

ELECT D

MAY 13 1958



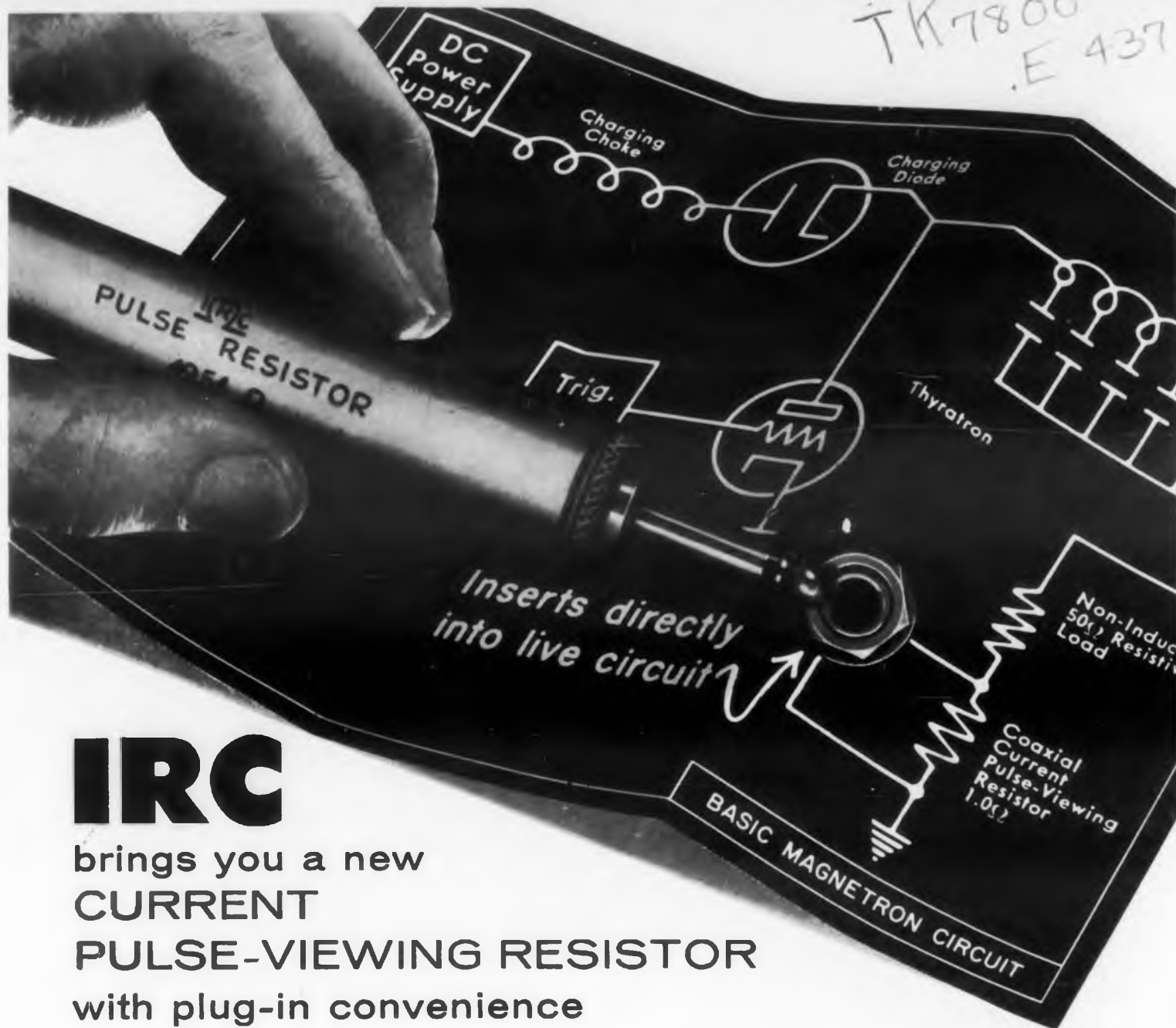
R O N I C
E S I G N

MAY 14, 1958

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HIGH
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IRC

brings you a new
CURRENT
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There is no longer any need to improvise a resistor network when you want to look at pulse shapes. Try the new way: plug an IRC Pulse-viewing Resistor into a standard 'phone jack and you're in business—fast—and at a welcome saving in engineering and test time.

ENDS TRANSIENTS OR RINGING. Special construction cuts inductance to .01 μ h or less eliminating the possibility of annoying transients or ringing.

18 STANDARD RESISTANCE RANGES—Resistance values from .022 to 150 ohms in 15-watt or 75-watt sizes (DC continuous duty rating) make it possible to test a wide range of pulse radar and similar magnetron circuits or their associated components. Low resistance and low inductance are ideal prerequisites for critical power pulse circuits. Resistor elements are of the highly-stable film-type.

INTERCHANGEABLE ELEMENTS. IRC Current Pulse-viewing Resistors are so designed that resistance values and connectors can be readily interchanged.

WRITE FOR
NEW BULLETIN S-4A



INTERNATIONAL RESISTANCE CO.

Dept. 334, 401 N. Broad St., Philadelphia 8, Pa.

In Canada: International Resistance Co., Ltd., Toronto, Licensee

CIRCLE 1 ON READER-SERVICE CARD

ELECTRONIC
DESIGN



COVER STORY

High Temperature Components 23

A staff written report evaluating the state of development of the principal components and materials for electronic equipment. Includes an industry wide survey.

Electronic Uses of High Temperature Liquid Dielectrics 48

Liquid dielectrics, which may help keep other components cool, may themselves have to run hot. Here's what you should know about how to use them.

Design Tips for Using High Temperature Precision Potentiometers 54

Like anything else, a high temperature pot may require many compromises.

Hot Wires Carry More Current Than You Think 58

This provocative article shows an area where high temperature operation can result in uprating rather than derating.

High Temperature Relay Designs Are Different 66

Here's what happens to high temperature relays when they operate at lower temperatures—and it happens to other components, too.

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Number

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MAY 14 1958

New!



For any conceivable counting job!
A new, low power, light weight, all transistor, 150 KC frequency time counter

Features maximum reliability, long life and small size. Direct Digital in-line readout, does not require matrix. Variable time base permits direct reading of results without consideration of transducer conversion factors.

SPECIFICATIONS

- Input Frequency Range**
0 to 150 kc
- Input Sensitivity**
0.1 volt rms, with input attenuation in decade steps
- Accuracy**
 ± 1 cycle of measured frequency
- Crystal Stability**
1 cycle/megacycle/frequency
- Registration**
5 digits
- Display Time**
Continuously variable up to 5 seconds on automatic, until reset on manual
- Gate Intervals**
Selection of gate duration, from 10 microseconds to 10 seconds is available in 10 microsecond increments
- Display**
In-line, 5 digit readout
- Reset**
Manual or automatic recycling
- Preset Interval Range**
10 microseconds to 10 seconds
- Accuracy as Interval Generator**
 ± 10 microseconds
- Recycling Time**
10 microseconds maximum
- Output**
Independent or simultaneous outputs, 10 volts positive, 500 ohms output impedance
- Dimensions**
8" wide x 12" high x 15" deep
- Weight**
20 pounds
- Output Connections**
Rear Panel Jacks
- Priced**
Competitively with the best vacuum tube counters

At last you can have a high quality, low-power, lightweight, transistorized 150 kc Frequency Time Counter that combines the precision of a laboratory instrument with the ruggedness required for factory applications and will last indefinitely.

The new Potter Model 860, Frequency Time Counter, is a small compact instrument. It may be used to perform normal counting functions and as a timing and frequency measuring device.

In addition, the Model 860 may be used as a preset interval generator to provide preset intervals, delays or counts saving the cost of an additional instrument when preset interval generating functions are required.

Timing and frequency features of the Model 860 include direct measurement of frequency from 0 to 150 kc, frequency ratio determination, period measurements for 1 or 10 cycles, and time interval measurements for intervals from inputs up to 150 kc. Predetermined counting to any number up to 9999 with extension in steps of 10 or 100 to 999900 and external count gating are additional features.

Call or write the factory or your Potter Instrument Company representative for further information or for assistance with your counting problems.

POTTER INSTRUMENT COMPANY, Inc.

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Overbrook 1-3200



CIRCLE 2 ON READER-SERVICE CARD



GAS FILLED TUBES

VOLTAGE REFERENCE • VOLTAGE REGULATOR • COLD CATHODE RECTIFIER
for Military and Industrial Applications

These Raytheon Tubes are designed, constructed and tested for severe military environment, including temperature ratings to 165°C, and shock and vibration resistance.

Raytheon custom designed gas filled tubes are backed by over thirty years of design, development and production experience. It will pay you to get in touch with Raytheon for gas filled tubes that meet your specific needs.

RAYTHEON GAS FILLED TUBES

VOLTAGE REGULATOR TUBES			
0A2, 0A2WA, CK6626	Miniature	150 volts,	5 to 30mA
0B2, 0B2WA, CK6627	Miniature	108 volts,	5 to 30mA
CK5787WA	Submin.	98 volts,	5 to 25mA
CK6542	Submin.	150 volts,	5 to 25mA
VOLTAGE REFERENCE TUBES			
CK5651, CK5651WA	Miniature	85 volts,	1.5 to 3.5mA
CK5783WA	Submin.	85 volts,	1.5 to 3.5mA
CK6213	Submin.	130 volts,	1 to 2.5mA
RADIAC TUBES			
Raytheon offers Corona Voltage Regulator Tubes for higher voltages in a wide range of ratings; also a variety of Radiation Counter Tubes.			

COLD CATHODE RECTIFIERS			
CK5517	Miniature	PIV = 2800	$I_o = 12mA$
CK6174	Miniature	PIV = 2800	$I_o = 3mA$
CK6659 (CK1042)	Submin.	PIV = 2800	$I_o = 8mA$
CK6763	Miniature	PIV = 2800	$I_o = 12mA$ (Ruggedized)
THYRATRONS			
RK61	Submin.	For control receivers in model aircraft, boats, etc.	
CK1054	Submin.		
CK5643	Submin.	For general purpose military use	
LIGHT INDICATOR			
CK1050	Submin.	Low drain, grid controlled indicator for semiconductor circuitry.	



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ENGINEERING REVIEW

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

Transistor Uses Field Effect



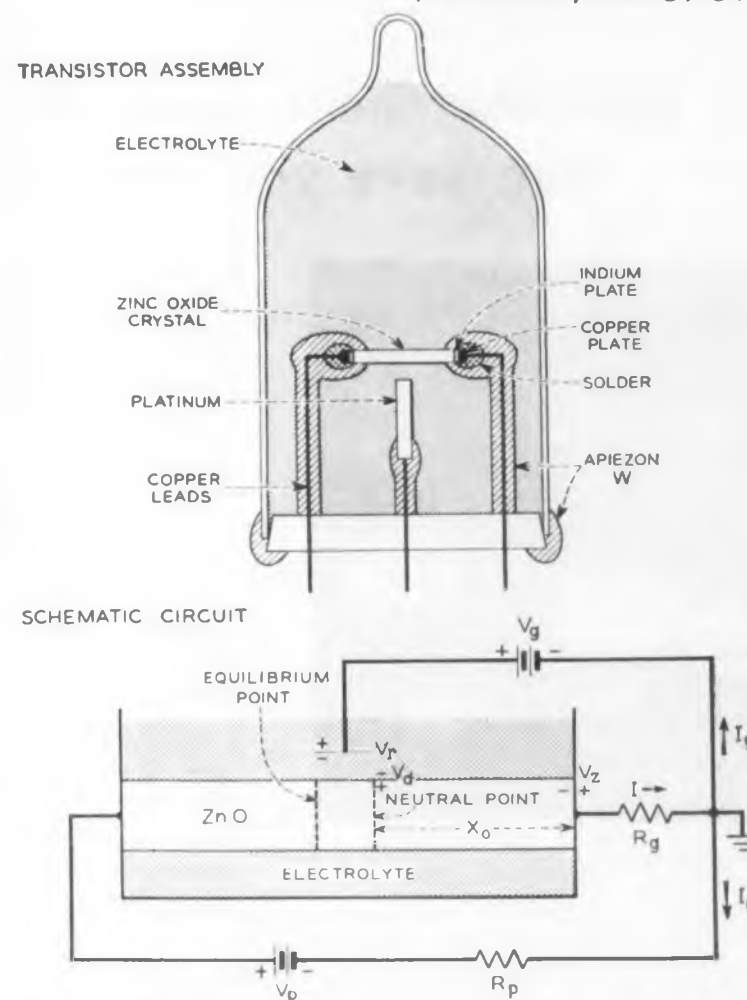
Laboratory model of transistor amplifier, using an electrolyte/semiconductor interface, with its inventor, J. F. Dewald.

A transistor amplifier using a semiconductor electrolyte interface modulated by an electrical field is being developed at Bell Telephone Labs. Experiments have demonstrated amplifier operation at 1000 cps with gain in excess of 15 db.

The experimental device uses a hexagonal rod-like crystal of very pure zinc oxide as the semiconductor, immersed in a highly conducting electrolyte. A platinum electrode placed nearby serves as the grid element. Since zinc oxide is a large-energy-gap semiconductor, it can be operated in a high enrichment condition, with one end of the crystal negatively biased with respect to the solution, and the other end positively biased. Between is a neutral point where the energy bands are flat right up to the surface of the crystal. As this neutral point shifts back and forth under the influence of varying biasing grid voltages, the resistance of the crystal changes, passing a current which follows the driving frequency closely. A fairly extended range of linear response is obtained, it is reported.

To make electrical contact to the zinc oxide crystal, the two ends are first indium plated to assure good ohmic contact. They are then copper plated to allow soldering of copper wire leads. The platinum grid completes the assembly. After insulating all wires and connections except the grid, the assembly is immersed in the electrolyte

(continued on following page)



Cross-section view of field effect transistor amplifier, with schematic circuit diagram showing principle of operation.

Which ceramic characteristics do you need . . .

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

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

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

Reprinted from Electronic Design, November 1, 1956

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



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

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

Ceramic parts manufactured from Raytheon R-95 High Alumina are available, either alone or as hermetic ceramic-to-metal assemblies, in accordance with your specifications. The assemblies can be soft or hard soldered into your production in your own plant.

Send sketches or drawings outlining dimensions and tolerances, together with operational conditions. We will be pleased to supply information and help on any of your ceramic needs.

Write for complete specification sheet and your copy of *Ceramics in Electronic Design*, comprehensive questions and answers on the growing role of ceramics in modern design. No cost or obligation, of course.

RAYTHEON MANUFACTURING COMPANY

Ceramic Sales

Waltham 54, Massachusetts



Excellence
in Electronics

ENGINEERING REVIEW

(5 per cent sodium tetraborate and boric acid solution), and hermetically sealed in a small glass tube to avoid electrolyte evaporation.

Small size is required to give high frequency operation. The smallest units constructed so far use crystals about 0.3 mm long, and 0.15 mm in diameter. It is expected that by going to a flat plate crystal instead of the rod geometry, the present low output power levels could be raised appreciably, without any overall increase in size, or any change in other operating characteristics.

USSR Produces 4 Micron-Thick Condenser Paper

The Leningrad factory for paper mill equipment has started the production of a machine which is to turn out condenser paper 4 microns thick. 250 sheets of such a flimsy paper would reach a height of one mm.

The output of the 98.4 ft fully automatic machine will be 99.18 lbs of paper per hour. The paper will be used for highly sensitive instruments.



1700 MPH Sled

This is an artist's conception of a seven-ton rocket sled that will streak to speeds of 1,700 mph under the explosive power of a liquid-propellant rocket engine developing 160,000 pounds of thrust. The slim, pencil-shaped vehicle, to be delivered this Fall to the Air Force for high speed tests at Holloman Air Development Center, New Mexico, measures 43 ft in length and 40 in. in height. With a single-chambered engine, the sled will accelerate with a force of 15 G's containing a one ton payload. The rocket sled was developed by Rocketdyne, Canoga Park, Calif.

◀ CIRCLE 4 ON READER-SERVICE CARD
CIRCLE 5 ON READER-SERVICE CARD ▶

GENERAL  ELECTRIC

TUBE DESIGN NEWS

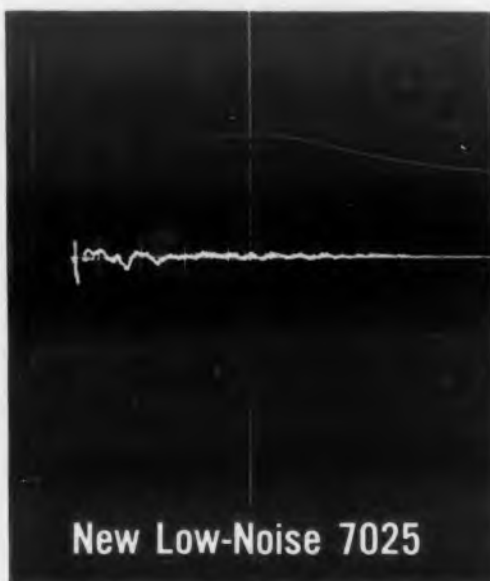
FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY



General Electric Low-Noise 7025 AF-Amplifier Tube Major Step Toward Improved Hi-Fi Reproduction!



Prototype (12AX7)



New Low-Noise 7025

Scope Trace at Right Shows Superiority of New 7025 Twin Triode

You can see by comparison the greatly reduced noise output of the new General Electric amplifier tube. A single, identical tap was applied externally to a 12AX7 and to a 7025, both representative tubes from current production. Vertical measurement is plate voltage . . . horizontal measurement is time. Conditions: E_p : 250 v, R_1 : 10 K, E_c : -2.5 v.

Military Equipment Builder Finds G-E 7077 Ceramic Triodes Have Mean Noise Figure Below 5 db!

Using a high-performance test circuit of advanced design, the research laboratory of a large manufacturer of military equipment has found that a sample lot of G-E 7077 RF-amplifier ceramic triodes show the mean noise figure of 4.6 db at 16 db gain. Tubes were operated at 500 megacycles.

The new 7077 is rated at 5.5 db noise at 14.5 db gain, 450 megacycles under power-matched conditions. Therefore, the test performance underscores the tube's suitability for military use, where low noise and high gain are vital.

Intended primarily for communi-

cations, radar, and navigation equipment, the new 7077 is a high-mu triode of planar construction. Altitude rating is 100,000 feet. It is economical in price, dependable, and rugged.

Ceramic construction gives the 7077 exceptional heat resistance. The tube is expected to be useful up to 300 C. It is designed for optimum mounting in grounded-grid UHF amplifier circuits. Size is extremely small—less than $\frac{1}{2}$ inch long and wide.

Orders are being accepted now for delivery this year. See page that follows for average characteristics and typical-operation data.

Modern sound-reproduction techniques put a premium on low background noise. The richness of today's high-fidelity 'ne calls for circuitry and tubes that reduce hum, microphonics, and other noise to a level approaching silence.

General Electric, long a pioneer in audio research—originator of the famous variable-reluctance cartridge and other basic aids to sound reproduction—now assists circuit designers with an outstanding low-noise amplifier tube, the 7025. This new twin triode promotes hum-free, noise-free reproduction of both disk and tape sound recordings.

In equipment now being designed or in production, the 7025 will directly replace Type 12AX7.

New Snubber Mica Holds Cathode Tight. Special Low-Hum Heater Employed.

The new 7025 features a spring snubber mica applied to the top of the cathode, which exerts a damping effect on any movement of the cathode caused by shock or vibration. This cuts microphonics substantially.

Also, a new tube heater of special design reduces hum by virtually eliminating heater magnetic influences on plate current and consequent hum in the plate circuit.

High-precision General Electric manufacture has been called on to achieve extremely close fits of all tube parts—a third, important factor in low-noise performance.

For best audio, apply the new General Electric 7025 AF-amplifier tube! Complete information about this low-noise twin triode is available from any G-E Receiving Tube office listed on the following page.



Tear off and keep this sheet for reference. It contains useful tube-application data.

GENERAL ELECTRIC 7077 RF-AMPLIFIER CERAMIC TRIODE AVERAGE CHARACTERISTICS

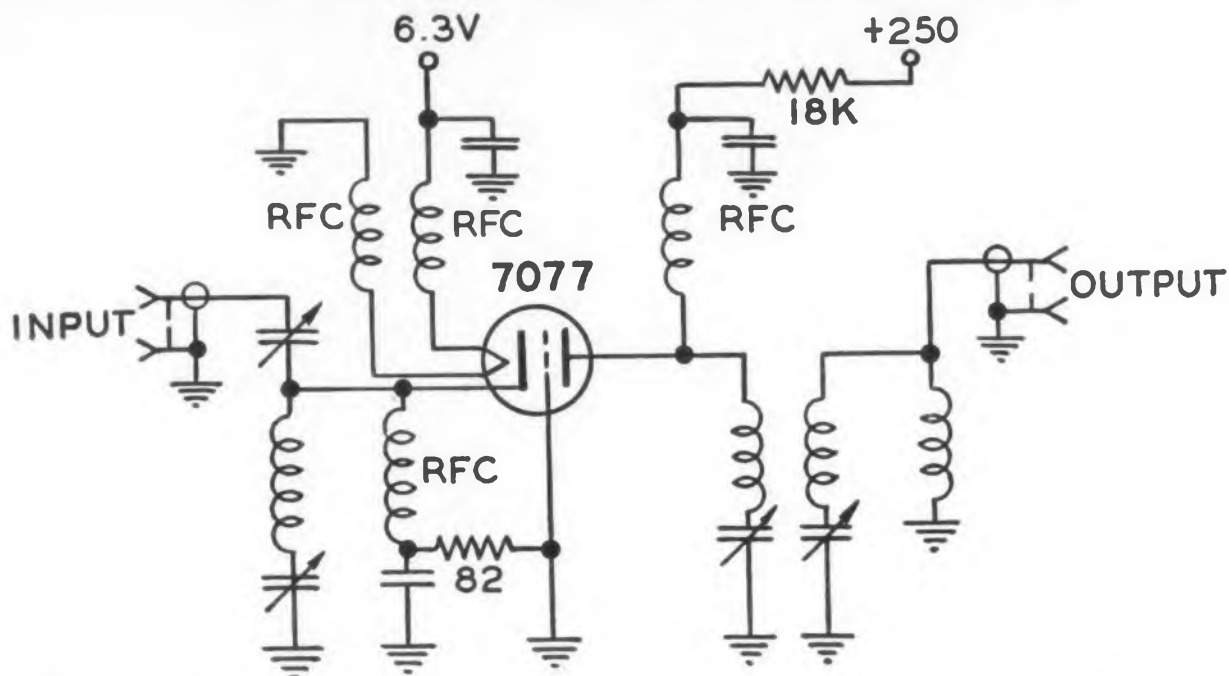
Plate Supply Voltage.....	250	Volts
Resistor in plate circuit (by-passed).....	18000	Ohms
Cathode-Bias Resistor.....	82	Ohms
Amplification Factor.....	80	
Plate Resistance, approximate.....	8900	Ohms
Transconductance.....	9000	Micromhos
Plate Current.....	6.4	Milliamperes
Grid Voltage, approximate $G_m = 50$ Micromhos.....	-5	Volts

TYPICAL OPERATION GROUNDED-GRID AMPLIFIER—450 MEGACYCLES

Plate Supply Voltage†.....	250	Volts
Resistor in plate circuit (by-passed)†.....	18000	Ohms
Cathode-Bias Resistor.....	82	Ohms
Plate Current.....	6.4	Milliamperes
Bandwidth, approximate.....	7	Megacycles
Power Gain, approximate.....	14.5	Decibels
Noise Figure (Measured with power-matched input, using argon lamp noise source), approximate.....	5.5	Decibels

† Lower supply voltage and a lower value of resistor may be used in the plate circuit with some sacrifice in uniformity of performance.

TYPICAL GROUNDED-GRID AMPLIFIER CIRCUIT USING THE 7077



Disclosure of the foregoing examples of the tube applications does not convey to purchasers of tubes any patent license, nor is it to be construed as recommending the use of such tubes in the infringement of patent claims.

For further information, phone nearest office of the G-E Receiving Tube Department below:

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GENERAL  ELECTRIC

12-11-102

Data Released on R & D Activities in 1954

About 230,000 scientists and engineers were engaged in research and development activities in the natural sciences in 1954—68,000 physical scientists, 139,000 engineers, and 22,000 life scientists. They represented only 25 per cent of all engineers and 40 per cent of all scientists employed in the organizations surveyed.

These results are contained in *Review of Data on Research and Development, No. 9, Scientists and Engineers in Research and Development, 1954*, recently issued by the National Science Foundation, Washington 25, D.C. The Federal Government, industry-oriented organizations, colleges and universities, and other private and non-profit research institutions were covered in the survey.

Of the 68,000 physical scientists employed in research and development, 68 per cent were in industry, 20 per cent in the Federal Government, 11 per cent in colleges and universities, and 1 per cent in the other institutions.

Industry employed about 117,000 engineers in research and development activities (84 per cent of all engineers so employed); the colleges and universities, 5600, or only 4 per cent. On the other hand, over half of the research and development life scientists were employed by the colleges and universities, only 19 per cent by industry and 22 per cent by the Federal Government.



Radar Images "Frozen"

A button is pressed on instrumentation panel and a radar image holds for more than five minutes on the screen of a 15-in. direct-view cathode-ray storage tube. Announced by Allen B. DuMont Laboratories, Inc., Clifton, N.J., the storage tube provides halftone or black and white images which may be viewed in a high ambient light environment.

← CIRCLE 5 ON READER-SERVICE CARD



* Tonotron picture of the Los Angeles Yacht Harbor

The Hughes TONOTRON tube presents a complete spectrum of grey shades. **Result:** high-fidelity picture reproduction. The illustration above, for example, is an unretouched photo of a typical radar display as viewed on the face of a TONOTRON E.I.A. Type 7033 Tube.

Additional outstanding characteristics of the TONOTRON tube are high brightness (in excess of 1500 foot lamberts with full half tone range) and controllable persistence. The family of TONOTRON tubes is ideally suited for ground mapping, weather radar displays, slow-scan TV, "B" scan radar, oscillography, armament control radar, optical projection systems, and miniature radar indicators.

Other Hughes cathode-ray storage tubes: The MEMOTRON® tube displays successive transient writings until intentionally erased. The TYPOTRON® tube, an exceptionally high-speed character writing tube, displays any combination of 63 letters or symbols until intentionally erased.



Creating a new world with ELECTRONICS

For complete technical data please write Hughes Products, Electron Tube Division, International Airport Station, Los Angeles 45, California

HUGHES PRODUCTS

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CIRCLE 6 ON READER-SERVICE CARD

ALLIED'S NEW ADDITIONS TO THE KH SUBMINIATURE LINE

Types KHJ and KHY GENERAL FEATURES:

Contact Data:

Contact Arrangement—DPDT

Contact Rating—

Low-level up to 2 amps at 29 volts d-c,
1 amp at 115 volts a-c 400 cps
non-inductive or 0.5 amp inductive.
Life—100,000 minimum at 125°C

Also available 3 amps at 29 volts d-c,
2 amps at 115 volts a-c 400 cps
non-inductive or 1 amp inductive.
Life—100,000 at 3 amps or 500,000
minimum at 2 amps at 125°C.

Initial Contact

Resistance—0.05 ohms maximum
Contact Drop—1 millivolt maximum
at low level rating, initial and during
low level miss test

Operate Data:

D-C Coil Resistance—up to 10,000 ohms
Nominal Power—1.2 watts
Pull-in Power—240 milliwatts (standard)
100 milliwatts (special)

Operate Time—5 milliseconds max.

Release Time—3 milliseconds max.

Dielectric Strength:

1000 volts rms at sea level
500 volts rms at 70,000 feet
350 volts rms at 80,000 feet

Insulation Resistance:

10,000 megohms minimum at 125°C

ENVIRONMENTAL FEATURES

Vibration:

5 to 10 cps at 0.5 inch double amplitude
10 to 55 cps at 0.25 inch double amplitude
55 to 2000 cps at 20 g
Shock: 100 g's operational • 200 g's mechanical

Ambient Temperature: -65°C to +125°C

MECHANICAL FEATURES

Weight: 0.5 ounces

Terminals:

Hooked Solder • Plug-in • Printed Circuit

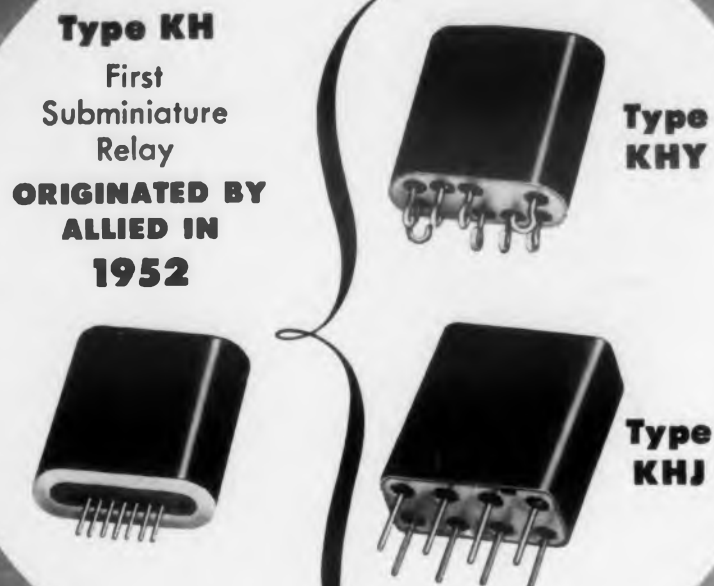
Mountings:

2 or 4 hole brackets at base or center of gravity
1 or 2 stud on top or side of housing

MILITARY SPECIFICATIONS

MIL-R-25018 • MIL-R-5757C

ACTUAL SIZES

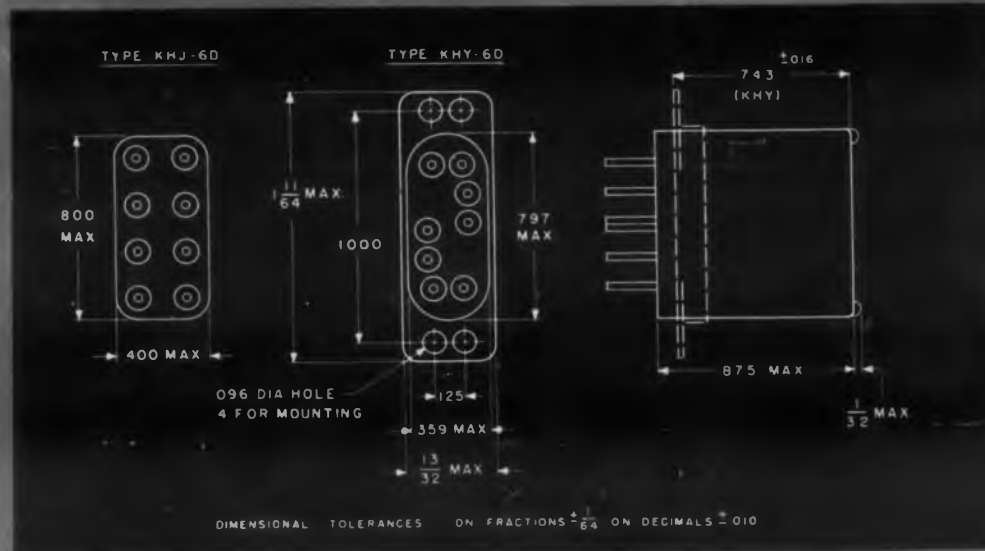


Type KH
First
Subminiature
Relay
**ORIGINATED BY
ALLIED IN
1952**

**Type
KHY**

**Type
KHJ**

Allied's type KHJ and KHY subminiature relays were developed to meet the present "Automation" need for relays with incremental grid spaced terminals and with improved performance. These relays have a higher contact rating and are designed to meet the increased vibration and shock requirements of the latest MIL specs. They are available with mounting brackets that are interchangeable with Allied's present type KH subminiature relay.



ENGINEERING REVIEW

Radar Antennas Developed For 3000 Mile Range

Radar antennas that will detect enemy missiles up to 3000 miles away and the effect of low pressures on guided missile antennas were revealed by Westinghouse Electric Corp., Pittsburgh, Pa.

Antennas for the 3000 mile range would normally be large and unwieldy, and difficult to sweep back and forth. A new and radical antenna solves the problem by having the beam moved back and forth electrically while the antenna is held in a fixed position. This feature becomes particularly important in the extremely gusty conditions existing on the Northern early warning defense line.

The outer reaches of space are creating problems for antenna designers as well. The low pressures are resulting in premature antenna breakdown and disruption of communications between the guided missiles and tracking stations.

High-Power Silicon Switches Block 200 v, Carry 10 A

Silicon switches capable of blocking up to 200 v and carrying currents up to 10 a have been developed by Westinghouse Electric Corp., Pittsburgh, Pa. The switching time required to go from the ON to the OFF condition is reportedly ten times faster for the switch structure than that of a comparable transistor. Selected laboratory samples of these devices have indicated the possibility of blocking voltages up to 1000 v.

Translators Beware

We recently covered a conference on relays at Oklahoma State University. The librarian there called our attention to a recent translation of a Russian Journal (not in ELECTRONIC DESIGN) in which the term "watergoat" appeared. Subsequent investigation by University personnel revealed the phrase meant "hydraulic ram."

◀ CIRCLE 7 ON READER-SERVICE CARD



ALLIED CONTROL



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

Computer Problems Not Being Thought Through

The many problems involved in the use of digital computers are not being successfully thought through. Many installations, and by no means the least successful ones have arisen more from faith than from reasoned plans, supported by adequate technical or economic justifications, according to P. A. Abetti and S. B. Williams of the General Electric Co., Pittsfield, Mass. in a technical paper prepared for the AIEE Winter Meeting.

As a result of a detailed study of computer problems, the following observations and recommendations were made:

- Personnel may be divided into three groups: the engineers, charged with the responsibility of obtaining solutions to various problems; the programming group, charged with the responsibility of preparing correct and economic programs for the selected applications; the computer operations group, charged with the responsibility of running the requested individual jobs on the computer;
- Applications which have a high degree of repetitiousness should be selected for computers;
- The selection of the type and size of computer depends upon application considered, amount of usage, organizational considerations;
- A closed shop where all programming is done exclusively by selected programmers is more advantageous for large-scale machines and for highly repetitive applications with large data-processing content, such as the design of electrical apparatus.



Unknot Gnat Production

Each of these "gnat gyros" goes through 100 different assembly and test operations before they are installed in the Army Hawk ground-to-air and the Navy Sparrow III air-to-air missiles. The gyro which spins noiselessly at 30,000 rpm measures 1 x 2 1/2 in. The size requires jewel bearings identical within nineteen millionth of an inch. Difficulty of setting up production line techniques has prevented until recently mass production of the missile gyros, by Raytheon Mfg. Co., Lowell, Mass.

ELECTRONIC DESIGN • May 14, 1958

new constant delay filters

give minimum intelligence distortion and maximum phase linearity in radar, telemetering and other missile applications

Now . . . Bunnell & Co.'s new Type 60051 Constant Delay Filter series provide delay constant to within 5% over the Pass Band — solve troublesome distortion caused by non-linear systems.

It has become apparent that the phase characteristics of telemetering filters are of greater importance than amplitude characteristics in creating intelligence distortion and minimum transient response of frequency modulated signals.

Inasmuch as delay is constant where the derivative of the phase function is truly linear it is an important measure of phase linearity. To obtain constant delay, a complete circuit configuration revision based on a lattice structure is required.

For compactness, a standard type 60051 housing is available. Upon special order JHU-APL housings for circuit replacements can be supplied.

For more detailed information on constant delay filters write for Bulletin CD-051.

TECHNICAL DATA FOR BAND PASS FILTERS

FOR ± 7 1/2% PASS BAND

- 1 Flat within 3 db over pass band
- 2 21 db at ± 15% of center freq.
- 3 40 db at ± 22% of center freq.
- 4 Time delay over the pass band, constant to ± 5%

FOR ± 15% PASS BAND

- 1 Flat to 3 db over pass band
- 2 Flat to 23 db at ± 30% of center freq.
- 3 Flat to 40 db at ± 44% of center freq.
- 4 Time delay over pass band constant to ± 7%

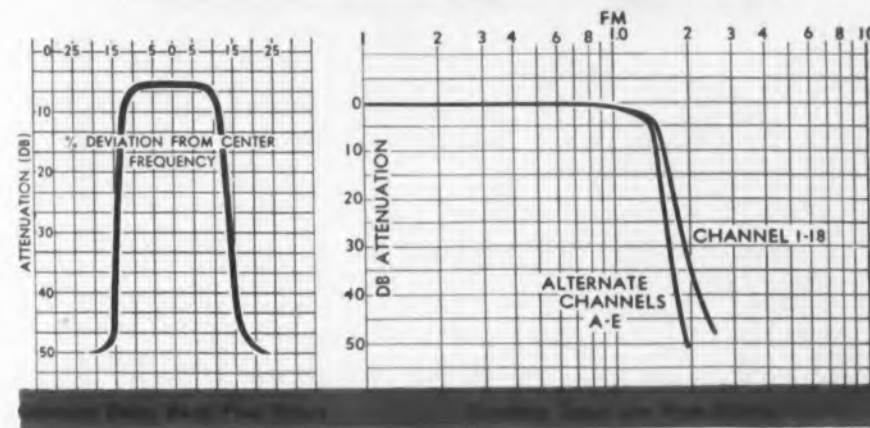
BAND PASS FILTERS					LOW PASS FILTERS		
Channel	Frequency	Part #	Delay in ms.	B/W	Frequency	Part #	Delay in ms
1	4 KC	S-60051	34.00	15%	400 cps	S-60101	2.95 ms
2	.56 KC	S-60052	24.30	15%	560 cps	S-60102	2.11 ms
3	.73 KC	S-60053	18.60	15%	730 cps	S-60103	1.62 ms
4	.96 KC	S-60054	14.20	15%	960 cps	S-60104	1.23 ms
5	1.3 KC	S-60055	10.50	15%	1300 cps	S-60105	.905 ms
6	1.7 KC	S-60056	8.00	15%	1700 cps	S-60106	.681 ms
7	2.3 KC	S-60057	5.93	15%	2300 cps	S-60107	.511 ms
8	3.0 KC	S-60058	4.40	15%	3 KC	S-60108	.392 ms
9	3.9 KC	S-60059	3.38	15%	3.9 KC	S-60109	.302 ms
10	5.4 KC	S-60060	2.44	15%	5.4 KC	S-60110	.218 ms
11	7.35 KC	S-60061	1.80	15%	7.35 KC	S-60111	.160 ms
12	10.5 KC	S-60062	1.26	15%	10.5 KC	S-60112	.112 ms
13	14.5 KC	S-60063	.91	15%	14.5 KC	S-60113	.0812 ms
14	22. KC	S-60064	.60	15%	22. KC	S-60114	.0535 ms
15	30. KC	S-60065	.44	15%	30. KC	S-60115	.0392 ms
16	40. KC	S-60066	.33	15%	40. KC	S-60116	.0294 ms
17	52.5 KC	S-60067	.252	15%	52.5 KC	S-60117	.0224 ms
18	70. KC	S-60068	.189	15%	70. KC	S-60118	.0168 ms
A	22. KC	S-60069	.305	30%	22. KC	S-60119	.0238 ms
B	30. KC	S-60070	.224	30%	30. KC	S-60120	.0181 ms
C	40. KC	S-60071	.168	30%	40. KC	S-60121	.0142 ms
D	52.5 KC	S-60072	.128	30%	52.5 KC	S-60122	.0109 ms
E	70. KC	S-60073	.096	30%	70. KC	S-60123	.00833 ms

CASE SIZE—4 1/8" x 2 x 3 1/2" H (CS-60051)
INPUT IMPEDANCE = 500 ohms
OUTPUT IMPEDANCE = 500 ohms and to grid

CASE SIZE—1 1/8" x 1 1/8" x 2 1/4" H
INPUT IMPEDANCE equals 500/600 ohms
OUTPUT IMPEDANCE equals 500/600 ohms

*optional impedance available on special order.

CONSTANT DELAY BAND PASS AND LOW PASS FILTERS ARE AVAILABLE WITH ATTENUATION SLOPES ILLUSTRATED.



Bunnell & Co., Inc.

PIONEERS IN TOROIDS, FILTERS AND RELATED NETWORKS



EASTERN DIVISION: Dept. D5
10 PELHAM PARKWAY, PELHAM MANOR, N. Y. • PELHAM 8-5000

PACIFIC DIVISION:
720 MISSION STREET, SOUTH PASADENA, CALIFORNIA • RYAN 1-2841

CIRCLE 8 ON READER-SERVICE CARD

New development...

combines **monitoring
and switching**

in **ONE COMPONENT**



MONITOR/SWITCH
C-8 SERIES

- One compact, modular, dual-purpose unit panel mounted
- Monitors three different circuit conditions through a 3-COLOR, INDICATOR-LIGHT assembly
- Switches by alternate-action or momentary-action control through unique PUSH-BUTTON ACTUATOR YOKE to switch assembly
- Reduces mounting hole requirements by 75%

- Saves 40% of panel space
- Reduces fatigue — increases operator efficiency, less panel area to watch
- Keyed lamp assembly — offset bayonet pins insure proper replacement
- Lamp circuit can be wired independently or through switching unit
- Quick lamp replacement, from the front — NO special tools required.



"Target" Screen

Insures even color distribution. Normally furnished translucent white.

Push-Button Switch

actuator yoke easily slides out for removal

Illuminator Assembly

Three prisms with lamps and color filters "pipe" monitoring signal to target screen. Removes as a unit from panel front for low-cost replacement.

Switch Actuating Mechanism

Alternate push-push or momentary, positive-feel action.

Switch Assembly

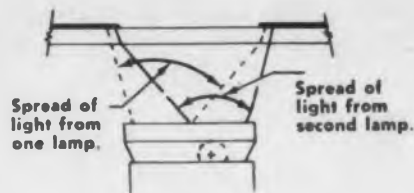
employs two Electro-Snap DPDT sub-miniature switches, conforms to military specifications.

Terminal Board

Easy to connect. Solder terminals standard, others available.

CHOOSE ANY THREE COLOR FILTERS FOR EACH LAMP ASSEMBLY

Lighted filters monitor three separate circuit conditions — one at a time by one color at a time. 35 standard color filters available.



Spread of light from one lamp.

Spread of light from second lamp.

Extreme Light Intensity

Precision-aimed prisms provide overall uniform high-intensity color illumination, well above ambient room lighting. "No Hot Spots."

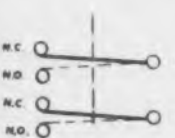
Lighting Circuit

Bayonet pins on lamp assembly are offset to insure correct lamp replacement. Wire independently or through switch.



Switch Circuit

Double-pole, double-throw unit can be wired normally-open or normally-closed.



Companion Unit

Single-color monitoring combined with push-button, panel switching also available.

For full details, write for engineering data sheet.

ENGINEERING REVIEW

Moon Radar Tracking System Disclosed

A punch card operated steering system for a moon radar antenna that is twenty-five times more accurate than previous electronic systems was disclosed by the U. S. Army Signal Corps Engineering Laboratories, Ft. Monmouth, N.J. The system can be applied in modified form for tracking other celestial bodies, including satellites.

Data regarding the orbit of the moon is punched into cards and fed to a digital computer which then calculates where the moon will be at different instants with respect to the antenna. This information is stored on magnetic tape and fed into an analog conversion system which provides a continuous flow of positional signals that keep the antenna aimed constantly and accurately at the moon as it orbits.

True Power Range Silicon Transistors Developed

A 2 to 5 a transistor that can handle power up to 1 kw, and a 10-20 a unit which handles up to 3 kw have been developed by Westinghouse Electric Corp., Pittsburgh, Pa.

New fusion and diffusion methods, together with improved alloy systems, etching procedures, and encapsulation techniques made the devices possible.

The 2 to 5 a units based on current at which gain is equal to or greater than 10, have been produced with emitter-to-collector voltages of from 50 to over 300 v. These devices serve in high-power switching operations with very high efficiencies. For example, as a dc switch handling 1 kw (200 v at 5 a) the internal dissipation of the units is about 5 w with a resulting efficiency of 99.5 per cent. Reverse leakages of these devices ranges from 2 to 3 ma.

The silicon transistor can be used at temperatures up to limits imposed by the silicon material itself.

◀ CIRCLE 9 ON READER-SERVICE CARD



ELECTRO-SNAP SWITCH & MFG. CO.

4216 West Lake Street, Chicago 24, Illinois • Telephone: VAn Buren 6-3100 TWX No. CG-1400



Silicon power transistor compared to a conventional low-power computer transistor.

This is due to the small case-to-junction temperature rise in switch operation. In the 1 kw switch this rise is 2.5 deg C.

Voltage ratings (collector-to-emitter) on present 10 to 20 a units range from 50 to 150 v. Development work should increase this range to 300 v according to Westinghouse researchers. The current ratings are specified at a current gain of 10 a. With the increased current ratings, the saturation resistance is decreased and varies from 0.1 to 0.05 ohm. Used as a dc switch, the 10 to 20 a device handles 3 kw of power with internal losses of less than 20 w.

The encapsulation cases for both the 2 to 5 a and 10 to 20 a silicon power transistors are designed with a screw stud to permit bolting to heat sinks in operation where heat dissipation is set by the operating condition.

Transistorized 100 W Mobile Radio Produced

The first thermostatically protected transistor-powered 100 watt mobile radio has been produced.

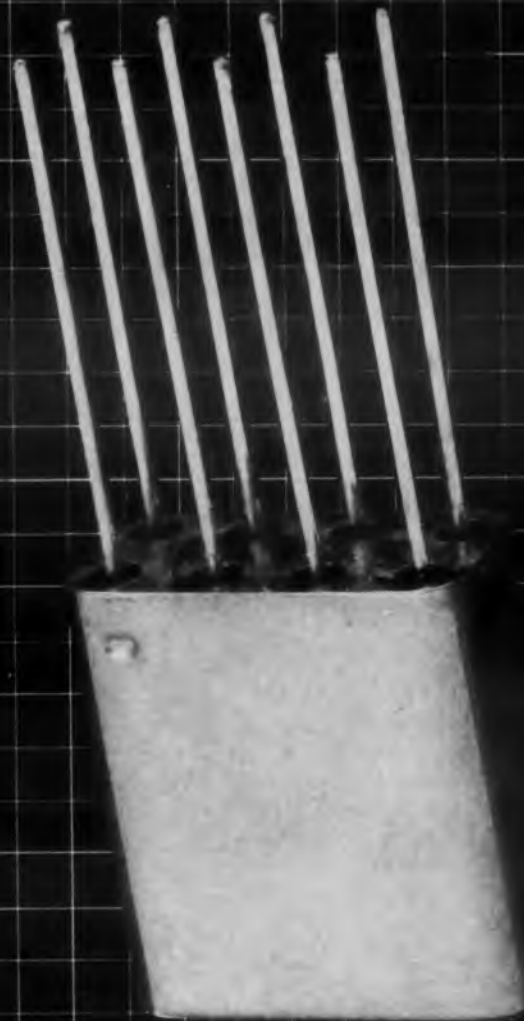
The new equipment is designed with automatic cut-off and re-set functions which keep the transistor power supply safe against abuse due to heat caused by overload, duty cycle and environmental conditions.

The mobile radio is equipped with a die-cast heat sink made of brushed aluminum which produces a high degree of reflectivity of radiant heat from external sources. The development was disclosed by General Electric, Syracuse, N.Y.

CIRCLE 10 ON READER-SERVICE CARD ➤



MINIATURIZED SEALED RELAYS



Relay shown is 2½ times actual size.

NEW... a grid-spaced relay!

Latest development in miniaturized sealed relays is General Electric's *new* grid-spaced (Type GS) micro-miniature relay. Terminals of this crystal-can size relay—spaced .2 inch apart—are tailored to the .1 inch standard spacing for printed-circuit board layout.

But, it's ideally suited to many other electronic jobs as well, particularly aircraft and missile applications.

All the production "know-how" gained in three years of experience with the popular Type G200 micro-miniature series has been packed into this new grid-spaced sealed relay.

Here are some of the basic specifications for the G-E Type GS relay:

Rating: 3 amps, 100,000 operations; 2 amps, 500,000 operations.

Temperature: -65 C to +125 C.

Vibration: 20 G's at 55-2000 cps.

Shock: 50 G's per MIL-R-5757C.

Sensitivity: 300 milliwatts.

Operating Time: 4.5 ms. nominal.

Release Time: 3.5 ms. nominal.

For more information on any G-E sealed relay, call your G-E Apparatus Sales Office—or—send today for the new 1958-59 Sealed Relay Catalog. *Specialty Control Dept., Waynesboro, Va.*

GET YOUR 1958-59 G-E SEALED RELAY CATALOG

General Electric Co., Sect. A792-10
Schenectady 5, N. Y.

Please send me a copy of GEA-6628, 1958-59 Sealed Relay Catalog.

Name _____

Company _____

Address _____

City _____ State _____

GENERAL  ELECTRIC

ENGINEERING REVIEW

Tracker Predicts Missile Landing Point

A system that tracks missiles in flight and continuously predicts where they will land was disclosed by the Air Force. Designed and built by Convair, San Diego, Calif., the system, dubbed Azusa, couples a ground transmitting station with a small receiver/transmitter carried by all ballistic missiles launched. The exchange of information between ground station and missile yields continuous precision data on the position and velocity of the missile. When data is fed into an IBM 704 computer, the result is an instantaneous prediction of where the missile would land if its power were cut off at any split-second.

The output from the IBM computer goes to a plotting board that traces this information for the AFMTC range safety officer. If it appears that the missile is straying unsafely, flight is terminated.

Instrumentation Technique Improves System Reliability

System reliability can be improved by an instrumentation technique introduced by Performance Measurements Co., Detroit, Mich. A constant voltage reference supply is being used to replace short-life dry cell batteries in various types of instruments. Previously, the dry cell battery was the only practical device for supplying the necessary low voltage in null balance servo systems. CVR-10 voltage supply is designed to replace No. 6 dry cells with no modification of the instrument. Dimensions of the new constant voltage reference supply are the same as those of the dry cell. In addition, two knurled positive and negative terminals correspond to those of the battery. Three leads make connections to 115 v line and ground terminals within the instrument. Operating at 1.5 v and 6 ma, the CVR-10 has $\pm 1/4$ per cent stability over a-c line voltage variations between 108 and 125 v.



SUBMINIATURE HELP AMERICA BLAZE NEW



ATLAS • BULLPUP • CORVUS • FALCON • HAWK • HOUND DOG • JUPITER C • MATADOR • POLARIS

Selected for Telemetry, Guidance, Tracking and Comput



COURTESY BENDIX RADIO DIVISION
BENDIX AVIATION CORPORATION

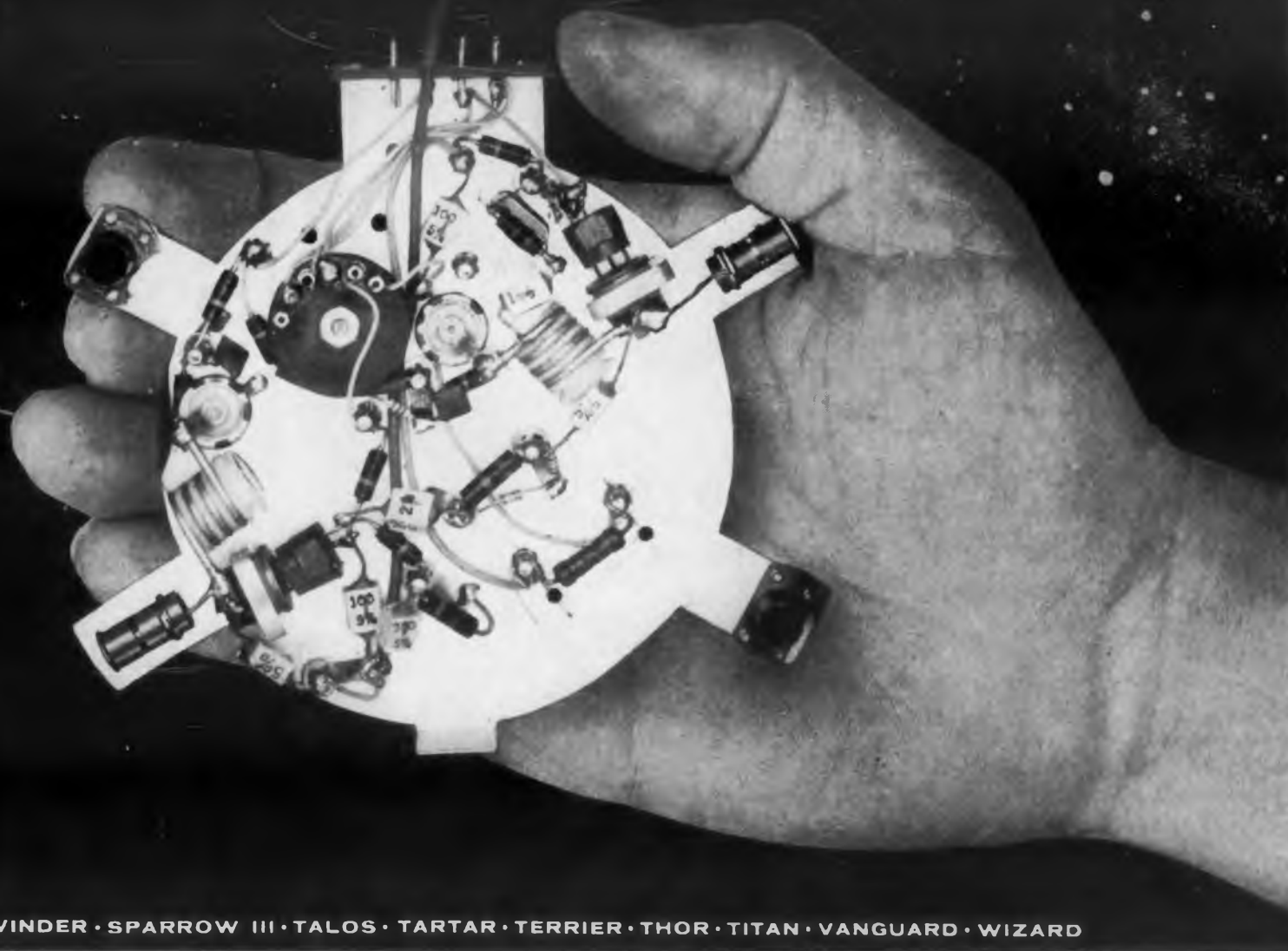
No margin for error for tuning capacitors rocketing through limitless space or helping pinpoint 18,000 mph. man-made moons! This calls for absolute stability and reliability under every conceivable condition of shock, vibration and climatic change—in less space. These are a few of the reasons why precision JFD Variable Trimmer Piston Capacitors were selected for the Explorer and Vanguard satellites, as well as telemetry, tracking and guidance systems of today's and tomorrow's missiles, anti-missiles and rockets.

The Vanguard satellite telemetry transmitter, for example, employs two JFD VC9G trimmers for linear tuning of its 108 mc. antiresonant LC circuits. Over 30 JFD VC5 and VC11 capacitors are used for stable precise adjustment of RF and IF amplifiers and oscillator tanks in the Minitrack ground receiver systems.

PRECISION CAPACITORS

TRAILS IN SPACE!

OFFICIAL U. S. NAVY PHOTOGRAPHS



LANEANT • SIDEWINDER • SPARROW III • TALOS • TARTAR • TERRIER • THOR • TITAN • VANGUARD • WIZARD

Systems of Explorer and Vanguard Satellites

Whether you are designing electronic equipment for a giant step into space or equally demanding applications, JFD Piston Capacitors belong. Their unique combination of physical and electrical characteristics speed circuit or system development—meet and beat exacting performance demands. Send for the new JFD 1958 Engineering File Folder covering 71 JFD Trimmer models. Or send us your special application requirements for recommendations by our engineering staff.



Pioneers in Electronics since 1929

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51 McCormack Street
Toronto, Ontario, Canada

JFD International
15 Moore Street
New York, New York

ONE DEWEY 1-1000



model VC9G ACTUAL SIZE 0.8 to 8.5 mmf



model VC5 ACTUAL SIZE 0.6 to 6 mmf

model VC11 ACTUAL SIZE 0.8 to 10 mmf

Feedback System Controls Road Grader Action

Based on principles used to control missiles and aircraft in flight, a control system is keeping the blade of a huge road grading machine at a constant angle regardless of the variation in contour and the roughness of the ground over which the grader is working. Sanders Associates, Inc., Nashua, New Hampshire, reports the road grader to be the first application by industry of an electrohydraulic feedback system to control heavy machinery. A vital part of the control system is the hydraulic servo valve used to provide control functions aboard the B-52 Stratofortress. The control systems are being produced for the Galion Iron Works & Mfg. Co., Galion, Ohio.

Keying Titles Changed

Names of two Library of Congress monthly publications, which serve as keys to new literature coming into this country from the U.S.S.R. and East Europe, have been changed from "Lists" to "Indexes." The purpose of the change is to indicate to scientists and other scholars not familiar with the monthlies that they are more than mere booklists and that they contain information about the content of new Russian and East European books and articles.

The Monthly List of Russian Accessions, which enters its 11th year of publication in April 1958, becomes the *Monthly Index of Russian Accessions*. The Government Printing Office sells it for \$12 a year (\$15 abroad).

The East European Accessions List, published since 1951, becomes the *East European Accessions Index*. The GPO sells it for \$10 a year (\$12.50 abroad).

The change in the names of the two bibliographies does not mean a change in the editorial content of either one. It should also be noted that they contain information about the content of books and articles, not translations of entire books and articles.

◀ CIRCLE 11 ON READER-SERVICE CARD



ZIRCONS

ALUMINUM SILICATES

FORSTERITES

STEATITES

CORDIERITES

MAGNESIUM SILICATES

ZIRCONIUM OXIDES

SILICON CARBIDES

ALUMINAS

LAVAS

ALSiMAG[®] TECHNICAL CERAMICS

*More
Materials
at one source!*

Here you will find industry's widest choice of advanced technical ceramics . . . dense or porous . . . key components in thousands of applications in widely diverse fields. Top performance is assured by careful matching of physical and electrical properties to end use requirements.

If heat is a problem: ALSiMag technical ceramics have higher insulation values at elevated temperatures than fused quartz. Excellent thermal shock resistance. Great strength. Low loss. Rugged ALSiMag Aluminas, for example, deliver superior performance at temperatures beyond the melting points of most commonly used metals.

There are ALSiMag materials which withstand higher compressive loads than steel . . . with lower coefficients of expansion than any general-use metal. Chemically inert . . . will not rust, oxidize or corrode. Permanently rigid . . . will not deteriorate. Some have unusual abrasion resistance. Some are hard as 9 on Mohs' scale.

No matter what your problem, ALSiMag ceramics may help solve it. And, this source has the machines and experience to produce precision parts in any quantity. Send blueprint with details of operating procedure for complete data on the ALSiMag material best suited for your application.

**MORE SPECIALIZED ENGINEERING TALENT . . .
MORE FACILITIES MORE "KNOW HOW"**

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**AMERICAN LAVA
CORPORATION**

CHATTANOOGA 5, TENN.
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For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Atlanta, Ga. • Boston: Newton Center, Mass. • Buffalo, N. Y. • Chicago: Bedford Park, Ill. • Cincinnati, O. • Cleveland, O. • Dallas, Texas • Detroit, Mich. • High Point, N. C. • Los Angeles, Cal. • New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash. **Canada:** Minnesota Mining & Manufacturing of Canada, Ltd., P. O. Box 757, London, Ontario. **All other export:** Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

ENGINEERING REVIEW

750,000 Watt Broadcast- ing Equipment by 1959

Efforts are under way at General Electric, Syracuse, N.Y. toward developing reliable equipment capable of broadcasting at 500,000 to 750,000 watts. It is expected that GE will begin marketing such equipment by the middle of 1959.

Although the FCC currently limits radio broadcasters to 50,000 w, the industry anticipates action to allow certain "clear channel" stations to move to a minimum of 500,000-watts and a maximum of 750,000-watts. These clear channel stations as those serving wide areas which are clear of objectionable interference. There are now 24 clear channel radio stations in the nation. Present indications are that the FCC may select 12 for the super-power classification. With a move to super-power, large rural areas in the nation will receive more adequate radio coverage.

Present plans call for a block-building system in which GE's 50,000-watt AM broadcast transmitter will be used to drive or excite a 500,000-watt amplifier. In the event a station desires to move to a maximum 750,000-watts, another block can easily be added to the equipment, thus eliminating the need for extensive alterations.

UHF Mobile Band Coverage Multiplied

A radio base station with a 250 w transmitter and a highly sensitive receiver which extends range of two-way mobile radio systems operating in the 450-460 mc band has been announced, designed by Motorola, Inc., Chicago, Ill. The high power transmitter used with a high gain antenna, provides effective radiated power of more than 2 kw. This will normally double the range and so quadruple the area covered by the low power transmitters presently available for use in this band. The equipment is designed to comply fully with FCC requirements for "split channel" operation, protecting users from obsolescence.

◀ **CIRCLE 12 ON READER-SERVICE CARD**

Radio Stations Set For Delivery

Combining all the functions of both a receiver and transmitter covering the two and six meter bands, a complete radio station will be ready for delivery to distributors in early summer. Designed for either am or cw, the SR-34, built by Hallicrafters Co., Chicago, Ill., includes a three way power supply for 115 v ac, 6 v dc, or 12 v dc operation. It is able to cross-band between the two and six meter bands and instantaneously selects the desired voltage. There is also a transistorized power supply for two or six v usage. The receiver, a double conversion, superheterodyne design, uses a crystal controlled second oscillator. Power output will run from 6 to 7-1/2 w on two meters, and from 7 to 10 w on six meters. Frequency coverage is from 49 to 54 and 144 to 148.5 mc.

High-Speed Eraser For Magnetic Tape Introduced

Magnetically recorded sound or pictures may be erased from a complete reel of tape or film with a newly developed high-speed electrical eraser. The unit, designed by RCA, Camden, N.J., is designed to provide 30 sec erasing of 4,800 ft of video magnetic tape up to two in. wide; 2,400 ft of 16 mm film; 2,000 ft of 35 mm film wound on a film core; or any narrow-width or tape in rolls up to a maximum of 15 in. in diam.

In operation, the tape or film roll is placed on the automatic turntable, which moves along the sliding carriage into the opening of the erasing coil at the other end of the instrument. As the carriage moves, it automatically switches on the coil and rotates the turntable, causing the rotation of the reel through the magnetic field. As soon as the tape or film has been erased, the carriage withdraws the rotating turntable and returns it to the other end of the instrument, automatically shutting off both coil and turntable.

CIRCLE 13 ON READER-SERVICE CARD ➤

Transitron

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

SILICON TRANSISTORS

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

HIGH POWER

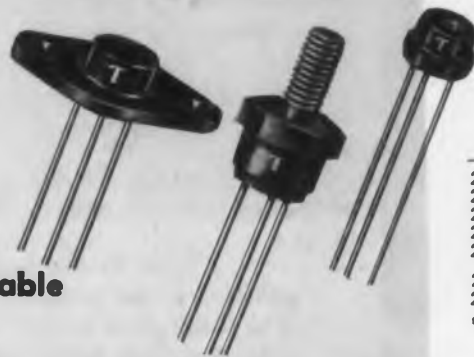
- Ratings to 85 watts
- Operation to 5 amps
- Low Rcs, 1.5 ohms typical
- Voltage Ratings to 60V
- High Current Gain
- High Speed Switching



Type	Maximum Power Dissipation at 25°C case (watts)	Minimum D.C. Common Emitter Current Gain B	Typical Collector Saturation Resistance (ohms)	Maximum Collector Voltage Vc (volts)
ST400	85	15@2 amps	1.5@2 amps	60
ST401	85	20@2 amps	2.5@2 amps	60
ST402	50	15@2 amps	4.0@2 amps	60
ST403	50	15@2 amps	3.0@2 amps	45

MEDIUM POWER

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

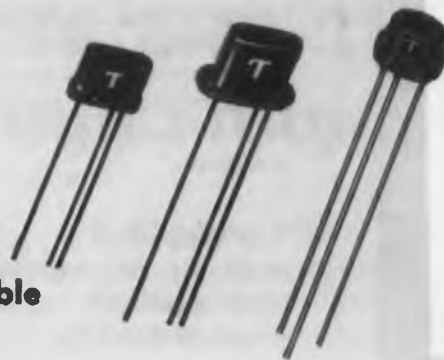


Type	Maximum Power Dissipation at 25°C case (watts)	Maximum Collector Voltage VcMax (volts)	Minimum D.C. Common Emitter Current Gain B	Typical Collector Saturation Voltage (volts)
2N545*	5	60	15@500 ma	3V@500 ma
2N547	5	60	20@500 ma	3V@500 ma
2N498	4	100	12@200 ma	4V@200 ma
2N497	4	60	12@200 ma	4V@200 ma
2N551	5	60	20@50 ma	1V@50 ma
2N243	.75	60	9@5 ma	3.5V@20 ma
2N244	.75	60	28@5 ma	3.5V@20 ma

*Fast Switching Type

SMALL SIGNAL

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



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

WRITE FOR BULLETIN TE-1353

Transitron

electronic corporation

wakefield, massachusetts



Transistors



Diodes



Regulators



Rectifiers



US

SEMCO

ALL STAINLESS STEEL FUSITE TERMINAL



1.

Terminal as supplied by Fusite. V-24 glass and all stainless steel.



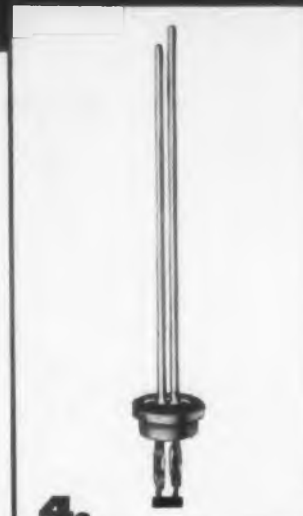
2.

Inside end of straight wire electrode is crimped to a hollow open top shell. (See photo A)



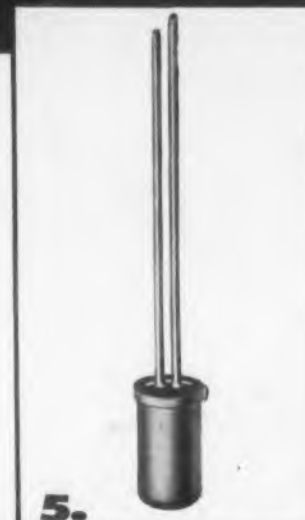
3.

Fraction of an inch of gold wire and aluminum wire are inserted and crimps folded over tight. (See photo B)



4.

Precision bit of silicon crystal is fused with heat to ends of wire inserts.



5.

Assembly is enclosed in miniature can and projection welded closed.



A



B

This application is typical of the hundreds of electronic components whose continuing operation is assured by the safety factor of a terminal with electrodes fused into the glass. The resulting rigidly fixed position of the electrode guards against damage to the finished assembly through movement of an electrode depending only on compression for its position in the glass.

Robert A. Rutherford, Vice President of U. S. Semiconductor Products, permits us this direct quotation.

"The Fusite header provides us with a very satisfactory solution to the problem of the lead wires turning in the header. The fused glass to steel has solved this very troublesome problem. The stainless steel material also provides excellent corrosion resistance. Aside from receiving a superior product from Fusite, we have also received very excellent service and a great deal of cooperation from both the company and their representative."

Test samples of any style terminal available on request. Stainless steel available on most Fusite Standard Headers.

Write Dept. C-2

THE **FUSITE** CORPORATION

6000 FERNVIEW AVE., CINCINNATI 13, OHIO

In Europe: FUSITE N.V. Königsweg 16, Alemlo, Holland

CIRCLE 14 ON READER-SERVICE CARD



WASHINGTON REPORT

Herbert H. Rosen

Space Challenges Everybody

There are few people who will not present their idea on control of space upon sighting a fallen star. Washington—the center of all confusion and activity—is also a hot bed of such ideas. The Defense Department recently freed \$8 million for its Advanced Research Projects Agency to move into space. The money will be spent "to determine our capability of exploring space in the vicinity of the moon, to obtain useful data concerning the moon, and provide a close look at the moon." One or two lunar probes will be made by the Army Ballistic Missile Agency. Three have been assigned to the Air Force Ballistic Missile Division (a combination of the Thor, Vanguard, and a third stage to be developed). The Naval Ordnance Test station at Inyokern was ordered to develop a mechanical scanning system for lunar probes.

Meanwhile, Defense Secretary McElroy and his advisors have been dreaming up plans for reorganizing the Department of Defense. The hierarchy will remain. So will the Joint Chiefs of Staff. The Secretary will be given greater power. A large number of the people who have collected in the offices of the Secretary and the Assistant Secretaries will find themselves without billets.

The more long-range decisions have not been made. The procurement people, in particular, have been passing on only those contracts of vital significance, short-term influence, or pressure-ridden. Only now is the dam beginning to break on contracting.

Up on Capitol Hill, the solons are introducing bills on space and are girding themselves for the wild blue yonder. Both the House and Senate have set up special space committees to deal with these matters. The Senate has proposed a far-reaching Science and Technology Act of 1958 that collects nearly every civilian agency doing scientific research under a single department with a Cabinet officer at its head. Some of the DOD responsibilities in R & D are also included.

Both Houses are considering identical bills on how the DOD should be reorganized. Fortunately, Mr. McElroy has had the benefit of their guidance in making his own proposal. After all, if he wants Congressional approval, his plan will have to resemble—or at least augment—the ideas proposed by the Congressmen.

The final authority on any reorganization, of course, rests with President Eisenhower. He and Mr. McElroy have been in constant consultation on the issue. The President's scientific advisors

under Dr. James Killian, have come up with a plan to create an AEC-like independent agency to work on space problems. The nucleus of the organization would be the NACA and the non-military portion of ARPA.

And so it goes. Virtually, a plan a week.

Army R & D Gains a New Chief

In what seemed almost like a funeral ceremony, Lt. Gen. James Gavin was retired from the Army. In the wake of his departure, he left a wide open split in his Research and Development organization. There was cleavage between what the Army Chief of Staff thinks should be spent on R & D and what Gavin felt was the barest minimum. Coming in to breach that split is line officer (for 34 years) Lt. Gen. Arthur G. Trudeau.

In his first public appearance as Army R & D Chief, Trudeau gave his thoughts on what role electronics will be playing in R & D.

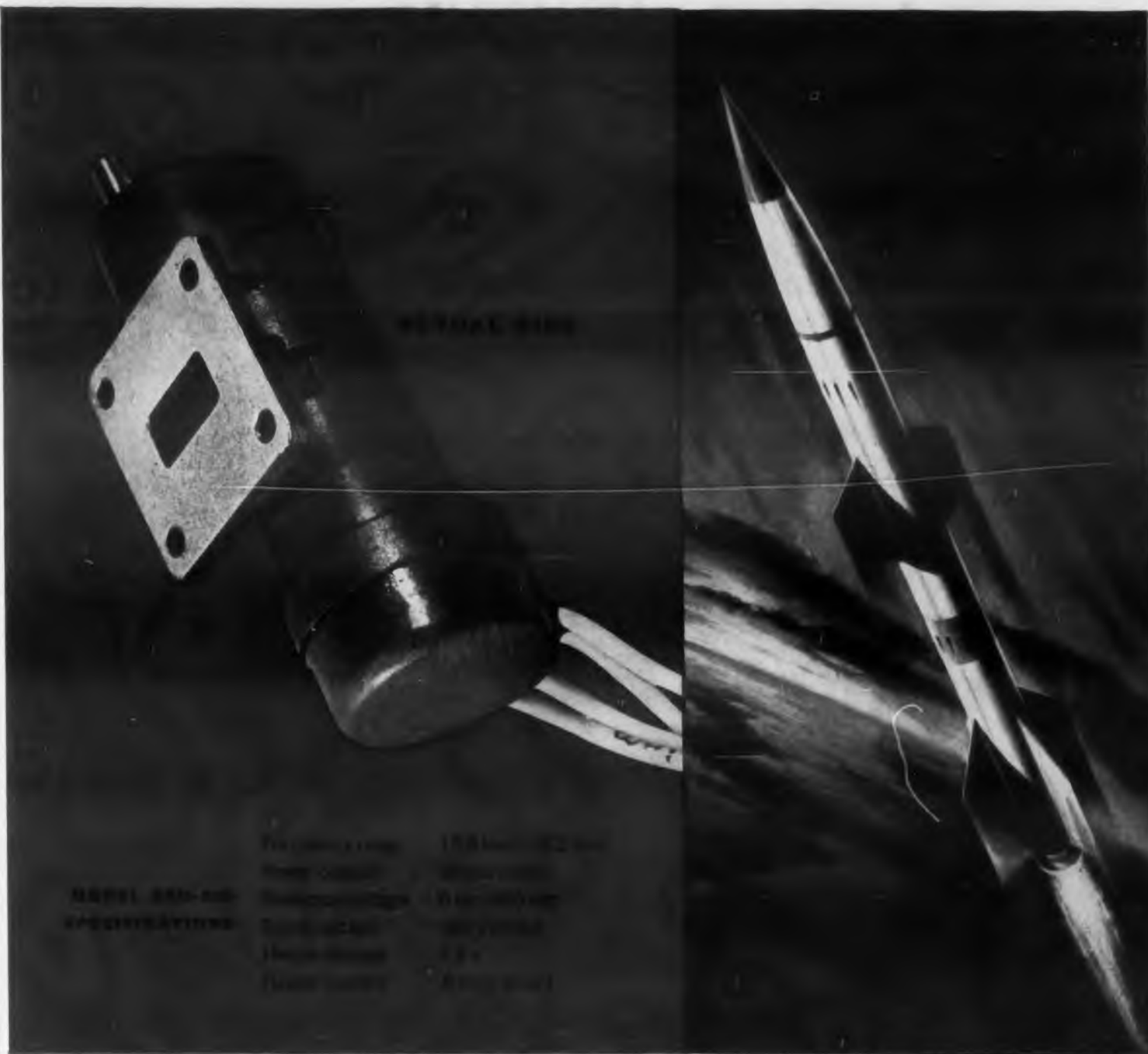
He pointed out that radio communication has come of age in the Army—at the expense of wire communications. That unless more people use radio, the lack of experience in its use and maintenance will play havoc with their organization.

Trudeau is quite taken with the computer business, too. He envisions a computer as being at the elbow of every field commander. Computed data will provide the basis for command decisions.

Ammunition and missile electronics is another area of concern to the General. The VT fuze is an example of these "one-shot" components that fall into this category. He points out that they must be highly reliable—they must work the one and only time they are asked to. They must also withstand a high order of shock, acceleration, vibration, temperature, and indefinite storage.

Still other applications present themselves to the R & D chief. "There are navigation aids and other methods for controlling the thousands of Army aircraft. To reduce the effectiveness of enemy electronic devices, we require electronic countermeasures and, in turn, counter-countermeasures. We need electronic systems to detect atomic bursts, predict fallout patterns and collect and collate data for damage assessment. We need better detection devices for mines and chemical or biological warfare."

As for the future, Gen. Trudeau said, "I'd like to see greater realization and greater anticipation of the tremendous, yet unavoidable, amount of wear and tear electronic devices must take in their route to the soldier. I'd like to see more accelerated technological progress . . . more use of . . . electronic computers . . . far more automation in our logistics and administrative systems . . . in air defense and counter-missile systems . . . (and) greater use of the module principle so that defective electronic components can be readily replaced . . ."



NEW FROM SPERRY

Ruggedized SRU-210 reflex klystron for very high altitude application

Sperry developed the new SRU-210 reflex oscillator specifically to operate reliably under the extremely severe conditions encountered by high-altitude aircraft and missiles. Its special features make it just as useful, however, for ground radar and missile test equipment.

The screw-type tuner, for example, is ruggedized to operate at high alti-

tude without pressurization, and it requires only 5 to 6 ounce-inches of torque. Another important feature of the SRU-210 is its insulated leads which prevent high-altitude arc-over. And, its cathode operates at lower temperatures which means the SRU-210 requires less input power than similar-type tubes.

Write or phone the nearest Sperry

district office for application data on the new SRU-210 klystron.

ELECTRONIC TUBE DIVISION
SPERRY GYROSCOPE COMPANY
Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION

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SAN FRANCISCO • SEATTLE IN CANADA: SPERRY GYROSCOPE
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CIRCLE 15 ON READER-SERVICE CARD

greater **VERSATILITY...RELIABILITY...COMPACTNESS**

MODEL 450-1100 CARRIER PREAMPLIFIER

Carrier Freq. — 2400 cps (std.); 600, 1200, 4800 cps optional
Carrier Exc. — approx. 4.5-5 volts, depending on transducer imped.
Transducer Imped. — 100 ohms min. - 1000 ohms max.
Input Imped. — approx. 2500 ohms, incl. zero sup. ckt.
Sensitivity — 100 uv rms from transducer (output imped. 1000 ohms or less) gives 1 volt at output under max. output loading
Output — preferred circuit: between one active cathode and one reference cathode
 alternate circuit: between active cathode and ground
Output Voltage Capabilities — (a) ± 3 volts into 2200 ohms min. load
 (b) ± 6 volts into 5000 ohms load
 (c) ± 7.5 volts open ckt.
Output Linearity — better than 0.2% for (a) above
Output Impedance — approx. 1000 ohms, preferred ckt., 500 ohms alternate output ckt.
Freq. Response — 3 db at 20% of carrier freq.
Zero Suppression — can suppress 0 to 100% of transducer output (either sense via switch)
Power Req. — 115 volts, 50-400 cps, approx. 30 watts
 All data subject to change without notice.

SANBORN 450 SERIES UNIT PREAMPLIFIERS

... FOR DRIVING OPTICAL OSCILLOGRAPHS
 ... TAPE RECORDERS
 ... SCOPES

Here is amplifier design that gives you *wider* usefulness, *improved* performance and a *choice* of packaging, in reduced size and weight. Individually in portable cases, or as four-unit modules for standard 19" racks, with their own power supplies, Sanborn "450" Preamplifiers can be used with a variety of popular optical oscillographs, tape recorders, oscilloscopes or other indicating devices. The 450-1100 is a carrier amplifier-demodulator with calibrated zero suppression, for measuring strain, pressure, velocity, flow, temperature, displacement, etc. with a strain gage bridge, resistance or reactance transducer, or differential transformer. For differential input measurements, the 450-1800 provides the wide range of an AC amplifier and DC stability of a chopper, in a design featuring low noise, low drift and high gain. The 1800's usefulness is increased by a choice of models: 1800, with high current output amplifier (± 2.5 v, ± 50 ma), position control, and zero suppression; 1800A, same as 1800 but without zero suppression; 1800S, with single-ended output amplifier, delivers ± 2.5 volts at ± 1 ma, linearity 0.1% full scale, 30 kc bandwidth, zero suppression and position controls; 1800SA, same as 1800S except without zero suppression.

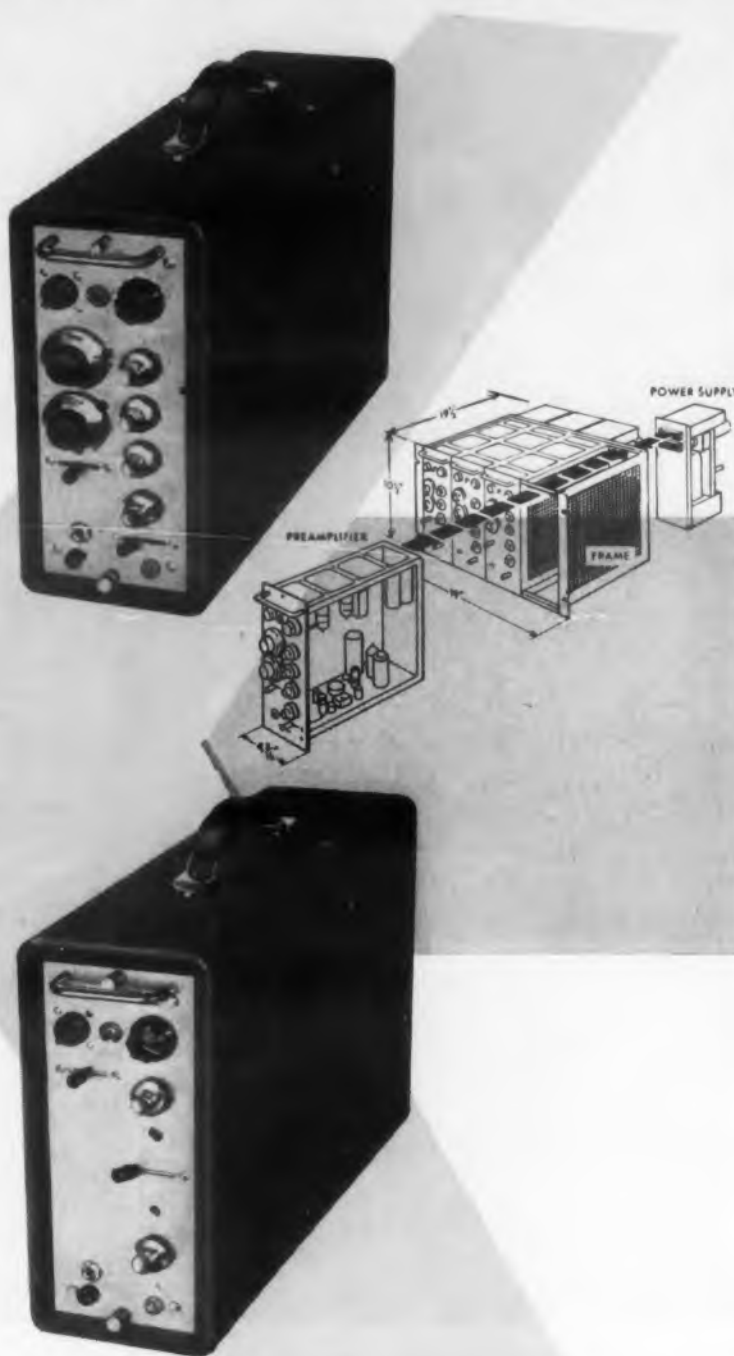
Investigate the many exclusive advantages these and other Sanborn "450" Preamplifiers offer your work. Call your local Sanborn Engineering Representative or write the Industrial Division in Waltham.

SANBORN COMPANY

Industrial Division

175 Wyman Street, Waltham 54, Mass.

CIRCLE 16 ON READER-SERVICE CARD



MODEL 450-1800 TRUE DIFFERENTIAL DC PREAMPLIFIER

Input — Impedance: 200,000 ohms differentially between terminals (balanced) or 100,000 ohms each input lead to gnd. (single-ended)
 Common mode rejections: at DC, 100 db; to 60 cps, 94 db;
 400 cps, 80 db.
 Equiv. input drift: ± 2 uv for 24 hours
 Equiv. input noise: 5 uv peak to peak (0-10 cps), 20 uv (0-1000 cps),
 50 uv (0-30 kc)
 Zero suppression: polarity pos. or neg. Ranges 0-100 mv and 0-1 volt.
 Accuracy 1% of full scale range.

Output — **Low Power Circuit:** (in all models)
 Output appears between two cathodes as true push pull signal.
 Common mode level of cathodes ± 0.2 volts with respect to ground.
 Output capability: ± 3 volts into 5000 ohms
 ± 10 volts open circuit
 Zero position control not active for this output
 Freq. response: 3 db down at 30 kc
 Linearity: 0.1%
 Gain: Fixed steps 1000, 500, 200, 100, 50, 20
 Gain Accuracy 0.5% for D.C.
 Smooth gain control covers range between fixed steps

High Power Circuit: (1800 and 1800A)
 Output appears between two emitters as true push pull signal.
 Common mode level of emitters ± 2.5 volts with respect to ground.
 Preferred load: 50 ohms
 Output: ± 2.5 volts, ± 50 ma
 Freq. response: 3 db down at 15 kc
 Linearity: 0.5%
 Zero position control is operative for high power output ckt.

Single-ended Output Circuit: (1800S & 1800SA)
 Output appears as single-ended signal between emitter and amplifier chassis.
 Load 2200 ohms, min.
 Output ± 2.5 volts
 Freq. response: 3 db down at 30 kc
 Linearity: 0.1%

Power Req. — 115 volts, 60 cps, approx. 50 watts



The False Economy of "Short Cut" Drafting

Dear Sir:

Drafting room systems of operation in the electronic industry have become greatly standardized in the past few years. This is due mainly to military standards controlling drafting practices.

In any drafting room engaged in military electronic programs, the military standards are the "Bible." This standardization is a grand thing, and work is done with great efficiency.

Now—along comes a contract requiring the delivery of several prototype models, but only the minimum of drawings; outline information and instruction book material being the extent of the drafting. Before the prototype can be delivered, there must be design and layout. Also, shop drawings must be made. After fabrication, the units must be marked and wired. Drawings must be made for these steps.

The project engineer would like all of these drawings to be done as quickly and economically as possible. Home shop drawings are in order; military standards should be promptly forgotten. All short cuts should be considered. The supervisor's troubles then increase by the hour. The drawings that the shop receive are anyone's and everyone's idea of simplified drafting.

With a careful conference with the shop foreman, parts can be made from these short-cut drawings. It should be understood that the shop must have talent not usual in the trade to read these "things."

Soon drawings are pulled for revision to cut the question and answer periods. Each day the job is becoming easier, but our old friend, the standards are creeping back into the picture, with each revision.

This malpractice does not stop with mechani-

LETTERS

cal drawings. Wiring diagrams and cable drawings get the treatment, also. A talent far greater than ordinary is required to wire units from poor information. Soon new notes and views are showing up on reissues of the tracings, and again, the drawings are an example of a standard-non-standard system.

There are many good points of simplified drafting. "Over" drafting a job is folly, but standards should not be discarded. Detailed parts should be clear and concise with all the information required to fabricate and finish the part stated on the drawing.

The wire man must know exactly what to do, or time is wasted in asking questions. The man preparing a cable is fabricating a part. He must be able to find all the information on the drawing necessary to do his job.

Final assembly can be accomplished with a parts list only. The average man on the bench will need a drawing to help him. A simple assembly drawing should be a part of the group of drawings.

Simplified drawings, by all means, reduce time spent in delineation. But, employ economy of line, not economy of information. Drafting people have learned that drafting to standards will be faster than making it up as they go along.

John B. Miller, Supervisor
Drafting Department
Jansky & Bailey, Inc.
Washington 7, D.C.

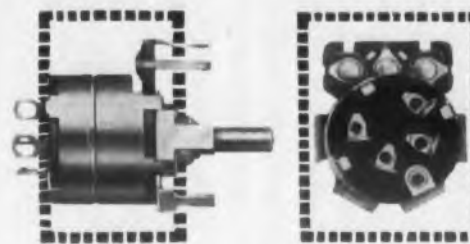
► This letter was prompted by suggestions of "short-cut" drafting to reduce costs that appeared in *ED*, Nov. 15, 1957. Certainly, changes in drafting procedure should not be allowed unless everyone concerned is made aware of the changes. But, what is wrong with changing the standards, if the necessary information can be supplied at lower cost in time and money? Basically, it seems that we are all in agreement.

WHEN IT COMES TO MINIATURE CONTROLS...



CHECK THE OVERALL SIZE...

including switch, if needed. For practical space-saving ability, Stackpole miniature "F" Controls lead the way — only 0.637" in diameter behind the panel for the entire length of both control and switch.



Photos show side and rear views of a Stackpole F Control with 2-pole switch. Dotted lines indicate behind-panel space occupied by a conventional "miniature" control.

Notice how Stackpole's small switch size perfectly complements the miniature control . . . saves precious chassis space where it's needed the most.

FEEL and HEAR THE SWITCH ACTION...



for the tease-proof, positive "feel" and audible "click" only a true snap-action switch provides. "B"-Series switches used on "F" Controls have the same time-proven mechanism as larger Stackpole control switches. They're U.L. Inspected for 1 amp. @ 125v ac-dc; 4 amps @ 25v dc.

CHECK THE COMPLETENESS OF BOTH CONTROL and SWITCH LINES

Printed wiring, wire-wrap, or standard lug terminals as well as fold-tab or threaded bushing mountings are available on all Stackpole miniature "F" controls. Both SPST and DPST switches can be supplied.

STACKPOLE miniature "F"-series VARIABLE RESISTORS

Electronic Components Division

STACKPOLE CARBON COMPANY, St. Marys, Pa.

In Canada: Canadian Stackpole Ltd., 550 Evans Ave., Etobicoke, Toronto 14, Ont.

FIXED & VARIABLE COMPOSITION RESISTORS • SLIDE & SNAP SWITCHES • IRON CORES • CERAMIC MAGNETS
FIXED COMPOSITION CAPACITORS • CERAMAG® FERROMAGNETIC CORES
HUNDREDS OF CARBON, GRAPHITE, AND METAL POWDER PRODUCTS.

CIRCLE 17 ON READER-SERVICE CARD

MEETINGS

May 26-27: Engineering Refresher (Electrical Engineering)

Featured as a part of the Engineering Institute that is being held at the University of Wisconsin from January through June, 1958. This refresher will review circuits and electrical machinery for electrical engineering. Interested persons should contact Mr. Robert A. Ratner, Director, Engineering Institutes, University of Wisconsin Extension Division, Department of Engineering, Madison 6, Wis.

May 27-28: 2nd EIA Conference on Maintainability of Electronic Equipment

University of Pennsylvania, Philadelphia, Pa. Technical Sessions will cover the following areas: Military Concepts and Requirements for Maintainability; Ground Environment Equipment; Missile Maintainability; and Airborne Equipment Maintainability. For more information, write to J. A. Caffiaux, Staff Engineer, Electronic Engineering Dept., 650 Salmon Tower, 11 West 42nd St., New York 36, N.Y.

June 2-4: National Telemetry Conference

Lord Baltimore Hotel, Baltimore, Md. Sponsored by the AIEE, ARS, ISA, and IAS. The technical program will feature sessions in telemetry in the IGY program, telemetry overseas, rocket telemetry, industrial telemetry, and data reduction. In addition, there will be the annual exhibit staged by manufacturers of telemetry equipment. For further details about the conference, write W. J. Mayo-Wells, Program Chairman, 3830 Beecher St., N.W., Washington, D.C.

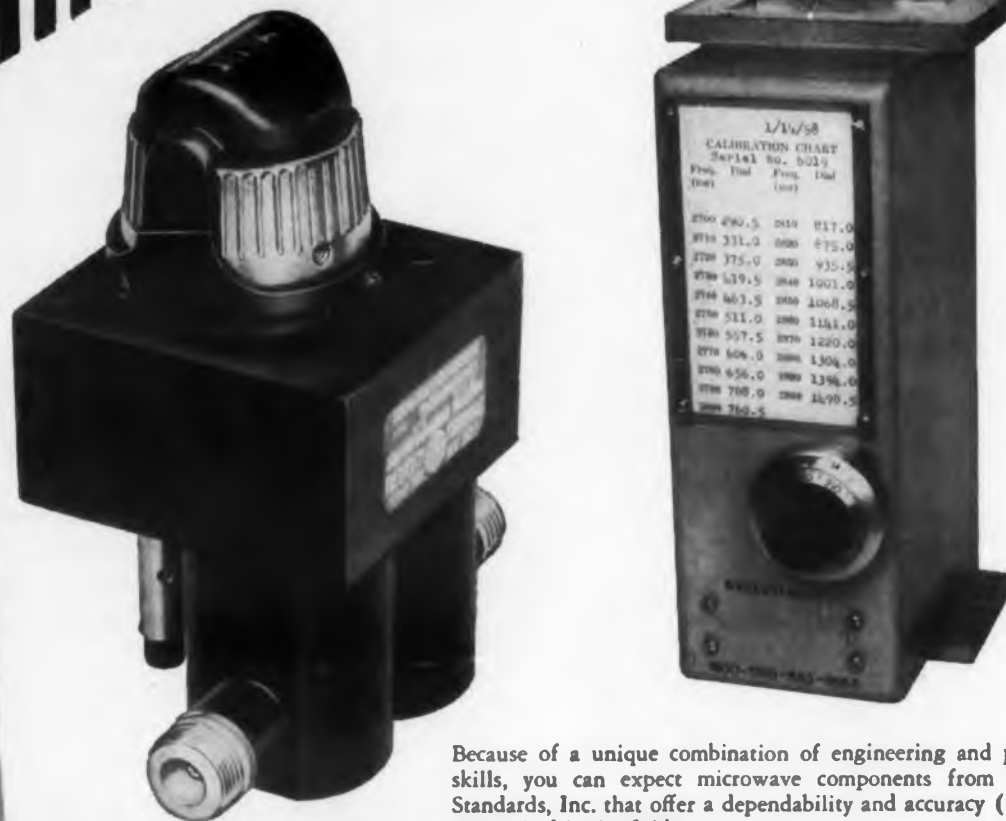
June 5-6: 2nd National Symposium on Production Techniques

Hotel New Yorker, New York, N.Y. Sponsored by PGPT. For information, write John W. Trinka, Sperry Gyroscope Co., Great Neck, N.Y.

June 8-12: National Association of Electrical Distributors

San Francisco, Calif. For more information about the convention write to the National Association of Electrical Distributors, 290 Madison Ave., New York 17, N.Y.

THE STANDARD FOR MICROWAVE COMPONENTS



Because of a unique combination of engineering and production skills, you can expect microwave components from Frequency Standards, Inc. that offer a dependability and accuracy ($\pm 0.01\%$) unmatched in the field.

For here you will find the highly specialized engineering experience and the intricate tooling and production facilities needed to produce such sensitive microwave components as the two pictured on this page.

These two Tunable Band Pass Filters, both passive frequency selective devices, are capable of providing large amounts of selectivity in the stop band consistent with low dissipation losses in the pass band. Our standard line includes 2-, 3- and 4-section filters with a ganged tuning control feature, over a wide frequency range, assuring you of an accuracy of $\pm 0.01\%$.

For details, contact Frequency Standards, Inc., and we will furnish information on our standard products, our custom products and our facilities for meeting all requirements, no matter how exacting, in the microwave components field.

