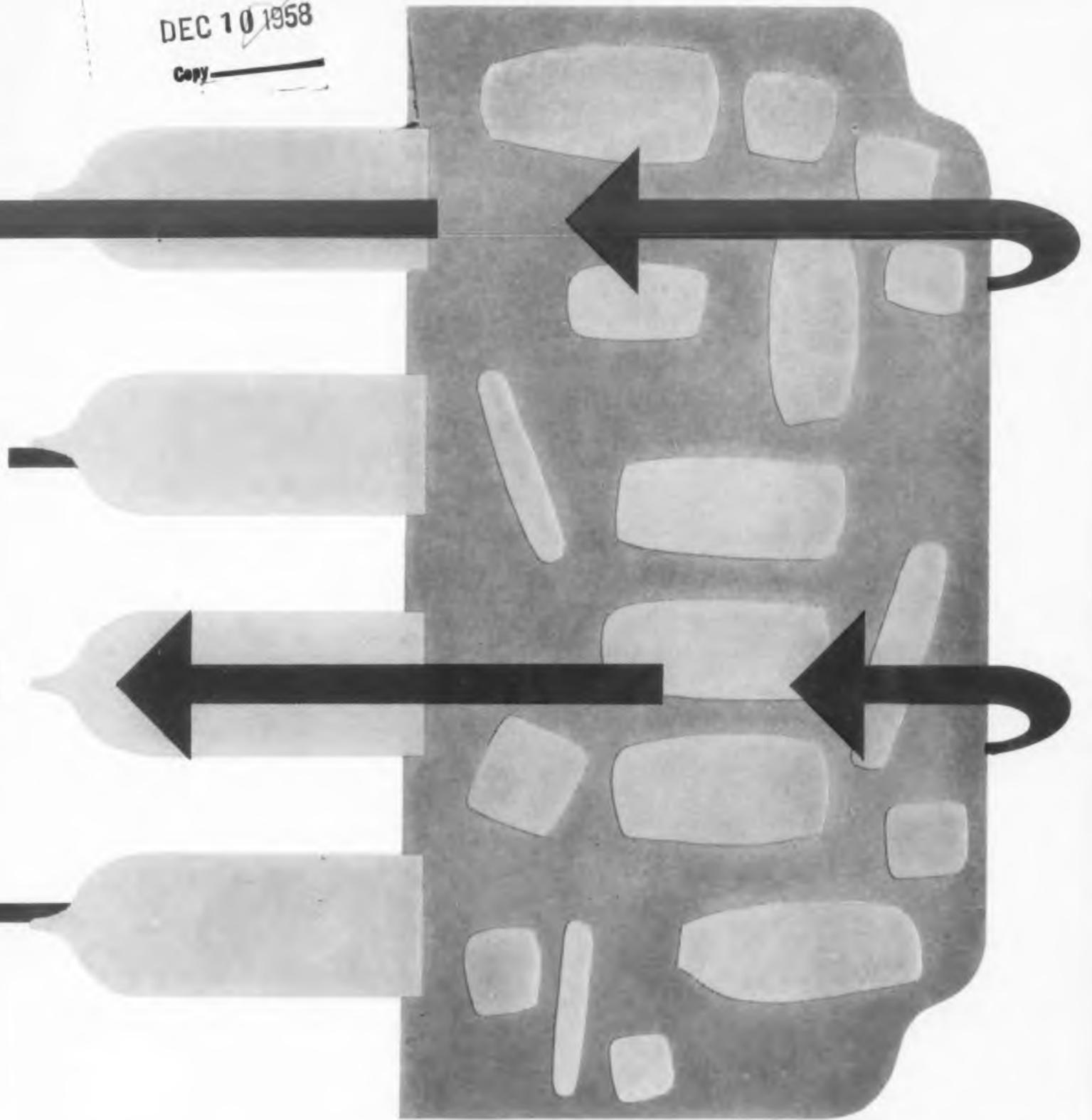


ELECTRONIC DESIGN

DECEMBER 10, 1958

THE CONGRESS
SERIAL RECORD
DEC 10 1958
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Immediate
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MAGNETIC AMPLIFIERS AND SATURABLE TRANSFORMERS

FAST RESPONSE MAGNETIC AMPLIFIERS

2~ response Phase reversible

Cat. No.	Supply Freq. C.P.S.	Power Out. Watts	Volt. Out. V. AC	AC or DC signal voltage req'd for full output.
RAF-1	60	13	110	1.0
RAF-4	400	5	57.5	Designed to be driven from vacuum tube or transistor preamplifier.
	400	10	57.5	
RAF-5	400	13	54	1.2
RAF-6	400	5	57.5	1.6
	400	10	57.5	0.6
RAF-7	400	15	57.5	2.5

SINGLE ENDED MAGNETIC AMPLIFIERS

Cat. No.	Supply Freq. C.P.S.	Power Out. Watts	Sig. req'd for full out. MA-DC	Total res. contr. wdg. K Ω	Load res. ohms
AO-1	60	4.5	3.0	.685	3800
AO-2	60	20	1.8	1.3	700
AO-4	60	400	9.0	10.0	25
AO-5	60	575	6.0	10.0	25

PUSH-PULL MAGNETIC AMPLIFIERS

Phase reversible

Cat. No.	Supply Freq. C.P.S.	Power Out. Watts	Volt. Out. V. AC	Sig. req'd for full out. MA-DC	Total res. contr. wdg. K Ω
AAP-1	60	5	115	1.2	1.24
AAP-2	60	15	115	1.6	2.4
AAP-3	60	50	115	2.0	0.5
AAP-3-A	60	50	115	7.0	2.9
AAP-4	60	175	115	8.0	6.0
AAP-7	400	15	115	0.5	8.8
AAP-8	400	50	115	1.75	0.6
AAP-11	400	10	115	.7	6.6

SATURABLE TRANSFORMERS

Phase reversible

Cat. No.	Supply Freq. in C.P.S.	Power Out. Watts	Volt. Out. V. AC	Sig. req'd for full out. MA-DC	Total res. contr. wdg. K Ω
MAS-1	60	15	115	6.0	27
MAS-2	400	6	115	4.0	10
MAS-5	400	2.7	26	4.0	3.3
MAS-6	400	30	115	4.0	8.0
MAS-7	400	40	115	5.5	8.0

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AUDIO TRANSFORMERS—STANDARD

Frequ. resp. 300 to 10000 c.p.s. \pm 2 db.

Cat. No. MGA	Type Designation TF1RX	IMPEDANCE LEVEL						Ratio	Max. Power DBM	Max. MA DC Unbal.
		Prim. K Ω	Cl.	Split	Sec. Ω	Cl.	Split			
-1	-15AJ	10.	\checkmark		90K	\checkmark	\checkmark	1:3	+15	10
-2	-16AJ	.6	\checkmark		4, 8, 16			6.12:1	+33	0
-3	-10AJ	.6	\checkmark		135K	\checkmark		1:15	+15	0
-4	-16AJ	.6	\checkmark		600	\checkmark		1:1	+15	0
-5	-13AJ	7.6 4.8			600	\checkmark		3.56:1	+33	40
-6	-13AJ	7.6 4.8			4, 8, 16			21.8:1	+33	40
-7	-13AJ	15.	\checkmark		600	\checkmark		5:1	+33	10
-8	-13AJ	24.	\checkmark		600	\checkmark		6.32:1	+30	1
-9	-13AJ	60.	\checkmark		600	\checkmark		10:1	+27	1

POWER TRANSFORMERS—STANDARD

All primaries 105/115/125 v., 60 c.p.s.

Cat. No. MGP	Type Designation TF1RX	Hi V	V DC	A DC	Fil. #1		Fil. #2	
					V	A	V	A
-1	-03HA001	400/200	185	.07	5 6.3	2	6.3	3
-2	-03JB002	650ct	260	.07	5 6.3	2	6.3	4
-3	-03KB006	650ct	245	.15	6.3	5	5.	3
-4	-03LB003	800ct	318	.175	5.	3	6.3	8
-5	-03MB004	900ct	345	.25	5.	3	6.3	8
-6	-02KB001	700ct	255	.25	400 ~ single and			
-7	-02LB002	1,100ct	419	.25	60 and 400 ~ three			
-8	-02NB003	1,600ct	640	.25	phase on special order			

FILAMENT TRANSFORMERS—STANDARD

All primaries 105/115/125 v., 60 c.p.s.

Cat. No. MGF	Type Designation TF1RX01	V	I A	Test KV	Cat. No. MGF	Type Designation TF1RX01	V	I A	Test KV
-2	-GB003	2.5	10	2.5	-7	-JB008	6.3	10	2.5
-3	-FB004	5.	3	2.5	-8	-KB009	6.3	20	2.5
-4	-HB005	5.	10	2.5	-9	-JB012	2.5	10	10.
-5	-FB006	6.3	2	2.5	-10	-KB013	5.	10	10.

*400 ~ single and 60 and 400 ~ 3 phase on special order

FILTER REACTORS

Cat. No. MGC	L Hy.	I DC MA	R DC Ω	Test KV	Case	Cat. No. MGC	L Hy.	I DC MA	R DC Ω	Test KV	Case
-2	4.	50	230	1.	AJ	-18	7.	200	135.	2.	HB
-3	10.	50	325	1.	EB	-19	10.	200	125.	2.5	JA
-4	20.	50	475	1.5	FA	-20	2.5	300	50.	2.	GA
-5	30.	50	650	1.5	FA	-21*	4.	300	62.	2.5	HB
-6	3.	75	175	1.	AJ	-22	6.	300	85.	2.5	JB
-7	6.	75	235	1.5	EB	-23*	8.	300	65.	2.5	KB
-8	12.	75	265	1.5	FA	-24	10.	300	100.	2.5	LA
-9	3.5	100	145	1.	EB	-25*	2.	400	37.	2.5	HB
-10	8.	100	180	1.5	FA	-26	6.	400	60.	2.5	KB
-11	12.	100	190	2.	GA	-27*	2.	500	35.	2.5	JA
-12	2.	150	92	1.5	EB	-28	4.	500	45.	2.5	KB
-13	4.	150	115	1.5	FA	-29*	7.	500	50.	2.5	MB
-14	8.	150	125	2.	GA	-30*	2.	700	20.	2.5	LB
-15	11.	150	120	2.5	JB	-31*	1.75	1,000	12.5	2.5	MB
-16	2.5	200	70	1.5	FA	*Not stocked, available on short del.					

PULSE TRANSFORMERS

Cat. No. MPT	Pulse Kilovolt	Duration Microsec.	Duty Rate	No. of Windings	Test KV	Z Ω
-1	.25 .25 .25	0.2-1.0	.004	3	.7	250
-2	.25 .25	0.2-1.0	.004	2	.7	250
-3	.5 .5 .5	0.2-1.5	.002	3	1.	250
-4	.5 .5	0.2-1.5	.002	2	1.	250
-5	.5 .5 .5	0.5-2.0	.002	3	1.	500
-6	.5 .5	0.5-2.0	.002	2	1.	500
-7	.7 .7 .7	0.5-1.5	.002	3	1.5	200
-8	.7 .7	0.9-1.5	.002	2	1.5	200
-9	1. .7 .1.	0.7-3.5	.002	3	2.	200
-10	1. .7 .1.	0.7-3.5	.002	2	2.	200
-11	1. .7 .1.	1.0-5.0	.002	3	2.	500
-12	.15 .15 .3 .3	0.2-1.0	.004	4	.7	700

TELEMETERING COMPONENTS

BAND PASS FILTERS					DISCRIMINATORS					
Cat. No. Z=500 Ω	Cat. No. Z=2,500 Ω	30dB Bandwidth per cent of F $_0$	Center Frequency F $_0$ (KC)	Per cent Deviation of F $_0$	Per cent Linearity	Cat. No.	FBP	FBP	9 3/4	19 1/2
-10	-34	\checkmark	.4	\checkmark	\checkmark	-10	-10	-34	\checkmark	\checkmark
-11	-35	\checkmark	.56	\checkmark	\checkmark	-11	-11	-35	\checkmark	\checkmark
-12	-36	\checkmark	.73	\checkmark	\checkmark	-12	-12	-36	\checkmark	\checkmark
-13	-37	\checkmark	.96	\checkmark	\checkmark	-13	-13	-37	\checkmark	\checkmark
-14	-38	\checkmark	1.3	\checkmark	\checkmark	-14	-14	-38	\checkmark	\checkmark
-15	-39	\checkmark	1.7	\checkmark	\checkmark	-15	-15	-39	\checkmark	\checkmark
-16	-40	\checkmark	2.3	\checkmark	\checkmark	-16	-16	-40	\checkmark	\checkmark
-17	-41	\checkmark	3.0	\checkmark	\checkmark	-17	-17	-41	\checkmark	\checkmark
-18	-42	\checkmark	3.9	\checkmark	\checkmark	-18	-18	-42	\checkmark	\checkmark
-19	-43	\checkmark	5.4	\checkmark	\checkmark	-19	-19	-43	\checkmark	\checkmark
-20	-44	\checkmark	7.35	\checkmark	\checkmark	-20	-20	-44	\checkmark	\checkmark
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-27	-51	\checkmark	30.0	\checkmark	\checkmark	-27	-27	-51	\checkmark	\checkmark
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-31	-55	\checkmark	52.5	\checkmark	\checkmark	-31	-31	-55	\checkmark	\checkmark
-32	-56	\checkmark	70.0	\checkmark	\checkmark	-32	-32	-56	\checkmark	\checkmark
-33	-57	\checkmark	70.0	\checkmark	\checkmark	-33	-33	-57	\checkmark	\checkmark

DISCRIMINATOR LOW PASS FILTERS

Cat. No.	Center Freq. F $_0$ (cps)	Cat. No.	Center Freq. F $_0$ (cps)	Cat. No.	Center Freq. F $_0$ (cps)	Attenuation
LPO-10	6	LPO-19	81	LPO-28	790	2 DB to 0.5 F $_0$ 7 DB to 1 F $_0$ 20 DB to 2 F $_0$ 30 DB from 2.5 F $_0$
-11	8	-20	110	-29	900	
-12	11	-21	160	-30	1,050	
-13	14	-22	185	-31	1,200	
-14	20	-23	220	-32	1,600	
-15	25	-24	330	-33	2,100	
-16	35	-25	450	-34	2,700	
-17	45	-26	600	-35	10,000	
-18	60	-27	660			

Characteristic impedance of all—330 Ω

INPUT

LPI	400	LPI-17	3,000	LPI-23	14,500
-11	560	-18	3,900	-24	22,000
-12	730	-19	5,400	-25	30,000
-13	960	-20	7,350	-26	40,000

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Hayden Publishing Co., Inc., 930 Third Avenue, New York 22, N.Y.

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BEHIND THE NEWS



New Radar Antenna Scans The Sky Without Moving

With 50 yards of drapery material bought in a Pittsburgh department store, Westinghouse scientists have built a working model of a new radar antenna which they say may be the forerunner of future antennas for powerful, long-range anti-missile radars.

Known as a Helisphere, it concentrates high-frequency radar waves into an intense, narrow, moving beam, scanning the sky in a complete circle without any motion of the antenna structure itself.

Dr. John W. Coltman, manager of the electronics and nuclear physics department, Westinghouse Research Labs, explained:

"A nonrotating design permits faster scan and track rates, and eliminates the driving power normally required to turn it. Antenna construction is simplified, and the problem of rotating bearings—especially acute in large ground-based

(continued on following page)

Ready to emerge through roof of Westinghouse Research Labs for its first test is six-foot model of Helisphere, an inflated drapery-material antenna which produces a rotating radar beam without rotation of the antenna structure itself.

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BEHIND THE NEWS

radar systems—is done away with. The Helisphere secures these advantages by substituting motion of radar energy inside the antenna for the customary rotation of the antenna structure itself."

Immovability of the structure would be particularly effective for stations of the early warning lines.

The Helisphere antenna is a sphere, either inflated like a balloon or rigid like a globe. Imbedded in the surface are narrow metal conducting strips wound in an endless spiral shape, or helix. In the drapery-material model, the helix was formed by the decorative metallic threads woven into the fabric when it was loomed. The fabric was placed around a rubber bladder inflated with air.

In operation, polarized radar waves are sprayed against the inside surface of the sphere so they vibrate parallel to the conducting strips and reverse their direction.



Portable Luxury

Described by Zenith as "the world's most elegant clock radio," the \$150 cordless, all transistor "Golden Triangle" powers its Swiss clock with a single flashlight "D" battery, its AM radio receiver with four mercury flashlight batteries. The three-sided die cast cabinet, with satin and gold surfaces, rotates at a touch to show its faces—the clock, radio dial and radio speaker grille. Designed for "move about" use, it includes a wake-to-music alarm.

◀ CIRCLE 4 ON READER-SERVICE CARD



Extensive studies in daylight photography of stars and planets through use of the "Cat Eye" are being conducted at Wittenberg College Observatory, Springfield, Ohio.

Direct View of Full Moon Photographed by "Cat Eye"

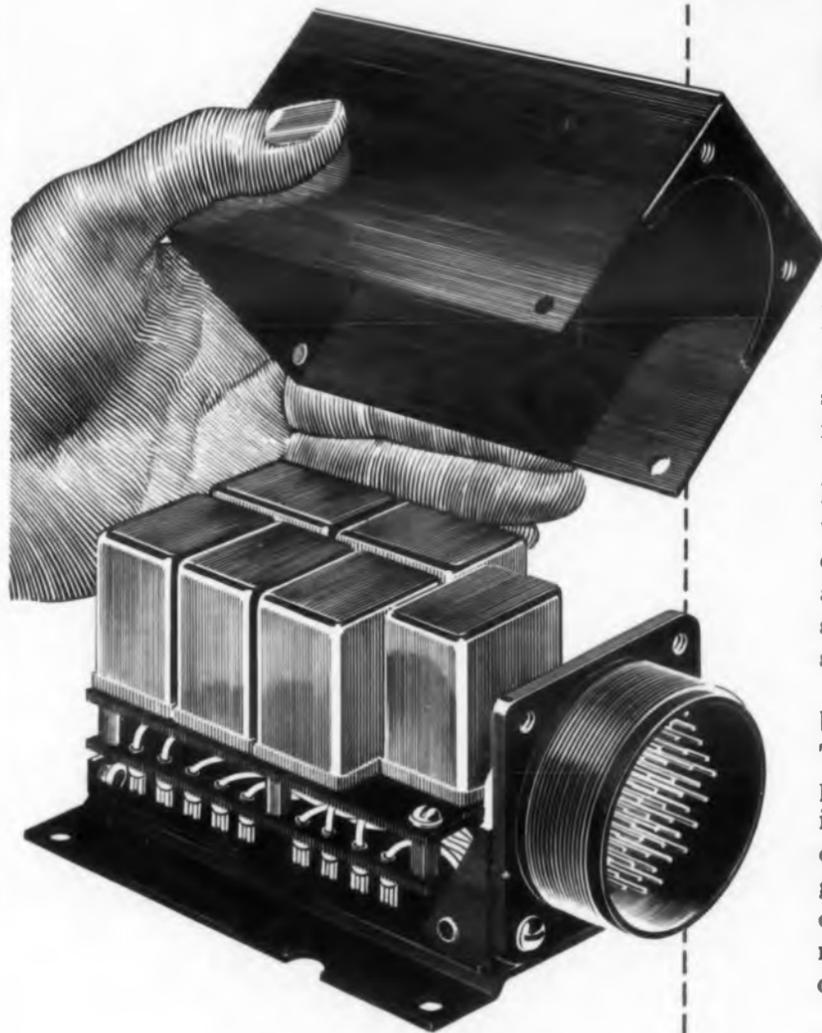
"Cat Eye," the new Air Force-Westinghouse opto-electronic telescope permitting previously impossible daylight photos of planets and stars, already has been used to produce a 40-in.-wide composite picture of the full moon. More than 200 separate frames show details invisible to ordinary photographic methods.

Because the moon was shot in direct view, the distortion accompanying photos made at oblique angles was eliminated. Oblique photographing heretofore had been necessary so shadows would produce sufficient contrast. Direct view was made possible because "Cat Eye" is three to four times more sensitive to white light than tubes previously used for telescopes, and is particularly sensitive to longer wave lengths in the spectrum from yellow to red.

Now in operation at Weaver Observatory, Wittenberg College, Springfield, Ohio, "Cat Eye" operates on principles similar to closed circuit TV, but contains an optical amplifier affording a sensitivity more than 1000 times that of an ordinary TV camera, and 10,000 times that of the best photographic film.

Images picked up through the 10-in. refracting telescope are transformed into electrical impulses by the camera tube, and are made visible on a cathode ray tube after passing through the video amplifier. Photographs then are made from the face of the picture tube.

"Cat Eye" may be the means of announcing the arrival on the moon of an earth-launched rocket, say its developers. It's the conception of Radar K. H. Gebel, civilian scientist at the Wright Air Development Center's lab.



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BEHIND THE NEWS



Model of solar-propelled space ship, which may provide man's simplest and cheapest transportation to nearby planets, is studied by Westinghouse aerodynamicist, Dr. T. C. Tsu.

Solar Sails May Propel First Space Explorers

When man explores the solar system, he may travel in space ships propelled simply and cheaply by sails—"solar sails" of aluminum foil or lightweight plastic unfurled to capture the sun's energy.

Explorers have employed the principle of the sail for 3500 years, and for 85 years man has known that light exerts a small but definite pressure when it shines on a body such as a sail. But now a Westinghouse Research Lab aerodynamicist, Dr. T. C. Tsu, has utilized the theories in constructing a model of a space ship with solar sails no more than one-thousandth of an inch thick.

His space ship would be launched by rocket, but once in orbit the parachute-shaped sail could be unfurled and attached to a gondola carrying payload and crew.

For a 1000-lb payload, Dr. Tsu estimates the sail diameter at 1600 ft—"somewhat larger than the Pentagon." But where a rocket ship with a one-ton payload would have to weigh 73 tons for a Mars round trip, a solar sail ship—requiring no fuel—would weigh little more than one ton.

Such a propulsion method not only is cheap, but it can be realized quickly. "The necessary basic information," says Dr. Tsu, "already is at hand and no extensive research is required."

"Ham" Sends 16,000 Miles With Tiny Low-Power Set

With a power input to his final amplifier of only 90 milliwatts supplied by a 15-volt battery, a "ham" with a small transistorized transmitter has sent readable signals 16,000 miles from Ontario, Calif., to Johannesburg, South Africa. Donald L. Stoner (W6TNS) said his circuit consists of an RCA-2N371 crystal-controlled oscillator driving an RCA-2N370 as a class C radio frequency amplifier. Both are pnp alloy-junction "drift" transistors.

Texas Instruments Wins Landis Contest Awards

Three work simplification training films prepared by Texas Instruments Inc. won awards in the Ralph H. Landis Methods Improvement Competition in Chicago. The motion pictures were part of a work simplification program expected to save the Semiconductor-Components Division \$700,000 this year.

Tiny "Brains" Seen For Vending Machines

Doubling of sales in the automatic merchandising industry within the next five years will go hand in hand with new advances in control systems, says D. M. Strathern, Controls Co. of America v-p.

Vending machines of the future, he told the National Automatic Merchandising Assn.'s 22nd annual convention in St. Louis, will have controls with the same degree of efficiency achieved by giant electronic computers. But they must be much smaller—in effect, miniaturized control systems.

Research aimed at modification, simplification and miniaturization of controls is being intensively directed, Strathern said, toward solution of control problems.

These include such vending factors as mixing or blending, metering, measure, stop and start, control pressure, temperature and flow, pressure differential, and rotary or lateral motion.

CIRCLE 7 ON READER-SERVICE CARD >



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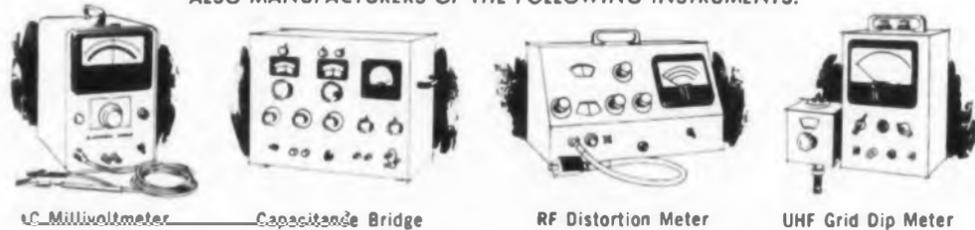
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CIRCLE 8 ON READER-SERVICE CARD

BEHIND THE NEWS

For Remote Stations Like DEWline: Portable Reactors

The first Argonne Low Power Reactor (ALPR) has been installed at Idaho's National Reactor Testing Station to train personnel in operating subsequent models—portable "package" power plant reactors considered ideal for such remote installations as DEWline radar bases.

The twin-function ALPR is designed to produce 200 kw of electricity, and 400 kw of space heat—the power for radar equipment, the heat for offices and barracks.

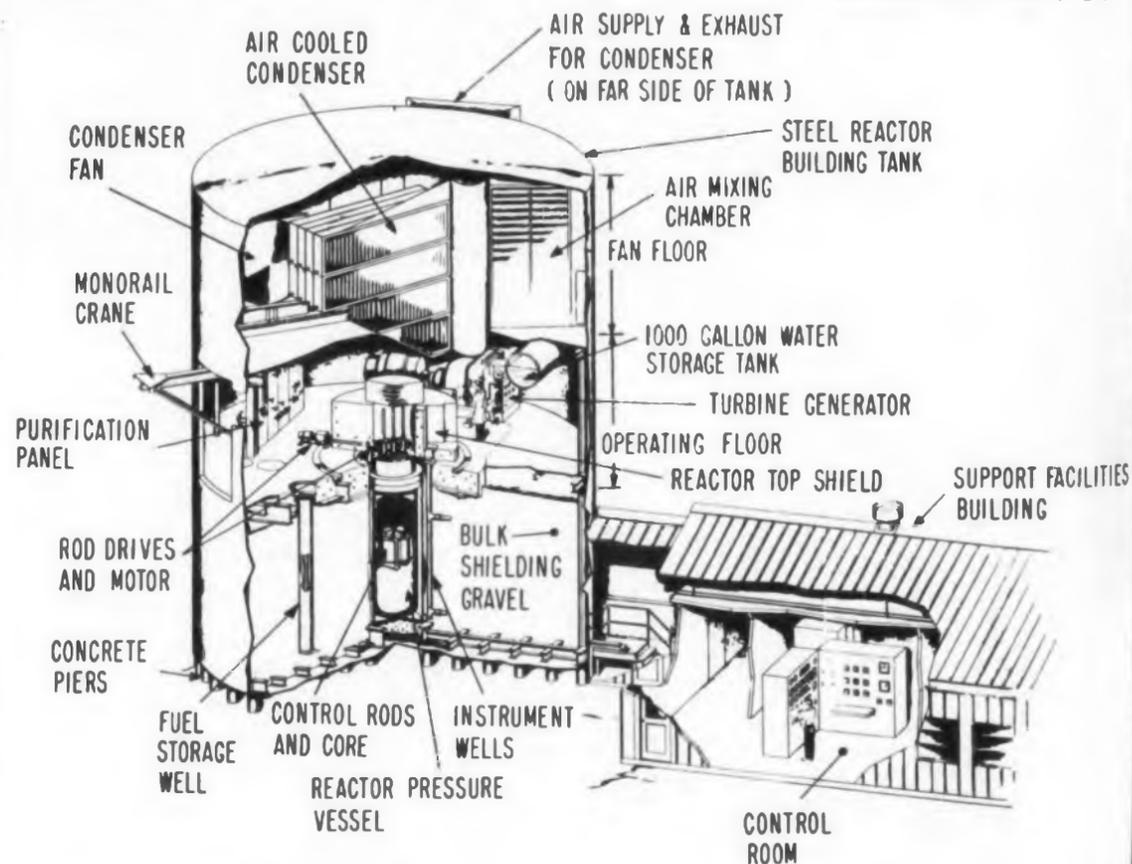
Designed and engineered at Argonne National Laboratory, Lemont, Ill., it was dedicated Dec. 2, the date pinpointed by the AEC as the 16th anniversary of the birth of atomic energy.

The ALPR, for which Pioneer Engineering and Services of Chicago did the mechanical and engineering design, is a direct-cycle boiling water reactor of 3000-kw gross reactor heat, with enriched uranium fuel. It is moderated and cooled by natural circulation of ordinary water, is air transportable, and has a high degree of inherent safety.

The Army Reactors Branch of the AEC calls ALPR "a major step in development of nuclear power" for such isolated areas as DEWline radar stations, and cites these advantages:

- It is designed for easy transportation in Air Force cargo planes, with no single component weighing more than 20,000 lbs or measuring more than 20 x 7 x 9 ft.
- It operates continuously for three years with a single fuel loading.
- It is simple to operate and maintain; continuous supervision may not be necessary because of automatic controls for the reactor and power-generating equipment.

(continued on next page)



Easily transportable in cargo planes, this Argonne Low Power Reactor is destined for such remote stations as DEWline radar bases. It provides 200 kw of electricity, 400 kw of heat.

■ requires minimum on-site construction, no excavation, and maximum use of site components. Ordinary gravel is used as a shield against radioactivity.

■ It needs a minimum supply of water, as the all-aluminum condenser is air-cooled.

A new aluminum-nickel alloy (X-8001) was used extensively; fuel elements were clad with the alloy, and it was used to fabricate the entire reactor core, with the exception of minor items. X-8001 is inexpensive to fabricate and process, and should have great resistance to corrosion at high temperatures and pressures.

In operation, saturated steam is generated in the ALPR pressure vessel at 300 lbs per sq in. and at 420 F. About 85 per cent of the steam generates power; the rest bypasses the turbine and can be used for space heating.

Among the "firsts" resulting from ALPR's development were (1) practical application of aluminum-clad fuel elements for a reactor power plant, and (2) use of an air-cooled condenser made entirely of aluminum.



Atomic-Age Giant

Berkley Nuclear Power Station, Gloucestershire, Eng. due for completion in 1960, is one of several large nuclear power stations now under construction in Britain. It will have two reactors, 16 giant heat exchangers, and an output of 275,000 kw. The first of Berkley's heat exchangers is being placed in position. 70 ft high, 17-1/2 ft. in diam, it weighs 133 tons.

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Complete information on "MAG MOD" miniature or standard magnetic amplifier components available on request. Call or write, today!

TYPE NUMBER	IMM-436-2 Magnetic Input Modulator	IMM-436-3 Magnetic Input Modulator	MTC-435-2 Magnetic Thermocouple Converter
Excitation Frequency — Carrier	400 cps	400 cps	400 cps
Signal Winding DC Resistance	1000 ohms \pm 15% each signal winding	1000 ohms \pm 15% each signal winding	10 ohms \pm 15%
AC Excitation Volts	5.5 V. @ 400 cps	2.5 V. @ 400 cps	6 V. RMS
Input DC Signal Range	0 to \pm 100 μa .	0 to \pm 80 μa .	0 to \pm 10 mv.
AC Output Range (400 cps)	0 to 2.2V. (sine wave)	0 to 1.5V. (sine wave)	0 to 2.7V. (sine wave)
Overall Dimensions (Inches)	27/32x27/32x1 5/16	27/32x27/32x1 3/16	1 1/4x7/8x5/8
Null Amplitude (Noise Level)	20 mv. RMS	15 mv. RMS max.	25 mv. RMS max.
Output Impedance	7000 ohms	7000 ohms	10,000 ohms
Null Drift (In terms of input signal) -65°C to $+100^{\circ}\text{C}$	\pm 0.5 μa . max.	\pm 0.5 μa . max.	\pm 0.1 mv. max.
Hysteresis — % of max. input signal	0.5% maximum	0.5% maximum	0.5% maximum
Type of Mounting	Male Stud	Female Insert	Male Stud
Maximum % Distortion in Output	25%	15%	20%
Weight Ounces	1.3 oz.	1.2 oz.	1.5 oz.

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CIRCLE 9 ON READER-SERVICE CARD

WASHINGTON REPORT



Airframers Edge Deeper Into Electronics

Airframe workers' request for a new and broader wage floor from the Labor Department is fraught with serious implications to the electronics industry. Immediately affected, if the Labor Department should rule in favor of the aircraft companies, are the manufacturers of both airframes and electronics—such as General Electric and Philco. They would be forced to bring into line the wages of airframe workers with their electronics people working on the same project. The airframers' proposal would tend to confuse wage rates throughout the missile and aircraft companies, irrespective of major product. Zenith, for example, would have to pay the missile electronics worker at a rate differing from the TV electronics man—although the job may be similar.

Obviously, this determination would tend to equalize wage rates for all missile workers from coast to coast. It puts the airframe manufacturers in a better position to bid on electronics proposals in competition with non-airframe companies in the East and Midwest.

The wage determination is just one in a series of steps the airframe manufacturers are taking to achieve balance between productive capacity and demands for their services. Republic Aircraft's new multi-million dollar research center is going to be well staffed with electronics people.

Douglas Aircraft has recently set up a new organization called Weapon Systems. Its main jobs are to keep top management informed of military WS programs in being and planned, so as to develop plans to get Douglas into them.

At Chance Vought, former Space Technology Lab scientist Dr. James F. Reagan has been hired to head up a new, "full-fledged" electronics department. So far the department has concerned itself with products for its own programs—but will soon branch out into the competitive market in such fields as antenna design, stabilizing systems, aircraft instrumentation, and ground support equipment.

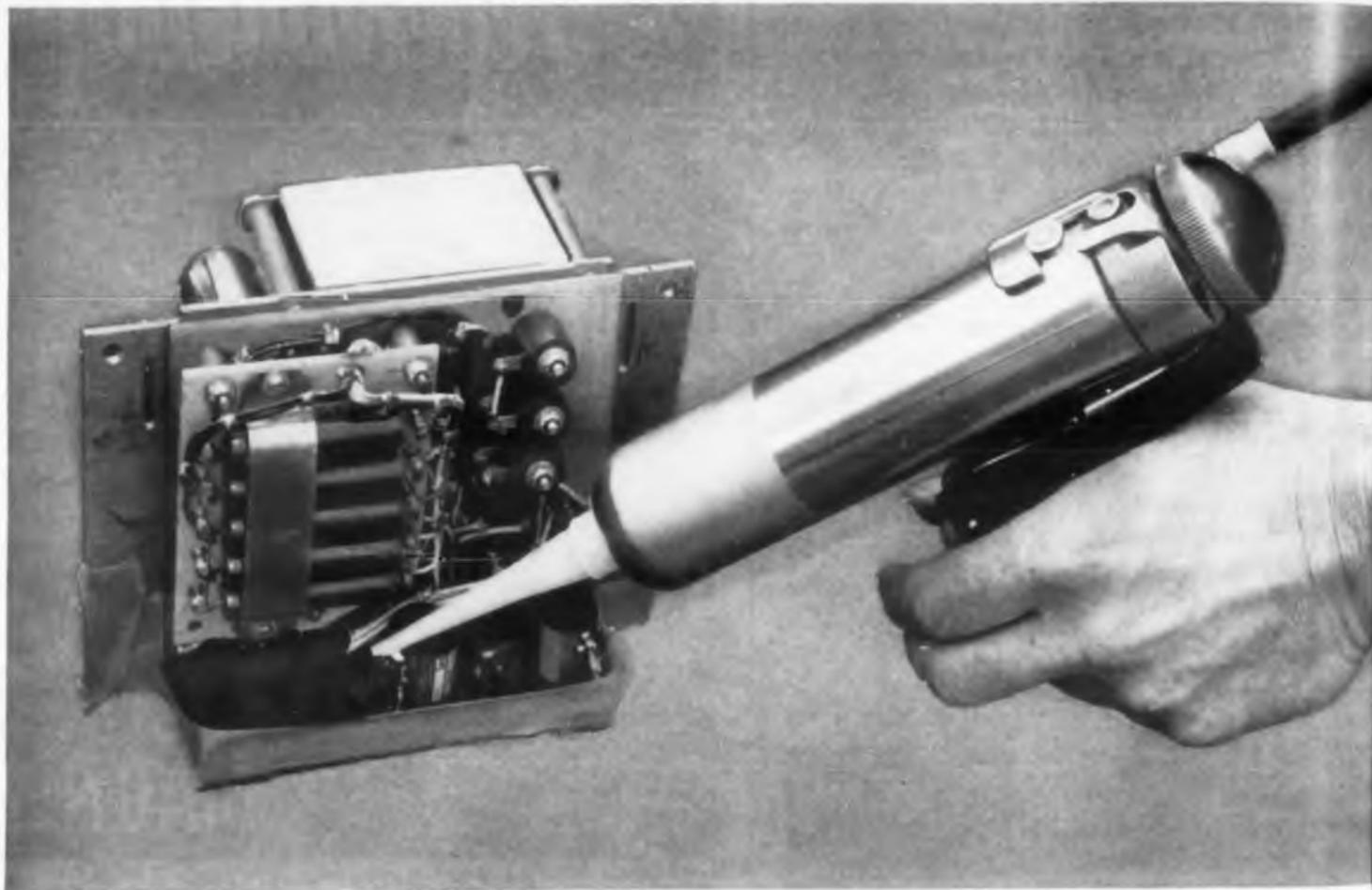
In spite of Defense Department directives to the contrary, Convair is going ahead with the Wizard anti-ballistic missile program with its

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SILICONE RUBBER

... seals and cushions delicate circuits



High impedance circuits in Northrop's Snark missile are coated with Silastic RTV for protection against moisture and vibration at temperature extremes. Silastic RTV is easy to apply . . . vulcanizes at room temperature.

TYPICAL PROPERTIES OF SILASTIC RTV

Temperature range, °C . . .	—70 to 260C
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Surface resistivity at 50% Relative humidity, ohms . . .	2.8×10^{13}
Dielectric constant, 10^5 cycles per second	2.5
Dissipation factor, 10^5 cycles per second	0.003

Sensitive electronic components are sealed against moisture and cushioned against vibration with a coating of Silastic* RTV, the Dow Corning silicone rubber. Silastic RTV forms a rubbery silicone solid in 24 hours at room temperature. Stays resilient from -70 to 260 C. This "do-it-yourself" material is used for a wide range of encapsulating, potting and caulking applications. Write for free sample and complete information.

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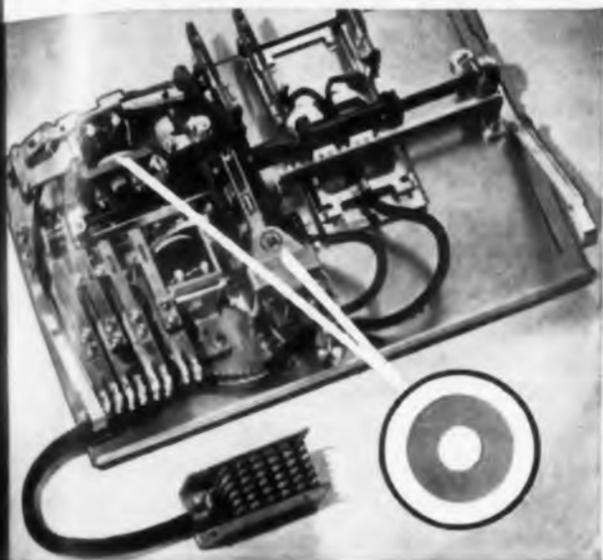
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A protective film of Dow Corning 200 Fluid spray coated on electronic assemblies protects terminals, clips, switches and other exposed connections from the harmful effects of condensation. Glass and ceramic insulators coated with silicone fluid have low current leakage and a high degree of surface resistivity, even under very humid conditions.

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Nonmelting, nongumming Dow Corning 3 Compound stays in place . . . provides an effective, moisture-proof dielectric seal for all types of electronic equipment. As a potting or filling material for electronic components and assemblies, silicone compounds flow into place with gentle pressure . . . have a serviceable temperature range of -40 to 205 C. Free sample available.

CIRCLE 503 ON READER-SERVICE CARD



AN Connector Terminals, Navy Helicopter

newly won funds. But this is only one of many strictly electronics projects Convair engineers are concerned with. One of great interest is applied research in antigravity techniques.

Nortronics Division of Northrup Aircraft is making a mark with its Datico. This "go, no-go" test instrument is said to save about \$150 million in the testing of missile components. The Air Force has ordered the unit, and Nortronics is now working on an Army version.

The attraction to electronics by the aircraft industry is underscored by recent fiscal reports by Douglas. Nine-month earnings were less than two per cent.

Where Do You Stand?

Defense contracting, by anybody's yardstick, is big business. DOD's listing of military prime contractors shows the first ten divided \$5.8 billion of nearly \$12 billion awarded during 1957 to the top 100. The \$12 billion figure represents 69.1 per cent of a total defense procurement budget of \$17.3 billion. Over the years — since July, 1950 — the top ten contractors have been represented by aircraft firms. Gradually, wholly electronic firms have crept into the coveted lineup. Some airframe manufacturers have solidified positions by going into electronics.

For the 1957 period, the top ten, in order of income, were: General Dynamics Corp. (\$1.1 billion), General Electric Co. (\$916 million), United Aircraft Corp. (\$699 million), Boeing Airplane Co. (\$638 million), American Telephone and Telegraph Co. (\$471 million), North American Aviation, Inc. (\$456 million), Hughes Aircraft Co. (\$369 million), Chance Vought Aircraft, Inc. (\$341 million), Martin Co. (\$322 million), and General Motors Corp. (\$309 million).

General Motors, which is actively searching every avenue to become more intimately associated with the missile business, moved up from position 16 during the 1955-1957 period. Significantly, Ford Motor Co., equally seeking missile contracts, moved down from the 12th slot for the earlier period right out of the top 100.

Douglas Aircraft, which publically avows that it wants to stay out of electronics, moved out of the top ten into position number 17.

But electronics remains all-powerful in this listing of the most influential manufacturers in the country. Going down the list after the first ten are: IBM (13), Sperry-Rand (14), Westinghouse (21), Raytheon (23), American Bosch Arma (27), RCA (31), IT & T (34), Collins Radio (39), MIT (45), Philco (49), Minneapolis-Honeywell (51), Ramo-Wooldridge (57), General Precision Equipment (58), Burroughs (60), Westinghouse Air Brake (69), Rand Corp. (79), Lear, Inc. (84), Hazeltine (88), Gilfillan Bros. (91), Johns Hopkins U (96) and Motorola (97).



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11 ranges, 1-3-10 sequence.

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Gain: 100,000 maximum

Output: 0 to 1 v, adjustable

Output Impedance: 10 ohms, 1,000 shunt

PRICE: \$500.00 f.o.b. factory

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NEWS BRIEFS . . .

. . . **UNDERWATER COMMUNICATIONS IS NEEDED** by the Navy if it is to play its role in controlling the seas, on, under, and over. The Navy's super weapon, the missile-bearing, atom-powered sub, can operate as an inflexible, pre-programmed device only if underwater communication techniques are not improved. Naval operations is generally concerned. They need systems to talk to both subs and aircraft.

. . . **RADAR JAMMING SIMULATOR** in production run at Fairchild Engine and Airplane Corp. Device will train radar operators to recognize various types of jamming so that they may learn to read through them. Simulator is used with radars in the 1220-1350 mc range. Basic rf signal can be cw or varied with sine wave, square wave, pulse or noise modulations. Means for sweeping the rf signal over the complete tuning range in 50-mc sectors are included.

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. . . **NEW RADAR EQUIPMENT** for the B-52 bomber boosting its protective coverage from all angles about ready to roll from GE. The new "black box" developed by the GE division is under a \$5-million sponsorship of the Air Research and Development Command. Forward surveillance radar integrates with other electronic systems in feeding data to a common display indicator (scope watched by an operator in a B-52).

. . . **ULTRA-FLEXIBLE COMPUTER**, which can change its own internal structure to solve a broad range of problems, is in the planning stage at National Cash Register's Los Angeles electronics division. Aimed at solving problems in the handling, storage and use of high-energy liquid rocket fuels, the machine is being hailed by NCR as the most flexible yet devised, "the first true general-purpose computer."

. . . **JOB OF RCA'S** new high-level Advanced Military Systems, which is to get its own Princeton, N.J., building, will be to "spearhead studies leading to the creation of new, complex and ever more effective weapons systems," says RCA. Dr. Nathaniel Korman is director.

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New printed circuit Standing Wave Amplifier.

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Reflector: 0 to 1000 V
Control Grid: -300 to 0 to +150 V, 5 ma max.
Regulation: 0.03%
Ripple: 3 mv max.
Internal Reflector Modulation: Square Wave, Pulse, Sawtooth, Sine Wave



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Helix or Beam: 0 to 1800 V, 125 ma max., 1700 to 3500 V, 100 ma or 250 W max.
Collector: 0 to 300 V, 100 ma max.
Anode: 0 to 600 V, 60 ma max.
G-1: 0 to 300 V, 5 ma max.
G-2 or Reflector: 0 to ± 1200 , 1 ma max.
G-3: 0 to ± 750 , 1 ma max.
G-4: 0 to ± 500 , 1 ma max.
Regulation: 0.03%. **Ripple:** 3 mv max.
Heater: 0 to 15 V D.C., Regulated.
Internal G-1 or G-2 Modulation: Sine Wave, Square Wave, Pulse, Sawtooth



KLYSTRON POWER SUPPLY, 819

Beam: 300 to 1000 V, 85 ma max.
Reflector: 0 to 900 V, 20 μ a max.
Control Grid: -300 to 0 to +150 V, 5 ma max.
Regulation: 1%
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RADAR COMPONENTS

ELECTRONIC TEST EQUIPMENT

EDITORIAL

Go, No-Go, No Good

My 1956 Ford, like everyone else's late model car, doesn't have an ammeter. A red light warns me if my battery is not charging. I don't know the rate of discharge. Consequently, I was caught with a dead battery after a few weeks of hard starting. My down time was about an hour. If I were equipped with a 95¢ ammeter I would have realized that I was requiring a maximum charge rate all of the time and that the battery was depleting itself. I could have remedied the hard starting before it caused serious down time. With all the emphasis on go, no-go test equipment in the electronics industry, I hope we know the true technical state of affairs. I hope our missiles will be ready to go if or when the time comes.

Go, no-go equipment is ideal for production line testing. This philosophy of testing can fail, however, to fully indicate operational readiness or to predict trouble-free operating time. When go, no-go tests are used by equipment operating personnel in the field, there can be huge wastes of manpower. We have heard of missiles being shot back to the factory because they registered no-go. The factory inspectors' tests said go. You can easily imagine the time lost in resolving the differences.

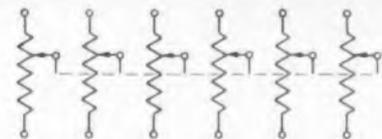
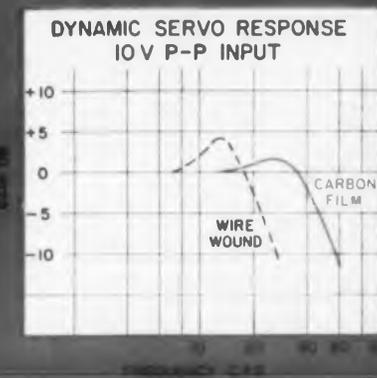
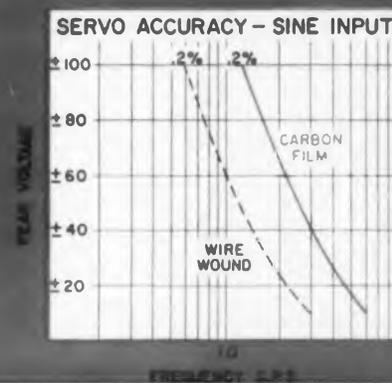
A man in the field with a quantitative indicator can be taught to use his head. He can then be employed as a human being rather than a two-condition robot. Light green: module stays; light red: module replaced. Admittedly, go, no-go equipment seems quite desirable because you don't have to count on the judgment of G.I.'s. But does this philosophy of test make the best use of available manpower or brainpower? What about over-all logistic problems? Do we really know when to adjust or repair in the field and when to go to a higher echelon repair or test station? When all we require of a man is sub-moronic intelligence, there is room to doubt. What kind of systems thinking has been given to this problem? What do the human-factors psychologists say? Fast check-out requiring go, no-go answers are often essential, but the degree to which yes or no is right, is crucial. There are few black and white answers in this world and one could doubt if red and green are any better absolutes.

James G. Koppke



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CIRCLE 13 ON READER-SERVICE CARD

Microwave Test Instruments

Part 1

David Fidelman

This series of articles on microwave test instruments should help the design engineer pick the proper instrument to do a proper job of measuring. The six parts to appear will discuss the following:

Part 1. Types of measurement

Includes a table of different measuring techniques and a list of manufacturers.

Part 2. Signal Generators

Describes and tabulates signal generators.

Part 3. Typical Test Setup

Included in this section is a description of test sets, terminations, attenuators and directional couplers, slide-screw and stub tuners, phase shifters and adjustable shorts.

Part 4. Power and Frequency Measuring Equipment

Available power and frequency meters are tabulated.

Part 5. Impedance Measuring Equipment

Slotted lines, VSWR indicators and impedance indicators and displays are discussed.

Part 6. Miscellaneous Instruments

This concluding article will discuss such accessory equipment as spectrum analyzers, wave guide benches and test stands, crystal calibrators, standard gain horns, echo boxes and microwave receivers.

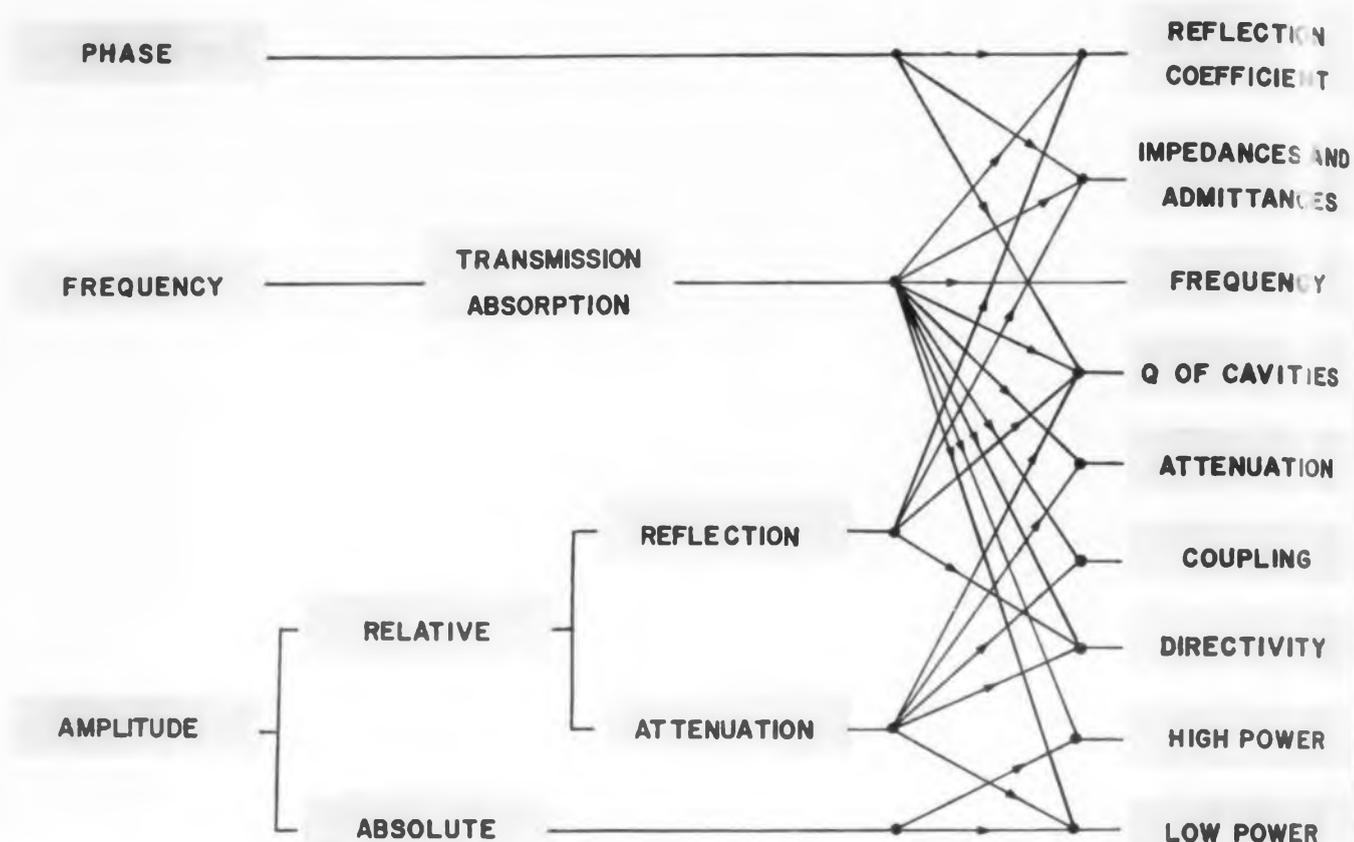


Fig. 1. Classification of microwave measurements

TECHNIQUES and instruments for microwave measurement are considerably different from those used at lower frequencies. The outstanding difference is the use of hollow waveguides as transmission elements, with coaxial lines also being used at the lower microwave frequencies. The range of frequencies in the microwave spectrum is not accurately defined. But this series of articles will include all instruments designed to have a major part of their operating frequency range above 100 mc. Almost all of the coaxial line and wave guide instruments will be included in the tables and listings.

Types of Measurements

The microwave measurement classification shown in Fig. 1, lists some of the more important specific measurements currently made in laboratories. The chart lists the different types of measurements and classifies them in several different ways: measurements of amplitude, frequency, and phase.

A further subclassification of these different measurements of can be considered as:

Absolute amplitude (or power) measurements

to determine the total energy in the signal relative amplitude measurements, if a comparison is required between the amplitudes of two signals at the same frequency, regardless of the absolute values. These may be subdivided into:

1. Attenuation measurements, to determine the relative amplitudes at two different points in the system.
2. Reflection measurements, to determine the relative amplitudes of two waves traveling in opposite directions at some point in the system.

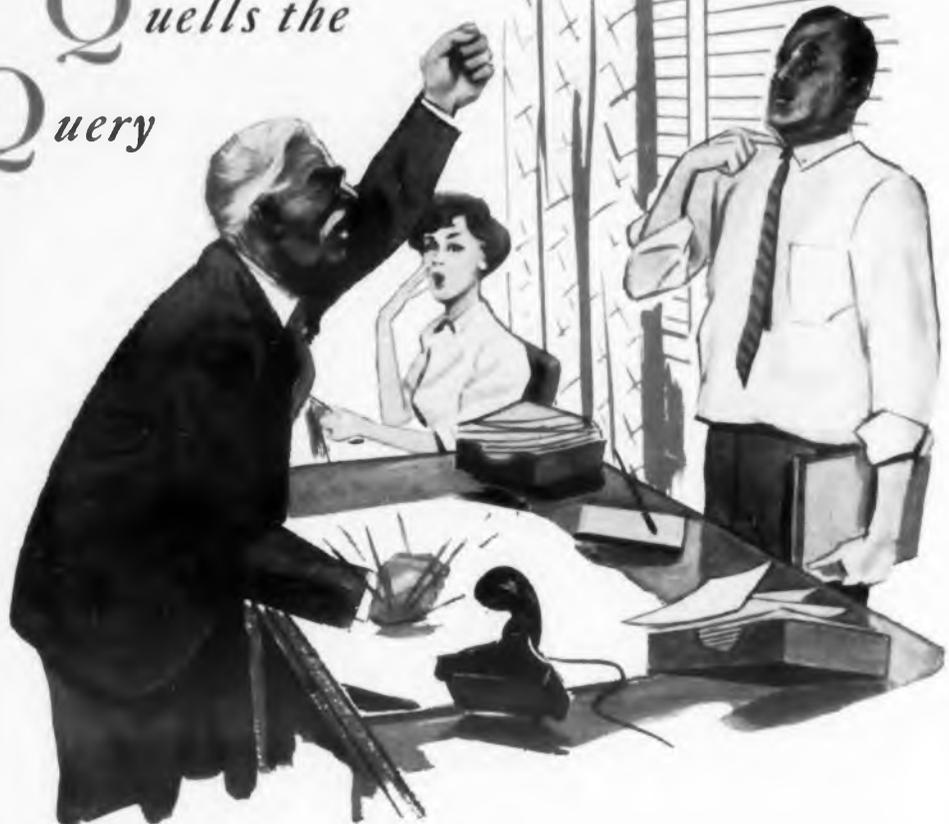
Frequency measurements are always absolute, but may be subdivided according to whether they are made with an absorption, transmission or reaction type of wavemeter. However, this subdivision refers to the method of measurement, and not to the measured quantity. Phase measurements are always relative, since they always require definition of a reference plane.

A summary of the different types of measurements which are made in microwave work is given in Table 1. This table lists the types of input and output signals required to perform each measurement, the method of measurement, and

TABLE 1. DIFFERENT TYPES OF MEASUREMENT

Type of Measurement	Type of Signal	Signal Source	Measuring Instrument	Manner of Measurement	Accessories Required	General Comments
Power measurement	CW, Pulsed, Modulated or Noise	Equipment under test	Calorimeter power meter	Temperature rise measured		Generally useful only for large powers
			Bolometer power meter	Measures changes in resistance due to heating	Bolometer mounts, attenuators, bolometer bridges	Useful for powers up to several milliwatts
Frequency measurement	CW, Pulsed or Modulated	Equipment under test, signal generator, or frequency reference	Cavity wave-meters Slotted sections	Frequency of reaction in system or transmission of maximum power is measured Measure wavelength from VSWR	Attenuators, directional couplers, stub timers, crystal mount and power meter, crystal frequency calibrators	Slotted sections accurate 0.1 to 5 per cent; cavity meters accurate 0.01 to 0.1 per cent; use of crystal reference standards permits accuracies of 0.02 to 0.0001 per cent
Impedance and Admittance	Variable-frequency modulated (CW)	Signal generator	Slotted line, probe, and VSWR indicator	Reflection coefficient measured and impedance plotted on Smith chart	Attenuator, frequency meter	Measurements made at various frequencies; accuracy depends upon slotted line
	Variable-frequency sweep-frequency signal	Signal generator	Impedance plotter	Impedance indicated directly on oscilloscope with chart reticle	Attenuator, frequency meter	Measurements made directly; eliminates need for point by point measurement and plotting
Attenuation	Modulated (CW)	Signal generator	Crystal or bolometer mount and power meter	Substitution method is used—measure tested component against known value of attenuation	Variable attenuator	Not accurate for small values of attenuation because resolution of test equipment is generally too low
Reflection coefficient and VSWR	Modulated (CW)	Signal generator	Slotted line, probe and VSWR indicator	(a) Measure ratio of maximum and minimum field with VSWR indicator, and distance between max. and min. (b) Measure required attenuation to give same maximum and minimum reading on meter	Termination, calibrated attenuator	Method (b) gives more reliable readings when VSWR greater than about 3
Measurement of Q	Modulated	Signal generator	Slotted line, probe and VSWR meter	Measure reflection coefficient at three equally spaced frequencies near resonance then obtain Q graphically on Smith chart	Attenuator, frequency meter	Suitable for low Q measurements
	Sweep-frequency signal	Signal generator	Precision wavemeter, crystal mount, oscilloscope	Frequency response is indicated on oscilloscope; 3 db points are measured with wavemeter and precision attenuator	Precision attenuator, directional coupler	Suitable for low Q measurements
	Pulsed	Q meter	Q meter	Amperes rate of decay of free oscillations in cavity under test with rate of discharge of known capacity into known resistance		Does not require highly stable oscillators, or accurate frequency or attenuation settings; accuracy of measurement ± 1 per cent.
Frequency spectrum analysis	Signals in frequency band under observation	Equipment or other source under test	Spectrum analyzer	Frequency band is displayed on screen of oscilloscope; signal amplitudes are displayed vertically, at horizontal positions corresponding to frequencies	Attenuators, directional couplers, etc.	Resolution depends on speed of sweep and bandwidth of analyzer
Noise measurements	Noise level of system and comparison signal of known level	Equipment under test and reference signal generator	Power indicator	Known amount of signal is added to the input, and noise level is determined from the change in output level	Directional coupler, precision attenuator	Comparison signal which is added must be of same order of level as noise in system; care must be taken not to mismatch input by insertion of test signal
Antenna measurements	CW or modulated	Medium or high power signal generator and auxiliary antenna	Antenna under test, receiver and power meter	Antenna under test is illuminated by auxiliary antenna, and gain on pattern measured	Standard gain horn, directional couplers, attenuators, frequency meter, crystal mount and power meter	Power required from signal generator depends upon noise level and required dynamic range; servo drive and automatic plotter may be used for pattern measurements
Radar performance	Pulsed	Radar under test	Radar under test	Small portion of transmitter signal is coupled into echo box.	Echo box, directional coupler, attenuator	Simple method of checking some of the basic performance characteristics of radar systems.

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Quells the
Query



...where to get the best bandpass filters?

Major Quiggle*, KC, AC, DC, MC, fixed his procurement manager with a withering stare. "So now our whole production line is held up," he barked, "while you try to find a good bandpass filter with a flat response between 17 and 20 kcs. And you also insist that it have sharp low and high frequency cut-off," he added.

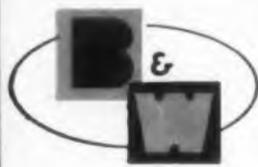
The manager reeled with the outburst. Never had he seen the old man in such a fury over a simple question of where to get the best bandpass filters.

Quiggle continued, "Haven't you been reading the trade paper advertisements? Why don't you call Barker & Williamson! They've been making filters of all types such as Band Elimination, High-Pass and Low-Pass for years . . . must be experts on the subject, they'll have the answer."

And B&W did have the answer. The Model 360 torroidal bandpass filter was perfect. With a flat response between 17.2 and 20.2 kcs, Quiggle's engineers found many other favorable characteristics when they obtained a spec sheet on the unit by the simple expedient of calling B&W.



*Now a confirmed customer and friend, name is withheld intentionally



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the instruments and accessories required.

Types of Microwave Instruments

Microwave instruments fall into certain logical categories as listed in the introduction. The names and addresses of all the leading manufacturers of microwave test equipment are shown below^o.

^o Based upon a survey by ELECTRONIC DESIGN and verified by Technical Information Corp., 41 Union Square, New York 3, N.Y.

MANUFACTURERS

- Acton Labs., Inc.
533 Main St.
Acton, Mass.
- Admittance-Namco Corp.
Farmingdale, L.I., N.Y.
- Airborne Instruments Laboratory, Inc.
Mineola, L.I., N.Y.
- Aircraft Armaments, Inc.
Cockeysville, Md.
- Airtron, Inc.
Linden, N.J.
- Alford Mfg. Co.
299 Atlantic Ave.
Boston, Mass.
- Alfred Electronics
897 Commercial St.
Palo Alto, Calif.
- Amerac, Inc.
116 Topsfield Rd.
Wenham, Mass.
- Andrew Corp.
363 East 75 St.
Chicago, Ill.
- A. R. F. Products, Inc.
7627 Lake St.
River Forest, Ill.
- Barker & Williamson, Inc.
237 Fairfield Ave.
Upper Darby, Penn.
- Bird Electronic Corp.
1800 East 38 St.
Cleveland, Ohio
- B J Electronics (Borg-Warner Corp.)
Santa Ana, Calif.
- Bogart Manufacturing Co.
315 Seigel St.
Brooklyn, N.Y.
- Browning Laboratories, Inc.
Winchester, Mass.
- Cascade Research Corp.
53 Victory Lane
Los Gatos, Calif.
- California Technical Industries
Belmont, Calif.
- Chemalloy Electronics Corp.
Gillespie Airport
Santee, Calif.
- Cubic Corp.
5575 Kearney Villa Road
San Diego, Calif.
- DeMornay-Bonardi Corp.
780 S. Arroyo Parkway
Pasadena, Calif.
- Diamond Antenna & Microwave Corp.
7 North Ave.
Wakefield, Mass.
- Dorsett Lab., Inc.
401 East Boyd
Norman, Oklahoma
- Douglas Microwave Co.
252 East 3 St.
Mount Vernon, N.Y.
- Dynac, Inc.
395 Page Mill Road
Palo Alto, Calif.
- Empire Devices Products Corp.
38-15 Bell Boulevard
Bayside, N.Y.
- Engineering Associates
434 Patterson Road
Dayton, Ohio
- Entron, Inc.
Box 287
Bladensburg, Md.
- Espey Manufacturing Co., Inc.
528 East 72 St.
New York, N.Y.
- Federal Telephone & Radio Co., Inc.
100 Kingsland Road
Clifton, N.J.
- Ferranti Electric, Inc.
30 Rockefeller Plaza
New York, N.Y.
- Ferris Instrument Co.
Boonton, N.J.
- F-R Machine Works, Inc.
26-12 Borough Pl.
Woodside, N.Y.
- Frequency Standards
P. O. Box 504
Asbury Park, N.J.
- General Communication Co.
681 Beacon St.
Boston, Mass.
- General Radio Co.
275 Massachusetts Ave.
Cambridge, Mass.
- Gertsch Products, Inc.
3211 S. La Cienega Blvd.
Los Angeles, Calif.
- Hewlett-Packard Co.
275 Page Mill Road
Palo Alto, Calif.
- Hickok Electrical Instrument Co.
10514 Dupont Ave.
Cleveland, Ohio
- Intercontinental Dynamics Corp.
170 Coolidge Ave.
Englewood, N.J.
- Jarrell-Ash Co.
26 Farwell St.
Newtonville, Mass.
- M. C. Jones Co., Inc.
Bristol, Conn.

Kay Electric Co.
14 Maple Ave.
Pin Brook, N.J.

Kearney Co., Inc.
Little Falls, N.J.

Wayne Kerr Instruments
P. O. Box 81
Philadelphia, Pa.

Laboratory for Electronics, Inc.
75 Pitts St.
Boston, Mass.

Lambda-Pacific Engineering, Inc.
14725 Arminta St.
Van Nuys, Calif.

Lavoie Laboratories, Inc.
Morganville, N.J.

LIECO, Inc.
3610 Oceanside Rd.
Oceanside, N.Y.

Loral Electronics Corp.
794 East 140 St.
New York, N.Y.

Marconi Instruments
111 Cedar Lane
Englewood, N.J.

Maxson Instruments Corp.
47-37 Austell Place
Long Island City, N.Y.

Metronix, Inc.
Trumbull Airport
Groton, Conn.

Mico Instrument Co.
80 Trowbridge St.
Cambridge, Mass.

Microlab
71 Okner Parkway
Livingston, N.J.

Microwave Associates, Inc.
Burlington, Mass.

Microwave Development Labs., Inc.
92 Broad St.
Babson Park, Mass.

J. Millen Mfg. Co.
150 Exchange St.
Malden, Mass.

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

New London Instrument Co.
New London, Conn.

Northeastern Engineering, Inc.
Manchester, New Hampshire

Panoramic Radio Products, Inc.
520 South Fulton Ave.
Mount Vernon, N.Y.

Polarad Electronics Corp.
43-20 34 St.
Long Island City, N.Y.

Polytechnic Research & Development
Co., Inc.
202 Tillary St.
Brooklyn, N.Y.

Presto Recording Corp.
Paramus, N.J.

Radar Design Corp.
3309 James St.
Syracuse, N.Y.

Radiaon, Inc.
Melbourne, Fla.

Radio Corp. of America
Camden, N.J.

Radiometer
3355 Edgecliff Terrace
Cleveland, Ohio

Rohde & Schwarz
230 Garibaldi
Lodi, N.J.

Sanders Associates, Inc.
Nashua, New Hampshire

Scientific-Atlanta, Inc.
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Atlanta, Ga.

Sierra Electronic Corp.
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Menlo Park, Calif.

Sivers Lab
Stockholm, Sweden

Sperry Gyroscope Co.
Great Neck, N.Y.

Stoddart Aircraft Radio Co.
6644 Santa Monica Blvd.
Hollywood, Calif.

Technical Materiel Corp.
700 Fenimore Road
Mamaroneck, N.Y.

Technicraft Lab., Inc.
Thomaston, Conn.

Telechrome, Inc.
80 Merrick Rd.
Amityville, L.I., N.Y.

Telerad Manufacturing Corp.
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New York, N.Y.

Telonic Industries, Inc.
Beech Grove, Ind.

Trad Electronics Corp.
1001 First Ave.
Asbury Park, N.J.

Transitron, Inc.
186 Granite St.
Manchester, N.H.

Uniwave, Inc.
109 Marine St.
Farmingdale, N.Y.

Van Norman Industries, Inc.
186 Granite St.
Manchester, N.H.

Varian Assoc.
Palo Alto, Calif.

Vectron, Inc.
1605 Trapelo Rd.
Waltham, Mass.

Wandel und Goltermann
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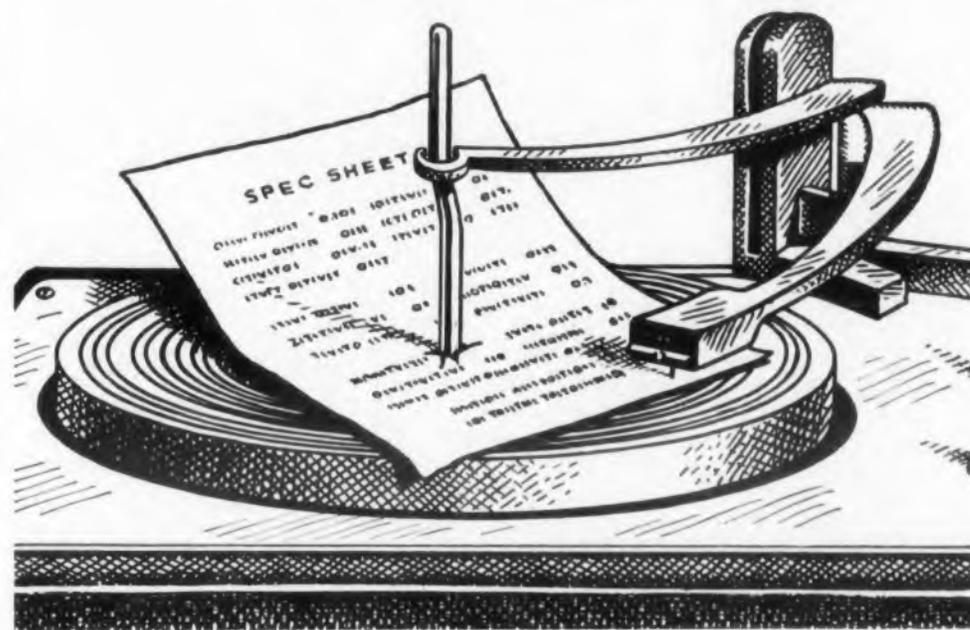
Waveline, Inc.
Caldwell, N.J.

Wave/Particle Corp.
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W. Caldwell, N.J.

Weinschel Engineering
10503 Metropolitan Ave.
Kensington, Maryland

Roger White Electronic Devices, Inc.
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PROC
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Communicating in Space

Laurence D. Shergalis

Associate Editor

Gen. Urhane: Modernize communications now.



NEW METHODS of communication, with emphasis on space communications problems, were discussed at the Fourth National IRE Aero-Com Symposium, October 20-22nd in Utica, N.Y. First two sessions covered communications media and equipment, the third covered systems, and the fourth session was devoted to space communications.

Big topic of discussion outside the lecture room was 456L, the proposed Air Force global communications net. Many designers are looking forward to getting in on the early design phases of the project. It means designing an entirely new system from the ground up.

See New System Coming

Most engineers feel that a new digital communications system will result from 456L. However, controversy still exists between the "analog" men and those favoring a digital system. Higher speeds of getting the called station are a must. A method of working the military priority system into the net will involve much ingenious design thinking.

But the basic problem, engineers say, will be to find a common "language." Telephone, teletype, video, etc., must be translated into just one form for transmission. Another problem will be the modernization of existing facilities. We need more high-grade telephone circuits, faster switching and more automatic equipment. Many old problems will be getting increased attention.

Featured luncheon speaker was Brig. Gen. Francis F. Urhane, Deputy Chief of Staff, Communications and Electronics, NORAD. His topic was NORAD's communications problems. In modernizing its communication system, said Urhane, NORAD needs to standardize its equipment. Its plant facilities are outmoded; switching speed is too slow. There is a definite need to convert to automatic facilities. Present circuit quality must be improved. NORAD needs more high grade trunk circuits. There isn't time to waste in modernizing, he said. We must take the big jump into the future now.

Interference Studied

One of the most interesting papers presented

at the technical sessions discussed results of IT & T's automobile ignition interference tests. Raymond Schildknecht, project engineer, presented results of interference tests on about 10,000 autos. Trucks, they discovered, generate about 10 times the electrical interference as autos. Also, spark plug suppressors are not too effective at the higher broadcast and TV frequencies.

A great deal of data was presented discussing results of long-range communications tests. In the first paper given, Rudolph Penndorf and Sam Coroniti, AVCO, investigated possibilities of reliable communications over polar routes. Their data is expected to be of importance to planning communications links between the U. S. and the Arctic. But the authors need processing facilities to put their data to use. Properly evaluated, they point out, their data will provide much useful information for both the theoretical ionospheric physicist and the practical engineer.

Terrain irregularities and weather are the principal causes of variations in radio transmission losses above 40 mc. Three National Bureau of Standards authors, P. C. Rice, A. G. Longley and K. A. Norton disclosed their prediction method and test data.

Study Pulse Distortion

Authors Losee and Lutz, Hughes Aircraft, have completed extensive investigation of ionospheric multipath distortion. Their paper warned that more extensive knowledge of multipath smearing is needed before applying some of the many pulse transmission techniques. Test indicated that there is frequent occurrence of abrupt phase changes during reception of any one pulse. But they also showed that the rate of phase change between portions of successive pulses was gradual. Results of test show that data transmission using millisecond pulses over distances of about 3000 miles are possible with little error.

S. C. Fritsch, Western Electric Co., reported on path loss studies for beyond-the-horizon radio systems. Data presented was the result of engineering studies on the White Alice communications net in Alaska. A method of estimating path loss was discussed as well as suggestions for im-

improving accuracy of estimates for knife-edge diffraction paths using the effective distance concept.

Using White Alice again as a test site, tests were made to determine if the network could be used for data transmission of 750 bits per second and higher. Using several different modes of transmission the authors, F. E. Willson and W. A. Runge, Bell Labs, found that high speed data may successfully be transmitted in a troposcatter system. But it must be a well engineered system, they say.

Frequencies between 100-10,000 mc are considered feasible for space communication. Thermal noise in receivers at these frequencies is a problem. L. P. Yeh, Westinghouse, limited his paper on space communication design to a discussion of thermal noise problems. A minimum usable carrier-to-noise power ratio depends upon the type of modulation used. An average acceptable figure seems to be about 15 db.

Two types of fading have been encountered in reception of signals from satellites. One has a period of seconds and is believed due to moon echos. Another, with a period of about an hour, is believed due to the Faraday effect. A fading margin of 10-20 db should be allowed for a workable system.

Many problems are still to be solved. The immediate problem, says Yeh, is to put up a large space vehicle with a high power transmitter and a large and elaborate antenna system. If this can be accomplished, more needed research can be done. Yeh believes that the time when the moon or a satellite can be used as a passive reflector is here now.

Communication between space vehicles and polar locations was discussed by Lt. William Stuart and Luther Kelley, U. S. Army Signal Radio Propagation Agency, Ft. Monmouth. Many unexpected propagation phenomena were reported during reception of Sputnik I signals. Long distance reception is dependent upon sunspot cycles and is affected by radio noise from the aurora. A great deal of data has been compiled giving variations in the number of useable frequencies with sunspot activity.

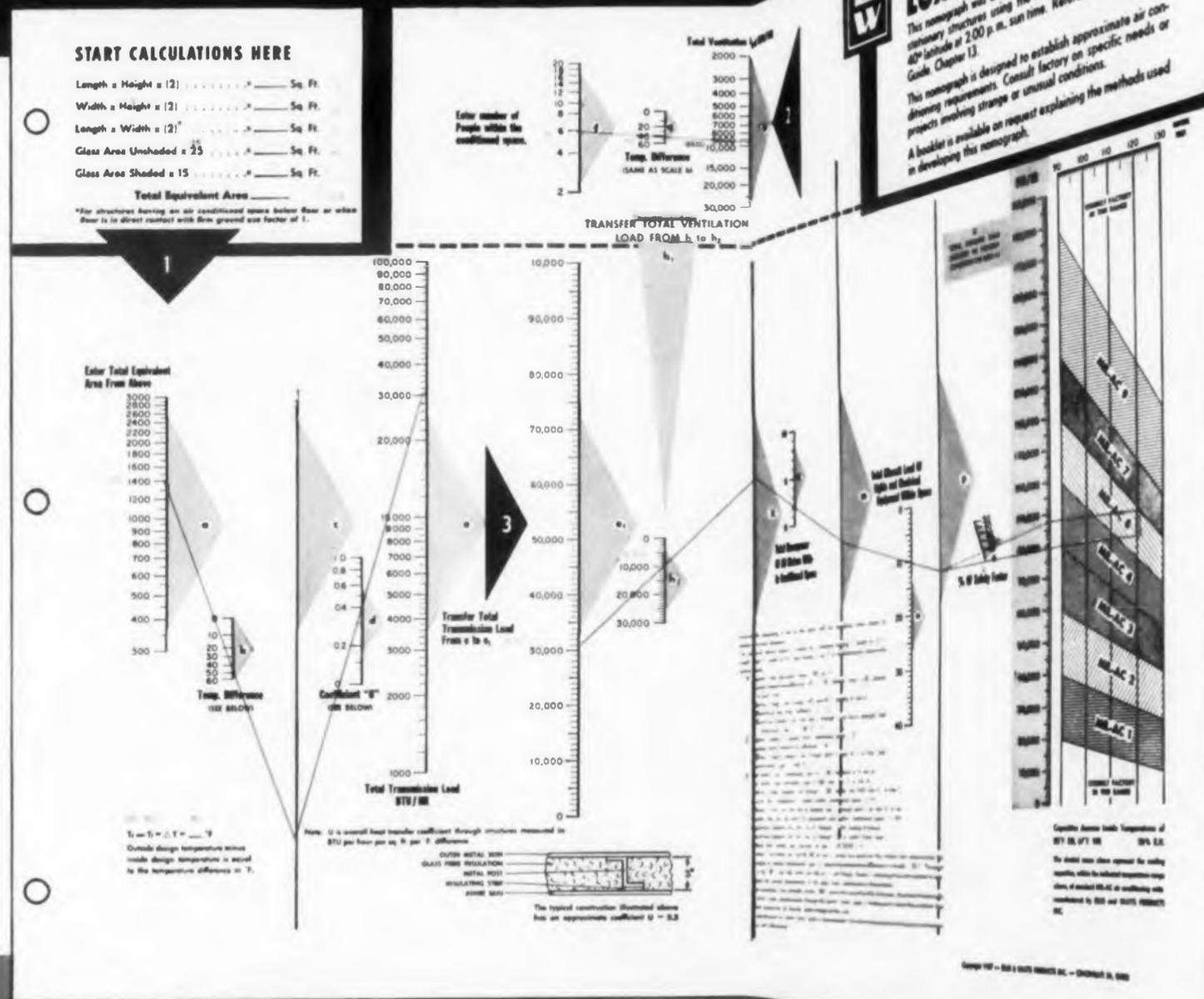
Reentry Problems

Other space communications problems discussed included regulation of space communication frequencies and communication during reentry. Reentry communications are limited to two spectral regions: millimeter wave and optical-infrared range. Transmission properties of the atmosphere determine these frequencies of operating frequencies. Also, thermal ionization of the air surrounding the vehicle on reentry attenuates signals in the normal range. ■■

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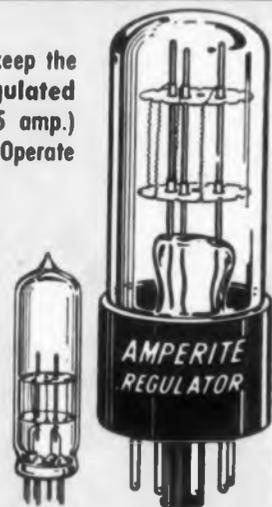
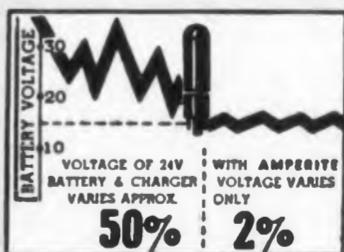
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AMPERITE

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Carl Tishler hopes that, as an outcome of this article, transistor manufacturers will produce transistors which are as uniform in the extended voltage range as they are in the low voltage ranges. There is a need to operate the transistors in these ranges.

He is a graduate of University of Michigan, BSEE. At Remington Rand Univac, he is a project engineer concerned with transistorizing computers and computer component design.



Rating Collecting to Emitter Voltage For Switching Transistors

Carl Tishler

Remington Rand Univac
Div. of Sperry Rand Corp.
Norwalk, Conn.

Here is a practical method needed by both users and manufacturers of switching transistors for accurately determining the maximum collector-to-emitter voltage rating. In many cases there actually exists as much as a two-to-one difference between the specified voltage rating and that at which a transistor can be safely used. Such a method has been developed and is described here.

TRANSISTORS for high current switching purposes are most frequently used in the common emitter configuration and biased at or beyond cutoff. The base is pulsed, driving the transistor into saturation which effectively connects the collector load to ground through a low impedance path. At the termination of the pulse, the circuit returns to its initial condition.

To make the collector current during saturation relatively independent of the drop across the transistor, the collector load resistor should be as large as possible. The designer has no choice in many cases where both current and resistance are specified. When the transistor is saturated, the amplitude of the collector current is simply the supply voltage divided by the total series resistance. To maintain a specified current when the series resistance is large, severe requirements

are placed on the voltage rating of the transistor as the entire supply voltage bridges the transistor when cutoff. Thus, the voltage rating between collector and emitter is of great practical importance for many applications.

During high current switching applications, certain phenomena were observed which could not be explained by any available information. For example, it was found that the application of a single short duration pulse to the base of a reversed biased switching transistor could destroy the transistor. This led to a series of investigations to learn more about what was happening. A logical explanation was developed which led to the establishment of a new method of voltage rating transistors. Many experiments have been conducted which seem to substantiate the validity of this approach.

Conventional Voltage Rating Methods

There are two methods by which manufacturers specify the collector-to-emitter voltage rating. In a common emitter configuration, a variable reversed bias voltage is applied to the collector and the base left disconnected while monitoring the collector current. Beginning at a low value, the collector voltage is increased until there is a sharp rise in collector current. When some arbitrary value of current is reached on the knee of the V_c-I_c curve, the voltage then present on the collector is called the rated maximum. This is illustrated in Fig. 1.

As an alternative method, one proceeds as above except that a reverse bias is applied to the base-emitter junction as illustrated in Fig. 2. The voltage rating with the base reverse-biased will be two to three times that obtained with the base disconnected. This voltage rating will change considerably as the magnitude of the reverse bias is changed. Between the two extremes obtained with the base open and reverse-biased, the practical voltage rating of a transistor may be found as explained in what follows.

New Voltage Rating Method

Extending the dc collector characteristics past the normal operating range of the transistor, the idealized V_c-I_c curves generally resemble those of Fig. 3. The information normally available from manufacturers represents performance in region II. If the base swing in the reverse-biased condition is included, region IV will be seen. The output impedance of the transistor is considerably less in this region than in II and the transistor is stable if biased anywhere in this region provided that the operating conditions do not cause the transistor to be over-dissipated.

The hyperbolic curve shown in Fig. 3 is the maximum dissipation boundary which is commonly drawn on output characteristics. The placement of the curve is approximately correct for a switching transistor in the 150 mw class. Operation between this curve and the coordinate axis will insure that the transistor is being operated within safe limits of dissipation. Operating beyond this region may cause the dissipation rating of the transistor to be exceeded depending upon the length of time. For high current switching applications, the transistor is usually driven from cutoff to saturation during the switching period as illustrated by load line #1 which includes regions I, II, IV and V.

In region V, the V_c-I_c curves have a negative slope indicating negative resistance or an unstable operating region. Region V lies almost entirely in the area of excessive dissipation; there-

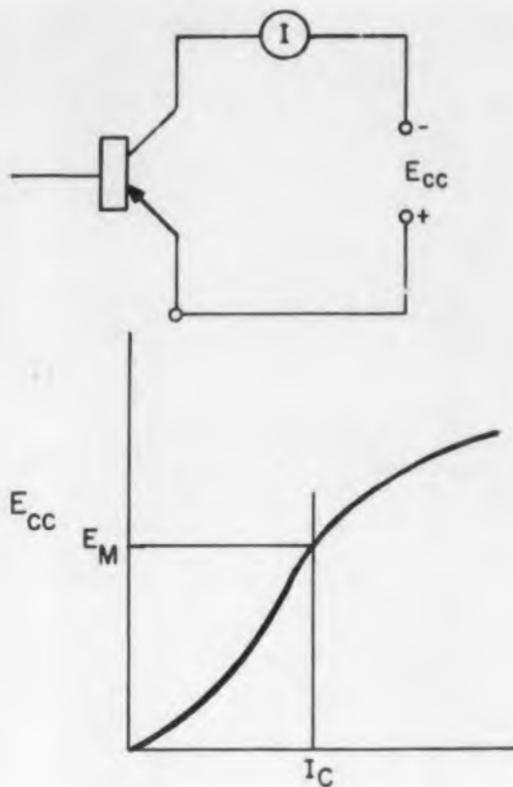


Fig. 1. Common emitter configuration. The voltage E_m is called the rated maximum. This is the collector voltage when some arbitrary value of current is reached on the knee of the V_c-I_c curve.

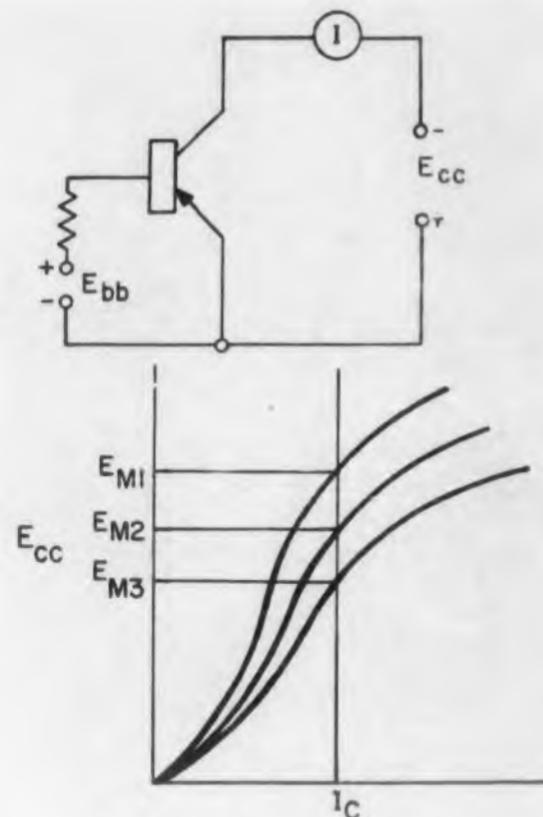


Fig. 2. A reverse bias is applied to the base-emitter junction. The voltage rating is 2 to 3 times that obtained with base disconnected.

