ELECTRONIC DESIGN

IRE National Convention
March 18-21

MARCH 1, 1957

FREED

Offers for Immediate Delivery

MINIATURE COMPONENTS

(MEET MIL-T-27A SPECIFICATIONS)

MINIATURE AUDIO TRANSFORMERS

Catalog No.	Input	Coupling	Power Level	Balanced DC Current	Unbalanced DC Current	Impedance Ohms	
			DBM	MA	MA	pri.	sec.
PMA-1	√		+8	0	0	50/200/500	60,000 center tapped
PMA-2	√		+8	0	0	4/8	
PMA-3	√		+8	0	0	50/200/500	
PMA-4		√	+8	0	0	15,000	
PMA-5		√	+8	2	2	15,000	
PMA-6	√		+8	0	0	15,000	50/200/500
PMA-7	√		+8	2	2	15,000	
PMA-8	√		+8	2	.25	30,000 ct	
PMA-9		√	+8	0	0	60,000	
PMA-10		√	+8	0	0	50/200	

All units ±2 DB 30 to 20,000∿; PMA 5 and 7 ±2 DB 200 to 10,000∿. Case size 15/16"D x 1½" high. Ranges 1½" long.

TRANSISTOR TRANSFORMERS

Catalog No.	200 to 15,000	300 to 15,000	Unbalanced DC Current	Max. Power Out	Impedance Ohms	
	DB	DB	MA	W.	pri.	sec.
TMA-1	±1		0	.25	500	500
TMA-2		±2	3	.25	50K	500
TMA-3		±2	3	.25	50K	6
TMA-4		±3	1	.25	100K	1.2K ct.
TMA-5	±2		3	.25	25K	1.2K ct.
TMA-6		±2	3	.25	50K	1.2K ct.
TMA-7	±1		4	.25	600/150	1.2K ct.
TMA-8	±2		3	.25	25K	600
TMA-9	±1		1	.25	4K ct.	600/150
TMA-10	±2		10	.25	2K	3.2
TMA-11	±1		1	.25	4K ct.	3.2
TMA-12		±2	4	.25	20K	50
TMA-13		±2	8	.25	1K	50
TMA-14		±2	0	.10	100K	1K
TMO-15		±2	1	.04	20K	50
TMO-16		±2	1	.04	20K	600
TMO-17		±2	3	.06	1K	50
TMO-18		±2	0	.10	100K	1K
TMA-19	±2		20	1.	1K	3.2

Case size 1"D x 1.5" high, flanges 1⅜". Specify TMO for open, TMC for encapsulated units.

MINIATURE HIGH Q TOROIDS

Cat. No.	Ind. MHY	Cat. No.	Ind. MHY	Cat. No.	Ind. MHY	Cat. No.	Ind. MHY
to 15 KC		10 to 50 KC		30 to 75 KC		50 to 200 KC	
F2050	1.	F2100	0.1	F2140	0.1	F2180	0.1
F2051	3.	F2101	0.2	F2141	0.2	F2181	0.2
F2052	5.	F2102	0.3	F2142	0.3	F2182	0.3
F2053	10.	F2103	0.4	F2143	0.4	F2183	0.4
F2054	15.	F2104	0.5	F2144	0.5	F2184	0.5
F2055	30.	F2105	1.0	F2145	1.0	F2185	0.6
F2056	50.	F2106	2.0	F2146	2.0	F2186	0.7
F2057	75.	F2107	3.0	F2147	3.0	F2187	0.8
F2058	100.	F2108	4.0	F2148	4.0	F2188	0.9
F2059	150.	F2109	5.0	F2149	5.0	F2189	1.
F2060	200.	F2110	7.5	F2150	7.5	F2190	2.
F2061	300.	F2111	10.	F2151	10.	F2191	3.
F2062	400.	F2112	15.	F2152	15.	F2192	4.
F2063	500.	F2113	20.	F2153	20.	F2193	5.
F2064	750.	F2114	30.	F2154	30.		
F2065	1,000.	F2115	50.	F2155	50.		
F2066	1,250.	F2116	75.	F2156	75.		
F2067	1,500.	F2117	100.	F2157	100.		
F2068	1,750.						
F2069	2,000.						

Case size: ¾"x11/32" x25/32h. Encapsulated 1"dx⅞"h. When ordering hermetically sealed units add H, encapsulated units MR to Cat. No.

FOR PRECISION LABORATORY OR PRODUCTION TESTING

FREED

1110-AB INCREMENTAL INDUCTANCE BRIDGE AND ACCESSORIES

Accurate inductance measurement with or without superimposed D.C., for all types of iron core components.

- **INDUCTANCE** — 1 Millihenry to 1000 Henry
- **FREQUENCY** — 20 to 10,000 Cycles
- **ACCURACY** — 1% to 1000 Cycle, 2% to 10KC
- **CONDUCTANCE** — 1 Micromho to 1 MHO
- **"Q"** — 0.5 to 100
- **SUPERIMPOSED D.C.** — Up to 1 Ampere
- **DIRECT READING** — For use by unskilled operators.

ACCESSORIES AVAILABLE:
1140-A Null Detector 1210-A Null Detector - V.T.V.M. 1170 D.C. Supply and 1180 A.C. Supply.

FREED

NULL DETECTOR AMPLIFIER TYPE 1140-A

USES

A sensitive null indicator for bridge measurements, providing visual null indications or aural when used in conjunction with headphones. The unit may also be used as a high gain amplifier for general laboratory work.

DESCRIPTION

Functionally the instrument consists of a high gain linear amplifier with a 30 db. input attenuator in addition to the variable gain control. A four-inch panel meter provides visual null indications, the response of the meter circuit is approximately logarithmic over a 40 db. voltage range. Resonant circuits tuned to 60, 400 and 1000 cycles limit the amplifier transmission characteristics to the three audio frequencies commonly used for bridge measurements or it may be used as a non-selective amplifier with filter "off."

SPECIFICATIONS

Input Impedance: 1 megohm in parallel with 25 mmf. **GAIN:** 98 db. with 1 megohm load (6 mmf. shunt capacity), down 1.5 db. at 25,000 cycles, down 5 db. at 50,000 cycles, down 2 db. at 20 cycles. **Null Detector Sensitivity:** At 1 kc. 100 microvolts will give a 15% meter deflection. **Selective Amplifier:** 26 db. second harmonic attenuation at 60, 400 and 1000 cycles. **Power Supply:** 105-125 volts, 50-60 cycles, 35 watts consumption. **Dimensions:** 13½" x 8½" x 10".

TELEMETERING COMPONENTS

BAND PASS FILTERS / DISCRIMINATORS

Catalog No. Z_0=500Ω	Catalog No. Z_0=2,500Ω	3DB Bandwidth per cent of F_0 ± 9¾	3DB Bandwidth per cent of F_0 ± 19½	Center Frequency F_0 (KC)	Per cent Deviation of F_0 8½	Per cent Deviation of F_0 15.	Per cent Linearity 0.5	Per cent Linearity 1.0	Catalog No.
FBP-10	FBP-34	√		.4	√		√		DST-10
FBP-11	FBP-35	√		.56	√		√		DST-11
FBP-12	FBP-36	√		.73	√		√		DST-12
FBP-13	FBP-37	√		.96	√		√		DST-13
FBP-14	FBP-38	√		1.3	√		√		DST-14
FBP-15	FBP-39	√		1.7	√		√		DST-15
FBP-16	FBP-40	√		2.3	√		√		DST-16
FBP-17	FBP-41	√		3.0	√		√		DST-17
FBP-18	FBP-42	√		3.9	√		√		DST-18
FBP-19	FBP-43	√		5.4	√		√		DST-19
FBP-20	FBP-44	√		7.35	√		√		DST-20
FBP-21	FBP-45	√		10.5	√		√		DST-21
FBP-22	FBP-46	√		12.3	√		√		DST-22
FBP-23	FBP-47	√		14.5	√				DST-23
FBP-24	FBP-48	√		22.0	√		√		DST-24
FBP-25	FBP-49		√	22.0		√		√	DST-29
FBP-26	FBP-50	√		30.0	√		√		DST-25
FBP-27	FBP-51		√	30.0		√		√	DST-30
FBP-28	FBP-52	√		40.0	√		√		DST-26
FBP-29	FBP-53		√	40.0		√		√	DST-31
FBP-30	FBP-54	√		52.5	√		√		DST-27
FBP-31	FBP-55		√	52.5		√		√	DST-32
FBP-32	FBP-56	√		70.0	√		√		DST-28
FBP-33	FBP-57		√	70.0		√		√	DST-33

DISCRIMINATOR LOW PASS FILTERS

Catalog No.	Center Frequency F_0 (cps)	Catalog No.	Center Frequency F_0 (cps)	Catalog No.	Center Frequency F_0 (cps)	Attenuation
OUTPUT						
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
LPO-11	8	LPO-20	110	LPO-29	900	
LPO-12	11	LPO-21	160	LPO-30	1,050	
LPO-13	14	LPO-22	185	LPO-31	1,200	
LPO-14	20	LPO-23	220	LPO-32	1,600	
LPO-15	25	LPO-24	330	LPO-33	2,100	
LPO-16	35	LPO-25	450	LPO-34	7,200	
LPO-17	45	LPO-26	600	LPO-35	10,000	
LPO-18	60	LPO-27	660			
Characteristic impedance of all=330Ω						
INPUT						
LPI-10	400	LPI-17	3,000	LPI-23	14,500	.05 DB at 9¾% F_0; 30 DB at third Harmonic; 50 DB at fifth Harmonic
LPI-11	560	LPI-18	3,900	LPI-24	22,000	
LPI-12	730	LPI-19	5,400	LPI-25	30,000	
LPI-13	960	LPI-20	7,350	LPI-26	40,000	
LPI-14	1,300	LPI-21	10,500	LPI-27	52,500	
LPI-15	1,700	LPI-22	12,300	LPI-28	70,000	
LPI-16	2,300					
Characteristic impedance of LPI-10 thru 23=30,000Ω; of LPI-24 thru 28=5,100Ω						

Send for NEW 48 page transformer catalog. Also ask for complete laboratory test instrument catalog.

FREED TRANSFORMER CO., INC.

1727 WEIRFIELD ST., RIDGEWOOD, BROOKLYN 27, NEW YORK

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ELECTRONIC DESIGN

Contents

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Editorial

May We Save Your Time?

The IRE National Convention and Show this year promises to be the biggest ever held. There will be more technical papers and more exhibits. Those of you who have attended in in the past may wonder how you will be able to "cover" it all in the limited time you have available. May we make some suggestions to help you save time?

▸ Check the technical sessions you want to attend in advance and note their locations. Those that will be held at the Coliseum are shown on page 27. All others will be held at the Waldorf-Astoria Hotel, 20 minutes away. Plan to tour exhibits while at the Coliseum for technical sessions.

▸ New products to be on display at the Show are all illustrated and described in this issue of ELECTRONIC DESIGN. The company name, together with the booth number where the product will be on display, is given for each new product. We suggest you check these over carefully in advance of arrival and make a list of those products and booths of special interest *to you*.

▸ To find the products of special interest when you arrive it will only be necessary to note whether the product is a component, an instrument, a basic material or tool, or a complete equipment, and go to the appropriate floor at the Coliseum. The exhibits are so arranged that complete equipments will be found on the first floor, components on the second and part of the third, instruments on the third, and basic materials and tools on the fourth.

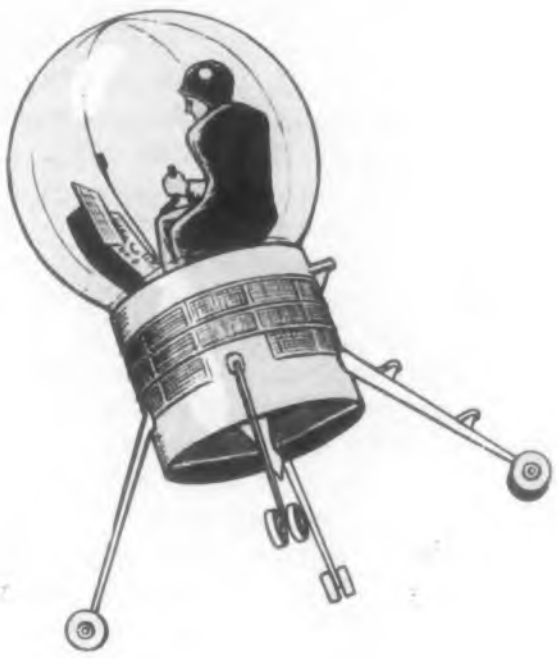
▸ For a *general* tour, start on the fourth floor and work down. This will save time, because the elevator from floor 4 to floor 3 does not stop at 3 going up.

▸ We suggest you make your first stop at ELECTRONIC DESIGN's booths (4101, 4102), right by the elevator as you get out on the fourth floor, to start your tour. Copies of ELECTRONIC DAILY and someone to guide you will be available at our booths to give you all the latest information and directions to save you time. An ELECTRONIC DESIGN editor will be on hand to receive your "design idea" for which we will pay $10 if accepted for publication. We will also have an "editorial office" where we hope you will drop in and say "hello."

▸ Make ELECTRONIC DESIGN your headquarters. Your interests are ours.—ETE

Engineering Review

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



Artist's conception of gas turbine powered "Flying Flash Bulb," tomorrow's answer to the overcrowded highway.

Tomorrow's Transportation

"Flying Flash Bulb" will be on the market within ten years, according to its designer P. G. Kappus, top product planner of the Flight Propulsion Lab., General Electric Co., Cincinnati, Ohio. Kappus indicated that vertical take-off and landing may do for aviation what Henry Ford's Model T did for the automobile. The designer anticipates that there will be many different types of such aircraft. Some will have wings and others will not, depending on the distance they will be expected to fly or the load they will carry.

Solid-State Oscillator for Microwaves

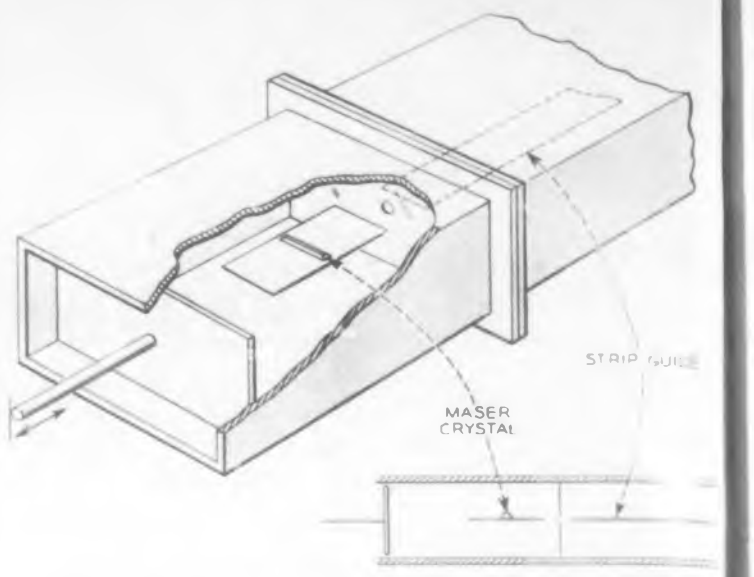
Successful operation of a revolutionary solid-state device, which will oscillate at microwave frequencies, has been achieved at Bell Telephone Laboratories by Dr. Derrick Scovil, Dr. George Feher and Dr. Harold Seidel. The experiment as carried out at Bell Laboratories produced oscillations at 9,000 Mc with a power output of about 20 μw. Operation at both much lower and higher frequencies is possible with proper choice of solid-state materials and operating conditions.

A completely new source of microwave power operating under new physical principles was demonstrated. Scientists believe it is only a question of time until microwave amplification can be obtained employing crystalline materials and operating under the same physical principles as the oscillator. Potential applications of this device as an amplifier are boundless.

One of the outstanding characteristics of the new device is that it is expected to have very low noise compared with conventional microwave devices. Thus, in theory, it could markedly extend the range of radio astronomy and could result in radically new long distance communication systems to carry television programs and telephone calls across the continent.

While this experimental result is completely new, the possibility of such an occurrence has been the subject of studies and speculative discussion by a number of physicists for some time. The development represents the first successful application to a solid-state device of a relatively new principle,

Drs. Harold Seidel, Derrick Scovil and George Feher inserting waveguide assembly containing the solid-state oscillator into a Dewar Flash. Flash will contain liquid helium at 1.2°K.



Sketch of resonant cavity and crystal used in obtaining the oscillations at microwave frequencies.

which has been called the "maser" principle. "Maser" was first demonstrated for molecular beams is gases in 1954 by Professor C. H. Townes and his collaborators at Columbia University. They coined the word "maser" which stands for "microwave amplification by stimulated emission of radiation." Because it operates with electron spins in a paramagnetic crystal, theory predicts that it should have very low inherent noise compared to ordinary electronic oscillators or amplifiers which depend on the motion of charged particles at high temperatures. Therefore, it may be possible to amplify extremely weak radio signals—signals which may be several hundred times weaker than those usable at present. An as amplifier, it should be moderately broadband with a bandwidth of the order of 100 Mc, and easily tuned since its frequency is proportional to the applied magnetic field. Preliminary theoretical estimates indicate that a noise figure corresponding to thermal noise at perhaps 5 or 10 degrees Kel should be attainable. This is hundreds of times better than is now available with conventional microwave circuitry and if realized in practice will open wide new vistas in the microwave field.

The basic operation of this particular type of solid state device can be explained roughly by assuming three different energy levels for the unpaired spinning electrons in a paramagnetic crystal lattice in a magnetic field. Normal electron spin states are such that the number in state 1 (lowest energy state) exceeds the number in state 2, which in turn exceeds the number in state 3. By irradiating with sufficient microwave power of the proper frequency, transitions from state 1 to state 3 take place until the populations of these two states are essentially equal (power saturation).

Under these conditions the population of state 2 can be made greater than that of state 1. If a small signal is applied at a frequency corresponding to the energy difference between these two, then

stimulated radiative transitions will occur, and power gain will be realized. In the experiment conducted at Bell Laboratories, the energizing frequency was 17,500 mc and the signal frequency (in this case a self-sustained oscillation) was 9,000 mc.

A number of conditions have to be established before operation such as that described above can take place. In the first place, a single crystal of a solid-state material having certain specific characteristics is necessary. A whole group of materials, known as "ionically bound paramagnetic salts," appear to be suitable. After a careful survey, gadolinium ethyl sulphate was selected, although it is recognized that other compounds might perform as well or better for specific applications. Secondly, this material has to be diluted with an isomorphous diamagnetic substance to separate the gadolinium atoms sufficiently to reduce electron spin interaction. Lanthanum ethyl sulphate was selected, and it makes up about 99 per cent of the finished crystal.

The crystal was mounted in a waveguide cavity having two resonant frequencies, one equal to the frequency of oscillation, and one the frequency of the energizing source. The sample occupied about 8 per cent of the cavity volume, and was located at the point of maximum magnetic field intensity.

Low temperature operation is used so that power saturation of the crystal takes place with a reasonable amount of energizing oscillator power and also to increase the population difference between the energy levels. The sample and cavity were immersed in liquid helium at reduced pressure which provides a temperature of 1.2 K.

To produce the necessary separation of the electron spin energy levels, a magnetic field is required. A value of 2800 oersteds was employed in the device built at Bell Laboratories. This magnetic field may be altered to change the electron spin energies and thus tune the frequency of the stimulated radiation. The field must be properly aligned with respect to the crystal, and can be provided either by a permanent magnet or an electro-magnet.

Equipment employed at the Bell Laboratories in demonstrating the operation of this new solid state device included a waveguide cavity, with the crystal in place, immersed in liquid helium. This assembly was located in the field of a strong electromagnet. The 17,500 Mc energizing oscillator signal was brought to the cavity through a rectangular waveguide, and the stimulated radiation of 9,000 Mc was taken away by means of a strip guide mounted inside the rectangular waveguide. Measured power output was about 20 μw. Energizing oscillator power, which might be compared to "B+" power in a conventional amplifier or oscillator, was about 100 mw to insure saturation of the crystal. Satisfactory operation can be attained with much less power.

Pocket-Size Television Camera

A pocket-size live television camera has been developed by RCA, Camden, N.J., for military airborne, mobile and field-closed-circuit TV application. The miniature TV camera utilizes a new design approach which combines transistor circuitry and a new RCA half-inch vidicon camera tube.

Used with an F-1.9 lens, it requires only 10 foot candles of scene illumination for clear, good contrast pictures. A photoelectric iris control automatically activates specific camera circuits to compensate for changing light levels. This iris control enables the camera to accommodate changes in the order of 100 to 1 in scene lighting.

Patent System Study

Dr. Vannevar Bush, retired director at the Carnegie Institution, has made a study of the U.S. Patent System at the request of a congressional subcommittee. In his report to Sen. J. C. Mahoney, he outlines the problems that have arisen out of an "archaic system that has failed to keep abreast of the times." He also makes some suggestions as to how the patent system may be improved to benefit a larger number of people.

Dr. Bush feels that the system has led to a number of objectionable effects. Among these are:

- Strong industrial groups dominating fields of manufacture. This includes not only a patent's statutory term, but often for perpetuity by adding improvements.
- Trivial applications wasting the time of patent examiners.
- Invalidations occurring too often became prior inventions have not been considered.
- No obligations for the holder to bring his invention to use.
- An inability—both in the courts and the Patent Office—to keep up with the great mass of scientific material. This discourages inventors and businessmen who might risk capital to manufacture the invention.

Among the recommendations for improvement, Dr. Bush suggests:

- Legislation that would determine the extent of monopoly in combination, cross licensing, infringement, and domination.

- Freshly defined criteria to raise the standard of invention from trivia to devices worthy of the public's use.
- A special tribunal, under the Department of Commerce, for judging patent cases now going to law courts. Technical matters would then be evaluated by properly qualified persons.
- Increased funds for facilities and employees.

Atomic Battery—Size of Button

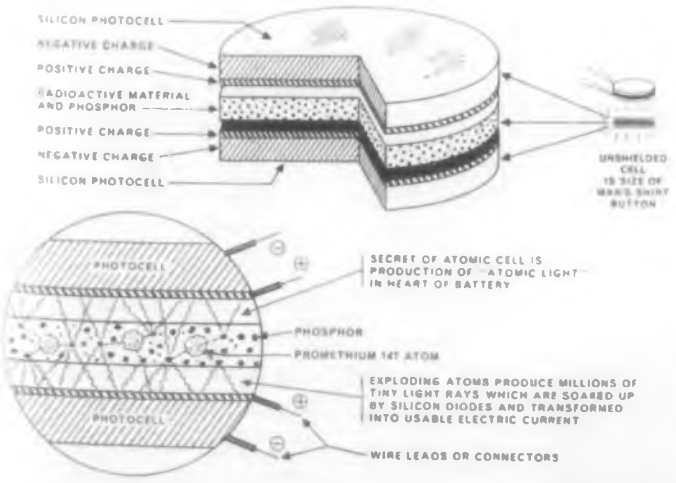
An atomic-powered battery no bigger than a cough drop, yet capable of delivering usable power for at least five years has been announced by the Walter Kidde Nuclear Laboratories, Inc., Garden City, N.Y. The atom-cell uses a radioactive substance known as Promethium 147, once considered an atomic "waste-product," as its power source. This material was chosen because it produces energy over a long period and requires little shielding against radiation. The energy output, limited only by radioactive decay, decreases at a far slower rate than conventional batteries.

A unique characteristic of the cell is its superior performance in widely varying temperatures ranging from boiling hot to bitter cold. Laboratory tests have shown it will actually increase power output in extreme cold, even in temperatures as low as —200 F.

Promethium 147, emits beta particles which are soaked up by a phosphor. The phosphor converts the beta particles into "atomic light." This in turn is captured by a photocell which converts the light energy into electrical current. Actually the principle is the same as using a phosphor to produce light in television picture tubes.

Termed as safe to carry as a house key, the miniature power unit will actually give off less radiation than radium dials on modern-day wrist watches.

Higher power output can be obtained by enlarging the battery.



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You are warmly invited to visit our booth, #2131, on the second floor of the IRE show.

CIRCLE 7 ON READER-SERVICE CARD FOR MORE INFORMATION

Computer Flies Copilot

Electronic computing techniques soon may come to the aid of "too busy" aircraft pilots according to Admiral Luis de Florez, president of the Flight Safety Foundation. He emphasized before an audience at the Institute of the Aeronautical Sciences 25th Annual Meeting that "safety in flight from now on is going to be increasingly dependent on bringing the mental problems within range of the average pilot and crew.

"With modern electronics and computing techniques it is not only possible to combine readings but integrate pertinent factors and come instantly with answers which now tax the pilot's mind and consume vital time which should be allotted to planning and consideration of factors beyond his control.

"It is furthermore possible to present the data sensed by instrumentation in a form which can be more readily understood and visualized by a pilot, again to save time, reduce the chances of error, and fatigue."

No Solar Furnace Boom

Dr. Peter E. Glaser of Arthur D. Little Co., Cambridge, Mass., doesn't see a boom in the industrial uses of solar furnaces in the near future. "Under today's economic conditions," he says, "it's cheaper to use conventional arc, gas or electrical resistance furnaces for production work." The occasion for this statement was the unveiling of Arthur D. Little's new solar research furnace, available for immediate delivery at about $14,500. Its importance to the electronics industry lies in its ability to refine materials like silicum without contaminating the sample. Other furnaces, says Dr. Glaser, can contaminate the product being processed. Crystal growing is another operation that can be carried out with much less complex equipment than required at present. Little's solar furnace utilizes a photocell control system and a sample moving system that allows the furnace to be programmed. Constant temperatures can be maintained to a higher degree of accuracy than with any other type of furnace, according to Dr. Glaser.

◄ CIRCLE 8 ON READER-SERVICE CARD
CIRCLE 9 FOR G.E. SPREAD AD ►

If it's a 4X250B by **Amperex**...*you know it's*

interchangeable

electrically and physically with the 4X150A!

Amperex TYPE 4X250B AS R-F POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony
(key down conditions, per tube)

MAXIMUM RATINGS

DC Plate Voltage	2000 volts
DC Screen Voltage	300 volts
DC Grid Voltage	—250 volts
DC Plate Current	250 ma
Plate Dissipation	250 watts
Screen Dissipation	12 watts
Grid Dissipation	2 watts

TYPICAL OPERATION

DC Plate Voltage	500	1000	1500	2000 volts
DC Screen Voltage	250	250	250	250 volts
DC Grid Voltage	—90	—90	—90	—90 volts
DC Plate Current	250	250	250	250 ma
DC Screen Current	45	35	30	25 ma
DC Grid Current	32	28	28	27 ma
Peak RF Grid Voltage (approx.)	118	116	116	115 volts
Driving Power	3.6	3.2	3.2	2.8 watts
Plate Power Input	125	250	375	500 watts
Plate Power Output	85	195	300	410 watts

The 4X250B has numerous applications as a replacement, in existing circuits, for the 4X150A, where longer life and additional plate dissipation up to 500 Mc are required. It is therefore imperative that the brand of 4X250B you choose be an *exact* plug-in replacement for the 4X150A – meaning the identical base, identical dimensions, identical electrode inductances and identical interelectrode capacitances. With the AMPEREX 4X250B you can be certain of getting just that – *total* electrical and physical interchangeability!

Write for Detailed Data Sheets

Amperex ELECTRONIC CORP.

230 Duffy Avenue, Hicksville, Long Island, N. Y.

In Canada: Rogers Electronic Tubes and Components
11-19 Brentcliffe Road, Leaside, Toronto 17, Ont.

CIRCLE 547 ON READER-SERVICE CARD FOR MORE INFORMATION

General Electric announces

GENERAL ELECTRIC VITREOUS-ENAMELED RESISTORS are available in both fixed and adjustable types. Most requirements can be met with immediate shipment from stock. Additional units with a wide variety of mounting arrangements are available for special applications.

GENERAL ELECTRIC

a new line of...

vitreous enameled resistors

General Electric presents a new line of enameled resistors designed for dependable. long-lasting service. These new resistors—rated from 5 to 218 watts—are ideal for both industrial and electronic applications.

RELIABLE PERFORMANCE THROUGH PRECISION MANUFACTURING

Maximum equipment-performance and long resistor life are assured with G.E.'s new line of resistors because:

- Low-temperature-coefficient wire means stable operation.
- Elimination of "hot-spots" reduces resistor burnouts.
- Special enamel coating is moisture and acid resistant.
- Wire junctions are silver brazed for positive connection.

NEW CATALOG SIMPLIFIES SELECTION AND ORDERING

To aid you in selecting the right resistors for your specific applications, General Electric's new easy-to-use resistor catalog puts complete information on performance, ratings, dimensions, mounting arrangements, and ordering instructions right at your fingertips.

For complete information on General Electric's new enameled resistors, contact your nearest General Electric Apparatus Sales Office. For your copy of the new G-E resistor catalog, GEA-6592, write Section 784-5, General Electric Company, Schenectady, N.Y.

Industry Control Department, Roanoke, Virginia

Progress Is Our Most Important Product

GENERAL ELECTRIC

For VARIABLE CAPACITORS...

"BFC" butterfly-type capacitor with isolated rotor, very low minimum capacity and low inductance. For VHF applications as series capacitor with no rotor connection.

"MAC" Low minimum capacity and very low inductance. Ideal for VHF-UHF applications. Designed for use in miniaturization. Also available as butterfly type "MACBF".

"APC" A compact, high quality air dielectric trimmer. Extremely high resistance to temperature changes, moisture and vibration.

"MAPC" A scaled down version of the "APC". Designed to fill the needs of miniaturization. Suitable for VHF use.

"HF" A high frequency design featuring extra long sleeve bearing and positive contact nickel-plated phosphor bronze wiper. Also available as a dual unit.

naturally,

"HFA" Similar to "HF" model, but with larger air gaps for higher breakdown ratings. Used for high-frequency, low-power transmitting. Also available as dual unit.

"MC" Designed for maximum versatility in mountings, connections and capacity characteristics. Rotor stop permits 180° clockwise rotation with increasing capacity. Also available as dual unit.

"RMC" Similar to "MC-S" but featuring extra rigid design. Heavy frame of aluminum tie rods and end plates.

"NZ" Compact transmitting neutralizing capacitor designed for easy and accurate adjustment. Long leakage paths to ground from both rotor and stator.

"VU" Permits use of "lumped constant" circuits up to 500 MC. Two sections in series eliminate rotor wiper. Pyrex glass ball bearings eliminate noise from usual metal-to-metal bearings.

it's HAMMARLUND

For commercial, military and industrial applications, you just can't beat Hammarlund Variable Capacitors for uniformly high quality design, materials and workmanship. The capacitors illustrated here are just a small representative portion of the complete Hammarlund line. In addition to stock designs, Hammarlund offers you unparalleled variable capacitor know-how in development, design and production. Whatever your needs, when it comes to special or standard variable capacitors, naturally, come to Hammarlund.

● *Send for your copy of Bulletin E 756*

HAMMARLUND MANUFACTURING COMPANY, INC.
460 West 34th Street, New York 1, N. Y.

CIRCLE 548 ON READER-SERVICE CARD FOR MORE INFORMATION

Radiation, Research and Development

First privately owned Cobalt-60 source of radiation in the New York area is now available to the industry on a regular service basis, for commercial research and development.

The center operated by Radiation Applications Inc. will use the source for experimentation and processing products by irradiation. The service will be offered to both private companies and government agencies on a contract basis. Experimental research development projects will also be performed directly by the R.A.I. Technical Staff.

Woman Wins "Ham" Award

Mrs. Mary D. Burke, a 45-year old housewife from Morton, Pa., has been announced the winner of General Electric's Fifth Annual Edison Radio Amateur award. Mrs. Burke has sent over 312,000 messages to servicemen overseas since 1949.

At times she has sent as many as 10,000 messages per month. Her longest stretch of operating without missing a schedule was 1,825 days—5 years without taking a vacation or a single day off. Her daily operating starts at 6:30 a.m. and closes down at 8:00 p.m. Congratulations to Mrs. Mary D. Burke, W3CUL.

Semiconductor Research

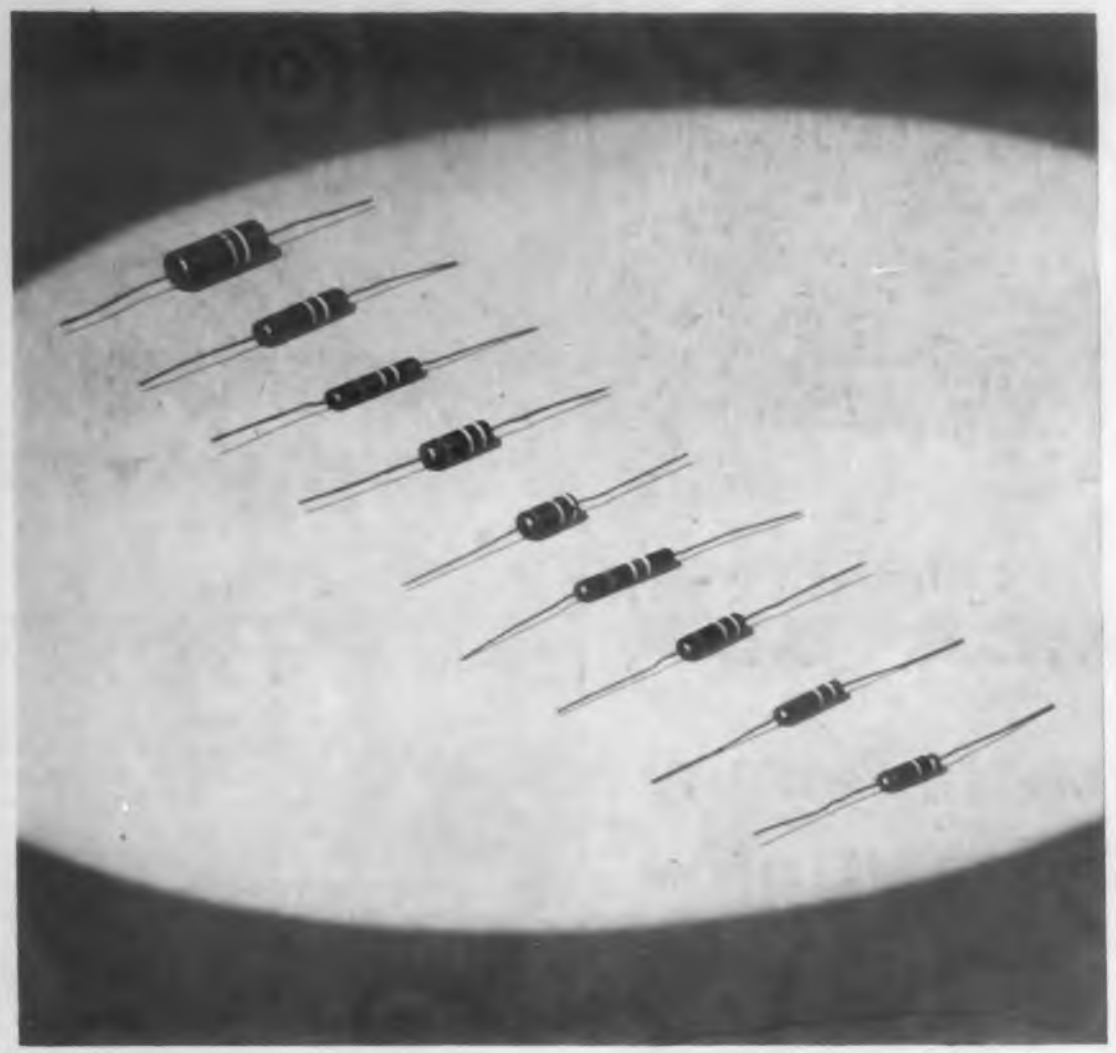
An advanced semiconductor laboratory, to bridge the gap between basic research and semiconductor product engineering, has been established by General Electric Co., Syracuse, N.Y.

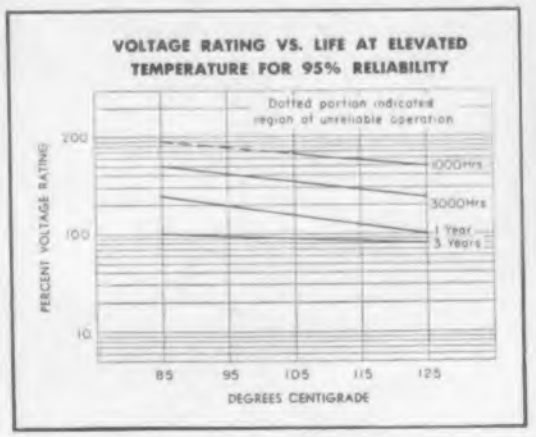
Dr. Sullivan, manager of the new laboratory, said that investigations will be conducted to find methods of producing more nearly perfect crystals of germanium and silicon as well as intermetallic compounds. In addition, research will be conducted on developing new techniques for placing selected impurities into the pure materials to obtain alloys with desired semiconductor characteristics.

New methods for measuring the physical characteristics of pure semiconductors and alloys will also be investigated and developed.

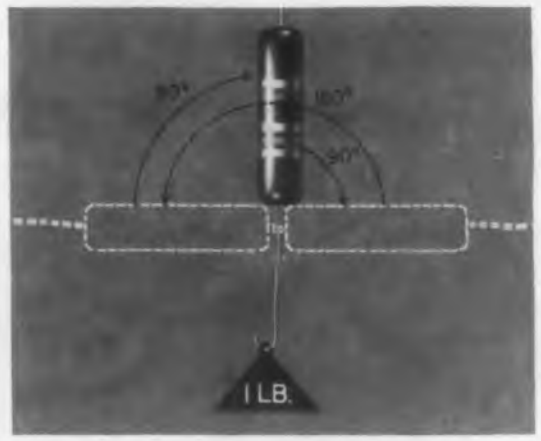
CIRCLE 9 FOR G.E. SPREAD AD

GE DESIGNER'S





TYPICAL PERFORMANCE CURVES for PVZ capacitors, designed for a minimum of one year's life at 125C operation, rated voltage.



HIGH LEAD BEND STRENGTH. Capacitors withstand 1-lb vertical pull test, moving unit 90°, then 180° opposite way, then back 90° to original vertical position.

TESTING TRANSISTORS in electronic equipment is one of many uses for the versatile M2 leak detector, shown in background.

New General Electric molded PVZ* paper tubular capacitors are moderately priced, operate from −55 C to +125 C

Now available for electronic designers is a new line of General Electric molded PVZ paper tubular capacitors—at moderate prices—for exacting applications in computers, missiles, telephone equipment, and other high-grade military and commercial electronic equipment.

Priced at less than half the cost of comparable metal-clad tubular capacitors, they offer characteristics similar to "K" of MIL-C-25A, and operate from −55 C to +125 C without voltage derating. They are designed for a minimum of one year's life at rated voltage and 125 C operation.

Completely solid after molding, the unit has excellent shock, vibration and moisture-resistance properties because of the high grade case material and controlled molding technique used. The paper tubular capacitor is impregnated with a high temperature organic material which is polymerized into a solid resin. The solid capacitor rolls are in a mineral-filled phenolic plastic case.

In this new line, General Electric PVZ capacitors are available in 100, 200, 300, and 400 volt ratings. Microfarad ratings are, respectively: .00047 to .15 uf at 100 V; .00047 to .1 uf at 200 V; .00047 to .068 uf at 300 V; and .00047 to .022 uf at 400 V. Capacitance ratings are available with ±20%, ±10%, and ±5% tolerances. To cover the various ratings, nine different sizes are offered, ranging from .175 inch diameter by ⅝ inch long to .375 inch diameter by $1\frac{1}{16}$ inch long.

For more details, check Bulletin GET-2671.

*Trade-mark of General Electric Co.

New leak detector can spot leak rate of one cubic inch of air over 5000-year span

The ultimate in leak sensitivity is now offered by the new General Electric Mass Spectrometer Leak Detector. It can detect a leak rate of 1×10^{-10} standard cc of air per second. At this rate it would take 5000 years for a thimbleful of gas to escape.

Among the many applications for this versatile aid in locating leaks in vacuum and pressure systems—to prove equipment reliability—are the testing of transistors, Klystron tubes, hermetic sealing of components, capacitors, and TV tubes.

Designed for greater reliability and ease of maintenance, the new leak detector makes extensive use of plug-in components—minimizing downtime. For example, the complete spectrometer tube is a single unit that is easily and quickly removed for repair or replacement. All electronics are mounted on three easily removed, plug-in type chassis, according to basic functions.

Unit's simplicity of operation is such that nontechnical personnel can operate it successfully. See Bulletin GEC-336B.

GENERAL ELECTRIC

DIGEST

GENERAL ELECTRIC COMPONENTS FOR ELECTRONIC MANUFACTURERS

Hermetically sealed germanium and silicon rectifiers now in cooling "packages."

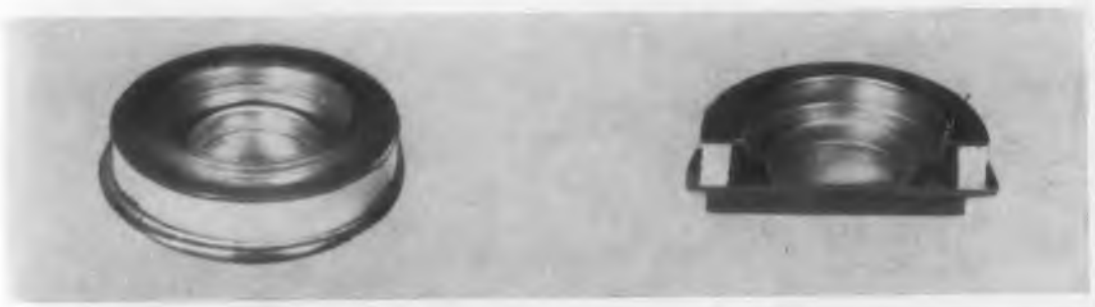
General Electric hermetically sealed germanium and silicon rectifiers are now available in carefully engineered, "cooling packages," either air-cooled or water-cooled designs. This eliminates the need for costly, time-consuming engineering on your part, and provides more efficient rectifier operation. General Electric's 30,000 kilowatts of field experience with germanium rectifier installations brings you these two important features:

1. These assemblies are furnished with matched electrical characteristics so that paralleling reactors or multiple transformer secondaries is not required when it is necessary to operate cells in parallel.

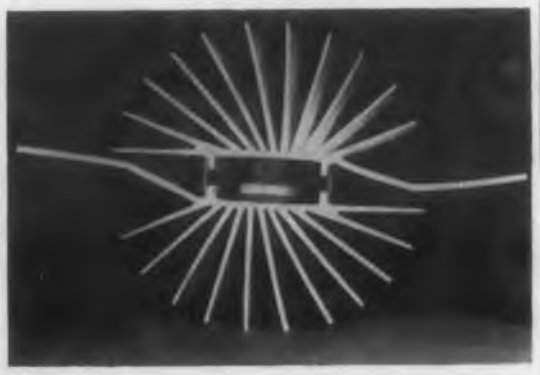
2. Better protection against atmospheric conditions is provided by a true hermetic seal which increases cell uniformity, permits a longer life expectancy, and maintains high rectifier efficiency throughout its life.

Where size and weight requirements are particularly important, General Electric packaged germanium and silicon rectifiers have broad application in efficient, low-cost power conversion equipment. Included among their advantages over other types of metallic rectifiers are increased efficiencies—up to 95%—less heat to be dissipated; exceptionally small size and light weight per watt output, meaning smaller units; excellent voltage regulation; and no aging indicated after five years of operation.

For data on G-E germanium rectifiers, check Bulletins GEA-5773C and GEA-6375..



ACTUAL SIZE OF G-E germanium and silicon rectifier cell, hermetically sealed in ceramic housing, is shown in side view (left) and cutaway (right).



AIR-COOLED type in new "sunburst" fin design provides efficient cooling by conducting heat away from both sides of cell.

WATER-COOLED assembly is mounted on hollow bus bar which serves as conductor for both water and current, providing compact, efficient design.

TYPE ARR-2

TYPE ARR-3

Dependable starting relays eliminate need for voltage adjustments, special mounting brackets

For such applications as starting single-phase motors, particularly where adverse atmospheric conditions exist, General Electric offers two starting relays that are inexpensive, quiet in operation, and easily wired. Both are especially useful where adverse atmospheric conditions exist, or where there is a need for remote control which can be built into an explosion-proof case.

Type ARR-2 current-type accelerating relay, silver-dollar sized, is designed for more than 1,000,000 operations because there are no pivots to wear out, and sturdy plastic case encloses all moving parts. Contact pressure and action are always dependably the same—regardless of line-voltage or motor-performance variations—because contact tips are independent of solenoid plunger.

Easily mounted from any direction, relay eliminates need for special mounting brackets. Readily accessible terminals, available in push-on, screw or lead-type, speed wiring. At 115 volts, relay will make and break 15 amperes; at 230 volts, 7½ amperes. See Handbook Sheet 3286, Page 23.

Type ARR-3 voltage-type relay, requiring no customer adjustments, is accurately calibrated at the factory to pick up at a voltage predetermined by the specific application. Repetitive accuracy is high—change in calibration is less than 5% after 500,000 operations. Molded cover helps protect against dust and water. Relay mounts in any position and adapts to many mounting brackets. Terminals, including two available spares, are easily accessible. For ratings up through 5 hp, relay at 115 volts will break 50 amperes; at 230 volts, 35 amperes. See Handbook Sheet 3286, Page 29.

GENERAL ELECTRIC COMPANY, APPARATUS SALES DIVISION, SECTION A667-36, SCHENECTADY 5, NEW YORK

Please send me the following:

\ for reference only X for planning an immediate project

- ☐ **GEA-6375 Liquid cooled germanium rectifiers**
- ☐ **GEA-5773C Air cooled germanium rectifiers**
- ☐ **GET-2671 Molded tubular capacitors**
- ☐ **GEC-336B Leak detector**
- ☐ **HB-3286, P. 23 ARR-2 relay**
- ☐ **HB-3286, P. 29 ARR-3 relay.**

For information on other products, contact your nearest G-E Apparatus Sales Office.

NAME.....

COMPANY.....

CITY.....**STATE**.....

CIRCLE 11 ON READER-SERVICE CARD FOR MORE INFORMATION

Giant Solar Furnace

A giant solar furnace, capable of concentrating the sun's rays to produce temperatures as hot as those of an atomic explosion, will be erected at the Quartermaster Research and Development Center, Natick, Mass., according to an announcement by the U.S. Army from Washington.

The Army explained that the furnace will collect the sun's rays with a huge flat mirror about 40 ft long and 36 ft wide. The mirror will reflect the rays 96 ft to a concentrating apparatus consisting of 180 curved mirrors, each 23-1/2 in. in diameter.

The furnace, the Army added, will be used to test materials designed to protect soldiers against the heat of nuclear and other weapons. Conventional heat sources do not produce sufficient temperatures to simulate atomic explosions. Rays of the sun ultimately will be concentrated in a small test chamber 4 in. wide in the proposed furnace.

Evaluating New Weapons Systems

Dr. Courtland D. Perkins, USAF Chief Scientist, emphasized the qualifications necessary for an evaluation team studying new weapon systems at a recent meeting of the Institute of Aeronautical Sciences. He said they "must not only be competent to compare the technical qualifications of the new weapon systems but also must evaluate their impact on the nation's economy as well as the political implications developing from their use."

In his comments directed to the scientist, Dr. Perkins said, "An increased effort must be made to find simpler and more ingenious solutions to missile problems. We seem to solve many of our military problems with too heavy a reliance on dollars and manpower. I feel that our scientific community has many times led the way towards these complexities. I feel that if we paid more attention to reducing problems to their simplest form, we could go a long way toward solving not only our money problems but our technical manpower shortages at the same time."

CIRCLE 12 ON READER-SERVICE CARD ➤

Magnetic Device Prevents Scale and Corrosion

A Belgium scientist has invented a device that prevents scale and corrosion in piping and industrial equipment. This new device passes water and other fluids through concentrated magnetic fields. The magnetic field induces a physical change in the incrustating salts which form scale with the result that their crystaline structure is altered and they become essentially amorphous, losing the ability to adhere as scale to piping and processing equipment.

The fluid conditioner is made in Belgium and distributed in this country by Cepi-American, Inc., Oak Park, Ill. In addition to preventing the formation of scale, the treated water will cause many old deposits to disintegrate. It is a compact, low-cost unit in contrast to expensive systems now used.

Two-Way Radio Promotion

Representatives of the nation's major two-way radio user-organizations met with leading equipment manufacturers recently at the Statler Hotel, Washington, D. C., to discuss ways and means of assisting the Federal Communications Commission to implement a more widespread use of mobile radio. Section Chairman Myron E. Whitney, of Motorola, Inc. offered several reasons which prompted the formation of the RETMA educational program for land mobile radio.

"The FCC has capable leadership," according to Whitney, "but does not have adequate manpower to do the necessary job. The Commission is still driving a 'Model T'. The FCC is keeping pace with the growth in the use of two-way radio just the way a 'Model T' would keep up with today's modern cars on a super highway."

The conferees were called upon to develop, mutually, a plan whereby a proper educational program could be aimed at the regulators of communications, legislators in Congress, manufacturers of two-way radio and the users of such equipment, in order to remove impediments of the growth of two-way radio.

◀ CIRCLE 12 ON READER-SERVICE CARD

Washington Report

Herbert H. Rosen

Mobile Radio Girds For FCC Battle

Beginning April 1, a parade of witnesses will appear before the Commissioners of the FCC to present their positions on the allocation of frequencies above 890 mc. So far, more than 150 responses to a request for comments have flooded the FCC offices. Some have only stated their position on service allocations, while others have asked to be allowed to present their case in person.

The main issue of the battle is the use of frequencies above 890 mc for common carrier, private point-to-point systems, and research.

The lines are rather well drawn. Western Union, for investment reasons, opposes any change in the frequencies now allocated to the common carrier TV broadcasters, on the other hand, argue for greater freedom in the use of private point-to-point communications systems. TV stations depend heavily on microwave links between towns, and frequencies above 890 are the only ones available for expansion. Besides, the broadcasters claim, common carrier systems cost too much.

While the FCC is sifting the briefs and setting up a schedule for next month, RETMA has offered its information services to the users of mobile radio. The goal, simply, is to make people as aware of and as appreciative of mobile radio as they are of other forms of radio communications. It's an ambitious program designed to supply raw data to the users for their own implementation.

From the manufacturers, Motorola for example, come the recommendations that 890 to 960 mc should be reserved for landmobile use. Provisions should be made for tropospheric scatter communications above 890. Sarkes Tarzian asks permission to conduct equipment experiments (for TV links) in the 1115 to 1200-mc region. Raytheon asks that marine navigation and anticollision instrumentation be allowed to go above 30 km. And A T & T reports that they have point-to-point systems operating in the 3700 to 4200-mc band. In addition to field trials at higher frequencies, A T & T, along with some other manufacturers, feels that it would be impractical to set standards for all types of microwave services. Naturally, there are others who feel that standards should be established soon by the FCC.

ngle Sideband Still a Controversy

As a result of an all-day meeting in Washington ecently, there is a better understanding of the ngle sideband issue, but the manufacturers and ers of mobile and aircraft communications are no oser to a solution. The issue was thought to center round single sideband transmission versus General lectric's synchronous detection technique. How-ver. the meeting, sponsored by the Airlines Elec-onic Engineering Committee of Aeronautical adio, aired single sideband with suppressed car-ier, single sideband with no carrier, and a compat-ble system fostered by Leonard R. Kahn.

A panel composed of proponents of four or five ystems presented cases for their particular choice. The discussion was then thrown open to the floor . . . and the dyke sprung a leak. Major concern f the users of mobile radio—and as a consequence, he manufacturers of the equipment—is the scarcity f frequencies in the available spectrum. This fact lone is the overriding influence in all discussions . . . and in all decisions that will have to be eached before long. However, there appears to be growing sentiment that perhaps what is really eeded is greater stability in the receiver. If that ould be achieved . . . along with more reliable detection, a good portion of immediate problem would be licked. At least an interim condition would exist that would allow a more thorough tudy of the competitive systems now proposed. However, both the FCC and an association of air-nes have tentatively agreed that conventional am ransmission is passé. Rules and plans are pending hat provide for the replacement of am by single ideband. Most people want the change to be grad-al—on an interim basis that won't cost a lot of oney at one time. With four or five opposing sys-ems, the situation is becoming very cloudy.

The final proof and resolution of the controversy ill not be found in a meeting of engineers. Rather he best proof will be found in experiments that are esigned to compare the systems with each other in n unbiased manner. Within the next few months. is expected that the Air Force and the manufac-rers will be conducting some of these experi-ents. GE, in fact, has expressed a willingness to fer synchronous detection adapters to any user of obile airlines radio who wishes to experiment. otorola expects to have SSB modulator units ady for the military some time this year.

issile Reinterpretation

he directive deliniating areas of missile responsi-ility does not appear to curtail present and pro-osed R & D programs forecast for the future. From l indications there will be renewed interest in the evelopment of new missiles, anti-missile missiles, d greater automaticity in flight operations and ontrol.

CIRCLE 14 ON READER-SERVICE CARD ➤

Letters to the Editor

Missile Control Suggestion

Dear Sir:

A number of radio control systems are in use for controlling types of guided missiles over limited ranges for flight test purposes. These systems vary in complexity in accordance with the degree and type of control required. All suffer from one or more defects such as lack of ranges, poor antenna radiation patterns, poor reliability and excessive complexity. I would like to point out a simpler approach to the problem.

I propose that a telemetering system be used in reverse! The operating frequency should be in the 40 to 400 mc range which will permit simple antennas, excellent antenna radiation patterns and long range control. Two telemetering systems would be employed, one from the missile to ground for flight test measurements, and the second, on a different frequency from the ground to the missile for control purposes.

A compact fm/fm receiver, such as the Land-Air Subminiature Airborne Receiver Model 127, would be installed in the airborne vehicle. This receiver weighs less than 6 pounds and can be mounted in various ways of close coupling. It is constructed in units which can be packaged together or placed in voids left by other instruments or airframe. The three units—r-f section, i-f section, and power supply, can be mounted in any one plane.

CIRCLE 96 ON READER-SERVICE CARD ➤

A **NORTHROP SNARK**, intercontinental guided missile, roars from its launching cradle at a U.S.A.F. base to begin a long range test flight over the Atlantic ocean. The Snark, which couples inter-continental range with the ability to carry a first priority warhead, utilizes Rheem amplifiers for a share of the telemetering chores.

LOCKHEED'S F-104, prototype Starfighter, climbs on razor blade wings to the upper stratosphere at ground speed equaling its speed in straight and level flight. The ship is described by Hall L. Hibbard, Engineering Vice President of Lockheed, as "a masterpiece of simplification." Rheem light weight, small space, amplifier components play an important role in this simplification.

If a power source is available in the missile, the receiver power supply can be omitted.

All receiver units are approximately 1 in. wide x 3 in. high x 9 in. long. Up to 16 subcarrier oscillator discriminator would be installed in the vehicle. The discriminator outputs can either actuate a relay for on-off functions, or the output can be used with a simple d-c null balancing servo system for proportional control. The complexity of the servo system will depend on the accuracy and drive power required, but it can be simple. More sophisticated circuits can use a commutator on one channel so that many more on-off functions can be achieved.

Frequency drift of subcarrier oscillators (at the ground station) can easily be controlled; and airborne discriminator drift should be of little consequence. Telemeter signals from the vehicle could be used to double check the proportional control positions.

The major problem today would be to subminiaturize the present ground station equipment, such as discriminator, for airborne use. This program should not be excessively expensive, as much work has already gone into subminiaturization methods.

Edwin N. Kaufman
6201 Jumilla Avenue
Woodland Hills, Calif.

► Mr. Kaufman has an interesting idea here. Although this is a very "sensitive" subject for discussion, we would welcome reader's comments on his suggestion.

Apologies

On page 6 (line 25) of the December 1st issue the company name Avion was incorrectly called Avien. Our apologies to the Avion Division, ACF Industries, Inc.

Engineering Shortage?

Dear Sir:

There has been much writing on the seemingly crucial issue of a shortage of engineering personnel.

In order that the whole of the issue be made clear, an examination of the engineering shortage is necessary. . . . A surface view divulges a shortage of engineers that varies in popular estimates from 40,000 to 60,000 in number. This apparently means that there are a like number of positions available into which graduate engineers can be absorbed. Today, a graduate engineer is one who has been exposed to at least 4 years of college education, most of which is of a technical nature, while others attend schools where the 4-1/2 to 5 years course is now required. After graduating, these engineers are routed into the humorously innumerable phases of industry's engineering world—where they are often employed in positions for which a technician or draftsman of six months training would be well qualified. Frequently, the remainder of their careers is spent in such positions.

Another heavily contributing factor to the engineer shortage is the oft-referred-to act of engineer stockpiling, a newly developed science (following World War II) which is simply the hiring of ten engineers into a situation that merits the hiring of only two—as there is work for only two.

The aforementioned vices have become so much the practice that such phrases (and they can be found in most engineering help wanted advertisements) as "stimulating," "challenging," "no stagnation of creative minds," have become a cause of laughter for most engineers.

It should be obvious that, though this shortage may exist in some degree, the problem, in the main, is not one of too few engineers, but one of mishandling of those engineers that are available. This quandary is one that is directly responsible to, and can only be solved by, this country's top level management; for it is at this level that these precedents have been set and the above mismanagements of personnel sanctioned.

William H. Goudy
Design Engineer
248 Broad Street
Tonawanda, N.Y.

► We are firmly convinced that better use can be made of our technical manpower—and we have often said so in our editorials. However, this is only a stop-gap measure, and some intelligent long range actions have to be taken. This is especially true as we see our technology constantly getting more and more complex.

The company that misuses its engineers in the manner referred to by Mr. Goudy is cutting its own throat. If it is "stockpiling" engineers, it is cutting the Industry's throat as well as its own.

Meetings

1957
IRE National Convention
Waldorf-Astoria Hotel
and New York Coliseum
March 18-21

Only a few of the 275 papers being read at the IRE National Convention are reported here. Those of most interest to electronic equipment designers are presented here. Papers are listed under subject areas.

Microwaves

THE SELECTION AND APPLICATIONS OF TRAVELING-WAVE TUBES, *Tues. PM, Mar. 19.*

X-BAND TRAVELING-WAVE TUBE FEEDBACK, *Tues. PM, Mar. 19.*

A LIGHT-WEIGHT, LOW-LEVEL TRAVELING-WAVE TUBE AMPLIFIER FOR S BAND, *Tues. PM, Mar. 19.*

A NEW METHOD FOR MODULATING ELECTRON BEAMS FOR PULSE APPLICATIONS AND LINEAR AMPLITUDE MODULATION SYSTEMS, *Tues. PM, Mar. 19.*

BEHAVIOR OF A BACKWARD-WAVE OSCILLATOR WITH EXTERNAL FEEDBACK, *Tues. PM, Mar. 19.*

A BROADBAND FIXED COAXIAL POWER DIVIDER, *Wed. PM, Mar. 20.*

BROADBAND WAVEGUIDE-TO-COAX TRANSITIONS, *Wed. PM, Mar. 20.*

TRANSMISSION PROPERTIES OF HYBRID RINGS AND RELATED ANNULI, *Wed. PM, Mar. 20.*

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HIGH PRECISION SAWTOOTH GENERATOR, *Thurs. PM, Mar. 21.*

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Circuit Theory

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WHAT GOOD IS INFORMATION THEORY TO ENGINEERS? *Tues. AM, Mar. 19.*

COST OF TRANSMISSION RELIABILITY *Tues. AM, Mar. 19.*

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Four reliability programs will be discussed *Thurs. AM, March 21.* Analysis and techniques for improved reliability will be discussed in 5 papers *Thurs. PM, March 21.*

Aeronautical Electronics

THERMAL DESIGN OF COMMERCIAL AIRBORNE ELECTRONIC EQUIPMENT, *Mon. PM, Mar. 18.*
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Other interesting sessions cover ultrasonics engineering, propagation, communications, navigation, high fidelity measurements, telemetry, production, and medical electronics.

March 11-15: 1957 Nuclear Congress

Convention Hall, Philadelphia, Pa. Theme of the Congress is "For Mankind's Progress" and peacetime uses of atomic energy will be discussed. Included in the Congress are four major elements, including the Second Nuclear Engineering and Science Congress, coordinated by Engineers Joint Council on behalf of twenty engineering and scientific societies. This will include 130 technical papers during a four-day program. The National Industrial Conference Board will hold its Fifth Conference on Atomic Energy in Industry, featuring twelve round-table discussions. The International Atomic Exposition, sponsored by the American In-

stitute of Chemical Engineers in cooperation with four other engineering societies, will display industry's latest items in the atomic field. The Fifth Hot Laboratories and Equipment Conference will take place March 14 and 15. For information, write to Engineer Joint Council, 33 W. 39th St., New York, N. Y.

March 18-21: The 1957 SPI Annual National Conference and Pacific Coast Plastics Exposition

Hotel Biltmore, Los Angeles, Calif., sponsored by the Society of the Plastics Industry, Inc. Sessions will cover plastics in the fields of electronics, aircraft and defense, building, and processing. Exposition will be held at the Shrine Exposition Hall. Further information may be obtained from the Society of the Plastics Industry, Inc., 250 Park Ave., New York, N. Y.

March 25-27: Special Conference on Research and Development

Palmer House, Chicago, Ill. Sponsored by the American Management Association. Subject will be "Product Development in Medium and Small Companies." For information, write American Management Association, 1515 Broadway, New York, N.Y.

April 4-5: Special Conference on Research and Development

Hotel Statler, New York, N.Y. Sponsored by the American Management Association. The conference will be an Engineering Forum. For information write to American Management Association, 1515 Broadway, New York N.Y.

April 8-11: Fourth National Electrical Industries Show

71st Regiment Armory, New York, N.Y. Sponsored by the Eastern Electrical Wholesalers Association. For more information, contact William S. Orkin, Co-Producer, The American Electrical Industries Expositions, Inc., 19 W. 44th St., New York, N.Y.

April 11-13: Southwestern IRE Conference and Electronics Show

Houston, Texas. Sponsored by the Houston Section of the IRE. This conference will be augmented by the National Simulation Conference which will be sponsored by the IRE Professional Group on Electronic Computers. For information, write to Ninth Southwestern IRE Conference and Electronics Show, P. O. Box 1234, Houston 1, Texas.

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April 15-17: Symposium on Systems for Information Retrieval

Western Reserve University, Cleveland, Ohio. Sponsored by the School of Library Science of Western Reserve University in conjunction with its center for Documentation and Communication Research. This will be a comprehensive demonstration of systems presently in use for the organization, storage and retrieval of recorded information, together with a symposium on information-han lling problems and techniques. Further information may be obtained from Jesse H. Shera, Dean, School of Library Science, Western Reserve University, Cleveland 6, Ohio.

April 16-18: Symposium on Nondestructive Tests Developed in the Field of Nuclear Energy

Morrison Hotel, Chicago, Ill. Sponsored by American Institute of Chemical Engineers, American Nuclear Society, American Society for Testing Materials, and Society for Nondestructive Testing. Information resulting from 15 years research and development in testing applications in the nuclear field will be presented. Papers will be in three categories: reactor materials, completed fuel assemblies, and miscellaneous. For information, write to American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

April 23-25: International Symposium on the Role of Solid State Phenomena in Electrical Circuits

Auditorium of the Engineering Societies Building, New York, N. Y. Symposium will cover recent developments in application to electrical circuits on systems of unusual physical effects in solids. For information write to the Polytechnic Institute of Brooklyn, Microwave Research Institute, 55 Johnson St., Brooklyn 1, N.Y.

April 24-26: Seventh Region IRE Conference

San Diego, Calif. Theme of the meeting is "Electronics in Space." Sessions will be held on electronic aids to air navigation, audio, management, uses of computers, antennas and propagation, nuclear activiation and damage of electronic equipment, electronic devices, electron tubes, microwave, instrumentation, telemetering, data handling and automation, magnetic components, and radio astronomy. For information, write to IRE Seventh Region Conference, U. S. Grant Hotel, San Diego, Calif.

April 25-26: Annual Technical Meeting of the Institute of Environmental Engineers

LaSalle Hotel, Chicago, Ill. For information contact the President of EEI, Henry F. Sander, Vapor Hearing Corp., 6420 W. Howard St., Chicago, Ill.

Location of technical sessions at the IRE National Convention, March 18-21.

Those shown are at the Coliseum; all others are at the Waldorf-Astoria Hotel.

Multiple Communications Systems, Information Theory-Coding and Detection, Solid State Devices, Antennas I and II and Microwave Antennas, Information Theory-Review and Recent Advances, Microwave Tubes, Televisual Systems Devices, Microminiaturization—The Ultimate Technique, Transistor Applications, Electron Tubes-General, Color Television Receivers, Microwaves I, II and III, Production Techniques, Symposium: Digital Techniques For Problems In Telemetering and Remote Control, Millimicrosecond Instrumentation-Special Topics, Symposium: Low Level Multiplexing For Telemetering and Remote Control, and Instrumentation II.

May 1-3: Electronic Components Conference

Hotel Morrison, Chicago, Ill. Sponsored by the AIEE, IRE, RETMA and WCEMA. Papers to be given on high temperature components, radiation effects, component reliability, passive components, active components, instrumentation and measurements, materials development and general component needs. For information write to J. S. Powers, Electronic Components Symposium, 84 E. Randolph St., Chicago 1, Ill.

May 3: Fourth Annual Conference for Engineers and Architects

Ohio State University campus. Sponsored by the College of Engineering.

May 13-15: National Conference on Aeronautical Electronics

Dayton, Ohio. Sponsored by Dayton Chapter, IRE.

Paper dealines

May 1: Deadline for papers submitted for the Wescon convention August 20-23 in San Francisco. Send 100-200 word abstracts, together with complete texts or additional detailed summaries, to D. A. Watkins, Technical Program Chairman, Stanford Electronics Laboratories, Stanford University, Stanford, Calif. Authors will be notified of acceptance by June 1. May 1: Deadline for papers submitted for the April, 195[illegible] convention of the American Society of Tool Engineers. ASTE membership is not required. Each proposal should include an outline of the paper, the author's name, his title and affiliation. Send outlines to L. S. Fletcher, Program Director, American Society of Tool Engineers, 10700 Puritan Ave., Detroit 38, Mich.

Junction T

COUNTERS for high speed operation are desirable in many applications such as in computers or in frequency measuring equipment. High speed operation often permits a reduction in equipment size when a high speed circuit performs in time sequence the function of a large number of slower circuits operating together in the same time interval.

The flip-flop circuit is the basic element of most counters. Fig. 1 shows a typical junction transistor flip-flop circuit. The circuit of Fig. 1 is similar to the Eckles-Jordan vacuum tube flip-flop. One of the transistors is always conducting and the other is always turned off. Applying a pulse to the complement input turns the 'on' transistor 'off' an the other one 'on'. A pulse applied to the set-to-zero input turns transistor TR_1 'off' and a pulse applied to the set-to-one input turns Tr_1 'on'. Outputs are taken at the collectors of the transistors.

There are numerous variations of the flip-flop circuit. Generally they become more complicated as higher operating speeds are attained although this is not always the case. For example, surface barrier transistors may be operated at pulse rates of 4 or 5 megacycles in a circuit similar to that of Fig. 1 without the resistor and condenser in the emitter circuit (emitter returned to ground). For high speed operation with most transistors it is necessary to prevent the transistors from going into saturation where minority carrier storage effects considerably delay turning a saturated transistor off. Nonsaturated operation may be achieved by several means such as having the proper relationships between the various resistors in the flip-flop circuit and the transistor parameters, by use of diode clamping circuits, circuits using breakdown diodes or diode and resistor combinations used to make certain that the collector to base voltage of the 'on' transistor never goes to zero.

Transistor Counters

A. William Carlson
Project Engineer
Transistor Applications Co.
Boston, Mass.

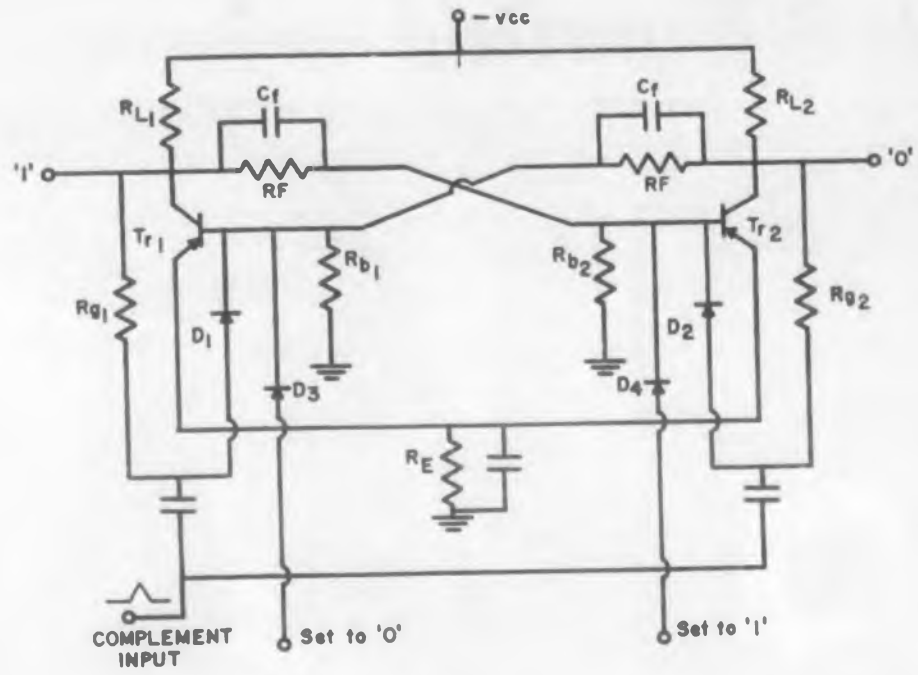

Fig. 1. Typical junction transistor flip-flop.

Circuits to reduce the rise and fall times of the collector wave forms result in further variations of the flip-flop circuit, sometimes leading to 4-transistor flip-flops. An example of a 4-transistor flip-flop is a circuit using transistor emitter followers in the cross-coupling circuits between the collector of one transistor to the base of the other to improve the impedance match between these two points and increase the switching speed. Another 4-transistor flip-flop replaces the collector load resistors with transistors of the opposite polarity type* (as shown in Fig. 2) giving a circuit with an active load. In the circuit of Fig. 2, one of the lower transistors is 'on' and the other 'off' with the transistor in series with an 'on' transistor being 'off' and vice versa. This circuit is particularly useful in driving capacitive loads as they are charged and discharged through low impedance by one or the other of the 'on' transistors connected to the load.

