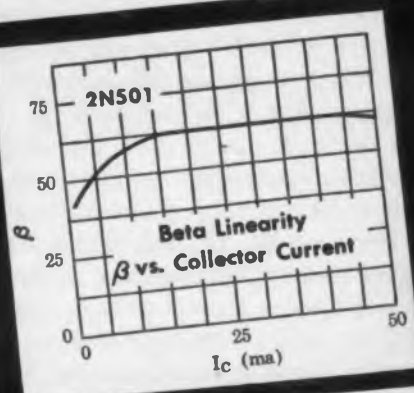
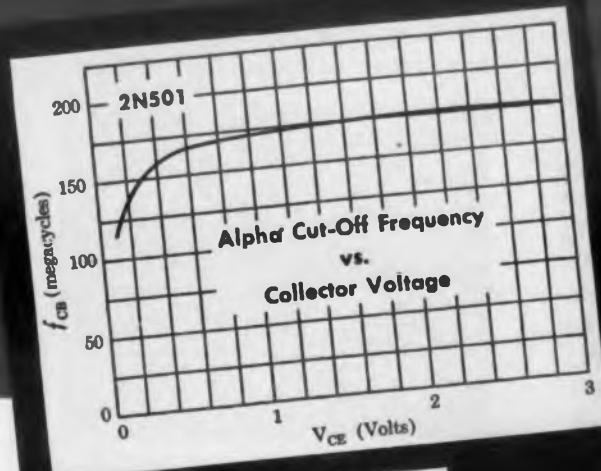
CIRCLE 136 ON READER-SERVICE CARD

VHF Transistors! First From PHILCO



New family of Micro Alloy Diffused-base Transistors (MADT)*

- Rise, Storage, Fall Time in Low μ sec Range
- High Oscillator efficiency at 200 mcs
- Amplifier gains of 10 db at 200 mcs



MADT FAMILY APPLICATIONS DATA				
TYPE*	f_{max}	Power Gain	Oscillator Efficiency	Class of Use
2N499	250 mcs (min)	10 db at 100 mcs	25% at 100 mcs (min)	oscillator and amplifier to 100 mcs
2N500			25% at 200 mcs (min)	oscillator to 400 mcs
2N501	Ultra high-speed switch typical $t_r = 12 \mu$ sec; (18 max.); $t_s = 7 \mu$ sec; (12 max.); $t_f = 4 \mu$ sec; (10 max.). In circuit with current gain of 10 and voltage turnoff.			
2N502†	500 mcs	10 db at 200 mcs		amplifier to 250 mcs
2N503†		11 db at 100 mcs (min.)		amplifier to 100 mcs
2N504	50 mcs	46 db at 455 KC		high gain IF amplifier

*Available in voltage ratings up to 35V and dissipation ratings to 100 mw.
†In JETEC TO-5 Case (widely known as JETEC 30 Case).

Here is a major breakthrough in the frequency barrier . . . a new family of *field-flow* Micro Alloy Diffused-base Transistors. Philco MADT's extend the range of high gain, high frequency amplifiers; high speed computers; high gain, wideband amplifiers and other critical high frequency circuitry.

MADT's are available to various voltage and frequency specifications for design of high performance transistorized equipment through the entire VHF and part of the UHF spectrum. These transistors range in f_{max} from 250 mc to as high as 1000 mc. MADT gains are typically 10 db at 200 mc and greater than 16 db at 100 mc. A low cost general purpose unit is available which will deliver typically 18 db at 50 mc and 32 db at 10 mc.

Make Philco your prime source of information for high frequency transistor applications.

Write to Lansdale Tube Company, Division of Philco Corporation, Lansdale, Pa., Dept. ED-1257

*Trademark Philco Corporation for Micro Alloy Diffused-base Transistor

PHILCO CORPORATION
LANSDALE TUBE COMPANY DIVISION
LANSDALE, PENNSYLVANIA

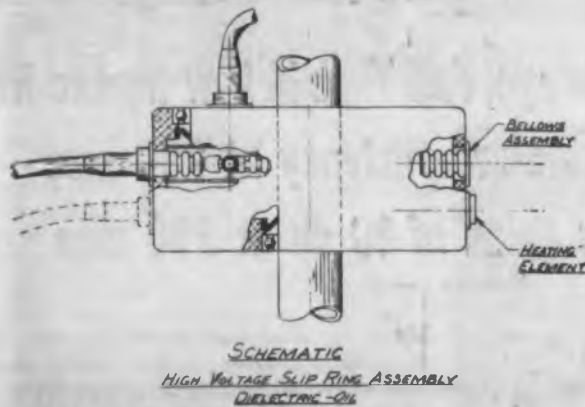


HIGH VOLTAGE SLIP RING ASSEMBLIES

NO. 4

of a Series of
Data Sheets

High Power electronic equipment often requires operation at high voltage. The power requirements are continually increasing and as a result the auxiliary equipment such as slip ring assemblies transmitting the power must be capable of transmitting high voltage. In the past slip rings were designed to transmit 8,000 to 10,000 volts, but today re-

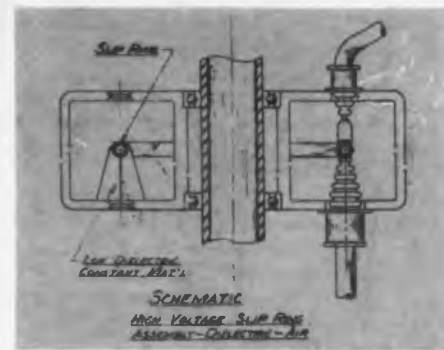


quirements for 30,000 volts and higher are not unusual. Available insulating materials will withstand voltages of this magnitude and if one considers only the dielectric strength of the insulating materials, the design of assemblies for high voltages does not appear to present too great a problem. However, the life of many insulating materials is greatly reduced by ozone generated by corona discharge and some excellent insulating materials will disintegrate in a few hours when operated in a confined corona field. Corona is electrical discharge and covers a very wide band of frequen-

cies. This energy can be transmitted over the lead wire and cause radio interference.

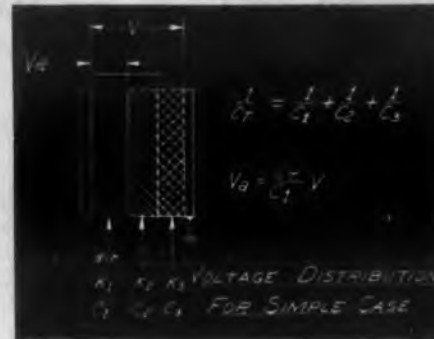
Good design requires that there be no corona in the slip ring assembly and the operation of the assembly corona-free is one of the primary problems. When a potential is applied to a configuration of conductors and several insulating materials, one of which may be air, the potential distribution throughout the configuration will be governed by the electric capacitance between the elements, and the higher the capacitance of any element, the lower the voltage gradient across that element.

The capacitance of the insulating elements is governed in part by the dielectric constant of the material, and since the dielectric constant of air is close to 1 and of all other materials is greater than 1, the voltage gradient across the air may become proportionately greater than across the other dielectric materials. If the voltage gradient across the air



exceeds the dielectric strength of the air, corona will result.

The proper design of the slip ring assembly is to effect a balance between the thicknesses and dielectric



constants of the materials in order that the potential gradients across any dielectric do not exceed the dielectric rating of the material.

For compact design of a slip ring assembly, operating voltages in excess of 20 KV require dielectric oil in place of air. Oil can withstand higher voltage gradients than air and the oil has a higher dielectric constant, thereby producing a more uniform voltage distribution in the assembly. This results in a much superior electrical design.

The use of oil dielectric gives some additional complications and these include the requirement of perfect sealing at all joints and bellows to take up expansion and contraction of the oil over a wide range of ambient temperatures. The dielectric oil also becomes viscous at low temperatures and heaters are required to keep the oil warm at low ambient temperatures.

Makepeace SLIP RINGS

D. E. MAKEPEACE COMPANY Attleboro, Mass.

ENGELHARD INDUSTRIES

CIRCLE 137 ON READER-SERVICE CARD

New Products



Components Oven
Regulation ± 3 C

Specifically designed for small components, such as capacitors, resistors, transistors, etc. The AM-200 oven cavity measures 1 in. diam x 2 in. length. Temperature regulation is ± 3 C over an ambient range of -55 to $+100$ C. Available with either plug-in or stud mountings.

Bulova Watch Co., Electronics Div. P-846, Dept. ED, Woodside 77, New York.

CIRCLE 138 ON READER-SERVICE CARD

Frequency Calibrator
For FM/FM Systems



Model 521 frequency calibrator permits the rapid and accurate calibration of oscillators and discriminators in fm-fm telemetering systems, and provides calibrated input voltage to each voltage-controlled oscillator to continuously measure deviations from standard frequencies. Alignment of each discriminator in the receiving system is checked by a standard frequency generated in the calibrator. The instrument features a proprietary circuitry which permits the direct, highly accurate, comparison of two frequencies without need for frequency restrictions or selective filtering. Reference frequencies are accurate to ± 0.02 per cent, with higher accuracies available. Deviation measurements are accurate to ± 0.05 per cent.

Fenske, Fedrick & Miller, Inc., Dept. ED, 12820 Panama St., Los Angeles 66, Calif.

CIRCLE 139 ON READER-SERVICE CARD

Test Clip Adapter

Tests Pig-Tail Units



Testing of resistors, capacitors, and similar pig-tail components is simplified by the use of this panel-mounting test clip adapter. Spring action of the clips permits positive contact without manual opening or closing of the jaws. Nickel plated clips and plugs are mounted on an MIL-M-14, type CFG phenolic board.

Grayhill, Inc., Dept. ED, 561 Hillgrove Ave., LaGrange, Ill.

CIRCLE 140 ON READER-SERVICE CARD

FM/FM Calibrator

Dynamic Checks

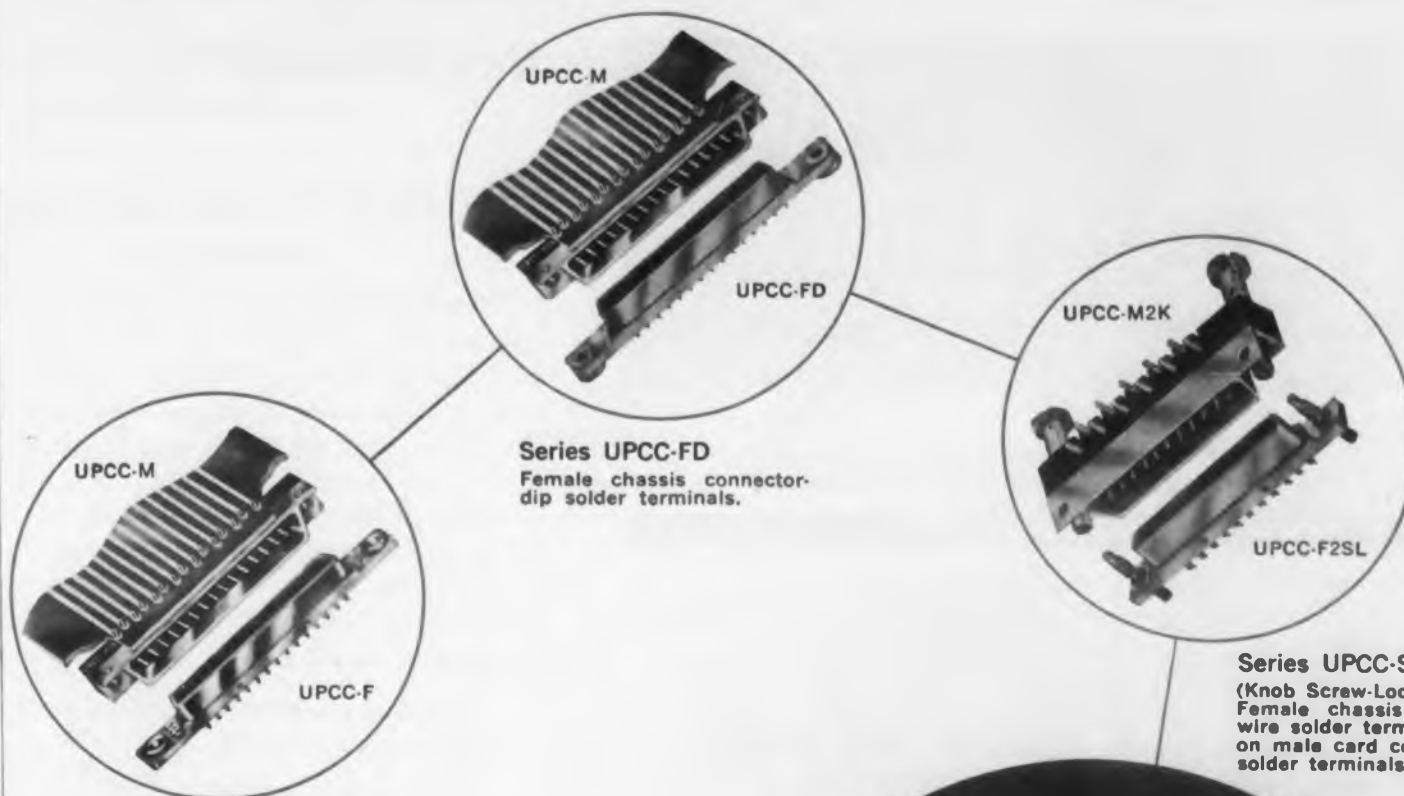


Test information for all fm/fm telemetering systems is obtained with model TDC-5 simultaneous 5-point calibrator and dynamic checker. The instrument offers a simultaneous five-point calibrator for discriminator linearity measurements in all of the 18 rdb subcarrier channels and 5 optional 30 per cent channels. A dynamic checker also converts phase distortion in the discriminator package into harmonic distortion which can then be analyzed on the screen of a panoramic spectrum analyzer.

In its first function, the TDC-5 furnishes five deviation frequencies, which may be set at whatever points desired. As a dynamic checker, a stepped fm wave is generated for each subcarrier discriminator. If the stepping rate is increased beyond the permissible information rate, marked harmonic distortion of the stepping frequency is detected on the screen of the analyzer. By adjusting the cycling rate, which is continuously variable from 2 to 2000 cps, until a clear picture is obtained, the maximum information capacity of each channel may be established.

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

CIRCLE 141 ON READER-SERVICE CARD



Series UPCC-FD

Female chassis connector-dip solder terminals.

Series UPCC-M & -F

NAS standard.
Male card connector-dip solder terminals.
Female chassis unit with wire-solder terminals.

Series UPCC-SLK*

(Knob Screw-Lock).
Female chassis connector-wire solder terminals. Knob on male card connector-dip solder terminals.

and now...

Series UPCC-SLH*

Male chassis connector-dip solder terminals.
Female hooded connector-wire solder terminals.



another "demand" member has joined U.S.C.

family of Printed Card Connectors . . . the new, hooded screw lock Series UPCC . . . SLH bringing the total of different available types to over 150.

- Conforms to MIL-C-8384 and NAS specs.
- Molding materials—melamine and diallyl phthalate
- Die cast aluminum shells—aluminum hoods
- Ideal for critical environmental conditions
- Silver plated—gold flash contacts
- Screw lock elements—stainless steel—double lead for double speed

All UPCC-M & -F units available with wire-solder; turret type; or solder dip terminals (for 1/16, 1/8, 1/4" boards).

Max. Wire Size #18 AWG
Voltage Breakdown (Min.) 1800v, AC, RMS
Insulation Resistance over 5000 megohms
No. of contacts 7, 11, 15, 19, 23
Current Ratings 7.5 amps

Also custom configurations to meet your specific application requirements.

*Pat. Pend.



U.S. COMPONENTS, INC. associated with U. S. Tool & Mfg. Co., Inc.
454 East 148th Street • New York 55, N. Y. • CYpress 2-6525

CIRCLE 142 ON READER-SERVICE CARD

DIRECTIONAL COUPLERS

VSWR and RF POWER MEASURING EQUIPMENT

New Products included in new Catalog No. 12 create the most extensive line available.



RF POWER and VSWR INSTRUMENTS

Model No.	Frequency Range (mcs.)	Power Range Incident & Reflected (watts)	RF Connectors and Impedance
261**	0.5 - 225	0 - 1000	Type 83-1R 52 ohms
262	-	0 - 1000 (relative)	Indicator only
263	0.5 - 225	0 - 10; 100; 1000	Type N* 52 ohms
702N	28 - 2000	0 - 4	Type N* 52 ohms
703N	20 - 2000	0 - 12	Type N* 52 ohms
▲705N	20 - 2000	0 - 120	Type N* 52 ohms
▲706N	28 - 2000	0 - 400	Type N* 52 ohms
711N	25 - 1000	0 - 30; 75; 300	N plus 83-1R Adapters
▲722N	1000 - 3000	0 - 4	Type N 52 ohms
▲723N	1000 - 3000	0 - 12	Type N 52 ohms
405B8	28 - 2000	0 - 4000	1 1/2" Flange 51.5 ohms
445A9	28 - 2000	0 - 12,000	3 1/2" Flange 50.0 ohms
445A10	20 - 2000	0 - 40,000	3 1/2" Flange 50.0 ohms



DC OUTPUT DIRECTIONAL COUPLERS

Model No.	Frequency Range (mcs.)	Power Range Incident & Reflected (watts)	RF Connectors and Impedance
576N1	42 - 2000	1.2	Type N* 52 ohms
576N3	20 - 2000	0 - 12	Type N* 52 ohms
▲576N4	46 - 2000	0 - 40	Type N* 52 ohms
▲576N6	28 - 2000	0 - 400	Type N* 52 ohms
▲592N	1000 - 3000	0 - 4	Type N 52 ohms
▲593N	1000 - 3000	0 - 12	Type N 52 ohms
402B8	28 - 2000	0 - 4,000	1 1/2" Flange 51.5 ohms
442A9	28 - 2000	0 - 12,000	3 1/2" Flange 50.0 ohms
442A10	20 - 2000	0 - 40,000	3 1/2" Flange 50.0 ohms



RF OUTPUT DIRECTIONAL COUPLERS

Model No.	Frequency Range (mcs.)	Coupling Attenuation	RF Connectors and Impedance
313N3	300 - 2000	30 db	Type N* 52 ohms
313N4	120 - 2000	40 db	Type N* 52 ohms
313N5	60 - 2000	50 db	Type N* 52 ohms
313N6	30 - 2000	60 db	Type N* 52 ohms
▲442A40	200 - 1000	40 db	3 1/2" Flange 50.0 ohms



ABSORPTION TYPE RF WATTMETERS

Model No.	Frequency Range (mcs.)	Power Range (watts)	RF Connectors and Impedance
621N	1 to over 1000	0 - 120 milliwatts	Type N* 52 ohms
▲624N	1 to over 1000	0 - 4	Type N* 52 ohms
625C5	50 - 1000	0 - 120	Type C 50 ohms
▲651N	25 - 1000	0 - 25; 100; 500	Type N 52 ohms
▲611A7	50 - 1000	0 - 1200	3 1/2" Flange 50 ohms
612A	44 - 1000	0 - 6000	3 1/2" Flange 50 ohms



RF LOAD RESISTORS

Model No.	Frequency Range (mcs.)	RF Power Dissipation (watts)	RF Connectors and Impedance
633N	3000	50 (air cooled)	Type N* 52 ohms
635N	3000	200 " "	Type N* 52 ohms
636N	3000	600 " "	Type N* 52 ohms
636A	2000	600 " "	3 1/2" Flange 50.0 ohms
638A	2000	6000 (water cooled)	3 1/2" Flange 50.0 ohms



CALORIMETRIC TYPE Primary Standard of RF Power

Model No.	Frequency Range (mcs.)	Power Range (watts)	RF Connectors and Impedance
641N	0 - 3000	0 - 3; 10; 30; 100; 300	Type N 52 ohms

▲New products

*Also available with UHF, C, and HN Connectors.
**Coupler Unit Only for use with 262 Indicator.



M. C. JONES ELECTRONICS CO., Inc.
BRISTOL, CONNECTICUT

CIRCLE 154 ON READER-SERVICE CARD

New Materials

Transformer Encapsulation Compound

Resist 175 C

Transformers encapsulated with Alcast encapsulation compound, have been subjected to temperatures as high as 175 C for a protracted period of time without being adversely affected. The thermo-setting compound features a coefficient of expansion close to that of glass and metal; excellent adhesion to metal, glass, and printed circuit surfaces; simple handling procedures; and long pot life.

Allen Plastics Corp. Dept. ED, 1015 East 173rd St., New York, N. Y.

CIRCLE 155 ON READER-SERVICE CARD

Elastic Insulation

In Cloth, Tape, and Tubing

Suitable for continuous-duty operation at about 150 C, Isolastane insulating material has resistance to transformer oils, silicone oils, silicone slipper compounds, askarels, and other synthetic insulating liquids. The material is available in bias glass cloth and tape and glass woven sleeving forms.

Natvar Corp., Dept. ED, Woodbridge, N.J.