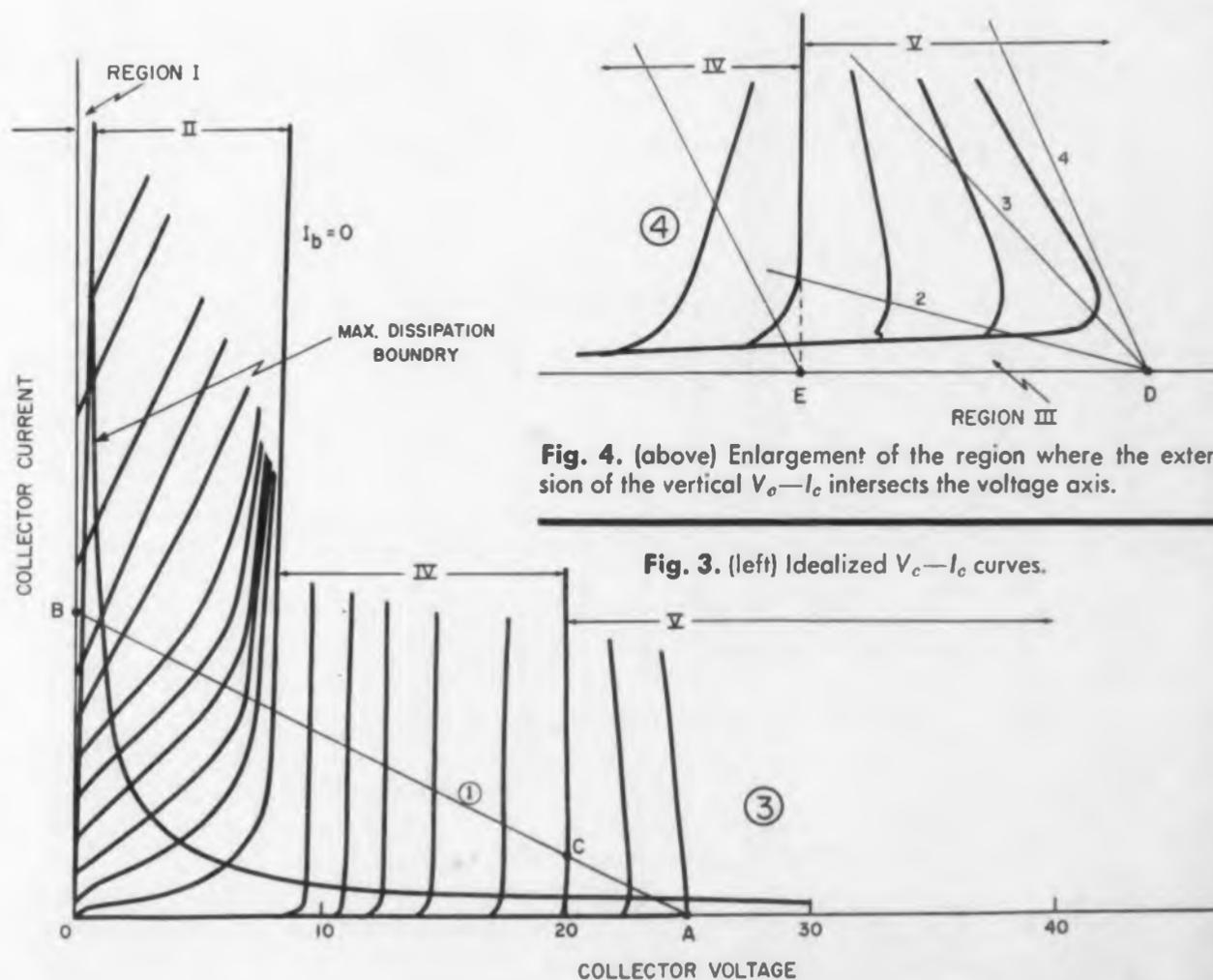


Fig. 4. (above) Enlargement of the region where the extension of the vertical V_c-I_c intersects the voltage axis.

Fig. 3. (left) Idealized V_c-I_c curves.

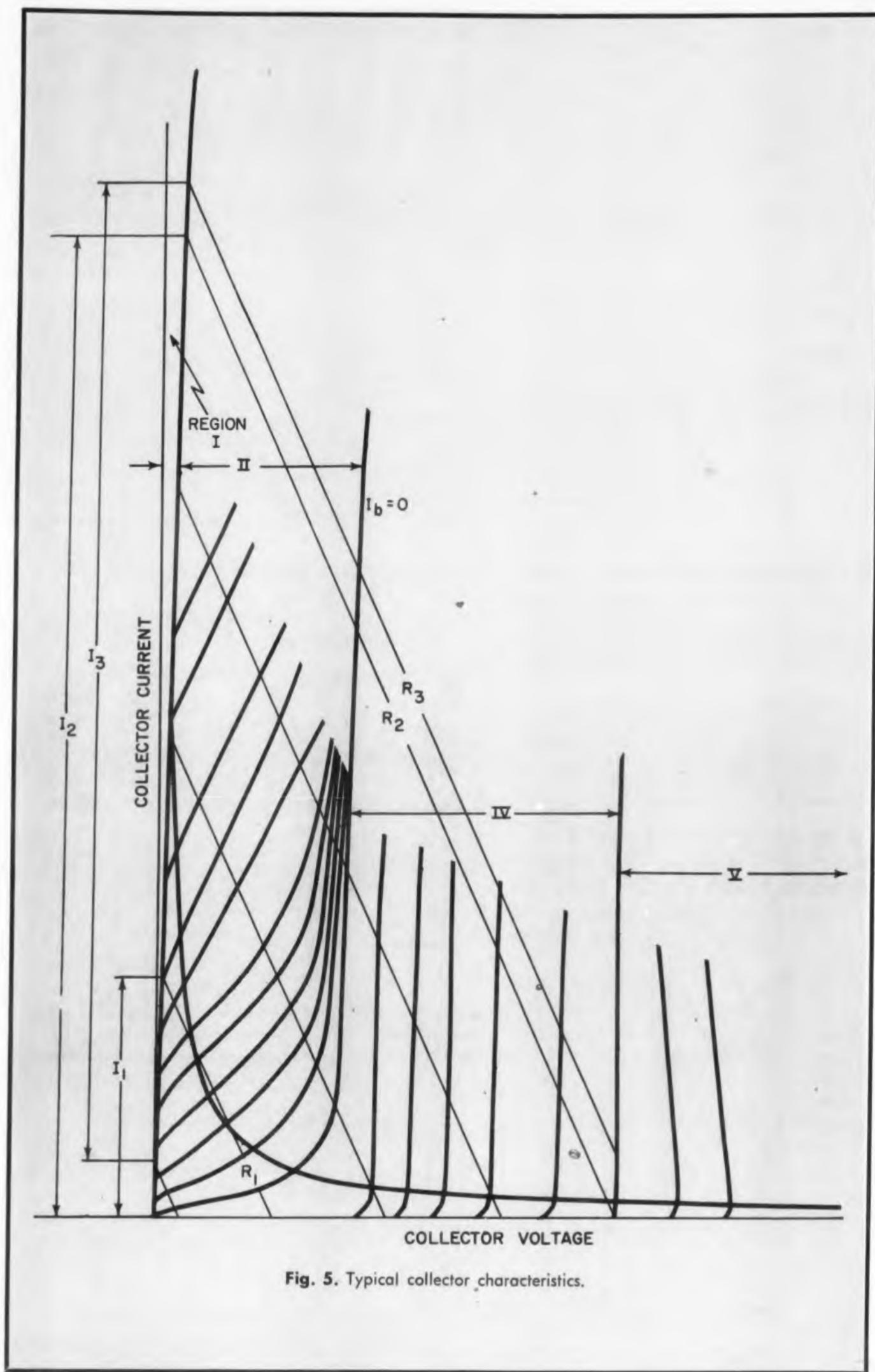


Fig. 5. Typical collector characteristics.

fore, any lingering in this area will usually be destructive to the transistor.

Consider a load having a characteristic represented by line #1. With no pulse applied, a collector voltage of 25 v, and the base biased with a sufficient reversed current, the transistor will be sitting at the quiescent operating point A which is in a low dissipation region. If a single pulse drives the transistor into saturation, the operating point will quickly pass through the safe operating point in a low dissipation region, high dissipation area to point B which is another As long as the rise time of the pulse is fast enough, the average dissipation in moving from point A to B will be low. The operating point may remain at B indefinitely without heating the transistor excessively.

When the pulse has ended, the operating point wants to return to point A, but it has to pass through the unstable region V. It cannot reach point A as the operating point upon entering the unstable region is working against a gradient which increases in instability as the depth of penetration into the region is increased. Therefore, the point will penetrate slightly, stop, reverse its direction, and go to point C which is the boundary between the stable and the unstable operating regions. The depth that the point will penetrate into the negative resistance region will vary slightly due to the dynamic properties of the transistor such as fall time and number of carriers.

During the time that the operating point is returning to C or while at C, the transistor will burn out. Since the only region having negative characteristics is region V, this phenomenon can not take place if operation in this region is prohibited. Therefore, for high current pulse operation, the maximum voltage rating between collector and emitter is that voltage which is determined by the intersection of the extension of the V_c-I_c characteristic separating regions IV and V and the voltage axis. The value of reversed base current represented by this characteristic must be known. The value of maximum voltage rating determined by this method is conservative as long as the minimum reverse bias current is supplied.

Fig. 4 is an enlarged portion of Fig. 3 of the region where the extension of the vertical V_c-I_c curve intersects the voltage axis. Point E represents the maximum voltage rating mentioned above at which operation with any value of load, such as represented by load line #1, will be stable. Point D represents a higher voltage at which operation with a load represented by line #2 is stable and at which operation represented by line #3 or #4 is unstable. Therefore, the safe maximum operating voltage may be increased slightly as the resistance of the load increases.

However, operation with a voltage to the left of or at point E will insure stable operation with any load resistor.

A quick nondestructive method of determining the maximum voltage rating without determining the characteristics of each transistor is possible. A low value of load resistor is chosen. The base is sufficiently reverse biased and pulsed into saturation at very low duty cycle. The collector voltage beginning at a low value is slowly increased while the collector current pulse is monitored with an oscilloscope having a dc amplifier. As the collector voltage is increased, the collector current will increase until a further increase of collector voltage will not result in an increase of collector current but a small dc shift will be seen. The collector voltage should be noted and quickly reduced.

This phenomenon can be seen by referring to Fig. 5. These characteristics are the same as Fig. 3 except that the family of parallel lines R_1, R_2 etc. represents a fixed load for various values of collector supply voltage. As the voltage is increased, the load line will shift from the lower left hand corner. At a given collector voltage, the corresponding load line R_1 , shows the collector current, when the base is pulsed driving the transistor from cutoff to saturation, to be I_1 . As the voltage is increased, the output current will increase uniformly until the knee of the vertical $V_{ce}-I_c$ characteristic separating regions IV and V is reached. This is represented by load line R_2 and its corresponding current I_2 . A further increase in voltage will not result in an increase in output current since the operating point when returning down the load line cannot penetrate the negative resistance region.

The transistor will not return to cutoff resulting in the above mentioned dc shift with no change in amplitude. This is illustrated by the load line R_3 , at which the pulse current amplitude I is no greater than I_2 but merely subjected to a dc shift. The noted maximum voltage at the dc shift will coincide with the extension of the vertical constant current base line if the load resistor is chosen sufficiently small.

Ambiguity in the maximum voltage rating of switching transistors can be eliminated by specifying that voltage determined by the intersection of the voltage axis and the extension of the $V_{ce}-I_c$ characteristic separating the stable and unstable operating regions under reversed base bias conditions. Operating at or below this voltage insures breakdown-free performance with any value of load resistor.

Reference

1. M. C. Kidd, W. Hasenberg and W. M. Webster, Delay Collector Conduction, New Effect in Junction Transistors, RCA Review, Vol. XV 1, March, 1955, pp 16-32.

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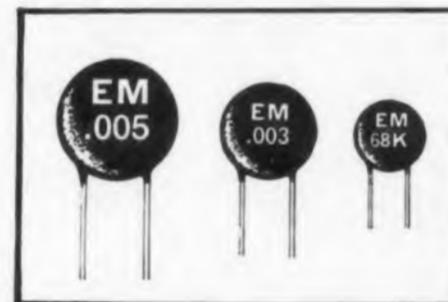


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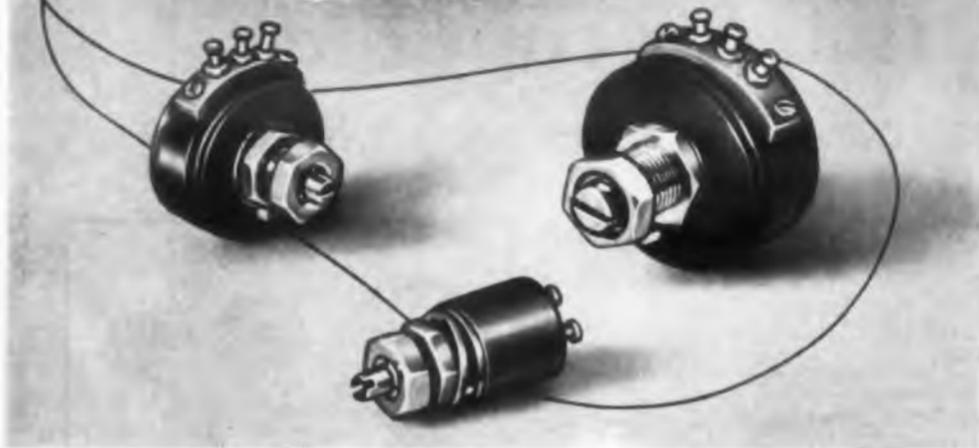
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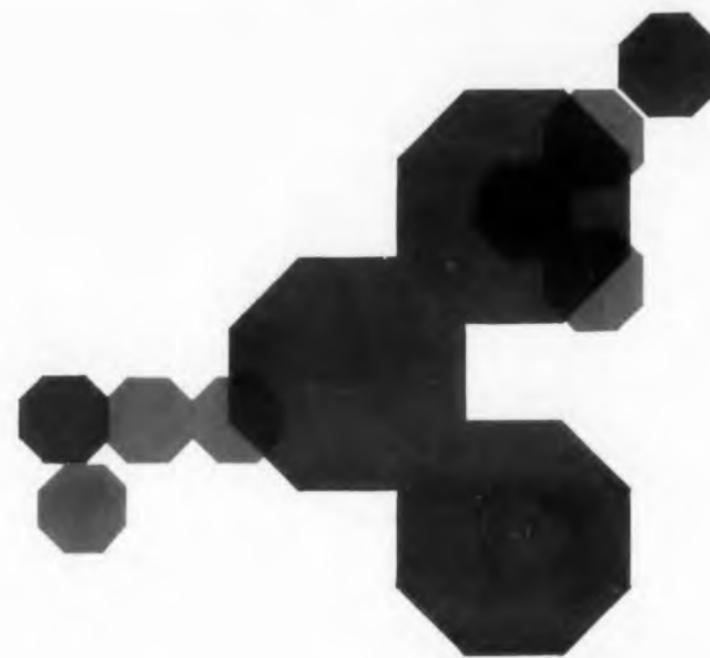
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Calculating With Octal Mathematics

Roger T. Stevens
Senior Engineer
Electronics Systems, Inc.
Boston, Mass.

MANY desk calculators used for preliminary preparation of computer problems operate in the octal number system. You can too. Here's how.

Number Theory

A number system is essentially a method of counting. The octal number system, like the decimal system, is a special case of a general technique for producing number systems.

In counting, different symbols are chosen to represent different sized

groups of objects. The counting process consists of assigning the symbols, in order, to the members of the group. The symbol assigned to the last member of the group represents the total size of the group. To count the number of cards in a poker hand we assign numbers to each card: "1" to the first card, "2" to the second . . . "5" to the last. Since "5" was the number assigned to the last card, it represents the total number of cards in the hand.

Infinite different counts are possible

0	1	2	3	4	5	6	7
1	2	3	4	5	6	7	10
2	3	4	5	6	7	10	11
3	4	5	6	7	10	11	12
4	5	6	7	10	11	12	13
5	6	7	10	11	12	13	14
6	7	10	11	12	13	14	15
7	10	11	12	13	14	15	16

Fig. 1. Octal addition table.

This would require infinite different symbols. And this would be inconvenient. To make all possible counts with a limited number of symbols requires the symbol "0." It represents a count of nothing. In counting, when all of the available symbols except zero are used up, we call the next count 0 and add 1 to the left of the zero. The 1 indicates that we have one group containing as many individuals as there are symbols in all (including 0). In continuing the count, the point is reached where there are two of these groups (20) and so on. When there are no more symbols for these groups, a 1 is placed in the column to the left. Thus, if there are N available symbols including 0, the number $ABCD$ represents $D + CN + BN^2 + AN^3$. This technique is familiar in the everyday decimal notation. But there is no reason why the total number of symbols, including 0, should be ten. There can be eight, as in the octal system.

Octal System

The octal number system is a system in which the available symbols are 1, 2, 3, 4, 5, 6, 7 and 0. This system is often used in computer work because it is more compact than the binary system for manual computations.

Addition, subtraction, multiplication and division are only the application of tables you have memorized. The tables were originally derived from the counting process. For example, there is no process of mathematics by which you can add $5 + 4$ and get 9 except by taking five individuals and four individuals and placing them together and counting them. The alternate is by remembering that $5 + 4 = 9$.

Octal adding and multiplying tables

	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	1	2	3	4	5	6	7
2	0	2	4	6	10	12	14	16
3	0	3	6	11	14	17	22	25
4	0	4	10	14	20	24	30	34
5	0	5	12	17	24	31	36	43
6	0	6	14	22	30	36	44	52
7	0	7	16	25	34	43	52	61

Fig. 2. Octal multiplication table.

operate like the decimal tables.

Addition

The addition table for the octal system is given in Fig. 1. This table is used by taking a number to be added in the top row and the other in the left column and moving straight down from the first and straight over from the second to the square of intersection. This is the number of the sum. This table may be used in reverse for subtraction.

Multiplying

The multiplications table for the octal system is given in Fig. 2. This table is used in the same way as the addition table. Using these tables any mathematical manipulation may be performed in a manner similar to those in the decimal system.

Octal to Decimal Conversion

Octal numbers may be easily converted into decimal numbers, and vice versa. For the octal to decimal conversion, the places in the octal number represent powers of eight. The octal number 4375 is:

$$\begin{array}{cccc} 8^3 & 8^2 & 8^1 & 8^0 \\ 4 & 3 & 7 & 5 \end{array}$$

which is equal to $4 \times 512 + 3 \times 64 + 7 \times 8 + 5 = 2301$ in the decimal system.

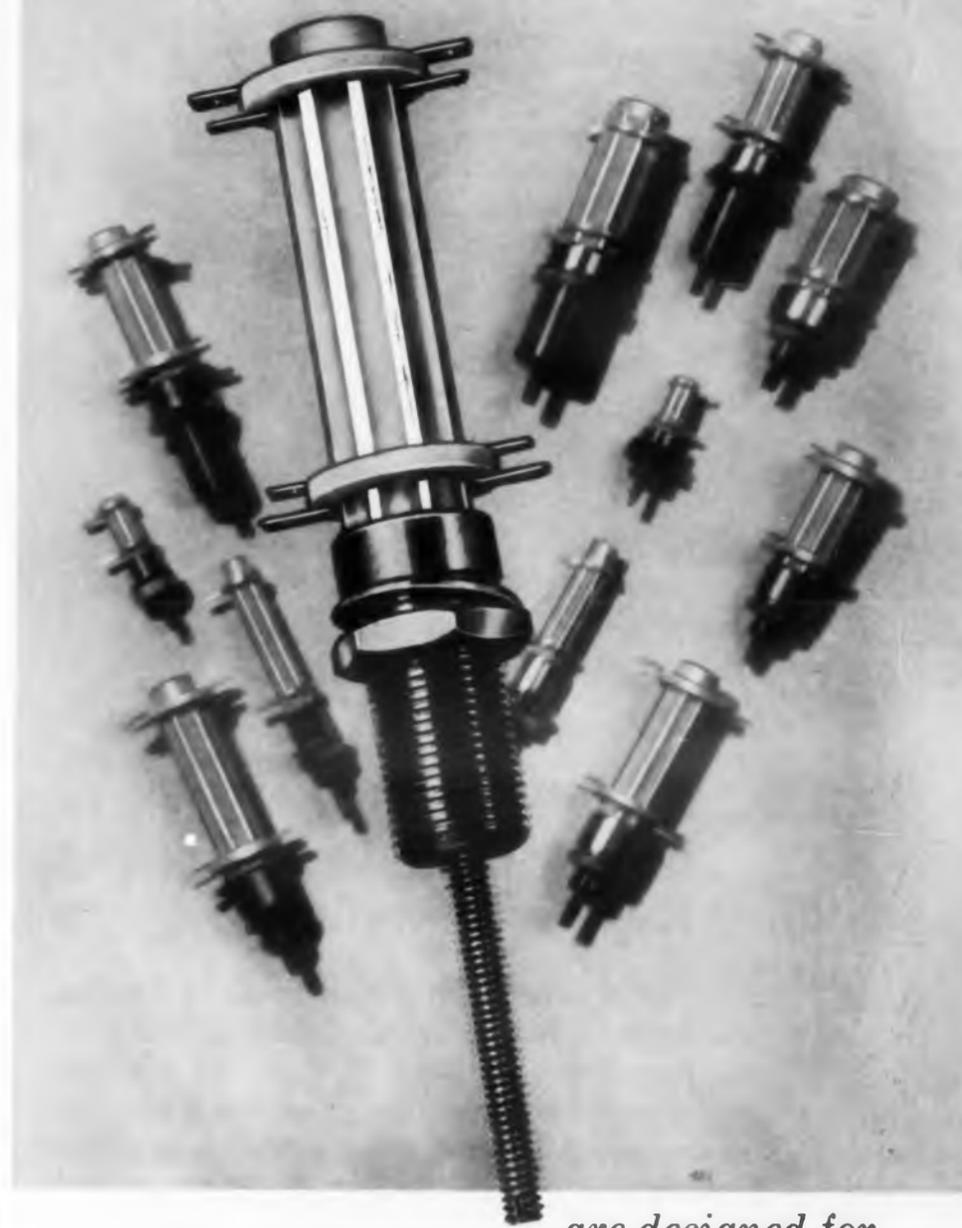
Decimal to Octal Conversion

To convert decimal to octal successive divisions by eight are performed. With the decimal number 2301:

$$\begin{array}{r} 8 \overline{) 2301} \\ 8 \quad \underline{) 287} \quad 5 \text{ remainder} \\ 8 \quad \quad \underline{) 35} \quad 7 \text{ remainder} \\ 8 \quad \quad \quad \underline{) 4} \quad 3 \text{ remainder} \\ \quad \quad \quad \quad \underline{0} \quad 4 \text{ remainder} \end{array}$$

4375 is the octal equivalent.

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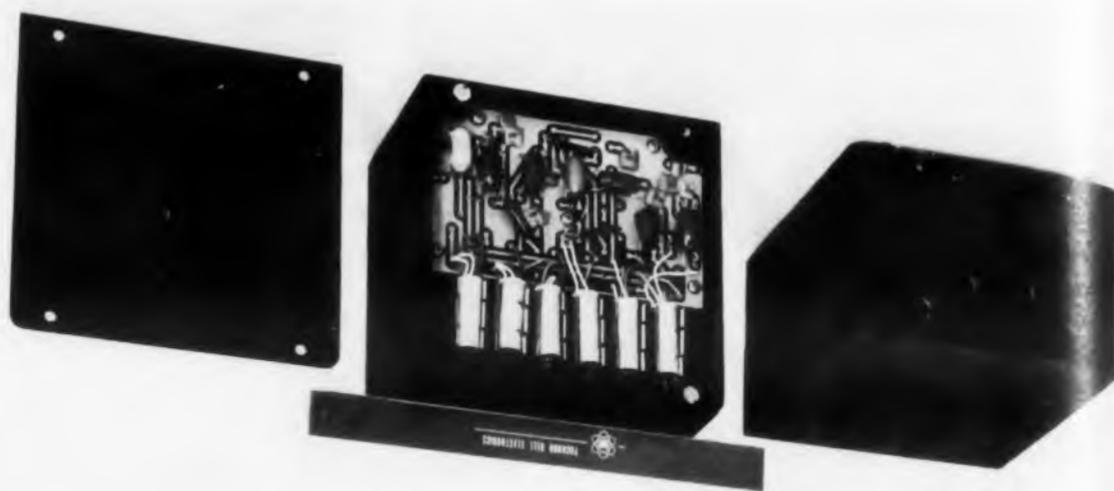
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DESIGN FORUM



Cooled to 225 C by ram air, this amplifier-decoder is one-third the size of its prototype. The i-f strip exposed above has 75 db gain, measures 1/2 x 4-1/8 x 3-3/4 in.

Hot Air Cools Hot Components in this Ram-Air Cooled Amplifier

AIR-HOT 200 C AIR cools the miniature 60 mc amplifier-decoder shown in the photo. The device doesn't need any refrigeration; just the friction-heated air rammed through a hole in the skin of a high-speed aircraft. Temperature of the unit stays below 225 C.

But that's still pretty warm.

How do you go about building a small 60 mc amplifier to work at 225 C? We went down to Packard-Bell Electronics Technical Products Division, 12333 W. Olympic Blvd, Los Angeles 64, Calif., to learn more about the unit. We found

- a lot of research went into discovering which manufacturers could—or would—supply components to work at exalted temperatures, and
- some clever design techniques that gave best cooling efficiency and reduced the size of the device from 1728 cu in. to 560 cu in.

PBE in the persons of Stan Plass, the senior project engineer and George Kis, Mechanical Engineer, reasoned that refrigeration units for the electronic gear in an airplane are large, heavy and expensive: the thing to do is avoid the need for them. Any electronics that doesn't need refrigeration saves just that much more money.

"We looked at all the ways we could reduce heat dissipation by design—like using a passive diode matrix instead of tubes in the spike discriminator and decoder—and then looked for components that would operate at high temperatures," Leuck told us.

Components

A combination of diodes, capacitors, resistors, tubes, fixed-tuned coils, printed circuit boards and a delay line were used in the unit. Manufacturers' catalogs were pored over and samples ordered. Hours of testing the samples were spent to weed out the unsuitable ones. Most manufacturers, PBE found, were very cooperative; sometimes discovered they could do better than they thought when it came to manufacturing high-temperature components.

Transitron Electronics Corp. in Wakefield, Mass., got special bouquets. Seems they supplied the only diodes that would work in the circuit up to 225 C. The PBE device uses 1N252's in the spike discriminator and decoder and S10G's for the tuning indicator and the detector, both operating at 60 mc. Problem: the circuits were designed so a difference of no less than ten per cent between forward and back resistances would work. Solution: Transitron diodes usually showed a greater difference.

Groundwork for the capacitors was laid by Valcap, North Hollywood, Calif., continued by Telecomputing Corp., Hollywood. Telecomputing's capacitors, in sizes up to 100 μf , showed less than 10 per cent change in capacitance.

Above 100 μf , capacitors are all used for decoupling: larger changes are tolerable, particularly since capacitance goes up with temperature. Glenco, Metuchen, N. J., is used for capacitances above 100 μf .

Three kinds of resistors are contained in the unit, all derated considerably. In the two watt size, IRC's metal film resistors, Dalohm's RS series (wirewound) and Pyrofilm Resistor Co.'s PT 501 series perform well. Pyrofilm's resistors are tested at 400 C, show less than one per cent change after storage for three months at 500 C.

Subminiature 5639's made by Sylvania are mounted in silver tube clamps. Any hard glass tube would do, Leuck reveals; and eventually PBE hopes to use Westinghouse's new match-box type, comparable to the 5639 or 6AK5: it

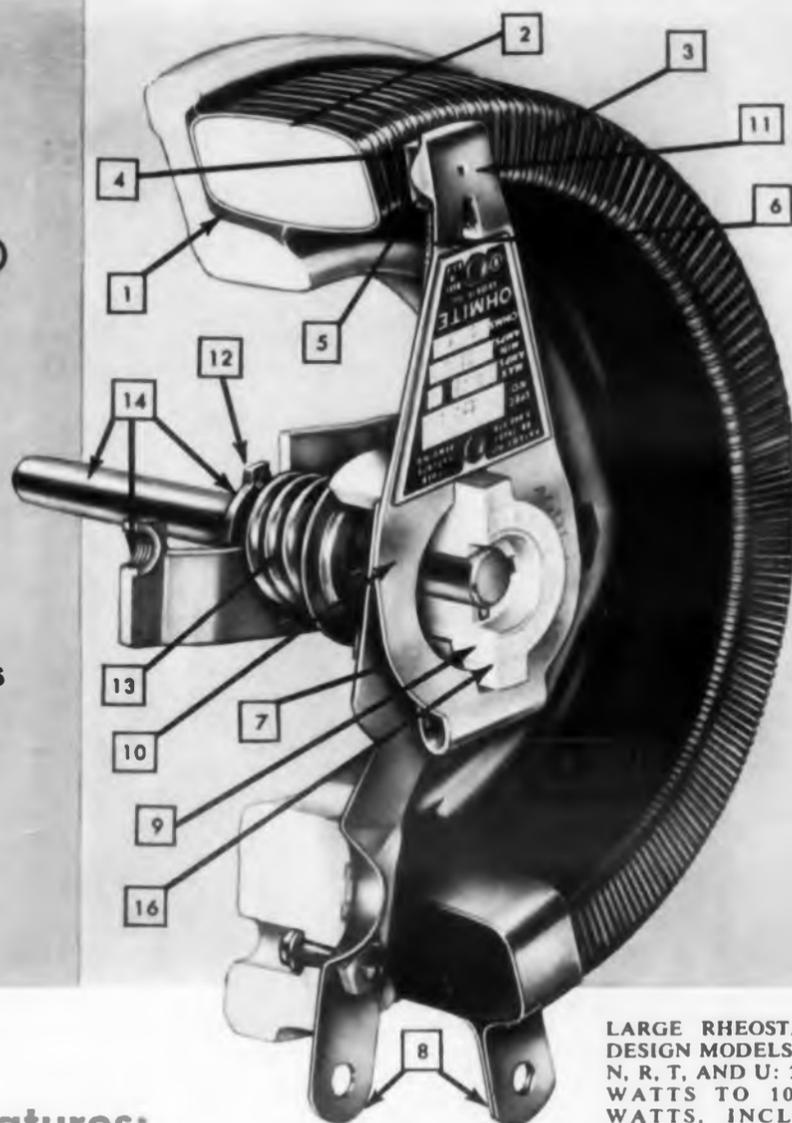
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5. Metal-graphite contact brush (varied to fit current and resistance) insures good contact, with negligible wear on the resistance wire.
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7. Large slip-ring of high-current carrying ability minimizes mechanical wear and provides connection from the moving contact to the terminal.
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9. High strength ceramic hub insulates the shaft and bushings from all live parts. All sizes will stand a 3000 volt a-c breakdown test to ground.
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12. Stops which are keyed to the shaft and base limit the rotation—thus no torsional strain is imposed on the contact arm on stopping.
13. Compression spring maintains uniform pressure and electrical contact between slip-ring and center lead at all times.
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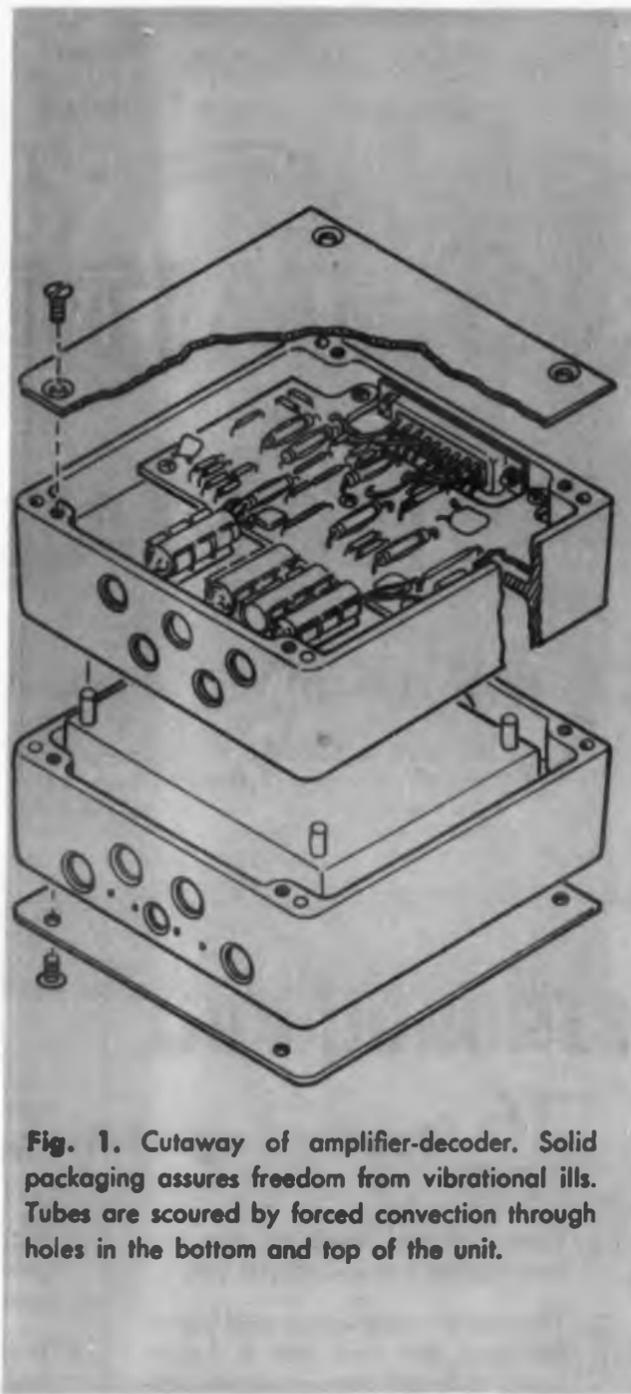


Fig. 1. Cutaway of amplifier-decoder. Solid packaging assures freedom from vibrational ills. Tubes are scoured by forced convection through holes in the bottom and top of the unit.

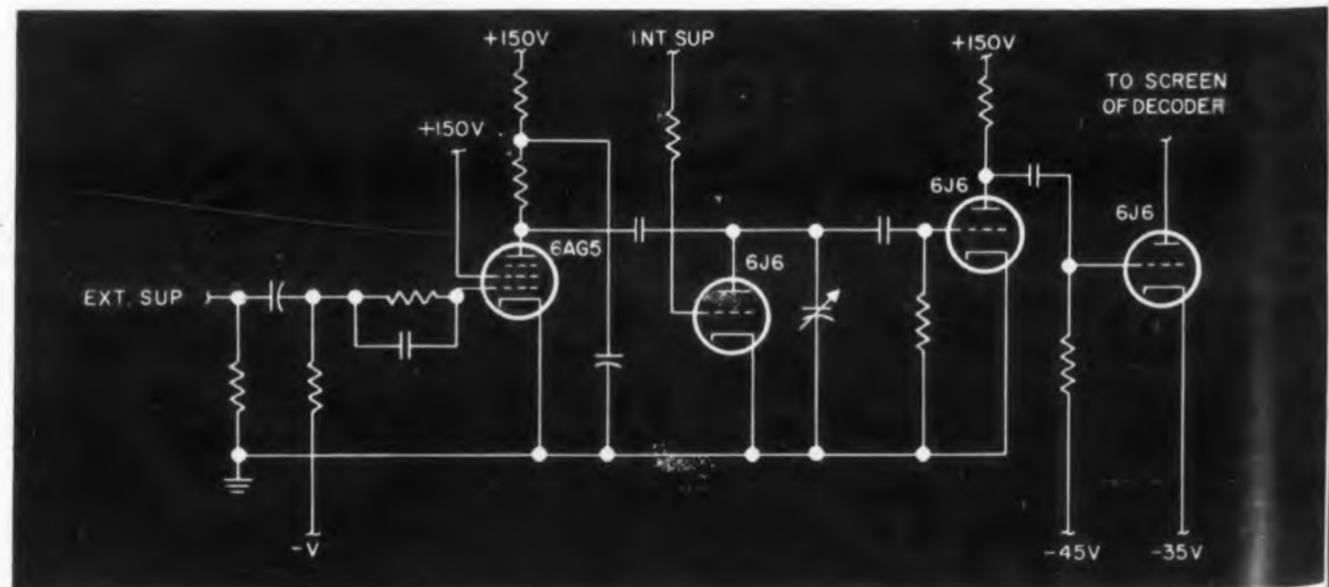


Fig. 2. Conventional suppression circuit, designed with tubes.

has a Fotoceram bottle and will withstand even higher temperatures.

Any one of these materials would be suitable for the printed circuit board: silicon glass, copper-clad Teflon or copper-clad Fotoceram. Glass and Leuck chose the last. It is made by forming Glass, withstands 500 C. Silicon glass is right, the engineers claim, but just on the borderline of working at 225 C. Copper-clad Teflon flexes, and under heavy vibration may cause component leads to break.

"The delay line is a little goody all our own," Leuck grinned. The Technical Products Components Lab covered wire with Eccoseal potting compound, pressure-sensitive Teflon tape and silicon rubber to come up with a delay line that works at 200 C with less than 0.1 μ sec change. The i-f coils in the unit are constructed in the same way—using Teflon-covered wire manufactured by Hitemp; bound with Teflon tape; sealed with silicon rubber to avoid thermal shock; and potted with the Eccoseal compound.

Design

The packaging of the module is important for cooling. As shown in Fig. 1 air enters through holes in the bottom, flows over the low-dissipation components first and is brought up around the tubes; ejected through holes in the top. Size of the holes is such as to force the air to scour the tubes thoroughly to eliminate hot spots.

The 60 mc i-f strip (shown in the photo) achieves a bandwidth of 9.5 to 14.5 mc and has from 75 to 80 db gain. It is exactly half an inch thick by 4-1/8 by 3-3/4 in. The wide bandwidth is mainly a result of using degenerative feedback. The i-f strip has avc and automatic overload control; one gain control varies the gain over a 35 db range.

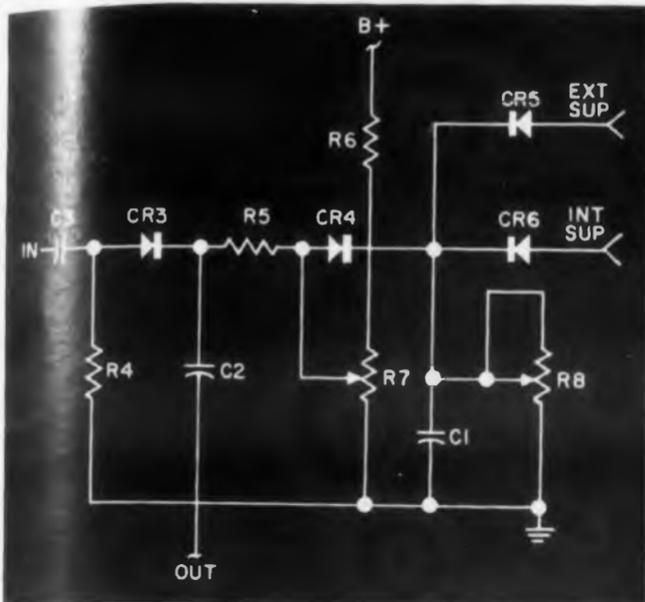


Fig. 3. Diode version of the suppression circuit shown in Fig. 2. Use of a passive diode matrix eliminates heat generated by tubes. Transitron diodes were the only ones showing a greater-than-10 per cent difference between forward and back resistances at 225 C.

Three major diode circuits were designed to replace conventional tube circuits. A three-tube decoder unit was replaced by a matrix of five diodes, and a spike discriminator uses two diodes in place of a pentode.

A clever suppression circuit, which allows the amplifier-decoder to accept only original pulses and reject all spurious pulses and echoes, was developed using a four-diode matrix in place of four tubes. The presence of a positive pulse at the suppressor input prevents the passage of interference pulses to the decoder.

The original tube circuit is shown in Fig. 2; its diode substitute in Fig. 3. Normally, with capacitor *C1* in Fig. 3 not charged, the gate diode *CR3* conducts with its cathode returned to ground through *R5* and *CR4*. The small bias on *CR3* from resistor *R5* and the rest of the network act to 'base clip' the noise coming in with the signal pulses.

When a suppression pulse appears *C1* charges and can discharge only through *R8*. This resistor is adjusted to provide an adequate *RC* time (100 μ sec) for suppression after the removal of the pulse. Shunt diode *CR4* is blocked by the positive potential at its cathode, causing the cathode of *CR3* to rise to the level of *R7* alone. This level is set to block the gate diode *CR3* for the time of the suppression pulse plus the *RC* time. In this way suppression is accomplished without using tubes.

For further information on this ram-air cooled amplifier-decoder unit, turn to the Readers Service Card and circle 107.

The FIRST and ONLY standard line of tunable Microwave Filters

S BAND FILTERS

Characteristics	Two (2) Section Resonator	Three (3) Section Resonator	Four (4) Section Resonator
Model No.	27-BW	27-CW	27-DW
Type of Resonator	TE ₁₀₁ mode rectangular	TE ₁₀₁ mode rectangular	TE ₁₀₁ mode rectangular
Tuning Range	2700-3150 MCS	2700-2950 MCS	2700-2900 MCS
3 db Bandwidth	4.5-6.5 MCS	4.5-5.5 MCS	4.5-5.5 MCS
Max 30 db Bandwidth	36 MCS	18 MCS	13 MCS
Max Insertion Loss	.9 db	1.3 db	1.8 db
Price	\$400.00	\$535.00	\$670.00
Model No.	27-BC	27-CC	27-DC
Type of Resonant Cavity	$\lambda/4$ coax	$\lambda/4$ coax	$\lambda/4$ coax
Tuning Range	2700-3200 MCS	2700-3100 MCS	2700-2950 MCS
3 db Bandwidth	8-11 MCS	8-10 MCS	8-9 MCS
Max 30 db Bandwidth	60 MCS	32 MCS	21 MCS
Max Insertion Loss	1.6 db	2.4 db	3.2 db
Price	\$350.00	\$475.00	\$600.00

C BAND FILTERS

Characteristics	Two (2) Section Resonator	Three (3) Section Resonator	Four (4) Section Resonator
Model No.	54-BC	54-CC	54-DC
Type of Resonator	$\lambda/4$ coax	$\lambda/4$ coax	$\lambda/4$ coax
Tuning Range	5400-5950 MCS	5400-5950 MCS	5400-5750 MCS
3 db Bandwidth	8-11 MCS	8-10 MCS	8-9 MCS
Max 30 db Bandwidth	60 MCS	32 MCS	21 MCS
Max Insertion Loss	2 db	3 db	4 db
Price	\$360.00	\$485.00	\$610.00

L BAND FILTERS

Characteristics	Two (2) Section Resonator	Three (3) Section Resonator	Four (4) Section Resonator
Model No.	96-BC	96-CC	96-DC
Type of Resonant Cavity	$\lambda/4$ coax	$\lambda/4$ coax	$\lambda/4$ coax
Tuning Range	960-1150 MCS	960-1100 MCS	960-1050 MCS
3 db Bandwidth	8-11 MCS	8-10 MCS	8-9 MCS
Max 30 db Bandwidth	60 MCS	32 MCS	21 MCS
Max Insertion Loss	1.2 db	1.8 db	2.5 db
Price	\$370.00	\$495.00	\$620.00

X BAND FILTERS

Characteristics	Two (2) Section Resonator	Three (3) Section Resonator	Four (4) Section Resonator
Model No.	75-BW	75-CW	75-DW
Type of Resonant Cavity	TE ₁₁₁ mode cylindrical	TE ₁₁₁ mode cylindrical	TE ₁₁₁ mode cylindrical
Tuning Range	7500-8500 MCS	7500-8250 MCS	7500-8000 MCS
3 db Bandwidth	8-11 MCS	8-10 MCS	8-9 MCS
Max 30 db Bandwidth	60 MCS	32 MCS	21 MCS
Max Insertion Loss	1.5 db	2.5 db	3.5 db
Price	\$475.00	\$625.00	\$775.00
Model No.	85-BW	85-CW	85-DW
Type of Resonant Cavity	TE ₁₁₁ mode cylindrical	TE ₁₁₁ mode cylindrical	TE ₁₁₁ mode cylindrical
Tuning Range	8500-9600 MCS	8500-9300 MCS	8500-9000 MCS
3 db Bandwidth	8-11 MCS	8-10 MCS	8-9 MCS
Max 30 db Bandwidth	60 MCS	32 MCS	21 MCS
Max Insertion Loss	1.5 db	2.5 db	3.5 db
Price	\$475.00	\$625.00	\$775.00

All of the above filters have Max VSWR of 1.5, and either a single shaft or counter dial for Tuning Control. Depending upon mode of operation, units are supplied with either Type N Connectors or Waveguide flanges.

DELIVERY IN 90 DAYS

FREQUENCY STANDARDS

A DIVISION OF

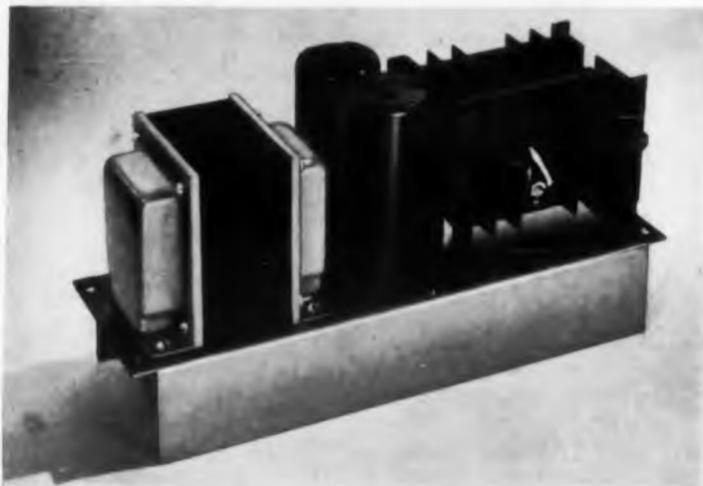
NATIONAL ELECTRIC PRODUCTS CORP.

P. O. BOX 504, ASBURY PARK, N. J.

Telephone: PRospect 4-0500

TWX A PK 588

CIRCLE 24 ON READER-SERVICE CARD



Models 22-111 thru 22-117

D/B

fully transistorized modular power supplies

—for use as components in your original equipment

You can build these sub-chassis power supplies right into your deliverable equipment, saving design time and production expense.

These Dressen-Barnes units—fully transistorized—are available in seven ranges, from 5-7 volts at 3.0 amps., up to 27-32 volts at 1 amp. The wide choice enables you to fill many special requirements with shelf items—available at low cost.

Units can be operated in series to provide higher voltages, and can be mounted on panels for standard rack mounting if required. These supplies are built to typical D/B quality standards. Complete specifications, prices and delivery data on request.

STANDARD OUTPUTS

Model No.	Voltage Range
22-111	5-7 VDC @ 0-3.0 amp.
22-112	7-10 VDC @ 0-2 amp.
22-113	9-12 VDC @ 0-2 amp.
22-114	12-17 VDC @ 0-1.5 amp.
22-115	17-22 VDC @ 0-1.5 amp.
22-116	22-27 VDC @ 0-1 amp.
22-117	27-32 VDC @ 0-1 amp.

SPECIFICATIONS (all models)

Ripple:	2 MV RMS
Regulation:	Line and Load combined .5%
Max. Transient:	NL to FL: 200 Mv.
Max. Operating Temp:	50°C. Ambient
Physical Size:	4" x 12" Sub-chassis, 1 3/4" below, 4 1/2" above

dressen-barnes

DRESSEN-BARNES CORP.

250 North Vinedo Avenue, Pasadena, Calif.

CIRCLE 26 ON READER-SERVICE CARD

Graphical Aids for Determining Tank Circuit Q Quickly

Elliott W. Markow
Wayland Laboratory
Raytheon Manufacturing Co.
Wayland, Mass.

These valuable curves make for quick and simple determination of tank circuit Q's, given bandwidth and normalized impedance.

THE Q of a resonant circuit is customarily determined by specifying the center frequency and the required bandwidth between the two 0.707 impedance points as shown in Fig. 1. From the usual relationship for Q_o , $Q_o = f_o/\Delta f$.

When it is necessary to determine the required tank circuit Q for a given bandwidth between two impedance points other than the 0.707 points the equation

$$Z_N(f) = \frac{1}{\sqrt{1 + \left[\frac{Q \Delta f}{f_o}\right]^2}}$$

is used, where $Z_N(f)$ is the impedance of a single section normalized with respect to impedance at f_o . In most circuits this is identical with normalized gain. Solution for the required Q, given any desired Δf and any value of $Z_N(f)$ is then

$$Q = \frac{f_o}{\Delta f} \sqrt{\frac{1}{Z_N^2} - 1}$$

By defining $\sqrt{1/Z_N^2 - 1}$ as the term r , the solution for required Q of the circuit may be expressed as

$$Q = f_o/\Delta f \cdot r = Q_o r$$

Plotting values of r as in Fig. 2, the required

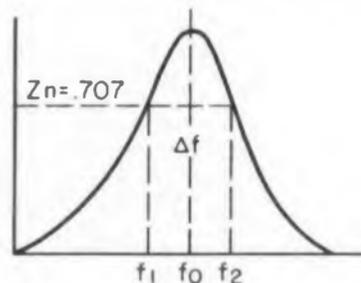


Fig. 1. Typical response of resonant circuit.

circuit Q can be immediately determined by this last equation, using the data from Fig. 2.

As a simple example, suppose the value of Q of a tank circuit centered at 1 mc, with a bandwidth of 10 kc between the $Z_N(f) = 0.9$ impedance points is wanted. (This is, of course, in most circuits identical with the normalized 0.9 voltage gain points.) From the curve for r in Fig. 2 with $k = 1$, $r = 0.48$ is read. The required Q is therefore

$$Q = 10^6/10^4 (0.48) = 48$$

The problem becomes a bit more complex when a number of circuits are cascaded and synchronously tuned. Assuming k tank circuits the general expression for Q for each tank circuit then becomes

$$Q = f_o/\Delta f \sqrt{(1/Z_N)^{2/k} - 1} = Q_o r$$

Suppose the value of Q for each of three synchronous tank circuits is desired which gives a bandwidth of 10 kc between the 0.9 impedance points. From the curve of $k = 3$ in Fig. 2 the value of $r = 0.415$ at $Z_N = 0.9$. Therefore

$$Q_{avg} = 100 \times .415 = 41.5 = Q_1 = Q_2 = Q_3$$

where Q_1 , Q_2 , Q_3 are the Q's of each of the three circuits.

For synchronously tuned circuits it can be shown that the Q of each of the circuits need not be the calculated value to satisfy the specified conditions, but only that the mean value of the individual Q's must equal the calculated value. Expressed analytically it is necessary that

$$Q_{avg} = \sqrt[k]{Q_1 Q_2 \dots Q_N}$$

Thus there is some freedom of choice for the individual Q's as long as equation 5 is satisfied.

For many applications the Z_N^2 or power relationship is the improved parameter. A plot of r versus $(Z_N)^2$ is shown in Fig. 3.

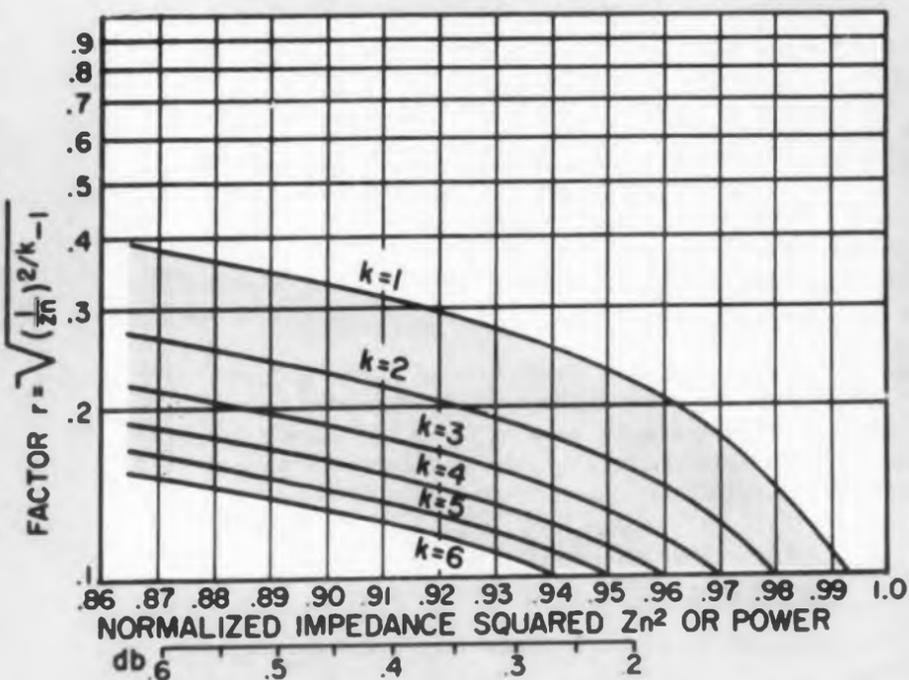
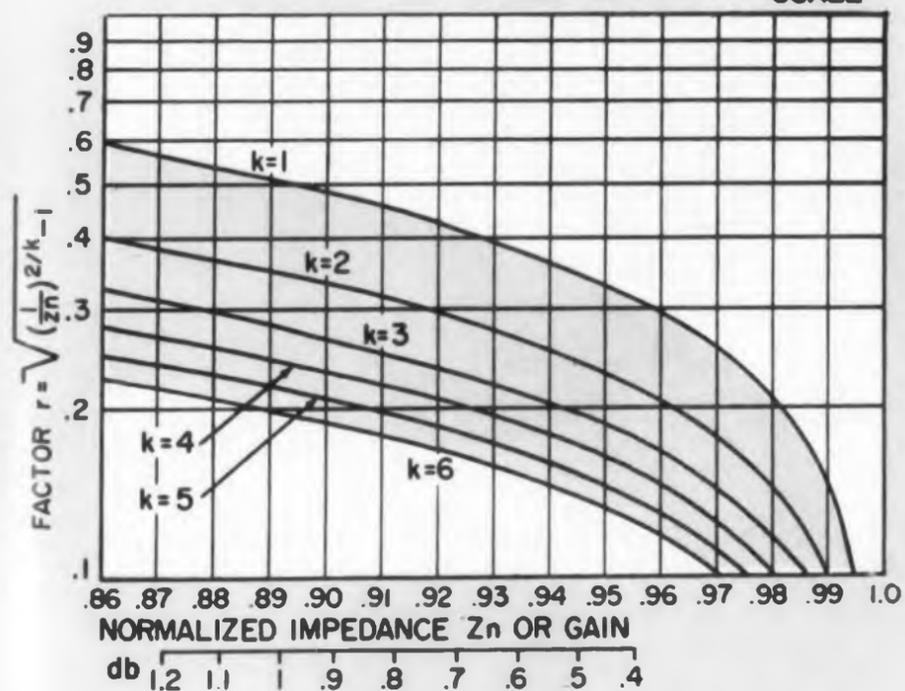
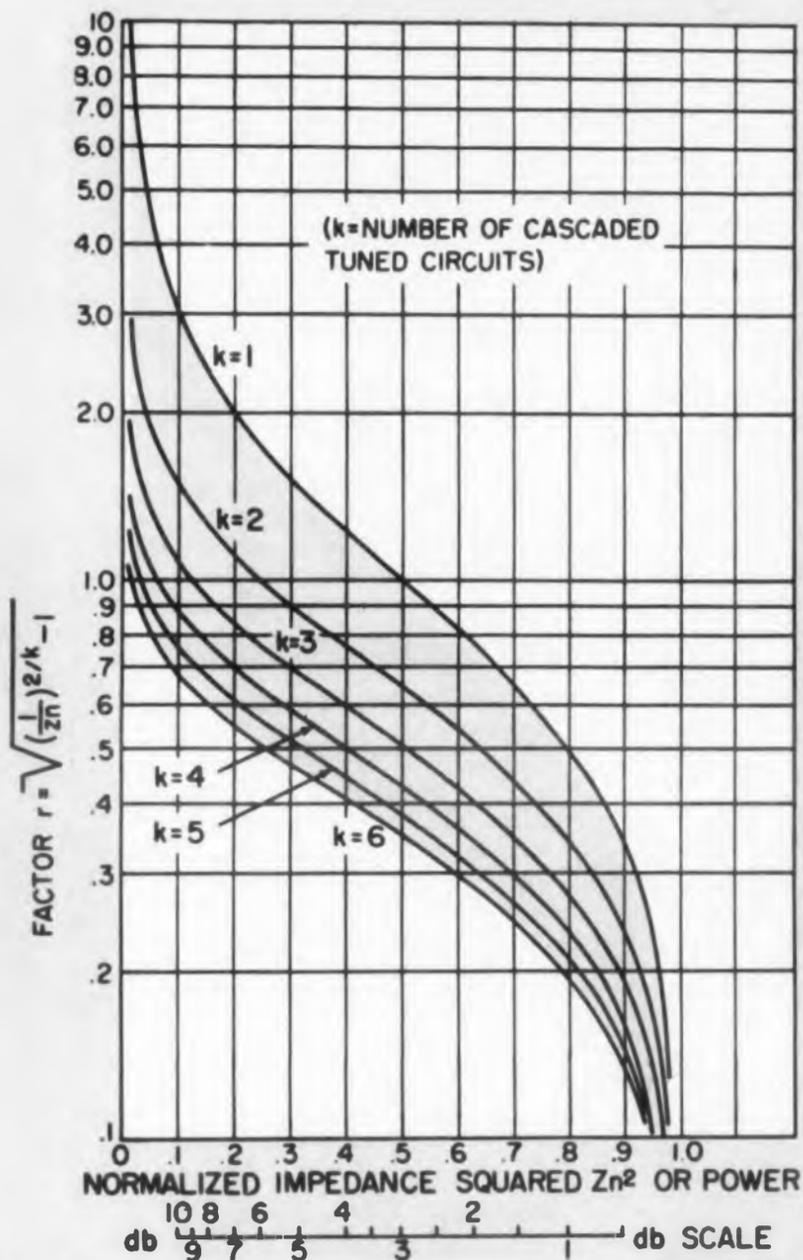
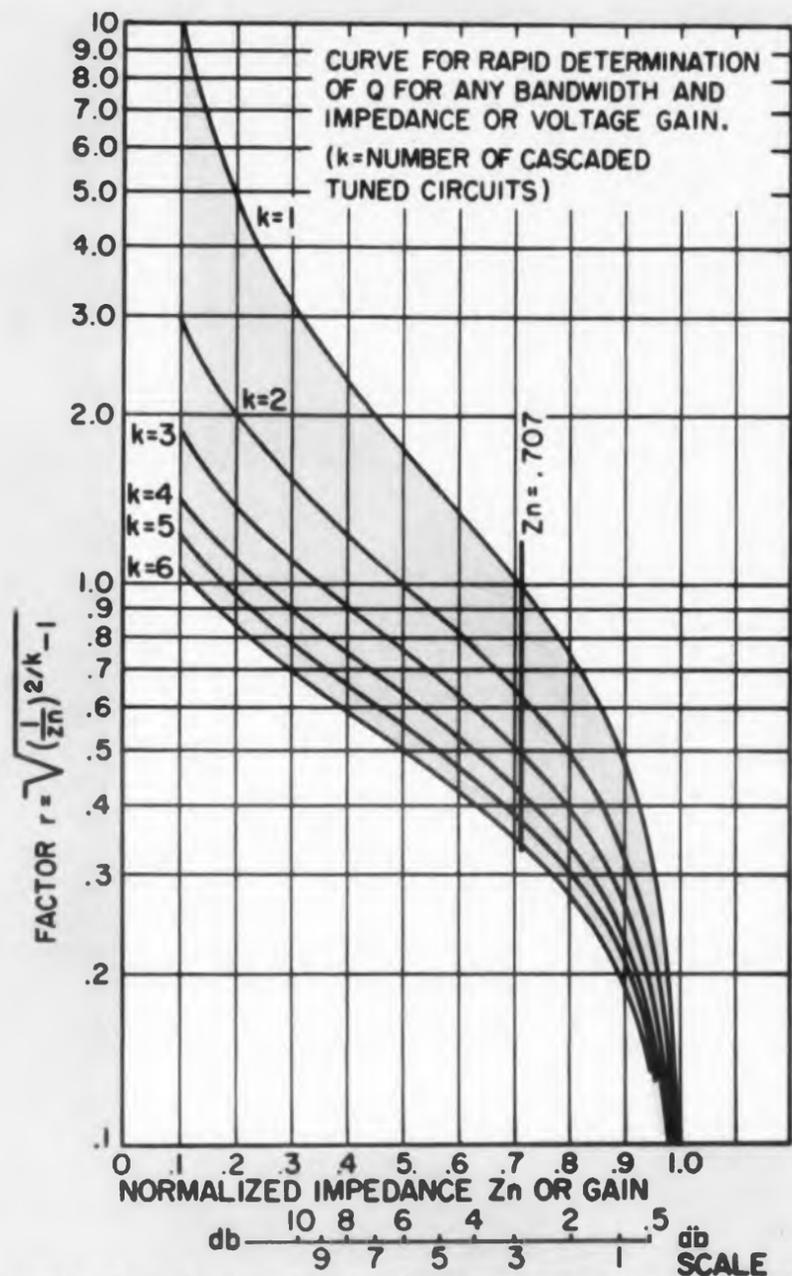


Fig. 2. Curves of r as a function of normalized impedance, Z_n , for various values of k . Region around the nose of the curve where Z_n is nearly unity is plotted on an enlarged scale for convenience.

Fig. 3. Curves of r as a function of Z_n^2 or power for various values of k . Region around Z_n^2 value of 1 has been redrawn on an expanded scale.

NEW IDEAS IN PACKAGED POWER

for lab, production test,
test maintenance, or as a
component or subsystem
in your own products



0.01% regulation—Why be half safe? You can get a-c line voltage regulation to the exact degree of precision you need from Sorensen. Model 2501 (left) regulates a-c line voltage to $\pm 0.01\%$ at 2500 VA. Other Sorensen a-c models range in precision from meter calibrators to rugged "constant voltage transformers," designed to give you maximum volt-amps per dollar.



Fully-transistorized regulated d-c supplies—The most complete line of transistorized low-voltage d-c power supplies on the market—like the new Model Q6-2 (left)—is offered by Sorensen. Regulation accuracy is $\pm 0.25\%$ (line and load combined). Life is exceptional. Response speed is extremely fast. They come with voltage adjustable over 2:1 range (Model Q Series) in 6, 12, 28 vdc and capacities to 200 watts. Also in 0-36, or 0-75 vdc continuously variable "Rangers" (Model QR Series) of 150-watt capacity.



Here's a d-c workhorse for rack-panel equipment—New Sorensen Model MD supplies feature magnetic regulation, semiconductor rectifiers, capacitance-input filters—and low cost. What's more you get any factory preset voltage you want, from 2.5 vdc to 1000 vdc. Available in 8 sizes from 25 to 3000 watts. No switches, no fuses (short circuited output is not recommended, but is not damaging). Ideal for powering your 19" rack-panel equipment.

Sorensen has many other ideas for packaging power to your needs, including standard off-the-shelf models, both electronic and transistorized, to take care of almost every need for controlled power—whether ac or dc, low or high voltage, low or high current. Ask for the latest Sorensen catalog. And let Sorensen engineers talk over with you a complete power system for your complex electronic equipment.

B. C.



SORENSEN & COMPANY, INC.

Richards Avenue, South Norwalk, Connecticut

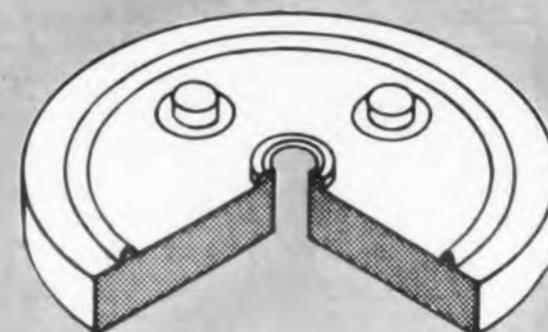
WIDEST LINE OF CONTROLLED-POWER
EQUIPMENT FOR RESEARCH AND INDUSTRY

IN EUROPE, contact Sorensen-Ardag, Zurich, Switzerland. IN WESTERN CANADA, ARVA. IN EASTERN CANADA, Bayly Engineering, Ltd. IN MEXICO, Electro Labs, S. A., Mexico City.

CIRCLE 27 ON READER-SERVICE CARD

New Approach to High Reliability
and Long Life in this . . .

Conductive Plastic Potentiometer



Conductive plastic potentiometer element. The raised ring is conductive throughout its cross section and circumference except for the short section between terminals. Rear ball bearing and wiper contacts are also shown.



CONDUCTIVE filler molded in thermosetting plastic produces the long-wearing resistance element in this precision potentiometer. High reliability, negligible noise and improved linearity are but a few of the advantages gained. Wire breakage, discontinuities, moisture absorption and corrosive action, as well as limited resistance range, are overcome.

The conductive plastic, in the form of a solid homogenous body, serves as the potentiometer element in the unit made by the New England Instrument Co., 320 Main St., Woonsocket, R.I. Diallyl phthalate and alkyd molding components are used for optimum freedom from moisture effects while a specially-filled phenolic material is satisfactory for standard applications.

Unusual Mechanical Construction

The insulating material, conductive track, and silver leads to the terminals are molded in one operation resulting in a single, rugged assembly, as shown. The wiper is free to rotate over a full 360 deg range without mechanical discontinuity; electrical discontinuity is achieved by the inclusion of a nonconductive section along a small region of the track.

Due to the smooth, polished surface of the conductive track, the coefficient of friction is extremely low. Thus, a torque of 0.5 in. oz is sufficient to initiate rotation. Wiper force can be set between wide limits without sacrifice in reliability.

Can Be Made Nonlinear

Nonlinear functions which have severe slopes can be duplicated by altering the cross section of the conductive track. This particular feature may be used to distinct advantage in analog computer applications.

Independent linearity is less than 0.04 per cent on 1-5/16 in. diam units; this figure is difficult to attain in wire-wound versions of twice this diameter. Further accuracy is possible by trimming the edge of the conductive track.

Test Results

Checks made after 35 million revolutions show no significant electrical change in resistance, noise, or linearity. When used in servo applications, it is claimed that potentiometer life should be comparable to that of the servo motor.

Total resistance values from 500 ohms to 10 meg are available with power ratings up to 2 w at 20 C. Temperature range extends from -55 C to +125 C. Components are offered with bushing or servo mount as well as rectilinear design for instrumentation applications.

For more information, turn to the Reader-Service card and circle 106.



DUAL HIGH DIRECTIVITY COUPLERS

Narda Dual High Directivity Directional Couplers are designed for reflectometer measurements in waveguide systems, and exhibit the same flat response (± 0.4) and high directivity (40 db min.) as Narda's single units. Primary line VSWR: 1.05 max. (1.10 for M1027); secondary line VSWR: 1.15 max.

Coupling structures are on opposite broad walls of the primary line; secondary output arms are on the same side. Detector mounts can be attached readily to facilitate connecting detector mounts.

BAND	FREQUENCY (kmc)	WAVEGUIDE O.D. (in.)	NARDA Model	PRICE
S	2.60-3.95	1 1/2 x 1 1/2	1034	8450
C	3.95-5.85	2 x 1	1033	400
XN	5.40-8.20	1 1/2 x 3/4	1032	255
XB	7.05-10.0	1 1/2 x 3/4	1031	220
X	8.20-12.4	1 x 3/4	1030	175
KU	12.4-18.0	7/8 x 3/4	1029	100
K	18.0-26.5	1/2 x 3/4	1028	295
V	26.5-40.0	1/2 x 3/4	M1027	330
M	50.0-75.0	2/8 x 1/4	M1027	900



3, 6, 10 and 20 DB

40 DB HIGH POWER

HIGH DIRECTIVITY COUPLERS

The 40 db High Power Coupler is another exclusive Narda product. Similar to standard types, except that coupling irises are in the narrow wall, it may be used at full rated power of the waveguide size. Nominal coupling value is 40 db; directivity 40 db. Directivity for 3, 6, 10 and 20 db couplers is also 40 db. Standard cover flanges on primary line; low VSWR termination and standard cover flange on secondary. All bands—2600 to 90,000 mc.



STANDARD REFLECTIONS

Narda offers five values of reflections for each of six different waveguide sizes... the most complete choice we know of! Provides calibrated reflections or VSWR's for use in standardizing reflectometers or calibrating slotted line impedance meters.

SPECIFICATIONS

Reflection Coefficient	0.00	0.05	0.10	0.15	0.20
Accuracy	0.002	0.0025	0.0035	0.0045	0.007
VSWR Equivalent	1.00	1.105	1.222	1.353	1.50

Models for 2.60 to 18.0 kmc, from \$125 to \$300

Complete Coaxial and Waveguide Instrumentation for Microwave and UHF — including:

DIRECTIONAL COUPLERS
TERMINATIONS
FREQUENCY METERS
HORNS
VSWR AMPLIFIERS

200 to 90,000 mc.
TUNERS
ECHO BOXES
SLOTTED LINES
BENDS
COAXIAL HYBRIDS

ATTENUATORS
STANDARD REFLECTIONS
BOLOMETERS
THERMISTORS
LOW PASS FILTERS



the narda
microwave corporation

118-160 HERRICKS ROAD, MINEOLA, L. I., N. Y. • PIONEER 6-4650

Microwave engineers—

Where can you use these exclusive features offered by NARDA?



BOLOMETER & THERMISTOR BROADBAND MOUNTS

- Exclusive plug-in elements

This new series of Narda matched Bolometer-Thermistor Mounts offers the optimum in accuracy and flexibility. At the same time, they permit instant replacement of the element. Bolometers and Thermistors, available from stock, simply plug in, without the use of tools, without the need of adjustments.

In addition, these mounts offer an extremely low VSWR over the full waveguide band, and require no tuning. Using bolometers, these units are designed for highest accuracy square law detection and power measurements. The thermistors are particularly recommended for accurate pulse power measurement. The new Narda N-605 Bolometer and N-333D Thermistor are recommended for use in these new detectors.

BAND	FREQ (KMC)	WAVE GUIDE (IN.)	NARDA MODEL	DETECTOR TYPE AND MODEL	MAX. VSWR	CRYSTALS†	LENGTH (IN.)	PRICE
L	1.12-1.70	6.66x3.41	516	BOLOMETER N 605 THERMISTOR N 333D	1.35 1.5	1N21 or 1N23	14	\$210.
LS	1.70-2.60	4.46x2.31	535	BOLOMETER N 605 THERMISTOR N 333D	1.35 1.5	1N21 or 1N23	9	210.
S	2.60-3.95	3x1 1/2	534	BOLOMETER N 605 THERMISTOR N 333D	1.35 1.5	1N21 or 1N23	7 1/4	110.
C	3.95-5.85	2x1	533	BOLOMETER N 605 THERMISTOR N 333D	1.5 1.5	1N21 or 1N23	5 1/4	80.
XN	5.40-8.20	1 1/2 x 3/4	532	BOLOMETER N 605	1.5	1N23	4 1/4	90.
			532	THERMISTOR N 333D	1.5	1N23	4 1/4	75.
XB	7.05-10.0	1 1/2 x 3/4	531	BOLOMETER N 605	1.5	1N23	3 1/4	85.
			531	THERMISTOR N 333D	1.5	1N23	3 1/4	65.
X	8.20-12.4	1 x 3/4	530	BOLOMETER N 605	1.5		2 1/4	65.
			530	THERMISTOR N 336	1.5		2 1/4	60.
KU	12.4-18.0	7/8 x 3/4	529	BOLOMETER N 604	1.5		2	65.
			529	THERMISTOR N 336	1.75		2 1/4	95.
K	18.0-26.5	1/2 x 3/4	538	BUILT IN THERMISTOR	2.0		1 3/4	150.

MAIL COUPON TODAY FOR
FREE 1959 CATALOG AND NAME OF
NEAREST REPRESENTATIVE

The Narda Microwave Corporation
118-160 Herricks Road
Mineola, L. I., N. Y.
Dept. ED-13

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COMPANY _____

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CITY _____ ZONE _____ STATE _____

CIRCLE 28 ON READER-SERVICE CARD

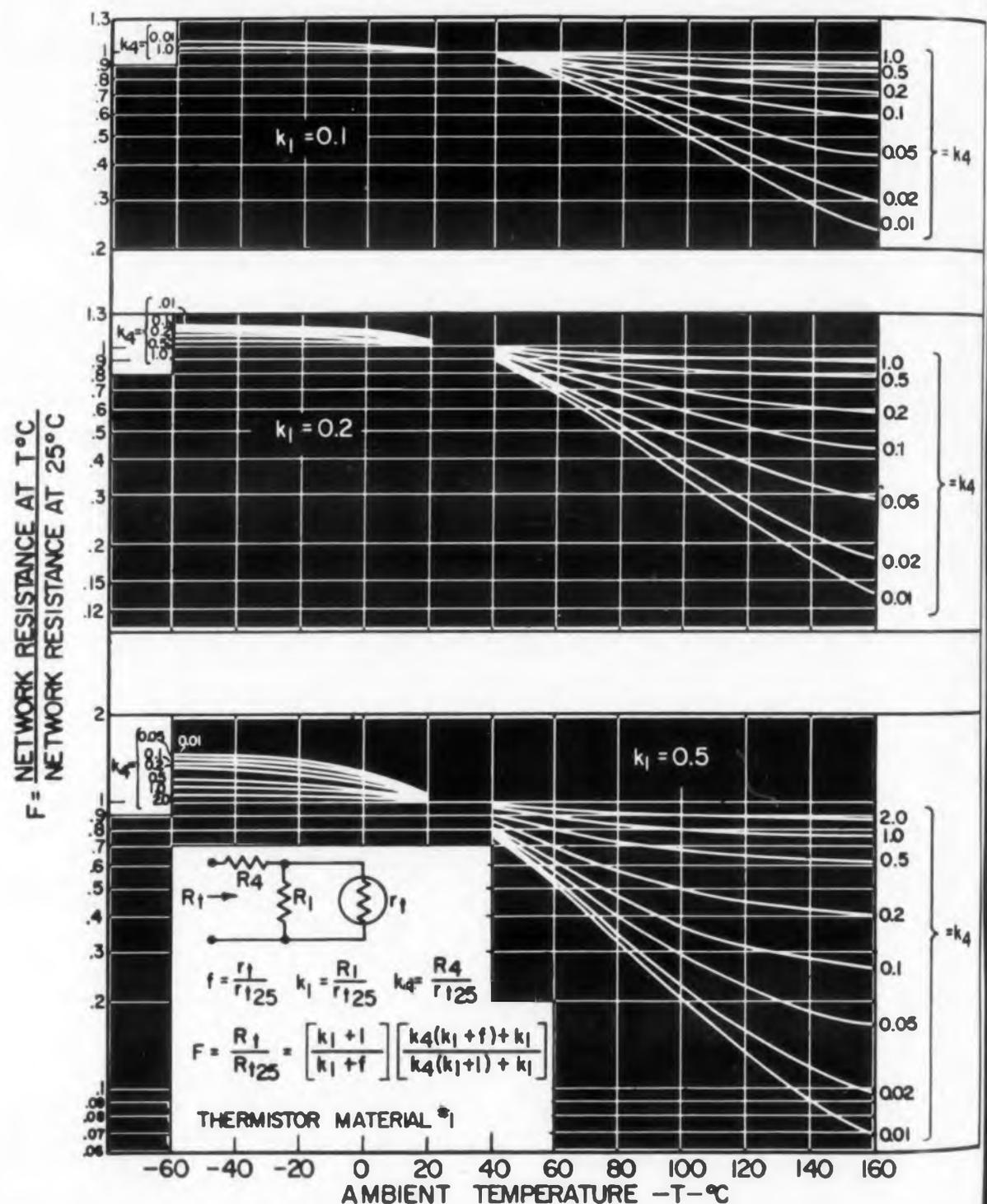
HOW UP-TO-DATE IS YOUR CONCEPT OF **RELIABILITY?**

- Why is reliability more important today than ever before?
- How can a manufacturer be sure of getting reliability in the silicon rectifiers he buys?
- What is meant by "reliability safety factor"?
- Does miniaturization affect the reliability of silicon rectifiers?
- Is there a *reliable* tantalum capacitor priced for industrial applications?
- How did one manufacturer get twice the capacity in a solid tantalum capacitor without increasing the case size?

The answers to these questions will be found on the next three pages in the Fansteel Advertisements.

Quick Design of Thermistor Compensation Networks—3

Bernard R. Schwartz
Radio Corp. of America
Defense Electronic Products
Camden, N. J.



Two-resistor network compensation circuit and characteristics for common thermistor materials are identified on opposite page. Additional information on these materials is given in April 30 and October 15 ELECTRONIC DESIGN.

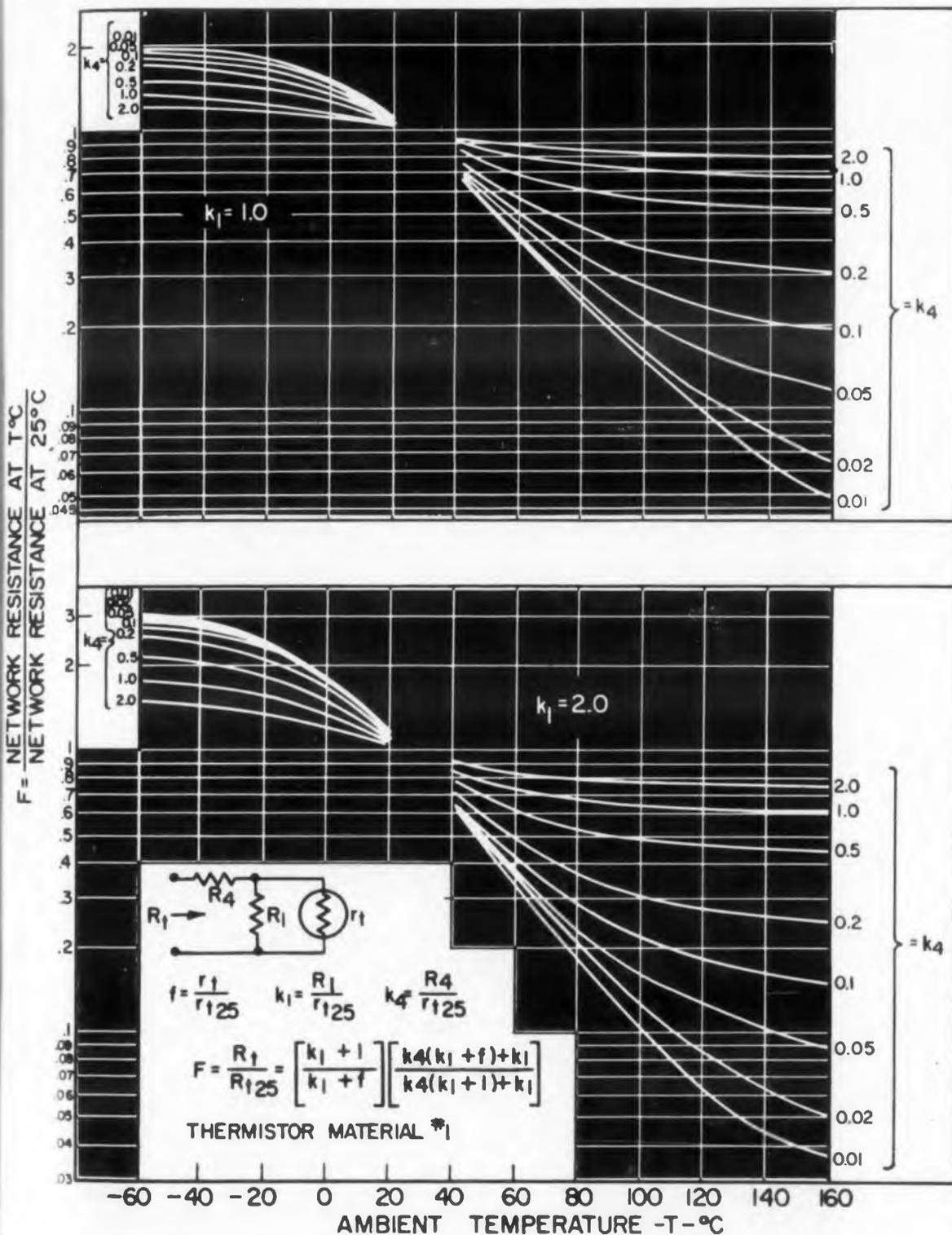
THE TWO-RESISTOR thermistor compensation network to be considered is illustrated in the accompanying curves. The procedure to follow in solving design problems with these curves and the nomogram was outlined in both preceding segments.

Example. A network is desired which has

the following resistance-temperature response: Resistance (ohms) Temp. (C)

10,800	-55
10,200	-25
8,520	0
6,000	25
3,600	50
2,130	80

(Continued on following page)



Common thermistor materials applicable are: Carborundum Corp.—type H; Fenwal Electronics—type No. 1; G. E. Carbide—Grade 1; Keystone Carbon—type 97; Thermistor Corp. of America (Gulton)—type D; Victory Engrg. Corp.—Type



Like a chain with one weak link, the malfunction of a single component in today's complex electronic gear means an aberration ranging from "slight" to "catastrophic." That's why, in much of today's equipment, particularly in military gear, *component reliability* takes precedence over all other considerations.

It is towards this goal of absolute reliability that Fansteel Silicon Rectifiers are engineered and produced. To achieve Fansteel's "Reliability Safety Factor" no check, no test and no precaution is omitted. If your product cannot tolerate component failure, Fansteel Silicon Rectifiers are your logical choice.



Write for Bulletin 6.302

The new Fansteel 1N1600 series Silicon Rectifiers are conclusive evidence that it's possible to get miniaturization without affecting reliability. Fansteel's unflinching reliability has been built into this smallest of silicon rectifiers rated at 750 milliamperes with a peak reverse voltage range of 50-600 volts, and an operating temperature range up to 165°C.

FANSTEEL

RELIABILITY

E588A

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill. U.S.A.

CIRCLE 31 ON READER-SERVICE CARD

**The Fansteel
"PP" Type**



**PROVEN
RELIABILITY
SINCE 1949**

**The New
Fansteel
BLU-CAP***



**WITH THE
SAME BUILT-IN
RELIABILITY**

**BUT PRICED FOR
INDUSTRIAL APPLICATIONS**

The new Fansteel Blu-Cap Tantalum Capacitor offers significant economies in any application where wider capacity tolerances are permissible. These savings are made possible because the tolerance range has been broadened to $-15\% + 75\%$ —but the increase in range is only on the plus side and not on the important minus side.

As with all Fansteel Tantalum Capacitors, the Blu-Cap more than meets today's demands for high reliability.

You can get all the details about today's biggest value in tantalum capacitors in our new Bulletin 6.120.

*Trademark



C5812A

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U. S. A.

CIRCLE 32 ON READER-SERVICE CARD

Step 1:

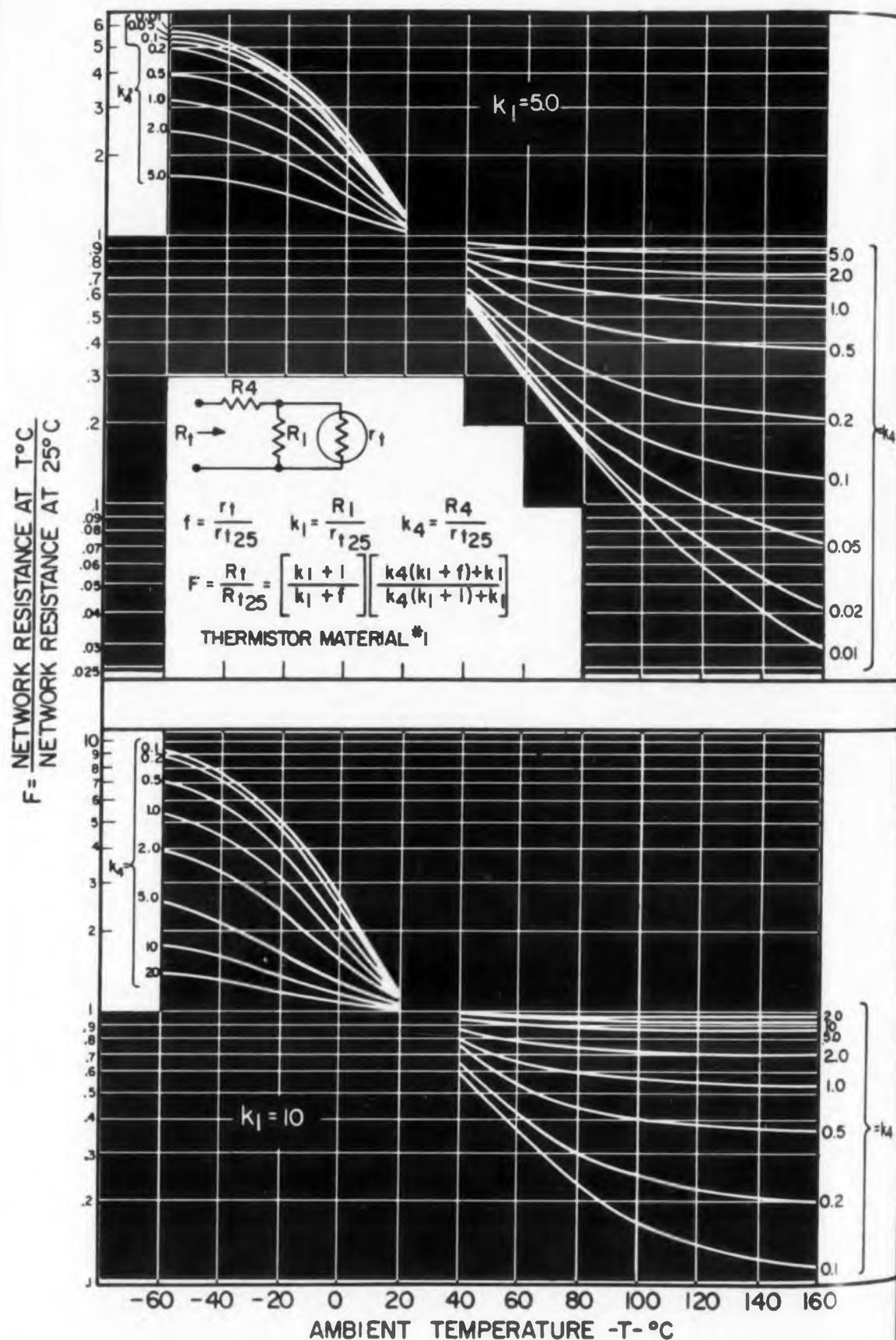
The network resistance value variation is then normalized with respect to the 25 C value. F (norm.

network resistance	Temp. (C)
1.8	-55
1.7	-25
1.42	0
1.00	25
.60	50
.355	80

Step 2:

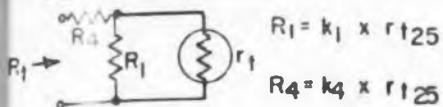
The graphs below yield a solution. When $k_1 = 1$ and $k_4 = 0.1$ the following network values are obtained.

F	Temp. (C)
1.8	-55
1.69	-25
1.41	0
1.00	25
.60	50
.36	80



lution.
owing

CIRCUIT SCHEMATIC

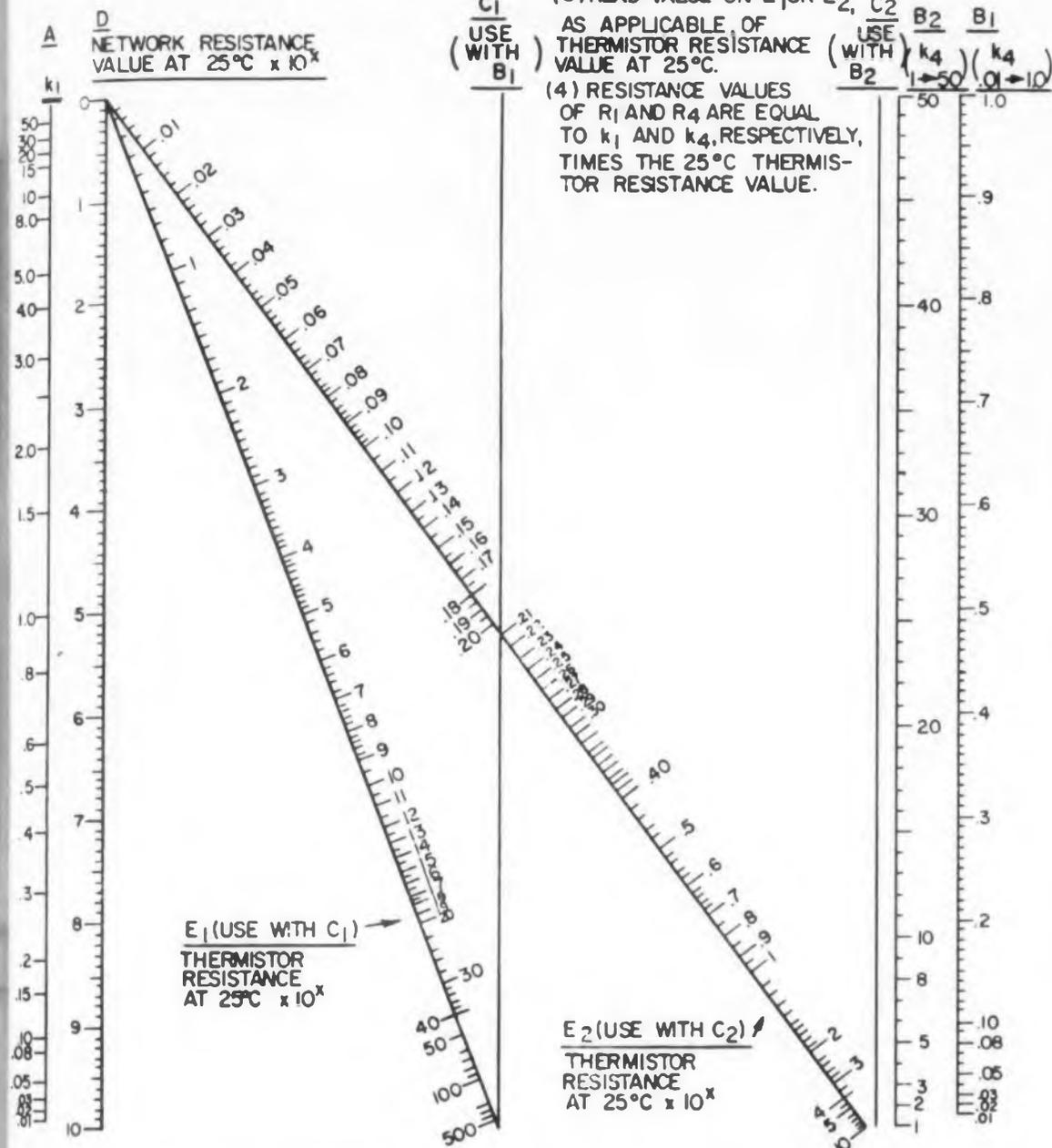


PROCEDURE: (1) DRAW FIRST LINE BETWEEN POINTS ON A AND B₁ OR B₂ APPROPRIATE TO SELECTED VALUES OF k₁ AND k₂, RESPECTIVELY. NOTE THAT B₁ AND B₂ ARE TO BE USED FOR VALUES OF k₄ FROM .01 TO 1.0 AND FROM 1.0 TO 50, RESPECTIVELY.