Binary counters may be made with a series of flip-flops as shown in the block diagram of a four stage counter in Fig. 3a. Fig. 3b shows the waveforms of the '1' outputs of each of the flip-flops in the counter. (Referring to Fig. 1, when Tr_1 is 'on' it will be said that the flip-flop is in state '1' and when Tr_2 is 'on' the flip-flop is in stage '0'.) The waveforms of '0' outputs are of the opposite polarity (when one transistor of the flip-flop is 'on' the other is 'off'). For convenience, it will be assumed that the flip-flops are similar to that of Fig. 1 in that the flip-flop changes state when a positive pulse is applied to the complement input of the next succeeding flip-flop. Thus each time the voltage at the '0' output lead of the first flip-flop goes positive, the second stage changes state, i.e., the second stage changes state at half the rate of the first stage. In a similar manner the third stage is controlled by the second and the fourth stage is controlled by the third. The four-stage counter of Fig. 3 counts 16 pulses before returning to its original state. An N stage binary counter counts 2^N pulses in completing a cycle. Other

*Circuit due R. H. Baker, Lincoln Laboratory, Massachusetts Institute of Technology

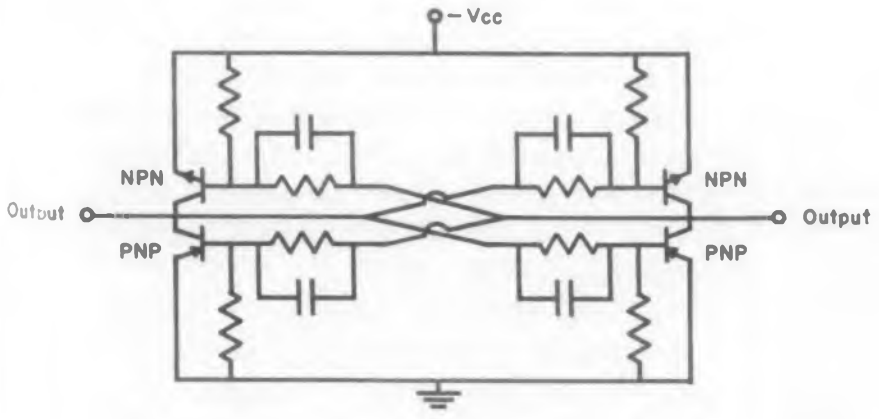

Fig. 2. Basic circuit of flip-flop with load switching.

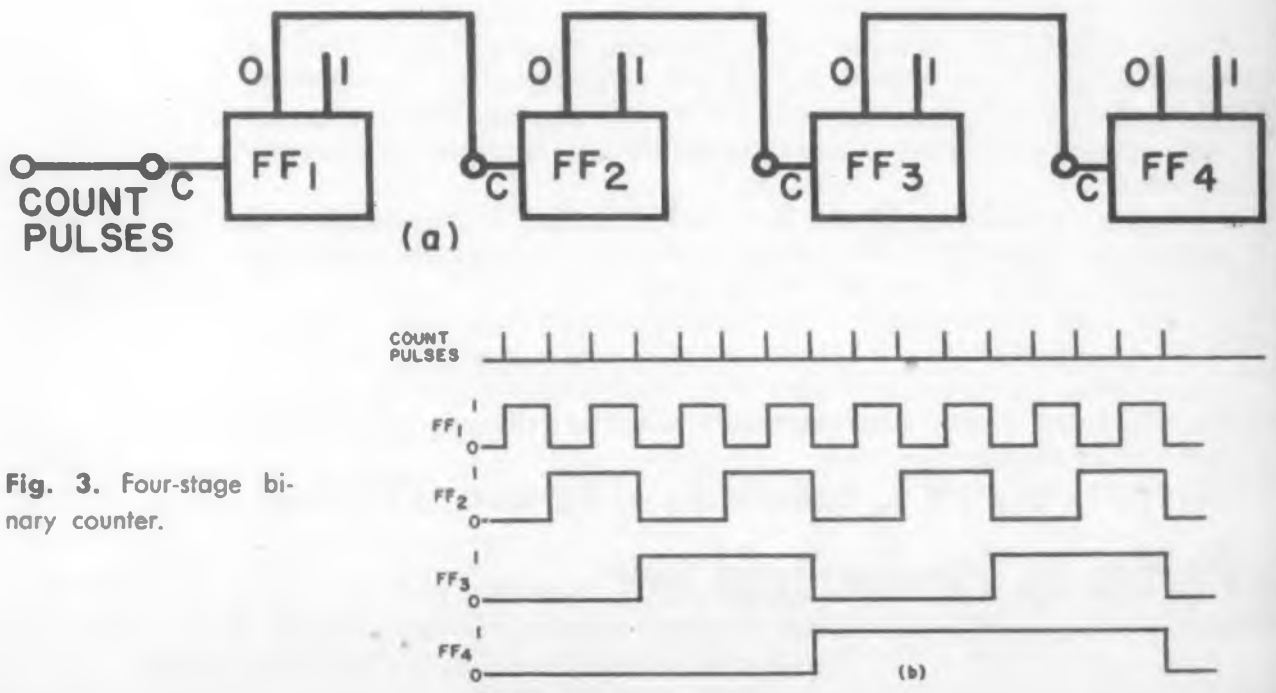

Fig. 3. Four-stage binary counter.

counts may be obtained by "feedback" circuits. For example, the four stage counter could be made to count to 10 with a circuit that would reset all the counter stages to '0' at the tenth count pulse. The counter of Fig. 3 cannot be used in some applications because of the delay in propagating the count down the counter chain. This delay comes about in the following manner. Assume that all the stages in the counter were in the state '1'. The next count pulse will switch all the flip-flops to the state '0' but this will occur in time coincidence with the count pulse which is applied directly to the first stage only. The first stage changing state generates a pulse transferred to the second stage but delayed because of the finite switching time of the first stage. The third stage cannot switch until the second stage has changed state and likewise with the other stages in the counter. The greatest delays occur in the situation just described where all the stages in the counter must change state. These delays are intolerable in some applications such as driving a matrix switch with the counter where the delays cause a narrowing of some of the output pulses and generate spurious pulses.

The delay problems of the counter shown in Fig. 3 may be overcome by applying pulses simultaneously to the proper stages. Methods of simultaneous switching are shown in block diagram in Figs. 4a and 4b. In Fig. 4 the rectangular blocks labelled G are gates controlled by the flip-flops. The arrow show the path of the count pulses through the rate when it is enabled. The gate permits the pulse to pass when all the flip-flops which control the gate are in the state indicated by the output lead to which the gate is connected. For example, G_1 in Fig. 4a permits a pulse to pass only when the first flip-flop is in the state '1'. G_3 in Fig. 4b permits a pulse to pass only when the first three flip-flops stages are in the state '1'. Assume that the first stage of the counter in Fig. 4a has just been turned 'on' by a count pulse and all the rest of the counter pulse stages are 'off'. Gate G_1 is now enabled. The second pulse turns off stage *1* and passes through G_1 to stage 2 (there is sufficient delay in G_1 being disabled for the pulse to pass) and changes it to '1'. G_1 is disabled and G_2 is enabled. The third pulse turns the first stage 'on' and enables G_1. The fourth pulse turns stage *1* 'off'; passes through G_1 to turn 'off' stage 2 and passes through G_2 to turn 'on' stage 3. The process continues with succeeding pulses and reproduces the waveforms shown in Fig. 3b.

The circuit of Fig. 4b operates in a similar manner except that the pulses, instead of passing through a series of gates, pass through a number of gates in parallel. The counter of Fig. 4b requires more components in the gate circuits than the counter of Fig. 4a and also loads the flip-flops more. For example, the first stage flip-flop is connected to all the gates. The counter of Fig. 4b has the advantage over the circuit of Fig. 4a if the pulse is delayed in passing through the gates.

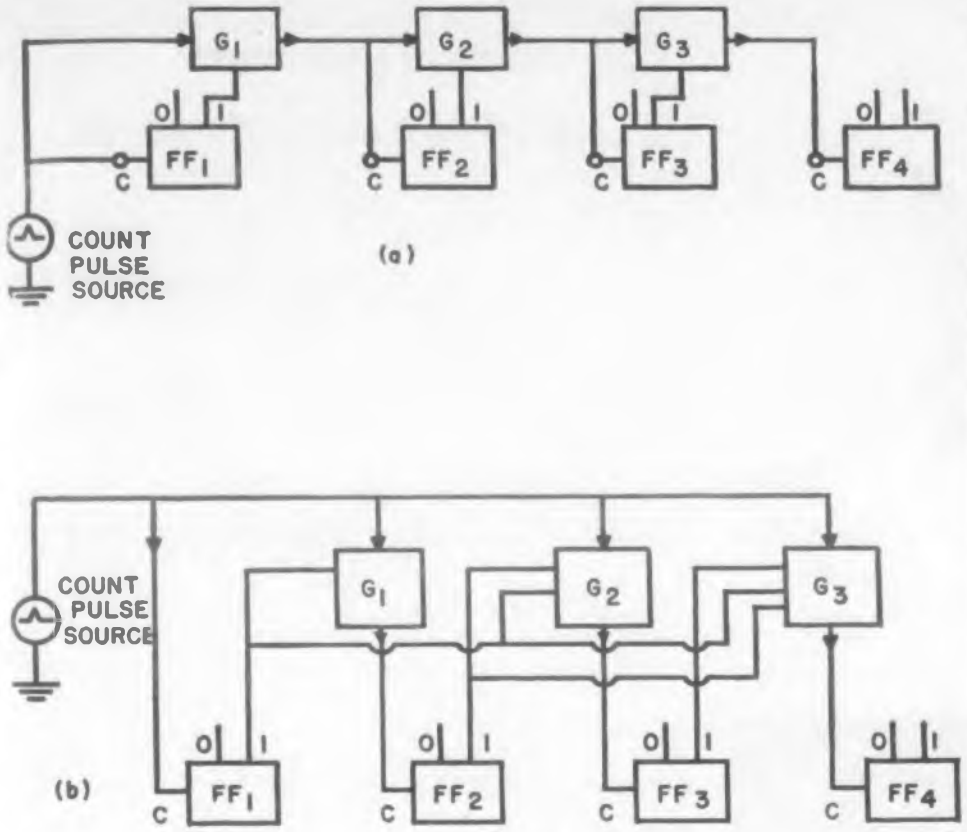

Fig. 4. Counter circuits with simultaneous switching.

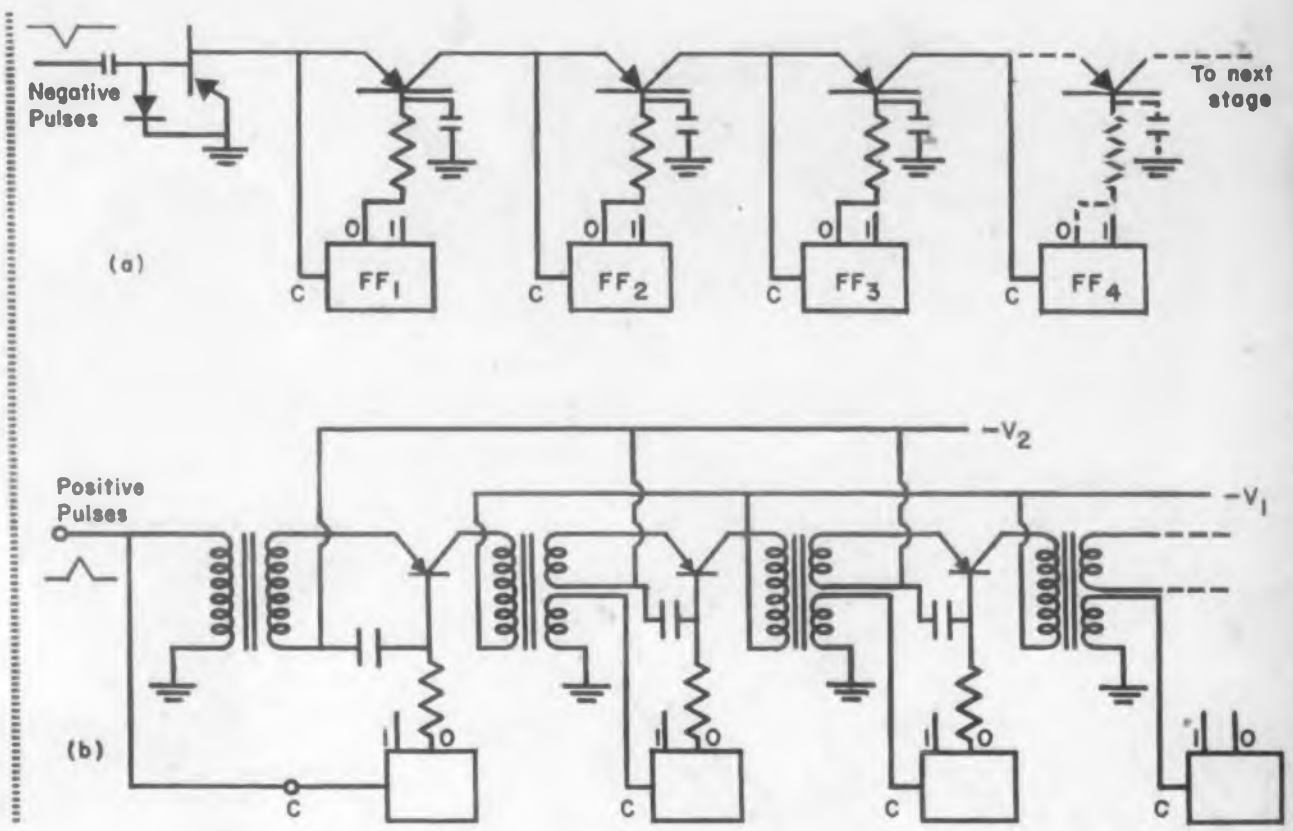

Fig. 5. Transistor gate circuits for four-stage counter.

Two of the many transistors gate circuits suitable for use with counters are shown in Fig. 5. The gate circuits of Fig. 5a require transistors with a very low impedance between emitter and collector when turned on (such as surface barrier transistors) but lead to very simple circuits. (The complement input circuit for flip-flops used with this gating circuit consists of two diodes with the anodes tied together at the complement input terminal and with a cathode connection to each of the flip-flop collectors when using PNP transistors.) The number of counter stages that may be controlled by the gates in Fig. 5a is limited by the reduction in size of the pulse at succeeding stages. The bases of the transistors in Fig. 5 are shown corrected to the '0' output since these gates are enabled by an 'off' collector voltage.

The gate circuit in Fig. 5b* is more complex than that of Fig. 5a but may be used with larger counters because the pulse is amplified in passing through the gate. The emitters are returned to a voltage V_2 which is slightly more negative than the voltage at the collector of the 'off' transistor in the counter flip-flops. The voltage V_1 is more negative than V_2 by several volts, representing the effective collector supply voltage. When the base voltage of the gate transistor is at the negative voltage of an 'off' transistor in the counter a small positive pulse at the emitter is amplified and transferred to the next gate and counter stage. When the base voltage of the gate transistor is at a low value as when the '0' transistor in the flip-flop is 'on' a positive pulse at the emitter cannot overcome the reverse emitter to base bias and the gate is disabled.

In both circuits of Fig. 5 the condensers are small ones giving the required delay in enabling and disabling the gates.

The conventional binary counters previously described have a varying number of stages, up to the total number of stages in the counter, changing state at a given count. The large number of transients taking place at certain counts can be troublesome in some applications such as in driving matrix switches where these transients may cause spurious pulses to appear at the outputs.

Two types of counters have been designed by the author to minimize the number of switching transients. In the first type a maximum of two stages, regardless of the length of the counter chain, change state at a given count. In the second type only one stage in the counter chain changes state at a given count (Gray code counter). These counters have the further advantage that switching is coincident with the appearance of the count pulse.

Junction transistors may also be used in ring counter circuits. A ring counter may be made up of flip-flop units in circuits which are essentially shift registers or variations of shift registers with the last stage connected to the first. One of the binary stages is set to the '1' state with the rest of the stages in the '0' state. The count pulses then move the '1' state on stage along the ring with each count. The disadvantage of this type of ring counter is the possibility that some perturbation of the circuit may cause an additional stage or stages to go to the '1' state or the reference '1' state to go to '0' thus putting the counter in error until the mistake is noticed and the counter reset.

Another type of ring counter uses one transistor per count (half as many as the ring using binary stages) but is limited to about a count of 10 in a single ring. Since this was written, faster junction transistors have become available. A ring counter using surface barrier transistors has been constructed and operated at megacycle pulser rates.

*(2) Circuit described by T. P. Bothwell, G. W. Booth, and E. P. English. "A Junction Transistor Counter with High-Speed Cory". Transistors I, RCA Laboratories, March 1956

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1. "Steady State Conditions of a Junction Transistor Flip-Flop", Edmund U. Cohler, Memorandum M-2686, March 11, 1954, Div. 6, Lincoln Laboratory, Mass. Inst. of Technology, Cambridge, Mass.

2. "A Design Procedure for Junction Transistor Flip-Flops", R. E. McMachon, I. L. Lebow and R. H. Baker, Internal Memo M24-34, April 28, 1954, Group 24, Lincoln Lab, M.I.T., Cambridge, Mass.

3. "A New Ring Counter for Junction Transistors and Vacuum Tubes," A. W. Carlson, AFCRC-TN-54-100, June 1954, Electronics Research Directorate, Air Force Cambridge Research Center, Bedford, Mass.

for milliwatt to watt power measurements . . .

△ Centimeter Dry Calorimeter

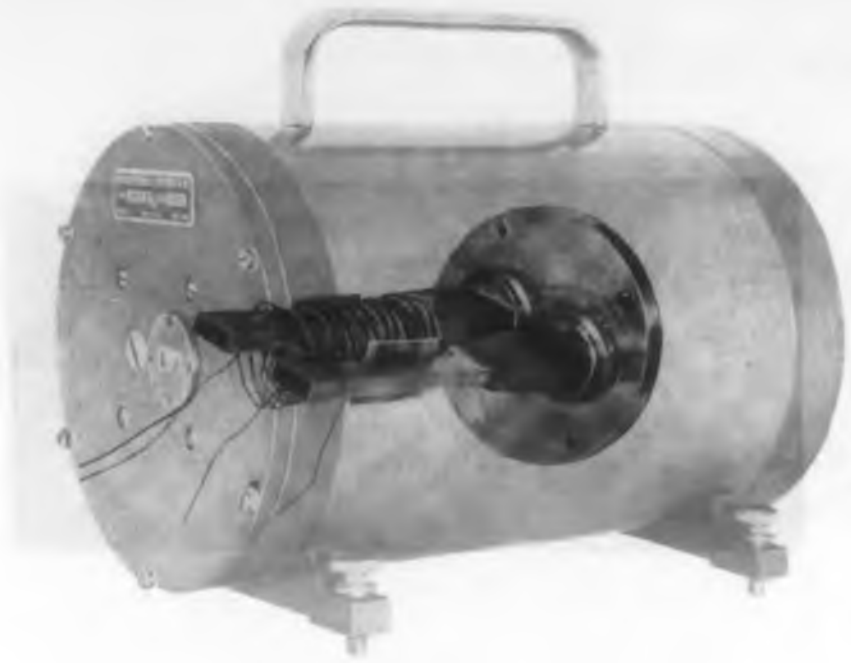
THIS dry-type calorimeter for microwave power measurements fills the gap between low-power bolometer devices and high-power water-type calorimeters. The unit is equipped with a K-band input waveguide and operates at frequencies from 18 to 26.5 kmc. Through the use of suitable tapers, measurements in the millimeter range are possible. The power range extends from 1 mw to 1/2 w. At 20 kmc and above the VSWR is below 1.2.

R-f power is measured in the Type 666 Calorimeter, designed by Polytechnic Research and Development Co., 202 Tillary St., Brooklyn 1, N.Y., by completely transforming the electromagnetic energy into heat. By calorimetric substitution, the heating effect produced by an unknown power is measured in terms of a known d-c power producing the same heating effect.

Construction

The calorimeter consists of two identical pieces of waveguide containing an absorbing r-f load. The active calorimetric body absorbs either the r-f power of the d-c power used for calibration purposes. The dummy waveguide acts as a thermal reference body for the temperature-sensitive detector, which in this case is a thermopile. The calorimetric bodies are enclosed in a thermal shield so that effects from external heat sources are minimized. The thermal shield consists of 3 isothermal envelopes separated by thermal resistances. The identical construction of the two calorimetric bodies also helps in minimizing the undesirable effects from external heat sources.

The active waveguide is made up of several sections designed to offer little transmission loss to the electromagnetic wave but have high thermal resistance. The pictorial diagram of the waveguide shows construction details.



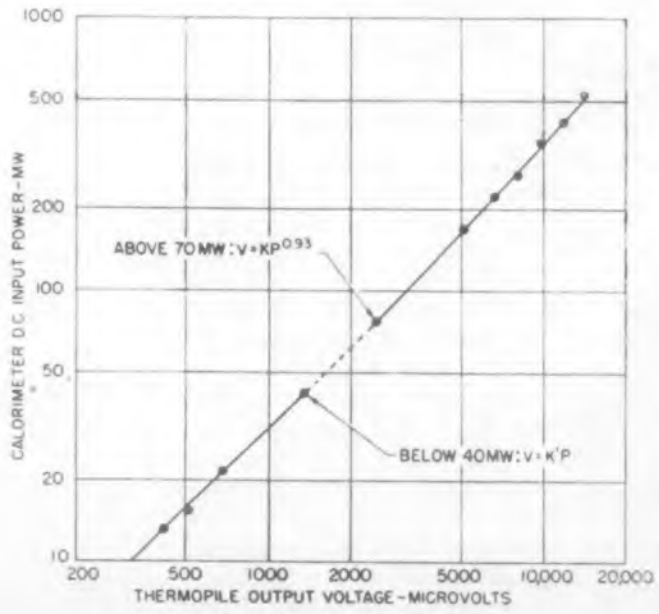
Internal view of dry calorimeter showing active and reference waveguide and thermopile.

The construction of the r-f load consists of a tapered metallized mica blade. Two silver point contact areas along the tapered part of the load provide electrical contact with the waveguide. A potential applied between the front and back contact areas will produce a current distribution in the film which resembles to some extent that produced by the r-f field. The load is mounted in narrow and accurately centered slits in the top and bottom walls of the waveguide. The wires strung between the two waveguides (see photograph) constitute the thermopile, an iron-constantan combination.

Performance

The total combined error is less than 2 per cent after corrections are made for load VSWR and insertion loss of the waveguide. The sensitivity is constant for lower levels; dropping at higher power levels. Higher power measurements are possible, but loads may burn out. Highest frequency is 75 kmc.

For additional information about this product, turn to the Reader's Service Card and circle 26.



Thermopile output voltage vs input power. Below 40 mw the output voltage is directly proportional to the input power. In the range from approximately 40 mw to 500 mw the output voltage is proportional to the input power raised to the 0.93 power.

See this product at the Radio Engineering Show, Booth 3602-04.

Simplified Calculations for Servo Function Generators

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New York, N.Y.

FUNCTION generation by means of resistance loading on tapped servo potentiometers is a simple and convenient method, but the average engineer is apt to shy away from the problem of calculating the values of padding resistances to produce a given function. With the proper approach, the calculations can be simplified so as to involve nothing worse than Ohm's law and Kirchoff's current law.

There are two major methods of padding tapped resistances, tap-to-tap loading and tap-to-end loading. In the following examples a 9-tap (10 segment) potentiometer is used.

Tap-to-Tap Loading

This system is the more straightforward of the two methods. In involves putting a resistance across each pair of taps on the potentiometer to bring the voltage across the segment between them down to the value required by the slope of the function between the corresponding points. The potentiometer is thus converted into a simple nonlinear resistance, and as the slider moves along the desired nonlinear function of Θ, and hence of X, is produced.

Consider the simple Monotonic, first quadrant function shown in Fig. 1. The simplest way to organize the calculations is to draw a schematic of the potentiometer and make the calculations right on it. The various stages are shown in Fig. 2.

1. Divide the abscissa of the function into 10 segments and draw in the 10 straight-line segments which best approximate the function. Try to keep deviations of the lines above and below the function equal and at a minimum. Mark the ordinate of each intersection between the straight-line segments on the corresponding tap on the potentiometer diagram (Fig. 2A).

2. Since the resistance of each segment is known (5 k for the pot used here) and the voltage across each segment is determined, the current that must flow in each segment to produce the desired voltage distribution can be calculated (Fig. 2b).

3. Consider now the segment having the greatest current, corresponding to the part of the curve having the greatest slope. This is the "control" segment. Since there is no point in drawing any more power from the source than necessary, it is left unparalleled.*

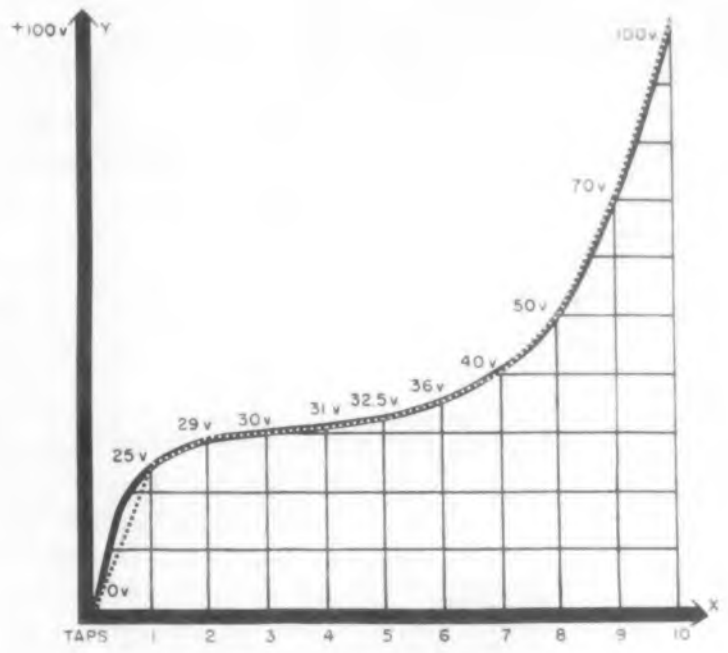


Fig. 1. Simple monotonic function

4. Working each way from this control segment towards the ends of the potentiometer the padding resistors are drawn in parallel with all other segments. Since the sum of the current in each segment and its padder must equal the current in the control segment, the current in each padder is easily determined by subtraction (Fig. 2c).

5. If the voltage across each padder and the current through it are known it is a simple matter to determine the resistance (Fig. 2d).

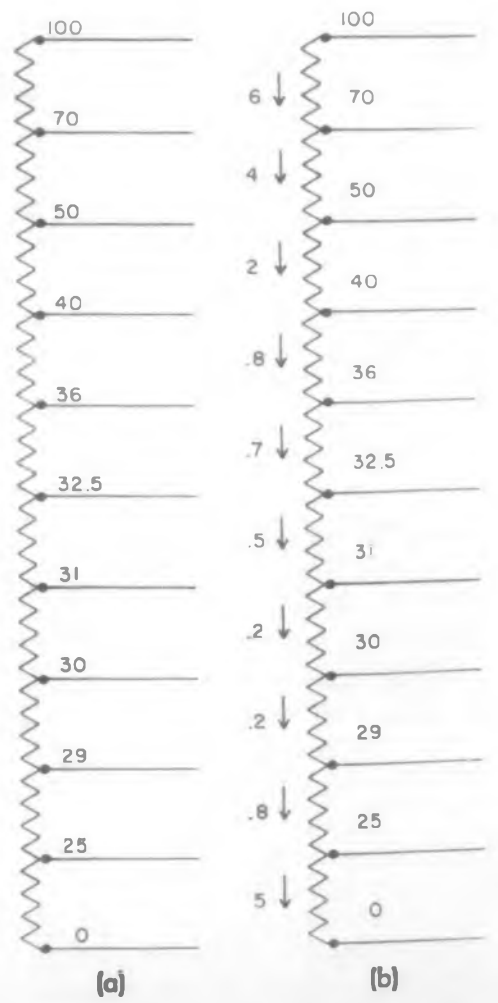


Fig. 2. Schematic of tap-to-tap loading technique.

* At this point make sure that the current required does not exceed the current rating of the potentiometer:

$$I_{max} = \sqrt{\frac{P}{R}}$$

where P = Power rating of the servo potentiometer in watts
R = Total resistance of the potentiometer in ohms
I_{max} = Potentiometer current rating in amperes.

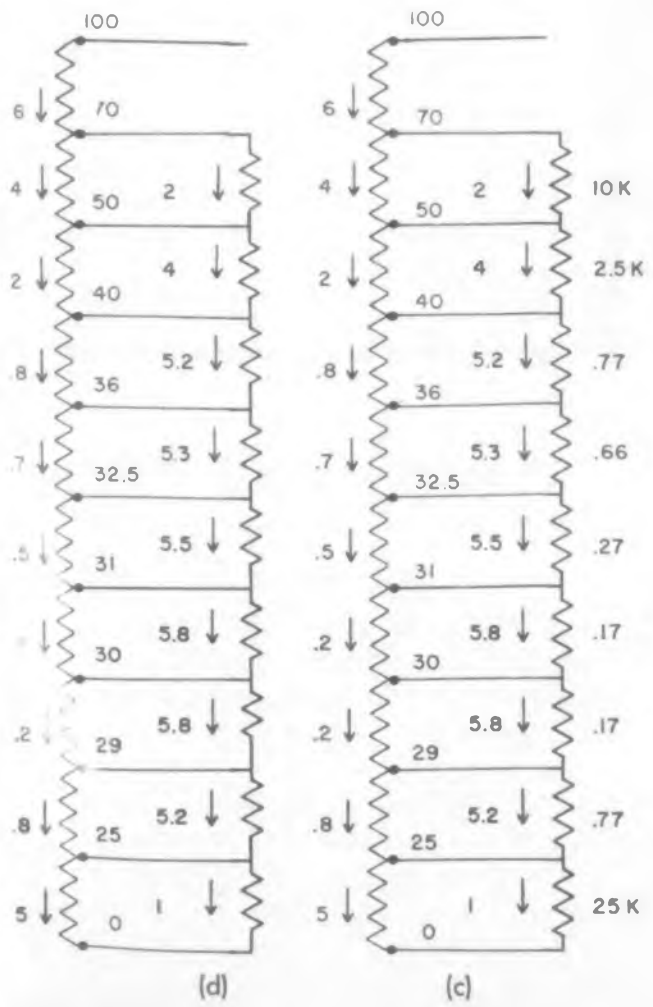
In the event that the required current is greater than the rated current of the potentiometer, it is usually possible for monotonic functions such as this to reduce all slopes by a constant and add a linear term by summation in an external amplifier.

In the above example, the greatest current is 6 ma in segment 10, well within the rating of the potentiometer.

Typical servo showing plug-in padding turrets with adjustable load resistors.

Terminal-to-End Loading

The other common method of loading brings the loading resistor from the tap to either end of the potentiometer in question, or to a point which is connected to the end of the potentiometer through an additional loading resistor. (It is sometimes misleadingly stated that the loading resistor goes from the terminal directly to ±100 v. To do so would eliminate the possibility of generating $y.f(x)$. The tap should be brought to a point which can then be connected to y,



to the ±100 v supply, or to a resistor leading to the end of the potentiometer).

The calculation for this same function is now as follows:

1. Plot the straight line function approximation.
2. Draw a schematic of the tapped potentiometer. Calculate the currents of each segment as before Fig. 3a).
3. Consider the segment having the greatest current as the "control" segment and make sure that the maximum current is within the power rating of the potentiometer.
4. Working each way from the control segment to the ends of the potentiometer, consider the tap points and make use of Kirchoff's current law, which states that the net current into or leaving any junction must be zero.

For example, at Junction 9 the voltage is 70 v, and 6 ma flows in from segment 10. Since only 4 ma flows out through segment 9, obviously 2 ma must flow to the ground through a parallel path (Fig. 3b). Since the voltage across this resistor is 70 v and the current through it is 2 ma, the resistance must be 35 k.

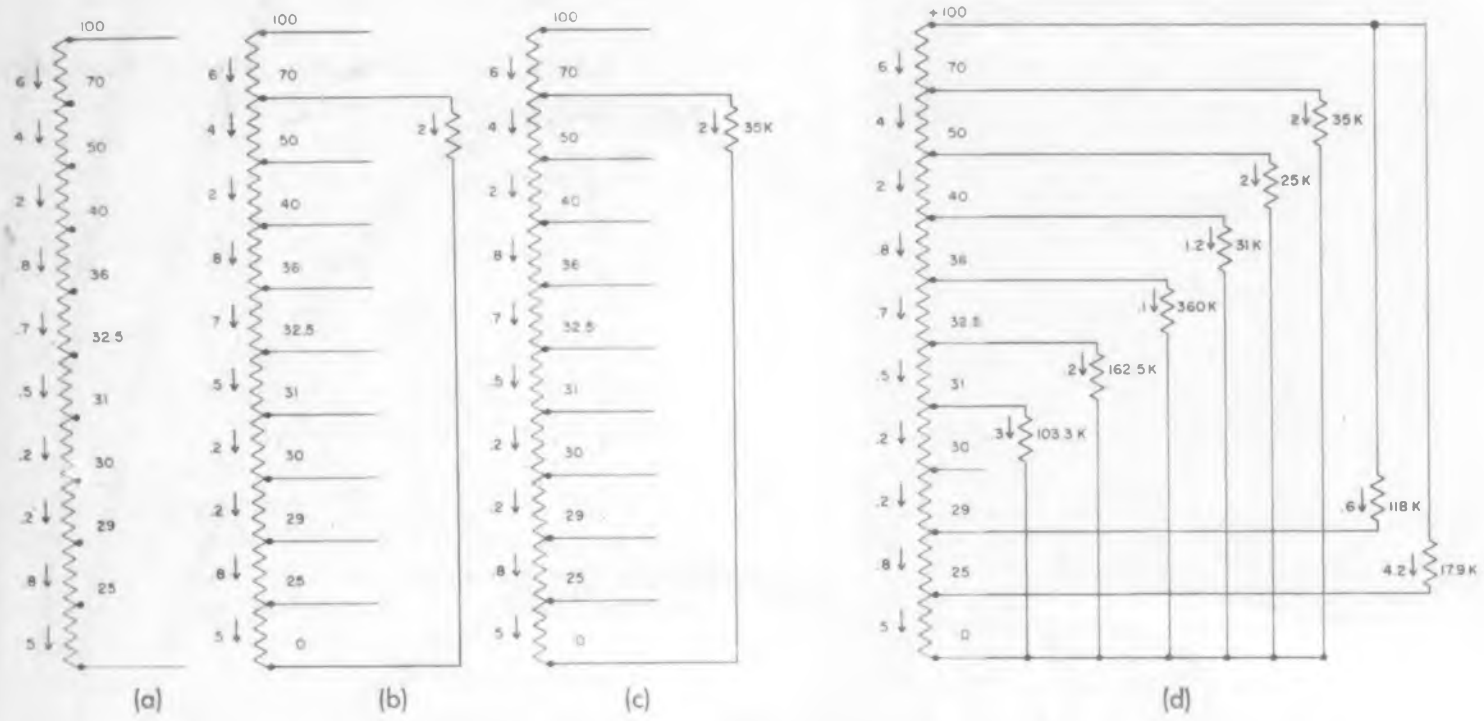


Fig. 3. Schematic of terminal-to-end loading technique.

The calculation proceeds in this manner until Junction 2 (29 v) is reached, at which point additional current must be supplied through a 118 k resistor from the top of the potentiometer (note in this calculation, not the tap potential but $100 - E_{tap}$ must be used). The fully loaded pot is shown in Fig. 3d.

Nonmonotonic Functions

The nonmonotonic function approximated by the straight lines in Fig. 4 is such that no point of the function reaches 100 v, and both ends of the potentiometer are at zero potential.

Tap-to-Tap Loading:

Simple tap-to-tap loading is not possible with nonmonotonic functions. Currents must be introduced at each maximum or minimum from the ends of the potentiometer to reverse the slope of the curve, although the same general method applies.

1. Calculate the current in each segment, and check to make sure that the safe current rating of the potentiometer is not exceeded.
2. Note the nodal point, where the proper voltage cannot be obtained by simply paralleling a resistor. Obviously current must be introduced into the pot at this nodal point.

Such nodal points divide the potentiometer into groups of segments. If the maximum current required in each group of segments are different, the total currents through segments and padders in each group need only to be as large as the largest current in that group. Each group then has its own "control" segment. This is not applicable to the function shown in Fig. 4, since this particular function is symmetrical.

A straightforward calculation leads easily to the loaded potentiometer of Fig. 5a.

Tap-to-End Loading:

This calculation proceeds exactly as before and yields the results shown in Fig. 5b.

Comparison of Methods

The tap-to-tap loading method has a number of advantages over tap-to-end loading, and in general is the recommended method:

1. It is more straightforward and the calculations are simpler.
2. It draws less current from the source.

For instance, in the first example tap-to-tap loading requires only 6 ma total from the source while tap-to-end loading requires 10.8 ma. In the second example tap-to-tap loading requires only 12 ma, while tap-to-end loading requires 20 ma. In some instances, particularly with nonmonotonic functions, tap-to-tap loading will require as much current, but will never require more.

This reduced power requirement is not too significant if only $f(x)$ is wanted, since the extra drain on the ±100 v supply is not great. But if $y.f(x)$ is to be obtained, in conjunction with an amplifier feeding several loads, the extra drain on the y amplifier might be troublesome.

3. The padding resistors for tap-to-tap loading usually have lower values. In the above example tap-to-tap resistances range up to 25 k, while tap-to-end padders have values up to 360 k. Lower values mean better stability for the function, since they permit the use of the more stable wire wound resistors, generally available only in lower resistance values. It also makes possible the use of small wire wound trimmer pots mounted in a turret which may be plugged right into the servo itself for easy changing of functions.
4. There is much less danger of ruining the main servo pot through inadvertent misadjustment. It is common practice to trim the function to exact values or to make minor adjustments while the padders are actually connected to the servo potentiometer. According to the pot loading schematic of Figs. 2 and 3, it is apparent that any one of the padder potentiometers in the tap-to-tap case could inadvertently be moved to any value from zero to infinity without seriously increasing the current through the servo potentiometer.

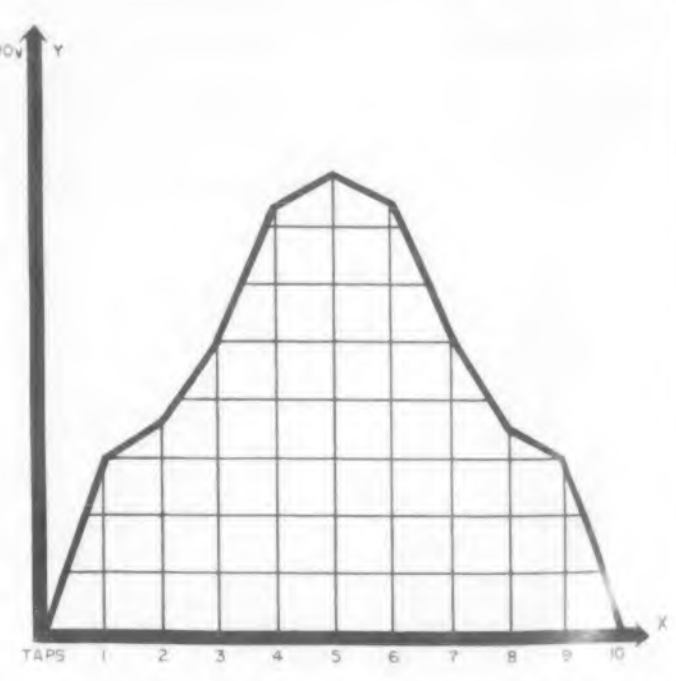


Fig. 4. Symmetrical non-monotonic function.

In the tap-to-end method of Fig. 3 however, where voltages are introduced directly, the situation is different. If one of the padding pots is inadvertently turned down to too low a resistance, the current through any given segment could exceed safe limits.

Padding turrets for those servos which are primarily multiplying servos (or resolver servos) are normally supplied with turrets arranged for padding with fixed resistors. Simple functions can be made up using stock resistors, and functions used repeatedly can be stocked to be used as required. If function generation is to be done more frequently, it is convenient to be able to adjust the padding without changing resistors, and

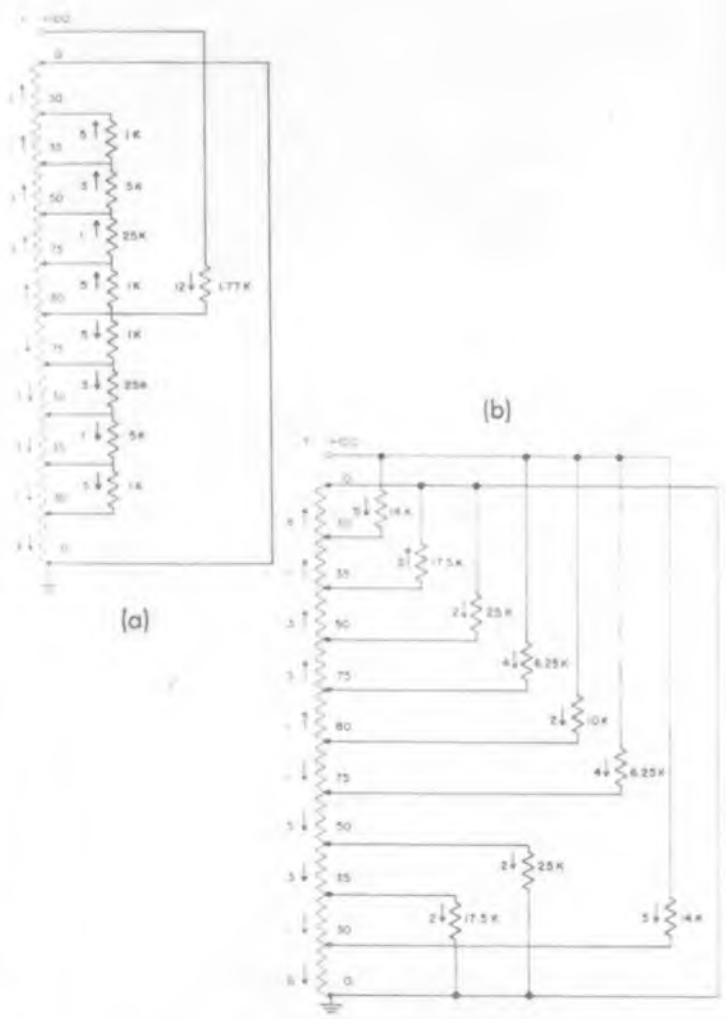


Fig. 5. Tap-to-tap and tap-to-end loading for non-monotonic function.

for this purpose padding turrets with built-in miniature wire-wound potentiometers can be used.

In practice a fixed resistor is supplied in series with each miniature padding pot, equal in value to the padder pot itself. The resistor is then shorted out for covering the lower half of the padding range and left in for the upper half. This arrangement serves the dual purpose of reducing the power dissipation in the padder pot and improving the resolution of adjustment. The padding pots used have approximately the same temperature coefficient as the servo potentiometer itself.

Pot Loading Computer

Although the calculations for the proper value of padding resistors to generate a given function can be made quite simple, in large computer installations, where a great deal of function generation is to be done, a quick mechanical means of arriving at the correct resistance is useful. A pot loading computer is available for this purpose in the "400" series REAC Computer.

The pot loading computer is simply a device for isolating the segment (tap-to-tap loading) or the node (tap-to-end loading) under consideration by making sure that the adjacent ones meet the specified conditions. It is then simple to adjust the padder until the one in question does also.

The pot loading turret is plugged directly into the front of the pot loading computer. The voltage at each of the nodes in the final function is then set up on a series of 21 ordinary scale factor potentiometers on the pot loading computer. The internal switching then isolates the segments (or nodes) one by one, and the padder is adjusted until a null is reached with the desired function, previously set up. Loading is normally done against a precision resistor string in the pot loading computer itself, so as not to waste analog computer time. Padding may also be done against the actual servo cup by means of an extension cable which leads from the pot loading computer and plugs right into the turret receptacle in the front of the servo itself.

Accuracy

It should be noted that all of the preceding calculations have ignored the effect of the load on the potentiometer. For the usual function generation this omission is justifiable. For a 50K pot operating into a 1 meg load, for example, even if no padding resistors are used, the error will only be 0.6 per cent from true value, and any padding resistors used will tend to reduce the total pot resistance, and hence the effect of loading. In general this error will be lower than those inherent in the straight-line approximation to the function. In any event, if this error is a problem, it can be removed by the us eof a standard unloading circuit.

The taps on some one-turn potentiometers may also vary by as much as 0.5 per cent from the theoretical value. A first order correction can be made to this error by calculating the padding resistance first from the theoretical tap resistance and then multiplying each padder by the ratio of the actual resistance measured between taps to the theoretical value. This correction will also take care of variations in the total pot resistance.

The accuracy of the calculation will also be affected by the original linearity of the potentiometer being used. This can be corrected to almost any desired value within the limits of the resolution by permanent connection of trimming resistors between taps on the pot itself.

UTILIZING a balun type feed, this coaxial hybrid ring achieves broadband operation and excellent isolation and balance characteristics. Isolation and balance are obtained in a size more compact than possible with waveguide techniques. The bandwidth of this unit is much broader than is presently achieved in comparable-sized conventional coaxial hybrid rings.

The broadband unit is ideally suited for ECM received mixers. The device, developed by Bogart Manufacturing Corp., 315 Seigel St., Brooklyn, N.Y., might find use in any system where balanced mixer operation is desirable. It can be used as a power divider; for example, feeding two antennas from a single transmitter. Conversely, a single load can be fed from two transmitters. Small size and weight suggest that this unit be considered for guided missile applications, in particular, where space is a problem.

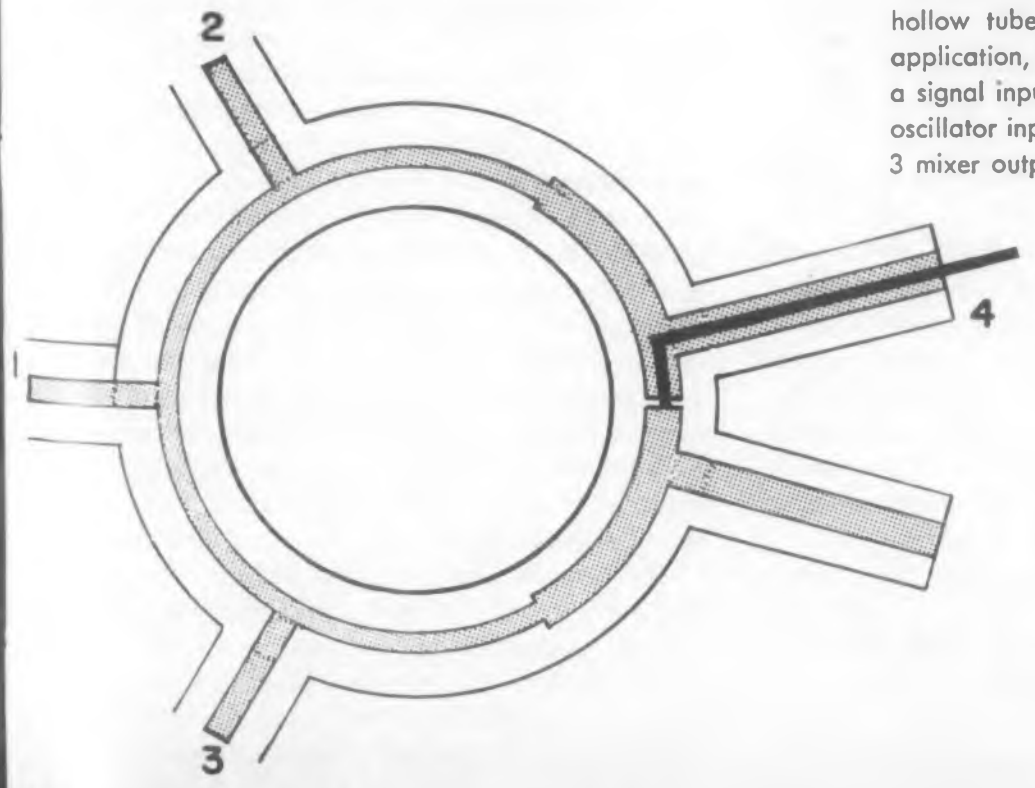
The "series-shunt" fed coaxial hybrid differs from the conventional coaxial hybrid in the positioning and feed of arm *4*. In a conventional hybrid all are are shunt fed. By moving arm *4* $\lambda/4$ at the design frequency, and changing it to a series feed the hybrid action is maintained ,although arm *4* will no longer be matched to the same Z_o. The series feed is achieved by lifting the outer conductor of the coaxial line above ground by means of a balun. The unit illustrated has a type *N* connector, but in special applications other types of connectors could be used.

Model NS 5802 for the S band has been designed to operate over a 50 per cent bandwidth centered about 3000 mc. Variations of this design are being

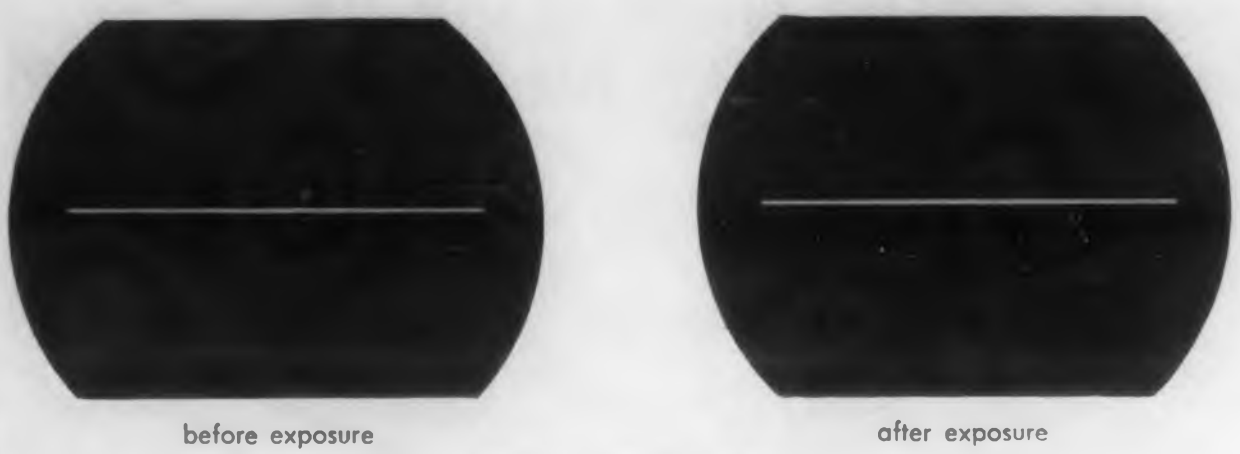
Compact Broadband Coaxial Hybrid Ring

developed for other frequency bands. The frequency range of NS 5802 is 2250-3750 mc. Average power rating of arm *1* is 200 w; arm *4*, 30 w. The VSWR looking into either arm *1* or *4* does not exceed 2.9. Isolation between arms *1* and *4* is greater than 30 db over the entire band. The degree of unbalance between arms *2* and *3*, when power is fed into either arm *1* or *4*, does not exceed 0.4 db. The unit, made of aluminum, weighs approximately 14 oz.

For more information on these coaxial hybrid rings turn to the Reader's Service Card and circle 31.

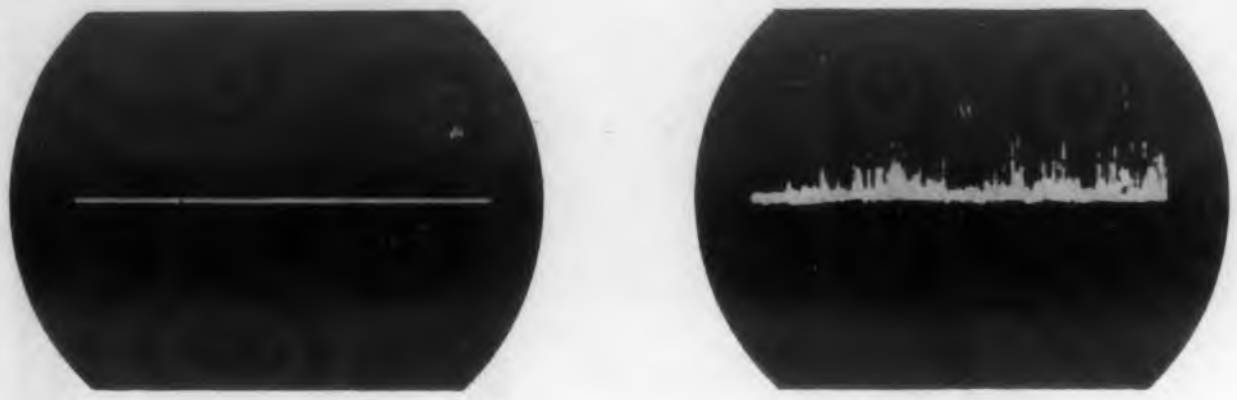


Schematic of coaxial hybrid ring with balun feed, arm 4. The conducting ring is a hollow tube. In a typical application, arm 1 could be a signal input; arm 4, local oscillator input; arms 2 and 3 mixer outputs.



before exposure — after exposure

Typical noble metal alloy



before exposure — after exposure

Typical nickel base alloy

Comparative noise patterns of potentiometers wound with noble metal alloys, *a*, and with nickel base alloys *b*, before and after a 6-hr exposure to humidified air containing a trace of ozone.

Noble Metal Wire for Precision Potentiometers

Adolph Cohn, President

Sigmund Cohn Corporation
Mount Vernon, N.Y.

RECENT developments in the wire industry make is possible for both the potentiometer designer and the equipment designer, who evaluates and selects potentiometers, to achieve performance not before possible.

The introduction of new noble metal alloys permits construction of potentiometers of very low noise level. This low level is maintained during long periods of inactivity of the potentiometer under severe environmental conditions. Noble metal windings require only light wiper pressure so that potentiometers can be constructed which require very small force to operate them.

Improvements in wire drawing and enameling methods enable the manufacturer to produce potentiometers of better linearity, life and resolution. It is now possible for him to obtain wire held to close and difficult specifications, so that he in turn may improve his own product along the lines suggested below. Characteristics of noble metals and their influence on potentiometer performance are covered in this article.

General Characteristics of Noble Metals

A noble or precious metal or alloy is one which is stable and very inactive chemically even at elevated temperatures. It is therefore not subject to atmospheric corrosion after prolonged exposures to extreme conditions and the contact area retains its initial characteristics over very long periods of time. Platinum and gold are typical noble metals.

Since precious metal windings are and remain free from oxides (and other chemical compounds) on the contact surface, the contact resistance retains its original low value, permitting the use of considerably lighter wiper or contact pressure than with metals which later form surface films of insulating oxides. It is this contact resistance which produces noise of the type discussed below.

With the precious metals it is not necessary to have sufficient contact pressure to break through such a layer. This low wiper pressure which is characteristic of noble metal potentiometers is a particular advantage in the design of instruments where only small forces are available for moving the brush. Instruments such as pressure transducers, gyros and accelerometers as well as others come within this classification.

Lighter contact pressures usually prolong the useful life of a potentiometer. On tests run by ourselves as well as by many manufacturers and users of potentiometers, life of twenty million or more cycles is not uncommon. In addition, since wear is held to a minimum, the initial high linearity can be maintained within closer limits for longer periods of time.

A further advantage of a noble metal winding is the ability of the potentiometer to withstand very high temperature. There is evidence that the useful life of a potentiometer with such a winding is not adversely affected by elevated temperature as would be the case with base metal windings.

Recent trends in potentiometer design have been towards miniaturization, higher resolution and sometimes higher total resistance values. This necessitates the use of smaller wires, in some cases as small as 0.0004". Wires of these small diameters require high tensile strength to prevent breaking in winding. In the present state of the art, the combination of high tensile strength (200,000 to 300,000 psi) combined with relatively low temperature coefficient of resistance, can be obtained with platinum alloys and with gold alloys of high precious metal content. The great hardness of these high tensile strength alloys assures excellent wear resistance.

Most precious metal alloys suitable for potentiometer windings are of lower resistivity than the usual chromium nickel alloys permitting the use of smaller wire diameters for comparable resistance. Therefore for any given resistance value of the winding, there is a considerable gain in resolution as a greater num-

ber of turns of the smaller wire will be required per unit length of the winding. Resolution is still further improved by the use of ultra thin enamel which is described below. As a general rule, noble metal alloy windings with proper contact materials make more nearly noise-free potentiometers than chrome nickel base alloys.

Noise and Corrosion Resistance

For many applications, it is important that a potentiometer retain its noise-free characteristics during long periods of inactivity. This requirement can be met by noble metal windings.

Accelerated tests were run in this company's laboratory to determine the relative noise level of potentiometers wound with noble metals and chrome nickel alloys before and after periods of inactivity. Two typical noble metal alloys were investigated (Sigmund Cohn No. 479 Platinum alloy and L.T.C. alloy, the newest member of the company's noble metal alloy family) and also typical chrome nickel alloys. Mandrels were wound with enameled wire of the alloy to be tested in the form of enameled wire 0.001 in. diam. The mandrel was Formvar covered copper wire 0.080 in. diam. One inch of winding was swept using a heat treated Paliney 7 contact, manufactured by the J. M. New Company in Hartford, Connecticut, 0.015 in. diameter, at a 5 gram pressure. Noise measurements were made using the conventional circuit in the oscilloscope, (as described in N.A.S.-710 of the National Aircraft Standards Committee) and a constant current source of 1 ma.

The specimens were carefully polished and mounted in the test fixture. A noise level of substantially zero was noted in this initial condition for each specimen. Observation and photographs were made using an oscillograph.

The potentiometers were then exposed for six hours to a moist atmosphere containing a trace of ozone, during which time the wipers were motionless. After this exposure, the potentiometers were again put into motion, and their noise level observed and photographed. No change occurred in the potentiometers with the 479 Platinum alloy or the L.T.C. alloy, but a noticeable change (more than 500 ohms equivalent noise resistance) occurred with the base metal chrome nickel alloy. In the photographs reproduced below, the vertical scale is 1 in. = 1,000 ohms equivalent noise resistance.

After 50 or 100 sweeps the noise of the potentiometer with the chrome nickel winding greatly diminished, and ultimately reached a minimum. The number of sweeps required to clear up the noise is dependent upon the exposure, longer periods of inactivity will result in longer periods of noisy operation.

Linearity

The potentiometer manufacturer is to a large extent dependent upon the linearity of the wire he purchases,

for the linearity of the potentiometer he can produce with it. Although non-linearity of the wire can be compensated for during potentiometer manufacture, such compensation is not necessarily perfect. The more nearly linear the wire, the better in this respect.

It is highly desirable that the electrical and physical characteristics of a wire remain as constant as possible throughout its length. However, minor and gradual changes continuing uniformly throughout the length are not as objectionable as abrupt random variations occurring within short lengths. A wire of good linearity is one in which these variations are held to a mimimum.

The manufacturer of the wire is aware that its linearity is dependent upon two basic requirements. The first requirement is homogeneity of the ingot as originally cast. It must be quite free from segregation. Ingots which are allowed to solidify over a longer period of time, generally speaking, exhibit more segregation than ingots which have solidified more rapidly. In other words, larger melts mean slower cooling and greater segregation. The use of a pure metal, as opposed to an alloy, would overcome this difficulty but unfortunately, no pure metal is known to make a truly satisfactory potentiometer winding. Hence an alloy must be used and the problem of segregation is always present to a greater or lesser extent.

The second general requirement for high linearity in wire (even though the ingot itself be almost completely free from segregation) is good drawing techniques. The diamond dies must be constantly maintained at maximum efficiency by polishing them to the highest finish, correct entrance angle and bearing and correct "draft" with respect to the preceding die. As the wire approaches the final size the last several drafts are made "single pass." In this way the wire does not come into contact with revolving drums or capstan and passes directly from one spool to another thereby avoiding a possible source of surface scoring or "galling."

Roundness, Smoothness, and Straightness of Wire

The life, noise level and linearity of a potentiometer are often governed by the physical condition of the wire used in the winding. The wire requirements of the potentiometer manufacturer are considerably more severe than wire requirements for most other purposes.

The term "roundness" is intended to cover not only a circular cross section, but also lack of surface irregularities such as longitudinal scratches which may result in a noisy potentiometer, as well as poor life. It is very desirable in the winding of potentiometers to have a wire with as nearly as possible a perfectly round cross section. This ideal condition can very closely be approximated by the selection and care of the diamond wire drawing dies, and by careful wire drawing techniques.

The diamonds used for drawing dies are never as perfect as might be desired. Nonuniformity of hardness or unsuspected flaws in the stone may result in uneven wear and therefore out-of-roundness or scratches on the wire the die produces. These defects may be of a very minor nature; however, with constant vigilance on the part of the operator during the drawing operation, they may be detected. At the first sign of out-of-roundness the die must be repolished or discarded.

The detection of out-of-roundness in a wire is much simpler than measuring the magnitude of such out-of-roundness. Visual inspection by an experienced operator is usually the most sensitive and most dependable method. A wire with sufficient out-of-roundness to be detected with ordinary measuring methods would be wholly unsuited for the manufacture of even semi-precision potentiometers. Optical methods have proven too cumbersome to be of practical usefulness.

Although out-of-roundness does not necessarily destroy the linearity of a wire, a potentiometer wound with such out-of-round wire will probably be less linear than one wound with a more nearly round wire. This is because the wire cannot be made to properly "lay" on a mandrel or card and usually results in uneven spacing of the turns. Occasional "high" wires may also result. When used in applications involving rapid wiper travel this may cause the wiper momentarily to break contact with the winding.

Although not related to the matter of roundness of wire, spaced turns are also produced by wire which exhibits a longitudinal twist. A twist of this kind is very difficult to detect, and even though present to a marked degree may not be evident except by the effect it produces on the winding. It may be introduced at various stages of the drawing process and care must be taken to avoid it.

Straightness of wire is very important and desirable. An excessively curly and wavy wire can create winding difficulties resulting in spaced turns, high wires and other defects that may be at once apparent or develop in the form of short life.

Characteristics and Specifications of Three Precious Metal Alloys Customarily Used in Potentiometer Winding

	479*	851	L.T.C.**
Resistivity ±5%	400Ω/cmf	180Ω/cmf	550Ω/cmf
Temperature Coefficient of Resistance (Nominal) (0 to 100°C.)	240 p.p.m.	600 p.p.m.	20 p.p.m.
Tensile Strength	300,000 psi	300,000 psi	200,000 psi
Composition (Nominal)	Pt 92% W 8%	Pt 79% Ru 6% Rh 15%	65% noble metal

Type designations refer to Sigmund Cohn Corp.
* Patented for use as a potentiometer winding
** Patent applied for

Enamel

The function of an enamel when used on a wire for winding potentiometers differs in many respects from that of wires used for fixed resistors. A wire quite suited for winding fixed resistors might be unsuited for winding precision potentiometers, and vice versa. The dielectric requirements of potentiometer wire are usually lower than for most other wire, but uniformity and thinness are of utmost importance in the manufacture of potentiometers.

When ordering wire, potentiometer manufacturers may now specify not only the kind of enamel the wire manufacturer must use, but also its thickness which may be far less than that formerly available. It is customary to specify an enamel thickness which results in an increase of diameter of the wire of 10% on wires of 0.0015 in. and smaller. However diameter increases of as little as 5% can be specified. The recent trend has been in the direction of thinner enamel for reasons mentioned below.

The method of applying the enamel for potentiometer purposes, consists of applying many extremely thin coats by free dip methods. When required, each individual coating may have a thickness of only about 0.000001 in. and many individual coats are usually

applied. Each coat is baked before the succeeding one is applied.

The above method results in an extremely smooth and uniform enamel coating, free from beads or other irregularities. Bare wire which is of high quality, as far as linearity and roundness is concerned, when enameled by this method, may be "close" wound or "butt" wound producing potentiometers of surprisingly high linearity. The good linearity of such a winding depends to a very large extent on the uniformity of the enamel.

A thermo-setting resin has been found very satisfactory as the enamel. Sigmund Cohn Corp. generally use a Class A enamel which although officially rated at 105 C. maximum, nevertheless for potentiometer purposes is frequently used successfully for temperatures up to about 150 C. With recent interest in potentiometers for operation at considerably higher temperatures, Class B enamel is now also available. This can also be used successfully for potentiometers at temperatures in excess of the official rating.

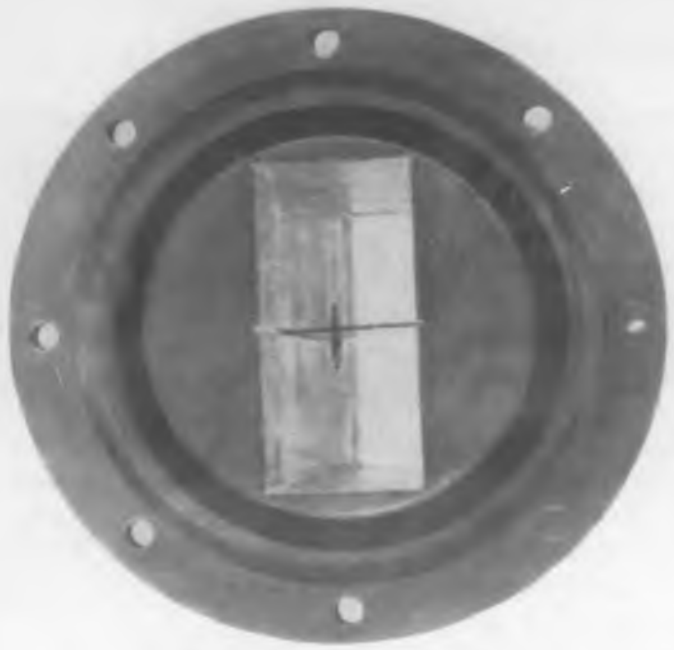
In addition to producing a more uniform and linear winding, thin enamel has two other important advantages. First, since more turns may be wound per unit length better resolution is possible. This may necessitate the use of a smaller mandrel or card if the same total resistance value is required, but this usually is no disadvantage and may be an advantage. Secondly, a thinner enamel coating may more easily be removed from the contact area of the winding than the conventional thicker enamel. It has been found for example that this thin type of enamel may quickly and conveniently be removed by buffing with a slurry of bicarbonate of soda and water. Details of this process will be supplied upon request.

If desired after all enamel on the contact area has been removed with bicarbonate of soda the winding itself may be lightly buffed by conventional methods. This final burnishing or polishing of the metal surface is considered by some to result in less noise and longer life.

The manufacturer of potentiometers is not limited to "stock sizes" as far as precious metal wire is concerned. Since this wire is drawn to order, he has unlimited choice in the selection of resistance values. These values are normally held to a tolerance of plus or minus 3%; where requested to a tolerance of plus or minus 1%. In addition, if enameled wire is required, he should indicate what kind and thickness of enamel best suits his design.

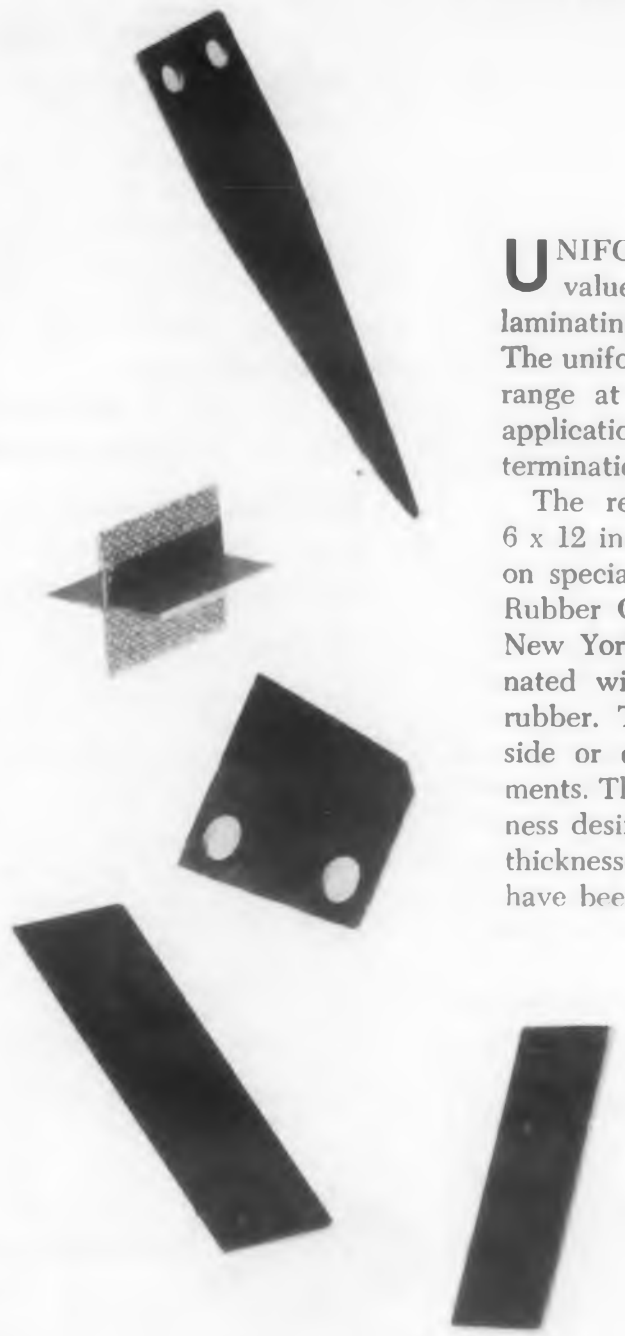
Conclusion

In potentiometers of low noise levels, where long shelf life and light wiper pressures are involved, the use of a noble metal winding is indicated. These modern precision potentiometers require wire of the utmost roundness and linearity. When enameled wire is used for the winding, the enamel must be thin, smooth and uniform to a degree not normally required in most resistance wires.



Waveguide fitted with attenuator made from conductive rubber laminate.

Conductive Rubber



UNIFORM area resistance in a wide range of values results from a unique process of plastic laminating involving the use of conductive rubber. The uniformity of resistance over a wide frequency range at microwave frequencies has resulted in applications for the "Cards" as attenuation and termination devices.

