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MAGNETIC AMPLIFIERS AND SATURABLE TRANSFORMERS

FAST RESPONSE MAGNETIC AMPLIFIERS

2 response Phase reversible

Cat. No.	Supply Freq. in C.P.S.	Power Out. Watts	Volt. Out. V. AC	AC or DC signal voltage req'd for full output.	
MAF-1	60	13	110	1.0	—
MAF-4	400	5	57.5	1.2	0.4
	400	10	57.5	1.4	0.4
MAF-7	400	15	57.5	2.5	1.0

SINGLE ENDED MAGNETIC AMPLIFIERS

Cat. No.	Supply Freq. C.P.S.	Power Out. Watts	Sig. req'd for full outp. MA-DC	Total res. Contr. wdg. KΩ	Load res. ohms
MAO-1	60	4.5	3.0	1.2	3800
MAO-2	60	20	1.8	1.3	700
MAO-4	60	400	9.0	10.0	25
MAO-5	60	575	6.0	10.0	25

PUSH-PULL MAGNETIC AMPLIFIERS

Phase reversible

Cat. No.	Supply Freq. C.P.S.	Power Out. Watts	Volt. Out. V. AC	Sig. req'd for full outp. MA-DC	Total res. contr. wdg. KΩ
MAP-1	60	5	—	1.2	1.2
MAP-2	60	15	115	1.6	2.4
MAP-3	60	50	115	2.0	0.5
MAP-3-A	60	50	115	7.0	2.9
MAP-4	60	175	115	8.0	6.0
MAP-7	400	15	115	0.6	2.8
MAP-8	400	50	110	1.75	0.6

SATURABLE TRANSFORMERS

Phase reversible

Cat. No.	Supply Freq. C.P.S.	Power Out. Watts	Volt. Out. V. AC	Sig. req'd for full outp. MA-DC	Total res. contr. wdg. KΩ
MAS-1	60	15	115	6.0	27
MAS-2	400	6	115	4.0	10
MAS-5	400	2.7	26	4.0	3.2
MAS-6	400	30	115	4.0	8.0
MAS-7	400	40	115	5.5	8.0

All units designed for 115V-AC operation

VARIABLE TEST VOLTAGE MEGOHMMETER NO. 1620



The Freed Type 1620 Megohmmeter is a versatile insulation resistance measurement instrument with a continuously variable DC test potential from 50 to 1000 volts.

Components such as transformers, condensers, motors, printed circuits, cables and insulation material can be tested at their rated voltage and above, for safety factor.

Resistance — 0.1 megohms to 4,000,000 megohms.

Voltage — variable, 50-1000 volts.

Accurate — plus or minus 5% on all ranges.

Simple — for use by unskilled operators.

Safe — high voltage relay controlled.

Self contained — AC operated.

ALSO AVAILABLE:

Type 1620C MEGOHMMETER — a type 1620 with additional circuitry for testing capacitors.
Type 1020B MEGOHMMETER — a 500 volt fixed test potential.

Type 2030 PORTABLE MEGOHMMETER — battery operated, 500 volt test potential.

FOR PRECISION LABORATORY OR PRODUCTION TESTING



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 10K
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

MIL-T-27A POWER, FILAMENT, PULSE & AUDIO TRANSFORMERS

POWER TRANSFORMERS-STANDARD

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

Cat. No.	Hi Volt Sec.	ct	DC Volts	DC Amps	Filament #1		Filament #2		MIL Case Size
					Volt	Amp.	Volt	Amp.	
MGP1	400/200	√	185	.070	6.3/5	2	6.3	3	HA
MGP2	650	√	260	.070	6.3/5	2	6.3	4	JB
MGP3	650	√	245	.150	6.3	5	5.0	3	KB
MGP4	800	√	318	.175	5.0	3	6.3	0	LB
MGP5	900	√	345	.250	5.0	3	6.3	0	MB
MGP6	700	√	255	.250					KB
MGP7	1100	√	419	.250					LB
MGP8	1600	√	640	.250					NB

FILAMENT TRANSFORMERS-STANDARD

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

Cat. No.	Secondary		Test VRMS	MIL Case
	Volt	Amp		
MGF1	2.5	3.0	2,500	EB
MGF2	2.5	10.0	2,500	GB
MGF3	5.0	3.0	2,500	FB
MGF4	5.0	10.0	2,500	HB
MGF5	6.3	2.0	2,500	FB
MGF6	6.3	5.0	2,500	GB
MGF7	6.3	10.0	2,500	JB
MGF8	6.3	20.0	2,500	KB
MGF9	2.5	10.0	10,000	JB
MGF10	5.0	10.0	10,000	KB

PULSE TRANSFORMERS

Cat. No.	Blck'g. Osc.	Int. Coupl'g	Low. Pow. Out.	Pulse Voltage Kilovolts	Pulse Duration Microseconds	Duty Rate	No. of Wdg.	Test Volt. KV RMS	Char. Imp. Ohms
MPT1	√	√		0.25/0.25/0.25	0.2-1.0	.004	3	0.7	250
MPT2	√	√		0.25/0.25	0.2-1.0	.004	2	0.7	250
MPT3	√	√		0.5/0.5/0.5	0.2-1.5	.002	3	1.0	250
MPT4	√	√		0.5/0.5	0.2-1.5	.002	2	1.0	250
MPT5	√	√		0.5/0.5/0.5	0.5-2.0	.002	3	1.0	500
MPT6	√	√		0.5/0.5	0.5-2.0	.002	2	1.0	500
MPT7	√	√	√	0.7/0.7/0.7	0.5-1.5	.002	3	1.5	200
MPT8	√	√	√	0.7/0.7	0.5-1.5	.002	2	1.5	200
MPT9	√	√	√	1.0/1.0/1.0	0.7-3.5	.002	3	2.0	200
MPT10	√	√	√	1.0/1.0	0.7-3.5	.002	2	2.0	200
MPT11	√	√	√	1.0/1.0/1.0	1.0-5.0	.002	3	2.0	300
MPT12	√	√	√	0.15/0.15/0.3/0.3	0.2-1.0	.004	4	0.7	700

AUDIO TRANSFORMERS

Catalog No.	Application	All Case Sizes AJ									
		Impedance					DC Current				
		Prim. Ohms	ct	Sec. Ohms	ct	Prim. Max. Ma	Sec. Max. Ma	Max. Level	DBm		
MGA1	Single or P.P. Plates — to Single or P.P. Grids	10K	√	90K Split	√	10	10	+	15		
MGA2	Line to Voice Coil	400 Split	√	4, 0, 16	√	0	0	+	33		
MGA3	Line to Single or P.P. Grids	400 Split	√	135K	√	0	0	+	15		
MGA4	Line to Line	400 Split	√	400 Split	√	0	0	+	15		
MGA5	Single Plate to Line	7.4K 4.8T	√	400 Split	√	40	40	+	33		
MGA6	Single Plate to Voice Coil	7.8K 4.8T	√	4, 0, 16	√	40	40	+	33		
MGA7	Single or P.P. Plates to Line	15K	√	600 Split	√	10	10	+	33		
MGA8	P.P. Plates to Line	24K	√	600 Split	√	10	1	+	30		
MGA9	P.P. Plates to Line	60K	√	600 Split	√	10	1	+	27		

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ELECTRONIC DESIGN

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DIGITAL PRESET INTERVAL GENERATOR

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NO CALIBRATION REQUIRED
SINGLE RANGE 100,000 STEPS

The "PIG" will —

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▷ GENERATE PULSE BURSTS



▷ GENERATE VOLTAGE GATES



▷ MEASURE TIME INTERVALS



- Internal 1 megacycle crystal oscillator time base
- Accepts any external time base up to 1 megacycle
- Fast reset—recycles in 50 microseconds
- Independent and simultaneous outputs
- Preset counter up to 1 megacycle

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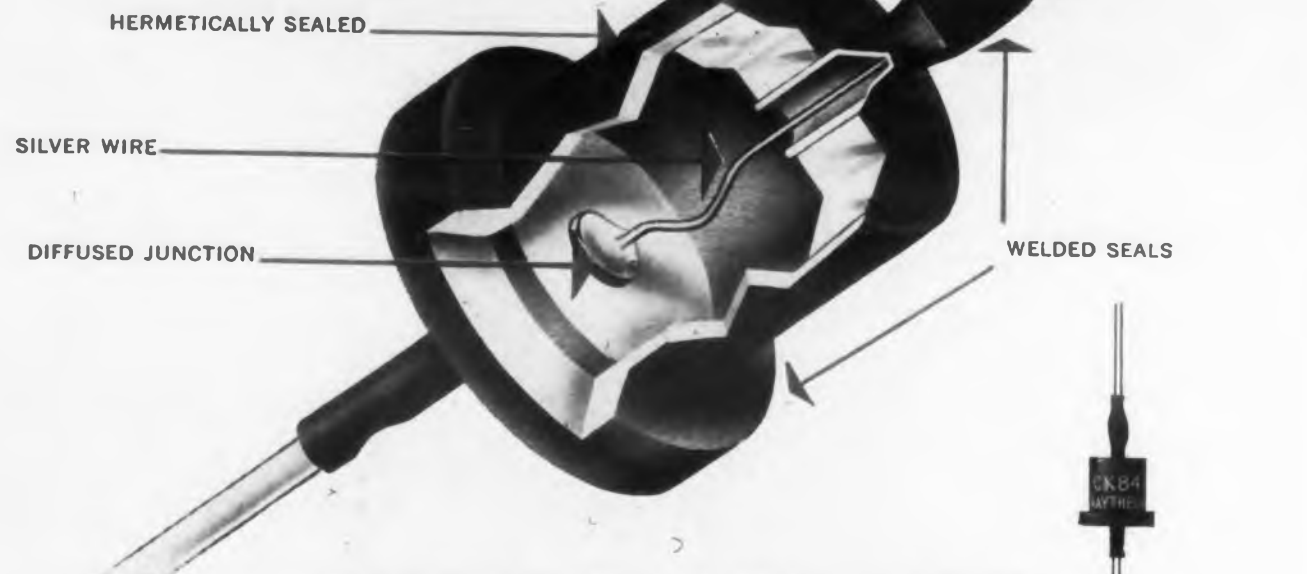
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SOLID STATE **DIFFUSED JUNCTION** SILICON RECTIFIERS now in QUANTITY PRODUCTION

Uniform Characteristics — Uniformly High Quality

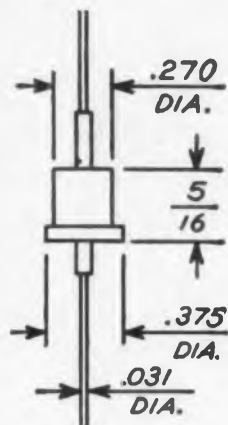
The Solid State Diffusion Process involves the formation of a junction by diffusing suitable gaseous materials into silicon at high temperatures. This process offers many advantages including:

1. Exact control of junction penetration.
2. Precise junction gradient for specific rectifier applications.
3. Flat junctions for uniformity and control of characteristics.

Operating Temperatures — minus 65°C to plus 150°C

Storage Temperature — up to 170°C

Hermetically Sealed — Welded



AVERAGE CHARACTERISTICS

Type	Peak Inverse Volts*	Forward Current**		Forward Volts*** at 350 mA 100°C	Reverse Current*** (max.) mA at rms volts 100°C
		100°C	150°C		
CK840	100	350	100	0.75	0.2 at 70
CK841	200	350	100	0.75	0.2 at 140
CK842	300	350	100	0.75	0.2 at 210
CK843	400	350	100	0.75	0.2 at 280
CK844	500	350	100	0.75	0.2 at 350
CK845	600	350	100	0.75	0.2 at 420

*PIV ratings apply from -65°C to +150°C

**Into inductive or resistive load

***Averaged over one complete cycle



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CIRCLE 3 ON READER-SERVICE CARD FOR MORE INFORMATION

Editorial

Engineers, Take to the Road

You could easily get frustrated if you tried to decide which of the many forthcoming conferences, meetings, or shows to take in. We just finished counting over 100 pages of literature announcing different meetings of interest to electronic designers. You couldn't possibly attend all because some are going on at the same time. On the other hand, maybe there's no conflict created because the department head says forget the whole thing, it's a waste of time and money going to such meetings. Get on with your project! The fact that more people do not go to meetings may be the bad thing.

Why go to meetings, conferences, symposiums? In many cases, a conference proceedings of all the papers can be purchased for \$5 or less. Timely good papers will be sought by technical journal editors and readers can get the data fast. Far faster than listening to drawn-out monotone, broken-English or stammering speakers who stimulate nothing more than soporific ideas.

The simple answer to why go is that there is no better time or place to exchange ideas or swap notes than at a technical conference. Even if you refuse to enter into the spirit of exchanging information, you may very likely make the whole trip worthwhile simply by eavesdropping on others' conversation. More than once something will be said that is the missing link in your own study and investigation. Ask the alert engineer who goes to a meeting. Very likely it's information coming entirely aside from the papers being read that is valuable to him. Of course the papers presented focus attention on the problem, and it may be that the real nugget of information will come up in the question and answer period following the delivery of the paper. The main point is that free interchange of ideas accelerate progress and technical meetings provide the time, place and direction.

Professional engineering and educational groups and trade groups that sponsor such affairs deserve respect and support. Support should be given by the industry by sending engineers to meetings and encouraging participation in committees that organize such meeting. For those whose interest is only self-interest, participate simply by sending your engineers. Even if you take part in only a unilateral way everyone will benefit. Why not assign at least one engineer, if not more to cover every meeting coming up? Stipulate only one thing, that they write a trip report. Possibly better yet, schedule your own interdepartmental meeting where everyone reports on what he learned from being on the road.—JAL.

Engineering Review

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

Biggest, Most Flexible Memory Yet

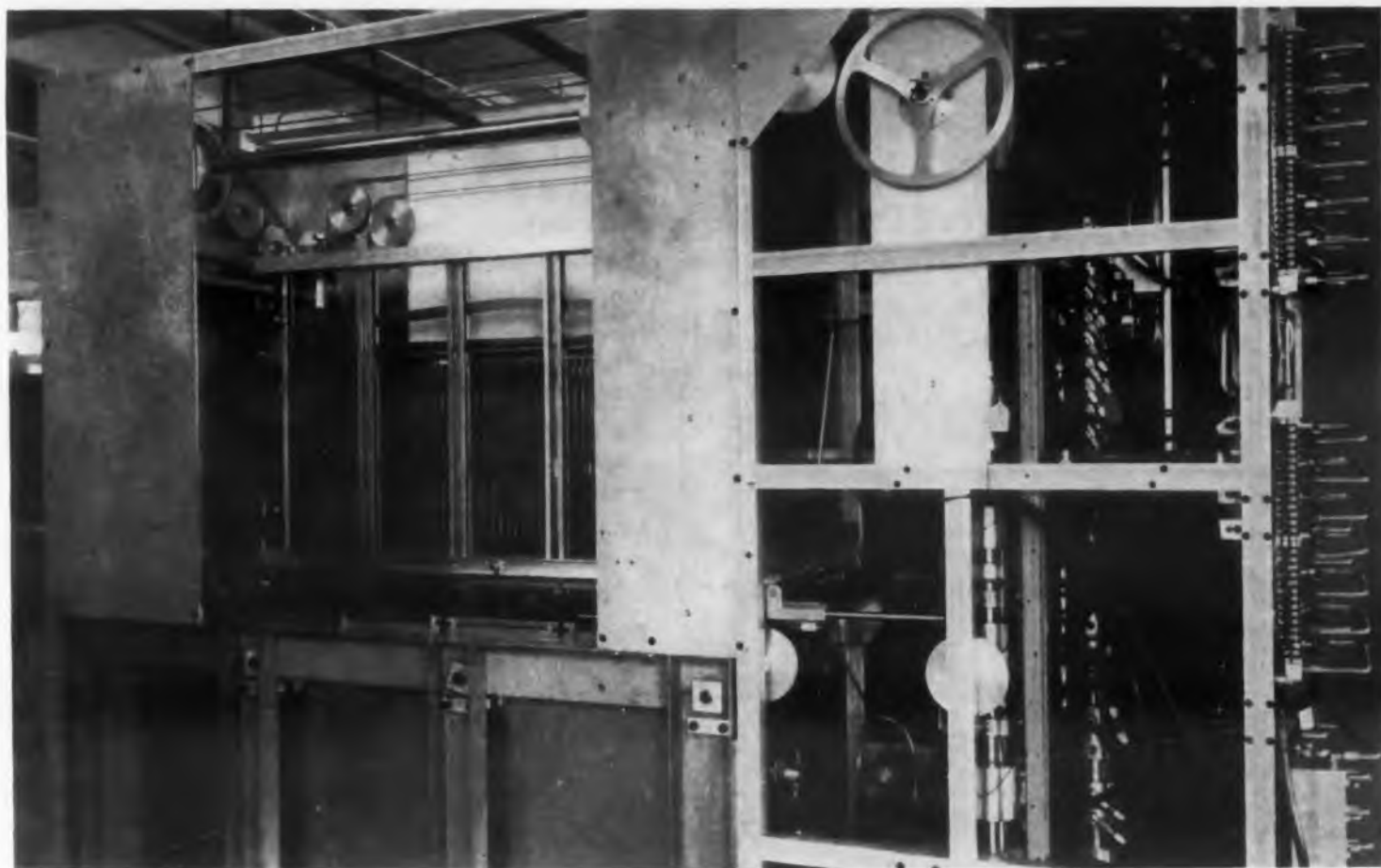
With access time of less than a second to any one bit of information out of a total of 500 million bits, the Potter RAM is ready to automatize large-size clerical filing systems. Inventory control recording for mass production manufacturers, lifetime subscription fulfillments, cataloging, or insurance record keeping are areas the RAM will serve. Four hundred thousand different addresses can store 64 million 8-bit characters. The Potter Instrument Co., Inc., Great Neck, N.Y., RAM is equal in capacity to 20 standard tape handlers or 13 of the heretofore largest random access memory mechanisms. The information can run high speed printers.

Memory tapes are supported in a bin which has a 3-dimensional physical configuration much like

a filing cabinet drawer. Data are stored on conventional 8-track magnetic tape strung in vertical columns on "pages" which can be lifted vertically to bring a selected data location into contact with the record-playback head. The removable storage bin holds 200 pages.

In normal usage, one of the eight tracks is used to identify the beginning and end of blocks and one is used as a clock track, leaving six tracks for binary-coded alphanumeric information. Positive and negative saturation recording is used with return-to-zero or non-return-to-zero techniques.

Positioning of the mechanical access mechanism is achieved by serially-connected pneumatically-programmed cylinders which contribute modified binary-coded motion increments simultaneously.



One "page" of memorized data of RAM is shown raised at the left for reading. At the extreme right are solenoid valves operated by digital code which send air signals through hoses to serially connected pistons, middle right. As pistons move a page is lifted from the bin, the recording head is positioned to pick up the right tape and the proper section selected and scanned.



IBM Electric Typewriter employing electronic tabulation. Note small size of electronic control unit which mounts beneath keyboard.

Electronic Control for Typewriters

In an effort to further simplify the typists job, the Electric Typewriter Division of International Business Machines Corporation has introduced electronic sensing and control equipment in their standard electric typewriter. Incorporating an electronic-tube switching circuit which operates a relay hooked up to the tabulator, the electronic unit makes tabulation entirely automatic.

Conductive ink is used on the billing or accounting forms which, according to IBM spokesmen, costs only a little more than ordinary ink. Contact for "tab sensing" is made by a conducting brush as it passes over the ink line, thus operating the relay and stopping the carriage in a prescribed number of spaces beyond the line.

Admitted by IBM officials to be only the first of a number of coming electronic applications to typewriters, an expanding market for electronic components and equipment seems assured.

The electronic unit currently being used by IBM, although employing a tube, measures only approximately 3 by 6 inches in size. It is mounted beneath the keyboard. One of the problems in "electronifying" the typewriter is the small space available for the electronic unit. Transistors can be expected to play an important part in this development.



Dow high temperature magnesium alloys have excellent fabrication characteristics

Lightweight structural metals with high strength, stiffness and elasticity at elevated temperatures! A new group of Dow magnesium alloys offers a great combination of these properties without the fabricating difficulties normally experienced with other high temperature materials.

Specially developed for use in airframes, missile and engine structures, the new alloys are already making weight reductions possible for several manufacturers. These alloys show advantages at temperatures up to 700°F. Limited test data on properties up to 800°F. are available for some of them.

FABRICATION: Fabrication characteristics are equal to those of standard magnesium alloys.

WELDABILITY: 95 to 100% weld efficiency at elevated temperatures.

FORMABILITY: Single deep draws can be easily accomplished.

MACHINABILITY: Best machining characteristics of any structural metal.

One of the new alloys is magnesium-thorium composition HK31A. It is now available in rolled form from stock. Castings and sheet in mill quantities are also readily available. A companion alloy for extruded shapes and forgings will soon be in production.

For more information about the new high temperature magnesium alloys, contact your nearest Dow Sales Office or write

to THE DOW CHEMICAL COMPANY, Magnesium Sales Department MA 362B-1, Midland, Michigan.



EASILY FORMED. These HK31A parts were drawn using production dies and processes for standard magnesium alloys. The parts retained a higher percentage of original properties than standard alloys.

you can depend on DOW MAGNESIUM

DOW

CIRCLE 4 ON READER-SERVICE CARD FOR MORE INFORMATION

Electric Contour Controls Miller

Boeing Airplane Company is using two new 85-ton contour profile milling machines, equipped with GE tracer control systems. The machines are being used in the production of B-52 global bombers for the USAF. Boeing's application of the GE control system has made possible stepped-up production and greater precision. Actual production figures are classified but Boeing officials report that the new machines quickly cleared away a six-week backlog of work immediately after their installation and have not been behind schedule since the third week of operation.

Onsrud Machine Works manufactures the milling machines which are used in processing spar and wing chords and wing skins requiring a wide variety of machine cuts. Many of the necessary cuts require rise and fall, transverse, and twist motions simultaneously. The GE tracer control system, which operates from cams or templates, includes six selsyn-type tracers capable of controlling three motions on each of two heads simultaneously.

Room Color Control by Electronics

The first full-scale presentation of man's newest light source, electronic light, was made recently in Pittsburgh when Westinghouse unveiled a complete room lighted by electroluminescence.

Panels no thicker than window glass lined the ceiling and three walls, giving off light (approximately 50-foot-candles at an efficiency of 3 lumens per watt) equivalent to that in a modern, well-lighted office or class room.

The unveiling was the climax of a demonstration on electroluminescence by Edward G. F. Arnott, lamp division director of research, and was a preliminary event in the dedication of Westinghouse's new multimillion dollar research laboratories.

Electroluminescence is light emission by suitable phosphor powders embedded in an insulator and subjected only to the action of an alternating current electric field. The phenomenon was first discovered in 1936 by French scientist Georges Destriau, who published a paper on his findings in 1947. Small-scale applications, such as flashlights, were perfected as early as 1954.

In the demonstration, one hundred and twelve glass panels, each one foot square and about 1/8 inch thick, were used to illuminate the room with soft green light.

Since the emitted color of electroluminescence varies with the frequency of the exciting energy, the 350 v ac, 3 kc green power source may be varied by means of an oscillator control knob. In this way, the housewife of the future may have complete mastery over the lighting in her house with two control knobs in every room, one for brightness and one for color.



Home television tape player developed by RCA reproduces pre-recorded black-and-white television selections on a standard TV set.

Television Tape Player for the Home

Recent developments in an air conditioner, the electronic light amplifier, and a home "hear-see" tape player were disclosed last week by RCA while celebrating Brig. General David Sarnoff's 50th year in the fields of radio television and electronics. All of the items have been announced previously but significant new developments have come about.

The principles employed in the television tape recording system have been applied in the development of a home television sight and sound tape player. An electronic room air conditioning system and a new larger electronic refrigerator have been developed from the earlier small refrigerator. From the original light amplifier, the scientists have developed a new amplifier capable of increasing by 1000 times the brightness of projected light. Such a system for industrial X-ray use has been perfected.

Dollar Savings Through Standards

Seventy-nine cases of savings resulting from standardization are covered in a newly-published survey by ASA entitled, "Dollar Savings Through Standards." The studies were prepared for ASA by 70 American companies and 6 associations. They cover about 27 industrial fields. Copies of the survey will be furnished by ASA free on request. Also recently published by ASA is a four-page booklet entitled "What Is an American Standard?". Copies of this booklet may also be obtained without charge from ASA.

Cool Weather on Demand

Airplanes based in warm-weather areas can have their high-altitude equipment properly serviced with the MA-3 weather simulator.

A cool 100 lbs of air per minute at 45 F can be supplied regardless of ambient temperatures. In operation the unit is towed to the aircraft site and then moved into final position under its own power. It is completely self-contained with compressor, evaporator, condenser, and all gauges and controls.

The weather simulator is now in production at American Electronics, Inc., El Monte, Calif.

There's a
standard
PERKIN
model for
your every
need!

In addition to the 28 volt models featured at the right, the following units are also available:

OTHER 28 VOLT MODELS

Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms
28-5VFM	0-32 V	5	20% (24-32 V range)	115 V 1 phase	2%
28-10VX	24-32 V	10	± 1/2%	100-125 V 1 phase	1%
28-15VFM	0-32 V	15	20% (24-32 V range)	115 V 1 phase	5%
28-80VX	24-32 V	80	± 1/2%	230 V* 3 phase	1%
MR2432-200	24-32 V	200	± 1/2%	230 V* 3 phase	1%
MR2432-300	24-32 V	300	± 1/2%	230 V* 3 phase	1%
MR2432-500	24-32 V	500	± 1/2%	230 V* 3 phase	1%

* ± 10%. Also available in 480 V ± 10% AC input. Will be supplied with 230 V input unless otherwise specified.

6, 12, 115 VOLT (NOMINAL) MODELS

Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms
6 Volt	6	5	± 1%	95-130 V 1 phase	1%
	6-5WX				
	6-15WX				
12 Volt	12	15	± 1%	95-130 V 1 phase	1%
	12-18WX				
115 Volt	115	5	± 1/2%	95-130 V 1 phase	1%
	115-5WX				
	MR18125-5				
6128-25**	115-125	25	1 1/2-4%	230/480 V 3 phase	5%

** Germanium Rectifier Unit † increases to 2% @ 15 V.

PERKIN...THE LEADER

In tubeless magnetic amplifier regulated

DC POWER SUPPLIES

No Moving Parts • No Vibrating Contacts

IMMEDIATE
DELIVERY
FROM STOCK



Model MR532-15A

2-36 VOLTS @ 15 AMPS SPECIFICATIONS

Regulation: 5-32 Volt Range: ± 1/2%
2-5 Volt and 32-36 Volt Range: ± 2%
AC Input: 105-125 Volts, (for 2-32 V.DC), 110-125 V, (for 32-36 V.DC), 1 phase, 60 cps (8 amps)
Ripple: 1% rms max. (@ 36 volts and full load. Increases to 2% @ 2 volts and full load).

Remote Sensing • Vernier Control



Model M60V

0-32 VOLTS @ 25 AMPS SPECIFICATIONS

Regulation: ± 1% @ 28 Volts (Regulation increases to 2% over range of 24-32 volts; does not exceed 2 volts over 4-24 volt range. Not stabilized for AC line changes.)
AC Input: 115 Volts, 1 phase, 60 cps (12 amps)
Ripple: 1% rms (@ 32 volts and full load - 2% rms max. @ any voltage above 4 volts).



Model MR1040-30A

5-40 VOLTS @ 30 AMPS SPECIFICATIONS

Regulation: ± 1% (over entire 5-40 volt range)
AC Input: 100-130 Volts, 1 phase, 60 cps
Ripple: 1% rms



Model 28-30 WXM

24-32 VOLTS @ 30 AMPS SPECIFICATIONS

Regulation: ± 1/2%
AC Input: 100-125 Volts, 1 phase, 60 cps (20 amps). (Unit rated for DC output of 28 volts ± 10% for 95-130 volt input.)
Ripple: 1% rms



Model MR2432-100XA

24-32 VOLTS @ 100 AMPS SPECIFICATIONS

Regulation: ± 1/2%
AC Input: 208, 230 or 460 Volts, ± 10%, 3 phase, 60 cps (14, 12 and 6 amps respectively). 230 volt input will be supplied unless otherwise specified.
Ripple: 1% rms

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CIRCLE 5 ON READER-SERVICE CARD FOR MORE INFORMATION

Silicon Coating Aids Printed Circuits Soldering

Silicon solution can be coated on printed circuit boards to produce better soldering connections. The silicon coating is applied by a silk screen process similar to the one used in transferring the printed circuit pattern itself to the board. The silicon solution, employed by Admiral Corp., 191 Merchandise Mart, Chicago 54, Ill., forms a hard heat-repellent film and covers the circuit side of the board, except for the points where component connections are to be soldered. By repelling the 550 F heat of the solder pot into which the board is dipped, the heat resistant silicon is said to force the solder toward the component connections.

High Speed Data Reduction

Electronic equipment at the Lockheed Missile Systems division in Van Nuys, Calif., changes a tape recording of scrambled tones into graphs from which scientists and engineers can interpret a missile's flight performance. The equipment cuts the analysis period of flight test data from months to days. Upper left is tape recording, line of equipment in rear transforms information on taped record to decks of punched cards, and foreground is a plotter which produces graphs from information on the cards.

Reflectoscope Protects Against Railway Accidents

Sound waves are being successfully used to indicate defects in railway car axles and journal areas. The Sperry Rail Service Co.'s reflectoscope, employed by the Chesapeake and Ohio Railway Co., sends a beam of sound energy into the journal area. If there is a crack in the axle or journal box a portion of the energy is reflected back to the reflectoscope's search unit.

The Chesapeake and Ohio Railway has in operation a mobile carrier on which the reflectoscope is mounted. It combines all the necessary equipment to test car journals while they are on a car. This method supersedes the time consuming and costly method of removing the journal before they can be checked.

a navigation system that solves jets' problems

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TECHNOLOGICAL



AERONAUTICAL SYSTEMS

have made vital contributions to the progress of jet aviation and its expansion into the civil transport field. Many have won recognition as the finest in the industry, benchmarks of American technology.

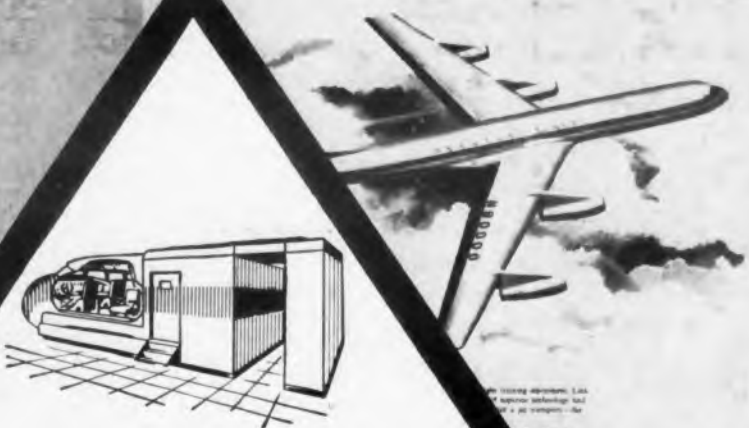
Whole generations of airmen, for instance, have been trained in flight simulators developed and produced by Link, pioneer of on-the-ground flight training. This GPE Company has delivered over 800 jet flight simulators—more than all other manufacturers put together. It has just been selected, on the basis of superior technology and equipment, to produce America's first simulators for jet air liners. Link-developed DC Computer Systems in Link supersonic simulators are the only ones meeting the needs of these advanced aircraft.

Equally dominant are the gyro-magnetic compass systems of Kearfott, another GPE Company. This company's new lightweight J-4 Compass System weighs only

GENERAL PRECISION

92 GOLD STREET, NEW YORK 38, NEW YORK

DOUGLAS SELECTS LINK TO BUILD FIRST DC-8 JET SIMULATOR



LINK
AVIATION, INC.
BINGHAMTON, NEW YORK

KEARFOTT AND AVIATION



BENCH MARKS

18 pounds. Yet it provides accurate heading information at all latitudes, is rugged enough to maintain its high accuracy despite the jolts and speeds of jet flight. The Air Force has just selected it as standard for all new fighter craft. Kearfott's N-1 Compass System has been the navigational standard for Air Force bombers for 5 years.

Still another member of the GPE Group, General Precision Laboratory, has developed and is currently making quantity deliveries of the most advanced airborne navigation systems in use. These GPL systems, which are self-contained and fully automatic, have flown millions of operational miles with unprecedented accuracy. Their adaptations to civilian jet needs—GPL's RADAN Systems—are expected to make equally far reaching contributions to the commercial jet transport field—in the way of increased safety, fuel economy, passenger convenience and efficient use of limited air space.

These are but some of the accomplishments in avia-

tion for which GPE Companies, working in conjunction with the Armed Services, are responsible. Librascope, an important member of the Group, produces outstanding instruments and equipment for the field. Librascope's computers, its highly advanced equipment for photo-reconnaissance work and photogrammetric equipment for the interpretation of photo data, its periscopes, pilot and navigator finders, are all leaders. Several GPE Companies are deeply involved in inertial guidance, guided missile projects and certain nuclear power applications.

In all GPE achievements in the numerous industries in which the companies work, GPE Coordinated Precision Technology plays an important part by inter-relating the wide range of skills and resources of the Group. This operating policy, and each company's unremitting insistence on highest quality, are major reasons for the frequency with which GPE systems and equipment continue to set standards in their fields.

Mobile Interference Labs

A fleet of mobile radio-interference shielded laboratories will soon be dispatched for on-site testing of electronic equipment. The mobile laboratory was designed because modern installations of major subassemblies are frequently so elaborate that they must be tested at the point of installation. This is especially true of today's missile systems.

A unit has been built by Filtron Co., Flushing, N.Y., completely equipped with 60 and 400 cycle rotary power supplies, air conditioning, and measuring and calibrating equipment to measure from 14 kc to 1000 mc, in accordance with military requirements. Screen room construction filters out interference from the portable power installation. The laboratories will be used to measure radio-frequency interference of electronic equipment which cannot be transported to stationary screen rooms or test facilities.

Magnetizer Produces 500,000 Gauss

A magnetizer, with a maximum line demand of only 6.6 kva, uses the stored energy principle to produce peak impulses of 1500 kva, of up to 50 milliseconds duration. An 1800 mfd. condenser storage bank is discharged through an ignitron tube to the primary of a step-down transformer. The single turn secondary acts as the magnetizing loop. Because of the single magnetizing loop and the high intensity, almost completely closed circuit magnets can be made easily.

Electronic control circuits assure precise field output, uniform from pulse to pulse.

Full Range Electrostatic Loudspeaker

Balanced response over the entire audible spectrum of 25 to 25,000 cps is possible with the electrostatic speaker system designed by Pickering & Co., Oceanside, L.I., N.Y. Low frequency woofers, which also operate electrostatically, can be used to complement the isophase high frequency electrostatic speakers being manufactured presently. Present state of the art indicates that electrostatic speakers have a place in the hi-fi market.

EQUIPMENT CORPORATION

THE GPE GROUP • Ampro Corporation • Askania Regulator Company • Bizzelle Cinema Supply Corporation • Bludworth Marine
General Precision Laboratory Incorporated • The Grisco-Russell Company • The Hertner Electric Company • International Projector Corporation
Kearfott Company, Inc. • Librascope, Incorporated • Link Aviation, Inc. • J. E. McAuley Mfg. Co. • National Theatre Supply
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◀ CIRCLE 6 ON READER-SERVICE CARD

Mighty Midget!



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16,000 VOLT
high temperature
SILICON DIODE
can reduce
your electronic
equipment
manufacturing
costs **3** ways!

ILLUSTRATED ACTUAL SIZE

95% SMALLER
than conventional units
of comparable rating!

COMPLETE ENGINEERING INFORMATION ON SILICON "CARTRIDGE-TYPE" DIODES IS AVAILABLE ON REQUEST.

SIMPLIFIES ENGINEERING...cuts time normally spent "designing around" bulky units...provides a quick answer to high temperature problems.

REDUCES EQUIPMENT SIZE...20 to 1 size ratio can reduce chassis and enclosure size *and* costs...the dramatic weight difference will be reflected in lower shipping and handling costs.

CUTS ASSEMBLY COSTS...Standard fuse clip mounting can save up to 90% of the assembly time spent with conventional multiple stacks...high temperature characteristics result in less dielectric material and installation labor.

This Silicon Diode is just one of the many thousands of different types of Selenium and Germanium and Silicon Rectifiers produced by International Rectifier Corporation for all DC power needs, from microwatts to megawatts. Produced to the most exacting standards of reliability, the performance of these products in your equipment will prove the soundness of your engineering judgement. Call upon International Rectifier to assist you in your application. An Application Advisory Department comprised of over 50 top-flight rectifier engineering specialists will be happy to provide a prompt evaluation and practical recommendations.



International Rectifier

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THE WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS

Electronic Printer Does Forty Different Documents a Minute

Using a "Compositron" tube which simulates typesetting, a new RCA printer decodes 4000 signals a second direct from "Bizmac" magnetic tape, composes translated information in specified form, and reproduces data on business stationery. All of these steps are done simultaneously.

The printer is thus capable of processing speeds of up to 50,000 words a minute. It will produce in one minute 40 complete and different documents as large as 8-1/2 by 11 in. According to Arthur L. Malcarney, V-P and General Manager, of RCA Commercial Electronic Products, the unit is in a developmental stage and no commercial plans as yet have been established.

The electron-image tube translates code by selecting the proper alphabet letters and numerals, one by one, from a "font" and projects them in any desired pattern on the tube's ten-in. face. The pattern is photographed direct from the tube face by a 35 mm camera.

A film-processing system develops the exposed film at the rate of 10 feet a minute. The RCA Electrofax dry-process enlarging printer accepts the 35 mm film, enlarges it about 11 times and reproduces the information.

Test Equipment Study

US Dept. of Defense has established a national center at NYU for monitoring research and development on electronic equipment. A team of NYU research engineers are to serve as staff for the Electronic Test Equipment Coordination Group. Test equipment research and development throughout the electronics industry and the armed services is to be studied. Other tasks include: providing technical assistance for analysis and evaluation of proposed and present electronic test equipment projects; calling attention to new lab advances and trends here and abroad; anticipating future needs for certain equipment and initiating research to meet those needs; ending unnecessary duplication of effort by reporting on industrial and service-wide developments.

◀ CIRCLE 8 ON READER-SERVICE CARD

1.2 Million Letters and Numbers Per Minute

Letters and numbers can be reproduced at the rate of 1.2 million per minute for recording photographically with the use of a new model of the Charactron Shaped-Beam Tube. The tube, designated Type C7C11, is produced at the San Diego plant of Stromberg-Carlson. It has a seven-inch diameter and is capable of nine times the information density possible with other models of the Charactron Shaped-Beam Tube. Each character has been reduced to a height of .035 inches. Ten thousand can be reproduced for photographing in one frame. They can be arranged in the form of 100 lines of 100 characters each.

The Charactron Shaped-Beam Tube has been called an "electronic typewriter" because it utilizes a stream of electrons to create numbers and letters on a phosphor-coated screen, similar to the screen of a television set.

The tube actually reproduces numbers and letters by squirting or extruding electrons through a tiny metal stencil within the tube itself.

Maximum Hardness in Beryllium-copper Strip

By changing from the customary 600 F treatments for processing and fabrication of beryllium-copper strip Penn Precision Products, Inc., Reading, Pa., have developed a stronger and harder product. The new process involves a slightly higher temperature and varying treatment times depending on the hardness desired.

100,000 Mc Generator Tube

Designed to operate at extremely high frequencies with large power outputs, a new electron tube, called a "retarding field oscillator," permits more accurate radio beam control and adds more channels to the available frequency spectrum. Ohio State University, under contract to USAF Air Research and Development Command, Baltimore, Md., developed the tube whose characteristics are such that it operates at 70,000 mc, and with reduced power output at 100,000 mc.

CIRCLE 9 ON READER-SERVICE CARD >

NEW RAYTHEON PRODUCTS



For those who need the most demanding ceramic characteristics ... RAYTHEON R-95 HIGH-ALUMINA

We make only one kind of ceramic—high-alumina. As a manufacturer of tubes, Raytheon demands ceramic quality of utmost *purity* and *controlled consistency*. Our own R-95 ceramic meets these exacting demands.

You will find R-95 high-alumina ceramic completely dependable where high strength, high temperature, reliable vacuum seal, improved electrical performance, and high corrosion or abrasive resistance applications are involved. Raytheon will supply ceramic parts manufactured from R-95 high-alumina either alone or as hermetic ceramic-to-metal assemblies in accordance with your specifications. The assemblies can subsequently be soft or hard soldered into your production in your own plant.

Write for complete specification sheet. Supply us with a sketch or drawing outlining dimensions and tolerances, together with operational conditions. We will be happy to provide information and assistance on any of your ceramic requirements—without cost or obligation.

Bright Futures for Ceramic Engineers

Join an outstanding group of engineers in expanded ceramic development, working in the most modern ceramic plant in operation. Fascinating projects, excellent salaries, fine living conditions. Write address below.

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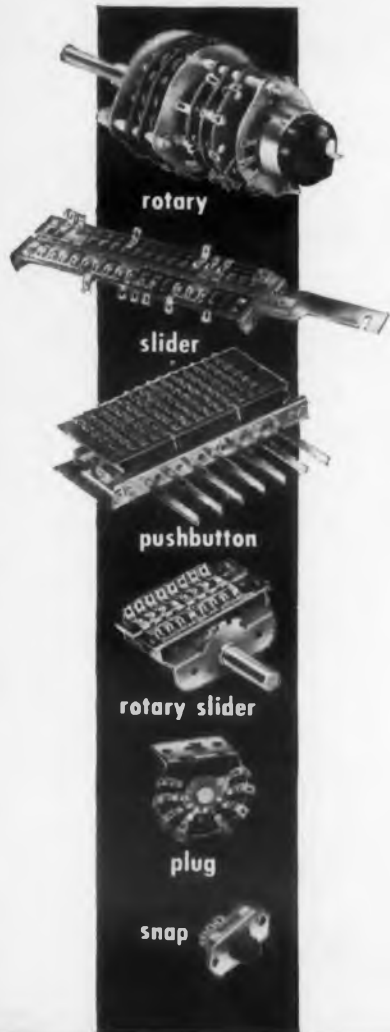
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In producing over 250,000,000 switches in over 70,000 varieties for manufacturers of electronics, OAK has developed the world's most extensive inventory of tooling for switch making.

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Thin Cathode-Ray Picture Tube

Radical departure from conventional cathode-ray display tubes is the thin cathode picture tube developed by Kaiser Aircraft and Electronics Corp., 1924 Broadway, Oakland 12, Calif. The tube consists essentially of a phosphor screen and transparent deflection plates sandwiched between glass face plates. The tube functions by electronically exciting selected areas or spots on the phosphor screen.

An electronic beam is injected along an edge of the tube. This beam flows in a field-free region along this edge of the phosphor screen and adjacent to a row of transverse deflection plates. Through control of the voltages on these deflection plates, the beam is bent vertically at any desired place along the edge of the tube. The beam then flows vertically in a second field-free region between a series of transparent deflection plates and the electrically charged phosphor screen. Deflection of the beam into the screen at any desired vertical level is made possible by controlling the voltages on the transparent deflection plates. The position of the spot created by the deflection beam may be exactly controlled.

Proton Beam Viewed by TV

The versatile closed-circuit television camera is now being put to work observing the Cosmotron's high-energy proton beam. Use of a small 5-pound television camera developed by General Precision Laboratory of Pleasantville, New York, enables the physicists at Brookhaven to watch the pattern made by the 3 Bev external proton beam on a sodium iodide mosaic with greater clarity and without exposure to radiation.

Federal Support for Science Students

Through various programs for the support of higher education, during 1954 the Federal Government aided better than 1 out of every 5 graduate students and 1 out of every 6 undergraduates, in all fields of study. At an average cost of more than \$1000 per student, over 101,000 science students

◀ CIRCLE 10 ON READER-SERVICE CARD

were helped. While only one-fourth (82,000) of the undergraduate group were studying in the sciences, approximately one half (18,000) of the graduate students, and virtually all (1300) of those receiving such assistance for postdoctoral training and research were pursuing scientific studies. The National Science Foundation report "Federal Support For Science Students in Higher Education" indicated that eligibility for Federal support at the undergraduate level was determined almost exclusively by military service, either through the completion of past service or commitment to future service.

Mobile Calibration Test Van

To assist field installations in maintaining equipment accuracy, the US Signal Corps has developed a mobile Equipment Calibration Test van which operates from signal depots to service field installations. Periodically visiting field maintenance shops, Signal Corps and Ordnance detachments supporting anti-aircraft defended areas, Strategic Air Command bases, National Guard shops and division signal companies, it is intended that by next year there will be one van for each Army area in the US.

In addition to adjustment and recalibration of field equipment, the van stocks some repair parts and basic meters to repair defective equipment on the spot.

Optical Driverless Tractor

Sniffing its way along a white line, the optical guidance system of this tractor can steer it without wires or operator.

The nose of the sniffer is a low-powered bulb which reflects from the white tape or paint on the floor and actuates photo-electric cells.

The Guide-O-Matic electronic industrial tractor, manufactured by the Barrett Cravens Co., 628 Dundee Rd., Northbrook, Ill., can be converted from optical type to wire type, should the need arise.

CIRCLE 11 ON READER-SERVICE CARD ►

Transitron SILICON VOLTAGE REGULATORS

	Type	Voltage Range (volts)	Maximum Average Current (ma)		Maximum Dynamic Resistance (ohms)
			at 25°C	at 125°C	
UP TO 50 ma	SV-5	4.3 - 5.4	50	10	55
	SV-6	5.2 - 6.4	40	8	20
	SV-7	6.2 - 8.0	30	6	10
	SV-9	7.5 - 10.0	25	5	20
	SV-11	9.0 - 12.0	20	4	70
	SV-13	11.0 - 14.5	17	3.4	100
	SV-15	13.5 - 18.0	14	2.8	120
	SV-18	17.0 - 21.0	12	2.4	200
UP TO 150 ma	SV-804	4.3 - 5.4	150	30	55
	SV-805	5.2 - 6.4	120	24	20
	SV-806	6.2 - 8.0	90	18	10
	SV-808	7.5 - 10.0	75	15	20
	SV-810	9.0 - 12.0	60	12	70
	SV-812	11.0 - 14.5	50	10	100
	SV-815	13.5 - 18.0	40	8	120
	SV-818	17.0 - 21.0	35	7	200
UP TO 2 AMPS	SV-904	4.3 - 5.4	2.0	400	2
	SV-905	5.2 - 6.4	1.6	320	2
	SV-906	6.2 - 8.0	1.2	240	2
	SV-908	7.5 - 10.0	1.0	200	2
	SV-910	9.0 - 12.0	.8	160	2
	SV-912	11.0 - 14.5	.7	140	4
	SV-915	13.5 - 18.0	.6	120	6
	SV-918	17.0 - 21.0	.5	100	8

Transitron's silicon voltage regulators (sometimes called Zener diodes) are constant voltage elements for control and similar circuitry. They provide excellent regulation and stability over a wide operating range.

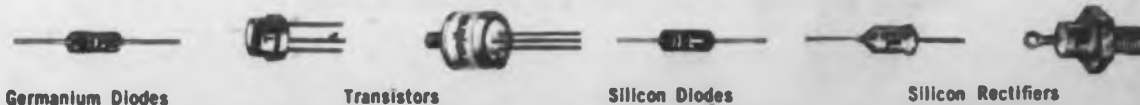
Through improved thermal design, each of the three regulator series will give high load currents in the smallest possible size. The subminiature glass types, for example, provide twice the current in less than half the size of conventional regulators. High power types can be used to simplify circuits and eliminate amplification stages.

Inquiries are invited on higher voltage regulators, and precision, temperature compensated voltage reference elements.

SEND FOR
BULLETIN TE 1352

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Germanium Diodes

Transistors

Silicon Diodes

Silicon Rectifiers

T

PRECISION



329-A

In one phrase, that's the story of the Du Mont Type 329-A. From the input attenuators, right through to the cathode-ray tube, tolerances have been held to a level that means what you can read — you can trust. Accuracy of measurement is limited primarily by the size of the fluorescent spot (and with the superb characteristics of our mono-accelerator cathode-ray tubes, that's an especially significant statement).

Prove to yourself what the extra precision and convenience of the Type 329-A will mean to you. Call your nearest Du Mont representative for a demonstration, or write to Technical Sales Dept. at the address below.

CONTINUOUS SWEEP CALIBRATION. If you can read numbers you can make precise time measurements. Adjust the event to be measured to fill exactly a major interval on the screen. Then read time directly from the large legible dial with no interpolation, no need to count squares. Accuracy? Better than 5% (including sweep generator and cathode-ray tube).

REAL SWEEP LINEARITY. Our test spec reads "no 10% increment of sweep shall vary from another 10% increment by more than 5% in time interval represented." In short, any non-linearity of sweep will be less than a trace-width!

CALIBRATED SWEEP EXPANSION. Exclusive Du Mont "Notch" speeds a segment of the sweep by a factor of exactly 10. Result — effectively two calibrated rates during the same sweep. Expanded portion is displayed in proper relation to the unexpanded portion. Uncalibrated notch offers greater expansion (up to 100 times on lower sweep ranges).

AMPLITUDE CALIBRATION. Accurate ($\pm 2\%$) voltage standard is applied by a flick of a convenient front-panel switch to calibrate screen in any of 11 full-scale ranges from 0.2 to 400 volts.

HIGH PRECISION TYPE 5ATP- CATHODE-RAY TUBE. Only a tube built to our stringent tolerances could exploit fully the precision inherent in the circuitry of the Type 329-A. Based on the mono-accelerator principle, the Type 5ATP- offers the superb deflection linearity as well as the freedom from spot and field distortions required to render measurements valid right down to the resolving power of the trace.

DC TO 10 MC (30% DOWN) VERTICAL RESPONSE is the nominal bandwidth of the Type 329-A. But owing to the gradual fall of the frequency response beyond this point, the amplifier is usable to 20 mc and beyond. Unique amplifier design assures display of d-c signals with no d-c slump.

HIGH-LOW-GAIN SELECTOR permits doubling deflection sensitivity (at some sacrifice in bandwidth) to 0.05 volt per major scale division for studies involving very low signal levels.

DUAL INPUT CONNECTORS permit switching from one signal source to another without changing leads.

MAJOR SPECIFICATIONS

Frequency response: dc to not more than 3 db down at 10 mc; rise time, .035 usec

Deflection factor: 0.1 d-c volt/major division†; high-gain switch gives optional double sensitivity at 5 mc bandwidth approx.

Sweep rates: driven or recurrent sweeps, continuously variable, calibrated from 1 sec to 0.1 usec/major div.†; max. rate, 7"/usec (20 milli-microseconds/minor scale division).

Sweep expansion: notch expansion, variable or calibrated rate, 10 times sweep rate on most ranges with calibrated notch and up to 100 times rate with uncalibrated variable notch

Amplitude Measurement: 11 full-scale ranges from 0.2 to 400 volts full scale

Cathode-ray tube — Type 5ATP- Mono-accelerator, operated at 6000 volts (equivalent light output to post-accelerator tube operated at 10KV). Price \$1090.00

TYPE 336-A

The Type 336-A offers all of the superb measuring facilities of the Type 329-A, but has a vertical frequency response extended to 18 mc (3 db down) at a sensitivity of 1 dc volt full scale. With pulse response of 0.02 usec, the Type 336-A is particularly well suited for measurement of very high-speed phenomena. Price, \$1125.00

*Spot Size = 0.02" (approx.) †Major scale division = 0.7 inch (10 minor divisions)

DU MONT

Technical Sales Department • ALLEN B. DU MONT LABORATORIES, INC. • 760 Bloomfield Ave., Clifton, N. J.

CIRCLE 12 ON READER-SERVICE CARD FOR MORE INFORMATION



The silhouette of the Ebicon, supersensitive television camera tube, is seen against a test pattern background.

Supersensitive Camera Tube

Seeing in the dark, or at levels of illumination below the human visual threshold, may soon be achieved by the "Ebicon" television camera tube developed by the Westinghouse Corp., Pittsburgh, Pa. The heart of the device is a selenium layer which acts as an electron multiplier with a factor of about 100. In this way a gain is achieved which overrides the noise inherent in the subsequent vacuum tube amplifiers.

The tube may replace photographic plates in astronomy, or improve medical fluoroscopic techniques which are now limited by the amount of radiation a patient can safely absorb. Indoor or outdoor events could be recorded regardless of time of day or weather conditions. In the field of nuclear physics, the tube might see and record high-energy atomic reactions as they take place inside luminescent crystals. Another version of the same type tube, which is the process of development, is expected to be eight times smaller by volume and weight than existing sensitive tubes.

New Core Material

Flakenol I, a new high permeability material developed by the Naval Ordnance Lab., White Oak, Silver Spring, Md., is intended to replace powdered molybdenum-permalloy as a magnetic core material for use at most communications frequencies. Flakenol I has the advantage of lower eddy-current losses and lower density than high nickel-content alloys presently used for magnetic cores. Its adoption offers the possibility of extending the frequency range of magnetic powder cores to the hypersonic and low radio frequencies, where they were prohibited earlier because of high eddy-current losses. Low in cost, Flakenol I is expected to surpass high-nickel alloys in performance.

Washington Report

Herbert H. Rosen

Project Vanguard Events are moving faster each day as the start of the International Geophysical Year approaches. A new radio tracking station for the earth satellite has been established at Blossom Point, Maryland. *Minitrack*, the NRL-developed tracking system is to be first tested here. It is supposed to have a 4000-mile range. J. Paul Walsh has been named deputy to Dr. John Hagen for the project.

Federal Trade Commission Industry-inspired rules of practice help guide the FTC in its job of protecting the consumer. The latest action has been taken by the environmental equipment industry. A conference (has been) was called on October 19 for the purpose of outlining trade practice rules for the industry. RETMA has also been active in this area and has recently agreed to supply the FTC with a definition of a "transistor radio." The RETMA resolution prescribes that sets using both transistors and vacuum tubes may properly attach the name "transistor" to its name only as follows: "transistor-power" or "transistor pick-up."

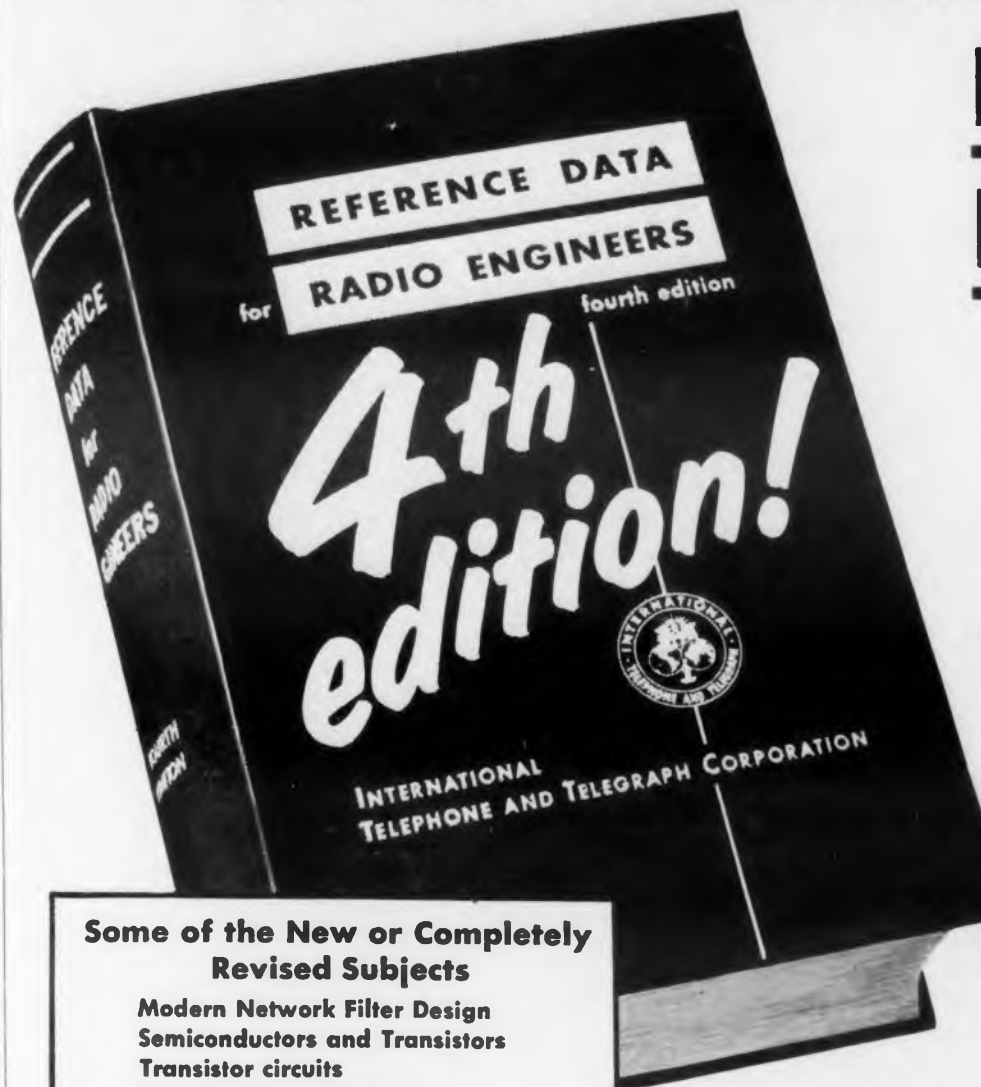
Civil Aeronautics Administration Ever since the start of the Government's mutual assistance programs, the CAA has been responsible for helping foreign countries get their civil aviation programs going. They have sent teams of expert engineers and aviation planners all over the world. Right now they have 26 such teams overseas. They operate through the International Cooperation Administration, which through itself and its predecessors has allotted \$10 or \$11 million to CAA for the procurement of navigation and airport control equipment. The latest contract for \$197,108 has been awarded to Gates Radio for high frequency transmitters to be used in Pakistan.

Nuclear Reactors Washington may soon become the reactor center of the world. The Naval Research Laboratory recently put a research reactor under test—the first operative one in the area. Fort Belvoir is on schedule for the construction of the first "transportable" power reactor. The University of Maryland has received a grant to build a "no-power" reactor to be used in teaching nuclear physicists and engineers. ACF Industries' Nuclear Energy Division, with headquarters in Washington, talks about building its own reactor in Maryland. And the National Bureau of Standards, too, is thinking of erecting one on its new grounds in Gathersburg, Maryland.

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Meetings

Nov. 7-9: Conference on Electronic Technology in Medicine and Biology.

McAlpine Hotel, New York, N. Y. Sponsored by the AIEE, IRE, Instrument Society of America. Two days of technical sessions and evening symposium to discuss latest electrical and electronic techniques in biology and medicine. For information, write to AIEE, 33 W. 39th St., New York, N. Y.

Nov. 13-16: Fourth Annual Meeting of the Investment Casting Institute.

Sheraton Cadillac Hotel, Detroit, Mich. "Vacuum Metals Symposium" is the theme of the meetings. An extensive program of talks has been scheduled. Registration fee is \$25.00. Details available from the Investment Casting Institute, 27 East Monroe, Chicago 3, Ill.

Nov. 14-16: Symposium on Optics and Microwaves.

George Washington University, Washington, D. C. Sponsored by the IRE Professional Group on Antennas and Propagation, the George Washington University and the Optical Society of America. For further information, contact the IRE, 1 E. 79th St., New York 21, N. Y.

Nov. 15-16: ORSA Tenth National Meeting.

Hotel Mark Hopkins, San Francisco, Calif. Operations Research is the theme of the meeting. Further information may be obtained from the Program Chairman at the U. S. Naval Postgraduate School, Monterey, Calif.

Nov. 17: Professional Group on Engineering Management of IRE.

Engineering Auditorium, New York City. General Doriot, pres. American Research Development. Subject of meeting, "Science and Management." For further information contact Harold Hechtman, Airborne Instruments Labs., 160 Old Country Road, Mineola, N. Y.

Nov. 26-30: **Third International Automation Exposition.**

Trade Show Building, New York, N. Y. Clinic sessions will be offered in electronic computers, process automation, machine tool automation, office automation, automatic materials handling, servomechanisms, electromechanical components, and electronic components. More than a hundred exhibitors will participate in the clinics. A two-day "Senior Officer Conference on Office Automation" directed by Gordon L. Mattson and sponsored by Fordham University School of Business will be held. For information, write to Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 22, Pa.

Dec. 3-4: **Second Midwest Symposium on Circuit Theory.**

Michigan State University. Symposium will consist of four sessions: Topology and Circuit Theory, System Analysis and Synthesis, Circuit Theory and Applications, and the Place of Circuit Theory in Education. A talk on "Engineering Education for the Future" will be given by Dr. J. D. Ryder on Monday evening. Papers will also be presented by engineers in the education field. Contact for further information, IRE, 1 West 79th St., N. Y., N. Y.

Dec. 5-7: **Second IRE Instrumentation Conference.** Biltmore Hotel, Atlanta, Ga. Sponsored by the Professional Group on Instrumentation and the Atlanta Section of the IRE. Sessions will be devoted to industrial applications, missile range instrumentation, and the application of solid state devices. For further information, contact the IRE, 1 E. 79th St., New York, N. Y.

Dec. 10-12: **Eastern Joint Computer Conference.** Hotel New Yorker, New York, N. Y. Sponsored by the IRE, AIEE, Association for Computing Machinery. "New Developments in Computers" is the theme of the meeting. In addition to an extensive program of technical papers, the meeting will feature exhibits by many manufacturers in the computing field. For information, contact Al Forman, Room 639, 480 Lexington Ave., New York 17, N. Y.

Dec. 19-20: **RETMA Symposium on Applied Reliability.**

Bovard Hall, University of Southern California, Los Angeles, Calif. Sessions on Mechanical Reliability, Information Feedback, Component Evaluation Usage will be presented. "Failure Feedback - Is It Effective" is highlight of the meeting. Registration in advance is \$3.00. Further information received from RETMA Engineering Office, Room 670, 11 West 42nd St., New York 36, N. Y.