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A DIVISION OF
NATIONAL ELECTRIC PRODUCTS CORP.

CIRCLE 18 ON READER-SERVICE CARD

June 18-20: Statistical Methods in Radio Wave Propagation

University of California, Los Angeles, Calif. Sponsored by the University of California Engineering Extension. Participants from England, France, India, and the United States will present papers in three major fields: statistical theory and techniques of use to scientists and engineers; phenomenological investigations with both statistical and physical structure; and instrumentation for the rapid reduction of large quantities of radio data. Inquiries should be addressed to Dr. W. C. Hoffman, Engineering Building, Room 3116, University of California, Los Angeles 24, Calif.

June 22-27: AIEE Summer General Meeting, Buffalo, N. Y.

Paper Deadline

June 25: Deadline for papers to be presented at the 1958 National Simulation Conference. The conference, sponsored by the IRE, is planned for **October 23-25** in Dallas, Tex. One hundred word abstracts and 500 word summaries of technical papers in the general field of simulation should be transmitted in duplicate to *D. J. Simmons, Rt. 8, Box 447, Ft. Worth, Tex.*

Courses—Seminars

July 8-12 and July 14-18: Two Special Summer Programs on Strain Gage Techniques. Massachusetts Institute of Technology, Cambridge 39, Mass. Additional information may be obtained from Dr. William M. Murray, Professor of Mechanical Engineering, M.I.T.

Aug. 4-15: Special Summer Program on Microwave Ferrites. Massachusetts Institute of Technology, Cambridge 39, Mass. Topics will include: Electromagnetic Theory of Fields in the Presence of Ferrites; Measurements of Ferrite Characteristics; and Linear and Non-linear Ferrite Devices (Theory and Application). Write to Dr. Hermann A. Haus, Assistant Professor, M.I.T. Department of Electrical Engineering, for information.

Aug. 4-15: Summer Study Course in Microwave Theory and Technique. Case Institute of Technology, Cleveland, Ohio. The course will be directed toward the engineer in industry who has found a growing need for training in the methods of measuring and analyzing with microwaves. Requests for additional information on the course should be directed to the Director of Special Programs, Case Institute of Technology, 10900 Euclid Ave., Cleveland 6, Ohio.

Ampli-NYL

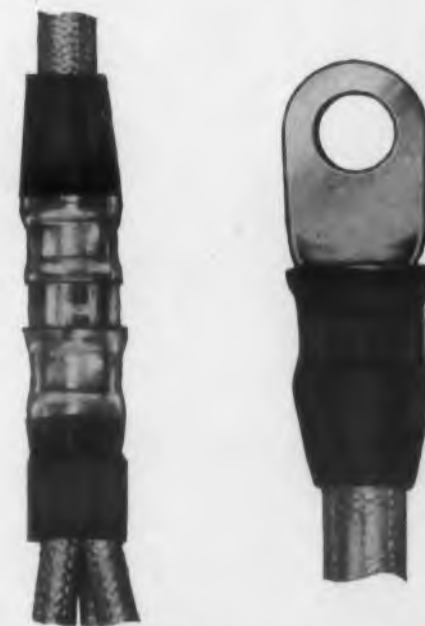


**the entirely NEW
insulated
AMP terminal line
for large wire sizes**

FEATURES:

- High Performance Nylon Insulation to provide continued satisfactory service life at elevated temperatures, plus resistance to ester-based oils.
- Helical tongue design to secure maximum structural utility at minimum weight penalty.
- Cast insulation has formed entry ramp to provide easy wire insertion and snug fit over standard AN wires.
- Color-coding to assure proper terminal selection for applicable wire sizes.
- Step-Lok Crimp to guarantee continued proper position of insulation with respect to terminal.
- Connector designs are available in single to single, single to multiple and multiple to multiple wire accommodations.

The A-MP Ampli-NYL Terminal is installed with the proven Confined "C" Crimp for maximum electrical and mechanical performance. Confining the spread of the terminal during the crimping process achieves more intimate contact and a homogeneous union of conductor and terminal.



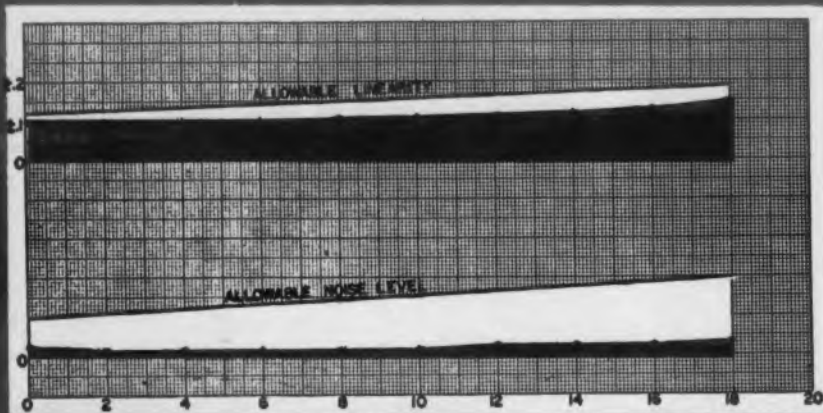
Additional information is available upon request.

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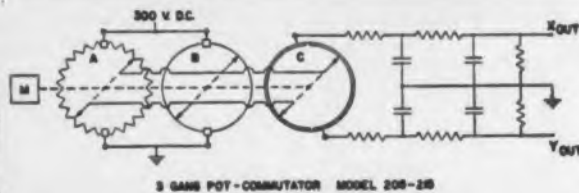
A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

CIRCLE 19 ON READER-SERVICE CARD

With CARBON FILM POTS
you get life of
18,000,000
revolutions



MILLIONS OF REVOLUTIONS AT 625 R.P.M.



PROBLEM

Reliable motor systems required adjustment to rapid rise rates continuously at 625 rpm. Pot must still be mounted in same position on a shaft. Effective density of pot is 12%. Ambient -73°C to 71°C , wet level to 60,000 feet, humidity, shock, vibration per MIL-E-8272A. Pot must operate in space for 200 hours at 625 rpm, equivalent to more than 18,000,000 revolutions.

SOLUTION

Excites carbon film potentiometer ganged with C.I.C. commutator type meet all performance requirements, with a life well beyond 18,000,000 revolutions at 625 rpm on production-line units.

The smooth surface of the carbon film combined with its natural lubricant properties insures long life at high speed. Wipers are not required to follow the contours of wire windings, therefore, with very low brush pressures which enhance pot life, no wiper bounce occurs at high speeds.

The conductivity of the resistors element does not depend upon a single lead-like wire. Failure of the potentiometer therefore does not occur suddenly, but any deterioration of performance is gradual. This fail-safe characteristic enhances reliability, and insures against catastrophic system failure at critical times.

Your critical pot requirements will readily be met with C.I.C. Precision Carbon Film Pot and Commutators. We welcome your inquiries.



92 Madison Avenue • Hempstead, N. Y.

CIRCLE 21 ON READER-SERVICE CARD

EDITORIAL

Hot And Cold

On October 15th, 1957, *ELECTRONIC DESIGN* featured a Staff Report on "Cooling Electronic Equipment." Now, seven months later, our theme is "High Temperature Components." In this issue we have articles dealing with such apparently diverse subjects as potentiometers, relays, liquid dielectrics, and wires.

These articles were written specifically for this "High Temperature" issue. Each was selected to provide not only a broad insight into the problems of high temperature equipment design, but also practical design approaches and techniques.

This issue of *ELECTRONIC DESIGN* also carries an extensive staff written report, evaluating the "state of the art" of high temperature components. It includes an industry wide survey of components available for operation in higher than normal ambient temperatures.

In an editorial, "Why Thermal Design?" in last October's "Cooling" issue, we said:

"There would be no thermal design problem if it were not for this frailty of electronic components. One might say, with tongue in cheek, perhaps, that once we have developed diodes, transistors, tubes, resistors, capacitors, and insulators to tolerate 500 C, we will no longer have thermal design problems."

Our readers wanted to know just where we stand. How far have we gone towards putting the fan manufacturer out of business? Just what is available in 500 C electronic components, or even 200 C components?

Our survey shows that we may safely conclude the cooling equipment manufacturer will be with us for a long time. Though great strides have been made in developing hotter components, improvements have not kept pace with new systems requirements.

Far from eliminating fans and blowers, we must develop better ones to tolerate higher temperatures. Even the fan manufacturer has been drawn into the quest for high temperature components.

He's not going to obviate the search for components for hotter ambients. Nor will the manufacturer of high temperature tolerant components mitigate the need for improved cooling equipment and better thermal design.

Cooling and high temperature components are two sides of the same coin in the reliability till. We need them both. They are companion weapons in our pursuit of more dependable equipment.

In a parallel vein, *ELECTRONIC DESIGN*'s "High Temperature" issue does not supplant the "Cooling" issue, but supplements it.

For a free copy of our Staff Report, please circle 22.

George H. Roath



HIGH TEMPERATURE COMPONENTS

How Hot Is HOT?

Introducing an **ELECTRONIC DESIGN** nine part Staff Report
on High Temperature Components for Electronic Equipment.

by George H. Kotfky

When electronic equipment cannot be cooled, components in the equipment must be able to withstand high ambient temperatures. In equipment for supersonic aircraft, missiles, satellites, nuclear powered vehicles, and perhaps soon, spaceships—there is no room for cooling facilities. Where the temperature is very high, cooling equipment often adds as much heat as it takes away, and can add intolerable weight.

We must increase the temperature endurance of our equipment. As a rule of thumb—you can triple the output of a motor, a transformer, or many other devices, if you double the temperature endurance.

The first problems in developing high temperature components are problems of materials. Conventional materials just won't do.

At 500 C:

- Many metals corrode and oxidize. Tiny dirt or grease particles accelerate corrosion;
- Most metals weaken;
- Copper conductors stretch;
- Nickel steels and ferrites lose their magnetic properties. Only a few general types of iron maintain their magnetic qualities—low carbon steel, silicon and grain-oriented silicon steels, powdered and cobalt iron;

High Temperature Components For Electronic Equipment

An Electronic Design Staff Report

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- 44** Manufacturers of High Temperature Components

For a free reprint of this section Circle 22.

- Conductor resistivity goes up;
- Insulation resistivity goes down.

Once the proper materials are found—materials that are mechanically and electrically suitable for high temperature operation—materials that can take tough military conditions like vibration, shock, and acceleration—materials that can take sand and dust and high altitude—materials that won't sop up water—once these materials are found, the next problem is to make them into components. And that's not easy.

Many inorganic materials, for example, are excellent for high temperature electrical insulation. But they're hard to work. They have no flexibility. They're brittle. It's hard to apply them to metals, and harder still to make them stick.

What Do We Need?

According to a recent survey, operating temperatures for aircraft and missile materials, in the next ten years, will reach 1400 degrees C for a few minutes, and 2200 degrees C for a few seconds. (Steel melts after a few seconds at 1400 C.)

Immediate requirements for electronic parts are not so stringent—but they aren't easy either.

Military Requirements. Last October, the Research and Engineering Office of the Assistant Secretary of Defense published

an "Environmental Requirements Guide for Electronic Parts." This report, prepared by an *ad hoc* group of the Office's Advisory Group on Electronic Parts, is available from the Office of Technical Services, Department of Commerce, Washington 25, D.C. (See *ED* 1/22/58)

The document suggests ten "plateaus" of environmental characteristics required by the Army, Navy, and Air Force. Each level calls for thousands of hours of operational life under different conditions of temperature, altitude, moisture, vibration, shock, nuclear radiation, and other uncomfortable environments.

To cover each environmental requirement listed is beyond the scope of this ELECTRONIC DESIGN staff report, as this report deals only with operation at elevated temperatures.

It is illuminating to see what the ten requirements are for temperature.

- Group I calls for operation from -55 to +55 C, and should fulfill the needs for electronic hardware handled by personnel.
- Group II, for -65 to +85 operation, covers stable components for general use.
- Group III, for general shipboard and ground components, calls for temperatures from -65 to +125, as do Groups IV and V.
- Groups IV and V include requirements

for nuclear radiation and for high performance aircraft and surface-to-air and air-to-air missiles.

- Groups VI and VII call for operation from -65 to +200 for high-performance aircraft, special shipboard needs, nuclear powered aircraft, and ballistic missiles.
- Group VIII, calling for -65 to +350 operation, is intended primarily for shipboard missile needs.
- Groups IX and X include nuclear powered weapons requirements, and call for operation from -65 to +500 and +1000.

The Army's *immediate* objective is to complete a family of 125 C military quality components for reliable operation in environments for ground signal equipment. The ultimate goal for this type of field service is an across-the-board family of 200 C parts with all the performance attributes of lower temperature military types.

The Air Force wants to see a complete family of components for operation at 200 C. These parts would be in Groups VI and VII of the Environmental Requirements Guide.

The Air Force also has many requirements for components to operate in Group IX at 500 C, and a few specific requirements (such as radome noses) in Group X, the "Blue Sky" category.

(Continued on following page)

New Product Announcement

HIGH TEMPERATURE COMPONENTS

Commercial Requirements. Most requirements for high temperature components are military. But there are non-military needs too. There are commercial applications where a component may operate in a 125 C ambient though it can work safely at 200 C. In many such cases, a hot component is used because its high temperature capabilities have endowed it with a longer life expectancy at lower temperatures.

Other commercial applications include aircraft electronics, where heavy fans and blowers may be eliminated if cramped electronic components can tolerate the higher ambient temperatures. And there are occasions when parts must operate in, or near, ovens, furnaces, combustion engines, and nuclear reactors.

What Do We Have?

Some components will never have to work at high temperatures. Meters, for example, require human observers, so until we have humans who can operate at 200 C, there probably won't be much call for 200 C meters.

But many components will have to work when they're hot. We already have a complete family of parts available for operation at temperatures up to 85 C.

We have a line of 125 C parts—almost complete—but not quite. Roadblocks include, for example, r-f and i-f transformers, available now to about 105 C.

Many parts are available for 200 C operation, and a few—very few—will work at 500 C.

For most of these components, there are no large quantities, even for 200 C. But there are no large orders either. In many cases, manufacturers can start rolling as soon as they get some big production orders.

Practically no 500 C components are in large scale production. Most 500 C parts are laboratory curiosities. They're wonderful for publicity, and they give us a taste of things to come—but don't design next year's equipment around them. At best, some are manufactured in sample quantities.

Many companies want to avoid the headaches associated with developing very high temperature components. A few have been vigorously exploring these domains. Corning Glass Works, for one,

STEMCO TYPE MX* THERMOSTATS

especially designed for missile, avionic and electronic applications

New Stemco Type MX Thermostats are miniature snap-acting units designed to *open* on a temperature rise. Being compact, lightweight units able to withstand high G's under wide ambient temperature ranges, Type MX thermostats are ideal for missile, avionic and other electronic applications where close temperature control is mandatory.

Basic design flexibility of the Stemco Type MX Series means the units can be supplied from regular production runs in a wide variety of models, both semi-enclosed or hermetically sealed. Ceramic or metal bases for semi-enclosed units, round enclosures or CR-7 crystal cans for hermetically sealed units. Several types of terminal arrangements, mounting provisions, brackets, etc., are available.

Stemco Type MX thermostats give you performance . . . small cubage . . . rugged reliability . . . at a production price.

* 2° to 6°F differentials available



AA-7285

TEVENS manufacturing company, inc.
Mansfield, Ohio



THERMOSTATS

◀ CIRCLE 23 ON READER-SERVICE CARD

Thanks

Our many thanks to researchers at the United States Army Signal Engineering Laboratories and at Wright Air Development Center. These men gave us invaluable background information to help us prepare this report.

At USASEL:

Stan Danko, Thomas Gore, Charles Lascaro, Ralph Osche, Irving Remis, Milton Tenzer

At WADC:

Max Bialer, A.H. Dicke, Roger Faust, Dr. Walter Knecht, A. H. Petit, L. P. Richmond, Gene Tarrants

has conducted extensive investigation into high temperature applications of glass and glass-ceramics. Corning has already developed resistors, capacitors, and circuit boards of these materials.

General Electric, another high temperature pioneer, has developed resistors, capacitors, and vacuum tubes for very high temperature applications. It's now studying lead metaniobate, a new piezoelectric material, operational to 550 C.

Manufacturers of materials—especially structural materials for tomorrow's aircraft and spacecraft—are carrying on extensive research to develop strong, high temperature tolerant materials.

ELECTRONIC DESIGN has canvassed thousands of electronic component manufacturers to determine what is available for operation at elevated temperatures. In the following pages, we have listed their hottest components of general interest to electronic design engineers. At the back of this report, we've listed the manufacturers who make them.

We have prepared charts and other listings to make it easy for you to find out what is available, who makes the parts you need, and what you can expect in the future. These charts and listings are intended as a time-saving guide. Complete specifications, prices, and information on availability can be obtained from the individual manufacturers.

Because we feel many engineers will want to keep this staff report for future reference, we have made free reprints available.

You may have one if you turn to the Reader Service card and circle 22.

CIRCLE 24 ON READER-SERVICE CARD >

ANTI

MISSILE

MISSILE

WHEN "MINUTES" COUNT

SYNCHRO FUNCTION	CPPC TYPE	PRIMARY						D. C. RESISTANCE		IMPEDANCE			Max. Null Voltage (MV)	ACCURACY Max. Error (Min.)
		Input Voltage (400~)	Input Current (Amps.)	Input Power (Watts)	Output Voltage (Volts)	Sensitivity (MV/dog.)	Phase Shift (dog. load)	Refer. (Ohms)	Stator (Ohms)	Z _{ro} (Ohms)	Z _{so} (Ohms)	Z _{rs} (Ohms)		
Torque Transmitter	CGC B-A-7	26	100	5	11.8	206	8"	37	12	54 + j260	12 + j45	80 - j20	30	7
Control Transformer	CTC B-A-1	11.8	.090	2	23.5	410	9"	150	24	212 - j684	22 - j115	246 - j60	30	7
Control Transformer	CTC B-A-4	11.8	.029	.08	22.5	390	8"	389	64	560 + j1860	90 + j340	640 + j190	30	7
Torque Receiver	CRC B-A-1	26	.100	.5	11.8	206	8"	37	12	54 + j260	12 + j45	80 - j20	30	30 sp.
Electrical Resolver	CSC B-A-1	26	.038	.42	10.8	190	20"	230	27	286 + j620	45 - j148	350 - j75	30	7
Electrical Resolver	CSC B-A-4	26	.038	.42	26	454	20"	230	170	286 + j620	250 - j830	350 - j75	30	7
Control Differential	CDC B-A-1	11.8	.085	.21	11.8	206	9"	36	25	38 + j122	27 + j120	48 + j14	30	7
Vector Resolver	CVC B-A-1	26	.057	.34	11.8	206	10.2"	78	27	103 + j440	8 + j30		30	7



ACTUAL SIZE

Count on CPPC Synchros

In the above diagram, which simulates the attack of an ICBM and its destruction by an Anti-Missile Missile, only 20 minutes will elapse from the time advanced radar picks up the ICBM at point α and the time ICBM reaches its target. These are a vital 20 minutes.

In these 20 minutes the path of the ICBM must be computed with extreme accuracy and the intercepting path of the Anti-Missile Missile computed equally accurately.

Minutes count—both minutes of time and minutes of maximum error in the computing devices.

Clifton Precision synchros offer highest accuracies in standard synchro units. Special units are available which eliminate, for practical purposes, all synchro error. In addition, reliability standards are the most stringent we can devise and still mass produce synchros.

Delivery time has been shortened and production capacity approximately doubled with the opening of our Western Division at Colorado Springs, Colorado.

For full information, call or write Sales Department, Hilltop 9-1200 (Suburban Philadelphia) or our representatives.

LOOK TO CPPC FOR SYNCHRO PROGRESS

CLIFTON PRECISION PRODUCTS CO., INC.

cppc

Clifton Heights, Pa.



In development—Eimac's 33CA2

TUBES AND SEMICONDUCTORS

Tubes

AMONG the newer high temperature components, vacuum tubes have made the most dramatic breakthrough. Following quickly on the heels of new materials developments, tube manufacturers have evolved techniques for making tubes to work with surface temperatures as high as 800 deg C.

These new tubes no more resemble their low temperature counterparts than do modern subminiatures resemble the early De Forest audion valves. Conventional glass and mica have been replaced by hard glass and ceramics. (One reason for replacing glass for very high temperature operation is obvious from Fig. 4.) Glass is objectionable even before it softens or melts because of problems of electrolysis, poor sealing, diffusion and fragility.

Mica raises problems, too. Mica sheets, with accurately spaced holes, hold electrodes in position. But the accuracy of the holes is limited by die design, and is affected by subsequent wear and tear on the die after repeated stamping operations. Furthermore, the holes can be mutilated during tube assembly or under conditions of shock or vibration.

The new tubes can take rough treatment. They can withstand high orders of shock, vibration and nuclear radiation. They are not only tough, but small—a welcome development.

Where most other components must sacrifice electrical performance when they're hot, the new tubes actually work better. The ceramic types, with their rugged planar construction, and their

extensive use of tantalum, are less noisy, less gassy, and less microphonic.

Heaterless Tubes

As tubes operate in hotter and hotter environments, a point is reached where less and less filament power is needed to heat the cathode. It's often necessary to compensate for this by cutting down the filament voltage as the temperature rises above about 400 C. Eventually, a point is reached where no filament power is required at all. Naturally, if you don't need filament power you don't need a filament. The cathode doesn't care how it gets hot.

With this in mind, General Electric's Schenectady Research Lab has developed a heaterless tube for operation between 480 and 820 C. This experimental tube measures only 1/4 inch in diameter and 1/8 inch in thickness—about the size of a small transistor.

Circuits For Hot Tubes

The development of tubes capable of operating at very high temperatures has prompted intensive investigation into circuits to take advantage of these tubes. About two years ago, the Hi-Q Division of Aerovox Corporation, armed with an Air Force contract, began research into the problems of integrating tubes and other suitable components into physically rugged circuitry to operate at 500 C.

Directing the work, Project Director Dr. A. R. Rodriguez, Project Engineer J. D. Cronin, and Research Chemists G. D. Schindler and J. A. Kyser had to develop circuit configurations adapt-

able to automatic production, and tough enough to take vibration, shock, nuclear bombardment, and 500 C.

Circuits were to occupy the smallest volume consistent with reliable construction and operation. They were to take the form of modules which could be interconnected simply. The configurations were to have high insulation resistance and a low dielectric constant throughout their frequency and temperature range.

A year's work at Hi-Q bore fruit in the form of a five volume scientific report containing a wealth of information on rugged, high temperature circuit configurations and materials.

For structural materials, the Aerovox engineers chose high grade alumina and stainless steel as having the best combinations of mechanical and electrical properties.

Cavities vs Baseboards

Early in their work, they assigned a secondary role to printed circuitry and concentrated on two other approaches—a cavity approach, and a metal channel baseboard approach. The former entailed placing components in cylindrical holes in a ceramic block with interconnecting stainless steel conductors. A photograph of a plastic model appears in Fig. 1.

The metal channel approach used stainless steel channels inserted in alumina baseboards (Fig. 2). Tabs on the ends of the channels are bent through slots in the baseboard and welded to components.

The baseboards and channels are easy to mass produce. The approach lends itself to automated

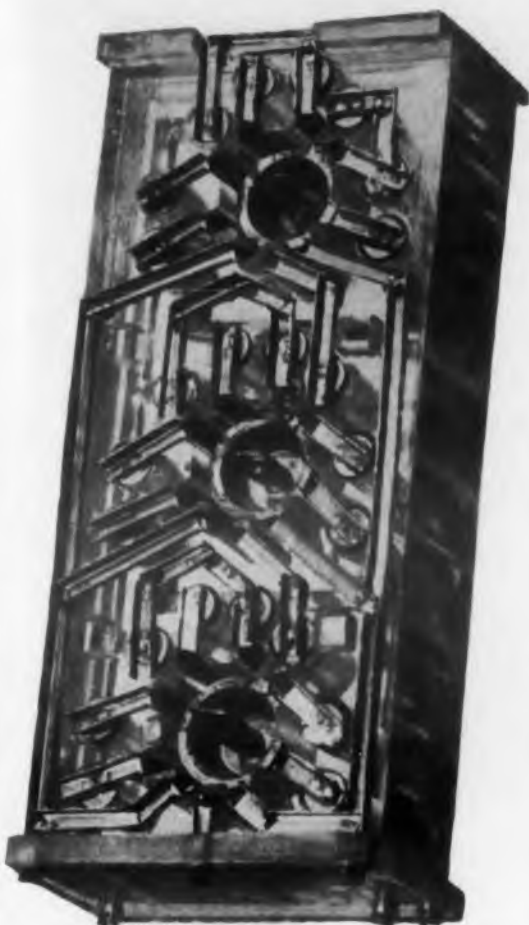


Fig. 1. Plastic model of experimental cavity circuitry developed at Aerovox

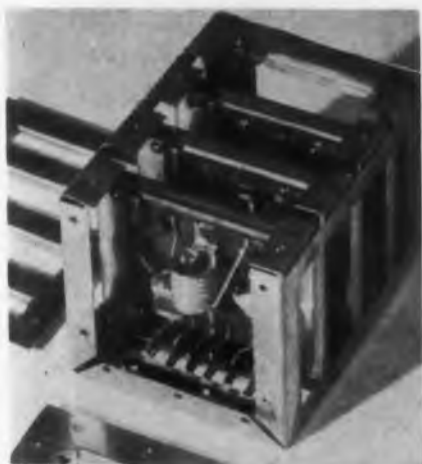


Fig. 2. Experimental metal baseboard circuitry.



Fig. 3. Any more in there? GE's uhf 7077 triodes.

Tube Manufacturers

Here are the manufacturers who've developed tubes to take heat. Most are not available in production line quantities, principally because there is no large market for them.

Wright Air Development Center's Electron Tube Branch Chief A. H. Dicke points out that there are too few of these tubes to evaluate them properly. He predicts that 1958 should provide larger quantities.

Bendix—hard glass HY-G-300 series with surface temperatures to 300 C, and external anode metal ceramic tubes to 400 C.

Eitel-McCullough—metal ceramic tubes to 300 C in development.

General Electric—metal ceramic uhf triode 7077 and others to 300 C in sample lot production, and heaterless tubes (480 to 820 C) in development.

Polarad—metal ceramic reflex klystrons to 200 C. (Not as hot as some of the other new tubes, but hot for a klystron.)

Raytheon—subminiature glass tubes to 265 C.

Sylvania—metal ceramic tubes to 400 C in sample lot production.

7 OFC TRANSFORMERS HELP GUIDE LACROSSE AT 170°C



At 20 miles, the Martin LACROSSE can be accurately guided to hit a small barn door. Helping to guide this missile are 7 transformers that maintain 1% voltage tolerance throughout this 20 mile journey at temperatures up to 170°C.

Ortho Filter Corporation custom designs and manufactures a complete line of transformers that meet and exceed MIL-T-27A, Class T, Grade 4.

Encapsulation of small runs is made possible by a unique mold-making procedure for non-standard sizes and shapes.

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Manufacturers of HIGH TEMPERATURE TRANSFORMERS, FILTERS AND MAGNETIC AMPLIFIERS

CIRCLE 25 ON READER-SERVICE CARD

production since parts can be assembled at room temperature. A further advantage of this process is that laboratory models can be made quickly and simply. Different size components can be mounted on the baseboard, and the designer can allow for forced air or convection cooling.

The cavity approach, on the other hand, lends itself better to miniaturization. Cavity-borne circuits take about one fifth the volume of equivalent baseboard circuits and weigh less. In the case of a six stage audio amplifier using three Eimac CD-16's, the volume reduction was six to one.

But the cavity approach increases the problems of heat dissipation. The thermal conductivity of alumina is so poor that the heat can't get out of the ceramic block easily. One approach is to clamp the body of a resistor, for example, in a metal wrapper, using suitable electrical insulation which can extend out one side of the cavity. This gets the heat out where it can be dissipated.

Any Circuit, Not Just One

In their evaluation of circuits, these researchers tried not so much to build specific circuits, but to find a method applicable to building any circuit. As a starting point, they experimented with the National Bureau of Standards' preferred video limiter and prf multivibrator circuits. To simplify tests, they evaluated the circuits at 150 C on glass melamine baseplates. Happily, this material has the same properties at lower temperatures that alumina has at 500 C. Tests on alumina boards at

500 C and 1000 cps revealed that circuit changes due to heating could be made practically negligible, with reasonable care in circuit conductor layout.

Basic Circuit Considerations

In the course of a discussion with C. R. Knight of Washington, D.C.'s Aeronautical Radio, Inc., several important circuit considerations were emphasized.

- Cathode temperature is critical in affecting tube life. A change in heater voltage from 6.3 to 6.9 v can reduce tube life by a four to one ratio.
- A tube with a glass envelope has a loose thermal coupling to the environment, so its heater and cathode lose heat almost entirely by radiation. A 400 F ambient change might cause only a 50 F change in cathode temperature. A ceramic tube is more tightly coupled to the atmosphere,

so its cathode temperature change is about equal to the ambient temperature change. The tube designer can't compensate for this, so it's up to the circuit designer.

- It may be necessary to compensate for changes in tube characteristics with temperature. Compensation can take the form of varying grid bias or varying heater power. The latter is preferred because it can extend tube life.
- Capacitor power factor can change drastically with temperature and alter circuit performance. (Increased power factor can be simulated at room temperature with a series resistor.)
- There is a greater tendency for arcing at higher temperatures.

The people at Aerovox have done a creditable job. They've helped lay the foundations for the electronics of tomorrow's aircraft, missiles, satellites, and spaceships.

Semiconductors

Manufacturer	Type	Temp.—°C	
		Max. Power	Zero Power
Audio Devices	Silicon rectifiers	100	170
Fretco	Aluminum antimonide diodes	25	400
G.E. (Syracuse)	Silicon rectifiers, diodes, transistors, and controlled silicon rectifiers	25	175
General Transistor	Silicon diodes, medium power	55	200
Hughes	Silicon diodes	25	225
International Rectifier	Silicon power diodes	—	200
Microwave	Silicon microwave mixer diodes	25	150
Raytheon	Diffused junction silicon glass rectifiers	25	200
Sarkes Tarzian	Silicon rectifiers	100	170
Sylvania	Silicon microwave mixer diodes and tripolar crystals	25	150
Texas Inst.	Silicon rectifiers, diodes, transistors	25	175
Transitron	Silicon rectifiers, diodes, transistors	25	175
Trans-Sil	Silicon rectifiers	150	—
Westinghouse	Silicon carbide rectifiers*	—	700

* In Development



Fig. 4. Conventional tubes sag after 800 C exposure. GE's experimental ceramic types thrive.



Fig. 5. Output of GE's heaterless tube (at 600 C) makes scope traces in background. (Normal operation is in hot environment, but blowtorch is not essential.)



Fig. 6. Silicon power diodes can operate at 200 C. (International Rectifier Corp.)

Semiconductors

THE OPERATING temperature of available semiconductor devices is limited by the allowable junction temperature. The use of silicon opened the way to higher temperature operation. But even the silicon semiconductors cannot be called high temperature devices in terms of today's requirements.

None are available to operate beyond the region of 150 to 200 C, and at the upper temperatures, they are derated so power dissipation is almost negligible compared with their operation at 25 C. Furthermore, at the upper temperatures, leakage currents and noise are normally much higher, and forward currents lower.

New departures, however, include an aluminum antimonide diode (Fretco, Inc.) which operates (at one third the room temperature dissipation) in a 300 C ambient. Westinghouse has developed a silicon carbide, grown-junction, large area rectifier which will operate with a 200 C rise above an ambient of 500 C. It can pass up to 10 amperes and can tolerate a peak inverse voltage of several hundred volts—but it is still a laboratory curiosity. People at RCA's Princeton Labs are investigating new semiconductor compounds (gallium arsenide and indium phosphide) for better performance at higher temperatures.

Tabulated here are some of the hottest semiconductors available.



HIGH TEMPERATURE AND

ENVIRONMENTAL TEST CHAMBERS

Designed Especially For Your Qualification and Control Laboratory, to Save Engineering Time and Accelerate Test Programs

Components of guided missiles, supersonic aircraft, and other products can be tested under reproducible conditions which permit accurate comparative evaluation data. Precision control of temperature, humidity, vibration. Standard and special design chambers in sizes from 2 cubic feet to walk-in rooms, with temperature ranges in excess of +1000° F. and -150° F. Highest standards of engineering and manufacturing in the industry.



3 x 3 x 4 Altitude Temperature — Humidity Chamber, +500° F. to -100° F., 20-98% humidity, 100,000-ft. altitude.



4 x 4 x 4 High-Low Temperature Chamber, +500° F. to -100° F., completely self-contained.



Combination Temperature-Vibration Chamber, +500° F. to -100° F., 10, 31 and 64 cu. ft. sizes.



Program Controlled Temperature — Humidity Chamber, +300° F. to -100° F. temperature, 20-95% humidity.



Portable 4 cu. ft. Test Chamber, range +500° F. to -100° F.



High-Low Temperature Chamber, CB Series, +300° F. to -100° F.



Conrad Square—ED5—Holland, Mich.
Subsidiary of Crampton Mfg. Co.

Write for Bulletins and Temperature-Humidity Altitude Conversion Chart

CIRCLE 26 ON READER-SERVICE CARD

RESISTORS



High temperature potentiometers, (l. to r.) by Maurey, San Fernando, Kintronic, and last, two by Fairchild.

THE HOTTEST low power resistors available today can carry their full load in a 150 C ambient. With derating to much lower power levels, many of these will work at 200 C and even higher.

The resistors which can dissipate most heat are the wirewound types. When wound with 3 mil wire, or larger, they can be quite reliable. But they have shortcomings. They use critical materials—hard to get in time of war. They are costly. They have a restricted resistance range—and they can be damaged by electrolysis.

Even 500 C resistors are available, but they are not stable, and certainly not reliable enough for most of their intended applications.

Tabulation of Hot Resistors

In the tabulation of resistors in this report, the maximum temperature ratings is the ambient temperature in which a resistor can safely dissipate its full power rating. Some companies, (Ward Leonard for example), rate resistors on their maximum safe wire temperature rise above 25 C. The zero rating temperature is the maximum safe ambient temperature when the resistor dissipates negligible power.

Tolerance ratings are for room temperature, and may not apply at higher temperatures. It should be noted that not all of a manufacturer's resistance values are available in all tolerances or power ratings.

Aspects of resistors and potentiometers beyond the scope of this report—noise, mechanical problems, and problems of wear—should be taken up

Fixed Resistors							
Manufacturer	Type	Range	Rating (Watts)	Tolerance (%)	Temp.—°C		
					Max. Power	Zero Power	
Corning Glass	Metal oxide film	S	50Ω-4.2M	0.5-2	1-10	120	200
		R	25Ω-1.0M	7-115	2-10	25	235
		H	25Ω-5.0M	7-4000	2-20	40	235
Dale Products	Wirewound	RS	0.1Ω-175K	1-10	0.05-3	25	275
		RS2A	0.5Ω- 28K	2	0.05-3	125	275
		RH	0.1Ω-100K	10-250	0.05-3	25	275
		C1	0.1Ω- 20M	0.1-4	0.01-1	125	190
GB Components	Wirewound	PLG	1.0Ω- 25K	1-6	0.1 -1	150	250
Instrument Resistors	Wirewound	—	100Ω-100K	0.5-2	1	200	250
International Resistance	Carbon Film	PT	250K- 1M	0.5-1	5	70	250
Pyrofilm Resistor	Carbon Film	—	1Ω- 16K	25	0.05-5	25	200
Topaz	Wirewound	RX4	200Ω- 50M	5	1-10	200	275
Victoreen Instrument	Deposited Carbon	RX5	200Ω-200M	10	1-10	175	325
		Vitrohm	1Ω- 1M	3-218	1-10	325	350
Ward Leonard	Wirewound	—	—	—	—	—	—

Variable Resistors							
Manufacturer	Type	Range	Rating (Watts)	Linearity (%)	Temp.—°C		
					Max. Power	Zero Power	
Ace Electronics	Ww	X500	10Ω-250K	1.5-2.5	2-5	75	150
Aero Electronics	Ww Trimmer	925	100Ω-100K	—	5	—	190
Analogue Controls	Ww (10 turn)	—	2K-100K	3	0.03	60	220
Beckman/Heliplot	Trimmer	50	500Ω- 20K	1.5	—	120	200
Dale Products	Ww Trimmer	A10-W	10K-100K	1-5	1-5	70	175
Daystrom Pacific	Ww	314	10Ω- 50K	4	5	50	250
Fairchild Controls	Metal Film	771	100Ω- 50K	3	1.5-2	85	225
	Film Trimmer	744*	50Ω- 30K	2	**	120	440
	Film Trimmer	768	50Ω- 25K	1	**	120	175
	Ww	RVG	25Ω- 50K	2-2.25	5	135	200
Gamewell	Ww	1000HT	100Ω-300K	1-6	0.1	155	225
Kintronic	Ww	—	10Ω- 10K	5	5	145	200
Mallory	Ww Control	—	100Ω- 20K	0.5	5	150	250
Maurey Instrument	Ww	50M14	50Ω-150K	2	1	85	165
San Fernando	Trimmer	*	—	—	—	—	—

* By Special Order

** Infinite Resolution

with individual manufacturers. Their full names and addresses are listed at the rear of this section.

Better Resistors To Come

The campaign for higher temperature resistors continues. International Resistance has film resistors in development, which should operate at 500 C. P. R. Mallory and Rho are continuing research. Rho has a wirewound resistor in development which can operate at full power in a 315 C environment. With negligible power, it can tolerate a 500 C ambient.

General Electric at Auburn developed a surface film resistor to operate at temperatures as high as 800 C. (That's hot!) They used hollow ceramic tubes with resistive coating on the internal surfaces. The tube was sealed, in vacuum, by two titanium caps which connect with the ends of the film. But this development has been discontinued.

With potentiometers, the problems of high temperature resistors are multiplied. Yet new techniques and new films hold great promise for the future.



GE's 800 C resistor can light cigarettes, but this is not its principal application.

RELIABILITY

must

START ON THE GROUND

Missile launching equipment manufacturers must be positive of every component in their vital equipment. For this reason, Air-Marine blowers are specified equipment in many of the launching beds built today. The blower shown here is currently being used in the Army's NIKE Hercules Program. Interested manufacturers are urged to look into the proven reliability of Air-Marine's complete line of sub-fractional H.P. Motors, Blowers and Fans.



F2331 Type,
130 CFM at
0" S.P.,
Hi-Ambient
Operation

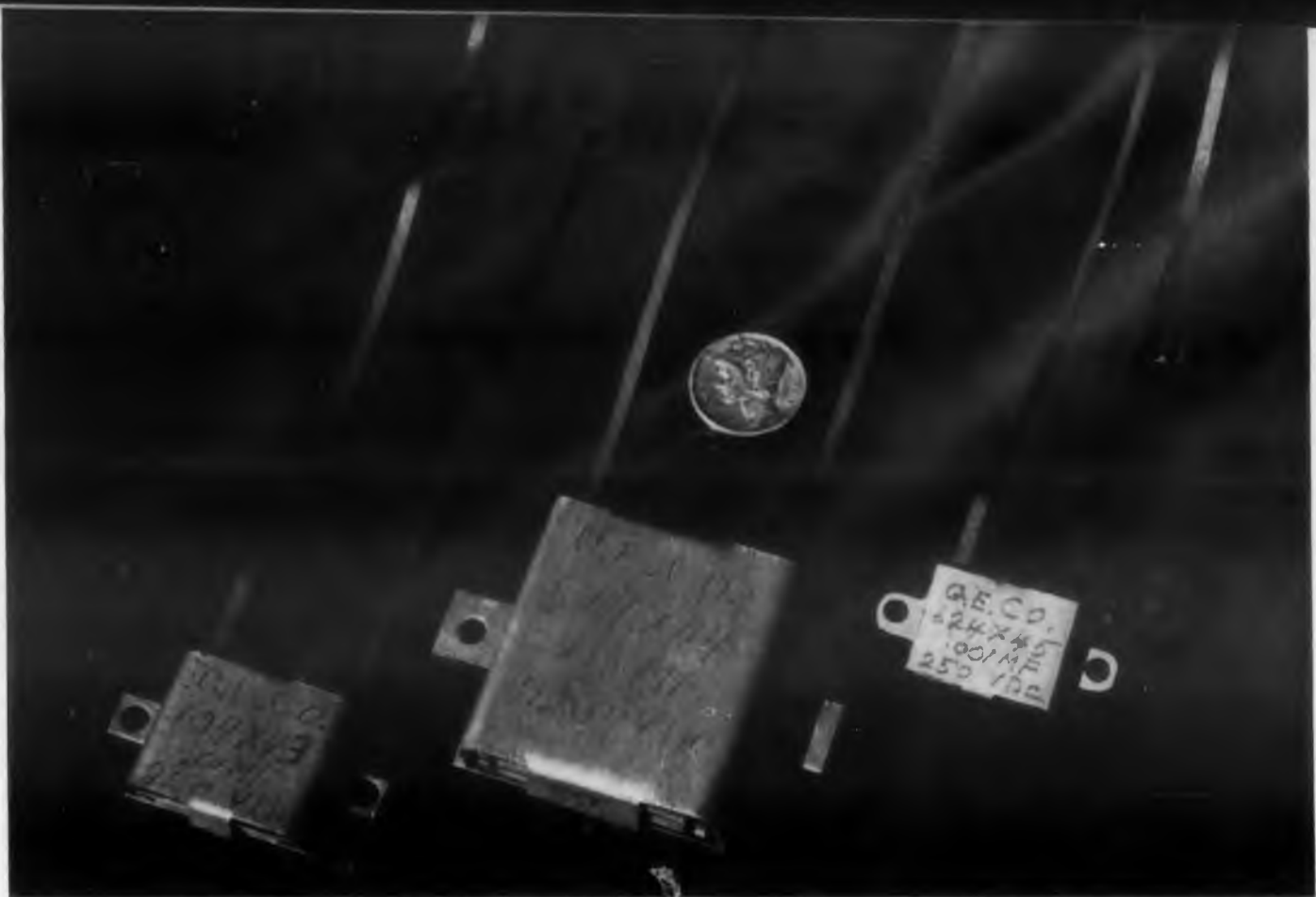
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motors, inc.**

AMITYVILLE, NEW YORK
LOS ANGELES, CALIF.



CIRCLE 27 ON READER-SERVICE CARD

CAPACITORS



Capacitors for 500 C operation. (Dime shows size—not price.)

GREAT strides in capacitor manufacturing have been made in the last two years. 200 C capacitors, almost unheard of three years ago, are today an off-the-shelf reality. They're costly—but they're available.

Capacitors to withstand 500 C are here too—in laboratories—or, at best, in sample production quantities. G.E. at Hudson Falls, has made some samples to operate at up to 800 C. They use

stacked mica with Inconel[®] electrodes and glass coated Inconel leads.

Almost all capacitors made to work at 200 C use a Teflon[®] dielectric. Some use special films. Balco has developed a film capacitor with a 1000 megohm insulation resistance from -60 to +200 C. Its stability over this entire range is 0.2 per cent, about ten times better than most Teflon types.

Capacitors					
Manufacturer	Type	Range	Rating (vdc)	Tolerance (%)	Max. Temp.—°C
Aerovox	Ceramic*	.05 mf-100 mf	100	2	350
Balco	Teflon	.001 mf-2 mf	100-4000	1-20	200
	Metal-Teflon	.1 mf-4 mf	50-400	1-20	200
	Plastic Film	5 mmf-.1 mf	10-100	.25-20	200
Chicago	Teflon	.001 mf-1 mf	200-1200	—	200
Corning	Glass*	to .01 mf	to 300	—	300
Courter	Quartz	50 mmf-10 mf	50-200	5-10	300
Dearborn	Teflon	.001 mf-10 mf	200-600	5-20	200
Diamond	Teflon	.005 mf-4 mf	100-1000	.5-10	200
G.E.	Mica	.001 mf-.05 mf	250	20	500
(Hudson Falls)	Mica	.01 mf-1 mf	400	10	300
General Lab.	Mica	.001 mf-10 mf	1600-6000	—	200
Gudeman	Teflon	.001 mf-.15 mf	100-1000	1-10	200
Gulton	Ceramic	5 mmf-.02 mf	75-500	5-20	225
Mallory	Tantalum	3.5 mf-240 mf	12-420	-15-+45	200**
Onandaga	Ceramic	25 mmf-.01 mf	300-2000	GMV	200
San Fernando	Teflon Film	.001 mf-10 mf	50-1000	1	200
Sangamo	Mica Button	.004 mf	200	—	230
Southern	Teflon Film	.001 mf-10 mf	50-15,000	1-20	200
Sprague	Film	.001 mf-1.0 mf	200-600	1-20	200
Telecomputing	Ceramic	47 mmf-.056 mf	200	5-20	150
United	Var. Vacuum	1 mmf-400 mmf	3000-10,000	—	500
Vitramon	Porcelain	.5 mmf-6800 mmf	300-500	1-10	85***

* In Development

Note: Teflon is DuPont's registered trademark for polytetrafluoroethylene resin

** With voltage derating

*** To 250 C with voltage derating

NEW! MICROWAVE SWEEP GENERATOR 1,000 to 15,000 mc

- 7 Bands...
- Interchangeable Units...
- Stable Backward Wave Oscillators...



TEST:

receivers, amplifiers, preselectors, jammers, intercept equipment, beacons, antennas, T/R tubes, crystal mounts, fixed and tunable filters, as well as complete radar and microwave systems.

SPECIFICATIONS

Basic Unit: Model E-B

MODEL	FREQUENCY RANGE	POWER OUTPUT
Model E-L1	1000 to 2,000 mc	80 to 1000 mw
Model E-L2	1600 to 3,200 mc	80 to 1000 mw
Model E-S1	2000 to 4,000 mc	80 to 800 mw
Model E-C1	3600 to 7,200 mc	25 to 400 mw
Model E-C2	4800 to 9,600 mc	20 to 150 mw
Model E-X1	6500 to 11,000 mc	20 to 100 mw
Model E-X2	7500 to 15,000 mc	15 to 40 mw

Sweep Width: Continuously adjustable to full frequency range of Microwave Oscillator Unit in use.

Sweep Rate: 60 cps

Internal Modulation Rate, during Sweep Operation:

(a) 1000 cps square wave. (b) 456 kc square wave.

Modulation capabilities, during non-sweep Operation:

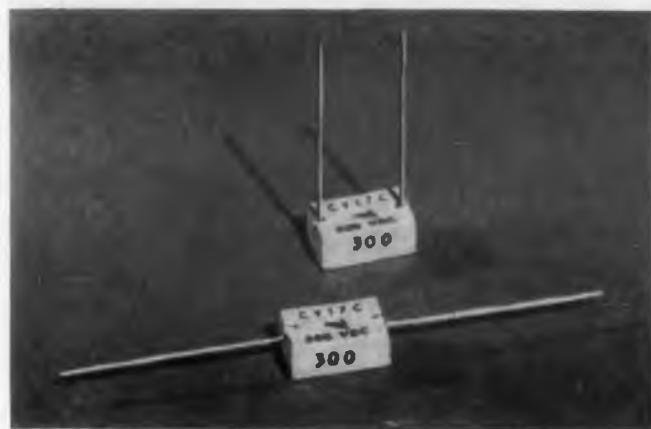
(a) 1000 cps square wave. (b) 456 kc square wave. (c) External modulation.

Output when modulated with external pulse:

(a) Pulse rise time less than 0.15 microsecond. (b) Minimum pulse width less than 0.3 Microsecond.



Corning's 300 C capacitors use glass dielectric.



Porcelain capacitors operate to 250 C with voltage derating. (Vitramon)

For higher temperature operation, quartz, mica, or ceramics are called for. For 500 C, promising materials include aluminum oxide, magnesium oxide, silicon dioxide, evaporated quartz, and boron nitride. But materials alone are only half the picture.

The Air Force wants an insulation resistance-capacitance product of five megohm microfarads. Few materials have better than one meg- μ f, and those are usually too lossy when they're hot. Materials must be very pure. Binding agents normally cannot be used. Some of the dielectrics which can take heat have very low dielectric constants; capacitors using them get too bulky.

And even when a promising material is developed, the problem is then posed as to how to fabricate the material into a practical capacitor. New techniques are often required to cope with the newer materials.

The Air Force already has production contracts for 200 C capacitors and research and development contracts for 500 C units.

In spite of all the problems, high temperature capacitors are being made, and in many cases, they are only slightly larger than their low temperature prototypes.

Polarad Model ESG Microwave Sweep Generator makes possible rapid, dynamic testing of broadband and narrowband microwave systems and components. Its operation is completely electronic, eliminating the need for point-by-point measurement. An integral variable r-f attenuator is provided with each microwave oscillator unit, and the r-f power output level is continuously monitored. This versatile instrument may be used for fixed frequency measurements. Frequency is read directly on face of meter.

Model ESG can be used with the Polarad Rapid Scan Ratio-Scope for direct and instantaneous measurement of reflection or transmission coefficients.



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CIRCLE 28 ON READER-SERVICE CARD

maintenance
available to field
service specialists

*Inconel—a registered trademark of International Nickel Co., Inc.

**Teflon—a registered trademark of E. I. duPont de Nemours & Co., Inc.

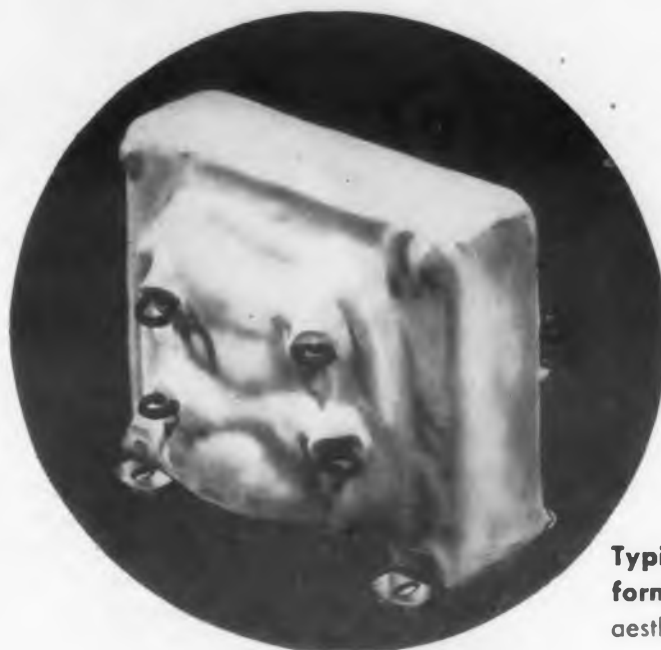
INDUCTORS



500 C transformers, available with ratings to 6 kva. (GE)



This electromagnet works in an oven at 540 C. The iron core in the prototype is a tenpenny common nail, probably not the most efficient core. (Secon Metals).



Typical high temperature transformers are not designed for the aesthete.

THE HIGH temperature transformer designer has his share of problems. Common copper conductors oxidize rapidly; common magnetic steels lose their magnetic properties; insulation resistance drops sharply.

Even with advanced materials, insulation resistance can change by a factor of a million over a wide temperature range; excitation requirements and conductor resistance can increase two or three times over their room temperature values.

The designer has to distribute the hot spot temperature—usually with a heavy copper shield to conduct heat to the mounting base and the chassis. He must use the best core configuration and window shape, and silicone rubber or ceramic impregnation.

500 C transformers may use nickel clad copper or glass served silver wire, and reconstructed mica interwinding insulation. For strength, they're often bound with stainless steel mesh.

What We Have

The quest for high temperature components dates back at least 13 years. As early as 1945, people, like Wright Air Development's Inductor Section Chief Gene Tarrants, urged a component goal of 200 C across the board. Only 40 C components were then available. 1948 saw the first results with transformers having 200 C winding temperatures. Allowing for a 115 C temperature

Inductors			
Manufacturer	Type	Range	*Temp.—°C
Acme	Power Transformers	1 kva, 60-1000 cps	300
Aladdin	Low Power Ferrite Inductors	10 μ h-680 mh	200
	Pulse Transformers	.1-13 μ sec	200
Chicago Standard	Power Transformers	mw-kw	250
Delevan	Rf Chokes (Molded)	.15-10,000 μ h	150*
Electro	Power Transformers	to 1100 va	170
G.E. (Ft. Wayne)	Power and Audio Transformers	to 6 kva	500
New York Transformer	Power Transformers	175 va, 400 cps	85/200**
	Filter Chokes	175 va, 400 cps	200/300**
Nothelfer	Power Transformers	10 va-10 kva	150/220**
NYT Electronics	Rf Chokes	.1-10,000 μ h	150
	Power Transformers	220 va, 400 cps	200
	Filament Transformers	25 va, 400 cps	200
	Filter Chokes	1.3 h, .25 adc, 800 cps	200
Polyphase	Toroids	—	200
Secon	Electromagnets	—	540
Speer	Rf Chokes	.15-18 μ h	100/150**
Tur-bo Jet	Teflon Bobbin Coils	—	250
	Mica Ceramic Bobbin Coils	—	540
United Transformer	Audio and Power Transformers, Toroids, Chokes	to 1 kva	200

* Maximum temperature rise plus ambient

** With current derating

rise, these could operate in an 85 C ambient. Dielectrics, then were only useful to 200 C, so transformer designers had to wait for the insulation manufacturers to move.

Bell Labs., in 1951-52, contracted to develop 200 C ambient transformers, electrically identical with Air Force lower temperature prototypes. The newer units were to be no larger than the miniaturized prototypes.

By 1957, only last year, transformers, 20 per cent smaller than the prototypes, were developed. They could take winding temperatures to 300 C, allowing for a 200 C ambient and a 100 C wire temperature rise.

In 1956, G.E.'s Specialty Transformer Department at Fort Wayne, demonstrated some laboratory models of small, two-winding transformers which operated at 520 C for 500 hours. Today, these are available in small quantities—not the quantities the Air Force would like to see for a thorough evaluation. These transformers used silver and nickel-clad copper conductors, and ceramic insulation.

The newer high temperature transformers are basically similar in appearance, construction, and methods of manufacture to their low temperature prototypes—but they tend to be larger and heavier than properly designed low temperature units.

There are variations in the way they are made by one manufacturer or another—but only small ones. Acme Electric uses glass fiber insulation. NYT Electronics, and the New York Transformer Co. use an open type construction, and encapsulate their transformers in a silicone compound.

What We Want

According to Mr. Tarrants, the Air Force expects production refinements on 200 C ambient transformers to be completed in about a year. 500 C transformers are in development now—and production refinements on these should begin in a year.

Military people are still on the lookout for more and better high temperature components. Right now, they'd like to see, for example, production of complete 250 C magnetic amplifiers. These have already been developed.

Magnetic Controls Co. already has high temperature magnetic amplifiers in production, but their maximum temperature rating is only 150 C, 100 degrees short of what the Air Force would like to see.

Military type power and audio transformers, to operate at 200 C, are easy to come by today. But rf and if transformers that operate beyond about 105 C are few and far between.

DUPONT
REG. U.S. PAT. OFF.

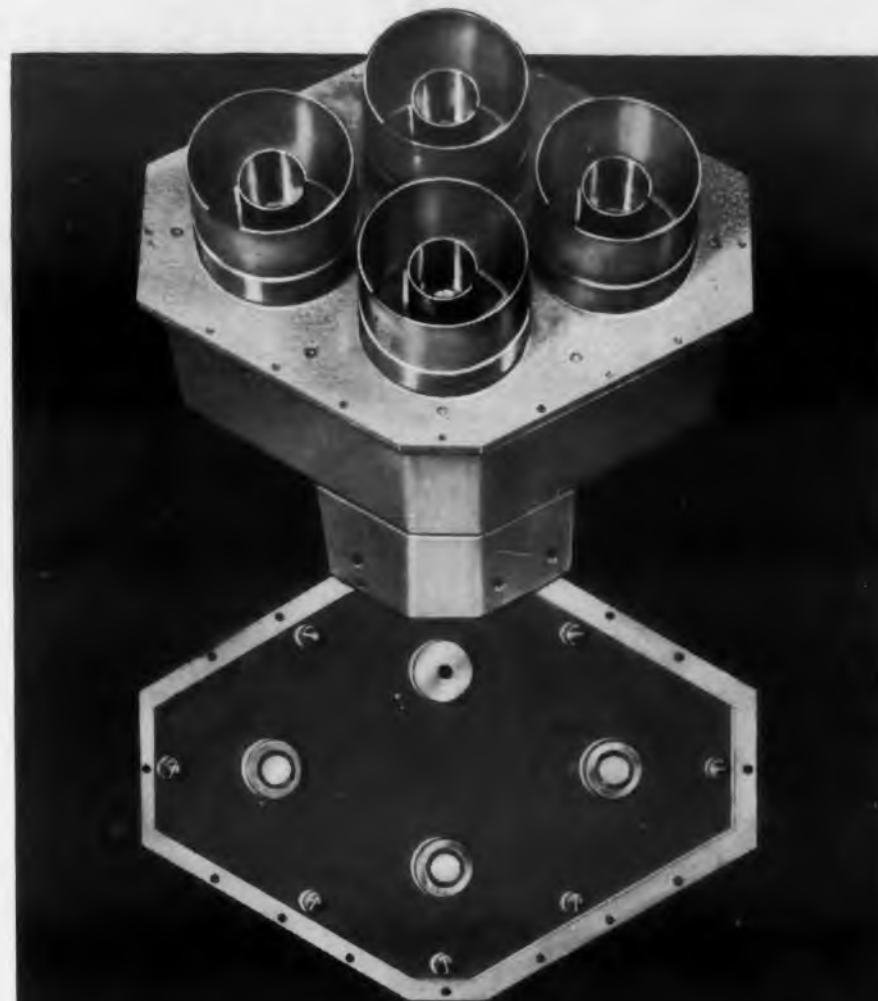
Better Things for Better Living
—through Chemistry

TEFLON[®]
FLUOROCARBON RESINS

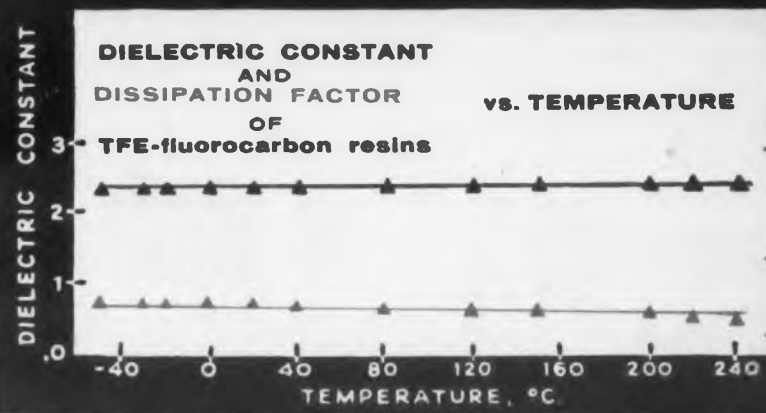
ELECTRONIC DESIGN NEWS

Design of 3 $\frac{1}{8}$ -inch coax switch to handle 55 KW made possible by Du Pont TEFLON[®]

TFE-fluorocarbon resins



TV TRANSMITTER SWITCH handles high powers with very low loss thanks to a machined layer of TFE-fluorocarbon resin. Reverse side of connector plate shows coaxial core connections through layer of TFE resin. A flat metal bar (not shown) switches power from top input connection to three outputs. Graph of properties shows why dielectric losses remain low regardless of operating temperatures. Switch is made by Thompson Products, Inc., Electronics Division, Cleveland, Ohio; and distributed by Andrew Corp., Chicago, Ill.



CIRCLE 29 ON READER-SERVICE CARD

When increased power allocations by the FCC resulted in the need for a switch to handle greater powers and higher frequencies, engineers of Thompson Products, Inc., were faced with a major redesign problem. It looked as though the higher requirements would make their new multi-position switch for 3 $\frac{1}{8}$ " rigid coaxial line obsolete. Needed were models that could handle 55,000 watts of average RF power and could cover the full UHF band to 1000 megacycles. The problem was solved by changing to a TFE-fluorocarbon resin for the dielectric.

Both electrical and mechanical properties of TFE resins proved important in this design. The resin is used to make sheet dielectric for backing the grounded connector plate and a strong shaft for turning the switching bar. One of the biggest problems—impact cracking—was entirely eliminated. In addition to their unique UHF properties, TFE resins have a Class H temperature rating. 260°C. continuous rating permits increased operating temperatures in the switch. The extremely low dielectric constant of TFE resins is a natural for this microwave design. TFE resins have a minimum dissipation factor, unexcelled by any other solid. Characteristic curves for these electrical factors show that they remain flat with regard to both temperature (see graph) and frequency (60 cps to 3000 mc).

This remotely controlled, motor-operated switch is another example of the use of Du Pont TFE resins to assure **RELIABILITY** and **SAFETY** in electronic operations. We will be glad to send you information covering design data and applications of these outstanding dielectric materials.

Write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Room 185, Du Pont Building, Wilmington 98, Delaware.

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec.

TEFLON[®]

Is a registered trademark...

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

Transducers and Electromechanical Devices



Probe transducers made by Charles Engelhard, measure temperatures in ranges to 820 C.



Exploded view of Air Marine Motors' high temperature induction motor. With a 2 in. diameter, this single phase 400 cycle motor operates in a 200 C ambient.

IF ANYTHING has to move, high temperature problems multiply. There are problems aplenty in making a resistor or capacitor behave at two or three hundred degrees C, but when you have to wiggle a contact, or spin a rotor, the problems are really compounded.

In motors and solenoids, torque goes down as winding resistance goes up—and up it goes, as the temperature rises. If you design the winding for low temperatures, you may not have enough torque when it gets hot. And, if you design for high temperatures, you may pull too much power when it's cool.

Motors need bearing lubrication. But the materials men haven't yet come up with a good high temperature lubricant that lubricates well at low temperatures. And they don't have a good cold lubricant that works well in heat.

Relay contacts return by spring tension. But springs get flabby when they're too hot—so contact return may be sluggish. And, the problems of varying coil resistance are with us here, too.

Choppers suffer from the same ailments. Their phase shift is a composite of the electrical phase of the drive coil and the mechanical phase of the vibrating reed. Both phase angle components are affected by temperature.

Here is a brief list of manufacturers who've broken through some of these thermal barriers.

Transducers

Temperature—Aero Research (1040), Charles Engelhard (820), Fenwal (590), H. A. Wilson (540), Arthur Ruge (1250), and Trans-Sonics (840).

Fluid and Gas Pressure—T. A. Edison (230), Norden-Ketay (pressure ratio 200), Schaevitz



Two oz.-in. brake—in a nutshell.

(230) and Statham (200).

Mechanical Displacement—Electro Products (260), and Schaevitz (linear 425, and rotary 200).

Mechanical Force—Schaevitz (dynamometer 230).

Vibration—MB Manufacturing (260).

Acceleration—Endevco (260).

Electromechanical Devices

Small Induction Motors—Air Marine (200 C), and General Electric (285 C units ready for final development for specific applications.)

Small Servo Motors—Beckman/Helipot (160), General Electric (500 C units waiting final development), Minneapolis-Honeywell (180), John Oster (150), and Thompson (315 C in air, and 290 C in jet fuel for 100 hours).

Synchros and Resolvers—Clifton Precision (175), Eclipse-Pioneer (200), and Beckman/Helipot (200).

400 Cycle Choppers—Airtax (200) and Bristol (175).

Electromagnetic Brakes and Clutches—Autotronics (200).

DC Permanent Magnet Motors—Barber Colman (200 C).

DC PM Tachometer Generators—Barber Colman (260 C).

Servo Torque Units—John Oster—(200).

Rotary Solenoids—Leland (260 for 48 hours)

Relays—Hart (4PDT 200 C), and Union Switch (4PDT 200 C). Jennings (stacked ceramic vacuum relays to 4PDT 200 C, or 400 C with aluminum foil coils).



Vacuum transfer relay by Jennings can switch 15 kv at 200 C ambients.



Stacked ceramic Jennings relay, available to 4PDT, operates at 200 C.

How to buy
RELIABILITY*
In A Precision
Potentiometer

Answer: ONLY FAIRCHILD CAN DELIVER ALL OF THESE RELIABILITY FEATURES at the lowest price in the industry!

1. Welded terminal and taps. A positive electrical and mechanical bond to withstand high temperatures, shock and vibration.
2. Machined metal case for retention of accuracy, especially under high temperature and/or humidity.
3. Metal inserts in molded wiper hubs for positive wiper positioning, for accuracy under shock, vibration, acceleration.
4. Precious metal resistance wires where needed for extremely low noise values, especially in corrosive atmospheres and for long storage life.
5. Precious metal contacts for low noise and high temperature.
6. One piece wiper construction for life, accuracy, low noise and low torque.
7. Stainless steel clamp bands capable of withstanding high torque, and the stresses and strains of shock, vibration and acceleration.
8. Precision stainless steel ball bearings — for low torque, high temperature, high vibration and shock characteristics.

PLUS 100% inspection AND a separate Quality Control program which puts 1 out of every 100 production units through complete environmental torture tests.

Since the ultimate price of a potentiometer is directly related to the reliability built into it . . . you only get what you pay for in a "pot".

Only Fairchild Linear and Non-Linear High Reliability Pots incorporate *all* of the above features. This High Reliability group can be had in 7/8" to 2" diameters, single and multi-turn, in standard and high temp versions and with accuracies as high as .009%.

For more information write Dept. 11G.

***Fairchild's Built-in SAFETY FACTORS Beyond the Specs for Reliability in Performance.**



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INSIDE
THE
BLACK BOX

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Potentiometers • Gyros • Pressure Transducers • Accelerometers

CIRCLE 30 ON READER-SERVICE CARD



nearly
for every dc measurement...
the Keithley 610 ELECTROMETER

THIS NEW INSTRUMENT virtually blankets the field of dc measurement, combining all the following functions:

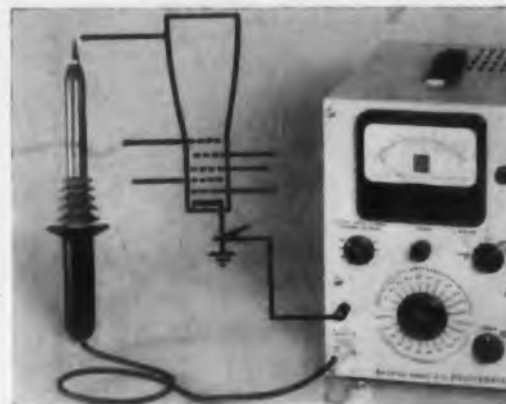
**DC Voltmeter, 10 mv to 100 volts full scale,
Ammeter, 3 amperes to 10^{-13} amp full scale,
Ohmmeter, 10 ohms to 10^{14} ohms full scale,
DC Amplifier, with gains from 0.1 to 1000.**

OTHER FEATURES include: zero drift less than 2 millivolts per hour after a 30-minute warm-up; 10-volt and 1-milliampere outputs to drive oscilloscopes and recorders; internal resistance and voltage supply standards.

Three accessory probes are available to facilitate measurements and extend the upper voltage range to 30 kv. A convenient accessory test shield permits rapid checks of small components.

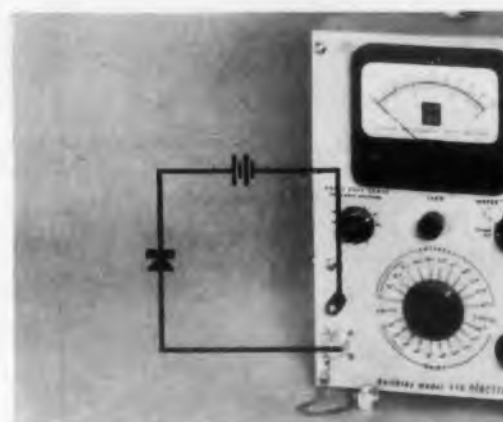
USES OF THE 610 include numerous common tests, plus measurements like these: voltages of piezo-electric crystals, vacuum tube electrodes and static charges; currents in photo cells, ion chambers and semi-conductors; and measuring very high levels of insulation resistance.

DETAILS about the new 610 Electrometer now are available in Keithley Engineering Notes, Vol. 6 No. 1. Write for your copy today.



VOLTAGE

Model 610 has full scale ranges of 0.01, 0.03, 0.10, 0.30, 1.0, 3.0, 10, 30, and 100 volts. Accuracy: 2% of full scale on all ranges. Input impedance: adjustable, from one ohm to greater than 10^{14} ohms. (Shown above with accessory high-voltage probe measuring kinescope potential.)



CURRENT

The 610 may be used as a direct-reading ammeter from 3 amperes to 10^{-13} ampere full scale. Accuracy: 3% of full scale from 3 amperes to 10^{-8} ampere; 4% of full scale from 3×10^{-9} to 10^{-13} ampere. (Sketch shows measurement of back current of semi-conductor.)

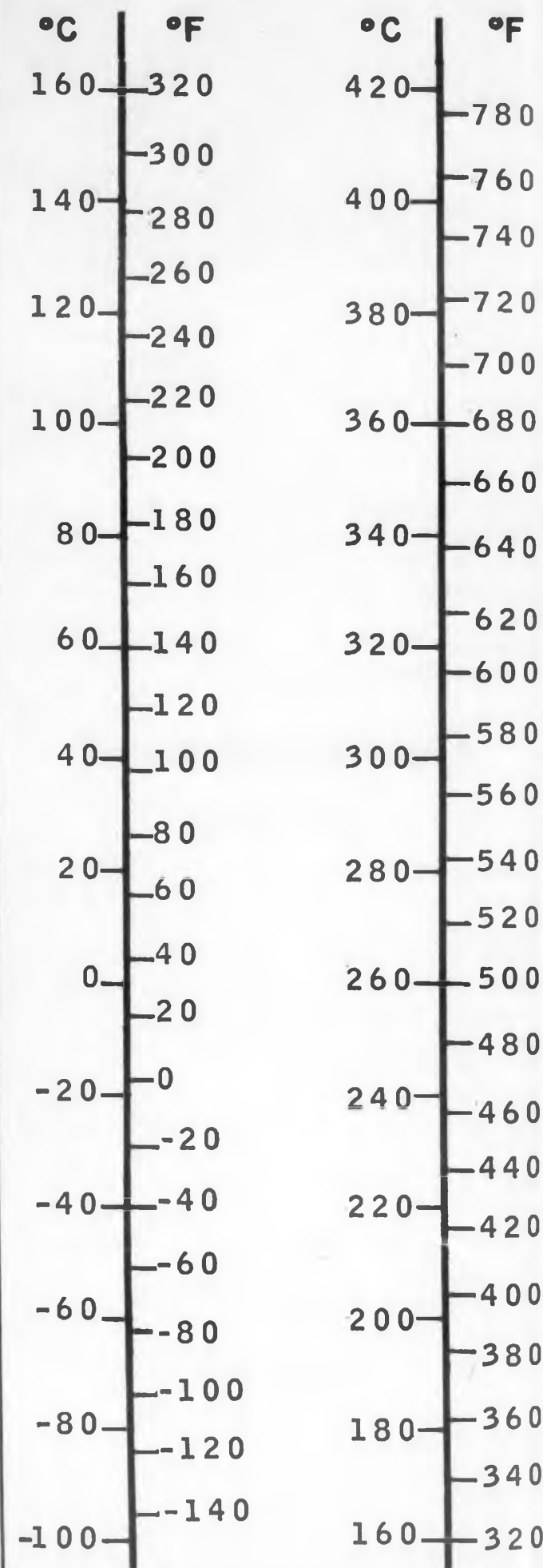


RESISTANCE

The 610 measures 0.2 ohm to 10^{14} ohms on the same two linear scales per decade used for current and voltage readings. Both guarded and unguarded connections are available. Accuracy: 3% of full scale up to 3×10^8 ohms and within 5% beyond. (Above, checking a resistor, using accessory test shield.)

HIGH TEMPERATURE COMPONENTS

Temperature



K Keithley Instruments, Inc.
12415 Euclid Avenue • Cleveland 6, Ohio

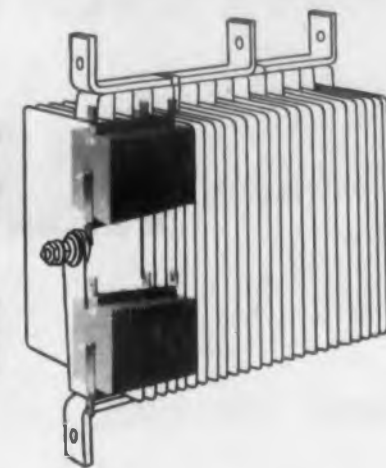
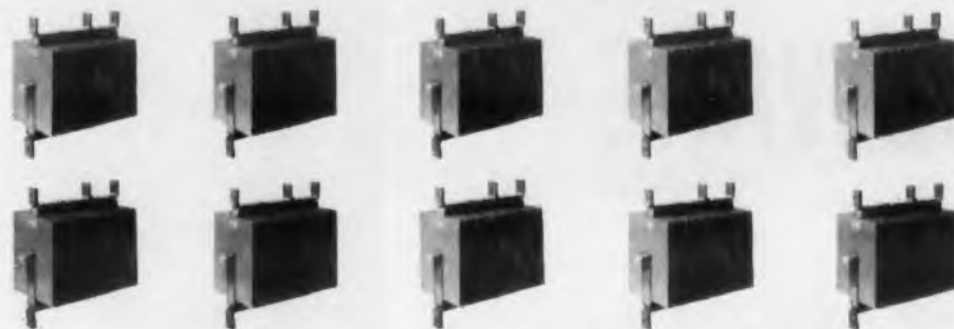
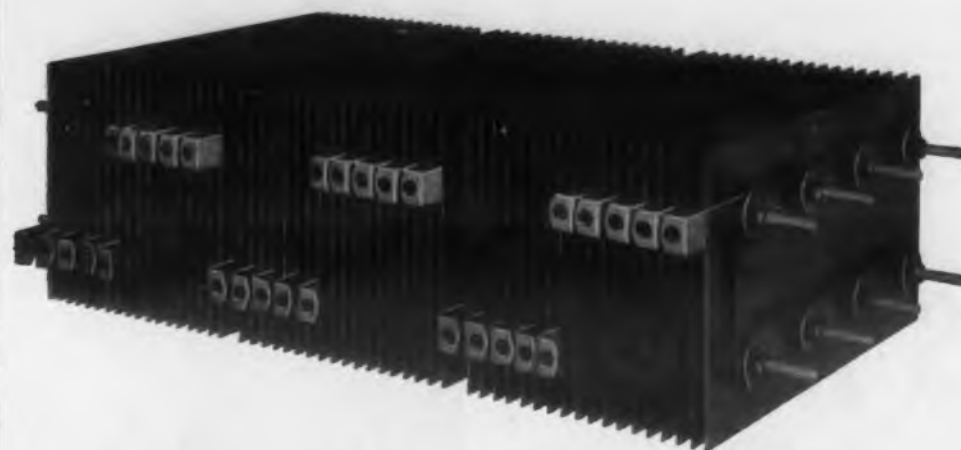
CIRCLE 31 ON READER-SERVICE CARD

Conversion Chart

°C	°F	°C	°F
920	1680	1440	2600
	1640		2560
880	1600	1400	2520
	1560		2480
840	1520	1360	2440
	1480		2400
800	1440	1320	2360
	1400		2320
760	1360	1280	2280
	1320		2240
720	1280	1240	2200
	1240		2160
680	1200	1200	2120
	1160		2080
640	1120	1160	2040
	1080		2000
600	1040	1120	1960
	1000		1920
560	960	1080	1880
	920		1840
520	880	1040	1800
	840		1760
480	800	1000	1720
			1720
440		960	
400		920	

Single New Rectifier Outperforms

**12 full size
conventional
stacks!**



Radio Receptor *HCD** Petti-Sel **High current density* Industrial Type Selenium Rectifiers

Produced by the improved new vacuum process developed by Siemens of West Germany and now manufactured exclusively by Radio Receptor in the U.S.

- Smaller cell sizes
- Lower voltage drop
- No artificial barrier
- Negligible aging with an estimated life of 100,000 hours!

Because the exclusive Siemens vacuum process eliminates the need of an artificial barrier layer, it is possible for Radio Receptor to offer smaller cell sizes operating at high current density, yet with lower voltage drop. In actual dimensions this means that just *one* RRco. HCD rectifier measuring 8" x 16" x 25", rated at 26V AC, 4500 amps DC, replaces *twelve* usual stacks 6" x 7 1/4" x 10".

RRco. Petti-Sel rectifiers do far more than save space. They reduce assembly time, require fewer connections and cost less per ampere. Their dependability has been proved for years in European circuits and the outstanding electrical characteristics are not even approached by other standard cells available today. For further information please write today to Section D-10R.

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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

CIRCLE 32 ON READER-SERVICE CARD

MATERIALS AND HARDWARE



Continuous flame test at 540 C doesn't disturb this Cannon plug.



Continuous operation at 540 C and 100,000 feet is assured in this AMP connector. It features floating contacts for perfect mechanical alignment.

Materials

GREAT strides in high temperature component designs often follow on the heels of new materials developments. Without the new plastics and ceramics, our electronics industries would not be where they are today.

The materials listed here represent the skills of many individual manufacturers. The listing is intended as a guide—not a catalog.

The maximum temperatures given, (always in degrees Centigrade), are for continuous opera-

tion. Often—almost always, materials can be used at very much higher temperatures for brief intervals. Many electrical and mechanical properties suffer at higher temperatures, so it is advisable to check with individual manufacturers for detailed specifications and specific applications. Their full names and addresses appear at the end of this detachable section.

Teflon[®], Fiberglas[®], and Silicone Glass—These dielectric materials are useful from -65 C or lower up to the 200-260 C range. They are available in sheets, rods, tapes, lacing cord, tubing, and a host of molded and machined products. Teflon, in particular, has found wide use in high temperature capacitors and wire insulation. Manufacturers of these materials and products include American Molded Products, American Super-Temperature Wires, Bentley-Harris, Connecticut Hard Rubber, Continental Diamond Fibre, Dodge Fibers, E.I. Du Pont, Enflo, Form-It, Gudebrod, Hitemp, Inso, O.J. Maigne, Natvar, Pennsylvania Fluorocarbon, Permacel-LePage's, Raybestos-Manhattan, Thermo Materials.

Laminates and PC Board Materials—Continental-Diamond Fibre (150 C), Corning Glass (300 C), Rogers (250 C), Synthane (200 C).

[®]Teflon is Dupont's registered trademark.

[®]Fiberglas is Owen-Corning Fiberglas Corp.'s trademark.

Mica and Ceramic Materials and Parts—These materials range in temperature tolerance from 200 C for synthetic mica to 1500 for certain ceramics. Aero Research (1375 C), Alite (900), American Lava (1500), Centralab (1300), Corning Glass (980), Electronic Mechanics (600), Mica Insulator (200), Mycalex (500), Russell (1100), Spruce Pine (540).

Metallized Ceramics and Seals—Advance Vacuum (700 C), Alite (900), Consolidated Electrodynamics (590), Frenchtown Porcelain (540), Mitronics (700).

Self Bonding Tapes and Markers—These can take about 260 C. Industrial Accessories, Mystik, Permacel-LePage's, Westline.

Adhesives, Cements, and Metal Joining Alloys—Alpha Metals (hard solder to 310 C), American Platinum (brazing alloys to 950), Charles Engelhard (cements to 540), Goodyear (aluminum adhesive to 260), H.A. Wilson (cements to 540).

Potting Compounds, Coolants, and Varnishes—These are good in the 200-260 C range. Carl Biggs, Dow Corning, Emerson & Cuming, Furane, G.E., Permacel-LePage's, Monsanto, Union Carbide.

Magnetic Materials—All begin to lose field strength at about 200 C. Arnold Engineering, G.E. (Waterford), General Magnetic, Magnetics, Perfection Mica, Permanent Magnet.

Hardware

Too often, the electronic design engineer takes his hardware for granted. In high temperature designs—he'd better not. Hot springs can lose their spring. Insulation can become leaky and lossy. Nuts and bolts loosen, and connectors can fail to connect.

Connectors and Terminals—Sometimes, environmental requirements may be so tough that parts must be sacrificed after they play their role. For example, Cannon Electric's Carlos Beeck designed a plug to work in an 1100 degree flame for five minutes. It wasn't much good after that, but in those five minutes it did its job.

Connectors must be carefully designed if they are to take high temperatures. If materials don't have matching coefficients of expansion, connections will loosen, become noisy, and develop undesirable voltage drop or connectors may crack. Poorly designed contacts will corrode and develop insulating films. Geometries must be chosen to guard against corona and flashover.

Connector and terminal manufacturers include Amphenol (to 440 C), AMP (650), Anton (260), Cannon (540), Ceramaseal (500), Enflo (260), Frenchtown (800), Garde (200), Gulton (260), Litton (1000), Nugent (230), Scintilla (200), and Wade (480). Other devices falling in this category include Airflyte's collector rings and brush block assemblies—to 200 C, H.A.Wilson's 425 C contacts, Mallory's 260 C phone plugs, and Raytheon's 260 C test jack.

Switches—Control Products (thermal switches to 950 C), I. T. & T. (10 position rotary to 150 C), Licon (subminiature to 200), Metals and Controls (thermostats to 230).

Fasteners and Springs—Associated Spring (540), Elastic Stop Nut (self locking fasteners to 480), Heli Coil (s.l.f. to 290), Nutt-Shel (s.l.f. to 650), and Waldes-Kohinoor (retaining rings to 480).

Wire and Cable—As with any other component, so with wires and cables, temperature tolerance doesn't tell the whole story. When it gets too hot—ceramic insulated wires may lack flexibility; silicone rubber gets hard and brittle, and Teflon forms vapors. At lower temperatures, fibrous coatings absorb too much water. Again, we face that old devil—compromise.

Manufacturers who make wires and cables for operation up to 260 C include American Super-Temp., Amphenol, Belden, Gulton, Hitemp, Inso, Pacific Automation, Plastoid, Sprague, Sequoia, Tensolite, and Warren Wire.

Wires for 540 C operation are usually made of nickel, nickel plated copper, or silver, and are normally insulated with ceramic. They are made by Boston Insulated Wire, Secon, and Warren Wire.

new

High Current DC Supplies



Fast Response...High Amps...External Sensing

Two new high output power-packs—with response time ranging from 0.2 second down, and with transistorized power reference and magnetic amplifier power control circuits for trouble-free performance—that's just part of the story on these Sorensen DC power supplies.

One model supplies an output of 18 to 36 VDC at 125 amperes; the other provides 5 to 36 VDC at 0 to 30 amps.

Zener diode reference circuit assures sharper regulation, and the external sensing provision puts this precise control at the load. Silicon power rectifiers and complete tubeless design increase durability with reduction in weight—and greater saving in size.

Get the full story from your Sorensen representative.

Or write for technical data.

Model MA28-125
Output: 28 VDC nominal at 125 amps.
Regulation accuracy of $\pm 0.2\%$.
Ripple: $< 1\%$ RMS.
Response time: < 0.1 second.
Choice of input voltage: 208, 230,
or 460 VAC, 3-phase.
Weight: 225 pounds.
\$1160 in cabinet.

Model MR36-30
Output current, 0-30 amps, output
voltage, 5 to 36 VDC continuously
adjustable with regulation
 $\pm 0.25\%$ against line or load
change.
Response time of 0.2 second.
Input voltage: 105 to 125 VAC,
single-phase.
Weight: 175 pounds.
\$890 in cabinet.

Also supplied, as Model MR36-15,
with output current 0-15 amps,
otherwise similar.
Weight: 100 pounds.
\$495 in cabinet.



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SORENSEN & COMPANY, INC.
Richards Avenue, South Norwalk, Connecticut

In Europe, contact Sorensen-Ardag, Eichstrasse 29, Zurich, Switzerland, for all products including 50 cycle, 220 volt equipment

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CIRCLE 34 ON READER-SERVICE CARD

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Somerville 44, Mass.

Acme Electric Corp.
Cuba, N. Y.

Advanced Vacuum Products, Inc., Div.,
General Ceramics Corp.,
430 Fairfield Ave.,
Stamford, Conn.

Aero Electronics Corp.,
1657 W. 134th St.,
Gardena, Calif.

Aero Research Instrument Co., Inc.,
315 N. Aberdeen St.,
Chicago 7, Ill.

Aerovox Corp., Hi-Q Div.
Seneca Ave.,
Olean, N. Y.

Airflyte Electronics,
535 Ave. A,
Bayonne, N. J.

Air-Marine Motors, Inc.,
369 Bayview Ave.,
Amityville, N. Y.

Airpax Products Co.,
Seminole Div.,
City of Plantation,
Ft. Lauderdale, Fla.

Aladdin Electronics,
703 Murfreesboro Rd.,
Nashville, Tenn.

Alite Div.,
U. S. Stoneware Co.,
Akron, Ohio

Alpha Metals, Inc.,
56 Water St.,
Jersey City 4, N. J.

American Lava Corp., Subs.
Minnesota Mining and Mfg. Co.,
Cherokee Blvd. and Manufacturers Rd.,
Chattanooga 5, Tenn.

American Molded Products Co.,
2727 W. Chicago Ave.,
Chicago 22, Ill.

American Platinum and Silver Div.,
Engelhard Industries, Inc.,
231 W. Railroad Ave.,
Newark, N. J.

American Super-Temperature Wires, Inc.,
West Canal St.,
Winooski, Vt.

Amphenol Electronics Corp.,
1830 S. 54th Ave.,
Chicago 50, Ill.

AMP, Inc.,
Harrisburg, Pa.

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

Anton Electronic Labs., Inc.,
1226 Flushing Ave.,
Brooklyn 37, N. Y.

Arnold Engineering Co.,
P.O. Box G
Marengo, Ill.

Ashland Electric Products
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Long Island City 1, N. Y.

Associated Spring Corp.,
Bristol, Conn.

Audio Devices, Inc.,
620 E. Dyer Rd.,
Santa Ana, Calif.

Autotronics, Inc.,
Rt. 1, Box 812,
Florissant, Mo.

Baker Platinum Div.,
Engelhard Industries, Inc.,
113 Astor St.,
Newark 2, N. J.

Balco Research Labs.,
49 Edison Pl.,
Newark, N. J.

Barber-Colman Co.,
1400 Rock St.,
Rockford, Ill.

Beckman/Helipot Corp.,
Newport Beach, Calif.

Belden Manufacturing Co.,
4647 W. Van Buren,
Chicago 44, Ill.

Bendix Aviation Corp.,
Red Bank Div.,
Eatontown, N. J.

Bentley-Harris Manufacturing Co.,
Conshohocken, Pa.

Carl H. Biggs Co.,
2255 Barry Ave.,
Los Angeles 63, Calif.

Boston Insulated Wire & Cable Co.,
63 Bay St.,
Boston 25, Mass.

Bristol Co.,
Waterbury 20, Conn.

Cannon Electric Co.,
3208 Humboldt St.,
Los Angeles 31, Calif.

Centralab Div.,
Globe-Union, Inc.,
900 E. Keefe Ave.,
Milwaukee 1, Wis.

Ceramaseal, Inc.,
New Lebanon Center, N. Y.

Chemfab Corp.,
40-30 23rd St.,
Long Island City 1, N. Y.

Chicago Condenser Corp.,
3255 W. Armitage Ave.,
Chicago 47, Ill.

Chicago Standard Transformer Corp.,
3501 W. Addison St.,
Chicago 18, Ill.

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Connecticut Hard Rubber Co.,
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Consolidated Electrodynamics,
300 N. Sierra Madre Villa,
Pasadena, Calif.

Continental-Diamond Fibre Corp.,
Newark, Dela.

Control Products, Inc.
308 Sussex St.,
Harrison, N. J.

Corning Glass Works,
Corning, N. Y.

Courter Products,
Boyer City, Mich.

Dale Products, Inc.,
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Daystrom Pacific,
9320 Lincoln Blvd.,
Los Angeles 45, Calif.

Dearborn Electronics Labs.,
1421 N. Wells St.,
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Roycraft Campus,
East Aurora, N. Y.

Diamond Electronics,
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T. A. Edison Industries,
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West Orange, N. J.

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San Bruno, Calif.

Elastic Stop Nut Corp. of America,
2330 Vauxhall Rd.,
Union, N. J.

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401 Preda St.,
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Electronic Mechanics, Inc.,
101 Clifton Blvd.,
Clifton, N. J.

Electro Products Labs.,
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Chicago 40, Ill.

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Canton, Mass.

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Enflo Corp.,
Fellowship Rd. and Rt. 73,
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Charles Engelhard, Inc.,
850 Passaic Ave.,
E. Newark, N. J.

Fairchild Controls Corp.,
225 Park Ave.,
Hicksville, N. Y.

Feedback Controls, Inc.,
899 Main St.,
Waltham 54, Mass.

Fenwal, Inc.,
Ashland, Mass.

Form-It Products, Inc.,
1619 W. Walnut St.,
Chicago 12, Ill.

Frenchtown Porcelain Co.,
Trenton 9, N. J.

Fretco, Inc.,
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Pittsburgh 13, Pa.

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4516 Brazil St.,
Los Angeles 39, Calif.

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Newton Upper Falls, Mass.

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588 Eddy St.,
Providence 3, R. I.

GB Components, Inc.,
14621 Armita St.,
Van Nuys, Calif.

General Electric Co.,
Capacitor Dept.,
Hudson, N. Y.

General Electric Co.,
Receiving Tube Department,
316 E. 9th St.,
Owensboro, Ky.

General Electric Co.,
Research Lab.,
P.O. Box 1088,
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Heli-Coil Corp.,
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Hitemp Wires, Inc.,
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International Rectifier Corp.,
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REDUCE INSERTION LOSS!! INCREASE USABLE POWER!!

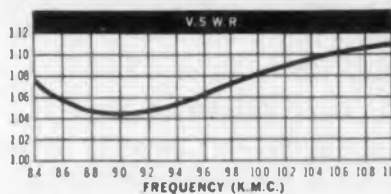
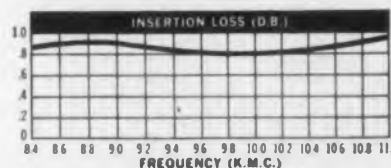
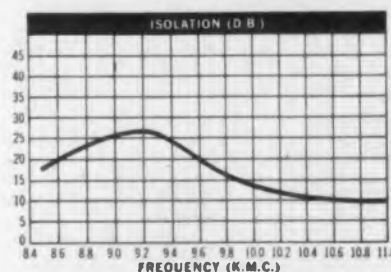
NEW

Kearfott

MIDGET FERRITE ISOLATOR



Typical Performance Curves



KEARFOTT COMPANY, INC.
MICROWAVE DIVISION
DEPT. 10E, 14844 OXNARD ST.
VAN NUYS, CALIF.

CIRCLE 35 ON READER-SERVICE CARD

MAXIMUM FREQUENCY STABILITY WHERE SPACE IS LIMITED...

A high power unit of exceptionally small size and weight, this newest Kearfott product is the answer to microwave circuitry applications where space is limited.

IMPORTANT FEATURES:

BROAD FREQUENCY RANGE—from 8.5 to 9.6 KMC

HIGH ISOLATION—Minimum of 15 DB

INSERTION LOSS—Only 1.0 DB Maximum

SMALL SIZE—1.000" deep x 2.100" high x 2.400" high

POWER—Average 200 Watts

TEMPERATURE-AMB—150°C

PRICE—\$135.00 each f.o.b., Van Nuys, Calif.

Quantity prices on request

DELIVERY—from stock

OTHER STANDARD Ferrite Isolators and Duplexers in a wide range of sizes and band widths are available plus facilities to produce special configurations if desired. Our sales engineers can help you.

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South Central Office:

6211 Denton Drive
Dallas, Texas

Northwest Area Office:

530 University Avenue
Palo Alto, California

Usage:



This special filament transformer has 400 cycles with 4 secondaries, 10 volts, 100 Amperes. Each secondary can be mounted in parallel series or series parallel. The extremely close tolerance between secondary potentials under load is of extreme importance in this design.

The filament transformer, a new member of the well-known family of NWL custom-built Transformers, is made to fit the particular needs of the user.

Each Nothelfer transformer is individually tested for core loss, polarity, voltage, corona, insulation breakdown and aging characteristics and must meet all customer's requirements before shipment. We shall be glad to receive your specifications and quote you accordingly.