The resistance cards are supplied in squares 6 x 12 in. in size as standard and up to 7 x 18 in. on special order. The material produced by U. S. Rubber Company, 1230 Avenue of the Americas, New York, N. Y., is laminated fiberglass impregnated with phenolic resin containing conductive rubber. The laminate can be conductive on one side or on both sides, depending upon requirements. The card can be made up in most any thickness desired and to close tolerances. For example: thicknesses of 0.025 in. ±0.004 and 0.070 in. ±0.005 have been provided. Resistance ranges from 50 to

Typical configurations of resistance cards consisting of fiberglass laminates impregnated with phenolic resin containing conductive rubber.

Resistance Cards

700 ohms per square ±15 per cent have been supplied. Other resistances can be provided upon order. Dimensional stability of the cards is excellent, and warp in width and length does not exceed 0.250 in. per foot. Aluminum foil terminal strips can be furnished, bonded to the cards for test purposes or for making connections.

Applications

Known as *US-KON HGP-4,* this material has been successfully used throughout the microwave frequency spectrum for applications requiring power dissipation, predetermined loss or attenuation, protection of crystals or other sensitive devices, isolation, or impedance matching. The chief uses have been as microwave terminations and attenuators. It has also been used as a radiation absorber to suppress unwanted vertically polarized electromagnetic waves.

How Used

For use in attenuating power in waveguides, the Resistance Card is placed in the center of the waveguide, aligned in the direction of the electric field. Generally, a symmetrical V or a taper is cut into one end or both ends of the rectangular strip of material to reduce the voltage-standing-wave-ratio. Under such conditions loads and attenuators can be built with VSWR under 1.01. The value of attenuation can be fixed by varying the resistivity of the conducting material.

For additional information about this product, fill out the Reader's Service Card and circle No. 36.

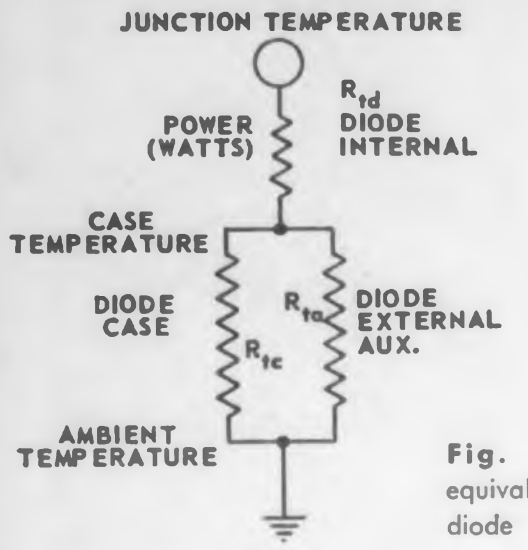


Fig. 1. Electrical equivalent (approx.) of diode thermal circuit.

Silicon Diode Application Notes

Arnold Bergson
Raytheon Manufacturing Co.

MEDIUM power silicon diodes can be applied where small size, high efficiency, high temperature operation, high reverse resistance, and medium forward currents are required. Equations and criteria for use in designing silicon diodes into practical circuits are given here together with problem examples.

Forward Power Dissipation

The general equation for forward power dissipation (P_{fd}) is:

$$P_{fd} = I_a E_o + K_f^2 I_a^2 R_d \text{ watts} \quad (1)$$

where, P_{fd} = forward power dissipation
E_o = approximate diode threshold voltage
K_f = theoretical forward current form factor
R_d = diode dynamic forward resistance
$I_a = 0.45 E_s/R_l$ avg amperes (E_s = sinusoidal rms supply voltage; R_l = load resistance)

Eq. 1 is quite useful for approximating diode forward power dissipation for various standard star and bridge configurations. The form factors and other characteristics of these combinations are shown in the table.

As an example, a single-phase, half-wave circuit has resistance load, R_L, and an ac supply voltage, E_s (such that $E_s \gg E_o$, and $R_L \gg R_d$). Using the specification limiting CK775 diode, $E_o = 1.0$ v, and the resistance $R_d = 0.1$ ohm. From equation (1), calculate the forward power dissipation (P_{fd}) for an average forward current of 5 amp:

The form factor (K_f) for the 111H circuit is 1.57, and K_f^2 is 2.46. $P_{fd} = 5 \times 1 + 2.46 \times 5^2 \times 0.1 = 11.2$ w

Using the same diode as part of a three-phase, half-wave circuit (311Y), carrying 15 amp total output current, the average current per diode would be 5 amp. K_f for this circuit is 1.76 and K_f^2 is 3.1 $P_{fd} =$ 12.3 w per diode.

The polyphase calculation above is based on equal load distribution through the diodes. In similar applications where diodes are not properly matched, single diode dissipation can be appreciably higher with noticeable increase in load ripple and commutation effects. Forward characteristics can be matched to within ±10 per cent forward current at a given forward voltage to insure good load division for polyphase and paralleling circuits. Magnetic amplifier units may require some matching in both forward and reverse characteristics, since circulating components of current in either direction cause loss of gain.

In some cases, maximum allowable P_{fd} watts are known, and it is required to compute average current (I_a) per diode, or load current for a given configuration, from diode characteristics E_o and R_d. For this case, equation (1) can be solved as a quadratic:

$$I_a = \frac{-E_o + \sqrt{E_o^2 + 4K_f^2 R_d P_{fd}}}{2 K_f^2 R_d} \text{ average amperes} \quad (2)$$

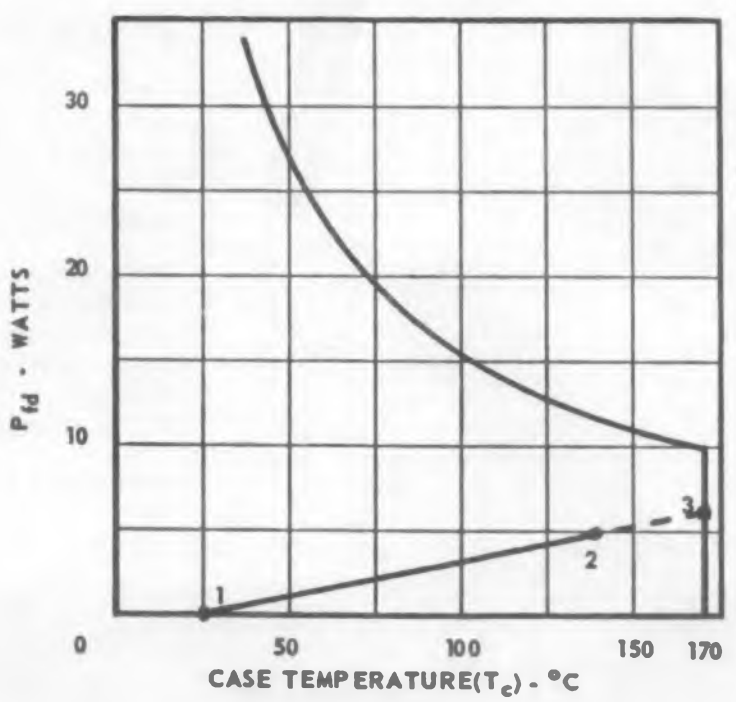


Fig. 2. Limiting relationship between junction power and case temperature. See text for design example.

Thermal Characteristics

Test results on a large number of diodes indicate a reliability requirement for limiting diode power dissipation, P_{fd}, as a function of junction temperature. Junction testing, however, has proven complex, requiring special calibration and interpretation of data, so as to make this method impractical for field use. An approximate electrical circuit to the "thermal circuit" of the diode is shown in Fig. 1. The analogy is based on electrical parameters of voltage, current and resistance; and thermal parameters of ambient temperature, power and temperature per watt. The relationship of these parameters is:

$$T_j = \frac{P_{fd}(R_{td} + R_{tc} + R_{ta})}{R_{tc} R_{ta}} + T_a \text{ deg C} \quad (3)$$

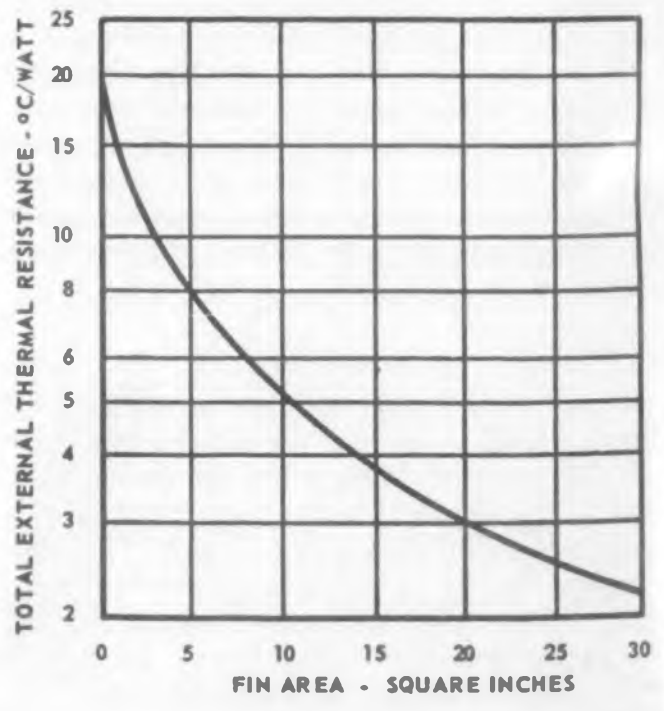


Fig. 3. External thermal resistance vs fin area for free convection cooling in typical diode application.

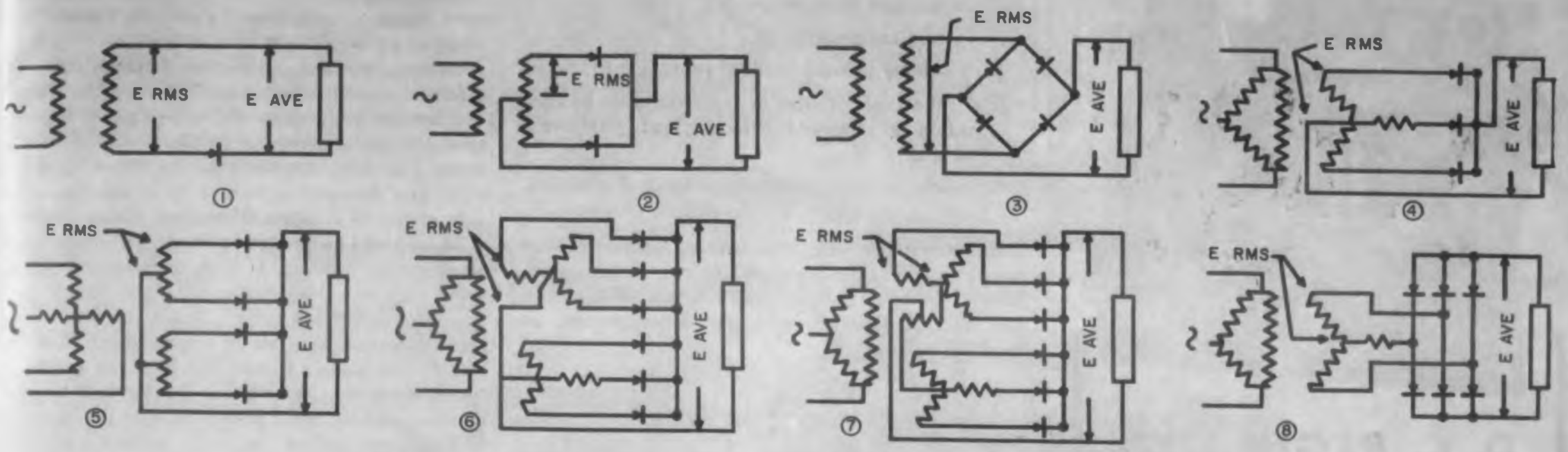


Table of characteristics for fundamental rectifier circuits with resistance loads.

Symbol	Circuit	Output Wave Values					Rectifier Cell Wave Values					Trans. Cap.	
		Wave Form	E (avg)	E (ac)	Form Fact.	dc Ripple %	Wave Form	I (avg)	I (ac)	Form Fact.	E (inverse)	Pri.	Sec.
1-1-1-H	1		0.45 E_{rms}	0.707 E_{rms}	1.57	121	½	1.00 I_{dc}	1.57 I_{dc}	1.57	1.414 E_{rms}	3.49 EI_{dc}	3.49 EI_{dc}
2-1-1-C	2		0.90 E_{rms}	1.0 E_{rms}	1.11	48	½	0.500 I_{dc}	0.786 I_{dc}	1.57	2.828 E_{rms}	1.235 EI_{dc}	1.75 EI_{dc}
4-1-1-B	3		0.90 E_{rms}	1.0 E_{rms}	1.11	48	½	0.500 I_{dc}	0.786 I_{dc}	1.57	1.414 E_{rms}	1.235 EI_{dc}	1.235 EI_{dc}
3-1-1-Y	4		1.17 E_{rms}	1.19 E_{rms}	1.02	18	⅓	0.333 I_{dc}	0.587 I_{dc}	1.76	2.45 E_{rms}	1.51 EI_{dc}	1.51 EI_{dc}
4-1-1-C	5		1.27 E_{rms}	1.28 E_{rms}	1.005	11	¼	0.250 I_{dc}	0.502 I_{dc}	2.01	2.828 E_{rms}	1.12 EI_{dc}	1.58 EI_{dc}
6-1-1-S	6		1.35 E_{rms}	1.35 E_{rms}	1.001	4	⅙	0.167 I_{dc}	0.408 I_{dc}	2.45	2.828 E_{rms}	1.28 EI_{dc}	1.81 EI_{dc}
6-1-1-Y	7		1.17 E_{rms}	1.17 E_{rms}	1.001	4	⅓	0.167 I_{dc}	0.293 I_{dc}	1.76	2.45 E_{rms}	1.07 EI_{dc}	1.51 EI_{dc}
6-1-1-B	8		1.34 E_{rms}	1.34 E_{rms}	1.001	4	⅓	0.333 I_{dc}	0.579 I_{dc}	1.74	2.45 E_{rms}	1.05 EI_{dc}	1.05 EI_{dc}

where,

T_j = junction temperature (°C)

T_c = case temperature (°C)

R_{td} = diode internal thermal resistance (°C/watt)

R_{tc} = the diode external thermal resistance by convection to air, and through lead conduction (°C/watt)

R_{ta} = the auxiliary thermal resistance due to fins, blast air, liquid cooling, or altitude (°C/watt)

Due to the difficulties in measuring junction parameters, Eq. 3 can be converted to case temperature, thereby eliminating the need for junction temperature, and internal thermal resistance measurements, as shown in Eq. 4:

$$T_c = P_{fd}\left(\frac{R_{tc}\,R_{ta}}{R_{tc}+R_{ta}}\right) + T_a \text{ deg C} \qquad (4)$$

The limiting relationship between junction watts and case temperature is shown in Fig. 2. An example of the use of Eq. 4 is as follows: Determine the maximum allowable power dissipation and the corresponding case temperature for a CK775 diode, operated at 25 C ambient, in free convection at sea level, without an external heat radiator: Locate T_a (point *1*) on the abcissa at 25 C. Using an external thermal resistance of 23 C/watt for R_{tc}, assume 5 w dissipation. Calculate case temperature rise to be 5 x 23 = 115 C. Therefore, the case temperature at 5 w dissipation will be 25+115 or 140 C (point 2). Connect points *1* and 2 with a straight line and extrapolate to the limiting curve (point 3). Read maximum allowable power dissipation as 6.3 w at a case temperature of 170 C.

This calculation assumed that R_{ta}, the auxiliary thermal resistance, was very high compared to R_{tc}. The addition of auxiliary cooling fins can be made to lower the external thermal resistance substantially, since conduction is generally much more efficient than either convection or radiation. Results are shown in Fig. 3 of an experimental relationship between total external thermal resistance (parallel combination of R_{tc} and R_{ta} of equation (4) and fin area for copper fins 1/16 in. thick in free convection at sea level.

Other parameters causing variation of external thermal resistance include blast air, liquid cooling, and altitude. In the case of the 25 C ambient temperature and a very low thermal resistance, say 1 C per watt, it is possible to dissipate 26 w at a case temperature of about 51 C. At high altitude, without a fin, the external thermal resistance can be considerably higher than the 23 C/watt figure used in the example.

Even with a fine finish on the base of the diode, it is rarely possible to utilize more than a fraction of the available area for heat conduction with direct metal-to-metal contact. In such applications, it has been found that the addition of a drop of 1000 CS, Dow Corning 200 type, silicone oil, or grease has been sufficient to provide great improvement in the thermal resistance of the joint. The 5.5 C/watt value shown for a 3x3x1/16 in. copper fin may be lowered by as much as 2.5 C per watt by such means.

Both the forward and reverse characteristics of the diode vary with temperature and since the specified characteristics are measured at 25 C, it is important to anticipate changes at ambient temperatures extremes. At low temperatures, the zener breakdown point may decrease in voltage by as much as 20 per cent of the 25 C figure. Therefore, diodes applied at −55 C should be derated to 80 per cent of the 25 deg peak inverse voltage. At high temperatures the forward resistance decreases and the transfer characteristics shows forward voltage at a given forward current decreasing at a rate of approximately 2 mv per deg. C. The leakage current also increases as temperature is increased. The junction leakage is of the order of microamperes at 25 C and roughly doubles every 10 C rise. At present the shunt resistance effect has not been adequately determined, but apparently increases at a much lower rate.

Surges and Overloads

Current surges are permissable for short periods of time within the watt-second thermal capacity of the diode. Compared to selenium rectifiers (having the rectifying element uniformly distributed on a large fin) the silicon diode has a very short thermal time constant. This is due in part to the extremely small thermal mass of the junction and the inherent physical properties of the package. Translating power to current, the limiting relationship is as follows:

$$X = 1/T \qquad (5)$$

where, $X = \dfrac{\text{actual current}}{\text{rated current}} = 10$ for any value of T

T = surge duration time in seconds = 1

(T of 1 second is considered steady state operation)

An example of permissible current surge is as follows: A CK775 is operating at a maximum rated average current of 5 amp. A short circuit current of 25 amp is required to blow a fuse. Determine the maximum allowable surge duration time.

$X = 25/5 = 5$ and $T = 1/5 = 0.2$ sec, max.

The silicon diode has very little capacity for absorbing over-voltage, since the reverse characteristic breaks very sharply above rated voltage. Inverse power dissipation increases very rapidly from milliwatts to watts as voltage is increased into the zener region. The two limiting specification parameters are $-E_b$, the continuous peak inverse voltage (abbreviated *PIV*), and e_{pz}, instantaneous, nonrepetitive *PIV*.

Applications where unusual transient or subtran-

sient over-voltage conditions can exist should be explored carefully before writing specifications. Switching or control circuits with inductive load can produce subtransient over-voltages of the order of several times the normal supply *PIV*. In certain instances, these isolated pulses have been detected as persisting for periods of the order of microseconds, but still providing sufficient energy to destroy diodes and puncture the insulation of associated components.

Problem Solution

A current military equipment requires a 150 v, 10 amp d-c supply for a resistive load over the ambient range of from −55 to 125 C. A 115 v, three-phase delta supply is available as a source. The rectifier must be capable of supplying 50 amp for 0.1 sec, in order to blow a fuse under load fault.

Considering the three-phase bridge (611B of the table), the average current per diode, I_a, will be 10/3 or 3.3 amp. Each diode will be conducting the peak current of 10 amp for 1/3 of the time, and therefore the diode forward voltage drop from Fig. 3 will be approximately 2 v. The output voltage of the bridge is:

$$E_L = 1.35\,E_s - 2\,E_f = 1.35 \times 115 - 2 \times 2 = 151 \text{ v dc}$$

The *PIV* across each diode will be $\sqrt{2}\,E_s$ or about 163 v. Therefore, a CK776 with a *PIV* of 200 v should be used to provide sufficient voltage derating for −55 C operation.

From the table, the current form factor for this circuit, K_f, is 1.74. Using Eq. 1:

$$P_{fd} = 3.3 \times 1.0 + (1.74)^2\,(3.3)^2\,(0.1) = 6.6 \text{ watts/diode}$$

From Fig. 2, the maximum case temperature corresponding to 6.6 w dissipation is 170 C. The temperature rise per diode would be 170-125 or 45 C. The external thermal resistance must be limited to 45/6.6 or 6.8 C/watt, max. From Fig. 3, this thermal resistance corresponds to a 1/16 in. thick copper fin of about 6 sq in. for conditions of free convection at sea level air density.

In computing the rectification efficiency, it is necessary to compute the load watts (150 x 10 − 1500 w), and all of the losses. The diode losses computed above are 6.6 w/diode or a total of 39.6 w for all six diodes. The ac load losses (I^2R_l) are approximately 4.7 per cent for this circuit. The diode losses are 39.6/1500 or 2.64 per cent. The total losses are 7.3 per cent giving a rectification efficiency of 92.7 per cent.

This bridge with closely balanced forward characteristics for all diodes supplies less than 4 per cent load voltage ripple. Diodes should be matched to within ±10 per cent forward current at a given voltage to insure good load division, and commutation.

The surge current requirement of 50 amp for 0.1 sec is permissible since:

$X = 50/10 = 5$ and $T = 1/X = 0.2$ sec max. (Eq. 5)

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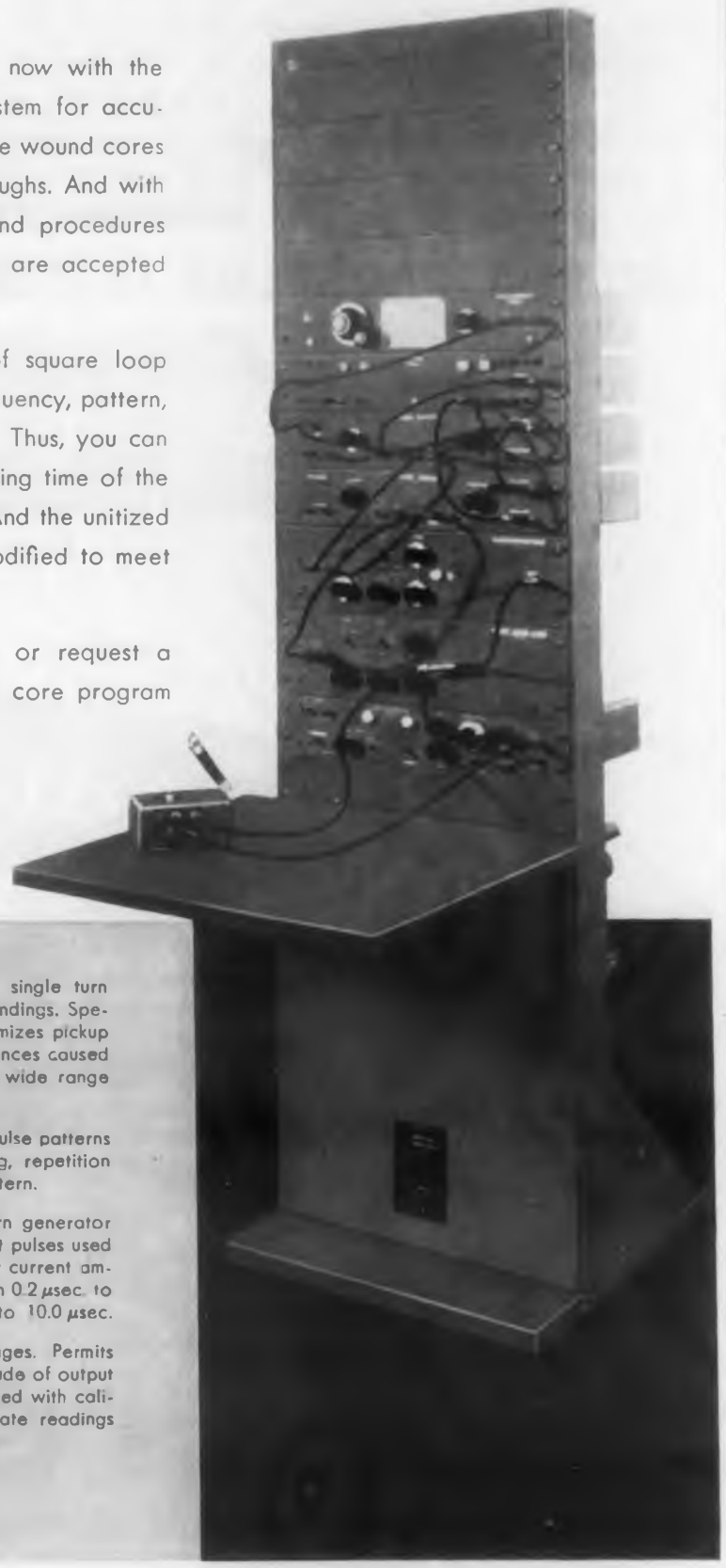

specifications

tools for engineers

core mounting jig:	Low-noise test mounting jig applies tight single turn loops around core for input and output windings. Special electrical and mechanical design minimizes pickup by the secondary as well as other disturbances caused by air flux. Adjustable pins accommodate wide range of bobbin sizes with equal precision.
pattern generator:	Provides extreme flexibility in generating pulse patterns applied to core, controlling pulse spacing, repetition rate of cycle, and number of pulses in pattern.
current drivers:	Two drivers convert voltages from pattern generator into positive and negative constant current pulses used for driving core. Front panel controls vary current amplitude from 0 to 1.0 ampere; rise time from 0.2 μsec. to 1.0 μsec.; pulse duration from 1.0 μsec. to 10.0 μsec.
calibrator:	Accurately measures currents and voltages. Permits measurement of driving current and amplitude of output voltage with an error of less than 1%. Used with calibrated oscilloscope, permits highly accurate readings of switching time.
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Military-specification

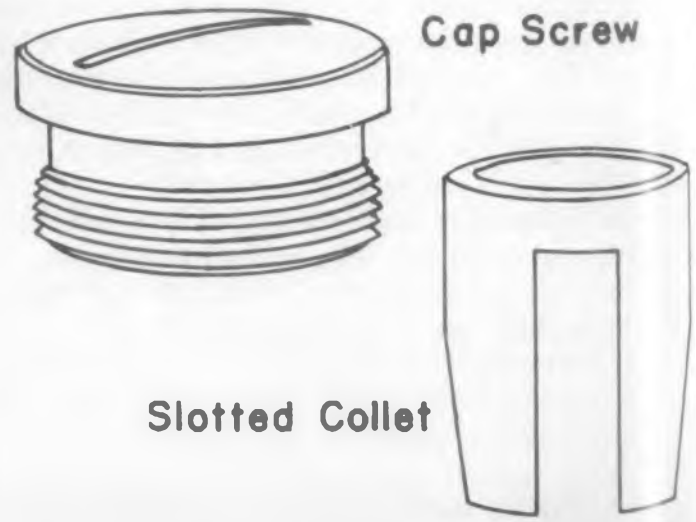
△Collet Fitting Knob

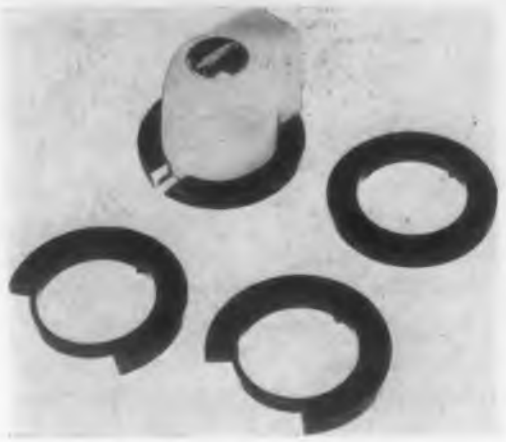
INCORPORATED into this newly designed knob is a positive locking collet, which eliminates all possibility of knob slippage due to set screw loosening. The collet snugly grips the shaft, evenly distributing locking pressure on all outside surfaces of the shaft. The bar knob illustrated here meets military spec requirements, MIL-K-25049.

The collet fitting attachment of the new knob produced by Dale Products, Inc., Box 136, Columbus, Neb., consists of three parts: cap screw, slotted collet, and knurled insert. The cap screw is threaded into the knurled insert after the slotted collet is inserted inside the knurled insert. The knurled insert is mounted in the inside diameter of the knob at the top. The lower surface of the inside diameter of the knob is tapered.

Tightening the cap screw closes the tapered slotted collet jaws on the instrument shaft by forcing it to move into the tapered inside diameter of the knob. This is similar to the operation of a collet attachment on turret lathes.

The slotted cap screw is positioned by two keyways on the inside diameter of the knob itself. This





Tightening cap screw secures this collet type knob onto the shaft. Several skirts meeting military specifications are shown

prevents the knob from slipping on the collet. The friction between the collet and inside diameter of the knob, both tapered, also prevents slippage due to the pressure of forcing them together.

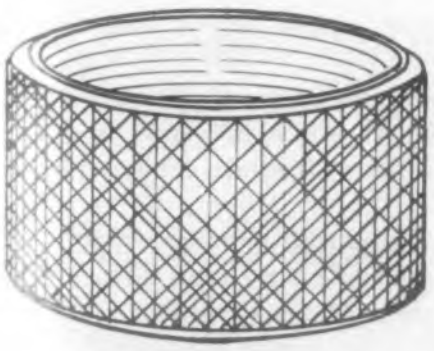
In actual mounting, the knob is positioned on the shaft and the cap screw is tightened in a clockwise direction. The knob is then absolutely secure from slippage without damage to the shaft.

The cap doesn't have to be completely removed to provide for removal. Simply loosen cap screw, push inward on knob to release collet and the knob can then be removed from shaft.

The MS 25170 bar knob has a 7/8 in. diameter and height, fitting on military style 1/4 in. flatted shafts. The knob material is tough thermoplastic, offering properties needed for hard use at high temperatures. It comes in standard gray color. A complete selection of skirts, dial plates and pointers meeting MIL specs are available.

For more information on this bar knob, turn to the Reader's Service Card and circle **41.**

This product may be seen at the Radio Engineering Show, Booth 2742-44.



Knurled Insert

The collet jaws clamp shaft as cap screw is threaded into knob insert.

Trends in Components

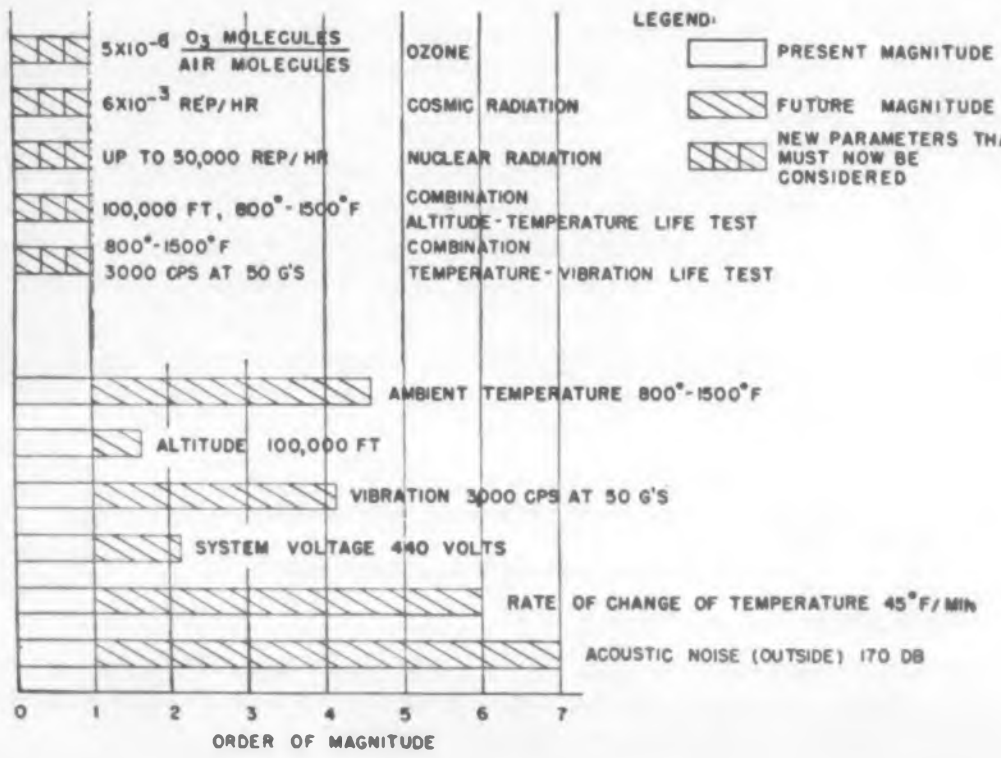
The proceedings of the seventh series of national meetings on electronic component parts and materials, the 1956 Electronic Components Symposium, has recently been published.

The Proceedings contains much fresh information and covers many novel developments to bring the reader up to date with the latest trends and the state of the art. Forty-three different papers cover a wide variety of subjects such as materials progress, electron tubes, solid state devices, passive components. Papers also include treatment of reliability and instrumentation and measurements.

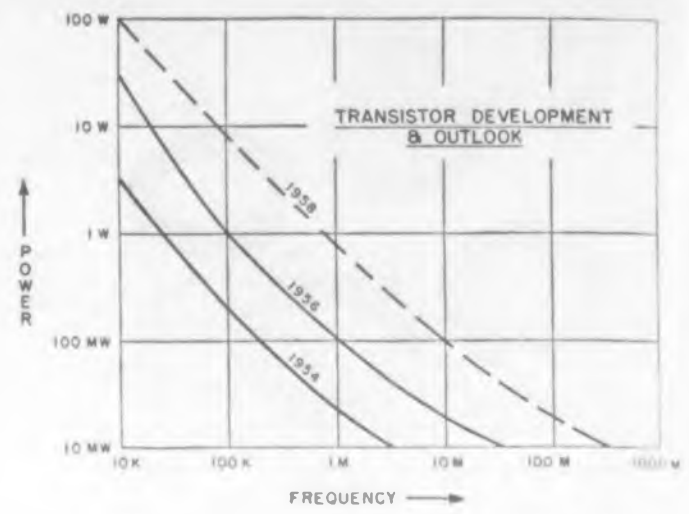
Several developments in the field of materials, resistors, capacitors, and semiconductors which may shortly affect the equipment designer are reported here briefly. The complete "Proceedings of the 1956 Electronic Components Symposium" may be obtained from Engineering Publishers, GPO Box 1151, New York 1, N. Y. The book is 240 pages long and contains 293 illustrations. Size 8½ x 11 in. Paper bound edition $5.00.

New Enviromental Referents

Increased accelerations, Mach number, and higher altitude for airborne equipment mean that electronic components and equipment must withstand altogether new environmental conditions. Reorientation to new reference points will be helpful in thinking about these conditions. Some of the situations that will be encountered and the order of magnitude of the changes are illustrated in the accompanying graph. *Extracted from "Looking Forward into the Future," Karl Martinez, Boeing Airplane Co.*



New reference points for thinking about environmental conditions.



Projection of logarithmic plot of past transistor advance shows what power and frequency ratings might be in 1958.

Transistors of the Future

General

Future developments in transistors promise an increase in both maximum frequency and maximum power. The history of the development of the transistor as a function of power and frequency is indicated in the accompanying graph where a logarithmic plot of frequency on the abscissa and power on the ordinant is shown. It appears that power can be exchanged for frequency and vice versa and that the exchange may not be severe on future devices. *"A Report on the Art of Semiconductor Devices," David B. Kret, Radio Corporation of America.*

High Power Silicon

Alpha cut-off high frequency response of a transistor is inversely proportional to W^2 (thin base width). The gain at high current also depends inversely upon W^2. Since thin base width is essential both for high frequency and high power performance, it is interesting to note whether further requirements of high frequency and high power are necessarily in conflict with each other, or whether a high-frequency high-power transistor is feasible.

As far as high power is concerned, the transistor must be able to safely dissipate enough power to perform its function. Germanium transistors have been operated at more than 100 w dissipation per cm². Silicon permits higher power density and/or higher operating temperature.

Capacitances must be minimized to overcome high-frequency limitation. Also, it is necessary to design a low-capacitance transistor structure for heat flow out of an electrode.

The high-power and high-frequency transistor both share a common requirement for high gain, which in most cases also requires low base resistance. The thin base width in itself tends to raise base resistance, but this can ordinarily be controlled by changing other dimensions.

The maximum useful frequency of a transistor is given roughly by

$$f_o = \sqrt{\frac{f_\alpha}{25 r_b C_c}}$$

which demonstrates the need for minimizing r_bC_c as well as maximizing f_α.

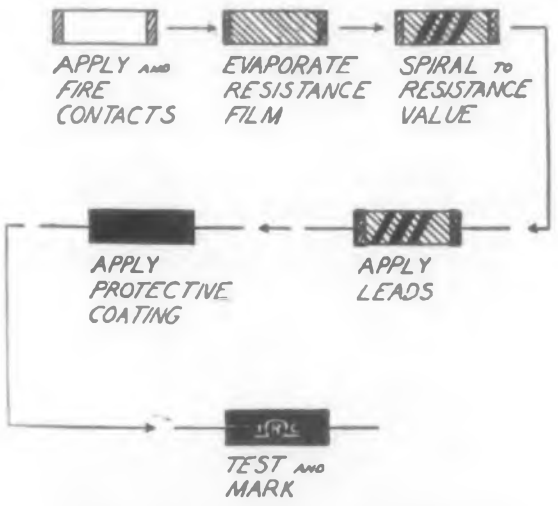
The C_c includes collector junction depletion larger capacitance which increases with collector area. This implies that the high-frequency high-power transistor should be designed for maximum power density. The collector capacitance also includes a diffusion capacitance term which is proportional to current and base width, but independent of area. Specifically, a silicon n-p-n alloy transistor whose base width is one mil, base resistivity 1 amp, will have a diffusion capacitance of about 1500 μμf at 1 v on the collector and 1 amp collector current. In addition to making W small this can be minimized by grading the base resistivity toward the collector junction. Fortunately, this also helps increase the maximum applicable collector voltage as well as improving alpha cut-off frequency. *Adapted from "High Power Silicon Transistors," John S. Saby, General Electric Co.*

Metal Film Resistor Developments

The following brief report covers recent developments in metal film power resistors, precision high-temperature metal film resistors, and pyrolytic alloy high-temperature resistors. All of these developments are reported by the International Resistance Company, Philadelphia, Pa. For a discussion of a thermally-fused metal-to-ceramic resistor see ELECTRONIC DESIGN, Feb. 1, 1956.

Metal Film Power Resistors

Resistors of this type have been produced that meet all the requirements of specification MIL-R-11804-A. The manufacturing process is described in the flow diagram. The resistance films themselves



Steps in preparing conventional metal film power resistors.

are stable at even much higher ratings. These units are capable of being produced in resistance values as low as 50 ohms and as high as 1 megohm with tolerances of ±2 per cent, temperature coefficient of resistance less than 100 ppm/deg C for the 1-, 2-, and 4-watt units and less than 250 ppm/deg C for the higher wattage ratings. Hot spot temperatures are less than 225 C at the rated wattages, and the units appear to be quite stable at high relative humidities.

Precision and High-Temperature Metal Film Resistors

The summary-type report describes performance of precision film resistors which operate successfully at 250 C. A metal film resistor can be made to do the job of precision wire-bound resistors. Furthermore, it can perform at high temperatures.

Pyrolytic Alloy High-Temperature Resistors

In conventional types of film resistors, the resistance is controlled basically by the film thickness. The resistivity of the carbon is essentially constant. High range films become too thin to be reliable. In the approach reported on here, the carbon-alloying process, controls resistivity while maintaining thick films. Such films have excellent characteristics at elevated temperatures, moisture, abrasion, and other environmental conditions.

Resistance to abrasion is excellent. The alloyed film material is combined with the substrate in the pyrolytic reaction so as to become an integral part of the substrate itself.

In pilot plant operations resistance ranges between 10 ohms and 100 megohms have been produced. Units of 100,000 megohms resistance have been made.

After 1000 hours of storage at 275 C, the average change of one-megohm resistors was less than 1 per cent. This was without overcoat protection; therefore resistance to oxidation is good. Load life tests at high temperatures bear this out.

		10K Avg % Change	100K Avg % Change
1 @ wattage		0.1	0.1
Short Time Overload		0.01	0.02
Temperature Cycle		0.3	0.4
Temperature Exposure 200 C.		0.07	0.03
Load Life 200 C.		0.1	0.1
Temperature Exposure 250 C.		0.1	0.1
Load Life 250 C.		0.2	0.2
Moisture Load 112 hr.		0.02	0.01
Temperature Coefficient (ppm/deg C, referred to 25 C.)	-70 C	71	66
	125 C	44	45
	250 C	45	56

Note. Seven resistors tested in each group.

Circuit of test set for direct reading of B and Ico.

Overloads do not damage the resistors. For example, a two-watt unit dissipating 5 w changed resistance less than 1.5 per cent after 1000 hours.

The paper also covers moisture cycle test data, low temperature tests, etc. Graphs cover these tests. The authors feel there will be a great demand for these resistors as volume production approaches.

New Glasses for Components

Several properties of new glass systems are presented in the accompanying table. These properties were chosen to give a basis for selection of glasses for various dielectric applications.

These glasses possess unique qualities in that:

1. Dielectric constants as high as 30 can be obtained and any of the systems is capable of giving values well in excess of conventional glasses.

2. Dielectric constant values can be varied almost continuously by composition control and, at most values, can be maintained constant while compositional adjustments can be made to give more desirable working properties.

3. Dissipation factor values for most of the glasses are below 0.005 at 1 mc as compared to Mylar with a value of 0.016.

4. Exceptionally high electrical resistivities at elevated temperatures were observed in some systems.

5. Coefficients of linear expansion range from 70 x 10^{-7}/C to 110 x 10^{-7}/C; a range of values which includes many of the metals commonly used in glass-to-metal seals.

Several types of initial evaluation tests were performed and indicate that glasses from these systems may find application in one or more of the following applications:

1. Low capacitance general-purpose capacitors (gimmick types).
2. Miniature capacitors.
3. High-temperature capacitors.
4. High-temperature insulators.
5. Glass-to-metal seals or terminals.
6. Feed-through condensers.
7. Sintered glass shapes.

These glasses have been prepared in laboratory batches and can be made available, in small quantities, for evaluation. Inquiries will be welcomed from anyone interested in the above or any other applications. *Taken from the paper "New Glasses and Electrical Component Applications," W. E. Hauth and A. L. Pugh, Jr., International Resistance Co., Philadelphia, Pa.*

System	K	Dissipation Factor	Dielectric Strength	Resistivity ohm-cm		Coeff. of Expan. $\alpha \times 10^7$ per °C	Sealing Properties
				100 C	300 C		
I. Bi-Cd-Si							
H1D	30	0.006	205	1 X 10^{13}	4 X 10^7	108	Dumet
H110	15	0.003	320			88	146
H 5B	17.3	0.004	270	8 X 10^{14}	1 X 10^{10}	85	146
II. Bi-Cd-B							
H 149	31	0.002	200			112	
H 153	23	0.004	270	4 X 10^{14}	1 X 10^9	89	Dumet
III. K-Si-Ti							
A 354	8.5	0.003	595	6 X 10^9	1 X 10^6	102	
A 359	12	0.002	545			110	
A 399	11	0.003	470			94	
IV. Na-Ca-Si-Ti							
E-48	15	0.002	425	1 X 10^{10}	6 X 10^6	96	Dumet
V. Pb-Ge							
G-323	19	0.002	300	5 X 10^{14}	2 X 10^9	78	146
G-327	9.3	0.002	320	1 X 10^{15}	5 X 10^{11}	70	
VI. Commercial*							
Na-Ca-Si (Corning 0800)	7.2	0.006	240	3 X 10^9	4 X 10^5	92	
Pyrex 7740	4.6	0.004	535	6 X 10^{11}	2 X 10^7	32.5	
High Lead (Corning 8870)	9.5	0.009				91	

*All Data, excepting dielectric strength, catalog values

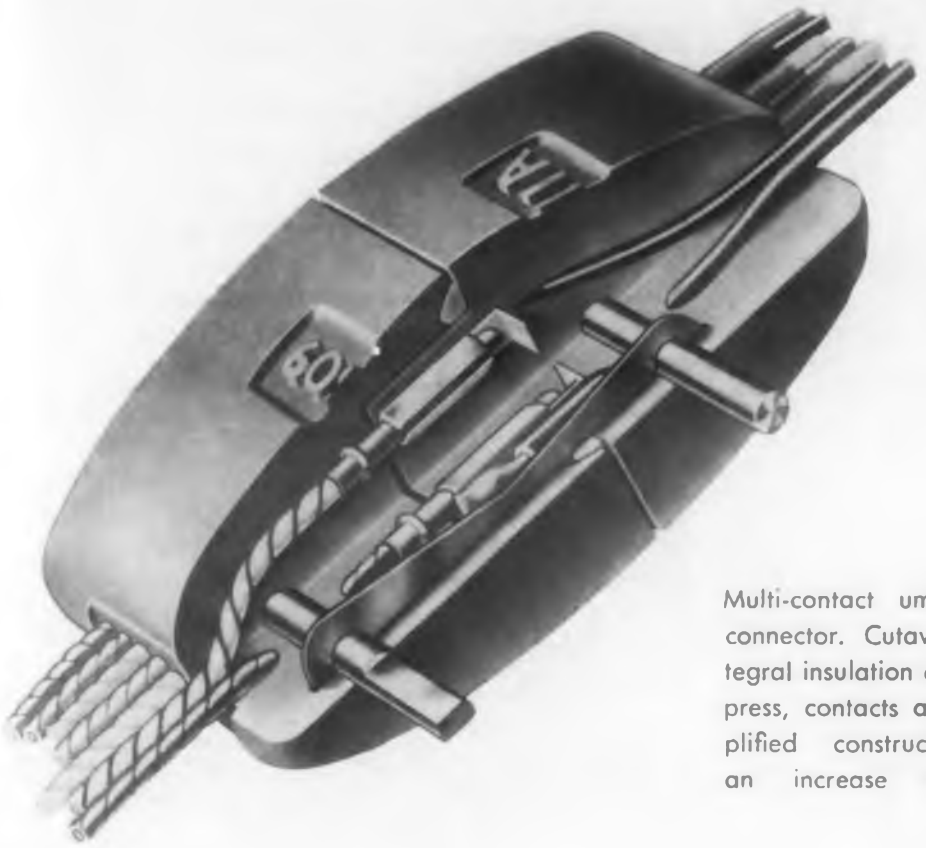
Glass properties of new glass systems suitable for electronic applications

Integral Mold Connectors

CONTACTS, leads, and even special inserts such as resistors, capacitors or chokes are molded as an entire connector assembly with a new single-shot injection process. With proper choice of insulation material a homogenous lead-insulation-to-connector bond is achieved.

These connectors, manufactured by Alden Products Co., 117 North Main St., Brockton, Mass., provide a good seal against flashover, dust or moisture, and, since the lead wires are integrally molded in the plastic insulating body, excellent strain relief for the leads and contacts. Punch press contacts are used instead of machine-screws, together with a patented crimping and soldering process. The connector may be sealed closed by means of a simple "O" ring. With this simplified construction additional reliability is obtained making these connectors sutable for applications such as the missile connector in the cutaway drawing.

Unit molded cable for high-voltage use. Note circuit resistors incorporated into body of insulation.



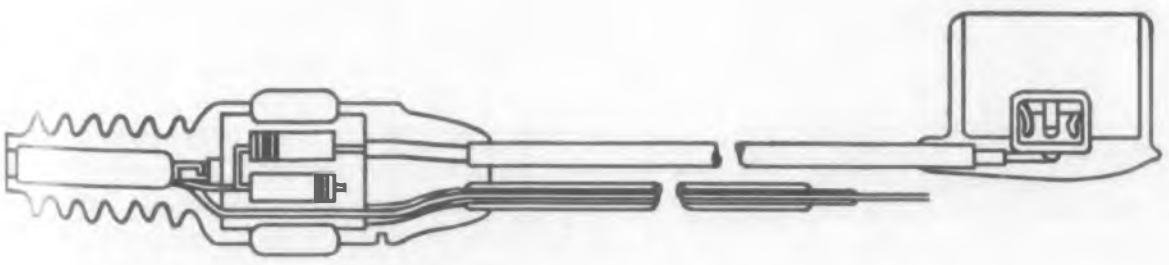
Multi-contact umbilical missile connector. Cutaway shows integral insulation of leads, punch press, contacts and body. Simplified construction provides an increase in reliability.

A variety of insulating materials lend themselves to the company's injection molding techniques. Polyethylene is good for high voltage applications; for other reasons it may be desirable to use nylon or polyvinyl chloride in special applications. Where the connector insulation is the same as or compatible with the wire insulation an integral bond is produced.

The integral molded insulation technique has been used to furnish high voltage tube cap connectors, and to construct unit molded cables as shown in the line drawing at the side for mobile communications, facsimile, and other commercial and military applications.

This product may be seen at Booth No. 1614-1616 at the New York IRE Show.

For more information about these integral molding insulation techniques for making connectors, fill in the Reader's Service Card and circle 47.



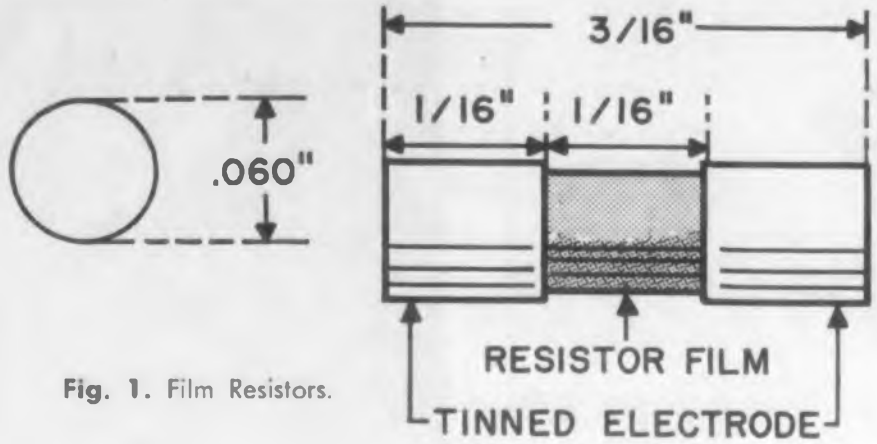


Fig. 1. Film Resistors.

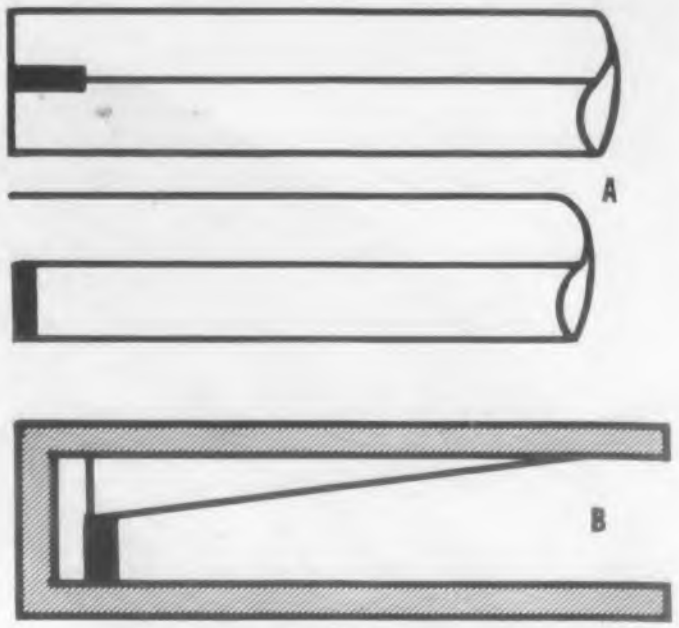


Fig. 3. Film resistor terminations. a. A coaxial termination. b. A waveguide termination.

Microwave Film Resistors

Bernard Rosen and Robert Saul

Polarad Electronics Corp.

Long Island City, N. Y.

A NEED has long existed for a resistance element with properties alike both at dc and at microwave frequencies. This is especially important in the design of broad-band microwave components, such as cutoff attenuators, series isolating sections, directional couplers and attenuators. The film resistors described here offer a partial solution, at least, to this problem.

Requirements

The general electrical and mechanical properties required of such a resistor are:

- Ability to withstand a maximum voltage standing-wave ratio over the required frequency range. This must include the resistor mount which is also frequency sensitive.
- Minimum possible variation of resistance from one resistor to another. Yet, the resistor must be capable of being made with standard manufacturing methods for ease of construction and reproducibility.
- High power handling capabilities. Since the resistors could be used in some type of pi or T network attenuator, the initial resistor in the circuit must be capable of handling a reasonable amount of power without burn out.
- The physical shape and size of the resistor must be such as to simplify the mounting problem in any type of transmission structure. The size must be considerably smaller than a wavelength at the highest frequency in order not to introduce appreciable reflection.

A new film-type resistor that meets the requirements listed has been developed. It is fabricated with tinned edges to allow for direct soldering into a circuit, and is small enough to be in effect a lumped constant at microwave frequencies. Because of its small cylindrical shape it may be used in shunt or series depending upon the required application.

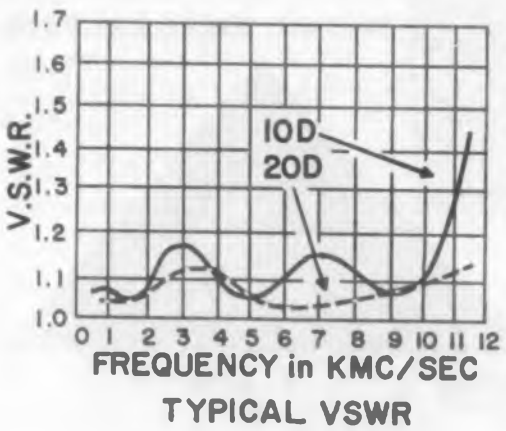
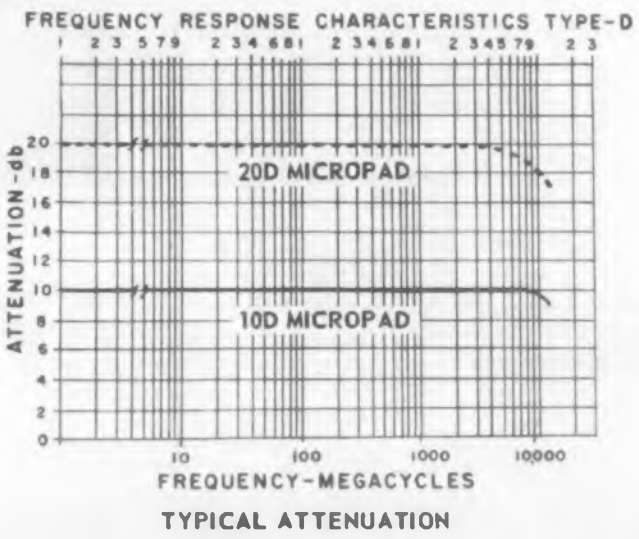


Fig. 2. Performance curves for a Pi-type pod, using a film resistor.



Construction

Microwave film resistors are formed on pyrex glass rods. Glass is used as the base material because of its stable properties (chemically inert, rigid, low thermal expansion) and for its ability to be metalized. Special drawn glass rods are used to insure a smooth surface of uniform diameter. The glass rods are cleaned thoroughly to remove all dirt and oil and then stored in distilled water until used.

The resistance coat is applied to the rods by a semi-automatic process using a metal-organic oil compound. Resistance value is controlled by the specification of the metal-oil compound. For this reason, it is not necessary to slot or trim the resulting film to achieve a desired value of resistance. The coating is carefully controlled to insure a thin, uniform 0.0015 in. coat on the rod. The coating is such that the current distribution depth will be essentially the same at dc and X Band. Because the skin depth at 10,000 mc is more than ten times the film thickness, a dc measurement will be a good measure of the film resistor's attenuation at the highest frequency of use.

The coated rod is finally baked at a temperature just below the melting point of the glass to burn off the organic oils and to bond the resistive film to the glass. The metalized rod is then coated with bands of platinum which space the resistor along the glass rod and then rebaked at high temperature. The platinum rings are then coated with solder, and a silicone varnish film is painted over the resistance film. The long rod is then cut up into individual resistance segments as indicated by the platinum bands. The resultant resistor is shown in Fig. 1. The resistance film and tinned ends, intimately bonded to the glass, are extremely stable.

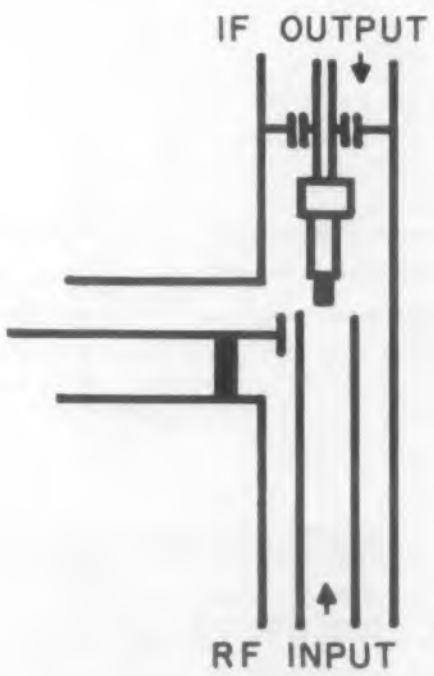


Fig. 4. Local oscillator injection padding with film resistor.

Characteristics

The overall length and circumference of the resistor is made small compared to the highest operating wavelength. The length of the resistive film (0.063 in.) at 10,000 mc is approximately one twentieth of a wavelength. Because of the film resistor's small diameter, short length, and microscopically thin resistive film, the resistor can be considered as a lumped element over its entire frequency range. At the upper-frequency end of the band, care must be taken in the physical mounting of the resistors. The resistor can be soldered to the microwave elements directly without any discontinuities.

The maximum temperature rise that the resistor can withstand will determine its power handling ability. Although electrically symmetrical, the part of the resistor closest to the power source will absorb the most power; and, consequently, the temperature will not be constant along its axis. Therefore, the design of the resistor and the electrical circuit will determine the maximum power that an attenuator can dissipate. Film resistors available commercially, such as the Type R, can dissipate 1/4 watt of average CW power. This is considered adequate for most applications where these resistors can be used.

Applications

A pi type pad, using a film resistor, is shown in Fig. 2a. Typical standing-wave ratio and attenuation characteristics are shown in Fig. 2b and 2c, respectively. Type R resistors can be used in waveguides as well as coaxial lines.

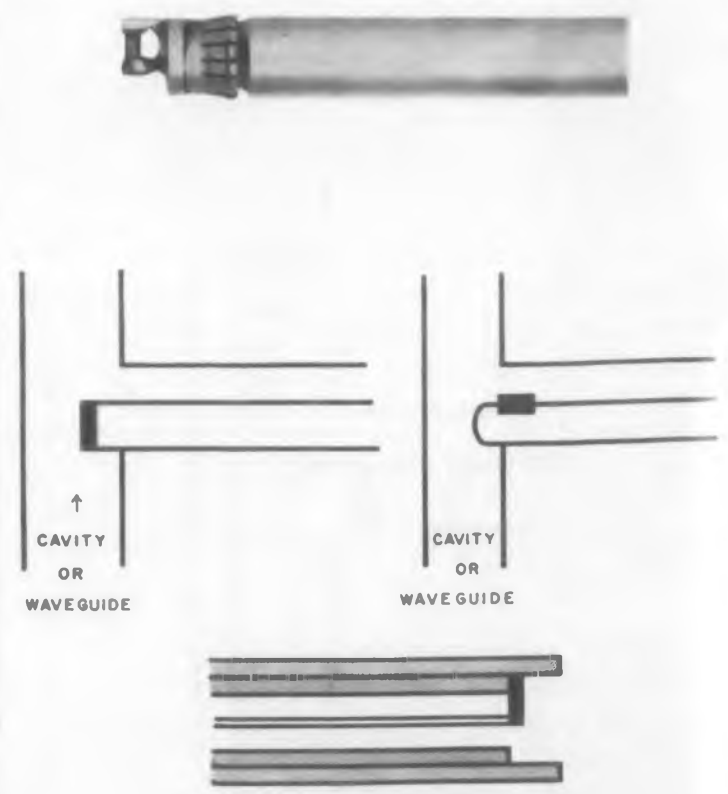


Fig. 5. Film resistors in pickup loops.

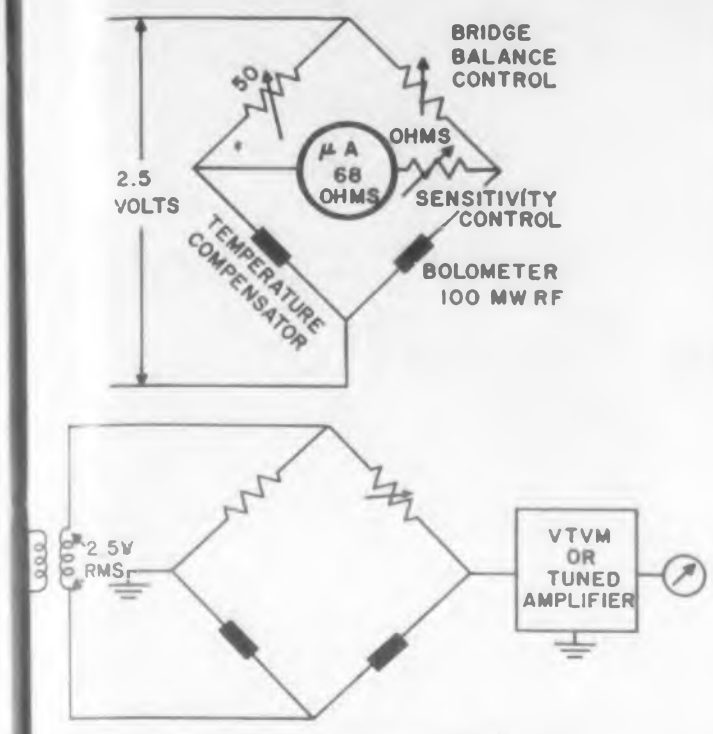


Fig. 6. Power measuring bridge circuits using film resistors.

Film resistors can be used for terminations in coaxial circuits as shown in Fig. 3a—either in series, as part of the inner conductor, or in shunt, across the coaxial line in a symmetrical layout to avoid the introduction of excessive reactance. The frequency insensitivity of these resistors allows low-frequency measurements to predict behavior at high frequencies. Good results as terminations have also been obtained when used with ridged waveguide, Fig. 3b. Values of vswr of less than 6 db have been obtained in frequency ranges up to K band.

An oscillator usually requires a degree of isolation from the device into which it works. If a film resistor is used in the coupling loop, it becomes an efficient means of coupling power with low vswr and with a predictable amount of decoupling. Illustrated in Fig. 4 is the use of a film resistor to isolate the local oscillator from a mixer and signal input line. Illustrated in Fig. 5 are typical uses of a film resistor in the coupling loop for good coupling from such a device as a signal generator.

Type R resistors can be used in power measuring bridges for monitoring power, Fig. 6. They have a lower power sensitivity than thermistors or hot wire barretters; consequently, they can be used for measuring power without the use of pads or attenuators. The circuit at *a* will measure 100 mw rf for full scale deflection. For measuring lower powers, the microammeter should be replaced by a galvanometer, magnetic amplifier, or a d-c vacuum-tube millivoltmeter as at *b*. A direct reading a-c bridge can be used for measuring power levels from 10 to 100 mw full scale. Any audio frequency from 1000 to 10,000 cps can be used for this application.

Switching Transistor

A POSSIBLE 1000 w of power can be switched with a single *2N174* transistor when used in the circuit of Fig. 1. The necessary input power for this switching operation is 1 w, giving the transistor a maximum possible power gain of 30 db.

The performance characteristics of the *2N174* transistor manufactured by the Delco Radio Division of General Motors Corp., Kokomo, Ind., include a high collector breakdown voltage, high maximum collector current and a low input impedance. It is an alloy junction PNP power transistor designed for general use with a 28 v power supply, or with a 12 v supply in applications where high voltage transients are encountered.

The transistor can be used in a switching circuit, in d-c power conversion, or as an audio amplifier. The large signal current amplification is relatively constant for collector currents up to 7 amp. The distortion is low, even in the common emitter configuration. A push-pull (matched pair) AB_1 audio amplifier can deliver 80 w of audio power output with 6 per cent total harmonic distortion.

A major application of the transistor is in dc-dc power converters, such as the one shown in Fig. 2. The low saturation voltage of the *2N174* reduces the internal power dissipation of the transistor in this application to an almost insignificant figure. For this reason very little self-heating is ap-

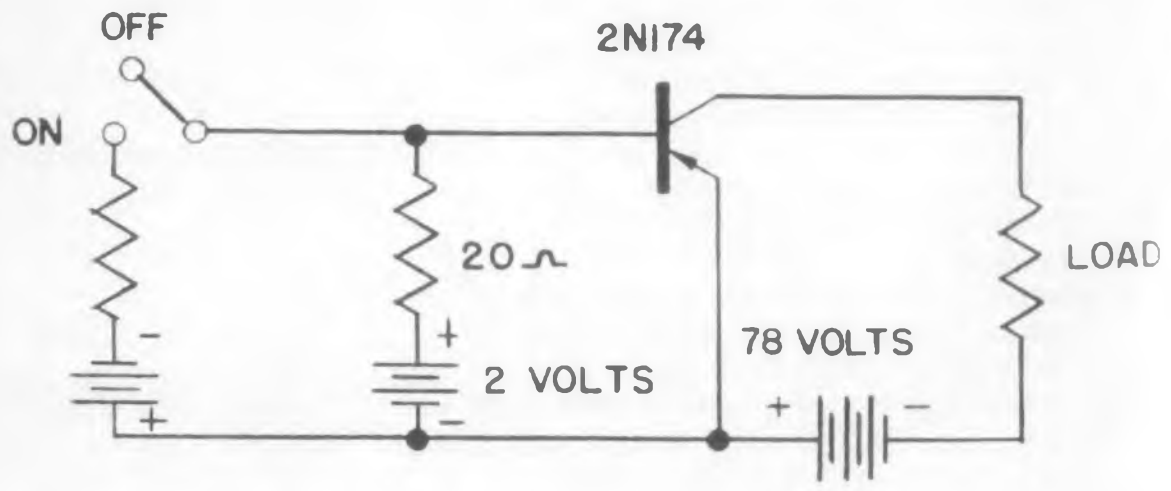


Fig. 1. Kilowatt switching circuit for *2N174* transistor. Input control power is 1 w, current in "on" position is 13 amp, and dissipation in "on" position is 8 w. Switching time is 60 μsecs.

parent in the transistor, permitting a small heat sink and an overall economy in size.

Maximum ratings are a collector voltage of 80 v (with emitter open), an emitter reverse voltage of 60 v and a collector current of 12 amp. Collector dissipation with 30 C mounting base temperature is 55 w. Junction and storage temperature is 95 C. The *2N174* is cooled by conduction and should be connected to a heat sink, such as an aluminum chassis. The transistor can be supplied in either single units or in matched pairs for dc-ac power conversion such as shown in the circuit of Fig. 2.

For further data about this product, fill out the Reader's Service Card and circle **52**. *See this product at the IRE Show, Booth 1520.*

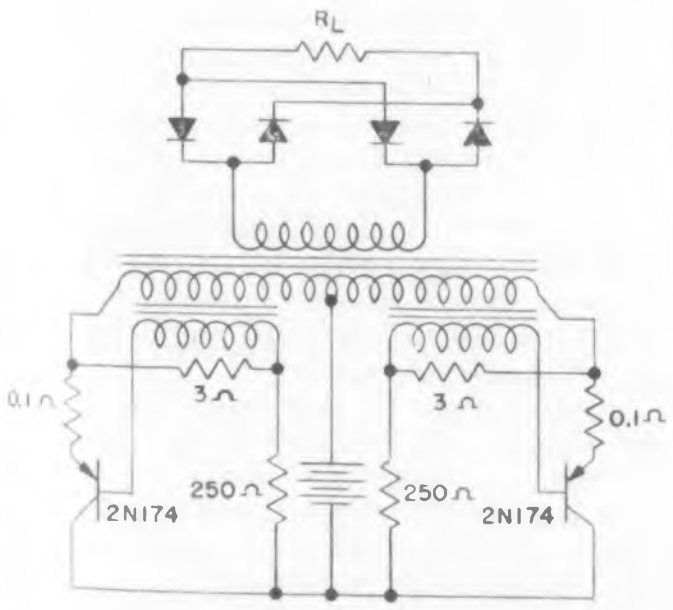


Fig. 2. D-c to d-c converter for conversion of 12 or 28 v to a higher d-c voltage (200 v) using the *2N174* transistor.

Coaxial Switching Connector

A BALL locking mechanism permits mating of this coaxial connector with a minimum of motion. The unusual method of connecting also makes possible use of the connector as a single-pole-double-throw switch. This feature is particularly useful in r-f and video applications that require external switching.

Known as the TRU-862, the combination coaxial connector and switch, is manufactured by Tru-Connector Corp., 416 Union Street, Lynn, Mass. Switching is accomplished by mating the two connectors. When the connector is unmated, there is a direct electrical connection between the external terminal and the coaxial center conductor. This connection is through a triangular spring which makes contact with an insulated circular conductor.

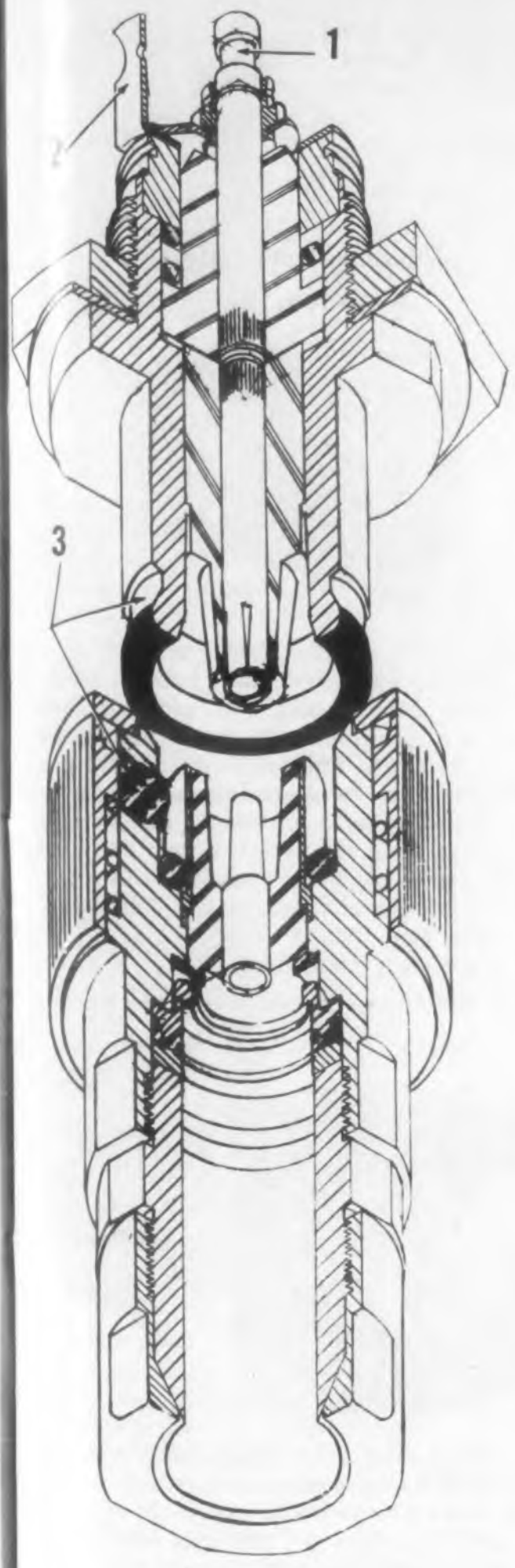
In mating the female connector with the male quick-disconnect the insulator is forced toward the coaxial terminal a distance of .060 in. This causes the triangular contact spring to separate from the circular conductor. The coaxial connector is now directly connected to the male coupling.