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Jan. 9-11, 1957: *Symposium on Communication Theory and Antenna Design.*

Boston University, Boston, Mass. Sponsored by the Air Force Cambridge Research Center and Boston University. For information, contact Miss Alice Cahill, Air Force Cambridge Research Center, Air Research and Development Command, Laurence G. Hanscom Field, Bedford, Mass.

Jan. 14-15, 1957: *Third National Symposium on Reliability and Quality Control in Electronics.*

Hotel Statler, Washington, D. C. Sponsored jointly by the IRE Professional Group on Reliability and Quality Control, the American Society for Quality Control, and RETMA. For information, write to IRE, 1 E. 79th St., New York 21, N. Y.

Jan. 16-18: *Society of Plastics Engineers, Inc., Thirteenth Annual Technical Conference.*

Sheraton-Jefferson Hotel, St. Louis, Mo. Sixty-eight advanced technical papers will be presented. For further information contact Jas. R. Davidson, Executive Secretary, Society of Plastics Engineers, Inc., Suite 116-18, 34 East Putnam Ave., Greenwich Conn.

Jan. 23-25, 1957: *Very Low Frequency Symposium.*

NBS Boulder Laboratories, Boulder, Colo. Co-sponsored by the Denver-Boulder chapter of the IRE PGAP and the Boulder Laboratories, National Bureau of Standards. The program is titled "Theoretical and Experimental Results in the Propagation and Radiation of Very-Low-Frequency Electromagnetic Waves (less than about 100 kc)." Authors are being requested to submit summaries for appraisal as soon as possible to Dr. J. R. Wait, Chairman, Denver-Boulder PGAP Chapter, National Bureau of Standards, Boulder, Colo. For further information, contact U. S. Dept. of Commerce, NBS, Boulder Laboratories, Boulder, Colo.

Feb. 7: *Annual Symposium of the New York Section of the ISA.*

Garden City Hotel, Garden City, N. Y. Short papers on "Practical Accuracy of Measurement" will be presented followed by a discussion. Afternoon session will be on "Data Handling." For further information contact G. Newberg, Publicity Chairman, Fairchild Engine Division, Fairchild Engine & Airplane Corp., Deer Park, L. I., N. Y.

MICRO precision switches

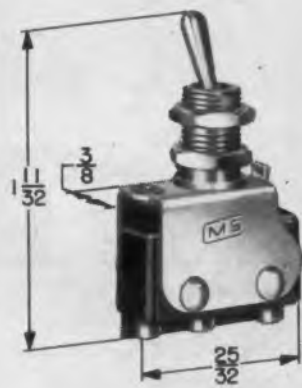
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MICRO SWITCH Engineering Service is devoted to assisting industrial designers in the solution of complex switching problems.

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RELIABLE TOGGLE SWITCH where inches and ounces count

Two of these MICRO SWITCH Type "AT" subminiature toggle switches serve as components for a small, lightweight portable geiger counter.

The extreme reliability and long life of the extremely small MICRO SWITCH units were important factors in their choice by the design engineers. This switch weighs but .02 lb. It has single-pole, double-throw contact arrangement. Rating of basic switch is 5 amperes 125 or 250 volts a.c.

(Send for Catalog 73B—"Toggle Switches" and 75A—"Subminiature Switches")



LIMIT SWITCHES operate 57,000 times a day— day-in, day-out

MICRO SWITCH "ML" Type limit switches—17 of them—are used in an automatic grinding machine to control the steps in grinding small parts. Features which governed their selection by the design engineers were:

- 1 Long Life:** some switches operate every 1½ seconds, three shifts a day—over 57,000 operations a day.
- 2 Precision:** switches repeat exact operating point through millions of precise operations.
- 3 Protection:** switches are well housed and protected against effects of oil splash, dirt and dust.
- 4 Versatility:** three different types of actuating heads are used. Switches are adjustable to meet varied types of actuation and for mounting in cramped quarters.

(Send for Catalog 83—"Industrial Enclosed Switches")

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...have uses unlimited



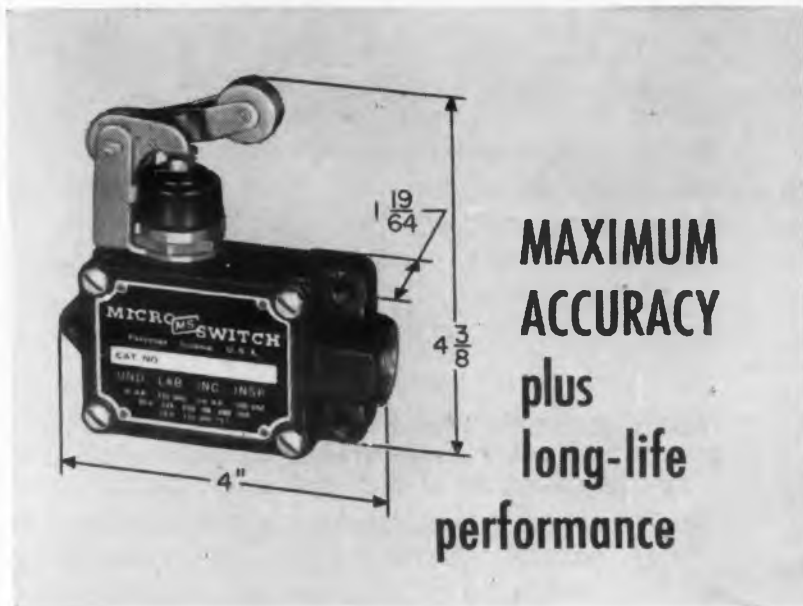
MERCURY SWITCH accurate to 1/8 inch in 12 feet on grader



(Send for Catalog 90-A—
"HONEYWELL Mercury Switches")

Mercury switches are not usually associated with such applications as heavy road grading machinery. However, four of these protected HONEYWELL Mercury Switches have proved successful as grader blade controls.

Tilt action of the switches actuates a series of power relays and valves to control the grader blade. The switches are so sensitive that they are able to control the level of the blade within 1/8 of an inch in an overall movement of 12 feet. The switches—embedded in epoxy within a metal case—are extremely resistant to shock and exposure to the elements.



Switches used in woodworking production equipment—cut-off saws, rip saws, gang saws and jointers—must take a lot of punishment and retain maximum accuracy for a long life.

These enclosed switches, with roller arm actuator and sealed plunger, were chosen by designers as controls on an automatic air-operated cut-off saw. One switch controls the reversing of the solenoid for length of stroke. The other is a return control.

Both switches must operate with maximum accuracy and give long-life performance. At an average of 1,250 strokes per hour, the switches are activated 10,000 times in the average 8-hour work day.

(Send for Catalog 83A—
"Industrial Enclosed Switches")

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A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

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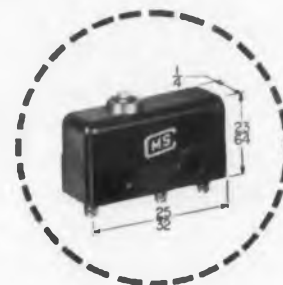


Five MICRO SWITCH subminiature switches were selected by design engineers in this rotary selector switch to provide the switching function for each of the pulse positions in a five-pulse binary code switch. Each switch is of single-pole, double-throw design, thus providing 32 on-off current combinations for data processing equipment.

The binary switch is a single control, positive locking, electro-mechanical device for converting rotary operation into a binary sequence.

According to the designers, the MICRO SWITCH subminiature switches were chosen because of:

- 1 Small size and light weight (3/4 x 1/2 x 1/4 inch)—(265 per pound).
- 2 Ease of operation.
- 3 Reliability.
- 4 Extremely low contact resistance (through use of fine silver).
- 5 Positive make and break action.
- 6 Resistance to shock and vibration.
- 7 Low capacitance between open contacts and from terminals to ground.



There is no limitation in the design as to the number of switches that can be used.

(Send for Catalog 75A—"Subminiature Switches")

Feb. 26-28: Western Joint Computer Conference.
Statler Hotel, Los Angeles, Calif. The Conference is under the joint sponsorship of the IRE, AIEE, and ACM. Theme of the meetings will be "Techniques For Reliability." For further information contact S. Dean Wanlass, Aeronutronic Systems, Inc., 13729 Victory Blvd., Van Nuys, Calif.

March 11-15: The 1957 Nuclear Congress
Convention Hall, Philadelphia, Pa. Exhibits and conference sessions covering latest developments relating to the utilization of atomic energy in its various non-military forms for civilian use. For further information contact Atomic Exposition Office, 304 Architects Bldg., Phila. 3, Pa.

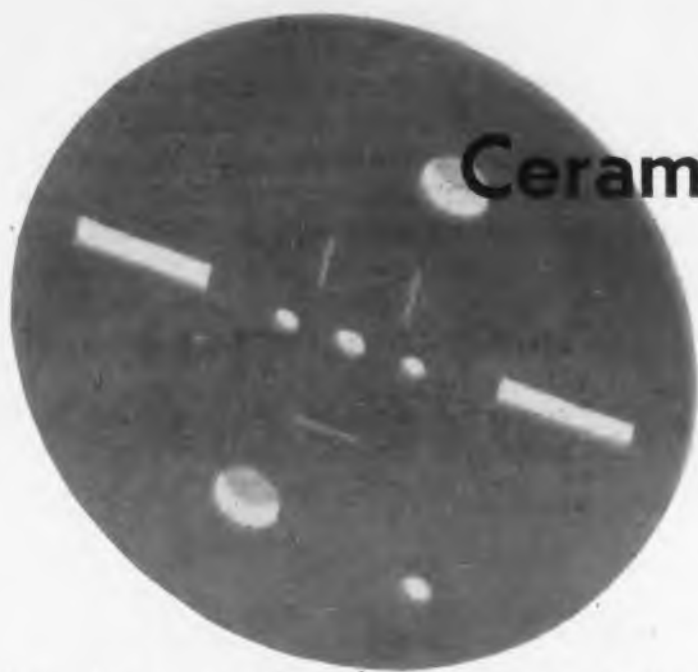
March 18-21: The 1957 SPI Annual National Conference and Pacific Coast Plastics Exposition.
Hotel Biltmore, Los Angeles, Calif., sponsored by the Society of the Plastics Industry, Inc. Sessions will cover plastics in the fields of electronics, aircraft and defense, building, and processing. Exposition 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.

April 8-11, 1957: 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, 1957: 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.

May 16-18: Eighth Annual Conference and Convention, American Institute of Industrial Engineers.
New York City, Hotel Statler. For information write to AIIE, P.O. Box 8, Substation 135, The Bronx 53, New York.

CIRCLE 16 ON READER-SERVICE CARD FOR MORE INFORMATION



Ceramics In Electronic Design

Peter J. Lazarkis

Raytheon Manufacturing Co.
Waltham, Mass.

With the rapidly growing importance of ceramics in electronic design, basic questions concerning these materials are continually being asked by design engineers. The questions that occur most frequently are answered below. For those whose knowledge of ceramics ends with conventional pottery and chinaware, these answers will serve as an introduction to a subject that sooner or later is bound to concern them. For those who are already acquainted with technical ceramics, reference tables are included as convenient guides towards more effective and economical ceramic applications. Thus, this brief article is intended to bridge the gap between the electronic engineer and the ceramic supplier and to provide a working knowledge of ceramic characteristics as related to electronic design.

What are ceramics?

Basically, they are metallic oxides of varying compositions that have been fired or matured at high temperatures, resulting in permanent form and hardness. Common examples are steatite, forsterite, and alumina.

Why are ceramics becoming so important?

Progress in electronics, aviation, and allied fields, spurred on by military necessity, demands utmost ruggedness and reliability under increasingly rigorous environmental conditions. These include extremes of temperature, vibration, and shock, as well as space limitations and seal requirements—hermetic, oil, gas, and vacuum—in the packaging of electronic equipment. These requirements can best be met by the unique properties of ceramics; often they can be met in no other way.

What are the properties of ceramic materials?

The properties of primary interest to electronic design engineers are shown in Table I. This table represents typical values from available literature as well as manufacturers' specifications for the materials shown. These values show the relative relationship of the various materials for each characteristic and should not be considered as absolute. Since a wide range of characteristics is available by varying the composition and processing, the ceramics manufacturer should be consulted for the precise values of specific compositions. (Ferroelectric and ferromagnetic ceramics, which have valuable properties peculiar to themselves, are not covered in this article.)

How are these properties so unique?

The outstanding characteristics of ceramics are: resistance to high temperature, shock, and vibration; high dielectric strength, high electrical resistance at all temperatures; extreme hardness; high mechanical strength; and sealing capability. These qualities are not found either in combination or to the same degree in any other material.

One of the most valuable characteristics is that certain ceramics can be joined to metals at high temperatures by hard solder techniques. This allows a vacuum seal that is a combination of conductor and insulator and will withstand high temperatures.

What standard shapes of ceramics are available and what shapes are practicable?

Bushings, cylinders, discs, rings, tubing, and rod, although not always offered as shelf items by all manufacturers due to the varied detail requirements, are readily available in a wide variety of sizes (see Fig. 1). Special shapes of differing contours and with differing numbers and sizes of holes are entirely practicable but should be worked out in the early design stage with the ceramic supplier (see Fig. 2).

Why are ceramics superior to glass in electron tubes?

Higher shock and vibration specifications, increased reliability, and more rugged construction are demands best met by ceramics. Ceramic tube construction with the elimination of glass allows higher "bake-out" temperatures limited only by the associated metals and solders. Bake-out temperatures of 700 C for ceramic

tubes are common as against a maximum of about 450 C for glass tubes. This permits a more thorough degassing of tube elements with a resulting increase in tube performance, life, and reliability. Microwave tubes with peak powers of several megawatts or more are made possible through the use of ceramic windows which are free from the customary softening of glass with consequent imploding of the vacuum tube. Ceramic construction also permits a reduction in overall tube size.

What dictates the choice of one ceramic over another or even over other materials such as glass or plastics?

The requirements of the application determine the selection. Usually, the high-temperature requirements rule out plastics, whereas fragility, higher loss factor, and lower softening point temperature discount glass. In general, most requirements, including the most stringent, can be met by alumina ceramics, while for lesser requirements, forsterite and steatite can be used.

Are ceramics really all they claim to be, with no drawbacks?

Within their rated characteristics, ceramic materials do live up to their claims, but along with advantages there are naturally certain limitations. Ceramics, like metals, should be used where there is an actual need for one or more of their properties; and a particular ceramic should be selected because it provides a predominance of the particular properties required. As a general rule, ceramics do not have as wide a flexibility of size and shape as do metals.

What are the size limitations on ceramic parts?

Size limitations depend on the facilities of the ceramic manufacturer as well as on the ceramic material, fabrication process, and end product under consideration. Extruded rods and tubing can be made in lengths up to several feet with various diameters; however, there is the problem of the camber and concentricity

allowable over the required length for the final ceramic piece. Discs and cylinders of alumina ceramics produced by the dry-press method are usually limited to about four inches in diameter. Special shapes and larger pieces can be made by processes such as slip casting or isostatic pressing combined with individual batch firing.

Do ceramic parts cost much more than parts made of other materials?

Ceramic parts cost little if any more in the final analysis, since the use of ceramics, particularly in ceramic-to-metal assemblies, often results in an overall saving in manufacturing cost. Ceramics permit better accuracy and dimensional control to be maintained in design and allow more precise assembly to be performed with actually less skill than that required in glass work. Ceramic-to-metal assemblies also allow one-shot brazing operations, for further savings.

How high a temperature can ceramics stand?

This depends on the material selected; with alumina ceramics operating temperatures up to 1700 C are permissible.

Can ceramics be joined to metals?

Using metallized alumina ceramics, the author's company has manufactured on a production basis many different types of vacuum seals that pass helium leak detector tests and meet military specifications. These joints are formed by brazing the ceramic to the metal with either soft or hard solder. Most of the metals are suitable, particularly Kovar.

What are the temperature limitations of ceramic-to-metal seals?

The metals and solders selected determine the temperature limitation of the entire assembly. For example, a copper brazed joint will form a vacuum seal at approximately 1100 C, thus allowing a variety of other seals to be made in subsequent brazing operations at successively lower temperatures. Copper-silver, eutectic, pure silver, and gold alloys are some of the other high-temperature solders that may be used, not to mention the soft solders.

In what state are ceramics supplied and used?

Contrary to some belief, ceramics are supplied not as powders but in a finished, fired state ready for use. The ceramic manufacturer forms the finished, fired ceramic compositions by methods akin to those used in powder metallurgy. For example, a ceramic might be obtained in the form of a bare ceramic insulator, a metallized shape, or a complete ceramic-to-metal vacuum-tested assembly.

What is meant by metallized ceramics?

Through special processes of the ceramic manufacturer, metal coatings are fired into the ceramic at high temperatures, thus producing a conductive layer. Since this layer is firmly bonded to the ceramic by chemical



Fig. 1. Some standard sizes and shapes of ceramic parts. Shown are parts of alumina ceramic.

reaction, it permits the ceramic to be brazed to metals by a wide variety of hard solders. The resulting bond permits a true vacuum seal and is as strong as the ceramic itself.

Are ceramics available already metallized for subsequent use in a ceramic-to-metal assembly?

Yes, ceramics can be supplied already metallized for production brazing in the customer's plant. Or, if preferred, ceramic-to-metal assemblies can be supplied complete, 100% helium-leak-tested, thus eliminating the need for ceramic-to-metal brazing by the customer. Final assembly operations may then be carried on by conventional methods that are essentially the same as those used for forming metal-to-metal brazes or welds.

What tolerances are possible on ceramic parts?

Generally speaking, a tolerance of $\pm 5\%$ or 0.005", whichever is greater, is desirable from a manufacturing point of view. Tolerances of tenths of thousands can be achieved by special control and processes such as diamond grinding if necessary. Fig. 4 shows typical as diamond grinding if necessary. Ceramic parts for electron tubes are being made. Silhouette on preceding page shows a tube part.

Can ceramics be machined and worked by the design engineer?

After firing, ceramics are extremely hard and do not lend themselves to machining. Alumina ceramic, for instance, has a Moh factor of 9 and is difficult to grind except by ultrasonic machining or diamond tools. This means that the entire fabrication is done by the ceramic manufacturer in his processing and by machining the piece in the "green" state. Thus, after firing, the ceramic is ready for use or metallizing.

In specifying a ceramic design, what are the general considerations?

A check list, next page, covers key points to be considered for good ceramic design. Careful use of this check list will result in a practical design that is



Fig. 2. Alumina ceramic parts of specialized form to meet exacting applications.

economical to produce, with the added benefits of minimum lead time and ensured quality and repeatability. It is important that the preliminary drawings supplied to the ceramics manufacturer be consistent with good ceramic practice, which is not necessarily the same as good metal practice. Expensive and time-consuming redesign work is thereby avoided, and the final details can be speedily handled by consultation with the ceramic sales engineer.

Why are ceramic terminals finding increasing applications?

Ceramic terminals, particularly those of the alumina type, are readily assembled into electronic units over a wide range of processing temperatures. They produce reliable seals that can meet the higher temperature, shock, and vibration requirements of advanced military equipment.

Why are ceramic spacers replacing mica spacers in electron tubes?

Vibration of tube elements eventually enlarges the support holes of mica spacers, thus altering the original tube parameters. Ceramic spacers are not affected by vibration, and in addition are non-flaking and permit more thorough outgassing during tube manufacture. Since these advantages all contribute to tube reliability, ceramic spacers are of increasing interest to the military.

What are some of the most common electronic applications?

Among the basic electronic circuit components that utilize ceramics in one way or another are resistor bodies, coil forms, condensers, condenser shafts, terminals, transducers, and printed circuit bases. Ceramics are employed in electron tubes for spacers, envelopes, and output windows.

What is the future trend in electronic applications?

Due to their high strength, high voltage, wide temperature range, and metallizing characteristics, ce-

amics will find increasing use in electron tubes. Stacked ceramic tubes as well as other ceramic tube designs are readily adaptable to mass production by automatic machinery. Ceramic terminals and connectors, which are already being used in military equipment such as airborne radars, will be used increasingly in high-quality commercial equipment. Due to temperature limitations, plastics will soon be overtaken by ceramics in the design of airborne radomes as velocity specifications further increase.

Of all the ceramic compositions available, the major trend is towards the alumina ceramics, since they can best satisfy the majority of electronic requirements.

Ceramic Design Checklist

Material

Select proper ceramic material on basis of characteristics required for your particular application. Consider mechanical strength, mechanical and thermal shock properties, temperature, dimension stability, porosity, hardness, water absorption, gas permeability, chemical inertness, and electrical properties such as losses, dielectric strength, and volume resistivity.

Shape

Simplicity is the rule. Good ceramic design practice invariably stems from simplicity. Avoid heavy, variable cross sections with abrupt changes in level and thickness. Attempt to simplify more complicated pieces by use of inserts. Does the item have to be entirely of ceramic? Consider use of ceramic-to-metal assemblies.

Dimensions

Indicate non-critical dimensions on ceramic piece in fractional form, key dimensions in decimal form with appropriate tolerances. Consult the ceramic manufacturer for dimensioning of metalized and brazed dimensions for best results.

Tolerances

Keep tolerances as broad as possible. Express wide tolerances in fractions of an inch, close tolerances in decimal form. A tolerance spread of ± 5 per cent or .005 in., whichever is greater, is required to avoid grinding. Tenths of thousands can be held by grinding, but such tolerances should be specified only when the application actually requires them. Remember that standard machine shop tolerances and practices for metals do not necessarily apply to ceramics.

Specifications

Specify completely. Make sure all important specifications are clearly stated and not merely implied. Even if a specification is not important, include it on drawing with broadest permissible tolerance to show that

you have taken it into consideration. Check:

concentricity	parallelism
perpendicularity	ellipticity
flushness	radii of fillets
camber	chamfer
threads	holes
inside angles	warpage
flatness	

Specify radii of fillets to reduce risk of cracking ceramic and to strengthen inside corners. On inside angles where ground surfaces are to meet, specify an undercut.

Reduce the camber and ellipticity by using proper and sufficient wall thickness. Likewise, in ceramic designs with holes or counterbores, avoid cracking by allowing sufficient material wall thickness. Avoid placing holes too near each other or to edge of piece; allow a wall thickness at least equal to diameter of hole.

Consider chamfers on exposed edges that may be subject to chipping.

On threads, specify a flat or radius to avoid a sharp "V"; check possibility of transferring thread to metal insert. Generally, threads increase cost of ceramic

parts, particularly on the harder ceramics, and should be avoided if possible.

Blisters, chips and cracks are acceptable commercially and by government specifications to a certain extent as defined and where there is no impairment of performance.

Drawings

Submit drawings on ceramic parts and assemblies in line with above comments to ceramic manufacturer. Save time; supply all environmental and operating data along with the drawings. On assemblies, your end requirement represents the most important drawing. The intermediate and ceramic drawings as far as seal dimensions and tolerances are concerned can be left to the ceramic manufacturer, provided he adheres to the final assembly drawing. This drawing should contain all dimensions requiring inspection.

Finish

Is surface to be unglazed, glazed, metalized, or specially treated?

The mechanical surface strength of ceramic is generally somewhat lessened by glazing, which aids only in the cleaning of ceramic.

Table I
Approximate Characteristics Of "Electronic" Ceramic Materials

Characteristic	Material								
	Electrical Porcelain	Steatite	Fused Quartz	Magnesia	Cordierite	Glass Bonded Mica	High Alumina	Forsterite	Zircon
Dielectric Constant (1 mc)	6-7	5.5-6.5	3.7	5.8	4-5	7-8	8-9	6.5	9
Power Factor (1 mc)	.009	.0008	.00035	.0008	.008	.002	.0006	.0002	.0014
Loss Factor (1 mc)	.055	.004	.0013	.004	.03	.016	.005	.0014	.013
Water Absorption (%)	0.1-0	0-0.01	0	16	3-8	0.5	0.00	0-0.01	0-0.01
Tensile Strength (p.s.i. x 10 ³)	2.6	13	8	2.8	3	8	26	10	10
Flexural Strength (p.s.i. x 10 ³)	11	20	—	6	7-10	18	48	12	18.5
Compressive Strength (p.s.i. x 10 ³)	30-65	65-65	200	48	50-95	25	275	80	80
Dielectric Strength (volts/mil)	100-200	250	200	65	200	245	500	250	200
Hardness, Moh's scale	7.5	7.5	5	6	7	—	9	7.5	8
Modulus of Elasticity (p.s.i. x 10 ⁹)	10	14	4	—	5	—	40	—	21
Specific Gravity	2.4	2.6	2.2	3.0	2.5	—	3.6	2.8	3.7
Linear Thermal Expansion 20-100 C (in./in./°C x 10 ⁻⁶)	3.6	6	.20	9.4	2.5-4	—	6.2	8.5	2.5-5
T _E Value (°C)*	—	450°-800°	—	—	750°	—	1000°	990°	700°

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

The region of metalized areas should be clearly defined. Is metalizing required for brazing or electrical conduction? State temperatures and solders involved, as well as any special plating requirements.

Application

State the application as clearly as possible. Include environmental as well as operating conditions.

Check:

- vacuum or non-vacuum
- mechanical shock and vibration
- temperature range, max and min
- continuous operating temperature
- temperature cycling
- mechanical stresses
- thermal shock
- humidity
- pressure
- altitude
- atmosphere, oil, or gas
- electrical ratings

If an assembly, what type of seal is involved? Hermetic, pressure, oil, gas, or vacuum? Remember that a hermetic seal does not mean a vacuum seal. Is pressure or helium leak detection required? On a sampling basis or 100 per cent? Indicate desired temperature range over which seal must be satisfactory.

Quantity

Specify quantity involved on sample or production order as well as future potential. The quantity may determine the manufacturing process selected as well as the design of temporary or permanent tooling. Thus, it may determine the ultimate unit cost.

Delivery

Allow as much time as possible so as not to needlessly rush the design and prevent proper consideration being given to it. Generally, at least several weeks are required for ceramic parts; where extensive tooling is needed, three to four additional weeks may be needed.

Use

Ceramics are technically dependable and reliable for doing the job they are intended for but are in general relatively brittle. Avoid mishandling or dropping of heavy parts and pouring or dumping of small pieces.

In brazing ceramic assemblies, check the brazing temperatures, temperature cycling, solders used, and the thermal shock to be encountered in all brazing operations. Consult freely with the ceramic manufacturer on all subsequent brazing operations or whenever questions arise.

The author is grateful to all those who gave him assistance and constructive criticism in the preparation of this article, with special thanks to L. J. Cronin, head of the Techniques Laboratory of The Raytheon Manufacturing Company.

A subsequent article will discuss ceramic-to-metal seals.



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The British Electronics Industry is making giant strides with new developments in a variety of fields. Mullard tubes are an important contribution to this progress.

**Britain's
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for 25W high
fidelity equipment**

The Mullard EL34 can be rightly acclaimed as the most efficient high fidelity output pentode tube yet produced in Britain. It is being fitted in many of the British sound reproducing equipments which are becoming increasingly popular in the United States and Canada.

Used in push-pull ultra-linear operation (distributed load), two EL34 tubes will give 32 watts output at a total distortion of less than 1%. The application of negative feedback reduces distortion even further.

The EL34 is equally capable of supplying higher power outputs where an increased distortion level is acceptable. Under class B conditions, 100 watts are obtainable from a pair of EL34 tubes in push-pull for a total distortion of 5%.

Another significant feature of this tube is its high transconductance value of 11,000 μmhos , resulting in high power sensitivity and low drive requirements.

Supplies of the EL34 are now available for replacement purposes from the companies mentioned below.



Principal Ratings

Heater
6.3V, 1.5A

Max. plate voltage
800V

Max. plate dissipation
25W

Max. screen voltage
425V

Max. screen dissipation
8W

Max. cathode current
150mA

Base
Octal 8-pin

Available in the U.S.A. from:—
International Electronics Corporation,
Dept. ED11, 81 Spring Street, N.Y.12,
New York, U.S.A.

Available in Canada from:—
Rogers Majestic Electronics Limited,
Dept. JN, 11-19 Brentcliffe Road,
Toronto 17, Ontario, Canada.

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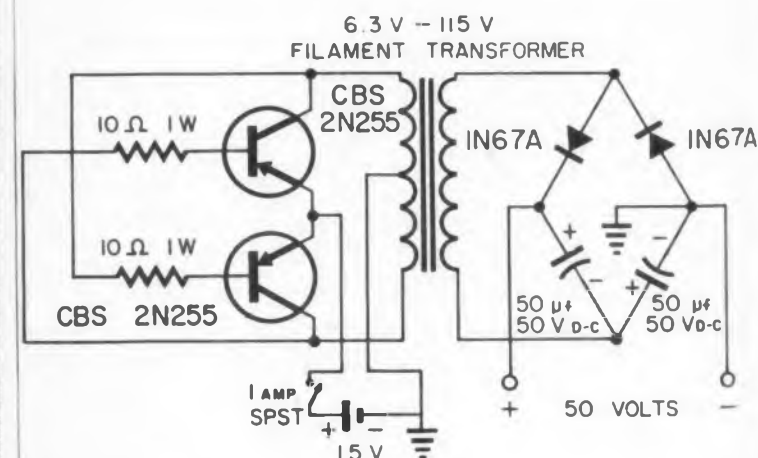
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CIRCLE 18 ON READER-SERVICE CARD FOR MORE INFORMATION

Low-Cost Power Transistors

COMPETITIVELY priced with vacuum tubes, two new power transistors have been announced which are designed expressly for experimental purposes. The pnp germanium alloy junction semiconductors are hermetically sealed and each incorporates a metal mounting flange electrically connected to the collector for good heat dissipation.

With a heat-sink, both the 2N255 and the 2N256, manufactured by CBS-Hytron, Danvers, Mass., are rated at 6.25 watts. The two transistors are electrically similar. The primary difference is that the 2N255 is intended for use with 6 volt power supplies and is rated at 15 v maximum, while the 2N256 is designed for 30 v maximum, utilizing a 12 v supply. Each unit has a collector



DC Voltage Multiplier—This dc voltage multiplier will provide high voltage from a low-voltage source, eliminating a vibrator or B+ battery. When the transistors oscillate, an ac voltage is provided across the transformer. The output voltage and current are determined by the battery voltage and transformer turns ratio; therefore, they may be varied to suit the application as long as the transistor and diode ratings are not exceeded.

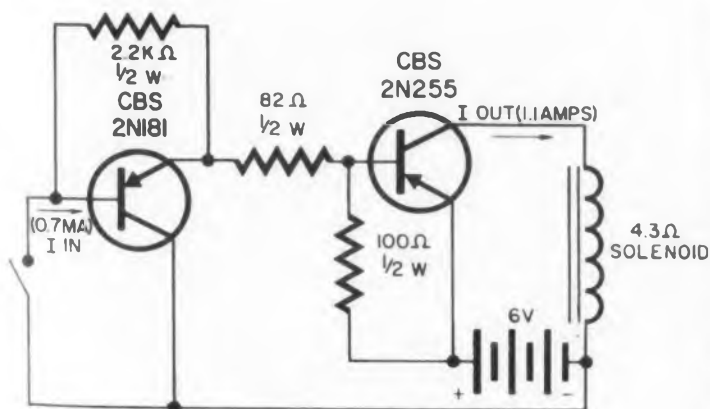


to base current dc amplification of 30 to 50.

Maximum ratings include 3 amps steady state dc collector current and operation from -40 to $+85$ C. Alpha cutoff frequency is 200 kc at 25 C.

Several methods of mounting are practical for amplifier circuitry. For grounded collector circuits, the transistor flange may be fastened directly to the chassis. A heat-radiator plate that is insulated from the chassis can be used for other circuits; or if high heat dissipation is not required, the base pins can support the transistor with the collector circuit lead fastened directly to the flange. The two heavy plug-in leads fit standard 9-pin miniature sockets.

For more information on these transistors, turn to the Reader's Service Card and circle 19.



Relay Circuit—A sensitive relay circuit with good temperature stability in which an input current of less than 1 ma will control a 1 amp solenoid.



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This insulation is recommended for applications in the class "B" temperature range where bonding between adjacent layers is achieved by the use of heat or heat and pressure, such as an inner layer or outer wrap of coils for transformers, rotating equipment, or cable conductors.

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CIRCLE 20 ON READER-SERVICE CARD FOR MORE INFORMATION

Guides to Tube Selection

Keats A. Pullen, Jr.

Ballistics Research Labs
Aberdeen Proving Ground, Md.

SELECTION of the proper tube to perform a given operation can be broken down into five steps: 1, selection of the triode group or pentode group as required; 2, selection of a tube capable of providing a required current change at the chosen minimum plate voltage, E_{bp} ; 3, selection of a tube having an adequate transconductance; 4, selection of a tube having adequate heat dissipation rating; and 5, selection of a tube capable of operating well within its dissipation rating. Other factors affecting the selection of the best tube for a specific application are listed later in this article.

Selection between triodes and pentodes frequently is difficult to make. The pentode has, because of improper techniques of use, been neglected for many of its most effective applications. The applications most suited to triodes include circuits best built with dual section tubes, circuits requiring minimum internal tube noise, and circuits providing the smallest possible voltage across the tube at high currents.

Plate conductance, g_p , in the triode, and screen-to-plate transconductance, G_{M2} , in the multigrid tube, control the ability of the tube to provide plate current change at any level of supply voltage. A high value of g_p or G_{M2} makes available a large plate current change at low supply voltages, and vice versa. As a result, they determine the ability of the tube to develop usable power within a specified dissipation rating for the tube. These g_p and G_{M2} parameters vary rapidly as a function of bias and plate voltage, or bias and screen voltage respectively. The maximum conductance values available in any tube type depend on the geometry of the elements in the individual tube.

The non-linearity, which is inherent in any tube, complicates the determination of power handling ability of a tube in a circuit. The presentation of data on the non-linearity of the tube characteristics may be accomplished in many ways. One most effective way is to plot contours of constant g_m and g_p or contours of constant G_{M1} . Tubular data on g_p and G_{M2} are particularly useful in tube selection, whereas the contour curves are of particular value in actual circuit design. See typical 12BH7 curves.

Tube Selection Tables

Table 1 lists a group of triodes in order of ascending g_p values. Table 2 lists a group of pentodes in order of ascending G_{M2} values. These tables offer a convenient method of guiding tube selections rapidly to the proper tube group. They include, in addition to the primary parameter data, values of g_m or G_{M1} and maximum power dissipation, limits for the plate or the plate and screen. The values of g_p and G_{M2} given in the tables are typical ones selected on the zero bias contour for the control grid, with the tube operating in the area near full dissipation, the values of g_p and G_{M2} from the tables are used with estimates of the g_p or G_{M2} obtained from equations (1a) or (1b), respectively.

Equations:

$$g_p = I_{bp}/E_{bp} \quad (1a)$$

$$G_{M2} = I_{bp}/E_{c2} \quad (1b)$$

are needed to develop the required maximum plate current at minimum plate voltage; because a large

signal estimate of g_p or G_{M2} is used to obtain the corresponding small signal value, the estimate is multiplied by a gamma factor to adjust for the non-linearity in the tube. For normal operation, the value of gamma used in the selection of a trial tube should be between 1.5 and 2. If the value of gamma chosen is less than 1.5, the tube cannot accomplish its function for extended periods without serious overload; if the value of gamma chosen is more than 2, the tube will accomplish its function, but does not provide best power economy.

Abnormal environmental conditions in some cases may make necessary selection of a gamma factor either above or below the 1.5 to 2 range recommended above. High altitude or high environmental temperature operation may make necessary the selection of a gamma greater than two. On the other hand, an operation requiring the tube to function for only a few seconds or minutes at a time, with a minimum of total input power, may be best obtained by use of a gamma less than 1.5 in the tube selection.

Table 2. Pentodes listed in order of ascending screen-to-plate transconductance.

Tube	G_{M1}	G_{M2}	Dissipation
6AU6, 6BH6	5000	160	3 w
6BA6, 6BJ6	5000	170	3 w
6CB6	7000	188	2 w
6AK5	7000	240	1.7 w
6AH6	12000	260	3.3 w
5840	6000	300	1.1 w
6134	12000	312	3 w
6AC7	12000	312	3.0 w
5686	4000	420	7.5 w
6CM6	5000	480	12 w
12BY7	13000	500	6.0 w
6CL6, 6AG7	12000	520	7.5/9.0 w
6V6/6AQ5	5000	580	12 w
6L6	6000	960	19 w
6Y6, 6BQ6	10000	2200	12.5/10 w

Table 1. Triodes listed in order of ascending plate conductance.

Tube	g_m	g_p	Dissipation
6SL7	2000	27	1 w
12BZ7	7000	54	1.5 w
12AY7	2500	55	1.5 w
6AM4	9000	100	2.4 w
12AT7	8000	105	2.5 w
6J6	6000	150	1.5 w
6J5	4000	175	2.5 w
12AU7	3500	180	2.75 w
12AV7	9000	180	2.75 w
2C51	6600	200	1.5 w
6BQ7A	8000	225	2.0 w
12BH7	8000	400	2.5 w
6AS7	10000	5000	13 w

In no case should a gamma be selected which is large enough to permit placing either plate or screen voltages (or both) in the low area of erratic characteristics. Normally this area lies below 25 to 30 v. Tests on some tubes have shown that such things as bias line crossovers and other abnormalities may develop in the low voltage area.

Calculation of Peak Plate Dissipation

The verification that a tube is being used within its dissipation ratings requires the calculation of the peak plate dissipation. The plate voltage at which maximum dissipation occurs may be found by dividing by two the plate voltage value at which the dynamic load line intersects the zero plate current line, E_{bz} . Or, the maximum power input is

$$P_{pm} = 1/2 E_{bz} [i_b]_{e_b} \quad (2)$$

where i_b is the current at which $e_b = 1/2 E_{bz}$.

Triode Peak Dissipation—For triodes, the initial steps in the evaluation are the plotting the static load line, the location of the static operating point, and the plotting of the dynamic load line. Then Eq. (2) is used to determine the maximum plate dissipation.

Example A—A triode R-C amplifier having a supply of 300 v and identical static and dynamic load impedances of 10,000 ohms, uses a 12BH7 tube. What is the maximum plate dissipation? From Eq. 1, $P_{pm} = 2.25$ w.

Pentode Plate and Screen Dissipations—Calculation of the plate dissipation of pentodes is accomplished in similar manner. First, the screen voltage (trial) to be used is selected. The static operating point is chosen, and the load impedance to be used is selected. The plate voltage at which the dynamic load line intersects the zero plate current line is determined. The balance of the calculation is the same as for the triode.

The maximum power dissipation on the screen of the tetrode or the pentode with constant screen voltage normally occurs at maximum plate current and minimum plate voltage. The screen dissipation is calculated as:

$$P_{c2} = E_{c2} I_{bp} X_{c2p} \quad (3)$$

where the value of X_{c2p} used is that of maximum plate current (or minimum plate voltage where the load reactance may be neglected).

Example B—A transformer coupled pentode amplifier uses a screen voltage of 100 v and a plate supply voltage of 250 v. The static plate current in the tube at the static operating point is 20 ma, and the load impedance is 10,000 ohms. $X_{c2p} = 0.08$. What are the maximum dissipations?

Equations	Solution
$V_{bz} = E_{bo} + I_{bo} R_L$	$E_{bz} = 450$ v
$[i_b] (E_{bz}/2) = (E_{bz}/2R_L)$	$[i_b] (E_{bz}/2) = 22.5$ ma
$P_{pm} = (E_{bz}/2) [i_b] (E_{bz}/2)$	$P_{pm} = 5.06$ w
$i_b = (E_{bz} - e_b)/R_L$	At $e_b = 70$ v, $i_b = 38$ ma
$P_{c2m} = X_{c2m} I_{bp} E_{c2}$	$P_{c2m} = 0.3$ w

Selection of Current Change in the Tube

The selection of the tube to accomplish a given function is based on the required power of voltage output, the available supply voltage, and the limitations applying to circuit impedance level. Several typical conditions are discussed in the following paragraphs to show how different combinations may affect the design procedure.

Power Output and Voltage Change Known—Frequently one needs to develop a certain average output power when a specified supply voltage is available. Since output power is a function of the product of the voltage change by the current change, the output power for sinusoidal wave-forms is:

$$P_o = 1/8 (E_{bn} - E_{bp}) (I_{bp} - I_{bn}) \quad (4a)$$

$$= 1/8 \Delta e_b \Delta i_b$$

From the above equation, the required current change to produce a specified average output power is for a single tube:

$$\Delta i_b = 8 P_o / (\Delta e_b) \quad (4b)$$

For push-pull output tubes, the current change per tube required is

$$\Delta i_b = 4 P_o / \Delta e_b \quad (4c)$$

where P_o is always the total required output power.

The required load impedance per tube is

$$Z_L = \Delta e_b / \Delta i_b \quad (4d)$$

For push-pull applications, the Z_L is half the plate-to-plate impedance.

Example C—A single tube amplifier, capable of developing 2-w output power, is required. For a peak plate voltage of 300 v and a minimum of 50 v, the current change is, from (4b):

$$\Delta i_b = 64$$
 ma

The load impedance is, from (4d)

$$Z_L = 3900$$
 ohms.

Power Output and Output Impedance Known—If the tube load impedance is the limiting factor in design, as is true in video amplifiers or transformer coupled audio output amplifiers, then a different design procedure is required. The current change required to develop a specified output power, for a single tube, is:

$$\Delta i_b = (I_{bp} - I_{bn}) = 2 \sqrt{2 P_o / Z_L} \quad (5a)$$

or for push-pull amplifiers,

$$\Delta i_b = 2 \sqrt{P_o / Z_L} \quad (5b)$$

Z_L is half the total plate-to-plate impedance.

The peak voltage change developed, for the single tube, is:

$$\Delta e_o = \Delta i_b Z_L = 2 \sqrt{2 P_o Z_L} \quad (5c)$$

and for push-pull, amplifiers

$$\Delta e_o = 2 \sqrt{P_o Z_L} \quad (5d)$$

Example D—A peak voltage change of 200 v peak-to-peak is required from a push-pull amplifier at an impedance of 2000 ohms plate to plate. What is Δi_b ? From (5d), and from (5b): $P_o = 10$ w, $\Delta i_b = 100$ ma.

Check List For Design Adequacy

1. Is the tube able to provide required power output within a conservative dissipation margin for all combinations of tolerances?
2. Does the circuit perform properly over an allowed range of line voltage variation?
3. Have minimum voltages, consistent with efficient operation, been selected throughout?
4. Has design been kept out of the low voltage erratic behavior area?
5. Is operation of the circuit independent of line supply frequency?
6. Is the design such that tubes and other components will not be damaged by failures in associated circuits? In other words, is the circuit safe with respect to failures in related circuits? Avalanche failures must be prevented.
7. Have environmental conditions been considered adequately?
8. Are ratings of chosen components adequate?
9. Has the tube check list been used to aid selection of tube?
10. Are shock or vibration serious considerations? If so, are tubes and components adequately designed and mounted to withstand the vibration, and mounted to provide adequate support and shock isolation?

Glossary Of Symbols Used

e_b	Instantaneous plate voltage*
$\Delta e_b = E_{bn} - E_{bp}$	(peak-to-peak)
E_{bb}	Plate supply voltage*
E_{bn}	Instantaneous plate voltage at negative bias limit
E_{bo}	Instantaneous plate voltage at static bias*
E_{bp}	Instantaneous plate voltage at positive bias limit
E_{bz}	Instantaneous plate voltage at plate current cut-off
E_{c2}	Screen-to-cathode voltage*
E_h	Heater voltage*
g_p	Plate conductance for triode
G_{M2}	Screen-to-plate transconductance
i_b	Instantaneous plate current*
$[i_b]$	Instantaneous plate current for $e_b = 1/2 E_{bz}$
I_{bn}	Instantaneous plate current at negative bias limit
I_{bo}	Instantaneous plate current at static bias*
I_{bp}	Instantaneous plate current at positive bias limit
I_h	Heater current
P_{c2m}	Maximum screen power dissipation
P_o	Power output
P_{pm}	Maximum plate dissipation
X_{c2m}	Screen correction factor at maximum screen dissipation is usually equal to X_{c2p}
X_{c2p}	Correction factor at positive bias limit
X_p	Correction factor for plate current
Y	Conductance ratio used in tube selection; corrects for tube non-linearity
R_L	Load resistance
$P_{pm} = 1/2 E_{bz} [i_b]$	where $[i_b]$ is the current at $e_b = 1/2 E_{bz}$

*An attempt has been made to extend the IRE definition in a consistent manner to fulfill the needs of the problem.

Selection of Triodes Based on g_p

The selection of the proper tube is based primarily on selection of a tube capable of providing the maximum required current with a sufficiently small difference of potential across the tube to provide efficient operation. For the triode, for example, the required g_p is

$$g_p = \gamma I_{bp} / E_{bp} \quad (6)$$

Example E—For the tube considered in Example A, calculate the plate conductance required using $\gamma = 1.5$ and $\gamma = 2$.

Using (6), the values of g_p are 1940 and 2560 micromhos respectively.

The calculations of required plate conductance in example E and the calculations of screen-to-plate transconductance in later examples are based on taking the maximum plate current as the plate current change; i.e., neglecting the minimum plate current. This assumption of a negligible minimum plate current may require selection of a tube having a value of g_p or G_{M2} somewhat higher than indicated by the described design procedure, or a gamma closer to 2 than to 1.5.

Table 1 may now be examined to find triode combinations offering a plate conductance of approximately 2600 micromhos. The only tube which appears to be satisfactory is the 6AS7 tube.

Selection of Pentodes Based on G_{M2}

Selection of the proper pentode differs in one minor respect from that of the triode. The plate voltage change in the pentode circuit design is established exactly as in triodes. After the minimum plate voltage has been chosen, the screen voltage must be selected. The screen voltage required should be between 1.3 and 2 times the minimum plate voltage. (Or the plate voltage is 1/2 to 3/4 the screen voltage.) The G_{M2} required then would be

$$G_{M2} = \gamma I_{bp} / E_{c2} \quad (7)$$

Example F—Determine the required G_{M2} for the amplifier considered in example C, if the minimum plate voltage is 50 volts. Take $\gamma = 2$. From Eq. $E_{c2} = E_{bp} (1.3)$, we get 67 v and from Eq. 7 $G_{M2} = 2600$ μ mhos.

Tubes meeting the requirement are the 6BQ6, 6Y6, and 6216.

Design for Reliability

Circuit design, whose objective is to design a circuit capable of reliable operation, should be based on the following steps:

1. Select the minimum plate voltage for the tube at maximum plate current and establish the required g_p or G_{M2} .
2. Where needed, select the screen voltage used.
3. Determine plate supply voltage if unspecified.
4. Select the load impedance if not specified.
5. Determine the maximum plate voltage at minimum plate current.

6. Determine g_p or G_{M2} .

7. Select trial tube from Table 1 or 2 on the basis of above steps.

8. Check the dissipations at the peak dissipation voltages to make certain that the tube is operating conservatively—dissipations should not exceed half the rated value.

9. Check distortion where important.

10. Check other tubes in a similar manner for the possibility of a better selection.

The application of the above steps to typical designs follows.

Triode Design—For efficient operation, the triode should be capable of providing the maximum required plate current with an instantaneous plate-to-cathode voltage not greater than one-quarter the total supply voltage.

Example G—A resistance-coupled amplifier is to be built to provide a half watt of power with a supply voltage of 250 v and a plate voltage at maximum plate current of 50 v (1/5 the supply voltage). Take, $\gamma = 1.5$, from Equations 4b and 6, $\Delta i_b = 20$ ma. and $g_p = 600$ μ mho.

The following table condensed from Table 1 and manufacturer's data gives the data on some possible triode choices.

Tube	g_m	g_p	P_p	E_b	I_b	Tube size
6J5	4000	175	2.5	6.3	0.3	Octal
6SN7	4000/sect	175/sect	.5	6.3	0.6	Octal
		800 tot	350 tot	5.0	6.3	0.6
12BH7	8000/sect	400/sect	2.5	6.3/12.6	0.6/0.3	Min. Nov.
		800 tot	800 tot	5.0	6.3/12.6	0.6/0.3
5687	8000/sect	600/sect	4.2	6.3/12.6	0.9/0.45	Min. Nov.
		1200 tot	1200 tot	7.5	6.3/12.6	0.9/0.45

Evidently, the 12BH7 tube, if both sections were paralleled, would be a suitable choice. A single section of a 5687 tube also might prove satisfactory. The plate current at zero bias for the paralleled sections of the 12BH7 would be 24 ma, and that for a section of a 5687 tube 19 ma at 50 v. Calculating the maximum dissipation as indicated in Example A gives

$$P_{pm} = 1.56 \text{ watts}$$

Pentode Design—For efficient operation, the plate voltage at maximum plate current for the pentode, as in the triode, should not exceed a quarter of the total plate supply voltage. The screen voltage may then be selected as in paragraph 1.6.

Example h—A pentode resistance type amplifier is required which is similar to the triode amplifier in Example G. Take the supply voltage as 250 v, the plate voltage at maximum plate current as 50 v, $\gamma = 1.5$, and the power developed as 1/2 w.

Equations:

$$\text{Eq. 4b}$$

$$E_{c2} = 1.33 E_{bp}$$

$$\text{Eq. 7}$$

Solution:

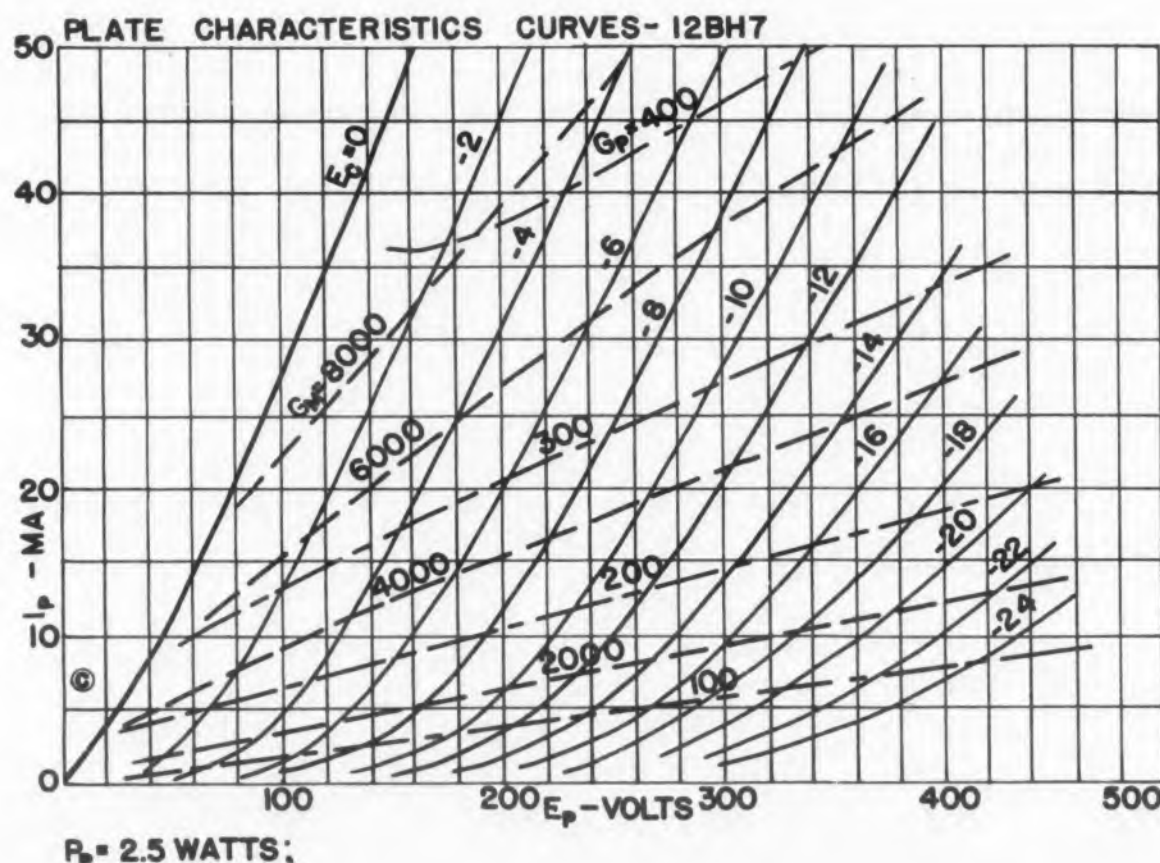
$$\Delta i_b = 20 \text{ ma}$$

$$E_{c2} = 67 \text{ v}$$

$$G_{M2} = 450 \mu\text{mho}$$

From Table 2 and manufacturer's data some possible pentode choices could be 5840, 6134, 5686, 6CM6, 12BY7, 6CL6.

Clearly, tubes cited before the 5686 tube in the foregoing sentence have insufficient power handling capacity to meet the listed requirements. If a low transconductance tube (first grid) is satisfactory, either the 5686 or the 6CM6 tube might be chosen. If high transconductance were required, however, either the 12BY7 or the 6CL6 tube would be chosen. The zero bias plate currents I_{bp} , for the four tubes with 67 v on the screen are: 5686, 14 ma; 6CM6, 22 ma; 12BY7, 18 ma; and 6CL6, 23 ma. As might be expected, the 5686



is marginal at $E_{c2} = 67$ v, but the rest would be satisfactory. Probably the screen voltage would actually be chosen to be 75 v.

Additional operating data on the amplifier are: $R_L = (E_{bn} - E_{bp}) / (I_{bp} - I_{bn}) = 10,000$. Maximum dissipation: from Eq. 2, $P_{pm} = 1.56$ w and from Eq. 3, $P_{c2} = 0.56$ w.

Other Important Factors in Tube Selection

The design of tube circuits is dependent on both controlled parameters of the tube and uncontrolled parameters of the tube. Manufacturers keep different characteristics under surveillance with different tube types. These characteristics which are kept under surveillance are called controlled parameters. (Plate current and transconductance are typical controlled parameters.) In addition, design is dependent on the characteristics of the remaining elements of the circuit, resistors, capacitors, inductors, transformers, and supply voltages, in addition to stray couplings and a variety of potential stresses. The basic objective of good design is to keep as many of the important parameters and characteristics as possible as controlled parameters of the system, and to relegate the remainder to the category of uncontrolled parameters. The greater the number of significant parameters which are uncontrolled, and consequently have to be adjusted by trial and error, the more time-consuming is the design, and the less reliable the final result.

Consideration of power handling ability in relation to the power requirements of a circuit is one of the more important design problems. In particular, the design should permit, with ordinary environments, the tubes to develop the power required without allowing static dissipations in excess of half the rated dissipation of the tubes. In addition to power handling ability, the selection of the transconductance level for the control grid, and the figure of merit in relation to frequency response and bandwidth requirements, a large number of other factors may have to be considered. The following check list is included to aid the user in remembering some of the more important factors requiring consideration. Characteristics in the check list below are often uncontrolled parameters.

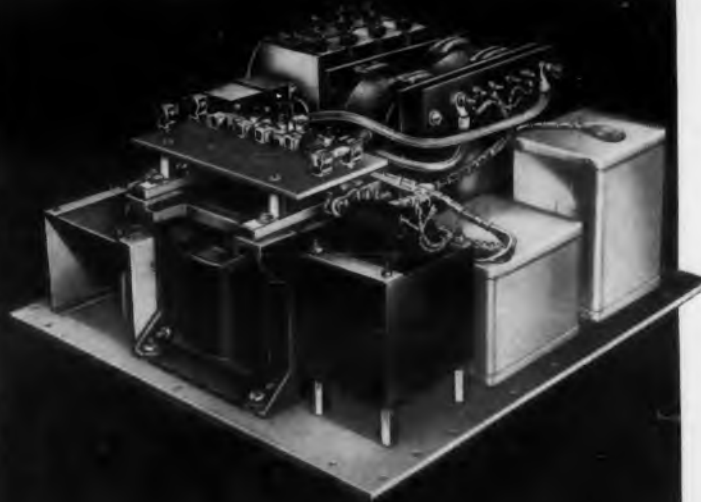
1. Cathode Interface Impedance
2. Cathode Current Drift with Time
3. Microphonics and Noise-Hum
4. Physical Size and Socketing Problems
5. Interelectrode Capacitances and Figure of Merit
6. Heater to Cathode Leakage
7. Heater to Cathode Voltage Rating
8. Internal Surface Leakage
9. Effects of Humidity, Ambient Temperature, and Altitude at which Equipment Must Operate
10. Reliability Characteristics Engineered into Components
11. Uncontrolled Tube Parameters such as Grid Current and Contact Potential
12. Sensitivity to Heater Voltage Variation and Similar Effects

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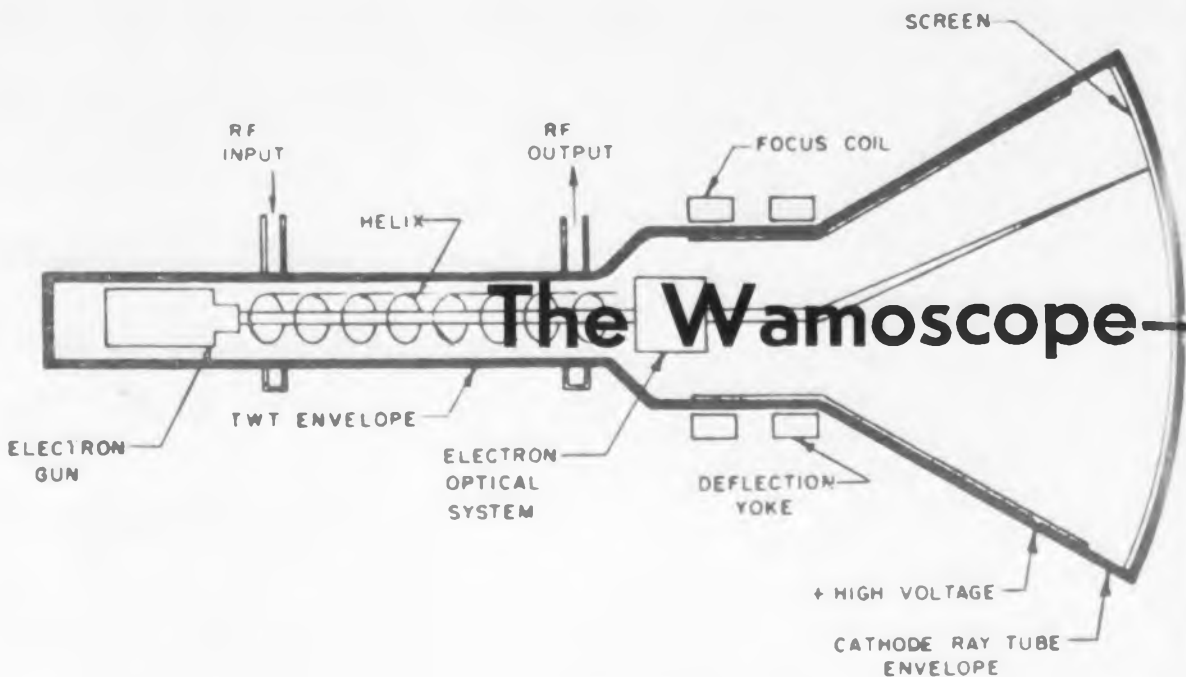
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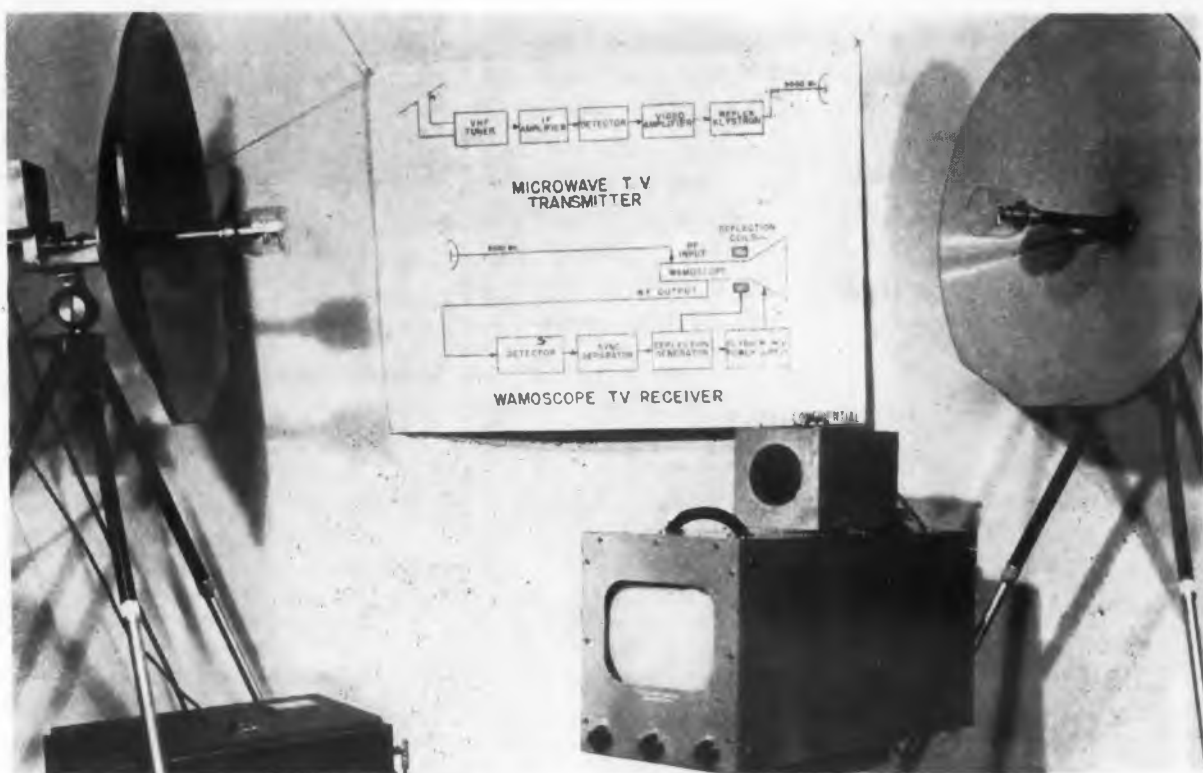
NORTHROP AIRCRAFT, INC., HAWTHORNE, CALIFORNIA

Producers of Scorpion F-89 Interceptors and Snark SM-62 Intercontinental Missiles



RADICALLY new, this cathode-ray tube for radar, TV and other display applications incorporates most conventional receiver functions in a single package. Many of the tubes and components required by a conventional microwave receiver are completely eliminated. Known as the "Wamoscope", the new tube represents a significant step in the trend for simplification and increased reliability of electronic equipment.