ESTABLISHED 1920



Nothelfer

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(Specialists in custom-building)

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- Kintronic Div.,
Chicago Aerial Industries, Inc.,
10265 Franklin Ave.,
Franklin Park, Ill.
- G. H. Leland, Inc.,
123 Webster St.,
Dayton 2, Ohio
- Licon Div.,
Illinois Tool Works,
2501 N. Keeler,
Chicago 39, Ill.
- Litton Industries,
336 N. Foothill Rd.,
Beverly Hills, Calif.
- Magnetic Controls Co.,
6405 Cambridge St.,
Minneapolis 26, Minn.
- Magnetic Metals Co.,
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Butler, Pa.
- O. J. Maigne Co.,
321 Pearl St.,
New York 38, N. Y.
- P. R. Mallory and Co., Inc.,
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Indianapolis, Ind.
- Maurey Instrument Corp.,
7924 S. Exchange Ave.,
Chicago 17, Ill.
- MB Manufacturing Co.,
P.O. Box 1825,
New Haven 8, Conn.
- Metals and Controls Corp.,
Spencer Thermostat Div.,
43 Forest St.,
Attleboro, Mass.
- Mica Insulator, Div.,
Minnesota Mining and Mfg. Co.,
P.O. Box 1076,
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- Micro-Switch Div.,
Minneapolis-Honeywell Regulator Co.,
Freeport, Ill.
- Microwave Associates,
Burlington, Mass.
- Minneapolis-Honeywell Regulator Co.,
Aeronautical Div.,
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- Mitronics, Inc.,
1290 Central Ave.,
Hillside, N. J.
- Monsanto Chemical Co.,
St. Louis 24, Mo.
- Mycalex Corporation of America,
Clifton Blvd.,
Clifton, N. J.
- New York Transformer Co., Inc.,
Alpha, N. J.
- Nugent Electronics Co.,
802 E. 8th St.,
New Albany, Ind.
- Nutt-Shel Co., Inc.,
811 Airway,
Glendale 1, Calif.
- NYT Electronics, Inc.,
2979 N. Ontario St.,
Burbank, Calif.
- Onondaga Pottery Co.,
1858 W. Fayette St.,
Syracuse 1, N. Y.
- John Oster Manufacturing Co.,
1 Main St.,
Racine, Wis.
- Pacific Automation Products,
1000 Airway,
Glendale, Calif.
- Pennsylvania Fluorocarbon Co., Inc.,
1115 N. 38th St.,
Philadelphia 4, Pa.
- Perfection Mica Co.,
1322 N. Elston Ave.,
Chicago 22, Ill.
- Permacel-Lepage's, Inc.,
New Brunswick, N. J.
- Permanent Magnet Co.,
Indianapolis 26, Ind.
- Plastoid Corp.,
42-61 24th St.,
Long Island City 1, N. Y.
- Polarad Electronics Corp.,
43-20 34th St.,
Long Island City 1, N. Y.
- Polyphase Instrument Co.,
E. Fourth St.,
Bridgeport, Pa.
- Pyrofilm Resistor Co.,
U. S. Highway 46,
Parsippany, N. J.
- Radio Corporation of America,
Princeton Labs,
Princeton, N. J.
- Raybestos-Manhattan, Inc.,
Manheim, Pa.
- Raytheon Manufacturing Co.,
Equipment Div.,
100 River St.,
Waltham, Mass.
- Raytheon Manufacturing Co.,
Receiving and Cathode Ray Tube
55 Chapel St.,
Newton 58, Mass.,
- Rho Engineering Co.,
2242 Sepulveda,
Los Angeles 64, Calif.
- Rogers Corp.,
Rogers, Conn.
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733 Concord Ave.,
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- San Fernando Electric Manufacturing Co.,
1509 1st St.,
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- Sangamo Electric Co.,
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- Sarkes Tarzian, Inc.,
415 N. College Ave.,
Bloomington, Ind.
- Schaevitz Engineering,
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Camden 1, N. J.
- Scintilla Div.,
Bendix Aviation Corp.,
Delaware Ave.,
Sidney, N. Y.
- Secor Metals Corp.,
7 Intervale St.,
White Plains, N. Y.
- Sequoia Wire and Cable Co.,
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- Southern Electronics Corp.,
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- Southwestern Industrial Electronics Co.,
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P.O. Box 13058,
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Speer Carbon Co.,
Jeffers Electronics Div.,
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Sprague Electric Co.,
North Adams, Mass.

Spruce Pine Mica Co.,
Spruce Pine, N. C.

Statham Instruments, Inc.,
12401 W. Olympic Blvd.,
Los Angeles 64, Calif.

Stoddart Aircraft Radio Co., Inc.,
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Hollywood 38, Calif.

Sylvania Electric Products, Inc.,
Radio Tube Div.,
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Synthane Corp.,
Oaks, Pa.

Taber Instrument Corp.,
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North Tonawanda, N. Y.

Telecomputing Corp.,
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Los Angeles 38, Calif.

Tensolite Insulated Wire Co., Inc.,
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Tarrytown, N. Y.

Texas Instruments, Inc.,
P.O. Box 312,
Dallas, Tex.

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

H. I. Thompson Fiber Glass Co.,
1733 Cordova St.,
Los Angeles 7, Calif.

Thompson Products, Inc.,
2196 Clarkwood Rd.,
Cleveland 3, Ohio

Topaz Transformer Products
Resistor Div.,
1337 Marina Blvd.,
San Diego, Calif.

Transitron Electronic Corp.,
168 Albion St.,
Wakefield, Mass.

Trans-Sil Corp.,
55 Honeck St.,
Englewood, Calif.

Trans-Sonics, Inc.,
Burlington, Mass.

Tub-Bo Jet Products Co., Inc.,
424 S. San Gabriel Blvd.,
San Gabriel, Calif.

Union Carbide Corp.,
Silicones Div.,
30 E. 42nd St.,
New York, N. Y.

Union Switch and Signal,
Swissvale, Pa.

United Electronics,
42 Spring St.,
Newark 4, N. J.

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

Victoreen Instrument Co.,
5806 Hough Ave.,
Cleveland 3, Ohio

Vitramon, Inc.,
Box 544,
Bridgeport 1, Conn.

Wade Electric Products Co.,
Sturgis, Mich.

Waldes Kohinoor, Inc.,
47-16 Austel Pl.,
Long Island City 1, N. Y.

Ward Leonard Electric Co.,
Mt. Vernon, N. Y.

Warren Wire Co.,
Pownal, Vt.

Westinghouse Electric Corp.,
East Pittsburgh, Pa.

Westline Products Div.,
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Los Angeles 54, Calif.

H. A. Wilson Div.,
Engelhard Industries, Inc.,
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In the past three years alone custom-built ESC delay lines have solved 6,704 different military and industrial application problems...so it's a good bet that we are already experienced in designing a unit very close to what you need. As the first company exclusively devoted to the manufacture of delay lines, we pioneered in the elimination of costly overspecification and brought economical custom-building to the delay line field.

To insure strict adherence to your specifications, the prototype unit is subjected to comprehensive test-

ing and the results of these tests are submitted to you. On this laboratory report are included submitted electrical requirements, photo-oscillograms (which indicate input and output pulse shape and output rise-time), the test equipment used, and an evaluation of the electrical characteristics of the prototype.

Whatever the application, the odds are 6,704 to 1 that ESC can design and build precisely the delay line you need—and do it easily, efficiently and exactly as specified! Write today for complete technical data.



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CLEVITE 'BRUSH' High Resolution Magnetic Heads

WITH GAPS AS NARROW AS 20 MICROINCHES

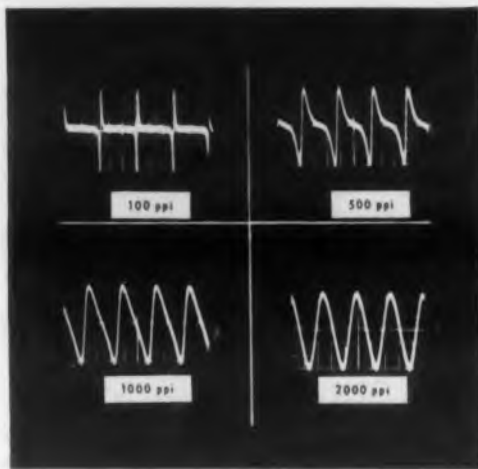
Clevite "Brush" high resolution magnetic heads permit major improvements in tape recording systems:

Greater packing density and/or higher frequency recording at your present tape or drum velocity. *Less volume of tape required.*

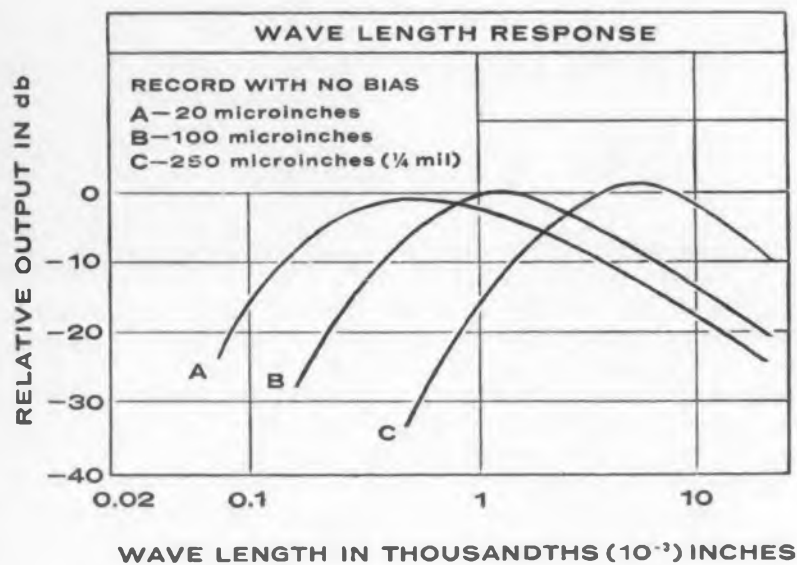
Up to 10 to 1 reduction in tape or drum velocity at your present frequencies or pulse repetition rate. *More recording time on the same length of tape.*

Reduced playback pulse width, allowing extended pulse width modulation (pwm) recording; for example, 10 microsecond pulse width at 120 inches per second tape velocity.

Special high resolution heads were developed by Clevite to meet specific customer applications. They are now commercially available in 2 to 32 channel form in a variety of mechanical configurations. These heads, slightly modified, may fit your present design requirements. One of our specialists will be pleased to discuss your application by detailed correspondence or personal visit. Write: Product Manager, Magnetic Heads, Clevite Electronic Components, 3311 Perkins Avenue, Cleveland 14, Ohio.



Oscilloscope photos of pulse recordings on Clevite high resolution head. Pulse duration, 1 microsecond; tape speed, 60 inches/sec.



Typical Clevite narrow gap multi-channel head records more data on an equal length of tape.

HIGH TEMPERATURE COMPONENTS

ELECTRONIC HIGH LIQUID

C. G. Currin

By providing a barrier between components and the atmospheric environment, liquid dielectrics reduce the probability of insulation failure, one of the prime causes of equipment malfunction and failure.

SILICONE fluids are aiding electronic design engineers to miniaturize equipment and increase reliability.

These high temperature liquid dielectrics are used in electronic components such as capacitors, transformers, and filter networks. They are also used as the dielectrics into which complete electronic assemblies, such as airborne transmitters, are immersed.

Liquid Dielectric Properties

In designing electronic components and equipment, liquid dielectrics are selected for the following reasons. They:

- are void-free;
- have low dielectric losses;
- are good heat transfer media;
- assure a constant environment for the components in an electronic assembly;
- have high electric strength

The void-free characteristic of liquid dielectrics is particularly important in high voltage equipment where corona may be encountered. Liquid dielectrics eliminate corona and the resultant electrical interference. Because they are highly purified in manufacture, most of them have extremely low losses, often so low that loss measurements are difficult.

By immersing electronic assemblies in a liquid dielectric, they can be subjected to many adverse atmospheric conditions including high humidity and high altitude. Convection currents within

Clevite 'Brush' High Resolution Heads for radar recording •
high density tape recording • high density drum recording •
video recording • VHF instrumentation for missile telemetering

**CLEVITE
ELECTRONIC
COMPONENTS**



DIVISION OF
MAGNETIC HEADS
TRANSDUCERS
PIEZOELECTRIC CRYSTALS,
CERAMICS AND ELEMENTS

CIRCLE 38 ON READER-SERVICE CARD

USES OF TEMPERATURE DIELECTRICS

Dow Corning Corporation Midland, Michigan

the liquid remove heat from energy dissipating components rapidly. This is important in equipment where a large amount of power is used or where temperatures of certain components must remain within narrow limits for proper performance.

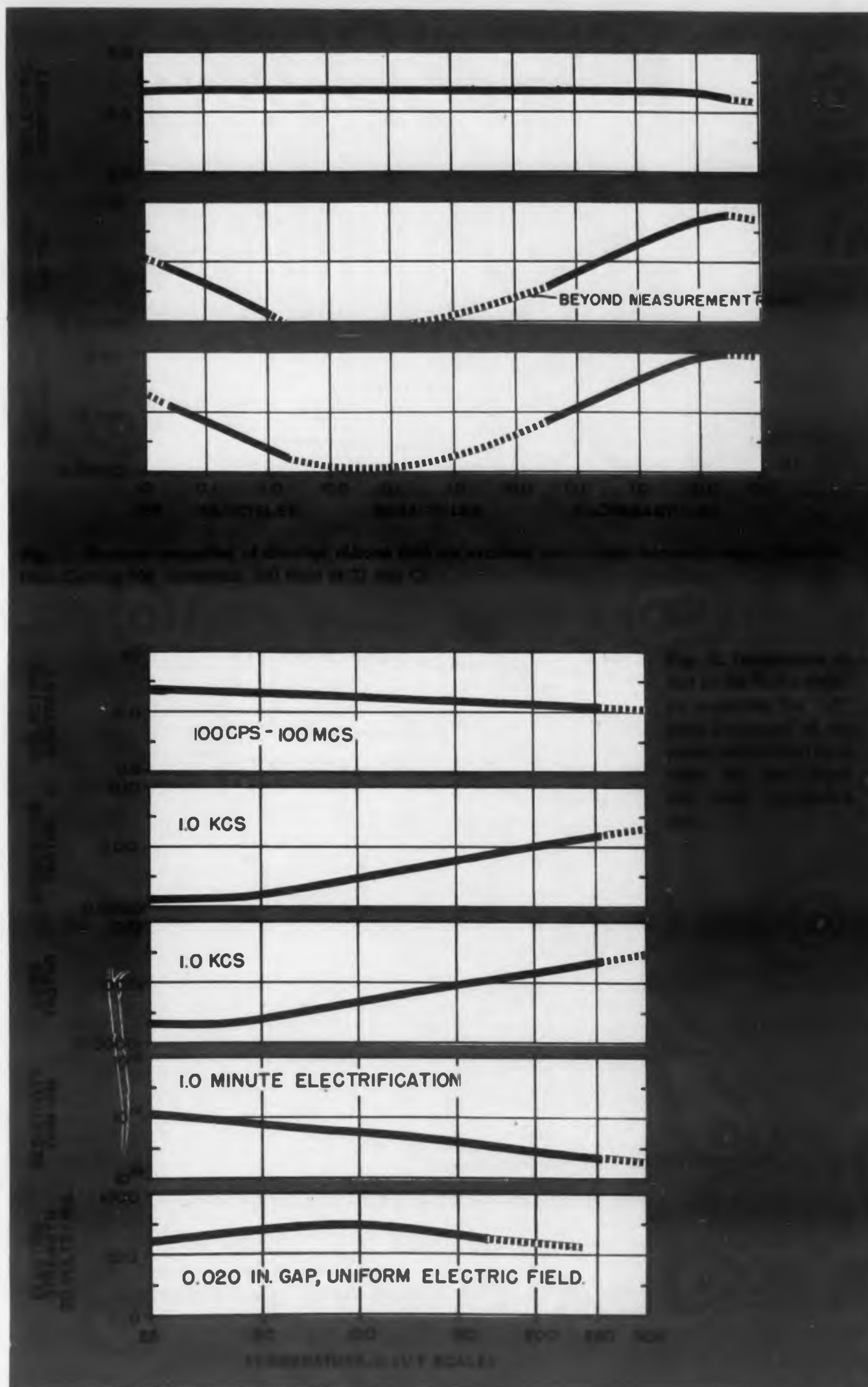
Compared to gaseous dielectrics, particularly at elevated temperatures, liquid dielectrics have much greater electric strength. Consequently, when liquid dielectrics are used to fill electronic assemblies, the space between high voltage conductors can be reduced greatly, aiding miniaturization. Frequently, smaller components can be specified. For example, smaller high voltage terminals may be used when circuitry is immersed in a liquid dielectric.

Because of the high temperatures encountered in present day electronic apparatus, due to either the energy dissipated by components or to environmental conditions, liquid dielectrics must have excellent thermal stability to be satisfactory. Of all of the different liquid dielectrics available, only two major types, the silicones and the fluorocarbons, are suitable for applications at temperatures of 200 C and above. Of these two types, silicone fluids are more economical. They have excellent dielectric properties over a wide range of frequencies.

Characteristics of Silicone Fluids

Many different types of silicone fluids are manufactured. Those generally used as liquid dielectrics are the dimethyl silicone fluids.* These fluids, produced in a high degree of purity, are available with viscosities ranging from 0.65 to 1,000,000 centistokes. Generally, fluids selected for dielectric applications have viscosities from 20 to 1000 centistokes. *(continued)*

*These fluids are available as Dow-Corning 200 Fluid, General Electric SF-96 Oil, and Union Carbide L-45 Oil.



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TO
DIE
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the LONGEST-LIVING CAPACITORS ever made!

TEST CONDITIONS

El-Menco Dur-Micas and Conventional Molded Units . . .
(same capacitance value, same case size)
Subjected to life test under same voltage and temperature
conditions for same period of time.

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El-Menco Dur-Micas yielded
1/25 the number of failures
that occurred in molded units.

DM30, 10,000 MMF, regular production "Undebugged" El-Menco Dur-Mica Capacitors . . .
Subjected to life test of 10,000 hours at 85°C with 150% of
the rated DC voltage applied.

Approx. 2.8% cumulative fail-
ures or 1 failure per 357,000
unit-hours.

DM30, 10,000 MMF, "Debugged" El-Menco Dur-Mica Ca-
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Subjected to life test of 10,000 hours at 85°C with 150% of
the rated DC voltage applied.

0.6% cumulative failures or
only 1 failure per 1,670,000
unit-hours.

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Subjected to 257,000 hours of life at 85°C with 100% of the
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per 43,000,000 unit-hrs.



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erated conditions of 1½ times rated voltage at ambient temperatures
of 125° centigrade . . . are test-proved to have longer life, most potent
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DM15, DM20, DM30 . . . perfect for extreme miniaturization; ideal
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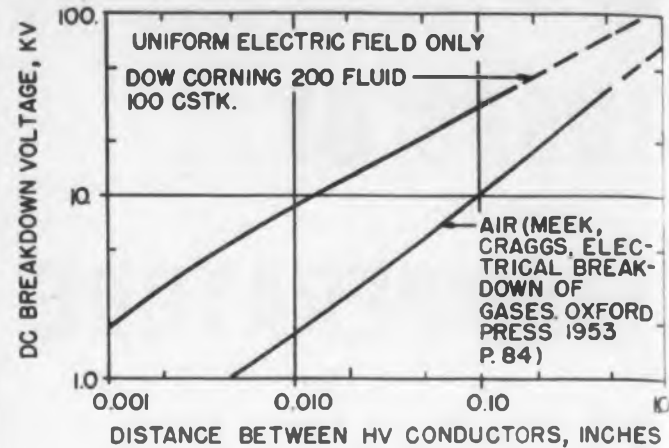


Fig. 3. Effect of gap on breakdown voltage of silicone fluids and air at 23 deg C. The curve for air is taken from *Electrical Breakdown of Gases* by Meek and Craggs, Oxford Press, 1953, p. 84.

The dielectric properties of all dimethyl sili-
cone fluids are essentially the same and are gen-
erally equal to the best properties of any liquid
dielectric.

Fig. 1 shows that the dielectric constant of 2.7
does not change with frequencies up to 5 kmc.
The dissipation factor and loss factor are ex-
tremely low over most of this range. Because of
these characteristics, silicone fluids have little
effect on the performance of immersed electronic
assemblies.

The effects of temperatures from 25 C to 300
C on the dielectric constant, dissipation factor,
loss factor, resistivity, and electric strength of
Dow Corning 200 Fluid are shown in Fig. 2.
Although temperature is a factor, all of these
properties remain above a generally acceptable
level at temperatures ranging from -55 to 300 C.

One of the major advantages of immersing
electronic equipment in silicone fluid is further
miniaturization. Size reduction is possible be-
cause high voltage components may be placed
much closer to each other without electrical
breakdown. The effect of spacing on breakdown
voltage in a uniform electric field is shown in
Fig. 3. Comparable data for air at atmospheric
pressure is also shown.

Satisfactory physical properties are also re-
quired of liquid dielectrics. Silicone fluids are
relatively inert to most environmental conditions
and materials. But, the physical properties of
dimethyl silicone fluids vary somewhat with
viscosity grades. Generally, the low viscosity
grades are better heat transfer media.

Aging at high temperatures has no appreciable
effect on the dielectric characteristics. The only
major effect is viscosity change. Even this effect
is small unless the fluid is exposed to air or

El-Menco

Capacitors

oxygen. In general, these fluids, when used in oxygen-free hermetically sealed electronic equipment may be expected to retain their initial characteristics for at least 15,000 hours at 200 C. At higher temperatures, the useful life will be less; at 250 C, however, life well in excess of 500 hours may be expected.

Most of the materials used in the manufacture of electronic components and assemblies are unaffected by silicone fluids. Conversely, silicone fluids are generally unaffected by these materials. Information on the few materials that are exceptions to the above generalization is readily available from both silicone fluid and insulating materials manufacturers.

When unusual operating conditions cause an arc to be struck between high voltage conductors immersed in silicone fluid, a gas, primarily a mixture of hydrogen and methane, evolves. In trace amounts, these gases are readily absorbed by the fluid and present no problem. However, under certain arc conditions, a gelatinous material may be formed between the conductors. This material may occlude small amounts of carbon and lower the maximum voltage which can be applied to conductors. By proper selection of viscosity grade, this effect is reduced.

Another environmental condition to which some electronic equipment is exposed is nuclear radiation. Radiation has no appreciable effect on any of the dielectric properties of silicone fluids. However, viscosity is affected. This in turn directly affects the heat transfer properties.

Here again, the proper choice of viscosity grade, will reduce this effect. Nuclear radiation, like arcing, produces hydrogen and methane gas. A dose of 50 megarad will evolve a quantity of gas which, at standard temperature and pressure, is 150 per cent of the volume of the irradiated fluid.

Application Techniques

In the application of silicone fluids to filling electronic equipment, some precautions are necessary to insure maximum equipment reliability. For example, silicone fluid should not be exposed to the atmosphere during storage, particularly when the relative humidity is above 50 per cent. Trace amounts of moisture in the fluid will greatly reduce its electric strength and loss characteristics. This also means that most equipment must be sealed in some manner.

Another characteristic to be considered is that silicone fluids, like all liquids, expand when heated. Since silicone fluids are usually subjected to a much greater temperature range than most other liquid dielectrics, this effect is more pronounced. This expansion may require the use of bellows, high temperature elastic foam, or some other device to absorb the increase in fluid volume.

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LOOK AT THE IMPORTANT FEATURES THIS NEW CLASS "E" OFFERS:

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- heavy-duty backstop that won't break or wear out
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*slow operate and slow release

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25 turn lead-screw adjustment

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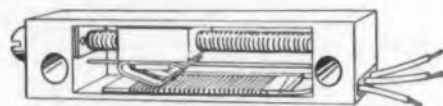
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Microwave and Optical Properties of

IN A PREVIOUS article in ELECTRONIC DESIGN,¹ various methods were indicated as a means to minimize circuit effects by radar with particular emphasis on transparent shielding materials. For use in design work, it is necessary to know the relative microwave attenuation characteristics as compared with the optical attenuation characteristics of

various suitable shielding materials. The accompanying table shows a comparison of the microwave properties of various transparent shields at three microwave frequencies representative of present radars, and the optical properties. The values of optical transmittance for the various gold films investigated are rather low compared to more recently prepared

Microwave and Optical Properties of Materials

Material	Microwave Transmittance (%)			Optical Transmittance %
	5.9kmc	9.7kmc	18.8kmc	
Gold Film about 11 μ thick on Plastic (300 ohms/square)	23	10	0.8	49
Gold Film about 30 μ thick on Plastic (12 ohms/square)	0.16	0.1	0.01	24
Gold Film about 75 μ thick on Glass (1.5 ohms/square)	0.04	0.01	0.004	3.2
Copper Mesh (20 per inch)	0.1	0.2	0.2	50
Copper Mesh (8 per inch)	1.0	1.3	2.5	60
Lead Glass (x-ray protective, 1/4" thick)	30	25	16	85
Lucite (3/16" thick)	80	50	25	92
Libby-Owens-Ford Electrapane Glass, with conductive coating about 150 $m\mu$ thick (120 ohms/square)	16	16	16	85
Libby-Owens-Ford Electrapane Glass, with conductive coating about 300 $m\mu$ thick (70 ohms/square)	9	10	8	80
Corning Heating Panel Glass, with conductive coating about 1.5 μ thick (15 ohms/square)	1.6	1.2	0.08	45
Waveguide Impedance (ohms)	554	448	568	—

Walter G. Egan

Ford Instrument Company

Long Island City, N. Y.

of Materials

gold films.² By proper cleaning of the substrate upon which the gold is to be deposited and by adequate annealing, the optical and electrical properties may be considerably improved. Further, by depositing the gold on oxides of nickel, silver, copper bismuth, or gold, the optical properties may be improved even more. For instance, a gold film 6 to 7 μ thick deposited on chalk cleaned glass on which a 10 μ thick layer of bismuth oxide had been deposited, followed by a final heating has a surface resistivity of 10 ohms per square and an optical transmittance of 75 per cent.

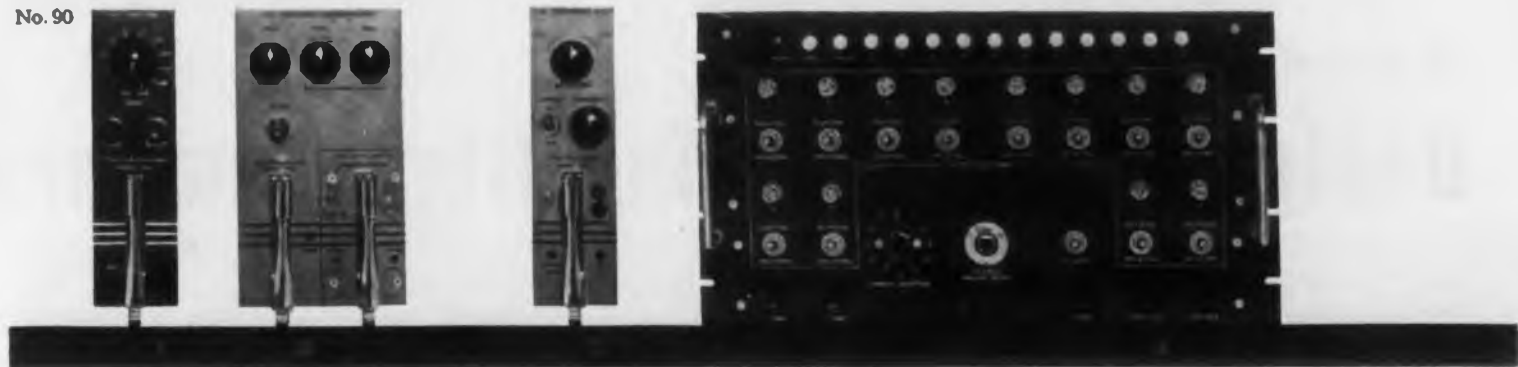
By using more complicated, and more expensive to produce layer combinations, the optical and electrical properties can be further improved. A typical sandwich film set of bismuth oxide-gold-bismuth oxide on glass heat treated at 400 C has a surface resistivity of 4-1/2 ohms per square and optical transmittance of 80 per cent.

When an engineer is faced with a problem of specifying a transparent microwave shielding material, he must carefully weigh the economic feasibility of the various types of transparent shielding available commercially against the cost of evaporated film preparation. Whether it is sub-contracted or done at the plant, evaporated films can be very expensive compared to commercially available materials. If one embarks upon a program of vacuum evaporation, a word of caution is in order; vacuum technique is quite an art, and the initial capital expenditure for vacuum equipment is high. A person trained in vacuum technique would be necessary to operate the equipment.

References

1. How to Minimize Radar Effects on Electronic Circuitry, W. G. Egan, *ELECTRONIC DESIGN*, March 19, 1958.
2. Vacuum Deposition of Thin Films, L. Holland, John Wiley and Sons, 1956, pp. 491-509.

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CIRCLE 42 ON READER-SERVICE CARD

Design Tips For Using High Temperature Precision

Robert J. Sullivan

Fairchild Controls Corporation

Hicksville, L. I., N. Y.

THE SYSTEM designer should know the limitations of the two basic types of high temperature potentiometers, the wirewound and film types. The film potentiometer is the logical choice for extremely high ambient temperatures since it can be made almost entirely from combinations of glass, metals, ceramic, or ceramic-like materials.

This type is best where exposure to nuclear radiation is a requirement, since it has no plastics which rapidly deteriorate near sources of nuclear radiation. However, film potentiometers are limited in maximum resistance due to the extremely thin films required. This can be overcome, to a certain extent, with larger diameter pots, but with today's emphasis on minimum size or volume, particularly in airborne applications, this choice is not always permissible.

Types of Film Pots Available

Film potentiometers are available in rotary and ganged single turn precision linear types, and in rotary and rectilinear trimmer types. Recent advances in evaporated films have indicated their capabilities as motor driven precision rectilinear potentiometers for actuators. Derated to five per cent dissipation, their range is from 150 C to 400 C with a 225 C standard.

When To Use Wirewound Types

For higher resistance values and applications requiring non-linear or multiturn types, the designer should look to the wirewound units. Also, where linearity tolerances are tight, wirewound varieties offer a wider selection. Single turn pots are available to better than 0.05 per cent linearity, and multiturns to 0.025 per cent. Rotary film types, on the other hand, are available to 0.5 per cent linearity, with values down to 0.25 per cent by selection. Wirewounds are normally derated to five per cent at 200 C.

Fit The Design To The Application

The potentiometer design specification must

Knowing a few basic qualities and limitations of high temperature potentiometers can help equipment designers insure best system performance. Included here are the important factors he should know.



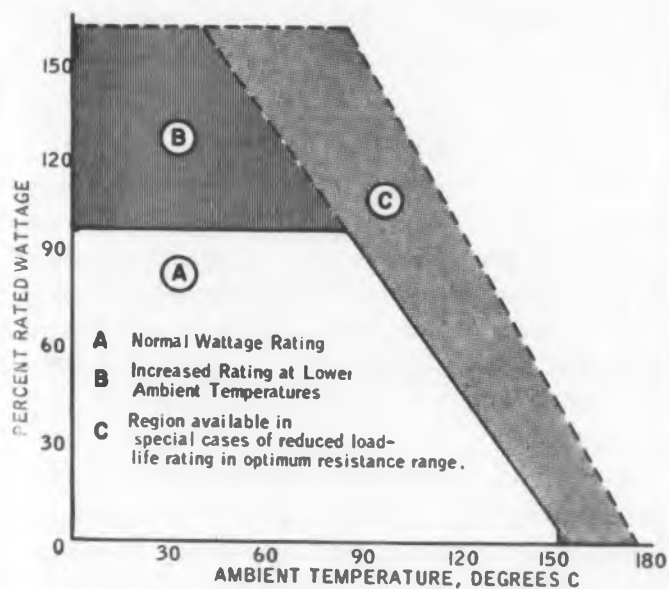
Potentiometers

be fitted to the application, not only in terms of temperature, but life, shock and vibration resistance, low temperature operation, and humidity exposure. Unfortunately, performance standards for high temperature pots have not been clearly established by military specifications.

Potentiometer users have many interpretations in their specifications for high temperature environmental performance and allowable degradations in these values. In some instances, the high temperature ability of the potentiometer is judged by its load-life characteristic, or sometimes by its ability to operate after a specified number of temperature cycles. Recently the trend has been towards specifying rotational life at elevated temperature, and to a certain extent, during temperature cycling. In other instances, a brief reference to the wattage dissipation requirements at a specified ambient is made.

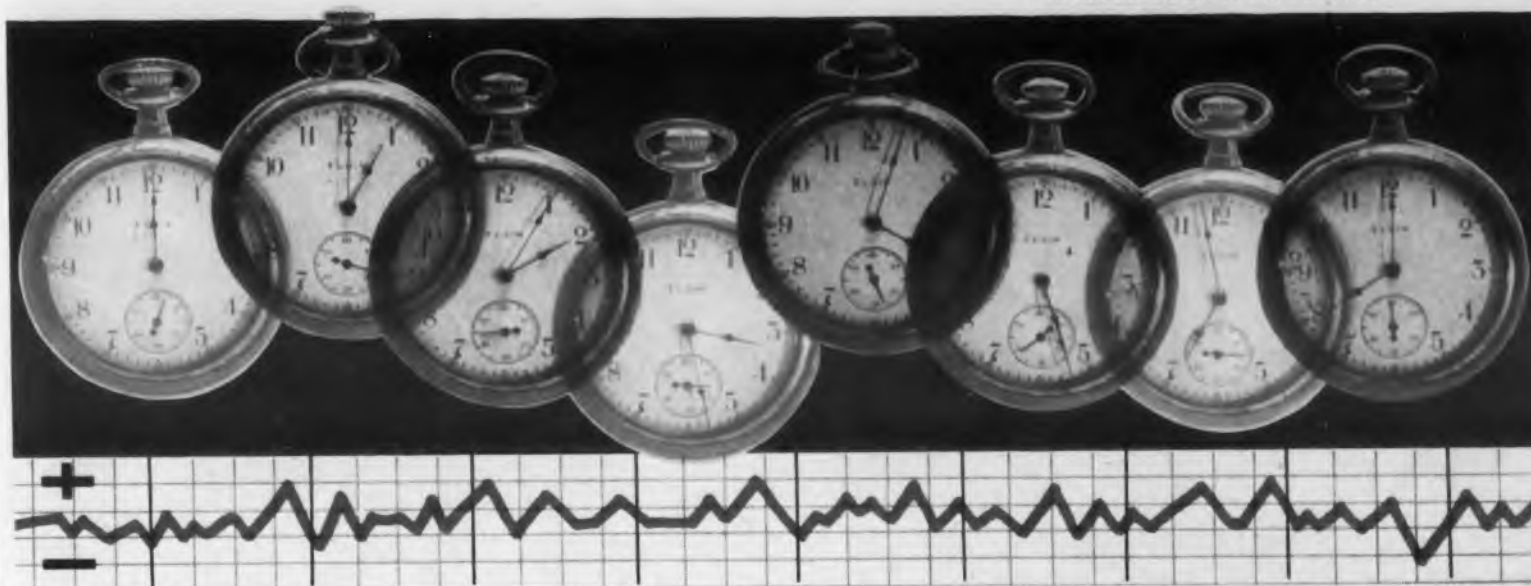
Where Do You Compromise?

The potentiometer designer must select a proper combination of materials. This selection



Potentiometer power rating curves.

**± SIX MICROVOLT INPUT DRIFT
OVER AN EIGHT HOUR PERIOD**



22

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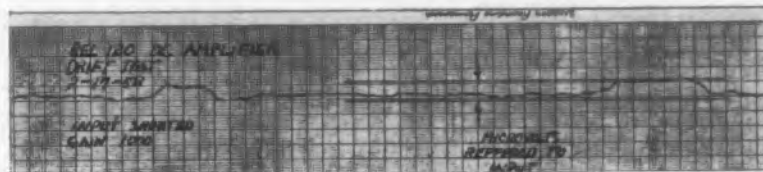
Some of the outstanding features are:

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REL-120 d-c amplifier
physical characteristics:
2-15/16" x 6-15/16" x 10"



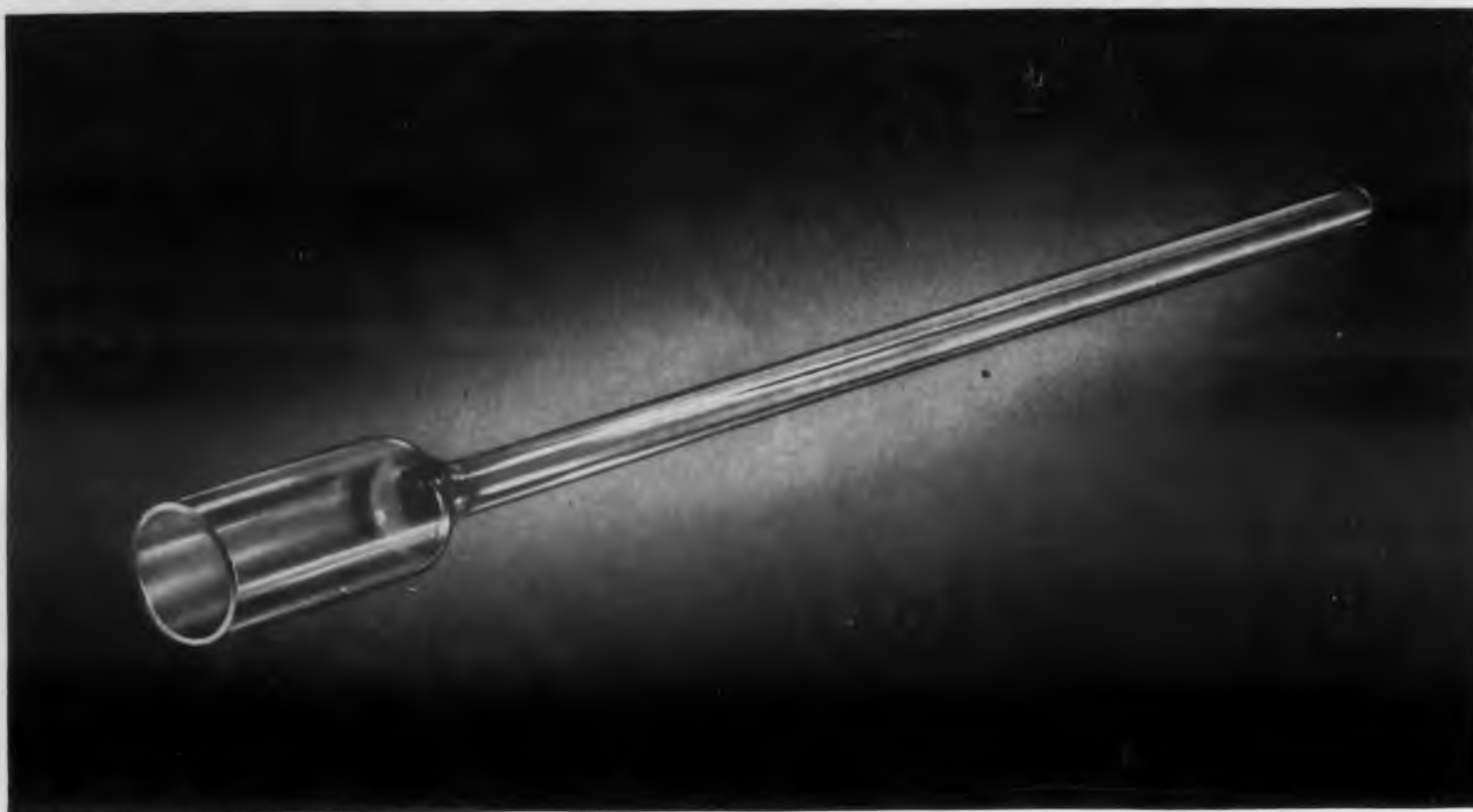
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If you would like to explore the possibilities of using precision glass in your designs, contact the Glass Products Division, Fischer & Porter Company, 5758 County Line Road, Hatboro, Pennsylvania.

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Glass Products Division

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is based almost entirely on the specific interpretation of high temperature performance. For example, where extended high temperature operation is called for, but operating speeds are relatively low, the designer may sacrifice some of the life characteristics to get better performance at the elevated temperature. He might use higher wiper and brush pressure to insure a minimum noise level.

On the other hand, if extremely long rotational life is required, together with extended high temperature operation, as in many servo applications, the pot designer has to maintain more normal wiper and brush pressure. In some instances, he may reduce these values, though the noise level may increase. If the allowable temperature coefficient is reasonably high, a precious metal alloy wire can be used.

The system designer and the potentiometer designer must agree on a specific interpretation of high temperature performance. Perhaps, for example, high temperatures are encountered only occasionally. This may result from a cooling system failure during jet aircraft takeoff. Perhaps a general safety feature is designed to protect against system failures overloading the pot temporarily. This sort of application requires a minimum design change to convert low temperature potentiometers to high temperature units, and it costs less than a new design to the most severe requirements.

Reliability

Many system manufacturers are now specifying higher temperature potentiometers for lower temperature applications merely to gain higher reliability. The failure rate is then inherently lower. Many manufacturers of electronic equipment for missile applications specify only high temperature potentiometers for this reason. They feel the added cost is more than paid for if the possibility of missile failure is reduced by even a fraction of one percent.

Derating Curves

The figure shows a typical wattage vs temperature curve for a standard high temperature potentiometer. Though the temperature ratings are somewhat arbitrary the curve helps the system designer select a pot size to fit his application. But it doesn't completely represent its ability to conform to a particular temperature characteristic.

For example, area B of the figure shows that one can obtain added wattage dissipation at lower temperatures. Furthermore, at maximum temperature, many specific values of resistance yield even higher dissipations. In unusual applications, the designer should consult the manu-



facturer before he rejects the possibility of a specific unit meeting his requirements.

Noise

Another important point to consider in choosing the electrical values for the pot is the noise specification. In general, as temperature increases, noise levels increase. By the same token, extended rotational life at elevated temperatures may result in a faster increase in noise. While in many instances it's hard to define the allowable noise in a system, it is important to do a more complete analysis with a high temperature unit than with a low temperature type. Requirements should be realistic, and should be inclined towards the maximum allowable noise level in the system rather than building the maximum safety factor in the noise spec for the pot.

A statistical approach to noise at high temperature is also worthwhile. By considering the frequency characteristics of allowable noise, one may specify several allowable levels rather than one maximum value, or possibly consider the design of an appropriate filter. Proper attention to other electrical and mechanical values can improve the noise characteristics.

If the manufacturer can use precious metal alloy resistance wires, he can effect a drastic improvement in the noise level and its degradation. Temperature coefficients for precious metal wire potentiometers are generally high, from 250 to 600 parts per million. But one wire manufacturer recently announced a precious metal alloy which may permit values as low as 50 parts per million, possibly with a slight sacrifice in total life, since the wire is slightly less abrasion resistant.

Other Considerations

Resistance values from 5000 to 20,000 ohms have superior temperature characteristics. The manufacturer can wind them with precious metal wires, with their lower resistivity, and he can wind with larger diameter wire of base metal alloy. These will withstand exposure and abrasion for much longer periods.

Torque is another vital characteristic. Manufacturers can use a high torque sealing device or can increase wiper and brush pressures to insure improved performance.

Wider tolerances on linearity or conformity allow the manufacturer to select larger wire.

Potentiometer manufacturers have made great strides in improving their products and in creating high temperature varieties. By proper design, and particularly by working with the pot manufacturer in the early stages of development or spec writing, the system designer can make it easier to insure superior system performance.



Type F: Miniature 12-position, 30-60° throw, can be mounted in 1-5/16" circle; phenolic, Mycalex or steatite.



Type H: Standard 12-position; 1-7/8" diameter; 15-30-60° throw; phenolic, Mycalex or steatite.



Types J, K, N: 1-17/32" diameter; provides for flexibility of layout; interchangeable sections, phenolic or steatite.



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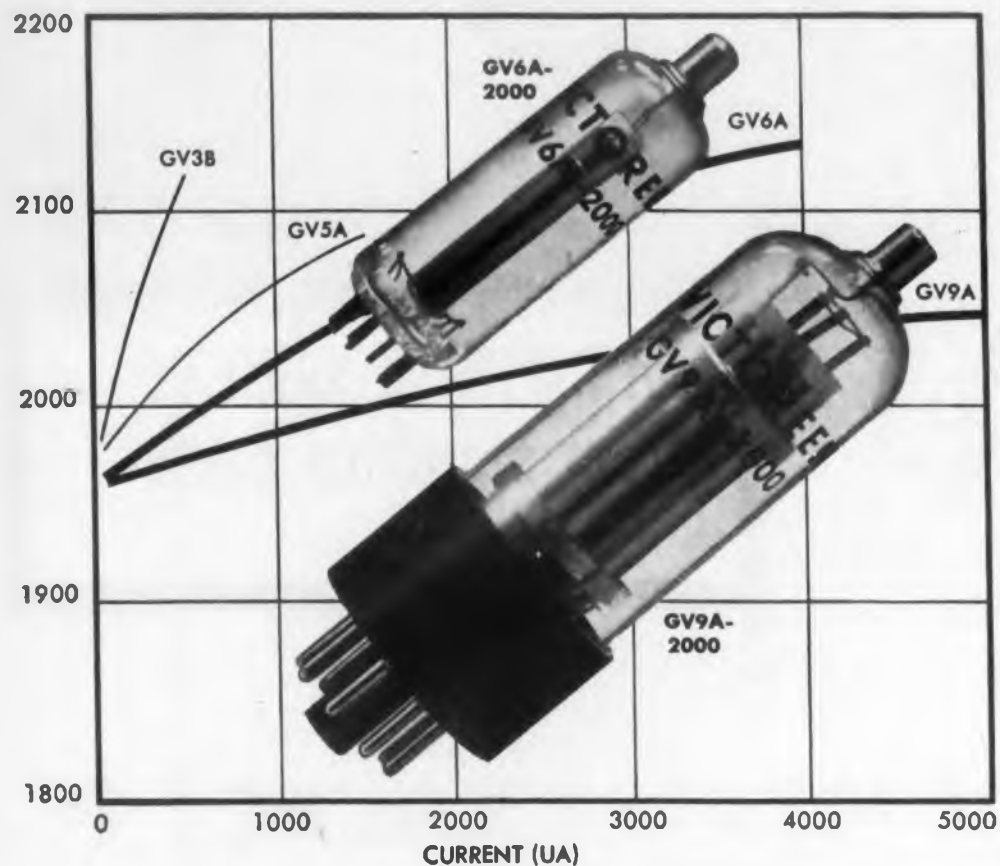


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HIGH TEMPERATURE COMPONENTS

HOT WIRES

CARRY MORE CURRENT THAN YOU THINK

John Mallinson

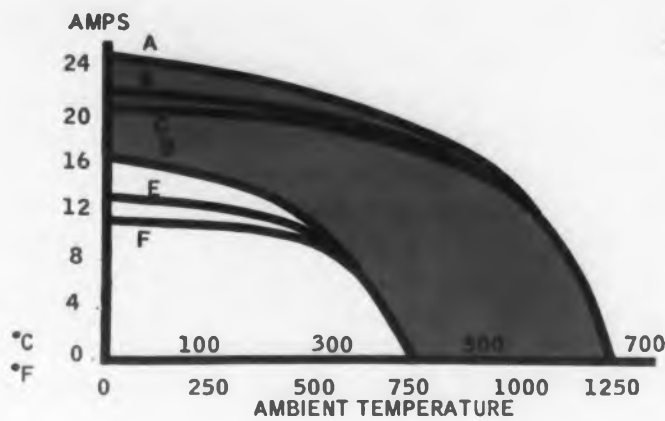
AMP Inc.
Harrisburg, Pa.

Startling as it may seem, you can often push more current through wire in a 500 C environment than you can at 25 C.

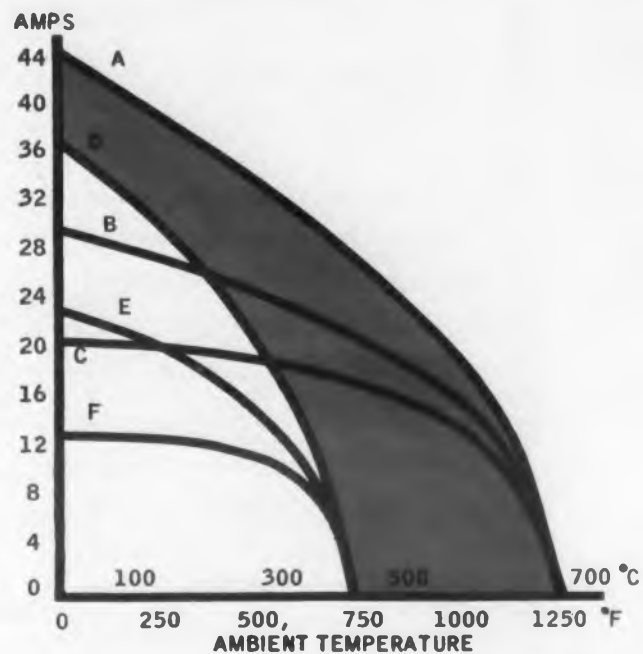
If you don't have to worry about changes in resistivity, as you do if you're building a transformer, but are merely concerned with ampere ratings, this article may save you wire weight and money.



It's hot in there!



(a) 16 gauge oxidized nickel wire (above).



(b) 16 gauge silver wire (right).

Fig. 1. Current ratings for bare wire at various ambient temperatures. Conductor temperature is 675 C for curves A, B and C; and 400 C for curves D, E and F. The colored section shows how much more current the hotter wire can carry. (A and D are at sea level, B and E at 50,000 ft, and C and F are in vacuum.)

AS THE operating temperature requirements of airborne electrical equipment increase, careful consideration must be given to the current carrying capacity of the associated wiring. It is well known that with increasing temperature the resistivity of a conductor increases, but there is, unfortunately, a widespread belief that this increase must lead to a considerable reduction in the current rating.

This article shows that derating only occurs when the temperature difference between the conductor and ambient is reduced. If this difference is held constant, uprating occurs at higher temperatures, rather than derating.

Handbooks See Only Half the Picture

Current ratings in available handbooks are invariably based on free convective heat disposal only. This is acceptable below 100 C ambient where the convective heat disposal is far greater than the radiative. But it is not even approximately correct at higher temperature.

Above 200 C ambient, convection plays a very minor role in comparison with radiation, so the current rating is considerably higher than would be anticipated. For instance, a #16 awg bare oxidized nickel wire can carry more than 20 amperes at 300 C ambient if the conductor temperature is 650 C.

Radiation and Convection

The magnitude of radiation depends on two temperature factors, the temperature difference between wire and ambient, and, where this difference is small, the ambient temperature cubed. It is independent of air density.

The magnitude of convection depends only on the wire to ambient temperature difference and the air density. It does not depend on ambient temperature.

Hence for a constant temperature difference the radiative current rating increases rapidly with ambient temperature while the convective rating falls slowly, (as the wire resistance increases). With changes in altitude the convective rating falls as the 4th root of the air density. The total current rating is the square root of the sum of the two ratings squared, so, if the convective rating is small compared to the radiative rating, its effect on the total rating is almost negligible.

Current Ratings

Current ratings of wires usually give the current required, at various ambient temperatures to heat the conductor to a fixed temperature. Obviously for a particular conductor temperature the temperature coefficient of resistivity cannot be a factor since the conductor resistance is constant. When we compare current ratings at two different conductor temperatures in the same ambient, the rating for the hotter conductor will be greater because of the larger temperature difference. Even if this temperature difference is constant, however, the higher temperature rating is still greater because of the increased radiation efficiency.

Fig. 1A shows the current ratings of bare oxidized nickel wire at various ambients with conductor temperatures of 675 C. (A, B and C), and 400 C (D, E and F). Lines A and D refer to sea level, B and E to 50,000 feet altitude and C and F to a vacuum.

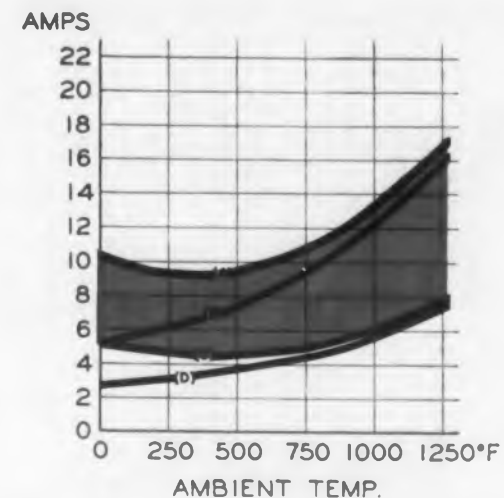


Fig. 2. This is essentially the same data as in Fig. 1a, but plotted differently. The current rating is assigned on the basis of a fixed conductor temperature rise above ambient. A and B have a 250 F rise; C and D have a 50 F rise. A and C are at sea level, B and D at 100,000 ft.

Fig. 1B shows the same conditions for bare silver wire which is, of course, a very poor radiator. Despite its very much lower resistance than nickel (16 per cent at 40 and 11 per cent at 550 C) the current ratings are not even doubled. Notice also how altitude dependent the ratings are. With low radiation, convection is still significant. It should be mentioned, however, that this is an extreme case. All practical wires have radiative efficiencies (emissivities) of the same order as the oxidized nickel.

Fig. 2 shows essentially the same data as Fig. 1A but it is plotted in a different manner. A current rating has been assigned on the basis of a fixed conductor temperature rise above ambient. Lines A and B refer to a 250 F rise, C and D to a 50 F rise where A and C are at sea level, with B and D at 100,000 feet.

Notice, comparing line A with line B, the large convection effect at low temperatures and how it decreases as temperature and resistivity increase. The large increase in radiation which offsets this convective decrease is obvious.

Effect of Insulation

With insulated wires these observations are essentially unchanged. The insulation, depending on its thickness and thermal conductivity alters the shapes of the graphs somewhat. Insulation can be chosen that not only increases the current ratings but also makes them nearly constant over a wide ambient temperature range.

With the advent of higher temperature flexible insulating media, the current rating picture will be excellent. This is indeed an unusual case in high temperature technology.

Applications of Non-Linear Magnetics

Part 4

Herbert F. Storm

General Engineering Laboratory
General Electric Co.
Schenectady, N. Y.

7 SR, Capacitor C, and Linear Reactor L

Line Voltage Stabilizer, Frequency Sensor

As long as the SR saturates twice each cycle (Sec. 3) the average gate voltage across the SR will remain fairly constant (eq. 3-5). In Fig. 7-1 the load resistance R is connected in parallel with the SR, so the average value of the load

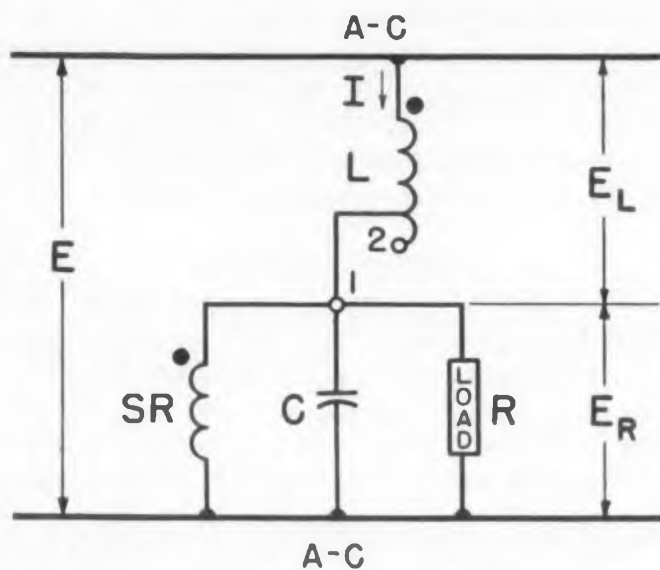


Fig. 7-1. Basic circuit for line voltage stabilizer. (Voltages are rms).

This is the concluding part of Dr. Storm's article on applications of the saturable reactor in combination with other circuit elements. Many of the unusual effects described cannot normally be achieved with linear circuitry. It is hoped that this article will stimulate further study, development and use of non-linear magnetic circuitry.

voltage E_R will also remain fairly constant. To take up the difference between the variable supply voltage E and average load voltage E_R , a linear inductor L is provided (Ref. 7-1).

As indicated, the load voltage E_R is not perfectly constant, but will change slightly in the same direction as the supply voltage changes. To counteract this variation, a voltage is added to the load circuit, which will decrease the load voltage when the supply voltage increases, and vice versa. Such a voltage can be introduced by connecting the load to tap 2 of the linear inductor L , instead of the tap 1. The capacitor C improves the regulation properties of the circuit, and affects the wave shape of the output voltage.

Line voltage stabilizers, using this principle, are commercially available for output powers from a few watts up to many kilowatts. The output usually is held within ± 15 per cent. In most commercial stabilizers the output circuit is isolated from the supply circuit. The speed of response of the circuit is usually such as to correct for line voltage fluctuation in less than two cycles. Another important feature of this circuit is the inherent limitations of line currents in case of short circuits in the load.

As the supply frequency changes, the number of pulses of fixed volt-seconds as controlled by the SR, also changes. Hence the load voltage becomes frequency sensitive (eq. 3-5). In cases where this sensitivity is undesirable, frequency compensators can be supplied.

However, there are applications where the object is to indicate or control the supply frequency. In such a case the load current of the voltage stabilizer is compared with a current derived directly from the same voltage via a fixed impedance, the difference between these currents being the error signal. A circuit similar to that shown in Fig. 6-2 would be useful. For a fixed supply voltage, the output voltage of the stabilizer will increase by about 1.5 per cent for an increase of 1 per cent of the rated supply frequency.

Square Wave, Constant Voltage Power Supply

The designer of a voltage stabilizer has several means for affecting the output wave shape. In most cases, one will attempt to obtain a sine shape. There are, however, cases where a square voltage is more desirable, the case in point being a power supply for magnetic amplifiers, whose control characteristics should be inherently linear (Ref. 7-2).

The output voltage E_R (Fig. 7-1) can be made fairly square by using a square loop core material and toroidal construction for the SR. (Refs. 7-3,7-4).

The core material of the SR (Fig. 7-2A) is represented by the flux-current relationship shown in Fig. 7-2B. The load resistance R is assumed to be infinitely large; the switch S is open, and capacitor C has been charged to a potential of E_m volts. The core of the SR has been set to point 1 of Fig. 7-2B. At $t = 0$, the switch is closed. The voltage E_m is now applied to the SR,

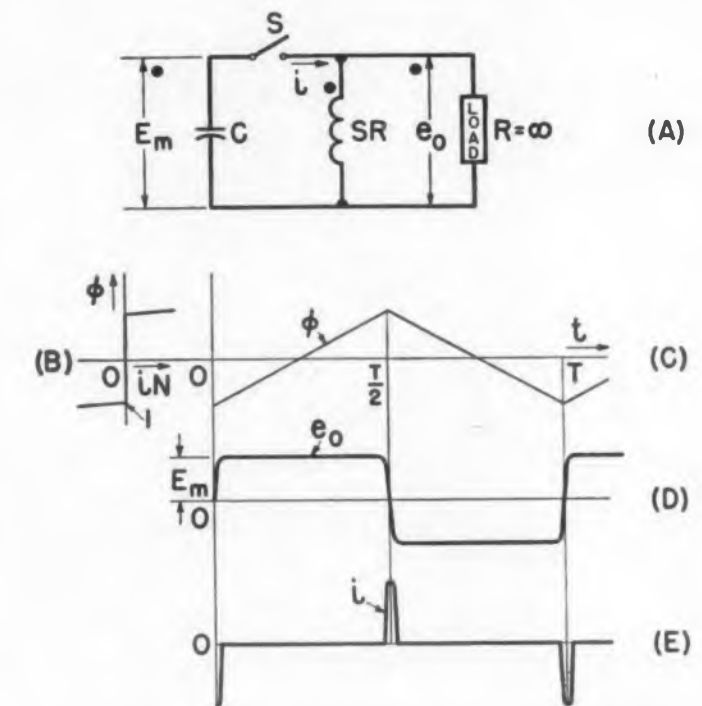


Fig. 7-2. Square Wave, constant power supply: (A) simplified circuit part; (B) flux-current relation; (C) core flux; (D) output voltage; (E) current between C and SR.

and its core flux ϕ increases according to

$$\phi = -\Phi_s + \frac{10^8}{N} \int E_m dt \quad (7-1)$$

By assuming zero width of the flux-current loop of the core, and infinite resistance for the load, no current is drained from the capacitor C , so the output voltage $e_o = E_m$. The flux ϕ increases linearly as shown in Fig. 7-2C. At $t = T/2$, saturation is reached. The only impedance in the discharge path of the capacitor C is assumed to be derived from the air flux of the SR.

A sinusoidal current i of very short duration will flow (Fig. 7-2E), transferring the electrostatic energy of the capacitor into electromagnetic energy of the air field of the reactor, and then returning this air field energy to the capacitor C , resulting in a voltage reversal of the capacitor. Under the influence of $-E_m$ the core of the SR will now decrease its flux linearly until $t = T$, where another reversal, similar to the one described above, takes place. Since the losses are assumed zero, this oscillation will continue, resulting in an output voltage e_o , of nearly square wave shape.

By connecting the circuit of Fig. 7-2 by means of a linear inductor L to an ac supply voltage (resulting in the circuit previously shown in Fig. 7-1), continuous generation of square waves is assured. At the same time, the constant voltage properties of this circuit are retained. It should be pointed out, however, that the flow of output current into the load spoils the squareness of the output voltage (Refs. 7-3, 7-4).

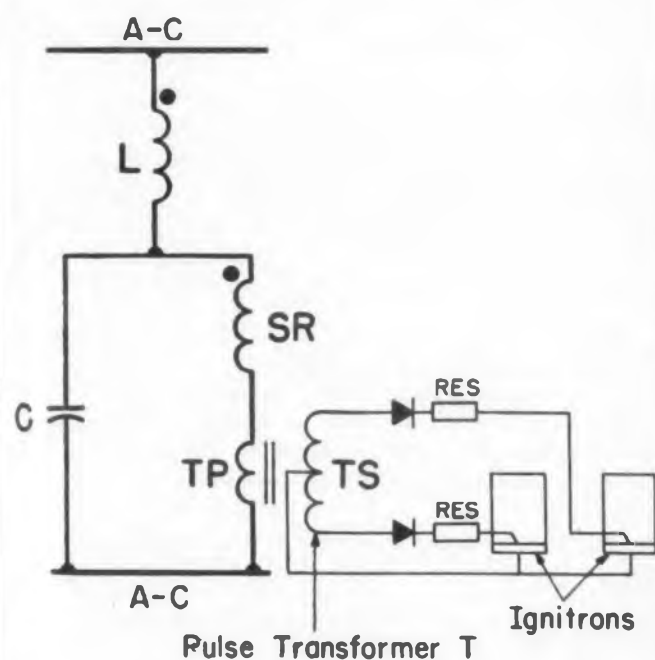


Fig. 7-3. Pulse former circuit for firing of ignitrons.

Pulse-Former Circuit, Firing of Ignitrons

It has been shown in Fig. 7-2E that a sharp current pulse flows between capacitor C and SR.



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This pulse can be used for firing ignitrons as shown in Fig. 7-3. The circuit is derived from Fig. 7-1 by connecting the primary TP , of a pulse transformer in series with SR . The secondary TS , of the pulse transformer energizes the ignitrons via rectifiers and resistors (Ref. 7-5). Rectifiers are used to avoid damaging the ignitrons with reverse current.

The circuit shown in Fig. 7-1 also serves as the starting point for so-called "pulse sharpening circuits" which are used, among other things for radar circuitry control (Ref. 7-5).

8 SR and Rectifier Rec

Self-Saturating, Half-Wave Magnetic Amplifier

By replacing the symmetrical, non-linear resistor of Section 5, Fig. 5-1, by a rectifier, the self-saturating, half-wave magnetic amplifier results (Fig. 8-1). This circuit is the basic building block of the vast majority of magnetic amplifier applications (Refs. 8-1 to 8-5).

Recently, the application of magnetic amplifiers to static switching applications has been revived. Since the operation of many of these switching applications is analogous to typical magnetic amplifier operation, references to static switching applications are listed here. Refs. 6-2, 6-11, 8-8 to 8-14.

Cores and rectifiers are also used in increasing numbers in computers and in digital information

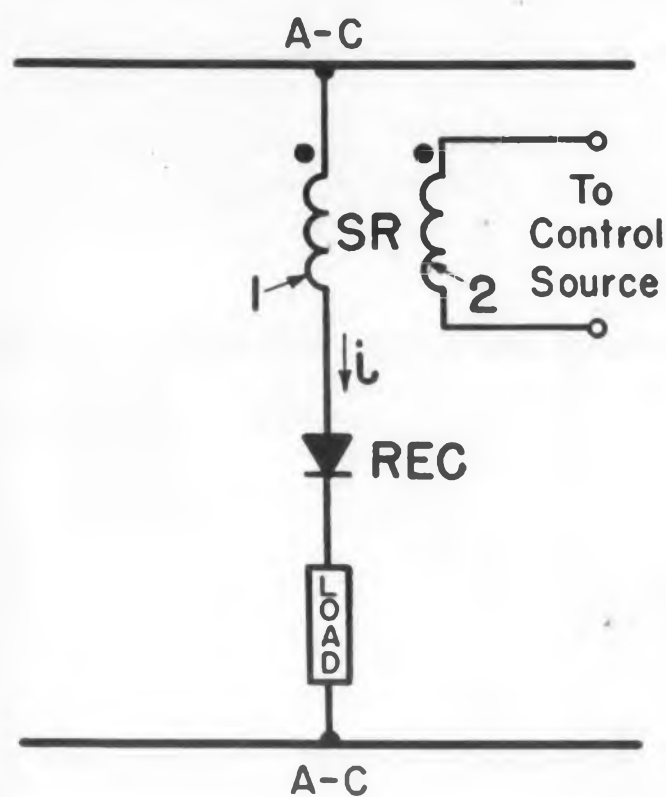


Fig. 8-1. Self saturated, half-wave magnetic amplifier.

handling equipment. These circuits usually use a plurality of cores and rectifiers and hence fall outside the scope of this paper. For readers interested in this field, Refs. 8-15 to 8-19 have been prepared.

9 SR and Transistor T

Oscillator, Frequency Modulator

An SR is connected in series with a transistor T as shown in Fig. 9-1. Winding 2 of the SR is connected to the load resistor by means of the closed switch S (Ref. 9-1).

Assume that the core of the SR is unsaturated. If the dc supply voltage is now applied to the circuit, the transistor will pass some current, and part of the dc supply voltage will appear as a positive voltage across winding 1 of the SR . This voltage is transformed into winding 3 which provides positive feedback and makes the transistor fully conducting. A positive output voltage e_o is induced simultaneously in winding 2. This supplies power to load resistor R , and also charges the distributed winding capacitance C , of the SR .

When the core flux reaches the positive knee of the flux-current loop, the voltage induced in winding 3 becomes smaller, so the emitter-collector resistance of the transistor goes up. This process is cumulative to the point where the voltage across winding 1 will even reverse (that is, it becomes negative) in order to maintain its state of magnetization according to Lenz's law.

The voltage on winding 3 also becomes negative and current flow in the transistor is blocked. However, a negative voltage also appears on winding 2, which is able to carry a current to satisfy Lenz's law. Thus, the capacitance C is rapidly discharged and recharged in the opposite direction.

As a result, the core flux returns from positive saturation to the unsaturated part of the flux-current loop. The output voltage e_o , which is now negative, decreases the flux in the cores according to Eq. 2-2. The transistor is blocked from conduction by winding 3. The core flux finally

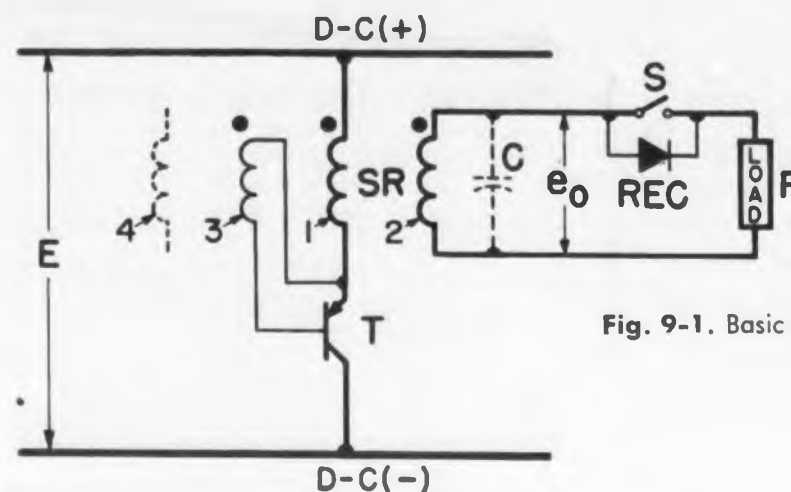


Fig. 9-1. Basic oscillator circuit.

reaches negative saturation, whereupon Lenz's law causes a positive voltage to appear across all windings of the SR . As a result, the transistor again turns full on, and completes the cycle of operation, producing ac in the load resistor R .

If one desires to obtain a series of unidirectional pulses in the load resistor, switch S is opened and rectifier Rec becomes effective.

The oscillator frequency can be controlled over a range of 3 to 1 by varying the dc supply voltage E (Ref. 9-1). A different manner of varying the frequency consists in introducing a de-control signal to the fourth winding of the SR .

An SR can be combined with two transistors to form a square wave oscillator, which, among many applications, can be used to energize magnetic amplifiers (Ref. 9-2 to 9-7).

Combinations of transistors and magnetic cores are used in computer engineering as indicated by Refs. 9-8 to 9-10.

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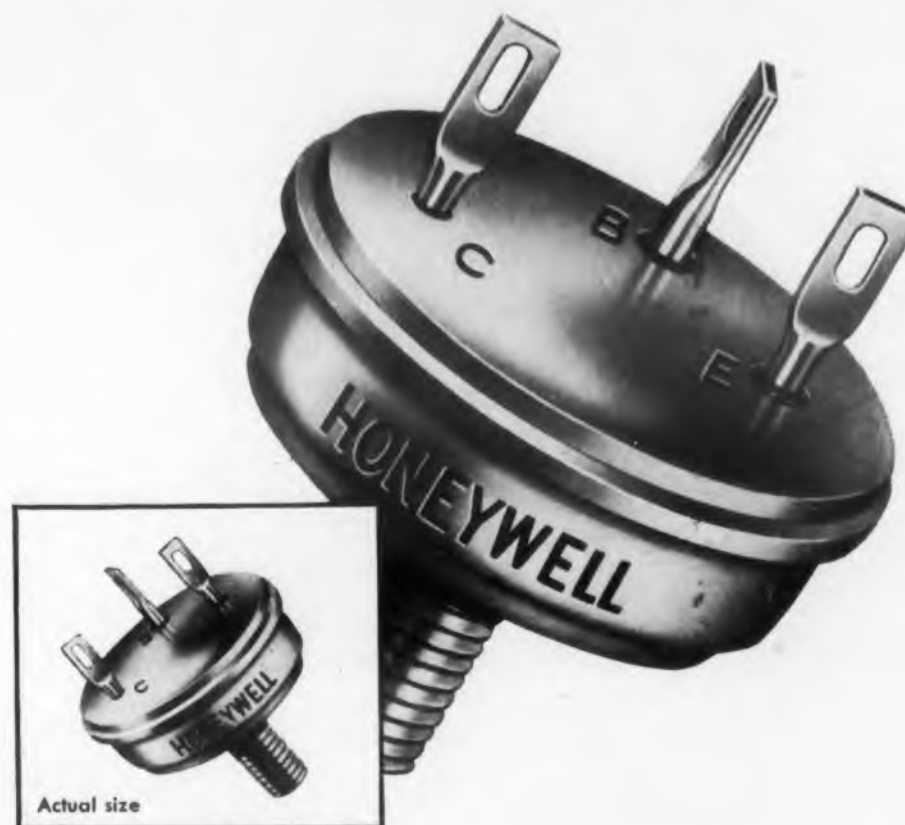
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From a paper presented at the Winter General Meeting of the AIEE in New York City, Feb. 2-7, 1958.

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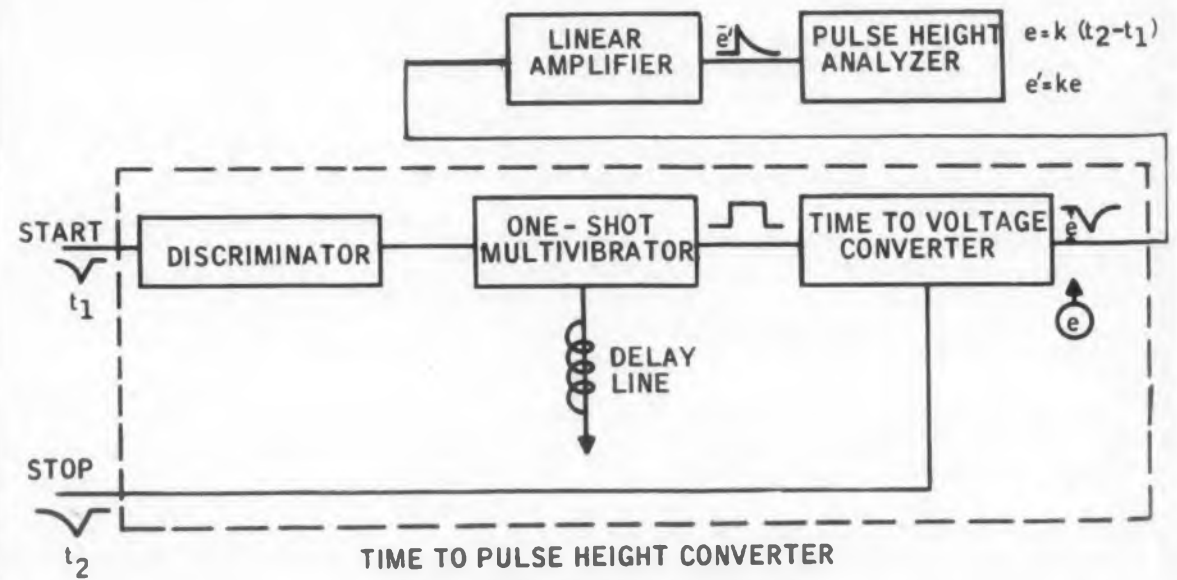


Fig. 1. Block diagram of Nanosec.

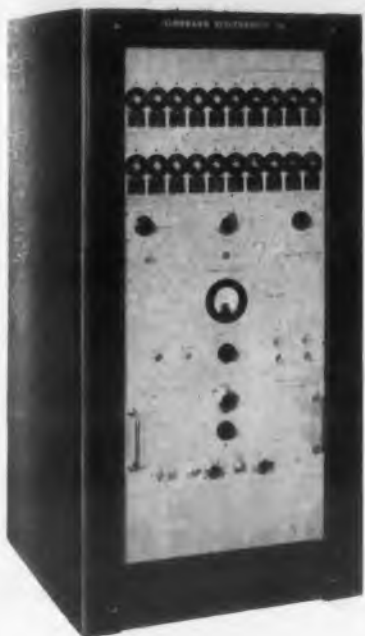


Fig. 2. Measured time interval is shown on the proper indicator in the top panel.

verter generates a negative linear ramp pulse. Maximum amplitude of the ramp is determined by the width of the gate pulse.

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Manufacturers of radar and other high frequency pulse equipment have long felt the need for a primary standard laboratory instrument to measure RF power in the microwave region. The Cubic Calorimetric Wattmeter, Model MC-1B, was designed particularly to provide you with a highly precise instrument of this type, and one with simple and fundamental instrumentation methods to establish long calibration life.

For example, precision thermometers are used, since they are far more stable and reliable than thermocouple or thermistor temperature-indicating circuits. The high accuracy of the MC-1B is maintained without frequent calibration.

Our Calorimetric Wattmeter consists of two units—a liquid circulator and a water load termination. The circulator unit controls the flow of metered amounts of distilled water through the termination, where RF output is converted to heat by means of a water load. Heat absorbed by the distilled water calorimetric fluid is measured on precision thermometers. A power scale on the termination permits direct, precise power readings in watts.

Distilled water is used as calorimetric fluid because of its

high dielectric loss characteristics above 1000 mcs. The circulator permits visual monitoring of the fluid flow rate at all times. All parts of the circulator are designed and fabricated to prevent fluid contamination.

Through the use of RF adapters, a match better than 1.15 in VSWR from 2600 to 26,500 mcs is achieved without problems associated with the excitation and propagation of higher order waveguide modes.

Metered fluid flow, precision temperature readings and well designed control of heat transfer permit extreme accuracies of power measurement.

Cubic Calorimetric Wattmeters are being used extensively by industrial and government laboratories. For example, RCA has over 30 of these instruments in use to check out and calibrate magnetrons and radar systems. Hughes Aircraft Company uses the Calorimetric Wattmeter in its laboratories.

Cubic's Calorimetric Wattmeter will prove its accuracy—as no other wattmeter can—in your laboratories, in your plant, or in the field.

For a prove-it-yourself demonstration of how you can obtain consistent, repetitive results in RF measurement, telephone or write...



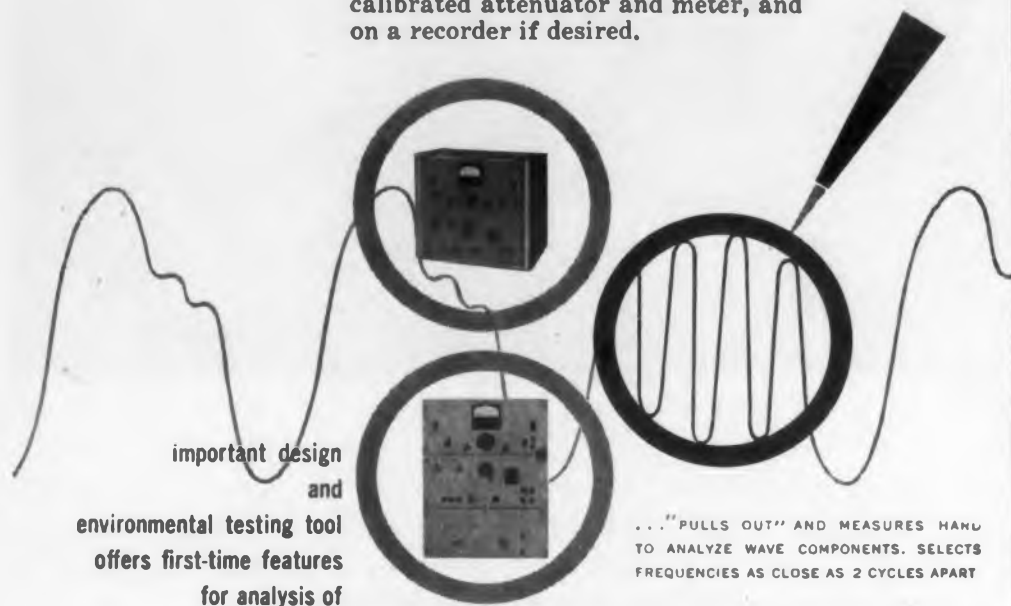
CUBIC CORPORATION

5575 Kearny Villa Road, San Diego 11, California

CIRCLE 51 ON READER-SERVICE CARD



Increasingly important to environmental testing, the TP-625 Wave Analyzer System offers performance features never before available. Determines frequency and amplitude of vibration... strain... pressure — any mechanical, chemical, optical or other variable which can be converted to an electrical signal ranging from 2 to 25,000 cycles. Individual wave components are measured in decibels, in percent of total signal, or both. Results are indicated on a calibrated attenuator and meter, and on a recorder if desired.



important design and environmental testing tool offers first-time features for analysis of

VIBRATION — STRAIN — PRESSURE

TRACKS AUTOMATICALLY

Auxiliary equipment — TP-628 Servo Drive — allows automatic tracking to frequency set by speed of equipment being analyzed... follows RPM, multiples of RPM, or shake-table drive... throughout an operating range. Uses and applications are limitless. Other auxiliary equipment includes a TP-633 Power Integrator, which provides a power spectral density analysis of random waves. Get full details on this important design and environmental testing tool. Write for new bulletin on the TP-625 Wave Analyzer System.

Developed, improved and manufactured by



INSTRUMENT DIVISION

Technical Products Company

6670 Lexington Ave., Los Angeles, 38

INTEGRITY IN INSTRUMENTS SINCE 1932

CIRCLE 52 ON READER-SERVICE CARD

HIGH TEMPERATURE COMPONENTS

High Temperature Relay Designs

S. M. DePuy

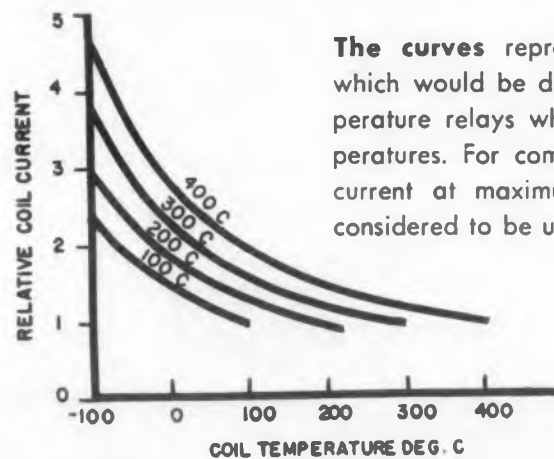
General Electric Company
Specialty Control Department
Waynesboro, Va.

THE SEARCH for high temperature reliability in relay design came at an unfortunate time, since it followed closely upon an industry-wide emphasis on miniaturization. With a product already reduced to the barest minimum in size and weight, the relay designer had no alternative but to find new dielectric materials and heat resisting metals. In this search the designer was partially successful. New techniques with Formex, and the use of Teflon where possible, carried dielectric problems toward a solution providing the 200 C relay.

At present, the 300 C relay does not seem impossible. By the use of inorganic insulation and high temperature springs and contacts, it can reasonably be ex-

pected that such relays will be available for use in the near future. The principal considerations in the design of such a relay will concern the increase in operating voltage and watts at higher temperatures, and the problem of making reliable connections.

Since magnetic relays are operated by coils which increase in resistance as coil temperature rises, it follows that as the temperature is increased, coil voltage and watts must be increased to provide the necessary coil current to operate the relay. Some designs depend on a reduction in spring forces and changes in adjustment resulting from thermal expansion. Changes such as these may adversely affect operation at extremes of tempera-



The curves represent the relative current which would be drawn by various high temperature relays when operating at low temperatures. For comparison purposes, the coil current at maximum design temperature is considered to be unity.

Are Different

ture and should be minimized or compensated for in the design.

In most designs, a coil operating at 400 C will require nearly twice the power and release twice the heat as one operating at 100 C. To reduce this coil heat and power requirement, a larger coil size will be required. However, a relay designed for high temperature operation will draw considerably higher currents when operated at low temperature. The graph indicates the current drawn by a relay which has been designed for high temperature operation and is operating at lower temperatures with the same applied voltage. While these higher coil currents will not cause undue heating at the lower temperatures, trouble may be experienced in associated equipment where close regulation of power supply is required or false operation of protective equipment may occur. Also, the magnetic forces of the relay will be increased and relay life may be shortened.

The type of termination used must be either high temperature solder, welding, or mechanical means capable of maintaining low contact resistance after long exposure to high temperature. Such connection must be protected by either finishes or inert atmosphere protection. Another problem is the loss in dielectric strength of air at elevated temperature, particularly at high altitude. As an example, the breakdown voltage of a gap at 300 C would approximate the breakdown voltage at one-half that gap at room temperature at the same pressure. To meet these conditions, either additional spacing and barriers may be required, or dielectric coatings may be applied to increase breakdown voltage at terminals.



Readin', 'Ritin', and Reliability



Synthane plastic laminated bushings and breaker arms for automotive ignition.

Dependable operation of a school bus, a truck, or your own car involves the functioning of many parts. One breakdown can wipe out the memory of ten thousand trouble-free miles.

Some of these parts are made of laminated plastics. They're usually unseen, unsung, small in size yet efficiently performing their job.

Their cost is relatively insignificant when compared with the cost of equipment in which they work, but it should be sufficient to insure dependability.

Actually, what you pay for Synthane laminated plastics is little or no more than you'd pay for any

other plastic laminate. But the Synthane price includes top quality materials, product control, excellent facilities and workmanship, an assurance of continuous supply, and a long reputation for fair dealing.

If you are interested in a reliable source of laminated plastics—sheets, rods, tubes, or completely fabricated parts, write for an interesting catalog or call our representative nearest you.

SYNTHANE
S

SYNTHANE CORPORATION, 42 RIVER RD., OAKS, PA.

CIRCLE 53 ON READER-SERVICE CARD



Now—guaranteed practical inductance limits for regular and frequency-stabilized permalloy powder cores

Call them frequency-stabilized or temperature stabilized, the important thing about these new molybdenum permalloy powder cores made by Magnetics, Inc., is our *guarantee* of core inductance within realistic limits. You can write—right now—for these guaranteed limits.

Filter circuit designers will take note that these guaranteed limits for permalloy powder cores are far tighter than those published before. Note also that they are guarantees on inductance which is the parameter of chief concern to the core user rather than on permeability.

This can save you dollars on your production line—by cutting down on adjustment of number of windings on coils.

And you know, too, that temperature stabilization eliminates difficult compensation problems.

But did you know that we guarantee these new inductance limits for all of our permalloy cores, whether stabilized or not? For all the facts, write us at *Magnetics, Inc., Dept. ED-47, Butler, Pennsylvania.*

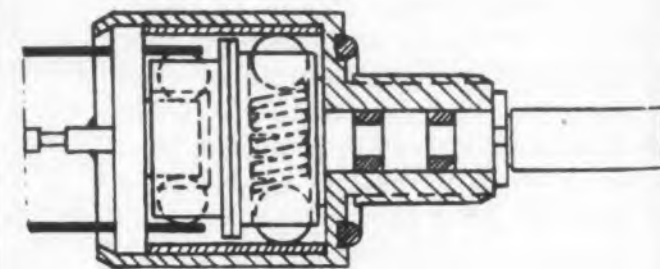


CIRCLE 54 ON READER-SERVICE CARD

Sealed Rotary Switch

SOME unusual constructional details, such as free-floating wipers and a completely water-tight 1/2-in. shell, make this switch notable. The switch has such ratings as: 100,000 cycle life; 125 C temperature; contacts 1 amp 250 v dc resistive, and 350 ma 100 v dc inductive; contact resistance less than 0.008 ohms; dielectric strength 1000 v rms between terminals or to ground; low capacity between all parts; and several environmental qualities, including good resistance to corrosion, shock and vibration.

Sixteen shorting and seven non-shortening switching arrangements are currently being produced by the Daven Co., Livingston, N.J. A typical arrangement of the series G switch might be one pole, with up to ten positions shorting. The materials used are of a corrosion resistant type or are suitably treated or plated to resist corrosion. All plastics used are heavily filled with glass or orlon fibres. The O rings are neoprene or silicone rubber. No ferrous material is used for current carrying parts, and the use of dissimilar metals



The design of the wiper assembly is generalized in this drawing. Circular in shape, the free-floating wipers are dropped into apertures in the rotor during assembly. The detent mechanism, consisting of two balls on either end of a spring, is near the shaft-end of the switch.



was avoided to prevent electrolytic corrosion.

Both the shell and the switch shaft are made of type 303 non-magnetic stainless steel. Two grooves for O rings are provided on the portion of the shaft inside the bushing. The end of the shaft inside the switch is terminated by a short cylinder about 1/3 in. in diameter. A hole is drilled through the center of this cylinder at right angles to the shaft, and a helical spring with a ball at each end (see drawing) is inserted to provide the moveable part of the detent mechanism. During assembly, a phenolic rotor is secured to the shaft by spinning over a hollow rivet on the flat end of the cylinder.

The rotor assembly, which is heavily filled with glass or orlon fibres, is provided with apertures which make it possible to drop in the wipers during final assembly. The wipers are in fact free floating due to the arrangement between the rotor and the contacts, and as a result they cannot be unduly stressed during assembly. The wiper material, which is rhodium-plated beryllium copper, is also not subject to the corrosion which might occur if they were fastened by a dissimilar material. The combination contact-terminals and pole pieces are precision formed out of silver alloy. The contact portion is curved slightly, so that the entire array of contacts is a discontinuous circle, which provides smooth wiper action and eliminates the possibility of the wiper hanging up on contact edges.

The assembly of the switch is a straight forward procedure which does not require bending, fitting or filing. After the switch parts have been assembled and tested, the shell is spun over the contact-terminal panel. Heavily filled epoxy resin is then applied to the contact-terminal panel to seal this panel to the shell.

For more information on the series G switch, turn to the Readers-Service card and circle 55.



Truly sub-miniature, these capacitors were devised especially for printed circuits and automatic assembly. Since they retain all the properties of larger, pig-tail capacitors, they are well suited to general circuitry as well.

Now—Corning Fixed Glass Capacitors in new sub-miniature size

Packing up to 1,000 uuf at 300 V. and 125°C. into 0.010 cubic inches, these new capacitors are designed for use on printed circuit boards and all applications requiring high-quality components. Advantages include fixed temperature coefficient, high insulation resistance, low dielectric absorption, the ability to operate under high humidity and high temperature conditions, plus the added advantage of increased miniaturization.

You can now up-grade your specs for miniature capacitors used on printed circuits.

These new capacitors measure only $\frac{3}{32} \times \frac{1}{8} \times .115$, yet have capacitances up to 1000 uuf at a full 300 V. rating at 125°C. Such exceptional thinness makes these capacitors particularly well suited for vertical mounting in small, high-rated units.

The capacitors have high temperature soldered leads which allow direct connection to circuit boards. The leads are .100 inches long, fitting most circuit board thicknesses and eliminating any trimming.

Reliable • Since the new construction is extremely simple, reliability is correspondingly high.

Rugged • These capacitors, when mounted, successfully withstand a standard five-hour vibration cycling test at 10 to 55 cycles, 15G Max.

Known as WL-4 capacitors, these units are in mass production. Your inquiries concerning data and prices are welcome.

FEATURES

1. to MIL C-11272A except smaller
2. 1 to 1,000 uuf
3. 300 volts
4. 125°C. full rating
5. .010 cubic inches

Corning means research in Glass



CORNING GLASS WORKS, 97-5 Crystal St., Corning, N.Y.

Electronic Components Department

CIRCLE 56 ON READER-SERVICE CARD

Fafnir presents a

NEW
series of
MINIATURE BALL BEARINGS

featuring

1. Vacuum melt 440C stainless steel
2. Balanced design
3. Precision tolerances

Fafnir now offers a series of miniature ball bearings, developed expressly for precision instrument applications, where performance and long life are vital.

Bearings in this new series are manufactured entirely of extra clean, vacuum melt, 440C stainless steel, to eliminate the chances of pits and imperfections in the races. Superior race finishes make supersensitive bearings with low torque values.

They are made to ABEC-5 tolerances or better, and offer a "balanced design" because each bearing is equipped with a separately designed retainer. Thus the pitch circle of the balls is centered between the bore and outside diameter.

Write for bulletin listing sizes and dimensions, available in Fafnir's new precision miniature series. The Fafnir Bearing Company, New Britain, Conn.

Four design variations in each size
Open Type • Two Shields
Flanged Type • Flanged Two Shields

FAFNIR
BALL BEARINGS

CIRCLE 57 ON READER-SERVICE CARD

Cool Canned Power Resistor

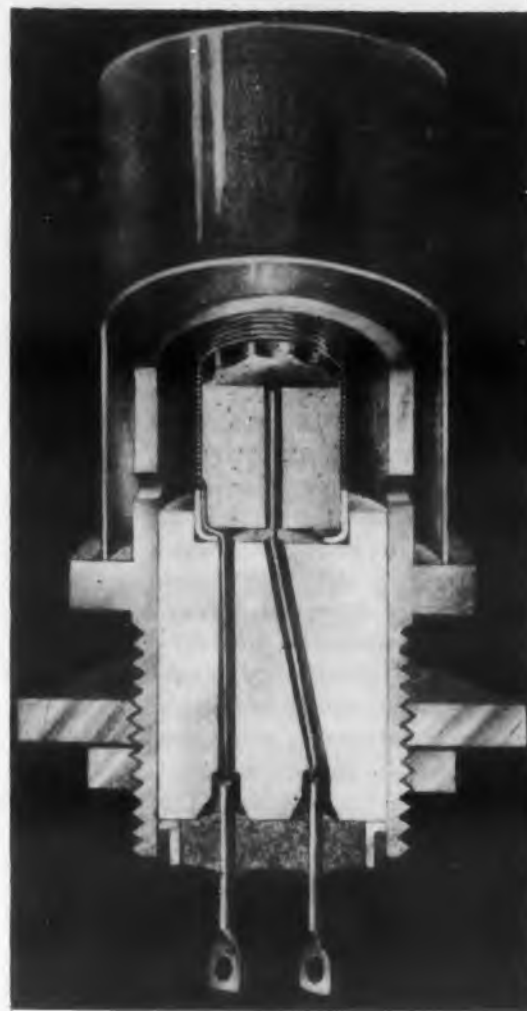


Fig. 2. New resistor construction.

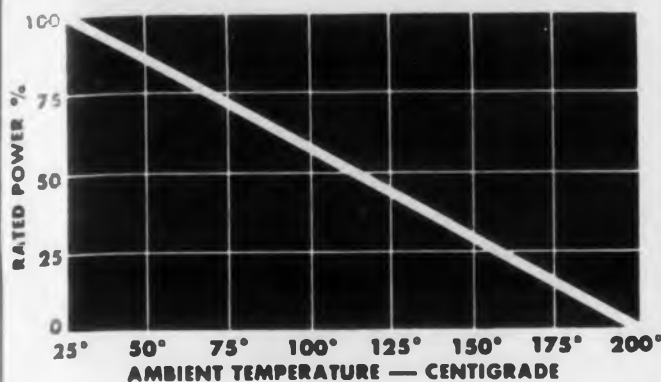
DISSIPATING 25 w, this power resistor gets no hotter than 175 deg C. With a stability on the order of 0.1 per cent change in 1000 hours at full load, and a temperature coefficient of less than 20 ohms per megohm per deg C, the resistor can be used for precision power attenuators, ultra-stable loads, precision power dividers, high reliability applications, and in corrosive or humid atmospheres. It is useful in places where heat might damage nearby components or where small size is important.

The new power resistor, manufactured by the Resistor Division of Topaz Transformer Products, Inc., 1337 Morena Blvd., San Diego, Cal., contains no moving mechanical parts. It can operate in any position and has a lower operating wire temperature than any other resistor of its size and wattage. The basic unit consists of a precision resistance wire wound on an extruded ceramic core. Connections to the leads and terminals are silver-soldered to eliminate failures which might be produced by spot welds or soft solder. The wire-wound core is mounted in two chemically inert and physically resilient end holders which provide for differential expansion of the other parts of the resistor. The wire itself is cemented to the ceramic core, to prevent slippage or shorting out between turns. Virtually all the resistance wire is surrounded by a chemically-inert, high-dielectric strength liquid. The entire unit is then enclosed in a copper housing which makes physical contact with a standard chassis.

