

electronics

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APRIL 1956

4/5/56

TELEMETERING
Electronic Data
Transmission

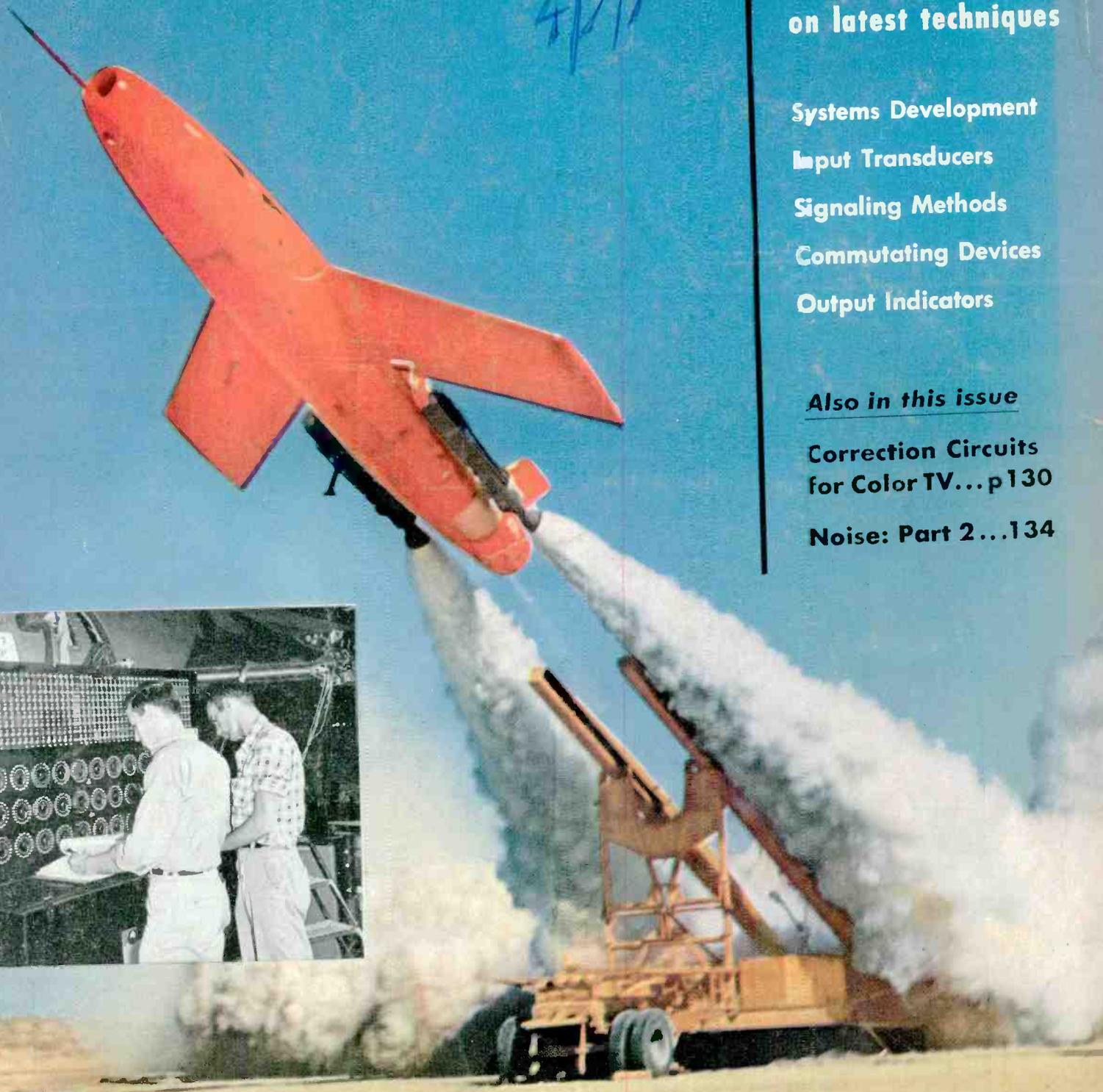
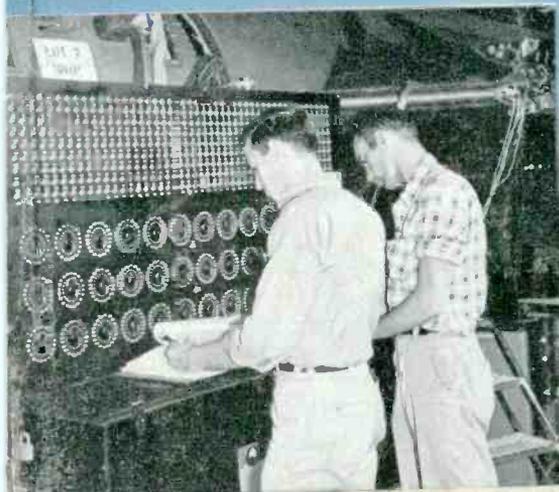
28-page
SPECIAL REPORT
on latest techniques

Systems Development
Input Transducers
Signaling Methods
Commutating Devices
Output Indicators

Also in this issue

Correction Circuits
for Color TV... p130

Noise: Part 2...134



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TWENTY YEARS...**



MINIATURIZED TRANSFORMER COMPONENTS **FROM STOCK**

Items below and 650 others in our catalog A.

HERMETIC SUB-MINIATURE AUDIO UNITS

These are the smallest hermetic audios made.

Dimensions . . . 1/2 x 11/16 x 29/32 . . . Weight .8 oz.

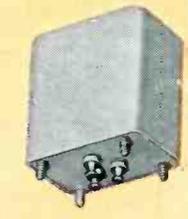


TYPICAL ITEMS

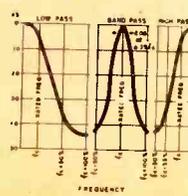
Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri MA	Response ± 2 db (Cyc.)	Max. level dbm
H-30	Input to grid	TF1A10YY	50*	62,500	0	150-10,000	+13
H-31	Single plate to single grid, 3:1	TF1A15YY	10,000	90,000	0	300-10,000	+13
H-32	Single plate to line	TF1A13YY	10,000*	200	3	300-10,000	+13
H-33	Single plate to low impedance	TF1A13YY	30,000	50	1	300-10,000	+15
H-34	Single plate to low impedance	TF1A13YY	100,000	60	.5	300-10,000	+6
H-35	Reactor	TF1A20YY	100 Henries-0 DC, 50 Henries-1 Ma. DC,	4,400 ohms.			
H-36	Transistor Interstage	TF1A15YY	25,000	1,000	.5	300-10,000	+10

*Can be used with higher source impedances, with corresponding reduction in frequency range and current

COMPACT HERMETIC AUDIO FILTERS



UTC standardized filters are for low pass, high pass, and band pass application in both inter-stage and line impedance designs. Thirty four stock values, others to order. Case 1-3/16 x 1-11/16 x 1-5/8 - 2-1/2 high . . . Weight 6-9 oz.

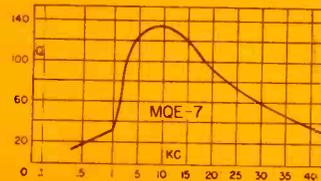


HERMETIC MINIATURE HI-Q TOROIDS

MQE units provide high Q, excellent stability and minimum hum pickup in a case only. 1/2 x 1-1/16 x 17/32 . . . weight 1.5 oz.

TYPICAL ITEMS

Type No.	Inductance	DC Max.
MQE-1	7 mhy.	135
MQE-3	20 mhy.	80
MQE-5	50 mhy.	50
MQE-7	100 mhy.	35
MQE-10	.4 hy.	17
MQE-12	.9 hy.	12
MQE-15	2.8 hy.	7.2

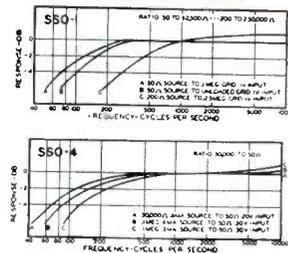


SUB-SUBOUNCER AUDIO UNITS

Standard for the industry for 15 yrs., these units provide 30-20,000 cycle response in a case 7/8 dia. x 1-3/16 high. Weight 1 oz.

TYPICAL ITEMS

Type No.	Application	Pri. Imp	Sec. Imp
0-1	Mike, pickup or line to 1 grid	50, 200/250, 500/600	50,000
0-4	Single plate to 1 grid	15,000	60,000
0-7	Single plate to 2 grids, D.C. in Pri.	15,000	95,000
0-9	Single plate to line, D.C. in Pri.	15,000	50, 200/250, 500/600
0-10	Push pull plates to line	30,000 ohms plate to plate	50, 200/250, 500/600
0-12	Mixing and matching	50, 200/250	50, 200/250, 500/600
0-13	Reactor, 300 Hys.—no D.C.; 50 Hys.—3 MA. D.C., 6000 ohms		



SUB-SUBOUNCER AUDIO UNITS

UTC Subouncer and sub-subouncer units provide exceptional efficiency and frequency range in miniature size. Constructional details assure maximum reliability. SSO units are 7/16 x 3/4 x 43/64 . . . Weight 1/50 lb.

Type	Application	Level	Pri. Imp.	MA D.C. in Pri.	Sec. Imp.	Pri. Res.	Sec. Res.
*SSO-1	Input	+ 4 V.U.	200 50	0	250,000 62,500	13.5	3700
SSO-2	Interstage /3:1	+ 4 V.U.	10,000	0-.25	90,000	750	3250
*SSO-3	Plate to Line	+20 V.U.	10,000 25,000	3 1.5	200 500	2600	35
SSO-4	Output	+20 V.U.	30,000	1.0	50	2875	4.6
SSO-5	Reactor 50 HY at 1 mil. D.C. 4400 ohms D.C. Res.		100,000				
SSO-6	Output	+20 V.U.	100,000	.5	60	4700	3.3
*SSO-7	Transistor Interstage	+10 V.U.	20,000 30,000	.5 .5	800 1,200	850	125

* Impedance ratio is fixed, 1250:1 for SSO-1, 1:50 for SSO-3. Any impedance between the values shown may be employed.

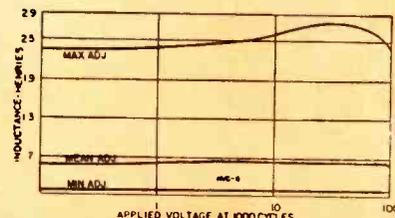
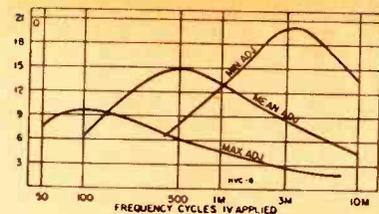


HERMETIC VARIABLE INDUCTORS

These inductors provide high Q from 50 - 10,000 cycles with exceptional stability. Wide inductance range (10 - 1) in an extremely compact case 25/32 x 1-1/8 x 1-3/16 . . . Weight 2 oz.

TYPICAL ITEMS

TYPE No.	Min. Hys.	Mean Hys.	Max. Hys.	DC Ma
HVC-1	.002	.006	.02	100
HVC-3	.011	.040	.11	40
HVC-5	.07	.25	.7	20
HVC-6	.2	.6	2	15
HVC-10	7.0	25	70	3.5
HVC-12	50	150	500	1.5



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GUIDED MISSILE TAKES OFF—Regulus, built by Chance-Vought for Navy, launched on test at Point Mugu in California, is controlled by electronic equipment shown in insert (see p 154) COVER

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SHOP

► **NO MOLE HE . . .** The editors frequently travel about New York City, using its famous subway system. Recently our newest staffer, Jack Kinn from New Jersey, ran afoul of the system to the extent that he now carries a subway map. Even so, he still occasionally gets lost.

Analyzing Jack's problem, we find that the train he selects often goes plus or minus 90 degrees from his intended route. We escorted him to the IRE annual meeting, at the Armory in the Bronx and two hotels in Manhattan.

Jack, incidentally, was born in New York City and lived here for 19 years. He just isn't acquainted underground.

► **POSITIVE FEEDBACK . . .**

Every month for the past four years, the Industry Report section of Electronics has carried the statistics of past performance and estimates of the future on the business side of the industry.

The many facets of data on the electronics field, and the details of curves and graphs published, are extremely difficult to remember.

This was brought home last month when a call was made to the research department of a major manufacturer of a certain component. We needed an estimate of annual volume, industrywide, and association and government data did not include that component.

The manufacturer gave us the

electronics

APRIL, 1956

Vol. 29, No. 4



Member ABC and ABP

TALK

figure. Then told us he got it from our Industry Report, published some months earlier.

► ELECTRONIC AUTHORING . . .

As most contributing authors have found out, the mechanics of putting a manuscript together varies all over the lot. Raw material such as circuits, graphs and other data may be worked on at the office or lab, at home, or enroute.

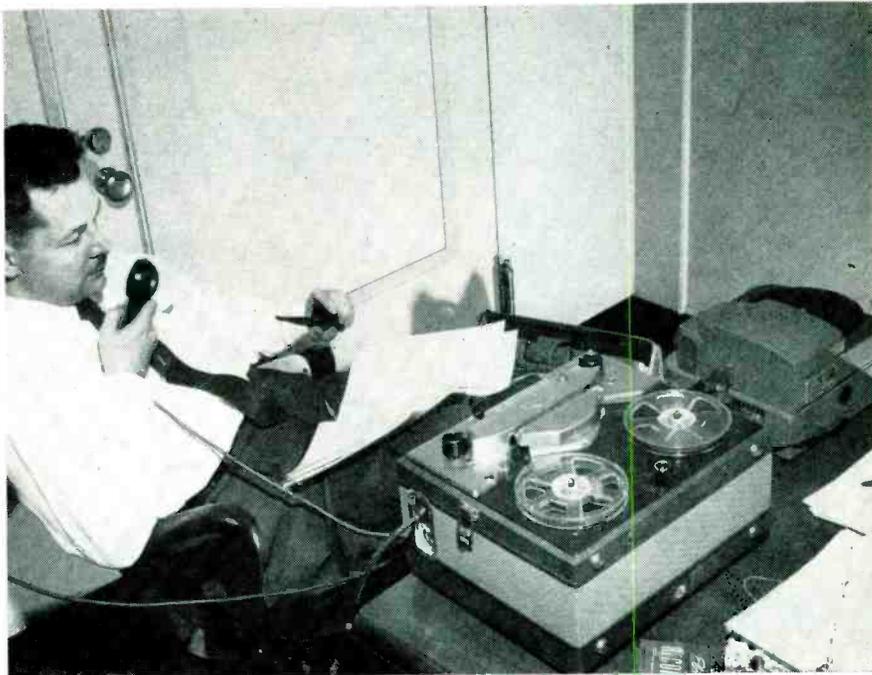
At odd times over a period of several months associate editor Carroll collected data for one article. Many of the notes accumulated at home while cleaning out his pockets after visits to engineers using electronics in various industries.

Beleaguered by the mounting pile of old envelopes, billheads and ordinary paper, he dictated his notes into his home recorder. Bit by bit, the tape grew, to a final length of 3,600 feet.

Translation of the information bits to manuscript draft was done at the office. He listened to sections of tape, then dictated text into another machine. Disks from that machine were transcribed to copy by a service department.

The final article, *Electronics in the Process Industries*, will appear next month.

► **AUDIO CUTOFF . . .** Man is said to have survived by adapting to his environment. McKenzie and



DUAL-TRANSDUCER Jack Carroll listens to playback of his rough notes, dictates draft to second recorder from whose disks a stenographer later produced typed sheets of copy for an article

Manoogian turned out the 28-page special report on telemetering, appearing in this issue, by use of survival techniques. One of the techniques they selected has intrigued other members of the editorial staff and may be useful to electronics engineers as well.

When they began the assignment, reading, studying and writing in the hubbub of a busy editorial office at first seemed impossible. However, they soon acquired several sets of rubber ear

plugs and devices for inserting them efficiently. From there on, concentration became simple.

There was one embarrassing interlude when the chief editor suddenly confronted them and began a friendly conversation in his customary gentle tones. Forgetting their ear plugs, the pair wondered for a few moments if he was suffering from a case of severe laryngitis.

What *he* wondered may be cleared up when he reads this.

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NEW PRODUCTS . . . BROADER ENGINEERING HORIZONS FROM SORENSEN

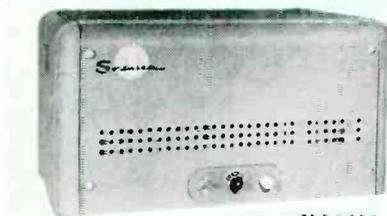
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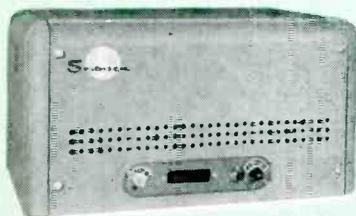
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within a wide frequency range, overcoming amplitude and frequency fluctuation and the proximity of component frequencies.

The MUIRHEAD Wave Analyzer operates as a negative feedback, tuned band-pass filter insuring constant selectivity at all frequencies, and simplifying frequency selection. Output voltage is available at tuned frequency for viewing or recording.

This highly versatile instrument has a wide diversity of applications in many industries: aviation, automotive and manufacturing, shipbuilding and electric power generation, to name only a few.

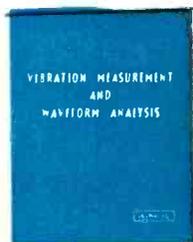
FEATURES

- No internal oscillator—eliminates drift
- R/C-tuned circuits—reduces hum and noise pickup
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- High selectivity characteristic (1% bandwidth for greatest discrimination)
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- Frequency range—19 c/s to 21 kc (extendable down to 2 c/s)
- Frequency Stability— $\pm 0.3\%$ over most of range
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- Output Voltage—10 v
- Input Voltage—1 mv to 300 v rms (FSD)
- Input Impedance—0.1 megohms
- Hum and Noise Level—Equivalent to .05 mv input at maximum gain
- Power Supply (external)—100/120 v, 60 or 400 cycles, 130 w
- Dimensions—12 $\frac{3}{4}$ " x 13 $\frac{1}{2}$ " x 17 $\frac{1}{2}$ "
- Weight—55 pounds

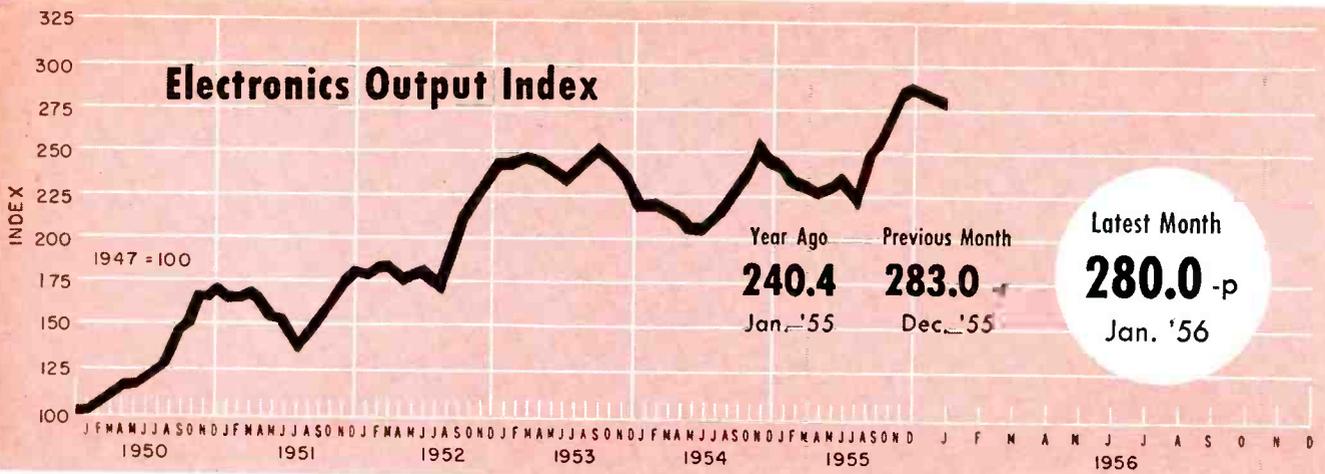
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FIGURES OF THE MONTH

	Latest Month	Previous Month	Year Ago		Latest Month	Previous Month	Year Ago
RECEIVER PRODUCTION (Source: RETMA)				BROADCAST STATIONS (Source: FCC)			
Television sets, total	Jan. '56	Dec. '55	Jan. '55	TV stations on air	Feb. '56	Jan. '56	Feb. '55
With UHF	588,347	604,626	654,582	TV stations CPs—not on air	485	484	448
Color sets	82,107	89,606	117,095	TV stations—new requests	106	105	130
Radio sets, total	nr	nr	nr	A-M stations on air	22	26	17
With F-M	1,078,624	1,786,330	1,068,146	A-M stations CPs—not on air	2,841	2,834	2,692
Home sets	nr	40,305	16,568	A-M stations—new requests	123	120	101
Clock radios	nr	396,535	280,121	F-M stations on air	247	242	186
Portable sets	nr	343,330	166,885	F-M stations CPs—not on air	539	538	542
Auto sets	nr	182,204	47,303	F-M stations—new requests	13	16	11
	519,648	864,261	573,837		4	3	5

	Jan. '56	Dec. '55	Jan. '55
RECEIVER SALES (Source: RETMA)			
Television sets, units	614,213	933,467	647,585
Radio sets (except auto)	531,206	1,388,801	474,947

	Jan. '56	Dec. '55	Jan. '55
RECEIVING TUBE SALES (Source: RETMA)			
Receiv. tubes, total units	40,141,000	38,049,000	37,951,000
Receiv. tubes, value	\$31,314,000	\$30,673,000	\$26,879,000
Picture tubes, total units	892,385	881,465	866,956
Picture tubes, value	\$17,016,391	\$17,533,105	\$17,661,018

	Dec. '55	Nov. '55	Dec. '54
SEMICONDUCTOR SALES ESTIMATES			
Germanium diodes, units	2,690,000	2,575,000-r	1,800,000
Silicon diodes, units			

	Latest Quarter	Previous Quarter	Year Ago
INDUSTRIAL TUBE SALES (Source: NEMA)			
Vacuum (non-receiving)	3rd '55	2nd '55	3rd '54
Gas or vapor	\$9,027,845	\$8,933,453	\$8,803,740
Magnetrons and velocity modulation tubes	\$3,438,835	\$3,365,008	\$3,570,586
Gaps and T/R boxes	\$10,998,967	\$13,193,395	\$13,112,244
	\$1,421,138	\$1,677,574	\$1,476,407

	Jan. '56	Dec. '55	Jan. '55
COMMUNICATION AUTHORIZATIONS (Source: FCC)			
Aeronautical	44,331	44,836	41,868
Marine	54,276	53,950	48,751
Police, fire, etc.	19,757	19,885	17,148
Industrial	27,599	27,269	23,223
Land transportation	8,576	8,481	7,289
Amateur	143,841	142,819	129,258
Citizens radio	14,920	14,426	9,579
Disaster	326	321	310
Experimental	644	674	649
Common carrier	2,137	2,093	1,810

	Dec. '55	Nov. '55	Dec. '54
EMPLOYMENT AND PAYROLLS (Source: Bur. Labor Statistics)			
Prod. workers, comm. equip.	404.0 -p	406.0 -r	379,000
Average weekly earnings, comm.	\$75.53-p	\$75.53-r	\$70.70
Average weekly earnings, radio	\$71.81-p	\$71.81-r	\$69.49
Average weekly hours, comm.	41.5 -p	41.5	40.4
Average weekly hours, radio	40.8 -p	40.8 -r	40.4

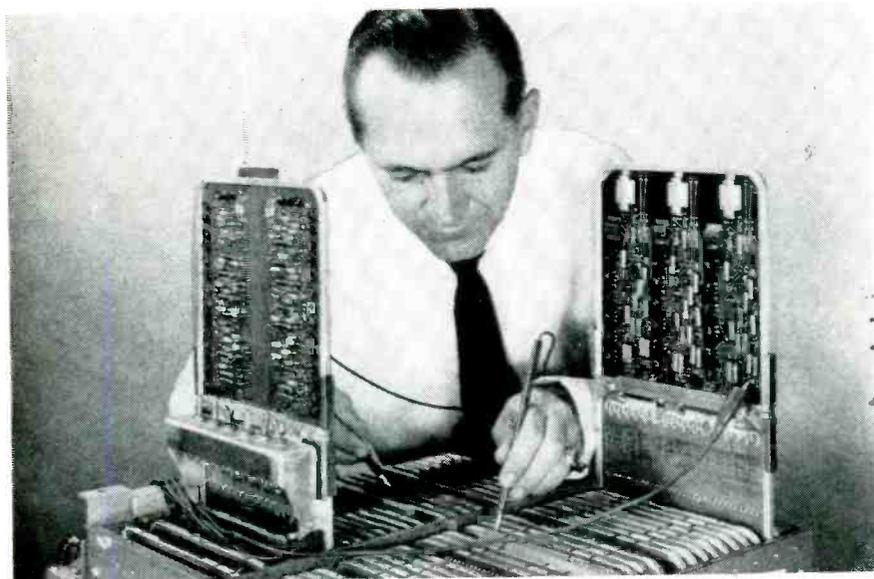
	Feb. '56	Jan. '56	Feb. '55
STOCK PRICE AVERAGES (Source: Standard and Poor's)			
Radio-tv & electronics	426.8	435.6	437.0
Radio broadcasters	489.8	500.5	496.8

p—provisional; r—revised
nr—not reported

FIGURES OF THE YEAR

Television set production	614,213	933,467	647,585
Radio set production	531,206	1,388,801	474,947
Television set sales	614,213	933,467	647,585
Radio set sales (except auto)	531,206	1,388,801	474,947
Receiving tube sales	40,141,000	38,049,000	37,951,000
Cathode-ray tube sales	892,385	881,465	866,956

	TOTALS FOR FIRST MONTH			1955 Total
	1956	1955	Percent Change	
Television set production	588,347	654,582	-10.1	7,756,521
Radio set production	1,078,624	1,068,146	+ 1.0	14,894,695
Television set sales	614,213	647,585	- 5.2	7,421,084
Radio set sales (except auto)	531,206	474,947	+11.8	6,921,384
Receiving tube sales	40,141,000	37,951,000	+ 5.8	479,802,000
Cathode-ray tube sales	892,385	866,956	+ 2.9	10,874,234



GUIDED missile's brain looks like a small filing cabinet when . . .

Designers Deal Tubes Out

Transistors and magnetic amplifiers share spotlight as prime computer elements

"ANY engineer who designs an electron tube into a new computer will have to tell me why." This word went out recently from the chief engineer of a large west coast electronics firm. It typifies contemporary thinking among computer designers.

Engineers look with jaundiced eye on the 4,000-odd electron-tube filaments that must be heated to incandescence when a big brain goes to work. Rusticating the tube would save power and cut down on space requirements. Cooling and air-conditioning problems would likewise evaporate.

► **On The Bench** — An attractive alternative to the electron tube is

the transistor. An airborne digital computer developed by North American Aviation's missile people uses 1,000 transistors in etched circuits. The three-cubic-foot, 125-lb brain is four times lighter than its electron-tube counterpart. It consumes 100 watts instead of 3,000 for the tube job. The computer can generate continuous solutions for differential and trigonometric problems. It can do 93 integrations at once. General Electric 2N43 transistors are used.

Philco is working on at least three Transacs. Introduced last year, this digital computer uses surface-barrier transistors in direct-coupled circuits. At least one of the units under development is for airborne computing.

IBM has already shown a transistorized electronic calculator, the model 608. This computer is designed for business and industry.

► **Dark Horse** — Although most computer designers are fondly eyeing the transistor Sperry Rand is betting on the magnetic amplifier. Magnetic components are not strange to the computer field. Ferrite-core internal memories and tape-wound-core shift registers are extremely important. Word, however, was that magnetic amplifiers were just too slow for high-speed stored-program digital computers.

A break came from Sperry Rand's South Norwalk, Conn. operations in the form of the \$12,500 Ferractor magnetic-amplifier computer. However, this unit was still relatively slow.

Then from Philadelphia came the Univac engineering calculator, an all-magnetic computer adapted from a device developed for the Air Force's Cambridge Research Center. This computer uses 1,500 magnetic cores, the magnetic clock drives magnetic amplifiers at 660 kc.

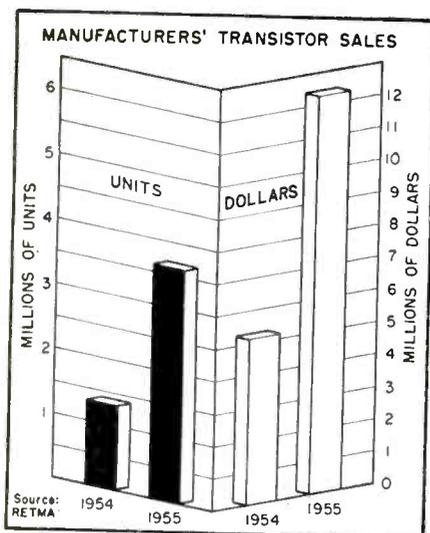
Transistor Shipments In Sharp Rise

Unit shipments tripled during 1955; 400 million sales figure seen for 1965

SNOWBALLING sales by transistor manufacturers reflect their wholehearted acceptance by equipment manufacturers in both entertainment and nonentertainment fields.

Sales for 1955 were 3,646,802 units, almost triple the 1954 figure of 1,317,327. Value in 1955 was \$12,252,741 against \$5,122,266 for 1954.

The upswing is continuing on a



month-to-month basis. December 1955 sales were 479,968 units at \$1,614,805 while for January 1956, 572,674 transistors worth \$1,893,250 were sold.

Total transistor sales for 1956 should reach 10 to 11 million units. For 1957 this is expected to double. By 1965 the transistor business should be well established at 400 million annually.

► **Breakdown**—Half of 1956 production will be for entertainment use, largely in portable radios and some auto sets. For the rest: 1.4 million will go into computers and digital devices, 1.3 into communications equipment and 2.8 into other applications, including hearing aids.

The 5.5 million transistors for nonentertainment use will include silicon and military-type units.

► **Applications** — For the short haul, entertainment uses are expected to take a high of 75 percent of production. Contributing factors will be 100-percent transistorization of portable, table and clock radios. Even the clocks may be transistorized. Almost every auto radio will be transistorized. The transistorization of tv sets will probably come about through introduction of transistors first in special circuits, for example, color decoders.

► **Shifting Balance**—For the long haul, the entertainment share may decline to about 66 percent as transistors in computers, industrial-control equipment and communica-

tions gear multiply. Transistors are already important in special communications, airborne control and navigation and missile-guidance equipment.

► **Production**—The predicted increase for transistor sales depends entirely on the market. Capacity

of manufacturers to produce transistors is more than sufficient to meet the predicted demand. Today, the combined production facilities of three of the larger transistor manufacturers total nearly $\frac{1}{2}$ million units a month. General Electric plans to double its production capacity by the middle of the year.

Low-Power TV Gains Ground

Philco and RCA introduce equipment for the field. Other companies eye the new market

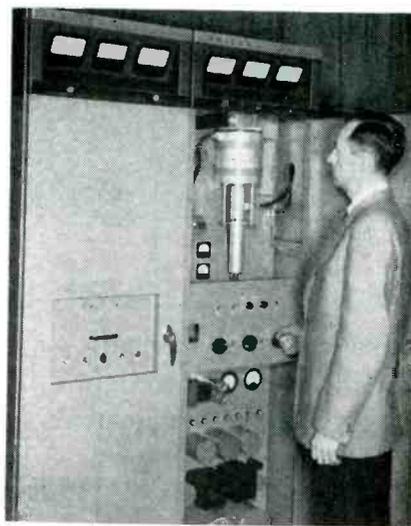
ANOTHER broadcast equipment manufacturer has entered the low-power tv station market created last June when the FCC amended its rules to permit uhf and vhf stations to operate with a minimum visual effective radiated power of minus 10 dbk (decibels below 1 kw or 100 watts) at any antenna height. Philco announced new low-power tv broadcasting packages chiefly for the estimated 800 small communities where tv has been unavailable because of high costs of conventional equipment. RCA is beginning production on a new 100-watt vhf transmitter.

► **Military** — Several broadcast equipment makers have been in the low-power tv field for some time. The equipment gained impetus when the military began establishing low-power tv stations for troops in isolated areas in the U.S. and abroad. There are now some 15 of the military stations in operation. About 75 are possible if all potential areas are equipped. So far, equipment for these stations has been supplied by various manufacturers with Dage and RCA supplying the bulk.

► **Firms**—With Philco's entry into the field and RCA's new equipment, other broadcast equipment manufacturers are watching the field more closely. Du Mont has not yet introduced equipment for low-power use but plans to move into the field if it develops successfully. GE is also watching the field closely but has not as yet announced low-

power gear. RCA has had low-power tv station equipment available through its International Division and has equipped one commercial station in Guatemala with an 18-watt transmitter.

► **Stations**—There are no 100-watt commercial tv stations in operation in the U.S. at the present time. Lowest power stations now operating in the U.S., according to FCC,



New Philco low-power tv equipment

are KINY-TV at Juneau, Alaska operating at 263 watts and KSHO-TV at Las Vegas, Nevada which began operating on March 9. Construction permits granted to WJMS-TV at Ironwood, Mich. to operate at 794 watts and KZIT-TV at Santa Fe, N. M. with 490 watts constitute present lowest power permits.

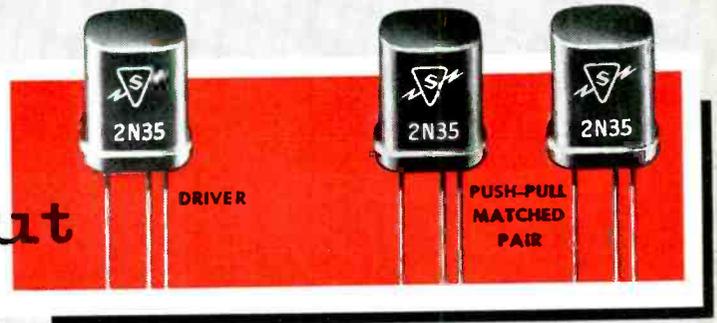
► **Equipment** — The new Philco package includes a transmitter, monitoring equipment, high-gain antenna and transmission line and local program originating facili-

(Continued on page 10)

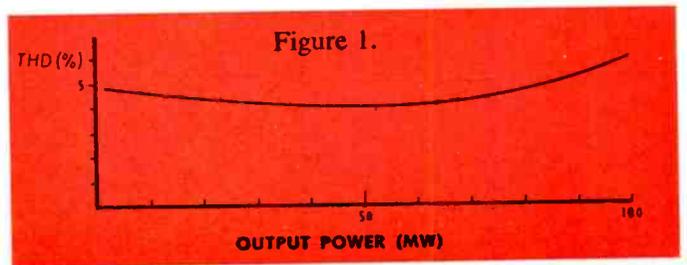
Sylvania **NPN** transistors

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audio output



with low
distortion



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DRIVER STAGE

Sylvania's 2N35 for Class-A driver use has linear characteristics at high current levels, thereby insuring maximum input to the push-pull stage with minimum distortion.

PUSH-PULL MATCHED PAIR

Output transistors in Sylvania's audio line-up are

matched to within 10% on collector current characteristics. The close tolerances to which the 2N35 push-pull pair is produced permit maximum power gain with minimum distortion as plotted in Figure 1.

Power output of the 2N35 pair is rated for a minimum of 100 mw at 50°C. Dissipation is rated at 50 mw, per unit, with higher rated counterparts available.

The all-important facilities — Sylvania is equipped to supply you with production quantities, so why not call your Sylvania Representative for samples. Or write for complete data. Address dept. D20R.



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ties for transmission of slides, films and local live shows.

Two types of studio buildings and towers can be included in the packages. The final power amplifier provides 150-watt peak visual power and 75-watt aural power output to the transmission line. The program

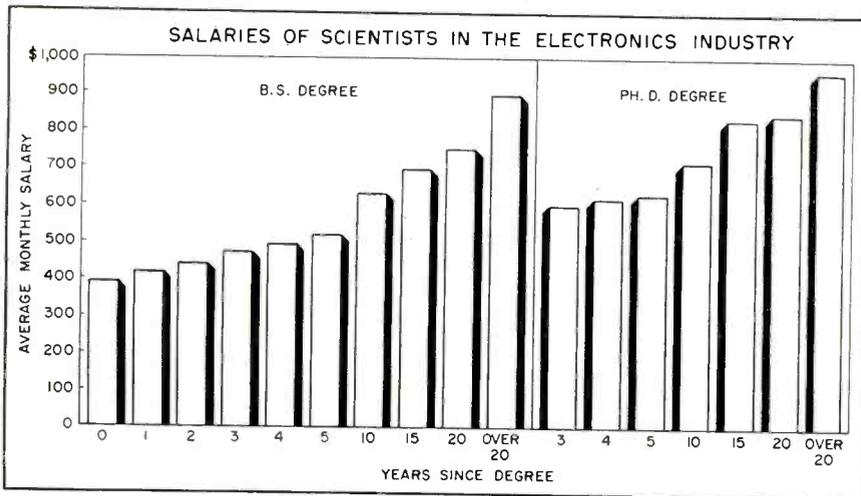
originating equipment consists of film and live camera chains, video monitoring and switching facilities, and audio facilities. The frequency band used in battlefield surveillance, 470 to 500 mc, can be covered by the transmission equipment.

in the aeronautical and petroleum fields and \$243 more than engineers in the machinery field.

► **Doctors**—Engineers with Ph.D. degrees in the electronics industry were not as well paid for experience as were engineers in some other industries, according to the survey. Three years after degree, Ph.D.'s in electronics were earning \$595 a month and ranked below those in the rubber industry who earned an average monthly salary of \$635.

More than 20 years after degree, Ph.D.s in electronics earned \$959 per month ranking behind Ph.D.'s in the machinery field earning \$1,064 per month and those in the instruments field earning \$1,058. In both of these industries, however, the number of Ph.D.'s surveyed or available for survey was small while the number in the electronics industry was among the highest of all industries surveyed.

Salaries Rise With Experience



Electronics industry among the top paying fields both in starting salary and raises

How engineers in the electronics industry fare salarywise as they gain work experience is shown in a national survey by the Los Alamos Laboratory of the University of California of professional scientific salaries in 1954.

The data are based on completed questionnaires submitted by 221 contributors reporting the salaries of more than 50,000 research and development scientists. Administrative and supervisory officials and scientific employees not holding academic degrees are excluded.

Profit sharing plans, production bonuses, cost-of-living allowances and other similar adjustments to base salaries have been added to the reported monthly averages wherever possible. Research and development, as used for the survey, is defined as any activity requiring formal technical training and the exercise of scientific judgment in selecting and applying techniques for the solution of problems related to the improvement of existing

products, services or methods and includes pure research.

The engineers classified under B.S. degrees in the chart include those with bachelor's or master's degrees in science or engineering who are engaged in research and development work.

► **Bachelors** — The survey shows that the monthly salaries of engineers with B.S. degrees in the electronics industry are higher at the start than those of engineers in eight other industries. And, although engineers in other industries may move ahead in salary at different times as experience is gained, engineers in the electronics industry with over 20 years experience were also the highest paid of the eight industries surveyed.

Compared to the next three highest paying industries, starting salary of engineers in electronics was \$5 higher than in the machinery field, \$7 higher than in the petroleum industry and \$10 higher than salaries in the aeronautical field. More than 20 years after receiving their B.S. degrees, engineers in electronics were earning \$127 more a month than comparable engineers

Synthetic Quartz Now on Open Market

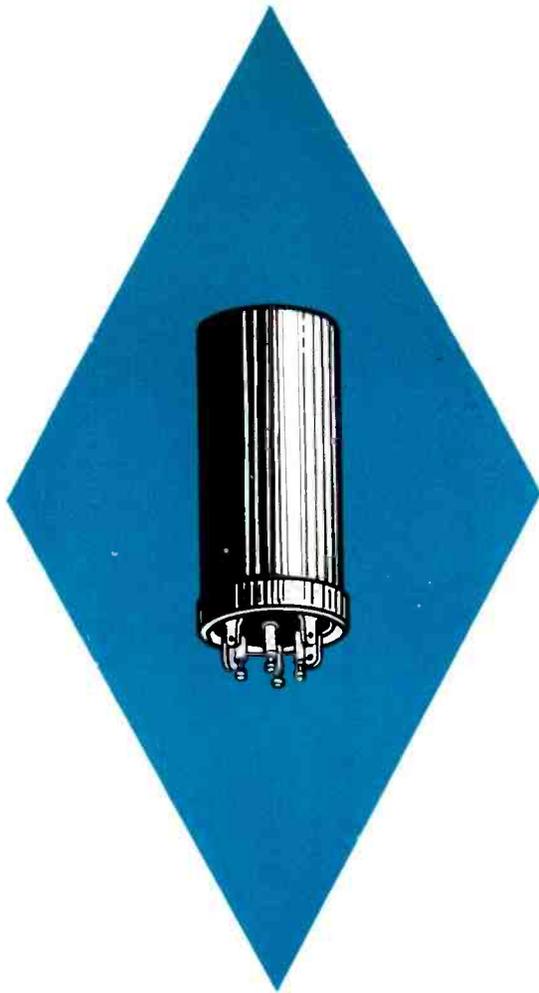
Though priced higher than natural crystals, yield is greater, labor costs lower

AVAILABILITY of synthetic quartz on the open market at \$52.50 a pound for the past eight months has resulted in many orders on a sampling basis, but as yet Brazilian natural quartz continues to fill production needs.

Chief reason for slowness of sales is believed to be the need for more time to develop new production techniques that take advantage of the greater perfection of the synthetic crystals. Of the total of over two tons already grown in the pilot plant of Clevite Research Center under Signal Corps contract, about 85 percent has been electronic grade, with this figure approaching 100 percent if experimental runs are neglected.

► **Cost Factors**—Yield per pound is higher because the synthetic is

(Continued on page 12)



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computers

laboratory test instruments

industrial controls

other electronic applications

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The use of especially high purity materials . . . utmost care in manufacture, constant observation and quality control of all operations have made Sprague Extended Life Capacitors outstanding for their long life and faultless performance.

Type 17D Extended Life Electrolytics have turret terminals and twist-mounting lugs. A special vent construction is molded right into the cover, as are the numbers identifying each terminal. The aluminum cans are covered with a corrosion-resisting insulating coating.

Nineteen standard ratings, all characterized by low maximum leakage current and remarkable life test capabilities are available in the new series. Complete technical data are in Engineering Bulletin 340, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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an almost perfect material having few flaws for discard. The synthetic bars are grown to practically the exact cross-section of the resonators being cut, minimizing cutting waste.

The crystals are grown in exactly the desired orientation, so that the cutting saw travels a shorter distance through the material; this permits use of a thinner saw without reducing cutting accuracy, thereby giving more plates per crystal.

Labor costs are reduced because inspection of raw materials for flaws is eliminated, orientation prior to cutting is simplified by the regularity of the grown crystal faces, and the large flat areas simplify cementing operations. Uniform size and shape of the grown crystals also suggests the possibility of mechanizing the entire cutting and finishing operations when producing one size of oscillator plate in high volume.

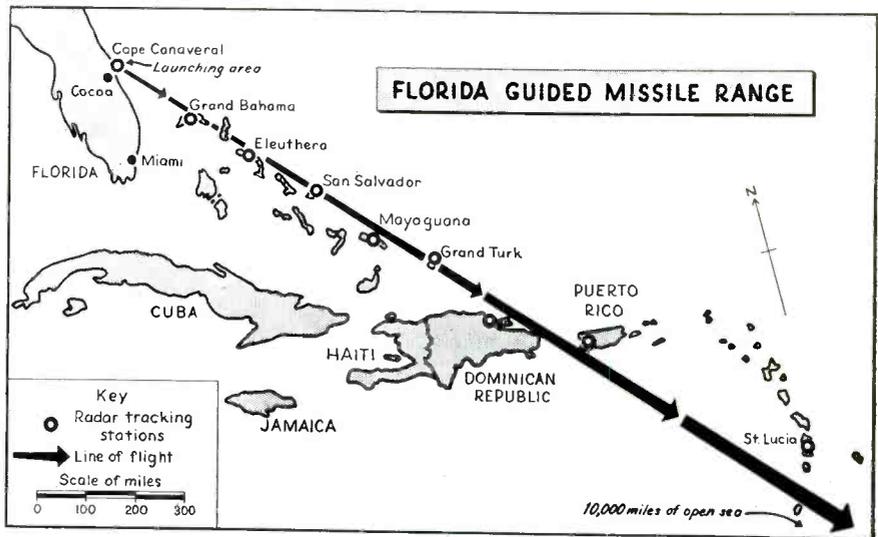
Where long quartz bars are required, as for low-frequency flexural units, synthetic quartz is actually cheaper on the basis of material cost alone, because of the premium prices on natural quartz long enough to give the required dimensions that are parallel to the Y axis.



Removing batch of half-pound grown quartz crystals from Clevite autoclave. All crystals are essentially identical in shape, weight and orientation

► **Future**—A new type of autoclave under consideration is expected to permit a substantial cost reduction in the grown crystals, chiefly

through savings in labor for loading and unloading. Expansion of production facilities will follow market demands. None is planned.



Radar Chain Boosts Missile Work

Ten million dollar system will help speed development of intercontinental missiles

FURTHER aid in the current international race to develop an effective intercontinental missile and other supersonic weapons is forthcoming as the world's largest chain radar tracking system nears completion off the coast of Florida.

The system is capable of checking the flight of the newest supersonic rockets and missiles over the full length of the U. S. Air Force Air Research and Development Command's Florida Guided Missile Range. It enables engineers to understand certain problems in aerodynamics that have hampered missile progress.

► **Timetable**—The first installation on the Florida Range was made at the test range's central control near Cocoa Beach, Fla. in January of last year. The Grand Bahama station was completed shortly thereafter and other installations followed at the other islands shown on the map. The chain is now complete except for St. Lucia and that installation will be finished early in 1956.

► **Equipment** — The radar chain was designed and built by Reeves Instrument Corp., a subsidiary of Dynamics Corp. of America. Value of the job was \$10 million.

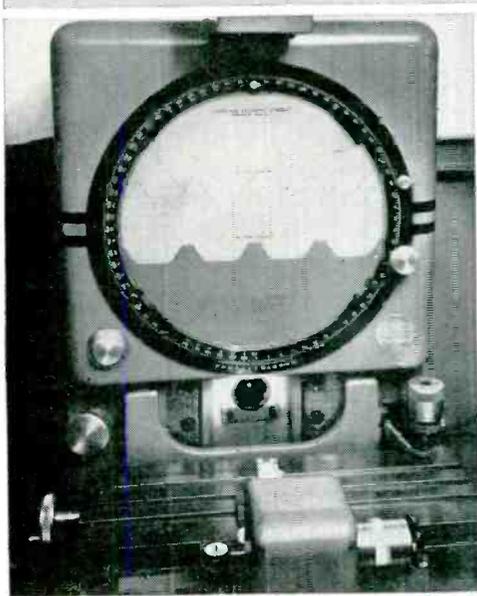
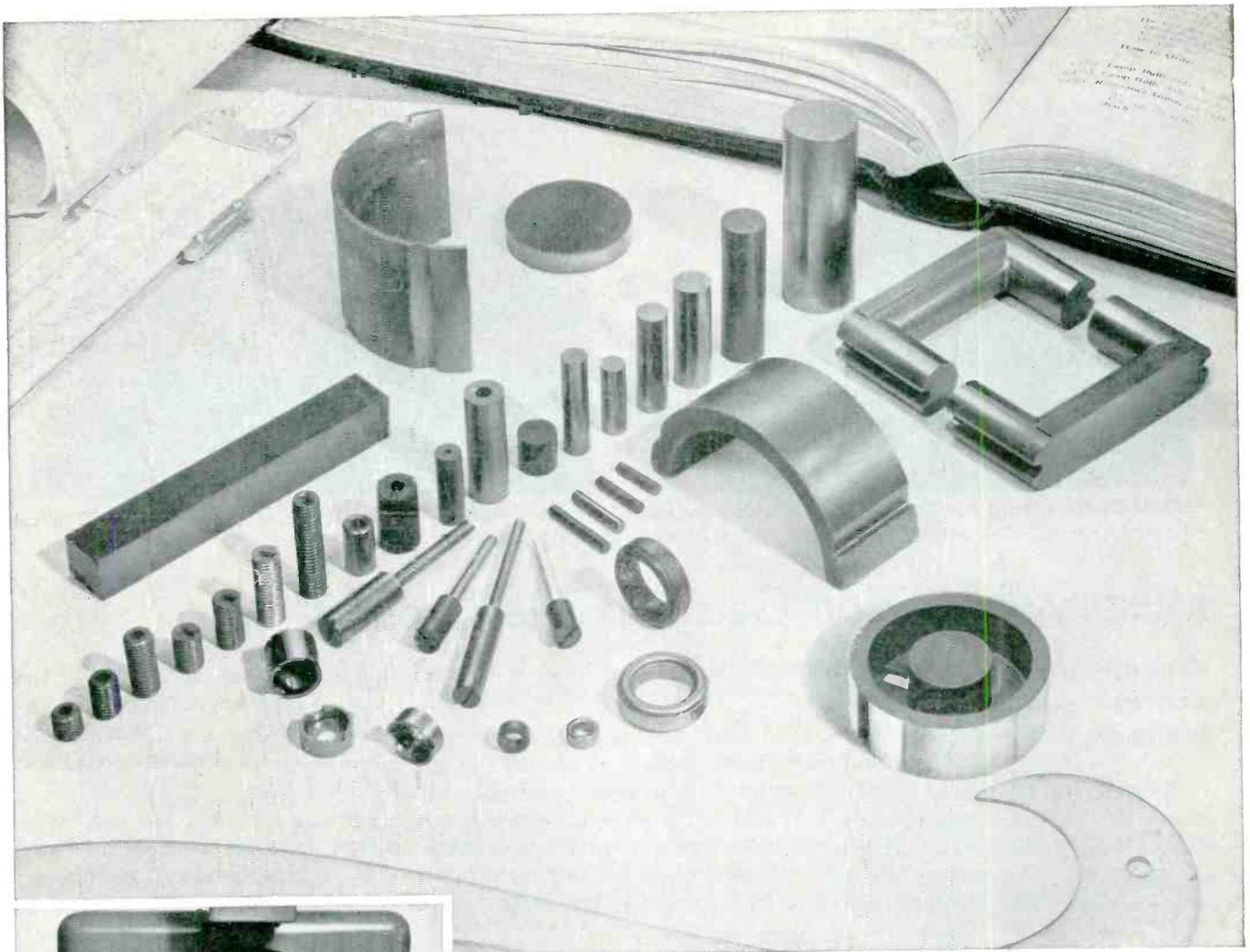
The chain comprises 21 radar installations. Sixteen of the radars are installed in pairs on each of eight islands.

The dual installations provide standby equipment. One installation checks on the other and can take over in case of failure. The island installations are in air-conditioned buildings. The remaining five installations are located in mobile vans.

► **Functions** — The five-ton radar systems are almost fully automatic. One operator is required at each installation for missile acquisition. Once the radar locks onto the missile the operation is carried on automatically. The radars record and report back position, course, velocity and acceleration. Accuracy is within 0.02 deg.

Tracking continues to the end of the test run. If the missile deflects from course or becomes erratic, a control to destroy it can be actuated. There have been no accidents from runaway missiles.

(Continued on page 14)



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APPROACHING aircraft can be watched on one of three control-tower monitors at Alameda Naval Air Station (left). Tactical television camera (right) gives Army more eyes. And new f-m gear will help when . . .

Military Television Gets Off The Ground

New air-surface system supplements existing closed-circuit and walkie types

INCREASED use of television techniques in defense operations is highlighted by three different systems for seeing at a distance. Navy has installed traffic control tv at NAS Alameda; the Signal Corps has developed a walkie-peepie and is testing an f-m airborne reconnaissance link.

► **Airborne Scout**—In contrast to commercial tv broadcasting, Army's new air-ground picture transmitter uses frequency modulation instead of amplitude modulation. Admiral Corporation engineers who built the equipment say that a plane flying at 1,000 feet could send back pictures to a command post receiver 25 or 30 miles away.

Not mentioned, but technically possible would be the relaying of such information through one or more intermediate aircraft to posts 100 or 200 miles distant.

► **Expendable Robot**—For the foot soldier, the Signal Corps has an 8-pound camera that sends out picture signals from a back-pack transmitter weighing 47 pounds with power supply.

A standard hand-held radio transmitter supplies the sound channel. Receiver is normally mounted in a jeep. The camera

could be left in a hazardous location, connected by cable with the receiver.

► **Visual Radar**—A closed-circuit system using three cameras, installed by Kay Labs, gives Navy airfield operators at Alameda positive control of runway operations a half mile distant. Intervening

buildings formerly blocked the view. Vehicular traffic on the airfield perimeter road that crosses the end of the runway is likewise visible.

Coming of the jet age, with longer runways, presages increased use of similar closed circuits at costs in the order of \$50,000 each.

Businessmen Appraise Computers

Uses continue to multiply; several new employment opportunities are created

NEARLY everything from electric bills to Holy Scripture is grist for the electronic computer's mill. Recent months have seen groups such as the American Management Association and the Society of Applied Anthropology seriously discussing electronics.

► **Applications**—It has been estimated that a stored-program computer is profitable when it can take over the duties of 90 or more clerks. Users of computers in the life insurance field were numerous at the AMA conference. They included John Hancock with 2 million policies in force; Franklin Life with ½ million policies; and Mutual Life of Los Angeles with 350,000 policies. All these firms have Univacs.

Consolidated Edison of N. Y. will use a Univac for customer account-

ing and an IBM 705 for payroll and general accounting. Chrysler has an IBM 702 for inventory control in its Parts Division and an IBM 650 doing payroll work at Plymouth. Dodge Truck division expects to have a Univac File Computer.

An unusual application of the Univac was preparing a concordance of the Holy Bible. Over 800,000 words were listed alphabetically with context and indexed by book, chapter and verse.

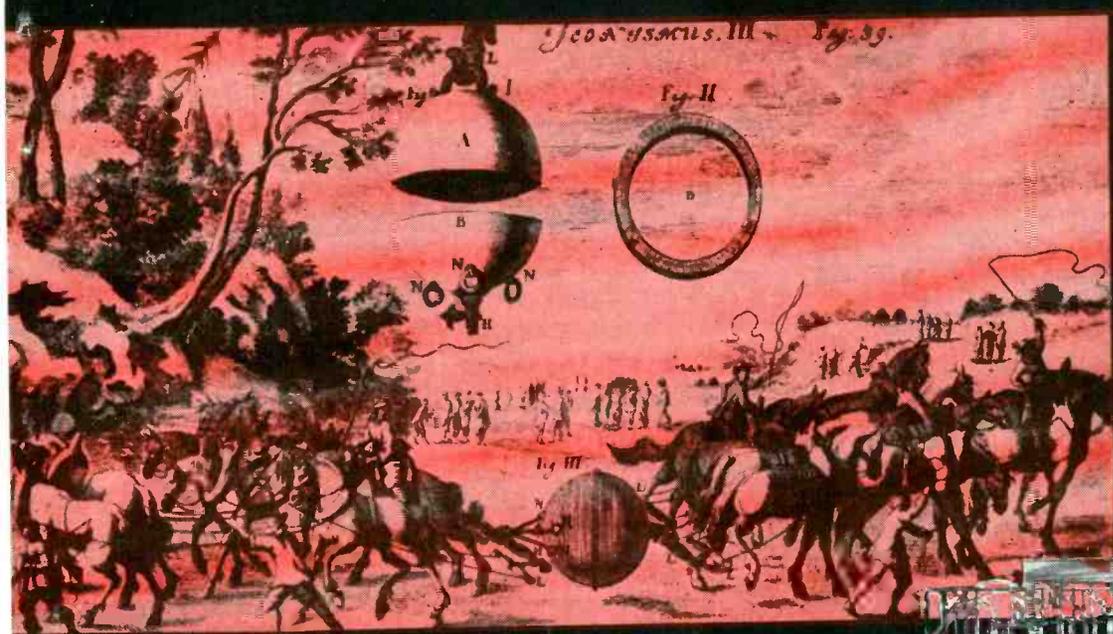
► **Installation**—Putting in a computer takes, on the average, 9 to 12 months and requires 20 to 35 man-years. At John Hancock, initial studies required 10,000 hours costing \$50,000 while Minneapolis-Honeywell reports its study cost \$42,000.

Preparation of the site cost John Hancock \$200,000 while overall installation at Franklin Life came to \$250,000.

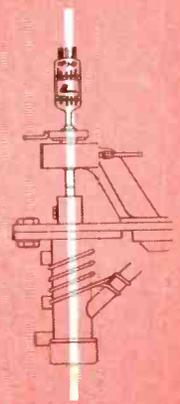
► **Personnel**—An average computer crew has been estimated at

Most
 revolutionary development
 in vacuums

SINCE 1650 A. D.



CONTINUOUS ALL-METAL
 VACUUM PATH FROM PORT
 THROUGH DIFFUSION PUMP

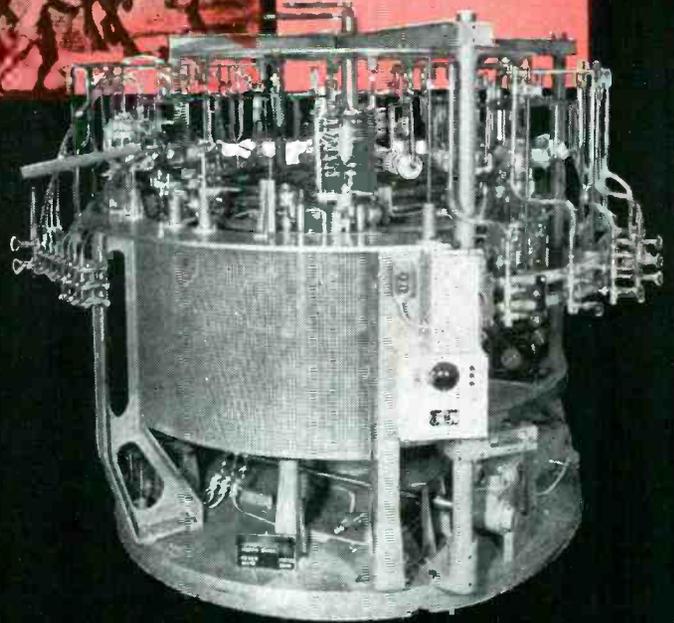


The Magdeburg Hemispheres Test was the first demonstration of creating a vacuum. That was in 1650 over 300 years ago . . . today Kahle has demonstrated a revolutionary new concept in vacuum . . . a valve-less rotary Exhaust Machine.

This rapid-speed, rotary-in-line, automatic Exhaust Machine features a continuous all-metal vacuum path from port through diffusion pump . . . completely eliminates the conventional slide valve . . . individual automatic leak detector and shut-off valve on each port . . . water cooled compression chucks are automatically operated . . . automatic tipping torch and automatic tubulation remover are also employed.

Ultra-high vacuum is achieved with the unique design and rugged construction of Kahle's automatic Exhaust Machine. Ideal for exhausting cathode ray tubes, transmitting tubes, receiving tubes, x-ray tubes, and all other high-reliability types.

The type Machine illustrated is one of a wide selection of sizes and ranges available at Kahle.



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17 men. John Hancock's team numbers 19. Franklin Life estimates a 70-man staff including clerks and typists for a 7-day 24-hour operation.

Although some manufacturers recommend only 1 or 2 mathematicians and engineers, Franklin Life, which does its own maintenance, employs a chief engineer and senior engineer, both with previous computer experience, 2 junior engineers and 4 technicians. Franklin has 10 programmers but feels the company should have set its sights on 20 to 25.

For all-week round-the-clock operation, Franklin estimates need for 25 clerical coders, 15 engineers, technicians, operators and tape handlers, 20 typists and 10 programmers.

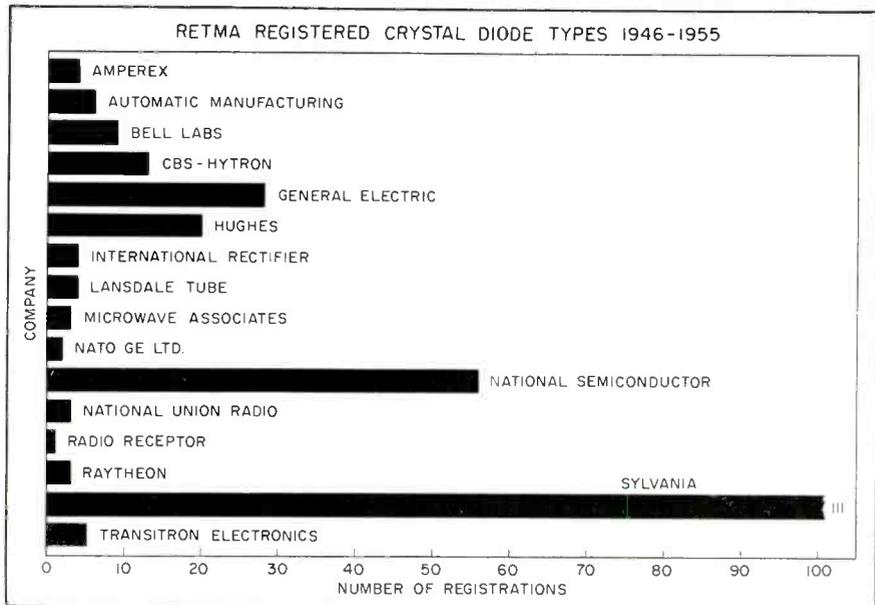
► **Outlook**—One major change that computers may cause is shift work for white collar workers. Another is creation of a new profession, the information engineer, as programmers have been called. They organize the sequence of control of information and understand operation of the machine. Within the next decade 17,000 programmers may be needed.

This new group is already in short supply. As a consequence, they are well paid and turnover is high in some installations.

Transistorized Radio Detects Interference



Exploring trouble sources in electrical equipment is a new use for pocket-sized transistor radios, according to Raytheon



Crystal Diode Registrations Rise

Over 270 types have been registered with JETEC since 1946

GROWING use of crystal diodes in electronic equipment is indicated by the growing number of types registered by manufacturers. Although registrations do not always mean that production of the device is underway, it usually indicates that the type has reached production level either by the company that sponsored its development or by licensees of the device.

► **Progress** — According to the Joint Electron Tube Engineering Council's summary of registered crystal diodes, in 1955 some 107 types were registered representing nearly 40 percent of total diode registrations since 1946. In 1954, 65 types were registered and in 1953 the total was 43. Until 1953 the number of diode registrations ranged between 2 and 20 each year for an annual average of 8 registrations.

► **Makers** — Some 16 electronics manufacturers have been active in the development of crystal diodes since 1946. Sylvania has been the leading sponsor of the devices, according to registration records, with about twice as many regis-

tered as any other company.

► **Material** — Silicon diodes have forged ahead in number of registrations. Of the more than 272 types that have been registered since 1946, some 57 percent have been silicon types. In 1955 only 15 of the 107 total registered were germanium types. The remainder were silicon diodes.

► **Use** — Although full details on the use for each type of diode registered is not given in the summary report, it shows that about 60 of the types were for general purposes. Four types were specifically indicated for use in computers, two for tv and six as power rectifiers.

Dielectric Heating On Up-Swing

Sales of sealing units increased by demands of fast-moving plastics industry

GROWTH in the dielectric heating business is accelerating due to demands for more and varied consumer products made from thermo-setting plastics. Such sealing units

(Continued on page 20)

All in One Package!

Millivoltmeter

Micro-microammeter

Mega-megohmmeter

The G-R Type 1230-A D-C Amplifier and Electrometer represents a new and important contribution to the field of electrical-measuring equipment.

A low-cost instrument of high performance for the measurement of extremely small d-c voltages, currents and charges has not been hitherto available. As if not enough, this device is also a completely self-contained megohmmeter with provision for measuring higher resistances than possible with many instruments specializing in this measurement. Output jacks, at the rear, permit use as a sensitive d-c amplifier to drive 1-ma or 5-ma recording equipment such as the Esterline Angus Recorders.

Superior performance is obtained through a carefully thought-out design. An electrometer tube is used in the first of three direct-coupled stages to keep grid current effects truly negligible. The stringent stability requirements necessary for an instrument such as this are met through use of excellent supply regulation, insulation of the highest quality, shock mounting, wire-wound resistors at all critical locations, and aging of both tubes and components . . . in short, through adherence to the high standards of engineering and manufacture which have come to be expected of the General Radio Company.

The Type 1230-A Amplifier and Electrometer has many applications in industrial-process control and in physical and chemical research, in addition to its obvious uses in the electronics laboratory. The instrument may be used: to operate from strain gauges; to indicate or record time-current curves of capacitors under charge or discharge; to record life tests on vacuum tubes and other components; to measure semi-conductor resistance, piezo-electric potentials, electrostatic fields, ph indications, contact potentials, grid currents in tubes, and insulation resistance of motors, generators and appliances; and, in general, to measure any physical or chemical reaction where a d-c voltage or current proportional to the change is available.

This instrument is a truly versatile device . . . one we're proud to present, and one every laboratory will want to own.

Six Voltage Ranges: ± 30 mv, 100 mv, 300 mv, 1v, 3v, and 10v d-c, full scale — accuracy, 2% of full scale on all five higher ranges, 4% of full scale on lowest 30-mv range.

Twenty Current Ranges: from ± 1 ma to $\pm 3 \times 10^{-13}$ amp d-c, full scale — accuracy, 3% of full scale from ± 1 ma to $\pm 3 \times 10^{-9}$ amp and 10% to $\pm 3 \times 10^{-13}$ amp.

Sixteen Resistance Ranges: direct reading 300 k Ω to 10 M Ω , full scale; 5×10^{14} Ω at smallest meter division — accuracy, 3% from 3×10^3 Ω to 10^{10} Ω and 8% to 10^{13} Ω — with external 300v batteries in place of the internal 9v source, resistance range can be extended to read 6×10^{16} Ω at smallest meter division.

Since resistance is easily measured with different voltages applied to the unit under test, voltage coefficients are readily obtained.

Internal Resistance Standards: 10^4 and 10^5 ohm steps accurate to 0.25%; 10^6 , 10^7 and 10^8 ohms accurate to 1%; 10^9 , 10^{10} , 10^{11} ohms accurate to 5% and have been treated to prevent adverse humidity effects. 0 and ∞ steps also available.

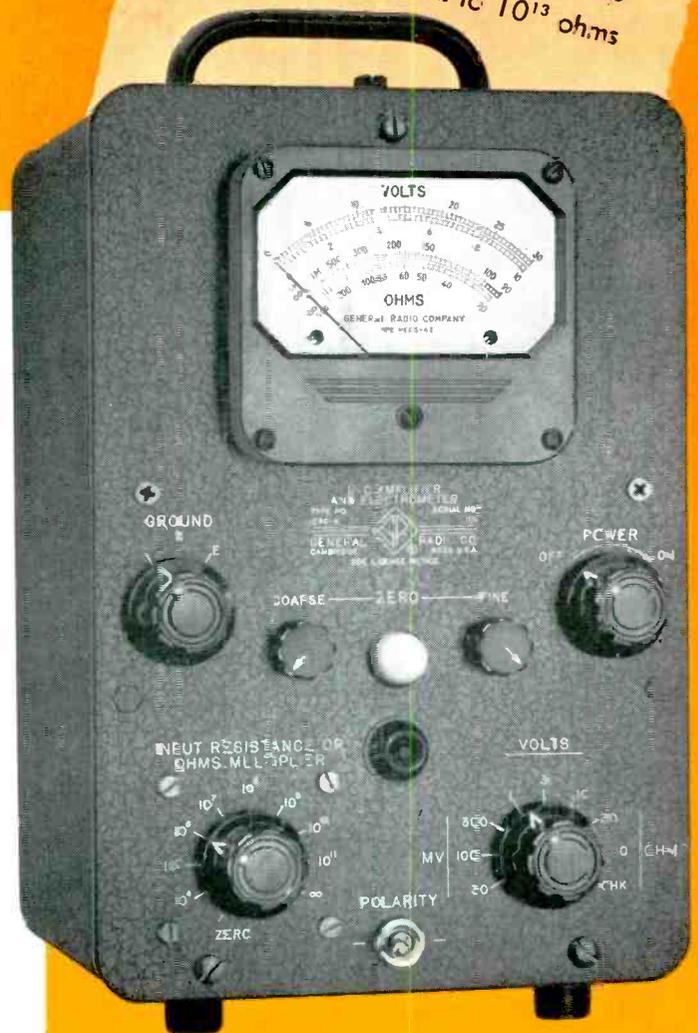
Switch provided for checking higher resistance standards in terms of more precise 10^4 and 10^5 ohm wire-wound units (makes possible working back to high basic accuracy over the complete range).

High Input Resistance: determined by setting of resistance standards switch; 10^{14} ohms at "open" position; input insulation is entirely teflon and siliconized glass, insuring reliable operation under high humidity conditions.

Drift: less than 2 mv per hour after initial warm up.

Temperature, Humidity, Line-Voltage Effects: all negligible.

Ranges, Full Scale
Voltage: 30 mv to 10 volts
Current: 1 ma to 3×10^{-13} amp
Resistance: 300 k Ω to 10^{13} ohms



Type 1230-A Amplifier and Electrometer as shown, \$440.
Type 1230-AE Amplifier and Electrometer in Esterline Angus Cabinet, \$502.

Output: panel meter indicates voltage, current and resistance; output jack provided for connecting recorder having resistance up to 1500 Ω .

Guard Terminals: three terminals in addition to input and output provide versatility in ground and guard connections.

Input Switch Disconnects Unknown: without upsetting unknown or electrometer input circuit.

Power Supply: 105-125v (210-250v), 50-60 cycles.

Useful Accessories: Esterline Angus 5-ma or 1-ma Graphic Recorder.

G-R Type 1230-P₁ Component Shield at \$40 provides a fully shielded chamber for measurement of very high resistance components.



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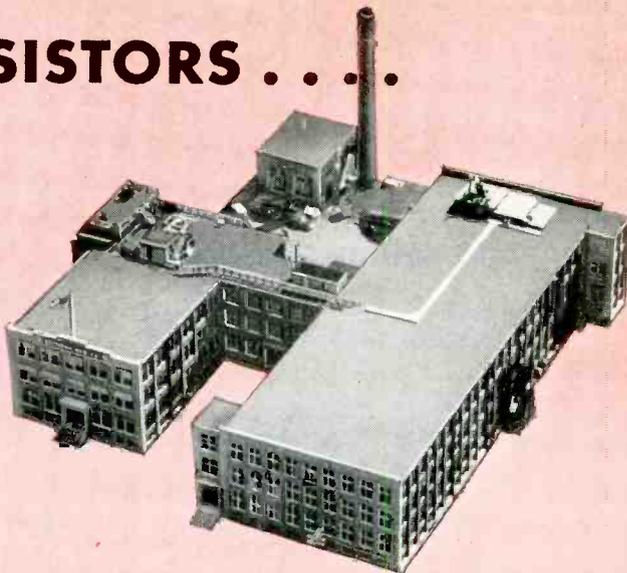
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FIRST PLACE for TRANSISTORS



Raytheon's three million dollar Semiconductor Division plants devote 180,000 square feet (over 4 acres) of floor space exclusively to semiconductor research, engineering and manufacturing. Raytheon's semiconductor operations employ 1500 people, including over a hundred scientists and engineers.

Raytheon Transistors possess the improved electrical performance, reliability and mass production advantages of Raytheon's *fusion-alloy* process — proved superior by the successful production of *millions* of transistors — more than all other makes combined.

SUBMINIATURE LOW FREQUENCY TRANSISTORS

Type	Collector			Emitter Current mA	Base Resistance ohms	Base Current Ampl. Factor	Max. Noise Factor db	Alpha Freq. Cutoff mc.
	Volts	Meg. ohms	Cutoff μ A					
2N130	-6	2.0	6	-1.0	350	22	25	0.6
2N131	-6	2.0	6	-1.0	700	45	22	0.8
2N132	-6	2.0	6	-1.0	1500	90	20	1.2
2N133	-1.5	1.0	6	-0.5	700	45	10	0.8
2N138	-6	2.0	6	-1.0	1800	140	25	1.2

Maximum Junction Temperature 85°C.

Temperature Rise (free air) 0.45°C/mW

LOW FREQUENCY TRANSISTORS

Type	Collector			Emitter Current mA	Base Resistance ohms	Base Current Ampl. Factor	Max. Noise Factor db	Alpha Freq. Cutoff mc.
	Volts	Meg. ohms	Cutoff μ A					
2N63	-6	2.0	6	-1.0	350	22	25	0.6
2N64	-6	2.0	6	-1.0	700	45	22	0.8
2N65	-6	2.0	6	-1.0	1500	90	20	1.2
2N106	-1.5	1.0	6	-0.5	700	45	12	0.8

Maximum Junction Temperature 85°C.

Temperature Rise (free air) 0.40°C/mW

HIGH FREQUENCY TRANSISTORS

Type	Collector		Emitter Current mA	Extrinsic Base Resis. ohms	Base Current Ampl. Factor	Alpha Freq. Cutoff mc.	Collector Capacity μ f	Gain (max. available)		Grounded Emitter Switching $I_b = -1\text{ma}$, $I_c = -20\text{ma}$.		
	Volts	Cutoff μ A						at 455kc db	at 2 mc db	Rise time μ sec.	Storage time μ sec.	Decay time μ sec.
2N111	-6	1	-1.0	50	25	3	12	33	18	—	—	—
2N112	-6	1	-1.0	55	40	5	12	35	20	0.8	0.5	1.0
2N113	-6	1	-1.0	60	65	10	12	36	22	0.1	0.6	0.15
2N114	-6	1	-1.0	75	100	20	12	36	25	0.05	0.7	0.10

Maximum Junction Temperature 85°C.

Temperature Rise (free air) 0.40°C/mW

NEW HIGH TEMPERATURE SILICON TRANSISTORS

Type	Reverse Current at -20v		Beta	Base Resistance ohms	Collector Resistance kilohms	Noise Factor db (max.)	Collector Capacity μ f	Alpha Freq. Cutoff KC
	Collector μ A (max.)	Emitter μ A (max.)						
CK790	0.2	0.2	14	1200	500	30	30	400
CK791	0.2	0.2	24	1400	500	30	30	600
CK793	0.2	0.2	16	1300	500	15	30	500

Maximum Junction Temperature 150°C.

Temperature Rise (free air) 0.50°C/mW

Write for data sheets

RAYTHEON TRANSISTORS

more in use than all other makes combined

the prime source of

special tubes



CK5783WA

Subminiature Voltage Reference Tube featuring extraordinary stability.



America's Largest Special Tube Manufacturer

CK6611 CK6612

Filamentary Subminiature Tubes for low battery drain plus high transconductance.



6AN5WA

Reliable Miniature Tube combining high permeance and long life with low interface resistance.



CK6533

Heater Cathode Subminiature tube featuring extremely low microphonics over the audio range.

Here are a few recent additions to the comprehensive range of tubes originated by Raytheon. They are representative of over two hundred active miniature and subminiature types out of the many developed and produced by Raytheon.



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RELIABLE MINIATURE AND SUBMINIATURE TUBES • VOLTAGE REFERENCE TUBES
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are made by over twenty companies in the U. S.

► **Sales** — For individual companies, volume of sealing unit sales for 1955 ranged from \$50,000 to the 1.2-million announced by the Theratron Division of Radio Receptor Corp.

The trend in sales has been up, with many companies experiencing a ten-fold increase within the past five years.

► **Prices**—Power output and application determine the price of sealing units. The range is from about \$1,000 to \$50,000 a machine. The average machine is rated at 3 kw and sells for about \$2,000

► **Example**—Kabar Manufacturing of N. Y. produces 1 through 6, 8, 10, 15 and 20-kw units. Price increases in the 3 to 6-kw group average \$500/kw, while those in the 8 to 20-kw group average \$750/kw. The power required for a given operation depends on the number of linear inches of seal and the thickness of the material.

► **Problem** — Fulfilling the radiation requirements set by the FCC is a major problem to manufacturers. Although units are engineered for minimum radiation, the user's set-up may allow considerable radiation. The only sure way to eliminate the problem is to operate the equipment in a shielded room.

► **Uses**—Sealers are used in such applications as curing rubber, dehydrating, pre-heating plastics before moulding, making padded safety equipment for autos and sterilizing beer after bottling. Manufacturers feel that units now being produced are not aimed for a replacement market but result from stimulating new manufacturing fields.

► **Other**—Tappan Stove of Ohio is producing dielectric ranges for the home (see Industry Report, p 12, Dec. 55).

GE and its subsidiary Hotpoint have already announced definite plans to produce high frequency ranges for the home. Raytheon has had commercial units available for some time.



PHOTOGRAPHIC enlarger that uses high voltage is an important step as . . .

Electronics Invades Graphic Arts

Electronic printing and special crt's to aid printing business

INDICATIONS are that the electronics industry which has already become part and parcel of countless diverse businesses from railroading to brewing beer may become an important factor in the printing industry. Printing is the third largest industry in U.S. in number of establishments. Gross sales for 1952 were \$8.5 million. Related to printing are blueprinting, office duplication and photo reproduction.

► **Navy "Blueprinter"**—The Electrofax machine shown was built by RCA for the Navy's aircraft overhaul and repair facility in Alameda, Calif. It produces 15 engineering drawings a minute from microfilm originals. It sells for \$85,000.

The printing paper is automatically sensitized by a high-voltage field. A light image is then projected onto it. The latent image is developed by a magnetic brush. This consists of a mass of iron filings held by a magnet. The iron filings carry positively charged pigmented resin powder. The powdered

ink clings to the negatively charged areas of the exposure. The image is fixed by heat.

► **Other Printers**—Other electrostatic printers include the Xerographic process of Haloid and the Electrographic process under development by Burroughs. A recent development by Haloid has been preparing printed circuits by Xerography. Smoke printing, a Standard Register process is essentially electrostatic. However, the pigmented material is in the form of a fine mist.

General Electric and IBM have experimented with electromagnetic dry printing processes.

► **Future**—Ultimate in electronic printing would be to display data as alphabetic and numeric characters on the face of a cathode-ray tube and produce permanent copy by electronic printing.

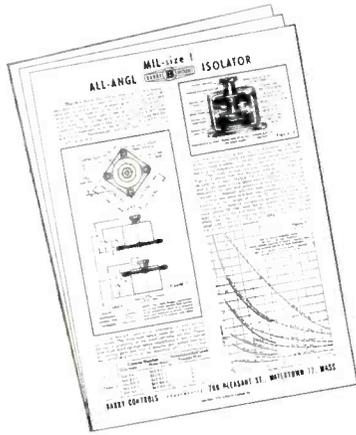
The Charactron, developed by Convair, uses special beam-forming plates to provide an electron-image beam that can display characters on the crt screen. Charactrons are used for reading data out of air-defense computers in Sage.

(Continued on page 22)

HOW to CHOOSE VIBRATION MOUNTS

For Jet and Missile Applications

Use our free engineering data sheets on ALL-ANGL Barrymount® Isolators. They describe and illustrate the operating principle of the ALL-ANGL Barry Mount, telling how it works to control shock and high-frequency vibration. They give



you load-deflection curves, transmissibility curves, and load-versus-natural-frequency curves that show how these isolators perform under various loads and vibration inputs and for different directions of applied acceleration. They explain how these curves can be used to evaluate isolator performance. And they contain detailed drawings that show all necessary dimensions and clearances.

Because of their proved efficacy in protecting delicate electronic apparatus through every flight attitude, ALL-ANGL Barry Mounts give the designer valuable aid in cramming the most instrumentation into the least space. They make it practicable to mount equipment on any available surface — upright on a deck or shelf, hung from above, attached to a bulkhead, or at any angle necessary to fit a unit into limited space. Regardless of mounting position, ALL-ANGL Barry Mounts give protection against high-frequency vibration through every operational maneuver of the most modern aircraft.

Barry engineering data sheets are free on request. Write for your copies today.

WILL MIL-SPEC MOUNTS WORK

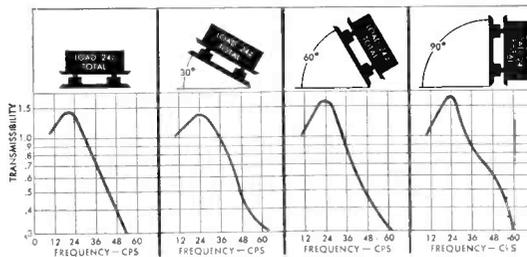
when you need protection most — at steep-angle attitudes?



ALL-ANGL ISOLATORS give vital in-flight reliability protection

Sure, you can meet the *specification* with a mount that only has to work at a 10-degree tilt. But what happens when the aircraft climbs at steep angles or goes into a 90-degree turn or dive?

That's where you need ALL-ANGL Barrymount® Isolators. You can mount 'em and fly 'em at any cock-eyed angle you choose. And they give the same sure protection to vital instruments and controls from take-off through every twist, turn, and dive of the aircraft's most violent maneuvers. These curves show why.



Write now for data sheets AA-0-1 containing detailed performance data. And remember — when your problem is protection thru every flight attitude, your answer is ALL-ANGL Barry Mounts. For recommendations, call your nearest Barry Sales Representative.

BARRY CONTROLS INCORPORATED



SALES REPRESENTATIVES
IN ALL PRINCIPAL CITIES

707 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

A project is reported underway by Convair, Haloid, IBM and Eastman-Kodak to combine electronic printing with Charactron readout. One important application would be instantaneous printing of data from high-speed computers

RCA has a so-called typesetter tube. A font of characters is im-

aged onto a photoemissive cathode. This forms the electron image beam that produces characters on the face of the cathode-ray tube. The company is looking into combining Electrofax with the crt typesetter. An initial application might be high-speed readout—perhaps for the Bizmac computers.

Register, which took over Computer Research and its CRC-102 machines some time ago, expects to offer a medium-sized digital computer for business and industry—perhaps this summer. Electronics Corp. of America is showing the Magnefile, a special-purpose machine designed for inventory work. A model is undergoing field trial in a New York department store.

► **Special Machines**—In the special-purpose machine field, Sperry Rand's St. Paul operation recently announced an order from Northwest Airlines for a computer to control airline reservations. Tele-register of Stamford, Conn. has been active in this field serving American Airlines, United Air Lines, N. Y. Central Railroad, National Airlines, Braniff, the Santa Fe and the New Haven.

Transistor-Silicon Sources To Increase

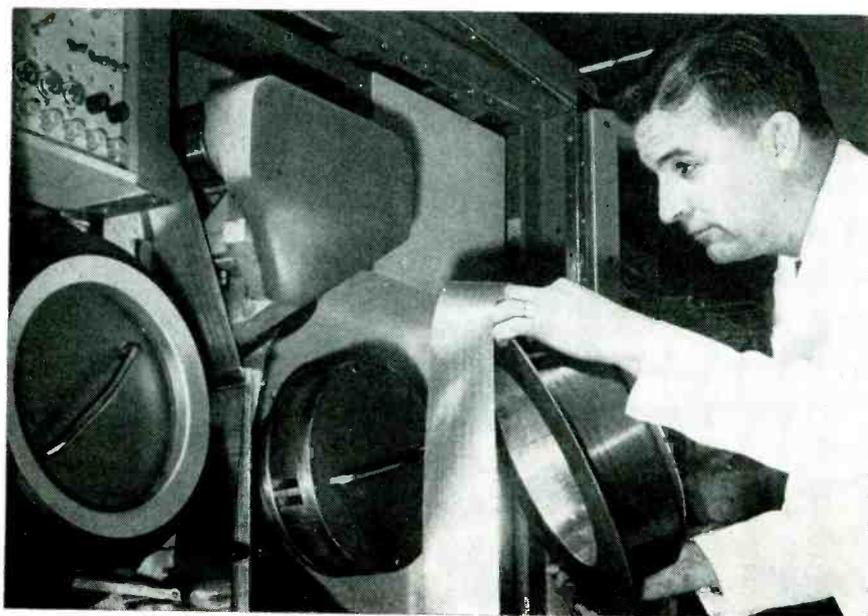
One refiner to enter supply market by mid-1956. Others may join in soon after

AT LEAST five companies have been investigating silicon processing techniques which will permit them to enter the market as suppliers. One, Sylvania, has successfully developed a zinc-reduction process and expects to be producing 300 pounds of high-purity silicon within three to five months. Sample quantities of 100 grams, refined by this process, are available now.

► **Prices**—Since November 1954, high-purity silicon has been selling for \$380 a pound. Before that time, the price was \$430 a pound. These high prices are partially attributed to the fact that silicon production has been and is today on a semi pilot-plant basis.

► **Specifications**—What constitutes transistor-grade silicon has been a continual source of confusion. Percentage values of purity are meaningless, since impurities are present of the order of 1 part in 10⁸

(Continued on page 24)



THREE-INCH wide magnetic tape is used as . . .

New Business Computer Appears

Fourth manufacturer builds giant machine. More activity evident throughout industry

PROGENY of Raytheon and Minneapolis-Honeywell, DATAmatic Corp. of Newton Highlands, Mass. last month became the fourth firm to offer a large-scale digital computer for business and industry.

The DATAmatic 1000 sells for \$1.5 million. The computer is planned in building blocks. For example, up to 100 magnetic files can be utilized. Running at 100 in. a second, each file can handle up to 60,000 decimal digits a second.

► **Wide Tape**—The machine is notable for use of a 3-in. wide tape with 31 parallel recording channels. Bits comprising the words are handled serially. Each numeric word consists of 11 decimal digits and sign. The tape is a plastic

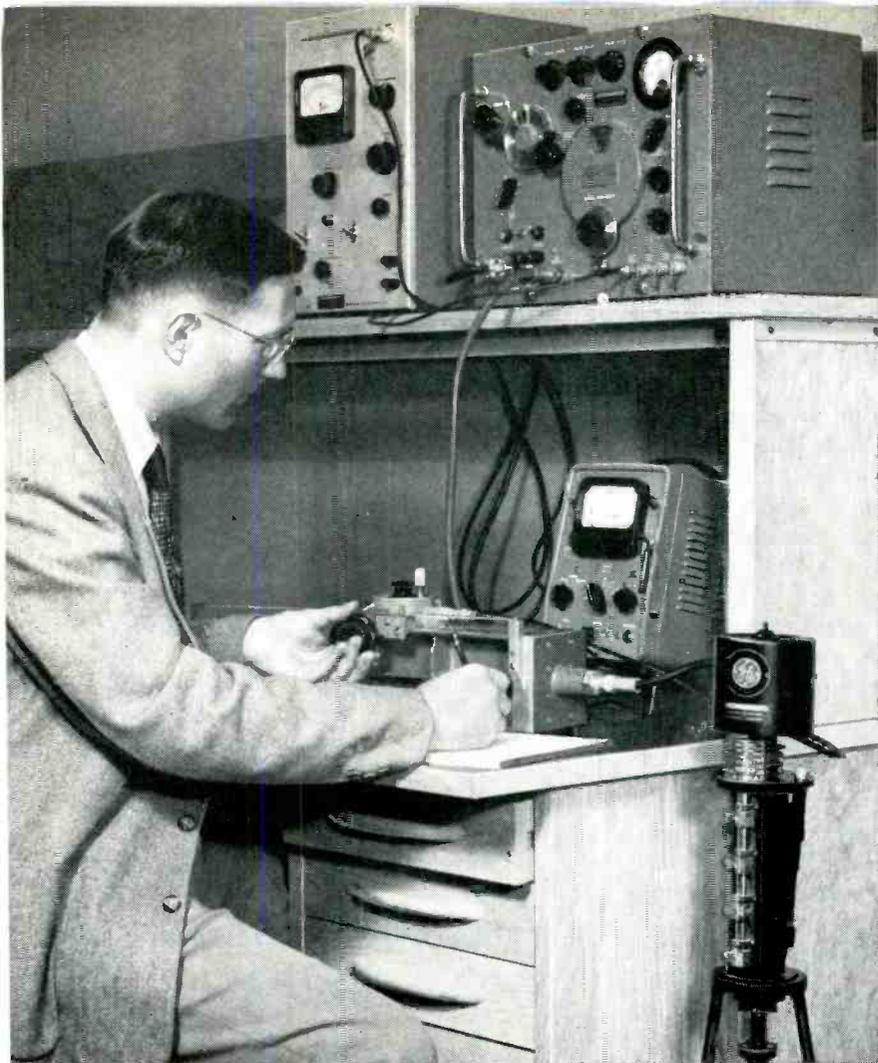
sandwich to protect the magnetic recording surface. Tape reels are 2,700 ft long and store more than 37 million decimal digits.

The machine uses a three-address code. Another feature is automatically controlled scanning of up to 10 tapes at once. This gives a scanning rate of 600,000 decimal digits a second.

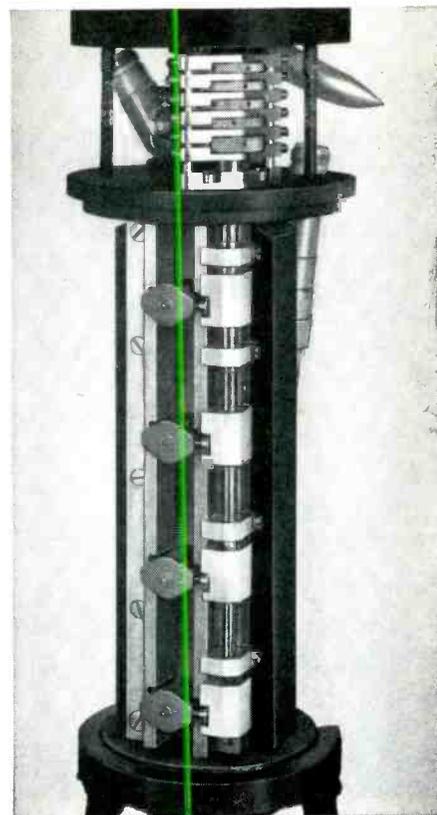
The input converter handles 900 punched cards a minute. Output is to punched cards—6,000 an hour, or printed records—either 150 120-character lines or 600 to 900 120-character lines a minute.

Other makers of large-scale computers are IBM with the 700 series, Sperry Rand with Univacs and RCA with Bizmac. A Bizmac was recently delivered to Army Ordnance in Detroit. A second machine is reported under development for business use.

► **Other Machines**—National Cash



A research engineer at the General Electric Microwave Laboratory, Palo Alto, California, measures the output-cavity tuning characteristics of G.E.'s new 15-kw high-gain klystron that features single-knob tuning.



Four knurled knobs (top of picture), one for each cavity—plus a fifth, master knob that gang-tunes the klystron—control the tuning adjustment through precision mechanical linkage. In normal band switching, only the master knob is used by the operator.

G-E klystron research originates single-knob tuning ... for rapid band switching ... for flat power output!

MORE efficient use of klystrons for radar—military and commercial—is a direct result of single-knob tuning pioneered by General Electric research. Band switching, whether to counter enemy jamming, to avoid friendly signal interference, or for other purposes, now is fast and sure—entails no loss of power.

One control knob tunes the new G-E klystron over its full 200-mc frequency range . . . and this control can be remotely actuated by cable or other device.

The operator needs no special knowledge or training to switch the General Electric klystron from one band to another—the four cavities are pre-tuned, and their alignment is preserved at all times. Power output of the klystron stays flat and high over the entire frequency range, varying less than 1 db.

General Electric has led in klystron research and development, applying major resources in order to

realize the full potential of these long-life, high-gain microwave tubes. G-E single-knob tuning advances klystron design still further. Ask for full information! Consult with G-E tube engineers on any problem which involves klystron choice and application! *Tube Department, General Electric Company, Schenectady 5, New York.*

CHARACTERISTICS OF NEW G-E KLYSTRON:

Peak power output	15 kw
Tuning range	2500 to 2700 mc
Efficiency	40 percent
Gain	53 db
Beam voltage	20.5 kv
Avg power output	150 w
Duty cycle . . . . .	.1 percent
Magnetic field requirements . . . . .	.600 to 700 gauss

Progress Is Our Most Important Product

GENERAL  ELECTRIC

to 10°. At these values, normal methods of chemical analysis to determine purity are totally unsuitable making it necessary to measure the resistivity of single crystals grown from each batch.

To help establish a standard, the Industrial Mobilization Activity has prepared a specification for transistor-grade silicon. It is believed that commercial production of silicon to meet these specifications will raise the quality of silicon to be sold and will aid in the development of various transistor devices.



ENGINE performance of sports car is rapidly checked out as

Electronics Aids Ignition Mechanics

Dynamic engine analyzer developed by oil company is marketed by electronics firm

RELATIVELY INEXPERIENCED personnel can now analyze automotive engine troubles in only a few minutes with the help of an electronic engine analyzer. Developed over a period of years by Socony-Mobil Oil Co., for use in its laboratories and for field work, the prototype version of the instrument has been redesigned by Du Mont for volume production.

The commercial version of the instrument sells for \$725 and is aimed at the automotive servicing market.

► **What It Does**—When connected to a car engine by two clip-on leads, the instrument shows simultaneous waveform presentations of the behavior of each cylinder of the engine. The condition of the capacitor, spark coil and plugs can be determined from the waveforms.

TV Screen Sizes Start To Shrink

Smaller picture tubes gain as lightweight portables for second set market increase

PUBLIC preference for larger tv screens seems to have reached saturation. Now smaller tubes under 15 inches are making a comeback. A year ago, the set industry was still pushing larger screens, the 24-inch and 27-inch set and wondering how far the large screen trend would go. Now the question seems to be how small a screen can be sold.

► **New Model**—RCA is now in production on a portable set with an 8½-inch screen. It measures 10¼-inches high, 9¼-inches wide and 10¾-inches deep. The new tube incorporates an electrostatic focus gun and its length has been reduced to 10¾ inches by using wide-angle 90-degree deflection. The chassis has 10 tubes plus kinescope, four crystals, one tube rectifier and a double selenium rectifier. Seven of the 10 tubes are double purpose.

General Electric triggered the trend to smaller screens when it introduced its 14-inch portable tv sets last year. Sales exceeded expectations and now the firm has three new 14-inch portables on the market. (ELECTRONICS, p. 20, Feb. 1956).



New RCA portable tv receiver with 8½ inch screen

► **Why**—In addition to the lower retail prices that the smaller sets make possible, their success is generally attributed to the growing replacement and second set markets which are estimated to account for half of all tv set sales.

► **Market**—Rise in sales of smaller-sized picture tubes as a result of the trend to portables does not yet show up in available RETMA statistics. But past sales trends of tubes under 15 inches indicate how far small-tube business has dropped. Even with increased sales of 14-inch sets last year, all tubes under 15-inches accounted for less than 3 percent of total picture tube sales.

Banks Extend Services By Facsimile Link

Two Boston banks use service to tie branches to central bookkeeper

TWO RECENT installations of facsimile equipment in Massachusetts have put into action the interest that banking companies have shown in electronics as a labor-saving device.

In both the Provident Institution for Savings in Boston and the Worcester County Institution for Savings, teller's cages in the main office and branches are tied to a central bookkeeping department by high-speed facsimile units. Copies of bank balance cards and signatures are transmitted to the teller on request in 5 to 6 seconds.

► **Permanent Records** — Advantages claimed for the facsimile method of connecting branches with the main office are the lower maintenance costs and the production of a permanent record.

► **Cost**—The \$8,000 system is serviced by Alden Electronic and Impulse Recording Equipment Co. The facsimile is used with a punch-

(Continued on page 26)

10 KC

540 KC



**IN THE
10 KC TO 540 KC
RANGE...**

The New

SP-600-VLF communications receiver

The new SP-600-VLF is *more* than just a receiver—it is a precision communications instrument that operates over the entire range from 10 KC to 540 KC with outstanding stability and precise calibration. It offers features and quality found in no other receivers—even those costing twice as much.

As a communications receiver, the SP-600-VLF is ideal for applications in AM radio telephone, CW telegraph, AM-MCW telegraph signals and carrier-shift radio teletype signals, as well as many military communication requirements.

As a laboratory instrument, the SP-600-VLF may be used in making measurements of low-frequency null detector devices, sonar equipment, and any other application where a stable, precisely calibrated very-low-frequency demodulating instrument is required.

The SP-600-VLF offers continuous tuning over the entire range from 10 KC to 540 KC in 6 bands. Exceptionally fine tuning mechanism plus a vernier dial provides continuous expanded scales over each frequency band for accurate logging and resetability. All components

have characteristics equivalent to military component specifications as is practical.

Whether you need a really good VLF communications receiver, or a precise VLF laboratory instrument—you'll find there is no equal to the SP-600-VLF at any price.

FEATURES

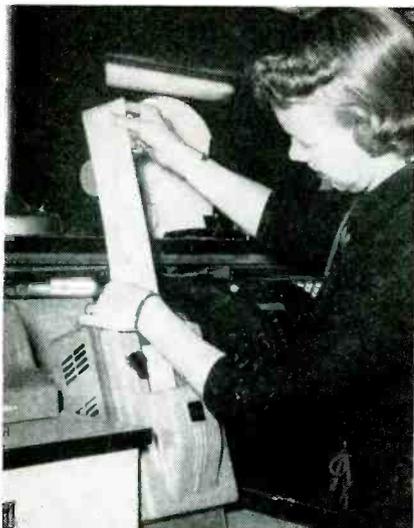
- 50:1 ratio between tuning control and main dial. 6:1 ratio between main dial and vernier.
- Provision for crystal-controlled fixed frequency reception.
- Extremely low drift—between .05% and 1.0% depending upon frequency.
- Noise limiter circuit reduces pulse type interference.
- Send-receive switch eliminates warm-up time between messages.
- 2-stage RF amplification provided on all bands.
- Taps provided for operation on 90 to 270 Volts, 50/60 cycle.

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SPECIFICATIONS BULLETIN E456**



HAMMARLUND

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Branch teller gets deposit card in 5 seconds via facsimile

tape bookkeeping system that reduces time on a deposit transaction to about 30 seconds.

Television Set Penetration Deepens

TELEVISION receivers in the U. S., both color and monochrome, totalled 36.9 million on Jan. 1, 1956 and may reach 39.8 million by the beginning of next year, according to new NBC estimates. Nearly 71 percent of the 48.6 million homes in the country are now tv equipped and penetration is expected to reach nearly 74 percent by the first of 1957.

► **Markets**—At the beginning of the year, there were 1.5 million secondary sets in homes. The number may increase to 2 million by the first of 1957. The figures indicate that 4.2 percent of all tv homes now have more than one set. It may soon go over 5 percent.

Sets in hotels, motels and institutions of all kinds are estimated at 1 million and are expected to total 1.3 million by 1957.

► **Replacement**—Growing proportion of new set sales are replacements for sets being scrapped. At the end of 1953 accumulated scrappage was about 800,000.

In 1955 about 40 percent of the 7.4 million sets sold replaced sets scrapped. Total set scrappage now is estimated at over 6 million.

FUTURE MEETINGS

APRIL 2-4: Harvard University, Air Force Cambridge Research Center, IRE Symposium on Microwave Properties and Applications of Ferrites, Harvard University, Cambridge, Mass.

APRIL 5-6: IRE, AIEE, ISA, Magnetic Amplifier Conference, Hotel Syracuse, Syracuse, N. Y.

APRIL 11-13: 1956 IRE 7th Region Technical Conference, Hotel Utah, Salt Lake City.

APRIL 13-14: Tenth Annual Spring Television Conference, IRE, Engineering Society Building, Cincinnati, Ohio.

APRIL 16-18-19: NARTB Tenth Annual Broadcast Engineering Conference, Conrad Hilton Hotel, Chicago, Ill.

APRIL 23-24: New England Radio Engineering Meeting, IRE, Sheraton Plaza, Boston.

APRIL 23-25: International Conference on Electron Physics, NBS, College Park, Md.

APRIL 25-27: Symposium On Nonlinear Circuit Analysis, II, Polytechnic Institute of Brooklyn, New York, N. Y.

APRIL 26-27: Conference On Recording and Controlling Instruments, AIEE, ASME, ISA, Bradford Hotel, Boston.

APRIL 29-MAY 3: Fourth Annual Semiconductor Symposium, Electrochemical Society, Mark Hopkins Hotel, San Francisco.

APRIL 30-MAY 3: URSI Spring Meeting, NBS, Wash., D. C.

APRIL 30-MAY 4: SMPTE 79th semiannual convention and exhibit, Hotel Statler, New York, N. Y.

MAY 1-3: The 1956 Electronic Components Symposium, U. S. Department of Interior Auditorium, Washington, D. C.

MAY 14-16: National Aeronautical & Navigational Conference, PGANE, Biltmore Hotel, Dayton, Ohio.

MAY 14-17: The Design Engineering Show and Conference, Philadelphia, Pa.

MAY 15-16: Industrial Nuclear Technology Conference, NUCLEONICS, Armour Research, Museum of Science and Industry, Chicago, Ill.

MAY 17-19: Thirtieth Engineering Industries Exposition and Annual Convention, New York State Society of Professional Engineers, Statler Hotel, New York, N. Y.

MAY 21-24: Electronics Parts Distributors Show, Conrad Hilton Hotel, Chicago, Ill.

MAY 21-22: RETMA Symposium on Reliable Applications of Electron Tubes, Irvine Auditorium, University of Penna., Philadelphia, Pa.

MAY 23-26: Annual meeting, National Society of Professional Engineers, Ambassador Hotel, Atlantic City, N. J.

Industry Shorts

► **Electronics** industry will grow by some 66 percent in the next eight years to reach a volume of \$18 billion, according to an announcement by RCA.

► **Motorola** has entered auto-radio after-market with eight-tube plus one-transistor hybrid set that will fit a number of 1956 models.

► **Million mark** in color tv sales may not be reached until 1958 and it may be 1959 or 1960 before color equalizes with black and white in total units sold, according to Dr. W. R. G. Baker of GE.

► **Royal Air Force** has created a new aircrew category of air electronics officers, primarily for Britain's V-bomber force.

► **Navy** awarded a \$22.7 million contract to Westinghouse for the Aero 13 fire-control system to be installed in the Douglas F4D Skyray.

► **Plan** whereby one share of Burroughs common stock will be issued for each two shares of outstanding Electrodata stock is in the works.

► **Estimated** 1,100 tons of metal powder was used for magnetic cores in 1955.

WIDE RANGE
WIDE SWEEP-
Sweeping
OSCILLATOR

The
KAY
CALIBRATED
Mega-Sweep



- **Continuously Tunable Thru Video VHF and UHF Frequencies, 50KC-950MC Range**
- **Sweep Widths to 40 MC**
- **Single Dial Tuning**

Used with a standard cathode ray oscilloscope, the Kay Calibrated *Mega-Sweep* will display the response characteristic of wide band circuits over the frequency range of approximately 50 kc to 950 mc. It features a calibrated dial indication of the approximate output frequency. The center frequency of the sweeping output voltage may thus be set to an accuracy of about 10%. The calibrated *Mega-Sweep* is the ideal instrument for use in alignment of amplifiers and filters... also as an FM source of wide range for instructional and lab purposes.

SPECIFICATIONS

- Freq. Range:** 50 kc to 1000 mc.
- Freq. Sweep:** Sawtooth, adjustable to 40 mc. Repetition rate, 50 to 100 c/s.
- RF Output:** *High*, approx. 100 mv max. into open circuit. *Low*, 5 mv into open circuit.
- RF Output Control:** Microwave attenuator continuously variable to 26 db.
- Output Waveform:** Less than 5% harmonic distortion at max. output.
- Meter:** Provides crystal detector current for peak output.
- Regulated Power Supply:** 105-125 v., 50 to 60 cps. Power Input, 100 watts.

Send for Catalog 110-A

\$495 f.o.b. factory

KAY
SWEEPING OSCILLATORS
for every application



KAY
Mega-Sweep

Widest range of the Kay line of sweeping oscillators. Provides continuous frequency coverage up through UHF-TV bands - 50 kc to 1000 mc. Widely used in radar system development and in alignment and testing of TV and FM systems and components, as well as wide band IF and RF amplifiers and filters. Freq. range, 10 mc to 950 mc. Write for Catalog 100-A. Price, \$465 f.o.b. factory.



KAY
111-A CALIBRATED
Mega-Sweep

Higher output model calibrated *Mega-Sweep*, with zero level baseline. Higher output facilitates frequency response testing of UHF converters or tuners. Wider sweep width permits multi-channel response viewing. Zero level baseline is convenient means of measuring gain of test circuit.