Microwave signals pass directly from the antenna into the tube, where, in a single envelope, the signals are amplified, detected, and displayed on the tube's fluorescent screen. Compared with



Block diagram, photo center, indicates stages of entire TV circuit. Transmitter shown at photo bottom left, its radiating dipole and reflector above. Receiving antenna system at upper right. Wamoscope display at lower center. Loudspeaker rests on Wamoscope receiver housing.

A New Microwave Display Device

a conventional radar receiver, this eliminates the local oscillator, mixer, if amplifier, detector, video amplifier and all their associated circuitry.

Operation of the Wamoscope, developed by Sylvania Electric Products Inc., Bayside, New York, is based upon velocity-sorting the electrons which emerge from the end of the helix of the traveling wave tube section. A dc beam of suitable voltage is passed down the helix. With an rf input, the beam interacts with the rf fields on the helix so that the beam is velocity and current modulated in accordance with the amplitude of the rf signals. The velocity-modulated beam enters the region where the special electron-optical system is located. By applying a suitable bias voltage to an aperture in the electron-optical system, the electrons whose velocity is greater than the dc velocity, pass through the aperture and are allowed to impinge upon the screen of the cathode ray tube while slower electrons are deflected.

A wide selection of channels is possible in the Wamoscope, which operates in the microwave frequency range of 2000 to 4000 mc. The name is derived from "wave-modulated oscilloscope."

Pilot quantities of the tube have been produced, and are being used with Naval approval. Additional tube types, operating in different frequency bands and incorporating other features, are now under development.

For more information on this display device turn to the Reader's Service Card and circle 23.



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SYNCHRO FUNCTION	CPCC TYPE	Input Volts	Input Amps	Input Watts	Ohms (DC)	Output Rotor (MV/deg.)	Sensitivity (MV/deg.)	Output Volts	Sensitivity (MV/deg.)	Input Volts	Input Amps	Input Watts	Ohms (DC)	Z _{ro}	Z _{so}	Z _{rs}	Phase R-S	Shift S-R	Nulls (MV)	Possible Error	Length in inches
Torque Transmitter	CGC-8-A-7	26.0	100	.5	37	—	—	11.8	200	—	—	—	12	54+j260	12+j45	76.4+j19.6	8°	—	30	7' 14'	1.240
Control Transformer	CTC-8-A-1	26.0	.050	.25	143	24	410	11.8	200	11.8	.090	.23	25	220+j740	28+j110	246+j60	—	8.5°	30	7' 14'	1.240
Control Transformer	CTC-8-A-4	—	—	—	381	24	410	—	—	11.8	.037	.09	60	508+j1680	67+j270	640+j190	—	9.2°	30	7' 14'	1.240
Control Differential	CDC-8-A-1	—	—	—	36	11.8	200	—	—	11.8	.085	.21	25	38+j122	27+j120	48.6+j13.8	—	9°	30	7' 14'	1.240
Electrical Resolver	CSC-8-A-1	26.0	.039	.43	230	23.2	400	10.6	180	11.8	.084	.27	27	280+j600	38+j136	70+j136	20°	11°	30	7' 14'	1.240
Torque Receiver	CRC-8-A-1	26.0	.100	.50	37	—	—	11.8	200	—	—	—	12	54+j260	12+j45	85.1+j20.4	8°	—	30	30' 30'	1.240



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MODEL B78 Used primarily for testing relays, switches, tubes, motors, valves, and other small components, and to calibrate and evaluate accelerometers. Accommodates objects weighing up to 25 lbs.; has G-range of 0.017 G to 120 G's. Maximum centrifugal capacity is 1200 G-pounds. Nominal radius of gyration 24".



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Miniature Camera Tube

MIDGET televisions, made possible because of the availability of the miniature camera tube illustrated here, can play the role of a Lilliputian Cyclops. A watchful remote-controlled eye can survey areas too dangerous or inaccessible for human beings or snoop into confines concealed from the human eye. The spectral response of the miniature photoconductive camera tube 0.595 inches in diameter and 3.5 inches long closely approximates that of the human eye. Overall performance is comparable to the Vidicon TV pickup tube.

Magnetic focusing and deflection is used on the 6912 camera tube manufactured by Resitron Laboratories, Inc., 2908 Nebraska Ave., Santa Monica, Calif.; it is ideally suited for industrial or broadcast television. A complete TV setup is illustrated by the block diagram. The scanned target area is 6 mm by 8 mm. The signal electrode voltage for a dark curve of 0.02 μ amp is 10 to 90 v. Maximum grid voltage rating is 320 v. The voltage for picture cut-off is 28 to 90 v. Heater voltage is 6.3 v ac and heater current is 0.6 amp.

The 5 by 2 by 1-3/4 in. camera illustrated was developed by Lockheed to aid in gathering flight test data. Possible uses include remote fire detectors, examination of controls both inside and outside the aircraft (the small camera offers a minimum of air resistance), and inspection of aircraft structures through hand-sized entry holes. Camera installations in wind tunnels have been used to show ice accumulation. The small camera can be put inside pipe lines to observe, for example, obstructions, and corrosion. The availability of the miniature tube will permit many equipment and system designers to build in monitoring features.

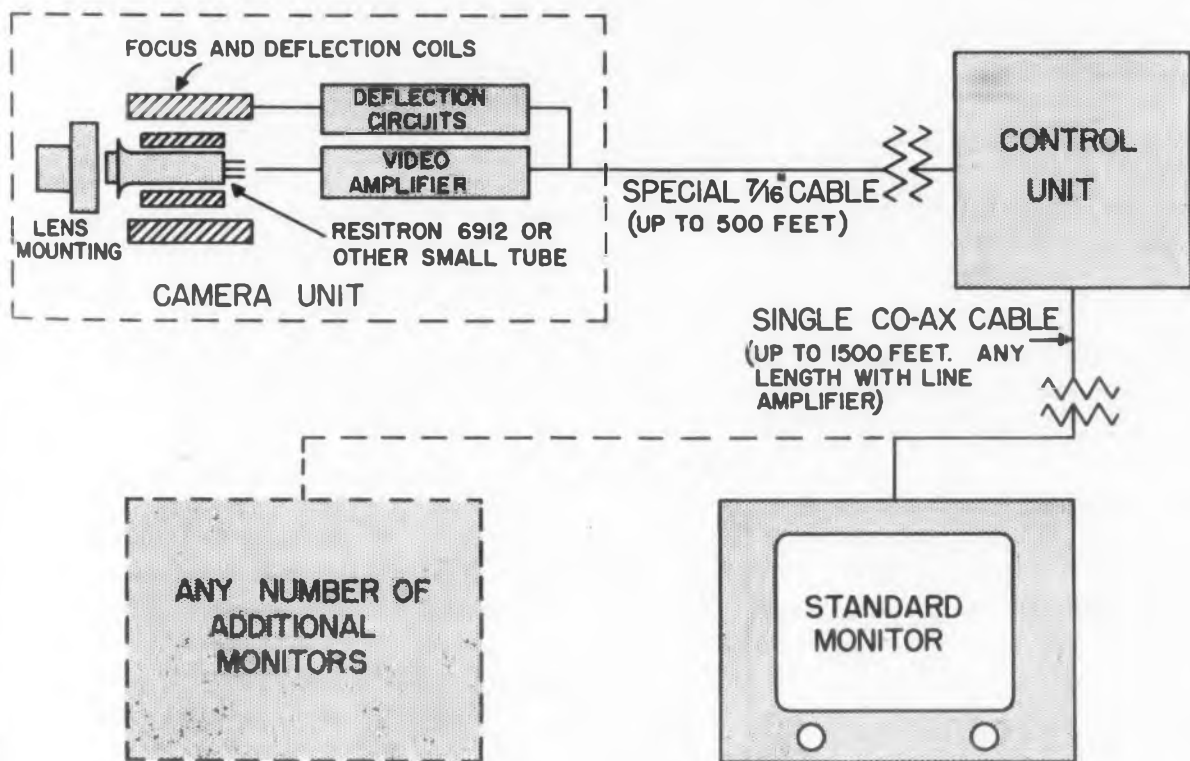
For more information on the miniature camera tubes and the availability of complete cameras turn to Reader's Service Card and circle 26.



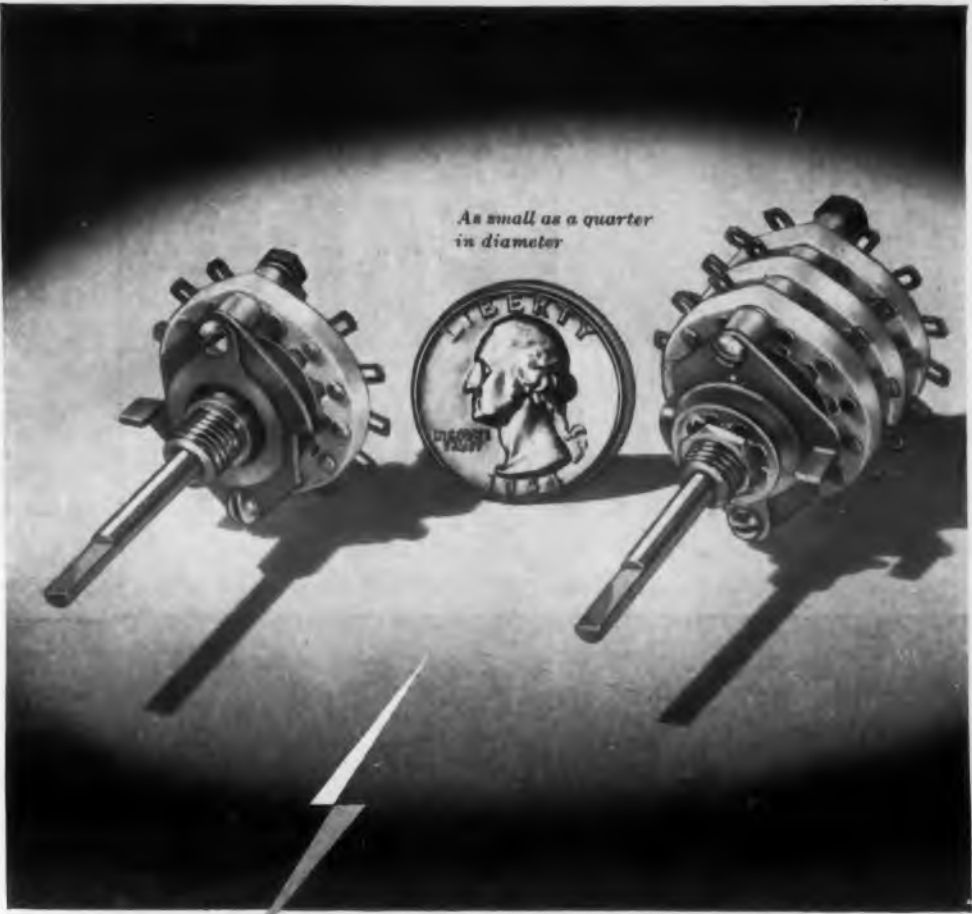
Typical remote-control camera for use in TV circuit.



Tube photograph is actual size.



Block diagram showing miniature camera tube in TV system.



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Modern

TABLES presented in this series of articles make the design of three classes of practical networks simple. The tables give the element values for the normalized low-pass network with a Butterworth, Tschebyscheff, or Bessel-polynomial characteristic. To convert the normalized element values to practical design values requires only simple multiplications. The low-pass networks that are realized can also be transformed in a straightforward manner to serve high-pass, band-pass, or band-elimination functions. Parts I, II and III covered Butterworth characteristics, several Tschebyscheff characteristics, and Bessel Functions (ED Sept. 15, Oct. 1, Oct. 15, 1956). In this Part IV, normalization, duality, reciprocity theorem, frequency transformations, and transformation of symmetrical networks are given. Additional Tschebyscheff characteristics are also included.

Normalization—The element values in the tables are normalized with respect to the load resistance R_1 and the radian frequency. In other words, the value of R_1 is considered as 1 ohm and that of the cutoff frequency (or $\omega_0=1t_0$ for the time-delay networks) is 1 radian per second. These frequency and impedance normalizations may be removed simply.

Since the impedance of the three different kinds of elements appearing in a network is given respectively by R , Ls , and $1/Cs$, we note that if the frequency is multiplied by a constant the resistance is unaffected, but that to maintain the impedance of the inductance and capacitance invariant, it is necessary to divide L and C by the same constant. This provides the simple rule for removal of the frequency normalization: to raise the radian frequency $\omega=1$ to $\omega=\omega_c$, divide all L 's and C 's in the network by ω_c . On the other hand, to raise the impedance level by a factor H we must multiply the impedance of each type of element by this factor, that is, multiply every R and L in the network by H , and divide every C by H . Thus we see only simple multiplications are involved.

The two rules may be combined into one operation: to raise the radian frequency to ω_c and the impedance level by H , we multiply every resistance by H , every inductance by H/ω_c , and every capacitance by $1/\omega_c H$.

Duality—The dual of a ladder network may always be realized simply. The impedance of every series arm is

Synthesis Network Design From Tables—IV

Louis Weinberg
Senior Staff Engineer
Hughes Research Laboratories
Culver City, Calif.

replaced by the admittance of a shunt arm, and vice versa. In simpler terms, this means that every capacitance of C farads is replaced by the dual element which is an inductance of C henrys, every inductance of L henrys is replaced by a capacitance L farads, and every resistance of R ohms becomes a conductance of R ohms; if the original element is a series arm then the dual element becomes a shunt arm, whereas if the original element is a shunt arm then the dual element is a series arm. For example, the dual of the network in *a* of Fig. IV-1 is given by the one in *b*.

What are the characteristics of the dual network with respect to that of a given network? The impedances (admittances) of one network (both transfer and driving point) become admittances (impedances) of the other. Thus in Fig. IV-1a the input is a voltage source and the output a current so that the transfer function is the admittance $Y_{21}=I_2/E_1$. In the dual given by Fig. IV-1b the transfer impedance $Z'_{21}=E'_2/I'_1$, is the same rational function as Y_{21} of *a*.

It is therefore clear that the primed and unprimed values lead to dual networks.

Reciprocity Theorem—Often a network designed by the use of the tables does not have the configuration demanded in a particular problem. For example, a shunt capacitance may be desired at the output and a resistance at the input, but the network obtained has

the form shown in Fig. IV-2a. By the use of the reciprocity theorem the network of Fig. IV-2b with the desired configuration may be obtained.

The reciprocity theorem states that the transfer impedance (or transfer admittance) remains unchanged if the excitation and measuring instrument change places. Thus in Fig. IV-2a we have the transfer impedance

$$Z_{21} = \frac{E_2}{I_1} = \frac{p(s)}{q(s)} \quad (16)$$

where the excitation is a current source I_1 flowing into the input terminals and the output is a voltage (measured by a voltmeter across R). Now if the current source is placed across R and the voltmeter placed across C_4 , then the conditions of the reciprocity theorem have been satisfied. Thus the transfer impedance of Fig. IV-2b is also equal to p/q .

It is therefore clear that by use of reciprocity a whole set of new network configurations may be obtained.

Frequency Transformations^a—The tables give the element values for low-pass filters. However, corresponding characteristics may be obtained for the high-pass, band-pass, and band-elimination cases by the use of transformations of the frequency variable.

High-Pass Filters

A normalized low-pass filter characteristic is shown in Fig. IV-3a; the corresponding high-pass characteristic is given in Fig. IV-3b. The latter characteristic may be obtained from the former by the use of the transformation $s^1=1/s$. Since by use of this transformation the impedance of an inductance Ls becomes the impedance L/s^1 , the impedance of a capacitance $1/Cs$ becomes s^1/C , and the value of a resistance remains unchanged, a simple rule for converting a low-pass ladder network to a high-pass one may be formulated. The rule is: replace every inductance of L henrys by a capacitance of $1/L$ farads; replace every capacitance of C farads by an inductance of $1/C$ henrys; and leave the resistances unchanged. Thus if the network in Fig. IV-4a has a low-pass characteristic, then the corresponding high-pass network is given in Fig. IV-4b.

Band-Pass Filters

A low-pass filter of bandwidth ω_0 may be converted to a band-pass filter of bandwidth $\omega_c=\omega_b-\omega_a$ by use of the frequency transformation

$$s = \frac{(s')^2 + \omega_0^2}{s'} \quad (17)$$

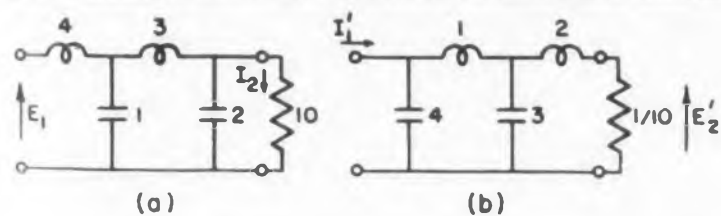


Fig. IV-1 Ladder network and its dual (values in ohms, henrys, and farads).

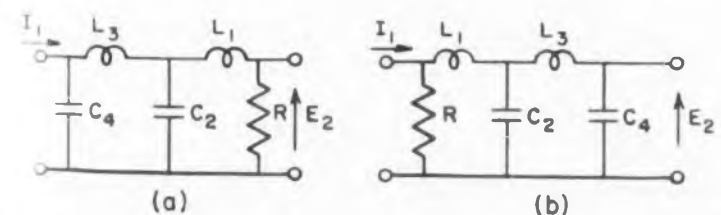


Fig. IV-2 Ladder network and one obtained from it by use of reciprocity theorem.

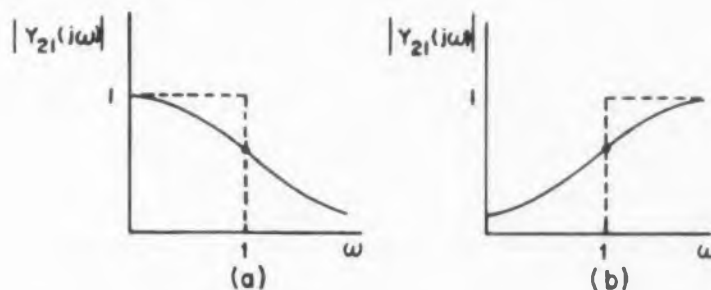


Fig. IV-3 Low-pass characteristic and the corresponding high-pass one obtained by a frequency transformation.

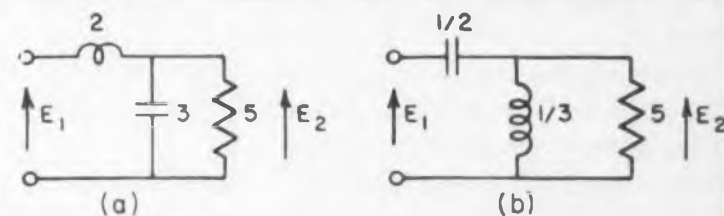


Fig. IV-4 Low-pass network and its corresponding high-pass network.

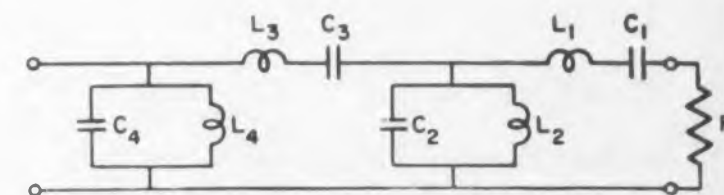


Fig. IV-5 Band-pass filter for example.

Thus the right-hand side of Eq. 17 is substituted for every s in the transfer function. Here ω_b is the upper frequency limit and ω_a is the lower frequency limit of the band, while ω_0 is the center frequency of the band. The band limits have geometric symmetry about the center frequency, that is, $\omega_a\omega_b = \omega_0^2$.

However, it is not necessary to actually carry out the transformation, since there is a simple rule for converting the low-pass network to a band-pass one: for each inductance in the network of L henrys add a capacitance in series with it of value $1/(\omega_0^2 L)$ farads; for each capacitance in the network of C farads add an inductance in parallel with it of $1/(\omega_0^2 C)$ henrys (that is, the added element always resonates with the original element at the center frequency ω_0); leave the resistances unchanged.

The complete process for converting a normalized low-pass filter to a desired band-pass one may be given as the following:

1. Determine the desired bandwidth $\omega_c = \omega_b - \omega_a$ and the desired center frequency $\omega_0 = \omega_a\omega_b$ from the given data.
2. Change the bandwidth of the low-pass filter to ω_c .
3. Perform the low-pass to band-pass transformation on the network.
4. Remove the level normalization from the resulting band-pass filter.

Example

Design an equal-ripple band-pass filter with the following characteristics:

- a. The ripple in the pass band is 1 db.
- b. The center frequency is $f_0 = 1000$ cy.
- c. The bandwidth f_c measured at 1 db points is 100 cy.
- d. At the frequencies corresponding to three times f_0 the response is to be down approximately 50 db.
- e. The network is driven by a current source and should have a load resistance of 1000 ohms.

In order to design this filter it is not necessary to find the actual frequencies at which the response is down 1 db and 50 db, but if we wished to find them we could use the formulas $f_a f_b = f_0(f_a + 100) = 10^6$ and $f_{50}(f_{50} + 300) = 10^6$, where f_a is the lower 1 db frequency and f_{50} is the lower 50 db frequency.

From Table II-2 we find that the 1 db ripple corresponds to 0.5088. We now calculate n and find that $n=4$ yields approximately 49 db attenuation at $\omega=3$. Therefore using $n=4$ and the primed values of Table II-2a, we find the element values:

$$L'_1 = 1.0495 \quad L'_3 = 1.9093$$

$$C'_2 = 1.4126 \quad C'_4 = 1.2817$$

The bandwidth is now changed to $\omega_c = 2\pi \times 100$ by dividing the above values by ω_c . The network is then converted to the band-pass form and the impedance level raised to 1000 ohms. The final network given in

Fig. IV-5 has the element values (in ohms, henrys, and farads):

$$R = 1000 \quad L_3 = 3.04$$

$$L_1 = 1.67 \quad C_3 = 8.33 \times 10^{-9}$$

$$C_1 = 1.52 \times 10^{-8} \quad L_4 = 1.15 \times 10^{-2}$$

$$L_2 = 1.41 \times 10^{-2} \quad C_4 = 2.20 \times 10^{-6}$$

$$C_2 = 2.25 \times 10^{-6}$$

Band-Elimination Filters

The transformation from a low-pass to a band-elimination characteristic is given by

$$s = \frac{s'}{(s')^2 + \omega_0^2} \quad (18)$$

As for the band-pass filter the transformation can be achieved by direct operation on the low-pass network. The rule follows:

- a. Add a capacitance in parallel with each inductance in the low-pass network; the value of the capacitance is $1/(\omega_0^2 L)$, where L is the value of the original inductance.
- b. Add an inductance in series with each capacitance of the network; the value of the inductance is $1/(\omega_0^2 C)$, where C is the value of the original capacitance.

c. Since the resistances are unaffected by the transformation, their values are not changed.

Transformation of Symmetrical Networks

It has been pointed out that the Butterworth and Tschebyscheff networks obtained for $D=1$ and n odd are symmetrical. This symmetry allows any specified resistance ratio $r = R_n R_1$ to be obtained simply; the method used transforms the symmetrical network to an unsymmetrical one with the desired resistance ratio.

If the symmetrical network is divided as it was in Fig. I-3, then the over-all transfer impedance is given in terms of the impedances of the component networks by⁹

$$Z_{21} = \frac{Z_{21a} Z_{21b}}{Z_a + Z_b} \quad (19)$$

The subscripts a and b have been used to designate the networks on the left and right, respectively. But because of the symmetry, the component networks are the same and consequently $Z_{21b} = Z_{21a}$ and $Z_b = Z_a$. Now suppose it is desired to increase the resistance ratio by r . If the impedance level of N_a is multiplied by r , the desired effect will have been accomplished. But this change also increases Z_{21a} and Z_a by r . Be-

Table IV-2 Zeros of Polynomials V_n derived from the Tschebyscheff Approximation

c) 2-db ripple ($\epsilon = 0.7647831$, $\epsilon^2 = 0.5848932$)

$n=1$	$n=2$	$n=3$	$n=4$	$n=5$	$n=6$	$n=7$	$n=8$	$n=9$	$n=10$
-1.3075603	-0.4019082 $\pm j0.6893750$	-0.3689108	-0.1048872 $\pm j0.9579530$	-0.2183083	-0.0469732 $\pm j0.9817052$	-0.1552958	-0.0264924 $\pm j0.9897870$	-0.1206298	-0.0169758 $\pm j0.9934868$
		-0.1844554 $\pm j0.9230771$	-0.2532202 $\pm j0.3967971$	-0.0674610 $\pm j0.9734557$	-0.1283332 $\pm j0.7186581$	-0.0345566 $\pm j0.9866139$	-0.0754439 $\pm j0.8391009$	-0.0209471 $\pm j0.9919471$	-0.0767332 $\pm j0.7112580$
				-0.1766151 $\pm j0.6016287$	-0.1753064 $\pm j0.2630471$	-0.0968253 $\pm j0.7912029$	-0.1129098 $\pm j0.5606693$	-0.0603149 $\pm j0.8723036$	-0.0492657 $\pm j0.8962374$
						-0.1399167 $\pm j0.4390845$	-0.1331862 $\pm j0.1968809$	-0.0924078 $\pm j0.6474475$	-0.0966894 $\pm j0.4566558$
								-0.1133549 $\pm j0.3444996$	-0.1071810 $\pm j0.1573528$

Table IV-3 Polynomials V_n in Expanded Form $V_n = s^n + b_{n-1} s^{n-1} + \dots + b_1 s + b_0$

c) 2-db ripple ($\epsilon = 0.7647831$, $\epsilon^2 = 0.5848932$)

n	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9
1	1.3075603									
2	0.6367681	0.8038164								
3	0.3268901	1.0221903	0.7378216							
4	0.2057651	0.5167981	1.2564819	0.7162150						
5	0.0817225	0.4593491	0.6934770	1.4995433	0.7064606					
6	0.0514413	0.2102706	0.7714618	0.8670149	1.7458587	0.7012257				
7	0.0204228	0.1660920	0.3825056	1.1444390	1.0392203	1.9935272	0.6978929			
8	0.0128603	0.0729373	0.3587043	0.5982214	1.5795807	1.2117121	2.2422529	0.6960646		
9	0.0051076	0.0543756	0.1684473	0.6444677	0.8568648	2.0767479	1.3837464	2.4912897	0.6946793	
10	0.0032151	0.0233347	0.1440057	0.3177560	1.0389104	1.1585287	2.6362507	1.5557424	2.7406032	0.6936904

cause $Z_b = Z_a$, however, the Z_{21} of the whole network is not changed except by a constant multiplier. For example, if $r=10$ then the transfer impedance before the level change is

$$Z_{21} = \frac{(Z_{21a})^2}{2Z_a} \quad (20)$$

whereas after the change it is

$$Z'_{21} = \frac{10(Z_{21a})^2}{11Z_a} \quad (21)$$

which differs from Eq. 20 only by a constant multiplier.

An analogous situation of course holds for transfer admittances.

Acknowledgement: The author expresses his thanks to the members of the Mathematics Section, Systems Analysis Department, Hughes Aircraft Company, who carried through the calculations for almost all of the tables in this paper.

References

- Automatic Feedback Control System Synthesis, J. G. Truxal, McGraw-Hill Book Co., Inc., New York; 1955.
- Synthesis of Transfer Functions with Poles Restricted to the Negative Real Axis, L. Weinberg, *Jour. Appl. Phys.*, vol 24, pp. 207-216; 1953.

Additional Tables and Data

Included in this last section are additional Tschebyscheff Filter Tables, IV-1 and IV-2. The element values are given for a 2 db ripple factor. Refer to Part II ELECTRONIC DESIGN, Oct. 1, for background information.

In the future an attempt will be made to compute additional tables giving element values of other practical networks such as Bessel-polynomial networks with resistance terminations at both ends.

The substitution of a voltage for a current source (and the consequent change of system function from Z_{21} to Y_{21}) may be achieved by the use of a completely dual network (Part I). However, in many practical problems this dual may not be desired; we may wish to use a voltage source to drive a network with a shunt capacitance at both ends (Fig. 1-2, Part I). This is simply realized by the application of Thevenin's theorem to the current source with its associated shunt conductance, which thus yields the desired network with a voltage source and its associated series R_n at the input. Analogously, the network forms of Fig. 11-2, Part I, can be used with a current source at the input terminal pair.

As the reader may have noted, table for $D = 1/2$ can be obtained from the $D = 2$ tables by the application of reciprocity and an impedance level change. Both forms of the tables have been given for the convenience of the reader.

Table IV - 1
Element Values (in ohms, henrys, farads) for a Normalized Tschebyscheff Filter with 2 db Ripple ($\epsilon = 0.7648$, $\epsilon^2 = 0.5849$).

Value of n	C_1 or L_1'	L_2 or C_2'	C_3 or L_3'	L_4 or C_4'	C_5 or L_5'	L_6 or C_6'	C_7 or L_7'	L_8 or C_8'	C_9 or L_9'	L_{10} or C_{10}'	R_n or $1/R_n'$
a) $D = 0$ (For this case unprimed values correspond to a current-source input for n odd and to a voltage-source input for n even.)											
1	.7648										∞
2	1.2441	.9766									0
3	1.3553	1.2740	1.7717								∞
4	1.3962	1.3389	2.2169	1.1727							0
5	1.4155	1.3640	2.3049	1.4468	1.9004						∞
6	1.4261	1.3765	2.3383	1.4974	2.3304	1.2137					0
7	1.4328	1.3836	2.3551	1.5159	2.4063	1.4836	1.9379				∞
8	1.4366	1.3881	2.3645	1.5251	2.4332	1.5298	2.3646	1.2284			0
9	1.4395	1.3911	2.3707	1.5304	2.4463	1.5495	2.4386	1.4959	1.4553		∞
10	1.4416	1.3932	2.3748	1.5337	2.4538	1.5536	2.4607	1.5419	2.3794	1.2353	0
b) $D = 1/2$											
1	1.1472										2.0000
2	1.8661	.7887									.21131
3	2.0330	1.0393	2.2485								1.8083
4	2.0943	1.0911	2.8881	.8935							.21330
5	2.1233	1.1104	3.0129	1.1334	2.3671						1.7940
6	2.1391	1.1198	3.0590	1.1769	2.9929	.9141					.21367
7	2.1492	1.1250	3.0820	1.1922	3.1046	1.1524	2.4010				1.7902
8	2.1550	1.1284	3.0944	1.1996	3.1432	1.1938	3.0243	.9214			.21379
9	2.1593	1.1306	3.1026	1.2037	3.1616	1.2078	3.1314	1.1596	2.4146		1.7885
10	2.1623	1.1321	3.1081	1.2062	3.1720	1.2143	3.1676	1.2000	3.0380	.9248	.21385
c) $D = 1$											
1	1.5296										1.0000
2	2.4881	.6075									.24418
3	2.7107	.8327	2.7104								1.0000
4	2.7925	.8806	3.6063	.6819							.24418
5	2.8310	.8985	3.7827	.8985	2.8310						1.0000
6	2.8521	.9071	3.8467	.9393	3.7151	.6964					.24418
7	2.8655	.9119	3.8780	.9535	3.8780	.9119	2.8655				1.0000
8	2.8733	.9151	3.8948	.9605	3.9335	.9510	3.7477	.7016			.24418
9	2.8790	.9171	3.9056	.9643	3.9598	.9643	3.9056	.9171	2.8790		1.0000
10	2.8831	.9186	3.9128	.9667	3.9743	.9704	3.9589	.9554	3.7610	.7040	.24418
d) $D = 2$											
1	2.2943										.50000
2	3.7322	.3943									.21131
3	4.0660	.5747	3.6763								.55301
4	4.1887	.6160	5.1152	.4467							.21330
5	4.2465	.6318	5.4052	.6189	3.8092						.55741
6	4.2782	.6395	5.5083	.6536	5.2408	.4571					.21367
7	4.2983	.6437	5.5579	.6659	5.5174	.6284	3.8474				.55860
8	4.3099	.6466	5.5838	.6720	5.6110	.6616	5.2779	.4607			.21379
9	4.3185	.6484	5.6005	.6753	5.6546	.6730	5.5490	.6321	3.8619		.55913
10	4.3247	.6497	5.6115	.6774	5.6783	.6783	5.6406	.6647	5.2941	.4624	.21385
e) $D = 3$											
1	3.0591										.33333
2	4.9763	.2863									.17260
3	5.4214	.4330	4.6747								.38657
4	5.5849	.4682	6.6656	.3279							.17614
5	5.6620	.4819	7.0737	.4674	4.8230						.39133
6	5.7043	.4886	7.2175	.4966	6.8113	.3362					.17680
7	5.7311	.4924	7.2860	.5072	7.2067	.4750	4.8657				.39262
8	5.7466	.4948	7.3215	.5124	7.3404	.5029	6.8538	.3391			.17703
9	5.7581	.4964	7.3441	.5153	7.4022	.5126	7.2433	.4780	4.6815		.39319
10	5.7663	.4976	7.3590	.5171	7.4355	.5172	7.3753	.5054	6.8722	.3405	.17714

Note: Impart C of Table IV-1, for $n=3$, L_3 should be equal to 2,7107 instead of 2,7104

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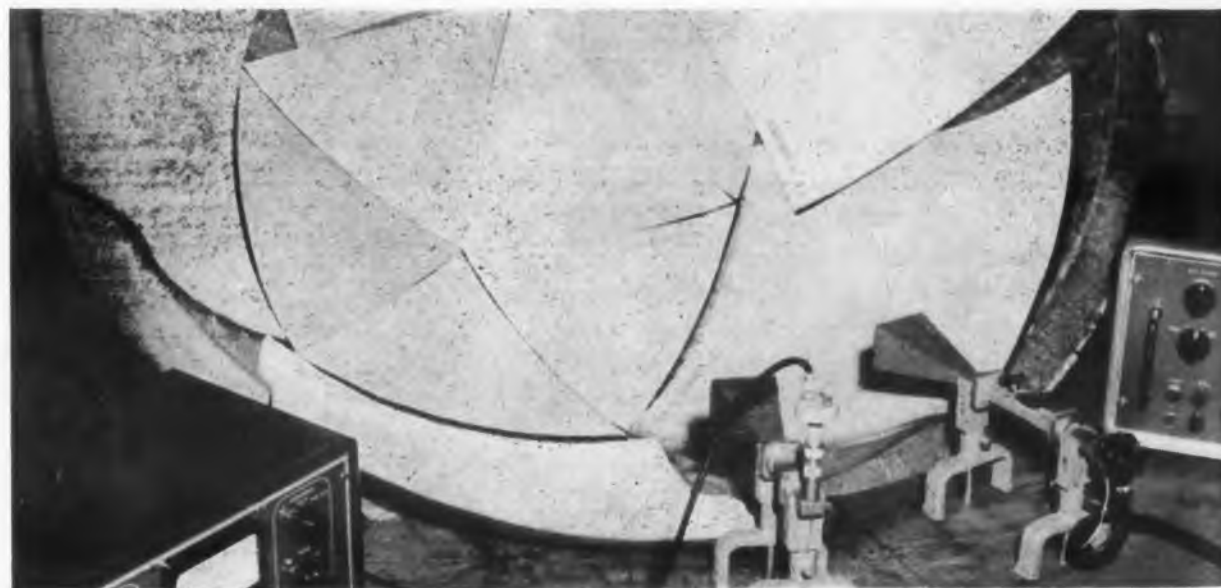
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Flexible Foam Microwave Absorber

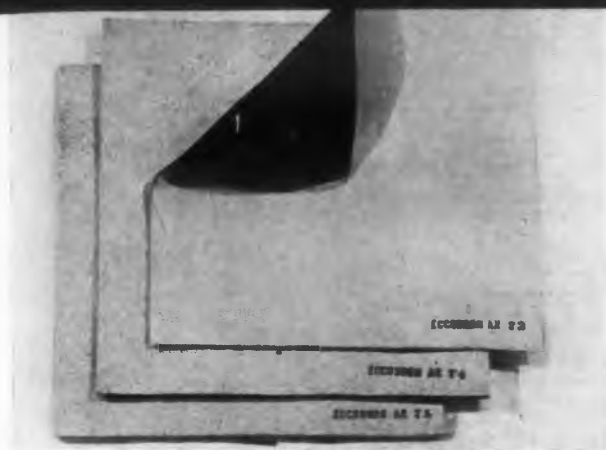
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This Type AN Eccosorb light-weight flexible foam sheet broadband microwave absorber material is available from Emerson and Cuming, Inc., 869 Washington St., Canton, Mass. It complements their previously announced Type CH absorbers in that it is especially suitable for the



Reflectivity test set-up for flexible foam microwave absorbing material. Note how material takes on contour of surface to which it is bonded.

Performance curves of reflected power versus frequency for four types of AN Eccosorb. AN72 is thinnest and designed for K band. AN75 is thickest and is broadbanded from K through S band.



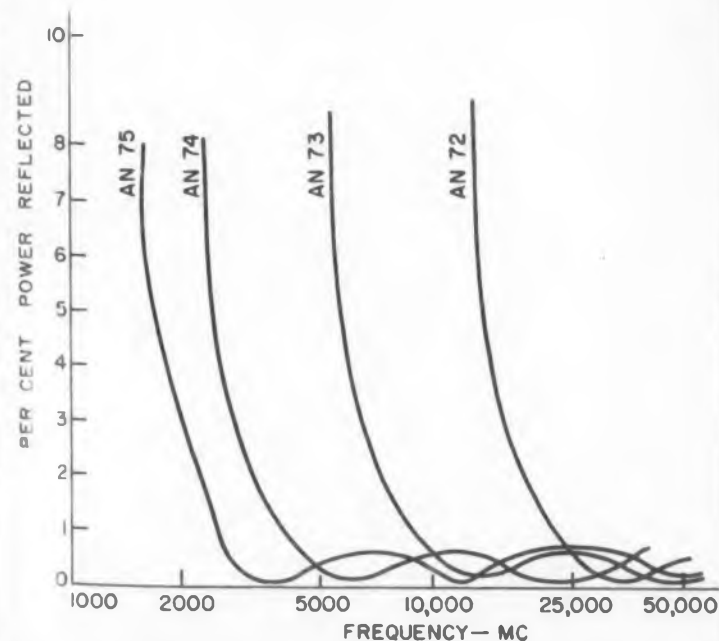
Flexible Foam AN Eccosorb. Available in sheet, the front surface is white, the back surface bronze. Able to take a three-dimensional contour, it is installed with cement.

higher frequency microwave regions where the greater thickness of the rigid foam CH material and its inflexibility make it hard to handle. Maximum thickness of the AN Eccosorb is 7/8 in. and it is available in thinner sheets for the higher frequencies. It can be fitted into corners as small as 1/8 in. radius. It is not designed for use at frequencies below S band, however.

Eccosorb AN is white surfaced for good light reflection and is useful from minus 94 to plus 300 F. Type AN 75 covers all bands from S through K, with AN 73 covering X through K. Nominally 3/8 in. thick, it weighs less than 2 oz per sq ft.

Minimizing weight and space aboard aircraft, particularly, Type AN Eccosorb can also be used in ground installations of antennas as well as in microwave darkrooms. Because of its flexibility, the absorber can be draped over and around posts, stands and equipment.

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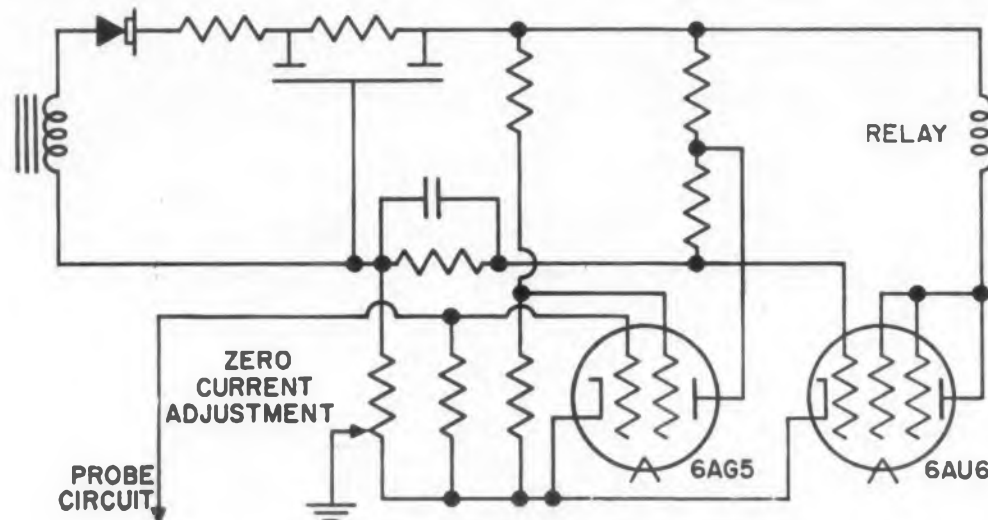
BY adding a digital counter to a precision electronic micrometer, a tool has been developed that virtually eliminates the source of human error in measuring material thickness accurately. The direct heading, counter type automatic electronic digital micrometer described here permits measurements with laboratory accuracy, repeatability and speed, with no pressure on the work.

Similar to most micrometers, material thickness up to 1 in. (7/8 in. with standard micrometer tip) can be accommodated. The throat depth is 2 in., and the upper head is adjustable in height for work up to 2 in. The standard anvil is removed readily for the use of special fixtures. Measurement repeatability is 0.00002 in. Required power is

18 w, 115 v ac. This Electronic Micrometer, Model HDR, is manufactured by J. W. Dice Co., Englewood, N.J.

The micrometer spindle is rotated by a motor in the instrument column until contact is made between the spindle face and the work. This contact is sensed by an electronic circuit which operates a relay, instantly stopping the motor drive, and holding the reading until released by the operator. The 4-digit counter, also driven by the motor, indicates the micrometer screw position directly in units of ten-thousandths of an inch.

The patented circuit shown, for detecting metal-to-metal contact, has an important characteristic essential to precise operation of the micrometer. When contact is estab-



Schematic for Electronic Micrometer

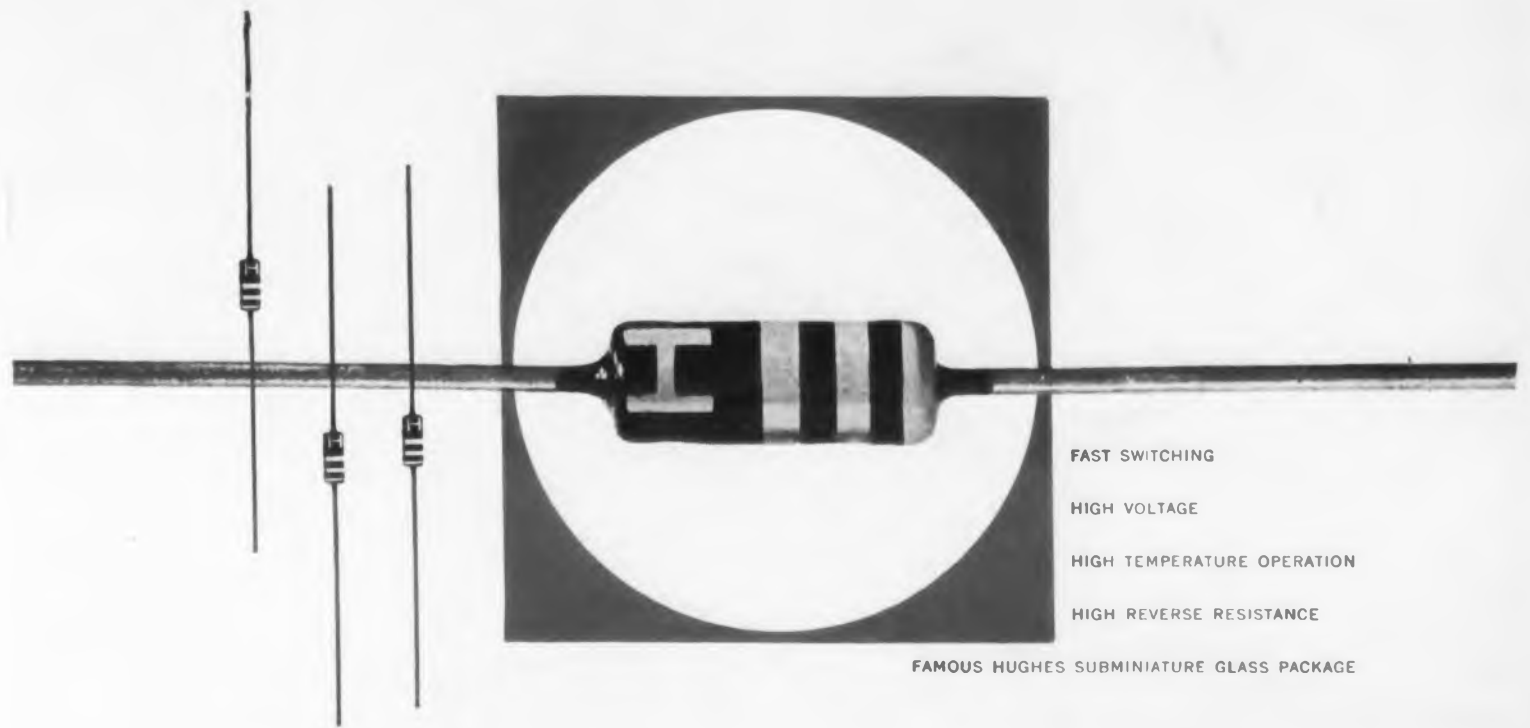


lished with the work, no current flows; thus no arcing occurs upon opening of the probe circuit.

Trigger action is caused in the plate circuit of the 6AU6, as the resistance changes in the probe circuit. Current through the relay coil changes little until contact resistance with the work falls to about 0.1 megohm. Further decrease in contact resistance to a few thousand ohms produces full swing in plate current. But actual contact resistance in operation is in the range of a fraction of an ohm. Thus, with the first instant of metal-to-metal contact, full circuit response occurs; with the first break in contact, the output swings all the way. The effect is similar to a flip-flop in performance. A displacement of less than 5 millionths of an inch at the micrometer tip produces a full swing in plate current.

The circuit is independent of wide variations in line voltage, temperature and leakage resistance, and is not affected by the aging of tubes. The zero-adjustment, once made, requires no additional change unless the 6AG5 is replaced. The electronic unit is enclosed within the instrument base and may be removed without disturbing the measuring system. The column and upper head can also be separated from the base for mounting on special stands; in this instance, the chassis may be relocated remotely.

For more information about this device, turn to Reader's Service Card and circle 33.



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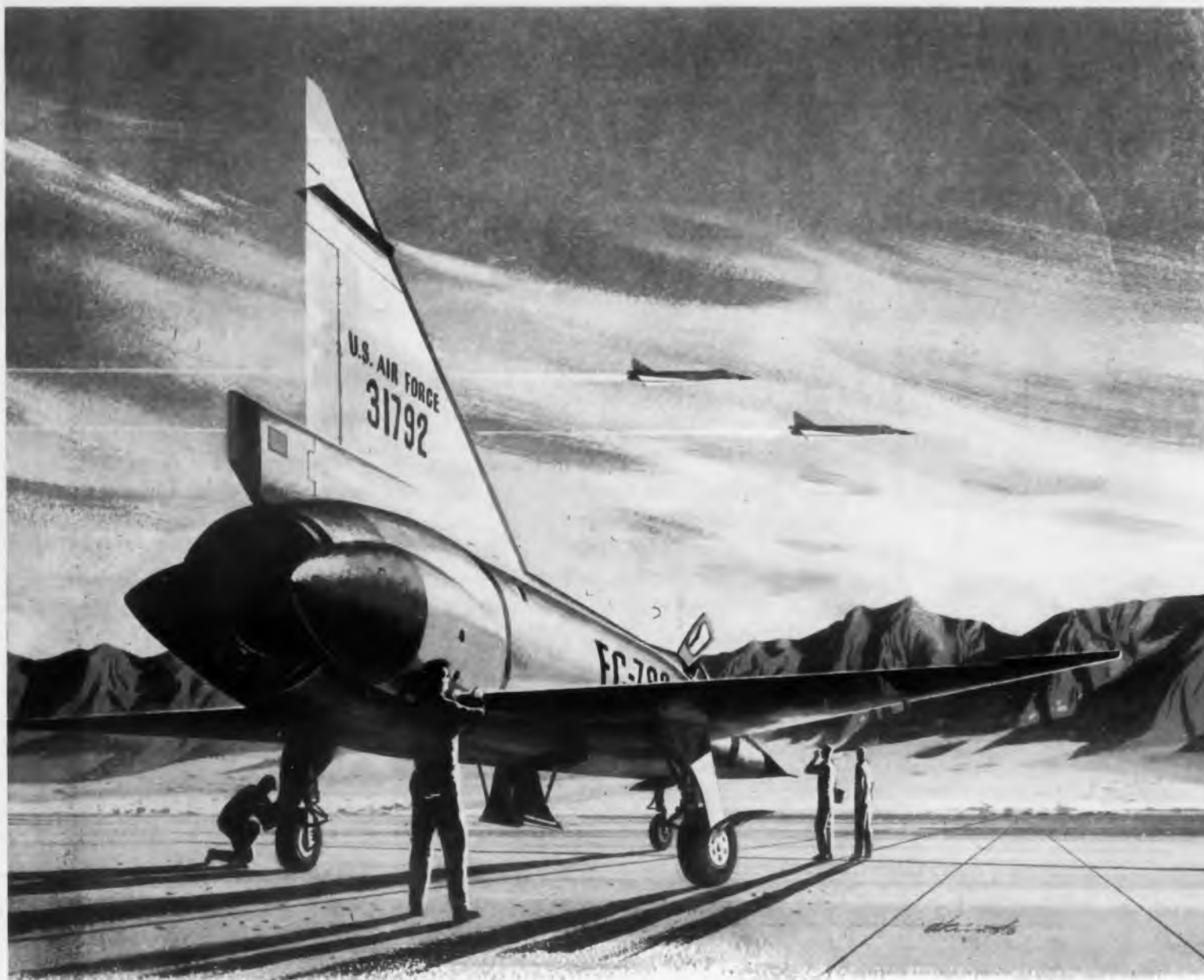
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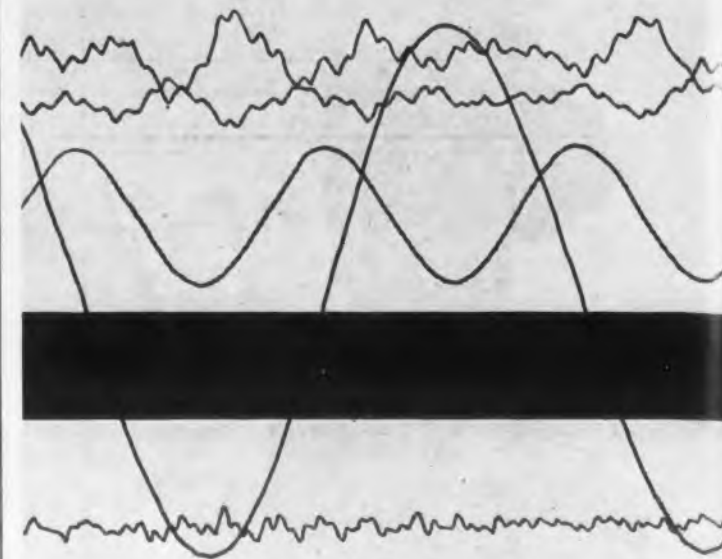
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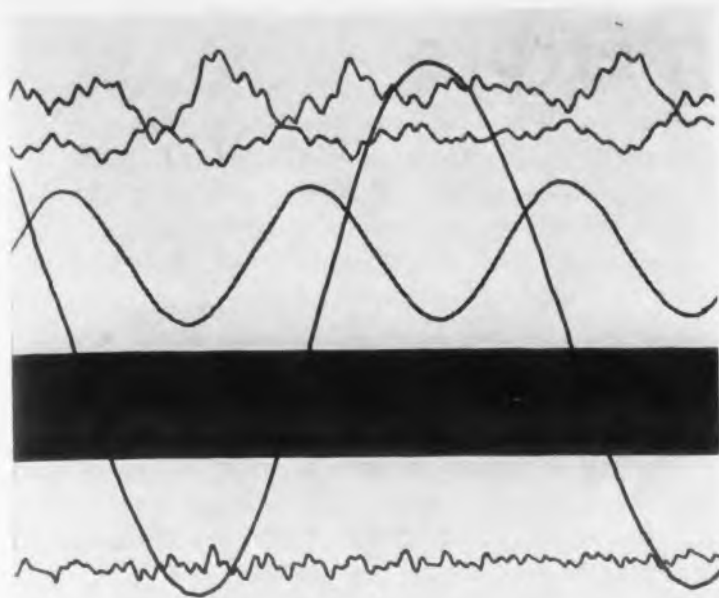
Artist's representation of typical waveforms.

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The instrument, developed by the Heiland Division of Minneapolis-Honeywell, 2500 E. Evans Ave., Denver, Col., can be loaded in daylight. It holds 100 feet of sensitive paper. The exposed paper is not impervious to sunlight, however short studies can be made of the raw output of the machine. If permanent records are desired, the paper must be fixed with a chemical. Storage time of raw exposed charts before fixing depends upon the amount of ultraviolet radiation present in the viewing area.

An added feature is a monitoring arrangement whereby the galvanometer light spots are viewed directly at the recording point on a calibrated view screen. A paper supply indicator shows the amount of unused paper remaining.



Dark band is h-f signal.

HF Oscillograph

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For further information about this product, fill out the Reader's Service Card and circle 36.

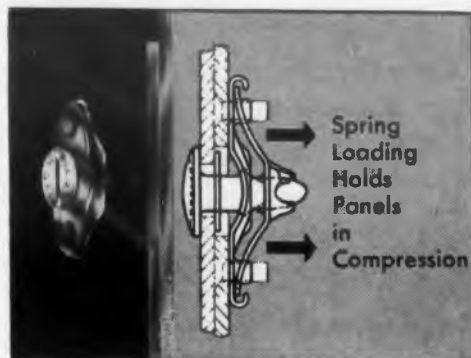


Quick-Opening Fasteners

Selecting Small Fastenings for Metal Closures

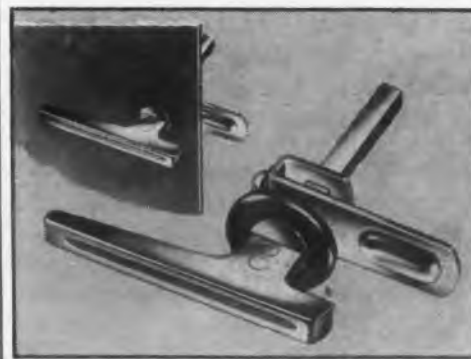
*"Use captive fasteners wherever feasible . . . Avoid the use of loose washers and loose nuts . . . Fasteners on equipment covers should be operable either with no tools or with standard hand tools"**

(John D. Folley, Jr. & James W. Altman, Research Scientists, American Institute for Research)



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Lion Fasteners open and close with a $\frac{1}{4}$ turn, hold sheets tightly under the compression of a rugged spring. Quickly operated and fully retained in the outer panel, they are approved under U. S. Government military specifications. Stud and receptacle float for easy alignment and simplified hole preparation. Flush, oval, wing, knurled, ring, and key head styles available. Sizes—No. 2, No. 5, and High Strength for extra heavy duty.

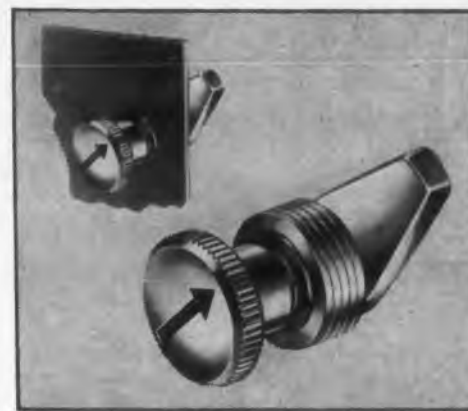


Cabinet Latch

Just drill a hole, push the fastener stem through, and slide the special push-on

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* Quotation from "Designing Electronic Equipment for Maintainability"; *Machine Design*, July 12, 1956.

CIRCLE 37 ON READER-SERVICE CARD FOR MORE INFORMATION

Location of Maximum Loading Errors in Potentiometers

D. A. Landauer
Engineer, Spectrol
Electronics Div. of Carrier Corp.

USUALLY the voltage output of a potentiometer varies linearly with shaft rotation. However, when a potentiometer contains a fixed resistance between the slider and either end, a non-linear output results. The maximum non-linearity, or error, occurs at some output value which varies with the magnitude of the ratio of load resistance to potentiometer resistance. This article tells how the point of maximum error can be found, explains why this point is important to know, and offers a graphical solution for a common range of load ratios.

The most familiar configuration for a loaded potentiometer circuit is that shown in Fig. 1. R is the potentiometer resistance, A is the load resistance, E is the total voltage applied across the control, e is the voltage from the slider to ground, and x is the shaft rotation expressed as a decimal part of the total. R and A are constants, $0 \leq e \leq E$, and $0 \leq x \leq 1$.

It can be readily shown that

$$e = \frac{Ex}{1 + \frac{R}{A}x(1-x)} \quad (1)$$

This is the equation for the theoretical output voltage versus shaft rotation curve (neglecting any errors such as linearity, concentricity, etc.). See Fig. 2. When a potentiometer has an infinite load resistance, this equation reduces to

$$e = Ex \quad (2)$$

Therefore, the deviation from a theoretically perfect line (the loading error), which will be called e' , is simply the difference between Eq. 1 and 2. Therefore,

$$e' = Ex - \frac{Ex}{1 + \frac{R}{A}x(1-x)} = \frac{Ex^2(1-x)}{\frac{A}{R} + x(1-x)} \quad (3)$$

Plotting e' versus x gives a cubic curve of error versus rotation as shown in Fig. 3. It has been shown¹ that this is the general shape of the curve for any loading ratio. In considering any one load ratio (and hence some one particular curve) it is apparent from Fig. 3 that the errors reach a maximum absolute value at one point. From Fig. 10 it can be seen that the maximum error occurs at about 2/3 rotation as the load ratio (A/R) increases. As the load ratio increases beyond 2/3 to infinity, the magnitude of the maximum error reduces, approaching zero. This maximum error point should actually be thought of as the 2/3 output voltage position rather than the 2/3 rotation point. In a sine function, for instance, 2/3 = the sine of 41° or 45% of the quadrant rather than 66%. Only in a linear potentiometer does the 2/3 output position coincide with the 2/3 rotation point.

The significance of this maximum error location is two-fold. First, the value of the maximum error must

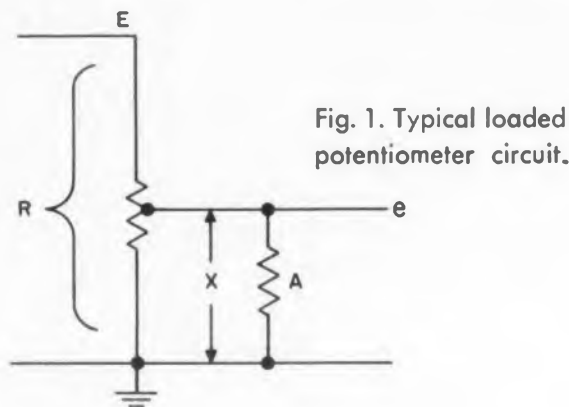


Fig. 1. Typical loaded potentiometer circuit.

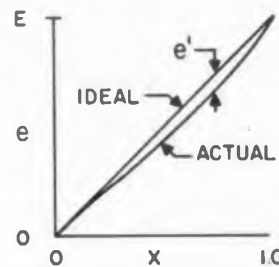


Fig. 2. Output voltage vs Shaft rotation curve for ideal and actual conditions.

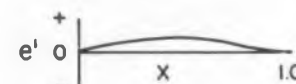


Fig. 3. Plot of loading error. The shape is as shown for any loading ratio.

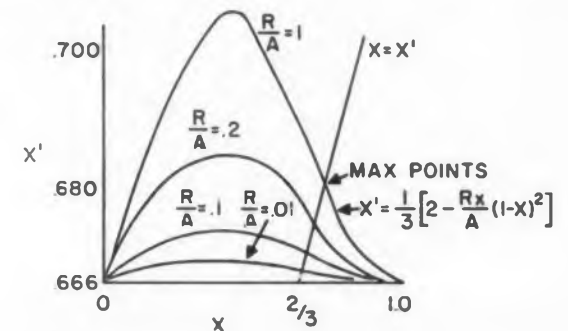


Fig. 5. Plots of Eq. 5 from which maximum error points can be determined as shown.

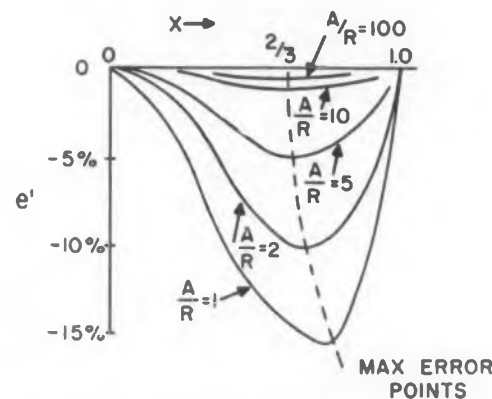


Fig. 4. Family of error vs rotation curves, using Eq. 3, for locating maximum error points.