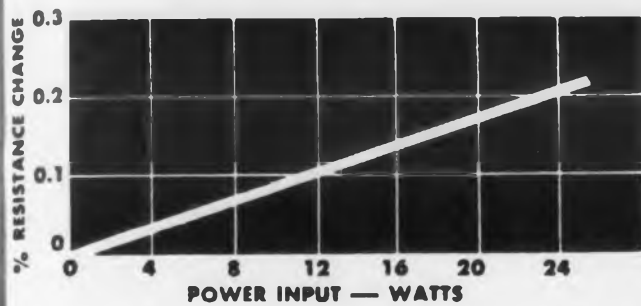
When current is passed through the wire, the liquid boils and, so doing, absorbs heat. Conduction and convection occur; the heat is given up by the liquid to the thermally efficient copper case. A high insulation resistance—approximately 10,000 meg—is maintained while the wire is cooled at a high rate. The wire temperature is over 300 per cent cooler than that of other types of similar-wattage heat-dissipating resistors. A short thermal time constant from load variations is valuable in applications where adjusted load drift cannot be tolerated.

A test group of units has been run for over 3000 hours without a single failure, boding well for the unit's reliability.

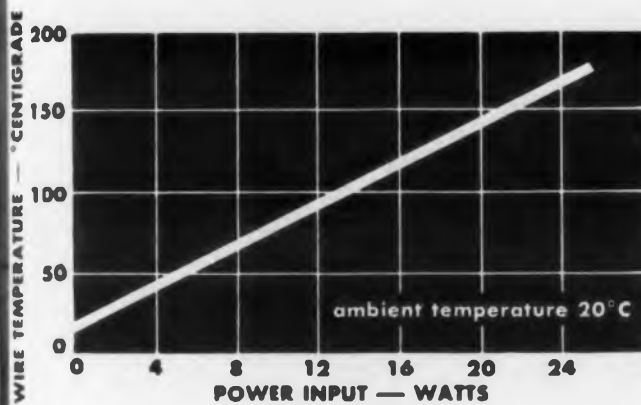
At the time of writing, the resistor is available in only one physical configuration, shown in the photograph. Other variations will be available as soon as the necessary tests are conducted. Overall length of the resistor is 1-1/2 in., and diameter is 3/4 in. Power rating is 25 w, resistance is from 1 to 16,000 ohms, with tolerances of from 0.05 to 5 per cent. Hi-pot rating is 1500 vdc. Winding is inductive; the unit is designed to be chassis-



(A)



(B)



(C)

Fig. 1. Typical operating conditions of the canned resistor on a 12 x 12 x .059 in. aluminum panel. Notice that the wire is kept much cooler than the wire in other power resistor types.

mounted. Fig. 1 (a), (b) and (c) show the typical operating conditions on a 12 x 12 x 0.059 in. aluminum panel.

This power resistor compares with power resistors typically operated at high wire temperatures—often higher than 500 deg C. In other units the wire is often exposed to the air which oxidizes it and prematurely causes “opens,” or are enclosed in glass and vitreous enamel which, while good electrical insulators, are also excellent heat insulators.

Similar canning of the type used in this power resistor can be applied to silicon power diodes and other high powered components.

For further information please turn to the Reader Service card and circle 58.

6 cps to 100,000 cps at
1,000 WATTS CONTINUOUS DUTY

...with
the new
Genisco-Savage
high-output
amplifiers!

Seven models—rugged enough for production line testing; versatile enough for almost all laboratory needs.



The Genisco-Savage Model V1000 Shaker

Here's the new line of quality, high-output amplifiers you've been waiting for! All seven models feature high power output, low distortion, exceptionally high reliability and stability, and excellent output voltage waveform.

The Model KLF, shown at left, is particularly useful as an exciter for vibration testing equipment and as a variable frequency power supply for a multitude of production and laboratory needs. It will operate *continuously* with an output of 1,000 watts from 6 to 2,000 cps.

Components of all Genisco-Savage Amplifiers are mounted on 19" vertical panels to facilitate easy inspection and maintenance. Quick-release grill covers make all tubes readily accessible from the front. Numerous built-in safety features protect the equipment from operator errors.

Two New Shake Tables Available The new Model V1000 Genisco-Savage Shaker features a very light moving coil assembly, high thrust-to-weight ratio, automatic impedance matching, and an excellent output waveform. A continuous alternating thrust of ± 600 lbs. is produced at 1,000 watts control power. Thrust can be increased to ± 750 lbs. peak by use of a blower (Model V1000B). Both models have been stress-tested to withstand continuous operation at accelerations of 100 G's.

BRIEF SPECIFICATIONS	MODELS						
	BM2	DM2	KM2	10K	KM2S	KLF	KRF
Output	250 w at 50 or 100 v	500 w at 50 or 100 v	1000 w at 50 or 100 v	10,000 w maximum	1000 w at 50 or 100 v	1000 w at 50, 100, or 200 v	1000 w at 25, 50 or 100 v
Frequency Range	50 to 10,000 cps at 250 w	50 to 10,000 cps at 500 w	50 to 10,000 cps at 1000 w	40 to 10,000 cps at 10,000 w	50 to 10,000 cps at 1000 w	6 to 2000 cps at 1000 w	5 to 100 kc at 1000 w
Sensitivity	0.036 v at 600 ohms	0.04 v at 600 ohms	0.1 v at 600 ohms	0.16 v rms at 600 ohms for 10,000 w output	0.1 v at 600 ohms	0.05 v at 600 ohms	0.5 v at 600 ohms
Distortion	1% at 250 w, 1000 cps	0.75% at 500 w, 1000 cps	Less than 0.75% at 1 kw, 1000 cps	Less than 3% at 10 kw, 1000 cps	Less than 0.75% at 1 kw, 1000 cps	Less than 5% at 1 kw, 10 to 1000 cps	

Price and delivery of both amplifiers and shakers are exceptionally good. For complete specifications and prices send for the new four-page illustrated brochure.

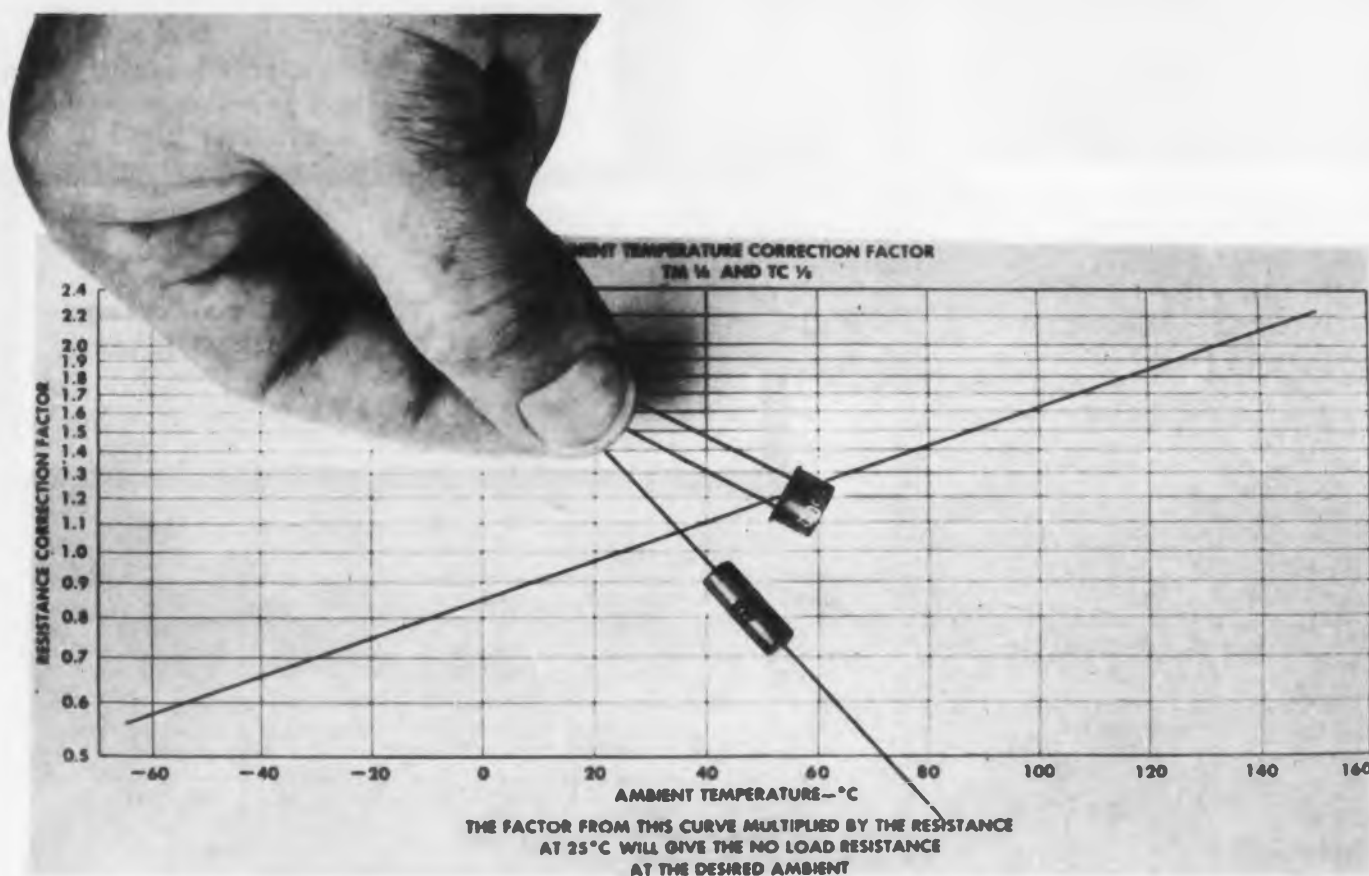


Genisco, Incorporated
2233 Federal Avenue
Los Angeles 64, California

CIRCLE 59 ON READER-SERVICE CARD

NEW PRODUCTS

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



SILICON RESISTOR

Called the **Sensistor**, this silicon transistor is noteworthy due to a stable positive temperature coefficient of resistance of 0.7 per cent per deg C. Because of this large positive coefficient, the Sensistor can be used as a temperature compensating device for a silicon transistor by simply connecting it in series. Two configurations are available: the TM 1/4 is an axial lead molded device which is linearly derated at full load from 100 to 150 C; the TC 1/8 is encased in a TO-5 round-welded package and is derated linearly at full load from 125 to 200 C. Both have standard resistance ratings ranging from 100 to 1000 ohm at 25 C.

Texas Instruments Inc., Dept. ED, P.O. Box 812, Dallas, Texas

CIRCLE 61 ON READER-SERVICE CARD



WAVEFORM ANALYZER

An electrostatic coupling probe minimizes loading of the circuit when using this waveform analyzer. Model EA-1 has applications in the testing or trouble-shooting of any type of electronic equipment having periodic or recurrent waveforms. A twelve-position rotary tuner, with an assortment of interchangeable tuner clips, makes it possible to tune to frequencies in a range from 3 mc to 240 mc. The use of tuned circuits achieves a high degree of sensitivity, and makes possible the viewing of rf waveforms without the use of an external demodulator.

Kingston Electronic Corp., Dept. ED, Medfield, Mass.

CIRCLE 60 ON READER-SERVICE CARD



WAVEGUIDE SWITCH

The double-ridged model H14A2AA provides broad frequency characteristics for DR19 or equivalent waveguide. The actuator is noise free and equipped with interlock circuitry. Frequency range is 4.7 to 11 kmc. VSWR is under 1.15 to 1; insertion loss is 0.5 db.

Thompson Products Inc., Electronics Div., Dept. ED, 2196 Clarkwood Rd., Cleveland 3, Ohio.

CIRCLE 62 ON READER-SERVICE CARD



DIRECT VIEW STORAGE TUBE

The black background of this direct view storage tube permits viewing of an image for over five minutes in virtually any ambient light environment. The 5-inch tube is one of a line of standard DVST's with screen sizes of 5, 10, 15 and 21 in. The tubes have applications in airport surveillance, transient studies, data transmission including half-tones, and visual communications requiring bandwidth transmission over telephone lines. The tubes are equipped with writing, viewing, and erasing guns. The erasing gun allows elimination of local areas from the display.

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

CIRCLE 63 ON READER-SERVICE CARD

in Teflon® multi-conductor cable...
**random lengths
 mean waste!**



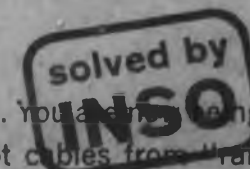
**REDUCE WASTE,
 SAVE MONEY...USE**

INSO Teflon®
MULTI-CONDUCTOR CABLE

**IN CONTINUOUS, UNSPLICED, UNBROKEN,
 PINHOLE FREE LENGTHS UP TO 1,000 FEET!**

Here's a
 typical
 problem in
 tele-meter,
 strain gage,
 miniaturized
 and
 transistorized
 applications

Your Production Spec calls out 27 foot cable. You are being supplied with cable in "random lengths." When you cut 27 foot cables from "random lengths" which are not exact multiples of 27 feet (i.e. 27 ft., 54 ft., 81 ft., 108 ft., etc.) you end up with waste pieces you can't use.



Stop paying for cable you can't use. Reduce costs on your next Cable P. O. Specify INSO Teflon Multi-Conductor Cable in continuous lengths up to 1,000 feet and save money. Cut it to your exact production requirements with no scrap, no waste, no leftovers.

And Inso gives you so much more...

- Maximum space savings—O.D. reductions as much as 53%
- Maximum weight savings—As much as 36%
- Maximum flexibility—"Dress" it once and it stays put

©DUPONT

Let us send you a sample and complete technical data.
 Write today to Section ED-5

INSO Products, Ltd. A Subsidiary of Adam Consolidated Industries, Inc.

Manufacturers of fused film Teflon wire and cable
 404 Fifth Avenue, New York 18, N. Y. WISconsin 7-4700
 TWX: NY 1-4621 Cable address: INSULATION, N. Y.

CIRCLE 64 ON READER-SERVICE CARD

Lord Manufacturing Company
 acknowledged leader in
Vibration and Shock Control
 invites you to utilize its
 extensive engineering knowledge and facilities
 to expedite your programs on
 missiles, rockets, and high performance aircraft.

Experience with current projects such as
Atlas, Bomarc, Jupiter, Redstone,
Talos, Thor, Titan
 and other missiles,
 can be applied to your
 vibration and shock control problems in this field.
 Contact the Home Office, Erie, Pennsylvania
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 KANSAS CITY, MO. - WEstport 1-0138
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 NEW YORK, N. Y. - CIRCLE 7-3326

In Canada—Railway & Power Engineering Corporation Limited

LORD MANUFACTURING COMPANY • ERIE, PA.



NEW PRODUCTS

Potentiometer

Dissipates 3 w at 60 C



Model C1110 potentiometer features high resolution and linearity. The ten turn unit measures 1-1/16 in. x 1-7/8 in. The potentiometer dissipates 3 w at 60 C, standard linearities are 0.5, 0.1 and 0.05 per cent, and the best linearity is 0.03 per cent above 5 K.

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

CIRCLE 66 ON READER-SERVICE CARD

Crossbar Scanner

High scanning speed



Model SC2 is capable of scanning 500 pairs of input connections at a rate of 50 pairs per second, bringing the selected pair to a set of output terminals.

The applications of this crossbar scanner are scanning thermocouple voltages, strain gage voltages, and analog computer outputs. The scanner is designed around the Type F crossbar switch which is operated from Burroughs magnetic-beam-switching commutators buffered with RCA 2N301 transistors.

To satisfy the speed requirement, a novel type of logic combining the advantages of electronic circuitry with those of the crossbar switch has been incorporated.

James Cunningham, Son & Co., Inc., Dept. ED, Rochester 8, N.Y.

CIRCLE 67 ON READER-SERVICE CARD

◀ CIRCLE 65 ON READER-SERVICE CARD

Data Recorder

Utilizes Magnetic film



This multi-channel data recording and reproducing equipment employs perforated 35 mm magnetic film as the recording media. The film is driven by a 32-tooth precision sprocket and synchronous drive motor to insure high timing accuracy. Audio components are plug-in assemblies.

Magnasync Mfg. Co., Ltd., Dept. ED, 5546 Satsuma Ave., N. Hollywood, Calif.

CIRCLE 68 ON READER-SERVICE CARD

Trimmer

100 ppm temperature coefficient



Model A10-W trimming potentiometer incorporates an internal design making possible such performance as 100 ppm temperature coefficient, dependable continuity, reduced end resistance, and zero end shake. The wirewound resistance element is available in 40 standard values, ranging from 10 ohms to 100 K. Standard tolerance is ± 5 per cent but 1 per cent tolerance can be ordered. The unit is rated at 1 watt to 70 C, derating to 0 at 175 C. Trimmer adjustment is achieved with a 25 turn screw. The wiper blade of this trimming unit has a safety clutch to prevent internal damage.

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

CIRCLE 69 ON READER-SERVICE CARD

CIRCLE 70 ON READER-SERVICE CARD



WHITTAKER CONTROLS The largest manufacturer and builder of custom built high performance hydraulic, pneumatic, and fuel valves, controls, and regulators for aircraft, missile, aircraft, and industrial applications.



BRUBAKER ELECTRONICS An R & D leader in the field of ground and airborne IFF (Identification Friend or Foe) equipment, systems, and Traffic Control systems, radar, display, and detection equipment.



WHITTAKER GYRO Leaders in electrically driven and spring-wound free gyro, rate and limited rate gyros for advanced aircraft systems—rate of roll, pitch, and yaw indicators; roll warning; heading, bank and turn indicators.



DATA INSTRUMENTS Pioneer in equipment for fast and accurate analysis of test data with automatic recording on punched cards. Types of printed lists—for aircraft and missile flight tests, industrial and scientific applications.



ENGINEERING SERVICES Specialty coverage in reduction of flight test data generated by data measuring troops and integrated Electronic White Sands Range. The specialized services can be performed anywhere in the world.



NUCLEAR INSTRUMENTS Designers and builders of high quality, reliable equipment for post-launch surveillance and scoring of missile nuclear weapons.

DIVISIONS AND SUBSIDIARIES OF TELECOMPUTING CORPORATION

Production line electronic components manufactured by TC include magnetic amplifiers • capacitors • microminiature relays



facilities... products... services... for america's inventory of airpower

NEW PRODUCTS

Plug-In Circuits

Utilizing germanium transistors



The T-series of 250-kc plug-in circuits using germanium transistors are for application in timing, control, and computer systems. The circuits are totally enclosed in a metal case of 7/8 in. diam with a seated height of 2-3/16 in. Cases may contain more than one circuit and are not potted. Standard hardware and sockets are used.

Engineered Electronics Co., Dept. ED, 506 E. 1st St., Santa Ana, Calif.

CIRCLE 71 ON READER-SERVICE CARD

Line Voltage Adjuster

Steps voltage from 95 to 135 v



Model 920B line voltage adjuster and stepper is designed to vary the input voltage for testing the performance of electrical and electronic equipment. The unit provides for adjusting and stepping the line voltage from 95 to 135 v ac for any fixed input voltage in the range of 95 to 135 v ac. The output capacity of this unit is 3.5 kva for input line voltage above 114 v. This output capacity decreases linearly to 3 kva at an input line voltage of 95 v. The output step voltage can be adjusted from 0 to 40 v.

Kepeco Labs., Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 72 ON READER-SERVICE CARD

these nuts
can be replaced
in

5 SECONDS!



with
NUTT-SHEL'S
New



TIME

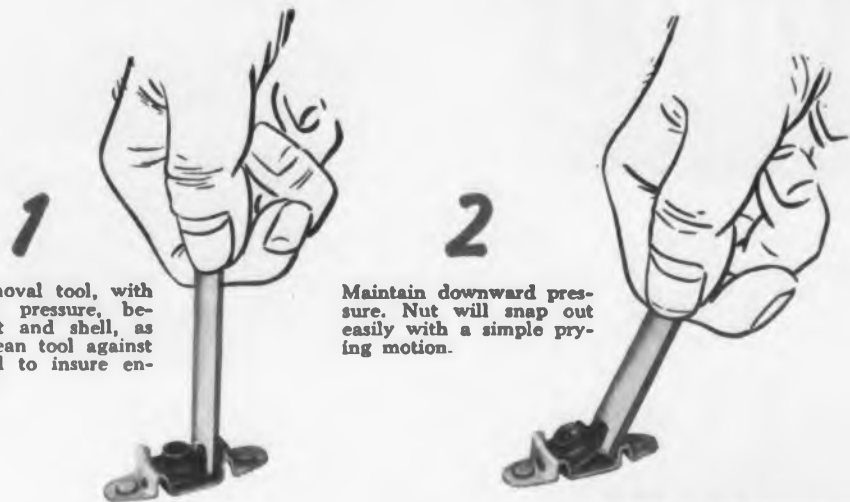
A PRIME WEAPONS SYSTEM CONTRACTOR SAYS:

"These nut sets of old plate nuts were replaced, due to insulation damage. Cool records show that it takes five days to 10 minutes each to replace a com-

mercial plate nut. When we switched to Nutt-Shel's new replaceable nut line, it took me less than 5 seconds for replacement."

This new Nutt-Shel line affects great greater time and cost savings during subsequent servicing and maintenance of any weapons system.

HERE'S THE **5 SECOND** METHOD



1 Insert removal tool, with downward pressure, between nut and shell, as shown. Lean tool against nut barrel to insure engagement.

2 Maintain downward pressure. Nut will snap out easily with a simple prying motion.

3 Install new nut by inserting one lug in shell and striking opposite lug with screwdriver. This lug snaps into place.



MAKE THIS SIMPLE TEST YOURSELF

If you haven't tested the TIMESAVER nut, write today for demonstration plate and tool. Convince yourself how fast and easy it is to replace a Nutt-Shel TIMESAVER nut. Write today on your letterhead.

- Low Cost** No more than the nuts you are now using.
- Light Weight** As light or lighter than anything available.
- Accepted** Meets latest military requirements.
- Available** Available in all popular thread sizes, we ship from stock.

Only One Inexpensive Removal Tool Is Needed

Only one inexpensive removal tool, (in two sizes) is needed, to handle the five most used thread sizes in the nine styles of self-locking nuts in the TIMESAVER line. This procedure may be repeated as often as necessary without impairing performance. The same nut element is used, and may be replaced, in *all* standard styles. Even the spacer nuts are interchangeable. This is not only a convenience for you; it means a reduction in your stock problems.

Nutt-Shel

CH 5-3693 CI 4-4191

811 AIRWAY
GLENDALE 1, CALIFORNIA
An **SPS** Company

MANUFACTURERS OF AIRCRAFT
AND INDUSTRIAL FASTENERS

SAVERS



Silicon Rectifier 12 amp, 500 piv



Type 304 silicon power rectifier can be used to provide forward direct current up to 12 amp with a maximum piv of up to 500 v. The rectifier is capable of operation at a junction temperature of 190 C with no detectable change of characteristics due to aging. Reverse leakage of the cell is a maximum of 10 ma at rated piv and temperature.

Westinghouse Electric Corp.,
Dept. ED, P.O. Box 2099, Pittsburgh 30, Pa.

CIRCLE 73 ON READER-SERVICE CARD

X-Band Ferrite Isolator Insertion loss less than 0.3 db



Model X103/S165 ferrite load isolation is designed for use in X-band radars where insertion loss must be held to a minimum. Operating at 100 kw power, the unit gives a minimum of 8 db isolation with a maximum of 0.3 db insertion loss between 8500 and 9600 mc. Units produced so far have shown only 0.2 db insertion loss over this bandwidth. With choke flanges, length is 2.07 in. With cover flanges, length is 1.6 in. Weight is less than one pound.

Litton Industries, Components Div., Dept. ED, 5873 Rodeo Rd., Los Angeles 16, Calif.

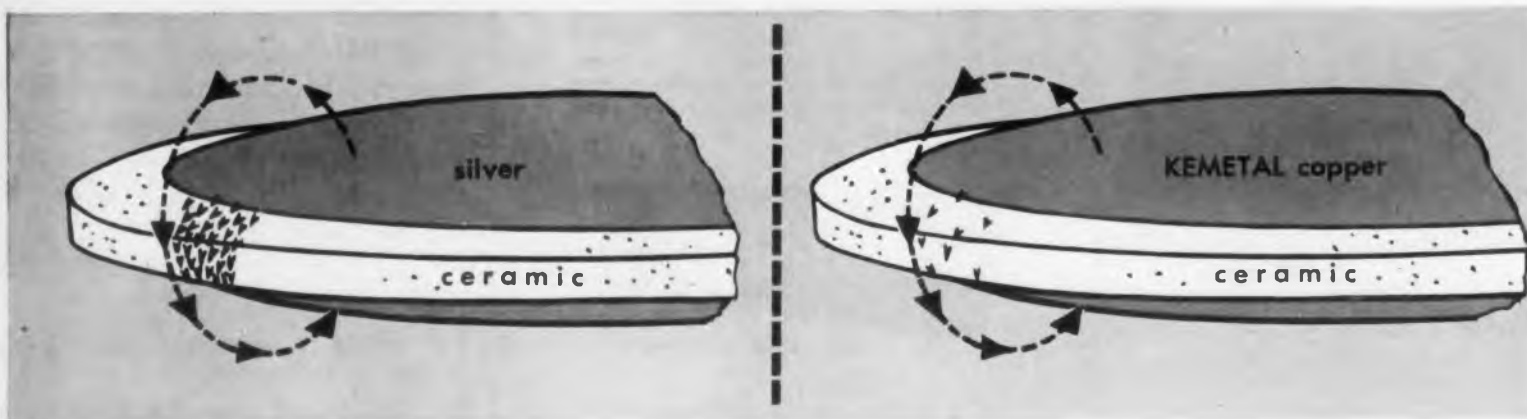
CIRCLE 74 ON READER-SERVICE CARD

◀ CIRCLE 75 ON READER-SERVICE CARD

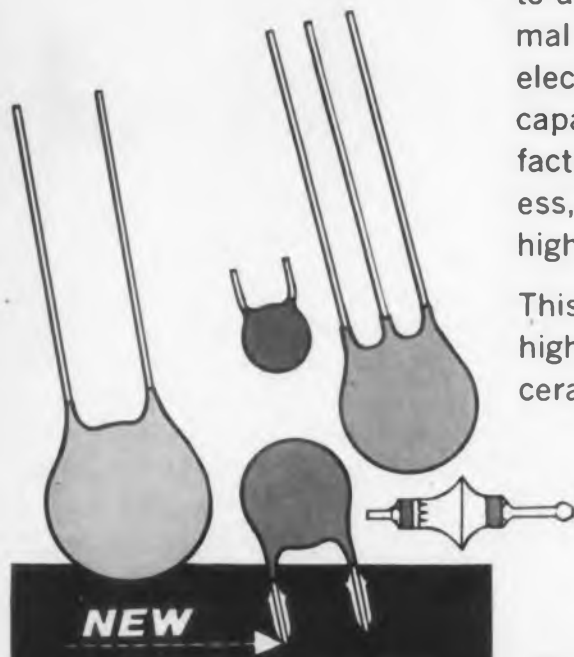
an outstanding RI achievement . . .

100 times less MIGRATION*!

the *new* KEMETAL electro-less process of copperplating



*as compared to silver in electronic circuit applications



NEW
SWEDGE LEADS
held to accurate dimensions
for printed circuit insertion.
Samples on request.

With migration activity reduced to a negligible minimum in normal Radio and TV applications, electronic components, such as capacitors and feed-thrus manufactured by the KEMETAL process, are assured a longer life of high dielectric effectiveness.

This process, of plating low-cost, high conductivity copper on a ceramic disc (or any other sur-

face) . . . DIRECTLY OUT OF SOLUTION . . . in large quantities, assures low-cost manufacturing. The process deposits copper uniformly on ALL surfaces of the body, regardless of how complex or irregular, and forms a tight chemical bond. This tight bond is not lost in soldering, hence solder time and temperature are not critical as in the application of silver coated parts.

the KEMETAL process is now used in the manufacture of RI-caps . . . CERAMIC DISC CAPACITORS and FEED-THRUS.

RADIO INDUSTRIES, INC.

5225 n. ravenwood ave. • chicago 40, ill.

CIRCLE 76 ON READER-SERVICE CARD



NEW PRODUCTS

Pulse Timer

Utilizes stepper motor



Original use for this automatic pulse timer was on test aircraft for timing the pulses from a fuel flow transducer and thus determining specific fuel consumption. The timer incorporates a uni-directional (rather than bi-directional) stepper motor along with complimentary gears, cams, solenoids, switches, an indicator light, and—for a better than 1 per cent independent time base—a stop watch. The pulse timer can count pre-selected quantity of 2 to 60 pulses, having a uniform or variable rate up to 25 pulses per second.

Stepper Motors Corp., Dept. ED, 7444 W. Wilson Ave., Chicago 31, Ill.

CIRCLE 77 ON READER-SERVICE CARD

Clutches

Torque of 40 in. oz



Model C-125 is an electro-magnetic clutch designed for commercial applications featuring small size, high performance, servo or face mounting, and zero backlash.

These units have 1.125 pilot mounting diameter, clutching torque of 40 in. oz, no slip rings, and are completely self contained. When energized the output and input shafts are coupled together; de-energized, both shafts are free running. Standard voltage is 24 to 28 v dc.

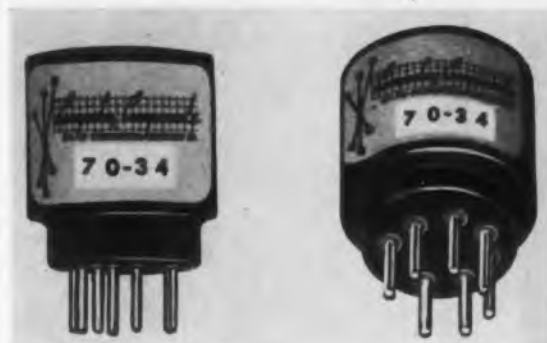
Autotronics Inc., Dept. ED, Rt. 1, Florissant, Mo.

CIRCLE 78 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 14, 1958

Pulse Transformers

Plug-in and solder types



Packaged in moisture resistant epoxy resin, series 70-1400 pulse transformers has a 7 pin miniature plug-in base or leads for soldering to printed circuit boards. Stock transformers offer a wide variety of electrical characteristics. The units are designed for use in blocking oscillators, impedance matching, phase inversion, interstage coupling, triggering, and counting circuits.

International Resistance Co., Computer Components Div., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

CIRCLE 79 ON READER-SERVICE CARD

VHF Admittance Bridges

Frequency ranges of 1 to 250 mc



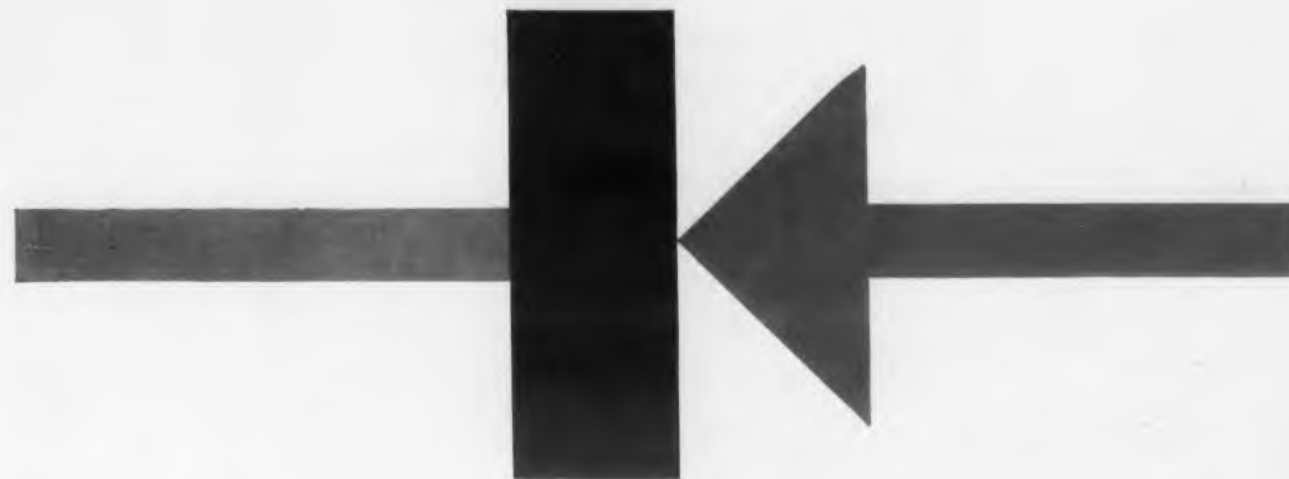
Two new vhf admittance bridges, types B-801 and B-901, have been designed primarily for the measurement of aerials, cables, feeders, and transmission lines.

The transformer ratio arm design incorporated in these bridges provides outstanding advantages over bridges of conventional design. The low impedance to ground and between the terminals ensures extreme stability. The difficulties arising from parasitic elements associated with large standards are eliminated by using the tapped transformer to obtain large ratios, thereby enabling the use of small standards. Utilizing the three-terminal facilities offered by a bridge of this design, enables transistor characteristics to be easily determined under working conditions.

Also, both balanced and unbalanced impedances can be measured with equal facility.

Wayne Kerr Instruments, Dept. ED, P.O. Box 801, Philadelphia 5, Pa.

CIRCLE 80 ON READER-SERVICE CARD



OVERCURRENT PROTECTION FOR SILICON, GERMANIUM AND OTHER METALLIC RECTIFIERS? CALL ON HEINEMANN

Now in use by a number of leading electrical equipment manufacturers, Heinemann Circuit Breakers and Silic-O-Netic Overload Relays are providing effective protection for "sensitive" metallic power rectifiers.

However, generalizations are difficult to make. This is a demanding application. We at Heinemann must honestly admit we don't have all the answers. But we have found — through extensive testing and customer evaluation — that the Heinemann hydraulic-magnetic actuating element can provide the close-tolerance, fast-acting response necessary to keep overload amperage within the required limits and, at the same time, eliminate nuisance tripping. Circuit breakers and relays can be produced with an instantaneous trip point low enough to prevent overcurrent heating and resultant rapid damage to rectifier barrier layers.

Heinemann protection has been an important factor in extending the practical application of metallic rectifiers.

But each particular situation requires treatment on its own terms. If you are concerned with the protection of silicon, germanium or other metallic rectifiers, chances are Heinemann engineers can help you. *Your inquiries are invited.*

HEINEMANN

ELECTRIC COMPANY

156 Plum Street

Trenton 2, N. J.



Circuit Breakers

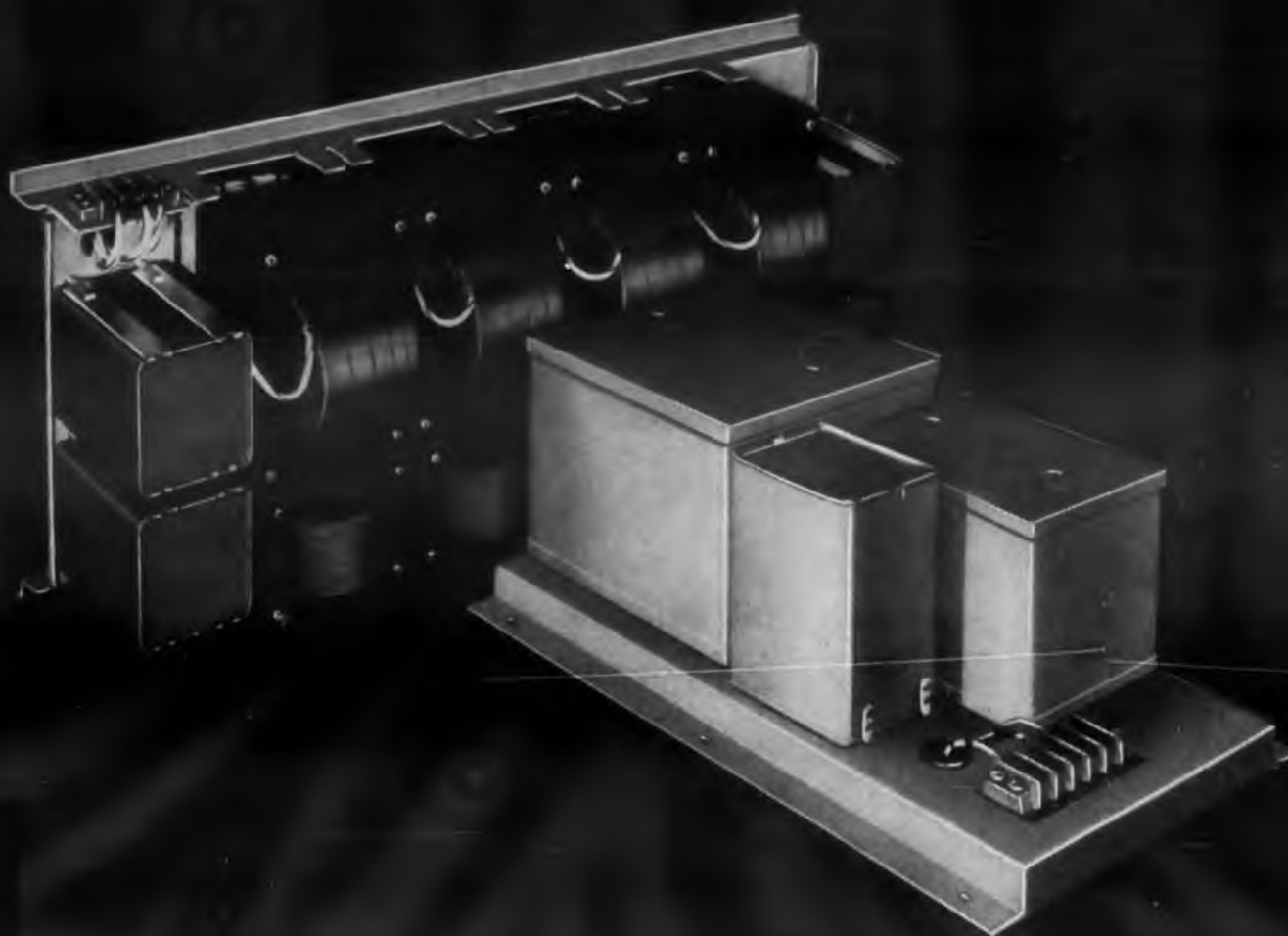


Overload Relays



S.A. 1728

CIRCLE 81 ON READER-SERVICE CARD



MODEL CRM-20-AA-3M

Designed to conform to MIL-T-27A, Grade 3, Class T, Life Expectancy X. Capacitor to JAN-C-25A. Input 100-130V, 60 cps, output 115V \pm 1%, 60 cps, "constant RMS", at 2000VA.

MODEL CAV-5-AA-1M

Designed to conform to MIL-T-27A, Grade 1, Class T, Life Expectancy X. Capacitor to JAN-C-25A. Input 100-130V, 60 cps, output 115V \pm 1%, 60 cps, "constant average" at 500VA.

**THESE HIGH-PERFORMANCE 60-CPS LINE VOLTAGE REGULATORS
ARE SPECIFICALLY DESIGNED TO MEET MILITARY SPECIFICATIONS!**

INPUT VOLTAGE:

Standard ranges 100-130V.
(180-240V and 190-250V, 60 cps on special order.)

OUTPUT VOLTAGE:

Standard (nominal) values 115V.
(208 and 230V, 60 cps on special order.)

TOTAL REGULATION:

Output voltage held within \pm 1% for worst possible combination of rated input changes and 0-100% load variations.

TRANSIENT RESPONSE:

Recovery time to the \pm 1% region (after 10% line "step" or 25% load "step") is less than 35 milliseconds.

POWER FACTOR:

(Wattmeter method) Approx. 85%, full load, nominal input.

EFFICIENCY:

Approx. 85%, full load, nominal input.

OUTPUT POWER:

Available in integral multiples of 500VA, up to 10KVA, single phase.

CONSTRUCTION:

Tubeless. No moving parts. Quiet operation. Advanced form of proven resonant-saturation principle.

WAVEFORMS:

Available in two modes of waveform behavior: type CAV holds "constant average" for choke-input rectifier power supplies; type CRM holds "constant RMS" for heater and lamp loads.

FREQUENCY:

Designed for constant-frequency use, but will operate reasonably well over 58 to 62 cps.

Check factory for details.

NJ E CORPORATION

Electronic Development & Manufacturing

343 CARNEGIE AVENUE, KENILWORTH, NEW JERSEY

Competent Engineering Representation Everywhere

Write For Engineering Manual LR-101

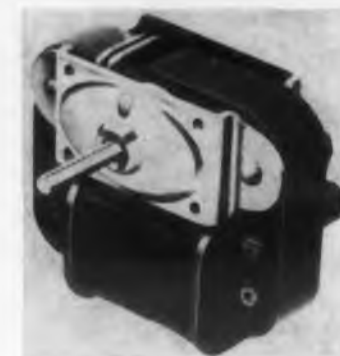
Full data, prices

N J E LEADS THE POWER SUPPLY FIELD

NEW PRODUCTS

AC Motor

Low-cost version



Some of the features of this low-cost, precision-made ac motor include long-life alignable bearings, large oil reservoirs with optional auxiliary oil cups to quadruple oil capacity, high starting torque, and low noise level.

Stack thicknesses of 9/16 in. and 5/32 in. are available. Horsepower ratings are up to 1/150 hp.

Barber-Colman Co., Dept. ED, Rockford, Ill.

CIRCLE 83 ON READER-SERVICE CARD

Computing Resolvers

Accuracies of 0.1 per cent



Size 15 and size 11 precision resolvers offer functional accuracies of 0.1 per cent, perpendicularity of axes of \pm 5 min, high Q and low phase shifts. A stainless steel size 15 series is also offered with functional accuracies of 0.05 per cent. Size 11 precision resolvers, with either terminals or leads, have the same accuracies as the size 15 units.

Clifton Precision Products Co., Inc., Dept. ED, 9014 West Chester Pike, Upper Darby, Pa.

CIRCLE 84 ON READER-SERVICE CARD

◀ CIRCLE 82 ON READER-SERVICE CARD

Current Converter

Provides dc proportional to ac input



Supplying a direct current output proportional to an alternating current input, this transformer-rectifier assembly has been designated as model 9886 current converter. The unit is available in three types for 60 cps use in circuits up to 5 amp. The three types have outputs of 1 ma into 100 ohms, 5 ma into 100 ohms, and 50 mv open circuit.

Weston, Instruments, Div. of Daystrom, Inc., Dept. ED, 614 Frelinghuysen Ave., Newark, N.J.
CIRCLE 85 ON READER-SERVICE CARD

Magnetron

1 kw X-band unit weighing



The MA-6229 is a mechanically tunable pulsed type magnetron with integral magnet for the frequency range of 8900 to 9600 mc. Weight is 1.5 lbs. Nominal peak power output is 1 kw; however, the tube may be operated with good spectrum characteristics over the range from 400 w to 1000 w. Typical electrical operating characteristics include a pulse voltage of 4000 to 4500 v, peak anode current 0.5 to 1 amp, pulling factor of 15 mc.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 86 ON READER-SERVICE CARD

CIRCLE 87 ON READER-SERVICE CARD ➤

700°F

600°F

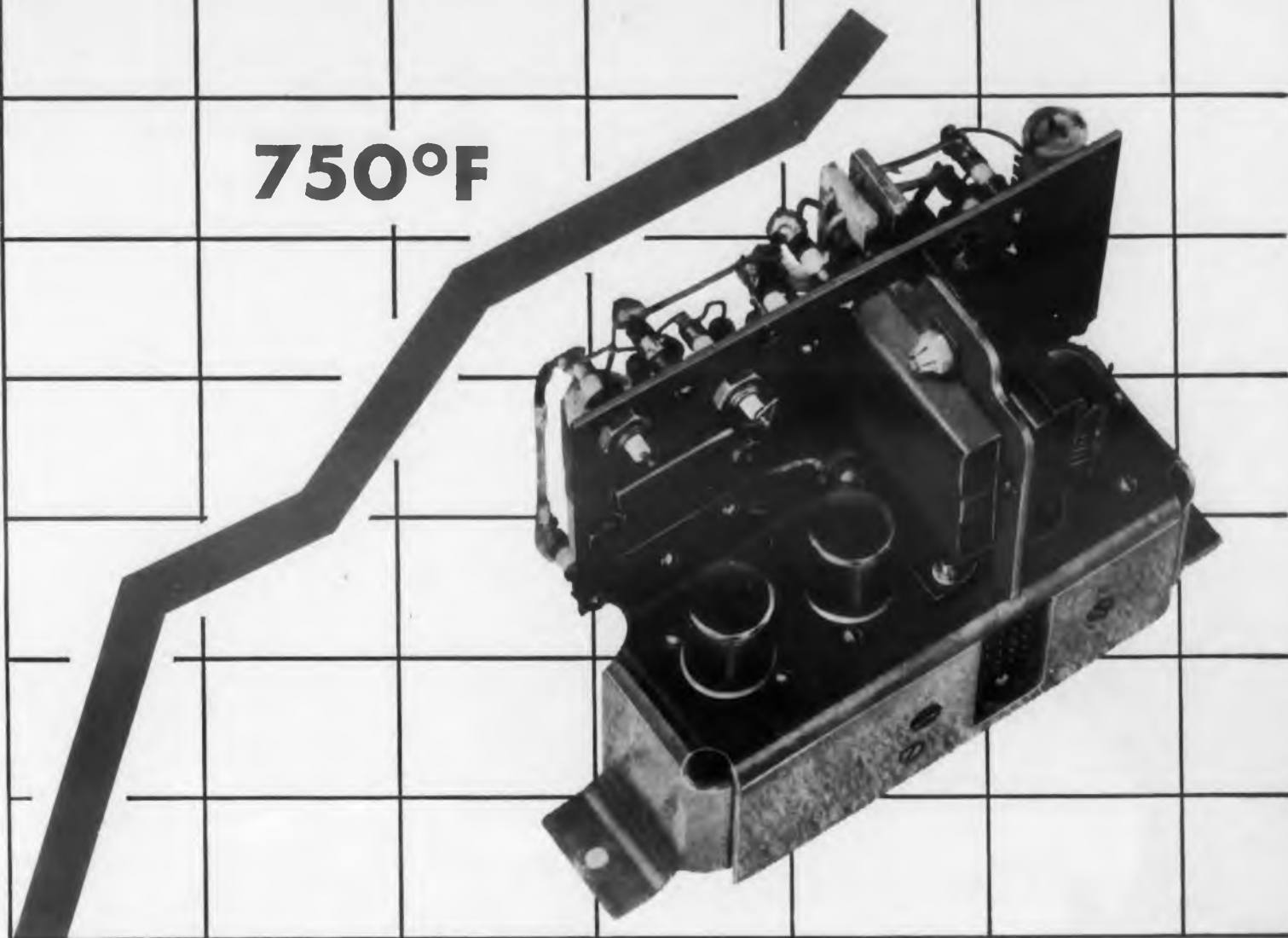
500°F

400°F

300°F

200°F

750°F



This General Electric designed and developed amplifier operates without the use of refrigerants at ambient temperatures from -67°F to 750°F .

High-temperature, Radiation Tolerant Electronic Equipment—Without Refrigerants

GENERAL ELECTRIC HAS PROVEN ABILITY TO MEET YOUR REQUIREMENTS

Here's important news for you if your systems project dictates the need for temperature and radiation tolerant electronic equipment. The General Electric Company stands ready to undertake the design, development, manufacture and evaluation of your equipment where your specifications call for successful operation up to 750°F , without refrigerants. And General Electric's ability to meet your high-temperature requirements is backed by

notable successes.

FOR EXAMPLE General Electric has already developed airborne amplifiers which have been successfully operated over an ambient temperature range from -67°F to 750°F . Special circuit designs and packaging techniques permitted this without the use of heavy, complex refrigerating equipment.

FOR INFORMATION on how General Electric can help you solve your high-temperature electronic equip-

ment problems, contact your G-E Missile and Ordnance Systems Department Field Sales Office or mail the coupon below.

FOR MORE INFORMATION
ON HOW TO MEET YOUR
HIGH-TEMPERATURE REQUIREMENTS

GENERAL ELECTRIC COMPANY
Section C222-6
Lakeside Avenue
Burlington, Vt.

- Please send me bulletin MPB-32, "High-Temperature Electronic Equipment."
 I would appreciate a discussion of my equipment requirements with General Electric High-Temperature Engineering Specialists.

NAME.....
TITLE.....
COMPANY.....
ADDRESS.....
CITY..... STATE.....

Progress Is Our Most Important Product

GENERAL  ELECTRIC

EDDINGTON, EPISTEMOLOGY and the ATOMICHRON[®]

Creative imagination, as Sir Arthur Eddington pointed out, is what takes knowledge and the knowledge of how we know it and projects further discoveries of the physical universe.

At National Company creative imagination has taken the known unvarying resonance of the Cesium atom and translated it into a frequency-producing instrument with a stability of frequency of 5 parts in 10^{10} throughout its entire operating life—This is the Atomichron, man's most accurate measurement of time.

The applications and adaptations of the basic Atomichron are many-fold and, as yet largely untouched.

Here is a known tool which properly applied can lead to tremendous further discovery and development.

You, who enjoy such creative challenges to scientific and technical development, should talk to *National*.

National Co. right now affords engineers and physicists the opportunity to grow and establish prestige in such advanced fields as multipath transmission, noise reduction and correlation techniques, Tropospheric scatter systems, Ionospheric scatter systems, molecular beam techniques, signal processing, and long range microwave transmission.

At *National Co.* in the heart of New England electronics, you can associate with a company in which creativity is required, recognized and rewarded.

Write or phone
tuned to tomorrow **National**

National Company, Inc., Malden, Mass.

BURTON BROWNE ADVERTISING

NEW PRODUCTS

Cam Switch

Six and ten position types



Type 8A cam switch is available in both six and ten position models for use as a decimal-to-binary converter switch, a control switch or a decade switch. The switch has been life tested in excess of 40 million breaks with no evidence of failure. Type 8A is rated at 1 amp, 110 v ac, and has a breakdown rating of 1500 v. Available in single and double-ended designs for clockwise and counter-clockwise operations.

Tech Labs., Inc., E. Edsall Blvd., Palisades Pk., N.J.

CIRCLE 89 ON READER-SERVICE CARD

Carrier Preamplifier

Wide band pass, high linearity



Second of the series 450 instruments, model 450-1100 is a carrier amplifier-demodulator with zero suppression, which will excite and accept outputs of various resistance bridge, variable reluctance, differential transformer, or other types of transducers. Front panel controls include attenuator, calibration factor dial, calibration signal pushbutton, zero suppression, smooth gain,

◀ CIRCLE 88 ON READER-SERVICE CARD

position, and balance controls. Standard carrier frequency is 2400 cps; 600, 1200, and 4800 cps are optional. With 100 μ v rms from a transducer with an output impedance of 1000 ohms or less, the pre-amp output is one volt under max output loading. Output voltage capabilities are: ± 3 v into 2.2 k load; ± 6 v into 5 k load; ± 7.5 v open circuit. Output linearity is better than 0.2 per cent for all these conditions. Frequency response is down 3 db at 20 per cent of carrier frequency. The zero suppression circuit can suppress from 0 to 100 per cent of transducer load (either sense via switch). Power requirements are: 115 v, 50-400 cps, about 30 w.

Sanborn Co., Industrial Div., Dept. ED, 175 Wyman St., Waltham 54, Mass.

CIRCLE 90 ON READER-SERVICE CARD

Auxiliary Capacitor

For temperature coefficient work



The measurement of temperature coefficient of capacitors is facilitated by use of model AC-1 auxiliary capacitor in conjunction with the model 74C capacitance bridge. With this combination it is possible to measure capacitance increments as small as one part per million for capacitors above 200 μ f or to 0.0002 μ f for smaller capacitors. The equipment permits the use of long shielded test leads between the bridge and test chamber without introducing capacitance errors that would normally result from vibration or temperature changes in the test leads.

Boonton Electronics Corp., Dept. ED, 738 Speedwell Ave., Morris Plains, N.J.

CIRCLE 91 ON READER-SERVICE CARD

CIRCLE 92 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

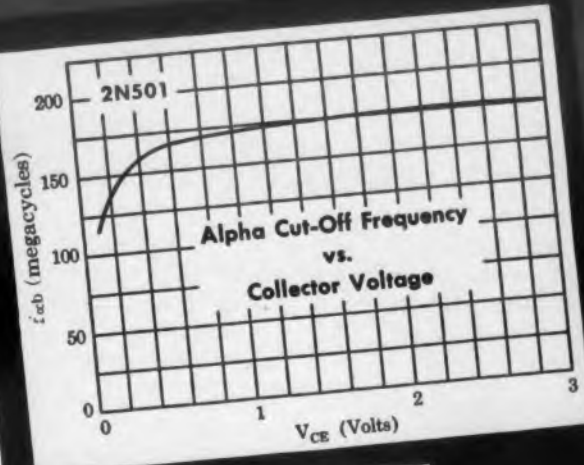
Here is a major breakthrough in the frequency barrier... a new family of field-flow Micro Alloy Diffused-base Transistors. Philco MADT's extend the range of high gain, high frequency amplifiers; high speed computers; high gain, wideband amplifiers and other critical high frequency circuitry.

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. E-558

*Trademark Philco Corporation for Micro Alloy Diffused-base Transistor



MADT FAMILY APPLICATIONS DATA

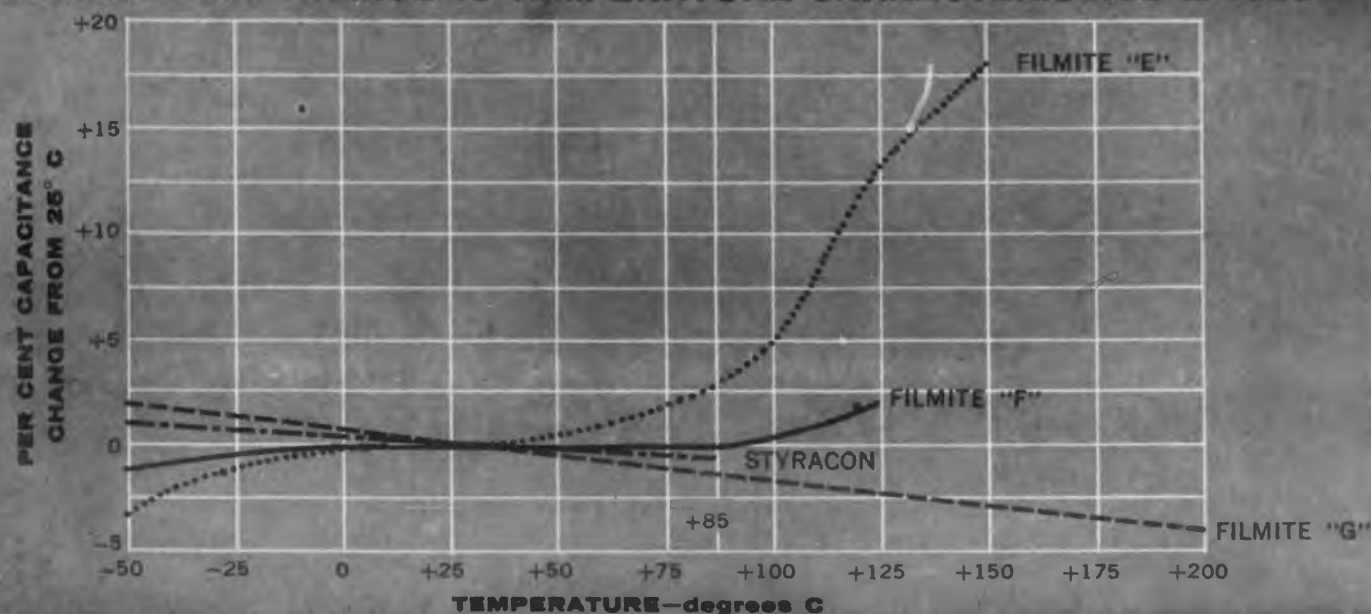
TYPE*	f_{max}	Power Gain	Oscillator Efficiency	Class of Use
2N499	250 mcs (min)	10 db at 100 mcs	25% at 100 mcs (min)	oscillator and amplifier to 100 mcs
2N500			25% at 200 mcs (min)	oscillator to 400 mcs
2N501		Ultra high-speed switch typical $t_r = 12 \mu$ sec; (18 max.); $t_s = 7 \mu$ sec; (12 max.); $t_f = 4 \mu$ 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.
†In JETEC TO-9 Case (widely known as JETEC 30 Case).

PHILCO CORPORATION
LANSDALE TUBE COMPANY DIVISION
LANSDALE, PENNSYLVANIA



TYPICAL CAPACITANCE vs TEMPERATURE CHARACTERISTICS at 1000 μ



	STYRACON (85 C)	FILMITE "E" (150 C)	FILMITE "F" (125 C)	FILMITE "G" (200 C)
RATINGS	.001 to 1.00 μ F 50 to 600 WVDC	.001 to 1.00 μ F 200 to 2500 WVDC	.001 to 1.00 μ F 200 to 600 WVDC	.001 to 1.00 μ F 200 to 600 WVDC
STYLES	tubular metal cases screw-neck cases drawn metal cases	tubular metal cases screw-neck cases	tubular metal cases screw-neck cases "bathtub" cases	tubular metal cases screw-neck cases drawn oval cases
WRITE FOR TECHNICAL DATA	Engineering Bulletin No. 2510	Engineering Bulletin No. 2410	Engineering Bulletin No. 2560	Engineering Bulletin No. 2610

4 kinds of film dielectric capacitors for specialized applications

Here are four plastic-film dielectric capacitors now in regular production at Sprague:

STYRACON CAPACITORS find wide application in laboratory equipment and in industrial controls where their low dielectric hysteresis (low "soak"), high insulation resistance, high "Q", low and linear temperature coefficient of capacitance are of great value.

FILMITE "E" CAPACITORS are general-purpose capacitors for use up to 150°C where capacitance stability with temperature is of secondary importance. They are also used at lower temperatures where very high insulation resistance is a prime requirement.

FILMITE "F" CAPACITORS are intended for use in circuits where

the absolute minimum in capacitance change with temperature is a must and relatively large capacitance values are used. These capacitors typically will be within .05% of their 25°C value from -10°C to +85°C. They may be used up to 125°C where greater capacitance excursion is tolerable.

FILMITE "G" CAPACITORS have the highest temperature rating of any organic dielectric. They may be used up to 200°C! All units are nickel-plated to withstand high temperature corrosion. They also have the highest insulation resistance, the lowest dielectric hysteresis, and the lowest dissipation factor of any capacitor made so that they are often used at lower temperatures which are above the 85°C limit of the lower-cost Styracon Capacitors.

CAPACITANCE VS. TEMPERATURE CHARACTERISTICS of all four types of film capacitors are compared in the chart above for the benefit of the circuit designer.

ALL SPRAGUE FILM CAPACITORS are designed to have positive electrical contact between leads and electrodes, even at low operating voltages.

WRITE FOR ENGINEERING BULLETINS on the Sprague plastic-film capacitors in which you're interested. Address your letter to Sprague Electric Co., Technical Literature Section, 347 Marshall Street, North Adams, Mass.

SPRAGUE[®]
the mark of reliability

SPRAGUE COMPONENTS:

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

CIRCLE 93 ON READER-SERVICE CARD

NEW PRODUCTS

Microwave Oscillators

From 2500 to 17,500 mc



Power outputs of series 814 microwave oscillators range from 20 mw to 1.5 w. Short-term frequency stability averages one part per million. The tuning dial is direct-reading and is a wave-meter with an accuracy of 0.1 per cent of reading. When the frequency is selected, a built-in stability circuit immediately takes over. This circuit locks the oscillator to the reference cavity until a different frequency is selected.

Laboratory for Electronics, Inc., Dept. ED, 75 Pitts St., Boston, Mass.

CIRCLE 94 ON READER-SERVICE CARD

Microwave Attenuator

Features remote indication and actuation

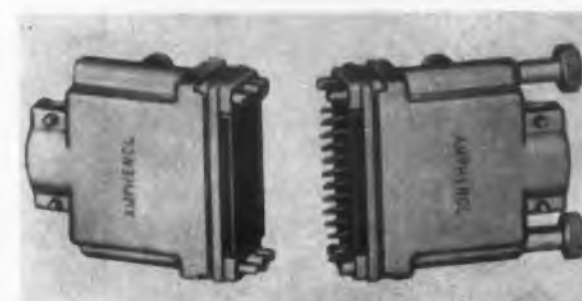
The attenuation range of this waveguide microwave attenuator ranges from 0-70 db. It has an accuracy of ± 0.2 db over its range with the use of calibration curves. Two attenuators will give a D-130 db range with a ± 1.5 db accuracy over its frequency range, 5.4-5.9 kmc. The unit can be operated remotely or directly, and has adjustable attenuation end points.

Progression Corp., Dept. ED, 14-25 128th St., College Point 56, N.Y.

CIRCLE 95 ON READER-SERVICE CARD

Connectors

Features removable contacts



These rack and panel connectors have insert arrangements of 34, 42, and 50 removable poke home contacts. Connectors are rated at 7.5 amp 500 v dc at sea level, and 7.5 amp 125 v dc at 70,000 ft. Temperature range is -65 to +200 C.

Amphenol Electronics Corp., Dept. ED, 1830 S. 54th Ave., Chicago 50, Ill.

CIRCLE 449 ON READER-SERVICE CARD

Attenuator

To 101 db in 1 db steps



Model 101 Attenuator has an attenuation range of 0 to 101 db in 1 db steps, with an accuracy of 0.5 db over a frequency range of 0 to beyond 100 mc. The basic circuitry consists of symmetrical pi networks which may be selected by operating the appropriate switches. The maximum power handling capacity is 500 mw. A selector switch provides input and output impedances of both 50 ohms and 75 ohms. Other impedances can be furnished. The chassis and cover are fabricated from brass which is then silver plated. UG 290/U receptacles are employed for both input and output connections.

General Antronics Corp., Dept. ED, 9036 Culver Blvd., Culver City, Calif.

CIRCLE 96 ON READER-SERVICE CARD

Microwave Amplifiers

Features periodically focused traveling wave tubes

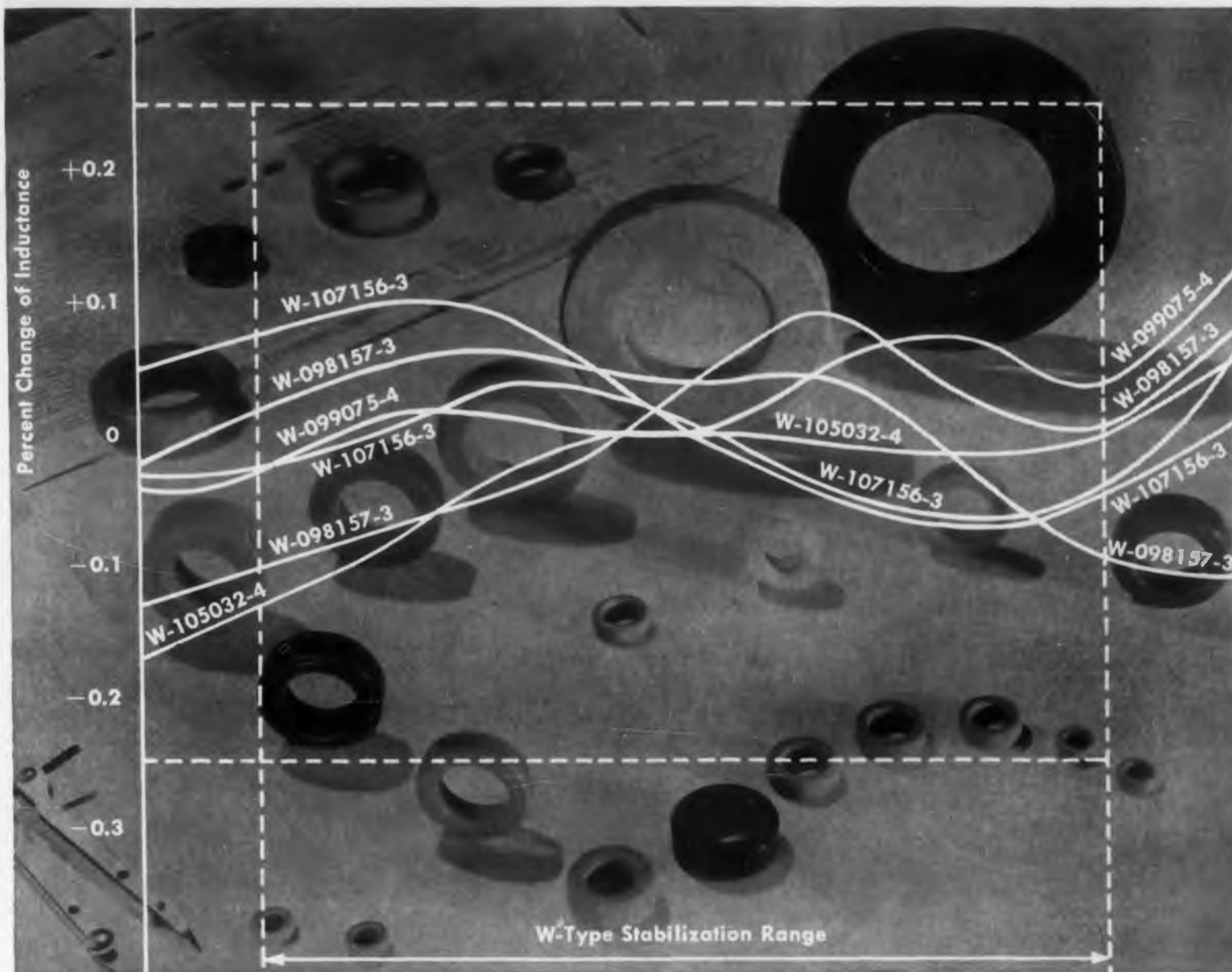


The four models, HMA-1, 2, 3, and 4, cover the frequency range between 1000 and 11,000 mc and have wide application where a high gain microwave amplifier is required to increase equipment sensitivity. All operate from a 105-125 v ac, 60 or 380-1000 cps, single phase power source.

Special features include a self-contained video detector, separate rf input, rf output, detector input, video output, receptacles for greater operational versatility, regulated power supplies for increased stabilization, and parallel input jacks which permit the blanking or gating of the traveling wave tube grid from external sources. These amplifiers provide protection against crystal burn-out of wide band crystal video receivers.

The Hallicrafters Co., Dept. ED, 4401 W. Fifth Ave., Chicago 24, Ill.

CIRCLE 97 ON READER-SERVICE CARD



ARNOLD offers you the widest selection of Temperature Stabilized MO-PERMALLOY POWDER CORES

Arnold Molybdenum Permalloy powder cores are available with the temperature coefficient of inductance controlled within certain limits over specific temperature ranges. Most core sizes and permeability combinations can be supplied in at least one of the four different types of temperature stabilization available.

For example, most of the popular core sizes are manufactured in the new type of wide range—"W"—stabilized cores whose temperature coefficient of inductance does not

exceed 0.5% over the temperature range covered by the MIL-T-27 specification of -55°C to $+85^{\circ}\text{C}$.

This type of guaranteed maximum change of inductance with temperature, as well as the constancy of permeability with time and flux level, are of particular importance to apparatus and circuit engineers. Many precision military and industrial applications demand the uniform performance and the excellent physical properties found only in Arnold Mo-Permalloy powder cores.

For design flexibility they are furnished in a full range of sizes, up to 5.218" O.D., in four standard permeabilities: 125, 60, 26 and 14. You will find them dependable and easy to use. You will find most sizes and types in stock now for immediate shipment.

● Let us furnish your requirements for temperature stabilized Mo-Permalloy powder cores, or any magnetic materials you need, from the most complete line in the industry.

waw 6000

For more information write for
Bulletin PC-104B

Lists complete line of Mo-Permalloy Powder cores . . . available in 25 sizes from 0.260" O.D. to 5.218" O.D. Furnished also with various types of temperature stability from Type "A" unstabilized to Type "W" stabilized over the temperature range of -65°F to $+185^{\circ}\text{F}$.

ADDRESS DEPT. ED-85

THE ARNOLD ENGINEERING COMPANY



Main Office & Plant: Marengo, Illinois

Repath Pacific Division Plant: 641 East 61st Street, Los Angeles, Calif.

District Sales Offices:

Boston: 49 Waltham St., Lexington Los Angeles: 3450 Wilshire Blvd.

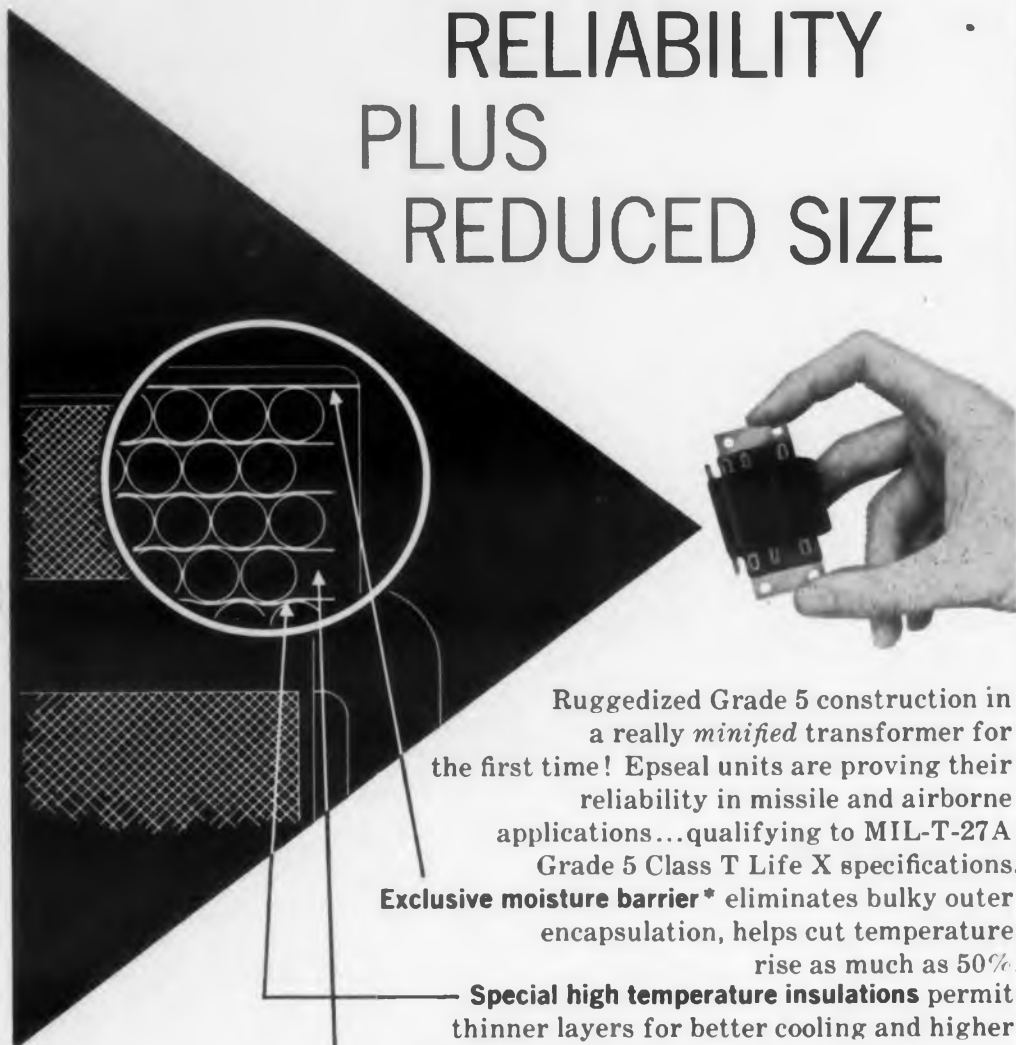
New York: 350 Fifth Ave. Washington, D.C.: 1001-15th St., N.W.

CIRCLE 98 ON READER-SERVICE CARD

EPSEAL

Encapsulated power transformers

**GREATER
RELIABILITY
PLUS
REDUCED SIZE**



Ruggedized Grade 5 construction in a really *minified* transformer for the first time! Epseal units are proving their reliability in missile and airborne applications...qualifying to MIL-T-27A Grade 5 Class T Life X specifications. **Exclusive moisture barrier*** eliminates bulky outer encapsulation, helps cut temperature rise as much as 50%. **Special high temperature insulations** permit thinner layers for better cooling and higher conductor space factor...permit reliable operation in 125°C to 175°C ambients! **Unique encapsulation process** saturates and fuses coil insulations into one mass...eliminates heat-retaining *microscopic boundaries* usually found in high temperature coils...permits additional size reductions. Result is a solid, rugged unit that combines extreme reliability with extreme miniaturization! Epseal transformers are designed to meet your requirements. Write today for the whole story.

LOOK TO ELECTRO

*Patent Pending

Precision transformers for electronics...miniature to 300 kva

ELECTRO ENGINEERING WORKS Inc. / 401 PREDA STREET, SAN LEANDRO, CALIF.

CIRCLE 99 ON READER-SERVICE CARD

NEW PRODUCTS

Ceramic Capacitors

Designed for transistor applications



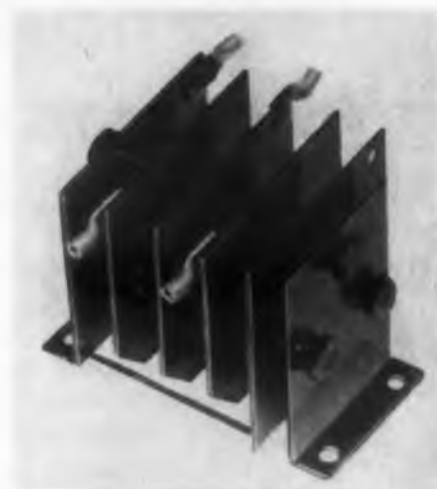
Called Ultra-Kaps, high capacity ceramic capacitors have been designed in four standard values, 0.22, 0.47, 1.0 and 2.2 μ f. These units are all rated at 3 wvdc and range in diam from 1/4 to 3/4 in. Engineered specifically for by-pass and coupling applications, the Ultra-Kap is suited for only low voltage use requiring extremely high capacities and low power factors. The units will withstand extremes of temperature, humidity, and vibration.

Centralab, Div. of Globe-Union, Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

CIRCLE 100 ON READER-SERVICE CARD

Rectifier Stacks

150 C operation



This line of diffused silicon rectifier stacks is for operation at an ambient temperature of 150 C with normal convection cooling. Shown is a single phase bridge assembly rated to deliver 10 amp with an rms input of 420 v, with convection cooling in an ambient of 150 C. The overall dimensions of this stack are 3 x 3 x 3 in.

Diffused silicon stacks are now available in circuit configuration to deliver up to 75 amp with convection cooling. Volume of a 20 kw silicon diffused stack is less than 150 cu in.

Trans-Sil Corp., Dept. ED, 55 Honeck St., Englewood, N.J.

CIRCLE 101 ON READER-SERVICE CARD

Electronic instrumentation and components



Application Engineering Procurement Service

Since 1936, we have been consulted regularly by electronic engineers throughout the Midwest.

Today, we can save your time with these important facilities:

- 4 well-staffed offices
- 12 factory-trained field engineers
- 3 service laboratories
- 4 maintenance technicians



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these top manufacturers**

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*CHICAGO 45
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SHeldrake 3-8500

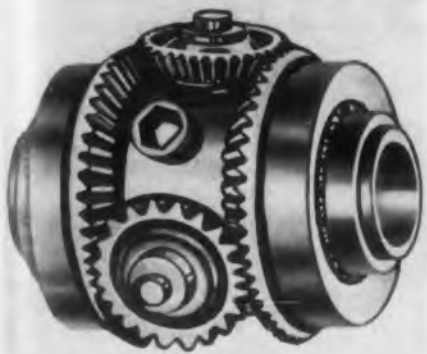
Branch Offices

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INDIANAPOLIS 20 • 5420 N. College Ave.
*ST. PAUL 14 • 842 Raymond Ave.
*Maintenance and Repair Laboratories

CIRCLE 102 ON READER-SERVICE CARD

Differential

For miniature servo applications



Designed for miniature servo and computer applications, this differential weighs only 0.2 oz, and is the smallest unit available for an 1/8 in. shaft. A max load rating of 5-6 in.-oz and a 500 rpm max operating speed are recommended.

Waldorf Instrument Co., Dept. ED, Huntington Station, Long Island, N.Y.

CIRCLE 103 ON READER-SERVICE CARD

RF Amplifiers

Broadband



Model HFW broadband rf amplifiers provide broadband band-pass amplification covering an octave or greater of frequency in the 40 to 600 mcs spectrum. Low noise, high gain, and low power drain are featured.

GE type GL-6299 co-planar triodes are combined with multi-pole networks to provide amplifiers with power gains of 5.5 db or greater per stage, with a 300 mcs bandwidth. A number of these stages are cascaded to provide gain of 20 or 30 db. The frequency spectrum of 40 to 600 mcs is covered by six basic octave rf amplifiers.

Applied Research Inc., Dept. ED, 76 S. Bayles Ave., Port Washington, N.Y.

CIRCLE 104 ON READER-SERVICE CARD

CIRCLE 105 ON READER-SERVICE CARD

FOR THE FIRST TIME



GENERAL SPECIFICATIONS

Size	1.79" long (maximum)
	1.063" in diameter (maximum)
Weight	3.0 ounces
Nominal Operating Voltage	26.5 volts
Contact Metal	gold alloy
Contact Bounce	less than 250 microseconds
Temperature Rating	-65° C to + 200° C
Shock	55 g
Vibration	2,000 cps at 25 g

a new 4PDT relay to meet all requirements of MIL-R-25018!

Don't compromise with the Class C, Type II, Grade 3 requirements of MS 24114-9, MIL-R-25018. You don't have to any more. Now Union Switch & Signal has a 4PDT, rotary-armature relay designed to meet these specifications completely. It is the first of its type to do so. In fact, it exceeds some of the rugged requirements.

Here is the kind of performance you can expect from this new relay:

High operating temperature. Even at an ambient temperature of 200° C, this relay gives optimum performance. The use of ceramic material provides consistently high insulation resistance. As a result, you can install this relay closer to engines. You often can use it *without* temperature controlled boxes. Always, you will find it supremely rugged and reliable.

High in shock resistance. This new UNION Relay withstands shock *greater* than 55 g for 11 milliseconds—and continues to operate. In vibration tests, it shows no contact chatter up to 2,000 cycles at an acceleration of 25 g.

New high in contact reliability. Contact reliability of this relay is *six times* that of comparable devices because of its new 2-button, bifurcated contacts. Bifurcation also increases current carrying capacity (each button easily handles a full 2-ampere load) . . . and makes gold alloy contacts practical for both low- and high-level loads.

Contact reliability is enhanced, too, by the ceramic insulation which contains no volatile material to contaminate contacts and by separate hermetic sealing of the magnet coil.

New torsion-type rotary-armature suspension improves resistance to thermal shock . . . increases reliability over the entire temperature range . . . and greatly extends the operating life of this new 4PDT relay. Call or send the coupon for complete information about this and other miniature relays manufactured by Union Switch & Signal.

COMPLETE FACTS

Union Switch & Signal
Division of Westinghouse Air Brake Co.
Pittsburgh 18, Pennsylvania

Please send the following:

Complete description of your new 4PDT relay which meets every requirement of MIL-R-25018. Catalog of other miniature dc and ac relays which you manufacture to MIL-R-25018, MIL-R-6106C, and MIL-R-5757C requirements. Description of your Digital and Alpha-Numerical Indicators for data display.

Name

Position

Firm

Address

City State

Also, put me on your technical mailing list.



UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18, PENNSYLVANIA

NEW PRODUCTS

Sapphire Seal

High-temperature, high-vacuum applications



These sapphire-to-metal seals are hermetic as tested by a mass spectrometer. Sapphire parts in the form of discs up to 3 in. in diam and 1/4 in. thick, and tubes up to 1/2 in. in diam, 2 in. long, with a bore of 1/4 in. have been sealed to tubular-type metal members of kovar, nickel-iron, and platinum. Some of the current applications of these sapphire seal assemblies include: waveguide windows for radar equipment; high-temperature windows for high-vacuum apparatus and fire-detection equipment; and ultra-violet studies in the nuclear energy field.

Ceramaseal, Inc., Dept. ED, Box 25, New Lebanon Center, N.Y.

CIRCLE 106 ON READER-SERVICE CARD

TR Switch

Rated at 4000 w peak power



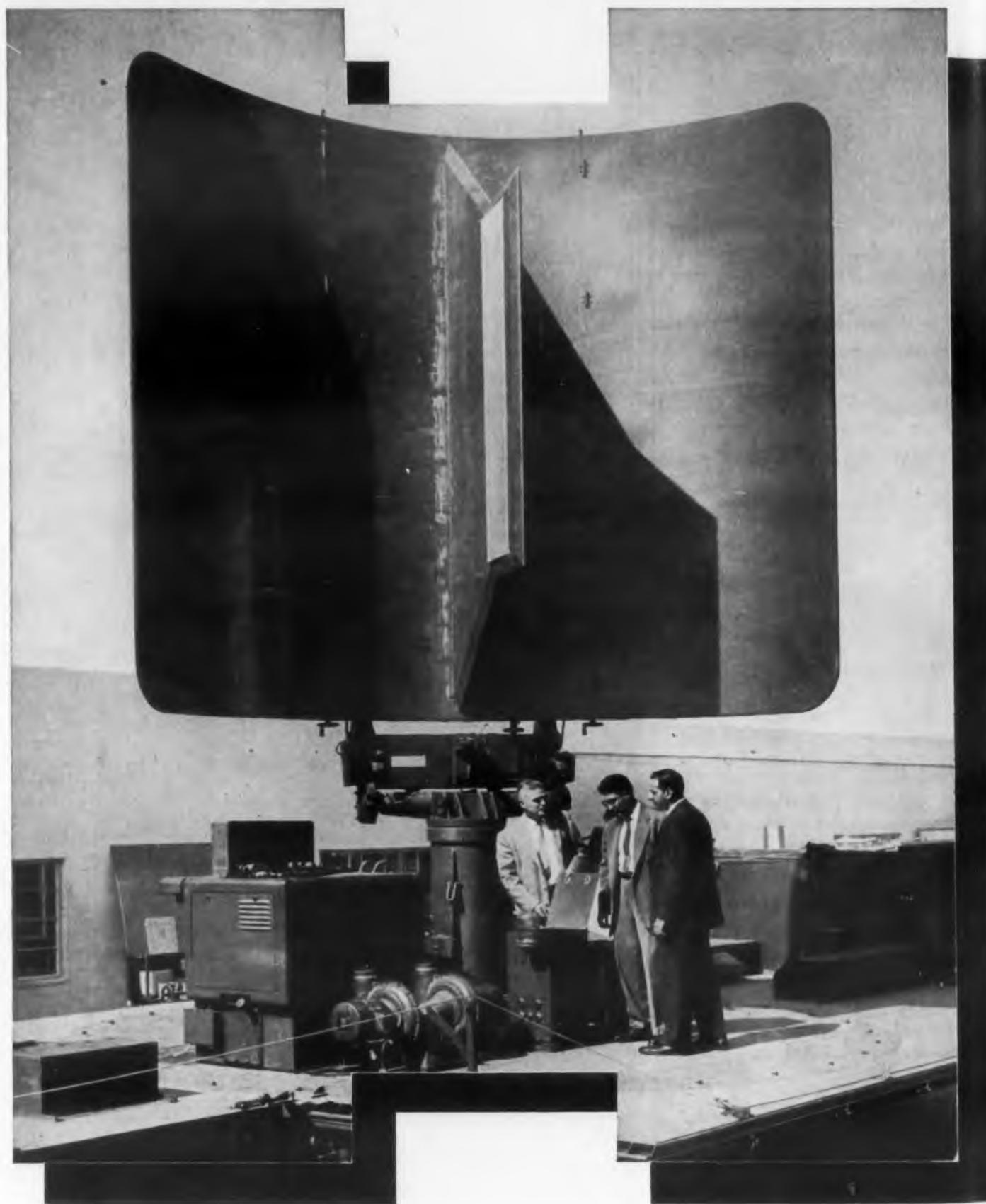
The new TR switch provides instantaneous high efficiency electronic antenna switching.

Double-gated cascode circuitry insures good receiver isolation and improved noise figure in addition to signal amplification up to 6 db, with frequency range continuous from 3.5 through 30 mc. Design technique permits handling the high peak power capabilities of new linear amplifiers. Instantaneous break-in on ssb, dsb, cw or am will not affect transmission line swr.

E. F. Johnson Co., Dept. ED, Waseca, Minn.

CIRCLE 107 ON READER-SERVICE CARD

HOW TO SEE IN A



ALL DIRECTIONS AT ONCE

They add new dimension to defense

Three dimensional radar... it is a positioning of radar beams in space by electronic rather than mechanical means. It provides three-dimensional target data from a single antenna, transmitter, and receiving channel. It is a radical new weapon for national defense.

Engineers at the Hughes Ground Systems Division in Fullerton are responsible for pioneering this advancement (see antenna at left). But even more importantly, these same engineers are working on an elaborate radar warning system which will not only provide this complete radar data, but also translate it into meaningful information and relay it to central communications centers.

Other Hughes activities offer similar engineering challenge. The Research and Development Laboratories in Culver City, for example, are probing into the effects of nuclear radiation on electronics equipment, studying advanced microwave theory and applications, examining communications on a global scale, and developing new methods for insuring product reliability.

The Hughes Products engineering team makes electronics useful in solving industrial problems. For example, this group has just unveiled an industrial electronics system which will automate a complete and integrated line of machine tools.

The diversity of Hughes activity offers prospective employees opportunity to build a rewarding career in a highly progressive and expanding environment.

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

Communications	Microwaves
Reliability	Crystal Filters
Circuit Design	Computer Engineering
Systems Analysis	Field Engineering
Vacuum Tubes	Semiconductors

Write, briefly outlining your experience, to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 17G-1, Culver City, California.

© 1958. HUGHES AIRCRAFT COMPANY



Advanced research on the Maser (Microwave Amplification by Stimulated Emission of Radiation) performed by the R&D Laboratories is directed towards applications of a portable, airborne Maser for missiles and aircraft.



Falcon missiles have been an important factor in establishing Hughes as a leader in advanced airborne electronics. Manufactured in Tucson, Arizona, the Falcon missiles have both infrared and radar guidance systems.

Creating a new world with *ELECTRONICS*

HUGHES

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

CIRCLE 108 ON READER-SERVICE CARD

Ultrasonic Cleaner

Large capacity

A capacity of 150 gallons is featured in this system. Model DR-2000 AH has a cleaning tank measuring 3 ft sq x 2.5 ft deep which is fitted with an array of 20 bottom-mounted transducers. These are driven by a simplified pulsed generator delivering 8000 w peak power. Either solvent or water detergent solutions can be used.

Acoustica Associates, Inc., Dept. ED, 26 Windsor Ave., Mineola, N.Y.

CIRCLE 109 ON READER-SERVICE CARD

Power Beam Pentode

Provides higher output as linear amplifier



The 400-watt PL-175 power pentode provides 25 to 30 per cent more output as a low voltage class-AB₁ linear amplifier than screen grid tubes of similar ratings previously available. The suppressor grid terminates in the metal base shell, which may be grounded for the majority of applications. Base pin connections are arranged to allow direct substitution of the PL-175 in equipment designed for old-type screen grid tubes. The PL-175 brings to the 500 to 1000-w output range the advantages of the exclusive vane-type suppressor grid introduced by Penta in 1956 in the 100-w PL-172.

Penta Laboratories, Inc., Dept. ED, Santa Barbara, Calif.

CIRCLE 110 ON READER-SERVICE CARD

FHP Motor

Variable speed

The RBD-25 variable speed sub-fractional hp dc motor is available in two standard models: RBD-2505; rating 0.5 oz in., 115 dc v, 1800 rpm, 10 w; model RBD-2510, rating 1.0 oz in., 115 dc v, 1800 rpm, 15 w, as well as in voltage ranges from 24 v to 115 v with speeds from 900 to 3600 rpm. Variable speed drive can be obtained by varying the armature voltage on the RBD-25 shunt wound dc motor.

Holtzer-Cabot Motor Div., National Pneumatic Co., Inc., Dept. ED, 125 Amory St., Boston 19, Mass.

CIRCLE 111 ON READER-SERVICE CARD

NEW PRODUCTS

High Voltage Connector

Carries 7500 v



Designed to carry 7500 v, this unit has an insert with two high-voltage contacts and three low-voltage carriers. The receptacle is 2-in. square-flange type. Solder pot ends can be potted to make the unit completely environmental if desired.

The Deutsch Co., Dept. ED, 700 Avalon Blvd., Los Angeles 3, Calif.

CIRCLE 112 ON READER-SERVICE CARD

Frequency Converter

Linearity of 0.1 per cent



This frequency converter provides a voltage directly proportional to the frequency level of the input. Linearity is 0.1 per cent, and output is up to 1 ma per 1000 cps of input.

George L. Nankervis Co., Cox Instruments Div., Dept. ED, 15300 Fullerton Ave., Detroit 27, Mich.

CIRCLE 113 ON READER-SERVICE CARD

External Coil Chopper

Results in low residual noise levels



This chopper is useful in chopper stabilized dc amplifiers where thermal stability and extremely low noise are of prime importance. As



WHAT IS "TOTAL ELECTRONICS"?

The picture suggests the answer.

In the new world of missiles and space systems to come, it's the *total* complex of control, guidance and communication—the whole interrelated nervous system correlating the eye, the hand, the head and the heart of the missile to that of man himself.

And in the company producing that missile, it's the *total electronics capability* necessary to specify, design, create and test this central nervous system as an integral part of the whole machine—from its conception, through delivery to the customer, to the final completion of its mission.

In the period of a dozen years since the word "electronics" first gained common currency in our industry, Martin has been systematically building toward just such a total electronics capability.

As a result of the rapid evolution in advanced electronics development, today one-third of all Martin engineering manpower is devoted to the electronics requirements of our customers' present and future products. And a major part of Martin's investment is in the special facilities necessary to this new concept of total electronics.

We believe that this capability is essential to our increasingly important function as a prime contractor to all branches of the military.

MARTIN
BALTIMORE • DENVER • ORLANDO

a result of the modular construction of this unit, interchangeable coils are available which are optimized for minimum power drive and thermal dissipation at preselected frequencies within the operating frequency range of 0-700 cps. Thermal stability of this unit is less than $\pm 2 \mu\text{v}$. Unaffected by shock and vibration, the unit mates with a standard 4 pin miniature socket.

Bristol Co., Dept. ED, Waterbury 20, Conn.

CIRCLE 114 ON READER-SERVICE CARD

Low Approach Indicator

Features rectilinear localizer and glide slope display



The rectilinear display design of the model ID-525 low approach indicator for aircraft results in improved readability. Two model MEP-1 end-pivoted high torque mechanisms are used for localizer and glide slope indications and two model MEP-7 short angle mechanisms are used for warning flags. All mechanisms employ self-shielding internal magnets making compass interference negligible. The model ID-525 weighs 24 oz.

Marion Electrical Instrument Co., Dept. ED, Grenier Field, Manchester, N.H.

CIRCLE 115 ON READER-SERVICE CARD

Power Supply

Delivers 70 ma at 270 v dc



This power supply has a regulation of 1 per cent, no load to full load. The output is continuously variable from 150-270 v dc. Filament voltage is also available.

Building Blocks Electronic Co., Dept. ED, 2172 E. 36th St., Brooklyn 34, N.Y.

CIRCLE 116 ON READER-SERVICE CARD

Testimonial:

**FSCHRS
RPTTN FR SPCLS
S NVRSL!***



Translation:

*** FISCHER'S
REPUTATION FOR
"SPECIALS"
IS UNIVERSAL!**

We really don't sell brass and aluminum turned nuts in "outer space" . . . but that's the only territory we can't supply! Manufacturers of all types of equipment are realizing substantial cost savings with dependable Fischer "special" nuts. Reason: FISCHER NUTS HAVE NO EQUAL FOR PRECISION, PRICE AND DELIVERY. And that applies to standards as well as specials!

If you use brass or aluminum nuts in production quantities, specify the finest . . . specify FISCHER!

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Please send your new 20-page
CATALOG FS-1000 containing complete
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CIRCLE 117 ON READER-SERVICE CARD

ND FACTS

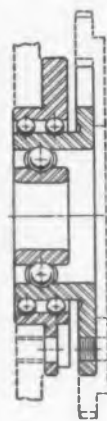
Symbol of a reputation for integrity, quality and service—for advanced creative engineering achieved by New Departure in over half a century of precision ball bearing manufacture.

1200% GAIN IN GYRO ACCURACY WITH NEW DEPARTURE BALL BEARINGS!

A major advance in gyroscope construction by Sperry Gyroscope Company results in a remarkable reduction of random drift rate. Involving a special design of gimbal bearings, rates of 2 to 3 deg. per hour, recently considered very good, are now cut to as little as 0.25 deg. per hour with still lower rates in sight.

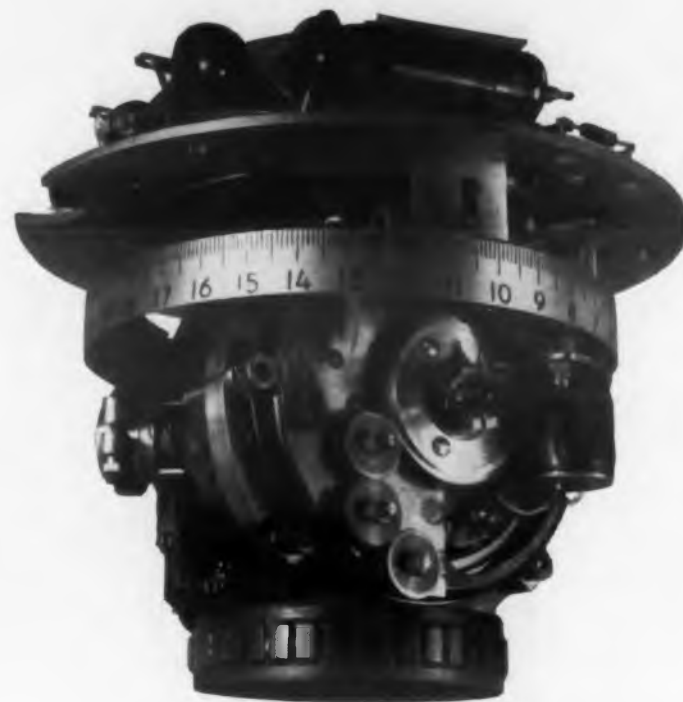
New Departure created the special manufacturing techniques for the high-

precision production of unique ball bearings—another indication of New Departure's ability to meet exacting instrument bearing requirements thru wide engineering experience and precision manufacturing facilities.