Frequency Range	SPECIFICATIONS	
	Output Impedance	Output Voltage (Into Load)
1. 10 mc-950 mc	70 ohms unbalanced	0.15 Volts
2. 450 mc-900 mc	300 ohms balanced	0.3 Volts

Sweep Width: Continuously variable to approx. 40 mc max.
Write for Catalog 111-A Price, \$575 f.o.b. factory

KAY 112-A CALIBRATED *Mega-Sweep*
Same as 111-A, except total frequency range is 800 mc to 1200 mc. Catalog 112-A. Price, \$575 f.o.b. factory.

Dept. E-4
KAY ELECTRIC COMPANY
14 MAPLE AVENUE PINE BROOK, N. J.
CAIdwell 6-4000

ELECTRONIC DESIGN AND PRODUCTION SIMPLIFIED

Plug-in Unit Construction Using Alden Terminal Card System Speeds Output, Eliminates Prototypes, Simplifies Trouble-Shooting and Servicing



NOT THIS — Typical "rat's nest" wiring results from point-to-point construction techniques traditional to the electronics industry.



BUT THIS—Neat, compact vertical "planes of circuitry" result from construction based on Alden Terminal Card Mounting System.

Once the electronic circuitry has been worked out, the construction of a piece of equipment or a system becomes a production engineering problem that is primarily mechanical in nature.

Alden's recognition of this fact has made possible a mass-production system of assembly to the electronics industry. Alden Products Company's time-proven Terminal Card System—based on modular, plug-in unitized construction of functional groupings of circuitry—brings new economies to production runs ranging from 100 to 100,000 pieces.

ADVANTAGES OF THE ALDEN TERMINAL CARD SYSTEM

First, you can lift experimental circuits right from the bread board onto the Alden Terminal Mounting Cards, utilizing the components layout you plan on Alden Full-Scale Planning Sheets. Thus, your production is organized immediately on a function-by-function basis on terminal cards mounted in compact vertical planes.

Second, circuitry organized on Alden Terminal Cards snaps into open-sided Alden Basic Chassis which provide a protective housing and convert each function into a compact plug-in unit.

Third, the finished equipment is easy to "trouble-shoot". You can include Alden "tell-tales" on the front panel of each chassis to indicate any defect instantly. Unskilled personnel spot trouble and replace the plug-in unit within 30 seconds.

Fourth, the Alden Back Connectors mounted on the chassis provide a single, readily accessible point of check for all "in" and "out" leads. These are easily numbered and color-coded so that the layman can make accurate first-level tests.

ELEMENTS OF THE ALDEN TERMINAL CARD SYSTEM

In the Alden System, you get all the elements you need to functionalize your production. Your assemblies are made up on a block diagram basis, as opposed to the normal circuit diagram point-to-point wiring method.

Terminal Cards: These cards are pre-cut to size, in lengths up to 3 feet. They are pre-punched with 0.101" holes on $\frac{1}{4}$ " centers for maximum flexibility in chassis layout.

Mounting Sockets: Available for 7, 8, 9 pin connections, miniature and stand-

ard octal, tube sockets are furnished for stud mounting or with right-angle brackets for mounting directly to the terminal card.

Miniature Ratchet Terminals: Stake into terminal card and provide positive grip for feed-through or single-end connections for all pigtail-lead components. Soldering serves only to establish the electrical connection. Lead dress is simplified—excess pigtails are snipped off at the terminal.

Jumper Strips: Stake under terminals for either jumper or common wiring. These strips and other wiring can be readily replaced with printed or etched wiring.

WHEN YOU USE THE ALDEN SYSTEM, you enable your production organization to build "custom" products on a true mass-production basis. Production planning is simplified, for at the design stage it becomes natural to break down equipment into simple sub-assemblies of extreme accessibility and ease of manufacture. You can use the Alden Full Scale Planning Sheets and have a custom design tailored to your needs but laid out to use standard components that are simple to procure and go together by the simplest assembly methods.

Procurement is made easy because all information comes to your purchasing department from the laboratory beautifully organized on the Planning Sheets. The standard items that are involved help eliminate the headaches of expediting, yet you have custom tailored features which do not delay procurements.

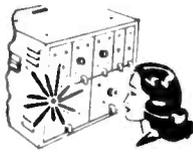
Sub-contracting becomes simpler because you can farm out your work, specifying Alden techniques or supplying Alden parts, and be sure of getting sub-units of satisfactory quality.

WRITE TODAY on your company letterhead for information on this improved system of designing, manufacturing and servicing.

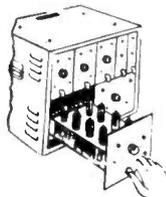
Electronic Construction and Servicing Are 4 Ways Better



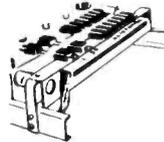
Circuitry subdivided, function by function into attractive plug-in units.



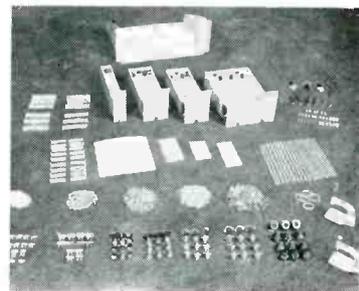
Tiny tell-tales spot trouble instantly, eliminate need for trained technicians on spot.



Layman can plug in replacement spare in 30 seconds.



All leads are at a single accessible point, numbered and color-coded so layman can make first-level tests.

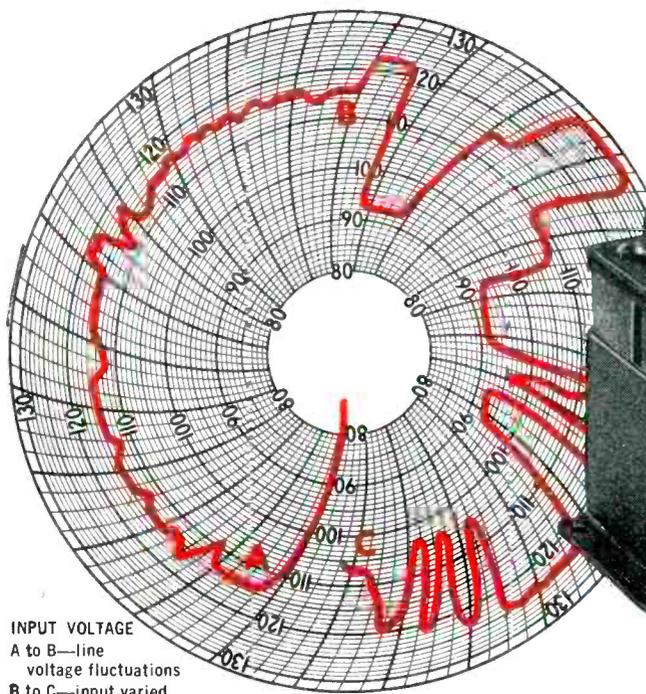


WANT TO TRY THE ALDEN SYSTEM? Send for this complete basic assortment of Alden Circuit Packaging Components. Includes all the elements you'll need to assemble a variety of complete chassis based on the Alden Terminal Card System. Price—\$249.50. Ask for Kit #37.

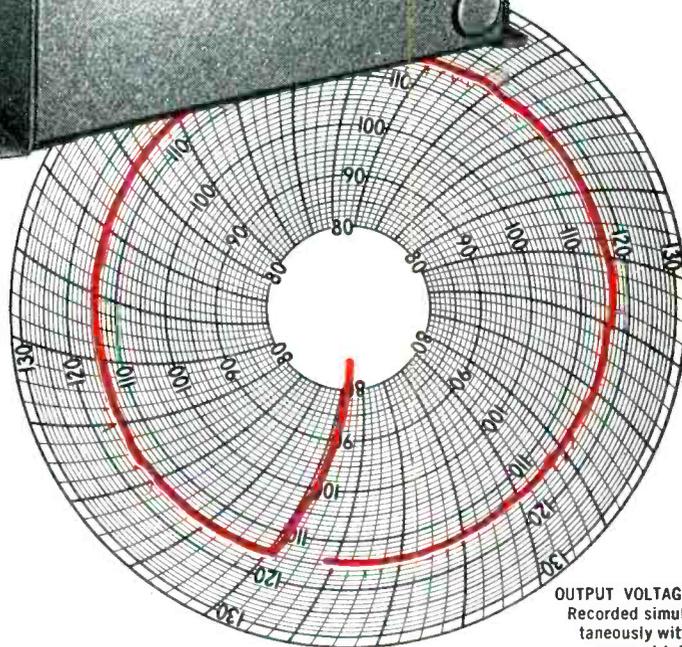
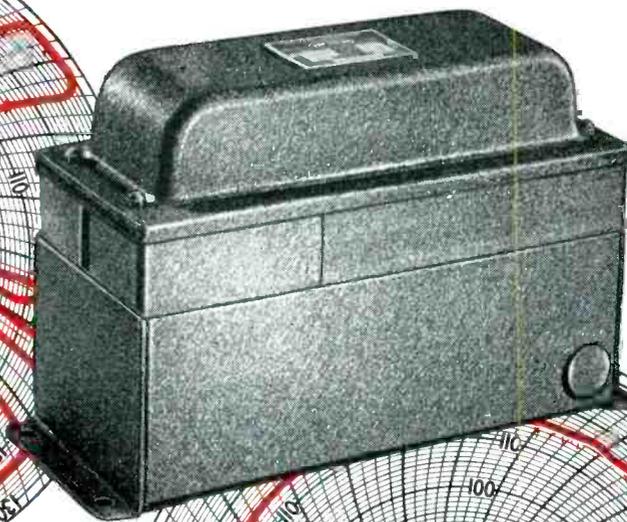
ALDEN PRODUCTS COMPANY

Manufacturing Product Engineers

Brockton, Mass.



INPUT VOLTAGE
A to B—line
voltage fluctuations
B to C—input varied
with variable transformer



OUTPUT VOLTAGE
Recorded simultane-
ously with
curve at left

± ½ % Stabilization

**MAKES YOUR EQUIPMENT
PERFORM BETTER**

RAYTHEON VOLTAGE STABILIZERS

These curves demonstrate one simple fact—that if the satisfactory operation of your equipment depends on a well regulated power supply, Raytheon voltage stabilizers are your assurance of top performance under virtually all conditions.

How these curves were made

These curves were traced simultaneously by identical recording voltmeters. The left hand chart indicates input voltage, and the other, output of a standard Model

VR-6110 Raytheon voltage stabilizer. Region AB results from actual line variations caused by motor-driven machines. The wider fluctuations, BC, are produced by a variable transformer in the stabilizer input.

26 Models

Raytheon voltage stabilizers are available in a wide variety of input and output voltages from 15 to 2000 watts and, where needed, harmonic filtered models for 250, 500 and 1000 watts.

For full information see your electronic supply house or write Dept. 6120—please request bulletin 4-260.

RAYTHEON MANUFACTURING COMPANY

Equipment Marketing Department, Waltham 54, Mass.

CHECK THESE IMPORTANT FEATURES

- Guaranteed stabilization to $\pm \frac{1}{2} \%$
- Stabilized voltage increases tube life as much as 50 %
- Close regulation with temperature and frequency changes
- Response time within 3 cycles
- Compact, rugged, dependable, low-cost

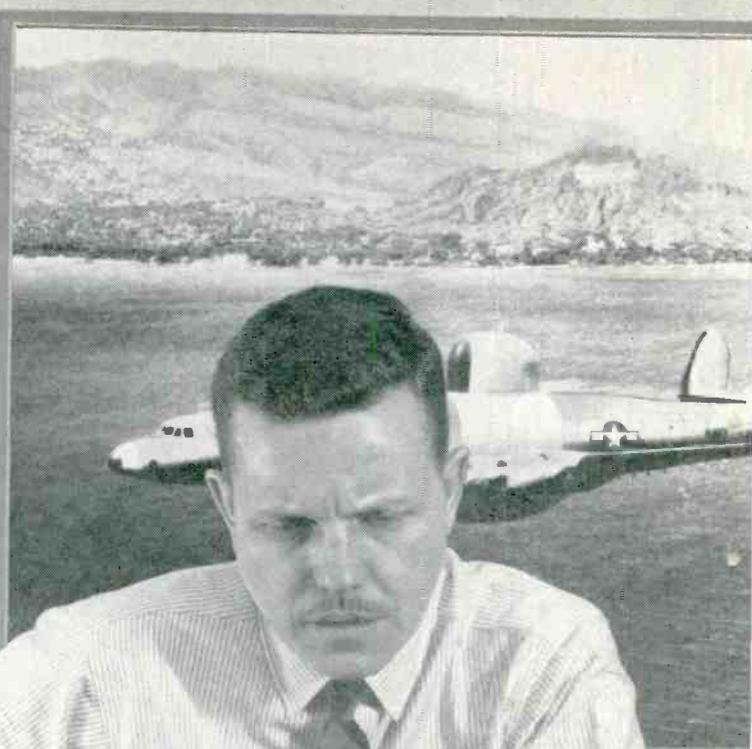
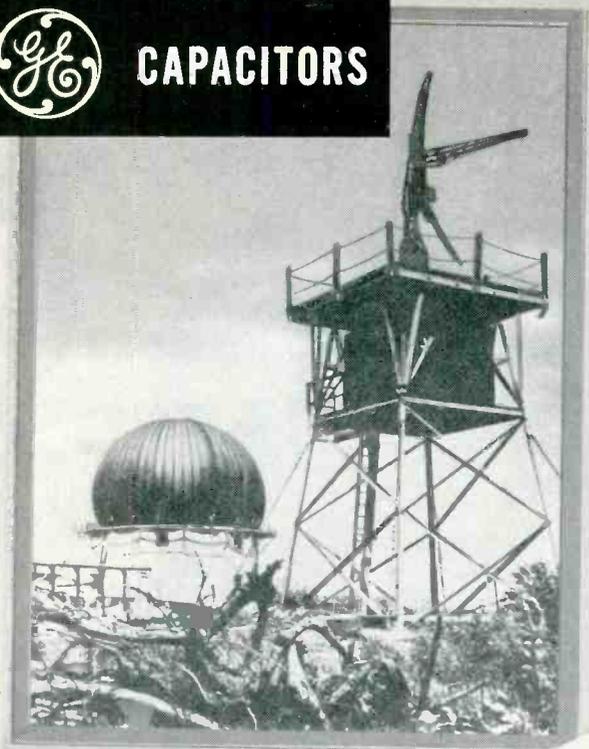


A-4014

Excellence in Electronics



CAPACITORS



10 seconds or 10,000 hours, whatever the life span required, G-E pulse-forming network capacitors are engineered for the specific job. The life-test data accumulated over more than twelve years helps G-E engineers meet your special conditions exactly.

12 years of test data back your selection of General Electric pulse-forming networks

Capacitor service life requirements from 10 to 10,000 hours filled for hundreds of radar and guided missile applications by accumulated data

Whatever service life your application calls for and whatever the conditions of operation, General Electric can deliver a capacitor pulse-forming network that will give the finest performance for your radar and missile needs.

The reason is the wealth of data accumulated by G-E engineers through twelve years of continuous life tests carried out on capacitor pulse-forming networks of practically every type, operating under widely varying conditions of temperature, voltage, and other service factors. From this data and experience, General Electric has established life limitations that enable networks to be produced that will match almost any specification—whether it calls for a service life of 10 hours or 10,000 hours. In addition, to the exacting needs regarding pulse width, rise time, number of pulses per second, and ripple, special requirements also can be met. These include multiple width networks and size reductions based on forced air circulation.

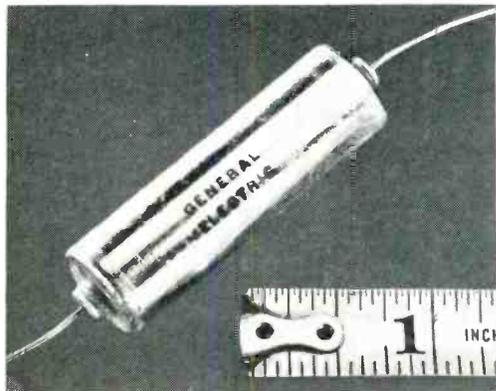
The secret of G-E network performance lies in quality manufacture. Capacitor sections are constructed of low-loss kraft paper and high purity aluminum foil. Inductance coils are wound on threaded forms for stability of inductance throughout the life of the unit. Highest quality mineral oil is used for impregnation. Rugged, hermetically sealed cases help protect all components.

G-E pulse-forming networks have already proved their dependability in thousands of military installations on aircraft, ships, and on the ground, as well as in highly specialized missile applications. The engineering facilities of the Capacitor Department, Hudson Falls, N. Y., are at your disposal. Your local G-E Apparatus Sales Office will see that you receive application assistance with your network problems. Or write for bulletin GEA-4996 to the General Electric Company, Section 442-32, Schenectady 5, N. Y.

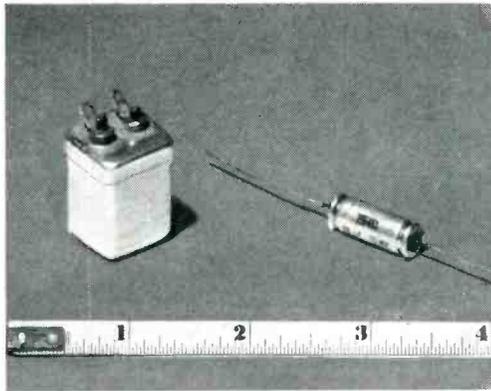
Progress Is Our Most Important Product

GENERAL  ELECTRIC

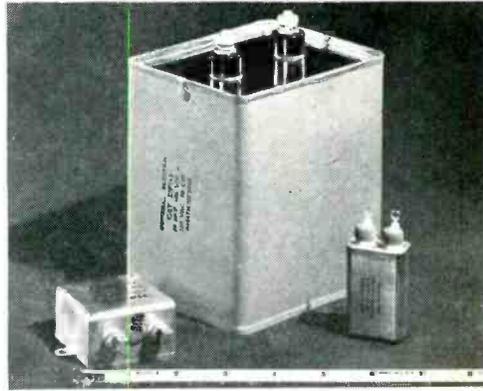
A FULL LINE OF CAPACITORS FOR THE ELECTRONICS INDUSTRY



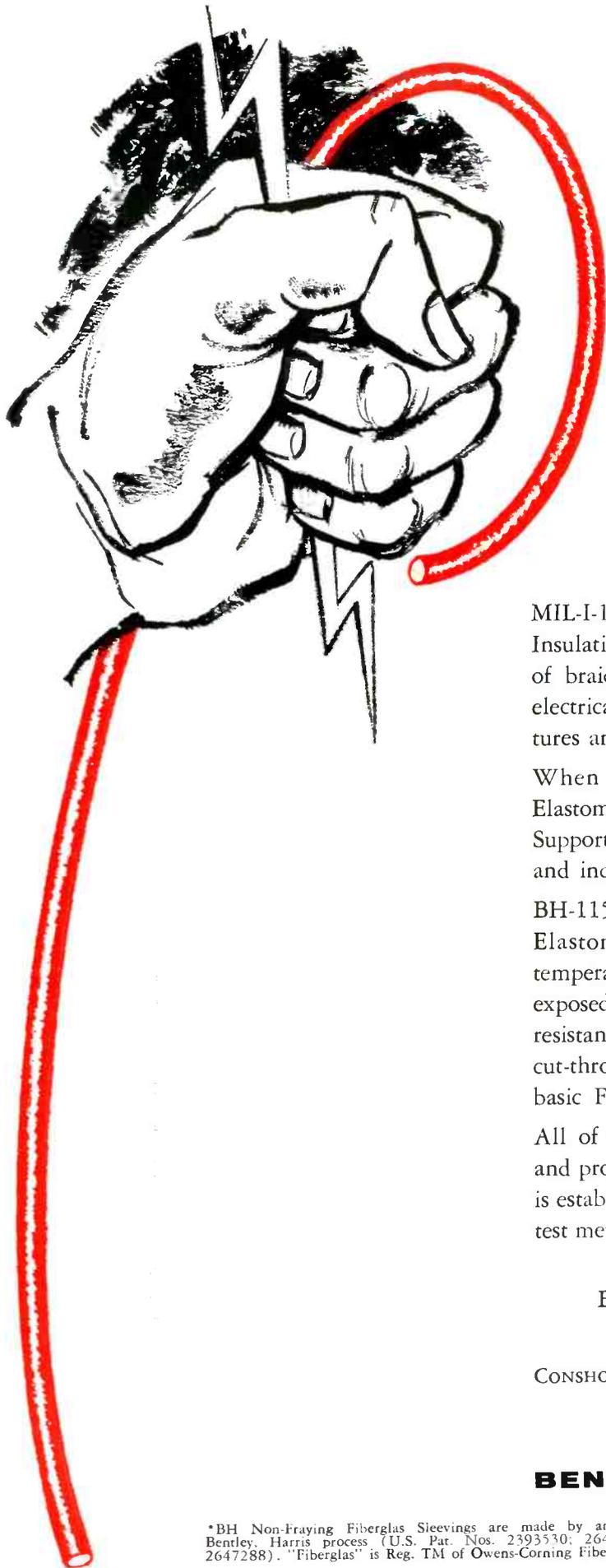
METAL-CLAD TUBULAR CAPACITORS for all d-c uses where utmost reliability is required. Ratings: .001 to 1.0 uf, 100-600 v. d-c. Tol: $\pm 5\%$, $\pm 10\%$, or $\pm 20\%$. Temp. range: -55°C to $+125^{\circ}\text{C}$ with solid impregnant; -55°C to $+85^{\circ}\text{C}$ with mineral oil. Write for GEC-987.



125 C TANTALUM* CAPACITORS—for high speed aircraft and missile systems where quality, long life, and small size are main requirements. In plain or etched foil, and rectangular or tubular designs. Ratings: .25 to 180 uf, 10 to 100 volts. Tolerance: $+20\%$ (plain foil), -15 to $+75\%$ (etched). Temp. range: -55°C to $+125^{\circ}\text{C}$. Write for GEA-6258. *Reg. trade-mark of General Electric Co.



MIL-C-25A CAPACITORS—for filter, by-pass, and blocking in military equipment. Built to MIL-C-25A specifications. Ratings: .05 to 15 uf at 100 to 12,500 v. d-c in case styles CP50, CP60, CP70 series. Temp. range: -55°C to $+85^{\circ}\text{C}$, and -55°C to $+125^{\circ}\text{C}$. Write for GEC-810.



**For all the stringent
requirements of
MIL-I-18057
BH "1151"**

MIL-I-18057 is a functional type test — for Class H Insulating Sleeving. It sets the standard for performance of braided Fiberglas Silicone Elastomeric sleeving in electrical insulating systems subjected to high temperatures and mechanical stress.

When you specify BH-1151 Fiberglas Silicone Elastomeric Sleeving, it meets these high standards. Supported by long record of service in both military and industrial applications.

BH-1151 combines the superior qualities of Silicone Elastomer — extreme low temperature and high temperature flexibility, resistance to degradation when exposed to high temperature, chemical inertness, and resistance to crazing — with the support, resistance to cut-through and dimensional stability offered by the basic Fiberglas braid.

All of these properties are required by MIL-I-18057 and proof of BH-1151's ability to meet these standards is established by data obtained in each of the prescribed test methods. These data sheets are available on request.

BENTLEY, HARRIS MANUFACTURING CO.

1304 Barclay Street

CONSHOHOCKEN, PA.

TELEPHONE: TAYLOR 8-0634

BENTLEY, HARRIS

*Fiberglas**
SLEEVINGS

*BH Non-Fraying Fiberglas Sleeveings are made by an exclusive Bentley, Harris process (U.S. Pat. Nos. 2393530; 2647296 and 2647288). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.



testimonial to a productive society...



The millions of components which make up our buildings, factories, homes . . . the manufactured items contributing to our way of life . . . all attest to the quality and speed of American production. Aiding efficiency by eliminating fatigue, are famous *Royal* stools and adjustable chairs like these shown. It will pay you to personally inspect the many models available.

now turn the page for additional examples...

Royal

METAL FURNITURE SINCE '97

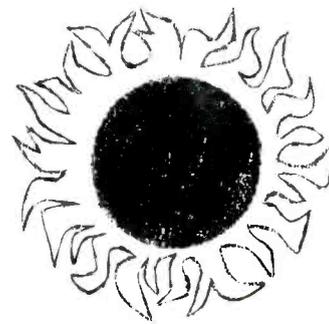
ROYAL METAL MANUFACTURING COMPANY
175 N. Michigan Avenue • Chicago 1, Illinois
Offices and plants from coast to coast



a



b



Shown on the other side of this page, are the 535-S Adjustable Chair, 621-T Stool and the 515-S Adjustable Chair.



c



d

**ROYAL'S EXCLUSIVE
MICRO-HITE SEAT
ADJUSTMENT. NO TOOLS
... WORKS INSTANTLY.**

Anyone can operate it effortlessly. Saves extra time when production shifts change. You don't even have to turn unit upside down to make adjustment. Simply raise seat to full height, tighten handwheel, sit down, then release handwheel 'til seat lowers to comfortable working height. Seat stays exactly at that position—no slipping—absolutely safe and dependable.



e

To meet your every industrial seating problem... *Royal* Factory Seating!

(a) 515-S ... ADJUSTABLE HEIGHT CHAIR—Standard equipment in hundreds of leading industrial plants. Back rest adjusts up, down, forward and back. 15-inch wide scroll shaped steel seat fitted with tempered Masonite panel. Construction is all-welded tubular steel. Gray enamel finish. Telescopic legs lock at 1-inch intervals, 17" to 25".

(b) 513 ... ADJUSTABLE CHAIR—Engineered to encourage proper seating habits—help eliminate backache and fatigue. All-welded tubular steel frame, large shaped back adjusts up, down, forward and back. Steel seat has Masonite panel. Patented leg extensions adjust at 1-inch intervals from 17" to 25".

(c) 625-T ... SWIVEL CHAIR—One of the finest factory chairs ever engineered. Back rest fully adjustable up, down, forward and back. Scroll-shaped Masonite panel in seat. Rubber-cushioned

floor glides. All-welded construction. Equipped with famous *Royal* MICRO-HITE seat height adjustment, from 27" to 33". Also 625-M, 22" to 28".

(d) 668 ... SWIVEL CHAIR—Exceptionally comfortable with extra-thick foam rubber 17" x 16" cushion mounted on a heavy-gauge steel seat pan. Form-shaped tilting back rest is well-padded, fully adjustable 4 ways. Has MICRO-HITE seat height mechanism, channel footrest. Model 668-M adjusts 21" to 27". Model 668-T, 26" to 32".

(e) 511 ... ADJUSTABLE STOOL—All-welded tubular steel construction. 14-inch diameter seat has Masonite panel. Patented leg extensions lock securely at 1-inch intervals. Available in two models: 511-S adjustable from 17" to 25", and 511-T adjustable from 24" to 32". Popular in both office and factory.

Royal Metal Manufacturing Co., Dept. 294
175 N. Michigan Ave., Chicago 1, Ill.

____ Please send information on complete line.

____ Please have representative call.

Name _____

Address _____

City _____ Zone _____ State _____



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Factories: Los Angeles • Michigan City, Ind.
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Showrooms: Chicago • Los Angeles
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Authorized Dealers Everywhere.

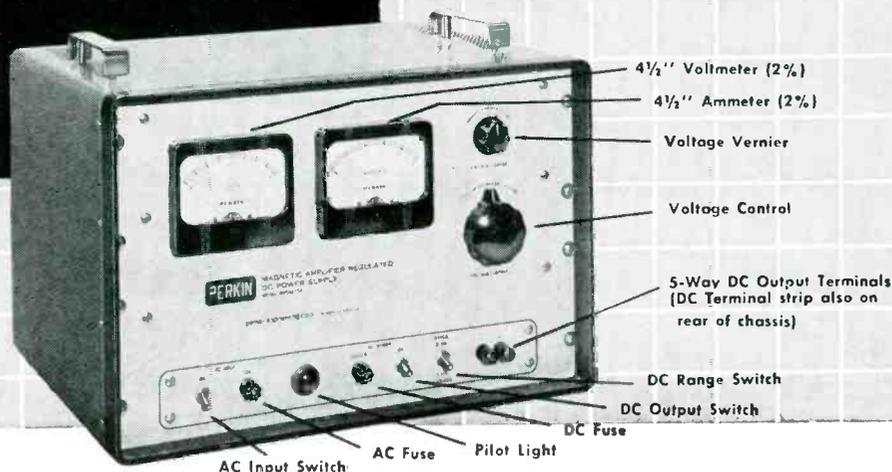
**2 TO 36
VOLTS
@ 15 AMPS
DC POWER SUPPLY**

The **NEW PERKIN**

MODEL MR532-15A

with $\pm 1/2\%$ **REGULATION**

**IMMEDIATE
DELIVERY!**



**Now...for Your Laboratory...the most versatile TUBELESS,
Regulated and Filtered Power Supply**

**OTHER STANDARD MODELS
AVAILABLE:**

VOLTS	AMPS	REG.	MODEL
0-32	25	$\pm 1\%$	M60V
24-32	10	$\pm 1/2\%$	28-10WX
24-32	30	$\pm 1/2\%$	28-30WX
5-40	30	$\pm 1\%$	MR 1040A
24-32	100	$\pm 1/2\%$	100 XA

Ripple on all above models: 1% rms
6, 12 and 115 V models also avail-
able. Write for complete specifica-
tions on all models listed above.

- REMOTE SENSING • VERNIER VOLTAGE CONTROL
- NO TUBES, MOVING PARTS OR VIBRATING CONTACTS

Specifications . . .

REGULATION: 5-32V Range: $\pm 1/2\%$ for combined line changes of 105-125VAC and load of 0-15A. DC.

2-5V Range: $\pm 2\%$ for combined line changes of 105-125VAC and load changes of 0-15A. DC.

32-36V Range: $\pm 2\%$ for combined line changes of 110-125VAC and load changes of 0-15A. DC.

RIPPLE: 1% rms max. @ 36 volts and full load. Increases to 2% @ 2 volts and full load

AC INPUT: 105 to 125 volts, 1 phase, 60 cps. (8 amps, Input)

RESPONSE TIME: 0.1 to 0.2 seconds maximum.

DIMENSIONS: 19 1/2" wide x 15 1/2" deep x 13 1/4" high with cabinet. (19" wide x 14 3/4" deep x 12 1/4" high rack panel construction)

FINISH: Gray Hammertone **WEIGHT:** Approx. 135 lbs.

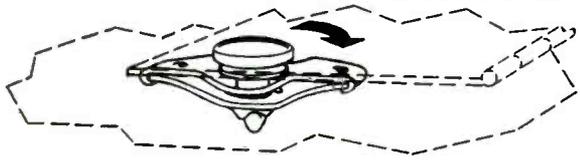
*Representatives in principal cities throughout the country.
Wire collect for complete price information.*



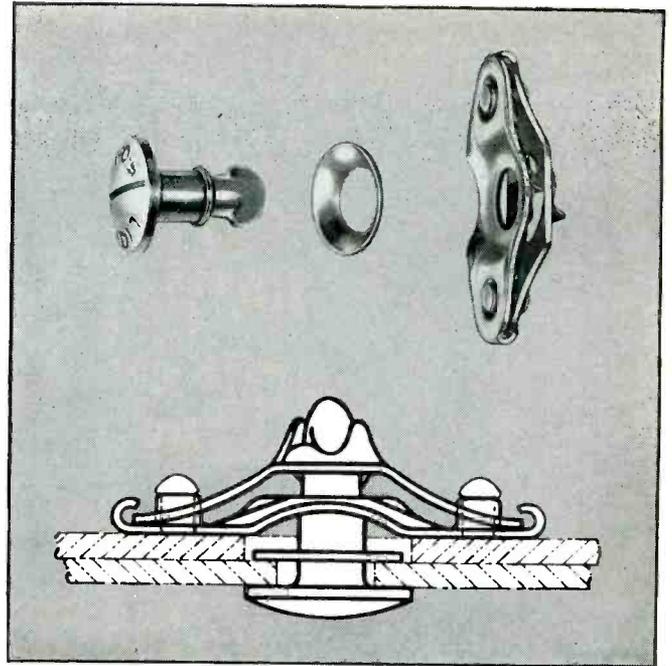
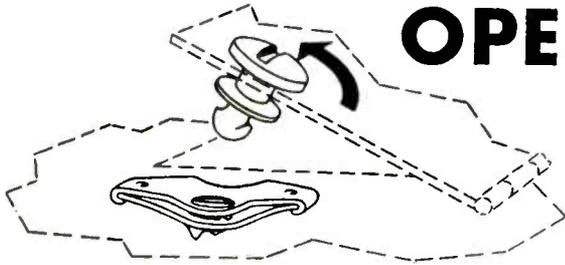
PERKIN ENGINEERING CORP.

345 KANSAS ST. • EL SEGUNDO, CALIF. • ORegon 8-7215 or EAstgate 2-1375

One-quarter turn . . .
CLOSED



One-quarter turn . . .
OPEN



LION QUARTER-TURN FASTENERS

QUICK TO INSTALL

Lion Fasteners can be installed rapidly. Studs simply slip through drilled hole and are retained by a grommet. Springs are riveted or spot-welded in place.

RUGGED

Lion Fasteners stand up under the most rugged conditions of shear, tension, and vibration . . . meet or exceed the exacting requirements of Army-Navy-Air Force Specifications MIL-F-5591A (ASG) and have Civil Aeronautics Administration approval for civilian aircraft use.

LIGHTWEIGHT

Made of cadmium-plated steel to provide a high strength-low weight ratio, No. 5 Fasteners weigh only 12 to 14 lbs. per 1000 . . . No. 2 Fasteners 3 3/4 lbs. per 1000 . . . No. H Fasteners approximately 35 lbs. per 1000.

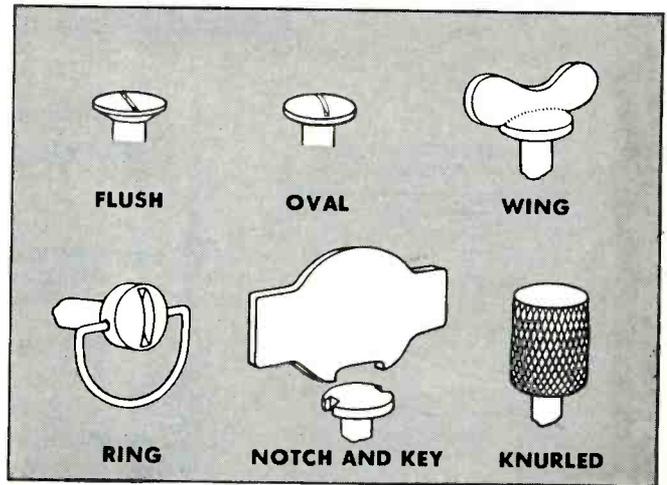
VIBRATION-PROOF

This group of fasteners is particularly suited to metal fastening conditions where vibration is an im-

portant factor. Lion Fasteners can't shake loose . . . can't open by themselves.

FULL RANGE OF HEADS...

The Lion No. 5 Fastener is available with flush, oval, ring, wing, knurled, or notched head and key; No. 2 Fastener is available with flush, oval, or wing type head; the No. H Fastener comes with an oval head.



LION Aviation FASTENERS

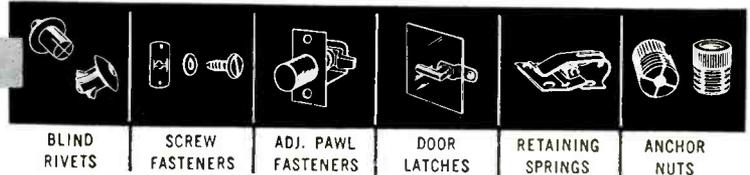
one of the



FASTENERS

© 1956

For complete information on Lion Quarter-Turn Fasteners, as well as on the complete Southco line, write today to Southco Division, South Chester Corporation, 233 Industrial Highway, Lester, Pa.



BLIND RIVETS

SCREW FASTENERS

ADJ. PAWL FASTENERS

DOOR LATCHES

RETAINING SPRINGS

ANCHOR NUTS

1 MINIATURE — Actual size shown. Diameter, 1¼". Overall length, 2".
Ideal for pulsed beacon applications.

2 EXCELLENT VIBRATION PERFORMANCE
Reliable characteristics up to 10 g.'s from 20 to 1000 c.p.s.

3 MECHANICALLY TUNABLE
Tunes mechanically over X-band region,
9300-9500 Mc min.

4 RUGGED
Withstands 1,000 g. shock
along cathode axis. 500 g. in
two other perpendicular planes.

5 PULSE POWER
50 watts peak

6 LIGHTWEIGHT — 6 ounces

7 LOW THERMAL FACTOR
Exceptional frequency stability, .05Mc./°C



Magnetron's
Actual Size

Challenging Characteristics FOR YOUR NEW EQUIPMENT DESIGNS

For specifications on the extraordinary QK 362 write today. Ask for copies of latest bulletins listing most of our unclassified Magnetrons and Klystrons and special tubes. Call on us for

help in your microwave tube problems. There is no cost or obligation, of course.

Similar tubes at other frequencies and power levels are available.



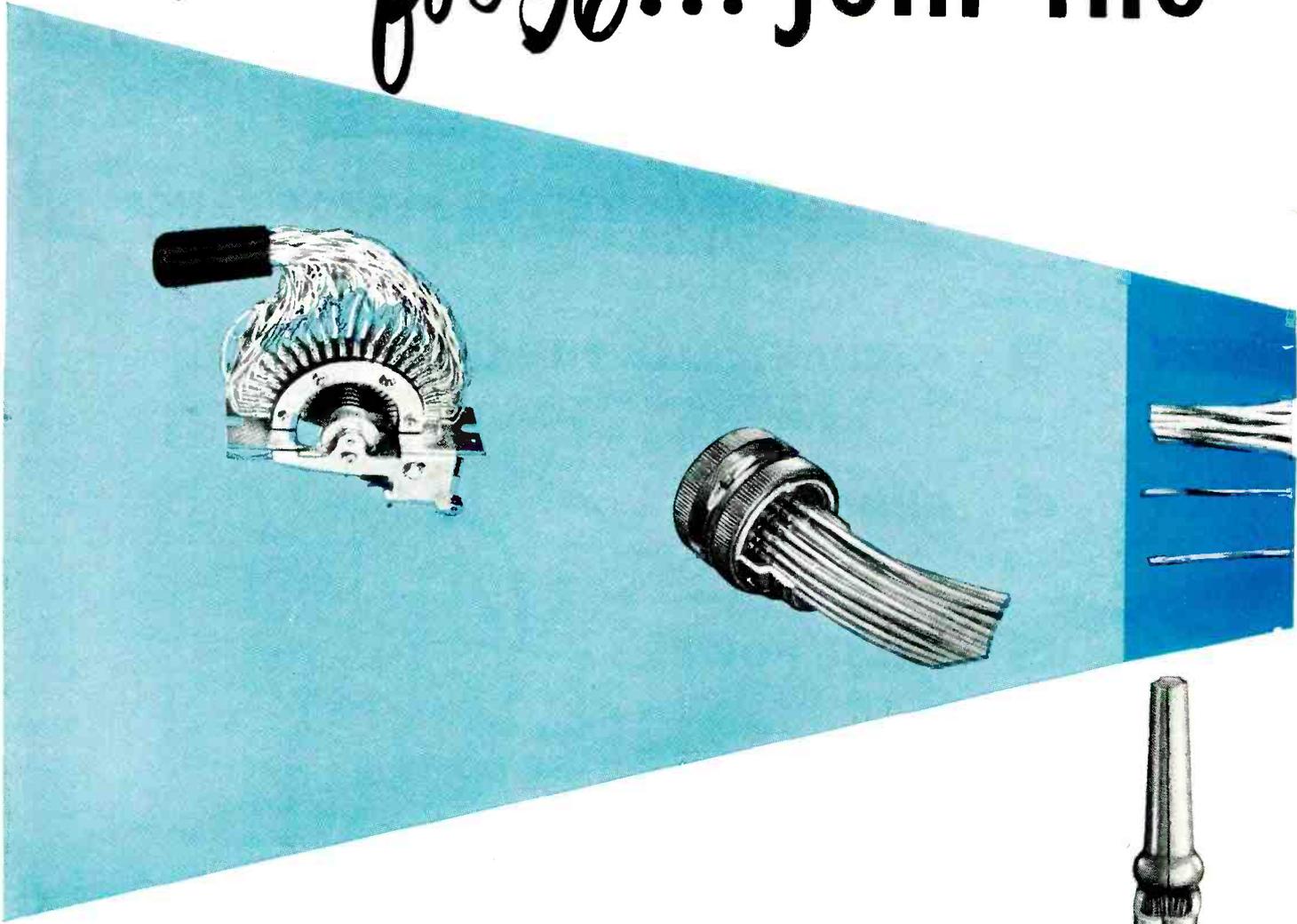
Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

Microwave and Power Tube Operations, Section PT-46
Waltham 54, Massachusetts

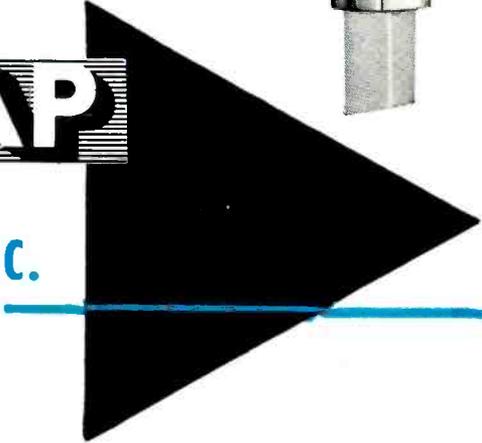
Raytheon makes: Magnetrons and Klystrons, Backward Wave Oscillators, Traveling Wave Tubes, Storage Tubes, Power Tubes, Receiving Tubes, Picture Tubes, Transistors.

project for '56... join the



A-M-P

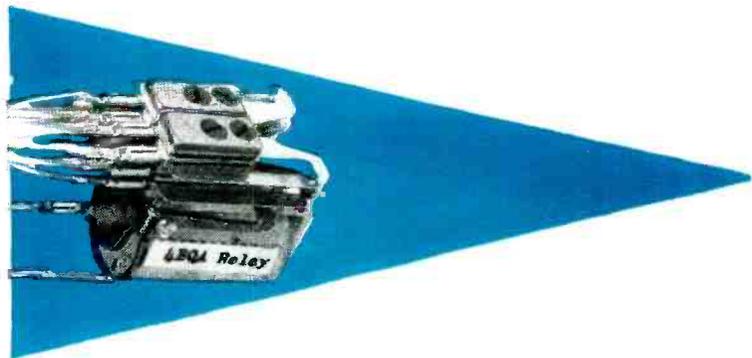
Aircraft-Marine Products, Inc.



®

A-M-P**taper**

parade



Are you in step with the more progressive manufacturers of BUSINESS MACHINES—AIRCRAFT—GUIDED MISSILES—ELECTRONIC EQUIPMENT—who have approved and are profiting by the use of A-MP TAPER TECHNIQUE?

There is still room on the A-MP TAPER TECHNIQUE Band Wagon for you to join the leaders. You, too, can increase speed of assembly, improve reliability, and save money by using A-MP TAPER PINS, TAPER TAB RECEPTACLES, TAPER BLOKS and TAPER TIPS.

And you'll be "cheered on" by the many alert manufacturers of electrical and electronic components who have modified their standard products to help you enjoy the advantages of A-MP TAPER TECHNIQUE.

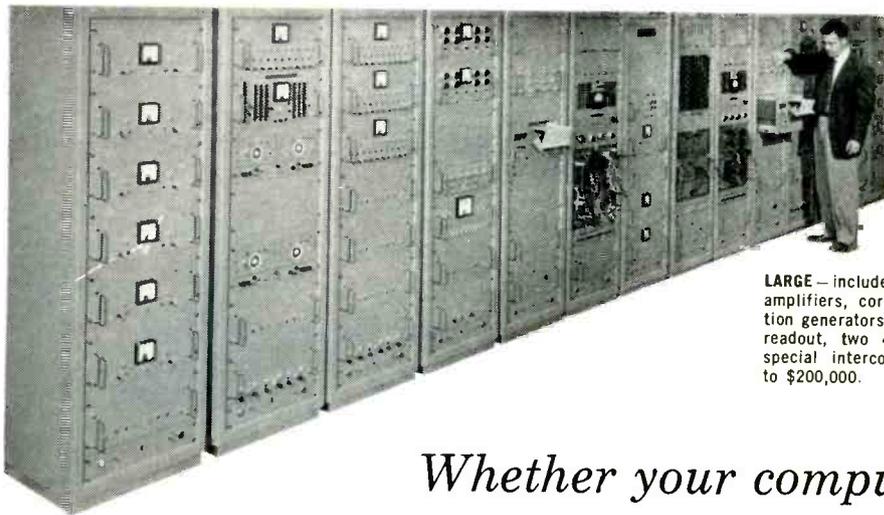
Make it a *MUST* to specify A-MP TAPER TECHNIQUE in your *PROJECTS* for 1956.



GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

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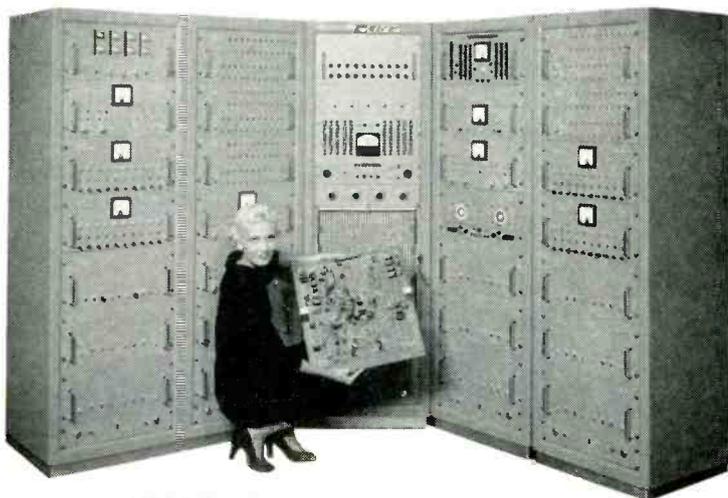
LARGE—includes two control units with 200 pots, 80 amplifiers, corresponding number of multipliers, function generators, etc., plus digital voltmeter with printed readout, two 4-channel recorders, timing matrix and special interconnecting panel. Price range, \$100,000 to \$200,000.

*Whether your computer needs
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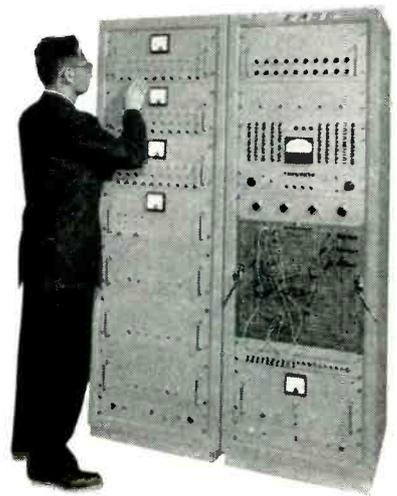
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Want the most for your computer dollar? Investigate EASE* now! Our consulting service will supply sample solutions to your typical computer problems, recommend the type of EASE* computer best suited to your work. For complete information, please address Dep't G4

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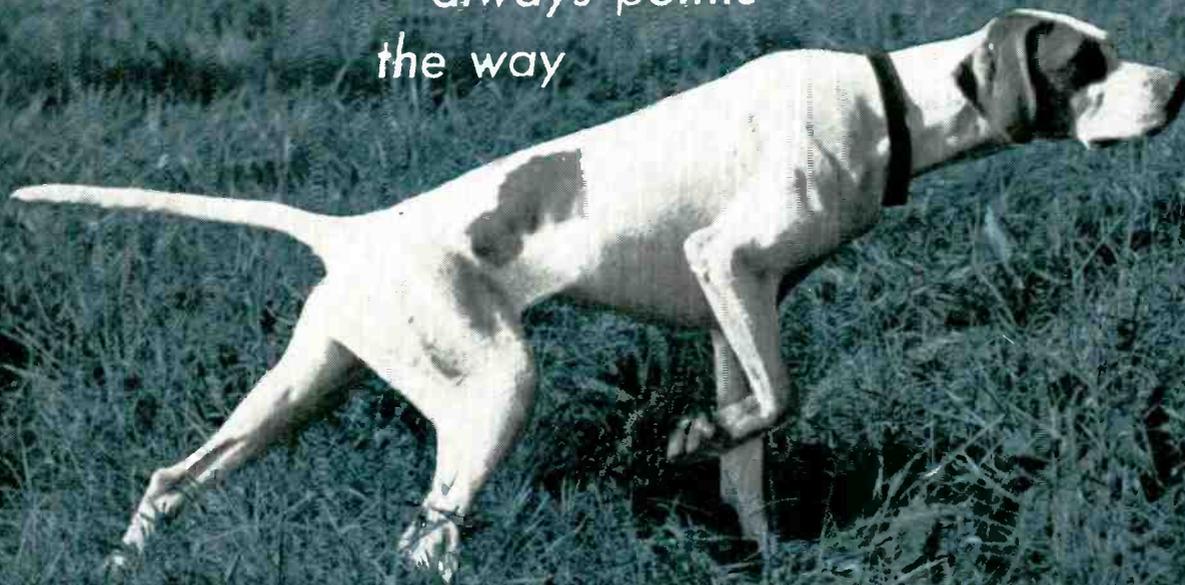
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to use anod C
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C·D...45 YEARS OF FAMOUS FIRSTS

Typical of these "famous firsts" are the three examples shown here . . . proof that whatever your capacitor requirements may be, your needs can be filled by C-D. Write to Cornell-Dubilier Electric Corp., Dept. K-46, South Plainfield, N. J.

FIRST-



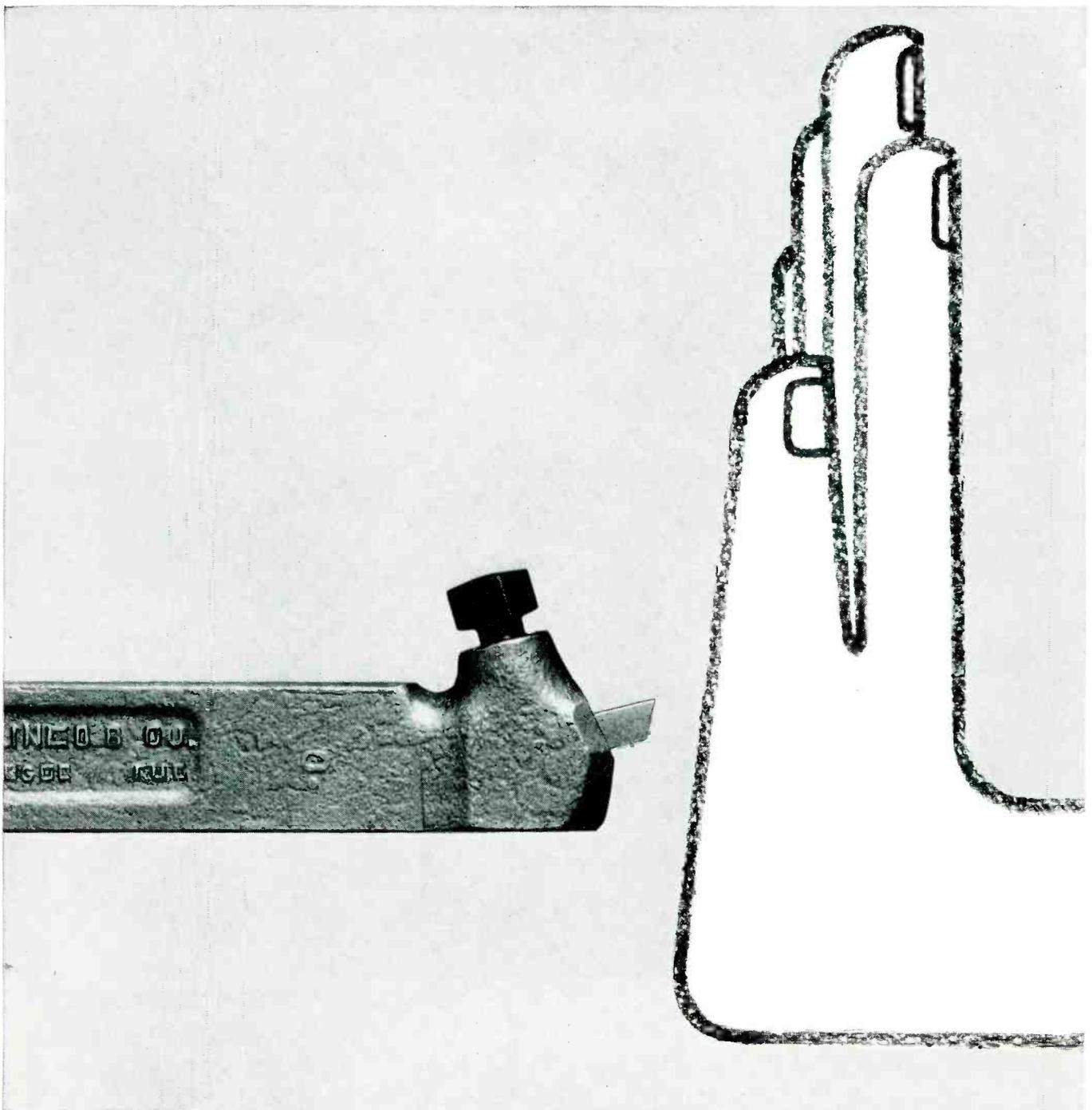
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electrolytic capacitors.



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If you need to control machine operations, it'll pay you to use

Adlake mercury relays



Adlake relays require no maintenance whatever...are quiet and chatterless...free from explosion hazard. Dust, dirt, moisture and temperature changes can't affect their operation. Mercury-to-mercury contact gives ideal snap action, with no burning, pitting or sticking. Time delay characteristics are fixed and non-adjustable.

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the original and largest manufacturers of mercury plunger-type relays

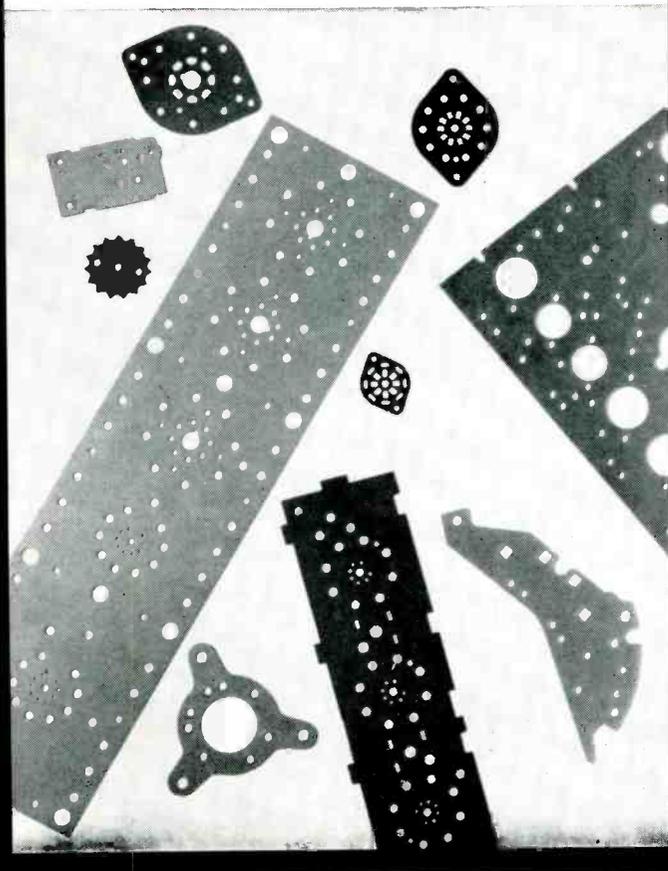




LOW COST—HOT OR COLD

Punching Grade Laminates

DESIGNED
FOR
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G-E TEXTOLITE punching grade laminates have been designed to provide low-cost hot or cold punching laminates with excellent electrical and mechanical properties, geared to meet the requirements of today's high-speed production techniques.

These hot or cold punching grade laminates, engineered by General Electric, have been developed to meet the varied requirements of electrical and electronics manufacturers. Among the wide selections available are:

TEXTOLITE HOT PUNCH 2053 — High mechanical strength and electrical properties at low cost.

TEXTOLITE COLD PUNCH 11561 — Can be cold punched to 1/8" thick. Has good mechanical strength.

TEXTOLITE 11562 — Warm punch grade with a good combination of mechanical strength and electrical properties. NEMA grade P.

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All TEXTOLITE punching grade laminates are available with copper foil on one or both surfaces, in flat sheets, for printed circuitry.

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Uncle Sam's
mighty
new
Flat Tops...*

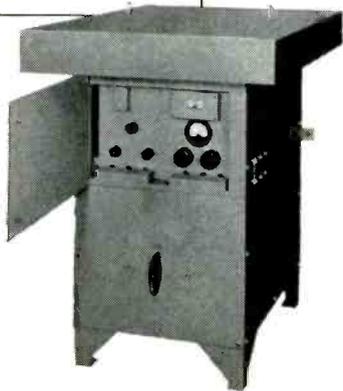
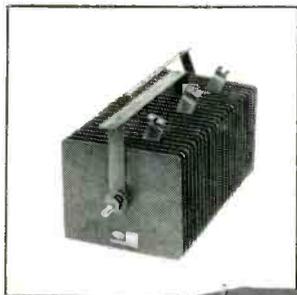


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used in the power supplies for

BATTERY CHARGERS

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For complete dependability Ther's 10 KW battery chargers use Radio Receptor Selenium Rectifiers.

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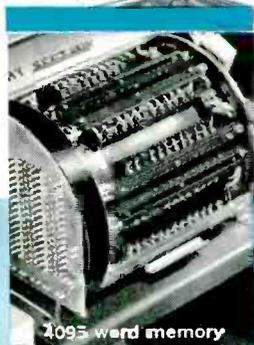
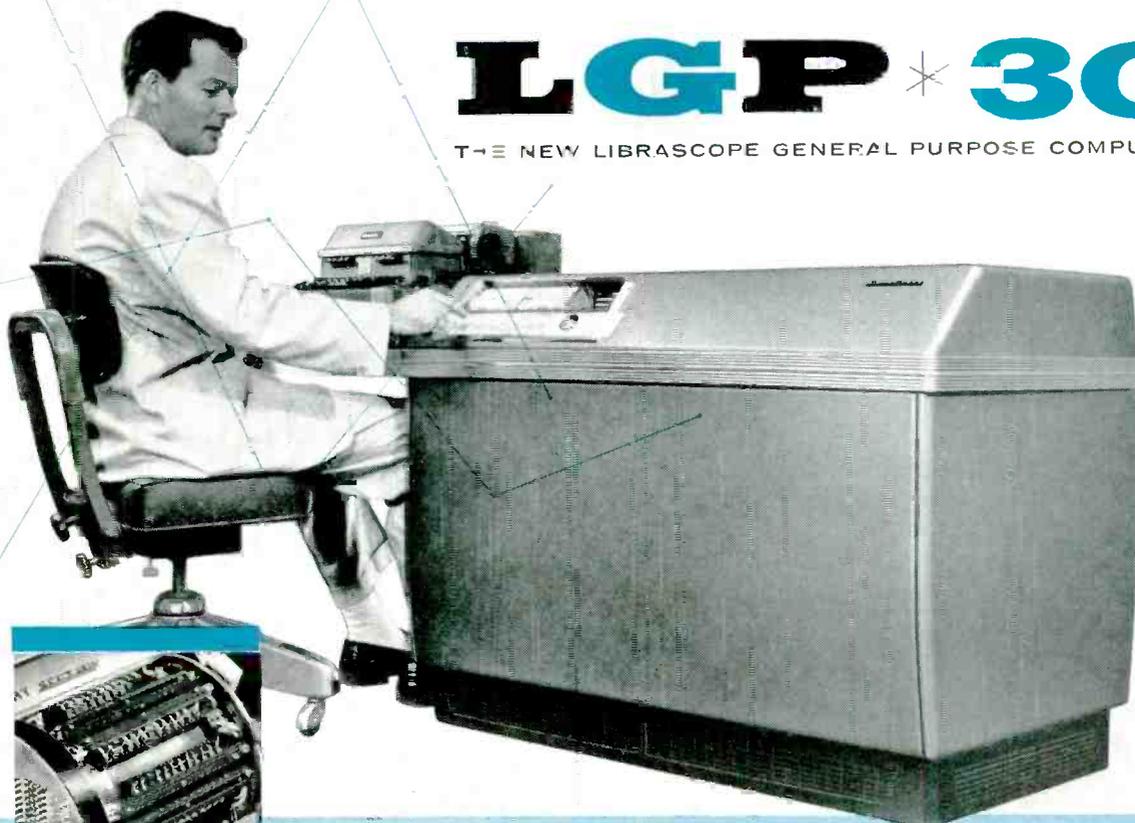
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THE NEW LIBRASCOPE GENERAL PURPOSE COMPUTER



2095 word memory

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Word length:
30 bits, and sign
Mode of Operation:
Serial, one address
Program Storage:
Internal
Access time:
8.5 ms av. 2 ms min.
Transfer time:
1 ms min. 17 ms max.
+ time: .26 ms
+ x time: 17 ms
Power: 1500 Watts

One word defines the "new approach" of the LGP-30...SIMPLICITY. *Operating Simplicity*...for the average engineer...made possible by the elimination of non-essential commands. Programming techniques are easily mastered. *Design simplicity*...that results in complete mobility. The LGP-30 may be operated from any 115 Volt AC outlet. *Service simplicity*...because fewer components, conservatively operated, mean less "time-out" for maintenance. And, too, the LGP-30 costs considerably less than any other general purpose computer—to buy and operate.

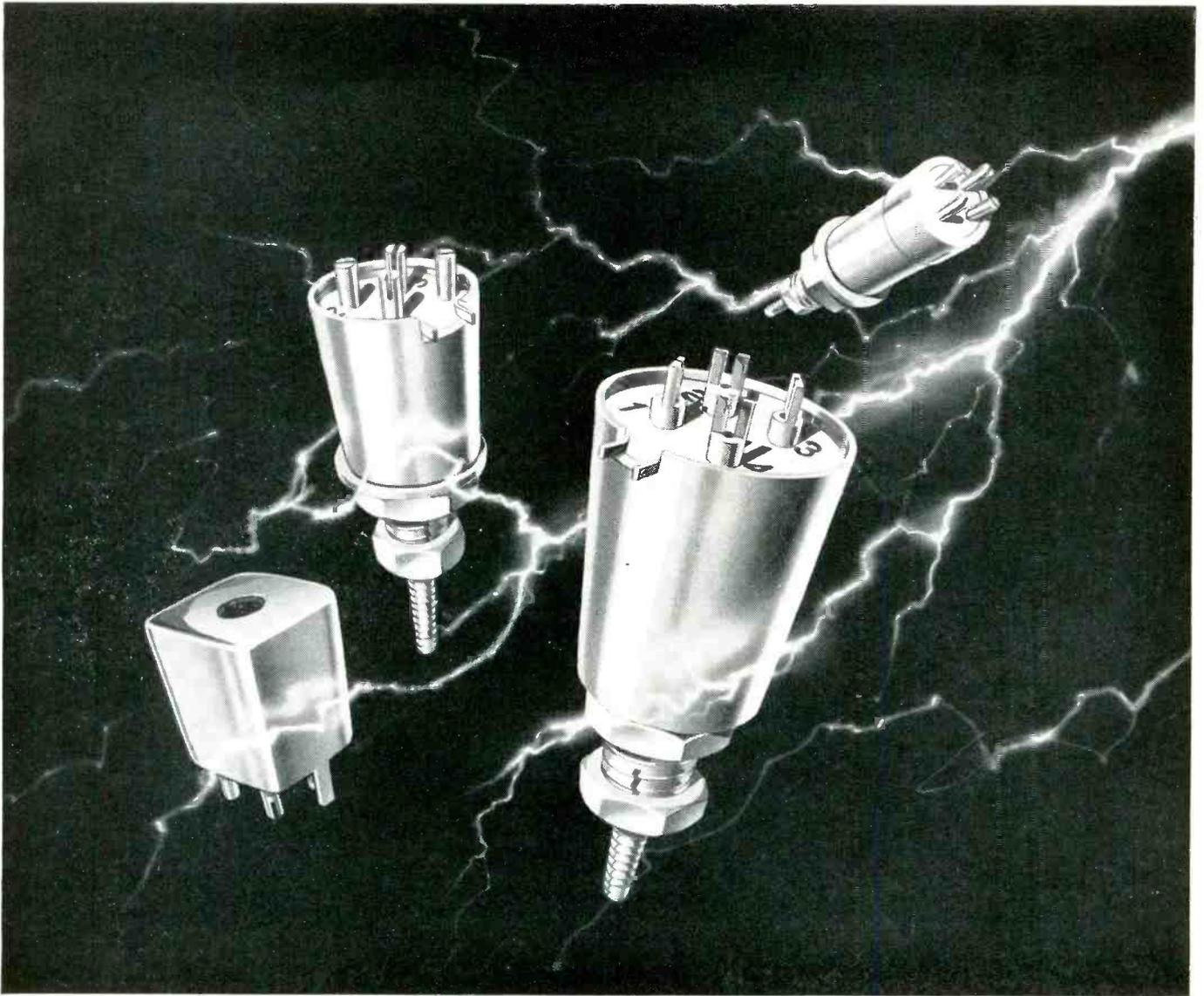
Write for brochure
describing applications,
operation and
detailed specifications.



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Four sizes of shielded coil forms cover a wide range of design requirements. Dimensions when mounted, including terminals, are: LS-12 (square type for printed circuits), $\frac{1}{2}$ " x $\frac{1}{2}$ " x $\frac{1}{2}$ "; LS-9, $\frac{7}{16}$ " diameter x $\frac{1}{2}$ " high; LS-10, $\frac{5}{8}$ " x $\frac{1}{16}$ "; LS-11, $\frac{1}{16}$ " x $\frac{1}{32}$ ". Each form mounts by a single stud. Windings may be universal or wound to your specifications.

Where shock treatment doesn't work

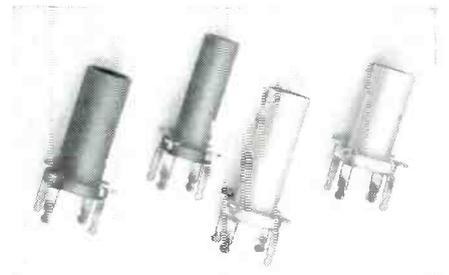
CTC miniaturized shielded coil forms are highly shock resistant. With mechanically enclosed, completely shielded coil windings, they bring all the ruggedness and dependable performance you require for your "tight spot" applications — IF strips, RF coils, oscillator coils, etc.

CTC combines *quality control* with *quantity production* to supply exactly the components you need, in any amount. CTC *quality control* includes material certification, checking each step of production, and each finished product. And CTC *quantity production* means CTC can fill your orders for any volume, from smallest to largest.

For samples, specifications and prices, write to Sales Engineering Dept., Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 38, Mass. On the West Coast contact E. V.

Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16, and 61 Renato Court, Redwood City, Cal.

TYPE SPC phenolic and ceramic printed circuit coil forms can be soldered after mounting. Phenolic forms: $\frac{3}{4}$ " high when mounted, in diameters of .219" and .285". Ceramic forms: $\frac{1}{4}$ " diameter, in mounted heights of $\frac{5}{8}$ " and $\frac{1}{16}$ ", with $\frac{19}{32}$ " powdered iron core, and collars of silicone fibre-glas. Forms come with threaded slug and terminal collar. Units mount through two to four holes, as required. Available as forms alone or wound as specified.



CTC

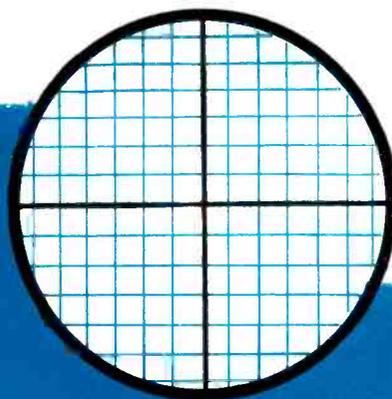
CAMBRIDGE THERMIONIC CORPORATION

*makers of guaranteed electronic components
custom or standard*





announces



2 all new OSCILLOSCOPES



130A Low Frequency Oscilloscope

High sensitivity, dc to 300 KC.
Sweeps 1 usec/cm to 15 sec/cm.



150A High Frequency Oscilloscope

Dc to 10 MC. Plug-in preamplifiers.
Sweeps 0.02 μ sec/cm to 15 sec/cm.

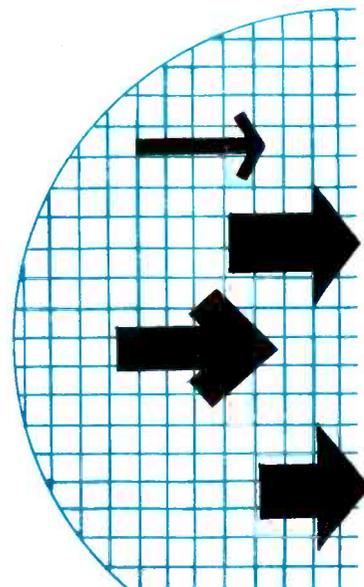
A new standard of versatility, a new kind of operating simplicity, and real, long-term dependability—these characteristics make Models 130A and 150A the most outstanding oscilloscope values ever offered.

A totally different oscilloscope design philosophy is followed in these instruments. Specifications on the following pages indicate the broad measuring versatility that has been achieved. The instruments' greater convenience and dependability is inherent in such unique features as:

Circuits are unitized and can be isolated conveniently for testing or service. Most circuits are etched and mounted on translucent plastic for "see-through" serviceability. All circuits and tubes are completely accessible. Components are of highest quality. Design is ultra-conservative, with circuits operated well below rated capacity. Controls are concentric, color-coded, grouped by function and much simplified. Sweep time selection is direct without interpolation or mental gymnastics. The high-frequency unit has a new "pen-sized" low capacitance probe with miniature clip-on alligator jaws, serving as a 10:1 voltage divider.

Both oscilloscopes have a "universal" automatic triggering system wherein one preset adjustment provides optimum triggering for almost all conditions.

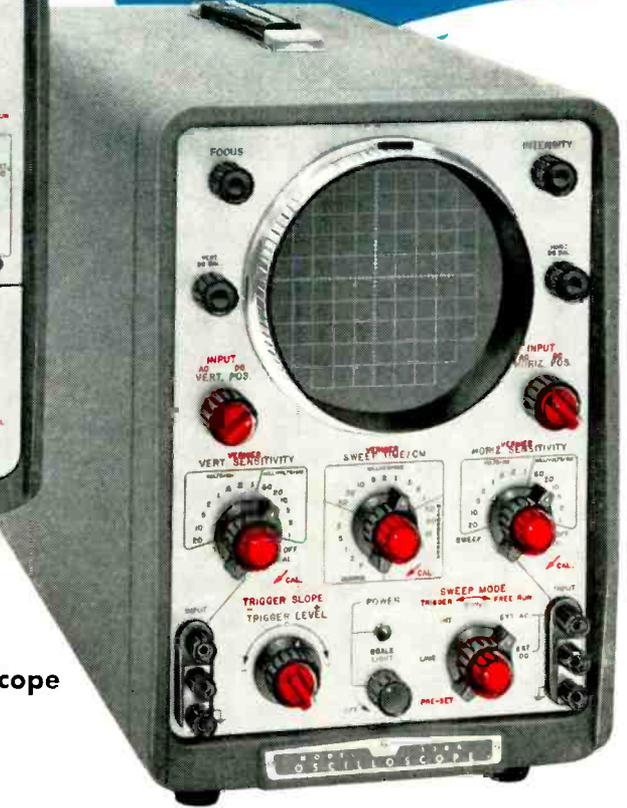
Truly, with these two instruments, -hp- adds to the oscilloscope field the two new dimensions of CONVENIENCE and RELIABILITY!



At long



150A High Frequency Oscilloscope



130A Low Frequency Oscilloscope

-hp- 130A Low Frequency Oscilloscope is a versatile, accurate tool for laboratory and design work, yet its high gain, balanced input, simple operation and rugged construction make it a practical production instrument. The instrument also serves as a millivoltmeter or voltmeter.

Horizontal and vertical amplifiers are similar. Sensitivity is 1 mv/cm or 10 mv full scale deflection. Amplifiers have wide pass bands from dc to 300 KC. Input circuits are balanced on the five most sensitive ranges. Single ended input is also available, either ac or dc coupled. Both amplifiers are highly stable, and their gain may be standardized by an internal 1,000 cycle square wave source. These features, together with

the instrument's precision input attenuator, permit use of the oscilloscope as a millivoltmeter or voltmeter accurate within 5%.

21 sweep times may be set and read directly. Horizontal sweeps are calibrated from 1 μ sec/cm to 5 sec/cm. Accuracy is within 5%, and sweeps are highly linear.

In most cases, **-hp- 130A** will accept signals direct from a standard transducer without preamplification, presenting findings as a brilliant, high resolution trace visible under

BRIEF SPECIFICATIONS

-hp- 130A Low Frequency Oscilloscope

- Sweep Range:** 1 μ sec/cm to 15 sec/cm.
- Calibration:** 21 sweeps: 1-2-5-10 sequence, 1 μ sec/cm to 5 sec/cm. 5% accuracy.
- Triggering:** Internal, line voltage or external 2 v or more. Pos. or neg. slope, +30 to -30 v trigger range.
- Preset Trigger:** Optimum setting for automatic stable triggering.
- Input Amplifiers:** (Similar Vert. or Horiz. Amps). Sensitivity 1 mv/cm to 50 v/cm; 14 ranges plus continuous vernier. Pass band dc to 300 KC.
- Amplitude Calibration:** 1 KC square wave. 5% accuracy.
- Price:** \$450.00.

-hp- 150A High Frequency Oscilloscope

- Sweep Range:** 0.02 μ sec/cm to 15 sec/cm.
- Calibration:** 24 sweeps: 1-2-5-10 sequence, 0.1 μ sec/cm to 5 sec/cm. 3% accuracy.
- Triggering:** Internal, line voltage or external 0.5 v or more. Pos. or neg. slope, +30 to -30 v trigger range.
- Preset Trigger:** Optimum setting for automatic stable triggering.
- Horizontal Amplifier:** Magnification 5, 10, 50, 100 times. Vernier selects any 10 cm part of sweep. Pass band dc to over 500 KC. Sensitivity 200 mv/cm to 25 v/cm.

Now, more than ever,  means "Complete"

last!

Real Dependability
day after day!



OSCILLOSCOPES

Revolutionary Convenience
Broadest Possible Usefulness

any light. A special feature of the instrument is the "universal" automatic triggering system — one preset condition which provides optimum triggering with almost any input signal.

-hp- 150A High Frequency Oscilloscope employs plug-in vertical preamplifiers. These include *-hp- 151A*, a high gain unit with 5 mv/cm sensitivity and frequency response from dc to 10 MC; and *-hp- 152A*, a dual amplifier permitting two phenomena to be presented on the CRT simultaneously.

Model 150A's vertical amplifier has good transient response and less than 0.035 μ sec rise time, pass band dc to 10 MC. A 0.25 μ sec delay line permits viewing the leading edge of the signal triggering the sweep.

A direct reading panel control selects any of 24 calibrated sweeps. The instrument includes the "universal" triggering adjustment providing optimum triggering for almost all conditions. Model 150A also features a single-shot sweep circuit which, after "firing", remains locked out until rearmed.

The instrument's horizontal amplifier provides sweep magnification of 5, 10, 50 and 100 times. "Reminder" lamps indicate when the circuit is in use, or the combination of sweep time and magnification exceeds the maximum calibrated sweep time. The amplifier's sensitivity is 50 mv/cm to 25 v/cm, pass band dc to 500 KC.

Vertical Amplifier: Pass band dc to 10 MC. Optimum transient response and rise time less than 0.035 μ sec. Signal delay of 0.25 μ sec permits leading edge of triggering signal to be viewed.

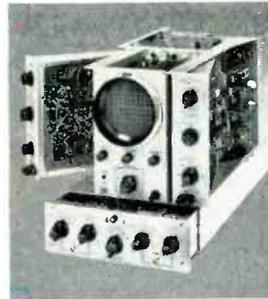
Amplitude Calibration: 18 calib. voltages, 2-5-10 sequence, 0.2 mv to 100 v peak-to-peak. Accuracy 3%. Approx. 1 KC square wave, rise and decay approx. 1.0 μ sec.

Prices: *-hp- 150A* High Frequency Oscilloscope, \$1,000.00.

-hp- 151A High Gain Amplifier, \$100.00.

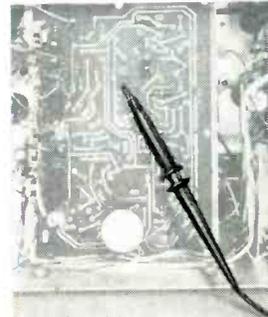
-hp- 152A Dual Channel Amplifier, \$200.00.

Data subject to change without notice. Prices f.o.b. factory.



Unitized construction. Basic circuit elements assembled as separate units. Translucent mounting boards, hinged sub-chassis for maximum accessibility.

15° turn removes bezel for filter replacement, or quick CRT interchange. Bezel provides solid camera base. Top access door permits direct CRT connections.



Voltage divider probe. New 10 μ f capacitance probe has exclusive clip-on nose; 10 meg-ohm input impedance.

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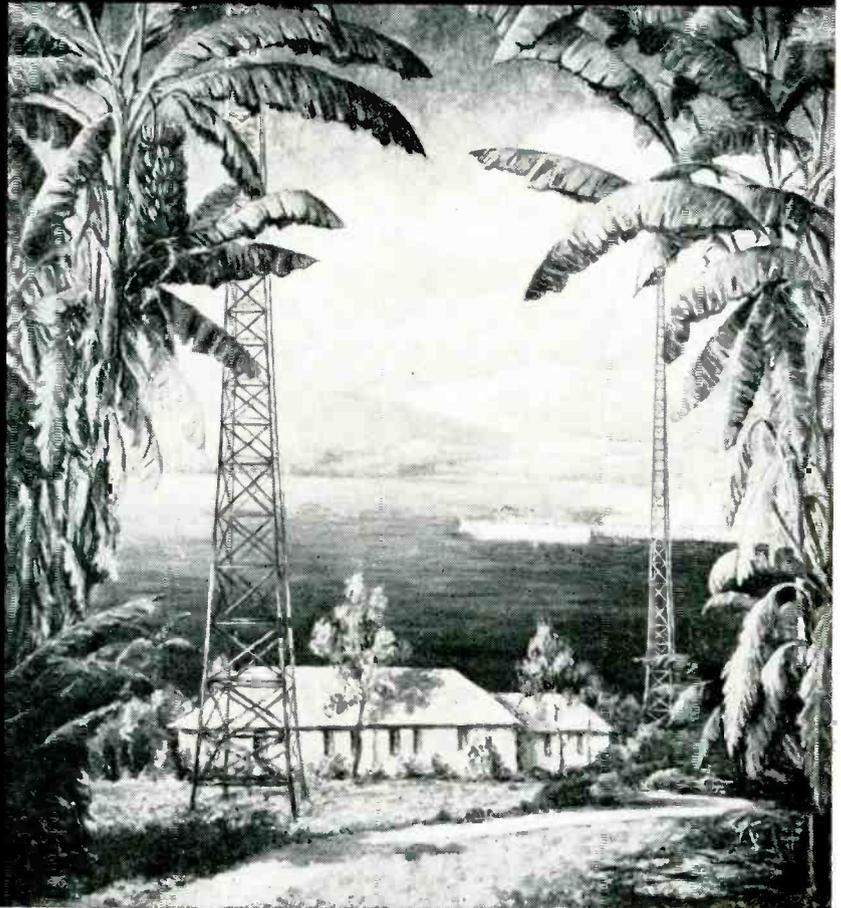
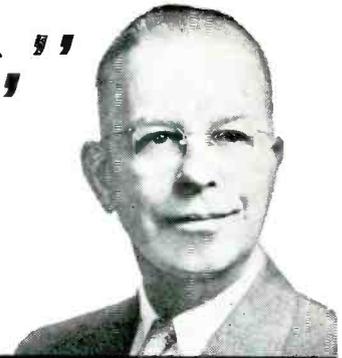
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Coverage" in electronic test instruments!

"Reliability where it counts,"



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Vice President and Chief Engineer,
Tropical Radio Telegraph Company,
about the Westinghouse . . .



WL-5736 POWER TUBE

"We have been using the WL-5736 for seven years," says Mr. Harris. "We have found it to be highly reliable and to give long life. Tropical Radio Telegraph Company requirements are strenuous, especially in hot, humid, tropical climates. Our radio network is vital to Middle-American tele-communications service, and the WL-5736 has given us reliability where it counts."

Reports from dozens of other users echo the experience of Tropical Radio Telegraph. For the WL-5736 has long set the

6ET-4106

standard of excellence in communications and RF heating equipment of all types.

Wherever you need 2.5 kilowatts RF in a small, dependable package, you too will find its performance unbeatable.* Write today for full design data. Commercial Engineering Dept., Westinghouse Electric Corporation, Elmira, N. Y. **ENGINEERS!** For challenge, security, growth potential, investigate career opportunities now being offered by Westinghouse Electronic Tube Division. Write Technical Placement Director today.

*Where cooling by low-pressure blower is desirable, specify the new WL-6623 with extra-large radiator and "flying leads."

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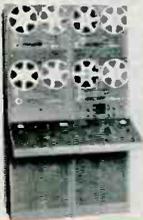
OTIS

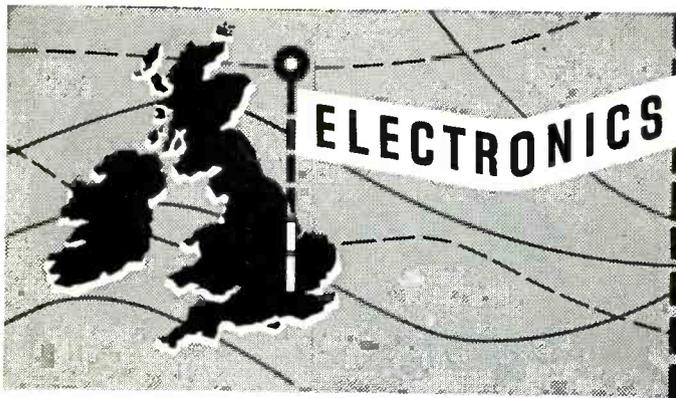
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in Britain

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.

Principal Ratings

Heater	6.3V, 0.2A
Max. plate dissipation	1W
Max. screen dissipation	0.2W
Max. cathode current	6mA

Characteristics

Plate voltage	250V
Screen voltage	140V
Grid voltage	-2V
Plate current	3mA
Screen current	0.6mA
Transconductance	1800 μ mhos



Base

Small button noval 9-pin

Supplies available from:—

In the U.S.A. International Electronics Corporation,
Dept. E4, 81 Spring Street, N.Y.12,
New York, U.S.A.

In Canada Rogers Majestic Electronics Limited,
Dept. IH, 11-19 Brentcliffe Road,
Toronto 17, Ontario, Canada.

EF86

Another Mullard contribution to high fidelity

The Mullard EF86 audio frequency pentode is one of the most widely used high fidelity tubes in Britain today. It has been adopted by the leading British manufacturers whose sound reproducing equipment is enjoying increasing popularity in the United States and Canada.

The marked success of this tube stems from its high gain, low noise and low microphony characteristics.

By careful internal screening, and by the use of a bifilar heater, hum level has been reduced to less than 1.5 μ V. Over a bandwidth of 25 to 1,000c/s equivalent noise input approximates 2 μ V.

When operated below 1,000c/s, internal resonances of the EF86 are virtually eliminated. Even at higher frequencies chassis and tube socket damping are usually sufficient to make vibration effects negligible.

Supplies of the EF86 are now available for replacement purposes from the companies mentioned here.

Mullard

ELECTRONIC TUBES

used throughout the world

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MEV 34

appropriateness.

re·li·a·ble (rē·lī'ā·b'l), *adj.* Suitable or fit to be relied on; worthy of dependence or reliance.

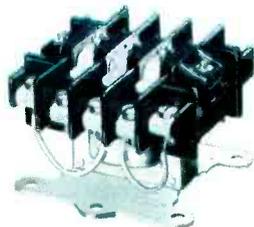
re·li·a·ble

This one definition sums up what we at Leach feel is the most important single thing we can build into a relay, be it a simple motor-starter type or a complex, hermetically sealed unit destined to help guide a missile. It's the starting point of our design thinking, the basis for all manufacturing and quality-control practices.

Reliability of any component is basically the *probability*

LEACH... standard of relay quality for over 30 years... offers a broad line for industrial, electronic and aircraft use... *and*, special types on order.

**commercial controls
and contactors**



**hermetically sealed
aircraft types**



**radio and
high-frequency relays**



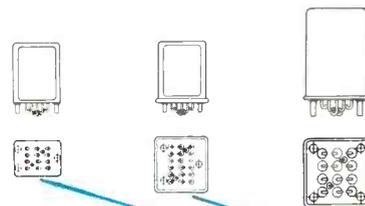
**motor starting
snap-action types**



of its successful operation during a given task. And in a relay, there's no halfway operation... it's either working or useless. So we say only this: whatever your relay needs, look to Leach *first*; then *test* Leach against any make on the market. You'll see why, for years, it has been a habit throughout industry to specify LEACH where complete system reliability is a must.

This is **NEWS** at LEACH

A new group of system designed relays, designed to insure system reliability in electronic, aircraft and missile work. Their square shape makes it possible to place 20% more relays in a given space... they have optional lead arrangements... are hermetically sealed, shock-resistant, can operate dependably at 120°C ambient. Complete specifications available on request.



	9220	9226	9230
Contact arrangement	4PDT	6PDT	4PDT
Operating voltage	18-30 VDC	18-30 VDC	18-30 VDC
Contact rating at 28 VDC			
Resistive	5 amp	5 amp	10 amp
Inductive	1.5 amp	1.5 amp	7 amp
Coil resistance	250 ohms	200 ohms	150 ohms
Duty	Continuous	Continuous	Continuous
Weight	.25 lb.	.25 lb.	.5 lb.
Case dimensions, inches	1.3x1x1.7	1.5x1.5x1.7	1.7x1.7x2.6

LEACH CORPORATION

Send for the latest Leach Relay Catalog... your best starting point when selecting any relay.



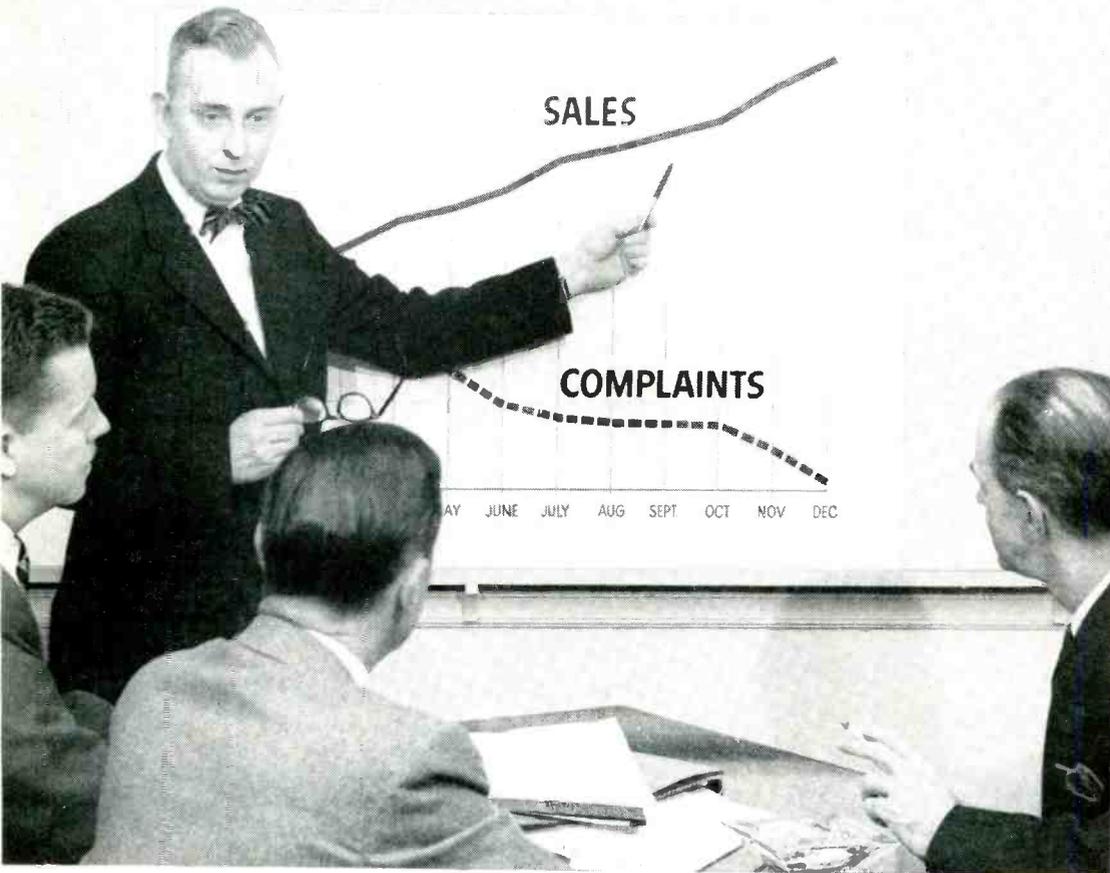
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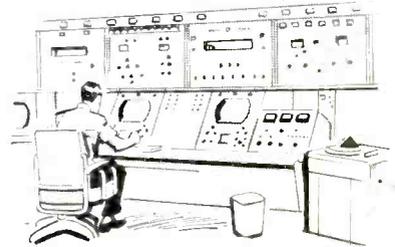
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profitable industrial
voltage regulation



RADAR



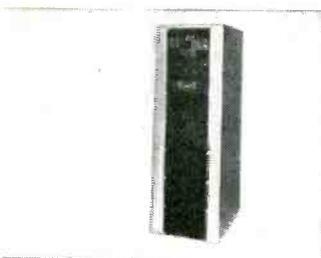
COMMUNICATIONS



COMPUTERS

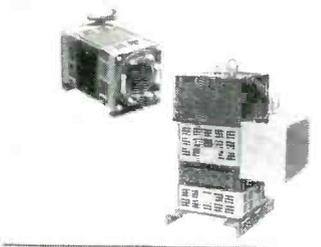
Performance of electronic equipment depends on proper voltage

Help assure customer satisfaction; Install G-E Inductrols* on your equipment



A G-E INDUCTROL FOR EVERY NEED

AUTOMATIC INDUCTROL— Applied where constant voltage is desired, as on radar equipment, electronic computers, induction heaters, rectifiers, welders. Available for single- or three-phase circuits, 600 volts and below.



HAND- OR MOTOR-OPERATED INDUCTROL— Provide stepless variable-voltage output over any desired range. For testing, heating, or illumination control, and similar applications. Single- and three-phase—600 volts and below.



INDUCTROL POWER PACK— This is a load center unit substitution for a-c power and lighting service. Unit includes a transformer, Inductrol, circuit breakers, and distribution panel board. Generally applied in three-phase circuits—600 volts and below—indoor service.

Yes, even small variations in the voltage supplied to sensitive electronic equipment can result in inaccurate operation, inefficiency, and drastically reduced life (a 10% overvoltage can reduce vacuum tube life by 70%!). However, many users do not realize they have a voltage problem, and when their electronic equipment fails to operate properly, the reputation of the original equipment manufacturer usually suffers.

G-E Inductrols (induction voltage regulators) provide a reliable, economical means of maintaining rated utilization voltage *without introducing harmful waveform distortion*. Installed on your equipment, G-E Inductrols assure proper operation even under adverse voltage conditions. Inherent high short-circuit strength and elimination of brushes make G-E Inductrols a simple, economical solution to voltage problems.

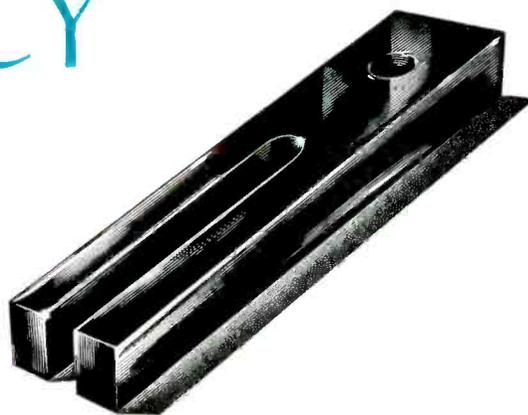
For complete information and application assistance, contact your nearest General Electric Apparatus Sales Office, or write Section 425-2, General Electric Company, Schenectady 5, N. Y.

*G-E Induction Voltage Regulators

Progress Is Our Most Important Product

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TUNING FORK
RESONATORS •
THE ULTIMATE
IN PRECISION
AUDIO
FREQUENCY
CONTROL



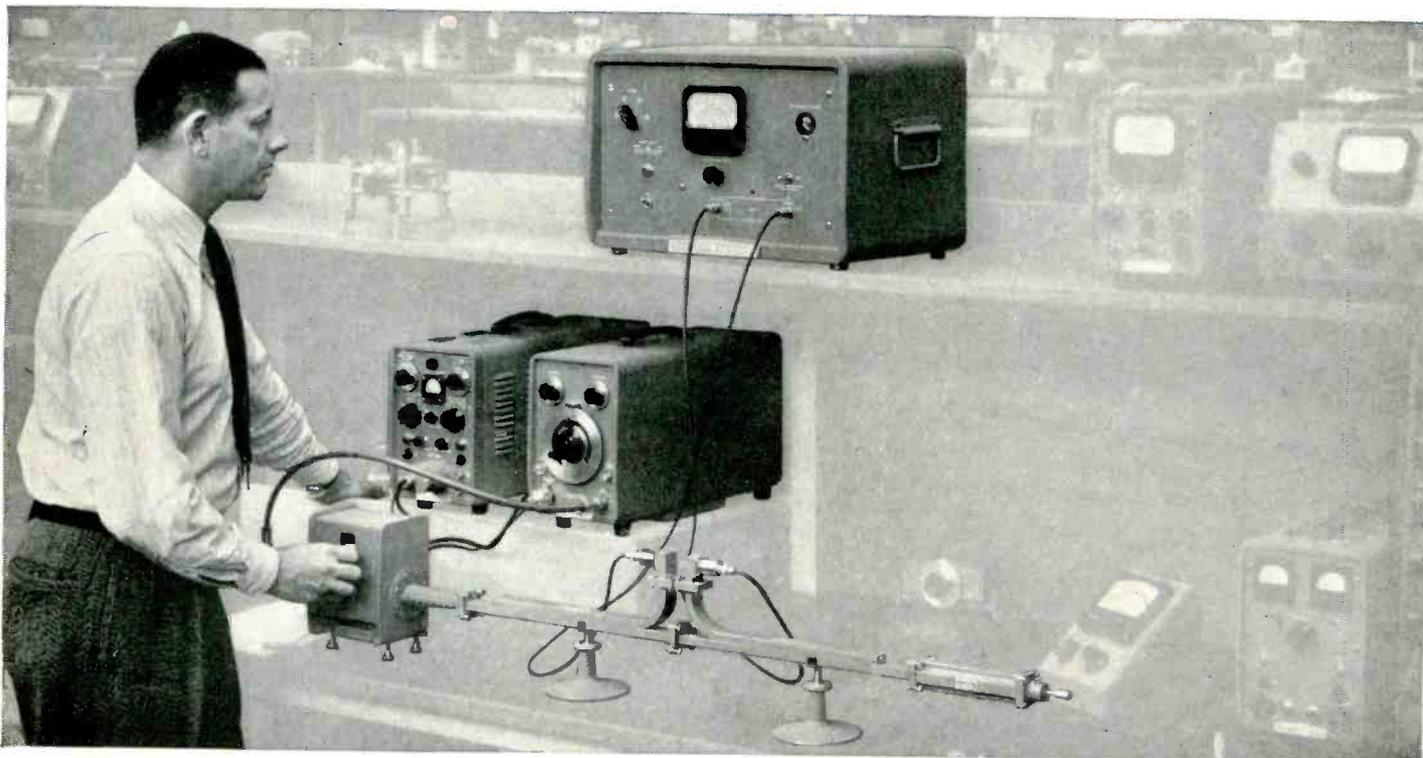
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PHILAMON LABORATORIES INC.

90 Hopper Street, Westbury, Long Island, N. Y. EDgewood 3-1700

IT'S HERE! A fast, accurate wide-range microwave



New -hp- reflectometer system comprises Klystron Power Supply, Swept Frequency Oscillator and Ratio Meter (rear) plus Variable Attenuator, Directional Couplers, Waveguide Crystal Detectors and Load (simulated by Short).

SPECIFICATIONS

-hp- 416A RATIO METER

METER PRESENTATION: (a) As a Reflectometer: Percent reflection (magnitude of reflection coefficient). Four ranges, full scale values of 100%, 30%, 10%, 3% reflection. (1.00, 0.30, 0.10, 0.03 reflection coefficient.) (b) As a VSWR Indicator Voltage Standing Wave Ratio. Four ranges, 1 to 3, 3 to 10, 10 to 30, 30 to 100 VSWR. (c) Decibel scale for either application: 0 to 10 db, 40 db total, ranges spaced exactly 10 db.

ACCURACY: $\pm 3\%$ of full-scale value for 20 to 1 range of incident or reference r-f power.

CALIBRATION: Square-law, for use with Crystal Detectors or barretters.

FREQUENCY: 1,000 cps. ± 40 cps.

INPUT VOLTAGE: Incident or Reference Channel: 3 mv to 100 mv rms. Reflected or Probe Channel: 0.3 mv to 100 mv rms. (Square-wave or sine-wave).

INPUT IMPEDANCE: Approximately 75 K ohms.

EXCESS COUPLER LOSS: Provision made for increasing sensitivity of the Incident Channel by 10 db for reflectometer setups employing couplers with different coefficients. Under certain circumstances, accuracy can be improved by this procedure.

OUTPUT: Connectors for oscilloscope and recorder.

ADJUSTMENTS: "Set to Full Scale" control for initial calibration with 100% reflection, or at VSWR peak.

INTERNAL CHECK: "Eye" tube continuously monitors input amplitude (and frequency indirectly) to assure proper operating range for instrument and for crystal detectors.

PRICE: \$365.00.

-hp- 670HM shf OSCILLATOR

FREQUENCY RANGE: 7.0 kmc to 10.0 kmc.

OUTPUT POWER: Approximately 10 mw entire frequency range.

ATTENUATOR RANGE: 100 db.

MODULATION: (a) Grid Modulation for optimum swept-frequency performance. (b) Reflector Modulation for optimum single-frequency performance. Modulating signals must be provided from external source (normally the -hp- 717A Power Supply). Pulses as short as 3 microseconds can be produced.

MECHANICAL SWEEP: Fully adjustable to cover any 10% or larger portion of the 7.0 kmc to 10.0 kmc spectrum. Sweep rate approximately 12 to 60 complete cycles per minute depending on swept frequency range. (Special sweep rates available at additional charge.)

SWEEP VOLTAGE PROVIDED: Linear voltage proportional to mechanical sweep. (Approximately 100 volts change provided for 7 to 10 kmc swept frequency range.)

PRICE: \$1175.00

-hp- 717A KLYSTRON POWER SUPPLY

BEAM SUPPLY:

VOLTAGE RANGE: 800 to 1,000 volts.

CURRENT: 25 ma, maximum.

REGULATION: (a) For constant load, less than $\pm 0.1\%$ output voltage change for $\pm 10\%$ variations from 115-volt line. (b) Less than $\pm 1\%$ output voltage change for output currents from 0 to 25 ma.

HUM: Less than 10 millivolts.

REFLECTOR SUPPLY:

VOLTAGE RANGE: 0 to 600 volts in 3 ranges.

CURRENT: 1 ma maximum; source resistance approximately 300 K ohms.

REGULATION: For constant load, less than $\pm 0.05\%$ change for $\pm 10\%$ variations from 115-volt line.

HUM: Less than 10 millivolts.

SQUARE WAVE MODULATION: (a) Amplitude adjustable 0 to 60 volts peak-to-peak. (b) Rise and decay times less than 10 microseconds. (c) Frequency adjustable from 400 to 1,000 cps.

SINE WAVE MODULATION FOR FM'ing: (a) Amplitude adjustable from 0 to 300 volts peak-to-peak. (b) Frequency: line voltage frequency. (c) Oscilloscope horizontal sweep voltage: 15 volts peak-to-peak, phase adjustable $\pm 45^\circ$ with respect to modulating voltage.

EXTERNAL: Terminals available for applying external modulating voltage. System will pass 3 microsecond pulses.

GRID SUPPLY:

VOLTAGE RANGE: 0 to +30 volts, open circuit, referred to cathode potential.

SQUARE WAVE MODULATION: (a) Amplitude adjustable 0 to 60 volts peak-to-peak. (b) Rise and decay times less than 10 microseconds. (c) Frequency adjustable from 400 to 1,000 cps.

EXTERNAL: Terminals available for applying external modulating voltage. System will pass 3 microsecond pulses.

FILAMENT SUPPLY: 6.3 volts ac., 2 amps.

PRICE: \$375.00.

-hp- X421A CRYSTAL DETECTOR

FREQUENCY RANGE: 8.2 kmc to 12.4 kmc.

SENSITIVITY: Approximately 1 mv/0.01 mw (average value).

VSWR: Less than 1.5 entire frequency range.

FREQUENCY RESPONSE: Flat within ± 2 db entire frequency range.

PRICE: \$75.00. (Includes 1N26 Silicon Diode and matched video-load resistor.)

-hp- 752 DIRECTIONAL COUPLERS

COUPLING: X752C = 10 db coupling

X752D = 20 db coupling

WAVEGUIDE SIZE (in.): $1 \times 1/2$

FREQUENCY RANGE (kmc): 8.2 - 12.4

DIRECTIVITY: Better than 40 db full range.

PRICE: \$100.00

All prices f.o.b., Palo Alto, California

Data subject to change without notice



ELECTRONIC TEST INSTRUMENTS for

reflectometer system for impedance measurement

Reflection coefficient or SWR measured instantly over wide frequency range

Direct, continuous swept-frequency oscilloscope presentation

Higher accuracy than slotted lines for single frequency measurement

Ends tedious point-by-point checking; system unaffected by amplitude variation

Ideal for fast production checks, system alignment, laboratory work checking waveguide components, antenna and rotary joint performance, etc.

Now *-hp-* offers a fast, accurate and *practical* reflectometer system that eliminates long hours of engineering previously required for microwave impedance measurements. The system provides direct meter readings of reflection coefficient, and is so simple to operate it can be used by non-technical personnel. An output is also available for oscilloscope or recorder presentation. The system eliminates the need for measuring forward and reverse power separately, and does away with tedious adjustments to correct for source amplitude variations. At present the equipment is available for X band operation only but components for other frequency ranges will be offered soon. The system includes several completely new *-hp-* instruments:

-hp- 416A Ratio Meter automatically combines forward and reverse signals and displays their ratio directly, irrespective of amplitude variations. Reflection coefficient may be read directly on the front panel meter. A signal at a rear terminal is provided to operate an oscilloscope or recorder. Model 416A contains an rf power monitor indicating proper power level. Obtainable accuracy for single frequency measurement is ± 0.005 reflection coefficient; for swept frequency measurement, ± 0.015 reflection coefficient.

Model 416A may also be used to measure SWR in connection with slotted lines. A reference voltage from the system power source applied to the ratio meter eliminates error due to amplitude variation.

-hp- 670HM Swept Frequency Oscillator operates over a frequency range of 7 to 10 KMC. It may be manually tuned or motor driven to sweep any portion of this frequency band automatically. Sweep is at a velocity which is constant and sufficient to insure a clear trace on a long-persistence cathode ray oscilloscope. *-hp-* 670HM has a direct-reading frequency dial, and a waveguide-beyond-cutoff attenuator. It is normally grid modulated for sweeping, but also has reflector modulation for both fm and pulsed output. The oscillator requires an external power supply.