The insulator is spring-loaded and slides freely within the connector body. Special flange construction limits the travel of the insulation to approximately 0.060 in. thereby prohibiting it from being pushed out of the connector.

Overall size and electrical features of the TRU-862 compare with "N" and "C" type connectors. The connector is made of brass with teflon insulators and beryllium copper contacts. It is a bulkhead receptacle and mounts from the front of the panel through a 3/4 in. hole.

For more data on this switching connector fill out the Reader's Service card and circle No. 55.

See this product at Booth 3949, IRE Show.



Coaxial switching connector: *1.* center conductor *2.* External switching terminal *3.* ball locking mechanism

New Products |

Products marked with a triangle are those being exhibited for the first time at the Radio Engineering Show, and include the company's booth number.

△ Crystal Ovens

Subminiature

The HC-18 series has been designed for the military CR types utilizing the subminiature BHC-18/U holder. These units will conform to the military warm-up requirement of 3 minutes. The 10 and 15 crystal oven will stabilize within ±2 C over an ambient of —55 C to below reference temperature.

This series is available in units capable of housing a single crystal, 10 crystals and 15 crystals. The operating voltage for the 10 and 15 crystals is 6 to 115 v ac or dc. The single unit oven is available from 6 to 24 v ac or dc.

Bulova Watch Co., Inc., Dept. ED, Electronics Div., 40-06 62nd St., Woodside 77, N.Y.
Radio Engineering Show, Booth 3930.

CIRCLE 57 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Compact VT Voltmeter

10 Megohms Input

Although it is a vacuum tube voltmeter, this instrument requires no more panel area than any ordinary 4-in. meter. Its housing extends only 3 in. behind the panel. This compactness is achieved by use of latest miniaturization techniques. The meter operates from 115 v 60 or 400 cps; it contains its own power supply and amplifier. Input impedance is 10 megohms. Range is 0.5 v zero center to 300 v full scale. Either zero center or zero left scales are available; and there is a ruggedized military version. The meter can be zeroed while connected.

Trio Laboratories, Inc., Dept. ED, Seaford, N.Y.
Radio Engineering Show, Booth M6.

CIRCLE 59 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Vibration Testing Machine

Range 10 to 55 cps

Developed for vibration testing of small items up to 5 lbs maximum, the Model 14-28 weighs 30 lbs. It has a variable speed drive mechanism and 1/15 hp split phase induction motor housed in a cast aluminum base. Frequency adjustment is provided from the front of the machine and is continuously variable while the machine is running from 10 to 55 cps. Amplitude setting is from 0 to 0.040 in., with double amplitude maximum 0.080 in.

Ahrendt Instrument Co., Dept. ED, 4910 Calvert Rd., College Park, Md.
Radio Engineering Show, Booth 3049.

CIRCLE 61 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Coax Connectors

For Printed Circuits

These subminiature coaxial connectors come in two types, bayonet lock and push-on for multiple unit application. Both are made in straight and right angle for cable attachment or modular unit connections. They are available in three types of insulation, Kel-F, nylon and Teflon.

Automatic Metal Products Corp., Dept. ED, 315 Berry St., Brooklyn 11, N.Y.
Radio Engineering Show, Booth 4426.

CIRCLE 58 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Traveling Wave Tubes

Have Long Life

These traveling wave tubes have frequency ranges in the 2000 mc and 4000 mc bands, and a life of 10,000 hours or more. The type N1001 is a power tube rated at 16 w. N 1002 has a noise factor of 10 db and a gain of 25 db while N1013 has a 35 db gain and 200 mw output.

Marconi Instruments, Dept. ED, 44 New St., New York, N.Y.
Radio Engineering Show, Booth 3315-3317.

CIRCLE 60 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Rotary Switch

Hermetically Sealed

Encased in metal, the Model H10-7 is sealed with a flexible silastic compound and has a leak rate of under one micron per cu ft per hr. This rotary switch can be wired externally from spst to dpdt, four circuit. Designed for aircraft use, its ambient temperature range is —100 to +250 F.

Electro Snap Switch & Mfg. Co., Dept. ED, 4213 West Lake St., Chicago 24, Ill.
Radio Engineering Show, Booth 2225.

CIRCLE 62 ON READER-SERVICE CARD FOR MORE INFORMATION

△ **Decimal Converter**
Binary Coded

This binary-coded decimal/analog/digital converter uses the 1, 2, 4, 8 pattern, and presents its output in parallel form on 12 terminals. Simultaneous presentation of the complement of the output is a standard feature. Accuracy is 0.1 per cent. Running torque is rated at less than 0.2 oz-in., moment of inertia at 31.4 gm/cm², and resolution up to 10,000. Life is rated at 3 x 10^6 revolutions at the recommended maximum operating speed of 200 rpm. The converter is mounted in a standard size No. 23 BuOrd synchro mounting arrangement, and is available in sizes weighing less than 5.5 oz.

Norden-Ketay Corp., Dept. ED, Commerce Rd., Stamford, Conn.

Radio Engineering Show, Booth 2401-2403.

CIRCLE 63 ON READER-SERVICE CARD FOR MORE INFORMATION

△ **VTVM**
For Low Frequencies

The MV-02B a-c VTVM has a frequency range of 2 cps to 250 kc and a full scale voltage range of 3 mv to 1 kv. The instrument is equipped with a galvanometer-attenuation switch which makes it possible to obtain fast needle response on all measurements above 20 cps while the necessary slow response is being maintained between 2 cps and 20 cps. The plate current supply is electronically regulated. There are individual calibration controls for all 12 ranges of the instrument.

Millivac Instrument Corp., Dept. ED, P.O. Box 997, Schenectady, N.Y.

Radio Engineering Show, Booth 3204-3206.

CIRCLE 64 ON READER-SERVICE CARD FOR MORE INFORMATION

△ RF Screen Room
Low Cost Portable

A special screen with sufficient attenuation, 100 db or more from 200 kc to 1000 mc makes it an ideal screen room for a wide range of commercial and military applications. The screen is woven of steel wire, then dipped in a special alloy. The Champion line is available in all popular screen room sizes, and special rooms can be constructed to meet any custom specifications. The door has strong contact fingers and single handle with 3-point pressure contact. Floor construction is extra strong with cross beams every 12 inches. Flooring is 3/4 in. plywood. Interchangeable panels are held in contact with each other with locks which supply continuous pressure of 1200 lbs. The screen room's easy to assemble and knock down for convenient relocation.

Erik A. Lindgren & Assoc Inc., Dept. ED, 4515 N. Ravenwood Ave., Chicago 40, Ill.

Radio Engineering Show, Booth 1924.

CIRCLE 66 ON READER-SERVICE CARD

△ Cold Punch Laminate
Low Loss

This cold punching laminate has high insulation resistance, low dielectric loss at high frequencies, and low moisture absorption. The laminate, called Insurok XT-896, punches at average room temperatures. This XXXP laminate in copper clad form has a high bond strength and good blister resistance.

The Richardson Co., Dept. ED, Melrose Park, Ill.

Radio Engineering Show, Booth 1628.

CIRCLE 67 ON READER-SERVICE CARD

△ Insulating Material
High Tensile Strength

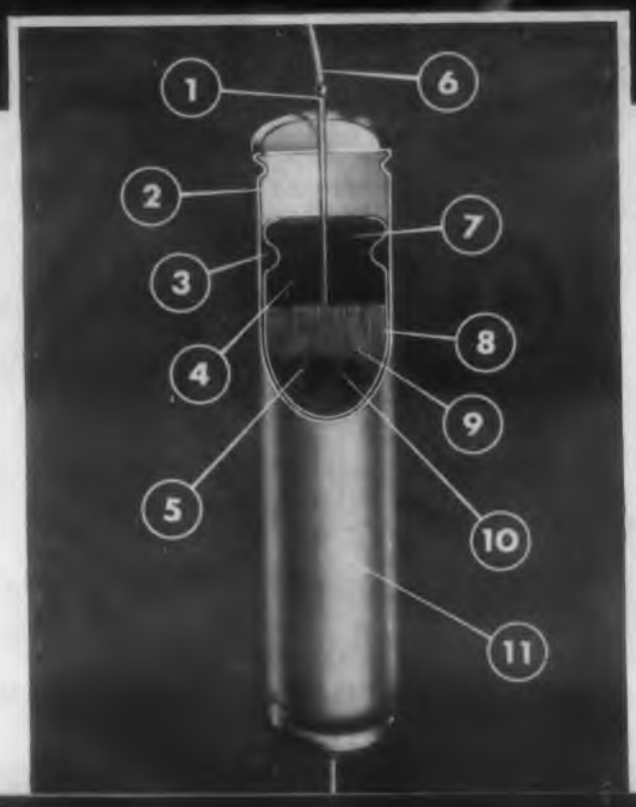
The tensile strength of phalene is 2800 to 6400 lbs/sq.in. It provides more heat resistance than standard polyethylene insulation. Hardness, by the Shore Hardness Test is 63 to 70. Dielectric strength in volts per mil is 500 to 700.

Phalo Plastics Corp., Dept. ED, 25-P Foster St., Worcester, Mass.

Radio Engineering Show, Booth 4704.

CIRCLE 68 ON READER-SERVICE CARD

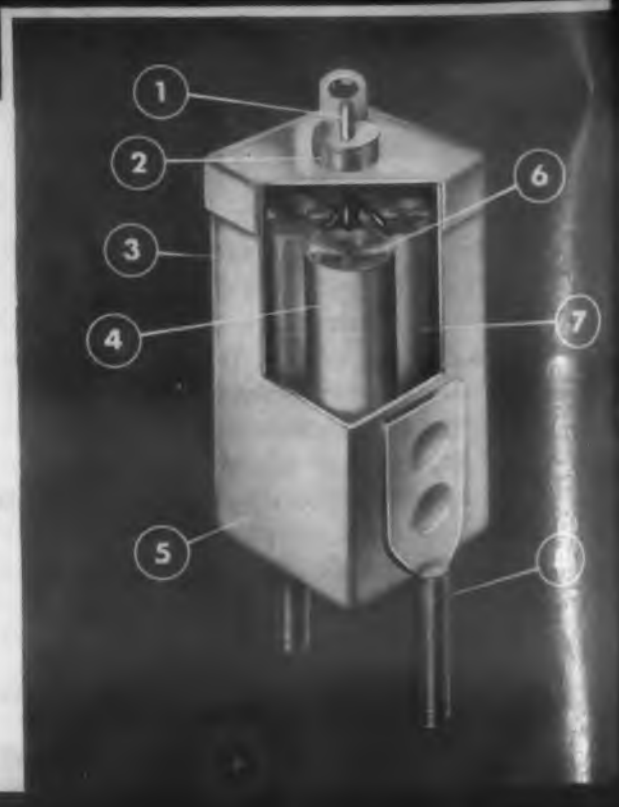
CIRCLE 69 ON READER-SERVICE CARD ➤



HIGH TEMPERATURE TANTALYTIC CAPACITOR — TUBULAR — features: 1 —Tantalum lead, 2 — Teflon* bushing, 3 — Mylar* insulating sleeving, 4 — Insulation, 5 — Paper and tantalum foil roll, 6 — Solderable nickel lead, 7 — Rubber bushing, 8 — Double metal case construction, 9 — Non-acid electrolyte, 10 — Plain and etched foil; 11 — Polar or non-polar construction.

HIGH TEMPERATURE TANTALYTIC CAPACITOR — RECTANGULAR — features: 1 — Tantalum stud, 2 — Silicone bushing, 3 — Polar or non-polar construction, 4 — Paper and tantalum foil rolls, 5 — Silver-plated metal case, 6 — Plain and etched foil, 7 — Non-acid electrolyte, 8 — Mounting stud (optional).

*DuPont Co. Trade Mark



△ Ag-Cd Oxide Contacts
For Long Wear

Silver-cadmium oxide top-lay contacts are available in clad strip widths of 1/16 to 4-1/2 in. and in base metal thickness from less than 0.010 to 0.250 in. or more. The silver-cadmium oxide metal on the contact section of top-lay varies from 0.015 in. thick by 1/8 in. wide, minimum, up to any practical maximum dimension. Silver-cadmium oxide can be combined with practically any rollable or malleable base metal in top-lay strip or contact form.

Metals & Controls Corp., Dept. ED, General Plate Div., Attleboro, Mass. *Radio Engineering Show, Booth 1226.*

CIRCLE 70 ON READER-SERVICE CARD

△ Silicon Rectifiers
For Miniaturized Circuitry

These low-power, glass packaged silicon rectifiers exhibit low forward voltage drop and low back leakage. They are adaptable to miniaturized circuitry and feature maximum a-c input voltages up to 275 v rms; maximum reverse d-c working voltages up to 375 v; maximum average rectified forward current up to 200 ma; maximum power dissipation at 25 C up 200 mw. Operating temperature range for all types is —75 C to +150 C. The maximum dimensions, rectifier glass body; length 0.265 in. diam, 0.105 in

Hughes Products, Div. Hughes Aircraft Co., Dept. ED, Semiconductor Div., International Airport Station Los Angeles 45, Calif.
Radio Engineering Show, Booth 2801-2805.

CIRCLE 71 ON READER-SERVICE CARD

Nylon Bonding Agent
Bonds Nylon to Metal

Bonding Agent R-323, an epoxy-based compound designed to bond Nylon to itself, to metal, or to other materials may be used with rubber

Carl H. Biggs Co., Dept. ED, 2255 Barry Ave., W. Los Angeles, Calif.

CIRCLE 72 ON READER-SERVICE CARD

◄ CIRCLE 69 ON READER-SERVICE CARD

25-Watt UHF Twin Tetrode

Useful To 1200 Mc

A new twin tetrode, Type 6907, is intended primarily for service in airborne and mobile communications. It will deliver power up to 1200 mc. The tube has a single cathode and screen, providing full output at unusually low drive. It has all-molybdenum leads for lower rf losses, and powdered glass base and anode support for maximum protection against mechanical and thermal shock. Heater connections may be either 6.3 or 12.6 v.

The tube will deliver up to 25 w in continuous operation when used as a Class C amplifier at 462 mc. It will deliver 20 w continuously in the 225-400 mc military bands, and in such use it does not require air cooling or special sockets. It is rated as an amplifier or frequency tripler up to 600 mc.

Amperex Electronic Corp., Dept. ED, 230 Duffy Avenue, Hicksville, Long Island, N.Y.

CIRCLE 74 ON READER-SERVICE CARD

Silicone Sponge Rubber

Flexible to −100 F

A silicone sponge rubber made of 50 durometer base stock is primarily of closed cell count and possesses the same general qualities as the base material. The new sponge, Style 9383, has extreme flexibility at low temperatures down to a minus 100 F, yet it has good heat resistance up to 500 F. Having good compression set characteristics, this silicone sponge is tough and strongly resists tearing and abrasions. Orange in color, Style 9383 sheds cold water well and resists adhesion to ice. Its aging and weathering qualities are excellent. This silicone sponge is available in sheets, round, odd and simple extruded cross sections.

The Garlock Packing Co., Dept. ED, 405 Main St., Palmyra, N.Y.

CIRCLE 75 ON READER-SERVICE CARD

◀ CIRCLE 73 ON READER-SERVICE CARD

△ Beam Power Tube

For 110 Degree Systems

The 5CZ5 is a high-perveance beam power tube of the 9-pin miniature type. It is designed for use as a vertical-deflection amplifier in TV receivers utilizing picture tubes having diagonal deflection angles of 110 deg and operating at voltages up to 18,000 v. The 4.7 v/0.6 amp heater has controlled warm-up time. The 5CZ5 has a maximum peak cathode current of 140 ma, and a maximum plate dissipation of 10 w.

Utilizing a T-6-1/2 miniature envelope, the 5CZ5 has an electrically isolated base-pin, and double base-pin connections for grid No. 1.

Radio Corp. of America, Dept. ED, Tube Div., Harrison, N.J.
Radio Engineering Show, Booth 1602, 1707.

CIRCLE 89 ON READER-SERVICE CARD

△ Servo Damper

Viscous Coupled Inertia Type

Designed to mount compactly without external support on either end of the Diehl FPE-25, 5 w servomotor, the Model CD-60 consists of a heavy cylindrical slug free to rotate inside a thin, low-inertia shell rigidly fastened to the servomotor shaft. Viscous silicone fluid between the inside slug and the shell provides the desired damping. All the necessary servo compensation is provided by the damper. Stabilizing dynamics are independent of line-frequency shift and each damper is adjusted to the specified value of time-constant.

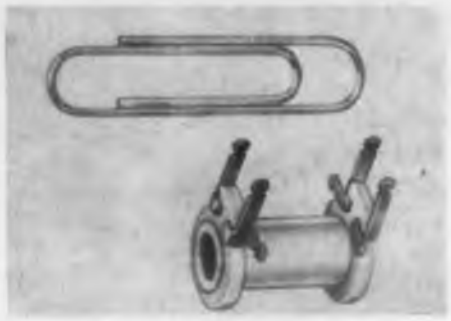
Feedback Controls, Inc., Dept. ED, 899 Main St., Waltham 54, Mass.
Radio Engineering Show, Booth 3013.

CIRCLE 90 ON READER-SERVICE CARD

CIRCLE 91 ON READER-SERVICE CARD ➤

△ Printed Circuit Coil Forms

In One Style, Two Lengths



These horizontally-mounted printed circuit coil forms are made with 1/4 in. o.d. internally-threaded ceramic tubing, impregnated with grade L5 silicone. They are slug tuned by a powdered iron core. Each form has two silicone fibreglass collars and four solder terminals attached to the collars. The forms come in two sizes; No. 2270 is 5/8 in. long overall and mounts on 0.5 in. x 0.2 in. mounting centers; No. 2271 is 13/16 in. long and mounts on 0.7 in. x 0.2 in. centers. The terminals for soldering are attached to the fibreglass collars and are so designed that coil leads can be attached to them separately from the printed circuitry, or the leads may be attached to the circuitry with the terminals.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.
Radio Engineering Show, Booth 2219.

CIRCLE 81 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Potentiometer

Precision Resistance

This 10-turn potentiometer measures 7/8 in. in diameter, and provides resistance values from 25 ohms to 125 k ohms at ±3 per cent tolerance. Its power rating is 2 w and it can accommodate 40 taps. Both mechanical and electrical rotation is 3600 deg. +5 −0 deg. The potentiometer's maximum starting torque is 0.6 oz./in. for bushing and 0.5 oz/in. for servo. Running torque is 0.5 oz/in. bushing and 0.4 oz/in. servo. Designed to operate over an ambient of −55 to 85C, this unit weighs 1 oz and has a voltage breakdown rating of 1000 v vms. Mechanical and electrical rotation of +1 and −0 deg. is available on request.

Spectrol Electronics Div., Carrier Corp., Dept. ED, 1704 So. Del Mar Ave., San Gabriel, Calif.
Radio Engineering Show, Booth 1726.

CIRCLE 82 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 83 ON READER-SERVICE CARD ➤

△ Switching Transistors

For High Currents

Three high speed germanium PNP computer transistors, the 2N-315, 2N-316 and 2N-317 are designed for high current switching applications.

The 2N-317 has, with a minimum of drive current, a typical switching speed of 0.3 microseconds at 400 ma of collector current. The series resistance of these transistors when conducting is 1/2 ohm; the nonconducting series resistance is 10 megohms.

General Transistor Corp., Dept. ED, 91-27 138th Pl., Jamaica, N. Y.

Radio Engineering Show, Booth 3828.

CIRCLE 84 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Multi-Switch

Modified Design

This switch can be manufactured economically in any multiple of stations from 1 to 37. A choice of functions are possible including interlock, nonlocking, all lock, interlock and nonlock combination, and an all lock and nonlock combination. This design offers a choice of mounting centers, center to center distance between buttons 5/8 in., and plungers designed to accept standard push-on buttons. Up to 4 stacks of stock switches can be mounted on a separate plate and operated by each button.

The flexible design makes it possible to connect together two or more rows of Multi-Switches and provide interlock action between all the buttons. A feature of the ganged assemblies is the lock-out bars which can be provided in switches of 1 to 37 stations so that only 1 station can be depressed at one time.

Switches can be provided with silver contacts or with welded cross bar Palladium contacts.

Switchcraft, Inc., Dept. ED, 1328 N. Halsted St., Chicago 22, Ill.

Radio Engineering Show, Booth 2228.

CIRCLE 85 ON READER-SERVICE CARD FOR MORE INFORMATION

◄ CIRCLE 83 ON READER-SERVICE CARD

△ 20 Kw Klystron
225-400 Mc

The 3KM50,000PA has a 20 kw cw power output in the range of 225 to 400 mc.

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

Radio Engineering Show, Booth 2410-2412.

CIRCLE 87 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Goniometer
Precision Angle Measurements

This unit has a machine-engraved, 4-1/2 in. diameter protractor which, by means of a vernier, can be read to one minute of arc. The accuracy of the graduation is ±15 sec. The angle head turns in a tapered steel bearing and a surveyor's transit. There is means to take up wear when required. The goniometer provides a means of mounting the instrument to be tested and it will accommodate six different diameters of locating boss in the range 0.750 up to 2.875 in. diam. All the standard size synchro and potentiometer mounting diameters fit without any alteration. Adaptors are available to accommodate nonstandard diameters. Shaft diameters from 0.078 up to 0.250 in. can be accommodated by means of collets. Shaft lengths up to 2 in. fit the fixture without alteration.

The goniometer is made of stainless steel and nonferrous materials. It is 8 x 10 x 9 in. and weighs 10 lbs. It is supplied in an instrument-type wood case, with collets to accommodate various diameters of shaft.

Electro-Mec Laboratory, Inc., Dept. ED, 47-51 33rd St., Long Island City 1, N.Y.

Radio Engineering Show, Booth 2713.

CIRCLE 88 ON READER-SERVICE CARD FOR MORE INFORMATION

Encapsulated Resistors

Microminiature, Wirewound

Measuring 3/32 in. dia x 5/16 in. long, this new resistor, designated HAOO, is available in the range 0.1 ohm to 25k ohms. Standard tolerance is ±1 per cent. Tolerances as low as 0.1 per cent are available on special order. Wattage rating is 1/10 w full load at 85 C, meeting the environmental conditions of MIL-R-93A. The HA 33 resistor shown in the picture for comparative purposes measures 3/8 in. dia x 1 in. long.

General Resistance, Inc., Dept. ED, 577 East 156 St., New York 55, N.Y.

CIRCLE 366 ON READER-SERVICE CARD FOR MORE INFORMATION

Transducer Limiter

For Automatic Operations

Stable repeatability to 0.000025 in. is one of the features of this limit controller. Any quantity measurable by differential transformer transducers, such as pressure, flow, acceleration, stress, size or weight can be controlled by the limit controller in highly accurate automatic operation.

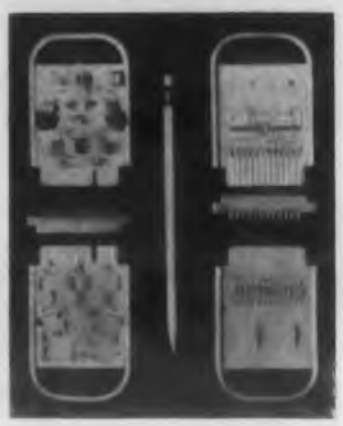
The limit controller is preset to any desired control point in the cycle of the standard transducer. Whenever input quantity equals or exceeds the preset limit a relay closes. When the output quantity falls short of the preset limit, the relay opens. Panel indicators, alarm devices or control devices are thus operated.

Operating time is approximately 0.05 seconds. Linearity is 0.1 per cent. The limit control is available in either portable or rack mounting models, both designated Model 561.

Daytronic Corp., Dept. ED, 216 S. Main St., Dayton 3, Ohio.

CIRCLE 367 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Computer Packages
Plug-In Type



This family of transistorized, digital computer units, designated 3C-PACS Series L, comes in plug-in packages and includes flip-flops, emitter-followers, pulse amplifiers, gating packages and others. Features are compact size, low power consumption, printed circuit wiring, complete transistorization and high reliability. Full compatibility between packages permits user to assemble digital systems merely by proper inter-package point-to-point wiring.

Computer Control Co., Inc., Dept. ED, 92 Broad St., Wellesley 57, Mass. *Radio Engineering Show, Booth 1322.*

CIRCLE 93 ON READER-SERVICE CARD

RF Preamplifiers
Have High Gain

The Model I preamplifier provides a gain of 35 db at band center and the Model 2 50 db, both with a maximum noise figure of 3.5 db. Frequency response is within 3 db over the band of 215-247 Mc. The unit occupies a volume of 1/3 cu ft and weights 3-1/2 pounds.

Radiation, Inc., Dept. ED, Melbourne, Fla.

CIRCLE 94 ON READER-SERVICE CARD

CIRCLE 15 ON READER-SERVICE CARD ➤

△ Nickel-Chromium Resistors

Fused to Steatite Tube

Utilizing a new alloy of the nickel-chromium family, thermally fused to the inner surface of a steatite tube, this new line of resistors is intended to replace the wire-wound type and to offer superior quality and stability. The Vamistor units are available in 1/2-w and 1-w ratings, from 1000 to 100,000 ohms, and with temperature coefficients of ±50 ppm. They meet or surpass MIL-R-93A, MIL-R-19074A and MIL-R-10509B. They are rated substantially non-inductive, and have a distributed capacitance of only 0.9 μμf. Noise level at 50 v d-c input is −200 db. Tolerance is ±1 per cent. Also available are variants with temperature coefficients of ±25 ppm and tolerances of ±5 per cent. Dimensions are 5/16 in. outside diameter by 3/4 in. long. The resistor is molded in epoxy resin.

Weston Electrical Instrument Corp., Dept. ED, Newark 12, N.J.

Radio Engineering Show, Booth 2907-2915.

CIRCLE 97 ON READER-SERVICE CARD

△ Terminal Blocks

Have Mylar Insulation

A mylar insulation strip on the back of these terminal blocks covers and seals in all counterbores having screw ends. The mylar used is one mil thick, plus 1-1/2 mils for cement, thus making the over-all thickness 2-1/2 mils. The dielectric strength is 5000 v.

Kulka Electric Mfg. Co., Inc., Dept. ED, Mt. Vernon, N.Y.

Radio Engineering Show, Booth 2901.

CIRCLE 98 ON READER-SERVICE CARD

◄ CIRCLE 15 ON READER-SERVICE CARD

△ Transistor Tester

Self-Contained Unit

Completely self-contained (although a scope may be plugged in if desired) this transistor tester measures grounded emitter current gain, collector saturation current, and input impedance. It embodies its own mercury cell power supply, with a rated battery life of about 1000 hours, and its own 1 kc oscillator. Printed circuitry has been used throughout to conserve weight, which is 3 lb.

Ranges and accuracies are: grounded emitter current gain, 0-200, ±3 per cent; input impedance, 0-10 k ohms, ±10 per cent; collector saturation current, 0-50 μamp, ±2 per cent. Emitter current is 0.5-10 ma.

Baird-Atomic, Inc., Dept. ED, 33 University Rd., Cambridge 38, Mass.
Radio Engineering Show, Booth 3219, 3221.

CIRCLE 103 ON READER-SERVICE CARD

△ Oscillograph Tubes

1-1/4 In. Diameter

This new series of 1-1/4 in. oscillograph tubes is intended for use in light, portable equipment, or in continuous monitoring service for larger installations. The IEP1 has a medium-persistence phosphor, the IEP2 has a long-persistence characteristic, and the IEP11 display is of short persistence. All have separate base-pin terminals for each deflecting electron to permit use of balanced deflection, all utilize electrostatic focus and deflection, all have a flat face, a minimum useful screen diameter of 1-16 in. a maximum overall length of 4-1/16 in., and weigh 2 oz.

Radio Corp. of Amer., Tube Div., Dept. ED, Harrison, N. J.
Radio Engineering Show, Booths 1602, 1707.

CIRCLE 104 ON READER-SERVICE CARD

CIRCLE 105 ON READER-SERVICE CARD ➤

Open Rack Cabinet

Prefab For Assembly

All-steel in construction, an open desk rack cabinet comes in black wrinkle finish as standard, gray wrinkle or gray hammertone to order. Cabinets are shipped in knockdown form. It will mount standard 19 in. panel chassis and panels for adapted uses in public address systems, table mountings of low or medium powered transmitters and other electronic instruments and assemblies.

Sturdy and rugged in construction, dimensions are 21 x 32 x 12 in. on the model DOR-28 and 28 x 19 in. panel space. It accommodates 28 in. panels. It is open air type, with no cover or back. Model DOR-21 is for 21 in. panel space. Larger open air telephone racks are also available with panel space up to 77 in.

California Chassis Co., Dept. ED, Lynwood, Calif.

CIRCLE 107 ON READER-SERVICE CARD

Self-Adhesive Printed Plates

Easily Hand Handled

Aluminum printed plates with pressure-sensitive adhesive on the back and which can be picked off the backing paper by hand for application are now available. A split along one edge is cut through to the backing paper forming a release tab. Formerly this type of identification material had the adhesive covered with cellophane film. To apply the plates, they had to be immersed in water to loosen the cellophane.

When applied, Pick-Off Permi-Cal becomes a semi-permanent identification piece; the adhesive is very aggressive.

Printing may be in one or two colors and pieces may be as large as 2-3/4 x 16 in. Permi-Cals are used as nameplates, instruction labels and for general identification purposes.

Topflight Corp., Permi-Cal Div., Dept. ED, York, Pa.

CIRCLE 108 ON READER-SERVICE CARD

CIRCLE 110 ON READER-SERVICE CARD ➤

Corrosion Coating in Colors

For Metal, Masonry or Wood

Profilm, a silicate modified coating having the appearance of paint, is applied by conventional spray equipment, yet dries to the touch on most applications in a few minutes. Profilm is designed for use where corrosive elements such as acids, alkalies, humidity, moisture, salt, etc., are a source of coating failure and excessive maintenance cost.

Profilm is available in colors, and also comes in black, clear, white and metallics, in both baking and air-dry grades. Profilm can be applied to virtually any coatable surface including metal (ferrous and nonferrous) masonry, wood, asbestos, etc. Because of its essentially inert composition, Profilm provides a uniform, continuous and low porosity film which lends resistance to a wide variety of chemical environments.

Allied Porcenell, Inc., Dept. ED, 851 S. Market St., Waukegan, Ill.

CIRCLE 111 ON READER-SERVICE CARD

△ FM Deviation Monitor

4 to 540 kc

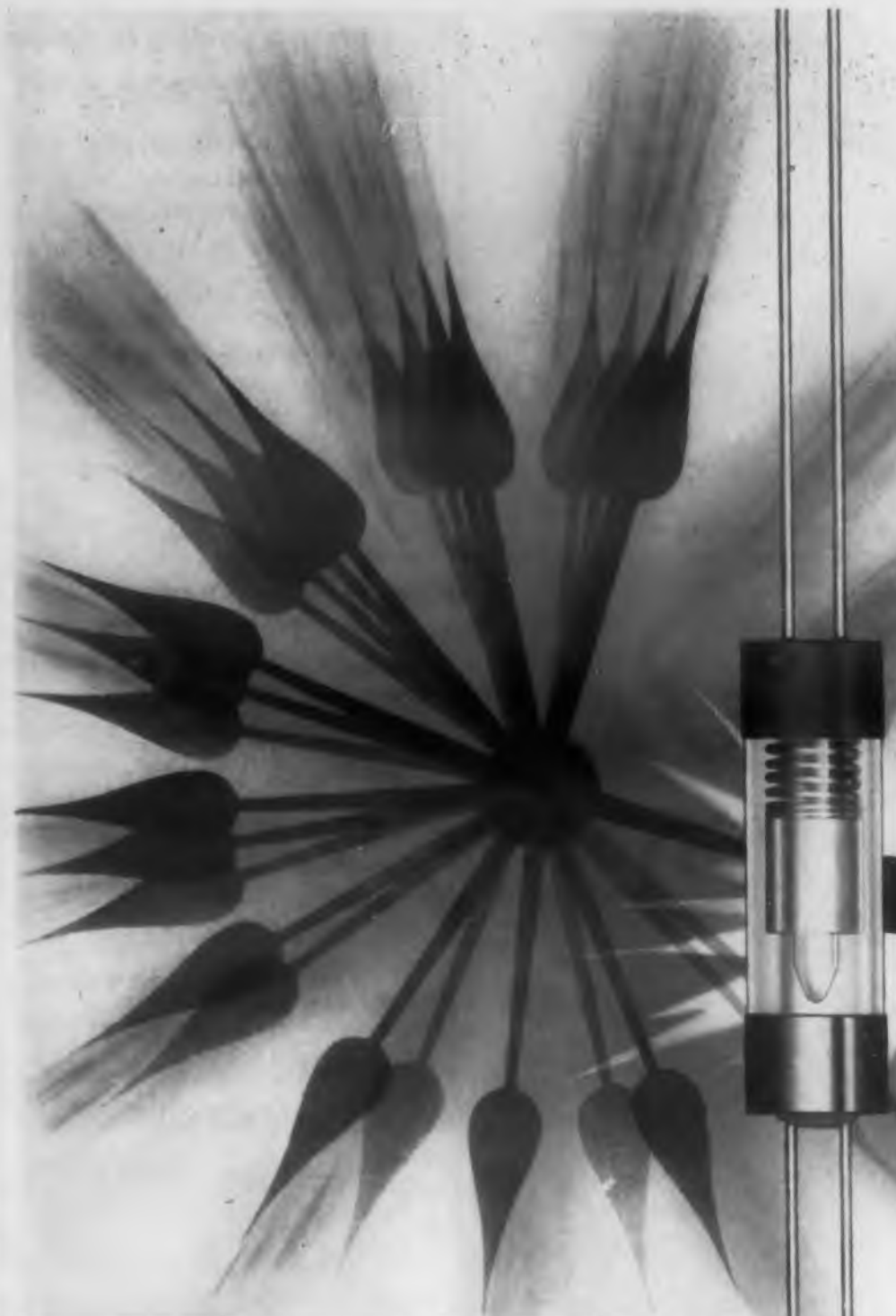
The Model 791C covers 50 cps to 35 kc at carrier frequencies from 4 to 540 Mc. Deviation ranges are 0 to 5, 25, 75 and 125 kc. The instrument uses the counter type discriminator and has an accuracy of 3 per cent. Harmonic distortion is less than 0.2 per cent. The instrument doubles as a fm receiver.

Marconi Instruments, Dept. ED, 44 New St., New York, N.Y.

Radio Engineering Show, Booth 3315-3317.

CIRCLE 112 ON READER-SERVICE CARD

◀ CIRCLE 110 ON READER-SERVICE CARD



Miniature Thermal Relays Hermetically Sealed in Glass

99.99% PLUS RELIABILITY

FIRING TIME... 0.1 SECOND

or any delay time specified

Miniaturized units are hermetically sealed by our EXCLUSIVE method of bonding metal headers to glass housing. Relay design is based upon the "fuse burnout" principle and permits wide latitude in systems design.

GUIDED MISSILES, ROCKETS SUPERSONIC AIRCRAFT

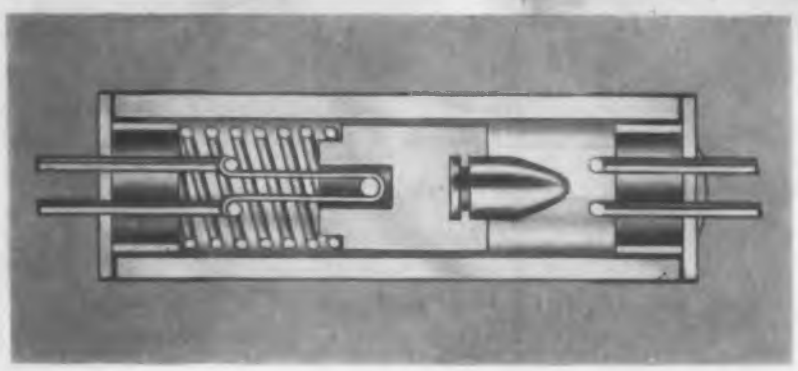
TYPICAL CHARACTERISTICS

TEMPERATURE: -100°F to +450°F
VIBRATION: 20-3000 CPS
SHOCK: 200 G's

Another example of the ONE and ONLY process of bonding metal to glass for better, more efficient hermetically sealed electronic components.

WHAT ARE YOUR REQUIREMENTS?

Write TODAY for samples and detailed specifications on how these Relays fit your specific needs.



EXACT SIZE

NETWORKS ELECTRONIC CORPORATION

14806 OXNARD STREET, VAN NUYS, CALIFORNIA

ORIGINAL DESIGNS FOR HIGHER RELIABILITY IN GLASS-HOUSED RESISTORS AND MINIATURE RELAYS FOR ALL PURPOSES

CIRCLE 114 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Bistable Time Delay Relay

20-30 Second Cycle

Thermally controlled by two separate heater circuits, this "memory relay" operates spdt snap-action switch contacts. Each heater transfers a movable arm from one contact to the other. The relay remains in either of the two contact positions until operated by the other heater circuit. Operating time is factory preset for either 20 or 30 sec on both transfers. The bimetal strips are matched, thus cancelling any effect of ambient temperature on relative deflection. The relays are temperature compensated between −55 C to +100 C. Standard voltage ratings are 6.3, 26.5 and 117 v; other values available on request. Each heater requires 2.7 w.

Curtiss-Wright Corp., Electronics Div., Dept. ED, Carlstadt, N.J.

Radio Engineering Show, Booth 1327.

CIRCLE 115 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Stainless Steel Grid Cups

In Any Design

Grid cups are made to order of many metals, including stainless steel, and with one or more apertures of precise size, shape and location as specified. Openings may be as small as 0.0001 in., and filaments of a thickness of 0.0001 in., with tolerances in each case of ±0.0002. Apertures and filaments are formed by etching processes. The cup metal also may be etched to varying thickness, if required.

Buckbee Mears Co., Dept. ED, Lindeke Bldg., St. Paul 1, Minn.

Radio Engineering Show, Booth 3809.

CIRCLE 116 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 117 ON READER-SERVICE CARD ▶

TUBE DESIGN NEWS

GENERAL ELECTRIC

RECEIVING • POWER • CATHODE RAY

Snow-White Cleanliness Extends to 5-Star Tube Parts Manufacture, Inspection, Handling

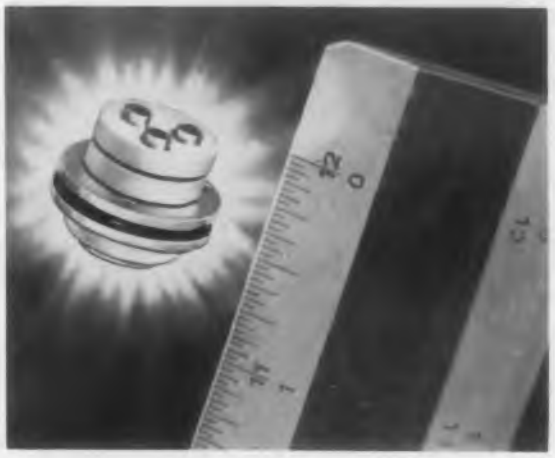
Broadened facilities for building G-E 5-Star high-reliability tubes under conditions of immaculate cleanliness, include dirt- and lint-free manufacture of the tube sub-assemblies.

All areas of General Electric's 5-Star Tube factory now are air-conditioned and pressurized to keep out dust. Workers, inspectors, and foremen who build and handle parts, wear the same lint-free Nylon and Dacron garments as employees who assemble and test 5-Star Tubes.

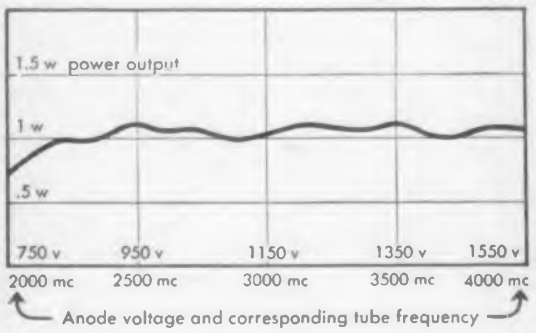
Grids are wound and cleaned with virtually no chance that a particle of dust or thread of lint will adhere, to cause tube "shorting". Heaters are formed, coated,

(Continued on Page 2, Column 1)

New G-E Voltage-Tunable Magnetrons in Development Permit Fast Tuning over Wide Range with Steady Output



ABOVE, LEFT: the developmental Z-5112 voltage-tunable magnetron is only 5/8 in. high and 3/4 in. wide. ABOVE, RIGHT: preliminary tests prove essentially stable power output throughout 2000-mc tuning range.



Latest developmental type in a series of voltage-tunable magnetrons pioneered by General Electric, the Z-5112 indicates the advantages which this group of tubes offers to designers of military equipment.

Recent tests of the Z-5112 prove its capability for rapid, efficient tuning over an extended frequency range, from 2000 mc to 4000 mc—with power output .5 w to 1 w throughout.

Counter-measures can benefit from this threefold tube advantage. Also, enemy jamming can be effectively circumvented by rapid tuning over a broad frequency spectrum with little or no reduction in signal power. With tube frequency a linear function of the anode voltage, the Z-5112 and other VTM types can be tuned merely by changing the potential of the anode. This makes for circuit simplicity.

Design benefits of General Electric voltage-tunable magnetrons now in development, are small size, light weight, and metal-ceramic construction. The latter adds strength, and gives high-temperature resistance. Tubes are designed to operate up to 60,000 feet altitude.

Besides being directly useful for counter-measure work, voltage-tunable magnetrons are suited to telemetering—for example, missile tracking; to FM altimeters; to air-navigation applications, broadband test equipment, and microwave communications generally.

Ask any G-E office listed on the next page for information on the development status of voltage-tunable magnetrons.

G-E Snow-White Workers Check Progress on Their 5-Star Tube "Factory", to Operate at March I.R.E. Show

Featured at General Electric's exhibit at the New York I.R.E. Show, will be the actual assembly of 5-Star Tubes in an air-conditioned, pressurized working area, housed in a transparent plastic "factory". Trained operators from General Electric's 5-Star Owensboro, Ky., factory will assemble the tubes . . . Another G-E show highlight: first public demonstration of voltage-tunable magnetrons, described elsewhere on this page.

'Lightning-Rod' Filament Shield for G-E High-Voltage Rectifier Tubes Increases TV Dependability

ABOVE: a special tungsten post shields G-E tube filaments from electrostatic pull of high anode voltages. BELOW: checking 1B3-GT and 1X2-A/B rectifier types during G-E flyback life test that further safeguards tube performance.

Among numerous steps taken to increase the reliability and long life of General Electric 1B3-GT and 1X2-A/B high-voltage rectifier tubes, mounting a "lightning-rod" shield beside the filament is important. Manufacturers of TV receivers thus are better protected against picture failures . . . . . in sets in production, on test, and in owners' hands.

G.E.'s tungsten shield, or post wards off electrostatic pull on the tube filament . . . . . thus minimizing pull-out and filament-to-anode shorts, and sharply reducing the incidence of broken filaments.

In addition, a highly adhesive filament coating further protects against arc-overs. Another special feature: the bulbs of G-E high-voltage rectifier tubes are ringed with conductive material to prevent vertical picture streaking that is caused by bulb charging.

To make sure that tube performance meets design targets, 1B3-GT's and 1X2-A/B's receive a 100% flyback test and a dynamic flyback life test—both at the top ratings for big-screen operation.

Realizing the importance to the TV industry of dependable, long-life rectifier tubes, General Electric is continuously improving its design, production, and test methods for these types.

Snow-White Cleanliness, 5-Star Parts

(Continued from Page 1)

and heat-treated . . . . . other parts built and processed . . . . . under the same strict conditions of near-surgical cleanliness.

There are 35 General Electric 5-Star Tubes, 11 of them subminiatures, meeting substantially every military and industrial need. Two new miniature types for computers are included in the line.

RIGHT: 5-Star Tube heaters, after forming and coating, are placed in individual glass cylinders for inspection. This helps guard heaters from contact with dust or lint until the tubes are assembled, exhausted, and sealed off.

Special bulb design of Z-4399 optimizes resolution, accommodates several types of magnetic deflection yoke for presenting various kinds of information on face plate.

New Z-4399 High-Resolution Tube Accents General Electric's Facilities For Special C-R Tube Development

Used primarily in equipment to pinpoint enemy mortar locations for quick counter-fire, General Electric's Z-4399 C-R tube combines a group of features essential for its purpose—a 5½-in. square face plate that lends itself to a rectilinear coordinate display system; extremely high resolution; magnetic focus and deflection; a bright image brought about by aluminizing.

The tube's neck has been specially lengthened in order to (1) increase image resolution to a new standard of fineness and sharp definition, (2) accommodate several types of deflection yoke.

Designing C-R tubes such as the Z-4399 for specific military or industrial functions, is a job for which General Electric has extensive facilities in research, engineering skill, and equipment. Problems calling for the selection or origination of special C-R types are welcomed.

JUST PRINTED!

New, complete booklet on General Electric 5-Star Tubes — their design, manufacture, and testing. A "must" for designers who require maximum reliability in critical tube sockets. Ask for Booklet ETD-1425!

EASTERN REGION
General Electric Company, Tube Sales
200 Main Avenue, Clifton, N. J.
Phones: (Clifton) GRegory 3-6387
(N.Y.C.) WIsconsin 7-4065, 6, 7, 8

CENTRAL REGION
General Electric Company, Tube Sales
3800 North Milwaukee Avenue
Chicago 41, Ill.
Phone: SPring 7-1600

WESTERN REGION
General Electric Company, Tube Sales
11840 West Olympic Boulevard
Los Angeles 64, Calif.
Phones: GRanite 9-7765; BRadshaw 2-8566

Progress Is Our Most Important Product

GENERAL ELECTRIC

162-1C9

ELECTRONIC COMPONENTS DIVISION, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

△ High Frequency Antenna

Adjustable Polarization

Dipoles of this antenna can be adjusted for either horizontal or vertical polarization. One of the dipoles pictured here, and the dish, cover the range from 1000 to 1350 mc; the other combination covers 2750 to 3000 mc. Similar units can be supplied in other frequency bands. Diameter of the dish shown is 24 in. The antenna combinations are designed and constructed to yield maximum possible performance in their respective bands. A type N coaxial fitting is provided on the dipole unit.

Sage Laboratories, Inc., Dept. ED, Waltham, Mass.

Radio Engineering Show, Booth 3946.

CIRCLE 118 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Two-Pen Recorder

For Comparative Measurement

Housed in a case 17-3/4 in. wide to fit standard racks, this Weston Model 6791 double recorder utilizes two separate amplifiers and two separate measuring circuits. It is intended for comparative measurements in the laboratory or on the production line. The range standards of either one of both zones are easily replaceable for quick range change. Alarm switches are available for each zone, and can be set in a matter of seconds. The two amplifiers are of plug-in construction for easier servicing.

Weston Electrical Instrument Corp., Dept. ED, Newark 12, N. J.

Radio Engineering Show, Booth 2907-2915.

CIRCLE 119 ON READER-SERVICE CARD FOR MORE INFORMATION

◀ CIRCLE 117 ON READER-SERVICE CARD

△ Nylon Thrust Washers

High Dimensional Stability

Where the best possible wear resistance is required under light thrust conditions (as in association with fractional horsepower motors, for example) these Nylatron "GS" thrust washers are recommended. Patents have been applied for for the material, a molybdenum disulphide filled nylon formulation, having better dimensional stability and lower deformation under load than standard nylon, a lower coefficient of friction and higher wear resistance in many applications. The washers can be used to advantage where lubrication is difficult. Outside diameters currently available are 3/8 in. to 1-5/16 in.; inside diameters 1/8 in. to 1 in. Thicknesses currently available are 1/64 in., 1/32 in. and 1/16 in.

Polymer Corp. of Pa., Dept. ED, 2140 Fairmont Ave., Reading, Pa.
Radio Engineering Show, Booth 4309.

CIRCLE 122 ON READER-SERVICE CARD

Two Circuits Controlled

By One Time Switch

A time switch recently introduced controls two electrical circuits at different times. Known as the Series V22000, they are especially well-suited for controlling lighting circuits.

The intermatic V22000 Series time switches permit varying timing periods from 30 mins. to 23-1/2 hrs. Actually, the time dial will accommodate up to 24 sets of ON-OFF trippers.

Housed in a steel case measuring 10 x 4-7/8 x 4 in. deep, it has a black crackle, rustproof finish. A permanently hinged door (with hasp) provides a dust and moisture-proof seal. Models are available for 125 or 250 v operation and carry a full guarantee against defects.

International Register Co., Dept. ED, 2624 W. Washington Blvd., Chicago 12, Ill.

CIRCLE 123 ON READER-SERVICE CARD

Epoxy Resin Hardener

For Rapid Mold Stripping

More efficient use of epoxy resin mold forms is made possible by curing the epoxy resin with Sonite No. 21, an acid anhydride available in pint, quart and gallon containers.

◀ CIRCLE 121 ON READER-SERVICE CARD

Epoxies cured with this hardener can be stripped from the molds within one hour and post-cured for desirable properties; they need not remain on the molds for the entire curing period. Typical physical properties of castings so made (post-cured for 23 hours, after one hour on the molds) are: 168 C heat distortion temperature, 12,000 psi tensile strength; 17,000 psi flexural strength, and 20,500 psi compressive strength.

Smooth-On Mfg. Co., Dept. ED, 572 Communipaw Ave., Jersey City 4, N.J.

CIRCLE 124 ON READER-SERVICE CARD

Dial, Name Plate, Adhesive
Bonds Without Fasteners

Name plates, meter dial faces, clock dial faces and similar items of metal can readily be affixed to metal, wood or ceramic surfaces by a resin adhesive known as Furane Resin XV. Strong and permanent bond is effected. The Resin XV is applied to the reverse side of the name plate or dial, and air dried. The adhesive film becomes dry and loses its tackiness. It is affixed to the surface on which it is to adhere by heating the plate or dial momentarily to 250 to 300 F and pressing it firmly against the surface. A firm bond is obtained without any compliaction of metallic fastening devices.

Furane Plastics, Inc., Dept. ED, 4516 Brazil St., Los Angeles 39, Calif.

CIRCLE 125 ON READER-SERVICE CARD

Soil-Moisture Block
Low Cost and Simple

A patent dealing with apparatus for measuring moisture of soil has been issued. The main claim of the issued patent is the use of platinized electrodes in absorption blocks used in measuring soil moisture, thereby eliminating the use of a capacitor in the associated Wheatstone Bridge type instruments. The improved-soil-moisture blocks permit simpler and less costly associated equipment to be used with them. Such blocks are buried in the soil at approximately root levels with their insulated leads extending up to the surface for connections with the measuring instruments.

Industrial Instruments Inc., Dept. ED, 89 Commerce Rd., Cedar Grove, N.J.

CIRCLE 126 ON READER-SERVICE CARD
CIRCLE 127 ON READER-SERVICE CARD ➤

Research and development at Lockheed Missile Systems Division laboratories in Palo Alto is of a most advanced nature. Particular areas of interest include microwaves, telemetering, radar, guidance, reliability, data processing, electronic systems, instrumentation, servomechanisms. Inquiries are invited from those qualified by ability and experience for exploratory efforts of utmost importance.

Here members of the Electronics Division discuss systems radar problems related to measurement of missile trajectories. Left to right: K.T. Larkin, radar and command guidance; Dr.S.B.Batdorf, head of the Electronics Division; Dr.H.N.Leifer (standing), solid state; Dr.R.J. Burke, telemetering; S.Janken, product engineering.

Lockheed

MISSILE SYSTEMS DIVISION

research and engineering staff

LOCKHEED AIRCRAFT CORPORATION

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CALIFORNIA

I·R·E NATIONAL CONVENTION AND RADIO SHOW

Significant developments at Lockheed Missile Systems Division have created new openings for:

Controls Systems Engineers – to analyze and synthesize complex automatic control systems.

Inertial Guidance Engineers – to perform systems analysis and design of inertial guidance systems.

Infrared Specialists – to perform preliminary systems design and parametric optimization of advanced infrared detection systems.

Data Processing Systems Specialists – to perform advanced system development and design in new techniques of automatic data processing.

Weapons Systems Specialists – to perform basic analysis and systems evaluation of advanced weapons systems.

Electronic Product Engineers – to translate laboratory electronic systems into prototype models meeting the rigid requirements of modern weapons systems.

Radar Systems Engineers – to develop advanced radar systems associated with guided missiles.

Theoretical Physicists – to analyze propagation of electromagnetic waves through the ionosphere and through dielectric materials and study radiation problems pertaining to advanced antennas in the microwave and millimeter domain, including scattering problems related to the reflection of electromagnetic waves from simple and complex boundaries.

Experimental Physicists – to investigate microwave circuit components including ferrites and various millimeter wave techniques such as MAZUR.

Antenna Specialists – to design and develop airborne antennas and radomes for high speed missiles for telemetering, radar, and guidance systems application.

Video Specialists – to develop advanced systems for the transmission of visual data by electronic means.

Circuit Design Specialists – to design telemetering and guidance systems utilizing advanced circuit components.

Positions are open at the Palo Alto Research Center and Sunnyvale and Van Nuys Engineering Centers. M. H. Hodge, M. W. Peterson and senior members of the technical staff will be available for consultation at the convention hotel. Phone PLaza 14860 or 14861.

Lockheed

MISSILE SYSTEMS DIVISION

Liquid Vinyl

Mixed on the Job

Mixing a liquid plasticizer with vinyl resin powder makes a fluid plastisol. When heated, the mix becomes a resilient solid, with wide application in the electro-mechanical field. Requires no expensive processing equipment or trained workers. Liquid Chemiflex vinyl, being "job mixed" prevents viscosity build-up, as with pre-mixed compounds. Altering ratio of ingredients permits control of flexibility or strength in the fabricated product. Substantial cost savings compared to pre-mixed vinyl plastisols. Available in production units from 2 to 32 lbs, with directions. Evaluation Experimental Kit is available.

Technicraft Co., Dept. ED, 1156 Commonwealth Ave., Boston 34, Mass.

CIRCLE 133 ON READER-SERVICE CARD

Portable Anechoic Chamber

For Testing Acoustical Equipment

Portable AN-ECK-IOC chamber is designed for scaled-down testing of small microphones, hearing aids, signal devices, and miniaturized electronic and mechanical equipment. Measuring 42 x 48 x 60 in. over-all, the portable AN-ECK-OIC chamber can be easily moved between widely spaced or remote industrial test areas. The test chamber, 16 x 20 x 32 in., is designed for a low frequency cutoff of 250 cps.

Sound absorption is accomplished by wedge-shaped, wire-enclosed fibrous glass units mounted on the walls, ceiling, and floor of the chamber.

The unit is designed to mount easily on the walls, ceiling, and floor of the chamber. AN-ECK-OIC wedge units are designed for low-frequency cutoffs ranging from 60 to 400 cps. The depths of the wedge units, including the necessary air space and the structural framing for the support, are 56 in. at 60 cps frequency cutoff, 34 in. at 100 cps, 22 in. at 150 cps, 16 in. at 200 cps, 10-1/2 in. at 300 cps, and 8 in. at 400 cps.

Eckel Corp., Dept. ED, 155 Fawcett St., Cambridge, Mass.

CIRCLE 134 ON READER-SERVICE CARD
CIRCLE 135 ON READER-SERVICE CARD ➤
➤ CIRCLE 569 ON READER-SERVICE CARD

Microton hardness test typifies quality control measures that leave nothing to chance at Automatic Electric

STANDARDS THAT DETERMINE RELAY QUALITY

the ideal relay iron

Only soft, pure iron assures proper release, even after millions of operations.

In service, many relays get progressively slower to release, until finally the armature hangs up permanently. Excessively "hard" magnetic relay iron often is to blame. But in all Automatic Electric relays, the magnetic iron is so soft and pure that it saturates quickly, yet the flux dies out instantly. Even after millions of operations!

This improved relay iron is made and rolled to our own exacting specifications. Chemical analysis then makes certain that no magnetic capabilities have been lost. Annealing is rigidly controlled, and grain size and temper carefully checked. Elongation, hardness, permeability, and density tests further safeguard this pampered material. Result: not the *ideal* relay iron, but *the most nearly perfect iron available.*

This is no isolated example. Exhaustive tests prove that all our raw material is equally fine. It's one of the many reasons why Automatic Electric relays enjoy far longer life.

Series SQPC Relay for printed circuitry applications. *Write today for Bulletin RH-9. Automatic Electric Sales Corporation, Chicago 7.* In Canada: *Automatic Electric Sales (Canada) Ltd., Toronto.* Offices in principal cities.

AUTOMATIC ELECTRIC

Originators of the dial telephone • Pioneers in automatic control

GENERAL TELEPHONE SYSTEM

CIRCLE 137 ON READER-SERVICE CARD FOR MORE INFORMATION

△ KiloMc Load Isolator

Up to 100 Kw Peak

With an operating range of 34 to 36 kiloMc, the Model KA-131 "Uniline" load isolator has an average power rating of 50 w, peak power rating in an unpressurized system up to 8 kw, and peak power rating in a pressurized system of 100 kw. Isolation is 20 db at band center, 15 db at edges. VSWR into matched load is less than 1.2 over the entire operating range; maximum insertion loss is 0.8 db. Largest dimension is 2 in. overall; weight 1 lb 9 oz.

Cascade Research Corp., Dept. ED, 53 Victory Lane, Los Gatos, Calif.

Radio Engineering Show, Booth 3607-3609.

CIRCLE 138 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Self-Sealing Screws

Resist Vibration

The combination of sealing and locking can be maintained even under conditions of vibrations by use of these O-ring-screw combination. Seelskrews are standard machine screws, in a broad range of standard and special sizes and threads, with an O-ring pressed into a groove under the fastener head. They come as one piece, are used in the usual way, and after installation is complete they look like conventional screws. But the act of tightening these screws compresses the O-ring, thus achieving high pressure sealing and vibration resistance. It maintains its seal even after frequent removals and replacements. The basic sealing material used in the O-ring is not impaired by weathering, salt water, sunlight or elevated temperatures, and resists petroleum and petroleum products.

Automatic & Precision Mfg. Co., Dept. ED, 252 Hawthorne Ave., Yonkers, N. Y.

Radio Engineering Show, Booth 3824.

CIRCLE 139 ON READER-SERVICE CARD FOR MORE INFORMATION

Square-Body Resistors

7 and 10 W Rating

A line of wire-wound, miniature, square-body resistors, available from 1 ohm to 6,000 ohms in 7-w rating, and from 1 ohm to 11,000 ohms in 10-w rating, is announced by Clarostat. The square-body shape facilitates certain types of assembly and wiring operations; and the new line supplements the manufacturer's previous round-body resistor family.

In these new units, the resistance element is placed in a square-body steatite casing and there imbedded in inorganic cement. Axial pigtails provide both support and connections.

Dimensions are 3/8 in. x 11/32 in.; with lengths of 1-3/8 in. in the case of the 7-w units and 1-7/8 in for the 10-w line.

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

CIRCLE 140 ON READER-SERVICE CARD

Low Cost Sintered Iron

Superior Machinability

Powdiron fm, pure sintered iron material, combines excellent machining properties with low cost.

Prior to the development of Powdiron fm, the machining of sintered iron has been the material's greatest drawback. It had been necessary to use special tools at low speeds when machining iron parts. Otherwise iron particles were torn out rather than cut through, and as each cut was an interrupted cut tools wore out rapidly.

The new powdiron fm part is clean and smooth with a mirror-like surface finish, comparable to mild steel. In addition to its unique machining properties new fm is inexpensive and readily available. Powdiron fm also has especially high ductility and triples tool life over ordinary sintered iron, including iron-copper.

Bound Brook Oil-Less Bearing Co., Dept. ED, Bound Brook, N.J.

CIRCLE 141 ON READER-SERVICE CARD

CIRCLE 142 ON READER-SERVICE CARD ➤

△ Miniature Trimmer
500-20,000 Ohms

Available in two models, one of which is encapsulated, this miniaturized trimmer utilizes a glass-film resistance element fused to a tough ceramic frame. The adjusting shaft is stainless steel and the contact spring is multi-fingered precious metal. Simplicity of design and economy of parts make the potentiometer insensitive to shock, vibration or heat: it functions efficiently at temperatures up to 120 C. The encapsulated model meets the humidity resistance requirements of MIL-E-5272A. Power handling capacity is 1.5 w. The basic Model 50 weighs 0.25 oz and measures 9/32 in. x 5/16 in. x 1-1/4 in.; the encapsulated model, Model 52, is 1/4 in. longer.

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

Radio Engineering Show, Booth 2602-2606.

CIRCLE 145 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Magnetic Amplifier
Range DC to 1000 cps

This magnetic amplifier, C-150-223, is intended for use with instrument and computing servo systems. It is suited to driving BuOrd Mk 7 or Mk 8 servo motors or equivalent without a vacuum tube or transistor driving stage in the servo loop. Although designed for self-contained input signals of 400 cps, it is adaptable, with addition of a reference transformer, to inputs ranging from dc to 1000 cps. The amplifier is potted and hermetically sealed in a MIL-T-27A size HA can. It meets the shock and vibration requirements of MIL-STD-202.

Ahrendt Instrument Co., Subsidiary of Litton Industries, Dept. ED, 4910 Calvert Road, College Park, Md.

Radio Engineering Show, Booth 3049.

CIRCLE 146 ON READER-SERVICE CARD FOR MORE INFORMATION

△ 5 W Potentiometer

Fine Resolution

Prototypes of this 910 Series single turn Micropot meet applicable military and commercial requirements. This precision potentiometer is linear in function, highly accurate, has fine resolution, low torque, consistent reliability and long life. Resistance element and terminal leads are moulded into one unit. Shafts are mounted on ball bearings. When units are ganged, each cup may be individually phased in the field. Standard resistance range is 50 to 10 k ohms (50 k ohms special); standard tolerance ±0.5 per cent; standard linearity accuracy ±0.5 per cent independent. Continuous mechanical rotation covers 340 deg; starting torque is 0.5 in.-oz per section. Net weight is 4 oz per single unit, 1 additional oz for each additional unit. A single unit measures 1-3/64 in. x 1-7/8 in. diam. Standard shafts protrude 5/8 in.; special lengths are available.

Geo. W. Borg Corp., Dept. ED, Janesville, Wisc.
Radio Engineering Show, Booth 3840-3842.

CIRCLE 147 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Microwave Generators

18,000 to 50,000 Mc

Sources of extremely high frequency, utilizing interchangeable tuning units, provide known frequency output for testing microwave equipment, components and systems. They cover the band 18,000 to 50,000 mc. The tuning units plug in, and need no further adjustment. They provide cw or modulated signals of known frequency.

Polarad Electronics Corp., Dept. ED, 43-20 34th St., Long Island City 1, N.Y.
Radio Engineering Show, Booth 3210-3214.

CIRCLE 148 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Control Amplifier

Transistorized

Used for aircraft fire power, this transistorized control amplifier weighs 11 oz and has a life expectancy of 10,000 hours. It is designed to operate in an ambient of from —65 to +125 C. The unit is adaptable to voltages of ±50 to ±1000 v, has a ripple less than 50 mv peak-to-peak, and an overall circuit gain of 60 to 80 db. The voltage regulation is ±1 per cent from 30 per cent to 100 per cent load, with appropriate external reference.

Packard-Bell Electronics Corp., Dept. ED, 12333 W. Olympic Blvd., Los Angeles 64, Calif.

Radio Engineering Show, Booth 3705-3707.

CIRCLE 153 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Dual Recording Galvanometer

10-Speed Chart Drive

For simultaneous recording of two independent wave-forms this Dual recti/riter utilizes one chart drive and one chart, two fine-line pens and two galvanometers. The galvanometers are available in 1, 5, 10 or 25 ma movements, have 4-1/2 in. scales, accuracy ± 1 per cent of full scale, and a rise time of 0.25 sec. Charts are 100 ft long; drives may be ac, dc, spring or external. Closed inking systems are non-spill, non-skip; ink is protected against contamination or evaporation. Additional event marker pens can be mounted on either side of the chart; and manual notations can be made accurately by use of the convenient "writing desk" rest provided by the instrument's construction. The front panel mounts the terminals and controls, including the 10-speed drive gear control. This dual recorder is a further development of a single-pen, single-galvanometer instrument that has been in satisfactory use for a year. The dual instrument comes in a portable case that measures 15 in. long, 13-1/2 in. wide and 9-1/4 in. high. Weight is 47 lb.

Texas Instruments, Inc., Industrial Instruments Div., Dept. ED, P. O. Box 6027, Houston, Tex.

Radio Engineering Show, Booth 2816-2820.

CIRCLE 154 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Dish Antenna
1700-2400 MC

This dish antenna handles 190 w in the 1700-2400 mc range, withstands 250 mph windload, and has a gain of approximately 34 db over isotropic source. Beamwidth is 4 deg at half power point; impedance is 50 ohms. Designated AS-554/U dish, the antenna is formed of heat-treated, cast aluminum frames and expanded mesh, irradiated and painted for weather protection. It can be rotated 360 deg in azimuth and ±10 deg in elevation. Shipment is in four sections for easier portability. The antenna conforms to MIL-R-13963. It is one of an extensive line of aircraft, submarine, telemetering, glide-path, disc cone and dish antennas by the same maker.

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

Radio Engineering Show, Booth 1428.

CIRCLE 157 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Semiconductor Inverters
150 VA Rating

New semiconductor inverter and converter models which will convert low voltage dc to ac or higher voltage dc are intended to replace vibrator and rotating machinery equivalents. They feature improved circuitry and incorporate the latest types of transistors. Additions to the line include six inverter models which convert 6, 12, or 24 v d-c battery input to 115 v ac, 60 or 400 cps. These new inverters are available in power ratings up to 150 va. Additional models provide outputs of 150 v dc and 300 v dc at current ratings of 100 or 200 ma, and available in regulated or unregulated designs.

All models are potted in transformer housings but transitsors are located on an inner header for servicing or replacement purposes. A choice of octal plug-in type or solder loop terminal is available.

Electronic Research Associates, Inc., Dept. ED, 67 East Centre St., Nutley 10, N. J.

Radio Engineering Show, Booth 2705.

CIRCLE 158 ON READER-SERVICE CARD FOR MORE INFORMATION

△ High Ambient Resistors

Carbon on Ceramic

The 1/2 w PT501 and 1 w PT1001 are usable to ambient temperatures of at least 400 C, and exceed MIL-10509B load life requirements at 160 C, derated 50 per cent. These resistors are made by pyrolytic deposition of carbon on ceramic rods. The leads are weldable tinned copper clad iron, 1-1/2 in. long. The two resistors measure 3/16 in. in diameter, the PT501 being 1/2 in. long, and the PT1001 1 in. long.

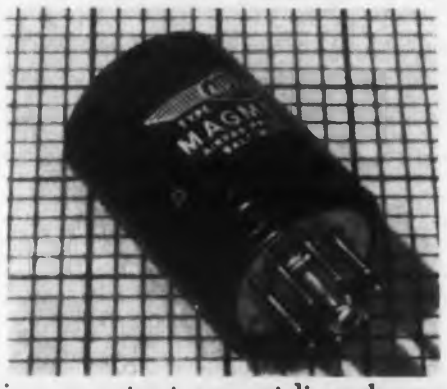
Pyrofilm Resistor Co., Dept. ED, 8 Whippany St., Morristown, N. J.

Radio Engineering Show, Booth 3938.

CIRCLE 159 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Narrow Band FM Detector

Hermetically Sealed



Providing an output current linearly proportional to frequency, this F-992 Magmeter detector operates in the band 375-425 cps. Other similar detectors can be supplied that will cover a 10 per cent bandwidth at any center frequency from 30 to 5000 cps. The output is suited to operating a d'Arsonval indicator, servo type recorder, or a control circuit, and may be used for instrumentation, telemetering or automatic control.

Linearity is within 1/4 per cent of midband frequency. Temperature range is −55 C to +72 C. The unit withstands 10 g vibrations to 2000 cps and omni-directional shocks to 30 g. Output at the low frequency end of the band is zero, thereby indicating absence of input.

The standard type Magmeter fits a standard octal socket, but special mounting and terminal arrangements can be supplied. Height, seated, is 2 in., diam 1-1/2 in. Weight, 6 oz.

Airpax Products Co., Dept. ED, Middle River, Baltimore 20, Md.

Radio Engineering Show, Booth 2505.

CIRCLE 160 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Variable Autotransformer

For Aircraft Controls

Designed to replace resistive-type light controls in aircraft, these variable autoformers accept 115 v 400 cps and deliver an output which is variable between 0 and 28 v, ac. The Vari-lite PA-1028, has a 4-amp capacity; measures 2-3/4 in. x 2-3/8 in. diam, weighs 19 oz, and meets MIL-T-9219 and MIL-E-5272A.

United Transformer Corp., Pacific Div., Dept. ED, 4008 W. Jefferson Blvd., Los Angeles 16, Calif.
Radio Engineering Show, Booth 2413, 14.

CIRCLE 163 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Rugged 2-W Pot

Teflon Shaft Seal

The 75-M30 Maureypot potentiometer here shown exceeds the requirements of JAN-R-19, and is recommended for rugged service of a precision instrument. The mechanical stops withstand a torque of 8 in.-lb. A standard 3/8-32 bushing provides firm panel mounting. The shaft is sealed with a Teflon bushing. An internal spring keeps the shaft at its assigned setting during even severe operating conditions. Independent linearity of ±1 per cent is available, and for values of 10,000 ohms and above a resolution of 1/3 deg can be attained.