CIRCLE 156 ON READER-SERVICE CARD

High Temp Cable Harness

Will Not Cold Flow



Known as Spiral Wrap-RN, this new type of Spiral Wrap cable harness will not cold flow at any temperature, and can withstand high temperatures. The material used is exposed to irradiation, resulting in a material that has no melting point. It will withstand continuous temperatures of 150 C, and will withstand 270 C for 48 hr. It is also usable at extremely low temperatures.

Illumitronic Engineering Dept. ED, 680 E. Taylor, Sunnyvale, Calif.

CIRCLE 157 ON READER-SERVICE CARD

Using Thermistors

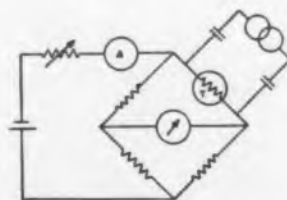
Edited by

FENWAL ELECTRONICS

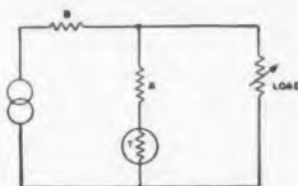
This is the third in a series of news columns devoted to thermistors — a device that is super-sensitive to temperature change.

The example in point: power measurement and voltage control.

A bead thermistor can be used to balance a bridge circuit, allowing the thermistor current to be measured and its DC power calculated. This is done with a 2000 Ω bead thermistor in a 200 Ω bridge circuit with a variable resistor in series with the bridge. This will heat the thermistor enough to lower the resistance to 200 Ω and balance the circuit to determine the H.F. power. By applying a source of high frequency power to the thermistor through capacitors this will further heat the thermistor and the bridge will be unbalanced. Then reduce the DC power until the bridge balances again. Calculate the new DC power, and the difference between the two calculations is the H.F. power.



To maintain constant voltage a thermistor with a suitable series resistor "A" can be placed in parallel with a load in a circuit. As the load resistance increases there is a reduced drop across resistor "B." This tends to raise the voltage across the load. The thermistor heats up, reduces its resistance, and more current passes through it and through resistor "B." This brings the voltage across the load back to its original state. Controls like this can maintain as close as 1% voltage regulation over a broad range of load resistance, or any voltage from $\frac{1}{2}$ volt to 100 volts can be regulated in this way with suitable circuitry.



Engineers: these and other thermistor applications are discussed in 12-page catalog EMC-1. Write for your copy to FENWAL ELECTRONICS, INC., 314 Mellen St., Framingham, Massachusetts.



Makers of Precision Thermistors

CIRCLE 158 ON READER-SERVICE CARD



Krohn-Hite

VARIABLE ELECTRONIC FILTERS



MODELS 330-A and 330-M

FEATURING

- **ULTRA-LOW
FREQUENCY COVERAGE**
- **100,000 to 1
FREQUENCY RANGE
IN ONE INSTRUMENT**
- **DIRECT FREQUENCY
CALIBRATION**

The Krohn-Hite Filter Line

Model	Type	Frequency Range	Price
310-AB*	Band Pass	20 cps to 200 kc	\$295.00
330-A*	Band Pass	.02 cps to 2 kc	\$475.00
330-M*	Band Pass	0.2 cps to 20 kc	\$475.00
340-A	Servo	.01 cps to 100 cps	\$385.00
350-A*	Rejection	.02 cps to 2 kc	\$475.00
360-A*	Rejection	20 cps to 200 kc	\$295.00

*Available for rack mounting at \$5.00 additional.

For further information on:

- Filters
- Power Supplies
- Oscillators
- Power Amplifiers

write for our free catalog D



Krohn-Hite CORPORATION

180 MASSACHUSETTS AVENUE
CAMBRIDGE 39, MASS., U. S. A.

CIRCLE 159 ON READER-SERVICE CARD

Epoxy Curing Agent

For High Temperatures

This colorless curing agent, hardener 929, permits the development of high temperature properties in epoxies. When cured with appropriate epoxy resins, the hardener will develop heat distortion temperatures of approximately 300 F. The hardener is both non-staining and colorless.

Furane Plastics, Inc., Dept. ED, 4516 Brazil St., Los Angeles 39, Calif.

CIRCLE 160 ON READER-SERVICE CARD



Electrical Contacts Precious Metal Type

Precision contacts of fine silver, coin silver, Conmet 4 and Conmet 17, are stocked in several different styles in recommended standard sizes. Also available are standard solid headed contacts and clad metal contacts made from composite metals, and special contacts for specialized electronic applications. Solid rivet and composite type contacts are supplied in all standard contact alloys and special metals where required.

Contacts Inc., Dept. ED, Wethersfield, Conn.

CIRCLE 161 ON READER-SERVICE CARD

Dip-Soldering Fixtures

High Temperature Ceramic

Designed for automatic dip-soldering of printed circuit boards, M120-F ceramic dip-soldering fixtures can not be wet by molten solders and have sufficient mechanical strength to prevent boards from warping. Suitable for use at temperatures to 1065 C, the material will handle fixturing of boards up to 12-in. wide. Molten solders will not adhere to M120-F ceramic. The material, with its low thermal expansion, maintains absolute flatness in the printed circuit board, preventing its warpage at soldering temperature. The printed circuit fixtures are made to print or are available in raw forms as unfired shapes.

Technion Design & Manufacturing Co., Inc., Duramic Products Div., Dept. ED, 262-72 Mott St., New York 12, N.Y.

CIRCLE 162 ON READER-SERVICE CARD

3 WATTS at 70°C



1 WATT at 200°C

± 1% !!

MEPCO TYPE P3 Power wire wound resistor has found immediate acceptance due to its small size and high power and temperature capabilities.

CHARACTERISTICS:

Size: 13/16" x 1/4"

Leads: 1 1/2" #18 hot solder coated

Wattage: 3 watts at 70°C
derate to 0 at 275°C

Protection: Multiple coats baked
silicone resin

Resistance: 1Ω to 6.5K

Tolerance: 1% standard .1% to 5% special

Temperature Coefficient: .002%/°C

Insulation: Multiple coatings of
Baked Resin Finish

Dielectric: 1000 V RMS Min.

Moisture: Characteristic G MIL-R-26C

Other types from 2 to 15 watts
Request Catalog WC-1

mepeco, inc.

MORRISTOWN
NEW JERSEY



New, Improved WOBBULATOR

Model 7200



**Features
New Technique
In Electronic
Swept Frequency
Signal
Generators!**

One of the objectives in the design of the Canoga Wobbulator 7200 is to obtain high sensitivity without the "hum" problems normally experienced with other swept frequency generators. The swept frequency output voltage of the Wobbulator 7200 is modulated at approximately 50 Kc; the probes, with their internal diodes, detect this modulation which is then amplified in the vertical CRT band-pass amplifier. This new principle allows the use of swept generator techniques for evaluation of low gain or lossy circuits where point by point frequency measurements were previously necessary.

Frequency Range:	2.0 to 1000 mc
Swept Frequency Band:	2.0 to 55 mc, continuously variable
Output:	More than 0.03 volts, 50 ohms
Sweep Circuit:	All electronic
Swept Output:	1) Constant within ± 1 db over 40 mc 2) Constant within fractions of db over 30 mc
Attenuator Dial:	Calibrated in 1 db increments
Probe Detectors:	1) Low impedance 50 ohms 2) High impedance
High Sensitivity Vertical Amplifier:	50 microvolts input gives at least 2" deflection
Cathode Ray Tube:	5UP1, with camera mounting bezel
Calibrated Panel Controls:	Center frequency Output Attenuator
Panel Controls:	Deviation Vertical Amplifier Gain Control Vertical Amplifier Gain Switch, high-low CRT intensity, focus CRT Vertical & Horizontal Centering On-off switch
Power:	115V, 60 cps, 175 Watts
Output Impedance:	50 ohms, BNC connector

WRITE TODAY FOR COMPLETE DETAILED INFORMATION

Radar Systems
Antennas
Receivers
Test Equipment
Microwave Components

CANOGA
CORPORATION
5955 Sepulveda Boulevard
Van Nuys, California

CIRCLE 164 ON READER-SERVICE CARD

New Materials

Mold Parting Agent

No Deterioration under Heat

Resin release type N is a non-silicone parting agent for use in releasing plastic parts from compression, injection, and casting molds or patterns. The material is a non-melting parting agent which will not change viscosity or deteriorate up to 450 F. The resin release has applications with polyester, epoxy, phenolic, silicone, neoprene, isocyanate, urea, melamine, alkyd, and vinyl resins used in laminating, potting, tooling, molding, casting, bonding, and filament winding operations. It is soluble in toluene, xylene, and related hydro-carbons. These solvents can be used to make a spray solution or dilute wipe-on film.

Specialty Products Co., Dept. ED, 192 Warren St., Jersey City 2, N.J.

CIRCLE 165 ON READER-SERVICE CARD

Titanium and Alloys

Rolled to Foil Thickness

Production quantities of commercially pure titanium and some titanium alloys are successfully being rolled to foil gage and annealed. Profile rolled L-shapes have also been produced in commercially pure titanium, and similar shapes in alloy 6AL-4V are under consideration. Potential uses of the titanium foil include tubes and honeycomb or sandwich material for aircraft use.

Metals & Controls Corp., General Plate Div., Dept. ED, Attleboro, Mass.

CIRCLE 166 ON READER-SERVICE CARD

Cold Punch Laminate

For Printed Circuit Boards

Textolite No. 11574 epoxy paper laminate is specifically adapted to use for printed wiring boards in high reliability applications. It is also recommended for tube sockets, terminal strips, and other intricate punched or machined parts. The epoxy paper laminate shears, punches and pierces cleanly without haloing at 80 F. Insulation resistance after 96 hours at environmental extremes is one million megohms. Available in sheets 36 x 72 in. or 36 x 36 in. in thicknesses from 1/32 in. to 1/4 in.

General Electric Co., Industrial Laminates, Dept. ED, Coshocton, Ohio.

CIRCLE 167 ON READER-SERVICE CARD

*An Engineer
Speaks Out...*

Here's the EASY Way to Work Up A Nyquist, A Bode, A Nichols



If you're working on servosystem test or design, you'll want to have these FREE chart forms... a wonderful time-saver! The coordinates are already lettered and the legend imprinted. They are transparent "masters". Almost any duplicator assures you of an immediate supply of charts at any time.

When you get the frequency, phase angle, and amplitude loci plotted on these worksheets, you've got a "standardized" permanent record of the system you are checking.

The Complex Plane Conversion Chart, Worksheet #104, should be particularly helpful. On it are plotted the loci of constant closed-loop gain (in units of voltage ratio) on the horizontally axial circles, and the constant-loop phase (in degrees) on the vertically axial circles. These loci are plotted over Cartesian coordinates, the ordinate of which represents the unreal, and the abscissa the real, component of the gain vector.

Suggestions for a uniform procedure in working up the different curves are included.



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OF AMERICA

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For your free SERVO Work Forms, call your nearest Servo Corporation representative, or write directly to Servo Corporation of America, Inc., Room 12A, New Hyde Park, New York.

CIRCLE 168 ON READER-SERVICE CARD



SPAGHETTI SLEEVING

MADE FROM

TEFLON*

*is Carefully Inspected
and Controlled
Dimensionally!*

● PF spaghetti sleeving made from Teflon* is widely used for slip-on insulation, instrument tubing, bundle sheathing, medical tubing, pigtailed and similar applications. It slips on easily, in long lengths up to 3 feet, can be used with tinned or bare wire rather than silvered and it wears longer. 25 sizes, 2 wall thicknesses, 10 colors in stock, 100% inspected and controlled dimensionally, are available, all with these important advantages:

- good dielectric strength (500 to 2000 volts/mil)
- lowest dielectric constant (2.0) and dissipation factor (0.0002) of any solid dielectric
- no change of electrical properties with temperature (-25°C to +250°C) or frequency (60 cycles to 100 mc)
- zero moisture absorption
- unaffected by any commercial chemical
- stress relieved for negligible shrinkage
- continuous service temperature of 250°C—intermittent to 300°C

Write, wire or call for further details and engineering assistance. Ask, too, for information on PF Teflon* flexible tubing, heavy-walled tubing and rod stock.

PENNSYLVANIA FLUOROCARBON CO., INC.

1145 N. 38th Street, Phila. 4, Pa. EVergreen 6-0603

*Teflon—DuPont trade name for Tetrafluoroethylene resin

CIRCLE 169 ON READER-SERVICE CARD

Solvent for Casting Resins

Recovers Embedded Items



Eccostrip 57 is a solvent which is used to attack epoxides, polyesters, polysulfides, and silicone rubbers, and is particularly useful in recovering items which are embedded in casting resins. The solvent attacks the resin, causes it to swell and allows it to be pulled off.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

CIRCLE 170 ON READER-SERVICE CARD

Epoxy Series

For Transformers and Coils

Series 6900 epoxies are especially designed for the casting of transformers, coils, magnetic amplifiers, and other similar equipment. They incorporate long pot life, low viscosity, and the elimination of settling. One feature of the epoxies is flexibility preventing cracking caused by temperature cycling.

Houghton Laboratories, Inc., Dept. ED, Olean, N.Y.

CIRCLE 171 ON READER-SERVICE CARD

Adhesive for Teflon

Binds Teflon to Metal



This adhesive, Type 80, is of the pressure sensitive type, and tests indicate a peel strength of over a thousand grams per inch or a direct pull of 12 to 15 psi per Teflon to Teflon, and Teflon to stainless steel. It has good acid and alkali resistance, excellent electrical properties. It can be applied by brushing, dipping, or spraying.

Flexrock Co., Packing Div., Dept. ED, 3608-B Filbert St., Philadelphia 1, Pa.

CIRCLE 172 ON READER-SERVICE CARD



DELAY LINES

standard or specially designed

BY TECHNITROL

These extra-compact delay lines assure a minimum of pulse distortion with maximum stability under ambient temperatures . . . and in a minimum of space. They can be had pencil-thin in plug-in, pig tail or fuse-clip mounting. Available cased or dip-coated in epoxy resin as well as hermetically-sealed units for military application . . . with any desired characteristics of impedance or frequency response. Typical are:



- Delay: 0.01 to 6 μ s
- Characteristic Impedance: 400 to 5600 ohms
- Band Pass Characteristics: Unique windings furnish maximum band width for given delay per inch.

We are prepared to design lumped constant or distributed constant delay lines for your particular circuit applications.



Write today
for Bulletin
ED 174



CIRCLE 173 ON READER-SERVICE CARD



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 174 ON READER-SERVICE CARD



CIRCLE 175 ON READER-SERVICE CARD

New Literature

Electrolytic Capacitors 176

Type CQM, computer quality electrolytic capacitors are described in engineering bulletin now available. The four-page, well-illustrated bulletin indicates that CQM capacitors may be ordered in various capacitance and voltage combinations ranging from 45,000 μ fd at 5 v to 850 μ fd at 400 v. Container diam are 1-3/8 in., 2 in., 2-1/2 in., and 3 in. Height of all units is 4-1/8 in. Pyramid Electric Co., North Bergen, N.J.

Induction Heaters 177

Induction Heaters are described in bulletin now available. Eight pages contain specifications on 15, 30 and 40 kw units; basic components; optional features; guide to induction brazing and soldering; frequency selector chart; static hardening curve; and other engineering information. Magnethermic Corp., Youngstown, Ohio.

High Voltage Resistors 178

Comprehensive data on construction, types, ratings, dimensions, tolerance, terminals, and installation are described in data bulletin G-1b now attached. The bulletin includes detailed charts and graphs. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Electronics Catalog 179

This 1958 catalog (404 pages) lists over 27,000 items. Special emphasis has been placed on equipment for industrial maintenance, research and production requirements. There are detailed listings of standard and special purpose electronic tubes, test instruments, voltage stabilizers, transformers, resistors, capacitors, printed circuit components, new transistors, rheostats, relays, switches, rectifiers, fuses, tools, wire, cable, photo-electric components, 2-way radio telephones, sound powered telephones, counters, program clocks, timers, batteries, sockets, generators, power supplies and a wide variety of other electronic equipment and components. The attractive rotogravure section includes approved public address amplifiers in systems ranging from 8 to 60 w. PA equipment is included for industrial applications, including indoor and outdoor paging, and plant-wide public address. Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.



Rugged XY[®] Deca Switch

for your selecting and control operations

This direct-drive impulse-controlled stepping switch (reset type) is designed to perform control and selecting functions in industrial and communication applications.

The lightweight Deca Switch offers exceptional reliability and compact ruggedness, plus these added features:

- positive stepping action with special locking device to eliminate bounce of wipers and off-normal contacts when the switch returns to the home position;
- 4 banks of 11 contacts each;
- such time-proven XY advantages as dust-free vertical wire banks, bifurcated wipers, dependable release magnet mechanism, and long-wearing, case-hardened working parts with Parco-Lubrite rust-resistant, oil-retaining finish;
- fast operate and release time.

You can order XY Deca Switches in a wide variety of off normal and release magnet spring combinations to suit your specific requirements. Compact and light, the switches are 4 3/4" long, 4" wide, 1 1/2" high and weigh 20 1/4 ounces.

Complete technical details are contained in Bulletin T-5001, available on request.



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● A special formulation of SICON now protects Corning Glass Works LP resistors against damage from moisture and handling, and acts as an effective insulating coating. It thus guards against dielectric breakdown and subsequent shorting to other parts of TV and radio equipment. SICON does not change the characteristics of the Corning low-power line, and is serviceable to 275°C.

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● The versatility of SICON as a high temperature protective coating is shown by its remarkably varied use on products of all kinds—resistors, jet engine parts, manifolds, heating elements—and its amazing adherence and color retention when used as a decorative finish for heaters, grills, incinerators, etc. Easy to apply. SICON protects up to 1000°F. in black or aluminum, and up to 500°F. in smart colors.

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Industrial Finishes Co.
Waukegan, Illinois

CIRCLE 181 ON READER-SERVICE CARD

Aluminum Bibliography

182

A selected bibliography has been made available to designers and design engineers in the metalworking industry. All available literature and motion pictures of possible interest to designers are discussed in "Bibliography of Information about Aluminum for the Designer." The final two pages of the booklet include forms to simplify ordering. Aluminum Co. of America, 1501 Mellon Square, Pittsburgh 19, Pa.

Rheostat Potentiometers

183

Type 2W rheostat potentiometer is fully described in a four page bulletin, A-3a, now available. The control is a compact unit which offers dependable service.

The bulletin gives comprehensive data on the construction, dimensions, materials, bushings, terminals, contactor, identification, hardware, and locating lugs of the potentiometer. The variable wire wound control provides maximum adaptability to meet rheostat and potentiometer applications. The unit's excellent linearity and resolution are featured in this data sheet. The sheet includes detailed charts and graphs. International Resistance Co., 401 North Broad Street, Philadelphia 8, Pa.

Environmental Test Facility

184

Facilities and functions of an environmental testing laboratory available to industry and government agencies for the critical operating examination of electronic and electromechanical products and systems are explained in 4-page technical bulletin 58-116 now available. BJ Electronics, Borg-Warner Corp., Santa Ana, Calif.

Heaters

185

Designed for a wide range of industrial applications, a cartridge heating unit is described in bulletin 365 now available. It shows that the unit is capable of producing up to 5 times more heat than any standard cartridge heating unit. A typical rating of a "Firerod," 1/2 in. diam by 4 in. long is 1370 w with a watts density of 250 w per sq in. used in a 600 F application.

Included are graphs, and helpful data on how to select the proper type and size unit, how to determine watts density required for a particular installation, proper fit, and other worthwhile information. A table of specifications (tolerance, type of seals) is also shown. Watlow Electric Mfg. Co., 1376 Ferguson Ave., St. Louis 14, Mo.

2 new

miniature cables

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All TEFLON RF Coaxial Cables

Standard constructions comply with MIL C-17B.

Special constructions which fall outside standard range and sizes available upon request.

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RG 187/U	75	.060	.110
RG 188/U	50	.060	.110
RG 195/U	95	.102	.155
RG 196/U	50	.034	.080

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Low Capacitance Cables

Smallest possible engineered cables (9.2 mmf range has OD of .185") for LF pulse transmission, HF RF coupling links and low shunt capacitance lead applications for temperatures up to 100°C.

Design range: 6 mmf thru 10 mmf/ft.

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Bulletin 31A

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NJE OFFERS 10 NEW MODELS OF SOLID STATE POWER SUPPLIES TO MEET THE GROWING DEMAND!