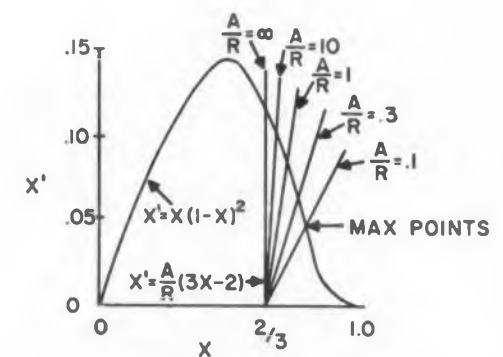


Fig. 6. An alternate to Fig. 5 using Eq. 5. See text.

Rules of Thumb

1. Maximum loading error occurs at approximately 2/3 full voltage output (not necessarily 2/3 shaft rotation).

2. Maximum loading error occurs at exactly the shaft position which satisfies either Eqs. 5 or 9, and approaches 2/3 as A/R approaches infinity.

3. The loading error curves for potentiometers loaded "up" or "down" are anti-symmetrical.

4. Loading error per cent and rotational location are independent of applied voltage.

be known to establish whether or not correction is necessary to maintain the desired conformity. If no correction is needed at the point of maximum error, no correction is necessary anywhere on the potentiometer. Also, if correction is found necessary, then location of the maximum error should be investigated for various characteristics depending on the corrective technique used (e.g. card width, wire size, spacing, tap point, etc.).

To find the maximum error location accurately, refer to Eq. 3. The maximum error occurs where $de'/dx = 0$.

$$\frac{de'}{dx} = E \left[1 - \frac{1}{1 + \frac{R}{A} x (1-x)} \right] + Ex \left\{ \frac{\frac{R}{A} (1-2x)}{\left[1 + \frac{R}{A} x (1-x) \right]^2} \right\} \quad (4)$$

By equating de'/dx to zero, the E drops out (indicating that the maximum loading error location is independent of the applied voltage), and Eq. 4 reduces to

$$Rx(1-x)^2 = A(3x-2) \quad (5)$$

Finding Maximum Error Point

There are thus several ways of determining and checking the location of the maximum error. All methods to be described are graphic, since no unique answer is available algebraically. The following methods are suggested:

1. Plot a family of error versus rotation curves and mark the locus of maximum points. Use Eq. 3 for this and obtain plots as in Fig. 4.

2. Plot a family of

$$x' = \frac{1}{3} \left[2 + \left(\frac{R}{A} \right) x (1-x)^2 \right]$$

curves and the line $x' = x$. x' is just a tool to separate the formula into two usable parts. The intersections of the line and the curves are the maximum error points. Eq. 5 is used and gives plots as in Fig. 5.

3. Plot an $x' = x(1-x)^2$ curve and some

$$x' = \left(\frac{A}{R} \right) (3x-2)$$

lines. Again the intersections are the points desired. This also comes from Eq. 5 but is plotted as in Fig. 6.

The first method is simplest, quickest, and least accurate. Methods 2 and 3 require more mathematical manipulation but offer discrete points.

Another frequently encountered loaded-potentiometer configuration is that shown in Fig 7, where the load is connected from the sliding arm to top of the control. e vs x and e' vs x for this configuration are shown in Figs. 8 and 9, respectively.

The formula for output voltage versus rotation for this "loaded up" circuit is



With UDOFT circuitry drawings as background, computer systems engineers at Sylvania's Avionics Laboratory discuss design of an extremely high-speed magnetic core memory. From left: J. J. Wargo, F. M. Bosch, and John Terzian.

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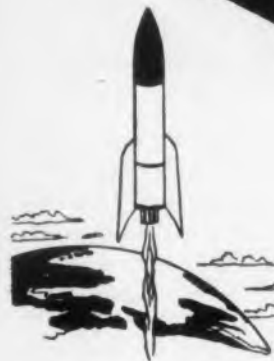
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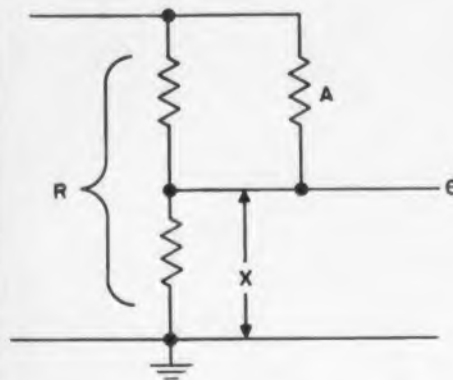


Fig. 7. "Loaded-up" potentiometer circuit, often found in practice.



Fig. 9. Loading error for "loaded-up" potentiometer.

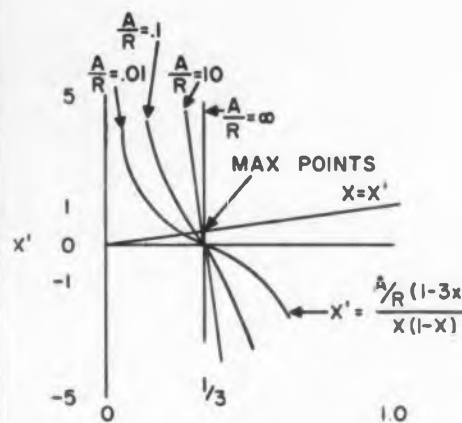


Fig. 11. Method 2. Alternative curves to those of Fig. 10 for finding maximum loading error points.

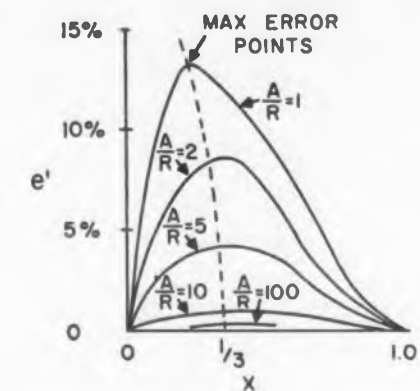


Fig. 10. Method 1. Error vs shaft rotation for various ratios R/A ("loaded-up" potentiometer).

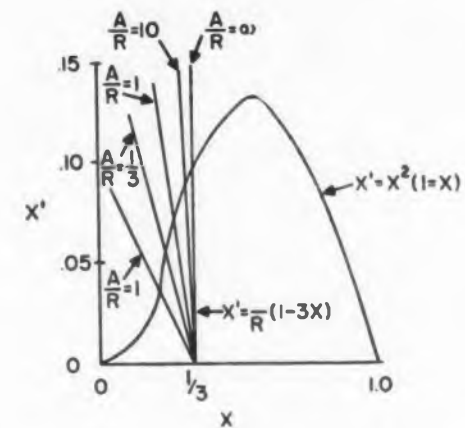


Fig. 12. Method 3. Second alternative method for finding points of maximum loading error (See text).

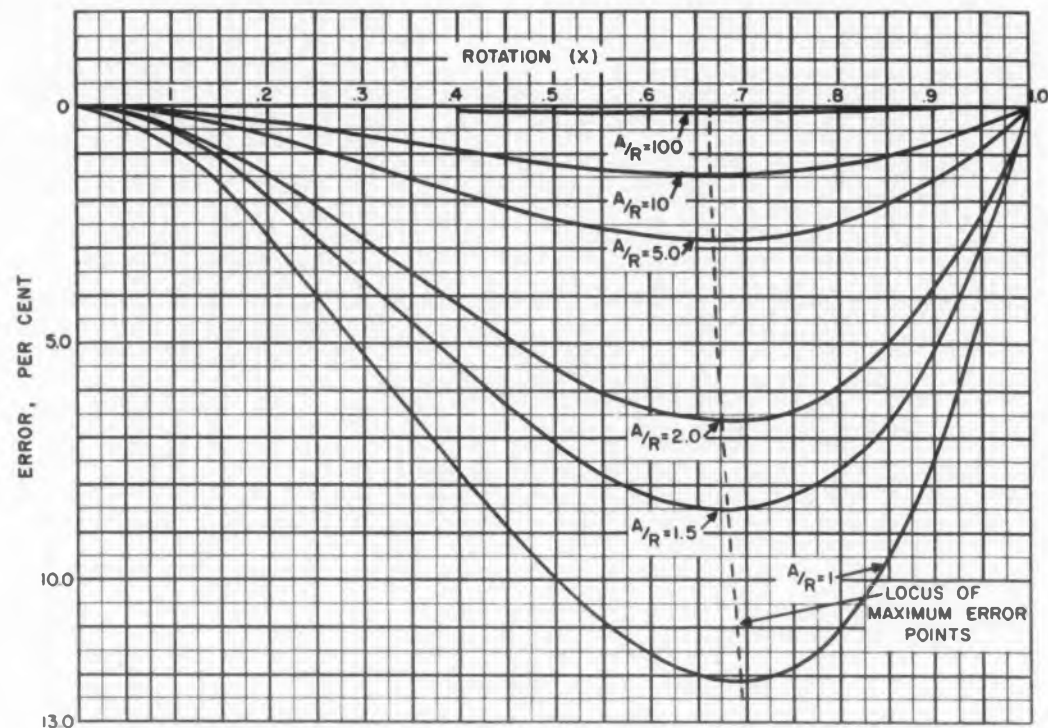


Fig. 13. Design curve for locating exact point of maximum loading error for either "loaded-down" or "loaded-up" condition.

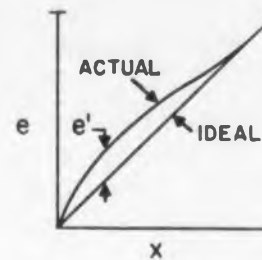


Fig. 8. Curves of e vs x for ideal and actual conditions. (Compare with Fig. 2).

$$e = \frac{Ex \left[1 + \frac{R}{A} (1-x) \right]}{1 + \frac{R}{A} x (1-x)} \quad (6)$$

The ideal potentiometer output is still expressed by Eq. 2; so the error versus rotation is Eq. 6 minus Eq. 2 or

$$e' = Ex \left[\frac{1 + \frac{R}{A} (1-x)}{1 + \frac{R}{A} x (1-x)} - 1 \right] = \frac{ERx (1-x)^2}{1 + \frac{R}{A} x (1-x)} \quad (7)$$

Again, the maximum error occurs when $de'/dx = 0$.

$$0 = \frac{de'}{dx} = E \left[\frac{1 + \frac{R}{A} (1-x)}{1 + \frac{R}{A} x (1-x)} - 1 \right] + Ex \quad (8)$$

$$\left[\frac{1 + \frac{R}{A} x (1-x)}{1 + \frac{R}{A} x (1-x)} \right] \left[\frac{-R}{A} \right] - \left[1 + \frac{R}{A} (1-x) \right] \left[\frac{R}{A} (1-2x) \right]$$

This reduces to

$$A (1 - 3x) = Rx^2 (1 - x) \quad (9)$$

Again, there are three methods for solution.

1. Plot Eq. (3a) using various values for R/A . See Fig. 7.

2. Plot $x = x'$ and $x' = \frac{A}{R} (1 - 3x)$. See Fig. 8.

3. Plot $\frac{A}{R} (1 - 3x) = x'$ and $x' = x^2 (1 - x)$. See Fig. 9.

In methods 2 and 3, the intersections are the points desired.

It will be observed by comparing Figs. 4 and 10 that the error curves for potentiometers loaded up or down (with any specific A/R value) are anti-symmetrical. Therefore, accurately drawn curves of Eqs. 3 and 7 can be used as a tool for quickly checking magnitude of loading error and maximum error location. Such a curve is drawn in Fig. 13, for use in design planning.

Using the Curve

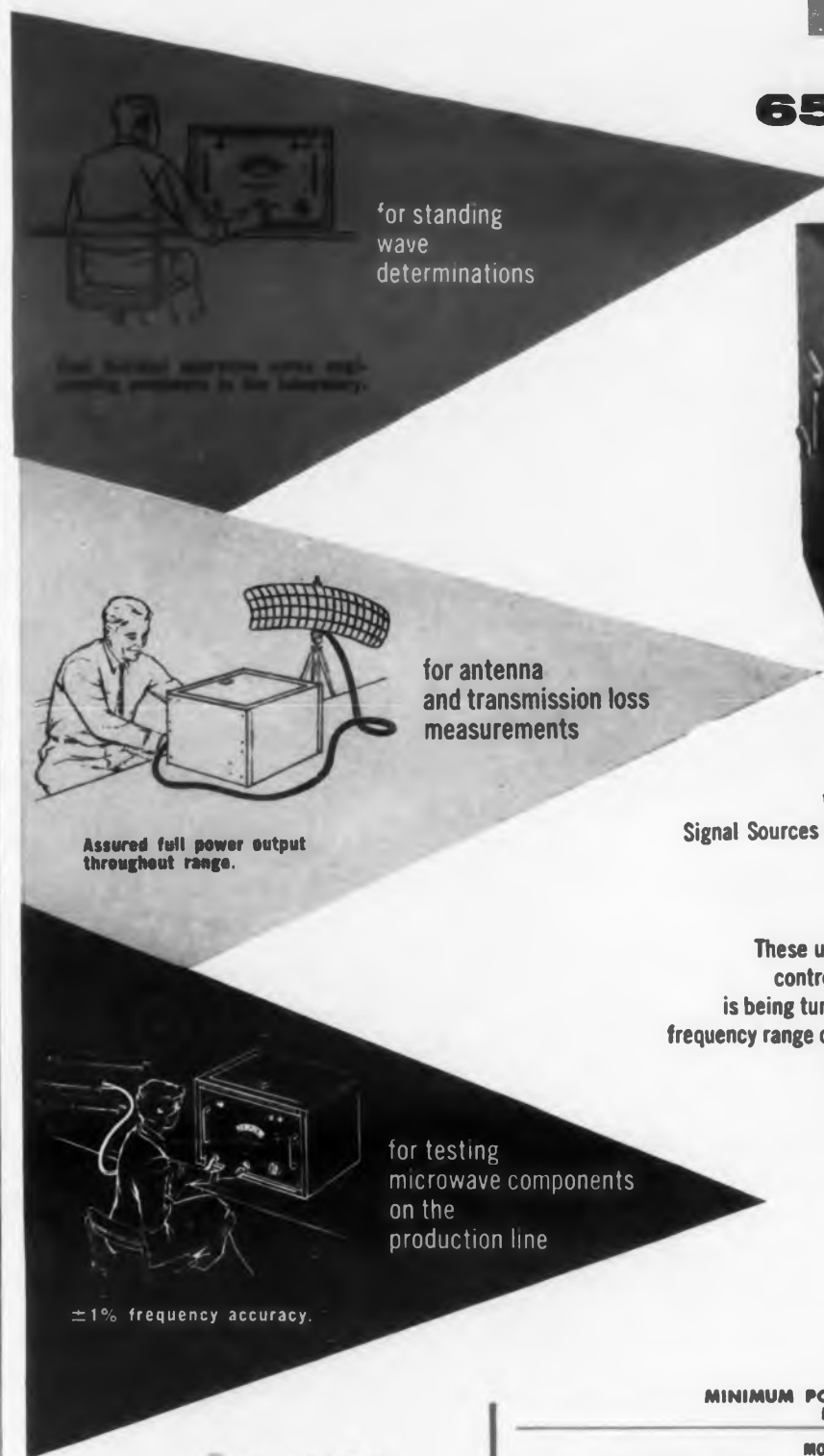
As an example of how Fig. 13 can be used in design, assume $A/R = 1$. From the curve, $e' = 12.2\%$ and $x = 0.69$.

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- Reducing Potentiometer Loading Error, L. A. Nettleton and F. E. Dole, *Review of Scientific Instruments*, Oct. 1946.
- Compensating Pot Loading Errors, J. Gilbert, *Control Engineering*, Feb. 1955.
- Characteristics of Precision Servo Computer Potentiometers, C. C. Duncan, *AIIE Conf.* Dec. 1951.

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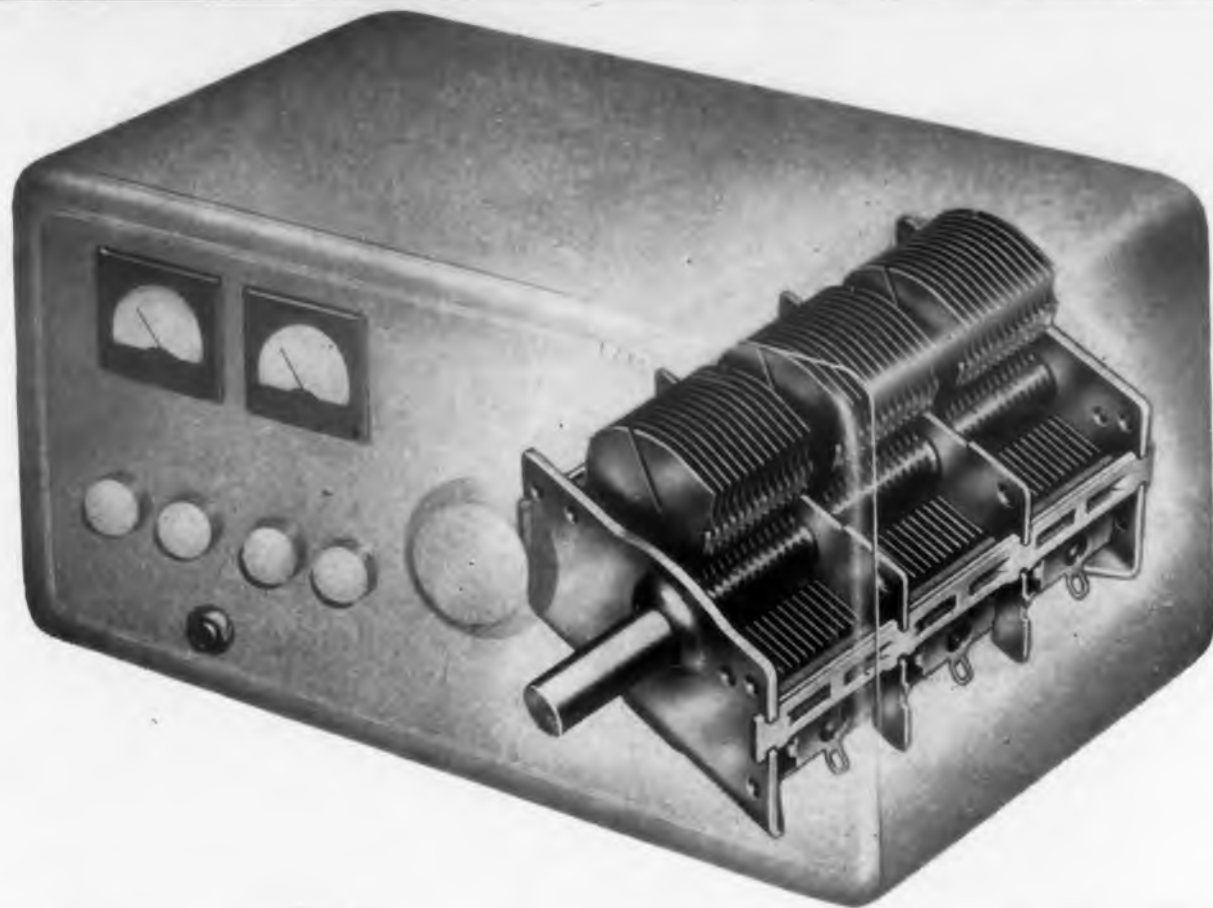
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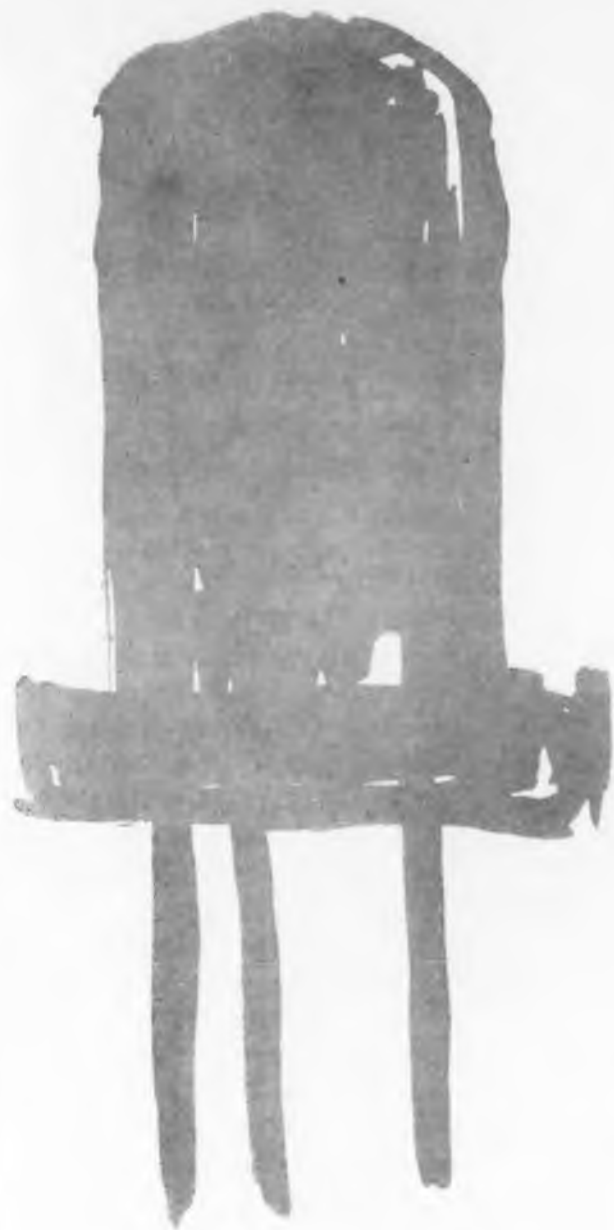
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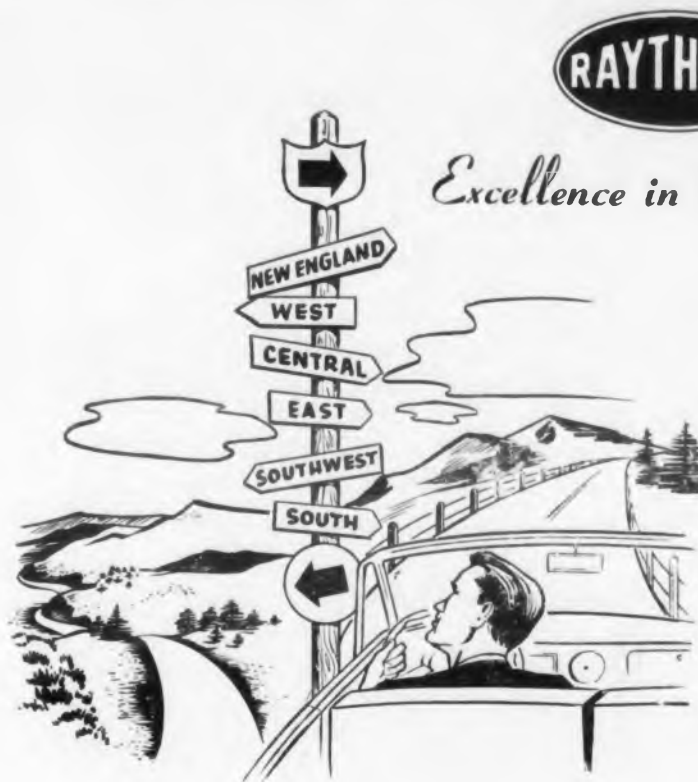


Maximum ratings are a dc collector to base voltage of -35 v, an emitter-to-base voltage of -1 v, a collector current of -10 ma, and an emitter current of 10 ma. The collector dissipation for an ambient temperature of 70 C is 35 mw maximum, and the storage temperature range is from -55 to $+85$ C.

The transistors come in two types, the 2N47 and the 2N67, with the latter having a slightly larger feedback capacitance in a common-emitter type of circuit. Both come hermetically sealed in an insulated metal case with flexible leads. The leads may be soldered close to the glass stem if suitable precautions are taken, or they can be dip-soldered for use in printed circuitry.

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CIRCLE 45 ON READER-SERVICE CARD FOR MORE INFORMATION

Tubeless DC Source .01 Per Cent Regulation



This tubeless dc source provides 6 v dc and 2 v dc output voltages regulated to within $\pm .01$ per cent.

A silicon diode is used as reference element, and a transistor

amplifier provides the control current for the magnetic amplifier. The transistor amplifier is temperature-compensated for small ambient room changes.

Input voltage range of the Model MA6501 is 105 to 125 v ac, single phase, 60 cy. There are 3 output voltages; 6 v dc, adjustable internally ± 5 per cent, 5 amp load; 6 v dc, 100 ma load; 2 v dc, 40-60 ma. Regulation is $\pm .01$ per cent for line changes within ratings on all supplies. Ripple is 15 mv rms maximum on the 6 volt outputs, 5 mv rms maximum of the 2 volt output. Typical stability after a 30 min warm-up is .01 per cent for an 8 hr period. Weight of the standard unit is 60 lbs.

Sorensen & Co., Dept. ED, Fairfield Ave., Stamford, Conn.

CIRCLE 46 ON READER-SERVICE CARD FOR MORE INFORMATION

Electronic Switch Wide Frequency Range



The electronic switch model ES-17 provides a wide range of frequency response for superimposing two separate signals on a single beam oscilloscope.

Phase and frequency are compensated by 5 step, input attenuators. Input signal amplitudes range from 10 mv rms to 200 v rms.

The frequency response is dc to 4 mc at 6 db and the free running multivibrator is continuously variable from 20 cps.

Vanguard Instruments Corp., Dept. ED, 184 Casper St., Valley Stream, N.Y.

CIRCLE 47 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistor Oscillator Battery Powered



A self-contained, battery powered unit, The Model J Transistor Oscillator is designed for locating trouble in carrier systems, audio circuits, and audio test equipment.

It provides pure, stable sine wave output voltages of 0, -13, -16

DBM at 1000 cy into 600 ohm line.

The oscillator uses a push-pull transistor and LC circuit inductively coupled to the output terminals by a separate transformer winding.

Distortion is less than 3 per cent, and frequency variation is less than 3 per cent at normal ambients under 125 F. Voltage output variation less than 4 per cent.

The 2-cell mercury battery, self-contained in the unit, has a life of 700 hrs with continuous use.

Stewart Bros., Dept. ED, 315 W. Walton Pl., Chicago 10, Ill.

CIRCLE 48 ON READER-SERVICE CARD FOR MORE INFORMATION

Teflon Products Pipe, Tubing, Special Parts



Teflon pipe and tubing up to 4 in. diam and Teflon lined steel pipe in 2 in. sizes are now available from this firm. Rods and special machine parts of

Teflon are also offered. These products can all be cut to desired lengths in the field and readily flanged.

Haveg Industries, Inc., Dept. ED, 900 Greenbank Rd., Wilmington 8, Del.

CIRCLE 49 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistor Reader

Portable Battery Operated



This instrument tests both pnp and npn low power junction transistors, permitting small signal Beta measurements to 250 using 2 scales, 0-50 and 0-250. The

direct comparison method is used, against a known attenuation factor using a self-contained oscillator and linear amplifier with 5 per cent accuracy. Calibration requires no standard transistor.

The Model 101 measures collector cut-off current, I_{co} , in microamperes (rather than collector current), as leakage I_{co} measurements afford direct correlation with noise factor and are valid in determining damage or defective transistors. Both I_{co} and Beta measurements are directly comparable with transistor manufacturer's specifications. Internal transistors interchangeable with similar types without circuit alterations or factory calibration.

Durson Co., Dept. ED, 10416 National Blvd., Los Angeles 34, Calif.

CIRCLE 50 ON READER-SERVICE CARD FOR MORE INFORMATION

Sensitive Relay Sealed Miniature



This relay is applicable where compactness, light weight are essential, or where external electromagnetic effects must be minimized. The Model 1081 is housed in a brass tinned finished case and is supplied for miniature

7 pin socket operation or with curved terminals for solder connection. For maximum shielding Mu-metal cases can be furnished. Sensitivities as high as 50-0-50 μ amp at a coil resistance of 2300 ohms are available. Non-magnetic contacts carry 35 ma at 6 v dc non-inductive at high-sensitivity. Loads up to 0.5 amp at 28 v dc non-inductive can be handled depending upon the moving coil sensitivity and number of operations. High and low contacts can be arranged for zero center, single pole, double throw operation or suppressed zero with one contact normally closed.

Weston Electrical Instrument Corp., Dept. ED, 61 Frelinghuysen Ave., Newark 5, N. J.

CIRCLE 51 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • November 1, 1956

KEPCO

with **NEW-IMPROVED FEATURES**

★ **FAST RECOVERY TIME**

★ **GOOD STABILITY**

★ **LOW OUTPUT IMPEDANCE**

KR Voltage Regulated Power Supplies are conservatively rated and are designed for continuous duty at 50°C ambient.

REGULATION: Less than 0.2 volts for line fluctuation from 105-125 volts and less than 0.2 volts for load variation from 0 to maximum current.

RIPPLE: Less than 3 mv. rms.

STABILITY: The output voltage variation is less than the regulation specification for a period of 8 hours.

RECOVERY TIME: Less than 50 microseconds. The excursion in the output voltage during the recovery period is less than the regulation specification.

OUTPUT IMPEDANCE: Less than 0.1 ohms from 20 cycles to 100KC. Less than 0.5 ohms from DC to 20 cycles. Many units have very much lower output impedance.



KR-3M

FEATURES:

- Fast Recovery Time, Suitable for Square Wave Pulsed Loading.
- Voltage Range continuously variable without Switching.
- Either Positive or Negative may be Grounded.
- Oil Filled Condensers.
- Wire Harness and Resistor Board Construction.
- Power Requirements 105-125 volts, 50-60 cycles.
- Terminations on rear of unit.
- Locking type voltage control AC, DC Switches, Fuses, and Pilot Lights.
- Color Grey Hammertone.
- Guarantee One Year.

All models available for 400 cycle operation on special order.



KEPCO LABORATORIES

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

CIRCLE 52 ON READER-SERVICE CARD FOR MORE INFORMATION

VOLTAGE REGULATED POWER SUPPLIES

for powering electronic equipment

S KR S

1.5 Amp. KR SERIES

Model	Volts	6.3V AC	Rack Mount			Price
			W	H	D	
KR16	0-150	Each supply	19"	12¼"	17"	\$625
KR17	100-200	has two	19"	12¼"	17"	\$625
KR18	195-325	15 Amp.	19"	12¼"	17"	\$695
KR19	295-450	outputs	19"	12¼"	17"	\$685

600 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount			Price
			W	H	D	
KR 8	0-150	Each supply	19"	10½"	13"	\$330
KR 5	100-200	has two	19"	10½"	13"	\$240
KR 6	195-325	10 Amp.	19"	10½"	13"	\$240
KR 7	295-450	outputs	19"	10½"	13"	\$250

300 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount			Price
			W	H	D	
KR 12	0-150	Each supply	19"	7"	11"	\$270
KR 3	100-200	has two	19"	7"	11"	\$180
KR 4	195-325	5 Amp.	19"	7"	11"	\$180
KR 10	295-450	outputs	19"	7"	11"	\$180

125 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount			Price
			W	H	D	
KR 11	0-150	Each supply	19"	7"	11"	\$180
KR 1	100-200	has one	19"	7"	7½"	\$ 90
KR 2	195-325	3 Amp.	19"	7"	7½"	\$ 90
KR 9	295-450	output	19"	7"	7½"	\$ 97

To include 3" Current and Voltage Meters, Add M to Model number (e.g. KR 16-M) and Add \$30.00 to the Price.

To include Dust Cover and Handles for Table Mounting, Add C to Model number (e.g. KR16-C) and Add \$18.00 to the Price.

To include Meters, Dust Cover and Handles, Add MC to Model number (e.g. KR-16 MC) and Add \$40.00 to the Price.

PRICES F.O.B. Flushing.

A LINE OF 50 MODELS

Available from Stock - Catalog on Request

Transistor Transformers

Miniature Lightweights

Thirty-three new transformer types are now available from a complete line of transistor transformers. All are wound on nylon bobbins, with a Mylar outer wrap. Laminations are of nickel steel or silicon steel. Average weight is 1-1/4 oz with 2 sizes available, 3/4 x 5/8 x 5/8 in. and 1 x 3/4 x 3/4 in. They combine the needs of miniaturization, power handling capacity and improved frequency response.

Argonne Electronics Mfg. Corp., Dept. ED, 27 Thompson St., New York 13, N. Y.

CIRCLE 53 ON READER-SERVICE CARD

Cooling Electronic Tubes

Applications Up To 100 KW

Radio, radar and TV Klystron vacuum tube cooling is available for applications requiring the dissipation from 1 to 100 kw of heat.

The Fluid Cooler equipment complies with commercial and military requirements, and is designed for operation anywhere in the world.

Major components of this electronic tube cooling equipment, which use ambient air as a cooling medium, are: an extended surface cooling coil, a centrifugal or propeller fan, a high pressure circulating pump, and automatic safety controls to safeguard the tube.

The Trane Company, Dept. ED, La Crosse, Wisc.

CIRCLE 54 ON READER-SERVICE CARD

Dioxane Reagent

High-Purity Solvent

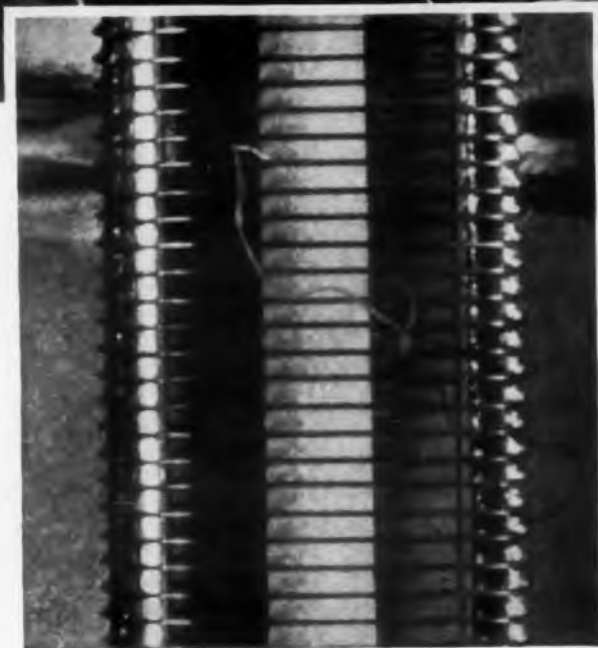
A new certified-reagent Grade Dioxane No. D-111 extends this reagent's usefulness to applications where a low iron, low peroxide, high purity solvent is a must. Typical Analysis of the new dioxane: water, 0.025 per cent; peroxides, 0.003 per cent; carbonyls, 0.004 per cent; iron and heavy metals, 0.0001 per cent.

It will be available in quarts and gallons.

Fisher Scientific, 717 Forbes St., Pittsburgh 19, Pa.

CIRCLE 55 ON READER-SERVICE CARD

CIRCLE 56 ON READER-SERVICE CARD >

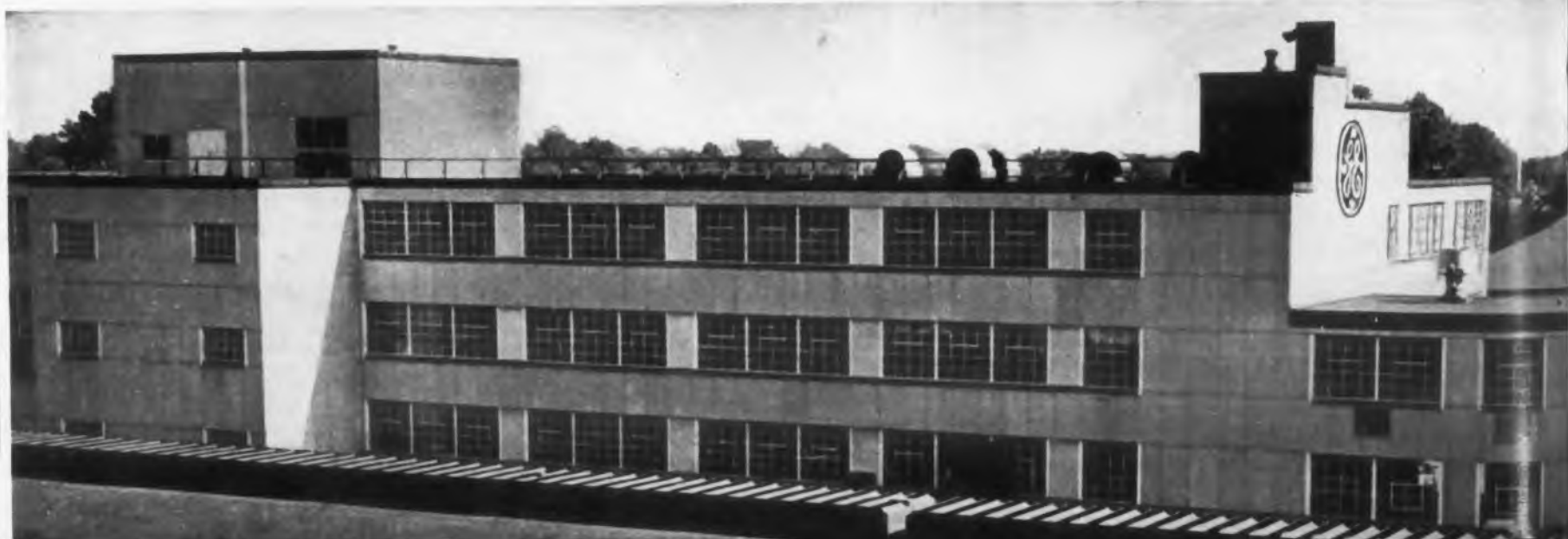


▲ **LINT IS A TROUBLE-MAKER!** The unretouched micro-photo above shows a strand of lint which easily can cause an inter-electrode short-circuit. Dust particles within a tube have the same harmful effect.

▲ **MANUFACTURED "UNDER GLASS"!** For optimum cleanliness, 6829's are assembled under glass-paneled protective hoods. All G-E employees who build 5-Star Tubes wear rubber finger cots, and their uniforms are lint-free Nylon and Dacron. These precautions are taken to ward off lint and dust, most frequent causes of intermittent tube "shorts".

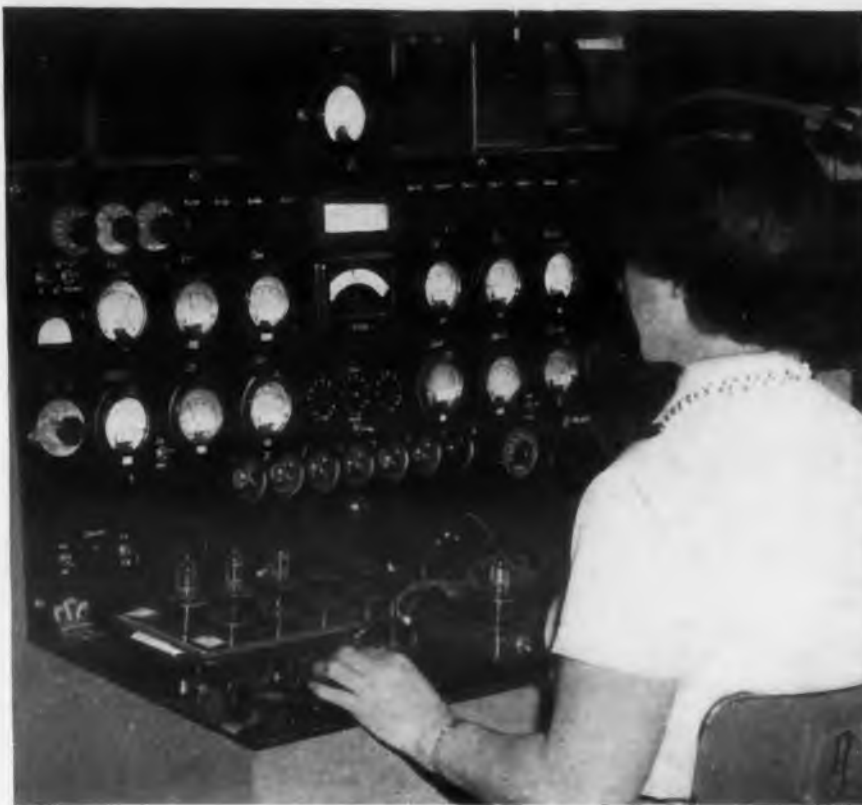
FIRST GENERAL ELECTRIC HAS LINT-FREE

▼ **1200 WORKERS ASSEMBLE 6829's AND OTHER HIGH-RELIABILITY TUBES** in this 5-Star building, located apart from the rest of G.E.'s Owensboro, Ky., tube factory. Because of the special white lintless uniforms, plus immaculately clean working conditions, "Operation Snow White" is aptly used to describe G-E 5-Star Tube manufacture. The entire assembly and inspection area is pressurized, with air that has been filtered, dehumidified and cooled.





▲ **SPECIALLY TESTED . . . BIASED TO CUT-OFF FOR LONG INTERVALS!** Life tests of G-E computer tubes under cut-off conditions, are made in order to be sure no "sleeping sickness", or failure to respond to grid input pulses, develops during inactivity. This is determined by means of periodic interface checks.



▲ **CHECKED FOR COMPUTER-SERVICE CHARACTERISTICS!** G-E computer tubes are specifically tested for those electrical qualities that closely affect tube operation in computer circuits. Among the characteristics checked are zero-bias plate current . . . cut-off performance . . . difference in cut-off between both triode sections.

5-STAR COMPUTER TUBE MANUFACTURE FOR ADDED RELIABILITY

**Shock-resistant design—comprehensive cut-off tests—further establish Type 6829
as the most trustworthy tube you can apply in military computers!**

General Electric, first to design and build a new line of tubes for computers, now pioneers the first 5-Star high-reliability tube for computer circuits—analogue and binary—where airborne, gunnery, or field-transport conditions call for resistance to mechanical shock and vibration.

Type 6829 has the many 5-Star design features that give added strength, such as a compact, sturdy tube cage . . . double mica spacers . . . a double-staked getter. In addition, tube assembly is carried on in immaculate surroundings free

from lint and dust, while special tests assure those electrical qualities that are essential in achieving computer dependability.

A 9-pin miniature, the 5-Star 6829 has similar characteristics to standard computer Type 5965. The new tube is designed for high-speed circuits—has high perveance, balanced, sharp cut-off qualities, and low heater power requirement (.45 amp).

Get the complete performance story! Write to *General Electric Company, Electronic Components Division, Schenectady 5, New York.*

Progress Is Our Most Important Product

GENERAL  ELECTRIC

167-1C1

Teflon-Base Coating

Is Anti-Static

The formula for "Gencote 108" utilizes Teflon as the base material, retaining all its characteristics, but reverses the electrical insulation feature to create electrical conduction. Thus, it is now possible to achieve an anti-stick, dry-lubricated, chemically inert surface that is anti-static as well.

The electrical resistance across this new coating, when applied in a 4 mil film, is approximately 1 ohm. Surfaces can be coated in multiples of 1/2 mil up to 10 mils, on any type metal or other materials which can withstand a temperature of 700 F, required for the baking process. As a result, electrically conductive surfaces can also be applied over an insulating base, such as glass, ceramics, and porcelain.

The anti-static feature: permits powders to flow freely; reduces friction between platens and film in cameras, eliminating static sparking; eliminates accidental detonation of explosives by static discharge in mechanical handling; has an unlimited range of other applications.

General Plastics Corp., Dept. ED, Paterson, N.J.

CIRCLE 57 ON READER-SERVICE CARD

Hydrogen Thyatron

For Mobile and Airborne Use

The BL-257 is a hydrogen thyatron that is electrically similar to an E37A but ruggedized for vibration and high impact service, especially in mobile and aircraft applications requiring moderately high power. The tube is conservatively rated for 5 g vibration from 60 to 500 cps, and 3 g from 500 to 1200 cps, and also for 60 g high impact shock in any direction.

Electrical ratings are 8.0 kv peak anode voltage, 90 amp peak current, and 100 ma maximum anode current. It is rated for an ambient temperature range of -50 to +90 C and for an altitude of 10,000 ft in air. The tube may be immersed in oil for high altitude application.

Bomac Laboratories, Inc., Dept. ED, Salem Rd., Beverly, Mass.

CIRCLE 58 ON READER-SERVICE CARD

◀ CIRCLE 56 ON READER-SERVICE CARD

**THESE ARE ONLY
THE BEGINNING...**

**Can you
help us
create more?**

The superior performance of these typical CBS semiconductors is acknowledged. Demand is growing fast . . . for them and for an ever increasing variety of new CBS transistors and crystal diodes. We need more scientists and engineers to help create them:

Specialists — physicists, chemists, metallurgists, as well as electrical and mechanical engineers for research on materials, devices, fabrication techniques, applications, and instrumentation.

Project engineers — men with broad capabilities to administer all the phases of research and development of new products.

To join us, you do not have to be experienced in semiconductors. We prefer for these positions, competent, intelligent men who welcome challenging problems. To them, we offer:

- Attractive salaries
- Opportunities for rapid advancement
- Association with leaders in the field
- Local educational advantages
- Many employment benefits
- Positions with an established organization of unexcelled reputation

If you are interested in a creative engineering opportunity in the growing field of semiconductors, write us today. Send your resume to our manager of semiconductor operations, Dr. Ben H. Alexander, CBS-Hytron, Lowell, Massachusetts.

*Reliable products
through Advanced-Engineering*



semiconductors

CBS-HYTRON

Semiconductor Operations, Lowell, Mass.
A Division of
Columbia Broadcasting System, Inc.

CIRCLE 61 ON READER-SERVICE CARD FOR MORE INFORMATION

Flyback Checker
Also Tests Condensers



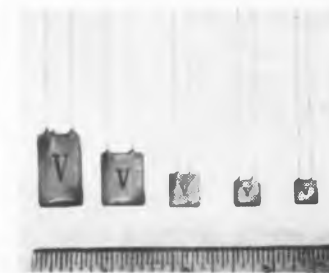
The Model 124 "Flybacker Plus" is an accurate condenser checker in addition to being a highly sensitive flyback transformer and yoke tester. It accurately shows up leakage in mica capacitors.

Five easy reading scales include a separate scale for yokes and one for capacitors. The unit tests all flybacks, yokes, and condensers without disconnecting them from the circuit, or tests them individually (not connected to anything). Tests are made at operating conditions of above 200 v of pulsed power. The unit weighs 8 lb and has a size of 10 x 6 x 5 in.

Radio City Products Co., Inc., Dept. ED, Centre & Glendale Sts., Easton, Pa.

CIRCLE 62 ON READER-SERVICE CARD FOR MORE INFORMATION

Ceramic Capacitor
Sub-Miniature



This series of sub-miniature extended temperature range ceramic capacitors maintain over 90 per cent of capacitance through temperatures ranging from 55 to ± 125 C. The capacitor

is rated at 200 working volts dc. It employs a high density ceramic material which provides a very high dielectric constant per unit area.

The Val-Cap 2000K series capacitor is initially offered in 5 sizes ranging from 1/4 in. x 1/4 in. x 0.050 thick with capacitance of 0.0033 μ f, to 1/2 in. x 3/4 in. x .080 thick with capacitance of 0.05 μ f.

Valco Engineering Sales Co., Dept. ED, 2538 S. Highland Ave., Los Angeles 16, Calif.

CIRCLE 63 ON READER-SERVICE CARD FOR MORE INFORMATION

Polyurethane Plastic Material
Insulating Foam

"Gemfoam," a complete line of polyurethane plastic material for cushioning, padding and insulation, is now available in rolls, sheets or slabs in thicknesses from 1/8 in. to 12 in., and widths up to 48 in. The line includes 10 resiliencies, from very soft to very firm in any shade of the 7 basic colors.

Polyurethane foam products are light in weight, durable, odorless and resistant to corrosion and oxidation. They also have excellent acoustical and thermal insulating qualities.

Texas Foamed Plastics Corp., Dept. ED, Gonzales, Texas.

CIRCLE 64 ON READER-SERVICE CARD FOR MORE INFORMATION

KAY LAB
CALIFORNIA

STABILITY  Locked in!
WITH CHOPPER AMPLIFIERS

**MEASURE
AMPLIFY**
μV...μA



MODEL 203

KAY LAB DC Microvoltmeters measure and amplify, exceptionally small DC voltages and currents, with unequalled stability. Zero centered mirrored scale for reading speed and accuracy.

SPECIFICATIONS

- 100 uv to 1000 v
 - 100 uua to 100 ma
 - 25 ranges
 - 100 megohms input
 - 80 db gain as amplifier
 - 10 uv equivalent drift
 - 1 v output
- Price \$550.00

Representatives in all major cities

KAY LAB

725 KEARNEY VILLA ROAD
SAN DIEGO 12, CALIFORNIA

CIRCLE 65 ON READER-SERVICE CARD

Silicone Foam Rubber

Highly Resilient



A new material, silicone foam rubber, is light in weight and remains soft and resilient over a temperature range of 100 F to 480 F. Because of its interconnecting cell

structure, the foam recovers shape instantly after being compressed for long periods at elevated temperatures, and can be readily molded into complex shapes.

Branded COHRfoam, the silicone rubber is inert to ozone and weathering, is non-sticking, non-corrosive, odorless and has good electrical properties. It will be offered in sheet form and custom moldings up to 8 in. thick.

Physical data on the foam include a specific gravity of 0.20 to 0.35, a compression deflection of 0.75 to 1.25 psi, a compression set of 14 per cent, and a flexibility from 100 F to 480 F.

Anticipated uses for the foam include sound and vibration packing, and electrical and thermal insulation.

Connecticut Hard Rubber Co., Dept. ED, 407 East St., New Haven 9, Conn.

CIRCLE 66 ON READER-SERVICE CARD FOR MORE INFORMATION

X-Band Ferrite Isolator

Medium Power Miniature



Shown here is a 100 kw resonant absorption miniature X-band ferrite isolator. It insures high magnetron spectrum and power output by furnishing isolation between magnetron and

RF energy reflected from line mismatches.

The uni-directional isolator has the ferrite material mounted directly on the waveguide wall. This, in conjunction with the full waveguide opening, permits the rapid conduction of heat away from the waveguide thus allowing operation at medium power levels without forced air cooling.

To cover the frequency range from 8500 to 9600 mcs, 4 units may be required with an isolation of 10 db min, insertion loss of 0.5 db max and input VSWR of less than 1.10.

Airtron Inc., Dept. ED, 1103 W. Elizabeth Ave., Linden, N. J.

CIRCLE 67 ON READER-SERVICE CARD FOR MORE INFORMATION



for MINIMUM SIZE

... the exceptionally reduced sizes and light-weight of Aerovox metallized-paper capacitors makes them ideal for those applications where space is at a premium.

for MAXIMUM PERFORMANCE

... the unique properties of Aerovox metallized-paper capacitors—ruggedness, reliability, and high safety factor assure you of longer equipment life.

for WIDEST OPERATING TEMPERATURES

... Aerovox metallized-paper capacitors are available in a wide variety of case styles for operation at temperatures ranging from -65°C to $+125^{\circ}\text{C}$.

Complex electronic equipment such as guided missiles, computers, airborne receivers, transistorized radios and color TV have successfully applied Aerovox metallized-paper capacitors. You are invited to consult with our capacitor specialists for experienced assistance in selecting the right metallized-paper capacitor for your particular needs. Complete detailed information, quotations, delivery schedules, available on written request.

AVAILABLE NOW...
METALLIZED MYLAR CAPACITORS!

[®]Du Pont Trademark



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CIRCLE 68 ON READER-SERVICE CARD FOR MORE INFORMATION



NEWEST PRINCIPLE

No wonder the new Silic-O-Netic Time Delay Relay has aroused such interest. It offers basic advantages as a delay device unequalled in its low price range.

The Silic-O-Netic Relay provides delay with no mechanical linkages . . . no mechanism to speak of. . . only one moving part, and that part is hermetically sealed, forever free of dirt and dust. It operates on a positive change in magnetic flux which is sharply defined as the movable core touches the pole piece. Moreover, the new Type A model has high speed contacts, affords good contact pressure.

in TIME DELAY RELAYS

Heinemann Silic-O-Netic Relays are already being used in dozens of volume applications where absolute dependability is essential. They are well worth your investigation.

Write for Bulletin T-5002

IT'S DIFFERENT...

No thermal elements . . . no aging, no fatigue . . . long-life stability.

Small size . . . Overall dimensions: 2 $\frac{1}{16}$ " x 1 $\frac{1}{16}$ " x 2".

Delay periods . . . $\frac{1}{4}$ to 120 seconds.

Low cost . . . achieved in 20 years of solenoid manufacturing experience.

HEINEMANN

ELECTRIC COMPANY

156 Plum St., Trenton 2, N. J.



CIRCLE 70 ON READER-SERVICE CARD FOR MORE INFORMATION

Frequency Calibrator Precision Unit



The Type 1213-C Calibrator comprises, with power supply headphones, all the circuits necessary for the calibration of oscillators, receivers,

and other wide-range devices up to frequencies above 1000 mc. It also provides square-wave markers for oscilloscope sweep-time calibration at intervals from 0.1 μ sec to 100 μ sec.

Features incorporated into this instrument include harmonic series with fundamentals of 10, 1, 0.1, and 0.01 mc, a crystal mixer good from low frequencies to frequencies above 1000 mc, an amplifier for audible beats, and a video-frequency amplifier output for sweep-time calibrations. The output can trigger pulse generators and oscilloscope sweeps, thus providing a stable driving source for timing pulse systems for various applications.

General Radio Co., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE 71 ON READER-SERVICE CARD FOR MORE INFORMATION

Portable Pyrometer Checks Many Instruments



A portable potentiometer pyrometer for checking and calibrating all types of industrial and laboratory temperature instruments, the "Pyrotest" 9B has interchangeable direct-reading scales. It can be used with as many as six types of thermocouples.

Equipped with a set of nine scales (six for temperature, and three for millivolts) the unit is essentially nine instruments in one. It may be used to check and calibrate any temperature recorder, indicator, or controller operating within 32-3215 F and employing any type of thermocouple. In addition, the unit measures the dc potentials of electrical equipment within a range of 0-155 mv.

Accuracy is 1/6 of 1 per cent of scale spans. Slide-wire resolution exceeds 4000 increments, and effective open scale length is 50-1/2 in., permitting the measurement of the slightest temperature or millivolt differences. The "Pyrotest" is completely self-contained with a built-in power supply. Weight is only 14 lb.

Technique Associates, Inc., Dept. ED, 211 E. South St., Indianapolis 25, Ind.

CIRCLE 72 ON READER-SERVICE CARD FOR MORE INFORMATION

SPEED PRECISION PUNCHING



with
"TAPER-WEDGE"
design

WALSCO PIONEER CHASSIS PUNCH



Save time and labor with the "TAPER-WEDGE" design... a permanent, precision cutting edge that bites into metal and plastic. WALSCO Pioneer Chassis Punches make hole punching faster, easier, more accurate. Complete size range available at Parts Jobbers everywhere.

WALSCO HAM-R-PRESS

PORTABLE
OR BENCH
MOUNTED



No drilling... chassis punching is done quickly, economically with a hammer. Change dies in less than 20 seconds. WALSCO Ham-R-Press cuts exact, clean mounting holes in all chassis, metal panels, plastic sheets, etc. Many sizes of WALSCO "TAPER-WEDGE" punches and dies available. See your Parts Jobber.

WALSCO ELECTRONICS CORP.

A SUBSIDIARY OF Tektronix CORPORATION

3602 Crenshaw Blvd.,
Los Angeles 16, Calif.

CIRCLE 73 ON READER-SERVICE CARD

for
applications

where

reliability

is

of

vital

importance—

SPECIFY

BAKER

CONTACTS

OF PLATINUM

AND

PLATINUM

ALLOYS

Particularly suited for applications where reliability is of vital importance, PLATINUM offers a higher resistance to atmospheric corrosion and tarnish than any other material. A low contact resistance can be maintained for some applications with contact pressures in the order of one gram. PLATINUM ALLOYS maintain the high resistance to corrosion and tarnish in addition to providing other desirable features, such as higher melting points and greater hardness. These physical properties produce increased resistance to surface deformation, metal transfer and sticking, as well as longer life.

BAKER PLATINUM and PLATINUM ALLOYS can be supplied as wire, rod, sheet or in fabricated forms—rivets, discs, solder-backs, welding types, overlay, edgelay, inlay and irregular shapes.

Consult BAKER for the solution to your contact problem. Request, on company letterhead, BAKER's new 28-page ELECTRICAL CONTACTS CATALOG.



113 Astor Street, Newark 5, N. J.

ENGELHARD INDUSTRIES

CIRCLE 75 ON READER-SERVICE CARD

Miniature DC Supplies

Operate from 115 V 400 CPS



Designed to supply regulated dc voltage for powering airborne electronic equipment from 115 v 400 cps single phase source, this new line of packaged power supplies operates reliably under aircraft and missile environments. Standard sizes are 100-600 v dc, up to 1000 ma.

Regulation, provided entirely through magnetic amplifiers, is 0.10 per cent, and ripple is 0.05 per cent. Units meet MIL-E-5272A and 1-6181B specs, and they are potted in hermetically sealed drawn steel cans. AN connectors or solder headers are available. Mounting is through studs projecting from the base.

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

CIRCLE 76 ON READER-SERVICE CARD FOR MORE INFORMATION

DC Hypot

With Range to 5000v



The Model 424 DC Hypot has been redesigned for increased efficiency and range of application. Continuously variable output voltage from 0-5000 v dc is provided and read on a

4-1/2 in. voltmeter connected directly across the high voltage output, accurate to 3 percent. For measuring leakage current, ranges of 0-5/10/50/100 μ amp are provided on a 4-1/2 in. microammeter automatically protected against overload, and accurate to 3 percent.

Ripple of the unit is less than 1 per cent at rated voltage and current. Output terminates in two 5 ft. high voltage leads, with the "hot" lead equipped with a retractable tip rod. Controls include a continuously variable auto-transformer to vary output voltage, a "high voltage on" switch with pilot light, and a "filament on" switch with pilot light.

The case is a rack and panel type, 22 x 14-3/4 x 12-5/16 in. high, equipped with carrying handles and lid interlock. The unit can also be supplied with chassis only for panel mounting. Net weight is 25 lb. It is recommended for testing ignition harnesses, electronic components, and electrical machinery.

Associated Research, Inc., Dept. ED, 3758 W. Belmont Ave., Chicago 18, Ill.

CIRCLE 77 ON READER-SERVICE CARD FOR MORE INFORMATION



THERMAL CONDITIONING OF ROCKETS AND GUIDED MISSILES



HEATING OPTICAL, ELECTRONIC, OR HYDRAULIC AIRBORNE EQUIPMENT

WHERE CAN YOU USE G-E SPECIALTY HEATING EQUIPMENT?

Whenever your equipment requires thermal conditioning, General Electric specialty heating equipment can help.

G.E. has had extensive design and manufacturing experience in providing controlled heating for a wide variety of applications. These applications range from giant guided missile blankets to tiny one-inch-long accelerometer heaters. Problems of intricate shape, large or small size, unusual environmental conditions, and amount of heat required have all been solved.

LET US ANALYSE YOUR HEATING PROBLEM; a General Electric specialty heating expert is available and a prompt answer is assured.

FOR MORE INFORMATION contact your General Electric Aviation and Defense Industries Sales Office or send coupon.

General Electric Company
Section W 220-10A, Schenectady 5, N. Y.

Please send me new bulletin GEA-6285,
G-E Specialty Heating Equipment.

for immediate project
 for reference only

Name

Position

Company

City..... State.....

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 78 ON READER-SERVICE CARD FOR MORE INFORMATION

Servo Actuator 400 Cps Rotary Unit



The Servo Controlled Flat Package Actuator is designed for 400 cps airborne applications. It can be operated from magnetic, transistor, or vacuum tube amplifiers,

and can be supplied in two output torque ratings: 100 in.-lb at stall and 50 in.-lb at 1.8 rpm; or 50 in.-lb stall and 25 in.-lb at 3.6 rpm.

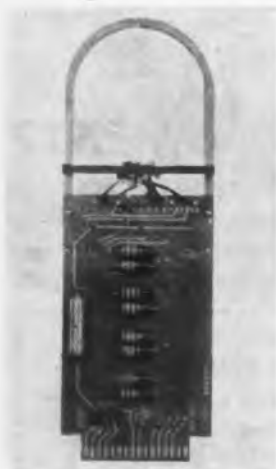
This rotary actuator is available with or without ac tachometer feedback for stabilization purposes. Position feedback may be provided by either an internal potentiometer or synchro signals. Internal fixed stops and limit switches can be incorporated, if required.

Maximum overall dimensions excluding shaft extension are 6 x 3-9/16 x 1-3/4 in. deep. External electrical connections are made by means of an AN type connector mounted either on the side or recessed in the back of the actuator.

White-Rodgers Co., Dept. ED, 4407 Cook St., St. Louis 13, Mo.

CIRCLE 80 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Core Driver Pulses TV Synchronizers



Using the binary storage principle of magnetic cores, the Model 1801 Sync-Pulser is a binary divider circuit which has been designed primarily as a subassembly for use in synchronizers of TV broadcast equipment. In this application it gives a 525 count synced to 60 cps, but units can be constructed for applications requiring other counts.

The magnetic divider consists of 10 identical binary stages whose inherent count of 2^{10} , or 1024 is modified by feedback to give a count of 525. The divider action is made possible by the square loop hysteresis characteristic of the magnetic cores used.

The 32.5 kc output is 22 v into 1000 ohms, the pulses 2 μ sec wide at the base. The 60 cps output is a 7 v pulse into a high impedance load. The construction is that of a 7-tube subassembly 7-3/4 in. x 3-1/4 in. x 3 in. using printed wiring techniques.

Laboratory for Electronics Inc., Dept. ED, 75 Pitts St., Boston 14, Mass.

CIRCLE 81 ON READER-SERVICE CARD FOR MORE INFORMATION

Meet the NEW DALOHM

Three new additions to the  line of
America's finest precision electronic components



PAT. PENDING

Wire wound, high temperature, humidity proof, ruggedized, MIL-E-Trized DALOHM A10-W-TRIMMER POTENTIOMETER

The culmination of four years of research and development, Dalohm A10-W-Trimmer is designed to meet the ever-increasing requirements of MIL specifications such as MIL-E-5272A and MIL-R-12934. It provides precision adjustment in critical electronic circuits under extreme environmental conditions. It has an extended winding surface and assures high precision resolution without sacrificing sub-miniature design. Size is .220 x .310 x 1.250; weight is 2.25 grams.