Maurey Instrument Corp., Dept. ED, 7924 S. Exchange Avenue, Chicago 17, Ill.
Radio Engineering Show, Booth 3845.

CIRCLE 164 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Rack and Panel Connector

Gold Plated Contacts

A resilient insert to facilitate pressurization and to give maximum protection against vibration is one of the features of this rack and panel connector, which is designated Type SR. Other features include heavily gold-plated contacts, solid shells, low contact engagement forces (easily pressurized to latest MIL specs), closed entry sockets and cadmium-plated clear irridite finish. Insert patterns will mate with equipment now in service. Temperature range is −67 to +250 F.

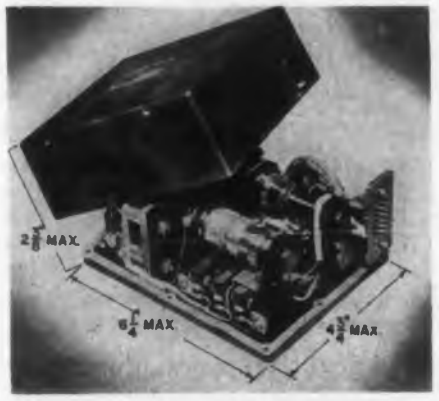
Scintilla Div. Bendix Aviation Corp., Dept. ED. Sidney, N.Y.

Radio Engineering Show, Booths 2332, 2425.

CIRCLE 165 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Multiple Sequence Timer

For Cyclic Switching



Up to 6 separate timing sequence operations can be controlled simultaneously by this rapid response multiple sequence timer. A magnetic clutch and cam arrangement, which resets to zero upon completion of a timing cycle, controls some operations, while others are subject to switches that pulse continuously. One of the latter remains in open position during 0.450 ±0.040 seconds, and in closed position during 0.050 ±0.010 seconds, thus completing one cycle every half-second. Switches operate under 0.250 amp load at 115 v 400 cps over an input voltage range from 24 to 30 v dc. There are no tubes nor other electronic equipment. All contacting devices are readily accessible for adjustment and servicing. Designated Type ST-9610-01, the controller conforms to MIL-E-5400.

John Oster Mfg. Co., Avionic Div., Dept. ED, Racine, Wisc.

Radio Engineering Show, Booth 2129.

CIRCLE 166 ON READER-SERVICE CARD FOR MORE INFORMATION

Vernier-Potentiometer

For Severe Environments

Designated RP04-0101, this vernier potentiometer combines flexibility in mounting provisions, mechanical travel and electrical characteristics with ability to withstand severe environments and to meet exacting and rigid operating conditions. Temperature range is −65 F to +275 F; vibration 10 g at 10 to 1500 cps, shock up to 60 g.

Travel distance is 4.13 in.; vernier scale reads to 0.010 in. increments, resolution is 0.001, life is 1,000,000 cycles. Power dissipation is 2 w, resistance, 30 k ohms ±10 per cent, linearity ±0.2 per cent. Weight is 2.5 oz.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

CIRCLE 169 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Vibration Mount

For All Flight Angles

The mechanical isolator pictured here is not limited in its action to horizontal positions or maximum inclinations of a few degrees, but affords continuing isolation through all positions in jets and missiles, during steep climbs, dives and maneuvers. The B-64 All-Angl Barrymount protects heavy electronic equipment against shock or vibration. Maximum load rating is 40 lb. The damping is effective in all directions, and keeps transmissibility at resonance below 3. Operating temperature range is −65 C to +120 C. Performance is unaffected by the salt spray, humidity, sand and dust environments of MIL-E-5272A. Still further improvement in structural stability of the mounted system under shock can be obtained by means of a wide-flange countersunk core, available with the mount, that permits seating its attachment screw in a dimpled base.

Barry Controls, Inc., Dept. ED, 875 Pleasant St., Watertown 72, Mass.

Radio Engineering Show, Booth 2534.

CIRCLE 170 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Transistor Curve Tracer

Used With Oscilloscope

Used with any oscilloscope, the instrument here pictured provides a basic method of transistor inspection and evaluation. The scope presents either an eight-family curve or a single curve of the dynamic output of the transistor under inspection. Instant indication is afforded of its gain, breakdown, leakage current, linearity, saturation resistance, collector resistance and operational anomalies.

The evaluator itself is of transistorized design, and incorporates a digital type step generator that provides the base current drive. This drive is controlled by the panel base drive selector switch which affords selection of ranges of 5, 10, 50 and 100 μamp, thus permitting low-power evaluation without danger of damage to the transistor to be tested. Setting the continuous base drive control at the right side of the panel on full, with the selector switch at 100 μamp, then provides a maximum total drive of 700 μamp. The output is in the form of either single or family curve presentation of collector voltage versus collector current.

Designated Model 504 transistor curve tracer, the instrument is small, light, self-powered and portable. Dimensions are 8-1/2 in. x 5 in. x 4-1/2 in.

Cubic Corp., Dept. ED, 5575 Kearney Villa Road, San Diego, Calif.

Radio Engineering Show, Booth 1723.

CIRCLE 171 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Synthetic Mica

Low-Loss Factor

This synthetic mica has a heat factor of continuous usage at 1000 F as compared to 800 F of regular mined and glass bonded mica. The loss factor of Mykroy is 0.0009 per cent as compared with 0.0028 per cent in glass bonded mica. The synthetic mica is made in sheet form and in molded shapes.

Electronic Mechanics, Inc., Dept. ED, 101 Clifton Blvd., Clifton, N. J.

Radio Engineering Show, Booth 4239.

CIRCLE 172 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Valve Position Indicators

For Aircraft and Missiles

Switches that signal the position, or the functioning, of a valve in a missile or aircraft or rocket engine, are made now in two lightweight models. The Capswitch model 65M41 is a spdt switch weighing 0.095 lb. Model 65M83 is a dpdt switch weighing 0.19 lb. Switching is accomplished by a sealed plunger, which is depressed by the valve stemp. The switch is completely sealed in epoxy resin, and the entire mechanism encased in a steel shell. It is adapted to any type of control where repeatability within ±0.001 in. is desired.

Robertshaw-Fulton Controls Co., Bridgeport Thermostat Div., Dept. ED, Milford, Conn.
Radio Engineering Show, Booth 2708.

CIRCLE 179 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Servo Accelerometer

Linearity ±0.1 Per Cent

Incorporating a high-gain electromechanical amplifier in closed-loop operation, a servo accelerometer designated Model 4112 provides precise measurements of or control of linear acceleration under severe environmental conditions. It is especially suited to aircraft and missile applications where high accuracy and rugged construction are needed. Frequency range is 0 to 25 cps.

The Model 4112 provides resolution better than 0.001 per cent and linearity within ±1 per cent at full range. It withstands hundreds of g's of shock. Compensation within 0.1 per cent of full scale over a temperature range of 100 C can be achieved. Available standard input ranges are from ±0.1 g to ±20 g. High output levels, requiring no further amplification, are available.

Donner Scientific Co., Dept. ED, Concord, Calif.
Radio Engineering Show, Booths 3616, 3618.

CIRCLE 180 ON READER-SERVICE CARD FOR MORE INFORMATION

Here's what to see at the IRE...

VICTOREEN

Components at Booth 2231

If tough specifications have you in a bind—check *Victoreen first*. For Victoreen is a major producer of prime quality electronic components. Many are off-the-shelf items we can ship immediately. If not, we can design and build them to exceed specification requirements . . . can generally beat delivery requirements, too.

Precision Encapsulated Deposited Carbon Resistors offering the ultimate in stability over thousands of operational hours; temperatures to 200°C; low temperature exposure; and moisture resistance.

Electrometer Tubes. Victoreen electrometer tubes provide extreme sensitivity for measurement of minute currents in extremely high resistance circuits.

New Corona Type Voltage Regulators offering new, simplified, and more economical means of solving high-voltage power supply regulation. January 1957 reprints and technical design considerations available on request. The author of these articles, Don Ward, will be in attendance to help solve your problems.

AA-6011

Exclusive Export Agency: Terminal Radio International, Ltd.
135 Liberty Street, New York City

The Victoreen Instrument Company
Components Division
5806 Hough Avenue, Cleveland 3, Ohio

CIRCLE 182 ON READER-SERVICE CARD FOR MORE INFORMATION

△ 4 mm Klystron
69.5-77.5 Kmc

Power output of this 4 mm klystron is 40 mw at band center, minimum of 10 mw. Heater power of only 4 w yields a beam current of 16 ma at a resonator voltage of 2400 v. Maximum repeller voltage is 400 negative with respect to cathode. A Philips "L" cathode furnishes the required beam current density of 2 amp per square centimeter.

Amperex Electronics, Dept. ED, 230 Duffy Ave., Hicksville, N.Y.
Radio Engineering Show, Booth 2522-2524.

CIRCLE 183 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Pulse Amplifier
320 Mc Bandwith

With the Model 206 wide band amplifier fast-rise pulses can be reproduced by providing a stable 20 db gain over a 320 mc band. Nominal gain for this model is 20 db, sloping to 18 db at 300 mc and 14 db at 320 mc, but both flat and roll-off characteristics are available by means of plug-in accessories. Three output modes, linear, pulse and high pulse, are selectable by a front panel switch. There are nine possible combinations of three response characteristics and three output modes. Integral regulated power supply and rack mounting are also provided.

The bandwidth of this amplifier is 300 mc at the 3 db point; rise time is less than 0.002 μsec. The output panel switch selects linear characteristic at 5 v rms, pulse at 30 v neg and high pulse at greater than 100 v neg, open circuit. Gain regulation is ±0.5 db for line voltage between 105 and 125 v, and the gain control varies 6 db. Phase is linear to 300 mc. Impedance is 180 ohms input, 200 ohms output. Its size is 19 in. x 8-3/8 in. x 7 in., and it requires 115 v 60 cycle power.

Spencer-Kennedy Laboratories, Dept. ED, 1320 Soldiers Field Rd., Boston 35, Mass.
Radio Engineering Show, Booth 3502-3504.

CIRCLE 184 ON READER-SERVICE CARD FOR MORE INFORMATION

Flexibility for Designers

Adjust-A-Volt
500BU
VARIABLE AUTO-TRANSFORMER

2-GANG 500BU
(Also available in 3-gang)

Designed for back-of-panel mounting, the versatile 500BU Adjust-A-Volt variable auto-transformer offers the dependability and flexibility you have been looking for.

Shaft can be adjusted without disturbing rotor and commutator alignment. Terminal board connections allow for either clockwise or counter-clockwise rotation, as well as over-voltage or line-voltage operation.

Ganged units are available to provide increased current output, increased voltages, or for polyphase operation.

Specifications of the 500BU type—input voltage, 115 V; load rating, 1.0 KVA; output—0 to 135 V; output amps max. 7.5 A; driving torque in oz., 20-40. For more data, send for the catalog on the complete Adjust-A-Volt line.

STANDARD
ELECTRICAL PRODUCTS CO.
2240 E. THIRD ST., DAYTON, OHIO

CIRCLE 185 ON READER-SERVICE CARD

Johnson pilot lights immediately available for original equipment or in-the-field replacement!

Save valuable specification time by selecting your panel indicators from Johnson's "preferred" line. This group contains over 47 separate assemblies carefully selected from Johnson's standard line by many of the nation's top design and development personnel. Available in a wide variety of types, these "preferred" units are immediately available at parts distributors throughout the country, for original equipment or in-the-field replacement. Write for your free copy of Johnson's newest pilot light specification catalog—see how easy it is to select the *right* pilot light . . . fast!

free!

New pilot light catalog—contains complete specifications, prices and technical data . . . everything you need to select the proper unit for original equipment or in-the-field replacement.

Available types include: continuous indication neon types; models for high and low voltage incandescent bulbs; standard or wide angle glass and lucite jewels in clear, red, green, amber, blue or opal. Specials, including those meeting military specifications are also available in quantities.

E. F. Johnson Company

3413 Second Ave. S.W. • Waseca, Minnesota

CIRCLE 186 ON READER-SERVICE CARD

△ Ruggedized Meter

20 Microamp Movement

Sensitivities as low as 20 μa are accomplished with a coil resistance of 3000 ohms in this core magnet meter movement. Shock mounted jewel assemblies incorporated in its construction ruggedize the instrument. The movement is available in a 2-1/2 in. round, clear plastic case, and in many attractive custom styles.

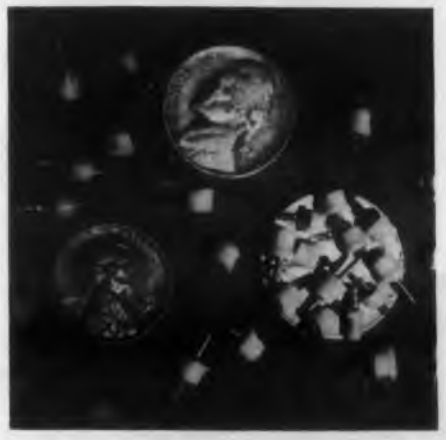
Phaostron Instrument and Electronic Co., Dept. ED, 151 Pasadena Ave., S. Pasadena, Calif.

Radio Engineering Show, Booth 3116.

CIRCLE 187 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Press-Fit Terminals

Need No Hardware



Without nuts, washers, lockwashers or sealing, but with only a simple insertion tool and drill-press equipment, these miniaturized terminals, designated Press-Fit, are installed simply by pressing them into place. Labor requirement is minimum. The terminals are shock and vibration proof, essentially unbreakable, immune to ordinary high temperatures, and they resist corrosion and fungus. Despite diminutive size, permitting their use in compact equipment and tight spots, they withstand the service requirements of guided missiles, radar, electronic computers and communications equipment. They measure 0.093 in. dia, and range in overall height from 0.250 in. to 0.5 in., depending on whether they are stand-offs or feed-throughs.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.

Radio Engineering Show, Booth 3714.

CIRCLE 188 ON READER-SERVICE CARD FOR MORE INFORMATION

AT LAST

a completely new kind of regulator!

ACTUALLY THREE REGULATORS IN ONE—*PLUS* MULTIPLE SENSING!

The APR 1010 combines many new regulation and sensing systems in one versatile package. Here's flexibility of operation never before possible... saves space, eliminates instrument duplication, means greater economy in engineering operations.

- **RMS VOLTAGE REGULATION**
- **AVERAGE REGULATION**
- **PEAK REGULATION**
- ***FIVE* PRINCIPAL SENSING ARRANGEMENTS**

1. Internal 2. External 3. Remote 4. Constant Current 5. DC

ELECTRICAL CHARACTERISTICS:

Input	95-130 VAC, 1Ø (50 or 60 cps ±10%)
Output	115 VAC, adj. 110-120V
Regulation accuracy (RMS, average, or peak, switch selected)	±0.1% against line ±0.1% against load
Distortion	3% max.
Load	0-1000VA
P.F. range	Unity to 0.7 lagging
Recovery time	0.1 sec.

WRITE FOR COMPLETE TECHNICAL DATA.

See the new APR 1010 at Booths 2627-9 I.R.E. Show!

Sorensen®

SORENSEN & COMPANY, INC. • STAMFORD, CONN.

CIRCLE 189 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Slotted Lines
1.7 to 5.85 KMC

For maximum flexibility and accuracy in standing wave measurements in the 1.7-5.85 kmc region the basic design of this universal carriage accepts interchangeable precision slotted sections in waveguide sizes RG-104/U, 112/U, 48/U, 49/U and WR-229. Additional slotted sections are soon to become available in the 0.750-0.985, 0.450-2.580 and 0.450-1.200 kmc ranges. Most standard probes can be used without alteration. Features include a stationary spinner knob for vernier control of probe position (which can be motor driven for remote operation by adding a suitable motor and limit stops), a push button probe release for faster operation, scale vernier and low residual VSWR.

Diamond Antenna and Microwave Corp., Dept. ED, 7 North Ave., Wakefield, Mass.

Radio Engineering Show, Booth 2733-2737.

CIRCLE 195 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Electronic Counter
Unitary or Binary

Accepting numerical information either as unitary pulse trains or in parallel in binary coded form this electronic counter, designated Add-Tractor, adds and subtracts, and is applicable to many industrial and laboratory uses. It adds, sums and subtracts; controls servos, digital positions and ratios; weighs, measures frequency deviations, converts digital to analog data and does other things. It functions as an accumulating register, it can be operated as a right and left shift register. It converts to nine's complement for subtraction in ten microseconds.

Tube complement is four type 5963. Power requirement is 6.3 v ac at 1.2 amp; 300 v dc at 16 ma.

Victor Adding Machine Co., Dept. ED, 3900 N. Rockwell St., Chicago 18, Ill.

Radio Engineering Show, Booth 1320.

CIRCLE 196 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Missile Tape Recorder

250 Sec Recording Time

The Model 600 system consists of a remote-controlled, two-track magnetic tape recorder. The unit will record and play back typical IRIG FM/FM subcarrier signals from 200 to 100,000 cps on a 1/4 in. tape for a recording time of up to 250 seconds.

The recorder is completely contained in two cases, which are designed for missile mounting. Total weight of the two packages is 21.5 lb. The tape transport has a maximum flutter and wow content of 1 per cent, peak-to-peak. Signal to noise ratio is 30 db, with 2 per cent maximum harmonic distortion. The unit is designed to withstand 30 g shock, sinusoidal vibration of 10 g, 2 to 2000 cps, and white noise acceleration density of 0.2 g^2/cps, 2 to 2000 cps.

Minneapolis-Honeywell Regulator Co., Davies Laboratories Division, Dept. ED, 10721 Hanna St., Beltsville, Md.

Radio Engineering Show, Booth 3118.

CIRCLE 199 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Unbalanced Ladder Networks

Low Impedance Controls

Recommended for broadcast, public address recording systems, as mixer or master gain controls, these compact, unbalanced ladder networks offer 30 steps of attenuation in housings only 1-15/16 in. x 1-3/4 in. diam. Their extremely small size makes them particularly useful in recording equipment, or where panel space is at a premium. A large selection of various impedance combinations and decibel losses is available. Designation is LA-130.

Daven Company, Dept. ED, Livingston, N.J.

Radio Engineering Show, Booth 2717-2719.

CIRCLE 200 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 201 ON READER-SERVICE CARD ▶

△ Miniature Load Isolator

Length 1 in., Weight 9 Oz

Operating over the frequency range 8.5 to 9.6 kmc this miniaturized ferrite microwave load isolator is for waveguide size RG-52/U, flanges UG-39/U. Designated Model X-125, it has a total length of only 1 in. and weighs 9 oz. Peak power is 100 kw, average power into 2:1 mismatch, 100 w. VSWR into matched load is 1.15. Isolation is 10.0 db over band; insertion loss 1.0 db.

Cascade Research Corp., Dept. ED, 53 Victory Lane, Los Gatos, Calif.

Radio Engineering Show, Booth 3607-3609.

CIRCLE 202 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Direct-Reading Phase Meter

1 Cps to 500 Kc

A stable and convenient device for measuring phase angle between two voltages without either amplitude or frequency adjustment, the 405 Series phase meters display phase angle directly in degrees on an 8-in. rectangular-panel mirror-scale. The instrument is also capable of plotting phase-frequency curves on a recorder or oscilloscope. It is stable when measuring small fractions of one deg on all ranges including the 0-12 deg range.

Consisting of a coincident slicer and cathode-coupled limiter stages with plate-to-plate degeneration, the meter features independence of the ratio of input signal amplitudes, equal accuracy for symmetrical wave-forms of any shape and identification of "lead" and "lag," self-calibration.

Relative accuracy is ±1/4 deg, absolute accuracy ±1 deg (or 2 per cent) at any range. There are eight phase ranges, covering the entire span from 0 to 360 deg. Model 405L has a frequency range from 1 cps to 20 kc and an input voltage range from 0.3 v to 70 v. Type 405H has a frequency range 8 cps to 500 kc and an input voltage range from 2 v to 40 v. Both types have high impedance inputs.

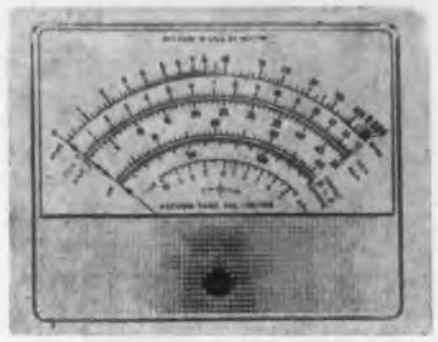
Advance Electronics Lab, Inc., Dept. ED, 249 Terhune Ave., Passaic, N. J.

Radio Engineering Show, Booth 3412.

CIRCLE 203 ON READER-SERVICE CARD FOR MORE INFORMATION

◀ CIRCLE 201 ON READER-SERVICE CARD

△ Long Scale Panel Meters
Have Plastic Covers



Featuring long scales and plastic covers, a new line of Weston meters is offered in Models 1341 and 1346. Model 1341 can be supplied from 100 μa maximum full scale sensitivity up 5 amp, self-contained. Model 1346 is for applications requiring 50 μa sensitivity. Used as d-c voltmeters, they can be supplied with sensitivities of 1000 ohm/v or greater. They can also be supplied as rectifier type a-c voltmeters in most standard ranges.

Being intended for panel mounting, these instruments are provided with shielded mechanisms that can be mounted on magnetic or non-magnetic panels with no special adjustment. They do not interfere magnetically with adjacent instruments and are not affected by adjacent instruments. The one-piece transparent cover admits light from many angles, improving visibility of the indication. Basic accuracy when used as d-c instruments is ± 2 per cent of full scale. When used as rectifier-type a-c instruments accuracy is ±3 per cent of full scale when measuring a sine wave 60 cps input at 25 C.

Weston Electrical Instrument Corp., Dept. ED, Newark 5, N. J.

Radio Engineering Show, Booth 2907-2915.

CIRCLE 208 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Missile Power Supplies
Multiple Output

Combining toroidal power transformers, toroidal filter chokes, high temperature capacitors and silicon rectifiers, these sealed units offer multiple output and low ripple, low stray field without internal shielding. Magnetic regulation where required.

Communication Accessories Co., Dept. ED, Lee's Summit, Mo.

Radio Engineering Show, Booth 3908-3910.

CIRCLE 209 ON READER-SERVICE CARD FOR MORE INFORMATION

Official U. S. Air Force photograph

Throws out electron tubes... keeps chopper

Today's aviation electronic standards are often tough to meet. Demands for extreme miniaturization are coming hard on the heels of new reliability and performance standards.

We've heard of one well-known manufacturer, for example, who has gradually eliminated all electron tubes and most other conventional electronic parts from his jet engine control system.

But it's significant that this manufacturer is still using the Bristol Syncroverter® Switch to convert servo signals from d-c to a-c.

The reason? There's no equivalent that comes up to the Syncroverter Switch's performance. *Long life* and *Immunity to Severe Shock* and *Vibration* are outstanding characteristics of the Syncroverter Chopper.

Bristol Syncroverter Switch. Covered by patents.

During vibration over the range of 5 cps to 2000 cps and up to 30G, the effect on output waveform is negligible.

Write today for data on this outstanding chopper for your critical signal conversion problems. The Bristol Company, 151 Bristol Road, Waterbury 20, Connecticut.

6.73

TYPICAL OPERATION

Driving frequency range:	0-2000 cps (400 cps used for these characteristics)
Coil voltage:	6.3V sine, square, pulse wave
Coil current:	55 milliamperes
Coil resistance:	85 ohms
•Phase lag:	55° ± 10°
•Dissymmetry:	Less than 4%
•Switching time:	15° ± 5°
Temperature:	−55°C to 100°C
Operating position:	Any
Mounting:	Flange or plug-in—fits 7-pin miniature socket

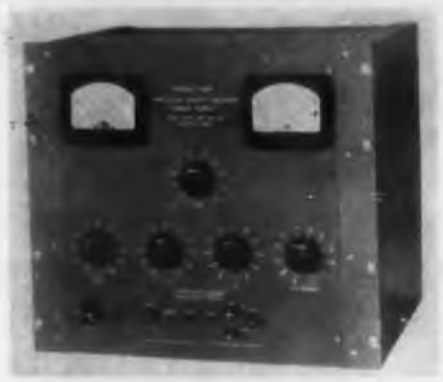
•These characteristics based on sine-wave excitation.

BRISTOL FINE PRECISION INSTRUMENTS FOR OVER 67 YEARS

CIRCLE 215 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Precision DC Supply

Wide Range



This instrument, the Model 301C, is designed to produce an output voltage from 1.02 to 1012 v dc at 0 to 400 ma, positive, negative, or floating ground. The supply is chopper stabilized and referenced against a standard cell. Resolution is better than 0.5 mv at any output voltage. Calibration accuracy is greater than ±0.1 per cent. Regulation is 0.005 per cent for a 10 per cent line voltage change or 200 ma load current change, while long term stability is less than 0.01 per cent per day. This supply is equipped with a removable cabinet for bench or rack mounting.

John Fluke Mfg. Co. Inc., Dept. ED, 1111 W. Nickerson St., Seattle, Wash.

Radio Engineering Show, Booth 3047.

CIRCLE 216 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Servo Tachometer

60 or 400 CPS

Available for either 60 or 400 cps 115 v drive, this tachometer delivers an output of 6.0 v per 1000 rpm. Linearity is ± 0.5 per cent above 1000 rpm and ± 0.25 per cent between 1000 and 50 rpm. Total residual voltage is 5.0 mv. The tachometer can be supplied either separately, as shown, or mounted integrally in an a-c servomotor. It is not only a useful component in servo systems but also, because of its accurate linearity, it can be used as an integrator in computing applications.

Diehl Mfg. Co., Dept. ED, Somerville, N. J.

Radio Engineering Show, Booth 2237.

CIRCLE 217 ON READER-SERVICE CARD FOR MORE INFORMATION

1 STANDS OUT!

NEW TYPE 405 SERIES PRECISION PHASE METER

Direct Phase Reading With No Adjustment From 1 cps to 500 kc

FEATURES

0.3 volt sensitivity, 1/4° relative accuracy. Measures a small fraction of 1° from 1 cps to 500 kc. Meter reading independent of signal amplitudes. No ambiguity at zero degree. Provision for self-calibration and self-adjustment. 6.5" long mirror scale on panel meter. New cathode-coupled limiter stages with plate-to-grid degeneration.

SPECIFICATIONS

Frequency Response: Type 405—10 cps to 100 kc; Type 405H—10 cps to 500 kc; Type 405L—1 cps to 20 kc. Phase Range: 0-12, 0-36, 0-90, 0-180 and 180-192, 180-216, 180-270, 180-360 degrees. Accuracy: 0.25° relative, 2% absolute. Input Voltage: 0.3 volt to 70 volts for Type 405 and 405L; 2 volts to 40 volts for Type 405H. Price: Type 405—$485.00; Type 405H—$524.00; Type 405L—$546.00.

Visit our Booth No. 3412 at the Coliseum

ADVANCE Electronics Lab., Inc.
249-259 Terhune Ave.. Passaic, N. J.

CIRCLE 218 ON READER-SERVICE CARD FOR MORE INFORMATION

Tubular's model 81 the Versatile riveter

- **AUTOMATICALLY feeds and sets any style of TUBULAR's rivets up to 16/16" long x 9/64" diam. heavy setting or 3/16" diam. light setting.**
- **can permanently fasten HUNDREDS of different products.**
- **precision automatic setting to SAVE you hours of fastening TIME and LABOR.**
- Motorized or pneumatic operation.
- Has 10" throat.
- Anvil Arm or Horn Adjustment of 19".
- Rivet-setting speed limited only by speed of operator.
- Single revolution clutch eliminates repeat settings, prevents damage to your products.
- Accessories include dial tables, loop anvils, etc. for more economical fastening.

Fastening "the *Tubular* Way" — with a Model 81 single head automatic riveter will equip your production line with the most versatile of riveting machines. Hundreds of products are permanently fastened every hour of the day with this versatile machine. There is no limit to its uses. The savings you can realize in labor and assembly time can be substantial. *For further information on this Model 81 or Tubular's other automatic riveting machines, write direct or call your nearest Tubular Branch Office.*

BRANCH OFFICES
BUFFALO • CHARLOTTE
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SAN FRANCISCO • SEATTLE

Tubular Rivet & Stud Company
Wollaston (Quincy) 70, Mass.
See your local classified directory for phone numbers

CIRCLE 219 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Power Transient Analyzer

Single-Step Technique

The Model TA-120 measures and records generator output voltage, frequency and KVA, providing this information simultaneously under both steady-state and transient conditions. Appropriate scales for metering voltage, frequency or KVA can be selected on dials, and accuracy is within 0.1 per cent for voltage and frequency and within 1 per cent for a constant phase to neutral voltage.

The voltage channel measures 120 to 416 v potentials across standard Y-connected circuits. Any one of four nominal voltages—120, 208, 240 or 416 v—can be selected. Step response of this channel is 15 milliseconds between the 10 per cent and 90 per cent point. The frequency channel measures frequencies from 46 to 54, 56 to 64 and from 375 to 425 cps. Three frequency scales—50, 60 and 400 cps—are available. Step response is 4 milliseconds between the 10 per cent and 90 per cent points.

American Machine & Foundry Co., Dept. ED, 1085 Commonwealth Ave., Boston 15, Mass.
Radio Engineering Show, Booth 1506-1508.

CIRCLE 222 ON READER-SERVICE CARD FOR MORE INFORMATION

△ 100 Kv D-C Test Set

For Non-Destructive Tests

For non-destructive testing of insulation the unit here shown develops and reads 100 kv dc. It has sufficient capacity for rapid charging of full reels of cable. It conforms to the new IPCEA standards and to MIL, JAN and ASTM specs. Its features include automatic output shorting, external interlock provision, kv meter and ammeter for determining leakage resistance, and overcurrent trip-out to de-energize hv.

Peschel Electronics, Inc., Dept. ED, 19 Garden St., New Rochelle, N. Y.
Radio Engineering Show, Booth 1921.

CIRCLE 223 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Vacuum Tube Voltmeter

700 Mc Response

With a d-c voltage range from ±1 to ±1000 v and a-c from 1 to 300 v rms, the Type 810-A VTVM exhibits a frequency response of ±1 db from 30 cps to 700 Mc. This meter is single scale calibrated from 0.2 to 500 ohms with 7 multipliers ranging from X1 to X1M. Its accuracy is rated at ±2 per cent of full scale d-c, and ±3 per cent of full scale a-c.

The input impedance of the unit is 100 megohms on all d-c ranges and 10 megohms in parallel with 2 μμf with probe nose cap removed, 3 μμf with cap in place on the a-c ranges.

Weighing 7-1/2 lbs, it measures 6-1/8 x 6-3/4 x 10-5/8 in. The a-c probe is 3/4 in. in diam.

Acton Labs, Inc., Dept. ED, 533 Main St., Acton, Mass.

Radio Engineering Show, Booth 1424.

CIRCLE 229 ON READER-SERVICE CARD

△ UHF Attenuator Panels

Laboratory Standard

These UHF Attenuator Panels, Model AT-106, consist of two or more variable step attenuator assemblies of up to six or twelve steps each. They are interconnected to provide a wide range of attenuation values. Increments as low as 0.1 db, and ranging in total attenuation to values up to 120 db may be obtained.

Empire Devices Products Corp., Dept. ED, 38-15 Bell Blvd., Bayside, N.Y.

Radio Engineering Show, Booth 3818-3820.

CIRCLE 230 ON READER-SERVICE CARD

△ Three-Position Controller

Fast Action

The unit corrects a signal to a specific point within a preset range. Two contact meter-relays are included in the circuit to provide limit control, but they are adjusted so that there is none of the delay inherent with periodic locking and unlocking of contacts while a signal is being sampled. Corrective action is steady rather than pulsing.

One of the meter-relays used in the control is a double contact model, adjusted for both high and low error. The other is a single contact model on which a control point is preset anywhere between the high and low limits of the first meter-relay. The control may be furnished with meter-relays in most standard ranges. The single contact meter may be adjusted to coast the signal back to the control point.

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

Radio Engineering Show, Booth 3916-3918.

CIRCLE 237 ON READER-SERVICE CARD

△ Silicone Resistors

For Power Application

The Type R silicone coated miniature resistors with radial leads in 3, 5, 7 and 10 w powers, and the Type BT, a metal-clad subminiature resistor in 10 and 15 w powers, aluminum housed, are available in tolerances from ±3 per cent to ±0.05 per cent. They meet the requirements of MIL-R-26B.

Sage Electronics Corp., Dept. ED, 302 N. Goodman St., Rochester 7, N.Y.

Radio Engineering Show, Booth 3945.

CIRCLE 238 ON READER-SERVICE CARD

△ Shock Mounted Crystal
16 Kc to 350 Kc

These crystals have a frequency range of 16 kc through 350 kc, with lower frequencies possible in holders of different configuration. They have withstood shock tests of 100 g. Vibration per Mil-T-5422, Mil-E-5272 and Mil-E-5400 met with this unit without adverse results.

Storage temperatures over a range of −65 to +135 C can be coupled with an operation temperature range of −55 to +100 C. Excursions of frequency as low as ±0.015 per cent are available over this range. Reference Mil-C-3098B Types CR-37/U, CR-38/U, CR-42/U and CR-50/U.

Bulova Watch Co., Inc., Dept. ED, Electronics Div., 40-06 62nd St., Woodside 77, N.Y.

Radio Engineering Show, Booth 3930.

CIRCLE 243 ON READER-SERVICE CARD

△ Power Relay
For Aircraft

The Type 57 power relay meets the applicable parts of MIL-R-5757C, MIL-R-25018, MIL-R-6106B and MS-25024. It has 4pdt contacts rated at 10 amp dc resistive load. Its temperature range is from −65 to +125 C, and operation vibration rating is 10 g at 10 to 500 cy per min. Operating shock is 25 g.

Phillips Control Corp., Dept. ED, Joliet, Ill.

Radio Engineering Show, Booth 2714.

CIRCLE 244 ON READER-SERVICE CARD

△ TACAN Test Set

For In-Plane Testing

This test set may be used with either military airborne TACAN (AN/ARN-21) or the new commercial version of airborne TACAN. The test set, designated as Type FTR 3156, provides testing of frequency, sensitivity, power output, range, bearing, and identity tone.

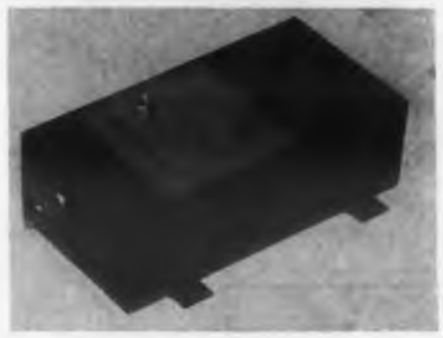
It weighs 17 lbs and measures 9 x 7 x 11-1/2 in. It has a handle for carrying and operates from standard aircraft power outlet (115 v 60 to 1000 cps, ac). No direct connection to the aircraft is needed. The unit is rainproof.

Federal Telephone and Radio Co., Dept. ED, 100 Kingsland Rd., Clifton, N.J.
Radio Engineering Show, Booth 2510-2625.

CIRCLE 245 ON READER-SERVICE CARD

△ Fork Unit

For High Vibration Applications



The sensitivity to external vibrations of this unit is reduced at least one order of magnitude through a vibration range of 2 to 2000 cps. No shock mounts are used. Inherent stability is 0.001 per cent at ±5 C or 0.00001 per cent with oven. Fork frequencies from 1000 to 4000 cps are available.

Times Facsimile Corp., Dept. ED, 540 W. 58th St., New York 19, N.Y.
Radio Engineering Show, Booth 1824.

CIRCLE 246 ON READER-SERVICE CARD

△ Decade Counting Units

Use Low Power

Operating from a plate supply of 150 v dc at 7.5 ma from 0 to 100 kc, these decade counting units have direct read-out in decimal numerals, a counting rate of 100,000 pps, a pulse pair resolution of 5 μsec. They require a negative pulse of 35 to 75 v peak with a rise time of 0.8 μsec and a duration of 2 μsec. The Model 100LA (pulse) output characteristics are a negative pulse, approximately 50 v peak, the Model 100LB (analog), a staircase and negative pulse of approximately 50 v peak, and the Model 100LC (binary) a 4-line 1-2-2-4 binary coded and pulse of approximately 50 v peak. These units are of modular plug-in construction and weigh 14 oz, with dimensions of 1-3/8 x 5-1/2 x 5-1/2 in., utilizing 4 type 5963 tubes.

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

Radio Engineering Show, Booth 1620-1622.

CIRCLE 251 ON READER-SERVICE CARD

△ Precision Differentials

Use No Oil

All parts of the Models V10, V11, and V12 are stainless steel except the aluminum spider gear. The units are black anodized. Lost motion between any two end gears is not more than 30 min of arc. They feature a removable clamp ring for assembling end gears, and have 1/8, 3/16 and 1/4 in. shafts –72, 64 and 48 pitch.

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

Radio Engineering Show, Booth 3057.

CIRCLE 252 ON READER-SERVICE CARD

△ Strain Analyzer

Static and Dynamic

The Model PA-2A provides amplification and control for the measurement and oscilloscope display of statis and dynamic strain. Sensitivity is provided by combining a 400 cy chopper and amplifier, with a resulting noise level of approximately 3 μv. Amplifier frequency response is flat from 5 cps to 50 kc. Any resistive type strain gage may be used. Two strain measuring ranges of ±5,000 and ±10,000 microinches per in. read directly on a 10 turn dial permit peak to peak measurements of dynamic strain. This analyzer operates on ac.

Polyphase Instrument Co., Dept. ED, Bridgeport, Pa.

Radio Engineering Show, Booth 2235.

CIRCLE 253 ON READER-SERVICE CARD

△ Size 15 Servo

Has High Torque For Size

A 60-cycle two phase servo with exceptionally high torque for its size and weight is now available. Coded Type 15-5156-03, it is a size 15 servo, weighing 7.6 oz, but delivering 1.45 in.-oz, minimum stall torque. Phase 1 is 115 v and phase 2 115/57.5 v. The unit comes housed in stainless steel. It can be built to conform to MIL-E-5272A. Speed is 3200 rpm at no load; at stall, current is 0.06 amp per phase and power 6.1 w per phase.

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

Radio Engineering Show, Booth 2129.

CIRCLE 254 ON READER-SERVICE CARD

△ Digital Printer
For Binary Code

Featuring rapid print-out, parallel entry, and up to 12 digit printing, this unit uses no stepping switches and can be connected to other electronic counting instruments. It will print, on standard adding machine tape, the total count accumulated by the basic instrument during each of its counting periods. The recycling rate may be increased several hundred per cent. The CMC Model 400A Digital Printer has been designed to operate from 4-line 1-2-3-4 binary code.

Specifications include: print-out capacity, 6 digits (up to 12 digits optional), accuracy, and counting period identical to characteristics of counting instrument, display time, 0.2 sec minimum controlled by counting instrument, dimensions: 14 in. width x 8 in. height x 10 in. diam.

Computer Measurements Corp., Dept. ED, 5528 Vineland Ave., No. Hollywood, Calif.
Radio Engineering Show, Booth 3501-3503.

△ Push-On Connectors
Subminiature

These push-on connectors are made in the following types: straight plug, angle plug, straight jack, and three types of panel jacks; 1/4 in. double D hole, 5/16 in. double D hole and 5/16 in. keyed hole. They are available in miniature and subminiature sizes up through 1/4 in. maximum O.D. The outside dimensions of each unit remain constant regardless of cable size used. Three types of receptacles are available for the above plug and a feed-through adapter.

Automatic Metal Products Corp., Dept. ED, 315 Berry St., Brooklyn 11, N.Y.
Radio Engineering Show, Booth 4426.

△ Tiny Test Point Jack

Bulldog Grip

Designated Type SKT-10, this tiny test point jack has exceptional holding power. A four-leaf floating contact of heat-treated beryllium-copper provides maximum and lasting spring power. The metal insert is gold-over-silver plated. Insulation is Teflon. The jack meets MIL spec requirements. This SKT-10 test point jack is press-fitted into a chassis hole with a simple insertion tool, needing neither hardware nor sealing. It mounts even into thin aluminum stock, eliminating insulating panels, and is available in eight RETMA colors.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.

Radio Engineering Show, Booth 3714.

CIRCLE 261 ON READER-SERVICE CARD

△ Recording Oscillograph

For Guided Missiles

Weighing 15 lbs, the Model 561 measures 5 x 6 x 9 in. and can withstand shock accelerations over 1500 g. It is designed to operate in an ambient of −65 to +160 F and at altitudes from 0 to 70,000 ft. Paper speeds are 1/2 to 80 in./sec. The magazine will hold 95 ft of DuPont Lino-Writ No. 4. This recording oscillograph handles up to 20 channels.

Midwestern Instruments, Dept. ED, P.O. Box 7186, Tulsa, Okla.

Radio Engineering Show, Booth 3103.

CIRCLE 262 ON READER-SERVICE CARD

KAY

Microwave Mega-Nodes

Calibrated Noise Sources at Microwave Frequencies

Designed for the measurement of noise figure, receiver gain, and to calibrate standard signal sources in radar and other systems, the Kay Microwave Mega-Nodes are available with either argon or fluorescent tubes. Argon tubes cover the ranges from 1200-1400 mc and 2600 to 26,000 mc; fluorescent tubes from 1120-12,400 mc.

SPECIFICATIONS

Noise Output, all sizes: Fluorescent, 15.8 db ±0.25 db; argon, 15.28 db ±0.1 db.
Temperature Correction Factor: Fluorescent,—0.05 db per degree C above 32 degrees C. Argon—no temp. coefficient
Power Supply: Input approx. 65 watts, 117 V (±10%), 50-60 cps ac.
For Complete Information Regarding These, and Other Kay Instruments, Write:

KAY ELECTRIC COMPANY

Dept. ED-3, 14 Maple Avenue, Pine Brook, N. J. CAldwell 6-4000

Prices:*

Universal Power Supply $100.
RG-69/U $400.
RG-48/U 195.
RG-49/U 195.
RG-50/U 195.
RG-51/U 195.
RG-52/U 195.

*One power supply and any 3 of the following waveguides: RG-48/U, RG-49/U, RG-50/U, RG-51/U, RG-52/U, PRICE $600. Additions of any of the above waveguides to the set of 3, $167.

SEE US AT THE IRE SHOW BOOTHS #2608-09-10

CIRCLE 263 ON READER-SERVICE CARD FOR MORE INFORMATION

from DIT-MCO, Inc.

. . . another startling new development in automatic electrical system testing!

New Model 850

MULTIPLIER SECTION

featuring . . .

plugboard programming

new jumper-wire system simplifies test make-up and maintenance testing

Model 850 multiplier section mobile unit, with DIT-MCO model 200 Circuit Analyzer.

Now! In one operation at his desk, planner can design circuitry, layout matrix chart and jumper plugboard to conform to test sequence.

Now! Thorough, periodic maintenance tests can be made quickly and economically throughout the life of any airplane or missile.

Now! Test Modified Wiring Systems Without Altering Adapter Cables!

Do modified and improved electrical systems throw your testing section into a tailspin? Normally, it means existing test machinery (or the adapter cables, if DIT-MCO equipment is used) must be changed to conform to the circuit modifications. Here's how the new DIT-MCO plugboard system has solved that problem.

Circuitry can now be connected to the tester by the most convenient point-to-point method. Connecting wires (adapter cables) do not have to conform to any pattern. The testing sequence is programmed, quickly and easily, on the portable plugboards. Any subsequent circuit modifications are also handled on the plugboards . . . without changing existing adapter cables.

This is just one advantage offered by this new development. Write for full details on how DIT-MCO can help solve all your test problems.

Write today for complete information:

ENGINEERS:

DIT-MCO needs executive calibre sales and design engineers *right now!* Excellent opportunity with respected organization on *the move.* Work with key men in aircraft and missile industries. Write today!

DIT-MCO, INC.
Electronics Division

Box 03-20, 911 Broadway
Kansas City, Missouri

Partial List of DIT-MCO Users:

Bell Aircraft Corporation, Texas Div. • Bendix Aviation Corporation, Sidney, New York • Boeing Airplane Company, Seattle, Washington and Wichita, Kansas • American Bosch Arma Corporation • Douglas Aircraft Company, Tulsa, Oklahoma • Fairchild Aircraft Division • Goodyear Aircraft Corporation • Martin, Baltimore • Naval Ordnance Laboratory, White Oaks, Maryland • Northrop Aircraft, Inc. • Motorola, Inc. • Temco Aircraft Corporation • Trans World Airlines • Convair • Chance Vought Aircraft • Servomechanisms, Inc. • Radio Corporation of America • Pacific Mercury Television Mfg. Corp.

CIRCLE 264 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW . . . COMPACT . . .

Energy Cartridge

For high loads at minimum deflection

The Energy Cartridge* fills the need for a spring with constant load deflection characteristics acting in compression. It is a one-piece unit of preassembled Belleville washers . . . stacked in varying sequence according to load and space requirement. For complete information about this versatile spring write for booklet "Energy Cartridge."

*Reg. U. S. Pat. Off.

ASSOCIATED SPRING CORPORATION

General Offices: **Bristol, Connecticut**

CIRCLE 265 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW TEFLON SILICONE HERMETIC TERMINAL

For electronic components in the intermediate voltage range, 1500 V operating.

Lundey Series 399 Hermetic Terminals are rugged, simply constructed terminals, utilizing Teflon and silicone rubber for improved performance. Designed to meet MIL-T-27A specifications, they have an operating voltage of 1500, test voltage of 4000 and current rating of 10 amps. Assembly needs only simple tooling. Depending upon the electrode, assembly is accomplished by clinching in a press with rudimentary jigging, or by drive fit with a press. As an added service, Lundey Associates will install terminals in customers' covers. The hermetic seal is completed by soldering the eyelet to the electrode at the time internal leads are soldered.

Available in three electrode styles: hollow electrode with lug, for minimum clearance; solid electrode with single turret; solid electrode with double turret.

Send for Lundey Bulletin #399.

LUNDEY ASSOCIATES

694 Main Street • Waltham 54, Massachusetts

CIRCLE 266 ON READER-SERVICE CARD FOR MORE INFORMATION

Vacuum Cell

Senses Pressure Changes

By means of a sealed metal bellows, which changes pressure on a load cell, a device with no moving parts, this vacuum cell senses changes in atmospheric pressure. With a power rating of 1 w, it operates directly into an ohm meter, or as a function of a circuit without amplification. The unit has a preloading adjustment, making initial resistance values to match a circuit parameter.

The size of the cell is 1/2 in. diameter by 1-1/2 in. overall, and has a total weight of 22 grams.

Clark Electronic Labs., Dept. ED, Box 165, Palm Springs, Calif.

CIRCLE 267 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Automatic Tube Tester

Uses Punched Cards

In the Model 123 tube tester pre-selected voltages on screen, grid, plate or filament are tabulated on an automation card. The 0.22 v rms signal used on the grid permits testing of the newer sensitive tube types without distortion. A large number of controlled voltages are furnished for testing tubes used in special-purpose circuits. Cut-off point, zero bias current (up to 200 mils) and other specific controlled emission or gm tests at designated points can be made.

Regulated d-c voltages available from this unit are 12 to 160 v plate, and 12 to 160 v screen, with combined plate and screen currents up to 100 ma. Bias voltage varies from 0.1 to 100 v. Filament voltage is 0.1 to 119.9 v ac, and signal is 0.22 v.

The Hickok Electrical Instrument Co., Dept. ED, 10514 Dupont Ave., Cleveland 8, Ohio.

Radio Engineering Show, Booth 3516-3518.

CIRCLE 268 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW—self-locking UNBRAKO socket head cap screws

The Nylok* self-locking feature locks these screws securely in place, seated or unseated, wherever you stop wrenching! They won't work loose. Can be used repeatedly. Tough, resilient nylon locking pellets permanently installed. Successfully withstand temperatures ranging from —70 to 250°F. Familiar UNBRAKO knurled heads for sure finger grip and fast assembly—accurate hex sockets for positive, nonslip internal wrenching. Heat treated alloy steel, controlled fillets, continuous grain flow lines, fully formed Class 3A threads for maximum strength and exact fit. Can be used as adjusting screws. Pellets act as liquid seals. Standard sizes from #6 to 1 in. diameter. Also available in plated finishes and in stainless steel. Write for Bulletin 2193. Unbrako Socket Screw Division, STANDARD PRESSED STEEL Co., Jenkintown 12, Pa.

*TM Reg. U.S. Pat. Off., The Nylok Corporation

STANDARD PRESSED STEEL CO.

UNBRAKO® SOCKET SCREW DIVISION

Unbrako Products are sold through Industrial Distributors

SPS JENKINTOWN ■ PENNSYLVANIA

CIRCLE 269 ON READER-SERVICE CARD FOR MORE INFORMATION

TRANSISTOR CLIP

Patent Pending

A silver-plated beryllium copper clip for holding G.E. and Texas Instrument oval silicon transistors under the rugged requirements of aircraft and missiles. This clip has been designed by a company* that knows these requirements at first hand.

See this NEW IDEA and many others for holding components under conditions of extreme heat, shock and vibration.

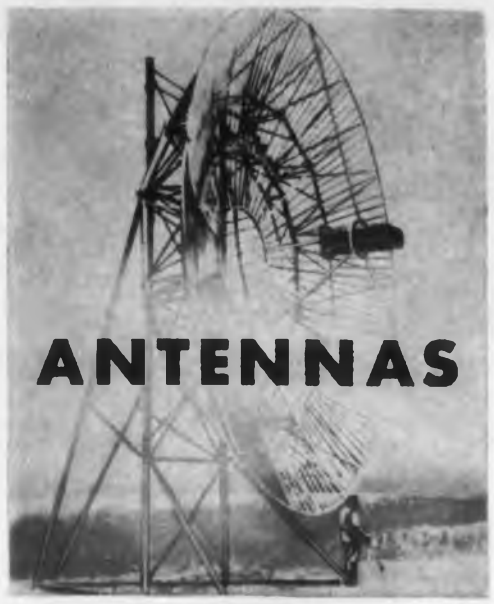
BOOTH 4235—I. R. E. SHOW

*Manufactured and sold under exclusive license from Northrop Aircraft, Inc.

ATLAS E-E CORPORATION

47 Prospect Street • Woburn, Massachusetts
3757 Wilshire Blvd. • Los Angeles, California

CIRCLE 270 ON READER-SERVICE CARD FOR MORE INFORMATION



ANTENNAS

Antennas for every need: airborne, telemetering, point-to-point, glide path, and dishes ranging from 4′ to 60′. Design development and manufacture of antennas is our business. Send for technical catalog . . .

BOOTH 1428 AT New York IRE Show

TACO
TECHNICAL APPLIANCE CORPORATION
SHERBURNE, N. Y.

CIRCLE 271 ON READER-SERVICE CARD FOR MORE INFORMATION

If it's HOT or DRY

USE 'DIAMOND H' SERIES R RELAYS

Where the temperature hits 200°C . . . or drops to —65° . . . where a dry circuit is downright arid . . . or a power circuit employs 10 amperes (or even 20 amps for a short life need) . . . your best bet for reliability is a "Diamond H" Series R miniature, hermetically sealed, aircraft type relay. Their shock and vibration resistance you may take for granted.

Variations on the basic 4 PDT Series R relay perform outstandingly over such a broad area that they are frequently used to do many different types of jobs in a given application, with resultant savings in spare part inventories. The range of possible characteristics covers:

Various brackets of vibration resistance from 10 to 2,000 cps, coil resistances from 1 to 50,000 ohms, operational shock resistances of 30, 40, or over 50 "G"; mechanical shock resistance to 1,000 "G", contact capacities from 350 V., D.C., 400 MA, to 10 A., at 30 V., D.C., as well as signal circuits.

For complete information send for a copy of Bulletin R-250

THE HART MANUFACTURING COMPANY
210 Bartholomew Avenue, Hartford, Conn.

CIRCLE 272 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Pulse Generator

Provides Clock Pulses

A standardizer Pre-Amplifier Input is incorporated in the Model 100B. The unit generates standard 2.5 v system pulses and 25 v variable amplitude pulses of both polarities, with digitized pulse interval selection. The new Input Standardizer section will trigger on any waveform with a positive rise time of at least one μsec, and ten v amplitude.

The unit is designed to operate as a general purpose laboratory generator, or to provide accurately timed clock pulses for logic units. Pulse intervals of 10 to 100 μsec in decade one μsec steps (plus or minus 2 per cent accuracy) are complemented by an extended range position to 150 Kc, a doubler for low frequency extended range, and push-button operation. Output impedance of the variable 25 v pulse is 5 kv with pulse width of 1.5 μsec and rise and fall times of .25 μsec.

The transformer coupled output stage of the standard negative 2.5 v pulse has a constant voltage characteristic which maintains an undeteriorated pulse when loaded between 0 and 200 ma. output current; or into resistive loads as low as 15 ohms.

A scope synchronizing pulse for a sweep lead of .3 μsec is also available from this unit.

The unit requires only —10 v and an average current range of 20 ma at 100 kc.

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

Radio Engineering Show, Booth 1909.

CIRCLE 273 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Relay Antenna

7000 Mc

This relay antenna has 65 to 70 per cent gain efficiency over a 5925 to 8100 mc frequency range. The sidelobes are 24 db down and the VSWR is 1.15 over the band. Parabolic reflectors of 4, 6, 8, and 10 ft are available.

The Gabriel Co., Dept. ED, Electronics Div., 135 Crescent Rd., Needham Heights 94, Mass.

Radio Engineering Show, Booth 2917-2918.

CIRCLE 274 ON READER-SERVICE CARD FOR MORE INFORMATION

get this FREE BOOK TODAY!

ALL ABOUT ENVIRONMENTAL TEST EQUIPMENT

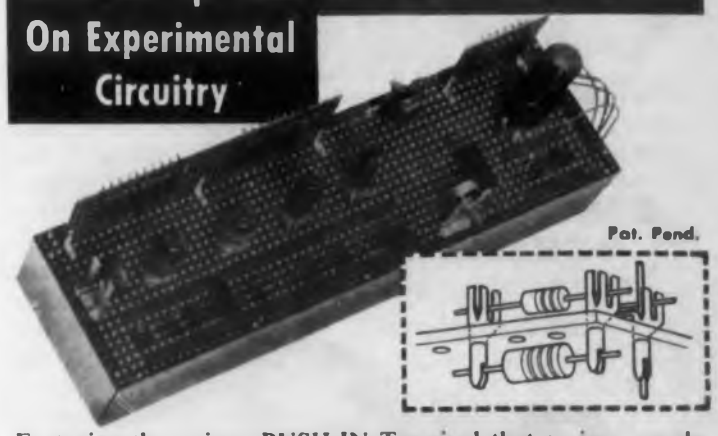
This 20 page digest of the M & M line of environmental test equipment gives you quick facts on the application, performance and economies of Murphy & Miller equipment. Illustrates and describes the industry's most modern units—provides tips on selection and use of all types of environmental test units. Write for it today.

MURPHY & MILLER, INC.
1350 South Michigan Avenue
Chicago 5, Illinois

CIRCLE 275 ON READER-SERVICE CARD FOR MORE INFORMATION

Vector EXPERIMENTER'S CHASSIS

Save Set-up Time On Experimental Circuitry



Featuring the unique PUSH-IN Terminal that springs snugly into the holes of the board to provide quick set up of circuitry. The serrated edges of the terminal forks firmly grip the leads of resistors and capacitors for testing without soldering. Terminal has through hole, two side connections and small fork for transistor leads. Kit, sockets and brackets assemble with self-tapping screws.

Write for complete information.

VECTOR ELECTRONIC COMPANY
3352 SAN FERNANDO ROAD
LOS ANGELES 65, CALIFORNIA
TELEPHONE CLinton 7-8237

CIRCLE 276 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Tube Tester
Universal Type

With the Model RMP 400, sixteen different types of tube bases are acceptable through as many socket adaptors. A patented adaptor to cross rail busbar construction insures that any future type of tube—irrespective of base or internal connections can be tested. There are fourteen meters with an accuracy of ±1.5 per cent full scale deflection. Meter protection is provided by relay devices. The unit uses rotary stacked selector switches.

In addition to testing tubes at rated characteristics complete families of curves can be plotted point by point. This applies not only to normal static characteristics but also to dynamic mutual conductance. Tubes can be tested for inter-electrode shorts and vacuum. Leakage can be detected. The mechanical structure is extremely rugged. A specially designed tubular carrier on caster wheels provides mounting and mobility. The weight including the carrier is four hundred pounds.

J. V. Kane & Co., Dept. ED, 1004 Cloverhill Rd., Wynnewood, Pa.
Radio Engineering Show, Booth 3014.

CIRCLE 279 ON READER-SERVICE CARD FOR MORE INFORMATION

△ VTVM
Laboratory Precision

The accuracy of the Model 1800-8 is better than ±2 per cent on all ac and dc voltage ranges, and its shielded diode probe is designed for use into the uhf range. It has a high input impedance, dc polarity switch, illuminated meter scale with mirror and knife-edge pointer. All input terminals are insulated from the panel.

General Radio Co., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.
Radio Engineering Show, Booth 2319, 3302-3306.

CIRCLE 280 ON READER-SERVICE CARD FOR MORE INFORMATION

△ **RF Voltmeter**

Has 400 μv Sensitivity

The 91B rf voltmeter covers frequencies from 0.2 to 500 mc and is useful up to 1000 mc with reduced accuracy. The voltage calibration extends from 0.001 to 3 v, but detection of signal levels as low as 400 μv is possible.

Two probes are supplied with the meter, one for general purpose high impedance work, the other a low VSWR 50 ohm probe for monitoring high frequency coaxial systems. Each probe contains a full wave diode detector with rms response at levels below 0.1 v.

Boonton Electronics Corp., Dept. ED, Morris Plains, N.J.

Radio Engineering Show, Booth 3121.

CIRCLE 285 ON READER-SERVICE CARD FOR MORE INFORMATION

△ **Adjustable DC Power Packs**

Transistorized

These new models are designed for either 60 or 400 cy operation, 105 to 125 v a-c input and are available for output ranges of 5 to 10, 10 to 20, 20 to 30, 30 to 40, 40 to 50, 50 to 55 v dc in current ratings up to 200 ma. These adjustable models are also available for 100, 150, 200, and 300 v outputs at 100 ma ratings. Line regulation is better than 0.5 per cent; load regulation is better than 0.5 per cent. Ripple is less than 0.05 per cent.

Units are potted in transformer type housing but transistors are available for servicing and replacement. Voltage variation is made via screwdriver adjustment. Size of a typical 60 cy unit is 2-1/2 x 3 x 4 in. and the 400 cy equivalent is correspondingly smaller.

Electronic Research Assoc., Inc., Dept. ED, 67 E. Centre St., Nutley 10, N.J.

Radio Engineering Show, Booth 2705.

CIRCLE 286 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Digital Comparator

Provides Servo Control

This digital comparator is designed for use in digital servo control systems. In conjunction with a 13-bit or 19-bit shaft position to the digital converter, the digital comparator can provide digital control through conventional servo amplifiers and motors. A 19-bit comparator allows control to one part in 524,288.

No relays or tubes are used. A built-in preamplifier provides adjustable gain up to 5 v maximum at 1000 ohms output impedance. The comparator has zero dead time. Voltage requirements are −40, −20 and +20 v dc and 115 v at carrier frequency.

Norden-Ketay Corp., Dept. ED, Commerce Rd., Stamford, Conn.

Radio Engineering Show, Booth 2401-2403.

CIRCLE 290 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Data Counters

Visual and Electrical Readout

Electrically or mechanically driven and provided with manual or electric reset, these counters show accumulated totals and automatically create specific control circuit contact closures for each number displayed. The electrically operated counter with electrical reset is illustrated. These instruments, with their five figure capacity, each provide 100,000 circuit arrangements. The counters are compatible with standard data processing equipment.

Veeder-Root, Inc., Dept. ED, Hartford 2, Conn.

Radio Engineering Show, Booth 1523.

CIRCLE 291 ON READER-SERVICE CARD FOR MORE INFORMATION

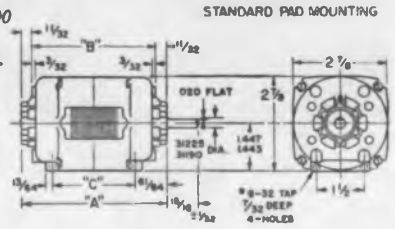
MINIATURIZED

NEW

HOWARD MODEL 9200 INDUCTION MOTOR

Unusual Power in A Small Frame Size

HOWARD MODEL 9200 1/300 to 1/30 h.p. Permanent Split Capacitor, Single Phase, 50/60 Cycle Induction, Torque, Synchronous Type—Also available in two or three phase designs.



Now available from Howard Industries, Inc. is an exclusive Miniaturized Induction motor with all the features of an ultra modern power motor for use in tape recorders, communication equipment, office machines, turn table, movie projectors, air craft, instruments, electronic devices and many more applications.

Howard's Model 9200 has been rated by experienced engineers as the finest small induction motor on the market. Performance ratings of these motors are outstanding, comparable to those of considerably larger frame sizes. For complete details, engineering drawings and samples, write, wire or phone HOWARD today.

HOWARD

Other Howard motors: UNIVERSAL & D.C. 1/200 to ½ h.p. • SHADED POLE 1/2000 to ⅙ h.p. • INDUCTION 1/1400 to ⅛ h.p. • SERVO MOTORS • GEAR MOTORS • BLOWERS

HOWARD INDUSTRIES, INC. 1725 State St., Racine, Wisc.

Divisions: Electric Motor Corporation—Cyclohm Motor Corporation—Racine Electric Products

CIRCLE 294 ON READER-SERVICE CARD FOR MORE INFORMATION

SHORT . . . in size LONG . . . in performance

NEW SODECO Type TCeBZ Electric Impulse Counters

The latest in the SODECO line, these new electric impulse counters offer designers a wonderful opportunity to squeeze a high-performance impulse counter into a very limited space.

Look at these features:

- AC or DC Models
- Counters measure as little as 1-3/8" wide x 2-1/16" high x 1-3/4" deep (designed for flush mounting)
- 4 or 5 digit models available
- Fast—can count up to 25 impulses/sec.
- Low power demand—as low as 1 W DC at 10 impulses to 6.5 W AC max. at top speed
- Instantaneous mechanical push-button reset

You'll want more information on these unique counters. Write to—

LANDIS & GYR, INC.

45 West 45th Street, New York 36, N. Y.

CIRCLE 295 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Single Turn Potentiometer

For Precision Applications

The resistance element and terminal leads of this potentiometer are moulded into a single unit. Units may be ganged and each cup may be individually phased in the field. All models have ball-bearing mounted shafts.

The 910 Series Micropot has a power rating of 5 w at 40 C, and a resistance range of 50 to 10,000 ohms, (50,000 ohms, special), standard tolerance ±5 per cent. Standard linearity accuracy is ±0.5 per cent independent. Starting torque is 0.5 inch-ounce per section. Continuous mechanical rotation, 340 or less electrical rotation. Net weight is 4 oz per single unit, with 1 oz added for each additional unit. The length of a single unit is 1-3/64 in., width, 1-7/8 in.; the shaft is 5/8 in. long with special lengths available.

George W. Borg Corp., Borg Equipment Div., Dept. ED, Jamesville, Wisc.

Radio Engineering Show Booth 3840-3842.

CIRCLE 296 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Pulse Packages

High Power or Trigger

The High power pulse package is built around the charging choke, pulse-forming network and pulse transformer of the line-type modulator, and is designed to provide an optimum required pulse shape.

The trigger-pulse package is designed to generate pulses of the required power and impedance to trigger any high-power hydrogen thyratron tube.

Filtron Co., Inc., Dept. ED, Flushing, L.I., N.Y.

Radio Engineering Show, Booth 2812.

CIRCLE 297 ON READER-SERVICE CARD FOR MORE INFORMATION

Designers—Engineers:

ADVAC TERMINALS

OUTSTANDING DESIGN ADVANTAGES INCLUDE —

- Immunity to Thermal Shock
- High Mechanical Strength
- Maximum Voltage 65,000 V.
- Adaptable for Brazing, Welding or Soft-soldering

Specify ADVAC for temperatures to 1400°F, pressures to 2000 P.S.I.

ADVAC Hermetic Seals are produced under an exclusive process that provides a superior seal capable of withstanding gruelling environmental conditions. Advac terminals feature a metallized high grade alumina construction that provides a super-strength seal. Performance-proven in critical commercial and military applications, ADVAC seals are available in standard types or custom designs for special requirements.

NEW BULLETIN — contains complete information on the ADVAC line. Address inquiries to Dept. DN.

ADVAC TERMINALS ARE PRODUCTS OF —

ADVANCED VACUUM PRODUCTS • INC

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430 FAIRFIELD AVENUE, STAMFORD, CONN.

Telephone: DAvis 4-2148

A DIVISION OF GENERAL CERAMICS CORPORATION

CIRCLE 298 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Video Monitors
Have DC Restorer

Designed for closed-circuit TV systems, these direct view monitors have eleven tubes and an aluminized picture tube. They are available in 14, 17 and 21 in. screen sizes. Total weight is 55 lbs for the 17 in. unit. The model DVM monitors which have a d-c restorer circuit have a video response within 1 db up to 10 mc. The input, either composite video or separate sync and video, handles a peak to peak voltage range from 0.25 to 5.0. Power requirement is 140 w from a standard 105 to 130 v 60 cy source. The operating temperature range extends from —10 C to 50 C.

Blonder-Tongue Labs. Inc., Dept. ED, 526-536 No. Ave., Westfield, N.J.

Radio Engineering Show, Booth 1210.

CIRCLE 301 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Network Switching Relay
Handles High Voltages

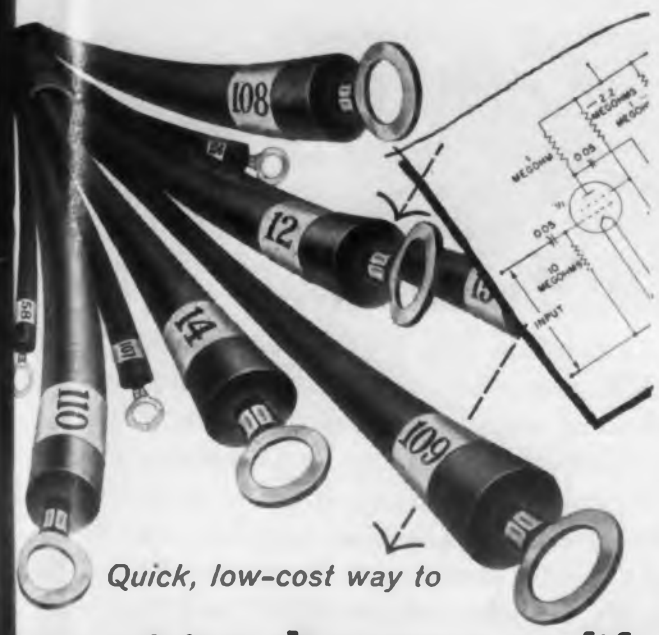
The Model BL-148 is a high voltage, hermetically sealed, armature type relay. It consists of one set of SPST high voltage switch elements and two sets of low voltage SPST elements, simultaneously operated from a 26.5 v d-c source. The high voltage elements are rated to handle 7500 v and 90 peak amps, 3.0 amp rms; the low voltage elements are designed to handle 1000 v and 1.6 amp dc. The switching time is less than 0.1 sec. The switch portion is immersed in silicone oil during high voltage operation.

This unit weighs 3.6 oz and has over-all outline dimensions of 3 in. length and 1-1/16 in. diam.

Bomac Laboratories, Inc., Dept. ED, Salem Rd., Beverly, Mass.

Radio Engineering Show, Booth 3815-3817.

CIRCLE 302 ON READER-SERVICE CARD FOR MORE INFORMATION



Quick, low-cost way to

ring wiring diagrams *to life*

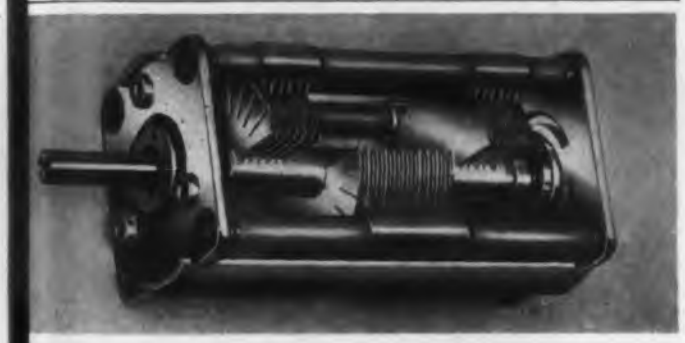
BRADY *PERMA-CODE* WIRE MARKERS

- For any wire, any temperature, any application.
- Tell which wire goes where—for less than 1/8¢ per lead.
- Self-sticking — go on fast.
- Insure proper installation of your electrical system.
- Reduce down-time for repair or trouble-shooting
- 1½" and ¾" lengths stocked by distributors in 160 cities.
- Over 2000 stock markers plus NEMA codes for immediate delivery. 51

Write for FREE SAMPLES you can use!

W.H. BRADY CO. 787 W. Glendale Ave., Milwaukee 9, Wis.
Established 1914

CIRCLE 305 ON READER-SERVICE CARD FOR MORE INFORMATION



Johanson Scanning Capacitor #1741 features rugged instrument quality

• Capacity variation SLC 7.5 mmf. to 128 mmf. • Dynamically balanced rotor designed to operate at 1800 r.p.m. with no vibrational problem • Pink alumina ceramic rods for rotor and stator insulation • Split stators — no wiping contacts • Rugged metal-frame construction — stainless steel ball bearings • Silver plated for high Q • Ideal for use in sweeping and scanning circuits.

Write for complete information

Johanson MANUFACTURING CORP.
16 Rockaway Valley Rd., Boonton, N. J.

CIRCLE 306 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Sine-Cosine Potentiometer

Two Voltage Outputs

The model C-300, a three-inch enclosed sine-cosine function potentiometer, has two separate voltage outputs. Independent brush contacts are mounted on a common shaft 90 degrees apart to produce sine and cosine voltages. Function accuracies of 1 per cent are standard; function angle is 360 degrees. Either sleeve or ball bearings can be supplied in one piece machined aluminum housings. Mounting designs include servo, three hole with central pilot, or threaded bushing. Multiple ganged units are available with sections in simultaneous or other conformity.