(2) DRAW SECOND LINE BETWEEN POINT OF INTERSECTION OF FIRST LINE WITH C₁ OR C₂, AS APPLICABLE, AND THE APPROPRIATE POINT ON D FOR THE NETWORK RESISTANCE VALUE AT 25°C.

(3) READ VALUE ON E₁ OR E₂, AS APPLICABLE, OF THERMISTOR RESISTANCE VALUE AT 25°C.

(4) RESISTANCE VALUES OF R₁ AND R₄ ARE EQUAL TO k₁ AND k₄, RESPECTIVELY, TIMES THE 25°C THERMISTOR RESISTANCE VALUE.



Nomogram for selecting values of R₁ and R₄ in the two-resistor network shown.

Step 3:

Referring to the nomogram, scale B₁ is used for the k₁ value of 0.1. A line drawn between the A scale (k₁) 1.0 point and the B₁ scale (k₄) 0.1 point intersects the C₁ scale. Another line drawn from the marked point on the C₁ scale and the D scale (network resistance value at 25°C x 10⁻³) 6.0 point intersects the E₁ scale

at point number 10.

Step 4:

Since the value of x is 3 in the 10^x scale factor used with scale D, the thermistor resistance value at 25°C is 10,000 ohms. R₁ then is equal to k₁ (1.0) times 10,000 ohms or 10,000 ohms. R₄ is equal to k₄ (0.1) times 10,000 ohms or 1000 ohms.

Network compensation characteristics (left) for K₁ = 5.0 and K = 10. (Opposite page)

The New Fansteel Solid Tantalum STA CAPACITORS GIVE DOUBLE THE RATING IN THE SAME CASE SIZE

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C5813A

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U.S.A.

CIRCLE 33 ON READER-SERVICE CARD

DESIGN FORUM



Measuring RF Power Between 10 mw and 10 w

CONVENTIONAL calorimeters and bolometers are useful instruments for the measurement of microwave power. But their range is limited. The calorimeter, for example, has a lower power limit in the 1 to 10 w range. The bolometer, on the other hand, has an upper limit of 10 to 100 mw. Here is a description of the Hewlett-Packard model 434A rf power meter, which uses both calorimeter and bolometer techniques to close this gap. The description of the design of this instrument is from B. P. Hand, development engineer at Hewlett-Packard.

The input of the 434A is a type-N connector which accepts power for measurement at any frequency from dc to 12 kmc without barretters, thermistors, external power terminations or external plumbing. It has two operating controls, the meter range switch and a zero set. Power is read directly in watts and dbw on the meter, on ranges from 10 mw full scale to 10 w full scale. Response time is less than 5 sec, and an accuracy of about ± 2 per cent is obtainable.

The instrument consists of a self-balancing bridge which has identical temperature-sensitive resistors (gages) in two legs, an indicating meter and two load resistors, one for the unknown input power and one for the comparison power. The circuit diagram is shown in Fig. 1.

The principles of operation are as follows: The input connector is terminated in a 50-ohm

axial resistor, over which flows a thin film of oil. The oil, which is heated by the resistor, then flows over a nickel-wire resistance gage. A rise in oil temperature results in an increased gage resistance.

High sensitivity is achieved by the unique use of an oil film for heat transfer, rather than a coaxial oil line. To eliminate calculations and to speed up response, a self-balancing bridge using negative feedback is employed. This is accomplished by the use of a comparison head which incorporates a load resistor and a resistance gage similar to the input head.

All elements of the oil system, shown in Fig. 2, are in series to insure equal flow rates in the two heads. Equal power inputs to the two heads then result in equal temperature rises. Prior to entering the heads, the two oil streams pass through a parallel-flow heat exchanger to bring their temperatures to about the same level. The effect of any small difference is eliminated in zero-setting, so that only output temperature gages are required.

The two resistance gages, which are closely matched in value, are arranged as two legs of a bridge. This bridge is driven by an audio oscillator, and zero-set potentiometers are provided to balance the bridge prior to the application of power.

When power is applied to the input, the resistance of the corresponding gage increases,

unbalancing the bridge. The resulting audio signal is amplified in an ac amplifier, rectified in a synchronous detector, further amplified in a dc amplifier, and fed to the feedback-head load resistor. This heats the corresponding gage and brings the bridge back toward balance. The meter reads the dc voltage across the feedback-head load resistor required to produce the matching rate of heat transfer.

Since the amplifier has finite gain, a small difference exists between the power applied to the input head and the power applied to the feedback head. At full scale on the meter, this difference is nominally 2 per cent. The meter is calibrated in terms of power applied to the input head.

This feedback system makes the instrument relatively independent of variations in both gain and oil flow rate. For example, a reduction in gain to 1/2 the nominal value merely doubles the difference between the two powers, resulting in a 2 per cent reduction in reading. Since an increase in flow rate causes a reduction in temperature rise for a given amount of power, it is the same as a reduction in gain. Therefore, doubling the flow rate results in an error of only 2 per cent.

When a signal coming from the ac amplifier has the correct phase relative to the oscillator, a positive dc voltage is developed. If the input signal is reversed in phase, a negative voltage is developed. The output stage of the dc amplifier is biased almost to cutoff in order to pass only the positive voltages. The non-linear tube char-

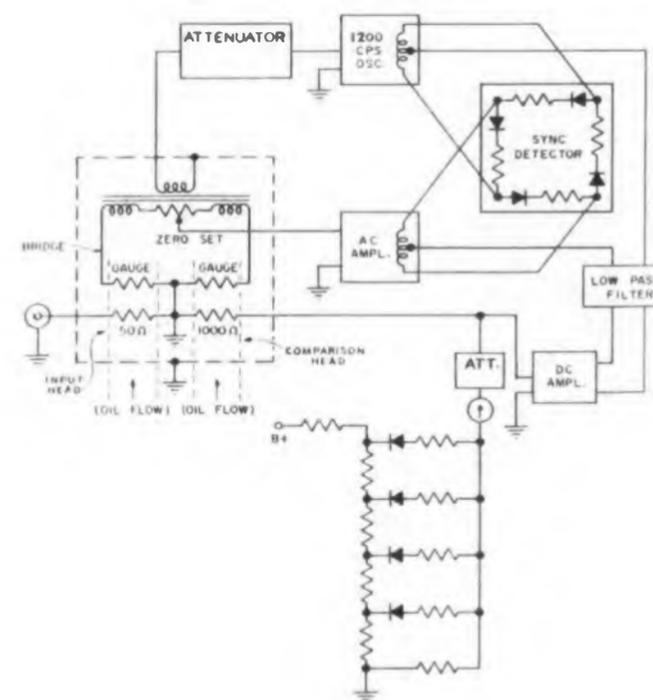


Fig. 1. Circuit diagram of the rf power meter.

characteristic of the output stage necessitates the use of feedback around the dc amplifier to linearize the overall gain.

Since it is impossible to provide enough gain and feedback to make the dc amplifier linear right down to zero tube current, the feedback network is returned to the negative power supply and has relatively low resistance. Thus several milliamperes flow through the output tube and the network when the cathode is at ground potential, making the dc feedback effective even though no current flows through the load resistor and the meter reads zero.

The circuit is designed to allow a small degree of runaway so that the meter may be moved through zero. When the meter is below zero, the grid of the output tube is driven toward cutoff. When this occurs the cathode drops below ground potential, allowing a reverse current to flow through the feedback-head load resistor and through the feedback network to the negative supply. Until the tube is completely cut off, the circuit runs away. A diode is provided on the lower ranges to shunt most of this reverse current around the load resistor so that the reverse power is never more than a few per cent of full-scale power.

A shaping circuit is used wherein the current through the meter passes through a series of diodes which are biased to various dc voltages. As the voltage applied to the circuit increases, the diodes start conducting in turn so that sensitivity is low at low voltages and high at high voltages. The result is a scale almost linear in power, and one which is easy to zero-set to a line.

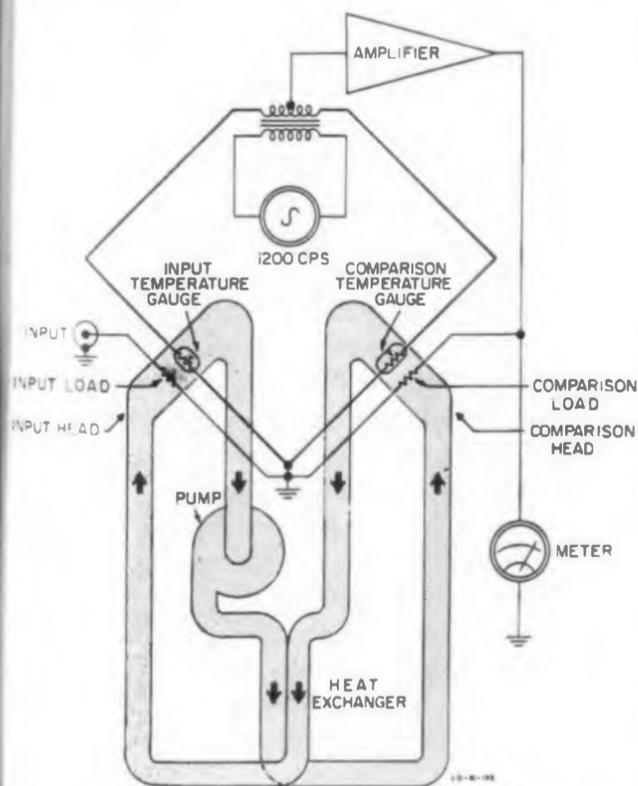


Fig. 1 The series operation of the oil flow guarantees equal flow rates over both sensing elements.

TUNG-SOL POWER TRANSISTORS IMPROVED THREE WAYS BY:

NEW

Cold-Weld



SEAL

Tung-Sol's new true cold-weld seal represents a major advance in transistor technology. An exclusive Tung-Sol development, cold-weld sealing increases TO-3 outline package efficiency and brings designers a threefold bonus in over-all transistor performance.

Improved thermal qualities. The cold-weld process produces a hermetic, copper-to-copper seal and makes possible a 100% copper transistor with thermal properties superior to previous high power types.

Improved reliability. Cold-weld encapsulation eliminates heat damage, "splash", and heat-caused moisture that can impair transistor performance.

Longer efficient life. Even through temperature fluctuations that cause "breathing", the cold-weld seal stays vacuum-tight, moisture-proof—result of actual integration of the copper molecules during sealing.

Tung-Sol power switches with the new cold-weld seal withstand the most rigid combination of tests given any transistor—the 100 psi "bomb" immersion test and the critically sensitive Mass Spectrometer leak test. Further, they meet all military environmental requirements. For full data on the improved Tung-Sol types . . . to fill any transistor need, contact: Semiconductor Division, Tung-Sol Electric Inc., Newark 4, New Jersey.

THESE TUNG-SOL HIGH POWER (TO-3 OUTLINE) TRANSISTORS FEATURE THE NEW, COLD-WELD SEAL

Type	BV _{CES} (V _{BE} = +1.0v) Volts (Min)	BV _{CEO} (I _B = 0) Volts (Min)	h _{FE} (I _C = 1.0 A)	h _{FE} (I _C = 2.0 A)
2N378	-40	-20	50	30
2N379	-80	-40	50	30
2N380	-60	-30	70	50
2N459	-105	-60	50	30



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

Collector Dissipation @ 25°C . . . 50 Watts
Collector Dissipation @ 55°C . . . 25 Watts
Thermal Resistance . . . 1.2°C/Watt Max.
I_{CB0} @ V_{CB} = -25v T = 25°C . . . 0.5 Ma Max.
I_{CB0} @ V_{CB} = -25v T = 85°C . . . 7.5 Ma Max.
Storage Temperature . . . -55 to +100°C

*Mounting base temperature

TUNG-SOL

CIRCLE 34 ON READER-SERVICE CARD

SHOCK

The T takes 50G's meeting MIL-R-19; exceeding NAS 710 proc. III

VIBRATION

The T takes 500 cps at 30G's, meeting NAS 710 proc. III

ACCELERATION

The T takes 100G's, exceeding MIL-R-19

The T takes -55° to +125°C, with 1.2 watts at 40°C

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and you'll find the Helipot Series T all-metal single-turn precision potentiometer can take it!

Name your linearity, to $\pm 0.20\%$...your resistance, from 650 to 100,000 ohms...up to 5 ganged sections and 9 taps per section...servo or bushing mount, with bearings front and rear for perfect alignment.

Put them all together, in the T's new cup-type housing, and you'll have the best-value miniature you can design into your system!

For the full T-Pot Story, whistle for data file C122.

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potentiometers : dials : delay lines : expanded scale meters : rotating components : breadboard parts

CIRCLE 35 ON READER-SERVICE CARD



Fig. 1. From left to right are the shell, the pre-metered pellet, the component and the header.

Encapsulation in Three Easy Steps

MAKING an encapsulated plug-in module is easy with the "E-Pak" system. Only three processes are necessary: soldering, assembling and heating.

To make an "E-Pak" module you need four things: (1) a component(s), (2) an all-epoxy header with lead wires, (3) an epoxy shell and (4) a pre-metered pel-

let. These are shown in Fig. 1. The last three items are manufactured by Epoxy Products, Inc., Div. of Joseph Waldman and Sons, 137 Coit St., Irvington, N. J.

Solder First

To start, the leads on the component(s) are soldered to the header. Since this

Potentiometer Shows What



Fig. 1. End cap of potentiometer is dual-calibrated. Unit is enlarged over three times.

THIS precision trimmer potentiometer has a dual-calibrated dial. By looking at the scribe on the side of the unit, or on the mounting panel, an operator can tell where the potentiometer is set.

The calibrated end cap, shown in Fig. 1, is attached to the potentiometer's slider. Rotation of the cap can be made by hand or screwdriver. The end cap is calibrated twice—radially for side reading, and on the end for top reading. Designed primarily for printed circuit applications, the trimmer is made by Waters Mfg., Inc., Wayland, Mass.

Graduations on the cap are from 0 to 10 in the 300 degree winding angle. The unit is available with a variety of mounting terminals. For printed circuit applications plug-in terminals are provided; standard terminals are solder type.

header is made of epoxy, the coefficient of expansion of the lead wires is not critical. The header won't split if too much heat is applied.

Then Assemble

Next comes the assembly process. A premeasured epoxy pellet is dropped into the cured epoxy shell. Then the header and component(s) are placed into the shell.

And Heat

Last, the entire package is placed into an oven and heated. The pellet automatically melts and cures. It embeds the component and seals the header. Within the shell is a chemically-inert seal which promotes reliability of the component.

Where encapsulation is desired without embedment, a self-sealing epoxy cover is available.

The shell, designed for miniature applications, can be obtained in diameters up to about three inches.

The "E-Pak" system is adaptable to the automatic manufacturing procedures of most components.

For more information on this encapsulation system, turn to the Readers-Service card and circle 101.

You Set

Size of the unit varies. For resistances up to 20 K, over-all length is 1/2 in. Up to 100 K, length is 5/8 in. Up to 250 K, length is 3/4 in. The diameter in all cases is 1/2 in.

Maximum dissipation of the potentiometer is 1 w at 400 C. Independent linearity, above 500 ohms, is 3 per cent. Equivalent noise resistance is 140 ohms, maximum.

The potentiometer meets the requirements of MIL-E-5272A, MIL-R-19 and others as applicable.

Uses of the potentiometer include encapsulated subassemblies. The entire unit can be encapsulated, leaving only the dial free for adjustment.

For more information on this calibrated potentiometer, turn to the Readers-Service card and circle 100.



CHASE FORGINGS



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Chase makes forgings of copper, tellurium copper, brass, bronze and aluminum. Chase supplies blank, machined, or polished and plated forgings. And Chase is ready to help you with your parts production. Talk over your forging needs with the Chase office nearest you—and ask your Chase representative to show you how forgings can be your best answer to precision-made parts at lowest possible cost.

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CIRCLE 36 ON READER-SERVICE CARD



About The Author

Among the responsibilities of Donald P. Allen, a manager in the Instrumentation Division of Ampex Corp., is planning all future product development programs. He has had experience in designing analog and digital instrumentation recorders and military electronics. A registered professional engineer, Mr. Allen envisions actuator devices based on electrostatic or vacuum principles. His article shows how a classic principle can be used as a basis for solving new problems.

Polar Relay Principle Speeds Tape Actuator

Donald P. Allen
Ampex Corp.
Redwood City, Calif.

ACCELERATING magnetic tape from 0 to 150 in. per sec in less than 2 ms was the challenge accepted by the Ampex Corp., Redwood City, Calif. For the course in the past were start and stop times of 5 ms and tape speeds of 75 in. per sec. Better operation was restricted by the limitations of the actuators being used.

Digital tape handlers have to do two things: accelerate tape from rest to a uniform speed and then stop it. And these functions have to be performed fast and in a uniformly reproducible manner. Basic design of the tape handler re-

quires that the tape pass between a capstan and a pinch roller, both continuously rotating. How to actuate the pinch roller becomes a critical factor because it is the key both to start-stop time and to reproducible, consistent start-stop time distances on the tape. In exploring the problem, polarized relay principles were given careful study and finally adapted to the tape actuator.

Polar Relay Principles

The polar relay has an armature which is centered by a spring, as shown in Fig. 1, and is

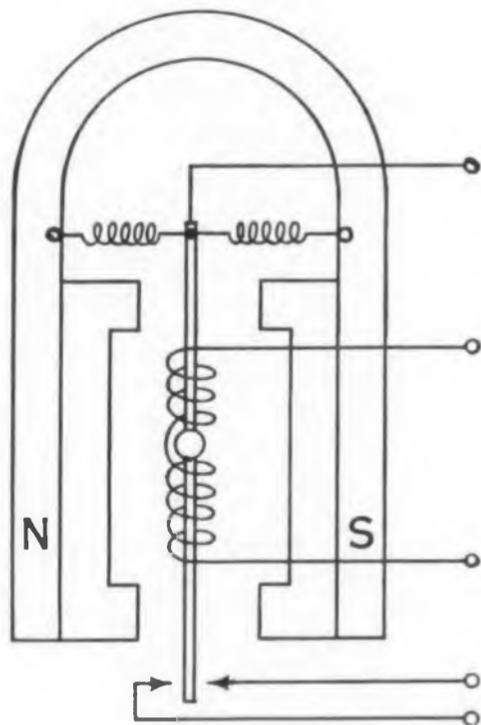


Fig. 1. Basic polar relay construction.

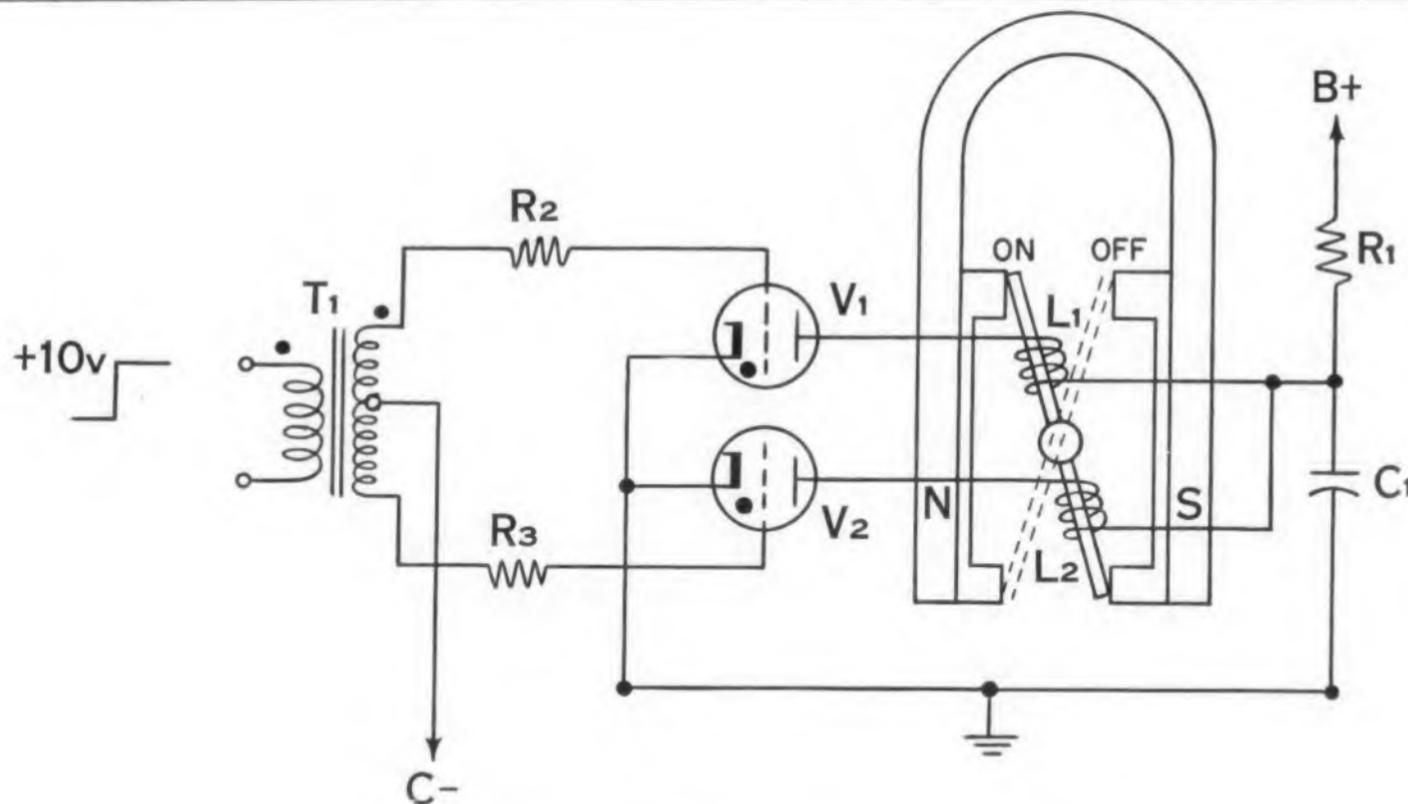


Fig. 2. Modified polar relay interconnected to a firing circuit.

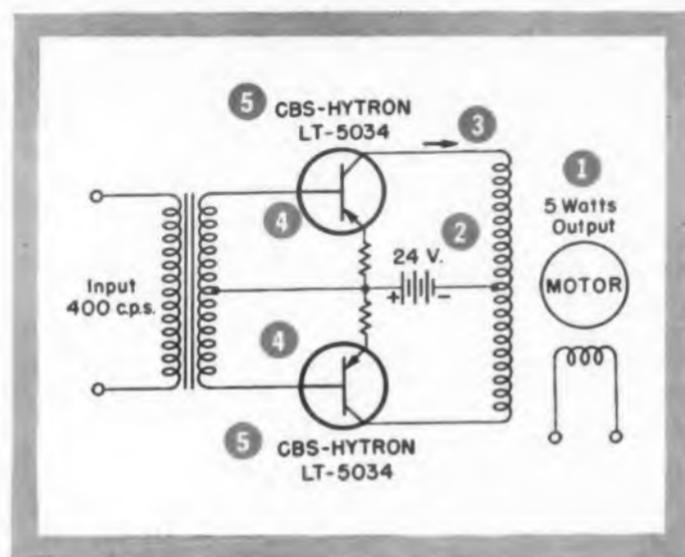
rotated to its contacts by passing direct current of the proper polarity through the armature winding. Rotation results from the interaction of the induced and permanent magnetic fields. The basic scheme is inefficient because the actuating current must produce a field force sufficient to overcome the fixed magnetic field and because the current must be supplied continuously to provide holding torque (or force).

Adaptation of this principle, which combined an electro-magnetic armature and permanently magnetized poles, produced a simple but effective answer which is illustrated in Fig. 2. The basic concept now became that of a dc motor with a limited armature rotation. By eliminating the spring, the permanent field provides the holding torque. The armature, if centered, is immediately attracted to a stable position against one of the poles. A pulse of the proper polarity through the armature winding will move the armature to the other stable position. In this manner, "on" and "off" or flip-flop operation is achieved. Circuitry that might be used to pulse the armature is shown in Fig. 2.

Assume the armature to be in the "off" position. If a pulse is passed through *L-1* in such a manner that a south pole is created at the top of the armature and a north at the bottom, the armature will move to the "on" position. This, of course, occurs through the attraction of unlike poles. When the armature current is removed, the armature is held in this position by virtue of completing the flux path of the permanent magnet. To bring the armature back to the original "off" position, a current is passed through *L-2* in such a manner to produce a south pole at the bottom of the armature and a north pole at the top.

The electronic firing circuit works this way: When a +10 volt square wave is applied to the input of *T-1* the leading edge will appear across the secondary of *T-1* as a pulse. The grid of *V-1* will see a positive going pulse and the grid of *V-2* will see a negative going pulse, since the secondary is returned to ac ground through the center tap. If both grids are biased to a -10 v, *V-2* will remain cut off, but the bias on *V-1* will be overcome. *V-1* will then conduct the charge stored in *C-1* through *L-1*, thereby providing the necessary current to rotate the armature. The armature will remain in this position until the input voltage swings back to zero. The discharge path of current is an LCR circuit and, as a result, the plate of *V-1* will tend to swing negative. This negative voltage swing, which occurs after the discharge of *C-1*, will extinguish *V-1* effectively and allow *C-1* to recharge through the voltage supply isolating resistor *R-1*. At this time a positive pulse will be induced on the grid of *V-2* and current will flow through *L-2* in a similar

Selection of the Right Power Transistor made easy



FOR EXAMPLE:

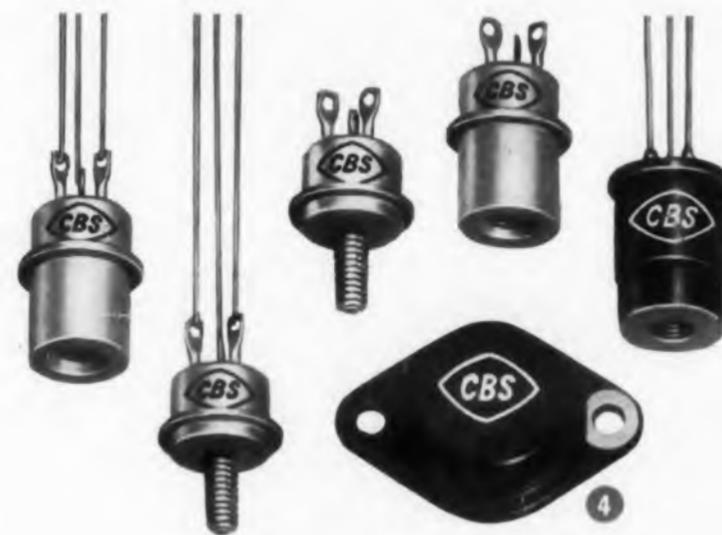
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Here's how easy it is to select the transistor with optimized characteristics at minimized cost:

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- 3 Input signal current, 7 ma. Power output of 5 watts divided by .707 times 24 source volts gives 300-ma. collector current. "Current Gain" of 43 is required . . . use 60.
- 4 For a convenient, plug-in standard package, you may want the "Diamond" version.
- 5 That is it . . . you have picked the CBS-Hytron LT-5034.

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Types Available

Current Gain	60	LT-5028	LT-5034	LT-5042	LT-5051	Diamond
		LT-5027	LT-5033	LT-5041	LT-5050	Male
		LT-5026	LT-5032	LT-5040	LT-5049	Female
40	LT-5025	LT-5031	LT-5039	LT-5048	Diamond	
	LT-5024	LT-5030	LT-5038	LT-5047	Male	
	LT-5023	LT-5029	LT-5037	LT-5046	Female	
20	LT-5022	2N157	2N157A	LT-5045	Diamond	
	LT-5021	LT-55	LT-5036	LT-5044	Male	
	2N156	2N158	LT-5035	LT-5043	Female	
	30V	60V	100V	120V		

Minimum Breakdown Voltage†

30-WATT GROUP
Types Available

Current Gain	100	LT-5060	LT-5069	LT-5078	LT-5087	Diamond
		LT-5059	LT-5068	LT-5077	LT-5086	Male
		LT-5058	LT-5067	LT-5076	LT-5085	Female
60	LT-5057	LT-5066	LT-5075	LT-5084	Diamond	
	LT-5056	LT-5065	LT-5074	LT-5083	Male	
	LT-5055	LT-5064	LT-5073	LT-5082	Female	
30	LT-5054	LT-5063	LT-5072	LT-5081	Diamond	
	LT-5053	LT-5062	LT-5071	LT-5080	Male	
	LT-5052	LT-5061	LT-5070	LT-5079	Female	
	30V	60V	80V	100V		

Minimum Breakdown Voltage†

40-WATT GROUP
Types Available

Current Gain	160	LT-5096	LT-5105	LT-5114	LT-5123	Diamond
		LT-5095	LT-5104	LT-5113	LT-5122	Male
		LT-5094	LT-5103	LT-5112	LT-5121	Female
80	LT-5093	LT-5102	LT-5111	LT-5120	Diamond	
	LT-5092	LT-5101	LT-5110	LT-5119	Male	
	LT-5091	LT-5100	LT-5109	LT-5118	Female	
40	LT-5090	LT-5099	LT-5108	LT-5117	Diamond	
	LT-5089	LT-5098	LT-5107	LT-5116	Male	
	LT-5088	LT-5097	LT-5106	LT-5115	Female	
	30V	60V	80V	100V		

Minimum Breakdown Voltage†

†Minimum large-signal current gain: 40-watt group at 1.0 A, 30-watt group at 0.75 A, 20-watt group at 0.50 A.
‡Minimum breakdown voltage, collector to base with emitter open.
#Five packages: diamond, female industrial with solder lugs or flying leads, and male industrial with solder lugs or flying leads.

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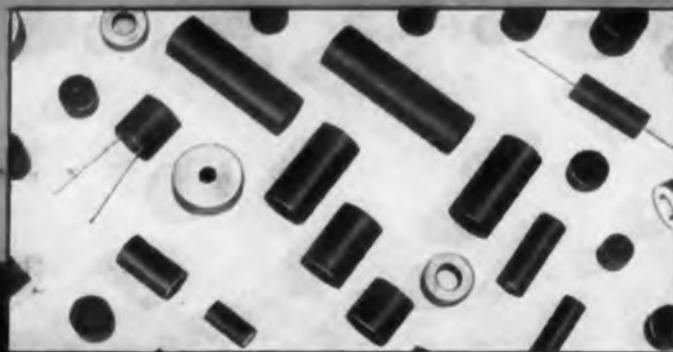
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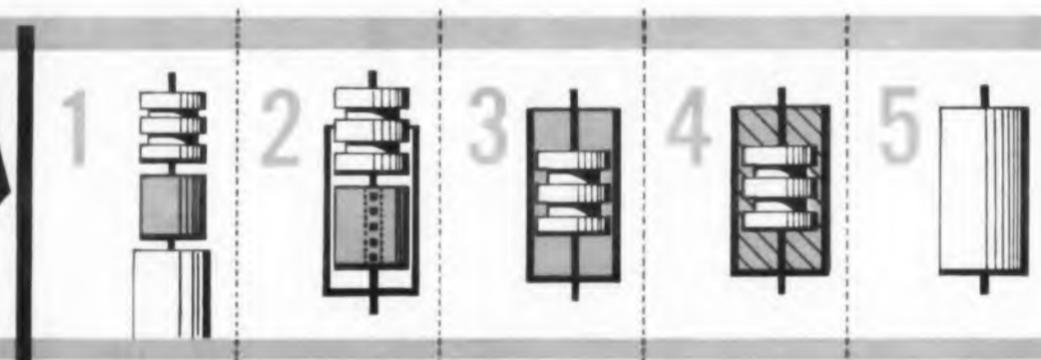
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The trouble of tedious mixing and measuring of hardener and resin, the danger of toxicity, the waste of material due to the instability of the compound... all of these factors combined, make epoxy encapsulation an extremely inefficient operation.

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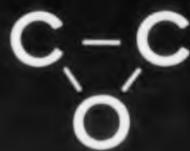
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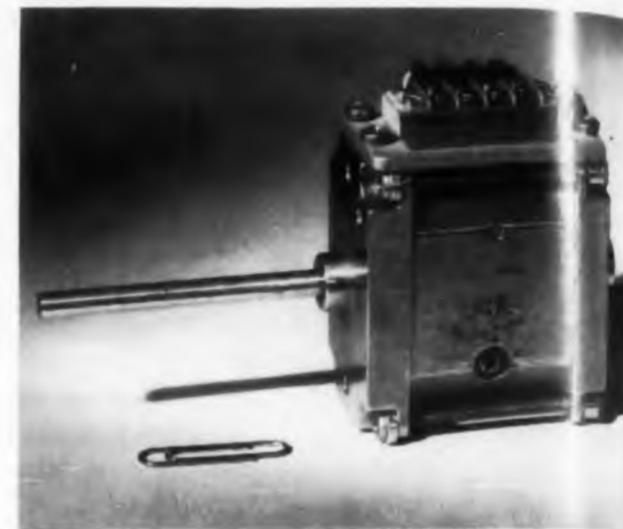


Fig. 3. Assembled high-speed magnetic actuator.

manner, returning the actuator to the original "off" position. Resistors R-2 and R-3 limit grid current and prevent overheating of the control grid.

Results

Optimizing the actuator design has resulted in a compact hardware assembly with an armature rotation of only 1.15 degrees between pole pieces. Measured at the point of pinch roller contact, this amounts to a mere 0.010 in. and a mechanical transfer that can be achieved in only 200 μ s. It provides a holding torque of 15 in.-lb. and there is no "bounce" in its action. Despite experiencing an acceleration of 2000 g, the design has been tested over 150 million cycles without failure.

Advantages and Comparisons

Practical advantages of the magnetic actuator are its small input power requirements and resulting low operating temperature. It is cool enough to touch even when operating at 100 cps. In addition to moving the pinch roller in or out from the capstan, the actuator also serves as a brake when disengaging. This is accomplished by the action of a pincher brake which, connected by a flat spring to the rotary shaft, engages the tape momentarily as the pinch roller disengages.

The new magnetic actuator overcomes the defects of the principle actuating mechanisms designed in the past. Loudspeaker voice-coil units and linear solenoids were the two outstanding devices. The loudspeaker systems were heavy and expensive, and they usually involved linkages and inertia that limited performance. Solenoids suffered from wear and had characteristics that were temperature- and duty-sensitive. The continuous power required by these devices resulted in excessive heating. And their



Fig. 4. Pole-piece design, showing detail of special silicon steel extrusions.

actuation time was limited by inductance and eddy current effects.

Construction Compromises

The assembled actuator, shown in Fig. 3, represents a balance among conflicting parameters, as well as special adaptation of seemingly standard or conventional elements. The size of the actuator lever arm is a point in case. A short lever implied greater angular travel, and accordingly, the possibility of slower action. This, in turn, was related to actuator pulse durations, which are determined by armature coil inductance and source capacity and must be long enough for the armature to complete one-half of its travel between pole pieces. A longer lever, on the other hand, raised problems of inertia and implied less holding torque.

Minimizing actuation time also led to study of pole piece construction. Eddy currents have a delaying effect on rapid changes of magnetic state. A common solution is the use of laminated pole pieces. But it was found that expensive laminations could be avoided by employing solid silicon steel, inherently high in resistivity. The choice of an extruded form provided further economy. Pole piece design is shown in Fig. 4.

Extensive tests of the magnetic actuator revealed interesting mechanical problems. As an example, the limiting element to long life proved initially to be the support bearings. Since the whole design is miniaturized, small shielded ball bearings were first employed. But it was soon observed that the extreme angular acceleration experienced by the bearings caused a fretting action that literally corroded them to death. A solution was found in the use of dry journal bearings made from a special Teflon compound. They show scarcely measurable wear after 150 million cycles.



Type

DNT



The DNT Detector Assembly operates on the heterodyne principle. Its local oscillator is set 30 Mc above or below the incoming signal to produce a difference frequency at the output of the mixer. Since the mixer operates linearly over an 80-db range, the level of the detected signal can be amplified and accurately measured with the calibrated step attenuator and meter built into the I-F Amplifier.

Type 1216-A Unit I-F Amplifier complete with oscillator power supply

Appropriate Unit Oscillator

Low-pass filter

Type 874-G10 10-db Pad

Type 874-MR Mixer Rectifier

Type 874-EL

The D Detector for High Frequency Measurements

USEFUL AS A

Bridge and Slotted-Line Null Detector

Detector for Insertion-Loss and Attenuation Measurements

Detector for Measuring Voltage Ratio

70-DB Step Attenuator Built In and a Meter Calibrated in DB for Interpolation Between Attenuator Steps — Mixer linearity over 80-db range permits direct measurement of levels. Calibrated attenuator has steps of 0, 3, 10, 20, 30, 40, 50, 60 and 70 db. Accuracy is $\pm(0.3 \text{ db} + 1\%$ of indicated attenuation).

AVC for Null Measurements — The I-F Amplifier can be switched to A-V-C operation, providing logarithmic instead of linear response. The AVC automatically increases sensitivity as balance is approached and prevents violent off-scale indications during unbalanced conditions.

High Sensitivity — The heterodyne principle of operation provides high, uniform sensitivity over wide frequency ranges. Four stages of amplification provide gain of 100 db. Less than 5- μv input from 50-ohm source will produce a 1% meter deflection over residual noise at any frequency between 50 and 950 Mc... less than 80 μv required for full scale deflection.

Broad Amplifier Bandwidth, yet Has Optimum Selectivity — System does not have to be re-tuned each time input signal drifts. Bandwidth between half-power points is 0.7 Mc; at 2 Mc from center frequency, response is down more than 20 db; 60-db down at 5 Mc.

Excellent Shielding Throughout — Input signal is confined to a separate, well-shielded mixer unit. Internal amplifier parts are shielded and isolated from each other by numerous filters to minimize leakage and regeneration.

Wide-Frequency Operation

Detector	Range*	Unit Oscillator Supplied	Price
DNT-1	40-530 Mc	1208-B	\$626
DNT-2	40-280 Mc	1215-B	\$606
DNT-3	220-950 Mc	1209-B	\$659
DNT-4	870-2030 Mc	1218-A	\$879

*Higher frequency operation to 5000 Mc by using oscillator harmonics. Any of these assemblies may be converted to another by using the appropriate local oscillator and filter for that range. Units making up the DNT Assembly can also be used singly for other measurements.

Write for Complete Information

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass., U. S. A.

NEW YORK AREA: Tel. N. Y. WOrth 4-2722 N. J. WHitney 3-3140 CHICAGO: Tel. VIlage 8-9400
 PHILADELPHIA: Tel. HANcock 4-7419 WASHINGTON, D. C.: Tel. JUniper 5-1088
 SAN FRANCISCO: Tel. WHitecliff 8-8233 LOS ANGELES 38: Tel. HOLLywood 9-6201
 In CANADA, TORONTO: Tel. CHerry 6-2171

CIRCLE 40 ON READER-SERVICE CARD



WE SELL DIRECT. Our District Sales Offices are staffed by engineers especially trained to help you in the selection of instruments and measuring systems best suited to your needs. We welcome your inquiries — will help solve your problems.

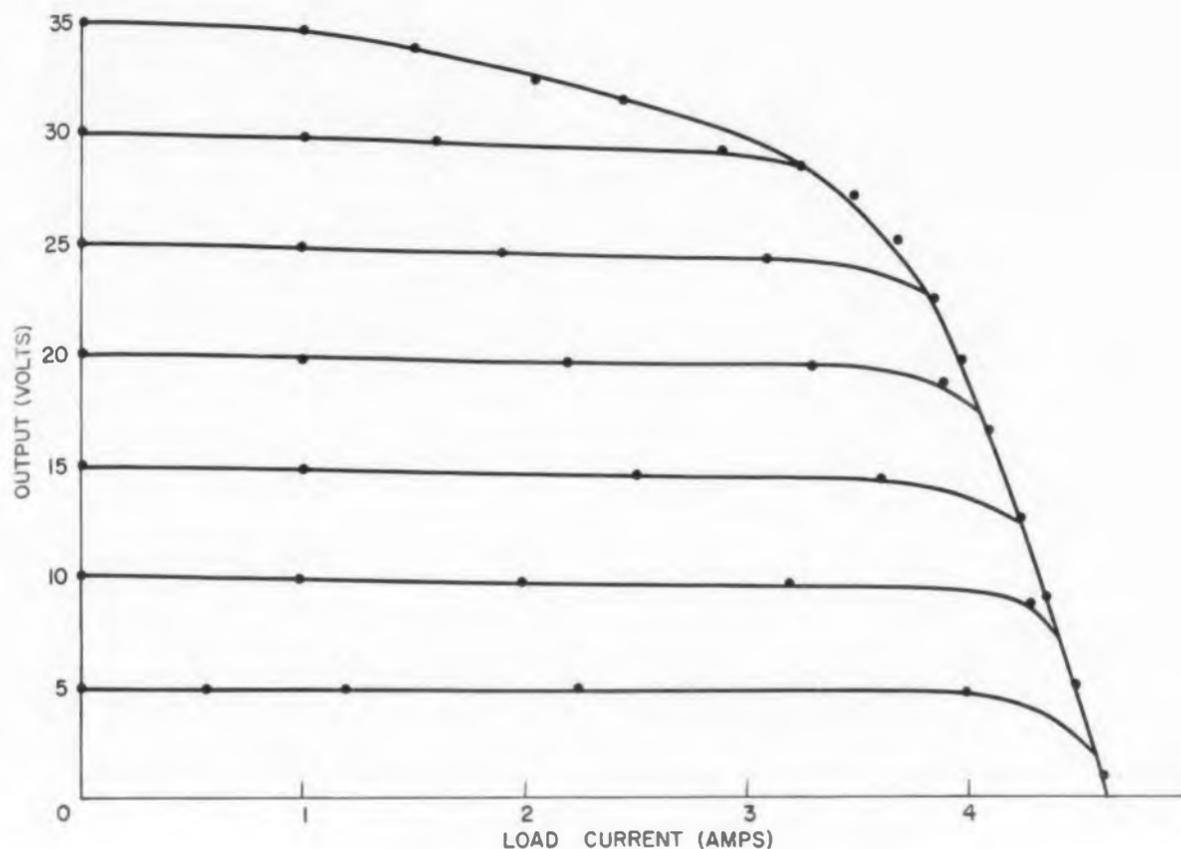


Fig. 2. Regulation curves.

the reference voltage of CR 6 and CR 5, which is a little over a volt, Q1 will start to conduct. Conduction of Q1 pulls down the base of the Q3 which causes the output voltage and thus the current to be cut down. With the values given the maximum current is limited on short circuit to about 4.6 amps. This, of course, can be changed to any desired value of limitation by simply changing the value of R4. R4 could, of course, be a front panel controlled variable element.

With power supplies which do not have this short circuit protection it is possible to gang the voltage control "POT" with a variac (in 110 v input line) so that the nonregulated voltage is, at all times, only a little above the desired regulated voltage and the series regulating elements only have to dissipate the difference in power between these two voltages. However, in a device of this sort, this is not possible, since, if the voltage is set to the maximum value and short circuit occurs, it will be necessary for the series elements to dissipate the full power of the device. This means that a good heat sink is required and that the series regulating elements have sufficient power dissipation to stand this drain.

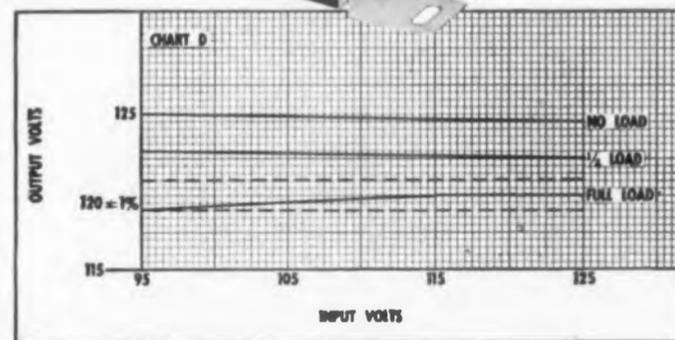
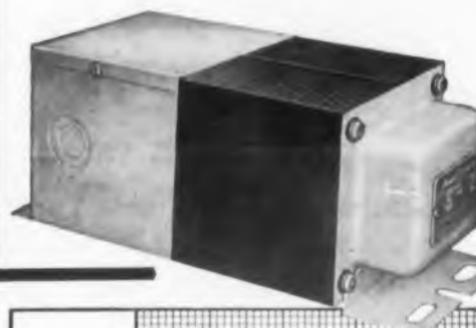
Fig. 2 shows the regulation curves for this power supply. The voltage was set, with no load initially, to the various values of 5, 10, 15, 20, 25, 30 and 35 v and then for each of these initial settings the output load was increased up to short circuit condition and the resulting voltage output versus current is plotted. It will be no-

ticed that at low output voltages the dynamic output impedance is lower than at higher values. This is because the feedback around the loop is a little higher at low values because the TAP on the POT is higher, thus taking a larger dynamic sample. It will also be seen that the supply is useful to about 3.5 amps over most of the voltage range, with the current limited to 4.6 amps on short circuit.

The resistor R6, as long as the circuit is operating normally, will actually degrade the performance somewhat by decreasing the amount of current that is fed into the base of Q2. Its purpose, however, is to prevent damage to Q2 and the other elements if the internal pot is set to deliver a low voltage and the output voltage does not fall externally (for example if the supply is connected to a battery or some other source). In this case this resistor will protect Q2 from excessive base current. This slight degradation of normal performance is accepted in the interest of giving a more rugged, trouble-free device. A large diode can also be put in series with the output, if its added drop is not bothersome, and this will also do some of the same work.

This power supply is electrically rugged and can stand to be loaded in any manner without injury to the power supply. Short circuits of any duration are acceptable and voltage is restored immediately on removal of the short. It is designed to be light, portable, and capable of giving rugged trouble-free service around the laboratory.

REDESIGNED TO STABILIZE 120 x 240 VOLT CIRCUITS



These constant voltage stabilizers designed to provide standard packaged units as practical, low cost replacements for many special designs we have been producing as components for electronic equipment manufacturers.

These features have been incorporated in these new units:

- ±1% Voltage Stabilization
- Current Limiting Output
- Wide Range of Input Voltage Stabilization

These standard stock units are available in ratings from 15 VA thru 2000 VA. Primary input range 95 to 130 volts; 190 to 260 volts. Stabilized output voltages 120; 240. For filament heating applications standard units are available with 6.3 volt stabilized output.

Write for Bulletin CVS-321.

ACME ELECTRIC CORPORATION
9012 WATER STREET • CUBA, NEW YORK

Acme Electric
TRANSFORMERS

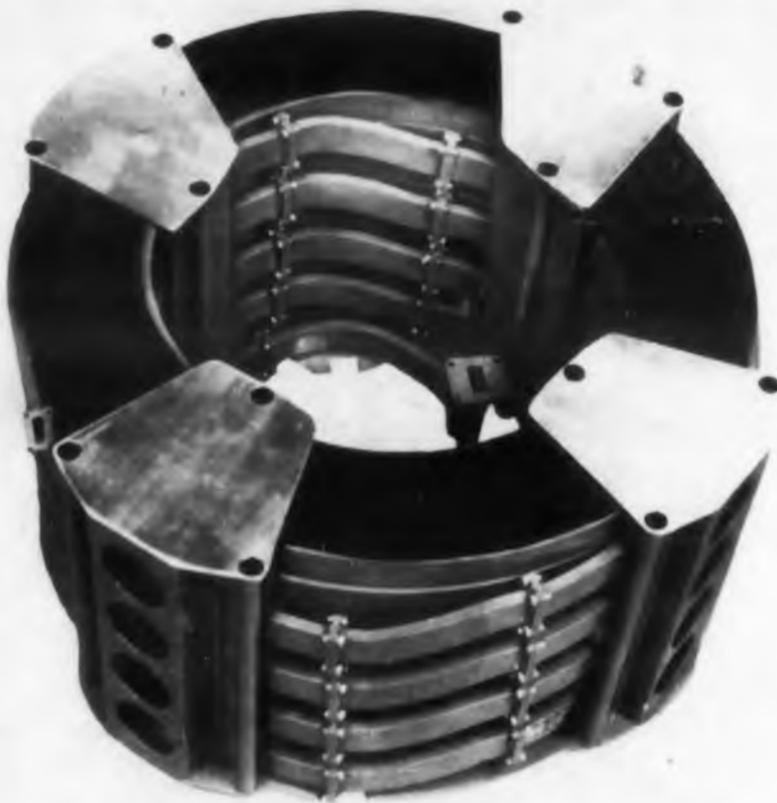
CIRCLE 41 ON READER-SERVICE CARD

NEW PRODUCTS

Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.

BIG AND SMALL

Electronic components come in a variety of sizes that range from miniature to mammoth. On this page are some of the latest components which show how big or small components can be.

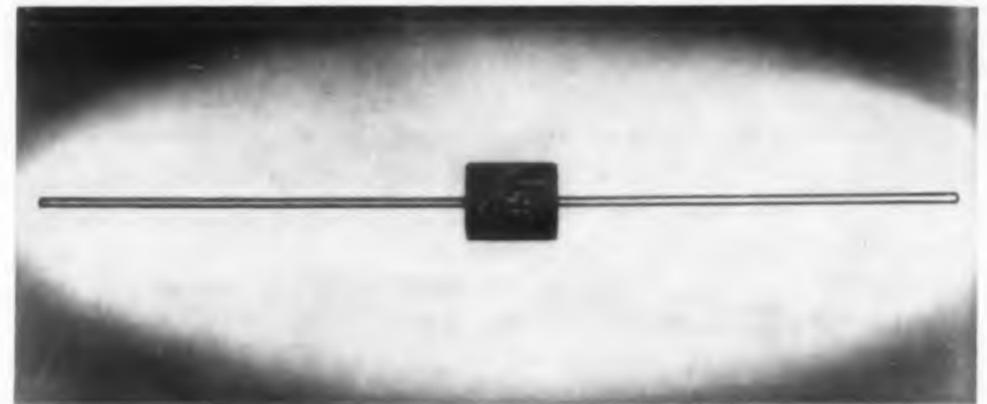


DELAY LINE

These spiral waveguide delay lines come in single coils up to 78 ft in length and multiple interconnected systems of any length. Typical input vswr measurements of these units are less than 1.2 at any X-band frequency. Insertion loss is less than 0.1 db per ft. Designs are available for assemblies of any length and are furnished with necessary accessories. A typical 1000 ft assembly at X-band occupies a cylindrical volume of diameter 2 ft, height 15 in.

Turbo Machine Co., Dept. ED, Lansdale, Pa.

CIRCLE 42 ON READER-SERVICE CARD



EPOXY-CASED RECTIFIERS

Handling an average forward current of 750 ma, the 1N20270 series silicon rectifiers are packaged in a nylon-cased epoxy capsule. They pass MIL-STD-202A immersion tests and have minimum lead-to-case insulation resistance of 10^{10} ohms at 600 v. Typed as 1N2069, 1N2070 and 1N2071, the three rectifiers have piv ratings at 200, 400 and 600 v, respectively. They can handle a 6 amp recurrent peak current and a surge current of over 32 amp for 1 ms.

Texas Instruments, Inc., Dept. ED, 6000 Lemmon Ave., Dallas 9, Tex.

CIRCLE 43 ON READER-SERVICE CARD



THERMOCOUPLES

Metal clad and ceramic insulated from the high temperature sheath, these thermocouples are available in diameters from 0.02 in. OD, 2-wire, to 0.04 in. OD, 2-wire. Readily formed, they resist corrosion, abrasion and erosion. Units come in several sheath materials and most conductor combinations.

Pyro-Electric, Inc., Dept. ED, P.O. Box 232, Barrington, Ill.

CIRCLE 44 ON READER-SERVICE CARD

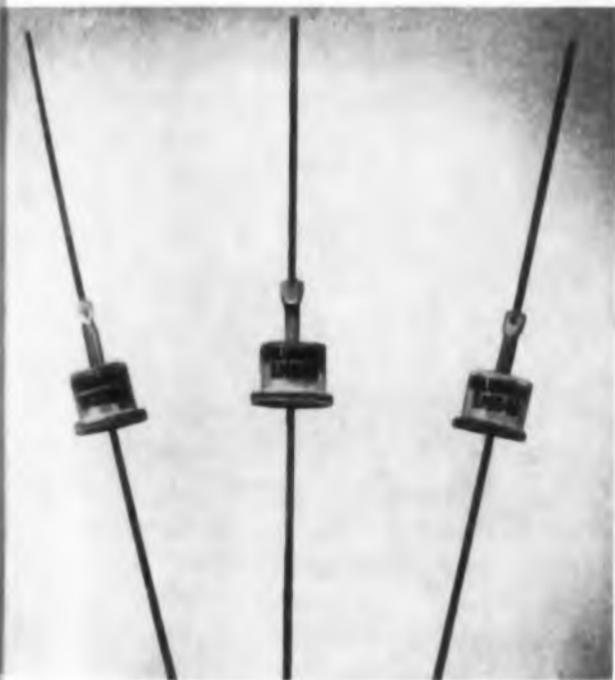


MINIATURE CONNECTORS

These coaxial cable connectors, labeled the TM series, are a miniaturized version of the TNC series. TM connectors are matched electrically for 50 ohm impedance and some designs are available for 70 and 93 ohm cables. The series will withstand 500 v rms. TM connectors have gold plated contacts and thread coupling for positive locking.

General RF Fittings, Inc., Dept. ED, 702 Beacon St., Boston, Mass.

CIRCLE 45 ON READER-SERVICE CARD



SILICON RECTIFIERS

Available in hermetically sealed, axial lead top hat design, these double-diffused silicon rectifiers come in two Jetec series: 1N536 through 1N540 and 1N2080 through 1N2086. The units have current outputs ranging from 500 to 750 ma, and withstand up to 600 piv without heat sink.

Columbus Electronics Corp., Dept. ED, 1010 Saw Neck River Road, Yonkers, N.Y.

CIRCLE 46 ON READER-SERVICE CARD

*
VR
PS

Kepeco

for the most complete line of POWER SUPPLIES

REGULATION and STABILITY 0.1%

VOLTAGE REGULATED POWER SUPPLIES

MODEL	OUTPUT VOLTS DC	OUTPUT AMPERES DC	OUTPUT IMPEDANCE		SIZE		
			DC-1KC	1KC-100KC	W	H	D
SC-18-0.5	0-18	0-0.5	.04	.4	8 1/4"	4 3/32"	13 5/8"
SC-18-1	0-18	0-1	.02	.2	8 1/4"	4 3/32"	13 5/8"
SC-18-2	0-18	0-2	.01	.1	8 1/4"	4 3/32"	13 5/8"
SC-18-4	0-18	0-4	.005	.05	19"	3 1/2"	13"
SC-36-0.5	0-36	0-0.5	.08	.8	8 1/4"	4 3/32"	13 5/8"
SC-36-1	0-36	0-1	.04	.4	8 1/4"	4 3/32"	13 5/8"
SC-36-2	0-36	0-2	.02	.2	19"	3 1/2"	13"
SC-3672-0.5	36-72	0-0.5	.15	1.0	8 1/4"	4 3/32"	13 5/8"
SC-3672-1	36-72	0-1	.08	.8	19"	3 1/2"	13"

Patent Pending

(TUBELESS) TRANSISTORIZED SHORT CIRCUIT PROTECTED

- REGULATION: 0.1% for line changes 105-125 volts at any output voltage in the range minimum to maximum.

0.1% or 0.003 volt for load changes 0 to maximum (whichever is greater) at any output voltage in the range minimum to maximum.

- RIPPLE: 1 mv. RMS.
- RECOVERY TIME: 50 microseconds.
- STABILITY: (for 8 hours) 0.1% or 0.003 volt (whichever is greater).
- AMBIENT OPERATING TEMPERATURE: 50°C maximum. Over-temperature protection provided. Unit turns off when over-temperature occurs. Power-on-off switch on front panel resets unit.
- TEMPERATURE COEFFICIENT: Output voltage changes less than 0.05% per °C.
- SHORT CIRCUIT PROTECTION: No fuses, circuit breakers or relays! Designed to operate continuously into a short circuit. Returns instantly to operating voltage when overload is removed. Ideal for lighting lamps and charging capacitive loads.
- OVER-CURRENT CONTROL: Can be set from 0 to 120% of full load. Current is limited to preset value for any load including short circuit.

KEPCO

LABORATORIES, INC.

131-38 SANFORD AVENUE • FLUSHING 55, N.Y.
INDEPENDENCE 1-7000



Model SC-18-2-M



*Two units mounted in Rack Adapter RA-2



Model SC-18-4-M

- REMOTE PROGRAMMING at 1000 ohms per volt is provided. Remote programming allows mounting a voltage control at a remote point.
- REMOTE ERROR SIGNAL SENSING is provided to maintain stated regulation directly at load.
- CONSTANT CURRENT OPERATION: These units can be set up for constant current operation without internal modification.
- POWER REQUIREMENTS: 105-125 volts, 50-65 cycles. 400 cycle units available.
- OUTPUT TERMINATIONS: DC terminals are clearly marked on the front panel. All terminals are isolated from the chassis. Either positive or negative terminal of each DC output may be grounded. A terminal is provided for connecting to the chassis. The DC terminals, the remote programming terminals and the remote error signal sensing terminals are brought out at the rear of the unit.
- CONTROLS: Power-on-off switch, one turn voltage control, on front panel. Over-current control on rear of unit. Ten turn voltage control available on special order.
- Continuously Variable Output Voltage. No voltage switching.
- Suitable for square wave pulsed loading.
- Either positive or negative can be grounded.
- Units can be series connected.
- High efficiency
- Low heat dissipation.
- Compact, light weight
- For bench or rack use.
- Color: Gray hammertone. (Special finishes available).

ORDERING INFORMATION:

Units without meters use model numbers indicated in table. To include meters add M to the Model No. (e.g. SC-18-1-M).

*Rack adapter for mounting any two 8 1/4" x 4 3/32" units is available. Model No. RA2 is 5 1/4" high 19" wide.

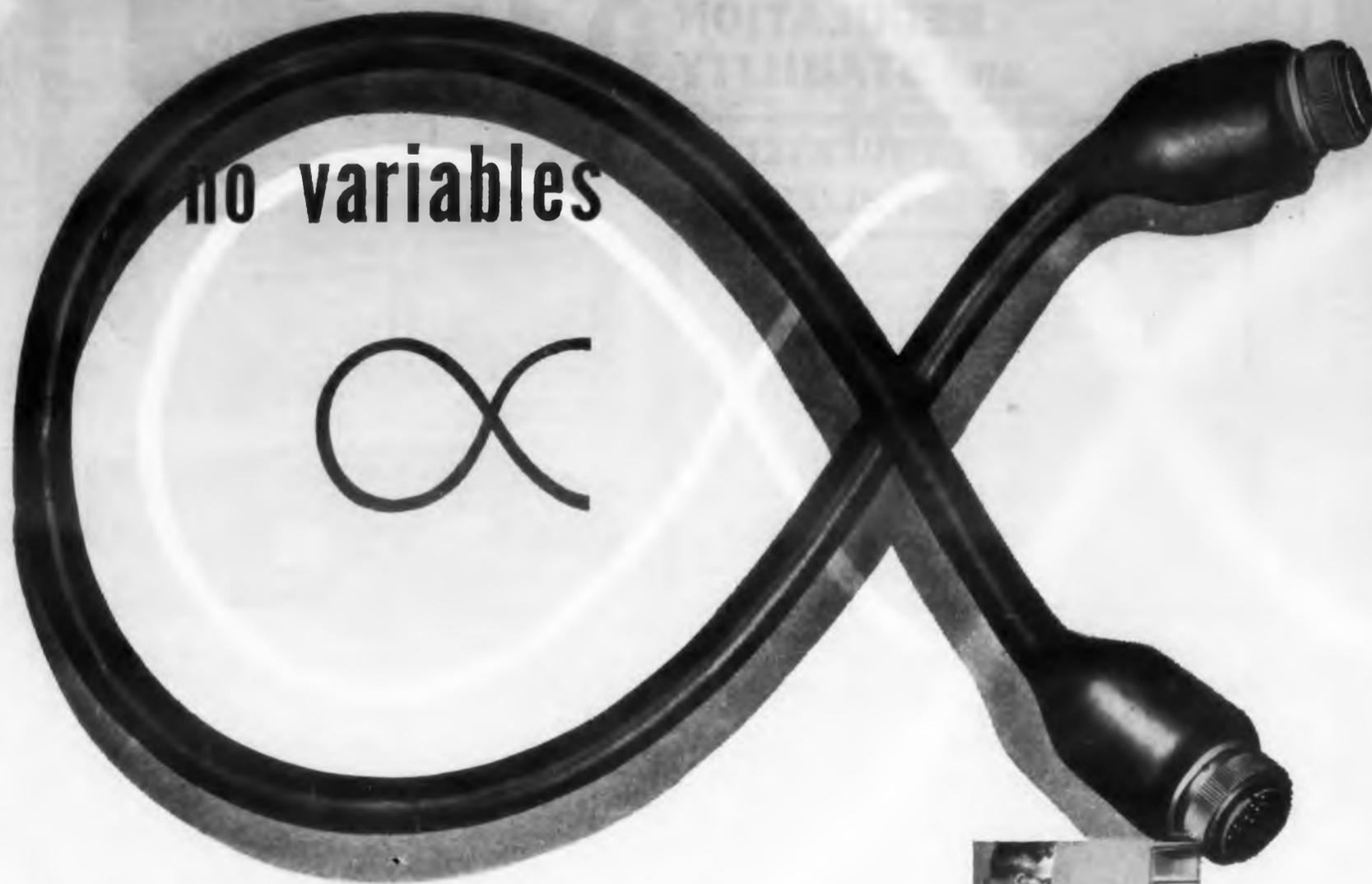
*Rack adapter for mounting any one 8 1/4" x 4 3/32" unit is available. Model No. RA3 is 5 1/4" high 19" wide.

AN 0.01% SERIES IS AVAILABLE IN 13 NEW MODELS
KEPCO OFFERS MORE THAN 120 STANDARD VOLTAGE REGULATED
POWER SUPPLIES COVERING A WIDE RANGE OF MAGNETIC, TUBE
AND TRANSISTOR TYPES. MOST MODELS AVAILABLE FROM STOCK.
SEND FOR BROCHURE B-587

CIRCLE 47 ON READER-SERVICE CARD

reliability that knows

no variables



Reliability in an electronic cable is the result of applying the most advanced cable technologies, thus providing the right answer for every variable that contributes to the performance of the end product.

Cables by Pacific Automation Products are reliable for these specific reasons:

- ▶ Every conductor and jacket which enters the PAP plant is carefully inspected.
- ▶ Every cable is custom designed to the customer's specifications or requirements.
- ▶ Every cable is fabricated to give optimum structural conformity, maximum flexibility, and greatest strength.
- ▶ Each cable is inspected and tested at every stage of the fabrication process.
- ▶ Assembly is completed at the plant, under rigid Quality Control surveillance, by highly skilled people. Each cable leaves the plant ready for installation. The variables of field fabrication or assembly are eliminated.
- ▶ Every cable is tested for electrical integrity. Environmental tests are performed to simulate conditions of heat or cold to prove flexure characteristics and abrasion resistance.
- ▶ Every PAP cable is mechanically, electrically, and environmentally suited to the most exacting service that may ever be required of it.

Put PAP's cable specialists to work for you today. Phone, write or wire:

PACIFIC AUTOMATION PRODUCTS, INC.

1000 AIRWAY, GLENDALE 1, CALIFORNIA

Phone: CHapman 5-8661 or Cltrus 6-2411

137 Walnut Hill Village, Dallas 20, Texas • FLeetwood 7-5751
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420 Lexington Avenue, New York, N.Y. • LExington 2-5193
4355 North Atlantic, Cocoa Beach, Florida • Cocoa Beach 2059



NEW PRODUCTS

Miniature Motor 1/100 hp



Rated 1/100 hp at 11,000 rpm, model 2PPI miniature motor is qualified according to MIL-M-8609 specifications. A 26.5 v dc unit, it is 1.18 in. in diameter and 1.9 in. long and weighs 3.5 oz. It will run 500 hours without change of brushes.

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

CIRCLE 48 ON READER-SERVICE CARD

SSB Generators

8.5 to 9.6 kmc

Single sideband generators GS1032A and GS1032B are iridite treated aluminum and silver plated beryllium copper assemblies, respectively. Sideband output power is 1 mw min; carrier suppression, 15 db min; and sideband suppression, 15 db min. Rf carrier input is 50 mw at 8.5 to 9.6 kmc. The two modulation inputs, 90 degrees out of phase with each other, are at a frequency of 30 mc. Crystals and pin terminal crystal inputs will be supplied with each unit unless otherwise specified. BNC, miniature, or bridge connections will be supplied on request.

Microwave Development Labs.
Inc., Dept. ED, 92 Broad St., Babson Park 57, Wellesley, Mass.

CIRCLE 49 ON READER-SERVICE CARD
◀ CIRCLE 50 ON READER-SERVICE CARD

Cathode Ray Oscilloscope

Dc to 30 mc



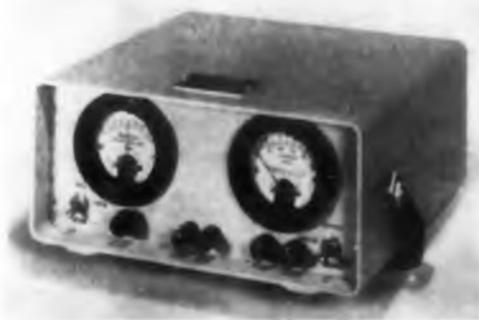
A fast-rise, cathode ray oscilloscope, type 543 handles dc to 30 mc. For versatility, nine plug-in preamplifiers are available. Sweep range is 0.02 μ sec per cm to 15 sec per cm; accelerating potential is 10 kv. The built-in voltage calibrator has 18 outputs from 0.2 mv to 100 v peak-to-peak. The unit has sweep magnifications of 2, 5, 10, 20, 50, and 100 times. A single knob controls 24 direct-reading calibrated sweep rates.

Tektronix, Inc., Dept. ED, P.O. Box 831, Portland 7, Ore.

CIRCLE 51 ON READER-SERVICE CARD

Frequency Voltmeter

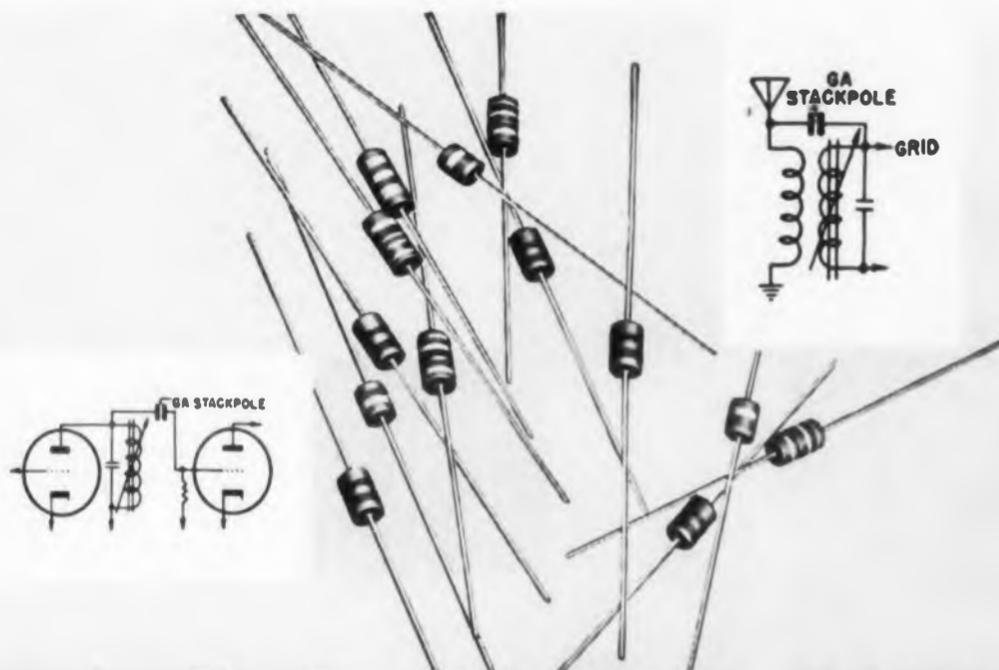
Checks 400 cps power



Combining model 6506 frequency meter and a voltmeter in one portable unit, the 7500 meter can be used to check 400 cps power in aircraft or missiles. Frequency accuracy is 0.05% at 400 cps. The voltmeter has a dual scale with $\pm 2\%$ accuracy from 0 to 150 v and $\pm 3\%$ from 110 to 120 v. The meter maintains its precision from -55 to $+71$ C. With leads clipped to the points to be measured and plugged into the single set of input terminals, the unit is furnished with operating power. This same power provides the signal for simultaneous measurement of frequency and voltage while using a maximum of 100 m at normal operating temperature.

Vac Mfg. Co., Dept. ED, 2201 Walnut St., Garland, Tex.

CIRCLE 52 ON READER-SERVICE CARD



CONVENIENT CIRCUIT COUPLING and BYPASSING... with the simplest, most inexpensive capacitor design yet produced

Pioneered by Stackpole, these sturdy little units make ideal low-cost coupling, bypass and neutralizing capacitors for TV, radio and military electronic equipment.

Insulated bodies, dielectrics and electrodes are integrally molded for maximum stability and durability. Securely anchored leads are treated for easy soldering. Ranging in size from

only 0.330" to 0.170" in length, Stackpole GA Capacitors have adequate stability and T.C. characteristics for a host of TV, radio and military electronic equipment uses.

Electronic Components Division
STACKPOLE CARBON COMPANY
St. Marys, Pennsylvania

46 E.I.A.
"preferred" values

0.10 TO 10.0 μ f

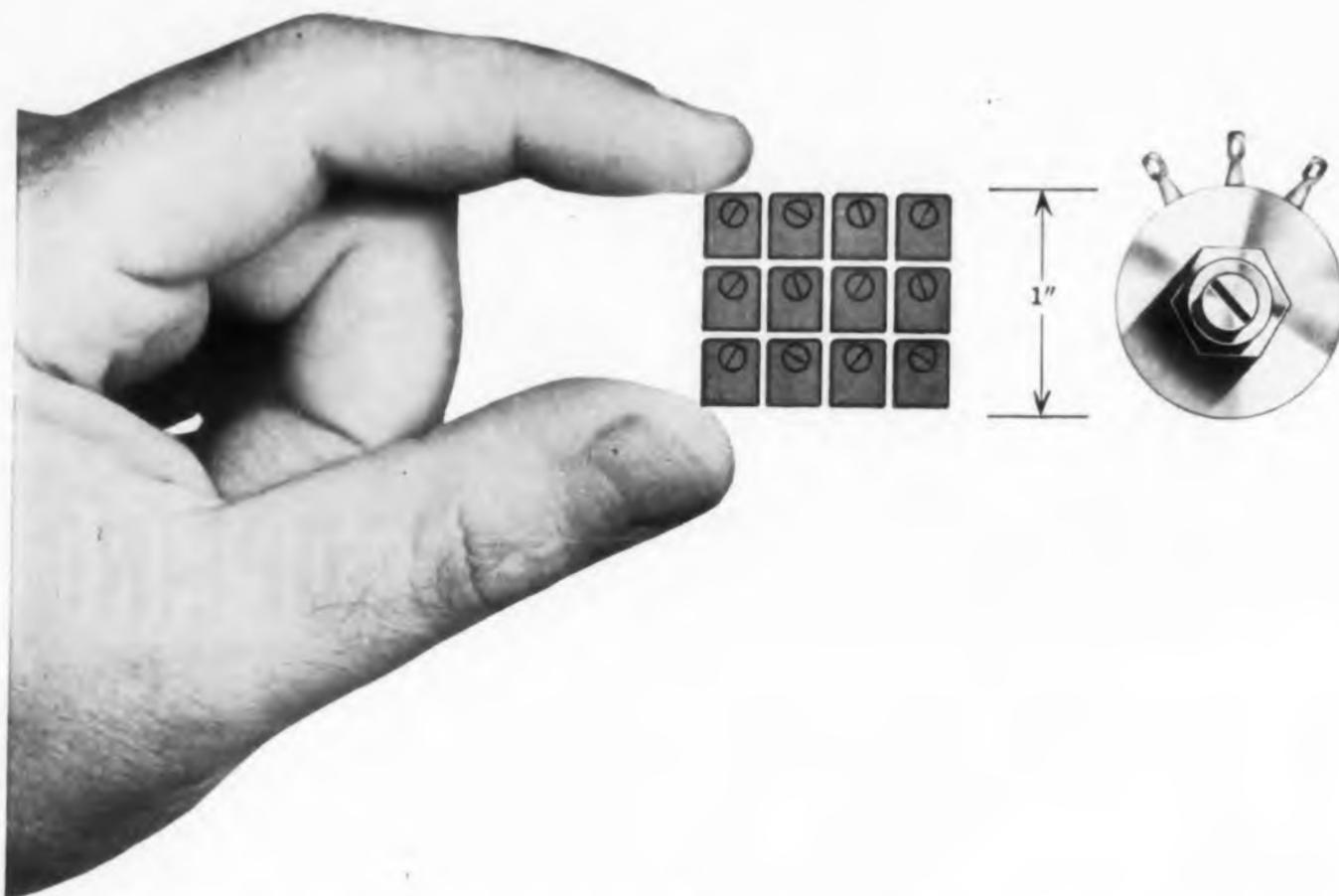
5%, 10% or 20% tolerances.
Standard 3- or 4-band color code.



STACKPOLE
"GA" FIXED COMPOSITION
CAPACITORS

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

CIRCLE 53 ON READER-SERVICE CARD



**FIT 12 OF THESE RECTANGULAR POTENTIOMETERS
IN A PANEL AREA OF 1 SQUARE INCH!**

You can pack 12 Bourns TRIMPOT® potentiometers in the
1-square-inch area occupied by the average single-turn rotary.

Fit the TRIMPOT into corners—between components—flat against
a chassis or printed circuit board. Mount them individually or in stacked
assemblies. Any way you use them—Bourns potentiometers save space!

You can adjust Bourns potentiometers more accurately, too.

The 25-turn screw-actuated mechanism gives you 9000° of rotation
instead of 270°. Circuit balancing and adjusting is easier, faster.

Repeatability is assured every time. Furthermore, adjustments are
self-locking—shock, vibration and acceleration have no effect!

Write for new Model Summary Brochure



BOURNS
Laboratories, Inc.

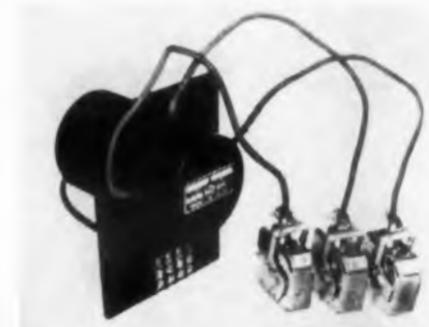
P. O. Box 2112-A • Riverside, California

ORIGINATORS OF TRIMPOT® AND TRIMIT®
PIONEERS IN POTENTIOMETER TRANSDUCERS FOR POSITION, PRESSURE AND ACCELERATION
CIRCLE 54 ON READER-SERVICE CARD

NEW PRODUCTS

Rotary Sampling Switch

Easy brush replacement



Driven by a single phase hysteresis motor, the
105A sampling switch has three poles, each
with 30 shorting or 15 nonshorting channels at
1 rps. No brush force or phase adjustments are
needed to replace the rotor and brush assembly.
The unit has multipin connectors.

General Devices, Inc., Dept. ED, P.O. Box
253, Princeton, N.J.

CIRCLE 55 ON READER-SERVICE CARD

Digital Indicator

For extended environments

Meant for extreme environments, this digital
indicator meets MIL-E-5272A and other tests.
With characters 0 to 9 and two blank spaces in
ascending order, it is 9/16 x 1-5/8 x 5-1/4 in.

Union Switch & Signal, Div. of Westinghouse
Air Brake Co., Dept. ED, Pittsburgh 18, Pa.

CIRCLE 56 ON READER-SERVICE CARD

Audio Tone Oscillators

400 cps to 30 kc range



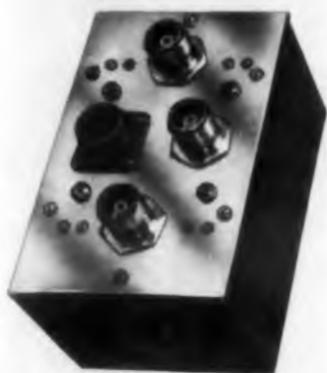
Operating from 12 or 28 v, series 101 and 102
audio tone oscillators have respective accuracies
of ±5% and ±2%. Pretuned, they have frequen-
cies in the 400 cps to 30 kc range. Harmonic dis-
tortion is 1%.

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

CIRCLE 57 ON READER-SERVICE CARD

Coaxial Lobing Switch

1020 to 1100 mc range



Model D18H2GA is an spdt coaxial lobing switch with a frequency range of 1020 to 1100 mc and an input vswr of 1.2 to 1 maximum. Crosstalk is 21 db; insertion loss, 1 db maximum; switching rate, 20 cps. The actuator is 115 v ac, 400 cps, single phase. Measuring 5-7/8 x 3-5/8 x 4-3/4 in. and weighing 2.75 lb, the switch has a life of 1000 hours and is designed to meet airborne environmental requirements. Its HN connectors can be changed to suit specific requirements.

Thompson Products, Inc., Tapco Group, Dept. ED, 23555 Euclid Ave., Cleveland 17, Ohio.

CIRCLE 58 ON READER-SERVICE CARD

Deposited Carbon Resistors

Have molded thermoplastic insulation

In values from 10 ohms to 100 meg, type N deposited carbon resistors are molded into a clear thermoplastic with 10^{13} ohms effective insulation. However close the leads are soldered to the component the insulation will not be harmed or melted. The units meet MIL-R-10509B specifications.

W. L. Wyn International Inc., Dept. ED, 355 Edgecliff Terrace, Cleveland 11, Ohio.

CIRCLE 59 ON READER-SERVICE CARD

The New Brush Mark II opens up whole new world of direct writing applications



Sensitivity

10mv/line (mm). Full scale deflection from chart center ± 200 mv.

Measurement Range

.010v. to 400v.

Input Impedance

5 megohm single-ended, 10 megohm balanced.

Frequency Response

D.C. to 100 cps.

Recording Channels

Four, 2 event channels and 2 analog.

Chart Speeds

1, 5, 25, 125 mm/sec.

Power Requirements

105-125v., 60 cps, 135 watts at 115v.

The portability and remarkable simplicity of the Brush Mark II make it practical to use *anywhere*.

Wherever you work—in research, design and development, production, field testing—you get an immediate *ultralinear* record of performance . . . for quick analysis and corrective action on the spot . . . for study at a later date . . . for reproduction by conventional low-cost copy methods.

As foolproof as you'd hoped for, this recorder has built-in amplifiers, permanent calibration, instant paper loading and a "white glove" writing system. Use it as a recording voltmeter . . . as a supplement to your "scopes".

CALL-WRITE-WIRE for immediate shipment from stock — \$1350 F.O.B. Cleveland.

brush INSTRUMENTS

DIVISION OF
3405 PERKINS AVENUE **CLEVITE** CORPORATION CLEVELAND 14, OHIO

CIRCLE 60 ON READER-SERVICE CARD >

KELLOGG'S

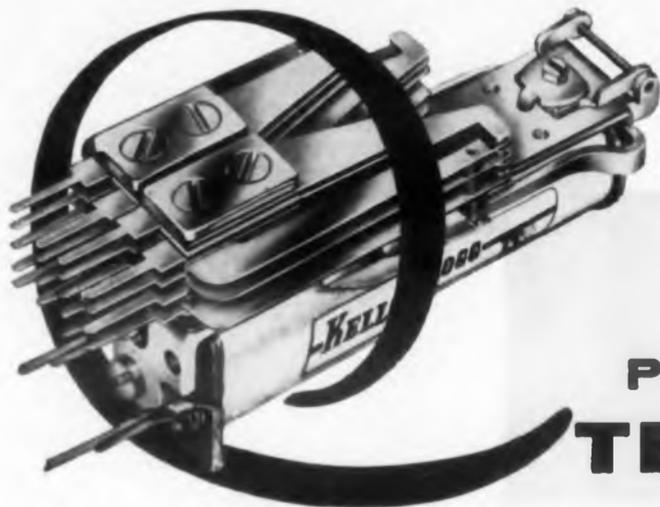
NEW type "AK"

telephone type direct current

RELAY

with

*TAPER TAB
WIRE WRAP
PRINTED CIRCUIT
TERMINALS

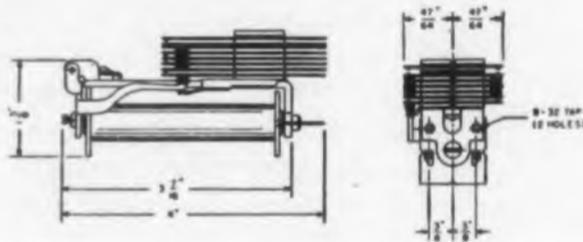


for industrial applications

*Another FIRST for Kellogg in the relay field
Three Terminals...in one design*

The "AK" relay is highly sensitive, adaptable for marginal operation and provides fast closing and opening of a maximum number of circuits. Its long coil construction permits the use of high resistance coils and it may be engineered to operate on as little as .002 amps. Delay in the opening and closing times may be provided through use of copper-slugged coils. Time delay relays are designated as Type AKSO (slow operate) and Type AKSR (slow release).

Inquiries are invited. Send for a free catalog on relays and other components manufactured by Kellogg. Kellogg Switchboard and Supply Company, 6650 South Cicero Avenue, Chicago 38, Illinois. Division of International Telephone and Telegraph Corporation.



COIL CHARACTERISTICS

Operating Voltage—Up to 230 volts D.C.
Single or double wound

CONTACT ASSEMBLY

Single or double pile-up
Forms "A" to "E"
14 springs maximum in each pile-up
Alternative: Single or double microswitch
Standard terminals also available

OPERATE AND RELEASE TIME

.002 sec. minimum operate
.100 sec. maximum operate delay
.400 sec. maximum release delay

WEIGHT

8—12 oz. net (approx.)

**Replacement when soldering is necessary.*



Manufacturers of:

- Relays • Hermetically sealed relays
- Switches • Solenoids

CIRCLE 61 ON READER-SERVICE CARD

NEW PRODUCTS

Electrical Heaters

0.065 in. thick



Flexible and rugged, Thermal-Heaters are designed for airborne and other electronic equipment. These 43 w circular heaters weigh less than 1/4 oz, including the 12 in. leads. They are under 0.03 in. thick over the element and less than 0.065 in. thick over the leads. They may be clamped or cemented to flat or curved surfaces. Insulation resistance is 1000 v rms. Heaters in various sizes and shapes are made to customer specifications.

Minco Products, Inc., Dept. ED, 740 Washington Ave. N., Minneapolis 1, Minn.

CIRCLE 62 ON READER-SERVICE CARD

Audio Compressor and Expander

Speeds data readout



Vari-Vox is a speech-time compressor and expander. Repeating or discarding minute signal parts such as vowels, consonants, and pauses, it retransmits complex signals with full intelligibility. The expander helps interpretation of foreign language monitoring; difficult stenographic transcription; intelligibility in noise; and readout signal frequency division. The compressor helps speed data readout; cut monitoring time and tape storage; speed analysis of complex signals; reduce time in speech records; and increase information rate for signal monitoring.

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

CIRCLE 63 ON READER-SERVICE CARD

Stepper Motor Bidirectional

A bidirectional size 11 permanent magnet stepper motor, the M112A3 provides rotary motion without reciprocating parts. Stepping rate is 90 pulses per sec in random pulse direction. The unit has a rotor inertia of 3 gm cm². It can be supplied with internal logic circuitry.

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

CIRCLE 64 ON READER-SERVICE CARD

Random Access Memory System

12 μ sec access time

With random access for both writing and reading, the 3122 memory system has a capacity of 128 binary digit characters. Access time is 12 μ sec. The system is modular and may be expanded in storage capacity and word length. Read and write access cycles may be mixed.

Rese Engineering, Inc., Dept. ED, 731 Arch St., Philadelphia 6, Pa.

CIRCLE 65 ON READER-SERVICE CARD

Transistor Transformers

5 and 10 w outputs

In both driver and voice coil types, these hermetically sealed transistor transformers operate from 30 cps to 20 kc. The H-280 driver transformer has a primary impedance of 200 ohms center tapped with secondary 400 ohms. The H-281 is a 5 w output transformer with 45 ohms center tapped to 16, 8, and 4 ohms. The H-282 is a 10 w output transformer with 20 ohms center tapped to 16, 8, and 4 ohms.

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

CIRCLE 66 ON READER-SERVICE CARD

CIRCLE 67 ON READER-SERVICE CARD

Transitron SILICON VOLTAGE REFERENCES

USE THIS EASY WAY TO CHOOSE
THE RIGHT REFERENCE FOR YOUR APPLICATION

Wide range of low temperature coefficients

Transitron's broad line of silicon voltage references lets you design the *right* temperature coefficient into your equipment . . . without the expense of more stability than is needed.

Operation from -55°C to +100°C

These units provide a stable reference voltage over an extreme range of operating conditions . . . from -55°C to +100°C.

Easily mounted, compact packages

The compact axial lead package may be used as easily as a two-watt resistor. Each reference consists of hermetically sealed glass diodes. It may be operated in any position without voltage variation. (Conventional types 1N430 and 1N430A are also available when equipment design requires stud mounting.)

Application Engineering service

Our Applications Engineers will be glad to discuss applications where low temperature coefficient references may be useful to you. Or, send for bulletin TE-1352, which contains full technical data.



FOR POWER SUPPLY VOLTAGE TOLERANCE OF	CHOOSE TRANSITRON TYPE NUMBER	TO GET TEMPERATURE COEFFICIENT OF
$\pm .18\%$	SV3176 OR SV3207	.001%/°C
$\pm .25\%$	SV3175 OR SV3206	.002%/°C
$\pm .5\%$	SV3174	.003%/°C
$\pm 1\%$	SV3173	.005%/°C
$\pm 1.8\%$	SV3171	.01%/°C
$\pm 2.5\%$	SV3170	.02%/°C

Transitron

electronic corporation

wakefield, massachusetts



Transistors



Diodes



Regulators



Rectifiers



for electronic and avionic devices

STEMCO® THERMOSTATS

give you more of what you want most

FEATURES such as snap or positive-action . . . various terminal arrangements or mounting provisions . . . different temperature ranges—there's a *standard* type Stemco thermostat for your *special* needs. That means you cut down on lead time, research and development costs, tooling and production inventory. Specify Stemco and you get *better thermostats, faster and for less* than you can make them or buy them elsewhere.

SIZE and weight are particularly important in avionic and electronic applications. And here Stemco thermostats score, too. Their compactness and lightness give a better product without sacrificing performance.

ECONOMY of mass production of many standard Stemco types with literally hundreds of terminal arrangements and mounting provisions means your product costs less to make.

AVAILABILITY of most types is good. Design is flexible for your special applications, tooling is in existence for short-term delivery. If heat control is your problem, Stemco thermostats can provide the answer.

AA-4092

*Refer to Guide 400 EO for U.L. and C.S.A. approved ratings.