-hp- 717A Klystron Power Supply provides 800 to 1,000 volts beam voltage with regulation better than 0.1%, and 0 to 600 volts reflector voltage with regulation better than 0.05%. Model 717A also includes square wave modulation for both grid and repeller, as well as sine wave modulation for fm'ing. It is specifically designed as a companion instrument to *-hp-* 670HM.

-hp- 752 Series Directional Couplers are high directivity units consisting of two waveguides joined on their broad faces. Coupling is obtained through a series of precisely matched, graduated holes. In the system pictured, two couplers (with 10 db and 20 db directivity respectively) are joined back to back. Power flow is then as indicated in Fig. 1.

-hp- 421A Waveguide Detectors have square-law characteristics and demodulate the rf signal for use by *-hp-* 416A Ratio Meter.

Brief specifications of major instruments in the *-hp-* reflectometer system are given here. Complete specifications on all instruments in the system will be sent on request. For a comprehensive discussion of reflectometer measurements with these instruments, see *-hp-* Journal, Volume 6, Number 1-2, or write direct.

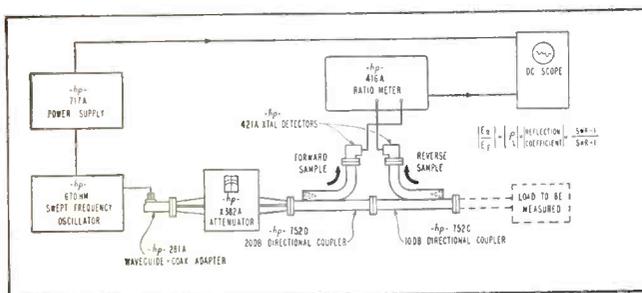


Figure 1. Reflectometer system. Swept rf power is provided by Oscillator. Directional Couplers sample forward and reverse power. Waveguide Detector Mounts terminating both Couplers demodulate power and present a 1,000 cps signal to Ratio Meter. Oscilloscope presents continuous visual study of reflection coefficient over the swept frequency range.

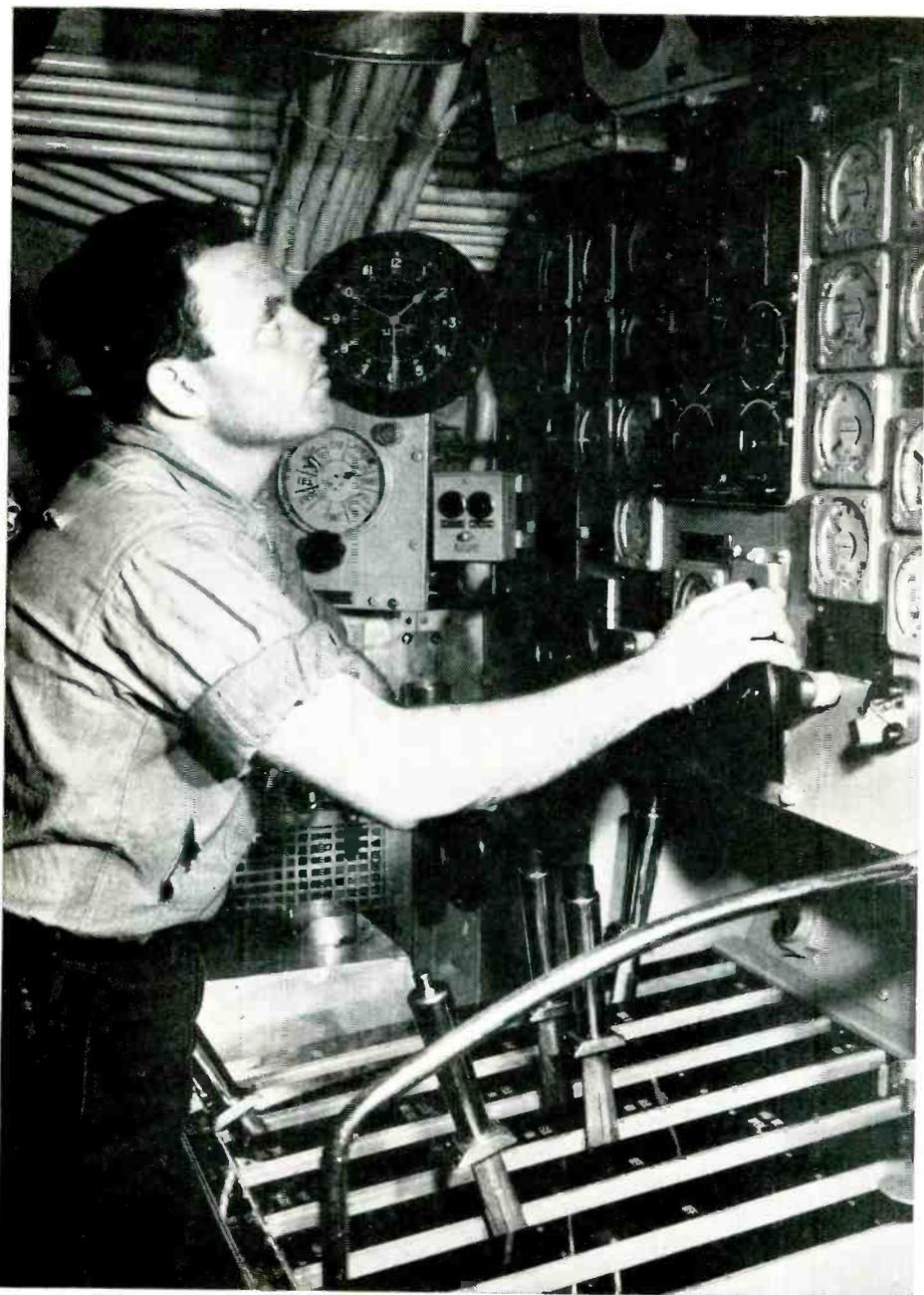
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ADDRESS DEPT. E-76

Sea sentinels

A key factor in the nation's defense is the Air Force's oceanic chain of Texas Towers now under construction. For communicating their findings, these radar stations—like those in the continental North—rely upon the forward propagation tropospheric scatter systems developed by REL.

In this case, REL has supplied the transmitter exciters and diversity receivers which make possible long range tower-to-shore and shore-to-tower communication without booster stations. Performance and dependability quite naturally exhibit REL's world-famed standard of excellence.

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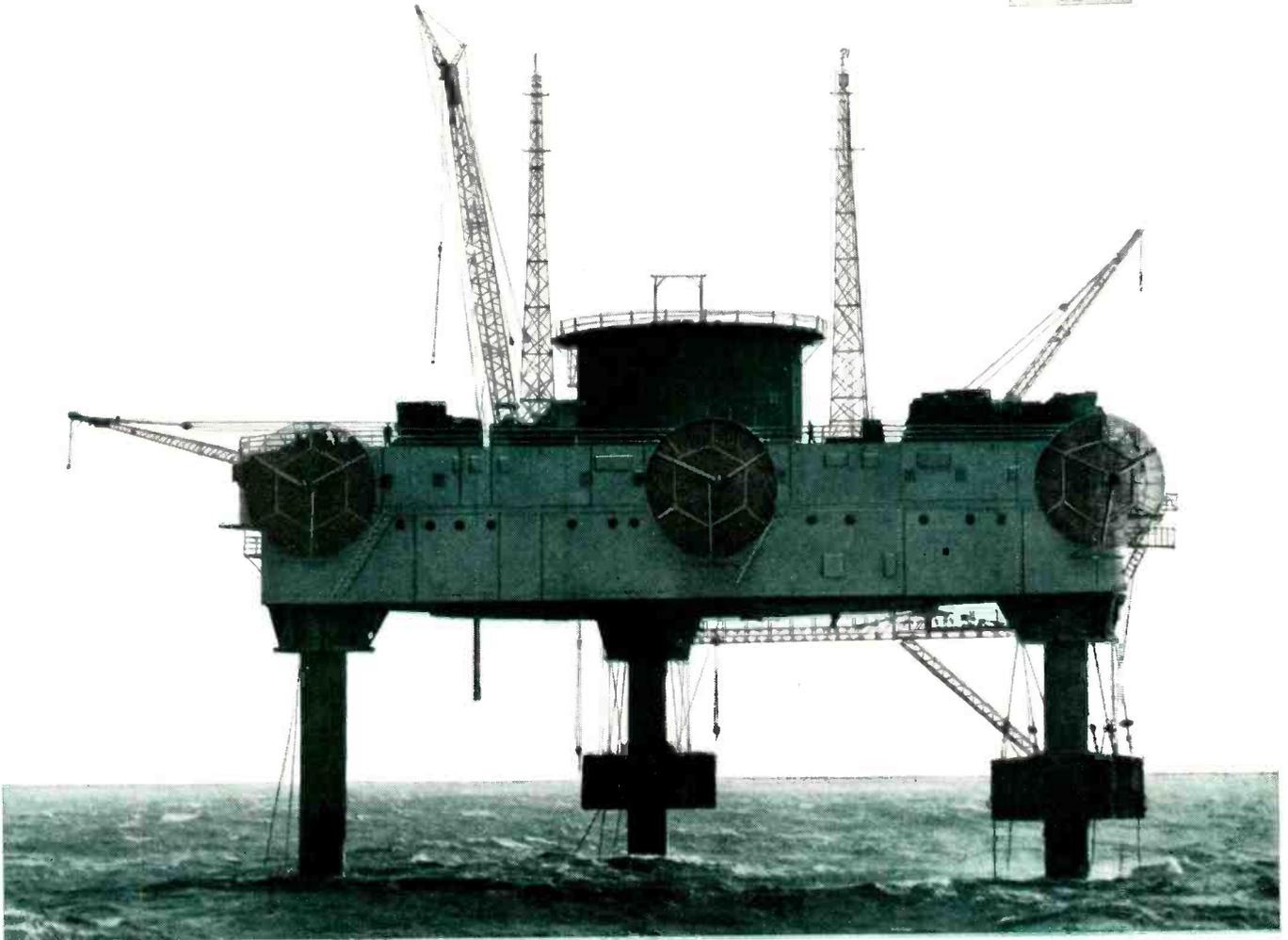
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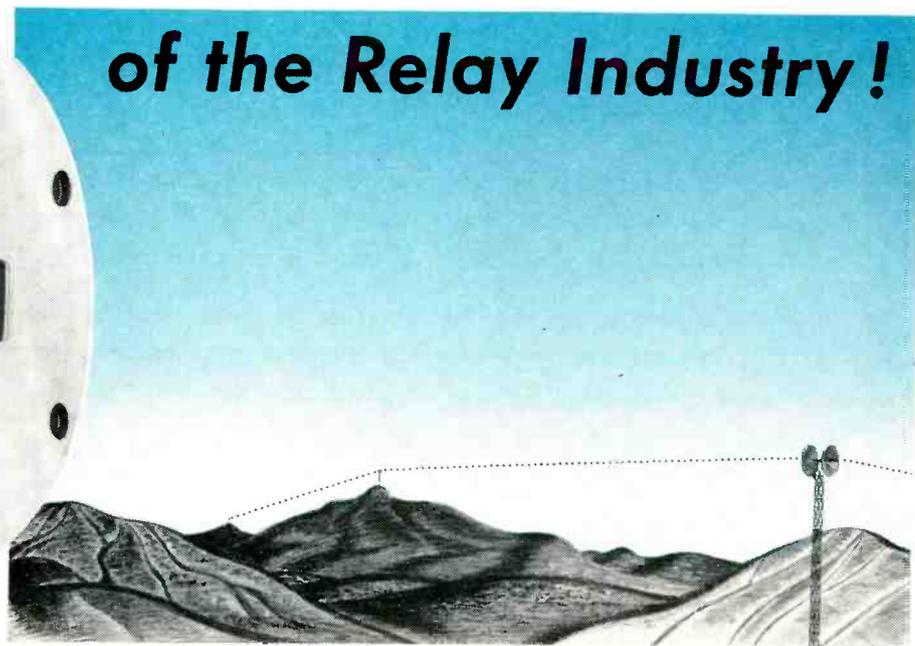
Type 7981 transmitter exciter



Type 834 receiver with Type 847 diversity combiner



NOW... the **accepted standard** of the **Relay Industry!**



Varian's high performance relay klystron

It's the VA-220, another outstanding example of Varian design leadership... research and product engineering that brings you optimum reliability plus performance characteristics unsurpassed by any other relay klystron.

**UNSURPASSED
FOR EVERY
RELAY APPLICATION**

Microwave relay system designers and equipment buyers have long known that Varian relay klystrons are unmatched for frequency stability, power to override noise, reliability and long life. The VA-220 gives you performance that even exceeds the high standards set by Varian X-26 klystrons... at half the cost.

In the 6000 - 8000 megacycle band, VA-220 klystrons will consistently outperform all others. Here are six reasons why this sensational new klystron is your best buy for all relay applications:

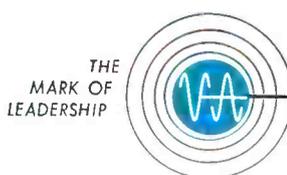
**THESE ADVANTAGES
MEAN TOP PERFORMANCE**

- **Greater Power**—VA-220 high power klystrons are conservatively rated. They will deliver **more** than rated power **without** failure.
- **Greater Frequency Stability**—VA-220 klystrons have negligible frequency drift.
- **Greater Uniformity**—Varian mass production techniques assure uniformity—every klystron is as reliable as a nut and bolt.
- **Longer Life**—VA-220 klystrons can be operated at full power for thousands of hours.
- **Less Distortion, Less Noise**—FM distortion and inherent noise are negligible—60 db below a 1-megacycle deviation.
- **Lower Cost**—VA-220 klystrons cost far less than any other relay klystron with comparable performance characteristics.

TYPE	FREQUENCY RANGE	RESONATOR VOLTAGE	POWER OUTPUT	BANDWIDTH	MODULATION SENSITIVITY
VA-220*	5925 - 7425 mc	750 v	1.2 watts	35 mc	375 kc/v
*VA-220 B, C, D, E and F each cover a frequency range of approximately 300 mc					

FOR COMPLETE SPECIFICATIONS

... and technical data on the VA-220 and other Varian klystrons, write to the Varian Application Engineering Department today.



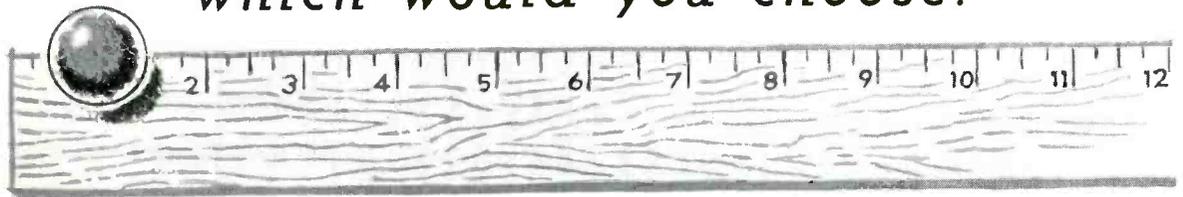
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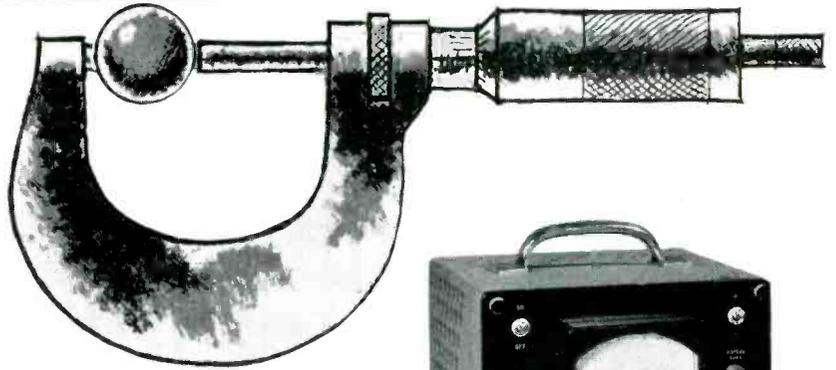
TO MEASURE A PRECISION BEARING . . .

which would you choose?



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The M-2 Oscillator covers the audio, geophysical and ultrasonic range with excellent stability and extremely low distortion. **The Model R-1 Voltmeter**, with its flat response D-C Amplifier and extremely wide range, provides a matching teammate for accurate circuit analysis.



**Where precise measurements are required . . .
SIE precision instruments are ESSENTIAL.**



SIE Model R-1 VOLTMETER

- DC: 1 mv. to 1000 volts full scale, accurate to 1½%.
- AC: 1 mv. to 1000 volts full scale, accurate to 3%.
- Balanced D-C Amplifier: flat to 100 kc, gain of 200x.
- Ohms: 0 to 500 megohms, with scale expansion.
- Distended DC Scales: for reading changes as small as one part in 10,000.

/ \$620

SIE Model M-2 OSCILLATOR

- Range: 1 to 120,000 cycles per second.
- Dial Calibration: within 1½% ±.1 cycle per second.
- Amplitude Stability: within ½ db. throughout range.
- Frequency Stability: within .1% after warmup.
- Harmonic Distortion, Hum and Noise: less than .2% at any level within audio range.
- Output: 20 volts at 20 milliamperes.

/ \$425

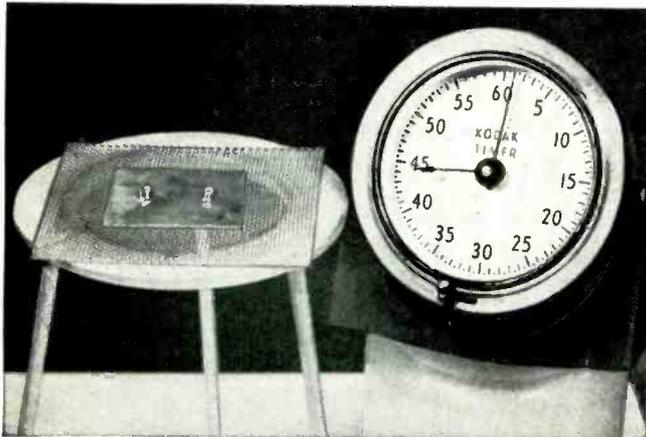


SOUTHWESTERN INDUSTRIAL ELECTRONICS COMPANY *Industrial Instruments Division*
P. O. Box 13058 • 2831 Post Oak Road • Houston 19, Texas

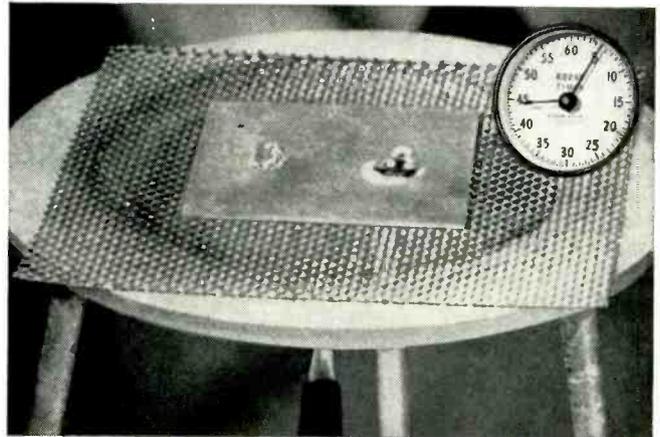
Make this test yourself

and prove "Dutch Boy" Solder with
Activated Rosin Flux* gives you

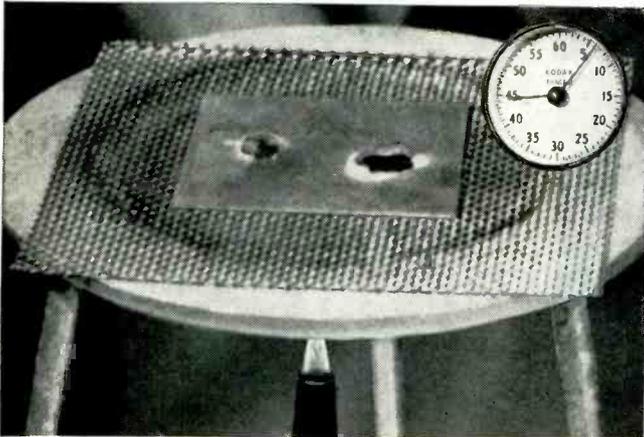
50-100% faster soldering
50-60% more soldering "mileage"



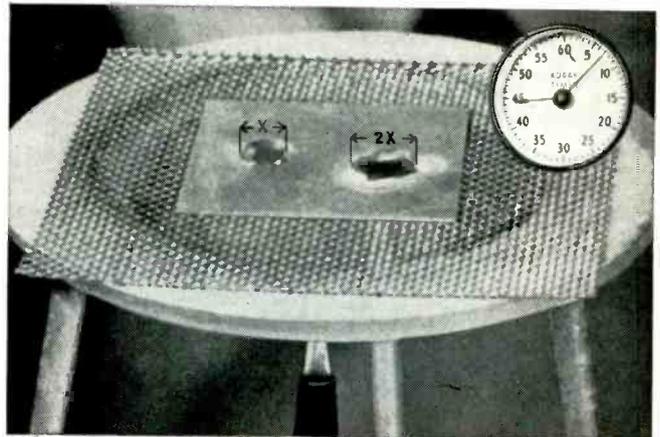
Set test up like this! Place one-inch, doubled-up samples of ordinary rosin core and "Dutch Boy" *activated* rosin core solders on sheet of clean copper. (In these pictures, "Dutch Boy" sample is on your right.)



Center torch flame under the copper sheet! Notice how the flux runs out — "Dutch Boy" a little ahead. All at once, the "Dutch Boy" sample melts, the special flux helping to conduct heat through the solder.



Keep the heat on! A second or so later, the ordinary solder starts to melt. But look at the "Dutch Boy" sample. See how it has spread . . . thanks to superior wetting properties of the activated flux.



Stop the clock when the ordinary solder reaches maximum spread (two to four seconds). No need to measure. "Dutch Boy", with *activated* flux, covers over 60% more area.

*"Dutch Boy" rosin core wire solder with activated flux sold under trade names "NUAX" and "HYAX".

Look to National Lead for . . .

1. **Solders and fluxes** . . . all "standard" and "specification" types, forms, and pre-forms.
2. **Solder application help** . . . National Lead specialists in metal-joining jobs are at your service . . . literally. They have the "backing" of plant laboratories all over the country and of the central Research Labs in New York.

What do users say?

Major producers of electronic equipment report "Dutch Boy" solder with "Dutch Boy" *activated* flux gives them 50 to 60% more joints per pound. Piece workers swear by it. Costs move down.

But don't take *anybody's* word for it. Try it yourself. Send for free samples. Write National Lead Company, 111 Broadway, New York 6, N. Y.

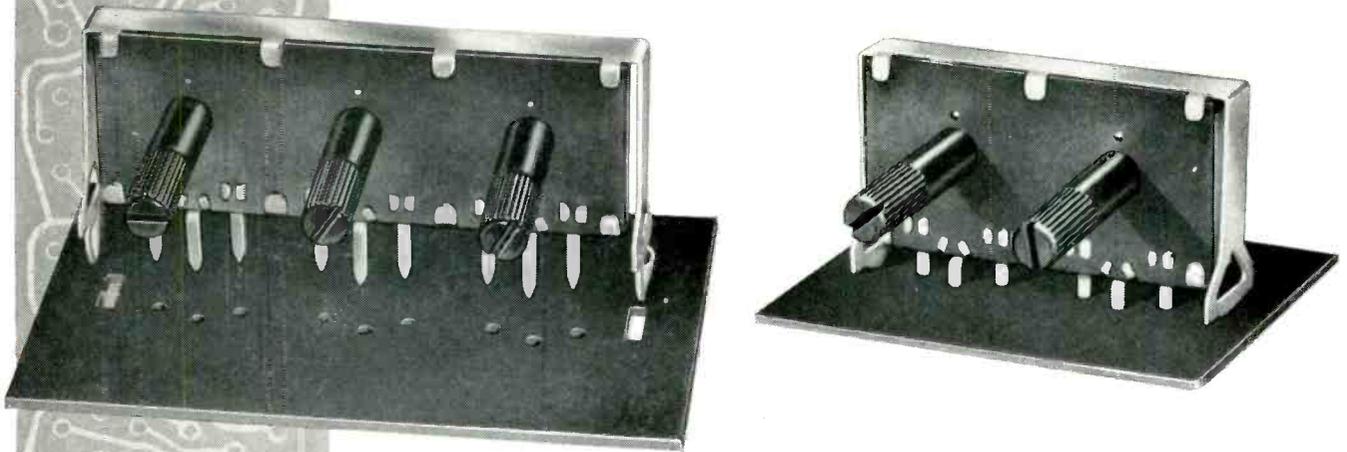
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No mounting hardware, no separate support needed.
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3. The only variable resistor with external contour designed specifically for mechanized handling and feeding into a printed panel.
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5. Mounts upright with shafts parallel to printed panel, eliminating need for shaft protection during panel solder immersion.
6. Available in 2-control units (Series X52) or 3-control units (Series X53) as illustrated.

Many other types of controls available for your printed circuit and automation needs.

A CTS control can be tailored to your specific requirement. Let CTS SPECIALISTS help solve your current control problems. Write or phone today.



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ME56-4

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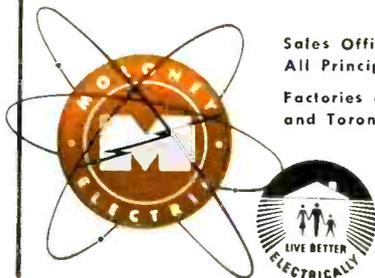


MOLONEY ELECTRIC COMPANY

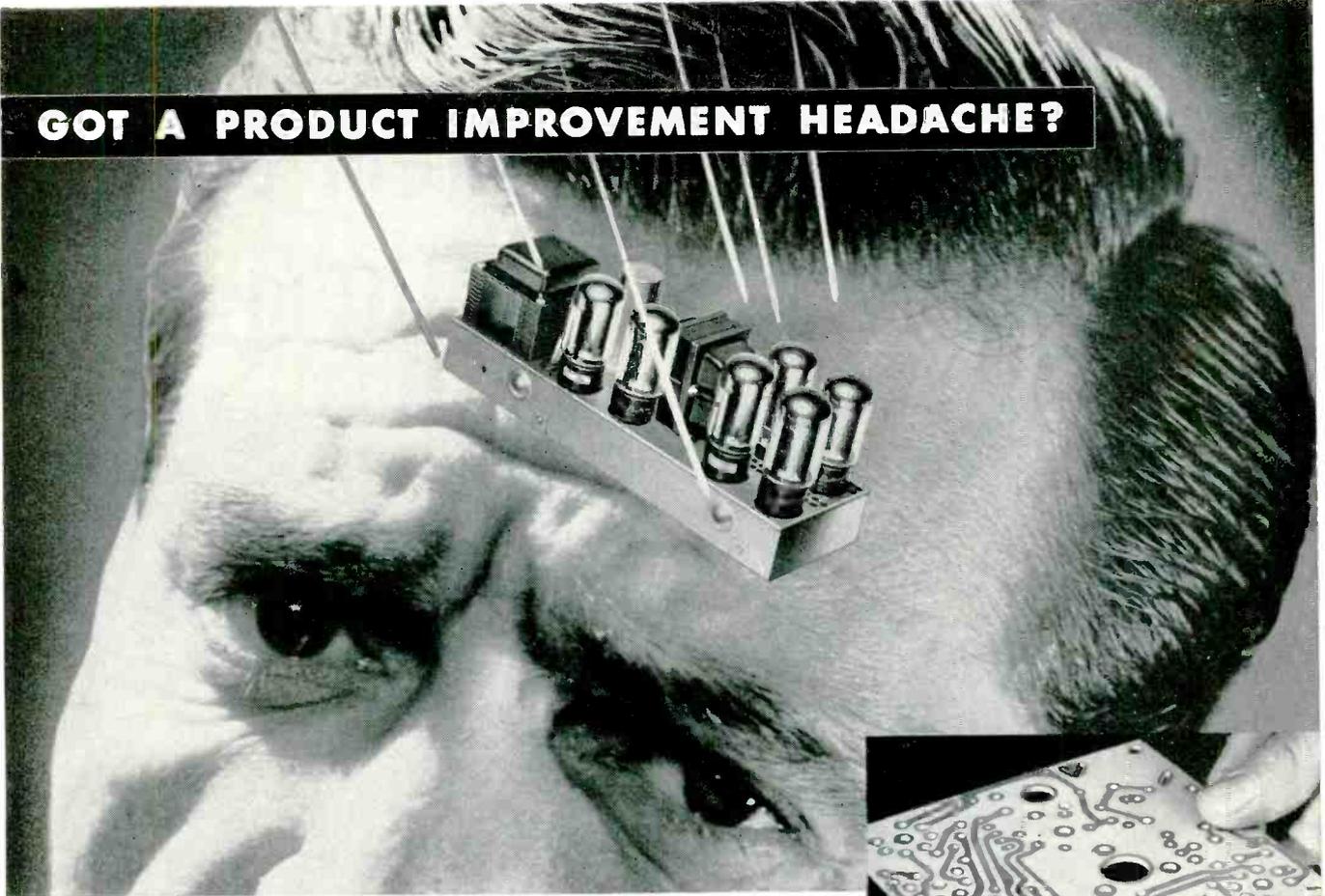
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All Principal Cities

Factories at St. Louis 20, Mo.
and Toronto, Ont., Canada



GOT A PRODUCT IMPROVEMENT HEADACHE?



LOOK TO G-E "THRU-CON" PRINTED CIRCUIT BOARDS FOR FAST, SURE RELIEF

General Electric "Thru-Con" Boards Eliminate Eyelets, Have Circuits Both Sides, Reduce Size and Weight

Aspirin can't help a product improvement headache—but a good design idea can! Printed circuitry, for example. A recent study shows that 7 out of 10 electronic and electric products may gain immediate improvements using printed circuits.

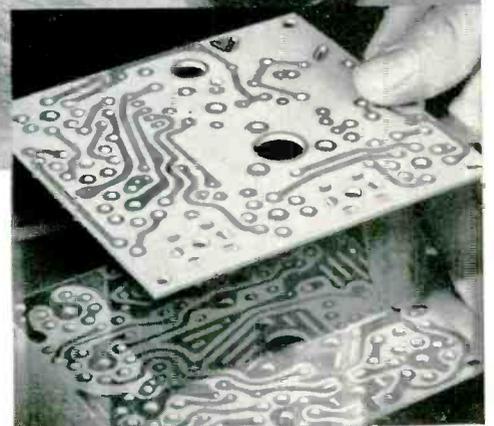
Circuits on Two Sides If Needed

Two-sided boards eliminate heavy metal parts, make miniaturization possible. Product is improved by simpler construction and more compact assembly design.

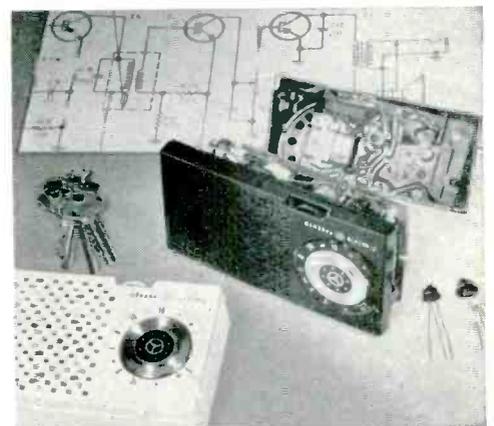
Printed Circuits Now In Many Products
G-E "Thru-Con" Boards are being

used now in lamps, fans, street lighting systems, kitchen appliances, radios, television, and control equipment of many kinds. In addition, General Electric engineers are working with other industries in the development of design improvements with "Thru-Con" Boards.

G-E "Thru-Con" Man Has The Answers
Your G-E "Thru-Con" man can guide you along the road to better product design. He will analyze present designs, study assembly methods, discuss your market needs. Then, he will show you how "Thru-Con" Boards may help smooth the way for product improvements. Call him in, or, write: *General Electric Co., Electronic Components Dept., Section X446, Auburn, N. Y.*



G-E "Thru-Con" Printed Circuit Boards offer positive connection through the holes, without staking pins, patterns on both sides if needed. Printed circuitry cuts assembly time, eliminates product bulk and weight, reduces inspection time and parts inventory.

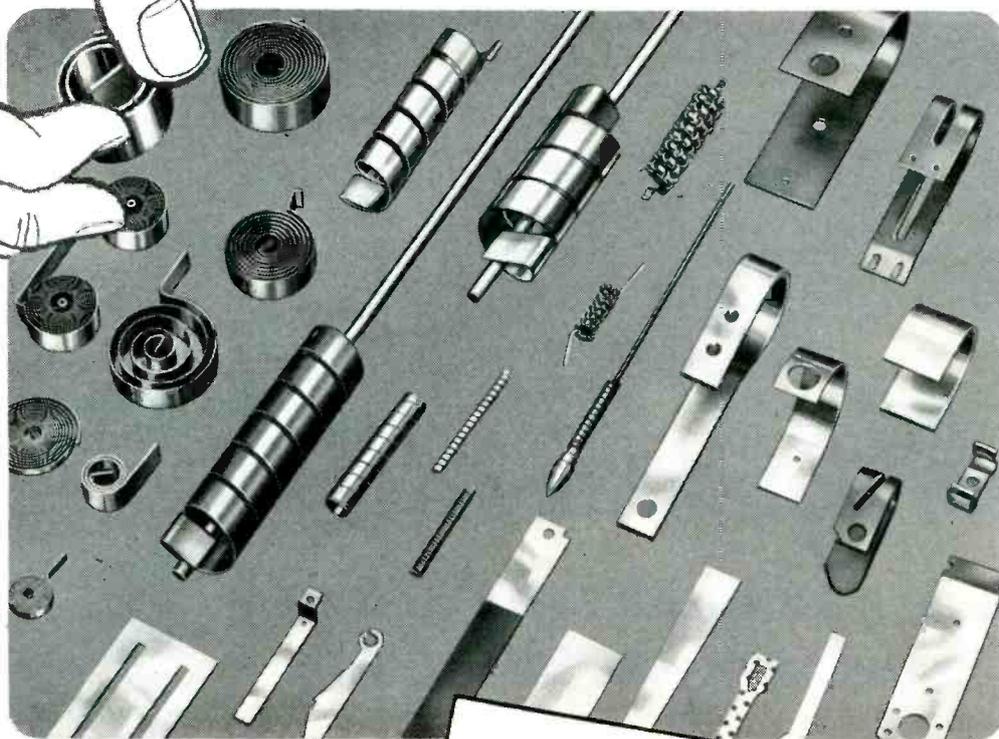
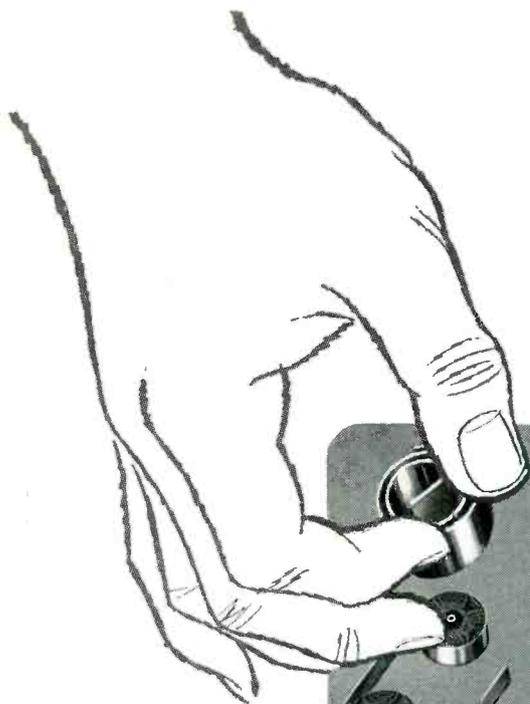


Positive Proof. This new transistorized portable radio features a full printed circuit using a General Electric "Thru-Con" Board. Combining other advances in electronics with a "Thru-Con" circuit makes possible sweeping changes in size, weight, and styling.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

Pick Them Up and Put Them In...



Yes — it can be that simple when you use TRUFLEX Thermostat Metal elements and assemblies.

Give us the specifications you want to work to, and we'll make TRUFLEX Thermostat Metal parts that are really at home in your product.

Or, if you prefer to make your own thermal elements, General Plate will produce TRUFLEX in strip form to accurately meet your thermostat metal specifications. Either way you will find that General Plate TRUFLEX Thermostat Metal brings about worthwhile savings in production costs by reducing assembly problems in your products. You get consistently accurate performance of parts or strip because every order comes to you an exact duplicate of the original.

And remember — over forty different types of TRUFLEX Thermostat Metal are available to you — types covering a wide range of temperature extremes for thermostat applications — for immersion in water or steam without corrosion problems — in preferred resistance series to simplify calibrations of current operated devices — for needed spring characteristics in thermal latches — or what have you? Write for TRUFLEX Thermostat Metal Catalog and engineering assistance.

GENERAL PLATE
TRUFLEX[®]
THERMOSTAT METALS

Fit Into Your Product Picture
**with economy, uniformity,
and outstanding
performance**

**You can profit by using
General Plate Composite Metals!**

**METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION**

34 FOREST STREET, ATTLEBORO, MASSACHUSETTS

POLARAD

TV EQUIPMENT FOR STUDIO and LABORATORY

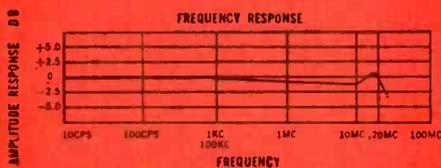
WIDE BAND VIDEO AMPLIFIER

10 cps to 20 mc

An oscilloscope deflection amplifier for measuring and analyzing pulses! Extremely wide band with extended low frequency response down to 10 cps. Will accurately analyze television signals. Excellent to increase the amplitude range of your vacuum tube voltmeters and signal generators.



MODEL VT



The Polarad Wide Band Video Amplifier offers an extremely wide band coverage: flat within $\pm 1\frac{1}{2}$ db from 10 cycles to 20 megacycles per second. It has a time delay of 0.02 microseconds and assures extreme stability because of its associated electronically regulated unit. A low capacity input probe is provided.

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

TV STUDIO MONITOR MODEL M-105



MODEL M-105

The Polarad Model M-105 is portable — comes in sturdy aluminum case, can be rack mounted as well! And it is one of the finest instruments available to check the picture quality of video signals. Equipped with 12½" aluminized kinescope, capable of presenting highest definition transmitted pictures with exceptionally good "sync" stability over a wide range of operating conditions.

PORTABLE TV WAVE FORM MONITOR



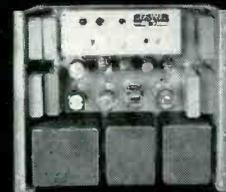
MODEL TO-1

EXCELLENT FOR SUBCARRIER MEASUREMENTS
LOOK AT THESE FEATURES:

1. Can be rack mounted.
2. Can be used for both color and black and white TV.
3. Vertical Amplifier Bandwidth Switch for 2MC, 4MC, 6MC.
4. Special TV Sync. Circuits.
5. Horizontal Sweep Magnification 20 Tube Diameters.
6. Compact and Rugged.

VERTICAL MOUNT REGULATED POWER UNITS

Here are electronically regulated power units completely accessible from the front and back because of their vertical mount design. They have extremely fine regulation, low ripple content and appreciable quantities of D. C. power.



MODEL
PT-110

SPECIFICATIONS

	Model PT-110	Model PT-111
Output Voltage DC	400-450 Volts	250-300 Volts
Output Current	150-230 ma	100-400 ma
Output Impedance	Less than 1.5 ohms	Less than 1.5 ohms
Regulation	Better than 0.2%	Better than 0.2%
Ripple	Less than 12 mv rms	Less than 8 mv rms
Negative Supply	-150 @ 0.05/20 ma	-150V @ 0.10 ma
Filament Supply	a. 6.3V @ 12 a b. 0.3V @ 12 a	a. 6.3V @ 12 a AC b. 6.3V @ 12 a
Power Input	105-125V 50/400 cps	105-125V 50/400 cps



MODEL
PT-112

SPECIFICATIONS

	Model PT-111D	Model PT-112
	Dual power unit, each slice provides:	
Output Voltage	250-300V DC	250-300 V DC
Output Current	100-400 ma	150-400 ma
Output Impedance	Less than 1.5 ohms	Less than 1.5 ohms
Regulation	Better than 0.2%	Better than 0.2%
Ripple	Less than 8 mv rms	Less than 8 mv rms
Line Voltage	105-125*, 50/400 cps	105-125V 50/400 cps
Series Operation	500-600 Volts	
Output Power	100-400ma	
Parallel Operation		
Output Power	250-300 Volts	
	200-800 ma	

These features assure dependable, highest quality performance:

- Precise electronic voltage regulation
- Low ripple content
- Does not utilize electrolytic condensers
- Sturdy construction
- Provisions for rack mounting.

Polarad manufactures a complete line of color TV equipment including a Color Slide Scanner, Sync Generator, Bar Generator and Color Monitors.



ELECTRONICS CORPORATION 43-20 34th STREET, LONG ISLAND CITY 1, N. Y.

REPRESENTATIVES • Albuquerque • Atlanta • Baltimore • Boston • Buffalo • Chicago • Dayton • Englewood • Fort Worth • Los Angeles • New York
Philadelphia • San Francisco • Syracuse • Washington, D. C. • Westbury • Winston-Salem • Canada, Arnprior, Toronto—Export: Rocke International Corporation

The Year Advertising Helped

IN 1954 we had a business recession in the United States. Sales fell about 4% during the year. If management had followed the historic pattern of business ups and downs, advertising volume would have fallen much further.

But in 1954 the volume of advertising did not fall. It increased over 5%. Every effort was made to stimulate sales when sales were needed to sustain prosperity.

This was something entirely new under the sun. It had a powerful influence in making the recession of 1953-54 one of the mildest on record. It helped greatly to speed business on to the record-breaking levels it has attained today.

There are several reasons why America's business management attacked this decline in sales with more advertising. One of them grew out of the greatly strengthened position of the American consuming market. Consumers' income after taxes has been rising an average of over \$10 billion a year since 1946, and this rising income is more widely distributed than ever before. Furthermore, consumers have piled up reserves of about \$215 billion in cash or its

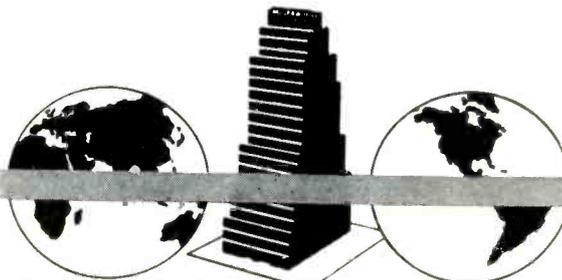
equivalent. These reserves offer a new and powerful inducement to increased selling and advertising effort even in the face of a possible decline in consumer income.

Taking the Longer View

However, the principal reason why a sales decline was attacked with increased advertising is management's new-found conviction that good advertising is essentially an investment in the development of a market. Successful development requires sustained investment. The inclination of business management to take this longer view, is, of course, motivated by the fact that the American market, with over 3 million consumers being added annually, is growing at a prodigious rate.

Ten years ago only a handful of companies had plans for investment in new producing facilities extending beyond the current year. Today almost all leading companies have investment programs running some years ahead. And keeping pace with these long-range business investment plans has been the development of sales and advertising programs to

McGraw-Hill
PUBLISHING COMPANY, INC.
330 West 42nd Street, New York 36, N. Y.



HEADQUARTERS FOR

BUSINESS INFORMATION

Kill a Business Recession

reach tomorrow's greatly expanded markets.

This crucial role of advertising in providing driving power for our economy is gaining greater recognition every day. In his recent book, "People of Plenty," Professor David M. Potter of Yale University remarked: "Advertising is not badly needed in an economy of scarcity, because total demand is usually equal to or in excess of total supply, and every producer can normally sell as much as he produces. It is when potential supply outstrips demand—that is, when abundance prevails—that advertising begins to fulfill a really essential economic function."

Advertising's Key Role

Today abundance so completely prevails in the United States that it has been conservatively estimated that as much as a third of everything offered for sale falls in the realm of "optional consumption." That is, consumers can "take it or leave it" without any immediate personal inconvenience. But if they decide to "leave it," a terrific economic depression will not be far behind. In such circumstances, advertising—in

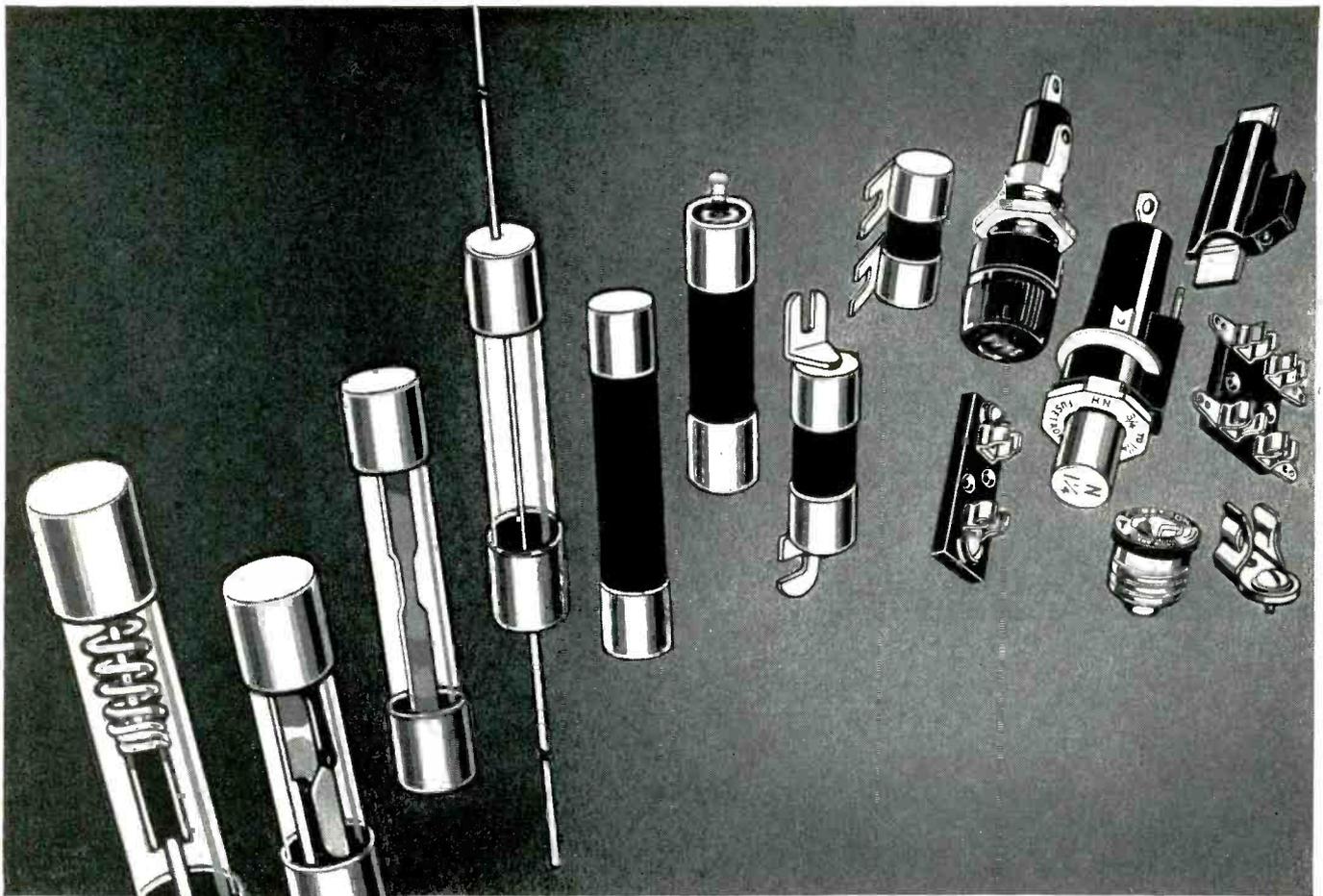
which, in all of its forms, we are now investing about \$9.2 billion annually—clearly is of crucial importance to our continued prosperity.

In performing its key role in past years, American advertising never realized its full potential. It successfully promoted sales. But it never was called upon to promote an overall economic stability as a direct outgrowth of increased sales.

By successfully promoting both sales and economic stability, as it did in 1954, advertising surely has added new strength to the American economy. It has also added a great new and constructive dimension to advertising itself. This accomplishment gave great significance to the celebration of the first National Advertising Week in February, 1956.

One of the surest means of expanding your sales volume in today's \$150 billion *industrial* market is through dominant advertising in the publications directly serving your major customers and prospects.

McGraw-Hill's business and technical publications can give you quick access to the men who initiate, specify and approve the purchases of industrial products and services. Because all are leaders in their respective fields, you are assured a maximum return on your investment when you specify a McGraw-Hill publication to carry your advertising to your most important markets.



You'll quickly find the right fuse for the job everytime — when you turn to BUSS Fuses

The complete BUSS fuse line includes: standard types, dual-element (slow blowing), renewable and one-time types — available in all standard sizes, and many special sizes and designs. Plus a companion line of fuse clips, blocks and holders.

Simplify your purchasing, stock handling and records — by standardizing on this one, reliable source for fuses.

BUSS Trademark is your assurance of "trouble-free" protection

BUSS fuses are electronically tested to make sure they will operate as intended under all service conditions. A sensitive device auto-

matically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

Save engineering time on electrical protection problems. The BUSS fuse engineers are at your service to help you determine the fuse or fuse mounting best suited to your needs. If possible, they will suggest a fuse or fuse mounting already available in local wholesalers' stocks, so that your device can be easily serviced.

For more information on BUSS and FUSETRON small dimension fuses and fuseholders, write for bulletin SFB.

ELRC 456

MAKERS OF A COMPLETE LINE OF FUSES FOR
HOME, FARM, COMMERCIAL, ELECTRONIC,
AUTOMOTIVE AND INDUSTRIAL USE.

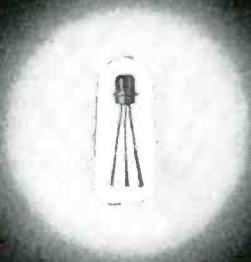


BUSSMANN MFG. CO.
(Div. of McGraw Electric Co.)

UNIVERSITY AT JEFFERSON, ST. LOUIS 7, MO.

New from PHILCO

SHOWN ACTUAL SIZE



ONLY 0.160" x 0.130"

World's Smallest Transistor

-  Hermetically sealed, resistance-welded metal case
... leads sealed in glass.
-  Exceedingly low noise.
-  Uniformity of electrical characteristics.
-  Maximum reliability and long life.
-  Impervious to moisture and humidity.

Opens the way to new advances in space-saving audio design

A new achievement from Philco laboratories, the M-1 "Audio Mite" Transistor is smaller than any transistor now in production! It retains all the desirable electrical characteristics, all the mechanical features, all the performance of the Philco 2N47... the transistor proved in the field to be without equal in hearing aid applications. The "Audio Mite" is hermetically sealed in metal the unique Philco way... the design that has earned a reputation as the most reliable hermetic seal in the industry. A wide new field in low level audio applications is opened to design engineers by this tiny PNP alloy junction transistor.

For complete technical information write to Dept. E-2

LANSDALE TUBE COMPANY
A DIVISION OF PHILCO CORPORATION
Lansdale, Penna.

PHILCO CORPORATION

LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA

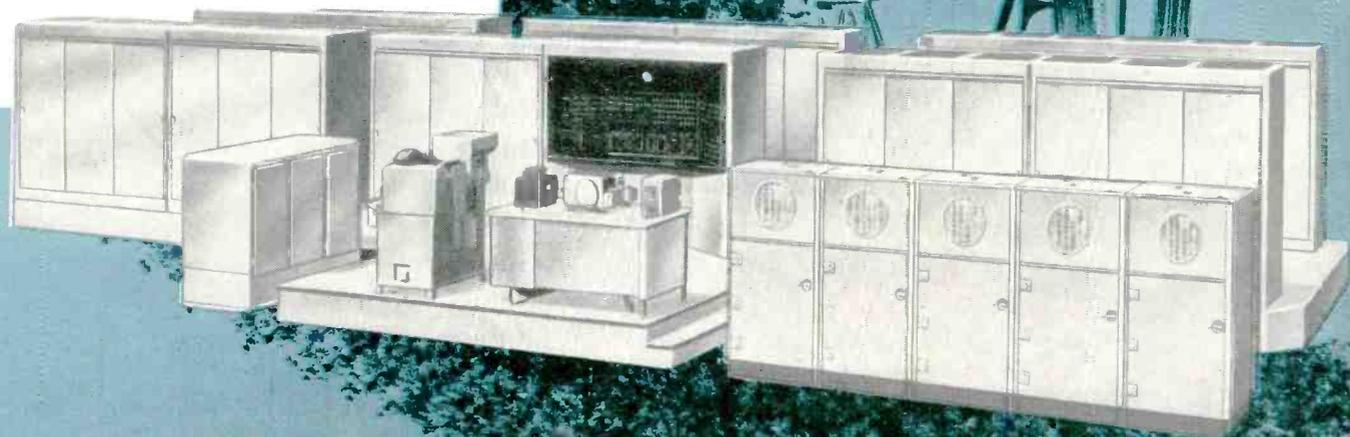
univac

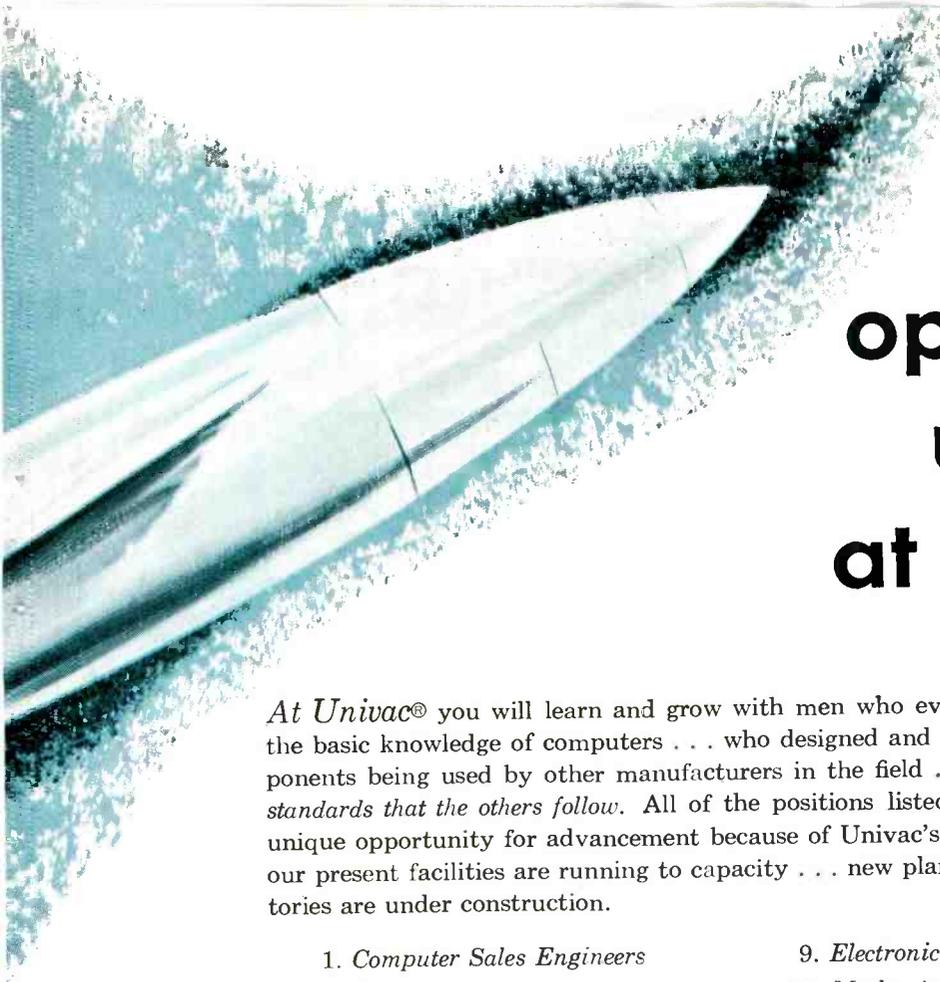
proves itself at White Sands

On a hundred-mile strip of barren New Mexican soil, Uncle Sam has teamed up one of his newest and mightiest weapons of war—the guided missile—with one of science's latest marvels—the ingenious electronic computer built by Remington Rand Univac.

Closely associated to the guided missile testing program, the Remington Rand Univac Scientific has proved a real short cut in the development of this new weapon which may play a vital role in any future war. The task of this "electronic brain" is to compute and analyze the enormous amounts of data taken from each firing of a missile and turn out the results in time for its use when the next missile is fired. This enables the corps of experts conducting the tests to push forward the program much faster than otherwise would have been possible.

Each day at White Sands and numerous other places, the Remington Rand Univac Scientific proves itself "First in Electronic Computer Systems".





opportunities unlimited at **UNIVAC**

At *Univac*® you will learn and grow with men who evolved much of the basic knowledge of computers . . . who designed and produced components being used by other manufacturers in the field . . . *who set the standards that the others follow.* All of the positions listed below offer a unique opportunity for advancement because of Univac's expansion . . . our present facilities are running to capacity . . . new plants and laboratories are under construction.

- | | |
|---|---------------------------------|
| 1. <i>Computer Sales Engineers</i> | 9. <i>Electronic Engineers</i> |
| 2. <i>Technical Liaison Engineers</i> | 10. <i>Mechanical Engineers</i> |
| 3. <i>Proposal and Quotation Experts</i> | 11. <i>Mathematicians</i> |
| 4. <i>Metallurgists</i> | 12. <i>Physicists</i> |
| 5. <i>Product Planning Engineers</i> | 13. <i>Programmers</i> |
| 6. <i>Field Location Engineers</i> | 14. <i>Logical Designers</i> |
| 7. <i>Contract Administration Engineers</i> | 15. <i>Production Engineers</i> |
| 8. <i>Instrumentation and Component Sales Engineers</i> | |

A man doesn't advance very far or very fast from experience alone . . . that experience must be coupled with professional development and recognition by superiors . . . and a man who is only "holding his own", while others are advancing, is actually losing ground.

Professional advancement is dependent upon many factors such as association with recognized technical leaders . . . recognition of individual contribution through merit review, publication of technical papers and technical society membership . . . participation in management decisions and planning . . . the availability of a continuing formal educational program . . . the guidance of a young, technically trained management.

Now is the time to come to Remington Rand Univac where ambition and professional skill find their reward . . . advancement comes quickest in an expanding organization.

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FOR THE
JUNE GRADUATE



FOR THE
EXPERIENCED
ENGINEER



FOR THE
SCIENTIST



Send complete resume to

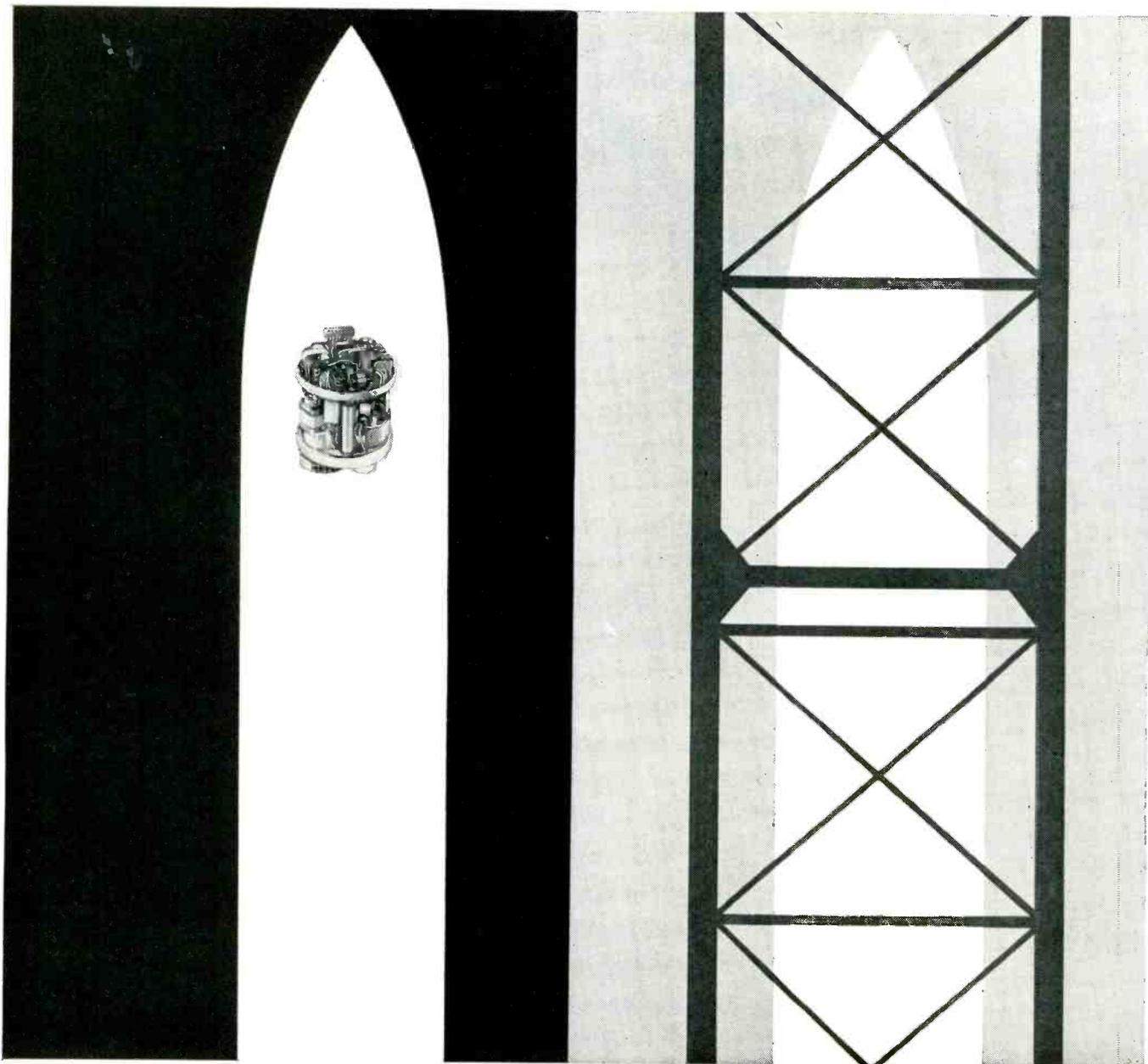
Remington Rand Univac

DIVISION OF SPERRY RAND CORPORATION
AT ANY OF THESE PLANT LOCATIONS

MR. D. A. BOWDOIN
Dept. AP-2
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Philadelphia, Pa.

MR. R. K. PATTERSON
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From sensitive components to brawny launchers...

AMF has missile experience you can use

• "Precisioneering" power supplies for electronic control systems and developing complex launchers are two of AMF's *many* important contributions to our nation's missile programs • Today, AMF plays a part in *more than half the missile programs now under way* • And its activities cover practically every stage of design, development, and production . . . including mechanical, hydraulic, pneumatic and electronic test equipment . . . auxiliary power supplies . . . field and depot handling equipment . . . launchers . . . ground and flight control systems • See for yourself why AMF's experience in missiles, as well as in a host of other fields, has made it the "can do" company.

Research, Development,
Production in these fields:

- Armament
- Ballistics
- Radar Antennae
- Guided Missile Support Equipment
- Auxiliary Power Supplies
- Control Systems



Defense Products Group

AMERICAN MACHINE & FOUNDRY COMPANY

1101 North Royal Street, Alexandria, Va.

ANNOUNCING A NEW HIGH IN MAGNET PERMANENCY

Unique Ceramic Permanent Magnets are extremely resistant to demagnetization . . . Are virtually electrical non-conductors—
Use no critical materials . . . Cost materially less

A LOW COST ceramic permanent magnet material developed by the Stackpole Carbon Company, St. Marys, Pa. combines adequate energy product with high coercive force, low residual induction, virtually 100% electrical resistivity and exceptional resistance to demagnetization. These unique characteristics plus the low cost and the non-critical nature of the ceramic make magnets of this material ideally fitted for all ordinary uses as well as highly critical applications such as those where the magnets may be exposed to strong demagnetizing fields.

No "Keepers" Needed

Known as Stackpole Ceramagnet* permanent magnets, the new units retain their energy even when used without "keepers" or other closed-circuit conditions, and in the presence of opposing fields.

As an example, Ceramagnet cannot be demagnetized by another magnet of a force up to 2,000 gauss.

Ceramagnet magnets are practically non-conductors. Electrical resistivity is 6×10^{10} ohm-cm, making them ideally suited for high-frequency and high-voltage circuits. They can be placed in the direct path of electro-magnetic energy to rotate the polarization plane, to focus cathode ray tube beams or for similar purposes.

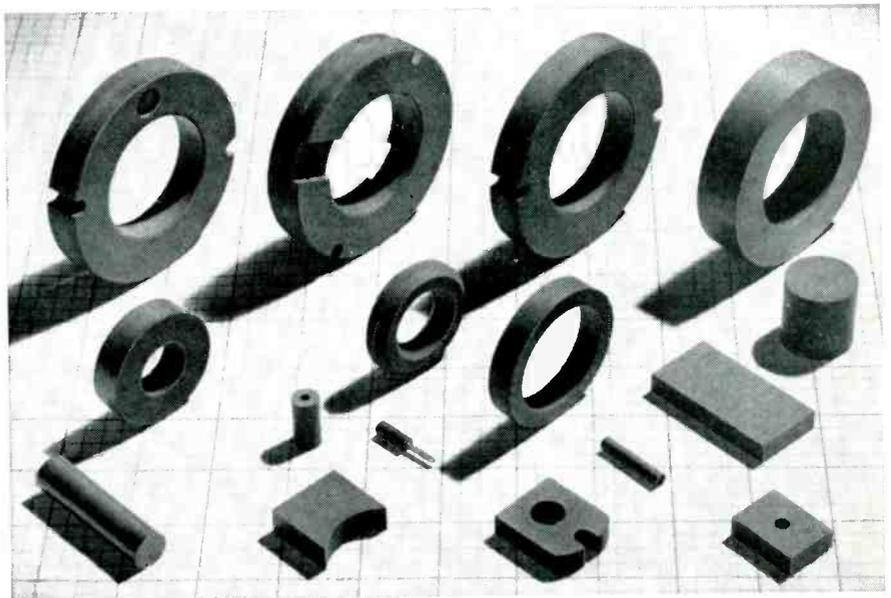
Unaffected by Strong Opposing Fields

Their magnetism is unaffected by their surroundings. They themselves exert little or no proximity effect on nearby circuitry.

Another feature that may offer interesting possibilities in some applications is the fact that Ceramagnet temperature characteristics are linear, including retrace, to 400°C.

Typical Ceramagnet applications range from magnetic focusing of cathode ray beam tubes to use on door latches, magnetic drives, instruments, oil filters, meters, toys, relays, magnetic attenuators, cou-

*Registered trademark



A TYPICAL GROUP of Stackpole Ceramagnet* ceramic permanent magnets. Practically any size or shape within the range of modern molding equipment can be supplied.

plings, magnetic seals, motors, small generators, H-F alternators, magnets, ion traps and others.

Cost Less, Weigh Less Than Metallic Magnets

Made of non-critical, inexpensive barium and iron oxides, the new Stackpole permanent magnets are blended, molded and sintered by much the same processes that have made Stackpole iron and ferromagnetic processes pre-eminent in the core fields for many years.

Ceramagnet is classed among the hard magnetic materials.

Cost is materially less than metallic magnets. Weight is also less . . . only 4.85 gms/cm³.

Although the energy product (0.915×10^6 gauss-oersteds) is less than that of metallic permanent magnets, the important point is that Ceramagnet's full energy is available

under practically any condition, even without "keepers".

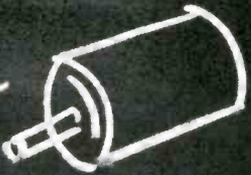
Even in cases where it might be necessary to use a larger Ceramagnet magnet, the cost factor would still be in its favor.

Units are machineable by wet grinding and may be machined *after* magnetizing.

Highest energy product is obtained by magnetizing across thinner sections although units can be magnetized in any direction.

Write for New Ceramagnet Data Bulletin

Complete engineering data on Ceramagnet including graphs of essential properties appears in the new Stackpole Ceramagnet Bulletin RC-10A. Copies are available on request to **Electronic Components Division, Stackpole Carbon Company, St. Marys, Pa.**

G-M Servo Motors 

GUARANTEED

TO MEET ALL MIL.
ENVIRONMENTAL
SPECIFICATIONS

By specializing in
servo motors only—not
systems—G-M gives
you these advantages...

- A broader line of servo motors in sizes and types to meet a wide range of applications.
- Servo motors available in *all* the standard sizes.
- Standard sizes specially modified to meet specific circuit requirements—available on a quick-service basis.
- Creative engineering in designing special motors with special characteristics.
- Faster production—better service.

When reliability under extreme conditions is essential—specify G-M Servo Motors! G-M has long specialized in supplying precision servo motors to the Military Avionic Industry, especially designed to meet

military specifications for humidity, salt spray, temperature, vibration and altitude. Whatever your needs, let G-M build a servo motor with the *right* characteristics to perform to your specifications.

Write today for G-M charts,
specifications, or consultation.



Servo
Motors



Motor Generators



Synchronous-
Hysteresis Motors



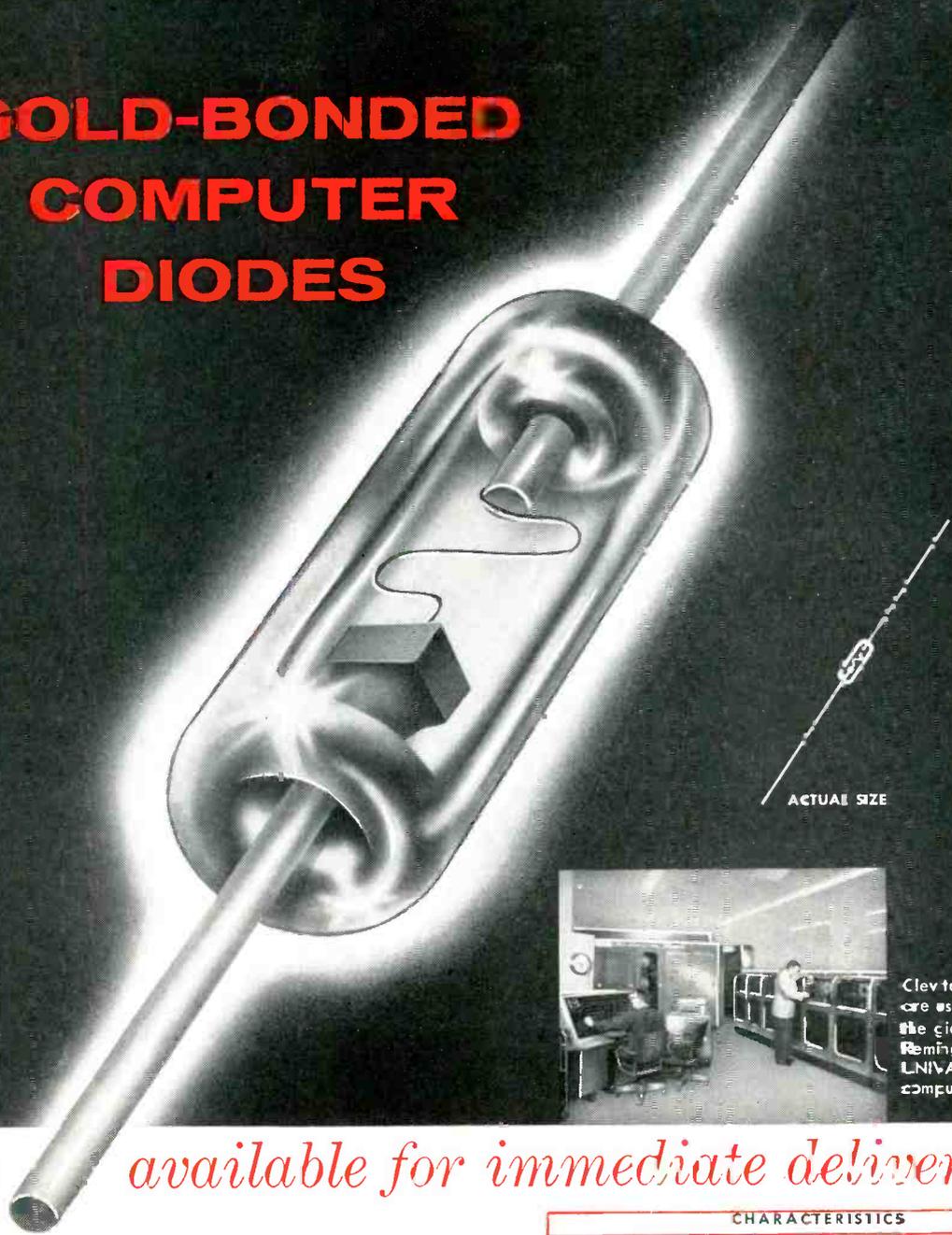
G-M Servo Motors

manufactured by the Components Division of

G-M LABORATORIES INC.

4336 N. Knox Avenue • Chicago 41

GOLD-BONDED COMPUTER DIODES



ACTUAL SIZE



Clevite diodes are used for the giant Remington Road LNVAC computer.

now available for immediate delivery...

ADDITIONAL DIODES AVAILABLE

- High Conductance Types
- High Resistance Types
- High Temperature Types
- JAN Types

For high forward conductance . . . for high inverse resistance . . . for fast pulse recovery . . . for low impedance and fast forward switching time . . . whatever you require in a subminiature gold bonded glass diode, Clevite Transistor Products can deliver the diode you need in the quantity you want, *when you want it* . . . and at competitive prices!

Contact us for Prices and Specifications.



CLEVITE

TRANSISTOR PRODUCTS

241 Crescent St., Waltham 54, Mass. TWinbrook 4-9330

CHARACTERISTICS				
TYPE	Forward Current at +1V (ma. Min.)	Inverse Current at Specified V (μa. Max.)	Continuous Inverse Operating Voltage	DESCRIPTION
CTP-301	40	25 @ -50V 100 @ -20V @ 75°C	60	Inverse Recovery Time Tested.
CTP-320 (Equal to 1N67A)	5	50 @ -50V	80	Inverse Recovery Time Tested.
CTP-319	150	500K between -20 and -90V	90	Inverse Recovery Time Tested.
CTP-318	50	500K between -10V and -50V	60	Forward and Inverse Recovery Tested.
CTP-307	300	20 @ -30V	40	Inverse Recovery Tested.
1N270	200	100 @ -50V	60	Low Impedance Fast Forward Switching Time.
1N283	200	20 @ -10V	20	" "
1N273	100	20 @ -20V	30	" "
CTP-316	100	20 @ -50V 2 @ -10V	60	Hi Resistance Hi Conductance
1N198 JAN Typo	4	50 @ -50V 10 @ -10V	80	Hi Temperature Diode



Standard Chrono-Tach shown front and center in "deep freeze" engine testing laboratory. (Courtesy of Thompson Products, Inc.)

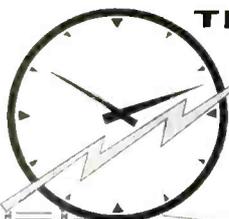
LOOK TO THE INSTRUMENTS USED FOR DEPENDABLE END RESULTS

In almost every research and testing laboratory the information needed to obtain a specific end result depends upon knowing, to an accurate degree, the speed of revolving shafts, motors, governors or other rotating equipment.

And it's a well-known fact that the end result can be no more reliable than the instruments that are used.

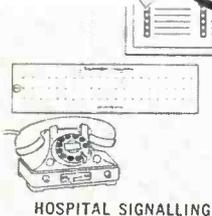
That's why the Standard Chrono-Tachometer plays such an important role in so many industrial, governmental and educational laboratories. Built for *continuous* service, it is a test instrument of extreme accuracy, invaluable wherever the precise measurement of speed of rotation is required.

Write for Engineering Bulletin #218

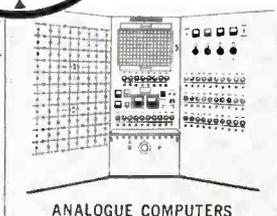


THE **Standard**
ELECTRIC TIME COMPANY

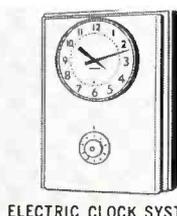
97 Logan Street • Springfield 2, Massachusetts



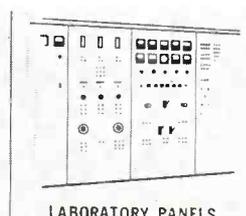
HOSPITAL SIGNALLING



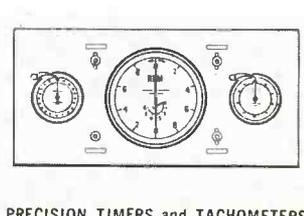
ANALOGUE COMPUTERS



ELECTRIC CLOCK SYSTEMS



LABORATORY PANELS



PRECISION TIMERS and TACHOMETERS



another research and development problem

Solved by Seeburg!

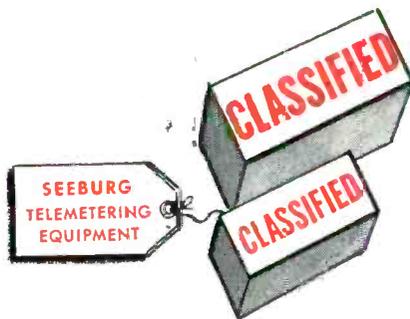
Navy selects Seeburg to develop telemetry...

PROBLEM—In the initial stages of a missile program, Seeburg was approached by the Bureau of Ordnance, Department of the Navy, to develop telemetering equipment . . . equipment which would transmit information while the missile was in flight.

SOLUTION—Now in production at Seeburg, and reliably performing the job for which it was intended, this Seeburg designed equipment is today checking and testing over 20 important channels of information.

Solving highly complex electronic and electro-mechanical problems is a specialty with Seeburg, where a major portion of facilities and talents are permanently devoted to engineering and production of defense products. It's the reason why more and more procurement agencies and defense contractors are making it a practice to see *Seeburg first!*

ENGINEERS—You are invited to write us for complete information on challenging opportunities in our engineering division.



- Servo Systems
- Radar Assemblies
- Aircraft Controls
- Audio Amplifiers
- Digital Storage Systems
- Airborne and Shipboard
- Navigation Equipment

J. P. Seeburg
CORPORATION
Established 1902

1500 North Dayton Street - Chicago 22, Illinois

- High and Low Frequency R.F. Transmission and Receiving Sets
- Guided Missile Electronic Units
- Airborne Radar Antennas
- Micro Wave Equipment
- Magnetic Tape Recorders
- Telemetric Equipment
- Electronic Computers
- Music Systems

WORLD'S LEADING MANUFACTURERS OF AUTOMATIC MUSIC SYSTEMS

THE
Heiland
**119 AMPLIFIER SYSTEM
 FOR OSCILLOGRAPHIC
 RECORDING**

**COMPARE
 THESE FEATURES
 WITH SIMILAR SYSTEMS:**

TWICE THE SENSITIVITY— $\frac{1}{2}$ millivolt for full current output

TWICE THE FREQUENCY RESPONSE—0 to 1000 c.p.s.

TEN TIMES THE CURRENT OUTPUT—50 ma into 20-ohm load

with—
EXCELLENT STABILITY—less than 2% variation with line voltage fluctuation and wide range of ambient temperatures

Carrier Amplifier Units for:

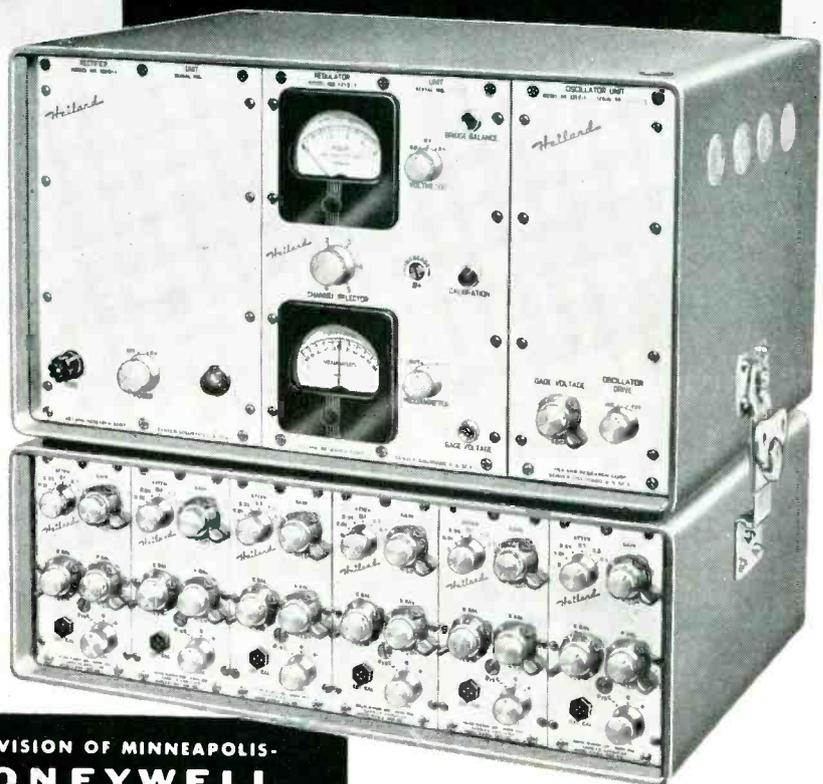
Resistive transducers

Linear differential transformer pickups

Variable reluctance gages

Linear-Integrating Amplifiers for:

Self-generating transducers.



Heiland®



A DIVISION OF MINNEAPOLIS-
HONEYWELL
 5200 E. Evans, Denver 22, Colo.

**FOR ADDITIONAL
 DETAILS
 WRITE FOR
 BULLETIN 101K**

All these features—plus many more—have moved Heiland 119 Amplifier Systems into leadership in the field!

All operating controls are on the front panel; all cabling is on the back panel for handy relay rack or test bench mounting without modification.

The 119 System is flexible to meet present or future needs, since all 6 individual amplifier units within the system are easily removable. You can build your system from the ground up, adding new individual units as your need expands.

In addition, linear-integrate and carrier units are interchangeable within the system case.

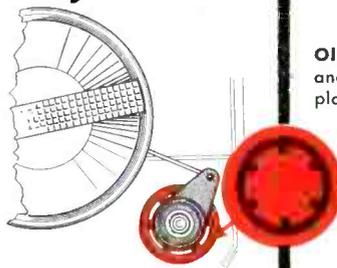
FOR PERFORMANCE AND CONVENIENCE—CHOOSE THE HEILAND 119 AMPLIFIER SYSTEM.

5 Waldes Truarc Rings simplify assembly, eliminate parts, bring big over-all savings to new design low-cost camera

Anscoflex II Camera



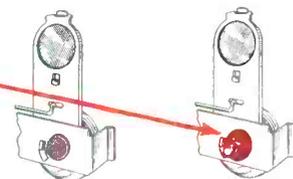
Key Shaft



Parts originally designed for self-locking Truarc ring (series 5105). Some cameras in the past had brass cup staked to the body. At times staking operation cracked the plastic, resulting in loss of expensive part.

Portrait and Filter Lens Knob Assemblies

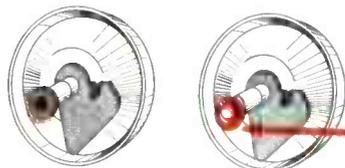
Old way: Knob with plastic shaft used washer and heat forming operation that flattened the plastic pin and locked the pivot in position.



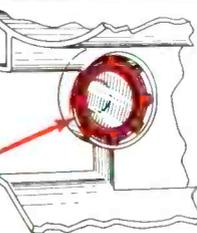
Truarc way: Molded plastic knob with pin is easily and quickly held by a Truarc self-locking ring (series 5105). No groove is necessary. Washer is eliminated and it is possible to remove ring if necessary without damage to knob.

Winding Knob

Old way: With screw and washer design, it was necessary to disassemble entire camera to remove screw which secured winding knob. Self-topping screw sometimes failed to secure knob, produced excessive end play.



Truarc way: Truarc "E" ring (series 5133) allows removal of winding knob without major disassembly of camera, reducing repair time. Use of stacked rings and Truarc applicator saved \$10.40 per M on labor. Material saving: \$2.29 per M.

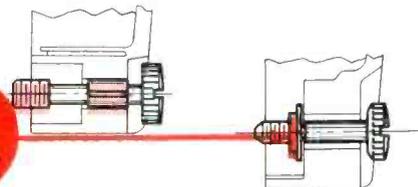


Rear Lens

Parts originally designed for self-locking Truarc ring (series 5005). Some cameras in the past had glass element secured by heat forming tabs from plastic body. Loose or chipped elements resulted in loss of both parts.

Flash-Gun Case Assembly

Old way: In the original design a sleeve was wrapped around neck of screw and pressed into hole of plastic cover. Close working areas made assembly difficult and required extra operation to lock ring into place.



Truarc way: Series 5133 E-Ring snaps onto unthreaded shank of screw quickly, needs no special groove. Labor saving \$7.06/M.

Anco, Binghamton, N. Y., uses the latest technical advances in construction to produce an economical, easy-to-use reflex camera. 5 Waldes Truarc Rings are used in this new design to save material and labor costs, eliminate parts, simplify assembly and reduce rejects.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality con-

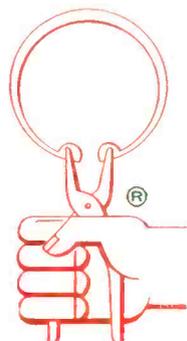
trolled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting... Waldes Truarc Grooving Tool!

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WALDES
TRUARC[®]
RETAINING RINGS

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Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
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City..... Zone..... State.....

E048

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

ALLIED'S HERMETICALLY SEALED RELAYS



MECHANICAL SPECIFICATIONS										ELECTRICAL SPECIFICATIONS			
ALLIED TYPE	TYPE OF TERMINAL	OUTLINE DIMENSIONS			WT. (OZ.)	MOUNTING DIMENSIONS		TYPE MOUNTING	CONTACT RATING (AMPS.)	CONTACT FORM MAX.	COIL DATA		
		A	B	C		D	E				MAX. D.C. OHMS	OPERT.	
ASH	SOLDER	2 1/8	2 1/8	1 1/8	1 1/8	3.5	.938	1.187	(3)#6-32 Studs	5	SPDT	3500 3485	AC DC
ASHO	PLUG-IN	3	2 1/8	1 1/8	1 1/8	4			Octal Plug-in	5	SPDT	3500 3485	AC DC
BJHR	SOLDER	3 1/2	2 3/32	1 5/8	1 1/2	7.5	.875	1.625	(3)#6-32 Studs	5	DPDT	3700 5000	AC DC
BJHRO	PLUG-IN	3 3/8	3 1/8	1 3/8	1 1/2	7.5			Octal Plug-in	5	DPDT	3700 5000	AC DC
BOH	SOLDER	3 1/2	2 3/32	2 3/8	DIA.	7.5	1.856	1.856	(4) 206 Dia. Holes	10	DPDT	2675 5000	AC DC
BOHO	PLUG-IN	3 3/8	3	2 3/8	DIA.	8			Octal Plug-in	5	DPDT	2675 5000	AC DC
BOHR	SOLDER	3 1/8	2 1/8	1 3/4	1 3/4	8.5	1.250	1.250	(3)#8-32 Studs	10	DPDT	2675 5000	AC DC
BOHRO	PLUG-IN	3 1/2	2 3/32	1 3/4	1 3/4	8.5			Octal Plug-in	5	DPDT	2675 5000	AC DC
BOYH	SOLDER	3 1/2	2 3/32	2 3/8	DIA.	8.5	1.856	1.856	(4) 206 Dia. Holes	10	DPDT	10,000	DC
BOYHO	PLUG-IN	3 3/8	3"	2 3/8	DIA.	8.5			Octal Plug-in	5	DPDT	10,000	DC
BOYHR	SOLDER	3 1/8	2 1/8	1 3/4	1 3/4	8.5	1.250	1.250	(3)#8-32 Studs	10	DPDT	10,000	DC
BOYHRO	PLUG-IN	3 1/2	2 3/32	1 3/4	1 3/4	8.5			Octal Plug-in	5	DPDT	10,000	DC
CNAH	SCREW	4 1/2	3 1/8	2 3/32	2 3/32	22	1 1/8	2"	(3)#10-32 Studs	50	SPST	600 4460	AC DC
DSH	SOLDER	3 1/2	3 1/2	3 1/2	1 1/8	13	1.375	3.125	(4) 206 Dia. Holes	5	DPDT	8,000	DC
DSHR	SOLDER	3 3/8	3 1/8	2 1/4	1 1/2	9.5	.687	1.750	(3)#8-32 Studs	5	DPDT	8,000	DC
KH-3-1D	PLUG-IN	1 3/4	3/8	3/8	4/8	0.33			7 Pin Plug-in	1/2	SPDT SPST NO	1,500	DC
KH-3-2D	PLUG-IN	1 3/4	3/8	3/8	4/8	0.33			7 Pin Plug-in	1/2	SPDT SPST NC	1,500	DC
KH-6D	PLUG-IN	1 3/4	3/8	3/8	4/8	0.33			8 Pin Plug-in	1/2	DPDT	5,000	DC
LKH-6C	SOLDER	3 1/8	3 1/8	1 1/8	1 1/8	8.5	1.375	1.500	(3)#6-32 Studs	2	6PDT	11,000	DC
LKH-4C	SOLDER	3 1/8	2 1/8	1 1/8	1 1/8	6	.938	1.187	(3)#6-32 Studs	2	4PDT	11,000	DC
LKHO	PLUG-IN	3 1/8	3"	1 1/8	1 1/8	5.5			Octal Plug-in	2	DPDT	11,000	DC
MEH-6	SOLDER	2 3/2	1 3/2	1 3/8	1"	3	.672	1.047	(3)#6-32 Studs	5	DPDT	1330 2930	AC DC
MEHG	PLUG-IN	2 3/2	1 3/2	1 3/8	1"	3.5	.750	1.125	Note 1 (3)#6-32 Studs	5	DPDT	1330 2930	AC DC
MEHX	SOLDER	2 3/8	2 1/8	1 3/8	1 1/8	5.3	.938	1.187	Note 2 (3)#6-32 Studs	5	4PDT	7260	AC DC
MH-6D	SOLDER	1 3/4	1 3/4	1 3/4	DIA.	1	CTR/CTR	.875	(2) Holes 125 Dia.	2	DPDT	15,900	DC
MH-12	SOLDER	1 3/2	1 3/4	1 3/4	DIA.	2.5	CTR/CTR	1.406	Note 3 (2)#6-32 Studs	2	4PDT	16,000	DC
MH-18	SOLDER	1 3/2	1 3/4	1 3/4	DIA.	4	CTR/CTR	1.562	Note 3 (2)#6-32 Studs	2	6PDT	22,100	DC
MHT-12	SOLDER	2 1/8	1 1/8	1 3/8	DIA.	3	CTR/CTR	.625	Note 3 (2)#6-32 Studs	2	4PDT	16,000	DC
MHT-18	SOLDER	2 1/8	1 1/8	1 3/8	DIA.	4.5	CTR/CTR	.625	Note 3 (2)#6-32 Studs	2	6PDT	22,100	DC
MHK-12	SOLDER	1 7/8	1 1/2	1 3/4	DIA.	3.5	.938	1.187	(3)#6-32 Studs	2	4PDT	16,000	DC
MHUO-12	PLUG-IN	1 3/4	1 3/4	1 3/4	DIA.	2.5	CTR/CTR	1.406	Note 4 (2)#6-32 Thd.	2	4PDT	16,000	DC
MHLO-12	PLUG-IN	1 3/4	1 3/4	1 3/4	DIA.	2.5	CTR/CTR	1.531	Note 4 (2)#10-32 Thd.	2	4PDT	16,000	DC
MHUO-18	PLUG-IN	1 3/4	1 3/4	1 3/4	DIA.	4.0	CTR/CTR	1.562	Note 4 (2)#6-32 Thd.	2	6PDT	22,100	DC
MHLO-18	PLUG-IN	1 3/4	1 3/4	1 3/4	DIA.	4.0	CTR/CTR	1.687	Note 4 (2)#10-32 Thd.	2	6PDT	22,100	DC
*MHJ-12	SOLDER	1 3/2	1 3/4	1 3/4	DIA.		CTR/CTR	1.406	(2)#6-32 Studs	2	4PDT	16,000	DC
*MHJ-18	SOLDER	1 3/2	1 3/4	1 3/4	DIA.		CTR/CTR	1.562	(2)#6-32 Studs	2	6PDT	22,100	DC
MHY-6	SOLDER	1 1/8	1 3/8	1 3/8	DIA.		CTR/CTR	1.406	(2)#6-32 Studs	10	DPDT	16,000	DC
MHY-12	SOLDER	1 3/4	1 3/4	1 3/4	DIA.		CTR/CTR	1.562	(2)#6-32 Studs	10	4PDT	22,100	DC
PBHW-6	SOLDER	2 3/8	2 1/4	1 3/4	1 3/4	6	CTR/CTR	1.468	Note 3 (2)#6-32 Studs	10	DPDT	380 4800	AC DC
PBH-6	SOLDER	2 3/8	2 1/4	1 3/4	1 3/4	6	1.218	1.218	(4)#6-32 Studs	10	DPDT	380 4800	AC DC
PBH-9	SOLDER	2 3/2	2 1/4	1 3/4	1 3/4	6	1.218	1.218	(4)#6-32 Studs	10	3PDT	380 4800	AC DC
PBH-12	SOLDER	2 3/2	2 1/4	1 3/4	1 3/4	6.5	1.218	1.218	(4)#6-32 Studs	10	4PDT	380 4800	AC DC
PBHN-6	PLUG-IN	3 1/2	2 3/2	1 3/4	1 3/4	9	Note 3		"AN" CONNECTOR	10	DPDT	380 4800	AC DC
PBHN-9	PLUG-IN	3 1/2	2 3/2	1 3/4	1 3/4	9	Note 3		"AN" CONNECTOR	10	3PDT	380 4800	AC DC
PBHN-12	PLUG-IN	3 1/2	2 3/8	1 3/4	1 3/4	9.5	Note 3		"AN" CONNECTOR	10	4PDT	380 4800	AC DC
PDH-6	SOLDER	2 1/8	2 1/8	1 3/8	1 3/8	6	.938	1.187	(3)#6-32 Studs	2	DPDT	475 4800	AC DC
PDH-9	SOLDER	2 1/8	2 1/8	1 3/8	1 3/8	6	.938	1.187	(3)#6-32 Studs	2	3PDT	475 4800	AC DC
PDH-12	SOLDER	2 1/8	2 1/8	1 3/8	1 3/8	6.5	.938	1.187	(3)#6-32 Studs	2	4PDT	475 4800	AC DC
PDHG	PLUG-IN	2 1/8	2 3/8	1 3/8	1 3/8	6.5	Note 1		14 Pin Plug (3)#6-32 Studs	2	4PDT	475 4800	AC DC
POHR-9	SOLDER	3 1/2	3 1/2	1 7/8	1 7/8	12	1.375	1.437	(3)#8-32 Studs	10	3PDT	870 5000	AC DC
POHR-12	SOLDER	3 1/2	3 1/2	2 1/4	2 1/4	13.5	1.625	1.812	(3)#8-32 Studs	10	4PDT	870 5000	AC DC
POHRO-12	PLUG-IN	4 1/8	3 1/2	2 1/4	2 1/4	13.5			14 Pin Plug-in	5	4PDT	870 5000	AC DC
PRH	SOLDER	3 1/2	2 3/2	3 3/8	1 1/2	9.5	CTR/CTR	2.687	(2) .161 Dia. holes	10	4PDT	620	DC
RSH-3D	SOLDER	2 3/4	1 3/4	3/4	DIA.	2.0	CTR/CTR	.973	(2) .125 dia. clearance holes	2	SPDT	14,000	DC
RSH-6D	SOLDER	2 3/4	1 3/4	3/4	DIA.	2.0	CTR/CTR	.973	(2) .125 dia. clearance holes	2	DPDT	14,000	DC
RSHO-6D	8 PIN PLUG-IN	2 1/4	1 3/4	3/4	DIA.	2.8	CTR/CTR	.973	8 pin plug-in; keyway + (2) .125 dia. clearance holes	2	DPDT	14,000	DC
RSH-3D	7 PIN PLUG-IN	2 1/8	1 3/4	3/4	DIA.	2.0			7 Pin Plug-in	2	SPDT	14,000	DC
SKH	SOLDER	2 3/8	2 1/8	1 3/8	1 3/8	4.5	.938	1.187	(3)#6-32 Studs	2	4PDT	4,500	DC
SKHO	PLUG-IN	3	2 1/8	1 3/8	1 3/8	5			Octal Plug-in	2	DPDT	4,500	DC
SKHW	SOLDER	2 3/8	2 1/8	1 3/8	1 3/8	4.5	.938	1.187	Note 3 (3)#6-32 Studs	3	4PDT	4,500	DC
SKHG	PLUG-IN	2 3/8	2 3/8	1 3/8	1 3/8	5	Note 1		14 Pin Plug-in (3)#6-32 Studs	2	4PDT	4,500	DC
SKHN	PLUG-IN	3 3/2	2	1 3/8	1 3/8	6.8	Note 3		"AN" CONNECTOR	2	4PDT	4,500	DC
SWHO	PLUG-IN	2 1/8	2 1/8	1 3/8	1 3/8	5.5			Octal Plug-in	2	DPDT	13,800	DC
SWH	SOLDER	2 1/8	2 1/8	1 3/8	1 3/8	5.5	.938	1.187	(3)#6-32 Studs	2	DPDT	13,800	DC
7RH	SOLDER	5 1/8	3	5	4 1/2	17	4	3.812	(6) .157 Holes	2 Amp. at 16000V.	SPDT	110 2630	AC DC

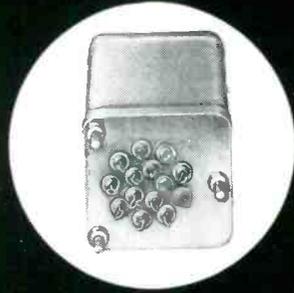
* NOTE: MHJ type relays are available in all MH type mountings.

NOTE 1: Use 14 pin miniature socket
NOTE 2: Two Relays in one enclosure
NOTE 3: Air Force approved
NOTE 4: Sockets available from Allied Control

TYPES OF MOUNTINGS AND TERMINALS



2 STUDS



3 STUDS



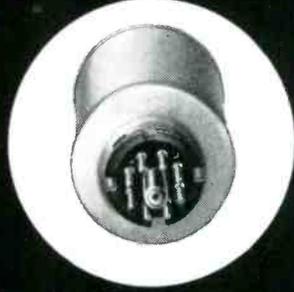
4 STUDS



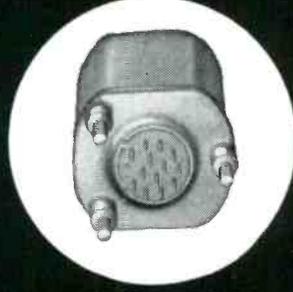
"AN" PLUG-IN



2 HOLE

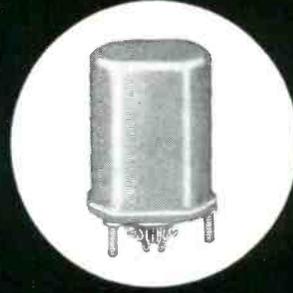
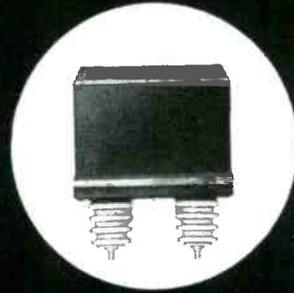
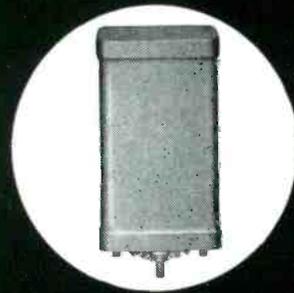
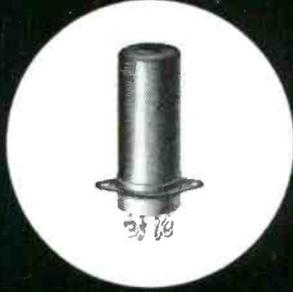
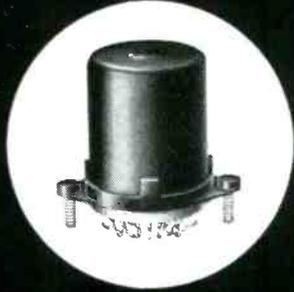
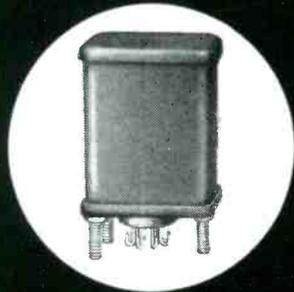


OCTAL PLUG

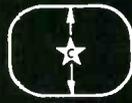


14 PIN PLUG-IN

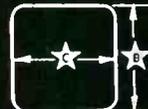
TYPES OF HOUSINGS



OUTLINE DIMENSIONS:



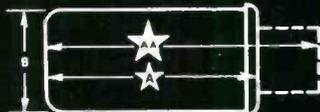
OCTAGON



RECTANGLE OF SQUARE

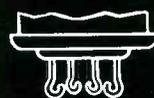


ROUND



SIDE VIEW

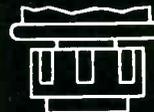
TYPE TERMINALS:



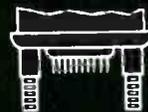
SOLDER TERMINAL



OCTAL 8 PIN PLUG

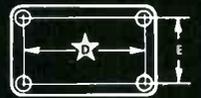
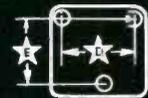


"AN" CONNECTOR



14 PIN PLUG-IN

MOUNTING DIMENSIONS:



ALLIED CONTROL

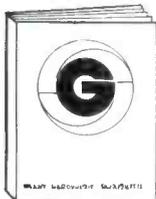
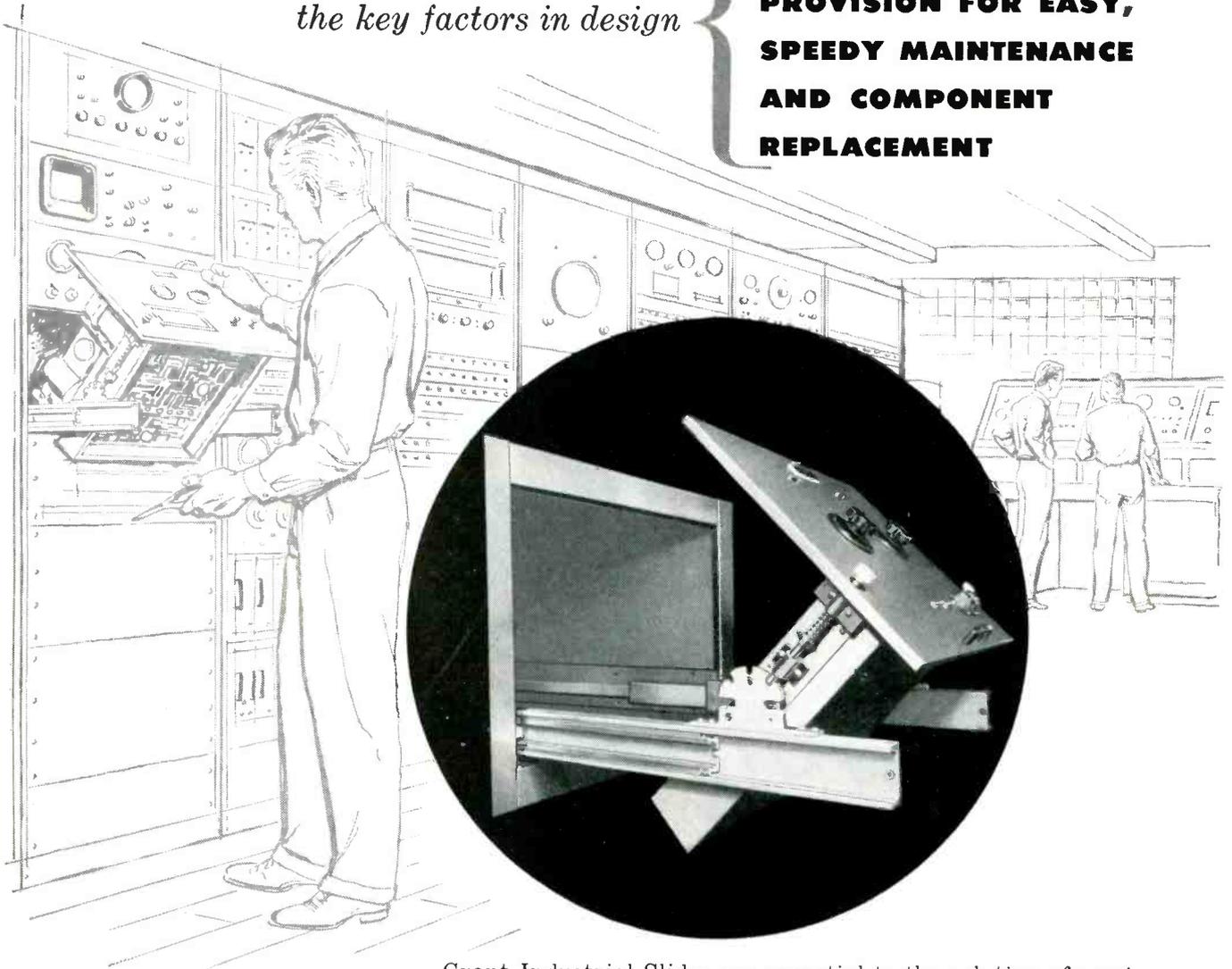


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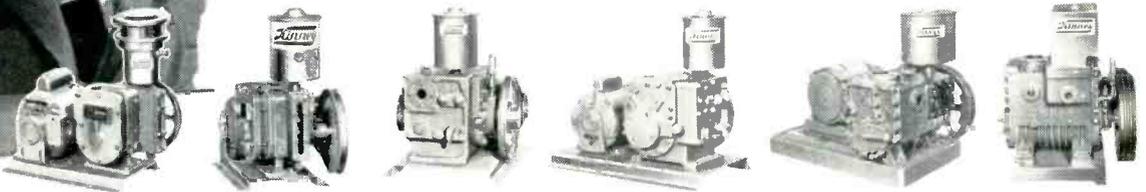
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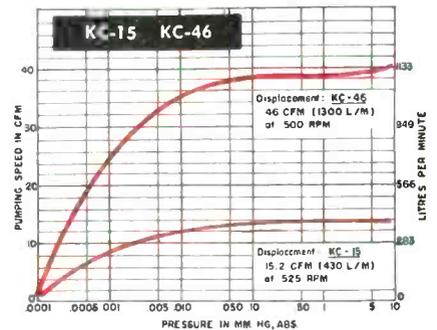
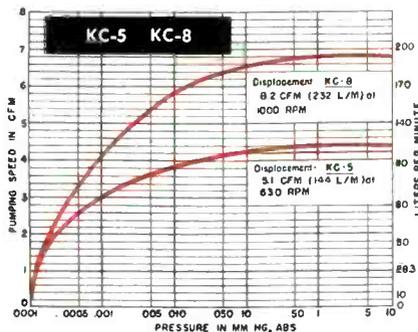
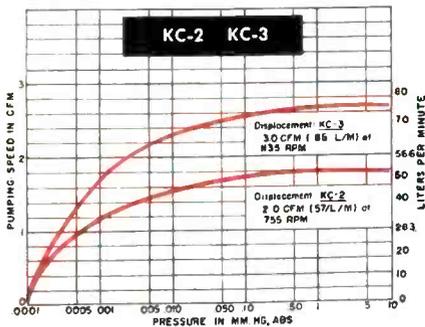
*The facts speak for themselves!
We rest our case!!*



KINNEY COMPOUND HIGH VACUUM PUMPS



SPECIFICATIONS	MODEL KC-2	MODEL KC-3	MODEL KC-5	MODEL KC-8	MODEL KC-15	MODEL KC-46
Free Air Displacement . . .	2.0 CFM	3.0 CFM	5.1 CFM	8.2 CFM	15.2 CFM	46.0 CFM
Free Air Displacement . . .	56.5 Liters/min.	85.0 Liters/min.	144. Liters/min.	232. Liters/min.	430 Liters/min.	1300 Liters/min.
Free Air Displacement . . .	.95 Liters/sec.	1.41 Liters/sec.	2.4 Liters/sec.	3.9 Liters/sec.	7.2 Liters/sec.	21.7 Liters/sec.
RPM	755	1135	630	1000	525	500
Motor H.P.	1/4	1/3	1/3	1/2	1	3
Motor RPM (syn.)	1800	1800	1800	1800	1800	1800
Oil Capacity	6 oz.	6 oz.	1 1/3 pt.	1 1/3 pt.	2 qt.	1 gal.
Shaft Diam.	3/4"	3/4"	3/4"	3/4"	3/4"	1 1/8"
Inlet Connection	3/4" Screwed	3/4" Screwed	1" Screwed	1" Screwed	2" Screwed	3" Screwed
Outlet Connection	None	3/4" Screwed	1" Screwed	1" Screwed	1 1/4" Screwed	1 1/2" Screwed
Net Weight, Complete . . .	70 lb.	78 lb.	140 lb.	148 lb.	300 lb.	585 lb.