MODEL	OUTPUT		RIPPLE RMS MILLIVOLTS	REGULATION (SEE NOTE 1)	INTERNAL IMPEDANCE DC - 100KC OHMS	PANEL HEIGHT (SEE NOTE 2) INCHES	DELIVERY DAYS	PRICE (INCLUDING METERS)
	VOLTS	AMPS						
SS-7-15	0-7	0-15	1.0	±0.1% or 3 MV	0.005	3½	75	\$ 880
SS-10-10	0-10	0-10	1.0	±0.1% or 5 MV	0.02	3½	75	700
SS-32-3	0-32	0-3	1.0	±0.1% or 10 MV	0.10	5¼	45	600
SS-32-10	0-32	0-10	1.0	±0.1% or 10 MV	0.04	8¾	45	790
SS-32-20	0-32	0-20	1.0	±0.1% or 10 MV	0.02	12¼	45	1100
SS-1003	50-100	0-1.5	1.0	±0.1%	0.03	5¼	30	490
SS-1503	100-150	0-1.5	1.0	±0.1%	0.06	5¼	10	520
SS-1603	0-160	0-1.5	1.0	±0.1% or 20 MV	0.50	7	15	600
SS-2003	150-200	0-1.5	1.5	±0.1%	0.10	7	30	630
SS-2503	200-250	0-1.5	1.5	±0.1%	0.15	8¾	45	720
SS-3003	250-300	0-1.5	2.0	±0.1%	0.20	10½	60	850
SS-1505	100-150	0-3	2.0	±0.2%	0.04	10½	75	950
SS-1605	0-160	0-3	2.0	±0.2%	0.30	12¼	75	1050

NOTE 1: Regulation figure includes total regulation against 105-125 volts slow or instantaneous input voltage variations, 50-1000 cps input frequency variation, 0-100% slow load variations, and ±25% instantaneous load current steps! When regulation is given as "±%" or "mv", the larger value governs.



MODEL SS-1603



MODEL SS-32-3



MODEL SS-1503

The enthusiastic reception which greeted our Solid State fully transistorized power supplies encouraged us to expand our stock line, incorporating the most popular of the custom designs of the last 2 years. All designs incorporate our unique short-circuit-proof (not merely short-circuit-protected) power-transistor circuit.

If power supply size, weight, efficiency, and reliability are important to you . . . you need N J E Solid State! We have developed several hundred special designs (series and shunt regulator configurations) and are prepared to quote on custom requirements.

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New Literature

Automatic Interpolation 189

A method of eliminating laborious and often inaccurate interpolation in reading measuring instruments having nonlinear characteristics is now available in a 6 page illustrated folder. This method is embodied in the spiral-scale dial used on Type 504 heterodyne frequency meter. The dial permits interpolated measurements to be read directly, without computation. Contents of the folder include material reprinted from ELECTRONIC DESIGN, plus a precis of a report by engineer Bob Lebowitz on "frequency measurement devices," as well as a brief description of the Type 504 heterodyne frequency meter. Polytechnic Research & Development Co., Inc., 202 Tillary Street, Brooklyn, N. Y.

Metal Panel Decoration 190

Panels and control boards for instruments and electronic equipment are featured in a 4-page brochure. Etched, engraved, lithographed and screened panels ranging from small dials to huge boards are illustrated and described. Etched Products Corp., Panel Dept., 39-01 Queens Blvd., Long Island City 4, N.Y.

Rotating Components 191

A catalog designed to aid in the selection and application of precision synchros, resolvers, and rotating components has recently been published. Synchros, stepper motors and similar products for a wide range of uses are illustrated and described. The catalog has a section covering points of consideration in synchro selection such as types (control or torque), military designations and engineering data. It also contains inquiry sheets enabling the engineer to specify his particular requirements for synchro types, power specifications and other characteristics. Dimensional data, materials and electrical data are given on the various types described. Induction Motors of California, Div. of Induction Motors Corp., 6058 Walker Ave., Maywood, Calif.

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CIRCLE 192 ON READER-SERVICE CARD

Mica Selector

193

Size and quality of natural mica material needed for fabricated parts can be determined accurately through a technical bulletin now released. The mica user merely lays the part or sketch on a full-size "grading chart" provided to estimate the material needed. High-quality natural micas are of particular interest to industry because of their excellent dielectric properties, and resistance to temperatures of 1000 F and higher. Ford Radio & Mica Corp., 536 63rd St., Bklyn 20, N.Y.

Facilities

194

Detailed information is provided in this 12 page brochure on facilities for the design and manufacture of custom magnetic components such as transformers, magnetic amplifiers, filters, converters, reactors, discriminators, and networks. The brochure includes photos of products which are available in miniature and subminiature sizes, with iron core construction, and may be packaged to a variety of specifications. Information is also included on hermetically sealed, toroidal, and open frame designs. Servomechanisms, Inc., Magnetics Div., 1000 W. El Segundo Blvd., Hawthorne, Calif.

Bimetal Thermometers

195

Thermometers made with 3 in. and 4-1/2 in. diam dials are described in catalog 2256, now available. They are actuated by a powerful, specially processed, bi-metallic helix that responds rapidly to temperature changes. Bimet Dials are dust, moisture and fume-proof, and withstand outdoor applications or highly adverse atmospheric conditions often encountered in the chemical, petroleum, and other industries. Moeller Instrument Co., 132nd St. and 89th Ave., Richmond Hill 18, N.Y.

Rod and Sheet Plastics

196

Rod and sheet plastics are described in 17 page brochure now available. It contains a technical data sheet and ordering information for each product. Included are Stycast Hi K, adjusted dielectric constant plastic for the range of dielectrics from 3 through 20; Stycast Lo K, low loss and low dielectric constant stock; Eccostock, and specialty epoxide materials. There is also information on a series of foams and absorbers both in rod and sheet form. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.



no beeps
... just clicks



This is probably about the most groundborne relay ever built by Sigma. Since its leviathan specifications include a brutish size of $3\frac{1}{2}'' \times 2\frac{3}{4}'' \times 2\frac{3}{8}''$ and a weight that can reach $\frac{5}{8}$ of a pound (even bigger and heavier when hermetically sealed), it's exceedingly doubtful that it will ever fly, orbitally or otherwise. Since *that* kind of quick fame is out of the question, the "61" should be able to do some other — though less timely — sort of job. It can, and here's where you product designers can start paying close attention.

The 61 is a polarized DC power contactor, with four separate heavy-duty contact circuits (DPDT only) for switching up to 20-ampere resistive loads in response to momentary $\frac{1}{4}$ to $\frac{1}{2}$ watt signals. Two switching forms are available: Form Z, magnetic latch-in, single or dual coils, and Form Y, magnetically biased, single coil. For special jobs, center-stable 61's can also be built (Form X). Since the Form Z types latch firmly in either of two positions by magnetic means, there are no mechanical wearing surfaces; the one part that does move uses miniature ball bearing pivots.



POLARIZED LATCHING CONTACTOR

Some of the places we'd expect the 61 to be particularly useful include machine tool control panels, battery-powered control systems, and other equipment where big fat loads must be dependably switched by comparatively meager signals, in the presence of contact-disturbing shakes, shocks and rumblings. Space and money can also sometimes be saved by a 61, in replacing a pilot and slave relay combination where 225-450 mw. signals have to control 1 to 2 kw. loads.

Series 61 relays are quite easy to order, once you master Sigma's international, all-encompassing system of code designation (readable east to west, north to south, without binoculars). Example: 61FZ2A2B - 200 - GD SC = an unenclosed latching DPDT 61 with 200-ohm dual coils and silver alloy contacts. Bulletin, on request, explains all this and more.

SIGMA INSTRUMENTS, INC.

91 Pearl Street, South Braintree 85, Massachusetts

CIRCLE 197 ON READER-SERVICE CARD

POLYPENCO® **TEFLON** SHAPES



POLYPENCO Spaghetti Tubing Proves Resistance To Heat, Simplifies Assembly

One of the newest applications for POLYPENCO Teflon Spaghetti Tubing is its use on a series of miniature rotary tap switches. The choice of this tubing was based on its complete resistance to soldering heats. These other valuable characteristics make Polypenco Teflon Spaghetti Tubing the ideal choice for your thin wall insulation applications:

- **SUPERIOR FOR COMPONENT PRODUCTION**
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 - Does not break down by bending or flexing
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 - High dielectric strength: 400-500 v/mil
 - Low dielectric constant: 2.0
 - High surface resistivity: above 10^{13} ohms
 - Serves entire frequency range
 - Unaffected by heat and moisture
- **SUPERIOR PHYSICAL PROPERTIES**
 - Service range: -320°F to 500°F
 - High vibration and flex life
- **SUPERIOR CHEMICAL PROPERTIES**
 - Resistant to solvents, alkalis, acids
 - Zero water absorption
 - Fungus resistant
 - Non-flammable, sunlight resistant

Polypenco Teflon Spaghetti Tubing is available in 10 coded colors and in AWG wire sizes #0 through #30. Polypenco Teflon is also available in rod, tubing, thin wall tubing, tape and sheet. Write today for more data on your applications.

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POLYPENCO Nylon, POLYPENCO Teflon,* NYLAFLOW® and NYLATRON® GS
CIRCLE 198 ON READER-SERVICE CARD

®DU PONT TRADEMARK

New Literature

Silicon Rubber Insulation

199

Just published is a new brochure devoted to the electrical insulating advantages of Silastic. Coded 9-105, the 4-page folder contains a tabular summary of dielectric properties of typical Silastic stocks at temperatures ranging from 25 to 250 C. Properties are illustrated with a variety of actual field applications on transformer and motor coils, wire and cable, strip heaters, and electronic assemblies. There is also a special section on the use of room temperature vulcanizing Silastic as a potting and encapsulating material. Dow Corning Corp., Midland, Mich.

Thermoplastic Resin

200

A full-color brochure describes, in words and pictures, the various properties of Cylolac, a high impact thermoplastic resin which is equally suitable for molding, extruding and calendaring. A comprehensive list at the back of the book suggests numerous applications for the product. Marbon Chemical, Div. of Borg-Warner, 7165 W. Chicago Ave., Gary, Ind.

Fail Safe Brake

201

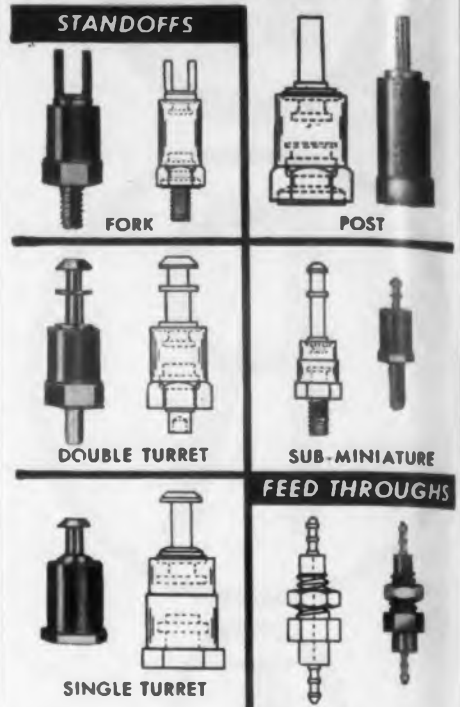
Technical Report WEB 6293 tells the story of an electric brake designed for fail-safe applications. Written for design engineers, the authoritative 36-page report is illustrated with photographs, drawings, and diagrams. It offers a complete explanation of operation, selection factors, torque characteristics, and controls. Warner Electric Brake & Clutch Co., Beloit, Wis.

Mail Order Electronics

202

A catalog has been issued as part of a plan to provide engineers with electronic and electro-mechanical equipment on a mail order basis. Entitled "Mechatronic Development Apparatus," the 52-page catalog lists more than 200 components which are frequently used in control equipment for automatic operation. All of the items, whether home manufactured or not, may be ordered from the company. The catalog describes in detail such equipment as precision amplifiers, potentiometers, modulators, power supplies, 60 and 400 cps motor, synchros, precision breadboard equipment, and a variety of functionally packaged units. Servomechanisms, Inc., Mechatrol Div., 625 Main St., Westbury, N.Y.

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FROM THE LARGEST STANDARD and CUSTOM LINE AVAILABLE...

Over 100 varieties are furnished as standard. This includes a full range of types, sizes, body materials and plating combinations. Specials can be supplied to any specification. The Whitso line is complete to the fullest extent of every industrial, military and commercial requirement.

Standoff terminals include fork, single and double turret, post, standard, miniature and sub-miniature body types—male, female or rivet mountings—molded or metal base. Feed through terminals are furnished standard or to specification.

Whitso terminals are molded from melamine thermosetting materials to provide optimum electrical properties.

Body Materials: Standard as follows—melamine, electrical grade (Mil-P-14, Type MME); melamine impact grade (Mil-P-14, Type MMI); and phenolic, electrical grade (Mil-P-14, Type MFE).

Plating Combinations: Twelve terminal and mounting combinations, depending on electrical conditions, furnished as standard.

Specials: Body materials and plating combinations, also dimensions, can be supplied to any custom specifications.

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CIRCLE 204 ON READER-SERVICE CARD

Tiny Indicators

205

Three illustrated handbook spec sheets introduce a line of tiny indicating lights and switches. For low voltage applications, the switches are designed primarily for pulsing remote control relays and indicating their operation. The leaflets discuss the construction, operation, installation, dimensions, and ratings of the units. Drawings help to illustrate the text. Alden Products Co., 117 N. Main St., Brockton 64, Mass.

Clock Movements

206

Eight-day spring wound clock movements and fitups are the concern of Bulletin 200. The 8-page booklet presents specifications and construction features of a variety of types, illustrating each with a photograph and dimensional diagrams. The E. Ingraham Co., Bristol, Conn.

Inertia Switch

207

A miniature inertia switch with automatic operation is the subject of a 2-page data sheet. Illustrated with photographs and drawings, the sheet covers the outstanding features, operating principle and specifications. Safe Lighting, Inc., 527 Lexington Ave., New York 17, N.Y.

DC Supplies

208

Tailor-made dc power supply systems for computer, aircraft, military, and special applications are discussed in GEA-6690, a bulletin of 6 pages. The publication cites typical applications, provides a chart showing the relative characteristics of various power supplies, and gives basic electrical and mechanical details for dc power units. General Electric Co., Schenectady 5, N.Y.

One-Shot Switches

209

Complete specifications and engineering data on a line of fast-acting electro-chemical squib switches for missile and telemetering applications are offered in a 4-page fact sheet. The text covers weight, total actuation time, contact resistance, and current capacity, contact bounce characteristics, and dielectric strength of insulation. A photograph, dimensional diagrams, and a switch contact diagram provide illustration. A table shows possible time delay combinations. Atlas Powder Co., Parke Thompson Ordnance Section, 9404 Watson Rd., St. Louis 19, Mo.



**LAPP
MULTIPLE-CONTACT
PLUG RECEPTACLE
UNITS FOR
SECTIONALIZING
CIRCUITS**

These plug-and-receptacle units are used for panel-rack or other sectionalized circuits where a number of connections must be made or broken. Any number of contacts can be provided (in multiples of twelve). Male and female contacts are full-floating for easy alignment and positive contact. Contacts are silver-plated brass and phosphor bronze with terminals tinned for easy soldering. Ceramic blocks are steatite, white glazed . . . non-carbonizing even under leakage flash-over caused by contamination, moisture or humidity. Write for specifications of available units or engineering recommendations for your requirement. Lapp Insulator Co., Inc., Radio Specialties Division, 103 Sumner Street, LeRoy, New York.



CIRCLE 210 ON READER-SERVICE CARD



Now... from Aerovox! Plastic-coated, dipped-mica capacitors that exceed many of the advantages of molded mica units, and at the same time are smaller than conventional units.

Meeting all the applicable RETMA Test Standards for molded mica units, these unique dipped-mica capacitors offer the following outstanding features:

- ★ High operating temperature -55°C to $+125^{\circ}\text{C}$.
- ★ Excellent long-life characteristics.
- ★ Improved temperature coefficient range.
- ★ Radial-leads for automatic insertion and plug-in assemblies. Ideal for printed-wiring applications.
- ★ Reduced physical sizes.
- ★ Excellent performance and stability characteristics.

Available in a complete range of standard capacitance values in standard $\pm 10\%$ tolerance. Other values and closer tolerances supplied on request. Conventional molded mica and silvered-mica units are also available from Aerovox in a complete selection of types and sizes.



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CIRCLE 211 ON READER-SERVICE CARD

New Literature

High Torque-to-Inertia Servomotor 212

Data Sheet 909 features a size 11, 115 v, 400 cps servomotor with low power input which will operate at 200 C. With all specifications, a list of characteristics, a three-view drawing, a torque-speed curve, and a schematic, the 2-page leaflet gives a complete picture of this high torque-to-inertia unit. Helipot Corp., Div. of Beckman Instruments, Inc., Newport Beach, Calif.

Single Sideband Linearity 213

"Transmitting Tubes for Linear Amplifier Service," a paper originally presented at the 1956 IRE Convention by R. L. Norton, has been reprinted as an illustrated booklet. The 9-page article details special problems of linearity in output and efficiency, and transmitter tube geometry in linear amplifiers for single-sideband operation. It presents comparative data on triodes, tetrodes, and pentodes, including oscilloscope patterns and tube loading characteristic curves. Design principles of new tubes are discussed and the results of electron-path studies are illustrated. Penta Laboratories, Inc., 312 N. Nopal St., Santa Barbara, Calif.

Tube Shield Finish 214

In Bulletin PP102-3-1-57 a dry lubricant finish for heat-dissipating tube shields is described. Pointed out are its characteristics, applications, effectiveness, and heat radiation and electrical conduction properties. International Electronic Research Corp., 145 W. Magnolia Blvd., Burbank, Calif.

Accurate Balls 215

A number of balls, among them a lapped high carbon variety that is accurate within millionths of an inch, are catalogued in Bulletin 101. Detailed specifications and application and design data are provided for balls of chrome steel, stainless steel, brass, bronze, and monel in various grades and in sizes ranging from 1/16 to 4-1/2 in. in diam. The 8-page bulletin discusses the confining limits of accuracy demanded of quality balls, together with material analysis and ball hardness. Hoover Ball and Bearing Co., Ann Arbor, Mich.

Beattie

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These modern, rugged cameras are designed for remote control operation, and automatically record any object or event on film . . . at fixed time intervals . . . or at random intervals, if desired. Known as demand-rate or pulse-type, they do not require an operator—an electrical pulse or signal causes the camera to take one or more pictures automatically without attention.

● Permit data recording under conditions where the use of a manual type camera or presence of an operator would be impossible.

● Offer greater flexibility, accuracy, and economy than any other known system of data recording.

● Use either 70mm or 35mm roll film for widest range of picture size.

● Ideal wherever data is recorded and stored for future analysis and reference, such as photo recording of meters, production-line operations, under-water life, etc.

Write today and we will send you our complete catalog as well as answer any questions you may have concerning your data recording needs.

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Accuracy-
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have established an outstanding record for accuracy and long life in airborne and mobile communications as well as missile programs. Rugged in construction, compact in size, Lavoie crystal ovens stand up under the most severe service, maintaining precise crystal temperatures and lifetime freedom of drift.

- **LONG TERM STABILITY.** An actual 5-year test showed widest drift to be 1° C.
- **SHORT TERM STABILITY.** Less than ½° C.
- **CONTINUOUSLY MONITORED** during 3-week aging cycle to insure accuracy.
- **SPECIALLY DESIGNED THERMO-STAT** with few moving parts, assures greatest longevity.

**MINIATURE
CRYSTAL
OVENS**



combine many of the characteristics of standard model in a package 1 3/16" O. D. x. 2 1/2" H.

More than 20 crystal ovens which will meet MIL-T-945 are available from the Lavoie "Custom-Standard" line. Inquiries for special requirement ovens invited.

Lavoie Laboratories, Inc.

MORGANVILLE, 7, NEW JERSEY

CIRCLE 217 ON READER-SERVICE CARD

Acoustic Excitation Testing

218

A system developed for environmental testing of critical jet and missile components is described in a 6-page brochure. The folder cites general specifications for two available test chamber models. It also gives application information, explains the operation of the noise systems, and describes testing procedure. Charts show frequency response characteristics of the high intensity noise systems and sound levels at various locations in typical jet aircraft. Radio Corporation of America, Electronic Instruments Sec., Camden 2, N.J.

Nuclear Measuring Devices

219

"Radiation Instrument Catalog C" outlines a variety of amplifiers, pulse height analyzers, scalars, rate meters, scintillation detectors, and crystals. It also covers a liquid scintillation beta spectrometer, an amplifier-high voltage power supply unit, and an ultra stable photomultiplier power supply. For each instrument there is a photograph, a description, a list of specifications, and a reference to a bulletin with more complete information. The 6-page folder also has a section devoted to ordering. Technical Measurement Corp., 140 State St., New Haven 11, Conn.

Bright Silver Plating

220

A bright silver plating process is explained in an 8-page technical paper. The text presents detailed discussions of bath make-up and maintenance; anodes, tanks, and temperature; current densities; agitation; plating procedure; and simplified removal of solution impurities. A price list is offered as an addendum. Sel-Rex Corp., 75 River Rd., Nutley 10, N.J.

Investment-Cast-Metals Chart

221

The composition and physical properties of alloys commonly used for investment castings have been tabulated on an 11 x 17 in. chart. The reference material covers both ferrous base and nonferrous alloys. Two sets of mechanical properties are listed: one for metal in the as cast or annealed state, and the other for hardened castings. The metallurgical composition of each alloy is also given. The reverse side of the chart contains investment casting design specifications covering such items as surface finish, dimensional tolerances, concentricity, cored holes, and cast threads. Alloy Precision Castings Co., 3855 W. 150th St., Cleveland 14, Ohio.



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If you're looking for a complete product line that includes Timing Devices for every application requirement and, in addition, features the highest quality and most advanced design at the lowest possible cost, HAYDON has it! And all Haydon timing devices incorporate the famous Haydon hysteresis and/or inductor timing motors available for 50, 60, and 400 cycle and DC power supplies.