STEVENS manufacturing company, inc.
Lexington and Mansfield, Ohio

NEW PRODUCTS

Transistorized Power Supply

24 to 32 v dc

Providing 24 to 32 v dc at 10 amp, the M-1136A transistorized power supply has an overload capacity of 125 amp for 15 minutes. Input is 208 v ac $\pm 10\%$, three phase, 57 to 63 cps. Regulation $\pm 0.1\%$ for line changes from 180 to 229 v ac.

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

CIRCLE 68 ON READER-SERVICE CARD

Coaxial Balanced Bar Hybrid

For L-band

Model NL5805 coaxial bar hybrid can be used as a power splitter with 900 to 1500 mc airer antennas. Power applied to one arm will divide equally between two other arms matched to 50 ohms or having the same degree of mismatch. The fourth arm ends in a matched load.

Bogart Mfg. Corp., Dept. ED, 315 Seigel St., Brooklyn 6, N.Y.

CIRCLE 69 ON READER-SERVICE CARD

Pulse Timer

Has own power source

With self-contained power sources from 1.5 to 12 v, these timers have $\pm 0.02\%$ accuracy from 10 to 110 F. They can serve as interval timers, slow dc motors, pulse source timers, and low frequency oscillators. On a 1.5 v C cell, they operate two years.

Hamilton Watch Co., Allied Products Industrial Div., Dept. ED, Lancaster, Pa.

CIRCLE 70 ON READER-SERVICE CARD

← CIRCLE 71 ON READER-SERVICE CARD



TYPE A*
Semi-enclosed

Insulated, electrically independent bimetal disc gives fast response and quick, snap-action control. Operation from -10° to 400° F or higher on special order. Various mountings and terminals. Average rating $6\frac{1}{2}$ amps at 115 volts AC, 4 amps at 230 volts AC and 28 volts DC. See Bulletin 3000.



TYPE A*
Hermetically sealed

Electrically identical to semi-enclosed Type A. Temperatures from -10° to 300° F. Various enclosures and mountings, including brackets, available. For appliance, electronic, apparatus applications. Bulletin 3000.



TYPE C
Hermetically sealed

Electrically identical to semi-enclosed Type C but sealed in crystal can. Also supplied as double thermostat "alarm" type. Turret terminals or wire leads. Request Bulletin 5000.



TYPE C
Semi-enclosed

Small, positive-acting electrically independent bimetal strip for operation from -10° to 300° F. Rated at approximately 3 amps, depending on application. Terminals and mountings to customer specifications. See Bulletin 5000.



TYPE M*
Semi-enclosed

Electrically independent bimetal disc type for appliance and electronic applications from -10° to 350° F. Rating 8 amps at 115 volts AC, 4 amps at 230 volts AC and 28 volts DC. Virtually any type terminal. Bulletin 6000.



TYPE M*
Hermetically sealed

Electrically same as semi-enclosed Type M. Can be furnished with pin or solder-type terminals, wire leads and various mounting brackets. Write for Bulletin 6000.

STEMCO THERMOSTATS

Miniature Power Supplies

No moving parts



There are no moving parts or vibrators in this rugged power supply. Converting battery to B voltages with 80% efficiency, the unit has 0.05% output ripple and 0.3 v rms input ripple. It is 3.5 in. sq and 1.7 in. high. Models TPS-1 and TPS-2 have outputs of 100 ma, 150 v and 200 ma, 250 v, respectively. Inputs are 12 and 24 v.

P. R. Mallory & Co., Inc., Vibrator Div., Dept. ED, DuQuoin, Ill.

CIRCLE 72 ON READER-SERVICE CARD

Converters

Binary to binary decimal



By simple switching, this converter translates pure binary code to binary decimal code. No error is introduced in the translation process.

Aeronca Mfg. Corp., Baltimore Div., Dept. ED, Hilltop and Frederick Rds., Baltimore 28, Md.

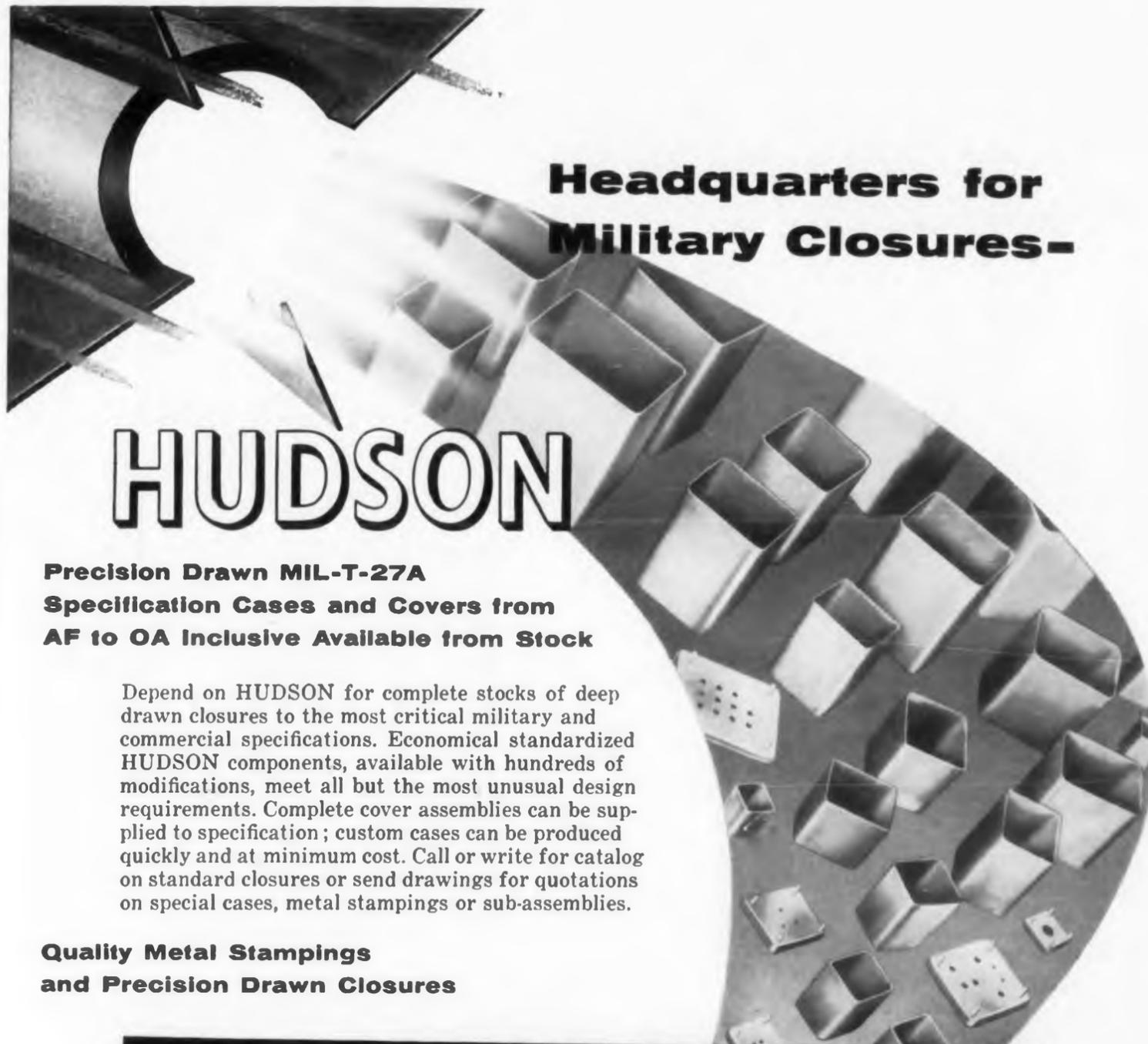
CIRCLE 73 ON READER-SERVICE CARD

Printed Circuit Connectors

For vertical board mounting

Model 2319 plug and 2320 jack are designed for mounting one printed circuit form perpendicular to another. The plug has a 0.0635 in. bore through the rectangular shank, which is slotted for board thickness. The jack comes in four shank lengths for boards 1/16 to 3/16 in. thick. Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

CIRCLE 74 ON READER-SERVICE CARD



Headquarters for Military Closures-

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**Precision Drawn MIL-T-27A
Specification Cases and Covers from
AF to OA Inclusive Available from Stock**

Depend on HUDSON for complete stocks of deep drawn closures to the most critical military and commercial specifications. Economical standardized HUDSON components, available with hundreds of modifications, meet all but the most unusual design requirements. Complete cover assemblies can be supplied to specification; custom cases can be produced quickly and at minimum cost. Call or write for catalog on standard closures or send drawings for quotations on special cases, metal stampings or sub-assemblies.

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and Precision Drawn Closures**

Available in Steel or Alloys Including Aluminum,

Brass, Copper, Mu Metal and Stainless Steel

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CIRCLE 75 ON READER-SERVICE CARD

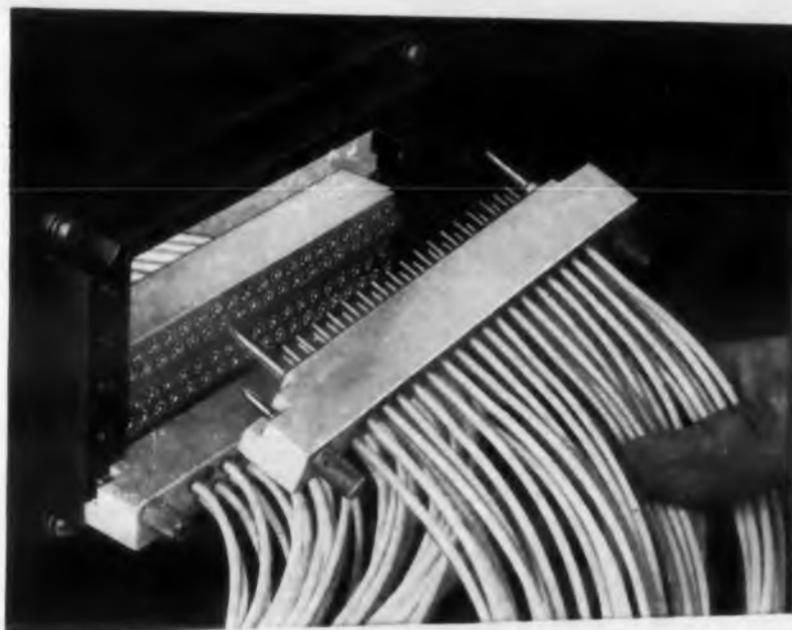


feed-thru,
multiple
insert

HYFEN® connector

with crimp-type,
snap-locked
contacts

Makes possible
the design of
lighter and more
compact equip-
ment. Each insert
holds 35 contacts.
Frames available
for 5 or 8 inserts.



crimp-type

MODULAR ELECTRICAL CONNECTORS

IN 3 NEW BASIC TYPES

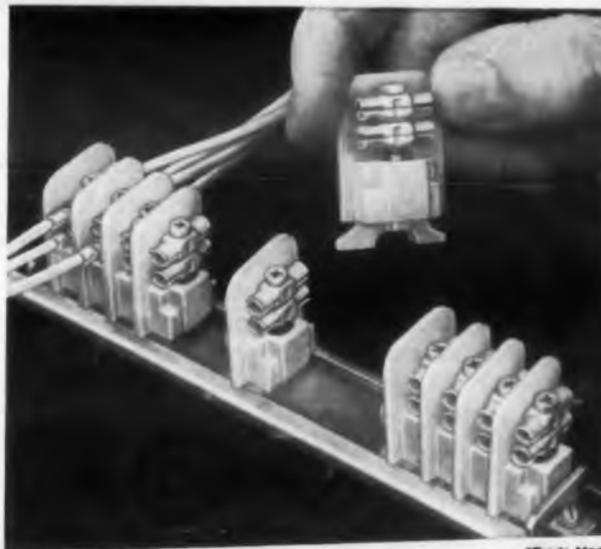
Modular units by Burndy provide versatile, rapid and reliable answers to the problem of connecting a multiplicity of wires in relatively limited spaces. Crimped contacts—installed with any of several hand, pneumatic, semi-automatic or automatic tools—can be removed, re-inserted or replaced, providing the most complete flexibility in the connector field. Computers, ground-based radar, missile ground controls, and instrumentation are typical applications for Burndy modular connectors.

quick-disconnect
or permanently
connected

MODULOK* terminal block

with snap-in,
spring-loaded
contacts

True versatility in a
terminal block. 30
modules (2 or 4 tier)
per foot. Twist of a
screwdriver transforms
quick-disconnect con-
tacts to permanent
connections.

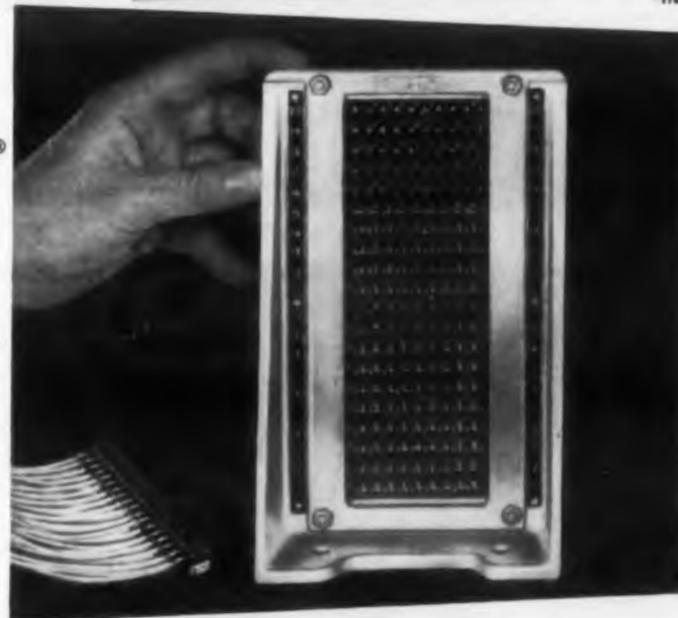


*Trade Mark

crimp-type,
solid-shank

STAPIN® taper pin contacts

Another
Burndy contribu-
tion to the
modular con-
cept of assem-
bling standard
units to pro-
vide custom-
fitted end
products.



For complete information, write: **OMATON DIVISION**

BURNDY

Norwalk, Connecticut

In Europe: Antwerp, Belgium

Toronto, Canada

CIRCLE 76 ON READER-SERVICE CARD

NEW PRODUCTS

Digital Ratiometer

$\pm 0.1\%$ full scale accuracy



Measuring ac and dc voltage ratios from 0 to 1 in direct numerical values, model 1594 digital ratiometer has a full scale accuracy of $\pm 0.1\%$. Inputs range from 0 to 6 v dc and 0 to 6.3 v ac at 400 cps. Reference input impedance for both ac and dc ratios is 1 K.

Performance Measurements Co., Dept. ED
15301 W. McNichols, Detroit 35, Mich.

CIRCLE 77 ON READER-SERVICE CARD

Microwave Leveler

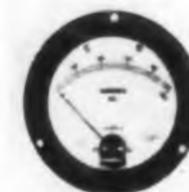
Flattens rf power to ± 1 db



Model 703 microwave leveler flattens rf power to ± 1 db from 2 to 4 kmc. It may be used with backward wave oscillators, klystrons, signal generators, and twt amplifiers. The unit also provides variable attenuation over the dynamic range of an associated control device.

Alfred Electronics, Dept. ED, 897 Commercial St., Palo Alto, Calif.

CIRCLE 78 ON READER-SERVICE CARD



Linear AC Ammeter

2% accuracy

Over a 300 to 2000 cps range, this linear ammeter provides 2% full scale accuracy. Self-contained up to 10 amp, the unit withstands 1000% overload for 5 sec or 100% continuously. It meets MIL-M-10304A standards.

Voltron Products, Dept. ED, 1010 Mission St., South Pasadena, Calif.

CIRCLE 79 ON READER-SERVICE CARD

Mass Flow Transducers

No moving parts

The range of this mass flow transducer is 20 to 180 lb of air per minute in a 6-in. duct. Without moving parts, it gives direct measurements of true mass flow independent of the temperature or pressure of the gas. It consists of two platinum resistance probes which form the active elements in opposite arms of a dc resistance bridge. The longer one is heated by a high, steady current and makes the fundamental density-velocity measurement as it is cooled by the mass flow in the duct. The shorter one is unheated and provides compensation for changes in the output of the heated probe as a function of the gas temperature. The transducer provides a 100 μ a output signal as a function of the mass flow of air or other gas from 0 to 150 F. It has an input of 28 v dc and weighs under 1 lb.

Trans-Sonics, Inc., Dept. ED,
Burlington, Mass.

CIRCLE 80 ON READER-SERVICE CARD

Microwave Antenna

For subsonic aircraft

Mounted on the underside of subsonic aircraft, the 15-200-S antenna gives circularly polarized horizon-and-down-coverage from 20 to 3300 mc.

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

CIRCLE 81 ON READER-SERVICE CARD

Ka Band Magnetrons

For missile radar

Ka band magnetrons M4063, M4064, and M4155 are rated at 70, and 40 kw respectively. For missile radar use, these rugged units weigh 9 to 13 lb.

Sylvania Electric Products, Inc.,
Special Tube Operations, Dept.
D, Williamsport, Pa.

CIRCLE 82 ON READER-SERVICE CARD

INTERNATIONAL RECTIFIER CORPORATION

RECTIFIER NEWS



64 Zener Diode Types Offer Advantages to Every Voltage Regulator Circuit

As compared to other voltage reference elements, the silicon diode regulator has a longer life expectancy because of its mechanical ruggedness. It does not deteriorate under storage nor age during its operating life. Small size and light weight make its use in airborne or portable equipment especially desirable from many standpoints.

International Rectifier Corporation now offers an extensive line of zener diode types numbering 64 in seven basic styles. From the miniature type rated at 750 milliwatts to the precision 1N430 reference element types, all are manufactured to meet the most rigid military requirements. See how these all-welded, hermetically sealed diodes can improve your circuit design. . . .

CIRCLE READER SERVICE CARD NO. 547

ZENIAC Provides a Shortcut to the Application of Silicon Zener Diodes

A flip of the Zeniac selector switch quickly tells you the exact diode required in complex breadboard circuitry. This unique innovation — the first semiconductor substitution box in history — has been designed specifically to aid system design groups by saving valuable lab time in the application of zener diodes. The eleven component diodes of Zeniac are rated at 1 watt and range in voltage from 3.6 to 30 volts. Zeniac is available at your local International Rectifier Industrial Distributor. For details on this time saver . . .

CIRCLE READER SERVICE CARD 549



FOR SAME DAY SERVICE ON PRODUCT INFORMATION DESCRIBED ABOVE, SEND REQUEST ON YOUR COMPANY'S LETTERHEAD

HZ Series Silicon Zener Voltage Regulators Replace Vacuum Tubes — Streamline Circuitry — Take Only Half The Space!

Semiconductor equivalents eliminate components and circuitry required by tube counterparts to overcome plasma oscillation and high firing potential.

Voltage regulation circuits can be simplified and the reliability increased by using silicon zener voltage regulators in place of conventional gas tube regulators such as the OA2, OA3, OB2, OC3, 1B46 and the 991.

The International Rectifier HZ series, provides a substantially lower dynamic resistance than do comparable tube types — and over a much broader temperature range (-65°C to $+165^{\circ}\text{C}$). This feature, and the unusually high zener reference voltage, stem from the unique construction of these units. Mechanical ruggedness of this package leads to longer term reliability than can be expected from tubes.

Other regulators restrict the engineer to a few specific voltages within a very limited current range. Not so with the HZ series. You may select the exact zener voltage your circuit requires within a range of from 24 to 160 volts — over a wide range of current values. This opportunity to select in discreet voltage steps obviates additional corrective circuitry . . . saves time!

If you are developing a voltage regulation circuit, write or call us today. We



will be happy to provide whatever assistance you need to improve your circuit with silicon zener regulators.

For Bulletin SR-253 describing the HZ series in technical detail . . .

CIRCLE READER SERVICE CARD NO. 548

Technical Service Provides XY Plot of Reverse Breakdown Characteristics of Each Diode in all Prototype Orders

To eliminate guesswork and tedious testing on your part, every zener diode sent on prototype orders will be accompanied by a specially plotted XY recording of its exact breakdown voltage point! This permanent record can come in mighty handy when it's time to match diodes or reorder to the same specs. This is just one of the many application engineering services we are prepared to extend to you at all times!

Write on your letterhead for Bulletin SR-250-A, a four page technical article describing the characteristics of zener diodes, how to select them, and application data with circuit schematics.

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 9-6261 • CABLE RECTUSA

BRANCH OFFICES: NEW YORK: 132 EAST 70TH ST. • TRAFALGAR 9-3330 • CHICAGO: 205 W. WACKER DR. • FRANKLIN 2-3666 • NEW ENGLAND: 17 DUNSTER ST., CAMBRIDGE, MASS., UNIVERSITY 4-6520 • PENNSYLVANIA: SUBURBAN SQUARE BUILDING, ARDMORE, PENNA. • MIDWAY 9-1426 • MICHIGAN: 199 COOLIDGE HIGHWAY, BERKELEY, MICH. • LINCOLN 9-1164

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Not all is **BLACK** that meets the eye...



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crisp,
opaque
drawings -

Use
Imported
Castell

"saturated" with graphite of
more than 99% carbon

Masters the world over have long known it. If you are a young creative man on the way up, you will do well to find out for yourself why imported CASTELL is hailed as The Drawing Pencil of the Masters.

Make a series of single and multiple pass lines with your CASTELL. Now examine them carefully with your magnifying glass. Note how each grade gives its own consistency of black in non-feathered lines of unvarying width, pencil after pencil. You will find this true even if you lay aside a drawing and

resume work on it months or years later.

CASTELL is saturated with "black gold" graphite—a natural crystalline allotropic form of carbon that has been microlet-milled to produce granules of perfect cohesion. No oily substances are added to give the illusion of black. Its low index of friction enables you to work smoothly, effortlessly, hour after hour, with almost no fatigue.

You owe it to your career to use CASTELL. 20 scientifically graded degrees, 8B to 10H. Call your dealer now.

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NEWARK 3, N. J.

The Proudest Name in Pencils

Castell in Canada • Write Hughes Owens Co., Ltd., Montreal



PREFERRED BY PROFESSIONALS IN EVERY CIVILIZED COUNTRY ON EARTH.
CIRCLE 84 ON READER-SERVICE CARD

NEW PRODUCTS

Vibration Meter

Permits remote testing



Type B-731A meter may be used for JAN MIL vibration tests on electronic components. It permits remote measurement of vibration distances from 50 μ in. to 0.5 in. and vibration rates from 1 cps to 10 kc. Accurate to 2%, the unit has a noncontacting probe and can measure the dilation and eccentricity of rotating parts.

Wayne Kerr Corp., Dept. ED, 2920 N. 4th St. Philadelphia 33, Pa.

CIRCLE 85 ON READER-SERVICE CARD

Precision Potentiometers

Miniature



Miniature model 1410 is a 1 w, 200 to 25,000 ohm precision potentiometer with an electrically isolated shaft and wiper. The stop mechanism associated only with the shaft, permits high rotational accuracy. The unit withstands 50 g acceleration and meets JAN-R-19, JAN-P-13, JAN-P-79, JAN-R-38, and MIL-E-5400 specifications.

S. A. Asquith Co., Dept. ED, 427 W. Chevy Chase Drive, Glendale 4, Calif.

CIRCLE 86 ON READER-SERVICE CARD

Pulse Height Analyzer

Operates at 1 million counts a minute

Pulse height analyzer PHA-2 can operate counting rates above 1 million cpm without appreciable data distortion. Input range is 0 to 50 v positive. The unit has 10 turn continuous controls for window level and width adjustment. Integral or differential operation are switch selected.

Tullamore Electronics Lab, Dept. ED, 6055 S. Ashland Ave., Chicago 36, Ill.

CIRCLE 87 ON READER-SERVICE CARD

Capacitors

Operate continuously at 315 C



The E-315 capacitor operates from -55 to $+315$ C. Capacitance is 0.05 to $4 \mu\text{f}$ at 600 v dc, with higher voltages available. The unit has been tested for 1000 hours at maximum temperature and rated voltage.

Bendix Aviation Corp., Scintilla Div., Dept. ED, Sidney, N.Y.

CIRCLE 88 ON READER-SERVICE CARD

Miniature Motor

20 lb thrust



When 100 ergs at 1.5 v or 0.2 amp are applied to it, this squib-actuated piston motor responds in 1 msec with a 20 lb thrust. The unit is $1/4$ in. in diameter and $15/16$ in. long. It functions from -65 to $+165$ F and withstands 20,000 g shock and acceleration.

Atlas Powder Co., Ordnance Materiel Dept., Dept. ED, Wilmington 99, Del.

CIRCLE 89 ON READER-SERVICE CARD

Limiting Audio Amplifier

50 cps to 15 kc range



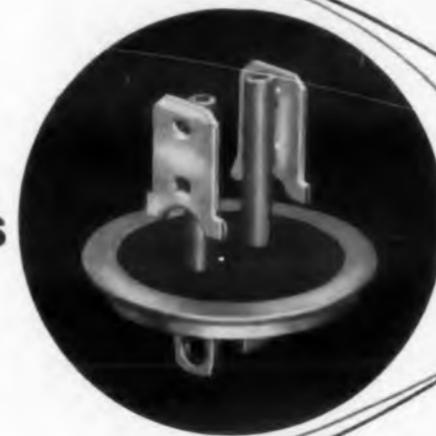
For a-m or f-m the 26U-1 limiting amplifier has 12 to 1 compression ratio for the first 10 db above the verge of compression. Frequency range is 50 cps to 15 kc ± 1.5 db; input level, -20 to -20 dbm. Input impedance is 600 ohms unbalanced, and output impedance is 600 ohms unbalanced adjustable or balanced fixed. Harmonic distortion is 1.5% at 25 db compression.

Collins Radio Co., Dept. ED, Cedar Rapids, Iowa.

CIRCLE 90 ON READER-SERVICE CARD

Now it's time to take a NEW LOOK

at HERMETIC TERMINALS

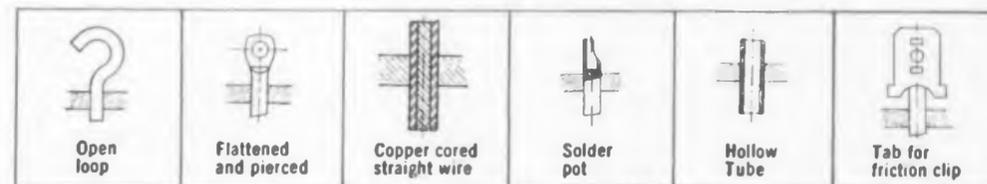


This Fusite two pin terminal opens new horizons of opportunity for electrical products not now hermetically sealed. It is practical in a wide variety of sizes and combination of materials for production installation by several different methods.

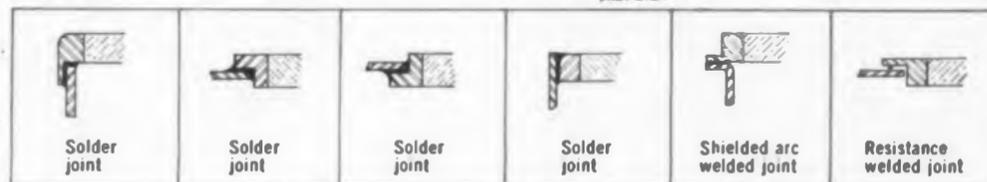
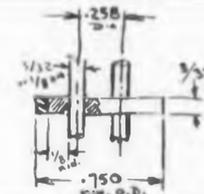
Features available:

- $1/8$ " OVER SURFACE PIN SPACING
- 20 AMPS OR MORE
- QUICK POSITIVE CONNECTING
- PRODUCTION WELD OR SOLDER
- COPPER CORE STAINLESS PINS
- STAINLESS STEEL BODY
- CUSTOM ELECTRODE TREATMENTS
- CUSTOM FLANGE TREATMENTS

Representative samples on request, write Dept. C-3.



This rough drawing of the basic terminal has purposely been rendered in a sketch form as it indicates no specific model but is used as a device to show minimum dimensions of this type terminal.



THE **FUSITE** CORPORATION

6000 FERNVIEW AVE., CINCINNATI 13, OHIO

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

CIRCLE 91 ON READER-SERVICE CARD



let your imagination
run wild

with this coating

**EMRALON . . . Acheson's
revolutionary new dispersion
"opens the door" to a host of
"restricted" applications**

Five years in development, 'EMRALON' surface coatings now make possible the application of Du Pont Tetrafluoroethylene (TFE) to heat sensitive materials such as aluminum, rubber, wood and plastic. Applied by spray, these versatile resin-bonded lubricating films exhibit the low-friction properties of the TFE pigment together with the durability of their specially-selected binders. Thus, hundreds of potential uses which heretofore were impractical because of the high fusing temperature of other processes, can now be re-considered as workable applications.

First in the Acheson family of TFE dispersions is 'EMRALON' 310,* employing a phenolic binder. Requiring a one-hour cure at only 300°F., it provides an unparalleled combination of low-friction coefficient, toughness, flexibility, adhesion and corrosion resistance. Substrates even more sensitive to temperature, or those where a bake cure is not practical, can be coated with 'EMRALON' 320† air-drying counterpart to 'EMRALON' 310.

Evaluate 'EMRALON' 310 or 320 in your plant and be among the first to "open the door" to new design possibilities. Send for an introductory package complete with data sheet. Enough to coat 5,000 sq. in. of surface is yours for \$4.25 prepaid (\$4.50 west of the Rockies). Write today.

Acheson Colloids Company
Port Huron, Michigan

Gentlemen: Your new 'EMRALON' surface coatings suggest themselves as possibilities for a current design problem. Send an introductory package to me promptly.

- | | |
|---|--|
| <input type="checkbox"/> 'EMRALON' 310 (bake type) | <input type="checkbox"/> Check enclosed |
| <input type="checkbox"/> 'EMRALON' 320 (air-dry) | <input type="checkbox"/> Please have your service engineer call: |
| <input type="checkbox"/> Bill me on Order No. _____ | |

NAME: _____ TITLE: _____

COMPANY: _____

ADDRESS: _____

CITY: _____ STATE: _____

APPLICATION: _____



LOW COEFFICIENT OF FRICTION



MAY BE APPLIED TO
HEAT-SENSITIVE MATERIAL



IDEAL FOR LIGHT LOAD MECHANISMS

*'EMRALON' 310 is manufactured under exclusive license from E. I. du Pont de Nemours & Co. (Inc.) under U. S. Patent 2,825,706. Not licensed for use or for sale for use in providing electrical insulation.
†'EMRALON' 320 — Patent applied for

ACHESON Colloids Company

PORT HURON, MICHIGAN

A division of Acheson Industries, Inc.

Also Acheson Industries (Europe) Ltd. and affiliates, London, England

CIRCLE 92 ON READER-SERVICE CARD

NEW PRODUCTS

Silicon Rectifiers

50 to 500 piv



Providing 6 amp over a 50 to 500 piv range, these diffused junction silicon rectifiers operate at diode base temperatures up to 150 C. They can be used for airborne power supplies, electrical instrument testing, and oscilloscopes.

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

CIRCLE 93 ON READER-SERVICE CARD



Potentiometers

Rated at 0.2 w

For transistorized circuits, series 44 0.2-w carbon potentiometers have standard resistances of 25 and 500 K with taper. Units may be ordered in 200 ohms to 5 meg linear, and 1500 ohms to 2.5 meg tapered.

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

CIRCLE 94 ON READER-SERVICE CARD



Oscilloscope

100 μ v per division sensitivity

Type 403 oscilloscope and its rack-mounted version, 403-R, have a full scale range of 1 mv to 500 v, continuously variable in 17 steps. Maximum sensitivity is 100 μ v per division; maximum drift, 1 mv. The unit has 19 sweeps from 1 sec to 1 μ sec per cm. Full scale accuracy is $\pm 5\%$.

Allen B. Du Mont Labs, Inc., Dept. ED, 760 Bloomfield Ave., Clifton, N.J.

CIRCLE 95 ON READER-SERVICE CARD

Differential Relay

Voltage sensing



This differential voltage sensing relay protects radar gear, microwave relay systems, and other equipment. Its control range is 70 to 100% of rated voltage for both dropout and pickup with a minimum 1 v differential. Dc ranges are 6 to 49 v and 50 to 250 v; ac ranges are 1 and 3 phase, 3 and 4 wire.

Lake Shore Electric Corp., Dept. ED, 205 Willis St., Bedford, Ohio.

CIRCLE 96 ON READER-SERVICE CARD

Time and Distance Actuator

Fires squibs

At a preset time or distance, model N10A time delay relay and distance sensor produces a 22 amp peak pulse to fire squibs. Times up to 3 sec and distances to 200 ft can be set on the dial.

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

CIRCLE 97 ON READER-SERVICE CARD

Tubeaxial Blower

Delivers 50 to 160 cfm

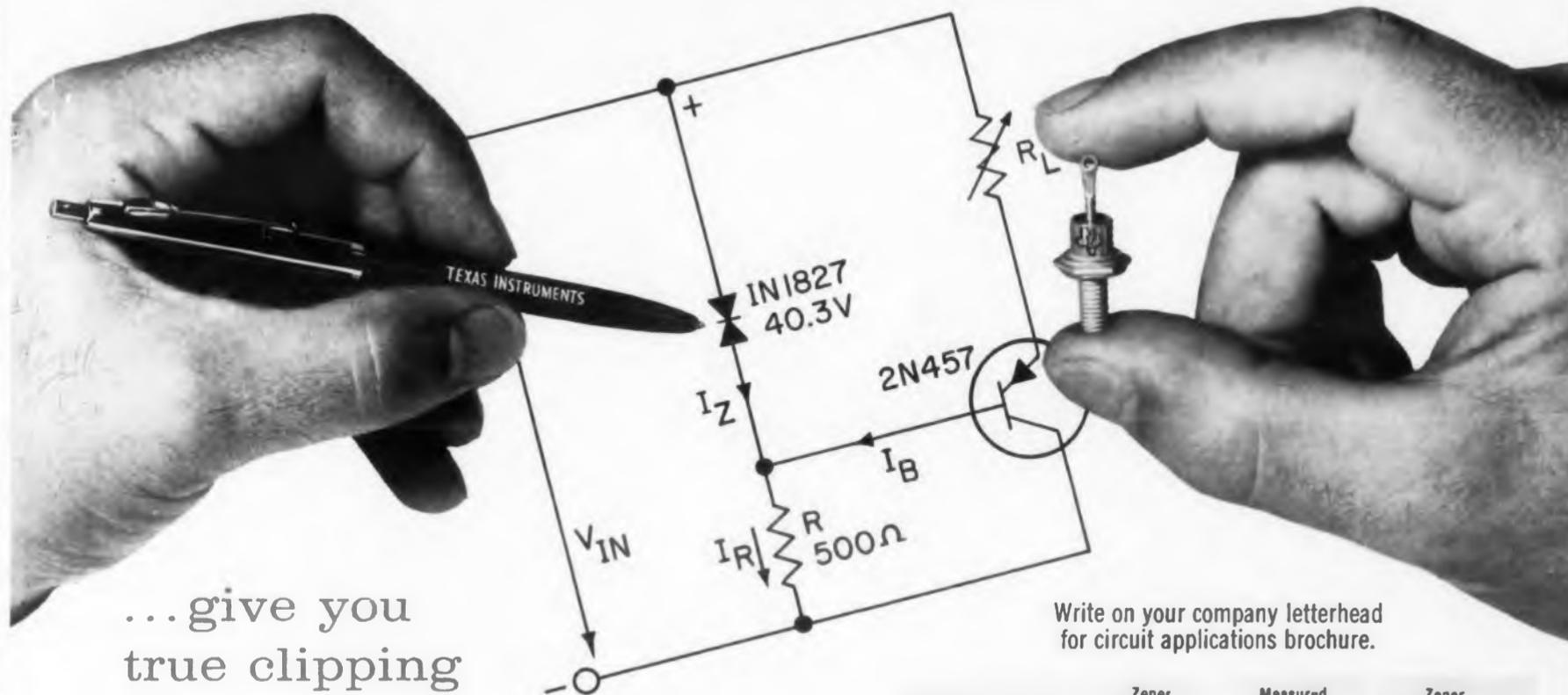
For cooling electronic equipment, the MSA 4707 tubeaxial blower is 6 in. in diameter, 4 in. long, and weighs 16 oz. It delivers 50 to 160 cfm and has an ac or dc motor.

The Torrington Mfg. Co., Dept. ED, Torrington, Conn.

CIRCLE 98 ON READER-SERVICE CARD

CIRCLE 99 ON READER-SERVICE CARD

NEW 10W VOLTAGE REGULATORS FROM TEXAS INSTRUMENTS



...give you true clipping characteristics!

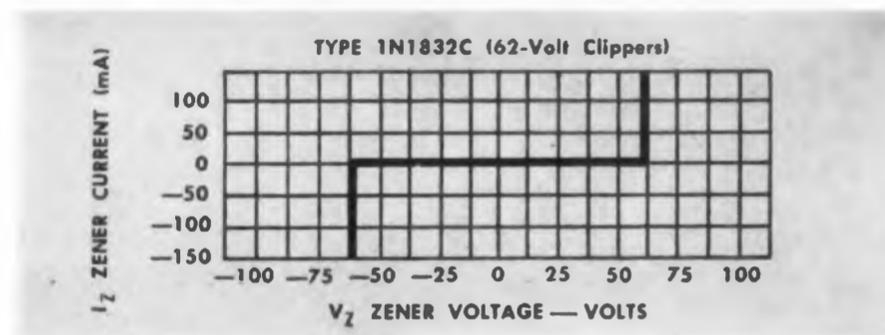
Write on your company letterhead for circuit applications brochure.

You get true clipping action with TI 1N1816-series double anode voltage regulators. A full line of regulators with dissipation ratings to 10 watts is available in 5 or 10% tolerances over a 13 to 91-volt range.

These stud-mounted silicon voltage regulators give you guaranteed zener impedance, -65 to 150°C operation, and are designed to meet or exceed strict military (MIL-T-19500A) requirements.

This new 1N1816-series provides greater design flexibility for your shunt regulator, surge protection, operating bias, and arc suppression applications. Select from 105 types... 16 voltage ratings... 5 or 10% tolerances... cathode-to-stud or anode-to-stud polarity.

Type	Zener Voltage V_Z Volts	Measured at I_Z I_Z mA	Zener Impedance at I_Z Z_Z (max) ohms
1N1816	13	500	2
1N1817	15	500	2
1N1818	16	500	3
1N1819	18	500	3
1N1820	20	250	3
1N1821	22	250	3
1N1822	24	250	3
1N1823	27	250	3
1N1824	30	250	4
1N1825	33	150	4
1N1826	36	150	5
1N1827	39	150	5
1N1828	43	150	6
1N1829	47	150	7
1N1830	51	150	8
1N1831	56	150	9
1N1832	62	50	12
1N1833	68	50	14
1N1834	75	50	20
1N1835	82	50	22
1N1836	91	50	35



1N1816C — 1N1836C CLIPPER

Types 1N1816C—1N1836C are specifically designed to clip, and exhibit true double anode characteristics. Each zener is held within 10% tolerance of the specified voltage. See "Typical Clipper Characteristics" curve at left.

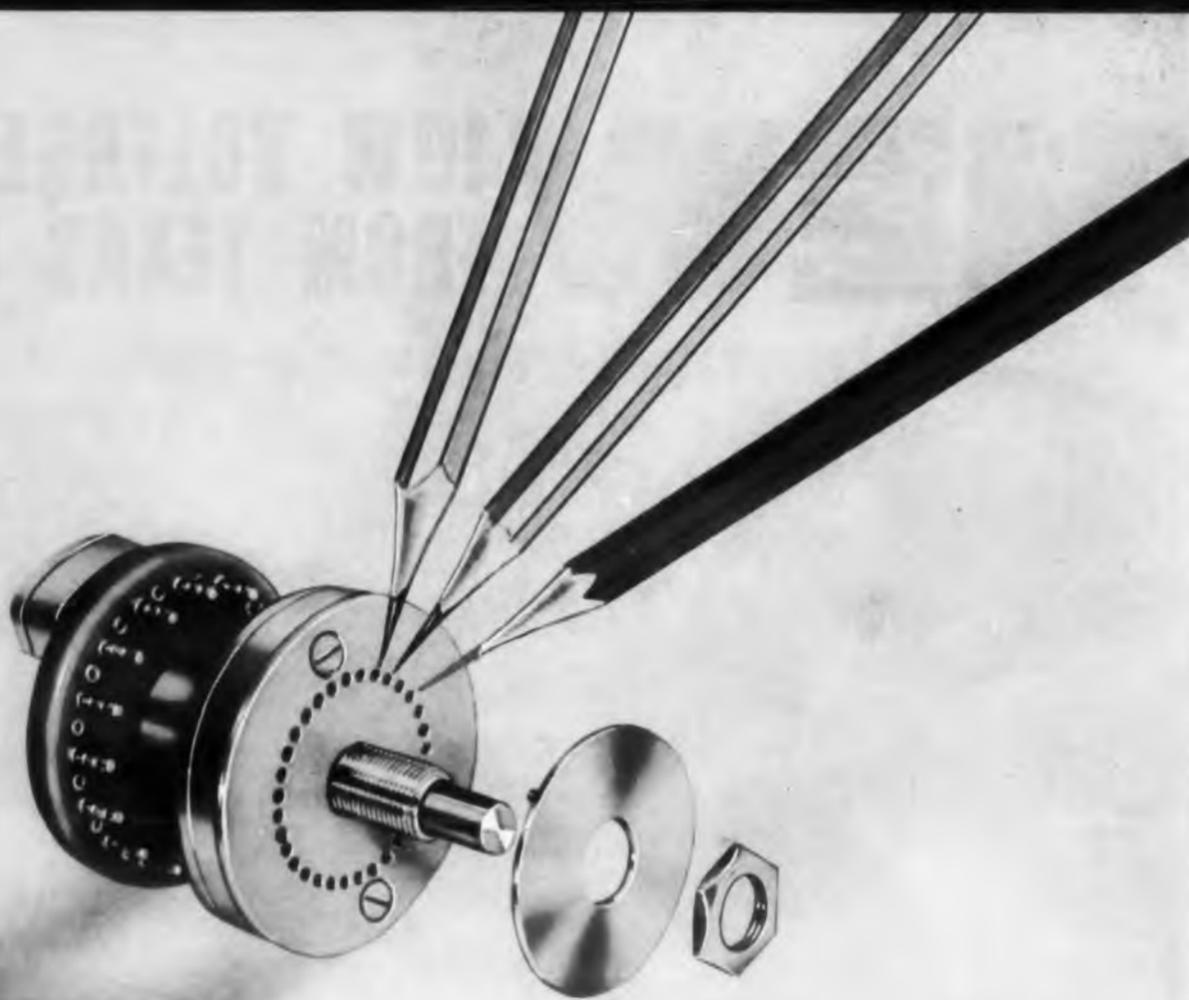


WORLD'S LARGEST SEMICONDUCTOR PLANT



TEXAS INSTRUMENTS
INCORPORATED

SEMICONDUCTOR-COMPONENTS DIVISION
POST OFFICE BOX 312 • 13500 N. CENTRAL EXPRESSWAY
DALLAS, TEXAS



Stop it

... where you want it!

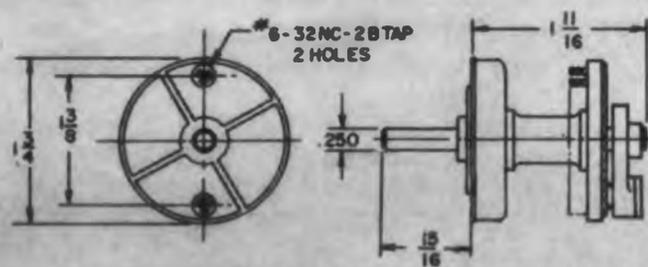
Daven's New Rotary Switch with Adjustable Stop

For flexibility in all types of circuit experimentation, laboratory work, breadboard setups, and in circuitry where the exact number of switch positions might be changed at a later date, the new DAVEN Rotary Switch with an Adjustable Stop is ideal. This unit, as a single pole switch, can have a maximum of either 24 shorting positions with 15° spacing or 32 shorting positions with 11½° spacing. One, two, three, and four pole units are available in this design.

In common with all other DAVEN Rotary Switches, the Adjustable Stop Switch features sturdy, dependable construction; silver alloy contacts and slip rings; tamper-proof,

KNEE ACTION* silver alloy rotor blades; high grade, accurately machined dielectric; and gold flashed turret-type terminals for ease of soldering.

*Patented



Write for complete information.

THE **DAVEN** CO.

LIVINGSTON, NEW JERSEY



Available From Stock Through Selected Distributors

TODAY, MORE THAN EVER, THE DAVEN SWITCH IS THE ANSWER FOR DEPENDABILITY!

NEW PRODUCTS

Transistor Tester

Checks 720 units an hour



In one hour, the T-200 transistor tester automatically runs 720 transistors through a series of ten tests. The test units may be pnp or npn, silicon or germanium. The T-200 will also perform three tests on 2400 silicon or germanium diodes in an hour. The plug-in unit is 2% accurate.

Atlantis Engineering Corp., Dept. ED, 1807 Stratford Dr., Garland, Tex.

CIRCLE 111 ON READER-SERVICE CARD

Snap Action Switch

Has mounting ears

These snap action Klikswitches have integrally molded ears with side mounting holes. Spdt or spst normally closed, they are rated at 8 amp, 115 v ac, noninductive load.

General Controls Co., Dept. ED, 8078D McCormick Blvd., Skokie, Ill.

CIRCLE 112 ON READER-SERVICE CARD

Alarm Control

2-7/8 in. diameter



Self-contained, this alarm control is 2-7/8 in. in diameter and 4-3/4 in. deep. It controls signals from almost any variable, usually without amplification. It may be used with any of the company's 4-1/2 in. meter-relays.

Assembly Products, Inc., Dept. ED, Chesterland, Ohio.

CIRCLE 113 ON READER-SERVICE CARD

← CIRCLE 110 ON READER-SERVICE CARD

Time Delay Relays

Instantaneous Reset



Preset for 20 to 180 sec delays and voltage compensated from 22 to 32 v dc, these time delay relays operate from -65 to +125 C. Series IR units are spno or spnc; series TR are dpdt; and series STR are spdt. All are rated 2 amp at 28 v dc, resistive.

Curtiss-Wright Corp., Electronics Div., Dept. ED, 260 Passaic Ave., West Caldwell, N.J.

CIRCLE 114 ON READER-SERVICE CARD

Solenoid

Has 20 msec stroke

Designed to operate with a 24 lb load, the R.S. 5174 solenoid operates from -65 to +160 F. Its 0.02 in. stroke occurs at 14 msec maximum and is completed in less than 20 msec. At 78 F, voltage rating is 24 v dc and coil resistance is 19.2 ohms.

Telecomputing Corp., Dept. ED, 115 N. Citrus Ave., Los Angeles 38, Calif.

CIRCLE 115 ON READER-SERVICE CARD

Servo Potentiometer

7/8 to 3 in. diameters



Linear or nonlinear with multiple taps, these precision servo potentiometers feature low torque operation. In various materials, they may be ganged to order. Diameters are 7/8 to 3 in.

Circuit Instruments Inc., 2801 Avil St., N., St. Petersburg 33, Fla.

CIRCLE 116 ON READER-SERVICE CARD

CIRCLE 117 ON READER-SERVICE CARD



ANOTHER BREAKTHROUGH from PHILCO.

High Frequency Switching Performance at Medium Frequency Transistor Prices!

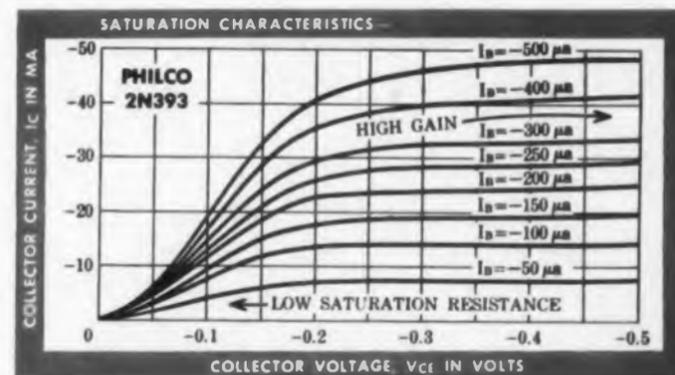
Philco 2N393 Micro Alloy Transistor (MAT) offers High Gain, High Frequency, Low Saturation at a New Low Price.

Philco 2N393 micro alloy transistors are now available for immediate delivery in *unlimited* quantities at \$4.75 (100 or more).

These transistors offer circuit designers and computer manufacturers a dramatic opportunity to combine the advantages of outstanding high frequency response (up to 50 megacycles) with excellent Beta linearity (to 50 milliamperes) and low saturation resistance at this new, low price.

Here are transistors with multi-million hour *proven* circuit reliability . . . and demonstrated stability in all types of switching circuits.

Philco 2N393 transistors are extremely well suited to the special branching requirements of high speed com-



puter circuits. They are also excellent for use in video amplifiers up to one megacycle.

Consider the many advantages of high frequency, low cost Philco 2N393 transistors . . . before you settle for lower frequency transistors in your equipment.

Make Philco your prime source for complete transistor application information . . . For complete specifications and prices on the 2N393, write Dept. ED-1258

PHILCO CORPORATION

LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA



Now . . . from Phelps Dodge . . .



First complete line of Solderable Magnet Wires for the Electronics Industry!

S-Y BONDEZE®

answers the long-awaited need for a self-bonding wire that is solderable at low temperatures. The high temperature cut-thru resistance of the underlying film will reduce the number of shorts in your coils.

NYLEZE®

a tough, all-purpose, solderable wire for your most severe applications. Especially suited for use in high speed automatic winding equipment or wherever extreme varnish or compound treatment is involved.

SODEREZE®

the magnet wire that is solderable at low temperature, proven over the years in thousands of customer applications.

GRIP-EZE®

a solderable film wire with controlled surface friction for use in lattice-wound coils. A special surface treatment provides mechanical gripping between turns and keeps the wire in place.

All Phelps Dodge solderable magnet wires are red in color.

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

FIRST FOR
LASTING QUALITY
—FROM MINE
TO MARKET!



**PHELPS DODGE COPPER PRODUCTS
CORPORATION**

INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA

CIRCLE 118 ON READER-SERVICE CARD

NEW PRODUCTS

Axial Lead Rectifiers

Rated at 1500 v



At 150 C, axial lead silicon rectifiers SL615 and SL715 are rated to 1500 v at 50 and 100 ma, respectively.

Transitron Electronic Corp., Dept. ED, Waltham, Mass.

CIRCLE 119 ON READER-SERVICE CARD

Oscillator

Center frequencies to 250 kc



A dual channel, voltage controlled oscillator model 956 has center frequencies that cover 10 IRIG channels and extend to 250 kc. Input ± 2.5 v for any deviation up to $\pm 40\%$ of center frequency; output is variable from 0 to 1.5 v rms.

Midwestern Instruments, Dept. ED, 41st and Sheridan, Tulsa, Okla.

CIRCLE 120 ON READER-SERVICE CARD

Storage Tube

1000-line resolution



A single-gun, recording storage tube, the Q685 has a resolution of 1000 lines at 50% modulation, and shading-to-signal ratios of less than 10%. Output capacitance is under 10 μ f. The tetrode gun is designed for magnetic deflection and focusing, with provisions for dynamic electrostatic focusing.

Raytheon Mfg. Co., Microwave and Power Tube Div., Dept. ED, Waltham 54, Mass.

CIRCLE 121 ON READER-SERVICE CARD

Toroidal Inductors

5 mh to 5 h



Wound toroidally on molybdenum permalloy powder cores, these high Q coils have inductances from 5 mh to 5 h, accurate to 1%. Open, epoxy encapsulated, or molded, they are 1-5/16 in. in diameter and 11/16 in. high.

Magnetics, Inc., Dept. ED, 6 Richter Court, East Northport, N.Y.

CIRCLE 122 ON READER-SERVICE CARD

Power Amplifier Tubes

Performance matched

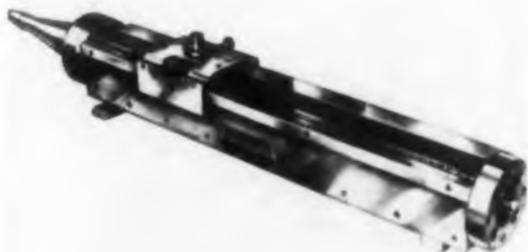
Packed in pairs, type 6550 and 5881 beam power amplifier tubes are performance-matched to tight limits. The matching eliminates much of the higher order distortion, thus improving sound reproduction. The 5881 is for use in amplifiers of 50 w and under; the 6550, for amplifiers of 100 w or less.

Tung-Sol Electric Inc., Dept. ED, 95 Eighth Ave., Newark 4, N.J.

CIRCLE 123 ON READER-SERVICE CARD

Slotted Line

Under 1.01 residual vswr



Slotted line type 1026 has a residual vswr below 1.01 and less than 1.005 rated error in detected signal. Important outer conductor surfaces are hand scraped to fine tolerance. The inner conductor is supported by compensated electric pins. The unit is furnished in 20, 40, 80, and 130 in. lengths and comes in standard impedances from 50 to 75 ohms. It may be used with tapered reducers for measurements in 6-1/8 in., 3-1/8 in., 1-5/8 in., and type N coaxial transmission lines.

Alford Mfg. Co., Dept. ED, 299 Atlantic Ave., Boston 10, Mass.

CIRCLE 124 ON READER-SERVICE CARD

What's your application for versatile *recti/riter*® recorders?

TI's Applications Engineering Department invites your requests for technical assistance in OEM or end uses. Here are a few of the present applications.



SINGLE



DUAL

Rectilinear Galvanometric Recorders, with a wide choice of sensitivities and "recti/riter" accessories, offer the most complete ranges available for recording electrical parameters from many types of transducers.



MISSILE TESTING

—a bank of "recti/riter" units record voltage frequencies and currents.



MEDICAL RESEARCH

—used with rate meters and nuclear scanners . . . also used to monitor rate of impurities in vaccines.



AIR NAVIGATION

—used to monitor ILS beams . . . also used to monitor LORAN signals.



QUALITY CONTROL

—used on numerous production lines to check sizes and contours of parts, as well as assembly rates.



METEOROLOGICAL

—records wind directions and velocities . . . also used in studies of Aurora and air glow through scintillometer counters.



AUTOMATIC COMPUTERS

—for studying stability of electrical parameters that affect accuracy.



OIL EXPLORATION

—used in well logging as well as airborne magnetometers and scintillometers.



RADAR SPEED METERS

—used in police vehicles to visually record speed of passing motorists.



OCEANOGRAPHY

—records wave frequency and magnitude . . . also monitors underwater pressures.



ATOMIC TESTING

—used to measure radiation fall-out at test centers and nuclear installations.

TI will custom manufacture "recti/riter" recorders to your specifications for OEM use. Write for complete information.



TEXAS INSTRUMENTS
INCORPORATED

INDUSTRIAL INSTRUMENTATION DIVISION

3809 BUFFALO SPEEDWAY • HOUSTON, TEXAS • CABLE: HOULAB

CIRCLE 125 ON READER-SERVICE CARD

PERFECT SURFACE...EXTREME HARDNESS...LOW COST
—all this and more, with LINDE Sapphire!

To assure dependability under the most severe conditions, tiny valve poppets and seats of pilot relief valves for space vehicle tanks built by Whittaker Controls are made from LINDE Sapphire. LINDE Sapphire was selected over other materials for this critical use because of its perfectly smooth surface, extreme hardness, and relatively low cost. Other advantages are resistance to corrosion and fast deliveries from LINDE.

Among other properties of LINDE Sapphire are zero porosity, great strength at elevated temperatures, and a high melting point of 2040 C. LINDE Sapphire is transparent, may be clear or red. It is easily sealed to metals or ceramics and has excellent IR transmission characteristics.

LINDE Sapphire is supplied in the form of balls, rods, tubes, domes, and special shapes to order. For more information, write Crystals Department, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. In Canada: Linde Company, Division of Union Carbide Canada Limited.



Pilot section of this pressure relief valve has poppet ball (red) and seat of LINDE Sapphire. Valve was designed and manufactured by Whittaker Controls Division of Telecomputing Corporation

Linde and Union Carbide are registered trade marks of Union Carbide Corporation.

Linde
TRADE MARK

**UNION
 CARBIDE**

NEW PRODUCTS

Coaxial Relay

Provides remote switching



For 3-1/8 in. coaxial lines, type RC10 relay provides remote switching at frequencies to 60 mc at 50 kw. It has a latching type actuator and vacuum enclosed contacts. Impedance is 50 ohms; frequency range, 0 to 100 mc; vswr, 1.02 at 30 mc and 1.05 at 60 mc.

Jennings Radio Mfg. Corp., Dept. ED, P.O. Box 1278, San Jose, Calif.

CIRCLE 127 ON READER-SERVICE CARD

Servo Motors

60 and 400 cps

In several sizes from 8 to 23, these 60 and 400 cps servo motors operate to 200 C ambient and meet MIL-E-5272A requirements. The line includes damping and tachometer generators, and inertia damped and synchronous motors.

Servo Dynamics Corp., Dept. ED, Somersworth, N.H.

CIRCLE 128 ON READER-SERVICE CARD

Pulse Tube

Provides 2 amp peak current



The 7318 miniature twin-triode is a 9-pin, medium-mu amplifier that provides 2 amp peak in 10 μsec pulses. It operates from -62 to +100 C, and provides 80% emission after a 10 sec warm-up.

CBS-Hytron, Dept. ED, Danvers, Mass.

CIRCLE 129 ON READER-SERVICE CARD

← CIRCLE 126 ON READER-SERVICE CARD

Vernier Potentiometer

Three decade voltage divider



Vernier potentiometer 81-A is a three decade voltage divider with a Kelvin-Varley circuit and a parallax-free dial that registers to four places. Standard resistance is 10 K; accuracy, $\pm 0.05\%$; linearity, $\pm 0.01\%$; resolution, 0.002%; power rating, 5 w; frequency range, dc to 10 kc.

Rinco, Inc., Dept. ED, 7962 E. Powell Blvd., Portland 6, Ore.

CIRCLE 130 ON READER-SERVICE CARD

Oscillographic Recorders

6 and 8 channel

Series 850 direct writing oscillographic recording systems contain six or eight interchangeable pre-amplifier modules in a cabinet 5 ft high. Available preamplifiers include the 850-1200 phase sensitive demodulator for use with resolvers, synchros, and differential transformers, and the 850-1300A dc coupling for single-ended or balanced input signals. Power for up to eight preamplifiers is provided by a single 850-500A power supply at the rear of the module. The complete module with power supply and rack is available for separate use. The recorder assembly consists of a flush-front recorder, a power supply, and transistorized current feedback amplifiers. It provides nine chart speeds from 0.25 to 100 mm per sec; individual stylus heat controls; 8 in. of visible record; contacts for remote control; and inkless recordings in true rectangular coordinates on plastic coated charts.

Samborn Co., Dept. ED, 175 Wyman St., Waltham 54, Mass.

CIRCLE 131 ON READER-SERVICE CARD

CIRCLE 132 ON READER-SERVICE CARD



TEAL rocket designed by TEMCO AIRCRAFT CORP., Dallas

What's the
coolest insulator
for hot products?

FORMICA® laminated plastic . . . withstands **2500° F for 8 minutes** in the Navy's XKDT-1 rocket drone. A modified standard Formica grade successfully insulates the solid propellant engine case and blast tube against this inferno.

This is the heat insulator Formica research developed by combining great mechanical strength with high heat resistance. It has helped break the heat barrier in aviation, missile and space craft.

This type of heat insulator can be useful in your hot products, too. In fact, product designers are getting more "assists" from Formica laminated plastics than any other material. Standard grades available for immediate use in your projects . . . without extensive delays for research and development. Forty-eight hour Streamliner shipment of most grades. For further information, write for bulletins 829 and 856-A. Formica Corporation, subsidiary of American Cyanamid, 4512 Spring Grove Ave., Cincinnati 32, Ohio.



a product of 

Tarzian F Series Silicon Rectifiers . . .

UTMOST

. . . in Performance

Ratings	S.T. Type	Max. Peak Inverse Volts	Max. RMS Volts	Current Ratings—Amperes											
				Max. D.C. Load			Max. RMS			Max. Recurrent Peak			Surge 4MS Max.		
				55°C	100°C	150°C	55°C	100°C	150°C	55°C	100°C	150°C	55°C	100°C	150°C
F-2	200	140	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35	
F-4	400	280	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35	
F-6	600	420	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35	

. . . in Ultra Small Size

Dimensions



. . . in Low Price

Tarzian

research, engineering and production know-how have combined to develop the "utmost" in a small size, very low cost silicon rectifier with giant performance. If your problem is miniaturization, or cost, or tough application, the solution is in the Tarzian F series.

Sarkes Tarzian, Inc., Rectifier Division

DEPT. C-7, 415 NORTH COLLEGE AVE., BLOOMINGTON, INDIANA

IN CANADA: 700 WESTON RD., TORONTO 9, TEL. ROGER 2-7535 EXPORT: AD AURIEMA, INC., NEW YORK CITY

CIRCLE 133 ON READER-SERVICE CARD

NEW PRODUCTS

Drive Amplifier
Dual channel



Model 940 dual channel amplifiers are designed to drive the company's 102 and 120 galvanometers. Frequency response is dc to 10 kc ± 1 db; input impedance, 1 meg constant; input sensitivity, ± 1 to ± 100 v for full scale output. The unit can provide ± 10 v at 200 ma.

Midwestern Instruments, Dept. ED, 41st and Sheridan, Tulsa, Okla.

CIRCLE 134 ON READER-SERVICE CARD



Stand-Off Terminals
0.36 in. long

These stand-off terminals are 0.36 in. long and weigh 0.75 oz per hundred. Hi-Alumina insulated, series 1480 units withstand 1000 F and are resistant to nuclear radiation. Teflon insulated series 1490 combine low electrical loss and good dielectric characteristics.

Litton Industries, Components Div., Dept. EL 5873 Rodeo Rd., Los Angeles 16, Calif.

CIRCLE 135 ON READER-SERVICE CARD



Transistor Tester
For pnp and npn types

For checking positive leakage and gain in pnp and npn transistors, the 690-A tester measures dc beta from 5 to infinity. It also checks diode forward and reverse leakage.

The Triplett Electrical Instrument Co., Dept. ED, Bluffton, Ohio.

CIRCLE 136 ON READER-SERVICE CARD

Patch Panels

Custom made

For control instruments and switching computer circuits, the 256 patch panel is custom made from a 6 x 6 x 1/8 in. aluminum panel. Gold plated, the pins are 0.045 in. in diameter and spaced on 0.2 in. centers. Individual contacts have a minimum capacity of 1 amp.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

CIRCLE 137 ON READER-SERVICE CARD

Oscilloscope

For rack mounting



Oscilloscope 90923 is a rack panel type 3.5 in. high. It has a 2 cps to 30 kc linear sweep and 2000 v accelerating potential. The vertical and horizontal balanced deflection amplifiers have frequencies of 7 cps to 125 kc ± 2 db and 2 cps to 125 kc ± 2 db, respectively. The 3XP tube is 3 x 1.5 in.

The James Millen Mfg. Co., Inc., Dept. ED, Malden, Mass.

CIRCLE 138 ON READER-SERVICE CARD

Size 8 Servomotor

Inertia-damped



No-load speed of the 8 IM 420 size 8 servomotor is 6000 rpm. Flywheel inertia is 2 gm cm² and flywheel damping factor is 40 dyne-cm-sec/rad. The unit has a 26 v fixed and a 40 v center-tapped control phase. It stands 30 g vibration and 100 g shock to 2000 cps and operates in ambient from -55 to +130 C. It also meets MIL-E-5272A requirements. Power input is 2.6 per phase.

Beckman Instruments, Inc., Helipot Div., Dept. ED, Fullerton, Calif.

CIRCLE 139 ON READER-SERVICE CARD



NEW! HIGH-TEMPERATURE FABMIKA® CAPACITORS

... standard ratings for 260°C

... up to 310°C in special designs

Sprague's new FABMIKA Capacitors can really handle the HOT ones! . . . jet ignition, missile controls, atomic reactors . . . any high voltage d-c power supply where high temperature, small size, and light weight are important . . . especially where components are immersed in a dielectric fluid.

● Sprague's new FABMIKA Capacitors rely on a specially processed dielectric for their heat resistant properties. Developed through three years of research and manufacturing, this dielectric consists of silicone-bonded mica paper which can function effectively in temperatures up to 260°C and, in special designs, up to 310°C. There's a choice of four standard temperature ranges: from -55°C to +125°C, +165°C, +200°C, and +260°C.

● Radiation resistance is another outstanding characteristic of FABMIKA Capacitors. They have been application tested in reactors under high dosage rates without harmful loss of capacitance.

● Another important application is 400 cycle a-c power supplies where their low dissipation factor results in small capacitors with minimum rise in temperature under operating conditions.

● Miniature, high-reliability pulse forming networks are still another well tested application.

● FABMIKA Capacitors are available in four constructions: uncased (up to 200°C), uncased and clamped (up to 260°C), cast epoxy housing (up to 200°C), and drawn metal case (up to 260°C standard and 310°C special).

● For complete specifications, write for Engineering Bulletins to the Technical Literature Section, Sprague Electric Co., 347 Marshall St., North Adams, Mass.

TYPICAL INSULATION RESISTANCE

Temp. °C	MΩ X μF
125	300 (min.)
165	100 (min.)
250	50 (min.)
260	10 (min.)

Maximum Dissipation Factor: .15% at 400 cy. 25°C.

SPRAGUE COMPONENTS:

CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS • HIGH TEMPERATURE MAGNET WIRE • PRINTED CIRCUITS
CIRCLE 140 ON READER-SERVICE CARD

SPRAGUE®
the mark of reliability

Recent Raytheon achievement in Radar



MOVING-TARGET INDICATOR is just one of the many dramatic achievements Raytheon engineers are making in radar every day. This development applies the electronic memory of a recording storage tube to a standard plan-position indicator (PPI).

ADVANTAGES: (1) trail of the moving target is displayed on the scope to permit immediate analysis of target course without the necessity of manual plotting. (2) Scope brightness is uniform and at a sufficient level for lighted area viewing!

HOW IT WORKS: both live and stored data are shown on a two-layer, two-color phosphor CRT on a time-shared basis—the stored pattern being read out onto the scope in the time between successive PPI sweeps. A yellow dot indicates the target and a blue-white trail depicts the history of its motion.

To the man who is looking for

FRONTIER PROJECTS IN ELECTRONICS:

As an engineer or scientist who wants to accomplish more in 1958, you naturally want to be where new things are happening.

Whatever your specialized background and interests, chances are you'll find a current Raytheon project that offers exceptional opportunity for you to put your scientific skill and creative imagination to work.

Raytheon's constant expansion during 1958 covers advanced activities in:

COMMUNICATIONS (Commercial and Military) — scatter, microwave relay, multiplex, mobile transistorized equipment.

COUNTERMEASURES—radar countermeasures equipment, advanced study projects.

RADAR (Pulse and CW Systems)—search, fire control, bombing, navigation, and guidance, air-traffic control, weather and marine, military and commercial.

MARINE EQUIPMENT—submarine, ship and airborne sonar, depth sounders, direction finders, radars.

GUIDED MISSILES—prime contracts:
Navy Sparrow III (air-to-air)
Army Hawk (ground-to-air)

MICROWAVE TUBES—"Amplitrons," magnetrons, klystrons, traveling wave tubes, storage tubes, backward wave devices.

SEMICONDUCTORS—devices, materials and techniques; silicon and germanium.

For interview at your convenience, please write to:
E. H. Herlin, Professional Personnel Section
P.O. Box 237, Brighton Station, Boston 35, Mass.

Excellence in Electronics



RAYTHEON MANUFACTURING COMPANY

NEW PRODUCTS

Pilot Lights

Neon



For voltages including 110 and 200 v ac, NE2H and NE51H neon lamps are over eight times as bright as their NE2 and NE51 counterparts. In many styles and lengths, they mount in 1/2 in. holes. They last 5000 hours.

Industrial Devices, Inc., Dept. ED, 982 River Rd., Edgewater, N.J.

CIRCLE 141 ON READER-SERVICE CARD

Rate Turntable

12 in. diameter

The T848 turntable is an accurate rate of test machine for calibrating and evaluating rate gyros. It is 12 in. in diameter and has an 8 in. diameter reading scale which expands in logarithmic fashion. Axis wobble is less than 20 sec of arc with full 100 lb loading.

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

CIRCLE 142 ON READER-SERVICE CARD

Galvanometer

Has built-in shunt



With instant varying sensitivity and critical damping, this galvanometer provides deflection and null measurements. It has a built-in 6-position shunt and a protective shorting switch. The curved scales are 0-150 mm and 75-0-75 mm.

Ealing Corp., Dept. ED, 40 University Rd., Cambridge 38, Mass.

CIRCLE 143 ON READER-SERVICE CARD

Pulse Generator

Has four prf ranges

The 2620 pulse generator has four continuously variable pulse repetition frequency ranges from 10 to 100,000 pulses per sec. It also has four pulse duration ranges continuously variable from 0.1 to 1000 μ sec. Rise time is 0.02 μ sec; decay time, 0.03 μ sec; output impedance, 93 ohms. Accuracy is $\pm 5\%$.

Simpson Electric Co., Dept. ED, 5200 W. Kinzie St., Chicago, Ill.

CIRCLE 144 ON READER-SERVICE CARD

AC Potentiometer

Linearity of 0.05%



Having a terminal linearity of 0.05%, the series 4 Vernistat's diameter measures 1.062 in. Units are available with maximum output impedances of 200, 100, and 40 ohms. Resolution is 0.01%. Weighing in at 2 oz, the unit can be produced in nonlinear versions.

Perkin-Elmer Corp., Dept. ED, Norwalk, Conn.

CIRCLE 145 ON READER-SERVICE CARD

Filament Transformers

Vacuum molded

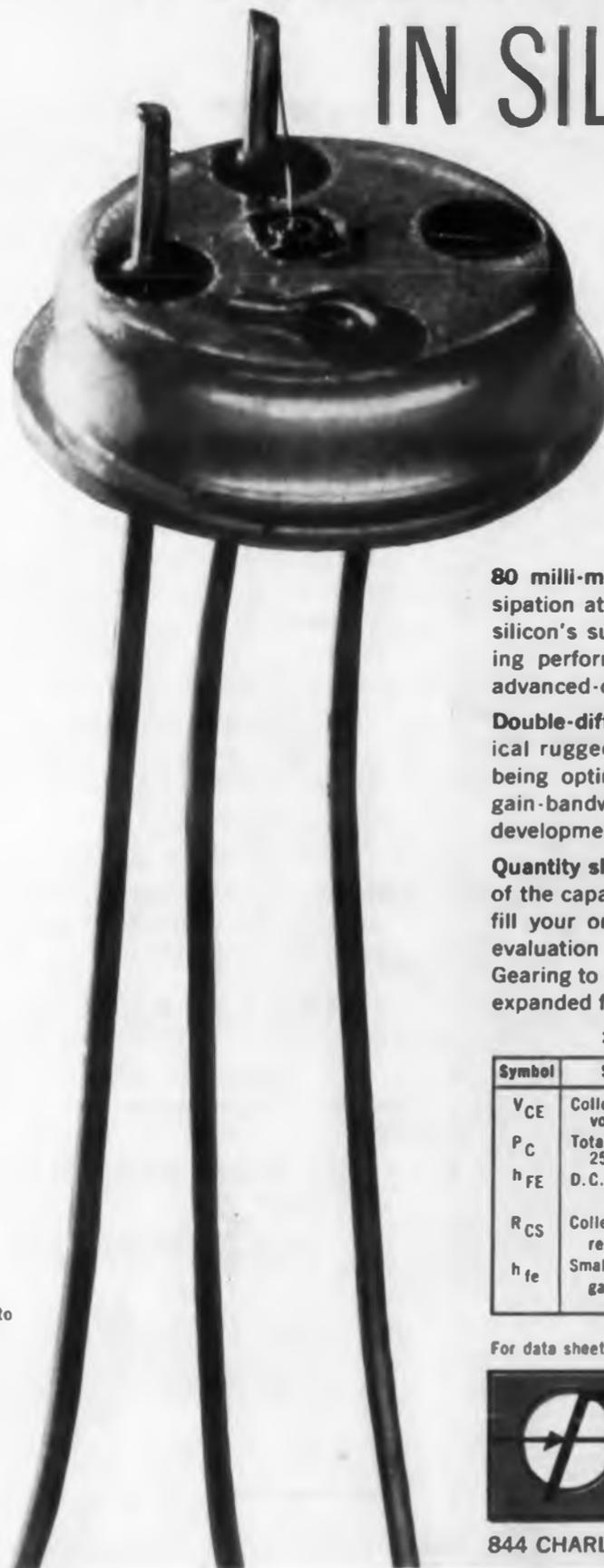
These 400 cps filament transformers are vacuum molded to MIL-T-27 Grade 5 specifications. Primary voltage is 105 or 115 v, 380 to 1000 cps. Secondary voltage is 6.3 v center tapped. Current ratings are 3, 5.5, 10 and 20 amp; sizes, 1-5/8 x 3/4 x 2 in. to 2-1/2 x 2-13/16 x 3 in.

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

CIRCLE 146 ON READER-SERVICE CARD

FROM FAIRCHILD

MESA TRANSISTORS IN SILICON



Greatly enlarged photo of Fairchild 2N696 before capping

80 milli-micro-second rise time with 2 watts power dissipation at 25° C. This speed and power is combined with silicon's superior high-temperature reliability. The switching performance that this affords has a place in every advanced-circuit evaluation program.

Double-diffused mesa-type construction provides mechanical ruggedness and excellent heat dissipation besides being optimum for high-frequency performance (typical gain-bandwidth product 80 Mc). This type is under intense development everywhere. Fairchild has it in production.

Quantity shipments now being made give conclusive proof of the capabilities of Fairchild's staff and facilities. We can fill your orders promptly. You can start immediately on evaluation and building of complete prototype equipment. Gearing to your future production needs, Fairchild will have expanded facilities to over 80,000 square feet by early '59.

2N696 and 2N697 — NPN SILICON TRANSISTORS

Symbol	Specification	Rating	Characteristics	Test Conditions
V _{CE}	Collector to Emitter voltage (25° C.)	40v		
P _C	Total dissipation at 25° C. Case temp.	2 watts		
h _{FE}	D. C. current gain		2N696—15 min. 2N697—30 min.	I _C =150ma V _{CE} =10v
R _{CS}	Collector saturation resistance		6 Ω typical 10 Ω max.	I _C =150ma I _B =15ma
h _{fe}	Small signal current gain at f=20Mc		4 typical	I _C =50ma V _{CE} =10v

For data sheets, write Dept. B-12



844 CHARLESTON RD. • PALO ALTO, CALIF. • DA 6-6695

CIRCLE 147 ON READER-SERVICE CARD



Engineered by Tinnerman...

NEW CAPACITOR SPEED CLIP® SNAPS IN, ELIMINATES RIVETING OR WELDING!

Speed up the assembly of capacitor clips to electronic equipment with this new Tinnerman SPEED CLIP. The "heel-and-toe" fastening feature permits the clip to slide into locking position in holes punched in metal, fiber or plastic as easily as your foot slides into a shoe. Once locked in place, the clip stays put, yet can be easily removed and reused over and over again. No riveting, welding or special tools required—no screws to start, no parts to loosen under vibration!

SPEED CLIPS can be provided in various sizes to hold capacitors and other cylindrical parts from 3/8" to 1 1/2" in diameter and to fit a wide range of panel thicknesses.

Samples and prices of these SPEED NUT brand fasteners are available from your Tinnerman sales engineer. If he isn't listed in your Yellow Pages, write to:

TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

TINNERMAN
Speed Nuts®

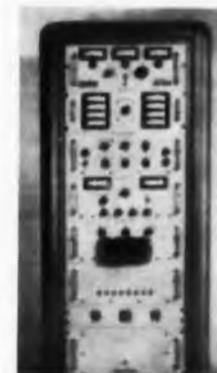


FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S. A., 2 rue Soliman de Rothschild, Suresnes (Seine). GERMANY: Mecano-Bundy GmbH, Heidelberg.

CIRCLE 148 ON READER-SERVICE CARD

NEW PRODUCTS



Decommutation Equipment

Handles pam and pwm coding

Made up of plug-in M-series modules, the telemetry decommutator and display handles up to 100 data channels. A 24 to 3600 pps sampling capacity makes the system compatible with standard IRIG pwm and pam rates and many nonstandard rates. The unit operates with high speed electronic multiplexers and plays tape recorded data back in faster than real time. It has an undecommutated, fully corrected output for digitizing, and a variety of corrected and separated analog voltage outputs. Long-term system accuracy is $\pm 0.5\%$.

Applied Science Corporation of Princeton
Dept. ED, P.O. Box 44, Princeton, N.J.

CIRCLE 149 ON READER-SERVICE CARD

Magnetic Shielding

Increases storage tube capacity

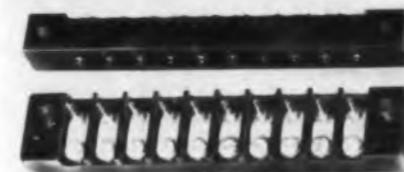
Metic Co-Netic dual laminae magnetic shielding improves resolution and capacity of data storage tubes. It is nonretentive and insensitive to shock. Effective indefinitely, it needs no periodic annealing.

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

CIRCLE 150 ON READER-SERVICE CARD

Terminal Block

Handles 15 amp



Rugged, 10-contact units, 200-19 terminal blocks can handle 15 amp and 10 kv rms at 5000 cps level. Each pin contact is common with individual buss plates and separated by molded barriers. Solder cups accept 14 awg wire.

DeJur-Amsco Corp., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N.Y.

CIRCLE 151 ON READER-SERVICE CARD

Resonant Reed Relays

Weigh 1.7 oz

Low cost electrochemical filters, these resonant reed relays can actuate sensitive relays, vacuum tubes, thyratrons, and transistors. They have 8 reeds with 280 to 500 cps spacing and weigh 1.7 oz. Operating power is 0.5 mw; maximum reed switch power, 0.5 w; and maximum contact voltage, 380 v dc. Respectively, models A and N have 6 K and 200 ohms dc resistance, 40 and 1.6 K ac resistance at 400 cps, and 5 and 0.8 v operating voltage. The units can be remote controlled.

Remote Control Mfg. Co., Dept. ED, 268 Marlborough Dr., Pontiac, Mich.

CIRCLE 152 ON READER-SERVICE CARD



Shaft Encoder

No ambiguity

For computer control of automatic machinery, Model 740 encoder translates analog shaft position to true binary digital information. It provides 10-bit resolution with a 3.5 in. disc that holds 1024 discrete position representations per turn. Special logic in the disc pattern eliminates ambiguity. The encoder is 4-3/16 in. in diameter and 1-1/4 in. thick. It has a life expectancy of over 1 million revolutions at 25 rpm input speed. Temperature range is -50 to +150 F.

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

CIRCLE 153 ON READER-SERVICE CARD

UHF Receiver

Covers 225 to 400 mc

Model 201 is a fixed frequency, superheterodyne receiver with a 225 to 400 mc range. It operates from a 10.5 v dc source. Sensitivity is 12 db signal to noise ratio, and attenuation of the intermediate frequency is 80 db. Spurious frequency response is 60 db below the desired signal.

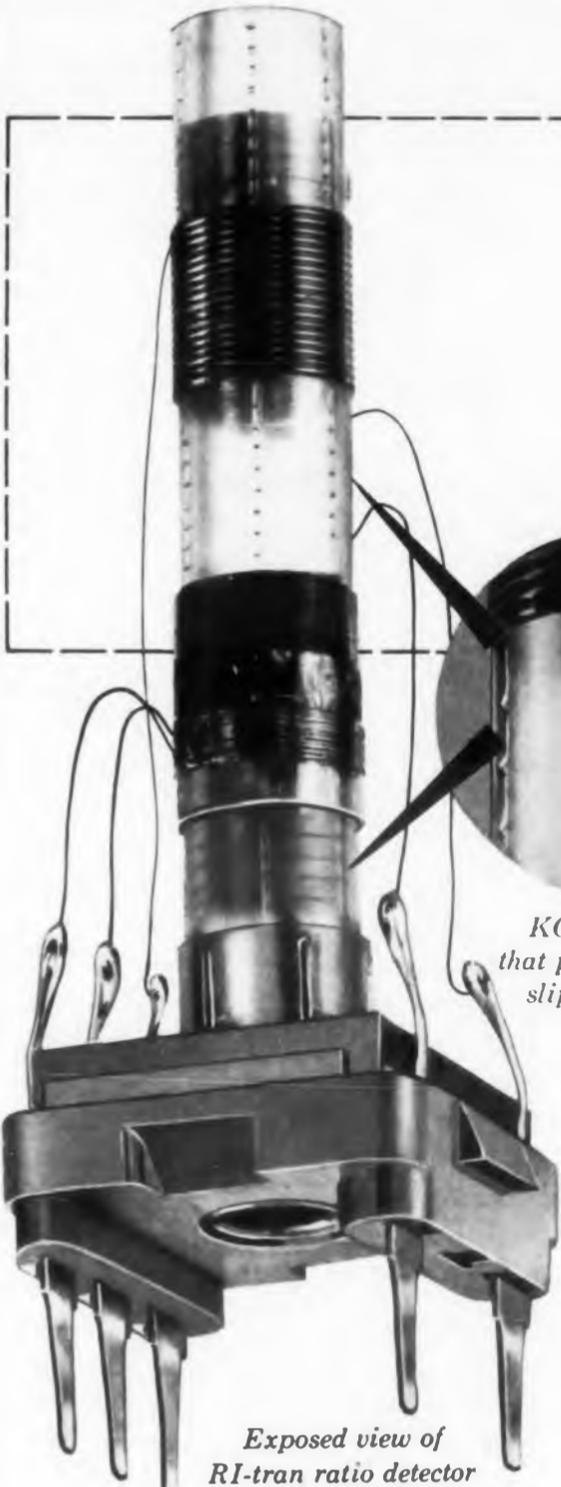
General Antronics Corp., Dept. ED, 9036 Culver Blvd., Culver City, Calif.

CIRCLE 154 ON READER-SERVICE CARD

RI·tran

I. F. TRANSFORMERS

for **FM** application



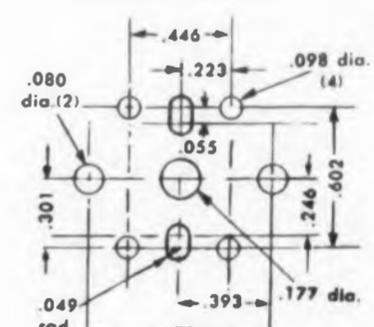
Exposed view of
RI-tran ratio detector
assembly



KOILOCK teeth
that prevent coil from
slipping on form

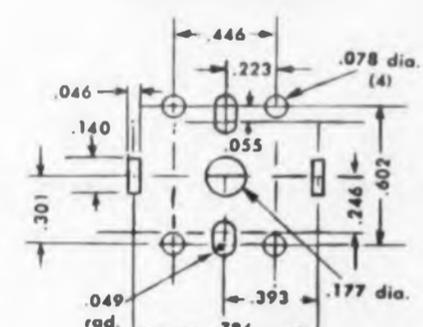


CHASSIS DETAIL





CHASSIS DETAIL



The many successful applications of RI-trans in discriminator, ratio detector, and other FM applications are further evidence of the electrical efficiency of the RI-tran design. Greatly simplified with low torque nylon coil forms, the RI design also makes mechanized production possible, resulting in top quality transformers at lower cost. All wiring attachments are made ABOVE the base, preventing lead breakage and break-downs from lug bending.

In addition to FM applications, millions of RI-trans are now in use in a variety of AM applications. RI-trans for transistorized circuits are available in 3/4", 1/2", and 3/8" sizes to cover ranges of unloaded "Q" from 45 to 200 with shunt capacities from 65 to 470.

Complete data, including core and lug details, suggested layouts, test and circuit diagrams as well as performance data, is shown in the RI Catalog.

write for your copy of Catalog no. 10

RADIO INDUSTRIES, INC.

also manufacturers of ceramic disc capacitors, feed-thrus, coils and selenium disc rectifiers

666 Garland Place • Des Plaines, Illinois

CIRCLE 155 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 10, 1958

77

NEW PRODUCTS

Power Supply

Low voltage

From an input of 105 to 125 v ac, single phase, 60 cps, the MTR28-30-2 power supply provides 24 to 32 v dc at 30 amp. The transistorized unit is short circuit proof and has $\pm 2\%$ regulation no load to full load. Ripple is 5 mv rms and dynamic impedance is 0.03 ohms from 0 to 20 kc.

Perkin Engineering Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

CIRCLE 156 ON READER-SERVICE CARD

Registration Buffer

Holds 1092 1 to 7 bit characters

Storing and interpreting data and instructions from digital computers, the M-10 registration buffer directs the printing format of the company's S-C 5000 high speed printer. It permits the S-C 5000 to print up to 5000 lines a minute. The unit stores up to 1092 1 to 7 bit characters and accepts 35,000 characters a second.

Stromberg-Carlson Co., Dept. ED, 1895 Hancock St., San Diego 12, Calif.

CIRCLE 157 ON READER-SERVICE CARD

DC Amplifiers

Weigh 7 oz



These dc amplifiers have adjustable voltage gains of 100 to 500. Linearity is $\pm 0.5\%$ based on a 5 v dc output value. The units are 2.5 x 1.19 x 1.19 in. and weigh 7 oz.

Networks Electronic Corp., Dept. ED, 14806 Oxnard St., Van Nuys, Calif.

CIRCLE 158 ON READER-SERVICE CARD



The G-E Power Tube Microwave Laboratory is located at Stanford Industrial Park, Palo Alto, California where it was one of the Park's pioneer installations. Its scientists and engineers have the advantage of technical exchange with the faculty and research staff of Stanford University, as well as extensive opportunities for graduate training. Constant technical liaison is also maintained with General Electric's own Research and General Engineering Laboratories, Schenectady, N. Y.

HIGH-POWER KLYSTRONS WITH WIDE TUNING ARE DESIGN GOALS OF GENERAL ELECTRIC

The Microwave Laboratory of the G-E Power Tube Department at Palo Alto, California, is placing major emphasis on the development of a line of advanced-design, high-power klystrons to meet the requirements of radar detection systems and missile guidance systems, as well as navigational equipment of the future.

The requirements for greater operating flexibility, longer life, and higher reliability are being satisfied through the development of klystrons with wider tuning ranges and higher tuning linearity sufficient to enable single-knob control. To achieve wide-range tuning, an exclusive cavity and tuner are employed, consisting of a ring-type tuning vane mechanically coupled to a high-precision single-knob tuning control. Multiple cavity designs and stagger tuning techniques in combination permit broadband operation. The single-knob control permits extremely rapid tuning, while the high tuning linearity permits precise resettability.

Klystron development is only one of a broad range of microwave activities being conducted at the General Electric Microwave Laboratory. Applied research, advanced development, and prototype design are conducted in all areas of microwave tubes and microwave techniques. Technical inquiries pertaining to advanced microwave tube development are invited. *Power Tube Department, General Electric Company, Schenectady, New York.*

* * *

Professional opportunities available for electron tube production, engineering, and scientific personnel. Inquiries are invited.

The extensive program of the General Electric Microwave Laboratory on advanced microwave components and techniques includes the following:

CW klystron amplifiers
Super-power klystrons
Voltage-tunable oscillators
High-power duplexers
Microwave filters

Pulse klystron power amplifiers
High-power pulsed TWT amplifiers
Medium-power CW TWT amplifiers
Low-noise, broadband TWT amplifiers
Frequency multiplier TWT amplifiers



RANGES AND HIGH LINEARITY MICROWAVE LABORATORY



▲ Typical of a family of high-power klystrons under development is this 1-KW CW power output tube (solenoid and cover removed) which tunes over a 1000 mc range at X-band, with 40 db gain. All tubes in this family are of rugged, metal-ceramic construction to meet performance standards of military specifications, and employ an extremely long-life, single-knob tuner. Other designs include high-power tubes for L, S and X bands.

◀ Controlled temperature processing of new materials contributes towards improvement in high-emission density cathodes for high-power beam tubes. L. to R., J. F. Kane, consulting engineer, with associates J. N. Lind, D. W. Latshaw and J. P. Fitzpatrick. In foreground, laboratory technician Paul A. Smith.