DeJur-Amsco Corp., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N.Y.
Radio Engineering Show, Booth 3911-3913.

CIRCLE 307 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Frequency Meters

0.1 per cent accuracy

The frequency meter assembly is composed of a 3 in. D'Arsonval movement and an accessory box, both components built to conform to applicable military specifications. It can be mounted on control or instrument panels. An accuracy of 0.1 per cent of input frequency is provided at a constant ambient temperature, with input voltages of 120 v ±35 per cent.

All PFM models are available with temperature control to operate in ambient temperatures of –55 C to +55 C. The dimensions of the accessory box for a 400 cycle unit are approximately 1-1/2 in. x 2 in. x 3 in. Power consumption is 1 w with intermittent values of 20 w in temperature controlled models.

American Machine & Foundry Co., Dept. ED, 1101 No. Royal St., Alexandria, Va.
Radio Engineering Show, Booth 1506-1508.

CIRCLE 308 ON READER-SERVICE CARD FOR MORE INFORMATION

HERMASEAL . . . Specialists in Glass-to-Metal Seals!

Hermaseal

CALL US ON STANDARD AND SPECIAL TERMINALS.

Hermaseal OCTAL Plug. ▶

Hermaseal

. . . A successful pioneer since 1943 in glass-to-metal seals, compression (cold rolled steel) and matched (Kovar), to meet *your* needs.

Hermaseal NOVAL Header and Bracket Assembly. ▶

Hermaseal

. . . with its expert engineering staff and the latest in production equipment is ready to serve you.

Hermaseal 10M Volt TERMINAL. ▶

For further information, phone 2-3773 or write.

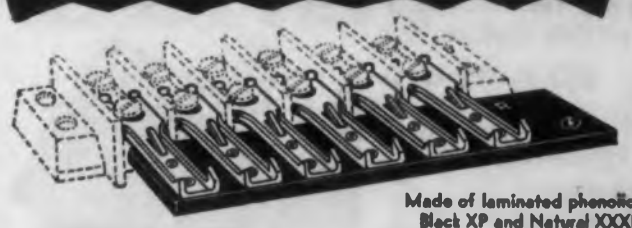
Hermaseal

THE HERMASEAL COMPANY, INC.
1010 N. Main, Elkhart, Indiana

CIRCLE 309 ON READER-SERVICE CARD FOR MORE INFORMATION

Terminal Connecting Strips

For Faster, Better Wiring Of Multiple Connections To Terminal Blocks



Showing No. 650 Strip connected (but not wired) to our No. 600 Terminal Block

Made of laminated phenolic: Black XP and Natural XXXP Lugs are of .031 thick brass, Hot-tinned for easy soldering.

Here is a practical device to simplify wiring work and to assure correct connections. Cable is attached at either end of strip with clamp. Each wire is soldered to terminal lug at raised nib. Pointed ends are clamped over insulation, holding wire fast. Work can be done at bench, or anywhere. Connect to matching terminal block by sliding spade-type lugs under binder screws and tightening. Lugs are double eyeletted and fit snugly between high barriers, so cannot shift. Upturned ends of lugs act as extra 'lock'. Supplied flat, or with 90° angle (A), with cable mounting hole at left (L) or right (R) of strip.

For further information contact our Engineering Department

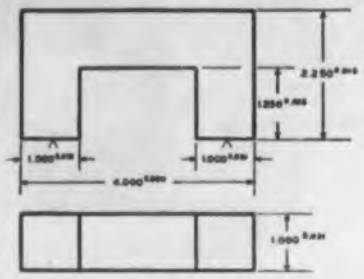
REQUEST CATALOG

KULKA ELECTRIC MFG. CO., Inc.
633 - 643 SOUTH FULTON AVENUE · MOUNT VERNON, N. Y.
Manufacturers of Electrical Wiring Devices

See Our Exhibit, 2nd Floor, I.R.E. Booth No. 2901

CIRCLE 113 ON READER-SERVICE CARD FOR MORE INFORMATION

HIGHER EFFICIENCY H-F POWER TRANSFORMERS



THIS IS A TYPICAL FERROXCUBE MAGNETIC CORE DESIGN

Smaller, lighter and less costly H-F power transformers of outstanding efficiency are being designed around Ferroxcube magnetic cores. The unique advantages of Ferroxcube are particularly marked in transformers required to handle up to 2 kilowatts of power in the frequency range from 2 kilocycles to 2 megacycles.

Ferroxcube-cored transformers are being used successfully in applications as diverse as ultrasonic power generators and rectifier power packs operating from an aircraft's normal a-c supply. In the latter application, the low leakage field of Ferroxcube eliminates the need for external shielding – for further reduction in transformer size and weight.

Ferroxcube cores are designed and produced to specifications. Our engineering department offers a complete, prompt service to assist in the design of Ferroxcube cores for specific applications. Your inquiry will receive immediate attention. ★ ★ ★ ★ ★

FERROXCUBE CORPORATION OF AMERICA

• A Joint Affiliate of Sprague Electric Co. and Philips Industries, Managed by Sprague •

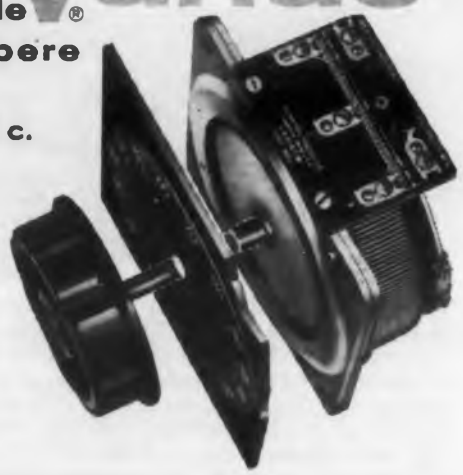
347 BRIDGE STREET • SAUGERTIES, NEW YORK

CIRCLE 310 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW Militarized Variac®

350 to 1200 cycle
20 Ampere

Input: 115 v., 350-1200 c.
Load Rating: 3.0 kva
Output Voltage: 0-115 or 0-135
Rated Current: 20 a.
Maximum Current: 26 a.



Manufactured to conform with rigid military specifications for shock, vibration, salt spray and tropicalization.

Type **M20** VARIAC (uncased): $48.00
Available also in 2-gang and 3-gang uncased models for $107.00 and $155.

GENERAL RADIO Company

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8055 13th St., Silver Spring, Md. WASHINGTON, D. C. — 1150 York Road, Abington, Pa. PHILADELPHIA
1000 N. Seward St. LOS ANGELES 38 — 1182 Los Altos Ave., Los Altos, Calif. SAN FRANCISCO

CIRCLE 311 ON READER-SERVICE CARD FOR MORE INFORMATION

A NEW DIMENSION IN DESIGN MATERIAL...

PRECISION BORE GLASS TUBING

Wilmad Offers Unheard-Of Accuracy and Low Cost

Design Engineers are constantly searching for new materials to reduce costs and improve preformance. Wilmad has helped make glass a "new" material by producing precision bore tubing of uniform accuracy with amazing tolerance limits. Wilmad Precision Bore Tubing can be used in making product components, instrument assemblies or sub-assemblies, wave guide tubes, manometers, rotameters, viscosimeters, barometers, McLeod gauges, dilatometers, burettes, dash pots, capacitors, diodes . . in virtually hundreds of precision applications in industry.

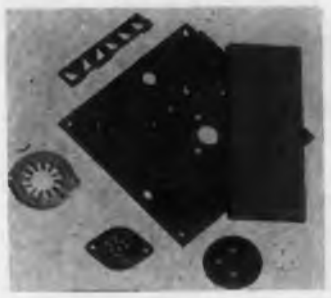
Learn how precision bore glass tubing can improve **your** product. Let our engineers help you determine how Wilmad Glass Tubing can solve your design problems.

Write for our **new** bulletin on Precision Bore Tubing.

WILMAD GLASS CO., INC.

Landisville, New Jersey

CIRCLE 312 ON READER-SERVICE CARD FOR MORE INFORMATION



△ Printed Circuit Laminate

Withstands Solvents

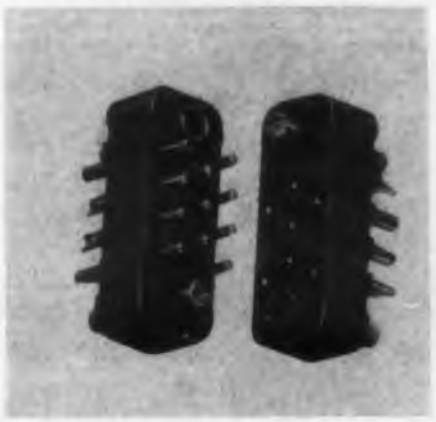
A new, low cost, paper-based laminate, Textolite 11572, is a printed-circuit laminate capable of withstanding common degreasing solvents. Exposure to trichloroethylene vapors for 15 minutes creates no deleterious effects on the laminate. It has an insulation resistance of 100,000 megohms after 96 hours at a relative humidity of 96 per cent. This material meets the standards for XXX-P and the property requirements of MIL-P-3115-PBE-P. 11572 can be cold-punched in thicknesses to 1/8 in.

General Electric Co., Dept. ED, Chemical & Metallurgical Div., Coshocton, Ohio.
Radio Engineering Show, Booth 2904-2932.

CIRCLE 313 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Miniature Connectors

Floating Contacts



The Series 22 precision Continental Connectors are suited for aircraft and instrumentation. The 11 contact connector has an over-all length of 0.78 in., width, 0.27 in.; mounting dimensions center to center on mounting studs, 0.532 in.

Polarization is positive with a reversed guide pin and guide socket made of stainless steel. Floating contacts insure positive self-alignment of each contact. Machined phosphor bronze contacts are gold plated over silver for low contact resistance and soldering ease.

Micro-Miniature Series 22 is available in 7, 11, 14, 20, 26, 29 and 34 contacts, with or without aluminum hoods.

DeJur-Amsco Corp., Dept. ED, Electronic Sales Div., 45-01 Northern Blvd., Long Island City 1, N.Y.
Radio Engineering Show, Booth 3911-3913.

CIRCLE 314 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Tube Shield Mount
For Miniature Tubes

his heat-dissipating tube shield unt cools miniature tubes. It is ilable in all sizes of 7- and 9-pin tron tubes. The shield features a silver or copper wrap-around for glass bulb. A special beryllium- per spring clip provides maximum e retention; design of the right- le mounting bracket assures proper alignment between tube and ket. A copper slug provides maxi- m contact and heat conductivity ween shield, base and chassis. be life and reliability are increased ordingly. Electrostatic shielding is ellent. The right angle design per- s the socket to be oriented to any four positions, allowing greater ibility in layout and design and a ater variety of solutions to prob- s of component crowding.

nternational Electronic Research rp., Dept. ED, 145 W. Magnolia d., Burbank, Calif.

dio Engineering Show, Booth 3704.

CIRCLE 315 ON READER-SERVICE CARD

Insulating Tapes
Eight Colors

Using a special coloring technique veloped in the Russell laboratories, se tapes are available in black, nge, blue, yellow, red, green, wn and white. Choice of colors kes it possible for user to select dily identifiable colors to simplify embly and maintenance.

Woven of continuous filament glass ns, these Rusco glass electrical in- ting tapes have high tensile ngth, dimensional stability and h resistance to deterioration. They be used as coil wrappers, protec- coverings, conductor insulating mechanical reinforcements.

norganic and fireproof, these glass lating tapes are suited to applica- s where high ambient heat is de- pped or where high internal peratures are encountered. In ad- on their stretch-proof and shrink- of qualities insure permanent, tight ppings which stay in place.

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

CIRCLE 316 ON READER-SERVICE CARD

△ Compact Magnetic Amplifier

2-36 V, 15 Amp

Designated Model MR532-15A, this tubeless unit, containing no moving parts, has a d-c output of 2 to 36 v, an a-c input of 105-125 v, 1 ph 60 cps, and a ripple content of 1 per cent, rms. Voltage regulation is ±0.5 per cent between 5 and 32 v, ± 2 per cent between 2 and 5 and between 32 and 36 v. Response time ranges from 0.1 to 0.2 seconds, maximum. The amplifier weighs approximately 110 lb, mounted in its cabinet; and in rack panel construction measures 19 in. wide x 15 in. deep x 12-1/4 in. high.

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

Radio Engineering Show, Booth 3711-3713.

CIRCLE 319 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Oscilloscope Enclosure

Mounts Large-Size Scopes

Illustrating the versatility of modular construction and its lower costs, this "deep scope enclosure" is capable of housing many of the larger oscilloscopes now available. It consists of two major parts, the main element vertical frame, designated F31, and the turret, designated FT21. Combined, they provide a means of mounting many of the largest oscilloscopes for instrumentation work, and afford a variety of other enclosure possibilities. The complete enclosure measures 40 in. high, with a minimum depth of 25 in. at the top and a maximum depth of 32 in. at the bottom of the enclosure face. The turret panel opening is 21 in. high, with a slope of 20 deg.

Amco Engineering Co., Dept. ED, 733 West Ainslie St., Chicago 31, Ill.

Radio Engineering Show, Booth 4122.

CIRCLE 320 ON READER-SERVICE CARD FOR MORE INFORMATION

NEW

AT BOOTH 1424 IRE SHOW
ALI VTVM TYPE 810

Featuring:

- Balanced amplifier for high stability
- 700 mc high frequency probe — smallest in the industry
- Voltage regulator provides stable dc for ohmmeter, minimizing line voltage effects
- High loop gain in the amplifier and total feedback assure long-time accuracy and nullify tube parameter variations
- Balancing diode used to match characteristics of probe, adding further stability

This VTVM, a new presentation from Acton Laboratories, provides circuit improvements and techniques which combine to give stable characteristics and long-time accuracy. The mechanical design provides an instrument of convenient size, and a miniature thermionic diode probe. Color coded meter scales, properly grouped, provides exceptional readability on all ranges.

SPECIFICATIONS

Voltage Ranges:
DC — Full scale ranges 1-3-10-30-100-300-1000 Volts (Plus and Minus)
AC — Full scale ranges 1-3-10-30-100-300 Volts (RMS)
Resistance Ranges:
0.2 — 500 ohms scale; multipliers, X1, X10, X100, X1K, X10K, X100K, X1M
Accuracy:
DC: ±2% AC: ±3%
Frequency Response:
±1 db; 10 cps to 700 mc

Write ALI for complete technical information — published in Laboratory Report, Vol. II, No. 1.

This instrument, and other ALI products, can be seen at the IRE Show, Booth 1424

Acton Laboratories, Inc.
[illegible] MAIN STREET, ACTON, MASS.

CIRCLE 323 ON READER-SERVICE CARD

△ Precision Phase Detector
To 1% or 0.1 Degree

This instrument measures time delay or phase angle at high frequencies with error of less than 1 per cent or 0.1 degree. It is recommended for high frequency precision work, as for example with color TV circuits. Designated Type 205A, the instrument consists essentially of two amplifier stages, two step-variable delay lines, a continuously variable delay line, a differential tuned amplifier, a balanced phase detector, and a sensitive output indicator. The continously variable delay line and the step-variable delay lines are used to delay input signals until the reading on the output phase indicator shows zero or minimum.

Specifications are: resolution time, 8×10^{-11} or smaller; smallest readable phase angle approximately equal to $8 \times 10^{-11} \times 360 \times$ frequency in cps; frequency range 100 kc to 15 mc. Time delay of the continuously variable delay line is from 0 to 0.1 microsecond; the step-variable delay lines have a total time delay of 11 microseconds in steps of 0.1 microsecond each. Indicator sensitivity is approximately 0.01 v full scale maximum without probe; 0.1 v with probe.

Advance Electronics Lab, Inc., Dept. ED, 249 Terhune Ave., Passaic, N. J.
Radio Engineering Show, Booth 3412.

CIRCLE 324 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Double Ridge Waveguide
2 to 5 KMC

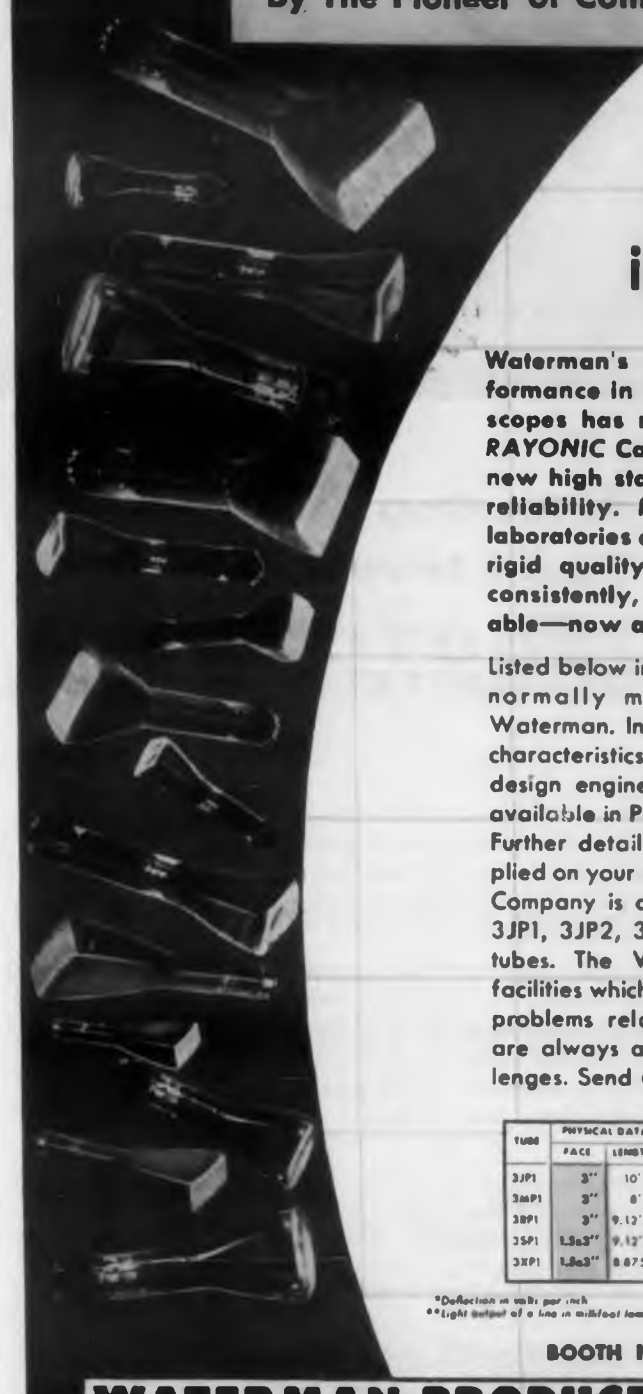
A double ridge waveguide, designated D-37, this unit has a maximum loss of only 0.04 db/ft. It is available, with components for the 2 to 5 kmc range, in both rigid and flexible models. Components include rigid bends and twists, and waveguide-to-coax adapters, which can be used with Type N, Type C or Type LC coax connectors. The photo shows a 4.75 to 11 kmc double ridged guide.

Technicraft Laboratories, Dept. ED, Thomaston-Waterbury Road, Thomaston, Conn.
Radio Engineering Show, Booth 3810.

CIRCLE 325 ON READER-SERVICE CARD FOR MORE INFORMATION

Waterman

RAYONIC CATHODE RAY TUBES
By The Pioneer of Compact Oscilloscopes



High Performance in Small Space

Waterman's demand for peak performance in its wide range of oscilloscopes has resulted in design of the *RAYONIC* Cathode Ray Tubes to meet new high standards of efficiency and reliability. Modern air-conditioned laboratories and assembly lines permit rigid quality controls which assure, consistently, the finest tubes obtainable—now available to you!

Listed below in tabular form are the tubes normally maintained in stock by Waterman. Included in the chart are the characteristics which most concern the design engineer. All of these tubes are available in P1, P2, P7 and P11 phosphors. Further detailed information will be supplied on your request. Waterman Products Company is a JAN approved source for 3JP1, 3JP2, 3JP7, 3RP1, 3SP1 and 3XP1 tubes. The Waterman experience and facilities which have solved many complex problems related to cathode ray tubes are always available to meet new challenges. Send us yours!

TUBE	PHYSICAL DATA		STATIC VOLTAGE		DEFLECTION*		LIGHT OUTPUT**
	FACE	LENGTH	A3	A2	VERT	HOR	
3JP1	3"	10"	3000	1500	111	130	40
3MP1	3"	8"		750	99	104	4
3RP1	3"	9.12"		1000	61	86	5
3SP1	1.5x3"	9.12"		1000	61	86	5
3XP1	1.8x3"	8.875"		2000	33	88	22

*Deflection in volts per inch
**Light output of a line in millifoot lamberts per millimeter of line width not to exceed .65mm

BOOTH NOS. 1902-1904

WATERMAN PRODUCTS CO., INC.
PHILADELPHIA 25, PA. CABLE ADDRESS: POKETSCOPE

MEMO... Write for details today!

WATERMAN PRODUCTS

MANUFACTURERS OF
PANELSCOPE*
PANELPACK*
POCKETSCOPE*
PULSESCOPE*
RAKSCOPE*
. . . And Other Associated Equipment
*Registered Trade Marks

CIRCLE 326 ON READER-SERVICE CARD FOR MORE INFORMATION

Small Hole Gage Set

Measures Diameters

A complete set of three of these gages measures hole diameters from 0.025 in. to 0.380 in., with an accuracy of 0.0005 in. Diameter is read directly with the help of the 2-1/2 x magnifying lens. In addition to the magnified scale, the gage consists essentially of a clutch mechanism and a tapered, retractable needle. The needle is inserted in the hole to be measured, the barrel is pushed down flush with the piece being measured, and the gage removed and read. The complete set of three Kwik-Chek gages is supplied in a velvet-lined case.

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

CIRCLE 329 ON READER-SERVICE CARD FOR MORE INFORMATION

Teflon Terminals

Subminiature Size

These Teflon-insulated subminiature stand-off and feed-thru terminals have capacitances ranging from 0.35 to 0.75 μμfd with "flash-over" points of better than 500 v ac. Service ratings include 60 cps to 30,000 Mc frequencies, temperature range of —450 to +500 F. Sizes range from 0.148 to 0.218 in. diam, with 0.040 in. diam pins.

Tri-Point Plastics, Inc., Dept. ED, Electronics Div., 175-177 I. U. Willets Rd., Albertson, N.Y.

CIRCLE 330 ON READER-SERVICE CARD FOR MORE INFORMATION

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HAYDEN PUBLISHING CO., INC.
19 E. 62 Street, New York 21, N.Y.

Plug-In Relays

Ten-Amp Silver Contacts

Utilizing the standard octal plug, these relays are housed in dust-proof enclosures measuring 3-1/4 in. x 1-7/8 in. x 2 in. Coils can be supplied in all standard ac and dc voltages. Contact arrangements are available up to dpdt. Contacts are silver, rated at 10 amps 115 v ac, non-inductive. The enclosure of the LR relays carry a clearly-printed relay wiring diagram.

Line Electric Co., Dept. ED, 1407 McCarter Highway, Newark 4, N.J.

CIRCLE 334 ON READER-SERVICE CARD FOR MORE INFORMATION

Broadband D-C Amplifier

For Floating Input

Designed for use with grounded transducers, such as thermocouples and strain gages, this model 111AF d-c amplifier contains its own power supply. Frequency response is flat within 0.3 db from dc to 10 kc, down 3 db at 40 kc. Resistance between amplifier chassis and signal ground leads is greater than 100 megohms; input impedance is 100,000 ohms and output impedance less than one ohm; 10 gain settings afford choice of gain from 20 to 1000 within 1 per cent accuracy. Output drift and 60 cps noise are exceptionally low. The unit is available in single-amplifier cabinets or six-amplifier modules which fit standard 19-in. racks. By slight modification of the input circuit, the amplifier may be adapted to non-floating, normal, inputs.

Kay Lab, Dept. ED, 5725 Kearny Villa Rd., San Diego 11, Calif.

CIRCLE 335 ON READER-SERVICE CARD FOR MORE INFORMATION

Water Bath Stirrer

And Temperature Control

This laboratory water bath apparatus can control the temperature of an uninsulated 4-gallon water bath while simultaneously circulating 1 liter per minute to external instruments such as viscosimeters or refractometers. Its temperature control system is sensitive within ±0.05 C. The 1-kw immersion heater is wound in the shape of a helix; the stirrer rotates inside the heating coil so that heat is effectively dissipated. The water bath is heated from room temperature to set point without excessive overshoot.

The Tempunit can be attached to a container by a rubber cushioned clamp. It weighs only 5-1/2 lb. Case dimensions are 5-1/2 in. x 4-1/2 in. x 3-1/2 in.; overall length, 10 in.

Arthur S. LaPine & Co., Dept. ED, 6001 S. Knox Ave., Chicago 29, Ill.

CIRCLE 339 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Supply

For Precision Measurements

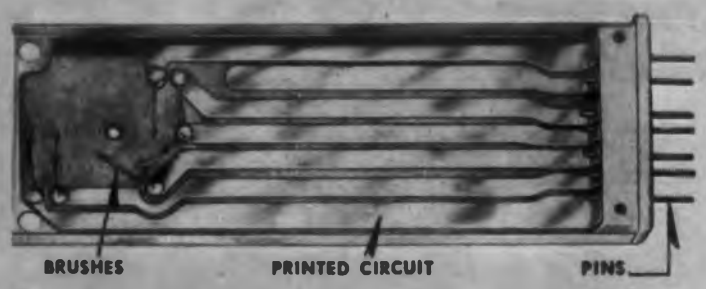
A power supply for precision laboratory measurements, the D1-100B provides two output voltages of 1 to 100 v dc each. Both are linear throughout the entire range. Output voltage is set by means of a 10-turn Multipot on which each turn is equivalent to 10 v of the outer scale. The inner dial is scaled for setting of 0.1 v increments. Current is 0 to 100 ma, with no derating necessary. Voltage regulation is 20 mv throughout the entire range. Outputs may be pulsed with square wave load without affecting normal regulation. Ripple under worst conditions is below 1.5 mv rms. The unit is of standard 7 x 19 in. relay rack construction, with a 13 in. depth.

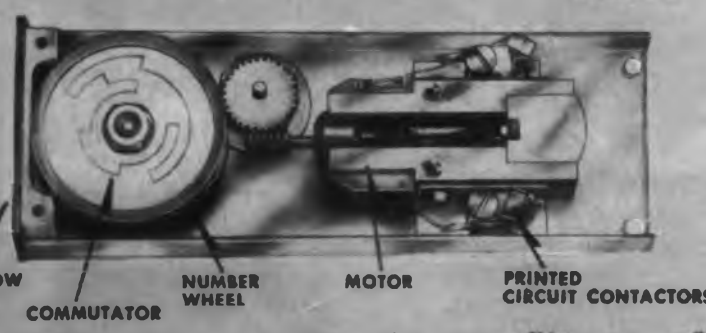
Dressen-Barnes Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena, Calif.

CIRCLE 340 ON READER-SERVICE CARD FOR MORE INFORMATION

New UNION Digital Indicator

combines data readout and storage facilities





Physical characteristics: Over-all length. . .5⅛", width. . .⅜", height. . .1⅜", weight. . .7 oz., operating time at 24 volts. . .0.8 sec., life expectancy. . . 1,000,000 operations. Character size. . .⅜" x ¼".

The new UNION Digital Indicator will satisfy most requirements for data display, either local or remote. It is a companion product to our Alpha-Numerical Data Display Indicator, but occupies only one-half the volume and requires under three watts power.

The ability of the indicator to operate as a storage facility, a readout device, and its inherent non-dissipating storage give it characteristics not to be found in any other indicator of this type.

The indicator is motor-driven and operates on a direct wire basis in response to binary code. The coded decimal notation was chosen for prototype to demonstrate more familiar uses, but other notations can be used.

A typical application in a pipeline remote control system works like this: Telemetered digital data on temperature and pressure is received at a central station and entered into an intermediate storage. From there it is routed to the appropriate digital indicators for visual display and electrical storage for time programmed input to a telelog printer. Each indicator can store four binary bits and eliminates the use of relays for this purpose. Write for our new Bulletin 1011.

See our exhibit at the I.R.E. Show, Mar. 18-21, Booths 2122-2124.

GENERAL APPARATUS SALES

UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18, PENNSYLVANIA

CIRCLE 343 ON READER-SERVICE CARD FOR MORE INFORMATION

△ High Temperature Capacitors

Operate at 200 C

Resistance of 10^{13} ohms at 25 C highlights the characteristics of these capacitors. They have low leakage up to 200 C. Others of important practical interest are tolerances up to 0.1 per cent, dielectric absorption of 0.01 per cent, dissipation factor 0.02 per cent; capacitance drift of less than 0.1 per cent per year and temperature coefficient smaller than 100 ppm/deg C. The units are metal-cased and truly hermetically sealed with glass-to-metal terminals. They come in standard or special configurations, and are immediately available.

San Fernando Electric Mfg. Co., Dept. ED, 1509 First St., San Fernando, Calif.

Radio Engineering Show, Booth 2710.

CIRCLE 344 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Miniature Switch

360 Degree Rotation

Hermetically sealed, this switch, designated No. 9135, has a 360 deg rotary action with 180 deg pretravel and 180 deg over-travel. It is available in two models, with potted leads or with pin connectors, and can either be mounted flat with four fasteners or vertically behind a retainer. Case is heavy nickel silver, qualified to withstand great shock and extreme environments. The switch operates at either 28 v dc or 110 v ac, with a 10-amp resistive, 4 amp inductive, rating. Rated life is 100,000 cycles. Dimensions are 2 in. x 1 in. x 1-3/4 in.

Haydon Switch, Inc., Dept. ED, Waterbury 20, Conn.

Radio Engineering Show, Booth 3922.

CIRCLE 345 ON READER-SERVICE CARD FOR MORE INFORMATION

This is the time of our annual subscription renewal.

DURANT

Electric "SP"

PREDETERMINED COUNTER

(COUNTS ELECTRICALLY and CLOSES SWITCH AT END OF PRE-SET COUNT)

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COMPACT • RUGGED
FAST • ACCURATE

Eliminates costly over-runs or time consuming under-runs. Actuated by Photo Electric Cell, Tube, Relay, or Contact Switch. Counter can be located where desired. Predetermined count may be set at any figure to 99,999. Hundreds of applications in all phases of production and instrument work.

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CIRCLE 346 ON READER-SERVICE CARD

△ Digital Voltmeter
Portable, Miniaturized

Operation of this instrument, which has been designated Mark IV, is completely fool-proof, needing no manual adjustments or manipulations. Measurements are made automatically. Readings are accurate to 0.05 per cent absolute, with linearity better than 0.01 per cent from a millivolt to 1000 v, dc. Balance logic positions the decimal point. Unitized packaging facilitates servicing. Readings are presented in 1-in. high numerals which can be read at distances as great as 30 feet. Dimensions are 7 in. x 10 in. x 13 in. The instrument provides a precision, general-purpose, digital voltmeter for a wide variety of laboratory and field applications.

Electro Instruments, Inc., Dept. ED, 3794 Rosecrans, San Diego, Calif.

Radio Engineering Show, Booth 3614.

CIRCLE 349 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Low-Voltage Supply
Mag-Amp Regulated

A light weight magnetic amplifier regulated 2 to 36 v at 15 amp power supply is a tubeless unit. It has a voltage range available between 2 and 36 v and between 5 and 32 v. The Model MR532-15A has a dc output, an ac input of 105 to 125 v, 1 phase, 60 cy, Ripple is 1 percent rms. Voltage regulation is ±1/2 percent over the range of 5 to 32 v, ±2 per cent from 2 to 5 v and 32 to 36 v. Response time is 0.1 to 0.2 sec maximum. Weight is approximately 110 lbs in cabinet.

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

Radio Engineering Show, Booth 3711-3713.

CIRCLE 350 ON READER-SERVICE CARD FOR MORE INFORMATION

Amplifier-Discriminator
Non-Overloading

This fast discriminator circuit generates a pulse whenever the built-in amplifier produces a signal which exceeds the preset discriminator bias. The discriminator bias is set manually by means of a ten-turn potentiometer calibrated directly in volts. The discriminator output is a positive pulse of 0.35 microseconds base width, 15 v amplitude.

The amplifier, which is excited by an input of either positive or negative polarity, has a gain of 9000. Its output consists of positive pulses of 100 v maximum amplitude, RC-shaped, with a base width that can be varied between 0.2 to 200 microseconds, and a rise time less than 0.2 microsecond.

The Model 155 amplifier-discriminator is recommended for high counting rate applications that require gain stability, linearity and non-overloading properties. The output from the discriminator may, for example, be fed to scintillation and proportional counters, or to coincidence circuits.

The panel, finished in gunmetal hammertone, measures 5-1/4 x 19 in. Shipping weight is 65 lb.

Beva Laboratory, Dept. ED, P. O. Box 478, Trenton 8, N. J.

CIRCLE 353 ON READER-SERVICE CARD FOR MORE INFORMATION

Variable Composition Control
Has Radial Element

The Model R variable control uses a molded composition resistance track and employs a radial resistance element which fills the entire inner perimeter of the resistor barrel. With this design current is spread over a larger area and external cooling surface is greater. The Model R offers a 3 w standard rating; 2 w under RV4 style. This new control has a rotational life of 100,000 cycles. After MIL moisture resistance testing it will exceed the "Y" environmental characteristic, with an average change of 2 per cent. Linear, clockwise and counter clockwise tapers are available.

Reon Resistor Corp., Dept. ED, 117 Stanley Ave., Yonkers, N. Y.

CIRCLE 354 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 356 ON READER-SERVICE CARD ➤

NOW: available on a

For engineering evaluation of thermistor and varistor characteristics, you can now obtain any of 37 individual test kits, each containing six pieces. The minimum quantity per order is three kits. Shipment will be made postpaid to any destination in the United States and Canada.

Globar THERMISTORS

To evaluate thermistor circuit applications for:
1. Temperature compensation.
2. Time delay.
3. Temperature sensing and control.

Test Kit No.	Type	Body Size		R at 25° C ± 20%	Nom. Temp. Coeff. "B" Constant	Max. Watt Loading at 40° C	Price
		Length	Dia.				
T-1	997F	19/64"	7/64"	40 ohms	1500	0.25	$3.95
T-2	997F	19/64"	7/64"	220 ohms	1750	0.25	3.95
T-3	997F	19/64"	7/64"	10000 ohms	1950	0.25	3.95
T-4	763F	5/8"	3/32"	5 ohms	1200	0.5	3.70
T-5	763F	5/8"	3/32"	10 ohms	1400	0.5	3.70
T-6	763F	5/8"	3/32"	15 ohms	1500	0.5	3.70
T-7	763F	5/8"	3/32"	20 ohms	1500	0.5	3.70
T-8	763F	5/8"	3/32"	120 ohms	1700	0.5	3.70
T-9	763F	5/8"	3/32"	1000 ohms	1800	0.5	3.70
T-10	763F	5/8"	3/32"	10000 ohms	2100	0.5	3.70
T-11	763F	5/8"	3/32"	120000 ohms	2150	0.5	3.70
T-12	763F	5/8"	3/32"	330000 ohms	2150	0.5	3.70
T-13	416H	1/16"	5/16"	1200 ohms	3800	0.5	3.95
T-14	479H	1/8"	1/2"	1000 ohms	3800	1.5	3.95
T-15	373H Metallized Faces Only	1/8"	3/4" o.d. 1/4" i.d.	10 ohms	2700	3.5	4.55
T-16	373H Metallized Faces Only	1/8"	3/4" o.d. 1/4" i.d.	40 ohms	2700	3.5	4.55
T-17	343H	1/8"	3/4" o.d. 1/4" i.d.	5.5 ohms	2700	3.5	4.85
T-18	343H	1/8"	3/4" o.d. 1/4" i.d.	20 ohms	2700	3.5	4.85
T-19	549H	3/4"	7/64"	5000 ohms	3200	0.75	3.95
T-20	588H	1"	7/64"	11000 ohms	3200	1.	4.25
T-21	763H	5/8"	3/32"	500000 ohms	4600	0.5	3.95

Globar THERMISTORS

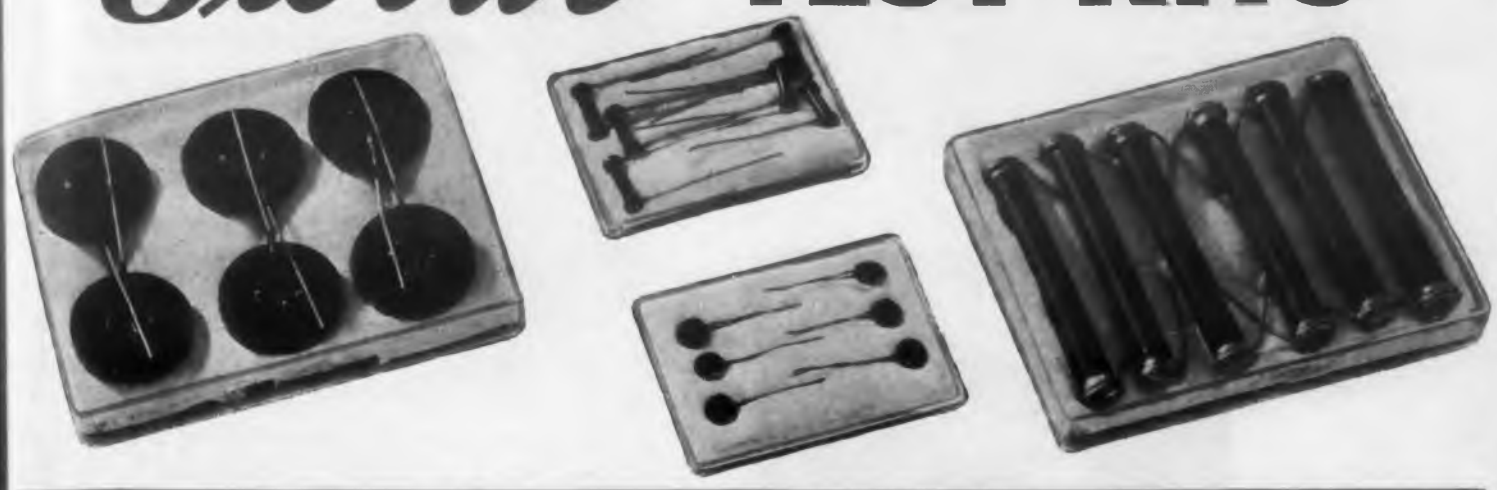
For evaluation of surge current suppression in series filament and pilot light circuits in radio and television receivers.

Test Kit No.	Type	Body Size		R at 25° C ± 30%	Nominal R at 45° C and Rated Current	Price
		Length	Dia.			
T-22	763F	5/8"	3/32"	145 ohms	40 ohms at 150 m.a.	$3.70
T-23	759F	3/4"	1/4"	500 ohms	85 ohms at 135 m.a.	3.95
T-24	441F	1 1/8"	3/8"	880 ohms	100 ohms at 150 m.a.	4.25
T-25	341F	3/4"	5/8"	375 ohms	40 ohms at 300 m.a.	4.55
T-26	525F	1 7/8"	1/2"	250 ohms	20 ohms at 600 m.a.	4.55
T-27	327F	3 1/8"	1/2"	460 ohms	35 ohms at 600 m.a.	4.85
T-28	421F	3 3/16"	1" x 1/8" Wafer Type	125 ohms	43 ohms at 600 m.a.	5.15
T-14	479H	1/8"	1/2"	1000 ohms	50 ohms at 150 m.a.	3.95
T-17	343H	1/8"	3/4" o.d. 1/4" i.d.	5.5 ohms	.31 ohms at 3.0 amps.	4.85

selective basis...

THERMISTOR AND VARISTOR

Globar® TEST KITS



Globar VARISTORS Type BNR

To evaluate varistor circuit applications for:

1. Reduction of surge voltage peaks.
2. Reduction of relay contact arcing.
3. Voltage stabilization.
4. Generation of harmonics.

Test Kit No.	Type	Body Size		R ± 20% at D.C. Calibration Voltage	Max. Watt Loading at 40° C	Price
		Length	Dia.			
V-1	432BNR	1/16"	1/2"	1000 ohms at 10.5V	0.25	$3.70
V-2	432BNR	1/16"	1/2"	25000 ohms at 10V	0.25	3.70
V-3	432BNR	1/16"	1/2"	100000 ohms at 10V	0.25	3.70
V-4	432BNR	1/16"	1/2"	1 megohm at 10V	0.25	3.70
V-5	479BNR	1/8"	1/2"	100000 ohms at 100V	0.3	3.75
V-6	328BNR	1/16"	3/4"	10000 ohms at 40V	0.5	3.85
V-7	463BNR	1/8"	1"	24000 ohms at 40V	1.	3.95
V-8	524BNR	3/16"	1 1/4"	24000 ohms at 100V	1.5	4.25
V-9	430BNR	1/4"	1 1/2"	17500 ohms at 175V	2.7	4.55

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Over 30 years' experience in the field of ceramic special resistance devices.

THE CARBORUNDUM COMPANY, GLOBAR DIVISION, Dept. ED-87-72,
Niagara Falls, New York

Please ship the following test kits (Min. quantity per order—3 kits).

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TEST KIT
Numbers_____

VARISTORS:
TEST KIT
Numbers_____

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

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87-72

High Power Rectifiers
For Aircraft

Available in capacities up to 1000 amps, and in dc ranges from 6 to 40 v, this line of high power rectifiers is offered as particularly suited to ground support equipment and missile testing, and in aircraft, electronic and industrial fields. The rectifying units are silicon diodes, hermetically sealed against humidity, fungus, salt spray, sand and dust. Operating temperatures are −55 C to +65 C. Response is 0.1 second, ripple 1 per cent rms, dc regulation ±0.5 per cent.

Christie Electric Corp., Dept. ED-S22, 3410 W. 67th St., Los Angeles 43, Calif.

CIRCLE 357 ON READER-SERVICE CARD FOR MORE INFORMATION

AC Millivoltmeter
Transistorized

Transistorized, this ac millivoltmeter has an input impedance of 22 megohms. Twelve full range scales provide coverage between 0.001 and 300 v ac, and between −80 to +52 dbm. Usable frequency coverage is from 1 cycle to 5 megacycles. Between 5 cycles and 1 megacycle the accuracy is ±3 per cent. Use of transistors eliminates instability resulting from temperature rise. Battery operation permits ready measurement of floating voltages and eliminates beating between line voltage fluctuations and 60 cps. The battery provides 400 hours of continuous operation. Accurate ac measurements can be made with it to 50 μv.

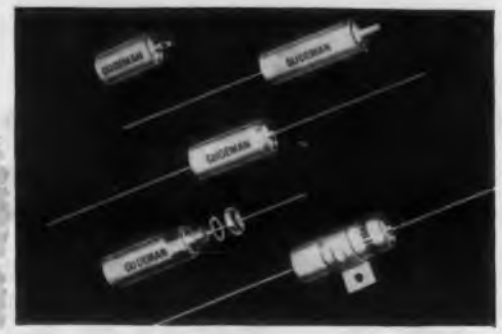
Fisher Research Laboratory, Inc., Dept. ED, 1961 University Ave., Palo Alto, Calif.

CIRCLE 358 ON READER-SERVICE CARD FOR MORE INFORMATION

◀ CIRCLE 356 ON READER-SERVICE CARD

GUDEMAN
Capacitors

Bathtub Type Military Capacitors
MIL-C-25 Types
CP53, CP54, CP55 Case Styles
Temperature Ranges:
−55°C to +85°C
−55°C to +125°C



"XC" Plastic Film Dielectric Capacitors
The development of the Gudeman "XC" capacitors provides high temperature capacitors that have exceptionally high insulation resistance, low power factor and low dielectric absorption. No voltage derating is required when used within a temperature range from −65°C to +165°C. Bathtub and rectangular case styles also are available.

Miniature Feed-Through Capacitors
The Gudeman Feed-Thru Capacitor, Types 271 and 272 is a three-terminal component designed to be used for R. F. Interference suppression in a manner similar to a low pass filter. The typical insertion loss characteristics for these Feed-Thru Capacitors when measured in a 50 ohm line are in accordance with MIL-Standard 220.

Military Capacitors
MIL-C-25 Types
CP70 Case Styles
Temperature Ranges:
−55°C to +85°C
−55°C to +125°C

Tubular Laminated Cardboard Capacitors
The 633 series gives extra protection in extremely high humidity applications.
Paper Dielectric: Wax or Oil Impregnated
Resin End Seals
Temperature Range: −40°C to +85°C

Dry Electrolytic Capacitors
MEand Printed Circuit Types
High Purity (99.99%) Aluminum Foil
Low Leakage
Temperature Range:
−30°C to +85°C

See these and other new products Booth #2227, New York Coliseum, March 18-21

Write for latest technical data

THE GUDEMAN COMPANY
Main Plant & General Offices
340 West Huron St., Chicago 10, Illinois, Dept. H 256
Mfg. Branches: Chelsea, Mich.; Sunnyvale and Monrovia, Calif.; Terryville, Conn.
Manufacturers of Electronic Components for Military and Commercial Applications.

CIRCLE 362 ON READER-SERVICE CARD FOR MORE INFORMATION

Silicon Diode Demodulator
Ruggedly Built

The Atlas electronic demodulator furnishes a dc voltage which is directly proportional to the phase and amplitude difference between an ac input voltage and an ac reference voltage. It consists of silicon diodes and miniaturized transformers enclosed in a small, hermetically sealed unit of rugged construction. Two models are available, designated ED-551 and ED-551-L. The former plugs into a standard octal socket and the latter into a 7-pin miniature socket. Both models supply a maximum dc of 10 v. Output is linear over a range of applied ac input voltage from 0 to 15 v rms. Reference voltage limits are from 0 to 25 v rms. Frequency response is flat from 60 cycles to 80 kc.

Atlas Electro-Mechanical Laboratories, Inc., Dept. ED, 14734 Arminta St., Panorama City, Calif.

CIRCLE 363 ON READER-SERVICE CARD FOR MORE INFORMATION

Free Gyro
Caging is Solenoid-Powered

The Model FG01-0203-1 free gyro weighs 2-1/2 lbs and measures 5-1/2 in. in length, 3 in. in diameter. It has cage indicating switches, precision potentiometers on both gimbals, and may be used with 400 cy 115 v (three-phase or single-phase), or 28 v d-c motors.

Humphrey Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

CIRCLE 364 ON READER-SERVICE CARD FOR MORE INFORMATION

△ High Voltage Transformers
High-Temperature Operation

These miniaturized high-voltage ansformers using evaporative cool- g techniques include pulse, magne- on filament, plate and audio trans- rmers. They comply with military ecifications and are capable of oper- ing in ambients from −50 to +125 g C. Cooling is effected by high- electric fluorochemical liquid which porizes in contact with the hot indings and then condenses on the ner surface of the transformer case. ondensation takes place in the space rmally provided for the expansion insulating liquids or gasses.

Raytheon Mfg. Co., Dept. ED, quip. Marketing Dept., Waltham 54, ass.

dio Engineering Show, Booth 2611-
14.

CIRCLE 76 ON READER-SERVICE CARD

△ Synchro Data Switch
Replaces Relays

This potted unit, Model DS-3, per- rms fine-coarse synchro switching d is suitable for all common synchro tios and sensitivities. It measures /16 in. in diameter and is 29/32 in. gh. This non-linear network sums e and coarse synchro signals in ch a way that the coarse signal is ocked for small errors, yet overrides e fine signal for large errors to pre- nt false nulls.

Feedback Controls, Inc., Dept. ED, 9 Main St., Waltham 54, Mass.

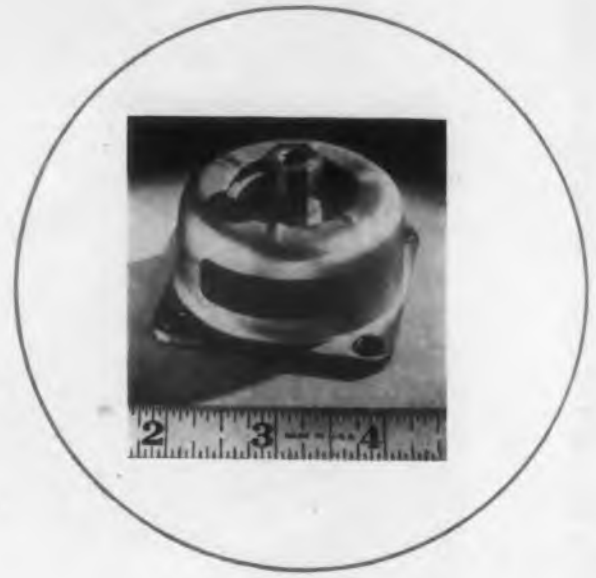
dio Engineering Show, Booth 3013.

CIRCLE 77 ON READER-SERVICE CARD

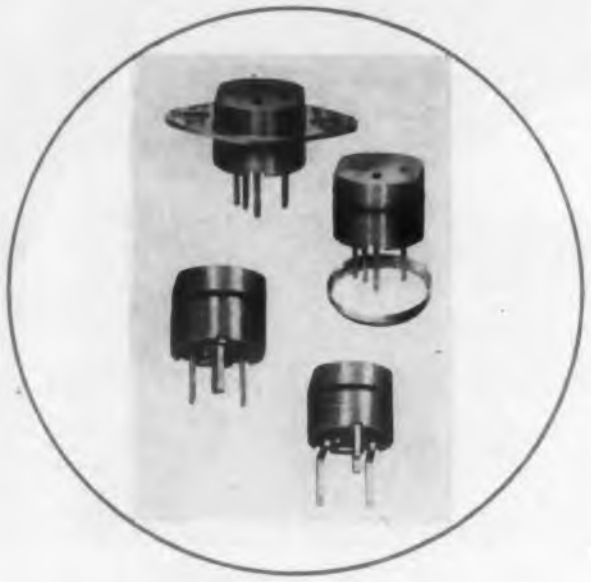
Long Lived Test Point Jack
One-piece Beryllium-Copper

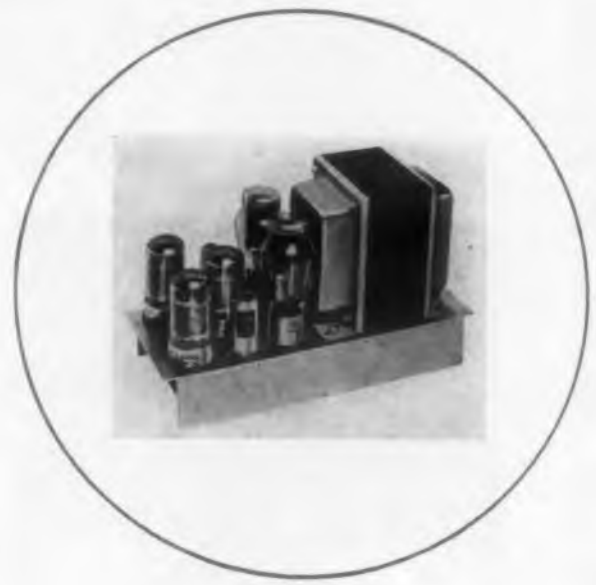
Utilizing fatigue-resistant beryllium- pper, a new test point jack for the ndard 0.080 in. test prod has an in- finitely long life. A solid beryllium- pper rod is machined into a one- ece metal insert with a four-leaf ntact at one end and terminal lug at e other. This is heat-treated, gold- ated, and inserted into a teflon in- lator body. The jack thus formed, lds firmly against a 2 oz pull any sertion having a diameter between 077 in. and 0.083 in. Insertion and thdrawal characteristics are very nooth. Type SKT-10 conforms to AN-S-28A. For eye appeal or color- ding, it is available in any of the ght RETMA colors.

Sealectro Corp., Dept. ED, 610 yette Ave., Mamaroneck, N.Y.



you'll see them A





Reference Voltage Supply

Stability 0.2 Per Cent

Supplied as a plug-in unit mounted on a standard 8-pin octal socket, this voltage supply unit is operated by 60-400 cps 115 v ac, and delivers a d-c reference level adjustable from 0 to approximately 87 v. With any load not exceeding 1 ma, with line voltage changes between 90 to 135 v, and through the temperature range −50 C to +40 C, the output stability is better than 0.2 per cent. Design is simple and construction encapsulated. Uses include supplying reference potential for d-c motor and servo systems, replacement of standard wet or dry cells, and replacement of more extensive electronic regulatory systems.

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

CIRCLE 372 ON READER-SERVICE CARD FOR MORE INFORMATION

Fractional HP Motors

6v to 220 v AC or DC

Available with universal, shunt or permanent magnet fields a group of 1/30th hp motors constitute the latest addition to Rae Motor Corp.'s line. The permanent magnet motor is designated M-100; the wire-wound fields are in motors designated M-20. The latter can be supplied for voltages from 6 to 220, ac or dc. All of these newly-announced motors are supplied either ventilated or enclosed, and with either ball or sleeve bearings, as desired. All have a maximum hp rating of 1/30th, shaft diameter of 5/16 in., and weigh approximately 2 lb. The same manufacturer's G-11A gear reducer was designed specifically for these motors.

Rae Motor Corp., Dept. ED, 2009 Kewanee St., Racine, Wis.

CIRCLE 373 ON READER-SERVICE CARD FOR MORE INFORMATION

GET THE FACTS

HIGH PERFORMANCE

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BRUSHES CONTACTS SLIP RINGS

& Slip Ring Assemblies

BRUSH HOLDERS, CONTACT ASSEMBLIES, BRUSH ASSEMBLIES

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Wide range of grades available for standard and special applications. Call on our 40 years of design experience to help solve your problems.

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COMPANY

STREET

CITY ZONE STATE

CIRCLE 376 ON READER-SERVICE CARD

Custom-Built Antenna Horns

1000 to 40,000 Mc

Beam width antenna gain can be provided to individual specifications in a complete line of custom-built antenna horns, available in bandwidths from 1 to 40 kmc. The small horn pictured here measures 0.28 in. x 0.14 in. and is intended for short range communication, laboratory use or as a field testing device for radar.

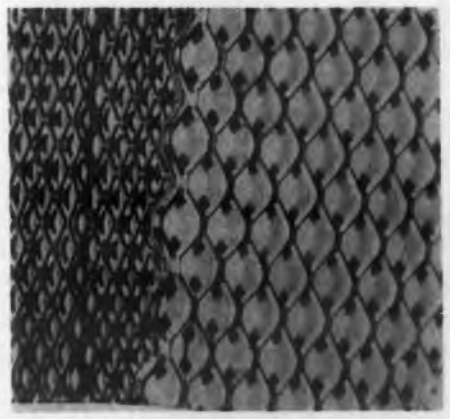
All horns can be supplied with quick disconnect for ease of installation and interchangeability. Silver brazed assembly provides high mechanical strength. Silver and rhodium are used for all electrical working surfaces to provide maximum resistance to corrosion.

J.V.M. Engineering Co., Dept. ED, 4633 Lawndale Ave., Lyons, Ill.

CIRCLE 377 ON READER-SERVICE CARD FOR MORE INFORMATION

Expanded Metals

Ultra Small



Aluminum, stainless steel, monel, copper, brass and other standard sheet materials can be used in forming these expanded metal sheets. The aluminum, moreover, can be supplied in any color. Among the many uses of these expanded metals are antenna dishes, electronic cabinet panels, radio or TV grilles and housings, machine guards, and the like. Openings may be as small as 1/16th in. and up to 2-1/2 in. Designations are Micromesh and Duromesh, the latter being for heavier duty. Both can be supplied either standard or flattened, as required.

Designers Metal Corp., Dept. ED, 456 E. 159 St., Harvey, Ill.

CIRCLE 378 ON READER-SERVICE CARD FOR MORE INFORMATION

From LFE's Special Products Division-

the ONLY OSCILLOSCOPE with x-axis diversification plus DC to 10 mc bandwidth 0.035 μs rise time 20 mv sensitivity

Look how versatile! Six plug-in adapters give you all these important features:

- any sweep delay between 1 μsec and 0.1 sec by the flip of a switch
- triggering from 0.5 to 5,000 cps
- two-signal display on separate sweeps
- markers 0.1, 1, 10, 100, 1,000, 10,000 μsec apart spaced to 1% time accuracy . . . also functions as width gate
- triggering on composite TV video signal . . . permits triggering on any part of leading or trailing edge of any signal
- sweep speeds down to 5 s/cm

Direct-reading, continuously-variable sweep speeds, 0.1 μs/cm to 0.1 s/cm, 5% accuracy. Timing measurement accuracy 1% with gated marker generator plug-in.

Simple operation . . . direct-reading, functionally grouped controls throughout.

Clean, brilliant trace and DC amplifier stability.

Direct-reading, continuously-variable square-wave calibrating voltage from 0.1 to 100 volts, 5% accuracy.

Versatile triggering facilities — external, internal signal, internal recurrent 500 to 5,000 cps or line voltage — trigger on leading or trailing edge of signal.

Internal trigger and sweep gate outputs, Z-Axis input for intensity modulation.

Elevation rack for easy viewing.

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$1210. without plug-ins F.O.B. BOSTON

NEW 411A with 1401 adapter

Model 1400 Extended Range Trigger Generator not shown

Model 1401 Delay Sweep Generator

Model 1402 Video Switch

Model 1403 Gated Marker Generator

Model 1404 TV Trigger Shaper

Model 1405 Long Sweep Generator

An outstanding instrument welcomes comparison

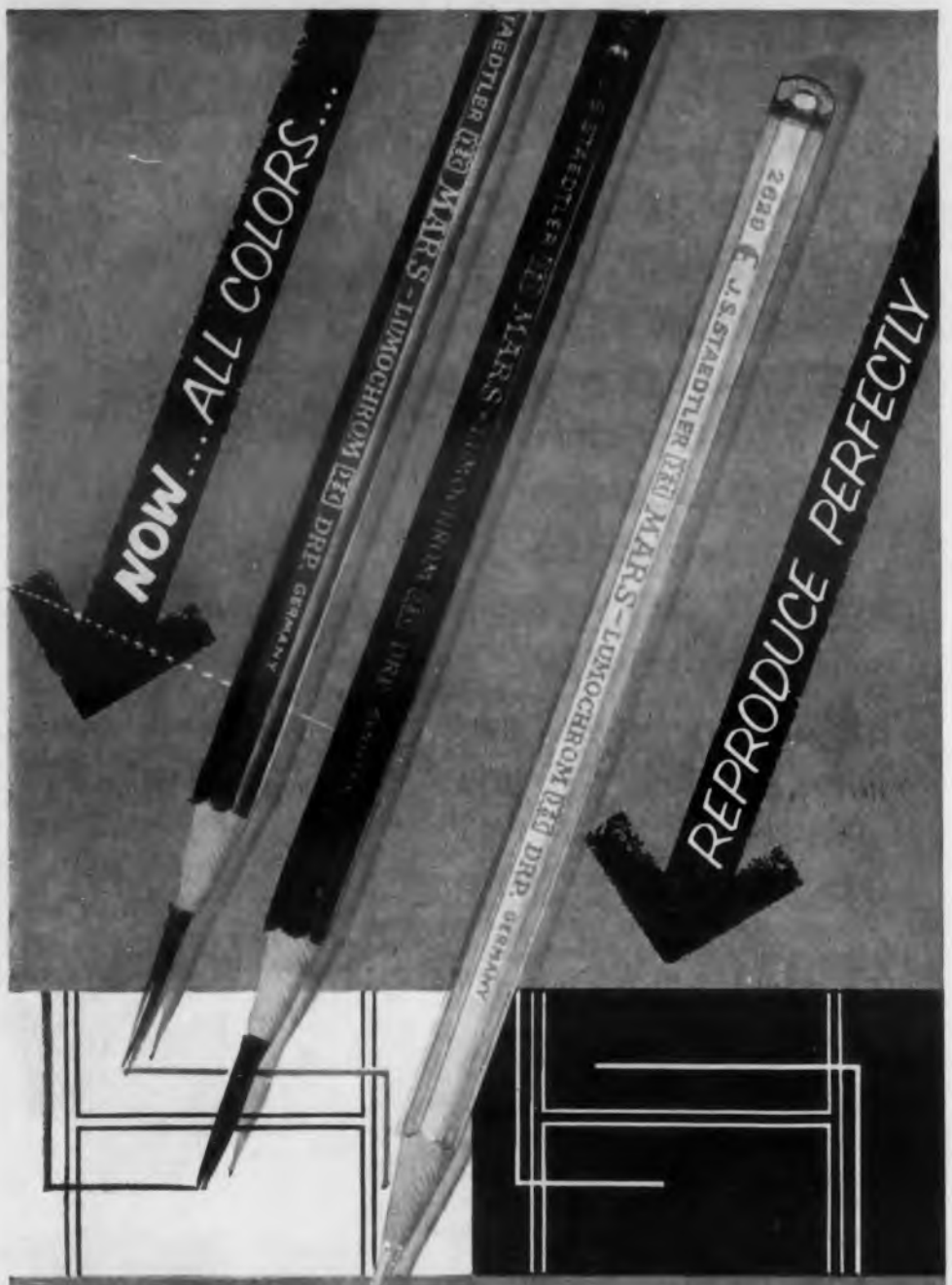
Get complete details today. Write Special Products Division

LABORATORY FOR ELECTRONICS, INC.

75 Pitts Street Boston, Massachusetts

manufacturers of oscilloscopes, digital test instruments, decade scalers, delay lines, transformers, radar sets, business machines and other types of complex electronic equipment.

CIRCLE 379 ON READER-SERVICE CARD FOR MORE INFORMATION



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makes possible an important new drafting technique. It's not just a colored pencil; it's a *color-drafting* pencil. Twenty-four colors—and every one reproduces perfectly. Lets you draft with as many colors as you need. Saves time, prevents mistakes.

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Other new Mars products include: the Mars-Pocket-Technico for field use, the Mars "Draftsmen's" Pencil Sharpener with the adjustable point-length feature, and the efficient, clean Mars lead sharpener. All available – along with the established standards: Mars-Lumograph black graphite drafting pencils, Mars-Technico lead holder and leads, and Tradition-Aquarell painting pencils – at all leading engineering and drafting supply dealers.

J.S. STAEDTLER, INC. HACKENSACK, NEW JERSEY

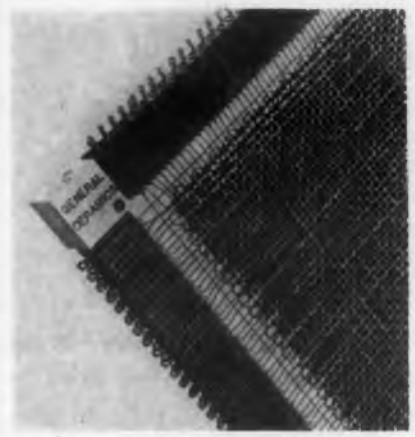
CIRCLE 381 ON READER-SERVICE CARD FOR MORE INFORMATION

△ **Plug-In Output Strip**
For Counting, Read-Outs

This decade counting, 10-wire output strip is useful in computers, punch card systems and in multiple sequence pre-set counters for data processing, recording and production control. It carries the designation Model 189B. Functional construction facilitates combination with other strips to meet a great variety of instrumentation requirements. Model 189B utilizes a Dekatron cold-cathode glow transfer counting tube and associated conservatively-designed drive circuits. Maximum counting speed is 4 kc, minimum inout requirement a 15 v positive pulse of at least 100 microseconds width. Output signal is a 30 v positive pulse; output impedance is 100 k. Power requirements are 0.5 ma at +400 v dc, 0.5 ma at +125 v dc, 0.5 ma at −125 v dc, 0.1 ma at −133 v dc, 0.6 amp at 6.3 v ac (gnd) and 0.6 amp at 6.3 v ac (−125 v dc); all ±10 per cent.

Baird-Atomic, Inc., Dept. ED, Cambridge, Mass.
Radio Engineering Show, Booth 3219, 21.

CIRCLE 382 ON READER-SERVICE CARD FOR MORE INFORMATION



△ **Magnetic Memory Planes**
Stack Construction

These magnetic memory planes, available in any frame size up to and including 10 in. x 10 in., are made in stacks which eliminate the need for molds. The planes have greater frame strength and rigidity, and spacers are not required for the vertical assembly of planes, since the four corners have a greater cross-sectional height than the remainder of the frame.

General Ceramics Corp., Dept. ED, Crows Mill Rd., Keasby, N. J.
Radio Engineering Show, Booth 1629.

CIRCLE 383 ON READER-SERVICE CARD FOR MORE INFORMATION

for MICROWAVE SIGNAL ANALYSIS

of radar communications equipment and components

VECTRON SA30 SERIES MICROWAVE SPECTRUM ANALYZER

Clearly and accurately displays:
Frequency of carrier and side bands
Undesired frequencies generated
Relative power of all signals
Details of intermittent signals.

SA30WR-1 2,000 to 12,000 mc/s
Direct Reading Dial
Recommended for laboratory or production use where wide frequency coverage is needed and moderate frequency accuracy (0.5%) is required.

SA30X5 8,500 to 9,660 mc/s
Direct Reading Dial
Frequency Accuracy 0.05% or better
Ideal for use in design, production and maintenance facilities where major requirements are fast, accurate readings within its frequency range.

THE SA30 SERIES IS LIGHTER: — uses all aluminum construction in a portable 80 lb. bench-top unit or as two rack-mountable assemblies.

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BOOTH 3106-3108
1957 RADIO ENGINEERING SHOW
MARCH 18-21 NEW YORK COLISEUM

VECTRON, inc.
Electronic and Electro-Mechanical Equipment
1583 Trapelo Road • Waltham 54, Mass.

VECTRON'S MINIATURIZED SPHERE RESOLVER requires less than 5 in/oz input for 1 to 2 in/oz from the sine and cosine output shafts. This precision mechanical resolver is 1½" square with a body block over 2⅛" long.

This product of Vectron design and manufacture is another example of the electro-mechanical problems which Vectron can help you solve.

CIRCLE 384 ON READER-SERVICE CARD

Glide Slope Receiver

Transistor Powered

Utilizing an all-electronic means of converting aircraft battery current to ac, instead of the usual dynamotor or vibrator, this glide slope receiver weighs only 6-3/4 lb. Two transistors, operating as a multivibrator circuit, provide all the ac required. The receiver, designated Model DGS-20, has up to 10 crystal channels in the 329.3 to 335.0 mc band, and is supplied with 10 additional crystals for future requirements. Crystals are selected by a rotary solenoid controlled by a panel switch. Vacuum tubes are ruggedized; modular design has been featured to simplify servicing. The entire unit conforms to the electrical performance requirements of RTCA paper DO-58.

Dare, Inc., Dept. ED, Troy, Ohio.

CIRCLE 386 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Remote Positioner

Small Input Torque

The Model 11 Torsynator is a low cost remote positioning device. It has small input torque and high output torque. Accuracy within ±1/2 degree. Input volts are 28 v dc, starting time is 20 milliseconds, idle current is 0.1 amp, starting current is 0.4 amp, and output is 7 in. oz. Gear reduction is 400-1 and temperature range is —40 to +80 C. Maximum vibration is 10 g. Weight of receiver is 6 oz, weight of transmitter is 2 oz, and weight of relay box is 11 oz. Max. follow-up speed is 60 degrees per second.

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

Radio Engineering Show, Booth 2315.

CIRCLE 387 ON READER-SERVICE CARD FOR MORE INFORMATION

Have you sent us your subscription renewal form?

Nylon Fasteners
Also Insulate

Self-locking, self-retaining fastening devices, made of nylon, create vibration-proof and shock-resistant assemblages in which metal parts may be physically joined but electrically insulated. The Grippit fastener is an unthreaded nylon nut. It has self-retaining features, so it can be inserted during production runs without danger of being dislodged during handling. A self-tapping screw, such as type "Z", is driven into the Grippit by either hand or power screwdriver. The screw impresses its own thread on the nylon inner wall. As the screw is tightened the Grippit is drawn up and forms a collar, as shown in the illustration, thus constituting a secure and rigid lock washer. Grippits are particularly recommended for assembling enameled parts without risk of the chipping or crazing sometimes caused by metal to metal contacts. The fasteners are presently available to take sizes #8 and #10 self-tapping screws.

Tru-Lock Fasteners, Inc., Dept. ED, Woodbury, Conn.

CIRCLE 391 ON READER-SERVICE CARD FOR MORE INFORMATION

Wide Angle Lens
165 Degrees

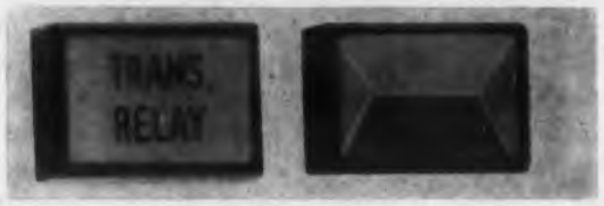
Equipped with iris ring adjustment from f/1.5 to f/8.0, this compact, 3.45 mm lens covers an area of 165 deg both horizontally and vertically. It is designated Triad 720 and is available in either a gun camera (GSAP) mount or a "C" mount. With the gun camera mount it protrudes 4-1/2 in. from the front plate of the camera and measures 4 in. in dia at its widest point. The Triad 720 is primarily intended for use in instrumentation.

Triad Corp., Dept. ED, 17136 Ventura Blvd., Encino, Calif.

CIRCLE 392 ON READER-SERVICE CARD FOR MORE INFORMATION

Rectangular Indicator Lamps

Flat or Prism Lens



These rectangular indicator lamps are supplied in two sizes: 1-13/32 in. x 31/32 in., and 31/32 in. x 11/16 in. Lamp bulbs are serviced from the front of the panel. Designations can be engraved directly on the lens. Lenses may be flat, or prismatic for wider visibility. The lamps are single-hole mounted in a circular opening. Multiple application in annunciator assembles is simple and can be made either by the user, or the manufacturer will assemble the lamps into multiple units meeting the user's requirements.

For low voltage applications T3-1/4 single-contact miniature bayonet lamp bulbs are recommended; and they may also be used for 120/220 v service with a 10-w resistor externally bracketed and secured by the lamp unit. A NE-51 neon lamp bulb may be used for 120/220 v applications with the prism lens, and the required resistor incorporated in the socket assembly.

H. R. Kirkland Co., Dept. ED, 8 King St., Morristown, N. J.

CIRCLE 396 ON READER-SERVICE CARD FOR MORE INFORMATION

Teflon Tubing In New Sizes

From AWG 0 to AWG 30

Teflon ("spaghetti") tubing, formerly supplied by its maker only in AWG sizes 8 through 26, has now been made available also in sizes 1, 2, 3, 4, 5, 6, 7, 28 and 30. Polypenco thin-wall tubing has a minimum dielectric strength of 750 volts/mil, dielectric constant of 2.0, surface resistivity above 10 to the 12 ohms per sq cm, zero water absorption, and a temperature service range from −320 to +555 F. The material resists soldering temperatures completely. Every size is available in ten colors for circuit identification.