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CIRCLE 222 ON READER-SERVICE CARD



Design department keeps in touch with production during prototype development . . .

Make Prototypes Compatible with Production

Stephen P. Sims
Filtron Co., Inc.
Flushing, N. Y.

ALTHOUGH one of the most important topics in electronics today is reliability, many fail to realize that the story behind this oft-times ambiguous term involves many phases of the industry. Not least of these is engineering-production compatibility. Following is a report of how this problem was attacked at Filtron Company, Inc. and what success was achieved. As this plan attains its full measure of anticipated results, it is expected to more than repay its initial costs through greater reliability and economy.

Why compatibility would be advantageous became apparent when two important facts were realized. First, greater production efficiency would strengthen the firm's position in competitive military and commercial markets and second, it would allow the experienced and highly valuable staff of engineers and technicians more time to concentrate on the customers' specific interference problems.

The Plan for Accomplishment

In broad outline it was felt that much waste

effort could be eliminated by employing the following three plans:

1. Having an engineering division cognizant of production capabilities and constantly serviced by an individual to keep it so informed;

2. Utilizing a manufacturing system composed of separate yet integrated sections, with each section able to divulge, at any time, any and all information as to its progress; and

3. Employing a production engineer who would act as liaison between the two main divisions. In addition to acting as a vehicle for all requests and information, his tasks would include passing on all designs from engineering before acceptance by production. On more complicated orders, he works directly with the engineer while the prototype passed through the design stage.

It can be seen why it was no small task initiating each necessary operation. But, because of the possible returns, management, production, and engineering collaborated to form these departments as close to the planned model as pos-

. . . while orderly and efficient manufacturing results from production-design planning at prototype stage.



sible. And today, these are working realities, whose functions are independent, yet related as part of an integrated whole.

Design, Research, and Development— All Cognizant

An attitude of cooperative thinking and action has been engendered by more frequent departmental meetings, among research, design, and development; a revised method of inter-office memoranda; and, most important, the ever-present, helpful production engineer. The engineer designs and personally directs the construction of his initial prototype unit, remembering or requesting all the production procedures that follow and all specifications that must be met. New ideas as to materials and procedure are also born in this creative atmosphere and disseminated throughout the department. These thoughts are either geared to present equipment or to equipment readily obtainable . . . information again obtained from the production engineer. It is this combination of "ivory tower" freedom and down-to-earth practicality that has since opened many diversified lines of investigation at Filtron.

Organization of Production Department

Each production section is an efficient, responsible group, expert in its own particular phase of the total operation. The group heads realize their responsibility to yield any and all information to the project engineer. The production worker, whether assembler, solderer, stamper or other, is trained to a set of standards in order to uphold the general workmanship capability of the group. In this way the engineer may never design too high and also, never lower than necessary. Thus management is assured that each production piece will be identical to the prototype design.

Why a Production Engineer?

The task of the production engineer explicitly outlined, is "right hand" to both engineer and production foremen. Any information the engineer requires during design, this liaison is expected to provide, rapidly and correctly. The link between the question, "Do we have machines capable of this job?" or "Are our men in that section skilled enough to perform this operation?" and a responsible answer, is the production engineer. Efficiency is his forte and watchfulness, whether for improvements or meeting standards, his key to efficiency.

It can be seen that an organized, yet departmentalized, production team, coupled with engineering foresight and planning can prove successful in widening electronic horizons.

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 223 on the Reader's Service Card.



New!

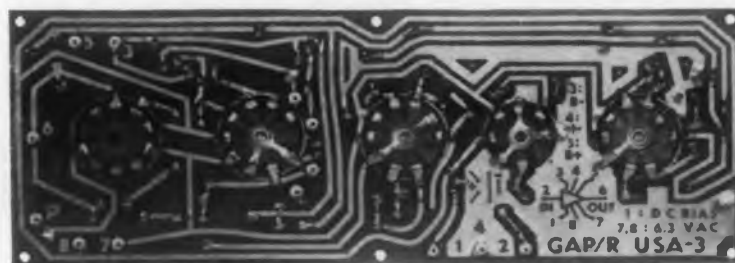
*Greater System Accuracy
and Reliability with the*

- PRINTED CIRCUIT: Economy, reliability and compactness.
- OPEN LOOP D-C GAIN: 10 million.
- LONG TERM DRIFT, NOISE and OFFSET: under 100 microvolts.
- OUTPUT VOLTAGE RANGE: ± 115 volts.
- SIZE: 7" x 2½" board.
- MOUNTING: Any convenient method.
- PRICE: \$95.00.

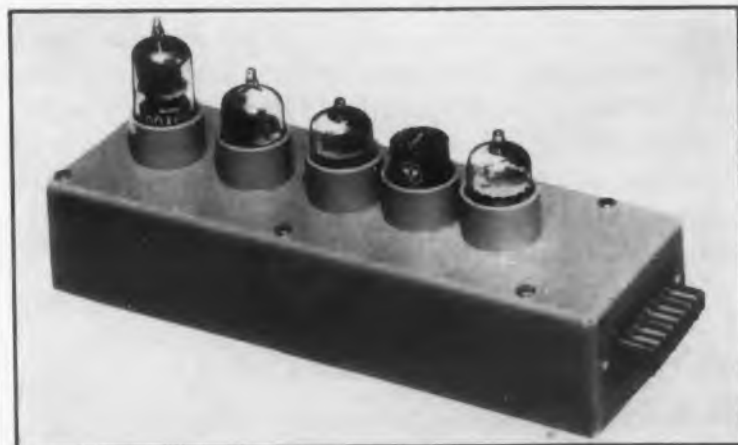
PHILBRICK PRINTED CIRCUIT AMPLIFIER

Model USA-3

High performance combined with the reliability and compactness of a printed circuit design are featured in the new Philbrick Universal Stabilized Amplifier, Model USA-3. It is ideally suited for applications to instrumentation, control and analog computation. Extremely high open-loop d-c gain, wide bandwidth, low noise and wide output range are important performance characteristics of this new chopper stabilized amplifier. An interesting design feature makes this instrument safe against self-destruction, even under prolonged overload conditions or direct grounding of its output. At a price of only \$95.00, it offers more performance per dollar than any other amplifier on the market today. Write to George A. Philbrick Researches, Inc., Dept. 00, for Bulletin USA-3.



Underside of Model USA-3 showing printed circuit, amplifier connection scheme, and connecting terminals.



Model USA-3 showing one of the several types of modular packaging available at extra cost.

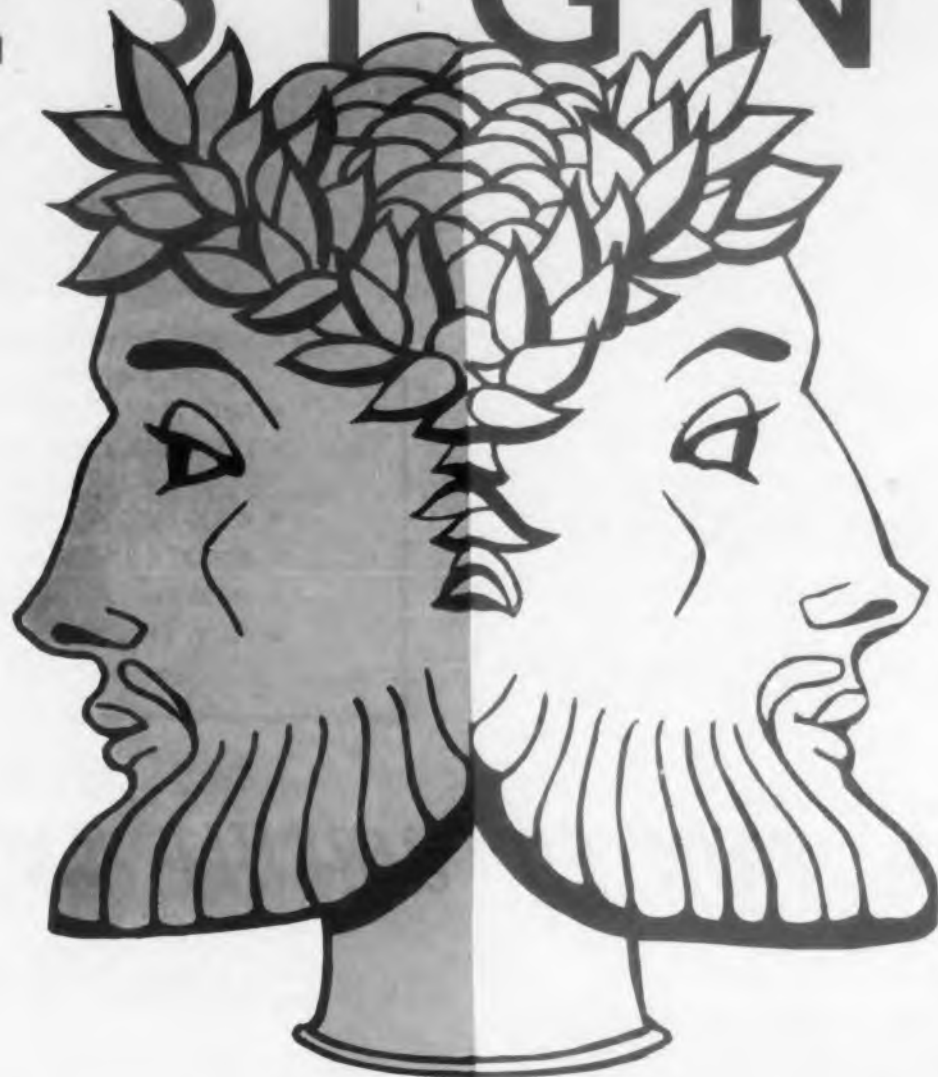
GEORGE A.
PHILBRICK
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230 Congress Street, Boston 10, Massachusetts

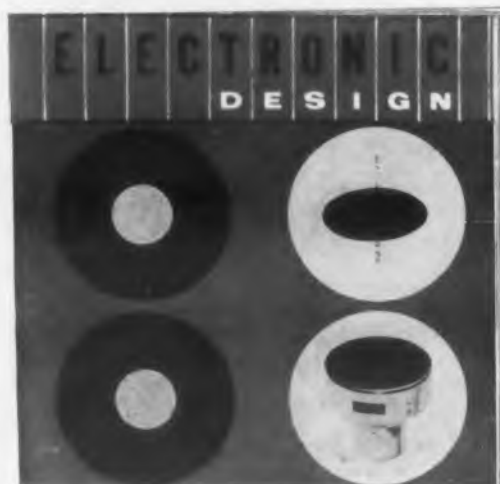
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coming January 8th *Ideas for Design*

DESIGN '58



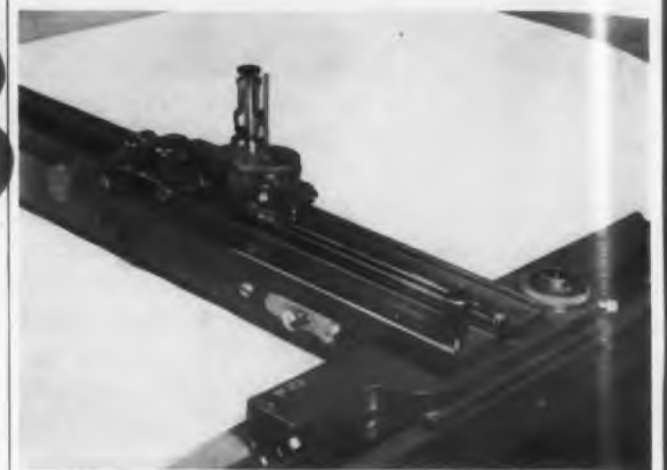
yearly feature issue of



Industry experts have been chosen, editors assigned, and data is being gathered from sources all over the country. DESIGN '58 promises to be bigger, better, and more informative than ever before. Look for greater depth in this third annual feature issue. Material will be written by leading manufacturers in each branch of the industry—radio and TV, communications, computers and business machines, audio, instruments and controls, avionics, etc. If your company is an advertiser don't miss the extra attention value and extra readership as the industry looks ahead in DESIGN '58.

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Los Angeles 36: 5720 Wilshire Blvd. WEstber 8-3881



A new precision plotting instrument to speed layout of printed circuits. Watch manufacturers working on defense projects, are using this Coordinatograph for measuring tiny component parts of electronic equipment. All of the units are equipped with chrome-steel pricker microscopes shown here in the center.

Electronic Circuit Plotter

A highly precise and versatile plotting instrument, developed for precision layout of grid systems and coordinate positions, has been finding new applications in production drafting for electronics design.

The Haag-Streit Coordinatograph, manufactured in Switzerland and distributed by Aero Service Corporation, Philadelphia, is being used to speed the layout of printed circuits and to measure accurately minute electronic parts.

One international manufacturer of electronic calculators is using the instrument to draft master copies of printed circuits. The master copies will be etched on copper, then checked by the Coordinatograph. Tests indicate a 30 per cent saving in layout time. The instrument is 4-1/2 times more accurate than conventional hand layouts, and often eliminates the need for jig boring machinery.

Construction

The 47.25 x 47.25 in. working surface is made of vertically laminated wood strips. It is equipped with a ruling pen, 7-power chrome-steel pricker microscope, brass counter dials, and endless steel scale tapes. The supporting frame and rails are cast iron. The pricking device, incorporated in the microscope, enables both pricking and check-

ing to be done in a single operation. Micrometer-type crews permit fine adjustments of both X and Y positions. Plotting accuracy in the longest dimension is $\pm .0015$ in.

The Coordinatograph can save time in laying out special minute parts of electronic equipment within fine tolerances. Watch manufacturers, now working on guided missiles and other defense projects, are using it in this manner.

Other drafting applications for the Coordinatograph include graphic plotting of scientific data, charting of flow patterns, designing precision resolution targets, control drawings for optical comparators, and surveying and mapping uses.

Aero Service Corporation, Philadelphia, Pa.

FIRST IN SERVICE



CNI

ELECTRONICS PACKAGE NOW IN FULL PRODUCTION

The AN/ASQ-17 CNI package, developed and built by Packard Bell Electronics, marks the first successful integration of communications, navigation and identification in one compact unit. It has been accepted for service use by the U.S. Navy in the Douglas A4D "Skyhawk" and the Chance-Vought F8U "Crusader." It has been in quantity production for several months. Hundreds are now in operation.

ENGINEERING BEYOND THE EXPECTED

Mutual interference between IFF and UHF is normally inevitable, even when the units are encased separately and spaced several feet apart. In the AN/ASQ-17 these two units are packaged together, a fraction of an inch apart. Yet in official trials *mutual interference was not noticeable or measurable*. This achievement "beyond the expected" resulted from coordinated efforts of Douglas, Chance-Vought and Packard Bell Electronics engineers.

Write for new Packard Bell Electronics facility brochure . . . just off the press.



PACKARD BELL ELECTRONICS
TECHNICAL PRODUCTS DIVISION
12333 W. Olympic Boulevard
Los Angeles 64, Calif., BRadshaw 2-2171
CIRCLE 246 ON READER-SERVICE CARD

Photo Preparation for Blueprint

Reproduction

Described is a process to make transparent positives of photographs which can be used as intermediates for making blueprint reproductions; and which will take pencil, ink, typing and erasures. These intermediates can be used for assembly drawings, when their preparation represents a savings in time without sacrifice of detail necessary for assembly. They can also be used to make copies of photographs with text added for service instructions, and can be used for operation sheets.

Procedure

Taking the photograph. Best results are obtained with Panatomic X sheet film. Its fine grain and slow speed are important to get detail and to the method of lighting the subject. Make exposure with f/32 lens setting. Expose for 1 to 1-1/2 min., using a hand-held flood with a 15 w lamp. "Paint" or "wash" the subject with the lamp from a distance of 12-15 in. to eliminate shadows and give sharp detail. A smaller lens opening and longer exposure would probably improve detail. Develop film in D-76 or extra-fine-grain developer, followed by regular developing processes.

Making a Half-Tone Positive. Tests showed a "screened," half-tone photograph makes the best reproductions on blueprint. Print negatives on



SOLID GLASS HEADERS



Val Cichowski
V. P. Manufacturing



There are several reasons that Fusite customers have for going to a solid glass header. Compact size is one of them. While 1" diameter is about maximum for this type terminal, we can pack 21 electrodes into this space with the same voltage limits that would require either a much larger disc or fewer pins in a multiple bead terminal. Size for size this is a more rugged terminal than one using a light gage stamping. Where the terminal serves as a structural part of an electrical assembly, solid glass is better able to support stress. Before resting the case for solid glass, it is worthy of mention that it costs less per pin. Fusite offers a complete line of solid glass headers.

MULTIPLE BEAD TERMINALS



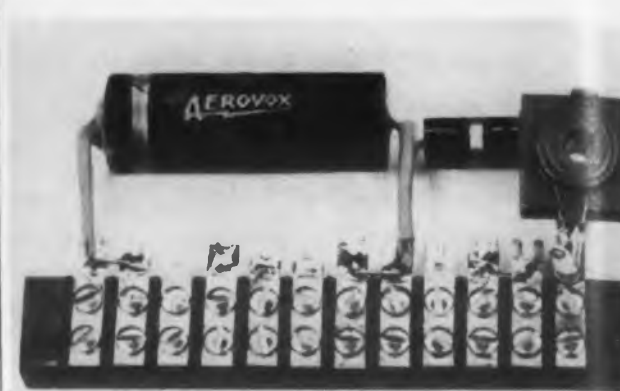
Andy Wyzenbeek
V. P. Engineering

While our friend Chichowski presents a strong case for the solid glass header, a large percentage of Fusite Terminal business is still done in multiple bead terminals. There are good reasons. Wherever weight is a factor, you'll usually find a multiple bead terminal in a light gage stamping with its remarkably favorable weight to strength ratio.

This type construction is more versatile. When large sizes are needed, where very heavy pressures are involved or extreme conditions of any nature exist, they can best be coped with, by using multiple beads in a heavy gage body.

While speaking of unusual conditions, it gives me an excuse to mention our special engineering section. Our line of standard terminals is very large but we are constantly at work developing special custom designs to solve specific problems. We solicit yours.

Ideas for Design



Typical film, processed for blueprint reproduction

Kodalith Autoscreen Ortho film, using an enlarger to obtain final size of print desired. Working with Safelight 1A (red) in darkroom, as recommended by Eastman, exposure time varied according to type of subject and negative obtained. Exposures ranged from 10 to 30 sec and lens settings from f/16 to f/32. Make additional exposure, following regular exposure, to bring out screening effect in the film. A 15 w lamp with OA (yellow) filter is used, exposing from 10 to 30 sec at a distance of 5 ft. Develop in Kodalith solution. Usual time is from 1-3/4 to 2-1/4 min. Solution should not be used for more than 6 sheets of 3 x 10 Autoscreen (per qt.), or background discoloration will appear. Use standard rinse, fix and wash processes. To obtain sharpest detail in transferring to Mylar intermediate (next step) by keeping emulsion side to emulsion side, make the Autoscreen in reverse (see sketch).

Making Positive Intermediate (to Accent Pencil, Ink, or Typing and Erasures). Transfer positive to Ozalid sensitized Mylar film (No. 402 XLP, .003, single matte) with Autoscreen emulsion side to emulsion side of Mylar, at speed giving best result. A transparent positive of title block, or several photos may all be spliced together with drawing mending tape to make up as complete a drawing as required for transfer to the Mylar. Fill in title block, add section views and part number callouts on matte surface of Mylar. Photo may be retouched with pencil. Erasures can be made on printed image by using a moistened ink eraser or by scraping the emulsion.



Jim Marsh
V. P. Sales

If you found anything helpful in the words of wisdom from Val and Andy, I'm real happy for you. But frankly, I can't get too excited over which kind of terminal you buy. As long as it comes from Fusite, you can be sure it's the best of its type available. We develop our own glass formulas and do our own smelting right here at the plant. It gives us the best control over quality in the industry.

Complete literature on all Fusite Terminals is yours for the asking. Write Fusite, Department L-6.