- Resistance values 10 ohms to 50,000 ohms with standard tolerance of 5%. Power rating 0.8 watt. Temperature coefficient of wire 0.00002/Deg. C. Other resistances, tolerances, and leads available on special order.
- Completely sealed. Housing is of thermosetting, glass filled material with heat resistance of 200° C continuous. Precious metal plating on all metal parts to eliminate corrosion and electrolysis. Air evacuated and replaced with silicone grease to eliminate breathing, moisture, dirt, oxidation and undesirable vibration characteristics.
- Unique new type sliding contact assures continuity at high vibration levels and eliminates slider to lead screw damage.
- Unique safety clutch prevents damage from over-excursion of trimmer adjustment screw.
- Unit holds set resistance values—internal units have nearly identical coefficients of expansion.
- Mounting flexibility provided by two #2-56 mounting screw holes for either stacked or multiple arrangements.

CIRCLE 83 ON READER-SERVICE CARD FOR MORE INFORMATION

TWINS...

Hermetically sealed,
moisture proof, ruggedized
Mil-E-Trized **DALOHM DP-12 POTENTIOMETER**

for critical electronic circuitry—built to surpass JAN-R-19



Dalohm DP-12 potentiometers are completely protected from arctic cold or tropic damp, from shock, vibration, salt-laden air and ultra-high altitude. The mechanism, winding and contacts are unaffected by atmospheric conditions outside the unit and are able to give the highest performance under extremely adverse conditions.

Powered at 4 watts, the DP-12 has a power rating of 100% at 40° C, derated to 0 at 125° C. Housing and shaft are made of black anodized aluminum with the back plate of corrosive resistant aluminum. The unit is designed for back panel mounting with integral threaded base.

- **OPERATIONAL CHARACTERISTICS**—Operating temperature range is -55° C to 125° C. Minimum rotational life is 25,000 mechanical cycles.
- **WIDE RESISTANCE RANGE**—Standard resistance range is 100 ohms to 40K ohms with standard tolerance of 5%. (Other ranges and tolerances available on special order.)
- **PRECISION WINDING**—Dalohm resistance winding gives excellent linearity with 3% maximum deviation. Resolution is precise with 0.5% maximum.
- **Temperature coefficient of the wire is 0.00002/Deg. C on values of 500 ohms and up; 0.00050/Deg. C on values below 500 ohms. Dielectric strength is 1,000 VAC up to 50,000 feet altitude—1000 megohms, minimum.**
- **SENSITIVE SHAFT ADJUSTMENT**—Constant shaft torque of 6 inch-ounces, max., throughout operating temperature range provides ease in sensitive adjustment. Effective shaft rotation is 275 degrees minimum. Shafts available screwdriver slotted, flatted or round in lengths of 1/4", 3/8", 1", 1 1/4", 2", and 2 1/2".

U.S. Patent No. 2596503, British Patent No. 678511. Also Patented in Canada

and their power packed little brother...

Wire-Wound DALOHM PH-25 POWERHOUSE RESISTOR

Here is a rugged new resistor for panel mounting. Like all Dalohm resistors, it is carefully designed and skillfully made for all applications where equipment must survive the most severe environmental, shock, vibration, temperature and humidity. Coated with special silicone material and sealed in black anodized finned aluminum housing, Type PH-25 is impervious to moisture, salt ions, vapors and gases.

- Resistance ranges from 0.1 ohm to 15,000 ohms with tolerances of .05% to 5%. Powered at 25 watts.
- Inductive winding; temperature coefficient of wire 0.00002/Deg. C.
- Applicable MIL specifications: Applicable paragraphs of MIL-R-26-B and MIL-R-18546-A (Ships).
- Two terminal lugs; 1 1/4-7 lock nut furnished as standard equipment.



Write for bulletins on these and other



equipment, including wire wound resistors, deposited carbon resistors and collet-fitting knobs

DALE PRODUCTS, INC.

1328 28th Ave.,
Columbus, Nebraska, U.S.A.

In Canada: Charles W. Pointon, Ltd. 6 Alcina Ave., Toronto
Export Dept. Pan Mar Corp. 1270 Broadway, New York

CIRCLE 83 ON READER-SERVICE CARD FOR MORE INFORMATION

Tantalum Capacitor Transistor Adjunct



This ultrasmall capacitor is .095 in. in diam by 11/64 in. long, and has a capacitance range of .02 to 4 µf.

The size N capacitors are applicable for coupling, filter, and by-pass requirements at low voltage dc in transistorized equipment. They have a usable temperature range from -55 C to +85 C.

Capacitor construction consists of a tantalum wire anode, having a specially processed oxide film, contained in cylindrical silver case, which is the cathode (negative). The case is electrically live and has the negative wire lead fastened to the end. The case is filled with an electrolyte and sealed by a Teflon bushing.

The capacitors are aged and tested for capacitance, power factor, and dc leakage current.

Ohmite Mfg. Co., Dept. ED, 3639 Howard St., Skokie, Ill.

CIRCLE 84 ON READER-SERVICE CARD FOR MORE INFORMATION

Cable Breakout For Military and Commercial Use



In this breakout there are 141 conductors, laid by a specially constructed planetary strander. Although terminating in a three-branch breakout, the cable permits

continuous circuitry, as there is no junction in the breakout. Furthermore, circuits can be completed between any two or all three branches of the breakout without originating in the prime cable. Developed especially for missile wiring, it is also adaptable to commercial applications.

Sheathed in neoprene and watertight, the cable is fungus-proof, rodent-proof, and is not adversely effected by short term exposure to oils, acids, alcohol, ozone, and water, and long term exposure to sunlight. The cable has flexibility from -65 to 175 F. Connectors are sealed against moisture and dirt.

Pacific Automation Products, Inc., Dept. ED, 1000 Air Way, Glendale 1, Calif.

CIRCLE 85 ON READER-SERVICE CARD FOR MORE INFORMATION

Crafted with Care



Torque as low as 0.003 ounce inches achieved by Giannini in MICROTORQUE® and MINITORQUE® Precision Potentiometers

For extremely sensitive instrument applications where minimum torque is essential, specify Giannini Microtorque and Minitorque precision potentiometers. Highly reliable performance under the most rugged operating conditions is assured by Giannini's care for detail and production crafting.

By using sapphire jewel bearings . . . and precision ball bearings in certain Minitorque models, these 1 inch diameter instruments effect an unusually low coefficient of friction.

Available in 12 standard linear wiring types, the potentiometer output can, on special order, be designed to perform to a wide range of natural or empirical functions. All models employ non-corrosive precious metal windings and contacts . . . thereby permitting light brush pressures and ensuring long noise-free life.

Dependability, reliability, and ten years proven application success are your benefits, when you use Giannini Microtorque and Minitorque potentiometers—precision instruments "crafted with care."

For additional information, please write for Bulletins 85111 and 85151.

SPECIFICATIONS:

Torque	0.003 to 0.008 oz. in. depending on resistance and wiring type. (Sleeve bushing Minitorque 0.025 oz. in.)
Resistance Range	100 to 100,000 ohms.
Linearity	±0.5% (±0.25% on special order)
Power Rating	1.63 watts @ 25°C.
Shaft Diameter	Microtorque, 0.031 in., Minitorque, 0.125 in.

Giannini

G. M. GIANNINI & CO., INC., 918 EAST GREEN STREET, PASADENA, CALIFORNIA

CIRCLE 87 ON READER-SERVICE CARD FOR MORE INFORMATION

Probes

Extend VTVM Ranges



Two new probes for high voltage and rf are available for this firm's Model 777 Vacuum Tube Voltmeter. The high-voltage probe extends the dc voltage range to permit measurements to 50,000 v.

The rf probe (illustrated) makes possible measurements up to 400 mc.

Phaotron Instrument and Electronic Co., Dept. ED, 151 Pasadena Ave., South Pasadena, Calif.

CIRCLE 88 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Motor

Is Governor Controlled



Featuring a governor controlled planetary gear train with integral filter, this miniature motor, the 1700-9-1, has a length of only 2.912 in. from the

mounting flange. Applications include use in timing units for telemetering, commutator switching, and kindred functions. The motor meets Noise Spec MIL-I-6181B. Load is 3 in.-oz; weight is 5-1/2 oz.; and output speed may be specified for 15, 20, 150, 300, 600, or 1800 rpm.

El Ray Motor Co., Inc., Dept. ED, 11747 Vose St., North Hollywood, Calif.

CIRCLE 89 ON READER-SERVICE CARD FOR MORE INFORMATION

Midget Infrared Oven

For Lab Use



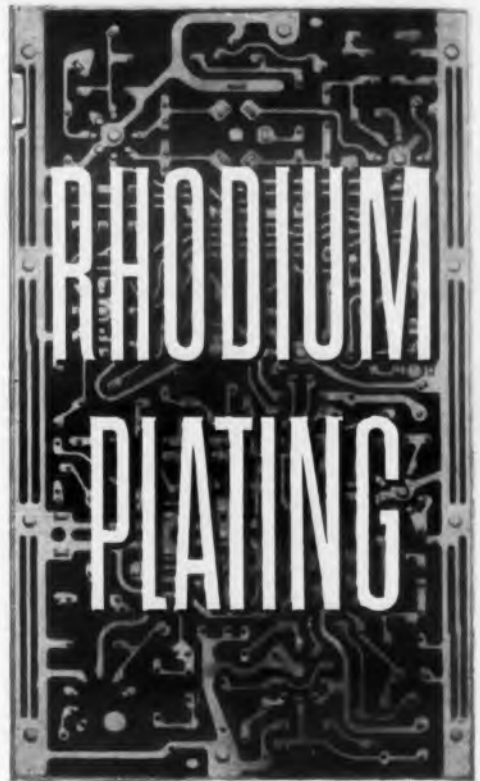
Oven temperatures of 1000 F are possible in this compact radiant oven which employs thermal shock and impact resisting, pencil-thin quartz lamps. The unit shown is 16 in. deep with a 13-1/2 in. opening. It holds eight 1600 w

quartz lamps. Each lamp is capable of providing an intensity of 100 w/in. of lamp length.

Fostoria Pressed Steel Corp., Dept. ED, Fostoria, Ohio.

CIRCLE 90 ON READER-SERVICE CARD FOR MORE INFORMATION

PROTECT PRINTED CIRCUITS AGAINST CORROSION...



Rhodium over nickel, or over silver in printed circuits—is only one of the many invaluable applications of Rhodium in electrical and electronic products. It improves performance wherever a low resistance, oxide-free contact is desired. Rhodium plate assures low noise level for moving contacts, low and stable contact resistance . . . and amazingly long wear.

For complete details send for free booklet on "Rhodium Plating" and its advantages.



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ENGELHARD INDUSTRIES

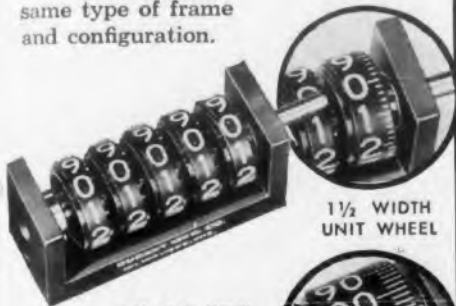
CIRCLE 91 ON READER-SERVICE CARD

96 STANDARD VARIATIONS

New Y

DIGITAL READ-OUT COUNTERS by DURANT

Design engineers can now select one or more standard units from a range of 96 Instrument Counters, having the same type of frame and configuration.



5-Y-8822 WITH SINGLE WIDTH UNIT WHEEL

1½ WIDTH UNIT WHEEL

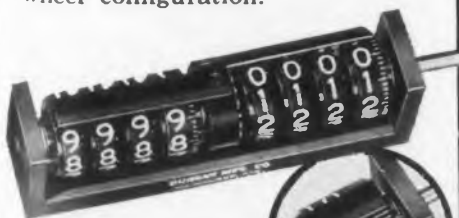
SINGLE BANK SERIES
(Right or Left Drive)
2 to 7 Figures



DOUBLE WIDTH UNIT WHEEL

Here is a family group that provides uniformity in digital recording to satisfy nearly all design requirements . . . on radar equipment, navigation instruments, computers, missile tracking devices, and gauging instruments.

They are compact, average weight only 2 ounces, have easy to read figures, white on black . . . speeds to 2500 RPM. Available in single or dual bank style, in 2 to 7 figures capacity . . . three styles of unit wheel configuration.



4-4-Y-8831 WITH 1½ WIDTH UNIT WHEEL

DUAL BANK SERIES
(Right or Left Drive)
2 to 5 Figures EA. BANK



DURANT MFG. CO.

1993 N. Buffum St., Milwaukee 1, Wis.
93 Thurbers Ave., Providence 5, R.I.
Representatives in Principal Cities

PRODUCTIMETERS
SINCE 1879 *Count Everything*

CIRCLE 92 ON READER-SERVICE CARD

Printed Circuits To Customer Specs



Printed circuit work of the type shown is available from this firm to customer specifications, particularly the kind which includes

the complete assembly of the circuit.

The circuit illustrated is designed for computer applications. Featuring a handle which enables the entire circuit to be withdrawn and replaced as a plug-in assembly, this board illustrates the ease with which circuit functions may be unitized and made replaceable.

Laboratory for Electronics, Inc., Dept. ED, 75 Pitts St., Boston 14, Mass.

CIRCLE 93 ON READER-SERVICE CARD FOR MORE INFORMATION

300 W Tetrode

Withstands Rough Environments



The 4CX300A is a 300 w anode dissipation ceramic power transmitting tetrode 2-1/2 in. long x 1-1/2 in. diam. Developed specifically for severe environments, it is made entirely of ceramic and

metal, incorporating ceramic support of internal electrodes.

This tube produces low noise output despite heavy accelerative forces from shock and vibration. Supported solely at its base by a standard Eimac air system socket, it will withstand repeated 11 millisecc 50 G shocks in any plane, without internal shorts or mechanical damage. There are no major electrode resonances when the tube is vibrated from 30 cps to 2000 cps. The metal-ceramic inhibits deterioration of electrical characteristics while operating continuously at envelope temperatures of 250 C.

The tube operates at full ratings through 500 mc: 500 w output as a radio-frequency amplifier or oscillator, and 300 w output as a plate-modulated radio-frequency amplifier.

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

CIRCLE 94 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 95 ON READER-SERVICE CARD

new members of the
PHILLIPS *family—a*
complete line of HERMETIC SEALS
backed by the engineering, the
rigid quality control, the plant
capacity needed for prompt
delivery and unvarying quality



Single and Multi
Terminal: Kovar and
Compression Types

Crystal Bases

Condenser End Seals

Transistor Mounts

Customized Seals To Order



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INSULATED HIGH TEMPERATURE HOOK UP and LEAD WIRE

For **MILITARY** and **COMMERCIAL**
END USE EQUIPMENT and
ELECTRONIC COMPONENTS

Conforming to MIL-W-16878B

Lenz High Temperature Hook-Up and Lead Wires contain thermo-plastic insulation that will retain its high dielectric characteristics over a temperature range from -55°C to $+105^{\circ}\text{C}$.

- Type B 600 Volts r.m.s.
- Type C 1000 Volts r.m.s.
- Type D 3000 Volts r.m.s.

This wire can be furnished in various jackets or shielding, and can be incorporated in multiple conductor cables. Available in solid colors or striping and built to Lenz unsurpassed standards.

Conforming to MIL-W-76A

General purpose Hook-Up and Lead Wires for internal wiring of electric and electronic equipment, with thermo-plastic insulation for use at temperatures to 80°C .

- Type LW 300 Volts r.m.s.
- Type MW 1000 Volts r.m.s.
- Type HW 3000 Volts r.m.s.

Can be furnished with nylon jackets, glass braid, lacquered, and shielding. Can be incorporated into multiple jacketed cables to suit your specifications. Available in solid colors or striping to meet your code requirements.



CONSULT LENZ FOR ALL YOUR ELECTRONIC WIRE AND CABLE NEEDS

In Lenz, you will find a dependable, experienced organization that will cooperate with you in the production of wires and cables to your requirements. Its high quality standards, intimate knowledge of the industry's needs and extensive facilities for wire insulating and cabling make Lenz an ideal source for all your wires and cables.



CABLES

and

WIRES

LENZ ELECTRIC MANUFACTURING CO.

1753 North Western Avenue

Chicago 47, Illinois

CIRCLE 97 ON READER-SERVICE CARD FOR MORE INFORMATION

Vibrometer

Measures up to 20,000 Cps



The Model 12A Vibrometer conveniently and accurately measures acceleration, velocity, and displacement of mechanical vibrations from 3 cps to 20,000 cps. It measures displacement as small as 0.0001 in. and as great as 3.0 in., velocities from 0.03 ips to 1000 ips; and accelerations from 0.03 G to 780 G. When used

with an oscilloscope, it permits quantitative analysis of impact shock and impulsive motions.

A polarity switch is provided for determining positive and negative peaks of vibration. A miniaturized, lightweight probe makes possible accurate measurements on small, low energy vibrating systems. Power required is 115 v, 50/60 cps, 60 w. Size of the unit is only 14 x 8 x 16 in., and weight is 22 lb.

Televiso Corp., Dept. ED, 1415 Golf Rd., Des Plaines, Ill.

CIRCLE 98 ON READER-SERVICE CARD FOR MORE INFORMATION

Test Equipment Calibrator

Has 1% Accuracy



A low-cost, laboratory-type test equipment calibrator with an accuracy of 1% or better in all of its voltage sections, the Model 750 Calibrator quickly checks test equipment accuracy, reveals how far any instrument may be off, and easily helps make necessary

adjustments. It calibrates VOM, VTVM, and other meters, signal generators, sweep and marker generators, and oscilloscopes.

It supplies 2, 5, 25, 100, and 300 v dc, and 5, 25, 100 and 300 v ac to check voltage ranges; provides 10, 100, 1000, 10,000, and 100,000 ohms and 10 megohms to check resistance ranges; and supplies a crystal oscillator capable of generating harmonic frequencies well over 300 mc, with accuracy of 0.1%. Plugging in the proper crystal facilitates use as a marker generator in radio and TV receivers, helps to check the calibration on AM signal generators, or check and align the audio if system of receivers.

The calibrator operates on 110-120 v 60 cps and measures only 8-3/4 x 8 x 5-1/2 in. Weight is 6-3/4 lb.

B & K Manufacturing Co., Dept. ED, 3731 N. Southport Ave., Chicago 13, Ill.

CIRCLE 99 ON READER-SERVICE CARD FOR MORE INFORMATION

Here it is...

a DC Reference Voltage

That's Constant
from -55° to $+100^{\circ}\text{C}$



k-Volt Standard*

Tubeless Constant Voltage Source
For Measurement & Control Circuits

Designed to replace the chemical cell and VR tube in airborne, laboratory and other instrumentation, the k-Volt Standard provides constant DC voltage through extremes of operating and environmental conditions... including ambients as low as -55° and up to 100°C !

Employing no tubes or moving parts, the k-Volt Standard is unaffected by position, vibration or mechanical shock. Its negligible temperature coefficient and freedom from hysteresis or switching effect make it applicable as an absolute reference, a constant output working supply or a precision voltage regulator wherever specifications demand highest stability with time and temperature. Other important features are:

- Small size: 1-11/16" x 1-5/16" dia.
- Power drain: less than 1.8 watts
- Life: more than 10,000 hours
- Vibration: conforms to MIL-E-5272A
- Base: miniature 7-pin
- Weight: less than 3 oz.
- Case: hermetically sealed
- Random drift: less than 0.1% over 1000 hrs.

Models to Meet Wide Range of Application Requirements: The k-Volt Standard is available for operation from 26.5V DC, or 115V AC, 60 or 400 cycles; DC output 6.2V at 1 ma or 10 ma, 1V at 1 ma. Specially modified units can be developed to meet particular needs.

For complete specifications
and performance data,
send for bulletin No. U128.

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Precision Instruments and Control Systems
58-15 Northern Blvd., Woodside 77, N. Y.

CIRCLE 100 ON READER-SERVICE CARD

announcing the new

recti/riter

first truly
**RECTILINEAR
GALVANOMETRIC
RECORDER**



**READ WITH
A RULER...**

the exclusive *recti/rite* trigonometric linkage inscribes the true signal form on a standard rectilinear chart. You have frontal access for all controls and making chart notations . . . $\pm 1\%$ accuracy over full 4½-inch scale; sensitivity—0.45-inch/100 microamperes; pen speed at a quarter-second over full 4½-inch deflection. Use ac or dc drive, spring drive, or external drive . . . with 10 optional chart speeds.

For complete information on the modern and versatile *recti/riter* — write for Bulletin R-501.



instrumentation subsidiary of

TEXAS INSTRUMENTS INCORPORATED

CIRCLE 102 ON READER-SERVICE CARD

**Thyratron Grid Pulser
Generates Spikes to 150 V**



This universal grid pulser generates voltage spikes as high as 150 v to fire thyratron tubes at accurate phase points in response to low level input signals.

The unit has two floating inputs to provide freedom in circuit design. Although it provides very fast half cycle response, it also minimizes thyratron misfiring due to pickup from relays or other random noise. It can be controlled by either ac or dc input signals, or by a variable resistor.

The grid pulser controls any size thyratron without additional bias supply. It provides extremely long life and trouble-free operation for industrial applications. It is rated 2.5 v 60 cps.

Hanson-Gorrill-Brian, Inc., Dept. ED, 85 Hazel St., Glen Cove, N.Y.

CIRCLE 103 ON READER-SERVICE CARD FOR MORE INFORMATION

**Trimming Potentiometer
Rugged Miniature**



This miniature trimming potentiometer features ruggedness, stability and long life. For maximum rigidity,

body and cover are made of aluminum, the cover being precision fitted to the body.

Trade name Aero-Pots, the units are adjustable through 32 turns by a screw driver in a slotted shaft. The shaft is precision threaded, and operated under controlled torque derived from inherent frictional properties of special plastics. With the wiper supported on two sides, settings are stable under extreme vibration, acceleration and shock. Temperature characteristics are stabilized by the use of resistance wire having a low temperature coefficient.

Case dimensions are 1-1/4 in. long, 1/2 in. high, 3/8 in. wide, weight: 1/4 oz. Resistances range from 100 ohms to 50,000 ohms in one case size. Resolution, depending on resistance is 0.2 to 2 per cent. Linearity is 1 per cent, temperature range is 55 C to +125 C. Units are available with Teflon insulated wire leads, plug-in terminals, or solder terminals.

Aero Electronics Corp., Dept. ED, 2311 W. Burbank Blvd., Burbank, Calif.

CIRCLE 104 ON READER-SERVICE CARD FOR MORE INFORMATION

Foolproof! Shockproof!

"FLOATING BODY ISOLATION"

for double-lead screw locking

CONNECTORS



New, "Floating Body Isolation"* guarantees vibra-shock protection and operation by complete separation of electrical contact body from mechanical elements. For connector reliability and fool-proof application.

- Unparalleled vibra-shock protection
- High environmental resistance
- Superior performance dependability
- Positive locking action

- Disengagement ease
- Melamine and alkyd molding compounds
- Aluminum cast brackets
- Connectors meet or surpass. MIL-Q 5923B and MIL-C 8384 specs

Patent No.
2,761,108
additional patents
pending

Write TODAY for complete technical data:

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CYpress 2-6525

CIRCLE 105 ON READER-SERVICE CARD FOR MORE INFORMATION





designed and
perfected by
PANORAMIC
... the leader:

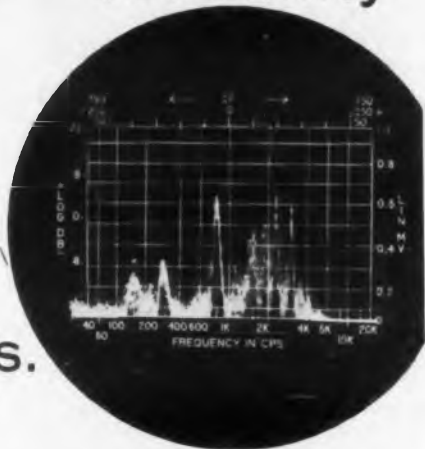
NEW

LP-1a



PANORAMIC SONIC ANALYZER LP-1a

provides extended versatility and flexibility for accurate analysis of sounds, vibrations, audio waveforms.



Featuring an additional mode of operation, the new model LP-1a Panoramic Sonic Analyzer is designed to operate with an optional companion recorder permitting permanent recordings of waveform content over extended periods with significantly greater resolution.

SUMMARY DETAILS

- **Frequency Range:** 40 cps-20 kc logarithmic or any 5 kc, 1 kc or 200 cps linear segment centered anywhere between 0 cps and 20 kc.
- **Scanning Periods:** 1 second (internal)
10 seconds, 3 minutes or 18 minutes (derived from recorder); usable only in linear frequency scan.
- **Resolution:** optimum dynamic on 1 second scan; static on 18 minute scan.

Find out today how LP-1a can speed up your laboratory and production operations; enable you to complete engineering projects with present personnel.

Write today for descriptive data sheets, prices and delivery schedules.

Panoramic Engineers are always available for discussion of SPECTRUM ANALYSIS problems. Special instruments to order.

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Phone: MOUNT VERNON 4-3970
Cables: Panoramic, Mt. Vernon, N. Y. State



PANORAMIC
RADIO PRODUCTS, INC.

CIRCLE 107 ON READER-SERVICE CARD FOR MORE INFORMATION

Ultra-Violet Source

Has Highly Adaptable Design



The "Blak-Ray" Model B-100 can be used in any method requiring a concentrated source of ultra-violet at 3660 angstrom units. The lamp head is attached to the base through a spring-tension arm which allows the ultra-violet

beam to be rotated in a 180 deg arc. A trigger mechanism makes it easy to slip the light source from the base and maneuver it in hand with pistol-grip handle. For mounting over a lab table or in a booth, there is a convenient D-ring on the back of the lamp head.

The light source is a 100 w long wave ultra-violet bulb, either flood or spot type. A 5 in. rounded filter blocks out visible light. The spot bulbs emits a concentrated beam which will fluoresce an area of 15 ft diam from a distance of 30 ft; the flood will activate an area of 30 ft diam from 30 ft.

Black Light Corp. of America, Dept. ED, San Gabriel, Calif.

CIRCLE 108 ON READER-SERVICE CARD FOR MORE INFORMATION

Constant Voltage Supply

Adjustable DC



This unit combines a voltage transformer, a germanium rectifier, and a special high-capacitance filter section with a small choke to

yield laboratory performance.

Output voltage from the DC Solavolt is regulated within 1 per cent with supply voltage variations up to 15 per cent. Ripple voltage is held within 0.10 per cent rms at full load and nominal input voltage. This assembly is able to handle transient or "pulse" loads up to twice the full load rating of the supply without failure due to severe voltage drop, and without damage to itself.

There are no tubes and all electrical circuits and terminals are insulated from ground, permitting operation at either polarity.

The unit is available in 6 models that provide output adjustable in different voltages ranges between 5 to 400 v, and currents up to 7 amps.

Sola Electric Co., Dept. ED, 4633 W. 16th St., Chicago 50, Ill.

CIRCLE 109 ON READER-SERVICE CARD FOR MORE INFORMATION



SPAGHETTI TUBING

MADE FROM

TEFLON*



For SLIP-ON INSULATION

BUNDLE SHEATHING

BUSHING INSULATION

BARRIER INSULATORS, PIGTAILS

And Similar Applications Where
Only PF TEFLON* Can Do The Job

ADVANTAGES . . .

- good dielectric strength (500 to 1000 volts/mil)
- lowest dielectric constant (2.0) and dissipation factor (0.0002) of any solid dielectric
- no change of electrical properties with temperature (-25°C to +250°C) or frequency (60 cycles to 100 mc).
- zero moisture absorption
- unaffected by any commercial chemical

PF spaghetti tubing is stress relieved for minimum shrinkage and carefully inspected and controlled dimensionally. A full range of sizes and colors are available to meet your specific needs. Write, wire or call for further information, competent engineering assistance and information on special sizes and walls. PF flexible tubing, heavy-walled tubing and rod stock made from Teflon* is also available.

PENNSYLVANIA

FLUOROCARBON CO., INC.

1115 N. 30th Street, Philadelphia 4, Pa.
Evergreen 6-7680

*Teflon—DuPont trade name for Tetrafluoroethylene resin

CIRCLE 110 ON READER-SERVICE CARD

Digital Ohmmeter

Has Oil-sealed Switches



A digital ohmmeter that provides automatic measurements, the Model 751 has oil-sealed stepping switches for a maximum trouble-free life.

Resistance values are displayed by four in-line luminous numerals 1 in. high, with

automatically-shifting decimal point and automatically-varied resistance symbols. Permanent records can be made by connection of accessory digital recording systems.

Range of the instrument is from zero to 9.999 megohms with minimum resolution of 10 ohms. Sampling rate is 60 cps; response, 1 sec (average); and accuracy is ± 0.1 per cent of measured resistance or one digit, whichever is greater.

Weighing 40 lb, this digital ohmmeter is available in rack mount and portable styles. The rack mount is 5-1/2 in. high, 19 in. wide and 15-1/4 in. deep; portable, 11 in. high, 8-1/4 in. wide, 15-1/4 in. deep.

Non-Linear Systems, Inc., Dept. ED, Del Mar Airport, Del Mar, Calif.

CIRCLE 113 ON READER-SERVICE CARD FOR MORE INFORMATION

Vibration Amplifier

Built-In Calibration



A new Vibration Pick-up Pre-amplifier, designed as a link between any type of vibration pickup and one of the Brush

AF Analyzers, provides absolute measurement of recording of acceleration, velocity or displacement.

The Model BL-1606 has a two-stage preamplifier with high input impedance that allows vibration measurements to be carried out to very low frequencies at extended distances from the measuring instrument.

A built-in calibration unit, consisting of a vibrating disc suspended on a metal strip, which is brought into resonance at the line frequency, affords a direct and quick calibration of the combination accelerometer, preamplifier and measuring instrument before the measurements are carried out.

A set of integrating networks is provided for measurements of the velocity and displacement of the vibrations in consideration.

Brush Electronics Co., Dept. ED, 3405 Perkins Ave., Cleveland 14, Ohio.

CIRCLE 114 ON READER-SERVICE CARD FOR MORE INFORMATION



VIP'S

YOU CAN DEPEND ON GENERAL TRANSISTOR FOR RELIABILITY QUALITY SERVICE

Transistors for Computers—
Radios—Hearing Aids



GENERAL TRANSISTOR CORP.
Richmond Hill 18, N. Y.
Virginia 9-8900

CIRCLE 112 ON READER-SERVICE CARD



BOUNDARY OF HUMAN KNOWLEDGE

there is a breakthrough point!
... many of our present
assignments involve
seeking solutions
currently unknown!
perhaps YOU* have
the answers . . .



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gyroscopic devices
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electronic components
airborne digital
computers

MIT

INSTRUMENTATION
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help break through
the boundary —

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MARTIN PHILLIPS
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INSTRUMENTATION
LABORATORY
Dept. of Aeronautical Engineering M.I.T.
68 Albany Street
Cambridge 39, Massachusetts

GRADUATE COURSES may be taken for credit while earning full pay . . .

CIRCLE 115 ON READER-SERVICE CARD FOR MORE INFORMATION

Looking for a "POT"?



PANEL MOUNT SHOWN
SERVO MOUNT OPTIONAL

ACTUAL SIZE

SERIES 341 TEN-TURN PRECISION POTENTIOMETER

Smaller in diameter than a fountain pen — no longer than a shriveled up Gryllidae Gryllus*, this tiny "pot" offers ultimate precision in the smallest package on the market.

Check some of the standard specifications of this precision-built, wire-wound, ten-turn potentiometer:

SIZE:	17/32" x 1-1/8"
WEIGHT:	10 gms. max.
BACKLASH:	Essentially Zero
PHASE SHIFT:	Less than 0.1° at 4000 cps.
VIBRATION:	10gs to 500 cps (3 attitudes)
LINEARITY:	Best Practical 0.05%

* also known as a cricket

STANDARD MODELS AVAILABLE IN PRODUCTION QUANTITIES NOW . . . SPECIAL REQUIREMENTS CAN USUALLY BE MET. WRITE TODAY FOR COMPLETE INFORMATION CONCERNING THIS AND OTHER MINIATURE WIRE-WOUND, PRECISION POTENTIOMETERS.

Openings exist for highly qualified engineers

WRITE TODAY FOR DETAILS

ACTUAL SIZE



POTENTIOMETER DIVISION

Daystrom PACIFIC CORP.

11150 LA GRANGE AVE., WEST LOS ANGELES 25, CALIF.



Series
304

One-turn, Wire-wound,
Precision
Potentiometer.
LOW COST
HIGH PERFORMANCE

CIRCLE 117 ON READER-SERVICE CARD FOR MORE INFORMATION

Precision Potentiometer

Multiple Ganged Sections



Series 5400 1-7/16 in. diameter precision potentiometers have been developed to fit A.I.A. dimensional standards.

Housed in a dimensionally stable one-piece plastic

cup, the single-turn continuous-rotation unit can have 8 sections ganged on a common shaft at the factory, each with a maximum of 12 taps. The standard range of resistance is from 25 to 51,000 ohms, with a linearity tolerance of $\pm 0.15\%$ at 10,000 ohms and above.

Available with or without ball-bearings, for servo or bushing mounting, the Series 5400 has a power rating of 2.8 at 25 C ambient and 2 at 40 C ambient. Operating range is from -55 to $+80$ C. Electrical rotation is $354^\circ \pm 2^\circ$.

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

CIRCLE 118 ON READER-SERVICE CARD FOR MORE INFORMATION

TV Tube Mount

Cuts Material Costs



This impact-resistant television tube mount, fabricated of soft steel wire, is designed for low cost and to accelerate tube installation on the assembly line. During drop tests, where a TV set is dropped from 12 to 30 in. from

various positions, this welded wire tube mount holds the tube intact, even after extensive cabinet damage. The soft, zinc-plated wire conforms closely to the tube contour. It will not etch glass, and consequently eliminates the necessity for gasket material previously required to prevent tube implosion or movement.

The simplified wire mount consists of two parallel contour wires (or one, depending on specifications) for the tube front, with four lightweight locating stampings and two adjustment stampings. A rear wire support is frequently used to complete the assembly.

E. H. Titchener & Co., Dept. ED, 67 Clinton St., Binghamton, N.Y.

CIRCLE 119 ON READER-SERVICE CARD FOR MORE INFORMATION

DO YOU NEED

a really
RUGGED*
COMPACT
SENSITIVE
LIGHT-BEAM
GALVANOMETER



*Will take
25 G's!

this is it...

Here is a new series of light-beam galvanometers that were developed to withstand the extremely severe conditions of shock and vibration encountered in field servicing and testing of jet aircraft.

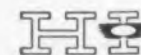
Through unique folding of the light beam, great compactness is achieved while retaining sensitivity to the highest degree...equal to that of laboratory instruments!

These Howell Galvanometers feature excellent readability. They are readily adaptable to existing instruments. They are competitively priced.

SPECIFICATIONS:

Sensitivity to .105 microamperes per millimeter. Resistances: 20, 100, 500 and 1000 ohms. Short period; high speed response. SIZE: ONLY 2.6" x 3.62" x 3.615" Sealed construction.

For full information
please write or wire



HOWELL INSTRUMENT Company
3101 Trinity St. • Fort Worth 7, Texas

CIRCLE 120 ON READER-SERVICE CARD

Solder Flux Kit

For Electronic Assemblies

A general purpose flux kit is available to provide the proper flux for specific soldering jobs. It contains 16 fluxes for electronic assemblies, printed circuits, tinning and hot solder dipping, stainless steel soldering and aluminum soldering.

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

CIRCLE 122 ON READER-SERVICE CARD

Waterproof Cloth Tape

High Tensile Strength

A colored waterproof cotton cloth tape, designated Permacel 68 combines excellent tensile strength with a high moisture resistance.

The pressure sensitive tape has an Adhesion 40 oz per in. of width to plastic, and 32 to steel, and a tensile strength of 60 lbs per in. of width. Colors are available for identification applications.

Permacel Tape Corp., Dept. ED, New Brunswick, N. J.

CIRCLE 123 ON READER-SERVICE CARD

UHF Receiver

A 16 Lb Military Type

This compact, lightweight, portable vhf receiver occupies less than 1/3 cu ft and weighs only 16 lb (approx). Developed for the military, it receives AM, FM, CW, and MCW signals in the 20-100 mc band. It may be operated from self-contained batteries or from a 24 v vehicular supply. It is intended for searching and monitoring the 20-100 mc spectrum, but with the proper DF antenna, it also provides direction-finding capabilities.

AM sensitivity varies from 0.3 to 0.4 μ v over the frequency range. On FM, a 1.0 μ v signal provides 30 db or more of quieting. The receiver uses 1.2 w of power, and can operate continuously for about 30 hr on one set of batteries. The components have been selected for stability in a range of -40 to +150 F. The receiver can be serviced easily; the various subassemblies can be pulled out and plugged in readily.

Radio Receptor Co., Inc., Dept. ED, Brooklyn, N.Y.

CIRCLE 124 ON READER-SERVICE CARD

CIRCLE 125 ON READER-SERVICE CARD >

Precision Instruments . . .

backed by the

RCA reputation

for engineering

excellence

VHF Signal Generator Type LG-22
(5 mc to 230 mc)

VHF Signal Generator

Now . . . For The First Time . . . Precision Features in a Low Priced VHF Signal Generator . . . Ideal For Production Use!

This attractively priced RCA Signal Generator has laboratory precision features that make it highly desirable for production use. Excellent frequency accuracy and stability. Individually calibrated. Negligible RF leakage. Wave-guide below cut-off type attenuator normally found in more expensive instruments.

Valuable in designing and evaluating receivers, amplifiers, and other apparatus that operate at frequencies between 5 and 230 mc. Particularly useful in measuring

sensitivity and gain and for driving impedance bridges. Other signal generators available to meet your equipment and price requirements.

RCA Instruments of Laboratory Precision

PULSE GENERATOR ★ RF POWER METERS ★ NULL VOLTMETERS ★ IMPEDANCE BRIDGES ★ SIGNAL GENERATORS ★ VACUUM TUBE VOLTMETER ★ MULTIMETER ★ CRYSTAL MODULATOR AND OTHERS.

*Price in U.S.A.,
subject to change
without notice.



RADIO CORPORATION of AMERICA

CAMDEN, N. J.

In Canada: RCA VICTOR Company Limited, Montreal

USE COUPON BELOW FOR COMPLETE INFORMATION

Radio Corporation of America
Precision Electronic Instruments
Dept. L-292, Building 15-1, Camden, N. J.

Please send me complete information on the following instruments:

Send name of nearest representative

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

model RF Cooling Panel

a green label product

- FOR 19" ENCLOSED RELAY RACK
- Full 2" thick dustfilter
- Filter pilot safety gage
- Good for 125°F ambient
- 7" panel height

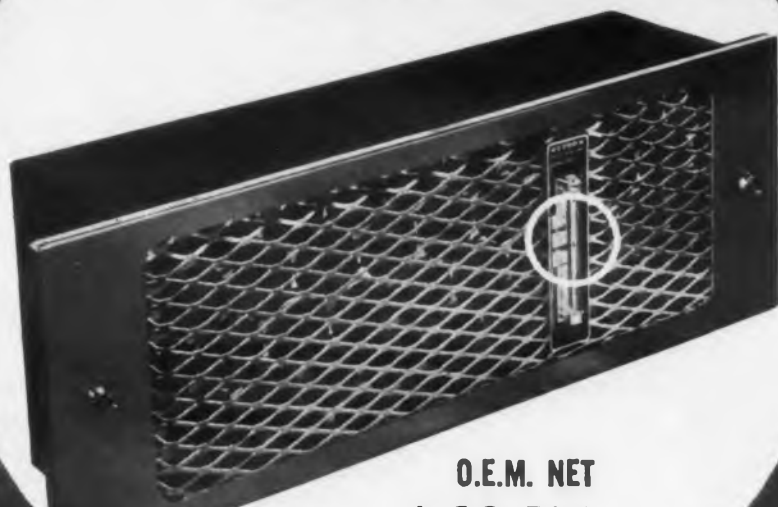
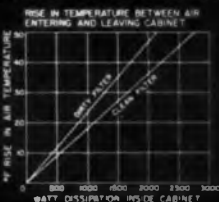


ROTRON

mfg. co., inc.

WOODSTOCK • N. Y.

FILTER PILOT



O.E.M. NET
\$49.75
from stock

CIRCLE 126 ON READER-SERVICE CARD FOR MORE INFORMATION

S-Band Ferrite Isolator Light Weight



Combining minimum size and weight, the S10/S18 ferrite load isolator provides 18 db isolation over a 300 mc band width from 2500 mc to 3000 mc. With waveguide flanges, maximum insertion loss is 1.0 db. Maximum input VSWR is 1.5. The isolator can handle up to 500 kw peak power and 250 w average without external cooling. With air or liquid cooling, power handling capacity is increased substantially.

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

CIRCLE 127 ON READER-SERVICE CARD FOR MORE INFORMATION

Silicon Diode Rectifier Aircraft Transformer



This tubeless, motionless transformer-rectifier is designed for direct current equipment in aircraft with ac supply.

Offering a considerable saving in weight and size as compared with selenium rectifier-transformer combinations, the Model CW-1001 transformer-rectifier has an output of 50 amp at 27.5 v dc with an input of 115/200 v phase Wye 400 cy. Silicon power diodes are used in the unit, which weighs less than 4.8 lbs.

Electrosolids Corp., Dept. ED, 7436 Varna St., N. Hollywood, Calif.

CIRCLE 128 ON READER-SERVICE CARD FOR MORE INFORMATION

Flag Type Terminal Has Insulation Support

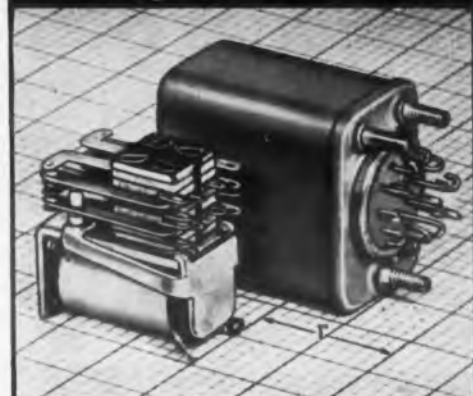


This line of "Junior Faston" Flag Type Terminals employs an insulation support. The flag-type feature make the terminals easy to apply in unusual position applications and the insulation support absorbs wire vibration and adds strength to the connection. Similar in performance but smaller in size than the larger standard "Fastons," they accommodate wire sizes 22-14.

Aircraft-Marine Products, Inc., Dept. ED, Harrisburg, Pa.

CIRCLE 129 ON READER-SERVICE CARD FOR MORE INFORMATION

New Midget Sub-miniature RELAY



MAGNECRAFT Class 33

featuring—

- Reliability unlimited by small size—within recommended range of use.
- Resistance to shock, vibration and temperature change available to meet military specifications.
- FLEXIBILITY for adaptation to wide range of application. Available for D.C. operation only.
- The same well proportioned magnetic structure characteristic of all MAGNECRAFT Relays.
- Dimensions—open type, 1-11/32" long, 11/16" wide and 1" high with DPDT contacts.
- Dimensions—hermetically sealed with up to 6 contact springs per stack, 12 springs total, and 8- or 14-pin solder terminal header, base dimensions 31/32" by 1-11/32", height 1-41/64".

Send for Catalog describing Class 33, Class 11 and Class 22 Relays for A.C. or D.C., open, plug-in, dustproof, hermetically sealed and many special models.



MAGNECRAFT ELECTRIC CO
3350D W. Grand Ave. Chicago 51, Ill

CIRCLE 130 ON READER-SERVICE CARD

AR★

specializes
in
ALTITUDE
simulation
to 150,000 ft. and higher



with **TEMPERATURES:**
+500°F to -100°F and lower

with **HUMIDITY** 20% to 95%

- ★ in any combination
- ★ in any size or shape chamber
- ★ in conformity to Gov. Specs.

Let AR's experience solve your problems in high-altitude low-temperature cooling air testing.

AR also designs, manufactures and services Fungus, Sand and Dust, Explosion, Rain and Sunshine, and Special Air and Liquid Chillers.

Write for our catalog
or quotation.

AMERICAN RESEARCH
CORPORATION
FARMINGTON 1, CONN.

CIRCLE 131 ON READER-SERVICE CARD

Strain Gage Can Be Welded To Surfaces



This weldable high temperature strain gage has a dynamic test range to 1600 F. It can be spot welded and test-ready on flat or curved surfaces in less than 5 minutes.

Available gages have a nominal resistance of 120 ohms and a gage factor of 1.80. Length and width dimensions of the two available gage types are 1.250 x 0.125 in. and 0.750 x 0.250 in.

Micro-Test, Inc., Dept. ED, 657 N. Spaulding Ave., Los Angeles 36, Calif.

CIRCLE 132 ON READER-SERVICE CARD FOR MORE INFORMATION

Pulse Generator High Output



This pulse generator provides source of fast time rise pulses for a wide range of laboratory and test applications.

High output, consistent with good waveform, is available through optional use of an internal load resistor. Controls provide high resolution, utilizing multiple defade ranges for pulse spacing, delay, and width.

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

CIRCLE 133 ON READER-SERVICE CARD FOR MORE INFORMATION

Force Transducers Wide Range



Combining the proving ring and differential transformer principles, these transducers provide an electrical output voltage that is proportional to applied force and exhibit high stability of calibration.

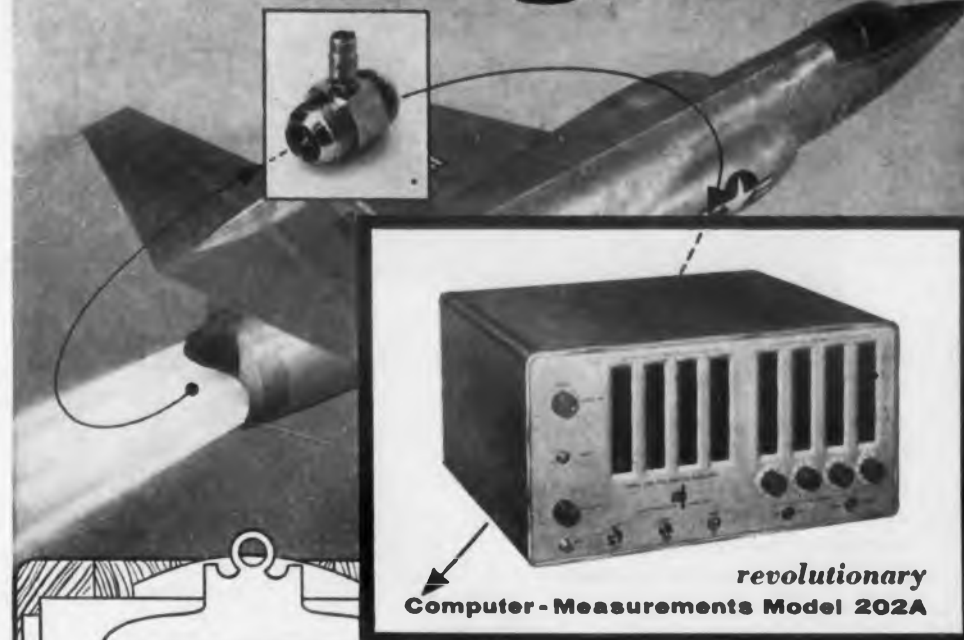
The Series 140 Force Transducers are available in 11 models with ranges from ±10 lbs to ±100,-

000 lbs, the units are accurate to 0.5 per cent. Excitation frequency range is 60 to 10,000 cps.

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

CIRCLE 134 ON READER-SERVICE CARD FOR MORE INFORMATION

translate flow
... into pounds per hour
at a glance!



revolutionary
Computer-Measurements Model 202A

TIME-FUNCTION TRANSLATOR

Applications:

- ✓ Gallons per minute ... into Gallons per hour
- ✓ Gallons per minute ... into Pounds per hour
- ✓ Pulses per second ... into Gallons per minute
- ✓ Total Count of Gallons or Pounds
- ✓ Tachometer Applications
- ✓ Direct Frequency Measurement
- ✓ Many Others

Translating flow into weight as required for jet engine analysis is just one of the many uses for the all-new Model 202A TIME-FUNCTION TRANSLATOR.

The 202A permits instant direct read-out of unknown quantities by translating one function of time into another function of time. It eliminates the need for conversion tables, graphs, charts, etc. The variable time base display may be illuminated or blanked at operator option. The versatile 202A fills a long recognized need in electronic measurement.

Write for complete information and detailed specifications on the Model 202A Time-Function Translator TODAY...

SPECIFICATIONS:

Frequency Range:	1-100,000 cycles per second 0-100,000 positive pulses per second
Input Sensitivity:	0.05 volt rms: 10-100,000 cps (5 millivolts optional) 0.07 volt rms: 1-10 cps Positive pulse rise time: 1/2 volt or more per sec.
Input Impedance:	0.5 megohm and 50 mmf.
Accuracy:	± 1 count ± stability
Stability:	Short Term: 1 part in 1,000,000 Long Term: 5 parts per million per week
Time Bases:	0.001 to 10 seconds in 1 millisecond steps 0.0001 to 1 second in 0.1 millisecond steps (0.0001 to 10 sec. in 0.1 millisecond steps, 0.001 to 100 sec. in 1 millisecond steps optional)
Read-Out:	Direct: Four digits. (Five digits optional)
Display Time:	Automatic: Continuously variable, 0.1 to 10 sec. Manual: Until reset
Power Requirements:	117 volts ± 10%, 50-60 cycles, 250 watts (50-400 cycles optional)
Dimensions:	17" W x 8 3/4" H x 13 1/2" D
Weight:	35 lbs. net.
Finish:	Panel: Light grey baked enamel Case: Dark grey baked enamel Data Subject to Change Without Notice



*Model FL Flow Pickup: Courtesy-Waugh Engineering Co., Van Nuys, Calif.

Computer-Measurements Corporation

5528 Vineland Avenue, North Hollywood, Calif. Dept. 76-N

CIRCLE 135 ON READER-SERVICE CARD FOR MORE INFORMATION

WHEN YOU NEED RESISTORS WITH BETTER THAN MIL SPECS.

VICTOREEN CAN SUPPLY THEM

MIL specifications 10509A are good—but for applications in a high temperature area where more than the normal life-expectancy is required, specify Victoreen carbon deposited resistors.



These resistors are made by depositing a pure crystalline carbon, by pyrolysis of hydro-carbon vapor, on specially prepared, smooth-textured ceramic bodies. Silver-plated brass caps make positive contact with the silvered ends of the element to provide terminals of highest conductivity. Elements are sealed in an inert-gas filled glass envelope.

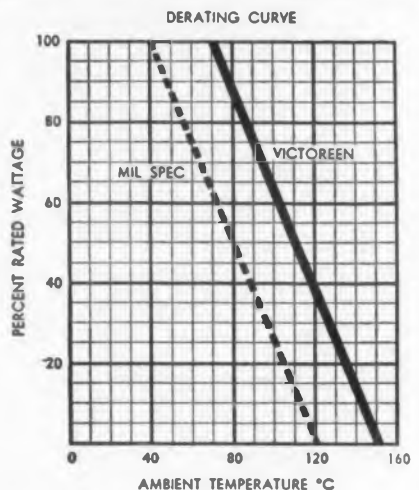
COMPARE THESE SPECIFICATIONS

MIL Paragraph		MIL 10509A Requirement	Victoreen Capabilities
3.3	Power Rating (Ambient Temperature)	40°C	70°C
3.7	Low Temperature Exposure (Change)	3%	1%
3.10	Moisture Resistance (Change)	5%	3%
3.4	Maximum Continuous Working Voltage at	40°C	70°C
4.6.10	Load Life (Test Condition)	40°C	100°C
4.6.10.2	Test Life Procedure (Minimum)	1000 hours	*2000 hours

*These units are being used in applications with life objective of 10,000 hours.

As shown in this derating curve, the Victoreen developed carbon deposited resistor is infinitely better than the commonly accepted types yet retains all the normal characteristics.

We invite your inquiry. Samples will be furnished for your testing.



COMPONENTS DIVISION



The Victoreen Instrument Co.

5807 HOUGH AVENUE • CLEVELAND 3, OHIO

CIRCLE 136 ON READER-SERVICE CARD FOR MORE INFORMATION

Transmitter Racks

Take 24 in. Panels



This line of heavy-duty transmitter racks is designed to accommodate 24 in. rack panels. The racks are 27 in. wide x 24 in. deep. They feature adjustable panel mounting angles 3/16 in. thick and tapped 12-24 on universal spacings.

Constructed of 16 gage steel with a 12 gage bottom and welded throughout, the racks have rear doors closed by a chrome handle.

Premier Metal Products Co.,
Dept. ED, 337 Manida St., New York 59, N.Y.

CIRCLE 137 ON READER-SERVICE CARD FOR MORE INFORMATION

AC Power Supply

Sub-Miniature



This miniature power supply has a size of only 2-1/2 x 2-1/2 x 3-3/4 in. Operating temperature range is -55 to 125 C. It has a rating of 2000 v at 5 ma with max current to 10 ma. Standard models have a frequency of 60 cps at 117 v; special models with frequencies to 400 cps are proportionately smaller in size. Standard models include 2-10 kv with higher voltages and temperatures upon request. All units are hermetically sealed and oiled filled.

The New Haven Electronics Co., Dept. ED, P.O. Box 888, New Haven, Conn.

CIRCLE 138 ON READER-SERVICE CARD FOR MORE INFORMATION

Rotary Potentiometer

in 100-50,000 Ohms Variations



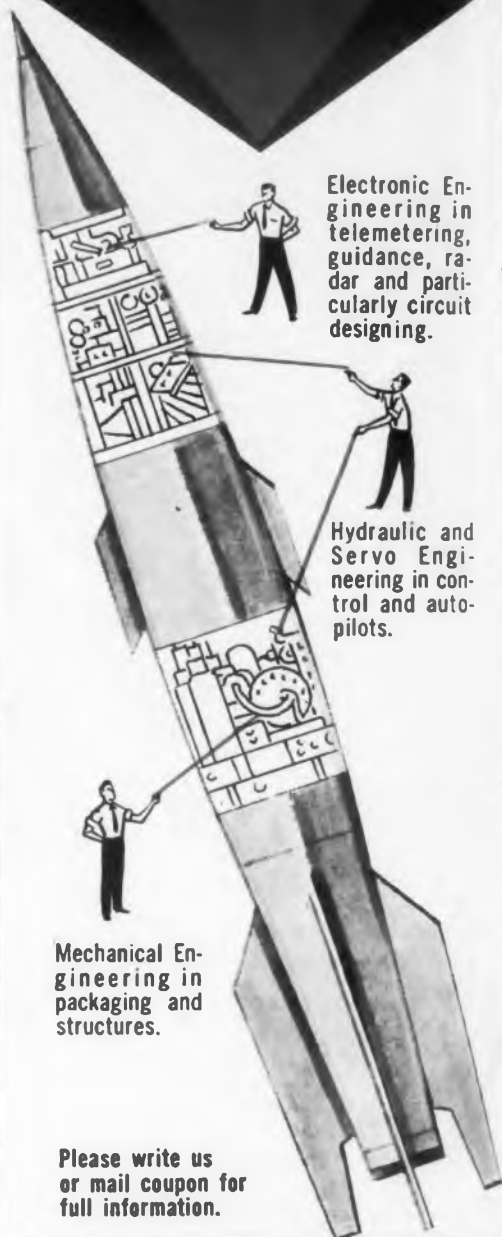
The PRM123 is a sealed rotary type 1-5/16 in. diam rotary potentiometer. It is constructed as a single gang only, bushing mounted, sleeve bearing model in variations from 100 to 50,000 ohms of resistance.

Standard tolerances are ± 3 per cent on resistance and ± 0.3 per cent on independent linearity. Operating temperatures for standard models are -65 to 275 F. Rotation is 360 deg mechanical (continuous).

General Controls Co., Dept. ED, Glendale, Calif.

CIRCLE 139 ON READER-SERVICE CARD FOR MORE INFORMATION

**THIS
IS THE KIND OF
ENGINEERING
HELP
WE NEED!**



Electronic Engineering in telemetering, guidance, radar and particularly circuit designing.

Hydraulic and Servo Engineering in control and auto-pilots.

Mechanical Engineering in packaging and structures.

Please write us or mail coupon for full 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 140 ON READER-SERVICE CARD

D.C. POWER SUPPLIES

For IMMEDIATE DELIVERY



OUTPUT
0-30 V.D.C.
5 Amps.

RIPPLE: 1/2% at Maximum Load
REGULATION: 1/10 Load, 34.5 V.
Full Load, 30.0 V.

RACK MODEL KM75
BENCH MODEL (illus.) KM75B

Request Bulletin No. 93



OUTPUT
0-30 V.D.C.
10 Amps.

RIPPLE: 1% at Maximum Load.
REGULATION: 1/10 Load, 35 V.
Full Load, 30 V.

RACK MODEL (illus.) KM81
BENCH MODEL KM81B

Request Bulletin No. 96



OUTPUT
0-28 V.D.C.
20 Amps.

RIPPLE: 1% at Maximum Load.
REGULATION: 1/10 Load, 33 V.
Full Load, 28 V.

RACK MODEL (illus.) KM88
BENCH MODEL KM88B

Request Bulletin No. 100



DUAL OUTPUT
0-32 V.D.C.
40 Amps.
0-64 V.D.C.
20 Amps.

RIPPLE: Less than 1%.
REGULATION: 1/10 Load, 36.5/73V.
Full Load, 32.0/64V.

RACK MODEL KM95
BENCH MODEL (illus.) KM95B

Request Bulletin No. 103

UNFILTERED MODELS AVAILABLE
Request Bulletin No. 178



New O-PAC
Self-Contained DC Power Pack

OUTPUT
30 V.D.C. ± 6.5%
0-1 Amp.

MODEL
3150
\$45.00

RIPPLE: Less than 1%.
INPUT: 115 V.A.C. 60 cy.
DIMENSIONS: 4 3/4 x 6 x 6 1/2"

Request Bulletin No. 185

Opad

ELECTRIC COMPANY

69-16 MURRAY STREET • NEW YORK 7, N. Y.
Telephone: BEekman 3-7548

CIRCLE 141 ON READER-SERVICE CARD

Cabinet Slide

Aids Access to Equipment



A 300 per cent increase in bearing surfaces on "Chassis - Trak" cabinet slides facilitates access to electronic components. Mounted components can be

pulled out on slides and locked in automatic "out" position. The "Basic" model tilts freely without position locks, while the "Detent" locks in six positions—at 45, 90, and 105 deg angles, tilted up or down.

Chassis-Trak Corp., Dept. 1-A, 6252 Iona Rd., Indianapolis, Ind.

CIRCLE 142 ON READER-SERVICE CARD FOR MORE INFORMATION

Teflon Terminals

Compact Press-Fit Units

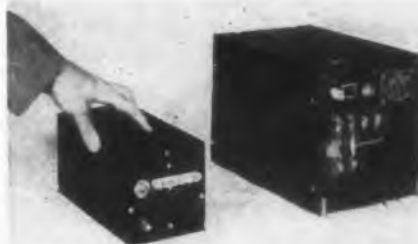
With dielectric strength ranging from 1000 v to 2000 v/mil of thickness, these Teflon "Press-Fit" terminals permit placing a multiplicity of terminals in very limited space, such as on canned transformers, precision potentiometers, and coil assemblies. This is an encased transformer top with two banks of 10 terminals each, with terminals spaced only 1/4 in. between centers. Each feed-thru terminal has turret lugs for inside and outside wrap-around and soldered connections.

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

CIRCLE 143 ON READER-SERVICE CARD FOR MORE INFORMATION

Exciter-Regulator

For Aircraft Application



This exciter voltage regulator, Model 05, is of the magnetic amplifier type. It supplies regulated excitation voltage for 8 kva alternator

systems. It is designed to hold a 115 v ± 1-1/2% rms exciter voltage over a range of 380-980 cps operating frequency. Operating life is 3000 hr or more, and the unit is primarily intended for B-1 alternator systems, which are standard for T-29, C-124, C-97, B-50, and other aircraft.

Cline Electric Manufacturing Co., Dept. ED, 3405 W. 47th St., Chicago 32, Ill.

CIRCLE 144 ON READER-SERVICE CARD FOR MORE INFORMATION
CIRCLE 145 ON READER-SERVICE CARD



11 million operations without a miss on low-energy switching test!

New test proves outstanding reliability of General Electric's Miniature relays

Laboratory tests using standard, production relays have confirmed the remarkable performance of General Electric Miniature relays on low-energy switching applications. These hermetically sealed relays made contact 11 million times without failure—switching 25 microamps at 50 millivolts—indicating permanent reliability.

This low-energy performance is combined with proved mechanical life. On one typical application, several of these

relays continued to function after 300 million switching operations.

A key reason for this outstanding reliability is extremely high (40 to 55 grams) tip pressure—designed into all Miniature relays. Ample wear allowance provided by G-E engineers also contributes to extra-long life.

Description: Available in standard, current-sensitive, and voltage-sensitive models; in 2-, 3-, or 4-pole double-throw and 6-pole normally open forms. Rated 5 amps at 28 volts DC at 85C.

OTHER G-E RELAYS TO MEET YOUR NEEDS

1 Micro-miniature relay: Weighs .35 oz; rated 2 amps resistive at 28 v DC or 115 v AC. Also, current-sensitive model. Standard relays withstand ambient temp of 125C.

2 2PDT sub-miniature relay: 2 amps; .651 in. in diameter, 1.6 in. long; weighs one ounce. Withstands shock

tests in excess of 50Gs. Available in wide variety of coil ratings.