Polymer Corp. of Pa., Dept. ED, 2140 Fairmont Ave., Reading, Pa.

CIRCLE 397 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Sharp Cut-Off Pentode

Frequencies to 400 Mc

Intended for critical military and commercial applications this sharp-cutoff pentode, designated 5636, incorporates a compact structure in which special attention has been given to features that enable it to resist shock and vibration. It has two separate control grids, each with a sharp-cutoff characteristic, a unipotential cathode and two cathode lead terminals to facilitate isolation of input and output circuits. The tube will serve with high efficiency in gated amplifier circuits, delay circuits, mixer circuits, gain-controlled amplifier circuits and many other applications, at frequencies up to 400 mc.

Radio Corp. of Amer., Tube Div., Dept. ED, Harrison, N. J.

Radio Engineering Show, Booths 1602, 1707.

CIRCLE 401 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Magnetic Counter

And Frequency Divider

Compared to a conventional four-tube counter, the Magnivider shown here consumes only half the power and occupies only one-third the size. It is intended for random counting, frequency division, preset counting, numerical accumulators, synchronizing television sweeps and similar applications. Two outputs provide 40 v at high impedance and 4 v at low impedance. The Magnivider is available in three scales, 9, 10 and 11.

Counting rate is dc to 50 kc. Power requirements are 6.3 v at 0.3 to 0.45 amp; 150 v at 15 ma for 50 kc counting rate but at 12 ma for counting rates below 1 kc. Input: a positive pulse of 32-48 v (which may be obtained from another Magnivider), with a rise time of 0-2 μsecs and a pulse width 10 μsecs less than the pulse spacing. The high impedance output delivers a nominal 40 v above ground pulse to another Magnivider or to a 100 k load shunted by 25 μμf max. The low impedance output delivers a 4 v pulse to cables or transistors offering a 100 ohm impedance. The unit utilizes a printed circuit and one electronic tube. Dimensions are 3-1/2 in. x 5-1/2 in. x 1-1/4 in.

Magnetics Research Co., Dept. ED, 255 Grove St., White Plains, N. Y.

Radio Engineering Show, Booth 3944.

CIRCLE 402 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Rotary Latch
Assembled on One Panel

Made of steel, cadmium plated, the rotary latch consists of four parts; latch-screw, shim plate, anchor block and latch-nut. The entire latch is assembled on the access panel only. The Paneloc Rotary Latch operates with a quarter turn. It is available in three standard sizes.

Scovill Mfg. Co., Dept. ED, Waterbury 20, Conn.
Radio Engineering Show, Booth 4007.

CIRCLE 406 ON READER-SERVICE CARD FOR MORE INFORMATION

Interference Detectors
Eliminates Screen Room

This Model 2A interference detector can eliminate the need for a screen room. Used on production lines to compare the order of interference given off by samples of the same type it provides a simple means of quality control. The meter detects interference that may be a cause, or a potential cause, of malfunctioning of critical equipment. Used with an antenna (available as an accessory) it reports interference within equipment, and on secondary power lines, of an intensity of 1 mv or more. A broad spectrum in mc region may be observed, or specific bands picked out for observation, by means of band-pass filters. Standard filters cover four bands: 0.075 to 35 mc; 0.150 to 0.500 mc, 0.450 to 1.2 mc, and 1.0 to 35 mc; other band-pass filters can be supplied to order.

Interference Testing and Research Laboratory, Inc., Dept. ED, 150 Causeway St., Boston 14, Mass.

CIRCLE 407 ON READER-SERVICE CARD FOR MORE INFORMATION

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△ Frequency Meter

Allows 20-Channel Servicing

A frequency meter capable of servicing multiple transmitter installations operating on from one to twenty channels in mobile radio communications systems, the Type 5890-A is portable and features transistorized circuitry. It can be utilized with any transmitter operating in the 25 mc to 470 mc band. The crystal-controlled meter can be used as a source for associated receiver alignment and for setting transmitter modulation deviation.

This meter's frequency source, a crystal oscillator/harmonic generator, has a stability of ±0.0005 per cent, and is controlled by one of twenty pre-selected crystals. Four additional crystals can be supplied to generate intermediate frequencies for receiver alignment procedures. With the exception of the crystal oscillator stage, all circuitry is transistorized.

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

Radio Engineering Show, Booths 3201-3203, 3301-3307.

CIRCLE 412 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Water-Sealed Splice

Has Nylon Sleeve

This permanent, water-sealed and insulated splice is composed of a highly conductive, electrotinned copper link; a transparent nylon sleeve, and anodized aluminum sealing rings. It is installed with a ratchet-type, controlled-depth-of-indent tool, designated Hytool. The Sealink splice accommodates AN wire sizes #26 thru #10, and can be used (see the illustration) for two-wire or multi-wire applications. It is color-coded for size identification, and meets MIL-T-7929A.

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

Radio Engineering Show, Booth 4424.

CIRCLE 413 ON READER-SERVICE CARD FOR MORE INFORMATION

△ **Miniature Crystal**
3 to 100 MC

This vacuum mounted quartz crystal unit, type BG6a, incorporates an AT-cut element. Aging of the unit is 2.0 ppm maximum during the first year of service under low drive conditions. The tolerance of the unit is ±0.0005 per cent of nominal frequency at 25 C, stability is ±0.0015 per cent maximum deviation from measured frequency at 25 C over an ambient range from —55 to +90 C. The overall dimension is 2-1/8 in., vacuum mounted in a T5-1/2 bulb, small button miniature base.

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

Radio Engineering Show, Booth 2736.

CIRCLE 416 ON READER-SERVICE CARD FOR MORE INFORMATION

△ **Vibration Mounting**
Load Ranges 50-1000 lbs

An all-metal mounting construction of aluminum and load carrying stainless steel resilient elements that will attenuate 20 g impact shocks. The W164 series is available in load ranges from 50 to a 1000 lbs per unit. The non-linear spring rate of Met-L-Flex resilient elements produces increasing stiffness as loads increase. The natural frequencies of the W164 series are between 13 and 17 cy per second and will provide vibration isolation at disturbing frequencies above approximately 1250 cy per minute. When used as either a compression hanger type mount or an inverted hanger type, performance remains approximately the same.

Four 1/4 in. bolts are used for floor or structural mounting. The equipment is mounted through one 3/8-16 UNC tapped center hole.

Robinson Aviation Inc., Dept. ED, Teterboro, N.J.

Radio Engineering Show, Booth 2506, 2508.

CIRCLE 417 ON READER-SERVICE CARD FOR MORE INFORMATION

Grid-Controlled Indicator Tube

Monitors Transistor Circuits

KP-125, Actual Size

The KP-125 is a subminiature, grid-controlled indicator tube which operates with small signal voltages and negligible current. A gas-filled triode of the glow-discharge type, the KP-125 provides a visual glow which may be viewed end-on or from the side. Both the filament (very low drain hearing aid type) and the anode may be operated from the AC line and consume power in the milliwatts region. The tube glows with 0 volts on the grid and extinguishes with —3 volts on the grid. Flying leads are provided for direct soldering into circuits, such as on printed boards. The characteristics of the KP-125 make it useful in computer transistor circuits as an indicator of current conditions which does not load the circuit under test. Additionally it serves as an indicator for monitor service in remote control panels. *For details on this and other special purpose electron tubes, write:*

KIP ELECTRONICS CORPORATION

Dept. E, Stamford, Connecticut

CIRCLE 422 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Magnetic Shift Register

Single Line

This unit requires only one shift pulse generator, utilizes one magnetic core and one germanium diode per stage with vacuum tube driver, or one magnetic core and one transistor per stage with transistor driver. Drivers can operate up to 50 stages of a register. Units are available at operating frequencies from 0 to 10 kc, 50 kc, 100 kc, 250 kc and 500 kc.

These units have demonstrated life expectancies in excess of 40,000 hours. Normal packing density is 120 units per square foot of panel space. The magnetic core is encapsulated. The components are mounted on a printed circuit board which is sealed from outside moisture. These units are available with printed circuit lugs, solder lugs, or plug-in type headers, and also custom-packaged to meet special requirements.

Mack Electronics, Dept. ED, Div. of Mack Trucks, Inc., 40 Leon St., Boston 15, Mass.
Radio Engineering Show, Booth 1815-1817.

CIRCLE 424 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Transistor Clip

Resists Vibration

This silver-plated beryllium copper clip will hold all transistors 0.235 x 0.375 in. including the *2N167* and *2N78*. The clip has a four point grip and a stop tab to prevent the transistor moving longitudinally. Provided with a single 1/16 in. diam. mounting hole, the clip has an integral tab to be inserted in a second hole to prevent twisting. It is designed to meet aircraft and missile heat, shock and vibration requirements.

Atlas E-E Corp., Dept. ED, 47 Prospect St., Woburn, Mass.
Radio Engineering Show, Booth 4235.

CIRCLE 425 ON READER-SERVICE CARD FOR MORE INFORMATION

ANALOG COMPUTER
MODEL 3000

Simplified analog computer solves wide variety of engineering problems. Detachable problem boards and plug-in components facilitate rapid problem set-up. Function generator, multiplier, chopper stabilizer, and other accessories available. Write for complete data. Model 3000, $1150 FOB Factory.

Problem board $95

DONNER SCIENTIFIC COMPANY

816 Galindo Street
Concord, California

CIRCLE 427 ON READER-SERVICE CARD

△ Multi-Channel Programmer
Small and Accurate

The MPR-13 multi-channel programmer provides up to 13 channels for repeat cycling or random programming. It has an accuracy of 0.002 per cent. It is designed for missile and aircraft use.

This unit provides for an insulating tape similar to 35 mm photographic film to be advanced between 13 contactors. The tape is marked lengthwise in time and divided in 13 channels. The Programmer MPR-13 weighs 3 lb, 10 oz and measures 2 x 3 x 6 in.

Photographic Products, Inc., Dept. ED, 1000 N. Olive St., Anaheim, Calif.

Radio Engineering Show, Booth 3001.

CIRCLE 428 ON READER-SERVICE CARD FOR MORE INFORMATION

△ Germanium Junction Photocell
Miniature Size

The PG40A miniature germanium junction photoelectric cell is designed to sense punched cards and perforated tape. It has a diameter of 0.093 in. which makes mass grouping in a small space possible.

This cell passes saturation current practically independent of the applied voltage. When the cell is illuminated, the current increases by an amount directly proportional to the illumination.

Due to their large current or voltage output a suitable relay or cold cathode trigger tube may be operated directly from the cell. It can be used at low light levels.

International Standard Trading Corp., Dept. ED, 22 Thames St., New York 6, N.Y.

Radio Engineering Show, Booth 2008.

CIRCLE 429 ON READER-SERVICE CARD FOR MORE INFORMATION

GYROS
for every application

For hours in aircraft or minutes in missiles, gyros must possess ruggedness and dependability that will assure performance of the mission. Kearfott Gyros possess this ruggedness and dependability coupled with extremely high accuracy. That is why they are so widely used in all types of aircraft and missiles. Kearfott Vertical, Rate, Free, Directional and Floated Rate Integrating Gyros as well as Stable Elements are designed to meet the most stringent airborne requirements.

Unsurpassed in Performance
Unequalled in Compactness

Kearfott Miniature Vertical Gyros satisfy the requirements of MIL-E-5272 as regards shock test (Procedure II) humidity, salt spray, fungus resistance, rain, sand, dust, immersion and explosion proof. Duplicates the performance of standard vertical gyros in ⅓ the volume and weight.

Write today for technical data on Kearfott Gyros.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

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CIRCLE 430 ON READER-SERVICE CARD FOR MORE INFORMATION

TELL US

And We'll Tell 25,000 Others

You're coming to the Show and Convention to pick up some ideas. You're bound to get plenty as you visit some of the 800 plus exhibits and catch part of all the papers being read.

Why not get your design ideas published in ELECTRONIC DESIGN. If you stop to think about it, ED is the only technical magazine devoted exclusively to passing along practical ideas for design engineers. It reaches more strictly design engineers than any other publication.

The code of the scientist is to publish his findings. Research engineers and scientists who use the Proceedings and Transactions of the IRE for this purpose are to be congratulated. But what about you, the practicing engineer who learned how to do something better than before. Are you passing along your knowledge as you can?

WHAT ARE YOU GOING TO DO IN RETURN?

You'll no doubt bump into old friends and associates and tell them about your latest brainstorms. They'll probably congratulate you. But in reality, you're as communicative as a clam. Only about 0.0005 per cent of your available audience will hear you. (Even if you read a convention paper, you will expose, aurally and in print, only 0.05 per cent of the available audience to your idea.)

An editor will be on hand at Booth 1401 at all times. We will have an Author's Guide and a list of suggested topics for you.

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Services for Designers

White Noise Test Facility
50 cy to 10 kc

The first independent commercial "White Noise" testing facility on the West Coast has been established at Rototest Laboratories, Inc., of Lynwood, California. With the equipment now available, Rototest is able to subject a test specimen to sound level intensities of 150 db over a cross sectional area of 64 square inches. This sound level is obtainable on a random frequency basis covering the entire frequency range from 50 cy to 10 kc with the required sound pressure level energy present in each octave over the entire range. Using discrete frequency testing techniques (concentrating the available energy at one specific frequency or narrow frequency band) the equipment now available can provide sound energy levels from 150 to 155 db.

The intense noise levels produced by rocket and jet engines has been proven to definitely cause equipment failure and, as such, decreases the reliability of newly designed missiles and aircraft. The purpose of the new "White Noise" testing facility at Rototest is to provide testing conditions in the laboratory comparable to normal flight conditions.

The Rototest equipment features an audio supply of 540 electrical watts which is then converted into sound energy which is in turn concentrated by use of a logarithmically shaped sound horn chamber to provide 150 db over a 64-in. cross sectional area.

Aluminum Plating
For Solderability

A new process for plating aluminum which makes electronic parts easily solderable is announced by E. S. Bennett, president of Anchor Plating & Tinning Co., Inc., El Monte, Calif. The new process discovery is known as "A-F14."

In addition to the exclusive process for plating aluminum, the firm plates precious metals, gold, silver and rhodium. Anchor Plating & Tinning is also an approved plant for plating of electrolytic tin, fused tin, white nickel, cadmium and copper on steel and most zinc base die castings. Quality work control is achieved through magna-gauge and drop-testing equipment to meet government specs.

New Literature

Miniature Bearing 438

A miniature ball and roller bearing line is shown in a catalog of 16 pages. Drawings, photographs, full descriptions, dimension tables and mounting information are presented. A number of inch dimensioned open and sealed radial bearings are listed in ABEC Class 1 and 5 tolerances. Two pages of the catalog illustrate applications for major type bearings. The booklet also contains technical data on tolerance standards, internal clearances, load capacity calculations, speed limitations, lubrication, packaging and handling and mounting. Landis & Gyr, Inc., 45 W. 45th St., New York 36, N.Y.

Magnets and Thermistors 439

"Trends and Developments for Electrical "Design Engineer" is a 12-page booklet of information on permanent magnets, thermistors and Thyrite varistors. The illustrated publication discusses its subjects in relation to a designer's problems. It points out new approaches, possibilities and methods for using the products. How magnets help designers miniaturize products, determining the proper magnet for a specific application, and how thermistors and Thyrite varistors can be harnessed for products are some of the topics covered. General Electric Co., Metallurgical Products Dept., Detroit 32, Mich.

Strain Gages 446

A price list on SR-4 strain gages instruments and accessories has been issued. In addition to offering flat grid gages and other products, the 16-page list contains a thorough discussion of gages and methods of using them. In constitutes a complete guide to proper gage selection. Other products priced are self-compensated gages, a complete high temperature and room temperature foil gage line, and an assortment of cement kits. The booklet is illustrated with graphs and sketches. Baldwin-Lima-Hamilton Corp., Electronics and Instrumentation Div., Waltham, Mass.

Power Supply Equipment 447

Standard low voltage rectifier power supply equipment is listed in the 16 pages of a recent catalog. A "Power Equipment Questionnaire" form for requesting information and quotations on special and custom-built power supplies goes with the booklet. Opad Electric Co., 69 Murray St., New York 7, N.Y.

Instrument Choppers 448

A complete chopper catalog is now available which includes electrical, technical and mechanical specifications.

The illustrated catalog describes the low frequency (from 10 cps to 120 cps) and the high frequency (from —350 to —500 cps) operation. James Vibrapowr Co., 4050 No. Rockwell, Chicago 18, Ill.

Electrical Contacts 449

The materials, properties, forms and uses of a line of electrical contacts have been outlined in "short-form" catalog C-522. A convenient, up-to-date condensation, the publication is designed to aid in contact selection and use. Discussed are contacts manufactured from fine silver, palladium and nickel; silver alloys including coin silver; and many powdered metal compositions. Featured is an outline showing the best contacts for various applications. The 4-page folder is illustrated with photographs. Gibson Electric Co., Frankstown Ave., Pittsburgh 21, Pa.

Glass Fiber Yarn 458

Form TYN-1, an 8-page brochure about glass fiber textile yarns is now available. The bulletin includes a description of the product and some end uses, a table comparing glass fiber continuous-filament yarn with other yarns, nomenclature and manufacturing processes. L.O.F. Glass Fibers Company, 1810 Madison Ave., Toledo 1, Ohio.

Silicon Junction Diodes 459

Data Sheets describing eight silicon junction diodes have been released. The sheets show that each of these diodes has a high-temperature device, characterized by good forward conductance, together with extremely high back resistance. These diodes have a very sharp back voltage breakdown, and evidences extremely low saturation current throughout wide temperature ranges.

They are illustrated and include the specifications, physical and typical characteristics of each diode. Hughes Aircraft Co., International Airport Station, Los Angeles 45, Calif.

Photo Reproduction Materials 460

A 16-page catalog, in two colors, describing complete line of photographic reproduction materials for drawings is available. The materials include silver-sensitized papers, vellums, films and tracing cloths for making negatives and prints, and also positive-to-positive prints.

One of the features of the bulletin is a guide to help in the selection of the best material for a particular job, and the use of these materials, with complete processing directions and development time. Grant Photo Products, Inc., 19000 Detroit Ave., Cleveland 7, Ohio.

Pressure Transistor 461

Bulletin 501 features a low differential pressure transmitter. The booklet describes the style H electric transmitter with ranges 0 to 2, 4, 6, 8 and 10 inches of water and with working pressure 50 lbs. per standard in. gage. Illustrations show construction, dimensions and operation. Burgess-Manning Co., Penn Instruments Div., 4110 Haverford Ave., Philadelphia, Pa.

Industrial Periscopes 462

Periscopes for distant viewing of inaccessible places and hazardous processes are depicted and described in a catalog of 4 pages. Several practical examples show how they have solved observation problems. A special stroboscopic periscope is also discussed. Lenox Instrument Co., 2010 Chancellor St., Philadelphia 3, Pa.

Thermostatic Controls 463

Tubular-type thermostats that make or break an electrical circuit by responding to changes in temperature or electrical load are discussed in a booklet of 8 pages. The design, construction, operation, and applications of the thermostat are treated in detail. The brochure is illustrated with cross-section drawings and photographs of models having various lead and terminal arrangements. Charts give sizes, capacities and other information. Research, manufacturing and testing facilities are also depicted and described. The Franklin Dales Co., 180 E. Mill St., Akron, Ohio.

Converters and Dynamotors 464

Bulletin No. 1256A describes the converters and dynamotors which are now available, and are made to operate diesel locomotive, telephone emergency standby, marine radio, mine, forestry and other industrial communications systems.

Several models of the converter and dynamotor are shown with a wide selection of ac and dc input voltages, and output specifications up to 750 watts.

The bulletin is printed in two colors and includes descriptions, performance charts and technical data. Carter Motor Co., 2711 W. George St., Chicago 18, Ill.

Electro-Magnetic Brain 465

Bulletin No. 571 describing an electromagnetic sensory and director system with "package" controls is now released.

The illustrated bulletin fully explains in detail the working functions of the system. Among the features are a safe-start and pulse forming network and cycle sequence control. Sensory Inc., New Vernon, N.J.

Magnetic Tape Recorder 468

Capabilities and characteristics of an instrumentation tape recorder are described in a 20-page booklet now available. Detailed specifications are also provided in the booklet, which is printed in four colors.

Numerous illustrations show transports, heads, and modular electronic assemblies used with graphs provided to clarify specifications and recorder operation.

The recorders are used in data acquisition, storage, analysis and reduction, in machine and process programming and in dynamic simulation. Data may be recorded and reproduced in the dc to 100 kc frequency range on one to 14 tracks at any of six standard tape speeds, 1-7/8 to 60 inches per second. Ampex Corp., Instrumentation Div., 934 Charter St., Redwood City, Calif.

Electrical Insulating Materials 469

Illustrated and completely indexed, Catalog 20 contains 32 pages of information on electrical insulations for repair and maintenance of motors, generators and electrical or electronic equipment. Descriptions, photos, prices and ordering data are presented. Among the products covered are tying cords and twines; cotton, asbestos, and woven glass tapes; cotton, glass, and varnished or saturated tubing and sleeving; mica plates and laminates; varnished cloth and combination insulations; dispenser packaged rag paper and paper-"Mylar" insulation coils; slot insulation creaser-cutters; formed fibre or wood wedges; fibre washers; fishpaper and vulcanized fibre sheets; papers; fibre rods and tubing. Silicone varnishes, treated cloths, and laminations; baking and impregnating varnishes; and pressure-sensitive tapes. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.

Die Casting 470

A booklet on die casting with zinc alloys, presenting specific operating details on requirements of alloys which affect properties both mechanical and physical of the casting produced is now available.

It discusses gating and venting of the die—and the advantages of a heavy gate with an opening of about .040 in. or better, depending on thickness of casting.

Proper venting and use of overflow wells; gate runner design which permits the development of increased uniform pressure at the gate opening; metal injection pressure which should be used in excess of 1000 to 1600 lbs/sq in. and maintenance of proper die temperatures are explained in detail.

The booklet is illustrated and contains many interesting items. Henning Bros. & Smith, Inc., 91-127 Scott Ave., Brooklyn 37, N.Y.

Thermometers and Hydrometers 474

Bulletin 40 contains 24 pages of information on thermometers and hydrometers. A complete listing of ASTM, and general and specific purpose thermometers and hydrometers is presented. ASTM thermometers are listed by number and test. Complete specifications and prices are given for all items, many of which are illustrated. The booklet also contains directions for reuniting mercury in thermometers, general facts about hydrometers and their use, and suggestions for assuring accurate hydrometer readings. Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.

Arms 475

"How Good is Your Arm" is a 16-page analysis of basic problems involved in arm design. Written in simple language and illustrated with numerous charts, the booklet covers such design aspects as resonance, tracking, tracking error, torsional resonance and pivot design. Fairchild Recording Equipment Co., 10-40 45th Ave., Long Island City, N.Y.

Tubular-Plastic Wire Markers 476

A time-saving, permanent method of coding wire with plastic tubular markers is described in bulletin now available. It is used to identify complicated thermoplastic wiring circuits.

The illustrated bulletin states that the markers resist attack from oil, grease, acids and heat, and withstand temperatures of at least 150 C (302 F). E.C.P. Corporation, 6808 Wade Park Ave., Cleveland, Ohio.

Technical Catalog for 1957 477

Revised catalog of Technical Data Books is now available covering every branch of engineering. These pocket size reference books each have approximately 140 pages of authoritative data, conversion tables and general information, including current advances.

Some of the subjects covered are aeronautics, automotive and steam engineering, AC Motors & Generators, Television & FM, General Mathematics, Metallurgy and others. Lefax Publishers, Philadelphia 7, Pa.

Microsized Socket Screws 484

Microsized socket screws for electronic equipment and industrial and scientific instruments are the subject of a 4-page folder. The brochure presents descriptions, photographs, drawings, and tabular data on threads per inch, length, recommended installation torques, and shipping weight. Listed are alloy and stainless steel socket head cap and set screws in sizes from No. 0 to No. 3. Standard Pressed Steel Co., Jenkintown, Pa.

Nuclear Fuel Elements 485

"Rolling Mills for Processing Nuclear Fuel Elements" is a 12-page booklet which discusses in detail the special equipment employed in rolling and fabricating the new metals required for the atomic energy program. The text covers the solution of many unusual problems confronted in the nuclear field with regard to avoidance of radiation hazards and special rolling techniques. Ample illustrations of facilities and equipment accompany the text. Stanat Mfg. Co., Inc., 500 Shames Dr., Westbury, N.Y.

Ceramic Magnets 486

Details about Indox V ceramic magnets are presented in Bulletin 16. The 2-page sheet outlines the magnetic properties and typical characteristics of the magnet and points out its design possibilities. Also discussed are the magnet's uses, and its advantages and limitations. In addition, there is a list of available standard sizes. The bulletin is illustrated with photographs, dimensional diagrams, and a graph showing demagnetization and energy product curves for Indox V and Indox I. The Indiana Steel Products Co., Valparaiso, Ind.

Non-ferrous Alloy Chart 487

Engineers and designers who specify the use of non-ferrous alloys can speedily find detailed information in a comprehensive wall chart. Standard brass, bronze and nickel silver casting alloys—37 in all—are described. The 17 x 22-inch chart lists designations for Navy, S.A.E., A.S.T.M. and Federal specifications. Also given are chemical compositions by percentages of ingredient metals. Henning Bros. & Smith, 91-127 Scott Ave., Brooklyn 37, N.Y.

Glass Products 490

A 65-page catalog, entitled "This is Glass," covering the manufacturing methods, applications and history of glass, has just been released.

The colorful brochure deals with such topics as "What is Glass?", "How is Glass Made?" and "How is Glass Used?" Illustrations, charts, and over 100 photographs are included in this catalog. Corning Glass Works, Corning, N.Y.

Industrial Television 491

This brochure just released covers a line of industrial television equipment. The booklet contains many illustrations of latest developments in cameras, monitors, controls, lenses and other accessories that are required for any type of camera chain.

Included are cameras with full remote control for adjustment of focus and iris apertures and for both high and low speed tilt and pan, and also listed are special weatherproof and explosion resistant housings as well as various lenses and turret heads. Philco Corp., Govt & Industrial Div., 4700 Wissahickon Ave., Philadelphia, Pa.

Research Facilities 492

Electrical Engineering Research facilities at the Admour Research Foundation of the Illinois Institute of Technology in Chicago are described in five 4-page folders. The literature explains research being conducted in the following areas: computer systems; electric machines, components, and measurements; electronic instrumentation; and communications and radio frequency applications. Armour Research Foundation, Electrical Engineering Research Dept., 10 W. 35th St., Chicago 16, Ill.

Fasteners and Parts 493

Design information on the manufacture of fasteners and small parts by the cold heading process is contained in a recent house organ issue. The 4-page illustrated publication is intended to give designers basic information on the possibilities and limitations of cold heading as a high-speed, low-cost production method for rivets, nails, screws, threaded parts, hinge pins, shafts, axles, spacers, and many other job-designed parts. John Hassall, Inc., Westbury, N.Y.

Simpl ra

THIS light, compact, transistor test set features simplicity of operation, complete portability, and an accuracy better than many general junction transistor test sets available for use outside the laboratory. This is accomplished by subjecting the questionable transistor to a dynamic check as an amplifier in the common emitter configuration. A 1000 cycle, small test signal ,supplied by a transistor oscillator, is applied to the base terminal of the device under test. The amplified signal from the collector is impressed on a full wave bridge measuring circuit, consisting of a 20 μa meter movement and four 1N198 gold-bonded germanium diodes. The relatively low impedance of this bridge circuit tends to preserve the validity of the grounded emitter current amplification factor designated as (β) beta, so that the indicated value read with a factor of ten (that is, full scale reading equal to 200), is quite close to the true beta of the transistor.

The collector leakage current, I_{co}, is measured by operation of a ganged function switch which inserts the 20 μa meter movement in series with the collector circuit while "floating" the emitter to achieve the test condition. I_{co} first appears on the 5 ma meter. If of sufficiently small magnitude, the 20 μa meter shun switch can be depressed.

P-n-p and n-p-n units are accommodated by switching the polarity of the self-contained battery supply and the metering circuits.

Proper bias is applied to the transistor by means of a potentiometer in the base circuit in conjunction with a current limiting resistor in series with the pot. The current is monitored in the collector circuit to preclude any degenerative effects of internal meter resistance in series with the emitter.

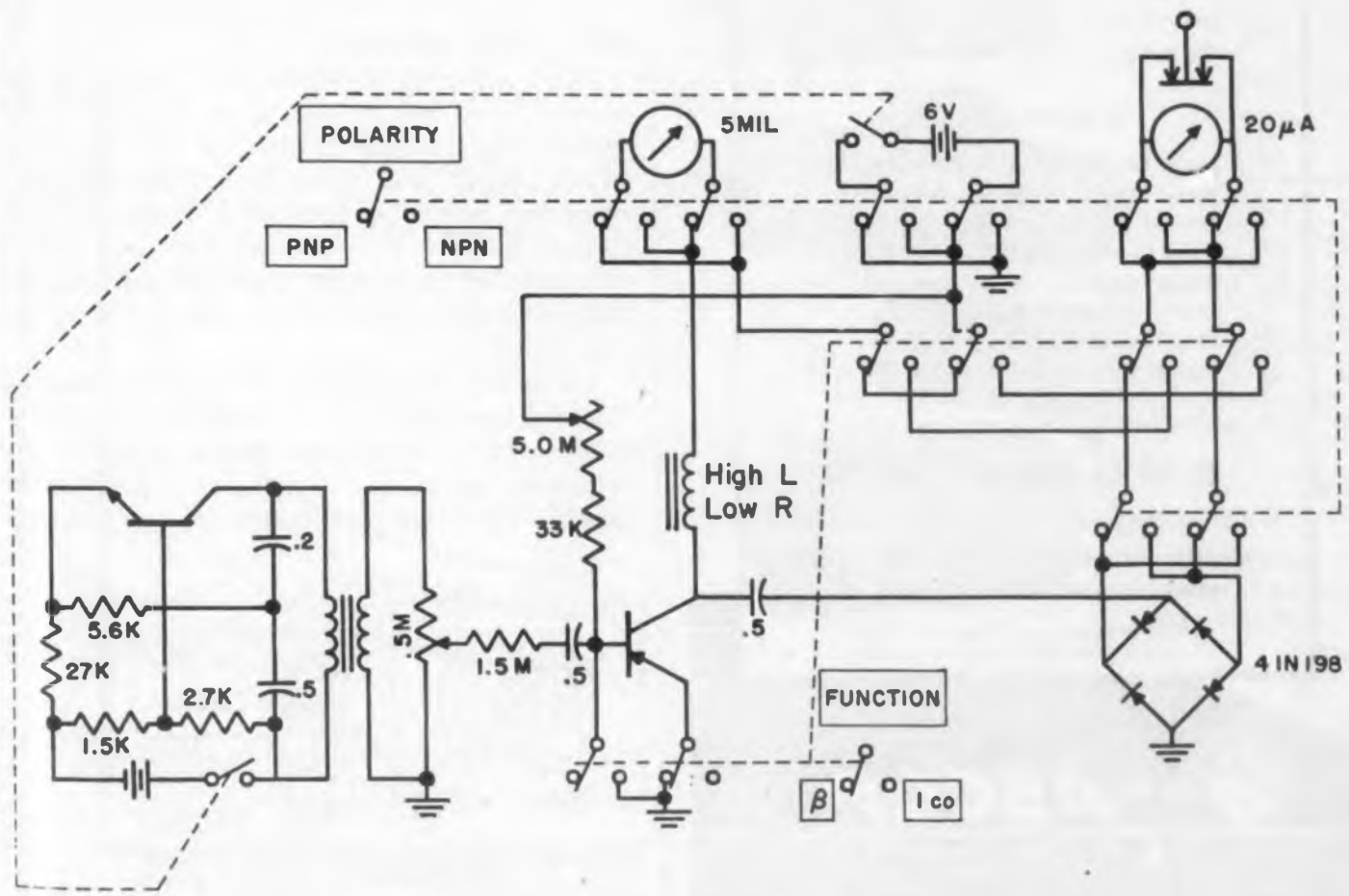
The test set is calibrated through the use of several premeasured units, the signal level being ad-

A new regular feature covering clever circuit and mechanical design ideas—individual contributors will be paid $10 for items published.

ransistor Test Set

justed to correlate with the measured or calculated beta values. Adjusted this way, good correlation was obtained with laboratory test sets in measuring a batch of 50 transistors.

Construction is non-critical and the entire test set was made to fit into a volume of less than 90 cu. in. The choke in the collector circuit should be of low resistance, so there is not too much of a drop in supply voltage. An alternate oscillator circuit using a phase shift oscillator may be used to replace the more expensive transformer. Oscillator transistor is not critical. Twelve-volt batteries are adequate.—*Victor Boxer, Signal Corps Engineering Laboratories, Ft. Monmouth, N. J.*



Circuit of test set for direct reading of β and I_{co}.

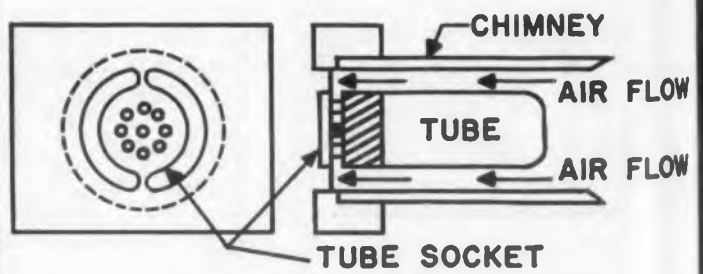
Tube Cooling with Chimneys

An electron tube envelope temperature is generally maintained below some predetermined level to obtain the desired life and performance from the tube. To accomplish this, a hollow cylinder or chimney can be placed over the tube and air forced through the annulus between cylinder and tube (Fig. 1). By properly selecting the air flow and the inner diameter of the chimney with respect to the tube diameter, the heat transfer coefficient from the tube surface can be controlled to give a desired tube envelope temperature.

Two temperatures are of interest, the maximum envelope or "hot spot" temperature, and the average envelope temperature. The hot spot temperature occurs only locally on the bulb, generally over a small area opposite the plate. The magnitude of the local hot spot is a function of the internal electrical design of the tube. Two tubes with identical envelopes and heat dissipations can produce different temperature profiles, and, therefore, different hot spot temperatures. Each tube type is a special case, and to predict the tube hot spot temperature is a difficult heat transfer problem. At the present state of the art, only if the hot spot temperature rise above average tube temperature is known for a particular tube type can the maximum envelope temperature be accurately predicted.

Three different chimneys were tested on two tubes (Fig. 2) over a range of air flows. Both tubes were pentode amplifiers with T-9 bulb types. One of the tubes was internally shielded while the other was internally unshielded. Temperature difference between the tube envelope and inlet air was recorded for each flow rate. Chimneys of three different inner diameters were tested: 1-5/16, 1-3/8 and 1-7/16 in.

The results are shown in Fig. 3. The internally shielded tube envelope operated at approximately uniform temperature over its entire surface and, therefore, the average envelope temperature and maximum envelope temperature are synonymous for



CHIMNEY COOLING

Fig. 1. Chimney Cooling.

TEMPERATURE DIFFERENCE, MAXIMUM TUBE ENVELOPE

this tube. The internally unshielded tube, however, had a hot spot temperature considerably above that of the internally shielded tube.

Melvin Mark, consulting engineer, 1384 Mass. Ave., Cambridge, Mass. Formerly with Raytheon Mfg Co.

[1]Based on a paper presented at the National Conference on Aeronautical Electronics, May 1956.

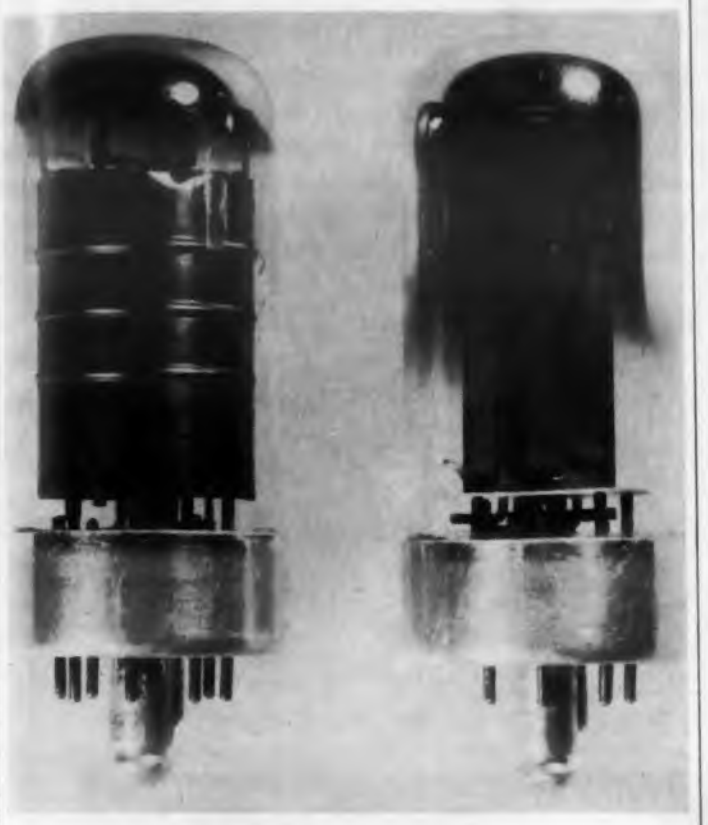


Fig. 2. Tube types tested.

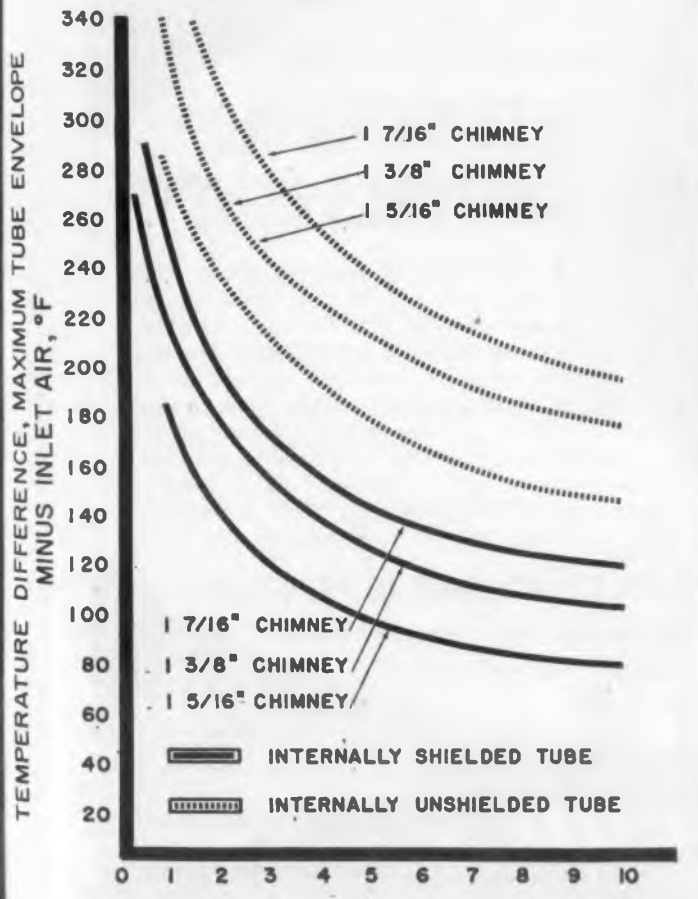


Fig. 3. Effect of various sized chimneys on cooling.

Report Briefs

Direction Finding System

A sector-type radio direction finder bearing computer-recorder, a bearing integrator, related equipments, and techniques are described. The computer samples the intermediate frequency outputs of a twin-channel RDF system at a 25 cps rate, calculates the indicated bearing for each sample via a logarithmic analog, and (sample for sample) delivers at the output a stretched pulse the amplitude of which is proportional to the bearing deviation from a preset reference zero. *PB 122982 Equipment and Techniques for Sector-Type Radio Direction Finder Bearing Data Computing, Recording, and Reduction, Albert D. Bailey, Illinois Engineering Experiment Station, Order from Library of Congress, Washington 25, D.C., Aug. 1955, 57pp, Microfilm $3.60, Photocopy $9.30.*

VLF Ground Propagation

Amplitude and phase data for low, very low, and ultra-low frequency ground-wave propagation is given in this report. Curves detailing amplitudes and phase of waves in the 200 cps to 500 kc band over distances from 1 to 1500 miles are presented. Although ionospheric effects were not considered and the total field at over 200 miles may be modified, special techniques can be applied to correct for the sky wave, and lend significance to the curves, out to their limit. *NBS Circular 574, Amplitude and Phase Curves for Ground-Wave Propagation in the Band 200 Cycles per Second to 500 Kilocycles, James R. Wait, and H. Herbert Howe, Supt. of Documents, U.S. Govt. Printing Office, Washington 25, D.C., May 1956, 17 pp. $0.20.*

Quality Control

Product description techniques and inspection risks are detailed in two RETMA bulletins. Methods of efficient description of products are outlined, and AQL sampling procedures are described. *Quality Acceptance Bulletins No. 4 (Product Description) and No. 5 (Inspection Risks), Order from Quality Acceptance Procedures Committee, Engineering Dept., RETMA, 11 W. 42nd St., New York 36, N.Y., 4pp ea. $0.25.*

Aerosol Sampler Controlling Transmitter

This transmitter is the FM type and operates on a frequency of 39.3 mc with 1 kw power output. The transmitter is designed so that one or all of the 6 control tones may be imposed upon the carrier at one time without interaction. The preliminary testing was done in the AF Armament Center's Heavy Systems Bldg. Final test was accomplished in the field under simulated operating conditions. *PB 120012 Acceptance Test of the Aerosol Sampler Controlling Radio Transmitter, D. M. Dechert, July 1955, Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 52, D. C., Microfilm $2.40, Photostat $3.30.*

Transmission Line Heat Losses

Two expressions are derived for the ac resistance per unit length due to conductor heating losses in a microwave strip transmission line with rectangular inner conductor of arbitrary dimensions. One expression is accurate in the low-impedance range; the two check well in the region of intermediate impedance. *PB 122378 Conductor Heating Losses In Strip Transmission Lines With Rectangular Inner Conductors, R. L. Pease, Tufts College, Order from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C., Dec. 1954, 23 pp, Microfilm $2.70, Photocopy $4.80.*

Portable Radar Simulator

A portable radar simulator designed to train air traffic controllers in guiding simultaneously three aircraft, properly spaced, into a landing system, and the final approach is described. Several changes in the design of the device are recommended as a result of basic radar training of control personnel at selected airports. *PB 111847 Development of a Portable Radar Simulator, T. K. Vickers, OTS, U. S. Dept. of Commerce, Washington 25, D. C., Report 285, Sept. 1956, 12 pp. $0.50.*

Patents

Dividing Circuit

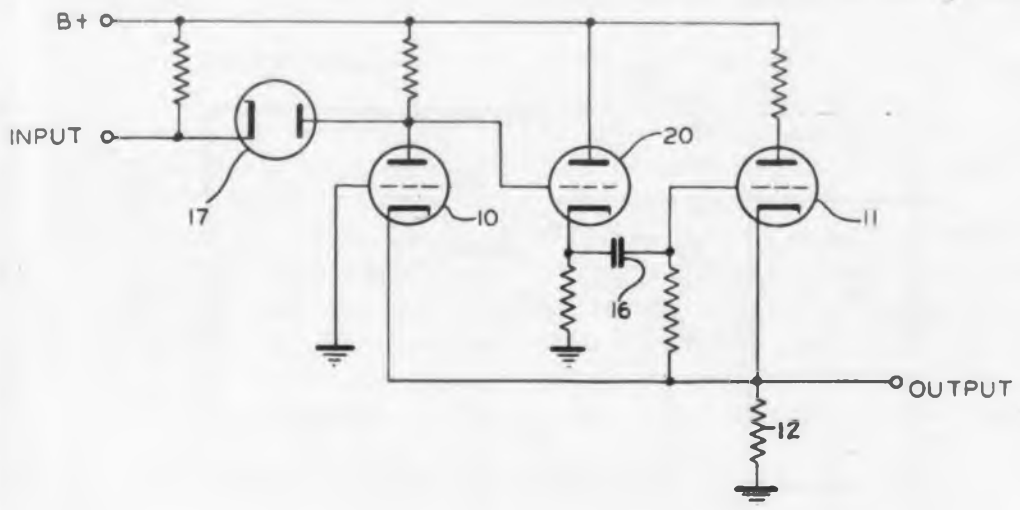
Patent No. 2,747,094. R. M. Walker. (Assigned to the United States of America)

Multivibrator circuits are frequently used for frequency dividing, however, as a class they are unstable. Also the value of circuit elements and stability of the voltage source must be relatively precise since they are critical. When it is desired to divide the frequency of a discontinuous series of pulses, it is desirable that the multivibrator be quiescent or not be free-running during the periods when there are no input pulses. The circuit illustrated provides a multivibrator which overcomes the enumerated disadvantages of the usual circuit.

In the frequency dividing circuit shown in the figure, the triodes *10* and *11* are the multivibrator tubes. Because these two tubes use a common cathode resistor *12* and the grid of the tube *10* is grounded, the tube *11* is normally conducting and the tube *10* is normally non-conducting with the result that the circuit is quiescent when there are no input pulses. The input connection is made with the anode of the tube *10* through a diode *17*. A negative pulse ap-

d to the cathode of the diode is transed through the condenser *16* to the rol grid of tube *11* so that this tube bees non-conducting whereupon tube *10* mes conducting. When the negative rge leaks off of condenser *16* the tube *11* in becomes conducting and tube *10* is red to non-conducting condition. en the tube *10* becomes conducting the ential on the anode of the tube *10* drops hat the diode *17* no longer can pass a ative input pulse until conduction is restored through tube *10*.

A simplified circuit from that illustrated in the figure connects the anode of the tube *10* directly with control grid of tube *11* through condenser *16*. By making this connection through a cathode follower tube *20* as shown, the rapidity of discharge of the condenser *16* is increased which restores the circuit to its initial condition in a shorter time. As a consequence the range of the circuit to divide the input frequency into a higher divided frequency is increased.

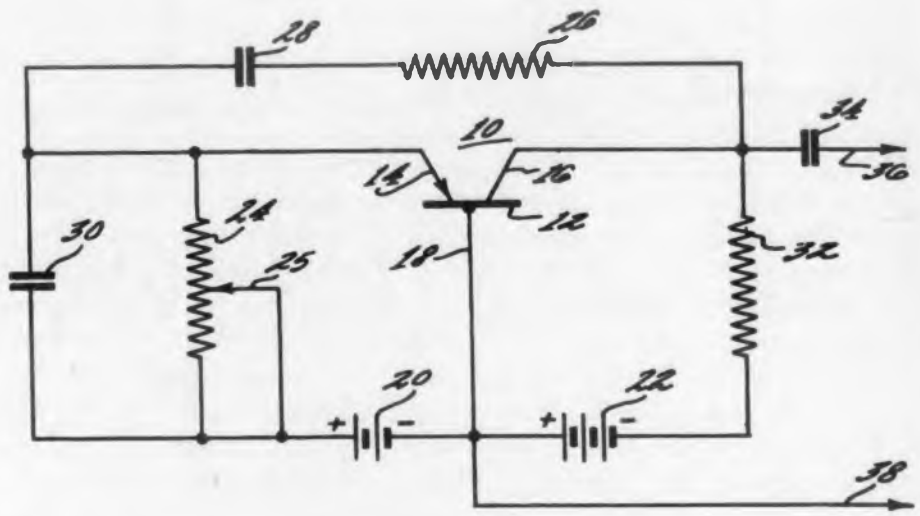


Semiconductor Signal Generator

Patent No. 2,745,960. B. D. Griffith. (Assigned to Radio Corp. of America.)

Feedback oscillators using vacuum tubes requiring either two tubes or a multi-element tube in order that the feedback voltage be in phase with the input voltage. A resistance capacity network can be used to achieve the same result but it is complicated. An effective oscillator of simple feedback circuitry can be made with a three element transistor. Such oscillator receives the full advantage of the inherent advantages of this type of electronic ment in requiring no heater circuit, b small in size and having high degre ruggedness.

The transistor *12* includes the usual b emitter and collector electrodes *18*, *14* *16* respectively which are biased by the directional voltage sources *21* and *22*. F back between the collector electrode the input emitter electrode is secured resistor *26* and condenser *28* connecte series between these electrodes and a sistor capacitor parallel combination of



istor *24* and the capacitor *30* connected tween the emitter and base electrodes. selection of the values of resistors and pacitors the feedback energy can be de large enough to overcome the losses the circuit which is the condition neces- y for oscillation. The frequency is con- lled by the value of the resistor *24* which y be adjusted by the slider *25*. This os- lator is considerably simpler than its uivalent vacuum tube oscillator circuit.

tent Briefs

nited Amplifier

tent No. 2,770,684. (Inventor, R. E. homas, AEC)

This patent relates to amplifier circuit signed to prevent a very large signal, im- essed upon the amplifier, from over- arging the interstage coupling capacitors, ereby rendering the amplifier inopera- ve. The plate resistor of the first tube limited so that the maximum voltage ange is less than the change in the thode voltage of the second tube so that bstantially no grid current flows in the cond tube and the coupling capacitor re- mains uncharged. The usefulness of the amplifier circuit is thereby increased for low level amplification.

Pulse Analyzer

Patent No. 2,760,064. P. R. Bell (Assigned to U. S. Atomic Energy Commission.)

An electrical pulse analyzer was designed to give an accurate indication of when the pulse conforms to certain preselected requirements. This function is particularly useful in proportional and scintillation counters which are extensively used in the nuclear field. In order to indicate the pulses above one selected threshold but below another, two channels are used each having a pulse height discriminator. The channel having the lower level discriminator has a delay circuit built in to compensate the time delay between passage of the two thresholds. The channel of the higher discriminator has a storage section to compensate for the shorter duration of the pulse seen by that circuit. An anti-coincidence circuit places these impulses in opposition so that output signal is produced only when the pulse crosses the lower but not the higher discriminator level.

Books

Documentation In Action

Edited by Jesse H. Shera, Allen Kent and James W. Perry. Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y., 471 pages, $10.00.

This book records the proceedings of the 1956 Western Reserve Conference on the Practical Utilization of Recorded Knowledge. It presents a concerted up-to-date review of the science and art of effectively organizing and utilizing recorded information. Recent advances are summarized and evaluated with particular attention to systems, equipment for making information available as needed, use of recorded information in research and in decision-making and education for librarianship.

Blocking Oscillators

Edited by Alexander Schure. John F. Rid Inc., 480 Canal St., New York 13, N.Y., pages, $1.25.

In nonmathematical terms, this te attempt a comprehensive explanation of t operation features, design factors, and i portant applications of blocking oscillat theory. Particular attention is given to t role of the transformer. The book also co tains qualitative discussions of the quiesce interval conduction due to grid bias, co duction due to regeneration, conducti due to circuit elements, the combined co duction effects, determination of conducti duration, termination of conduction an shock excited circuits.

Electrons, Waves and Messages

John R. Pierce. Hanover House, Garden City, N.Y., 318 pages, $5.00.

The following questions may seem unsophisticated to an electronic engineer. Chances are, though, that you will not be bored but fascinated and illuminated with this lucid intellectual description.

Why do you sometimes get "snow" in your television picture? How small an object can be seen in a microscope? Will a machine ever be able to write detective stories? Can people in a rocket ship be kept from freezing, and will you be able to talk to them on a telephone? The answers to these questions and the why of the answers are presented in this book. Chapters on electric fields, waves, and Maxwell's equations will no doubt "refresh" the understanding of the brightest engineer. After providing this general background of basic electronic principles and how they are applied, the author discusses amplifiers, television, radiation, microwave systems and the most important problems that scientists face in electronics. The book contains chapters on communication theory and noise, relativity and the future of electronics. In an entertaining style, Dr. Pierce has attempted to explain electronics to the general reader and to acquaint technically trained men with specialties other than their own.

Electronics Data Handbook

Edited by Nelson M. Cooke. Allied Radio Corp. 100 N. Western Ave., Chicago 80, Ill., 64 pages, 35¢.

For this handbook, Nelson Cooke has selected the formulas and data most often needed in radio and industrial electronics. Despite the fact that the information it contains is basic and for the most part obtainable from other sources, the guide should be a convenient and useful reference for design engineers. Formulas needed for basic circuit analysis, transmission line calculations, determination of vacuum tube characteristics, resonance calculations and meter calculations are among the many listed. Tables for directly interchangeable radio and TV picture tubes, interchangeable batteries, decimal equivalents of fractions, pilot lamps, logarithms and trignometric functions are included.

Russian Television Camera Tube

J. George Adashko

A NEW photoconductive television pickup tube of the Vidicon type was recently developed in Russia and designated LI-18.

The choice of material for the photoconductive target of the tube was dictated by the following design objectives:

1. Dark resistivity on the order of 10^{12} ohm-cm.
2. Sensitivity (ratio of dark to bright sensitivity) on the order of 2-3 with target illumination of one lux and one volt applied to the conductive layer.
3. Spectral photo-conductivity characteristics matching the operating conditions of the tube.
4. Minimum picture lag.

A study of various photo-conductive materials of the sulfide and selenide types has shown that the material most closely meeting the above requirements is stibnite (antimony tri-sulfide).

Pickup Tube

A schematic diagram of the tube is shown in Fig. 1. The sensitive element employed is a thin layer of antimony tri-sulfide, which is deposited on the signal plate. One side of the layer is exposed to the scanning beam from the electron gun, and the other is illuminated by the optical image. The scanning beam is focused by means of an external uniform magnetic field reduced by a long focusing coil *(FC)* and is swept horizontally and vertically over the surface of the target by a magnetic deflection yoke (*DY*).

Fig. 2 shows the variation of the potential of a point (elementary area) on the raster. Before it is touched by the beam (Fig. 2a) the point is at potential U_{sp} (signal-plate voltage) relative to the collector, owing to the dark conductivity of the layer. When the electron beam makes contact with the point, the secondary emission charges the point to a certain higher potential. During the time between scans, leakage in the photo-conductive layer discharges the point, and its potential again nearly equals that of the signal plate. The second scan will again charge the point to a value approaching the anode potential, and the process wi repeat until a steady state is reached, at which the ri in potential at the time of scanning is exactly compe sated by the drop in potential due to leakage betwe scans.

Illumination increases the sensitivity of the phot conductive layer and reduces the resistance of t scanned point. This in turn decreases the dielectr time constant of the photo-conductive layer, and th steady-state values of the upper and lower potenti thus become functions of the image brightness (Fi 2b).

As in all iconoscopes, the image signal is produce in photo-conductive tubes at the instant of the sca ning by the variable component of the secondar emission current that flows from the target to the co lector. Passage of the electron beam from a dark poi to a bright one changes the secondary-emission cu rent in the collector circuit. The a-c component of th current flows in the signal-plate circuit and produc

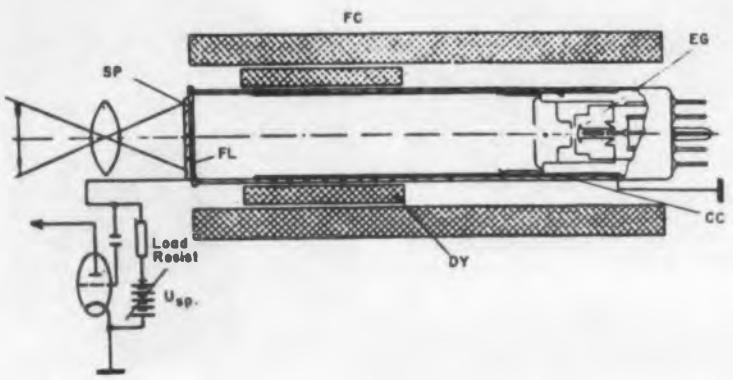


Fig. 1 — Schematic diagram of LI-18 tube installation: *SP* — signal plate; *FC*—photo-conductive layer; *CC*—conductive cover; *FC*—focusing coil; *EG*—electron gun; *DY*—deflecting yoke

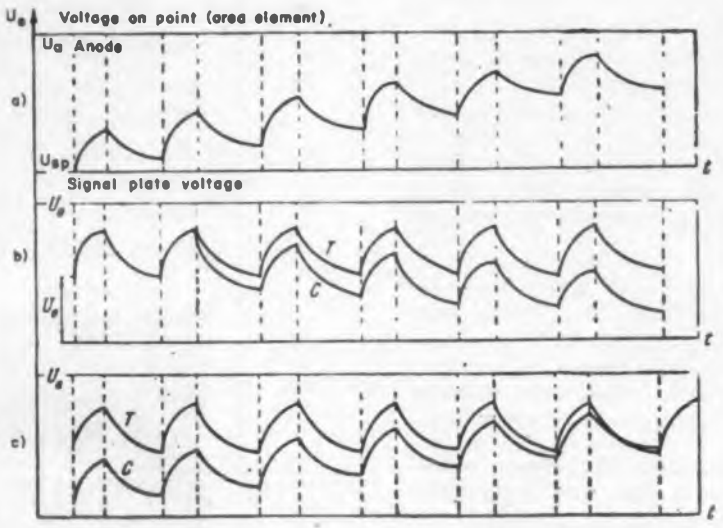


Fig. 2—Variation of potential: a—target point dark when scanned by electron beam; b—after start of target-point illumination; c—after conclusion of target-point illumination; *T*—point not illuminated; *C*—point illuminated.

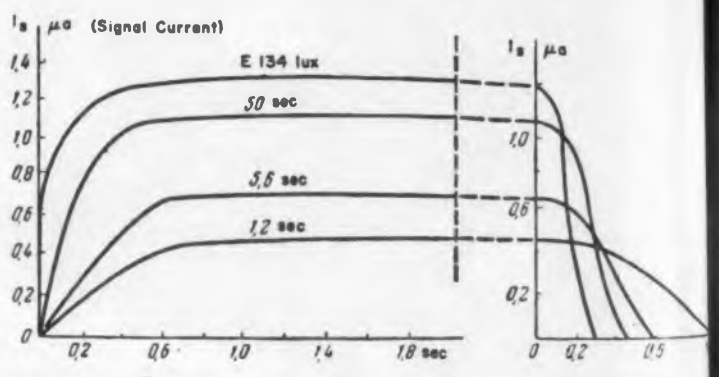


Fig. 3—Rise and fall time of signal at various values of tube illumination.

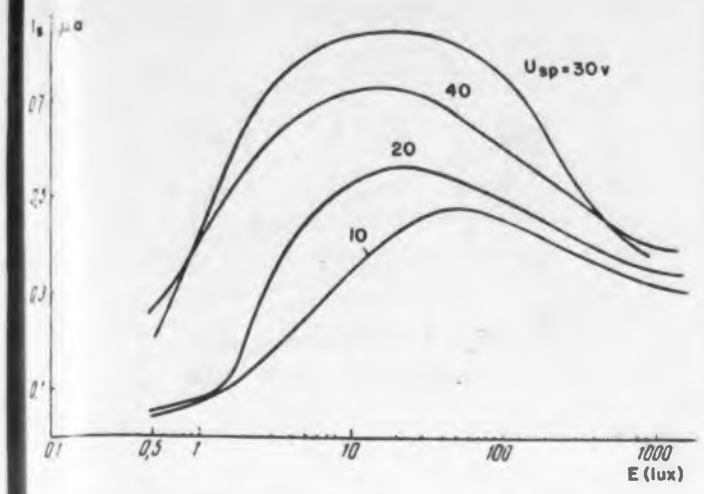


Fig. 4—Illumination characteristics of LI-18 tube

voltage drop across the load resistance, which is connected at the input of the television-channel pre-amplifier.

Picture Lag

A photo-conductive pickup tube introduces a time lag in signal storage and pick-off. Fig. 3 shows the rise and fall time of the signal for various values of target illumination.

A study of this lag shows that it is due principally to the time required to re-establish the potential equilibrium upon change in illumination. Experimental and theoretical investigations have shown that this lag can be reduced by one of the following measures: reduce the working voltage on the target, bringing it closer to the anode voltage; increase the beam current; reduce the gamma of the tube; reduce the coefficient of secondary emission of the photo-conductive layer and reduce the resistance of the layer (thereby reducing the time constant) by using lower-resistivity material; use bias lighting, supplementary heating, or higher target illumination.

Characteristics of the LI-18 Tube

The illumination characteristics shown in Fig. 4 establish the operating range of target illumination at various values of signal-plate voltage. The curves show that there is an optimum target illumination for all signal-plate voltages. This optimum depends on the physical and chemical constants of the layer and fluctuates from tube to tube. It is seen that to obtain the maximum useful signal it is necessary to work at the optimum signal-plate voltage, which ranges from 20-60 v (with respect to the anode). If low-signal-plate voltages (0-20 v) are used to reduce the picture lag, the target illumination must be increased to approximately 100 lux, and the resultant signal current is 0.1-0.4 microampere.

The temperature characteristics are shown in Fig. 5 and make it possible to determine the permissible

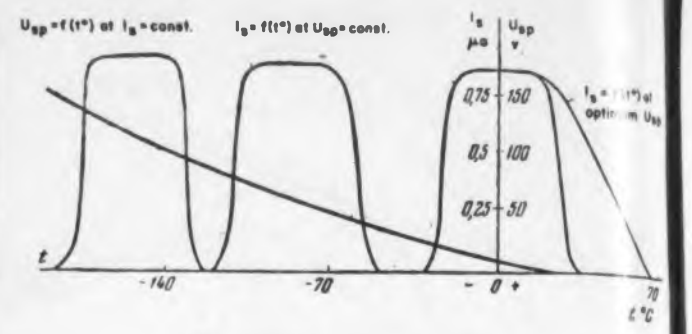


Fig. 5—Temperature characteristics of LI-18 tube

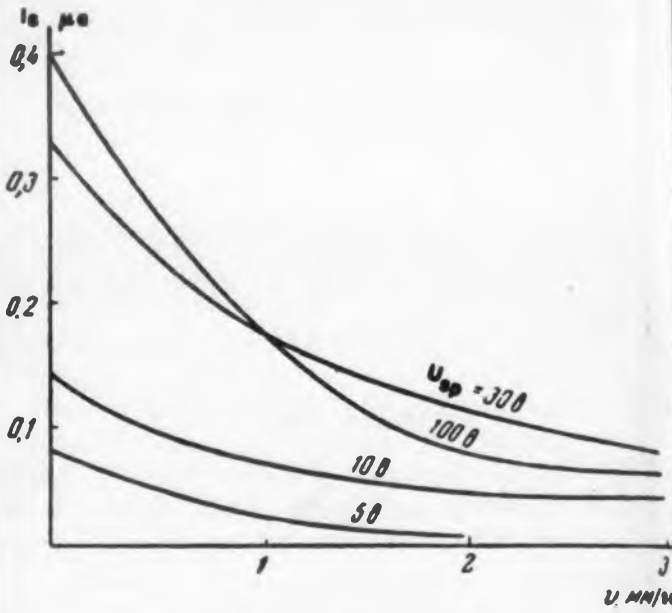


Fig. 6—Signal current (microamperes) vs. target speed, mm/sec

range of ambient temperatures. A change in temperature changes the conductivity of the layer, necessitating an adjustment in signal-plate voltage to keep the signal current constant. The curve marked $U_{sp} = f(t°)$ gives the approximate variation of the working signal-plate voltage with target temperature at a constant signal.

Fig. 6 shows the variation of the signal current with the speed of the transmitted object at various signal-plate voltages. These curves were plotted using a special test pattern which was projected at various rates of speed required to obtain the prescribed image definition. This curve shows that as the speed of the object increases the signal current decreases for all signal-plate voltages, but that this decrease is at a minimum for the optimum voltage. Thus, for example, to use the tube at a projection speed of 3 mm/sec in the target plane it is necessary to employ a signal-plate voltage ranging from 0 to 50 v and varying from tube to tube.

Fig. 7 shows a plot of image definition vs. target illumination at various object speeds. Increasing the target illumination increases the definition up to a certain point, owing to the increase in the sensitivity

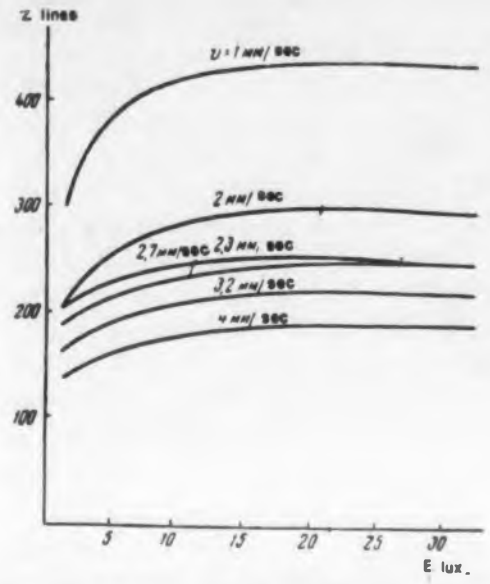


Fig. 7—Variation of definition (Z) with illumination (*E*) in lux for various object speeds.

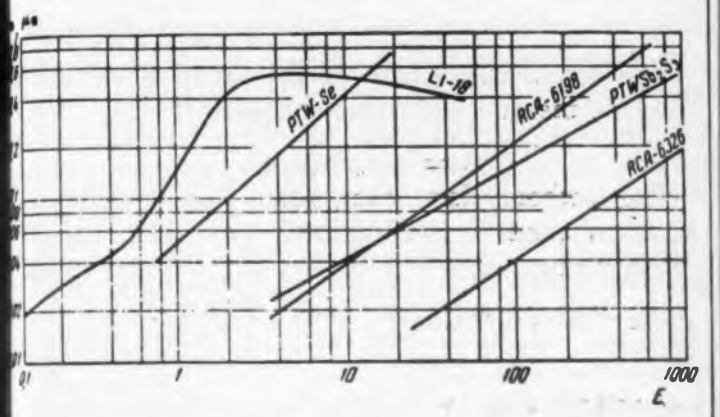


Fig. 8—Comparison of illumination characteristics of several photoconductive tubes; PTW-Se Resistron, LI-18, RCA 6198, PTW Sb_2S_3 Resistron, Motion-picture vidicon RCA-6326.

of the photo-conductive layer. The definition decreases as object speed decreases.

Investigations of the illumination and picture-lag characteristics of the LI-18 tube make it possible to establish the optimum operating conditions of the tube. For example, maximum current signal (in the transmission of still images) is obtained with target illumination on the order of 2-20 lux and with 50-100 v on the signal plate. The resultant signal current is 0.5-1 microampere with image definition up to 600 lines, although picture lag reduces both signal and image definition. The recommended optimum for the transmission of moving images is 5-50 lux target illumination and 10-50 volts signal-plate potential. Under these conditions, if the image projection does not move faster than 3 mm/sec, it is possible to obtain a signal current from 0.2 to 0.8 microampere at a definition up to 300 lines.

Fig. 8 compares illumination characteristics of several American and German tubes with the LI-18.

Abstracted from an article by N. L. Artem'ev, V. K. Sokolov, and S. K. Temiriazeva; Radiotekhnika i Elektronika *No. 2, 1956, pp 245-252.*

What the Russians Are Writing

J. George Adashko

Contents of Radiotekhnika i Elektronika, No. 4, 1956

Equation for the Frequency of a Toroidal Cavity, V. A. Tepliakov, B. K. Shembel', (4 pp, 3 figs).

A simple empirical equation is proposed for the frequency of the capacitively-loaded cavity shown in Fig. 1. The empirical equation for the detuning due to the central post is

$$\Delta = \frac{\lambda - \lambda_0}{\lambda_0} = \left(\frac{2d+h}{D}\right)^2 \ln\frac{h}{b}$$

where λ_0 is the resonant wavelength of the cavity without the post.

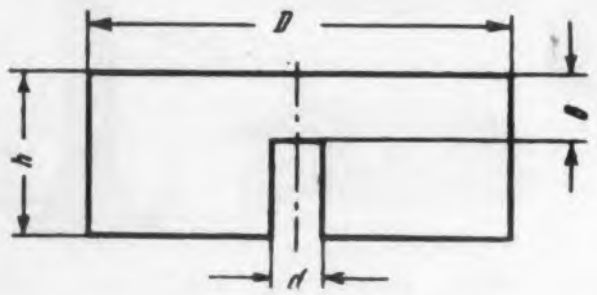


Fig. 1.

This equation is valid as long as a radial mode exists in the cavity, and for $\Delta \leq 0.3$ the error of the equation does not exceed 5-10 per cent.

A more accurate empirical equation is

$$\ln\Delta \leqq 0.64 - 1.7\frac{b}{h} + 2.11\ln\left(\frac{2d+h}{D}\right)$$

The value of Δ can be readily calculated from Figs. 2 and 3, the former giving the variation of Δ with $\left(\frac{2d+h}{D}\right)$, the latter giving the dependence of Δ on b/h for various values of $\left(\frac{2d+h}{D}\right)$.

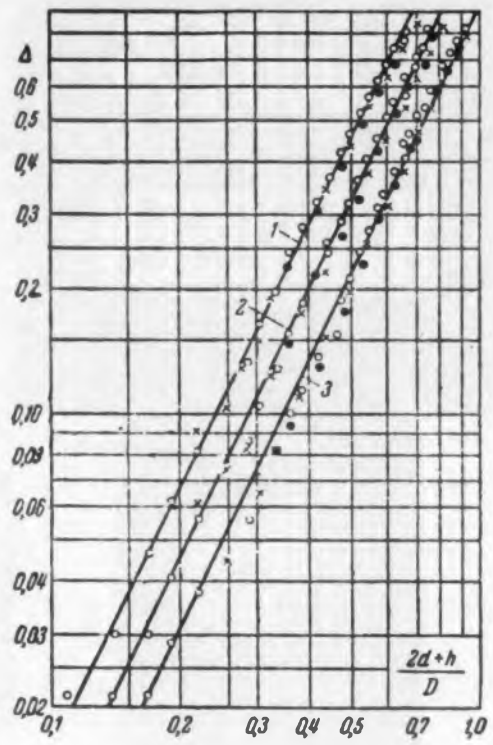


Fig. 2

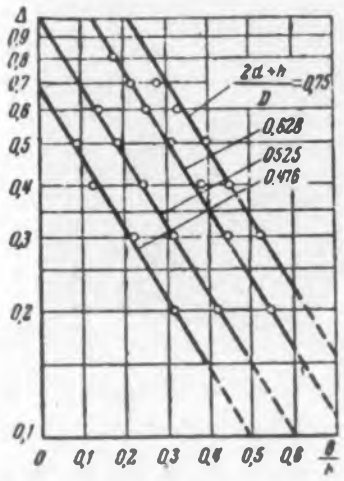


Fig. 3

The actual wavelength of the cavity is calculated from the theoretically-rigorous equation

$$\lambda = 1.31\,D\,(1+\Delta).$$

The authors claim that none of the theoretical equation cited in the literature give more accurate values for the resonant frequency of the toroidal cavity at the specified values of b/h and $\left(\frac{2d+h}{D}\right)$.