The Sperry Rotorace (TM) Gyroscope employs two bearings, one concentric within the other. One outer race is fixed to the gimbal frame, while the other carries a light gear by which it is rotated in periodically alternating directions.

In addition to reducing random drift due to any microscopic irregularities or possible foreign particles, rotation of the bearing race also reduces bearing static or break-away friction.

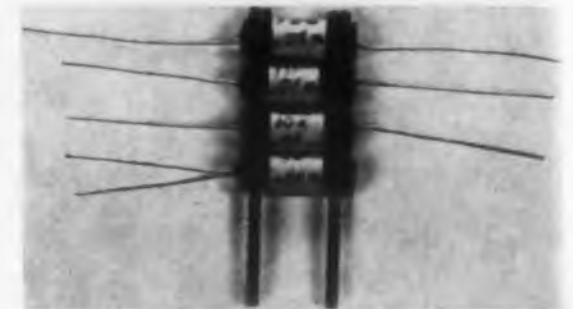


Sperry C-11 Gyrosyn[®] Compass with Rotorace bearings will give ultra-precise navigation to the new jetliners.

1908-1958
GM
FORWARD FROM FIFTY
ND
NEW DEPARTURE
DIVISION OF GENERAL MOTORS, BRISTOL, CONN.
NOTHING ROLLS LIKE A BALL
CIRCLE 118 ON READER-SERVICE CARD

NEW PRODUCTS

Wirewound Resistors Stacked for close assembly



Series 300 multi-stacks, encapsulated wirewound resistors, is provided with a pair of radial holes through the body for secure mounting and stacking. The mounting hardware is insulated and tends to equalize temperature differences between respective resistors.

Consolidated Resistance Co. of America, Inc., Dept. ED, 44 Prospect St., Yonkers, N.Y.

CIRCLE 119 ON READER-SERVICE CARD

Dials

For a variety of applications



Disc type dials range in sizes from 2 to 6 in. diam. Drum type dials range in diameters from 1-1/2 to 3 in. having 0.375 id to accommodate hubs in 4 basic shaft sizes 1/8, 5/32, 3/16, and 1/4 in. These are supplied in wide selections of graduations, with accuracy of 6 min. Verniers allow close readings of 6 min, 15 min, and 1/1000 rev.

Ackerman Engravers, Dept. ED, 458 Broadway, New York 13, N.Y.

CIRCLE 120 ON READER-SERVICE CARD

Trimming Potentiometers

Rated 1/2 w at 100 C for 1000 hrs



These two trimmer potentiometers are available in 15 standard resistance values from 47 to

ELECTRONIC DESIGN • May 14, 1958

10,000 ohms. All values are manufactured with 20 ppm resistance wire and can dissipate 1/2 w at 100 C, derated to zero at 150 C, for a period of 1000 hours. Type 101F may be mounted by its leads alone, in a fuse clip or a 0.29 in. hole. Type 101G is supplied with a nut for mounting and a nut for locking the shaft against rotation. Both units employ humidity-proof construction.

Carter Mfg. Corp., Dept. ED, 23 Washington St., Hudson, Mass.

CIRCLE 121 ON READER-SERVICE CARD

Digital Voltmeter

0.5 per cent accuracy



The DVM-1 digital voltmeter may be set for full scale reading of plus or minus 10, 100, or 1000 v and measures voltages to a full-scale accuracy of better than 0.5 per cent. The unit operates from a 117 v ac source, 20 w, and consists of transistorized computer elements including a precision digital-to-analog converter, comparator, logic and a reference power supply, which is held to an accuracy of better than 0.1 per cent.

Ranson Research, Dept. ED, 323 W. 7th St., San Pedro, Calif.

CIRCLE 122 ON READER-SERVICE CARD

Pulse Generator

Repetition rates to 2 mc



Model 3450B megacycle pulse generator is an improved version of the model 3450A. Repetition rates continuously variable from 200 cps to 2 mc are provided in 5 calibrated decade ranges. Secondary emission tubes and extremely fast recovery time circuitry provide 0.1 to 100 µsec continuously variable control of pulse delay and duration, even at megacycle repetition rates.

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

CIRCLE 123 ON READER-SERVICE CARD

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MAGNET
WIRE**

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of a friend...
send for it!*

Electrical Wire Division
John A. Roebling's Sons Corp.
Trenton 2, New Jersey

Please send my free copy of Roebling's new
Magnet Wire Fact Book.

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WIRE BETTER
ELECTRICALLY

This illustrated book covers every type of
Roebling Magnet Wire—how it's made, tested,
packaged. Complete tables of sizes, weights, shipping
information—plus interesting temperature, specification
and test data. You shouldn't be without these facts if
magnet wire of any description fits into your manu-
facturing picture!

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to Electrical Wire Division, John A. Roebling's Sons
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CIRCLE 124 ON READER-SERVICE CARD

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Broad-

avail-
47 to

COMPLETE LINE 125° C SERVO MOTOR TACH GENERATORS

to your precise specification

Oster[®]

- Both Damping and Integrating types available with parameters to your requirement.
- Complete size range: 8, 10, 11, 15, 18. Can be designed with gear train.
- -54° C to +125° C ambient temperature range.
- Designed to MIL-E-5272.
- Assembled under closely controlled environmental conditions.

Burton Browne Advertising



400 CPS SERVO MOTOR - TACHOMETER GENERATORS

Oster Type	Size	Length Inches	Wt. Oz.	Rotor Inertia gm cm ²	MOTOR				GENERATOR					
					Rated Voltage		No load speed RPM	Watts per phase @ Stall	Stall Torque OZ. IN.	Excit. Volt.	Output Volts per 1000 RPM	Lin. % to 3600 RPM	Null MV	Phase Shift @ 25° C
					Ø 1	Ø 2								
8MTG-6201-01	8	1.850	2.3	0.77	26	40/20	6,500	2.2	0.16	26	0.25	0.5	15	± 5°
*10MTG-6228-02	10	2.157	4.2	0.72	115	115/57.5	9,500	2.8	0.26	115	0.45	1.5	19	± 10°
10MTG-6229-12	10	2.100	2.9	1.09	33/16.5	52/26	9,500	3.0	0.28	26	0.45	1.5	13	± 10°
*10MTG-6229-03	10	2.100	2.9	1.09	26	26	10,500	3.0	0.26	18	0.3	1.5	12	± 10°
10MTG-6229-15	10	2.100	2.9	1.09	26	26	10,500	3.0	0.26	26	0.3	1.5	12	± 10°
*10MTG-6232-05	10	2.104	4.2	1.1	115	36/18	6,500	3.5	0.26	115	0.30	1.5	15	± 10°
11MTG-6251-13	11	2.531	7.0	1.3	115	115/57.5	6,500	3.5	0.63	115	0.55	0.5	19	± 10°
11MTG-6251-00	11	2.531	7.0	1.1	115	40/20	6,500	3.5	0.63	115	0.55	1.5	19	± 10°
11MTG-6254-01	11	2.200	6.0	1.1	115	115/57.5	6,500	3.5	0.63	115	0.55	1.5	19	± 10°
15MTG-6280-01	15	3.281	14.0	5.3	115	115/57.5	5,000	6.2	1.5	115	3.0	0.2	13	± 5°
†15MTG-6276-03	15	3.875	15.0	4.4	115	57.5	8,500	5.8	0.70	115	2.75	0.2	13	± 0.5°
18MTG-6302-02	18	3.680	20.0	5.7	115	115/57.5	9,000	16.0	2.7	115	3.0	0.2	13	± 5°
18MTG-6302-04	18	3.680	20.0	5.7	115	115/57.5	4,800	9.2	2.4	115	3.0	0.2	13	± 5°

*These units designed for 85°C ambient but same characteristics can be designed for 125°C. †Additional 21.4 watts for heater, the values given are independent of ambient temperature.

Other products include servos, synchros, resolvers, motor-gear-trains, AC drive motors, DC motors, servo mechanism assemblies, reference and tachometer generators, servo torque units, actuators and motor driven blower and fan assemblies.

John Oster

MANUFACTURING CO.
Your Rotating Equipment Specialist
Avionic Division
Racine, Wisconsin

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Engineers For Advanced Projects:

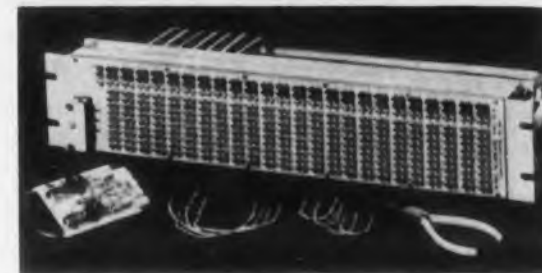
Interesting, varied work on designing transistor circuits and servo mechanisms. Contact Mr. Robert Burns, Personnel Manager, in confidence.

CIRCLE 125 ON READER-SERVICE CARD

NEW PRODUCTS

System Plugboard

Permits fast prototype design



The M-PAC plugboard is designed to afford a quick and easy means for implementing a system in the prototype stage without resorting to expensive labors. Model PB101 provides standard 12-pin printed circuit connectors with guide pins for 24 transistorized 3C-PAC's series M. Any package of the series M family may be mounted in any connector. All twelve terminals per connector are wired to the corresponding vertical column of paired jacks on the front panel of the plugboard to provide usage flexibility.

Computer Control Co., Inc., Dept. ED, 92 Broad St., Wellesley, Mass.

CIRCLE 126 ON READER-SERVICE CARD



Signal Generator

For low frequency work

Model BL-1015 audio signal generator and control system is a signal source for electrical and electro-mechanical measurements. The instrument, working on the heterodyne principle, has a frequency range from 2 to 4000 cps. An accuracy better than 2 per cent is provided by a built-in vtm. Other unique features include: accurate reading at low frequencies; automatic output regulator; accurate output attenuator in 10 db steps; and automatic frequency scanning.

Clevite Corp., Brush Instruments Div., Dept. ED, 3405 Perkins Ave., Cleveland 14, Ohio.

CIRCLE 127 ON READER-SERVICE CARD

Terminals

For printed circuits

Printed circuit terminals, no. 2228 and no. 2420, are precision-machined in brass and finished with copper flash and a 0.003 in. tin-lead

solder plating. No. 2228, with a split end, is 3/32 in. long when mounted. No. 2420 is 3/64 in. long when mounted. Both are push fit with over knurl and fine straight knurl.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

CIRCLE 128 ON READER-SERVICE CARD

Thermocouple Reference Junction

Provides 0.5 F regulation



This heated reference junction replaces the conventional ice bath as reference temperature for thermocouples. It offers regulation to 0.5 F or better by multiple temperature control. The warm-up time is 0.5 hour at -65 F. The unit permits the user to record several types of thermocouples. The reference temperature is field adjusted and monitored with a precision resistance element.

Aero Research Instrument Co., Dept. ED, 315 No. Aberdeen St., Chicago 7, Ill.

CIRCLE 129 ON READER-SERVICE CARD

Moving Coil Forms

Tight tolerances



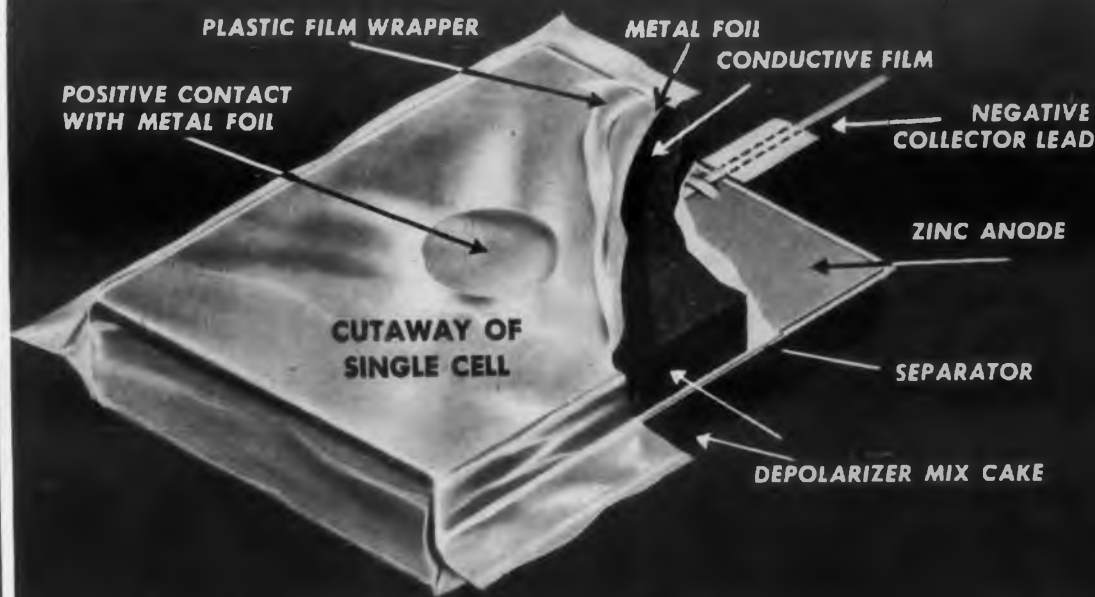
Precisely dimensioned, moving coil forms for d'Arsonval galvanometers are produced in a variety of sizes and shapes, weighing as little as one grain (1/480 oz). Tolerances as close as ± 0.0002 in. can be obtained on wall thicknesses which range in size from 0.003 to 0.01 in. Tolerances on other dimensions can be within ± 0.001 in. The anodized forms meet 250 or 500 v dielectric strength tests.

H&H Machine Co., Inc., Dept. ED, Noble and Jackson Sts., Norristown, Pa.

CIRCLE 130 ON READER-SERVICE CARD

NEW **EVEREADY** TRADE-MARK ENERGIZER with exclusive **CATHODIC ENVELOPE** construction

Has more than 3 times the life of 6 D-cells



No. 2762

ENERGY IN A SANDWICH — a new concept in battery design . . . doubles the active anode surface . . . gives high current, lower voltage required by transistor circuits . . . provides volume efficiency unknown to other carbon-zinc cells. And there are no side penalties for peak performance. You actually get *more hours of power in one-third the space at the lowest possible cost!*

For new transistorized . . .

- **Cordless Radios** with up to a year's service on normal listening schedules.
- **Standard Portables** with longer service, fewer battery changes, trouble-free listening.
- **Pocket Portables** use leakproof "Eveready" Energizer No. 2713 for these handy radios, easy battery snap-on connection.
- **Electronic Equipment**, any transistorized battery-operated device whose drain approximates that of transistor radios.

This, and other "Eveready" Energizers in this series, take one-third less volume than round D-size cells for same service life!

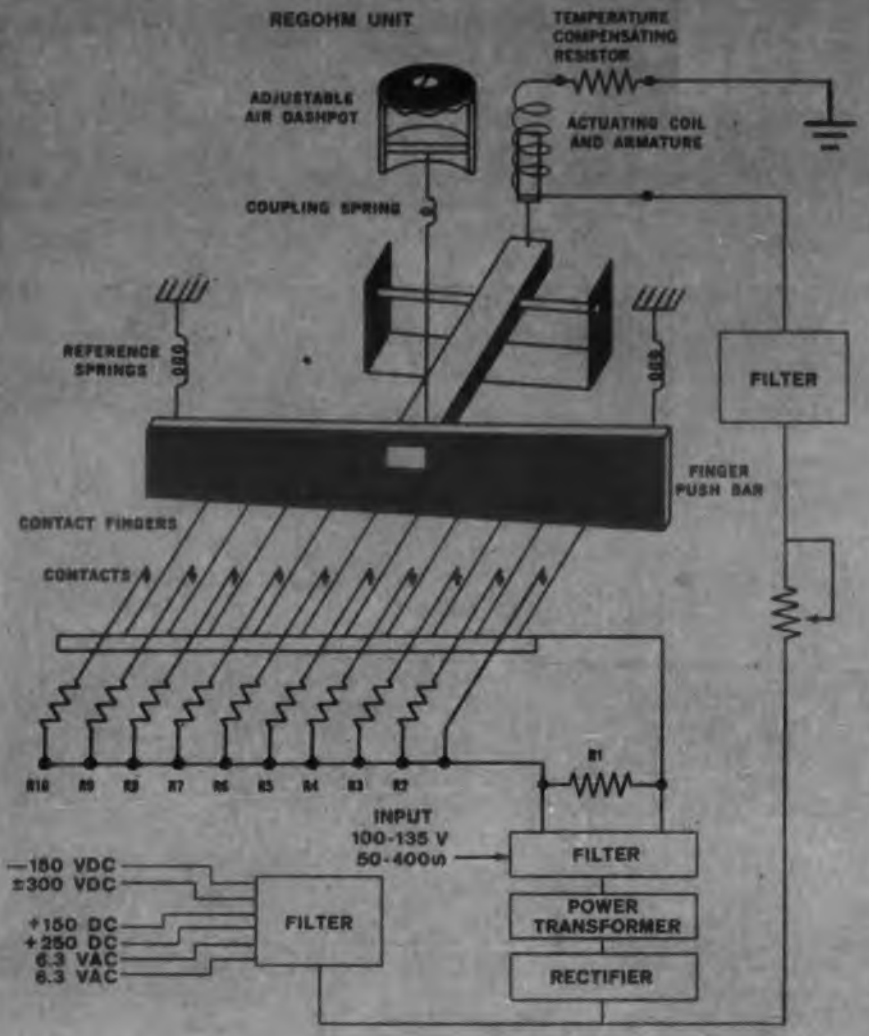
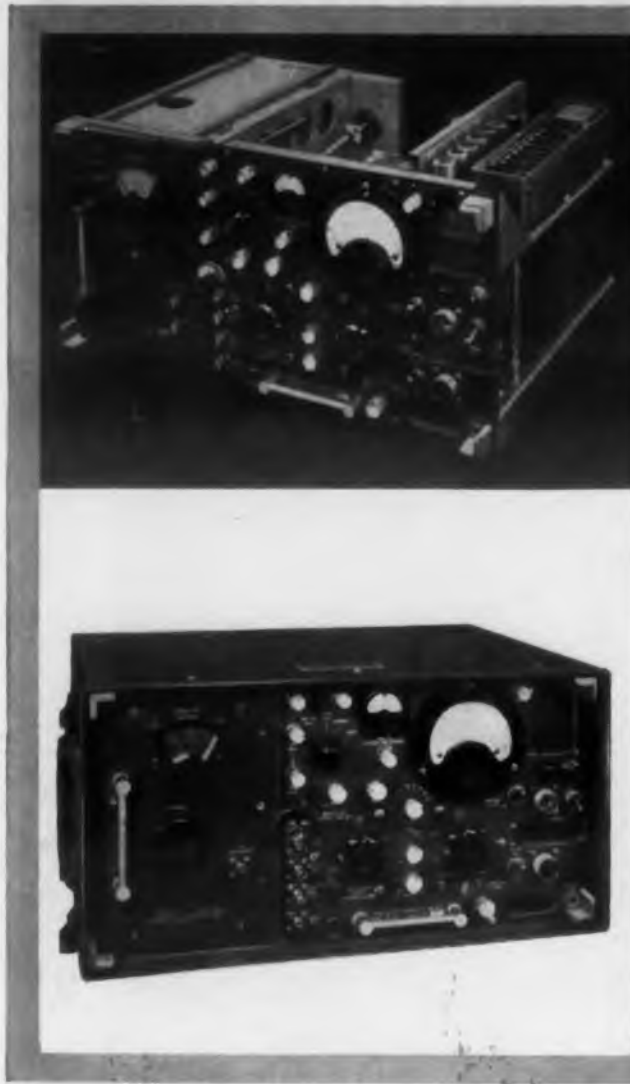
For complete information write for our fully illustrated brochure: Manager, Battery Engineering Dept., National Carbon Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York, N. Y.

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CIRCLE 131 ON READER-SERVICE CARD



REGOHM SOLVES Another Electronics Control Problem



REGOHM REGULATOR GIVES EMPIRE NOISE METER PRECISE AC INPUT—FROM LINE OR BATTERY

Empire Devices Products Corp. uses the compact Regohm regulator as the heart of the voltage control system in its Noise and Field Intensity Meter, Model NF-105. This meter is a precision instrument, covering the frequency ranges from 14 to 1000 MC, and is noted for its outstanding reliability and calibration stability.

The essential requirement of a closely controlled power supply is met by a unique regulator system that was developed by Empire and Electric Regulator engineers jointly. This control circuit, with elements shown in the accompanying schematic, holds the instrument's supply at the pre-set characteristics, although the external power supply may vary from 50 to 400 cycles, and potential from 100 to 135 volts. The wide range of regulated inputs permits precise measurements with this meter under severe field conditions and aboard aircraft as well. Frequently, when utility lines or other AC sources are not available, the instrument is

powered with batteries working through an unregulated inverter.

Empire Devices regards the dependable Regohm circuit as a main factor in the Meter's unparalleled performance which has such high acceptance in both military and commercial circles around the world. The remarkable record of nine years in top-flight service proves both the excellence of the Empire Devices' design and the Regohm's durability and capacity for sustained performance.

Manufacturers of control and many other types of electronic equipment are finding answers in the Regohm's exclusive combination of: Sensitivity, Stability, Wide Range of Control Resistance, Long Life, Light Weight, Permanent Adjustment, Freedom from Maintenance, Rugged Design, and *Low Cost*. Our engineers will gladly discuss with you how Regohm may simplify your design, performance, and cost problems. Please call, wire, or write: Electric Regulator Corporation, Norwalk, Connecticut.

CIRCLE 132 ON READER-SERVICE CARD



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



ELECTRIC REGULATOR CORPORATION
NORWALK CONNECTICUT

NEW PRODUCTS

Preamplifier Plug-in servo types



Digitol servo preamplifier, Model DLA-10, is mounted on a printed circuit chassis 4-1/2 x 6 in., and provides an adjustable voltage gain up to 10,000, including rate network losses. The unit has less than 0.02 per cent servo nulling error with the proper output stage and actuator.

Electro Precision Corp., Dept. ED, Arkadelphia, Ark.

CIRCLE 133 ON READER-SERVICE CARD

Snap-action Switch

Mounting and terminals combined



Panel mounting flexibility is offered by the snap-action switch, S25-24B. Using the mounting stud as a terminal connector, it permits installation on one side of the panel and wiring from the other. Characteristics are: 5 oz max operating force; 3 oz max release force; 3/16 in. pretravel; 3/64 in. movement differential. The switch is rated 10 amp 125 v ac, 5 amp 250 v ac.

Cherry Electrical Products Corp., Dept. ED, 1650 Deerfield Rd., Highland Pk., Ill.

CIRCLE 134 ON READER-SERVICE CARD

Relay Analyzer

Tests relays quickly



This generalized relay analyzer, model RA-2, is designed to test subminiature, general purpose,

polarized, and time-delay relays. When connected to an oscilloscope the analyzer will perform the electrical tests described in MIL-R-5757C and recommended by the Guided Missile Relay Working Group. The analyzer also serves as a pulse generator for life testing electromechanical devices, supplanting motor and cam switch mechanisms. An accessory fixture to fit typical relay headers or terminal configurations is supplied with the analyzer.

Pacific Technical Developments, Dept. ED, 1632 Pico Blvd., Santa Monica, Calif.

CIRCLE 135 ON READER-SERVICE CARD

Programmer

Uses accurately punched tape



The LPR-6 is an electro-mechanical device designed to control a number of precisely timed functions at pre-set intervals. Current transmitted through the sensing device actuates six single pole double throw relays. A punch locates the holes in the Mylar tape within $\pm 1/1000$ of a second.

Beattie-Coleman, Inc., Dept. ED, 1000 North Olive St., Anaheim, Calif.

CIRCLE 136 ON READER-SERVICE CARD

Eyelets

Twelve standard sizes



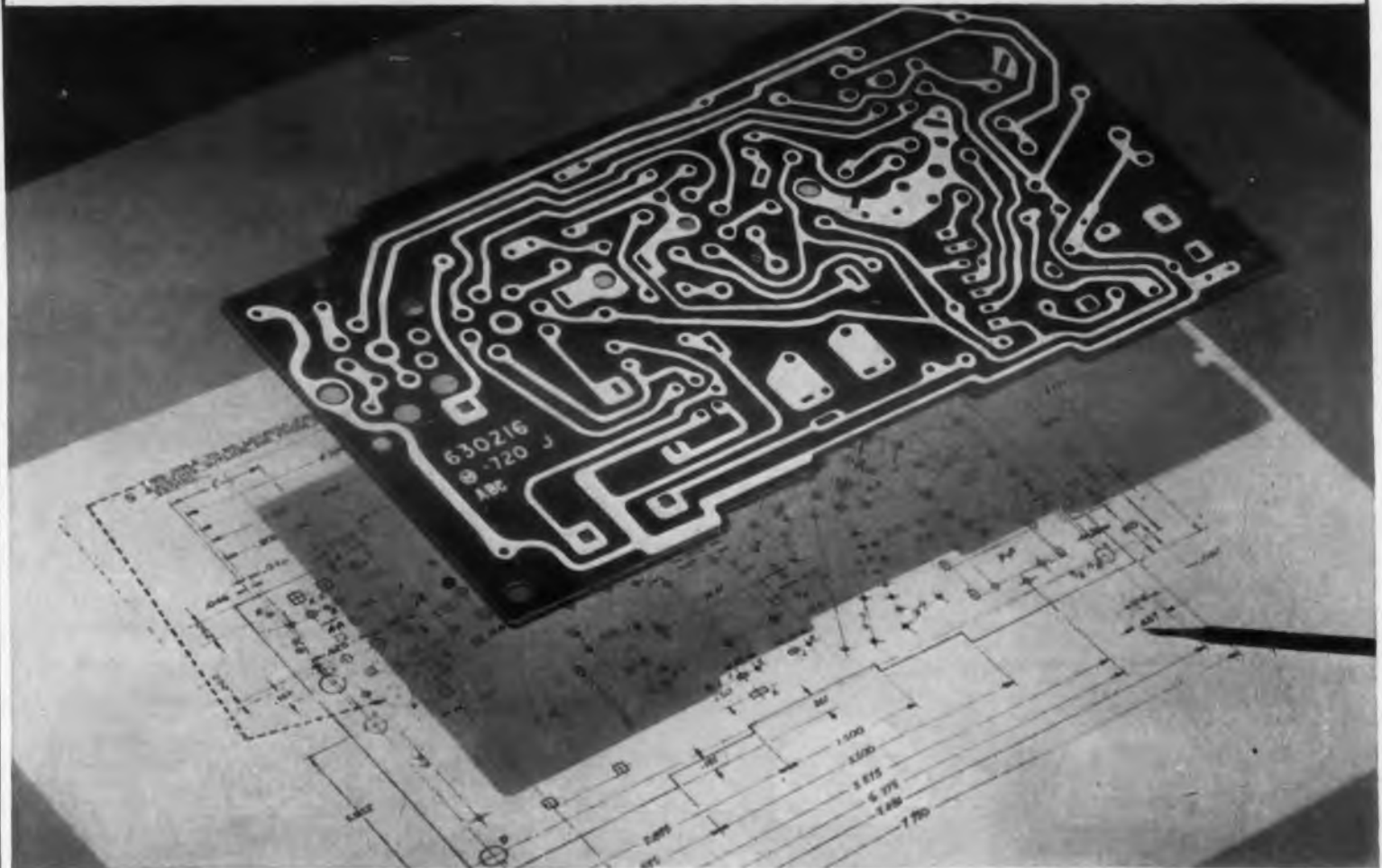
Used for terminal and feed-through connections on printed circuits, the flared flange of these eyelets provides a good fillet of solder between the eyelet and the circuit pattern. The smallest eyelet in this line is less than 1/32 in. diam, 1/16 in. long and, has a 1/16 in. head diam. Sizes range upward to 3/32 in. diam, 5/32 in. long, with a 0.150 head diam.

Circon Component Corp., Dept. ED, Santa Barbara Municipal Airport, Goleta, Calif.

CIRCLE 137 ON READER-SERVICE CARD

Industrial Laminates

from the company that really knows the electrical and electronics industry—General Electric



Textolite 11572 circuit board, made for Emerson Radio & Phonograph Corp. by Methode Mfg. Co.

Why exacting circuit engineers specify low-cost General Electric Textolite 11572 for TV wiring boards

Paper-base laminate offers electrical properties surpassing NEMA XXX-P standards. It cold-punches precisely . . . resists degreasing solvents . . . does not vary from part to part.

Design engineers find inexpensive General Electric Textolite 11572 ideal for TV and radio printed circuits. Here's why:

General Electric Textolite 11572 combines superior machinability with high insulation resistance and low water absorption. It's not harmed by the solvents used in the printing process. Also, Textolite's properties never vary; you get uniformity in piece after piece.

Select General Electric Textolite whenever you need reliable structural insulation. Sweet's Product Design File, Catalog 2b/Gen, gives full, concise technical data. Independent local fabricators (listed in the Yellow Pages under "Plastics") assure quick, local delivery of parts. And our experienced Technical Service Department will help with special problems. For fast action, write: Laminated Products Dept., Section ED-85, General Electric Company, Coshocton, Ohio.



For higher IR (250,000 megohms in humidity) in structural insulation, specify Textolite 11570. Like 11572, it cold-punches cleanly in intricate shapes.

Textolite®

INDUSTRIAL LAMINATES

GENERAL  ELECTRIC

CIRCLE 138 ON READER-SERVICE CARD

TRIPLETT

Reliability... through 15,631 accepted types



Clear plastic (PL) meters feature;

- Longer scale length
- Visibility unlimited
- Light unobstructed—no shadows
- Interchangeability—universal
- Appearance revolutionized

UNIQUE FEATURES AND CHARACTERISTICS

These guarantee superior quality in *all* TRIPLETT meters:

- High torque to weight ratio for extra rugged movement. Specially developed bearings withstand severe vibration and reduce friction to a minimum.
- Bearings are microscopically graded not only for depth and radius, but also for *polish*. Only best quality jewels are used.
- Unique hardening method assures uniformly hard pivots.
- High flux scientifically aged alnico magnets for greatest permeability. Micrometrically balanced all metal frame construction protects bearings against vibration from any direction.
- Simplicity of frame construction assures easy, accurate alignment in servicing.
- Dials are all metal—no paper dials are ever used—will not become abrasive, warp, crack or discolor under normal conditions. (Printing presses in Triplet's own plant allow fast, inexpensive service on special dial requirements.)
- Extra strong ribbed pointers precisely balanced with triple "slide and lock" adjusting weights.
- Insulations provide extra allowance for breakdown voltages.
- All metal parts processed, all molded parts pre-cured to eliminate distortions from stresses and strains.

TRIPLETT ELECTRICAL INSTRUMENT COMPANY • 52 years of experience • BLUFFTON, OHIO

Triplet design and development facilities are available for your special requirements for meters and test equipment.

CIRCLE 139 ON READER-SERVICE CARD

NEW PRODUCTS

Silicon Rectifiers

Delivers 30 a dc



These silicon rectifiers have peak inverse voltage ratings ranging from 50 to 600 v and can deliver 30 a of rectified current. The operating temperature extends from -65 to $+175$ C.

Bendix Aviation Corp., Marketing Dept., Red Bank Div., Dept. ED, Long Branch, N.J.

CIRCLE 140 ON READER-SERVICE CARD

Equatorial Platform

Tests navigation systems weighing up to 500 lb



The T818 system test turntable is a precise tiltable earth axis suitable for mounting complete navigation system platforms. The unit checks alignment of inertial components and allows observation of gyro and platform drift characteristics. The table is tiltable to ± 90 deg with inbuilt leveling and full azimuth adjustment for accurate polar axis alignment. The 36 in. diam table top is a precise flat with tapped mounting holes. A demountable cradle with micrometer adjustments provides for mounting a 32 in. diam, 500-lb spherical platform.

Although the rotating element weighs approximately 3000 lb, the table turns smoothly on pressurized fluid bearings. Rotational and alignment accuracies of ± 2 sec of arc are attained under tilted conditions. Turntable drive is by means of

Provision is made for incorporating a direct drive servo motor for closed loop operation. Unit measures 50-in. diam, 63 in. high (from floor to table top) and weighs 7000 lbs.

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

CIRCLE 141 ON READER-SERVICE CARD

Programmed Testing

Selects according to resistance values



This tape-programmed resistance measuring instrument can select any two of 240 points and measure the resistance between them, in a range from 1 ohm to 9.99 meg. In addition to selecting either a 1, 5, 10, or 20 per cent nominal tolerance, the Robotester may be programmed to pass any value below or above a selected median resistance.

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

CIRCLE 142 ON READER-SERVICE CARD

Temperature Test Chamber

From -65 to +500 F range



This portable temperature testing oven utilizes dry ice in maintaining minimum temperatures and heating coils for the development of maximum temperatures. The unit operates on 110 v ac current. Temperatures to -90 F are available when the unit being tested is not a heat source. Overall dimensions are 24 x 10-1/2 x 14-1/2 in., and the interior test chamber dimensions are 10 x 7 x 7 in.

Delta Design Engineers, Inc., Dept. ED, 3039 Adams Ave., San Diego 16, Calif.

CIRCLE 143 ON READER-SERVICE CARD

New trends a in designing

P-6... A special high hysteresis

P-6—a cobalt-nickel-vanadium-iron alloy developed by G-E research engineers—possesses a unique combination of high residual induction and low coercive force.

These properties make it ideal for applications where high residual induction is required without the excessive magnetizing forces necessary with other magnetic materials such as the high cobalt steels, the cobalt-nickel-iron alloys, the cobalt-vanadium-iron alloys, and the alnicos.

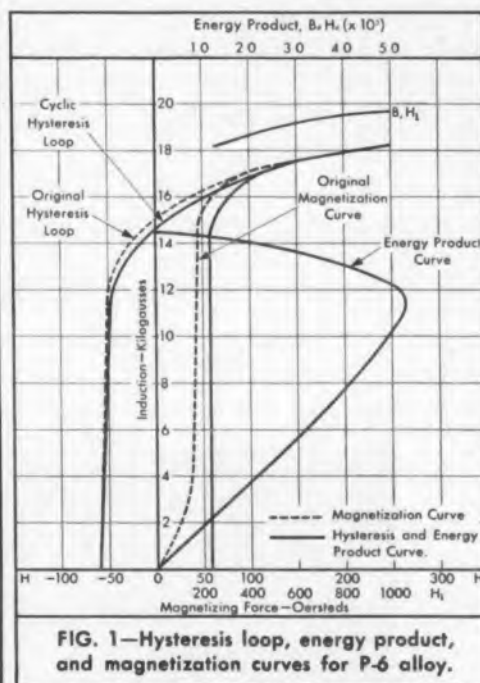


FIG. 1—Hysteresis loop, energy product, and magnetization curves for P-6 alloy.

The residual induction of P-6 is 14,000 gauss... over 30% greater than either 17% cobalt-steel alloy or 6% tungsten-steel alloy. The maximum energy product of P-6 is 410,000 gauss-oersteds. Figure 1 shows the magnetization, hysteresis loop, and energy product curves for P-6 alloy.

The P-6 alloy is also useful where ease of workability of the magnetic material is desired. Because it is aged at a high temperature, it can withstand greater operating temperatures than tungsten-steels and cobalt-steels without undergoing subsequent aging.

One of the major uses for P-6 is in rotors* for hysteresis motors (fig. 2). These motors exhibit high starting torques and can synchronize high inertia loads without auxiliary starting equipment. Most important, the

and developments electrical products . . .

General Electric magnetic alloy with its loss and torque characteristics



materials tested, P-6 best fulfills the desired characteristics.

Another use for P-6 is in hysteresis clutches. This type of clutch is formed when the wound field in the hysteresis motor is replaced by a rotating permanent magnet member to provide field excitation.

Although hysteresis clutches are larger than friction or magnetic particle clutches of the same torque rating, they have many advantages such as high degree of reliability, repeatability, linearity, and freedom from excessive drag torque.

General Electric P-6 alloy is available in strips from .010" to .100" thick, and in widths up to four inches. In wire form, it is available in .0201" to .102" diameters. P-6 should be capable of being swaged, welded, extruded and drawn. General Electric Engineers currently are experimenting with these forming operations.

The development of P-6 alloy by General Electric is one of the many examples of how G.E.'s research in magnetic materials is paying off. The same experience, skill and facilities that made this development possible can be put to work solving your magnet problems.

To get the expert design assistance of G-E Magnet Engineers, or your copy of the new G-E Magnet Design Manual, simply write: *Magnetic Materials Section, General Electric Company, 7820 N. Neff Blvd., Edmore, Michigan.*

torque produced is constant and doesn't fluctuate with rotational speed.

In this type of motor, there is a hysteresis loss in the rotor material caused by the revolving magnetic field. This loss produces torque between the permanent magnet rotor and the spatially revolving magnetic field.

Because the theoretical torque produced is directly proportional to the hysteresis loss in the rotor, it is advantageous to obtain the highest possible value of hysteresis loss in the rotor material.

To do this, a material must possess a high hysteresis loss for a given applied magnetizing force. Figure 3 shows a comparison between P-6 and other magnetic materials. Of the

Material	Peak H Oersteds	Peak B Gausses	Coercive Force H _c —Oersteds	Residual Induction B _r —Gausses	Loop Area Gauss-Oersteds
P-6 Alloy	70.0	15,500	51.7	13,400	2,860,000
	65.0	15,000	51.0	12,900	2,720,000
	60.0	14,500	50.8	12,200	2,540,000
	55.0	10,900	45.2	8,500	1,610,000
5.75% Chrome Steel	50.0	4,100	25.0	2,100	290,000
	70.0	6,900	38.0	4,600	1,210,000
	90.0	8,700	44.0	6,100	1,700,000
17% Cobalt Steel	118.0	12,500	68.7	9,250	2,872,500
	91.4	10,000	61.9	6,950	1,885,000
	79.2	7,500	52.1	4,540	1,005,000
	69.6	5,000	35.0	2,315	446,000
6% Tungsten Magnet Steel	100.0	12,450	28.0	9,150	1,297,000
	61.5	10,000	23.2	7,200	774,000
	50.0	8,500	20.5	6,050	624,000
	45.5	8,000	18.0	5,650	499,000

FIG. 3—Comparison of P-6 and three typical magnetic alloys.

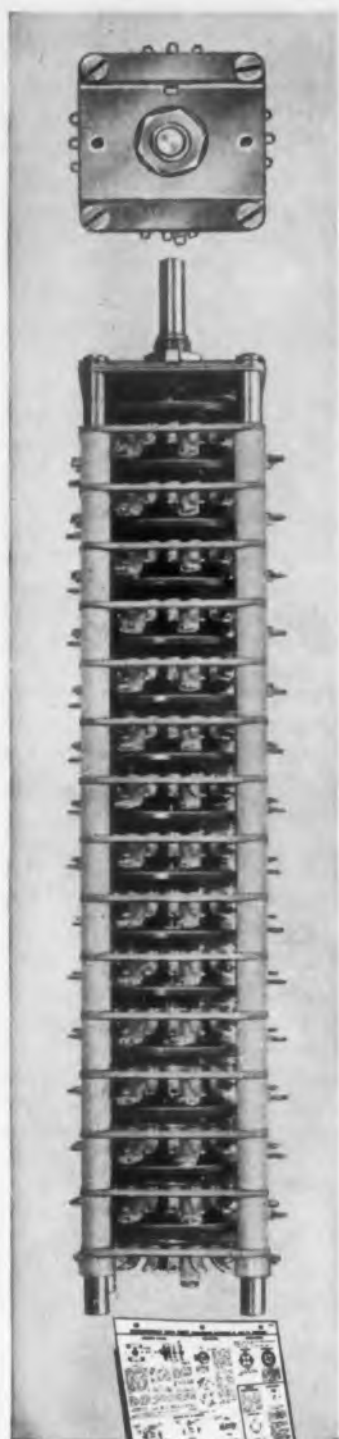
*Gyro spin motor rotor courtesy of Minneapolis-Honeywell Regulator Company

Progress Is Our Most Important Product

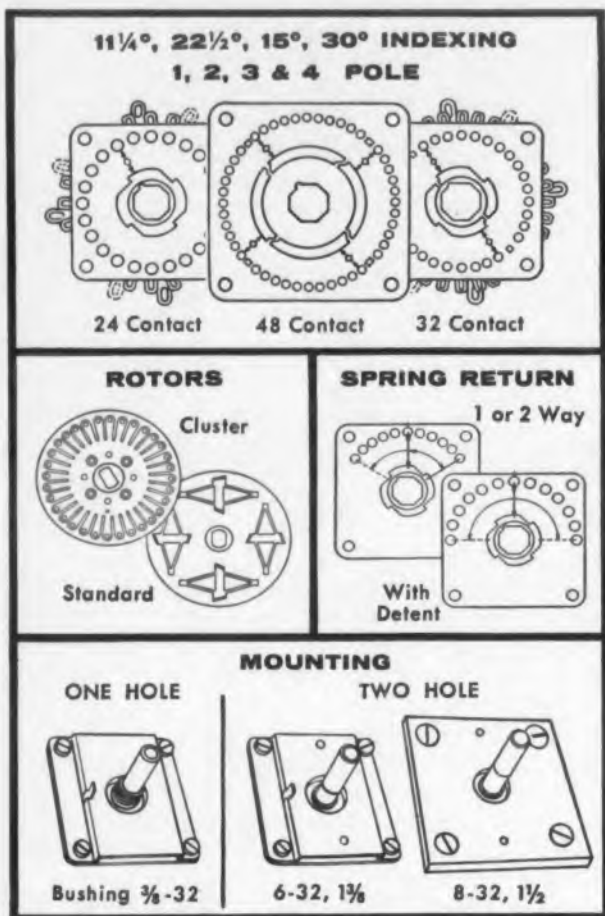
GENERAL  ELECTRIC

CIRCLE 144 ON READER-SERVICE CARD

NEW Compactness... NEW Versatility in ROTARY SWITCH DESIGN



SHALLCROSS *Miniature* ROTARY SELECTOR SWITCHES give the long-lasting dependability of multi-leaf wiper, button-contact design . . . and the added advantages of compactness and new versatility. The sketches below detail some of the many unusual features of this new switch series . . .



ELECTRICAL SPECIFICATIONS: Operating Voltage—to 2000 volts; Breakdown Voltage—to 3000 volts; Breaking Current—5 amp @ 125 V. ac.; Carrying Current—15 amp.

Write for complete specifications on the new Shallcross "Miniature Series".

Shallcross

SHALLCROSS MANUFACTURING COMPANY, 526 Pusey Avenue, Collingdale, Pa.

CIRCLE 145 ON READER-SERVICE CARD

NEW PRODUCTS

Vibration Camera

Provides detailed vibration studies



Based upon the Slip-Sync technique of continuous visual slow motion observation, this equipment takes slow motion movies of vibration tests with the film running at normal speeds. In application, the vibration test is illuminated by Strobe lights synchronized with a pulse-type motion picture camera so that only one exposure is made per frame. When the film is run through a standard projector at normal speeds, a slow motion movie of the test is displayed.

Chadwick-Helmuth Co., Dept. ED, Monrovia, Calif.

CIRCLE 146 ON READER-SERVICE CARD

Transistors

Features new method of mounting



Transistors have been designed to be rugged enough to still work after being shot from a 12-gauge shotgun into a telephone book. Instead of suspending the minute piece of germanium or silicon between two upright posts within the transistor, the newly-developed technique mounts the semiconductor bar on a flat, circular, ceramic wafer. The ceramic wafer in turn rests solidly on the floor of the transistor housing. The fixed-bed mounting technique protects against expansion and contraction of metal parts caused by hot and cold temperatures, direct impact, and vibration which tends to separate the internal transistor parts.

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

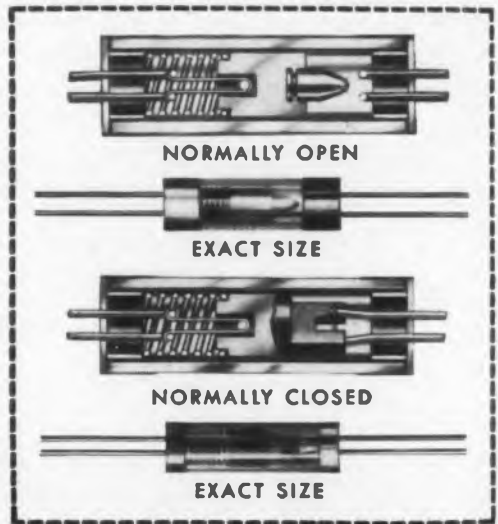
CIRCLE 450 ON READER-SERVICE CARD

MINIATURE THERMAL RELAYS

with
99.99% Plus
Reliability

SERVICE-FITTED
SERVICE-TESTED
SERVICE-APPROVED

Our complete environmental testing laboratory samples and certifies daily production.



New NORMALLY CLOSED RELAYS NOW AVAILABLE. They both meet or exceed requirements for guided missiles and complex electronic gear.

They are hermetically sealed by bonding metal headers to high thermal, shock resistant glass housings.

They open or close a circuit positively in 0.1 second or other delay times.

They can also be safely used as a "squib" or timing mechanism.

Typical Characteristics

Temperature: $-100^{\circ}\text{F. to } +450^{\circ}\text{F.}$
Vibration: 20-3000 CPS at 40 G's
Shock: 250 G's

Brochure containing complete characteristics and specifications available upon request.

NETWORKS ELECTRONIC CORPORATION

14806 OXNARD ST., VAN NUYS, CALIF.

Original designs for highest reliability in glass housed miniature Relays and Resistors for all purposes

CIRCLE 147 ON READER-SERVICE CARD

AC Summing Amplifier

Weighs 12 oz



Weighing 12 oz, and measuring about 2-1/2 x 1-1/2 x 2-1/2 in., model W1806 offers a low power consumption of 50 ma drain at 45 v. Phase shift is less than 1 deg 20 cps to 1 kc, and the unit has a signal frequency of 20 cps to 2 kc (within 1 db at 250 mw output), an input impedance of 3000 ohm and a 10 ohm output impedance.

Waldorf Instrument Co., Electronics Div., Dept. ED, Huntington Station, N.Y.

CIRCLE 148 ON READER-SERVICE CARD

Transistorized Amplifier

Delivers 500 mw over -55 to +125 C range



Series 101 silicon transistor amplifier weighs less than 5 oz and occupies 5 cu in. The unit consists of a voltage and current amplifier followed by a phase discriminator stage, designed to operate from a single external power source. Input signal may be either a square wave or sine wave. Power requirements are 115 v at 400 cps and power gain may be externally controlled from 50 to 75 db.

Depending upon the model desired, the unit will produce either 500 mw of phase sensitive direct current into a three-terminal center tapped load, or 500 mw of phase sensitive alternating current output across a three-terminal load. Power output is constant throughout the entire temperature range of -55 to +125 C. Input impedance is greater than 100 K.

Precision Inc., Dept. ED, 730 Lyndale Ave. North, Minneapolis, Minn.

CIRCLE 149 ON READER-SERVICE CARD

PRODUCT-DESIGN

MEMOS

FROM DUREZ

Metallized phenolics
Dip coating compounds

Making epoxies
flame-resistant



American Optical Company

Bright Idea

Next time you want to put a bright reflective surface on a part, think of *metallized phenolic*. It may save you a costly production step.

Object: economy For instance, this housing for a microscope lamp requires a mirror to focus the light.

To sidestep the cost of a custom-made mirror, the housing is molded of Durez phenolic. Then an aluminum mirror is deposited right on the plastic by vacuum evaporation.

This is easy to do with the Durez compound chosen for this part. It provides a good hard surface for metallizing. It incorporates other wanted properties: high impact strength and low thermal conductivity.

... or good looks More often, perhaps, you'd use metallizing for the sake of *appearance*. An example is this handle for a combination coffee-and-tea maker and carafe.

Molded of Durez phenolic, the handle stays cool regardless of the appliance's



The Silex Company

temperature. And it takes on a lustrous metallized finish, in copper or brass, to match the trim on the appliance and add sales appeal.

You're on sure ground when you base bright ideas like these on phenolics. They give you a bigger choice of controlled properties than any other material in their

class. You can select the right balance from *more than 150 Durez compounds*.

To take a fresh look at today's phenolics, just check the coupon for a new four-page bulletin describing some typical Durez molding compounds and what you can do with them.

Components in a package

These preassembled components can be great timesavers if you're producing printed circuits.

A package combines capacitors and resistors in one compact module, easily and quickly installed in a printed circuit.

You can have as many as 21 or more components in one subassembly, with complete choice of design. Known as "PAC" units, they're made by Erie Resistor Corp.

Their neat design points up an application of phenolics that may give you an idea. To insulate these units, Erie dips



Erie Resistor Corp.

them in a Durez phenolic resin compound. Dried and baked, the compound hardens to a tough, heat-resistant, moisture-resistant coating that doesn't melt or peel when a unit is soldered, and is hard enough to permit stamping or color coding.

Do you need a resin compound for electronic coating? For more information, check the coupon.

How to make epoxies resist flame

Your epoxy laminates and castings will shrug off heat, moisture—even fire—if you cure them with a new Durez product called HET[®] Anhydride.

In the picture, the laminate cured with a conventional hardener (left) ignites in less than 30 seconds and burns to destruction in about 3 minutes. Exposed to a similar flame source for the same time, a HET-cured laminate snuffs itself out as soon as the flame source is removed.

This leads to some interesting possibilities. For instance, you can now make



glass-reinforced laminates that keep practically all their flexural strength, *even when heated within the 300-350°F range*.

You can make potting resins that retain room-temperature electrical properties at high humidities *and at temperatures above 300°F*—and won't feed a fire.

If you'd like complete information on HET Anhydride, methods of use, and properties of cured resins, check the coupon for Bulletins 19 and 43.

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

- Phenolic molding compounds—descriptive bulletin
- Phenolic resin compounds for dip coating
- HET Anhydride—Bulletins 19 and 43

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



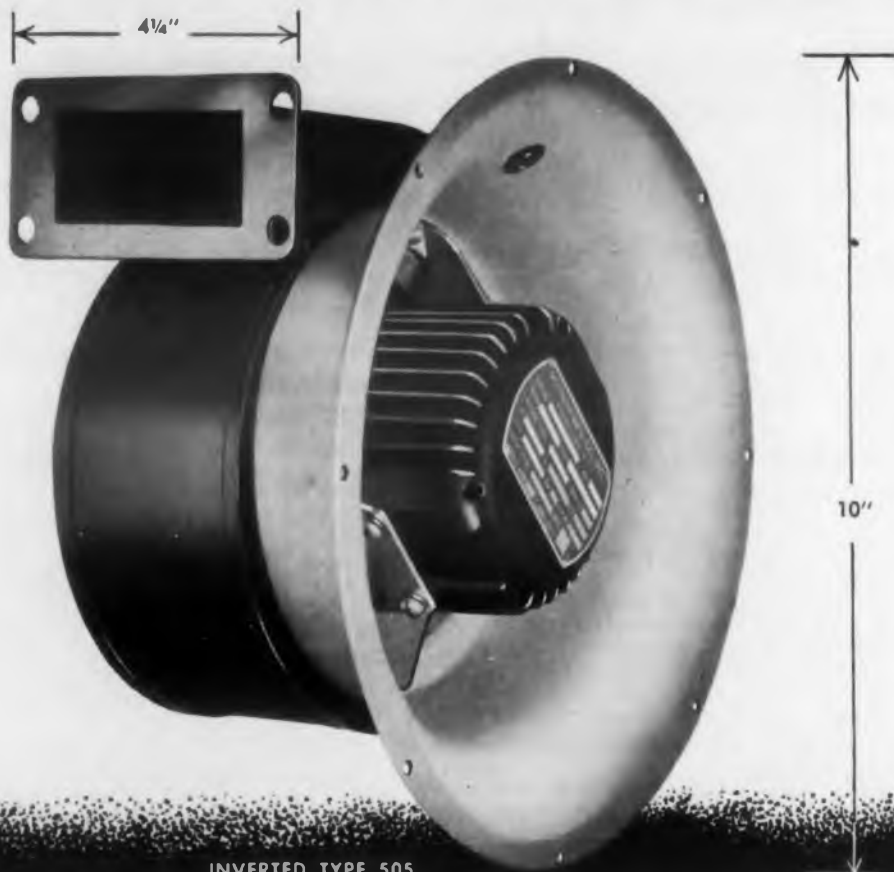
PLASTICS DIVISION

HOOKER ELECTROCHEMICAL COMPANY

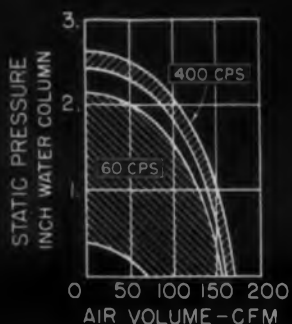
2205 Walck Road • North Tonawanda, N. Y.

CIRCLE 150 ON READER-SERVICE CARD

Cool Magnetrons and Power Tubes with Model D Blowers



INVERTED TYPE 505



Shown is one of a family of high-pressure blowers designed for turbulent cooling in Commercial and Military Electronic applications where space is at a premium and long trouble-free life is mandatory.

OPTIONAL AIR INLET & OUTLET ADAPTORS & MOUNTING SURFACES

SEE Catalog Sheets:
40102-31
40102-32
30102-3



ROTRON

MANUFACTURING CO., INC.

WOODSTOCK • NEW YORK

•CIRCLE 151 ON READER-SERVICE CARD

NEW PRODUCTS

Coil Lead and Hookup Wire

Miniature type for 90 C



Called Milac, this hookup wire is furnished in sizes #26 thru #20 with stranded or solid tinned copper conductors. The 90 C thin wall extruded plastic is covered with a durable lacquered cotton braid. One foot immersed in mercury withstood 6000 v ac and the insulation resistance is approximately 200,000 megohms. Milac is furnished in all solid colors and tracer combinations.

Lenz Electric Mfg. Co., Dept. ED, 1751 No. Western Ave., Chicago 47, Ill.

CIRCLE 152 ON READER-SERVICE CARD

Electrostatic Voltmeter

Measures peaks or rms

Measurements of either positive peaks, negative peaks or true rms values can be easily selected by a switch on this instrument. Basic range is 0-1 kv with multipliers to 100 kv supplied. Accuracy of the basic instrument is 1 per cent of full scale.

Sensitive Research Instrument Corp., Dept. ED, 310 Main St., New Rochelle, N.Y.

CIRCLE 153 ON READER-SERVICE CARD

Potentiometer

Miniature size



This potentiometer, when manufactured as a single gang has an overall length, excluding shaft, of 0.780 in. Multi-gang potentiometers of up to three gangs are considered standard; the overall length, excluding shaft, being increased by 0.281 in. per gang. The resistance range is 1 to 50 K ohms and in general resolutions of between 2 and 6 turns per deg can be achieved,

new and full of advantages



BENDIX GEAR HEAD MOTORS AND MOTOR GENERATORS

One-source engineering of complete package • Volume-production prices • Wide range of frame sizes with immediate delivery on size 8s • 18 standard size 8 gear ratios from 10:1 to 5250:1—lower, higher, and intermediate ratios available on special order • High operating torque capacities • Compact, lightweight package • Corrosion-resistant gears • Ball bearings—ABEC 5, or better • AGMA precision 2 gears, or better.

Another reason why . . .



*You Can't Beat The Bendix Supermarket.

For complete details on new Bendix Gear Head Motors and Motor Generators, and other precision components, write—

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Division
Teterboro, N. J.

Bendix
AVIATION CORPORATION

District Offices: Burbank and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D. C. Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

CIRCLE 154 ON READER-SERVICE CARD

while the independent deviation is better than 0.5 per cent. This single unit can be supplied with a starting torque of less than 0.5 gm/cm and reliable noise-free operation is ensured by the use of double wiping contacts.

Ferranti Electric, Inc., Dept. ED, 30 Rockefeller Plaza, New York 20, N.Y.

CIRCLE 155 ON READER-SERVICE CARD

Power Supply

Employs silicon rectifiers



With 105-125 v dc, 60 cps input, model RS 410A modular dc power supply delivers 400-550 v dc at 0-100 ma output. Filament output is 6.3 v unregulated. Ripple and noise is less than 7 mv peak to peak, with a recovery time less than 25 μ sec. The unit measures 7-1/4 x 5-1/2 x 6-1/2 in., and designed for chassis as well as sub-chassis use.

Trans Electronics, Inc., Dept. ED, 7349 Canoga Ave., Canoga Pk., Calif.

CIRCLE 156 ON READER-SERVICE CARD

Linear Rate Meter

Range of 30 to 300,000 cpm



The model RM-7 presents an average count rate per minute on a large panel meter in one of 7 different linear ranges or in a logarithmic scale circuit permits initial counts to be made over a full range and thus helps to avoid trial and error scale shifting. The instrument is equipped with a separate panel meter for the high voltage supply. This enables the technician to use the coarse and fine adjustments and read the voltage continually, as contrasted to spot checks when both voltage and cpm are shown on one meter.

Technical Associates, Dept. ED, 140 W. Provi-dencia Ave., Burbank, Calif.

CIRCLE 157 ON READER-SERVICE CARD



Null Indicator wins preference test at IRC. At International Resistance Company, where hundreds of stock resistors are daily subjected to rigid MIL performance tests, an *ElectroniK* Null Indicator was recently matched against a spotlight galvanometer for speed, sensitivity and ease of use. The Null Indicator proved superior on each count, and operators indicated a strong preference for it.

ElectroniK Null Indicator is easier to watch, easier to use

THE BIG, clearly legible dial on this all-electronic instrument is easy to read, reduces the chance of error. Even in bright light, there's no need to shade the meter. The needle comes to rest in less than half a second. And there's never "loss of spot" when excessive signal is applied—you always know which direction to go for bridge correction.

The *ElectroniK* Null Indicator goes to work quickly . . . without need for leveling or special mounting. Zeroing is simple, with just a turn of the front-of-panel bar knob. The unit withstands shock and vibration.

The Null Indicator is sensitive enough for all your d-c bridge measurements, and rugged enough for production line work. Order this modern successor to the galvanometer today. Price: \$175, f.o.b. Philadelphia.

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

SPECIFICATIONS

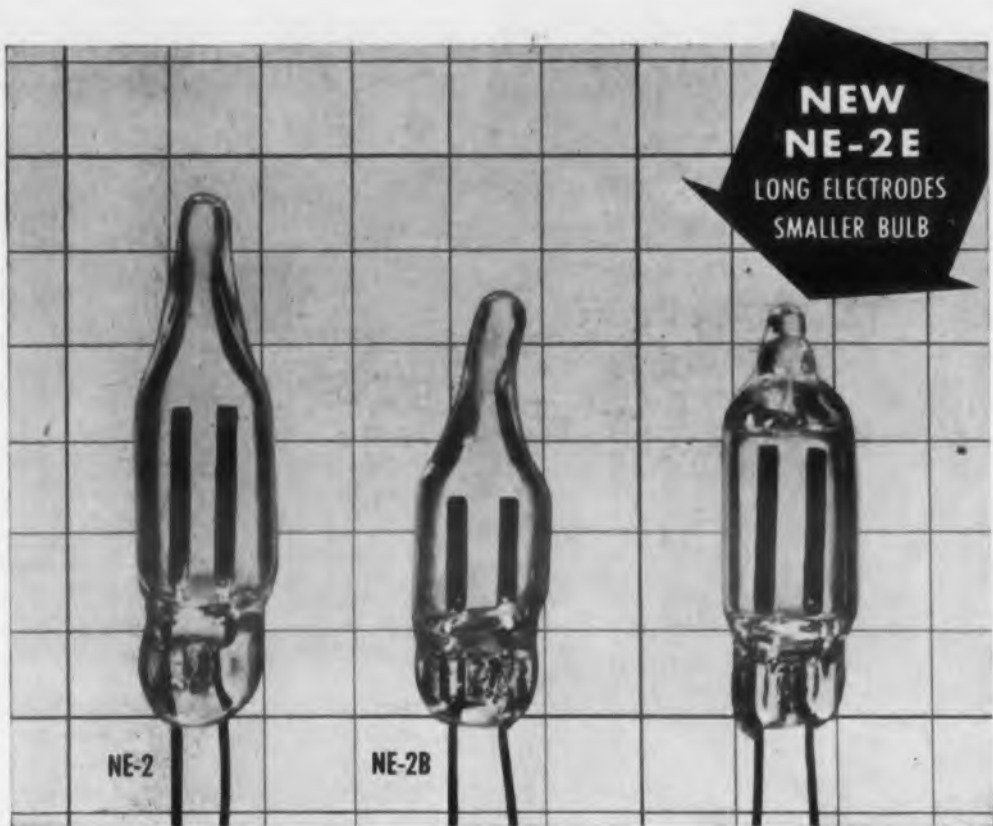
Period—less than 1/2 second
Current Sensitivity—.001 microamp/mm.
Voltage Sensitivity—1 microvolt/mm.
Input Impedance—1000 ohms at max. sensitivity
Overload Rating—1 volt at max. sensitivity
Stability—less than 1 mm. zero shift/hour
Damping—critically damped; independent of external resistance
Terminals—input and ground; for spade, pin or banana plugs
Power—115 volts, 60 cycles
Scale Markings—
 -1 to +1 in mm. } over 2 1/8" radius
 -4 to +4 in cm. }
Dimensions—17 3/8" long x 5 3/8" wide x 7 3/4" high
Weight—15 lbs.

Honeywell



First in Controls

CIRCLE 158 ON READER-SERVICE CARD



Three diameter enlargement

Introducing General Electric's NE-2E Glow Lamp

**NEW "SNUB-NOSE" DESIGN
PERMITS LONG ELECTRODES
IN SMALLER BULBS
FOR BETTER PERFORMANCE**

The new General Electric NE-2E is as small in length as the NE-2B—yet has electrodes fully as long as those in the larger NE-2. The exclusive molded tip permits use where space is restricted—performs better and provides better indicator viewing—especially end-on.

Only glow lamps offer small size, low wattage, long life, wide voltage tolerances, rugged construction. And they don't fail suddenly—so there's almost no chance of false indications.

Any G-E Glow Lamp can be used in many ways. A single lamp may serve as a relaxation oscillator, a leakage indicator, a switch, a voltage regulator, or a voltage indicator. Send for the folder, "G-E Glow Lamps As Circuit Control Components". Write: General Electric Co., Miniature Lamp Dept. ED-58, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

NEW PRODUCTS

Quartz Crystals

Low frequency types withstand high vibration



These low frequency crystals have been fully tested from 2 to 2000 cps vibration, with acceleration of 15 to 30 g. Frequency range is 16 to 100 kc. Typical tolerance is ± 0.012 per cent from -40 to $+70$ C. Lower frequencies down to 400 cps are also available.

Monitor Products Co., Dept. ED, 815 Fremont Ave., South Pasadena, Calif.

CIRCLE 160 ON READER-SERVICE CARD

Static Inverter

Operates from 28 v dc

A transistorized unit specifically designed to supply dc and ac power in target drones. Model M-977 operates from a 28-29 v dc input to provide outputs of 150 v dc, 6.5 v, 400 cps, and $-22\frac{1}{2}$ v dc. The inverter has a load regulation of ± 3 per cent and a ripple of 0.1 per cent rms. The efficiency at full load is 85 per cent.

Perkin Eng. Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

CIRCLE 161 ON READER-SERVICE CARD

F-M Telemetering Transmitter

2 w power output



Model TR-10 is a hybrid unit incorporating both transistors and vacuum tubes. The unit ac-

NOW...1 to 80 polaroid exposures in ONE loading with the newest BEATTIE OSCILLOTRON!



LABORATORY recording of oscilloscope traces is far more efficient with this new camera.

Key to the versatility of the new Beattie Oscillotron with a polaroid back is the feather-touch Multiple Exposure Positioning Bar. Now you can get one-to-one presentation or up to 10 exposures on a

single frame—by a simple adjustment. Other features: f/1.9 lens, shutter speeds from 1 sec. to 1/100 sec., time, and bulb.

This new Oscillotron camera fits the same periscope to which all other Beattie Oscillotron cameras are attached.



Multiple Exposure Positioning Bar

for more information write to



1000 N. Olive St., Anaheim, California
CIRCLE 162 ON READER-SERVICE CARD

cepts inputs from standard IRIG subcarrier oscillators.

Power output is 2 w in the 215-245 mc telemetering band. The transmitter measures 4-1/4 in. long and weighs 16 oz.

United Electrodynamics, Dept. ED, 1200 S. Marengo Ave., Pasadena, Calif.

CIRCLE 163 ON READER-SERVICE CARD

Synchro Bridge

Measures servo error



Model SB-12 measures the angular position of ac servo systems as well as the electrical error of synchros and resolvers. During three million revolutions of the dial, its basic error is guaranteed not to exceed eight seconds. One fifth the volume of previous models, the model SB-12 measures 3-1/4 x 4-1/4 in., with 4 in. dial diam. It has a 360 deg range and line-to-line resistance of 10,000 ohms.

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

CIRCLE 164 ON READER-SERVICE CARD

Heating Elements

Flexible in any direction



These three-dimensional electric, flexible heaters are made of silicone rubber without the use of expensive tooling. A 14 in. diam hemispherical heater used to heat a peroxide storage tank on a rocket engine is shown. The unit features cut-outs for brackets and an attached thermostat which senses tank, not heater, temperature.

Electro-Flex Heat, Inc., Dept. ED, 83 Woodbine St., Hartford 6, Conn.

CIRCLE 165 ON READER-SERVICE CARD

	<u>331</u>	<u>332</u>	<u>334</u>
Epoxide Eq. Wt.	187-193	179 Max.	178-186
Viscosity (cps.)	11,000-16,000	6400 Max.	500-900
Color (Gardner)	5 Max.	1 Max.	5 Max.

New Dow epoxies feature "lens clear" liquid resin

Dramatic evidence of the striking clarity and purity of Dow Epoxy Resin 332—unique member of Dow's new line of liquid epoxy resins—is shown in the illustration above. The magnifying lens was actually cast from this new water-clear resin. In addition to improved clarity and uniformity, DER 332 has very low viscosity, longer pot life and greater heat resistance than conventional epoxies.

Also available, for formulations where absolute purity is not so important, are Dow Liquid Epoxy Resins 331 and 334.

Dow's position as a basic producer of all epoxy raw materials assures top quality control and a narrower range of

specifications. It will also enable Dow to introduce, in the near future, a complete line of solid epoxy resins and a new line of polyfunctional liquid epoxy resins outstanding in high temperature service.

Prompt delivery of these three Dow Liquid Epoxy Resins can be made in drums, truck or tank car lots. For more information contact your nearest Dow sales office or write THE DOW CHEMICAL COMPANY, Midland, Michigan, Coatings Sales Dept. 2259P-1.

YOU CAN DEPEND ON

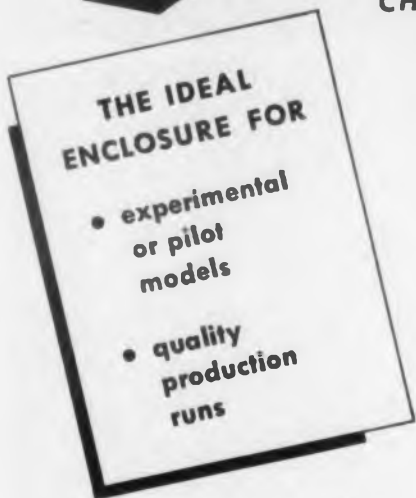


CIRCLE 166 ON READER-SERVICE CARD

CUT COSTS FOR ENCLOSURES

1 OR 1,000 UNITS WITH LINDSAY STRUCTURE

CHECK THESE ADVANTAGES:



- ✓ Shipped K/D for savings in storage and shipping . . . material readily available as needed for assembly. Shipments can be scheduled to meet production runs.
- ✓ Production possible right away without "tooling-up" first.
- ✓ Easy to alter design or make revisions with no loss to you for costly dies or special tools.

LINDSAY PREFABRICATED ASSEMBLIES are available 3 ways!



◀ K/D KIT



SHELL ASSEMBLY ▶



◀ COMPLETE FINISHED ASSEMBLY ▶



Write for descriptive folder . . . or send single-line drawing for prompt cost estimate.

LINDSAY STRUCTURE DIVISION

INTERNATIONAL STEEL COMPANY

1427 Edgar Street



Evansville 7, Indiana



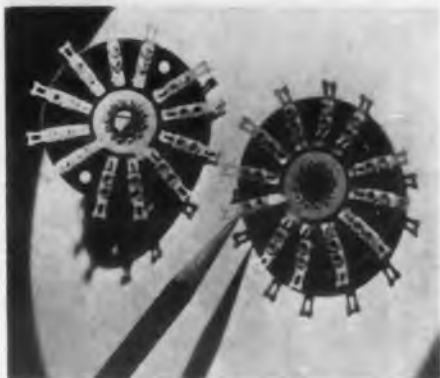
Canadian Affiliate: Lindsay International, Ltd., Port Credit, Ontario

CIRCLE 167 ON READER-SERVICE CARD

NEW PRODUCTS

Rotary Switches

Band change and tap switch applications



The double eyelet series 275 H-type rotary switches are designed to insure rigidity, and are available in switches containing up to 12 sections. The double eyelet sections have 1-9/16 in. mounting centers and are interchangeable with units presently designed for this dimension mounting centers.

Centralab, Div. of Globe-Union, Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

CIRCLE 168 ON READER-SERVICE CARD



Time Delay Relays

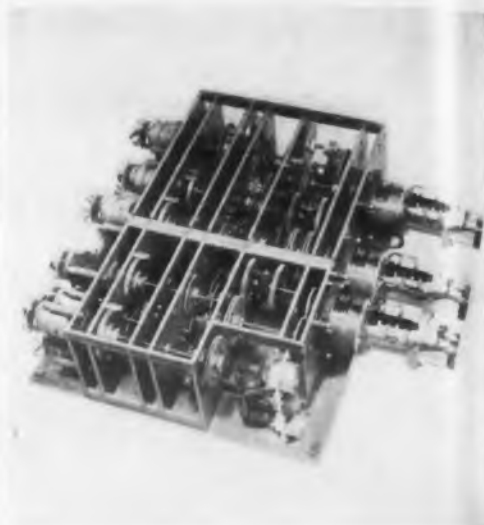
For loads to 60 a

These spst, 2pst and 3pst time delay relays rated at 20, 35 and 60 a or up to 5 hp at 115 v ac, offer high load capacities in the non-mechanical timer field and feature hermetically sealed, positive, mercury-mercury snap section. Adjustable make delay periods are pre-set in several ranges covering delays of from 3 to 120 sec. The delay timer settings may be shifted at any time with a standard hex key applied to an accessible set screw. These time delay relays may be compensated for ambient temperatures of from -65 to +85 C or ambient adjusted to suit application requirements. The timer has a repeat accuracy of ± 5 per cent.

Ebert Electronics Corp., Dept. ED, 212-26 Jamaica Ave., Queens Village 28, N.Y.

CIRCLE 169 ON READER-SERVICE CARD

CALL ON LINK'S EXPERIENCE FOR...



DESIGN and PRODUCTION of ELECTROMECHANICAL ASSEMBLIES... PRECISION SERVOS... GEAR HEADS...

Link Aviation can provide expert assistance in the design and manufacture of precision electromechanical assemblies, because:

- Link has years of experience designing computer assemblies
- Fabrication and assembly are performed under environmentally controlled conditions
- Stringent quality control includes 100% inspection of precision gears with graphical record

Call Link at Binghamton 3-6311 today—or send your specifications or drawings directly to Industrial Sales, Department ED.

Link's #026 precision Gear Reduction Kit, with 16 interchangeable gear and pinion clusters for making 23 different ratio setups, is available for your experimental and development needs.



A SUBSIDIARY OF
GENERAL PRECISION EQUIPMENT CORPORATION

LINK AVIATION, INC.
BINGHAMTON, NEW YORK

CIRCLE 170 ON READER-SERVICE CARD

NEW BULK PACKING FOR SOUTHERN SCREWS

... designed for you!



DESIGNED FOR MODERN MATERIALS MOVEMENT, FITS ALL PRODUCTION LINES. WHETHER LARGE OR SMALL

Southern Screw's new bulk packing answers your long-time need for a conveniently sized industrial package that can be handled easily by one man without the use of power equipment, yet is ideal for mechanized mass handling with or without palletizing.

Here's how Southern's NEW BULK PACKAGE can save you handling time, production time, storage space and paperwork.

EASIER TO STORE • EASIER TO OPEN and CLOSE • EASIER TO USE • EASIER TO IDENTIFY • HEAVY DUTY CORRUGATED CARTONS • DISPOSABLE PALLETS AT NO EXTRA COST!

Based on the new pallet and carton system, standard packing quantities for each item have been established. For complete information, write for chart BP-1, to Southern Screw Company, Box 1360, Statesville, N. C.

Wood Screws • Stove Bolts • Machine Screws & Nuts • A, B, C & F Tapping Screws • Wood Drive Screws •

Warehouses: New York • Chicago • Dallas • Los Angeles



CIRCLE 171 ON READER-SERVICE CARD

Magnetic Tape Recorder

Designed for flight tests



Type 5-702 magnetic tape recorder operates at altitudes up to 100,000 ft and at temperatures from -55 to $+100$ C. Other features include 6 tape speeds from 1-7/8 to 60 ips, elimination of belts and pulleys, and grouping of all controls on top of instrument. The instrument is available in 7 or 14 track models, using 1/2 or 1 in. tape respectively. Power supplies are contained within the 12-7/8 x 25 x 7 in. case.

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

CIRCLE 172 ON READER-SERVICE CARD

Vibration Pickups

15 to 2000 cps range

Known as the types 4-121, 4-122, and 4-123, these pickups are operable over the temperature range of -65 to $+500$ F. The 4-121 and 4-122 will monitor vibrations in the range of 15 to 2000 cps. The 4-123 has a 45 to 2000 cps operating range, ideal for jet-engine monitoring where the lowest frequency encountered is about 50 cps.

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

CIRCLE 173 ON READER-SERVICE CARD

AC Outlet

Overload protected and grounded



This ac outlet assembly provides five overload-protected and safety-grounded outlets. Each of the five outlet sockets has a 15 amp on-off switch and accepts both three-prong grounding plugs and conventional two-blade plugs. An instant reset circuit-breaker trips at 15 amp to protect equipment.

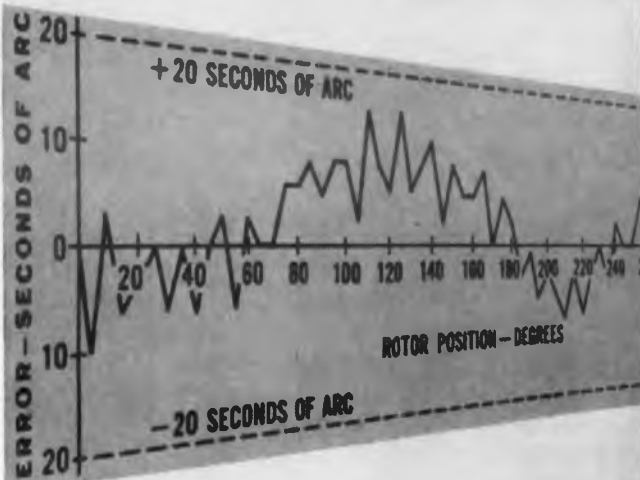
Arthur S. LaPine and Co., Dept. ED, 6001 S. Knox Ave., Chicago 29, Ill.

CIRCLE 451 ON READER-SERVICE CARD

SYNCHRO
ACCURACY

20 SECONDS OF ARC

ELIMINATE MULTI-SPEED SERVOS
AND COMPLEX ELECTRONIC DEVICES



NEW ULTRA-PRECISE SIZE 25 SYNCHROS

Extremely precise data transmission is possible through the use of Kearfott's Size 25 synchro resolvers. The inherent precision of these units provides a three sigma accuracy of approximately 35 seconds in a typical 3 unit string without the use of auxiliary equipment. Ruggedly constructed of corrosion resistant materials, they possess the required reliability for all missile applications. Available as transmitters, differentials and control transformers with a maximum error from E.Z. of 20 seconds arc.



SIZE 11 SYNCHROS

Size 11-2 phase 4 wire synchro resolvers for data transmission combine the advantages of small size with high accuracy. Corrosion resistant materials are used in the construction of these units. Available as 60X transmitters, differentials and control transformers with a maximum error from electrical zero of 3 minutes arc. Standard 3 wire synchros are available from production with 5, 7 and 10 minute maximum error from E.Z.

ENGINEERS

Challenging opportunities at Kearfott in advanced component and system developments.

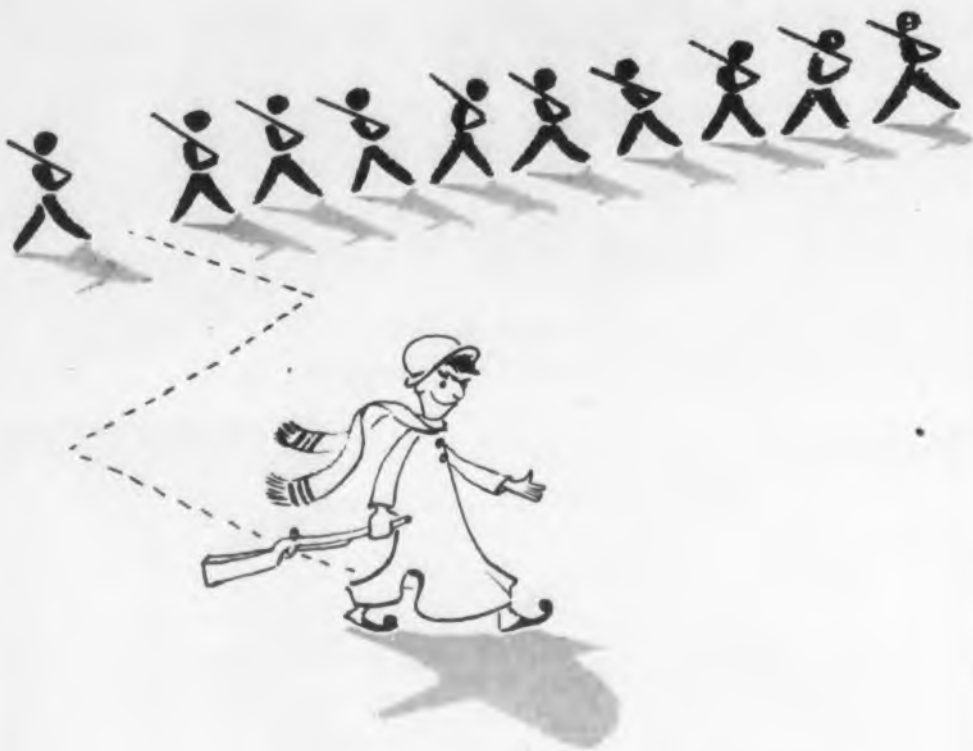
Kearfott

PRECISION
EQUIPMENT
GENERAL
GPE
CORPORATION

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, New Jersey
Midwest Office: 23 W. Calendar Ave., La Grange, Illinois
South Central Office: 6211 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, California

CIRCLE 452 ON READER-SERVICE CARD



In the inexorable March of Progress, many are in step — some having picked up the cadence and who are stoutly maintaining it, others clinging to it and moving more by induction than by skill. Still others, however, aren't in step at all, and it is in this group that Sigma has (again) found itself. It is doubtful, indeed, if Sigma is even in line.

Relays the size of sugar lumps aren't news. Nor is there any point in designing relays which control only a little more power than their own coils consume. So —

The Sigma Series 32 (pictured) needs *no* power except for a trifle at the instant of switching. It is as modern as a flip flop, because it operates like a flip flop. The principle of a magnetic latching relay is old, but a truly practical and low cost embodiment is new.

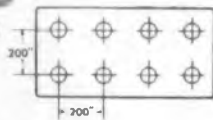
For those whose present problem is too well grounded in existing circuitry to take advantage of such watt wilting concepts, we have the 33, which while requiring something like 100 milliwatts to hold it energized, still switches real power, withstands more vibration than most test equipment can inflict, and won't break your bank roll.

Relays of both types are now available. Your inquiry will bring complete specifications.

ACTUAL
SIZE



.800" x .400" x .900" high, max.



SIGMA

SIGMA INSTRUMENTS, INC.,
91 Pearl Street, So. Braintree 85, Mass.
CIRCLE 175 ON READER-SERVICE CARD

NEW PRODUCTS

Servo Kit

Contains 262 items



Servo kit BP-101 conveniently packages 262 standard parts for high-precision servo-system breadboarding. Among the parts in the kit are two grid plates, grid plate hardware, component and shaft hangers, electric limit stops, selected precision class 2 gears, couplings, hand crank, dial assemblies, terminal blocks and brackets, various lengths of shafting, a differential and mounting screws and washers.

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

CIRCLE 176 ON READER-SERVICE CARD

RF Attenuators

Operate above 250 mc



Single rotating units are available at 0.1, 1 or 10 db per step. Standing wave ratio at 100 mc is less than 1.01. The maximum change in loss from 0 to 100 mc is 0.1 db. Multiple unit assemblies are available in various combinations and are supplied mounted on a standard 3-1/2 x 19 in. panel with front or rear access connections.

Ortho Filter Corp., Dept. ED, 196 Albion Ave., Paterson 2, N.J.

CIRCLE 177 ON READER-SERVICE CARD

Transistors

Power and medium frequency switching types

Rated from 1 w to 1.2 w maximum power dissipation, this series of power transistors consists of general purpose audio transistors, a 1 mc transistor for communication or switching applications and a pulse amplifier. Relays requiring 3 amp at 40 v may be operated by the transistor.

Also a new family of five medium-frequency, medium power germanium pnp alloy junction

intolerance about TOLERANCES

Twenty years of experience in producing tubing for the indicating pointers in sensitive measuring instruments, some tubing so fine it is hardly visible to the naked eye—and supplying tubular components for electronic and precision mechanisms — have made us very intolerant about tolerances. For when a thousandth of an inch may represent the entire wall thickness of a tube, you can't afford to be otherwise.

This daily habit of precision and small tubing "know-how" has won widespread preference for Uniform's products.

Uniform offers a complete "tailor-made" small tubing service to industry.

SIZES: O.D. from .625" down to .010". Wall thickness down to .0010". Every order is "made to order"—to exact specifications.

METALS: Nickel, Monel, phosphor bronze, aluminum, copper, brass, low carbon and stainless steels, precious metals and many other analyses.

DELIVERY: Three to four weeks. Less for emergency requirements.

TUBULAR COMPONENTS: Uniform offers extensive facilities for forming and machining, large or small quantities. Close tolerance, burr-free cutting, flaring, bending, flanging, flattening, expanding, beading, grooving, threading, tapping, drilling, milling, etc. Concentrateresponsibility, cut sub-contracting costs, save scrap losses, get better delivery of finished components.

Write for literature or send specifications for quotations.

UNIFORM TUBES,

INC. 1200 Level Rd., Colledgeville 2, Pa.
HUxley 9-7276



Chicago, Ill., DElaware 7-7644
Pasadena, Cal., RYan 1-9534
St. Paul, Minn., Mldwav 5-4637
Wellesley, Mass., CEDar 5-5450
Buffalo, N.Y., SPing 8481
Ramsey, N.J., DAvis 7-5527

CIRCLE 178 ON READER-SERVICE CARD

transistors has been designed primarily for use in switching circuits. This transistor family features good beta linearity, high maximum collector current ratings (400 ma for most types), high maximum collector rating ($30 \text{ v } V_{CB}$), high beta, and low saturation resistance. Depending on type, these transistors can be used at switching rates ranging from 300 kc to 1 mc.

Philco Corp., Dept. ED, Church Rd., Lansdale, Pa.

CIRCLE 179 ON READER-SERVICE CARD



Brake

Torque rating from 10 to 105 lb-ft

This shunt wound direct current brake offers maximum flexibility in mounting on motors utilizing the familiar stub shaft, a standard double shaft extension, or it can be easily modified for thru shaft applications.

Stearns Electric Corp., Dept. ED, 120 N. Broadway, Milwaukee 2, Wis.

CIRCLE 180 ON READER-SERVICE CARD



Tube Shield

Increases tube life

This shield meets applications where equipment design layout requires vertical mounting of subminiature tubes. Beryllium copper spring finger liner making multipoint contact with the tube bulb, provide anti-vibration control and maximum transfer of tube heat which is dissipated by radiation, convection and conduction. The shield reduces the bare bulb temperature of 122 C on a sub-miniature tube to 75 C in room ambient conditions. Shields are available for round button and flat press tubes.

International Electronic Research Corp., Dept. ED, 145 W. Magnolia Blvd., Burbank, Calif.

CIRCLE 236 ON READER-SERVICE CARD

Now...

MASS-PRODUCED COMPUTER-TYPE H-F TRANSISTORS

For high-speed switching
For high-frequency amplification

Production of CBS high-frequency transistors has been stepped up for a growing variety of applications. The 2N438, 2N439 and 2N440 are now available in quantity for multivibrator and blocking oscillators . . . gate and flip-flop circuits . . . and r-f, i-f, and high-fidelity a-f amplifiers.

All three types are alloy-junction for greater uniformity, higher voltage and current, flatter gain and lower saturation resistance. They employ the standard JETEC TO-9 package welded to achieve reliability never before approached with NPN transistors.

Note the many desirable features. You may be able to use these CBS transistors. Write for Bulletin E-268 giving complete data and helpful application notes.

CHECK THESE FEATURES

1. High frequency response:
 - 2N438 2.5 to 5 mc.
 - 2N439 5 to 10 mc.
 - 2N440 10 mc and up.
2. High operating voltage up to 30 volts.
3. High switching speed below 0.2 μ sec.
4. High current amp. factor up to 100.
5. High dissipation rating up to 100 mw.
6. Low leakage current 2 μ amps av.
7. Low collector capacitance 10 μ f.



Reliable products
through Advanced-Engineering



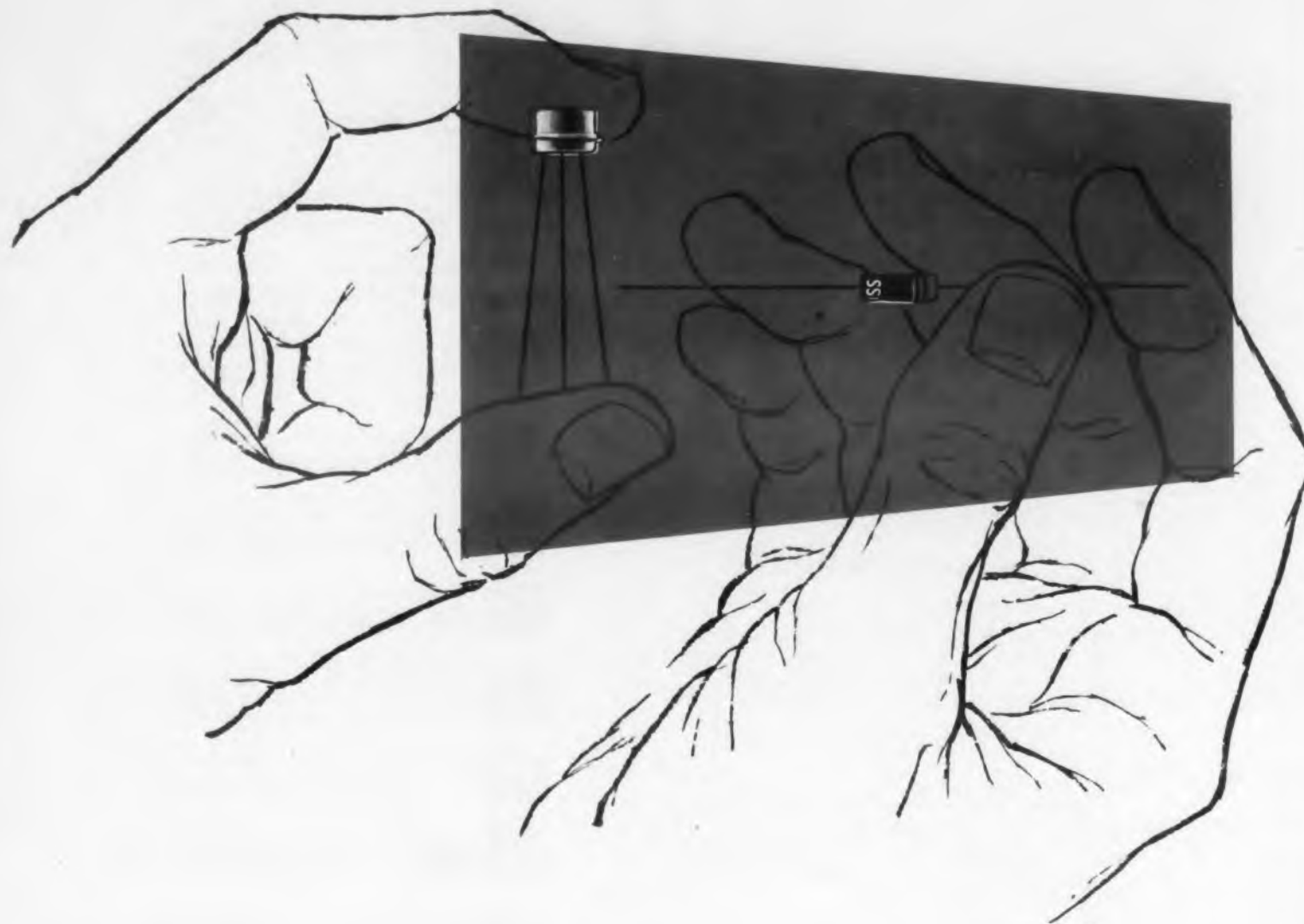
semiconductors

CBS-HYTRON

Semiconductor Operations, Lowell, Mass.

A Division of Columbia Broadcasting System, Inc.

CIRCLE 181 ON READER-SERVICE CARD



ANNOUNCING Sperry Silicon Semiconductor Devices

High-temperature diodes and transistors now in production

The Sperry Semiconductor Division of Sperry Rand Corporation is now making available to military and commercial manufacturers a new line of silicon devices. Performance proven, these high-quality diodes and transistors have been employed in many Sperry Rand systems which had to meet stringent military and commercial specifications.

SILICON DEVICES NOW IN PRODUCTION

- High-conductance diodes for general purpose applications. 100, 200 and 400 ma types (rated current at 1.0 v). Working voltage up to 300 volts. Subminiature glass package.
- High-current switching diodes. Switches ½ amp. in less than 0.8 μsec. Reverse voltage up to 200 volts. Subminiature glass package.
- Ultra-fast computer diodes for all computer requirements. Working voltage up to 200 volts. Subminiature glass package.
- High-speed computer transistors. Total switching time typically less than ½ μsec. Very low saturation resistance. JETEC-30 case.

CIRCLE 182 ON READER-SERVICE CARD

Write for data sheets on all these new production items. We also welcome inquiries on any applications calling for special silicon semiconductor devices.

SPERRY SEMICONDUCTOR DIVISION
Sperry Rand Corporation
South Norwalk, Connecticut

ADDRESS ALL INQUIRIES: Marketing Department, Great Neck, N. Y., or Sperry Gyroscope offices in Brooklyn, Cleveland, Seattle, San Francisco, Los Angeles, New Orleans, Boston, Baltimore, Philadelphia.

NEW PRODUCTS

VTVM

Has built in memory feature



The REL-500 contains a built in memory enabling a measurement to be taken and retained for several hours. Erasure is done manually, or by a new input which automatically removes the recorded reading. Basic measurements are: voltages from 10 mv to 20 kv; currents from 1 μa to 2 μa; resistances (with resist multiplier) from 1000 ohms to 100 meg.

Rheem Mfg. Co., Electronic Div., Dept. ED, 7777 Industry Ave., Rivera, Calif.

CIRCLE 183 ON READER-SERVICE CARD



Power Supply
For stable, low level power

Model PT 111, a transistorized power supply, has high current output with low heat generation and six nominal voltages, ranging from 2.5 to 15 v dc and varied by means of a high resolution, 10 turn potentiometer. It operates on 117 v (95 to 125 v), 50-60 cps input with output current of 200 ma. Output voltage change is less than 0.4 per cent over a temperature range of 60 F to 90 F.

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

CIRCLE 184 ON READER-SERVICE CARD

Servoamplifier

Drives servovalves in pneumatic systems



Model 34 transistorized servoamplifier is designed with both ac and dc summing networks

ELECTRONIC DESIGN • May 14, 1958

to allow the amplifier to accommodate a wide range of feedback and control signals. Quiescent output current is 150 ma per coil in push-pull into approximately 50 ohm coils. Maximum coil resistance is 75 ohm, and differential current is 0 to 300 ma. Ac sensitivity is approximately 200 ma differential current per 0.05 v rms input into 100,000 ohm impedance.

Raymond Atchley, Inc., Dept. ED, 2340 Sawtelle Blvd., Los Angeles 54, Calif.

CIRCLE 185 ON READER-SERVICE CARD

Subcarrier Oscillator

Operates directly from thermocouples



This oscillator is designed for use with thermocouples and other low output transducers. The unit achieves a $\pm 7\frac{1}{2}$ per cent deviation from a ± 5 mv (less than $1 \mu w$) input signal and is available in standard RDB bands. The unit features good stability and high output with low distortion.

Invar Electronics Co., Dept. ED, 1749 N. Eastern Ave., Los Angeles 32, Calif.

CIRCLE 186 ON READER-SERVICE CARD

DC Instrument Motor

Permanent magnet rotor



Type B subfractional-watt dc instrument motor, has a stainless steel shaft supported in instrument-type ball bearings. The rotor is a permanent magnet disc actuated by a stationary field coil. Commutation of periodic field flux reversal is attained by a nylon roller cam, actuating a spring contact assembly. The motor weighs approximately 2 oz, and operates at a current input of 12 ma at 4.5-6 v dc.

Brailsford & Co., Inc., Dept. ED, 670 Milton Rd., Rye, N.Y.

CIRCLE 444 ON READER-SERVICE CARD



Sylvania RF-IF Transistors

Five new PNP Drift transistors, types 2N247, 2N370, 2N371, 2N372 and 2N544, for radio frequency amplifier service

Sylvania's new PNP Germanium Drift transistors feature high output resistance for increased gain at 1.5 mc to 20 mc, low feedback capacitance and high alpha cutoff frequency.