3 High-speed 4PDT relay: Especially designed for use where operation as fast as 500 microseconds is required. Ideal for applications like ground-based radar, multiplexing of electronic signals, and computer circuits.

MAIL TODAY FOR SEALED-RELAY DATA

General Electric Co., Sect. E792-5, Schenectady 5, N. Y.

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| <input type="checkbox"/> Miniature—Bulletin GEA-6213 | <input type="checkbox"/> High-speed 4PDT miniature—Bulletin GEA-6212 |
| <input type="checkbox"/> Micro-miniature—Bulletin GEA-6346 | <input type="checkbox"/> HAVE G-E SALES ENGINEER CALL |
| <input type="checkbox"/> 2PDT sub-miniature—Bulletin GEA-6412 | |

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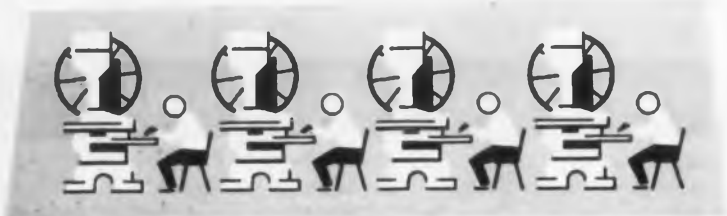
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Why not see what ALSiMag can do in your application? Blueprint or sketch plus outline of operating procedure will bring you complete details.

Rugged Midget Relay

Moisture Resistant

This relay features simplicity of design, ruggedness, and dependability.

In the Series 1100, the coils are completely sealed against moisture, corrosion, and from high humidity. For high-frequency use, special low-loss phenolic insulation is available.

Voltages range from 6 to 110 v dc, with resistances up to 11,000 ohms. Capacitance to ground is only 3 mmfd.

This two-ounce midget relay will withstand shock and vibration up to 10 G, and has a sensitivity of 2 w dc. Its silver contacts are rated up to 1 amp at 115 v ac non-inductive load.

Price Electric Corp., Dept. ED, Frederick, Md.

CIRCLE 147 ON READER-SERVICE CARD

Electrical Tape

Made of Rayon Reinforced Film

"Permacel 246," an electrical grade rayon reinforced film tape, has been added to the "2-in-1" line. It has high insulation resistance and high dielectric strength. The adhesive used is both pressure sensitive and heat curing. The tape's high tensile strength, tear strength, and shock resistance permit it to withstand breakage caused by high stresses which are prevalent in heavy duty electrical equipment. Uses include application in the production of heavy-duty equipment where anchoring is needed for heavy gage electrical wiring in the equipment coils and for banding armature coils prior to "forming."

Average basic properties are: tensile strength 225 lb/in. width; elongation 15%; adhesion strength 30 oz/in. width; thickness 12 mils; and impact strength of 150 in. lb. This tape has insulation resistance of 1000 megohms at 95% relative humidity, indirect electrolytic corrosion current of 1000 μ mhos, and dielectric strength of 6000 v. The minimum curing cycle is 2 hr at 250 F or 1 hr at 300 F. It is available in widths ranging from 1/4 in. in rolls of 60 yd.

Permacel Tape Corp., Dept. ED, New Brunswick, N.J.

CIRCLE 148 ON READER-SERVICE CARD

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Engineers have always been VIP's at GPL

At General Precision Laboratory engineers are very important people indeed. They have *always* been—in this advanced electronics organization that was founded by top scientists and has been run by them ever since.

As you would expect with this type of management, the basic operating policies of the Lab put continuing emphasis on availability of the most advanced equipment . . . small research teams that give every man a chance to show what he can do . . . following each career closely . . . prompt recognition.

The brilliant work of its engineers has brought the Company into front rank in little over a decade. A few notable GPL achievements: airborne navigation systems that are the most accurate in operational use today . . . stereophonic sound reproduction equipment that pumped fresh life into the motion picture industry . . . closed-circuit television systems so flexible and so simple that they find new fields of usefulness every day.

Success means growth—growth in both the size and the range of our activities. We need more engineers and scientists with a solid background in advanced electronics, creativeness and the perseverance and practical know-how that transform bright ideas into realities.

For such men we have unusual opportunities—opportunities that not only provide notable returns in pay and benefits now, but that also build lifetime careers. If you are such a man, we are interested in knowing about you—what you have done and what you hope to do.

Currently, GPL seeks engineers interested in:

**Missile Guidance,
Radar Navigation
and Bombing Systems
(Doppler & Inertial)**

Research • Development • Applications
Systems Analysis • Systems Test
Administrative Engineering • Mechanical Packaging
Field Engineering • Technical Writing
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Computers • Magnetic Amplifiers
Servos • Microwave Techniques
Pulse Circuitry • Transistorization

Write Richard D. Hoffman, Employment Manager. Interviews can be arranged for any time, including weekends. We will pay expenses of qualified applicants.

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53 Bedford Road, Pleasantville, N. Y.

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Video Signal Generator Provides Keyed Signal



This is a versatile unit for use in testing telecasting studio, microwave and transmitter equipment. It provides a keyed composite video output signal (blanking, sync & video) throughout two continuously variable frequency ranges of 90 kc to 1.0 mc and 900 kc to 10 mc. There is no need to disable clamp circuits or dc restorers so that a realistic dynamic test is obtained.

In the Model VO3B, amplitude of sync, blanking and video are independently variable. A phase-locked sine wave (flat to within 0.5 db from 90 kc to 10 mc) serves as the video portion of the composite signal. Optionally externally-generated signals may be used as the video component.

It has a self-contained regulated power supply and may be used as portable or rack-mounted test equipment.

Foto-Video Labs., Inc., Dept. ED, Eagle Rock Bldg., 25 Amity St., Little Falls, N. J.

CIRCLE 151 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistorized Intercom For Aircraft Use



Housed in a laminated-phenolic tube 6-1/2 in. long and 1 in. diam, the device consists of a high-gain, low-impedance microphone, the transistor - battery - operated amplifier, and highly sensitive rubber - cushioned earphones. A printed circuit board is used to hold all the amplifier components including the battery which is good for over 100 hours of use. The printed circuit makes extreme miniaturization possible and insures trouble-free performance.

The Goldak Co., Inc., Dept., ED, 1544 W. Glendale Blvd., Glendale 1, Calif.

CIRCLE 152 ON READER-SERVICE CARD FOR MORE INFORMATION

Correction:

The Coaxial Power Pad, manufactured by the Weinschel Engineering Corp., was erroneously rated in the September 1 issue. The correct rating is 30 watts.

CONDUCTORS AND HARNESS—100% TEFLON*

“TEMPBRAID”

“TEMPBRAID” FOR -90°C. TO +250°C. OPERATION

Wherever cost, space, weight and production time are a problem . . . such as in electronic computer installations—telemetry equipment and missile and aircraft wiring . . . “Tempbraid” offers the solution.



“TEMPBRAID” cables come in 2 to 30 conductors in sizes 12 to 30 AWG. These cables are available with Teflon insulated conductors with a 5 mil (.005”) wall, or the conventional Type E and EE insulated conductors that conform to MIL-W-16878, and a combination of coaxial cables.

METALBRAID

A flat harness woven of tin/lead or silver plated copper. This harness eliminates lacing cord, binding posts, cable clamps.

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HITEMP WIRES INC.

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CIRCLE 153 ON READER-SERVICE CARD FOR MORE INFORMATION



A
NEW
SERIES OF

**VERSATILE
PLUG-IN
CONNECTORS**

Easy action precision machined contacts . . . Guide pin or machine screw mounting . . . Coax for new miniature cables . . . Full floating female contacts . . . High strength insulators . . . Rugged Design . . . Small size . . .

The standard series of connectors is offered in five sizes with various combinations of 3 to 17 power contacts and one or two coaxial contacts. The power contacts have an 8 ampere rating and a minimum sea level flashover voltage of 3500 volts RMS. The insulators are a new high strength polyester melamine laminate that has good arc resistance and low moisture absorption. The coaxial contacts are approximately 50-ohms impedance and generally satisfactory for frequencies up to 1,000 mc. Clamping parts, that require no soldering of the braid wires, are available in various sizes for coaxial cables from 1/16 OD up to 1/4 inch for RG-59/U etc. cables.

The basic connectors are supplied for standard machine screw mounting. A Guide Pin and Bushing Kit GK-1 is available that adapts the standard connectors to guide pin engagement and mounting. Cover and cable clamp assemblies are available for hand engagement of the connectors in patch cord or test applications.

The design of the connector parts is such that the pin and socket contacts, coaxial contacts, insulator, and guide mountings can be arranged to make practically any shape or size of connector. The flat insulators do not require molds. Therefore special shapes and combinations can be supplied promptly without special tooling charges.

In addition to the standard types, the parts are available separately. These parts can be readily assembled into special connectors by merely drilling standard size holes in the insulator plates and assembling the component parts.

Write or call for descriptive folder.

DANBURY  KNUDSEN

INCORPORATED
DANBURY, CONN.

CIRCLE 155 ON READER-SERVICE CARD FOR MORE INFORMATION

Transistor Tester

Self-Calibrating



A general purpose Transistor Tester for laboratory, field, and industrial use, the Model TT-102 measures and reads small signal beta, collector leakage current,

and collector resistance. These parameters may be measured on all npn, pnp surface barrier, grown or diffused junction transistors.

Sonex, Inc., Dept. ED, Upper Darby, Pa.

CIRCLE 156 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetostriction Transducer

High Power



The first high-power magnetostriction type transducer, Model AM-203B, is designed for large scale ultrasonic appli-

cations. Average rf power applied to the transducer is 66 w sq in. of radiating area, producing cavitation effects throughout a large volume of solution.

This 400 w unit operates at 25.9 kc and measures 4-3/8 in. diam x 4-5/8 in. H. Proper water cooling minimizes frequency drift and output loss. Each transducer features built-in biasing magnets eliminating separate dc bias supplies.

Acoustica Associates, Inc., Dept. ED, Glenwood Landing, L. I., N. Y.

CIRCLE 157 ON READER-SERVICE CARD FOR MORE INFORMATION

Potentiometer

$\pm 0.25\%$ Linear; Weighs 2 oz



The Series 5300 Precision Potentiometer, a 1-1/2 in. diam, 2 oz, bushing-mount unit, improves upon and will eventually replace this firm's Series G. It is housed in a drawn one-piece aluminum cup. The unit is compact, extra rugged, and long-lived.

It also offers considerable improvement in mechanical runout, noise, and torque. Up to nine taps can be added during manufacture, each spot-welded to a single turn of resistance wire without shorting out adjacent turns.

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

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MARS OUTSTANDING DESIGN SERIES—featured in the current advertising of J. S. Staedtler, Inc.—has attracted widespread attention among the users of fine drafting pencils. It has fulfilled our expectation that the men who appreciate the finest working tools are those with a lively creative interest in new designs, new projects, new ideas.

Concerned with unusual projects—*designs of the future*—Mars Outstanding Design Series provides a “showcase” for originality, for interesting work of engineers, architects, and students which so often lies buried. To stimulate you to send in your designs, Mars Pencils

will pay you \$100

for any design accepted. This \$100 is paid you simply for the right to reproduce your project in the Mars Outstanding Design Series. There are no strings attached. You will be given full credit. (See ad on this page—one of the ads in the current series.) All future rights to the design remain with you. You can reproduce it later wherever you like and sell or dispose of it as you wish.

The subject can be almost anything—aviation, space travel, autos, trains, buildings, engineering structures, household items, tools, machines, business equipment, etc. It should be a project that appeals to design-minded readers, be of broad interest, and be attractively presented. Do not submit a design that has been executed. As a matter of fact, the project does not need to have been planned for actual execution. It should, however, be something that is either feasible at present or a logical extension of current trends. It cannot be unrealistic or involve purely hypothetical alterations of natural laws.

There is no deadline for entries but the sooner you send yours in, the greater the probability of its use as one of the subjects in the 1957 Mars Outstanding Design Series.

It Is Simple To Submit a Design For Mars Outstanding Design Series

Just mail in an inexpensive photostat or photocopy of the subject—one you can spare, since it cannot be returned.

If your entry is accepted, we will ask you to send in a sharp photograph of the design, or the design itself, so that we can make a sharp photograph suitable for reproduction—after which it will be returned to you promptly.

Send your entry to:

J.S. STAEDTLER, INC.

DICAROLIS COURT, HACKENSACK, NEW JERSEY

CIRCLE 160 ON READER-SERVICE CARD

Transformers and Reactors

Variety of Toroidal Units



Expanded facilities at the west coast plant of this firm include additional equipment for making transformers and reactors that involve toroidal windings. In the past, the firm has produced

miniature pulse transformers with ID's of 1/4 in. With the expanded facilities, the range will extend to sizes up to 4 in. OD.

Acme Electric Corp., Dept. ED, Cuba, N.Y.

CIRCLE 161 ON READER-SERVICE CARD FOR MORE INFORMATION

High Potential Tester

Provides Automatic Go, No-Go



This Go, No-Go instrument is intended for high speed test of slip ring assemblies, relays, electron tubes, synchros, and motors. Each electrode of the

specimen is successively energized at high potential with respect to the others. Deterioration of the dielectric causes a current to flow which is monitored by a sensitive relay.

Theta Instrument Corp., Dept. ED, 204 Market St., E. Paterson, N.J.

CIRCLE 162 ON READER-SERVICE CARD FOR MORE INFORMATION

X-Band Rotary Joint

Takes 600 kw Peak



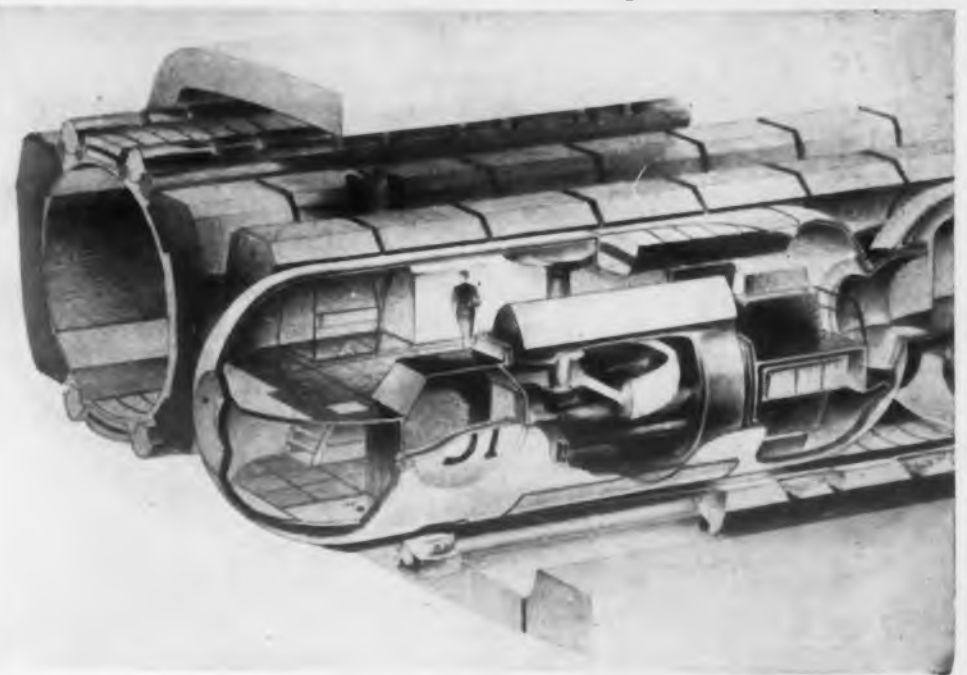
The Model H250T/S61 Rotary Joint is a broad band, high power waveguide coupler designed especially for operation under severe shock and vibration conditions. Capable of operating at 600

kw peak power for short intervals, it operates at 350 kw during extended use. Impact and vibration tests per MIL-T-17113 show unimpaired mechanical operation and no internal damage. Vswr is less than 1.10 over a frequency band of 8400-9600 mc. Change of vswr with rotation is less than 0.2 db.

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

CIRCLE 163 ON READER-SERVICE CARD FOR MORE INFORMATION

MARS outstanding design SERIES



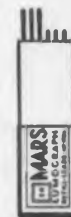
man and motion:

The wonders of the future are still little whispers in men's minds, or maybe — like Detroit Designer Norman James' magnetically suspended inter-city train — a drawing on a piece of paper. Traveling in a vacuum in an air-tight tube, it floats in space, held by a system of magnets built into cars and tunnel. Propelled electrically by “rolled-out” motor, train acts as rotor, tunnel roof as stator. Converter aboard train changes light projected through windows into electrical energy.

No one knows which ideas will flower into reality. But it will be important in the future, as it is now, to use the best of tools when pencil and paper translate a dream into a project. And then, as now, there will be no finer tool than Mars—sketch to working drawing.

Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and “Draftsman's” Pencil Sharpener with the adjustable point-length feature; and — last but not least — the Mars-Lumochrom, the new colored drafting pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.

The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom colored drafting pencil, 24 colors.



J.S. STAEDTLER, INC.
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at all good engineering and drawing material suppliers

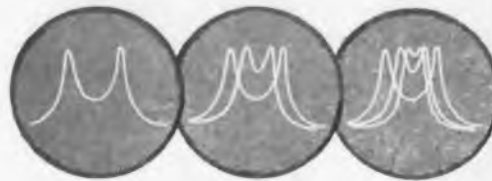
CIRCLE 164 ON READER-SERVICE CARD FOR MORE INFORMATION

The Memo-Scope, incorporating the famous MEMOTRON, combines the unique quality of information persistence with all the features of a superior quality laboratory oscilloscope.

The Memo-Scope by Hughes is a storage oscilloscope that captures and retains any number of traces indefinitely at a constant intensity until intentionally erased. Traces are readily visible in a brightly-lighted room, and may be easily photographed.

NEW!

The only scope
with a memory.



MEMO-SCOPE

Memo-Scope is available in two models: Portable (Model 103), and Rack Mounted (Model 103-R).



Plug-in vertical amplifiers of a variety of characteristics are available to increase flexibility. Hinged camera mount swings photographic apparatus aside for direct-display view.

TYPICAL APPLICATIONS

Study of transient electrical phenomena as short as 10 microseconds in duration.
Presentation of tube or transistor characteristics without the necessity of repetition.
Display of frequency response curves without the need of a sweep generator.
Spectrum analyses.
Shock testing.
Electrocardiographic studies.
Detection and measurement of relay bounce or contact noise.
High-speed X-Y plotting.
Investigation of transient behavior of power supply regulation.
Camera shutter timing.

CONDENSED SPECIFICATIONS

5-INCH MEMOTRON STORAGE TUBE
Erasure: internal waveform generator triggered by a push button or by application of a 25-volt, 1-millisecond positive external pulse, erases stored traces within 250 milliseconds.
DC Blanking: CRT grid direct coupled to external or internal blanking gate allows beam to be turned off except during sweep and insures constant sweep-time intensity.
Deflection Plates: available at rear terminal strip for direct connection.
AMPLIFIERS
Frequency Response: DC to 250 kilocycles within 10%.
Rise Time: 2 microseconds.
TRIGGERED LINEAR SWEEP
Range: 10 μ sec to 10 seconds per division, adjustable continuously or in 18 calibrated steps.
Trigger: vertical amplifier signal, AC line or external pulse, either polarity, DC or AC coupled. Minimum external trigger amplitude, 0.1 volts.
Ready Light: neon lamp indicates sweep is at left side of screen, ready for trigger.
AMPLITUDE CALIBRATOR
Available at front panel terminal—one kilocycle square wave with peak-to-peak amplitude of 0.01, 0.1, 1.0 or 10 volts, within 3%.
BEAM POSITION INDICATORS
Four neon lamps show position of writing beam when not on screen.
ILLUMINATED GRATICULE
Illuminated scale calibrated in $1/3$ " squares in 10 X 10 array.
RACK MOUNTING
Model 103-R available on standard 14" X 19" relay rack panel.
DIMENSIONS
13" wide, 14" high, 20" deep. Etched circuit epon-glass electrical chassis.

For additional
information on
Memo-Scope

HUGHES PRODUCTS

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

write to: HUGHES PRODUCTS · ELECTRON TUBE
International Airport Station, Los Angeles 45, California

CIRCLE 165 ON READER-SERVICE CARD FOR MORE INFORMATION

Power Transistor

Operates from 12 V Battery



The 2N235A, a germanium pnp audio power transistor, operates from a 12 v battery. It can readily dissipate 5 w at a 75 C mounting base temperature and 25 w at room temperature. The collector current rating is 2 amp at 75 C. Power gain is 30-40 db, and it has ac current gains up to 100 at 0.5 amp collector current and 50 at 2 amp.

Semiconductor Products, Red Bank Div., Bendix Aviation Corp., Dept. ED, 201 Westwood Ave., Long Branch, N.J.

CIRCLE 166 ON READER-SERVICE CARD FOR MORE INFORMATION

Oscillogram Reader

Converts Data to Shaft Rotations



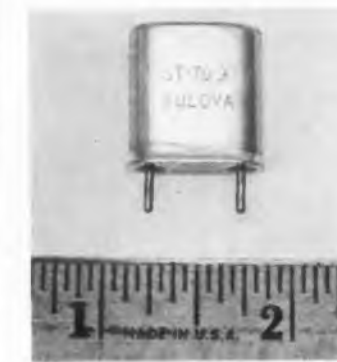
The Oscillogram Reader converts amplitude measurements, as determined by the position of a horizontal cross-hair, into shaft rotations so that this information may be digitally converted for use by typewriters, printers, and punched card or tape devices. The basic measuring unit is provided by a precision leadscrew the length of which cannot vary with changes in voltage.

Coleman Engineering Co., Inc., Dept. ED, 6040 W. Jefferson Blvd., Los Angeles 16, Calif.

CIRCLE 167 ON READER-SERVICE CARD FOR MORE INFORMATION

Crystal Unit

Withstands 100 G Shock



With a frequency range of 200-500 kc, the Model ST 70X Crystal Unit meets a shock test of 100 G's. It will withstand vibration of 15 G's, 10-55 cps for 2 hrs, per MIL C 3098B; 5 G's, 5-500 cps for 45 minutes, per MIL E 05272A; and 3 G's, 500-1200 cps per MIL T 5422 (ASC). Storage temperatures are -65 to 135 C; operable temperature range is -55 to 120 C. Frequency excursion is low as ± 0.001 per cent over any given 30 C temperature range. This crystal has been developed primarily for missile requirements.

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

CIRCLE 168 ON READER-SERVICE CARD FOR MORE INFORMATION

Small Antenna Lead-In

Coupler Bleeds off Static



This high-voltage ceramic capacitor, shunted by a printed bleed resistor, links antenna feed-in lined to the input of TV front-end tuners, and bleeds off static charges. The capacitor serves as an rf coupling between receiver and the antenna lines. The resistor bleeds off charges developed on the antenna system from precipitation static or inductive surges due to nearby lighting.

Capacity of the DN-96-10 is 470 mmf G.M.V. Solar Mfg. Corp., Dept. ED, E. 46th St. & Seville Ave., Los Angeles 58, Calif.

CIRCLE 169 ON READER-SERVICE CARD FOR MORE INFORMATION

Radar Test Set

Has Complete Instrumentation



This Radar Test Set combines all of the instrumentation necessary for complete check-out of radar and other microwave transmitters in the

field or otherwise. Available in C-Band (5200-5900 mc), X-Band (8500-10,000 mc), and Ku-Band (15,000-17,000 mc) frequencies, it includes all necessary test functions in one self-contained unit.

Kearfott Company, Inc., Western Div., Dept. ED, 253 N. Vinedo Ave., Pasadena, Calif.

CIRCLE 170 ON READER-SERVICE CARD FOR MORE INFORMATION

Relay

Operates at 0.0035 amp

The HD-8 Sensitive Power Relay is a special purpose unit that allows extremely low surge current through the actuating coil, preventing damage to fine instrument control contacts. It requires only 0.0035 amp from an external contact (thermometer, contact-meter, probes, etc.) to operate. Power amplification is a high 17,300.



Ebert Electronics Corp., Dept. ED, 212-312 Jamaica Ave., Queens Village 28, N.Y.

CIRCLE 171 ON READER-SERVICE CARD FOR MORE INFORMATION

NOW! TEST KLYSTRONS AS EASILY AS ORDINARY VACUUM TUBES

tests all tubes...



The successful testing of klystron tubes may save lives, prevent breakdowns and assure continued reliability.

Now, klystron tube testing is as easy and practical as the testing of ordinary vacuum tubes — with the Polarad Klystron Tube Tester Model K-100

Here, for the first time, is a compact, portable instrument developed to test the performance of all commercially available klystron type tubes, including those with built-in cavities and those requiring external cavities. The unit has been designed with a complete flexibility to allow for the testing of future klystron tubes not yet manufactured.

Model K-100 provides complete metering functions, control adjustments, and precautionary methods for testing at high voltages safely. A finger-controlled data chart on the face of the unit quickly determines proper control settings.

- Filament continuity
- Short circuit tests between all elements
- Static d-c tests — measurements of rated d-c currents and voltages
- Life tests — relation of cathode current versus reduced filament voltages
- Dynamic test — provision is made for external modulation so that klystron tubes may be dynamically tested with external rf measuring equipment

POLARAD ELECTRONICS CORPORATION

43-20 34th Street, Long Island City 1, N. Y.

PROVEN RELIABILITY
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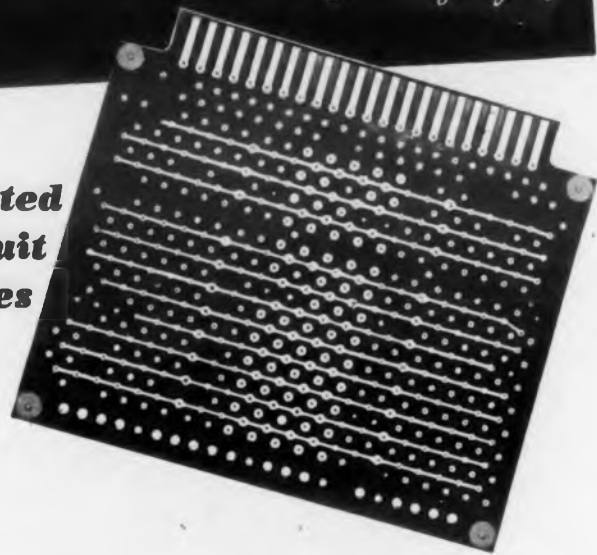
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TRACER-GUIDED DRILLING

100 HOLES P. M.

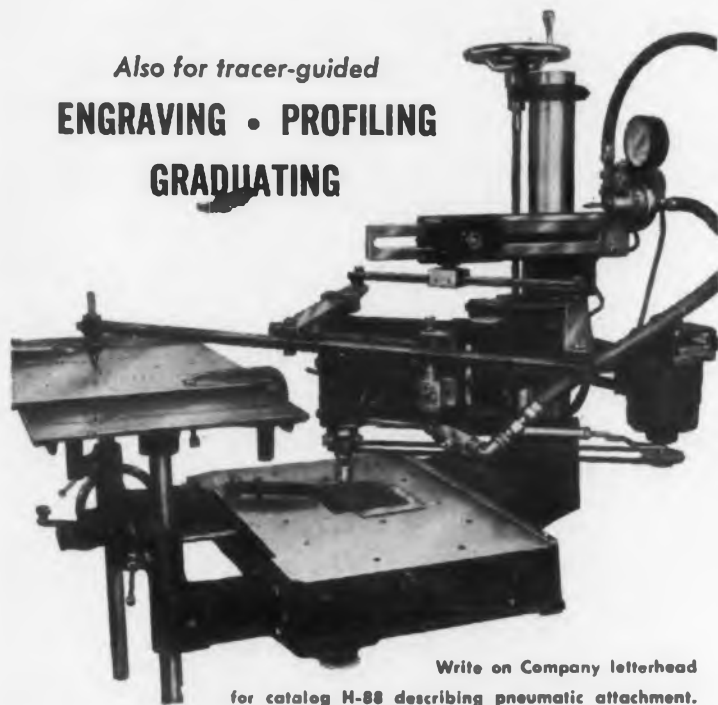
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Write on Company letterhead
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new hermes
ENGRAVING MACHINE CORP.
13-19 University Place, New York 3, N.Y.

New Literature

Electrical Contacts and Contact Materials 174

A 28-page catalog details contact materials, material characteristics, types of contacts and applications. Technical information includes electrical and physical properties and applications of contacts made from various materials. The catalog also contains reference charts to facilitate selection of the most satisfactory contact material and type of contact. Baker & Co., Inc., 113 Astor St., Newark 5, N.J.

Aeronautical Research 175

Progress in aeronautical research over the last ten years has been outlined in a 67-page booklet. Amply illustrated, the brochure discusses technical programs for aerodynamics, aeroelasticity, aircraft design, atmospheric physics, combustion and propulsion, electronics, flight instrumentation, helicopters, materials, stability and control, structures, etc. Cornell Aeronautical Laboratory, Inc., of Cornell University, Buffalo 21, N.Y.

Oscillographic Recording Brochure 176

A 2-color 8-page brochure features Lino-Writ photo-recording papers. Illustrated with charts and photographs, the bulletin describes Lino-Writ 1, 2, and 3 papers and indicates the proper application of each. Included are relative paper speeds for tungsten, cathode-ray green, and cathode-ray blue exposures; complete processing data for both regular and rapid stabilization methods, by hand or automatic machine; time and temperature relationships; spectral response; paper thickness; and core and winding data. E. I. du Pont de Nemours & Co., du Pont Photo Prods. Dept., Wilmington 98, Del.

Socket Slotted

SET SCREW

**Application 7 Times Faster,
New SETKO HOPPER-FED Way**

One plant's production rate zoomed from 300 per hour to 2,000 per hour after installing Setko Hopper-Fed Special Equipment* which adapts readily to present machines. Others are making similar gains and getting many additional advantages such as great reduction in cross-threading and floor loss; adaptability to all metals or plastics and smaller set screw inventory.

Arrange for demonstration at our plant, without cost or obligation to you. Get full details by writing your name and address in margin of page and mailing to us today.



Set Screw & Mfg. Co.
265 Main St., Bartlett, Ill. (Chicago Suburb)
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Other Patents Pending

We Specialize in Solving Puzzling Set Screw Problems

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FOR POSITIVE,
**LOW-COST
SPROCKET
DRIVES...**

TRY
GENUINE
**BEAD
CHAIN**



Now successfully employed in radio and TV tuners, recorders, air conditioners, timing devices, etc. Designed for economical, positive gear trains or drives free of slippage and backlash.

VERSATILE BEAD CHAIN

has many other advantageous applications such as:

- part retainers
- remote control devices
- fan or ventilator pulls
- revolving displays

and many others

WRITE TODAY FOR CATALOG AND SPECIFICATION SHEETS

THE BEAD CHAIN MFG. CO.

58 Mountain Grove St., Bridgeport, Conn.

CIRCLE 178 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • November 1, 1956

TENSION GAUGE is PRE-SETTABLE



For GO/NO-GO Tests of Springs and Contact Pressures

Speedy, one-hand operation and precise calibration over a range of 4 to 2500 grams, with adjustable zero setting, are the important features of GENALEX tension gauges. Designed for GO/NO-GO checking of spring tensions or other resistive forces, these gauges permit inspection or production testing by unskilled personnel.

To use this gauge; just preset the tension by turning the micrometer knob until the pointer shows the desired tension on the scale and apply the tip of the gauge-operating strip where force is to be checked. If the force being checked matches the gauge setting, the operating strip and the resisting element will move at the same time. Attention is focused on one point only—movement at the point of contact; there are no dials or scales to be read.

Six models are available, covering ranges of 4-24, 10-80, 50-250, 100-500, 200-1600, and 500-2500 grams. For detailed descriptive bulletin and prices, write: General Electric Company, Limited of England, c/o Imtra Corporation (U. S. Agents), 58 Charles Street, Cambridge, Massachusetts, U. S. A.

CIRCLE 179 ON READER-SERVICE CARD FOR MORE INFORMATION



161 control steps!

That's what you get in Ward Leonard's 13" Multi-step plate rheostat — what's more, you get 161 steps whether it's a 2 ohm or a 1000 ohm plate.

You get smoother operation and longer life in any W/L rheostat and you take your pick from the most complete line of power rheostats ever offered for industrial and commercial applications.

Write for free data-packed Bulletin 60A. Ward Leonard Electric Co. 77 South St., Mount Vernon, N.Y. 4.12

WARD LEONARD ELECTRIC CO.

Result-**E**ngineered Controls Since 1892

RESISTORS • RELAYS • MOTOR CONTROLS • CHROMASTER



CIRCLE 180 ON READER-SERVICE CARD FOR MORE INFORMATION

Temperature Controllers 181

Bulletin MC-133 offers information on the Series 53,000 temperature controller which is designed as an individual unit to be plugged into a separate power supply chassis. For multi-point control, the brochure shows how the requisite number of controllers can be plugged into a single power supply chassis, centralizing control and conserving space while maintaining a choice of locations for temperature adjusting controls. The illustrated bulletin also describes the thermistor sensing elements which permit control as close as 25 per cent of scale range, and lead wires 200 ft and more in length. Fenwal Inc., Ashland, Mass.

Vibration-Damped Fasteners 182

An illustrated brochure on Vibrex fasteners, which combine quick-release closures and vibration dampeners, has been issued. The bulletin lists information on different types of fasteners together with specific tensile strength, sealing and anti-vibration characteristics and also cites applications, including instrument mounting and panel fastening for metal or plastic fiberglass. A special leaflet covers the use of fasteners for vibrationproof quick-release mounting of printed circuits. Vibrex Fastener Corp., Mount Kisco, N.Y.

Report On Metalphoto Plates 183

The first of a series of reports on how specific segments of industry are using Metalphoto plates. In this report, applications used in industrial research laboratories are detailed. Printed from standard photographic negatives and developed and printed by standard photographic techniques, the plates are being used over the range from simple nameplates to highly intricate calculators. Metalphoto Corp., 6811 Superior Ave., Cleveland 3, O.

Automatic Machine Spec Sheets 184

Eleven illustrated specification sheets explaining the operation, dimensions, uses and adaptability of automatic and semi-automatic machines. Covered in the sheets are the automatic lamp finishing machine, automatic bottoming machine, continuous vacuum firing furnace, automatic crack-off and glazing machine, transistor metal-flanger subminiature button stem machine, cathode ray tube button stem machine, CRT neck splicing machine, self-centering tubular bulb sealing heads, miniature and subminiature sealing machine, sealed beam lamp single head equipment, and automatic pinch welder. Kahle Engineering Co., 1400 7th St., North Bergen, N.J.



These are typical of parts that Torrington produces daily by the hundreds or millions. If you use similar small precision parts, mail the coupon today for the Torrington Small Precision Parts condensed catalog. Even better, send a sketch, blueprint or sample part. We will give you a prompt quotation which will mean substantial savings to you.

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Specialties Division
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TORRINGTON SPECIAL METAL PARTS

Makers of Torrington Needle Bearings

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Now Available!

PHILCO Silicon Transistors



Unmatched performance and reliability! Characteristics assured by extensive life tests under typical operating conditions. Philco PNP Silicon Transistors make practical complete transistorization of military and commercial circuits—where high ambient temperatures are encountered.

Philco Silicon Transistors are now in pilot production and immediately available for initial design work. Specify Type T-1025 for amplifier, oscillator and low level general purpose applications and Type T-1159 for high speed switching applications.

FEATURES

- HIGH TEMPERATURE PERFORMANCE • VERY LOW LEAKAGE CURRENT • HIGH SPEED • SUITABLE FOR DIRECT COUPLING
- LOW SATURATION VOLTAGE • ABSOLUTE HERMETIC SEAL

Make Philco your prime source of information on Silicon Transistor Applications.

Write to Dept. ED, Lansdale Tube Company Division, Lansdale, Penna.

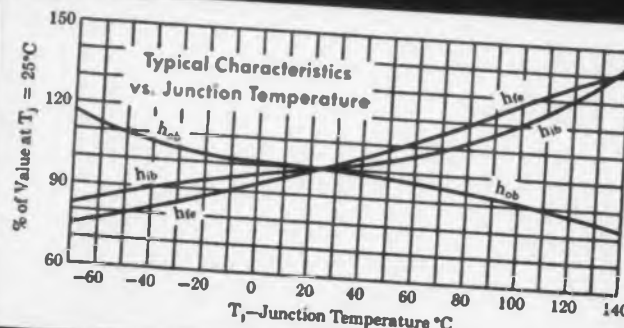
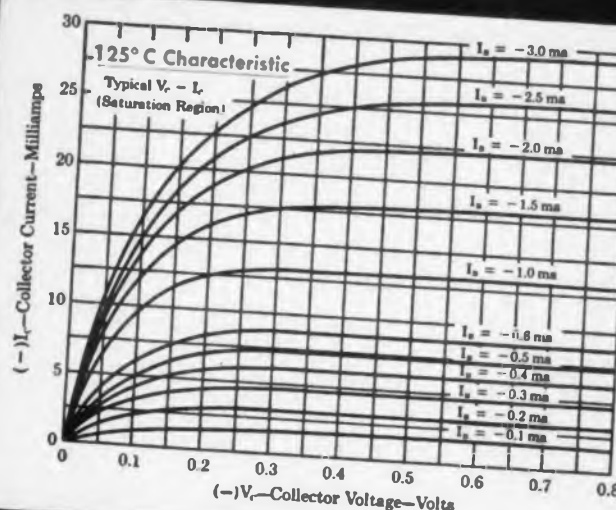
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LANSDALE TUBE COMPANY DIVISION
LANSDALE, PENNSYLVANIA



Characteristics of Types T-1025 and T-1159
($T_j = 25^\circ\text{C}$)

Characteristic	Condition	Typical Value
Current Amplification Factor, h_{fe}	$V_{ce} = -6\text{ v}$ $I_b = 1\text{ ma}$	18
Output Capacitance, C_{ob}	$V_{ce} = -6\text{ v}$ $I_b = 1\text{ ma}$	$7\ \mu\text{f}$
Maximum Oscillation Frequency, f_{max}	$V_c = -6\text{ v}$ $I_b = 1\text{ ma}$	15 mc
Cutoff Current, I_{cso} or I_{eso}	V_{ce} or $V_{es} = -10\text{ v}$.001 μa

Maximum Power Dissipation—150 mw
 Maximum Collector Voltage—T-1025-25 v
 T-1159-10 v



Computers

187

Brochure No. 108 has been issued describing the advance design features of the 400 series analog computer. The brochure states in detail the problem system, time scale check system, plug-in servo padding turrets, 400 cycle high-performance servo, and automatic recording of recorder calibration data. Reeves Instrument Corp., 207 E. 91st St., New York 28, N. Y.

Metal Forgings

188

A 32-page booklet has been released giving design, properties and applications of brass, bronze, aluminum hot-pressed forgings. The booklet discusses design factors involved in specifying and producing forgings. Factors of strength, core size, flash line, projections, staggered lines, fillet, lettering, dimensional tolerances, and other problems are treated with text and photos. Titan Metal Mfg. Co., Customer Service Div., Dept. U-35, Bellefonte, Pa.

Threaded Connections

189

Newsletter No. 2 has been issued describing lubrication of threaded connections. The booklet includes a description of the causes of galling and seizing in threaded connections and power screws and procedures for lubrication to eliminate these problems. Descriptive charts show coefficients of friction. Alpha Molykote Corp., Stamford, Conn.

Generator Excitation System

190

Bulletin 5.08 has been published describing the "McHenry Excitation System, an advance in the technique of alternator regulation and control." The McHenry Excitation System provides extremely fast response, positive stability, close regulation, and low cost; it will simplify new designs; and it can be easily installed in existing equipment. Electric Regulator Co., Pearl St., Norwalk, Conn.

◀ CIRCLE 186 ON READER-SERVICE CARD

Nylon Fasteners

191

This catalog describes a complete line of nylon one-piece self-locking fasteners. The locking principle used in these fasteners consists of a nylon plug imbedded permanently in the threaded section. It can be applied to any male or female threaded part, making leakproof joint which cannot be jarred loose by shock or vibration. The nuts, bolts and screws eliminate the need for lock washers, jam nuts, safety wiring or other locking devices. Nylon's "plastic memory" feature enables a fastening to be repeatedly removed and reinstalled. The catalog lists and describes the complete range of nylon self-locking bolts and screws, set screws, etc. The Nylok Corp., 475 Fifth Ave., New York 17, N.Y.

Phenolic Molding Compounds

192

Bulletin CDC-324 describes the automatic molding applications of one-stage phenolic molding compound 12902. Cited are fast cure and other characteristics demonstrated in early applications, as well as technical data.

Brochure No. CDC-326 describes characteristics of general purpose phenolic molding compounds, 12920 and 12921.

Bulletin CDC-325 describes the high impact strength of phenolic molding compound, 12906. The bulletin describes cure speed, finish, pourability and performability and also contains technical data. General Electric, Chemical Materials Dept., 1 Plastics Ave., Pittsfield, Mass.

Wound Toroids

193

A 16-page catalog describing the complete line of wound toroids, including standards, miniature, sub-miniature and high-frequency toroids; "Adjustoroids," "Rotoroids," telemetering band-pass filters, miniaturized band-pass filters, communications filters, and side-band filters has been released. The catalog describes the various characteristics and uses of each of the toroids or filters, and is illustrated with photographs. Performance curves for inductance ranges and inductance changes with direct current are given for each product as well as charts and graph illustrations. Burnell & Company, Inc., 5 Warburton Ave., Yonkers 2, N.Y.

Ceramic Magnets

194

A review of the several characteristics of this permanent magnet material is given in Applied Magnetism, Vol. 4, No. 3. How its special properties have been used to advantage in electronics is also discussed. The Indiana Steel Products Co., Dept. AM, Valparaiso, Ind.

DRIVER-HARRIS ALLOYS AT WORK IN PRODUCT ADVANCEMENT



First transparent full-scale model of the Earth Satellite made by the U.S. Naval Research Laboratory. The Satellite will be launched under the sponsorship of The National Academy of Sciences as a part of the United States participation in the International Geophysical Year (1 July, 1957—31 December, 1958). It will revolve around the earth at estimated altitudes of 200 to 1500 miles.

How measure the impact of micro-meteorites on the first "Earth Satellite"?

When physicists at the U.S. Naval Research Laboratory consider an instrument or a material to record accurately the secrets of outer space—it's not size alone that counts, but dependability, reliable precision.

The strip of "Nichrome"* evaporated on glass ("A" in the photo above) which may be fitted to the outer skin of the Satellite, measures only 1/4" wide x 1 1/2" long. Its thickness: 100 Angstrom units (1/10,000 mm). Its function: to measure

the surface erosion caused by the impact of micro-meteorites. The resistance of the Nichrome ribbon increases as the film becomes pitted by meteor particles.

"Nichrome is being considered for making this gage," states the Naval Research Laboratory, "because it supplies electrical resistance in a desirable range; adheres satisfactorily to glass in thin film form; and has a very low thermal coefficient of resistance."

There'll be no one on hand, 300 miles

out in space, to check on or supervise the performance of the Nichrome strip. Nichrome needs no one. It will do its job dependably there—just as it will in your electronic or electrical equipment, after it is in your customers' hands.

And remember, Nichrome is only one of the 132 special purpose alloys developed by Driver-Harris since 1899 for electrical heating, resistance, and electronic applications. Do you need a special alloy? Send us your specifications.

*T.M. Reg. U.S. Pat. Off.



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COMPANY

BRANCHES: Chicago, Detroit, Cleveland, Louisville, Los Angeles, San Francisco In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD
CIRCLE 195 ON READER-SERVICE CARD FOR MORE INFORMATION

**New small basic switch is
low cost; directly interchangeable
with AN3234 Specs**

The new Electro-Snap F2 Series snap action switches are extra-compact with extremely high electrical capacity for their size. Mechanical and electrical life at 1/32" overtravel is 150,000 operations, minimum, with accurate repeatability and constant stability of tolerances. Self-aligning springs provide contact wiping action rare in a switch of this size.

Durable case of special plastic gives the switch an ambient temperature rating of -100° to +275° F. or +375° F. Available, at low cost, in three basic models with a wide selection of actuators.

SERIES F2 BASIC SWITCH: F2-3: Single Pole, Double Throw
F2-2: Single Pole, Normally Open; F2-1: Single Pole, Normally Closed

OPERATING CHARACTERISTICS

Electrical Rating: 10 AMP, 125/250 V. A.C. 60 cycles
30 V. D.C. inductive and resistive (6 AMP, 30 V. D.C. for Airborne Application)
Operating Force, 7 to 12 oz. Movement Differential, .011 ± .002
Reset Force, 4 oz. Min. Overtravel, 1/32 Min.
Pretravel, 3/64 Max.

WRITE FOR DETAILS IN DATA SHEET FS-11



ELECTRO-SNAP
SWITCH & MFG. CO.
4216 W. LAKE ST., CHICAGO 24, ILLINOIS

**New simultaneous triple-pole switch
interrupts 3-phase ac. circuits;
6-circuit control in a small package**



MODEL K3-4

Triple-Pole, Double Throw
15 AMP., 125/250 V. A.C.
30 V., D.C. Res.
10 AMP., 30 V., D.C., Ind.
Overtravel, .015 Min.
Move. Diff., .028 ± .007
Mech. Life, 1,000,000 ops.
Elec. Life, 500,000 ops.

This completely new Electro-Snap triple-pole switch simultaneously reverses current flow through three windings of a 3-phase motor up to 1 H.P. and interrupts other types of multi-switching installations. Instantaneous "make" and "break" snap-action of the three poles is independent of the speed of actuation—even extremely slow moving cams can be used.

The K3-4 Series offers designers a wide variety of 3-phase circuit hookups for servo-controls, to limit movement of machine members and as a start-and-stop switch which formerly were possible only with complicated relays or a number of separate switches. A large selection of standard actuators is available.

WRITE FOR DETAILS IN DATA SHEET KS-11



ELECTRO-SNAP
SWITCH & MFG. CO.
4216 W. LAKE ST., CHICAGO 24, ILLINOIS

CIRCLE 196 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Connectors

197

An 8-page catalog illustrates and describes a complete line of miniature electrical connectors. The catalog presents standard plugs and receptacles which are moisture-sealed, vibration-dampened and corrosion-resistant. All are quick-disconnects, operate from -67 to 250 F and have continuous dielectric separation. They meet applicable MIL-C-5015B requirements for instrument ratings. The connectors listed include the Spherical Orientation Connectors designed to self-align and mate in blind connections. The Deutsch Co., 7000 Avalon Blvd., Los Angeles, Calif.

Pulse Patterns

198

A 16-page technical bulletin providing information on tape-wound or ferrite cores has been released. Bulletin 136 discusses how reliable testing procedures are a must, and goes on to point out the need for equipment which not only tests how a core will meet specifications within all necessary ranges of tolerance, but also how it will eventually operate in the system for which it is intended. Burroughs Corp., Electronic Instruments Div., 1209 Vine St., Philadelphia 7, Pa.

Continuous Sheet Mica

199

Availability of a 16-page booklet, "What Every User of Electrical Insulation Should Know About ISOMICA" has been announced. This illustrated booklet describes the background and development of continuous sheet mica, and tells how it is made today. It includes detailed information about the various types of ISOMICA—molding, segment, heater and flexible plates; tapes, flexible combinations, tubes and capacitor grade as well as SAMICA, the untreated continuous sheet mica. Mica Insulator Co., PO Box 1076, Schenectady 1, N.Y.

Custom Transformers

200

A 26-page catalog describes and illustrates a variety of custom transformers together with engineering specifications. The regular units list open frame transformers, cased transformers and channel frame and end bell cased units. The special units comprise air core reactors, special heater transformers, special output transformers and special furnace transformers. The catalog includes price lists as well as specifications and diagrams. Nothelfer Winding Laboratories, Inc., 111 Albemarle Ave., Trenton, N.J.



**Sweep Operation
of G-R Oscillators and Signal Generators
with Simple, Inexpensive, Automatic
DIAL DRIVES**

A number of manually-operated G-R oscillators and signal generators can be converted to sweep drive by means of the Type 908-P Synchronous Dial Drive which uses a synchronous motor that reverses when it touches adjustable stops.

Two drive speeds are available. One (Type 908-P1) is intended for use with graphic recorders where the synchronous motor provides a convenient time base; the other (Type 908-P2) has a higher speed particularly suitable for limited sweep applications with oscilloscopes.

Both of these drives can be attached readily to either the G-R Type 907 or Type 908 Dial. These dials can be used on many instruments not now equipped with them. The Type 908 Synchronous Dial Drive (either model) is moderately priced at \$27.50.

Write for Complete Data

GENERAL RADIO Company

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1150 York Road, Abington, Pa. PHILADELPHIA

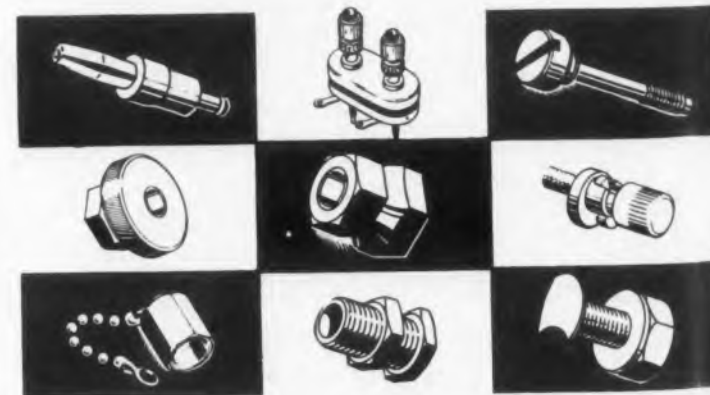
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CIRCLE 201 ON READER-SERVICE CARD FOR MORE INFORMATION



Dress Up your instrumentation with the finest electronic hardware from USECO. Increase sales appeal. Precision workmanship. Sparkling quality plating. All meet MIL specs. Prompt deliveries. 135 Jobbers and 31 Representatives to serve you. For name of nearest, write Dept. 7.

Complete line of standardized electronic hardware, terminal boards and etched circuits. Over 500 items. World's most complete stock of plated terminal lugs.



U. S. ENGINEERING CO., INC.

A Division of Litton Industries, Inc.

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CIRCLE 202 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetic Control Systems

203

An 8-page illustrated booklet TD 52-670 on magnetic controls and logic functions for industrial control is available. The booklet discusses the basic "and," "or," "not," and "memory" logic functions; the circuitry providing these functions, including the basic Ramey magnetic amplifier circuit; and current applications to industrial control. Westinghouse Electric Corp., P.O. Box 2099, Pittsburgh 30, Pa.

Vibration Mountings

204

A new 16-page bulletin entitled "Plate Form and Multiplane Mountings" contains engineering data, performance curves, specification tables, details on the design and use of plate mountings and multiplane mountings. The latter isolate vibration regardless of the direction of disturbing force. This feature makes them particularly useful to the aircraft and guided missile industry. A guide to selection and illustrated application and installation information is included. Lord Mfg. Co., 1635 W. 12th St., Erie, Penn.

Silver Bearing Soft Solders

205

A 2-page technical bulletin, No. 3, on silver bearing soft solders is now available. Included in the bulletin are a graph for determining proper alloy use and information on silver scavenging, alloy selection, applications and available alloys. Alpha Metals, Inc., 56 Water St., Jersey City, N.J.

Rotary Solenoids

206

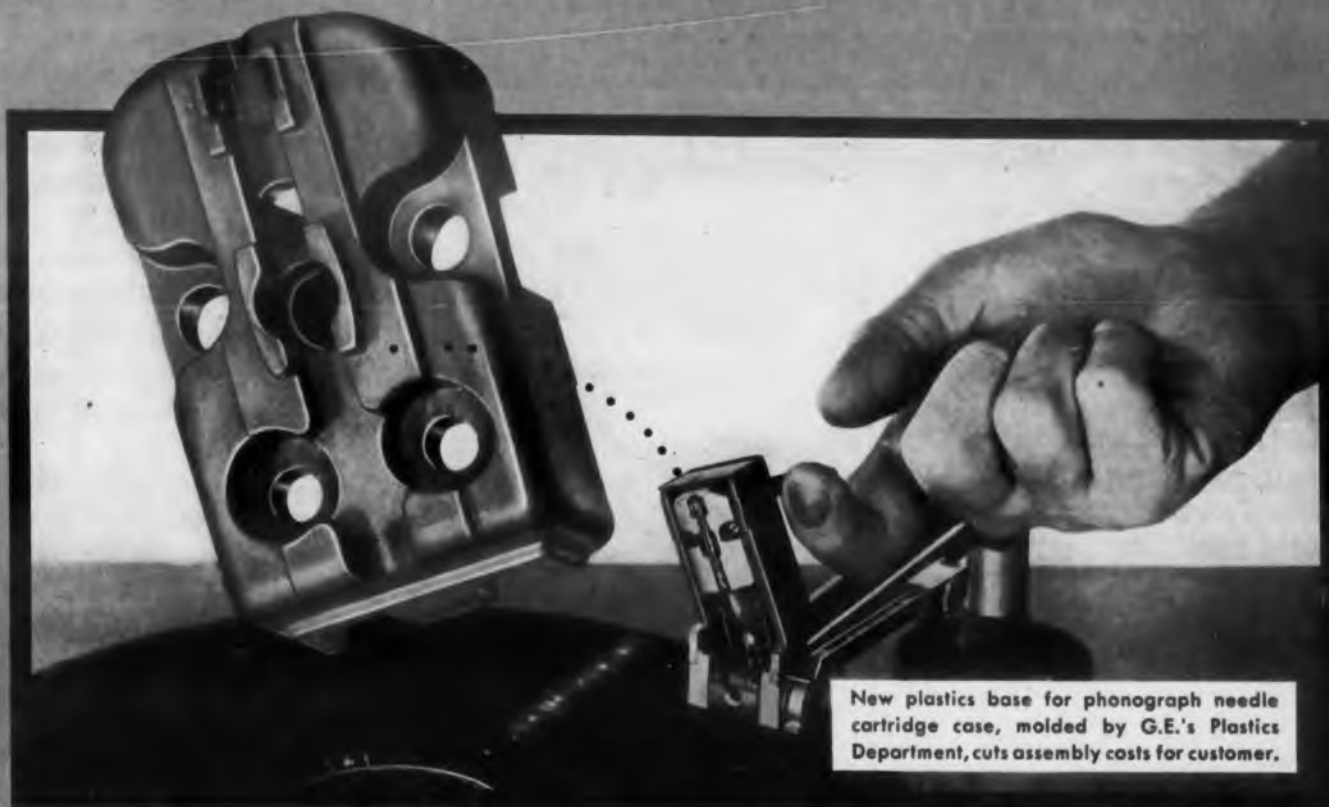
An 8-page booklet has been prepared to describe and illustrate a line of high-torque rotary solenoids. The solenoids feature instant starting, very high torque in relation to size, uniform force throughout the stroke, and rugged construction. They function under extreme conditions of vibration thus meeting all military aircraft specifications. The booklet contains a dimensional chart, mechanical supplements, and 8 complete engineering data charts. Oak Mfg. Co., 1260 N. Clybourn Ave., Chicago 10, Ill.

Regulated DC Power Supplies

207

This 3-page bulletin describes in detail the 2K series of transformers and chokes for electronically regulated power supplies. Schematics and block diagrams are included. Sterling Transformer Corp., 297 N. 7 St., Brooklyn, N.Y.

*A good product... made even better
... with plastics parts by G.E.*



PLASTICS PARTS SAVE TIME AND MONEY! Inserts in this cartridge case base were formerly added through a costly cementing operation. Working closely with the customer, General Electric Plastics Department engineers redesigned the base . . . used steel instead of beryllium for the mold . . . suggested a new high-impact styrene. **RESULT?** Now the customer can force inserts in place under pressure at high speed. They hold fast without cement because of the part's close tolerances and resilience. Further cost reductions are achieved because the part's high-impact resistance reduces rejects for-

merly incurred during the customer's riveting and soldering operations.

Where can YOU use plastics parts by G.E. to make a good product even better? If you are contemplating a new product, or are looking for a way to improve a present one, keep plastics in mind! As one of the world's foremost custom-molders, General Electric has helped scores of manufacturers improve product performance and appearance, realize important cost savings. G.E.'s custom-molding service will be happy to help you in engineering and developing your products —through plastics.

Write today on your company letterhead for a free copy of "The G-E Plastics Story," containing stimulating case histories of how customers profit through plastics. Just write: *Plastics Department, General Electric Company, Section 6X5A2, Decatur, Ill.*



Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 208 ON READER-SERVICE CARD FOR MORE INFORMATION

RADIO INTERFERENCE AND FIELD INTENSITY *measuring equipment*

Stoddart equipments are suitable for making interference measurements to one or more of the following specifications:

AIR FORCE—MIL-I-6181B

150 kc to 1000 mc

BuAer—MIL-I-6181B

150 kc to 1000 mc

BuShips—MIL-I-16910A (Ships)

14 kc to 1000 mc

SIGNAL CORPS—MIL-I-11683A

150 kc to 1000 mc

SIGNAL CORPS—MIL-S-10379A

150 kc to 1000 mc

The equipments shown cover the frequency range of 14 kilocycles to 1000 megacycles.

Measurements may be made with peak, quasi-peak and average (field intensity) detector functions.

F.C.C. PART 15—Now in effect, the revised F.C.C. Part 15 places stringent requirements upon radiation from incidental and restricted radiation devices. Stoddart equipment is suitable for measuring the radiation from any device capable of generating interference or c-w signal within the frequency range of 14 kc to 1000 mc.

Write Stoddart Aircraft Radio Co., Inc., for your free copy of the new revised F.C.C. Part 15.



NM-10A (AN/URM-6B)
14 kcs to 250 kcs



NM-20B (AN/PRM-1A)
150 kcs to 25 mcs



NM-30A (AN/URM-47)
20 mcs to 400 mcs



NM-50A (AN/URM-17)
375 mcs to 1000 mcs



The Stoddart NM-40A is an entirely new radio interference-field intensity measuring equipment. It is the commercial equivalent of the Navy type AN/URM-41 and is tunable over the audio and radio frequency range of 30 CPS to 15 kc. It performs vital functions never before available in a tunable equipment covering this frequency range. Electric and magnetic fields may be measured independently over this range using newly developed pick-up devices. Measurements can be made with a 3 db bandwidth variable from 10 CPS to 60 CPS and with a 15 kc wide broadband characteristic.

STODDART Aircraft Radio Co., Inc.

6644-J SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA • Hollywood 4-9294

CIRCLE 209 ON READER-SERVICE CARD FOR MORE INFORMATION

Photoelectric Controls 210

A revised bulletin, PA 561, is offered on photoelectric controls. The 24-page illustrated brochure contains detailed specifications, descriptive data and operational charts on "packaged" photoelectric systems for industrial control applications, including conveyor control, counting, inspecting and sorting, smoke detection and high-temperature measurement and control. Introduced is a line of miniature and subminiature photoelectric receivers and light sources which allow new control applications. Electronics Corp. of America, Photoswitch Div., 1 Memorial Drive, Cambridge 42, Mass.

Convergence Dot Generator 211

The model V-6 convergence dot generator, its features, applications and specifications, are described in an illustrated spec sheet. The unit is used for adjustment of the convergence of shadow mask tri-color kinescopes, and also checks linearity of color and monochrome monitors or receivers. Foto Video Laboratories, Inc., Eagle Rock Bldg., 25 Smith St., Little Falls, N.J.

Electric Ovens 212

A 4-page brochure illustrates and describes mechanical convection ovens, muffle furnaces, gravity type ovens, mechanical recirculating, and indicating pyrometers. Construction and listing of 8 models, with operating ranges, power requirements and prices are shown. Blue M Electric Co., 138th & Chatham St., Blue Island, Ill.

Digital Printers 213

Digital printers are the subject of a 12-page manual which covers all operating specifications. Details on many types of special calculating and printing techniques are also provided. Victor Adding Machine Co., 3900 N. Rockwell St., Chicago 18, Ill.

TV Quality Control 214

A quality control brochure describes the company's attention to product quality in television manufacturing. The booklet details in 16 pages the quality control steps taken in each of four sections on machines, materials, methods and men. Motorola Inc., 4545 W. Augusta Blvd., Chicago 51, Ill.

Electro-Pulse

PULSE INSTRUMENTATION

- PULSE GENERATORS
- TIME DELAY GENERATORS
- PULSE CODE GENERATORS
- MAGNETIC CORE TESTING EQUIPMENT
- BLOCK UNITS FOR TEST SYSTEMS

VERSATILE...

... WIDE RANGE... ACCURATE... SERVICEABLE

Utilizing advanced circuitry, Electro-Pulse offers a broad line of proven equipment for applications in development and test of RADAR, navigational aids, digital computers, data handling equipment, fire control systems, guided missile control, ballistics research, etc.

**MEGACYCLE PULSE GENERATOR
MODEL 3450A** ↓
20 CPS to 2 Megacycles
0.1 to 5 μs pulse width
0.1 to 5 μs pulse delay
50 volt low impedance output



Representatives in Major Cities

EP Electro-Pulse, Inc.

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CIRCLE 215 ON READER-SERVICE CARD FOR MORE INFORMATION

How to Charge HIGH-FLUX Magnets

Day-long
production
charging in
complete
safety and
comfort.



MODEL
942

Use the MODEL 942 Magnet Charger

RECOMMENDED BY LEADING MAGNET MAKERS

This high powered condenser discharge unit will saturate large Alnico and ceramic permanent magnets of any shape, using interchangeable, plug-in pulse transformers or wire-wound fixtures. 100,000 ampere-turn output of basic unit can be increased to 200,000 ampere-turns at any time by adding 100 μ f condenser banks and appropriate pulse transformer. Adapters for multi-pole rotors, rod, bar, ring and various other shapes are available.

Operates from regular 115 volt, 60-cycle line with only intermittent 10-ampere drain (the few seconds when condensers are charging). Mounted on casters for convenient mobility. Price of basic unit with pulse transformer is less than \$2,000.



WE CAN HELP YOU

Our 12 years of magnet charging experience is yours for the asking — send a sample magnet or sketch for free charging analysis.