SUMMATION

- Reliable High Vacuum (Cam and piston displacement)
- Rapid Recovery of Vacuum
- Simple to Maintain
- Dynamically Balanced
- Standard Small Motors
- Gas Ballasted (optional)
- Economical
- Dependable
- Small, Compact Design

VERDICT

Your verdict will be FAVORABLE when you review all the facts. Request Bulletin 403 for additional data or contact one of our competently staffed district offices in Baltimore, Chicago (LaGrange), Cleveland, Los Angeles, New York, Philadelphia, San Francisco, or St. Louis.

write

today

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY

3565 WASHINGTON STREET • BOSTON 30 • MASS.
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N.Y.

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Our vacuum problem involves

(N) Name

Company

Street

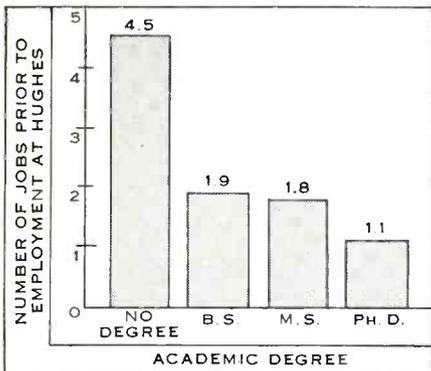
City

State



Some of the young fellows on our staff have been analyzing our files of personal data regarding scientists and engineers here at Hughes. What group characteristics would be found?

With additional facts cheerfully contributed by their colleagues they have come up with a score of relationships—some amusing, some quite surprising. We shall chart the most interesting results for you in this series.



The above chart represents the number of positions held prior to employment at Hughes—by academic degrees (and by lack of a degree). The Ph. D. has changed jobs the least. Data obtained from a 20% random sample of the 2400 professional engineers and scientists of Hughes Research and Development Laboratories.

Education and Job Change

In our laboratories here at Hughes, more than half of the engineers and scientists have had one or more years of graduate work, one in four has his Master's, one in 15 his Doctor's. The Hughes research program is of wide variety and scope, affording exceptional freedom as well as exceptional facilities for these people. Indeed, it would be hard to find a more exciting and rewarding human climate for a career in science. Too, the professional level is being stepped up continually to insure our future

success in commercial as well as military work.

Hughes is pre-eminent as a developer and manufacturer of airborne electronic systems. Our program includes military projects in ground and airborne electronics, guided missiles, automatic control, synthetic intelligence. Projects of broader commercial and scientific interest include research in semiconductors, electron tubes, digital and analog computation, data handling, navigation, and production automation.

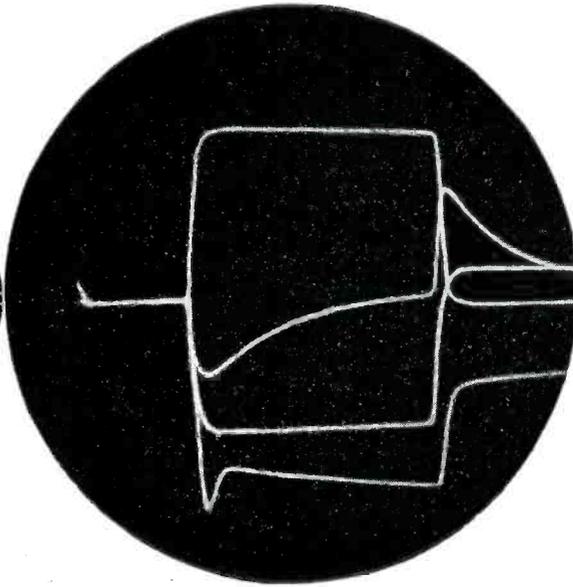
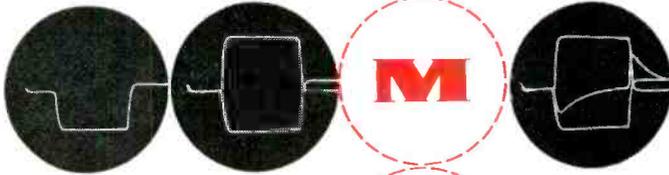
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RIGHT NOW the Laboratories have positions open for engineers with experience in the design of electronic circuits in all areas mentioned in this advertisement.

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Successive traces of waveforms associated with one-shot multivibrator, visually stored by MEMOTRON.

SAVE VALUABLE TIME. WASTED FILM

Transients need not be photographed unless a file record is needed. When such a record is required, photography is greatly simplified, because all displays occur at a constant, uniform brightness regardless of difference in writing speeds. Therefore, a single camera exposure setting is sufficient.



FOR PERMANENT TRANSIENTS

Now non-recurrent phenomena ("transients") can be held and studied directly on the viewing screen of your oscilloscope. The HUGHES MEMOTRON—first in a new series of direct-display cathode ray storage tubes—captures and retains waveforms visibly until they are intentionally erased.

Since the MEMOTRON will display and retain successive writings, it is ideal for plotting curves. The tube will also store reference lines for convenient data analysis.

Our engineering staff invites your inquiries concerning specific laboratory and industrial applications for these tubes.

MEMOTRON GENERAL SPECIFICATIONS

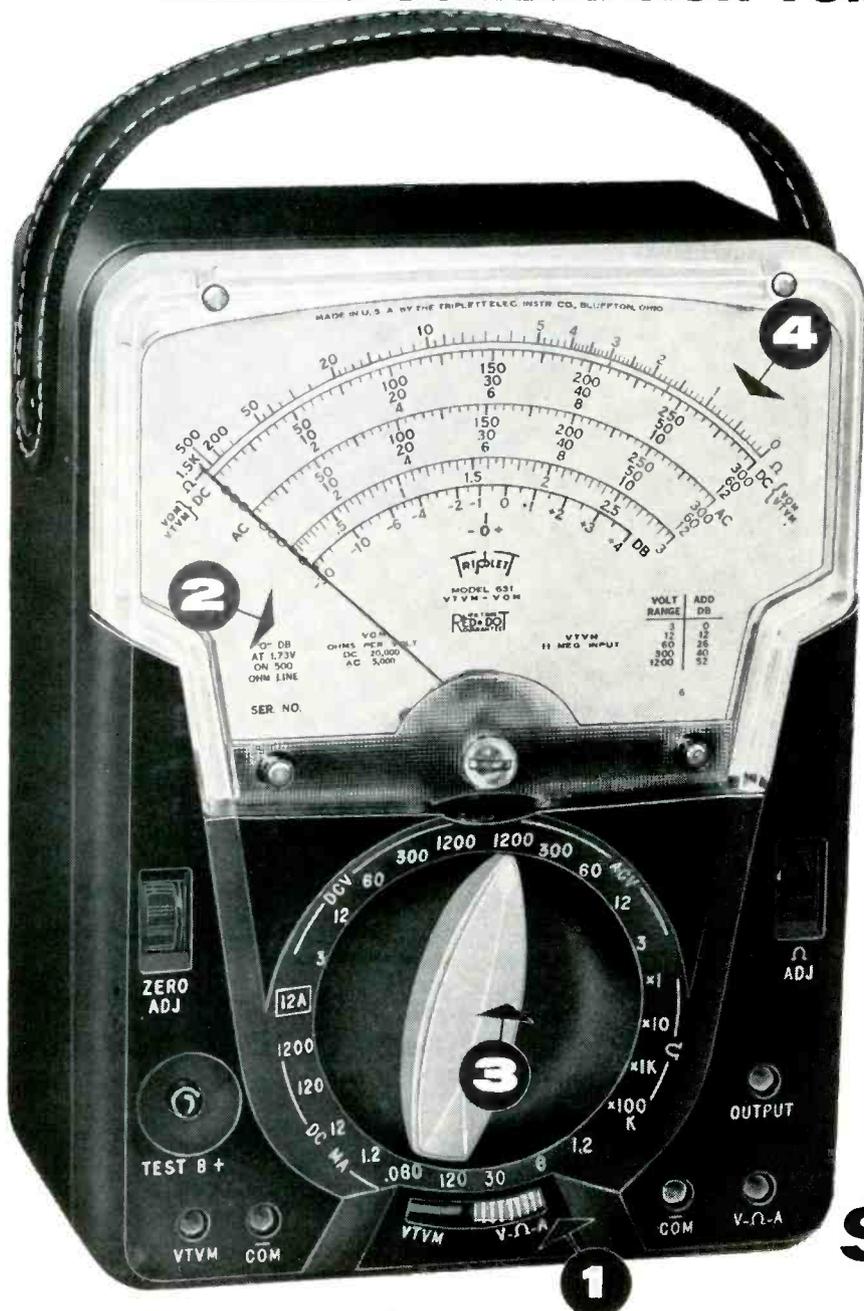
- RESOLUTION... 60 written lines per inch.
- WRITING SPEED... From zero to at least 50,000 inches/sec.
- BRIGHTNESS... 50 foot-lamberts.
- USABLE SCREEN DIAMETER... 4 inches, minimum.
- DIMENSIONS... Over-all length: 18³/₄ inches, ± 1/2-inch.
Bulb diameter: 5⁵/₈ inches, maximum.
Neck diameter: 2¹/₄ inches, ± 3/32-inch.

HUGHES PRODUCTS
A DIVISION OF THE HUGHES AIRCRAFT COMPANY

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a **VOM** ■■■ plus a **VTVM** when you need it.
DOUBLE USE...HALF THE PRICE
TRIPLETT MODEL 631—In one year accepted as the
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4 Battery operated

1 Just flip the switch.

2 Standard sensitivities as used in servicing manuals.

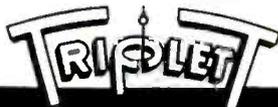
3 34 ranges—with the famous Triplet single knob control.

4 Extra long scales —unobstructed visibility.

\$59.50

By using the Volt-Ohm-Mil-Ammeter for all general testing (90% of your testing) and the Vacuum Tube Voltmeter only when you need it, you have the advantage of a VTVM with extremely long battery life. Batteries are used only about one-tenth as much as in the ordinary battery-operated VTVM. Features: Ohms, 0-1500-15,000 (6.8-68 center scale. First division is 0.1 ohm.)

Megohms: 0-1.5-150 (6,800-680,000 ohms center scale.) Galvanometer center mark “-0+” for discriminator alignment. RF Probe permits measurements up to 250 MC. \$7.00 net extra. Featured by leading electronic parts distributors everywhere.



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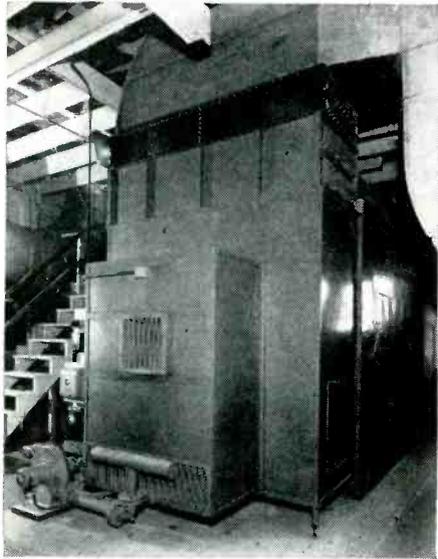
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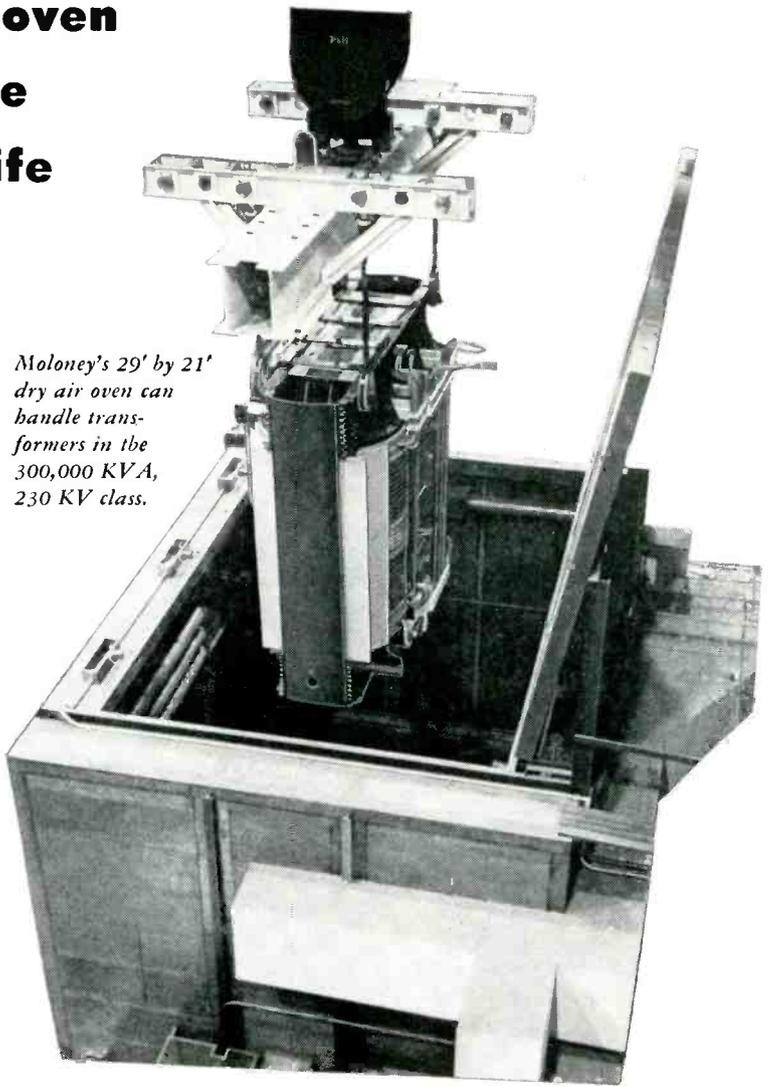
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Moloney power transformers are dried in new controlled atmosphere oven to further improve performance and life



A Type CH Lectrodryer like this does the DRYing.



Moloney's 29' by 21' dry air oven can handle transformers in the 300,000 KVA, 230 KV class.

Air fed to oven by Lectrodryer* contains only 1/10th grain of water per cubic foot

In expanding facilities for building the giant power transformers demanded by industry today, Moloney Electric Company added this DRY air oven at their St. Louis, Missouri plant. DRY, constant temperature air is circulated through it at 25,000 cfm. to speed insulation drying.

The extra DRYness of insulation obtained in this oven improves the performance of their transformers,

increases dependability and assures longer useful life.

Lectrodryers are being used elsewhere in the electrical industry to equal advantage, speeding production, safeguarding materials in storage, improving quality. Some of the newer precision electronic products couldn't be made without the extreme DRYness provided by Lectrodryers. For advice on where you may use them, write Pittsburgh Lectrodryer Company, 359 32nd Street, Pittsburgh 30, Pennsylvania (a McGraw Electric Company Division).

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
 In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
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 WITH ACTIVATED ALUMINAS**

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PRECISION CONNECTORS with KEL-F plastic parts have high RF insulation and dimensional stability. Plastic's high impact and compressive strength permit rough

handling without chipping, cracking, or deforming. Zero moisture absorption and anti-adhesive surface prevent formation of conductive residue.

KEL-F[®] FLUOROCARBON PLASTIC

permits components to operate over a wider temperature range . . . under highly humid and corrosive atmospheres

KEL-F plastic's unique combination of properties can help your product meet more rigid performance specifications. Because of the extreme stability of the fluorocarbon plastic molecule, this dense, tough thermoplastic has superior dielectric properties, excellent resistance to corrosive chemicals, outstanding thermal and dimensional stability, and zero moisture absorption.

Molded and extruded parts operate over an extremely wide range of temperatures (-320°F. to 390°F.) . . . are unaffected by humidity or operational vibration. Metal inserts, lugs and contacts are held

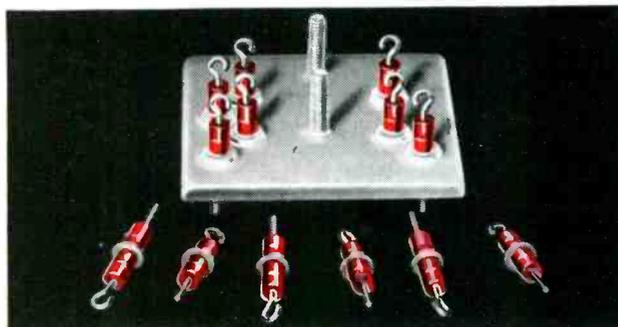
firmly, forming a hermetic seal.

KEL-F plastic is available from Kellogg as a molding material, or in sheets, rods, strips, tubing, film and "spaghetti" from qualified fabricators and molders throughout the country. For further information, write: The M. W. Kellogg Company, Chemical Manufacturing Division, P. O. Box 469, Jersey City 3, N. J.



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HERMETICALLY-SEALED TERMINALS with KEL-F plastic insulation handle high voltage without flash-over or tracking. Won't shrink, swell, age or lose hermetic seal at high and low operating temperatures. Can be used in contact with highly corrosive chemicals.



TUBE SOCKETS of tough KEL-F plastic. Hermetic seal defies thermal cycling, aging and humidity. Withstands high shock loads without chipping or cracking insulation. Plastic's high dielectric strength prevents shorting or arc-over at high altitudes.

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CBS

transistors

The versatile CBS 2N180 and 2N181 are particularly useful in audio driver and output amplifiers . . . servo amplifiers . . . computers . . . and military equipment. These medium-power PNP junction transistors offer high and uniform gain at high current levels.

The 150 mw dissipation of the 2N180 permits outputs of 75 mw in Class A and 300 mw for a pair in Class B. The generous dissipation rating is achieved with all elements of the 2N180 insulated from its case for flexible circuitry. The 2N181 version has an integral C clamp for attachment to a heat sink. This increases its dissipation rating to 250 mw, giving outputs up to 600 mw in Class B.

Like all CBS semiconductor products, the CBS 2N180 and 2N181 are processed, not just selected, to tight specifications. Their round metal cases help to make possible closer tolerances and more dependable hermetic seals. Put these versatile and reliable high-gain transistors to work in low-frequency amplifiers and switching equipment. Write today for bulletin E-264 giving complete information on the CBS 2N180 and 2N181.



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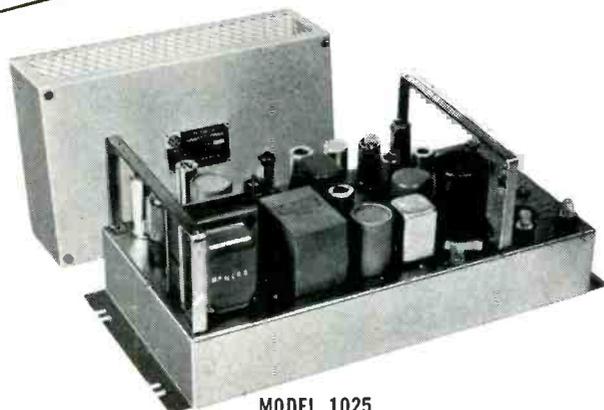
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Telemetry and Telegraph Terminals

NEW

Frequency Type Telemeter Terminal



MODEL 1025

Model 1025

*Highly Accurate, Fast Acting, Frequency Type
Telemeter for Transmission over Wire Lines,
Microwave, and Power Line Carrier*

APPLICATION

The Model 1025 Telemeter Transmitter and Model 1090 Telemeter Receiver will accurately telemeter electrical and mechanical variables which can be converted into a DC voltage or will actuate a slidewire, potentiometer, etc. Quantities such as temperature, speed, pressure, flow, volts, amperes, watts, vars, etc., are only a few of the many quantities which can be telemetered accurately and instantaneously.

DESCRIPTION

The Model 1025 first converts the DC voltages to a proportional 10-30 cycle frequency which, in turn, modulates a built-in audio frequency carrier. Approximately 45 individual carrier channels are available in the frequency range of 765 cps to 20 kc for simultaneous telemetering over a single communication link. Relay output for power line carrier keying and 10 to 30 cps AC output are also available.

Comvor Data Transmission Terminal



MODEL 912

Model 912

*Audio Frequency Shift Terminal for
Telemetry and Supervisory Control*

APPLICATION

The Comvor may be employed for data transmission, signaling, telephone dialing, telemetering, and supervisory control. Through multiple use of the equipment, information from more than sixty individual functions may be simultaneously transmitted over a single communication facility. In control applications dials, stepping switches, and relay pyramids may be used in conjunction with the equipment for the control of a virtually unlimited number of functions.

DESCRIPTION

The Model 912 Comvor is a low cost audio frequency shift terminal designed for continuous reliable operation. Each equipment contains its own power supply and is available as either a transmitter, dual transmitter or dual receiver. Electrical specifications: 22 channels from 300 to 3000 cps, 38 additional channels from 3200 to 20,000 cps; power source 115 v, 50/60 cps, 35 to 45 watts; receiver - 600 ohm filter input, 0 to -40 dbm level, 60 ma loop current; transmitter - 600 ohm filter output -30 to -10 dbm output levels.

Comtel Telegraph Terminal



MODEL 995

POWER SOURCE

115 v \pm 10%, 50/60 cps.
35-45 watts

AC SIGNAL LINE

600 ohms nominal

SIGNAL LEVELS

Receiver input: 0 to -40 dbm
Transmitter output: -20 to 0 dbm

Model 995

*Low cost Telegraph Terminal for keying speeds
up to 100 words-per-minute*

APPLICATION

The Comtel may be used in simplex, half-duplex, full-duplex, and multiplex telegraph systems. It is capable of handling keying speeds up to 100 words-per-minute with less than 10% distortion. Fourteen channels with a frequency shift of 85 cps are available in the voice band from 720 to 3017 cps. It may be applied to all common communication facilities and will perform with satisfaction under conditions of noise and varying signal levels.

DESCRIPTION

Each equipment contains its own power and loop supply and is available in either transmitter, dual transmitter or dual receiver. The unit is completely electronic and requires no relays. All essential controls such as transmitter output level, receiver input level, and bias are included.

Prices are FOB Boonton, N. J. Descriptive literature on each product is available. Telephone: DEerfield 4-3100

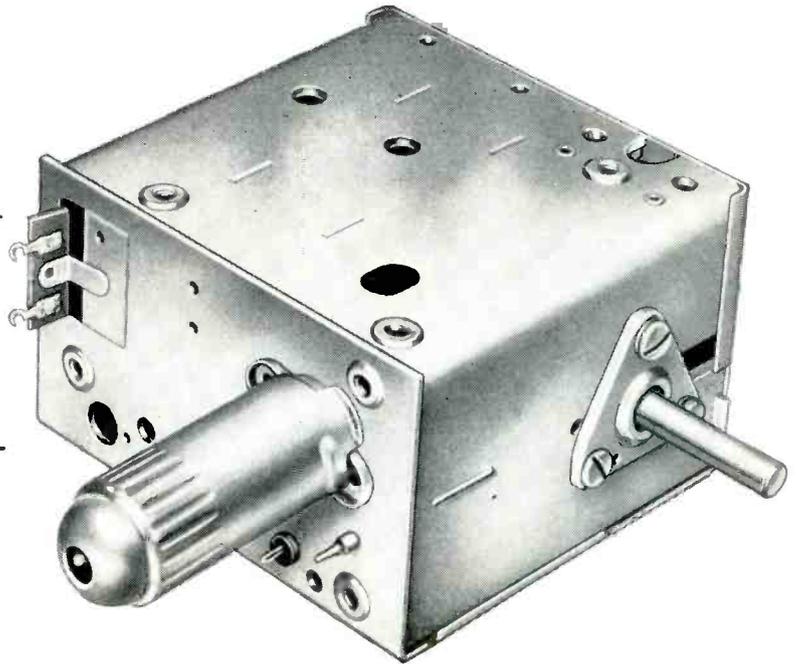
Radio Frequency Laboratories, Inc. BOONTON 3, N. J., U.S.A.

DESIGNERS AND MANUFACTURERS OF COMMUNICATIONS EQUIPMENT SINCE 1922

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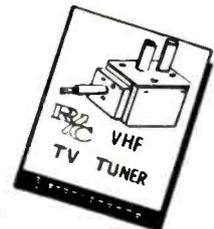
how we cut tuner costs without cutting quality corners

The hotly competitive TV market has long wanted high quality tuners at low prices. But everytime we took a production tuner and cut enough circuit and package "corners" to effect a significant price cut, we wound up with a product unworthy of our R/C trademark.

But last year we had our Engineering Department design a new series of tuners from scratch . . . requesting top performance and bottom costs. What we got was remarkable performance—better than requested—but no appreciable price differential. Until production got into the act, that is. Production designed and sold management on setting up a line of mechanized production equipment. And that equipment brought costs down to the desired level.

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If you want information on the new R/C line of low cost tuners, we'll be happy to have one of our engineers call at your convenience.



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Write Radio Condenser for your free copy of Bulletin T-90

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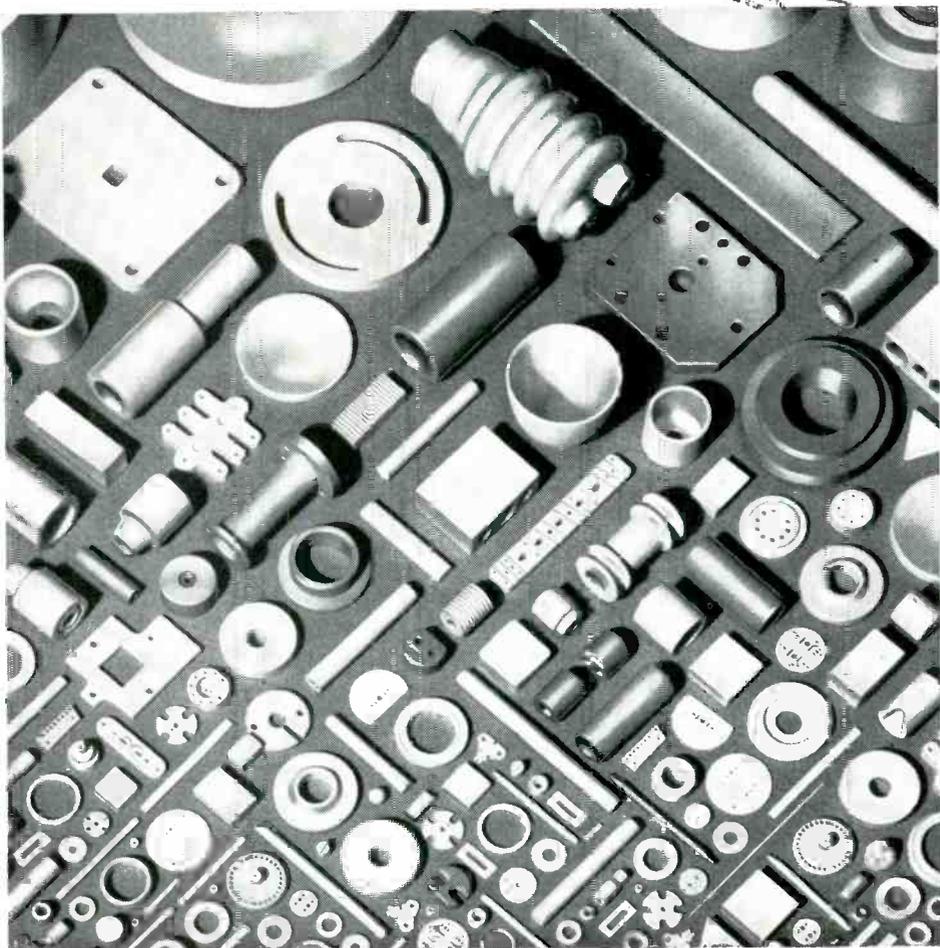
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STRENGTH. High compressive, flexural and tensile strengths.

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HARDNESS. Extremely hard, 9 on Mohs' scale. Resist wear and abrasion of most known materials.

UNIFORMITY. Manufactured under the most rigid standards of Quality Control. Shipped within your tolerance spread.

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THERMAL CONDUCTIVITY. Dissipate heat by rapid thermal conduction.

SUPERIOR ELECTRICAL CHARACTERISTICS. Markedly superior electrical characteristics even at extremely high frequencies and elevated temperatures.

THE ANSWER TO YOUR PRODUCTION PROBLEMS MAY BE ALSIMAG ALUMINA CERAMICS!
Why not investigate? Send us a blueprint or sketch along with details of your operating procedure, for complete details. Special Alumina Bulletin on Request.

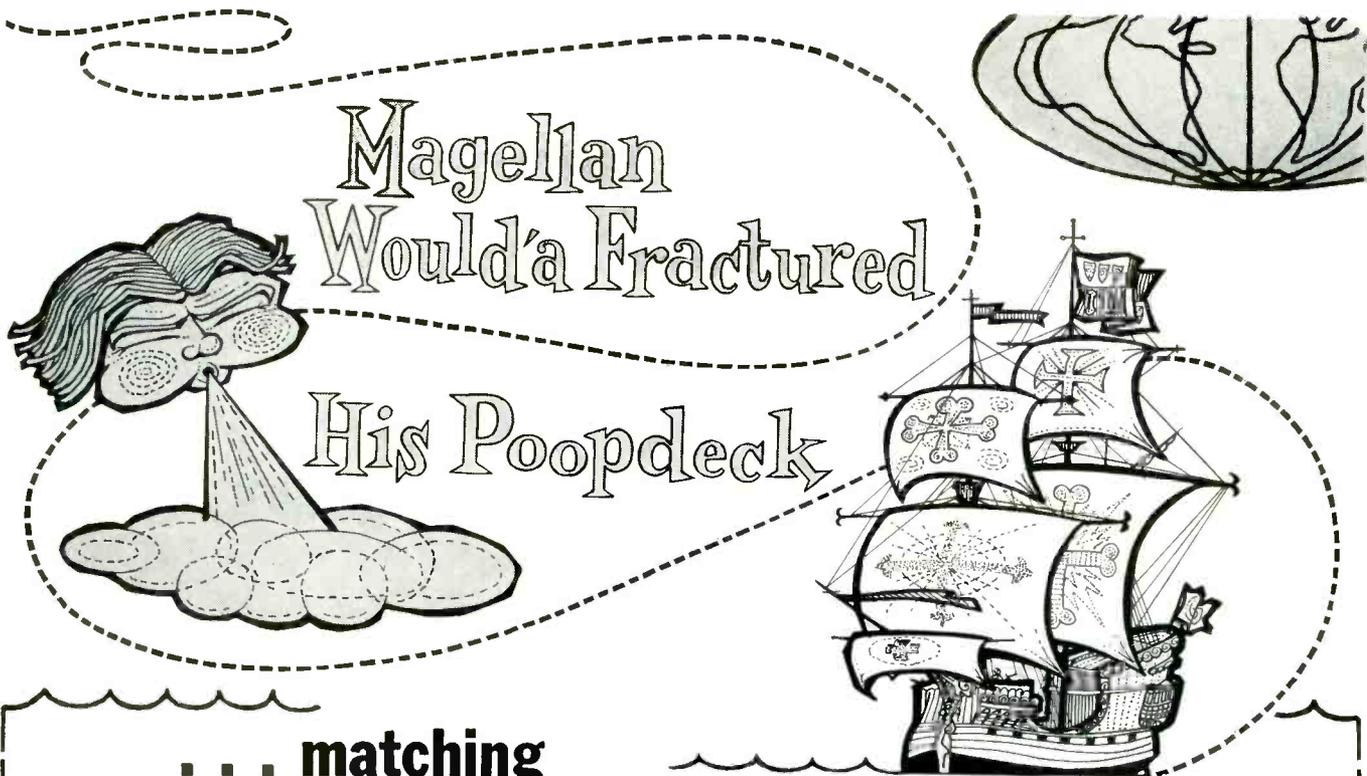
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First two Weeks of July

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LEADERSHIP**

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FERDINANDO MAGELLAN was quite a fiddle-foot in his day, but he was an amateur compared with TOWER construction crews. History records that old Ferd and his men traveled approximately 27,000 miles on their global circumnavigation. TOWER crews have virtually traced and retraced this journey 27 times, while erecting more than 2,000 tower installations around the world. TOWER installations are serving in corners of the globe Magellan never dreamed existed ... like Reykjavik, Thule, and Okinawa. So, no matter what or where your tower problems are, TOWER will solve them for you ... on time and according to your exact specifications.

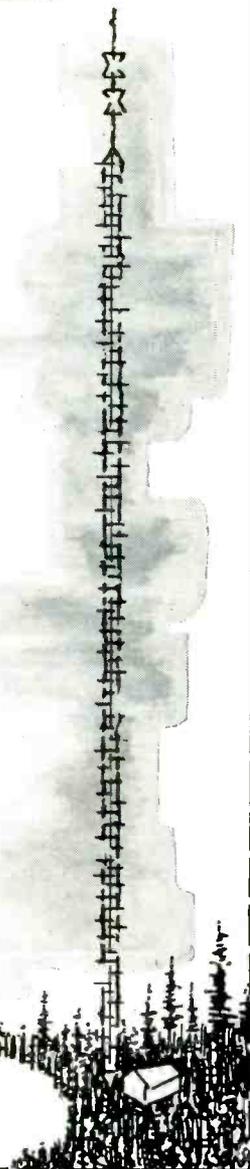
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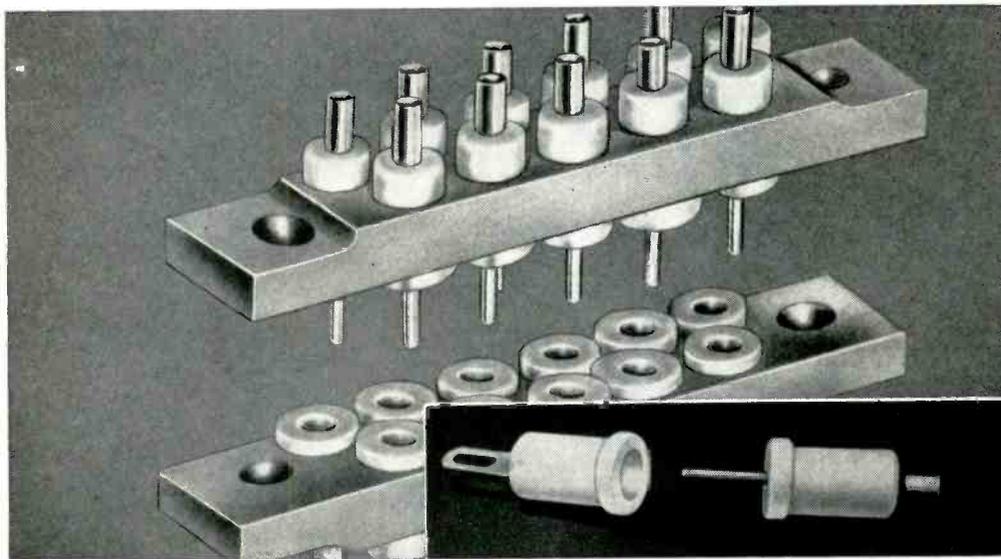
ELECTRONIC DESIGN

PROPERTY AND APPLICATION DATA
ON THESE VERSATILE ENGINEERING MATERIALS:
"ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NEWS

No. 4, 1956

Electronic connectors of Du Pont TEFLON® unaffected by temperature changes, humidity and mechanical shock



"Connectors of Teflon" with their respective mating parts. Male and female connector pins can be compression-mounted directly into drilled or

punched chassis holes. Available in various RMA colors. (Manufactured by Fluorocarbon Products, Inc., Division of United States Gasket Co., Camden 1, N.J.)

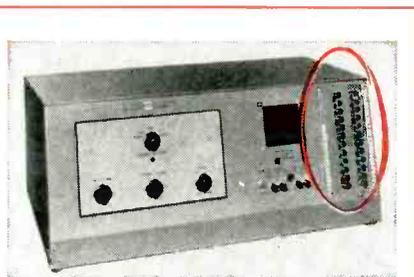
Laminations of TEFLON® for printed circuit bases

Typical uses for laminations of glass cloth and Du Pont "Teflon" tetrafluoroethylene resin include: conductor and ground insulation, hookup wire, power cable, printed circuit bases and structural parts. The laminations combine the dielectric properties, chemical inertness and heat resistance of "Teflon" with the tensile strength, resistance to cut-through, and resistance to creep of woven glass fiber.

An informative free bulletin describing the preparation and uses of laminations and impregnations of glass cloth employing "Teflon" tetrafluoroethylene resin is now available. Specify Bulletin X-64.

SEND FOR MORE INFORMATION

For complete details that will help you further evaluate the Du Pont engineering materials for use in your product-development programs, mail the coupon at the right. Specific property and application data will be sent to you.



Magnifying lens of LUCITE® for Stromberg-Carlson communication-system control panel. Names or numbers under the lens are magnified with maximum optical clarity—easily visible from a distance. "Lucite" resists cracking, crazing and chipping and is unaffected by age. (Lens extruded by Anchor Plastics Co., Long Island City, New York.)

New connectors with bodies of "Teflon" are designed for low-loss, high-frequency service in interconnection of radio, radar and other electronic equipment—where connectors are subjected to a wide range of temperatures, pressure, humidity and mechanical shock and vibration.

Continuous current rating is 3 amp. for .040 pins and 5 amp. for .063 pins. Voltage rating is 3,300 V. RMS (short time test at sea level).

Du Pont "Teflon" tetrafluoroethylene resin was selected for this particular insulation job because of its unique properties. In this application, it is serviceable at temperatures from -110°F . and operates in pressure altitudes from sea level to 60,000 ft. It has zero water absorption by ASTM test D570-42.

"Teflon" is nonflammable and will not carbonize under arcing; it has good dielectric strength. Resiliency of "Teflon" enables the insulation to expand to original diameter after it is pressed into the hole—and locks the connector securely and permanently in place.

Have you investigated the possibilities for "Teflon" in your electronic design application? Do you require material that is chemically inert, suitable for use at extreme temperatures of -450°F . to 500°F ., tough and resilient? For complete property data on this versatile Du Pont engineering material, mail the coupon below.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department
Room 224 Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada Limited, P.O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked:
"Teflon"* , "Lucite"* . I am interested in evaluating these materials for _____

Name _____ Position _____

Company _____

Street _____ City _____ State _____

Type of Business _____

*Registered trademark of E. I. du Pont de Nemours & Co. (Inc.)



versatile

Multi-channel --
telegraph A1 or
telephone A3.

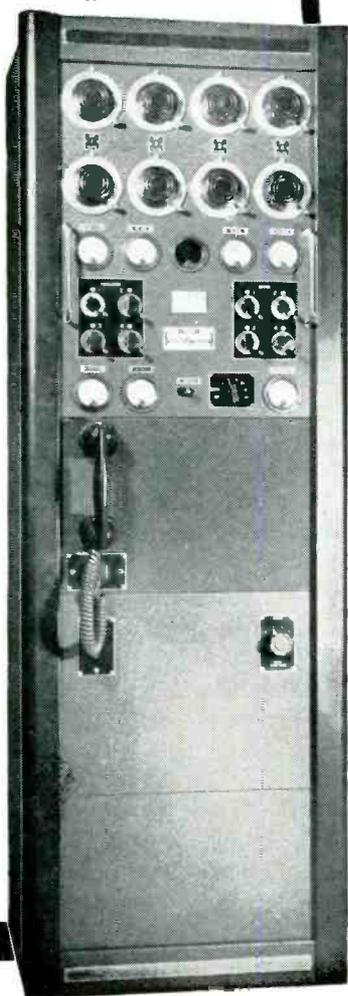
FROM GROUND TO AIR OR POINT TO POINT

STABLE

High stability (.003%) under
normal operating
conditions.

RUGGED

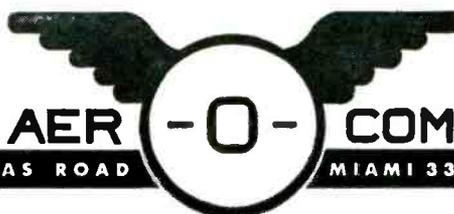
**Components
conservatively
rated. Completely
tropicalized.**



Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-24.0 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3. Stability .003%. Operates in ambient -35° to 45°C. Nominal 220 volt, 50/60 cycle supply. Conservatively rated, sturdily constructed. Complete technical data on request.

Here's the ideal general-purpose high-frequency transmitter! Model 446... 4-channel, 6-frequency, medium power, high stability. Suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Co-axial fitting to accept frequency shift signals.

Now! Complete-package, lightweight airborne communications equipment by Aer-O-Com! Write us today for details!



3090 DOUGLAS ROAD

MIAMI 33, FLA.

from **Transitron**

SILICON RECTIFIERS



STUD MOUNTED



LEAD MOUNTED



MINIATURE

No matter which mounting you prefer. . . . Reliability is assured

Transitron's silicon rectifiers are now available with both lead and stud mountings. The three versions now in production provide a current range from 100 ma to 1 ampere. Their small size and high temperature characteristics make them ideal for missile, aircraft or other applications where reliability is of prime importance.

RATINGS AT 135°C*



	Peak Recurrent Inverse Voltage (volts)	Maximum Average Forward Current (ma)	Peak Recurrent Forward Current (amps)
1N253 *	95	1000	4.0
1N254 *	190	400	1.2
1N255 *	380	400	1.2
1N256 *	570	200	0.6

RATINGS AT 100°C AMBIENT



	Peak Recurrent Inverse Voltage (volts)	Maximum Average Forward Current (ma)	Peak Recurrent Forward Current (amps)
TL12	100	350	2.0
TL22	200	350	2.0
TL42	400	350	2.0
TL61	600	200	1.0

RATINGS AT 100°C AMBIENT



	Peak Recurrent Inverse Voltage (volts)	Maximum Average Forward Current (ma)	Peak Recurrent Forward Current (ma)
TJ- 5	50	100	500
TJ-10	100	100	500
TJ-20	200	100	500
TJ-30	300	100	500

See Bulletin TE1321, 1336 for additional types and complete specifications.

See Bulletin TE1335 for additional types and complete specifications.

See Bulletin TE1338 for additional types and complete specifications.

* JAN types

Transitron

electronic corporation melrose 76, massachusetts



Germanium Diodes



Transistors

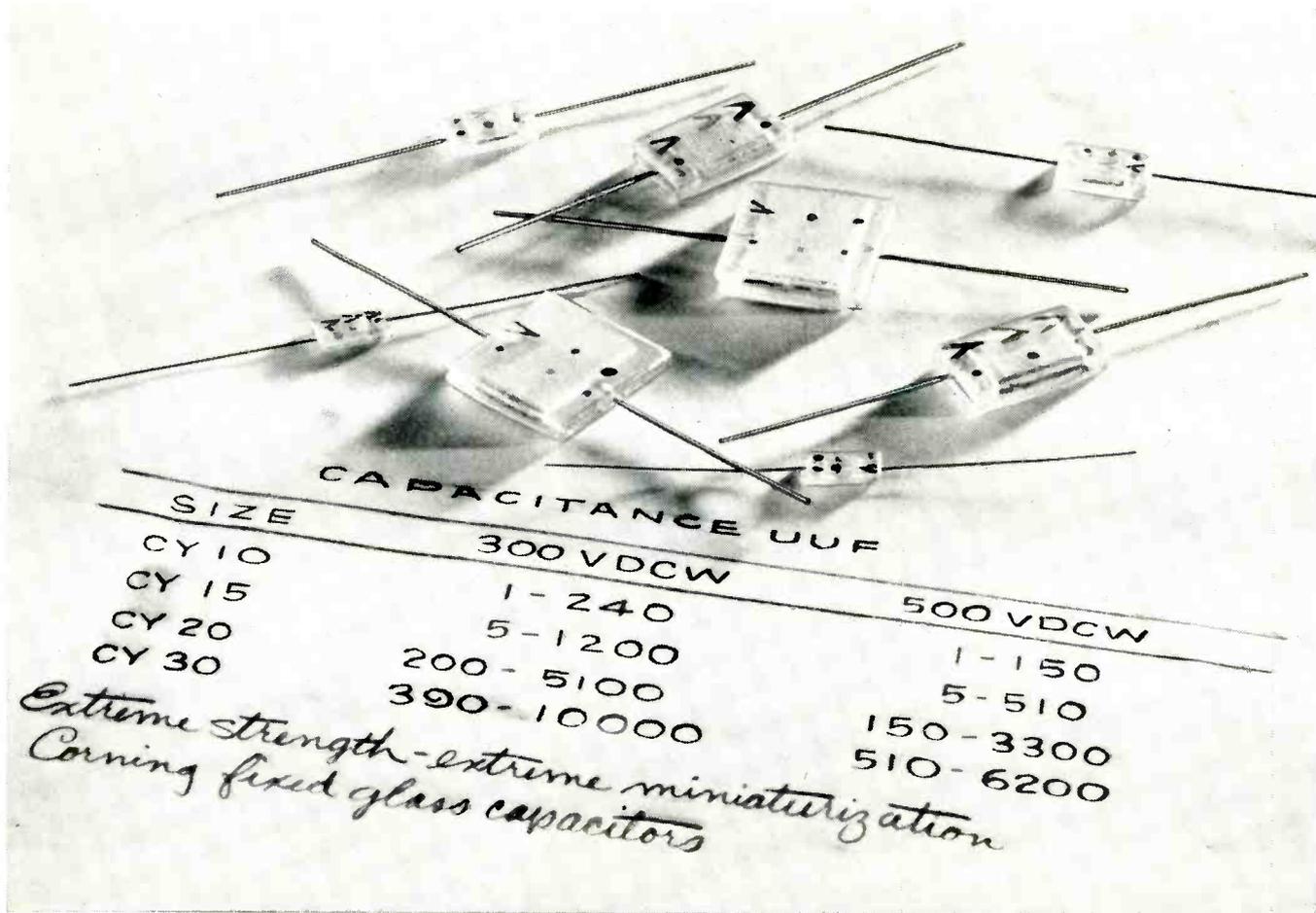


Silicon Diodes



Silicon Rectifiers





You'd have to smash a Corning Capacitor before you could alter its values by mechanical shock

That's how rugged these miniature fixed glass capacitors are. ("Miniature" means about one-third smaller than other kinds of equal capacitance.)

Their strength comes from the way we make them. Layers of conductor and dielectric are sealed together under heat and pressure into a monolithic structure. No mechanical shock short of shattering the seal alters the value. Speaking of values, the table illustrated above shows them.

Because everything is sealed in the same material as the dielectric, nothing outside can get inside.

You can use these capacitors to tem-

peratures of 125° C. and higher with proper voltage derating. Even after repeated temperature cycling, the TC remains the same. And TC stays within close limits over a wide temperature range, varies little between capacitors. Capacitance drift is so close to zero that it's generally less than the error of measurement.

We can make capacitors to your electrical and physical specifications over an unusually varied range. Single, self-supported units can be designed for high voltages or high capacitances. Series parallel combinations still further extend the range.

Circle the reader service of this publication, or write direct for more information about Corning Fixed Glass Capacitors, prices and samples.

Ask for information on these other Corning Capacitors:

Medium Power Transmitting—CY-60 and CY70. Ideal for mobile RF transmitters.

Canned High Capacitance—provide the advantages of rugged glass design to your specifications.

Subminiature Tab-Lead—up to 90% less volume compared to pigtail types. To your specifications.

Special Combinations—the performance and benefits of glass in infinite shapes, sizes and leads. To custom order.

Other electronic products by Corning Components Department:

Fixed Glass Capacitors*, Transmitting Capacitors, Canned High-Capacitance Capacitors, Subminiature Tab-Lead Capacitors, Special Combination Capacitors, Direct-Travel and Midget-Rotary Capacitors*, Metallized Glass Inductances, Resistors.

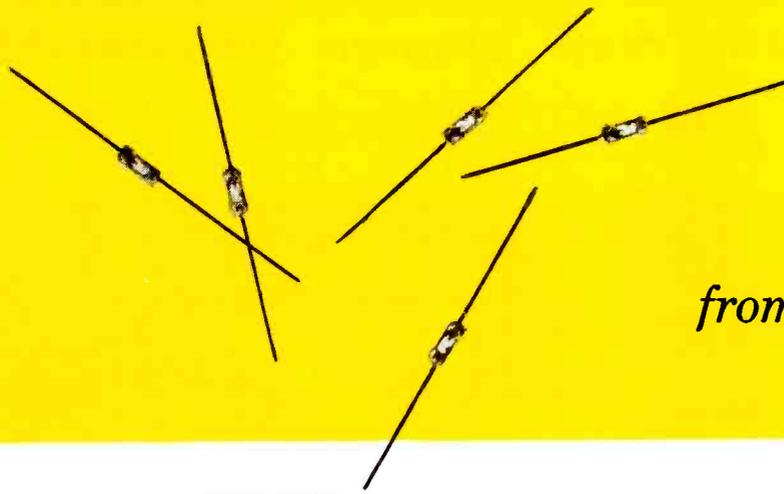
*Distributed by Erie Resistor Corporation



CORNING GLASS WORKS, 94-4 Crystal Street CORNING, N. Y.

Components Department, Electrical Products Division

Corning means research in Glass



from **Transitron**

new **MILITARY** *type*
GOLD BONDED Diodes



The proven performance and superior characteristics of gold bonded diodes are now incorporated in three new military types.

1N270*

The 1N270 is designed for efficient core switching. It features 200 ma at +1-V.

1N277*

The 1N277 is recommended for critical high temperature applications. It replaces the existing military types 1N127, 1N198, 1N38A and 1N70.

1N281*

The 1N281 offers 40 ma at +1-V, and replaces the existing military types 1N126 and 1N69.

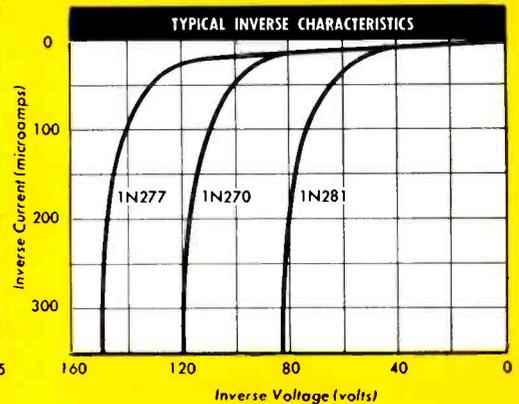
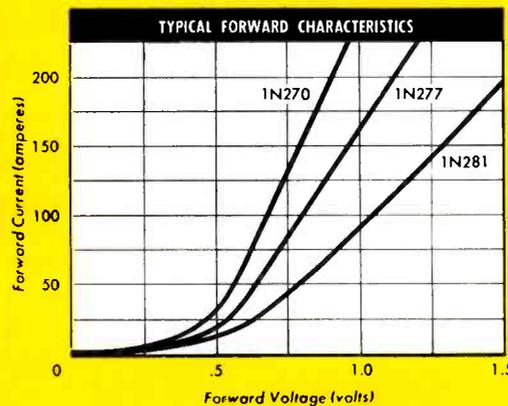
The 1N270, 1N277 and 1N281 are preferred types for new design.

Transitron's gold bonded diodes are characterized by reliability under the most severe operating conditions. This is achieved by rugged construction and 100% testing of electrical and mechanical characteristics.

WRITE FOR BULLETIN TE-1319.

SPECIFICATIONS AT 25°C			
	Forward Current at +1V (ma)	Inverse Current at Specified Voltage (ua @ volts)	Maximum Operating Voltage (volts)
1N270*	200	100 @ -50V 75 @ -10V at 75°C	80
1N277*	100	250 @ -50V at 75°C 75 @ -10V at 75°C	100
1N281*	40	500 @ -50V 30 @ -10V	60

*JAN types



Transitron

electronic corporation melrose 76, massachusetts



Germanium Diodes

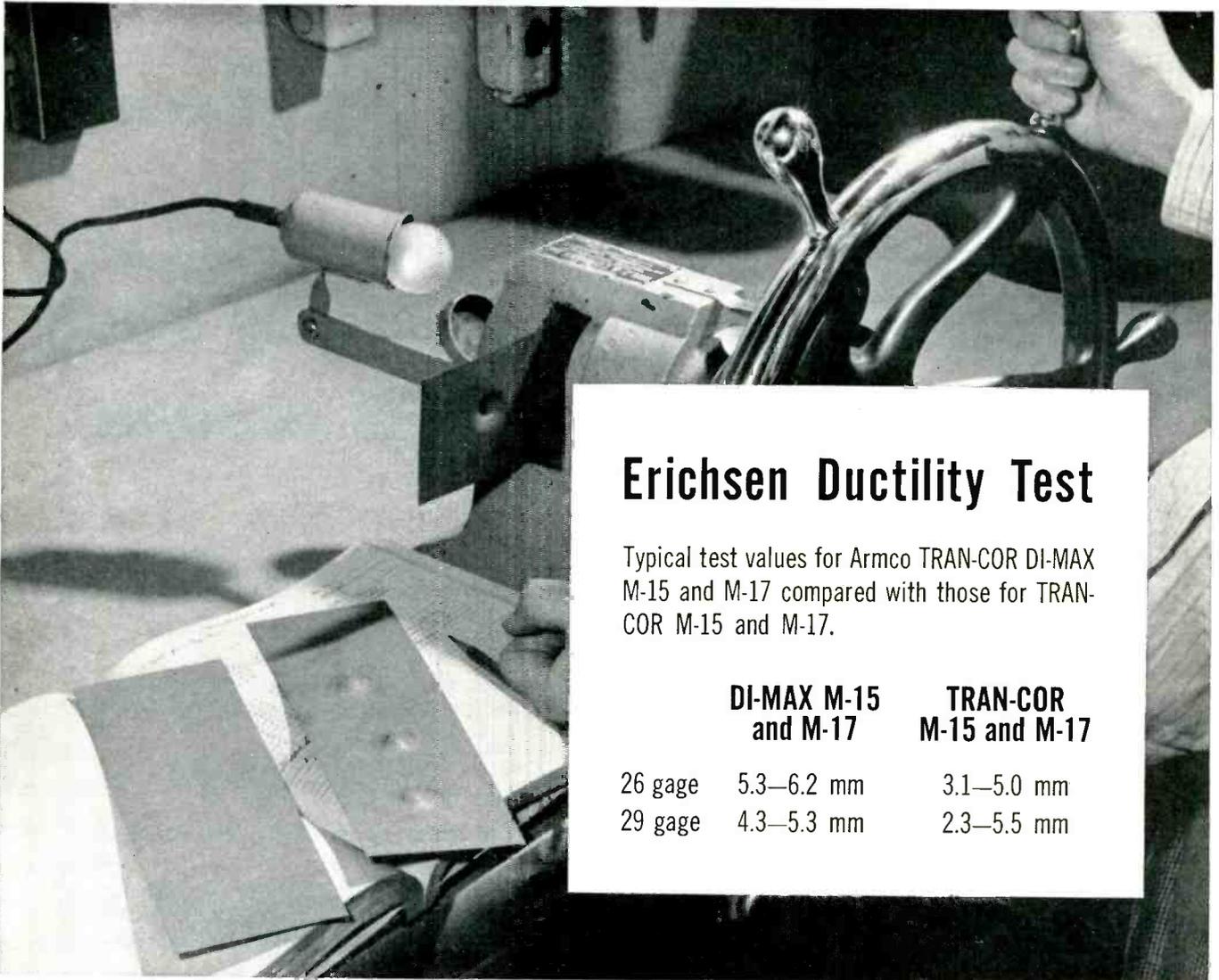
Transistors

Silicon Diodes

Silicon Rectifiers



Armco DI-MAX Adds New Design "PUNCH" to M-15 and M-17 Grades



Erichsen Ductility Test

Typical test values for Armco TRAN-COR DI-MAX M-15 and M-17 compared with those for TRAN-COR M-15 and M-17.

	DI-MAX M-15 and M-17	TRAN-COR M-15 and M-17
26 gage	5.3—6.2 mm	3.1—5.0 mm
29 gage	4.3—5.3 mm	2.3—5.5 mm

Armco's DI-MAX process now offers a new design advantage in the low core loss M-15 and M-17 electrical steels. Better, more uniform ductility now makes it possible for designers to use punched laminations where they need the low core losses of these grades.

Besides punchability, Armco TRAN-COR DI-MAX M-15 and M-17 offer other performance-improving properties. In large motors and generators, induction regulators, TV power transformers and other applications calling for segmented, "E" and "I" or rectangular laminations, here are some of the plus factors you get:

- **Better permeability at high inductions**
- **Greater gage uniformity**
- **Better space factor**
- **Smoother surface**
- **Improved flatness**

For complete information on how DI-MAX M-15 and M-17 can help you design and produce more efficient electrical equipment, write us at the address below or phone the nearest Armco Sales Office.

ARMCO STEEL CORPORATION

1146 CURTIS STREET, MIDDLETOWN, OHIO



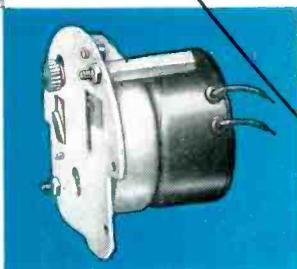
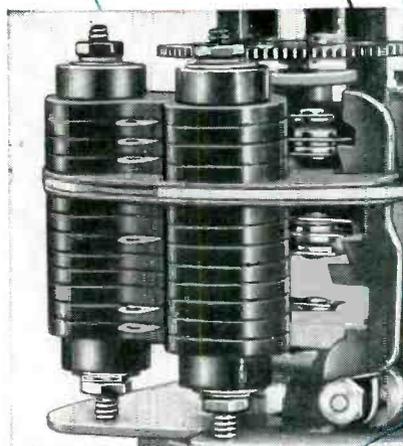
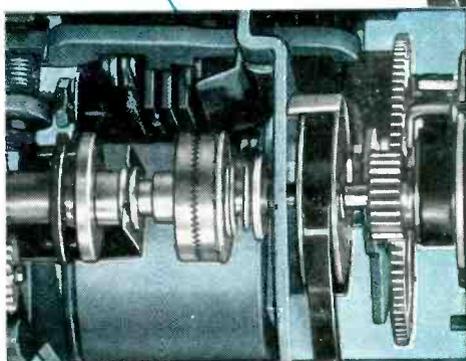
SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

NEW

from face to terminal block

Cramer

type 412 TIME DELAY RELAY



NEW—Repeat Accuracy within $\pm \frac{1}{4}$ of 1% of full scale (30 sec. and longer ranges); $\pm \frac{1}{2}$ of 1% on faster timers.

NEW—Full Vision Dial. 300 degree scale assures precise settings and fast, accurate readings. Dial and pointers protected by transparent cover.

NEW Contacts, rated 15 amps., give positive quick-make, quick-break operation. Contacts are of silver cadmium oxide with ability to handle high inrush currents.

NEW Flexibility in wiring. Nine-position terminal block offers side or rear connection, presents a variety of wiring possibilities.

NEW Reset Shock Spring Design laboratory tested for more than a million operations.

NEW Friction Setting Mechanism allows adjustment even while timer is operating.

NEW—Ratchet Clutch operated by powerful relay, provides instant action, no slip.

NEW O-Ring Retainer permits quick removal of bakelite housing, exposing entire timer mechanism.

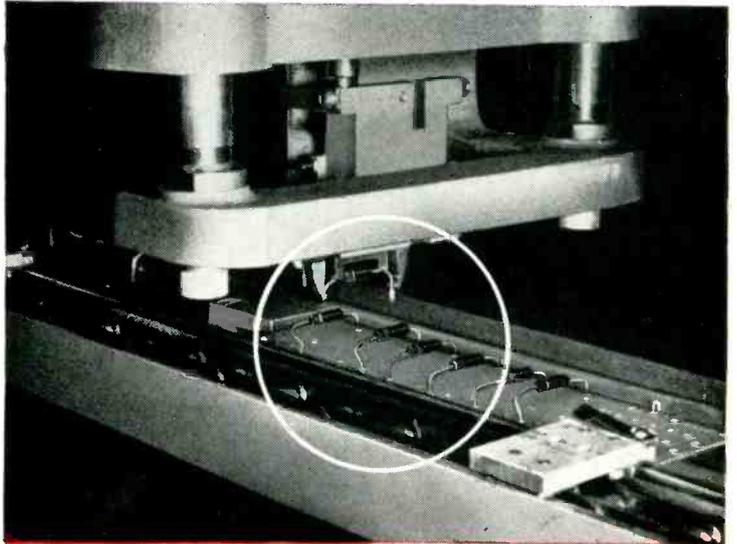
Timer driven by high torque (30 in. oz. at 1 r.p.m.) Cramer Type 112 Synchronous Motor.



The R. W. CRAMER CO., Inc.

SPECIALISTS IN TIME CONTROL
BOX 3, CENTERBROOK, CONNECTICUT

Unique method of anchoring IRC leads keeps them from being twisted or pulled out in automatic bending and insertion operations.



HOW TO BE SURE OF TERMINAL SECURITY

No matter how you assemble or solder them, IRC resistors provide the extra terminal security that prevents termination failures in the production line or in the field. Leads of IRC Type BT Resistors, for example, are uniquely anchored in the resistor body so that they won't twist or pull out. A new IRC alloy coating which overcomes copper migration also assures improved and more uniform solderability. Together, these features speed up production, cut inspection costs, and assure reliable long-range performance. For more information, send coupon today.



Why Leads Won't Come Loose

Leads of IRC Type BT Resistors are so securely joined to the element that even the unmolded assembly exceeds the standard 5-lb. pull requirement. For still greater strength, leads have a crimped collar which provides a tooth-and-notch effect when the assembly is molded as a unit.

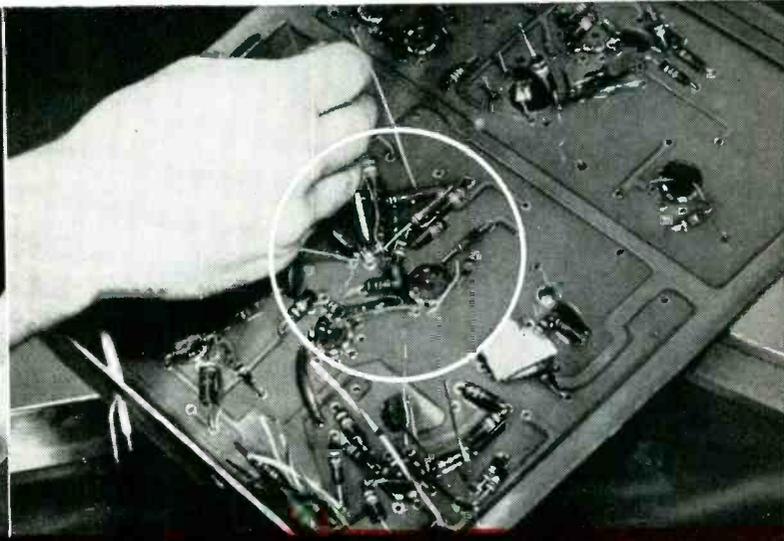
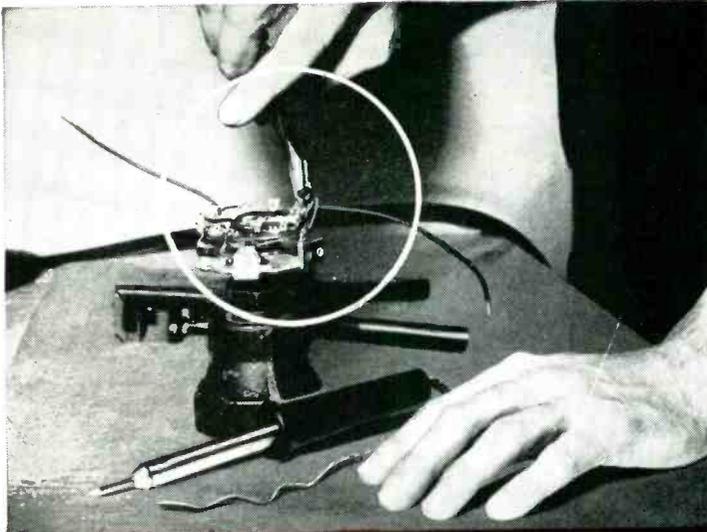


Straight Leads Speed Automation

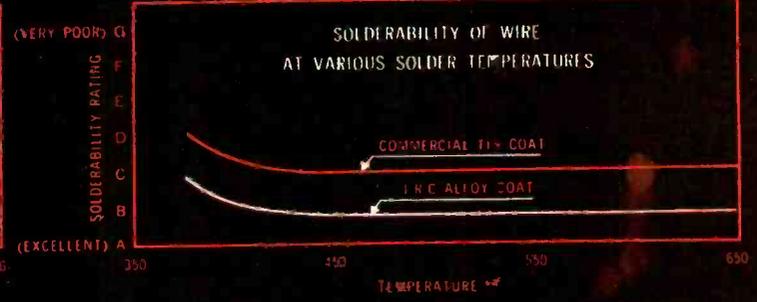
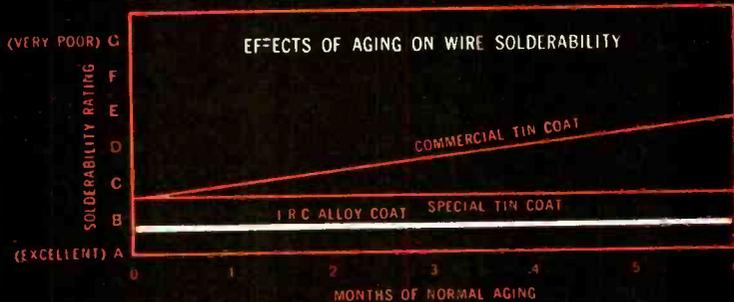
The IRC Automation Package assures you of consistently straight leads suitable for automatic feed. This permits automatic, trouble-free feed to holding devices or into inserting heads of printed wiring lines.

Because they can be bent up to resistor body, IRC leads solve special "fit" problems and simplify production and soldering operations.

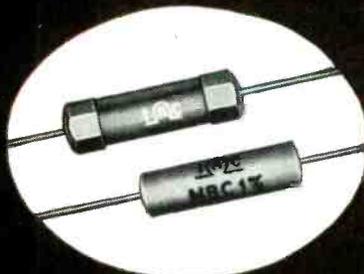
New alloy surface on leads overcomes tendency of copper to migrate toward coating. This assures superior solderability by any method, with low or varying temperatures.



here's how much IRC's new alloy coating improves solderability

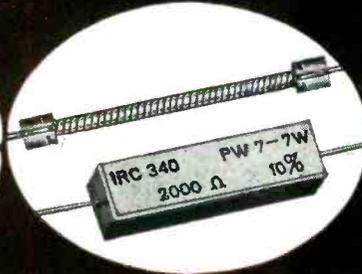


EXTRA TERMINAL SECURITY ALSO FEATURES OTHER IRC RESISTORS



Deposited and Boron-Carbon Resistors

The metal used in terminations passes ASTM tests for season cracking. In addition, terminations are automatically assembled for uniform strain strength.



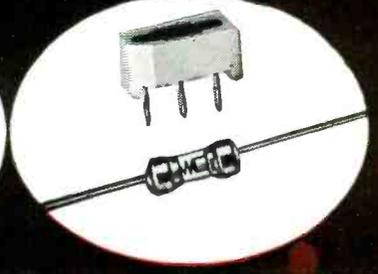
Wire Wound Low Wattage Resistors

Through machine assembly, the element, terminal clips, and leads are assembled simultaneously. No other method assures such uniformly high resistance to twisting or pulling.



Wire Wound Precision and Power Resistors

Lugs can't turn or twist and break the fine resistor wire. This also eliminates any "strain gauge" effect which would change the resistance value.



Microstak Selenium Rectifiers

Miniature rectifiers and diodes with low capacitance cells as small as .060 dia. Superior characteristics and uniformity. Wide variety of types including hermetically sealed units.

Voltmeter Multipliers • Boron & Deposited Carbon Precistors • Insulated Composition Resistors • Power Resistors • Controls and Potentiometers • Low Wattage Wire Wounds • Germanium Diodes

Wherever the Circuit Says



Precision Wire Wounds • Ultra HF and Hi-Voltage Resistors • Selenium Rectifiers • Insulated Chokes • Hermetic Sealing Terminals

HYCOR DIVISION of International Resistance Co.
Los Angeles, California
CIRCUIT INSTRUMENTS INC. (IRC Subsidiary)
St. Petersburg, Florida

INTERNATIONAL RESISTANCE CO.
Dept. 233, 401 N. Broad St., Philadelphia 8, Pa.

Send data on resistors checked:

- Fixed Composition Resistors
- Deposited and Boron-Carbon Resistors
- Wire Wound Power Resistors
- Wire Wound Precision Resistors
- Selenium Rectifiers

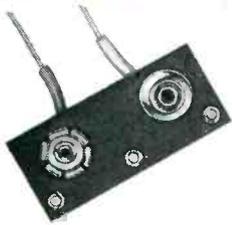
Name _____

Company _____

Address _____

City _____ State _____

Ucinite Electrical Assemblies



BATTERY CONNECTORS

Wired snap-an units for use with batteries equipped with United-Carr electrical snap fasteners. Wiring to customer's specifications.



BANANA PINS

Four sizes of plugs with one-piece beryllium copper springs. Adaptable mounting ends in threaded, staking, or solder lug types. Similar Mating Jacks also available.

SHOCK MOUNTS

Offered in several sizes — brackets and durometer of rubber bushings can be varied. With threaded Teenuts or plain bushings. Insulated versions if needed.



ANODE CONNECTORS

Plug button contacts for positive firm connections. Corona resistant neoprene or silicon shields in straight or right angle types. Wiring to customer's specifications.



TUBE CAPS

Positive gripping, heat treated steel springs in corona resistant metal housing. Insulated or non-insulated. Wired to specifications. Type shown has silicon shield for special application.



TUBE SOCKETS

Ceramic octals and special types. Ring or saddle mounting. Open ended plates for shock mounting with rubber grommets. J A N types.

SWITCHES

Oak type switches manufactured as a licensee. Variety of rotary and push-button assemblies to specifications.



SNAP SWITCHES

Precision, momentary contact push-button switches. Small and dependable. Several circuit arrangements. Water tight version shown.



TEST JACK

Ucinite's quality jack for .080 probes. Beryllium copper contacts. Nylon insulation in colors. Metal shell for firm dependable mounting.



VIBRATION ISOLATORS

Equiflex (1 to 1 ratio) metal mounts ensure long life, fit small spaces, can be used in any direction. Three sizes, cup or plate mountings.

METAL STAMPINGS

Volume production in Metal stampings. Years of engineering and tooling skill available to solve your particular problem.



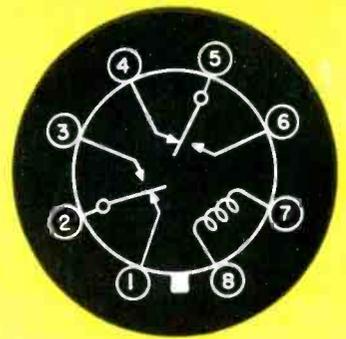
With years of specialized experience in the electronics field and complete facilities for the volume production of small metal stampings as well as the assembly of metal to plastic and ceramic components, Ucinite is fully equipped to supply you with special electrical parts and assemblies... designed, assembled, wired and marked to your specifications. For complete design, engineering and production service, call your nearest Ucinite field engineer.

The UCINITE Company

DIVISION OF UNITED-CARR FASTENER CORP.

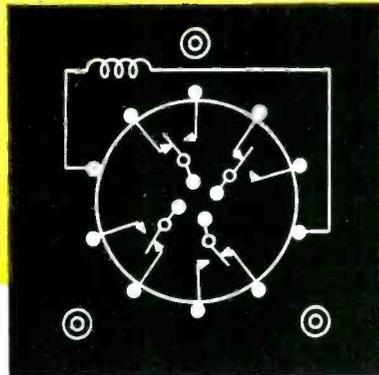
Newtonville 60, Massachusetts

3 NEW CLARE MERCURY-WETTED CONTACT RELAYS TO HANDLE MULTIPLE CIRCUITS

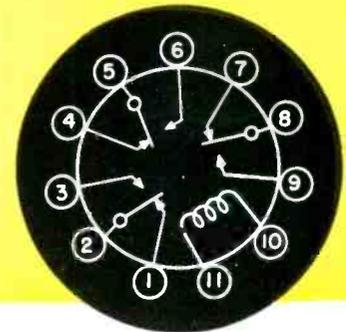


2 FORM C

TYPICAL BASE CONNECTION DIAGRAMS



4 FORM C



3 FORM C

These relays contain 2, 3, or 4 magnetic switches. Each switch is hermetically sealed in a high pressure hydrogen atmosphere in a glass capsule. Platinum contact surfaces are continuously wetted with mercury by capillary connection to mercury reservoir.

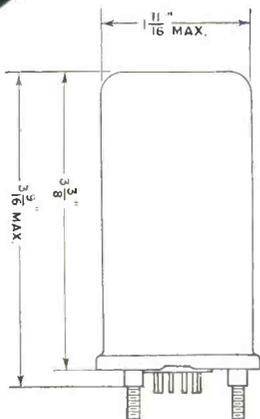


Photo and dimensional drawing of steel can in which 4 Form C switches are enclosed with coil. Plug-in header shown.



SAVE SPACE, MONEY and POWER

In applications requiring more than 1 Form C contact, a multicontact relay may be used instead of 2, 3 or 4 of the standard type HG Mercury-Wetted Contact Relays described in Sales Engineering Bulletin No. 120, thereby saving chassis space, first cost, and operating power.

ELECTRICAL FEATURES

LONG LIFE: Conservative life expectancy of over a billion operations when operated within ratings.

HIGH-SPEED: Give consistent performance at speeds up to 60 operations per second.

HIGH CURRENT—and voltage-handling capacity, up to 5 amperes, up to 500 volts; (250 volt-amperes, max.)

UNIFORMITY: Operating time varies by only about 0.1 millisecond under constant drive conditions.

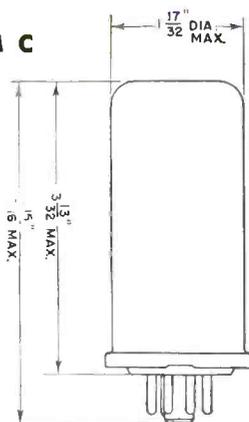
NO CONTACT BOUNCE

MECHANICAL FEATURES

- Small chassis space required
- High sensitivity
- Convenient plug-in mounting
- Maintenance-free
- Environment-free
- No contact wear
- Tamperproof
- Adjustment cannot change

2 OR 3 FORM C

Photo and dimensional drawing of steel can for either 2 or 3 Form C switches. Octal base plug shown is for 2 Form C. An 11 pin base is standard for 3 Form C. Solder terminals also available.



FOR COMPLETE INFORMATION

on CLARE Mercury-Wetted Contact Relays for single or multiple circuits contact your nearest CLARE representative or address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois.

Send for CLARE Sales Engineering Bulletin No. 120

FIRST
in the
industrial
field

CLARE RELAYS



Picture flutter from planes flying overhead is greatly reduced.



In fringe-reception areas, there is less picture roll.



Lightning will not materially affect sync—cause picture distortion.

WITH THE NEW G-E 6BU8, YOUR POPULAR- MAINTAIN PICTURE STEADINESS UNDER

New General Electric twin pentode combines sync and AGC tubes in one envelope. Costs substantially less than the pair of tubes formerly needed for picture stability.

You can score a real advance in TV picture performance with the 6BU8—new G-E 9-pin twin pentode that combines the functions of the 6BE6 and 6AU6, two tubes commonly used to assure a steady, undistorted screen image.

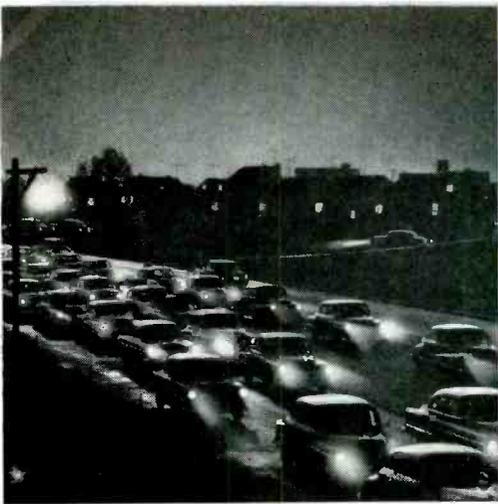
Cost of the 6BU8 is materially less than cost of the 6BE6 and 6AU6 as a pair. Consequently, you can afford to design the new tube—or Type 3BU8, its series-string counterpart—into your volume-production, popular-price television sets.

Your portables and small table models will have picture quality that is proof against flutter and distortion from passing planes, passing cars, lightning. The image

will have far less roll in fringe areas . . . tuning will be “one-hand,” with no need for distance switch. All these are features usually found only in deluxe TV receivers.

The 6BU8 and 3BU8 are the latest in a long series of General Electric tubes for TV that have helped set manufacturers cut costs and improve performance. Use them to increase receiver sales by upgrading picture quality over your entire line!

Complete information and prices will be sent you on request. Or, if you prefer, a G-E tube engineer will be glad to call on you in person at your convenience. *Tube Department, General Electric Company, Schenectady 5, New York.*



Passing automobiles leave the picture steady, free from distortion and jitter.



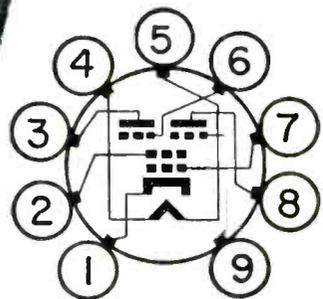
◀ ALSO no more bothersome "both-hands" tuning of the set! The distance switch can be eliminated—another 6BU8 plus and cost-saver. When choosing programs, viewers no longer need manipulate two controls: tuning knob and distance switch. One control knob will tune in *all* stations, near and far.

**PRICE SETS WILL
ALL CONDITIONS!**



6BU8 and 3BU8

9-pin twin pentodes with common connections for the screen grid, control grid, and cathode. The two types are identical except for heater voltage—6.3 v and 3.15 v respectively. Also, the 3BU8 has controlled heater warm-up time for operation in series-string television sets.



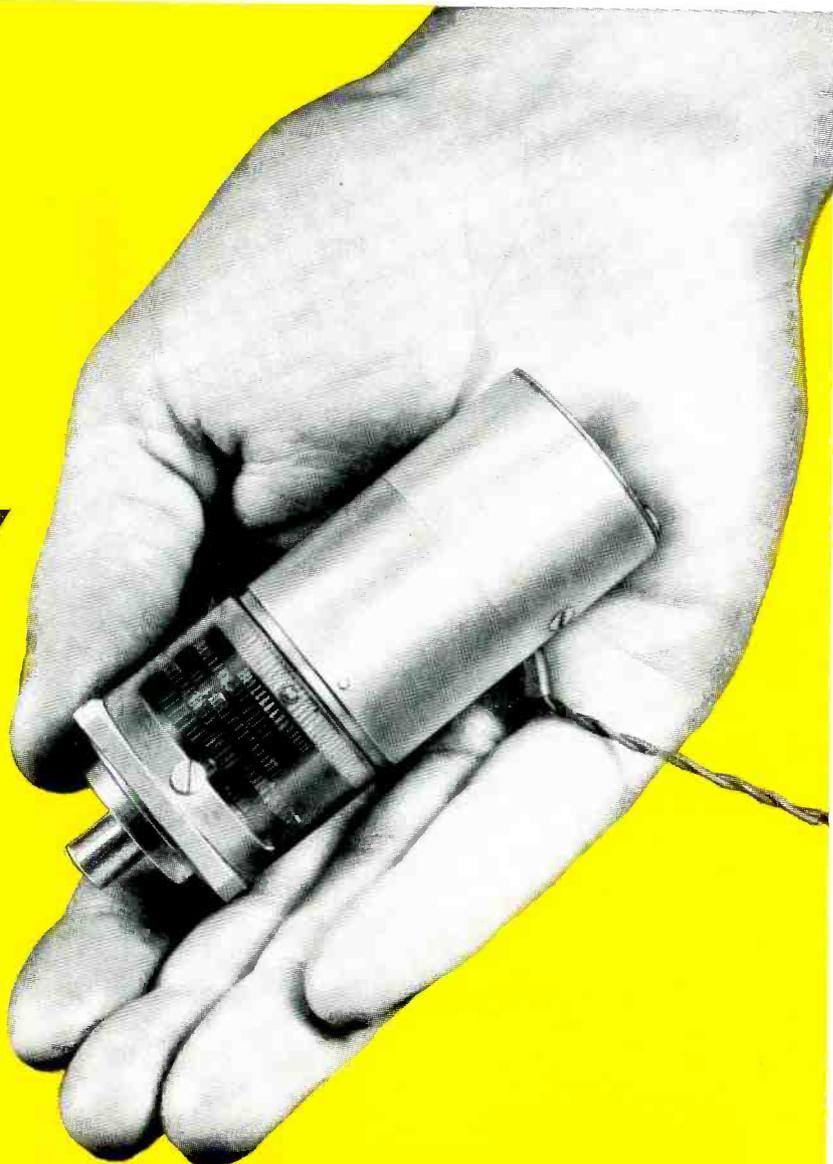
Progress Is Our Most Important Product

GENERAL  ELECTRIC

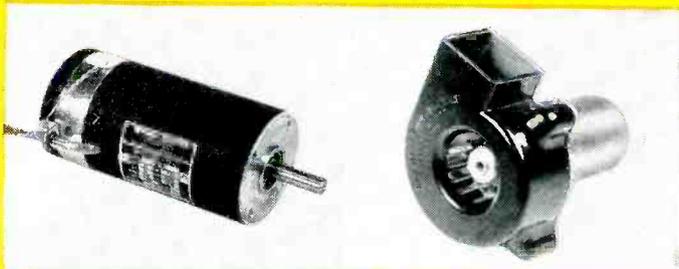
how to reduce
costs with

**WESTERN
GEAR**

rotary electrical
equipment



We have more than 50 basic prototype motors, fans, blowers, converters, alternators and generators. Motor designs range from 1/500th to 4 HP, 50 to 1,000 cycles in frequency, any desired voltage. Extensive line enables economic modification to your requirements or special design. Complete engineering service gladly offered for help on any rotary electrical equipment problem. Write for new catalog No. 254-A.



Precision fine pitch gears, constructed to the highest specifications for electronics use, available from 200 to 6 diametral pitch and from .125" to 10" diameter. Complete engineering and manufacturing facilities for the application of high precision gearing and gear drives in electronics equipment. Ask for help on your problem. No obligation!

"The difference is reliability" • Since 1888

5596

Detail your requirement on any electronic problem. Utilize Western Gear's production facilities to cut your product costs. Our engineers will give their recommendations promptly. Address Western Gear Corporation, Electro Products Division, 132 W. Colorado St., Pasadena 1, Calif.

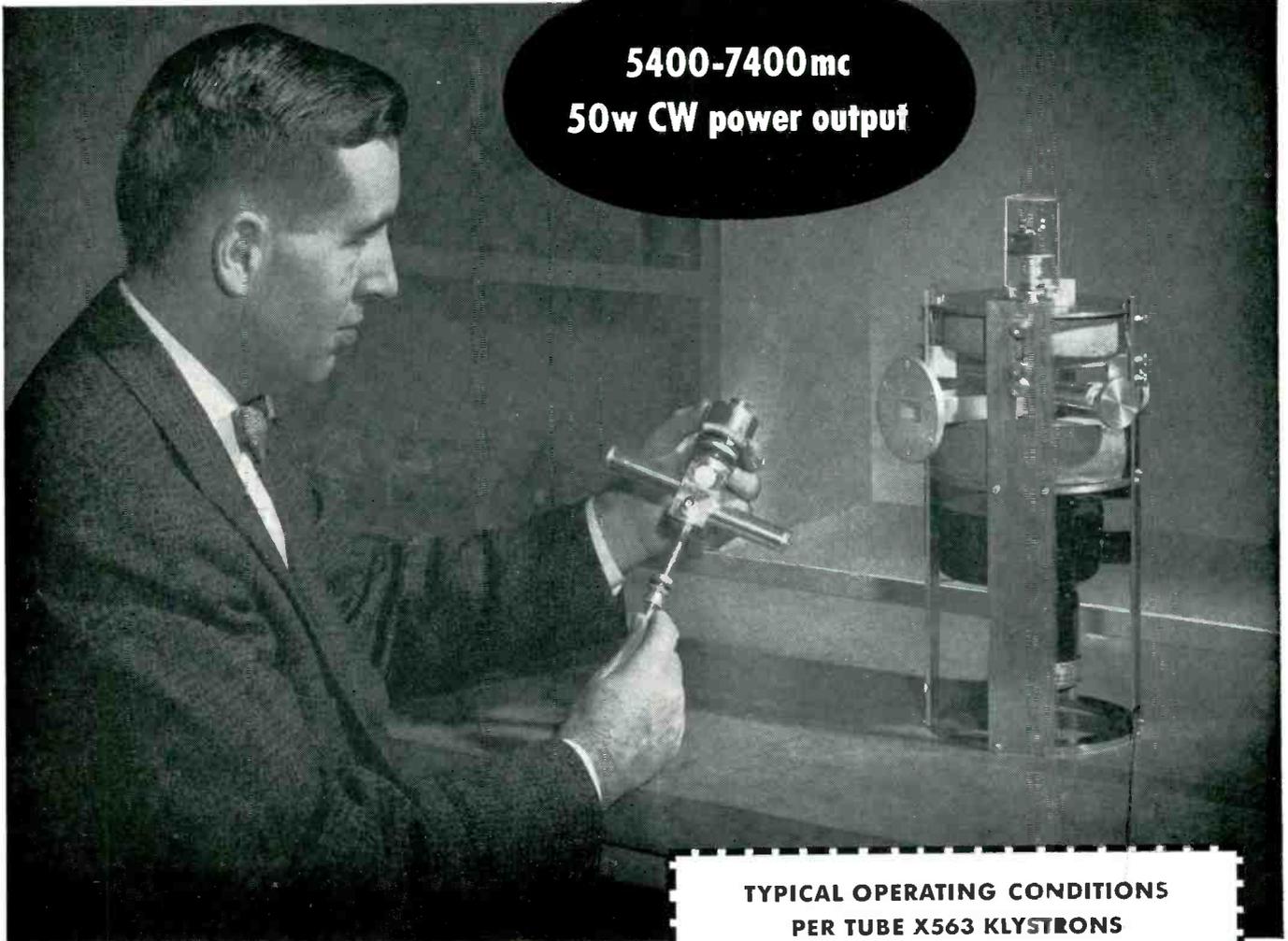
WESTERN GEAR
Corporation



ENGINEERS AND MANUFACTURERS

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**5400-7400mc
50w CW power output**

Eimac X563E, 5900-6400mc, and amplifier circuit assembly.

Eimac X563 amplifier klystrons make 50 watt CW power output commercially available at 5400-7400mc. A bonus feature of the X563 is its adaptability to present C-Band systems. Existing milliwatt equipment is sufficient to drive a conservatively rated X563 to power gains of 10,000 times and efficiencies of 20-25%. Single adjustment tuning knobs make each of the X563's four integral cavities as easy to

TYPICAL OPERATING CONDITIONS PER TUBE X563 KLYSTRONS			
D-C Beam Voltage . . .	2750v	Power Output	60w
D-C Beam Current . . .	110ma	Efficiency	20%
D-C Focusing Voltage . .	-50v	Driving Power	5mW

tune as a standard AM broadcast receiver.

The Eimac X563 is also available with magnetic circuit components, output waveguide fitting and collector and cathode sockets comprising a suitcase-size amplifier assembly weighing only 20 pounds.

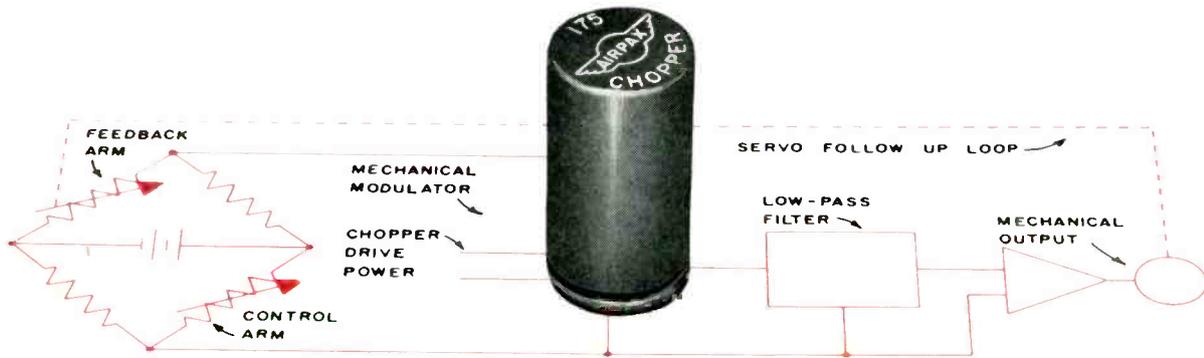


● Eimac offers the most extensive selection of high power amplifier klystrons for pulse, CW and AM applications. For information and a copy of "KLYSTRON FACTS #3" contact our Technical Services Dept.



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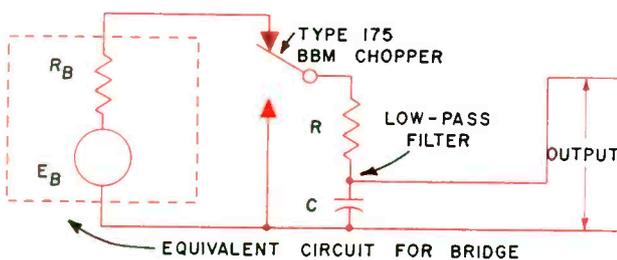
HIGH IMPEDANCE MODULATOR



To minimize loading the bridge, a high-impedance modulator is used such as Airpax Type 175

CONTROLS frequently require a modulator that presents high impedance to a bridge circuit. Perhaps you are faced by such a problem.

A typical solution is illustrated above. One arm of the bridge is used for control, the other for feedback. Output from the bridge is modulated, filtered, fed to an amplifier and used to



In basic modulator circuit, chopper alternately connects filter across bridge and then shorts filter

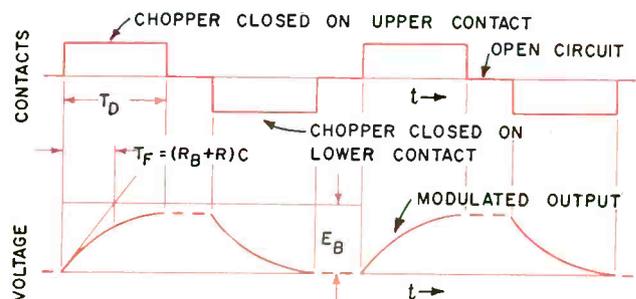
drive a motor. The follow up to the feedback arm is phased to drive the bridge toward balance. A modulator with inherently low zero offset is essential if the bridge is to be balanced accurately.

The mechanical modulator, popularly called a chopper, is ideal in this application. The break-before-make type, such as Airpax Type 175, is naturally used. (A MBB type momentarily shorts the bridge producing transients that mask the null.) The basic circuit is shown above.

A high-pass filter integrates the modulated signal to hold the output during the open-circuit interval. The action is shown in the accompanying timing diagram.

From modulation theory, we know that the circuit is insensitive to signal frequencies above half the chopper drive frequency (60 CPS for Type 175). Thus the filter is made to cut off at this limiting frequency. It also serves to narrow the noise spectrum out of the modulator.

Where an especially low noise level is required, Airpax Type 176 chopper is used. This



Upper diagram shows timing of chopper action, lower one shows effect of low-pass filter on output

is like Type 175 but the drive-coil leads come out the top. Another way to reduce noise is to use a variation of Type 175 with solder-lug terminals.

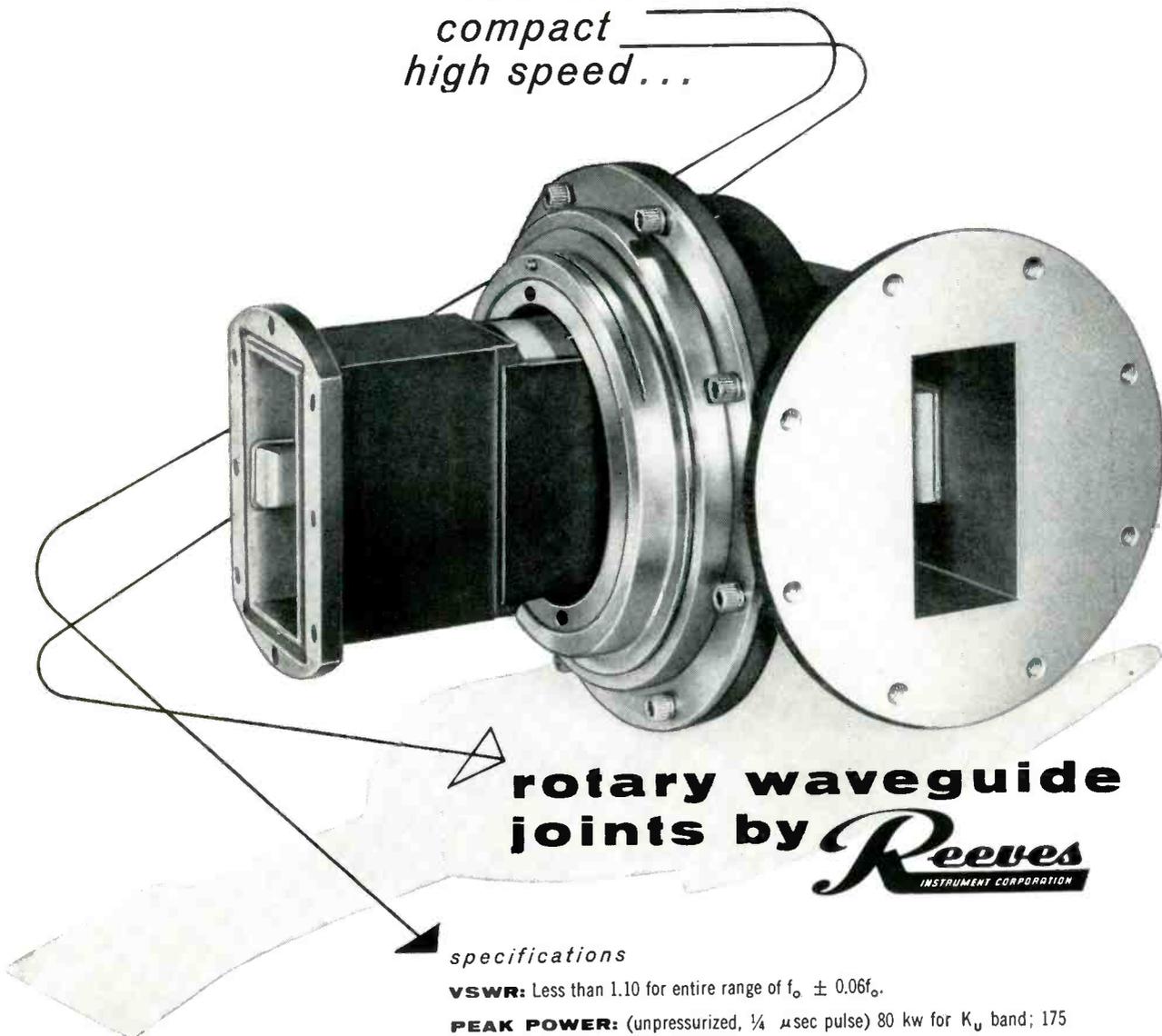
For further recommendations on the chopper best suited to your particular requirements, write to



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*low VSWR
compact
high speed...*



rotary waveguide joints by *Reeves* INSTRUMENT CORPORATION

specifications

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PEAK POWER: (unpressurized, $\frac{1}{4}$ μ sec pulse) 80 kw for K_u band; 175 kw for X band; 1500 kw for S band.

PEAK POWER: (pressurized, $\frac{1}{4}$ μ sec pulse) approximately proportional to square of the absolute pressure.

HIGH ROTATIONAL SPEEDS: Center conductor supported in oilite bearing; main housing supported on ball bearing.

LOW LEAKAGE: RF chokes incorporated to prevent leakage.

MEETS MIL SPECS: Including weatherproofing for outdoor use.

NO WOW: Coaxial design eliminates amplitude changes with rotation.

Compact rotary joints for either 90° or 180° orientation of input waveguide sections provide 360° continuous rotation at high speeds with broadband operation and high power handling capability. May be operated fully pressurized if desired. Standard models for K_u , X and S bands—other bands available on special order.

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at approx. 5 m.a.

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400 or 500 cycles

Type 2007T

+ $-.02\%$ from -65° to $+85^{\circ}$ C.

Type R2007T

+ $-.002\%$ from $+15^{\circ}$ to $+85^{\circ}$ C.

Type W2007T

+ $-.005\%$ from -65° to $+85^{\circ}$ C.

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5 volts, sine wave.

Substantially uniform
from -65° to $+85^{\circ}$ C.

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CYCLES
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20 to 35
VOLTS
D.C.

Precision

FREQUENCY STANDARDS

These units, which are the result of several years of development and testing, offer a new standard of simplicity and reliability. Particularly noteworthy is the uniformity of output signal voltage with temperature change. Small size and light weight make them ideal for airborne and portable use.