Designed for RF-IF circuits, they open the door to more transistorized electronic equipment operating from the broadcast band to the higher frequencies.

The new Sylvania drift transistors incorporate a diffused base on an intrinsic germanium layer for improved control over base thickness, more uniform base region, lower base resistance and reduced collector capacitance. The end result is superior performance at higher frequencies.

The new PNP drift transistors feature Sylvania welded hermetic seal construction for maximum protection in rugged environments. They are encased in a modified JETEC class 30 case with four flexible in-line leads. The additional cen-

ter lead is connected to the metal case providing a complete unit shield and interlead shield. Coupling to adjacent circuit components is reduced to a minimum.

Call your Sylvania Sales Representative or write direct for information on new Sylvania PNP drift transistors, types 2N247, 2N370, 2N371, 2N372 and 2N544.

ELECTRICAL CHARACTERISTICS (25°C)						
	2N247	2N370	2N371	2N372	2N544	Unit
Power Gain, Pg						db
V _{CE} = -8, I _C = 1 ma, Freq. = 20.0 mc						
Minimum	24	10	12	10	30.5	
Typical	27					
Maximum	31.5	17	17	17	37.5	
(V _{CE} = -9 Freq. = 1.5 mc)					(V _{CE} = -9 (Freq. = 1.5 mc) (R _L = 750 ohms) (Neutralized)	
Reverse Biased Collector Voltage, V _{CB}						v
V _{EB} = -0.5, I _C = 50 μ a						
Minimum	-40	-20	-20	-20	-20	
Typical						
Maximum			(I _C = 0.50 ma)			
Collector Base Capacitance, C _{cb}						uuf
V _{CB} = -12, I _C = 0, Freq. = 1.5 mc						
Minimum	1.5					
Typical	2.5	2.5	2.5	2.5	2.5	
Maximum						
(V _{CB} = -9)						



SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
Shell Tower Bldg., Montreal

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY
CIRCLE 187 ON READER-SERVICE CARD

Plain facts about... **BURROUGHS**

BEAM SWITCHING TUBES

CUSTOMERS

Over 750 manufacturers have purchased Beam Switching Tubes.

RELIABILITY

Shock	375 g
Temperature	-60° to + 150°C
Vibration	to 20 g
Speed	to 20 mc
Life	to 50,000 hours
Power	min. input - useful output

COST

One Beam Switching Tube may replace as many as 4-6-10-20-or more tubes, transistors, and their associated components.

VERSATILITY

Compatible with tubes, transistors, cores, thyratrons, relays, Nixie numerical indicator 6844, and other devices.

APPLICATIONS

Wherever there is electronic distribution or switching - i.e.:
Counting, Telemetering, Frequency Dividing, Timing, Sampling, Coding, Matrixing, or Controlling

Tubes to
Mil - E - 1/1058
Available



Write for further information on all tube types.

ANOTHER ELECTRONIC CONTRIBUTION BY
Burroughs Corporation

ELECTRONIC TUBE DIVISION

Plainfield, New Jersey

CIRCLE 188 ON READER-SERVICE CARD

NEW PRODUCTS

Electronic Tachometers

Transistorized

This transistorized tachometer, for monitoring speed of rotating equipment, operates from signals obtained from a variable reluctance transducer or an existing tachometer generator. One per cent or better accuracy is obtained from the frequency to dc converter circuit. It is insensitive to amplitude changes in input signal above minimum sensitivity.

Atlas Electro-Mechanical Labs., Dept. ED, 14734 Arminta Ave., Panorama City, Calif.

CIRCLE 189 ON READER-SERVICE CARD

Potentiometer

5 w at 145 C



Only 3/4 in. in diameter, this potentiometer is designed for high heat dissipation. At 145 C ambient, the control is rated at 5 w dissipation. The unit is available in linear resistance tapers from 10 to 10,000 ohms. Standard tolerance is ± 5 per cent. The unit has a 1/8 in. diameter shaft, with a 1/4 in. 32 threaded bushing 3/8 in. long.

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

CIRCLE 190 ON READER-SERVICE CARD

28-Volt Power Supplies

Single and three-phase, 400-cycle inputs

Three of these units utilize three-phase, 400-cycle input. Smallest of the units is the one-a, 28-v convection-cooled airborne transformer-rectifier which weighs only 14 oz and operates from single-phase, 400-cycle power input.

The 100-a silicon transformer-rectifier has efficiency of 83 per cent and power factor of 90 per cent. The unit operates at 500 per cent overload for 15 sec. The company has also designed a 200-a airborne power supply which weighs less than 17 lb.

Also included in the new line is a 200-a, 28-v dc power supply for missile support applications. Voltage regulation of this fan-cooled unit is less than two volts from no-load to full-

load with a constant input. Ripple is less than 0.5 v peak-to-peak under all load conditions and at temperatures ranging from -65 to +160 F. The unit weighs less than 65 lb and has plug-in type input-output connections. The built-in filter is protected by fast-acting fuses.

General Electric Co., Dept. ED, Schenectady 5, N.Y.

CIRCLE 191 ON READER-SERVICE CARD



400 CPS Frequency Standard

Stable to 0.001 per cent

The 400-cps Vibra-Time consists of a 1600-cps resonator and transistorized flip-flop circuits. This 400-cps frequency standard has been designed to be insensitive to changes in position, vibration from 50 to 2000 cps up to 18 g, shock up to 50 g, and steady-state accelerations to 20 g. The unit performs to specifications at temperatures between -20 and +70 C.

The Gyrex Corp., Dept. ED, 1654 Lincoln Blvd., Santa Monica, Calif.

CIRCLE 192 ON READER-SERVICE CARD

Signal Limiter

Protects galvanometers from signal overloads

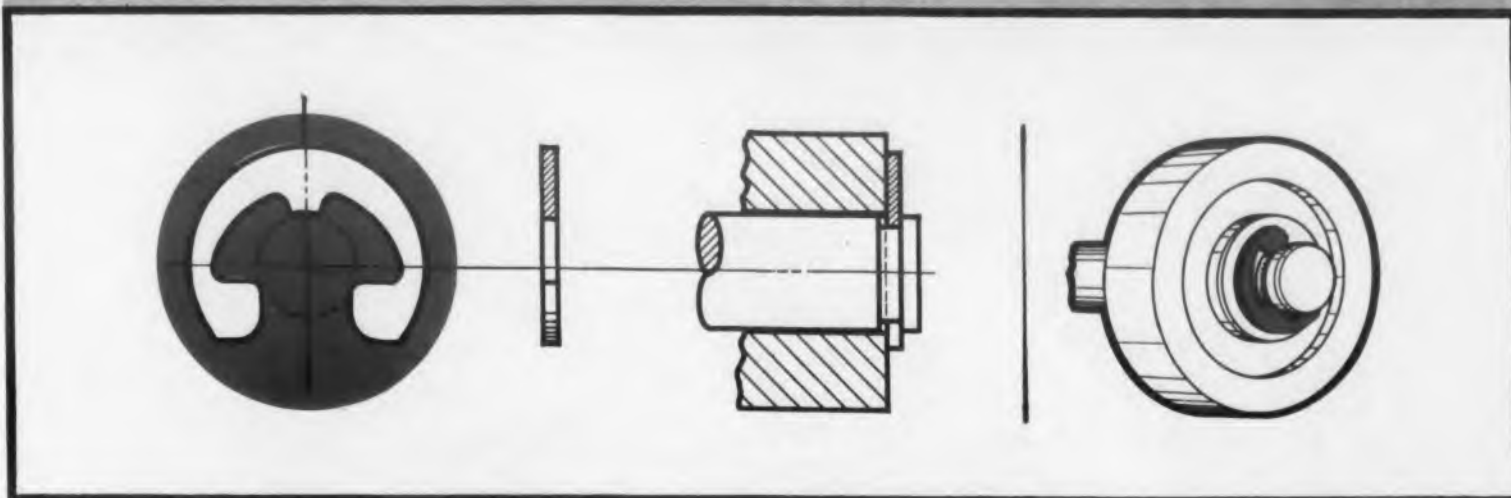


Permitting the amplifier to run with linearity through the entire galvanometer pen-recording range, the automatic electronic signal limiter eliminates excessive amplifier output signals which would cause galvanometer burn-out. Unlike a fuse, the automatic signal limiter activates whenever needed, without stopping normal pen movement. Pens can be safely adjusted for full deflection over the entire usable chart paper width.

Edin Co., Inc., Dept. ED, 207 Main St., Worcester 8, Mass.

CIRCLE 237 ON READER-SERVICE CARD

New Waldes Truarc Reinforced "E-ring" Provides 5 Times More Gripping Power, 50% Higher RPM Limits Than Conventional E-Type Rings



The new Waldes Truarc Series 5144 is a radially-installed reinforced "E-ring." It is designed for use in assemblies where the ring is subject to strong push-out forces resulting from heavy vibration and shock loads, high rotational speeds or relative rotation between the retained parts.

Series 5144 provides the following application advantages over conventional E-type fasteners:

- 1. GREATER GRIPPING STRENGTH**—approximately five times greater than conventional "E-rings" of the same metal and thickness.
- 2. HIGHER RPM LIMITS**—approximately 50% higher in most sizes.
- 3. POSITIVE LOCKING IN THE GROOVE**—large corner radii or chamfers can be accommodated without separator washers.
- 4. LOWER GROOVE COSTS**—because recommended groove tolerances have been increased, machining grooves for the series 5144 is less expensive.

5. WIDER APPLICATION—because series 5144 rings made of aluminum are stronger than conventional "E-rings" made of steel, the fastener may be used in applications where corrosion resistance or weight are factors.

Truarc Series 5144 Reinforced "E-rings" are available for shaft diameters from $\frac{1}{2}$ — $\frac{3}{8}$ in. in carbon spring steel, stainless steel, beryllium copper, aluminum, and phosphor bronze. They are available stacked on rods for high speed installation with Truarc applying and dispensing equipment.

As in all Truarc rings, you get statistically controlled quality from engineering and raw materials to the finished product. Complete selections are available from leading OEM distributors in 90 stocking points throughout the U. S. and Canada. Design Engineering Service is available to you. Send us your blueprints. Let our Truarc engineers help you solve design, assembly and production problems... without obligation.

SEND FOR FREE SAMPLES AND ENGINEERING DATA



WALDES

TRUARC
RETAINING RINGS

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

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

CIRCLE 193 ON READER-SERVICE CARD

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y.

Please send me sample Reinforced "E-rings."
(please specify shaft size) _____

Please send me Engineering Data Sheet

Name _____

Title _____

Company _____

Business Address _____

City _____ Zone _____ State _____

E B 050

WHY COMPROMISE RELIABILITY?

switch to... **ARNOUX**
ELECTRONIC
COMMUTATORS



GREATLY INCREASED RELIABILITY &
LIFE...LESS POWER REQUIRED

COMPLETELY QUALIFIED TO MIL E-5272A
QUALIFICATION TEST DATA AVAILABLE

Now in production...New rectangular case "DASH 10" series'
Available in 30, 45, 90 Channels PDM and PAM

THESE ADVANTAGES make Arnoux electronic commutators a must: long life, reliability, low noise level, and low power requirements.

The ETC commutator has a guaranteed service-free life of 5000 hours. Without vacuum tubes—built of all solid-state elements—the ETC has no moving parts. There are no switching transients. The frequency variation does not exceed ± 5 percent throughout the operating temperature and voltage ranges.

There is no radio interference; the ETC meets MIL-I-6181C specification. Signal noise (less than 0.05 percent) and crosstalk (less than 0.01 per-

cent) values are guaranteed; by actual test, these values are so low they cannot be measured.

Power requirement is only 2 watts (150 vdc at 12 ma) for the 30-channel unit.

The small, lightweight ETC can be used as a direct replacement for mechanical commutators in 0-3 v and 0-5 v airborne telemeter applications. It meets all IRIG requirements, exceeds MIL-E-5272A specification, and is available in all PAM and PDM sampling rates. A signal limiting feature, with the ETC, makes limiters unnecessary elsewhere in the telemetry system.

Write for Arnoux Bulletin 700

Sales Offices: Los Angeles, Seattle, Dallas, Bryn Mawr (Pa.), Arnprior, Ontario (Canada)



ARNOUX CORPORATION

Designers and Manufacturers of Precision Instrumentation

11924 WEST WASHINGTON BLVD • LOS ANGELES 66, CALIFORNIA

CIRCLE 194 ON READER-SERVICE CARD

NEW PRODUCTS

Bi-Directional Couplers

Three types cover frequencies from 2.6 to 12.4 km



Three broadband waveguide directional couplers have been designed for continuous vswn and power comparison measurements in microwave systems, each with approximately 20 percent bandwidth. Coupling ratio measures 10 db with no more than 0.5 db variation over the entire frequency range. Minimum directivity is 40 db. The units are bi-directional couplers which take accurate percentage samples of the power flow in a waveguide transmission line. Two opposing coupler units on the single main waveguide unit provide separate outputs for forward and reflected power in the line. Each output samples power flow in only one direction.

Sperry Gyroscope Co., Microwave Electronics Div., Dept. ED, Great Neck, N.Y.

CIRCLE 195 ON READER-SERVICE CARD

Rotary Solenoid

Eliminates Mechanical Linkage



This rotary solenoid, called the Motoroid, provides true rotary motion from an ac or dc input without linkages. The output torque and angle of rotation are easily selected and adjusted. They are changed by shifting two stops that limit rotation. These stops allow selection of any portion of the overall Motoroid torque curve and rotation.

Series 100, the first of this line, provides outputs of up to 4 inch pounds. Models are available in closed or open-frame type and in continuous or intermittent duty models with either left or right hand rotation standard. They have an operating temperature range of -65 to $+300$ F with special models up to 500 F. Standard operating voltage is 110 v, 60 cps. Other voltages and dc are available on special orders. The standard angle of rotation is 60 deg, with longer travel designed upon request.

Leetronics, Inc., Dept. ED, 30 Main St., Brooklyn, N.Y.

CIRCLE 196 ON READER-SERVICE CARD



DC Gearmotor

Withstands locked rotor for 20 min

Identified as model P7P6TFRP80, this miniaturized 27 v dc permanent magnet gearmotor has been designed with thermal protection and radio frequency filter. Designed for use in an airborne fire control system, the motor has an extended shaft with special bearings to compensate for an overhung load. It develops 180 in.-oz maximum stall torque and 16 in.-oz running torque. The gear reduction provides an output speed of 1000 rpm at full load, and 1400 rpm at no load.

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

CIRCLE 197 ON READER-SERVICE CARD

Coaxial Line

Semi-flexible, air dielectric



Called Spir-O-line, this transmission line has a dielectric supporting structure between the aluminum outer conductor and the copper inner conductor. It employs high density 100 C low-loss polyethylene tubing (Teflon for higher temperatures) under uniform radial compression to provide maximum air space with no direct air path between conductors. This construction permits a voltage rating increase of approximately 20 per cent over equivalent size semi-flexible lines. The lower attenuation of Spir-O-line permits higher average power ratings.

Avoidance of dielectric discontinuities provides high efficiency and low vswr. The transmission lines terminate in standard EIA flanges and other specified dimensions. The cables have broadband characteristics.

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

CIRCLE 198 ON READER-SERVICE CARD



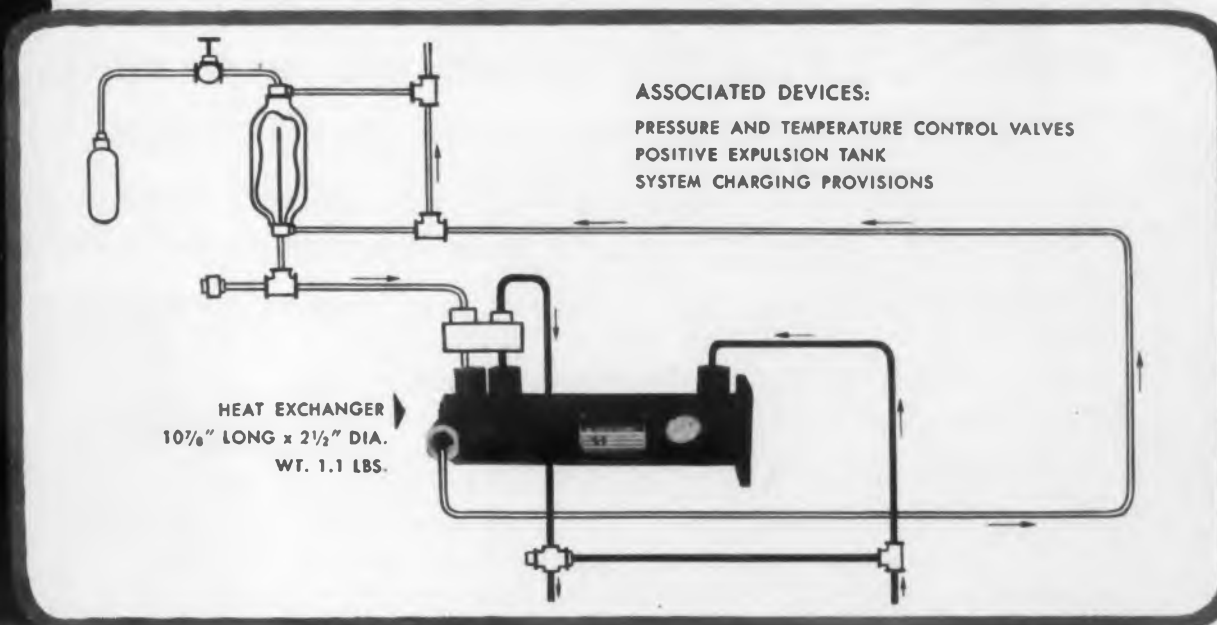
UAP primary and supplemental EVAPORATIVE COOLING SYSTEM

NEW, exclusive features... 3 to 30 times greater evaporating heat transfer coefficients!

This new UAP cooling system for electronic equipment, fluid systems and structural component seals includes UAP's latest exclusive Hi-D developments in the heat exchanger arts, and associated UAP devices. Unique Hi-D configuration develops heat transfer coefficients 3 to 30 times greater than any previous development. 95% to 98% boil-off of evaporative fluid has been obtained.

UAP heat transfer devices are tubular and plate types of stainless steel or aluminum and can be applied to various evaporative fluids including water, water-alcohol, water-glycol, and aqueous ammonia mixtures for pool boiling or forced circulation systems.

Schematic: AQUEOUS AMMONIA-TO-OIL EVAPORATIVE COOLING SYSTEM



ASSOCIATED DEVICES:

PRESSURE AND TEMPERATURE CONTROL VALVES
POSITIVE EXPULSION TANK
SYSTEM CHARGING PROVISIONS

HEAT EXCHANGER
10 7/8" LONG x 2 1/2" DIA.
WT. 1.1 LBS.

More specific information in Engineering Report form can be made available to qualified inquirers by contacting UAP Contractual Engineering Offices.

CALIFORNIA 1101 Chestnut St., Burbank, Calif., VI 9-4236
NEW YORK 50 E. 42nd St., New York 17, N.Y., MU 7-1283
OHIO 1116 Bolander Ave., Dayton, Ohio, BA 4-3841
CANADA United Aircraft Products, Ltd., 5257 Queen Mary Road, Montreal, Canada, Elwood 4131

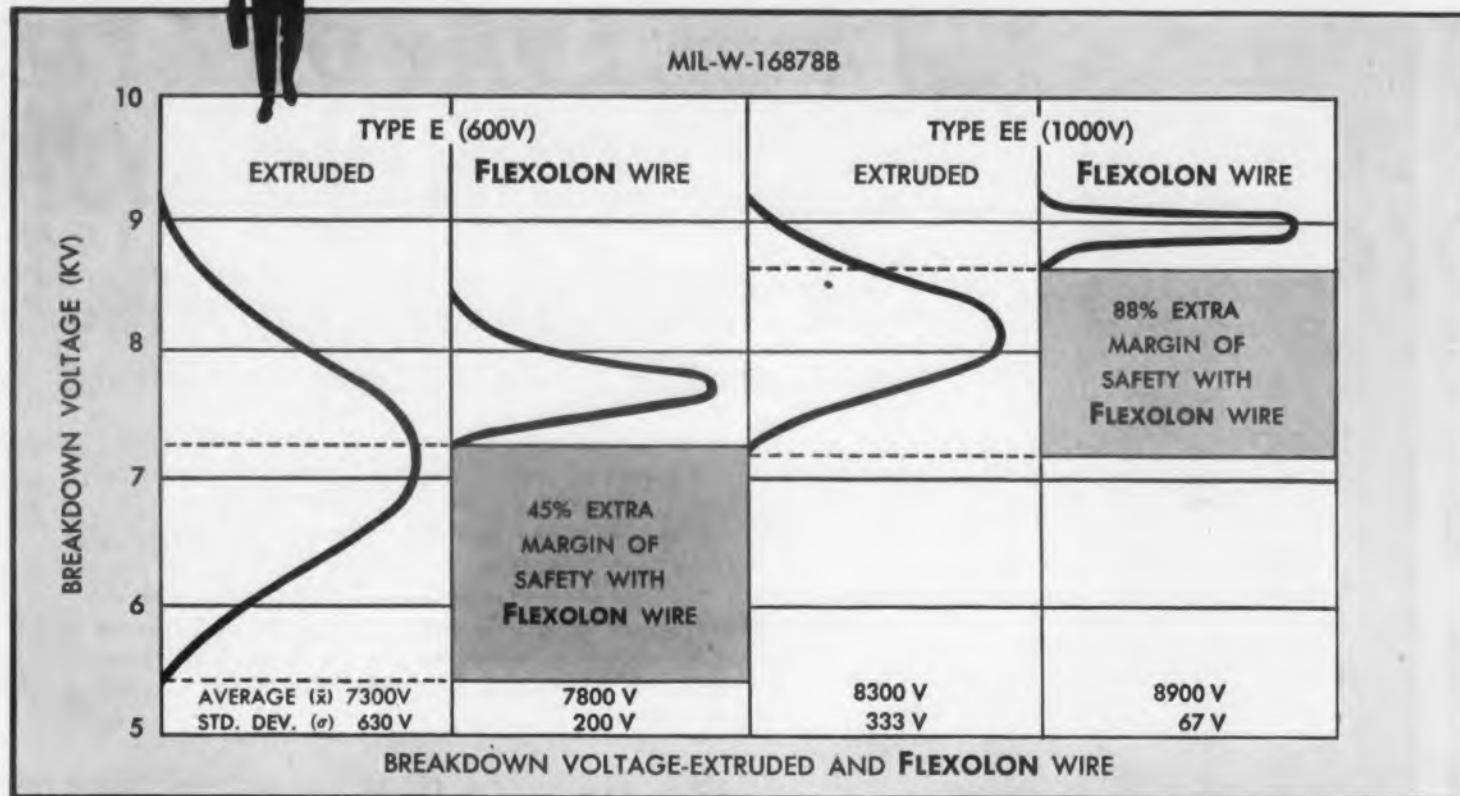
a famous family of aircraft essentials since 1929

UNITED AIRCRAFT PRODUCTS, INC.

1116 BOLANDER AVENUE, DAYTON, OHIO

CIRCLE 199 ON READER-SERVICE CARD

How the man from Tensolite can widen your safety margins on 250° C. hook-up wire



New FLEXOLON hook-up wire with "Teflon" tape proves highest in dielectric strength

Superiority of Tensolite's new FLEXOLON wire, manufactured to exceed the requirements of MIL-W-16878B, Types E and EE, gives designers greater safety factor than ever before

If you want to widen the safety margins in your product or merely maintain the present margins with smaller wire, Tensolite's new FLEXOLON high temperature hook-up wire can solve your problem.

Rugged tests—In a series of extensive tests, FLEXOLON wire's dielectric strength was charted against the strength of extruded wire. Ten-foot samples, selected at random, were immersed in a water bath containing a suitable wetting agent for 4 hours. Each piece was then subjected to a high-potential test with voltage increasing from 0 at the rate of 3 kv per 10-second interval until breakdown was observed.

Results conclusive—In the type E category, extruded wire fell 45 per cent below FLEXOLON wire's minimum dielectric strength. In the type EE category, the extruded samples were 88 per cent lower than the minimum dielectric strength of FLEXOLON wire.

Extra advantages—Tensolite's unique process which permits application of 2½ times more layers of Raybestos-Manhattan R/M "Teflon" tape to FLEXOLON wire assures full insulation protection and far superior performance. The new technique also gives FLEXOLON wire perfect concentricity which provides easier stripping, faster and cleaner cuts, and added protection against strand damage.

Complete information—Ask the man from Tensolite for full details on the many advantages of FLEXOLON high temperature hook-up wire. Or write to Tensolite for informative FLEXOLON wire bulletin.



88 per cent extra margin of safety—This high potential test proved that Type EE extruded wire fell 88 per cent below FLEXOLON wire's minimum dielectric strength.

Tensolite INSULATED WIRE CO., INC.

West Main Street, Tarrytown, N. Y. • Pacific Division: 1516 N. Gardner St., Los Angeles, Calif.

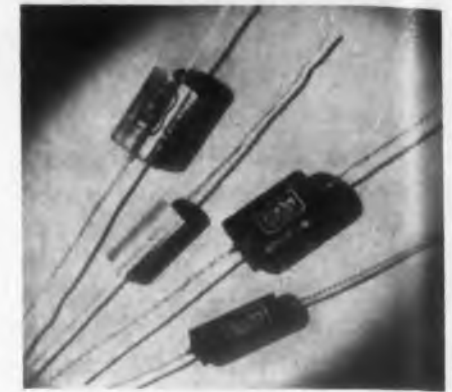
"FLEXOLON" is a trademark of Tensolite Insulated Wire Co., Inc.

"TEFLON" is a registered trademark of the DuPont Company

NEW PRODUCTS

Selenium Rectifiers

Primarily for arc suppression



The hermetically sealed SP3 series and phenolic housed SP7 series are selenium rectifiers designed specifically for use as arc suppressors. Units are suitable for ac circuits which draw up to 600 ma operating current at 150 v and for dc circuits drawing up to 750 ma operating current at 147 v.

Bradley Labs., Inc., Dept. ED, New Haven, Conn.

CIRCLE 200 ON READER-SERVICE CARD

Thermal Switch

For very high temperatures



A high temperature thermal switch for jet engines, gas turbines, rocket motors, after burner control, and other high temperature applications has been developed. The switch is easily installed and will operate in temperatures as low as -20 F with safe momentary overshoots to 2200 F. Constructed of special stainless steel alloys, single or two wire leads, with either standard thread or plate type mounting. Resistive rating is 1 1/2 amp at 28 v dc.

Control Products, Inc., Dept. ED, 306 Sussex St., Harrison, N.J.

CIRCLE 201 ON READER-SERVICE CARD

◀ CIRCLE 159 ON READER-SERVICE CARD

Wide Band Amplifier

Covers 6-60 mc without i-f change



Model WA-600 amplifier is designed to allow complete coverage of the 6 to 60 mc range without adjustments or change in i-f strips. Performance under any conditions of pulsed operation is exceptional due to a 20 μ sec recovery time and a full wave detector. The amplifier is a special video type using both shunt and series peaking coils. A full wave detector follows these with a conventional two-stage 10 mc wide video amplifier for pulse work, or a narrower band dc one for cw.

Specifications include an input frequency of 6-60 mc to 3 db points, gain 80-90 db, video band width 10 mc, input impedance 93 ohm, output impedance provided by cathode follower terminated externally, output voltage +10 v max, and noise figure of 11-13 db.

Arenberg Ultrasonic Lab. Inc., Dept. ED, 94 Green Street, Jamaica Plain 30, Mass.

CIRCLE 203 ON READER-SERVICE CARD

Servo Couplings

Use flexible disc



Designed for the coupling of shafts which are in angular misalignment, these units consist of a flexible disc riveted to a pair of precision hubs. The unit is entirely free of backlash. The couplings are designed to accept 1/4-in. shafting, and are available for either clamp or pin fastening.

Shafts having an angular misalignment of up to 2 deg can be coupled and operated at speeds to 5000 rpm with maximum torque of 50 oz in. Reeves Instrument Corp., Dept. ED, Roosevelt Field, Garden City, N.Y.

CIRCLE 204 ON READER-SERVICE CARD

SANGAMO
TYPE 71

HIGH VOLTAGE CAPACITORS

OIL
FILLED
PAPER

for blocking and by-pass service
energy storage—power supply filters
and many similar applications

These hermetically sealed, compact units are designed for high voltage commercial electronic applications.

High volume resistivity, low power factor, and high dielectric strength are assured by impregnation with Sangamo Diaclor, a specially compounded chlorinated dielectric that is non-inflammable and non-explosive. Type 71 capacitors can be operated at temperatures up to 85°C with proper voltage de-rating.

WEATHER-PROOFED CASE

Tin-plated steel case is metalized with pure aluminum and finished with two coats of baked vinyl resin base paint. Rust and corrosion won't attack this case even if the finish is scratched through to the steel.

Type 71 High Voltage Capacitors are available in standard case sizes in ratings up to 25,000 WVDC.



VOLTAGES UP TO 25,000 WVDC

SANGAMO

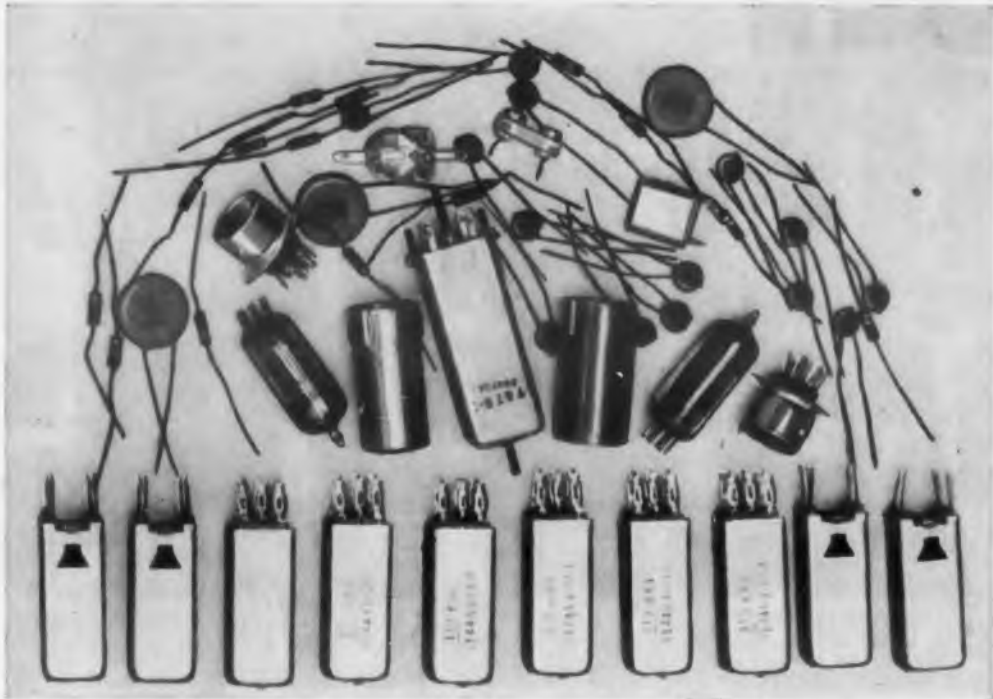
Electric Company
SPRINGFIELD, ILLINOIS

6C58-2

CIRCLE 206 ON READER-SERVICE CARD

CRYSTAL FILTERS

NOW YOU CAN REPLACE ALL OF THESE COMPONENTS



Shown approx. 1/2 size

WITH A SINGLE HYCON EASTERN CRYSTAL FILTER



Shown approx. 1/2 size

**AND REDUCE WEIGHT, SAVE SPACE,
IMPROVE PERFORMANCE AND RELIABILITY**

It will pay you to investigate how this unique component can improve performance and reduce costs of your communications equipment. Hycon Crystal Filters make possible single conversions in AM and FM receivers while retaining the important advantages of double and triple conversions. These units permit excellent reception in the presence of strong jamming or interfering signals. Center frequencies are accurate to .001%. Insertion loss is 1/10 of other filtering methods. Aircraft and guided missile environmental requirements are exceeded. Write for Crystal Filter Bulletin.



HYCON EASTERN, INC.

75 Cambridge Parkway Dept. F, Cambridge 42, Mass.

CIRCLE 207 ON READER-SERVICE CARD

NEW PRODUCTS

Voltmeter

Accurate from -55 to $+65$ C



Expanded scale construction provides good readability and 0.5 per cent accuracy. Meter is time-stable. No thermal elements are used, thus eliminating thermal aging. The unit maintains frequency accuracy from 50 to 2000 cps. Power consumption is less than 1 w at any temperature within a -55 to $+65$ C range. The line comprises ac and dc types: military types are supplied in 2-1/2, 3-1/2, and 4-1/2 in. round sizes; industrial types in 2-1/2 and 3-1/2 in. round or square, or 4 x 6 in. rectangular sizes.

Voltron Products, Dept. ED, 1010 Mission St., S. Pasadena, Calif.

CIRCLE 208 ON READER-SERVICE CARD

Stepping Relay

Printed circuit switching board



This stepping relay uses a printed circuit board for switching currents up to 250 ma. Designated the SA, the relay can be furnished for ac or dc voltage operation. It operates on 3 w dc or 20 va ac. It is normally a pulse operated relay but the dc coil will withstand 3 w continuously. The ac relay must be pulse operated. An armature-driven pawl operates a ratchet to drive a movable arm in steps of 30 deg over the 12 non-shorting printed circuit strips.

Potter & Brumfield, Inc., Dept. ED, Princeton, Ind.

CIRCLE 209 ON READER-SERVICE CARD

FOR TIMELY DESIGN INFORMATION



In *Electronic Design*, engineers find not only more new products, but *all* the new products normally encountered in the design of electronic original equipment. 26-time publishing frequency brings this information quickly to the engineer's attention, timed to a fast-moving industry. *Electronic Design* is more up-to-the-minute, more complete, more helpful, and easier to read than any other electronic publication. No wonder more and more engineers read *Electronic Design* first!

ELECTRONIC DESIGN

a HAYDEN publication

830 THIRD AVENUE, NEW YORK 22, N. Y.

CIRCLE 210 ON READER-SERVICE CARD

Zener Diodes

Axial leads for pc assembly

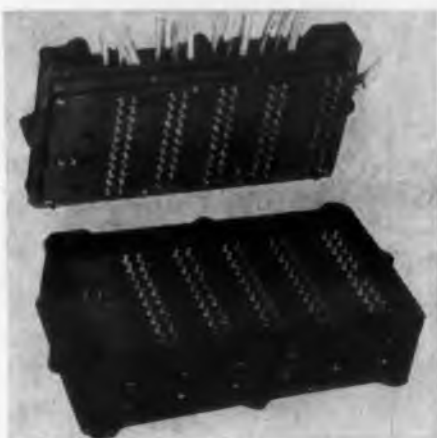
Axial leads on these low power silicon Zener diodes makes possible automatic machine assembly on printed circuit boards. The diodes are not position-sensitive, and may be inserted by automatic machines on an assembly line basis. A heat-dissipating path from the diode junction is built-in, making possible a conservative power rating of up to 200 mw at 25 C.

U.S. Semiconductor Products, Inc., Dept. ED, 3536 W. Osborn Rd., Phoenix, Ariz.

CIRCLE 211 ON READER-SERVICE CARD

Connector

Universal joints allow misalignment



Developed to overcome the problems encountered where rigid connectors are subject to high shock and vibration, this sealed connector employs a ball and socket principle for its contact pins. Two ball-type pins are connected by a split sleeve held together by two garter springs. The action of the ball-contacts in the sleeve is that of a universal joint action. The location of the pins does not have to be held to a close tolerance and allows for further misalignment due to shock and vibration as well as temperature changes.

Cole Electric Co., Dept. ED, 8439 Steller Dr., Culver City, Calif.

CIRCLE 212 ON READER-SERVICE CARD

Baluns and RF Transformers

1.5 to 30 mc and 14 to 60 mc range

In the full kilowatt size, transmitting baluns and rf transformers are designed for matching 50 ohms coax to balanced impedances ranging from 50 to 470 ohms, and matching 75 ohms coax to balanced impedances ranging from 75 to 600 ohms. Appropriate similar models are available in a 150 w junior series. Baluns are useful in enabling transmitters of the single ended type to feed a balanced transmission line without the use of switches or complicated circuitry.

Lynmar Engineers, Inc., Dept. ED, 1432 N. Carlisle St., Philadelphia 21, Pa.

CIRCLE 453 ON READER-SERVICE CARD



Orders for DRIVER-HARRIS Nickel and Nickel Alloy Wire FILLED IN 24 HOURS

If we receive your order in the morning, it will be shipped out before evening . . . this is the new service policy of Driver-Harris in the manufacture and distribution of 18 most frequently purchased Nickel and Nickel Alloys in wire form. In addition to this new warehouse stocking program, is the improved delivery schedule for Monel, Grade "A" Nickel, Inconel, R Monel and some Stainless Steels with lead time reduced to only 7 days in certain cases. The following list covers immediate availabilities. For complete detailed current listing showing all sizes and specifications, contact the nearest Driver-Harris branch — or call HUmboldt 3-4800 (New Jersey), REctor 2-9579, 80, 81, 82 (New York City).

IN STOCK READY FOR DELIVERY

MONEL	25 wire sizes from .0021 to .091
GRADE "A" NICKEL	12 wire sizes from .0025 to .091
GRADE "D" NICKEL	9 wire sizes from .005 to .015
INCONEL	3 wire sizes from .0253 to .050



Driver-Harris* Company

HARRISON, NEW JERSEY • BRANCHES: Chicago, Detroit, Cleveland, Louisville

Distributor: ANGUS CAMPBELL, INC., Los Angeles, San Francisco • In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario
MAKERS OF THE MOST COMPLETE LINE OF ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING INDUSTRIES

CIRCLE 213 ON READER-SERVICE CARD

STAINLESS STEEL

Type 304	24 wire sizes from .0016 to .164
Type 316	6 wire sizes from .007 to .0135
Type 330	25 wire sizes from .0063 to .144
NICHROME*	65 wire sizes from .0007 to .289
NICHROME* V	62 wire sizes from .00045 to .289
CHROMAX*	35 wire sizes from .0031 to .258
KARMA*	36 wire sizes from .0005 to .036
ADVANCE*	49 wire sizes from .0008 to .258
MANGANIN	37 wire sizes from .001 to .1285
LOHM*	29 wire sizes from .001 to .182
MIDOHM*	28 wire sizes from .00175 to .182
30 ALLOY	28 wire sizes from .0015 to .182

LEAD TIME FOR MANUFACTURING WIRE & RIBBON

As low as 10 days for	
COLD DRAWN MONEL	wire sizes from .001 to .1875
GRADE "A" NICKEL	wire sizes from .001 to .1875
COLD DRAWN INCONEL	wire sizes from .001 to .1875
R MONEL	wire sizes from .0285 to .204

As low as 7 days for
STAINLESS STEEL wire and ribbon

Types: T-302, T-304, T-305, T-316, T-430, T-446

*TM. REG. U.S. PAT. OFF.
INCONEL & MONEL
TM. REG. U.S. PAT. OFF.
INTERNATIONAL NICKEL
COMPANY INCORPORATED

TRANSISTORS



TRANSISTOR ISSUE

PUBLISHED JULY 9th—CLOSES JUNE 9th

CBS-Hytron Photo

ELECTRONIC DESIGN FEATURE REPORT

- TRANSISTORS
- COMPONENTS FOR TRANSISTORIZED CIRCUITS
- TRANSISTOR ASSEMBLIES
- TRANSISTOR TEST EQUIPMENT
- DESIGN FOR TRANSISTORS
- MATERIALS FOR TRANSISTORS

The 6th annual Transistor Data Issue of *Electronic Design* will be published July 9th—complete with TRANSISTOR DATA CHART, the first and only complete transistor data source of its kind in the industry. The chart is bound in each copy of the magazine—can be removed for permanent reference. Extra editorial, extra readership, extra reader action! Schedule this issue of greatest value NOW . . . forms close June 9th.

JULY 23rd—DIODES

Also in July: an *Electronic Design* feature report on *Semiconductor Diodes*. Special editorial, characteristics charts, performance data, will make this issue in extra demand by design engineers throughout the industry. Forms close June 23rd.

NEW PRODUCTS

Relay

5-amp 4 pole dc unit



This 5-amp dc 4 pole relay, meets the requirements of Mil-R-5757C and Mil-R-25018. Life tests indicate a minimum life of 100,000 operations at 5 amp 26.5 volts dc, with a non-inductive load on the contacts. Better construction minimizes contact contamination.

Radio Corporation of America, Commercial Electronic Products, Dept. ED, Camden 2, N.J.

CIRCLE 214 ON READER-SERVICE CARD

Chassis

Universal type featuring rigidity



This series of universal chassis emphasizes rigidity and versatility. Single-panel models are readily punched or drilled for fore-and-aft or cross mounting of assemblies and provide unrestricted front panel mounting area. Modular models shown are available with multiple subchassis units to facilitate fore-and-aft or cross mounting and good cooling of assemblies.

Maximum-height side frames with Heli-arc'd corners give rigid equipment-protection in any position. Materials used are steel or aluminum.

Western Devices, Inc., Dept. ED, 600 W. Florence Ave., Inglewood, Cal.

CIRCLE 215 ON READER-SERVICE CARD

ELECTRONIC DESIGN

a HAYDEN publication • 830 Third Avenue, New York 22, N.Y., Telephone PLaza 1-5530

Duplexer-Switch

Handles 300 kw peak



For handling 300 kw peak power and 300 w average power in the frequency range of 8.5 to 9.6 k mc, model XL447 ferrite duplexer-switch performs the function of switching between two waveguide outputs from a single input.

In its use as a duplexer switch, the unit directs microwave energy to one or another of two antennas when current is reversed in the coil of the electromagnet. The need for a power-absorbing isolator is eliminated because antenna reflections are always directed to the receiver t-r tube.

Giving a 20 db isolation between outputs, the XL447 has an insertion loss of 0.5 db, and an input vswr of 1.2. Switching time is 4 msec. Standard coil specifications are 1 amp at 28 v dc, but coil parameters can be established to meet individual requirements.

Monogram Precision Industries, Inc., Cascade Research Div., Dept. ED, Los Gatos, Calif.

CIRCLE 216 ON READER-SERVICE CARD



Microwave Termination

Accurately adjusted to any reactance

Five different types of sliding shorts are available in frequency ranges from 12.4 to 75 kmc. With short-circuit vswr's of up to 100:1, they are useful as terminating impedances in waveguide measurements. These units consist of a section of waveguide in which a short-circuiting plunger can be moved by means of a micrometer drive. This is a non-contacting short of the two-section coaxial-filter type.

Polytechnic Research & Development Co., Inc., Dept. ED, 202 Tillary St., Bklyn, N.Y.

CIRCLE 217 ON READER-SERVICE CARD

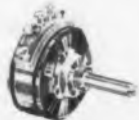
HIGH TEMPERATURE COMPONENTS

POTENTIOMETERS

ROTARY TRIMMERS



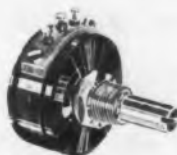
AP 1/2



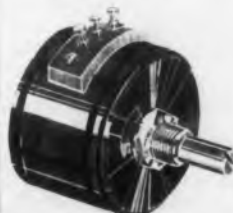
RT 7/8



AP 1-1/16



AP 1-1/8



AP 1-5/8

The Waters' complete line of rotary trimmer and miniature precision potentiometers is derated to 125° C standard and is **NOW AVAILABLE TO 150° C.**

ROTARY TRIMMER POTENTIOMETERS are built, tested and certified* to rigid military environmental specifications and are available in a wide variety of mechanical configurations: ganged, tapped, with various electrical and mechanical angles, locking bushings, anti-rotation pins, "O" ring seals, custom shafts, or with the new Waters concentric shaft construction that provides two pots on a single mounting with two separate controls.

MINIATURE PRECISION POTENTIOMETERS are built, tested and certified* to such rugged specifications as: AIA, RETMA, JAN-R-19, MIL-E-5272A, and other applicable military specifications. This new line of single-turn pots packs Waters quality, performance and reliability into smaller-than-ever size.

*Complete data on request. Write for the new potentiometer catalog.

MINIATURE PRECISION



WP 1/2



WP 7/8



WP 1-1/16



WP 1-1/8



WP 1-5/8

New!

"HOT POT" precision potentiometer 1 watt at 200° C

This new high temperature pot is now available for consideration in your high temperature circuit designs. Built in a stainless steel, 1" x 3/4", case. The "HOT POT" with its welded construction offers the ultimate in high temperature component reliability. Element is wound on a ceramic core.

Complete information on request.

Waters

Potentiometers, Pot Hook® Panel Mounts, Panel Meters, Epoxy Encapsulated Chokes, RF Coils, Slug-Tuned Coil Forms, Torque Watch® Gauges, Instruments, Potentiometer Test Equipment

MANUFACTURING INC.
Wayland, Massachusetts

CIRCLE 218 ON READER-SERVICE CARD

by

Waters

EPOXY ENCAPSULATED CHOKES & COILS

AVAILABLE TO 125° C

The new Waters family of epoxy encapsulated chokes offers a wide range of inductances from 0.1μh to 200.0MH. Among the wide variety of physical configurations is a flat side type with axial leads for use in printed circuits. It also provides an index surface for automated production. With heavier components, printed circuit mechanical mounting leads are provided for extreme shock and vibration isolation.

A tubular model is provided with leads at one end for use in printed circuit or conventional high temperature applications.

Included in the new encapsulated choke family is a complete line conforming to MIL-C-15305A, Grade 1, Class B.

Shielded encapsulated chokes, which mount with two 6-32 spade bolts are also available. Write for the new encapsulated choke catalog.



CER — Epoxy Encapsulated Round Molded



CES — Epoxy Encapsulated Flat Bottom



CPC — Epoxy Encapsulated Flat Bottom with Leads



CPA — Epoxy Encapsulated — Aluminum Can



CCA — Epoxy Case — Axial Leads



CCS — Epoxy Case Leads Single Ended

CPD — Epoxy Encapsulated



Epoxy Encapsulated Slug-tuned coil form



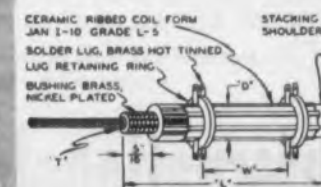
CPS — Vinyl Sleeve



CCT — Epoxy Encapsulated — Ceramic Sleeve

New!

RIBBED CERAMIC SLUG-TUNED COIL FORMS



New rugged ceramic coil forms. Ribbed construction permits leads to be brought under windings to lugs, eliminates loose leads. Retractable type bushing allows core to enter bushing providing more effective winding area. Unique internal permanent-tension device eliminates loose parts. New design permits forms to be stacked, or have bushings on each end for double tuned coils. Special windings can be supplied to meet your specifications. Wide choice of slugs available for various frequency ranges. Write for the new coil form catalog.



IERC HEAT-DISSIPATING ELECTRON TUBE SHIELDS



**— AND EQUIPMENT “DOWN TIME” LOSSES
CAUSED BY HEAT, SHOCK AND VIBRATION!**



Investigate the extraordinary tube-saving, cost-saving potentials of IERC Heat-dissipating Tube Shields — the only complete, commercially-available line of effective heat-dissipating electron tube shields for **miniature, subminiature and octal/power** size tubes. IERC's expanded line of heat-dissipating tube shields for the larger size power tubes offer, for the first time, a practical method to retain these tubes in severe shock and vibration environments!

The most complete electron tube heat-dissipation information is yours for the asking! Technical data comprised of IERC and independent laboratory test reports will be sent upon request on your company letterhead.

CROSS-LICENSED WITH NORTH AMERICAN AVIATION, INC.
PATENTED OR PATS PENDING.

International



electronic research corporation

145 West Magnolia Boulevard, Burbank, California

LATEST addition to IERC's product line is the IERC HEAT DISSIPATOR for POWER TRANSISTORS. Effective reduction of temperatures, elimination of heavy, large or finned surfaces plus adaptability for use in confined spaces are prime features. Technical Bulletin PP112 is included with general IERC information sent on request.

Heat-dissipating electron tube shields for miniature, subminiature octal and power tubes

CIRCLE 219 ON READER-SERVICE CARD

NEW PRODUCTS

Rotary Switch

Up to 6 levels, 30 points each



The high speed R VF rotary switch can be furnished with 2, 4, or 6 levels, 30 points each, with single wiper. With double wipers, the same switches become 4, 8, or 12 level units, respectively, with 15 points per level. Any combination up to 30 inputs and/or outputs per bank level. Bank terminals are designed for use with either soldered connections or solderless connectors. Bank contact ratings: 1 a at rest; 0.2 a resistive when stepping. Gold plated bank contacts and wipers are available for low level switching. Available with 12, 24, 48, 110 v dc coils. Built-in spark suppression on 24 and 48 v switches.

North Electric Co., Dept. ED, Galion, Ohio.

CIRCLE 220 ON READER-SERVICE CARD

Calibrator

For instruments used with resistance type pressure cells



The model 104 calibrator is used by substituting it for the sensing element in a measuring system. Defective components are easily isolated by substitution. The 104 is made in three standard versions supplying a maximum output voltage of .002, .004, and .008 volt/volt. Output voltage from the calibrator can be selected in ten equal steps from zero to the rated output of the unit. Voltages are guaranteed to be within 1/10 per cent of the rating over an operating temperature of 40 to 100 F. The unit can be used on frequencies up to 1000 cps.

Gilmore Industries, Inc., Dept. ED, 13015 Woodland Ave., Cleveland 20, Ohio.

CIRCLE 221 ON READER-SERVICE CARD

STROMBERG-CARLSON



PUSH-KEYS now available with automatic interlock

In such precision operations as automation programming, you can now eliminate the risk of pushing more than a single button at a time.

This new interlock feature is based on a simple arrangement of sliding cams. Only one button at a time can be depressed. This feature is available in all multiple-pushbutton assemblies (7, 10, 12 and 20 button arrangements).

All "telephone-quality" advantages of Stromberg-Carlson keys continue as before. You may apply "make," "break," "break-make" and "make-before-break" combinations as required. You get standard spring combinations with Form A, C or D contacts—or you may order special strips of keys with intermixed contacts.

Buttons are available in white or colors—blank or with letter or number designations.

For complete technical data on Stromberg-Carlson Key Switches send for our illustrated Bulletin T-5002R.



STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION

Telecommunication Industrial Sales

111 Carlson Road, Rochester 3, N. Y.

Electronic and communication products for home, industry and defense

CIRCLE 222 ON READER-SERVICE CARD

VITREOSIL®

**FUSED QUARTZ
MEETS YOUR
CRITICAL
REQUIREMENTS**



CHECK WHAT VITREOSIL OFFERS:

- ✓ Absolute Chemical Purity
- ✓ Extreme Heat Resistance
- ✓ Thermal Shuck Resistance
- ✓ Chemical Inertness
- ✓ Outstanding Electrical Properties
- ✓ Full-Range Radiant Energy Transmission

VITREOSIL fused quartz products can be supplied in an unusually large variety of types and sizes. Also fabricated to specification to meet semi-conductor requirements.

TRANSPARENT VITREOSIL

For ultra-violet applications, metallurgical investigations and processes, chemical research and analysis, photochemistry, spectroscopy and physical, optical and electrical research and production operations. Send specifications for your requirements. Please use coupon below.

See our ad in

Chemical Engineering Catalog

**THERMAL AMERICAN
FUSED QUARTZ CO., INC.**

18-20 Salem Street, Dover, New Jersey

Please send technical data on

Company _____
Name & Title _____
Street _____
City _____ Zone _____ State _____

CIRCLE 223 ON READER-SERVICE CARD

Phase Sequence Indicators

Indicates the proper phase rotation



Type PSI-AC phase sequence indicators contain an electrical network designed to sense the phase rotation and provide a voltage greater than, or less than, that required to light a neon lamp. Standard dimmer-type lenses are available for 60 or 400 cps operation at voltages from 110 to 440 v.

Brunswick Instruments, Dept. ED, P.O. Box 813, New Brunswick, N.J.

CIRCLE 224 ON READER-SERVICE CARD

AC Voltage Regulator

Regulates average peak and rms

Model APR1010, a tubeless multi-purpose ac voltage regulator, can be used to regulate average and peak voltages as well as rms, independent and input waveform. By turning a switch, the regulator output can be matched to the special requirements of the load.

The regulator also has five different sensing arrangements: internal (normal ac regulation); external ac (any ac voltage); remote (115 v ac at a remote location); constant current; and dc.

Sorensen & Co., Inc., Dept. ED, Richards Ave., South Norwalk, Conn.

CIRCLE 225 ON READER-SERVICE CARD

Power Supplies

1 to 25 v dc



The TPC-5 power supplies can be furnished for any desired output between 1 and 25 v dc. Rated output current is 350 ma and the regulation over the entire input voltage and output current ranges is 1 per cent.

Southwestern Industrial Electronics Co., Dept. ED, 2831 Post Oak Rd., Houston, Texas.

CIRCLE 454 ON READER-SERVICE CARD

New

P R E C I S I O N F R E Q U E N C Y

STATIC INVERTER SUPPLY

INPUT 28V D.C. $\pm 10\%$

OUTPUT Nom. 115V $\pm 2\%$ 400 CPS $\pm 0.01\%$
1 ϕ (2- or 3-phase output available)

RATINGS: 30VA 50VA 100VA
Higher ratings available.

APPLICATION:

For gyro wheel supplies and where precise 400 cycle voltages are required in aircraft, radar and missile computers.

FEATURES:

- PRECISION OUTPUT FREQUENCY
- RUGGED
- EXCELLENT WAVEFORM
- SIMPLICITY OF CIRCUITRY
- FAST STARTING TIME
- GOOD VOLTAGE REGULATION
throughout an adjustable range
- ISOLATED CASE DESIGN
- HIGH RELIABILITY
- VIBRATION ISOLATED
- COMPACT
- LIGHTWEIGHT
- MILITARY SPECIFICATIONS

(Send for Bulletin S-864)



PERFORMANCE SPECIFICATIONS

MODEL NUMBERS	$\pm .01\%$ CPS $\pm .05\%$ CPS	SIS 40311 SIS 40315	SIS 40511 SIS 40515	SIS 410011 SIS 410015
INPUT VOLTAGE	28V DC $\pm 10\%$			
MAX. OUTPUT POWER	30VA	50VA	100VA	
OUTPUT VOLTAGE	115V AC (Adjustable $\pm 10\%$)			
OUTPUT FREQUENCY	400 CPS $\pm .01\%$ 400 CPS $\pm .05\%$			
VOLTAGE REGULATION	$\pm 1\%$ For Line Variations $\pm 2\%$ For Load Variations			
FREQUENCY DISTORTION	3% Maximum At Full Load			
LOAD POWER FACTOR	+0.5 to -0.5 Maximum			
MILITARY SPECS.	MIL-E-5400A & MIL-E-5272A			
AMBIENT TEMPERATURE	-55°C to +71°C when mounted to heat sink			
VIBRATION	20G 10 to 2000 CPS			
UNIT DIMENSIONS	LS" D 2 7/8" H 2 13/16"	LS" D 2 7/8" H 2 13/16"	L10" D 4 1/2" H 2 13/16"	
WEIGHT (Approx.)	2 lbs.	3.5 lbs.	5 lbs.	



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 226 ON READER-SERVICE CARD

**always
the leader
— all ways**

**Engineered Economy[®] Iron Cores
originated by
Radio Cores, Inc.**



*trademark

★ the leader in quality

★ the leader in price

★ the leader in engineering

★ the leader in volume

★ the leader in design

Just a few short years ago, Iron Cores cost over 100% more than at the present time. This has been achieved by the creation of our line of ENGINEERED ECONOMY[®] IRON CORES which enables us to reduce the amount of your minimum inventory through guaranteed immediate delivery service this has been achieved by the new use of automation which enables us to cut costs and pass these savings on to you this has been achieved by more efficient production methods, which reduce processing and material costs which again means savings to you.

Now, you can select from over
19 types of ENGINEERED ECONOMY[®]
IRON CORES which do the job of over 100 types
custom-made cores at stock prices. We invite your inquiry.
Also, custom iron cores to your specifications.

Radio Cores, Inc.

9540 Tully Avenue Oak Lawn, Illinois

Copyright 1956
Radio Cores, Inc.

CIRCLE 227 ON READER-SERVICE CARD



NEW PRODUCTS

Magnetic Clutches

Feature 5 msec engagement



This line of miniature magnetic clutch, brake, clutch-brakes is available in 32 models of frame sizes 8, 11, and 18, and feature 5 msec engagement. Temperature range is from -65 to $+350$ F. Complete range of operating voltage are available with 24-28 v as standard.

F AE Instrument Corp., Dept. ED, 42-61 Hunter St., Long Island City, N.Y.

CIRCLE 228 ON READER-SERVICE CARD

Program Timer

Intermediate switching in 1-sec increments



This adjustable program timer can be furnished for any time cycle up to a maximum of 4000 sec (66-2/3 min). Range brackets are specified in 100-sec increments. The overall time cycle is adjustable in one-second increments from zero to one-half of the maximum range, and in two-second increments from one-half to full range. Intermediate switching events can be pre-set at any points throughout the full range of the unit in one-second increments. The number of intermediate switching events is limited only by the length of the time cycle setting. The maximum would be one per second. Any selected switching program is recycled automatically, and will continue indefinitely until shut off. When operated on a line having a controlled frequency of 60 cycles per second, switching accuracy of the adjustable program timer can be held within $\pm 1/10$ second.

The Cramer-Krasselt Co., Dept. ED, 733 N. Van Buren St., Milwaukee 2, Wis.

CIRCLE 229 ON READER-SERVICE CARD

Using Thermistors

Edited by

FENWAL ELECTRONICS

Thermistors are "thermal resistors" with a high negative temperature coefficient of resistance — semiconductors with amazing sensitivity.

Thermistors discussed here — for liquid level measurement and altimeters.

Liquid level measurement: When a thermistor is suspended in air in series with a light bulb and battery, the bulb lights, because the thermistor heats and resistance drops, permitting current to flow to the bulb. Reversing this process, a thermistor submerged in a liquid (Fig. 1) cools, extinguishing the light. This is a liquid level indicator. A liquid level control substitutes a relay for the light bulb.

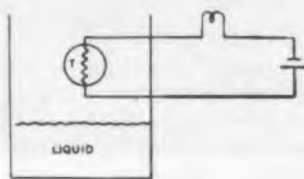


Fig. 1

Altimeter: A hypsometer, an extremely sensitive altimeter, is a thermistor placed at a liquid's surface (Fig. 2); thermistor resistance is a function of the liquid's boiling point, which depends on the altitude. A hypsometer of this type can measure altitude from sea level to over 125,000 feet with precision better than 1% of the measured pressure.

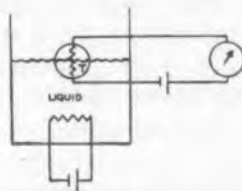


Fig. 2

Designers: If you are considering thermistors, write for more information about their tremendous possibilities to FENWAL ELECTRONICS, INC., 35 Mellen St., Framingham, Mass.



Design — Engineering — Production of Precision Thermistors

CIRCLE 230 ON READER-SERVICE CARD

NOW YOU CAN BUY OFF THE SHELF!



SHIPMENT GUARANTEED WITHIN 10 DAYS FOR COMMERCIAL UNITS

... and within 30 days for Mil Spec units.

THESE UNITS ARE NOW ON THE SHELF

(subject to prior sale)

1HG	1HDG	3HCT	5F	1HG400*
1F	3HG	3HDG	5D	1F400*
1HCT	3F	5HG	5HDG	1HCT400*

* 400cy units are available to commercial specs only. All others are available to both military and commercial specs.

In addition to above units, Ford Instrument currently has many sizes and types of synchros in production and approaching shelf status — also specials. Call or wire F. Robertson, Component Sales Division (STillwell 4-9000) for prices, or check and mail coupon below stating quantity. Check coupon space indicated if you wish FREE booklet on Ford's complete synchro line.

Component Sales Division
FORD INSTRUMENT CO.
 DIVISION OF SPERRY RAND CORP.
 31-10 Thomson Ave., Long Island City 1, N. Y.

Please send me prices and characteristics of the units checked below: ED

- | | | |
|-------------------------------|-------------------------------|-----------------------------------|
| <input type="checkbox"/> 1HG | <input type="checkbox"/> 3F | <input type="checkbox"/> 5D |
| <input type="checkbox"/> 1F | <input type="checkbox"/> 3HCT | <input type="checkbox"/> 5HDG |
| <input type="checkbox"/> 1HCT | <input type="checkbox"/> 3HDG | <input type="checkbox"/> 1HG400* |
| <input type="checkbox"/> 1HDG | <input type="checkbox"/> 5HG | <input type="checkbox"/> 1F400* |
| <input type="checkbox"/> 3HG | <input type="checkbox"/> 5F | <input type="checkbox"/> 1HCT400* |

* Available to commercial specs only.

- Units should meet military specs.
 Please send me FREE booklet.



Name _____
 Position _____
 Company _____
 Street _____
 City _____ State _____

CIRCLE 231 ON READER-SERVICE CARD

Encoder

Has 1024 positions



The C-711 series encoders are available with discs coded in Gray code (reflected binary) or a cyclic binary coded decimal. Accuracy is better than \pm one bit and the transition points of each bit are held to within \pm 0.05 deg. Torque is less than 0.4 in.-oz and inertia is less than 150 gm-cm². Dimensions of the unit are three inches in diameter by 1.250 in. in depth. Two versions are presently available: a 1/4 and 3/8 in. diam shaft.

G. M. Giannini & Co., Inc., Datex Div., Dept. ED, 918 E. Green St., Pasadena 1, Calif.

CIRCLE 232 ON READER-SERVICE CARD

Volt-Ohm Meter

Transistorized digital type

This transistorized digital volt-ohm meter has 4 switchable bipolar voltage ranges, 5 switchable resistance ranges, automatic polarity indication, automatic decimal point indication, less than 10 msec reading time.

Epsco, Inc., Dept. ED, 588 Commonwealth Ave., Boston 15, Mass.

CIRCLE 233 ON READER-SERVICE CARD

RF Filter

Weights 5 oz



This lightweight low-pass filter is designed for low insertion loss in the 225 to 400 mc band with attenuation in the 950 to 1200 mc band of 80 db. The size of the rf filter is 4-3/4 x 3/4 x 1-1/4 in. and it weighs less than 5 oz.

Bird Electronic Corp., Dept. ED, 1800 E. 38 St., Cleveland 14, Ohio.

CIRCLE 455 ON READER-SERVICE CARD

SPECIALLY BUILT TO WITHSTAND
SEVERE OPERATING CONDITIONS

Bendix
Red Bank



HARD GLASS TUBES



6094
BEAM POWER AMPLIFIER



6384
BEAM POWER AMPLIFIER



6754
FULL-WAVE RECTIFIER

- Ideal for modern high-performance aircraft and missiles.

- Processing at higher vacuum and under the higher heat permitted by the hard glass reduces gas and contamination and provides greater operating stability at higher temperatures.

- Ceramic element separators prevent emission loss from high heat and vibration.

- Solid aluminum oxide heater-cathode insulator eliminates shorts, reduces leakage.

For complete line of tubes, write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

ELECTRICAL RATINGS*	6094 Beam Power Amplifier	6384 Beam Power Amplifier	6754 Full Wave Rectifier
Heater Voltage (AC or DC)**	6.3 volts	6.3 volts	6.3 volts
Heater Current	0.6 amp.	1.2 amp.	1.0 amp.
Plate Voltage (Maximum DC)	300 volts	750 volts	350 volts
Screen Voltage (Maximum DC)	275 volts	325 volts	—
Peak Plate Voltage (Max. Instantaneous)	550 volts	750 volts	—
Plate Dissipation (Absolute Max.)	14.0 watts	30 watts	—
Screen Dissipation (Absolute Max.)	2.0 watts	3.5 watts	—
Heater-Cathode Voltage (Max.)	≈ 450 volts	≈ 450 volts	≈ 500 volts
Grid Resistance (Maximum)	0.1 Megohm	.1 Megohm	—
Grid Voltage (Maximum)	5.0 volts	0 volts	—
(Minimum)	-200 volts	-200 volts	—
Cathode Warm-up Time	45 sec.	45 sec.	45 sec.

*For greatest life expectancy, avoid designs which apply all maximums simultaneously.

**Voltage should not fluctuate more than ±5%.

MECHANICAL DATA	6094	6384	6754
Base	Miniature 9-Pin	Octal	Miniature 9-Pin
Bulb	T-6½	T-11	T-6½
Maximum Over-all Length	2½"	3½"	2½"
Maximum Seated Height	2½"	2½"	2½"
Maximum Diameter	¾"	1½"	¾"
Mounting Position	Any	Any	Any
Maximum Altitude	80,000 ft.	80,000 ft.	80,000 ft.
Maximum Bulb Temperature	300°C	300°C	300°C
Maximum Impact Shock	500G	500G	500G
Maximum Vibrational Acceleration	50G	50G	50G

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

Export Sales & Service:

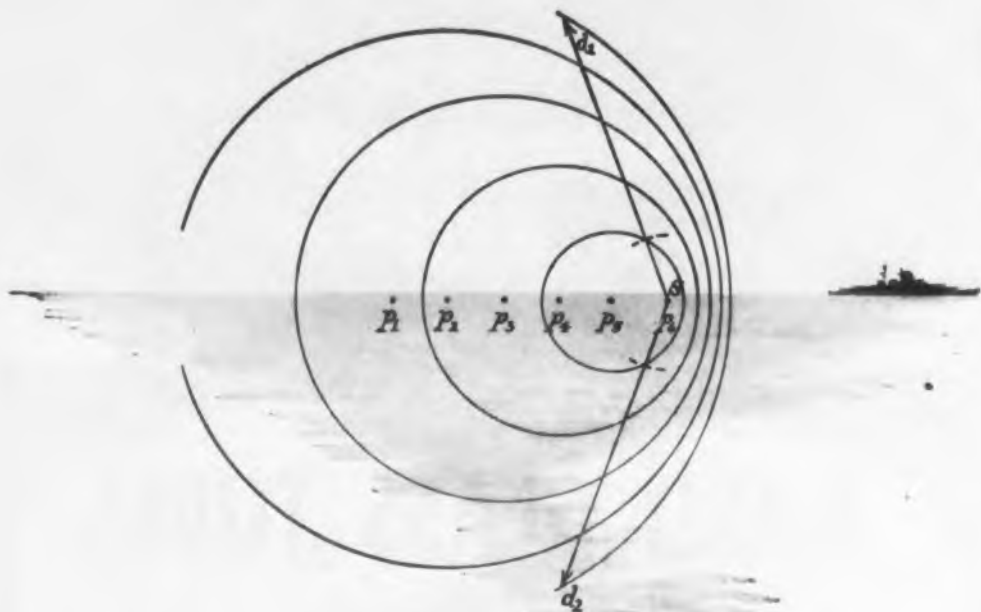
Bendix International Division, 205 E. 42nd St., New York 17, N.Y.

Canadian Distributor: Computing Devices of Canada, Ltd., P.O. Box 508, Ottawa 4, Ontario

Red Bank Division



CIRCLE 234 ON READER-SERVICE CARD



NEW 1E1 BANDPASS FILTER



The new Bulova 1E1 Bandpass Filters give today's radar microscopic eyes. Shaving the broad frequency range of returning signals into tiny segments, they help reconstruct signals faithfully for maximum information, for accurate measurement of Doppler effect... all at greatly reduced noise levels.

With characteristic Bulova precision, bandwidths and insertion losses are closely controlled, so that many filters may be paralleled to cover an almost unlimited frequency spectrum.

Now in production for virtually all leading manufacturers in the radar field are filter packages of 200 cps bandwidth with cross-overs at the 1/2 db. point, and with insertion losses equal to within 0.3 db. from filter to filter.

Typical specification of a single filter in 10 K.C. spectrum:

- Center frequency: 144.400 KC
- Lower 1/2 db. point: 144.330 KC
- Upper 1/2 db. point: 144.470 KC
- Lower 3 db. point: 144.300 KC
- Upper 3 db. point: 144.500 KC
- 40 db. bandwidth: less than 2 KC
- Insertion loss: less than 1 db.
- Ripple in pass band: less than 1/2 db.
- Frequency variation of pass band: less than 10 cps over temperature range of 0°C. to +70°C.
- Size: 2-9/32"W x 2"D x 1-3/8"H
- Weight: less than 7 oz.



Write today for full information on Bulova's standard and custom design filters.

BULOVA

WATCH COMPANY

FAMED FOR PRECISION SINCE 1875

ELECTRONICS DIVISION • WOODSIDE 77 • NEW YORK

CIRCLE 235 ON READER-SERVICE CARD

NEW PRODUCTS

Filament Transformer

Close tolerance between secondary potentials under load



This filament transformer has 400 cps with 4 secondaries, 10 v, 100 amp. Each secondary can be mounted in parallel series, or series parallel. A close tolerance between secondary potentials under load is maintained. Each transformer is individually tested for core loss, polarity, voltage, corona, insulation breakdown, and aging characteristics.

Nothelfer Winding Labs., Inc., Dept. ED,
P.O. Box 455, Trenton, N.J.

CIRCLE 456 ON READER-SERVICE CARD



Wave Analyzer

Has range to 10,000 cps

This analyzer produces accurate analysis in permanent record of any repetitive complex wave form. The analyses are plotted as either amplitude vs frequency, power vs frequency, or amplitude of a specific frequency vs time. Cross spectral or transfer function data is provided when two channels are used. Frequency accuracy is within 1 cps from 3 to 50 cps and 2 per cent from 50 to 10,000 cps. Amplitude accuracy is ± 5 per cent of reading or ± 0.2 per cent of full scale, whichever is larger.

Minneapolis-Honeywell, Davies Laboratories
Div., Dept. ED, 10721 Hanna St., Beltsville, Md.

CIRCLE 457 ON READER-SERVICE CARD

NOW...ANY MICROWAVE COMPONENT CAN BE BUILT AND ENGINEERED TO YOUR PARTICULAR APPLICATION

Regardless of complexity, design or tolerance problems—you can get UHF or microwave components that are job-engineered to your application. All units are delivered, *electrically tested and proven*, ready for immediate operation.

Components can be built from your prints or can be designed and built to integrate with the application. Close and confidential coordination is maintained from drawing board stage to installation.

Range of assemblies is practically unlimited—from dc. to over 40,000 mc., military or industrial. Typical examples are these components, delivered ready for field use:

Telemetering . . .



Tunable S-Band

Transmitter Cavity—

re-entrant type, pulse output 150 w., operates at extreme altitudes and under extreme conditions of temperature, humidity and salt spray.

Improving signal-to-noise ratio . . . selectivity . . .



Tunable UHF

Pre-Selector—

relatively low frequency coaxial resonator with very low insertion loss, extreme selectivity and very high signal-to-noise ratio. Especially adapted to use in aircraft or in crowded communication bands.

Calibrating . . . designing S-Band components . . .



S-Band Signal Generator Cavity—

re-entrant type, complete with thermistor mount and calibrated variable attenuator. Frequency range 2700 to 3400 mc.

Get the facts on our complete design, engineering and mechanical fabrication facilities. Have us quote on your needs—cavities, mixers, duplexers, multipliers, rotary joints, twists, bends and other components or assemblies.

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J-V-M MICROWAVE COMPANY

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Phone: Lyons 3-7990—TWX: Lyons, Ill. 2796

CIRCLE 458 ON READER-SERVICE CARD

How to house & cool a MONSTER*



**and cool that problem*

AMCO B-350 BLOWER DELIVERS 350 CFM • TAKES UP ONLY 3½" OF PANEL SPACE!

Another one of the outstanding components of Amco's complete modular system for instrument enclosure. The B-350 blower, as tested and certified by Inland Testing Laboratories, delivers 350 cubic feet of filtered air per minute. Yet this compact blower takes up only 3½" of panel space when mounted in the base of an Amco enclosure.

This and other integrated accessories of the Amco system greatly simplify cooling and mounting problems in housing equipment. Blowers, chassis roller slides & guides, small instrument cabinets, everything down to the smallest hardware is included, integral part of the Amco system. 19", 38" and 57" wide standard, stock cowlings, panels, and writing surfaces provide custom appearance in Amco modular console assemblies.

Write today for full information. Take advantage of an instrument enclosure system that gives you

**STRENGTH • VERSATILITY • CUSTOM
APPEARANCE • REASONABLE COST
SHIPMENT WITHIN 3 WEEKS**



ENGINEERING CO.

7033 W. Ainslie St. • Chicago 31

Buhl-Roberts Advertising
Ad No. 3202 May 1958

CIRCLE 238 ON READER-SERVICE CARD

Adjustable Coils

Cover 2 to 200 mc range



Designed for low power transmitter use, these high Q coils cover a frequency range from 2 to 200 mc. Illustrated is the 1300-B, for use from 50 mc to 100 mc. The 1300 Series has ceramic coil forms, and Permatune core ranges.

North Hills Electric Co., Inc., Dept. ED, 402 Sagamore Ave., Mineola, N.Y.

CIRCLE 239 ON READER-SERVICE CARD

Digital Data Handling Devices

Combined functions performed

Digitalizers, digital code converters, digital comparators, and digital to analog converters have been modularized so that by assembly of a series of modules, combined functions can be performed: arabic to digital conversion; conversion of any binary code to any other binary code; digital comparison of voltage tolerance, and digital to arabic conversion. Use of this equipment makes analog to digital converter compatible with existing types of readout and computing equipment devices and allows assembly of a digital system from off-the-shelf components.

Aeronca Manufacturing Corp., Dept. ED, Hilltop & Frederick Rds., Baltimore 28, Md.

CIRCLE 240 ON READER-SERVICE CARD



DC Power Supply

Ranges from 105 to 450 v

Using transformer type, steel ventilated housings, these supplies provide an economical source of constant dc power. A terminal is provided for adding external filtering when ripple less than 10 mv is required. They are available in ranges from 105 to 450 v.

Datascan, Inc., Dept. ED, 48 Notch Rd., Little Falls, N.J.

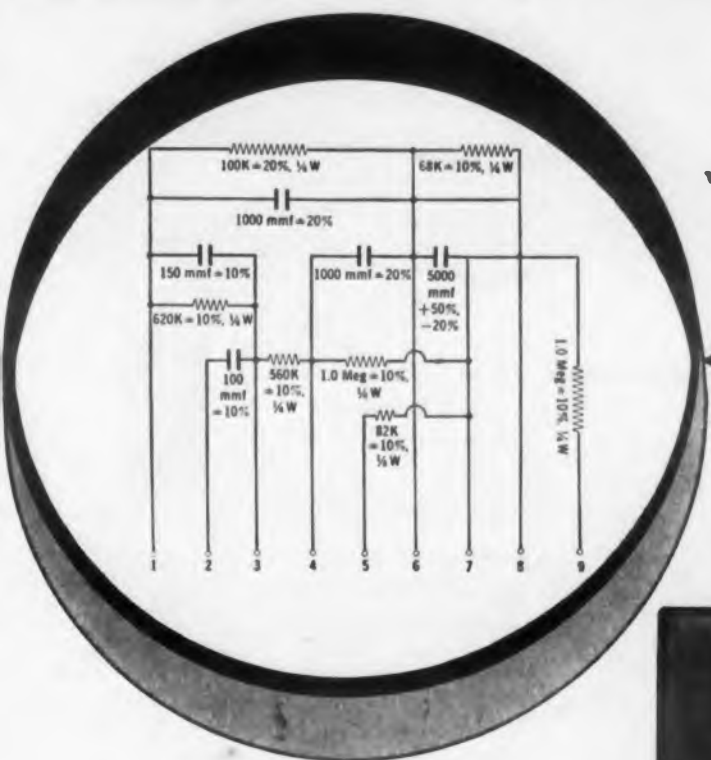
CIRCLE 459 ON READER-SERVICE CARD

**CRAMPED
FOR SPACE?**

Component Density 221,000 per cubic foot in **Centralab**.



vs. 55,000 per cu. ft.
with conventional
components



ACTUAL SIZE



This complex circuit is produced in its entirety in the unit shown here actual size. This almost unbelievable component density is achieved routinely by Centralab. The same basic component/cu. ft. ratio can be maintained where larger or smaller numbers of resistors and capacitors are involved. Centralab **PEC** circuits are your most sensible way to achieve ultra-miniaturization with superior reliability. You gain many other advantages by using **PEC** circuits in your equipment design.

- Reduces assembly costs and weight
- Eliminates wiring errors and testing
- Simplifies inventory and purchasing procedures
- Frequently costs less than individual components

A **PEC** circuit can be designed to incorporate capacitors (printed or attached), resistors (fixed or variable) plus inductors, sockets and other components. They are supplied with plug-in terminals for printed wiring or wire leads for metal chassis.

For the best solution to your miniaturization and assembly problems, contact Centralab's packaged circuit engineers now . . . or write for Bulletin 42-227 containing detailed design information.

Centralab

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VARIABLE RESISTORS • SWITCHES • PACKAGED ELECTRONIC CIRCUITS
CERAMIC CAPACITORS • ENGINEERED CERAMICS • SEMI-CONDUCTOR PRODUCTS
CIRCLE 241 ON READER-SERVICE CARD

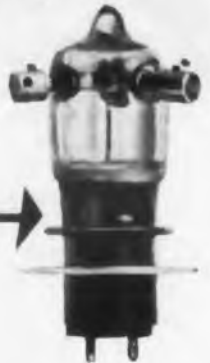
JENNINGS PRESENTS

NEW RB VACUUM RELAYS



*"Better performance
in a smaller package"*

New SPDT RB1
Only 2 1/2" High



2PDT RB3

2PDT RB2

4PDT RB4

An all new series of vacuum relays designed for use where space is critical and voltages high.

Jennings vacuum transfer relays have long been unsurpassed in difficult rf and dc switching situations involving aircraft antennae, antennae tuning coils, and radar pulse forming networks. The minimum space requirements of these new miniature relays make them even more effective than previous vacuum relays for airborne applications.

High voltage in a vacuum requires only 1/64 inch contact separation. This fractional movement permits construction of very small, efficient actuating mechanisms. The compact design of these miniature relays has resulted in much higher shock and vibration characteristics. Voltage and current ratings are increased over previous vacuum relays through new design use of ceramics and improved processing techniques.

These new RB relays employ unique self-aligning roller contacts to achieve positive, reliable operation. Available contact arrangements include SPDT, 2PDT or 4PDT relays.



Write for further information
on this new series.

JENNINGS RADIO MANUFACTURING CORP. - 970 McLAUGHLIN AVE. P.O. BOX 1278 - SAN JOSE 8, CALIF.

CIRCLE 242 ON READER-SERVICE CARD

NEW PRODUCTS

GERMANIUM DIODES.—Gold bonded diodes suited to computer industrial and military applications are in full production.

General Transistor Corp., Dept. ED, 9127 138th Place, Jamaica, N.Y.

CIRCLE 243 ON READER-SERVICE CARD

TRANSFORMERS.—The company's line of transistor driver and transistor output transformers in molded construction is available.

Microtran Co., Inc., Dept. ED, 145 E. Mineola Ave., Valley Stream, N. Y.

CIRCLE 244 ON READER-SERVICE CARD

RADIATION COUNTER.—Features a response rate of the order of 10 msec or better. The present model uses a 2 in. diam by 2 in. long sodium iodide crystal.

Stanley Aviation Corp., Dept. ED, 2500 Dallas St., Denver, Colo.

CIRCLE 245 ON READER-SERVICE CARD

VINYL INSULATION.—Formerly offered only in black, Resinite 125 C vinyl insulation sleeving is now available in four additional colors.

Borden Chemical Co., Dept. ED, 350 Madison Ave., New York 17, N. Y.

CIRCLE 246 ON READER-SERVICE CARD

PRESSURE STANDARD.—A piston-cylinder combination available for the Type 6-201 primary pressure standard extends the range of this instrument to 500 psi.

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

CIRCLE 247 ON READER-SERVICE CARD

L-BAND ANTENNA.—Type DM NI 13 has been designed to replace type AT-234. The antenna is an annular slot backed by a high strength aluminum alloy cavity.

Dorne & Margolin, Inc., Dept. ED, 29 New York Ave., Westbury, N. Y.

CIRCLE 248 ON READER-SERVICE CARD

DC TO AC INVERTERS.—Transistorized static types measuring 2/3 cu in. per va, with efficiency up to 98 per cent. Units are available that operate from 6, 12, 28, or 64 v dc.

Universal Transistor Products Corp., Dept. ED, 17 Brooklyn Ave., Westbury, N. Y.

CIRCLE 249 ON READER-SERVICE CARD

TIMER.—Model No. 5 repeat cycle timer is now available with calibrated off and on cycle controls.

G. C. Wilson & Co., Dept. ED, Huntington, W. Va.

CIRCLE 250 ON READER-SERVICE CARD

400 CPS MOTORS.—A line of three-phase induction motors with full load speeds comparable to 60 cps motors have been designed for 40 C continuous duty.

B. A. Wesche Electric Co., Dept. ED, 9027 Shell Rd., Cincinnati 42, Ohio.

CIRCLE 251 ON READER-SERVICE CARD

NEW RIDER BOOKS

with modern concepts
spark electronic progress

A 'tool' for all who design vacuum tube circuits

CONDUCTANCE CURVE DESIGN MANUAL, by R. Pullen, Jr., Ph.D., Eng.D. The author, a well known electronics authority, has devised an original technique for designing electronic circuits based on conductance curves. G_m , R_p and μ are plotted as necessary so as to enable design with small signal parameters to predict large signal performance. This technique greatly shortens design time and minimizes problems arising from approximation. A vitally important contribution to engineering progress.

Circuit reliability can be improved and distortion reduced at the same time by using the tables and curves in the manual. Engineers, engineers-in-training, students, and laboratory technicians can now select the proper tubes and their associated components to suit the needs of almost any type of circuit with greater reliability than ever before. The manual contains conductance curves for more than 70 of the most representative vacuum tubes used in services. #210, 8½" x 11", stiff cover, spiral binding, \$4.25.

Physics, mathematics and their relationship to electrical communications made crystal clear in this brilliant work.

PHYSICS AND MATHEMATICS IN ELECTRICAL COMMUNICATION, by James Owen Perinne, Ph.D. This is a profound and probing explanation of what happens in electrical circuits that control resistance, inductance and capacitance. While in a penetrating analysis, it is presented in an unusually lucid manner. The author demonstrates talent for selecting that avenue of approach and analysis which leads to utmost clarity. The book contains numerous explanatory diagrams, meticulously conceived by the author, that point out and simplify concepts that normally are considered complicated. Each graph, complete with point-by-point identifying nomenclature, illuminates the text. A foundation of associated mathematics made completely understandable and replete with numerous examples, the author brilliantly ties together physical concepts and electrical communications. An entirely new approach is used in analyzing hyperbolic functions, exponential equations and related functions. Of special significance is the content of the graphical demonstrations of electrical behavior. #219, 8½" x 11", cloth bound, \$7.50.

First Omnibus of the Transistor Art

TRANSISTOR ENGINEERING REFERENCE HANDBOOK by H. E. Marrows. Covering transistor performance characteristics, operating specifications, manufacturing processes, applications, test sources, etc. Related components—electrical characteristics, physical dimensions, sources, etc. The most complete handbook for use in engineering, scientific research and manufacturing of transistor devices. #193, cloth bound, 288 pp., \$9.95.

CLOSED CIRCUIT TV SYSTEM PLANNING, by M. Mayers & R. D. Chipp, P.E. Closed circuit television is science and industry's newest means of visual communication. This book is devoted to applications of equipment and the planning of closed circuit TV systems for use in factories, schools, hospitals, railroads, department stores, banks, advertising agencies, airports, transportation terminals and in numerous other areas. System layout, available equipment, composition of complete system are covered. Fully illustrated. #208, cloth bound, 8½" x 11", \$10.00.

FUNDAMENTALS OF TRANSISTORS, by Leonard Krugman. Written by one of the pioneers in transistor development, this book deals with basic operation, characteristics, performance, and application. Soft cover, 144 pp., illus. #160, \$2.70.

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CIRCLE 252 ON READER-SERVICE CARD



Duck, Smedley! Here comes that crazy coffee pot!

As a designer of space ships, Smedley, you should have stood in bed. You forgot—there's no gravity in outer space . . . and you didn't provide any means to contain loose equipment like pots and pans.

Thomas & Skinner could have solved your problem with T&S permanent magnets .

Thomas & Skinner offers other services, too . . . such as quoting realistic delivery dates and then shipping on schedule with permanent magnets (as well as all T&S products) meeting customer specifications in every respect. T&S's entire staff is constantly aware of the importance of handling customer orders, no matter how large or small the order, no matter how large or small the customer. All T&S customers are VIP's to the T&S staff.

Specify T&S permanent magnets for your next project. Write for brand new Bulletin No. 158 on Permanent Magnet Design.

SPECIALISTS IN MAGNETIC MATERIALS

Permanent Magnets  Magnetic Tapes 
Laminations  and Wound Cores 

**Thomas &
Skinner, Inc.**



157 East 23rd St. Indianapolis 7, Indiana

CIRCLE 253 ON READER-SERVICE CARD

DECIMAL KEYBOARD.—Model 410 provides rapid manual digital input to a variety of devices. The unit contains 10 decimal and three optional-assignment keys.

ElectroData, Dept. ED, 460 Sierra Madre Villa, Pasadena, Calif.

CIRCLE 254 ON READER-SERVICE CARD

GEAR HEADS.—Measuring about 1-in. long, units supply ratios from 15:1 to 4300:1. Operational loads to 50 oz-in. can be handled.

Daco Instrument Co., Dept. ED, Tillary and Prince Sts., Brooklyn 1, N.Y.

CIRCLE 255 ON READER-SERVICE CARD

LACING TAPES.—Made of Teflon and glass, these cabling and wire-harnessing tapes have high-temperature, chemically resistant, fungus resistant properties.

Bentley, Harris Mfg. Co., Dept. ED, Conshohocken, Pa.

CIRCLE 256 ON READER-SERVICE CARD

RECEIVERS.—Two range extension units will extend the operating range of the company's receivers as high as 900 mc. The REU-100 and REU-200 have noise figures of approximately 12 to 14 db.

Nems Clarke Co., Dept. ED, 919 Jesup-Blair Dr., Silver Spring, Md.

CIRCLE 257 ON READER-SERVICE CARD

TEFLON TERMINALS.—Addition of new standards, feed-thrus, jacks, plugs, reverse, and double constructions have been announced.

Tri-Point Plastics Inc., Trinseel Inc. Div., Dept. ED, 175-177 I.U. Willets Rd., Albertson, N.Y.

CIRCLE 258 ON READER-SERVICE CARD

PRESSURE PICKUP.—Type 4-322, with unbonded strain-gage sensing, operates on line pressures to 350 psi, while measuring pressures in ranges of ± 7.5 , ± 12.5 , ± 25 , and ± 50 psid.

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

CIRCLE 259 ON READER-SERVICE CARD

FUSES.—Miniature hermetically sealed fuses are available in two sizes, in an amperage range of 1/20 to 1/2 a rated at 125 v; and in a range of 1 to 5 a rated at 32 v.

McGraw-Edison Co., Bussman Manufacturing Div., Dept. ED, University at Jefferson, St. Louis 7, Mo.

CIRCLE 260 ON READER-SERVICE CARD

OSCILLOSCOPE.—Model 535, 5-in. oscilloscope kit has a 10 mv rms/cm sensitivity from dc to 5 mc, (differential vertical inputs) four electronically regulated power supplies, and push-pull circuitry throughout.

Electronic Industries, Dept. ED, State Rd., Paterson, N.Y.

CIRCLE 261 ON READER-SERVICE CARD

Lighten Your Load...

Increase Your Load Capacity...

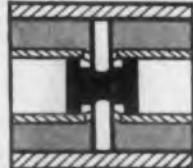


with *Prodelin's* New
ALUMINUM

COAXIAL TRANSMISSION LINES and COMPONENTS

Here is a new high in rigid coaxial transmission line efficiency and performance! Now Prodelin has applied its field-proved, reactance-compensated teflon pin insulator support within aluminum outer conductors.

This service-tested construction technique provides constant broadband impedance characteristics consistent with high power handling capability and low VSWR . . . and aluminum offers strength, corrosion-resistance, lightweight, and handling ease.



Diagrammatic of reactance compensated insulator

VHF SERIES "700" teflon pin supported inner conductor

UHF SERIES "900" service tested reactance compensated inner conductor support

Both series lines are available in the $\frac{7}{8}$ ", $1\frac{1}{8}$ ", $3\frac{1}{8}$ ", $6\frac{1}{8}$ " and 10" sizes, 50 and 75 ohm impedances. EIA (RETMA) flanges are available.

FOR MILITARY AND COMMERCIAL SERVICES

FEATURES

- Highest Power Handling
- Low VSWR
- Performs up to 250°C
- Constant 50 or 75 ohm Impedance
- Corrosion Resistant
- High Tensile Strength
- Lightweight, Easy to Handle
- Little Maintenance Required

WHEN COPPER IS PROPER

Prodelin still stocks rigid coaxial transmission lines with copper outer conductor.

VHF SERIES "600"
teflon pin supported inner conductor

UHF SERIES "800"
service tested reactance compensated inner conductor support

50 ohm only
 $\frac{7}{8}$ " $1\frac{1}{8}$ " $3\frac{1}{8}$ " $6\frac{1}{8}$ "
all EIA (RETMA) standardized

WRITE TODAY
FOR TECHNICAL BULLETIN

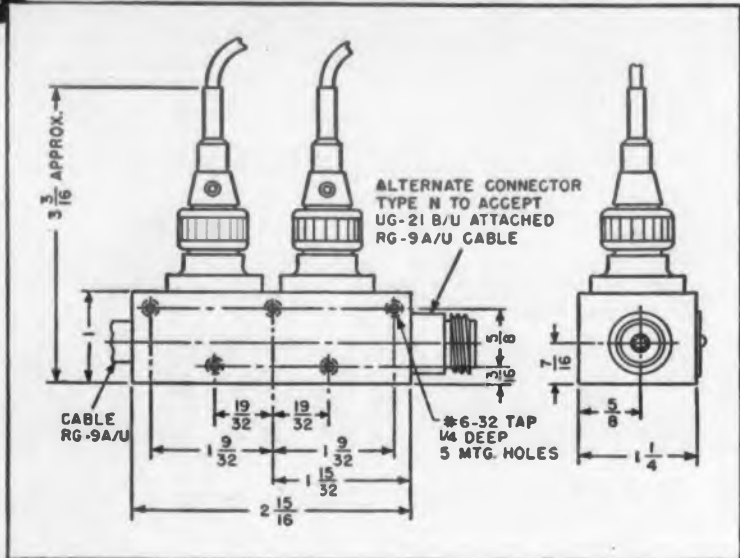


Dept. ED-5
307 Bergen Ave., Kearny, N. J.

Manufacturer of the World's Finest Air Dielectric Transmission Lines, Connectors, and Associated Components
CIRCLE 262 ON READER-SERVICE CARD



No Transmitter should be without one!



OUTLINE DRAWING MODEL 575N DOUBLE COUPLER



WHEN YOU BUILD MicroMatch Directional Couplers into your transmitters, you add an invaluable feature at extremely low cost — positive confirmation of transmitter performance. Your customers stay sold by the coupler's continuous RF Power indication.

Its VSWR monitor, in addition, stands watch over your customer's transmission line and antenna.

Now incorporated in most modern Government and commercial transmitters, MicroMatch Directional Couplers produce an output essentially independent of frequency. Units are available for use within the range of 20 to 4000 megacycles. Couplers are adjusted to produce full scale meter deflection at power levels of 1.2 watts to 120 KW. Accuracy of power measurements is plus or minus 5% of full scale.

For complete details on the MicroMatch line of monitoring equipment, write for our 68-page catalog.



**WHEN MICROMATCH IS BUILT IN—
YOU KNOW WHAT'S GOING OUT**



M. C. JONES ELECTRONICS CO., Inc.
BRISTOL, CONNECTICUT

CIRCLE 263 ON READER-SERVICE CARD

PRODUCTION PRODUCTS

Ultrasonic Comparator

Tests Material Fatigue



Knowledge of the fatigue strengths of materials can be developed through the use of a laboratory instrument, an ultrasonic attenuation comparator. The instrument has been used for widely varied laboratory materials investigations, including hydrogen embrittlement in metals, internal oxidation, nuclear radiation damage, magnetic properties, plastic deformation and dislocation damping. A linear circuit presents multiple and comparable echo patterns on an oscilloscope viewing screen. These multiple echoes are compared with a calibrated exponential decay curve which permits direct reading in decibels per microsecond.

Sperry Products, Inc., Dept. ED, Danbury, Conn.

CIRCLE 264 ON READER-SERVICE CARD

Toroidal Coil Winding

And taping machines



A new series of automatic dual-purpose toroidal winding and taping machines features simultaneous, separate, or equential 360 deg continuous



True
Hermetic
Sealing!

GASEAL®

Pressurized metal hermetic seals for easy installation anywhere without special tools. Withstand more than 850 degrees F., high pressures and altitudes. For any sealing configuration.

Best Insurance for Component and Systems Reliability!

Corrosion...dust...fungus...altitude... humidity...pressures. *True* hermetic sealing completely eliminates their usually disastrous effects on electronic and mechanical apparatus.

GHS offers uniquely qualified techniques and specially developed facilities in the field of hermetic sealing. They are guaranteed to add a *permanent plus* to your product reliability.

For inert gas filling, 100% mass spectrometer leak testing of any assembly, and every phase of *true* hermetic sealing to meet military or industrial specs, GHS in-plant services are unequalled.

The GHS Megpot®



Quickly, efficiently tests your components, insulation. Features 10 million megohms, 100, 200 or 500V DC, automatic "charge" and safety controls, non-destructive (as high as 5000V AC) high-potential test set with current limiting and automatic shut-off circuit. Portable.