Write for Technical and Application Data.

Radio Frequency

LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

CIRCLE 216 ON READER-SERVICE CARD

Low-Torque Gauges

217

A 4-page bulletin describes six models of Torque-Watch dial-reading gauges that measure extremely low torque (starting and moving) on such devices as potentiometers, servo mechanisms, spring mechanisms, gear trains, magnetic clutches, and small motors. The bulletin gives mechanical data and specifications, ranges and direction of measurable torque for each model; lists and illustrates features and uses. Waters Mfg., Inc., P. O. Box 368, So. Sudbury, Mass.

Printed Circuit Data Book

218

A 16-page copper clad technical data book has been released explaining the principles and some of the problems of printed circuitry. It advises on the proper selection of laminates, and tells how to make a printed circuit using both the photo engraving and silk screen methods. It also covers the subjects of plated circuits, plating through holes, flush circuit production and circuit fabricating. Formica Corp., subsidiary of American Cyanamid, 4614 Spring Grove Ave., Cincinnati 32, Ohio.

Automatic Instrumentation

219

A 12-page folder, No. 716, on automatic instrumentation components and systems is now available. Among the devices illustrated and described are resistance bridge indicator 101B, voltage ratio indicator 301B, miniature bridge balance BP-18A, warning system 401 RB and RBI systems for automatic digital recording of data. Fairchild Engine & Airplane Corp., Fairchild Electrotechnics Div., 118 E. 16th St., Costa Mesa, Calif.

Loudspeakers

220

A 24-page catalog, No. 1070, on Professional Series loudspeakers has just been issued. The catalog lists information on projectors drivers, rectangular horns, transformers, high fidelity and other equipment. Jensen Mfg. Co., 6601 S. Laramie Ave., Chicago 38, Ill.

Alnico Magnets

221

Catalog No. 200 describes and illustrates many of the stock-size Alnico magnets available. Horseshoes, rods, bars, discs and channels are shown together with dimensions and rated pulling power. Also included are representative costs of cut-to-size segments and their line of heavy duty, high powered retrieving magnets rated from 40 to 125 lbs pull. Park Magnet Co., Highland Park, Ill.

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° Bakelite Trademark.

UNITED STATES GASKET CO.
CAMDEN 1, NEW JERSEY

CIRCLE 222 ON READER-SERVICE CARD FOR MORE INFORMATION



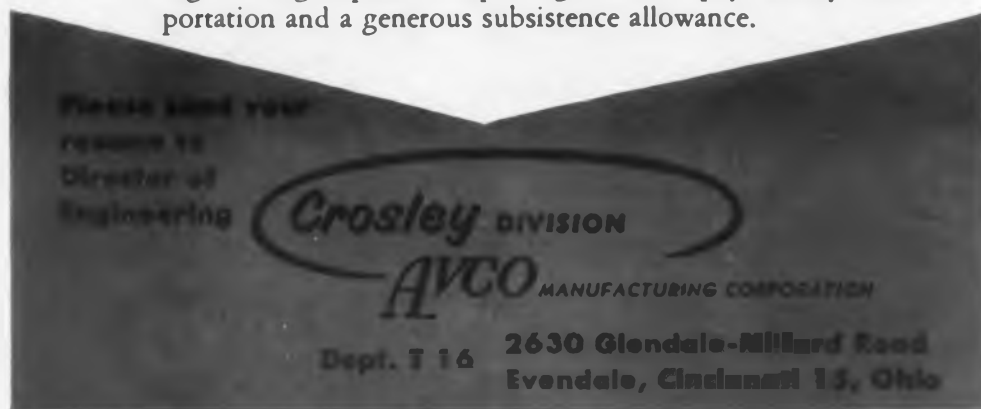
We have present openings for experienced Electronic Engineers in the design and development of ground radar systems, airborne transmitters and receivers and in the electrical systems of guided missile fuzes.

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CIRCLE 223 ON READER-SERVICE CARD FOR MORE INFORMATION

Polyethylene Pillows 224

Recently published is a 1-page catalog sheet describing the design and application of polyethylene pillows, devices to reduce evaporation of liquids in open vessels. The illustrated sheet lists prices and also gives information on polyethylene and polyvinyl chloride corrosion resistant tanks. American Agile Corp., P. O. Box 168, Bedford, Ohio.

Thermistor Overheat Detectors 225

An illustrated bulletin, MC-134 describes a line of thermistor overheat detectors for aviation service. The bulletin discusses the advantages of thermistor elements for temperature detection which include stability and compactness and permit leads up to 200 ft long and relatively simple circuitry. Applications are depicted, and physical and performance specifications are listed. Fenwal Inc., Ashland, Mass.

Retaining Rings 226

An illustrated catalog gives data and specifications on Industrial retaining rings. Listed in the catalog are 24 sizes in open type retaining rings for shafts measuring 1/25 to 1 in., 37 sizes in internal retaining rings conforming to NAS 50 for housings measuring 1/4 to 2-1/16 in. in diameter, and 48 sizes in external retaining rings conforming to NAS 51 which fit shafts from 1/8 to 2-1/4 in. Industrial Retaining Ring Co., Dept. P 29, 57 Cordier St., Irvington 11, N.J.

Hollow Aluminum Bar Stock 227

An illustrated technical brochure gives details on hollow aluminum bar stock. The 8-page publication discusses tolerances, mechanical properties and applications and offers case studies and comparison charts. Complete tables of the standard sizes available in round and hexagonal stock, listing the wall thicknesses, dimensions, and weight per foot are also included. Harvey Aluminum, 19200 S. Western Ave., Torrance, Calif.

Motors 228

Two 11-page catalogs GEC-1026A and GEC-1027A give buying information on a selected group of the company's motors. Included are application data, ratings and prices for fractional hp motors, integral-horsepower polyphase and single phase induction motors, motors and control, for part-winding starting, gear-motors and resilient-base integral-horsepower induction motors. General Electric Co., Schenectady 5, N.Y.

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CIRCLE 229 ON READER-SERVICE CARD



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when you
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To avoid the costly pitfalls of "over-specification" of custom-designed delay lines, take advantage of the consultation and lab reports offered by ESC. As pioneer manufacturers and specialists in this field, ESC offers a complete engineering consultation service on the construction and equipment application of fixed and variable delay lines. "You tell us the problem . . . let us recommend the realistic and economical specifications for your delay line requirements." The well-rounded equipment background of the ESC Engineering Staff makes this possible.

A lab report, submitted with the ESC prototype, will include your submitted electrical requirements, photo-oscillograms, which indicate input and output pulse shape and output rise-time; the test equipment used, and evaluation of the electrical characteristics of the prototype.



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IRCLE 230 ON READER-SERVICE CARD

Receiving Tubes

231

Chart ETD-1163-C for quick selection of G-E series-string receiving tubes has been revised to include 600 and 450 ma controlled heater warm-up tubes. The chart classifies 52 tube types in the 600 ma series and 24 types in the 450 ma series according to elements, typical service, heater voltages, maximum ratings, and gives average characteristics. The 450 ma types are for use in medium to small size series-string TV receivers where reduced heater wattage eases ventilation design problems in compact cabinets. General Electric Tube Sales, 1 River Rd., Schenectady, N.Y.

TV Parts

232

A recent catalog lists component parts for TV multi-outlet systems for both color and black and white. Included are a complete line of amplifiers and pre-amplifiers, line splitters, and line taps, as well as the model 704A field strength meter, a portable precision testing instrument for balancing master antenna systems, checking cable losses and locating and orienting antennas. The catalog also explains free engineering and layout services. Jerrold Electronics Corp., 23rd & Chestnut Sts., Philadelphia 3, Pa.

Tape Playing Time Chart

233

A chart has been issued which shows playing time for standard lengths on reels of various sizes. Superseding previous charts, the sheet lists data for standard 1-1/2 mil tape except where 1 mil or 1/2 mil thickness is indicated. The first four columns, for speeds of 1-7/8 to 15 ips. show playing time for single-track tapes. The last two columns, headed 3-3/4 and 7-1/2 ips., are for dual-track recording and recorded tapes. ORRadio Industries, Inc., Shamrock Circle, Opelika, Ala.

Temperature Controls Catalog

234

MC-135 is a 6-page catalog outlining the company's complete line of Thermoswitch temperature controls. Literature gives physical specifications, performance data and temperature ranges. Also described are modifications and special features, such as moisture-proof seals, armored cable, extended shell, and temperature-setting knob and dial, which can be supplied to adapt the switch to varied service requirements. Fenwal Inc., Ashland, Mass.



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rapid growth is almost twice that of the electronics industry as a whole... think what this can mean to *you* in opportunity and rapid advancement. And Sylvania helps underwrite your advanced studies in leading universities in both locations... because we want you to assume greater responsibility and leadership. Here are some typical problems being solved by Sylvania engineers and physicists in our Buffalo, N. Y. and Waltham, Mass. laboratories.

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If you believe that you can assist us in the solving of these problems, please write:

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SYLVANIA ELECTRIC PRODUCTS INC.



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X-500 Sub-Miniature ACEPOT* rated to 150° C.

ACEPOT* - ACETRIM* sub-miniature, precision wire-wound potentiometers and trimmers are shooting to new highs!

X-500 "Hotpot" operates from -55° C. to 150° C.
1/2" size
up to 250K
± .3% linearity
proved in use

ACEPOTS and ACETRIMS meet unusually rigid functional and physical requirements and are setting new standards for dependability in sub-miniaturization. The designs are the result of 4 years' development and over a year of successful use by leading electronic and aircraft equipment manufacturers.

Condensed Engineering Data

	ACEPOT (potentiometer)	ACETRIM (trimmer)
Resistance Range	200 \sim to 250K \pm 2%	10 \sim to 150K \pm 3%
Size	1/2 x 1/2"	1/2 x 1/2"
Linearity	\pm .3%	\pm 3%
Resolution	extremely high	excellent
Ambient Temperature	-55° C to 150° C	-55° C to 125° C
Torque	low or high	low or high

The above specifications are standard — other values on special order. All units sealed, moistureproofed, and anti-fungus treated. Meet applicable portions of JAN specs and MIL-E-5272A standards.

Ace also offers larger size precision potentiometers, to RETMA specifications, manufactured to highest standards to meet your most rigid requirements. Expedited delivery from special order section.



For applications where you must be positive, answer your potentiometer and trimmer needs with space and weight saving, highly accurate and dependable ACEPOTS and ACETRIMS.



Available in threaded bushing, servo, flush tapped hole or flange mounts, and ganged units. Special shaft lock is self-contained. Internal stops and taps as required. Indexing pin provides non-rotational mounting.

Expedited delivery on prototypes; prompt servicing of production orders. Write for Fact File and application data sheets.

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ACE ELECTRONICS ASSOCIATES

Dept. ED, 101 Dover St. • Somerville 44, Massachusetts

CIRCLE 236 ON READER-SERVICE CARD FOR MORE INFORMATION

Miniature Electrolytic Condensers 237

Bulletin H covers a complete line of miniature electrolytic condensers which are encased in solid-drawn single-ended aluminum cans spun on to plastic end plugs to give a moisture proof seal. Included are a dimension chart and data on tolerance, power factor and leakage current. Gary Wells Co., 3 Park Row, New York 38, N.Y.

FHP Electric Motor 238

A 4-page illustrated brochure describes features and applications of the AL-4 micromotor. Included are standard ratings, a dimensions diagram and a detailed cut-away photograph. The Redmond Co., Inc., Owosso, Mich.

Microlite Insulation 239

Form WML-5 provides information on Microlite insulation. The 4-page brochure tells how and of what Microlite is made and cites its uses which include heating and air conditioning systems, and industrial applications. L.O.F. Glass Fibers Co., 1810 Madison Ave., Toledo 1, Ohio.

Research and Engineering 240

An illustrated 4-page brochure describes the company's electronic research and development facilities. Infrared, electro-mechanical, optical, electronic, communication and navigation, and control and data systems engineering capabilities are cited. Fields of interest and completed contracts are listed. Servo Corp. of America, 20-20 Jericho Tpke., New Hyde Park, N.Y.

External Cotter Data 241

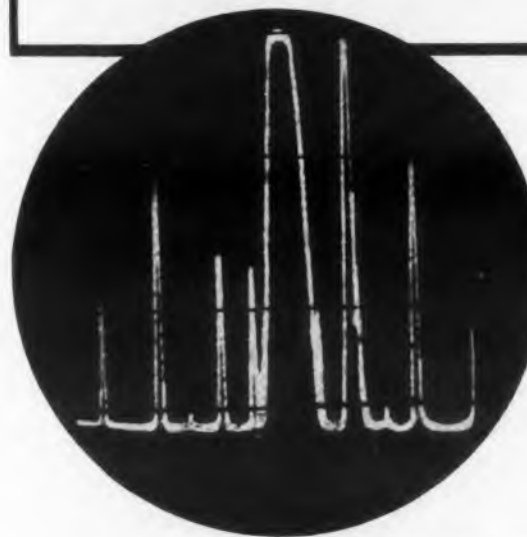
Dimensional data and price information of 14 standard external cotters are presented in a data sheet which is now available. Pin dimensions for each cotter are also given. Hunter Spring Co., Engineering Dept., Lansdale, Pa.

Coated Yarns 242

A 5-page folder describes application, properties and yarn data on glass and colored glass yarns coated with vinyl, teflon, and silicone. Data information is given according to yarn size and average yards per lb. Chemo Textiles, Inc., West Warwick, R.I.

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3 to 30 Mc



Designed by GPO
Precision-built
by Marconi

In transmitter hall or laboratory, Model 1094 will measure sidebands only 40 cycles off carrier frequency and 60 db down in amplitude.

Illustration shows spectrum width set to 600 cycles, range -30 to -60 db.

Hand calibrated and extremely stable, Model 1094 is a delight to use.

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Frequency: 3 to 30 Mc in 9 ranges
Amplitude Range: 0 to -30 and -30 to -60 db
Accuracy: \pm 1 db
Selectivity at 3 db points: 6, 30 and 150 cycles
Spectrum width: variable, 100 cycles to 30 kc
Sweep duration: 0.1, 0.3, 1, 3, 10 and 30 secs

4 Page illustrated brochure on request



MARCONI Instruments
44 New Street, New York, N.Y.

CIRCLE 243 ON READER-SERVICE CARD FOR MORE INFORMATION

Movies In Engineering

244

Information about recent advances in film sensitivity which have extended the scope of high speed movies for industry is provided in a 12-page booklet. Five illustrated case histories are used to show how such movies have helped to solve engineering problems. In addition to facts on lighting, speed selection, and lenses for a high speed camera, the pamphlet gives data on films for black-and-white movies in the visible spectrum, in full color, and by infrared radiation. Eastman Kodak Co., Rochester 4, N.Y.

Industrial Instrumentation

245

F-403 is a 4-page bulletin which illustrates and describes recording, indicating and controlling instruments required in industrial processing. The systems outlined feature four basic components that can be interchanged to perform a variety of functions, as well as minimize maintenance problems. Robertshaw-Fulton Controls Co., Fielden Instrument Div., 2920 N. 4th St., Philadelphia 33, Pa.

1957 Electronics Catalog

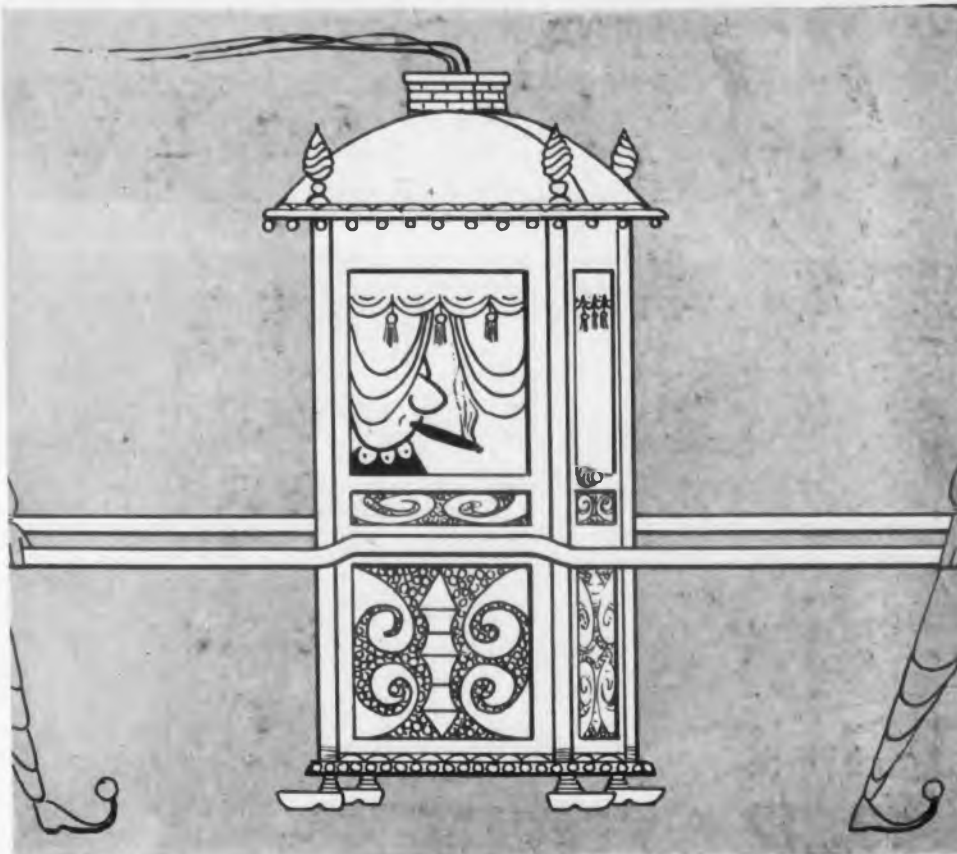
246

Over 27,000 items fill 356-pages in a 1957 catalog of nearly everything electronic. Among many others are detailed listings of test instruments, transistors, tools, wire, photo-electric components, nuclear instruments, sound-powered telephones, counters, program clocks, generators, radio amateur gear, phonographs and TV accessories. The catalog also has sections on recording equipment, electronic kits, technical books, and high fidelity and public address systems and components. There are 160 pages of rotogravure. Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

Electrical Contacts and Rivets

247

A list of 300 standard electrical contacts and rivets available in a wide range of precious and base metals including silver, gold, platinum, palladium, brass, steel, aluminum, copper, and precious and base metal alloys are tabulated in a 4-page specification bulletin. Many cold headed specialties are also illustrated. Deringer Metallurgical Corp., 8131 Monticello Ave., Skokie, Ill.



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Model 83 YZ 144, Wide-Band Oscilloscope Kit. Net \$69.00

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Permits use of any scope as a precision peak-to-peak AC voltmeter. Puts a true square-wave voltage on scope screen. Range switch and calibrated potentiometer selects any voltage between .01 and 100 volts in 4 ranges. Fifth position feeds external signal to scope for comparison. Has voltage regulator tube—output voltage stays constant with line variation from 80-135 volts. Accuracy, $\pm 6\%$ on all ranges. Shunt capacitance only 15 mmf. Includes control for providing precision initial setting. Direct coupling of output provides ground reference for DC scopes. Complete kit includes all parts, case, full instructions. Shpg. wt., 5 lbs.

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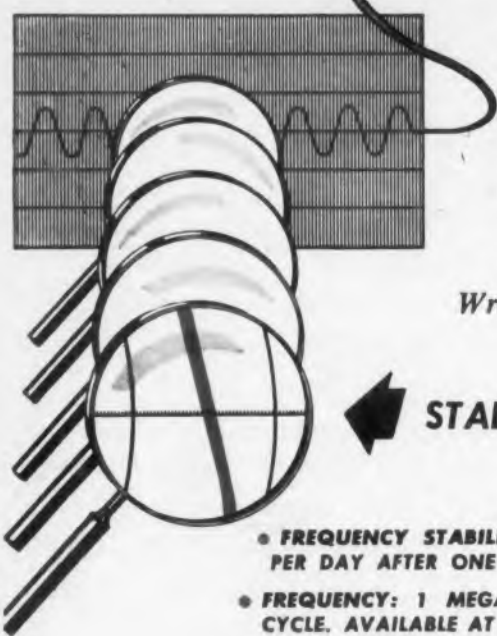
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- **POWER REQUIRED:** 150 VOLTS, 100 MA, REGULATED DC, AND 6.3 VOLTS, 3 AMPERES, AC OR DC. (Matching Power Supply available)

HYCON EASTERN, INC.

75 Cambridge Parkway Dept. F-11 Cambridge 42, Mass.
Affiliated with HYCON MFG. COMPANY, Pasadena, California

CIRCLE 344 ON READER-SERVICE CARD FOR MORE INFORMATION

Patents

Pulse Width Discriminator Circuit

Patent No. 2,737,684. E. L. Hughes and Harold B. Rose. (Assigned to International Telemeter Corp.)

A discriminator circuit is used to decode signals utilizing pulses of different time durations. A simple circuit for accomplishing this result is advantageous. Such a circuit is shown in the figure.

Negative-going input signals are applied at the input terminals and to the control grid 16 of the tube 12 through the condenser 10. The diode 22 clamps the positive side of the input signal at the bias level E_c . Normally the tube 12 is conducting so that a negative-going pulse biases the tube 12 to non-conducting condition. The diode 44 normally maintains the control grid of the second tube 32 a little above ground potential. Since the tube 12 and the second

tube 32 have the same cathode resistor 40, the second tube 32 is normally biased to a non-conducting condition.

When a negative-going input pulse renders tube 12 non-conducting, the cathodes of both tubes go to ground potential and a negative-going pulse is transmitted through condenser 42 to the control grid of the second tube. With a negative potential across this condenser, the diode 44 becomes non-conducting. With the diode 44 cut off, the condenser 42 begins to charge in a positive direction through the resistor 52 from the power source $+E_b$. If the pulse is of short duration, the condenser does not have time to charge to a potential level to render the tube 32 conducting. Termination of the input pulse restores the circuit to initial condition without generation of an output signal.

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easier to use
saves winding time
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insulation is where you need it

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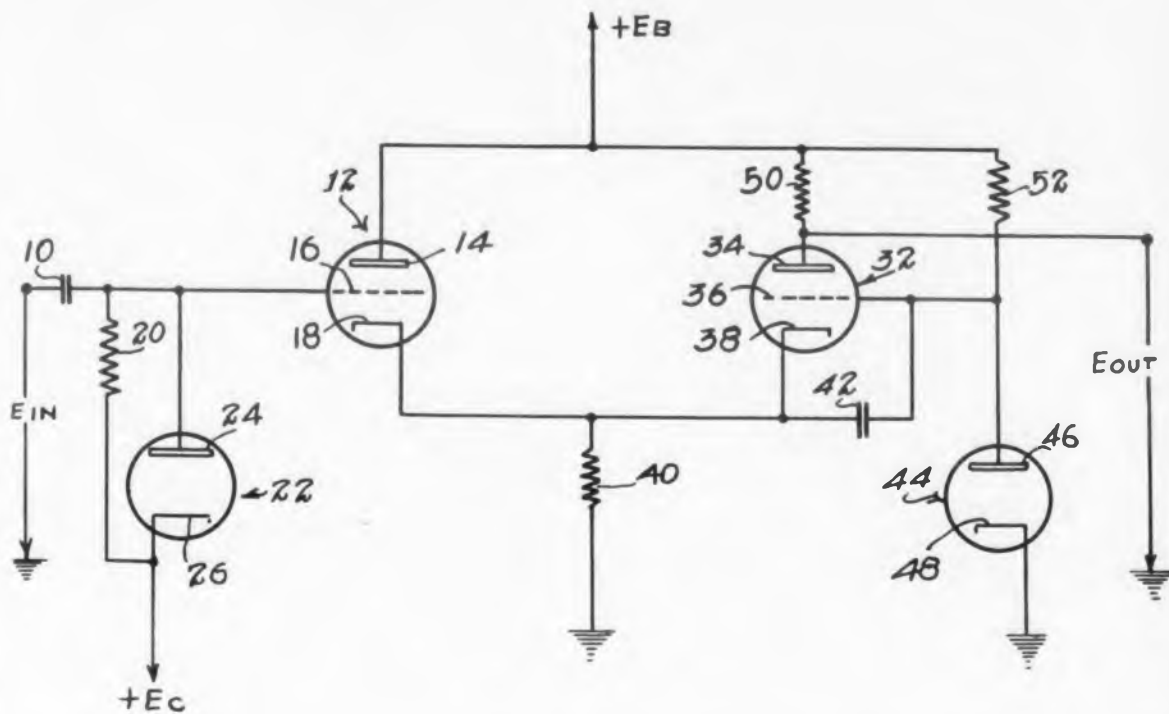
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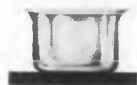
CIRCLE 345 ON READER-SERVICE CARD FOR MORE INFORMATION

If, now, a pulse of sufficiently long duration is applied at the input terminal, the condenser 42 charges to a potential, and hence places a potential on the control grid 36, that renders the tube 32 conducting. A pulse is then generated at the anode of the

tube 32 to which the output terminal is connected. The tube 32 continues to conduct, until the end of the negative pulse at the input. Termination of the input pulse restores conduction through tube 12 and cuts off tube 32 to terminate the output pulse.



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At this modern cable plant, build custom-made cable and facilities for telephone, radio, molding, multi-level, and numerous grid attaching and pulling connections as well as numerous SYSTEM features as provided.



SYSTEM INSTALLATION

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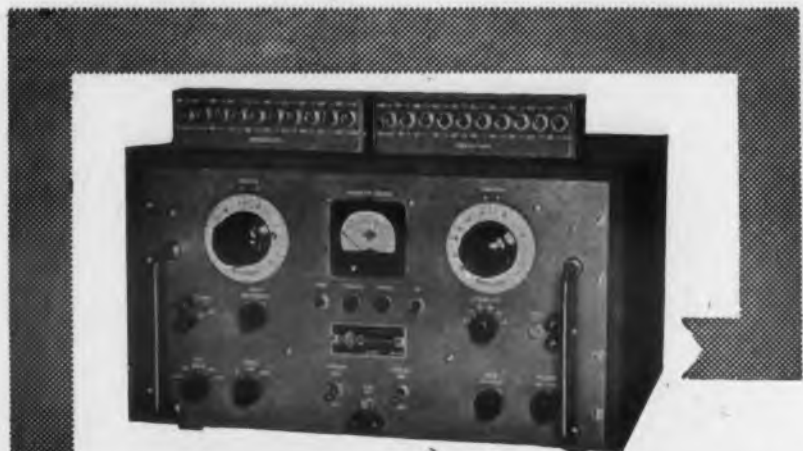
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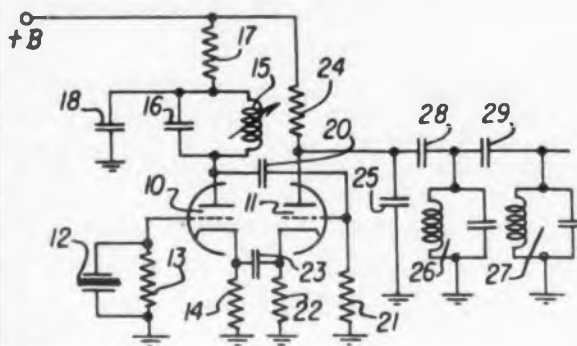
TELETRONICS LABORATORY, INC. 54 KINKEL STREET
WESTBURY, L. I., N. Y.

CIRCLE 348 ON READER-SERVICE CARD FOR MORE INFORMATION

Oscillator

Patent No. 2,740,891 W. W. Bowser (Assigned to Motorola, Inc.)

An oscillator which is to give accurate control of the frequency generated, utilizes a crystal to maintain frequency stability. It is impossible to manufacture crystals with such precision that they have precisely the desired frequency. As a consequence, it has been necessary to "warp" the crystal in order to shift the oscillator frequency to that desired. In prior circuits, such warping of the crystal rendered the oscillator circuit unstable. An oscillator which maintains its frequency stability, irrespective of some variation in its frequency from the natural frequency of the crystal, is advantageous. Also, in superheterodyne receivers it is easier to warp the oscillator frequency somewhat so that the received



signal will have a frequency between that of the intermediate frequency amplifier and the discriminator which may be slightly mistuned.

In the circuit illustrated in the figure, the crystal 12 is in the grid circuit of tube section 10. A tuned oscillator circuit 15, 16 is used in the plate circuit. Feedback is obtained through a cathode follower tube section 11, the control grid of which is coupled to the plate of the oscillator tube 10 by a coupling condenser 20. Feedback is secured through the condenser 23 between the cathodes of the two tubes. Tuned circuits 26 and 27 may be provided in the output circuit for frequency multiplying.

The circuit illustrated has a relatively flat frequency characteristic over a relatively wide frequency range. It also provides a stable circuit irrespective of the fact that the oscillator generates a frequency which is not the same as the natural frequency of the crystal. The patent describes variations of the circuit by which a flatter frequency characteristic is secured over a wider frequency range. One such variation includes an inductor in series with the crystal. The circuits in addition to providing a highly stable oscillator in operation also gives adequate output.

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Electronic Inverter System

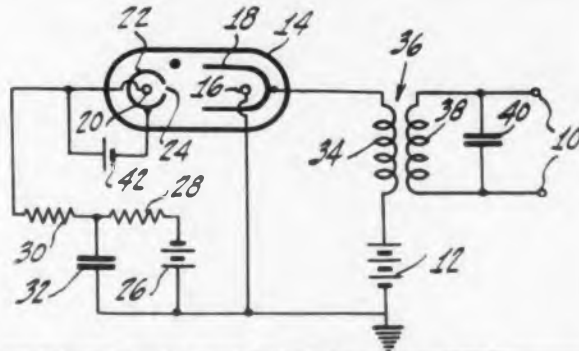
Patent No. 2,730,669. W. M. Webster, Jr.
(Assigned to Radio Corp. of America.)

The conversion of a dc potential into an alternating voltage has been accomplished by the vibration of a reed contactor which makes and breaks the circuit. The vibration of the reed is secured electromagnetically. The voltage output from this type of inverter is not sinusoidal and requires additional circuit elements to give it this form. In addition, arcing deteriorates the contact surfaces of the reed and contact point. The circuit and tube accomplishes the conversion of a dc potential into an ac sinusoidal voltage wave entirely electronically.

The circuit uses a so-called separate function gas tube which separates the functions of ionizing the gas in the tube and of the conduction of current through the tube. This type of tube is illustrated in the figure and the ionization of the gas in the tube is secured by battery 26 which charges capacitor 32 through resistor 28. The potential on the capacitor increases as it becomes charged until it reaches a potential to ionize the gas and current can pass through the tube between electrodes 20 and 16. Electrode 22 is a so-called constricting electrode in that it surrounds cathode 20 and has a narrow slot 24 directed towards main

cathode 16. Current flow between cathodes 16 and 20 discharges the capacitor until the current becomes too low to support gas ionization. Consequently, current ceases and the capacitor again begins to charge from battery 26 for the next discharge.

When the gas within the tube is ionized, current flows between cathode 16 and anode 18 through the primary winding of transformer 36. The dc potential is supplied by battery 12 whose potential is sufficient to support current flow when the gas is ionized but insufficient independently to ionize the gas. The output across tube terminals 10 is a sinusoidal wave. Battery 26, however, supplies a potential sufficient to ionize the gas and controls the flow of current between electrodes 16 and 18 and the circuit including primary winding 34. Capacitor 40 across the secondary winding of the transformer improves the wave form.



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Books

Handbook of Basic Circuits TV-FM-AM
Matthew Mandl, The Macmillan Co., 60
Fifth Ave., New York, N.Y., 365 pages,
\$7.50.

A unique book which presents 136 commonly used TV, FM and AM circuits in a manner for easy reference. Each circuit is a representative one. Accordingly, the reader will find in this one volume virtually every one of the standard circuits, each presented in sufficient detail to provide a basis for recognition and understanding of any design variations he may meet. Because many basic circuits are common to other branches of electronics, the illustrations and descriptions are applicable to industrial and commercial electronics.

For each of the circuits described there are: (1) a schematic diagram, (2) a description of the place the circuit occupies in electronic equipment, (3) a discussion of the purpose of the circuit, and (4) a description of its characteristics and function. Mathematics and formulas have been held

to a minimum, thus allowing discussions of circuit theory and applications to be kept as simple as possible.

Essential reference data will be found in the Appendixes. Included are: a classification of amplifiers, standards for color and for monochrome television, block diagrams of complete receivers and transmitters, and summaries of the operational theory of complete communications units.

Electrical Interference
A. P. Hale. Philosophical Library, 15 East
40 St., New York 16, N.Y., 122 pages, \$4.75.

From a practical point of view, a valuable feature of the book is the series of TV displays showing the effects on the picture of different types of interference. Chapter headings are: Causes of Interference; Effects of Interference; Receiver Aerial Systems; Measurement of Interference Levels; Location of Sources of Interference; Avoidance of Interference; Basic Filters—Safety; Practical Filters—Faraday Cages.



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Mechanical Design For Electronic Engineers
 L. H. Garner. D. Van Nostrand Co., Inc.,
 120 Alexander St., Princeton, N.J., 223
 pages, \$5.00.

Written by a Britisher, this book discusses mechanical designs of electronic equipment and methods of production with which electronic designers should be familiar. It is especially interesting because of illustrations which show methods of construction different from practices generally encountered in the U. S.

Chapters include: Standard Rack Systems; Apparatus Cabinets; Chassis and Sub-Panel Construction; Accessibility For Servicing; Ventilation and Cooling; Anti-Vibration Mountings; Sheet-metal Working; Finishing Processes; Printed Circuits and Printed Components; Potting of Components; Labelling Panels and Cables; Soldering, Brazing and Stripping; Coil Winding; Codes of Practice and Specifications; Special Service Valves (tubes.).

Automatic Digital Computers

M. V. Wilkes. J. Wiley & Sons, 440 Fourth Ave., New York 16, N.Y., 305 pages, \$7.00.

This book is intended to provide a general introduction to the principles underlying

the design and use of digital computers. It covers the subject now generally known as "logical design" without entering into a detailed discussion of electronic circuit techniques. It also deals with the way in which programmes are constructed, and methods by which the machine itself can be made to assist the programmer in his task. Discussion of what operations need to be programmed to solve particular problems, the subject of numerical analysis, is outside the scope of this book. A typical machine is described in some detail. References are made to a number of other machines to illustrate specific points.

Commercial Waxes, A Symposium and Compilation

H. Bennett. Chemical Publishing Co., Inc., 212 Fifth Ave., New York, N.Y., 688 pages, \$15.00.

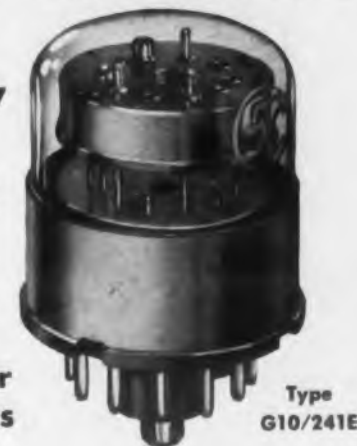
A very thorough treatise on waxes, not directed to any specific industry, this second edition should be an excellent reference on the subject for it discusses all waxlike substances of various chemical compositions. Chemical properties, origin or manufacture and applications of waxes are covered in detail. A glossary and wax formulary are also included.

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Abstract

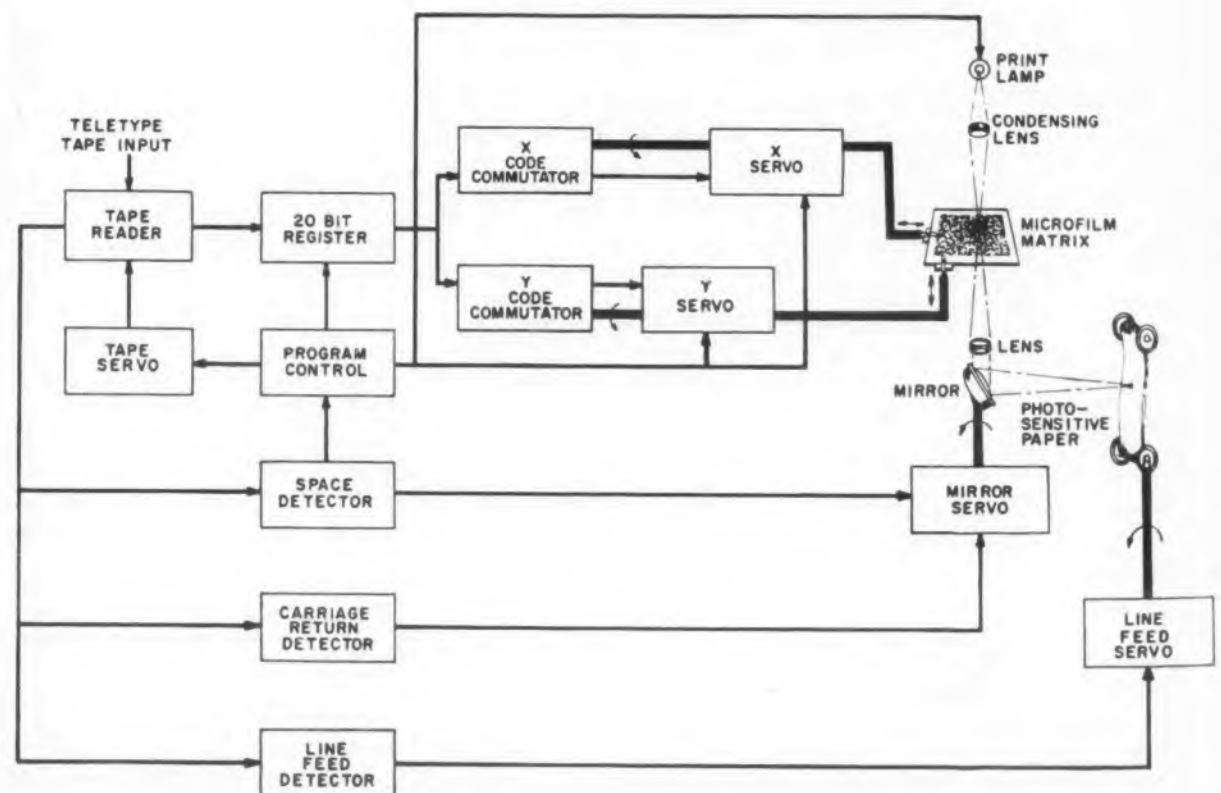
Automatic Micro-image File

THE data storage and retrieval device described here provides rapid access to any one of 10,000 information-containing frames recorded in miniature on a 10 in. square sheet of microfilm. Operating continuously, it automatically searches the microfilm and photographically prints out one frame every two seconds. Designed and built by M. L. Kuder of the electronic instrumentation laboratory of the National Bureau of Standards, the device is intended for use in Government agencies.

Particularly applicable where large volumes of data must be assembled in a predetermined sequence from a master random file, information may be in the form of pictures, drawings, fingerprints, sets of numbers, letters, or other symbols, or even single stages of electronic circuit diagrams. Quantity and kind of data are limited only by the size of the individual frame (1/10 in. square) and the photographic resolution of the film emulsion.

Input to the machine is from a perforated teletype tape containing the coded locations of the desired frames in the order in which they are to be printed out. The assembled data produced by the machine comes out on a 10 in. wide strip of photosensitive paper of any required length. Individual frames are enlarged to 1/2" squares. Commercial automatic developing equipment processes the photographic paper.

The instrument is essentially a combination of digital computer electronic circuitry and a pair of precision servomechanisms that search X and Y axes of the matrix. The location of the desired frame is fed into a 20 bit (binary digit) register from the teletype tape. The register consists of a capacitor memory and coin-



Block diagram of automatic micro-image file system.

idence identification circuitry. The first 10 bits recorded in the register control the Y position selection while the second 10 bits control the X position.

The matrix is supported on a 10-in diam drum. The drum is servo-controlled in both linear and rotary axes of motion, corresponding to the X and Y axes of the matrix. The servos that shift the matrix to the chosen coordinates are mechanically coupled with precision gearing to two code commutators.

The code commutators, one associated with each axis, control the coordinate positions to which the matrix is located. These commutators are photoetched with one hundred 10-bit numbers corresponding to the standard teletype binary bit code. The two particular positions on the commutators are selected by a serial mechanical search with contacting brushes until a code combination is found that matches the binary bits recorded in the 20-bit register. Magnetic clutches and brakes provide rapid starting and stopping of the drum with uniform overtravel in locating every position on the matrix. A single induction motor supplies all motive power to the machine.

At the beginning of the cycle of operation, a teletype tape reader reads a 4-decimal-digit code. A space symbol is customarily inserted in the teletype tape following each 4-digit number. On detecting this space symbol, the machine's program control stops the tape reader, engages the magnetic clutches on the X and Y servos, and looks for the compatible code on the two coordinate axes. When the compatible code is found, the clutches disengage and magnetic brakes stop the drum. A print lamp is briefly turned on to make a photographic exposure of the selected microfilm frame on the photosensitive paper. When the exposure is completed, the teletype tape advances to the next instruction, the drum returns to its zero position, and the machine proceeds with the next search cycle.

Fifteen successive frames are printed in a row across the 10 in. width of the print paper by means of a step positioning mirror. This mirror performs a function similar to the character spacing on a typewriter: it automatically advances the image one space on the photographic paper for each printout. Upon completion of a line, a line-feed servo advances the paper a fixed amount.

The instrument recognizes two other symbols, the "carriage return" and the "line feed." These symbols instruct the machine to return the step positioning mirror to its zero position, and to advance the paper one line. Whenever these functions are desired, they can be inserted into the teletype tape.

Although the machine was primarily designed as an outscriber for obtaining programmed printing from a large file of negatives, it can temporarily be set up as an inscriber to prepare its own matrices of 10,000 frames each. Using the same machine to prepare a matrix insures that each frame will be accurately located whenever it is subsequently used.

Abstracted from the National Bureau of Standards Technical News Bulletin, Volume 40, No. 7, July, 1956.

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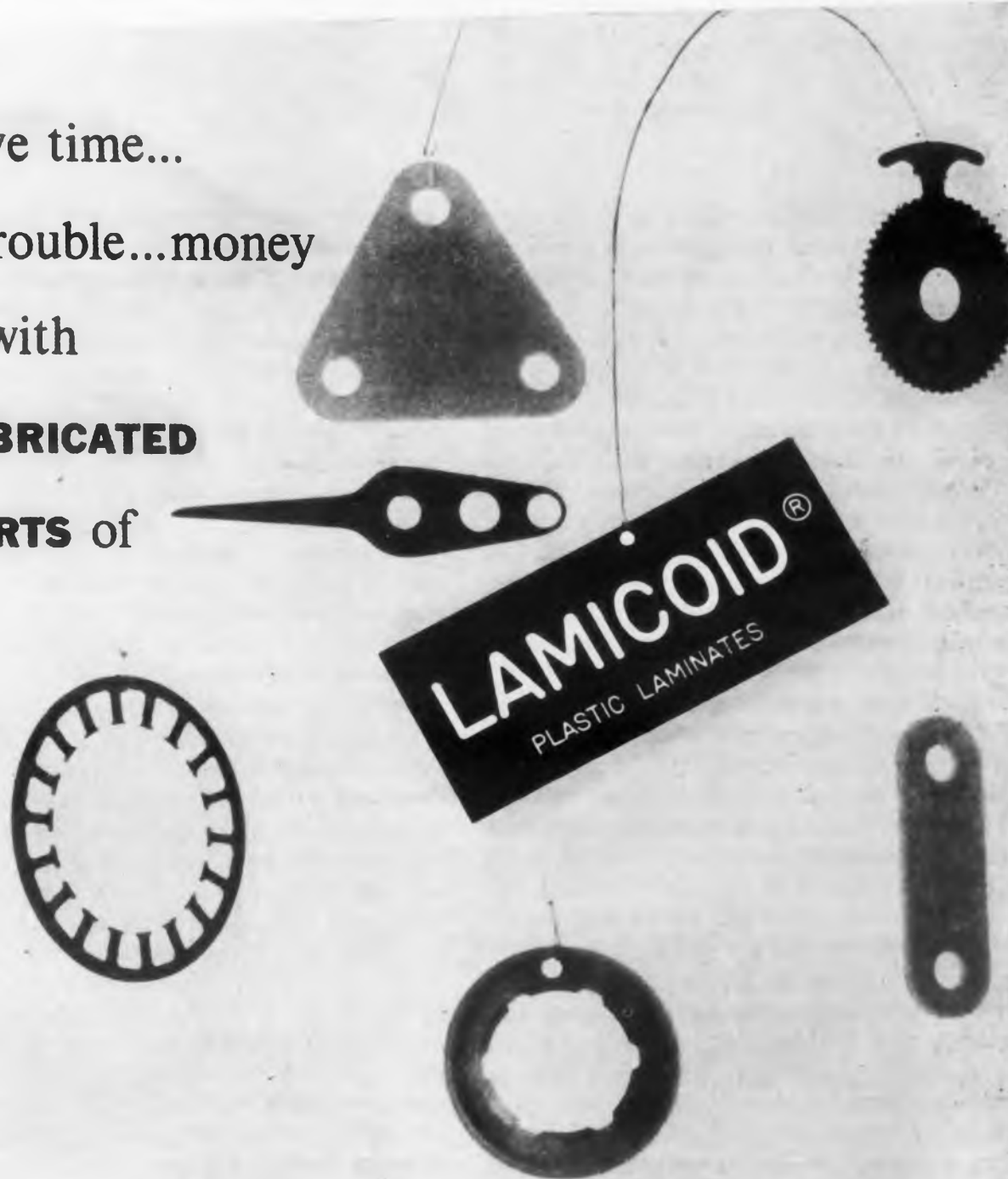
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IN every company that is engaged in producing a complex system, or even a component of a complex system, there must be individuals who can design, install, and administer a system for achieving reliability. Such a system will always require coordination of men, materials, machines and money.

The probability of success of a complex system is roughly equal to the product of the probabilities of success of all the essential components. The well-known P-overall rule* states, for example, that if each component of a five hundred component system is 99% reliable, the system is only about 1% reliable. This means that to achieve acceptable system reliability, component reliability must be raised by orders of magnitude above that achieved by normal commercial practice.

Also, it is cheaper to make a poor component than to make a highly reliable one. Therefore, to obtain reliability, procurement methods must depart from the lowest bidder method of doing business. This departure has not taken place to a satisfactory extent, at least not in Government procurement.

Further, an engineering product can be made reliable if all modes of failure are known and understood, or if unknown modes are quickly revealed by direct feed-back from service failures. Unfortunately, in the case of complex systems there are many unknown modes, and feed-back is usually feeble. In the case of non-recoverable weapons, feed-back is almost entirely absent.

The ultimate cause of each case of unreliability is some form of human error. To achieve reliability, these errors must be recognized and then controlled.

In a traditional product such as an automobile,

errors in design or workmanship cause easily recognized service failures. These failures are reported back very quickly through a sales organization with emphatic demands for immediate corrective action. Technically, corrective action is facilitated by a complete and accurate description of the condition under which failure occurred, and by the return of the failed part. Psychologically, corrective action is aided by easy identification of the responsible person and by the certainty of economic punishment if action is not rapid and effective.

By contrast to more traditional engineering products, consider the case of a part such as small precision snap-action switch that is sold to a gyro manufacturer, who sells to the Air Force. Suppose further that under battle conditions the part fails to function because of the combined effects of high altitude, low temperature, aircraft vibration, maneuvering acceleration, and gunfire shock. If the plane is shot down, the feed-back on the error that caused the failure is lost entirely. If the plane lands, and under static ground conditions the part operates satisfactorily, feed-back is still lost. Even if an Air Force maintenance man discovers and replaces a defective sub-assembly, the only feed-back may be an unsatisfactory material report stating that under certain unknown conditions, an unidentified part of the fire control system failed. With such meager information, it is not possible to identify the responsible manufacturing company, much less the responsible individual, and even if he were reached, he would not possess the facts required to generate corrective action.

This is the problem. The solution is to be found in the full and skillful exploitation of laboratory testing. The control of human errors that cause unreliability has much in common with the control of human errors in civilized communities. In each case, three major steps are required. These steps are (1) indoctrination

or preaching of a gospel, (2) evolution of written laws, and (3) evolution of a system of law enforcement that includes a police force equipped for the scientific detection of errors and identification of authors.

In this general plan, reliability coordinators are required to preach the basic principles of reliability, and parts application and quality control engineers are required to write a system of laws in the form of specifications and classifications of defects. The job of police detective must be accomplished by experimental physicists or by test engineers.

The characteristics of the required system are dictated by the types of errors that must be detected and corrected, and by the existing industrial pattern of vendor-buyer relationships. Industrial procurement patterns vary somewhat in different areas and different industries, but the pattern of human errors is universal for all areas and all industries.

Long experience in design evaluation has shown that in complex systems subjected to varied environments, lack of knowledge, understanding or measurement of modes of failure is responsible for about half of all new design failures.

When all modes are known, the designer still may fail to provide an adequate margin between the strength of the part or the stress that will be experienced in service. This is the familiar "Inadequate safety factor error." In calculating safety factors, a single value is assigned to the strength of the part, and another single value to the maximum service stress.

If the part is such that strength variation from item to item is very small, and if maximum service stress is never exceeded, a moderate safety factor of, say, 1.5, provides for reliability. If this variance is not small, a moderate safety factor will not prevent the low strength items from causing failure. Therefore, a designer commits an error whenever he chooses a

*For a thorough treatment of this principle, see Robert Lusser "Basic Lecture on Reliability" obtainable from Redstone Arsenal, Huntsville, Alabama.

part that has inherently large strength variance.

Manufacturing errors include: defective materials or workmanship, inspection errors or limitations and process drift.

"Process drift" includes a wide variety of errors, such as machine tool wear, chemical composition changes, and so on. It is important because components for complex systems are qualified by tests on a first article. Unless subsequent production items are identical, the basis for acceptance becomes invalid.

To detect unknown modes of failure, the only possible procedure is to subject the component to laboratory simulations of every one of the adverse environments to which it will be subjected in service. If possible, the component must be made to function during the applications of the environment. If the adverse effects of several environments are additive, they must be applied simultaneously. For example, it is generally true that the effects of shock and extreme temperature are additive and therefore they should be applied simultaneously.

To measure the actual value of a safety margin, it is necessary to carry the test to failure. A very elementary example of this is the burst test on hydraulic components. To establish that a specified minimum value has been achieved, a nondestructive proof test may suffice.

To detect excessive variance, it is necessary to perform tests to failure, and to do so in a statistically designed experiment.

Control of unreliability in only qualitative terms is satisfactory for guidance in the choice of control methods, but it is not enough to permit decisions on how far reliability improvements must be pushed.

The answer can be provided in two steps. First, the systems engineer must give the component vendor a value for the highest probability of failure in service that can be permitted for each component. In a typical missile, the value might be 10^{-5} . In a radar system, it might be 10^{-6} failures per hour. Then the following can be applied.

$$P_f = \frac{P_o P_i + (1 - P_o) P_s}{1 - P_o + P_o P_i}$$

Where: P_f = Probability of occurrence of a component failure under specified conditions;
 P_o = Probability of occurrence of a manufacturing error that will cause failure;
 P_i = Probability of occurrence of inspection missing a manufacturing error;
 P_s = Probability of occurrence of a strength-stress scatterband overlap.

The error detection system must be able to measure P_o , P_i , and P_s , and when these values are too high, the system must facilitate corrective action.

Abstracted from a talk presented by Leslie W. Ball, Technical Director, United ElectroDynamics Division, United Geophysical Corp., Pasadena, Calif., to the Engineering and Management Course at the University of California, Los Angeles 31, Calif.

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What the Russians Are Writing

J. George Adashko

Radiotekhnika i Elektronika No. 1, 1956

Possibility of Extending the Similarity Concept to Multi-resonator Magnetrons with Unequal Numbers of Resonators, I. E. Rogovin (20 pp, 4 figs).

The author derives the equations (similarity criteria) under which the phenomena that take place in the coupling space of a multi-cavity magnetron are similar, and determines the operating conditions under which a magnetron with a certain number of cavities can be considered similar to one with a different number of resonators.

Synchronization of Self-Excited Oscillator using Pulses with Sloping Edges, E. S. Voronin, R. V. Khokhlov (9 pp, 6 figs).

This article contains a theoretical discussion of the use of non-rectangular waveforms, including an analysis of the effects of varying the amplitude and frequency of the synchronizing voltage.

Mutual Synchronization of Reflex Klystrons, R. V. Khokhlov (10 pp, 5 figs).

The Van-der-Pol equations are used to describe the synchronization of reflex klystrons and to illustrate the possibility of a smooth transition from the oscillatory region of one klystron to that of the other.

Photocells and Photomultipliers with Magnesium Cathodes for Ultraviolet Rays, O. P. Dorf, N. G. Kokina, T. M. Lifshits, D. A. Shklover (8 pp, 5 figs).

This report discusses the absolute sensitivity and spectral characteristics of photocells made of magnesium containing various impurities. Experiments have shown that magnesium cells are not affected excessively by impurities, and that a cell with a magnesium cathode and an alloy (activated copper-aluminum-magnesium) emitter has enough sensitivity to record a flux of 10^{-15} watts at 253.7 micromicrons. Reference is made to work by Dunkelmann (*J. Opt. Soc. Am.*, Feb. 1955, p 134), Hinteregger & Watanabe (*J. Opt. Soc. Am.*, July 1953, p. 604), and Wainfan, Walker, & Weissler (*J. Appl. Phys.*, Oct. 1953, p. 1318).

Effect of Secondary Electron Emission from Insulators on the Stability of Electron-Tube Parameters, N. V. Cherepnin (13 pp, 14 figs).

The secondary emission from the insulating material (mica) used in vacuum tubes liberates gases that eventually poison the oxide coating on the cathode and cause deterioration of the tube parameters. The article contains a thorough experimental discussion of the process and proposes measures for combatting its ill effects, which are particularly pronounced in miniature tubes. These measures are:

1. Reduce the length of the oxide coating of the cathode to a minimum, thereby reducing the effect of positive charges produced by secondary emission on the edges of the cathode.
2. Increase the surface resistance of the mica insulators and prevent the formation of conducting films by the metals and oxide salts liberated from the cathode. Reducing the cathode temperature is also effective.
3. Increase getter activity.
4. Reduce the working voltages of the electrodes.
5. Replace metal strips on the upper and lower mica members adjacent to the suppressor grids of pentodes or confining electrodes of beam-power tubes.

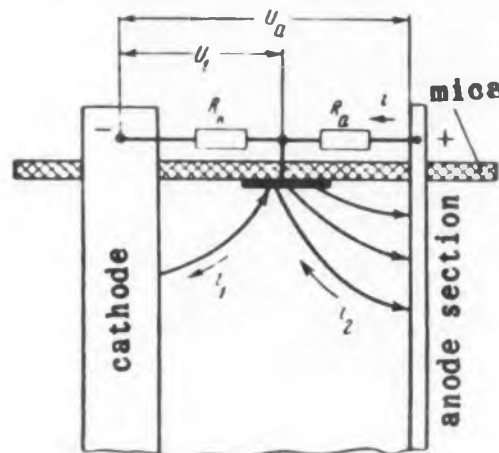


Fig. 1. Diagram of the path of secondary emission and its equivalent circuit. The ratio of the currents flowing into and from the insulator is defined as the emission factor and is a function of the potential U_1 of the emitting portion of the insulator.

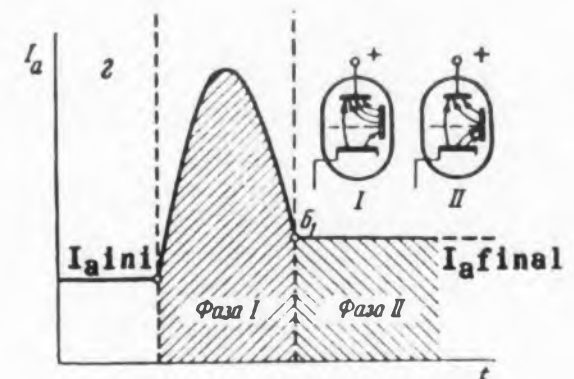


Fig. 2. It can be readily seen that the surface of the insulator is in equilibrium if $i_1 = i_2$, but not all equilibrium points are stable (point B is unstable). This leads to a discrete change in the plate current with time, as shown in the lowest curve, which indicates that after the transient (phase I) produced by the secondary emission the secondary current does not return to its initial value, but settles at a higher level (phase II).

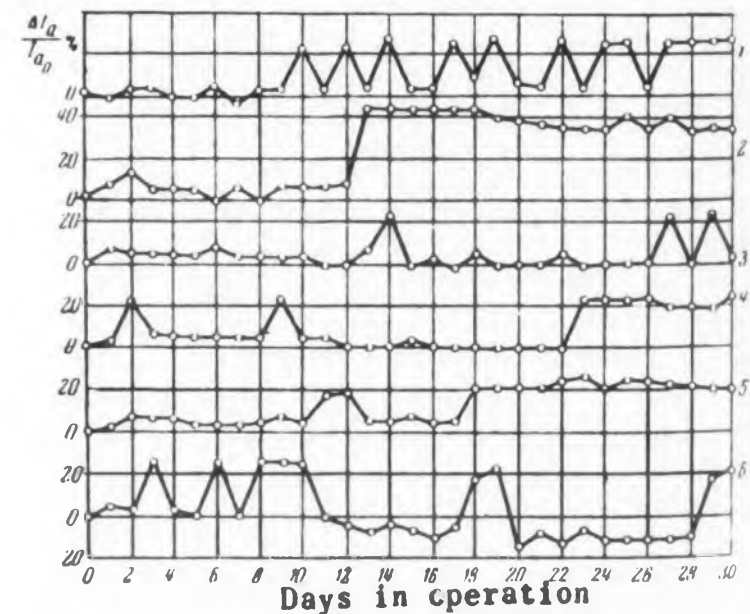
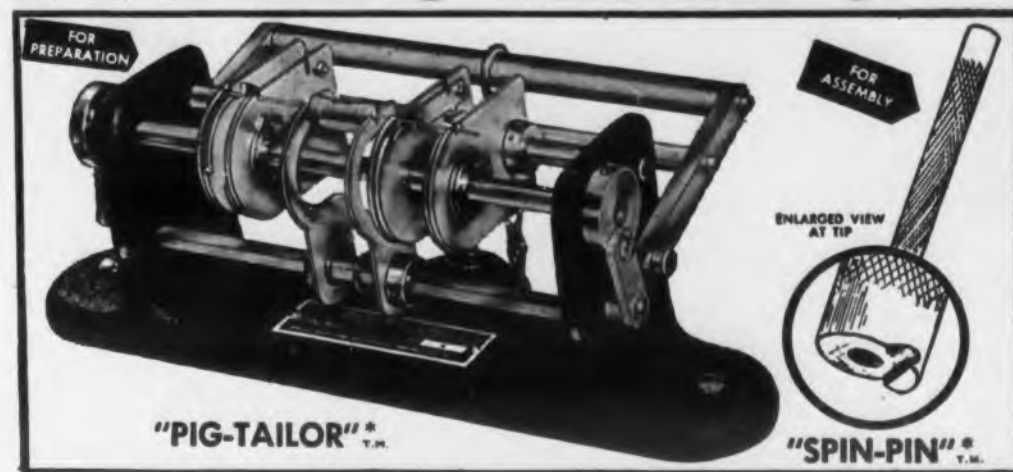


Fig. 3. Differences in plate current of the same 6N2P miniature dual-diode tube measured at intervals of 1-2 days (six tubes tested).

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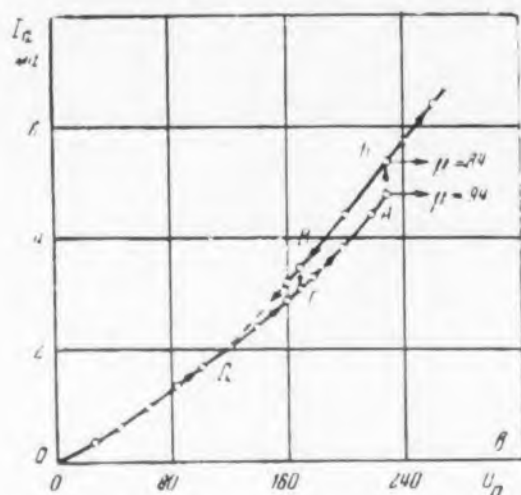


Fig. 4. The nominal amplification factor of the 6N2P tube is 100. In this case it dropped from 94 to 84 at an approximate plate voltage of 230.

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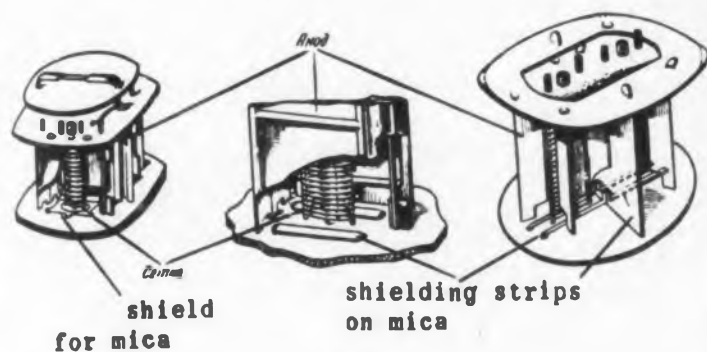


Fig. 5

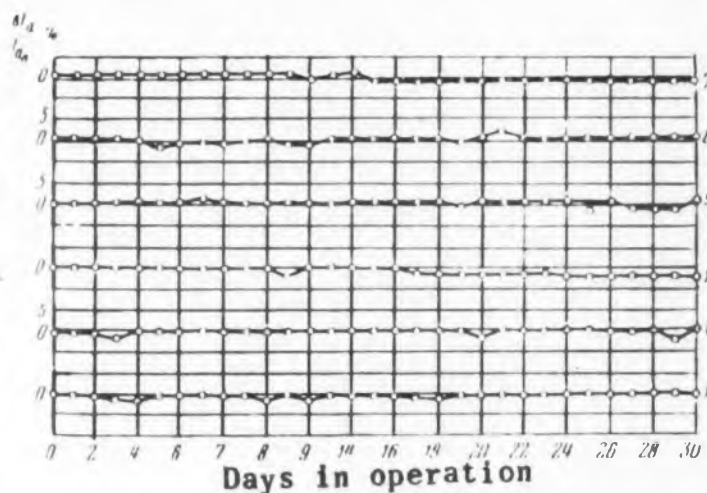


Fig. 6

Figs. 5-6. The secondary emission can be eliminated by using metal screens or strips connected to the cathode. The method used depends on the tube construction. Fig. 6 shows the resulting improvement (six tubes).