Binary Translator

For digital output devices

Binary translator DT-2 transfers parallel digital data from most standard electronic counters to various digital output devices. It automatically translates 1-2-2-4 or 1-2-4-8 code to 1-2-4-8 parallel binary.

Aeronca Mfg. Corp., Dept. ED, Hilltop and Frederick Rds., Baltimore 28, Md.

CIRCLE 159 ON READER-SERVICE CARD

Distortion Meter

Covers af spectrum

This distortion meter measures fundamentals from 30 cps to 15 kc, and harmonics to 45 kc. It provides full scale readings of 0.3, 0.1, 0.03, 0.01, and 0.003 v for measurements of low level audio voltages in determining noise and harmonic content.

Barker & Williamson, Inc., Dept. ED, Bristol, Pa.

CIRCLE 160 ON READER-SERVICE CARD

Mercury Battery Packs

Secondary voltage standards

Made from basic cells of 1.357 v $\pm 0.5\%$ these mercury battery packs can be supplied in any voltage to serve as secondary standards. Voltage declines 1% in two years of storage at 70 F.

The Mallory Battery Co., Dept. ED, 60 Elm St., North Tarrytown, N.Y.

CIRCLE 161 ON READER-SERVICE CARD

Program Timer

Handles 16 circuit functions

For missile, aircraft, and ground use, model 1000 program timer can handle 16 separate circuit functions. Its switch and linear and nonlinear potentiometer function strips are interchangeable. MIL-E-5272 designed, it has $\pm 0.5\%$ repeat and timing accuracy.

Hub-Pot, Inc., Dept. ED, 13827 Saticoy St., Van Nuys, Calif.

CIRCLE 162 ON READER-SERVICE CARD

◀ CIRCLE 163 ON READER-SERVICE CARD

Progress Is Our Most Important Product

GENERAL  **ELECTRIC**

9545-8481-16



LECTROFILM* -B CAPACITORS



For Computer Applications, General Electric Announces . . .

New Lectrofilm*-B Capacitors With a Design Life of 44,000 Hrs.

Over 3,000,000 unit-hours of life test data in accordance with G-E Specification MTC-3 indicate a probability of survival in excess of 0.99 for 44,000 hour life, under rated voltage at 85 C. At 125 C, indicated probability of survival is in excess of 0.98 . . . and low unit cost means the highest order of reliability per dollar invested.

LOW FAILURE RATE AND LONG LIFE of these inexpensive G-E capacitors result from using only the highest quality materials and the closest of process controls . . . units are precision wound with high-purity aluminum foil and capacitor-grade Mylar† film dielectric. No solder is used, and introduction of contaminants through impregnation is eliminated.

SMALL, LIGHTWEIGHT ENCLOSURE consists of tape wrapped around the compact roll and sealed with epoxy resin, forming a rugged case which resists humidity, vibration and shock.

TO MEET YOUR APPLICATION REQUIREMENTS, 14 case sizes are available in five ratings—100-, 200-, 300-, 400-, and 600-volt. Capacitance range within each rating is: 0.015 to 0.68 uf in 100 volts; 0.010 to 0.47 uf in 200 volts; 0.0047 to 0.22 uf in 300 volts; 0.0033 to 0.15 uf in 400 volts; and 0.0010 to 0.10 uf in 600 volts.

GET A QUOTATION TODAY ON NEW LECTROFILM-B CAPACITORS by contacting your General Electric representative. Ask for your copy of life-test data and G-E Specification MTC-3. Or, write to Section 117-5, General Electric Co., Schenectady, N. Y.

* Trade-mark of General Electric Co.
† Registered trade-mark of DuPont Co.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

NEW PRODUCTS

Power Supplies

Provide dc and ac outputs

Variable output, unregulated power supplies, the Nobaton RC series, provide both dc and ac. Available models, each with an ac output of 0 to 130 v, supply 0 to 36 and 0 to 150 v dc. Both the 36 and 150 v models come with maximum dc power ratings of 500 and 1000 w.

Sorensen & Co., Inc., Dept. ED, Richards Ave., South Norwalk, Conn.

CIRCLE 165 ON READER-SERVICE CARD

Test Set

Checks out magnetic tape equipment

Designed for the company's 752 magnetic tape recorder-reproducer, the Datatape 23-203 test set is also for general use. The mobile cabinet contains a volt-ohm milliammeter, audio oscillator, vtvm, oscilloscope, and voice amplifier.

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

CIRCLE 167 ON READER-SERVICE CARD

Signal Generator

±1 ppm stability

For automatic frequency control of doppler radar, missiles, and other frequency comparison circuits, this uhf signal source has ±1 ppm stability from 32 to 105 mc. Noise is -64 db; output frequency 450 to 460 mc; power output, 18 mw into 51.5 ohms.

The Hallicrafters Co., Dept. ED, 4401 W. Fifth Ave., Chicago, Ill.

CIRCLE 168 ON READER-SERVICE CARD

Panel Indicator

Integrally lighted

Filled with inert gas, type IN 9811-02 is a 1 in., integrally lighted indicator built to MIL-I-25950 and

CIRCLE 164 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 10, 1962

MIL-L-25467A specifications. Designed for remote indication of jet engine oil pressure, it can be adapted to any indicator function. Ambient range is -65 to +160 F. John Oster Mfg. Co., Avionic Div., Dept. ED, 1 Main St., Racine, Wis.

CIRCLE 169 ON READER-SERVICE CARD

Digital Displays

Plug-in type

These plug-in, in-line digital display units incorporate an Amphe-nol Blue Ribbon connector. They are easily changed without disturbing the internal wiring of the system where they are being used. The digits, 0 to 9, are 1 in. high and include a shifting decimal point.

Industrial Electronic Engineers Inc., Dept. ED, 3973 Lankershim Blvd., North Hollywood, Calif.

CIRCLE 170 ON READER-SERVICE CARD

Demodulator

Phase sensitive

The 10043 demodulator is designed for missile and aircraft instrumentation systems. It provides three phase sensitive demodulation channels and one ac rectification channel for reference signals. Inputs are 400 or 1200 cps; outputs, 0 to 5 or ± 2.5 v dc.

Hoover Electronics Co., Dept. ED, 110 W. Timonium Rd., Timonium, Md.

CIRCLE 171 ON READER-SERVICE CARD

Power Supplies

Portable

ToroPak P14-65 portable power supply can provide 110 v 60 cps single phase power to 200 w for eight hours. It can also provide 12 v dc for an extended period. It can then be recharged with ac or dc current in several hours.

Francis Bros., Dept. ED, 446 C Street, Justin, Calif.

CIRCLE 172 ON READER-SERVICE CARD

CIRCLE 173 ON READER-SERVICE CARD



Barden Precision SFRI-5 miniature bearings as used in a computer gear train.

Specify **BARDEN** Precision miniature ball bearings



Precision-built computer gear trains must have uniformly low torque and minimum backlash; mounting surfaces for the bearings should be simple to manufacture.

Barden Precision miniature-size bearings have the required low torque. Their low eccentricity and closely controlled radial play assure minimum backlash. Precision flanges provide accurate positioning surfaces and permit through-boring, eliminating the need for housing shoulders.

Barden Precision miniature bearings are built to the same high standards of consistent quality as Barden's larger instrument sizes.

Barden Precision means not only dimensional accuracy but performance to match the demands of the application.

Your product needs *Barden Precision* if it has critical requirements for accuracy, torque, vibration, temperature, or high speed. For less difficult applications, the *predictable* performance of *Barden Precision* bearings can cut your rejection rates and teardown costs.

Write today for your copy of Catalog Supplement M1 which gives dimensions, performance and engineering data on *Barden Precision* ball bearings $\frac{5}{8}$ " O.D. and smaller.

THE **BARDEN** CORPORATION

47 E. Franklin St., Danbury, Connecticut • Western office: 3850 Wilshire Blvd., Los Angeles 5, California

SPECIFY **BARDEN** PRECISION BALL BEARINGS FOR: INSTRUMENTS • AIRCRAFT ACCESSORIES • COMPUTERS AND RECORDERS • MACHINE TOOL AND TEXTILE SPINDLES • OTHER PRECISION APPLICATIONS

NEW PRODUCTS

Servo Control

Corrects nonlinear outputs

Linearizer model 110 is an electronic servo-mechanism which corrects the output data of a nonlinear instrument. The output it produces is directly proportional to the input of the nonlinear instrument. Eliminating the need to replot nonlinear data for final interpretations, the unit saves a lot of time in processing families of curves or integrating under a data curve. The linearizing is continuous and automatic once a correction template is inserted and a few adjustments are made. The nonlinear output is fed into the linearizer, and the corrected data output can be fed into a recorder amplifier or any other readout device. The instrument acts on input voltages up to 100 v and has a frequency response from dc to 2000 cps.

Custom Engineering and Development Co., Dept. ED, 1429 S. Ewing Ave., St. Louis 4, Mo.

CIRCLE 174 ON READER-SERVICE CARD

Transponder Test Set

For L-band units



This tester checks out L-band airborne transponders built to ARINC characteristics 532B and ANDB (AMB) 2.3 NAIB. Frequency range is 950 to 1220 mc; repetition rate, 15 to 2000; pulse spacing, 1 to 30 μ sec.

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

CIRCLE 175 ON READER-SERVICE CARD

Static Inverter

± 1 cps frequency regulation

For converting dc to ac, model W-1347 static inverter has an output frequency of 400 ± 1 cps. Output voltage is $115 \text{ v} \pm 2\%$. The 3-phase, 100 va unit is designed to meet MIL-E-5272A specifications.

Electrosolids Corp., Dept. ED, 13745 Saticoy St., Panorama City, Calif.

CIRCLE 176 ON READER-SERVICE CARD



NEW PROOF OF SAME RUGGED IN BOTH NON-MILITARY AND

New environmental lab provides rigid in-plant testing of all Westinghouse electronic transformers

Westinghouse Specialty Transformer Department has established a new qualification testing laboratory in the Greenville, Pennsylvania, plant. It is fully equipped for in-plant environmental testing—humidity, altitude and temperature cycling—as well as shock and vibration testing.

Specifically designed for testing the complete line of Westinghouse MIL-T-27A electronic transformers, these facilities are also available for all other Westinghouse electronic transformers—whether for MIL-specs or non-military applications. Here is extra assurance that you get the same rugged dependability in all Westinghouse electronic transformers—regardless of use.

The test lab permits in-plant testing of all types of electronic transformers—hermetically sealed to open type—according to MIL-T-27A and MIL-T-9219 specifications for Grades 1 through 6. These units include the Westinghouse hermetically sealed MIL-T-27A transformers, Grades 1 and 4, and the Westmold, West-seal and molded case transformers, MIL-T-27A, Grades 2 through 6, or MIL-T-9219.

Located at the point of manufacture, this laboratory now means single responsibility by Westinghouse for design, manufacture and testing of the MIL-specs transformers—and non-military transformers—with less delays and faster delivery.

Call your Westinghouse representative for the full story of how in-plant testing in this new laboratory can aid *your* production. Ask, too, about the Westinghouse MIL-T-27A electronic transformers. J-70897

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

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS

ED DEPENDABILITY ND MIL-SPECS TRANSFORMERS

types of
to open
9 speci-
include
-T-27A
d, West-
Grades

laboratory
house for
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J-70891

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V. MCHANE

10, 1958



Westinghouse electronic transformers being shock-tested according to specifications of MIL-T-27A with new in-plant qualification testing equipment.

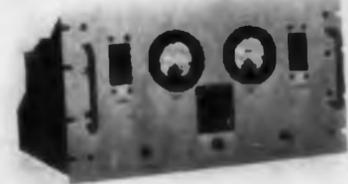
P. K. Goethe, Specialty Transformer Engineering Manager at the Greenville plant, observes shake-down run of vibration test equipment in new laboratory.

Particularly designed for power applications involving 60-400 cycles, the Westinghouse hermetically sealed MIL-T-27A transformers are available in the complete line of standard MIL-T-27A case sizes.

CIRCLE 177 ON READER-SERVICE CARD

DC Power Supply

Delivers 28 v at 10 amp



Transistorized power supply M-1137 provide 24 to 32 v dc at 10 amp. Regulation is $\pm 1\%$ no load to full load; ripple is 5 mv rms; and output impedance is 0.05 ohms. The unit operates from 105 to 125 v ac, single phase, 60 cps.

Perkin Engineering Corp., Dept. ED, 341 Kansas St., El Segundo, Calif.

CIRCLE 178 ON READER-SERVICE CARD

Bandpass Filters

For 12 frequencies

These filters consist of a model A49 3-stage amplifier, Twin-T networks, and a model F508-I switching chassis. The amplifier has a voltage gain adjustable to 60 db and a 500 K input impedance. The output voltage is 3 v across 10 K. The switching chassis has a panel switch that selects any one of 12 filter frequencies.

T T Electronics, Inc., Dept. ED, P.O. Box 180 Culver City, Calif.

CIRCLE 179 ON READER-SERVICE CARD

Coaxial Switch

For 6 1/8 in. transmission lines



Type 1038 coaxial switch has a 0 to 450 mc frequency range and a vswr under 1.05. It is designed for 6-1/8 in. coaxial transmission lines and has about the same cw power rating as they do. It comes in motor and manually operated models.

Alford Mfg. Co., Dept. ED, 299 Atlantic Ave. Boston 10, Mass.

CIRCLE 180 ON READER-SERVICE CARD



GUARANTEED TO WITHSTAND 1,000 VOLTS!

GVB-finished tape wound core boxes drop your production costs

We have developed a radical new finish for aluminum boxes for tape wound cores. Your production department will glow with delight, for we guarantee this finish to withstand 1,000 volts (at 60 cycles) without taping!

GVB, for Guaranteed Voltage Breakdown (limits), is what we call this new finish. It is perfectly matched to our aluminum core boxes, for it will withstand temperatures from -70°F to 450°F . Potting techniques need not change, for GVB-finish lives happily with standard potting compounds.

By eliminating the need for taping the core box, you also eliminate a time consuming production step. By combining GVB-finish with our aluminum core box, we assure you a core capable of being vacuum impregnated down to 20 mm. of mercury.

And they are Performance-Guaranteed! Like all tape wound cores from Magnetics, Inc., aluminum-boxed or phenolic-boxed, you buy them with performance guaranteed to

published limits. The maximum and minimum limits are for B_m , B_r/B_m , H_l and gain. This data is published for one, two, four and six mil Orthonol® and Hy Mu 80 tape cores.

GVB-finished cores are ready for you now. So are the published limits for all Magnetics, Inc. tape wound cores. Write today for more GVB details, and for your copy of the guaranteed performance limits: Dept. ED-51 Magnetics, Inc., Butler, Pennsylvania.

MAGNETICS inc.

CIRCLE 181 ON READER-SERVICE CARD

NEW PRODUCTS

Temperature Test Chamber

± 2 F accuracy

Portable temperature test chamber model 6545 W cools to -100 F in 6 minutes, and heats to 500 F in 30 minutes. Over the whole range it keeps within ± 2 F of the desired temperature. Test capacity is $16 \times 7 \times 7$ in.; outside dimensions are $24 \times 10 \times 14.5$ in.

Delta Design Engineers, Inc., Dept. ED, 3090 Adams Ave., San Diego 16, Calif.

CIRCLE 182 ON READER-SERVICE CARD

Digital Torque Indicator

For direct hp measurements



The DTI-2 digital torque indicator supplies an output proportional to horsepower. It is equipped with a slidewire which, when excited by the output of a tachometer generator, will supply a strip chart recorder with direct horsepower readings. For 115 v, 60 cps ac operation, the indicator has an accuracy of $\pm 0.15\%$. A constant voltage supply within the unit prevents it from responding to line transients.

Performance Measurements Co., Dept. ED, 15301 W. McNichols, Detroit 35, Mich.

CIRCLE 183 ON READER-SERVICE CARD



Power Amplifier Tube

Dissipates 1500 w

A forced-air cooled, uhf beam power tube, the 7213 can be used as a linear or class C rf power amplifier. Its maximum plate dissipation rating is 1500 w. The unit will operate with full ratings up through the 960 to 1215 mc band.

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

CIRCLE 470 ON READER-SERVICE CARD

Dustproof Relays

6 mw sensitivity

Dust protected, series 23D spdt relays have sensitivities down to 6 mw with 2.25 w maximum coil dissipation. The adjustable contacts can carry 2 amp, 115 v ac or 28 v dc. Coils may be wound up to 13 K for ac or dc operation. Mounting is 8 pin octal plug-in. The unit is 1-3/8 in. sq and 2-1/16 in. high.

Kurman Electric Co., Dept. ED, 191 Newel St., Brooklyn 22, N.Y.

CIRCLE 184 ON READER-SERVICE CARD

Digital Ohmmeter

Low cost



Providing continuous automatic measurements, the low cost model 781 digital ohmmeter was designed mainly for receiving inspection and production checking of resistors. It measures resistance from 0.1 ohm to 10 meg in five ranges. Accuracy is 0.05% of reading plus one digit. Maximum voltage across the test resistor at balance is 6.3 v at the top of each range and zero volts at zero resistance. Average balancing time is 1 sec.

Non-Linear Systems, Inc., Dept. ED, Del Mar, Calif.

CIRCLE 185 ON READER-SERVICE CARD

Miniature Power Transformer

Toroidal

Encapsulated and hermetically sealed, series 335 1-w toroidal power transformer passes MIL-E-5272 and MIL-T-27A tests. OD is 1 1/16 in.; height, 15/32 in.; and weights, 0.5 oz. Temperature range is -55 to +100 C. Primary voltage 115 v, 400 cps and secondary voltage is 1 to 100 v, 400 cps. The unit is designed for printed circuit boards or stacking on a single screw for chassis mounting.

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

CIRCLE 186 ON READER-SERVICE CARD

Nickelonic News

DEVELOPMENTS IN NICKEL AND NICKEL ALLOYS AND THEIR APPLICATIONS



"A" Nickel laminations produce high-frequency vibrations in these cleaning and rinsing pots of the "Watchmaster" unit, developed by American Time Products, Inc.

High magnetostrictive effect of Nickel proves useful in new ultrasonic cleaners

NEW YORK, N. Y.: The large magnetostrictive effect of Nickel makes possible the development of ultrasonic cleaners with a great range of usefulness. In radioisotope laboratories and other atomic energy installations, for example, these cleaners remove radioactive particles from equipment. In hospitals, they clean surgical instruments.

One ultrasonic cleaner, developed by American Time Products for cleaning watches, can also be used to clean tiny component parts in electronic equipment.

ATP's chief engineer writes: "Electronic-Grade 'A' Nickel enables us to produce a simple, economical transducer for converting electrical energy into high-frequency vibrations. The Nickel withstands high heats, mechanical abuse and corrosive solutions, providing a long, stable life."

Pertinent Literature: Write for "Design of Nickel Magnetostriction Transducers".

(108)

Three Inco Nickel Alloys help push life of magnetron to 6,000 hours

HARRISON, N. J.: Commercial airlines need reliability and long life in components for weather radar equipment. Especially in high power tubes. And they've been getting it with the type 6521 magnetron made by the Electron Tube Division of the Radio Corporation of America. Tube 6521 delivers a peak power output of 85 kilowatts and has a normal operating life of 6,000 hours.

RCA designers give much credit for the tube's long life to outstanding properties of Inco Nickel Alloys:

Monel "403"* low-permeability nickel-copper alloy, used for the cathode sup-

port, provides high strength, corrosion resistance and low magnetic permeability certified not to exceed 1.1 in a field of 0.5 oersted. Monel "403" alloy has the dimensional stability needed to maintain the cathode centered in the anode over many heating cycles. It also offers easy machining and retains its non-magnetic characteristics after cold-working and forming so that high-strength parts can be assembled without annealing.

Monel* nickel-copper alloy, used for the output flange and the mounting plate, provides the strength, toughness and corrosion resistance required to help push the magnetron's life into the 6,000 hour class.

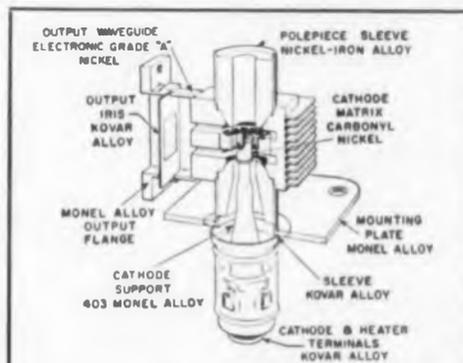
Electronic-Grade "A"* Nickel, used for the cathode foundation, supports the electron-emitting carbonyl nickel cathode matrix. The "A" Nickel provides essential strength to prevent distortion and purity to prevent contamination of the vacuum and the cathode matrix at high temperatures.

Two other Nickel-containing materials are also used to assure tube reliability and long life: Kovar** nickel-cobalt-iron alloy, a glass sealing material, for the output iris, cathode sleeve and heater terminals; a magnetic nickel-iron alloy for the polepiece sleeve.

Pertinent Literature: Write for "Basic Data - Monel "403" Low-Permeability Nickel-Copper Alloy" and Bulletins T-5 and T-15.

(109)

*Trademark, The International Nickel Company, Inc.
**T.M. of Westinghouse Electric Corp.



Cut away shows where Inco Nickel Alloys buttress construction of RCA magnetron.



Forecast of Nickel availability spurs design of tubes with Inco Nickel Alloy parts

WALTHAM, MASS.: Notice that the production of Nickel exceeds all anticipated demands for future years is a big reason why designers at Raytheon Manufacturing Company make many klystron parts of Electronic-Grade "A" Nickel. For example, the two Raytheon tubes at right, designed for operation at 8500-9660 megacycles, have twenty-one "A" Nickel parts.

Plenty of "A" Nickel right from warehouse stocks in a wide range of

mill forms permits Raytheon designers to take advantage of this material's excellent vacuum and mechanical properties . . . and gain the benefits of simplified production and processing as well.

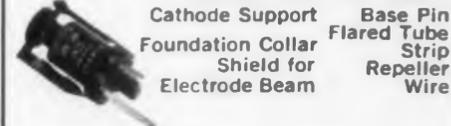
Electronic-Grade "A" Nickel, and other Inco Nickel Alloys, are supplied as wire, rod, strip, tubing, ribbon, clad-copper wire, bimetallic strip and wire, wire cloth, knitted mesh and a variety of other forms.

Thirteen 2K45 Klystron Components made of Electronic-Grade "A" Nickel



Cathode Support Wire (formed)
Cathode Collar Clip
Pin Repeller
Eyelet Washer
Wire (cut) Flared Tube
Wire (bent)

Eight 2K25 Klystron Components made of Electronic-Grade "A" Nickel



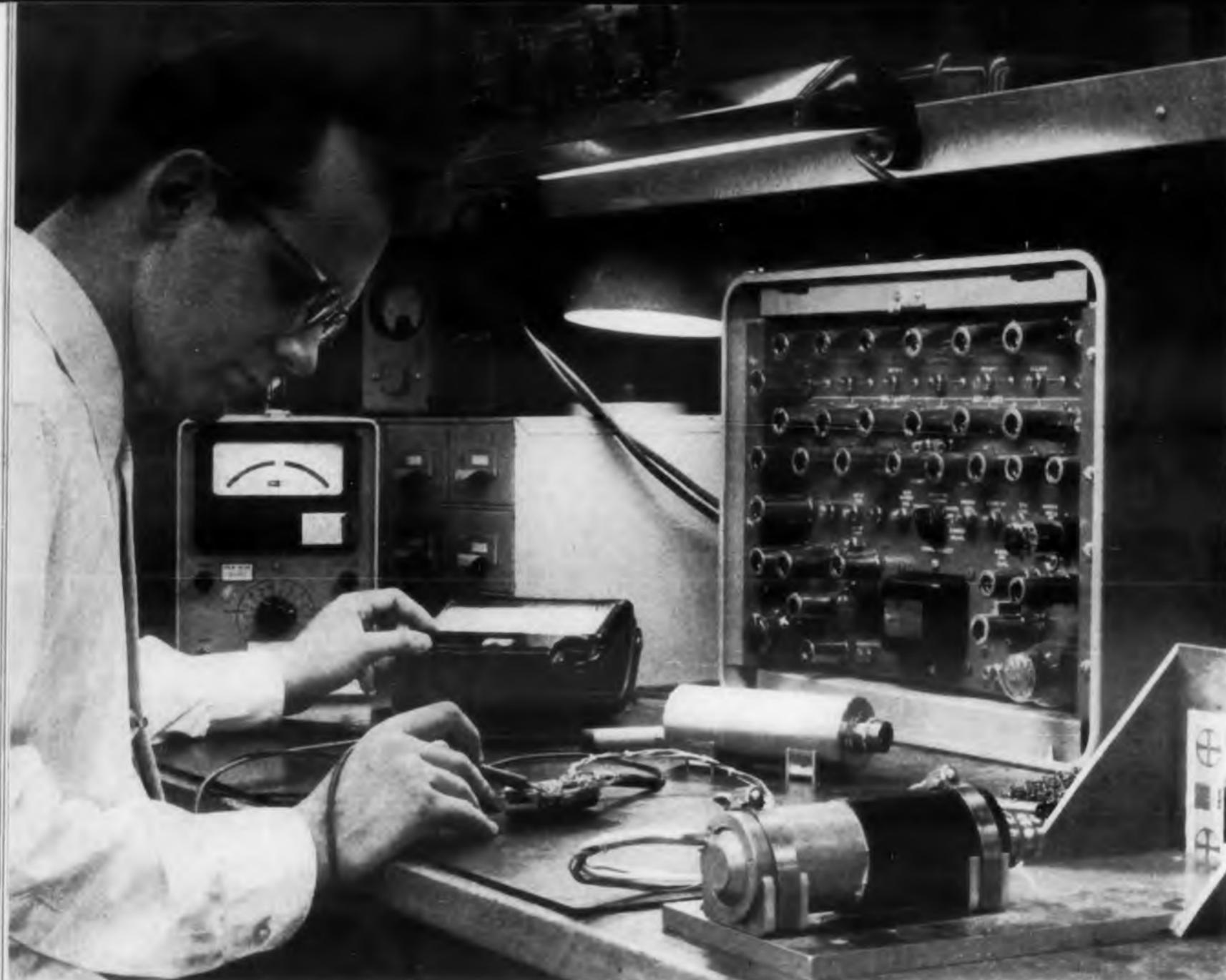
Cathode Support Base Pin
Foundation Collar Flared Tube
Shield for Strip
Electrode Beam Repeller
Wire



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



CIRCLE 108 OR 109 ON READER-SERVICE CARD



A MISSILE AND TELEVISION INDUSTRY FIRST. Lockheed-developed, miniaturized TV cameras, designed for both government and commercial use. Only 6 inches long and 2 1/4 inches in diameter, tiny cameras extend man's vision into the unexplored. Unmanned lunar probes to the far side of the moon; lunar landings; monitoring interiors of manned spacecraft and remote TV coverage of on-the-spot happenings on a scope never before possible are some of the uses foreseen for the cameras.

ELECTRONIC ENGINEERS AND SCIENTISTS

Lockheed Missile Systems Division is systems manager for such major, long-range programs as the Navy Polaris IRBM, Earth Satellite, Army Kingfisher, Air Force X-7 and Q-5 ramjet vehicles, and other important research and development programs.

Responsible positions for high-level, experienced personnel are available in research and development, in our project organizations, and in manufacturing.

Particular areas of interest include microwave, telemetry, radar, guidance, solid state, reliability, data processing, instrumentation, servomechanisms, flight controls, circuit design and systems analysis, test, infrared, and optics.

If you hold a degree and are experienced in one of the above fields, we invite your inquiry. Please write to Research and Development Staff, Dept. 2112, 962 W. El Camino Real, Sunnyvale, California.

Lockheed

MISSILE SYSTEMS DIVISION

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO

NEW PRODUCTS

Pressure Standard
0.05% accuracy



Portable type Q3401 secondary standard has plug-in units for gage differential, and absolute pressures and is suited for calibration or direct parameter measurement. Accuracy is 0.05% for ranges up to 2500 psig, psid, or psia.

Wiancko Engineering Co., Dept. ED, 255 N. Halstead Ave., Pasadena, Calif.

CIRCLE 188 ON READER-SERVICE CARD

Oscillogram Scanner

Speeds to 100 ft per min

The S-10 oscillogram scanner has a 66 in. illuminated surface across which strips of 1000 ft may be tracked. Record speed may be adjusted to a max. of 100 ft per min.

The Gerber Scientific Instrument Co., Dept. ED, 89 Spruce St., Hartford, Conn.

CIRCLE 189 ON READER-SERVICE CARD

Microwave Filter

For 2 to 4 kmc range



This coaxial filter covers the 2 to 4 kmc range. Its single micrometer knob is set to reject any frequencies in this range to the extent of about 30 db with less than 1 db loss at nonresonant frequencies.

Radar Design Corp., Dept. ED, Pickard Dr., Syracuse 11, N.Y.

CIRCLE 190 ON READER-SERVICE CARD

CIRCLE 557 ON READER SERVICE CARD

Voltage Calibrator

±1% accuracy



Voltage calibrator model 600 has two ranges, 0 to 5 and 0 to 50 v dc, with available current up to 5 ma. Each is divided into 10 steps with ±1% accuracy of adjustment. Input is 115 v ac, 60 cps.

Mid-Eastern Electronics, Inc., Dept. ED, 32C Commerce St., Springfield, N.J.

CIRCLE 191 ON READER-SERVICE CARD

Delay Lines

0.05 to 1 μsec delays

In varied standard cases, these distributed parameter delay lines have delays from 0.05 to 1 μsec per 6 in. length. Impedances are 330 to 700 ohms, and rise times are 0.02 to 0.21. Standard tolerance is ±5%.

Technitrol Engineering Co., Dept. ED, 1952 Allegheny Ave., Philadelphia 34, Pa.

CIRCLE 192 ON READER-SERVICE CARD

Electronic Counter

Bidirectional



With a single zero, this decimal electronic counter indicates true positive and negative numbers. Counting to ±99999, it operates at rates up to 50 kc. Available with a buffer storage unit, the counter receives its input from a photoelectric shaft to pulse converter which generates 10 counts per shaft revolution.

Benson-Lehner Corp., Dept. ED, 11930 Olympic Blvd., Los Angeles, Calif.

CIRCLE 193 ON READER-SERVICE CARD

3-D



RADAR



ON



WHEELS



How to CONCEIVE a radically improved radar scanning technique. How to integrate this technique into a superior data handling system. How to make the complete scanning and data handling system mobile.

These were the problems faced by engineers at the Hughes Ground Systems Division in Fullerton, California. Utilizing a completely new engineering concept, these engineers developed a radar scanning system which positions beams in space by electronic rather than mechanical means...thereby providing three-dimensional radar protection.

They developed high-speed data processors which monitor the action of hundreds

of aircraft and store the shifting tactical situations for high-speed assignment of defense weapons. They produced compact electronic display systems which present the tactical information in symbolic and language form.

And then they made this complete radar and data handling system mobile. The radar scanning antennas (shown above) can be converted for travel on the road in minutes. The complete data processing and radar scanning systems, with all of their wide capabilities, have been engineered to occupy only a few standard size army van trucks.

The research, development and production of this advanced system is typical of

the creative engineering now underway at Hughes in Fullerton. If creative engineering is your forte, you will find abundant aesthetic and monetary reward at Hughes. To investigate write to Mr. L. N. Wike at the address below.

HUGHES

GROUND SYSTEMS
Personnel Selection and Placement
Hughes Aircraft Company
Fullerton, Orange County, California



MICRO SWITCH Precision Switches



Precision switches for every design requirement ... plus nationwide topflight engineering service

The very variety of shapes and sizes, actuators and mountings of the sixty or so switches illustrated here may suggest an answer to a switching problem. And these switches suggest the scope of the MICRO SWITCH precision switch line, numbering thousands of switches with mechanical and electrical characteristics to meet nearly any need.

Control of quality is as complete as the line itself. Successful development of precise, reliable switching components has made MICRO SWITCH the leader in the industry.

And, to complete the picture of MICRO SWITCH

as your best first source for precision switches, the competent counsel of MICRO SWITCH field engineers in branch offices across the country is available to help you save time in switch selection.

You are invited to call the branch office near you for information about any of the switches shown, or for help on a specific problem. Consult the Yellow Pages.

MICRO SWITCH... FREEPORT, ILLINOIS

A division of Honeywell

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



Honeywell

MICRO SWITCH PRECISION SWITCHES

CIRCLE 195 ON READER-SERVICE CARD

NEW PRODUCTS

Key Switches

Locking and nonlocking



Small, lever action switches, series 12000 have silver contacts rated at 3 amp, noninductive load. In 2 and 3 position types, they are locking and nonlocking. A 3 position model locks on one side only.

Switchcraft, Inc., Dept. ED, 5555 N. Elm Ave., Chicago 30, Ill.

CIRCLE 196 ON READER-SERVICE CARD

Power Supply

Two ranges

Tubeless magnetic power supply KM-255 has two ranges: 60 to 120 v, 0 to 2 amp, and 120 to 180 v, 0 to 1.4 amp. Regulation is $\pm 1\%$; ripple 0.03%.

Kepeco Labs, Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 197 ON READER-SERVICE CARD

Preset Counter

Five decade



Made of printed circuit plug-in modules, the 7250C five decade preset counter operates to 100 kc. It will recycle at rates to 5 kc without missed counts. The unit features pulse and variable duration or locking relay contact output and gated input.

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

CIRCLE 198 ON READER-SERVICE CARD

Converter Toroids

For dc to ac and dc to dc

Used with transistors, these toroids convert dc voltage to higher potential ac or rectified dc. The ac output can serve as a source of 60 cps, 400 cps, or any design frequency. The dc output can supply B+, B-, or bias voltage for vacuum tubes, transistors, and like devices. The units cover 6, 12, or 28 v dc source power, and provide 10, 50, 100, or 200 w at 250 v dc.

Magnetico, Inc., Dept. ED, 6 Richter Court, East Northport, N.Y.

CIRCLE 199 ON READER-SERVICE CARD

Connectors

Weatherproof



Weatherproof LR and MR connectors have clear and black anodic coating to resist corrosion and rubber glands and gland nuts to seal out moisture. Chain-attached caps seal unmated units. Coupling threads and sizes are standard to MIL-C-5015.

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

CIRCLE 200 ON READER-SERVICE CARD

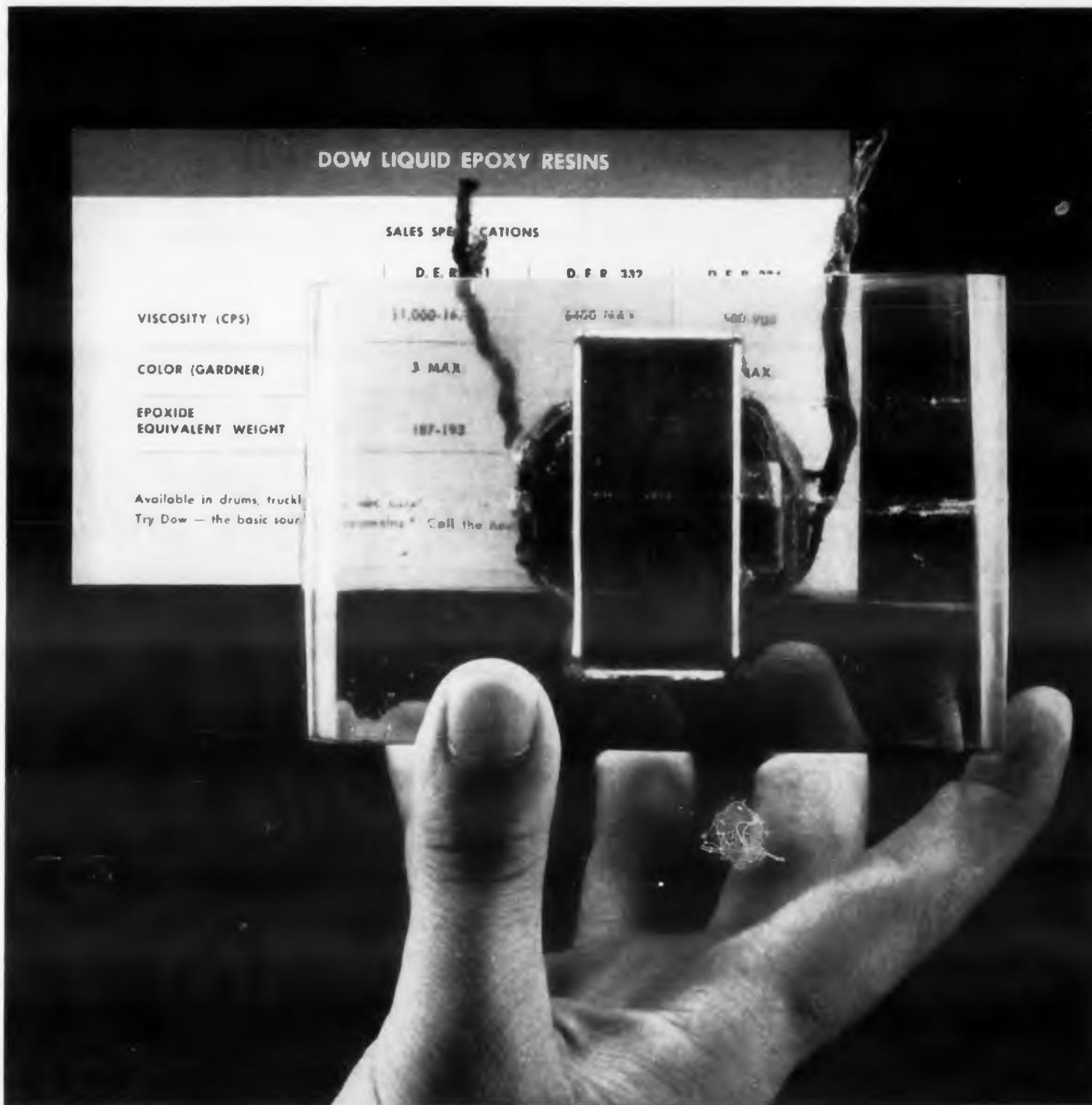
Infrared Detectors

6 to 9 micron wavelength cutoffs

These three detectors provide high sensitivities to the far infrared. The n and p type gold-doped germanium units are photoconductors with 1 meg impedance levels and respective wavelength cutoffs of 6 and 9 microns. Respective time constants are 30 and 0.1 μ sec. The indium antimonide unit is a low impedance, low noise photovoltaic detector with a 6 micron wavelength cutoff and a 2 μ sec time constant.

Phillips Corp., Dept. ED, 4700 Wissahickon Ave., Philadelphia, Pa.

CIRCLE 201 ON READER-SERVICE CARD



This hand-poured casting was not evacuated to remove bubbles.

See for yourself the clarity of new Dow Epoxy!

This unretouched photo demonstrates how easy it is to see through several inches of Dow Epoxy Resin 332—and thus how easy it is to visually inspect parts which are encapsulated in D. E. R. 332.

But a perfect inspection "window" is not the only advantage you get when you use D. E. R. 332 for encapsulation. Compared to ordinary epoxies, the high purity of D. E. R. 332 makes possible more uniformity, lower viscosity, longer pot life and greater heat resistance. Of special interest also for electrical applications, D. E. R. 332 and D. E. R. 331 are very low in total and hydrolyzable chlorides.

D. E. R. 331 is a standard unmodified resin designed for customary applications and D. E. R. 334 is a modified low-viscosity resin especially suited for laminating.

All three of these Dow Liquid Epoxy Resins are available for prompt delivery to you in drums, truck or tank car lots. For complete information on Dow liquid and solid epoxies and epoxy novolaks, call your nearest Dow sales office. Or write THE DOW CHEMICAL COMPANY, Midland, Michigan. Coatings Sales Dept. 2262P-3.

YOU CAN DEPEND ON



CIRCLE 202 ON READER-SERVICE CARD

Now . . . Ratings > 120 kw
for rectifiers made with
DU PONT SILICON

compact units can eliminate need for dc lines

A wide range of rectifiers made with Du Pont Hyperpure Silicon—with ratings from a few microwatts to > 120 kw per cell—are now available. Manufacturers cite efficiencies up to 99% in units operated at 60 cps, operation at temperatures from -65° to 175°C., rectification ratios as high as 10 million with negligible reverse conductance, and the elimination of special dc lines when these compact rectifiers are used in bridges.

Du Pont, pioneer and first commercial producer of silicon, supplies manufacturers of rectifiers, diodes and transistors with several grades of Hyperpure Silicon. (Du Pont does not produce devices.)

Write today for our free booklet containing full data on Du Pont Silicon: E. I. du Pont de Nemours & Co. (Inc.), 2420 Nemours Bldg., Pigments Department, Wilmington 98, Delaware.



HYPERPURE SILICON

Better Things for Better Living
 . . . through Chemistry

CIRCLE 203 ON READER-SERVICE CARD

NEW PRODUCTS

Tube Tester

3000 to 60,000 μ mho range

Tube tester 1700 can be used to evaluate the G_m of electron tubes according to Army-Navy specifications, or to study tube behavior. Its G_m meter has eight overlapping ranges that cover 3000 to 60,000 μ mhos with 3% accuracy. In addition, the unit has eight 1% meters for other parameters.

The Hickok Electrical Instrument Co., Dept. ED, 10514 Dupont Ave., Cleveland 8, Ohio.

CIRCLE 204 ON READER-SERVICE CARD



**Wattmeter-
Var Adapter**
 Universal

For 60 cps measurements, model 100 wattmeter-var adapter may be used with all dynamometer wattmeters. It permits them to function as var-meters and power factor meters and improves their over-all accuracy. This adapter indicates the nature of the load with regard to leading or lagging power factor, and the amount of reactive volt-ampere compensation for unity power factor systems.

Vars Co., Dept. ED, P.O. Box 272, Park Ridge, Ill.

CIRCLE 205 ON READER-SERVICE CARD

Coupling

Supplies oxygen and electrical contacts

Series 1000 coupling supplies oxygen, electrical heating, and communications through one unit. Designed for pilot breathing apparatus and survival kits, the unit is adaptable for ground handling and test equipment. When the coupling is connected, the seal engages before electrical contact is made and vice versa. This makes the unit suitable for use with inert and inflammable gases.

Perfecting Service Co., Dept. ED, 332 Atand Ave., Charlotte 6, N.C.

CIRCLE 206 ON READER-SERVICE CARD

Servo Amplifier

For panel mounting



Panel mounted, type T861 servo amplifier is a self-contained module for driving turntable servo motors or motor generators. It has a provision for tachometer damping. The unit has a straight proportional single channel and also provides for the addition of one or more channels for carrier or dc lead and lag loop compensation.

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

CIRCLE 207 ON READER-SERVICE CARD

Potentiometers

For high voltage

Designed for the kilovolt range, type HVC high voltage potentiometers may be used in color TV, radar, computers, telemetry, infrared detection, ion accelerators, and nuclear research. The unit has a high power rating, and close resistance tolerance.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.

CIRCLE 208 ON READER-SERVICE CARD

Pulse Generator

0.02 μ sec rise time



From an internal oscillator, model B-7 pulse generator provides repetition rates from 20 cps to 2 mc. The unit may also be triggered externally. Pulse widths are 0.05 to 1000 μ sec; pulse delays, 1 to 10 msec. Output is ± 50 v into a 50 ohm load. Rise and fall time is 0.02 μ sec.

Rutherford Electronics Co., Dept. ED, 8944 Lindblom St., Culver City, Calif.

CIRCLE 209 ON READER-SERVICE CARD

FROM OUR GALLERY OF "DOUBTING THOMASES"

righteously resolute, Ronald Rue DOUBTED THE MERIT OF ANYTHING NEW!

And, in so doing, was responsible for introducing the phrase, "Rue the day" into our language. Luckily, he lived and languished before Elco (and many other fine manufacturers) entered the scene.

Yes, Elco would be among the first to admit that other fine manufacturers there are; but Elco would also ask that its products be compared with others before you judge them. Many of you already have done so and have found our Varicon, printed circuit and micro-miniature connectors — as well as our tube-sockets and shields — to offer the versatility, quality and reliability you must have. If your shelf lacks our Catalogs and Bulletins, please write us and we'll forward them at once.

IF IT'S NEW... IF IT'S NEWS... IT'S FROM

ELCO CORPORATION

"M" St. below Erie Ave., Phila. 24, Pa., CU 9-5500

Elco-Pacific: 3260 Motor Ave., Los Angeles, Cal., TEXAS 0-3000

SERIES 5201 P. C. VARICONS



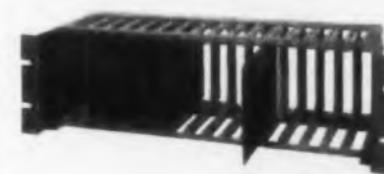
Board-to-board connectors for tandem, parallel or (as shown above) perpendicular plugging module boards into mother boards. Male contacts up to 61 supplied in disposable plastic strips. Write for Bulletin 108A and Staking Bulletin TB-001.

ELCO-PACIFIC EL SERIES



3 or 4 contact audio connector. Also available, our light-duty "B" Series. Both series are completely interchangeable with comparable units. Immediate delivery. Write for Bulletins EP-1 and EP-2.

ELCO'S "VARIPAK"



Printed circuit board enclosure for printed or etched circuitry. 78 parts may be retained with only 8 screws. For standard relay rack or standard electronic enclosure mounting. Bulletin A-1.

CIRCLE 210 ON READER-SERVICE CARD

THE FIRST NEW CONCEPT IN DIGITAL DISPLAY SYSTEMS

Cubic
TRANSISTORIZED
SYSTEMS
 with built-in
rely/ance*



* Cubic's engineering philosophy regards reliability and ease of maintenance as inseparable features of a truly functional system.

ONLY CUBIC DIGITAL DISPLAY SYSTEMS GIVE YOU:

LOW COST OF OPERATION

Proven reliability and practical maintenance features reduce costly down-time to a minimum.

VERSATILITY

All systems units standard size: each unit plugs into its own chassis; modifications for special equipment readily available; interchangeable units ideal for rack mounting.

RELIABILITY

Accuracy to .01%; resistor stability assured; complete transistorization eliminates warm-up time.

EASE OF MAINTENANCE

Stepping switches mounted on horizontal bars — swing up and out for easy access. Slide-out features allow quick replacement if system requirements change.



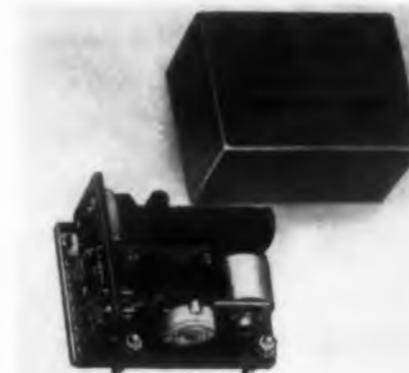
Compare Cubic Digital Systems . . . compare them for price, reliability and versatility. A fast prove-it-yourself demonstration will show you why Cubic Digital Systems will be your best instrument aid.

For complete information and/or demonstration call **BR 7-6780**
5575 KEARNY VILLA RD.
SAN DIEGO 11, CALIFORNIA

CIRCLE 211 ON READER-SERVICE CARD

NEW PRODUCTS

Crystal Controlled Oscillators Variable frequency



Series VCF oscillators are small, variable frequency crystal controlled units with a 10 kc to 20 mc range. Variations are up to 6 cps at 10 kc, up to 12 kc at 20 mc. Resolution is infinite and drift is 1 part in 1 million. The following models are available: AM-03, AM-02, AM-015, MB 101-V, OS-1.

Bulova Watch Co., Electronics Div., Dept. E-100, 40-06 62nd St., Woodside 77, N.Y.

CIRCLE 212 ON READER-SERVICE CARD

Pressure Switch

Measures gas density



Miniature RM-73 gas density switch detects gas leakage and critical arc-over gas density. It actuates along a temperature line of 0.025 psia per deg Rankin. Rated 28 v dc, 110 v ac, 100 ma, spst or spdt, the unit stands ± 20 g shock, 10 g vibration from 5 to 1000 cps, and -85 to $+200$ F. It meets MIL-E-5272 specifications.

Newark Controls Co., Dept. ED, 15 Ward St., Bloomfield, N.J.

CIRCLE 213 ON READER-SERVICE CARD

Servo Amplifiers

0.2 amp dc output

Transistorized power amplifiers SC-AU20-001 and -002 are designed for servo control systems.

From ac inputs below 1 v they produce enough output to drive 5 w ac and dc motors. Input impedance is 2.5 K; input power, 25 w, 115 v, 60 cps; maximum output, 0.2 amp dc into a 100 ohm load.

The Oilgear Co., Dept. ED, 1560 W. Pierce St., Milwaukee 4, Wis.

CIRCLE 214 ON READER-SERVICE CARD

Ultrasonic Cleaner

For small parts



For cleaning small parts, blind holes, and painted circuits, model 1106 low frequency ultrasonic cleaner also removes radioactive contamination. The unit is designed so that two tanks may be used alternately without either being disconnected. The tank is 9-1/4 x 6 x 5 in.

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

CIRCLE 215 ON READER-SERVICE CARD



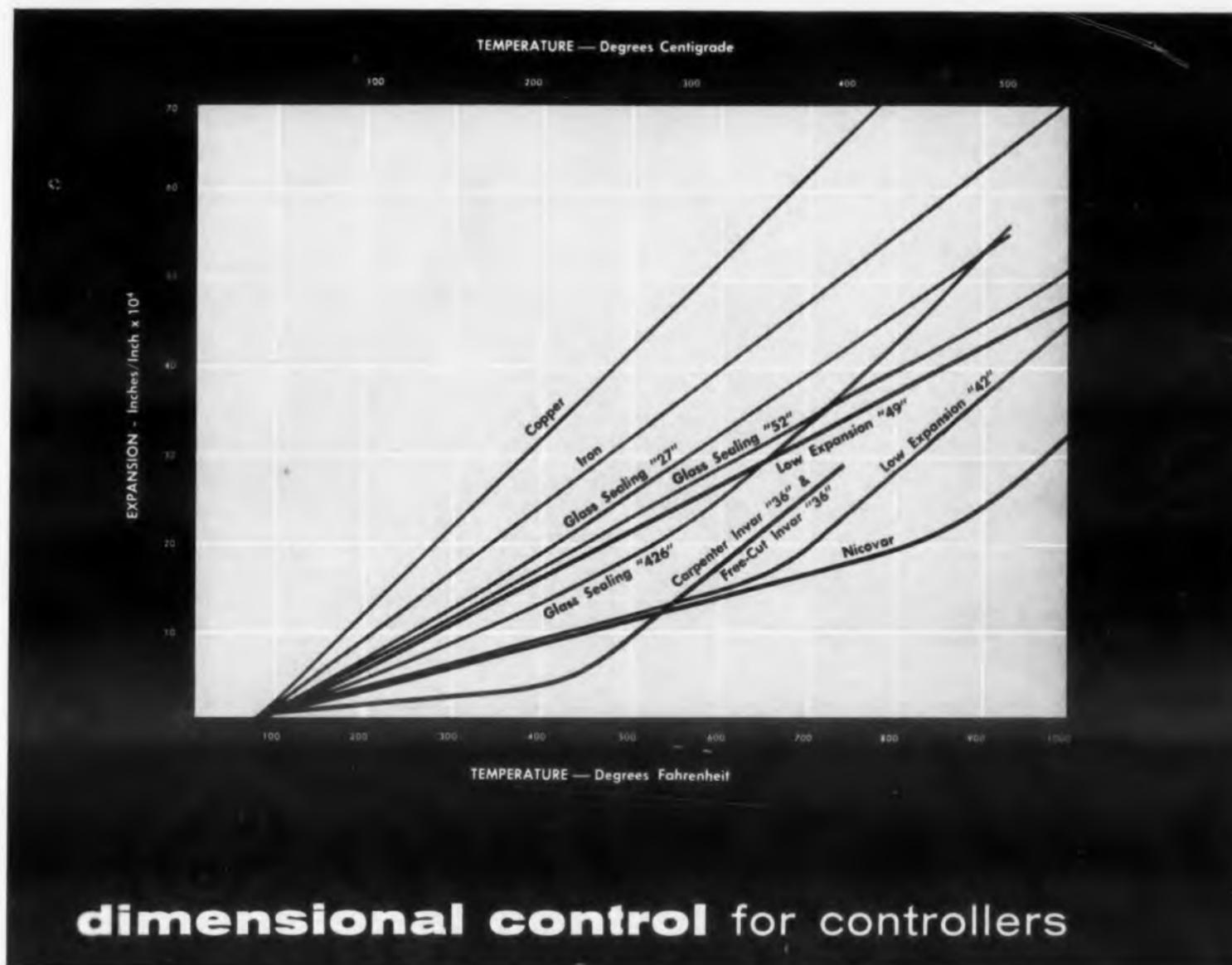
Spectrum Analyzer

Center frequencies from 40 cps to 32 kc

Spectrum analyzer model 2110 has switch selected true rms, average, and peak readout. Produced by Bruel & Kjaer, Denmark, the unit is a 1/3 octave type with center frequencies from 40 cps to 32 kc. The filters have tops flat within ±0.5 db, sides with maximum slope of 120 db per octave; and skirt selectivity of more than 40 db per octave, 70 db per 2 octaves, from the center frequency.

B & E Instruments, Inc., Dept. ED, 3044 W. 106th St., Cleveland, Ohio.

CIRCLE 216 ON READER-SERVICE CARD



dimensional control for controllers

Here are the answers . . . to requirements for precise dimensional control . . . in electrical, electronic and glass or ceramic sealing applications.

You choose from the widest range of low expansion alloys available today from any producer, including glass sealing alloys suitable for vacuum-tight seals . . . when you choose *Carpenter* as your supplier.

Experimental work at *Carpenter* has also produced many additional bonus benefits, such as freer machining, easier fabrication of these alloys.

And if you have special low expansion requirements conventional alloys can't meet, *Carpenter* is still your best bet. A continuing research and development program with an outstanding record of achievement is ready and willing to accept your challenge.

Tell *Carpenter* your needs, today. Write, describing your requirements fully . . . and ask for your free copy of *Carpenter's* new, 64-page technical booklet covering alloys now available for electronic, magnetic and electrical applications. The Carpenter Steel Co., 145 W. Bern St., Reading, Pa.

Carpenter STEEL

The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
Alloy Tube Division, Union, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.
Webb Wire Division, New Brunswick, N. J.

CIRCLE 217 ON READER-SERVICE CARD



WHITE ALICE

WESTERN ELECTRIC PHOTO



DEW LINE



POLE VAULT



TEXAS TOWERS

OFFICIAL U.S. AIR FORCE PHOTO

EIMAC KLYSTRONS performance proved in original Tropo-Scatter systems

Eimac klystrons are used in nearly every major military and commercial tropo-scatter system in the world. The list is impressive: Pole Vault, Texas Towers, Dew Line, White Alice, SAGE, NATO, Florida-Cuba TV, and numerous commercial networks. They have been selected for systems from Norway to North Africa, from the Arctic Circle to the Andes, from the United States to the Far East.

In most of these systems Eimac klystrons are used exclusively. The reason is simple: Eimac-pioneered external-cavity klystrons make it possible to generate high power at ultra-high frequencies simply, reliably and at low cost. With the Eimac external-cavity system, tuning cavities, couplers and magnetic circuitry are all external to and separate from the tube. This permits ex-

ceptionally wide tuning range and simplifies equipment design. Cost is lowered because this external circuitry is a permanent part of the transmitter and is not repurchased when tubes are replaced.

The reliability of these high-performance devices is exceptional. Some of the original Eimac klystrons installed in Project Pole Vault—the first major tropo-scatter network ever established—are still going strong with more than 25,000 hours of air time logged to their credit.

Eimac manufactures a complete line of amplifier and pulse klystrons covering the most important areas of the UHF spectrum. Write our Application Engineering Department for specific information.

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA

Eimac First with ceramic tubes that can take it



Cable address
EIMAC
San Carlos

CIRCLE 218 ON READER-SERVICE CARD

NEW PRODUCTS

Wire Marker Dyes 500 ft a minute



Spectra-Coder model 701 dyes 500 ft of wire a minute. It handles any vinyl insulated wire, and can be used with Spectra-Ink or other instant drying ink.

Spectra-Strip Wire & Cable Corp., Dept. E
P.O. Box 415, Garden Grove, Calif.

CIRCLE 219 ON READER-SERVICE CARD

Impact Grinder Ultrasonic



Model 2-335 ultrasonic impact grinder cuts slices, drills, and trepans regular and irregular shapes. It handles semiconductors, ceramics, ferrites, carbides, metals, jewels, and other hard or brittle materials. Its magnetostrictive transducer permits a 100% duty cycle.

Raytheon Mfg. Co., Dept. ED, Waltham, Mass.

CIRCLE 220 ON READER-SERVICE CARD

FLIGHT DATA and CONTROL ENGINEERS

Cross new frontiers in system electronics at The Garrett Corporation.

High-level assignments in the design and development of system electronics are available for engineers in the following specialties:

1. ELECTRONIC AND FLIGHT DATA SYSTEMS AND CONTROLS A wide choice of opportunities exists for creative R & D engineers having specialized experience with control devices such as: transducers, flight data computers, Mach sensors, servo-mechanisms, circuit and analog computer designs utilizing transistors, magamps and vacuum tubes.

2. SERVO-MECHANISMS AND ELECTRO-MAGNETICS Requires engineers with experience or academic training in the advanced design, development and application of magamp inductors and transformers.

3. FLIGHT INSTRUMENTS AND TRANSDUCERS

1) DESIGN ANALYSIS Requires engineers capable of performance analysis throughout preliminary design with ability to prepare and coordinate related proposals.

2) DEVELOPMENT Requires engineers skilled with the analysis and synthesis of dynamic systems including design of miniature mechanisms in which low friction freedom from vibration effects and compensation of thermo expansion are important.

4. PROPOSAL AND QUALTEST ENGINEER For specification review, proposal and qualtest analysis and report writing assignments. Three years electronic, electrical or mechanical experience required.

Forward resume to:

Mr. G. D. Bradley

THE GARRETT CORPORATION

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

DIVISIONS:

AiResearch Manufacturing—Los Angeles
AiResearch Manufacturing—Phoenix
AiResearch Industrial
Air Cruisers • Airsupply
Aero Engineering
AiResearch Aviation Service

THE NAVY'S FIRST WEAPON SYSTEM...



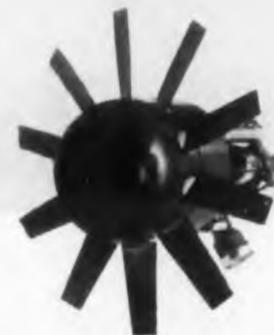
**The A3J "Vigilante,"
equipped with vital
AiResearch subsystems**



Centralized Air Data Computing System



Refrigeration Package



Ram Air Turbine

North American Aviation's twin-jet A3J "Vigilante" is the Navy's newest attack weapon system... an all-weather, carrier-based, 30,000 lb. thrust aircraft which delivers both conventional and nuclear weapons from high or low altitudes at supersonic speeds.

Contributing to the success of the first aircraft produced under the Navy's weapon system management concept is the following AiResearch equipment:

AiResearch Centralized Air Data Computing System pro-

vides information for the major flight data subsystems dealing with bombing, navigation, engine inlet control, radar, automatic flight control and includes cockpit indicators showing true air speed, altitude and engine inlet air temperature.

AiResearch Environmental System Components for personnel and compartment air conditioning and pressurization include: cabin pressure regulators, safety valves, cabin refrigeration package, equipment compartment refrigeration package, primary heat

exchangers, pressure suit heat exchangers and water-alcohol tanks for evaporative cooling.

AiResearch Ram Air Turbines provide power for operation of surface controls, instrumentation and landing gear in case of emergencies. Also included are miscellaneous valves and electro-mechanical equipment.

Systems engineering, support services and systems management have enabled AiResearch to integrate these vital subsystems into North American's A3J.

THE GARRETT CORPORATION

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

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

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

CIRCLE 224 ON READER-SERVICE CARD

CIRCLE 56 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 10, 1958

LAMBDA'S ALL-TRANSISTOR LINE

Delivered now • Guaranteed for five years

FOUR NEW POWER SUPPLIES



1-AMP and 2-AMP • CONVECTION COOLED

No internal blowers • No moving parts

0-32 VDC

0-1 AMP

0-2 AMP

Model LT 1095	\$285
Model LT 1095M (metered)	\$315
Model LT 2095	\$365
Model LT 2095M (metered)	\$395

- Ambient 50° C at full rating.
- High efficiency radiator heat sinks.
- Silicon rectifier.
- 50-400 cycles input.
- Special, high-purity foil, long-life electrolytics.

- Compact. Only 3½" panel height.
- Short-circuit proof.
- Protected by magnetic circuit breakers.
- Hermetically-sealed transformer. Designed to MIL-T27A.

- All transistor. No tubes.
- Fast transient response.
- Excess ambient thermal protection.
- Excellent regulation. Low output impedance. Low ripple.
- Remote sensing and DC vernier.

CONDENSED DATA

Voltage Bands . . . 0-8, 8-16, 16-24, 24-32 VDC

Line Regulation . . . Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 105-125 VAC.

Load Regulation . . . Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.

AC Input 105-125 VAC, 50-400 CPS

Electrical Over-

load Protection . . . Magnetic circuit breaker, front panel mounted. Unit cannot be injured by short circuit or overload.

Thermal Over-

load Protection . . . Thermostat, manual reset, rear of chassis. Thermal overload indicator light, front panel.

Size 3½" H x 19" W x 14⅜" D.

Send for complete LAMBDA L-T data.



LAMBDA Electronics Corp.

11-11 131 STREET • COLLEGE POINT 56, NEW YORK
INDEPENDENCE 1-8500

Cable Address: Lambdatron, New York

NEW PRODUCTS

Precision Resistors
Molded metal film



These molded metal film resistors feature low controlled temperature coefficient, low noise level, and long stability under severe humidity conditions. Their precision is comparable to that of wirewound resistors. The units offer good performance, and uniformity of values over wide resistance ranges. They come in five sizes from 1/8 to 2 inches.

Electra Mfg. Co., Dept. E
4051 Broadway, Kansas City, Mo.

CIRCLE 226 ON READER-SERVICE CARD

In-Line Input Transformer
Microphone type



Ruggedly built, this in-line microphone input transformer is designed for insert into cable circuit. It features a shielded core of Mumetal and electrostatic shielding to improve its signal to noise ratio. The unit has a frequency response of 20 cps to 20 kc ±2 db. Supplied with in. shielded microphone cable, it mates with Amphenol 91-PC-100 plugs. Weighs 11 oz; 1-1/8 in. diam., 2-3/8 in. long.

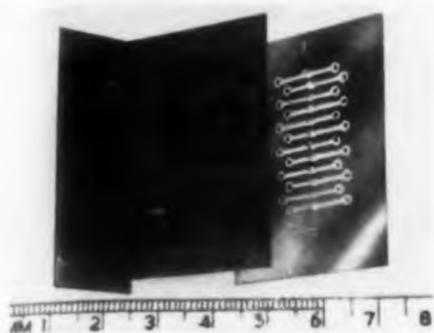
Microtran Co., Inc., Dept. E
145 E. Mineola Ave., Valley Stream, N.Y.

CIRCLE 227 ON READER-SERVICE CARD

← CIRCLE 225 ON READER-SERVICE CARD

Printed Circuit Connectors

8, 12, and 18 pole



Belling & Lee type L.1355 printed circuit connectors are molded from Bakelite and have gold-plated beryllium copper contact springs. The 0.1 in. modules have 8 poles; the 0.15 in. modules, 12, or 18 poles. The contacts are suited for dip soldering.

Ercona Corp., Dept. ED, 16 W. 46th St., New York 36, N.Y.

CIRCLE 228 ON READER-SERVICE CARD

Silicon Rectifiers

50 to 600 piv ratings



With piv's from 50 to 600, these diffused junction silicon rectifiers deliver 750 ma dc at 50 C, 50 ma dc at 150 C. EIA numbers are 1N536, 1N537, 1N538, 1N539, 1N540, and 1N547.

Bendix Aviation Corp., Semiconductor Products, Red Bank Div., 201 Westwood Ave., Long Branch, N.J.

CIRCLE 229 ON READER-SERVICE CARD



Carbon Film Resistors

Fully insulated

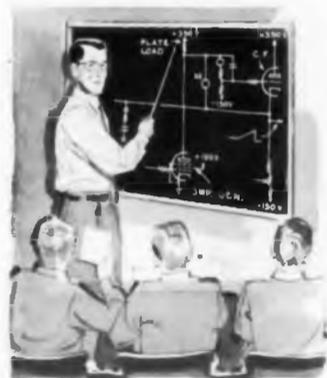
Fully insulated, type DCF deposited carbon film resistors have a strong, stable coating that enables them to operate in severe environments and surpass MIL-R-10509B tests. The units have 1/8 to 2 w ratings; 1 ohm to 50 meg resistances; and 1% tolerance.

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

CIRCLE 230 ON READER-SERVICE CARD

The Manufacturer's Responsibility to the User

YOUR REQUIREMENTS for increasingly higher performance in oscilloscopes inevitably lead to instruments of greater complexity, and therefore to an enlarged responsibility on the part of the instrument manufacturer to provide needed assistance in the field. As a user of Tektronix Instruments you have easy access to a large well-trained field organization, anxious to help with any problems that arise due to unfamiliarity with new circuits or other factors. All services described below are readily available through twenty-four Tektronix Field Offices in North America. Most of these services are also provided by more than twenty Tektronix Engineering Representatives in pertinent overseas locations.



Maintenance—Tektronix willingly assumes much of the responsibility for continued efficient operation of the instruments it manufactures. If you should experience a stubborn maintenance problem, your Field Engineer will gladly help you isolate the cause. Often a telephone discussion with him will help you get your instrument back into operation with minimum delay. If yours is a

large laboratory, your Field Engineer can be of service to your maintenance engineers by conducting informal classes on test and calibration procedures, trouble-shooting techniques, and general maintenance.

If you are responsible for the maintenance of a large quantity of Tektronix Instruments, ask your Field Engineer about the free factory training course in maintenance and calibration.

Operation—Your Tektronix Oscilloscope can be most useful to you when you are familiar with all control functions. Your Field Engineer will be glad to demonstrate the use of your instrument in various applications to help you become more familiar with its operation. If your instrument is to be used by several engineers, your Field Engineer will be happy to conduct informal classes on its operation in your laboratory.



Instrument Reconditioning—An older Tektronix Oscilloscope, properly reconditioned, can give you many additional years of service. Your Field Engineer will gladly explain the advantages and limitations of factory reconditioning, and make the necessary arrangements if you decide in favor of it.

Many major repair and recalibration jobs can be performed at a nearby Field Repair Station. Ask your Field Engineer about this at-cost service to Tektronix customers.



Applications—Perhaps the answers you need in a specific application can be obtained faster and easier through use of your Tektronix Oscilloscope. Your Field Engineer can help you find out, and if use of your oscilloscope is indicated, help you with procedures. He may also be able to suggest many time-saving uses for your oscilloscope in routine checks and measurements.

Ordering—There are many types of oscilloscopes, each designed for a specific application area. Your Field Engineer can help you select the one best suited to your present and future needs, and he will be happy to arrange a demonstration of the instrument... in your application if you so desire.

If you are a Purchasing Agent or Buyer, your Field Engineer or his secretary can help you with information on prices, terms, shipping estimates, and best method of transportation on instruments, accessories, and replacement parts.



Communications—Your Field Engineer is a valuable communication link between you and the factory. He knows the exact person to contact in each circumstance, and he can reach that person fast and easily. Let him help speed your communications with the factory on any problem related to your Tektronix Instruments.



Tektronix, Inc.

P. O. Box 831 • Portland 7, Oregon

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

TEKTRONIX FIELD OFFICES: Albertson, I. I., N.Y. • Albuquerque • Bronxville, N.Y. • Buffalo • Cleveland • Dallas • Dayton • Elmwood Park, Ill. • Endwell, N.Y. • Houston • Lathrup Village, Mich. • East Los Angeles • West Los Angeles • Minneapolis • Mission, Kansas • Newtonville, Mass. • Palo Alto, Calif. • Philadelphia • Phoenix • San Diego • Syracuse • Towson, Md. • Union, N.J. • Willowdale, Ont.

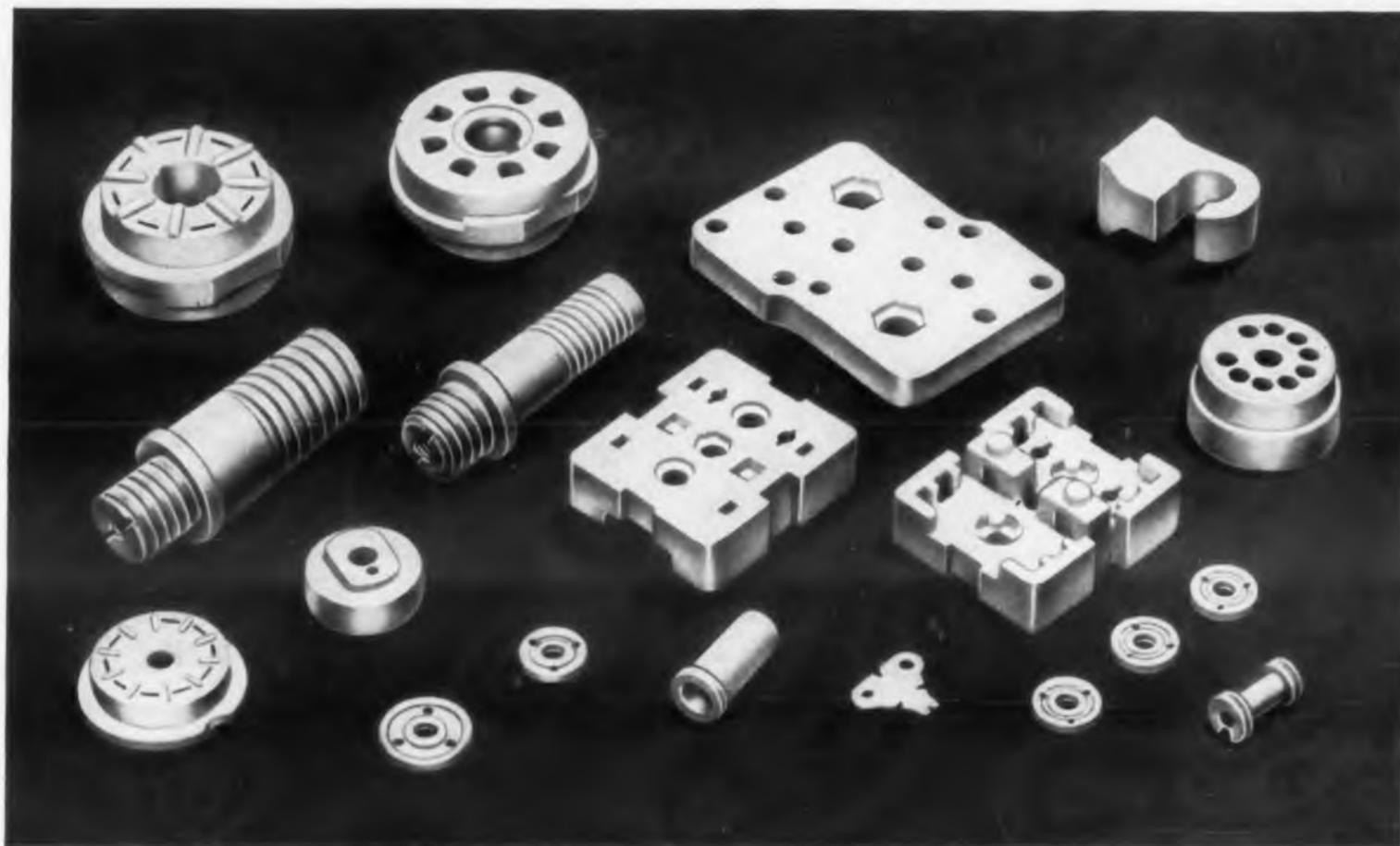
TEKTRONIX ENGINEERING REPRESENTATIVES: Arthur Lynch & Assoc., Ft. Myers, Fla.; Gainesville, Fla.; Brvins & Caldwell, Atlanta, Ga.; High Point, N.C.; Hawthorne Electronics, Portland, Ore.; Seattle, Wash.; Hytronic Measurements, Denver, Colo.; Salt Lake City, Utah.

Tektronix is represented in 20 overseas countries by qualified engineering organizations.

CIRCLE 231 ON READER-SERVICE CARD

No. 1 solution to dielectric problems—

PRECISION STEATITE by GENERAL CERAMICS



G-C steatite solves all of these problems...economically

- ▶ Widely varying ambient temperature
- ▶ Severe mechanical or thermal shock
- ▶ Permanence of dimensional accuracy
- ▶ Intricate shapes to close tolerance
- ▶ Efficient compaction of physical size
- ▶ Low electrical loss at high frequency
- ▶ High dielectric and mechanical strength
- ▶ Extreme immunity to environmental conditions

G-C electrical ceramics are news! Offering a far higher degree of dimensional accuracy than ever before possible, *precision* dielectrics provide a far greater design latitude in all types of electronic and electrical equipment. These new high accuracy ceramics are another example of

General Ceramics progressive manufacture . . . better products at lower cost through advanced research and improved methods of production. Why not ask for all the facts on *precision* electrical ceramics, now! Write General Ceramics Corporation, Keasbey, New Jersey, Dept. ED.

GENERAL CERAMICS

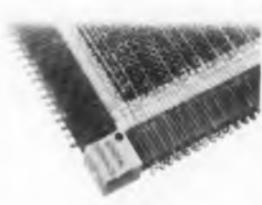
Industrial Ceramics for Industrial Progress... Since 1906



FERRAMIC CORES



FERRAMIC
MAGNETIC CORES



MAGNETIC
MEMORY PLANES



"ADVAC" HIGH
TEMPERATURE SEALS



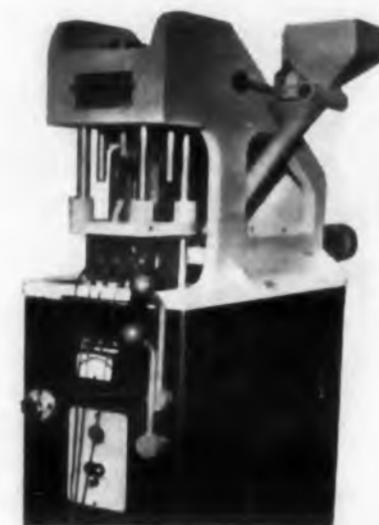
SOLDERSEAL TERMINALS

CIRCLE 232 ON READER-SERVICE CARD

NEW PRODUCTS

Injection Molding Machine

For small plastic parts



Mini-Jector 70VC95 is a precision injection molder for intricate parts requiring inserts or loose cores. It handles 0.33 to 1.5 oz parts and all thermoplastics, including Nylon. Maximum injecting pressure is about 30,000 lb.

Newbury Industries, Inc., Dept. ED, Newbury, Ohio.

CIRCLE 233 ON READER-SERVICE CARD

Terminal Blocks

125 and 250 amp capacity

Insulated from one another and ground, these sectional power unit terminal blocks provide high pressure, solderless connection for machine tools or switchboards. Model P-3 carries 125 amp and model HP-3, 250 amp. Three circuits are standard, but added ones can be provided.

Marathon Special Products Corp., Dept. ED, 12th and Cranberry Sts., Erie, Pa.

CIRCLE 234 ON READER-SERVICE CARD

Commutator Switch

Has 0.03 in. rectangular contacts



With a high sampling speed for PDM telemetry, this commutator switch has 180 contacts which obtain 90 individual pulses on a break-before-make basis from a contact pin ring 0.35 in. in diameter. The rectangular, gold-plated

ver contacts are 0.03 in. and similar to the segmented contact rings of printed circuit commutator plates. Precision molded to the Supramica 555 ceramoplastic commutator plate, their placement is accurate to within ± 1 min.

Mycalox Electronics Corp., Dept. ED, Clifton, N.J.

CIRCLE 235 ON READER-SERVICE CARD

Inert Gas Welding Machine

For reactive materials



Type 742 inert gas welding machine is a production unit for reactive materials such as zirconium, tantalum, and columbium. For manual or semiautomatic operation, it has dual welding positions with glove ports, sight glasses, automatic welding shields, and lights. It has a high speed, high vacuum pumping system and an inert gas backfill system. In lengths from 6 ft, the units are 42 in. in diameter.

General Vacuum Corp., Dept. ED, 400 Border St., East Boston 28, Mass.

CIRCLE 236 ON READER-SERVICE CARD

Automatic Component Dispenser

Handles 4000 parts an hour



This automatic component dispenser cuts and forms leads at the assembly station. It processes 4000 parts per hour for inventory. Four quick adjustments change the cut or bend, and the six hoppers dispense components in a precise order.

Schnit Engineering Co., Dept. ED, 862 Fabian Way, Palo Alto, Calif.

CIRCLE 237 ON READER-SERVICE CARD

HETHERINGTON

SWITCHES • INDICATOR LIGHTS • SPECIAL ASSEMBLIES

ENGINEERING NEWS



FOOT SWITCHES SIMPLIFY COMPLEX SWITCHING PROBLEMS

For many control operations, the foot is often quicker than the hand and a whole lot more convenient—especially where many switches must be attended or where the operator's hands must be freed for other more exacting chores.

Foot switches can often handle heavy-duty multiple-pole, 2 or 3-position switching more reliably, more conveniently, and with decided savings in panel space compared to hand-operated switches or relay circuits.

The two Hetherington Foot-operated Switches illustrated can be supplied in a wide number of single and double-pole circuit arrangements with ratings up to 15 amps, 115 volts ac. Sturdy aluminum frames have a non-skid abrasive compound on treadles.

CIRCLE 102 ON READER-SERVICE CARD



SPACE-SAVER LIGHTS for Standard or Edge-Lit Panels

Only $1\frac{1}{4}$ inches from terminal to lens, these tiny indicator lights give bright and moderately wide-angle visibility in minimum front-panel area. Colored plastic lenses unscrew from the front for quick replacement of AN3140 lamps; 6, 14, 18, or 28 volts.

One-piece terminal and contact assemblies are solidly molded as an integral part of the assembly. Lamp circuits cannot be broken by pulling on the terminal.

Full details on Hetherington Series L1000 (for regular panels), or Series L2000 (for edge-lit aircraft panels) are in Bulletin L-1.

CIRCLE 103 ON READER-SERVICE CARD

HETHERINGTON INC. Delmar Drive, Folcroft, Pa. • 139 Illinois St., El Segundo, Calif.

THE SWITCH WITH THE 1,800 PIECE WARDROBE



Take any Hetherington "JR"-Series Switch, screw on any of 14 anodized aluminum adapters such as those above, and you have a to-

tally different unit . . . in style as well as in mounting characteristics.

Most adapters can be furnished with any of 2 or 3 different auxiliary push buttons to meet individual requirements. In addition, any of 7 or 8 colors can be added to either or both the adapter or button—making a total of more than 1,800 possible combinations for each of the six basic switch circuits.

Adapters range from standard flange-mounting types to force-fit, blind-hole, and molded stick-grip types. Many can be engraved in $\frac{1}{8}$ -inch letters to indicate switch function.

"JR"-Series Switches use the positive Hetherington snap-action mechanism rated for 17 amps at 28 volts dc, or UL Inspected for 15 amps at 115 volts ac.

Complete ratings, specifications and dimensions of all switches and adapters are shown in Bulletin S-5. CIRCLE 105 ON READER-SERVICE CARD

WHEN YOU NEED SWITCHES IN A HURRY

Small quantities of many Hetherington products are now stocked for same-day delivery on both the East and West Coasts. See your local Hetherington sales engineer for an up-to-date list of stock items.



JET-AGE RELAYS

Meet Tough Shock
and Vibration Specs

Designed originally to withstand the extreme shock, vibration, and high temperatures of high altitude aircraft, missiles, and rockets, these Hetherington G-Series Relays have proved remarkably successful and economical for many less exacting earth-bound applications as well. Typical aircraft types with up to 6 single-throw or 4P-DT contacts, withstand 20G vibration at over 500 cycles. Temperature barriers have been raised to 600°F in many specific types. Single and multiple-unit assemblies are available in a variety of open, dust-proof, and hermetically-sealed types with contact ratings up to 10 amps.

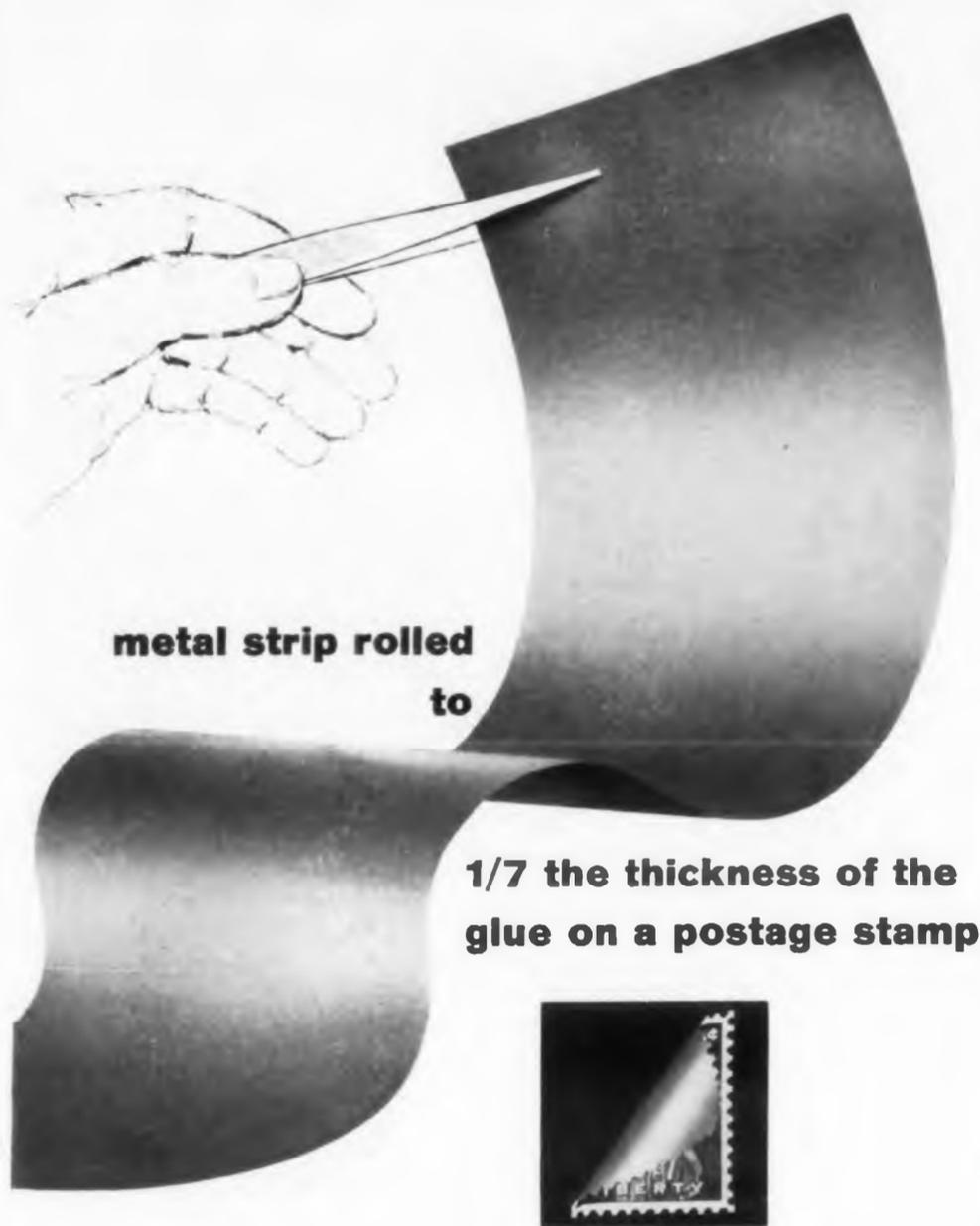
Industrial models for less critical applications are available at correspondingly lower prices.

Details are in Bulletin R-1.

CIRCLE 104 ON READER-SERVICE CARD

... for jobs where a better switch is far-sighted economy

A CONTROLS COMPANY OF AMERICAN SUBSIDIARY



Here is metal strip—available in virtually any alloy—produced in thicknesses ranging from .010" to .0001". (The glue on a stamp measures .0007".) Many of the miniaturization problems facing designers are being solved today by this ultra-thin strip and foil from the Precision Metals Division of the Hamilton Watch Company.

When product emphasis is on compactness and lightness, Precision Metals Division strip and foil will meet your exact mechanical, magnetic and physical specifications. For production orders or the development of new designs, this ultra-thin strip is available in any quantity. Special alloys to your own specification can also be made and furnished in the form you require.

A new 8-page facilities booklet illustrates and describes the operation of the Precision Metals Division, and shows how your precision metals problems can be solved practically and economically. Write on your letterhead today to Dept. D-12.



Hamilton Watch Company

Precision Metals Division / Lancaster, Pennsylvania

Creator of the world's first electric watch
CIRCLE 238 ON READER-SERVICE CARD

NEW PRODUCTS

Wire Cutter Cartridge Kits

Permit 1000 combinations

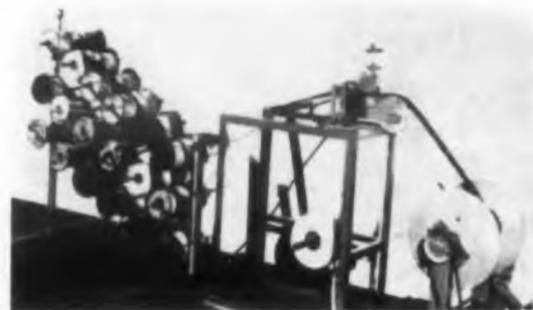
Designed to set up the company's Mark II wire cutter and stripper for one-time production, each of these kits can be made into 1000 cartridge sets. Model 65-101 is for 14 to 20 awg wire; model 65-102, for 18 to 24 awg; model 65-103, for 22 to 28 awg; and model 65-104 for 14 to 30 awg. The 65-105 is a custom kit.

Technical Devices Co., Dept. ED, 2340 Centinela Ave., Los Angeles 64, Calif.

CIRCLE 239 ON READER-SERVICE CARD

Automatic Cable Maker

Produces up to 900 ft per hour



With this automatic cable machine, any type of Zippertubing cable can be made at speeds up to 900 ft an hour. Easily operated, the unit eliminates an extruder. It makes cables of up to 108 conductors and from 3/8 to 2-1/2 in. in diameter.

The Zippertubing Co., Dept. ED, 752 S. San Pedro St., Los Angeles 14, Calif.

CIRCLE 240 ON READER-SERVICE CARD

Molding Compound

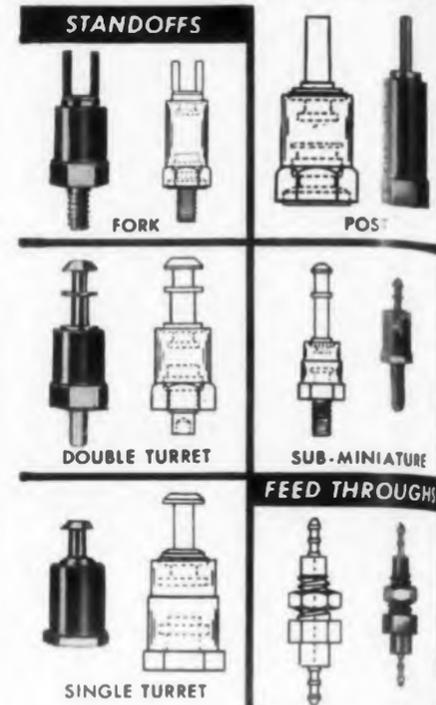
Thermoplastic

A methylstyrene thermoplastic molding and extrusion compound, Cymac 325 is an insulating and dielectric material which retains its properties in high temperature and humidity. It exceeds the 10 kv minimum radio frequency heating and breakdown requirement for antenna components specified in MIL-A-7965-ASG. Under test, the strain insulator withstood 18 kv at 3.44 in. of mercury and 3 mc. It also satisfied the insulation to space and other electrical requirements of the above specification, both before and after exposure to the severe environmental testing conditions set forth in MIL-E-5272.

American Cyanamid Co., Plastics and Resins Div., Dept. ED, 30 Rockefeller Plaza, New York 20, N.Y.

CIRCLE 241 ON READER-SERVICE CARD

GET THE EXACT TERMINAL YOU NEED AT NEW LOW PRICES!



FROM THE LARGEST STANDARD and CUSTOM LINE AVAILABLE...

Over 100 varieties are furnished as standard. This includes a full range of types, sizes, body materials and plating combinations. Specials can be supplied to any specification. The Whitso line is complete to the fullest extent of every industrial, military and commercial requirement.