THE FUSITE CORPORATION

6026 FERNVIEW AVE.,

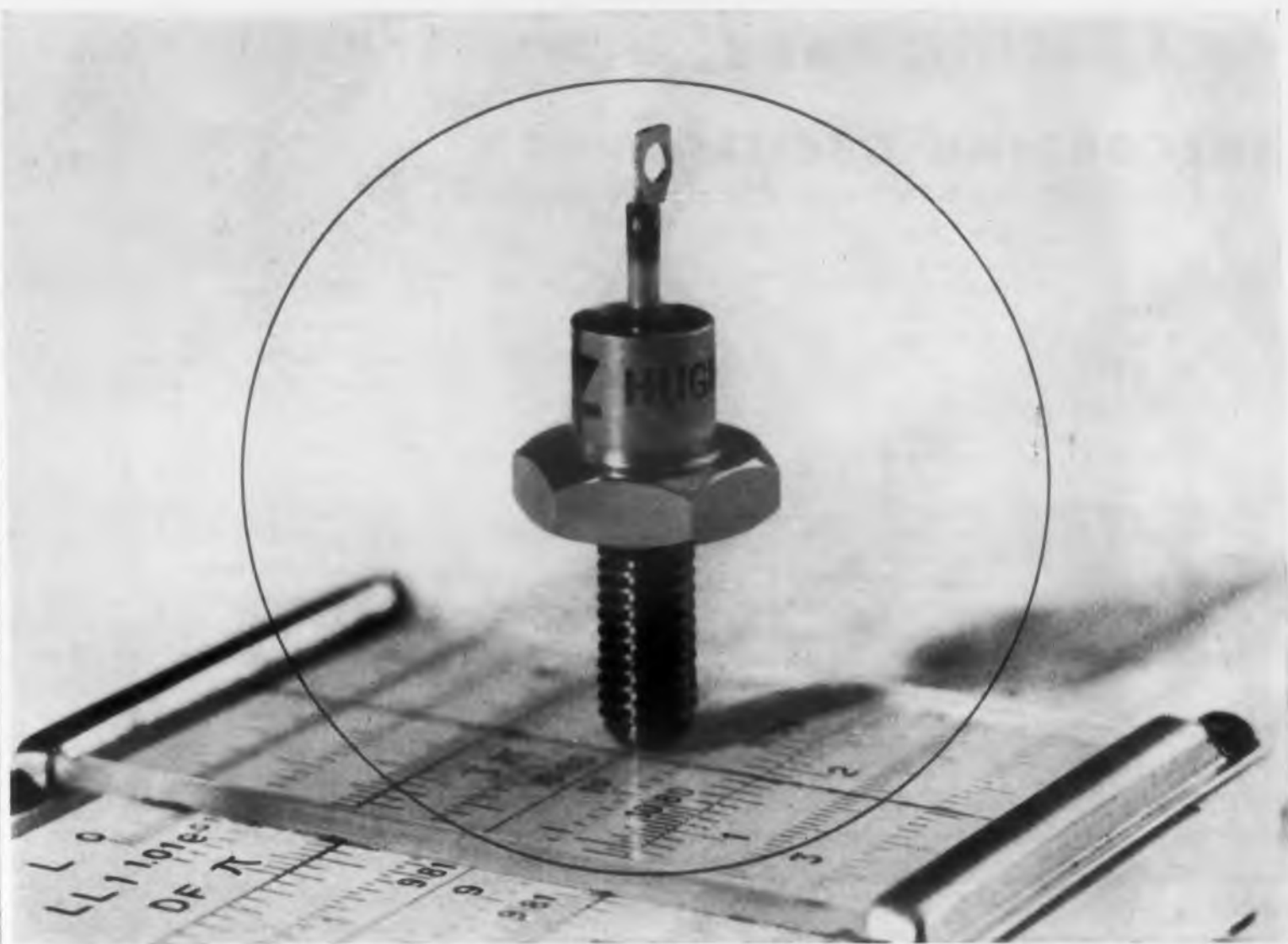
CINCINNATI 13, OHIO

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Line Drawing Reproduction. This process may also be used for making reproductions of line drawings usually to make a reduction in size of the drawing by photo process. The best film for taking pictures of flat (black and white only), line drawings is Contrast Process Ortho. If positive is made on Autoscreen film, omit the second exposure to bring out screening effect. Excellent results were obtained in reducing a 40 x 24 in. schematic tracing to 8 x 10 film size.

Approximate Time For Process. Shooting Picture—10 min.; developing negative—20 min., plus drying time; autoscreen reproduction—75 min., plus drying time; Mylar reproduction—10 min.; plus additional time for composing, determine what is required in photos; retouching adding callouts and section views to Mylar intermediate.

Shirley Long, Heiland Division of Minneapolis-Honeywell Regulator Co.



announcing a new Hughes series — high efficiency, medium power silicon rectifiers

For the first time, you can obtain high forward conductance and a high breakdown voltage, together in one rectifier. High forward conductance increases the efficiency of the rectifier, thereby providing *more* power to the load at lower junction temperatures. And low junction temperatures ensure long life plus reliable rectifier operation.

The unique combination of high forward conductance and high breakdown voltage permits rectifier performance never before achieved in the standard EIA Group 20 (7/16" hex.) stud mounted package. This package is welded and hermetically sealed with a glass-to-metal seal to provide complete protection from contamination and moisture penetration. Inside, where it counts, protection like this is essential.

The **HR10681**, a typical rectifier in the series.

Min. Breakdown Voltage	= 600V
Max. Average Rectified Current @ 25°C	= 2A*
Average Reverse Leakage Current @ 2A and 420V _{rms} @ 25°C	≅ 100 μ A
Typical Full Load Average Forward Voltage Drop	≅ 1.0V
Typical Dynamic Forward Resistance	≅ 0.2ohm
*Higher currents obtainable with heat sink.	



Our sales engineers welcome the opportunity to discuss application of these new units to your circuitry. For address of sales office nearest you, or for complete information, write:

SEMICONDUCTOR DIVISION • HUGHES AIRCRAFT CO.
International Airport Station, Los Angeles 45, California

Creating a new world with **ELECTRONICS**

HUGHES PRODUCTS

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Simple Solution to Vibrator Problem

Although vibrators may be completely enclosed and sealed against the effects of humidity, they are still apt to fail due to a minute condensation of moisture on the contact points. This moisture, though slight, will eventually cause corrosion and sticking contacts.

A simple solution is used by one manufacturer of vibrators. The company found that no precaution could completely prevent the sealing in of a certain amount of moisture which, in too many cases, led to eventual failure of the vibrator. To solve the problem, a dehydrator disc was inserted into the top of the vibrator can, where it is held in place by a rubber liner that surrounds and protects the operating assembly until the unit is ready for final assembly. The can is sealed, and the dehydrator disc absorbs any remaining moisture with the result that contact-corrosion failures were virtually eliminated.

James Vibrapowr Co., 4050 N. Rockwell, Chicago 18, Ill.



Century MODEL 409

RECORDING OSCILLOGRAPH FOR VIBRATION, TEMPERATURE, STRESS, STRAIN RECORDING

The Century Model 409 Oscillograph was designed for operation under the most adverse conditions and more especially, where space and weight considerations are limited.

This Oscillograph is one of the smallest and most compact units available on the present market, yet it incorporates many features found in larger oscillographs, such as trace identification, trace viewing, continuously variable paper speeds and others. The Model 409 Oscillograph has been tested and proven to record faithfully during accelerations in excess of 20 g's.



Model 409 with
100 ft. Capacity Magazine

This makes it especially desirable for uses such as missile launching, parachute seat ejection, fighter aircraft and torpedo studies.

Write for Bulletin CGC-303 and CGC-301

Century Electronics & Instruments, Inc.

1333 No. Utica, Tulsa, Oklahoma

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NEW TRANSISTOR ANALYZER MEASURES ALPHA AND BETA CUTOFF TO 50 MC

KAY Transalyzer

- Displays Alpha or Beta and Reference Trace Simultaneously
- Input Jack Available for Insertion of Variable Frequency Marker

The Kay Transalyzer provides an oscilloscopic display of the Alpha and Beta characteristic of point contact, junction, and triode transistors.

The unit includes a sweep oscillator, attenuators, DC biasing and metering circuits for the transistor, an RF amplifier and detector and all power supplies for accomplishing measurements. The sweep oscillator may be used independently of transistor test circuitry. All transistor biases are electronically regulated. An oscilloscope is the only auxiliary equipment needed with the Kay Transalyzer.

SPECIFICATIONS

Sweeping Oscillator—Frequency Range: 50 kc to 50 mc; RF Output: 1.0V peak-to-peak into nominal 70 ohms. Flat within ± 0.5 db over widest sweep; Sweep Rate: Variable around 60 cps; locks to line frequency; Sweep Width: Continuously variable, 2.5 to 50 mc. Center frequency may be set anywhere in 50 kc to 50 mc ranges; Markers: Eight sharp crystal-controlled pulse-type markers, individually selected at 10, 20, 30, 40, and 50 mc. Substitutions in 10-50 mc range on order; Attenu-

ators: Individually switched 20, 20, 10, 6 and 3 db steps plus continuously variable 3 db; Biasing and Metering Circuits—Collector Voltage: Continuously variable, 0.45 volts, metered; Collector Current: Up to 50 ma, metered; Emitter Current: Continuously variable, 0 to 10 ma, metered; RF Amplifier Gain: 42 db maximum; Flatness: ± 0.5 db from 30 kc to 50 mc; Attenuators: 20, 20, 10, 6, 3, 2, and 1 db. Price: \$2095, f.o.b. Pine Brook, New Jersey.

Write for Catalog of the Complete Line of Kay Instruments

KAY ELECTRIC COMPANY

Dept. ED-12, Maple Avenue, Pine Brook, N.J., CAldwell 6-4000

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Report Briefs

Design Guide Oscillator

This design guide has been prepared to expedite the design for production of retarding-field oscillators operating over ranges of frequency that have been investigated at this laboratory. Dimensions, details of construction, and drawings of parts for the basic oscillator design have been included, along with brief discussions of operating principles and theory of the oscillator. Design details are provided on the Heil gun prototype and scaled versions of it. Analysis and design of the power-coupling system are presented. Details are given on resonator structure, and other parts of the standard oscillator design. A discussion of the frequency limitation is provided. Design data for specific frequency ranges with performance characteristics both at high and at low voltages are provided. The effects of design refinements of the coupling system and of the electron gun show the trend in oscillator performance as small changes are made. Laboratory measurements of noise characteristics show that the tube compares favorably with reflex klystrons operating at equivalent wavelengths. Construction techniques involving hobbing methods, brazing, and the preparation of cathodes prepared by compressing properly proportioned mixtures of nickel powder and the carbonates of barium and strontium have been described. It is shown that tubes with nickel matrix cathodes produce more power output at the same beam current than the same structures using oxide-coated cathodes. *Design Guide for the Retarding-Field Oscillator, E. Milton Boone, Ohio State University Research Foundation, May 1957, 185 pp., \$4.75. Order PB 131201 from OTS, U. S. Dept. of Commerce, Washington, D. C.*

Reusable Seals

Hermetic sealing of airborne electronic assemblies, subassemblies, and equipment has become increasingly important as a reliability safeguard against rugged operation in extremes of altitude and environment. Maintenance problems have also increased, and new techniques have become necessary to permit repeated sealing and unsealing of a protective enclosure without damage to it or its contents, while still maintaining an effective hermetic seal. This report describes the investigation, development, design, and tests of the fused type seal which can be opened and re-



Here's why Southern fasteners help keep assembly lines on the move—fast:

- Southern manufacturers from the highest quality materials.
- Southern fasteners are precision-made for precision production—are headed, threaded and tested for speedier assembly.
- Southern's stock of over a billion screws mean that the screws you want are ready now for shipment.
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Let Southern help speed your production. Write us, on Company letterhead, your requirements and we will send you free samples and the current Southern Stock List. Box 1360-ED, Statesville, N. C.

Wood Screws • Machine Screws & Nuts • A, B, C&F Tapping Screws • Wood & Type U Drive Screws • Speaker Screws • Stove Bolts • Roll Thread Carriage Bolts • Hanger Bolts



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sealed 15 times without harm to the contents of a container. Temperature measurement techniques were devised to determine exact heat distribution in and on the seal. Comparative measurements produced criteria for the best possible seal joint, the best metal for the can enclosures, and the most efficient heat transfer methods. Also developed was a heat reflecting baffle which decreases temperature inside a sealed enclosure to below 85 C. The "band heater" technique was shown to be best for sealing and unsealing containers. The report gives practical details for the operation. *Reusable Seals for Electronic Equipment*, W. Brown and A. Razdow, General Hermetic Sealing Corp., for Wright Air Development Center, U. S. Air Force, May 1957, 94 pp., \$2.50. Order PB 131194 from OTS, U. S. Dept. of Commerce, Washington, D. C.

Arc Cathodes

Experiments directed toward extracting high voltage electron beams from dc and pulsed arc plasmas are described. A mercury arc plasma was used for dc extraction with the necessary high vacuum near the plasma obtained by refrigeration. Extraction from pulsed arcs was accomplished prior to appreciable expansion of the local arc vapor. Confinement of the beams produced and high voltage breakdown were the main difficulties encountered. A cure for both problems is felt to be a highly convergent, strong magnetic field in the arc cathode region. *High Perveance Beams from Arc Cathodes*, Charles W. Hartman, California University, Berkeley, Calif., May 1957, 37 pp., \$1.00. Order PB 131212 from OTS, U. S. Dept. of Commerce, Washington, D. C.

Thermodynamic Properties

The potential of the ReO_3/ReO_4 electrode has been measured over a wide range of concentration and pH. The cell was demonstrated to be satisfactorily reversible by the close agreement of the standard potential calculated from measurements in both acidic and basic solutions, as well as from the reasonable entropy values obtained from a determination of the temperature coefficient. *Thermodynamic Properties of Technetium and Rhenium Compounds. VI: Potential of the ReO_3/ReO_4 Electrode and the Thermodynamics of Rhenium Trioxide*, J. P. King and J. W. Cobble, Purdue University, Dept. of Chemistry, Lafayette, Ind., July 1956, 16 pp. Microfilm \$2.40, photostat \$3.30. Order PB 124141 from Library of Congress, Washington, D. C.



How R/M Teflon[®] Tape improves electronic component design

Has high dielectric strength • conforms to intricate shapes

Certain coils in a modern electronic computer required a special kind of insulator. Problem: to design an insulator of the high dielectric strength required—even in thin sections—and conforming to the contours of the small circular coils.

R/M "Teflon" Tape provided the ideal solution to the problem. "Teflon" has unusually high dielectric strength. It is completely unaffected by the many adverse conditions to which electronic components are frequently subjected—corrosive elements (including ozone) in atmospheres, high temperatures, and the like. R/M "Teflon" Tape is relatively easy to apply—even on intricate shapes, such as the ferrite coil shown above.

Here are some of the electrical properties of R/M "Teflon" products:

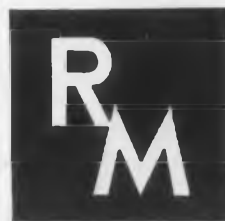
1. **Power factor** — less than 0.0003 over entire spectrum from 60 cycles to 30,000 megacycles.
2. **Volume resistivity** — greater than 10^{15} ohm-cm, even after prolonged soaking in water.
3. **Surface resistivity** — 3.6×10^{12} ohms, even at 100% humidity.
4. **Good arc-resistance** — on exposure to an arc, the material vaporizes, leaving no carbonized path.
5. **High short-time dielectric strength** — values range from 1000 to 2000 volts per mil, depending upon thickness.
6. **Resists high temperatures** — electrical properties are essentially unchanged up to at least 400°F.

Raybestos-Manhattan has extensive experience in developing R/M "Tef-

lon" products for use in the electrical and electronics industries. Let us fabricate R/M "Teflon" products to your specifications or supply the material in rods, sheets, tubes and tape. Write for your free copy of our bulletin "R/M Teflon Products."



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- Freq. range: 0.2 - 500 megacycles
- Accuracy: 5% full scale to 200 mc
10% full scale to 500 mc
- No zero drift
- RMS response below 0.1 volt
- High impedance probe: 2.5 mmf
- 52 ohm probe: vswr approx. 1.1 to 500 mc
- Power sensitivity: .02 microwatt
- Calibration in both db and volts
- Lighted meter scale

Model 91B

Price: \$375.00

APPLICATIONS

The Model 91B Sensitive RF Voltmeter will be recognized as a valuable laboratory or production tool for broadband low level testing applications, where expensive and cumbersome tuned detector equipment would normally be required. A few examples are listed below:

- Amplifier gain measurements
- Attenuator loss measurements
- Mixer gain or loss measurements
- Transistor gain measurements at low levels
- Frequency - gain characteristic measurements over 70 db range
- Null indicator
- Filter network loss measurements
- Signal generator output measurements
- General purpose experimental work
- Low level comparison measurements of signal sources and attenuators

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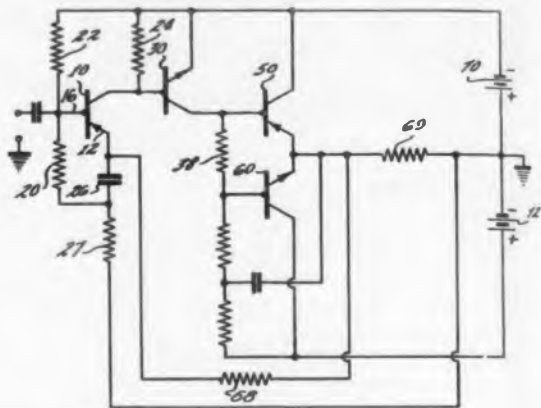
Patents

Semiconductor Signal Amplifier Circuit

Patent No. 2,789,164 T. O. Stanley. (Assigned to Radio Corporation of America)

Transistors have symmetrical properties which have been previously described in the literature. Transistors may be of opposite conductivity, that is, if the current through the base should be changed in the same direction for an npn and a pnp transistor, the emitter current will increase through one transistor and will decrease in the other. If two transistors, therefore, are properly connected together they may serve as a pushpull amplifier. Transistors are useful devices in circuitry since there is usually no need for coupling devices, that is, they may be directly connected thereby resulting in a circuit having a minimum of components and enabling the circuit cost to be at a minimum. The circuit of the patent improves the performance of a push-pull circuit by providing improved stability under variations in temperature and differences in the characteristics of the transistors used.

The circuit illustrated uses an amplifying transistor 10 of one type in series with a second amplifying transistor 30 of the other type which serves as a driver for the transistors 50 and 60 having their collectors directly connected for push-pull operation. The transistors 50 and 60 are of different types so that a signal applied to the bases of both transistors render one transistor conducting and the other non-conducting. A resistor 38 is provided between the base



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electrodes of the push-pull transistors so that the current through the driving transistor 30 and resistor provides a small potential bias between these two electrodes. As a consequence a differential current will be supplied to the output load impedance 69. The required potentials are secured from the source 70, 72 with the potential on the base electrode 16 of the first amplifying transistor 10 through a bleeder circuit of resistors 22, 20 and 27. Resistor 24 permits the first and second amplifiers to be directly coupled and assures stability under varying temperatures.

A direct current feedback circuit is provided to the emitter 12 of the first transistor by a resistor 68 in order to insure balanced current flow to the load. Unbalanced currents to the load generated by variations in temperature or differences in transistor characteristics will be subtracted from the bias applied to the first transistor. This emitter is also connected to ground through the capacitor 26 and resistor 27 so that any feedback from the load circuit is attenuated. As a consequence the voltage gain of the entire amplifier will be approximately the ohmic ratio between the resistors 20 and 27. The resistor 20 may be of a low value without introducing any signal

degeneration. With a resistance 20 of a low value the circuit performance so far as temperature variations is concerned is improved and also makes interchangeability of the transistors more readily accomplished. The overall result is an efficient and stable circuit having a high gain.

Color Television

*Patent No. 2,803,697 Walter G. Gibson.
(Assigned to Radio Corporation of America)*

A color television system receives a plurality of component color signals and a signal nominally representative of luminance. A signal path for each of the component color signals is provided having a high pass filter. The outputs of all of the signal paths is applied to a network which compares the amplitude of the output of all of the signal paths and selectively passes the signal path output of greatest amplitude to an output circuit. The selective output of this network has added to it in the output circuit, a low frequency portion of the signal nominally representative of luminance.

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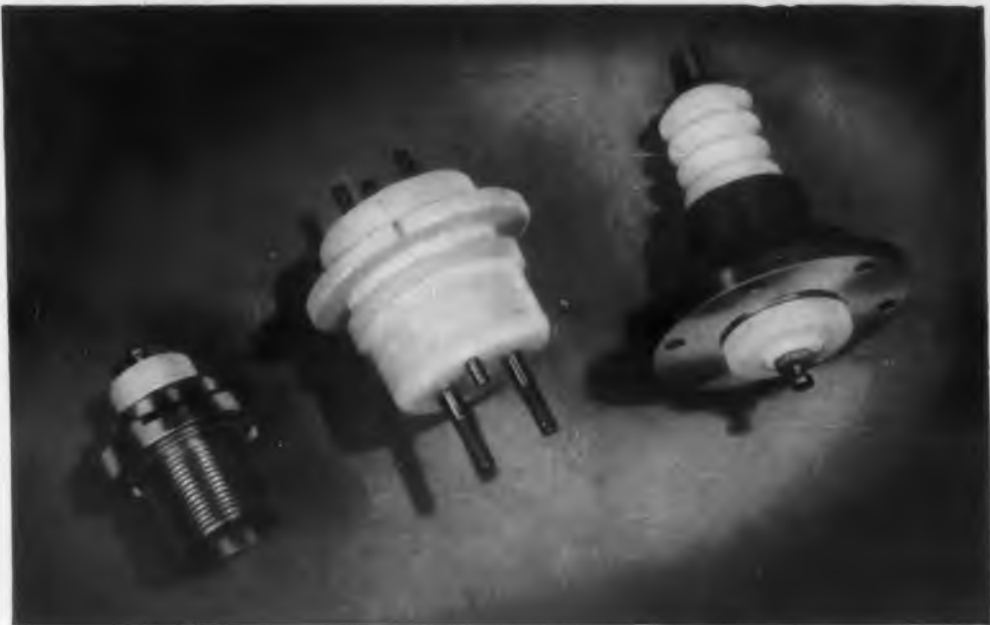
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The receiver operates in effect as a linear voltmeter having a 100 db range in 20 db steps. The receiver contains an output meter which has a logarithmic scale calibrated between 1 and 10. An IF gain control and a 20 db step attenuator in this receiver permits the microvolt-meter to be set at any desired full-scale range from 10 microvolts to 0.1 volt.