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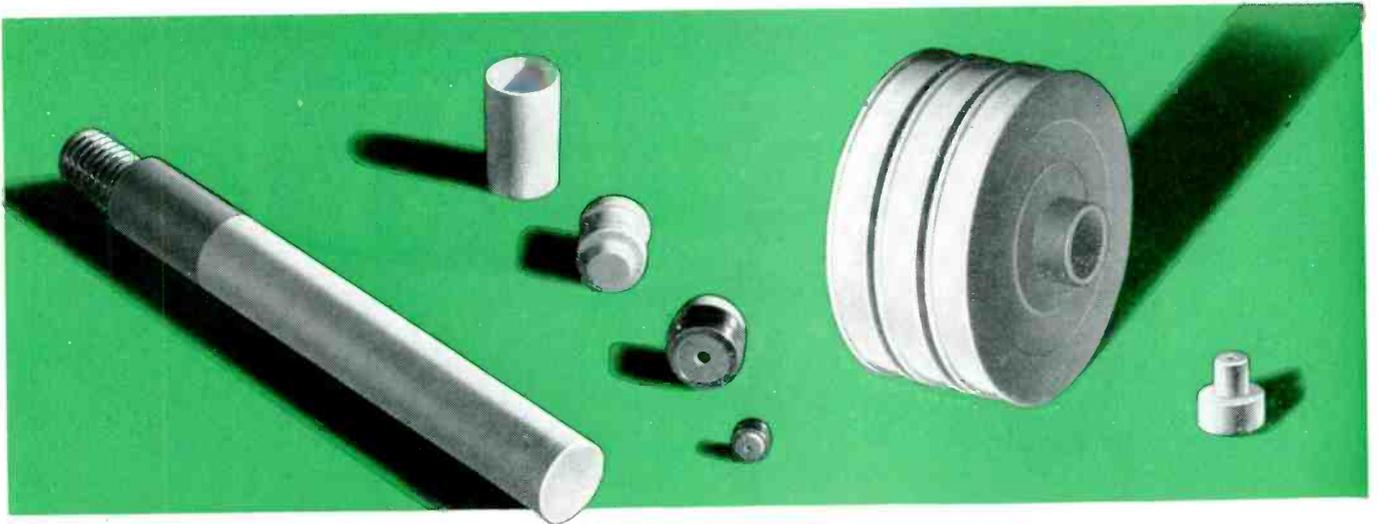
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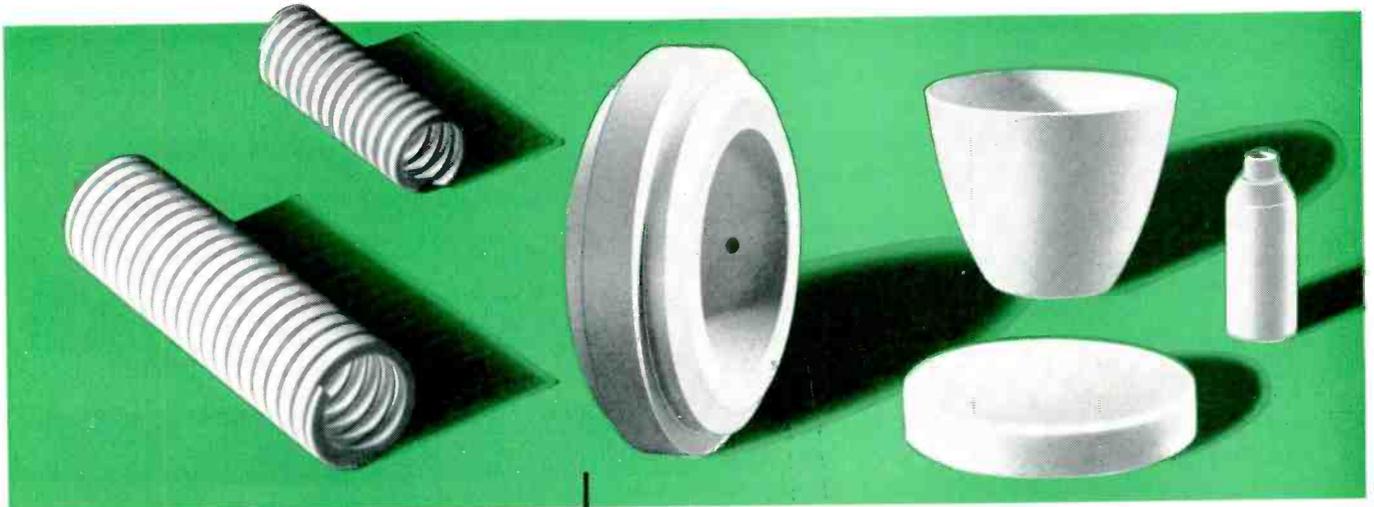
- ▶ *Its diamond-like hardness?*
- ▶ *Its electrical resistivity?*
- ▶ *Its high temperature characteristics?*

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its resistance to chemical attack it is comparable to fine quality chemical porcelain.

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- 6 A left-hand thread is used on the cable accessory to prevent inadvertent loosening.
- 7 High-grade copper alloy contacts are used which provide for high current capacity and low voltage drop. The famous Bendix closed entry socket is used for contacts sizes 12 and 16.

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AUTOMATIC ASSEMBLY, using the new G-E Silicon Rectifiers, is made possible by the Axial Lead design. There is no heat sink required, no troublesome screw terminals. Leads slip easily into the board, and dip-soldering quickly completes the assembly.

New General Electric Silicon Junction Rectifier operates at 150°C with full rating, delivers 250 MA at 200 V PIV—no heat sink required

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General Electric Silicon Rectifiers provide a strong combination of desirable features. They operate at much higher temperatures, making possible their use in close, air-tight assemblies. Applications are much

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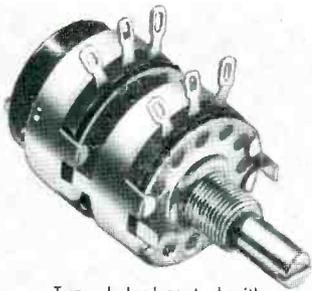
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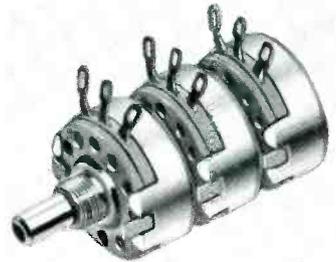
Type J dual control with line switch



Type J resistor with short shaft and lock-type bushing



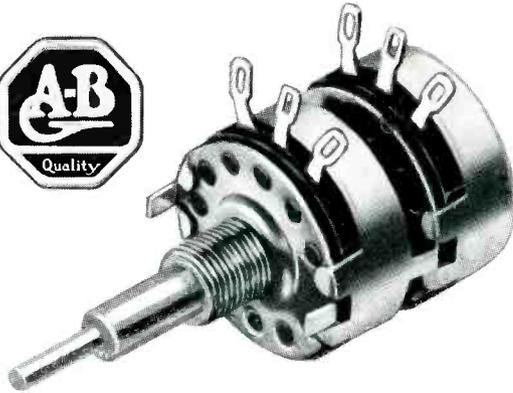
Type J single-unit resistor with plain, short shaft



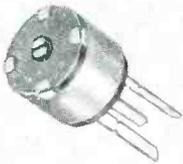
Type J triple-unit resistor



Type J single-unit with long shaft and 125v switch



Type J dual-unit resistor with short, flatted shaft



Type GP small variable resistor for printed circuits

AN "INDUSTRY STANDARD" WHERE LONG LIFE AND QUALITY PERFORMANCE ARE NECESSARY



Type J single-unit variable resistor with long shaft



Type G small variable resistors—plain or lock-type bushings



Type G small variable resistor with line switch

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The resistor element in all units is a solid molded ring (not paint or film) supplied for standard or special tapers. The resistance material, insulation, terminals, faceplate, and bushing are molded in **ONE** piece. You can expect improvement with use as brush wears smoothly to flat molded resistor. There are no welded joints, no rivets, no soldered connections.

TYPE J—2 watts—in single, dual, or triple construction. With or without line switch. Dual units can be supplied with concentric shafts for individual resistor control.

TYPE G & GP— $\frac{1}{2}$ watt— $\frac{1}{2}$ inch in diameter. Type GP units have long terminals for printed circuit applications.

TYPE T— $\frac{1}{2}$ watt—compact units for hearing aids and similar applications.

A-B variable resistors are available in standard **RETMA** values up to 5 megohms.



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MEMO

FROM: THE ENGINEERING STAFF AT NJE
TO: ELECTRONIC SYSTEMS ENGINEERS

SUBJECT: HINDSIGHT ...

"Your foresight may be poor", they say,
"but your hindsight is always 20-20."

Maybe so, but there are days
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As everyone knows by now (we
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one, we add it to our list, hoping
to sell it again, minus the design fee.

When the same custom design has been sold to a number
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We've selected about 200 of the most-frequently-
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200-400	0-1.5 amp.	.15%	± 2% (± 1.5% at 400V)	Brute-force Germanium (Tubeless)	CS-4091	600.00
0-1500	0-200 ma	.1%	0.5% line or load	Series-tube reg.	CS-3361	900.00
250-300	0-1 amp.	10 mv	0.3% line or load	"	CS-4625	400.00

Incidentally, delivery is excellent—5 to 6 weeks, usually. Minor variations in range, performance, packaging, etc., are cheerfully done at nominal additional charge.

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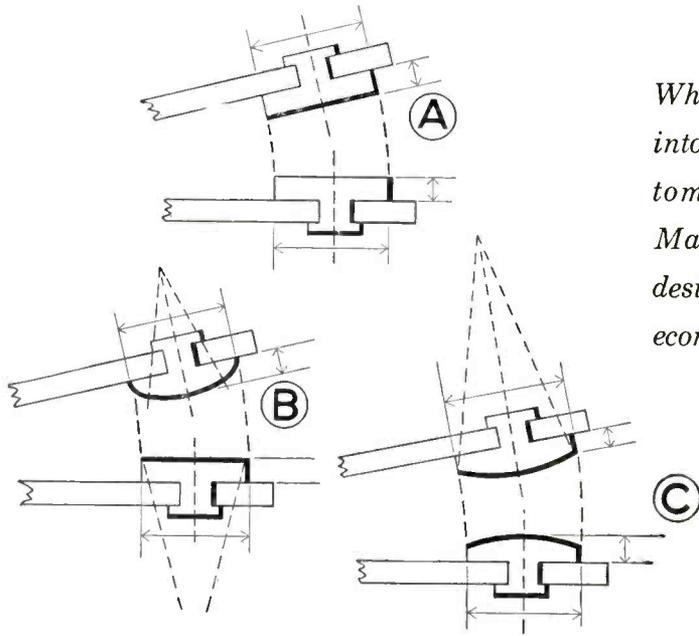
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When Original Design A ran into alignment trouble, the customer proposed design B. Mallory engineers recommended design C as the most efficient and economical solution.

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1. **The most effective contact material** from the extensive line developed by Mallory. More economical alloys often can satisfy actual service conditions.
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4. **The most economical backing member design . . .** in relation to contact and product design requirements.
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DESIGN of electrical contacts is an engineering job in which Mallory's specialized experience can often lead to substantial savings for you. A case in point—a manufacturer of circuit breakers wanted to use a combination of flat and radius-faced contacts to lick an alignment problem in production. This design required buying and stocking of two separate contact parts.

Mallory contact engineers came up with a money-saving improvement. They recommended a modified radius design to go on both the stationary and moving contacts. Substantial production time was saved by elimination of the alignment difficulty in assembly. In addition, by buying a *single* type of contact engineered for the job, instead of two separate designs, the manufacturer cut his inventory problem in half, simplified purchasing and handling, and saved a significant percentage of direct contact cost as well.

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CROSS TALK

► **TRAVELOG . . .** This is written in Los Angeles, half way through a field trip, in response to a gentle yet insistent wire from New York re deadlines.

Chicago (cold), Cedar Rapids (colder), Denver (still colder, plus snow), San Francisco (wet) and now southern California (cool air, hot sun). Soon Phoenix (?), Dallas (?) and back home to the east, where we hope the weather is better than when we left.

► **HI-FI HELP WANTED . . .** Most frequent topic of conversation out this way is the continuing search for more engineers.

Apparently most of the young men who could be readily enticed to move west for, among other things, the salubrious climate, have already emulated Horace Greeley. Now many manufacturers who have successfully sold the sun are losing talent to new plants in still sunnier locations.

We met a man just the other day who is altering the layout of a building already under construction to provide plushier quarters for engineering. Another is advertising for engineers over a local hi-fi broadcasting station, hoping perhaps that there may be some affinity between lovers of Bach and Bessel Functions.

► **DISTRIBUTION DILEMMA . . .** Right across the country, manufacturers have expressed some

concern about the current difficulty of obtaining good sales representatives for their lines, particularly in the instrument business.

It seems that some of the larger companies, in the interest of diversification, have started to produce items with which they have not previously been concerned. These new items are frequently competitive with similar products handled by their reps but made by other companies. So something has to give.

Caught in this nutcracker, newer and smaller manufacturers who have not yet built up nationwide distribution are feeling the pinch.

► **TALENT BANK . . .** For obvious reasons, we have been sounding out people anent patents, and can report that while there is some satisfaction about the government's interest in preserving a free economy this satisfaction is indeed mild.

More often, men we have talked to have wondered out loud if the price that has been paid for what might be considered centralized banks of research talent hasn't been quite moderate. How are these talent banks to be supported? Will small companies pick up the load if they cannot be supported?

Thinking is generally along these lines.

LOOKING AHEAD . . .

Modified polyethylene subjected to high-energy nuclear radiation during production retains its excellent insulating characteristics at 150 degrees centigrade. Wire using such insulation is expected on the market within a month

Amateur single-sideband enthusiasts will have plenty of commercial company from now on. Design of much point-to-point communications equipment for use above 30 mc is headed in that direction

Electrical radiation from some two-hundred discrete points in the heavens has been charted in Britain, in Australia and in the United States. These signals can be the basis for new systems of navigation

Relatively noise-free high-frequency amplification can be obtained with traveling-wave tubes. It may not always be necessary to heterodyne to get receiver gain

New Applications For

SUMMARY — Ten-target magnetron switching tube, now in commercial production, combines accurate visual read-out with high-speed electronic reset. Circuits given here show its versatility as a regular or variscale counter, multiplexer, distributor or gate

A BEAM SWITCHING TUBE contains ten identical arrays of spades, targets and grids symmetrically located around a central oxide-coated cathode as in Fig. 1. The spades form and sustain the electron beam, the targets produce a functional pentode-like output and the grids switch the beam from array to array.

Normally, when the tube is turned on by applying B+ voltages after a suitable filament warmup time, the tube will remain in its clear state and there will be no beam formed. This corresponds to the cut-off condition of a split-anode magnetron.

With the tube initially in this cut-off or cleared condition, the static voltage-current characteristic of an individual spade is represented by curve 1 of Fig. 2.

The dynamic spade characteristic, represented by curve 2, is obtained with the lagging spade at 0

By **JOHN BETHKE**
*Applications Engineering Department
 Hayden Brothers of New Jersey
 Plainfield, New Jersey
 Subsidiary of Burroughs Corp.*

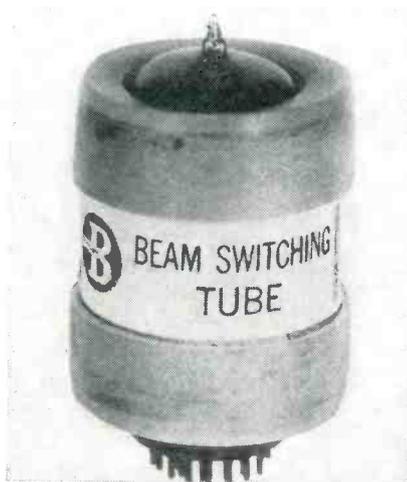
or cathode potential, simulating the condition that exists during switching. Actually, the dynamic curve decays to the static curve after the switching transition as the lagging spade's voltage recovers at a rate determined by its R-C time constant.

These curves, taken with all the other electrodes at 100 v, can be used to determine the values of spade load resistors that will provide bistable operation for each spade. Load line R_M for a 60,000-ohm resistor indicates the lower limit, whereas R_M for a 500,000-ohm resistor indicates the upper limit.

A smaller resistor than 60,000 ohms would create a load line that

and hence there would be only one stable point, at a ; this means that the beam could not be formed. A resistor larger than 500,000 ohms would form a load line that would intersect the dynamic curve only at d , which is the lower state. This implies that as each spade in turn is the leading spade, the beam will automatically be formed to this position, causing astable operation or continuous switching of the beam at a frequency determined by the spade current and the R-C time constant associated with each spade.

Load line R_M , for a 100,000-ohm spade resistor, intersects the characteristic at points a , b and c . Intersection a corresponds to the tube in the cut-off condition, with no beam formed; point b is unstable; intersection c represents the second stable state with a beam formed. The beam may be formed from the cleared condition to any one of the tube's ten positions by



Tube is 3 inches long including polyethylene end caps, 1.7 inches in diameter and weighs 5 oz including its encapsulating cylindrical permanent magnet

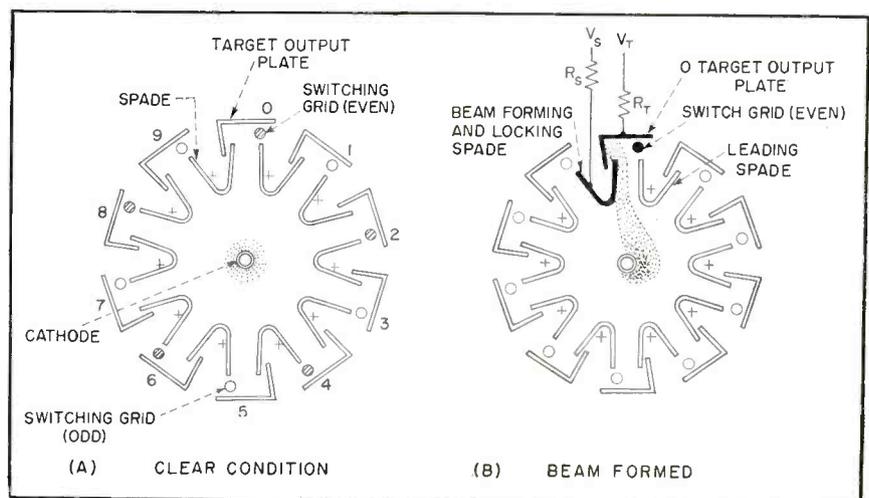


FIG. 1—Electron beam in 450-gauss axial magnetic field serves as equivalent of contact arm in switching from one to another of the ten target output plates under control of spade and grid potentials. Tube designation is now type 6700 (formerly type MO-10)

Beam Switching Tubes

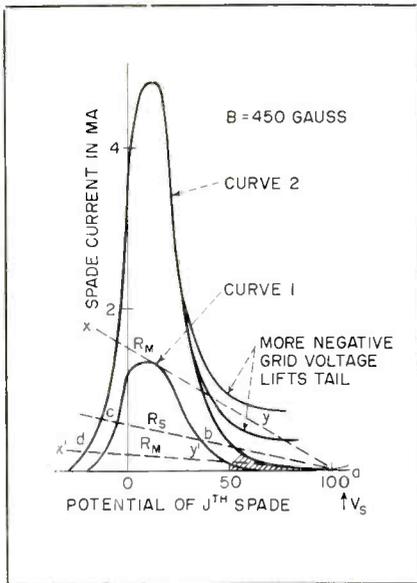


FIG. 2—Spade characteristic curves

lowering the potential of the respective spade from point *a* to where the negative characteristic will take over and lock the beam in at point *c*.

The general shape of the electron beam with it holding on a spade is shown in Fig. 1B. The spade B+ is instrumental in controlling the magnitude of cathode current and hence the spade and target currents. The normal range of spade voltage with 100,000 ohm spade load resistors is 90 to 110 v, producing 4 to 8 ma of target current respectively. The targets are essentially pentode-like in that they receive a constant current within a target voltage range of from $\frac{1}{2} V_s$ to the maximum target voltage rating. Pulses up to 1,500 v at frequencies above 150 kc have been obtained experimentally. The grids are effective switching electrodes, taking little or no current and hence representing high-impedance inputs.

Switching Action

The beam may remain holding indefinitely as in Fig. 1B or it may be advanced sequentially or reformed to any other position at 1-microsecond rates as will be discussed later. The shape of the dynamic or leading spade's characteristic is altered by varying the

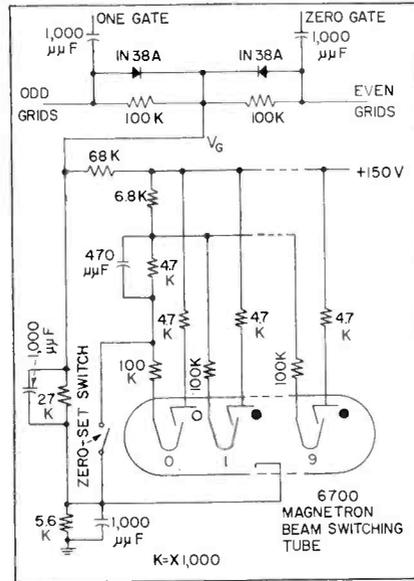


FIG. 3—Basic switching circuit

potential of the switching grids. Making the grids more negative raises the right-hand portion of the dynamic characteristic so that load line *R*, has only one intersection, at point *c* which is the *on* state.

If the grids are connected in parallel a quantized input pulse is required to insure single-step sequential switching, due to the fact that the switching time is in the order of 0.1 microsecond. The spades can be padded with additional capacitance, as determined by the maximum scaling frequency, to reduce the stringency of the input pulse requirements. Actually, the grids are internally connected in groups of five and the external connections are termed even grids and odd grids. The even grids are associated with the even spades and serve to switch the beam from an even position to an odd position. With the grids so connected, they can accept pulses as supplied by a flip-flop or they can be driven from a push-pull sine-wave source

The beam switching tube circuit shown in Fig. 3 is basic enough to introduce the tube and yet versatile enough to have many applications with few modifications. The modifications to meet the requirements of the particular application may be in the type of input drive used, the method of zero setting or

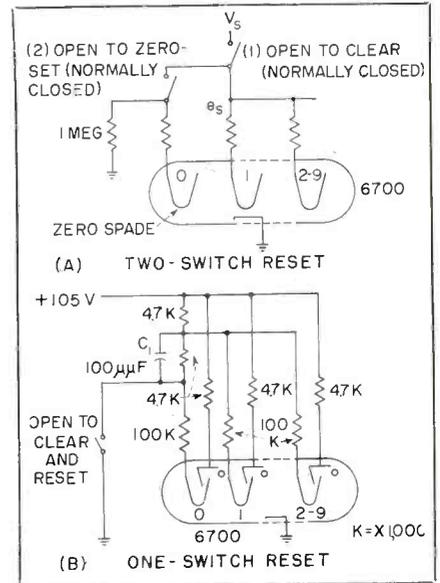


FIG. 4—Resetting circuit arrangements

the type of target load. The circuit has a degeneration resistor in the cathode circuit and a bleeder network to obtain the grid bias, both of which serve to insure reliable operation with wide B+ tolerances. The input signal, whether in the push-pull form shown or a single discrete pulse, should be of sufficient amplitude to vary the grids from their bias of approximately +25 volts to -20 volts with respect to the cathode.

Zero Setting

When B+ is first applied, the tube remains in its cleared state and no beam is formed. The beam may be formed to any position from this cleared condition by lowering the potential of the respective spade to where the negative spade characteristic will take over and form and lock the beam. This method, which can be accomplished with a spst switch, functions well when the tube is being zero-set from the clear or cut-off condition. However, once the beam is formed, depressing such a zero-set switch will not always return the beam to the zero position.

This is explained as follows: The beam, holding in the zero position, can be formed to a leading position (1 through 4) merely by lowering the potential of the respective

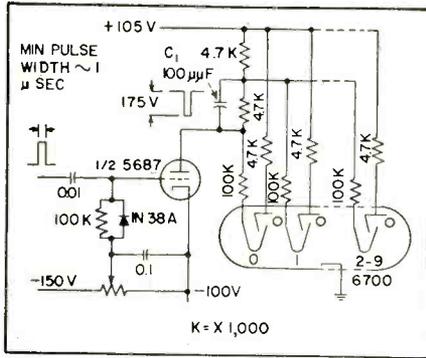


FIG. 5—High-speed clear and reset circuit using direct coupling

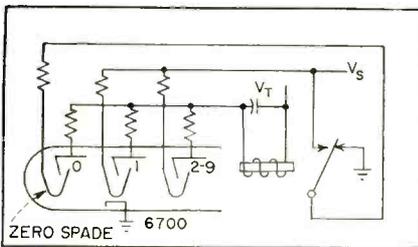


FIG. 6—Automatic zero reset circuit

spade, whereas lowering the potential of a lagging spade (6 through 9) will not shift the beam from the zero position. Spade 5 is a borderline position and its influence will be determined by the magnitude of the spade supply voltage. Thus, the beam cannot be reset to zero from every position merely by lowering the voltage of the zero spade.

One way to circumvent this phenomenon is to clear the tube before resetting. This clearing can be accomplished by momentarily removing B+ or by lowering the spade-cathode potential to a voltage that will not sustain beam formation. Figure 4A illustrates the use of two spst switches, for clearing and zero setting respectively. Switch 1 in this circuit is normally closed and serves to interrupt B+ for clearing the tube.

Simplified Zero Setting

Figure 4B indicates how one spst switch can accomplish simultaneous clearing and zero-setting. Depressing the normally open switch reduces the spade potential sufficiently to extinguish the beam. When the switch is released, the common spade bus begins to recover to B+. Since the 0 spade has been lowered beyond the others

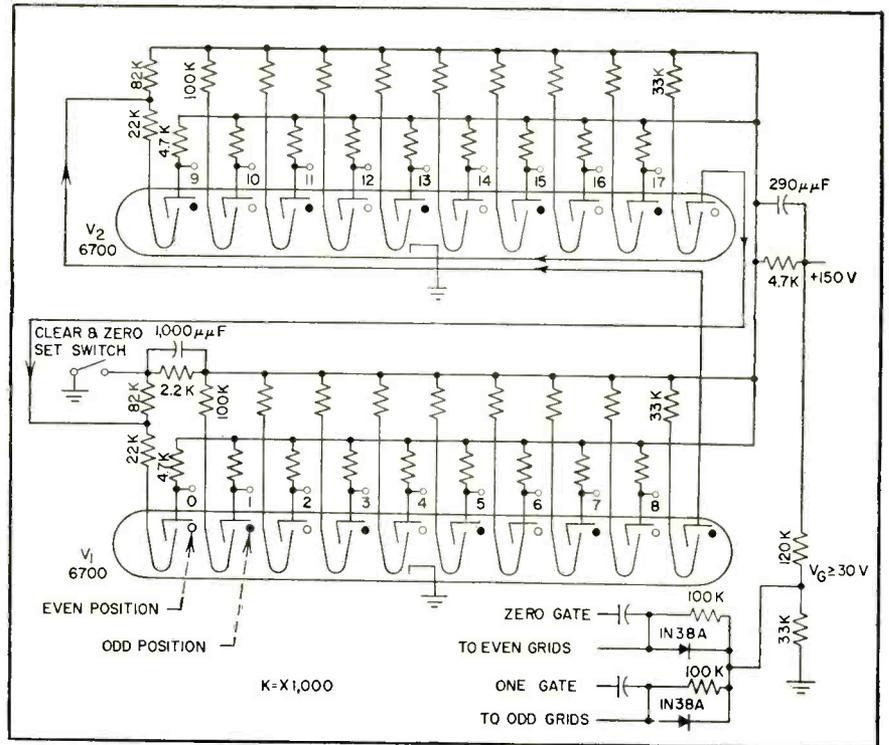


FIG. 7—Multiposition distributor using two type 6700 magnetron beam switching tubes

and is slowed in its recovery by C_i , it follows that when the common spade connection reaches a potential that will form and sustain the beam, the lower voltage of the 0 spade will form the beam to this position.

Electronic Zero Setting

The circuit of Fig. 5 allows the beam switching tube to be reset with a pulse of approximately 1 microsecond duration. The resetting pulse, applied to the grid of a normally cut-off triode, triggers this tube on, allowing the plate current to flow through the two 4,700-ohm resistors to B+. The spade bus is thus lowered, which suffices to clear the tube. At the

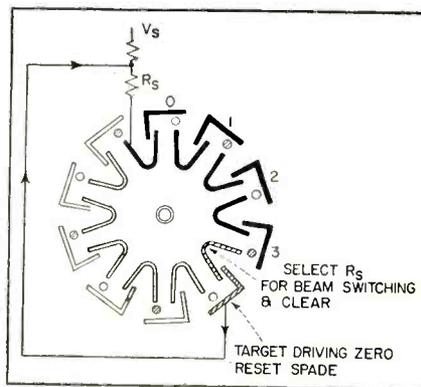


FIG. 8—Tube interconnection for four-position indication

termination of the pulse, when the voltages begin to recover to B+, the 0 spade voltage recovery is retarded by C_i . Thus, when the spade bus recovers, the beam will form to the spade with the low potential.

The targets are returned directly to B+. This is done to prevent pulses from appearing on all targets when resetting. This method of resetting can be used in a variscale distributor, as will be discussed later.

Certain applications call for an automatic zero set. Figure 6 shows how a relay may be used to reset the tube. The 0 spade is held at cathode potential by normally closed contacts. When the beam is formed, the target current energizes the relay which serves to open these contacts, permitting normal operation of the tube. If B+ should be interrupted for any reason, the beam will automatically be reformed to the 0 position when B+ is again applied.

Nondecimal Counting

Certain applications call for scalars of other than ten counts having a functional output at each position. As previously mentioned, the beam need not be advanced sequentially, but rather may be formed

from any position to any other position either within the same tube or between separate tubes. One way to accomplish this is to select a spade load line large enough to produce switching using the dynamic curve in Fig. 2, but not large enough to sustain the beam using the static characteristic.

One example of this type of switching is shown in Fig. 7, a schematic for a multiposition distributor. In this circuit, only one beam switching tube is *on*, the other or others being in the cleared state. The switching pulses applied to all tubes in parallel cause the beam to advance in V_1 from position 0 to position 8 in the normal manner. When the beam is switched to position 9, two simultaneous actions occur. Target-9 current of V_1 lowers the 0 spade voltage of V_2 , thus forming the beam on the 0 position of V_2 which is the overall 9th position. Further, the 9 spade resistor of V_1 is of such a value that

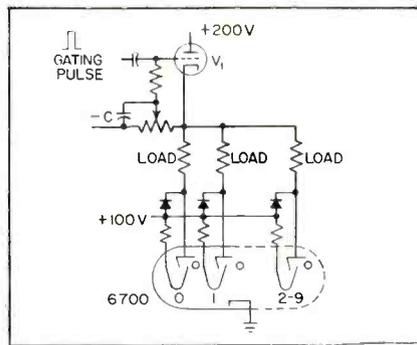


FIG. 9—Single-triode gating circuit

circuit shown in Fig. 4B is another method of obtaining a count of less than 10 that lends itself to a variscale application. The variscale is a counter-distributor capable of having its count varied from 2 to 10 positions. In this operation, a pulse is taken from the N th position to trigger the high-speed clear and reset circuit which in turn resets the beam to the 0 spade.

Some applications call for the

tube to scale in its normal manner with no beam apparent, that is, without having the beam current reach the load associated with each target until a gating pulse is applied. The technique of using a single triode to obtain this gating function is shown in Fig. 9. Each target is returned to the spade B+ of approximately 100 v through a diode.

With gating tube V_1 normally biased beyond cutoff, these diodes provide the path for the target current. Under this condition, the loads are void of any target current; however, when V_1 is gated on by the application of a positive signal, current flows through the load associated with the target on which the beam of the switching tube is impinging.

Transfer-Storage Circuit

In the transfer-storage circuit of Fig. 10, V_1 and V_2 are normally biased beyond cutoff. Switching tube V_3 is in its cutoff or cleared state and V_4 is made to scale or count in its normal manner. Under the above conditions the target current of V_3 flows through diodes D_1 to the higher B+ of 300 v and the 20,000 ohm load resistors are void of any switching tube or leakage currents. The positive transfer pulse gates on tube V_1 , causing its plate current of approximately 25 ma to flow through the 8,000-ohm resistor; this lowers the potential at the junction of the V_1 plate, the 8,000-ohm load resistor and diodes D_1 to approximately 100 v. With this lowered voltage the target current of V_3 will now flow through diodes D_2 . This target current will also pass through the 20,000-ohm resistor associated with the holding target, developing a voltage drop of approximately 100 v that is coupled to the corresponding spade of V_4 .

Storage switching tube V_4 can be connected to remember the position of the beam in V_3 at the initiation of the transfer pulse, or V_4 can be connected to follow the count of V_3 for the duration of the transfer pulse and remember the position of the beam at the termination of the transfer pulse. The latter method can be accomplished by connecting targets 0, 1, 2 etc of V_3 to spades

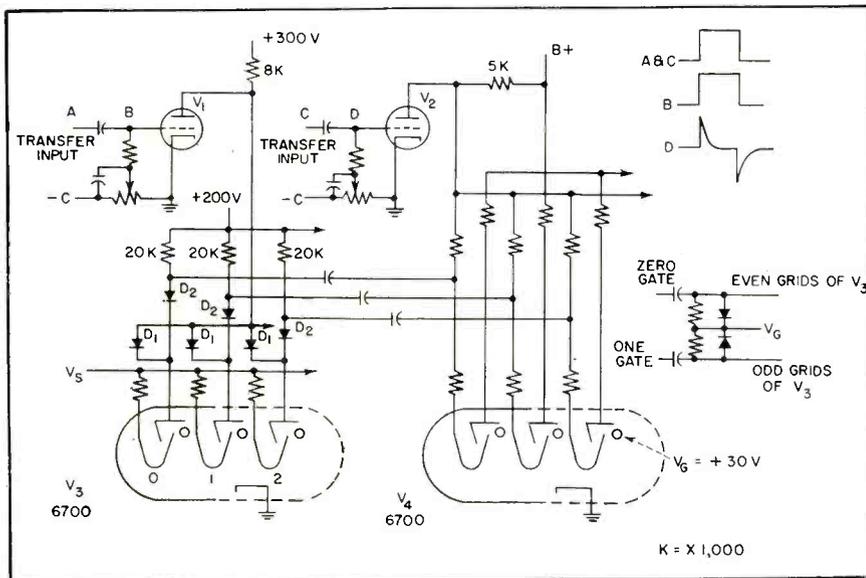


FIG. 10—Transfer-storage circuit using two switching tubes

this tube clears itself. When the beam reaches a corresponding section of V_2 the action is repeated and can be used to initiate a third tube or reset V_1 . A distributor of 9N positions (N being the number of tubes) is thus obtained with no reduction of scaling frequencies and using the B+ power requirements of only one tube. Figure 8 employs the same technique within a single tube to obtain less than 10 positions.

The high-speed clear and reset

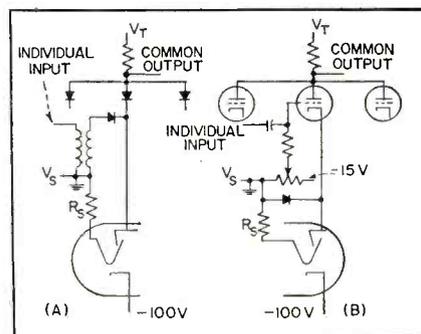


FIG. 11—Beam-gated sampling circuits

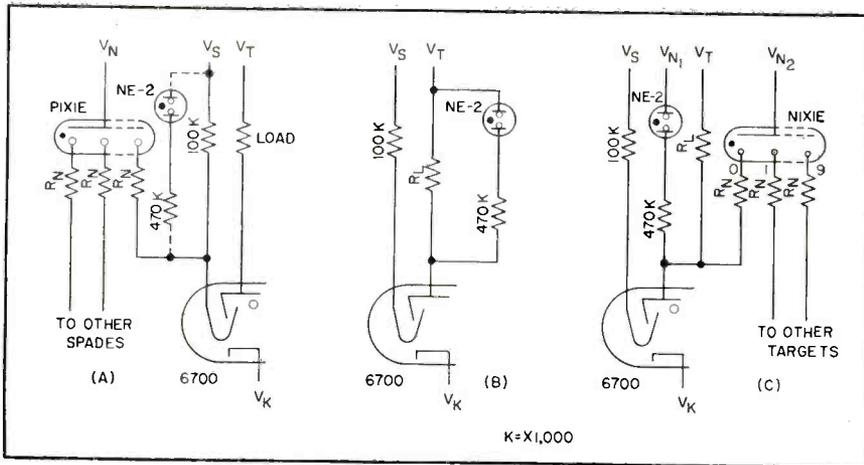


FIG. 12—Three methods of obtaining visual read-out

0, 1, 2 etc of V_4 respectively. With V_4 connected in reverse order, so that targets 0, 1, 2 etc of V_3 are connected to spades 9, 8, 7 etc of V_4 respectively, V_4 will remain locked in on the first position even though the transfer pulse should remain on for as many as four counts of V_3 . This is accomplished because of the inherent ability of the switching tube not to step backwards.

At the termination of the transfer pulse V_3 will continue to scale whereas V_4 will remain holding on the transferred position. The next transfer pulse serves to clear V_4 by gating on V_2 for a shorter time than the duration of the transfer pulse (by differentiating the transfer pulse in the grid circuit of V_2), thus making it possible to store to any position of V_4 including a lagging position.

Multiplexing Circuit

A low-impedance beam-gated sampling circuit using crystal diodes is shown in Fig. 11A.

A triode gate similar to that used in the Beamplexer multiplexing unit, currently manufactured by Burroughs, is given in Fig. 11B. One use of the instrument is as an electronic switch for a single-channel oscilloscope. The technique can also be used as a parallel to serial converter taking many parallel inputs and sequentially gating them to a common load resistor.

Various methods are available for obtaining visual read-out. The functional pentode-like output of each position within the new switching tube again comes to the foreground

as an advantage over conventional tubes, transistors or magnetic core counters.

Figure 12A shows the use of either NE-2's or the Haydu position indicator (Pixie) in the spade circuit, providing a visual indication without altering the versatility of the target output. The Pixie 10-position low-power, low-cost indicating device has a single plug-in envelope fitting a standard socket. The addition of the indicating device in the spade circuit has the disadvantage of adding capacitance to the spade, which reduces the maximum operating frequency of the switching tube.

The two above-mentioned indicating devices, as well as the National Union Inditron and the Haydu Nixie, can also be included in the target circuitry. In Fig. 12B the target supply voltage must be sufficiently high to prevent the ON target voltage from becoming lower than half the spade supply voltage, since the entire ionization voltage is developed across target R_L .

In Fig. 12C the NE-2 neons, the

Nixie or the Pixie can be prebiased with a separate power supply and a pulse developed across R_L to vary the voltage across the indicating device from below sustaining to above ionization voltage. The same precaution of preventing the ON target voltage from becoming less than $\frac{1}{2} V_s$ must be observed.

The Nixie numerical indicator has low current, long life, small size and little parallax, and provides a visual read-out directly in numerical form.

Low-Voltage Version of Tube

A new low-voltage version of the switching tube, currently available as a production prototype, is capable of 1-mc operation and will supply 1 ma of target current with a B+ of 24 v. Figure 13 shows a transistorized flip-flop driving this new beam switching tube with a single 22.5-v battery supplying the B+ power. The advantages of this tube are: (1) Low voltage and low power that makes the tube compatible with transistors; (2) output currents of sufficient magnitude to operate relays directly; (3) improved switching requirements.

Reducing the magnetic field from 450 gauss to approximately 160 gauss produces more uniform switching around the periphery of the tube so that 20-v pulses provide reliable operation.

This new beam switching tube is proving its versatility in pulse counting, frequency dividing, distributing, multiplexing, gating, matrixing, coding and timing as an integral part of communications equipment and other data-handling devices such as telemetering, fire control, radar, loran and automatic control.

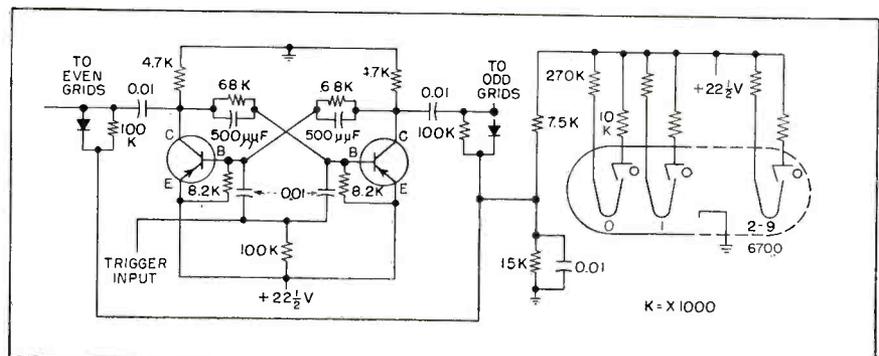


FIG. 13—Transistor driver used with low-voltage version of beam switching tube. One switching tube can do all the functions of approximately twenty transistors

VIBRATION METER Uses Transistors

By JOHN F. KINKEL and M. CARR WILSON

Consolidated Electroynamics Corp., Pasadena, California

SUMMARY — Instrument that measures vibration frequencies from 5 to 1,000 cps can be used in the field conveniently without power-line connection. Transistors are immune to vibration effects that might cause microphonics in tubes. Biasing circuit compensates for fluctuations over temperature range -20 to 120 F

VIBRATION MEASUREMENTS must frequently be made where portability is desirable and power not readily available. The transistor

vibration meter to be described satisfies these requirements. Operated with conventional vibration pickups, it indicates peak-to-peak linear

and torsional vibratory displacements. It can be adapted to velocity and frequency analysis of vibration by auxiliary equipment.

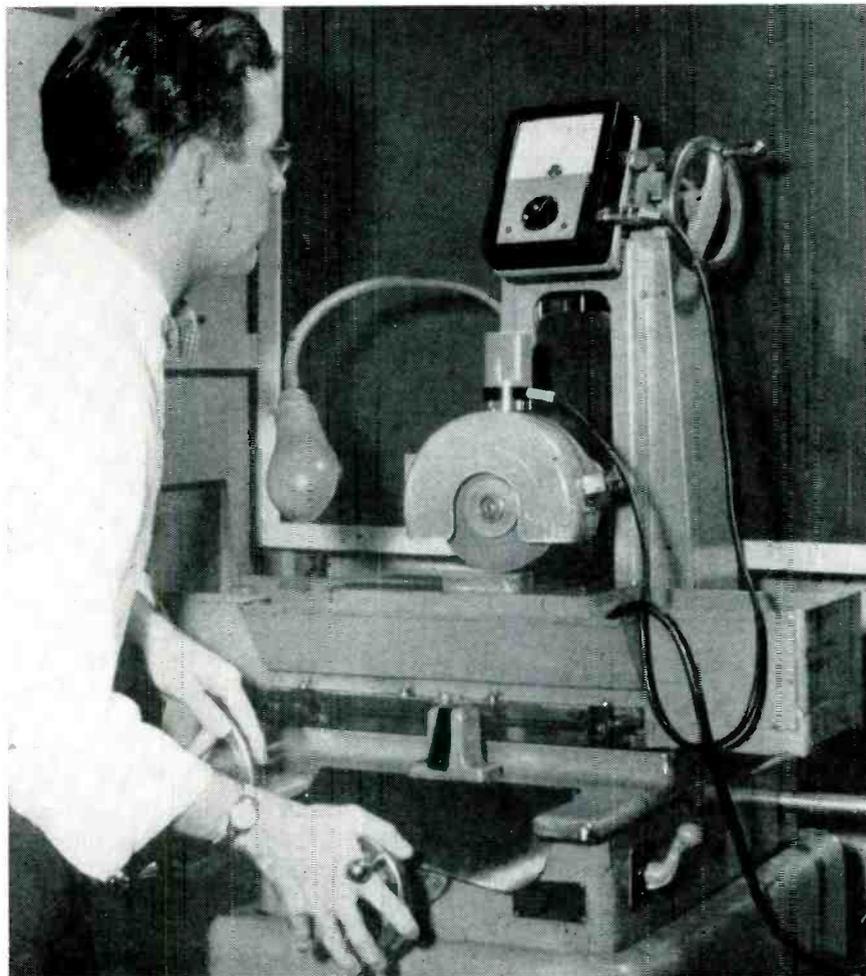
Vibration in machine tools can substantially reduce tool life and adversely affect quality. Vibrations of only 0.00006 in. amplitude in a grinding machine can produce marked degradation in the quality of a ground surface.^{1,2} The shift from propeller-driven to jet aircraft has produced a significant vibration problem. Important vibrations in reciprocating-engine, propeller-driven aircraft are low frequency and large amplitude. They are readily detected and evaluated by the pilot or flight engineer. Vibrations in turbine and jet aircraft are high frequency, small amplitude and can reach dangerous levels before being recognized.³

Design Requirements

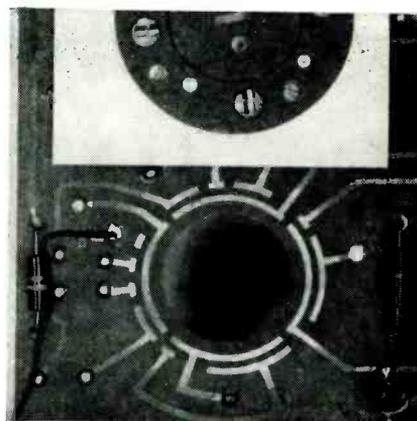
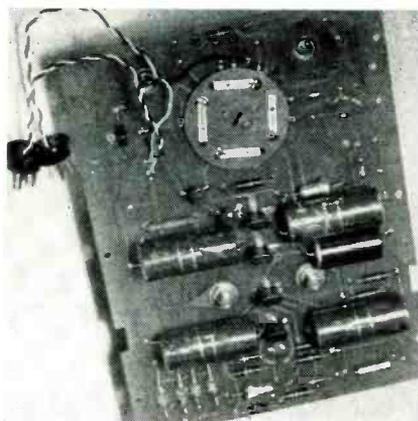
Portability of vibration-measuring equipment is important in pre-flight jet-engine runups, machine-shop operation and mobile testing. Ambient temperatures are expected to range from -20 to 120 F.

The environment can be expected to have fairly high sound levels and microphonic elements cannot be tolerated. The use of transistors avoided the problem of microphonics and also eliminated the need for long warmup periods.

Vibrations in the range of 5 to



Engineer uses transistor vibration meter to check performance of grinding machine



Front panel of vibration meter having six-position frequency range switch, one side of double-etched circuit board and front and rear closeup views of etched range switch

1,000 cycles are conveniently detected with self-generating electromagnetic transducers. These transducers consist of a permanent magnet and a moving coil arranged such that motion between the transducer case and an internal seismic mass causes the magnet to induce a voltage across the coil. A typical vibration transducer is shown in Fig. 1A. The induced voltage across the coil is directly proportional to displacement and inversely proportional to the period of displacement. It is a velocity signal having the characteristics shown in Fig. 1B. If this pickup voltage is applied to an integrating circuit or integrating amplifier having the characteristics shown, ideally the output frequency plot will be as indicated. This integrated velocity signal is a voltage proportional to displacement.

Separation and analysis of frequency components of vibration can be accomplished by filters of known characteristics between the pickup and the integrator. Use of high-pass or band-pass filters eliminates unwanted portions of the vi-

bration spectrum under study. For example, it is necessary to determine separately propeller vibration and turbine vibration in turboprop engines. Since these are separated in frequency by approximately a decade, band-pass filters permit ready identification and measurement.

Vibration Meter

A schematic of the vibration meter is shown in Fig. 2. The instrument consists of a constant-impedance resistive attenuator, followed by a two-stage integrating amplifier. The integrated output is further amplified and applied to the bridge detector. Bridge current is read on a 500-microampere meter. All power is supplied by two 22½-v batteries.

The integrating amplifier consists of two junction transistors TR_1 and TR_2 . The input stage employs the common-emitter connection, while the second stage uses the common-collector mode. Feedback around these two stages provides integration to produce a displacement output. The low-fre-

quency gain characteristic is shown in Fig. 3.

A particular feature of the circuit is its ability to increase overall displacement-signal sensitivity by sacrificing the low-frequency response of the integrator. Figure 3 shows two gain characteristics displaced by one frequency decade. These characteristics are obtained by switching the 1 and 0.1- μ f range capacitors. This results in a 10-to-1 change of displacement voltage for a given velocity signal and provides an effective ten-fold increase in sensitivity without additional amplifier gain.

Performance

Design-center maximum sensitivity is approximately 35 microvolts rms for full-scale meter deflection, which corresponds to 0.5 ma peak-to-peak displacement. At this level, signal-to-noise ratio is significant and care must be taken in selecting the input transistor. Variation in noise output with temperature is appreciable for some types of transistors; the maximum noise figure allowable in 1-cps bandwidth at 1,000 cps has been established as 15 db. The noise is predominantly flicker noise.

Meter Amplifier

The meter amplifier uses transistors TR_3 and TR_4 , both connected in the common-emitter mode. Feedback around these two stages, including the bridge rectifier, assures a meter deflection proportional to the average input. The deflection is essentially independent of the

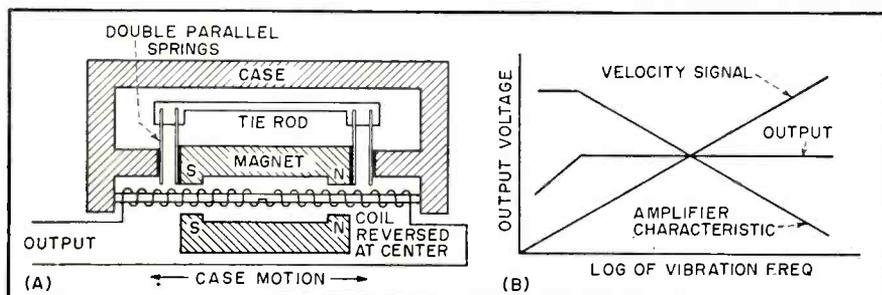


FIG. 1—Electromagnetic vibration transducer used as pickup (A) and voltage-frequency transfer characteristics of system (B)

Correction Circuits for

SUMMARY — Gamma and matrix correction circuits offset restricted brightness ranges of color cameras for live and film pickups, giving more pleasing color reproduction despite brightness range that may be as high as 180 to 1 in normal theater color film. Matrix amplifier corrects for hue shift and loss of saturation caused by gamma overcorrection

IN TRANSMISSION and reproduction of color television images, overall system gamma or gradient plays an important role in faithful translation of the original image.¹ Arbitrary attempts to alter the system transfer characteristic can result in serious hue and saturation distortions. Because of the kinescope power-law transfer characteristic and restricted brightness range, it is necessary to employ some system gamma correction.

The equipment described was designed to provide considerable flexibility in brightness gamma correction as well as hue and saturation modification. Although the amplifiers were designed specifically for use in color film reproduction, their operational flexibility should make them useful for live pickup cameras also.

Measurements show the typical color kinescope to be capable of a small-area brightness range of between 20 and 50 to 1 with a gamma characteristic of about 2.2. The brightness range is restricted on the high end by phosphor emission and allowable beam current, and on the low end by ambient light on the face of the kinescope.

Correction Gammas Needed

Assuming that a nearly linear overall system is desirable for pleasing reproductions, the pickup and transmission equipment must have a combined gamma of $1/2.2$ or 0.45 to compensate for the 2.2 gamma of the kinescope.

For color television studio use, image orthicon cameras are most commonly employed. They are usually operated below the knee of the transfer curve, at which point

they exhibit a gamma of about 0.65 and thus require an additional correction of 0.7 in the transmission system to achieve the desired 0.45 before being applied to the kinescope.

Flying-spot scanners, on the other hand, have an inherent gamma of unity and thus require a 0.45 gamma in the transmission system. The most recent figures for the vidicon film camera show a 0.6 characteristic requiring a 0.75 correction.

Brightness Ranges

Using the above-mentioned correction gammas for the transmission system in conjunction with the correct color filters for the pickup tube, colorimetrically correct transmission in accordance with NTSC Standards will be achieved provided the subject brightness range is kept within the 50-to-1 limitation imposed by the color kinescope.

In a live studio this is usually possible by careful control of lighting and reflectance values for the scene to be transmitted. Unfortunately, however, in film transmission the brightness range is not under control of the television broadcaster and may be as high as 180 to 1 for normal theater release prints, thus

far exceeding the capabilities of the reproducing kinescope.

It has been shown² that using a lower correction exponent than needed to linearize the system will reduce the brightness range of the signal to a value within the handling capability of the kinescope. Such overcorrection results in a loss of saturation and some change in hue of the reproduced picture. This undesirable condition can be corrected by a masking amplifier following the gamma amplifier. Because of the nonlinear nature of the problem, it is difficult to compute the exact coefficients required and, therefore, experimentally determined coefficients are normally employed.³

Gamma Circuit Requirements

The demands placed on the gamma amplifier are extremely stringent. To allow for various pickup devices with provisions for overcorrection requires a gamma range of 0.4 (or lower) to 0.75. The circuit must follow the given characteristic over at least a range of 50 to 1, and preferably 100 to 1 for film reproduction.

Fortunately, a first-order approximation to the desired curve is visually acceptable.⁴ It is possible to obtain the desired curves by mixing variable amounts of a true 0.4-power-law signal with a linear signal. In this manner approximation can be had to curves lying between 0.4 and unity.

Since three gamma amplifiers are required—one each for the red, green and blue channels—it is important that they be capable of producing similar curves, accurate to within at least 2 percent of each

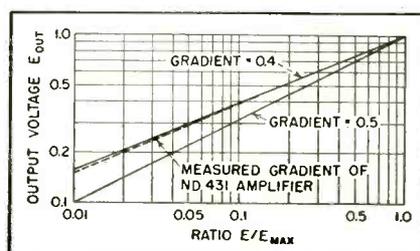


FIG. 1—Measured transfer characteristic of gamma correction amplifier

Color TV Transmitters

By K. E. MULLENGER* and R. H. McMANN, JR.**

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Development Laboratory
New York, N. Y.

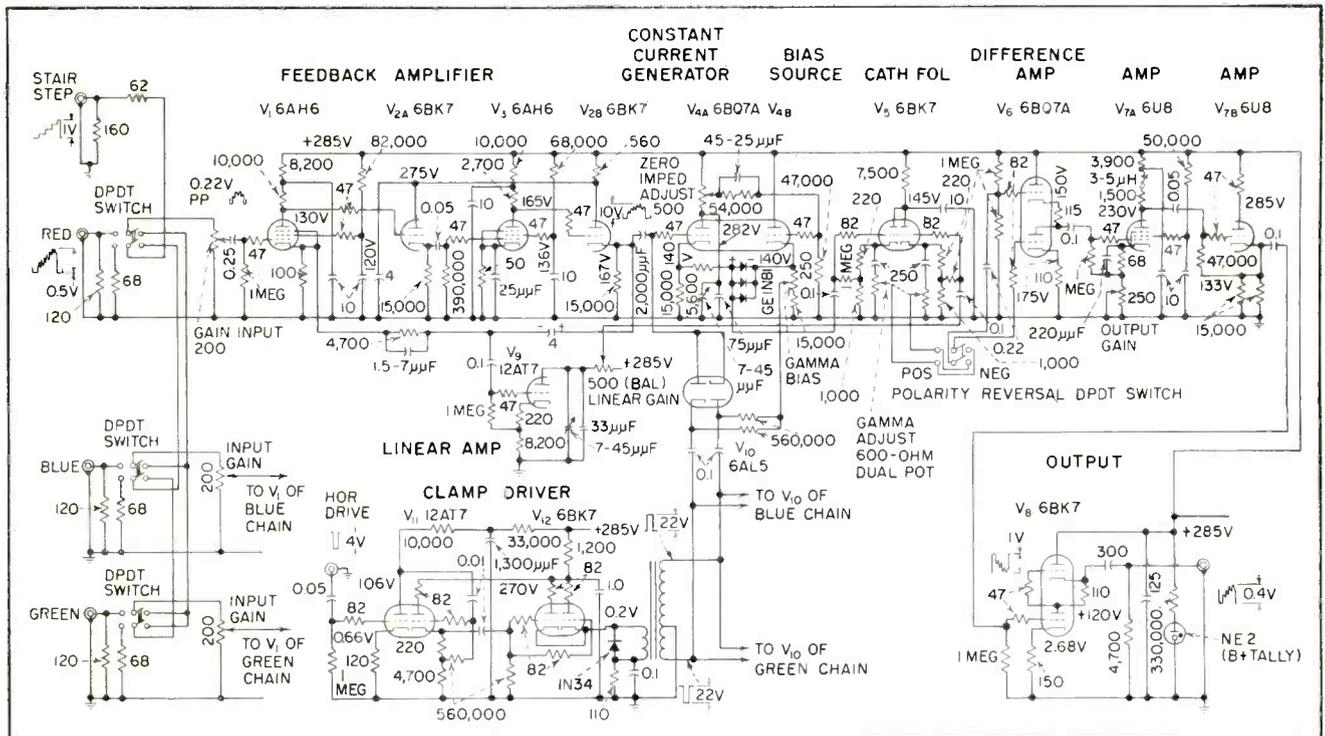


FIG. 2—Red-channel gamma or gradient correction amplifier. Blue and green channels are identical

other. Any dissimilarity would become immediately apparent as a hue error varying with brightness.

The voltage characteristic of a crystal diode driven from a constant-current source closely follows the 0.4 power law desired. This is the basis for the gamma amplifier described.

Gamma Correction Amplifier

Although the measured contrast range of a typical color film print can run as high as 180 to 1 and higher, as a practical matter stray light in the optics of a typical camera system will limit this range to perhaps more nearly 100 to 1. The gamma correction amplifier

was therefore designed to provide a minimum gamma of 0.4 over a 100 to 1 input range. This provides some gamma overcorrection or brightness range reduction over and above that required to linearize the kinescope.

Figure 1 is a plot of the measured transfer characteristic of the amplifier. Small-signal gain at -40 db input referred to peak

white is about 15. This points up the importance of maintaining excellent clamp and gain stability to avoid introduction of serious color unbalance due to such factors as voltage drifts or normal aging of the vacuum tubes.

A schematic diagram of the gamma amplifier is shown in Fig. 2. Tubes V_1 , V_2 and V_3 are used in the feedback amplifier to give a gain of approximately 45 with good linearity and good stability. The feedback factor is 17 db. This amplifier drives the clamped grid of V_{4A} , used as a constant-current generator to drive three crystal diodes in parallel. Constant-current operation is achieved by virtue of the 5,600-ohm series resistor. Signal voltage drop across the nonlinear crystals is then a

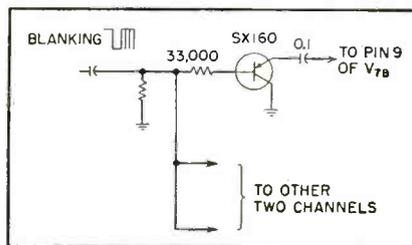


FIG. 3—Noise reduction circuit for blanking in gamma correction amplifier

* Now with Radio Corporation of America, New York, N. Y.
** Now with CBS Laboratories, Inc., New York, N. Y.

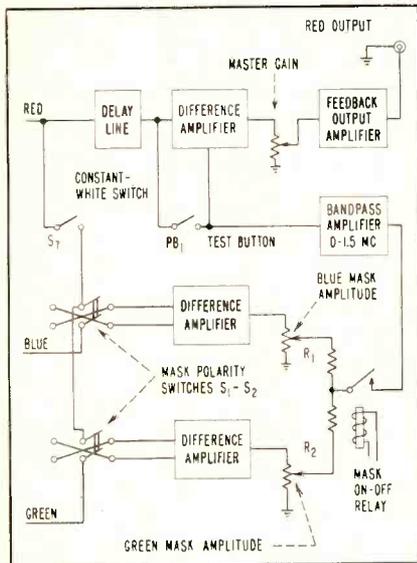


FIG. 4—Matrix amplifier for red channel

function⁵ of signal current flow:
 $E = KI^{0.4}$.

Tube section V_{4B} is used as a zero-impedance bias source for the crystal cathode return.⁶ The cathode of V_{4B} is adjusted to provide zero impedance by setting the ZERO-IMPEDANCE POT in the plate circuit of V_{4A} so as to cancel out all signal at the cathode of V_{3B} . Three crystals are operated in parallel as the nonlinear element to average out their characteristics and thereby provide a much better match between the amplifiers.

Tube V_5 is a dual cathode fol-

lower used to provide ganged variable gain control of the linear signal from V_4 , and the nonlinear signal from the germanium diodes. The outputs of V_5 are mixed in V_6 , a stable difference amplifier. Tube V_7 is a variable gain stage and V_8 is a shunt-regulated linear output stage.

Clamping in Gradient Amplifier

A common low-impedance clamp driver is used for all three channels so that any slight drift that might result in this amplifier (V_{11} and V_{12}) should be common to all three amplifiers. Clamp bias drift as a function of pulse amplitude is held to a minimum by using a balanced transformer and 1-percent resistors on the clamp bias return.

The d-c bias stabilization on the crystals is achieved by returning the clamp bias to the crystal bias source, which is the cathode of V_1 . Any variation in bias voltage is reflected to the other side of the crystal through the constant-current driver, thereby maintaining a constant operating bias across the crystal.

Operating bias is adjusted with the 250-ohm potentiometer in the cathode lead of V_1 . This technique provides excellent stabilization over a wide range of d-c supply variation and is effective in mini-

mizing gradient tracking variations between color primaries due to tube aging or changes in B+ supply voltage.

Flat-top clamp keying pulses are employed instead of a sine wave to reduce line-rate clamp noise (clamp restoring on noise during blanking). In use with a flying-spot scanner, clamp pulses should be delayed as much as possible externally to avoid clamping during phosphor decay noise that carries over into the early part of the blanking interval. Because this noise is stretched at least 15 times by the nonlinear element, it should be suppressed in level so that future clamps in the system will not set up on it and produce highly objectionable line rate noise. One practical circuit that has been employed with this amplifier is shown in Fig. 3. Another practical solution would be to gate the multiplier phototubes with blanking pulses.

Transfer Characteristics

Adjustment for proper transfer characteristics can be made by inspection of a stair-case waveform fed through the amplifier or by the use of a blanking waveform and a precision video attenuator. With input gain adjusted to give 10 v peak white at the cathode of V_{4A} , the GAMMA BIAS control is adjusted

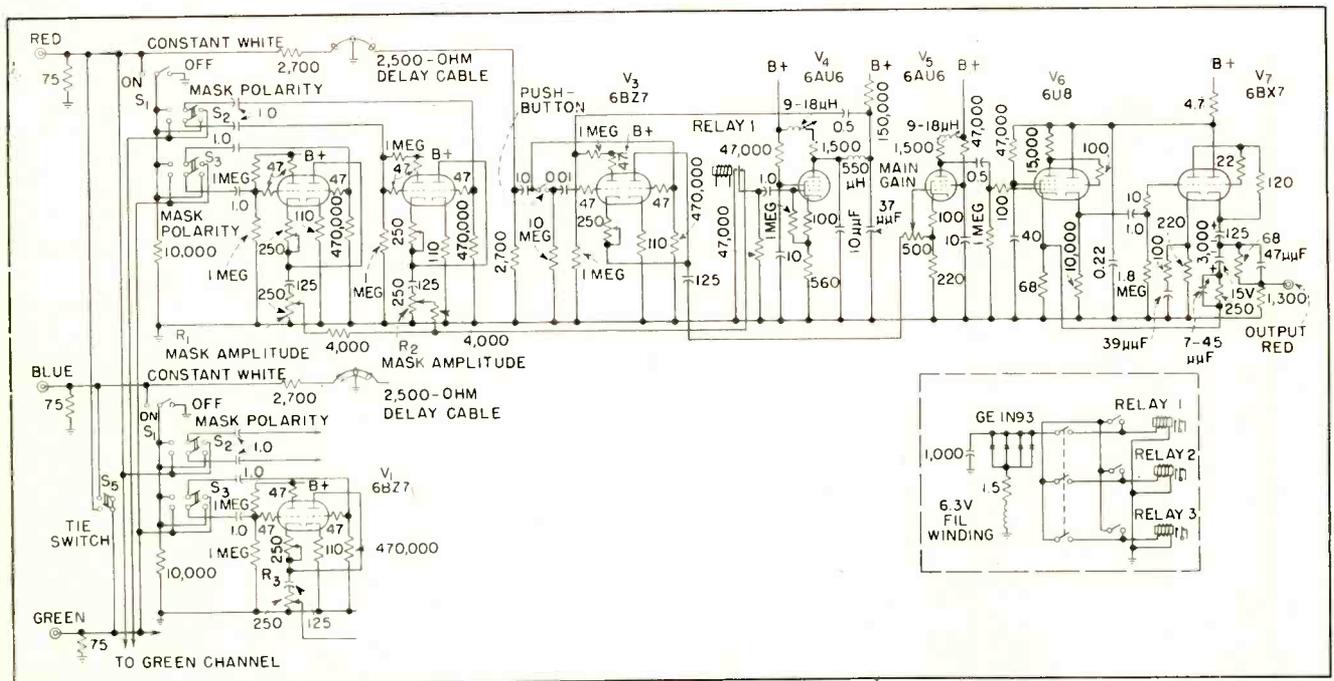


FIG. 5—Complete red-channel circuit for universal or matrix masking amplifier, with first stage of identical blue channel and input of identical green channel

for proper gain at -20 db input.

In summary, the gradient correction amplifier has the following desirable characteristics:

(1) Gain stability and linearity due to generous amounts of negative feedback.

(2) Minimum gamma of 0.4 over a 100-to-1 input contrast range, providing appreciable expansion of shadow detail in color film (15-to-1 stretch at 1 percent input referred to unity white gain).

(3) Continuously variable gamma from 0.4 to 1, providing flexibility in compensating for film gamma errors and general contrast variations.

(4) Improved gamma tracking between channels through the use of three nonlinear elements (germanium diodes) in parallel, thereby averaging out nonuniformities. Bandwidth over the 15-to-1 impedance range is slightly improved, with the resultant lower range impedance achieved by operating a number of nonlinear elements in parallel.

Matrix Amplifier

The matrix or masking amplifier used to correct for hue shift and loss of saturation caused by over correction of gamma is shown in Fig. 4 and 5. It has been designed with extreme flexibility in mind to permit any possible matrix equation to be set up easily.

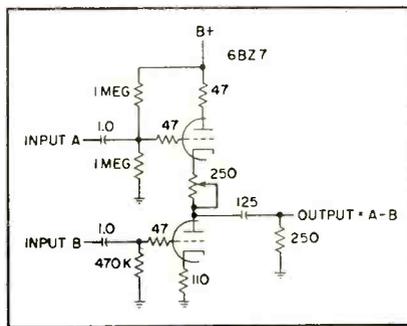


FIG. 6—Simplified diagram of difference amplifier used in each masking amplifier channel

The matrix amplifier uses three symmetrical difference amplifiers per channel, each like that in Fig. 6. These amplifiers are easy to convert from simple RGB matrixing to constant-white masking in which the correction signal disappears for white.⁸ The constant-white feature can be extremely useful as it is possible to produce large hue and saturation changes in colored areas such as blue sky and green grass while only slightly affecting the more neutral flesh colors.

The masking signal is bandwidth-limited before being added to the main channel. This is possible as only color correction is desired and fine detail information continues to pass through the main channel. Bandwidth-limiting results in an improved signal-to-noise ratio as the signals add algebraically, while the noise adds as the root-

mean-square. Compensation for the time delay in the bandwidth-limiting filter is accomplished by inserting wide-band delay cable in the main signal path.

Difference Amplifiers

Reversing switches S_1 and S_2 at the inputs of the difference amplifiers in each channel in Fig. 4 allow the matrix signal polarity to be reversed, making it possible to reduce color saturation if desired. This feature can be especially useful with poor-quality film as it sometimes permits the correction of film faults which would otherwise render the films unusable.

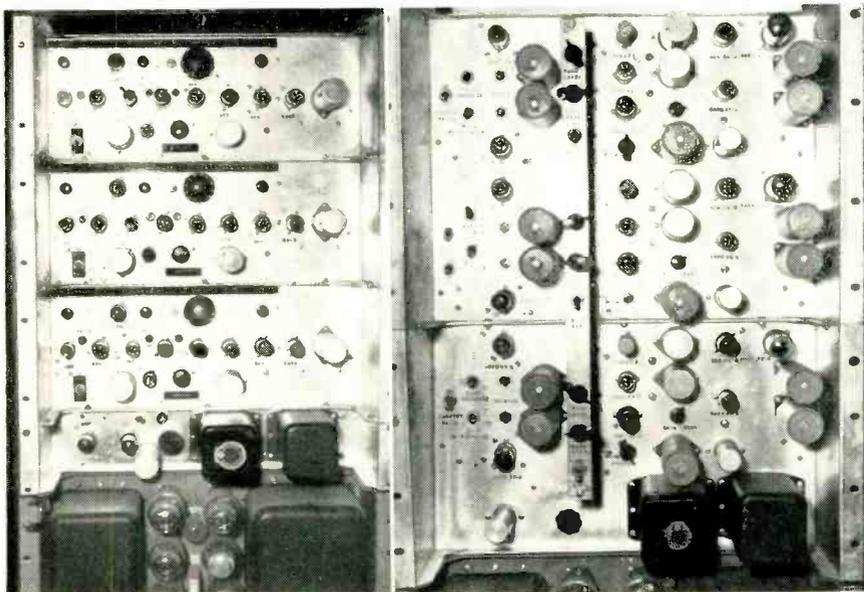
Pushbutton switches S_3 in each channel in Fig. 5 connect together the difference amplifier inputs for initial setup of the amplifiers. With signal applied and the buttons pushed, the balance potentiometers are adjusted for a null at the difference amplifier outputs. An additional switch S_4 ties all three channels together to insure equal input signals while adjusting the individual channel gains to equality.

Potentiometers R_1 and R_2 in each channel can be ganged in combinations² for ease in correlating manual masking adjustments with desired visual effects. The mask on-off relay permits masking to be inserted or removed remotely.

Acknowledgements are due to the management of NBC for permission to publish this paper, to G. M. Nixon, manager of the Engineering Development Laboratory, for his encouragement and to J. O. Schroeder for his assistance in video circuitry design.

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Complete three-channel gamma correction amplifier

Complete matrix amplifier, with power supply below

SUMMARY — Wide-band random-noise sources are useful in designing and testing receiving systems and their components. This article, second in a series, describes performance and frequency characteristics of hot-cathode arcs in gas-discharge tubes, photoelectron multipliers, noise diodes, glow-discharge noise sources and other devices

Part II

Equipment for

NOISE GENERATORS may be used to simulate signals or to provide a calibrated standard for measuring other noise. These uses differ in the amount of output power required.

In the first case the noise power needed is of the same order of magnitude as the power in the signal to be simulated, from microwatts to a few watts.

In the second case, the unknown power to be measured by comparison is typically the small amount contributed by the early stages of an amplifier. It is disadvantageous for a standard to be much larger than the quantity to be measured. Insertion of a large loss in the standard to obtain a match decreases the accuracy of the result.

Noise generators for determining the noise figures of amplifiers deliver at the most about 20 db more power than thermal noise rather than the 100 to 150-db increments needed to simulate typical signal sources.

Testing With Noise

One of the early uses of noise for signal simulation was in testing a broadband carrier telephone system.¹ Such a system, designed to transmit several hundred voice channels simultaneously by frequency separation, is awkward to

load with actual talkers for a trial run. The composite signal when the modulated waves are superimposed does however resemble a noise wave occupying the same bandwidth.

It is feasible for testing to replace several hundred speech sources by a single wide-band noise source. The interference occurring in an idle channel is simulated by filtering out a narrow band of noise-frequency components from the noise-wave input by a band-elimination filter centered on the idle channel.²⁻⁴ The output of the idle channel consists of the ambient noise from the transmission system plus the interference from cross-modulation of the other channels.

The ambient-noise component is measured with no input to the system and the increment caused by the cross-modulation is determined as a function of the applied noise load. A similar procedure can be applied to single-channel systems to obtain a distortion-against-frequency curve for specified loading conditions. An example is the noise behind the signal, a signal-depend-

ent distortion observed in magnetic recording.

Other Uses for Noise

The fact that a noise wave can in one measurement put a system through its paces with respect to a considerable frequency and amplitude range offers a speedup over obtaining data by a number of separate sine-wave measurements. Applications⁵⁻⁶ include determinations of network characteristics, room acoustics, loudspeaker and microphone performance and distortion in recording and reproducing.

The method is particularly helpful in obtaining smoothed data for cases in which single-frequency waves exhibit fine structure variations of little practical interest. In acoustic response measurements in an auditorium, a slight shift in position of the receiver may make a large difference in the result when a single-frequency test wave is used but will not have much effect on the power received from a noise-band source.

In the synthesis of speech as in the vocoder or voder,⁷ a noise generator provides a hiss which is shaped in its spectrum by proper controls to produce consonant sounds.

Noise generators in the range from near d-c to about 5 mc have

Previous Article

Characteristics and Origins of Noise,
p 154, March 1956

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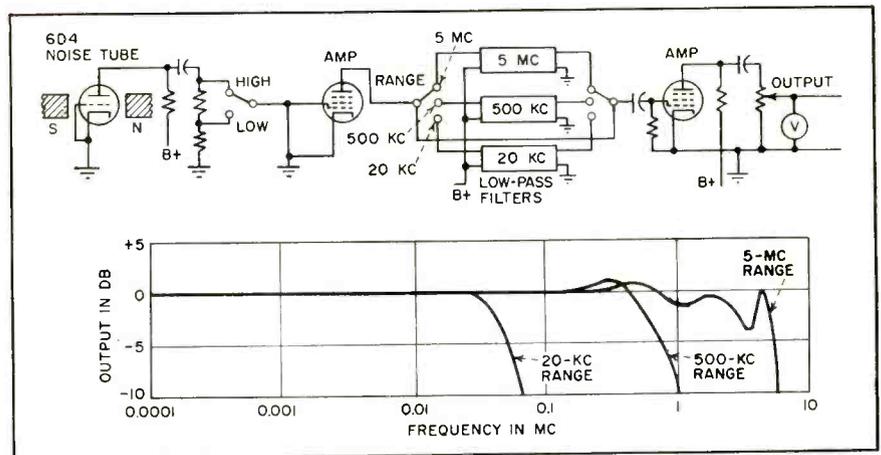


FIG. 1—Circuit (A) and spectral density (B) of noise generator using hot-cathode arc

Generating NOISE

been realized by amplifying the noise spectrum from a hot-cathode arc in a grid-controlled gas-discharge tube. Two or three stages with shaping of the frequency selectivity to obtain a uniform output band are sufficient for most uses.

Hot-Cathode Arcs

The main part of the noise arises from fluctuations in the dense layer of positive ions near the cathode. The frequency beyond which this noise begins to fall off varies inversely with the atomic weight of the gas. Ions can be produced almost instantaneously but have a finite life inversely proportional to their mobility. This varies inversely with atomic weight. The reciprocal of the lifetime determines the upper-frequency limit of the noise energy.

In early applications some difficulty was encountered with sharp resonance peaks associated with natural oscillation frequencies of the ions. It was demonstrated⁸⁻¹⁰ that the resonant peaks could be suppressed and the high-frequency output increased by application of a transverse magnetic field from a permanent magnet enclosing the tube.

The magnetic field turns back to the cathode those electrons which

would otherwise go directly to the anode without colliding with gas atoms. Removal from the anode current of electrons which would otherwise arrive immediately after being velocity-modulated by ionic oscillations breaks up the sharp resonance condition.

Another effect is to narrow and intensify the region of high ion

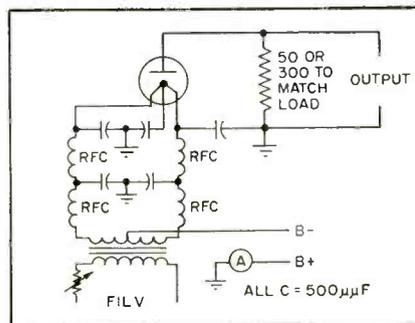


FIG. 2—Noise diode and its circuit

density. Ionic oscillations of a frequency varying with the square root of the local ion density can occur.¹¹ The variations of density over the ionized layer result in a wide range of possible oscillation frequencies and high density values extend this range at the upper part of the band.

The Sylvania 6D4 miniature argon-filled triode has been extensively used as a hot-cathode arc

noise source. Noise-generator units including this tube are available commercially with a choice of bandwidths. A typical circuit and its spectral response are shown in Fig. 1.¹²

Photoelectron Multiplier

To obtain a flat band beyond 5 mc it would be possible to amplify thermal noise with sufficient gain, bandwidth and linear range. It is simpler however to start with a noisier wide-band source. A cascade of secondary-emission multiplier stages following a photoelectric cathode⁶ forms one convenient way since a large gain may be realized in a single tube structure.

A flashlight shining on the photoelectric surface serves to initiate wide-band shot noise which is amplified and slightly augmented by the multiplier stages. Constant power in the noise output requires a well-regulated power supply for the dynode voltages.

Noise Diode

Of the lower-power sources more commonly used as noise standards, the noise diode¹³ has found a considerable field of application. It consists of a two-element vacuum tube operated at temperature saturation—that is, at sufficient anode voltage to collect electrons at the anode as



fast as they are emitted by the cathode.

Under these conditions the shot-noise equations as originally derived by Schottky for random emission of electrons are valid over a range of frequencies from about 10 kc up to frequencies at which finite electron transit time begins to exert an effect. For a considerable range white gaussian noise is available as from a current generator with average squared current

$$I^2 = 2 e I_0 b$$

where e is the electronic charge of 1.6×10^{-19} coulomb, I_0 is the diode current in amperes and b is the bandwidth in cps. The value of I_0 can be conveniently controlled by varying the filament current.

The noise diode is usually shunted by a resistance R to match the load. The available noise power from the diode alone is then

$$I^2 R/4 = e I_0 b R/2$$

Compared to thermal noise power kTb , where k = Boltzmann's constant and T = absolute temperature, the combination of noise diode and shunting resistance gives a noise ratio at 17 C of

$$n = [(e I_0 b R/2) + k T b] / k T b = \frac{e I_0 R}{2 k T} + 1$$

At the low-frequency end, the noise is contaminated by flicker effect and at high frequencies the noise falls off because of electron transit time effect, parasitic series lead inductance and shunt capacitance.

In narrow-band work it is feasible to tune out the reactive components at a particular operating frequency. The reduction from transit time can be evaluated and corrected by calibration. The Sylvania type 5722 noise-generating diode¹¹ is commonly used in this country and has been incorporated in commercially available noise-measuring devices. A typical circuit shown in Fig. 2 gives usable output up to about 500 mc. At the rated maximum anode current of 35 ma and a load resistance of 300 ohms, the noise power output is 23 db above thermal noise in the lower part of the frequency band.

Extension of noise diodes into the microwave range has been accomplished by a coaxial structure

suitable for matching into a waveguide or coaxial transmission line. Several versions were developed in England.¹⁵ Figure 3A shows their water-cooled disk-seal structure in which the copper disks may be directly incorporated into waveguide sections.

Microwave Noise Sources

The anode and cathode are hollow coaxial cylinders forming a broadband transmission line of impedance $138 \log_{10} (r_a/r_c)$ ohms where r_a and r_c are the anode and cathode radii respectively. The cathode is heated from the inside by a fine coaxial tungsten filament.

Shot noise in the current between cathode and anode is propagated as a wave in both directions along the coaxial line. Matched untuned impedance terminations at the ends give the noise source broadband properties. The effect of electron transit time is small because of the small distances traveled and has been evaluated for calibration.

An American version of the coaxial noise diode¹⁰ is shown in Fig. 3B. A coaxial structure similar to the English tube is used but the central wire within the inner conductor is used as a filament lead, and the actual filament is a loop of tungsten wire between inner and outer conductors. The other filament lead is the inner conductor itself.

A mica capacitor inside the inner conductor bypasses the filament leads. The electron flow is from the filament loop to the outer conductor. With an anode voltage of 300 v, the filament emission is temperature-limited up to 100 ma.

The impedance of the coaxial line is 50 ohms. Noise outputs 20 db up on thermal noise are obtained at

a few hundred mc. Electron transit time reduction of noise power amounts to 3 db at 3,000 mc. A tube based on this model is available commercially as the Bendix TT1.

A simplification in microwave noise measurements was introduced by Mumford.¹⁷ He showed that the positive column in a low-pressure gaseous discharge is a stable noise source, which is uniform over a wide frequency band and has the right order of intensity for convenient comparison with the noise in typical microwave apparatus.

Positive Column of a Gas Discharge

The positive column contains electrons and ions in nearly equal concentration. Its maintenance depends on a continuing supply of electrons from the cathode. These may come from thermionic emission of electrons by the cathode and from secondary emission caused by positive-ion bombardment of the cathode surface.

In the latter case the emitted electrons produce positive ions to make the process self-sustaining. The electrons entering the positive column have acquired sufficient energy to ionize gas molecules and excite emission of the light which gives this region its luminous appearance.

The relatively long free path enables the electrons to gain more energy during their free flights than they lose during collisions. They thus build up to an equilibrium energy considerably higher than either the neutral gas molecules or the positive ions.

The higher average energy defines a correspondingly higher electron temperature. Electron tem-

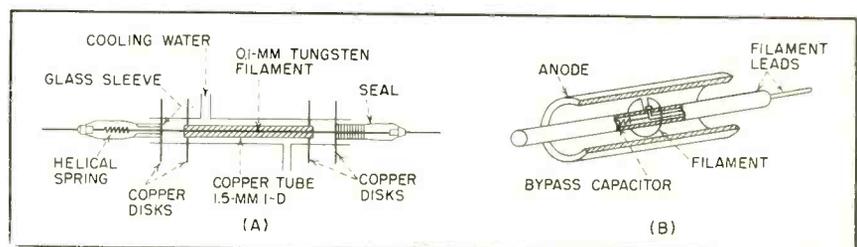


FIG. 3—Disk-seal coaxial noise diode (A) and coaxial-line noise diode (B)

peratures of approximately 12,000 K are typical; the positive column emits thermal noise as if it were a resistance at this elevated temperature. The ratio of this temperature to ordinary room temperature is about 40. The resulting thermal noise source therefore has about 16 decibels more available noise power than a resistor at room temperature.

Practical Device

Mumford inserted a commercial fluorescent lamp in a rectangular waveguide as shown in Fig. 4A. The positive column crossed the interior of the guide in the longer dimension with its axis parallel to the magnetic vector. The two cathodes were outside the guide and were surrounded by cylindrical metal shields beyond cutoff and thereby restricted the microwave circuit to the positive column only.

The susceptance component of the discharge was tuned out by a piston and trimming screw. The conductance component was adjusted to match the waveguide by varying the direct-current supply. When the match was made at 3,960 mc the standing-wave ratio was less than 3 db from 3,700 to 4,240 mc. The spectral density of the noise power available from the discharge was found to be uniform with frequency over the microwave range tested. The amount of power was substantially independent of the direct current over a range from 40 to 140 ma. It was almost independent of the ambient temperature of the waveguide circuit, the variation amounting to -0.055 db per degree centigrade.

Thirty-one different colored lamps were within plus or minus $\frac{1}{2}$ db of each other in output. The source of the noise is the gaseous discharge and is not affected by the fluorescent material which is provided to convert from ultraviolet radiation to the visible band.

Further Investigation

The constancy with frequency extends over an even wider range

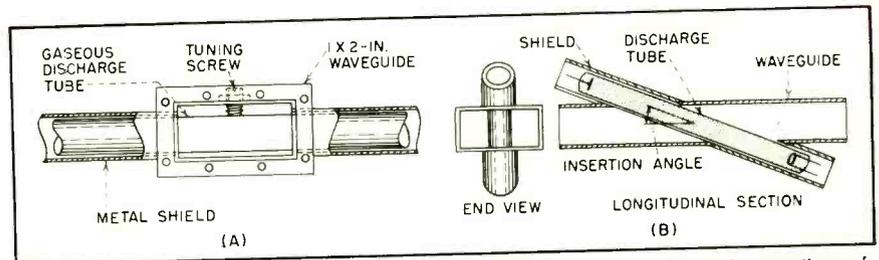


FIG. 4—Glow-discharge noise source for microwave frequency (A) and mounting of small-bore tube to generate shf noise (B)

than explored in Mumford's original experiments. Isolated measurements in a 65-mc i-f circuit indicated that the same noise density was present. The noise was coupled into a tuned circuit by wrapping a coil of wire around the outside of the tube.

Johnson and Deremer¹⁸ extended microwave application to 26,000 mc. Specially constructed elongated small-bore tubes were constructed to fit the smaller waveguides. A type of mounting recommended is illustrated in Fig. 4B.

The tube is inserted through the broad faces of the guide in the plane formed by the vertical and horizontal axes and its axis makes a small angle with the longitudinal axis of the guide. The 20-db or more attenuation through the discharge gives a good waveguide termination without the use of any tuning elements and insures a broadband source. With a 10-degree angle of an argon-discharge tube, a maximum vswr of 1.1 was found over the recommended band of the guide. The shot noise flowing along the tube axis makes only a small contribution in this case since its direction of flow is at an angle of 80 deg with the electric vector in the guide. This is an advantage since the shot noise is dependent on the electron transit phase angle and hence would introduce a component variable with frequency.¹⁹

Earlier work on standards for microwave noise measurements made use of nonoscillating klvs-trons, hot wires and silicon crystals as noise sources. These were either narrow band, not noisy enough or required calibration and have become superseded.

There are still some applications made of resistors heated in ovens

and matched into waveguide to serve as thermal noise sources up to 1,000 C.²⁰⁻²¹ The increment over ordinary thermal noise obtained in this way is only a few db. Recent work in which the waveguide itself is heated offers usefulness in highly accurate measurements of low noise figures.

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Radar AFC System Uses

SUMMARY — Servo system, controlled by signals from radar i-f amplifier, tunes wide-range local oscillator operating in L-band. Bistable multivibrator circuit provides automatic switching from search to afc. A reactance tube senses changes in intermediate frequency

RADAR RECEIVER local oscillators must be tuned to a frequency that differs from the magnetron frequency by the intermediate frequency. Flexible local-oscillator tuning is required not only because the natural frequency of a fixed-frequency magnetron may differ from that of other magnetrons of the same type but also because tunable magnetrons can operate anywhere within a frequency band as wide as 200 mc. In addition magnetron frequency drifts usually occur while the magnetron warms up.

The motor-driven mechanically tuned system to be described consists of electronic control circuits which control a driving motor, to tune the system over wide ranges to within a few megacycles of the desired frequency (search func-

tion). The system then switches to a precise sensing method and adjusts the system to within a few kilocycles of the desired frequency (afc function).¹ An alternating voltage whose amplitude and phase are functions of the amount and direction of the deviation from the desired frequency is applied to the control phase of a two-phase motor for afc action.

The transition from the search function to the afc function is accomplished in the control circuits.

Both afc and switching from search to afc described in terms of a circuit designed for the frequency control of stable local oscillators (stalo) in radar receiving systems with moving target indication (MTI).

Local oscillators can be built to

meet the stability requirements of MTI receiving systems for L-band and S-band operation using any of several types of conventional uhf tubes. Figure 1 shows such an oscillator. Its frequency is determined by the high-Q external cavity. The motor shown, rotates the cam which positions the spring-loaded plunger in the cavity. A complete rotation of the cam causes the oscillator to tune through its search frequency range twice. In a typical case a band of 100 mc is searched twice.

Searching

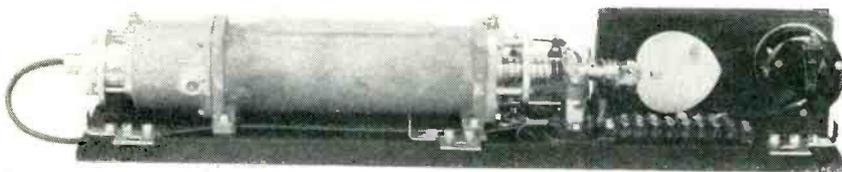
In the automatic search condition, a voltage of constant amplitude and phase is applied to the control phase of the motor. The cam rotates in one direction only, and the oscillator frequency sweeps through the band cyclically.

System alignment is apparent when signals appear in the i-f circuits of the receiver. When tuning automatically, a voltage developed by these signals in the i-f channel is used to actuate a relay, which switches the control phase of the tuning motor from the source of search voltage to the afc circuits.

Afc Circuit

To tune the local oscillator precisely, the afc system must be able to operate over the range of frequencies within the pass band of the i-f amplifier.

Since receiver i-f bandwidths and gain characteristics are governed by other considerations, it is common practice to use a separate i-f amplifier whose bandwidth is equal to that over which afc is desired,



Heart-shaped cam actuates plunger in coaxial oscillator to change frequency

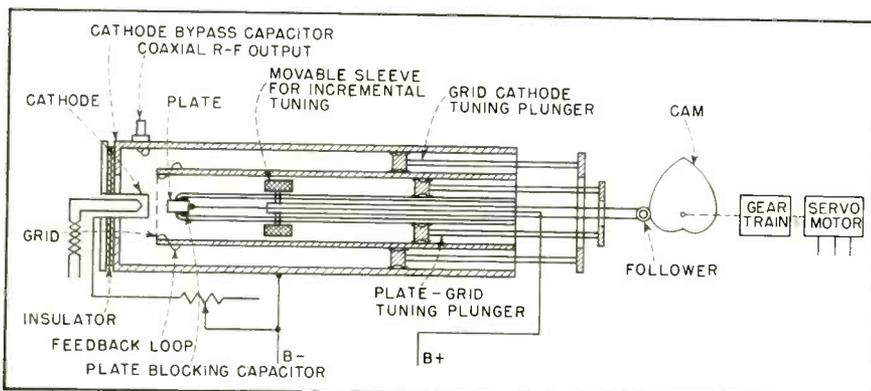


FIG. 1—Cross-section of stable L-band local oscillator

Mechanical Tuning

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and

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and whose gain characteristic is suited to the afc requirement. In this circuit the output signal from the receiver i-f is amplified in a pentode stage and applied to a resonant circuit whose frequency is controlled over a small range by a reactance tube.

If the resonant-frequency is varied by the application of an a-c modulating voltage to the reactance tube grid, the impedance of the circuit, and the gain of the amplifier will vary. Thus, the voltage developed across the plate circuit of the reactance tube will vary in amplitude at the frequency of the modulating voltage, though the i-f signal applied to the amplifier grid is constant in amplitude and frequency. This voltage variation is detected, amplified in a servo amplifier, and applied to the control phase of the tuning motor. The modulating voltage itself is applied through a 90-degree phase-shifting network to the second winding of the motor.

Frequency Characteristics

Curve 1 of Fig. 2 shows the impedance-frequency characteristic centered about f_0 , which is the resonant circuit midfrequency when the modulating signal has zero value, and is also the passband midfrequency of the receiver i-f amplifier. Curve 2 shows the impedance-frequency characteristics shifted to a new position, centered around f_3 , which is the resonant circuit midfrequency when the modulating signal attains its maximum negative value. Curve 3 shows the impedance-frequency characteristic shifted to a position centered about

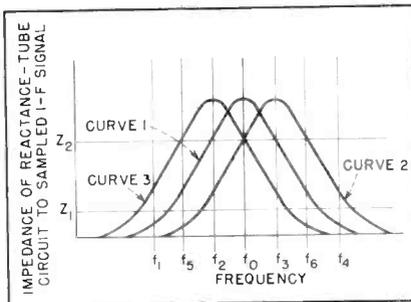


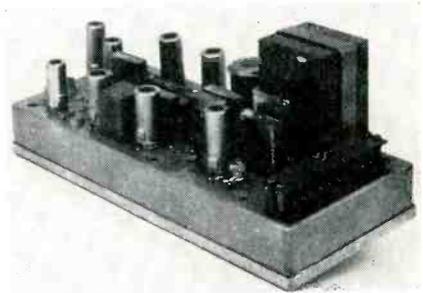
FIG. 2—Variation of impedance-frequency characteristic of resonant circuit

f_2 , which is the resonant circuit midfrequency when the modulating signal attains its maximum positive value. The impedance-frequency characteristic can be considered to move between curves 2 and 3 at the sinusoidally varying rate established by the modulating signal.

If, because of local oscillator detuning, the intermediate frequency is at some value lower than f_0 , such as f_5 of Fig. 2, then as the resonant frequency of the reactance-tube circuit decreases from f_3 to f_2 , the circuit impedance to the i-f signal increases from Z_1 to Z_2 . However, if the intermediate frequency is at some value higher than f_0 , such as f_6 , then as the resonant frequency of the reactance-tube circuit decreases from f_3 to f_2 the circuit impedance decreases from Z_2 to Z_1 .

Fig. 3 shows the transfer characteristics (a) of the reactance-tube circuit. When a sinusoidal modulating voltage (b) is applied to the grid, the resonant frequency of the reactance-tube circuit (including the pentode plate circuit) varies sinusoidally (c) as shown.

In the ranges between either f_1 and f_2 or f_3 and f_4 (Fig. 2), the impedance of the reactance-tube circuit to the i-f signal, and therefore the gain of the pentode, also changes sinusoidally at the rate of the modulating signal on the reactance-tube grid. The output signal of the servo amplifier, which results from detection and amplification of the voltage variation across the reactance-tube resonant circuit, is therefore an approximate sinusoidal voltage at the modulating frequency. This voltage is



Control circuits and servo amplifier are combined on one chassis

either in phase or 180 degrees out of phase with the modulating voltage depending whether the intermediate frequency is in the range f_1 to f_2 or f_3 to f_4 .

Servo Output

Figure 4 shows the phase relations existing between the modulating voltage V_m , at the reactance-tube grid (Fig. 4A), the variation in resonant frequency of the reactance-tube circuit (Fig. 4B), the output signal V_o of the servo amplifier for intermediate frequencies between f_1 and f_2 (Fig. 4C) and the output signal of the servo amplifier for intermediate frequencies between f_3 and f_4 (Fig. 4D).

The output signal of the servo amplifier is used with phase sensing which causes cam rotation in the direction producing the right change in local-oscillator frequency. This is reflected in the sampled i-f as a shift toward the center resonant frequency of the reactance-tube circuit.

As the sampled i-f signal approaches f_0 , the waveform of the variation of the detector output voltage becomes complex and at f_0 approximates the double-frequency characteristic of a full-wave rectifier. Thus, at this point, tuning action ceases since only the fundamental frequency component is selected for amplification in the following servo amplifier.

Driving Voltage

The amplitude of the variation of the detector output voltage is reasonably constant for an i-f signal

* Formerly with Airborne Instruments Laboratory.

whose frequency is anywhere along the slope of the resonance curve (for example, anywhere in the region f_1 to f_2 in Fig. 2), though the average value of the i-f carrier signal in the circuit may change appreciably in accordance with average circuit impedance. Thus, ample drive voltage for the tuning motor can be developed over a wide frequency range in incoming signals if the Q of the resonant circuit is sufficiently low. By deliberately lowering the Q with a shunting resistor, afc action has been obtained over a band of ± 7 mc centered on an intermediate frequency of 30 mc. The afc channel i-f amplifier should be equally wide if this characteristic is to be used.

If the incoming i-f signal frequency is in the region f_2 to f_3 of Fig. 2, the available driving voltage is reduced by the decrease in the modulating-frequency component of the resulting complex voltage variation in the detector output. There is a small frequency range centered at midband in which there is insufficient output voltage to drive the motor. The width of this notch or null region is dependent upon the gain in the following amplifier, the extent of the electronic tuning and Q of the tuned circuit and the incoming signal level. In the practical case, it is small compared with the passband of normal receiver i-f strips.

When the frequency of the incoming i-f signal is outside the range f_1 to f_4 in Fig. 2, the available driving voltage is too low to actuate the tuning motor. As such regions are approached, it is necessary that a transfer to the search condition be effected.

Search to Afc

There is available in the output of the crystal rectifier (CR in Fig. 5) a d-c voltage whose amplitude is related to the amplitude of the i-f signal appearing across the reactance-tube circuit. This voltage can be used to control the state of a bistable multivibrator² and, through a plate-circuit relay, the application of either a search or afc voltage to the servo amplifier and control motor. In the absence of an incoming signal, the relay contacts apply a constant-amplitude

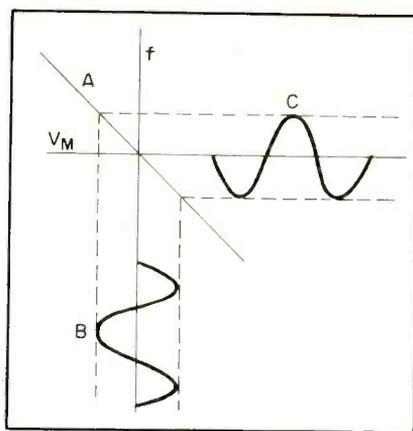


FIG. 3—Transfer characteristic of reactance-tube circuit

search voltage. When a signal appears that exceeds a preset level, the relay is actuated and connects the motor to the afc circuit for precise tuning.

The problem may be complicated in the case of a cam-driven tuning mechanism. If an oscillator is controlled over a wide tuning range, it frequently is possible to establish several tuning relationships that provide an i-f signal of proper frequency. The local-oscillator frequency may be either higher or lower than the transmitter frequency by an amount equal to the intermediate frequency of the system, and either condition can be intercepted on both sides of the cam. This adds to the complexity, because the direction of the frequency change for a given direction of cam rotation is reversed on the two sides. As a result, an i-f signal can appear at four cam positions. At two of these four positions an unstable condition will exist

wherein the sensing of the afc circuit will be incorrect. The resulting afc action will change the i-f away from the desired value to a value at which the search condition is reinstated. The system is then returned immediately to the unstable afc state, and a continuing oscillation will result.

In the present circuit, the situation is treated by applying a sharp triggering waveform, through a second set of contacts on the search-afc relay, to a flip-flop circuit. This circuit reverses the phase of the modulating voltage applied to the reactance-tube grid each time the transition from afc to search is made. The circuit does not operate when the condition shifts from search back to afc. Thus, if an unstable point is encountered, the momentary transition back to search is made. However, on the second try a moment later, the point has become stable because of the reversal in modulating voltage phase and afc sensing, and normal afc action results.

The triggered phase-reversal action can be accomplished electronically or with a stepping relay combination. Figure 5 shows an electronic arrangement. Modulation voltages 180 degrees out of phase are introduced into the grid circuit of a triggered bistable multivibrator called the phase-reversing multivibrator. The phase of the output voltage (a-c component across common cathode resistor R) depends on the section that is conducting. A phase change occurs with each transition from

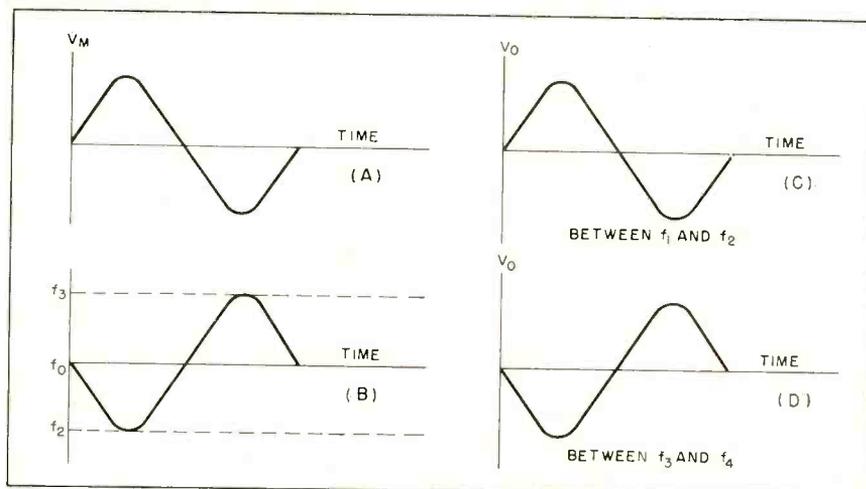


FIG. 4—Phase comparison between modulating voltage (A), reactance-tube resonant frequency (B) and servo output (C) and (D)

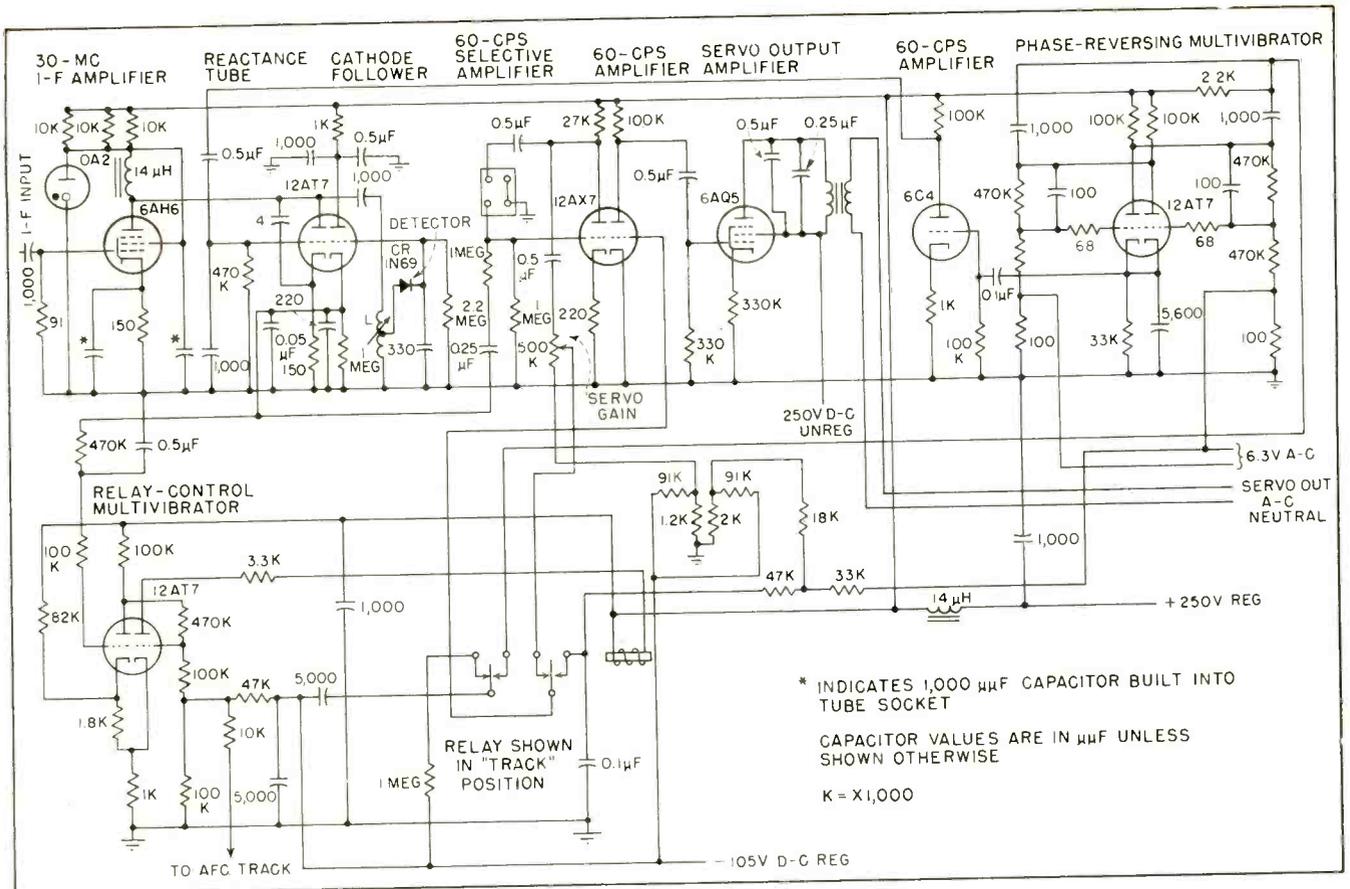


FIG. 5—Complete circuit provides frequency deviation detection and electronic control over search-afc transition

the search to afc condition.

Figure 5 shows the complete afc circuit embodying the features described. This circuit has been used with the oscillator also described and was tuned (for frequency searching) over a 200-mc range. The afc pull-in range was ± 1.7 mc and the afc loop was adjusted to hold the intermediate frequency within ± 50 kc of that established by the center frequency of the reactance-tube circuit (adjustable by L).

Figure 6 shows oscilloscope photographs of waveforms at the output terminals of the servo amplifier for different tuning conditions. These photographs were taken while the i-f signal was pulsed at 300 pps using 2- μ sec pulse widths.

The input amplifier and reactance-tube circuits were designed to work at a 30-mc intermediate frequency. Since a 115-volt, 60-cps tuning motor was used, a related 60-cps voltage was used to modulate the reactance tube.

An input signal of 2 volts peak applied to the reactance-tube cir-

cuit will develop an output voltage of about 20 to 40 volts at mid-frequency. The exact value depends on the input signal, the resonant

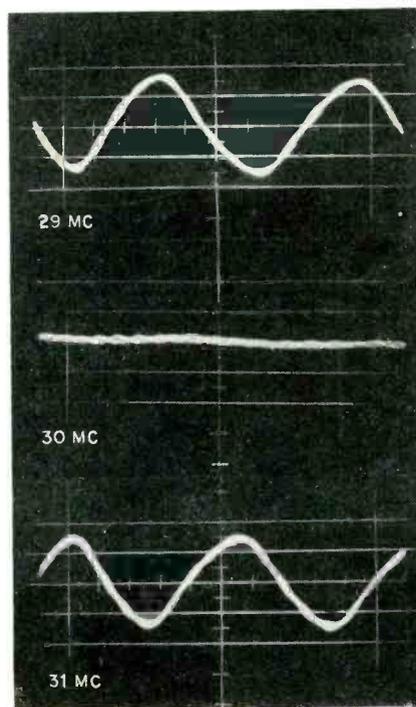


FIG. 6—Servo amplifier output waveforms at null and at either side of null

impedance of the circuit and so forth. The voltage variation in this signal at the modulation frequency depends upon the midfrequency amplitude of the i-f signal and the frequency excursion of the reactance-tube circuit (generally held to 0.5 to 1 mc). It is usually approximately a few volts. Sufficient gain must be present in the following servo amplifier to raise this level to the normal motor voltage.