Standoff terminals include fork, single and double turret, post, standard, miniature and sub-miniature body types—male, female, rivet mountings—molded or metal base. Feed through terminals are furnished standard or to specification.

Whitso terminals are molded from melamine thermosetting materials to provide optimum electrical properties.

Body Materials: Standard as follows—melamine, electrical grade (Mil-P-14, Type MME); melamine impact grade (Mil-P-14, Type MMI); and phenolic, electrical grade (Mil-P-14, Type MFE).

Plating Combinations: Twelve terminal mounting combinations, depending on electrical conditions, furnished as standard.

Specials: Body materials and plating combinations, also dimensions, can be supplied to any custom specifications.

PROMPT DELIVERY IN ECONOMIC QUANTITY RUNS

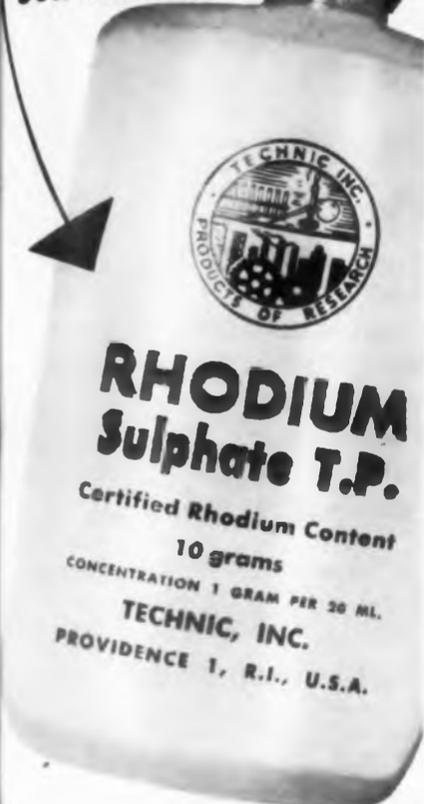
Get facts on the most complete, most dependable source for terminals and custom molded parts. Request catalog.



9326 Byron Street, Schiller Park, Illinois
(Chicago Suburb)

CIRCLE 242 ON READER-SERVICE CARD

Test this
NEW Rhodium
Concentrate



an improvement
by **TECHNIC**

Technic developed this superior Rhodium concentrate to meet today's electroplating specifications with —

- * Lower Stress
- * Higher Purity
- * Finer Grain

Testing is easy because of high compatibility with existing Rhodium baths. Ask for complete data on characteristics and applications. When you adopt Technic solutions or methods, our technical staff is yours until optimum performance is assured. Write or phone today.

TECHNIC, INC.

39 Snow Street
Providence, R. I.
Jackson 1-4200
Chicago Office



7001 North Clark St.
55-8

THE LARGEST ENTERPRISE OF ITS KIND IN THE WORLD

CIRCLE 243 ON READER-SERVICE CARD



Microwave Horn

Has two waveguide inputs

With two waveguide inputs, this dual polarized feed horn provides the same center of radiation for both signals. It handles 10 kw with more than 30 db decoupling between the signals. Standard frequencies are 400 to 450, 755 to 985, and 1700 to 2400 mc. Others are available.

D. S. Kennedy & Co., Dept. ED, Cohasset, Mass.

CIRCLE 244 ON READER-SERVICE CARD



Multimeter

For R, I, and E

Multimeter 5620 measures 2×10^2 to 2×10^8 meg with $\pm 1.7\%$ to $\pm 6\%$ accuracy; 1×10^{-12} to 5×10^{-6} amp with 1.5% to 3% accuracy; and 0.005 to 500 v with $\pm 0.5\%$ to $\pm 3\%$ accuracy. Measurements are drift free.

Leeds & Northrup Co., Dept. ED, 4934 Stenton Ave., Philadelphia 44, Pa.

CIRCLE 245 ON READER-SERVICE CARD

Remote Angular Readout

0.5% accuracy



Using a dc synchro and a potentiometer transmitter, this remote readout system reads valve flapper and shaft angles through 360 deg. Accurate to 0.5%, it operates from 28 v dc and requires less than 0.1 w.

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

CIRCLE 246 ON READER-SERVICE CARD



for the engineer
who has everything

With the same Philanthropic Genius responsible for such world-renowned items as Finder-Fixing Kits, micromcarthys, automation relays and other assorted contributions to the scientific community, Sigma now proudly offers a new GIFTRELAY just in time for Christmas.

Model 1932 WPA G.R.'s are designed to please engineers, inventors, executives, small boys, mothers, brothers and distant cousins.

Coil power, shock mountings and circuit connections can be forgotten; 1932's are above all that. Their usefulness is their ability to provide basic pleasures, free of psychological complications or additional investment.

For example, you can easily carry a 1932 around in your pocket, ready for instant use in any conversation . . . or just to remind yourself that you are part of today's World of Electronics. Or a certain Technical Atmosphere can be created by casually placing a 1932 on your desk, living room mantelpiece or bar counter—wherever you happen to be. (This quality will undoubtedly have immediate appeal to executives of advertising agencies with technical accounts.) And for plain utility, a 1932 WPA G.R. with its removable base is handy for carrying pills, parking meter money, rare emeralds, BB gun pellets, secret messages printed on bible paper, truth serum and other small items of everyday usefulness. (It is not recommended that alcohol be placed in a 1932; it could eat the genuine finish; besides, it only holds 0.379 oz.)

If you hurry, you can get a Sigma GIFTRELAY for that person; if you don't hurry, you'll still probably be able to get one but we'll be disappointed. Send 25 cents in hard cash or mint stamps (no rare coins this time, please), to L. B. Quinlan, Adv. Mgr. Offer closes sometime and all decisions of the shipping room are final.



MODEL 1932 GIFTRELAY,
actual size; outwardly
similar to Sigma Series 32;
inside, there ain't nuthin'.

SIGMA

SIGMA INSTRUMENTS, INC.

91 Pearl St., So. Braintree 85, Mass.

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

CIRCLE 247 ON READER-SERVICE CARD



New Westinghouse series of VHF beam-power pentodes especially useful in mobile communications

Now Westinghouse introduces three improved octal-based pentodes for use as VHF amplifiers and oscillators . . . also as audio amplifiers or modulators.

Their small size does not limit their excellent performance characteristics. They have high power output, low plate and grid 2 voltages, and low driving power. They are designed for effective radio frequency ground, cool operation and long life.

WL-6146—with conventional 6.3 volt heater

WL-6159—with 26.5 volt heater
(for aircraft equipment)

WL-6883—with 12.6 volt heater
(for service with 12-volt storage battery)

Write for complete information on these three new beam-power types. Westinghouse Electric Corporation, Electronic Tube Division, Elmira, New York.

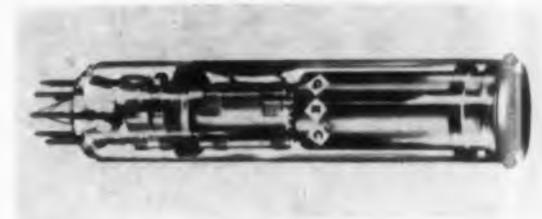
YOU CAN BE SURE...IF IT'S **Westinghouse**

CIRCLE 248 ON READER-SERVICE CARD

NEW PRODUCTS

TV Camera Pickup Tubes

5.15 in. long



Vidicon 7226 and the ruggedized 7226A are meant for transistorized cameras. They are 5.15 in. long and have 150 ma heaters. Built to MIL-E-5272A requirements, the 7226A gives good pictures despite severe noise, vibration, and shock.

General Electrodynamics Corp., Electronic Tube Div., Dept. ED, Garland, Tex.

CIRCLE 249 ON READER-SERVICE CARD

Control Motor

Permanent magnet type

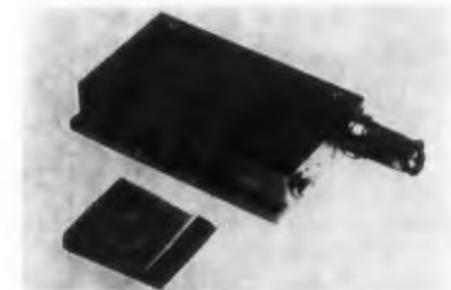
Designed as a building block for control equipment, this industrial dc motor is built to withstand severe abuse in adverse environments. At 1/6 hp, permanent magnet type, the motor is available with an integral tachometer generator which gives a 0 to 5 ma output signal linearly proportional to its speed. Torque is 40 oz-in. speed, 0 to 4000 rpm.

Rotron Controls Corp., Dept. ED, Woodstock, N.Y.

CIRCLE 250 ON READER-SERVICE CARD

Telemetry Amplifiers

2 cps to 20 kc range



Airborne amplifier 2617 has a 2 cps to 20 kc range and 1000 meg input impedance with less than 50 mv residual noise. Preset fixed gain may be 10, 30, or 100. Current requirement is 5 ma. Used with the company's accelerometers and 2980 mounting studs, the 2617 forms an electrically isolated system.

Endevco Corp., Dept. ED, 161 E. California St., Pasadena, Calif.

CIRCLE 251 ON READER-SERVICE CARD

CORROSION TEST CHAMBER.—Model G-S for salt, Comodkote, and humidity tests. Meets ASTM and government specifications. Test-heats to 150 F with all temperatures held to 0.5 F.

The G. S. Equipment Co., Dept. ED, 15583 Brookpark Rd., Cleveland, Ohio.

CIRCLE 252 ON READER-SERVICE CARD

INSULATING SLEEVES.—Type V-105 polyvinyl chloride sleeving 1 to 1000 ft long. Temperature range, -30 to +105 C.

Illumitronic Engineering, Dept. ED, 680 E. Taylor, Sunnyvale, Calif.

CIRCLE 253 ON READER-SERVICE CARD

CRYSTAL PROTECTORS.—About 1/2 the size of previous types. X-band tube is 3/4 in. between flange faces. For all microwave bands.

Bomac Labs, Inc., Dept. ED, 1 Salem Rd., Beverly, Mass.

CIRCLE 254 ON READER-SERVICE CARD

TUBE CAP CONNECTORS.—Insulated with glass-filled silicone or silicone rubber, units stand 750 or 500 F. For high voltage, high altitude applications.

Alden Products Co., Dept. ED, 117 N. Main St., Brockton 64, Mass.

CIRCLE 255 ON READER-SERVICE CARD

PRECISION GEARS.—Two mechanical differentials with 1/8 in. hollow shaft. Units are 0.5 and 0.563 across inside face of end gears and have 0.88 and 1.032 diameter working circle.

Arch Instrument Co., Inc., Dept. ED, 101 Holmes St., North Quincy 71, Mass.

CIRCLE 256 ON READER-SERVICE CARD

DUAL POTENTIOMETER UNIT.—Improved model 209 Twinpot has Silverweld termination. Provides virtually 100% usable potentiometer range.

Bourns Labs, Inc., Dept. ED, P. O. Box 2112, Riverside, Calif.

CIRCLE 257 ON READER-SERVICE CARD

MOLDING MATERIAL.—Castflex M-3 castable rubber makes flexible molds for casting cold-setting epoxy resins.

Cincinnati Research Co., Dept. ED, 10100 Beech Lane, Cincinnati 15, Ohio.

CIRCLE 258 ON READER-SERVICE CARD

NOBLE METAL CONTACT POLES.—Individual units to adapt industrial control relays to electronic and instrumentation circuits. Easily replace one or more relay poles without disturbing the others.

Clark Controller Co., Dept. ED, 1146 E. 152nd St., Cleveland 10, Ohio.

CIRCLE 259 ON READER-SERVICE CARD

ELECTRONIC MICROMETER.—Sets to 1.5, 5, 10, or 20 gram standard reference measuring pressures. Counter reads directly in decimal fractions of an inch. Last wheel reads to 20 millionths.

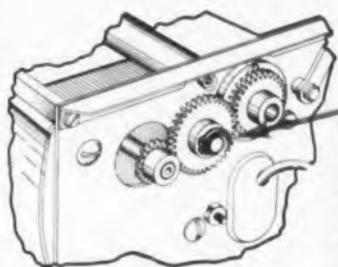
J. W. Dice Co., Dept. ED, Englewood, N. J.

CIRCLE 260 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 10, 1958

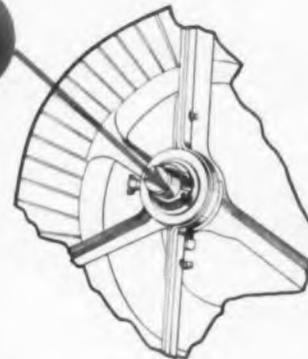
Truarc Rings Eliminate Parts and Machining, Speed Assembly, Reduce Manufacturing Costs

Ring eliminates nut and threading, saves \$365/M



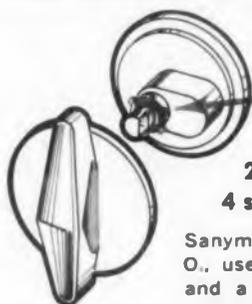
Sanborn Co., Waltham, Mass., uses a Waldes Truarc Series 5555 Grip ring* to secure the idler gear assembly of its portable electrocardiograph. The ring assures faultless gear performance necessary for diagnostic accuracy, eliminates a nut and threading operation for savings of \$365 per 1000 units.

Ring saves parts, speeds assembly for savings of \$260/M



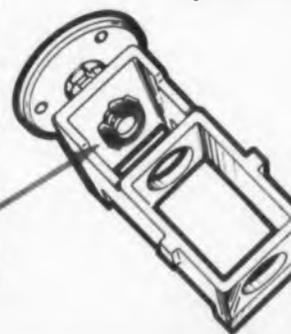
Fraser and Johnston Co., San Francisco, Calif., uses a Series 5555 Grip ring* to secure the fan shaft and speed assembly of its furnace blowers. The ring eliminates a collar and set screw for savings of \$180/M on materials, \$80/M on assembly time—a total of \$260 per 1000 units.

Ring replaces spring and washer; speeds assembly 50%, saves \$15/M



2 standard rings replace 4 special parts, save \$170/M

Sanymetal Products Co., Inc., Cleveland, O., uses a Series 5005 Self-locking ring and a Series 5103 Crescent® ring* to hold the escutcheon plate and handle of this doorlatch for toilet compartments. The two standard rings replace four expensive chrome-plated brass parts for savings of \$170 per 1000 units.



Allen-Bradley Co., Milwaukee, Wisc., uses a Series 5139 Prong-Lock ring* to secure the adjustment knob of its pneumatic timer. Ring eliminates a costly coil spring and washer, simplifies a tough assembly operation. Cost saving: \$15 per 1000 units. Assembly time saving: 50%.

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

In Truarc, you get:

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

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

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

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

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today . . . let our Truarc engineers help you solve design, assembly and production problems . . . without obligation. e.2



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."

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*Covered by one or more of the following patents: Nos. 2,382,948; 2,491,306; 2,574,034; 2,755,698.

CIRCLE 261 ON READER-SERVICE CARD

Waldes Kohinoor, Inc., Long Island City 1, N. Y.

Please send me your new 24-page Catalog No. RR 10-58 with descriptions and illustrations of the complete line of Truarc retaining rings, pliers and accessory tools and 80 typical applications.

(please print)

Name _____

Title _____

Company _____

Business Address _____

City _____ Zone _____ State _____

ED-120

From General Electric . . .

PLAIN TALK ON TANTALYTIC* CAPACITOR AVAILABILITY

It's time for plain talk on the facts of tantalum electrolytic capacitor availability. There is no "availability" problem as far as General Electric is concerned.

Here's why:

- No metal shortage—Stocks of capacitor-grade tantalum have doubled within the past year.
- No production capability shortage—General Electric's production facilities have tripled in the past year.
- No delivery bottlenecks—General Electric's improved manufacturing processes and techniques have virtually eliminated production rescheduling.
- Few military directive priorities—Since the supply of Tantalytic capacitors has met demand, the military requirements can be met without directive priorities.

This is why we say—now and in the future, General Electric will continue to provide Tantalytic capacitors in the types and ratings you want—when you want them.

For specific information on Tantalytic capacitor ratings, prices, deliveries, contact your nearest General Electric Apparatus Sales Office or write to General Electric Co., Section 449-4, Schenectady 5, N. Y.

*Registered trade-mark
of General Electric Co.

**Trade-mark of
General Electric Co.



SOLID TANTALYTIC CAPACITORS
—for transistorized circuit applications—rated up to 60 volts, polar units only—sizes down to 0.125 inches by 0.250 inches.

125C TANTALYTIC CAPACITORS—for aircraft electronic systems—ratings 10-180 mfd, 30 to 100 volts. Sizes 1/2 to 1 1/8 inches in height. Also tubular, double-cased units.

KSR TANTALYTIC CAPACITORS**—for missiles, radar, airborne electronic equipment applications—ratings up to 3500 mfd—three case sizes 1.375, 2, 2.5 inches in height.

85C TANTALYTIC CAPACITORS
—for applications requiring high quality but where temperatures are less severe.

GENERAL  ELECTRIC

CIRCLE 262 ON READER-SERVICE CARD

NEW PRODUCTS

Test Turntable

Multimode

Designed to evaluate inertial navigation equipment, the 052 multimode turntable also determines transfer functions of gyros or other inertial devices to programmed sinusoids or step functions. It may be used either as a servo table or a sidereal rate table. Rugged and accurate, the table has a 26-in. diameter platform which handles loads up to 500 lb. The platform turns on precision roller bearings at rates from 0 to 2 rps. The microsyn drive maintains a positional accuracy of ± 10 sec of theoretical value. The hollow platform drive shaft has 30 shielded slip rings with 3 amp capacity, providing the means for wiring platform test elements and the leads to the microsyn. The photoelectric readout system, accurate to 2 sec of arc, indicates turntable motion in the form of an electrical pulse coincident with each 6 or 10 sec of arc.

J. W. Fecker, Inc., Dept. ED,
6592 Hamilton Ave., Pittsburgh 6,
Pa.

CIRCLE 263 ON READER-SERVICE CARD

Servo Motor

Size 11



For 60 or 400 cps, the 11M202 size 11 servo motor operates from 6 to 200 v ac. At maximum power output, torque is 0.3 oz-in. and speed is 3800 rpm. The unit operates from -65 to $+200$ C and meets MIL-E-5272A and MIL-S-17087 requirements.

Servo Dynamics Corp., Dept. ED,
Somersworth, N.H.

CIRCLE 264 ON READER-SERVICE CARD

Silicon Rectifiers

0.004 cu in.



Rated at 750 ma dc and 200, 400, and 600 v, F series encapsulated silicon rectifiers take up less than 0.004 cu in.

Sarkes Tarzian, Inc., Dept. ED,
415 N. College Ave., Bloomington
Ind.

CIRCLE 265 ON READER-SERVICE CARD

Phase Sequence Indicator

For panel mounting

The VA5 phase sequence indicator instantly shows the order in which voltage peaks occur in a three-phase, 115 v, 400 cps power line. A panel instrument, it consumes under 1 w. Voltage range is 75 to 135 v rms; frequency range, 300 to 560 cps.

Opad Electric Co., Dept. ED,
Murray St., New York 7, N.Y.

CIRCLE 266 ON READER-SERVICE CARD

Wirewound Power Resistors

3/16 in. in diameter



These Blue Jacket resistors are vitreous-enamel, wirewound power units with axial leads. The 2 w size is 3/8 in. long; the 2-1/2 w, 17-32 in. long. Diameters are 3/16 in. Tolerances are ± 1 , ± 2 , ± 5 , and ± 10 %. The series also includes 5, 7, and 11 w units.

Sprague Electric Co., Dept. ED,
347 Marshall St., North Adams
Mass.

CIRCLE 267 ON READER-SERVICE CARD

NEW PRODUCTS

Telephone Relays

Arrangements up to 4pdt

Hermetically sealed, series SM-400 miniature telephone relays are rated at 3 amp, 115 v ac, or 28 v dc, 0.5 amp. Contact arrangements are up to 4pdt. The units meet MIL-R-5757B requirements and come with solder lug terminals or plug-in header. They operate on 110 v ac, 60 to 400 cps.

Kurman Electric Co., Dept. ED, 191 Newel St., Brooklyn 22, N.Y.

CIRCLE 268 ON READER-SERVICE CARD

Power Supplies

3% load regulation



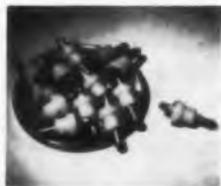
Compact and light, these transistorized power supplies have 3% load regulation. Model PS-T-U6 has a 6 v output at 2 amp; model PS-T-G12 provides a selectable output of 6, 12, or 18 v at 2 amp.

The Reflectone Corp., Dept. ED, Post Rd. and Myano Lane, Stamford, Conn.

CIRCLE 269 ON READER-SERVICE CARD

Feed-Through Terminals

Miniature



Twelve FT-SM-125 feed-through terminals fit on a dime. These Press-Fit connectors have a truncated lug to keep wire leads in place until they can be soldered.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.

CIRCLE 270 ON READER-SERVICE CARD

Static Converters

Deliver 25 amp at 28 v dc

Type 2596-A ac to dc static converters operate from -55 to +85 C and deliver 25 amp of load current at 28 v dc. They require a 3 phase input of 108 to 117 v ac, 400 cps. Maximum excursion is 26 to 30 v dc. The units are 5 3/4 x 4 1/4 x 4 in.

R/S Electronics Corp., Dept. ED, 435 Portage Ave., Palo Alto, Calif.

CIRCLE 271 ON READER-SERVICE CARD

Amplifiers

200 to 500 mc range



With ± 1.5 db uniformity, amplifiers 90182, 90183, and 90214 cover the 200 to 500 mc band. With maximum noise figures of 3.5 to 5 db, they provide 20 to 22 db gains. The units operate from -30 to +180 F.

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

CIRCLE 272 ON READER-SERVICE CARD

Oscilloscope

For medical measurements

Medical oscilloscope model PIB1X8 fits a 5-1/4 x 5-3/16 in. panel space. Its built-in signal amplifier has 2.4 mv rms per in. sensitivity and dc to 50 kc response. Input information is portrayed against one of five repetitive sweeps from 0.5 cps to 1 kc.

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

CIRCLE 273 ON READER-SERVICE CARD

free kit

sample lengths of

L. FRANK **MARKEL** & SONS

SINCE 1922

FLEXITE **TEFLON** **FLEXLEAD**

INSULATING TUBINGS
AND LEAD WIRE

If your specifications call for wide thermal characteristics, superior electricals, excellent flexibility, chemical inertness — or any combination of these properties — you will want to see Markel FLEXITE Teflon tubing and Markel FLEXLEAD Teflon insulated lead wire — which will meet your specs, or make them!

To acquaint you with these precision products, we will be glad to send you free experimental lengths of Markel FLEXITE and FLEXLEAD. Just mail the coupon today for your valuable Markel Teflon Kit.

* Du Pont tetrafluoroethylene resin

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Gentlemen: I shall be glad to receive a free Markel TEFLON Kit

Name _____ Title _____

Firm Name _____

Address _____

City _____ Zone _____ State _____

CIRCLE 274 ON READER-SERVICE CARD

Rotary Sampling Switches

Contact-saving design

Built with a wiper for each contact, these commutators wear no more at 100 rps than do conventional switches at 0.5 rps. The individual wipers are laminated into one piece and damped to eliminate chatter or vibration at high speeds. The contacts are so spaced that interchannel leakage resistance does not increase with wear, and back resistance remains close to infinite. Contact points not in use are suspended, causing no frictional loss or drain from the power source.

Lind Corp., Dept. ED, Research Park, Princeton, N.J.

CIRCLE 283 ON READER-SERVICE CARD

Automatic Tuners

For local or remote control

Instantuners automatically tune radio transmitters by local or remote control. Types 201 and 202, for airborne and mobile units, have 12 preset positions from 0 to 360 deg. Type 203 has 12 positions within a range of 0 to $n \times 360$ deg, where n is less than 25. Types 106, 107, and 108, for large transmitters, have 6 preset positions.

Philips Electronics, Inc., Instruments Div., Dept. ED, 750 S. Fullerton Ave., Mt. Vernon, N.Y.

CIRCLE 284 ON READER-SERVICE CARD

Potentiometers

Gang type

Resistance wipers in model 319 gang type potentiometers can be biased and rephased independently with no effect on settings in adjacent cups. Available in resistances to 200 K with 0.05% linearity. Units also come in nonlinear functions. They are 7/8 in. in diameter and meet MIL-E-5272A, MIL-STD-200, MIL-R-19, and NAS-710 requirements. Power dissipation is 100 mW.

Daystrom Pacific, Potentiometer Div., Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.

CIRCLE 285 ON READER-SERVICE CARD

Spring Motors

Constant-torque

Through the full extension of their 6 ft output cable, constant-torque spring motors A-2025-1 and -2 exert 1 and 2 lb tension, respectively. Their output torques are 0.75 and 1.5 lb-in. Both motor springs deliver 15 turns to the output bushings.

Hunter Spring Co., Negator Div., Dept. ED, 1 Spring Ave., Lansdale, Pa.

CIRCLE 286 ON READER-SERVICE CARD

Autotransformers

Continuously adjustable

Type W20 continuously adjustable autotransformers are offered cased or uncased. The uncased models are for 115 and 230 v service with ratings of 3 and 2.4 kva, respectively. Cased models have knockouts for conduit or armored cables.

General Radio Co., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE 287 ON READER-SERVICE CARD

Electrolytic Capacitors

10 year life expectancy

Used within their rated limits, type QE electrolytic capacitors will last more than 10 years. For computer equipment, power supply filters, telephone networks, and other precision devices, they are rated for -20 to +85 C operation.

Aerovox Corp., Dept. ED, New Bedford, Mass.

CIRCLE 288 ON READER-SERVICE CARD

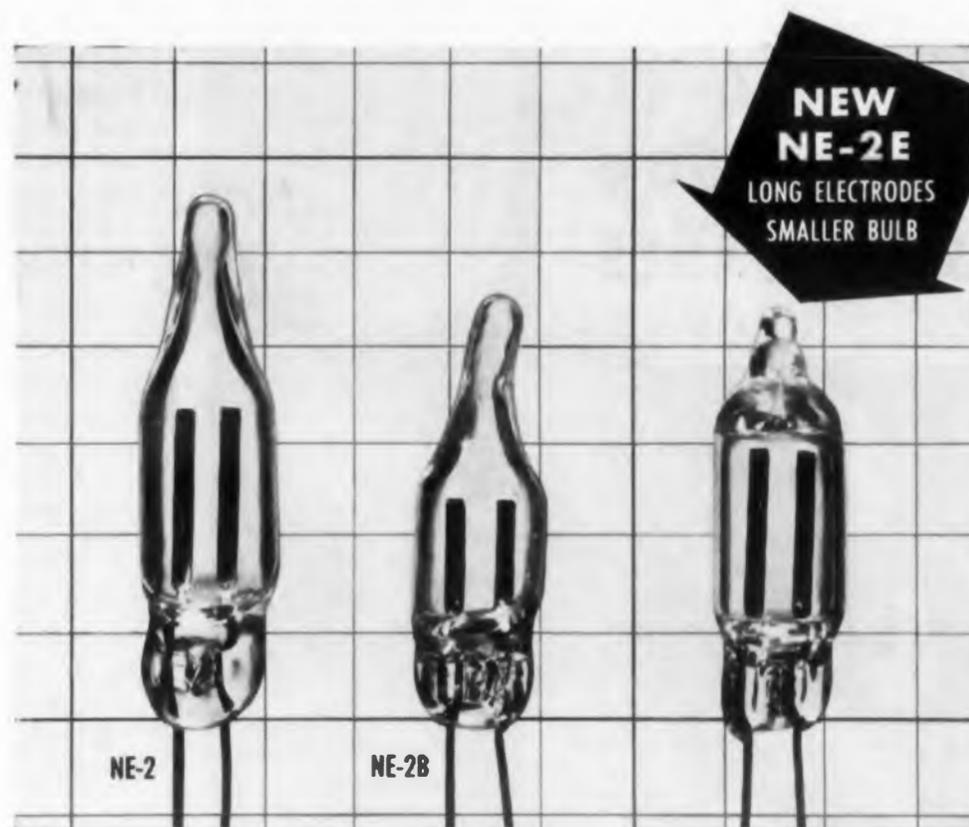
Coaxial Switch

0 to 500 mc range

For 3-1/8 in. rigid coaxial transmission lines, type 1136 coaxial switch has a 0 to 500 mc range and a vswr under 1.05. Crosstalk through its unused branch is over 60 db down at 80 mc, over 40 db down at 500 ms.

Alford Mfg. Co., Dept. ED, 299 Atlantic Ave., Boston 10, Mass.

CIRCLE 464 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-128, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

Difficult FLUOROCARBON PLASTICS PARTS



- Gain greater design freedom without penalty in production costs.

Send us your difficult TEFLON* and KEL-F† part problems for quotations. Intricate shapes, inserts, thin sections, molding around metallic structures, threaded parts, precision tolerances—all are routine to U.S.G. production.

Unmatched experience and facilities for cold molding and sintering, injection molding and high speed machining—guarantee the best parts made by the right methods and at the right price, when you come to the pioneers and world leaders in fluorocarbon plastics fabrication.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write

United States Gasket Company
Camden 1, New Jersey

United States Gasket *Plastics Division of*
GARLOCK



CIRCLE 290 ON READER-SERVICE CARD

NEW PRODUCTS

PUSHBUTTON SWITCH.—Oil-tight control panel unit for critical space requirements. Contains the company's type 16 switch, rated 10 amp, 125 or 250 v ac or 30 v dc, inductive.

Illinois Tool Works, Licon Div., Dept. ED, 6606 W. Dakin St., Chicago 34, Ill.

CIRCLE 291 ON READER-SERVICE CARD

SELENIUM DIODES.—Improved type K1615 center-tap and K1616 doubler encapsulated diodes have Bakelite cases and new fillers. For use in horizontal phase detector circuits of TV receivers.

International Telephone and Telegraph Corp., Dept. ED, Clifton, N. J.

CIRCLE 292 ON READER-SERVICE CARD

BULB ADAPTER.—W-series permits 40 mil bulbs to replace 100 mil bulbs in instrument control panels. Adapts 327 incandescent bulbs for 1819, 1820, and 1829 sockets.

Electrosnap Corp., Dept. ED, 4220 W. Lake St., Chicago 24, Ill.

CIRCLE 293 ON READER-SERVICE CARD

SLIDES.—Series 54 slides handle 50 lb per pair with wide safety margin. Can be equipped with pivot and locking mechanism for 45, 90, or 135 deg. In any length from 6 to 30 in.

Jonathan Mfg. Co., Dept. ED, 720 E. Walnut Ave., Fullerton, Calif.

CIRCLE 294 ON READER-SERVICE CARD

CLOSED-CIRCUIT TV.—System 1986 has built-in automatic light control. Instantly adjusts to light level variations up to 1000 to 1. Signal to noise ratio is over 25 db.

Kin Tel, Div. of Cohu Electronics, Inc., Dept. ED, 5725 Kearny Villa Rd., San Diego 12, Calif.

CIRCLE 295 ON READER-SERVICE CARD

ENCLOSURES.—MEK-6440 junior size NEMA 12 for small control panels, pushbutton enclosures, and electronic devices. Sizes from 4 x 4 x 3 in. to 26 x 20 x 8 in.

Machinery Electrification, Inc., Dept. ED, 56 Hudson St., Northboro, Mass.

CIRCLE 296 ON READER-SERVICE CARD

SWITCHING TRANSISTORS.—Germanium alloy junction units. Types 2N311, 2N404, 2N426, 2N427, and 2N428 are pnp; types 2N312, 2N439, and 2N440 are npn. Packaged in JETEC 30 cases.

General Transistor Corp., Dept. ED, 91-27 138th Place, Jamaica 35, N. Y.

CIRCLE 297 ON READER-SERVICE CARD

FLIGHT SIMULATION TABLE.—Single-axis, hydraulic model A916 for testing airborne components under simulated pitch, yaw, and roll. Range, ± 15 deg maximum rotation; resolution, ± 2.5 sec of arc; amplitude response, flat within ± 2 db to 45 cps.

Gensico, Inc., Dept. ED, 2233 Federal Ave., Los Angeles 64, Calif.

CIRCLE 298 ON READER-SERVICE CARD

Reaching for a better way to read and record industrial data?



BEATTIE MODEL D VARITRON cameras, electrically pulsed, are used to record photographically on still pictures the data required by business, science and industry. The versatile Model D Varitron is a fixed position instrumentation camera that may be mounted conventional or on its face plate. A complete data recording chamber completes the camera's efficiency giving time, number or written identification to every exposure.

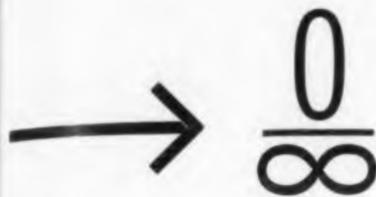
for more information write to

B C BEATTIE-COLEMAN

1000 N. Olive St., Anaheim, California

CIRCLE 299 ON READER-SERVICE CARD

IT'S NOT
"HOW THIN"



BUT
HOW EXACT!

With the recent trend in strip metal towards thinner and thinner gauges, Somers, a pioneer in thin strip for nearly 50 years, is naturally among the leaders in rolling ultra-thin strip. In addition to rolling production quantities of strip as thin as can be obtained anywhere in the world, Somers utilizes exclusive techniques and equipment to make sure that every foot of metal is up to the most exacting standards.

1. Accu-Ray nuclear gauging to assure absolute uniformity of thickness throughout.

2. Unique rolling mill for strip from .001" down, makes possible extremely close control of the final pre-anneal temper, and uniform accuracy of the final temper.

3. Experience exclusively with thin strip metals gives Somers an unmatched background in engineering ultra-thin strip to meet all special requirements.

NEARLY
FIFTY
YEARS

FOR EXACTING STANDARDS ONLY

Somers

Somers Brass Company, Inc.
116 BALDWIN AVE., WATERBURY, CONN.
CIRCLE 300 ON READER-SERVICE CARD

FLIGHT SIMULATOR.—Modified model 11A two-axis table has higher frequency response: 15 cps on one axis, 10 cps on the other, with a 25 lb load.

Micro Gee Products, Inc., Dept. ED, 6319 W. Slauson Ave., Culver City, Calif.

CIRCLE 301 ON READER-SERVICE CARD

MULTIPLIER PHOTOTUBE.—Model 7265 14-stage head-on type for use in scintillation counters. Response of 3000 to 7500 angstroms.

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

CIRCLE 471 ON READER-SERVICE CARD

TELEGRAPH EQUIPMENT.—Type 211 frequency shift tone keyer, 19 x 5 1/4 x 18 in., and type 212 frequency shift tone converter, 19 x 10 1/2 x 18 in., have 18 channels, transistorized circuitry.

Northern Radio Co., Inc., Dept. ED, 147-49 W. 22nd St., New York 11, N. Y.

CIRCLE 302 ON READER-SERVICE CARD

EPOXY ADHESIVE STICK.—Epistik rubs on heated parts like sealing wax. Parts are then assembled and cooled. Bonds any material that can stand curing temperature of 260 F.

Robert Marks Co., Dept. ED, 47 Goddard St., Providence, R. I.

CIRCLE 303 ON READER-SERVICE CARD

VIBRATION EXCITER.—Model LCM-100 has horizontal, air-supported shake table. Frequency range is 5 cps to 15 kc; force output, to 100 g.

L. C. Miller Co., Electrodynamic Div., Dept. ED, 5005 E. Slauson Ave., Los Angeles 22, Calif.

CIRCLE 304 ON READER-SERVICE CARD

INDUSTRIAL PRESSURE SWITCHES.—Models P428A, B, C, and D for control, signal, or alarm service. Units control liquid or gas pressures to 3000 psi.

Minneapolis-Honeywell Regulator Co., Industrial Div., Dept. ED, Wayne and Windrim Aves., Philadelphia 44, Pa.

CIRCLE 305 ON READER-SERVICE CARD

ADHESIVES.—Ray-Bond R-86009 and R-86044 two-component systems for bonding etched Teflon to wood, steel, glass, aluminum, ceramics, and plastics. Resistant to water and chemicals; cure at room or elevated temperatures.

Raybestos-Manhattan, Inc. Dept. ED, Bridgeport 2, Conn.

CIRCLE 306 ON READER-SERVICE CARD

PICK-UP ATTENUATOR.—Portable types 5890-A and -B measure transmitter signals directly from transmission line. Accommodate transmitter outputs from 25 to 250 w. Attenuation of 40 to 100 db from 25 to 54 mc; 35 to 80 db at 450 mc.

Allen B. Du Mont Labs., Inc., Dept. ED, 760 Bloomfield Ave., Clifton, N. J.

CIRCLE 307 ON READER-SERVICE CARD

ANTENNAS by CANOGA

and Antenna Tuners

COMMUNICATION & NAVIGATION



Airborne UHF-VHF communications and navigation antenna with built-in dual channel filter.

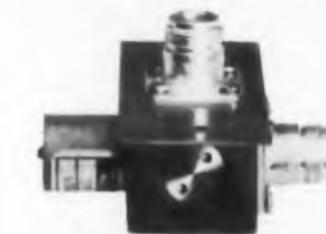
An extremely low drag L-band blade antenna for C&N applications.



At right is a Tuner Assembly for matching a Marker Beacon Antenna which is mounted in a supersonic aircraft.

At left is high-Q VHF parallel resonant circuit for matching a VOR antenna of a commercial airplane.

ANTENNA MATCHING DEVICES



TELEMETERING ANTENNAS



A very broadband antenna which easily covers the 2Kmc telemetry band.

A high gain telemetering antenna for the 200 mc band.



RADAR SYSTEMS USING
ANTENNAS DESIGNED AND
MANUFACTURED BY CANOGA

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CORPORATION
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5955 SEPULVEDA BLVD
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SCR-584 MPQ-7 MPQ-21
SCR-615 MPQ-10 MSQ-1
SPQ-2 MPQ-12 MSQ-1a
MPS-6 MPQ-14 AFMTC-II
MPG-2 MPQ-18 AFMTC-III

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REGARDING THE FOLLOWING:

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COMPANY _____

ADDRESS _____

CITY _____

STATE _____

- ANTENNAS
 TEST EQUIPMENT
 RECEIVERS
 RADAR SYSTEMS
 MICROWAVE COMPONENTS

DESIGN, DEVELOPMENT, AND PRODUCTION TO YOUR SPECIFICATIONS

CIRCLE 378 ON READER-SERVICE CARD

Economy and Quality with

NEW 22 Circuit Centralab.

MINIATURE SWITCHES



ACTUAL SIZE



For detailed specifications, write for Bulletin EP-90 or contact your Centralab representative.

These new switches are designed for application where costs must be kept to a minimum without compromising rigid electrical specifications. New laminated construction allows up to 22 separate switch points on a 1 1/8" diameter.

- Voltage breakdown, 1000 volts R.M.S. Back to back insulated clips, 500 volts R.M.S. Laminated phenolic sections type PBE per specifications MIL-P-3115.
- Current rating 2 amp. at 15 volts DC; 150 milliamps at 110 volts AC (resistive load).
- Minimum life, 10,000 cycles.
- Supplied as single section, double section, or single section with line switch. 2-12 positions per switch.
- AC line switches for single section units in SPST, DPST and SPDT switching arrangements.

Centralab

A DIVISION OF GLOBE-UNION, INC.
960M E. KEEFE AVE. • MILWAUKEE 1, WIS.
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VARIABLE RESISTORS • PACKAGED ELECTRONIC CIRCUITS • ELECTRONIC SWITCHES
CERAMIC CAPACITORS • ENGINEERED CERAMICS • SEMI-CONDUCTOR PRODUCTS

CIRCLE 379 ON READER-SERVICE CARD

NEW PRODUCTS

MAGNET WIRE.—For use in light weight moving coils. Specific resistance and temperature coefficient: 12.11 ohms and 0.00377 ohms per deg C for bare wire; 13.5 ohms and 0.00339 ohms per deg C for gold plated wire. Tensile strength: 115,000 psi.

Secon Metals Corp., Dept. ED, 17 Intervale St., White Plains, N. Y.

CIRCLE 380 ON READER-SERVICE CARD

SOLENOID VALVES.—SV-54 series 3-way units for general purpose and O.E.M. installations where millions of operating cycles are essential. Nylon seat and port threads outlast steel, are three times stronger. In all normal ac and dc voltages.

Valcor Engineering Corp., Dept. ED, 365 Carnegie Ave., Kenilworth, N. J.

CIRCLE 381 ON READER-SERVICE CARD

TV CAMERA PICKUP TUBE.—Vidicon 7262 for transistorized TV cameras. Bulb diameter of 1 in.; overall length of 5 1/8 in. Produces broadcast quality pictures with 1 ft-c of highlight illumination. Resolution of 600 lines.

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

CIRCLE 472 ON READER-SERVICE CARD

MICA FILM WAFERS.—Low cost, noncritical grade for transistors and other semiconductors. Prepunched to fit wide variety of bases, they insulate base from heat sink.

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

CIRCLE 382 ON READER-SERVICE CARD

MICROWAVE ANTENNA SYSTEMS.—Complete line featuring semiflexible Spir-O-line coaxial cable. Spun aluminum parabolic type with 2, 4, 6, 8, or 10 ft diameter. Aluminum mesh type with 4, 6, or 10 ft diameter.

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

CIRCLE 383 ON READER-SERVICE CARD

INSULATING VARNISH.—Fast-curing brand 133 has oven dry time of 30 min at 275 F; mil pickup of 3 to 4 mils; dry dielectric strength of 2480 v per mil. Available in test or production quantities.

Minnesota Mining and Mfg. Co., Irvington Div., Dept. ED, 900 Bush St., St. Paul 6, Minn.

CIRCLE 384 ON READER-SERVICE CARD

ALARM SYSTEM.—Model ST-DF static switching annunciator for process and automation control. Self-contained unit with no relays or solenoids. Operates on 24 to 250 v ac or dc.

Scam Instrument Corp., Dept. ED, 1811 W. Irving Park Rd., Chicago 13, Ill.

CIRCLE 385 ON READER-SERVICE CARD

MINIATURE TWIN PENTODE.—4BU8 sharp-cutoff, 9-pin tube for use in agc amplifier and TV receiver sync circuits.

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

CIRCLE 473 ON READER-SERVICE CARD

THERMISTOR



G-E high temperature thermistor RF-111 is capable of sensing temperatures up to 750° F.

General Electric RF-111 Thermistor

DETECTS EXPLORER I SKIN TEMPERATURE IN OUTER SPACE

One of the critical pieces of information relayed from space by Explorer I was the external skin temperature of the satellite as it orbited from sun to shadow around the earth. This exacting job of sensing temperature variations was assigned to a standard General Electric RF-111 high temperature thermistor.

Thermistors are thermal-sensitive semi-conductors with large negative temperature coefficients of resistance. In some types of G-E thermistors, it is possible to double the resistance with a temperature change of as little as 20° C.

In addition to temperature measurement, control, and compensation, G-E thermistors can suppress initial current surges which damage filaments or trip relays. They also are used in time delay sequence switching, and voltage regulating devices.

General Electric thermistors can be supplied with resistance values from 1 to 10,000,000 ohms and temperature coefficients of resistance from -1% to -5% at 25°C. For more technical information—or the assistance of a G-E engineer—write: Magnetic Materials Section, General Electric Company, 7820 N. Neff Street, Edmore, Michigan.

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GENERAL ELECTRIC

CIRCLE 386 ON READER-SERVICE CARD

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GIVES
YOU
MORE
FOR YOUR
POWER
RESISTOR
DOLLARS

Here's Why...

LIGHT WEIGHT
Hollow Ceramic Cores

NOMINAL T.C.
 ± 20 ppm/ $^{\circ}$ C

PRECISE
Tolerances to $\pm .05\%$

HIGH TEMPERATURE
Derating to 275 $^{\circ}$ C

INSULATED
1000 V-RMS Minimum

STABLE
.3% Max. Lifetime Drift

RELIABLE
"Built-in" Quality Construction



"SILICOHM" TYPE S • Axial Lead Units
(2-10 Watts) (.1 to 60,000 ohms) to
MIL-R-26C (Insulated) Specifications



"SILICOHM" TYPE M • Metal-Clad
(Chassis-Mounted) Units (25-50 Watts)
(.1 to 60,000 ohms) to MIL-R-18546B
(Ships) Specifications

WRITE FOR DESCRIPTIVE LITERATURE

SAGE

ELECTRONICS CORPORATION
P.O. BOX 126, ROCHESTER 10, N. Y.

TITANIUM ALLOY.—MST 881 exceeds long time strength properties of most steels at 1100 F. Withstands 1500 F for short periods.

Mallory-Sharon Metals Corp., Dept. ED, Niles, Ohio.

CIRCLE 388 ON READER-SERVICE CARD

SWAGE NUTS.—Series SPS female-threaded steel fasteners can be firmly anchored in sections 0.02 to 0.25 in. thick. Strong enough to break 160,000 psi bolts before failing themselves.

Standard Pressed Steel Co., Dept. ED, Jenkintown, Pa.

CIRCLE 389 ON READER-SERVICE CARD

PUSHBUTTON LAMP.—Miniature Echo-Lite combination pushbutton switch and neon lamp for computers and control systems. Mounts in 3/8 in. panel hole.

Transistor Electronics Corp., Dept. ED, 3357 Republic Ave., Minneapolis 26, Minn.

CIRCLE 390 ON READER-SERVICE CARD

FHP MOTOR.—Model 35YH37 develops 1/20 hp at 6500 rpm. Rated 200 v ac, 400 cps, three phase; draws 0.42 amp. Diameter, 2.5 in.; length, 2.5 in.

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

CIRCLE 391 ON READER-SERVICE CARD

VIDICON CAMERA TUBE.—Model WL-7290 for slow speed scanning. Holds resolution of 350 lines for two minutes.

Westinghouse Electric Corp., Electron Tube Div., Dept. ED, P. O. Box 284, Elmira, N. Y.
STOP—Turc. .30

CIRCLE 392 ON READER-SERVICE CARD

ULTRASONIC GENERATOR.—Model APT-500 for large-scale automatic cleaning operations. Activates up to 6 sq ft of transducer area or 300 gal of cleaning solution. Average power output of 3 kw.

Branson Ultrasonic Corp., Dept. ED, 40 Brown House Rd., Stamford, Conn.

CIRCLE 393 ON READER-SERVICE CARD

RECEPTACLES.—Hart-Lock duplex receptacles for grounding electrical equipment. Rated at 10 amp, 250 v and 15 amp, 125 v. Variety of grounding arrangements.

The Arrow-Hart & Hegeman Electric Co., Dept. ED, 103 Hawthorn St., Hartford 6, Conn.

CIRCLE 394 ON READER-SERVICE CARD

SOLENOID VALVE.—Type TT single-seated angle type, 3-1/4 in. high. For air, gases, water, oil, steam, and other media not harmful to brass. Pressure range: 0 to 400 psi. Pipe sizes: 1/8 and 1/4 in.

Atkomatic Valve Co., Inc., Dept. ED, 545 W. Abbott St., Indianapolis 25, Ind.

CIRCLE 395 ON READER-SERVICE CARD

HANDLES.—Formed from rugged 0.035 in. aluminum tubing with 1/2 in. diameter grip. Three sizes: no. 2000-1, 5-5/16 x 1-3/4; no. 2000-2, 7-3/16 x 2; no. 2000-3, 9-3/4 x 2-1/4. Special sizes to order.

Alpine Electronic Components Corp., Dept. ED, Wolcott Rd., Waterbury, Conn.

CIRCLE 396 ON READER-SERVICE CARD

DELAY LINES



by
TECHNITROL

Technitrol standard or specially-designed delay lines, continuously wound to close tolerances, are extremely compact and very stable. Standard tolerances of these distributed constant delay lines are: on delay, $\pm 5\%$; on impedance, $\pm 20\%$. Extremely stable with respect to environmental conditions, they are available cased in epoxy resin or hermetically sealed for military applications.



3 1/2" EPOXY CASE

Standard windings with delays from 0.1 μ sec to 1.0 μ sec and impedances from 560 to 5000 ohms are available in 3 1/2" case and 6" case. This is a stock item.



BD 1000-100

Epoxy resin case with leads grouped at one end. 1 μ sec delay; 1000 ohms impedance; rise time 0.1 μ sec max. This is a stock item.



STEEL CASES
HERMETICALLY SEALED

For multiple stick needs and military applications. Completely sealed, potted in foam. Delays are based on stick capacity and type of winding.



DIP-COATED

For economy, any standard winding is dip-coated in epoxy resin. Moisture resistant; stable for temperature range from -25° C to $+85^{\circ}$ C.

Write for
New Catalogs



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CIRCLE 387 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 10, 1958



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MODEL 1715

NEW SQUARE WAVE GENERATOR

Frequency range of 1 cps to 1 megacycle.
Rise time of 0.02 microseconds.
Highly stable.
Voltage regulated.
New centerline construction improves reliability.

\$265

SINE-WAVE SQUARE-WAVE GENERATOR

Covers a wide frequency range of 20 cps to 1 megacycle—both sine-wave and square-wave. Sine wave total harmonic distortion is below 1%. Square wave rise time is less than 0.1 microseconds.

\$495



MODEL 710

MICROVOLT and CRYSTAL CONTROLLED GENERATOR

Continuous frequency coverage from 125 kilocycles to 175 megacycles on fundamentals. Direct reading. Vernier tuning. Metered output from 0.1 to 100,000 microvolts—No external pad required.

Crystal controlled RF oscillator 400 kilocycles to 20 megacycles—to 250 megacycles on harmonics.

\$497

A demonstration or technical literature is available at your request



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FOR RESEARCH AND DEVELOPMENT

The Hickok Electrical Instrument Company • 10514 Dupont Ave. • Cleveland 8, Ohio

CIRCLE 308 ON READER-SERVICE CARD

NEW PRODUCTS

EXTRUDED POLYETHYLENE PLATE.—Widths to 48 in., thicknesses to 1-1/2 in. For neutron shielding on nuclear reactors. Tensile strength of 1700 psi.

Westinghouse Electric Corp., Micarta Div., Dept. ED, P. O. Box 2099, Pittsburgh 30, Pa.

CIRCLE 309 ON READER-SERVICE CARD

MYLAR HARNESS.—Lightweight Zippertubing with chemical and tensile qualities of Mylar, reflective quality of aluminum, and abrasion and tear strength of vinyl. Stands 400 F. In 1/8 in. increments from 3/8 to 4 in. ID. Lengths from 20 ft.

The Zippertubing Co., Dept. ED, 752 S. San Pedro St., Los Angeles 14, Calif.

CIRCLE 310 ON READER-SERVICE CARD

RF SEALS.—Electr-O-Seals for X-band wave guides. Provide fluid sealing, prevent rf leakage, and eliminate burning and arcing. Made to fit EIA standard guides.

Parker Seal Co., Div. of Parker-Hannifin Corp., Dept. ED, 10567 W. Jefferson Blvd., Culver City, Calif.

CIRCLE 311 ON READER-SERVICE CARD

SHIELDING GASKETS.—Die-formed from knitted wire mesh. For shielding wireguide joints, feed-through interference filters, and other openings in rfi shields. Can be made in almost any shape.

Technical Wire Products, Dept. ED, 48 Brown Ave., Springfield, N. J.

CIRCLE 312 ON READER-SERVICE CARD

VIBRATION SYSTEM.—Consists of 10 K amplifier, type V1001 vibrator, and type 1001 dc field supply. Provides ± 3000 lb thrust, 5 to 5000 cps. Meets requirements for vibration and fatigue testing to all MIL-E-5272A, -005272B, and -5422D procedures.

Genisco, Inc., Dept. ED, 2233 Federal Ave., Los Angeles 64, Calif.

CIRCLE 313 ON READER-SERVICE CARD

TV SILICON RECTIFIERS.—Unistac TV-500 delivers 750 ma and 130 v dc from 117 v rms input. Eyelet construction eliminates need for special sockets.

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

CIRCLE 314 ON READER-SERVICE CARD

PLIABLE ELECTRICAL CONDUIT.—Kopex tubing can be bent and set for corners and curves, eliminating need for bends and elbows. Can be easily cut with a knife. In standard sizes from 1/2 to 1-1/4 in.

Gemmer Mfg. Co., Kopex Div., Dept. ED, 6400 Mt. Elliott Ave., Detroit, Mich.

CIRCLE 315 ON READER-SERVICE CARD



Transistorized

FREQUENCY STANDARDS

- ★ Provide stable frequency source for missile requirements
- ★ Light weight—small size
- ★ Ruggedized for missile service

Compact, rugged, completely transistorized units . . . consisting of crystal controlled oscillator, six binary counter stages and tuned power output stage. Provides precision time and frequency reference. Proved out in current missile projects by all three armed services. Various frequencies and accuracies are available as required.

TYPICAL SPECIFICATIONS

Type TFS-400-28D

Output Frequency . . .	400 CPS
Frequency Accuracy . . .	$\pm 0.002\%$
Under the following conditions:	
temperature	0 to $+60^{\circ}\text{C}$
voltage variation	25 to 30 VDC
vibration	0 to 2000 CPS @ 100
Output Power	50 Milliwatts
Output Impedance	80 Ohms
Input Voltage	28 Volts DC
Input Power	1 Watt
Heater Voltage	28 Volts DC
Heater Power	3 Watts DC
Size	4 1/2" long x 1 3/4" diameter
Weight	11 Ounces

Write for data sheet or information on your specific requirements.

Designers for Industry
Incorporated 1935

4241 Fulton Parkway • Cleveland 9, Ohio

CIRCLE 316 ON READER-SERVICE CARD

NEW VIBRATING CAPACITOR



A vibrating-reed type capacitance modulator for use in measuring currents as low as 10^{-16} amperes.

Long term stability for process control. Drift ± 0.2 millivolts per day, non-cumulative.

Write for
Catalog 523.



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S/A-15

CIRCLE 317 ON READER-SERVICE CARD

MOLDED KNOBS.—Type K824 supplied with stainless steel skirts etched to suit. Military approved. Positive locking device, type L856, also available. Allows for locking without change in setting.

EPR Special Products Corp., Dept. ED, 675 Barbey St., Brooklyn 7, N. Y.

CIRCLE 318 ON READER-SERVICE CARD

REUSABLE CABLE LACING BOARD.—Type 120 permits unlimited cable pattern design and production with one or two board sizes per worker. Only drawings are needed for cable making preparations. In three sizes: 12 x 24, 20 x 24, and 24 x 30 in.

Fellows Engineering Co., Dept. ED, 1168 Meadowbrook Rd., Altadena, Calif.

CIRCLE 319 ON READER-SERVICE CARD

FHP MOTORS.—Ac, dc, pm, and universal types; speed governor and gear motors; induction and brake motors. Capacities from 1/1000 to 1/3 hp. Made by A. B. Ecliptic Co., Stockholm, Sweden.

Carter Motor Co., Dept. ED, 2764A W. George St., Chicago, Ill.

CIRCLE 320 ON READER-SERVICE CARD

CATHODE RAY BULBS.—Optical quality high temperature alumina-silicate glass. Flaws can be held to 0.001 in. or less. Stands temperatures to 700 C. Radiation and shock resistant. Dielectric constant of 6.4; resistivity of 8 at 600 C.

Corning Glass Works, Dept. ED, Corning, N. Y.

CIRCLE 321 ON READER-SERVICE CARD

TR TUBES.—Self-contained units meet all standard electrical and mechanical specifications between -55 and $+125$ C. Interchangeable with present JAN TR tubes in all bands.

Bomac Labs, Inc., Dept. ED, Salem Rd., Beverly, Mass.

CIRCLE 322 ON READER-SERVICE CARD

CONTINUOUS TAPE MAGAZINE.—Model 203 for computer, automatic test equipment, and similar use. Holds up to 100 ft of paper or plastic punched tape. Needs no driving belts or external mechanisms other than the tape punch or reader itself.

Brooks Research, Inc., Dept. ED, P. O. Box 67, Rochester 10, N. Y.

CIRCLE 323 ON READER-SERVICE CARD

FLEXIBLE PLASTIC WIRE MARKERS.—Indelible markers on vinyl tubing. Resistant to ultra violet light, oils, gasoline, alcohol, hydraulic fluids, salt spray, and carbon tetrachloride. Unaffected by temperature or abrasion. Surpass requirements of military Janization program.

Atlas Products Corp., Dept. ED, 30 Rockefeller Plaza, New York 20, N. Y.

CIRCLE 324 ON READER-SERVICE CARD



only the **Insuloid cradleclip** **WIRING SYSTEM**
offers these advantages to designers and producers of wire harness assemblies!

FAST

... takes only 5 seconds per fixing point ... many times faster than any other methods now in use. Provides a significant savings in time and labor ... speeds up production

FLEXIBLE

... ideal for the harnessing of any type of electrical or electronic wiring system. In case of design changes wires may be quickly and easily removed or relocated ... merely open the clip, remove the wire and the reclose the clip ... it's fast, easy and economical. No need to use new fastening devices for each change as with other methods. Saves time and materials.

EFFICIENT

... "Cradleclips" not only provide a strong vibration-free method of anchoring and binding wire harnesses but also provide greater ventilation for the cables. Cradles hold cables free of panel walls for excellent air circulation and heat dissipation. Provides a better cable rating with the possibility of using smaller diameter cables at the same diameter with a higher load.

**ALL BACKED UP BY FACTUAL PROOF
IN THIS TIME STUDY REPORT...**



Tests conducted by an independent Time-Study Organization provide positive proof of the time and material savings that can be realized through the use of "Cradleclips." This report could show you how to save your firm thousands of dollars each year. Write today for your free copy of the "Cradleclip" Time Study Report plus a free kit of "Cradleclip" samples.

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ELECTROVERT INC. 124 EAST 40th ST
NEW YORK 16, N.

CIRCLE 325 ON READER-SERVICE CARD

IMPROVED SWITCHING CHARACTERISTICS!

DELCO HIGH POWER
TRANSISTORS
OFFER UNSURPASSED
PERFORMANCE
FOR HIGH VOLTAGE,
HIGH POWER
APPLICATIONS



TYPICAL CHARACTERISTICS AT 25°C

	DT100	DT80	2N174A	2N174
Maximum Collector Current	15	15	15	15 amps
Maximum Collector Voltage (Emitter Open)	100	80	80	80 volts
Saturation Resistance	.02	.02	.02	.02 ohms
Thermal Gradient (Junction to Mounting Base)	.8	.8	.8	.8 °C/watt
Nominal Base Current I_b ($V_{EC}=2$ volts, $I_c=5$ amps)	135	100	135	135 ma
Collector to Emitter Voltage (Min.) Shorted Base ($I_c=.3$ amps)	80	70	70	70 volts
Collector to Emitter Voltage Open Base ($I_c=.3$ amps)	70	60	60	60 volts

*Designed to meet MIL-T-19500/13A (Jan) 8 January 1958

HERE IS A LINE OF TRANSISTORS SPECIALLY
DESIGNED FOR SWITCHING APPLICATIONS.

Check your switching requirements against the new characteristics of Delco High Power transistors. You will find improved collector to emitter voltage characteristics. You will find higher maximum current ratings—15 amperes. You will find that an extremely low saturation resistance has been retained.

Another important improvement is the solid pin terminal. And, as always, diode voltage ratings are at the maximum rated temperature (95°C.) and voltage.

Write today for engineering data on the *new* characteristics of *all* Delco High Power transistors.

DELCO RADIO

Division of General Motors • Kokomo, Indiana

BRANCH OFFICES

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

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

CIRCLE 326 ON READER-SERVICE CARD

PRODUCTION PRODUCTS

Tube Furnace Grows silicon crystals

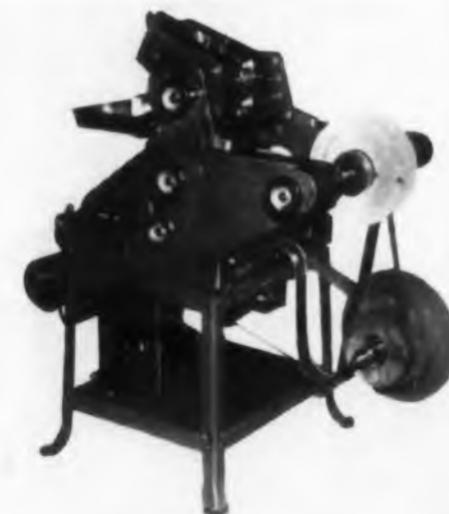


The growth of silicon crystals in an inert atmosphere takes place inside a 2-in. OD quartz tube in the G-02720-PT furnace. The furnace can maintain uniform temperatures up to 2560 F for 150 hours. The crystals are sliced into wafers, then cubes, for use in semiconductors.

Hevi-Duty Electric Co., Dept. ED, 2040 W. Wisconsin Ave., Milwaukee 1, Wis.

CIRCLE 327 ON READER-SERVICE CARD

Reel Packaging Machine For axial lead components



Designed expressly for diodes, this lead straightening and taping machine automatically reel packs axial lead components. It is adjustable for a variety of body lengths and diameters and can be adapted to lead or body taping.

Universal Instruments Corp., Dept. ED, 130 E. Frederick St., Binghamton, N.Y.

CIRCLE 328 ON READER-SERVICE CARD

Engravers

For drilling printed circuits



Unskilled operators can drill 100 holes a minute with the model D-2 printed circuit engraver. Various holes can be drilled without changing tools. For two dimensional work, this pantograph has an air cylinder attachment and a single micrometer adjustment for height.

Green Instrument Co., Dept. ED, 385 Putnam Ave., Cambridge, Mass.

CIRCLE 329 ON READER-SERVICE CARD

Silk Screen Press

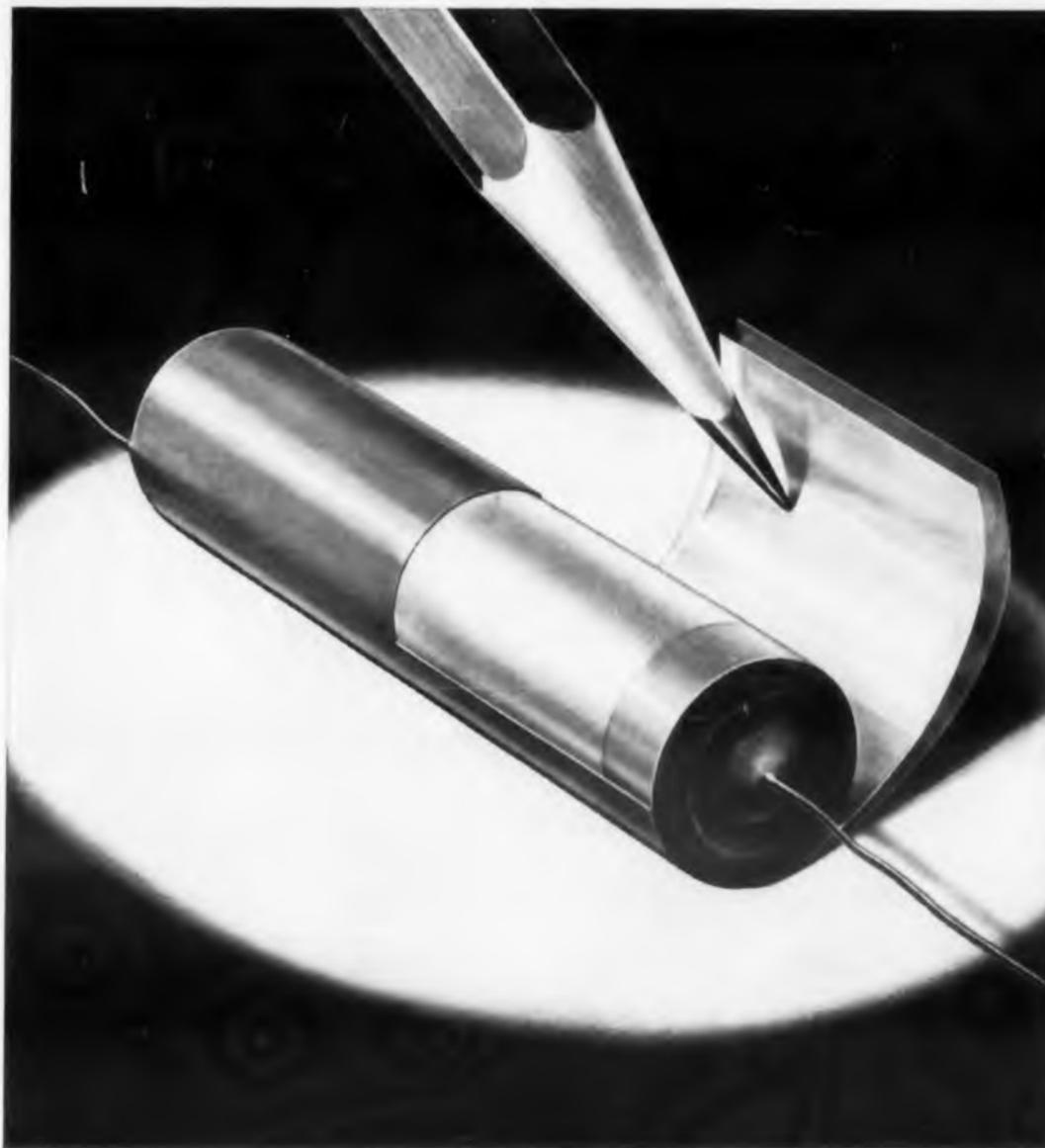
For printed circuits



Model 12 silk screen press is designed for screening etched circuitry resists, nameplates, panels, and components. The press screens a single pattern at a time. Then the screen is moved laterally to a stop and the pattern repeated. With this step and repeat system, all circuits or designs can be screened from a single pattern. For economical handling, they can be screened onto strips up to 18 in. long. Fast setup with registry to tolerances of 0.005 in. is obtained with two heavy crossfeed motions adjusted by handwheels reading thousandths of an inch, and a rotary indexing head reading 0.25 deg. Instantaneous vertical positioning of the screen mechanism permits adjustment of off contact distance. The screen moves laterally a total of 15 in. and locks rigidly in printing position. Printing base dimensions are 19.5 x 15.5 in.; vacuum area is 10 x 6 in.

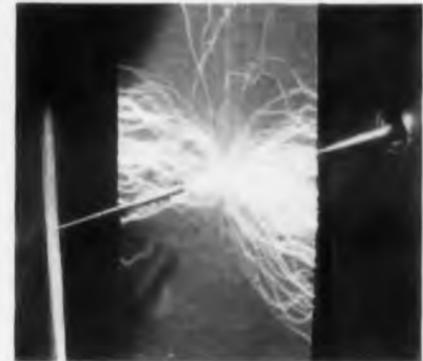
ECM Corp., Dept. ED, 8160 Orion Ave., Van Nuys, Calif.

CIRCLE 330 ON READER-SERVICE CARD



PROPERTIES OF "MYLAR"

"Mylar" offers a unique combination of properties that may help you improve performance and lower costs of your product. Here are two of the many important properties for evaluation.



HIGH DIELECTRIC STRENGTH: Average of 4,000 volts per mil... average power factor of 0.003 at 60 cycles.



SUPERIOR CHEMICAL RESISTANCE: Unaffected by oils, grease, most acids and alkalis, moisture and solvents.

Western Electric reports ...

Du Pont MYLAR® cuts capacitor costs

PROBLEM: Western Electric was searching for a dielectric material which, when used in film-foil construction, would lower manufacturing costs.

SOLUTION: Du Pont "Mylar" polyester film. According to Western Electric, the moisture resistance of "Mylar" minimized the need for costly encapsulation; high dielectric and physical strength in thin gauges helped reduce over-all size;

capacitance stability under normal voltage stress maintains long life.

RESULTS: Capacitors insulated with "Mylar" provide excellent performance for selected types of equipment produced by Western Electric. These new capacitors achieve high reliability and long life. Materials savings have been realized through reductions in size and use of less costly encapsulation.

HOW CAN "MYLAR" HELP YOU? Whether your product uses miniaturized capacitors or heavy-duty cables, it will pay you to investigate the performance benefits of "Mylar"... and products made with "Mylar". Component makers find this tough, thin polyester film will often cost less on an area basis than present insulating materials. For more detailed information, send in the coupon.



BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY

DU PONT
MYLAR
POLYESTER FILM

"MYLAR" is Du Pont's registered trademark for its brand of polyester film.

E. I. du Pont de Nemours & Co. (Inc.)
Film Dept., Room ES-12, Nemours Bldg., Wilmington 98, Del.
Please send booklet listing properties, applications
and types of "Mylar" polyester film available.

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

CIRCLE 331 ON READER-SERVICE CARD

CTS

ert gas
quart
furnac
2560
wafers

040 W

s lead
atically
ustable
ers and

D, 138

1958

"Metals for Precision
and Performance"



TUBING PROBLEMS?

Get help in less than 24 hours from

BISHOP'S QUICK SERVICE TEAM*

Don't let tubing problems delay your operations! When you need help in a hurry, call in BISHOP—manufacturers of *unexcelled* quality tubing. Within 24 hours BISHOP's Quick Service Team (QST) will go into action to provide expert assistance on your specific problems.

What is this Quick Service Team? It's a corps of metallurgists and specialists who will provide *sound*, sure advice . . . qualified men in sales who *know* tubing, are pledged to give *fast* reliable service . . . and production experts who will push your job through for *quickest* possible delivery.

BRIEFLY, THE BISHOP LINE . . .

STAINLESS STEEL TUBING Seamless, Welded & Drawn	Mechanical, Aircraft, Capillary, Hypodermic also NEW Stabilized and L grades, precipitation hardening alloys	0.008" to 1.000" OD 0.003" to 0.083" wall
NICKEL & NICKEL ALLOY TUBING	All standard grades	up to 1.000" OD 0.065" wall max
TUBULAR FABRICATED PARTS	Flanged, flared, milled, slotted, swaged, threaded	
GLASS-TO-METAL SEALING ALLOYS	Low expansion alloys for glass sealing applications	
CLAD METALS & COMPOSITE WIRES	Base metals & precious metals in various combinations.	
PLATINUM GROUP METALS	Fabricated products—chemicals	
CATALOGS, DATA SHEETS ON THE ABOVE SENT PROMPTLY ON REQUEST		

Get help in a hurry—start the Quick Service Team working for you. Contact Bishop by phone: Malvern 3100, by TWX: Malvern 570, or call your local steel warehouse.



Tubular Products Division



J. BISHOP & CO.

platinum works

MALVERN, PENNSYLVANIA

CIRCLE 332 ON READER-SERVICE CARD

PRODUCTION PRODUCTS



Carbon Arc Printing Lamps

For printed circuit
production

Fully automatic, Grafarc high intensity carbon arc printing lamps use a point source of light. This and the absence of undercutting permit speed and accuracy in printed circuit production. The lamps are single or three phase with power ranges for printing frames of all sizes.

The Strong Electric Corp., Dept. ED, 140 City Park Ave., Toledo 1, Ohio.

CIRCLE 333 ON READER-SERVICE CARD

Cold-Heading Machine

For small parts



The Omega 00 is an accurate cold-heading machine designed for miniature parts. It can produce electrical contacts, rivets, pins, and similar parts with diameters of 0.012 in. A standard solid die, double stroke machine, it cuts between 80 and 120 pieces a minute to length, head, and form. It handles wide diameters of 0.07 in. for most alloys, 0.12 for soft aluminum. Part lengths may range from 0.016 to 0.4 in. The Omega 00 will also hollow rivets. The depth of the hole is three times the wire diameter in aluminum, one and a half times in copper and brass. The cabinet has a double decker drawer to receive completed parts.

The Robert E. Morris Co., Dept. ED, 500 Farmington Ave., West Hartford, Conn.

CIRCLE 334 ON READER-SERVICE CARD

NEW MATERIALS

Epoxy Casting Systems

For low dielectric loss applications

Isocast 405 and 441 are 100 per cent solids epoxy resins containing no reactive diluents. The 405, suitable for most casting, potting, and encapsulating operations, may be used over a wide temperature range and facilitates encapsulation of heat sensitive components. The 441 is recommended for sealing, potting, and encapsulation of coils, resistors, transformers, rectifiers, capacitors, and other components.

Isochem Resins Corp., Dept. ED, 221 Oak St., Providence 9, R.I.

CIRCLE 335 ON READER-SERVICE CARD

Silicone Laminate

Heat resistant



Made from a coarse weave, continuous filament glass fabric bonded with a silicone laminating resin, CDF grade Dilecto GB-89S is resistant to heat, flame, arc, and moisture. The laminate comes in sheets or molded shapes. It is suited for such applications as terminal, mounting, and spacer blocks for motors and generators; spacers for separating coils in dry type transformers; terminal boards and switch bases in electronic equipment and dielectric heaters; and power devices, such as switchgear and electric welders, which involve arcing and localized or ambient temperatures to 200 C. Dielectric strength is 60 kv; dissipation factor, 0.0025 at 1 mc; dielectric constant, 4 at 1 mc; and loss factor, 0.01 at 1 mc. Surface resistance is 2000 meg; insulation resistance, 5000 meg.

Continental-Diamond Fibre Corp., Dept. ED, Newark 107, Del.

CIRCLE 336 ON READER-SERVICE CARD

another
RADIO RECEPTOR
semiconductor
achievement

3* AMP / IN²

with the revolutionary new

Tri-AMP SELENIUM RECTIFIER

3 times normal current density

- life expectancy of 100,000 hours.
- 26 volt cells — lower forward voltage drop.
- no parallel devices for voltage division.
- no series devices for load sharing.

THE DIFFERENCE AT A GLANCE!

New Tri-AMP 3-phase Bridge		Standard Type 3-phase Bridge	
Dimensions	Amp.	Dimensions	Amp.
4" x 4" *Fan Cooled	54	4" x 4" Fan Cooled	16.8
4" x 4" Convection Cooled	18	4" x 4" Convection Cooled	6.7

Now you'll understand why conventional selenium rectifiers are now obsolete!

Not just a variation of standard selenium rectifiers — TRI-AMP is a *new* selenium semiconductor with far greater reliability, operating at *three times* the current density of standard stacks. It has the overvoltage and overcurrent advantages of selenium, which means there is no need for the expensive and elaborate protective

devices so necessary when using other semiconductors.

Our Radio Receptor plant, working with unique equipment developed by Siemens of West Germany, is now producing TRI-AMP selenium semiconductors for immediate delivery. Please request full information from Section ED-12R

General Instrument Corporation
also includes Automatic Manufacturing
Division, F. W. Sickles Division,
Micamold Electronics Manufacturing
Corporation (subsidiary)



semiconductor division

RADIO RECEPTOR COMPANY, INC.

Subsidiary of General Instrument Corporation

240 Wythe Avenue, Brooklyn 11, N. Y.

GENERAL INSTRUMENT DISTRIBUTORS: Baltimore: D & H Distributing Co. • Chicago: Merquip Co. • Cleveland: Pioneer Electronic Supply • Los Angeles: Valley Electronics Supply Co., Burbank • Milwaukee: Radio Parts Co., Inc. • New York City: Hudson Radio & Television Corp., Sun Radio & Electronic Co. Philadelphia: Herbach & Rademan, Inc. • San Francisco: Pacific Wholesale Co. • Seattle: Seattle Radio Supply • Tulsa: Oil Capital Electronics

CIRCLE 337 ON READER-SERVICE CARD



NEW MODEL 122A

Here at last is a 200 KC oscilloscope—priced at just \$625—giving you “big-scope” versatility and the time-saving convenience of simultaneous two-phenomena presentation.

Engineered to speed industrial, mechanical, medical and geophysical measurements in the 200 KC range, the new Φ 122A has two identical vertical amplifiers and a vertical function selector.

The amplifiers may be operated independently, differentially on all ranges, alternately on successive sweeps, or chopped at a 40 KC rate.

Other significant features include universal optimum automatic triggering, high maximum sensitivity of 10 mv/cm, 15 calibrated sweeps with vernier, sweep accuracy of $\pm 5\%$ and a “times-5” expansion giving maximum speed of 1 $\mu\text{sec}/\text{cm}$ on the 5 $\mu\text{sec}/\text{cm}$ range. Trace normally runs free, syncing automatically on 0.5 cm vertical deflection, but a knob adjustment eliminates free-run and sets trigger level as desired between -10 and $+10$ volts. Rack or cabinet mount; rack mount model only 7” high.

For complete details, write or call your Φ representative, or write direct.

HEWLETT-PACKARD COMPANY

5140K PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
CABLE “HEWPACK” • DAVENPORT 5-4451
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

AT LAST! A Precision 200 KC Scope with Dual Trace Presentation!

BRIEF SPECIFICATIONS Φ 122A

Sweep: 15 calibrated sweeps, 1-2-5 sequence, 5 $\mu\text{sec}/\text{cm}$ to 0.2 sec/cm, accuracy $\pm 5\%$. “Times-5” expander, all ranges. Vernier extends 0.2 sec/cm range to 0.5 sec/cm.

Trigger selector: Internal + or -, external or line. Triggers automatically on 0.5 cm internal or 2.5 v peak external. Displays base line in absence of signal. Trigger level selection -10 to $+10$ v available when automatic trigger defeated.

Vertical Amplifiers: Identical A and B amplifiers, 4 calibrated sensitivities of 10 mv/cm, 100 mv/cm, 1 v/cm and 10 v/cm; $\pm 5\%$ accuracy. Vernier 10 to 1. Balanced (differential) input available on all input ranges. With dual trace, balanced input on 10 mv/cm range. Input impedance 1 megohm with less than 60 μmf shunt. Bandwidth DC to 200 KC or 2 cps to 200 KC when AC coupled. Internal amplitude calibrator provided.

Function Selector: A only, B only, B-A, Alternate and Chopped (at approx. 40 KC).

Horizontal Amplifier: 3 calibrated sensitivities, 0.1 v/cm, 1 v/cm, 10 v/cm. Accuracy $\pm 5\%$. Vernier 10 to 1.

Bandwidth DC to 200 KC or 2 cps to 200 KC, AC coupled.

General: 5AQP1 CRT, intensity modulation terminals at rear, power input approximately 150 watts, all DC power supplies regulated.

Price: (Cabinet or rack mount) \$625.00.

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

NEW LITERATURE

Sealed Relays

339

The latest information on hermetically sealed relays for military and general purpose industrial applications is described in Bulletin GEA-6628. Photographs, circuit diagrams, coil data, and specifications for microminiature (including the new Type GS), subminiature, miniature, and high-speed relays are included. General Electric Co., Schenectady 5, N.Y.

Resistive Phase Dividing Systems

340

Six-page bulletin, complete with graphs and schematics, compares the sine-cosine and linear potentiometer methods of phase dividing. Also included are modified linear methods. Technology Instrument Corp., 7229 Atoll Ave., N. Hollywood, Calif.

Miniature Connectors

341

Illustrated bulletin gives specifications and outline dimensions for series C-18 miniature hexagonal connectors which were designed for use in small electronic instruments, aircraft and portable field equipment. As stated in the bulletin, the series is available in 4, 5 and 7 contacts. DeJur-Amsco Corp., Electronic Sales Div., 45-01 Northern Blvd., Long Island City 1, N. Y.

Solder Terminals

342

For engineers working with circuit design problems a 21 x 27 in. wall chart of Cambion (R) solder terminals is being offered. The chart shows actual scale drawings, including dimensions and materials, of 60 of the most commonly used Cambion solder terminals. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.

Graphite

343

Presented in a Handbook of Engineering Data are graphs, tables, and curves relating to the use of manufactured graphite in a range of industries including the chemical processing, metallurgical, electrical, and nuclear fields. Printed in loose-leaf form, the handbook emphasizes a number of different grade of graphite, each of which has mechanical, chemical, thermal, and electrical properties suiting it to a specific industrial application. Supplementary data will be released as new information becomes available. National Carbon Co., Div. of Union Carbide Corp., 30 E. 42 St., New York 17, N. Y.



now offers 8 different precision scopes

CIRCLE 338 ON READER-SERVICE CARD

Test Equipment

344

An expanded line of microwave and uhf test equipment and components is described in an 84-page catalog. It provides illustrations of typical component setups for the measurement of impedance, attenuation, and other properties of waveguide and coaxial systems. In addition, typical problems and recommended solutions are given. The Narda Microwave Corp., 118-160 Herricks Rd., Mineola, N. Y.

Power Supplies

345

Covered in a 6-page multi-color folder type catalog. It includes transistorized inverters and converters, Transpac miniaturized power packs, power supplies for transistor applications, transistorized power supplies, transistor regulated dc power supplies, and transistorized frequency changers. Technical descriptions, specifications, application notes, model numbers, and prices are provided. Electronic Research Assoc., Inc., 67 Factory Pl., Cedar Grove, N. J.

How Not To Use Resistors

346

A sequel to the folder "How Not To Use Transistors," is another idiot's delight entitled "How Not To Use Resistors." Requesting this folder places the reader under no obligation to laugh. General Transistor Corp., 91-27 138th Place, Jamaica 35, N.Y.

Resistive Phase Dividing Systems

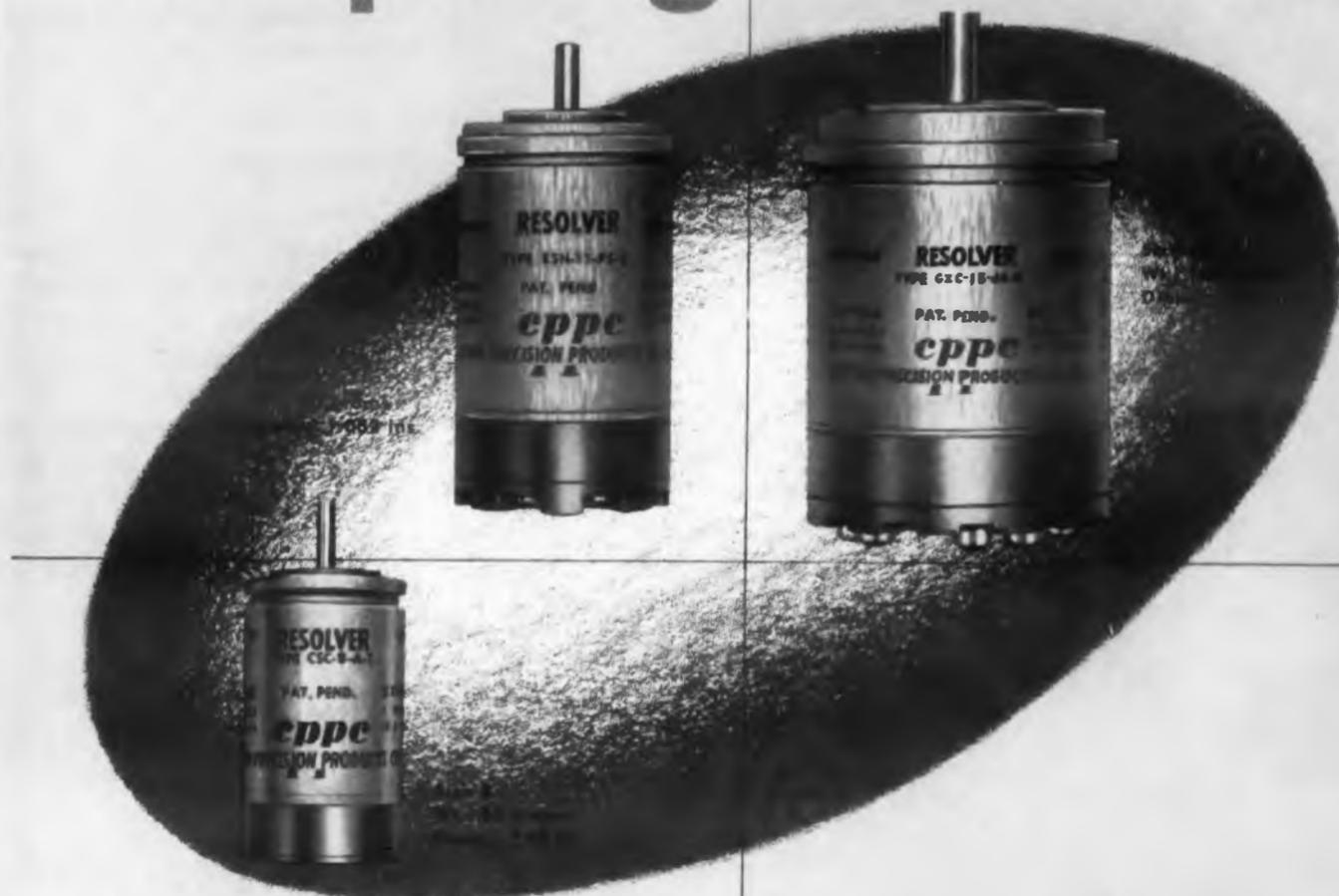
347

A six-page engineering bulletin, complete with graphs and schematics, discusses the comparison between sine-cosine and linear potentiometer methods of phase dividing. Technology Instrument Corp., 7229 Atoll Ave., North Hollywood, Calif.

Photosensitive Devices and Cathode-Ray Tubes

This revised catalog presents technical data, basing diagrams, and text descriptions of more than 100 tube types, with photographs of representative types. Included within its 32 pages are spectral-sensitivity curves on the photo-sensitive devices, dimensional outlines for all of the phototubes and the photoconductive cells, and a concise description of the features of each of the phosphor types used in the various cathode-ray tubes. The catalog may be obtained from RCA Tube Distributors or by sending 30 cents direct to Radio Corporation of America, Commercial Engineering, Harrison, N. J.

Precision Computing Resolvers



ACCURACY

Highest accuracy in rotating components is a CPPC fundamental. Our Precision Computing Resolvers are no exception. Without compensation, a recent production run of resolvers showed functional errors of .06% or less. Perpendicularity of axes was $\pm 3'$ in 360° . Due to extreme symmetry of rotor and stator, nulls are excellent in these resolvers. Low phase shifts are also a feature.

VERSATILITY

CPPC Precision Computing Resolvers can be had with any of the following features: corrosion resistant construction, stainless steel or aluminum housing. Units to resist temperatures up to 450° F. The following compensation is avail-

able in any or all units: resistive, feedback winding, thermistor. Types available for transistor circuitry. Pin or screw terminals or lead wires. BuOrd type shafts and BuOrd MK 4 Mod 0 brush block obtainable.

PRICE AND DELIVERY

We ask you to review what you are paying for precision computing resolvers. In the past CPPC has been able to lower traditional prices of rotary components.

We are already tooled for many types of these resolvers and can make quick delivery in quantity or short run. Whenever you need any rotary component, think of CPPC.

Call or write Sales Department, Hilltop 9-1200 (Suburban Philadelphia) or our Representatives.

cppe

CLIFTON PRECISION PRODUCTS CO., INC.

CLIFTON HEIGHTS, PENNSYLVANIA

CIRCLE 348 ON READER-SERVICE CARD



Now! RCA Victor powers its newest transistor radios with rechargeable batteries made to RCA specifications by Gulton



smaller size, longer life and ... it's rechargeable!

Rigid specifications of RCA Victor called for a tiny rechargeable battery to power two of its newest transistor radios. This battery had to be of sufficient reliability to permit advertising a 5-year warranty on performance. After extensive testing, it chose a "VO" sealed nickel cadmium button cell battery which exceeded specifications.

Makes New Designs Possible

Powering the RCA Victor sets is only one of many new applications for these batteries. Imaginative engineers have already designed them into photoflash power packs, burglar alarms, missiles, aircraft, prosthetic devices — wherever *small size, large capacity, light weight, long life, no maintenance, complete reliability and easy recharging* are desired.

Most Complete Line Available

"VO" cells are available in capacities of 100, 180, 250, 500 and 1750 mah; have a nominal 1.2 voltage; can be packaged in any combination to meet your voltage specs. Patented sintered plate construction provides exceptional cycling characteristics; highest capacity per unit size. Like more information? Write us for Bulletin No. VO-110.



Actual size of 100 mah button cell



ALKALINE BATTERY DIVISION

Gulton Industries, Inc.

Metuchen, New Jersey

CIRCLE 349 ON READER-SERVICE CARD

NEW LITERATURE

Wire Markers 350

4000 different self-adhesive wire markers are described in 8-page Perma-Code Wire Marker Bulletin, which includes markers for wire identification conforming to NEMA, National Machine Tool Builders Association specifications and ASA Std. C6. 1-1944, "Markings for Electrical Apparatus." Bulletin No. 130, W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis.

Transformers

"American Standard Requirements and Terminology for Specialty Transformers" is a 46-page publication including standards of ratings, dielectric strength, losses and impedance, regulation, temperature rise, construction, marking, service conditions, and definitions. *American Standard C89. 1-1957 at \$2.50 a copy, available from: American Standards Association, Dept. PR 20, 70 E. 45 St., New York 17, N.Y.*

Tape Recorder 351

Brochure describes the characteristics, specifications, and operating features of Model C-100 series of instrumentation tape recorders. The four-page bulletin, printed in 2-colors, describes how the new tape recording system utilizes a tape transport unit with dynamic braking. In addition, engineering specifications of the new transistorized recording system are included. Minnesota Mining & Mfg. Co., Mincom Div., 2049 So. Barrington Ave., Los Angeles 25, Calif.