Audio frequency circuits in the receiver permit oral monitoring of both AM and FM transmission. The receiver is supplied in a cabinet and the panel is a light blue smooth finish.



SPECIFICATIONS

Frequency range	54 to 240 megacycles
Sensitivity at input terminals as a voltmeter	1.0 microvolt
Maximum signal input direct to receiver	0.1 volt
Receiver input impedance	51 ohms
Intermediate frequency	21.4 megacycles
IF bandwidth	300 kilocycles
Output indicator	panel meter with logarithmic scale
Auxiliary outputs	a: Audio for headphones b: DC output to operate a 1-ma chart recorder



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Books

Engineering Properties and Applications of Plastics

Gilbert Ford Kinney, John Wiley & Sons, Inc. 440 Fourth Avenue, New York 16, N.Y. 278 Pages, \$6.75.

This book is written for those who work with plastics, and for those who require background information for the proper utilization or specification of these materials. The various plastics are described separately, in the order of increasing complexity. A unified treatment, rather than a topical approach, permits the principles, concepts, and terminology to be established in the similar cases, and is used on the study of the more complex materials. Separate chapters describe methods for fabrication, and the mechanical electrical, optical,

and thermal properties of these materials. Also provided is an abbreviated survey of the type reactions of organic chemistry. Emphasis is placed on an understanding of the fundamental nature of plastics, and pertinent material is selected to illustrate the presented principles.

Atomic Radiation and Its Effects

Prepared by the Government Service Dept. R.C.A. Service Co., Inc., Camden 8, N.J. 110 pages, \$1.60.

This book, *Atomic Radiation*, discusses, in simplified terms, nuclear physics, observed biological effects of radiation, shielding



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methods, monitoring instruments, permissible radiation doses and medical evaluation of injuries and treatments.

Primarily designed for use by technicians and scientists engaged in nuclear power activities, it was originally prepared under contract for the United States Air Force which has approved reprinting and commercial sale.

The understanding of radiation derived from a study of this manual, will indicate to the worker his personal responsibilities in avoiding injury by observing safety precautions devised for his benefit.

While this timely publication is of vital interest to technical personnel, it will be of equal value to teachers, students, medical and civil defense workers, and the general public.

In quantities of ten or more, copies are \$1.45 each.

Fundamentals of Electron Devices

Karl R. Spangenberg, McGraw-Hill Book Co., Inc., 330 W. 42nd Street, N.Y. 36, N.Y. 505 pages, \$10.00.

The book stresses the internal physics of electron devices, and it discusses the role physics plays in determining external characteristics. A fundamental treatment of commonest circuit applications is also included. About 60 per cent of the book is devoted to the devices themselves, 40 per cent to their circuit applications.

A new approach is represented in the detailed treatment of energy levels in semiconductors and the influence of these on junction effects, emission, and photo-effects. There is an unusual emphasis on the analogous features of vacuum tubes and transistors and photo-conductive and photo-voltaic cells.



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Model .6-1MB: 0-60 V.D.C. @ 1 amp. Bulletin 1024

Model D.6-300B: dual 0-60 V.D.C. @ 300 MA. Bulletin 1030

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What the Russians are Writing

J. George Adashko

RADIO ENGINEERING AND ELECTRONICS

(Contents of Radiotekhnika i Elektronika No. 4, 1957)

KLYSTRON STABILIZATION

Modulation Circuit for Frequency Stabilization of a Reflex Klystron with a Cavity Wavemeter, V. G. Velelago, N. A. Irisova (4 pp, 6 figs).

Fig. 1 shows the block diagram of a modulation circuit for the stabilization of a reflex klystron. The cavity resonator (9) is used as the frequency standard, and a simple pentode synchronous detector (see Fig. 2) serves as the error detector. Continuous measurement of the stabilized klystron frequency is possible over the substantial range from 20 to 60 mc. The complete circuit diagram is shown in Fig. 3.

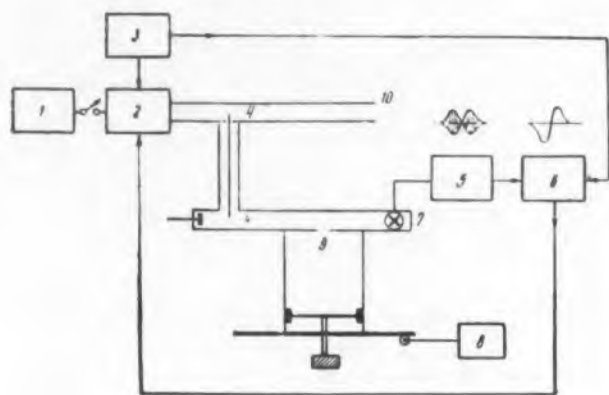


Fig. 1. Block diagram of stabilizer. 1—sawtooth generator; 2—klystron; 3—900 kc modulator; 4—waveguide-coax junction; 5—tuned amplifier, 900 kc; 6—synchronous detector; 7—crystal detector; 8—2 rpm motor; 9—cavity wavemeter; 10—power output of klystron.

INFORMATION THEORY

Concerning One Class of Random Pulse Processes, Ia. I. Khurgin, (9 pp, 3 figs).

Spectral analysis of a train of identical pulses appearing at random instants of time, with the intervals between neighboring pulses having a specified distribution probability.

Stationary Random Processes in Linear Pulse Systems with Variable Parameters, G. P. Tartakovski (9 pp, 2 figs).

Equations are derived for the mean value and for the correlation function of the stationary intermittent random output of a pulse system with variable parameters in response to stationary random variations in both the input signal and the system parameters.

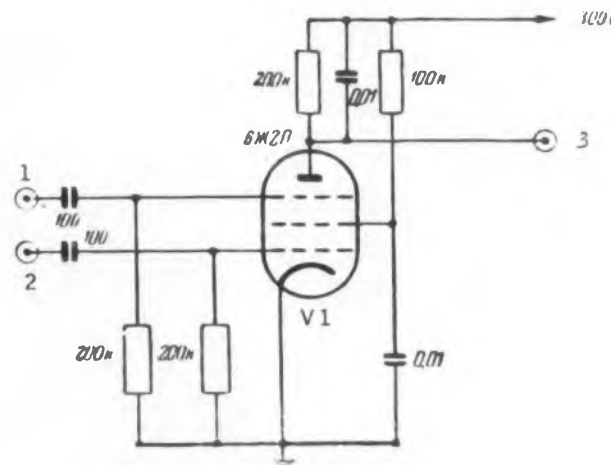


Fig. 2. Synchronous detector (principal diagram) 1— from 900 kc oscillator; 2— from 900 kc wavemeter amplifier; 3— output.

Concerning the Excitation of an Ellipsoid of Rotation, G. T. Markov (5 pp, 1 fig).

This very old problem is being revived in modern antenna theory, and an attempt at a complete solution is given by Spence and Wells (Comm. on Pure and Appl. Math., 1951, vol. 4, 1). The publication of "Spheroidal Wave Functions" by Stratton, Morse, Chu, and Little affords the author a new attack on the problem of asymmetrical excitation of a perfectly-conducting ellipsoid of rotation. The difficulties involved are pointed out, and it is shown that the problem can be recast as an infinite system of linear algebraic equations, amenable to numerical computations.

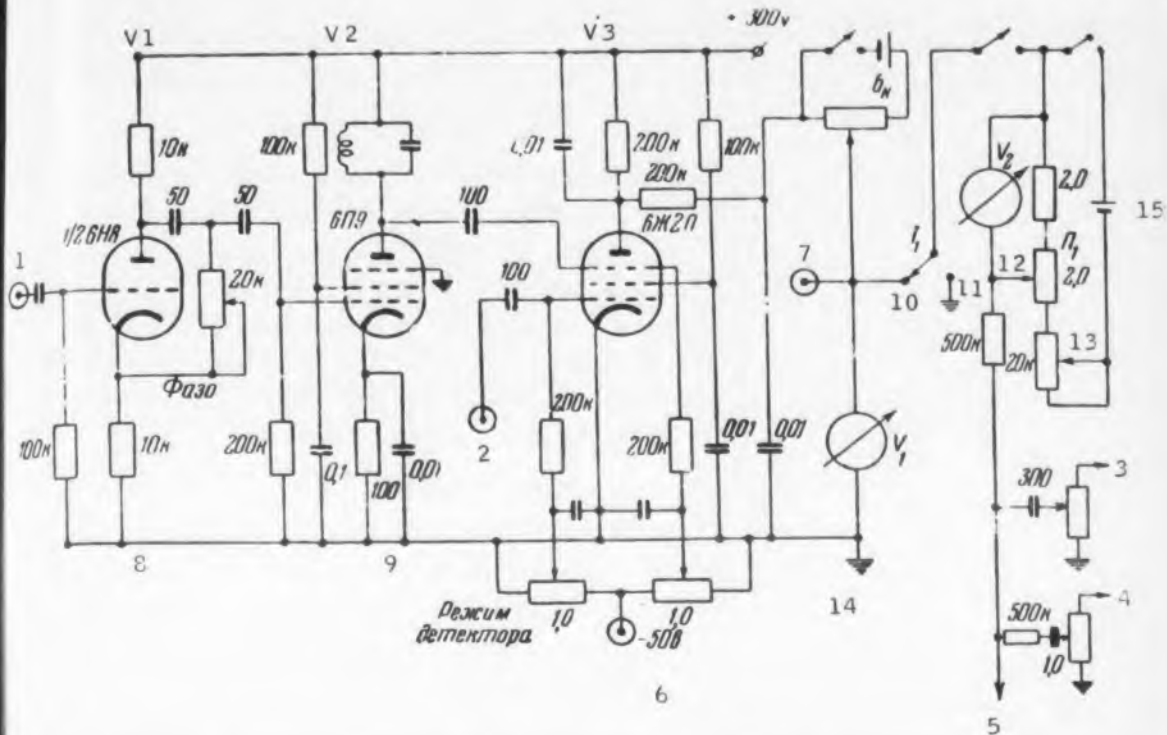
WAVEGUIDES

Calculation of the Propagation Constants in a Rectangular Waveguide Containing Ferrite Plates, A. V. Voronova, A. G. Gurevich (7 pp, 10 figs).

The variation of the propagation constants and of their frequency dependence with plate dimensions and with the ferrite parameters was determined with an electronic computer for one and two ferrite plates in contact with the shorter walls of the waveguide. A waveguide with two ferrite plates is shown to have a considerably greater bandwidth. Refers to work by Lax, Button, and Roth (*Journal Applied Physics*, 1954, vol. 25, 1413), J. H. Rowen (*Bell System Technical Journal*, 1953, vol. 32, 1333), and Epstein (*Review Modern Physics*, 1956, vol. 28, 3).

Certain Problems in the Theory of a Cylindrical Waveguide with a Ferrite Rod, Ia. A. Monosov, (10 pp, 1 fig).

The behavior of a cylindrical waveguide containing a magnetized ferrite rod is determined. It



is shown that in such a waveguide it is relatively easy to determine the basic characteristics of the magnetic rotation of the plane of polarization of a quasi- H_{11} mode, provided the ferrite rod is matched to the waveguide and the external magnetic field intensity does not exceed 50-150 oersted. The accuracy is better than 10 per cent. Refers to work by Kales (*Journal Applied Physics*, 1953, vol. 24, 816), Rado (*Physical Review*, 1953, vol. 15, 529), and others.

ANTENNAS

On the Design of Optimal Endfire Antennas, V. L. Pokrovski (6 pp, 1 fig).

The polynomials required for the analysis of antennas having optimum directivity patterns are obtained by a new method. As in the case of an earlier work by the author (*Radiotekhnika i Elektronika*, May 1956, ED, March 1, 1957), the method is valid for any distance between array elements, and can further be used for antennas having an even number of elements, thus being superior to DuHamel's solution (*Proc. IRE*, 1953, vol. 41, 652), which holds only for an odd number of elements. Further extension makes possible the design of antennas with an optimum directivity at an angle to the antenna axis.

MICROWAVES

Use of the Lorenz Lemma to Determine the Constants of Propagation due to Interaction between an Electron Beam and Space Harmonics, L. N. Loshakov (7 pp).

An approximate method is proposed for the calculation of the constants of propagation due to an electron beam in a retarding system. Equations are derived for the interaction between the beam and spatial harmonics (forward and backward) in the form of EH waves. Reference is

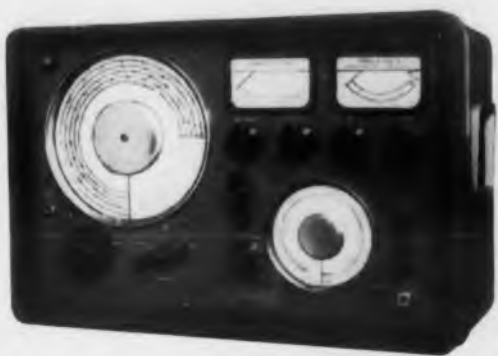
Fig. 3. Complete diagram of synchronous detector. 1—to 900 kc oscillator; 2—from wavemeter signal amplifier; 3—to 900 kc oscillator; 4—to sawtooth generator; 5—to klystron; 6—synchronous detector; 7—to oscillograph; 8—phase shifter; 9—amplifier; 10—On; 11—Off; 12—Coarse tuning; 13—fine tuning; 14—detector mode; 15—negative voltage.

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Russian Translations

made to two articles by P. K. Tien, "Travelling Wave Tube Helix Impedance (*Proc. IRE*, 1953, vol. 41, 617) and "Bifilar Helix for Backward-Wave Oscillators (*ibid.*, 1954, 42, 1137).

On the Interaction between an Electron Beam and a Spatial Harmonic Field, M. F. Stel'makh (144 pp, 5 figs, 1 table).

The author calculates the propagation constants and the gain in the interaction between an electron beam and a forward and backward TM field, and determines under what conditions self-sustained oscillations are possible in a backward-wave tube. Refers to H. Heffner's "Analysis of the Backward-Wave Travelling-Wave Tube" (*Proc. IRE*, 1954, vol. 42, 930).

SYNCHRONIZATION

On the Synchronization of an Oscillator to the Frequency of an External Signal, R. R. Lisitsian, (15 pp, 12 figs).

The author investigates the synchronization of an external signal to a continuously-operating single-tuned oscillator with instantaneous self-bias. The characteristics of the tube are approximated in the differential equations by a second-degree curve. The stationary states are determined from the amplitude and phase balance conditions, while the transients are obtained by numerical methods with an electronic digital computer. The resultant phase is determined statistically, owing to the random character of the initial phase.

RADAR

On the Accuracy of Range Determination in Radar Systems, S. E. Fal'kovich (11 pp).

Statistical error analysis, leading to optimum range parameters of radar receivers used for strong-signal reception.

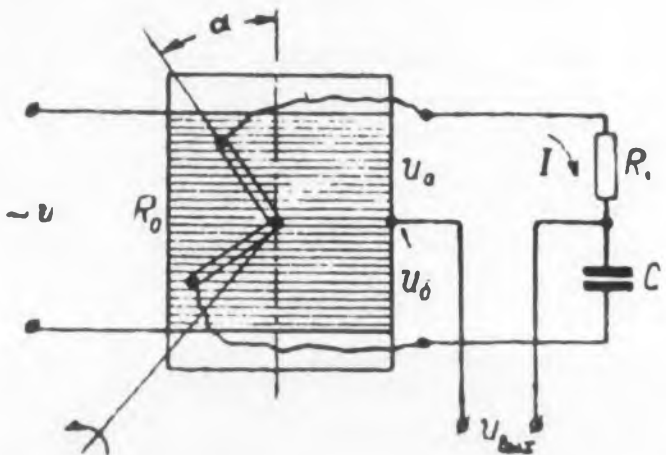


Fig. 1. One variant of potentiometric phase shifter. If $R_1 = X_c$ and is much greater than R_0 , and the input voltage is sinusoidal, then the output voltage is a function of α only, and the amplitude remains constant.

TRANSMISSION LINES

Method for Calculating the Local Reflection Coefficients of Optimum Stepped Functions, Ia. M. Turover (6 pp, 1 fig, 1 table).

In the February 1956 *Radiotekhnika i Elektronika* (*ED*, November 15, 1956) the author, jointly with N. I. Strutinski, developed the theory of the application of Chebyshev polynomials to the design of stepped discontinuities in transmission lines. The method necessitates the calculation of certain reflection coefficients, a procedure for which is now given.

MODULATION

Carrier Modulation by Changing the Magnetic Permeability of Ferromagnetic Conductors, V. S. Etkin, (2 pp, 3 figs).

Description of an experimental set-up used to investigate the possibility of modulation by means of varying the magnetic permeability of ferromagnetic conductors, i.e., by varying the depth of surface effect. The method, originally proposed by Johnson and Rado (*Physical Review*, 1949, 75, 841), is extended by the author to cover decimeter and meter waves.

ANALYZERS

Possible High-Speed Amplitude Analyzer, V. O. Viazemski (2 pp, 1 fig).

Signal quantization of a regenerative system, having a number of stable states equal to the number of analyzer channels, is used as the basis for the design of an analyzer having a resolution time on the order of 10^{-5} sec. Unlike the schemes described by Van Renners (*Nucleonics*, Sept. 1952, p 32 and Oct. 1952, p 50) and Kelley UN Reports of Geneva Conference, vol. 14), this requires no cumbersome registration units and requires no photographic development.

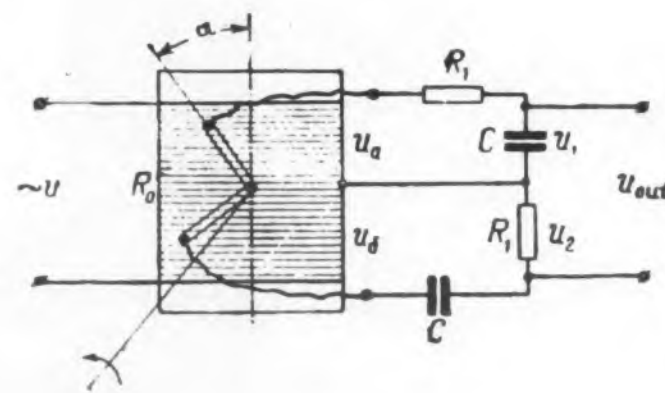


Fig. 2. Another variant of phase shifter, requiring fewer network elements.

CIRCUIT THEORY

Gain Fluctuations in Vacuum Tube Amplifiers, A. N. Malakhov, (12 pp, 11 figs).

The author considers the origin of gain fluctuations and their connection with resistance fluctuations in the circuit components, tube flicker, and supply-voltage fluctuations. The results obtained are shown to be of particular significance for dc amplifiers.

Other Articles In This Issue

Asymmetry of Optical System of Electrostatic Microscope and its Resolving Power, D. V. Fetison, V. I. Miliutin, (6 pp, 6 figs).

Region of Low-Voltage Arcs in Inert Gases, A. V. Nedospasov, K. E. Torgonenko, (8 pp, 8 figs).

One method of Determining the Envelope of Quasi-Harmonic Fluctuations, V. I. Tikhonov (4 pp, 1 fig.)

Statistical approach, referring to Middleton's "Some General Results in the theory of Noise through Nonlinear Devices" (*Quarterly of Applied Mathematics*, vol 5, 445 (1948).

RADIO ENGINEERING

(Contents of *Radiotekhnika* No. 5, 1957)

MODULATION

Experimental Investigation of the Method of Optimum Amplitude-Phase Modulation, S. I. Tetel'baum, Iu. G. Grinevich (6 pp, 3 figs, 2 tables).

The author proposed in 1950 that simultaneous amplitude and phase modulation of the broadcast signal (called by him amplitude-phase modulation) would increase the broadcasting effectiveness by narrowing the spectrum radiated by the transmitter down to half the value of the spectrum required for amplitude modulation. Recep-

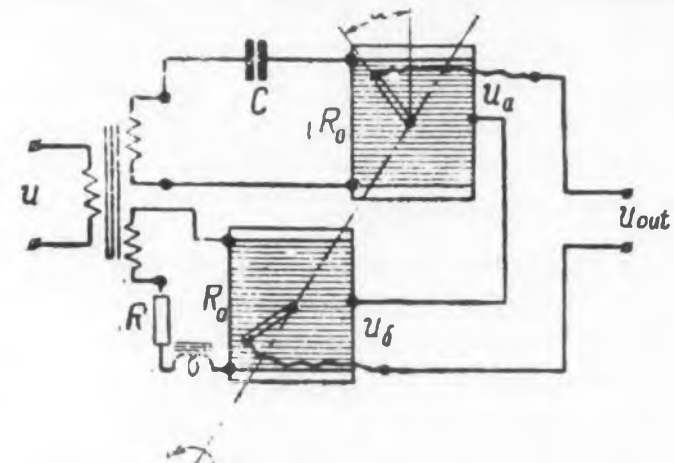


Fig. 3. If the phase shifter must feed a load of finite impedance (rather than an infinite-impedance amplifier), this circuit is somewhat better, for it requires merely the condition R_{load} much greater than R_0 .

tion of such a signal without noticeable distortion is possible with an ordinary radio-broadcasting receiver having a linear detector. The article describes a phase integrator that could be used for the purpose and gives results of comparative measurements of intelligibility of speech in amplitude and optimum amplitude-phase modulation, in the presence and in the absence of noise. Results of experimental transmission of musical programs are also reported. The author claims that the experimental data obtained make large-scale experiments of his system advisable.