It is desirable that the reactance-tube circuit exhibit a relatively constant Q at all frequencies in the i-f passband. This is facilitated by the triode grounded-grid reactance-tube circuit.³

In radar systems, the input signal is generally pulsed. With pulsed inputs, the d-c plate voltage for the input amplifier and reactance tube should be low (100 to 150 volts).

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Flux Gate Magnetometer

By **J. P. ISAACS**

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GEOFFREY GREY*

William Miller Instruments, Inc.
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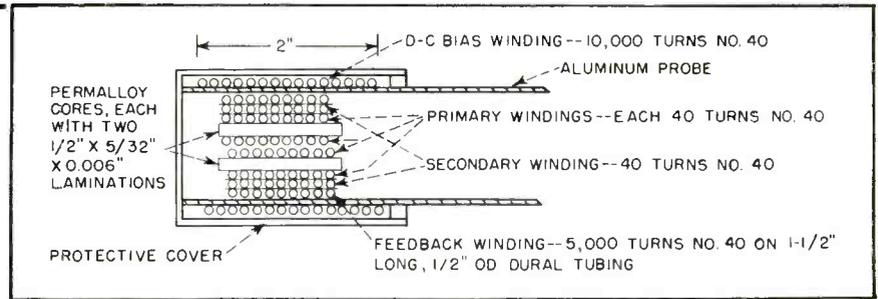


FIG. 2—Probe construction details. Spacings and insulating techniques are critical

ammeter serving as a deviation indicator.

Under no-signal conditions (zero flux), the two voltages induced in the secondary are identical in magnitude and waveform and therefore balance each other. When a flux is present, the voltage waves become dissimilar and a voltage E_s , composed of even harmonics of the fundamental frequency f , appears at the input to the amplifier. This arrangement is sensitive to the direction of the flux since the phase of E_s reverses when the direction of the flux is reversed.

Construction of the special probe used for checking hardness of steel tubing is shown in Fig. 2 and 3. Each primary winding of the probe consists of 40 turns of No. 40 copper wire wound on small Permalloy laminations. These are laid side by side and connected in opposition. The secondary is a single 40-turn winding laid over the primaries.

Operation

Whenever an external magnetic field is present, a second harmonic (4-kc) voltage is present at the secondary. This is coupled to the amplifier through a transformer and filter, the other even harmonics being rejected. This 4-kc signal is amplified and applied to a ring demodulator using 1N40 diodes. The ring is also supplied with a 4-kc reference signal through a second amplifier excited from a selectively filtered full-wave rectifier using two

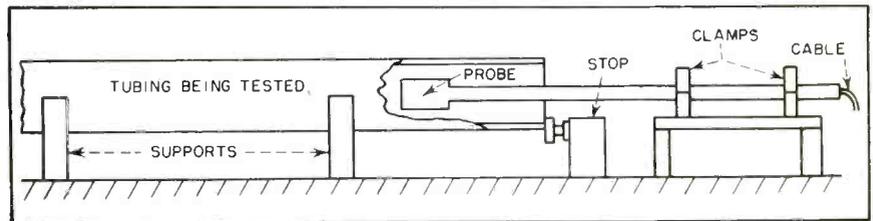


FIG. 3—Method of using probe for testing hardness of steel tubing

CK705 crystal diodes. A phase-shift circuit is provided in this second amplifier so that the phase relationship between the two currents applied to the ring demodulator can be adjusted.

In operation, the output of the demodulator is filtered and fed back, in the interests of linearity, to the probe by means of a 5,000-turn winding applied over the previous windings. This feedback current is polarized and its magnitude and direction are indicated on a zero-center meter. The deflection of this meter is directly proportional to the intensity of the magnetic field of the metal sample being tested and hence to the hardness (except as noted previously).

To provide increased flexibility, an additional winding of 10,000 turns was placed over the previous windings (supported by the aluminum tubing in which the other windings are mounted). This winding is supplied from a regulated d-c source and a rheostat is connected in series to control the current.

In practice, the probe is inserted into the metal part being tested (a piece of special steel tubing) and the rheostat adjusted until the

field produced by the 10,000-turn winding bucks out the external field and the deviation meter reads zero. The current through this coil is then read on the hardness indicator.

Applications

This method is particularly adaptable to checking the average hardness of tubing as it is easily magnetized and the probe can be placed inside. The lateral position of the probe is then not critical if the walls of the tubing are uniform.

Many other applications are possible as long as the object to be tested can be magnetized by convenient means and the magnetic retentivity is reproducible. In these cases, the position of the probe relative to the test piece may be much more critical than in the case of the tubing. As a practical matter, the hardness of steel test pieces must be above Rockwell C 40 if consistent results are to be obtained.

The flux gate magnetic hardness tester was developed in conjunction with William Miller Instruments, Inc., Pasadena, California, who now manufacture the probe. George Downs, formerly chief engineer with that organization, suggested the circuits and method.

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Using TRAVELING-WAVE

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SUMMARY — Characteristics of traveling-wave tubes make them adaptable to many applications in radar and microwave systems as modulators, mixers and power-level limiters with increased circuit efficiency

TRAVELING-WAVE TUBES are functionally broadband, high-gain, microwave amplifiers. However, their characteristics make them useful as receiver input r-f stages, transmitting tubes, modulators, mixers, limiters and oscillators.

A curve of gain versus frequency for a typical S-band amplifier tube is shown in Fig. 1A.

The magnitude of gain obtainable is primarily a function of beam current and tube length. However, leakage around coaxial connectors and stem leads place a practical limit on the usable gain obtainable. In low-noise designs, low gain is often desirable to extend the dynamic range of the tube, since dynamic range is determined by the ratio in db of saturation power to noise power, minus tube gain.

In high-power designs, excessive magnet power is required to focus the beam over the lengths

needed to obtain high gains. In addition, power tubes are operated at voltages above those required for synchronous velocity and the large reduction in velocity along the beam tends to limit gain. Both low-noise and high-power tubes are customarily designed at gains in the order of 20 to 25 db. Intermediate level tubes may provide gains as high as 45 db.

Bandwidth

To obtain gain, it is necessary that the signal velocity be matched to electron velocity, and if wide bandwidths are to be obtained, it is necessary that the signal velocity be the same at all frequencies. Velocity relationships, which are proportional to synchronizing voltage, of the tube of Fig. 1A are shown in Fig. 1B. Increase in velocity at lower frequencies determines the lower frequency limit

of the gain curve. A second, more complicated, relationship causes the gain to fall as signal wavelength decreases in proportion to the helix diameter. This causes a fall-off in gain at higher frequencies. Careful design of these and other parameters will produce a gain-frequency characteristic as shown in Fig. 1A. Such a characteristic is desirable in r-f amplifier stages in receivers, in power amplifier stages for multichannel or tunable transmitters, in amplifying the output of signal generators and in increasing the sensitivity of measurements at low levels.

An increase in electron velocity obtained by increasing the accelerating voltage as indicated in Fig. 1B, will increase gain at low frequencies at the expense of gain at the high frequencies. This is known as operation in the dispersive region and a tube designed specifi-

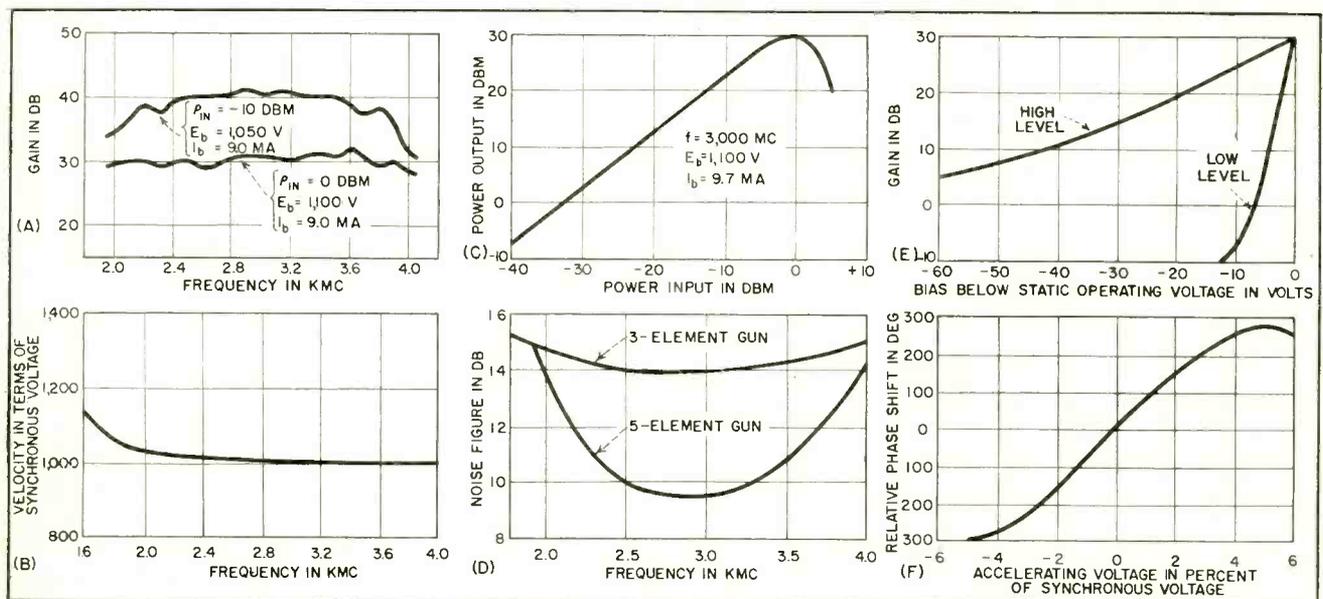
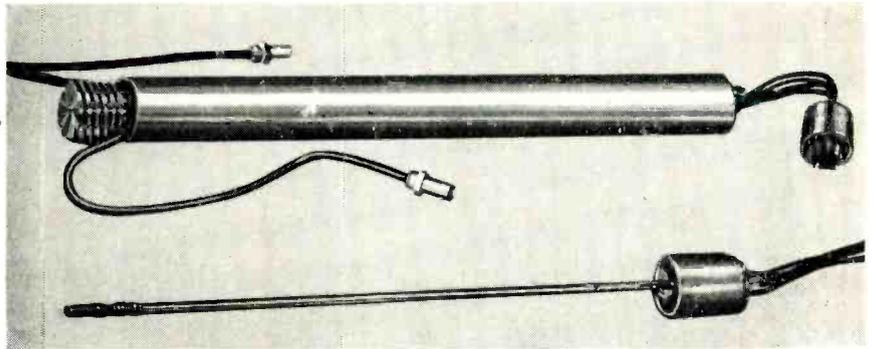


FIG. 1—Typical traveling-wave tube characteristics show value of tube in wide variety of applications described in text

TUBES



Traveling-wave tube with helix and electron gun assembly shown in foreground

cally for operation in this region as a voltage-tunable bandpass amplifier is known as a dispersive tube. In this type of operation, bandwidth may be restricted to values of 10 to 20 percent of the operating frequency.

Power Output

The power levels at which traveling-wave tubes can be designed to operate cover a span of over 80 db. Low-noise tubes rarely have a maximum power output greater than 1 mw. Power tubes producing greater than 100 kw are in development. Figure 1C shows the transfer characteristic of the tube previously discussed. The shape of this curve is illustrative of the general transfer characteristic of any traveling-wave tube. A long linear range and a region of saturation is followed by a reduction in gain and power output. This characteristic makes the traveling-wave tube useful for a further group of applications since the saturation level may be set by the designer at any desired level.

The efficiency of the traveling-wave tube varies widely with its function. A low-noise tube may deliberately be operated at 1 percent efficiency, or less, while in power tubes beam efficiencies of 30 percent are obtainable.

If a traveling-wave tube is used as a low-level r-f amplifier, the noise generated in the tube must be considered. Two characteristic types of noise-figure designs are compared in Fig. 1D.

Modulation

Gain of a traveling wave tube is a function of tube current, making it relatively easy to obtain ampli-

tude modulation. Some designs provide an element for that purpose. A typical grid-control characteristic is shown in Fig. 1E.

Total range of gain control available is from maximum gain to the cold loss of the tube, a range of 80 db or more. A third use of this characteristic is to provide a microwave pulsed signal of short duration. Rise and fall times approaching 1 millimicrosecond have been obtained in this fashion. Such a gate has a further advantage in that a klystron or other signal source may be operated c-w into the matched load of the traveling-wave tube with no resultant frequency pulling of the klystron.

Since the transmission line in which the traveling-wave tube gain occurs is electrically very long, for example 40λ , a small change in the phase velocity can produce a sizable change in phase in the tube. This change in velocity can be accomplished by small variations in accelerating voltage. A typical characteristic is shown in Fig. 1F.

These characteristics make the traveling-wave tube an efficient modulator, since neither grid nor anode draw appreciable current. Single-sideband modulation can be produced by application of a sawtooth waveform to the accelerating anode. Such a waveform continually advances the phase, thus effectively shifting the frequency of the applied signal.

Limiter

If a traveling-wave tube whose saturation power level has been set at a desired power limit is used in a system, it becomes virtually impossible to exceed this level.

A traveling-wave tube preceding the crystal in a microwave receiver protects it from damage in both the operating and nonoperating conditions. The nonoperating protection results from the insertion loss of a nonoperating traveling-wave tube and is usually greater than 40 db.

Mixing

When two signals are applied simultaneously to a traveling-wave tube, several intermodulation components appear. When the tube is operating well below saturation, these components are at a low level. They are usually outside the frequency band of the tube and are further reduced in the coupling circuits. However, when the combined signal power is sufficient to drive the tube to saturation, the amplitudes of these components increase markedly. By appropriate design, tubes have been produced which function as r-f mixers. It is expected that further development of this technique will produce microwave mixes in which the local oscillator will be isolated from the antenna circuit by as much as 60 db of attenuation, the entire mixer will be essentially as broadband as normal traveling-wave tubes and it is expected that conversion gains can be realized.

It is relatively simple to use the traveling-wave tube in an oscillator circuit, if a small portion of the output power is fed back into the input of the tube. If a highly selective network such as a high-Q cavity, is placed in the feedback network, the frequency of oscillation will be determined by the cavity resonant frequency.

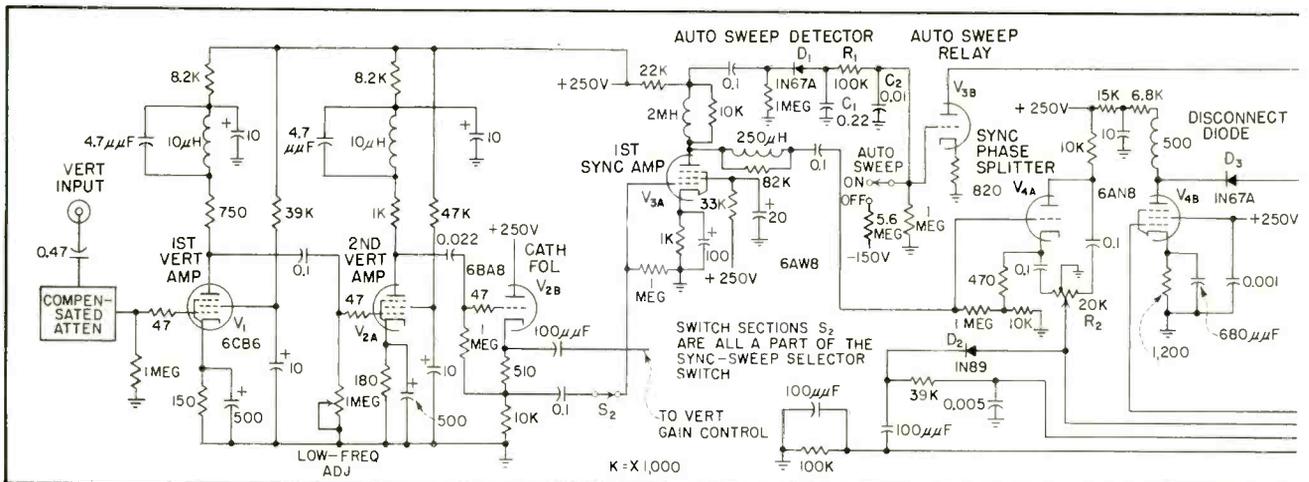


FIG. 1—Automatic triggered sweep circuit as used in Hycon model 622 oscilloscope, with conventional unmodified stages of

Signal-Triggered Sweep

SUMMARY — Automatic sweep control circuit for cathode-ray oscilloscope initiates horizontal sweep cycle for each pulse edge at vertical input terminals. Signal pulse display may then be expanded as desired by increasing sweep frequency, independently of pulse input frequency

AUTOMATIC triggered sweep provides a recurrent waveform when no signal is applied to a cathode-ray oscilloscope, serving to establish a reference base line of the desired frequency and intensity. In the presence of vertical deflecting signals, the sweep circuitry assumes a monostable condition, responding thereafter to triggering signals derived from the display channel or applied from a related external source.

An oscilloscope circuit incorporating this sweep feature is shown in Fig. 1. In the absence of signal, automatic sweep relay tube V_{3B} is conducting and a relay closes the return circuit through R_1 . The latter is internally adjusted to bias unsymmetrical multivibrator V_5 to an astable or recurrent mode. The period of the multivibrator is determined by selecting C_{15} or C_6 through C_{17} . Sweep range switch S_3 simultaneously selects the appropriate sawtooth-forming capacitor C_8 or C_3 through C_7 . Pentode V_{4B} is held cut off by the gate supplied from the plate of V_{6A} through R_5 . When the gate dura-

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tion is terminated, V_{4B} conducts, discharging the sawtooth-forming capacitor and thus creating the retrace or flyback time.

A signal present at the vertical input terminals of the oscilloscope passes through a compensated attenuator to first vertical amplifier V_1 . From there it progresses to second vertical amplifier V_{2A} and cathode follower V_{2B} . The path to the vertical deflection plates of the cathode-ray tube continues from the cathode of V_{2B} .

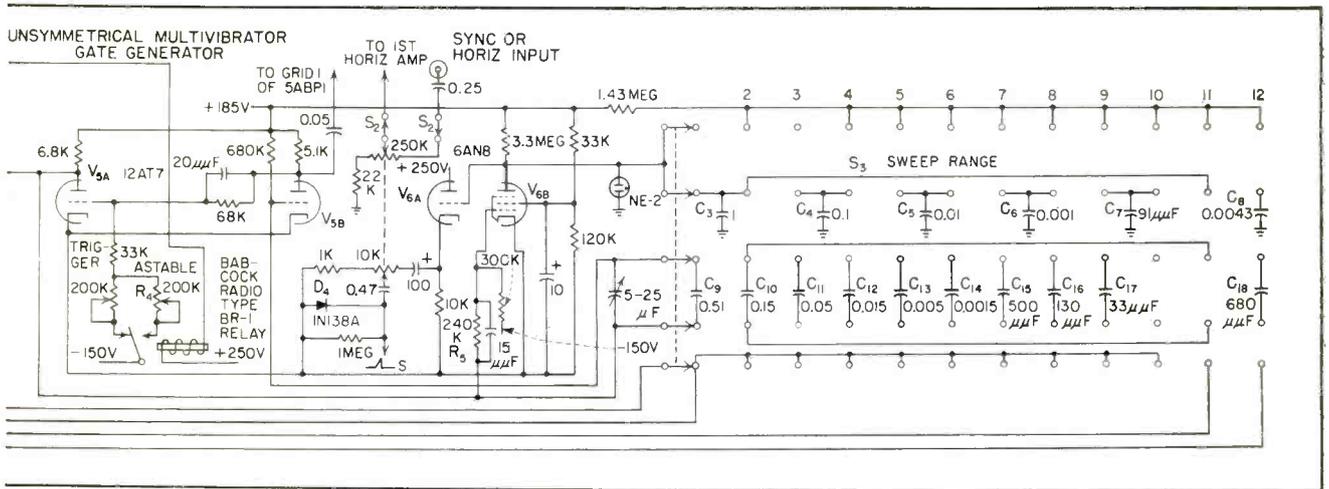
Tapped down on the cathode of V_{2B} , a 0.1- μ f capacitor connects the vertical input signal through SYNC-SWEEP selector switch S_2 to the grid of first sync amplifier V_{3A} . The frequency-compensated plate circuit of V_{3A} is connected through a 0.1- μ f capacitor to the grid of sync phase splitter V_{4A} .

At the same time, the uncompensated portion of the signal is taken

from the plate circuit of V_{3A} to AUTO SWEEP detector D_1 . The latter, a germanium diode, develops a negative voltage across C_1 which is further filtered by R_1 and C_2 .

The presence of signal in the vertical amplifier channel thus results in a negative bias being developed at the grid of V_{3B} , the AUTO SWEEP relay tube. With such bias present the tube current falls sufficiently to make the relay drop out. In this condition the sweep gate generator return circuit is transferred to a 200K preset control which is adjusted to keep V_5 cut off or in a monostable condition. The operator function of readjusting a front-panel sweep stability or sweep sensitivity control is then eliminated by the circuit action just described.

To trigger gate generator V_5 , now in a monostable mode, it is merely necessary to advance the single control R_5 in the desired polarity direction. The voltage, originating from the vertical channel, is applied through switch contacts of sweep range selector S_3 to the grid of V_{4B} . From the com-



scope circuit omitted for simplicity. Recurrent sweep is provided in absence of vertical signal to avoid burning screen

Magnifies Pulse Widths

compensated plate circuit of V_{4B} negative triggering pulses are applied to the gate generator through disconnect diode D_3 to complete the process.

The action of automatic sweep restoration is such that effectiveness has been measured with fractional-microsecond pulse widths at duty cycles as low as 0.2 percent.

If the phenomenon to be observed is nonrecurrent and has too low an energy content to actuate the mode transfer of the sweep circuits, part of the waveform at the start of the trace may be missed or a stationary pattern may not be achieved. For such situations, front-panel AUTO SWEEP switch S_4 may be set to OFF. This places a fixed negative bias

on the relay tube which keeps the gate generator permanently in a cut-off condition and ready for triggering.

The sync amplifiers are compensated in order that sufficient triggering voltage may be available to operate the instrument in the intended fashion with sine waves as high in frequency as 5 mc. Past this point the AUTO SWEEP will not switch to triggered mode, but stationary patterns are still obtained because the gate generator will synchronize when running recurrently. The vertical amplifier is down not more than 3 db at the 6-mc point.

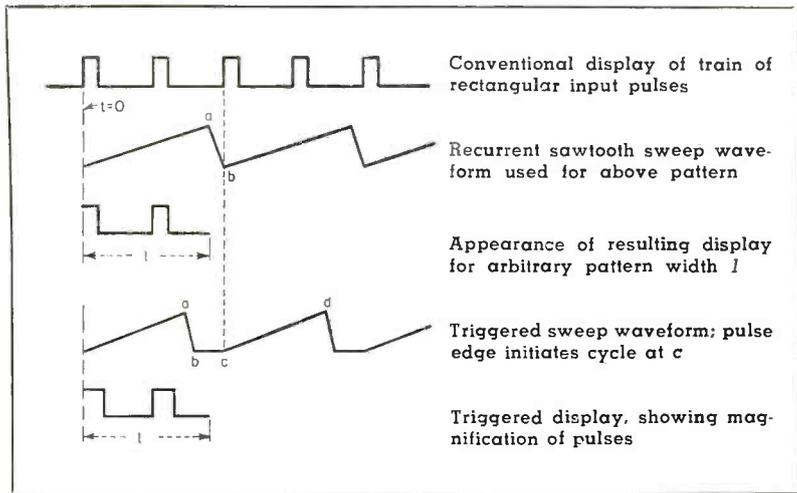
The reference trace frequency is nominally the same as that of the

triggered sweep. It is this unusual condition which allows synchronization of high-frequency sine waves which otherwise cannot actuate the automatic circuitry.

The power supplies of the instrument are electronically regulated, resulting in trace fluctuation immunity under varying line voltages and surges. A total of 3,000 volts between the cathode-ray tube gun and post-accelerator ensures adequate brightness even for P7 and P11 phosphors. The horizontal amplifier is balanced and d-c coupled, providing left-hand edge clamping of the trace. The cathode-ray tube unblanking voltage is also clamped, resulting in uniform beam intensity at low-frequency sweeps.



Oscilloscope incorporating triggered sweep



Comparison of triggered or driven sweep with synchronized free-running sweep

Permanent-Writing

SUMMARY — Inertialess electron-beam recorder for writing directly on high-sensitivity electrographic paper uses 26 in-line targets swept by the beam of a modified cathode-ray tube. Targets are connected to external styli across which paper is pulled. System is unaffected by vibration

IN THE RECORDING system to be described, a virtually inertialess electron beam serves as the writing element for producing permanent markings on electrographic paper. The recorder resembles a modified cathode-ray tube, as shown in Fig. 1. At the upper end of the tube, coplanar closely spaced targets are sealed into the face of the tube, with the external portions serving as styli. Electro-sensitive paper is drawn over the styli at constant speed in a direction perpendicular to the plane of the styli.

Spring back-up fingers press the paper against the styli and serve as electrodes.

In operation, the signal to be recorded is used to deflect the electron beam in the plane of the elements. As the beam strikes each target in turn, the beam current passes through the face of the tube to the corresponding stylus. By the application of suitable potentials between the spring fingers and the cathode of the electron gun, this current is made to pass through the electro-sensitive paper and pro-

duce a mark. The recording thus consists of a series of dashes, a continuous line through which constitutes a reasonable facsimile of the incoming signal.

A typical example of such a recording is shown in Fig. 2A, where a set of dashes may be seen, one for each stylus. The pattern is easily recognized as a sine wave.

Tube Construction

To simplify fabrication of the tube, the required number of targets is sealed into a press stem

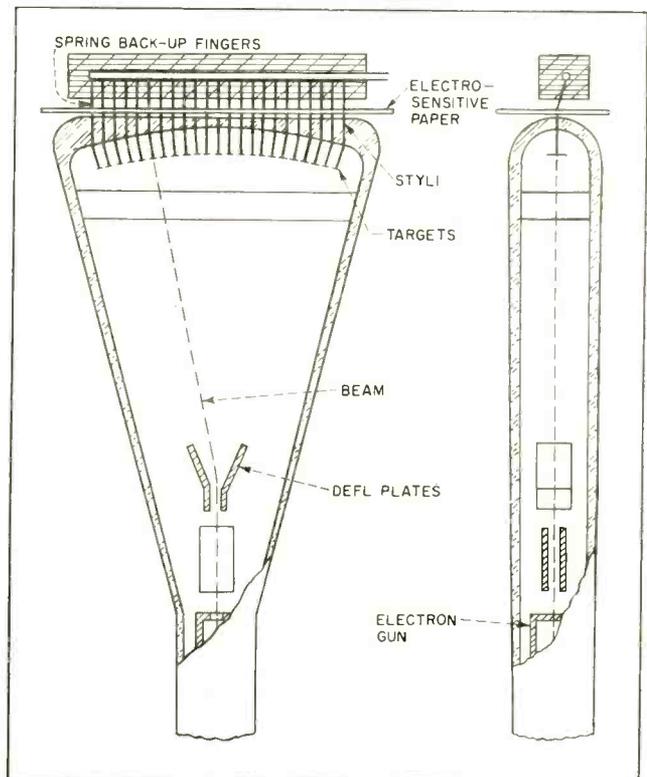
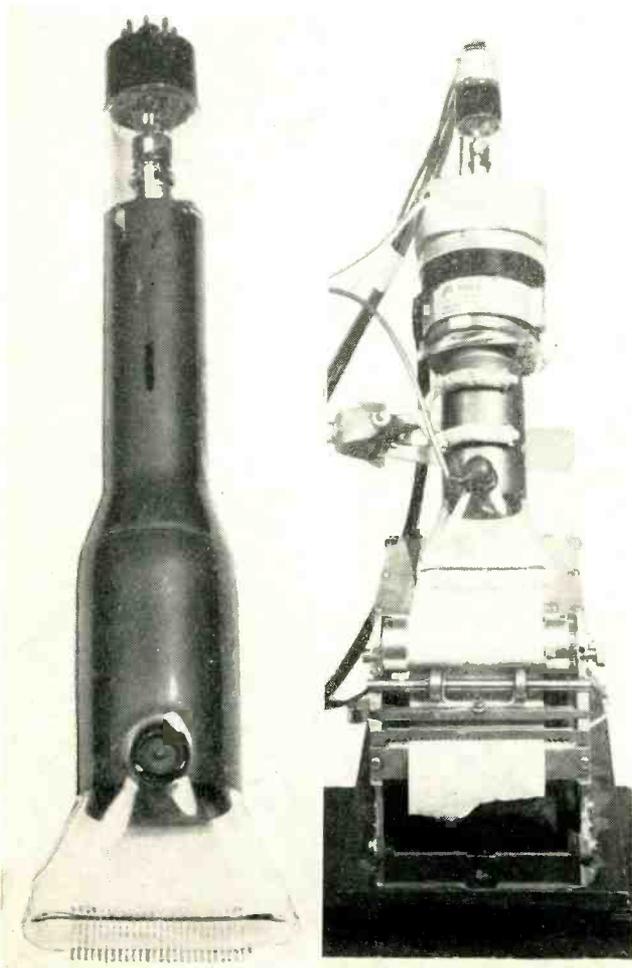


FIG. 1—Original concept of recorder tube, as shown by front and side views in patent application. Recording paper is pulled across face of tube by drive mechanism

Unmounted direct-writing cathode-ray tube and completely assembled recording system incorporating this tube

Cathode-Ray Recorder

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mounted in place of the face. Since level recording was the primary application, 26 styli were uniformly spaced in a 2-inch row to give a range of 50 db in 2-db steps.

The tube styli can be used directly for writing, but it is usually more convenient to connect a set of external styli to the tube pins with a cable and plug. Deposition of a layer of phosphor on the glass areas adjacent to the targets aids in locating, centering and focusing the electron beam.

An electrographic paper developed recently by Naval Research Laboratory, having about 30 times the sensitivity of the best commercial papers available, yielded writing with the available beam current of the tube. However, the special paper required platinum styli held at a positive potential relative to the spring fingers. Electron flow was therefore in the direction opposite to that of the electron beam.

To provide a platinum writing surface, a piece of 20-mil platinum wire was bent into a U-shape and welded over each nickel stylus of the tube. The secondary electron yield from the targets proved sufficient to override the 0.5-ma primary beam and give the required reverse current.

Performance of System

Based on deflection over all 26 targets, sine-wave response is 11 cps, square-wave response is 500 cps and linear writing speed is 80 inches per second. The system limitation is the necessity for delivering sufficient charge to each stylus being swept by the signal to produce visible marking of the paper. For square waves, the beam need stay only on the initial and final targets about one millisecond, whereas for sine waves the beam must dwell on each intermediate target for at least this time interval. The sine-wave response limit is in-

versely proportional to the number of targets swept, whereas the square-wave response is independent of the number of targets swept.

The sine-wave response limit was verified at paper speeds of 25 and 125 mm per second, but at 5 mm per second the individual cycles of the input frequency merged into a continuous set of lines as shown in Fig. 2B. When the frequency is

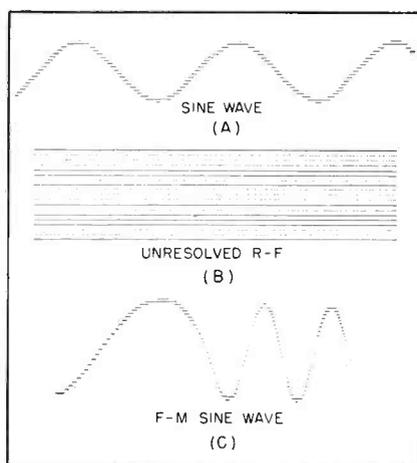


FIG. 2—Examples of traces obtained

raised at this slow paper speed, the individual cycles become more closely spaced as in Fig. 2C and merge at around 11 cps. Each paper area under a given stylus then receives the charge from more than one beam traverse over the corresponding target before it leaves the stylus. Under these conditions the delivered charge is independent of frequency. As frequency goes up, the shorter dwell time of each beam traverse is compensated for by the corresponding increase in the number of traverses.

The linear writing speed of the cathode-ray recorder is only about one-fifth that of the best commercial recorders. It has only 4-percent resolution, while that of commercial instruments is 2 percent. On the other hand, the square-wave response limit is about 5 times the

upper limit of commercial recorders.

Larger writing currents can be obtained by using electron guns of greater current capabilities or by enhancing the secondary emission, or both. The frequency response will go up in direct proportion to the increase in writing current.

Other Applications

An in-line target tube may be used as a pulse-height analyzer, the voltage discrimination of which is fixed by the number of targets. Fast counters may be employed on selected pins to determine the incidence of the corresponding levels.

Another related application is as an analog-to-digital converter, wherein any arbitrary function may be chopped into its decimal equivalents. A third application is as a function transducer and recorder. External pins may be connected to the tube styli and spaced logarithmically or in any other manner along the width of the paper.

Acknowledgment is made to L. D. Chirillo of Boston Naval Shipyard for the original conception of this type of direct recorder tube, to Naval Research Laboratory for furnishing samples of their electrosensitive paper, to S. M. Sterling and J. P. Attard of the Electron Physics Section of the Material Laboratory for fabrication of the recorder tube, and to R. Winfield and N. Burton of the Cathode Ray, Storage and Phototube Section of the Material Laboratory for evaluation of the system.

The opinions or assertions herein are those of the authors and are not to be construed as reflecting the views of the Department of the Navy or the Naval Service at large.

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Balanced-Capacitance

SUMMARY — Fence surrounding power plant, radar station or atomic energy installation is protected automatically against intrusion, minimizing size of costly four-shift guard patrols, by fail-safe electronic system that detects movement of person up to 7 feet away from antenna wires

TO SUPPLEMENT the protection provided by barbed-wire fences around electric power generating plants and substations, an electronic system was devised that set off an alarm when anyone approached or touched the barbed wire. This alarm system was so fool-proof that even if the details of its operation were known, it could not be penetrated.

The field of protection even extends into the ground below the fence to some extent, depending on soil conductivity, to detect anyone attempting to tunnel under.

The system corrects for capacitance changes automatically to correct for drift due to changing weather conditions, but at a sufficiently slow rate that it is practically impossible to penetrate by crawling slowly toward the fence antenna. Close to the fence, the slightest movement of a person's body trips the alarm. System sensitivity remains constant at all

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times, despite changes in antenna capacitance. Changes in antenna loss due to growth of weeds, rain on the wood antenna posts or damp insulation are of no consequence unless extreme, because two separate antennas are used and are connected to oscillators rather than to a tuned receiving circuit whose selectivity depends directly on antenna losses.

Design Experiments

A beat-frequency oscillator system was decided on because of the electrical leverage obtainable when employing beats between harmonics of the oscillators. An unbalanced system of wires was constructed outside the fence and capacitance measurements made at about 100

kc. It was found that capacitance changes of $50 \mu\mu\text{f}$ in a total of $2,000 \mu\mu\text{f}$ took place at sundown too rapidly to compensate for and still make the alarm effective.

A balanced system of wires extending in either direction from the end equipment was then tried. Measurements showed that the differential capacitance change was only a fraction of a $\mu\mu\text{f}$ in $5,000 \mu\mu\text{f}$. Inductive interference did not affect the end equipment when the oscillator frequency was in the 50 to 150 kc range.

Practical System

The final design, shown in Fig. 1, employs two oscillators, with the lines along the fence serving as part of the tuning capacitance of each oscillator. A mixer produces beats between the harmonics of the two oscillators. A frequency-selective network in the low audio range provides d-c voltages which are used as a bias for sharp-cutoff relay

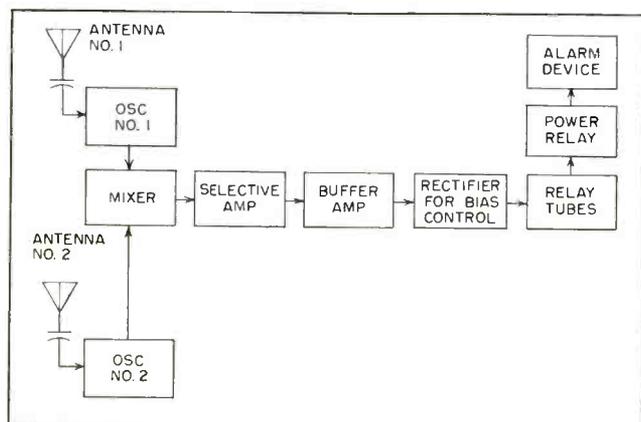


FIG. 1—Elements of complete electrostatic intrusion alarm

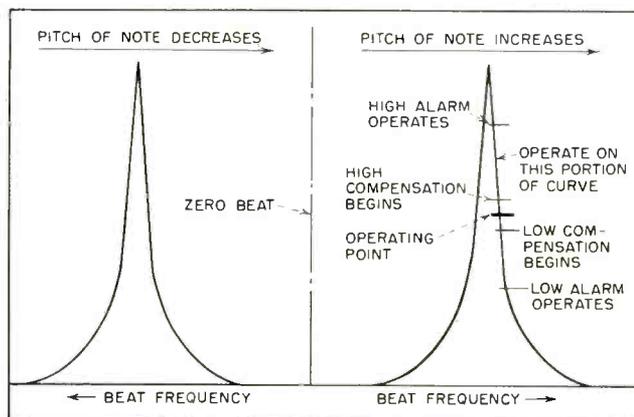
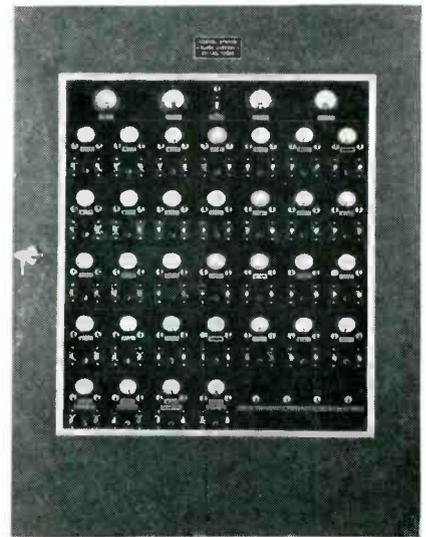


FIG. 2—Curves used for slow differential corrective system

FENCE ALARM SYSTEM



Front view of control unit, showing tuning dials, tuning meter and phone jack



Typical panel used at guard station

tubes that actuate the alarm through a power relay.

The inductances of the two oscillators are so proportioned that equal capacitance changes on the two halves will be balanced when employing harmonics of the oscillators. If the third harmonic of one oscillator is to beat against the fourth harmonic of the other oscillator and an equal capacitance change takes place on both oscillators, the resulting beat between the two must remain constant. Thus if $3f_1 = 4f_2$ and $C_1 = C_2$, then

$$\frac{f_1}{f_2} = \sqrt{\frac{L_2 C_2}{L_1 C_1}} = \sqrt{\frac{L_2}{L_1}}$$

$$\frac{L_2}{L_1} = \frac{16}{9} = 1.78$$

where f_1 and f_2 are the frequencies of the oscillators and L_1 , C_1 , L_2 and C_2 are the inductances and capacitances in the tuned circuits.

Thus, the required inductance of one oscillator must change according to the harmonics employed. Harmonic operation of the oscillators is essential.

If the selective network is so designed that maximum response comes at 500 cycles, then $500 = N_1 f_1 - N_2 f_2$, where N_1 and N_2 are the harmonics used. If f_1 and f_2 are large, a small percentage change in either will produce a large percentage change in the beat note. Under

typical operation $N_1 = 3$, $N_2 = 4$, $f_1 = 100,000$ and $f_2 = 74,875$. Now if f_1 should increase to 100,010 cycles (an increase of 0.01 percent), the beat note will increase to 530 cycles (6 percent or 600 times the percentage increase in f_1). It is this electronic leverage which gives the system its sensitivity.

Drift Correction

The balanced system shown in Fig. 1 performed well over areas where the ground soil was about the same, but when one half of the antenna was run over swamp and the other half was over sandy soil (an extreme case) the capacitance change on the two halves was far from equal. A slow differential corrective system was therefore added. This served to determine whether the capacitance on one oscillator should be increased or decreased, and provided control circuits to start and stop capacitance correction.

By operating on the side of the selective cusp, the required sense indicator is obtained as shown in Fig. 2. The increasing or decreasing rectified current makes the control circuit increase or decrease the capacitance of one oscillator to bring the system back to balance at the operating point as indicated. Working on one side of the selective

circuit requires an additional alarm tube and associated relay.

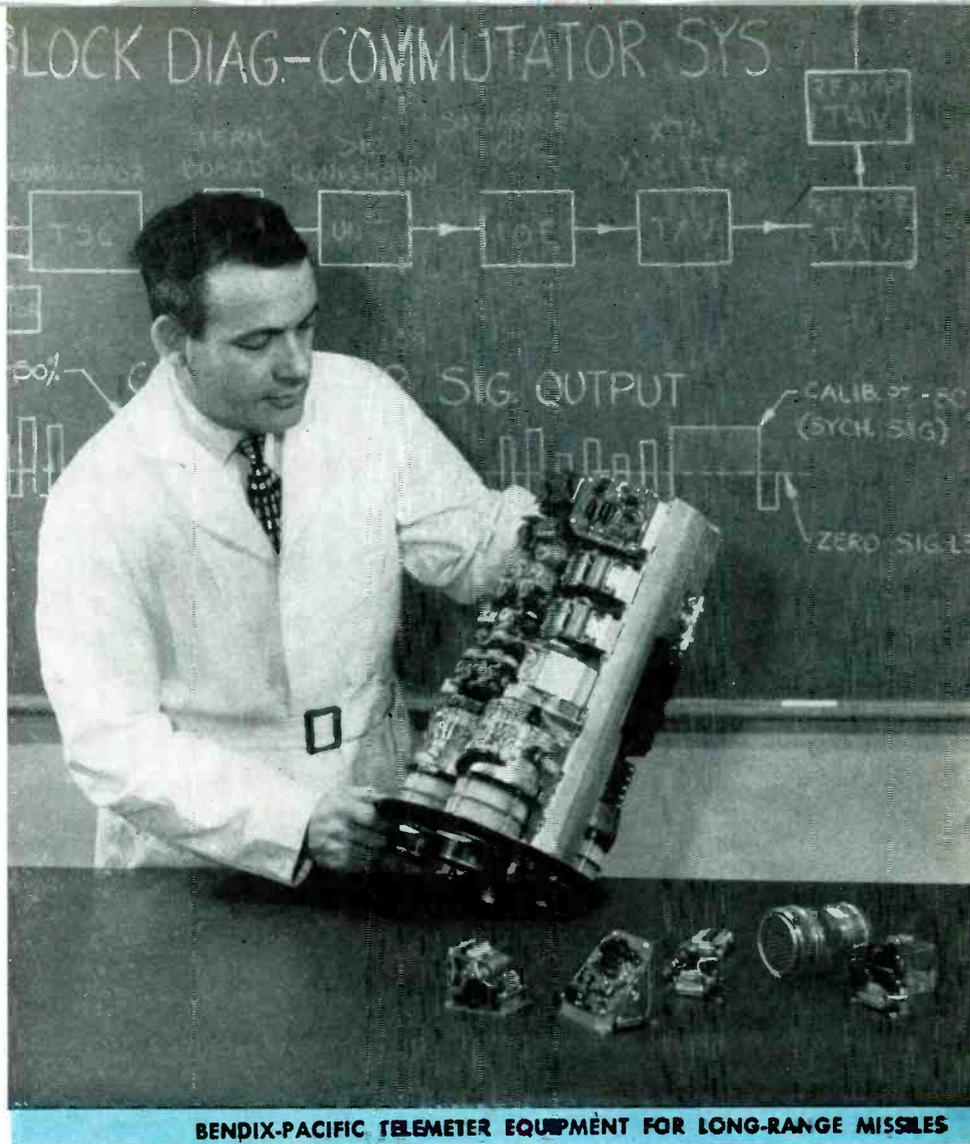
The method employed for differential correction, shown in Fig. 3, uses a variable capacitor connected to one oscillator and driven by a reversible Telechron motor which in turn receives its power from four thyratrons. Two of these thyratrons get their control bias from diodes which are adjustable so that compensation can be started at a desired point. The other two thyratrons are connected inverted and fired by a network from the control thyratron, thus operating the motor. One thyratron of the type used had insufficient power to drive the motor.

Adjustable controls permit setting the operating point as well as the high alarm, high compensation and low compensation at the required point on the selective curve shown in Fig. 2.

An alarm must be given should any tube or component in the end equipment fail. Thus, the low-alarm relay is energized under normal operation and drops out when in alarm condition. The filament of the high-alarm thyratron is placed in series with the 6N7 low-alarm tube so that the low-alarm relay will drop out should the high alarm be inactive.

With a two-wire antenna system

Systems Development
Input Transducers
Signaling Methods
Commutating Devices
Output Indicators
and Bibliography



Telemetry

Electronic Data Transmission

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An
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TRANSMISSION of information, or data, plays an increasingly important role in man's conquest of his environment. The development of means for transmitting data is as significant to modern technology as was the formulation of spoken, or written, language to earlier progress.

The summary represented by this Special Report describes a number of the more frequently used techniques for transmitting data from one place to a distant point. There are others that cannot be treated here and there are techniques as yet unexploited.

The measurements of science and the control of many industrial processes depend largely upon meter readings. It is natural that the reading of meters at a distance has become known as telemetering. In a broad sense, telemetering, or data transmission, includes not only meter readings but also comparable intelligence. Sometimes, for example, it is more profitable to study the integration of a series of meter readings that have been printed upon a moving chart or photographed in sequential steps upon a film.

Keeping this survey within reasonable confines required that limits be set. Telemetering is generally defined as the indicating, recording or integrating of a quantity at a distance by electrical translating means. The main emphasis here is upon electronic data transmission. Examples are drawn from many branches of electronics, but communications, remote control and automation as such are not the subject of discussion

AFTER TAKE-OFF

REGULUS guided missile shown at right (and on the front cover of the April 1956 issue of *ELECTRONICS*) was developed by Chance Vought Aircraft, Inc., under sponsorship of Navy Bureau of Aeronautics. It may be launched from submarines, surface ships and shore bases. Many of these missiles equipped with tricycle landing gear and parachute-type brake have been recovered and used for further data gathering flights



Systems Development

Telemetry systems have grown with need. An early application, over existing wires, aided in the distribution of electric power. Later, scientific exploration of the atmosphere made radio transmission necessary. Today, the demands of business, industry and defense make telemetry of many kinds mandatory

PATENTS issued in 1885 in the United States described electrical telemetry systems. It was not until 1912, however, that a Chicago public utility installed a system that was employed to aid in load dispatching.

In the years since, power-line telemetry systems have become available in standard packages. Equipment used for the measurement and control of temperature has likewise become available. There are, as well, commercial systems for measurement of fluid flow and many other parameters.

In the mid-thirties, particularly with increased use of radio frequencies above 50 mc, great interest developed in exploring and investigating phenomena of the upper atmosphere. Weather and cosmic ray data began to be accumulated using balloon-supported radio transmitters. This interest resulted from the findings of the Second International Polar Year, 1932-33. Plans for the International Geophysical Year (IGY) call for further sounding the nature of the atmosphere and the region above it during 1957-58.

During the early forties, there was accelerated interest in systems for broadcasting position data, particularly to military ships and aircraft. Detection systems, such as radar and sonar, that would give evidence of enemy presence were in demand.

Automatic control of anti-aircraft armament brought a further need for data that was answered to some extent by iff (identification, friend or foe) equipment that kept most friendly planes from being shot down.

The war that had spurred these interests came to an end before the Germans could produce and launch any quantity of guided missiles in which they had specialized their research. United States forces used some remotely controlled drones loaded with explosives, as well as devices equipped with television transmitters.

As a result of continued research the art of hurling equipment high into the atmosphere has now reached a point at which it is possible to envision the use of an intercontinental ballistic missile (ICBM). Telemetry equipment to test such a missile is shown on the cover of this Special Report.

The need to know what is happening to a missile under test has opened a whole new field of telemetry. Because of the tremendous activity here, standards were set up for

certain aspects of missile telemetry. While these standards (reproduced here) have been outgrown, they are still used where possible.

The field of telemetry is growing. During 1957-58 some dozen earth satellites will be separately launched by the United States. Each one is expected to circle the earth about once every 90 minutes and remain in orbit a matter of days or weeks. New telemetry devices will turn on the satellite transmitter briefly while it sends down scientific data from overhead.

System Principles. Although data transmission systems are generally complex, they can often be divided into simpler component parts. The development of an industrial or power-line type of telemetry system is shown

Table I—Teletypewriter Codes

UPPER CASE			LOWER CASE	5-UNIT					7-UNIT							
WEATHER	ARMY PRIVATE	RCA		1	2	3	4	5	1	2	3	4	5	6	7	
⊕	—	—	A	•	•			•		•	•					
⊗	?	?	B	•		•	•	•		•	•				•	
○	:	:	C	•	•	•	•	•					•	•		
↗	\$	\$	D	•		•		•				•	•			
3	3	3	E	•									•	•		
→	!	!	F	•		•		•				•	•			
↘	&	&	G		•	•							•	•		
↓	#	#	H			•				•			•	•		
8	8	8	I		•					•			•	•		
↖	'	BELL	J	•		•					•		•	•		
←	(	(	K	•	•	•						•	•	•	
↖	)	)	L		•			•		•	•		•	•	
·	·	·	M			•		•		•	•		•	•		
Ⓢ	·	·	N		•	•				•			•	•		
9	9	9	O			•		•		•			•	•		
0	0	0	P		•	•		•		•			•	•		
1	1	1	Q	•	•	•		•		•			•	•		
4	4	4	R	•		•					•		•	•		
BELL	BELL		S	•		•					•		•	•		
5	5	5	T					•		•			•	•		
7	7	7	U	•	•	•		•		•			•	•		
Ⓛ	:	:	V	•	•	•		•		•			•	•		
2	2	2	W	•	•			•		•			•	•		
/	/	/	X	•		•		•			•		•	•		
6	6	6	Y	•	•	•		•			•		•	•		
+	"	"	Z	•		•		•			•		•	•		
SPACE										•			•	•		
LETTERS					•	•	•	•	•	•	•	•	•	•	•	
FIGURES					•	•		•		•		•	•	•		
CARRIAGE RETURN								•		•		•	•	•		
LINE FEED					•					•		•	•	•		

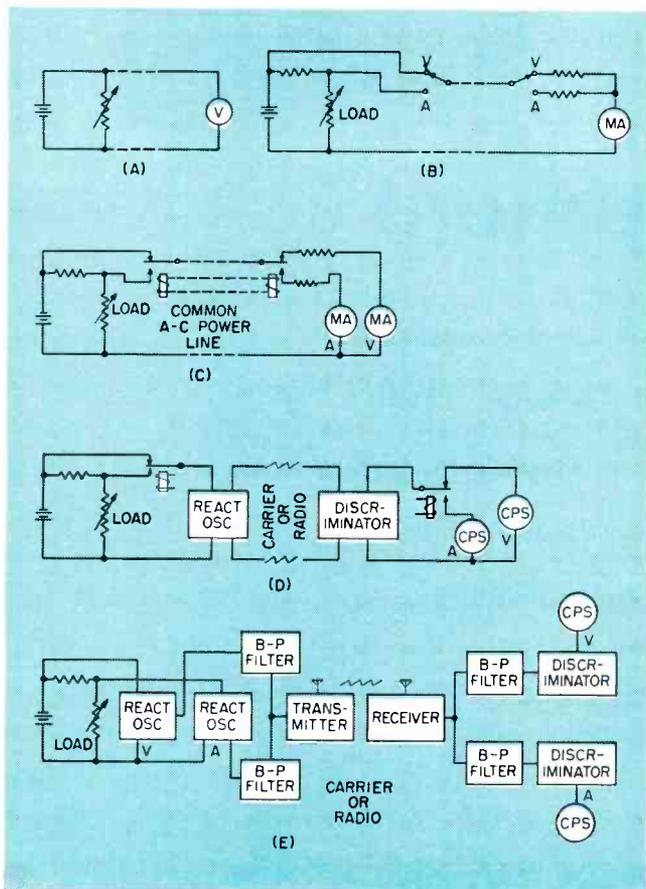


FIG. 1—Development of time-division and frequency-division telemetering systems. Means of computing power at a distance using wire line, radio or carrier is shown

in Fig. 1. At (A) is shown a battery and load. The voltmeter, whether it be viewed at the load or some distance away (assuming the resistance of the line be compensated) reads the potential across the resistance.

If a resistor is placed in series with the variable load, as at (B), there is means for determining the power absorbed in the load through measurement of voltage and current. The resistors in series with the milliammeter allow compensation for line resistance.

Although it is necessary to have someone throw the switch from V to A according to a prearranged plan in order to meter at a distance, this is not so if the sampling system at (C) is used. Assuming a conventional a-c power line, the switching is automatic. (Such synchronization is common in other telemetering systems like facsimile and teleprinting.) Dwell time of the relay contacts must be considered in adjusting the meter resistors.

A carrier-current can be superimposed upon the connecting line, or a radio circuit can be used to tie together the transmitting and receiving locations. At (D) is shown a simplified reactance oscillator, the frequency of which is varied by the input d-c. Voltage and current indications at the receiver are given by frequency-sensitive devices that sample the output of the discriminator.

The system shown in Fig. 1E operates on a frequency multiplex basis without sampling. Here two separate reactance oscillators are controlled over an adequate frequency band and then output signals are combined in a radio or carrier transmitter. At the receiver, filtered signals from the output pass separately through discriminators to indicating meters.

Simple System. The distance between transmitter and

receiver need not be great to qualify a telemetering system.

An example is the device shown in Fig. 2. It comprises a couple of bimetal units, one of which opens a normally closed electrical contact. The other controls the position of a pointer.

The measuring element can be moved, as by float in a tank of liquid, and it then controls the length of time that the contact is maintained. The longer the receiver bimetal is heated the higher the pointer rises on the scale. Thermal inertia bucks out sudden fluctuations, as might occur in the gasoline tank of a moving vehicle.

Radiosondes. Although balloon-supported radiometeorographs were used in several countries prior to 1930, significant American developments stem from the mid-thirties. The radiosonde, as it became known, was arrived at through necessity. During periods of worst weather when meteorological information is most desired it is unfeasible to fly kites or send aircraft aloft. Probably more thousands of weather telemeters have been manufactured and used than any other one data transmitting equipment.

American radiosondes in present use employ a sampling system to send back data. An early type used the Olland principle that gave a weighted sample unlike the signal from a simple commutator device. As shown in Fig. 3, the meteorograph elements comprise a hair hygrometer, bimetallic thermometer and aneroid cell. To these are attached contact arms that bear upon the surface of a disk rotated by clockwork. A reference mark gives a fixed time mark against which the other elements are measured, because the clockwork is affected by temperature. An idealized chart is shown at the right indicating changes in pressure, temperature and relative humidity.

The circuit used in developmental models built at Blue Hill Observatory employed an oscillator that sent out impulses of modulated carrier when the meteorograph made contact. Modulated plate voltage was provided by a buzzer transformer. Carrier frequency was near 60 mc. Output from a super-regenerative receiver was connected to a magnetically operated pen bearing against a rotating drum to which the chart was fastened. A modern version of the radiosonde is described in the section on commutation, where it is used to illustrate a means for plotting one function against another.

Cosmic Ray Counting. The direction of arrival of cosmic rays upon the surface of the earth depends upon geomagnetism. The number of particles increases with elevation above sea level. Because these facts were known only qualitatively around 1935, a few investigators began a program of balloon ascensions. These experiments have

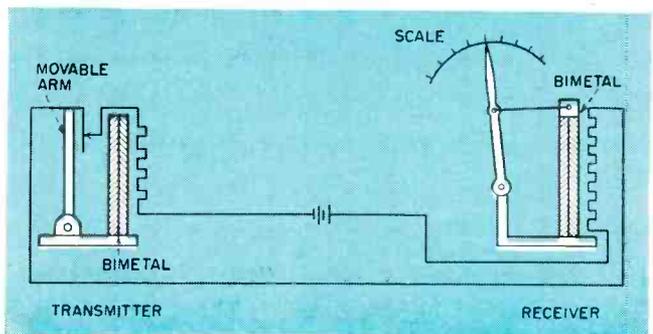


FIG. 2—Simple telemeter that depends upon the heating of bimetallic strips. Position of the movable arm determines height on scale to which pointer will rise

been supplemented since the war by telemetering rockets and will be further pursued during the International Geophysical Year.

One model of cosmic-ray sounding equipment used successfully during 1936 and 1937 employed an escapement switch. Two kinds of information were time-multiplexed: altitude and the number of vertical cosmic rays. The escapement allowed the equipment to fall gradually away from the balloons that carried it aloft.

Elements of Telemetering. The essential portions of a data transmission system include a transducer, sometimes called a pickup, or sensing device, to change some other form of energy into electrical energy, a transmission or signaling system and a receiver with an output transducer or recorder.

If it is desired to transmit information from a number of pickups, there are two possible ways to perform the function. Either more simultaneous channels of transmission must be provided or data from a number of pickups must be sampled in sequence and properly identified at the receiver. Sometimes both methods are used at once.

A number of present and proposed telemetering systems are indicated in the dot chart, Table II.

Military Applications. Missile data transmission systems during the war were generally confined to guidance functions. The only German system known to have seen service is the Strassberg-Kehl command link.

Shown in Fig. 4 is the modulated data transmitter (A) into which two pairs of audio frequencies are fed through the control that is actuated like the joystick of an airplane. With the control in a neutral position, a rotating commutator feeds equal periods of each frequency through movable brushes to the modulator.

Moving the control in any direction causes one frequency in either or both of the low and high-frequency oscillator pairs to predominate. This effect is illustrated in (B) where the normal and downward signals of the up-down channel are blocked out on the basis of time. In the downward position, the 1-kc signal predominates.

In a guided aircraft equipped with the receiving devices shown in (C) the control surfaces are continually vibrating. Change occurs when the control is caused to spend more time on one side than the other of its neutral position.

Since the commutator at the transmitter rotates at 5 rps, it sends out alternate 1/10-second pulses from each half of each pair of oscillators.

Other Telemeters. Many types of telemeters have similarities to those already described. Some of them are data systems—others fringe upon control as well, such as chart recorders in which the off-zero position of an associated potentiometer can supply a control voltage.

Another type of telemeter equipment is the teletypewriter, for which codes are shown in Table I. Although teleprinter equipment used for communications is standardized, its output can be encoded and its input signal decoded.

The teleprinter has been used as a computer output device. Although it is customarily equipped with letters and numbers, these may be essentially meaningless in certain telemetering applications in which provision of a different keyboard and type keys convert impulses to symbols. This, in fact, is true for weather map symbols.

Propagation-affected Data. A data transmission system

Table II—Applications of Telemetering

	now	future
BUSINESS		
Accounting.....		○
Branch tie-in.....		○
Burglar alarms.....		○
Fire alarms.....		○
Inventory control.....		○
Space-reservation.....	●	
Stock ticker.....	●	
Telautograph.....	●	
Teleprinter.....	●	
COMMUNICATIONS		
Automatic teleprinter correction.....	●	
Broadcast remote control.....	●	
Telecasting remote control.....		○
Wire data circuits.....		○
INDUSTRIAL		
Data for automatic control.....		○
Fluid depth measurement.....	●	
Measuring gas flow.....	●	
Pipe-line control.....	●	
Rainfall reporting.....	●	
Reading gages by tv.....	●	
MILITARY		
Battleground television.....		○
Doppler devices.....	●	
ICBM.....		○
Personnel data.....	●	
Radioactive monitoring.....		○
SAGE.....	●	
Search-Rescue operations.....		○
Sonobuoy.....	●	
Target drone aircraft.....	●	
TV-guided missiles.....	●	
Ultrafax.....		○
Underwater detection nets.....		○
RESEARCH		
Aircraft design.....	●	
Flight testing.....	●	
Landing on planets.....		○
Medical research.....	●	
Missiles.....	●	
Navigation-data sendback.....		○
Nuclear experimentation.....	●	
Projectiles.....	●	
Radiosondes.....	●	
Satellites.....		○
TRANSPORTATION		
Automatic flight plans.....		○
Automatic railroading.....		○
Hyperbolic navigation.....	●	
Radar speed detection.....	●	
Radar traffic detection.....		○
Rho-theta navigation.....	●	
Train identification.....	●	

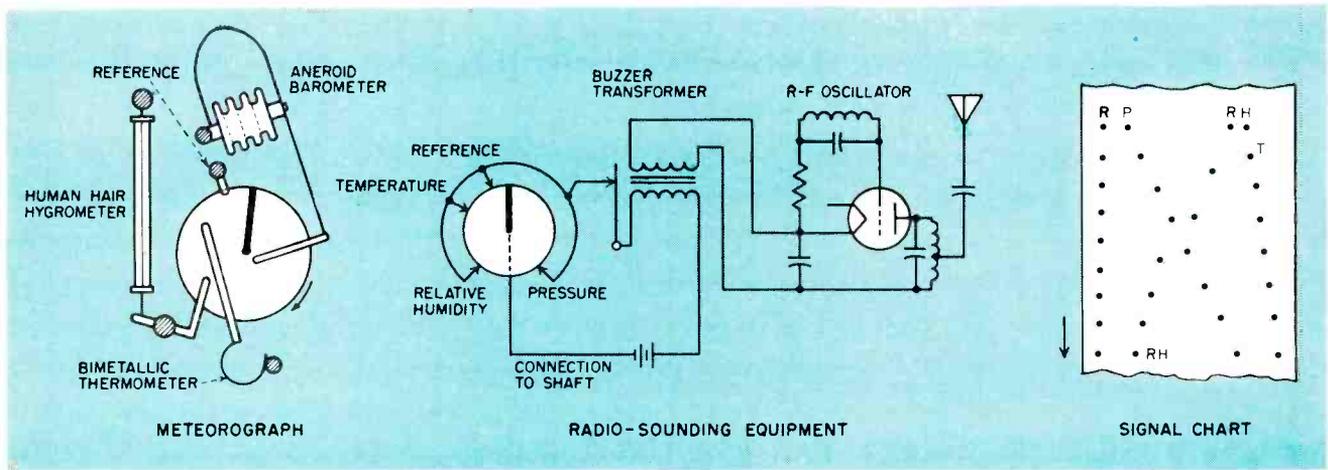


FIG. 3—Elements of a radiosonde based upon the Olland sampling principle. Relative displacement of elements is shown by a series of short dashes on moving chart paper at ground station

that receives increasingly wider use is one in which the finite delays in the propagation of radio waves from a pair of suitably synchronized radio transmitters is used to plot a line of position. Two properly disposed pairs of transmitters provide a fix. A fix can likewise be obtained from so-called rho-theta systems, but usually the distance between master and slave transmitters would be less than 200 miles.

A simplified hyperbolic line of position intersecting a second is shown in Fig. 5A. Such a diagram is basic to navigation data systems like Gee, loran, Lorac, Raydist and Decca. It suggests possibilities of moderately long-range missile guidance in which a single line of position is used to take the missile to its target where it is dumped, either by impulse from an intersecting line or by some other means.

Relayed Fixes. Of peacetime interest for purposes of sea rescue is the automatic relay of hyperbolic data. Equipment requires only the operation of a switch by any occupant of a lifeboat. Line-of-position data that would ordinarily be read off by a navigator can be used to modulate a pulse transmitter. These pulses, together with other identifying codes, would be picked up at one or more receiving stations.

Only one line of position is shown in Fig. 5B for simplicity. In actuality, pulse signals giving line-of-position data from two pairs of navigation-aid stations would be alternated. Such information would be much more exact and definite than the bearings of even the best conventional direction-finding equipment. At least one relayed-fix system of this general type is under development in the guided missile program.

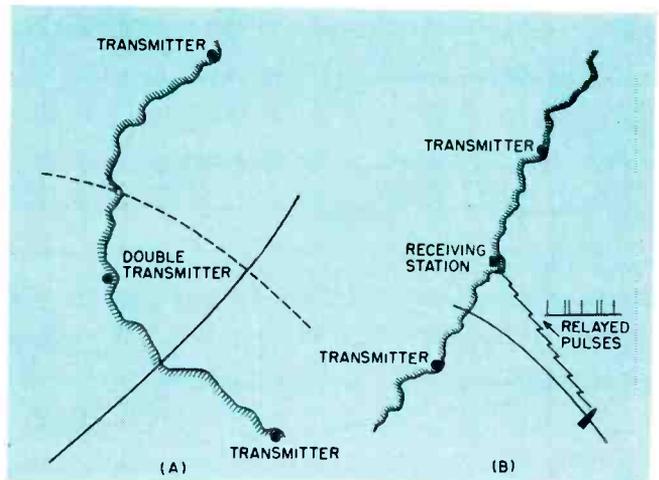
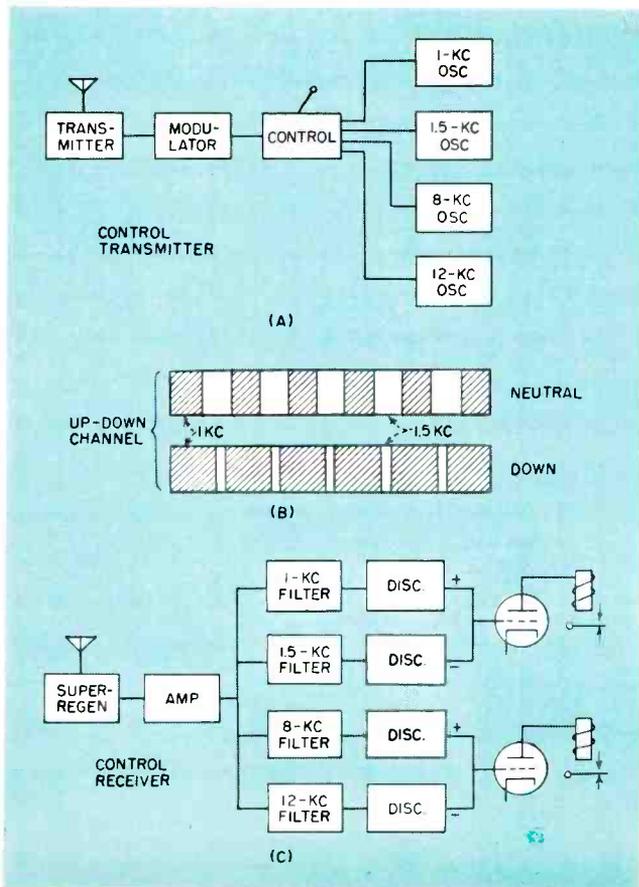


FIG. 5—Data transmission in position-finding system often depends upon time of propagation. A standard hyperbolic fix from two pairs of transmitters is shown at (A). A relayed line of position comes from the lifeboat at (B)

FIG. 4—Strassberg-Kehl command (left) was used by the Germans for remote radio guidance of missiles. Employing two pairs of audio tones, it vibrates control surfaces more to one side than to the other for guidance

Input Transducers

**Transducers, or pickups, are important links in a telemetering chain. These devices transform the energy of the measurand —
the physical quantity, property or condition to be measured —
into another form of energy such as an electrical current or voltage**

IN CHOOSING a transducer for a particular application, factors such as hysteresis error, resolution, frequency response, sensitivity, calibration, repeatability and compatibility are considered.

Compatibility of a transducer must be considered from two aspects, mechanical and electrical. Mechanical compatibility encompasses environmental conditions such as vibration, temperature, pressure, atmosphere, space limitations and mounting arrangements.

Electrical Compatibility. If a commercial telemetering system is to be used, the transducers must be electrically compatible with the other equipment of the system. In conventional frequency-division-multiplex systems, the f-m subcarrier oscillators may be modulated in any of three ways, as variable-voltage, variable-resistance or variable-inductance controlled oscillators.

Most voltage-controlled f-m subcarrier oscillators have been standardized to produce a ± 7.5 -kc subcarrier frequency deviation from an input of 0 to 5 volts.

Manufacturers of time-division-multiplex systems have adopted both a 0 to 5-v and a 0 to 5-mv standard. The 0 to 5-v standard was recommended for pwm telemetering by the Research and Development Board.

Consideration must be given to transducer sensitivity. In an f-m multiplexing system, excessive transducer output can cause the associated subcarrier oscillator to be driven into an adjacent channel, thereby causing interference. Transducer sensitivity is consequently not higher

than actually needed for an application.

Resistive Transducers. Potentiometer, strain gage and nonmechanical-resistance-variation devices are three major types of resistive transducers.

In the potentiometer type, a change in resistance is obtained by causing a linear or rotary motion to displace the wiper arm. In most applications, the potentiometer is connected across the voltage source, as shown in Fig. 6, and the variable output voltage used directly to modulate an a-m or f-m subcarrier oscillator. It is also connected as a rheostat in the frequency-determining circuit of an oscillator, providing an f-m subcarrier signal.

One of the potentiometer transducer's advantages is the comparatively high output voltage available, depending on the voltage source, making it possible to reduce or eliminate subsequent amplification and accompanying deficiencies. Other favorable factors are that precision devices will provide readings in voltage ratio versus measurand with errors of the order of tenths of a percent; wear, of the order of a million cycles, will cause little change in the initial error. If the supply voltage is transmitted as a reference, output accuracy is not affected by changes in supply voltage or temperature since the output is in the form of a ratio.

Limitations. Accuracy of these devices is limited by geometric precision and improves with the length of the wound element. Sensitivity or resolution of a potentiom-

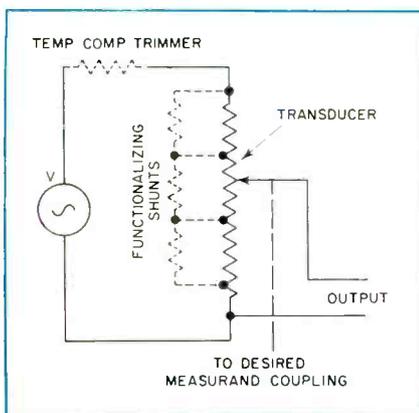


FIG. 6—Typical potentiometer-transducer circuitry. Dashed-line components may be added as needed

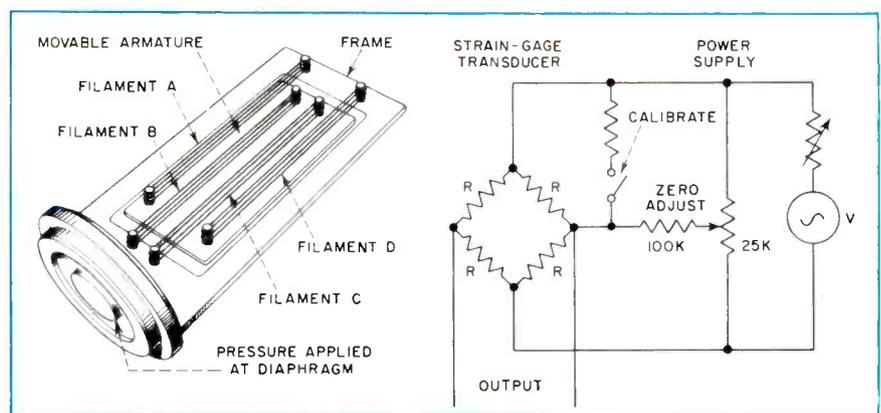


FIG. 7—Unbonded strain-gage pressure transducer has diaphragm mechanically coupled to movable armature. Pressure variations cause armature to move and change tension of wire filaments. Typical circuit is shown at right; source voltage can be a-c or d-c

Table III—Characteristics of Accelerometers

	Potentiometer	Variable Reluctance	Differential Transformer	Piezoelectric	Variable Capacitance	Strain Gage	EMF Generating
Acceleration Amplitude (1/sec)	1 to 50	1 to 200	1 to 200	0.1 to 30,000	1 to 200	1 to 1,000	up to 100
Highest Resonant Frequency (cps)	90	500	500	80,000	50,000	2,000	5
Useful Freq Range	0 to 50	0 to 350	0 to 350	3 to 25,000	0 to 25,000	0 to 1,500	5 to 2,000
Self-Generating	no	no	no	yes	no	no	yes
Damping	magnetic fluid	fluid	magnetic fluid	none fluid	none	fluid	magnetic
Excitation	d-c carrier	carrier	carrier	none	carrier	d-c carrier	none
Output Impedance	10,000 ohms resistive	1,000 ohms inductive	200 ohms resistive	1,000 $\mu\mu\text{f}$ capacitive	50 $\mu\mu\text{f}$ capacitive	600 ohms resistive	200 ohms resistive
Accessories	none	bridge	carrier	cathode follower	bridge	bridge	none
Upper Temp Range (without coolant)	350 F	350 F	350 F	500 F	500 F	250 F	500 F
Resolution	$\frac{1}{2}$ percent	limited only by design					
Accuracy	1 percent full-scale	1 percent full-scale	1 percent full-scale	1 percent full-scale	3 percent actual reading	1 percent full-scale	1 percent full-scale

etc is inversely proportional to the number of turns on the resistive element. Present techniques permit wiping as many as 1,500 turns, which is equivalent to a resolution of 0.067 percent. Another limitation is imposed by the frequency of the potentiometer wiper motion. Above approximately 10 cps, the wiper tends to bounce on the element surface.

Potentiometer transducers as shown in the photographs are often used to measure pressure and acceleration. The measurement of the accelerating force is obtained as a resistance or voltage ratio by having a spring-supported, magnetically or fluid damped mass move the wiper arm of the potentiometer in direct proportion to the value of acceleration. The characteristics of such accelerometers are shown in Table III.

Wire-Strain Gages. Probably the second most widely used type of resistive transducer is the resistance-wire strain gage. Operation of this device is based on the change of electrical resistance that occurs when the wires constituting a gage are stretched.

Bonded gages are made in the form of a continuous resistance-wire grid cemented to a carrier sheet. The carrier transfers strain to the wire through the cement. Gages are available with resistance values of 60 to 5,000 ohms. The basic gage has a resistance of about 120 ohms, which is large compared to the resistance of lead wires and switch contacts. Bonded gages are commonly applied to test structures for the measurement of stress-strain, torque and deflection.

The unbonded gage in its basic form is a displacement transducer. In the center of a stationary frame an armature is supported rigidly in the plane perpendicular to the longitudinal axis in such way as to allow free movement along this axis. Wound between rigid pins mounted in the frame and armature are four windings of strain-sensitive resistance wire which comprise the four elements of a Wheatstone bridge, as shown in Fig. 7.

As the armature is caused to move longitudinally by an external force, two sets of filaments are elongated and increase in resistance, while the other two sets shorten and decrease in resistance. The resistance change of the filaments alters the electrical balance of the bridge to produce an electric signal in the output circuit. When a bellows or diaphragm is attached to the linkage of the unbonded displacement transducer, the element becomes a pressure transducer. The basic element becomes an acceleration transducer when a mass is attached to the armature.

Unbonded gages have nominal bridge resistance of from 50 to 15,000 ohms. With 5 to 200 volts d-c or a-c input, they supply full-range open-circuit voltages from 10 millivolts to 1 volt and full-range currents of 30 to 400 microamperes. Unbonded gages are available which have an accuracy of 0.25 percent of full scale.

The stepless character of the output of bonded or unbonded gages makes their ultimate resolution limited only by the characteristics of the associated equipment.

Both bonded and unbonded gages may be used with either d-c or a-c bridge circuits. An a-m subcarrier may be obtained directly by exciting the bridge with the subcar-

rier frequency. The bridge output may also be used to modulate an a-m or f-m subcarrier oscillator.

Temperature and Voltage-Sensitive Materials. Nonmechanical-resistance-variation devices include temperature-sensitive and voltage-sensitive materials. Temperature-sensitive materials are usually of two types—pure metals which normally have linear temperature-resistivity characteristics and semiconductors, which have nonlinear temperature-resistivity characteristics.

These materials are usually used as an arm or arms of a bridge circuit and the bridge used as previously mentioned. Where the resistance change is sufficient, they can also be used as the frequency-determining components of phase-shift or blocking oscillators.

Typical of the pure-metals are platinum, tungsten, nickel and copper.

Fine-wire grids of metals, embedded in a protecting material, can be fixed to an object whose temperature is to be measured. Response time of the wire elements may be controlled to some degree by varying the wire diameter.

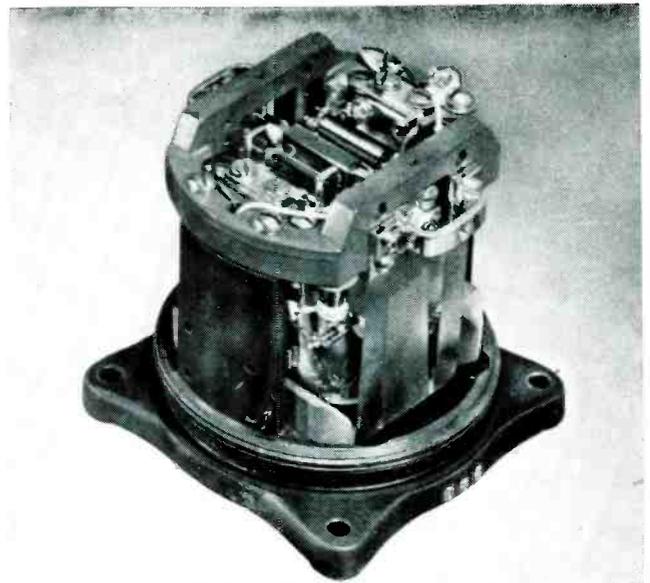
In contrast with metals, which often have small positive temperature coefficients of resistance, some semiconductors have relatively large, nonlinear negative temperature coefficients. Thermistors are probably the most widely used semiconductors. They are usually a sintered mixture of ceramic materials and manganese, nickel, cobalt or other metallic oxides, formed in various shapes. The resistance of a thermistor may change by 2.5 to 8 percent per degree C of temperature change at 20 C, in comparison with $\frac{1}{3}$ percent for average metals. Resistivity of various thermistor materials is 100 to 500 times greater than that of platinum.

Thermistors are used in much the same way as other resistive (metal) materials and are generally used over the temperature range of -60 to $+300$ C.

This self-heating characteristic of thermistors may be used to measure flow rates of gases and liquids, low-level air pressures (5 mm to 1 micron) and dew-points, among others. These measurements are all based on the principle that a heated thermistor will dissipate heat at a rate which is a function of the medium surrounding it.

Some types of ceramic resistors have properties similar to those of thermistors, with negative temperature coefficients of 1 to 3 percent per degree C at 25 C.

The property of certain materials, such as lithium chloride, to change in resistivity as a function of moisture absorption is used to measure relative humidity over a



Giannini potentiometer accelerometer consists of magnetically damped, spring-supported mass system which actuates wiper arm of linear potentiometer through linkage system

range of 15 to 100 percent. A humidity cell usually consists of a plastic or glass plate coated with a hygroscopic film of lithium chloride. Electrodes attached to the edges of the plate permit measuring of the variable resistance.

In addition to its sensitivity to moisture, lithium chloride is also temperature sensitive to a small degree. Consequently, accurate humidity measurements with this material require temperature compensation.

Capacitive Transducers. These devices consist basically of two or more electrodes or conductors separated by an insulating material. Since capacitance is a function of the separation of the electrodes, the area of the conductors and the dielectric constant of the insulator, changing any one of these parameters causes a capacitance change which can be analyzed. For example: two fixed electrodes can be immersed in a medium of variable dielectric constant; the dielectric constant of a medium may remain fixed and the amount of dielectric varied; one electrode can be fixed and the other made to vary with the amount of dielectric. The latter two methods permit measuring volume. Angular displacement can be measured by rotating one of the

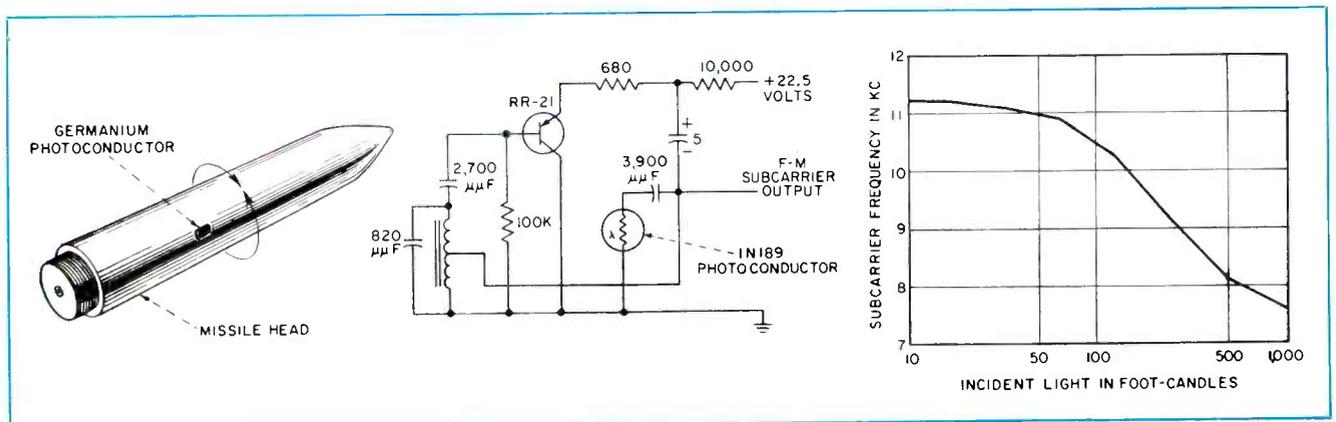


FIG. 8—Test-missile head contains germanium photoconductor which is employed as frequency-determining element of transistor f-m subcarrier oscillator. Spinning of missile causes light falling on photoconductor to vary and in turn vary subcarrier frequency

Table IV—Phosphors for Scintillation Counters

Phosphor	Chief Application	Scintillation Time in μsec
Nickel-Killed Zinc Sulphide	α particles	3.0
Thallium-Activated Potassium Iodide	$\alpha\beta$ particles γ rays	1.5
Naphthalene +0.01% Anthracene	β particles γ rays	0.06
Anthracene	β particles γ rays	0.02

electrodes of a parallel-plate variable capacitor. This system is self-referencing as it goes through a minimum and maximum every 360 degrees of rotation.

Linear displacement is measurable by fixing one electrode and causing the other to approach it or recede from it as a function of the measurand.

Capacitor transducers may be used as frequency-determining elements of oscillator circuits or in bridge circuits.

Advantages of this type of transducer include high frequency response, high sensitivity, small to high displacement ranges, good resolution, high-temperature operation and ability to measure static quantities. Disadvantages are sensitivity to vibration and electrical noise, temperature drift and maintenance of original calibration (except for self-referencing arrangements). Sensitivity usually decreases approximately 1 percent per 20 C rise.

Piezoelectric Materials. The ability of certain materials to generate an electrical voltage when subjected to mechanical stress may be utilized in a transducer. This piezoelectric property is common to natural crystals, such as quartz and tourmaline, synthetic materials, such as Rochelle salts, ADP (ammonium dihydrogen phosphate) and ceramics such as barium titanate.

Transducers of these materials are self-generating; the electrical energy produced being linearly proportional to energy of the measurand. This property permits them to directly voltage modulate an a-m or f-m subcarrier oscillator.

Piezoelectric transducers have wide dynamic range, with virtually no hysteresis and infinite resolution. Certain types have excellent reproducibility of results. The mechanical structure of these transducers is normally stiff, causing them to be rugged and have a wide frequency-response range. They are usually limited, however, to the measurement of frequencies above 2 to 3 cps.

In all applications, electrostatic shielding, along with short cable lengths, requires careful consideration, as crystals are sensitive to electrical-noise pickup. Excessive cable lengths can also be detrimental to the signal level because of the cable's shunting capacitance.

Of the various piezoelectric materials commonly employed, no one material exceeds, in all respects, characteristics of the others. Piezoelectric ceramics are frequently used in telemetering; they have a good combination of energy-conversion efficiency, temperature stability, ruggedness and ease of fabrication into any shape. These ceramics are capable of operation from -85 to $+500$ F.

Piezoelectric transducers are often used for the measurement of shock and vibration, high acoustic levels, as well as fluctuating pressures. Pressure measuring and force measuring devices are capable of measuring pressures from 0.01 psi to more than 30,000 psi over frequency ranges of 3 to 25,000 cps.

Electronic Devices. Transducers which utilize the motion, production or control of free electrons can be classified as electronic. These include photoelectric, ionization, thermoelectric and other devices.

Any phenomena which produce a variation in light intensity, position or color may be measured or detected with photoelectric transducers. These include photoconductor, photovoltaic and photoemissive devices.

Photoconductive Devices. The term photoconductivity is used to describe changes of conductivity induced by illumination in a gas, solid or liquid medium. For some time selenium was the principal material used for photoconductive transducers. However, in recent years, lead sulfide and germanium devices have also become prominent.

Selenium cells may show a decrease in resistance by a factor of five when exposed to strong illumination. They pass appreciable dark-state current and are comparatively slow to respond to light changes.

Lead sulfide cells usually consist of a semitransparent coating on the inside surface of an evacuated glass bulb. They have linear illumination-versus-resistance response and low noise level and are particularly useful where frequency is less than 10,000 cps, color temperature is in the range 400 to 3,900 Kelvin, light flux is concentrated in an area

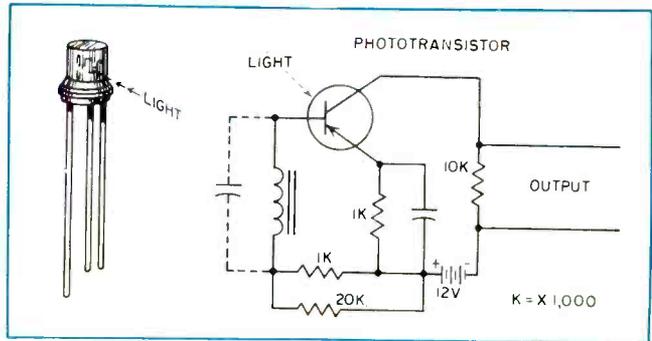


FIG. 9—Typical Radio Receptor pnp germanium-junction phototransistor and circuit for modulated-light use. Base inductance is tuned to light-modulation frequency for best signal-to-noise ratio

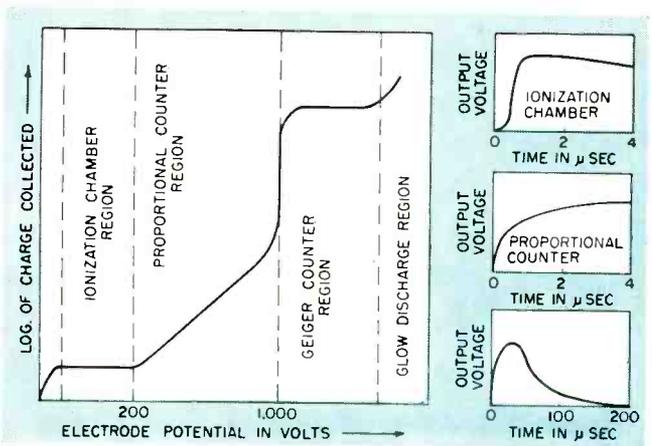


FIG. 10—Operating regions of various nuclear radiation detection instruments and shapes of output-voltage pulses. Waveshapes shown are for infinite input time constants

up to 1 sq cm and rapid response is required. A resistance change of up to 80 to 1 can be obtained.

Operation of lead-sulfide cells above temperatures of 100 C is not ordinarily recommended. A slow drift in resistance and sensitivity may be encountered if the lead-sulfide surface is exposed to air. In certain applications, temperature compensation may be required to offset the high temperature coefficient of these cells.

Germanium photoconductive devices may be either photodiodes, phototransistors or photoconductors. Photodiodes are basically germanium diodes whose resistance is dependent on incident illumination and, to some degree, temperature.

Photoconductors are germanium bars without directional characteristics. They can be used in a-c circuits without the clipping effect of photodiodes. An application is illustrated in Fig. 8. Phototransistors are essentially grounded-emitted transistor amplifiers, as shown in Fig. 9. Their characteristics are a function of $a/(1-a)$, where a is the current amplification factor.

All of these photoconductive devices, except phototransistors, are generally used in series with a voltage source. The variations in conductivity produce a corresponding output voltage which may be applied as discussed in previous paragraphs.

Generating Devices. Photovoltaic cells develop an internal emf when illuminated by energy in the visible, infrared and ultraviolet regions of the spectrum. Such cells usually consist of a pure metal base over which is placed a layer of semitransparent semiconductor material. Electrodes are attached to the base and semiconductor material. The barrier layer may be between the top electrode and semiconductor layers or between the semiconductor and base metal layers. The former, a front-wall cell, has greater sensitivity than the latter, a back-wall cell.

Under short-circuit conditions these cells produce a maximum output current that varies linearly with the light intensity; open-circuit output voltage increases logarithmically with light intensity. This characteristic requires that low values of load resistance be used for linearity. Output is usually used in a voltage form by producing a voltage drop across a load resistor.

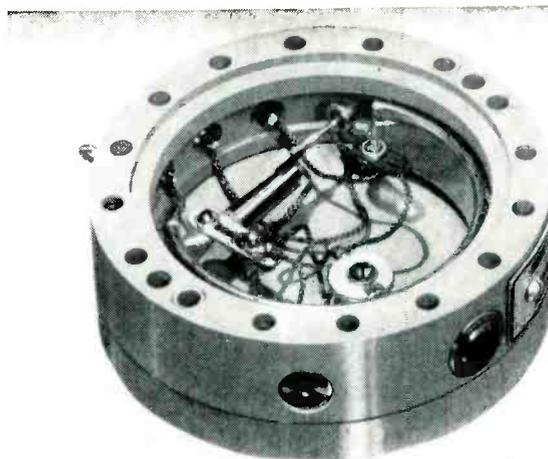
Commercially available photovoltaic cells are either copper-copper oxide, silicon *pn*-junction or iron selenide-silver. All of these devices have outputs which are proportional to the area exposed to radiant energy. A 1½-inch diameter silicon-junction cell will generate 0.25 v across 10 ohms in sunlight. Other cells ordinarily produce outputs in the milliamper or millivolt range.

Frequency response of these cells is affected by the large capacitances involved. With equal 60-cps on-off intervals of light, the off current can be as much as 50 percent of the on current. At 1,000 cps, the off current can be as high as 97 percent of the on current.

These devices have a tendency to become fatigued. This characteristic necessitates fairly frequent calibration in some applications.

Phototubes. Photoemissive transducers are of two general types, gas or high-vacuum diodes and multiplier phototubes.

Gas and high-vacuum phototubes consist of a semi-cylindrical cathode of large area, on which a photosensitive substance is evaporated, and a wire anode coaxial with the cathode. With a positive potential on the anode, photoelectrons are emitted from the cathode and collected at the anode as a function of the wave length and intensity of the light illuminating the cathode. As the light on the



Giannini Bourdon-tube potentiometer pressure transducer has liquid-filled case to isolate mechanism from corrosive media and to provide damping against shock and vibration

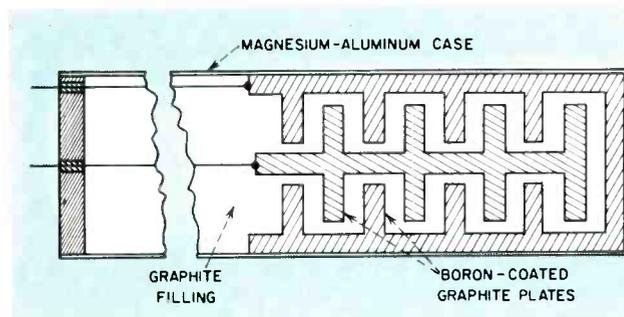


FIG. 11—Parallel circular-plate ionization chamber has boron-coated electrodes for detection of slow neutrons. Wire leads are of lead and are coated with quartz

cell varies, the current changes, causing a variation in the voltage drop across a load resistor in series with the cell.

By filling the glass envelope with an inert gas such as argon or neon, at a pressure of the order of 0.5 mm, the photocurrent for a given illumination intensity is greatly increased. Increasing the anode voltage of gas phototubes beyond a certain point causes photoelectrons traveling to the anode to ionize the gas molecules, releasing more electrons and producing an amplification effect. This gas amplification ratio is dependent on the incident-light flux in addition to the anode voltage. If amplification ratios of about 10 are reached a glow discharge usually takes place.

The ionization-deionization time of gas phototubes operating in gas-amplification regions causes an approximately 6-db drop in response at 10,000 cps relative to 800 cps.

Plate potentials of gas phototubes are required to be of the order of 100 volts d-c while high-vacuum tubes operate at about 250 volts. Both types have a maximum temperature limitation of 75 to 100 C.

To provide greater sensitivity, electrostatic electron multipliers or dynodes may be incorporated with the basic phototube. Multiplier phototubes are usually made with nine or 10 dynode stages, although any number is permissible. Each dynode is maintained at a potential from 50 to 150 volts more positive than the previous dynode. This multiplication process can increase sensitivity by about 500,000 compared to nonmultiplier phototubes. Final anode potentials of 1,000 to 3,000 volts are required.

Ionization Devices. Some transducing devices operate on the principle that a fast-moving charged particle will eject

an orbital electron from an atom if it approaches sufficiently close to the atom. Since the residue of the atom is a positively charged ion, the process is referred to as ionization and the incident particles as ionizing radiations. Utilizing this property, nuclear radiations can be measured by observing the resulting ionization when they pass through a medium such as a gas.

A typical instrument consists of a metal cylinder with a coaxial central electrode, in a gas-filled enclosure. The central electrode, the anode, is usually positive with respect to the outer electrode, the cathode. When an ionizing particle enters the gas between the electrodes, ions are formed and the positive ions are collected by the cathode and negative ions by the anode. Magnitude of the collected charge will depend on the number of initial ionizations and the voltage applied to the electrodes.

Variation of collected charge with the voltage between the electrodes is shown in Fig. 10. The characteristics vary in nature over the four voltage ranges shown in the graph.

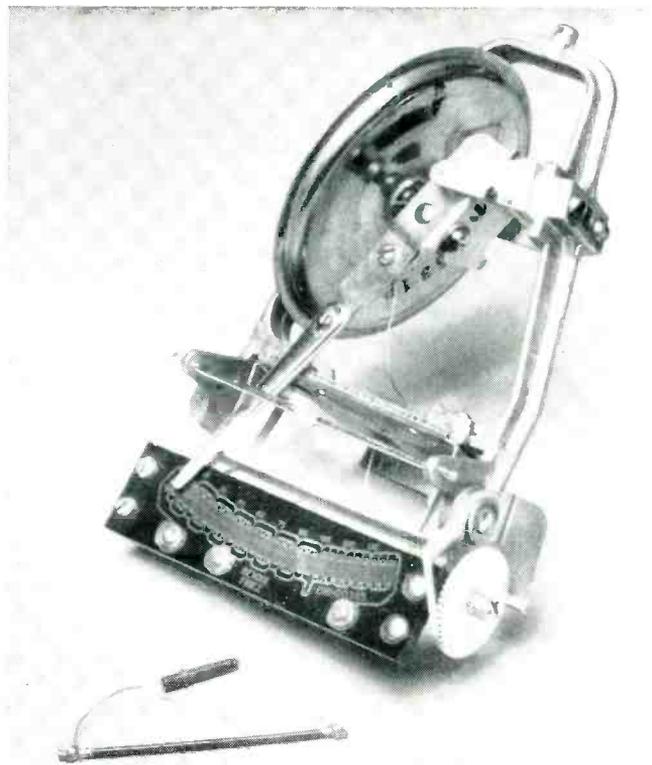
At very low voltages the ions move so slowly that many recombine before reaching the electrodes; charge collected increases with plate voltage. Increasing the voltage, a point is reached where the ions move sufficiently fast that they are all collected before they can recombine. Continuing to increase the applied voltage in this region will not increase the number of ions collected. When operating in this second region the device is called an ionization chamber. Such a chamber produces current pulses whose amplitude is proportional to the total amount of ionization in each ionizing event. Output pulses are usually of the order of 10^{-6} to 10^{-8} volts or fractions of microamperes and subsequent amplification is a necessity. By plotting the number and size of the ionizing events, the nature of the radiation can be inferred.

As the voltage applied to the electrodes is increased beyond the ionization-chamber region, the operation of the chamber enters the proportional-counter region. The proportional counter is similar to the ionization chamber except that the negative ions formed move sufficiently fast to cause secondary ionization in the gas. As a result the current pulses for bursts of radiation are larger, but proportional to the initial amount of ionization.

Increasing the electrode voltage still further causes the device to operate in the Geiger region. Geiger counters give an output pulse of constant width and amplitude for each radiation particle regardless of the number of electrons formed in the initial ionizing event.

Table V—Thermocouple Characteristics

Element	Operating Range in centigrade	Output at 100 C and 0 C in mv
Copper and constantan	-200 to +400	4.3
Iron and constantan	-100 to +300	5.4
Chromel and Alumel	0 to +1,200	4.1
Platinum and platinum-rhodium	+500 to +1,400	0.643



Transducer elements of radiosonde include, from top to bottom, barometer for altitude, thermistor for temperature and lithium-chloride coated plastic sheet for humidity measurements

Geiger-Muller tubes are usually operated with a potential of 1,000 to 2,000 volts. Depending on this voltage, the output pulses may be as high as 100 volts, permitting the output to be used directly without subsequent amplification.

In all of the ionization devices discussed, resolution of number of radiation particles is limited by the recovery time of the gas used. For argon, which is usually employed in Geiger counters, there is a dead time of 100 to 200 microseconds while the gas deionizes. This limits resolution for argon devices to 10,000 particles per second. Alcohol vapor is sometimes added to argon in Geiger counters to shorten the discharge recovery time. Resolving times of ionization chambers or proportional counters are about 200 times less than that of Geiger counters.

All of the devices discussed are sensitive to ionizing radiations such as gamma rays, cosmic rays and alpha and beta particles. Neutrons, however, do not cause ionization because they carry no charge. By using a gas such as boron trifluoride, or by using boron-coated electrodes, as shown in Fig. 11, impinging slow neutrons knock alpha particles out of the boron and the alpha particles produce the necessary ionization. For fast-neutron detection, hydrogen is used instead of boron trifluoride.

Pulse counting rates of the order of thousands per second, from the various radiation measuring devices, are not unusual. Consequently, scaling circuits are used to count down the number of pulses detected. Count-down scales of 32, 64 and 128 are common.

The property of phosphor materials to fluoresce or scintillate, employed in conjunction with multiplier phototubes, is another important method of detecting ionizing radiation. Gamma rays or other ionizing radiations bombarding a phosphor such as anthracene, sodium iodide or naphthalene produce flashes of light. These light flashes are picked up and amplified by the

phototube by a factor of 10^6 or more.

Scintillation counters are particularly noted for their high efficiency, counting rate and accuracy. They do, however, have a relatively high thermal noise level. Lifetimes of excited atomic states are about 10^{-8} sec and the light flashes and recovery times are corresponding short in duration (Table IV). Since the phototube output pulses are proportional to the energy of the particles causing the ionizing events, these counters are used to determine both the energy and number of the ionizing particles or photons.

Scintillation counters are usually used to measure or detect weak gamma radiation. By using phosphor containing lithium, they can be used to measure slow neutrons.

Thermoelectric Devices. Thermocouples operate on the thermoelectric principle that two wires of metals with different work functions and in physical contact at both ends will generate a circulating current if one junction is at a temperature different from the other. The value of this current will be proportionate to the temperature differential, the work-function differential of the wires and the circuit resistance.

Typical wire combinations are copper-constantin, chromel-alumel, platinum-platinum rhodium and iron-constantin. Temperature operating ranges and output voltages of these combinations are listed in Table V. Though the current may reach relatively high values, output voltage of such devices is usually limited to several microvolts.

Thermocouples are particularly suitable for measuring temperatures in localized areas. They can be securely welded to the surface under measurement, providing good transfer characteristics over the area of the weld. Average response times are such that transient temperatures of the order of 0.1 second may be measured.

Magnetic Transducers. These devices may be classified in two general categories, variable reluctance devices and emf-generating devices.

Variable-reluctance transducers usually consist of one or more coils and a core. By fixing either the coil or the core and moving the other, the length of the magnetic path through which flux linkages pass will be made to vary. These changes in magnetic path result in varying magnetic reluctance and in turn varying electrical inductance.

A typical differential transformer consists of a concentrically wound transformer with one primary winding and two secondary windings connected in series opposition. The relative magnetic linkage between the a-c excited primary and the secondary output windings is varied by changing the position of a ferromagnetic core. The output voltage is proportional to the mechanical displacement of the core, which is made a function of the quantity being measured. Its phase leads or lags the input current by a maximum of 90 degrees, depending on the displacement.

Differential transformers are usually used with excitation frequencies of 60 to 20,000 cps at up to 12 volts input. Linearity of these units can be within 0.10 percent for full-scale core displacements of 0.025 to 0.800 inch. Output impedance is of the order of a few hundred ohms.

This type of transducer is used primarily with displacement-type elements such as floats, bellows, Bourdon tubes and diaphragms.

Another group of reluctance-type transducers are essentially rotating transformers. They are similar, in appearance and construction, to miniature wound-rotor induction motors. Either the rotor or stator winding is a-c excited. The other winding then produces an output voltage which is a function of the input shaft angle and sealed to the input voltage.

These devices are analogous to resistance potentiom-

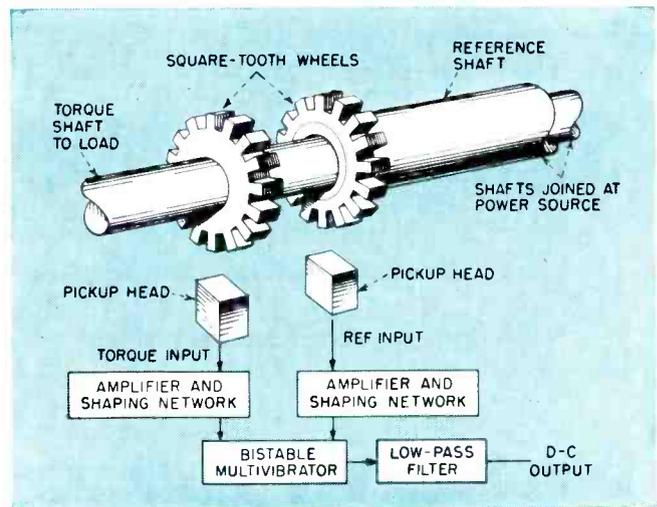


FIG. 12—Phase shift between signals from two pickup heads is proportional to amount of twist between torque-carrying shaft and reference shaft and gives indication of dynamic torque

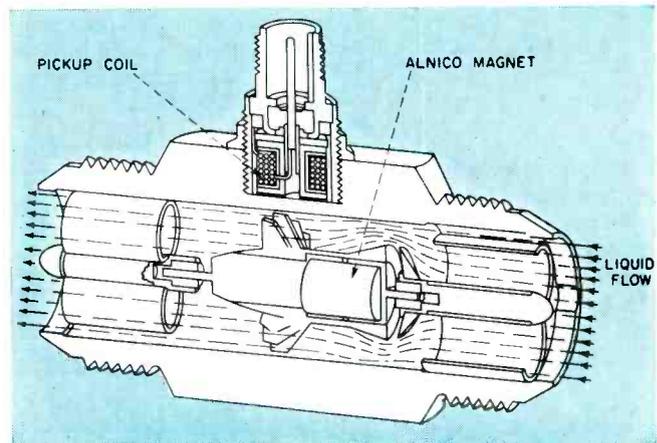


FIG. 13—Permanent magnet in hub of hydraulically suspended Potter flow meter induces signal in pickup coil. Signal frequency is proportional to flow rate; total pulses are proportional to total flow

eters. Life expectancy is high—over 10^6 cycles. Lack of a wiper eliminates contact bounce and permits speeds of 1,500 rpm. Resolution is infinite. Also, unlike resistive units, induction units have isolated input and output.

Other variable reluctance devices consist essentially of different variations of ferromagnetic-core inductors. These devices can produce as much as ± 20 percent change of the initial inductance. They can be used with a-c bridges or used directly as frequency-determining elements in L-C f-m subcarrier oscillators.

EMF Generators. Generator types of transducers are usually characterized by a coil or conductor cutting across the lines of flux of the magnetic fields causing a voltage to be induced in the coil. Conversely, the conductors may be kept stationary and the lines of flux of the magnetic field moved. Output voltage is dependent on the number of conductors, the rate at which they cut the magnetic field and the field's strength.