Relays 352

Bulletins 700 & 780 describes single-pole and double-pole microminiature relays with 0.2-in. modular pin spacing, particularly well suited for printed circuit applications. Electronics Div., Iron Fireman Mfg. Co., 2838 S. E. 9th Ave., Portland 2, Ore.

TRU-OHM RESISTORS and RHEOSTATS

Designed to MEET and EXCEED MIL Specifications

TRU-OHM is your prime source for quality resistors and power rheostats to meet your most intricate requirement . . . for civilian or military applications. A TRU-OHM representative is in your area to serve you.



Find out why TRU-OHM is America's No. 1 Source for Wire-wound Resistors and America's Fastest Growing Source for Power Rheostats . . . Your inquiry will receive immediate attention.

Our latest catalog is available upon request

TRU-OHM PRODUCTS
Division of Model Engineering & Manufacturing, Inc.

General Offices:
2800 N. MILWAUKEE AVE.
CHICAGO 18, ILL.
FACTORY:
HUNTINGTON, INDIANA

CIRCLE 353 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 10, 1958

Industrial Tubes 354

A 30-page flip-style chart supplies electrical and physical characteristics for the most important electron tubes having industrial, special purpose and military applications. It indexes industrial tubes by class, explains the use of each class, and gives technical information pertinent to each type within the class. Design features and particular applications data are also included. Tung-Sol Electric Inc., 95 Eighth Ave., New 4, N. J.

AC Capacitors 355

Bulletin GEA-6789 describes outstanding features of company's newly designed ac drawn-case capacitors used in a wide variety of industrial applications. General Electric Co., Schenectady 5, N.Y.

Control Cable 356

Various constructions available and suggested applications of Triangle control cables are described in four-page

booklet. Lists the various sizes of control cables and describes the sheaths and insulations used. Triangle Conduit & Cable Co., New Brunswick, N.J.

Trimmer Potentiometer 357

Literature on the W-10 miniature trimmer potentiometer includes actual-size reproduction of product and diagrams showing its special features; physical, electrical and environmental specifications; de-rating chart; and resistance and resolution values. Bruce Industries, ATOHM Electronics Div., 515 E. Rosecrans Blvd., Gardena, Calif.

DC Amplifier 358

Bulletin AI 132.1 details new, high current, high voltage, wideband dc amplifier. Amplifier is designed for applications requiring a differential, isolated or grounded amplifier. Computer Engineering Associates, Inc., 350 N. Halstead, Pasadena, Calif.



SPECTRONIC PLATING CO., INC.

652 Hudson Street • New York 14, N.Y.

CIRCLE 359 ON READER-SERVICE CARD

1958 ELECTRONIC DESIGN • December 10, 1958

MEASURE VIBRATION AT 500° F

Endevco Accelerometers, employing Piezite Element Type II, measure vibrations and shock from -100° F to +500° F without correction. Complete cable and cathode follower systems to withstand 500° F are part of the many accessories for making up Endevco systems for flight and laboratory use. Endevco isolated compression accelerometer systems effectively measure 10 g of vibration in a 160 db noise field with signal/noise ratio of 20 to 1.

Calibration techniques and methods of best using accelerometers are discussed in a new Endevco Engineering Manual. Write for a copy. It will be helpful in solving your accelerometer requirements.

ENDEVCO CORPORATION

CIRCLE 360 ON READER-SERVICE CARD



The Saucer Fan represents an entirely new design concept whereby the driving motor is built within the propeller hub limiting its axial length to the minimum measurement required by a highly efficient motor. Ideally suited for tightly packed electronic packages, where space is critical, the Saucer Fan will provide cooling air to the amount of 280 cfm. Power requirement is 115 vac. 50-60 cps, 1 0.

The fan's pressure performance is tailored to the requirements of a modern, washable dustfilter. "Servo type" mounting flanges at each end of the venturi ring permit simplicity of mounting without loss of space. Direction of airflow may be easily reversed by turning the fan end for end. Electrical connections are made to a compact terminal block.

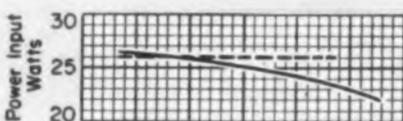
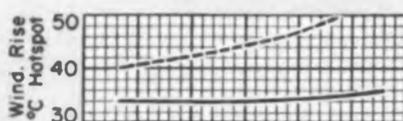
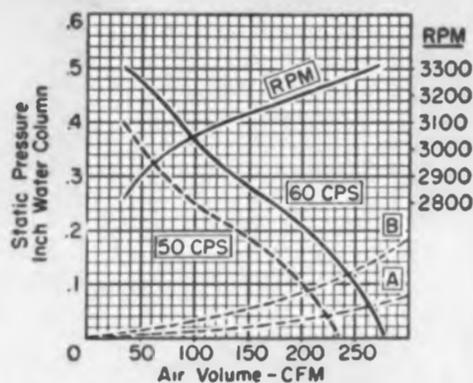
For complete technical details write to . . .



ROTRON

MANUFACTURING COMPANY, INC.

WOODSTOCK, NEW YORK In Canada: The Hoover Co., Ltd., Hamilton, Ont.



CIRCLE 361 ON READER-SERVICE CARD

NEW LITERATURE

Miniature Fan 362

Catalog sheet describes the Aximax-3 fan which delivers 165 cfm free delivery when turning at 20,000 rpm. The fan, meeting applicable Air Force specifications, is used for cooling electronic gear in missiles and aircraft. Mounting features and performance curves are given. Rotron Mfg. Co., Schoonmaker Lane, Woodstock, N. Y.

Batteries 363

This 16-page bulletin, T-533, covers the use, design, and construction of the firm's standard line of lead-antimony grid batteries of telephone, carrier and microwave service. The bulletin includes complete cell data on the entire line from 10 to 1680 amp hour ratings, curves on discharge characteristics, rack data, accessory details, and a complete listing of the company's sales and service offices. C & D Batteries, Inc., Conshohocken, Pa.

Transformers

Brochure describes facilities for the design and manufacture of custom transformers for industrial, military aviation missiles, and broadcast applications. List of transformer types include Epsal encapsulated and hermetically sealed transformers for aircraft and missile applications, high temperature transformers, and high power audio and power transformers in ratings up to 300 kva. Electro Engineering Works, 401 Preda St., San Leandro, Calif.

Ampifiers

This 16-page booklet provides data on the Model UPA-2 utility-packaged amplifier. Operation data, applications and schematic diagrams are included. George A. Philbrick Researches, Inc., 285 Columbus Ave., Boston 16, Mass.

Complex Ratio Bridge

Gertsch

MODEL CRB-1 & 2



- MEASURES:
 - X (in phase) RATIO
 - JY (quadrature) RATIO
 - TANGENT ϕ
 - ϕ IN DEGREES (10°)
 - ϕ IN DEGREES (1°)
- SELF CONTAINED
- HIGH ACCURACY
- USABLE SIX PLACE RESOLUTION
- PERMANENT CALIBRATION (no correction or "standardization" required)

The Complex Ratio Bridge is supplied in two models: The CRB-1 covering a frequency range of 30 to 1000 cps with the input voltage limited to 2.5 times the frequency in cps (ie: 150 volts at 60 cps); and the CRB-2 covering the frequency range of 50 to 3000 cps with the input limited to 0.35 times the frequency in cps (ie: 140 volts at 400 cps). The units are identical in all other respects.

Gertsch PRODUCTS, INC.

3211 South La Cienega Boulevard, Los Angeles 16, California • TEXAS 0 2761 - VERMONT 9-2201

CIRCLE 366 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 10, 1958

Wire

367

Brochure deals with comprehensive line of wire and wire bundle securing devices. The literature describes Dakota Bayonet Hangers, for fixed mountings with Dakota Straps, and the new Bundle-Tie Pliers, designed to facilitate fast firm strapping. Dakota Engineering, Inc., 4315 Sepulveda Blvd., Culver City, Calif.

Audio Connectors

368

Four-page catalog describes XLR Audio Electronic connector series for use on tape recorders, amplifiers, test instrumentation, computers, and other electronic instruments. Ordering nomenclature, construction details, and dimensions are included. Catalog XLR-3 from Cannon Electric Co., 3203 Humboldt St., Los Angeles 31, Calif.

Ceramics

369

Bulletin no. 858 includes mechanical and electrical properties of alumina ceramics AD-85, AD-94, AD-96, and

AD-99; and porous ceramic AP-100. Also included is a discussion of production and forming techniques, precision facilities for finishing ceramic parts, and facilities for high temperature metalizing and brazing. Coors Porcelain Co., 600 Ninth St., Golden, Colo.

Test Chambers

370

One page bulletin—SP 58—describes Walk-in Altitude, Sand & Dust and other testing chambers, with advanced designs built to customer specifications. Mr. Jack Shamroth, President, American Research Corp., Farmington, Conn.

Switches

371

New 4-page bulletin 858A describes latest line of precision snap-acting switches. Unimax Type A. Type A switch line described with photographs, dimension drawings, circuit arrangements, force and movement specifications, and electrical ratings. Mr. J. Martinez, Unimax Switch Div., The W. L. Maxson Corp., Ives Road, Wallingford, Conn.

PROGRAMMED AUTOMATIC CHECKOUT SYSTEM



The Robertshaw 500 System

*Tape Programmed—
Interchangeable Test Fixtures—
Visual Display and/or Printout—
Random Control Access—*

REDUCE ELECTRONIC CHECKOUT TIME— INCREASE RELIABILITY

The new Robertshaw 500 System shortens electronic instrumentation test time while assuring reliable checkout using semi-skilled personnel.

More than one million test combinations may be sequenced to cover virtually all checkout combinations. The test instrument is simply placed in the holding fixture and the "Start" button depressed. The ensuing operations are completely automatic and continue until test completion or an unacceptable test measurement is encountered.

As the test cycle commences, a tape reader distributes instructions from a *punched tape* to operational control elements, which 1) control *instrumentation*, 2) set *stimulation*, 3) set high and low limits into the *digital comparator*, and 4) establish special *holding fixture* operations. Comparison of test measurements with programmed tolerances is performed by the *digital comparator* and the results presented in a visual GO, NO-GO display form. A printed numerical record of test results is also provided as a permanent log of system operation. Test versatility is afforded through use of various tapes and holding fixtures. Full technical information will be gladly provided upon request.

Field offices and sales representatives in principal cities.

AERONAUTICAL AND INSTRUMENT DIVISION

Robertshaw-Fulton CONTROLS COMPANY

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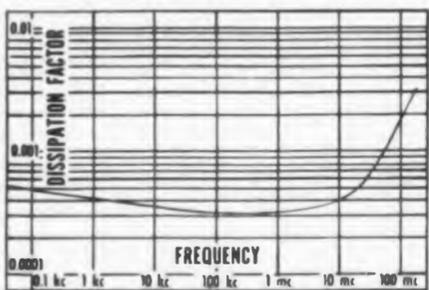
The biggest names in electronics use VITRAMON capacitors in guided missiles, jet ignition, proximity fuses and in radar, servo, guidance, fire control, telemetering and carrier telephone systems.

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VITRAMON capacitors have low dissipation over wide frequency ranges.

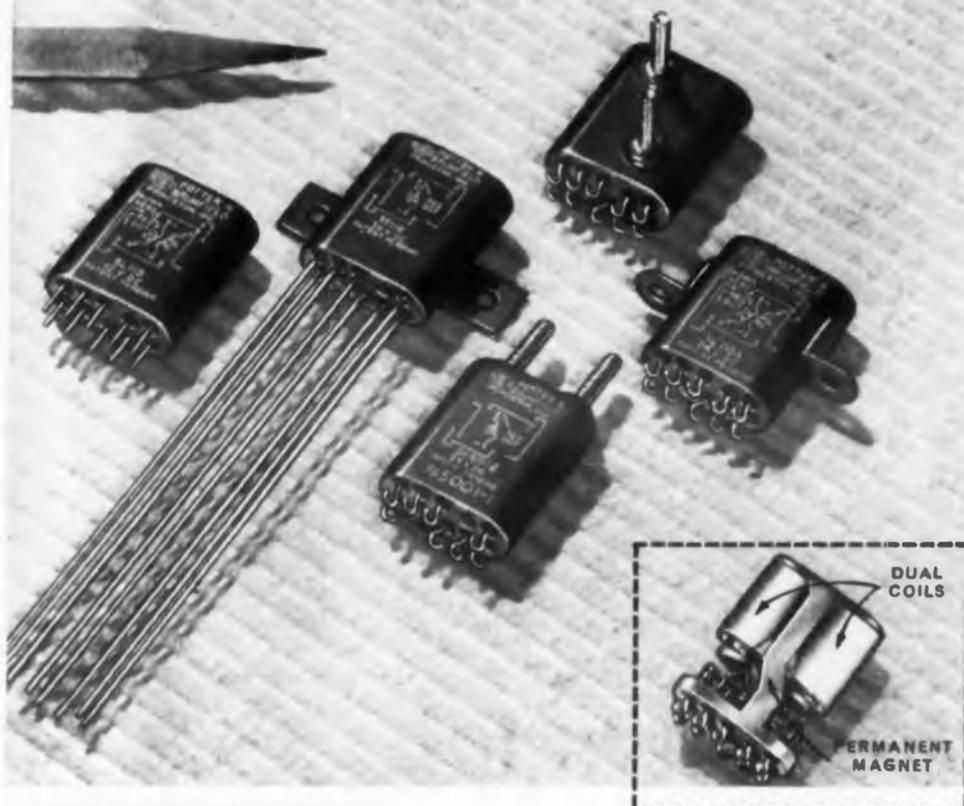


Two materials — a monolithic block of porcelain enamel and fine-silver electrodes — fused into one strong, stable, efficient and effectively homogeneous **RELIABLE** unit.

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P&B MICRO-MINIATURE RELAYS LEAD IN performance

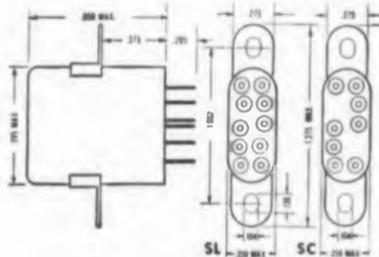
SHOCK: 100g* VIBRATION: 30g to 2000 cps*



*NO CONTACT OPENING

New P&B crystal-case size relays, the SC and the SL (magnetic latching), show amazing shock and vibration capabilities. They absorb shocks of 100g and vibrations 30g to 2000 cps. without contact openings!

One watt of power for 3 milliseconds operates either relay. Transfer time is unusually fast—0.5 milliseconds maximum.



SL—dual coil latching relay. Operates on a 230 mw, 3 ms. pulse at 25° C. Permanent magnet latch locks the armature in either position.

SC—non-latching relay with series-connected dual coils. Operates on approximately 260 mw at 25° C. Coils must remain energized to hold the armature in the operate position.

SC and SL Series Engineering Data

GENERAL:

Insulation Resistance: 10,000 megohms, min.
Breakdown Voltage: 1,000 V. RMS.
Shock: 100g. for 11 ms.

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

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

Weight: 15 grams without mounting bracket.

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

Transfer Time: 0.5 MS max.

Terminals: (1) Plug-in for microminiature receptacle of printed circuit board.
(2) Hook end solder for 2 #24 AWG wires.
(3) 3" flexible leads.

Enclosure: Hermetically sealed.

CONTACTS:

Arrangement: 2 Form C.

Load: 2 amps (at 28 V. DC, resistive; 1 amp (at 115 V. 60 cycles AC, resistive).

Pressure: SC—16 grams min.; SL—20 grams min.

COIL:

Power: SL—230 mw (at 25° C.

SC—260 mw (at 25° C.

Resistance: SL—10,000 ohms per coil max.

SC—20,000 ohms max.

Duty: Continuous.

MOUNTINGS:

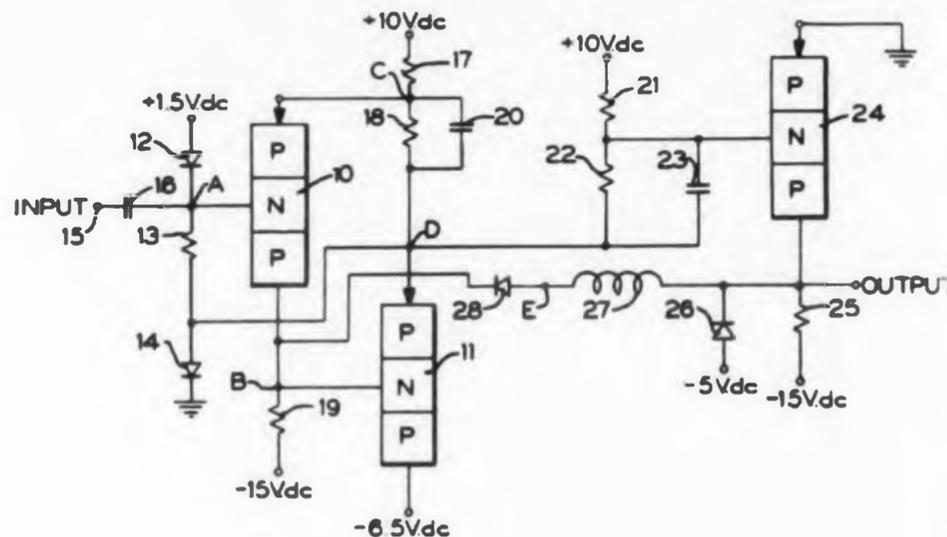
Bracket, stud and plug-in.

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CIRCLE 374 ON READER-SERVICE CARD

PATENTS



Pulse Generating Circuit

Patent No. 2,842,683. Genung L. Clapper (Assigned to International Business Machines Corp.)

The bistable transistor circuit generates a square wave pulse having a period of 0.3 μ sec to 3.0 μ sec which is fixed by delay line feedback.

A positive impulse cuts off transistor 10 and transistor 11 conducts. Inverted transistor 24 couples the step function to delay line 27. The step is maintained in the output for the predetermined period until the delay line feeds back a pulse to cut off transistor 11. Transistor 10 resets to its initially conducting state.



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Frequency: DC to 300 Mc
50 mV to 300 V in 5 ranges
Accuracy \pm 3% AC, \pm 2% DC
Measures R, 50 Ω to 5M Ω
Has Overload Protection
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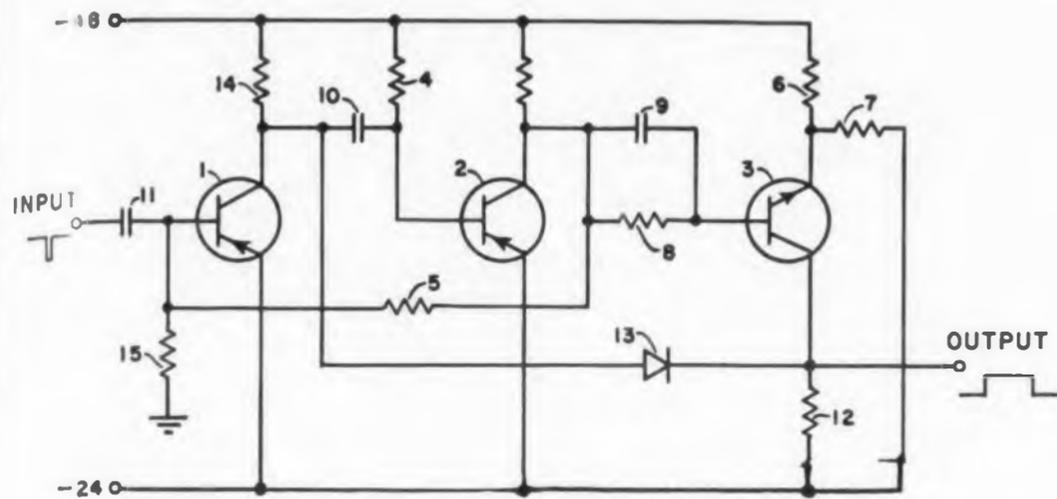


MARCONI INSTRUMENTS

111 CEDAR LANE • ENGLEWOOD, NEW JERSEY
CIRCLE 375 ON READER-SERVICE CARD



ELECTRONIC DESIGN • December 10, 1958



Monostable Trigger Circuit

Patent No. 2,837,663. Paul F. Walz. (Assigned to General Dynamics Corporation.)

The circuit generates a 100 msec pulse when triggered by a 10 µsec pulse. Another input pulse can trigger the circuit after output pulse terminates.

Initially pnp transistor 1 is cut off, pnp transistor 2 and inverter npn transistor 3 are conducting, capacitor 10 is charged through diode 13 to the voltage at the

junction of resistors 6 and 7. A negative input trigger causes the circuit to flip so that transistor 1 conducts and transistors 2 and 3 cut off. Therefore diode 13 cuts off since the plate and cathode are at equal voltage levels and capacitor 10 discharges through resistor 4. When the base-emitter voltage of transistor 2 becomes negative, the circuit flops back to its initial state and capacitor 10 quickly recharges through diode 13.

NEW

NEW

AMCI COAXIAL SWITCHES

Type 1038 for use in 6 1/8" lines

and now Type 1136
for use in
3 1/8" lines



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For use in Rigid
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- VSWR is under 1.05 over rated frequency range: 0-450 mc for the Type 1038 6 1/8" Coaxial Switch; 0-500 mc for the Type 1136 3 1/8" Coaxial Switch.
- CW rating is approximately that of the mating transmission lines.
- Switches are available in either motor-driven or manually operated models.

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TORNADO



IN A TEAPOT



The new 1802 Hydrogen Thyratron—available now in commercial quantities—offers unprecedented performance and ruggedness in a miniature ceramic envelope.

This new EG&G tube delivers 30 megawatts peak power in a smaller package than any comparable unit. It supersedes many older types and surpasses the performance of the Type 5948 1754 on all counts, in less than 1/7th the size. The new 1802 is air-cooled by convection and will tolerate ambient temperatures up to 100° C. Yet its warm-up time is only 5 minutes. Other comparisons with the 5948 1754:

	1802	5948/1754
Input Trigger Power	250 V at 400 ohms max.	650 V at 250 ohms max.
Delay time	0.5 µs rated (average is 0.25 µs)	1 µs
Jitter	.002 to .005 µs	.02 µs
Reservoir range	± 10%	± 5%
Filament power	90 watts	200 watts
Ambient temp. max.	100° C.	75° C.

Ever since the hydrogen thyratron was invented by K. J. Germeshausen, president of EG&G, this company has kept in the forefront of hydrogen thyratron development. For specific data on the 1802 and for most authoritative information on gas-discharge tube types and MILLI-MIKE* CRT's, TW oscilloscopes and systems, write to us on your company letterhead.

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...and now for a spot of welding!

Still at it? Trying to improve potentiometer reliability by building 'em yourself? Well, you're on the right track about one thing — welding's a sure way to eliminate a lot of operational headaches — like gassing contamination of contact metals at high temperature, from organic solder flux. No chance of "cold joints", either, to increase circuit resistance. No soldered connections to come loose under vibration and shock. Welding is the way to reliability!

But why set the wife's drapes afire to get a reliable, all-welded pot? Utilizing welding techniques, Ace produces reliable potentiometers operable at temperatures exceeding 150°C. and able to withstand 50 G's at 2000 cycles. All this, plus extremely low contact resistance and longer rated life. All taps, end connections, resistance elements, contact assemblies and terminal leads are specially prepared beforehand — then welded with pure nickel or palladium silver. So, for built-in reliability through sounder construction techniques, see your ACErep!



This 2" AIA Acepot® (shown 1/2-scale) incorporates all these exclusive welding construction features, for superior reliability.

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Acepot® Acotrim® Acoset® Aceohm® *Reg. Appl. for
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PATENTS

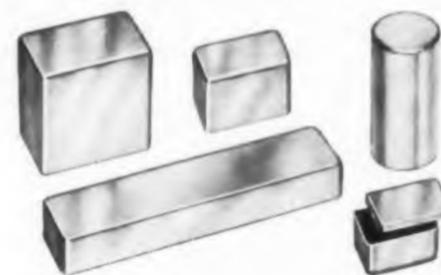
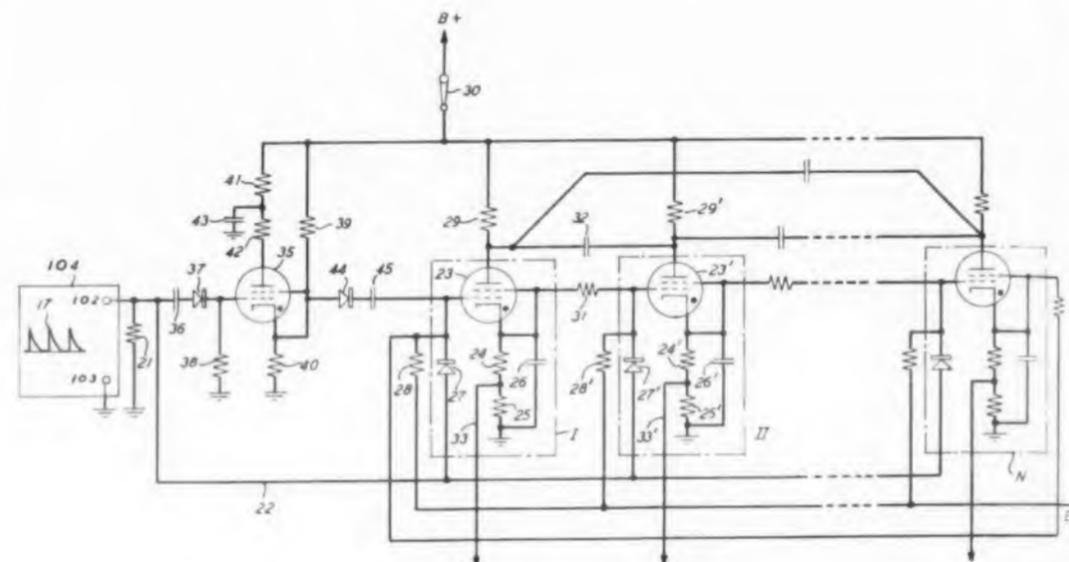
Pulse Initiator

Patent No. 2,851,635. Fred West (Assigned to Bell Telephone Laboratories, Inc.)

A ring counter consisting of several identical gas tube stages has provision for operating a preselected stage in re-

sponse to the initial input pulse

For the arrangement shown thyra-
trons 23, 23', etc, are connected in cas-
cade. The control grids are sufficiently
biased to prevent firing of any stage by
control pulses applied through cable 22.
Closing switch 30 sets the circuit oper-



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ELECTRONIC DESIGN • December 10, 1958

ating. The initial input pulse applied to terminal 102 fires tube 35. The rise in cathode voltage reduces the bias only on tube 23. This tube fires in response to the input pulse. When tube 23 conducts, its cathode voltage is raised and the bias on tube 23' is thereby reduced. The next input pulse fires tube 23' and the drop in plate voltage is fed back through capacitor 32, cutting off tube 23. The sequence continues with each stage cutting off the previous stage in response to successive pulses.

Adjustable Linear Amplifier

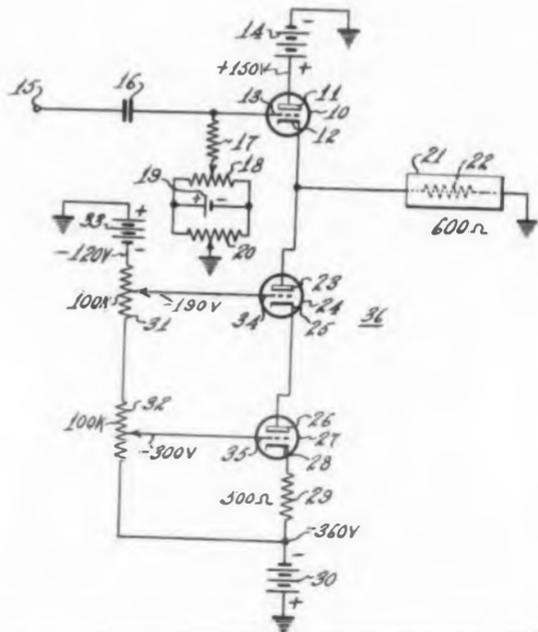
Patent No. 2,845,574. Louis Shapiro (Assigned to Radio Corporation of America.)

A cathode follower connected to the parallel combination of a load and a constant current source becomes a stable, adjustable, linear amplifier over a load current range of -120 to +120 ma.

When the signal applied to terminal 15 (see figure) goes positive, the cathode voltage remains fixed and the load current follows the increase in cathode cur-

rent. A negative signal causes the cathode voltage to decrease below ground potential and the decrease in cathode follower current reflects as a linear decrease in the load current.

The varying source impedance is given $(1+u)^2 R_{20}$ which, for the illustrated circuit components, is about 200,000 ohms.



High-temperature gyro and motor insulation problems solved with precision ceramic wedges

The failure of conventional rotor and stator insulating materials under severe heat conditions has restricted, in many cases, the high temperatures desirable in many modern technological applications.

The high temperature resistance of ceramic materials is well known, but insulating wedges for rotors and stators also require properties of mechanical strength and resilience that are not ordinarily typical of ceramic materials. Economical assembly of rotors also requires precision shapes without individual grinding.

Carborundum engineers solved these problems by ingenious modifications in design which provide precision shapes with mechanical strength far in excess of the requirements for resistance to the severe stresses of assembly and operation.

Wedges shown are typical of the precision ceramic parts now being supplied to gyro, motor and pump manufacturers.

For further information on these ceramic wedges or for help in solving one of your own problems, contact Carborundum, Refractories Division, Dept. ED-128, Latrobe Plant, Latrobe, Pa.

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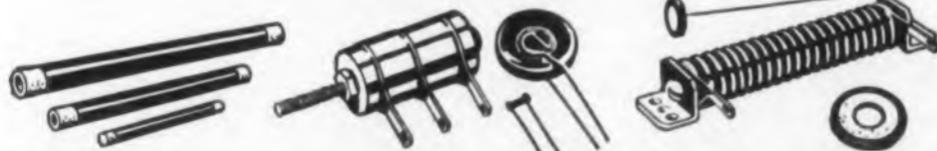
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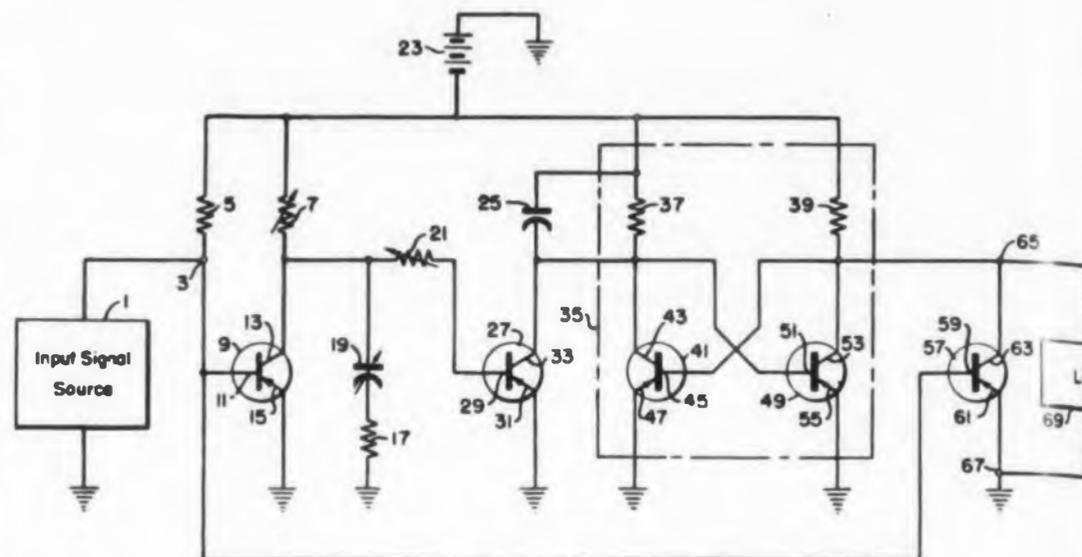
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WALLINGFORD, CONN.
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PATENTS



Static Time Delay Circuit

Patent No. 2,845,548. Sheldon D. Sillimon and John F. Reuther. (Assigned to Westinghouse Electric Corp.)

Time delay of a step-function is provided by a simple low-power transistor circuit.

In the circuit illustrated, transistor 9 is initially conducting. Capacitor 19 is

shorted and transistor 57 which is conducting shorts the output load. The coupled multivibrator has transistor 49 cut off while transistor 49 is conducting.

A negative step-function applied to the input signal source simultaneously cuts off transistors 9 and 57 to remove the shorts across both capacitor 19 and the load. Capacitor 19 now charges through

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ELECTRONIC DESIGN • December 10, 1959

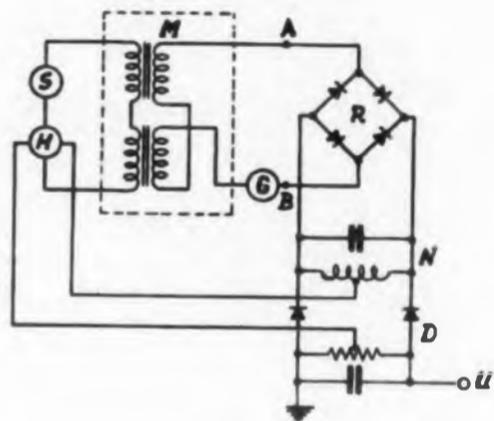
resistor increasing the current through transistor 27. After the predetermined period, the current through transistor 49 decreases regeneratively and a step-function is applied to the load. Finally, when the input signal terminates, capacitor 19 and the load are again shorted, the multivibrator switches back to its initial state and the step-function in the load terminates.

Magnetic or Dielectric Amplifier

Patent No. 2,835,747. Johannes Meijer Cluven (Assigned to North American Philips Co., Inc.)

An auxiliary oscillator adjusts the degree of polarization of a magnetic or dielectric material to reduce nonlinear amplification. Even-numbered harmonics are thereby suppressed. By suitable adjustment of the magnitude of the oscillation, the third harmonic may likewise be reduced.

The magnetic amplifier shown consists of transformer *M*, tank circuit *N* tuned to the frequency of the auxiliary oscillator and detector *D*. The trans-



former primary contains signal source *S* and auxiliary generator *H*.

Supply generator *G*, which controls the ferromagnetic core, is connected into the secondary winding. The frequency of the auxiliary generator *H* is intermediate to that of the lower frequency signal source and that of the higher frequency supply source.

The amplifier input consisting of the combined signal and auxiliary voltages is modulated by the supply source. After detection amplification of the signal having low harmonic content is developed.

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DIALL FS-6 withstands prolonged exposure up to 500°F. At this temperature it retains a flexural strength of 1800 psi, a compressive strength of 6000 psi, and a tensile of 4300 psi. Substantially greater strengths at lower temperatures. An asbestos-filled, Diallyl Iso-Phthalate compound, it has succeeded where the best Silicone materials failed.

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The Couch Type 4A relay heads a family of rugged relays — relays that can withstand the extremes of shock, vibration, and acceleration — all because of a unique patented rotary armature design. The 4A design will answer your dry circuit switching problems too. Our Bulletin 132 will tell you more. Write for it today.

IMPORTANT SPECIFICATIONS

Contacts: 4PDT (4 Form C)

Size & weight:
1 1/32" D x 1 1/2" H, 3.2 oz.

Pull-in power: 1/2 watt

Ambient temperature:
-65°C to 125°C

Vibration resistance:
20G, 5 to 2000 cps

Shock resistance:
75G operating
200G non-operating

Illustrated on the right are some of the many possible mounting variations available.

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COMPACT, 3-OUNCE TIME DELAY RELAY

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delay from 1/4 to 120 seconds



Worth a closer look . . . the Heinemann Type A Silic-O-Netic Relay. Despite its small overall size, the relay offers many big performance features.

For example, double-pole, double-throw switching . . . at fast snap-action contact speed.

The relay is a load carrier in itself: it may be energized continuously . . . does not require auxiliary lock-in circuits.

And it has a hermetically sealed time element that is forever free from the effects of aging or fatigue. The Type A Relay has proven itself in countless applications; it will give you reliable service over a long, long operational life.

BRIEF SPECS

Time Delays: from 1/4 to 120 seconds

Overall Dimensions: 2-1/16" x 2" x 1-9/16"

Contact Capacity: 3 amps at 120V AC, 1.5 amps at 240V AC (non-inductive load), 1 amp at 50V DC, 0.5 amp at 125V DC.

For full details, refer to Bulletin T-5002. A copy will be sent on request.

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S.A. 1078



BOOKS

Introduction to the Design of Servomechanisms

John L. Bower, Peter M. Schultheiss, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 510pp, \$13.00.

Emphasis is placed on stability and feedback system design in both single and multiple-loops. The authors provide a systematic approach to design, dealing with the principal performance requirements, such as harmonic response, time response, error coefficients and noise response. They attend to the common aspects of nonlinear operation. An attempt is made to treat the synthesis problem on a basis that permits the specifications on performance, given components, and noise to be handled at the same time.

An appendix covering servomechanism components is included.

TV and Radio Tube Troubles

Sol Heller Gernsback Library, Inc., 130 West 14th St., New York 11, N.Y. 200pp, \$2.90 and \$4.60 (hard cover).

The book is devoted to diagnosing and correcting electron tube troubles. Designed to be a workbench companion, it covers a variety of tube troubles and associated symptoms that might be mistaken for signs of a faulty tube.

Nine chapters discuss tube and component damage, tube troubles in TV and radio, picture and sound troubles, sync troubles, picture tube troubles, and replacement considerations.

Machlett ML-6442

UHF Medium-Mu Ceramic Triode



Machlett Laboratories announces the availability of a new ceramic UHF medium-mu triode designed primarily for use in grounded-grid cavity circuits as a plate-pulsed oscillator at frequencies up to approximately 4000 megacycles per second. This new tube also finds application as a radio-frequency power amplifier, continuous wave oscillator or frequency multiplier at frequencies to ap-

proximately 2500 megacycles per second.

Improved lighthouse design provides many advantages over previous types including short electron transit time, low inter-electrode capacitances, low electrode lead inductance, and excellent isolation of the anode from the cathode for efficient operation at higher frequency. Only 2-1/2" long and 19/32" in diameter, exclusive of grid flange, the ML-6442 is sturdy and light in weight and highly resistant to vibration and shock. The cathode heater is isolated from the cathode proper.

Maximum Ratings and Typical Operating Conditions. Plate-Pulsed Oscillator—Class C

Maximum Ratings, Absolute Values

For a Maximum Conducting Period of 5 Microseconds in any 5000 Microseconds Interval	
Peak Positive-Pulse Plate-Supply Voltage	3000 Max. Volts
Peak Negative-Pulse Grid-Bias Voltage	100 Max. Volts
Peak Plate Current From Pulse Supply	2.5 Max. Amperes
Peak Rectified Grid Current	1.25 Max. Amperes
DC Grid Current	0.00125 Max. Amperes
Plate Dissipation	7.5 Max. Watts
DC Plate Current	0.0025 Max. Amperes
Plate Input	7.5 Max. Watts
Pulse Duration	2.0 Max. Microseconds

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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Control System Components

John E. Gibson, Franz B. Tuteur, McGraw-Hill Book Co., 330 West 42nd St., New York 36, N.Y. 39 pp., \$12.00.

Aim of this book is the calculation of transfer functions of a number of the most commonly used components in servo mechanisms and other feedback control systems. Methods of analysis and basic engineering principles are presented from the systems engineer's viewpoint. It is directed towards the non-specialist interested in the analysis of components for application purposes. Electronic, electric, mechanical, hydraulic, and pneumatic components are discussed. In addition, recent advances, in magnetic amplifiers, transistors, hydraulic, and pneumatic systems are covered. Up-to-date information on network synthesis and thyatron amplifiers is provided.

The Plasma in a Magnetic Field

Edited by Rolf K. M. Landshoff, Stanford University Press, Stanford, Calif. 130 pp., \$4.50.

This volume came out of a symposium on magnetohydrodynamics held last year. The papers deal with plasmas rather than with liquid metals. Section One, on kinetic theory, shows how individual orbit analysis of important configurations can be simplified. The use of magnetic fields appears to be the most promising means for confining a hot deuterium plasma long enough to produce controlled thermonuclear power. However, the interface between a plasma and a magnetic field tends to be unstable. In Section Two evidence is presented for such an instability from both pinch effect studies and astrophysical observations. Section Three describes the method for generating flow.

Industrial Electronics Handbook

Edited by William D. Cockrell, McGraw-Hill Book Co., 330 West 42nd St., New York 36, N.Y. 35 pp., \$22.50.

The product of more than 100 contributors, this handbook offers descriptive and reference material covering all phases of industrial electronics and control. Nine sections cover basic engineering and mathematics, physical laws, control elements, power supplies, control circuits, circuit applications, mechanical design, ultimate utilization requirements, and technical information sources. Components and devices are described more from the standpoint of function than an aid in using them for particular applications. Subjects covered include computers, industrial instrumentation, regulators, relays, transmitters, amplifiers, military applications.



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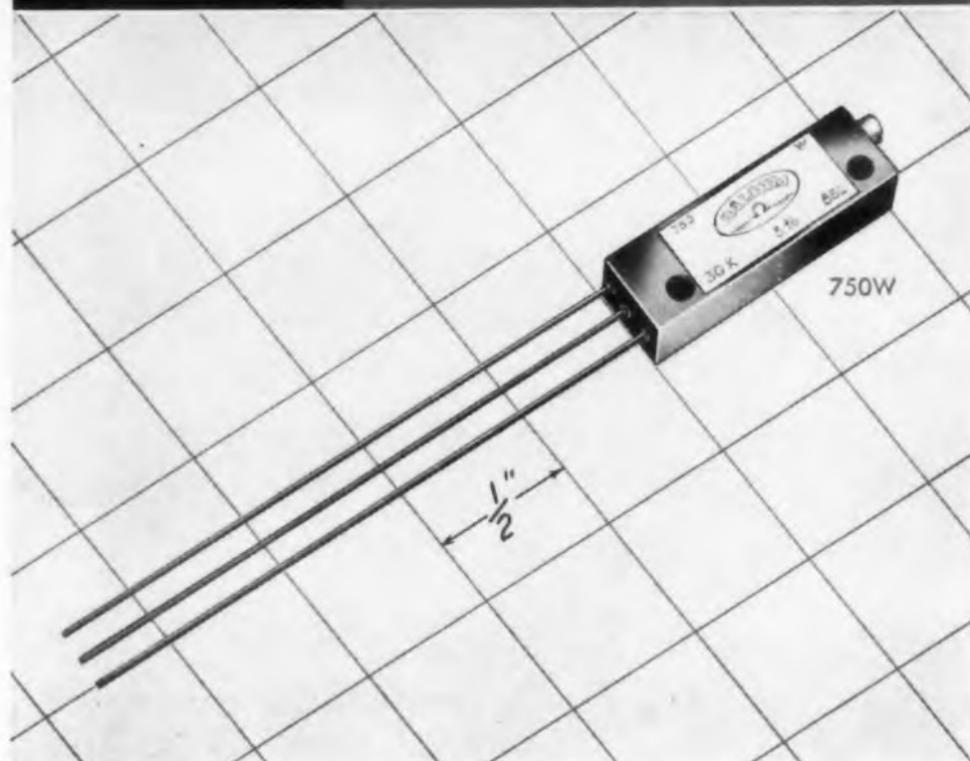


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TYPE 750 TRIMMER POTENTIOMETERS

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The 750 trimmer, with a completely sealed case and welded construction, offers outstanding performance and stability.

It has a space saving design for advanced electronic circuits where it's mandatory to meet demanding conditions of miniaturization, reliability, precision and severe operating conditions.

Two terminal styles available: 750W—with leads extending from end of case; 750WP—with leads extending from bottom of case for printed circuits.

• Rated at 2 watts, up to 70° C. ambient.

• Resistance range from 100 ohms to 30K ohms.

• Standard tolerance: $\pm 5\%$, closer tolerance available.

OPERATING TEMPERATURE RANGE: -55° C. to 175° C.

SUPER-MINIATURE SIZE: .180 x .300 x 1.00 inch.

RESOLUTION: .1% to 1%, depending on resistance.

SHAFT TORQUE: 5 inch ounces max.

BACKLASH: 10° maximum.

SCREW ADJUSTMENT: 18 turns, nominal.

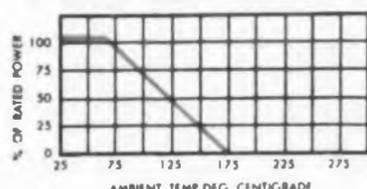
MOUNTING: Individually or in stacked assemblies with standard 2-56 screws.

SAFETY CLUTCH: Clutch arrangement on movable wiper contact prevents breakage due to over-excursion.

WEIGHT: 1.8 grams.

MILITARY SPECIFICATIONS: Surpass applicable paragraphs of MIL-R-19A, MIL-R-12934A, MIL-E-5272A and MIL-STD-202A.

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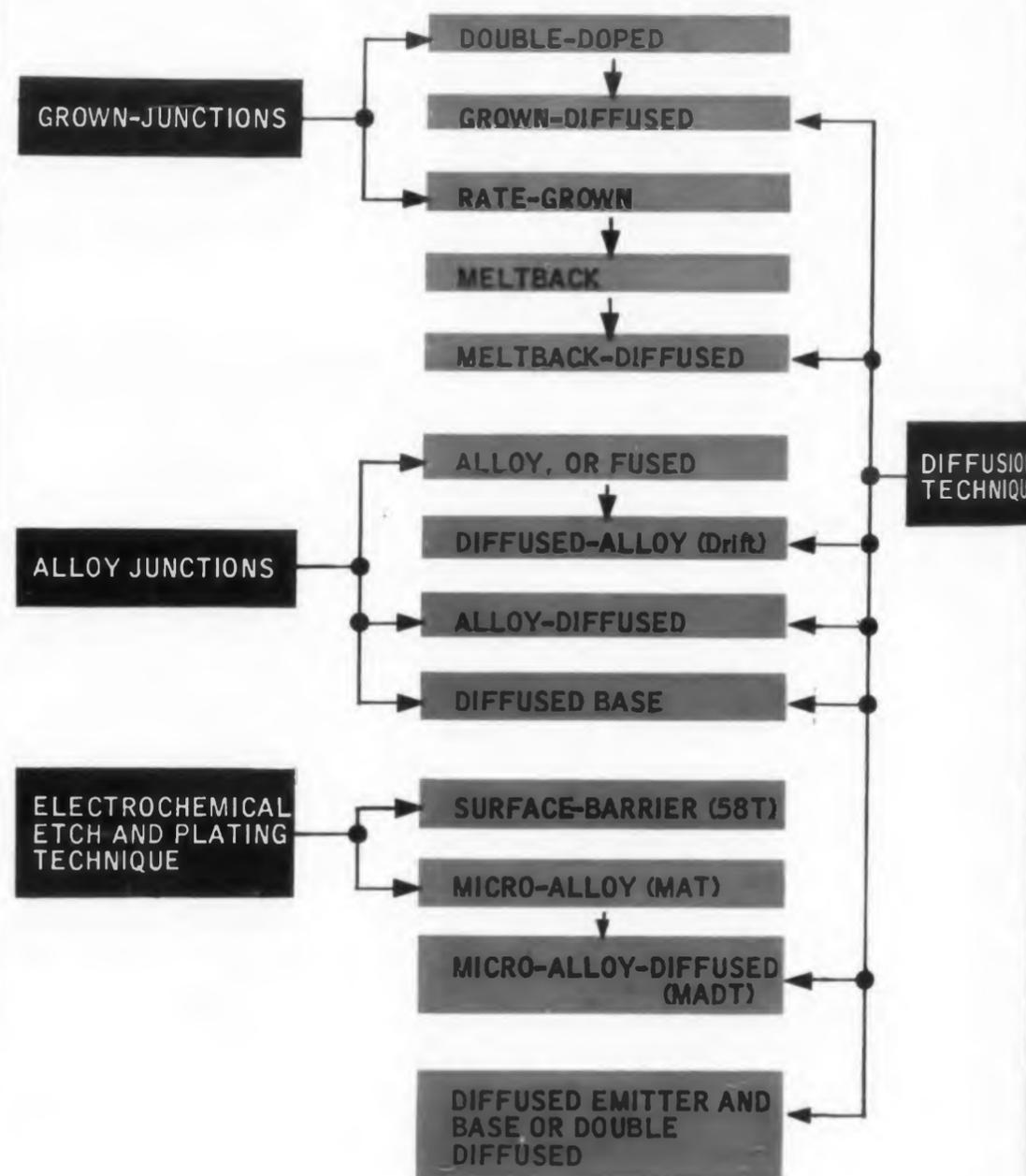
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Classifying

Junction Transistors

R. L. Pritchard

Texas Instruments Incorporated
Dallas, Tex.



Junction Transistor Classification Scheme

TRANSISTOR TYPES are classified according to four major categories: grown, alloy, electrochemical, and diffusion, according to the technique used for fabricating the emitter region. In this classification scheme the diffusion category includes only one of many types of transistors made by diffusion. Other types of transistors made by diffusion are listed under alloy, grown and electrochemical categories. For cross-reference purposes, an index is provided at the end of this article. A chart (see above) also is included to illustrate how diffusion is combined with the other transistor fabrication methods to produce different types of transistor structures. Only p-n-p and n-p-n structures are discussed here. However, transistors having an intrinsic region, that is, a p-n-i-p or n-p-i-n structure, also can be formed by the diffusion technique.

Grown-Junction Transistors

Double-doped Transistor. The original grown-junction transistor, formed by growing a crystal and successively adding p- and n-type impurities to the melt during the course of growing the crystal.¹

Rate-grown or Graded-junction Transistor. A variation of the double-doped type described above, in which n- and p-type impurities are added to the melt from which the crystal is grown.^{2,3} The growth rate then is varied in a periodic manner while the crystal is drawn from the melt. During one stage of the growth cycle, the crystal contains a predominance of p-type impurities. During the other stage of the cycle, n-type impurities dominate, resulting in a crystal from which n-p-n transistors can be cut.

Melt-back Transistor. A variation of the rate-grown transistor in which the rate growing is performed on a very small physical scale.⁴ This results in a lower thermal time constant for the crystal growing system, so that thinner base regions, and hence higher frequency transistors, can be obtained.

Melt-quench Transistor Very similar to melt-back transistor described above.⁵

Grown-diffused Transistor. This transistor is made by combining diffusion techniques and the double-doped process.⁶ In this case, suitable n- and p-type impurities are added simultaneously to the melt during the course of growing the crystal. Subsequently, the base region is formed by diffusion during the continued growth of the crystal.

Melt-back Diffused Transistor. This transistor is made by combining diffusion techniques and the melt-back process, analogous to the combination of the grown and diffusion techniques described above leading to grown-diffused transistors.^{7,8,9} In this case, however, the impurities are added to the transistor bar by the melt-back process, and the base region subsequently is formed by diffusion by growing the transistor bar.

Alloy-Junction Transistors

Alloy or Fused Transistor. Comprises a wafer of semiconductor material of n- or p-type conductivity with two dots containing p- or n-type impurities, respectively fused, or alloyed, into the wafer on opposite sides of the wafer to provide emitter and base junctions, while the base region comprises the original semiconductor wafer.^{10,11,12}

Drift Transistor. In scientific literature, a drift transistor refers to a type of transistor having a non-uniform, or graded, base region so that high-frequency response is improved relative to a similar uniform-base structure.¹³ Drift transistor is also a commercial name (RCA) for what is called below as a diffused-alloy transistor.¹⁴

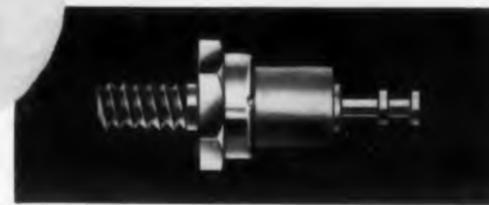
Fused-alloy Transistor. A transistor made by combining diffusion and alloy techniques. The semiconductor wafer first is subjected to a gaseous diffusion to produce the non-uniform base region. Then alloy junctions are formed in exactly the same manner as in a conventional alloy transistor.¹⁴ An intrinsic region transistor, e.g., a p-n-i-p unit, can be made by this technique by starting with a semiconductor wafer of essentially intrinsic conductivity.

Alloy-diffused Transistor. Another type of transistor is made by combining diffusion and alloy techniques. In this case, the alloy dot material contains both n- and p-type impurities. Then the emitter-base junction is formed by the conventional alloy process, while the base region and collector-base junction are formed by diffusion. The collector region comprises the original semiconductor wafer.^{15,16} Alternatively, if the original wafer is of the same conductivity type as the base region, then

(continued on following page)

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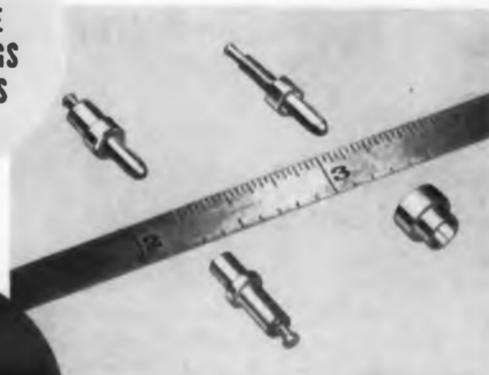


Swage type in 5 shank lengths ranging from .062 to .156, and the 6-32 internal thread type, and the 6-32 external thread type. All terminals are gold over silver plated.

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the emitter-base junction and the base region can be formed as described above, while the collector junction can be formed as in a conventional alloy transistor.¹⁷ In this case, as in the case of the diffused-alloy transistor, an intrinsic region can be included between base and collector.

Diffused-base Transistor. Another type of transistor made by combining diffusion and alloy techniques. In this case, a non-uniform base region and the collector-base junction are formed by diffusion into a semiconductor wafer that constitutes the collector region. Then the emitter-base junction is formed by a conventional alloy junction on the base side of the diffused wafer.^{18,19,20}

Etched and Plated Transistors

Surface-barrier Transistor (SBT). Comprises a wafer of semiconductor material into which depressions have been etched on opposite sides of the wafer by electrochemical techniques.³¹ The emitter and collector base "junctions," or metal-semiconductor contacts, are formed by electroplating a suitable metal on the semiconductor in the depression areas on opposite sides of the wafer while the original wafer constitutes the base region.

Micro-alloy Transistor (MAT). A variation of the surface-barrier transistor described above in which suitable n- or p-type impurities are first plated in the etched depressions, and then alloyed into the p- or n-type semiconductor wafer.^{22,23,24}

Micro-alloy Diffused Transistor (MADT). A transistor made by incorporating diffusion techniques with the micro-alloy transistor construction. In this case the semiconductor wafer is subjected to gaseous diffusion to provide a non-uniform base region prior to the electrochemical plating process.^{24,25,26}

Diffusion Transistors

Diffused-emitter and Base, or Double-diffused Transistor. Comprises a semiconductor wafer which has been subjected to gaseous diffusion of both n- and p-type impurities to form two p-n junctions in the original semiconductor material.^{27,28} An intrinsic-region transistor, e.g., p-n-i-p, also can be made by a variation of this process.²⁹

Summary of Transistor Types

Alloy	Graded-junction
Alloy-diffused	Grown-diffused
Diffused	Grown-junction
Diffused-alloy	Intrinsic Barrier
Diffused-base	Melt Back
Diffused-base Diffused-emitter	Melt-back Diffused
Double Diffused	Melt Quench
Double Doped	Micro-alloy
Drift	Micro-alloy Diffused
Fused	Rate Grown
	Surface Barrier

Acknowledgement

The material presented here by no means describes original work. A number of other semiconductor-device workers have categorized transistors in similar schemes. In particular, R. N. Hall has written an excellent survey paper describing the methods used to fabricate transistors.³⁰ The concept of the chart shown in the figure originated with Harry L. Owens.

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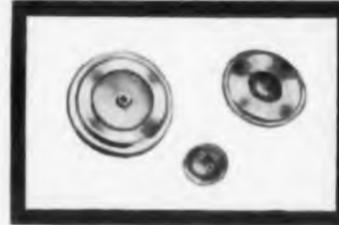
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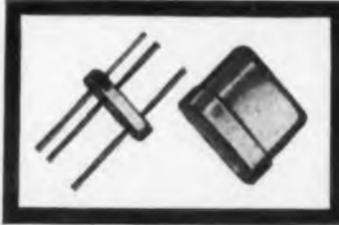
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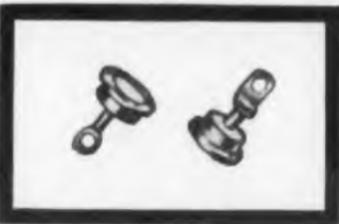
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Transistor Closures



Miniature Closures

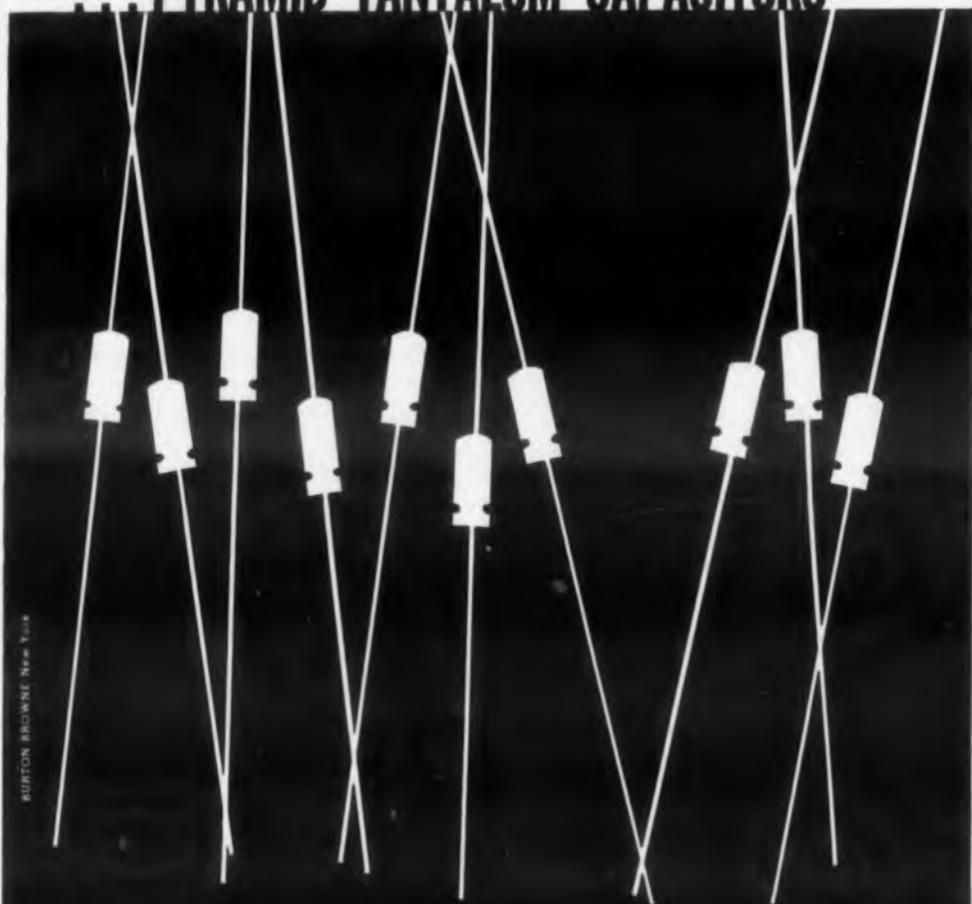


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Pyramid Tantalum slug capacitors are miniaturized to provide maximum space economy.

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

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

To obtain complete engineering data and prices for Pyramid Tantalum slug capacitors, write to: Pyramid Research and Development Dept., Pyramid Electric Company, 1445 Hudson Boulevard, North Bergen, New Jersey.

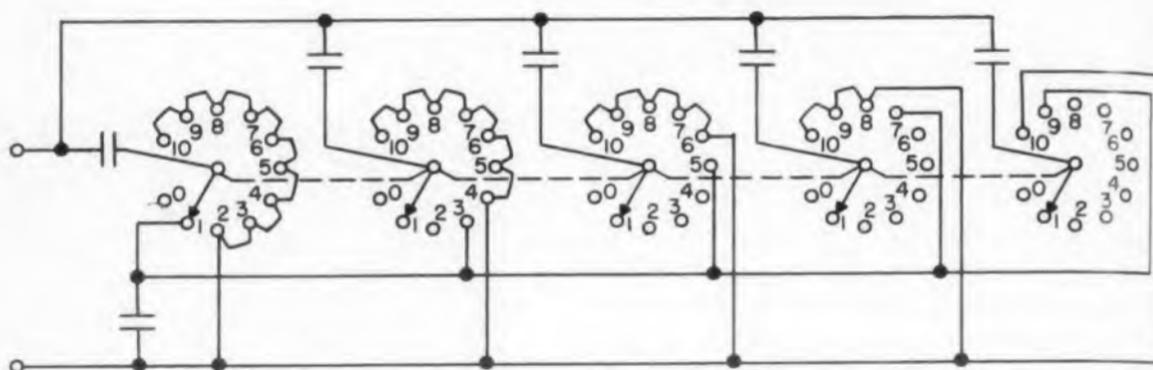
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Decade Capacitor



This decade capacitor doesn't open the circuit when it is switched from one value to the next.

Extra Scale For Better Measurements

DURING measurements of parallel resistance and capacitance on a group of high frequency resistors with a Boonton RX meter, it was found impossible to obtain the desired precision with resistors of 10K or greater at frequencies above 100 mc.

Resonance is indicated by a null deflection of the meter covering several divisions on the scale. Because the R_p scale is logarithmic, the length of divisions varies, the precise reading is often difficult to determine. A known method can overcome the difficulty in reading the R_p scale: detuning slightly on either side of the null region, and noting readings on an equal-division scale.

This is quickly and inexpensively done, without affecting the calibration of the RX meter, by making a scale from a piece of polar coordinate paper and cementing it to the front of the control knob in back of the R_p control knob as shown in the photographs. A wire pointer is attached to the control knob.

The coordinate paper scale is divided into 180 divisions so, by noting the pointer setting for the two positions on either side and the resonance, it is easy to adjust the pointer to the mean position. The R_p scale reading is still difficult to read in many cases because it is logarithmic.

(Continued on page 137)

\$10.00 plus a by-line for the time it takes to jot down your clever design idea. Payment is made when the idea is accepted for publication. Full information and an "entry blank" can be obtained by circling #166 on the Reader's Service Card.

MOST DECADE capacitors interrupt the circuit in which they're placed when they are switched from one value to the next. Between capacity values there is usually a momentary open circuit.

With the arrangement shown here there is a clean jump from one capacity value to the next, and there is always capacity in the circuit.

A five deck 11 position switch, of the make-before-break variety, is required for each decade, in addition to six equal capacitors.

For the 0-10 μf range in 1 μf steps each capacitor is 2 μf . Naturally, other decades can be wired across the terminal.

J. Johannessen, North American Aviation, Autonetics Div., Downey, Calif.

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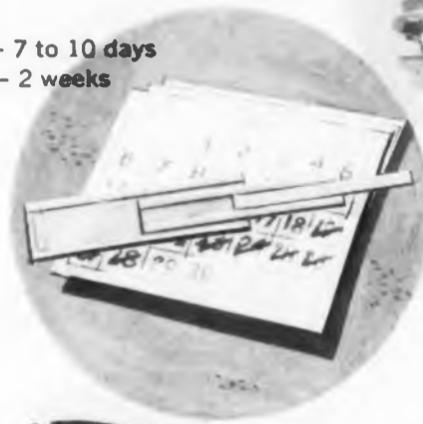
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illary scale, drawn on polar paper, extends the frequency usefulness of an RX meter.

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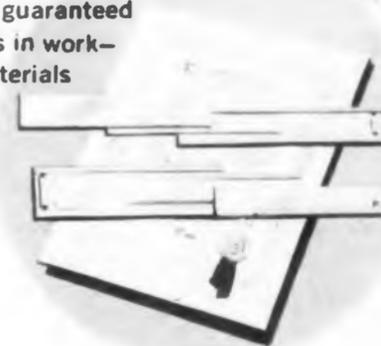
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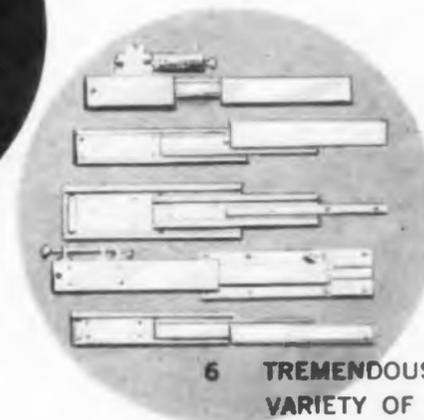
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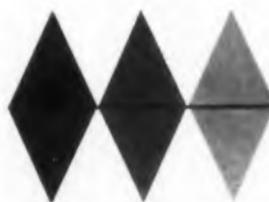
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IDEAS FOR DESIGN

If one wishes to further simplify the use of the auxiliary scale when obtaining the resonant point, it may be made of metal and arranged to be rotated about the shaft. Then it may be set to zero for one reading, and after the second reading, the pointer may be set at the mid point.

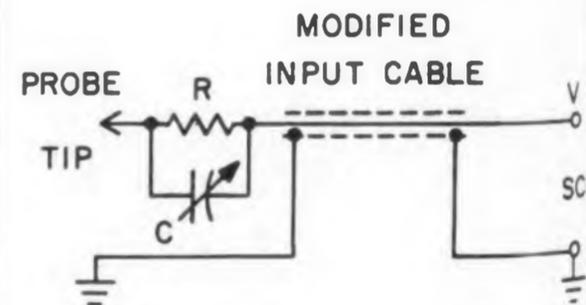
E. L. Hall, *Diamond Ordnance Fuels Laboratories, Washington, D.C.*

More Signal With Low C Probe

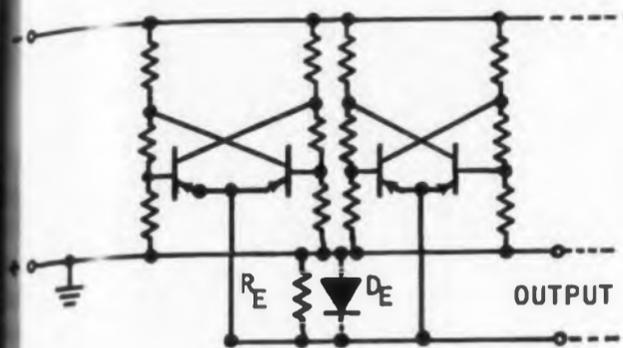
Here's how to obtain less signal attenuation with a low capacitance probe, without increasing the value of input capacitance. Conventional low capacitance probes provide signal attenuation of 10 to 1, with 1/10 of the input capacitance imposed by the input cable when used directly. It was desired in one case to raise the signal level by designing the probe system for 3 to 1 attenuation, with no increase in input capacitance.

Since the major portion of the input capacitance to a low capacitance probe is determined by the capacitance of the cable with which it is used, the shielded input cable was modified by removing the inner conductor. This was accomplished by clamping the inner conductor in place, and forcing the poly tube with braid jacket off the inner conductor. The inner conductor was then replaced by threading a length of No. 32 copper wire through the poly tube. The probe resistor was next replaced with another resistor having twice the value of the scope's input resistance. The trimmer capacitor was then adjusted to obtain uniform signal level at 600 and at 4 mc, and the probe assembly was completed.

R. G. Middleton, *R. E. T. S. Schools, Detroit, Mich.*



Modified low capacitance probe provides less signal attenuation with same capacitance. $R =$ twice input resistance of the scope. C is a 2 to 12 μf trimmer.



Uniform output is available from transistor flip-flops if a common emitter resistor (or diode) is used. The flip-flops are shown simplified (without capacitors or drive).

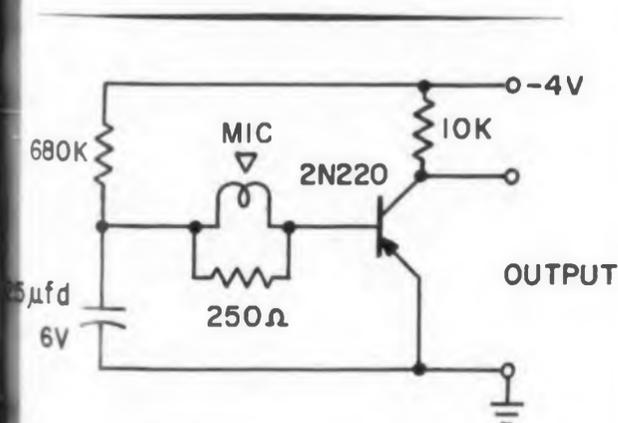
Uniform Output With Transistor Flip-Flops

It is often desirable to have a series of transistor flip-flops with their outputs as uniform as possible. This uniformity is difficult to achieve in the usual configuration without precision resistors. If all the emitters are connected together, though, the emitter voltages of each series are necessarily constant.

This system uses only one emitter resistor to carry the total current, instead of the usual one resistor per flip-flop. The "on" outputs are quite uniform, varying only with the saturation voltage variations.

Further improvement results if a silicon diode is used in place of the emitter resistor, as shown in the figure. This gives an emitter voltage of about 1.0 v (the forward drop across the diode). This is constant in spite of changing load conditions.

John L. Nairn, Electronics Engineer, Naval Ordnance Test Station, Pasadena 8, Calif.



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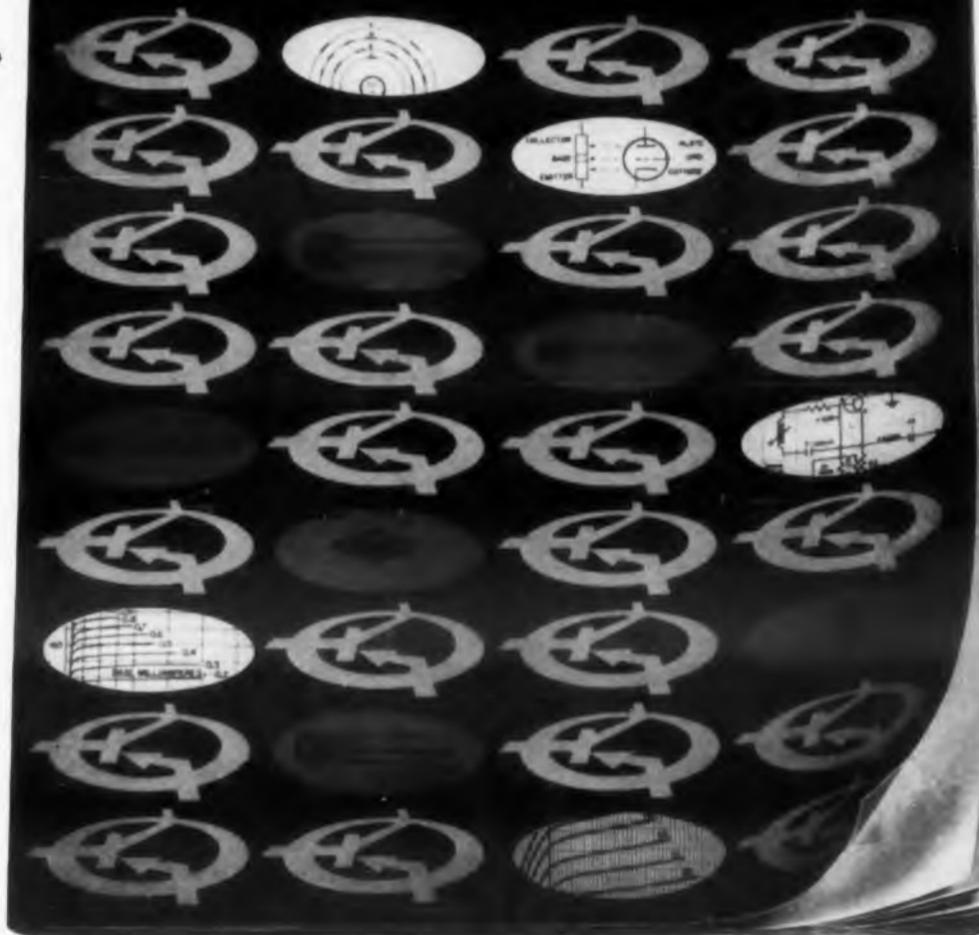
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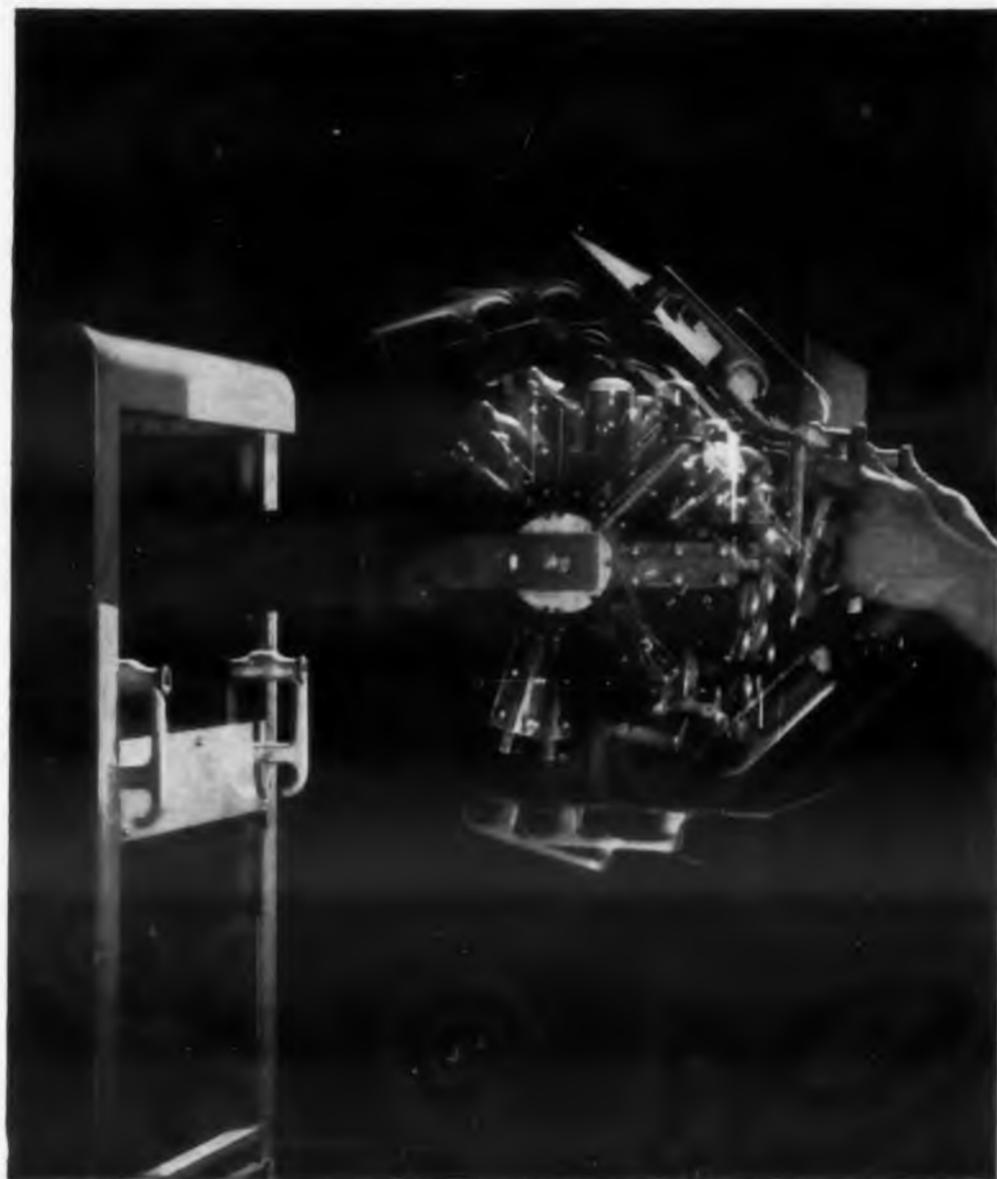
Semiconductor Products
Harrison, New Jersey

RCA
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48 pages...16 sections!

- 1—Introduction
- 2—Transistor Physics
- 3—The PN Junction
- 4—The PNP & NPN Junction Transistor
- 5—The Point-Contact Transistor
- 6—Transistor Characteristics
- 7—Types of Transistors
- 8—Transistor Amplifiers
- 9—Methods of Coupling
- 10—Gain Controls
- 11—Power Amplifiers
- 12—Oscillator Circuits
- 13—Power Supplies
- 14—Practical Transistor Circuits
- 15—Transistor Components
- 16—Servicing Transistor Circuits



with Chassis-Trak slides chassis locks in seven positions

With the touch of a finger on the handles of the chassis, it can be tilted up or down (45°, 90°, or 105°), and locked in any one of seven different positions.

This means you can remove tubes or check circuitry on the chassis quickly and easily, even though the chassis is at the top or the bottom of the rack . . . and the chassis will not swing or move during servicing. It is firmly locked in position! A spring mechanism allows instant removal of the chassis for complete maintenance.

Chassis-Trak slides are produced from cold rolled steel, and give smooth slide action because of a permanent-dry, dust-repellant phenol epoxy formulation . . . the more you use the slides, the smoother they operate.

With the pencil-thin Chassis-Trak design, you can cut engineering costs, by mounting 17" chassis in standard

19" racks. The slides (9 lengths, 10" to 24" supporting up to 275 lbs.), are available from stock, in either the "detent" model shown above, and the "basic" model, which tilts freely upwards but has no lock assembly. Chassis-Trak engineers will also custom-build slides for any of your special installations.

"Detent" model, locked in one of seven different positions.



For further information, contact:

525 South Webster, Indianapolis 19, Indiana

CIRCLE 419 ON READER-SERVICE CARD

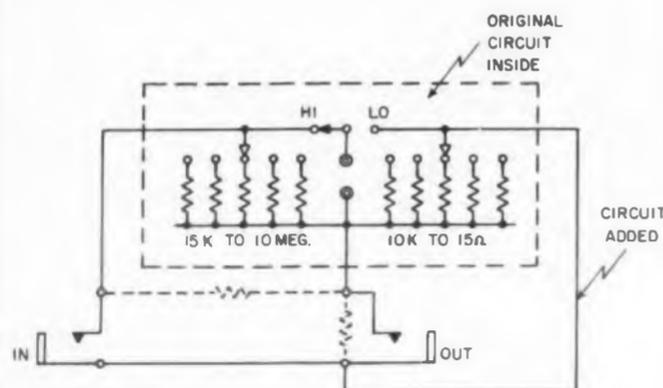
IDEAS FOR DESIGN

Low Cost Attenuators

We needed some voltage attenuators that had to be variable but not continuously variable. The voltages to be attenuated were at a telephone jack patchboard.

We had some Heath substitution boxes available with a circuit as shown in the figure. We added two telephone jacks as shown. The boxes were light enough to allow them to hang from the patchboard by cables connected to the jacks.

Joseph Augustine, Douglas Aircraft Co., Santa Monica, Calif.



Heath substitution box, modified to serve as attenuator. The attenuation equals the "Lo" resistance divided by the sum of the "Lo" and "Hi."

Multi Wire Cable Checker

This cable checker was designed to check cables automatically, one wire at a time. In the event an open or shorted wire is found, a *No-Go* lamp lights on the front panel. If no fault is found after testing the cable, the *OK* lamp lights.

Locating Shorted Wires. Each wire in the cable is connected to the cathode of tube V (Fig. 1) through a resistor which limits the plate current of the tube to a value which is insufficient to energize the *short* relay. If, on the other hand, there are two wires in the cable that are shorted to each other two of the resistors will be in parallel. As soon as the stepper switch comes to that position, the tube will draw sufficient current to energize the *short* relay.

Whenever the *short* relay is energized, the stepper and the pulser are disconnected from their supply voltage. Therefore, the normally closed contacts of the pulser relay will close the circuit to the *No-Go* lamp, which will remain on until the circuit is reset.

Locating Open Wires. Current for the *pulser* relay (Fig. 2) flows through the normally closed contacts of the *short* and the *pulser* relays and through the first wire of the cable under test.

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Type "A" Relays with Plug-in mountings



For fast, easy removal and replacement you can get Stromberg-Carlson Type "A" Relays with plug-in mountings.

The Stromberg-Carlson Plug (illustrated above) automatically locks the relay in place and guarantees a low-resistance connection between plug and socket. Its 36 terminals provide enough connections for practically all relay applications. Coils and contacts are wired to terminals as your needs dictate. Contacts can be furnished in silver, palladium-gold alloy or palladium-silver alloy.

Spring combinations possible with this assembly are 17 Form A or Form B; 10 Form C or Form D.

Also available in an "A" Relay plug used with commercial radio type sockets. It can mount relays with 8, 9, 12 or 20 connections.

For technical details and ordering information, send for Bulletin T-5000R, available on request. Write to:



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Decimal



now Five models
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One model
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Features of Librascope Shaft Position-to-Digital Converters include serial/parallel time sharing, double brush pick-offs, no dead time, variety of codes, digital-analog and analog-digital conversions. They are designed for the transfer of data from a shaft position to a form suitable for digital computers or data logging systems. Special converters are designed to meet customer requirements (including Sine Cosine). Please submit desired characteristics.

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CIRCLE 421 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 10, 1958

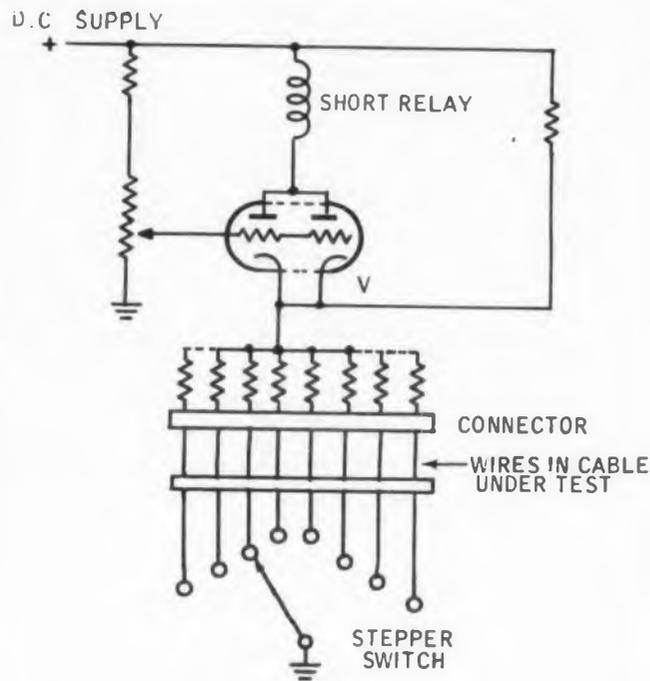


Fig. 1. Simplified drawing of short locator.

The *pulser* relay is energized and its contacts complete the circuit to the *stepper* coil. The *stepper* advances to the next wire. If no open wires are located, the *stepper* will automatically move from wire to wire. Since current for one *pulser* relay must flow through the wire under test, the relay will not be energized if the *stepper* switch encounters an open wire. The *No-Go* lamp will light and will remain on until the circuit is reset.

Herbert Piller, Consultant Engineer, Douglaston, N. Y.

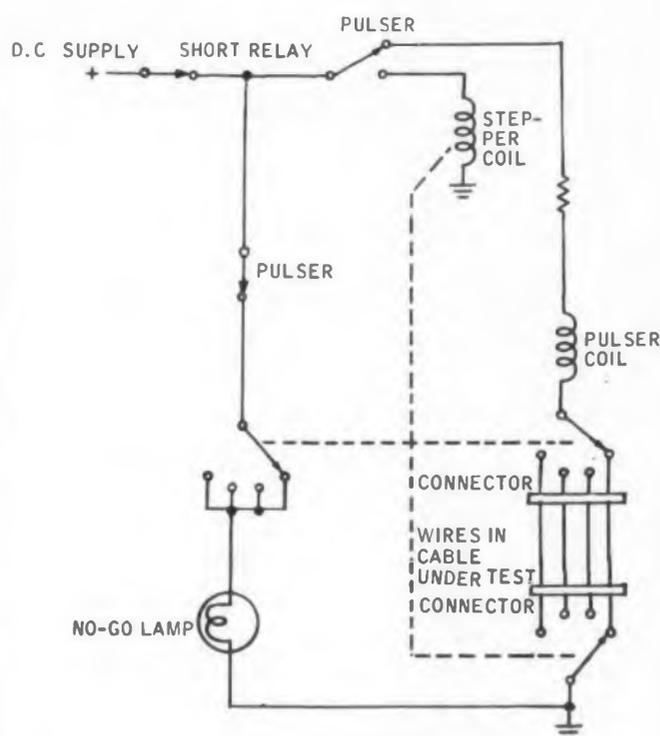


Fig. 2. Simplified drawing of open locator.

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accuracy...reliability



SIZE 8

SYNCHROS FOR EVERY APPLICATION

Kearfott offers the widest range of synchros in the industry. Ruggedly constructed of corrosion-resistant materials, they give unequalled performance under every environmental condition. For best characteristics and reliability, specify Kearfott for all your synchro requirements. Here are a few typical models:

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Available as transmitter, control transformer, resolver, and differential. Max. error from EZ: 10, 7 and 5 minutes.

Size 11 Standard: 1.062"x1.766". 4 oz. -54C to +125C.

Available as transmitter, control transformer, repeater, resolver and differential for 26v and 115v applications. Max. error from EZ: 10, 7 and 5 minutes standard, 3 minutes in 4-wire configurations.

Size 11 MIL Type: Dimensions and applications same as above. Meets Bu. Ord. configurations: max. error from EZ: 7 minutes.

Size 15 Precision Resolver (R587):

With compensating network and transistorized booster amplifier, provides 1:1 transformation ratio, 0° phase shift. Max. error from EZ: 5 minutes.

Size 25 Ultra-Precise: 2.478" x 3.187". 45 oz.

Available as transmitter, differential, and control transformer. Max. error from EZ: 20 seconds arc.

Engineers: Kearfott offers challenging opportunities in advanced component and system developments.

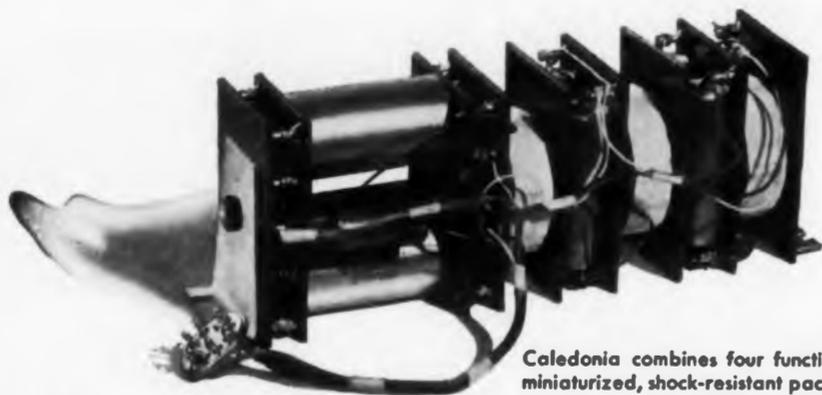
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2. a negative d.c. pulse selector
3. a high level 60 cps band pass filter
4. a 400 cps detector circuit (all with tight tolerances, naturally).

Design it to operate within the usual military environmental conditions, including high vibration and shock.

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shishkabob in a metal case filled with an epoxy foam compound to hold the parts in a firm cushion.

TIME ELAPSED: From original assignment, through design to volume production—two months.

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Operational tested and now being used by leading television, radio and coil manufacturers.

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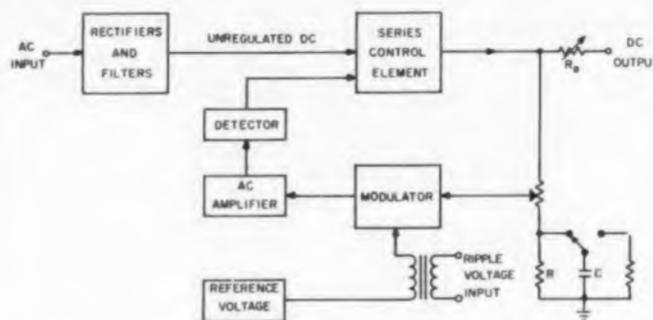
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CIRCLE 424 ON READER-SERVICE CARD

IDEAS FOR DESIGN



Block diagram of a typical regulated power supply with provision for increasing load regulation, introducing ripple, and creating transients.