PHASE SHIFTER

Potentiometric Phase Shifter, A. M. Melik-Shakhnazarov, (2 pp, 4 figs).

Description of a potentiometric phase shifter made of RC elements and sine and cosine potentiometers, and producing a continuous phase shift up to 360 deg. See Figs. 1, 2, and 3.

CIRCUIT THEORY

Design Features of Radio Transmitters with High-Resistance Plate Supplies, N. I. Shtein (6 pp, 5 figs).

Discussion of the optimum utilization of d-c sources with relatively high internal resistances (such as dynamotors or kenotron rectifiers). The conditions under which vacuum tubes can deliver maximum power to a tuned circuit are analyzed, and recommendations are made concerning the design of vacuum-tube oscillators.

Method for the investigation of Amplifying Systems Having Third-Order Characteristic Equations at Low Values of Time, E. Mokhov, (8 pp, 8 figs).

The method proposed in this article is fundamentally less laborious and more effective than other known methods. It is illustrated with an example describing the analysis of a compensating circuit consisting of an inductance in series with the grid circuit.

Operating Features of Interconnected Long Lines in Inductive Distributed Communication, V. S. Mel'nikov (5 pp).

Circuit-theoretical analysis of two infinite lines with only inductive coupling between them. The terminal loads required to produce standing waves in a finite length of line are computed.

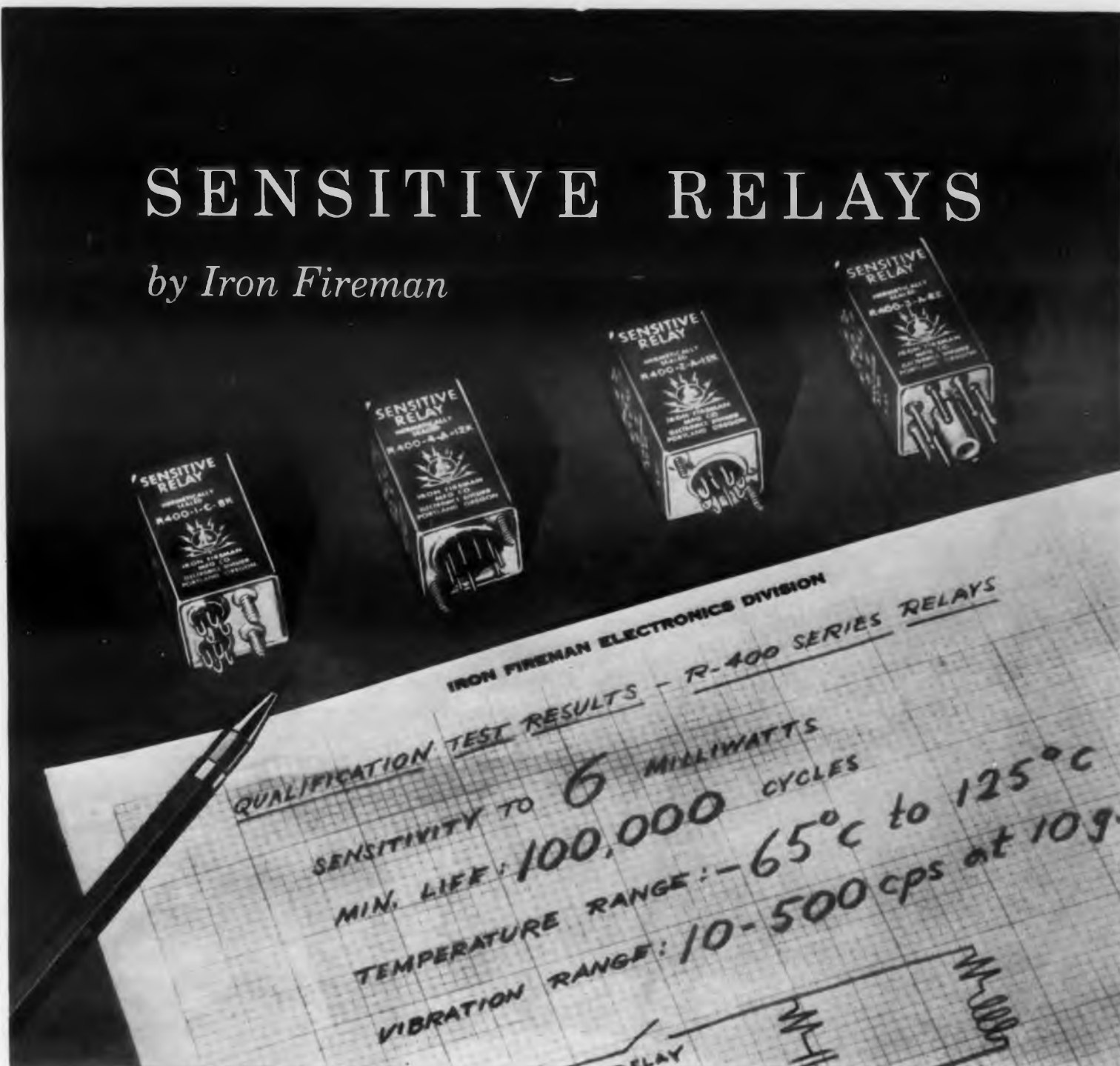
RADIO NAVIGATION

Concerning the Characteristic of the Accuracy of Position Determination in Radio Navigation, A. G. Saybel', (5 pp, 4 figs).

Various positional-accuracy characteristics of radio navigation are compared statistically for

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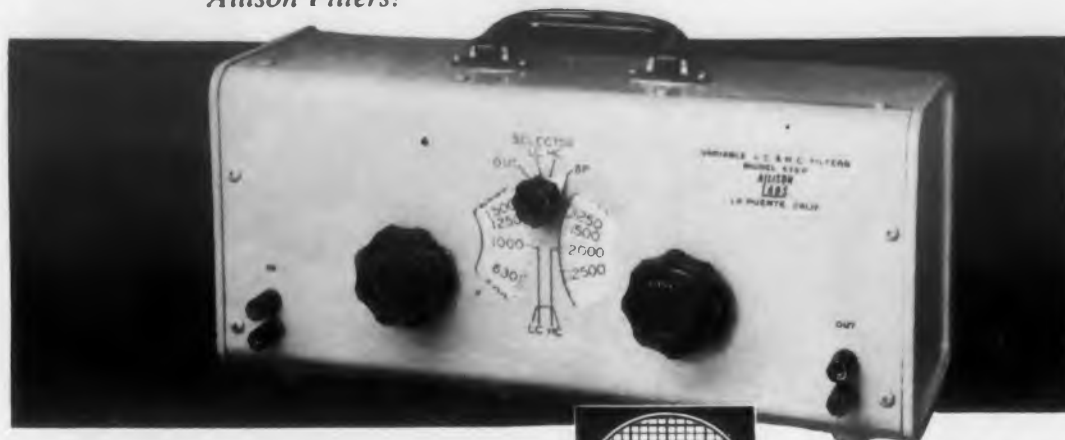
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Russian Translations

the case of elliptic scattering. Various accuracy criteria are studied, including the major diagonal of the error parallelogram, the major axis of the error ellipse, the mean squared error, and others.

Frequency Measurement by Signal Time Delay, A. I. Danilenko, (6 pp, 8 figs).

The frequency is measured by introducing a time delay in the signal and measuring the frequency dependence of the amplitude of the sum of the original and delayed signal, or by measuring the phase difference between the two with a linear meter. It is shown that the phase-difference method is superior and can be used to plot the phase characteristics of a delay line, to plot the frequency dependence of its time delay, and to determine its temperature coefficient.

INFORMATION THEORY

Refinement to One Premise in Textbook Literature, A. M. Zaezdnyi, (4 pp, 3 figs).

It is shown that the difficulties involved in the analysis of lossless circuits, such as a parallel resonant circuit or a short circuited lossless line, can be treated rigorously with the aid of the Dirac delta-function.

Statistical Properties of Signals and of Noise in Two-Channel Phase Systems, V. V. Tsvetnov (18 pp, 10 figs, 1 table).

Phase differences between coherent oscillations are widely used in radio navigation at the present time to measure geometrical parameters (range, azimuth or range difference) in radar systems. The usefulness of such methods is limited, however, by the various types of noise present. The author offers a derivation and an analysis of the basic statistical properties of the amplitudes and phase differences of sinusoidal signals and of noise with Gaussian distribution.

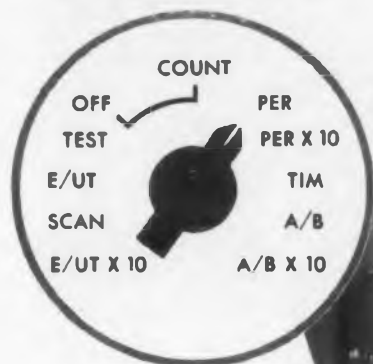
On the Calculation of the Spectra of Random Processes, A. A. Kharkevich, (7 pp).

A theoretical statistical discussion of methods used in the spectral analysis of both stationary and non-stationary random processes. Such random processes may be telegraph signals, amplitude-pulse modulated random signals, phase-pulse modulated random signals, a-m and f-m modulated random signals, etc.

CIRCUIT DESIGN

Low Plate-Voltage Circuits for Forming Pulses from Sinusoidal Voltages, V. I. Zabavin, (5 pp, 5 figs).

Several pulse forming circuits that are superior to multivibrators or triggers are considered. The



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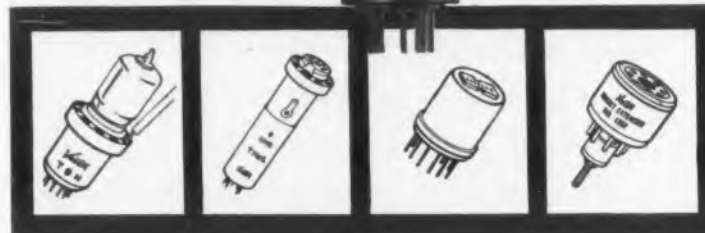
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Circuits proposed employ tubes alone, transistors alone, or tube-transistor combinations, and form pulses from a sinusoidal voltage by discharging a capacitor through a vacuum tube and by using positive feedback. To prevent parasitic excitation a low plate voltage must be used for the discharge tube and that the capacitor circuit must have a sufficiently large time constant.

SCATTER PROPOGATION

Effect of Refraction on the Diffuse Propagation of UHF Waves in the Troposphere, D. M. Vysockovski (7 pp, 2 figs).

Approximate equations are derived for several factors that can serve as a measure of the effect of refraction on diffuse radio-wave propagation. Such factors are a reduction in the altitude of the scattering volume, a change of the scattering angle, or a change in the size of the scattering volume. The receiver power change caused by refraction is calculated. Data from the theory of radio-wave scattering of turbulent irregularities in the troposphere and experimental data are used in the calculations.

AUTOMATION AND TELEMCHANICS

(Contents of *Avtomatika i Telemekhanika*
No. 5, 1957)

OPERATIONAL AMPLIFIER

Operational Amplifier without Stabilized Power Supply, V. M. Evseev, (10 pp, 10 figs).

A serious limitation on the use of operational amplifiers in automatic-regulation systems is the need for stabilized power supplies particularly if not too many amplifiers are needed. The author reports on the results of experimental and theoretical investigations on a new operational-amplifier, requiring no stabilized supply.

SERVO SYSTEMS

Method for Determining the Optimum Characteristics of one Class of Self-Adaptive Control Systems, A. M. Batkov, V. V. Solodovnikov, (15 pp, 4 figs).


The fact that automatic-regulation systems have inherently a "rigid" structure with invariable dynamic properties is one of the basic limitations on their dynamic accuracy. It is therefore interesting to speculate on "self-adapting" system, which would adapt their dynamic properties to the external conditions and would therefore provide automatically optimum operation, i.e., produce a minimum sum of the squared dynamic and mean errors.

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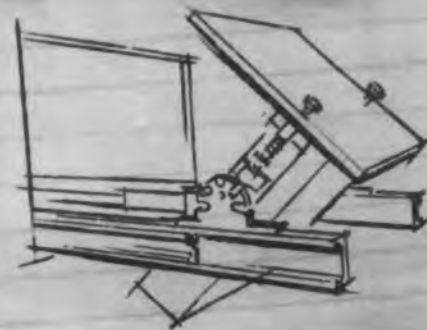
Specification of Grant tilting slides to pivot the chassis over for "on-top" servicing.



The Soroban Engineering Company recently completed a repackaging program of their Perforated Tape Sequencer for Digital Control of Analogue Computers. This sequencer is a vital component of the Automatic Digital Input-Output Device (the ADIOD System) used at the White Sands Proving Grounds in New Mexico. Tape readers and their associated equipment are mounted within the desk, on Grant three-section tilt slides. These provide quick accessibility to every part of the chassis. Some of the equipment requiring servicing and adjustment is mounted underneath the chassis and Grant Slides are used to tilt the unit, bringing the bottom-mounted equipment into the view of the operator for easier servicing.

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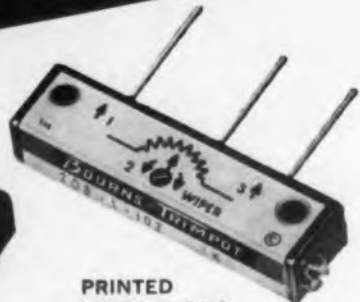
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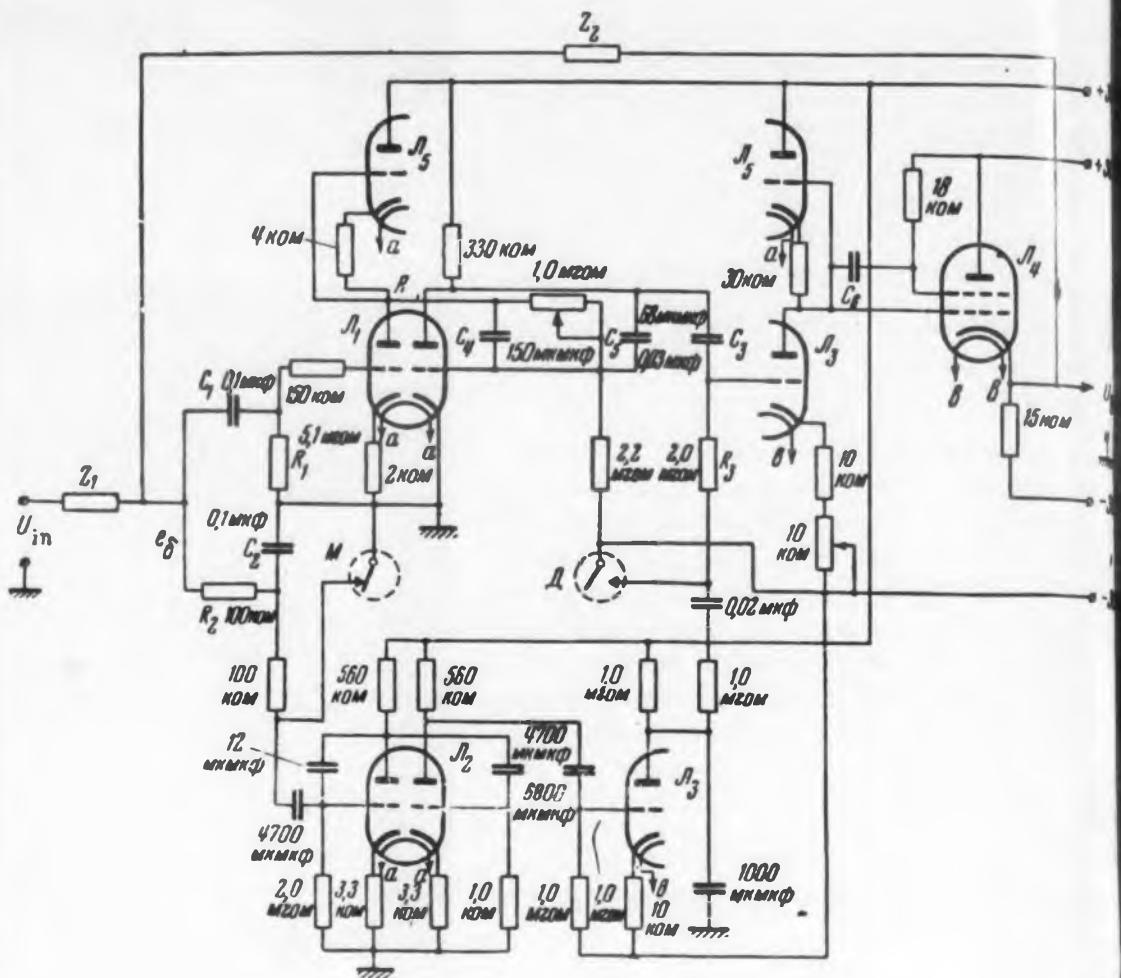


Fig. 1. Diagram of amplifier. All tubes except for the output tube are 6N2P dual triodes with high amplification factors ($\mu = 80 - 110$). The output tube is 6P1T. The gain of the three-stage amplifier is approximately 2500, the output voltage is ± 100 v across a 10,000 ohm resistor and is quite linear. The bandwidth is 600—700 cps at 100 v and 7—8 kc at 10 v.

The article treats specifically optimum filtering of random inputs to a group of linear systems with variable parameters. A method for realizing the resulting optimum systems as self-adaptive ones is proposed with the input characteristics being taken into account.

Pulse Stabilization of Relay-Type Automatic Regulation System, N. A. Korolev, (12 pp, 10 figs).

A pulse method of increasing the self-oscillation frequency in relay type automatic regulation systems is described and methods are given for the design of several stabilizing circuits.

On the Theory of Derivative Control in Third-Order Linear Systems, G. A. Bendrikov, K. F. Teodorichik, (4 pp, 1 fig).

The locus of roots method is used by the authors to analyze derivative control, which often increases the stability margin and improves the system accuracy.

Synthesis of Linear Servo Systems on the Basis of the Criterion of the Minimum Practical Critical Tracking Error, K. I. Kurakin, (18 pp, 10 figs).

A servo system can be synthesized to satisfy

riterion of minimum of practical critical tracking error by defining and determining the optimum transfer function of the system for the case when the input is a slowly-varying time function and when the noise is uniformly distributed over the entire working spectrum. The optimum transfer function of the servo system can be realized with the aid of dc corrective devices.

SELSYNS

Graphic Determination of the Rotation EMF in Selsyn Circuits, I. M. Sadovski (5 pp, 4 figs).

A graphic chart is given to simplify the calculation of the additional emf produced when a selsyn control transformer is rotated at a constant speed and to determine the shift of the electrical zero of the selsyns. Reference is made to H. Chestnut's "Electrical Accuracy of Selsyn Generator-Control Transformer System" (*Electrical Engineering*, Aug-Sept, 1946).

MAGNETIC AMPLIFIERS

On the Theory of the Half-Wave Magnetic Amplifier, II, R. A. Lipman and I. B. Negnevitski (17 pp, 11 figs).

Continuation of the theory of the half-wave magnetic amplifier from the April 1957 issue of *Avtomatika i Telemekhanika* (ED, November 15, 1957). Allowances are made for the finite dynamic permeability of the core material, and a connection is established between the structural and the design parameters of the amplifier. References to Storm's "Theory of Magnetic Amplifiers with Square Loop Core Materials" (*Trans. AIEE*, vol 72, part I, 1953), Krabbe's "The Residual Time Constant of Self-Saturated Auto-Excited Transducers" (*Proc. IEE*, No 3, 1956), and Ramey's "The Single-Core Magnetic Amplifier as a Computer Element" (*Trans. AIEE*, vol 72, part I, 1953).

ANALYZER

Electronic Analyzer for Contact-Making Circuits, V. N. Rodin (7 pp, 9 figs).

This article describes a high speed instrument which analyzes contact circuits and solves certain problems in the synthesis of such circuits. Shannon and Moore in "Machine Aid for Switching Circuit Design" (*Proc. IRE*, 41, October, 1953), discussed a similar machine but gave no diagrams or calculations.

Also

Static Transfer Device for Pulse Frequency Telemetering Systems, A. M. Pshenichnikov, (5 pp, 2 figs, 1 table).