Write for Specific Information... and use the GHS Advisory Services without obligation.

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HERMETIC
SEALING
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LAND, SEA AND SPACE CORPORATION
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CIRCLE 265 ON READER-SERVICE CARD

can
you afford
to gamble
with quality
on parts
like these? . . .

BREAKER POINT BODY
for automobile-
engine distributor



COMMUTATOR
for
electric
motor



DISTRIBUTOR BAR
for automobile-
engine distributor



ACTUAL SIZE
(produced in one operation on high-
speed multi-slide equipment)

Our customer list always
includes world leaders
in electrical and
electronic products.

They depend on us year-in
and year-out for stamped
parts to match the
quality they build into
their products.

They refuse to gamble! . . .
Can you afford to do so?



**DETROIT STAMPING
COMPANY**

Established 1915

411 Midland Ave. • Detroit 3, Mich.
America's Leading Job Stamping Manufacturer

Depend on Detroit!

CIRCLE 266 ON READER-SERVICE CARD

winding of wire and/or tape in one operation, and can be operated by one unskilled operator. Series UT machines are designed for medium, large, and super-size toroidal coils, where precision winding and taping are required.

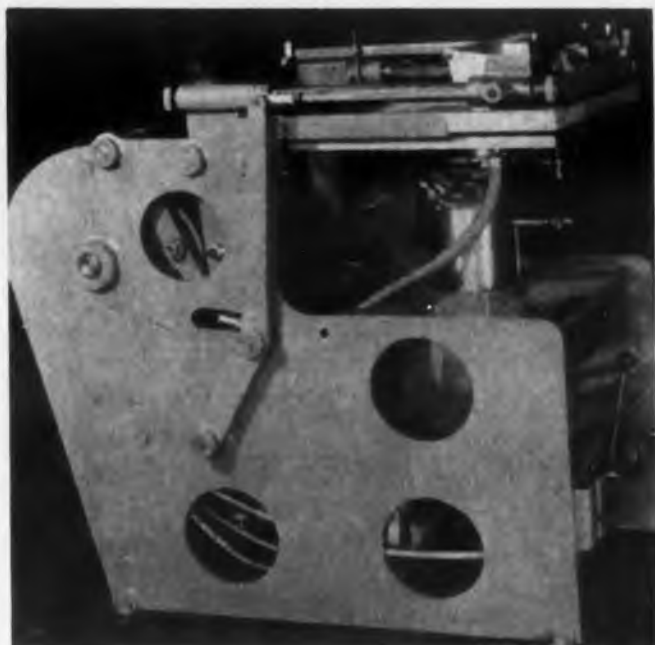
They are equipped with core-turning table, automatic forward and reverse feed, stepless variable pitch control, calibrated adjustable twin tension brakes, quick-locking shuttle-gear and magazine, automatic predetermining counter, tape footage indicator, and automatic cut-off. An adjustable coil clamp fixture, for sector winding up to 270 degrees, is available as optional.

Universal Mfg. Co., Inc., Dept. ED, 410 Hillside Ave., Hillside, N.J.

CIRCLE 267 ON READER-SERVICE CARD

Press For Circuit Printing

Automatic silk screen



Production of electronics silk screen work is improved and increased by an automatic press designed specially for printing etched circuit blanks. It serves as well for printing decals and instrument panels. The unit improves circuit printing by allowing ink of ideal consistency to be used. Ink flow is controlled by fountain settings and squeegee pressure controls rather than doctoring the ink itself. These features permit high speed with excellent uniformity. Waste, starting time, and cleanup are reduced.

The automatic printing cycle can be set up to 1000 impressions per hour. Register is achieved by micrometer dials graduated in one-thousandths of an inch. Any flat material up to 6 in. thick may be printed. Two models of the new press provide printing areas of 12 x 15 1/2 in. and 12 x 18-1/2 in.

Masterscreen Printing Equipment Corp., P. O. Box 707, Stockton, Calif. for additional information.

CIRCLE 268 ON READER-SERVICE CARD

COMMAND
SIGNAL
GENERATOR

COMMAND
SIGNAL
RECEIVER

SYNCHRO
POSITIONER

AUTO PILOT
CONTROL

LEFT

RIGHT

CLIMB

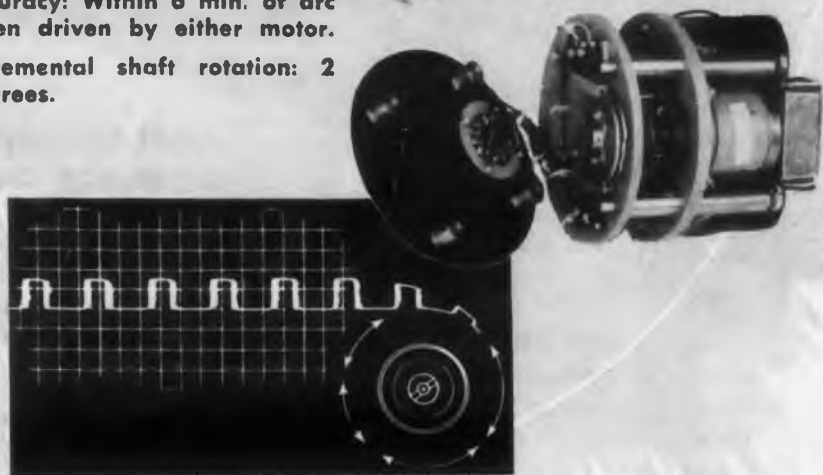
DESCEND



STEPPER SYNCHRO POSITIONER

Accuracy: Within 6 min. of arc
when driven by either motor.

Incremental shaft rotation: 2
degrees.



This is one of the many applications for the Stepper Motor — a device for translating electrical pulses into accurate, bi-directional, incremental shaft displacements.

The Synchro Positioner uses two Stepping Motors, an Autosyn differential, and a built-in pulse generator. One motor positions the Autosyn Shaft in coarse increments in either direction, while the other motor, using a different gear ratio, positions the same shaft in vernier increments in either direction. As the reset command signal is of steady-state type, the built-in pulse generator permits use of the driving motors for the reset function.

STEPPER MOTORS CORPORATION

Subsidiary of California Eastern Aviation, Inc.

7445 West Wilson Avenue • Chicago 31, Illinois

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CIRCLE 269 ON READER-SERVICE CARD

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CIRCUIT AMPLIFIER

USES AIRPAX CHOPPER

Universal Chopper-Stabilized Amplifier



Open-loop gain of this operational amplifier drops at 6 db/octave over entire working range. This feature enables the user to shape the response from DC to well above 100 KC by means of feedback to meet nearly any application.

Grid current at the input is completely eliminated. Drift and noise are held under 100 microvolt referred to the input by a stabilized preamplifier stage using an Airpax Type 175 chopper.

The amplifier is manufactured by George A. Philbrick Researches, Inc., Boston 10, Massachusetts. The chopper, naturally, is by Airpax.

CHARACTERISTICS OF TYPE 175 CHOPPER

Airpax 60-CPS chopper Type 175 is a miniature unit with permanently adjusted SPDT BBM contacts.

DRIVE

Frequency .. 60 \pm 3 CPS
Voltage 6.3 \pm 0.6 RMS volts

CONTACTS

Dwell Time . 167 \pm 10 electrical deg.
Balance within 15 electrical deg.
Phase Angle 20 \pm 5 electrical deg.
Voltage up to 100 DC volts
Current up to 2 MA
Noise 50 microvolts average

Hermetically sealed for trouble-free operation in any atmosphere; internal mechanism rigidly mounted to withstand shock and vibration encountered in portable equipment.

Airpax Products Co., Cambridge Division, Jacktown Rd., Cambridge, Maryland



CIRCLE 270 ON READER-SERVICE CARD

NEW MATERIALS

Insulated Metal Foils

Replaces magnet wire in some applications

The processing and coating of aluminum, copper, and lead foils with either organic or inorganic dielectric chemicals results in the production of foils capable of replacing magnet wire. Features include weight reduction, space savings, and high temperature operation without size increase.

Foil gauges ranging from 0.00025 to 0.025 in. with formulations of organic, inorganic, and combination systems of coatings from 0.000175 to 0.001 in. depending on the gauge and characteristics of the metal, are available. Dielectric strength up to 400 v per mil of insulation is provided. Coating operating temperatures are available in various formulations for continuous duty from 105 through 200 C.

Modern Adhesives & Electronics, Inc., c/o Herbach & Rademan, Inc., Dept. ED, 1204 Arch St., Philadelphia 7, Pa.

CIRCLE 271 ON READER-SERVICE CARD

Silicone Oil

High dielectric strength

Type L-45 electrical grade Silicone Oil is a clear dimethyl silicone polymer for use as an insulating and cooling medium in capacitors, small transformers, circuit breakers, and similar devices. The oil is available in viscosities of 50, 100, and 1000 centistokes, with other viscosities available upon request. The liquid is specially dried, packaged, and control-tested in order to insure maximum dielectric strength and volume resistivity.

Union Carbide Corp., Silicones Div., Dept. ED, 30 E. 42nd St., New York 17, N.Y.

CIRCLE 272 ON READER-SERVICE CARD

Printed Circuit Ink

For etching and plating

Called C-992, this ink has high resistance to both ferric chloride, chromic acid and cyanide solutions, making it suitable for etching and plating processes. The ink prints smoothly without pinholes. It air dries in 20 to 30 min. or can be force dried in 30-60 sec. Immediately upon air-drying, C-992 resists etching with no further cure necessary. For plating, a baking schedule of 20 to 45 min at 200-250 F is necessary.

Union Ink Co., Inc., Dept. ED, Ridgefield, New Jersey.

CIRCLE 273 ON READER-SERVICE CARD

THIS IS
ZIPPERTUBING
... a method of making custom
electronic cables in seconds
at a fraction of the cost!



MEETS
MIL
SPECS.

Now available in Vinyl, New Stretch Vinyl, Teflon, Nylon, Mylar, Neoprene.

Major Advantages

1. Cables are made by you, on the spot, as needed, without machinery. Production delays eliminated.
2. New stretch compound provides tighter jacketing.
3. Highly abrasion-resistant. Temperature range, -90°F to 450°F .
4. Eliminates expensive lacing or tying of conductors.
5. Provides re-accessibility to conductors, or can be permanently sealed.
6. New method permits cable termination with any type of connector.
7. Sizes from $\frac{1}{4}$ " ID — continuous lengths to 1000 ft.
8. New metal laminations for shielded or co-axial cable construction.
9. Perforated type or molded "Ys" and "Ts" simplify branchouts.

Important

If you design or work with electronic cables, it will pay you to try ZIPPERTUBING. Field representatives are nearby — or send for free sample and technical literature.

Offices & Warehouses in All Principal Cities

THE ZIPPERTUBING CO.

752 So. San Pedro St. • Los Angeles 14, Calif.

TWX LA 840

CIRCLE 274 ON READER-SERVICE CARD



STIFF DOSE OF SALT



Exposure . . . to the equivalent of a stiff sea spray . . . on a hot, humid day—one more test the G-M Servos take in stride.

Not just a promise—but a tested fact.

G-M Servo Motors are built to deliver the ultimate in performance. The salt spray test shown above is just one of a battery of tortures designed to prove G-M Servos under all extremes of humidity, temperature, altitude, vibration and salt spray.

At G-M "Designed to Meet Mil. Environmental Specifications" is backed by production testing that does just that!

4 GOOD REASONS WHY G-M SERVO MOTORS SERVE YOU BEST!

- 1 G-M Servo Motors are available in standard sizes.
- 2 Standard G-M Servo Motors can also be modified to meet specific requirements.
- 3 Creative engineering in designing special servo motors with special characteristics.
- 4 Fast production—better service.

Write Now for information, or send for complete G-M charts and specifications. No obligation, of course.



CIRCLE 275 ON READER-SERVICE CARD

Copper-Nickel Resistance Alloys

Offer extremely low temperature coefficients

A series of copper-nickel resistance alloys for standard and precision resistor and instrument applications has been developed. Supplied in five different specific resistances, 294, 180, 90, 60, and 30 ohms per circular mil foot, the Cuprothal alloys provide designers a wide working range of materials. Cuprothal 294 for one, is available in three different temperature coefficient classifications of ± 0.00002 , 0.00004 and 0.00006 per deg C. The low thermal emf to copper of approximately 50 mv per C of this material makes it particularly suitable for precision applications.

The Kanthal Corp., Dept. ED, Amelia Pl., Stamford, Conn.

CIRCLE 276 ON READER-SERVICE CARD

Motor Insulation

A rugged material used for motor slot cells

This thin insulation, called Spauldo, is made from pure rag stock, on wet machines, and glazed to a smooth finish. The material is tough, flexible, and highly resistant to edge-tearing. Its high dielectric strength and absorption of insulating varnish make it useful for motor slot cell insulation. Furnished in sheets, rolls, coils, and fabricated parts.

Spaulding Fibre Co., Inc., Dept. ED, 310 Wheeler St., Tonawanda, N.Y.

CIRCLE 277 ON READER-SERVICE CARD

High Permeability Alloys

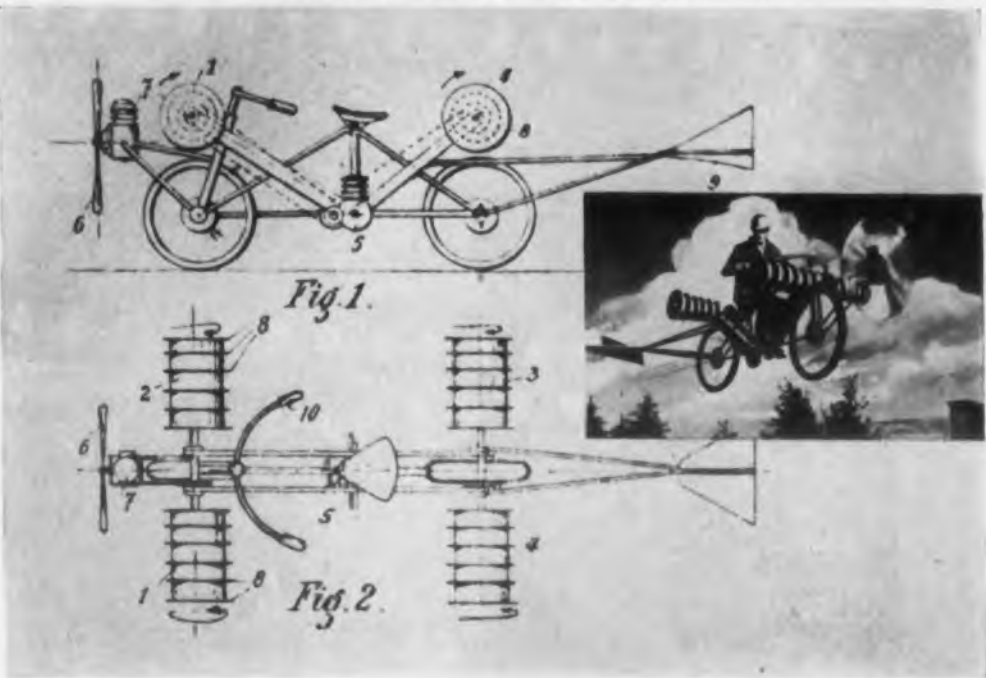
In thin gauge strip

Four high permeability alloys are available in thicknesses from 0.002 to 0.006 in. and in widths between 1/4 and 3-1/4 in. Called HyMu 80, Hy-Ra 80, High Permeability 49, and Hy-Ra 49, the alloys are used in components where high flux densities are required in response to low magnetizing forces. HyMu 80 is an unoriented 79 per cent nickel-iron-molybdenum alloy which offers high initial permeability and maximum permeability at low magnetizing forces. Hy-Ra 80 is a similar material processed to exhibit square hysteresis loop properties. High Permeability 49 has a saturation flux density of approximately 16,000 gauss after hydrogen annealing. Hysteresis loss is very low in either dc or ac circuits in which the frequency is less than 400 cps. Hy-Ra 49 is similar but processed to exhibit square hysteresis loop properties.

The Carpenter Steel Co., Dept. ED, Reading, Pa.

CIRCLE 278 ON READER-SERVICE CARD

.....
MARS outstanding design SERIES



flight without wings

Getting over, rather than around, traffic jams is easy, with this flying motorcycle, says its designer Dr. Manfred Mannheimer, of Newark, N. J. Encountering heavy traffic, it quits the ground. An auxiliary motor rapidly rotates four cylindrical "wings." By the action of the "Magnus effect" these lift the vehicle into the air at 15 mph with 70 hp. The aerodynamic principle involved was discovered by Gustav Magnus in 1858. The cycle's tail-end has a rudder and elevator fin for steering during flight; the rotary wings are telescoped for surface travel.

Whether or not this design will be the answer to traffic congestion, it certainly is an ingenious solution. Aloft or aground, all engineering solutions must originate on the drafting board. And only professionals know how the best in drafting tools smooths the way from dream to practical project.

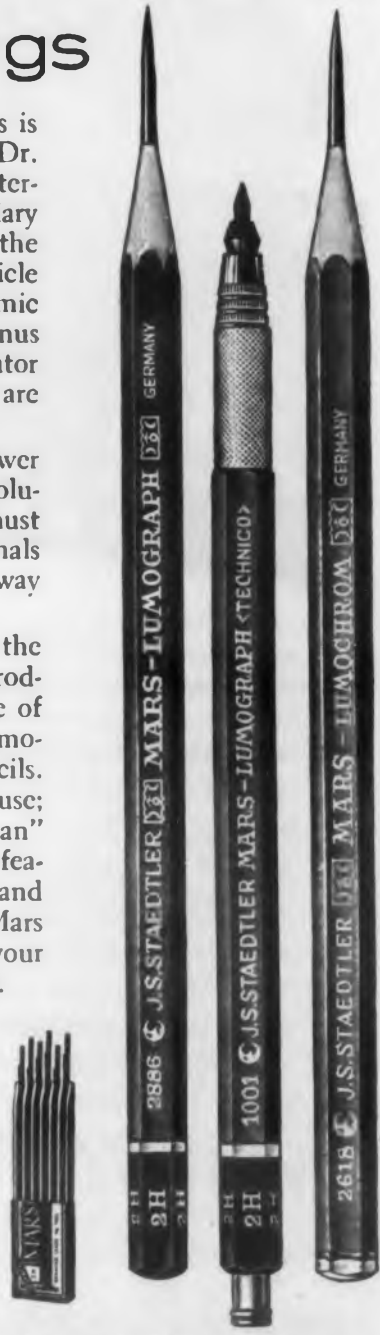
In pencils, of course, that means Mars, long the standard of professionals. Some outstanding new products have recently been added to the famous line of Mars-Technico push-button holders and leads, Lumograph pencils, and Tradition-Aquarell painting pencils. These include the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman" pencil sharpener with the adjustable point-length feature; Mars Lumochrom, the color-drafting pencils and leads that make color-coding possible; the new Mars Non-Print pencils and leads that "drop out" your notes and sketches when drawings are reproduced.

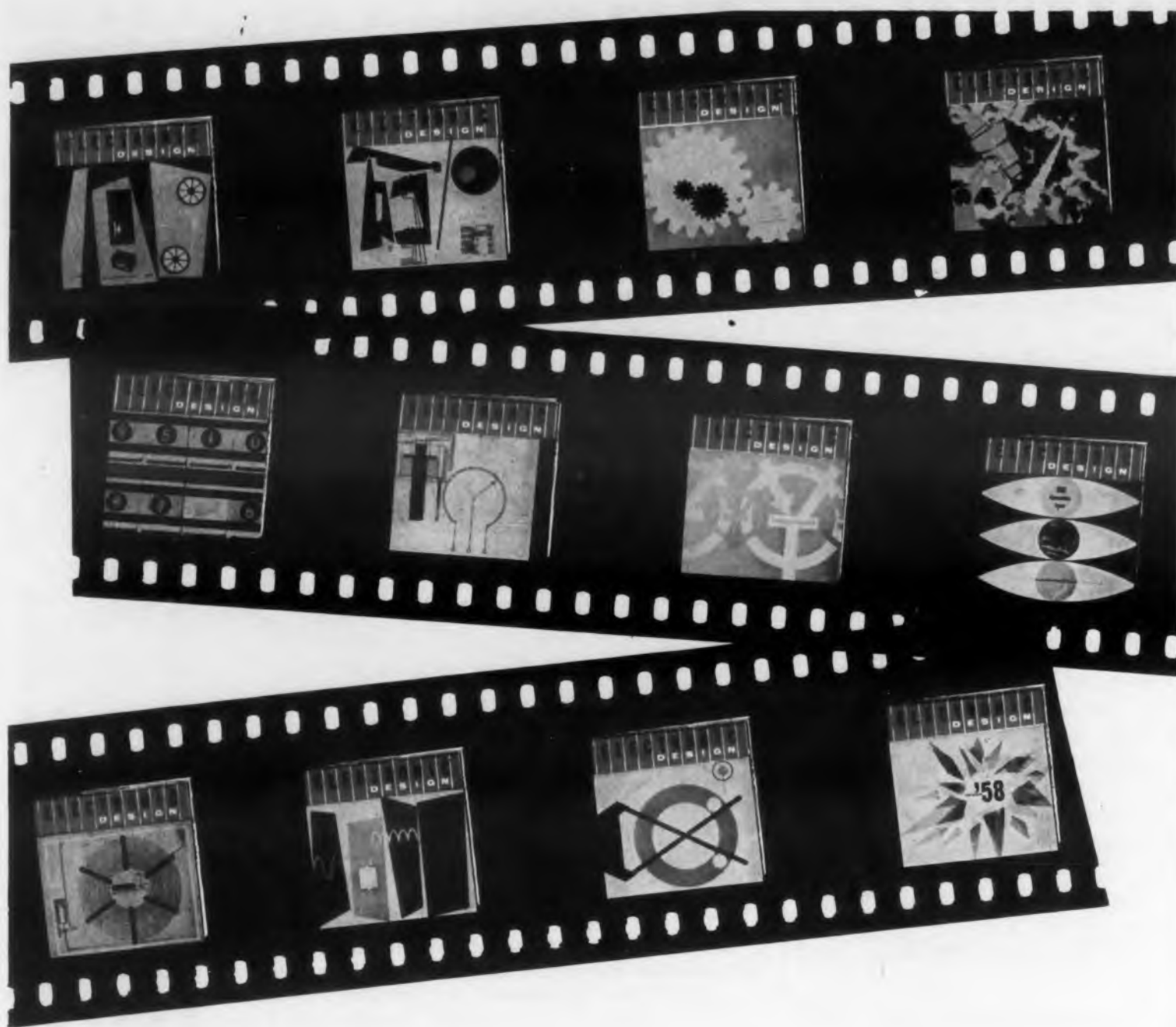
The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXXB to 9H. The 1001 Mars-Technico push-button lead holder, 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom color-drafting pencil, 24 colors.

J.S. STAEDTLER, INC.
 HACKENSACK, NEW JERSEY

at all good engineering and drawing material suppliers

CIRCLE 279 ON READER-SERVICE CARD





- ENGINEERING REVIEW
- NEW PRODUCTS
- DESIGN FORUM
- AIDS TO DESIGN
- PRODUCT FEATURE
- IDEAS FOR DESIGN
- STANDARDS AND SPECS
- RUSSIAN TRANSLATIONS
- DESIGN FEATURE
- NEW LITERATURE
- WASHINGTON REPORT
- ABSTRACTS

MOST HELPFUL

Again and again readers report that *Electronic Design* is the publication most helpful in their work. One project engineer in California writes:

"It may interest you to know that in answering a poll conducted by an advertising agency, I was able to place your magazine at the top of the list, in my own personal preference. This in spite of the fact that I subscribe to and pay for one of the other magazines listed in the poll! Keep up the good work."

Electronic Design is more timely, more complete, and of more practical use to engineers than any other electronic magazine. Engineers now rely on *Electronic Design* alone to keep them posted on complete developments in the design field.

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**ELECTRONIC
DESIGN**

NEW MATERIALS

Impregnated Glass Cloth

For high temperature laminates

Stanpreg A-Ph heat resistant phenolic resin pre-impregnated glass cloth is available for high temperature applications requiring high physical strengths. Typical properties of laminates made from this material would include 59,000 psi flexural strength at 500 F after 100 hr exposure at 500 F and 80,000 psi flexural strengths at room temperature. Certification for use under MIL-R-9299 can be supplied. The material retains its flexibility and tack for periods in excess of one year. It is supplied in various degrees of resin content, drape and tack for low and high pressure molding.

Standard Insulation Co., Dept. ED, East Rutherford, N.J.

CIRCLE 280 ON READER-SERVICE CARD

Miniature 300-V Wire

Insulation thickness as thin as 0.004 in.

Called Mini-Thin, this thin wall, extruded Teflon insulated wire is rated for 300 v rms with an insulation wall thickness of 0.004 to 0.007 in. The high temperature wire is available color coded with stranded or solid conductor in sizes 36 through 22 awg. The wire is supplied in continuous lengths on non-returnable reels or cut and stripped to specifications.

Thermax Wire Corp., Dept. ED, 304 E. 45th St., New York 17, N.Y.

CIRCLE 281 ON READER-SERVICE CARD

Silicone Rubber Compound

A dielectric that cushions

A room temperature vulcanizing silicone rubber compound, type 81726 has such uses as a dielectric compound for components and assemblies, for filling voids, for sealing and cushioning. Typical electric properties, as determined on a 0.08 in. ASTM slab at 77 F and 50 per cent relative humidity, include: volume resistivity, 1×10^{18} ohms cm; dielectric strength of 490 v/mil; and power factor of 1.1 per cent at 60 cps.

Typical physical properties, after a cure of 72 hr at 80 F, include: tensile strength, 600 psi; durometer hardness, 60; elongation, 100 per cent; and die B tear strength of 30 pi. This compound may be used over the temperature range of -70 to +500 F. Cure time may be varied from 2 min to 6 hr.

General Electric, Silicone Products Dept., Dept. ED, Waterford, N.Y.

CIRCLE 282 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 14, 1958

**NEED
SPEED
IN
DELAY
LINE
DELIVERIES**

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**CUSTOM MADE
TO THE
MOST DIFFICULT
SPECIFICATIONS**

**1 to 3*
WEEKS
COMPLETION**



Within 1 week we will supply you with an electronically suitable model, to enable your engineering to continue, while waiting for completed deliveries (within 3 weeks), of delay lines made to your specific configurations.

Designers, manufacturers and mass-producers of Standard and custom made Lumped Constant, Distributed Constant, Variable, miniature Variable and Complete Delay Line Systems.

WANTED: Sales Reps. — Key areas
Open. Contact E. Wendolkowski.

CONTROL ELECTRONICS SALES CO., INC.

1925 New York Avenue
Huntington Station, New York

CIRCLE 285 ON READER-SERVICE CARD

SERVICES FOR DESIGNERS

Wire and Cable Processing

To further assist development and prototype work in electronic wire and cable, Alpha Wire Corporation has instituted an exclusive short-run department specifically geared to process wire and cable. Delivery is immediate and no minimum order is required for cutting, stripping and tinning, striping, braiding, cabling, jacketing, shielding, marking, numbering, and special color coding. These "short run" services apply to any of 200 Alpha in-stock item and to special construction wire and cable.

Alpha Wire Corp., Dept. ED, 200 Varick St., New York 14, N.Y.

CIRCLE 286 ON READER-SERVICE CARD

Mil Spec Coil Forms



Fabricated coil forms to customer specifications are available from Peerless Products Industries, 812 N. Pulaski Rd., Chicago, Ill. Special tooling has been developed to enable the manufacturer to hold close tolerances on both large and small quantity runs. Coil forms can be fabricated from Nylon, Teflon, Kel-F, Rexolite, Plexiglas, Glass Base Laminates and other Phenolic materials with little difficulty.

Peerless Products Industries, Dept. ED, 812 N. Pulaski Rd., Chicago, Ill.

CIRCLE 287 ON READER-SERVICE CARD

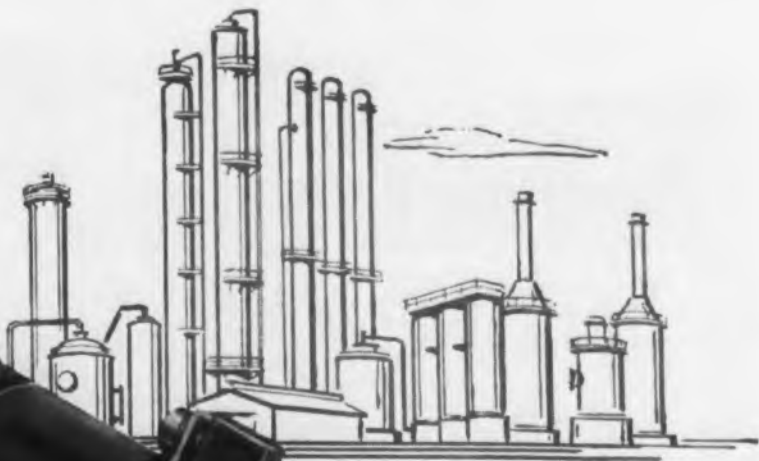
Custom Terminal Boards

A new terminal board section offers to the industry a source of precision, high quality terminal boards to custom designs meeting all applicable military specifications. The efficiency of this service has been geared so quick requirements can be met in prototype and production quantities.

Facilities are available to fabricate all plausible configurations. All standard terminals are available and special terminal designs can be incorporated as well as miscellaneous hardware.

Pilgrim Products, Inc., Dept. ED, 271 Central St., P. O. Box 1178, West Acton, Mass.

CIRCLE 288 ON READER-SERVICE CARD



NEW DIEHL* SERVOPOT

...solves your servo packaging problems!

The **DIEHL SERVOPOT** is an integral combination of a two-phase instrument servomotor, gear reduction, slip clutch, and precision potentiometer.

Conceived with the idea of offering precision servo performance in a modular construction, the **SERVOPOT** eliminates the present burden of mounting, testing and aligning separate units.

The **SERVOPOT** finds wide application in balancing, positioning and computing servos. Addition of an integrally-mounted **DIEHL 0.5% A.C.** tachometer makes the **SERVOPOT** a *complete integrating servo*.

The built-in slip clutch is factory adjusted to permit servo operation into potentiometer stops without damage. Standard pots featuring 0.5% linearity can be obtained in a wide range of resistances. Single, multi-turn, and non-linear models are available.



Consult **DIEHL** for further information, including integral mountings for resolvers and variacs.

DIEHL MANUFACTURING COMPANY

Electrical Division of **THE SINGER MANUFACTURING COMPANY**

Finderne Plant, **SOMERVILLE, N. J.**

Other available components:

**A.C. SERVOMOTORS • A.C. SERVOMOTORS WITH A.C. TACHOMETERS
A.C. SERVOMOTORS WITH D.C. TACHOMETERS • A.C. AND D.C. TACHOMETERS
D.C. SERVO SETS • RESOLVERS**

*A Trademark of **DIEHL MANUFACTURING COMPANY**

CIRCLE 289 ON READER-SERVICE CARD

Electronic Designers:

OVER 250 MODELS OF JOY FANS...

... Designed especially for
your applications



LIGHTWEIGHT because they are made of aluminum or magnesium castings produced in Joy's own foundries.

COMPACT design—with motor mounted inside the fan—permits installation anywhere... even inside a duct.

EFFICIENT vaneaxial design provides more air per given size than any other type fan.

AVAILABLE on a production line basis... Joy has over 250 standard models with 1300 designs available to your specs... from 1/500th horsepower up.

RUGGED because of simple design... the outer casing, the vanes and motor mounts are cast in one piece... vibration free.

Get more information from the world's largest manufacturer and supplier of vaneaxial fans to companies like G.E., Hallicrafters, Lear, R.C.A., Motorola, Raytheon, Sylvania.

Write to *Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.* In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*



Write for **FREE**
Bulletin 135-57

WSW 16348-135

CIRCLE 290 ON READER-SERVICE CARD

JOY

WORLD'S LARGEST MANUFACTURER
OF VANEAXIAL-TYPE FANS

NEW LITERATURE

Stabilized Amplifier 291

A 2-page bulletin is now available. The bulletin includes application diagrams, descriptions, specifications, block and circuit diagrams, photographs and outline drawings on model USA 3 amplifier, a highly stable amplifier for instrument, computer, and control applications. The amplifier features negligible drift, noise and distortion. George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.

Miniature Connectors 292

A four page, four color illustrated technical brochure gives specifications, diagrams, and general information on a line of micro-miniature connectors. These connectors meet MIL-C-8384 specifications and are ruggedized to withstand shock and vibration extremes. Ordering instructions are also included in the brochure. Dejur-Amsco Corp., Electronic Sales Div., 45-01 Northern Blvd., Long Island City 1, N. Y.

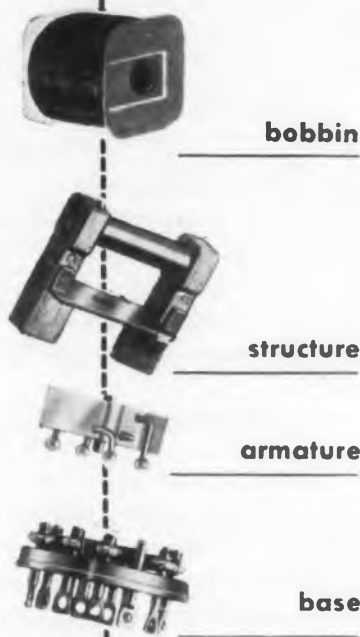
ADF System 293

A complete automatic direction finder system is described in this 16-page bulletin. It is illustrated and gives a complete detailed explanation of the various parts making up the system. Collins Radio Co., 315 Second Ave. S.E., Cedar Rapids, Iowa.

Copper Tape 294

A type data sheet which not only describes a metal but actually contains a sample strip is now available with pertinent engineering information on its line of ultra-thin and high-precision tolerance metal strip for coil winding. This just-published data sheet supplies engineers with physical and chemical characteristics, hardness factors, and mill limits. It also contains a unique chart simplifying the task of converting copper wire dimensions into equivalent copper strip. American Silver Co., Inc., 36-07 Prince St., Flushing 54, N.Y.

design
simplicity ...



... **RUGGED
RELAY**



Couch balanced-armature rotary relays withstand 20G vibration, 75G shock. Answers your dry-circuit switching problems too. Our bulletin #132 tells you more. Write to-day.



ORDNANCE INC.

A Subsidiary of S. H. Couch Co., Inc.

3 Arlington Street North Quincy, Mass.

CIRCLE 295 ON READER-SERVICE CARD

Nylon Parts

296

Nylon rollers, roller bearings, slide bearings and gears, are featured in the new parts catalog, Bulletin No. 501. Specifications, sizes and colors are given. Pipco International Corp., 1731 Stanford St., Santa Monica, Calif.

Current Pulse Amplifiers

297

Bulletin 57-A describes current pulse amplifiers, model 1070 (2 amp output from a moderately high source impedance) and model 1070A (1 amp output from a high source impedance). These amplifiers receive a low-level voltage pulse input and deliver a shaped high-current pulse output, for designing and testing of digital computer components, logic circuits, magnetic cores, memory systems, and transistors. The 2-page illustrated bulletin describes the basic circuit groups and points out that both linear and exponential rise time, and exponential fall time are fully controlled. Application suggestions and detailed specifications are also included. Rese Engineering, Inc., 731 Arch St., Philadelphia 6, Pa.

Sample Counting

298

A concise summary of the essentials of selecting nuclear equipment for sample counting is covered in this bulletin. The basic considerations common to the selection of all sample counting equipment are included, with particular emphasis being placed on the choice of the detector, its shielding, and the sample positioner or changing mechanism. Tracerlab Inc., 1601 Trapelo Rd., Waltham 54, Mass.

Rotary Accelerators

299

The history, development, design, and application of these machines is reviewed in a booklet both from the standpoint of environmental tests and from that of instrument calibration. The fundamental considerations involved in applying a precisely controlled radial acceleration to a test object are explained. Speed control, speed measurement, construction, balancing, optical systems, programming, and electrical, pneumatic, and hydraulic connections are covered. Schaevitz Machine Works, P. O. Box 505, Camden, N.J.

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ELECTRICAL INSTRUMENTS

CLEAR
PLASTIC
IN 3
SIZES

2PL - 2 $\frac{3}{8}$ x2 $\frac{3}{8}$
14 - 3 $\frac{13}{32}$ x3 $\frac{13}{32}$
23 - 4 $\frac{5}{8}$ x4 $\frac{5}{8}$



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AVAILABLE
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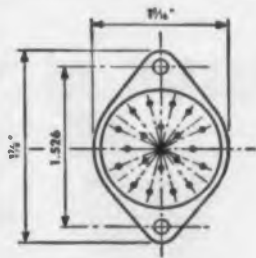
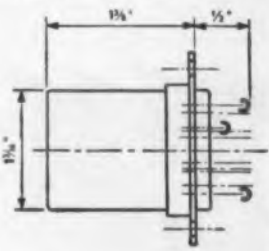
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PENACOOK, NEW HAMPSHIRE

CIRCLE 300 ON READER-SERVICE CARD

The First...

wedge action relay



New concept... High reliability... Rugged construction

A completely new and original concept in relay design. Unique "Wedge Action" contacts have solved the problem of reliability under rugged environmental conditions.

The high reliability and exacting performance demanded by developers of complex electronic systems is offered "off-the-shelf" in the Electro Tec Mark II Relay.

This exceptional relay is the result of advanced engineering, careful selection of component materials, sound structural design, and absolute quality control during manufacture.

"Wedge Action" effectively burnishes contact surfaces during every operating cycle, reducing resistance to micro-level currents. It renders the relay extremely shock and vibration resistant.

Write for illustrated literature.

ELECTRO TEC CORP.

P. O. Box 37B, SOUTH HACKENSACK, N. J.

*Products of Precision
Craftsmanship*



Pat. No. 2,696,570

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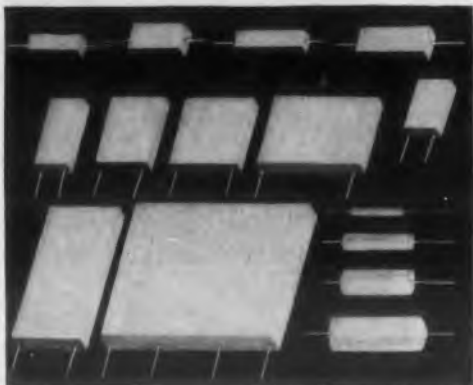
NEW CTS BOBBINLESS PRECISION WIRE FIXED RESISTORS

Featuring Unique CTS "Floating" Element
Small Space Factor • More Stable

New CTS patented winding process now permits resistance elements and contacts to be firmly embedded in epoxy resin, forming a monolithic mass. No bobbin or winding form—no wire strain. Exceptional Stability—permanent change in resistance less than 0.2% under most environmental conditions.

Guaranteed Close Tolerance—resistors guaranteed to be in tolerance under normal conditions of measurement. Tolerances down to $\pm 0.05\%$ available in standard sizes depending upon resistance value. Closer tolerances or matched multiples available.

Low Inductance and Low Capacitance Characteristics with reproducible uniform frequency response made possible by new CTS patented winding technique. Less than 0.2% resistance change with humidity (MIL-R-93). Less than 0.2% resistance change with temperature cycling (MIL-R-93). Withstands extreme vibration and shock due to unique construction and encapsulation method. Extremely stable—resistance change with load life or 100% overload (MIL-R-93) less than 0.3%. Low temperature coefficient wire available. Offered in rectangular or tubular shapes in a wide variety of standard sizes with wattages ranging from 0.25 to 2.0 and resistances from 0.1 ohms. Special dimensions, tolerances, wattage ratings, etc. can be made to your exact specification.



CHICAGO TELEPHONE SUPPLY CORPORATION
Elkhart, Indiana • Founded 1896

CIRCLE 302 ON READER-SERVICE CARD

BLUE M



**NO MOTORS
NO STIRRERS**
100% WORKING SPACE
WIDE RANGE OF TEMPERATURES



MORE CONVENIENT • SAVES COST AND TIME • MORE EFFICIENT



NEW! MAGNI-WHIRL Baths OBSOLETE conventional baths using motors which allow only a partial working space and partial agitation

NEW! MAGNI-WHIRL Baths have built-in automatic stirring and circulating systems for maximum uniformity and superior results. Magnetic pumping action gives automatic gentle agitation in all areas of bath—irrespective of work load DC, power supply and magnet fully protected

COMPETITIVELY PRICED
MAGNI WHIRL BATHS AVAILABLE FOR ALL NEEDS

- Utility Water Baths (100°C.)
- Visibility Jar Baths (70° and 100°C.)
- Utility Oil Baths (180° and 260°C.)
- Refrigerated Baths (0° to +100°C.)
- Super-sensitive Baths (100°C.)
- Hydrometer Jar Baths (70°C.)

BLUE M ELECTRIC CO. BLUE ISLAND, ILL.

MANUFACTURERS AND DESIGNERS OF COMPLETE TEMPERATURE CONTROLLED EQUIPMENT

CIRCLE 303 ON READER-SERVICE CARD

NEW LITERATURE

Crystal Filters 304

A two-color, four-page brochure outlining a product line of stock and special miniaturized quartz crystal filters is now available.

The brochure includes technical data, typical and representative curves of crystal filters. Symmetrical band pass filters, asymmetrical or single side band filters, narrow band filters, and wide band filters are described. Burnell & Co., Inc., 10 Pelham Pkwy., Pelham Manor, N.Y.

Components 305

A microwave relay components brochure containing ten specification sheets giving diagrams, photographs, descriptions, physical, and electrical characteristics of the various microwave relay components in the WR-137 waveguide size is now available. The brochure is designed to be a working tool for the communications engineer with difficult application assignments to solve. Airtron, Inc., 1096 West Elizabeth Ave., Linden, N.J.

Laminated Plastics 306

A summary of application and engineering data on laminated plastics and vulcanized fibre is furnished in this catalog. Containing eight pages, the catalog provides photos, descriptions, data tables, and a selector chart to aid engineers in selecting and applying more than 50 grades of laminated plastics, copper-clad laminates, and vulcanized fibre. Taylor Fibre Co., Norristown, Pa.

Temperature Controls 307

Bulletin MC-157 is a 4-page folder about a line of thermostats and their uses. Complete construction details of the control are given along with six basic design configurations. Fenwal, Inc., Ashland, Mass.

Communications Receiver 308

An 8-page bulletin gives a complete description of this HF Fixed-Tuned AM, CW, MCW air-to-ground or point-to-point communication receiver. The bulletin is well illustrated and includes specifications. Collins Radio Co., Cedar Rapids, Iowa.

Now POSITIVE ACTION SWITCHES

... another first from
Cutler-Hammer

- Wiping contacts insure perfect switching for very low energy circuits
- Positive-break action insures safe, reliable switching with high energy circuits
- Direct toggle-to-contact mechanism guarantees switching action
- First totally enclosed, environment proof toggle switch
- 1° lever throw opens circuit
- Positive detent action prevents switch teasing
- New insulating material gives 3 times greater arc tracking resistance
- Greater terminal clearance for easier wiring
- Improved bushing seal is molded in place.



Cutler-Hammer single, double, and four pole Positive Action Switches are available in unlimited circuit arrangements . . . single throw, double throw, momentaries, etc. For detailed information, write for Publication EA-168. CUTLER-HAMMER Inc., 1227 St. Paul Avenue, Milwaukee 1, Wisconsin.



CIRCLE 309 ON READER-SERVICE CARD

Solderless Wiring Devices 310

Time saving solderless terminals and connectors are described in this revised catalog. Valuable data and sizes of various devices are included to facilitate selection for every wiring job requirement. Electrix Terminals and Connectors Inc., 990 E. 67th St., Cleveland 3, Ohio.

Oscillographs 311

This is a 16-page catalog containing descriptions, specifications, and prices of the "150" Oscillographic Recording Systems. The full line of unit instruments and accessories such as recorders, galvanometers, and permaper chart paper is fully described in the catalog. Sanborn Company, Industrial Div., 175 Wyman St., Waltham 54, Mass.

Electronic Densitometer 312

With technical detail, a bulletin describes an electronic densitometer that is accurate to ± 0.02 density units and responds instantaneously. The literature is illustrated with step-by-step photographs. Macbeth Daylighting Corp., Subsidiary of Macbeth Corp., P.O. Box 850, Newburgh, N.Y.

Transistor Specs 313

A revised transistor specification chart which covers pnp germanium alloy-junction transistors is available. The chart also contains an interchangeability guide showing transistors of all manufacturers for computer, entertainment, and industrial applications. Industro Transistor Corp., 35-10 36th Ave., Long Island City 6, N.Y.

Digitometry 314

"Digitometry, A Concept of Digital Control and Indication" is the title of this four-page technical bulletin. It describes five components for use as digital actuators and feedback devices in servo and instrumentation systems. Block diagrams are presented of servo and measurement systems with accuracies of 1 part in 1000 parts. Illustrations feature these digital devices in rotary or linear positioning with bi-directional pulse motors, for telemetry of shaft or pulse input data and as preset controllers. Digital feedback elements are specified which produce systems with improved feedback accuracy. Anatron, 165 E. California St., Pasadena, Calif.

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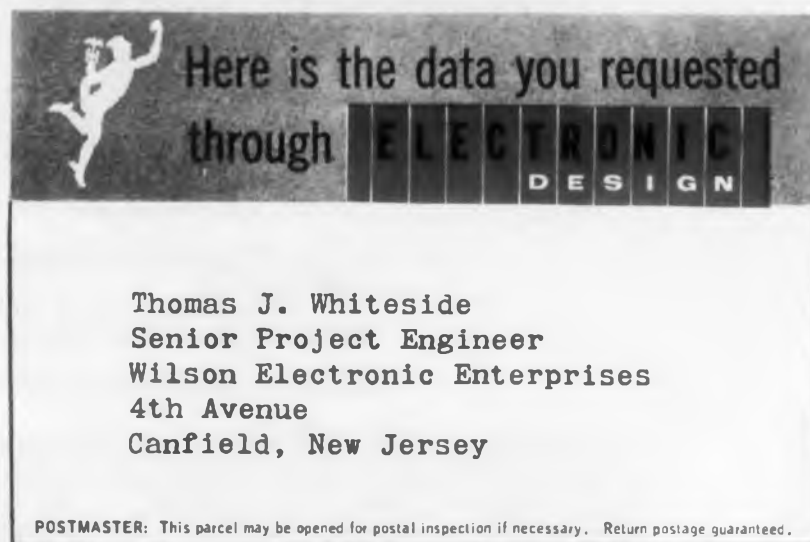
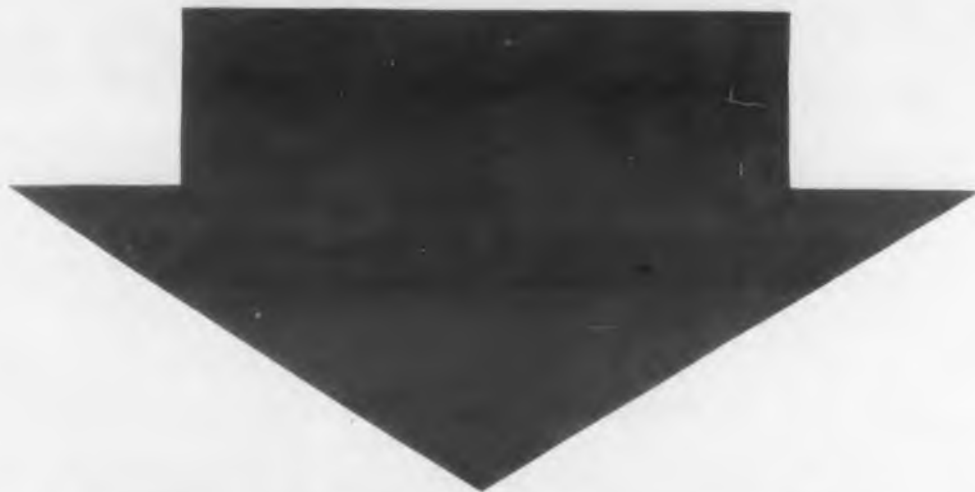
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NEW LITERATURE

Marking Machines 317

Twenty-five standard machines for marking items ranging from transistors and 110 deg TV tubes to instrument scales and spaghetti tubing are described in this 8-page catalog. All major specifications are included. Markem Machine Co., Keene, N.H.

Frequency Meter 318

A data sheet covering complete details of a self-contained 400-cycle expanded scale, frequency meter is now available. Applications, dimensional drawings of five basic models, product photos that clearly illustrate readability, complete specifications and a discussion of circuitry are featured. Beckman/Helipot Corp., Newport Beach, Calif.

Cable Systematics 319

Facilities and capabilities of a custom electronic cable manufacturing center for missile and aircraft requirements is explained in Technical Bulletin RF-582. Cable systematics, a unique method of cable engineering is explained in the bulletin. Robertshaw-Fulton Controls Co., 401 N. Manchester, Anaheim, Calif.

Mounting Systems 320

A four-page bulletin, describing engineered vibration and shock mounting systems for airborne electronic equipment and other applications is available. Designated Bulletin F1A, the publication cites the several different types of damage to sensitive instruments caused by vibration and shock. Descriptions and illustrations are given of variable-damped engineered mounting systems, along with a detailed discussion of the design and selection of the component parts of these systems. Federal Shock Mount Corp., 1060 Washington Ave., New York, N.Y.

Control System 321

Complete information about current-adjusting type control system for use with magnetic amplifiers and saturable core reactors is now available. Illustrated sheets describe how this control system will regulate power input to a variety of electric furnaces—either continuous or batch. In addition, these sheets list specifications for individual components which can be supplied in a complete package or tailored to an individual need. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Penna.

Industrial Parts 322

This electronic parts and equipment catalog contains 188 pages and is designed primarily for industrial electronics users. In addition to the listings of products for industrial applications, it also includes service parts and equipment listings. The catalog also has an industrial vacuum tube cross reference guide listing existing tubes with industrial applications. Gifford-Brown, Inc., 140 Walnut, Des Moines, Iowa.

R-F Filters 323

Performance features and design innovations of a line of miniaturized radio frequency filters and capacitors are described in this bulletin. The four-page, two-color bulletin, No. 57B, provides photos, schematic drawings, charts, and graphs to illustrate the line. Data on the use of Mylar film are also given. Stability under temperature extremes is illustrated in a graph showing a capacitance variation of only 12 per cent over a range of -75 F through $+300\text{ F}$. Another bulletin table lists diameters and lengths of all standard-design capacitors which are

available in capacities from $0.25\ \mu\text{f}$ through $18.0\ \mu\text{f}$. Airborne Accessories Corp., Hillside, N.J.

Telemetry Thermometers 324

The first compilation of information on platinum resistance thermometers is given in a 15-page booklet called "How To Use Platinum Resistance Thermometers in Temperature Measurement, Telemetry, and Control." Various types and characteristics of specific resistance thermometers and the use of these transducers in a variety of bridge circuits and control systems are described. Trans-Sonics, Inc., Burlington, Mass.

Supervisory Control 325

A 16-page bulletin, GEA-6603, provides information on supervisory control equipment. The bulletin describes functions ranging from opening and closing of switches and valves, to adjustments of speed, voltage or load. The literature is designed to show how versatile supervisory control can help solve control problems economically. General Electric Co., Schenectady 5, N. Y.

Electroplated WIRES for many applications

Continuous electroplating methods permit coating of many metals on to wire (or ribbon) in specified thicknesses of plate . . . This very flexible operation makes it possible to designate a desirable base or precious metal with a coating of another metal for its own particular characteristics. In our laboratory Tungsten wire as small as .00015" has been electroplated with Gold. . . . New combinations of plating on wire are being developed by our research staff from time to time.



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**Broadband, All-Electronic Oscillator
 for Sweeping Radar IF's to 350 mc Center**

- Single Unit Sweeping Oscillator with Ten Wide Bands
- Single Switch Provides Sweep and Markers Simultaneously
- 30 Crystal-Controlled Markers Set to Customer Specification
- Highly Stable—Low Harmonic Content—No Spurious Signals

SPECIFICATIONS

Freq Range: 1-350 mc center. Any 10 switched bands with freq set to your specifications. Fundamental frequency. All-electronic sweep.

Sweep Width: 70% of cen. freq from 1-100 mc; 60 to 70 mc from 100-350 mc.

Sweep Rate: Variable around 60 cps. Locks to line freq.

RF Output: 0.5 V rms into nom 70 or 50 ohms. Higher for lower freq units. AGC'd constant to ± 0.5 db.

Zero Reference: True zero base line produced on 'scope during retrace time.

Attenuators: Switched 20, 20, 10, 6 & 3 db plus cont. variable 6 db.

Markers: Up to 30 crystal-controlled pulse marks

set to your spec. Accuracy, $\pm 0.05\%$. Up to 3 marks per band (more at lower frequencies); no individual switches on marks.

Marker Amplitude: Cont. variable, 0-10 V approx.

Sweep Output: Reg. sawtooth in sync with sweeping oscillator.

Power Supply: Input approx. 150 watts, 117-V ($\pm 10\%$) 50-60 cps ac. B+ electronically regulated.

Dimensions: 8 $\frac{3}{4}$ " x 19" rack panel, 13" deep.

Weight: 34 lbs.

Price: \$795.00. f.o.b. factory. \$15.00 extra per marker ordered.

Write for 1958 Kay Catalog

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space-saving D-B power supply

*— has 2 independent outputs,
each closely regulated,
plus a variable filament supply*

(Model 5-300F)

Output Voltages:

1. 0-500 V.D.C. continuously variable without switching . . . current 300 MA. max.
2. 0-300 V.D.C. continuously variable without switching . . . current 150 MA. max.
3. 4 to 8 V.A.C. unregulated @ 10 amps max. (varied by tapped switch).

Regulation

For output voltages: 500 V/300 MA=100 MV. change N.L. to F.L.; 300 V/150 MA=60 MV change N.L. to F.L. For line voltage 115 V.A.C. $\pm 10\%$, the voltage change is .1% for 500 V. output, .16% for 300 V.

Ripple — both high voltage outputs less than 2 MV. R.M.S.

Grounding — either pos. or neg. of either high voltage outputs may be grounded.

All 3 on a chassis only $8\frac{3}{4}'' \times 19'' \times 16''$, for rack or bench use. Here is a real work-horse for general laboratory use. You get this widely versatile, compact power supply at a saving over separately supplied units. Request literature on Model 5-300F.

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DRESSEN BARNES CORP., 250 N. Vinado Ave., Pasadena 8, Calif.

CIRCLE 330 ON READER-SERVICE CARD

NEW LITERATURE

Semiconductor Materials 331

The 4-page brochure contains facts for ordering and purchasing ultra high purity material for semiconductors and custom formed high purity semiconductor soft solder preforms for automatic soldering. Standard die sizes and standard alloy combinations are available in the brochure, as well as a description of the company's facilities. Alpha Metals, Inc., 56 Water St., Jersey City, N.J.

Engine Testing System 332

A bulletin describing the S-100 automatic data handling and recording system for engine test facilities is now available. The system as described and block-diagrammed in the bulletin, will measure and process up to 500 test variables at sampling and readout rates to 100 per second. It may be modified to meet particular engine test program requirements. BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.

High Vacuum Valves 333

A 2-page leaflet gives design and installation data on high vacuum valves which have a thin design and a choice of flange dimensions. Photographs and diagrams illustrate the valves. Vacuum Research Co., 420 Market St., San Francisco 11, Calif.

Facilities 334

An 8-page booklet describes facilities for producing special machinery, tools, and equipment for the electrical, electronics, and communications industries. Also discussed is the manufacture of components, machinery and controls for aircraft and other use. General Machine Products Co., Inc., Old Lincoln Hwy. at Pennsylvania Tpke., Trevese, Pa.

Calibrator 335

Specifications and applications for a voltage and current calibrator are given in Bulletin sheet a/eh 6020B. This calibrator provides a ready means of accurately measuring complex waveform amplitudes and dc levels. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.

PULSE FORMING NETWORKS

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Meet Mil. Specs. for environmental conditions. Other matching impedance values available. High Power and Special Requirements Invited.

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HIGH VOLTAGE TYPE CP70 CAPACITORS

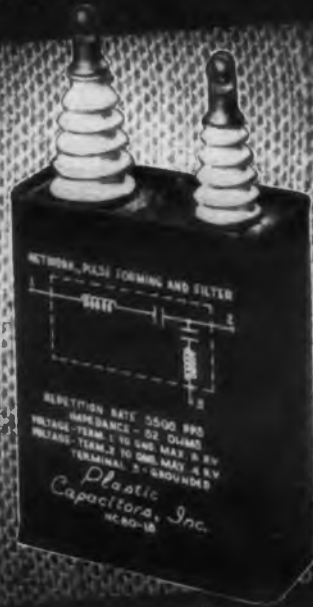


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Plastic Capacitors, INC.

2620 North Clybourn Avenue
Chicago 14, Illinois

Write for further information and our complete catalog



CIRCLE 336 ON READER-SERVICE CARD

Valves

337

Thirteen specialized valves, solenoids, and switches get complete coverage in a 30-page catalog. Pictures, descriptions, and specifications are given for each unit. Listed are one, two, and three-way solenoid operated valves; speed sensitive switches; and other items. The booklet also illustrates and describes engineering and production facilities. Koontz-Wagner Electric Co., Inc., 516 N. Michigan St., South Bend, Ind.

Socket Screws

338

A four page, illustrated bulletin describes self-locking socket screws. Listed with sizes and specifications are socket head cap screws, button head socket screws, flat head socket cap screws, socket set screws, shoulder screws, and dry seal pressure plugs. Self-locking pellet location, type of thread, locking torque, and other data are noted for all types. The bulletin also recommends installation practices. The Cleveland Cap Screw Co., 4444 Lee Rd., Cleveland 28, Ohio.

Limit Switches

339

This 4-page data sheet describes a line of small size, 2 circuit, limit switches which have the capacity to handle electrical loads usually assigned to much larger limit switches. Actuator versions covered are: the roller arm; flush mounted roller arm; low force rod; flexible coilspring; in-line plunger; and roller plunger. Photographs, dimensional and line drawings, characteristics, electrical ratings, and price information are included in this data sheet. Minneapolis-Honeywell, Micro-Switch Div., Freeport, Ill.

Sampling Equipment

340

This literature is a catalog of sampling equipment and other accessories for the company's IR-4 Infrared Spectrophotometer. The catalog, Bulletin 725, lists and describes applications for large-volume and micro sampling cells for liquids, gases, and solids; prism interchange units; recording accessories; and other IR-4 attachments. Beckman/Scientific Instruments Div., 2500 Fullerton Rd., Fullerton, Calif.

Power Supplies

341

This one-page illustrated product sheet describes 3 "T-Nobatron" tubeless power supplies, recommended for use in the development and testing of transistor circuits or for other applications within their voltage ranges, such as relay testing and computer circuitry development. Sorenson & Co., Inc., Richards Ave., S. Norwalk, Conn.



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They serve my systems
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*For the standard parts
to breadboard your system,
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*Within 3 days of order!

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Radial
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in Miniaturization

Find out how you can perform miracles in miniaturization with the help of MPB's hundreds of radial and radial retainer bearings, all smaller than $\frac{3}{8}$ " O.D.! Flanged, single or double shield, precision machined in chrome bearing steel and stainless steel.

Applications include continuous operation instruments, delicate measuring devices such as electrocardiographs and gyroscopes, optical equipment, and computers. High speed, duplex, pivot, angular contact, and thrust bearings also available. Specials on request. For the MPB catalog write to Miniature Precision Bearings, Inc., 905 Precision Park, Keene, New Hampshire.



CIRCLE 344 ON READER-SERVICE CARD

NEW LITERATURE

Vacuum Metallizing 345

The process of developing a thin metallic film by evaporation and condensation under high vacuum conditions is fully described and many of its applications are illustrated in a brochure, "Vacuum Metallizing," of which a revised and up-to-date version has just been issued. The brochure also contains complete specifications for current models of vacuum metallizing equipment, which includes units with 24, 36, 48, and 60 in. diameter vacuum chambers. F. J. Stokes Corp., Vacuum Div., 5500 Tabor Rd., Philadelphia, Pa.

Potting and Casting Compounds 346

Four improved potting and deep casting compounds which give excellent results in a variety of electrical uses are described in a four-page technical data sheet #102577. The bulletin gives detailed formulations, physical and electrical properties, methods of preparation, storage stability, approximate costs, and a list of raw material suppliers. Allied Chemical Corp., National Aniline Div., 40 Rector St., New York 6, N.Y.

Power Supply 347

The publication of a catalog covering the widest and most diversified power supply line in the electronic development and manufacturing industry has been announced. The 16-page data source covers more than 900 power supply models, over half of which have been completely redesigned. In each category, complete price information, formulas, tables, diagrams, and application data are included. NJE Corp., 345 Carnegie Ave., Kenilworth, N.J.

Sheath Connectors 348

A complete line of one- and two-piece compression sheath connectors for shielded or coaxial cable is described in this 16-page catalog. Complete listings, dimensional drawings, assembly procedures, and tooling information are available. Burndy Corp., Omaton Div., Norwalk, Conn.

Ball Bearings 349

A twenty-four page bulletin describing miniature ball bearings is now available. The catalog contains descriptive information on standard radial miniature bearings and other types of bearings. Applications and special features of the bearings are described in this catalog. A numbering system is provided for classifying bearings by material, size, type, mounting, torque, and lubrication. Miniature Precision Bearings, Inc., Precision Park, Keene, N.H.

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MODEL 355-C METER-RELAY

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RUGGED?

Rugged 355-C control relay meets or exceeds the following:

- Shock test:** Total of 18 impact shocks of 15 G's.
- Water tightness:** submerged in tap water at a pressure of $2\frac{1}{2}$ " mercury for 5 minutes.
- Dielectric strength:** 1000 volts RMS at insulated parts.
- Vibration:** Survives 10-55-10 cps, .060 amplitude, 1 minute cycle, 1 hour, 3 axes.
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- Contacts:** Rated 100 Ma, insulation to signal coil rated 300 volts DC.
- Description:** Has a set of contacts in series with locking coil. Signal and locking coil, both on moving structure, lock pointer contacts positively. Resets when contact circuit is interrupted.

UP TO 20,000,000 OPERATIONS!!!

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Chesterland 17, Ohio

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Booth 307, Automation Exposition
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CIRCLE 351 ON READER-SERVICE CARD

Terminals

352

This literature is a 40-page, tabbed-index catalog on 96 standard terminal lugs plus available sizes of each design. It includes a price list, engineering information of sizes, dimensions, finishes, materials, and prices, and full-size drawings on all the company's 96 standard terminal designs. An accompanying wall chart also illustrates and gives dimensions on the line of terminals available. Precision Metal Products Co., Stoneham, Mass.

Plastics

353

In a four page short form catalog, plastics for electronics are listed with brief descriptions. Microwave absorbers; casting resins; plastic foams; plastic rods and sheets; reflectors and Luneberg lenses; plastic surface coatings; adhesives, cements, and sealants; impregnating resins; and laminating resins are covered. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

End Seals

354

Catalog No. 657D describes a line of end seals, crystal holders and mounts, and transistor and diode closures. This 16-page folder contains physical dimensions and line drawings of more than 1000 different styles and sizes of military and RETMA type hermetic seals and their appropriate part numbers. It also offers specific illustrations and information about the company's custom design engineering service on all types of glass-to-metal seals. Hermetic Seal Corp., 29 S. 6th St., Newark 7, N.J.

Bonded Mica

355

With illustrations, Bulletin 101 discusses glass-bonded mica, synthetic powdered mica, and other high frequency insulating materials. The six page folder lists electrical and mechanical properties, specifications, and standard sheet and rod sizes. Operating temperatures are up to 1200 F. Electronic Mechanics, Inc., 101 Clifton Blvd., Clifton, N.J.

Cable Guide

356

Hints for electrical cable buyers on selecting the proper cable construction are contained in a 20-page booklet just released. In easy reading style it emphasizes the importance of examining all the facts surrounding each installation to be sure of obtaining the right cable for the job. Included is a typical check-list of the many technical points to be covered when specifying an electrical cable circuit. The Okonite Co., Passaic, N.J.

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UHF
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SIGNAL AND SWEEP GENERATORS

THE ULTIMATE IN PRECISION

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MODEL SG-132 (15-400 MC)

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SG 153
1,800-4,000mc

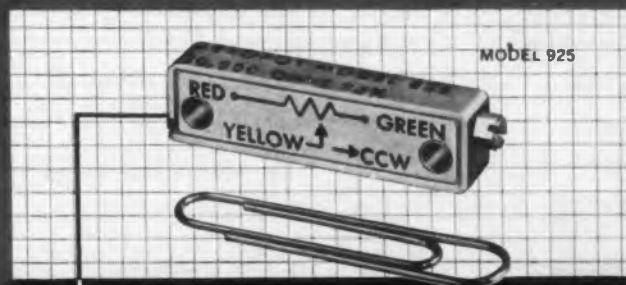
SG 161
900-2100mc

SG 109
400-1000mc

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GENERATORS ARE NOW AVAILABLE
FOR RACK MOUNTING

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miniature! humidity proof!

Mechanical — all metal structure
Stability — 10 to 60 ppm $^{\circ}$ C.
Environment — passes MIL-STD 202, method 106.
Power — 4 watts at 25 $^{\circ}$ C. Derates to zero at 190 $^{\circ}$ C.
Resistance — 100 to 100,000 ohms
Size — 1.257 x .330 x .242 \pm .003
1,000 mtg centers.

Comprehensive data on the Aero-Pot Model 925 and other Aero products will be sent to you on request.

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NEW Development!

HICKOK

250° Arc

LONG SCALE METERS

Save Valuable Panel Space

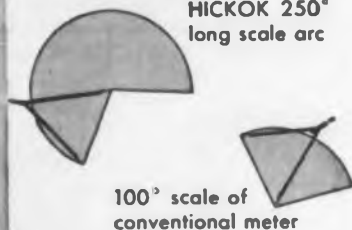
The scale in these new instruments is 2½ times as long as conventional meters. A 3½" HICKOK 250° meter has a scale length equal to a conventional 6" instrument.

These exclusive panel style 250° meters fit a smaller space though still provide easier, more accurate readings.

Available in all popular AC or DC ranges. Square, semi-flush or round flush cases. 2½" thru 5½" sizes.



HICKOK 250° long scale arc



100° scale of conventional meter

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RUGGEDIZED and SEALED

AC rectifier or DC types

The highly efficient HICKOK shock mount construction permits pointer and scale divisions to be easily read when meter is under vibration. The DC movement is a precise and rugged type.

The AC movement is of the AC rectifier type with unusually efficient magnetic damping for ruggedized purposes. Case is permanently sealed at the factory, however, may be opened and resealed.



These instruments meet military specifications and are in volume production. Your inquiry is invited. Kindly list details of your requirements or request Catalog No. 37

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Tests for "Choppers"

—to determine their operating characteristics

THESE ELECTRICAL tests can be used to examine and evaluate chopper characteristics which affect performance in end equipment. The methods described correspond to those used by the production and quality control departments of the James Vibrapowr Co. Specification limits for the various characteristics must be established to correspond to the chopper manufactur-

er's specifications for the particular chopper, and for any particular end equipment required.

Closure and Closure Balance

Closure (contact dwell time) may be conveniently and accurately measured by taking advantage of the integrating characteristics of a dc microammeter. It has been found convenient to use a 0-100

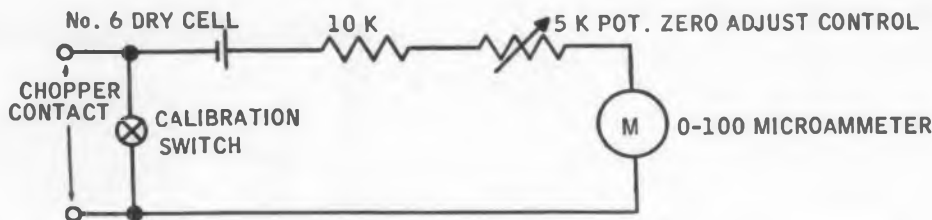


Fig. 1. Measuring circuit for contact dwell time. As shown, one chopper contact at a time can be checked.

OCTAL BASE (SEE MODEL SPECIFICATIONS FOR OTHER BASE CONNECTIONS)

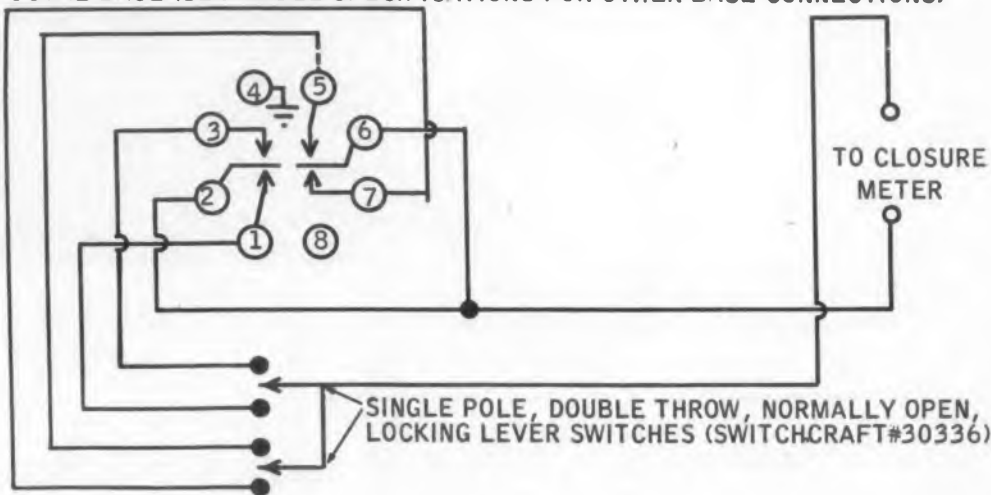


Fig. 2. Test jig for rapid testing of contact dwell time. Output of "jig" goes to input of circuit in Fig. 1.

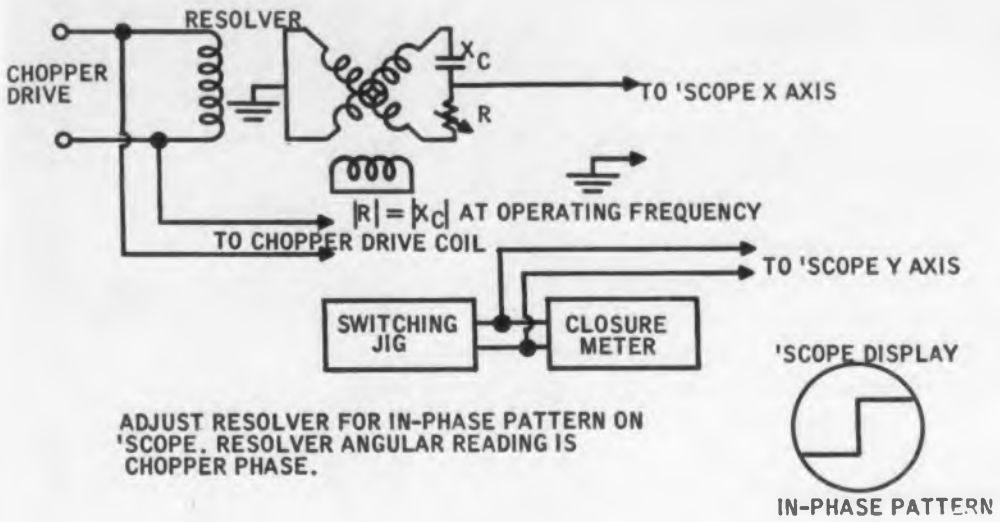


Fig. 3. Phase measurement circuit using a calibrated resolver. The resolver is used in conjunction with an oscilloscope for Lissajou displays.

microampere dc movement, in series with a suitable limiting resistor, and a No. 6 dry cell. Each chopper contact may be connected across the terminals of such a closure meter; and the meter, when properly zeroed, will read directly in percentage closure of one full cycle. A schematic diagram of such a closure meter is shown in Fig. 1. In quantity testing, it is desirable to use a switching jig to allow rapid connection of the chopper contacts across the closure meter. A representative switching system of this sort is shown in Fig. 2.

Contact Bounce

Contact bounce is usually defined as the uncontrolled opening and closing of

contacts after initial closure due to forces within the chopper. Its duration is generally considered to be the time from the beginning of the first closure discontinuity to the end of the last closure discontinuity at either the beginning or end of closure time. If a closure meter is used, an oscilloscope may be connected across the meter and current limiting resistor. This will display closure as a function of the oscilloscope linear time base. Contact bounce may be measured directly in terms of sweep speed if the oscilloscope has a calibrated sweep generator; otherwise, it may be measured or estimated as a percentage of contact dwell time, by making proper adjustment of sweep width. (continued)

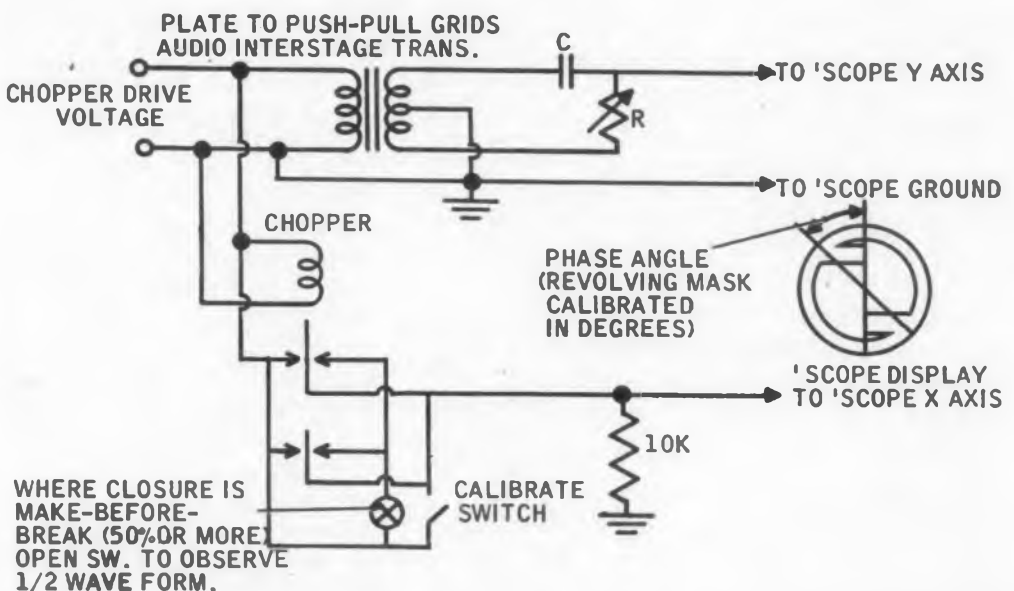


Fig. 4. Alternate circuit for phase measurement. Less accurate than method of Fig. 3, phase is measured by a protractor directly from oscilloscope screen.



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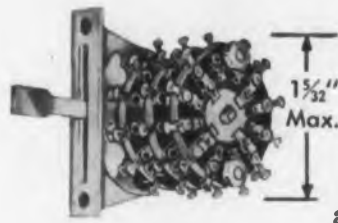
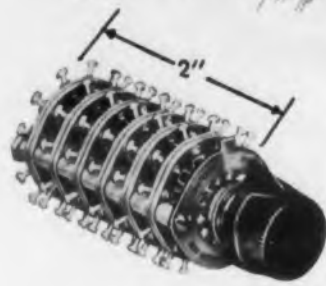
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IDEAS FOR DESIGN

Phase

Chopper phase is customarily defined as the angular displacement of the center of contact closure time from 90 deg point of the driving voltage. There are various methods for determining the magnitude of this angle. One of the most convenient and accurate methods employs a calibrated resolver to phase shift one of the signals applied to an oscilloscope connected for Lissajous display. This configuration is shown diagrammatically in Fig. 3. A second method in general use is similar but somewhat less accurate owing to effects of parallax, circuit ringing, etc. In this method, a reference signal is fed to the oscilloscope horizontal axis; the same signal, shifted 90 deg in phase is fed to the vertical axis through the chopper contacts. The phase may then be read directly from the oscilloscope using a protractor. A diagram of this type of phase measuring equipment is shown in Fig. 4.

Noise

For most purposes, the performance of the chopper in the end equipment is the best criterion of noise acceptability. It is generally possible to correlate this performance, with the individual manufacturer's method of noise measurement, allowing the establishment of mutually agreeable inspection methods and limits.

James Vibrapour Company, 4050 N. Rockwell St., Chicago 18, Ill.

New Gear Principle

- Has Interesting Design Possibilities

A patented new mechanism, developed by Girard Perregaux and Co. as the heart of the self-winding mechanism in a new automatic watch, may have many applications in electro-mechanical design. The device, called Gyrotron, permits a transmission of power to the mainspring with no mechanical resistance.

In effect, the new device converts a gear into a continuous free-wheeling clutch. The "Gyrotron" has solved the automatic watch problem of converting the motion of a swinging weight, or "rotor," into a unidirectional and continuous rotation without the mechanical resistances of clicks, springs and ratchets. Girard Perregaux and Co. has achieved this by replacing the latter component, which are subject to wear, with a free wheel clutch mechanism employing jeweled bearings, or "rollers," which are harder than steel and require no oiling. The use of two Gyrotrons provides an automatic clutch and rotation inverter system.

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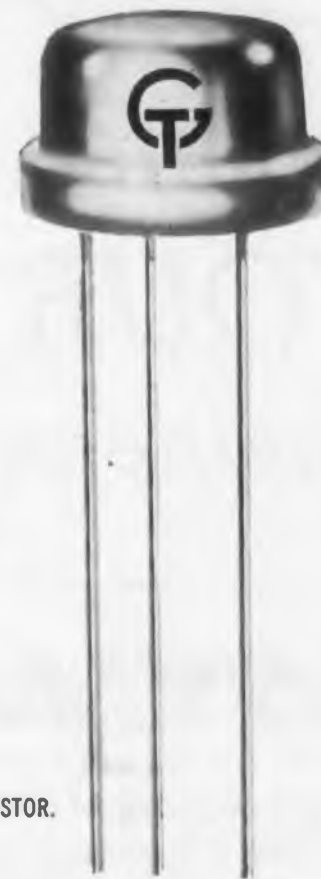
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The characteristics of these transistors are guaranteed in both directions. Their symmetrical design allows extremely low saturation resistances and switching properties. Ordinary uni-directional types lack this advantage. The NPN types have an alpha cutoff frequency range of 1.5 to 10.0 megacycles.

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New self-winding mechanism in automatic watch. Jewels in the Gyrotron replace clicks, ratchets, and springs in other movements, transferring power with no mechanical resistance. Gyrotron "A" is engaged while "B" swings freely, providing automatic clutch and rotation inverter system.

How It Operates

Object of the Gyrotron is to obtain coupling as and when required, between two coaxial components—a disc secured to the arbor, and therefore rotating with it, the arbor carrying a pinion which transmits its motion to the mainspring, and a circular ring gear with teeth on its outer circumference. The ring gear is not connected directly with the disc which it drives; there are a number of formed notches on its inner surface, which are of trapezoidal shape; and in each notch a small jewel is lodged. There are seven jewels in each Gyrotron used in the automatic watch. The radial depth of the notch increases progressively from one end to the other. When the roller is in the narrowest part of the notch, it is forced under pressure into contact with the disc, which is therefore coupled to the ring gear. This takes place when the latter is driven in a particular direction by a swinging weight. If the weight is going in the opposite direction, the ring is also turned in reverse, and each roller is forced to move to the widest part of the notch, so that the disc now becomes free.

Two Gyrotrons are employed in the self-winding watch mechanism, to provide unidirectional movement to wind the mainspring at each swing of the rotor. The ring gears of the Gyrotrons engage with one another as shown; one of the ring gears is in engagement with the pinion mounted on the swinging weight and the two Gyrotron gears therefore rotate in opposite directions. When the swinging weight turns clockwise, one of the ring gears drives the corresponding disc, arbor and pinion, which ensures that the barrel

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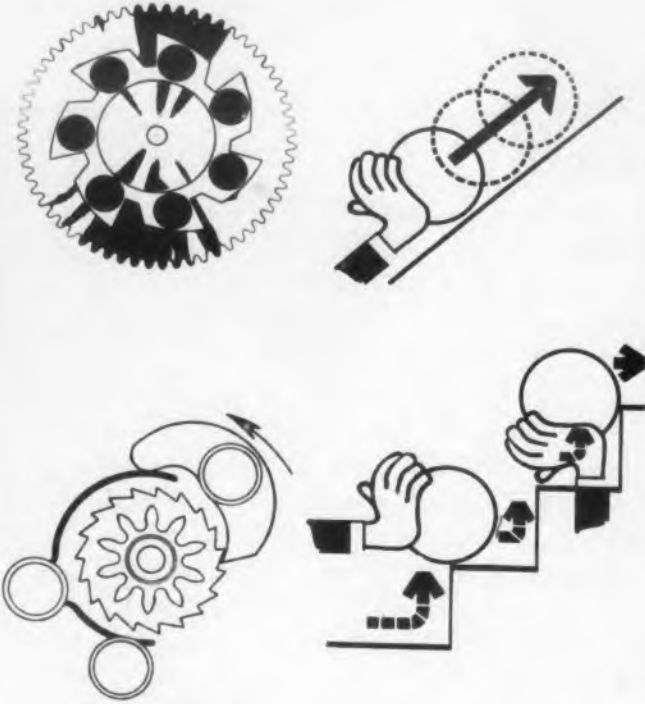
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IDEAS FOR DESIGN

is rotated. The second ring gear, which is revolving in the opposite direction, turns freely.

When the swinging weight turns in the opposite direction, the second ring gear drives its disc and pinion, and now transmits motion while the first turns freely. In this manner, the mainspring is always wound in the same direction since the two ring gears are always moving in opposite directions. This simple design was invented by M. Jean-Pierre Graef of Girard Perregaux, La Chaux-de-Fonds, Switzerland.



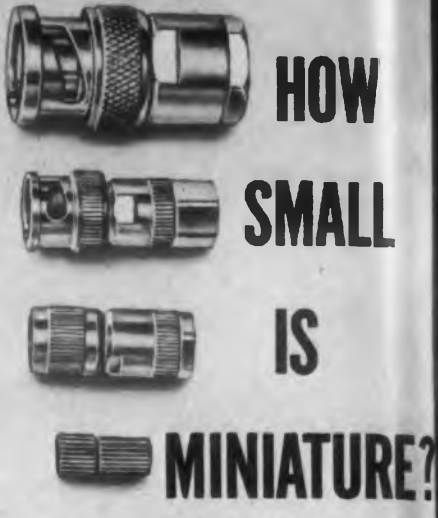
New Gear Principle Gyrotron wheel (upper left) transfers energy continuously and without mechanical resistance. Operation is comparable to pushing weight up a plane, where each bit of energy will move it up at least slightly. This is contrasted with conventional gear (below) using click and spring which exerts resistance similar to that of moving weight up stairs, where at least enough energy must be used to move the weight to the next higher step in order to keep the weight from falling back.

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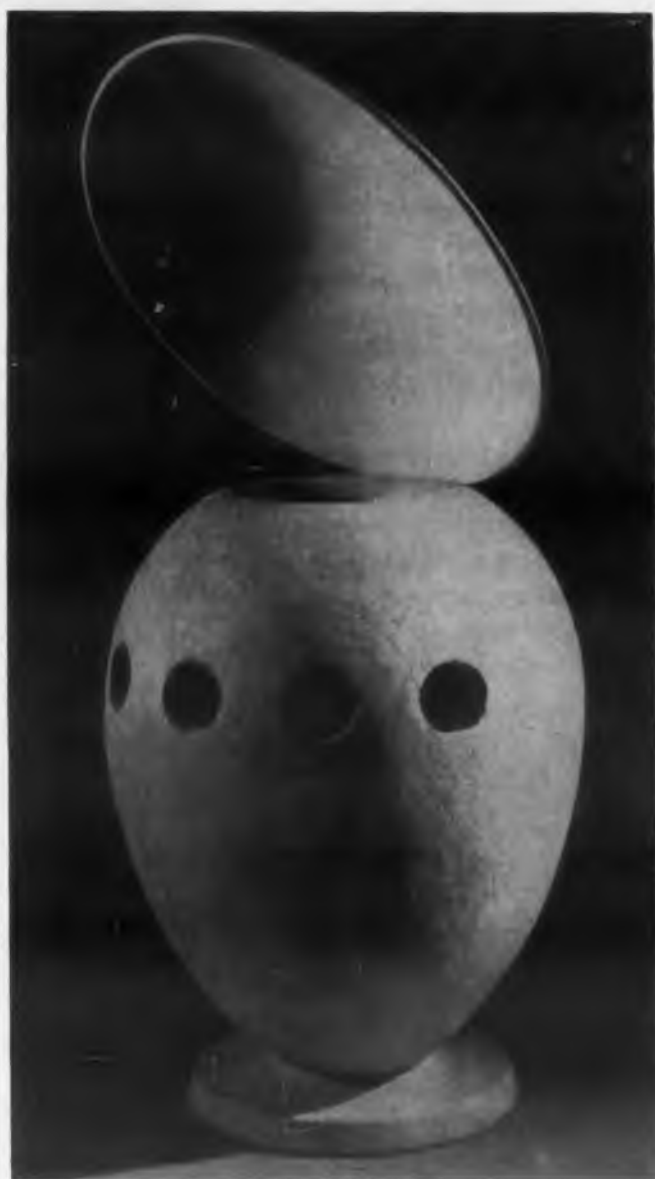
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Sound Pattern

reflection, these will pass through the second focus F, a focus of concentration situated in a forward position in relation to the "shell" or reflector, and, for a listener within the radiated useful cone, all reflected sounds of frequencies above 800 cps seem to be emitted from this focus.

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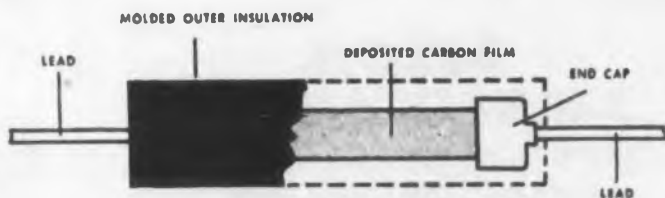
In applications calling for low-cost composition resistors, the new Welwyn Type C-1 offers the performance advantages of deposited carbon at essentially the same cost. Among these advantages are stability, size, low noise level, high insulation and moisture resistance.

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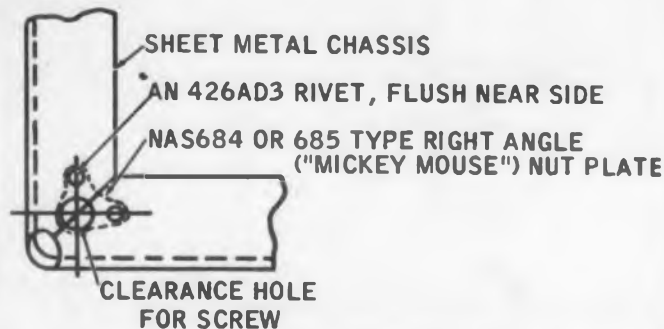
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Burt Mondshein, Sr. Product Design Engineer, Minneapolis-Honeywell Regulator Co., W. Los Angeles, Calif.



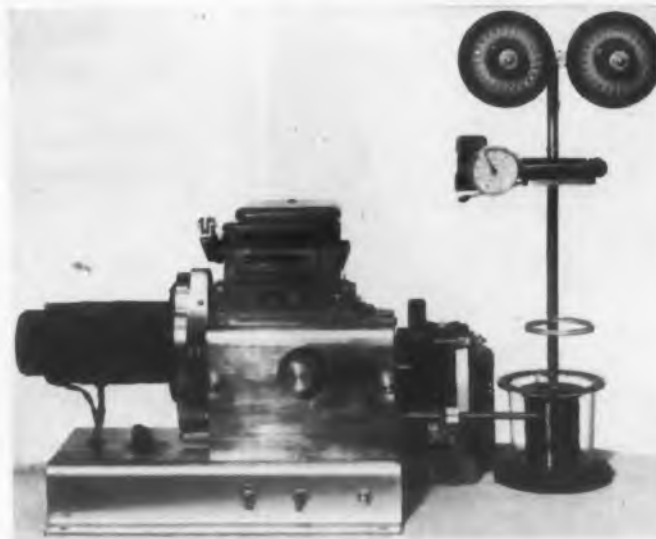
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The tension of wire can be kept within safe and proper limits at all times by monitoring with a tension meter and making the necessary adjustments.

In the winding of coils for electronic instruments (such as inductance coils, wire-wound resistors, and ammeters, to mention but a few), the tension of the wire is of the greatest significance. Too heavy a tension gives a loose coil or makes wires protrude into the air gap (e.g. of the rotor of a gyro).

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fluenced by every restraint—from friction to magnetic detention—through which it passes. For the finest wires even the air resistance of the wire whipping from an overhead pull-off through paths of various lengths influences tension.

By mounting the Tension Meter in the aforesaid manner, the sum of all the tensions is indicated where it matters most, to wit just before the final point of application to the wire-wound product. In this manner all the individual influences that produce tensioning are summed up into the final indication of tension, as shown.

Dr. Erwin J. Saxl, Tensitron Inc., Harvard, Mass.

Stabilizing the Wien-Bridge Oscillator

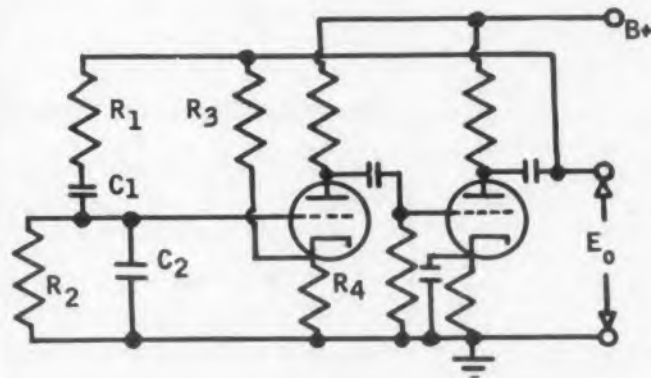
The usual amplitude stabilizer used in a Wien-bridge oscillator is a 3 w, 120 v lamp. Such a lamp, however, causes instability of amplitude under vibration or temperature change.

The tendency toward instability was corrected by filling the bulb with a solid material. Specifically, the resistance-ballast filament was surrounded with a solid heat-conducting material such as epoxy resin and powdered alumina. This encapsulating gives the filament rigid support and protection against rapid external temperature variations.

The ballast lamp used was a common GE No. 356 120 v, 3 w light bulb. The oscillator thus modified was used in a telemeter transmitter simulator-calibrator. In this application the oscillator output level simulates information where a 1 per cent change is meaningful.

Before modification the oscillator frequency was varying 7 per cent per minute due to local air temperature variations and 4 per cent instantly by vibration. The resulting improved oscillator output varied less than 1 per cent. The oscillator output was still affected by the average temperature drift of the air.

Robert H. Barton, Design Engineer, Boeing Airplane Co., Hangar "B," Melbourne, Fla.



Basic Wien-bridge circuit. The ballast resistor, R_4 , is an encapsulated lamp bulb to improve stability.



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- small size . . . high power and temperature capabilities!

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Protection: Ceramic sleeve coated with multiple coats of specially formulated baked-on resin

Tolerance: .5% to 1%, standard (others special)

Moisture: Characteristics G Mil-R-26C

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REPORT BRIEFS

Miniaturized Pulse Connectors

Miniaturized pulse connectors able to withstand the severest climatic and environmental conditions, yet operate satisfactorily at working voltages of 7500 v peak have been developed for the Air Force. The connectors, said to be the smallest developed to the date of the research, were intended to replace larger pulse connectors in airborne electronic equipment. The devices met or exceeded all electrical and mechanical requirements of the associated cable and were capable of operation over the temperature range -65 to 150 C at altitudes up to 70,000 feet. They measured approximately one inch in diameter and three inches in length, or five inches for plug and mated receptacle. Development of semi-conducting silicone rubber for high temperature operation is discussed in the report of the research. Tests for performance characteristics of connector assemblies and components are reviewed in detail. *Miniaturized Pulse Connectors*, J. H. Gesell, *Federal Telecommunications Labs. for Wright Air Development Center, U. S. Air Force. Dec., 1956, 49 pp, \$1.25. Order PB 131048 from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.*

Human Factors System Design

An introduction and general discussion of the field of human factors for designers of systems incorporating men as operators, maintainers, or monitors of machines. Five areas are covered: the human component and the process of designing systems; characteristics of the human component with implications for design engineering; effects of human characteristics on engineering tests and system evaluation; an annotated reading list; and a checklist of human factors considerations in system design and evaluation. *Human Factors in the Design of Systems*, H. W. Sinaike and E. P. Buckley, *Naval Research Lab., Aug., 1957, 52 pp, \$1.50. Order PB 131248 from OTS, U.S. Department of Commerce, Washington 25, D.C.*

Direct Synthesis of Servomechanisms

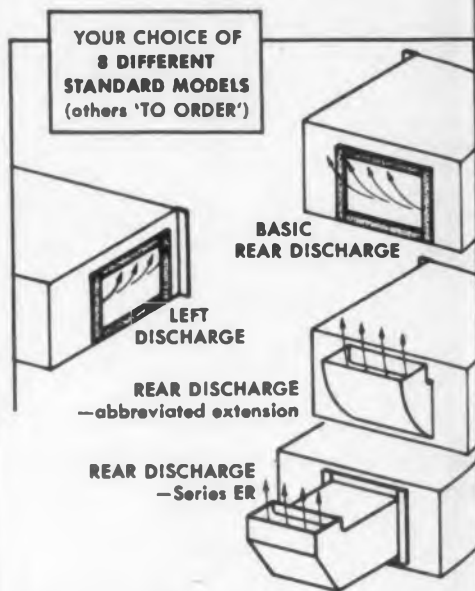
The purpose of this report is to show how the simple and direct methods of the polynomial transform theory may be used in the analysis and synthesis of automatic control systems. Part I is an elementary presentation of the polynomial transform theory in simple and condensed fashion. Part II presents the elements of the analysis and synthesis of servomechanisms in terms of the mathematics explained in Part I.