One type of generator transducer consists of a permanent magnet on which is wound a pickup coil. Passing magnetic objects near the unit distorts the magnetic field and generates a voltage proportionate to the rate of motion of the objects. This principle of operation is utilized in the dynamic-torque transducer of Fig. 12 and the flow-rate meter shown in Fig. 13.

Signaling Methods

Means for sending data depend upon the transmission medium. When wire lines are available, signaling systems may be simple. More complex data call for frequency or time sharing of facilities. Radio systems depend upon available channels and type of modulation must include noise discriminating ability

INDUSTRIAL devices for transmission of data usually operate over short distances where two or more wires can be economically furnished. When several types of data must be transmitted to any distance simultaneously, electronic systems are frequently required and the original elements may become a part of the new system.

Bridge Circuit. An elementary bridge system for which a diagram is shown in Fig. 14 requires a source of constant potential and two potentiometers, one of which is moved by the measurand. Manual adjustment of the receiver potentiometer for galvanometer null gives the measurement according to a previously calibrated scale. The

bridge has two arms at the transmitter and two at the receiver. Off-null galvanometer current can be used to control the rotation of a motor or clutch system so the proper scale reading is shown automatically and continuously. The transmitter arms of the bridge need not comprise a simple potentiometer. One arm AB can be a fixed resistor and the other BC a resistance thermometer. As resistance changes with temperature, unbalance causes the pointer to show temperature on the scale.

Dial Position. Direct indication of a dial position is possible by several means. Developments of ferromagnetic and permanent magnet materials have made practicable the construction of so-called d-c synchros. As shown in Fig. 15A, a tapered resistance bridge with two fixed and four sliding connections is connected to a motor-type device with two sets of paired series windings. Rotation of the bridge assembly results in rotation of the effective field.

The commonly used a-c synchro is shown at (B). Movement of the rotor relative to the stator windings results in corresponding movement of the receiving rotor. Use of a common power line for both rotors effectively reduces the control lines to three.

Another stepless positioner, directly adapted to transmission by radio or carrier uses the position-seeking tendency of a two-phase motor in which one of the windings is controlled by a series tuned circuit. If the motor is mechanically coupled to one of the elements, as the inductor in (C), the motor will automatically tune to line frequency and an indicator attached to the shaft will assume an appropriate position.

Such a remote-reading indicator can be actuated by a similar tuned circuit controlling a servomotor. In this case, the motor is coupled to an audio oscillator that furnishes the line voltage. Thus, changing the tuning by moving the position transmitter varies the line voltage. This change is automatically followed by the receiver.

Frequency Variation. A variable frequency system, of which the elements are shown in Fig. 16A, was in operation in the power field at an early date. As originally used, the transmitter was connected to the receiver by a wire line. Later systems transmit the data by carrier current or microwave link. The carrier equipment is indicated.

In the transmitter, a small variable capacitor is mechanically attached to the shaft of the instrument to be telemetered. Movement of the shaft then changes the frequency of the variable oscillator, which may be well above the audio range in order to employ small, lightweight com-

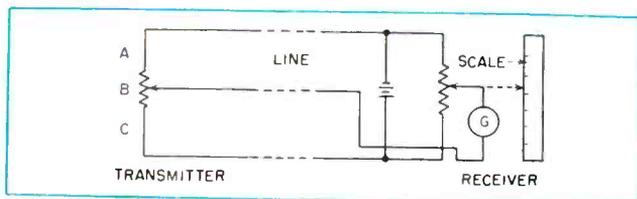


FIG. 14—Elementary bridge system requires manual operation at receiver but is easily adapted to servo balancing control

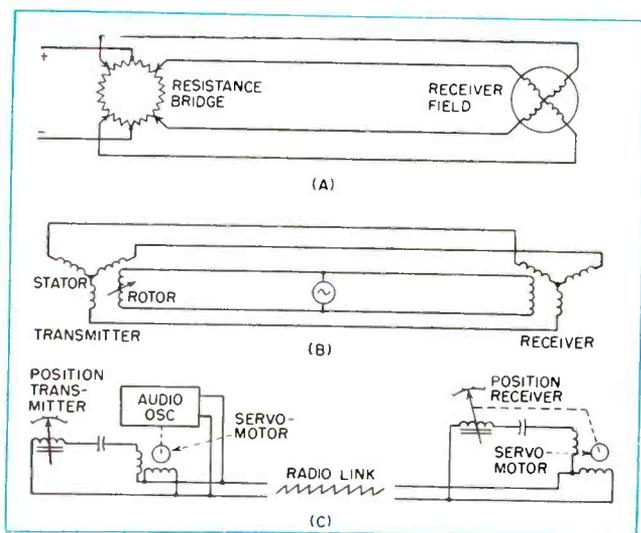


FIG. 15—Remote dial reading systems. So-called d-c synchro (A), conventional a-c synchro (B), and tuned audio system (C)

ponents that will have minimum effect on the shaft.

Mixing this frequency with output from a fixed oscillator that produces a frequency of the same magnitude is effected in the beat detector. A more usable low frequency is thereby produced.

Output from the beat detector can be fed through a wire line (as shown by the alternate dashed connection) to an amplifier and a meter calibrated in terms of the quantity to be measured.

The output can also be used to modulate a transmitter coupled through high voltage capacitors to the power line. One or more receiving units can be attached at other points along the line. Losses occurring from phase-to-phase coupling and phase-to-ground coupling attenuate the signals.

A frequency system used by Control Corp., shown in Fig. 16B, uses two frequencies somewhat in the manner of a bridge, in that two variable capacitors are in effect used at the transmitter. As the capacitance of one increases, that of the other decreases. By this means, the reaction on the measuring instrument is minimized.

Output from two oscillators is heterodyned and the desired combination from the converter is selected with a low-pass filter. After modulation and transmission to the receiver, the incoming frequency is again heterodyned with a fixed frequency, filtered and appropriately displayed on a frequency meter calibrated in terms of the measurand.

Cam Type. An impulse-duration telemeter suitable for slow-speed data is shown in Fig. 17. A signal is transmitted every twelve seconds. This principle is used in equipment manufactured by the Foxboro Co. The contactor shown at the left has two degrees of freedom. It can be positioned around its axis by the motion of a pickup. It normally rides on the back surface of the cam, during which time a switch is closed. The cam rotates in the direction shown at 5 rpm.

As the cam rotates, the contactor is off the cam for a portion of each cycle, depending upon its position in relation to the cam axis. Because the position is determined by the measuring element, the time during which the contactor is off the cam is proportional to the measurement. The switch is thus closed for a period proportional to the measurement.

At the receiver, a similar cam is motor driven in synchronism. When the transmitter is energized, relay K_1 closes and connects one side of the up winding for the reversible motor, assuming that the receiver cam switch is open. Its contactor is likewise movable and is positioned by the reversible motor.

By using a clamping mechanism, the contactor is allowed to move only during a short reset period at the beginning of each cycle. When the contactor is off the receiver cam K_2 , operating the other coil (down) is energized providing the transmitter switch is open.

When both transmitter and receiver switches are closed or open simultaneously, neither motor coil is energized and the pointer does not move. Two telemetering systems for power and water-level data, shown in Fig. 18, are manufactured by General Electric. Only the elements of the systems are described here.

The transmitter for a-c measurements is shown at the left of (A). A watt-hour mechanism is used to translate the a-c electrical quantity into a varying rotational speed. A light-modulating disk is mounted on the shaft of the watt-hour meter. The serrated edge of the disk (shown in the drawing as a series of holes) interrupts the light falling on a phototube. The disk is shaped so that phototube output varies sinusoidally with time.

Table VI—Subcarrier Bands

Band	Subcarrier Band		Upper limit in cps	Deviation in percent	Intell freq in cps	Nominal Maximum
	Lower limit in cps	Center freq in cps				
1	370	400	430	± 7.5	6	30
2	518	560	602	± 7.5	8	40
3	675	730	785	± 7.5	11	55
4	888	960	1,032	± 7.5	14	70
5	1,202	1,300	1,398	± 7.5	20	100
6	1,572	1,700	1,828	± 7.5	25	125
7	2,127	2,300	2,473	± 7.5	35	175
8	2,775	3,000	3,225	± 7.5	45	255
9	3,607	3,900	4,193	± 7.5	60	300
10	4,995	5,400	5,805	± 7.5	80	400
11	6,799	7,350	7,901	± 7.5	110	550
12	9,712	10,500	11,288	± 7.5	160	800
13	13,412	14,500	15,588	± 7.5	220	1,100
14	20,350	22,000	23,650	± 7.5	330	1,650
15	27,750	30,000	32,250	± 7.5	450	2,250
16	37,000	40,000	43,000	± 7.5	600	3,000
17	48,560	52,500	56,440	± 7.5	790	3,950
18	64,750	70,000	75,250	± 7.5	1,050	5,250
Optional Bands						
A.	18,700	22,000	25,300	±15	660	3,300
B.	25,500	30,000	34,500	±15	900	4,500
C.	34,000	40,000	46,000	±15	1,200	6,000
D.	44,620	52,500	60,380	±15	1,600	8,000
E.	59,500	70,000	80,500	±15	2,100	10,500

These bands can be used by omitting adjacent bands

There is a 21-cycle range, between 6 and 27 cps, from minimum to maximum input. The cathode follower reduces output impedance of the phototube to avoid extraneous a-c pickup. The following amplifier provides sufficient output to operate radio or carrier equipment.

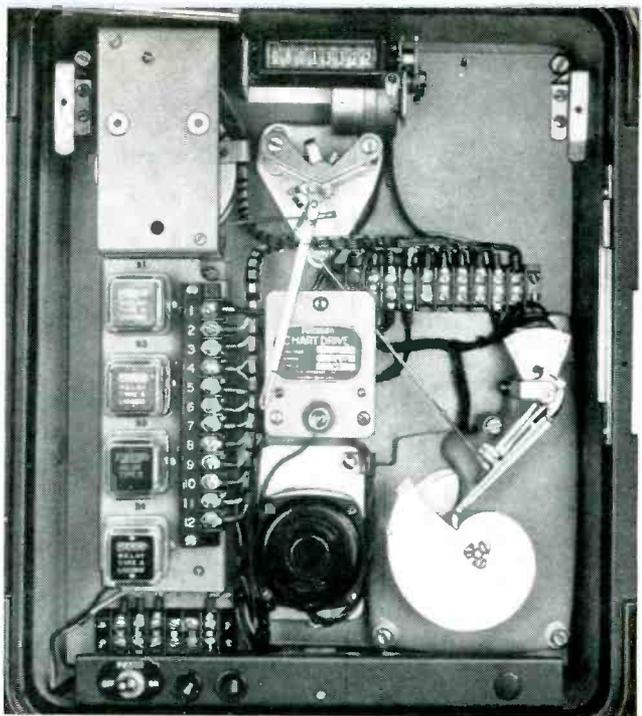
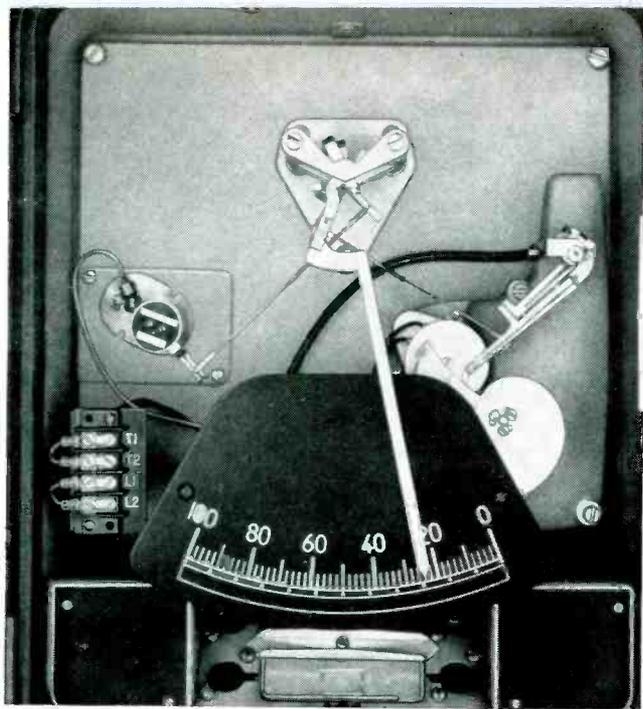
Zero indication is accomplished using a constant-torque element driven from a constant-voltage transformer. This torque adds directly to that of the primary detector. When there is no output to the primary detector, the constant torque causes the light modulating disk to revolve at such speed as to result in 6-cps output.

At the receiver (right) the signal goes through a low-pass filter that attenuates all frequencies above 27 cps. Square-wave input to a saturating transformer is provided with a limiter, inverter and power amplifier. Transformer output is a square-wave pulse of constant energy content. Rectification of the pulses gives a d-c output through a constant-resistance load that varies with the input frequency.

The end device is an indicating or recording milliammeter with the scale graduated in units of the measurand. Since zero reading is actually determined by the constant-torque 6-cps output from the transmitter, a failure of the system results in a below-zero indication. Alternatively, the subzero reading can be used for special signaling purposes.

The transmitter (B) used for d-c measurements converts a millivolt or milliamperere signal into the conventional 6 to 27-cps frequency range. Input, reference and feedback signals are applied to a sensitive galvanometer system that detects any unbalance. If the galvanometer mirror is deflected, a beam of light is reflected onto the cathode surfaces of a double phototube with its sections connected in series.

This phototube is one element of a relaxation oscillator



This telemeter transmitter (left) uses a cam to transmit the temperature pickup reading. The receiver (right) has a reversible motor that moves in either direction or remains motionless. A pen is attached to the drive

that operates over the range from 12 to 54 cps. Its output is amplified through both grids of a double-triode tube that functions as a bistable multivibrator. In this circuit, the frequency is halved and the output at 6 to 27 cps is connected through output amplifiers.

Tone Combinations. Data is frequently sent by audio tones, either singly or in combination. One system manufactured by Motorola uses two pulses of two tones each. Each pulse takes about 0.75 second with a delay of 0.2 second between the end of the first and the beginning of the second. Such systems are used in communications work for selective calling of mobile vehicles or aircraft. Tones are also used in the control of oil pipe lines. For purely data purposes they are needed in the remote operation of broadcast stations. The Federal Communications Commission provides that continuous measurement be made of frequency and modulation characteristics.

Missile Systems. Military telemetering in current use tends towards either pwm/f-m or f-m/f-m. They are both

capable of handling several data channels. Pulse-width modulation of a frequency-modulated carrier (pwm/f-m) is a time-sharing system. As such it has limitations in accuracy for fast-changing information. Frequency-modulating one or more subcarriers of a frequency-modulated transmitter (f-m/f-m) provides instantaneous continuous presentation of several data channels. It is likely, however, to be more prodigal of bandwidth.

The principles of the two systems are shown in Fig. 19. The pwm/f-m system provides from 30 to 90 channels with frequency response up to about 2 cps. The composite signal resulting from the commutation is a series of pulses on an f-m carrier. The width of the pulse is analogous to the measurand. The system automatically corrects each revolution measuring zero and full scale.

F-M/F-M System. Current standards permit as many as 18 frequency multiplexed subcarriers from 400 cps to 70 kc. The telemetry standards in Table VI show that each subcarrier can be modulated ± 7.5 percent. The higher channels can be modulated ± 15 percent if alternate

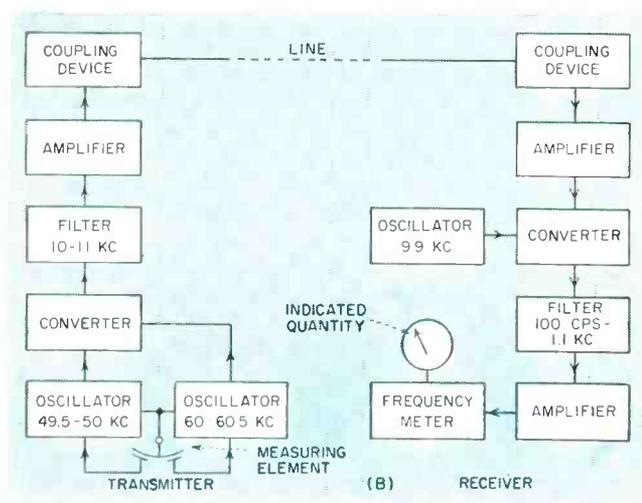
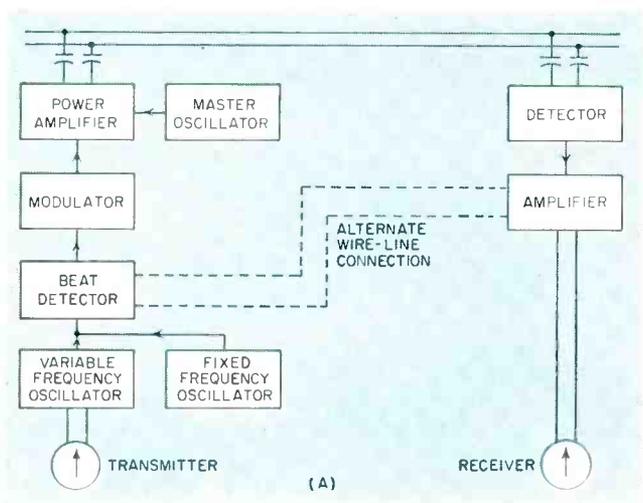


FIG. 16—Frequency telemetering system depends upon transmission of audio tone (A). Variation of the system uses two oscillators whose frequencies are varied in opposite directions (B)

channels are omitted. Limiting accuracy in the f-m/f-m system is the frequency stability of the subcarrier oscillator.

There are other modulation systems possible and some of them have been used. Pulse amplitude modulation of an f-m carrier (pam/f-m) permits the output of a high-speed switch to frequency modulate an f-m transmitter directly. This permits telemetering a large number of channels with a frequency response in excess of that using present time-multiplexed systems. It would allow sampling each of 100 channels 500 times a second for a channel response of better than 100 cps. Such a system could combine the frequency capability of f-m with the automatic error correction of any time-multiplexed system.

Pulse Code. High accuracy could be obtained from a pulse code system in which the transducer output is translated into a binary code and thus transmitted. Data could be presented at the ground station in either analog or convenient binary form for processing.

At the present time, equipment light enough for either missile or general aircraft use by which data could be encoded in binary form is not in general use, although a system has been developed by engineers of Radiation, Inc.

Modulation Systems. Various types of modulation are shown in Fig. 20 and their characteristics of bandwidth and signal-noise ratio are shown in Fig. 21.

Telemetering uses a radio-frequency band between 216 and 235 mc. The specific carrier frequency will usually depend upon the facilities of a government test range

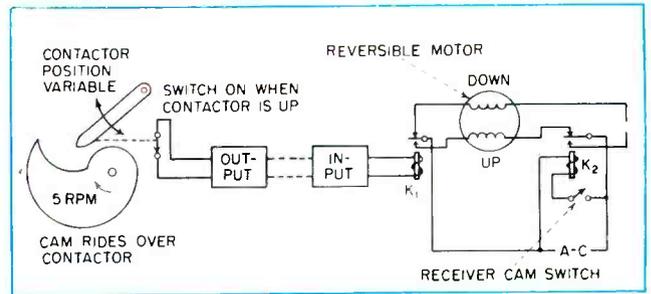


FIG. 17—Position of mechanical contactor arm relative to rotating cam is compared with a similar cam that controls direction of rotation of motor to move receiver dial in the Foxboro telemeter

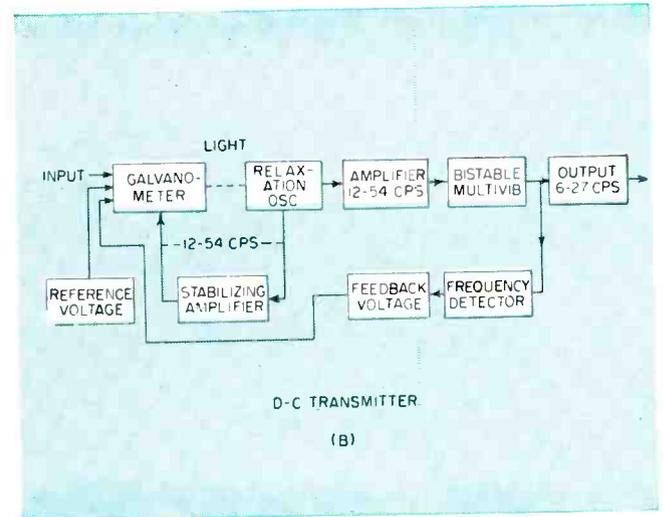
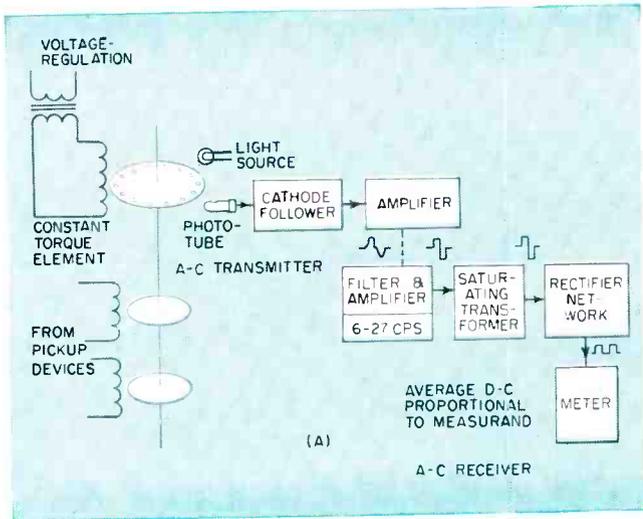


FIG. 18—Power-line telemetering system sends low-frequency pulses derived from rotation of disk between light and phototube caused by variation in a-c parameters (A). Information derived from d-c is transmitted by equipment (B)

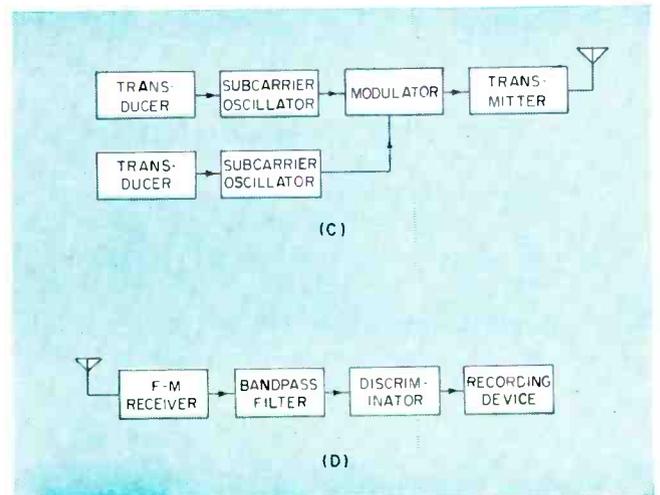
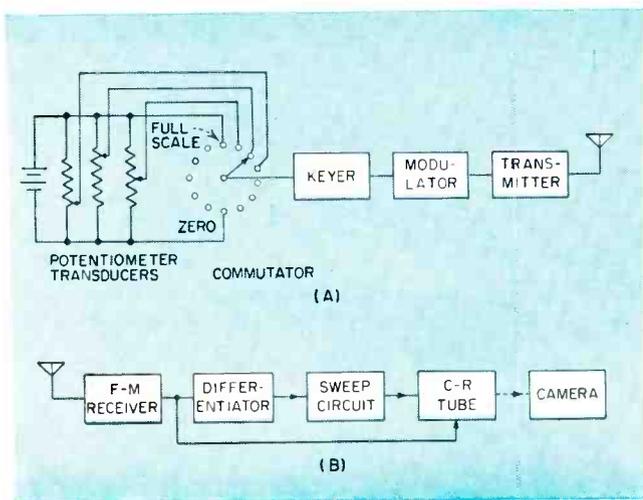


FIG. 19—Basis of pulse-width modulation of a frequency modulated carrier (pwm/f-m) transmitter (A) and receiver (B). Two-channel f-m/f-m transmitter (C) and receiver (D)

Table VII—Bandwidth and Noise

MODULATION METHOD	TRANSMISSION BANDWIDTH	SIGNAL-NOISE
AMPLITUDE (a-m) double sideband and carrier single sideband and carrier single sideband	$2 f_m$ f_m Δf_m	$(S/N)f_m = (C/N)f_t$
FREQUENCY (f-m) wideband ($f_m < f_d$) narrowband ($f_m > f_d$) frequency shift—Usually at least the third harmonic of the keying frequency f_k must be transmitted, thus $f_m = 3 f_k$, using this value of f_m see above	$2 f_d$ $2 f_m$	$(S/N)f_m = \sqrt{3} (C/N)f_t (f_d/f_m)$
PHASE (p-m) double sideband and carrier $m_p < 60^\circ$ $m_p > 60^\circ$ single sideband and carrier $m_p < 60^\circ$	$2 f_m$ Required transmission bandwidth increases greatly as depth of modulation is increased beyond about 60 degrees f_m	$(S/N)f_m = \phi (C/N)f_t$
PULSE height..... (phm) width..... (pwm) rate..... (prm) number..... (pnm) displacement... (pdm) (pulse displaced either in position or time)	Depends on repetition rate, wave-shape, and duration of pulse: for approximations use $2/t_p$ where if t_p is duration of pulse in microseconds, transmitted bandwidth is in megacycles per second	$(S/N)f_m = m_w t_p (C/N)f_t$ $(S/N)f_m = t_m f_t (C/N)f_t$
PULSED amplitude (pam) frequency (pfm) phase (ppm)	$8 f_m$	Inferior to unpulsed modulations of like type unless pulse rate is very high and transmitted bandwidth is very wide

$(C/N)f_t$ is ratio of peak carrier to peak fluctuation noise in transmission channel f_t cycles per second wide.

$(S/N)f_m$ is ratio of peak signal in output channel to peak noise (due to fluctuation noise) in output channel f_m cycles per second wide.

f_d is maximum deviation frequency of frequency-modulated carrier in cycles per second.

f_m is maximum frequency component in modulating wave in cycles per second.

f_t is frequency bandwidth that is transmitted; that is, it is the bandwidth of the modulated carrier that is passed by the system.

Δf_m is frequency interval between lowest and highest frequency components in modulating wave.

m_p is maximum deviation angle of phase-modulated carrier in degrees.

m_w is maximum width modulation factor for pulse width modulation.

t_m is pulse displacement produced by pulse modulation, in seconds.

t_p is duration of transmitted pulse in seconds, for frequency in cycles per second.

ϕ is peak phase deviation in radians of phase-modulated carrier.

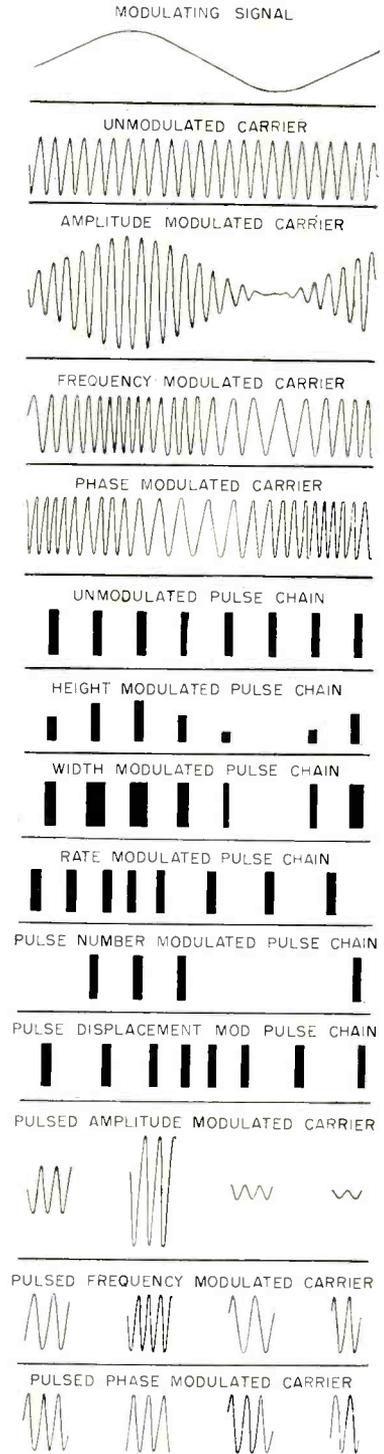


FIG. 20—Comparison of various types of modulation useful in telemetering data

and the bandwidth of the information to be transmitted.

Beacon Telemetry. The data transmitting set illustrated, built by Stavid Engineering, is a subminiaturized airborne unit that operates in conjunction with a radio beacon to telemeter data to the ground. The set provides an instrumentation facility that is supplementary to the normal ground-radar tracking of rocket-propelled missiles. The system utilizes the existing r-f link between beacon and radar as an information path.

This ppm telemetering set has a data capacity of ten channels at a maximum sample rate, for each, of 100 per second. Integral pickup and data conversion circuits are included to measure temperature, vibration amplitude, vibration frequency, the radio beacon peak power output, B+ voltage and filament voltage.

The unit, developed for the U. S. Army Signal Corps, contains the system multiplexing and pulse-position modulation circuits for handling nine 0 to 5-volt d-c input data signals and one 6 to 7-volt d-c synchronization signal.

Subcarrier Discriminator. One type of receiver output device is shown in Fig. 22. Units of this type are used to produce useful output from the f-m subcarrier.

Industrial PCM. At least two manufacturers (Bendix Pacific and Vapor Recovery Systems) employ variations of

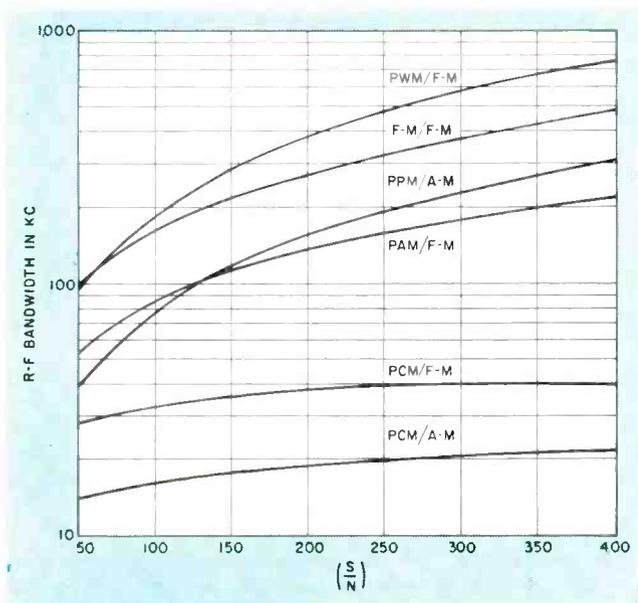


FIG. 21—Pulse-code signaling systems compared with other types on the basis of signal-noise ratio and bandwidth



Signal Corps telemetering unit designed by Stavid Engineering
Subcarrier discriminator built by Electro-Mechanical Research (right)

Table VIII—Decimal and Binary Numbers

Decimal	Natural Binary	Minimum Error
0	000	000
1	001	001
2	010	011
3	011	010
4	100	110
5	101	111
6	110	101
7	111	100

pulse-code modulation in industrial data transmission systems. In one, a circular dial calibrated in degrees is moved relative to a pointer. At the receiving end a similar dial is caused to be illuminated at the proper angle. Alternatively, a 120-lamp matrix and switching circuit gives direct readout of the appropriate number.

The actuating dial is connected to a commutator disk on which ride seven brushes. The commutator segments take the form of a minimum error or Gray binary code. Depending upon the segments contacted, anywhere from one to seven audio tones are transmitted to the receiving decoder. Signaling is essentially an on-off function comparable to teleprinter coding.

The minimum-error or reflected binary code differs from the natural binary code as shown by the example given in Table VIII. The rearrangement of the binary numbers has the advantage that adjacent binary numbers differ by only one digit. Coding errors resulting from mechanical imperfections in the coding device are thus greatly reduced.

Fluid Measurement. A system employed by Varec, while essentially the same in that it employs pulse-code modulation, differs in many details. It is designed primarily to telemeter liquid level readings accurate to the nearest $\frac{1}{8}$ inch. Transmission of the binary code indications is somewhat unconventional in that instead of marks and spaces (like the teleprinter) the system uses dots and dashes. A dot represents an off and a dash an on pulse.

The binary code wheels are set up through appropriate gearing to be rotated by a float. The disk in Fig. 23A is used to send inches and fractions while that at (B) sends feet and tens of feet. Brushes bearing against the code disks are connected to commutator segments on another disk that encodes the dots and dashes.

As the propelling motor is called upon by the receiving station to send out the code, a pair of brushes contact



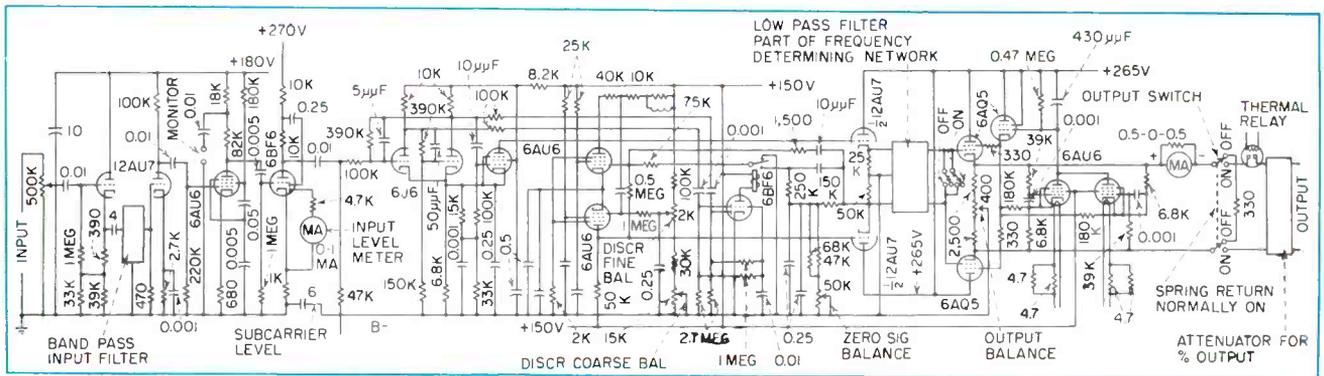


FIG. 22—Circuit diagram of linear multivibrator type of subcarrier discriminator. Plug-in filters permit use on any of the standard channels. Output limiting circuit protects the load (such as recording galvanometer) if output becomes unbalanced in excess of ± 150 percent full scale

circles of short and long conducting segments. In any case, the short-time contacts are made and sent out. If the binary code disk brushes associated with the commutator segments are making contact, a dash is sent out instead, by extending the time otherwise sent as a dot. An ancillary dial circuit allows selection of the desired tank. **Project Vanguard.** In the research program planned for the International Geophysical Year is exploration of the region 200 to 300 miles above the earth. To obtain information for a period longer than that usually afforded by use of a rocket, it is proposed to cause an earth satellite to orbit around the earth at a velocity of some 18,000 miles an hour.

Present plans call for the first instrumental satellite to weigh 21.5 pounds. It will be a metallic sphere with a diameter of at least 20 inches. Among the phenomena it will observe are temperature and pressure, density, strength of the earth's magnetic field, ultraviolet spectrum



Receiving station for liquid level pulse code telemetering system

of the sun and cosmic radiation.

While a satellite of the size contemplated will be unable to transmit all these data, several could be observed and transmitted simultaneously or in sequence. To save battery power, it may be necessary to control data transmissions from the ground as indicated in Fig. 24, turning on the equipment during the time that signals can be received as the satellite makes a revolution around the earth once every 90 minutes.

Optical tracking using phototheodolites would be satisfactory and least expensive, except for the fact that the object will be hard to spot. In cloudy weather, even the favored periods previous to sunrise and after sunset will be useless. A miniature radio transmitter that radiates a signal to sensitive ground receivers will undoubtedly be employed.

The exact nature of the Minitrack equipment has not been revealed but the function of the radio links is shown in the drawing.

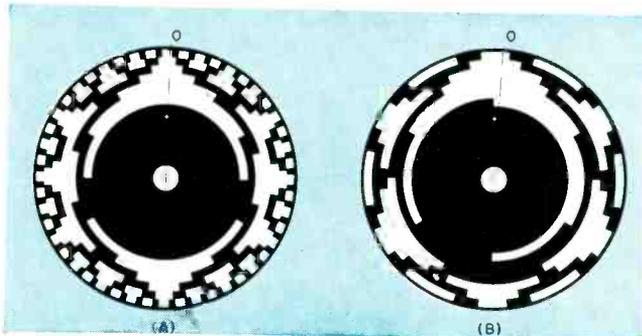


FIG. 23—Binary code disks used to sense fluid level and convert it to pulse code. Disk (A) measures inches and (B) measures feet

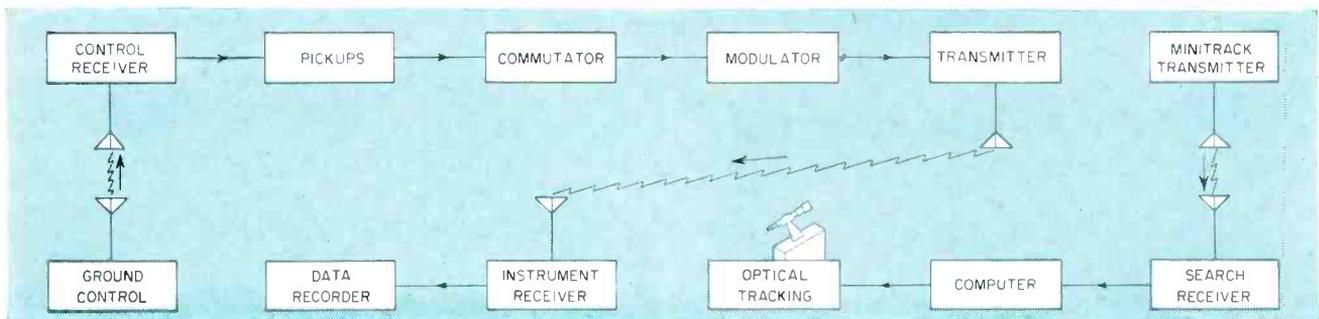


FIG. 24—Possible arrangement of tracking and telemetering equipment to observe phenomena between 200 and 300 miles above the earth from the Vanguard satellite on its orbit about the earth

Commutating Devices

Radio channels or wire lines can generally be used for more than one kind of information. If data characteristics are changing slowly, time sharing can be employed. Switches that connect the various measurands to the modulator may be mechanical, semiconductor or electron-tube devices

TIME SHARING of telemeter channels is possible if the data to be transmitted are changing slowly. Sampling temperatures in the free air with equipment lifted by a free balloon requires only a simple switching device. Recording the outputs of a large number of strain gages at the instant of impact will permit of no time sharing owing to the short-term nature of the phenomenon. Sufficient channels must be provided to transmit data for all the parameters.

It is a rule of thumb that ten points are necessary properly to identify a sine wave. By simple arithmetic it can be shown that as the frequency of the wave increases, the speed of the commutator must be raised. This rule also imposes an upper frequency limitation on commutator operation in practice.

There are multicontact, motor-driven rotary switches



Beam switching tube of a type being used in telemetering equipment

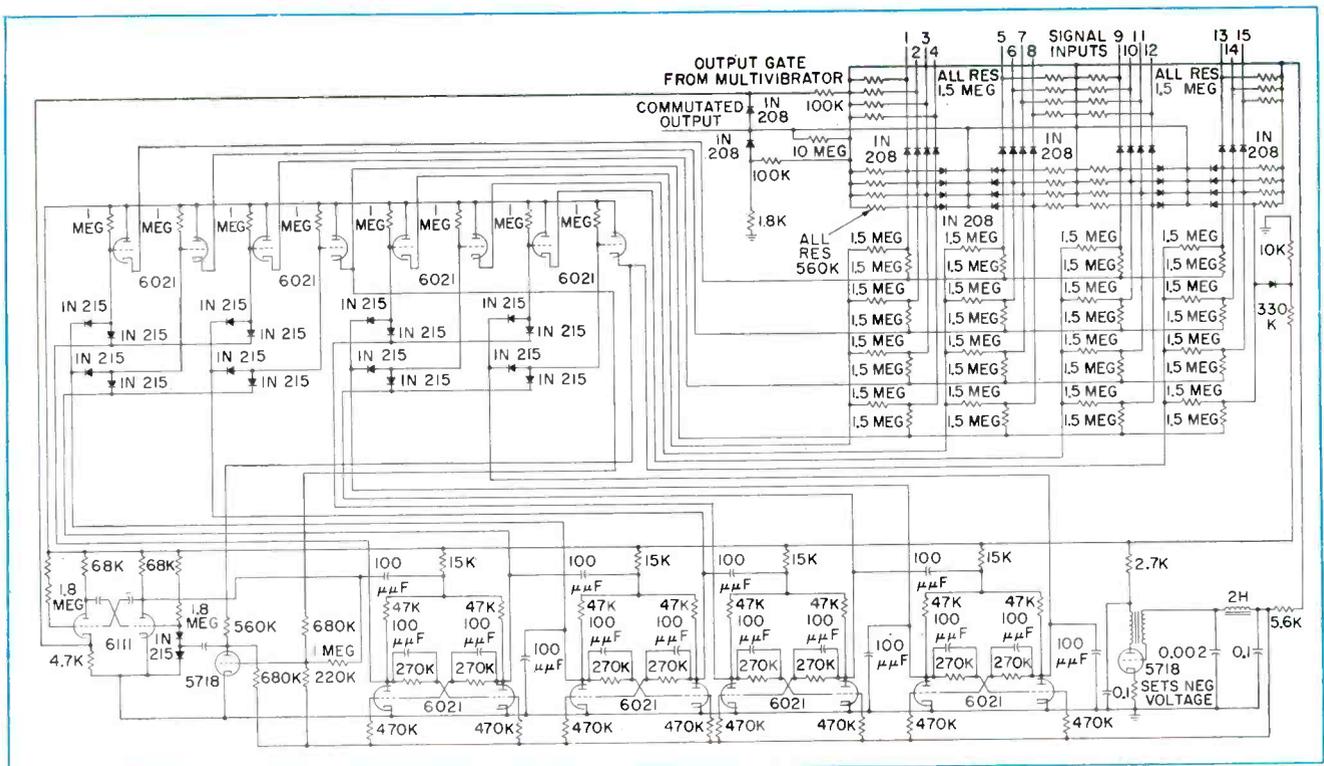


FIG. 25—Circuit diagram of an electronic commutator using tubes and diodes. Time sharing of radio-frequency channels is possible without use of rotating devices when fifteen channels are employed. Equipment is built by Electro-Mechanical Research



Baroswitch operated by the variation of atmospheric pressure in weather sounding radio telemeter switches the signal elements

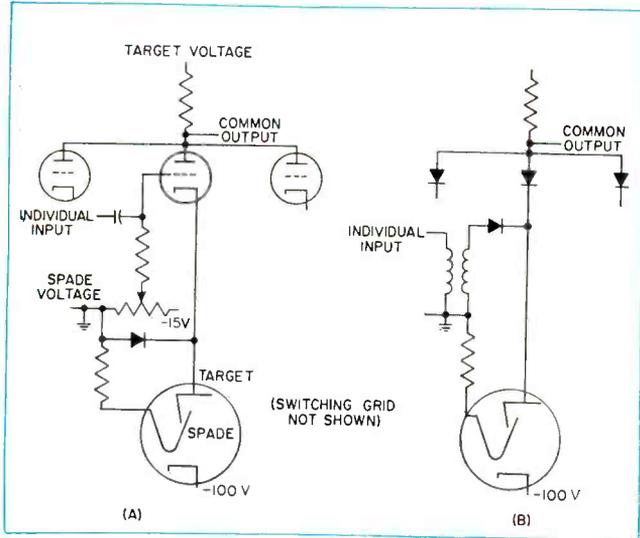


FIG. 26—Typical beam-gated sampling circuits using the Burroughs magnetron beam switching tube built by Haydu.

with standard sampling rates of 900 samples a second. The rate for a given channel is generally limited to about 20 per second (or a sine-wave frequency of 2 cps).

Diode Switches. Another approach, which involves no moving parts, is an electronic sampler handling 15 inputs. Using silicon diodes the switch samples as high as 15 kc and is basically able to go as high as 100 kc. One version of the device is shown in a photograph (circuit in Fig. 25).

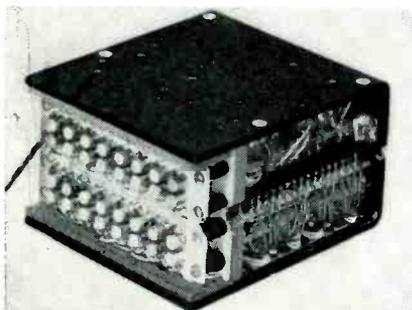
Tube Switches. Electron tube devices are being used in the field of military telemetering. One electron-beam tube, manufactured by Haydu Brothers, uses a switching grid, a spade and a target output plate as its basic electrodes. The switching grid is designed to initiate high-speed sequential switching without drawing current.

The two circuits in Fig. 26 show typical beam-gated sampling methods for switching a number of inputs to a common output. At (A) the cathode gated triode is normally cut off. The beam clamps the target to ground, turning the triode on with the same voltage across it each time.

The input at that position is the only one effective at the output. Positive clamping to ground permits individual grid bias position control.

If the inputs to be sampled are low impedance, the crystal diode gate circuit at (B) can be used. Isolation crystal diodes between circuits are necessary.

The sampling or commutating device in a modern weather radiosonde, Fig. 27, uses 150 segments of conducting metal alternating with insulating strips. An aneroid capsule moves the contacting brush. The circuit detail (B) is arranged for selective sampling such that humidity is switched on at low altitude.



Electronic commutator (left) uses 20 tube sections and 50 semiconductor diodes. Sampling switch built by General Devices (center) has three poles with 60 shorting channels for each pole. Unit at right, operating at 1,800 rpm, is used in ground tests

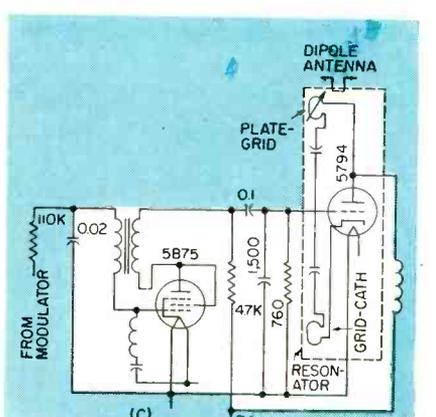
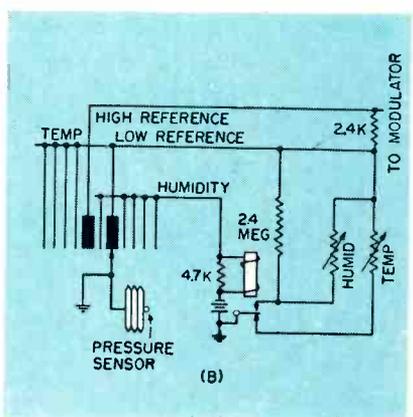
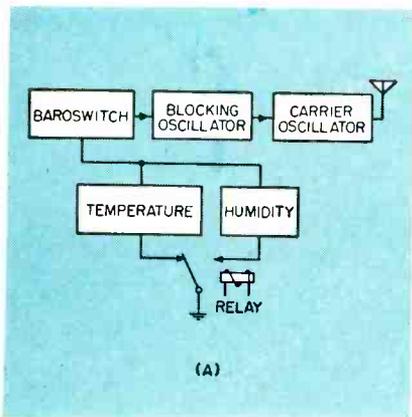


FIG. 27—Elements of a modern weather radiosonde (A) that show dependence upon the commutating system (B). Modulator and r-f transmitter shown at (C) transmit tones representing weather measurements

Output Indicators

At the receiving end of a telemetering system, the transmitted data are recorded in some form of information storage device — paper tape, magnetic tape, photographic film, punched cards — or displayed visually.

Recorded data are played back and processed as needed

QUITE OFTEN, incoming received signals are recorded initially on magnetic tape. The recorded information is then played back, processed and recorded again, usually on one of the various other recording mediums.

In time-division systems, the telemetered information is stored by recording the leading and trailing edges of the received pwm signal as positive and negative pulses on magnetic tape. The recorder playback circuits recreate the original rectangular wave at the output signal. The signal is applied to a data-reduction system, which decodes the original multiplexed signal into its components. These signals are then recorded on an oscillograph or other device. Analogously, in frequency-division systems, the received information is stored on magnetic tape in the form of a frequency-modulated signal. The playback signal is processed and recorded.

Magnetic-tape recorders are of two types, amplitude

modulated and frequency modulated. Amplitude-modulated recorders are similar to standard tape recorders except that frequency response is extended over a range of 100 to 100,000 cps by increasing the tape speed and using special head designs. In addition, special instrumentation is employed to minimize flutter and wow. Heads are available that will permit recording up to 28 different tracks, with an accuracy of 20 percent of full scale.

The overall bandwidth of f-m tape recorders is the same as that for a-m recorders. Accuracy, however, is about 2 percent of full scale. Individual tracks may be multiplexed to provide an even greater number of channels at the expense of limiting individual information channels to 0 to 5,000-cps frequency response.

Information from the data-reduction system is usually applied to a direct-writing oscillograph, galvanometer oscillograph, cathode-ray oscillograph or self-balancing

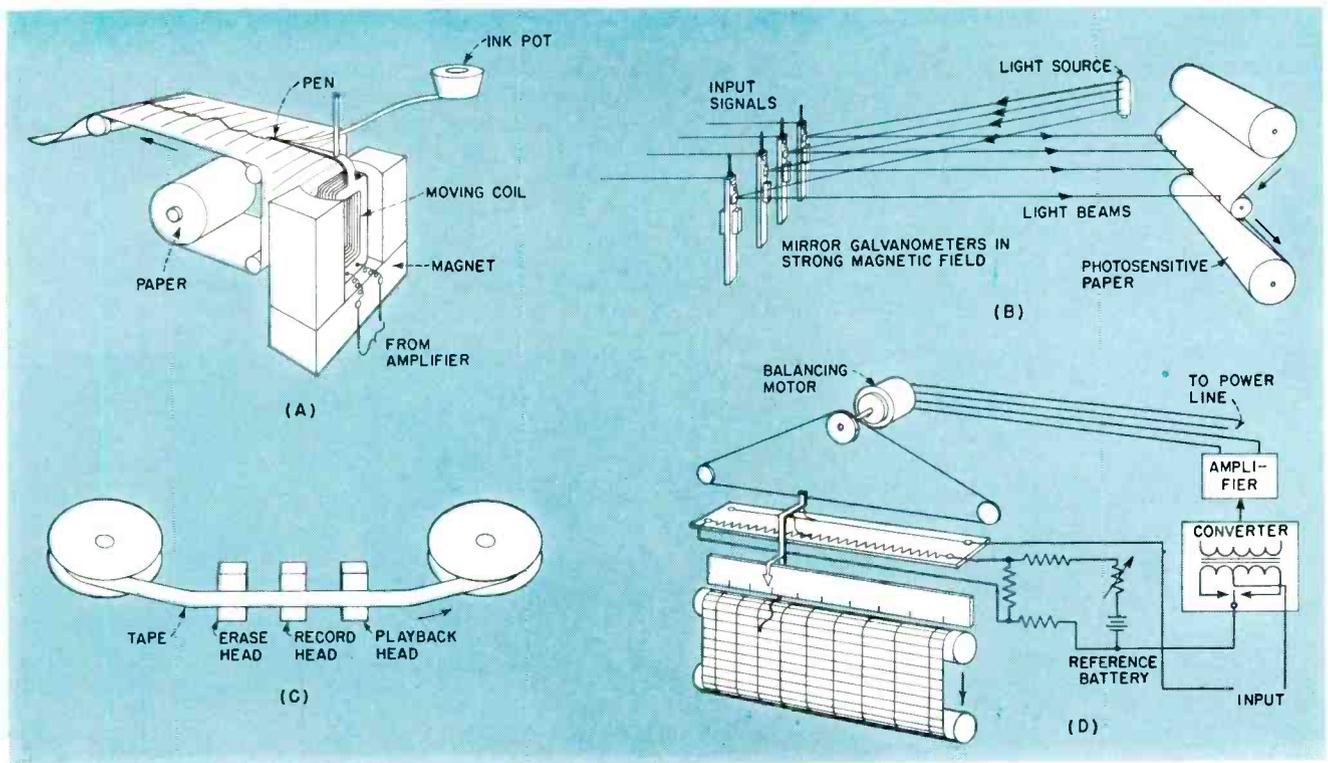
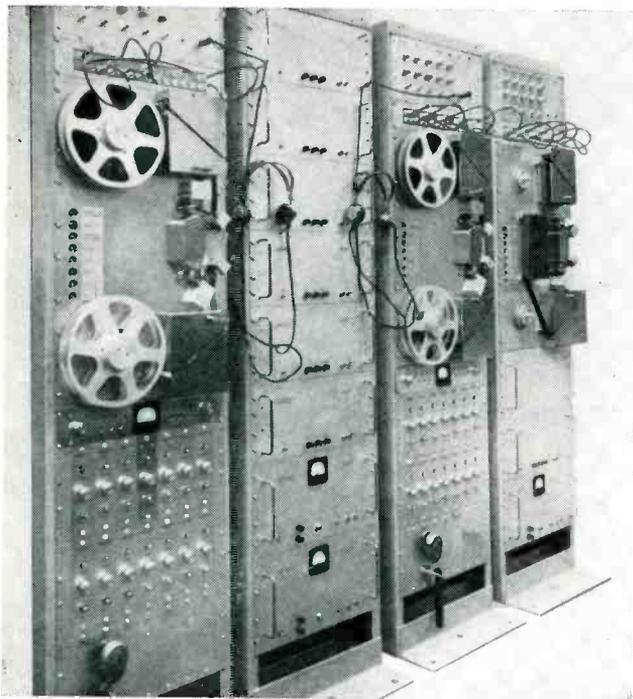


FIG. 28—Typical data recording devices include direct-writing oscillograph (A), galvanometer oscillograph (B), magnetic-tape recorder (C) and self-balancing recorder (D). Telemeter signals are usually stored on tape then played back, processed and recorded on one of other types of recorders. Information is processed as many times as necessary to get into desired final form



Double 14-track magnetic-tape data recorder system built by A-V Mfg. Corp. runs one machine while other is reloaded with tape. End machine reproduces loops for repetitive analysis. Tape speed is 60 ips

recorder. In choosing a recorder, factors such as sensitivity, input impedance, method of registration, cost, accuracy, coordinate system, linearity, resolution, response speed, drift stability and number of channels should be considered.

Oscillographs. Individual channels of direct-writing oscillographs consist of a pen moved across a paper tape by a D'Arsonval movement (Fig. 28A); the movement energized by an amplifier integral in the recorder. These devices can have up to six channels, each channel capable of 0 to 100 cps. response with 5-percent full-scale accuracy. Calibration is generally desirable shortly before use.

Each channel of a galvanometer oscillograph consists of a galvanometer movement to which a mirror is attached (Fig. 28B). The image of a light source is reflected from the mirror to a roll of photosensitive paper. Input signal variations cause the galvanometer movement and mirror to rotate, in turn causing the light beam of the mirror

to scan the photosensitive paper. These instruments are made with up to 48 separate channels; each channel capable of 0 to 8,000 cps frequency response with an approximate full-scale accuracy of 2 percent. Most instruments of this type have provision for interchanging galvanometers with widely varying characteristics.

Cathode-ray oscilloscopes can consist simply of a cathode-ray oscilloscope with a motion-picture camera attached to the screen. Accuracies of 5 to 10 percent and frequency response of 0 to 10 mc are available with these instruments. The number of channels is determined by electronic switching circuits and is usually limited to eight.

Null Recorder. Self-balancing recorders (Fig. 28D) compare the input signal, in a bridge circuit, with an internal reference signal. A servo system keeps the bridge balanced. When the bridge is unbalanced by a change of the signal being measured, the servo system rebalances the bridge moving the indicator arm. These recorders are usually limited to one or two channels per unit. Each channel is capable of 0.5 to 24 sec full-scale balance time with 0.25-percent full-scale accuracy. The amount of information handled per channel is sometimes increased by mechanically time-multiplexing the input signals.

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Also G. M. Giannini & Co., Inc.; Gulston Mfg. Corp.; Haydu Brothers of New Jersey; Naval Research Laboratory; Nems Clarke, Inc.; Research Division, New York University College of Engineering; Potter Aeronautical Co.; Radiation, Inc.; Radio Frequency Labs., Inc.; Raymond Rosen Engineering Products, Inc.; Statham Laboratories, Inc.; Stavid Engineering; Taller & Cooper, Inc.; The Vapor Recovery Systems, Inc.; Vitro Laboratories.



Indicating panel of power station has linear and circular self-balancing recorders to record steam-gas and air, feedwater and other temperatures on continuous basis



Data recorded on multitrack paper-tape oscillograph, at receiving end of telemetering link, is read off by engineering staff for subsequent interpretation and evaluation

Glossary of Telemetry Terms

(condensed from AIEE suggested terminology)

ACCELEROMETER—instrument that measures one or more components of acceleration.

ACCURACY—if an indicated or recorded value, is a measure of conformity to an accepted standard.

AMBIENT—surrounding medium.

AMBIENT CONDITIONS—such as pressure, temperature.

AMPLITUDE MODULATION—(a-m) conveys intelligence by varying the amplitude of a wave.

BAND—limited continuous region which is part of a more extended region. Used in connection with frequencies and pressures.

BANDWIDTH—extent of the band.

BAUD—a unit of signaling speed derived from the duration of the shortest code element. Speed in bauds is the number of code elements per second.

BIDIRECTIONAL PULSES—single polarity pulses, not all of which have the same sense of departure from normal.

BINARY CODE—composed of a combination of entities, each of which can assume one of two possible states and which is identifiable in time or space.

BIT—a quantity of intelligence which is carried by an identifiable entity and which can exist in either of two states.

CALIBRATION ACCURACY—finite degree to which a device can be calibrated. (Influenced by sensitivity, resolution, and reproducibility of the device itself and the calibrating equipment.) Usually it is expressed in percent of full scale.

CARRIER—a wave suitable for modulating by a modulating wave.

CARRIER-TO-NOISE RATIO—magnitude of the carrier to that of the noise after selection and before any nonlinear process, such as amplitude limiting and detection.

CHANNEL TELEMETERING—route required to convey the magnitude of a single telemetering measurand.

CHANNEL PULSE—represents intelligence on a channel by virtue of the modulation characteristic.

CLAMPING CIRCUIT—maintains either amplitude extremity or a waveform at a certain potential level.

CLIPPER—a device whose output is zero or a fixed value for instantaneous input amplitudes up to a certain value, but which has an output that is a function of input for amplitudes exceeding the critical value.

CLIPPER LIMITER—a device whose output is a function of the instantaneous input amplitude for a range of values lying between two predetermined limits but is approximately constant at another level, for input values above the range.

COMMUTATION SWITCH—device used to execute repetitive sequential switching.

CROSS MODULATION—of a carrier of the desired signal by an undesired signal.

CROSS TALK—interference in a given channel originating in another channel of the same system.

DECODING—process of obtaining intelligence from a code signal.

DETECTION—process by which a wave corresponding to the modulating wave is obtained in response to a modulated wave.

DEVIATION FROM LINEARITY—in percent of full scale, deviation from linearity is the maximum deviation of a curve from the most favorable straight line that can be drawn through the curve.

DEVIATION RATIO—in a frequency-modulating system, the ratio of the signal frequency to the maximum frequency of the system.

DISCRETE SAMPLING—individual samples of such long duration that the intelligence frequency response of the channel is not deteriorated by the sampling process.

DISCRIMINATOR, FREQUENCY—a device that responds only to a given set of frequencies having a particular characteristic, such as duration, amplitude, period.

DISCRIMINATOR, PULSE—a device that responds only to a pulse having a particular characteristic, such as duration, amplitude, period. The latter is also called a time discriminator.

DISCRIMINATOR, PHASE—a device in which amplitude variations are derived in response to phase variations.

DUTY FACTOR—in a pulse carrier composed of pulses that recur at regular intervals, the product of the pulse duration and the pulse repetition frequency.

END DEVICE—the final system element that responds quantitatively to the measurand and performs the final measurement operation.

ELECTRIC TELEMETERING—telemetry performed by deriving from the measurand or from an end device a quantitatively related separate electrical quantity or quantities as a translating means.

ERROR—of an indicated value is the difference between the indicated value and the true value of the quantity measured. (It is the quantity which algebraically subtracted from the indicated value gives the true value. A positive error denotes that the indicated value of the instrument is greater than the true value.) Usually expressed in percent of full scale.

FRAME—one cycle of a cyclically recurring number of pulses.

FRAME FREQUENCY—the number of frames per unit time.

FRAME SYNCHRONIZING PULSE—a recurrent signal establishing each frame.

FREQUENCY DEVIATION—the deviation in frequency from its assigned value.

FREQUENCY MODULATION—angle modulation in which the instantaneous frequency of a sine wave carrier is caused

GLOSSARY OF TELEMETERING TERMS

(continued)

to depart from the carrier frequency by an amount proportional to the instantaneous value of the modulating wave.

FREQUENCY MODULATION DEVIATION—peak difference between the instantaneous frequency of a modulated wave and the carrier or reference frequency.

FREQUENCY MULTIPLEX—technique for the transmission over a common path of two or more signals, each characterized by a distinctive reference frequency or frequency band.

FREQUENCY RESPONSE CHARACTERISTIC—variation with frequency of the gain or loss of a device or a system.

FREQUENCY SHIFT KEYING—that form of frequency modulation in which the modulating wave shifts the output frequency between predetermined values and the output wave is coherent with no phase discontinuity.

FREQUENCY SWING—in frequency modulation, the peak difference between the maximum and the minimum values of the instantaneous frequency.

FRICTIONAL ERROR—as applied to pickups, is the difference in values measured in percent of full scale before and after tapping, with the measurand constant.

HARTLEY—a unit of information content, equal to one decimal decision, or the designation of one of ten possible and equally likely values or states of anything used to store or convey information. A Hartley may be conveyed by one 10-ary code element. One Hartley equals $\log_2 10$ bits; ($\log_2 10 = 3.323$).

HYSTERESIS ERROR—the maximum difference in percent of full scale in readings obtained by making a complete full-scale cycle of the measurand at a specific value of the latter.

INDICATOR—an instrument that makes information available but in which there is no provision for storage of such information.

INDICATION—the display to the human senses of information concerning the measurand.

INTERFERENCE—in a signal transmission system interference is the extraneous power that tends to interfere with the reception of the desired signals.

KEYING—forming of signals such as those employed in telegraph transmission by an abrupt modulation of the output of a direct-current or an alternating-current source, as, for example, by interrupting it or by suddenly changing its amplitude or frequency or some other characteristic.

LIMITER—a device whose output is virtually constant for all inputs above a critical value.

LINEARITY—a relationship existing between two quantities when the change in one quantity is exactly and directly proportional to the change in the other quantity.

MEASURAND—a physical quantity, property, or condition that is to be measured.

MODULATION—the process or the result of the process in which the amplitude, frequency, or phase of a wave is varied with time in accordance with a wave.

MODULATION INDEX—a measure of the degree of modulation for any type of modulation.

MULTIPLE MODULATION—a succession of processes of modulation in which the modulated wave from one process becomes the modulating wave for the next.

NATURAL FREQUENCY—frequencies of a body or system are the frequencies of free oscillation.

NOISE—any electrical disturbance tending to interfere with normal reception of a transmitted signal.

PHASE DEVIATION—peak difference between the instantaneous angle of the modulated wave and the angle of the carrier.

PHASE MODULATION—angle modulation in which the angle of a sine wave carrier is caused to depart from the carrier angle by an amount proportional to the instantaneous value of the modulating wave.

PHASE RESPONSE CHARACTERISTIC—the phase displacement versus frequency properties of a network or system.

PICKUP—a device that converts a magnitude (which may be of a measurand) into a corresponding electric signal.

PRIMARY DETECTOR—the first system element or group of elements that responds quantitatively to the measurand and performs the initial measurement operation.

RECORDER—an instrument for the storage of information concerning the relationship among variables.

RIPPLE—percent ripple is the ratio of the effective root-mean-square value of the ripple voltage to the average value of the total voltage, expressed in percent.

SAMPLE, INTELLIGENCE—part of a signal used as evidence of the quality of the whole.

SIGNAL—in telemetering, is the electrical intelligence or message conveyed.

SIGNAL-TO-NOISE RATIO—the ratio of the magnitude of the signal to that of the noise. This ratio is often expressed in decibels.

SUBCARRIER—a carrier applied as a modulating wave to modulate another carrier.

SYNCHRONISM—the phase relationship between two or more periodic quantities of the same period when the phase difference between them is zero.

TELEMETERING—measurement with the aid of intermediate means that permit the measurement to be interpreted at a distance from the primary detector. The distinctive feature of telemetering is the nature of the translating means, which includes provision for converting the measurand into a representative quantity of another kind that can be transmitted conveniently for measurement at a distance. The actual distance is irrelevant.

TIME DIVISION MULTIPLEX—the process of transmitting two or more signals over a common path by using different time intervals for different signals.

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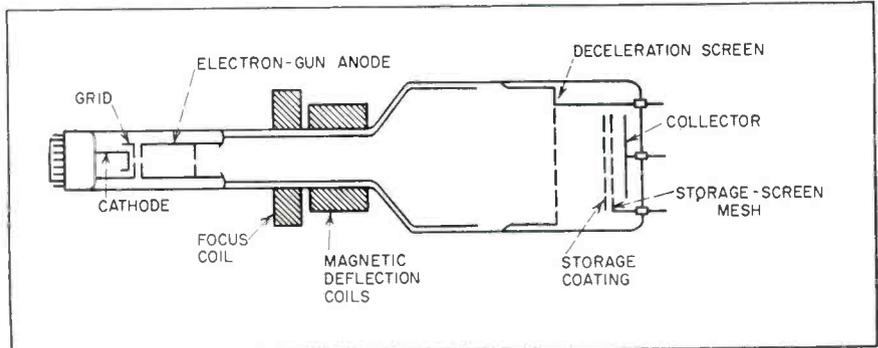
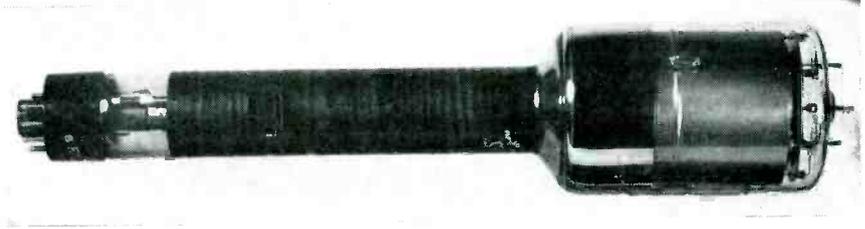
By SAUL SHENFELD

and

MANUEL FINKLE

U. S. Navy Underwater Sound Laboratory

New London, Connecticut



Appearance and structure of type QK-464 storage tube

Storage-Tube Device Simulates Radar Net

SUMMARY — Video signals are obtained in the form in which they would be received from two or more separated radar stations. Moving targets may be simulated. Cathode-ray storage tube retains information fed alternately to separate radar indicators

IN EVALUATING radar indicator equipment, the problem of synthesizing video signals, which represent the return echoes of moving targets, frequently arises. This problem may be complicated by the need for presenting the targets as they would be displayed on indicators of two or more radar stations geographically displaced.

In Fig. 1A is shown a possible configuration of the targets and two radar stations whose returns are to be simulated. The radar stations are labeled *A* and *B*. Although only three targets are shown, many more could be simulated.

Three radar indicators using ppi presentation were used. In one, the

oscilloscope was replaced with a QK-464 storage tube. This indicator employed the resolved-time-base type of sweep and had provision for off-centering in the X and Y directions. The other indicators used centered ppi presentation.

Synchros

A slewing motor drove a 5G synchro at 5 rpm. The output of the synchro was connected to the servo system in each indicator so that the three indicators had identical speeds of angular rotation. The instantaneous bearing of each sweep was aligned by zeroing each synchro.

In Fig. 1B is shown the indicator presentations simulating those used

for stations *A* and *B*. It is assumed that the targets and stations are in the positions shown in Fig. 1A.

To achieve the video signals for each channel, it was necessary to modify the indicator containing the storage tube so that the position of the sweep origin could be off-centered on a time-shared basis between the points on the storage tube corresponding to the locations of stations *A* and *B*.

The configuration on the screen of the storage tube is shown in Fig. 2A. Because of time-shared off-centering, one sweep will emanate from *A* and the next sweep will emanate from *B*. The sweep starting from *A* will give an electrical

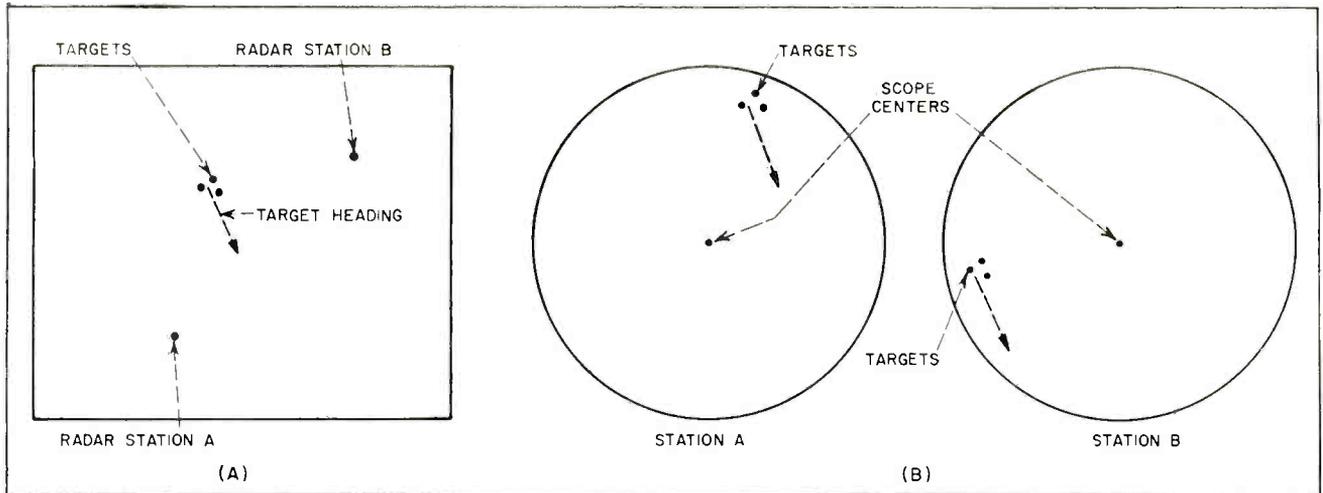


FIG. 1—Configuration of targets and radar stations (A) and simulated ppi presentations (B)

output from the storage tube as shown in Fig. 2B. The next sweep, starting from *B*, will have no echo. It is then possible to obtain video which will have bearing and range connotation of returns obtained at positions *A* and *B*.

Storing Signals

The QK-464^{1,2} is an electrical-input and electrical-output storage tube. To prepare the storage surface for the WRITE operation during which the target signals are stored, it is necessary to operate the tube first in an ERASE and then in a CHARGE condition. For erasure, the storage screen is connected to +300 v and a constant beam current is scanned across the entire surface of the storage screen.

For charging, the surface of the storage screen is again scanned with a constant beam current but with the voltage of the storage screen reduced to approximately 30 v d-c.

For the WRITE operation, the storage screen is connected again to +300 v, but sufficient bias is applied to the control grid to prevent current flow except during the actual writing of the signal. With this voltage, secondary emission ratio of the storage surface is greater than unity. As a result, any electrons striking the surface will cause a greater number of electrons to leave the area. A positive potential is created at this point relative to the rest of the screen.

For writing, the 5G synchro was operated manually. The sweep was positioned along the bearing of the

target with respect to *A* and a range strobe was used to give a sharp pip at the range of the target. See Fig. 2C. The intensity control of the range strobe was turned up for a fraction of a second to write. This sequence may be continued for writing any number of targets.

An alternative procedure consists of disabling the sweep circuits during the WRITE operation and, by *X* and *Y* positioning controls, locating the beam spot at the desired target positions. When the grid bias of the tube is reduced for a fraction of a second, the target positions may be marked. The sweep is then restored to normal operation.

Read Out

For reading out the stored information, the potential on the storage screen is reduced to approximately +20 v. The beam current is set for a few microamperes.

Electrons will reach the collector plate only at those points which

were written positively during the WRITE cycle. If the sweep starts at point *A*, target pips will be obtained only when the sweep line crosses the positively charged spot area. The time of occurrence along a sweep line will depend upon the time necessary for the sweep to move from its start to the location of the target.

This procedure will give video signals corresponding to the radar returns detected by a radar station located at *A*. The start of each second sweep may be displaced to the location of *B*. This is accomplished by time-shared gates, which provide off-centering potentials on an every-other-sweep basis. See Fig. 3.

The input that triggers the sweep gate is applied to a flip-flop. The output of the flip-flop is connected to off-centering clamps that determine the magnitudes of the off-centering voltages. The gates from the flip-flop determine whether the *A* or the *B* off-centering clamp is activated. The amount of the *X* and

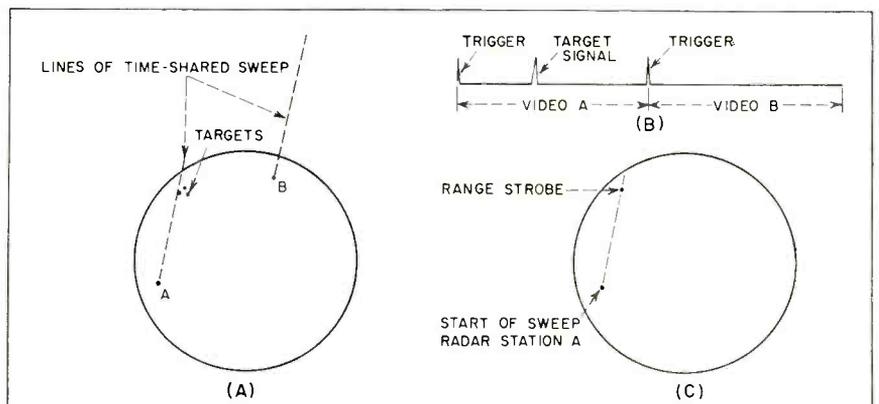


FIG. 2—Target pattern (A), video output (B) and method of writing targets on storage tube (C)

Power Transformer Design Charts

By REUBEN LEE and N. E. MULLINIX

Westinghouse Electric Corp.
Baltimore, Md.

SUMMARY — Design time for two-winding, 60-cps power transformers is reduced by charts based on use of specific core series under typical operating conditions. Data is also useful as starting point in more complex designs

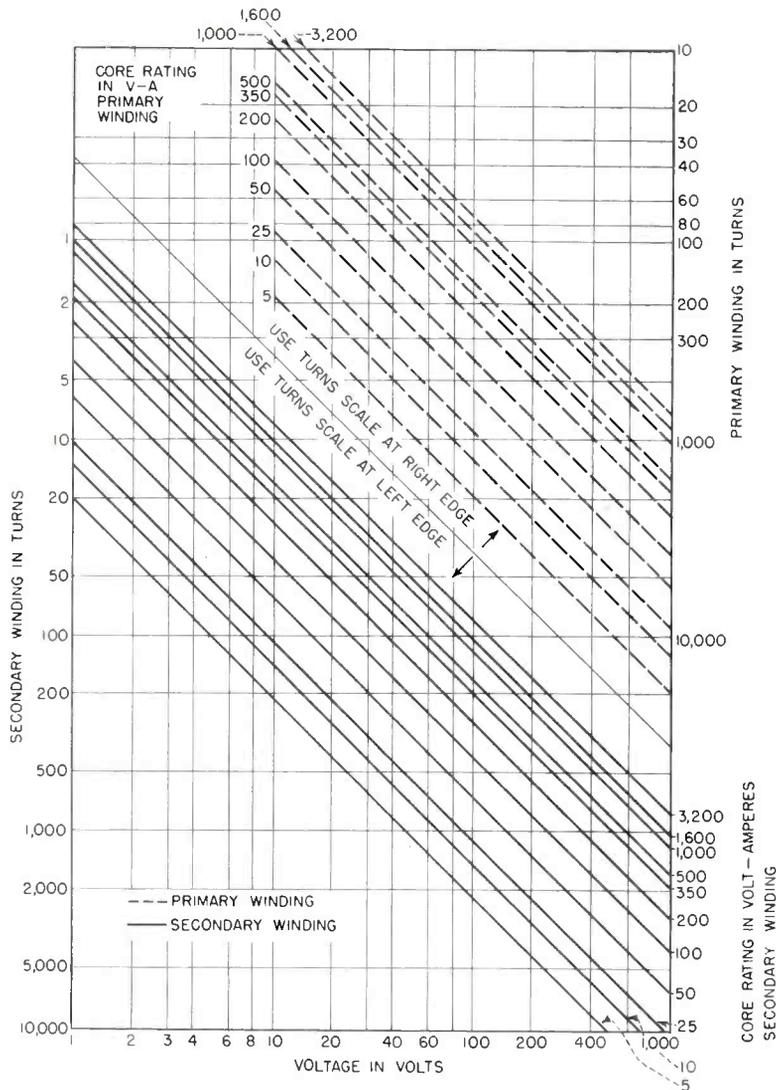


FIG. 1—Primary and secondary winding turns as determined from core volt-ampere rating

DESIGN of simple, low-voltage transformers creates a problem for most transformer design groups. These design charts eliminate or minimize the amount of calculation necessary.

Chart Design Conditions

Limiting assumptions had to be made so that the values for the chart could be calculated. These were based on the use of type-C cores but a similar chart could be made for any given series of cores at 60 cps or other frequencies. The assumptions were:

- (1) The core is used at maximum rated volt-amperes.
- (2) Core flux density is 16,500 gauss at 60 cps.
- (3) The transformer is a single-section secondary wound over primary with 1,000-volt insulation throughout.

(Continued on page 186)

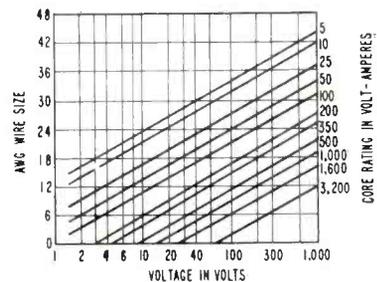


FIG. 2—Winding wire size in relation to voltage and core rating

NEW

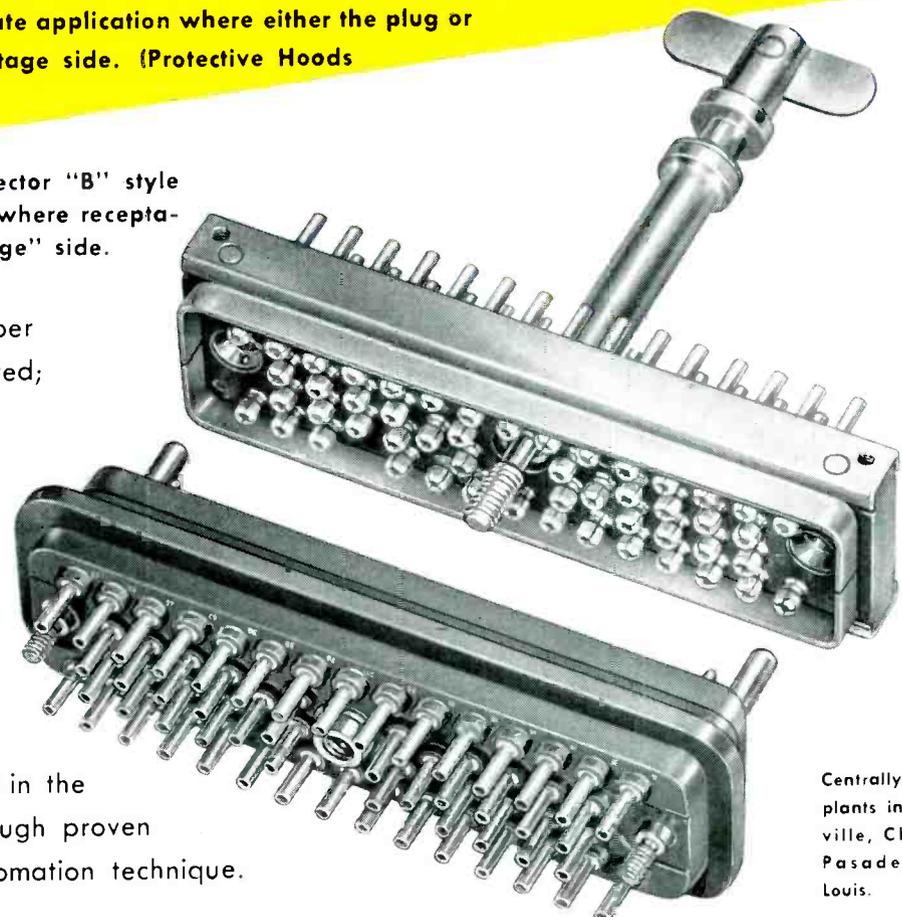
Compression type—28, 32, 40, 48 and 52 contact connectors. Center engaging screw with wing nut or screw driver slot and spring action contacts—permits easy, quick and reliable engagement and dis-engagement. Receptacle side available for pressurized applications.



40 contact connector "A" style for applications where plug is "live voltage" side.

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52 contact connector "B" style for applications where receptacle is "live voltage" side.

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Power Transformer Design Charts

(Continued from page 184)

(4) Primary and secondary windings occupy equal amounts of space. Total coil height occupies nine-tenths of core-window height.

(5) Copper loss is divided equally between the two windings.

(6) Total transformer temperature rise is 40 C with a 65 C ambient except for the four smallest cores. These were limited by the regulation values shown in Table I.

(7) All units are uncased, vacuum impregnated with resin.

Procedure in using the design charts is as follows:

(1) Choose a core from Table I which has a v-a rating equal

to or greater than that required. (2) Using rated primary and secondary voltages, find number of turns for both windings from Fig. 1.

(3) From rated primary and secondary voltages, find wire size for both windings from Fig. 2.

(4) Use the chart of Fig. 3 to obtain winding resistances.

Ratings rarely fall exactly on the v-a values assigned to each core. Therefore, choose the core with the next higher rating. Wire size in Fig. 2 also increases in discrete sizes. If the chart indication falls between two sizes the smaller size should be used.

Departures from the assumed conditions preclude direct use of

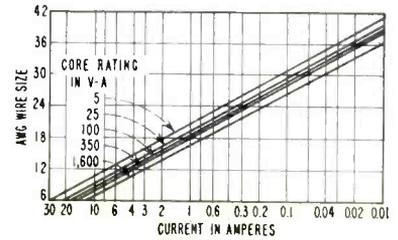


FIG. 4—Relation of winding wire size to current

the chart, but it is still useful as a starting point in designing transformers for high voltages or with multiwinding secondaries. The following notes apply to such modifications:

(1) For each additional secondary winding reduce the core maximum rated volt-ampere by 10 percent.

(2) For 5-kv rms working voltage reduce the core maximum rated volt-amperes approximately 33 percent.

(3) For 50/60-cycle transformers, reduce the core maximum rated volt-amperes 10 percent.

(4) When permissible temperature rise is higher than 40 C, the core maximum volt-amperes equals (v-a in table) $\times \sqrt{\text{temperature rise}/40 \text{ C}}$.

(5) For rectifier plate transformers use the average of primary and secondary volt-amperes to determine core size. Multiply the primary-wire size in circular mils on chart by primary v-a/average v-a, and secondary wire in circular mils by secondary v-a/average v-a.

(6) When taps are required, additional layers of wire may be needed, and unless the transformer rating falls well below the maximum core rating in Table I, size is larger than for a transformer with no taps.

Figure 4 gives the relationship between wire size and current for various cores.

Table I—Core Size, Rating and Regulation

Core	Maximum V-A Rating	Per Cent Regulation	Total Wt in lb	Overall Size in Inches
1	5	15	0.38	$1\frac{3}{4} \times 1\frac{3}{4} \times 1\frac{3}{4}$
2	10	15	0.68	$1\frac{7}{8} \times 2\frac{3}{8} \times 1\frac{3}{4}$
3	25	10	1.2	$2\frac{1}{4} \times 2\frac{7}{8} \times 2\frac{1}{4}$
4	50	10	2.2	$2\frac{1}{2} \times 3\frac{1}{8} \times 2\frac{1}{2}$
5	100	8	3.8	$3\frac{1}{8} \times 3\frac{3}{4} \times 3$
6	200	6	6.4	$3\frac{7}{8} \times 4\frac{3}{4} \times 3\frac{5}{8}$
7	350	4	11.0	$4\frac{3}{8} \times 5\frac{3}{8} \times 4$
8	500	3	15	$5\frac{1}{8} \times 6\frac{1}{8} \times 5$
9	1,000	2.2	24	$5\frac{7}{8} \times 6\frac{3}{4} \times 6\frac{1}{8}$
10	1,600	1.8	36	$7\frac{1}{4} \times 8\frac{1}{4} \times 7\frac{1}{2}$
11	3,200	1.2	75	$9\frac{3}{4} \times 12\frac{3}{4} \times 8$

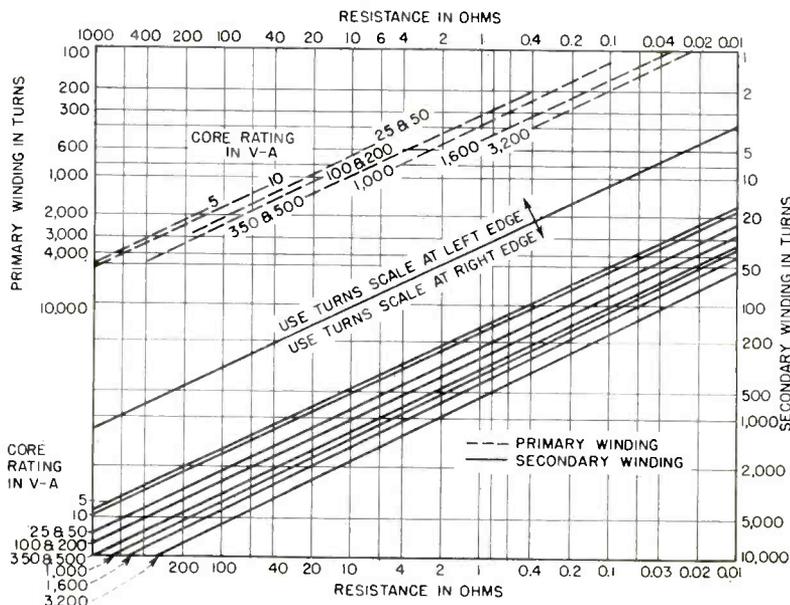


FIG. 3—Resistance of primary and secondary windings for type-C cores

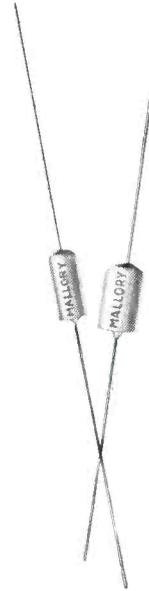
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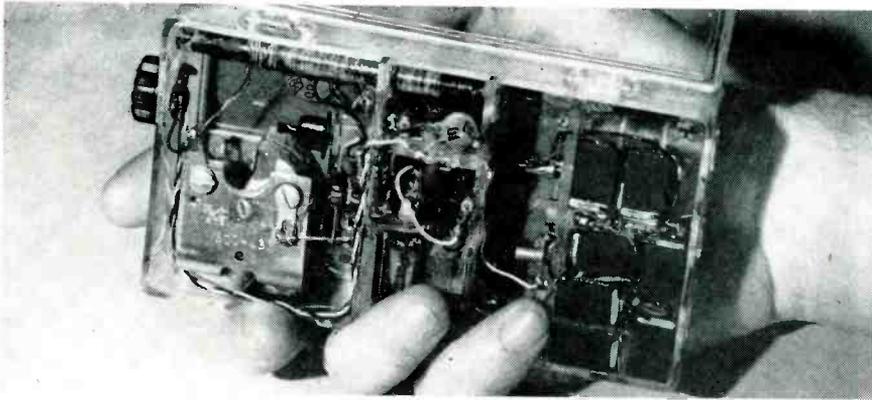
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Electrons At Work

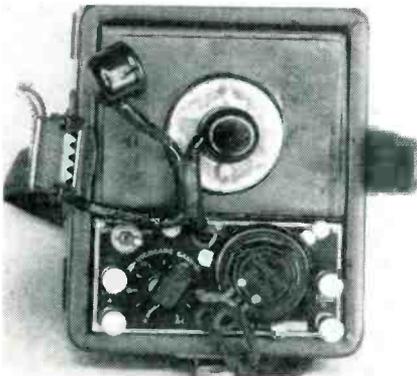
Edited by ALEXANDER A. MCKENZIE

Transistor Receiver Powered By Sun

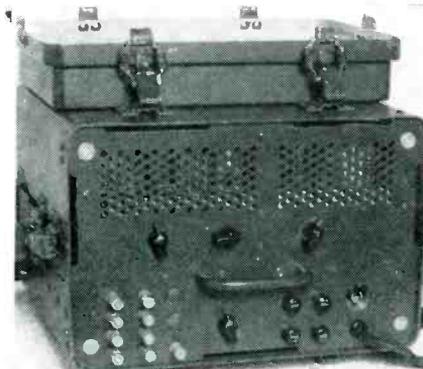


Weighing only 10 ounces, the receiver shown is said by General Electric engineers to be capable of working two hours a day for more than eight months in total darkness although solar powered. A miniature storage battery is charged by seven solar cells contained in the transparent plastic case. Artificial light, like that from a 100-watt bulb, can be used to operate the experimental receiver in the absence of daylight. Costs are still too high to contemplate use of highly efficient solar cells for production receivers. Size of the unit could be cut in half by substituting new subminiature components. Four npn transistors are used

Army's First Semiconductor Equipment



Vacuum tube repeater (EE-89) that weighs 16 pounds will be replaced



Type TA-126 repeater weighing 65 pounds will give way in some cases

ENGINEERING models of Signal Corps first fully transistorized equipment have gained approval necessary for large-scale procurement. The item is a throw-away

telephone repeater (*ELECTRONICS*, p 178, Jan. 1956).

The negative-impedance repeater (TA-287) is intended for use on field wire as a 2-wire intermediate, unattended type equipment. Designed for insertion at 6-mile intervals in a line, it can be employed in circuits using up to 30 miles of wet field wire with a net circuit loss of only 0.8 db per mile at a frequency of 1 kc.

In event of defective operation, the entire repeater is thrown away, since it is sealed in a waterproof compound with external wire leads, thus precluding repair.

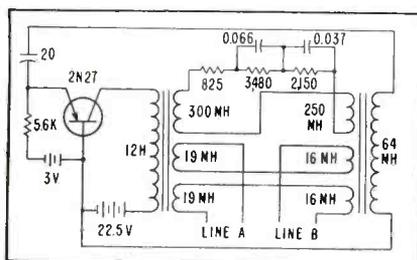


FIG. 1—Transistor negative-impedance telephone line repeater

Weighing about 3½ pounds, it will replace the EE-89 equipment, which weighs 16 pounds. It will likewise replace type TA-126 equipment in

BRANE Guides Bomber



Known less glamorously as the MA-2 bombing and navigation system, BRANE (Bombing RAdar Navigation Equipment) is the new name for equipment built by IBM for installation in the Boeing B-52 Stratofortress, the biggest, fastest bomber employed by Strategic Air Command. In the photograph, an Air Force officer peers into the bombsight periscope of the combined navigation-bombing device that weighs 1,457 pounds, requires 30 cubic feet of space and has over 300 electron tubes

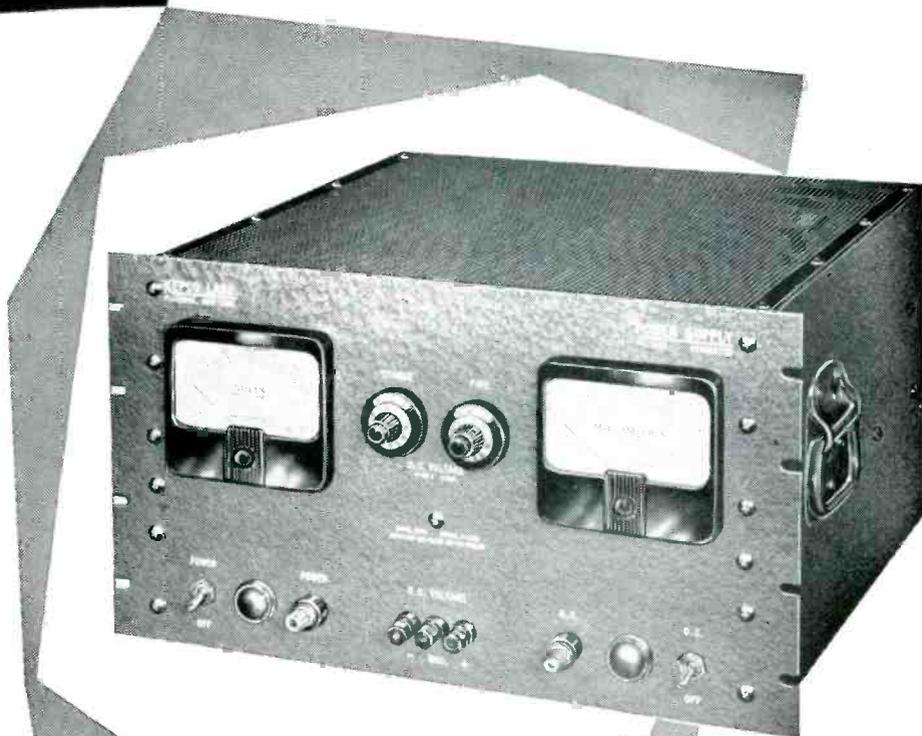
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REGULATION: As shown in table for line fluctuations from 105-125 volts and load variations from minimum to maximum current.

SPECIAL FEATURE: Provision is made for picking up the error signal directly at the load, compensating for the voltage drop in external wiring.



Model 2600

OUTPUT	VOLTS	CURRENT	REGULATION	RIPPLE
1	0-60	0-2 Amp.	5 Mv.	1 Mv.

Model 2650

OUTPUT	VOLTS	CURRENT	REGULATION	RIPPLE
1	0-60	0-5 Amp.	5 Mv.	1 Mv.

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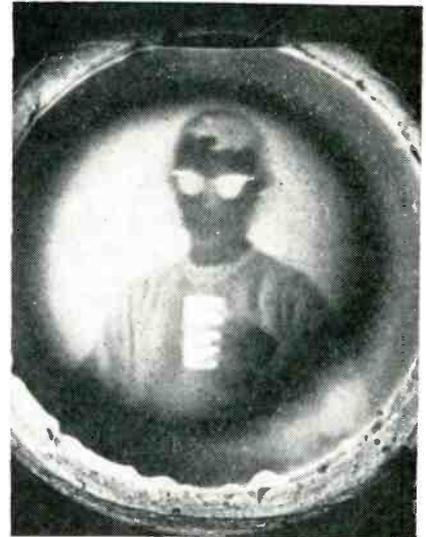
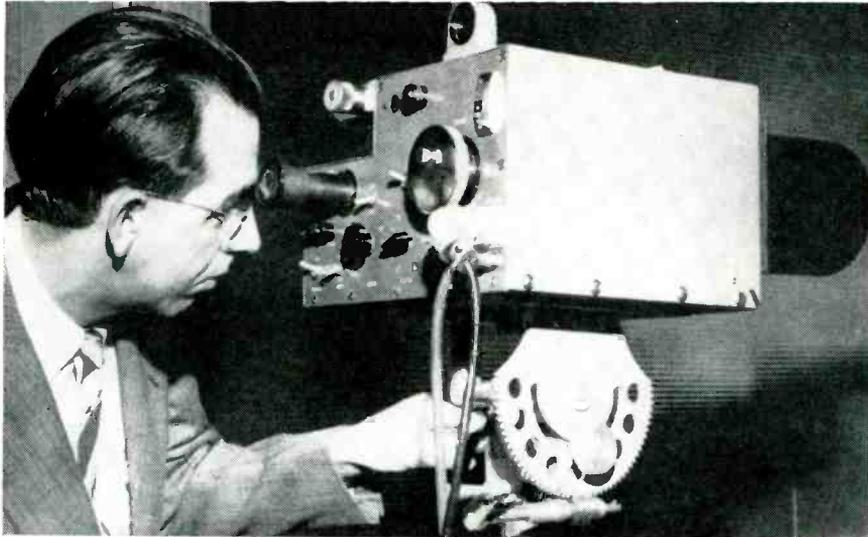
many applications. The latter unit weighs 65 pounds.

Other transistorized versions of communications equipment are under development at Signal Corps

Engineering Labs. Among these are field telephones, 2 and 4-wire voice frequency repeaters, signal generators, telegraph line units, telephone ringers, teletypewriter

tape sensing devices, audio test amplifiers, teletypewriter converters, dynamic microphone preamplifiers and other audio or intermediate-frequency devices.

Infrared Oil-Film Camera Shows Heat Patterns



Engineer adjusts the evaporograph (left) to pick up image of girl holding a glass of ice water. The picture (right) was taken in a completely darkened room at a distance of 30 feet

CALLED Eva (for Evaporograph) by Baird Associates, Inc., who developed it for the Signal Corps, a new instrument makes it possible to see many objects in the dark. A human body, automobile or other object that has differences in temperature can be seen easily and identified. A man can be spotted at 200 yards and a house a mile dis-

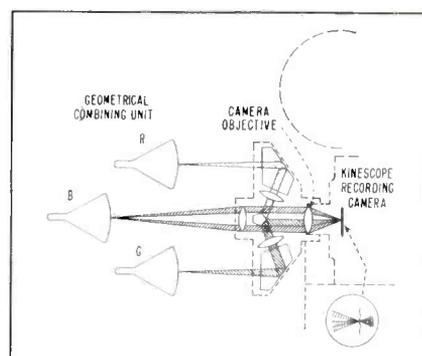
tant can be seen in total darkness. In operation, the evaporograph collects radiation emitted from an object and focuses it as an image upon an oil film. The oil evaporates from point to point at rates varying with the amount of radiation received at each point. Viewed in reflected light, the differences in oil-film thickness appear as dif-

ferent colors of the visible spectrum. One practical use of the newly declassified device in the field of electronics may be photographing vacuum-tube envelopes or other components for studies of life expectancy. Temperature studies are now generally conducted by observing the effects of temperature at discrete points.

Lenticular Film For Color Kines

PRACTICAL help for the telecaster desirous of using color kinescope recordings may lie in the use of embossed film. Thus far, other methods, such as employment of magnetic tape, have not proved practicable.

The diagram shows the principles of color kinescope recording on embossed film. The red, green and blue video signals in a color television system are fed to three separate kinescopes, marked respectively, *R*, *G* and *B*. The phosphor screens of the three kinescopes are all of the same type, for example, P-16.

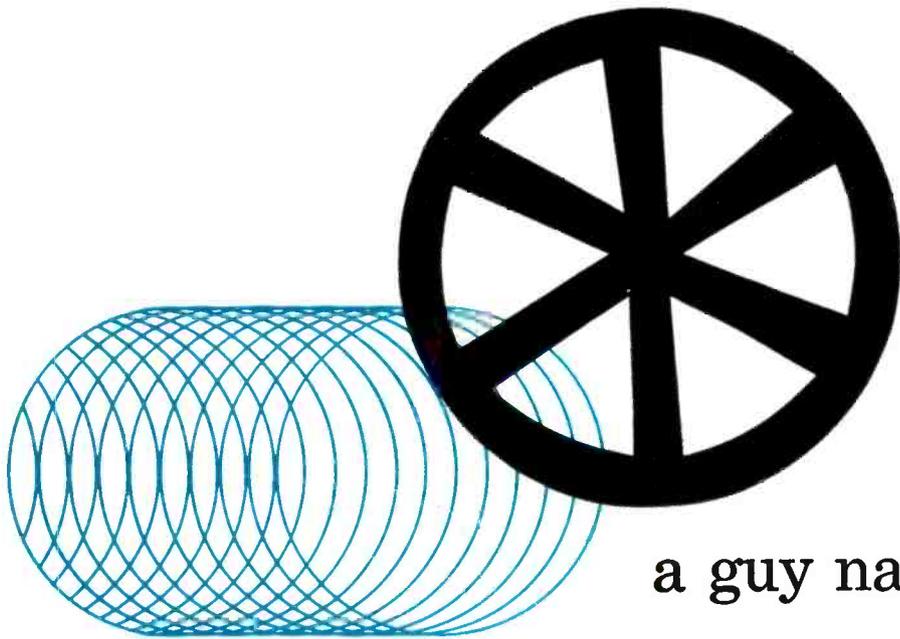


Method of recording color programs on monochrome lenticular film

Tonal values of the red content of the scene being televised are rep-

resented by the tonal values of the picture appearing on tube *R*. This picture may therefore be referred to as a red-separation image. Similarly, the green separation appears on *G* and the blue separation on *B*.

► **Monochromes**—It should be noted that the pictures on the kinescopes are not themselves colored, red, green and blue. All pictures have the color that is characteristic of the phosphor used in all three tubes. For the P-16 phosphor, the light is blue, extending into the ultraviolet. By the design of the optical system, light



a guy named Og

Once your name was Og. You tired of shouldering
mastodon steaks...of dragging your mate by her hair.
You invented the wheel.

Later, your name was Watt. Steam made your kettle-lid
dance...and the Industrial Revolution was on.

Yesterday, you were a bicycle mechanic named Henry...today,
your brainchild's descendants are counted in millions.

Your name is legion. You created every linkage...
every device...every system.

You're an engineer.

You make things work better...faster...more accurately
...more economically.

Next week...next month...next year...some system will need
a better, faster, more accurate or more economical
means of recording...or indicating...or computing...or
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You'll discover that Helipot makes the most complete line...
linear and non-linear versions...in the widest choice
of sizes, mounting styles and resistances.

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from *R* reaching the kinescope recording camera film appears to come from one of four parallel apertures, or bands.

Light from *G* comes through a second one of these apertures and light from *B* comes through the remaining two apertures. In the diagram, which schematically displays a vertical cross-section of the optical system, the four bands of light approach the camera objective lens from the left.

An enlarged view of a cross-section through the recording beams and embossed film is shown in the circle at the bottom right of the diagram. The film has tiny cylindrical lenses called lenticules, formed in the film base itself by an embossing process.

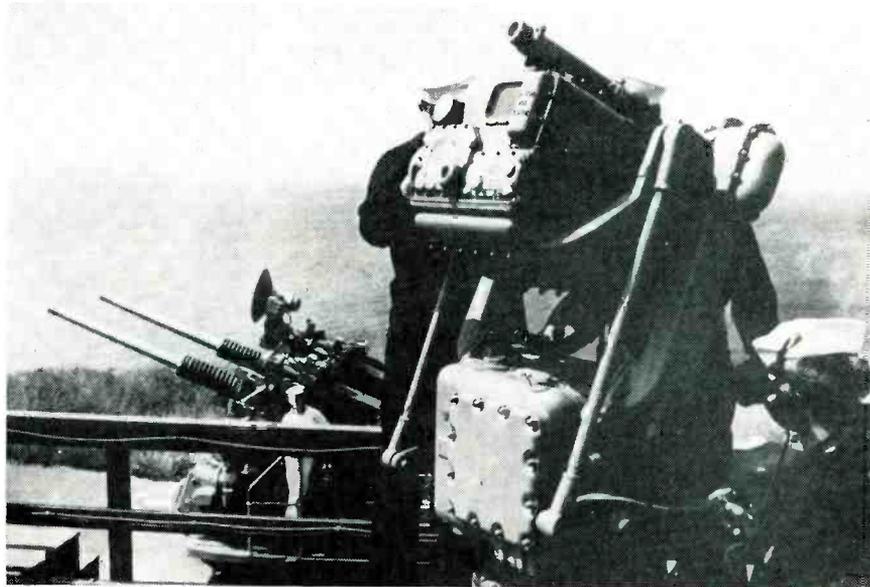
These lenticules face the camera lens, so that light entering the camera must pass through the lenticules before striking the light-sensitive emulsion that is coated on the back of the support. The camera lens forms images of all three kinescope rasters, superimposed in register on a single frame of the film. Simultaneously, each lenticule images the four separate apertures on the emulsion lying directly behind itself. Thus the red, green and blue separation images are recorded in separate positions within the emulsion.