PROBLEM #6



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Secondary: Three terminal, center-tapped winding, 500 ohms nominal impedance.
Secondary Resistance: 5 ohms.
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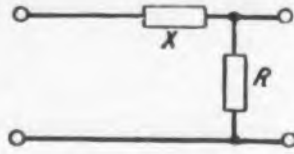
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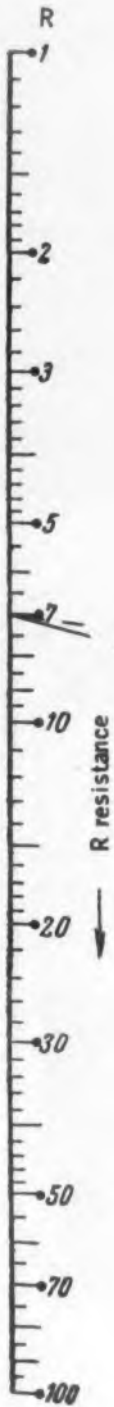
Equations

$$\operatorname{tg} \varphi = \frac{X}{R}$$

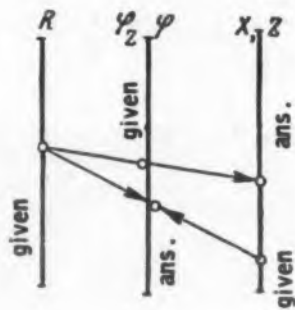
$$Z = \frac{R}{\cos \varphi}$$

Example

Given:
 R = 7 kilohm
 X = 5 kilohm
 answer:
 $\varphi = 36^\circ$
 Z = 8.6 kilohm



Key



Phase-Shift Network



Nomogram

THIS NOMOGRAM is intended for the computation of the phase shift and of the total impedance of a phase-shifting L-pad. The nomogram is based on the equations:

$$\begin{aligned}\tan\varphi &= X/R \\ Z &= R/\cos\varphi\end{aligned}$$

where X , R , and Z are the reactance, resistance and impedance respectively, and φ is the phase difference between the input and output voltages.

Given X and R , the value of φ is first found by drawing a straight line through X and R on the corresponding scales. Another straight line, drawn through R and the thus-obtained value of φ on the φz scale gives the unknown value of Z .

Example: A line drawn through $R = 7$ and $X = 5$ kilohms gives $\varphi = 36$ deg. Another line drawn through $R = 5$ kilohms and $\varphi z = 36$ deg gives $Z = 8.6$ kilohms.

From "Nomogram Collection on Radio Engineering" by V. M. Rodionov, Soviet Radio Publishers.

Phase-Shift Oscillator

Nomogram



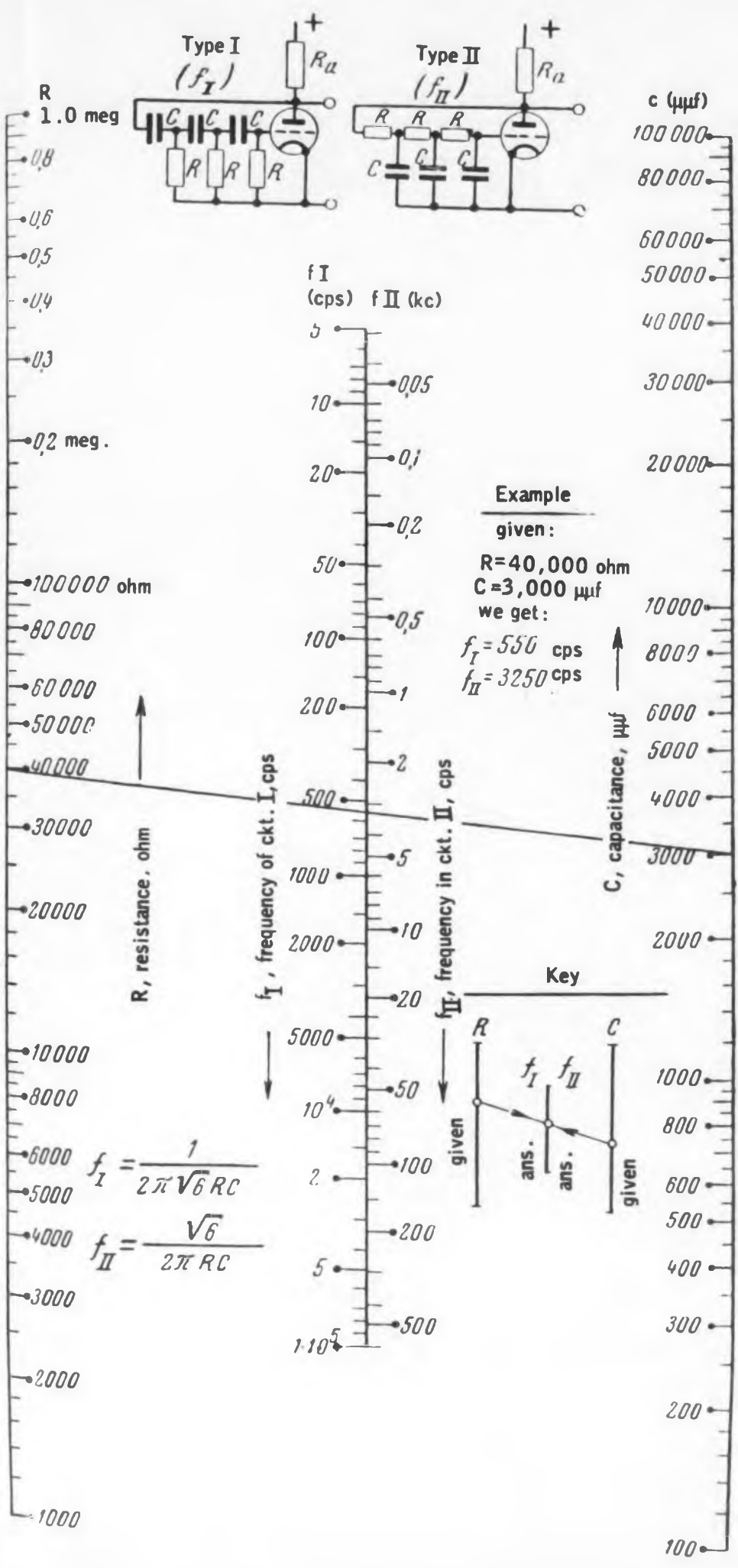
THIS NOMOGRAM is intended for the design of the two types of phase-shift oscillators shown in the diagram. Each oscillator contains a three-element phase-shift network comprising equal resistances and capacitances. The equation for the frequency is

$$\begin{aligned}f_I &= \frac{\sqrt{6}}{2\pi RC} \\ f_{II} &= \frac{1}{2\pi\sqrt{6} RC}\end{aligned}$$

Given any two of the three quantities, f_I (or f_{II} , R , and C), one can readily obtain the third from the nomogram.

Example: Given $R = 40,000$ ohms and $C = 3000$ μmf , we get $f_I = 550$ cps and $f_{II} = 3250$ cps.

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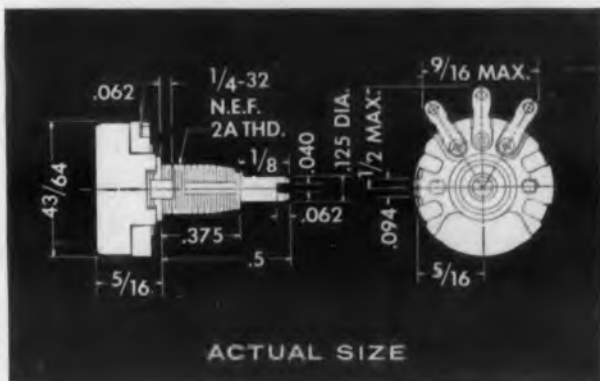
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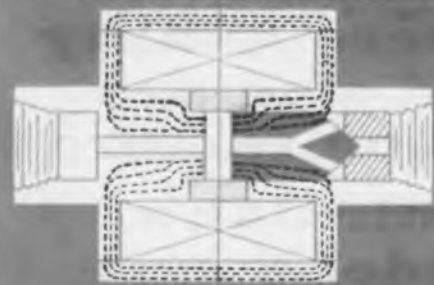
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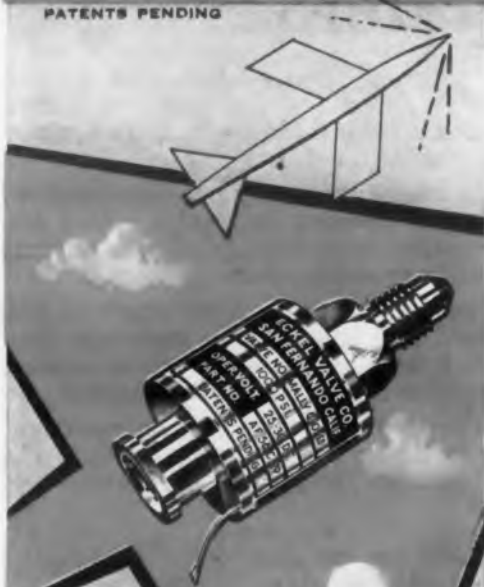
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German Abstract

Equivalent Circuits for Transistors

WHILE in vacuum tube circuits the load impedance has, in the absence of feedback directly to the input, no effect on the input impedance, this is not the case in transistor circuits. An equivalent circuit which takes this effect into account conveniently can be deduced.

If the transistor parameters are considered resistive then the transistor is a special case of the unilateral two terminal pair shown in Fig. 1. The mesh equations for this four-pole network are

$$V_1 = Z_{11} I_1 - Z_{12} I_2$$

$$V_2 = Z_{21} I_1 - Z_{22} I_2$$

where

$$Z_{11} = r_1 + r_3; Z_{12} = r_3; Z_{22} = r_2 + r_3; Z_{21} = r_3 + r_4$$

The ratio $D = Z_{12}/Z_{21}$ is defined. This ratio is unity only when the network is unilateral. Each side is now terminated in its image impedance so that the input termination is

$$Z_1 = \sqrt{\frac{Z_{11}}{Z_{22}}} \cdot \sqrt{Z_{11} Z_{22} - Z_{12} Z_{21}}$$

and the output termination is given by

$$Z_2 = \sqrt{\frac{Z_{22}}{Z_{11}}} \cdot \sqrt{Z_{11} Z_{22} - Z_{12} Z_{21}}$$

The transmission factor in the forward direction, g_1 , is defined by

$$g_1 = \ln \frac{V_1}{V_2} + \frac{1}{2} \ln \frac{Z_2}{Z_1}$$

which for the terminations stated gives

$$g_1 = \frac{1}{2} \ln D + \cosh^{-1} \sqrt{\frac{Z_{11} Z_{22}}{Z_{21} Z_{12}}}$$

Defining the transmission factor in the reverse direction, g_2 in an analogous manner:

$$g_2 = \ln \frac{V_2}{V_1} + \frac{1}{2} \ln \frac{Z_1}{Z_2}$$

one obtains

$$g_2 = g_1 - \ln D$$

Elaborate manipulations of the mesh equation (by matrix algebra) result in the

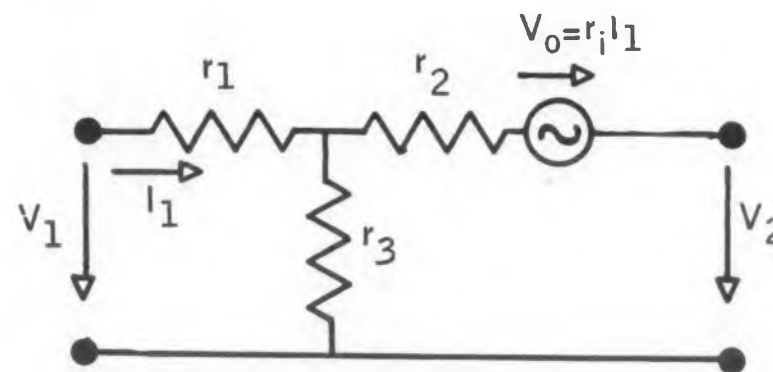


Fig. 1. Active unilateral four-pole network.

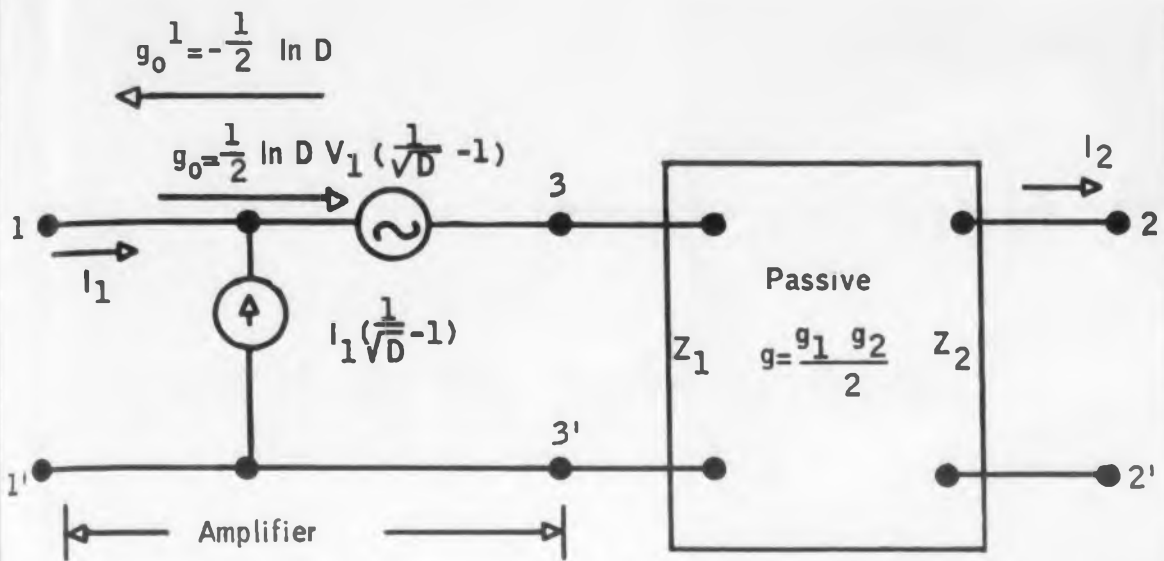


Fig. 2. Cascade connection of an ideal amplifying four-pole network and a passive bilateral four-pole network to represent active four-pole network.

equivalent circuit shown in Fig. 2. This circuit is particularly convenient because the general four-pole is represented as a cascade connection of an ideal amplifier and a passive bilateral two terminal pair. The transmission factor of the ideal amplifying section of this circuit is g_o in the forward direction, and for the passive section this factor is g , where

$$g_o = \frac{1}{2} \ln D \text{ and } g = \frac{g_1 + g_2}{2} = \cosh^{-1} \sqrt{\frac{Z_{11} Z_{22}}{Z_{12} Z_{21}}}$$

Note that if g exceeds g_o then no amplification is possible in either direction.

For a transistor the "h" parameters, may be more convenient. They are defined as follows: (See Fig. 3.)

$$V_1 = h_{11} I_1 + h_{12} V_2$$

$$I_2 = h_{21} I_1 + h_{22} V_2$$

With these parameters

$$g = \sinh^{-1} \sqrt{-\frac{h_{11} h_{22}}{h_{12} h_{21}}}$$

$$g_o = \frac{1}{2} \ln \left(-\frac{h_{12}}{h_{21}} \right)$$

The order of magnitude of the decoupling which was achieved with typical transistors was about 8-10 db or 1 to 1.2 nepers in an application where it was desired to decouple a mixer from a band-pass filter. While vacuum tubes at low frequencies can furnish practically arbitrary decoupling, the use of transistors to amplify and decouple simultaneously seems to recommend itself in diverse applications.

Abstracted from an article by C. Kurth, *Frequenz*, Vol. 11, No. 4 April 1957, pp 107-114.

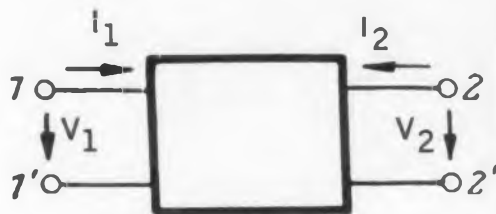
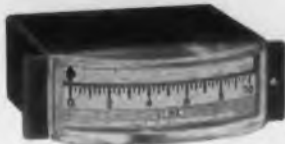


Fig. 3. Reference directions for transistors.

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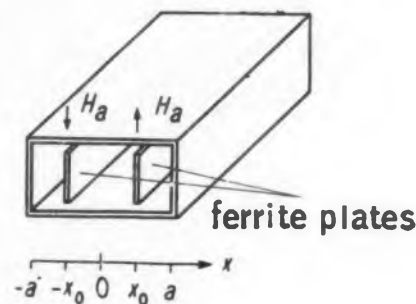
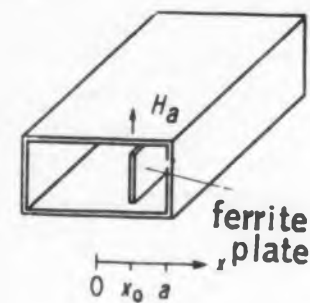
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German Abstract

A Nonreciprocal Attenuator at 4 Kmcps



Waveguide with ferrite plates.
 H_a represents the externally required dc magnetic field.

A NONRECIPROCAL attenuator which has the following properties can be constructed by using the principle of resonant absorption in ferrites:

Bandwidth: 400 Mcps (3.8 to 4.2 Kmcps)
 Reflection factor: 1 per cent
 Forward attenuation: 0.5 db (approx)
 Attenuation in reverse direction: 13 db (min)

The device is based on the principles illustrated in the figure. Insertion of a single ferrite plate in the waveguide will cause resonant absorption and consequently attenuation when the frequency of the electromagnetic waves corresponds to the frequency of precession of the magnetic moments in the ferrite. If two ferrite plates are inserted symmetrically, then there are two positions ($\pm x_0$) at which the phenomenon becomes directional, i.e. it will depend on the direction of propagation of the electromagnetic waves. The correct position of the ferrite plates depends on the dielectric constant and permeability of the material and is best determined experimentally.

While several Ni-Zn-ferrites could be used in principle, several objections to their suitability were discovered. With some, the bandwidth was too narrow, while with others, the coercive force was too large so that excessive dc fields were required. Those Ni-Zn-ferrites for which the coercive force was appropriately small have too low a Curie-point and exhibit too great a temperature dependence to be generally useful. The GY-ferrites (Siemens-Halske AG) were found to be suitable from both points of view.

The original paper also includes sketches of the actual waveguide structure which was built and tested. (Abstracted from an article by J. Deutsch and W. Haken, Frequenz, Vol. 11, No. 7, July 1957, pp. 217-220.)

A Waveguide Slide Rule

IN THE DESIGN of cavities as well as in other waveguide problems the calculation of the wavelength within the guide for various modes is often time consuming, especially when moderately high precision is required. The "guide-wavelength," λ_g , the free space wavelength λ_o and the cutoff wavelength λ_c are related by

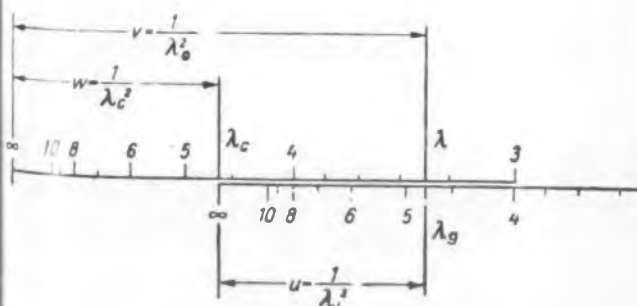
$$1/\lambda_g^2 = 1/\lambda_o^2 - 1/\lambda_c^2 \quad (1)$$

Setting $u = 1/\lambda_g^2$, $v = 1/\lambda_o^2$ and $w = 1/\lambda_c^2$ and introducing a proportionality constant p , we have the relationship

$$pu = pv - pw \quad (2)$$

This subtraction can be represented graphically as shown in the Figure. This illustration shows how the slide rule is used: calculate the cut-off wavelength and match the infinity mark on one scale with λ_c on the slider. The free space wavelength on the rule will then match the guide wavelength on the slider.

The proportionality constant, p is used to determine the physical size of the slide rule once the required precision is specified. Using $p = 2000$ the length of the scales is 22.5 cm and the rule yields four significant figures in the 3-3.4 cm region. (Abstracted from an article by W. Otto, Nachrichtentechnik, Vol. 7, No. 7, July 1957, pp 294-296.)



Principle of the slide rule.

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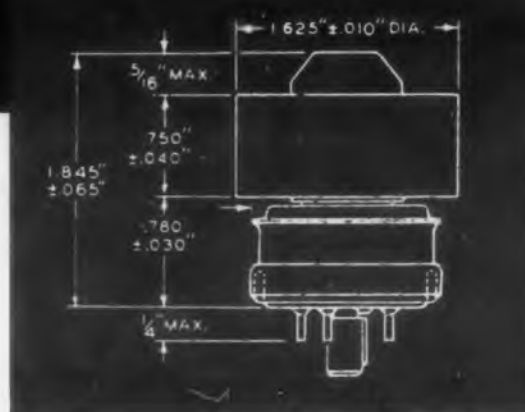


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DC Plate Ma.	170	200
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