Degrading Power Supplies

Analysis of electronic subsystems is not complete unless the performance of the system with its associated power supplies can be predicted or measured. Laboratory dc supplies are designed to give optimum performance. Their regulation is excellent (± 0.1 per cent not unusual), their ripple content is teasingly low (a few mv), and transients have been evicted. With today's never ending attempt to miniaturize systems for space and weight savings, consideration must be given to using power supplies with minimum requirements.

Incorporating the features for accurate degrading of a regulated power supplies is simply accomplished as shown in the block diagram. Load regulation is increased by actually adding an external series resistor. Ripple at a continuously variable frequency and amplitude can be introduced at the point of comparison. Similarly, transients are created by switching (repetition rate) a capacitor across a resistor (duration proportional to $C \times R$ and amplitude a function of R).

Donald B. Stein, Sr., Electronic Engineer, Waldorf Instrument Co., N.Y.

Meter Protection Table

In the design of transistor test equipment for production use, it was found necessary to employ several sensitive microammeters. To protect these meters, conventional circuits using the sharp forward conduction characteristics of silicon diodes were employed.

A silicon diode, with its anode connected to the meter's positive terminal, is connected across the meter and a series resistor R . For zero-center meters, a second diode with the reverse polarity, is connected across the first.

The type 1N138A diode was found to be well suited for this application because of its sharp

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CIRCLE 425 ON READER-SERVICE CARD

LOW NOISE

AC AMPLIFIER

has selectable bandwidths
and a 40M megohm, 3 mmf input

VERSATILITY teams up with high input impedance in this new, improved broad-band amplifier. Used as a general purpose amplifier or as an isolation amplifier, it is neatly in scores of tests at both audio and ultrasonic frequencies.



**KEITHLEY
MODEL 102B
ISOLATION
AMPLIFIER**

TYPICAL applications are: vibration and noise studies, work with accelerometers and timing aids, and pulse amplification. A built-in 50-ohm output is provided for driving oscilloscopes, sound level meters, and recorder power amplifiers.

FEATURES of the Model 102B are:

- Variable decade gains of 0.1 to 1000;
- Selectable bandwidths of 2 cps to 150 kc or 1.7 mc; noise below 10 microvolts
- 150 kc response, and below 20 microvolts with 1.7 mc response.

- Very low capacitance input probes are available: 5 mmf, 2 cps to 150 kc response; 20 mmf, 2 cps to 1.7 mc response.

NEW CATALOG B gives detailed data on the Model 102B and all other Keithley instruments and accessories. Your copy will be sent promptly upon request on your company letterhead.



**KEITHLEY
INSTRUMENTS, INC.**
2415 Euclid Ave., Cleveland 6, Ohio

CIRCLE 26 ON READER-SERVICE CARD

forward conduction cut-off. The "R Plus R_m " suggested the table gives adequate protection and introduces negligible meter error.

Equipment employing these protection circuits has been in heavy use for two years by unskilled personnel without the need for meter maintenance.

Sanford J. Demby, *The Liquidometer Corp., L. I. C., N. Y.*

Full Scale Current	R Plus R_m (Ohms)	Approx. Diode Current
25 μ a	12.8K	220 μ a
100 μ a	4.4K	10 ma
200 μ a	2.4K	17 ma
500 μ a	1.0K	20 ma

This table gives the sum of meter resistance and external resistance required to protect different microammeter movements with silicon diodes. The last column gives the approximate diode current for twice the full scale meter current applied across the terminals.

Sturdy Brackets from Flimsy Ones

A formed, flimsy bracket can be redesigned to fit fixed mounting holes and screw lengths, to be extremely rigid, and to require no tooling. In our case, it was necessary to hold a critical rf tuning capacitor in a fixed position above an array of similar components which were not to be disturbed.

A stiffer, formed bracket would have required extensive tooling. A large metal block would have disturbed the surrounding rf circuitry.

The solution was in a three in. deep stock, extruded, aluminum I-section. It was cut off in 1/4 in. lengths, tapped in all flanges, and twisted 90 degrees to accept the hole location of both chassis and part.

Robert A. LeMassena, *Senior Engineer, Heiland Div., Minneapolis-Honeywell, Denver, Colo.*



COMPONENT
MOUNTING



CHASSIS
MOUNTING

A twisted aluminum I-section for a sturdy bracket.

TUBE FORMING PROBLEM

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MULTIPLE BENDS ■ SHARP RADII

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Technical inquiries welcomed.
Write for illustrated catalog of representative parts.

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CIRCLE 427 ON READER-SERVICE CARD

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

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



Write today for
Bulletin 13535-X217
CUTLER-HAMMER Inc.,
Milwaukee 1, Wisconsin

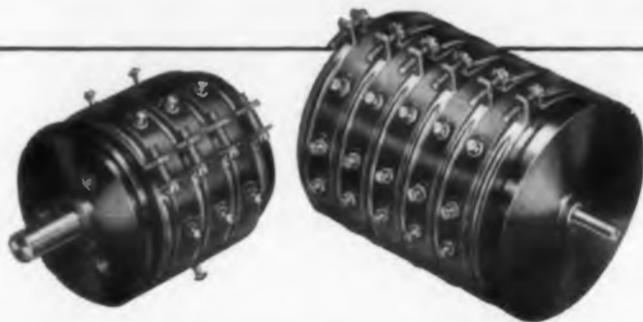


CUTLER-HAMMER

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

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Linearity determined dynamically on each unit on NEW Gamewell *LARTester
(*Linearity — Angle — Resolution — Tap location)

This special Gamewell Phasing Clamp design has two important extras: Extreme compactness and High Temperature compatibility. Check these features . . .

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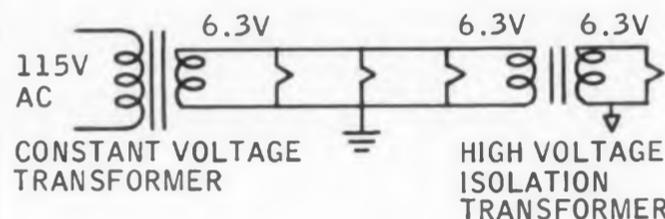


RVG-17XS $1\frac{1}{16}$ "
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IDEAS FOR DESIGN



Stable Off-Ground Filament Voltages

In equipment where heater voltages must be stabilized against line voltage variations, constant voltage filament transformers are very useful. In some cases, due to heater-cathode voltage limitations, it is also necessary to operate heaters at various voltages above ground, usually only a small amount of current being necessary. While individual constant voltage transformers could be used they are comparatively bulky and do not have sufficient insulation for some applications.

There is a 6.3 to 6.3 volt isolation transformer available from several manufacturers for TV use. It has a secondary, usually rated at 1.2 amp with 5 kv secondary insulation. By using a single constant voltage filament transformer operating at the dc level of the majority of heaters, and isolation transformers where isolation is required a saving in space and weight can be achieved with little loss in regulation for the usual constant heater loads. The transformers also have sufficient insulation and current capacity for operating cathode ray tube heaters in most applications.

*D. C. Harrington, Los Alamos Scientific Lab,
Los Alamos, N.M.*

Better Relay Control With Zener Diodes

To overcome relay hysteresis and large pull-in to drop-out ratio, one often has to resort to such "speed up" devices as magnetic switches. As shown typically in Fig. 1, they provide a good remedy. But they require bulky magnetic components which may be highly sensitive to temperature changes. Compensation is often successful, but it requires more complicated circuitry and added weight and size.

Zener diodes can often perform these "speed up" functions very effectively. For illustration, consider the following components: a relay with 30 vdc maximum pull-in voltage and 3 vdc minimum drop-out voltage, and a zener diode with a 20 v breakdown.

Why do it Yourself?



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R.F.
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Transistor or Vacuum tube drive.

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Automation Soldering your concern? Be sure to send for Speer's Bulletin on this subject.

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CIRCLE 2 ON READER-SERVICE CARD

ELECTRONIC DESIGN • December 10, 1958

The relay alone has a pull-in to drop-out ratio of 10:1 for the worst case. If the zener is connected in series with the energizing coil, as shown in Fig. 2, a more sophisticated situation prevails.

Up to the 20 v zener breakdown level, all the voltage appears across the diode, and the very low diode leakage current flows in the loop. As the control signal rises above the 20 v level, the diode breaks down, allowing a current flow of

$$I = \frac{E - 20}{R_{\text{relay}} + R_{\text{diode}}}$$

When E reaches 50 v, sufficient power will be supplied to the relay to energize it. If the control voltage is decreased, the relay will remain energized due to its hysteresis till the 23 v level is reached. Then the relay will de-energize. Thus the pull-in to drop-out ratio has been reduced from 10:1 to 2.17:1. By selecting the proper zener, any ratio can be obtained.

This design is relatively insensitive to temperature changes. For the average zener, the breakdown level varies by only 0.08 per cent per degree. If the control voltage is ac, two zeners, connected back-to-back, are required as in Fig. 3.

E. Hartog and J. E. Rizzo, Project Engineers, Eclipse-Pioneer, Div. of Bendix Aviation Corp., Teterboro, N.J.

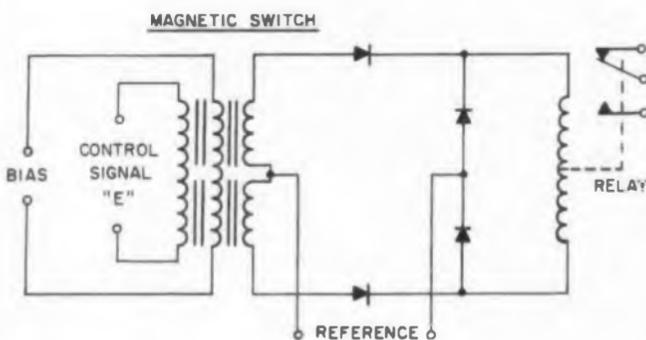


Fig. 1. Magnetic switches can speed up relays, but they're bulky and temperature sensitive.

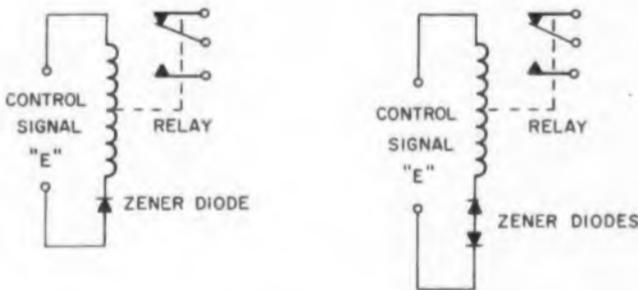


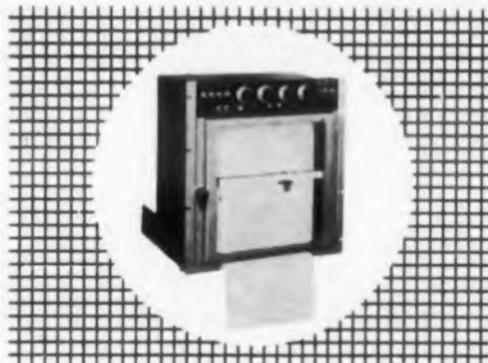
Fig. 2. (left) For dc circuits, a single zener diode can simplify relay speedup.

Fig. 3. (right) Two zeners back to back can speed up relays in ac circuits.

THE MOSELEY

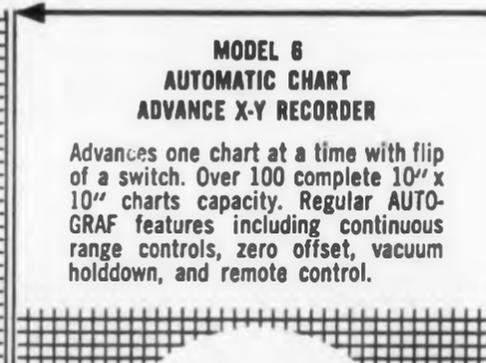
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MODEL 80
STRIP CHART RECORDER

Laboratory type with PUSH BUTTON control of up to 12 speeds from 60 in./min. to 1 in./hr. Over 100 feet of chart capacity, 10" wide. Multiple span range control with zero offset; 200,000 ohms/volt input resistance.



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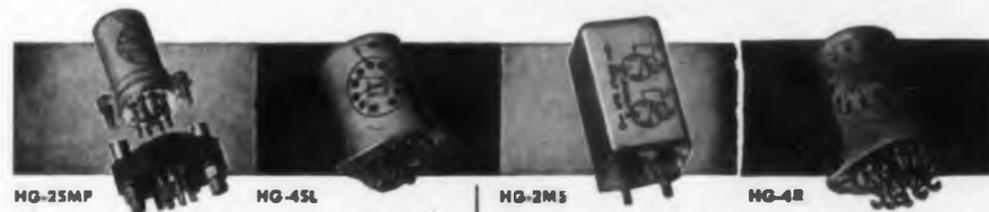
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REPORT BRIEFS

New Low-Density Artificial Dielectric

The results are reported of an investigation into an isotropic, wide-band, artificial dielectric of low specific gravity for use at microwave frequency. Approximate relations for dielectric constant, permeability, and loss tangents are derived, and it is shown that experimental work to date support these formulae. *New Low-Density Artificial Dielectric*, J. A. Carruthers, McGill University, Eaton Electronics Research Laboratory, Montreal, Canada. 57 pp, microfilm \$3.60, photocopy \$9.30. Order PB 130871 from Library of Congress, Washington 25, D. C.

R-F Tuners and I-F Amplifiers

Miniature transistorized inductive devices were developed for use in r-f tuners and i-f amplifiers. New i-f amplifiers use six double-tuned stages and each is constructed with newly developed miniature i-f coils with unloaded Q's as high as 250. The selectivity characteristics are said to be the best achieved in transistorized amplifiers to the date of the research. A novel permeability-type r-f tuner using a combined rotary and axial motion of two ferrite cups was also developed. It can operate in any of the frequency ranges from 0.5 mc to 1.5 mc, 1.5 mc to 5.0 mc and 5.0 mc to 15 mc with excellent linearity and tracking characteristics. The variable inductor was designed to operate with a transistor oscillator-mixer circuit. It was shown that a "rotary-axial" tuner can cover a 15 to 1 tuning range when used as a semicontinuous tuner. *R-F Tuners and I-F Amplifiers for Transistors*, E. Abbot, Emerson Radio & Phonograph Corp., Wright Air Development Center, U.S. Air Force. Oct. 1957, 53 pp, \$1.50. Order PB 131602 from OTS, Washington 25, D.C.

Standardizing Specs for Insulated Cable

The standardization study of specifications for multiconductor cables was designed to eliminate duplications and minor variations in cable materials, constructions, and test procedures. It is to incorporate the results of the standardization study in a single specification that would supersede all the specifications under study. *Study, Standardization of Specifications for Insulated Cable*, Robert E. Barbieri, Philip M. Costanzi, and Bruce Compton, Radio Corp. of America, Camden, N.J. Dec 1957, 244pp, \$3.50. Order PB 131805 from OTS, Washington, D. C.

Status of Thermal Radiometer

This report describes the progress made on the design and manufacture of the components of a thermal radiometer. It includes mathematical analyses of both the heat transfer and control system problems. Among other activities was the forming of a cone by an electroforming technique. Adhesives of epoxy resins filled with aluminum powder were developed to bond wires onto the system's copper sink. Simulators which approximated operating conditions were built and included in a complete electronic system from which data is obtained. The instrument responded properly over a range of operating conditions. Also included is a discussion of the specifications as originally outlined and revisions suggested on the basis of analytical and experimental work performed. *Status of Thermal Radiometer, State of development of thermal radiometer, A. Pfenninger, H. E. Henry, M. Godet, and C. A. Wogrin, Quantum Inc, U. S. Air Force, March 1958, 57pp \$1.50. Order PB 131746 from OTS, Washington, D. C.*

Lumped-Filtered Circuits For TWTs

This report presents a family of curves of the properties of lumped-filter circuits which are useful as slow-wave circuits for external circuit traveling-wave tubes with distributed or lumped and distributed circuits. *Some Properties of Lumped-filtered Circuits for Traveling-wave Tubes, Chih Tang Sah and G. A. Loew, Stanford University, Electronics Laboratories, Stanford, Calif. Jul 1956, 169 pp, microfilm \$7.80, photocopy \$25.80. Order PB 127464 from Library of Congress, Washington 25, D. C.*

Nondestructive Readout of Multilevel Magnetic Memory

An infinite-resolution method of reading the flux level in a magnetic core without destroying this flux level was developed. The method uses solid-state devices and requires less than 10 mw supply during nondestructive interrogation, while standby power drain is in the microwatt range. Output information is in the form of an alternating waveform whose frequency is a function of the flux level of the storage core. Frequency ratios of 30:1 were obtained. Also developed was a circuit for clearing and resetting a core in preparation for further information storage. *Nondestructive Readout of Multilevel Magnetic Memory, R. L. Van Allen and C. B. House, Naval Research Laboratory. Feb. 1958, 26 pp, \$1.75. Order PB 131475 from OTS, Washington, D.C.*

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Total weight: Less than 0.1 oz.

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Firing: 2 volts minimum required. Actual voltage dependent upon closing time desired.

After Firing: Circuit resistance less than 0.3 ohm.

ALTITUDE—Any.

OPERATING TEMPERATURE: -55°C to +125°C.

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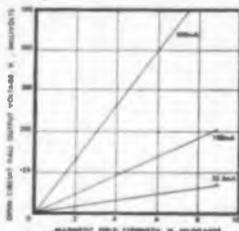
TYPE HS-51

The HS-51 HALLTRON is based upon the Hall effect. Its output characteristics are related to the product of the input current and magnetic field, hence are useful in many new applications. The HS-51 Halltron is a fully developed production unit utilizing indium antimonide and is designed to work in the customer's magnetic circuit. The thin encapsulated unit provides the strength and durability necessary for circuit applications.

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 - Transducers
 - Circulators
 - Power meters
 - Control applications
 - Computer applications
 - DC to AC converters
 - Magnetic field measurement

Typical Room Temperature Characteristics

Typical open circuit Hall output voltage of an HS-51 HALLTRON vs. magnetic field strength for various values of control current I_c.



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REPORT BRIEFS

250 C Ceramic Capacitor

New capacitors, with capacities up to 0.01 microfarad, were sought which would conform in general to the ratings described in MIL-C-11015A, with two important exceptions. These were (a) the reference temperature should be 250 C instead of 85 C, and (b) the insulation resistance sought would be in excess of 5 megohm microfarads at 200 C and 0.5 at 250 C. Products with desired capacities were developed with insulation resistances up to 6 megohm microfarads at 250 C and up to 50 megohm microfarads at 200 C. Final products were composed of 80.10 per cent of barium titanate, 16.99 per cent of lead titanate, and 2.91 per cent of tantalum oxide. Processing methods employed resulted in higher degrees of mixing and far greater reproducibility than was possible by conventional procedures. *250 C Ceramic Capacitor with Wide Temperature Range*, Cameron G. Harman and Edward F. Mayer, *Horizons, Inc., Cleveland, Ohio, Mar 1958, 66 pp, \$3.00. Order PB 131893 from OTS, Washington 25, D. C.*

Test Data on Resistors

Report consists of tables and graphs, no text. *Test Data On Resistors, Wirewound, Variable (precision type)*, Battelle Memorial Institute, Columbus, Ohio, June 1954, 274pp, microfilm \$11.10, photocopy \$42.60. Order PB 127267 from Library of Congress, Washington 25 D. C.

Estimation of Signal Parameters

This memorandum summarizes some results obtained in the study of certain aspects of signal reception in the presence of noise. Two types of difficulties are considered, as explained below. First, the problem of obtaining best estimates of pulse heights occurring with certain non-Gaussian distributions is treated. The solution in each case implies some nonlinear filtering operation. Second, pulse trains with Gaussian statistics but interdependence between adjacent pulses are considered. The "best" estimate of any pulse height is found to be a certain linear combination of the present and previous signal samples. Some suggestions for extending this result to the case of interdependence between an arbitrary number of pulses are included. *Some Results in the Estimation of Signal Parameters*, D. R. Bennion, *Stanford University, Electronics Laboratories, Stanford, Calif. Sept 1956, 23 pp, microfilm \$2.70, photocopy \$4.80. Order PB 128701 from Library of Congress, Washington 25, D. C.*

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ELECTRONIC DESIGN • December 10, 1958

Interference From Radar Modulators— Vol. II

Includes Vol. I in table of contents. Vol. II deals with electromagnetic leakage from coaxial cables, estimation of required shielding, conducted interference and appendices on leakage from long slits, derivation of the calibration factor for surface transfer impedance measuring equipment, construction of a pressure chamber for gasket tests, and variation of cabinet attenuation with door size. *Investigation of Interference From Radar Modulators. Vol. II: Electromagnetic shielding principles, Rensselaer Polytechnic Institute, Research Division, Troy, N. Y. Mar 1956, 129 pp, microfilm \$6.30, photocopy \$19.80. Order PB 130459 from Library of Congress, Washington 25, D. C.*

VHF Communication System

A vhf teletype communications circuit has been established from Bozeman, Mont., to Palo Alto, Calif., using radio signals reflected from ionized meteor trails. The great circle distance between these two points is approximately 830 miles. This report discusses the design and operation of a teletype system which detects these reflected paths and controls the flow of information coincident with an acceptable signal strength from transmitter to receiver. Information is transmitted during meteor bursts at ten times the normal 60-wpm teletype rate. It is recorded and stored at the receiver and then read out at normal speed into standard teletype printers. *Long Range VHF Meteor-burst Communications System, Russell Wolfram and Bruce M. Sifford. Stanford Research Institute, Menlo Park, Calif. Sept. 1957, 55pp, microfilm \$3.60, photocopy \$9.30. Order PB 132115 from Library of Congress, Washington 25, D. C.*

Electron Tubes for Critical Environments

The present state of development of electron tubes for operation at temperatures up to 500 C at high levels of shock and vibration and in nuclear radiation has been investigated. The data presented were gathered from published reports, periodicals, interviews, and through questionnaires. The materials and techniques that enter into electron tube design are examined separately, and the effects of high temperature are analyzed. Those areas of technology requiring further research are enumerated. *Electron Tubes for Critical Environments, Walter H. Kohl and Philip Rice, Stanford Research Institute, Menlo Park, Calif. Mar 1958, 219pp, \$3.50. Order PB 131852 from OTS, Washington 25, D. C.*



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REPORT BRIEFS

Linear High-Gain Amplifier

This report presents some basic material on D'Arsonval galvanometers and cathode-coupled amplifiers, leading to the design of practical amplifiers suitable for use as drivers for recording meters. *Linear High-Gain Amplifier for Recording Meters*, G. P. DuBose, Jr. and F. E. Brooks, Jr. Texas University, Electrical Engineering Research Laboratory, Austin, Tex., Nov. 1956, 48 pp, microfilm \$3.30, photocopy \$7.80. Order PB 130786 from Library of Congress, Washington 25, D. C.

Backward-wave Local Oscillators

A contract was awarded to Hughes Aircraft to investigate and develop backward-wave oscillators at X-band (7.6 to 12.4 kmc) and Ku-band (11.6 to 18.0 kmc) that would meet certain rigid objective specifications. The first and principal phase of this contract on backward-wave oscillators is summarized in Part I of this Final Report. The investigation of noise reduction is described in Part II. *Backward-wave Local Oscillators*, M. R. Currie, H. R. Johnson, and R. D. Weglein. Hughes Aircraft Co., Electron Tube Lab., Culver City, Calif. June 1956, 38pp, microfilm \$3.00, photocopy \$6.30. Order PB 132497 from Library of Congress, Washington 25, D. C.

Circuit Properties of Hook Transistor

The following significant novel results are obtained: (a) the switching speed of hook common base circuits is much larger than that of hook common emitter circuits. Compared to the speed of similar circuits using point contact transistors with the same alpha cutoff frequency, it is somewhat lower. (b) The amplifying properties of hook common emitter and hook common collector configurations are unique; in particular a stable unilateral amplifier may be designed with very large input impedance, very low output impedance and good transfer gain. The input impedance may also be adjusted to a preset value in a wide range, thus permitting input matching. The dual case (infinite input admittance, zero output admittance) may be synthesized similarly with a hook common base amplifier using positive feedback. *Circuit Properties of Hook Transistor*, L. M. Vallese, Polytechnic Institute of Brooklyn, Microwave Research Institute, Brooklyn, N.Y. Mar 1957, 28pp, microfilm \$2.70, photocopy \$4.80. Order PB 132956 from Library of Congress, Washington 25, D. C.



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ELECTRONIC DESIGN • December 10, 1958

Electromagnetic Radiation Patterns and Sources

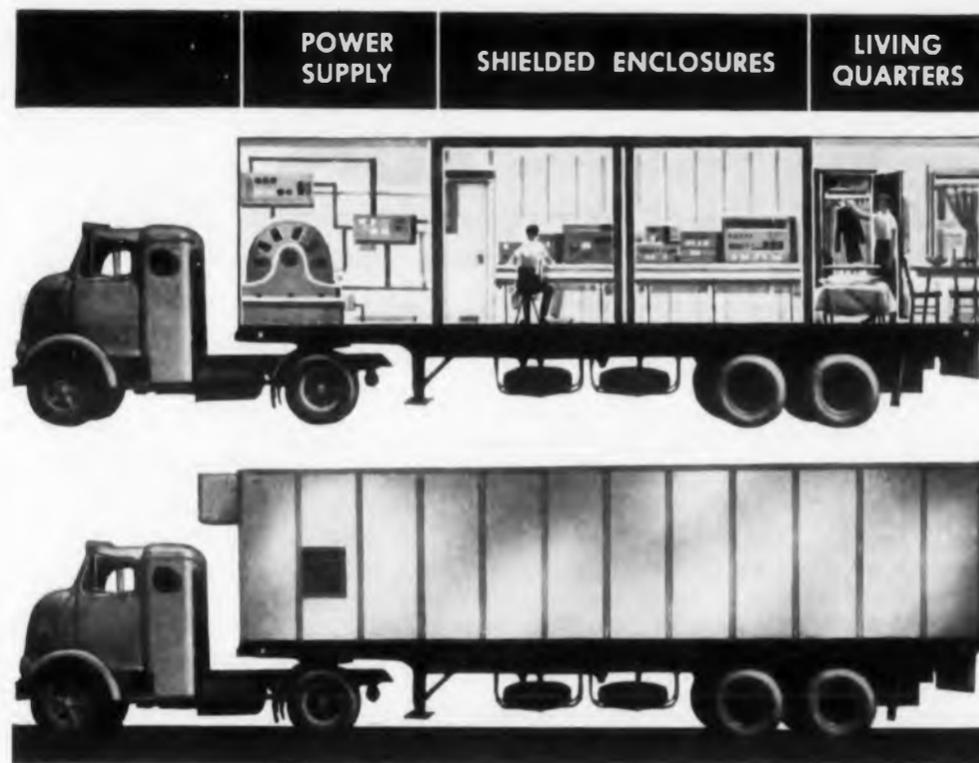
Reprinted from an electromagnetic wave theory symposium. 1. Waves, Electromagnetic—Radiation—Theory 2. Antennas—Radiation patterns—Mathematical analysis. *Electromagnetic Radiation Patterns and Sources, Claus Muller, New York University. Division of Electromagnetic Research, New York, N.Y. July 1956, 10pp, microfilm \$1.80, photocopy \$1.80. Order PB 127213 from Library of Congress, Washington 25, D. C.*

Microwave Resonant Cavity

Expressions are derived for the frequency shift of a microwave resonant cavity resulting from the insertion of a sample of magnetic material small compared with the wavelength. Principal consideration is given to spherical samples. Cavity perturbation theory is used. The internal field in the sample is specifically calculated and used in the integration over the sphere. Results of the theory are compared with measurements and with the results of recent theoretical treatments of the problem. *Effect of Ferrite Sample Size on the Frequency Shift of a Microwave Resonant Cavity, J. E. Tompkins and E. G. Spencer, U. S. Ordnance Corps, Diamond Ordnance Fuze Laboratories, Washington, D. C. Jan 1957, 22 pp, microfilm \$2.70, photocopy \$4.80. Order PB 132001 from Library of Congress, Washington 25, D. C.*

Resonance Phenomena At Microwave Frequencies

The present study of resonance phenomena at microwave frequencies in gaseous discharge plasmas was made to explore, in particular, the possibility of using such plasmas for the purpose of spectrum analysis of rf electromagnetic waves. The various resonances are classified in this report and a theoretical analysis for the case of linearly polarized waves, considering collisions, as well as for the circularly polarized waves, is given. *Further Studies of Resonance Phenomena at Microwave Frequencies in Gyromagnetic Gaseous Discharge Plasma: Application to Radio Frequency Spectrum Analysis, L. P. McGrath, A. K. Chatterjee, and J. P. Monier, Illinois University, Engineering Experiment Station, Electrical Engineering Research Laboratory, Gaseous Electronics Section, Urbana, Ill. Aug. 1957, 93 pp, microfilm \$5.40, photocopy \$15.30. Order PB 132099 from Library of Congress, Washington 25, D. C.*



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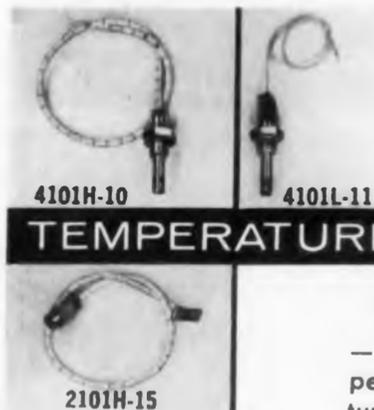
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REPORT BRIEFS

Circuit Parameters of Waveguide Tuning Post

This paper is concerned with the theoretical treatment of the circuit parameters of a tuning post in a rectangular waveguide. Some applications of the results to the approximate calculation of the circuit parameters of a radiating post in a trough guide and a resonant slot in a strip line, are given. *Circuit Parameters of the Tuning Post in a Rectangular Waveguide and Its Applications*, Michio Suzuki, Polytechnic Institute of Brooklyn, Microwave Research Institute, Brooklyn, N.Y. July 1957, 61pp, microfilm \$3.90, photocopy \$10.80. Order PB 132147 from Library of Congress, Washington 25, D. C.

Optimum Linear Filtering

This report considers the optimum linear filtering of polynomial message plus stationary random noise. The derivation is similar to that of Lees but is formulated differently. This formulation is more conventional and facilitates a consideration of desired operations on the message other than smoothing and prediction. *Optimum Filtering of Sampled Polynomial Message Plus Random Noise*, Arthur R. Bergen, Columbia University, Dept. of Electrical Engineering, Electronics Research Laboratories, N. Y. May 1956, 24pp, microfilm \$2.70. Order PB 126359 from Library of Congress, Washington 25, D.C.

High-Power Beam Tubes

In summary the projects have progressed as follows: (1) The investigation of assembly techniques continues in the cross-wound helix project. The fundamental problem is the support of ringbar structures inside a metal envelope by means of ceramic disks. (2) Use of the cavity-probe device for study of the bunching phenomena in Brillouin-focused beams has provided a considerable amount of excellent data on the distribution of r-f current density in the klystron beam (under both small and large signal conditions, and for a wide range of parameters). (3) Construction of the velocity spectograph has been completed, and initial calibration measurements have been made. *Research in High-Power Beam Tubes*, Scientific Report No. 5, Stanford University, W. W. Hansen Laboratories of Physics, Microwave Laboratory, Stanford, Calif. Sept 1956, 15 pp, microfilm \$2.40, photocopy \$3.30. Order PB126945 from Library of Congress, Washington 25, D. C.

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Electrode Process in Metal Deposition

When a metal electrode is immersed in an electrolyte an electric potential difference arises between metal and solution. Though it cannot be determined, the electrode potential can be measured. On electro-deposition the cathode potential decreases below its equilibrium value. The change is called (electrolytic) polarization and three types of it can be distinguished: concentration, ohmic polarization, and activation polarization. *Electrode Process in Metal Deposition from Aqueous Solutions*, Einar Mattsson, Sweden. 1955, 58 pp, microfilm \$3.60, photocopy \$0.30. Order PB 124926 from Library of Congress, Washington 25, D.C.

Low Pass Video Amplifiers

This paper deals with the design of low-pass video amplifiers for specified amplitude or phase response. This is accomplished by what is essentially stagger-tuning similar to that used for narrow-band amplifiers, except that in this case the problem is complicated by the presence of finite zeroes in the amplifier gain function. The method used is an iterative process by means of which the elements in the predetermined amplifier configuration can be adjusted so that the gain function may approximate the desired response. The performance of the resulting design is shown to approach the theoretical limits gain-bandwidth product in cascaded amplifiers. *Iterative Methods in Amplifier Interstage Synthesis*. George A. Caryotakis, Stanford University, Electronics Research Laboratory, Stanford, Calif. May 1955, 101pp, microfilm \$5.70. Order PB 126469 from Library of Congress, Washington 25, D.C.

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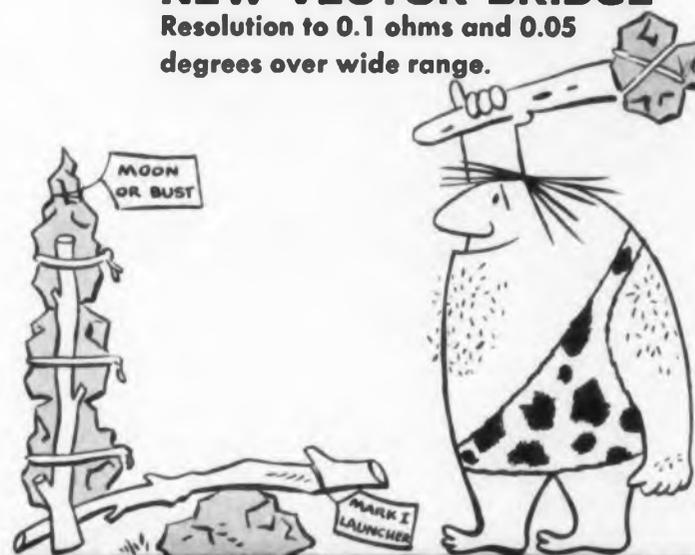


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REPORT BRIEFS

Causality and Frequency-Response Functions

A general system is studied under the assumption of linearity, passivity, reproducibility, and causality. Under essentially no further assumption, frequency-response functions are defined for such systems and identified with positive functions, suitably defined. Through the Lebesgue decomposition theorem, any frequency-response function may be decomposed to be the sum of a minimum-reactive part and two reactive parts, one of which is of unfamiliar nature. This procedure is carried through for a system with one input-output and again for a system with multiple input-outputs. As an illustration, the result is applied to the study of the Kronig-Kramers relations. One of the relations is proved to be true under very general conditions, but not the other. *Causality and Frequency-Response Functions*, T. T. Wu, Harvard University, Cruft Laboratory, Cambridge, Mass. April, 1955, 47 pp, microfilm \$3.30, photocopy \$7.80. Order PB126790 from Library of Congress, Washington 25, D. C.

Reversible Properties of Ferromagnets

Using a statistical model, equations are developed for the variation of the reversible susceptibility, both parallel with and normal to the biasing magnetization, as a function of the magnetization assuming that the susceptibility arises by domain rotation. The results are contrasted with previous results based upon domain-wall motion. It is concluded that the theory points out a new technique for the separation of the origins of the susceptibility. Equations are also given for the expected variation of the differential magnetostriction with magnetization both parallel with and normal to the field and for both domain-wall motion and domain rotation. An expression is given for the susceptibility matrix arising from domain rotation as a function of magnetization. *Reversible Properties of Ferromagnets, I. Theory of the expected variation of the reversible susceptibility with magnetization, II. Comparison of theoretical and experimental susceptibility curves, III. Summary*, Dale M. Grimes, Michigan University, Engineering Research Institute, and Dept. of Electrical Engineering, Solid State Devices Laboratory, Ann Arbor, Mich. Dec, 1956, 58 pp, microfilm \$3.60, photocopy \$9.30. Order PB 126868 from Library of Congress, Washington 25, D. C.

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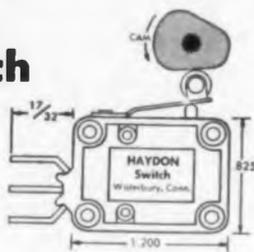
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This report describes the all-transistor voltage regulator which was developed at this station to replace the carbon pile regulator Mk 1, Mod 0 in applications demanding precise voltage regulation. Embodied in the report are sections concerning specifications, theory of operation, and test results. *All-Transistor DC Voltage Regulator, Gerald M. Ford, U. S. Naval Ordnance Plant, Engineering Dept., Indianapolis, Ind. Mar 1955, 35 pp, microfilm \$3.00, photocopy \$6.30. Order PB130965 from Library of Congress, Washington 25, D. C.*

Reliability Stress Analysis

Presents basic techniques and numerical values required to calculate the reliability risk accumulated in the process of making electronic design commitments in the matter of component-part selection and application stress. *Reliability Stress Analysis for Electronic Equipment, John A. Connor, RCA, Engineering Standards and pp. Order PB131678 from OTS, Washington 25, D. C.*

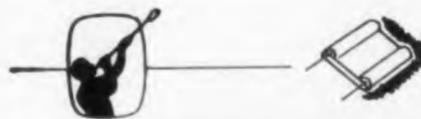
Heater-Cathode Leakage Investigation

1. Vacuum tubes, Cathode ray—Materials; 2. Vacuum tubes, Cathode ray—Leakage. *Heater-Cathode Leakage Investigation, Julius Cohen, Paul Cutler, J. V. Florio, A. L. Wilson, and R. Rechtschaffner, Sylvania Electric Products, Inc., Product Development Labs, Kew Gardens, N.Y. December 1956, 36 pp, microfilm \$3.00, photocopy \$6.30. Order PB 126374 from Library of Congress, Washington 25, D.C.*

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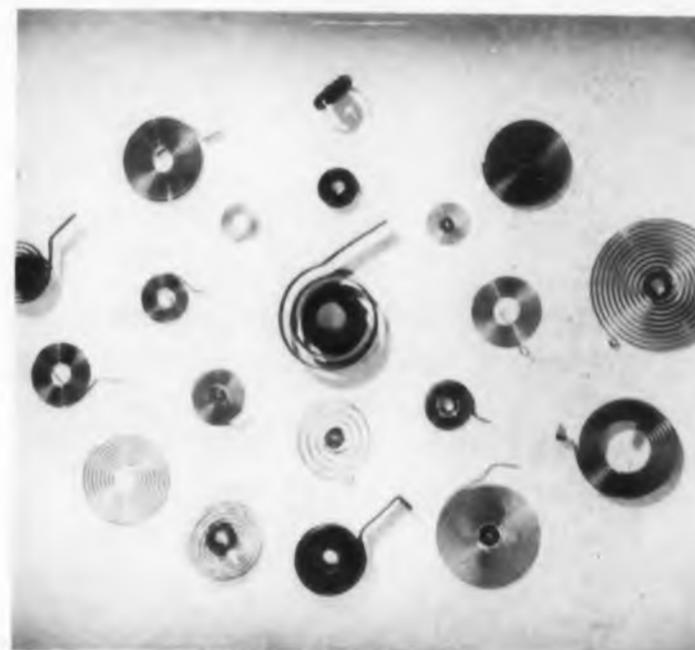
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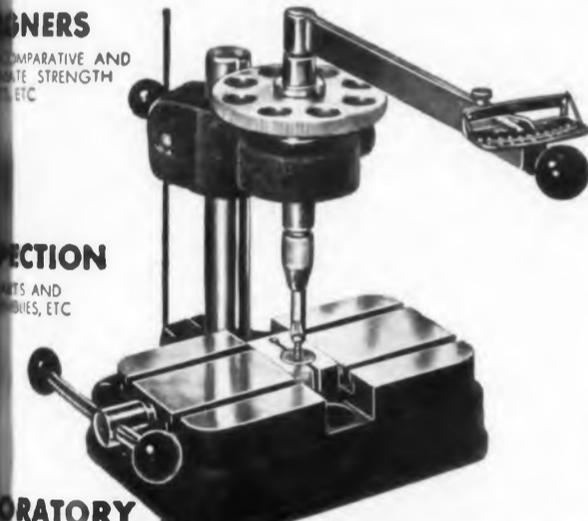
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Nonlinear and Parametric Phenomena in Radio Engineering

Part 7

A. A. Kharkevich

(Translated by J. George Adashko)

Chapter 1

Nonlinear Circuits and Fundamental Nonlinear Processes

Here, in Part 7, we conclude our translation of Professor Kharkevich's discussion of detection which appears in his Section 9. Our translation of his book continues in the December 24th issue of **ELECTRONIC DESIGN**.

9. Detection (contd.)

Square-Law Detection

Let the detector characteristic be given by the relation

$$I = k U^2$$

Inserting the expression for an oscillation, am-

plitude modulated by a sine wave, we get

$$\begin{aligned} I &= k U_m^2 (1 + m \sin \Omega t)^2 \sin^2 \omega_0 t = \\ &= \frac{k}{2} U_m^2 \left[1 + \frac{m^2}{2} + 2m \sin \Omega t - \frac{m^2}{2} \cos 2\Omega t \right. \\ &\quad \left. - \left(1 + \frac{m^2}{2} \right) \cos 2\omega_0 t - m \sin (2\omega_0 - \Omega) t \right. \\ &\quad \left. + m \sin (2\omega_0 + \Omega) t + m^2 \cos 2(\omega_0 - \Omega) t \right. \\ &\quad \left. + m^2 \cos 2(\omega_0 + \Omega) t \right]. \end{aligned}$$

We see that the resultant spectrum is limited; it contains only five high frequencies, namely

$$2\omega_0, 2\omega_0 \pm \Omega, 2(\omega_0 \pm \Omega).$$

However, the signal is distorted; in addition to the frequency Ω , the spectrum of the detected oscillation contains also the frequency 2Ω , i.e., the second harmonic of the signal (a distortion in

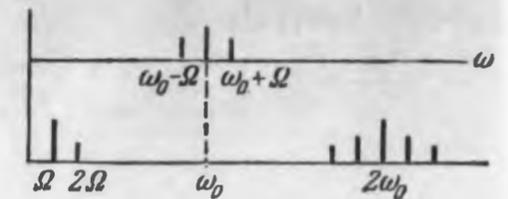


Fig. 25. Frequency spectra of modulated oscillation before and after square-law detection.

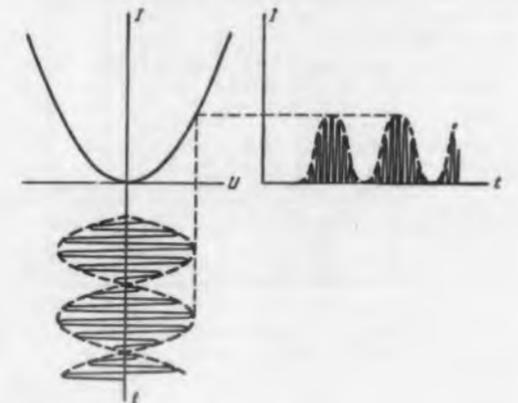


Fig. 26. Waveforms at the input and output of a beat detector.

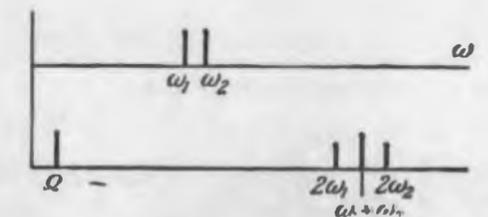


Fig. 27. The beat spectrum before and after square-law detection.

the signal waveform). The spectra of the modulated oscillation before and after square-law detection are shown in Fig. 25.

Thus, as expected, a detector with a square-law characteristic is not suitable for detecting amplitude modulated signals. Nevertheless, square-law detection plays a very important role in radio engineering.

It is used, for example, for detecting beats when the purpose of detection is to obtain a pure sinusoidal oscillation at the difference frequency. Exactly the same situation prevails in heterodyne audio frequency generators. The principle of these generators is based on adding the outputs of two high frequency oscillators so as to produce beats. The beats are detected and a low frequency oscillation is obtained, at a frequency equal to the difference of the two high frequencies. If one of the high frequency oscillators is made adjustable, one can obtain a low frequency that varies smoothly over a wide range.

Thus, for example, to obtain a low frequency ranging from 0 to 10 kc, it is possible to employ two high frequency oscillators, one, say, with a 100 kc frequency, the other, adjustable from 100 to 110 kc (merely 10 per cent).

An obvious advantage of heterodyne audio-frequency generators is the simplicity of control: the entire range is covered by turning just one knob which controls a small variable capacitor in the tank circuit of one of the high frequency oscillators.

Let us analyze the problem of beat detection. We start by assuming that the amplitudes of both high frequency oscillations are equal, i.e.,

$$U = U_m (\sin \omega_1 t + \sin \omega_2 t).$$

Transforming, we obtain

$$\begin{aligned} U &= 2U_m \sin \frac{\omega_1 + \omega_2}{2} t \cos \frac{\omega_1 - \omega_2}{2} t \\ &= 2U_m \sin \omega_0 t \sqrt{\frac{1}{2} (1 + \cos \Omega t)}. \end{aligned}$$

where

$$\omega_0 = \frac{\omega_1 + \omega_2}{2}, \quad \Omega = \omega_1 - \omega_2,$$

i.e., ω_0 denotes the average high frequency, and Ω the low beat frequency. The voltage waveform applied to the detector is shown in Fig. 26.

It must be noted, that beats can be considered as high frequency oscillations of frequency ω_0 , modulated by the beat frequency. However (and this is an important factor), the modulation is nonsinusoidal, and the modulation factor is of the form.

$$\sqrt{\frac{1}{2} (1 + \cos \Omega t)}.$$

If we now apply square-law detection, we obtain

$$\begin{aligned} I &= kU^2 = 2kU_m^2 (1 + \cos \Omega t) \sin^2 \omega_0 t \\ &= kU_m^2 (1 + \cos \Omega t) (1 - \cos 2\omega_0 t) \\ &= kU_m^2 \left[1 + \cos \Omega t - \frac{1}{2} \cos 2\omega_0 t \right. \\ &\quad \left. - \frac{1}{2} \cos 2\omega_0 t - \cos (\omega_1 + \omega_2)t \right], \end{aligned}$$

i.e., purely sinusoidal oscillation at the difference frequency Ω , the sum of the initial high frequencies, and double the value of each high frequency. The beat spectrum before and after the square-law detection is shown in Fig. 27. Our conclusions concerning the advantages of



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the square-law beat detector hold also in the more general case, when the amplitudes of both high frequency oscillations are unequal. Assume

$$U = U_1 \sin \omega_1 t + U_2 \sin \omega_2 t.$$

Fig. 28 shows a vector diagram, illustrating the addition of two voltages of unequal frequencies. We have for the amplitude of the resultant voltage

$$U_m^2 = U_1^2 + U_2^2 - 2U_1U_2 \cos \alpha.$$

But, as can be seen from the diagram

$$\alpha = \pi - \Omega t$$

and consequently

$$-\cos \alpha = \cos \Omega t.$$

Thus,

$$U_m = U_1 \sqrt{1 + \frac{U_2^2}{U_1^2} + 2 \frac{U_2}{U_1} \cos \Omega t}.$$

This formula represents the varying amplitude, i.e., the beat envelope, in the case of component oscillations of unequal amplitudes. In square-law detection, squaring causes the square root to disappear, and we obtain in this case a purely sinusoidal oscillation at the difference frequency Ω .

It must be noted that if there is a great difference between the amplitudes of the two voltages, i.e.,

$$U_2 \ll U_1$$

or

$$U_2 \gg U_1,$$

then a low frequency sinusoidal voltage can be obtained also with linear detection. This follows from the fact that, for example, if $U_2 \ll U_1$

$$\begin{aligned} U_m &= U_1 \sqrt{1 + \frac{U_2^2}{U_1^2} + 2 \frac{U_2}{U_1} \cos \Omega t} \cong \\ &\cong U_1 \left(1 + 2 \frac{U_2}{U_1} \cos \Omega t \right)^{\frac{1}{2}} \cong U_1 \left(1 + \frac{U_2}{U_1} \cos \Omega t \right). \end{aligned}$$

An added comment concerning square-law detection is that this method plays a very important role in modulation and frequency-conversion circuits. This will be discussed later.

Detector Characteristics

We can now turn to a general discussion of detector characteristics. The characteristic of a detector must be nonlinear—this is obvious. But this is not enough. Were we to choose a nonlinear characteristic of the form

$$I = kU^3$$

no detection would result, since the oscillation,

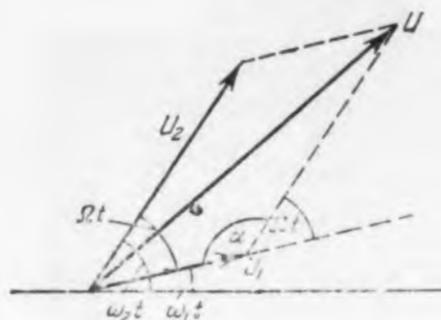


Fig. 28. Vectorial addition of two voltages of unequal frequencies.

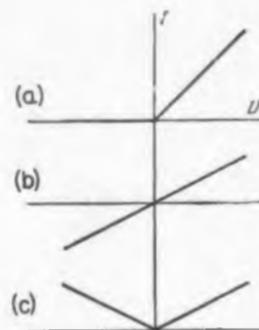


Fig. 30. Three basic nonlinear characteristics. Characteristics are shown in a, c, and e; while b, d, and f show the counterparts for the amplifier.

as shown in Fig. 29, although it would change its form, would remain symmetrical about the time axis. The only nonlinear relations suitable for detection are those asymmetrical with respect to the U axis which, consequently, yield a direct current component in response to an alternating voltage. Relations of this kind must contain even components.

Let us recall the following definitions:

An even function is one satisfying

$$f(x) = f(-x).$$

An odd function satisfies the condition

$$f(x) = -f(-x).$$

Some even functions are x^2 , x^4 , $\cos x$, etc.

Examples of odd functions are x , x^3 , $\sin x$, etc.

A power function x^n is either even or odd, depending on whether the exponent n is even or odd.

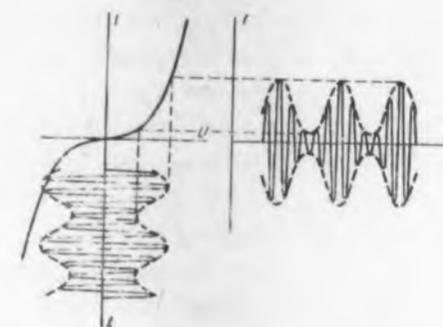


Fig. 29. The nonlinear characteristic $I = kU^3$ is not suitable for detection since the oscillation remains symmetrical about the time axis.

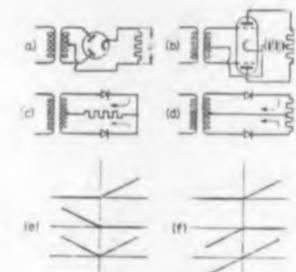


Fig. 31. Comparison of a full wave double-diode rectifier and a double-triode push-pull amplifier. The rectifier circuit, its general form, and its idealized characteristics are shown in a, c, and e; while b, d, and f show the counterparts for the amplifier.

A detector can detect, and a rectifier can rectify, only if its characteristic contains an even component. Any function can be expanded into a sum of even and odd parts. Let

$$f(x) = f_e(x) + f_o(x),$$

where f_e is the even part and f_o is the odd part. Let us reverse the sign of the argument. Then, by definition, we get

$$f(-x) = f_e(x) - f_o(x).$$

Adding and subtracting, we get

$$f_e(x) = \frac{1}{2} [f(x) + f(-x)],$$

$$f_o(x) = \frac{1}{2} [f(x) - f(-x)].$$

By way of an example, let us expand the broken characteristic of Fig. 30a into even and

odd parts. Analytically, this characteristic can be written as

$$I = \begin{cases} kU & U > 0, \\ 0 & U < 0. \end{cases}$$

The even part of the characteristic will be

$$I_e = \frac{k}{2} |U|,$$

and the odd one will be

$$I_o = \frac{k}{2} U$$

It is readily seen that by adding (b) and (c), we obtain (a). Thus, we can represent the broken characteristic in Fig. 30a by means of the formula

$$I = 1/2k (|U| + U)$$

which is suitable for all values of U , both positive and negative.

The detector or rectifier characteristic can contain an odd component, but this component is ineffective. It is natural, however, to use rectifiers and detectors with purely even characteristics. Such characteristics are inherent in all symmetrical push-pull circuits—the odd terms of the characteristics are eliminated in this circuit because the rectified or detected voltage is applied to both branches of the circuit with opposite signs (in counterphase), and the currents of both branches add up.

In this sense, the rectifier or detector circuit has properties that are the inverse of the properties of the push-pull amplifier circuit. In the latter, the voltage is also applied to both branches and in counterphase, but the output voltage is proportional not to the sum, but to the difference of the currents.

Thus, a full wave rectifier circuit employs only the even portion of the characteristic of the nonlinear element, while the push-pull amplifier circuit employs only the odd portion of the characteristic of the nonlinear element. This is why all the even harmonics drop out in a push-pull circuit.

It is understood that in the case of amplification the tendency is to retain, of all the odd harmonics, only the first one, corresponding to un-distorted amplification, when the resultant characteristic is straight. To explain these concepts, Figs. 31a and 31b show the circuit of a full wave double-diode rectifier and that of the double triode push-pull amplifier. Figs. 31c and 31d show the same circuits in generalized form. Finally, Figs. 31e and 31f show the construction of the resultant characteristics, under the assumption that the characteristic of the individual element is a broken line. (To be continued)

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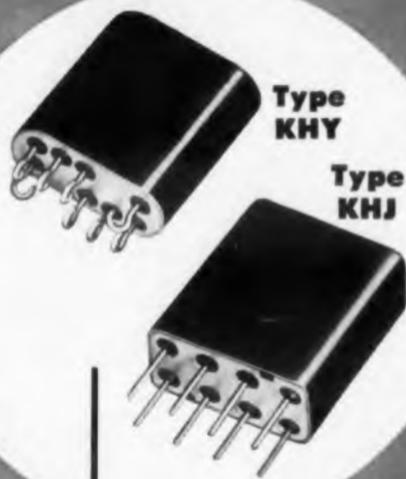
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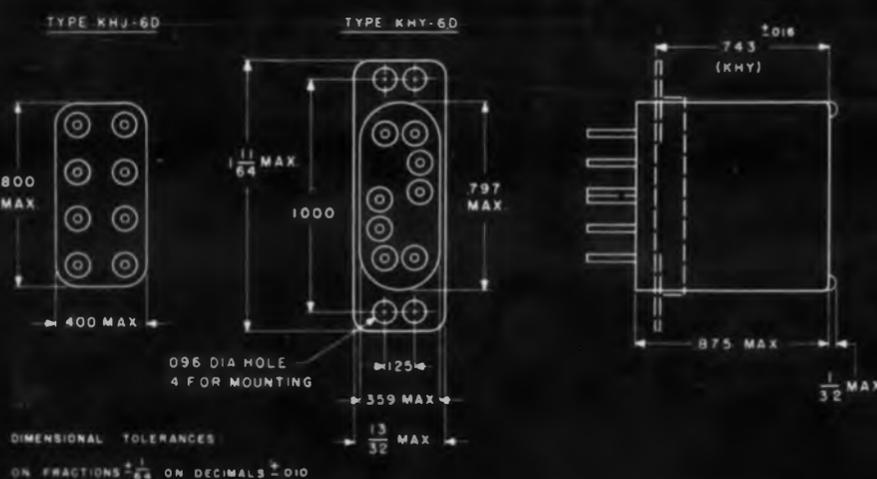
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RUSSIAN TRANSLATIONS

What The Russians Are Writing

J. George Adashko



AUTOMATIC CONTROL

Concerning One Method of the Analysis of Pulsed-Follow-Up Systems by Fan-Chun-Wui. AT 4/58, pp 296-305, 4 figs.

Known methods from the analysis of linear continuous systems are extended to include sampled-data systems through the use of the discrete Laplace transformation. The forced motion of a sampled-data system is qualitatively estimated on the basis of analysis. Reference is made to "Analysis of Errors in Sampled-Data Feedback Systems" by Sklansky and Ragazzini (*Transactions AIEE*, Volume 74, Part II, 1955) and "The Effect of Pole and Zero Locations On the Transient Response of Sampled-Data Systems" and "Correlation Between Root-Locus and Transient Response of Sampled-Data Control Systems" by Eliahu I. Jury (*Transactions AIEE*, Volume 74, Part II, 1955).

Improving the Transients in Corrective elements With Variable Parameters by Ye. K. Shigin. AT 4/58, pp 306-311, 4 figs.

Some means are proposed for improving transients in automatic control systems of fourth order with two integrat-

ing elements. It is shown that if a differentiator element with variable time constant is introduced into the system it is advisable to introduce an integrator with variable time constant into the correction network.

Grapho-Analytical Method of Determining Relay System Characteristics by L. Kuz'min. AT 4/58, pp 285-295, 14 figs.

A standard procedure for analyzing relay systems groups together all the linear elements of the system and separates them from the nonlinear portion. If the nonlinear portion is a relay, the problem reduces essentially to the response of the linear portion to a sequence of rectangular pulses of constant amplitude. If periodic modes are superimposed on the system, the problem is to be quite complicated, and requires a complicated analysis in the complex plane. Certain auxiliary graphs for the purpose are offered in the article.

CIRCUITS

Simulation of the Input Admittance of a Tube by A. M. Gasanov. RE 1/58, pp 77-79.

To simulate a tube at high frequencies, where the input conductance becomes substantial, it is necessary to have

two-terminal network whose active resistance varies in proportion to the square of the frequency. If this two-terminal network contains a reactance, in addition to an active resistance, the latter must be independent of the frequency. The article deals with the synthesis of such a network.

Use of the Potential Analogy in the Design of Electric Filters by A. F. Ufel'man. EC 4/58, pp 49-58, 6 figs.

After giving a brief description of the potential-analog method of filter synthesis, the author describes a simple electrolytic trough to facilitate the choice of infinite-damping frequency and the summary attenuation curve of filters with considerable economy in time and labor.

New Circuits of Amplitude Selectors by A. Kornienko. R 5/58, pp 35-38, 4 figs.

Discussion of various modifications of amplitude selectors used in Russian television sets.

On the Design of Coaxial Tank Circuits for Decimeter Wave Amplifiers by P. Minashi. EC 4/58, pp 24-29, 9 figs.

Coaxial resonant circuit terminated by capacitances are considered. It is shown that the equivalent impedance of the coaxial tank circuit, terminated by capacitors, for a specified value of Q of the circuit, is greater than that of a tank circuit operating with two high frequency voltage nodes. In this case the resultant dimensions of the resonant circuit become quite suitable for practical application. Such tank circuits find application as plate loads for triode broad-band amplifiers in the decimeter range.

Synthesis of Characteristics by V. V. Golonov. EC 3/58, pp 3-10, 5 figs.

It is frequently necessary in experimental work to modify the amplitude-frequency and phase-frequency characteristics. This calls for laborious computations and experimentation. The article presents the theoretical principles of the construction of devices for a synthesis of characteristics, methods for the synthesis of characteristics, an investigation of the errors, and a brief description of the apparatus for the synthesis of characteristics, constructed in 1955-56

in the laboratory on the development of scientific problems of wire communications, Academy of Sciences, USSR.

Interconnection Between Parameters of a Vacuum Tube and Those of a Transistor by M. G. Margolin. RE 2/58, pp 79-85, 8 figs.

Although there is a radical difference between the internal physical processes that take place in transistors in vacuum tubes, nevertheless the analysis of the processes connected with the external circuit permits the use of the same equivalent circuit and the same design procedure. The reason for this is that a transistor, like a vacuum tube, can be considered as a current generator. The system used in this article is of the h0parameters.

On the Theory of the Critical Overshoot of Multi-Stage Pulse Amplifiers by V. P. Shasherin. RE 3/58, pp 35-47, 4 figs. 5 tables.

It is shown that the previously formulated theory of the critical overshoot of multi-stage amplifiers is inaccurate, and the necessary corrections to the theory are made.

Automatic Frequency Control Circuit for a Synchronizing Oscillator by I. Yu. Klugman. RE 3/58, pp 48-60, 10 figs.

The article describes the "four diode" circuit, used in most Russian synchronizing oscillators. The stability condition for this circuit is derived and a connection is established between the circuit parameters and the stability conditions. Experimental confirmation of the stability criterion is given. The author also calculates the required parameters necessary to insure stable operation of the circuit for best regulation.

Matrix Method for the Synthesis of Multi-Cycle Relay-Contact Communication and Control Circuits by M. L. Tsetlin and G. S. Eydus. EC 4/58, pp 41-48, 4 figs.

The authors develop briefly the concepts of the matrices of the state of relay-contact circuits and employ this concept for the synthesis of control systems. Several examples of the procedure are given. It is stated that the method is effective for certain applications and can serve as a useful supplement to the standard method of algebraic logic.



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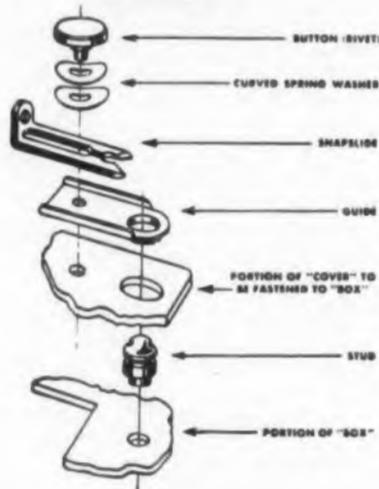
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RUSSIAN TRANSLATIONS

Self Excitation Conditions and Frequency of Self Oscillations of Junction Transistor Oscillators by P. D. Berestnev. RE 2/58, pp 36-43, 5 figs.

Expressions are derived for the self-excitation conditions and for the self-oscillation frequency for oscillators with transformer, auto transformer, and capacitive feedback. Ideas concerning the choice of elements of the phase-correction network as a function of the transistor parameters and the self-oscillation frequency are discussed. Reference is made to "Small-Signal Parameters for Transistors" by R. F. Pritchard (*Electrical Engineering*, October, 1954).

Graphic Determination of Input Impedance of a Two-Port Network by V. M. Drugov. EC 3/58, pp 49-53, 2 figs.

Description of a method of plotting the curves of the input impedances of two-port networks in the Z plane for changing load impedances within specified limits. Formulas and practical examples are given.

Semiconductor RC-Oscillators With Phase Shift RE 2/58, pp 44-50, 7 figs.

Formulas are derived for the oscillation frequency and for the gain, without resorting to analogy with vacuum tube circuits. The concept of the coefficient of maximum possible stability is introduced.

Phase Detector for Multiple Frequencies by R. Ya. Berkman. AT 4/58, pp 360-365, 7 figs.

In many circuits the output voltage has a frequency that is a multiple of the excitation-voltage frequency. This is particularly true in magnetic-amplifier circuits. The detection of this output, usually second harmonic, with the aid of phase detectors of the ordinary type usually involves complication of the circuit, for a frequency doubler is required. The differential amplitude voltmeter, frequently used for the same purpose, has poor null stability, a narrow linearity range, and produces low output power. The author has developed a new phase detector circuit, employing nonlinear symmetry resistances.

Method of Analysis of Amplifiers With Distributed Constants by Yu. N. Prozorovskiy. REE 4/58, pp 518-521, 4 figs.

A method is given for the analysis of three types of distributed amplifiers (with grounded cathode, with grounded grids, or with grounded

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anodes). The amplifier is considered as a system consisting of a finite number of multi-port networks connected in cascades. See Figs. 1 and 2.

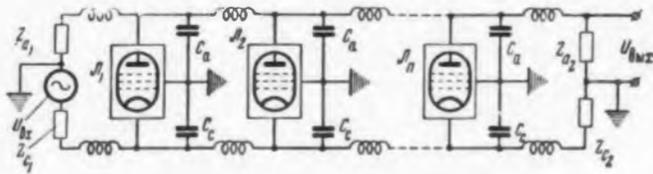


Fig. 1. Distributed amplifier.

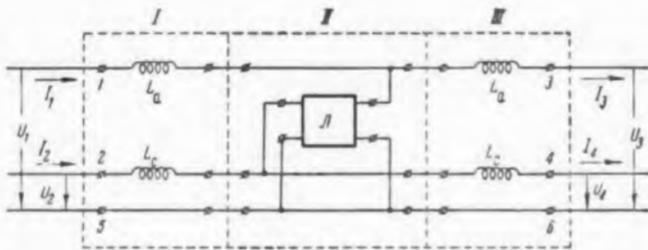


Fig. 2. Section of amplifier in the form of a chain of multi-port networks.

ELECTROMAGNETIC THEORY

Solution of Problems of Electrodynamics from Known Solutions of Corresponding Problems of Electrostatics and Magnetostatics by A. I. Potekhina. REE 5/58, pp 587-591.

A method is proposed for seeking the solution of certain boundary problems in electro-dynamics from known solutions of corresponding problems in electrostatics or magnetostatics. The solution is expressed in terms of fractional-order Hankel functions. The method is applicable in those cases, when the dependence of the field intensity on the angular coordinates does not change with frequency.

Calculation of the Induced Magnetic Moment of a Flattened Ferromagnetic Ellipsoid of Rotation in an Alternating Magnetic Field by L. A. Gel'bukh. JTP 3/58, pp 592-598, 2 figs.

An approximate method is used to calculate the magnitude and the phase of the induced magnetic moment on the longitudinal and transverse axes of the ferrite.

WAVEGUIDES

Calculation of Lowest-Mode Critical Wave For Rectangular Waveguides with Longitudinal Rectangular Grooves and Projections. RE 3/58, pp 8-14, 4 figs.

A system of equations is derived, connecting the dimensions of the waveguide cross-section with the critical wavelength. The derivation is made by joining the solutions derived for individual rectangular regions, into which the entire complicated cross-section of the waveguide can be broken up. The author presents, in the form of graphs, certain calculation data on wave-



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RUSSIAN TRANSLATIONS

guides with two longitudinal grooves and projections. Some of the calculated data are compared with experiment.

Effect of Asymmetry of Exciting Slit on the Accuracy of a Limiting Attenuator of the Capacitive Type by Ye. S. Zhavoronkova. RE 1/58, 29-39, 11 figs.

The author investigates the effect of mechanical precision with which the exciting slit is manufactured on the accuracy of a model limiting attenuator of the capacitive type. It is demonstrated that the amplitude of the E_{01} wave excited by the slit is independent of the frequency, while the amplitude of a H_{11} wave is proportional to the square of the frequency. The systematic error of the capacitive attenuator of this type, resulting from the excitation of a parasitic H_{11} mode along with the fundamental E_{01} mode, is calculated.

COMMUNICATION SYSTEMS

Radio Relay Communication System "Vesna" With Automatized Repeater Stations by N. I. Kalashnikov. CJ 5/58, pp 4-6.

This radio relay system is intended for communication over lines up to 5000 km. The described version of the system makes it possible to transmit intelligence over three high frequency trunks, to duplex trunks, and a single simplex one. The simplex trunk, serving for the transmission of television, permits reversal, i.e., change in the direction of transmission. This leads to a reduction in the equipment in those cases, when no simultaneous two-way exchange of television programs is necessary. A block diagram and the basic features of the equipment are described.

Reduction of Interference Between Aerial Telephone-Telegraph Lines by Means of Feedback Networks by M. A. Klimov. CJ 2/58, pp 10-12.

The author considers the problem of reducing the interference between aerial telephone-telegraph lines with the aid of feedback circuits. It is indicated that it is possible to employ such networks to reduce interference between steel circuits used in VS-3 carrier systems.

MISCELLANEOUS

Input Impedances of Germanium and Silicon Detectors in the Centimeter Wave Region by N. A. Penin, F. S. Rusin, and N. Ye. Skvortsova. REE 4/58, pp 543-546, 3 figs.

The authors calculated the dependence of the input impedances of germanium and silicon de-

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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.

AJ	Acoustic Journal (<i>Akusticheskiy Zhurnal</i>)
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>)
JTP	Journal of Technical Physics (<i>Zhurnal Tekhnicheskoy Fiziki</i>)
ME	Measurement Engineering (<i>Izmeritel'naya Teknika</i>)
R	Radio
RE	Radio Engineering (<i>Radiotekhnika</i>)
REE	Radio Engineering and Electronics (<i>Radiotekhnika i Elektronika</i>)

tectors on the positive bias current and on the frequency. The experimental and calculated relations compare well.

Investigation of Ionospheric Irregularities by Radio Astronomical Methods by V. V. Vitkevich. REE 4/58, pp 478-486, 8 figs.

The radiation from radio stars is used to investigate the electronic irregularities in the ionosphere. Data on the irregularities of the vertical ionospheric refraction are used to calculate the dimensions and the electronic concentrations of large-scale irregularities. Data are given on the irregularities in the horizontal radio refraction, and also on electronic irregularities that disturb interference patterns.

Concentrators Used in the Central Telegraph Office of the USSR by M. I. Grebenshchika. CJ 5/58, pp 28-30.

Description of two types of concentrators used in the USSR Central Telegraph Office—key concentrators, and concentrators with use of automatic equipment of subscriber telegraph. The two types are described in detail.

Choice of the Ratios of the Dimensions of the Apertures of the Radiation and the Reflector in a Periscopic System by A. M. Pokras. EC 2/58, pp 20-24, 1 fig, 6 tables.

The periscopic antenna was treated by the same author in the November 1957 issue of *Radiotekhnika*. In this article he treats the best ratio between the dimensions of the antenna elements and shows that it is advisable to use a construction in which the radiator is larger than the reflector.

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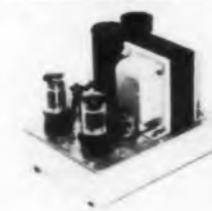
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RR 205				3 1/2 x 19 x 8 1/2					69.50
RS 305	225-325	0-50	6.3/3	No	6 1/2 lbs	3 1/2 x 19 x 8 1/2	5 x 4 1/8 x 6 1/2	3 1/2 x 19 x 8 1/2	49.50
RR 305				3 1/2 x 19 x 8 1/2					69.50
RS 217A	150-225	0-175	6.3/8	No	12 1/2 lbs	6 1/2 x 19 x 9 3/4	5 1/4 x 19 x 9 3/4	6 1/2 x 5 1/2 x 7 1/4	79.50
RM 217A				5 1/4 x 19 x 9 3/4					134.50
RS 317	225-325	0-175	6.3/8	No	12 1/2 lbs	6 1/2 x 19 x 9 3/4	5 1/4 x 19 x 9 3/4	6 1/2 x 5 1/2 x 7 1/4	79.50
RM 317				5 1/4 x 19 x 9 3/4					134.50
RS 410A	400-550	0-100	6.3/8	No	12 1/2 lbs	6 1/2 x 19 x 9 3/4	5 1/4 x 19 x 9 3/4	6 1/2 x 5 1/2 x 7 1/4	99.50
RM 410A				5 1/4 x 19 x 9 3/4					158.00
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RM 110				5 1/4 x 19 x 9					156.00
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Back Current Tester Model BT1	0-100 V, 0-300 V 0-300 V, 0-1000 V	0.1%	0.1%	0.1%	0-10-30-100-300-1000 V UA, MUA	575.00
Combination Back-Forward Tester Model 997	0-5 VDC 0-1000 VDC	2 MVPP	10 MV	10 MV	0-10-30-100-300-1000 V, MA, UA, MUA	895.00
Peak Inverse Voltage Tester Model PIV 1					Linear voltage rise of 90 volts/sec to 400 volts. Automatic shut-off when dynamic impedance equals zero.	990.00

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Mechanical Tuning Range - MC	6125 - 6425	6575 - 6875	7125 - 7425
Resonator Voltage - Volts	750	750	750
Reflector Voltage - Volts	-250 to -400	-250 to -400	-250 to -400
Cathode Current - MA	80 (max)	80 (max)	80 (max)
Power Output - Watts	0.7 (min)	0.7 (min)	0.7 (min)
Heater Voltage - Volts	6.3	6.3	6.3
Heater Current - Amperes	0.8	0.8	0.8
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GERMAN ABSTRACTS

E. B. Janner

Two-Frequency Oscillator

IN AN OSCILLATOR circuit it is possible to choose the reactive elements of the feedback network so that the conditions for oscillation are fulfilled at two frequencies. If the circuit elements are chosen so that the two frequencies involved are (approximately) multiples of each other, then the principles of synchronization can be used for frequency division or frequency multiplication.

A typical two-frequency oscillator is illustrated. A second arrangement is essentially the dual of the circuit shown, in the sense that the parallel resonant circuits are replaced by series resonant circuits. The condition for oscillation requires that the transconductance of the oscillator satisfy the equation

$$g_m = (Z_1 + Z_2 + Z_3) / Z_1 Z_2$$

Choosing $Z_1 = Z_2$, the two radian frequencies at which this condition is fulfilled are given by

$$\omega_1^2 = \frac{a}{2} \left[1 - (1 - 4b/a^2)^{1/2} \right]$$

$$\omega_2^2 = \frac{a}{2} \left[1 + (1 - 4b/a^2)^{1/2} \right]$$

where

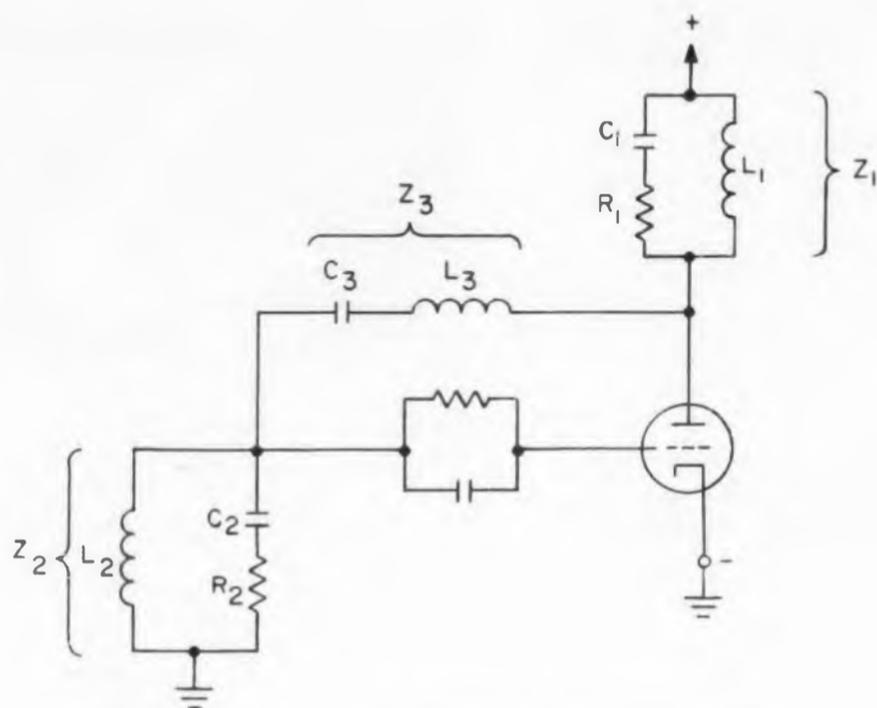
$$a = 1/L_3 C_3 + 1/L_2 C_2 + 2/C_2 L_1$$

and

$$b = 1/L_2 C_2 L_3 C_3$$

These expressions are approximate and are based on the assumption of high Q resonant circuits.

While the circuit can be used either as a frequency multiplier or a frequency divider it appears to be particularly suited for frequency division. A signal whose frequency is to be divided is coupled inductively into the high frequency resonant circuit, i.e., to L_2 . Theoretical



Oscillator in which the conditions for oscillations can be fulfilled at two frequencies.

and experimental investigations show that exceedingly low signals are required because of the gain and internal synchronization provided by the circuit. Frequency division down to 100 kc

from 0.8-8.0 mc, (i.e. in a ratio from 8 to 80) were possible in an experimental model.

Abstracted from an article by G. Becker, Frequenz, Vol. 12, No. 14, April 1958, pp 98-103.

Those Missing Illustrations

TWO GERMAN Abstracts in the November 26 issue were published without illustrations: "Design of Quartz Crystal Oscillators" and "Operating Temperature of Transistors," pp 104-105. The missing illustrations are reproduced below. A cut was left out in the November 12 issue in the article, "High Power Transistor Switches," p. 36, (Fig. 2). This illustration is also included here.

Design of Quartz Crystal Oscillators

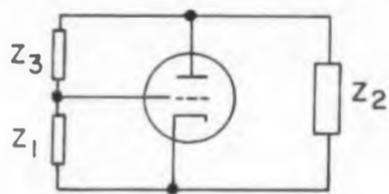


Fig. 1. Schematic of three pole oscillator (supply voltages not shown).

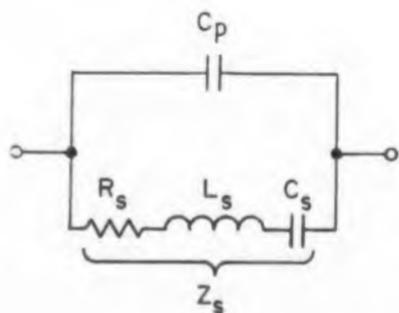


Fig. 2. Equivalent circuit of quartz crystal.

Operating Temperature of Transistors

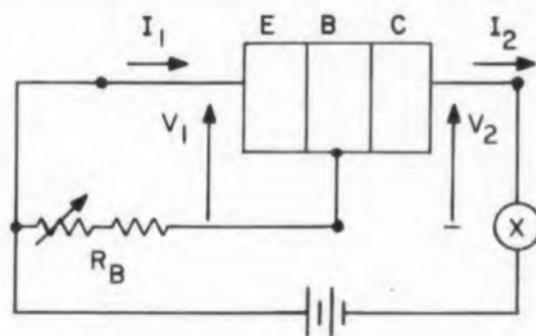


Fig. 1. Basic Circuit

High Power Transistor Switches

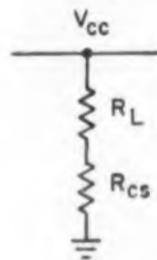


Fig. 2. Equivalent circuit, "on" state of single ended or push-pull transistor switch.

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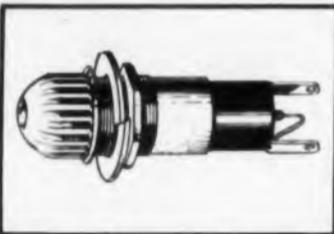
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MEETINGS

Calendar of Events

December

- 18-20 American Physical Society, Los Angeles, Calif.
- 26-31 Annual Meeting American Assoc. for Advancement of Science, Washington, D. C.

January

- 12-14 5th National Symposium on Reliability and Quality Control in Electronics, Philadelphia, Pa.
- 26-29 27th Annual Meeting Institute of Aeronautical Sciences, New York, N.Y.
- 28-29 1st International Symposium on Nuclear Fuel Elements, New York, N.Y.

February

- 1-6 AIEE Winter Meeting, New York, N.Y.
- 12-13 1959 Solid State Circuits Conference, Philadelphia, Pa.*

March

- 3-5 Western Joint Computer Conference, San Francisco, Calif.
- 5-6 Flight Propulsion Meeting, Cleveland, Ohio
- 17-21 8th Electrical Engineers' Exhibition, London
- 23-26 IRE National Convention, New York, N.Y.
- 26 15th Annual Quality Control Clinic, Rochester, N.Y.
- 31-Apr. 2 21st American Power Conference, Chicago, Ill.
- 31-Apr. 2 Symposium on Millimeter Waves, New York, N.Y.*

April

- 5-10 5th Nuclear Congress, Institute of the Aeronautical Sciences, Cleveland, Ohio
- 6-8 3rd Annual Astronautics Symposium, Air Force Office Scientific Research, Washington, D. C.
- 6-9 16th Annual Radio Component Show, London
- 16-18 SW IRE Regional Conf. and Elec. Show, Dallas, Tex.
- 20-21 New Techniques in Elec. Industrial Instrumentation, Philadelphia, Pa.

*Indicates meetings described below.

1959 Solid State Circuits Conference, Feb. 12-13

Philadelphia, Pa. Sponsored by IRE, AIEE, and Univ. of Pennsylvania. Devoted to transistor circuit technology, applications, and circuit technology, applications, and circuit techniques of a variety of solid state devices.

Symposium on Millimeter Waves, March 31-April 2
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ELECTRONIC DESIGN • December 10, 1958

Polytechnic Institute of Brooklyn, Microwave Research Institute under the co-sponsorship of the Air Force Office of Scientific Research, U.S. Army Signal Research and Development Laboratory, Office of Naval Research, and the IRE. Intended to highlight the present state of research in, and applications of, millimeter wave technology, the program will be devoted to the following topics: Interaction of millimeter waves and materials; Solid state active millimeter circuits; Millimeter electron tubes; Radiating circuits and antennas; Coupled line, multimode, and non-convention transmission systems; Millimeter components; Millimeter circuit measurement techniques.

Paper Deadlines

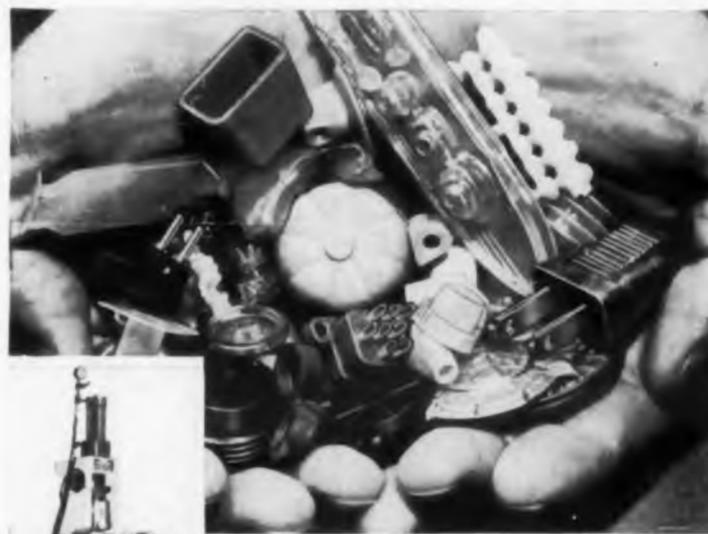
December 22: Deadline for receipt, in triplicate, of a detailed 750-word summary of papers for presentation at the **International Symposium on Circuit and Information Theory** to be held at the University of California at Los Angeles on June 16-18, 1959. All correspondence should be addressed to *Dr. G. L. Turin, Hughes Research Laboratories, Culver City, Calif.*

Jan. 30: Closing date for submission of papers and/or 100 word abstracts treating the generation, transmission, control, measurement, and detection of millimeter wave energy for presentation at the **Symposium on Millimeter Waves** to be held in New York, March 31-April 2. Address correspondence to *Professor Herbert J. Carlin, Polytechnic Institute of Brooklyn, Microwave Research Institute, 55 Johnson St., Brooklyn 1, N.Y.*

Feb. 15: Final deadline for contributors desiring to present papers at **Fifth Annual Symposium on Instrumental Methods of Analysis** to be sponsored by ISA in Houston, Texas on May 18-20. Theme of the Symposium: *New Techniques in Analytical Instrumentation for Laboratories and for Processing Plants.* Prospective contributors should send title, authors, and three copies of a 100-word abstract to *M. D. Weiss, Program Chairman, Special Instrumentation Div., Union Carbon Olefins Co., South Charleston, W. Va.*

Seminars

Jan. 13: Clear Technical Writing. Hotel Sheraton-West, Los Angeles, Calif. **Jan. 15: Hotel Sheraton-Palace, San Francisco, Calif.** Conducted by Robert Gunning, authority on writing and readability techniques. Further information and Seminar schedules may be obtained by writing *Industrial Education Institute, 25 Huntington Ave., Boston 16, Mass.*



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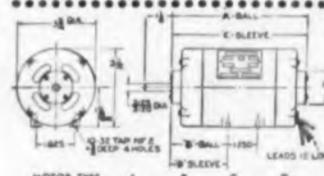
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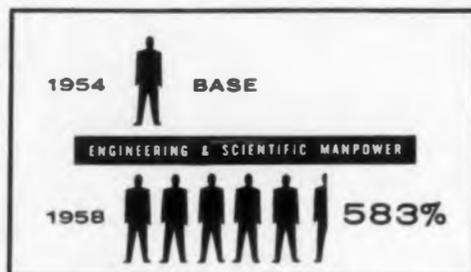
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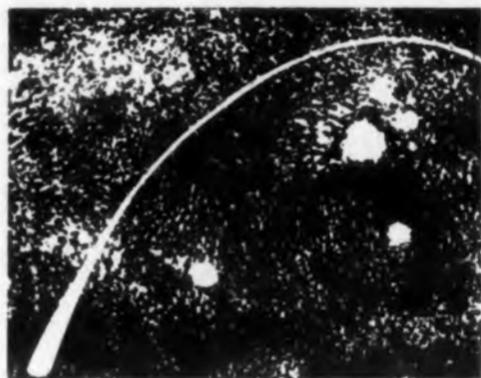


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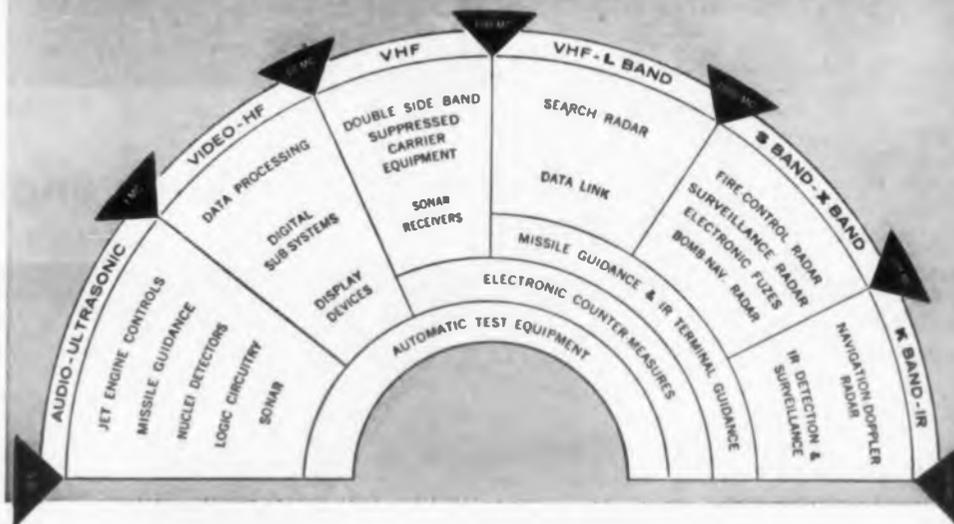
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Qualifications: B.S. or Advanced Degree in E.E. or A.E.

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analyze relationship of inertial equipment with bombing and navigation computer.

Qualifications: B.S. or M.S. in E.E. or Physics.

RADAR ENGINEER to analyze ultimate limits of present techniques and develop new concepts of providing topographical sensors for advanced airborne and space systems; to design airborne radar pulse, microwave and deflection circuitry; to analyze doppler radar systems in order to determine theoretical accuracy and performance limitations.

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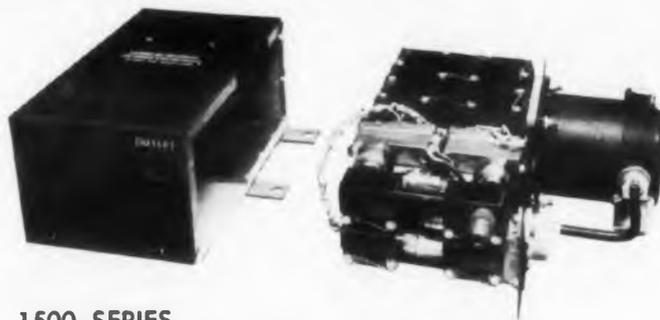


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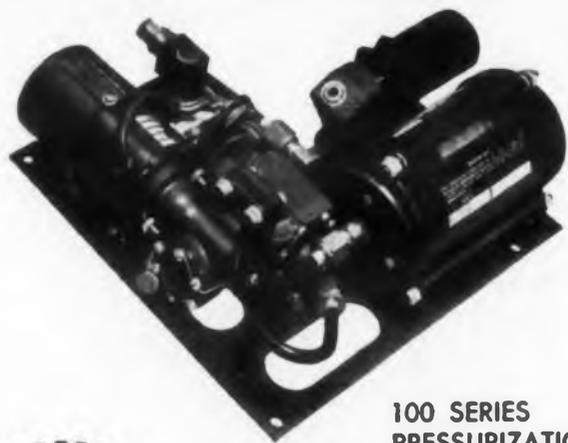


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1N1763	400	140	500	100 μ a at 400 volts	3 volts at 15 amperes	Black-and-white TV, radios, phonographs and other electronic equipment operating direct from power line
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