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Weight (ounces):	1 1/2	6
Size (inches):	1 1/8 long 1 5/16 diam.	2 5/8 long 2 1/2 diam.
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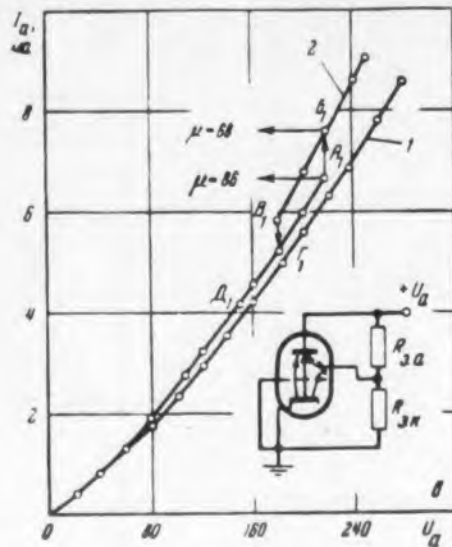


Fig. 7. Demonstration of effectiveness of shielding the mica insulator. If the shields are connected to the plate and cathode through high resistances, secondary emission can again be produced in the tube. Curve 1 is plotted for the case when the upper of the two resistors is infinite, i.e., when no charge can accumulate. Curve 2 is for both resistances finite and shows the re-appearance of secondary emission.

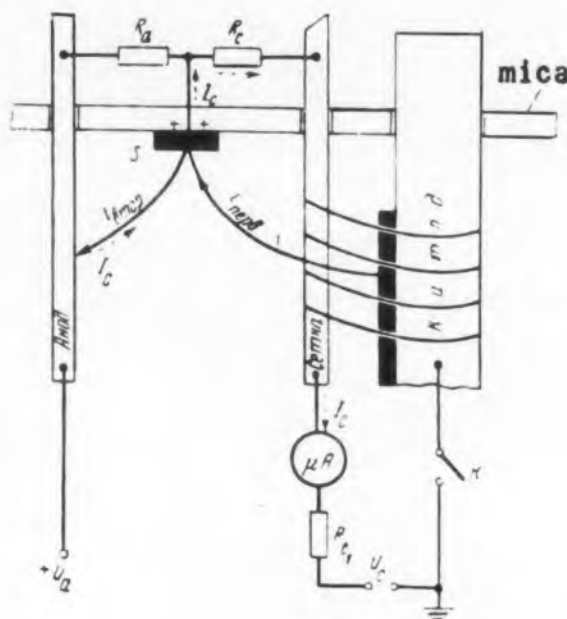


Fig. 8. Secondary emission is also responsible for an unstable inverse grid current in some tubes. The mechanism is illustrated in this figure.

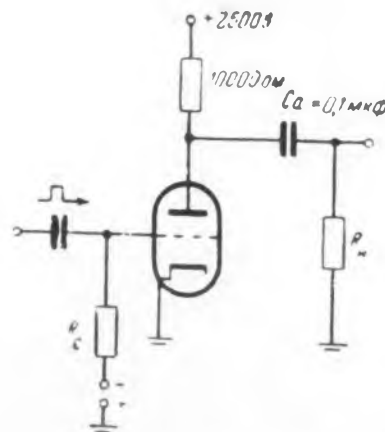


Fig. 9

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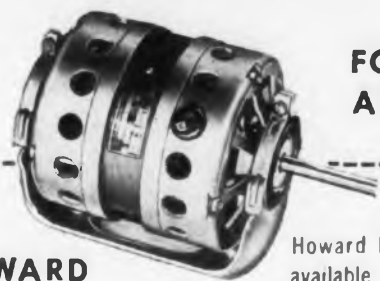
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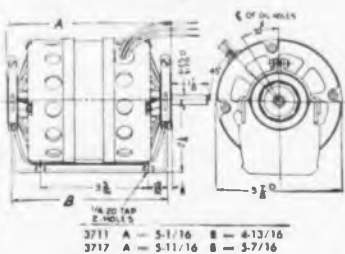
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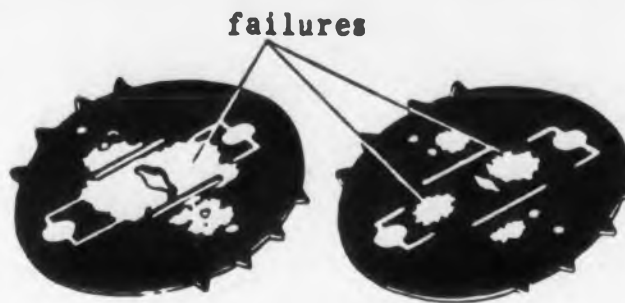


Fig. 10

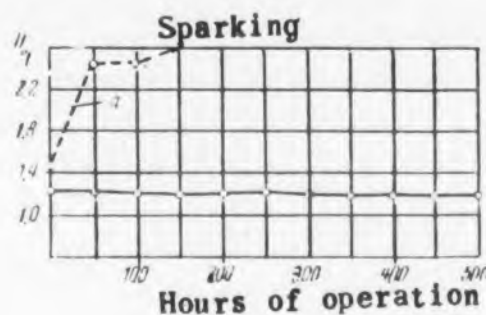


Fig. 11

Figs. 9-10-11. Secondary emission is most dangerous in high-voltage pulse-circuit tubes, such as the G1-3, used in the typical circuit of Fig. 9. Damage can occur to the mica, Fig. 10, and to the cathode of the tube, mostly because the gas and moisture liberated from the insulator cause the tube to spark over. Fig. 11 (curve a) shows that the pulse voltage rises to a dangerous value within 50 hours of operation, followed by sparking in 100 hours. Curve b shows the effect of shielding the mica.

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Coherent Electron Beams in Synchrotrons at Centimeter Frequencies, A. M. Prokhorov (8 pp, 5 figs, 2 tables).

This appears to be the first experimental attempt to use a synchrotron to produce power at these wavelengths.

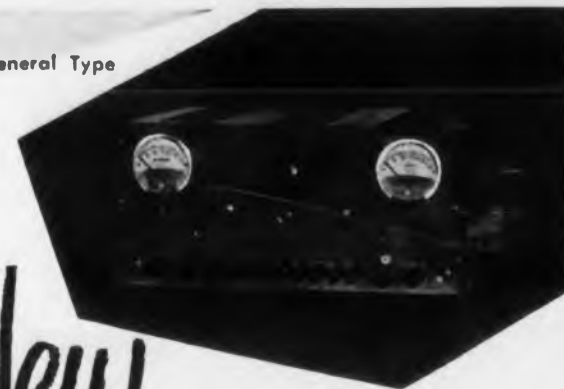
Effect of Semiconducting Film on the Attenuation of a Radio Wave in a Round Waveguide, V. V. Malin (4 pp, 3 figs).

The equations derived in this article are valid only if the film is much thinner than the surface layer of the metal and if the depth of penetration is much less than the wavelength and the thickness of the surface layer in the dielectric. Refers to Ramo and Whinnery (Russian translation, 1950).

Other Articles in this Issue:

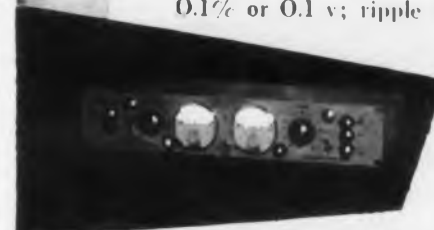
"Self-Excited (Cold) Electron Emission and Cathodes," D. V. Zernov, M. I. Elinson (18 pp, 12 figs.); "Distribution of Durations of Overshoots of Normal Fluctuations," V. I. Tikhonov (11 pp, 2 figs., 2 tables); "Shot Effect in Semiconductors," L. I. Pervova (8 pp, 3 figs.).

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What The Russians Are Writing

J. George Adashko

Avtomatika i Telemekhanika No. 3, 1956

Electronic Differential Analyzer of the G. M. Krzhyhanovskii Power Institute of the USSR Academy of Sciences, I. S. Bruk & N. N. Lenov (11 pp, 10 figs.). Detailed description of an electronic analog computer for ordinary linear and non-linear differential equations. The computer is housed in a cabinet equal to two and one-half relay racks. It contains 38 operational amplifiers, four multipliers, four functional converters, and one harmonic generator. With this number of components it is capable of solving differential equations of the 20-25th order. A power supply and long persistence CRT are furnished separately.

Among the interesting features of the analyzer is the automatic drift correction circuit (marked BY in Fig. 1), which is essentially a two-stage auxiliary amplifier included in the feedback loop of the operational amplifier (marked OY). The vibrator pulse-modulates the input signal e_1 and the common cathode resistor of the (main) operational amplifier combines the de-modulated amplified signal with the original one to produce the necessary drift correction. One auxiliary amplifier (BY) can be alternately switched to as many as 26 main operational amplifiers (OY). Fig. 2 shows the null drift of an integrator with (2) and without (1) the compensator.

Other interesting circuits are those used for function multiplications (Figs. 3, 4, and 5), the harmonic generator, which produces 8 multiples of the fundamental, and the functional converter which generates prescribed functions of the independent variable (time) which in turn is represented during the solution process by instantaneous values of voltage.

The output can either be photographed from the cathode ray tube (where the output is either shown as a function of time or as a phase-plane sweep) or recorded with a strip-chart oscillographs; the solution can also be stopped at any instant and quantities measured with ordinary instruments. The natural scale permits investigation of processes lasting from several seconds up to 5-10 minutes. Simulation of processes with an ac component down to 10 cy is possible.

The multiplier error does not exceed 1%, that of the function converter is less than 1.5%, and that of the harmonic generator is on the order of 0.2%.

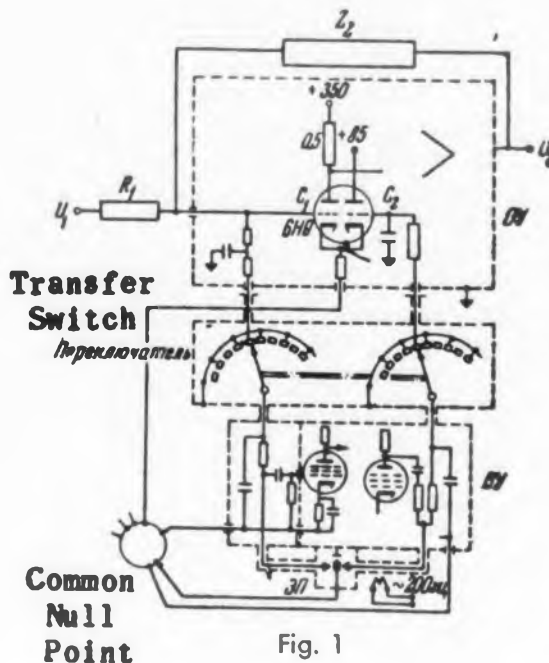


Fig. 1

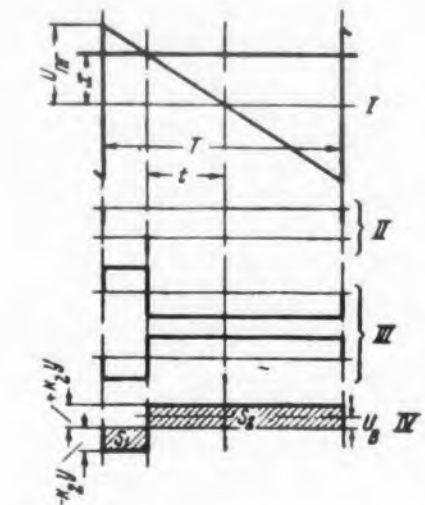
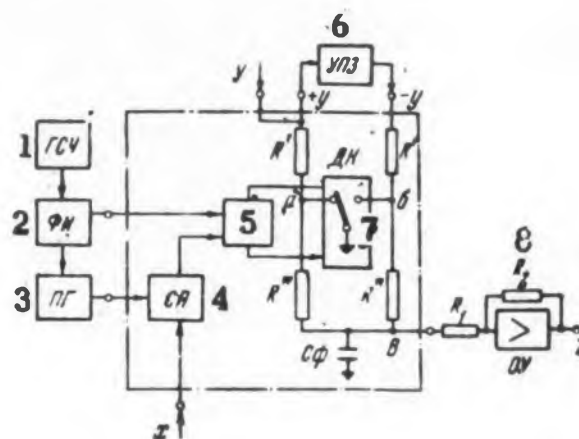


Fig. 3. Block diagram of multiplier. 1—Stable-frequency oscillator; 2—Pulse shaping circuit; 3—Sawtooth pulse generator; 4—Amplitude comparator; 5—Trigger circuit; 6—Sign-reversing amplifier; 7—Diode switch; 8—Operational amplifier

Fig. 4. Principle of operation of multiplier. I—Operation of amplitude comparator; II—Pulses at input of trigger; III—Pulses at output of trigger; IV—Output.

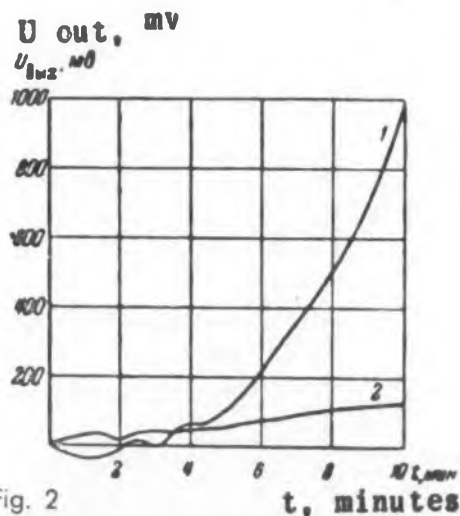


Fig. 2

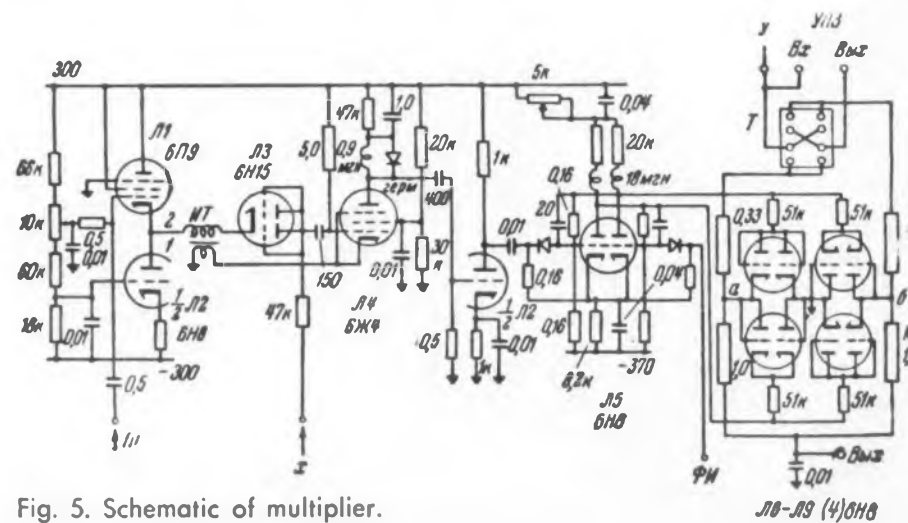


Fig. 5. Schematic of multiplier.

Procedure for Calculating Self-Excited Oscillations in Pneumatic Regulators. A. A. Abdulayev & E. M. Nadzhafov (16 pp; 15 figs).

Approximate frequency-response analysis of the behavior of the widely-used type 04 regulator.

High-Speed Magnetic Amplifiers for Servo Systems Employing AC Motors. A. I. Dem'ianchit (14 pp, 18 figs.)

Description of a newly developed full-wave magnetic amplifier stage which can be cascaded without increasing the time constant excessively. Comparison is made with half-wave amplifier circuits; the author concludes that the use of such amplifier jointly with transistor (or vacuum-tube) preamplifier stages will permit design of ac servo systems with an error-system sensitivity to 0.3 mv per angular minute. References are made to articles by C.W. Lufcy, H. H. Woodson, and P.W. Barnhart.

New Type of Servo System with Corrective Networks. L. N. Fitsner (10 pp, 7 figs).

Describes a particular servo system compensated by first and second-derivative voltages available from a dc analog computer. Refers to an article by Ziebolz and Paynter, "Possibilities of a Two-Time Scale Computing System for Control and Simulation of Dynamic Systems" (*Proc. Nat. Electronics Conf.* vol 1X, 1953), to an article by Moore, "Combination Open-Cycle Closed-Cycle System" (*Proc. IRE*, vol 39, No. 11, 1951), and to work by Ragazzini, Ruthel, and Rendel.

Electric Variable Speed Servo Drive. O. I. Aven, E. D. Demidenko, S. M. Domanitskii, and E. K. Krug (12 pp, 16 fig).

Description of a reversible servo drive using a 250 watt three-phase induction motor controlled by a two stage magnetic amplifier and a vacuum-tube phase-sensitive amplifier. It uses a filter network rather than a tachometer generator for velocity feedback.

Graphical-Analytic Method of Analysis of Characteristics of Magnetic Circuits subject to Joint Action of Constant and Alternating Fields. I. Ia. Lekhtman (10 pp. 10 figs).

Continuation of article in the Sept-Oct 1955 issue of *Avtomatika and Telemekhaniga* (see *ELECTRONIC DESIGN*, March 15 issue).

Remarks on the effect of the Presence of Liquids in the Ducts on the Equivalent Mass of the Moving Parts of Hydraulic Regulators. L. A. Zal'monzon (2 pp, 1 fig).
Book Reviews.

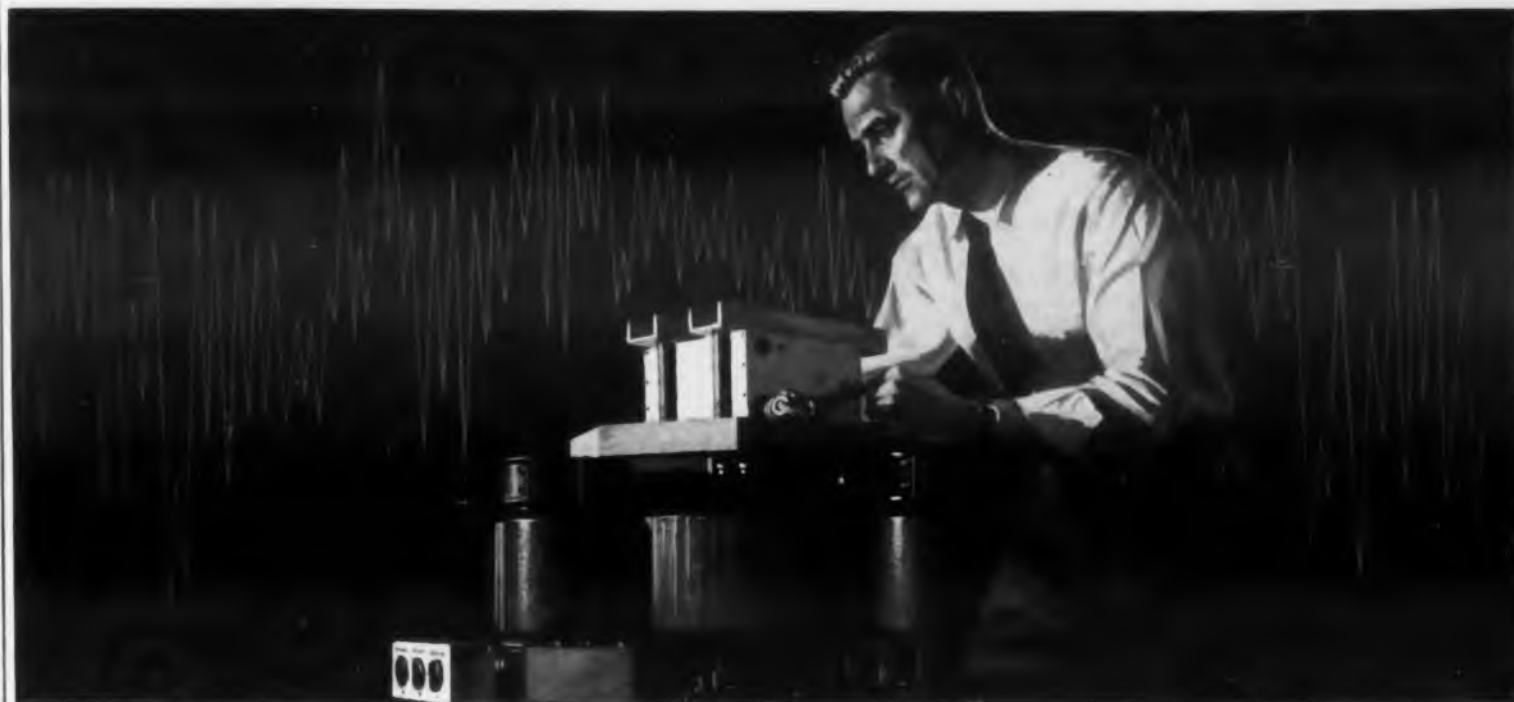
Bibliography of Russian and foreign literature on mathematical simulation (with analog computers), 1947-1954.

Very extensive (10 pp and more to come).

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Russian Translations

Elektrosviaz' No. 4, 1956

Improving the Stability of Devices that Form a Single-Sideband Signal, A. M. Semenov & M. V. Verzunov (12 pp, 8 figs, 1 table).

One of the major problems in the design of single side-band transmitters is stable suppression of the carrier and second sideband. This article analyses the effect of the asymmetry of the balanced modulators employed for that purpose on the undesired frequency components. A rigorous analysis of the circuits involved is followed by a description of an experimental verification of the theoretical results. The asymmetry can be eliminated by employing current feedback in the af circuit.

Increased Interference between Two Lines Owing to Reflections from the Ends of a Third Line, P. K. Akul'shin (8 pp, 8 figs).

Increased crosstalk between two telephone lines may result from reflections induced by a third line which is not terminated by its characteristic impedance. Qualitative and quantitative effects of this phenomenon are discussed in detail.

Reducing Attenuation in Coaxial Cables, K. K. Sergeeva (6 pp, 4 figs).

Theoretically, the attenuation of a transmission line is minimum when $R/L = G/C$. In actual lines, however, R/L is usually much greater than G/C , and the attenuation can be reduced effectively only by increasing L . In a relatively narrow high-frequency band, say 30-100 kc, this can be done by stranding and twisting the inside conductor of a coaxial cable. Reference is made to an article by G. W. Howe, "The High-Frequency Resistance of Multiply Stranded Insulated Wire" (*Proc. Roy. Soc.*, Vol 93, No A 654).

Shifting Signal Spectra, A. Iu. Lev, B. I. Iakhinson (7 pp, 5 figs).

Discussion of the transformation occurring in a realizable signal when its spectrum is shifted along the frequency scale from one region to another. Determination of the conditions under which such a transformation is reversible. Also discussed are the possibility of effecting single sideband transmission by means of spectrum shifting, and the possibility of synthesizing a signal with shifted spectrum given the discrete ordinates of the initial signal. Refers to articles by D. Gabor (*J. Inst. Elec. Engr.* vol 93 part 3, 1946), Norgaard (*QST*, July 1948), Weaver (*Proc. IRE*, Apr. 1954), J. Kohlenberg (*J. Appl. Phys.* Dec. 1953).

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New Method of Computing Losses Produced in Cylindrical Conductors by Proximity Effects, V. N. Kuleshov, (9 pp, 3 figs).

The Carson and Butterworth equations for the propagation of electromagnetic waves along parallel lines, taking the proximity effect into account, are valid only for frequencies up to 50 kc. Approximate equations valid up to 1 mc are derived by using a standing-wave representation of the solutions to Maxwell equations, with the proper boundary conditions imposed.

Harmonic Analysis of Asymmetric Pulses, S. I. Evtianov (11 pp, 9 figs).

Derives equations for the harmonics of asymmetrical plate-current pulses that occur when a vacuum-tube oscillator feeds a complex load. Refer to article by L. E. Dwork, "Maximum Tank Voltage in Class-C Amplifiers," *Proc. IRE*, No. 6, 1950.

On the Theory of the Ideal Receiver, A. A. Kharkevich (7 pp, 14 figs).

"An ideal receiver is one that picks out from among all the transmitted signals the desired transmitted signal where it is most likely to be found." The ideal receiver is alternately defined as one that chooses from among all the transmitted signals the one signal that is nearest the receiver. The article shows that either type of receiver can be the "better" one, depending on the applicable noise-distribution probability.

Procedure for Calculating the Channel Interference between Signals of Short-Wave Radiotelegraph Stations, V. M. Rozov (4 pp, 2 figs, 2 tables).

Experimental determination of effects of interference and fading on telegraph signals.

Monitoring Broadcast Transmission using Averaging (Volume) Meters and using Peak-Value Meters (6 pp, 8 figs).

Abstract made by B.S. Mints of an article by E. A. Pavel, A Gastell, M. Bidlingmaier in the West-German publication *Fernmeldetechnische Zeitschrift*, No. 4, 1955. Comparison of the peak-value level indicator used in Germany having an approximate integration time of 10 milliseconds (depth of modulation meter), with the standard U.S. VU meter, which has a 200 millisecond integration time. The comparison favors the peak-value meter over the VU meter, which usually reads 4-6 db too high.

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Phase Measurement with a Lissajous Ellipse

COVERING the frequency range from 50 cy to 30 mc, the phase meter described here has an accuracy of plus or minus one degree. It uses a Lissajous ellipse for the determination of the phase angle.

Fig. 1 indicates the relationship between the phase angle, the maximum a of the ellipse in the horizontal direction and the inter-section b with the horizontal axis.

$$\sin \varphi = \frac{b}{a} \quad (1)$$

The maximum beam deflection is assumed to be the same for the two sinusoidal voltages whose phase angle is being measured.

Another expression for the phase angle can be ob-

tained by measuring the large and small axes of the ellipse. If their values are $2A$ and $2B$ respectively, and if the maximum deflection is again a ,

$$\sin \varphi = \frac{AB}{a^2} \quad (2)$$

The meter to be described is based on the relationships shown in Fig. 2. Here p and q present distances measured on axes at 45 and 135 degrees respectively. For equal maximum deflections, p equals A and q equals B , and the phase angle can be computed from

$$\tan \varphi/2 = B/A \quad (3)$$

By plotting the function $\tan (\varphi/2)$ along the B axis and selecting A equal to one, the phase angle can be

read off directly.

Fig. 3 shows the block diagram of the complete instrument. The two input impedances are 75 ohms to match the most commonly used coaxial cable. Cathode follower stages provide separation in each channel between the input and an accurately calibrated attenuator. A switching arrangement permits direct application of the attenuator output voltages to individual deflection amplifiers for phase measurements up to 14 mc or conversion to an intermediate frequency of 1 mc, thereby extending the range of the instrument to 30 mc. A band pass filter of 200 kc bandwidth is provided for each channel and a separate discriminator permits measurement of the intermediate fre-

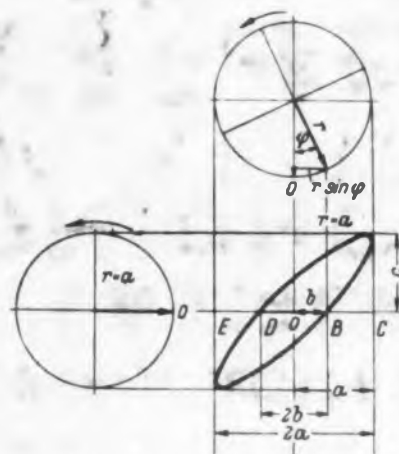


Fig. 1. Lissajou's ellipse.

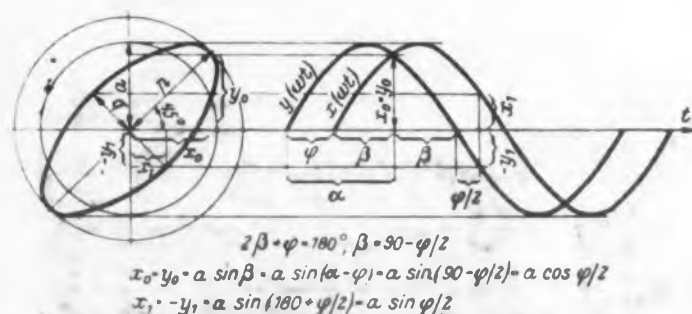


Fig. 2. Relationship between phase shift and Lissajous figure used in the phase meter.

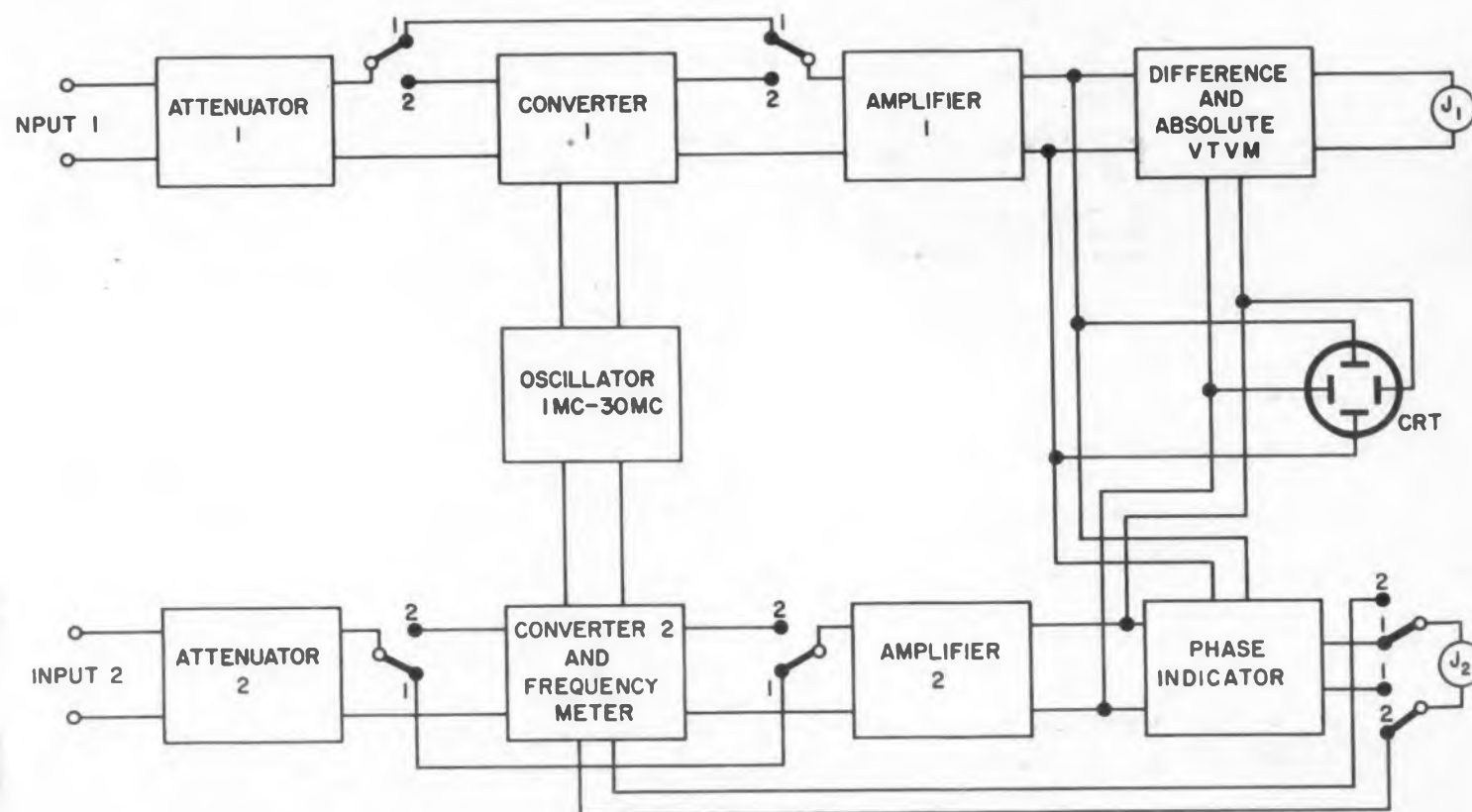


Fig. 3. Block diagram of phase meter.

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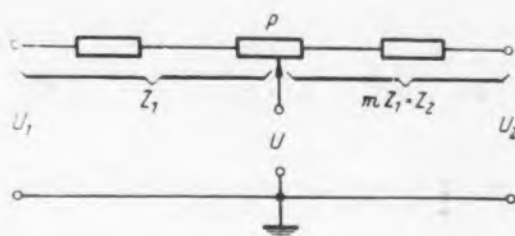


Fig. 4. Simple method for phase measurement with an indicating instrument.

quency to plus or minus 5kc, to insure accurate location of the intermediate frequency in the center of the band pass filter. Equal deflections in both x and y directions are obtained with the aid of a difference amplifier vacuum tube voltmeter, while the absolute value of the deflection voltage is adjusted with an off-set zero type vacuum tube voltmeter. The latter adjustment is required to make A equal to unity.

A ten centimeter diameter cathode ray tube is being used, but the diameter of the circle enclosing the ellipse is limited to four centimeters in order to limit geometrical distortion in the cathode ray tube. An optical magnification of five times permits accurate positioning and adjusting of the ellipse. An electronic magnifier increases the deflection sensitivity of both plates by a factor of approximately five. This is achieved by reducing the electron gun voltages in the cathode ray tube without appreciably increasing the spot diameter. An ellipse with a small axis of 0.1 cm can thus still be measured, resulting in an accuracy of about ten minutes of arc per phase angles of the order of a few degrees.

Phase shifts up to ten degrees can also be read on a separate phase indicating instrument. The circuit is illustrated in Fig. 4. The input voltages U_1 and U_2 are kept constant and the potentiometer p is adjusted to make

$$\frac{U_2}{U_1} = \frac{Z_2}{Z_1} = m \quad (4)$$

The voltage U , which is measured with a vacuum tube volt meter, is then a function of the phase angle, permitting direct calibration of the meter scale in degrees.

$$U = \frac{2m}{1+m} U_1 \sin \varphi/2 \quad (5)$$

An extension of the phase meter for the direct indication of a phase angle on the cathode ray tube screen is also mentioned.

Abstracted from an article by O. Macek, "A Phase Meter for the Frequency Range from 50 cy to 30 mc," *Frequenz*, vol. 10, pp. 147-152; May 1956.



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 <p>209 TWINPOT — Dual Potentiometer</p> <p>Two outputs electrically independent, and controlled simultaneously by one adjustment.</p>	 <p>160 TRIMPOT — High Temperature</p> <p>Operates at 175°C. High power rating: 0.6 watt at 50°C.</p>	 <p>230 TRIMPOT — Humidity-proof</p> <p>Completely sealed, unit meets MIL-E-5272A Specifications for humidity.</p>



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Report Briefs

Sonar Automatic Data Processing

Called the Digiter, a system has been developed for automatic processing of sonar data at sea, and may have applications in studies other than sonar. Instrumentation is described which prints automatically the acoustic level of a sonar signal in decibels, accurate to ± 0.2 db and having a dynamic range of 50 db. The associated range may also be printed. *PB121220 Sonar Digital Recorder—"Digiter," Pieper and Tillman, Naval Research Laboratory, OTS, US Dept. of Commerce, Washington 25, D.C., June 1956, 10 pp. 50 cents.*

Low Noise Converter

To reduce noise in VHF receivers, a 215 to 225 mc converter has been designed and developed by the Naval Research Laboratory. The converter achieves a low noise figure in the receiver equipment which was unattainable with previous tubes. Using a GL6299 triode (GE manufacture), the converter tunes the desired frequency range while the noise figure remains essentially constant. Improvement in the noise figure is due to low losses, low equivalent noise resistance, and low transit time conductance of the tubes. *PB121214 A Low Noise 215-225 Mc Converter, L. Hoffman, Naval Research Laboratory, OTS, US Dept. of Commerce, Washington 25, D.C., June 1956, 7 pp. 50 cents.*

VLF Ground-Wave Propagation Curves

Curves presented in this publication provide basic information on ground-wave propagation in the low, very low, and ultra-low frequency bands. Several extensions were made to the formulas of Van der Pol and Bremmer. Ground conductivity values of 4, 0.01, and 0.001 mhos per meter were chosen, corresponding to sea water, well-conducting land, and poorly conducting land, and the field strength and phase values were computed at the selected frequencies. Range was from 1 to 1500 miles. *Amplitude and Phase Curves for Ground-Wave Propagation in the Band 200 Cycles Per Second to 500 Kilocycles, Wait and Howe, NBS Circular 574, May 1956, 17 pp. 20 cents.*



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Section 3: Physical specifications, electrical specifications and manufacturer type number and part number of all components — capacitors, transformers, batteries, thermistors, miscellaneous items — designed for use with transistors. List of transistor test sets.

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CIRCLE 287 ON READER-SERVICE CARD

Digital Computer Survey

Eighty-four different domestic digital electronic computing systems are described. The survey treats engineering characteristics, logical features, operating experiences, cost factors, and personnel requirements. An analysis of the computer field, a discussion of trends and a complete glossary of computer engineering and programming terminology are included. *PB111996, OTS, US Dept. of Commerce, Washington 25, D.C., 272 pp. \$4.75.*

Printed Circuit Packaging Techniques

Covering the period of '52 to '54, this report indicates a five step procedure to provide adequate Auto-Sembled systems with regard to circuitry, ruggedization, climatic protection, thermal adequacy, size and weight, maintenance, and integration. The procedure consists of the selection of a system, selection of techniques, design, fabrication and analysis. Methods of predicting the size and weight of a package are included and estimates of ruggedization and thermal adequacy. *PB111714, Packaging and Integrating Printed Circuit Electronic Assemblies, Final Report, Part II, OTS, Dept. of Commerce, Washington 25, D.C., 95 pp. \$3.75.*

RF Wattmeter

Covers the investigation, development and design of an rf wattmeter to be used in field and depot testing. The Wattmeter AN/URM-73(XA1) measures power in the high and medium power ranges over the 20 to 1000 mc frequency band. In order to obtain the best system to measure rf power in the most accurate manner consistent with simplicity of design and reliability of operations, several methods were evaluated. The one finally evolved was the one using a high-power precision attenuator and a heater-thermocouple detector delivering dc voltage to a panel meter. *Radiation, Inc. for USAF, July 1955, Order PB121096, OTS, US Dept. of Commerce, Washington 25, D.C., 81 pp. \$2.25.*

Waveform Generator

Describes development of a periodic waveform generator in which the magnitude, slope, polarity, and points of inflection may be controlled at will by simple resistance or voltage changes. It is composed of standard magnetic cores, diodes and resistors, with switching transistors added for special applications. With supplementary circuit additions, power outputs in the watts range may be supplied to low impedance loads. When used with a compatible analogue computer system, it provides output transfer functions which may be tailored to any complexity desired. *C. B. House, Naval Research Lab., May 1956, Order PB121157, OTS, US Dept. of Commerce, Washington 25, D.C., 10 pp. 50 cents.*

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for **SHORTS** and **OPEN CIRCUITS**



MODEL M-1

NEW **B&K** SHORTED TURNS INDICATOR

Gives "Go—No Go" Indication for

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This unique new "M-1" coil tester prevents losses in material and labor by finding shorts and open circuits before the coil is mounted onto a relay, transformer or other device. Adjustable sensitivity provides selective testing—permits passing or rejecting coils with any particular number of shorted turns. Actually measures the coil "Q" but under conditions whereby a small difference in "Q" can easily be detected. Fast, easy to use. Safeguards are built-in. No shock hazard to operator. Operates on 110-120 volts, 60 cycle AC.

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NEW **B&K** TEST EQUIPMENT CALIBRATOR

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Enables you to use inexpensive test instruments and yet maintain testing accuracy.

Accurately calibrates VOM, VTVM and other meters, signal, sweep and marker generators, and oscilloscopes. Provides: DC and AC voltages for checking voltage ranges—standard resistances from 10 ohms to 10 megohms for checking reliability of resistance ranges—crystal oscillator generating harmonics over 300 mc. for use as marker generator, and to align audio I.F. system—built-in tone generator for signal tracing amplifiers in all audio equipment. Measures peak-to-peak voltages of unknown waveforms. Complete with 5 mc crystal. Operates on 110-120 volts, 60 cycle AC.

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Standards and Specs

Sherman H. Hubelbank

Terminals

MIL-T-0015659D (SHIPS), TERMINALS: LUG, SOLDER TYPE, COPPER, 18 APRIL 1956

This limited coordination spec has been prepared by BuShips based upon currently available information, but it has not been approved for distribution as a revision of MIL-T-15659A.

MIL-E-16366B (SHIPS), ELECTRICAL CLAMPS AND LUG TERMINALS: PRESSURE GRIP, AMENDMENT 2, 4 APRIL 1956

A cable connector for a 349,000 circular mil cable was added by this amendment.

Parts

MIL-STD-242A (SHIPS), ELECTRONIC EQUIPMENT PARTS (SELECTED STANDARDS), 4 MAY 1956

A list of selected standard parts covering the following major categories is contained in this standards manual: acoustic parts, cables, capacitors, insulators, cable clamps, rf connectors, control knobs, electro-mechanical parts, power plugs, resistors, switches and tip jacks, transformers, chokes, filters, tubes, transistors, quartz crystals, attenuators, and waveguides. This standard is mandatory for use on BuShips contracts by both the prime contractor and all subcontractors in the design of new electronic and associated electrical equipment where specs MIL-E-16400, MIL-E-19100, and MIL-I-983 are specified. In general, this standard makes an excellent reference for electronic component parts.

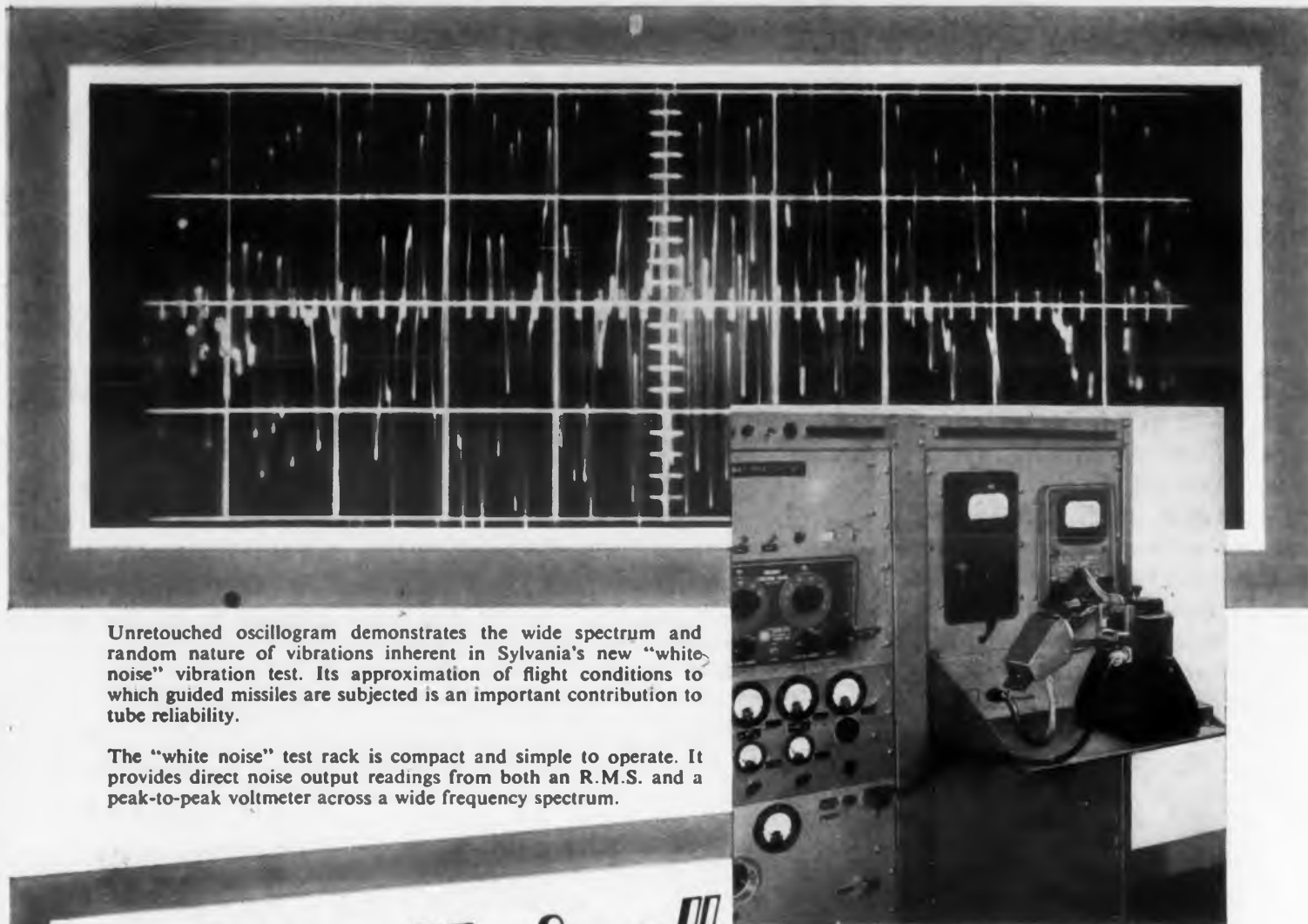
Resistors

MIL-R-19438 (NORD), PRECISION WIRE WOUND VARIABLE RESISTOR, 1 MAY 1956

The design requirements of accurate wire wound variable resistors having a maximum resistance tolerance of 2 per cent are established by this spec. These resistors are suitable for continuous full load operation at any ambient temperature up to 65 C.

MIL-R-19365 (SHIPS), RESISTORS, ADJUSTABLE, WIRE-WOUND POWER (ONE FERRULE, ONE TAB TERMINAL), 8 MAY 1956

Power-type wirewound, adjustable resistors with one ferrule and one tab terminal used in electrical, electronic, communication, and associated equipment are covered by this spec. These resistors have an effective resistance range of 100 to 3000 ohms and a resistance tolerance of plus or minus 5%. A typical type designation for a resistor covered in this spec is RX10G100.

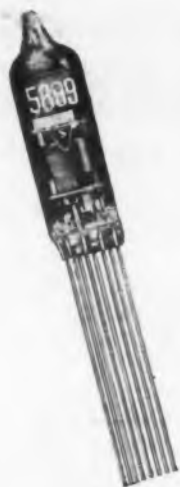


Unretouched oscillogram demonstrates the wide spectrum and random nature of vibrations inherent in Sylvania's new "white noise" vibration test. Its approximation of flight conditions to which guided missiles are subjected is an important contribution to tube reliability.

The "white noise" test rack is compact and simple to operate. It provides direct noise output readings from both an R.M.S. and a peak-to-peak voltmeter across a wide frequency spectrum.

"White Noise"

*puts wings on a test rack,
advances tube reliability*



By providing a more realistic tube vibration test which can be adapted to large-scale production techniques, the "white noise" vibration test is contributing to greater tube reliability.

Developed by Sylvania engineers in conjunction with Naval contracts, the "white noise" vibration test meets important requirements for testing tubes used in guided missiles and other vehicular applications.

First, it simulates environmental conditions by presenting a wide range of vibrational frequencies. Secondly, it presents these frequencies at random g-levels. Thirdly, it provides specification limits through direct meter readings.

If you are interested in additional analysis of the "white noise" vibration test, write on your company letterhead. Please address Department L22P.

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ADN-CAP-1, TYPE DESIGNATIONS AND COLOR CODING OF CAPACITORS, 31 JULY 1956

Compiled from six capacitor specs, this Application Design Note represents a departure from the previous practice of dealing with individual components. Specs MIL-C-5A, JAN-C-20A, MIL-C-91A, MIL-C-11015A, and MIL-C-11272A were used as the source for this ADN. A tabulation of the type designations appearing in the six specs is included to show the meaning and order of appearance of each of the symbols. Also included are charts showing capacitance tolerance color coding and value and capacitor characteristics, in addition to capacitor coding illustrations.

Capacitors

MIL-C-25A, CAPACITORS, FIXED, PAPER-DIELECTRIC, DIRECT-CURRENT (HERMETICALLY SEALED IN METALLIC CASES), 5 JULY 1956

1000 v rated types have been added for styles CPO4, CPO5, CPO8, CPO9, and CP10, by this revision. Style CP11 was not affected. The statement that polarization is not required during the performance of the moisture resistance test has been deleted. The duration of the life test for 1000 volt characteristic capacitors is 500 hours with 120% of rated voltage applied.

Waveguides

MIL-W-3970, WAVEGUIDE ASSEMBLIES, RIGID, 20 JULY 1956

Rigid waveguide assemblies, such as bends, corners, and twists, for general Armed Services application in conjunction with standard rf transmission lines are covered in this recently issued spec.

Batteries

MIL-B-15072A, AMENDMENT 1, BATTERIES, STORAGE, LEAD-ACID, PORTABLE (EXCEPT FOR AIRCRAFT AND AUTOMOTIVE VEHICLES), 18 JULY 1956

Requirements for clamp terminals have been added and pin-type terminals have been deleted. Filler plug requirements have also been added. Twenty three "MS" standards have been added covering batteries, and three additional ones have been added covering battery terminal clamps and battery filler plugs.

Shipboard Enclosures

MIL-E-2036B (NAVY), ENCLOSURES FOR ELECTRIC AND ELECTRONIC EQUIPMENT (NAVAL SHIPBOARD USE), AMENDMENT 3, 16 MAY 1956

Disconnect switches are now included under this spec. Enclosed, self-ventilated enclosures are no longer considered to be Class 1 enclosures. Splashproof and splashproof protected enclosures are no longer considered to be Class 2 enclosures. The requirements for approved joints and bolts and spacing have been revised. Requirements for spray-tightness and water-tightness have been added, as have been requirements for welding.



MOLONEY HyperCore ELECTRONIC CORES

Check and double Check

HyperCore Electronic Cores measure up to the highest standards of quality and performance. One check is not enough . . . each core undergoes at least two rigid inspections. The first makes certain that it is of the specified size . . . and the second determines that finished cores have the desired electrical qualities. All HyperCore electronic cores *must* test well within industry tolerances. Special tests for specific operating conditions can be made also if desired.

These tests are the real proof of the superior fabrication which combines the finest materials with superior "know how". Result; electronic cores that give better performance . . . have greater flux carrying capacity and lower losses. And since Moloney HyperCore Electronic Cores are wound cores of cold-rolled oriented silicon steel, they are smaller and lighter.

ME66-17



Specify HyperCore Cores for smaller, low loss transformers



Write for Catalog SR 206 "HyperCores for Magnetic Components" and Catalog ST 3506 "Magnetic Components for Electronic Applications."

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LIQUID COOLING

of
Electronic
Tubes



WITH **Eastern** COOLING UNITS

By a sustained program of research, Eastern continuously extends the uses of the latest units in electronic tube cooling, pressurizing electronic equipment, and pumping fuels and hydraulic fluids. Research and testing laboratories, a model shop, and three manufacturing plants provide the specialized equipment and manpower to turn out fully qualified units to meet appropriate government specifications.

From our extensive line of existing units, adaptations of these units, or completely new designs, Eastern can provide equipment to handle your project well. Your inquiry is welcomed.



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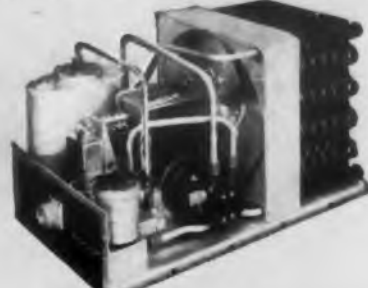
Eastern Cooling Units provide coolant liquid for maintaining within safe operating temperature limits liquid cooled electronic tubes or similar devices. The units are completely self-contained and usually comprise such components as heat exchangers, fans or blowers, liquid pumps, reservoirs, flow switch, thermostat, etc. Cooling units can be modified as required for varying conditions encountered in land or sea as well as aircraft service. Almost all units are designed to meet such specification as MIL-E-5400 and MIL-E-5272.

The units shown below are intended only to illustrate the varying requirements which can be satisfied. By utilizing fairly standard components and designs based on broad experience in this field, Eastern is able to provide at minimum cost equipment exactly suiting a specific requirement.

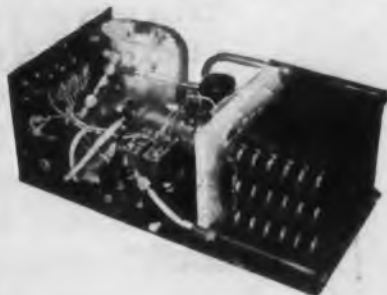
Eastern welcomes your consultation on liquid cooling problems ranging from 200 to 20,000 watts dissipation.



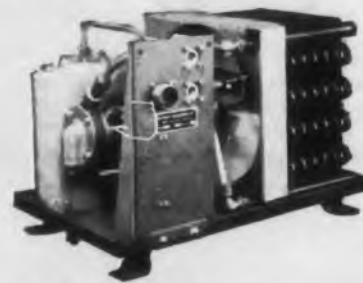
MODEL MB-175, TYPE 200 DISSIPATION: 2,000 watts. **ALTITUDE RANGE:** sea level to 50,000 feet. **POWER REQUIRED:** 28 volts D.C. **WEIGHT:** 25 pounds. **SIZE:** 10" x 15-15/16" x 10 1/4" high.



MODEL E/MT-205, TYPE 200A DISSIPATION: 1600 watts. **ALTITUDE RANGE:** sea level to 5,000 feet. **POWER REQUIRED:** 28 volts D.C. **WEIGHT:** 25 pounds. **SIZE:** 10" x 21" x 10" high.



MODEL MB-177, TYPE 202 DISSIPATION: 1700 watts. **ALTITUDE RANGE:** sea level to 50,000 feet. **POWER REQUIRED:** 110 volt, 400 cycle, 3 phase. **WEIGHT:** 27 pounds. **SIZE:** 10" x 19 13/32" x 7 1/4" high, per JAN-C-1720A, size B1-D1.



MODEL E/MT-210, TYPE 200 DISSIPATION: 1500 watts. **ALTITUDE RANGE:** sea level to 10,000 feet. **POWER REQUIRED:** 208 volts, 400 cycle, 3 phase. **WEIGHT:** 35 pounds. **SIZE:** 11 1/4" x 19 1/2" x 12 1/2" high.



MODEL E/MT-200, TYPE 201 DISSIPATION: 1,000 watts. **ALTITUDE RANGE:** sea level to 50,000 feet. **POWER REQUIRED:** 28 volts D.C. **WEIGHT:** 14 1/2 pounds. **SIZE:** 10" x 10" x 6" high.



MODEL NO. 5-A DISSIPATION: 1,000 watts. **ALTITUDE RANGE:** sea level to 5,000 feet. **POWER REQUIRED:** 100 to 110 volts D.C. **WEIGHT:** 10 pounds. **SIZE:** 7 1/4" x 13 1/2" x 9-1/16" high.

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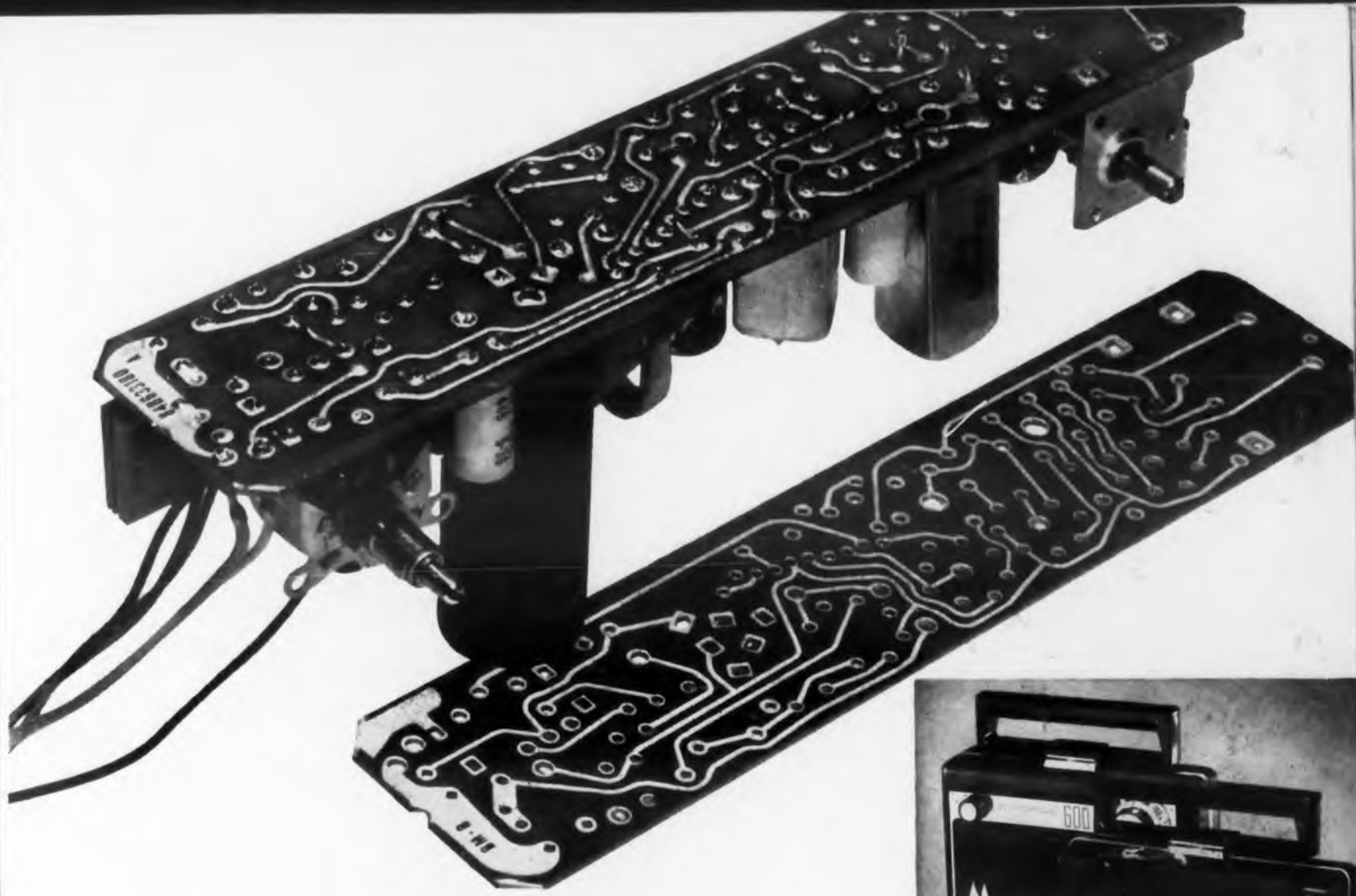
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What this resin does for Motorola's plated circuits

- ... gives a good base for bonding of copper firmly to the laminate
- ... provides high insulation resistance and low dielectric loss
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- ... withstands 500° F. heat of dip-soldering
- ... results in a lamination that exceeds U. S. Government standards and NEMA specifications.

All these advantages are found in BAKELITE Brand Phenolic Resin CLSA-3914, a superior hot punch laminating varnish used in the Motorola "Ranger" portable radio shown here. When high surface resistance is needed, CLSA-3914 is used on paper stock pre-treated with 12 to 16 per cent of a water-miscible resin, such as BAKELITE Phenolic Resin BLL-3913. Both XXXP and XXXP-1R grade laminates are produced by this method.

Technical information on BAKELITE Laminating Varnishes made especially for printed circuits is available by writing Dept. SO-56.

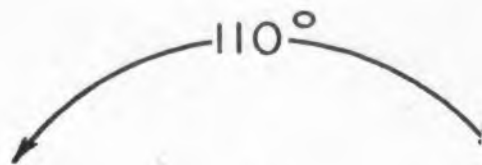
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The Motorola "Ranger" achieves compact, sturdy construction and fast assembly with plated circuits on laminated stock produced by **Farley & Loetscher Mfg. Co.**, Dubuque, Iowa, using BAKELITE Laminating Varnishes.



New "110-degree" SHORT PICTURE TUBE



*...Sets a new concept
for compact TV receivers*

Introducing a new dimension in picture tube design for black-and-white TV receivers, RCA-21CEP4 opens new possibilities for designers looking for a compact tube capable of producing big, high-quality pictures—in a smaller cabinet. Here, RCA has successfully incorporated wide-angle 110° deflection and "straight"-gun design into a compact unit at least 5½ inches shorter than 21-inch envelope types with 90° deflection.

Read these important facts about the new RCA-21CEP4:

(1) "Straight" electron-gun design employing unique pre-focus electrostatic lens maintains image sharpness over the entire picture area (262 sq. in., minimum)—and eliminates need for an ion-trap magnet. (2) Smaller neck diameter permits use of a deflecting yoke having higher sensitivity—and requiring only slightly more power than is needed for 90° deflection. (3) Super-aluminizing produces bright, high-contrast pictures.

First of a new line of 110° wide-angle tubes for "black-and-white", RCA-21CEP4 is in production! For tube-delivery information, call your RCA Field Representative. For technical data on the RCA-21CEP4, write RCA, Commercial Engineering, Section K-18Q-1, Harrison, New Jersey.



Radio Corporation of America

Tube Division

Harrison, N. J.

Components Division, Camden, N. J.

ree"

RCA-21CEP4



Associated Tubes and Components

Designed for use in 110° deflection-angle systems. For horizontal deflection, RCA-6DQ6-A; for vertical deflection, RCA-6CZ5. Both of these types are now commercially available. In addition, a developmental horizontal deflection transformer and a developmental deflecting yoke—both designed especially for use with 110° tubes—are available to TV equipment manufacturers on a sampling basis.

ELECTRONIC
DESIGN

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