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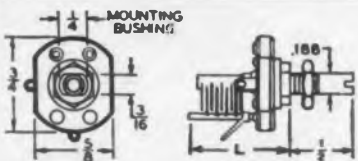
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Part III works out in detail, as in an illustration of the theory in Part II, the design of a fifth order, type 1 position servomechanism with proportional, derivative and integral control. A detailed appendix discusses the important question of design criteria under the customary classifications of servomechanisms as to order, type and kind of control. *Direct Synthesis of Servomechanisms*, Frank W. Budd, U. S. Air Force, Air Research and Development Center, Aeronautical Research Lab., Wright-Patterson Air Force Base, Dayton, Ohio. June, 1953, 164 pp, diagrams, graphs, tables, microfilm \$7.80, photocopy \$25.80. Order from Library of Congress, Washington 25, D. C.

Correlation Techniques for Acoustical Systems

The application of correlation techniques to acoustic receiving systems is considered theoretically and experimentally. The study is limited, for the most part, to random signals in a background noise which arises in the signal-bearing medium (not in the receiver amplifiers). In some cases, the correlator can effect an improvement in the signal-to-noise ratio of as much as 3 db, while, in other cases, conventional methods result in higher signal-to-noise ratios. Several methods of performing multiple correlation for use with arrays of more than two elements are considered; nothing significantly superior to a simple adding of all the signals and detecting has been found. *Application of Correlation Techniques to Acoustic Receiving Systems*, James J. Faran, Jr. and Robert Hills, Jr., Harvard University. Nov. 1952, 92 pp, microfilm \$5.40, photocopy \$15.30. Order PB 126816 from Library of Congress, Washington 25, D.C.

Microwave Filters Design Criteria

This is the second quarterly report on a broad program, the purpose of which is to investigate design criteria for uhf and microwave filters, and to present this information in handbook form. This report is devoted almost exclusively to describing a new synthesis technique that allows one to synthesize a class of low-pass and band-pass microwave filters to have any desired physically realizable insertion loss characteristics over frequency bands of an octave or more. Several typical examples are worked out in detail to further illustrate the techniques. *Research on Design Criteria for Microwave Filters, Second Quarterly Progress Report*, SRI Project 1331 Covering the Period June 15 to Sept. 15, 1955, E. M. T. Jones, Stanford Research Institute, Menlo Park, Calif. Oct., 1955, 44 pp, microfilm \$3.30, photocopy \$7.80. Order PB 130027 from Library of Congress, Washington 25, D.C.



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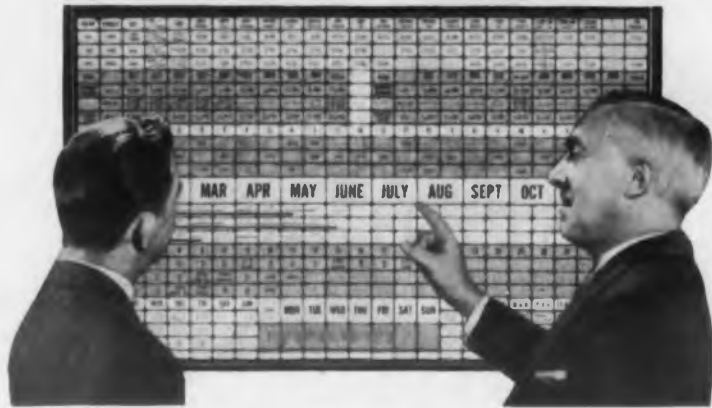
Frequency range:
 100 cps to 5 mc/s in 7 bands, continuously variable tuning across each band
 Waveform:
 Essentially square except above 1 mc. Above 1 mc, it becomes essentially sinusoidal
 Output voltage:
 0 to 10 volts peak-to-peak across 1000 ohms (cathode follower output stage)
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REPORT BRIEFS

Human Factors in Design

This report describes problems encountered by maintenance men in the utilization of ground electronics test equipment and details recommendations for the human engineering design of test equipment. The purpose of the report is: (1) to determine what difficulties are found in the use of test equipment; (2) to suggest means of eliminating these difficulties by using human engineering principles in test equipment design; and (3) to outline a method of applying these human engineering principles in actual design of test equipment. *Human Factors in the Design of Electronics Test Equipment*, Paul Spector, Alan D. Swain and David Meister, American Institute for Research, Inc. April, 1955, 134 pp, microfilm \$6.90, photocopy \$21.30. Order PB 125981 from Library of Congress, Washington 25, D.C.

H-f Crystal Rectification Efficiency

An extension of Bethe's simple theory of capacity in crystal detectors reveals that it is inadequate to explain the observed dependence of conversion gain on frequency. A new model is suggested which makes it possible to correct this deficiency. This model requires that the donor levels lie somewhat deeper than hitherto supposed and that the time required to ionize them is sufficiently long to produce a saturation effect in the capacitative component of the current at high frequencies. The evidence supporting such a model is discussed. *High Frequency Rectification Efficiency of Crystals*, A. W. Lawson, P. H. Miller, L. I. Schiff and W. E. Stephens, Pennsylvania University. July, 1943, 33 pp, microfilm \$3.00, photocopy \$6.30. Order PB 127076, from Library of Congress, Washington 25, D.C.

Identity vs No-Identity Displays

An evaluation was made of the performance of one controller in an air traffic control system when engaged in a series of simulated return-to-base missions with an omnipresent identity code for all aircraft on the primary Plan Position Indicator display, as contrasted with the absence of coded identity. Efficiency was measured for a single pattern-feeder controller responsible for moving traffic through a control zone of 50-mile radius. *The Use of Displays Showing Identity Versus No-Identity*, L. M. Schipper, C. L. Kraft, A. F. Smode, and P. M. Fitts, The Ohio State University and the OSU Research Foundation for Wright Air Development Center, U.S. Air Force, Feb., 1957, 30 pp, \$0.75. Order PB 131270 from OTS, U.S. Department of Commerce, Washington 25, D.C.

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Atmospheric Radio Noise

Investigation of the electromagnetic field components (E_z and H_z) of the ground wave from individual spheric pulses is initiated. Preliminary experiments indicate that H_z exceeds the theoretical value obtained from Sommerfeld's theory, and that H_z and E_z probably have a common functional dependence upon the distance of propagation. *Investigation of Atmospheric Radio Noise*, P. J. Nawrocki, *Engineering and Industrial Experiment Station*. Nov., 1956, 40 pp, microfilm \$3.00, photocopy \$6.30. Order PB 126602, from Library of Congress, Washington 25, D.C.

Distributed Power Amplifier

Use of distributed amplification in a pulsed power amplifier was investigated as a possible method of attaining a broadband source of rf power at a level suitable for use as a final transmitter stage for radar in the vhf and uhf bands. Following a simplified procedure which is described in the report, an experimental amplifier was built which delivered a pulse power of approximately 100 kilowatts throughout a frequency band of 45 mc, centered at 188 mc. Within this band, plate efficiency varied from 31 to 37 per cent and power gain was approximately 15 db. Fourteen 4X150A tetrodes were used. Among its advantages, the distributed amplifier's obtainable frequency bandwidth is sufficient for most conceivable applications. Each of its small tubes contributes independently to the total output, and several of them could fail without total loss of transmitter power. *An Experimental Distributed Power Amplifier*, S. K. Meads, *Naval Research Lab.*, Aug., 1957, 19 pp, \$0.50. Order PB 131164 from OTS, U.S. Department of Commerce, Washington 25, D.C.

Ferrites at Microwave Frequencies

Relation concerning reciprocity and energy conservation in a microwave structure containing anisotropic media are derived. The properties of the impedance matrix of such a non-reciprocal network are considered. The effects of shape on the design of ferrite devices, and several new devices including two broadband isolators, an electronically controllable attenuator, and a new type circulator, are discussed. Frequency doubling in ferrites and the factors influencing the bandwidth of isolators are investigated. Measurement techniques necessary to characterize the basic ferrite microwave properties are considered. *Theory and Applications of Ferrites at Microwave Frequencies*, Perry H. Vartanian, Jr., *Electronic Defense Lab.*, Mountain View, Calif. April, 1956, 152 pp, microfilm \$7.50. Order PB 127642 from Library of Congress, Washington 25, D.C.



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PATENTS

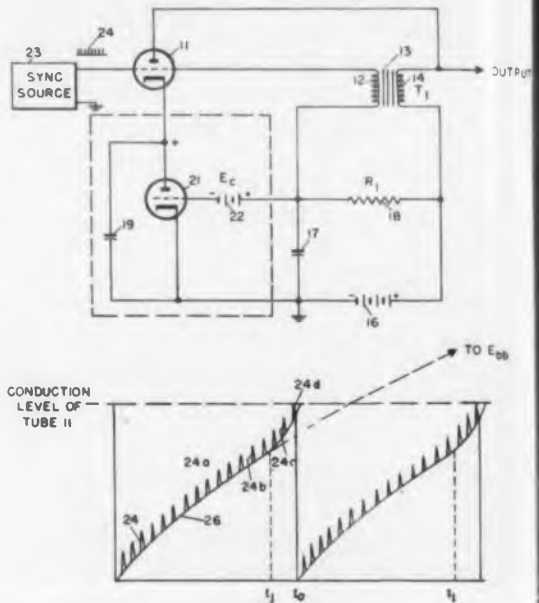
Frequency Divider Circuit

Patent No. 2,820,899. Emil E. Sanford.
(Assigned to Allen B. DuMont Laboratories, Inc.)

Stability of frequency division and increase of division ratio is achieved by increasing the slope of the grid-voltage recovery curve in the vicinity of the conduction level of a blocking oscillator. This permits an increase in voltage between the peaks of the synchronizing pulses so that each synchronizing pulse in the vicinity of the conduction level is more definitely distinguished and jitter and instability are reduced.

Triode 11 is a blocking oscillator which is controlled by sync source 23. The voltage recovery curve for the grid of triode 11 is shown. Without triode 21 the curve would continue with reducing slope along the curve marked "To E_{bb} ". Triode 21 and the auxiliary capacitor 19 change the slope of the curve in the following manner:

At time t_0 , triode 11 is below cutoff due to the charges on capacitor 17 and capacitor 19. Triode 21 is below cutoff due to the charge on capacitor 17 and



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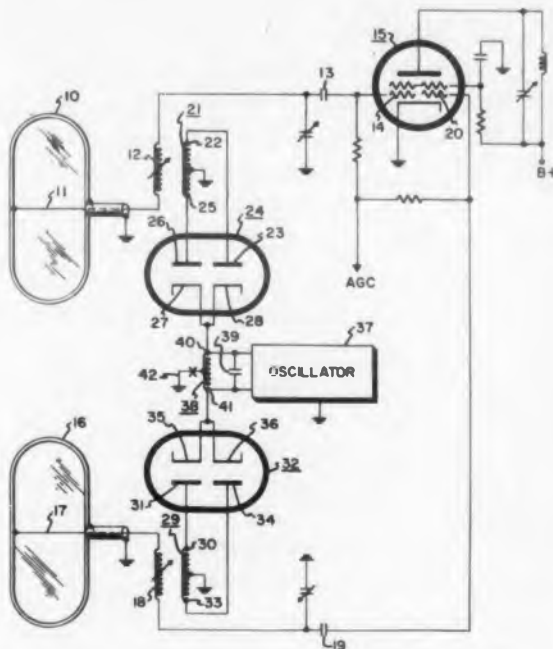
the bias voltage E_c . The grid of triode 11 recovers as capacitor 17 discharges through resistor 18. At time t_1 , triode 21 begins to conduct and to discharge capacitor 19. The grid voltage on triode 11 is reduced and the slope of the recovery curve increases. The voltage level notably different from the voltage level corresponding to sync pulse 24d. The corresponding to trigger pulse 24d is blocking oscillator will lock more exactly to sync pulse 24d.

grid 14. During the next interval duodiode 24 is non-conductive and duodiode 32 conducts. Damping inductance 29 acts as a short circuit. Inductances 21 and 29 are balanced and center tapped to prevent the signals from oscillator 37 to couple inductances 12 and 18 through the diode capacitances.

R-F Circuit Selector

Patent No. 2,815,443. Ross A. Davis.

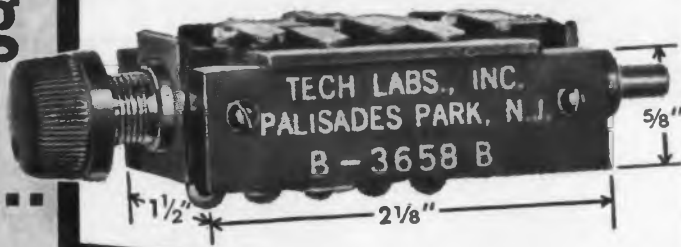
The patent describes an electronic circuit which permits sequential coupling of separate antennas, such as 10 and 16, to the input stages of radio apparatus. Oscillator 37 periodically causes duodiodes 24 and 32 to conduct alternately. When duo-diode 24 conducts, there is substantially a short circuit across inductance 21 which reflects as a very low impedance across tuning inductance 12 and damps it to the point where substantially no signal passes from antenna 10 to



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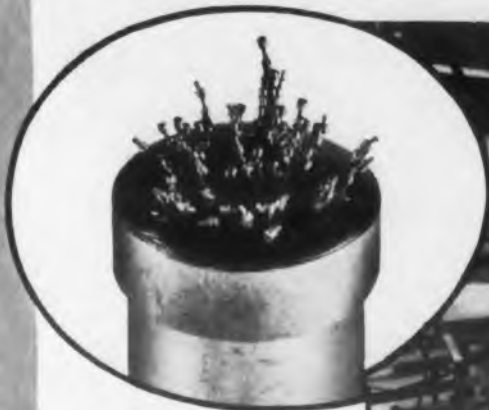
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PATENTS

Electro-Optical System

Patent No. 2,810,863. Kenneth D. Smith.
(Assigned to Bell Telephone Laboratories, Inc.)

The electro-optical system includes a primary series circuit having a light-sensitive device and a resistor, the resistance of which varies in response to changes of illumination of the light sensitive device. A vacuum tube amplifier is connected in the system which includes a series condenser in the input circuit. This input circuit is coupled to a portion of the series circuit across which there is a voltage drop dependent upon the illumination of the light sensitive device. The amplifier has an output circuit which may be controlled by impulsive changes of light on the device.

Magnetic Pulse Doubling Circuit

Patent No. 2,814,737. Joseph E. Sunderlin and Ray E. Lee. (Assigned to Westinghouse Electric Corporation)

The pulse generator uses a first and a second saturable core transformer with

the primary windings in series. A voltage is applied across the series combination of the primary windings. A third saturable core transformer is used which has its primary winding in series with the secondary windings of the first and second transformers. A capacitor connects the midpoint of the primary winding of the third transformer to the junction of the secondary windings of the first and second transformers. The output voltage is derived from the generator across the secondary of the third transformer.

Pulse Type Transverse Magnetic Amplifier

Patent No. 2,811,652. Daniel M. Lipkin.
(Assigned to Sperry Rand Corporation)

The amplifier is designed particularly for use in computer circuits and includes a core of magnetic material having a channel through it. An input winding threads this channel. Input blocking pulse terminals are in series with the input winding and a blocking diode. An output winding also threads the channel, and the blocking diode is so connected that blocking pulses prevent current flow in the input winding producing an in-

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ELECTRONIC DESIGN • May 14, 1958

duced current in the output winding. A signal output terminal and a load impedance is connected to the output winding. A drive winding and a bias winding is wound around the core in a direction orthogonal to the input winding. A direct current power source supplies current to the bias winding establishing a magnetic field in the core of sufficient magnitude to carry the core material into the region of vanishing rotational hysteresis loss and thus produce a clamping action between the resultant magnetic field and the magnetic flux.

Distortionless Audio Amplifier

Patent No. 2,802,907. A. P. G. Peterson and D. B. Sinclair. (Assigned to General Radio Company)

The patent discloses a number of push-pull amplifier circuits which dispense with a transformer therefore eliminating the distortion arising from incomplete coupling or leakage reactance between the windings.

The tubes 1 and 3 shown in the figure are balanced triode amplifiers. Other circuits illustrated in the patent use tetrodes

and pentode tubes. The tubes are rendered alternately conducting through a phase-inverter stage formed by the tube 37 having a resistor 55 in the plate circuit which is the same value as resistor 57 in the cathode circuit. Control of the amplifier tubes is secured through the connection of the grid 7 with the plate of the phase-inverter tube and the grid 13 with the cathode of this tube. Thus, the amplifiers function identically but 180 deg out-of-phase.

The input signal is applied at the terminals 61 and 63 or between the control grid and cathode of the inverter tube through the condenser 59.

In the operation of the circuit when tube 1 conducts the current flows through the load and condenser 27. The condenser 45 serves as a storage condenser for dc current during this event. When the tube 1 is cut off, tube 3 conducts current flows through the load from the storage condenser 27, and the amplifier tube 3. During the conducting with the result that some slight unbalance might occur. The patent describes several additional circuits which are modification of or additions to the basic circuit illustrated.

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INPUT RESISTANCE—Infinite at null; 1000 megohms per volt of input when 1% off null.

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ACCURACY— $\pm .05\%$ of input voltage from 10 volts to 500 volts; below 10 volts. $\pm .1\%$ or 5 millivolts.

INPUT RESISTANCE—Infinite at null; 1000 megohms per volt of input when 1% off null.

SEARCH RANGE—500-0-500 volts.

SIZE AND WEIGHT—Cabinet, 13" H x 9 $\frac{3}{4}$ " W x 14" D—21 lbs.; Rack, 8 $\frac{3}{4}$ " H x 19" W x 16 $\frac{3}{4}$ " D—23 lbs.

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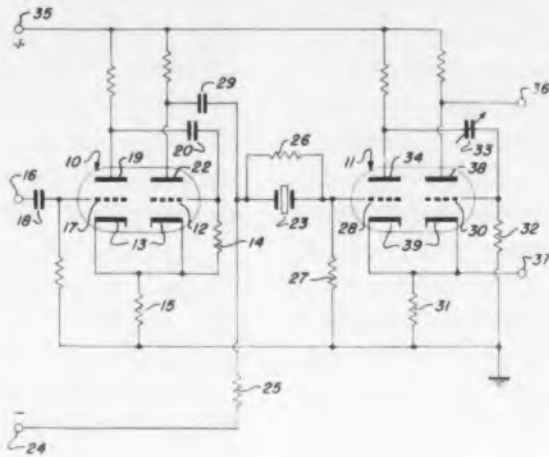
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PATENTS



Shock-Excited Oscillator

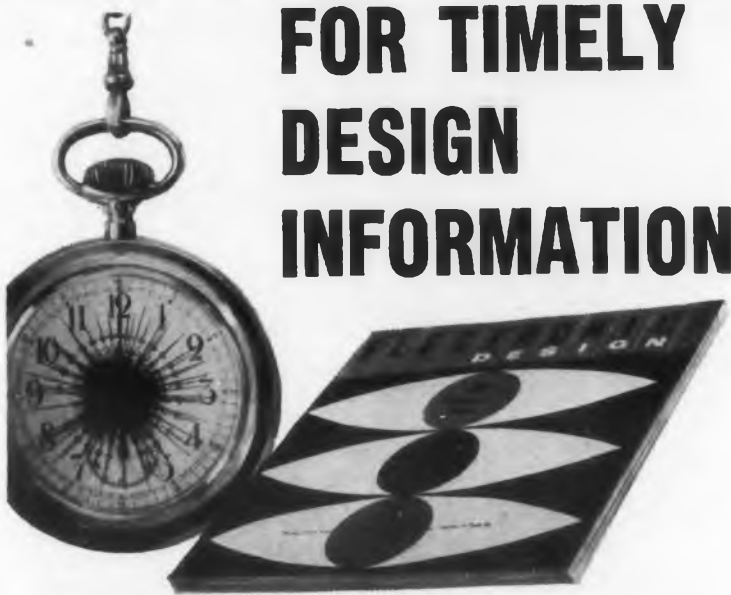
Patent No. 2,817,019. Robert Creveling.
(Assigned to the United States of America as represented by the United States Atomic Energy Commission)

The oscillator employs a crystal which is prestressed with a suitable voltage in order that the oscillations will start and stop precisely with the beginning and end of a specified interval. Electrical prestress of the crystal gives the shock-excited oscillator the stability of a crystal for precision time measurements.

An adaptation of the invention utilizes a crystal-controlled cathode-coupled os-

cillator which is gated by a one-shot multivibrator. Initially, plate 22 is conducting and plate 19 is cut off. A positive trigger at terminal 16 causes the flip-flop of current; that is, plate 19 conducts until the negative voltage of grid 12 is discharged. The positive gate on plate 22 is coupled through condenser 29 to remove the prestress voltage across crystal 23 allowing the cathode coupled circuit to oscillate in the positive pulse interval.

Prestressing a quartz crystal and releasing the stress is analogous to instantaneously releasing a pendulum located at the point of maximum displacement.



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Stabilizing Means for Semiconductor Circuits

Patent No. 2,816,964. Lawrence J. Giacometto. (Assigned to Radio Corporation of America)

In circuit applications of transistors it is desirable to keep the dc emitter current constant and independent of variations in ambient temperature and changes in circuit parameters. This is achieved by using a transistor dc amplifier to compare the emitter voltage of the transistor to be stabilized with a reference voltage and changing the voltage of the base of this transistor to maintain constant current.

One aspect of the invention for pnp transistors is illustrated wherein transistor 8 is stabilized by transistor 18. For npn transistors, the polarity of the batteries would be reversed.

Stabilization is obtained as follows: Suppose the dc emitter current of transistor 8 increases. The voltage across resistor 34 changes with the polarity as shown such that the base 26 of stabilization transistor 18 becomes more negative. The collector current of transistor 18 increases resulting in a change in potential across resistor 32 with polarity

as shown. This causes the base 16 of transistor 8 to become less negative and transistor 8 current is reduced. By contrast, should the dc emitter current of transistor 8 decrease, the collector current of transistor 18 will also decrease tending to make the base 16 more negative. The emitter current of transistor 8 will then tend to increase.

Power Supply And Bias Arrangement For Push-Pull Transistor Amplifier

Patent No. 2,812,393. William S. Patrick. (Assigned to Zenith Radio Corporation)

The amplifier may be energized from either a battery or from an unregulated commercial power source and includes a pair of transistors. Signals are applied in a push-pull relationship to the input electrode. The power supply has a change-over switch which in a first operating position couples the amplifier to the unregulated power source and in a second position couples the amplifier to the battery. The amplifier has a bias circuit which includes a switch for either class A or class B operation. A unicontrol is coupled to both switches to establish power and bias concurrently.



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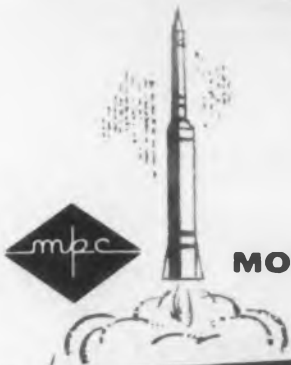
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PATENTS

Electronic Switches

Patent No. 2,816,238. George Elliott. (Assigned to General Dynamics Corporation)

Communication circuits are switched by applying either positive or negative voltage to the control electrode of a transistor. The circuit shown in Figure 1 uses conventional transistors 3 and 7 in each leg of the lines connecting Line 1 to Line 2. Bilateral transistors 23 and 27, shown in Figure 2, are used to limit large dc currents when the switch is in the ON condition. In Figure 1, a pair of pnp junction transistors are connected between Line 1 and Line 2. When switch S is in the OFF condition, the transistors are non-conductive since the base of each transistor is positive with respect to its emitter. When switch S is in the ON condition, the negative voltage is applied to the base of each transistor and collector 5 of transistor 3 and collector 9 of transistor 7 conduct to close the circuit between Line 1 and Line 2.

In the bilateral arrangement shown in Figure 2, transistor 23 has emitter-collec-

tor junctions between electrodes 24 and 26 and electrodes 25 and 26 respectively connected with one wire of the circuit to be closed. Electrodes 28 and 30 and electrodes 29 and 30 respectively correspond to emitter-collector functions of transistor 27. The switching occurs as follows:

When switch S is in the OFF condition, both transistors are non-conductive since the base of each emitter is positive with respect to each emitter-collector junction. When switch S is operated to its ON position, the transistors conduct with their first and second junctions biased in the forward direction as if they were emitter junctions and a saturation

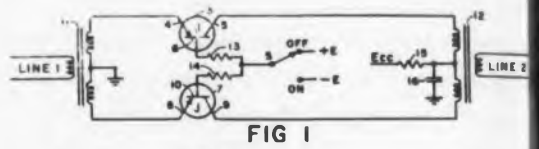


FIG. 1

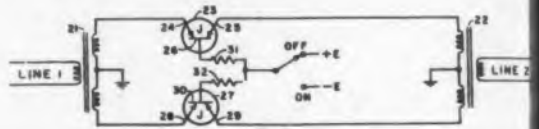


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...se current flows in both transistors. A signal which causes electrode 24 of transistor 23 to become positive makes electrode 24 the emitter and electrode 25 the collector. Electrode 25 follows the potential of the signal applied to electrode 24. Should the applied signal cause electrode 24 to become negative, then electrode 25 becomes the emitter and the signal acts to subtract from the controlling base current. The operation of transistor 27 is the reverse of the operation of transistor 23. Tests on the circuits have shown that a very low series impedance is presented to the circuit when the transistors are conducting and a rejection ratio greater than 90 db per transistor is achieved when the switch is non-conductive.

Pulse Width Modulator

Patent No. 2,814,739. Robert F. Cline. Assigned to Electric Machinery Mfg. Company)

The modulator consists of an electro-mechanical relay having an element which is operative in response to voltage pulses of short duration. This relay has an output circuit which is controlled from con-

tacts. Both a dc voltage and an ac voltage are applied to the active element of the relay. The voltages are adjustable relative to each other in order to apply an operating voltage to the relay for variable portions of the cycle of the ac voltage so that a modulated signal in the output circuit may be produced.

Apparatus Employing Radioactive Isotopes

Patent No. 2,810,850. Ernest G. Linder. (Assigned to Radio Corporation of America)

The patent discloses an application of isotopes which provide a cold source of high energy emission. An electrode collects the charged particles and establishes a potential relative to the source. A dielectric member, having an apertured portion, is placed between the source and the collector electrode. The dielectric member is capable of being ionized by the emission. This ionization produces a current effectively flowing in opposition to the high energy emission. A suitable electrode is positioned in the medium to control the flow of current.

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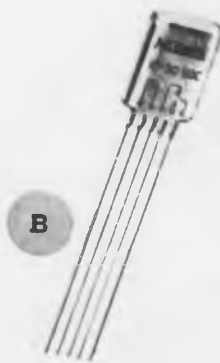
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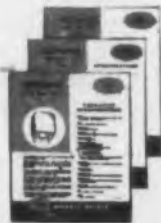
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BOOKS

Basic Feedback Control Design System

C. J. Savant, Jr., McGraw-Hill Book Company, Inc., 330 W. 42 St., New York, N.Y., 418 pp, \$9.50.

The fundamentals of servo theory and design are described in this volume. Feedback control system design is treated by a combination of the root locus method and the Bode and Nyquist frequency methods. A wide range of servo transducers and components are discussed in terms of how to use them in designing systems including gyroscopes, force-balance transducers, and inertial navigation. Special tables permit the design of certain components including bridged and parallel-T notch networks. While emphasis is on linear servomechanism design, a chapter is included on non-linear analysis where such tech-

niques as the describing function and phase plane analysis are covered.

Transistor Physics and Circuits

Robert L. Riddle and Marlin P. Ristebatt, Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N.Y., 428 pp, \$10.00.

The product of authors with both teaching and engineering experience, this text offers a practical comprehensive discussion of the basic physics and circuit aspects of transistors. Treatment of the material is primarily non-mathematical and may serve as a basic introduction to transistor theory as well as a worthwhile reference for the designer. One advantage of the book is the attention given to recent developments of transistors for the person unfamiliar with them.

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Ultra High Frequency Performance Receiving Tubes

E. Benham and I. A. Harris, McGraw-Hill Book Co., 327 W. 41st St., New York 36, N.Y., 169 pp, \$6.50.

A detailed account of the behavior of radio receiving tubes in the vhf and uhf bands is offered in this volume. It describes those tubes, chiefly triodes, which show promise of outstanding performance as low noise amplifiers, as oscillators, and, to a lesser extent, as mixers. The objects of the book are twofold: to present the theory of the conventional tube as a circuit element, and to give a clear picture of the electronic processes in a tube. The first objective enables circuit analysis to be applied to the problem of tube amplifiers for small signals at ultra high frequencies; the second provides an introduction to the transit time theory of thermionic devices. In this account of the electronic processes in a tube, the more suitable methods associated with the work of Benham, Muller, Llewellyn, Bakker, de Zuhrt have been used to supplement one another. One feature is the analysis of the effect of elastically reflected electrons from the anode of a

triode on the signal and noise characteristics. The book includes a chapter on the limited knowledge of large signal transit time theory and a chapter on the calculation of noise factor.

Engineering Materials Handbook

Charles L. Mantell, Editor, McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N.Y. \$21.50.

With almost 2,000 pages compiled by 150 contributors, this volume is intended to supply information on materials required by personnel concerned with design, structure, and servicibility. Consideration is given to materials from the viewpoint of engineering structures, machinery, and equipment. Metals, organic materials, and inorganic materials are covered. Emphasis is placed on the fabricated forms of materials, their adaptations, advantages, limitations, competition with each other, protection against deterioration, and increase in their stability to withstand use and abuse. There are sections included on magnetic materials and electrical alloys, and electrical conductors and contacts.

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Machlett Laboratories, Inc. makes available to the designer the ML-6198, a small television camera tube intended primarily for industrial use. Tube design includes a photoconductive layer as a light sensitive element characterized by a spectral response approaching that of the eye.

ML-6198 has a resolution capability of approximately 600 lines. Advantages include high picture quality, uniformity of signal, maximum tube cleanliness and low microphonics.

Pertinent technical data follow:

General Characteristics

Focusing Method	Magnetic
Deflection Method	Magnetic
Overall Length	6 1/4" ± 1/4"
Greatest Diameter, excluding side tip	1.125" ± 0.010"
Maximum Radius, including side tip	0.800"
Bulb	T-8
Operating Position	Approx. Horizontal or faceplate up

Typical operation

Faceplate Illumination (Highlight)	10 to 20 ft-c
Signal-Electrode Voltage	20 to 70 volts
Grid No. 4 (Decelerator) & Grid No. 3 (Beam Focus) Voltage	250 to 300 volts
Grid No. 2 (Accelerator) Voltage	300 volts
Grid No. 1 Voltage (For picture cutoff)	-45 to -100 volts
Highlight Signal-Output Current	0.1 to 0.2μ amp
Maximum Dark Current	0.02μ amp
Uniform 2870° K. Tungsten Illumination on Tube Face to Produce Signal-Output Current of 0.1 to 0.2μ amp	3 to 10 ft-c
Average "Gamma" of Transfer Characteristic for Signal-Output Current between 0.02 and 0.2μ amp	0.65



For full technical data on this or any other Machlett tube type, write: Machlett Laboratories, Inc., 1063 Hope Street, Springdale, Connecticut

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BOOKS

Feedback Control Systems

Otto J. M. Smith, McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York 36, N.Y. 695 pp, \$13.50.

A unified philosophy for analysing and designing all types of feedback systems is presented.

The book shows the rigorous relationship between the open-loop transient, sinusoidal, or statistical responses and the closed-loop transient, sinusoidal, and statistical responses. From any one of the six responses above, the other five may be computed. The closed-loop transient response is available from open-loop measurable data such as vector margin and vector attenuation.

Linear statistical design is based on a minimum spectral error power. The only approximation is the expression for signal noise, and disturbances in analytical form. The final system is the optimum linear predictor to compensate for the unalterable components.

Transportation lags and dead times are incorporated into feedback systems by a block-diagram statement of what

is possible, followed by block-diagram substitutions to form a linear analytical predictor.

Ceramic Fabrication Processes

W. D. Kingery, Editor, Technological Press, Massachusetts Institute of Technology, and John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 440 pp, \$9.50.

Twenty-two scientists and engineers contributed to this volume which provides both the technical basis and present practice of ceramic fabrication showing the relationship between principle and the art. The outgrowth of the 1964 Special Summer Program in Ceramics at M.I.T., the book covers all the steps in the complete fabrication of the material including forming, firing, and resulting properties as affected by fabrication. Provision is therefore made for both the student and the practicing engineer. The book is applicable to new high temperature materials, ferrites, ferroelectrics, and other special ceramic materials.

The book is applicable to new high temperature materials, ferrites, ferroelectrics, and other special ceramic materials.

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which are particularly important to development of electronics and high-temperature devices.

Network Synthesis, Volume I

David F. Tuttle, Jr., John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N.Y. 1175 pp, \$23.50.

The first volume of a proposed two-volume work offers a lucid presentation of the principles of synthesis of two-terminal networks. (The forthcoming Volume II will investigate four-terminal networks).

A reasonable background in circuit analysis and some familiarity with the complex frequency variable is presupposed. However, some review material is included. The author has gathered the major advances in network synthesis of the past twenty years to which is added the classical material.

To provide a full treatment the book is organized in terms of a three-step procedure to: (1) obtain a working knowledge of the properties of networks; (2) investigate ways of approximating behavior which may be desired, but

which the results of step 1 indicate not to be realizable; and (3) carry out actual synthesis.

Proceedings of the EIA Symposium on Numerical Control Systems for Machine Tools

Engineering Publishers, AC Book Co., GPO Box 1151, New York 1, N.Y. 106 pp, \$5.00.

The full text of the 15 technical papers delivered at the 1957 EIA Symposium describing the design and practical application of numerical control are contained in this book.

Basic principles, definitions, and terminology are reviewed. The operation and application to machine tools of the several commercial numerical control systems are discussed in detail. In addition, the Keynote Address by Lt. Gen. C. S. Irvine, USAF, is included. Several papers are devoted to a detailed review of the various steps used in machining the test piece, and also to an analysis of manufacturing costs by both manual methods and automatic numerically controlled methods.

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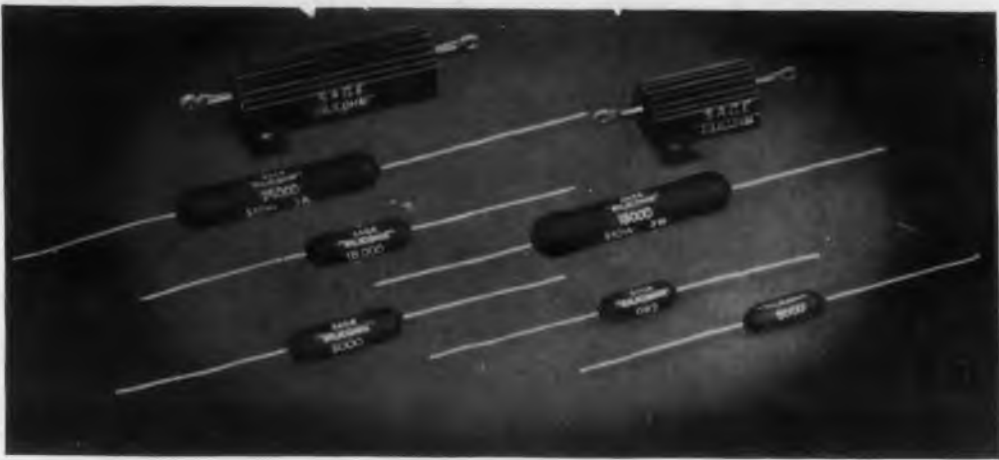
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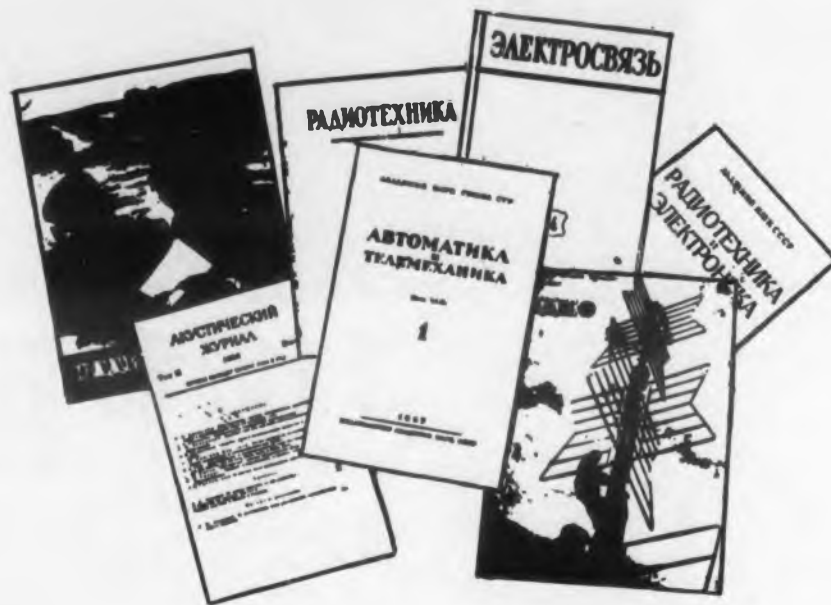
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RUSSIAN TRANSLATIONS



What The Russians Are Writing

J. George Adashko

CIRCUITS

Certain Types of RC Sinusoidal Generators Employing Transistors by V. M. Lyubin. EC 8/57, pp 20-25, 6 figs.

Several transistorized RC oscillator circuits for sinusoidal voltages are considered. Methods are given for their approximate calculation. The calculated and measured values of the oscillation frequency are compared. Problems of interchangeability of transistors in oscillators are discussed. See Figs. 1 and 2.

Mutual Interference between Circuits of High-Frequency Cables of Symmetrical Construction by V. O. Shvartsman. EC 8/57, pp 39-49, 7 figs.

Here is an analysis of the transfer parameters and mutual interference between symmetrical

cables and circuits containing irregularities. These parameters are analyzed on the basis of the theory of active four terminal networks with distributed parameters. Equations are derived for the input impedance of circuit irregularities and for the shielding effect in the case of interference between inhomogeneous circuits with arbitrary distribution of couplings and irregularities.

Transistorized Contactless Telegraph Relays by Ye. V. Bazilevich. EC 8/57, pp 50-60, 16 figs.

Report on an experimental investigation of several types of contactless telegraph relays employing transistors. The discussion covers ac and dc circuits (diode triggers, dynatron-effect triggers, cascade-effect triggers, etc.), as well as modulating and keying circuits.

Analysis of Bridge Connections of Four-Terminal Networks by I. P. Paderno. EC 8/57, pp 69-70, 2 figs.

Equations are derived for the currents and voltages in circuits of complex configuration, containing four terminal networks consisting of bridges, the arms of which are four terminal networks of varying complexity.

Operation of a Television Transmitting Tube with a Long Camera Cable by O. I. Yudzon. EC 8/57, pp 71-73, 5 figs.

The author suggests a new method for compensating for the time delay produced by long television camera cables. Each camera channel contains a network, which permits time delay of the horizontal pulses of the transmitting tube by an amount equal to the difference between the duration of the line (64 microseconds) and the time delay corresponding to the length of the camera cable employed.

Certain Problems in the Theory of Magnetic Amplifiers and Magneto-Modulation Probes of the "Second Harmonic" Type by V. N. Mikhaylovskiy and Yu. I. Spektor. AT 8/57, pp 716-723, 6 figs.

These amplifiers are analyzed at no load with sinusoidal excitation. Allowances are made for magnetization and eddy current losses. It is shown that the presence of losses causes the phase of the output voltage to vary with the intensity of the measured magnetic field. Reference is made to an article by F. C. Williams "The Fundamental Limitation of the Second Harmonic Type of Magnetic Modulator" Proceedings of Electrical Engineers, Part II, Vol. 97, August 1957 and to "Preliminary Development of a Magnetor Current Standard" by E. P. Felch and J. L. Potter, Trans. AIEE, Part I, vol. 72, 1953.

KEY

The sources of the Russian articles and their dates of issue follow the authors' names. Here is the key to the names of the journals in which the articles originally appeared.

AT	Automation and Telemechanics (<i>Avtomatika i Telemekhanika</i>)
CJ	Communications Journal (<i>Vestnik Svyazi</i>)
EC	Electrical Communications (<i>Elektrosvyaz'</i>)
IET	Instruments and Experimental Techniques (<i>Pribori i Tekhnika Eksperimenta</i>)
R	Radio
RE	Radio Engineering (<i>Radiotekhnika</i>)
REE	Radio Engineering and Electronics (<i>Radiotekhnika i Elektronika</i>)

TRANSLATIONS AVAILABLE

ELECTRONIC DESIGN is gratified to learn of the growing availability of full translations of important Russian electronics journals.

Consultants Bureau, Inc. of 227 W. 17th St., New York 11, N.Y. translates *Automation and Telemechanics* regularly.

Pergamon Press of 122 E. 55th St., New York 22, N.Y. is preparing translations of *Radio Engineering, Radio Engineering and Electronics, and Electrical Communications*.

Readers interested in specific Russian journals can obtain more information by writing directly to one of these publishers.

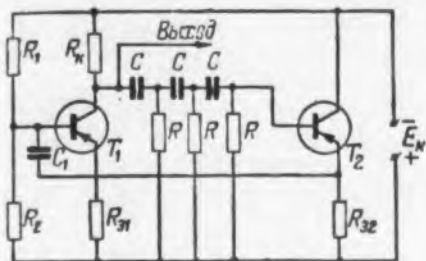


Fig. 1. This phase shift oscillator feeds back from the second emitter to the first base.

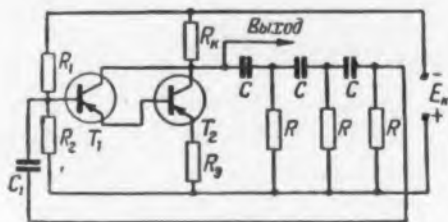


Fig. 2. In this oscillator, feedback is from the output of the phase shift network.

Choice of Operating Conditions and Design of Electronic Voltage Stabilizers by I. Bayda and V. K. Zakharov. AT 8/57, pp 724-739, 12 figs.

"Starved amplifiers" (see G. E. Kaufer, Electronic Engineering, November 1954) are used in feedback loops to produce very high gain amplifiers with pentodes and to provide necessary voltage stabilization. In a "starved amplifier" the tube operates at very small currents (on the order of microamperes) and very high resistances in the plate circuit, so that the gain of the stage can approach the static amplification factor of the tube. By using such amplifiers in the feedback loop of the stabilizer, as in Fig. 3, one can obtain very high stabilization coefficients with very low internal resistance.

Certain Properties of Circuits Containing Thermoresistances by G. K. Pechayev. AT 8/57, pp 740-748, 6 figs.

The temperature dependence of the conductance and resistance of two-terminal networks containing thermoresistances were determined by Beakley (Journal of Scientific Instruments, vol. 28, no. 6, 1951) and Bleuze, for certain specific cases. This article treats a general derivation of expressions for the conductivity and resistance, and indicates under what conditions the relations obtained are close to linear. A method is given for designing temperature compensators for thermoresistances.

Analysis of the Overdriven Mode of a Vacuum Tube Oscillator by Yu. V. Bogoslovskiy. RE 8/57, pp 28-41, 8 figs, 5 tables.

The author considers a procedure for the design of an overdriven vacuum tube oscillator, based on the use of graphs prepared for discrete values of the lower cutoff angle $\theta_1 = 75, 80, \text{ and } 90$ degrees.

The specified parameters are the oscillation power or the dc component of the plate current, the ratio of the dc component of the grid current to the dc component of the total current, and the lower cutoff angle θ_1 . The results of the calculations and instructions for the use of the graphs are given, and the results of calculations with the graphs are compared with results of calculations performed by grapho-analytic means.

Certain Problem in Resonant Amplification by A. G. Anisimov. RE 8/57, pp 54-58, 2 figs, 4 tables.

Nonlinear effects in resonant amplification are characterized by the ratio of the second derivative of the transconductance of the tube to the transconductance itself. The smaller this ratio, the less harmonic distortion and cross modulation, and the better the reproduction of the signal and the noise rejection of the radio receiver. The literature contains no formulas for the determination of this ratio, and this article tries to fill this gap. The data listed in the article lead to conclusions concerning the selection of tubes and the regulation of the amplifier.

(Continued on following page)

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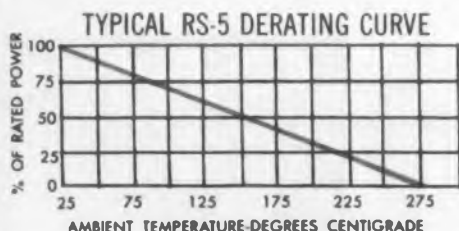
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RUSSIAN TRANSLATIONS

Certain Features of Transients in a Tuned Amplifier with Nonlinear Load by I. Ya. Kremer. RE 8/57, pp 59-65, 5 figs.

Tuned amplifiers with specially introduced nonlinear loads are used in receivers with logarithmic amplitude characteristics. These are used in radar stations to increase the noise rejection and to improve other characteristics of the radar receivers. The characteristic features of the transients in such a receiver are the dependence of the signal delay and of the output voltage rise time on the level of the input signal. This article deals with the effects of these characteristics on the accuracy of radar sets.

Notes on the Design of Networks for the Formation of Rectangular Pulses by P. N. Matkhanov. RE 7/57, pp 23-29, 5 figs.

The calculations in this article are based on network synthesis in the time domain. The approximations are made in the complex frequency domain by representing the hyperbolic functions in terms of the first factors of infinite products. The computation procedure is simple and makes it possible to take the load capacitance into account. Data are given on an experimental investigation of the forming network obtained.

Certain Problems in the Application of the Theory of Four Terminal Networks to the Design of Transistor Circuits by Kh. I. Cherne. RE 7/57, pp 41-50, 5 figs.

It is known that if a transistor is operating at weak signals, it can be considered as a linear irreversible four-terminal network, regardless of the method of connection (grounded base, grounded emitter, or grounded collector). In this case the analysis of transistor circuit can be made with methods developed in the ordinary four-terminal network theory. In practical applications, however, there are some inconsistencies between the notation and current directions adopted in transistor circuitry and those employed in four-terminal network theory. This article is devoted to a reconciliation of the two practices and contains an extensive list of matrix equations for various transistor circuits.

Use of Stepped Filter for the Correction of Transients in Linear Systems by V. I. Gukov. RE 7/57, pp 51-62, 14 figs.

"Stepped filters" are based on the use of delay elements interconnected to obtain specified response curves. American references on the subject are papers by Ford and Calvert (Transactions AIEE, May 1954) and Sonnenfeldt ("Selectivity and Transient Response Synthesis, IRE

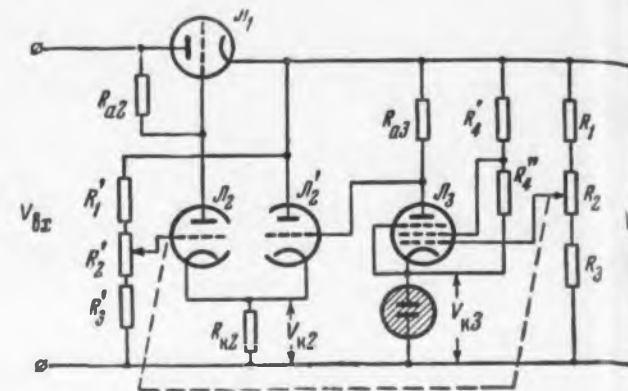


Fig. 3. The pentode in the feedback loop operates with a very high plate load resistance and helps provide excellent voltage regulation.

Transactions, BTR-1, No. 3, 1955). This article devoted to analytical and graphical calculation methods in the time domain. It is shown that cascade connection consisting of a stepped filter and a linear system can be described by an equation of arbitrary order making it possible to eliminate the transient within a specified time.

Transients in Ridge Filters by M. I. Finkel'shteyn. RE 7/57, pp 63-69, 5 figs.

The optimum filter for a signal in the form of a periodic sequence of pulses is the so-called ridge filter, i.e., a series of narrow band filters which are transparent for the spectral lines of the frequency spectrum of the signal. Such filters were described by Zadeh and Ragazzini (Optimum Filters for the Detection of Signals in Noise, Proceedings IRE, October 1952) and by Davis (Convention Record, IRE, Part 8, Information Theory, 1953). This article considers the response of a system of such filters to a single sinusoidal voltage step function. A method is proposed for determining the form of the transient amplitude and the time required to achieve steady state. It is shown that the initial slope of the transient amplitude is directly proportional to the number of filters.

INFORMATION THEORY

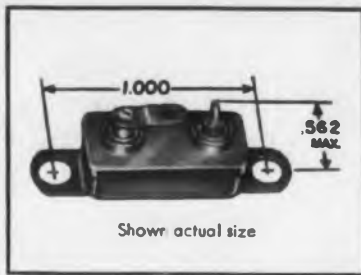
Noise Rejecting Codes by K. A. Meshkovskiy. RE 8/57, pp 3-12, 3 figs.

Based on the theory of the maximum possible noise rejection and on the geometrical theory of coding, the author explains the fundamental principles used in the compilation of noise rejecting codes. A geometric interpretation is given for the concept of optimum code. A very convenient criterion is proposed for comparison of codes. Extensive groups of noise rejection codes are given.

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TELEMETRY

Exponential Time-Pulse Converters by A. I. Novikov. AT 8/57, pp 749-755, 6 figs, 1 table.

Systems with time-pulse modulation are widely used in radio telemetering. Such systems have a relatively high noise rejection, relatively narrow band in the communication channel, and require simple circuitry. The converters used in them usually comprise Kipp relays or similar devices. Such converters have substantial shortcomings in that they have low stability with ambient temperature and supply voltage changes and with aging of tubes. Converters are described which generate exponential voltages and are shown to be preferable for the purpose. Various converter circuits are described. Among their advantages are independence of the variation in the supply voltage, a wide range of operating speeds, and the possibility of creating a multi-channel contactless telemetering system

Code Rings and Their Use in Telemechanical Systems by A. N. Radchenko. AT 8/57, pp 756-763, 10 figs.

The great interest in digital code methods of transmission and conversion of information is due to the fact that these methods make it possible to solve a great variety of problems requiring accuracy, remote operation, and high speed. However, the use of code methods in practice is frequently made difficult owing to the complexity of the coding and decoding apparatus. This article describes a new device that can simplify the problem, namely a coding ring, capable of representing a complete set of codes so as to present the same information in one compact form. Some principles of ring coding are elaborated in this article, and it is shown that they can be used to simplify the existing pulse-code devices used in telemetering and remote control.

TELEVISION

Allowance for the Integrating Properties of the Eye and of the Phosphor of the Screen in the Observation of a Television Image in the Presence of Fluctuating Noise by N. N. Krasilnikov. RE 8/57, pp 14-20, 3 figs.

The author investigates the process of averaging out fluctuation noise, observed on the screens of receiving television tubes due to the finite time of afterglow of the phosphor and to the time lag of visual perception. Equations are derived with which one can obtain the ratio of signal to noise with allowance for this averaging.

Notes on the Design of Amplitude Selector for Television Receiver by A. Ya. Korniyenko. RE 7/57, pp 15-22, 4 figs.

An "amplitude selector" is a network designed to separate the synchronizing pulses from the total television signal. The article treats selectors based on diodes as well as those employing amplifier tubes.

(Continued on following page)



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*—Ratings based on a 300°C rise in a 40°C ambient.

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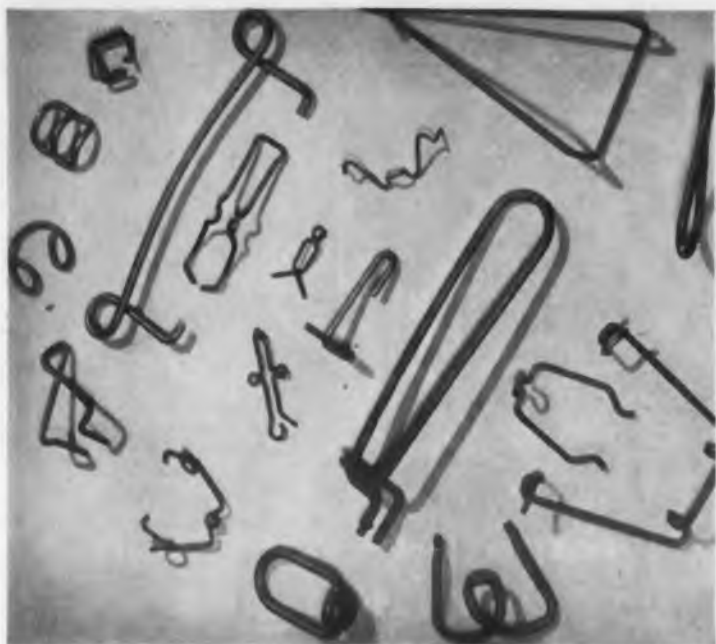
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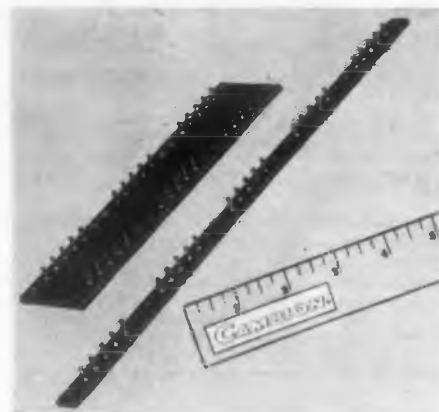
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RUSSIAN TRANSLATIONS

COMPONENTS

Frequency Behavior of Composite Transistors by A. G. Filippov. RE 8/57, pp 21-27, 11 figs.

Calculations from experimental data are given to show the features of the frequency dependence of the current gain of composite transistors compared with ordinary (non-composite) transistors. Reference is made to "Some Properties in Circuit Applications of Super-Alpha Composite Transistors" by A. R. Pearlman, Transactions IRE, ED-2, No. 1, 1955, pp 25-39.

New Type of High Power Oscillating Tetrode by Z. M. Lifshitz, G. M. Moskovskaya, and M. I. Pass. RE 8/57, pp 66-69, 6 figs.

List of basic characteristics and set of characteristic curves for a 10 kw oscillator tetrode designed for operation in the short wave band.

Design of Wide Band Transformers Operating Between Active Loads by V. I. Dubrovskaya. EC 8/57, pp 32-38, 1 fig.

In spite of the fact that the wide-band transformer is a widely used circuit element for long distance communication and for measurement, little attention has been paid so far to design procedures for such transformers. This article attempts to clarify certain relationships between the required performance of a wide-band transformer and parameters such as the transformation ratio, the winding and leakage inductances, the active resistance of the windings, the reflection coefficient, and the attenuation. Various equations are derived for the relationships between these parameters.

Certain Features of Aperture Correction of Cathode Ray Tubes with Charge Storage by D. A. Novik. RE 7/57, pp 9-14, 6 figs.

The author published an article on cathode ray tubes with a charge storage in the May 1957 Radiotekhnika i Elektronika.

In the present article, the transfer characteristics of cathode ray tubes with charge storage are defined and used to analyze the aperture correction of such tubes. The aperture correction features are characterized by allowance for the phase distortion that are inherent in cathode ray tubes with charge storage, unlike tubes without charge storage, which introduce no distortion.

MEASUREMENTS

Equivalent Electric Parameter of Quartz Plates Excited at Higher Harmonics by M. M. Pruzhanskiy. RE 8/57, pp 42-53, 9 figs.

The author gives a description and the theoretical analysis of two independent methods of measuring the equivalent parameters of quartz operating at higher harmonics. The first method involves the substitution of the quartz crystal in an oscillating circuit, and the second involves a resonant measurement method with the aid of a

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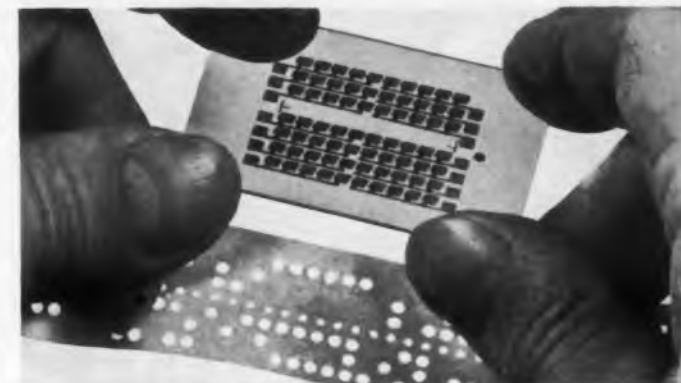
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Q meter. Results of the measurement of the quartz parameters are given. It is shown that the performance of the quartz first improves with increasing number of harmonics, reaches a maximum, and upon further increase in the number of harmonics it begins to give poor performance. Refers to standard works by Vigoureux, Cady, and Mason.

PROPAGATION

Electrons, Photons, and Radiowaves by L. B. Slepyan. RE 8/57, pp 3-12, 2 figs.

This is a speculative article, in which radio wave propagation is considered from the point of view of the possible role of electrons and photons. The possibility of experimental verification of the existence of radiophotons is considered.

Approximate Calculation of the Relative Power of Parasitic Radiation of UHF Transmitters by Ya. I. Efrussi. EC 8/57, pp 13-19, 3 figs.

Examination of one of the possible methods of approximate computation of the relative power of parasitic radiation of transmitters with multiple frequency multiplication and with a single master generator.

MISCELLANY

Design of Electromagnetic Systems by Means of Electrical Analogs by S. A. Aleskerov. AT 8/57, pp 764-772, 4 figs.

The distribution of magnetic fields in electromagnetic systems is determined by means of field plotting techniques known from electrostatic theory. This is applicable to configurations which can be reduced to the external Dirichlet problem for the Laplace equation.

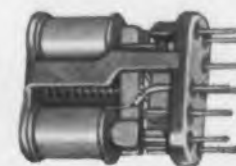
Synchronous Single-Machine Electric Drive with Magnetic Amplifier for Facsimile Apparatus by O. B. Pevzner and K. A. Brusilovskiy. EC 8/57, pp 61-68, 3 figs.

Description of an economical system for the synchronization of the electric drive of a facsimile apparatus using a dc motor and a high-frequency generator, both having a common magnetic circuit. Instead of using an electronic brake, the high-frequency generator is shunted with a magnetic amplifier, controlled by a phase discriminator circuit. Expressions are given for the motor and generator power as functions of the voltage and load. Approximate linear dynamic equations are derived, from which it is possible to determine the influence of the lag of the magnetic amplifier on the stability of the system.

Formulation of Problems in the Theory of Periscopic Antennas by B. Ye. Kinber and A. M. Pokras. RE 7/57, pp 30-40, 4 figs.

A periscopic antenna is the microwave analog of an ordinary optical periscope, consisting of two parts—the basic antenna (dipole) placed on the surface of the earth, and a reflector mounted at great height. The article is devoted to the analysis and synthesis of such an antenna.

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GERMAN ABSTRACTS

Transistor Oscillator for 8mc

E. Brenner

AN AMPLIFIER with feedback as shown in Fig. 1 can be described by the equations

$$\begin{aligned} V_1 &= A_1 V_2 + B_1 I'_2 & V_2 &= A_2 V_1 + B_2 I_F \\ I'_1 &= C_1 V_2 + D_1 I'_2 & I'_F &= C_2 V_1 + D_2 I_F \\ I'_1 &= I_1 + I_F; & I'_2 &= I_2 + I'_F; & V_2 &= Z_L I_2 \end{aligned}$$

To obtain the conditions for oscillations the current amplification I_2/I_1 is found as a fraction of combinations of the various parameters and the denominator of this fraction is set to zero. The result is the elaborate equation

$$1 - A_2 \left(A_1 + \frac{B_1}{Z_L} \right) - B_1 C_2 - B_2 \left(C_1 + \frac{D_1}{Z_L} \right) - D_1 D_2 + \Delta_1 \Delta_2 = 0$$

where

$$\Delta_1 = (A_1 D_1 - B_1 C_1) \text{ and}$$

$$\Delta_2 = (A_2 D_2 - B_2 C_2)$$

Using the simplified high frequency

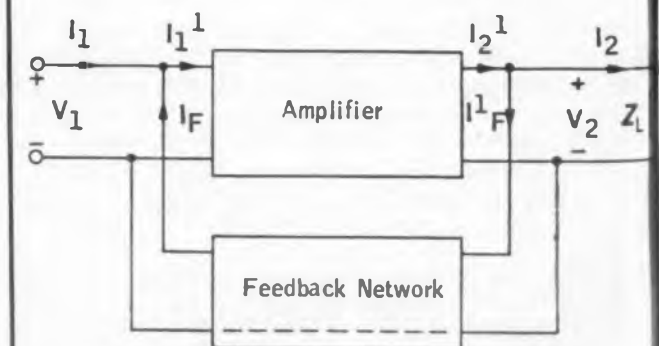


Fig. 1. Feedback amplifier with load.

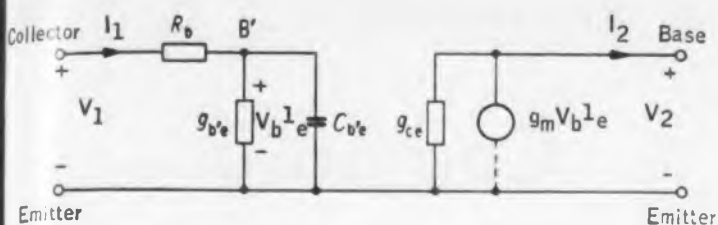


Fig. 2. Simplified high-frequency equivalent circuit of the transistor.

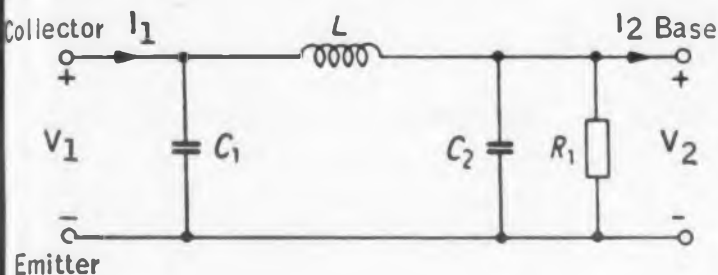


Fig. 3. Feedback network without load.

equivalent circuit of the transistor amplifier shown in Fig. 2 and the equivalent circuit of the feedback network shown in Fig. 3, equations for L_1 , C_1 and C_2 can be deduced.

The equivalent circuit arrangement applies to the crystal controlled transistor oscillator shown in Fig. 4.

Even with these equations for the parameters, numerical results are not immediately applicable because of loading and other practical problems.

Nevertheless these values were used as a guide to design an oscillator which was to be tested for stability.

It was found that at no-load the oscillator had a temperature coefficient which showed a relative decrease in frequency of 7.10^{-5} per cent per deg C. Low load resistances increased this effect while for values of R_L above 50 K ohms the frequency was independent of load.

The dependence of the frequency on

the supply voltage (at the base) indicates a $1.5 \cdot 10^{-4}$ per cent decrease in frequency for a 20 per cent increase in supply voltage.

Investigation of the input side of the amplifier revealed that a 10 per cent increase in temperature increased the emitter current 26 per cent above its nominal value, while the input impedance remained constant. Some attempt was made to adjust R_1 , as shown in Fig. 4, to compensate for the effect of input parameter variation but no general procedure could be found.

The original paper includes all numerical values of the oscillator as well as the design procedure and the results of the stability tests in the form of numerous convenient curves.

Abstracted from an article by H. Scheffhauser and M. J. O. Strutt, Archiv Der Elektrischen Uebertragung, Vol. 11, No. 11, Nov. 1957, pp 455-460.

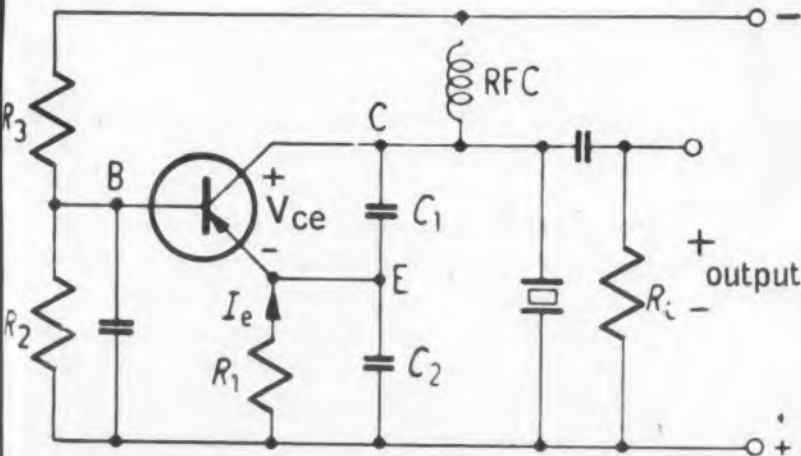


Fig. 4. Transistor oscillator for 8 mc. A Philco transistor SB100 is used. The unmarked capacitors are for blocking.

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ALTHOUGH many hundreds of stages are required in computer design, a single basic tube circuit or pulse repeater, with minor modifications, is adaptable to the majority of computer requirements. The same basic circuit, when combined with delay lines as needed, can serve as a low-impedance pulse driver, as a flip-flop and in a number of gating functions. This general circuit uniformity invites the use of mass-produced packages.

Tube Package

The tube package contains a tube, a pulse transformer, five *and*-gates, an *or*-gate for feeding the output of the gates to the grid of the tube, and an output *or*-gate to permit the transformer to drive the gates of subsequent packages. Not all of the components are connected together in their normal operating configuration inside the package. Instead, leads are brought out to the plug, as shown in Fig. 1, and the connections are wired into the socket. This procedure facilitates trouble shooting and provides many possible component combinations.

The component side of the tube package shown in Fig. 2. The tube is the type 404A, high-transconductance pentode. The transformer consists of a ferrite, two-piece cup core with



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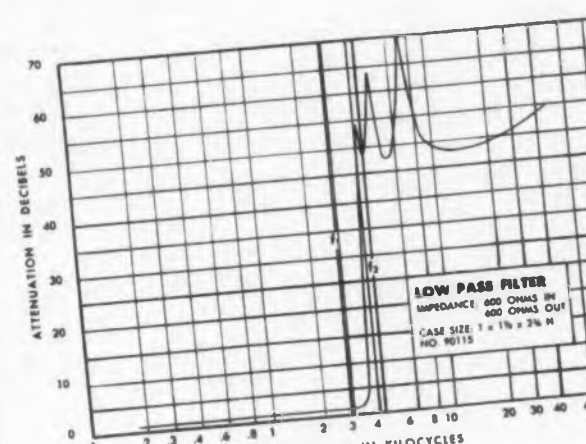


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90435	600	6000	9000
90436	5000	6000	9000
90437	10000	6000	9000
90438	600	10000	15000
90439	5000	10000	15000
90440	10000	10000	15000
90441	600	15000	22500
90442	5000	15000	22500
90443	10000	15000	22500



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30-turn primary and two 5-turn secondaries. Two types of diodes are used in the packages: one on the grid side of the tube, where low capacitance and low-voltage drop for low currents are of greatest importance; a second at the output of the transformer, where there is a low-voltage drop for high currents. A number of deposited carbon resistors are used, the largest of which are rated at 0.25 w. Two bypass capacitors are included.

One of the five *and*-gates is used only to shape and set the duration of the pulse. Of the other four *and*-gates, one has provision for four inputs, two for five inputs, and one for six inputs. In addition there is a clock input to each gate to govern pulse timing. All *and*-gates are con-

nected to the grid at all times; if a gate is not used, -1.8 v must be connected to one of its inputs to prevent it from operating.

One of the transformer secondaries is always connected to provide a positive output pulse required for regeneration. A direct output from this secondary is provided, as well as an indirect output separated from the transformer by a buffer *or*-gate. The indirect output of the package is sent to *and*-gates of other tube packages. The direct output goes through either a delay line or a logical *or*-gate before the input *and*-gate of the next tube package. The other secondary can be left unconnected, although it normally is connected to provide a negative output pulse whenever required.

(Continued on following page)

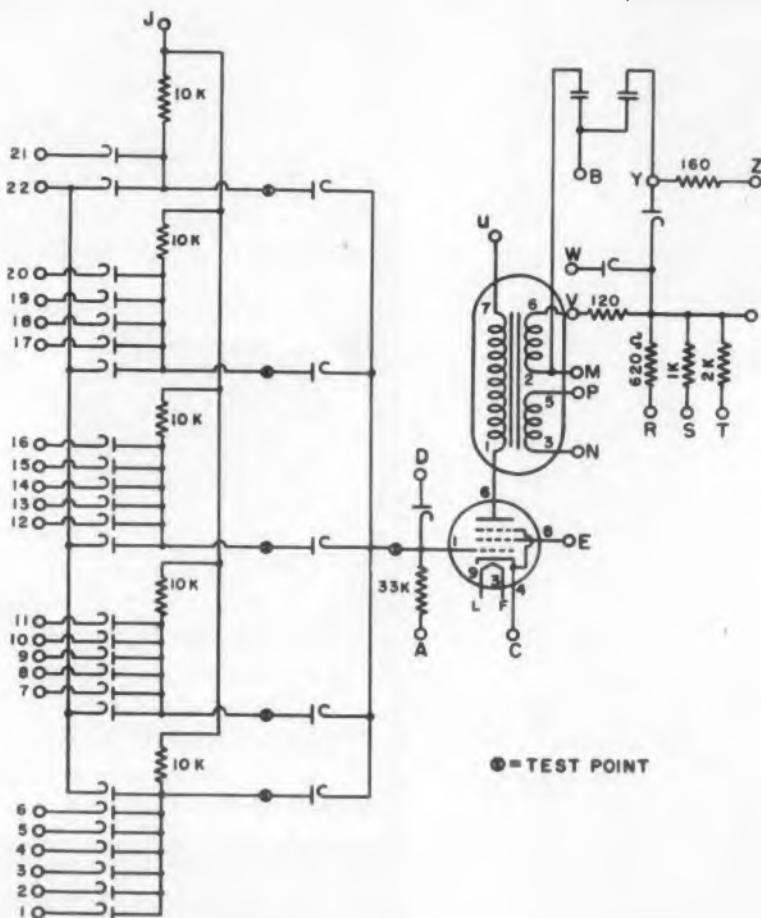


Fig. 1. Circuit diagram for the low-power plug-in computer package.

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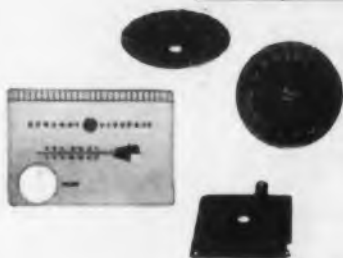
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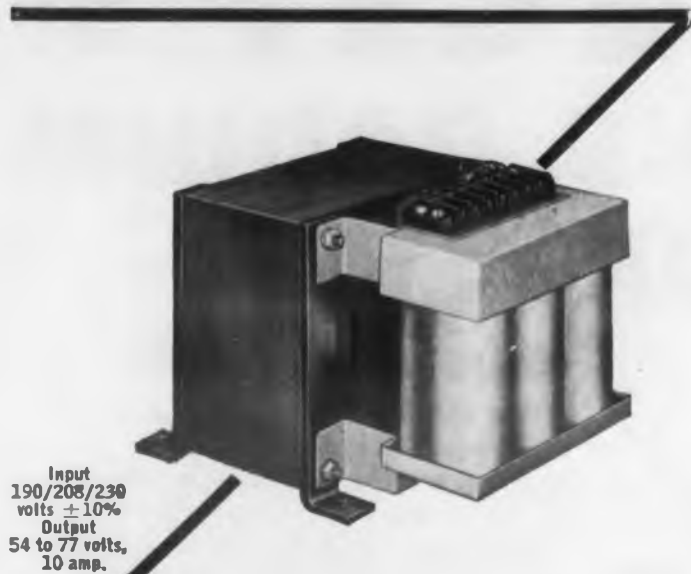
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The loading of the package is expressed in terms of the equivalent number of gates which a tube can drive. The unit load is an *or*-gate that is driven directly from the positive output of a transformer, and in turn drives a single *and*-gate. The maximum resistive load which a tube package can drive is 34 gates in addition to the regeneration gate.

Delay-Line Package

The delay line package contains 11 sections of delay line, some of which are permanently connected together. It also contains a number of delay-line terminations consisting of resistor-diode networks. Two of these terminations are

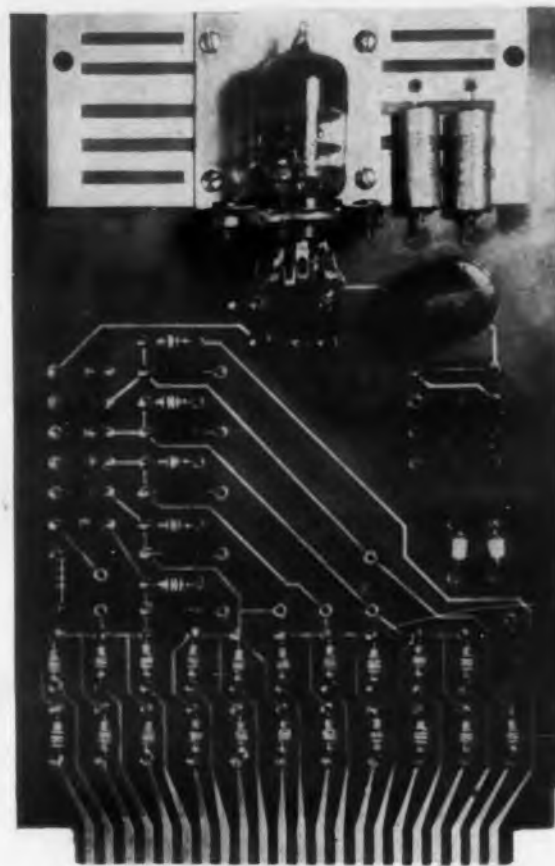


Fig. 2. Component side of tube package.

for negative pulses and five for positive pulses. Each termination is made up of an input section, connected to the direct transformer output of a previous stage, and an output section, connected to the *and*-gate input of the next package. Some of the positive terminations are combined with *or*-gates and others are permanently connected to delay line sections to make best use of the available number of pins on the connector. The component side is shown in Fig. 3.

Since the positive output termination includes some of the same components that an *or*-gate requires, it is easy to add an extra *or*-gate input to a termination to make it either an *or*-gate or a termination, or both. One of the positive output terminations has three of these diodes perma-

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mently connected in, and another one has two. One of the positive input terminations has an extra diode added to form a logical *or*-gate that can be used when two signals are to go to the same *or*-gate and receive the same delay.

Mounting

The tube and delay line packages are mounted on 4-1/2 in. x 7 in. printed circuit boards designed to plug into conventional 44 pin printed circuit connectors. The center-to-center spacing of adjacent packages when mounted in a rack is 1-1/8 in. to accommodate the type 404A tube. The printed circuit boards are 1/16 in. epoxy glass double-clad with 0.0027 in. copper foil.

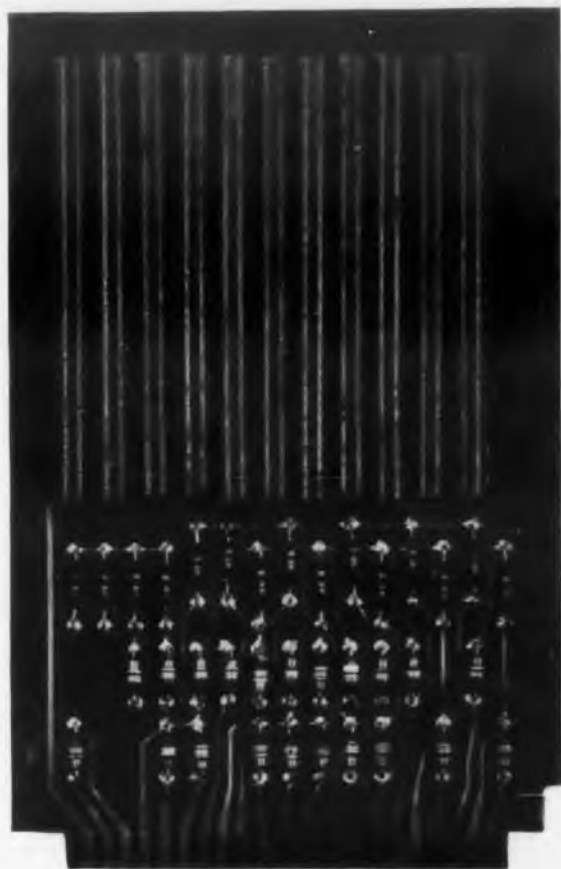
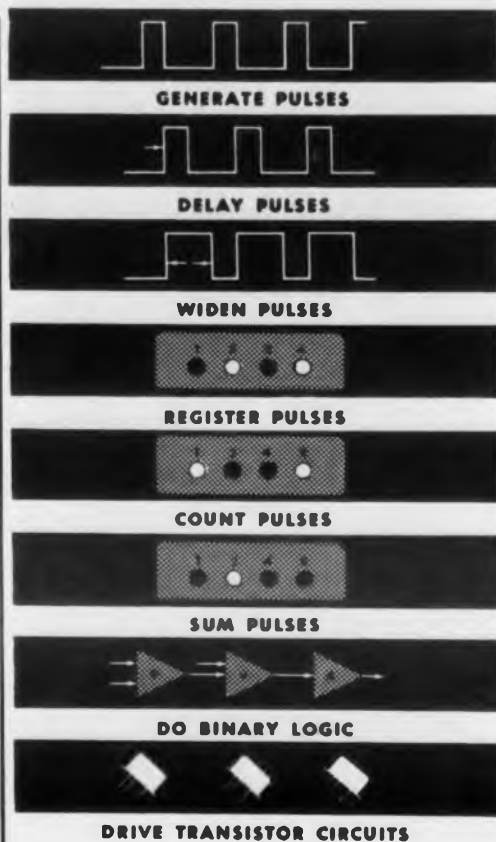


Fig. 3. Component side of delay line package.

Since all components are mounted on one side of the board, dip-soldering is appropriate only on the other side. If the component side is to be soldered, it must be done by hand. To avoid the necessity of soldering both sides, eyelets for making connections from one side of the board to the other are not used in the packages. Instead, all component mounting holes are plated through. Several test points are provided on the board to facilitate complete individual component-checking after mounting. These points are also plated-through holes into which small test pins can easily be inserted.

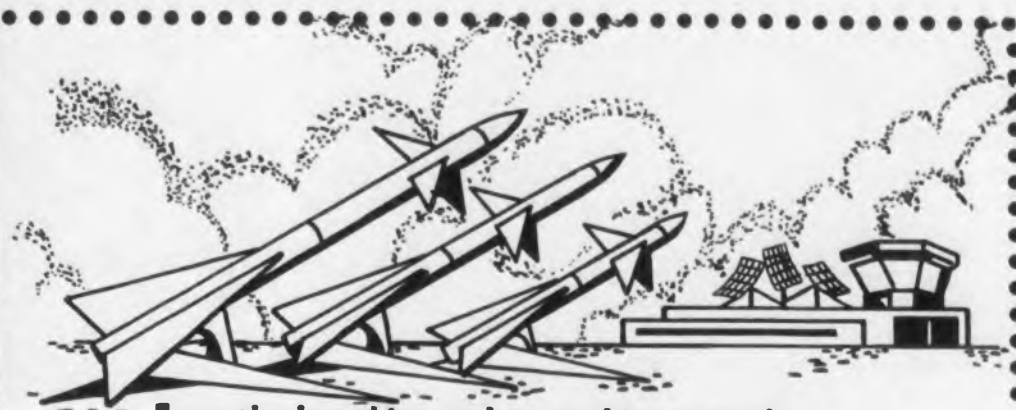
Photocopies of the printed circuit conductor patterns for the tube and delay line packages may be obtained by writing to the editors of ELECTRONIC DESIGN.



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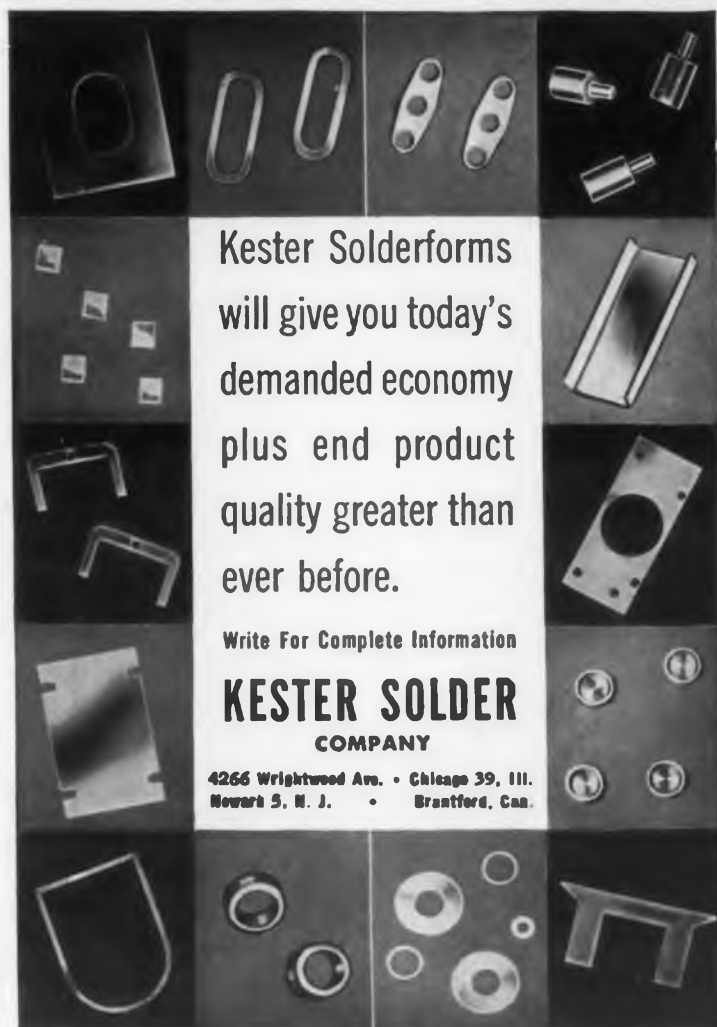
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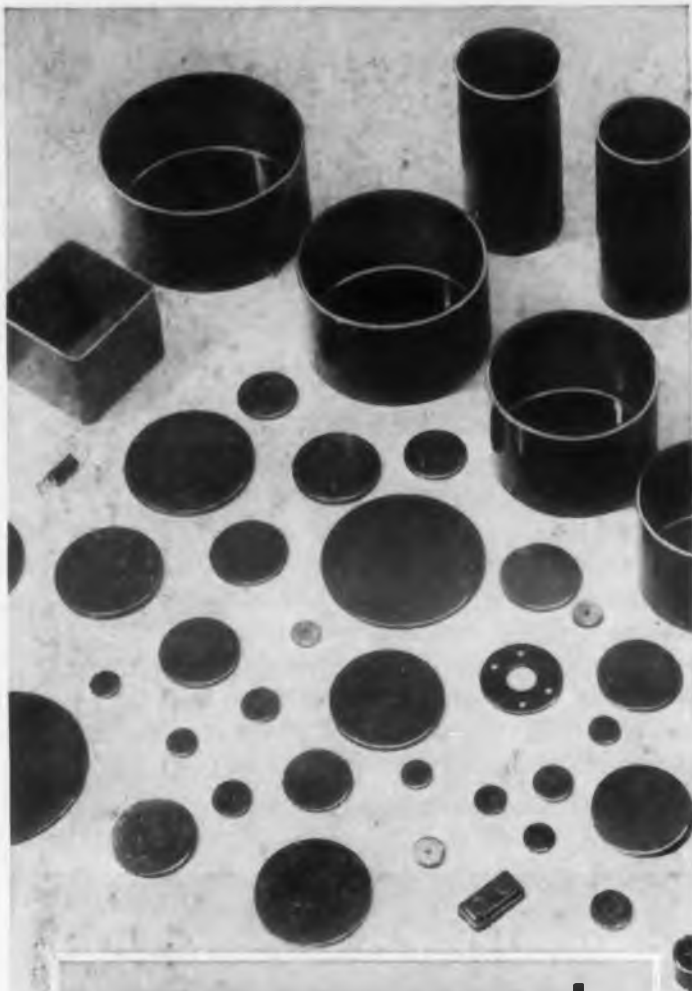


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Waveguides

EIA RS-200, CIRCULAR WAVEGUIDE, JANUARY 1958 Standards have been established by this spec for 39 rigid circular waveguides. Included in this standard are definitions of nominal inside diameter, wall thickness, out-of-roundness, frequency range, and bow. A typical EIA designation for a waveguide meeting this standard is WC150B. Copies of this standard may be obtained from the Electronic Industries Association, Engineering Department, 11 West 42nd Street, New York 36, N.Y. for 30 cents per copy.

Connectors

MIL-C-3767A, CONNECTORS, ELECTRICAL (POWER, BLADED TYPE), GENERAL SPECIFICATION FOR, 23 SEPTEMBER 1957

The general requirements for power-type electrical connectors are established by this edition of this spec. Superseding the June 12, 1952 issue, this spec covers plugs and receptacles with bladed contacts for use in d-c circuits up to 600 volts or in a-c circuits up to 600 volts at frequencies up to 400 cycles. A typical type designation for a plug meeting this spec is UP101M; a typical receptacle designation is UR101M. Included as part of the spec are eleven detail specs for specific plugs and receptacles.

Microwave Transmission

EIA RS-203, MICROWAVE TRANSMISSION SYSTEMS, JANUARY 1958

Minimum performance requirements for the r-f portion of microwave relay systems are detailed in this standard. Definitions of pertinent systems parameters are given and methods of measurements are included. This standard applies to line-of-sight systems. The emphasis in this standard has been to establish a common language and define certain reference points in the system, rather than to standardize on specific values. Terminology used by recognized organizations has been used wherever applicable. This standard includes new terms and definitions not previously available. Copies of this standard may be obtained from the Electronic Industries Association, Engineering Department, 11 West 42nd Street, New York 36, N.Y. for \$1.30 per copy.

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Mobile Receivers

EIA RS-204, MINIMUM STANDARDS FOR LAND-MOBILE COMMUNICATION FM OR PM RECEIVERS, JANUARY 1958

Standard test conditions are established to apply to a receiver while it is being tested for minimum requirements. Definitions, methods of measurement, and minimum standards are given for usable sensitivity, quieting sensitivity, audio squelch sensitivity, modulation acceptance bandwidth, adjacent channel selectivity and desensitization, spurious response attenuation, intermodulation spurious attenuation, audio power output, audio frequency response, hum and noise ratio, power supply voltage range, undesired conducted power, undesired radiated power, temperature range, high humidity, vibration stability, and shock stability. Copies of this standard are available from the Electronic Industries Association, Engineering Department, 11 West 42nd Street, New York 36, N.Y. for 90 cents per copy.

Printed Circuits

MIL-STD-429, PRINTED CIRCUITS, TERMS AND DEFINITIONS, 13 DECEMBER 1957

Preferred terms generally used with printed circuits are established and defined by this standard. Other synonymous terms which in the past have been used with printed circuits are cross referenced; however, only the preferred term is defined.

Capacitors

EIA RS-205, ELECTROLYTIC CAPACITORS FOR USE PRIMARILY IN TRANSMITTERS AND ELECTRONIC INSTRUMENTS, JANUARY 1958

Special types of polarized, aluminum electrolytic capacitors are covered by this standard which is a revision of TR-140. These capacitors are intended for use primarily in low-frequency filter, by-pass, and coupling applications in transmitters and electronic instruments where the service is normally d-c and where a high degree of reliability is essential. The capacitors covered by this standard are intended for operation over a maximum ambient temperature range of -20°C to $+85^{\circ}\text{C}$ and where the operation at ambient temperatures above 65°C is not expected to exceed 10 to 15 per cent of the total operating time. Covered in this standard are ratings, styles, case sizes, test conditions, and basic requirements. A typical EIA designation for a capacitor meeting this standard is RCEO1A. Copies of this standard may be obtained from the Electronic Industries Association, Engineering Department, 11 West 42nd Street, New York 36, N.Y. for 80 cents per copy.

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Mr. Emmanuel A. Blasi, right, Manager of Antenna and Propagation Department, discusses results of radiation performance after antenna pattern measurements with staff scientist Allen S. Dunbar. Column bearing missile in background is operated automatically from laboratory.

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Just connect and read powers 10 mw to 10 watts!



-hp- 434A

Covers dc to 10 KMC

No barretter or thermistor needed

No external terminations or plumbing

Measures CW or pulsed power

No technical skill required

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mic power meter

Stated simply, the new *-hp-* 434A Calorimetric Power Meter offers you this:

The fastest, easiest means yet devised to measure powers accurately from 10 mw to 10 watts between dc and 10 KMC.

With the 434A, measurement is literally as simple as connecting to a 50 ohm, type N front panel terminal and reading power directly. The instrument is particularly ideal for use by non-technical personnel.

The new meter fills the important range between bolometer-type microwave power meters (such as *-hp-* 430C at right) and conventional calorimeters whose lower range is approximately 10 watts. But unlike previous cumbersome equipment suggested for its range, the *-hp-* 434A is completely self-contained and requires no external detectors or plumbing of any type.

Rapid Response Time

Model 434A employs a self-balancing bridge and a high efficiency heat transfer system to and from an oil stream to provide a full scale response time of 10 seconds or less. This fast response, a fraction of the reaction time needed by ordinary calorimeters, means the 434A quickly follows small adjustments in input tuning circuits. Further, the use of twin power sensitive elements in one oil stream plus a feedback system makes the accuracy virtually independent of variations in oil flow rate or ambient temperature, and prevents fluctuations due to changes in oil flow rate or oil temperature.

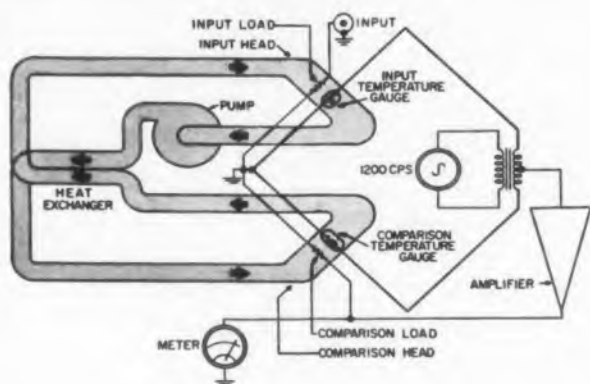


Figure 1. *-hp-* 434A Calorimetric Power Meter

New *-hp-* 434A comprises two load resistors, one for input and one for comparison power, a self-balancing bridge with temperature sensitive gauges in input and comparison legs, and an indicating meter. Heat dissipated in the input load resistor heats the gauge in the input leg and unbalances the bridge. The unbalanced signal is amplified and applied to the comparison resistor. The heat thus generated is transferred to the gauge in the comparison leg and rebalances the bridge. The meter measures the power supplied to the comparison gauge to rebalance the bridge. Since heat transfer and temperature sensitivity are identical, the meter reads input power direct, with presentation in watts or DBW.

For complete details, see your
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SPECIFICATIONS

-hp- 434A Calorimetric Power Meter

Input Power Range:	7 ranges; full scale readings of 0.01, 0.03, 0.1, 0.3, 1.0, 3.0 and 10 watts. Meter calibrated -10 to 0 DBW, continuous readings -30 to +10 DBW.
Frequency Range:	dc to 10 KMC
dc Input Impedance:	50 ohms \pm 5 ohms at Type N input jack
Input SWR:	Less than 1.5 full range
Meter Response: (Full Scale)	Approximately 10 seconds on highest range, approximately 2 seconds on lower ranges.
Controls:	Zero Set and Meter Range
Accuracy:	Within 5% full scale
Power:	115/230 v \pm 10%, 50/60 cps, approximately 155 watts.
Size:	Cabinet: 20 1/2" wide, 12 1/2" high, 14 1/4" deep. Rack: 19" wide, 10 1/2" high, 13 1/2" deep. Wt. 50 lbs.
Price:	\$1,115.00 (cabinet) \$1,100.00 (rack mount)

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

Microwave Power Meter

0.1 to 10 mw, CW or pulsed, without calculations!



-hp- 430C Microwave Power Meter is the finest, most dependable source of milliwatt power measurements offered. It gives you power readings direct in db or mw and eliminates all computation or adjustment during measurement. The instrument measures either pulsed or CW power, on either coaxial or waveguide systems. Operation is entirely automatic, and accuracy is \pm 5% of full scale reading. For CW or pulsed power measurements, *-hp-*

430C uses either an instrument fuse, barretter or thermistor as a bolometer element. Operation may be at either 100 or 200 ohms. Power is read direct in mw from 0.02 to 10 mw, or in dbm from -20 to +10 dbm. The broad nominal range may be extended by means of directional couplers and attenuators.

SPECIFICATIONS

Power Range: 5 ranges, front panel selector. Full scale readings of .1, .3, 1, 3, and 10 mw. Also continuous readings from -20 to +10 dbm. (0 dbm = .001 watt). Power range may be extended with attenuators or directional couplers in microwave system.

External Bolometer: Frequency range depends on bolometer mount. Bolometers can operate at resistance levels of 100 or 200 ohms and can have positive or negative temperature coefficients. Any dc bias current up to 16 ma is available for biasing positive or negative temperature coefficient bolometers. Dc bias current is continuously adjustable and independent of bolometer resistance and power level range.

Suitable bolometers are:

Instrument fuses: *-hp-* G-28A and G-28B 1/100 amp fuse.

Barretters: Sperry 821, Narda N821B or N610B, PRD 610A, 614, 617 or 631C.

Thermistors: Western Electric D166382, Victory Engineering Co. 32A3, 32A5, Narda 333, 334.

Accuracy: \pm 5% of full scale reading.

Power: 115/230 v \pm 10%, 50/1,000 cps, 75 watts.

Dimensions: Cabinet Mount: 7 3/8" wide, 11 1/2" high, 14" deep. Rack Mount: 19" wide, 7" high, 12 1/2" deep.

Weight: Net 14 lbs. Shipping 32 lbs. (cabinet mount).

Price: \$250.00.

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