Television Systems with Statistical Matching, B. B. Gurfinkel', (19 pp, 3 figs).

Communication-theoretical treatise, dealing with television as a communication problem and with the statistics of television signals.

Investigation of Electromagnetic Field in Cavity Using Probe with High-Impedance Connecting Line, V. S. Lukoshkov, A. S. Bondarev, and B. N. Shvetsov, (15 pp, 17 figs).

The probes employed are miniature electric or magnetic dipoles and are placed, together with a miniature detector, in the cavity under investigation. The lead-in conductors comprise thin strips of high-impedance carbon paste coated on a quartz tube 2-3 mm in diameter. The resistance of the wiring is on the order of several tenths of a megohm per centimeter. The method is suitable for the study of fields produced in cavities at resonant and non-resonant frequencies; its accuracy is on the order of 5 per cent.

A probe if this type causes practically no distortion of the investigated field but does reduce the intensity of the field, and this is of particular importance in the study of cavities at resonance. The lower the Q of the cavity and the higher the lead resistance, the smaller error introduced by the probe. Best results are obtained at lead resistances from 0.3 to 0.5 megohm/cm and at values of Q ranging from 200 to 400. Under those conditions, the change in field intensity is on the order of 3-5 per cent.

On the Theory of Ideal Coding of Binary Transmission, V. I. Siforov, (11 pp, 4 figs).

The article is devoted to finding the quantitative relationships between noise stability, bandwidth, and the parameters of an ideal code in the sense of Shannon's definitions. An approximate expression is derived for the probability of the decoding error as a function of the probability of the error in the elementary message, the number of messages in the code combination, and the bandwidth. Refers to Shannon's "Communication in the Presence of Noise," *Proc. IRE*, Jan. 1949, pp 10-22, and to C. A. Barnard's "Simple Proofs of Simple Cases of the Coding Theorem," Imperial College, London, 3rd Symposium on the Theory of Information, September, 1955.

Self-Oscillations in a System with Time-Delay Feedback, Iu. M. Az'ian, V. V. Migulin, (10 pp, 2 figs).

Theoretical discussion of self-excited systems containing no resonant elements (LC circuits or cavities) but in which the steady-state oscillations are produced by delaying the signal in the feedback loop. The mathematical treatment of such circuits is quite difficult, involving as it does non-linear integral equations, the solution of which is dependent on the initial conditions. The article discusses the theory of an idealized network of this type and some experimental investigations of an equivalent circuit.

Effects of Slow Fluctuations on Self-Excited Oscillator, V. I. Tikhonov, I. N. Amiantov, (5 pp, 2 figs).

Derivation of equations that define the statistical phase and amplitude characteristics of the response of a self-excited oscillator to slowly-varying fluctuations. The resulting phase fluctuations are computed.

Detection of Complex-Waveform Pulses, E. L. Gerenrot, (5 pp, 4 figs).

Each article treats a different phase of weak signal detection. The first derives an equation for the distortion accompanying the detection of a pulse of arbitrary waveform. The second discusses the transients in a detector circuit where the internal impedance of the current source cannot be neglected, and derives the load voltage resulting from detection of a pulse of arbitrary form.

Measurement of the Properties of Ferrites at Ultra High Frequencies, Part I, V. V. Nikol'ski, (22 pp, 15 figs).

Very extensive theoretical discussion of the measurement of the permeability and dielectric-constant tensors of ferrites using cavity resonators. Proposes various measurement schemes and cites certain experimental results.

Frequency Characteristics of Kinescopes, L. M. Seliakov, (10 pp, 5 figs, 1 table).

Discusses the resolving power of the kinescope along the scan line. Derives the frequency characteristic of the kinescope, taking the halation effect into account. Shows the qualitative and quantitative rela-

tionships between halation and resolving power. Gives experimental characteristics of certain Russian television kinescopes, and concludes that the optical distortion in modern kinescopes is quite high and requires correction.

Other Articles In This Issue:

"Transients Involved in the Detection of Weak Signals," L. S. Gutkin, (5 pp. 2 figs); "Microwave Spectroscope for Observation of Electron Paramagnetic Resonance in the Centimeter Band," A. A. Manenkov, A. M. Prokhorov, (9 pp, 4 figs); "Secondary Electron Emission from Alloys," B. S. Kul'varskaya, (13 pp. 1 figs); "Secondary Emission from Tungsten Carbide," L. M. Volkova, (2 pp. 2 figs).

Contents of Radiotekhnika i Elektronika, No. 5, 1956

Radio-Engineering and Electronic Problems in ...gh Power Accelerators for Heavy Charged Particles, A. L. Mints, (17 pp, 11 figs).

Approximate Equation for the Propagation Distance in the Presence of Super-refraction, V. A. Fok, (15 pp)

Theoretical paper, in which the exact contour integral involved in such calculations is approximated by assuming the index of refraction to vary parabolically with height.

Propagation of Radio Waves Near the Horizon in the Presence of Superrefraction, V. A. Fok, L. A. Vainshtein, M. G. Belkina, (18 pp, 9 figs).

Another theotretical paper devoted to the calculation of the anomalous propagation of radio waves near the horizon in the presence of an inversion layer (which has no horizontal variation). Curves are derived for the attenuation factor for the case when the transmitting antenna is located high above the inversion layer, and the receiving antenna in located at low altitude and below the inversion layer (or vice versa). The results obtained may prove significant in the analysis of propagation of microwaves in the troposphere.

Optimum Linear Antennas, V. L. Pokrovski, (8 pp, 5 figs).

Discussion of current distribution in linear antennas with radiation perpendicular to the axis and with optimum directivity pattern. It is shown that a suitable mathematical approach (the Chebyshev-Akhiezer polynomials) leads to a solution of this problem even if the distance between radiators are less than half a wavelength.

Radio-Astronomical Methods of Antenna Investigation, V. S. Troitski, (10 pp, 1 fig, 1 table).

Gives several methods for determining the losses and directivity coefficients of antennas by using extra-terrestrial radio signals. This involves calculating the losses from the intrinsic thermal noise of the antenna system.

Use of Orthogonal-Polynomial Method in the Solution of Certain Problems in the Analysis and Synthesis of Multi-Stage Amplifiers, S. V. Samsonenko, (4 pp, 2 figs).

Several applications of a method discussed in an earlier article (*Radiotekhnika i Elektronika*, No 3, 1956—see *ED*, Dec 15, 1956). Treated specifically are the transient response of a system to an arbitrary signal (without using the convolution theorem), the solution of the synthesis problem for arbitrary signal, and the determination of the input waveform from known system parameters and known output-signal waveform.

Accumulation of Noise Caused by Signal Fading in FM Radio Relay Lines, Iu. B. Sindler, (11 pp, 4 figs).

Discusses the effect of amplitude limiters on the noise accumulating in fm communication lines. The treatment is similar to that used by V. I. Siforov in *Elektrosviaz'* No 5, 1956 but involves fewer simplifying assumptions.

Measurement of Ferrite Parameters at UHF, part II, V. V. Nikol'ski, (9 pp, 11 figs).

Continuation of article started in *Radiotekhnika i Elektronika* No 4, 1956. Refers also to article by Alberts and Schoenberg, *J. Appl. Physics*, 954, 25, 152.

Analysis of Nearly-Harmonic Transistor Oscillator Operating at Frequencies above Critical, K. S. Rzhevkin, L. A. Logunov, L. N. Kaptsov, (7 pp, 7 figs).

This oscillator was first analyzed by D. E. Thomas (*Electronics*, 27, 2, 130), but his approximations are claimed to be invalid for higher frequencies. The author extends the calculations to higher frequencies and determines the highest possible oscillation frequency. To be abstracted in a future issue.

Analysis of Processes in Transistor Blocking Generator, K. Ia. Senatorov, G. N. Berestovski, (16 pp, 15 figs, 1 table).

The analysis leads to equations for the design of circuit elements from prescribed pulse parameters. Lists the experimentally-obtained quasi-static (pulse) characteristics of Russian commercial junction transistors. To be abstracted in a future issue.

Equivalent Reactance Circuits Employing Junction Transistors, L. N. Kaptsov, K. S. Rzhevkin, (10 pp, 10 figs).

Reactance tubes (equivalent-reactance circuits employing vacuum tubes) are widely used in fm oscillators. This article gives a theoretical analysis of the transistor counterpart, citing both similarities and differences. To be abstracted in a future issue.

Calculation of the Entropy of Certain Special Probability Distributions, M. M. Bakhmet-ev, (10 pp, 6 figs).

Brief Communications:

Frequency Division with Reflex Klystron, E. N. Bazarov, M. E. Zhabotinski, (2 pp, 2 figs); Low-Loss Ferrites at UHF, R. G. Mirmanov, L. G. Lomize, N. V. Riumshina, (7 pp, 1 table).

Abstract—German

Applications of Travelling Wave Tubes

THE recent rapid development of travelling wave tubes has made available a valuable component for measurement systems up to the centimeter wave length band, such as wobbulator systems, frequency multipliers, or oscillators.

Fig. 1 shows the basic scheme of an active wobbulator system which may be used to test a transmission system (e.g. filter as shown). Fig. 2 shows the basic block diagram of a swept frequency source with center frequency of 4000 mcps and 60 mcps band. The basic r-f signal is obtained from a reflex klystron (which should have an r-f output of about 50 to 100 mw such as a *2K56 or 2K45*). The klystron reflector voltage is modulated with the line frequency (50 cps in Germany), and furnishes therefore a frequency which differs from the center frequency instantaneously because of the modulation. The klystron alone is not suited as a wobbulator source, however, because the output amplitude is frequency dependent. The output of the klystron is decoupled from the rest of the system by means of the attenuator D_I (see Fig. 2). Attenuator D_{II} is used to adjust the input level to the travelling wave tube. Before the input of this tube a marker signal

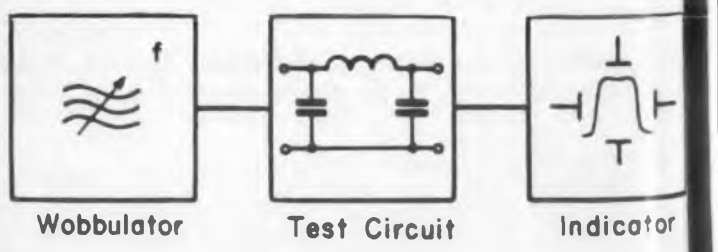


Fig. 1. Active wobbulator system.

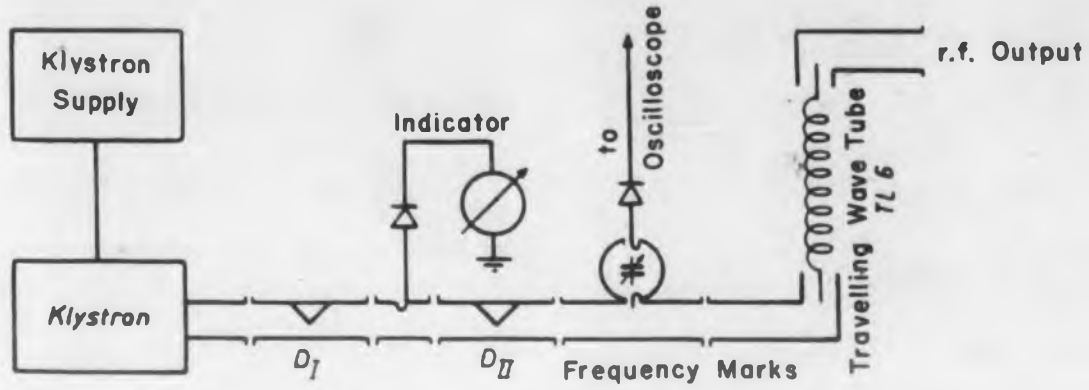


Fig. 2. Wobbulator at 4000 Mcps.

derived from the guide system for use on the scilloscope. The travelling wave tube makes the utput amplitude independent of the frequency.

The functioning of the klystron-travelling wave ube combination is explained in Fig. 3. Fig. 3a hows the output amplitude of the klystron N_a as a unction of reflector voltage with the static reflector oltage adjusted to $U_{R\ opt}$. Fig. 3b indicates the fre- uency variations of the klystron which correspond o the instantaneous reflector voltage variations and ig. 3c shows the input (N_e) - output (N_a) ampli- ude of the klystron. The characteristic of the travel- ling wave tube shown is Figs. 3c and 3d explain how the constant amplitude output is achieved. The travelling wave tube which was used is the "Telefunken" type TL 6.

For frequency multiplication, in particular frequency doubling, the travelling wave tube may be used with an appropriate filter because of the large harmonic content of the output signal at high output levels.

Abstracted from an article by A. Lauer, Elektronische Rundschau, *Vol. 10, No. 7, July 1956, p. 190.*

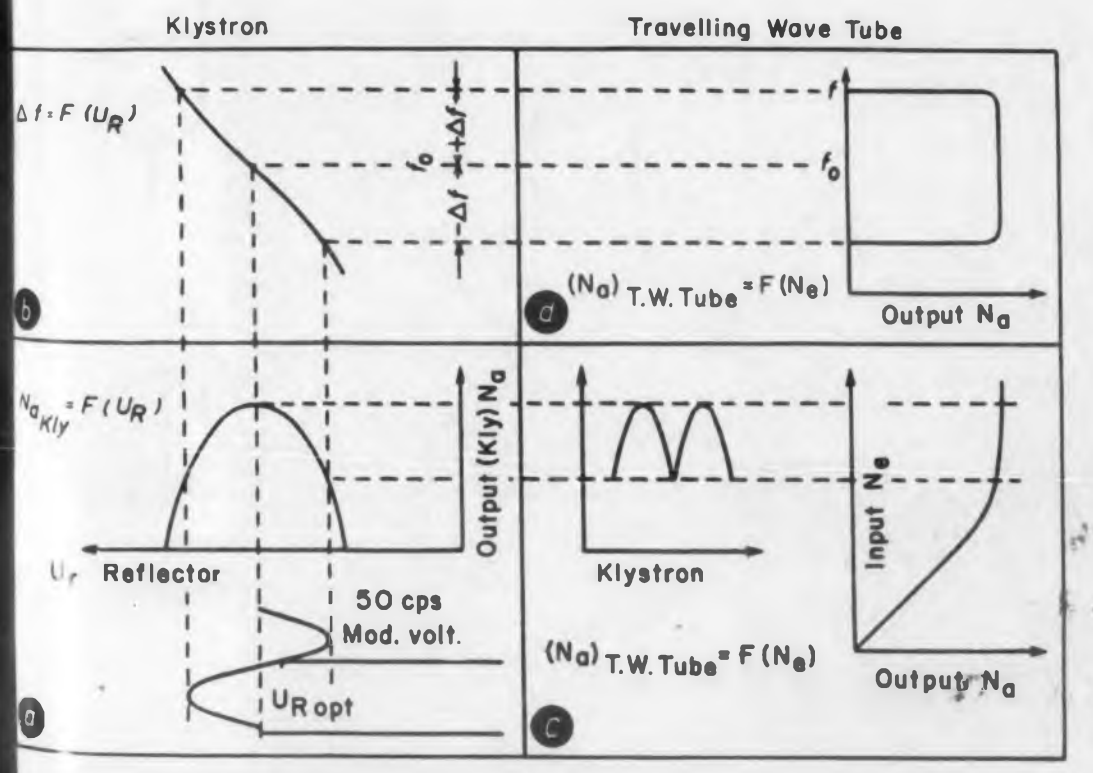


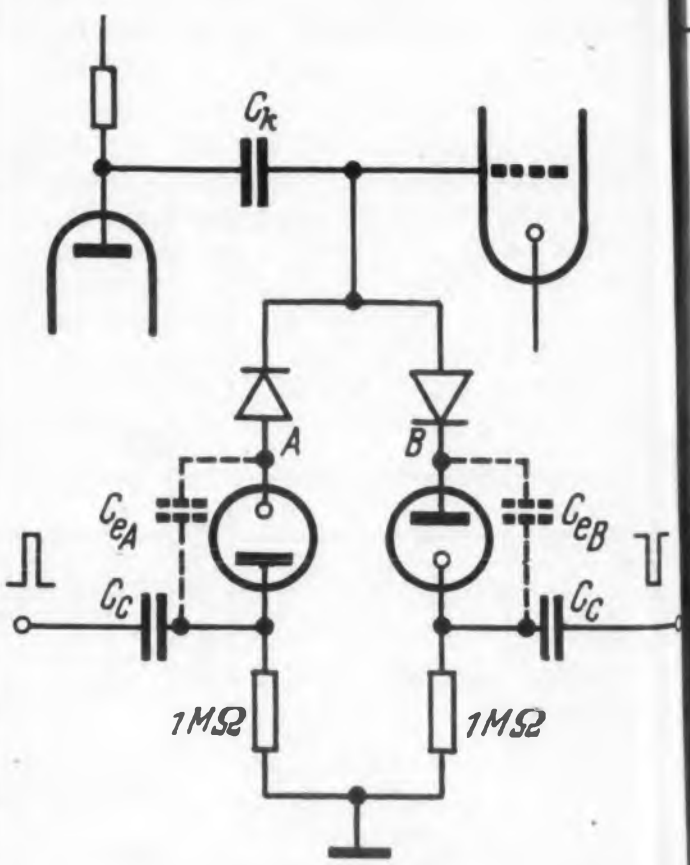
Fig. 3. Output amplitude of the Klystron as a function of reflector voltage.

Abstract—German

A DC Restorer

THE design of clamping circuits requires a sufficiently large discharge time constant toget with a sufficiently small charging time consta The series connection of germanium and vacuum odes shown in the figure makes possible the mi mizing of the effective shunt capacitance beca the capacitance of such diodes is of the order magnitude of one micromicrofarad. At the same ti the benefit of the high resistance of vacuum diod in the reverse direction is obtained. The effecti capacitance at the grid is equal to the capacitan of the germanium diode so that a saving of ten may be expected. This corresponds to an increa of band width, for that stage, of about twenty pe cent. The circuit has considerable popularity German television sets. The effects on the resulti picture are practically insignificant although linea ity measurements on the amplifier stage, using saw tooth with 4 mc show some distortion.

Abstracted from an article by W. Dillenburg and E. Sennhenn, Frequenz, *Vol. 10, No. 9, Se 1956, pp. 283.*



Clamping circuits with series diode.

A New UHF Diode

HARACTERISTICS of a new diode, the EA-52 Valvo Corp., Hamburg, Germany) with a frecy range up to 1000 mcps are reported in this r. Referring to the high frequency equivalent it shown in Fig. 1, the shunt capacitance for tube is less than 0.5 μμf. The resonant frecy, $\omega_o = (1/L_s C_P)^{1/2}$, is 5000 mc so that at the ing frequency the resonant rise of output ge is only 4 per cent. At that frequency the ince of transit time is negligible. The back resist- exceeds 10^4 megohms. The peak inverse volt- is 1 Kv for frequencies 100 mc and given by f, where f is in mc for frequencies above 100

he frequency characteristics in a measuring ap- tion are shown in Fig. 2. Details of construc- and other characteristics are also given.

bstracted from an article by H. Stietzel, Elek- ische Rundschau, *Vol. 10, No. 2, Feb. 1956,* 34.

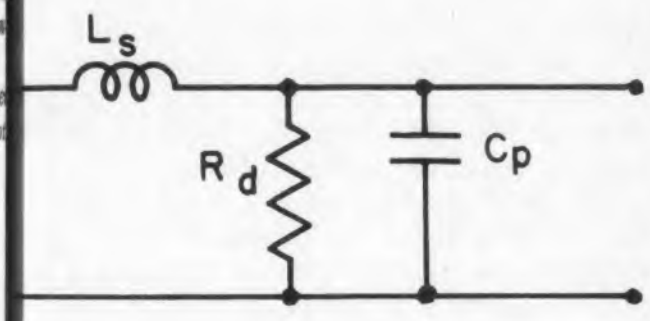


Fig. 1. High-frequency equivalent circuit of the diode.

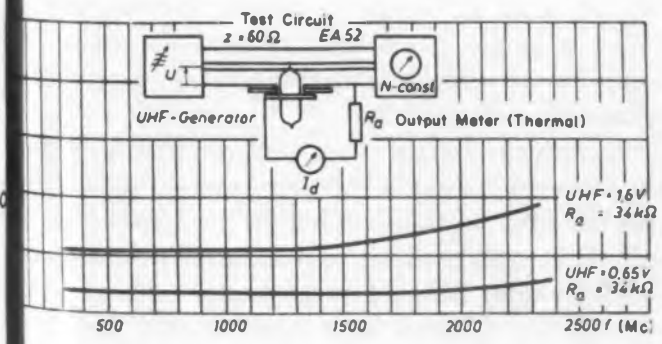


Fig. 2: Frequency characteristics of the EA-52.

Abstract—German

Audio Spectrum Analyzer

A NEW "tone frequency spectral analyz covers the frequency range from dc to 20.5 in two bands and presents the results on a cath ray tube screen. The instrument is used primar for the analysis of all kinds of mechanical vib tions.

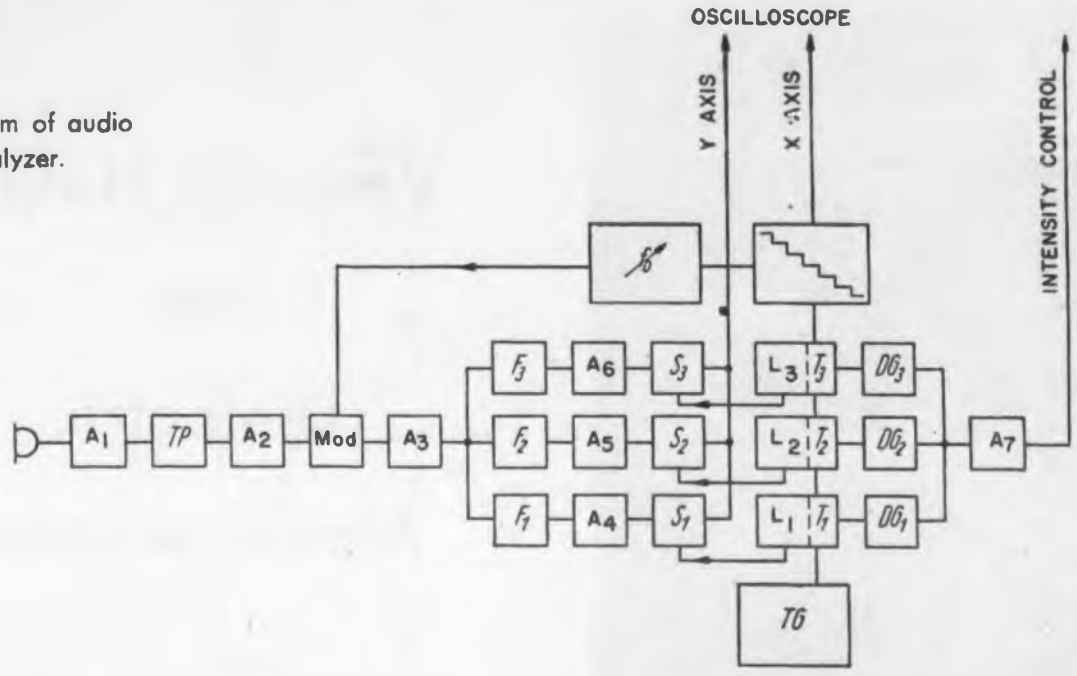
The system uses three 50 cps filters in Band (0 to 1 kc) and three 500 cps filters in Band (0 to 20.5 kc). Band I has 21 frequency marks 50 cycle intervals, and Band II has 42 frequen marks at 500 cycle intervals, displayed (in th rows) on the screen of the oscilloscope.

The block diagram for one band is shown Fig. 1. The signal is amplified in A_1, pass through a low pass filter (cut off frequency 1 kc Band I and 20.5 kc for Band II) and again a plified in A_2. A variable carrier is mixed with t signal. The variation of the carrier frequency obtained in steps by use of a reactance tube wh reactance is controlled in steps so that only select points on the filter curves are obtained.

The output of the modulator, amplified in is fed to three capacitively coupled band pass ters with 50 cps or 500 cps bandwidth, dependi on the band. The filtered signals are amplifie detected, and passed through electronic switch S_1, S_2, and S_3 to the Y-axis of the oscilloscop Since a single beam tube is used the three fil outputs are sampled sequentially and displayed three rows on the screen.

In order to obtain clean pictures after each jum in frequency a sufficient time interval must elap for the filter to stabilize before the signal is picke off. This synchronization is controlled from a ti ing generator (*TG*). This generator generates pos tive pulses at fixed time intervals. An impulse stage T_1 closes electronic switch S_1 through i pulse limiter L_1 so that the output of filter F_1 fed to the Y-axis of the oscilliscope. In order blank out the transients of the electronic switch

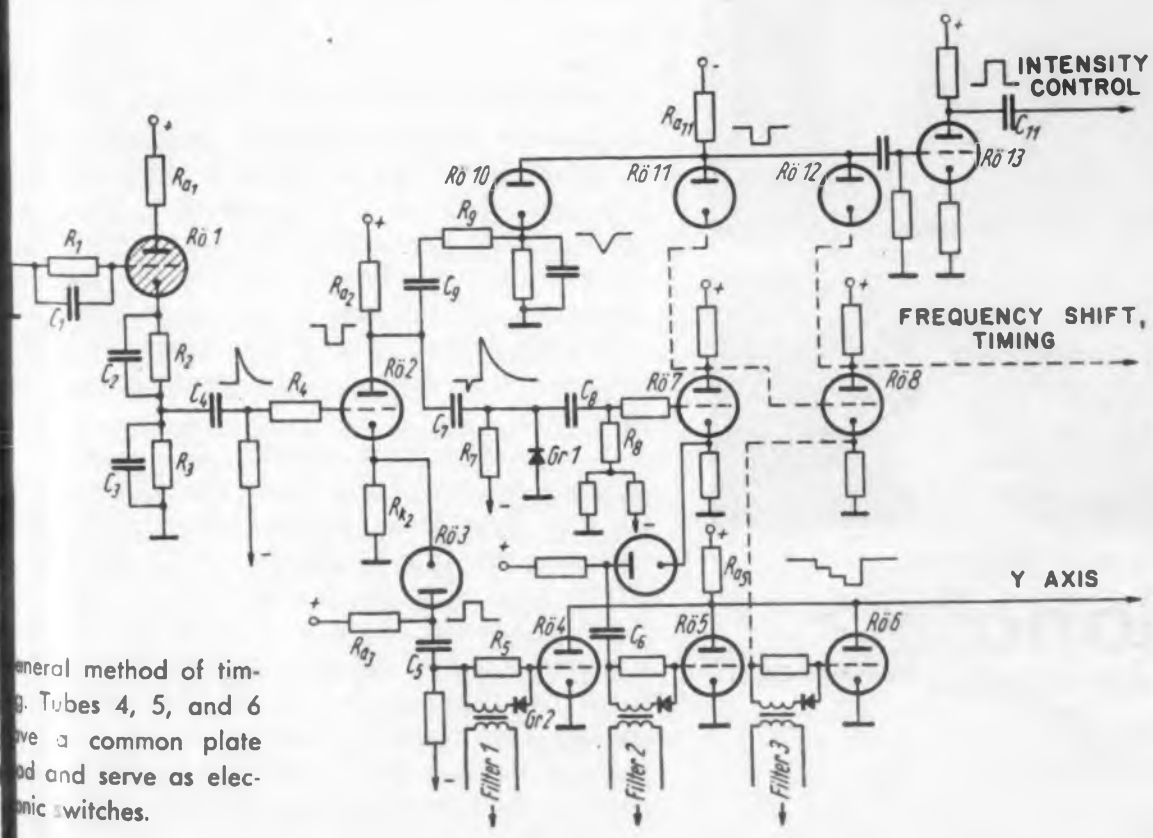
ock diagram of audio
ectrum analyzer.



mewhat delayed and differentiated impulse *(DG)* used to control the intensity on the oscilloscope. ter the impulse has activated stage *1*, the process repeated. Each time the frequency is shifted to next increment. Band switching is accomplished means of five relays.

The timing generator consists of a gas triode weep circuit operating in Band I at 32 cps and in and II at 170 cps. The impulses from the sweep rcuit are shaped to furnish appropriate signals r intensity control, frequency shifting and elec- onic switching. The schematic is shown in Fig. 2.

Abstracted from an article by W. Kaule and A. hne, Nachrichtentechnik, *Vol 6, No. 1, Jan. 1956,* p. 35



neral method of tim- . Tubes 4, 5, and 6 ve a common plate d and serve as elec- nic switches.

Versatile Holder for Dielectric Measurements

A VERSATILE specimen holder to be used wi a bridge or resonant circuit in determini electrical properties of dielectrics over a wide ran of temperatures and frequencies has been dev oped by the National Bureau of Standards. The i strument is designed to make precise measuremen of the dielectric constants, dissipation factors, a thermal expansions of insulating materials.

Devices previously developed for measuring hi polymer and ceramic insulating materials have be limited to use at a single temperature or over a co paratively small range of temperatures. Furth more they did not measure thermal expansion of t specimen, nor were they sufficiently precise.

The device, shown in Fig. 1, is essentially a p of gold-plated stainless steel electrodes, about 2 i in diameter, between which the dielectric specim is placed. The lower electrode is stationary, wh the upper electrode can be moved up or down accommodate the thickness of the specimen. A movable silver electrostatic shielding case covers t electrodes and the case in turn is enclosed in electrically-heated oven for high-temperature me urements, or a cooling unit for measurements do to —40 C.

A thermocouple is inserted in a hole bor through the axis of the upper electrode to with 0.5 mm of its lower surface, permitting accura measurement of the temperature of the specimen.

The upper electrode is constrained to move in direction parallel to the axis of the electrodes. micrometer adjustment gives absolute values of t specimen's thickness, before and after temperatu change. The supporting frames and electrodes a made of stainless steel to minimize differential e pansion; the micrometer can be used to deter mi

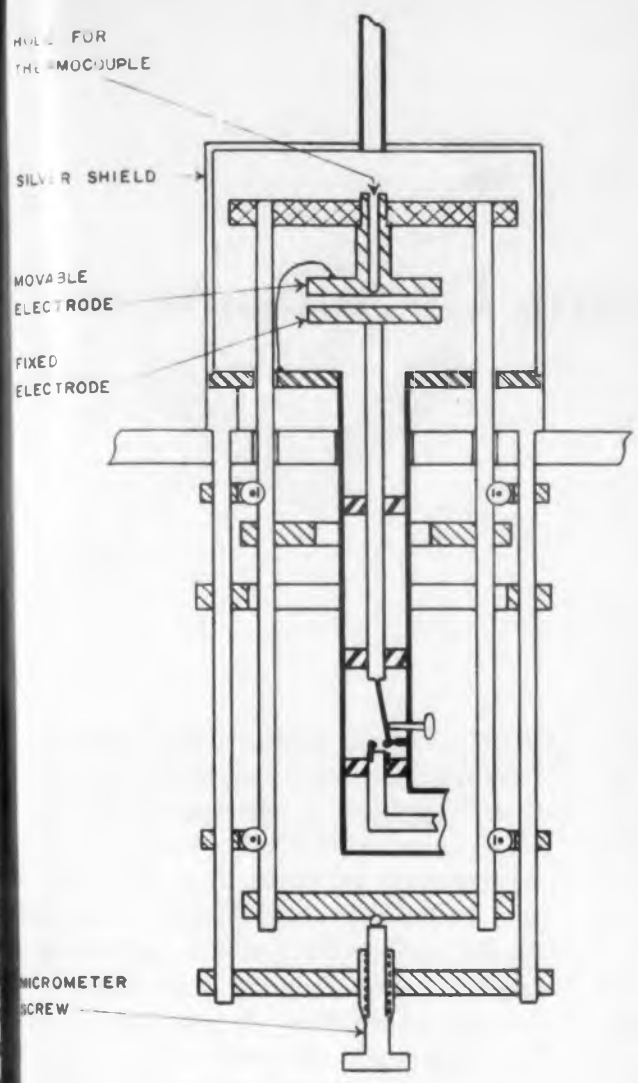
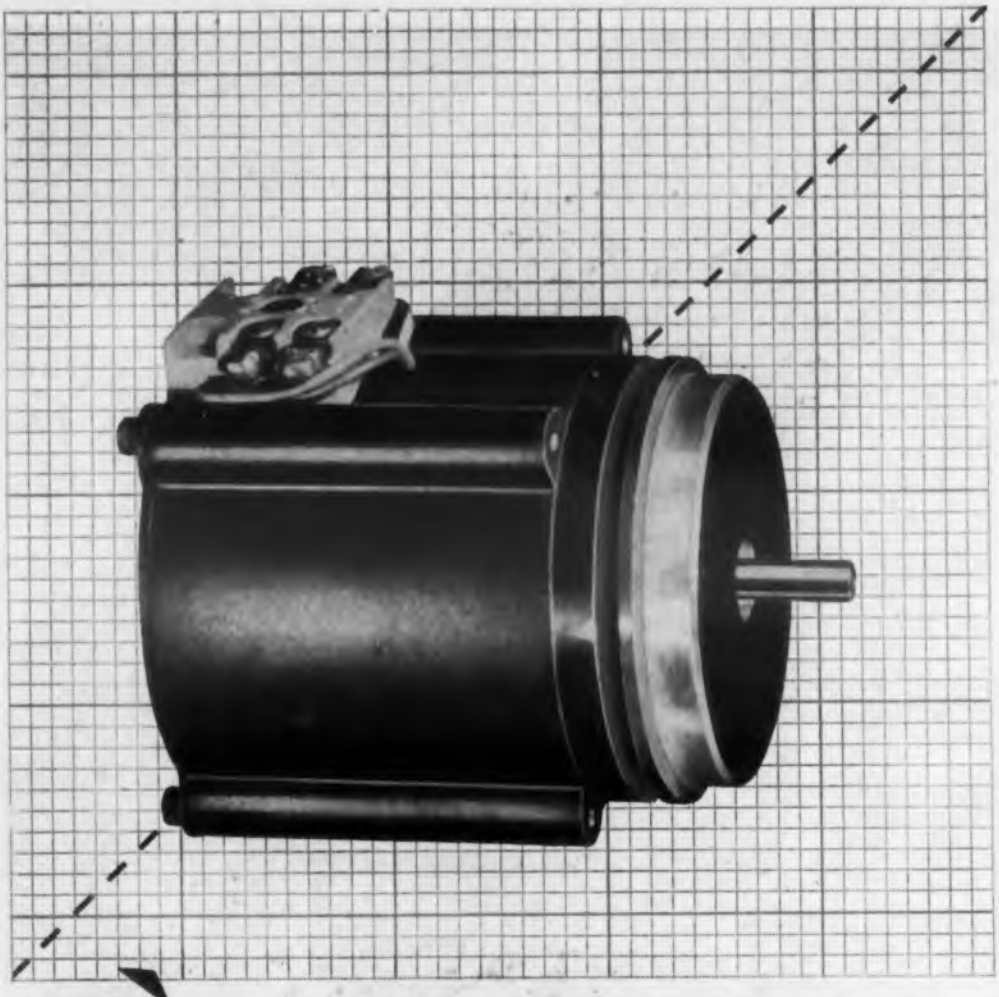


Fig. 1. Cross section drawing of dielectric specimen holder. Movement of upper electrode is controlled by micrometers.

perimentally any residual expansion, and derive a rrection curve. The upper electrode is rested on e lower and the change in micrometer reading is ted after equilibrium is reached at each operating mperature.

The upper electrode is electrically grounded to e stainless-steel case by a stranded silver wire. he inductance of the leads to the wide-range lder introduces errors in the capacitance and dis- pation factor measurements, but these errors are gligible below 1 mc and are readily eval- ted for frequencies between 1 and 10 mc by a ries of measurements with air as a dielectric. The rototype holder cannot be used at frequencies ove 10 mc because the resonant frequency of e holder is only about 60 mc. The holder is also ed for dc measurements. *Abstracted from "Ver- tile Specimen Holder For Dielectric Measure- ents," National Bureau of Standards, U. S. Depart- ent of Commerce, Dec. 1956.*



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This tachometer can be furnished separately as shown or mounted integrally with an A.C. Servomotor. Temperature compensated units are also available.

Note these specifications:—

Input	115 volts, 60 cycles
Output	6.0 volts per 1000 RPM
Linearity	± 0.5% above 1000 RPM and ± 0.25% between 50 & 1000 RPM
Total Residual Voltage — 50. millivolts	

A similar unit has been developed for 400 cycle operation.

Send for additional engineering data.

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CIRCLE 534 ON READER-SERVICE CARD FOR MORE INFORMATION

Abstract

British Component Developments

SEVERAL interesting examples of component developments in Britain are discussed briefly here. Components under investigation are tested for reliability, life-length, and high temperature stability.

Resistors

Gold-platinum alloy films. These are now in the pre-production stage; normal resistance values up to 10 or 20 megohms can be provided and tolerances are well within Grade I limits. Low and medium values of resistance are met by zig-zags on glass plates or by helices on glass tube and the highest resistances are made from metallized glass fiber.

Typical sizes are:

1/3 w—1 x 1/2 in. glass plate
1/8 w—1/2 x 1/4 in. glass plate
3/4 w—1 x 1/4 in. glass tube

These resistors have very high stability under both normal and tropical conditions. Their present temperature coefficient of 0.0003/ deg C is too high and it is hoped that a small modification in the alloy will improve this.

Small resistors having very high values are being made from 0.001 in. glass fibers, metallized with the same gold-platinum alloy and then wound on tubular forms in the same way as wire. This metallized glass fiber has a resistance of about 5000 ohms/in. and the fiber resistors are similar to Grade I in stability and as good or better in noise, typical values being 0.02 to 0.1 μv per volt under normal working conditions.

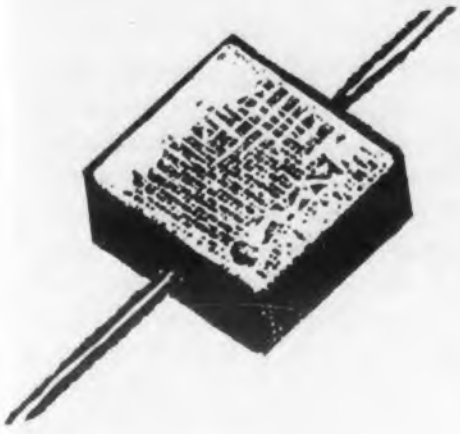
Metal film potentiometers. Long-life potentiometers are now in a late state of development. High resistance up to about 300 KΩ ohms is obtained by use of a "meandered" film on a glass base; long life, [illegible] building up contact strips by electrodepo[illegible] tion. In laboratory tests these potentio[illegible] eters have withstood almost a milli[illegible] sweeps with no more than about 0.2 p[illegible] cent to 0.4 per cent change in resistan[illegible] At the end of the test the potentiomet[illegible] appeared good for much more life.

Metal oxide films. A considerable stu[illegible] has been made of metal oxide resistors [illegible] the types originated by McMaster a[illegible] Mochel, U.S.A. Stannic oxide systems c[illegible] taining small amounts of one or more of t[illegible] oxides or antimony, bismuth and indi[illegible] have received the most attention in t[illegible] group. The best results have been w[illegible] films of 93 per cent stannic oxide and 7 p[illegible] cent antimony oxide; of the oxides t[illegible] this has the lowest temperature coeffici[illegible] of resistance.

By cutting helices in films on 1 x 1/4 [illegible] glass tubing, resistances as high as 1 m[illegible] ohm, and having stabilities better than [illegible] per cent after a 2000 hr electrical load t[illegible] at 70 C, have been made.

Very long-life wire-wound resist[illegible] Early supplies, either from commerc[illegible] stock or individually made for the job, w[illegible] unsatisfactory. These resistors are made [illegible] winding 37-41 SWG resistance wire on [illegible] aluminum oxide form and sealing it c[illegible] pletely with a ceramic glaze. Sometimes t[illegible] wire was nicked by cutters when maki[illegible] off, sometimes the glaze was crazed a[illegible] sometimes the turns in the helix had slipp[illegible] during glazing and were touching. In a[illegible] dition to the ordinary electrical tests ev[illegible] resistor is now examined under a low-pow[illegible] microscope and by X-rays.

In resistors for more normal usage fa[illegible]



t low current densities may be due to crazing of the glaze which allows moisture to penetrate and electrolytic corrosion of the wire to occur.

Capacitors

Glaze-type having controlled temperature coefficients. Glass capacitors are made by coating metal sheet, strip or plates with a slip of special ceramic glaze, stacking or rolling and heating to fuse the glaze. A solid capacitor is formed whose characteristics depend in some measure on the composition of the glaze. It is important to match the coefficient of expansion of the glaze to that of the metal base; typical glazes are lead borosilicates modified by the inclusion of oxides such as those of barium, calcium, aluminum, zirconium and titanium.

Tests on three batches of production capacitors have shown stability within ±0.25 per cent between −60 and 80 C.

Precision variable capacitor. A very precise and robust capacitor is now in production. It has a straight-line frequency law within ±0.1 per cent and a temperature coefficient of −15 ±10 ppm/ deg C. Capacitors are matched to ±0.03 per cent and the component will withstand the usual robustness tests without change. The long-terms stability is comparable with that of the measuring equipment.

Electrolytic capacitors. Although many detailed improvements are being made, electrolytic capacitors are not reliable long-life components. Breakdown is frequently due to corrosion, although it can be controlled to a degree by using very pure metals and electrolytes. It has not, however, been possible to eliminate electrolytes completely; sealing, therefore, is inadvisable. Sealed capacitors for relatively short life can be made if a hydrogen acceptor is added to the electrolyte but the real answer would seem to be the production of a truly dry capacitor, free from electrolyte. Since the capacitance resides in the oxide film it seems reasonable to make this film either chemically or by anodizing, free it from electrolyte and metallize. Anodized aluminum plates having capacitances of 10,000 μμf/ sq cm and capable of withstanding 90 v have been made and a process is ready for factory trial. Most of these anodized films are hygroscopic so capacitors must be hermetically sealed.

In the remainder of the capacitor field progress has been on conventional lines and is unremarkable. Glass capacitors are not so fully developed as in the U.S. but very small tantalum electrolytics are available. High-stability polystyrene capacitors are also available and 30 years' life is expected from the paper capacitors in the transatlantic telephone repeaters.

Teflon dispersion film-dielectric capacitors have been made in considerable numbers experimentally. They are now in small production in the rolled type, mainly intended for low-loss, high-temperature capacitors. The production film thicknesses are around 52 microns, experimental thicknesses are from 3 to 1000 microns.

Magnetic Materials

Nickel is a scarce metal whose properties make it attractive in many important fields. Its use in components may be conserved by improvements in nickel-iron alloys so that they can be more economically used. Domain-oriented 65/35 nickel-iron with a coercivity of only 0.01 oersted has been made in the laboratory; commercial alloy is only 0.03 to 0.05.

As part of this work a new rolling technique has been developed which simplifies the production of very thin strip. Three microns thickness is the present limit but it is hoped to go further. As a result of this work the United Kingdom is not convinced that ferrites are the answer to every magnetic memory question. A metal tape-core delay line has been produced which works at over 200 kc and needs much less drive than a ferrite line. *Abstracted from* Proceedings 1956 Electronic Components Symposium, *A Review of Recent British Component Developments, C. E. Richards, May, 1956, available from Engineering Publishers, G.P.O. Box 1151, N. Y., $5.00.*

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Standards and Specs

Sherman H. Hubelbank

ASTM Standards

1956 SUPPLEMENTS TO BOOK OF ASTM STANDARDS

Issued in seven parts, the 1956 Supplements gives in their latest form 420 specs, tests, and definitions which either were issued for the first time in 1956 or revised since their appearance in the 1955 book. Part 6 covers rubber, plastics, and electrical insulating materials and has 75 standards. These supplements can be obtained from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., at $4.00 per part, or $28.00 for the complete set of seven parts.

Drawings

It has been announced by the military that MIL-D-9281 (USAF) DRAWINGS AND DRAWING INDICES; PREPARATION OF BY MANUFACTURERS (FOR PRODUCTION ELECTRONIC EQUIPMENT) has been cancelled and superseded by MIL-D-5028.

Relays

MIL-R-19523 (SHIPS), RELAYS, AUXILIARY, NAVAL SHIPBOARD, 10 SEPTEMBER 1956

High-impact (class HI) shockproof auxiliary relays are covered by this spec. These relays are for use in control circuits where a number of relays are interconnected to control the proper sequencing and functioning of a complex electrical, hydraulic, or pneumatic system or combination of systems. Such relays are also required to provide suitable indication and alarm circuits directly associated with these systems.

MIL-R-5757C, RELAYS, ARMATURE (FOR ELECTRONIC AND COMMUNICATION EQUIPMENT), AMENDMENT 1, 6 SEPTEMBER 1956

Detailed physical and electrical requirements have been added for relay types RY1003A3 and RY1003B3. Relay type RY1001B3 has been substituted for relay type RY1000B3.

EMA Bulletins

OUR GUIDE TO NEMA STANDARDS PUBLICATIONS, DECEMBER, 1956

Over 150 separate NEMA standards blications for electrical apparatus and uipment are listed and described in s 17-page publication. The following ssifications are covered: appliances, illuinating equipment, signalling and comunication equipment, industrial apparatus, ilding equipment and supplies, insulating terials, insulated wire and cable, and neration, transmission, and distribution uipment. Copies of this guide may be tained from the National Electrical anufacturers Association, 155 East 44th reet, New York 17, N.Y.

EMA BULLETIN, SIGNALING APPARATUS

Covered in this bulletin are standards for avy-duty electrically-operated audible malling devices; low-tension, manual- d electric-reset signal-target-type annunators; and symbols for use on architectural awings. Copies of this bulletin may be tained from the National Electrical Manacturers Association, 155 East 44th Street, w York 17, New York, for 25 cents per py.

NEMA BULLETIN WD 1-1956, RECEPTACLES, (OUTLET), ATTACHMENT PLUG CAPS AND APPLIANCE PLUGS

The configurations and dimensions necessary to provide for intended interchangeability are dealt with in this standard. Also covered is information regarding the proper use of receptacle outlets, attachment plug caps and appliance plugs in accordance with the National Electric Code. Copies of this bulletin may be obtained from the National Electrical Manufacturers Association, 155 East 44th Street, New York 17, N.Y. for 50 cents per copy.

NEMA BULLETIN, INSTRUMENT TRANSFORMERS

All instrument transformers except bushing current transformers which are mounted inside of circuit breakers and power switchgear assemblies are covered by these standards. They supplement the ASA Standard for Transformers, Regulators and Reactors. Ratings and dimensions of particular classes of transformers and limits and methods of test for radio influence voltage are included. Copies of the bulletin may be obtained from the National Electrical Manufacturers Association, 155 East 44th Street, New York 17, N.Y., for 20 cents per copy.

here are the specs. on

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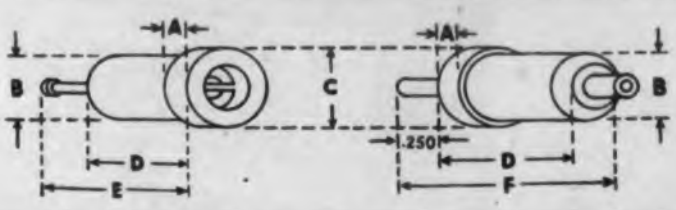

CHEMELEC CONNECTORS PART NO. CN-401	Male Dash Numbers	Mating Female Dash Numbers	Female (Only) Dash Numbers		Pin-Socket Dia. (Inches)
	M-40 M-50 M-64	F-40 F-50 F-64	F-80	F-80-L	.040 .050 .064 .080
DIMENSIONS (Inches) "A"	.052	.052	.046	.187	
"B"	.199	.199	.185	.185	
"C"	.234	.234	.234	.234	
"D"	.349	.349	.443	.443	
"E"		.510	.640	.640	
"F"	.691				
TORQUE					
Pin from body	4 in. oz.				
Body from 1/16" deck	8 in. oz.	8 in. oz.	7 in. oz.	7 in. oz.	
Body from 3/16" deck	11 in. oz.	14 in. oz.	14 in. oz.	14 in. oz.	
PULL					
Pin from body	25 lbs.	25 lbs.	25 lbs.	25 lbs.	
Body from 1/16" deck	15 lbs.	12 lbs.	25 lbs.	25 lbs.	
Body from 3/16" deck	25 lbs.	25 lbs.	25 lbs.	25 lbs.	
CAPACITANCE (at 1000 KC)					
1/16" deck	.5 MMFD	.5 MMFD	1.5 MMFD	1.5 MMFD	
3/16" deck	.9 MMFD	.9 MMFD	1.55 MMFD	1.55 MMFD	
FLASH OVER POINT (Short time—sea level)	4500 VRMS	4500 VRMS	3000 VRMS	5000 VRMS	
COLOR	white, red, green, blue, violet, yellow, orange, brown, grey, black.				
MOUNTING HOLE	.187*	.187*	.173*	.173*	
CONTACTS	Brass or Beryllium Copper				
FINISH	Hot tin dipped or silver plate and gold flash.				

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MARCH 18-21

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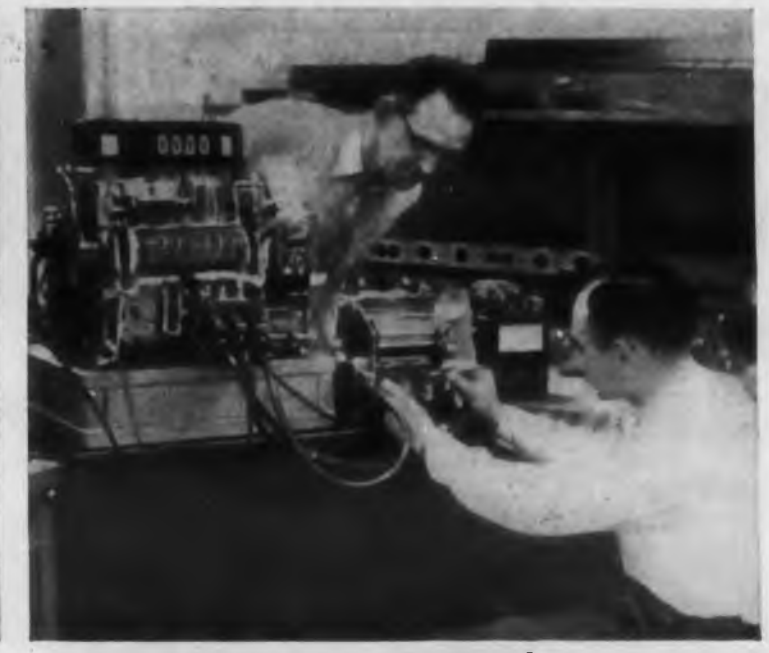

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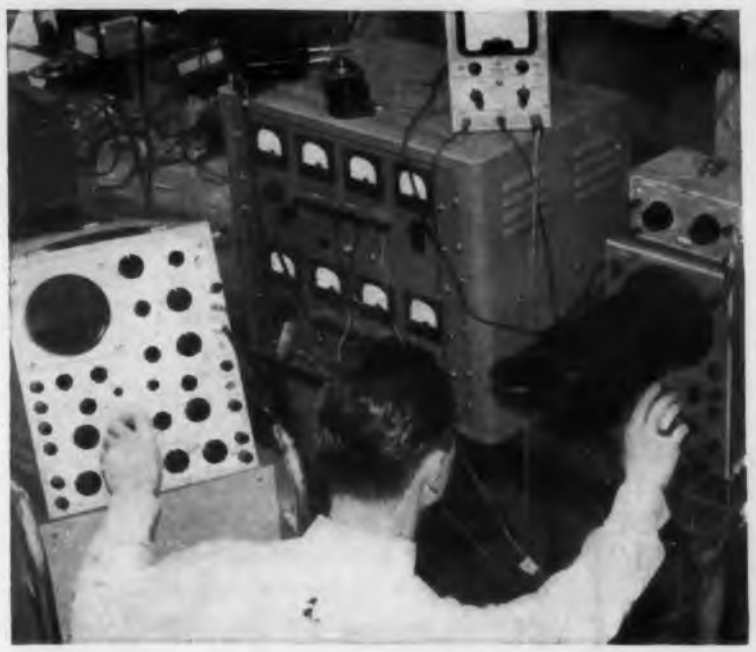

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MARCH 18, 19, 20, 21

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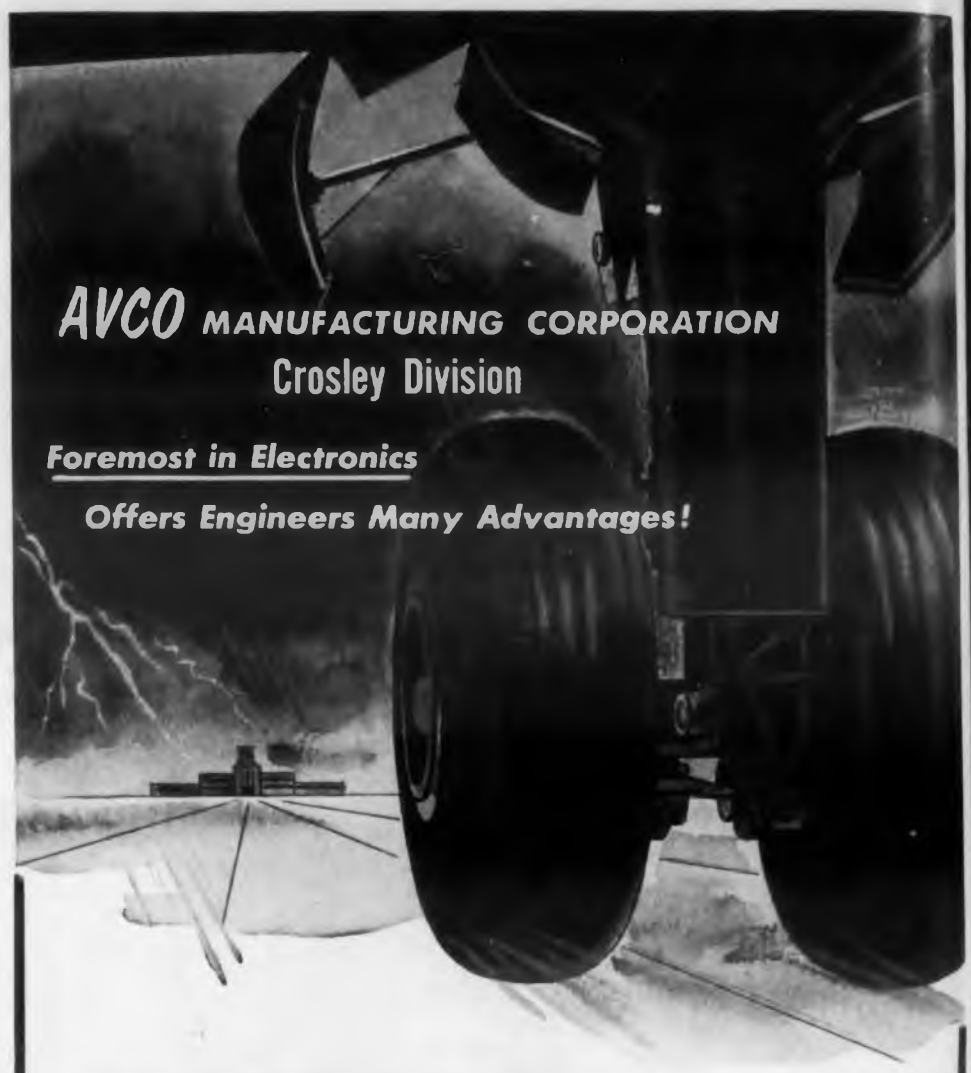

WHEN THE PILOT CAN'T SEE

"Volscan" BRINGS

HIM DOWN . . . *SAFELY! SURELY!*

One of the major advances in aviation history is "Volscan." This remarkable electronic device enables the pilot to come in even though he can't see where he is or where he is going. Wouldn't you like to play a part in important achievements such as this? If so, we have top openings for engineers in many different categories.

1. **Guided Missiles**
2. **Computer and Analytical Services**
   (Design and Development)
   (Programming and Application)
3. **Ground Radar**
4. **Air Traffic Control**
5. **Antenna and Micro-Wave Equipment**
6. **Communications**
   (Airborne Transmitters and Receivers)
7. **Airborne Fire Control**
8. **Airborne Defense Systems**
9. **Servo Mechanisms**
10. **Transistorized Equipment**

Contact us and find out where you can fit into the major programs now being started. There are numerous company benefits and you will be paid generous relocation expenses.

SEND A RESUME TO:

Mr. Nick M. Pagan,
Employment Manager
Dept. H

AVCO Manufacturing Corp.
Crosley Division
2630 Glendale-Milford Road
Evendale, Cincinnati 15, Ohio

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ENGINEERS!

ARE YOU LOOKING FOR DIVERSITY?

You can work in these fields at **Bendix** in Southern California

Telemetering

Servo Valves

Airborne Radar

Miniature Electric Motors

Missile Guidance

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Industrial Sonics

Aircraft Hydraulics

Bendix-Pacific offers you this broad cross section of absorbing tasks.

Here, in Southern California, you will find excellent positions open in electronic, hydraulic and mechanical engineering at all levels. At Bendix-Pacific the diversity of work means you're in the economy of a one product job.

Write us today or send this handy coupon for complete information.

W. C. Walker, Engineering Employment Mgr.
Pacific Division, Bendix Aviation Corp.
11606 Sherman Way, North Hollywood, Calif.

I am interested in this engineering field____.
I am a graduate engineer with____degree.
I am not a graduate engineer but have ____ years experience.

Name _____

Address _____

City _____

Zone____State _____

CIRCLE 558 ON READER-SERVICE CARD

ENGINEERS

Be certain *you*

MAKE THE *RIGHT* CHOICE!

HAVE THE *RIGHT* JOB!

ASK YOURSELF THESE QUESTIONS —IT WILL PAY YOU.

CHALLENGING OPPORTUNITIES IN

•

AVIONICS

•

INERTIAL SYSTEMS

•

COMPUTERS
(Digital and Analog)

•

MISSILE GUIDANCE

•

JET ENGINE
FUEL CONTROLS

with
AC ELECTRONICS
DIVISION
OF

GENERAL MOTORS Corporation

Flint 2, Mich.
and
Milwaukee 2, Wis.

Whether a Recent Graduate making his first choice or a veteran Engineer seeking that permanently RIGHT position, ask yourself the following questions:

MY TALENTS ARE BEST SUITED FOR?
Engineers come all sizes, shapes and potentials. G.M.'s policy of decentralization creates individual opportunity for development and advancement.

STARTING WAGE? POTENTIAL EARNINGS?
At G.M. these two questions are best answered by another question—"How high is up?" Earnings both present and future are entirely dependent upon you. At AC you determine your earnings.

PERMANENCY OF POSITION WITH AC?
AC has been designated the official ELECTRONICS DIVISION for *all* General Motors Divisions. We are permanently dedicated to the research, development and manufacture of things Electronic . . . making America so it's safer and better.

RESEARCH FACILITIES?
At AC you enjoy working with the latest and the finest of equipment and with the top men in the field.

LIVING CONDITIONS?
Are the finest possible in Milwaukee, America's most progressive town combining big town cultural and civic advantages with small town hospitality. "An ideal town for ideal family living."

WHAT CAN AC DO FOR ME?

Write us in strictest confidence . . . you will hear from us by return mail. Send us the coupon below . . . YOUR FUTURE DEPENDS UPON IT.

AC The Electronics Division
General Motors Corporation, Milwaukee 2, Wis.

Send me full particulars about AC ENGINEERING OPPORTUNITIES

☐ So you can better "tailor make" your offer to me I have attached a resume of my education and/or work experience.

☐ I will send it at a later date.

Name _____

Address _____

City _____ Zone____ State _____

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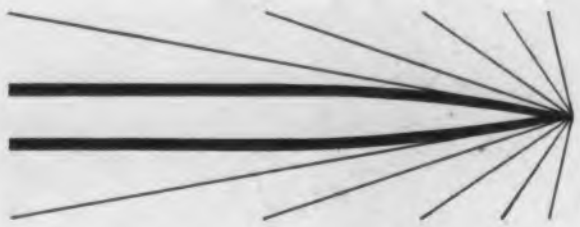


MISSILE ENGINEERS

Many new positions are being created at Northrop Aircraft for missile engineers in a wide range of activity: control, guidance, servo, computers, recording, optical, reliability, electro-mechanical, telemetering and electronics. There's an interesting position for you, at your own experience level, with attractive remuneration and steady advancement, in one of the following groups:

GUIDANCE AND CONTROLS, encompassing research and development of advance automatic guidance and flight control systems for both missiles and piloted aircraft. Specific areas of development include: radio and radar systems, flight control systems, inertial guidance systems, instrument servo systems, digital computer and magnetic tape recording systems, airborne analogue computer systems, optical and mechanical systems, and systems test and analyzer equipment.

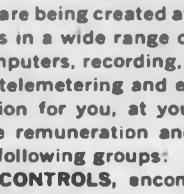
FLIGHT TEST ENGINEERING SECTION, which plans the missile test programs and establishes test data requirements in support of the programs. The data requirements are predicated on the test information required by the engineering analytical and design groups to develop and demonstrate the final missile design, and are the basis from which instrumentation requirements are formulated.

The analysis work performed consists of aerodynamic, missile systems, dynamics, flight control, propulsion and guidance evaluation. The Flight Test Engineering Section is also responsible for the field test program of the ground support equipment required for the missile.

FLIGHT TEST INSTRUMENTATION SECTION, which includes a Systems Engineering Group responsible for the system design concept; a Development Laboratory where electronic and electro-mechanical systems and components are developed; an Instrumentation Design Group for the detail design of test instrumentation components and systems; a Mechanic Laboratory where the instrumentation hardware is fabricated; and a Calibration and Test Group where the various instrumentation items and systems are calibrated and tested.

For 17 years Northrop Aircraft has pioneered in missile research and development. As a member of this forefront organization in this growing field, new opportunities for full expression of your initiative and ability will always be yours at Northrop.

If you qualify for any of these attractive positions, we invite you to contact the Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., telephone ORegon 8-9111, Extension 1893, or write to: 1015 East Broadway, Department **4600-S,** Hawthorne, California.



NORTHROP

NORTHROP AIRCRAFT, INC., HAWTHORNE, CALIFORNIA

Producers of Scorpion F-89 Interceptors and Snark SM-62 Intercontinental Missiles

5-A-68

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COMMUNICATIONS SYSTEMS ENGINEERS

I.R.E. CONVENTION
March 18th-21st

Senior Members of the Hoffman Technical Staff will be at the Convention Hotel — Please telephone EL 5-3456 for appointment.

The expanding scope of advanced communications projects has created several unique positions in fields related to VHF, UHF, microwave transmission and reception, forward scatter and single sideband applications at Hoffman. Electronics engineers with appropriate backgrounds will find these new assignments professionally stimulating and financially rewarding. Please write or call Vice President of Engineering, RIchmond 9-4831.

Hoffman LABORATORIES, INC.

A SUBSIDIARY OF HOFFMAN ELECTRONICS CORP.
3761 South Hill St., Los Angeles 7, Calif.

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Opportunities in Design & Engineering for

DESIGN ENGINEERS
ELECTRICAL ENGINEERS
PROJECT or SYSTEMS ENGINEERS
ELECTRONIC ENGINEERS
FIELD ENGINEERS

Kollsman's expansion in the airborne equipment field has created openings for additional engineers and electromechanical designers, and offers unusual scope to alert, capable and enthusiastic professional men. For engineers, a degree in Mechanical Engineering, Electronic Engineering or Physics is necessary, plus experience or a strong interest in airborne instrumentation or allied fields.

The congeniality at Kollsman, plus the modern facilities and top professional men provide an atmosphere conducive to creative effort and achievement. Here are designed America's finest aircraft instruments.

Submit resumes to T. A. DeLuca. During IRE Convention in New York, phone Dr. N. Kaplan, NE 9-2900.

kollsman INSTRUMENT CORPORATION

80-08 45th AVENUE, ELMHURST, NEW YORK • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.

Flight Test Facility . . . Bedford, Mass.

Missiles are TOPS and we're TOPS in Missiles!

Included among the most important efforts in this country's plans for defense are the design and development of missiles. History making events, such as the first interception of an aircraft by a guided missile (Navy's LARK) were made possible by Raytheon's engineering staff. Raytheon is the only electronic company in the country with TWO prime missile contracts (Navy and Army). The Missile Systems Division is composed of a dynamic active organization of over 3400 employees including more than 500 engineers. Our contract commitments are increasing—we need additional engineers to grow with us.

You start at an excellent rate of pay with periodic increases based on ability and performance. Raytheon pays the major cost of graduate study at Harvard, M.I.T., Boston University or Northeastern. Our staff attends meetings and seminars at Company expense.

Raytheon's tradition of achievements in the forefront of electronic research and development—the opportunity to advance rapidly as an individual—the combination of exceptional, living conditions (suburban or rural), proximity to Boston (cultural, educational, medical, recreation & research center)—a healthy and varied climate—engineer management—all these have attracted a growing number of able engineers to us.

If you are interested in guided missile systems and have experience in these fields:

Circuit Design
Microwave
Antenna Design
Systems Engineering
Electronic Packaging
Test Equipment Design
Specifications
Tube Applications
Infra-Red

Come in, telephone or send brief resume to:
G. P. O'Neil

RAYTHEON MISSILE SYSTEMS DIVISION
BEDFORD, MASS.

CIRCLE 563 ON READER-SERVICE CARD FOR MORE INFORMATION

ENGINEERS DO ENGINEERING WORK AT ELECTRIC BOAT

At Electric Boat an engineer does the work for which he was professionally trained.

He might be working on intricate packaging problems in submarine design, or on radiation shielding in nuclear propulsion—but whatever he works on, he does *engineering* work.

For at Electric Boat the engineer finds himself backed up by a staff of specialists and technicians—designers and draftsmen and metalsmiths, mathematicians and computer specialists, literature searchers and librarians—each as skilled in his particular field as the engineer is in his own.

This is one reason why engineers come to Electric Boat—to do *engineering* work on varied, non-routine problems. And engineers with BS, MS and PhD degrees, and with 0-10 years' experience, will find that they can take professional pride working in:

FLUID FLOW • HEAT TRANSFER & THERMODYNAMICS • ELECTROMECHANICAL, -HYDRAULIC, -PNEUMATIC SYSTEMS • SERVO ANALYSIS • MECHANICAL DESIGN & FABRICATION • SUBMARINE DESIGN • NOISE, SHOCK & VIBRATION • STRESS ANALYSIS • METALLURGY • MATHEMATICAL ANALYSIS & APPLIED STATISTICS • COMPUTER PROGRAMMING & APPLICATIONS • NUCLEAR ENGINEERING • ELECTRO-CHEMISTRY, CHEMICAL ANALYSIS & PROCESS DESIGN • HUMAN FACTORS IN SUBMARINE DESIGN • MARINE ENGINEERING

There are other reasons why engineers enjoy working at Electric Boat, of course. Salaries are highly competitive; insurance, hospitalization, and retirement plans are among the best in the industry.

And the location on the Connecticut shore provides a relaxed way of life, with hunting, fishing, sailing, skiing—all manner of recreational activities for the entire family.

But come and see it with your own eyes. For an interview send a resume in full confidence to Mr. James P. O'Brien, Technical Employment Supervisor.

ELECTRIC BOAT DIVISION
GENERAL DYNAMICS CORPORATION
GROTON • CONNECTICUT

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ENGINEERS

advances in military electronics

TODAY

pave the way for commercial developments

TOMORROW

at Otis electronic division

The full resources of the century-old Otis Elevator Company are available for expansion of its new Electronic Division. And engineers who join this division now will have the satisfaction of working in the forefront of the military electronics field . . . with the realization that its potentialities in commercial development will also be explored by Otis . . . that is a long-range program in which Otis will spare no effort in broadening the position of its Electronic Division as a leader in this important field of industry.

Current prime contracts are on basic development work in the most advanced areas of bombing navigation systems, radar systems and missile launching test equipment.

Engineering know-how is required in servo-mechanisms, analog computers, pulse and sweep generators and in the field of microwaves.

If you are interested in a high level career in electronics . . . with promotions waiting to be earned . . . send your resume now to William B. DeFrancis. All inquiries in strict confidence.

Electronic Division
OTIS ELEVATOR COMPANY
35 Ryerson Street Brooklyn 5, N. Y.

CIRCLE 565 ON READER-SERVICE CARD FOR MORE INFORMATION

Engineers
who want to

Be Engineers

. . . rather than glorified draftsmen, paper jockeys or re-hash artists

Come to Sanders and Go to Work . . .

ON ACTUAL, PRACTICAL, THOUGH INTRICATE, OFF-BEAT AND INTRIGUING PROBLEMS IN ADVANCED ELECTRONICS AND ELECTRO-MECHANICS.

Sanders is particularly interested in engineers versed in:

- **Hydraulic servo systems, gyroscopes, accelerometers, circuit design & development, magnetic amplifiers, receivers & transistors.**
- **Men with similar experience, interested in sales engineering, have real opportunity here.**
- **Also openings for Physicists and Applied Mathematicians.**

You'll be working on projects to meet specific customer requirements—not making plans to gather dust in filing cabinets—and you'll be doing it in the company of first rate minds, men who have sparked Sanders' many "firsts"—Panar, Dare pulse doppler radar and seekers, countermeasure systems and special fusings.

This is a company owned by engineers, run for engineers, in the interests of better engineering. If engineering is more to you than a name on an imposing organization chart . . . if the opportunity to make a genuine contribution to the state of the art ranks higher than a fancy location (though we think ours is pretty nice) . . . then we'd welcome the opportunity to read your resume. A convenient interview will be arranged. Please address D. H. Johnson.

SANDERS ASSOCIATES INCORP. **Nashua, in New Hampshire**
Only an hour from downtown Boston

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