► **Lens Ridges**—Each lenticule runs transversely all the way across the 35-millimeter film width and there are 25 lenticules per millimeter of film length. The recorded image of the televised object is thus divided into about 390 horizontal strips, corresponding to the number of lenticules contained in the height of a 35-millimeter motion-picture frame. Each of these strips is further divided into red, green and blue components.

It is an important fact that the emulsion layer is an ordinary blue-sensitive black-and-white type. The color separations are obtained as colorless, silver images. Since complicated color processing of the film is not required, it can be developed rapidly, easily meeting the requirements for time-zone-delayed broadcasting.

Televising embossed film color records is accomplished either by

Gunfire Control Tracks Jets



Tracking jet aircraft with 3 and 5-inch naval guns in any weather is possible using U. S. Navy's mark 63 gunfire control system manufactured by Sperry Gyroscope Co. Newer gunfire controls and radars have been combined with gyro-optical tracking principles used previously

means of a flying-spot scanner, which requires the use of a continuous projector, or by means of storage tubes such as the Vidicon, in which case an intermittent projector is used.

A suitable optical system for use with Vidicons is essentially the reverse of the geometrical combining unit used in recording. In this case, the film as it passes through the projector gate is illuminated from the emulsion side. Light transmitted by the various black-and-white color-separation images in the film is directed by the film lenticules in bands corresponding to the taking apertures.

Suitably arranged reflecting surfaces and lenses image the three separations on three different Vidicon storage surfaces, serving the red, green and blue channels of the television system.

In addition to meeting the time requirements for quick-kine recording, embossed film gives high-quality color rendition and picture sharpness. Furthermore, a permanent record is obtained from which color prints may be made on ordinary color films.

The greater part of this report has been kindly furnished by the Research Laboratories of Eastman Kodak Co.—A. A. McK.

WWV Modifies Broadcasts

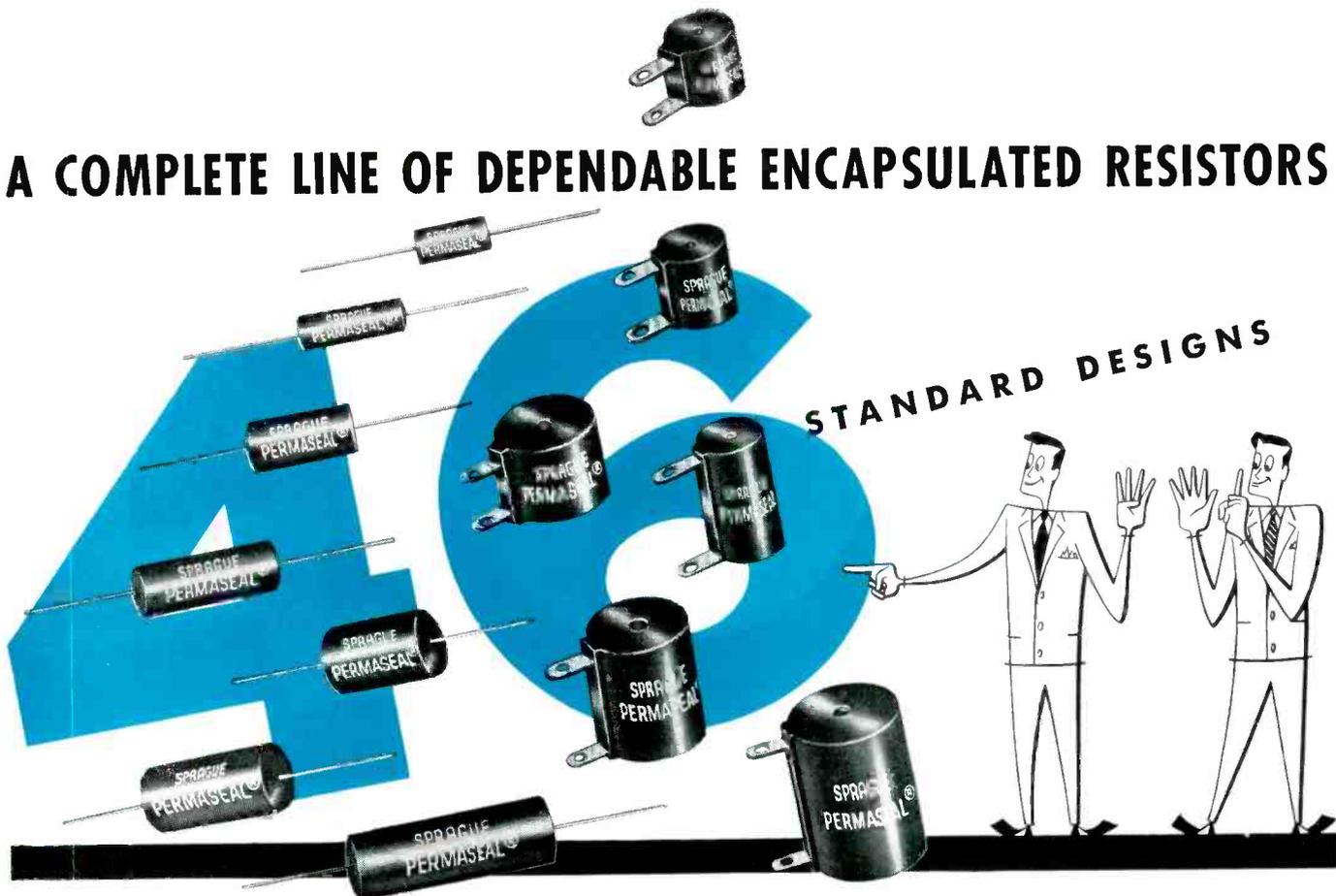
TIME signals from WWV, near Washington, D. C., are maintained in close agreement with a new uniform time called UT2, determined by the U. S. Naval Observatory. Occasional step adjustments of exactly plus or minus 20 milliseconds are made on Wednesdays at 1900 UT (Universal Time, which corresponds with GMT).

The time adjustments are necessary several times a year because of variations in the earth's rate of rotation. Final corrections to the broadcast time signals are published weekly by the Naval Observatory.

► **Frequency**—Improvements have been made in the accuracy of broadcast frequencies, which are now accurate to a part in 100 million. Carrier frequencies of 2.5, 5, 10, 15, 20 and 25 mc are used, the frequencies of 30 and 35 mc having been discontinued Jan. 1, 1953.

To give longer intervals free from modulation, the tones 440 and 600 cps have recently been shortened from 4 to 3 minutes duration. This is likewise true for WWVH near Maui, Hawaii. A silent period of 4 minutes is observed by WWV commencing at 45

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minutes, plus or minus 15 seconds, after each hour.

► **Single-Sideband**—Except on 25 mc, the tone frequencies of 440 and 600 cps from WWV are being operated experimentally as single upper sideband with full carrier. Power output from the ssb transmitter is about a third the carrier power. Announcements and seconds pulses use double-sideband 100-percent amplitude modulation.

Many other technical details can be obtained by writing National Bureau of Standards, Boulder Laboratories, Boulder, Colorado.

Low Capacitance Probe For Video Testing

By HOWARD L. ROBERTS
Denver Research Institute
University of Denver
Denver, Colorado

IN SIGNAL TRACING pulse and video circuits, the input capacitance of the usual oscilloscope probe is generally sufficiently large (12 to 15 μmf) to load the circuit under test. In addition, capacitance added by a probe may disturb the time constant of R-C circuits.

The need for a low input capacitance oscilloscope probe that does not overly attenuate the signal gave rise to the instrument to be described in this article. The instrument consists of a tandem cathode-follower that has an input capacitance of less than 3 μmf and an attenuation of only 2-to-1.

Input capacitance of a triode-connected cathode-follower is

$$C_{IN} \approx C_{gp} + (1 - G) C_{ok}$$

where C_{gp} is the grid-plate capacitance, C_{ok} is the grid-cathode capacitance of the triode and G is the gain of the cathode-follower.

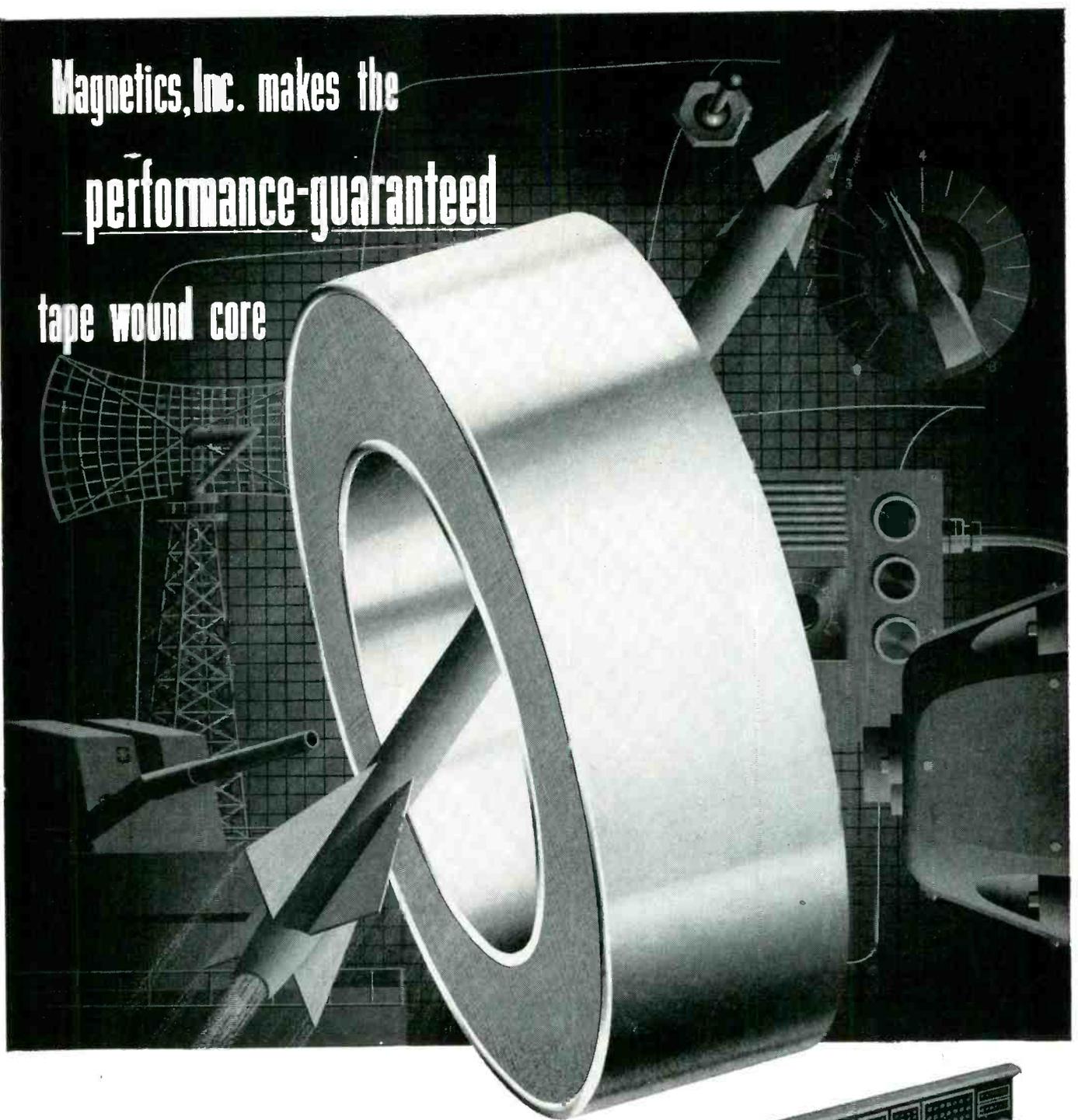
The grid-plate capacitance can be practically eliminated by the use of a pentode with the suppressor tied to the cathode and the screen bypassed to the cathode. In this case, the input capacitance is

$$C_{IN} \approx (1 - G) (C_{ok} + C_{os})$$

where C_{os} is the grid-screen capacitance of the pentode.

Total input capacitance for a given tube, disregarding wiring capacitance, now depends upon the

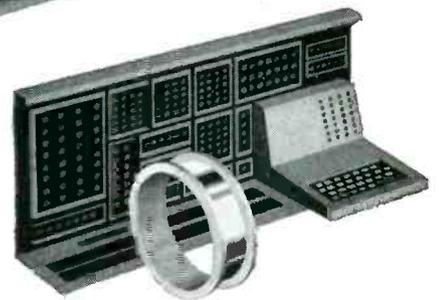
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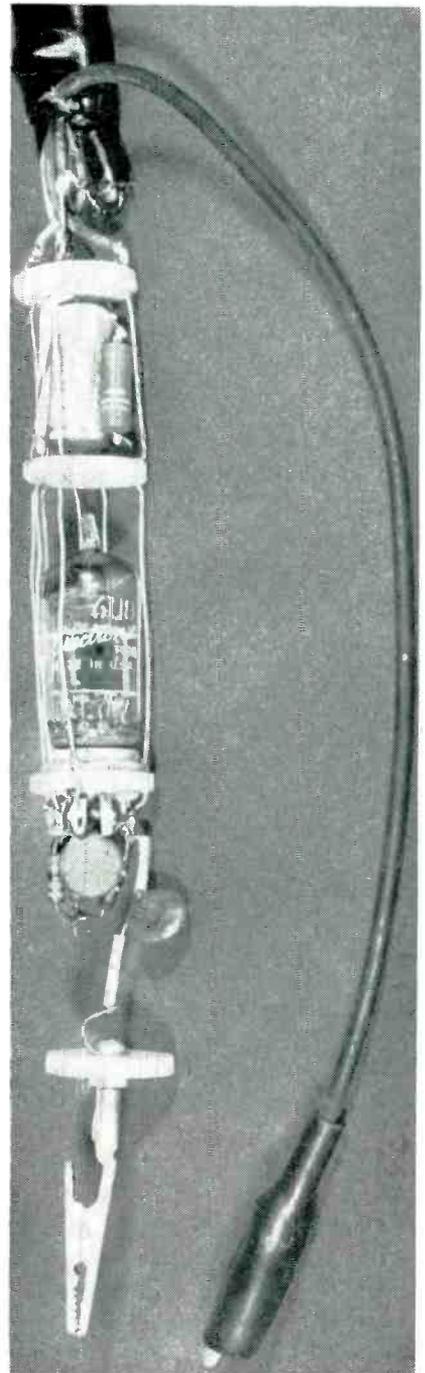


ELECTRONS AT WORK

(continued)

gain of the cathode-follower—the higher the gain, the lower the capacitance.

Physically, this means that the



Components mounted on tube socket are connected to power supply and output wiring by bus wires running up sides of tube as shown in the photograph

more nearly the cathode and screen voltage follow the grid voltage, the less capacitive effect there will be between the grid and these elements. Thus it is desirable to make the gain of the cathode-follower as near unity as possible



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ELECTRONS AT WORK

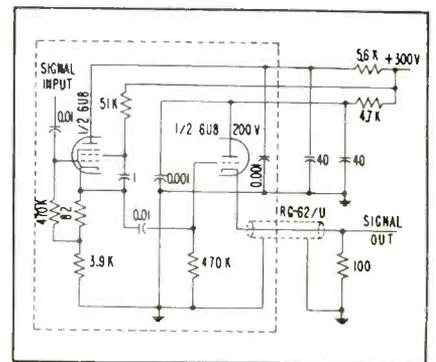
(continued)

to reduce the input capacitance.
Gain of a cathode-follower

$$G \approx \frac{g_m R}{1 + g_m R}$$

where R is the cathode load resistor.

From this, it is seen that it would be desirable to make R large to cause the gain to be as near unity as possible. However, this is contrary to the requirement that the cathode-follower drive a low-impedance cable. This difficulty is surmounted by using an input cathode-follower with high gain to drive another cathode-follower providing the proper output impedance.



Tandem cathode-follower probe has attenuation of only 2 to 1 with input capacitance of less than 3 μm

A 6U8 triode-pentode was used with the pentode section as the input. In choosing a cathode resistor for the input stage, transient response of the circuit had to be considered. Gain considerations dictate the use of a large load resistor but the R-C time constant of the cathode circuit should be as low as possible for good transient response.

A compromise was reached by choosing a cathode resistor no larger than necessary for maximum gain. The calculated gain for the 6U8 pentode section with a cathode load resistor of 3,900 ohms is 0.95, assuming a transconductance of 5,000 μmhos at the particular operating point chosen. If the normal input capacitance for the tube is considered as 5 μm , the calculated input capacitance for the cathode-follower circuit is 0.25 μm .

The input resistance of the circuit is higher than the 470,000-ohm grid resistor shown on the circuit diagram. When the grid resistor is returned to the cathode network, to establish correct grid-



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The Model 95 with its low residual fm, less than 60 DB below full deviation, permits accurate evaluation of equipment characteristics in which low noise level is essential. An internal barretter bridge in conjunction with mutual inductance type attenuators provides a high degree of output voltage accuracy.

The Model 95 Standard Signal Generator is now available from production.

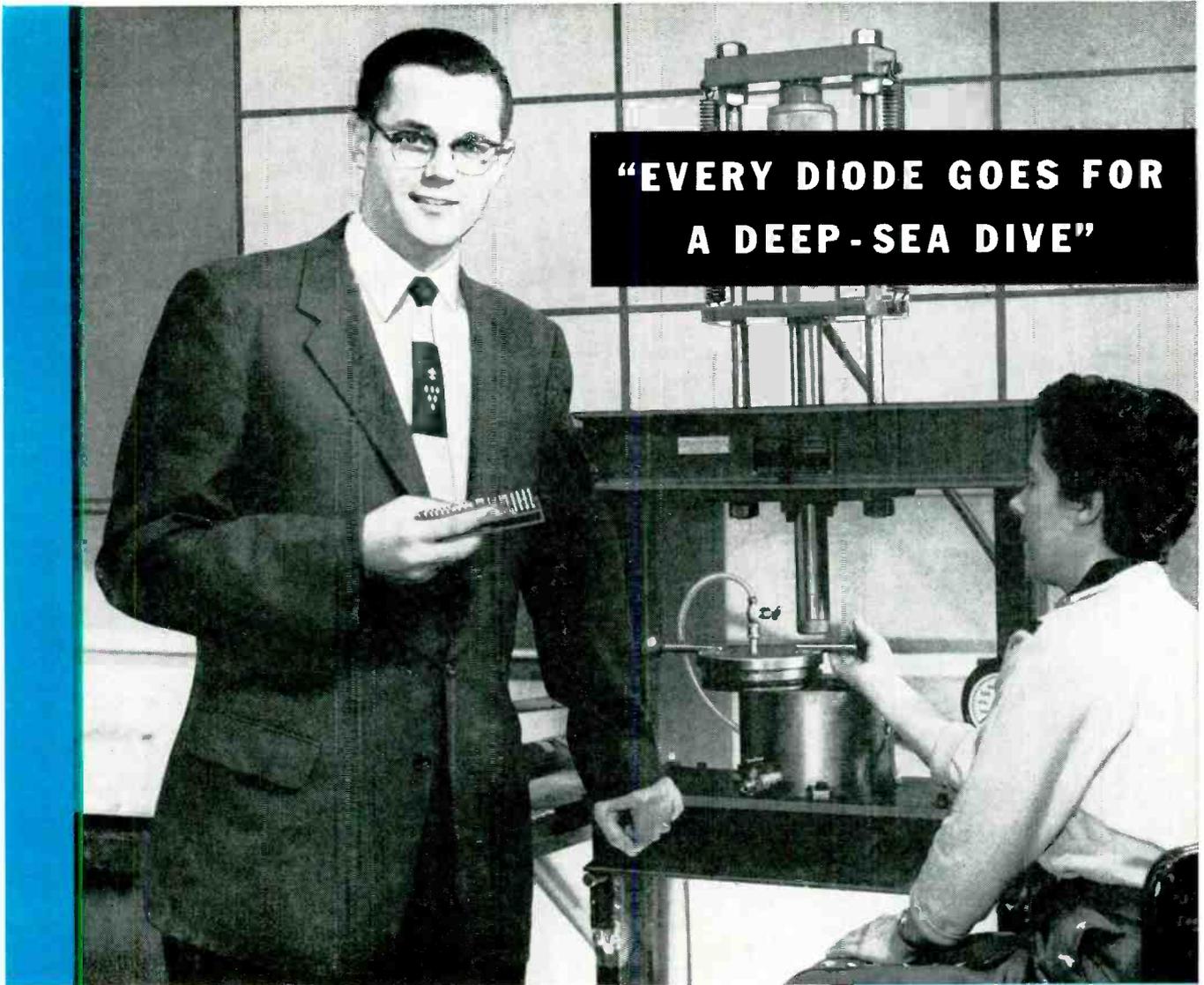
SPECIFICATIONS

<p>CARRIER FREQUENCY RANGE: 50 to 400 Megacycles in 3 bands, 50-100 Mc. 100-200 Mc. 200-400 Mc.</p> <p>FREQUENCY ACCURACY: $\pm 1\%$ Direct reading dial.</p> <p>FREQUENCY DRIFT: Less than .05% after warm-up.</p> <p>OUTPUT VOLTAGE: Continuously variable from 0.1 to 100,000 microvolts.</p> <p>OUTPUT VOLTAGE ACCURACY: At 100,000 microvolts the output voltage accuracy is $\pm 10\%$.</p> <p>OUTPUT IMPEDANCE: 50 ohms, VSWR less than 1.4</p> <p>LEAKAGE AND STRAY FIELDS: Attenuator leakage less than 0.1 microvolt. Power line leakage and stray fields negligible.</p>	<p>MODULATION: Frequency modulation continuously variable, 0-150 Kc on 50-100 Mc band, 0-300 Kc on 100-200 Mc band, 0-600 Kc on 200-400 Mc band.</p> <p>MODULATION FREQUENCY: Internal 400~ and 1000~, $\pm 5\%$ accuracy. External modulation flat within ± 1 db, 250~ to 70 Kc.</p> <p>FM DISTORTION: Less than 0.5% for 75 Kc deviation on 50-100 Mc band, 150 Kc deviation on 100-200 Mc band, 300 Kc on 200-400 Mc band.</p> <p>RESIDUAL FM: Better than 60 db below full deviation.</p> <p>POWER SUPPLY: 117 volts 50-60 cycles, 140 watts.</p> <p>DIMENSIONS: 17-1/4" wide x 11-3/16" high x 14-7/8" deep overall.</p> <p>WEIGHT: Approximately 70 pounds.</p>
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Laboratory Standards



**MEASUREMENTS
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**"EVERY DIODE GOES FOR
A DEEP-SEA DIVE"**

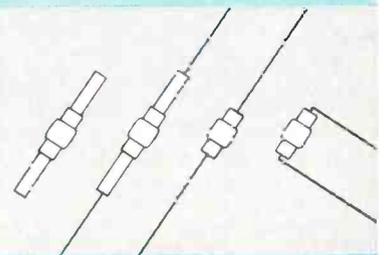
Morgan McMahon, Head of Engineering Services, is in charge of PSI's product applications and manufacturing engineering. Here he holds diodes prior to subjecting them to 1000 p.s.i. hermetic seal test.

"In effect, we take each PSI Diode on a deep-sea dive during our hermetic seal test. *Every* unit is immersed in liquid inside a pressure bomb and subjected to 1000 p.s.i. pressure. Then we test it, viewing its dynamic characteristics on an oscilloscope. Any unit exhibiting instability or possible long-term degradation (evidenced by hysteresis, drift, flutter, discontinuities, excessive reverse current, or low breakdown voltage) is rejected.

"Since no diode is actually *used* under 1000 p.s.i. pressure, what's the point? Just this: Only through application of very high liquid pressures is it possible to identify minute openings through which moisture or other damaging contaminants can ultimately migrate during the service life of the diode. This rigid test increases assurance of the long term reliability of PSI diodes, and therefore, the reliability of the equipment in which they are used."

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If you wish to compare your own procedures for evaluating semiconductor hermetic seals to the Pacific Semiconductors' 1000 p.s.i. liquid-pressure test described here, we will be pleased to send complete test instructions and an equipment list upon request.



PSI germanium and silicon diodes (here, actual size) are offered with these four basic lead arrangements.



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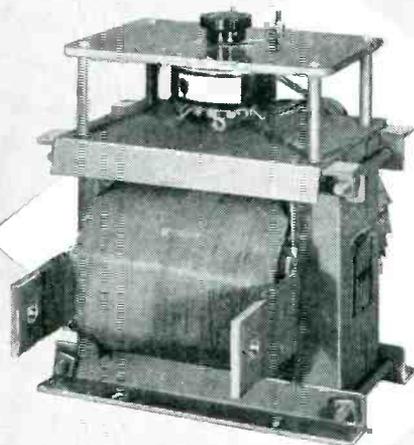
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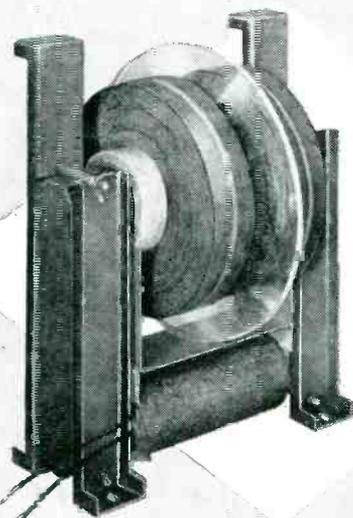
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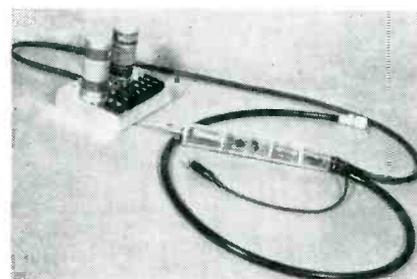
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cathode bias, the input resistance is $R_i \left[\frac{e_1}{e_1 - e_2} \right]$. Here, e_2 is equal to $0.95e_1$, so that the input resistance is calculated to be 9.4 megohms.

The pentode section is capacitively coupled to the triode section which serves as the output cathode-follower driving the low-impedance cable. The cathode resistor for the triode serves also as the terminating resistor for the cable and its size is therefore determined by the characteristics of the cable. An RG-62/U cable terminated with 100 ohms was found satisfactory if the input signal did not exceed 2 volts peak-to-peak, as the circuit overloaded for signals larger than 2 volts.



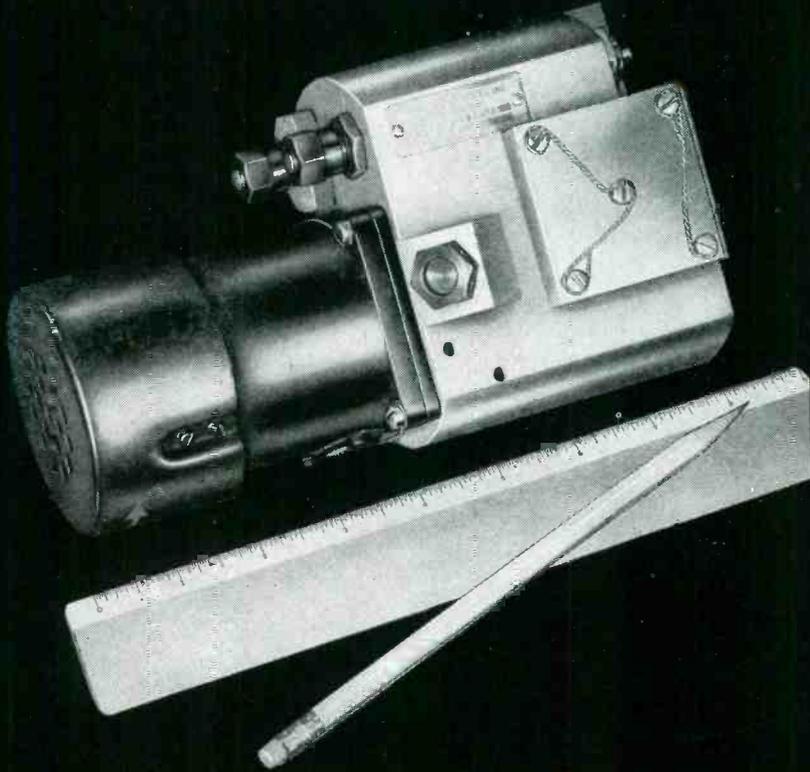
Video probe with power-supply filter chassis. Cable terminating resistor is located in cable connector

Since the particular application for this probe required that the probe be able to accept input signals as large as 8 volts peak-to-peak, the maximum output of the driver stage was increased by using a 200-ohm load and RG-114/U cable.

Mechanical design required that the probe be of convenient size, and that the input network have minimum wiring capacitance and be adequately shielded. The photograph shows the layout of the parts within the probe. The components that carry the a-c signal are grouped together on the bottom side of the tube socket, except for the relatively large screen by-pass capacitor which is located in the space above the tube.

The other leads from the tube socket are brought around the tube by the bus-wires shown. There is enough space between one pair of the bus-wires to permit replacement of the 6U8. The d-c filter components are located with the

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To supply dependable hydraulic power for critical applications, Eastern units are engineered to perform under extreme conditions. Compact design and varying motor sizes make them unique power sources, especially desirable for airborne use. The equipment illustrated in detail presents a typical Eastern Power Unit designed for one application. Many other requirements can be satisfied with designs of this general type.

Unit consists of: positive-displacement pump, electric motor drive, oil reservoir, expansion chamber, porous bronze ten-micron filter, pressure regulating valve, filter relief valve, and expansion relief valve.

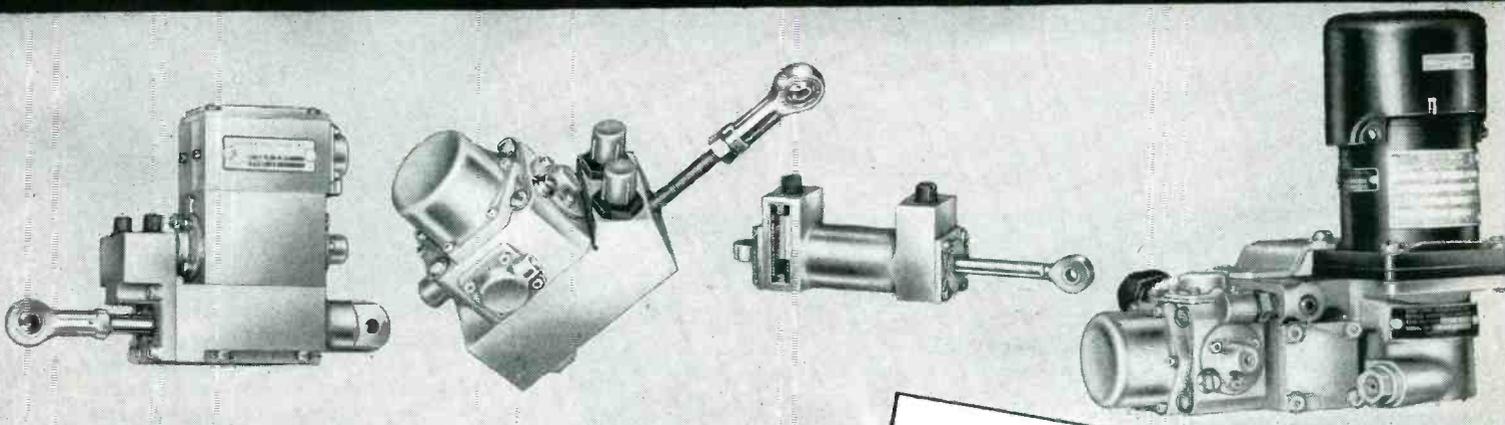
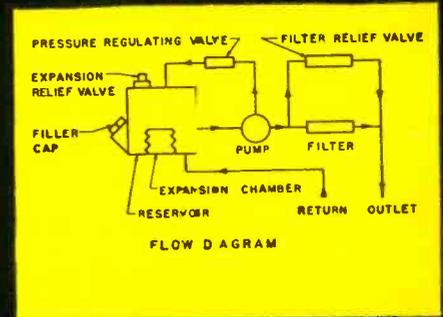
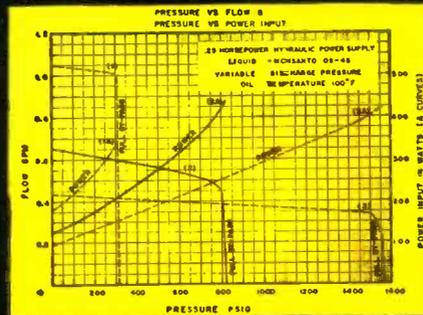
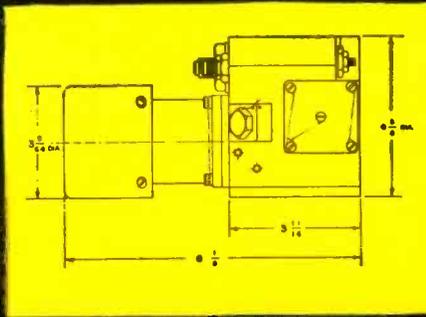
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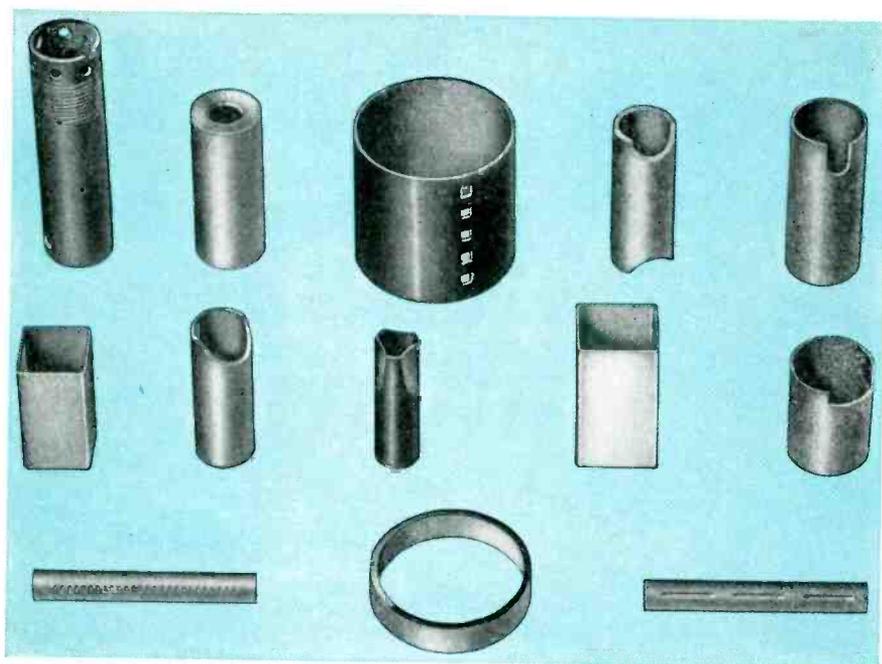
Available with various pump characteristics. Under certain operating conditions, units can be made self-cooling. Example: $\frac{1}{4}$ H.P. Unit has a continuous-duty oil-temperature rise above ambient of approximately 60°F . at sea level. Pressure range from 0 to 1500 PSIG with compatible flow.

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power supply and the d-c voltages are brought to the probe, along with the filament current, on a separate cable.

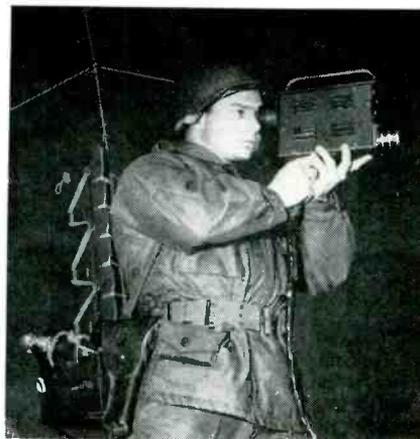
The input is shielded by a copper cylinder that fits inside the probe wall and around the a-c circuit components. Another thin sheet of plastic on the inside surface of the copper shield insulates it from the components within.

The shield is electrically attached to the output circuit and therefore moves voltage-wise with the components within it, minimizing capacitance between these elements and the shield. The low-impedance source to which the shield is attached reduces electrical pick-up from extraneous sources.

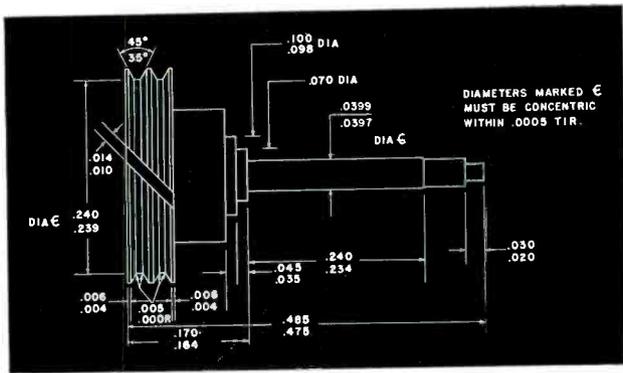
The probe body itself is a plastic cylinder that has a relatively high melting point. Ventilation holes aid in dissipating the heat generated within the 6U8.

The equipment available for testing the bandwidth of the probe indicated that its frequency response was flat to at least 10 mc. Satisfactory transient response was demonstrated by inserting the probe in series with the video line of a closed-circuit tv system that was reproducing the standard RETMA test pattern to better than 600 lines. Except for the loss in

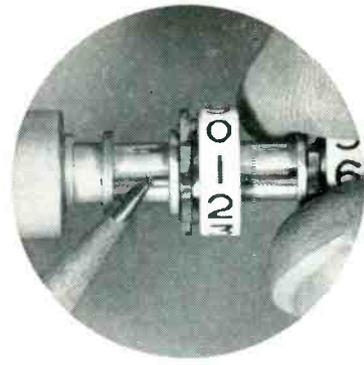
Reconnaissance TV



The hand-held television camera shown weighs only 8 pounds. Transmitter, complete with power supply that will transmit pictures continuously for two hours, weighs 47 pounds. Developed by Signal Corps Engineering Laboratories, the new equipment has a range of about a mile. It could be set up to report, unmanned, from a radioactive or other hazardous location



Inspection of incoming precision shafts took 10 to 15 minutes each by mechanical gaging—involving concentricity, diameters, shoulder locations, and other tough-to-measure dimensions to tolerances of .0002". Doing the work on a Kodak Contour Projector cut time to 2 to 3 minutes per shaft.



The problem was to check many small calculating machine parts averaging about 13 critical dimensions for each with shapes mostly complex. With carefully engineered mechanical gages, inspection time averaged 50 seconds each. Optical gaging on a Kodak Contour Projector brought the average down to 12 seconds.



Spacing the parallelism of a special tuning condenser for electronic test equipment had to be held to very close tolerances. "Use of the Kodak Contour Projector," the company reports, "permits economical measurements of parallelism to an accuracy impossible to obtain by other methods."



On a flexible rubber-like part, rejects ran as high as 30%. By using a Kodak Contour Projector to measure the parts and then plotting results by statistical quality control methods, production changes were made that resulted in rejects dropping from 30% to less than 1/4 of 1%. Optical gaging eliminated distortion of the part while gaging, and proved 4 to 5 times faster than usual methods.

One instrument inspects these varied parts

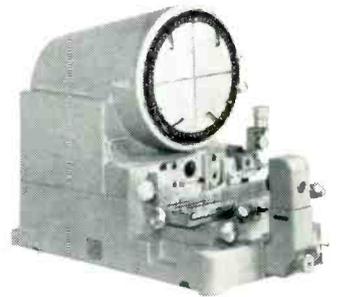
Here is another economy optical gaging can provide: switching from one part to a second part requires only a change of chart and fixture. You still use the same basic instrument. And with a Kodak Contour Projector, the variety of parts you can check is almost without limit. Here's why:

1. *Capacity*—Screen size on an optical comparator does not restrict the size of parts you can handle, for multiple-position fixtures allow the handling of parts larger than the screen itself. What's important is the staging area—and Kodak's unique relay lens provides uniform ample clearance regardless of magnification. The distortion-free image lets you measure anywhere on the viewing screen. The choice of lenses, of horizontal or vertical projection, and of surface or shadow illumination gives you the greatest possible flexibility.
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Projectors are designed for maximum speed and minimum operator training. The bright screen image reduces fatigue, lets you use the instrument in normal room light. Images are erect and unreversed at all magnifications. Finger-tip controls are within convenient reach of the operator.

3. *Optical stability*—The adjustment-free optical elements on Kodak Contour Projectors eliminate the need for operator adjustments. Rigidly mounted lenses and mirrors maintain alignment and position. Rugged construction withstands rough and heavy use.

Whether you are now using optical gaging or just considering it, you should have a copy of the booklet, "Optical Gaging with Kodak Contour Projectors." It gives complete details on Kodak optical gaging equipment and how it can work for you. Write to *Special Products Sales Division*.



EASTMAN KODAK COMPANY, Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Kodak
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gain (0.5), there was no loss in quality of the test pattern while the probe was in the line.

While the same pattern was being reproduced on the tv system, the probe was then attached to various points in the video amplifier circuits without disturbing the quality of the test pattern reproduction, thereby demonstrating that the capacitance introduced by the probe was sufficiently small to prevent loading of the video circuits.

Tube Interchangeability

OF INTEREST to industrial electron tube users is a revised edition of a commercial publication listing 2,000 type designations of 26 different manufacturers. Vacuum power tubes, rectifiers, magnetrons, phototubes and oscillograph types are among categories covered in the industrial listing. The manual is available at moderate cost from RCA Tube Division, Harrison, N. J.

Hurricane Prediction

SEA WATER, an electrical conductor moving through the earth's magnetic field, generates an electromotive force. Across the Florida Straits, from Key West to Havana, about 1 volt is generated as a result of 10^{10} gallons flow every sec-

Power Tube Assembly



Typical of the step-by-step sequence of operations in assembling a beam-power, water-cooled RCA tetrode for use in uhf television is that of placing cathodes in position with tweezers. As shown in the photograph, the tool in the left hand is used to depress the pantograph cathode spring to which the cathode is clipped



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A big advance in hi-precision 10-turn potentiometers



Quality Far Beyond Anything of Comparable Price

Standard Linearity $\pm .3\%$ (as close as $\pm .025\%$ available)
Standard Resistance Tolerance $\pm 3\%$
Standard Resistance Range 500 Ω to 400K Ω
(Resistance Tolerance as close as $\pm .5\%$ available)

Cost advantages are not made by shortcuts at Spectrol. Design and production knowhow make the cost savings. Every potentiometer is produced under the same hi-standard conditions—from precision winding to the rigid quality-controlled final assembly.

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Versatile, accurate, reliable over a long life—available in volume quantities—immediate delivery from stock—the Model 800 is a great advance.

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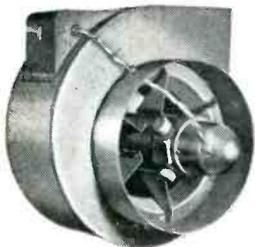
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Rotron inverted blowers are fitted with numerous well conceived inlet and outlet adaptors as well as mounting provisions.

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TYPE 901
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TYPE 702
CATALOG SHEET RM 162



TYPE 505
CATALOG SHEET 40102-10

ond. However, this voltage varies as a function of the discharge or velocity of ocean-current flow through the Straits. The volume of flow varies by a factor of nearly three.

► **Measurements** — Experiments have been carried on since 1952 by physical oceanographers of the Oceanographic Institution at Woods Hole, Mass., using one of the Western Union cables between Key West and Cojimar, Cuba.

In an article in the *Western Union Technical Review* of Jan. 1956, it is suggested that there may be a relation between lower discharge rates and weaker Trade winds and that this might be related, in turn, to a severe hurricane season.

Mobile Tower For TV Remotes

By JOSEPH MITCHELL
*Radio Station WFLA
Tampa, Florida*

IN TELEVISION broadcasting, the trend is to more on-the-spot and remote pickups. In many cases, since there is no handy place of adequate height to mount the microwave transmitter, some means of getting the transmitter high enough must be built.

To construct a 50-to-80 ft tower or scaffold for this purpose is costly for a single show and also takes considerable lead time ahead of the telecast. A 60-foot heavy duty tower has been designed by E-Z Way Towers, Inc. for getting a signal on the air as quickly as possible without the need of guy stays. It can be operated either on the trailer or on a specially rigged truck.

This tower will support a 4-foot dish and microwave transmitter fully extended in winds up to 15 mph and will have less than 3-degree torsion from side to side. Guys can be used to hold down torsion and sway when greater winds are expected.

A special panning head has been developed, which mounts on the top of the tower. The mounting ring

TI PROGRESS REPORT ON
SILICON SEMICONDUCTORS

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TI line of silicon transistors and diodes and stockpile of grown silicon crystals.

TWO YEARS AGO the first silicon transistors were put on the market by Texas Instruments. Enthusiastic acceptance of these high gain, high temperature units has allowed Texas Instruments to repeatedly increase production and reduce prices because of improved mass production techniques.

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4 high temperature small signal transistors

For reliability and economy at high temperatures. Dissipation at 150°C, 50 mw; at 25°C, 150 mw. Maximum collector voltage, 30 volts.

type no.	alpha	alpha frequency cutoff (mc)	gain (db) (design center)
903	0.9 to 0.95	4 (Design Center)	30.5
904	0.95 to 0.975	5 (Design Center)	34
905	0.975 (Min.)	6 (Design Center)	36.5
904-A	0.95 (Min.)	8 (Minimum)	35

3 high temperature medium power transistors

For audio and amplifier stages. Dissipation at 150°C, 150 mw; at 25°C, 1 watt.

type no.	alpha (minimum)	collector voltage (maximum)	gain (db) (minimum)
951	0.9	50	30
952	0.9	80	30
953	0.9	120	30

high temperature power transistor

For output power stages, as in servo amplifier outputs. Dissipation at 100°C, 3.5 watts; at 25°C, 8.75 watts.

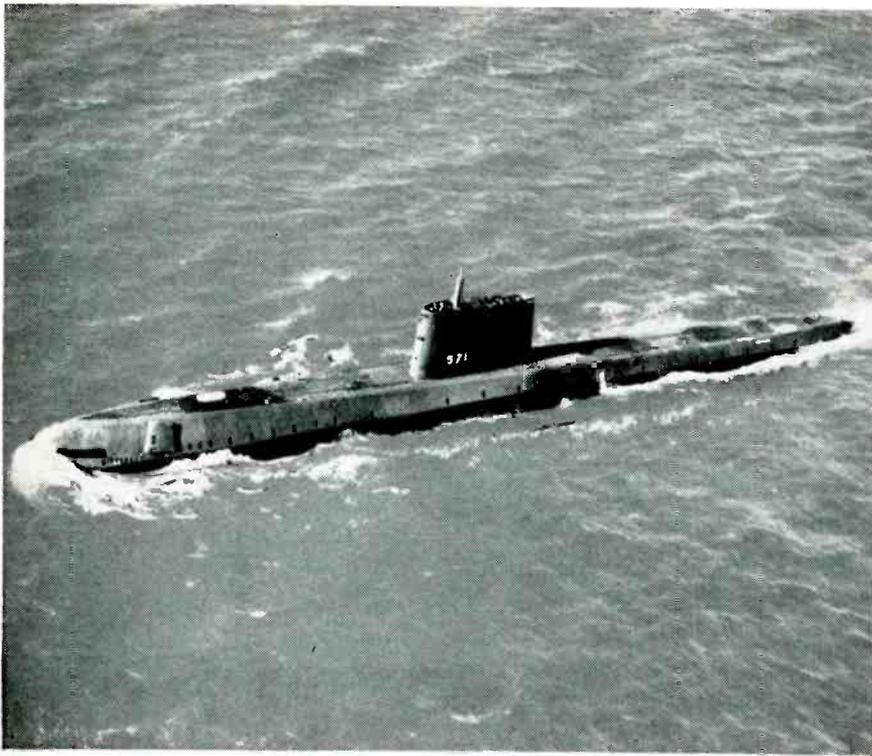
type no.	operation	output (minimum)	gain (db) (minimum)
970	Class A (100°C)	1 watt	28
970	Class B (100°C)	2.5 watts	18

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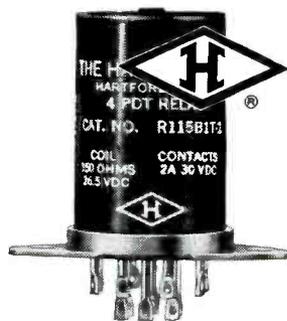


Official U. S. Navy Photograph

'Diamond H' Aircraft-type Relays Go to Sea in the Nautilus

Their reliability proven in such critical land and air applications as guided missiles, jet engine controls and fire control systems, "Diamond H" miniature, hermetically-sealed, aircraft-type relays were chosen by Westinghouse for an important role in the world's first atomic-powered submarine. They're used in the reactor control system of the Nautilus.

Possible performance characteristics of "Diamond H" Series R 4 PDT relays span such broad ranges that the modifications which can be arranged to meet particular sets of requirements are almost endless. They're fully described in Bulletin R250, a copy of which is yours for the asking. Our engineers will gladly work with you to develop a variation for your specific need.



THE HART MANUFACTURING COMPANY

202 Bartholomew Avenue, Hartford 1, Conn.

for the dish and transmitter bolts on this head and the head can be rotated 380 degrees or tilted 15 degrees below the horizontal or 30 degrees above the horizontal by means of two cranks placed at the base of the tower. This allows panning to be done from the ground.



FIG. 1—Trailer carrying tower is located at desired spot. Outriggers keep unit steady while tower is raised in about three minutes

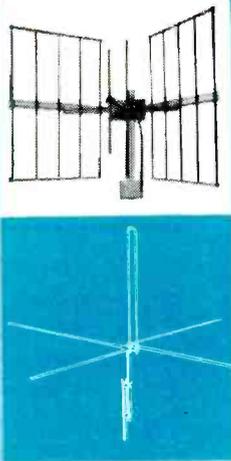
Telescopic shafts are used with this mechanism so that the tower can be raised or lowered to any level without any adjustment to the shafts.



FIG. 2—Panning head and driver shafts. Ring mounted on plate holds transmitter and dish antenna

A second panning head has been developed that will operate two 4-foot dishes with their respective receiver and transmitter; each dish can be rotated 210 degrees and tilted 15 degrees above or below the horizontal. Intended use is at repeater or relay points.

This tower can be loaded on the trailer, pulled to location and set up quickly with the assistance of the trailer and then guyed. The



BARGAINS in POWER

No single piece of radio equipment can equal the antenna for economically increasing effective power.

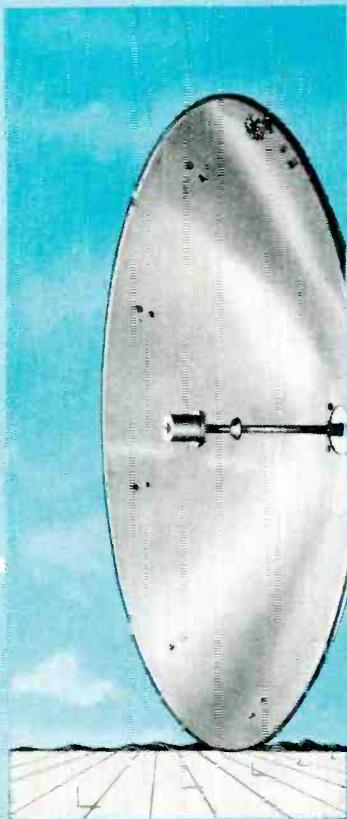
One of the less expensive components in a radio communications installation is the antenna. Yet the antenna, which usually represents less than ten per cent of the total equipment cost, can multiply the effective power of every transmitter in the system *several hundred per cent*. Equally true, a poorly designed or inappropriate antenna can waste the power produced by the costly equipment behind it.

In planning a new system, selection of the proper antenna often will allow a lower power transmitter to achieve desired signal range. For existing systems, the use of a higher gain antenna will reduce "dead spots."

Andrew is a pioneer in designing and developing antennas. We make over 30 standard types for microwave, broadcast and mobile communications. Special models or adaptations of standard models are readily made to order.

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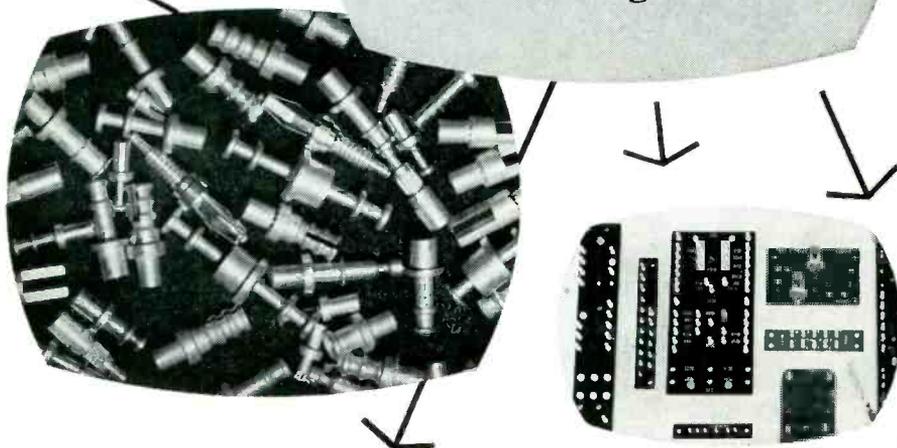
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CATALOGS—See our condensed catalog pages in The MASTER and in ELECTRONIC BUYER'S GUIDE. For more information, write for complete catalog. Please address Dept. 16

trailer can then be unbolted from the tower and taken away for other use.

Scenioscope TV Tube

IMAGE orthicon camera tubes are generally used by tv broadcasters in the United States and for European programs in which there would otherwise be a requirement for special lighting.

The image iconoscope is believed in Europe to produce a somewhat superior picture quality at illumination levels above 1,000 lux. (The lux is equivalent to the foot-candle.) Line-by-line clamping becomes necessary from that value down to about 400 to 500 lux. At low levels, the picture is also likely to be affected by noise.

Operation of the Scenioscope tube is most easily explained in terms of the forerunner image iconoscope for which a schematic cross-section is shown.

An image of the scene to be televised is formed by a special lens on a transparent photocathode. Photoelectrons emitted are deflected by both an electric and a magnetic field. They strike points on a mica target corresponding to the image points from which they were emitted. On the target is produced a pattern or

Transistor Two-Way Portable



Among the growing list of transistorized firsts is the Motorola two-way portable communications set that employs transistors in i-f amplifiers and audio stages of the receiver. Battery drain is thereby reduced more than 70 percent

U. S. ENGINEERING CO., INC.

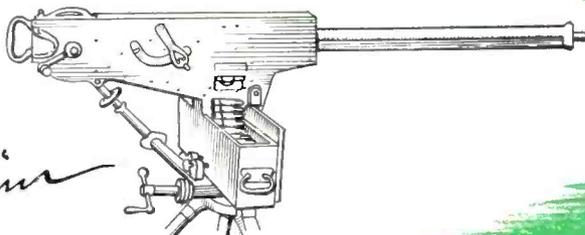
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Hiram Stevens Maxim



FXR BROAD-BAND MICROWAVE SIGNAL SOURCES



with
direct reading
frequency dial—
one-knob control

from
950 to 4000 Mc/s

SPECIFICATIONS

- Type No. N771A: 950 to 2000 Mc/s.
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- Direct Reading Frequency Dial Accuracy: $\pm 1\%*$
- Power Output: 50 mw (average) over the band.
- Internal Modulation: CW, Square Wave and Pulse (400 to 1800 cps)
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*When greater accuracy is required, the FXR Type No. N410A Direct Reading Coaxial Frequency Meter will provide $\pm 0.1\%$ accuracy from 1000 to 4000 Mc/s.

Convenience is the "big gun" of the FXR all-in-one Signal Sources. Into one compact package has been built a power supply, klystron, klystron cavity, modulator, variable rf attenuator and an automatic reflector voltage tracking system. These Signal Sources are as easy to use as your home radio. The speed and ease with which broad-band measurements may now be made increases efficiency and allows more time for other tasks. Also, the output power across the band is high enough for most attenuation measurements.

Microwave engineers who use the compact FXR Signal Sources will appreciate the valuable time saved, the convenience, improved stability and simplicity of operation of these units. This represents another example of FXR's leadership in contributing to progress in the Microwave Test Equipment Field.



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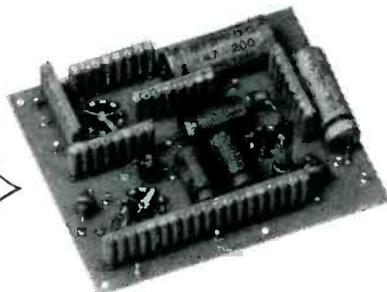
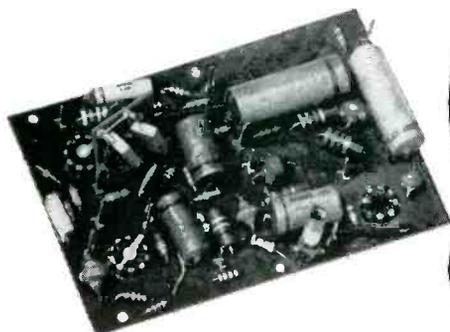
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The ERIE PAC terminal provides a "U" shaped cross section and tapers in both planes to assure easy insertion, self-adjusting—rigid fit, and large contact area.

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All Resistance values between 5 ohms and 50 megohms. Wide range of capacitor temperature characteristics. Parallel and series arrangements readily obtained. Excellent circuit flexibility thru use of printed wiring type base.

REDUCED CHASSIS AREA

Chassis area is reduced by use of the vertical plane design feature. 15 components per square inch.

Erie's new Packaged Assembly Circuit is able to reduce assembly and labor costs for electronic component users by simplifying automation. By employing standard size resistor and capacitor pins, a PAC module can be assembled simply, automatically, and economically.

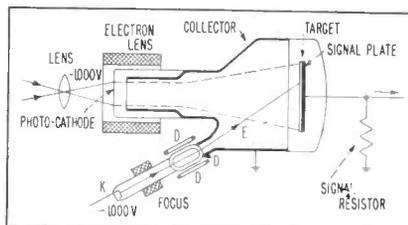
PAC will drastically reduce the number of component insertions in TV, radio, computers, and other electronic equipments by combining up to 90 components into one PAC module. The illustration above clearly exemplifies how Erie's Packaged Assembly Circuit will clean up and simplify nearly any printed circuit board. The original conventional design, at left, contains 44 individual components. The electrically equivalent ERIE PAC design, at right, contains but 16 individual units—a savings of 64% in the number of insertions.

Experimental PAC Design Kits have been prepared and are available at a moderate cost. The 5% PAC Kit includes 195 different resistance and capacitance values, strips, wiring boards, clips, eyelets, and other material essential for building complete PAC circuits. The 10% PAC Kit contains 105 values along with the other items, and the 20% PAC Kit has 54 values plus equipment. This Design Kit is your key to cost savings.

Write for Erie Engineering Bulletin No. 450-1

image of positive charges that is then scanned by an electron beam.

As they are scanned in sequence, the separate picture elements assume a potential corresponding to a secondary-emission factor of unity. Between consecutive scanings, the potential of the individual target elements drops owing to the fact that they intercept slow secondary electrons released from other points on the target by the fast photoelectrons and the equally fast electrons of the scanning beam. This interception effect is known as redistribution. As potential decreases it is increasingly probable that photoelectrons will release secondary electrons from a particular target element.



Cross-section of image iconoscope showing deflection coils *D* and scanning beam *E*. In the new tube, the insulated mica target plate is replaced by a conducting glass plate

Essential difference between the image iconoscope and the Scenioscope lies in the target. This comprises a glass plate having a certain conductivity. It is substituted for the insulating mica plate employed in the image iconoscope.

The back is covered with a layer of metal that acts as the signal plate. It assumes a negative potential with respect to the collector. The scanning beam periodically stabilizes the surface elements of the target at a potential slightly higher than that of the collector.

The potential of a particular element drops in the interval between successive scanings, partly because of interception of redistribution electrons. Main cause of the drop is leakage current through the target. Dominance of leakage current as compared with redistribution tends to eliminate spurious signals.

Signal versus photocurrent in the new tube has a curvature opposite to that of luminance versus control characteristic of a picture tube,

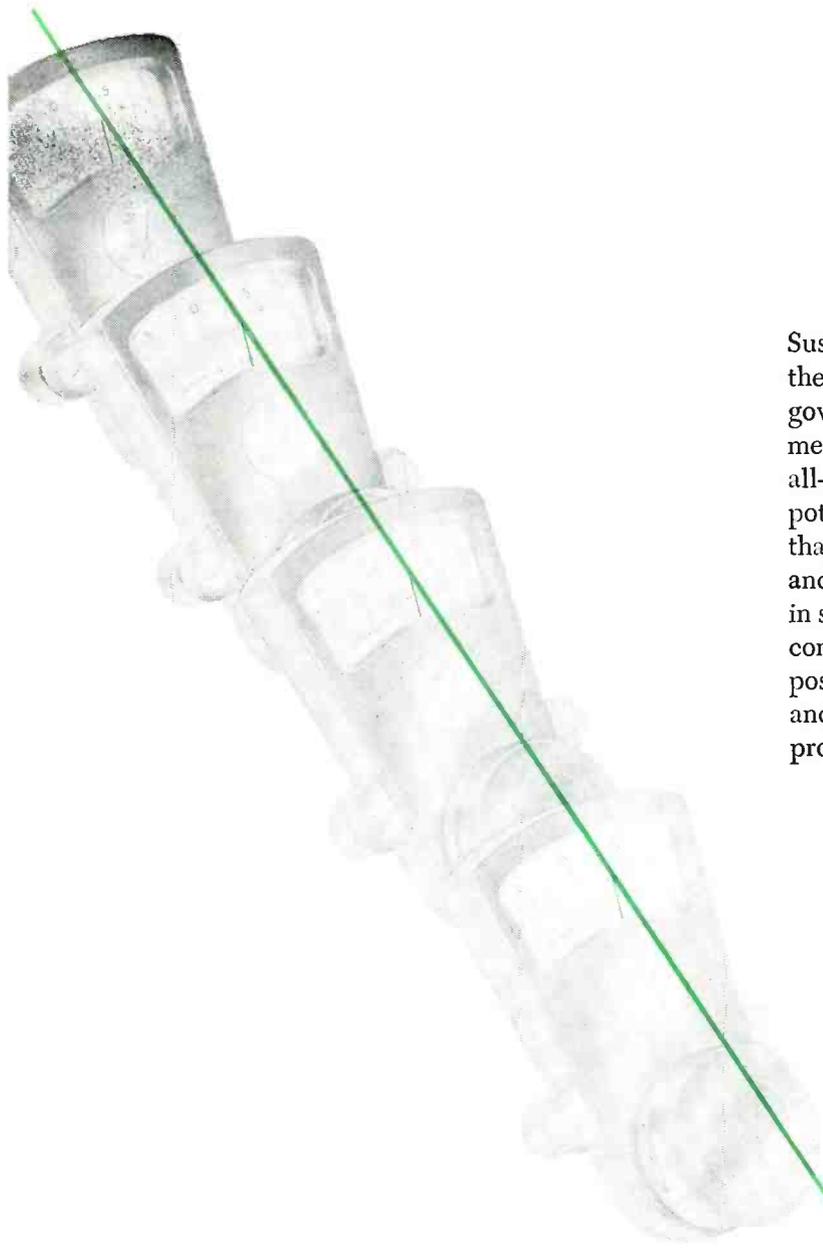


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Sustained electrical accuracy throughout the life of a potentiometer is largely governed by the unit's ability to resist mechanical dimensional changes. The all-metal-case construction of Fairchild potentiometers assures mechanical rigidity that maintains superior initial accuracies and tolerances throughout a long life cycle—in spite of severe changes in environmental conditions. This is another advance made possible by Fairchild's continuous research and quality control program on materials, processes and manufacturing.

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through
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Now for the first time Fairchild brings you the sustained accuracy of all-metal-case construction in a 10-turn potentiometer. This unit has only $\frac{1}{2}$ the diameter and $\frac{1}{3}$ the weight of usual standards. It is the Fairchild Standard Type 920. Its $24\frac{1}{2}$ " coil length assures linearities of $\pm 0.25\%$ in a resistance range of 1,000 to 200,000 ohms, with $\pm 0.1\%$ available for special applications. Your choice of servo, threaded bushing or three-hole pilot bushing mountings.

This is another example of how Fairchild's complete line can give you the answers, no matter what factors govern your choice of precision potentiometers. Write Fairchild Controls Corp., Components Division. Dept. 140-62A2.

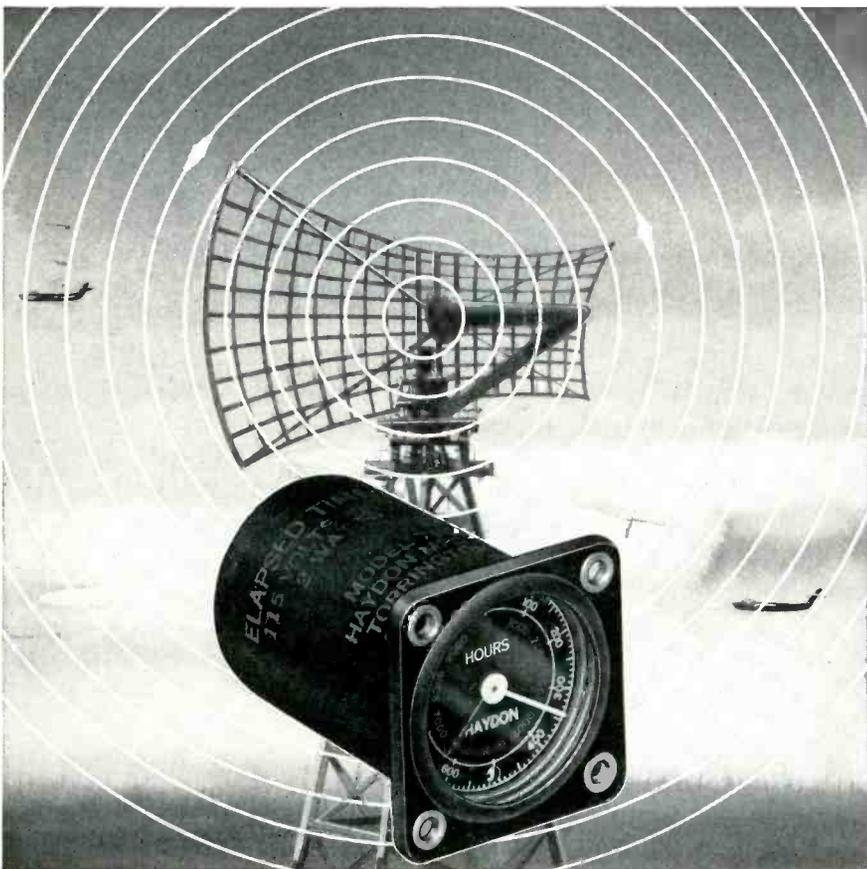
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which eliminates need for gamma correction. A picture of acceptable quality is now obtained with only 100 lux of illumination on the scene. A value of 300 lux is sufficient to insure a virtually noise-free picture.

This information has been abstracted from *Philips Technical Review*, courtesy of North American Philips Co., Inc.

Phonetic Alphabet Changes

STARTING March 1, CAA controllers abandoned use of the phonetic words, COCA, METRO, NECTAR, UNION and EXTRA and substituted CHARLIE, MIKE, NOVEMBER, UNIFORM and XRAY.

These changes have been approved by the International Civil Aviation Organization (ICAO) after tests showed that the five words now replaced were causing confusion.

The latest international phonetic alphabet is

ALFA	NOVEMBER
BRAVO	OSCAR
CHARLIE	PAPA
DELTA	QUEBEC
ECHO	ROMEO
FOXTROT	SIERRA
GOLF	TANGO
HOTEL	UNIFORM
INDIA	VICTOR
JULIETT	WHISKEY
KILO	XRAY
LIMA	YANKEE
MIKE	ZULU

Tube Information Service

NATIONAL Bureau of Standards has on file some 10,000 cards filed by tube type number and appropriately referenced to manufacturers' source material. About 10 percent of the cards, representing more popular types of tubes, have been coded on punched card for mechanical sorting.

With this service it is possible to find information on any tube, all tube types whose electrical characteristics, bulb sizes or base configurations fall within particular



A. Louis Oresman, President of Catalina, Inc., asks

“Can you pick the winner?”

“The bathing suit business is like a beauty contest. You never can tell in advance which models are going to win!

“This year, for example, we designed more than 400 different suits. Those that catch on in the stores get a flood of rush orders! They push our production facilities to the utmost. And that, in turn, puts the pressure on shipping and delivery.

“But even though our manufacturing is done in the Los Angeles area, we never have delivery problems anywhere in

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“Using Air Express regularly, we can fill rush orders anywhere in the country in a matter of hours. And in the highly competitive fashion business, that's important!

“And yet, most of our shipments cost less than any other air service. 10 lbs., for instance, Los Angeles to Dallas, is \$5.70. It's the lowest-priced complete air service by 81¢!”



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We at Lapp are mighty proud of our record in the field of tower insulators. Over 30 years ago, the first insulated broadcasting tower was erected—on Lapp insulators. Since then, most of the large radio towers in the world have been insulated

and supported by Lapp insulators. Single base insulator units for structures of this type have been design-tested to over 3,500,000 pounds.

A thorough knowledge of the properties of porcelain, of insulator mechanics and electrical qualities has been responsible for Lapp's success in becoming such an important source of radio insulators. Write for description and specification data on units for any antenna structure insulating requirement. Lapp Insulator Co., Inc., Radio Specialties Division, 248 Sumner Street, LeRoy, N. Y.

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ranges and domestic tubes that can be substituted for foreign types.

The service is now available to scientists and engineers in government and industry who have legitimate requests. Coding on punched cards is proceeding as rapidly as possible for the balance of the data.

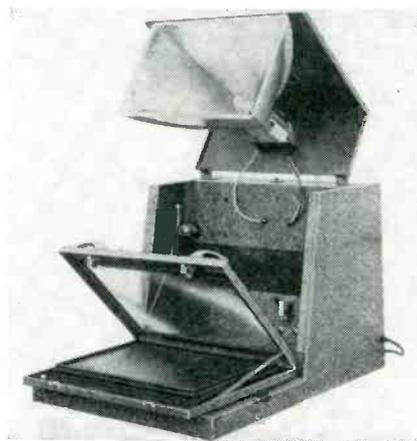
Inquiries can be made by telephone. Written requests should be addressed to C. P. Marsden, Chief, Electron Tubes Section, National Bureau of Standards, Washington 25, D. C.

Microammeter Measures Frequency

AUDIO-FREQUENCY measurements can be made with considerable precision at the lower end of the spectrum using a saturable reactor and a rectifier. A plug-in unit that has been developed recently combines components and requires only a suitable source of voltage and a microammeter to give direct frequency readings.

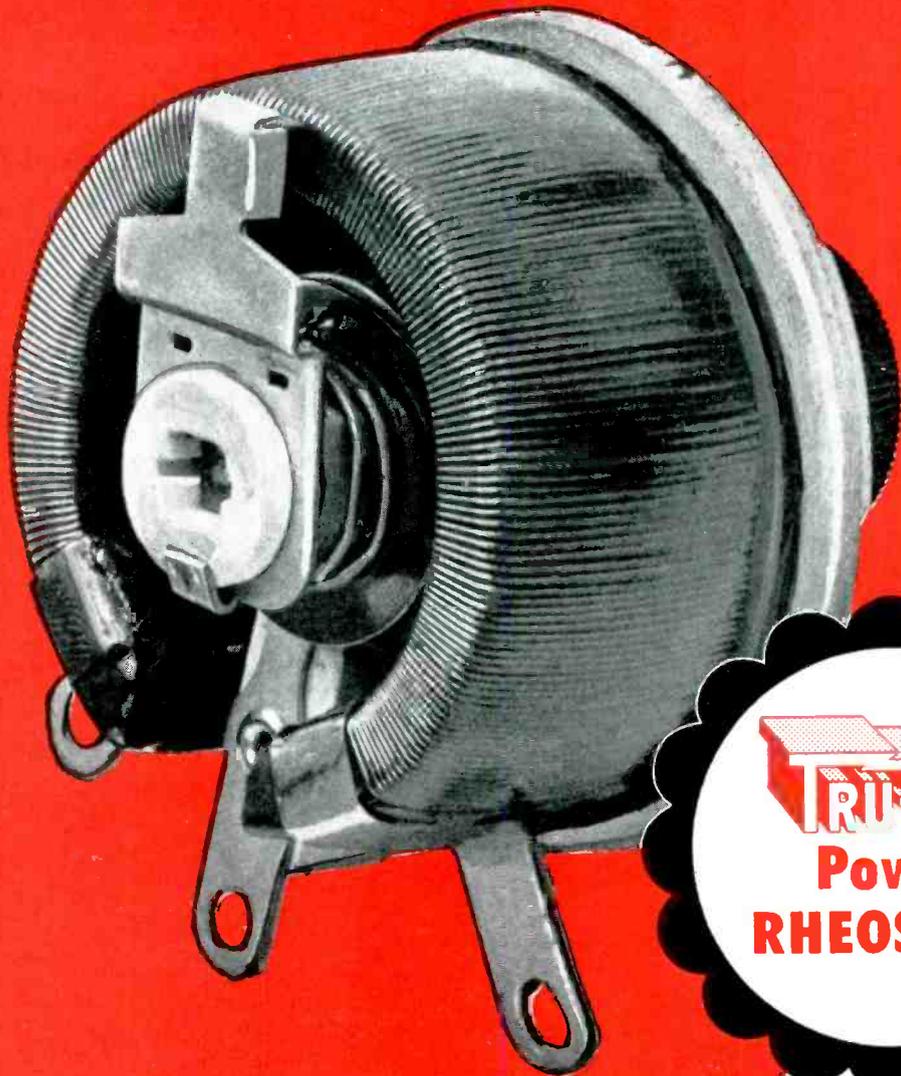
The magmeter is essentially a saturable reactor that serves as a volt-second limiter providing constant output pulses for each reversal of the input signal. These pulses are rectified and delivered to a d-c microammeter to provide output indication. The character-

Plate Photocontrol



A new printer for making presensitized offset plates is controlled automatically by a photoelectric device. Manufactured by Robinson Photomechanix, Inc., it can also be used for albumen and deep-etch plates or with sensitized papers. An etched circuit is employed in the electronic control unit

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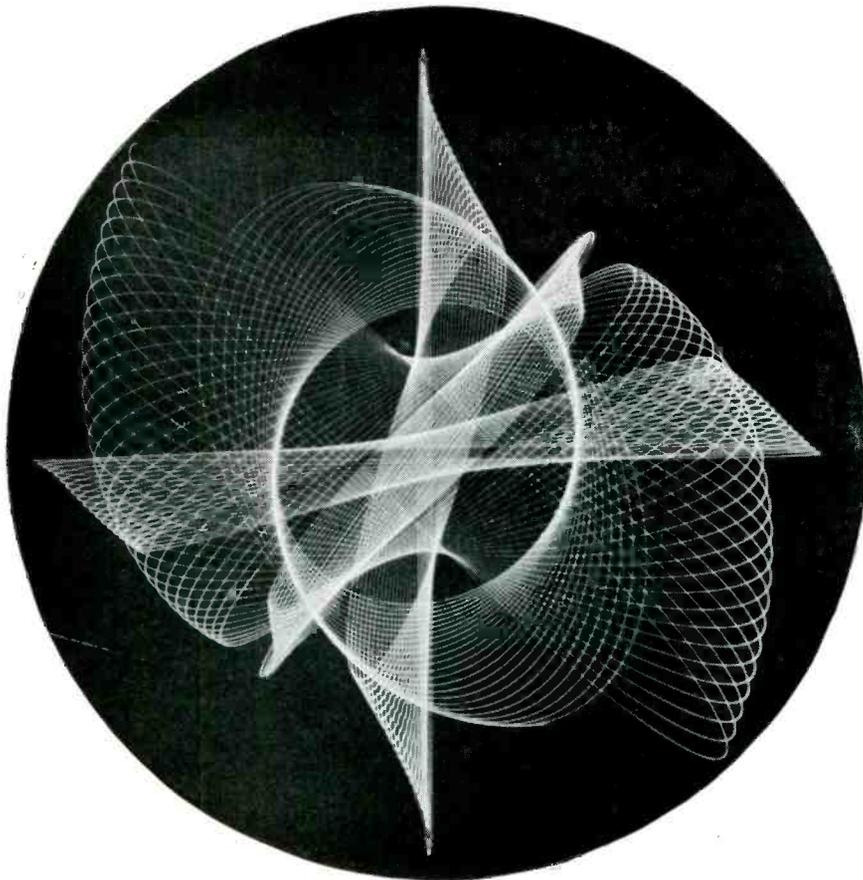
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MARTIN
BALTIMORE

istics of the core material on which the reactor is wound are essentially invariant with time and temperature.

The basic unit lends itself to applications over wide frequency ranges. At low frequencies of 1 to 20 cps it can be used for measurements in which counter-type instruments tend to be inconvenient because they require about 10 seconds for their indications to obtain an accuracy of at least 5 percent.

► **Aircraft Use**—In a typical application, the frequency range is from 0 to 500 cps when used with a 0-500 microampere meter. Where limited signal is available, a vacuum-tube driver (Fig. 1) is used. In this application the frequency detector has a linearity of better than 2 percent of full scale (± 10 cps) plus a temperature coefficient up to 550 parts per million per degree centigrade.

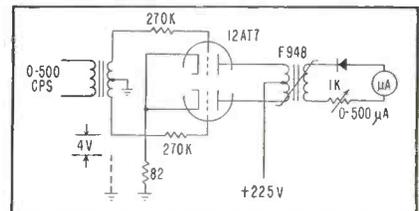


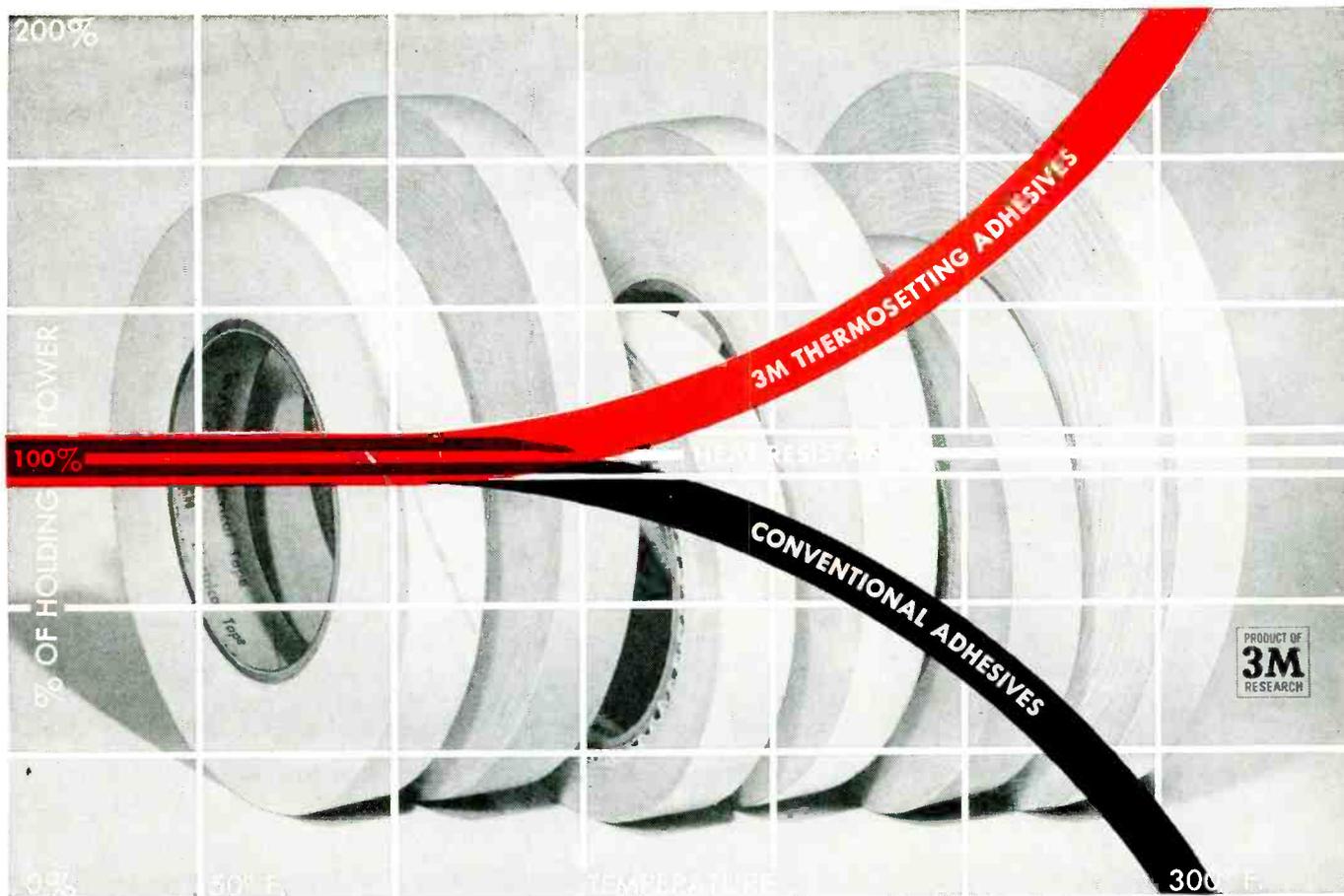
FIG. 1—Reactor and rectifier count cycles

When the input signal is 4 volts rms across each half of the input transformer, a 25-percent change in excitation produces less than 1-percent change in frequency indication. Minimum reliable drive at this point in the circuit is 2 volts rms; maximum safe drive is 6 volts rms.

Response of the magnetic frequency detector is essentially independent of wave form. There is less than 1-percent change in indication for sine, square, or triangular waves having the same rectified average value.

In the circuit shown, the 12AT7 dual triode draws an average current of 15 ma. Interchanging tubes produce less than 1-percent change in output.

► **Operation**—The input transformer matches the driver stage to the low-power signal source whose frequency is to be measured. The bias resistor develops self-bias for



These curves tell a straight story!

Do you find such insulation adhesive terms as *thermosetting*, *heat-resistant*, and *solvent-resistant* confusing at times? For instance, the difference between a pressure-sensitive tape with a "thermosetting" adhesive and one with "heat-resistant" adhesive?

The difference in holding power of the two is graphically demonstrated in the chart above. A "heat-resistant" adhesive simply has a higher-than-average softening point. For many applications, where not subjected to high temperatures, tapes with conventional or heat-resistant adhesives may offer adequate holding power. But if extreme or prolonged temperature is the problem, you need "Scotch" Brand Tapes with 3M *Thermosetting* Adhesive.

The "thermosetting" adhesive on "Scotch" Brand Tapes is soft enough at application to be pressure-sensitive — tapes stick at a touch. When subjected to heat, however, a positive chemical

change takes place which *increases* the adhesive's bond strength — it develops into a firm, insoluble, infusible bond.

Once cured, 3M Thermosetting Adhesive holds under extreme operating heat without softening . . . has high bond-strength for anchoring leads . . . bakes dry to prevent throw-out . . . resists action of solvents, waxes, and varnishes. The only tapes combining all four of these advantages are "Scotch" Brand Tapes with 3M Thermosetting Adhesive.

Why not let us show you how 3M Thermosetting Adhesive Tapes can give better performance in insulating your products? Just write on your letter-head to 3M Co., St. Paul 6, Minn., Dept. CA-46.

These "Scotch" Brand Insulating Tapes have 3M Thermosetting Adhesive: No. 27, Glass Cloth Backing; No. 28, Acetate Cloth Backing; No. 29, Cotton Cloth Backing; Nos. 38 and 39, Treated Paper Backings; No. 56, Polyester Film Backing.

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INFRASONIC

(Ultra-Low Frequency per I.R.E. "Standards on Electroacoustics, 1951")

Voltage Measurements

with the NEW

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FREQUENCY RANGE

0.05cps to 30KC
down to 0.01cps with corrections

VOLTAGE RANGE

0.02 to 200V peak to peak
lowest reading corresponds to
7.07mv rms of a sine wave

ACCURACY

3% throughout ranges
and for any point on meter

IMPEDANCE

10 megohm by an average
capacitance of 30 μ f

OPERATION

Unaffected by line variation
100 to 130V, 60 cycle, 45 watt

APPLICATIONS

The Ballantine Infrasonic Voltmeter Model 316 has been introduced to satisfy a growing need for an instrument to facilitate the measurement of ultra-low frequency potentials as are encountered in low frequency servomechanisms, geophysics, biological research, and in loop analysis of negative feedback amplifiers. Among many other uses, it will serve as a very satisfactory monitor for the output of commercially available ULF signal generators most of which are not fitted with an output indicator.

FEATURES

- Pointer "flutter" is almost unnoticeable down to 0.05cps, while at 0.01cps the variation will be small compared to the sweep observed when employing the tedious technique of measuring infrasonic waves with a dc voltmeter.
- A reset switch is available for discharging "memory" circuits in order to conduct a rapid series of measurements.
- The reading stabilizes in little more than 1 period of the wave.
- Meter has a single logarithmic voltage scale and a linear decibel scale.
- Accessories are available for range extension up to 20,000 volts and down to 140 microvolts.

For further information on this and other Ballantine instruments write for our new catalog.

MODEL
316



PRICE: \$290

BALLANTINE LABORATORIES, INC.



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the dual triode. Bias is such that on positive peaks, the grids draw current.

The 270-ohm limiting resistors clip these peaks so that the reactor unit will not be overdriven. The 1,000-ohm compensating rheostat is initially adjusted with an input of known frequency to produce the correct indication on the meter. The unit weighs 3½ ounces. Information on the circuit has been furnished through courtesy of Airpax Products Co.

F-M Transistor Transmitter

BUILT to demonstrate practical vhf performance of transistors, the f-m transmitter described briefly here occupies a volume of 3½ cubic inches. The essential components in the small device require only a plastic case and compact battery for completion of a working unit.

Only one transistor, shown in the figure, is used. As an r-f oscillator, the transistor operates by virtue of energy fed back through interelement capacitances. Characteristics of the transistor provide an effective phase shift that compensates for that resulting from capacitive feedback.

The transmitter is made to operate in the region of 100 mc principally because of the convenience in obtaining receiving equipment at this frequency. It is adjusted to a channel not occupied by a commercial f-m station.

The mechanism of frequency modulation lies in the characteristic current-gain and phase-shift behavior of the transistor. The d-c operating point is defined by d-c emitter current and d-c collector voltage when no audio signal is applied. If this d-c operating point is changed, there will be a phase shift in fed-back energy.

The oscillator will therefore change frequency by the amount necessary to restore the necessary phase relationship and will continue to oscillate, but at a different frequency. When the operating point is varied at an audio rate, the oscillator will be frequency modulated.

The diode in the base circuit permits stable operation using only one



Consult CHATHAM for all four

including tubes, aircraft conversion equipment, selenium rectifiers and radar components. Illustrated bulletins sent on request.

1 HIGH PERFORMANCE HYDROGEN THYRATRONS

Years of experience in the design and production of these special types have resulted in tubes that offer superior service in the generation of pulse voltages in the order of microseconds.

CHATHAM TYPE 5949/1907



Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 6.25 megawatts.

CHATHAM TYPE VC-1258



Zero bias miniature thyratron for generation of peak pulse power to 10 KW. Available with 28 volt heater, ruggedized for extreme vibration.

CHATHAM TYPE 5948/1754

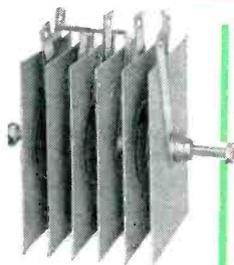


Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 12.5 megawatts.

CHATHAM TYPE VC-1257



Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of pulse power up to 33 megawatts.

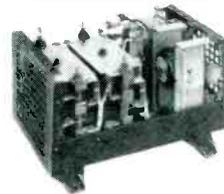


2 LIGHTWEIGHT CHATHAM "kotron" SELENIUM RECTIFIERS

Both electrically and mechanically, Chatham kotron Selenium Rectifiers offer important design advantages. Combining lighter weight with smallest efficient size, kotrons are built rugged to last longer. Improved design assures longer short circuit loads, twice the voltage surge of ordinary rectifiers.

3 ADVANCE DESIGNED

AIRBORNE CONVERSION EQUIPMENT



Input - 195 to 210 volts,
3 phase, 400 cycles
Output - 28 v. DC, 100 amps.
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Weight - under 17 lbs.

Type 28V100 Power Supply illustrated provides substantial weight savings, reduced size, greater reliability and improved electrical characteristics. Ruggedized throughout. Type 28V-100 exceeds MIL-P-7212 requirements.

IF YOU HAVE A PROBLEM — Chatham facilities are available for the solution of problems involving tubes and special equipment for industrial and military applications. Your inquiry will receive prompt attention.

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High power Radar modulators built to government specifications.

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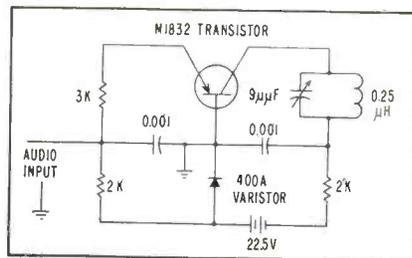
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Circuit of simple 1-m transistor transmitter originally described in *ELECTRONICS*, p 130, Feb. 1954

battery for emitter and collector circuits. The 3,000-ohm resistor prevents undesirable oscillation and the 2,000-ohm resistor (left) provides a path for emitter current without shorting the audio signal. The other 2,000-ohm resistor (right) adjusts d-c voltage on the collector and acts as load resistance in the audio circuit.

Distance covered with the transmitter, using only radiation from the coil of the oscillator circuit, is limited to a few hundred feet. One practical use for such a unit is in conjunction with a lapel microphone and a public address amplifier, leaving the speaker free to roam at will without dragging a microphone cord behind him.

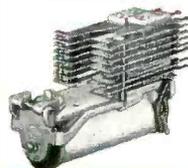
More complete details of the device have been published in the *Bell Laboratories Record*, Feb. 1956, from which this abstract was made with permission.

Hot Dials

ELECTROLUMINESCENT dials have found their way into automobile radio receivers, where, according to the diagram in one service manual, they are caused to glow using 210 volts a-c from the secondary of the vibrator transformer.

A measure of protection would seem to be afforded the user or service man by virtue of a gap, one side of which is connected to the back of the dial scale, the other being at high voltage. The front of the dial scale is grounded.

In the same brochure, it is indicated that some receivers have a 270,000-ohm resistor in series with the high-voltage lead. The value of this resistor can be changed to vary the brilliance of the scale illumination.



MORE THAN A MILLION DEPENDABLE RELAYS IN STOCK

Products of the following well-known manufacturers are represented: Advance, Allied, Automatic Electric, Clare, Cutler Hammer, G.E., Guardian, Leash, Philtrol, Potter Brumfield, Price Bros., RBM, Sigma, Struthers Dunn, Terado, Western Electric and many others.

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An intrstng exprmnt in spch

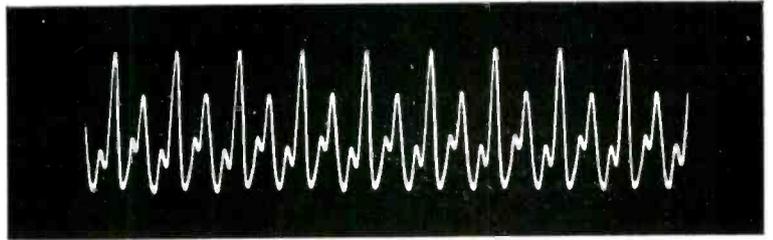
Some day your voice may travel by a sort of electronic "shorthand" when you telephone. Bell Laboratories scientists are experimenting with a technique in which a sample is snipped off a speech sound—just enough to identify it—and sent by wire to a receiver which rebuilds the original sound. Thus voices can be sent by means of fewer signals. More voices may economically share the wires.

This is but one of many transmission techniques that Laboratories scientists are exploring in their search for ways to make Bell System wire and radio channels serve you more efficiently. It is another example of the Bell Telephone Laboratories research that keeps your telephone the most advanced on earth. *The oscilloscope traces at right show how the shorthand technique works.*

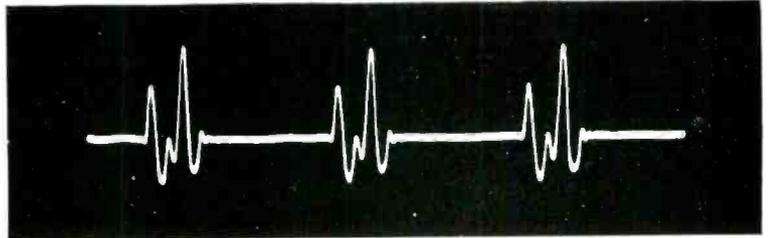


BELL TELEPHONE
LABORATORIES

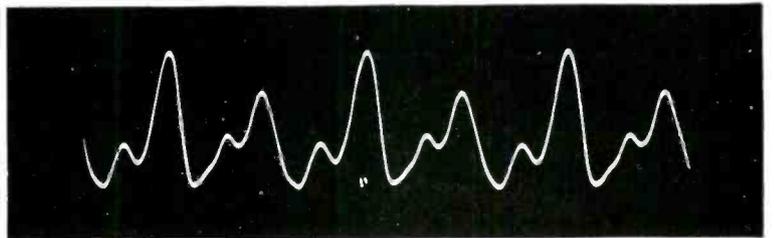
*World center of communications research
Largest industrial laboratory in the United States*



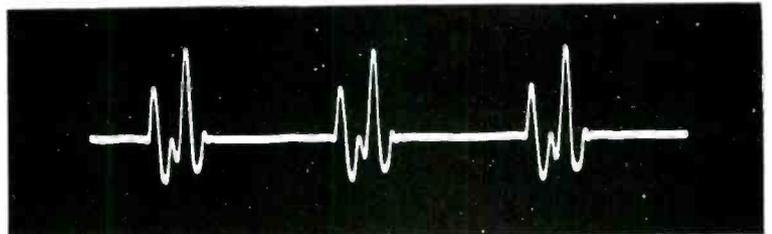
Vibrations of the sound "or" in the word "four." Pattern represents nine of the "pitch periods" which originate in puffs of air from the larynx when a word is spoken.



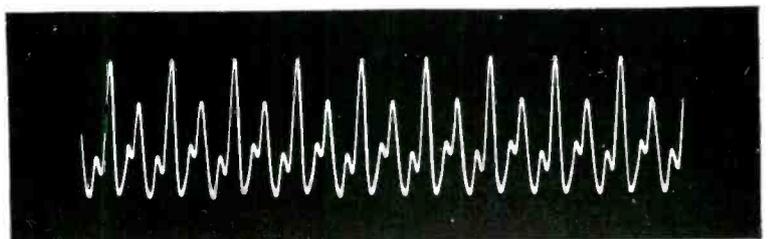
An electronic sampling of the "or" sound. One "pitch period" in three has been selected for transmission. This permits great naturalness when voice is rebuilt. Intelligible speech could be sent through a 1 in 6 sampling.



The selected samples are "stretched" for transmission. They travel in a narrower frequency band than complete sound.



Using the stretched sample as a model, the receiver restores original frequency. In all speech, sounds are intoned much longer than is needed for recognition—even by the human ear. Electronic machines perform recognition far faster than the ear.

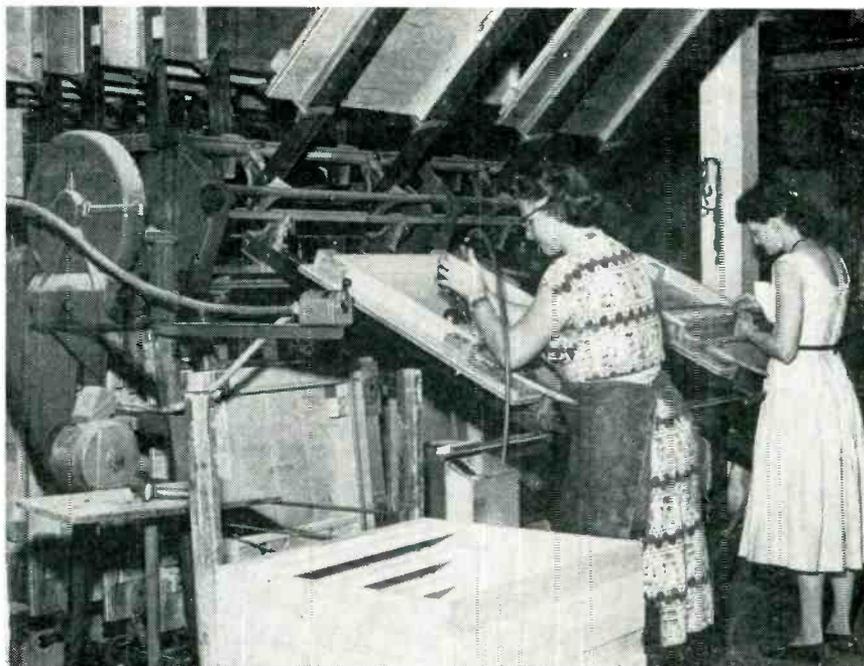


The receiver fills in gaps between samples, recreating total original sound. Under new system, three or four voices could travel at once over a pair of wires which now carries only one—and come out clearly at the end!

Glue-Drying Machine for Television Receiver Cabinet Frames

WOOD FRAMES for fronts of wood-and-metal television receiver cabinets are assembled and dried on a huge revolving-carrier clamping machine at the G-E Rockford, Ill. cabinet plant. The frames are glued and placed in the captive wood clamps for installation of screws. The completed frames then move over the top, down and back underneath the long horizontally mounted drying machine to the starting position while the glue dries. Two sets of clamps are on each carrier, so frames can go through two at a time.

Installing screws after loading glued frames onto carriers of horizontal endless-chain clamping and drying machine. Crank handles of clamps are at outer ends of carriers



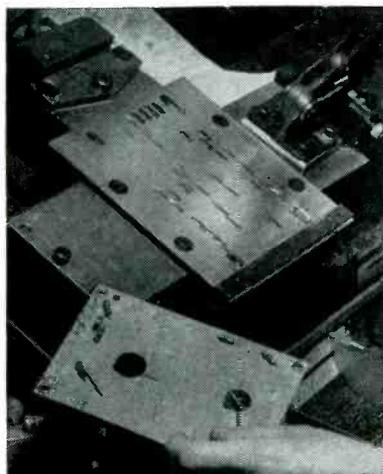
Cutting and Clinching Machine for Etched Wiring Boards

A SIMPLE air-operated machine is widely used in RCA's Bloomington, Ind. plant to cut and clinch leads of components automatically after they have been manually inserted

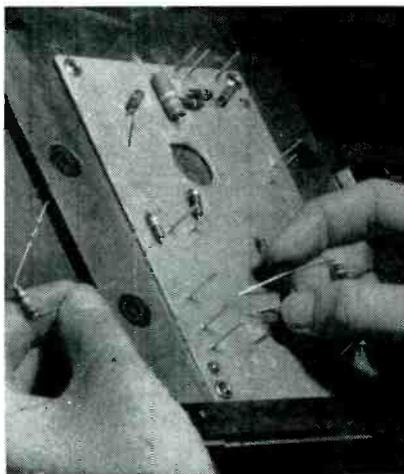
in etched wiring boards. These setups eliminate the need for preliminary preparation of components, since the operator can bend the leads with her fingers as she in-

serts them in the holes in the board.

Each operator inserts only a specified group of parts, just as in a conventional manual assembly line. Boards are transferred from



Cutting and clinching blade of machine. Holes in plate under blade serve as cutting die for shearing action



Method of loading components into wiring board on cut-and-clinch machine. Operator bends leads herself



Bringing up lever to press down newly inserted components preparatory to cutting and clinching



going...

going...



gone!



KESTER "44" RESIN, PLASTIC ROSIN AND "RESIN-FIVE" FLUX-CORE SOLDERS owe their production line popularity to the simple fact that they provide the exactly right solder for every soldering application. It's not difficult to realize why Kester is consumed so rapidly . . . because of its great adaptability to so many different soldering operations.

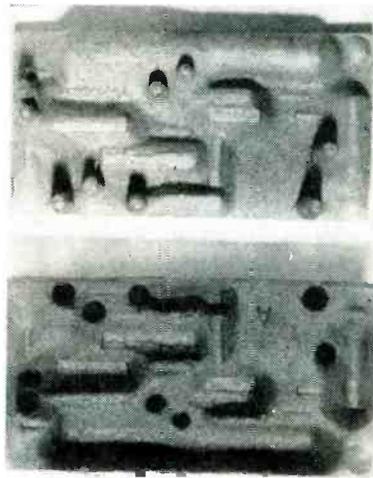
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KESTER SOLDER

COMPANY 4204 Wrightwood Avenue, Chicago 39, Illinois; Newark 5, N. J.; Brantford, Canada

one station to the next by a conveyor belt that runs under the cut-and-clinch machines. Taking a board off the belt, the operator places it over positioning pegs on the machine, then loads in her assigned components one by one. Next, with her right hand she brings up a lever that presses a rubber-cushioned plate down over the board. This plate has appropriate recesses and cushions to press the newly loaded parts down without crushing them and damaging previously inserted parts.

Pressure on a foot pedal then operates the air cylinder of a Speedy Air Vise to move the shearing blade down toward the operator. This blade cuts all leads simultaneously. Further movement bends the cut ends down against the



Aluminum mold (top) and sponge rubber pressure pad made from it for use in holding components down on wiring board while cutting and clinching leads

the desired rubber pad. This board is then used as a pattern in a sand mold for pouring an aluminum mold. The aluminum mold is used in turn as the master for producing as many rubber pads of that pattern as are desired. This is done by placing a sheet of uncured sponge rubber over the aluminum and then curing under heat and pressure much as when making rubber stamp pads. The resulting contoured rubber pieces are then cemented to the metal pressure plates.

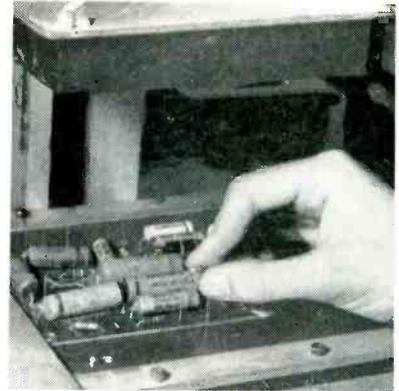
Newer versions of these cut-and-clinch machines use a vertically mounted air cylinder to bring down the pressure pad, speeding up the operation still more. The two air cylinders are interlocked, so that one touch of the foot valve operates them both in sequence.



Initial method of contouring pressure plate by glueing carved pieces of sponge rubber in position

etched wiring. Contoured recesses in the shearing blade give a neat clinch without crushing the board. A slanting trough collects the cut leads and guides them down into a scrap box on the far side of the belt.

Initially, the rubber hold-down pads were made by carving pieces of sponge rubber and cementing them in appropriate positions on a metal plate. Increasing use of the highly successful cut-and-clinch machines justified changeover to a casting technique. For each machine, a board having the parts correctly assembled on it is plastered with modeling clay in the reverse of

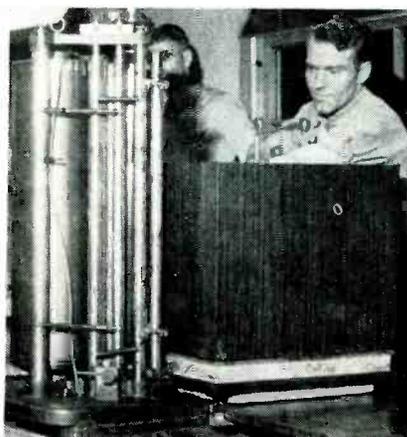


Setup using overhead pressure pad having its own air cylinder

Finishing Techniques for Wood-Metal TV Cabinets

ACCURATE MATCHING of simulated and actual wood finishes on combination wood-metal television receiver cabinets is achieved at the G-E Rockford, Ill. cabinet plant, by combining roller-graining and electrostatic painting with final hand spray gun touchup.

After receiving the prime finish coat, the metal cabinet shells that form the sides and top of each table-model cabinet are moved by overhead conveyor to the roller-grain room. Here the cabinets are transferred manually to wheeled pallets that can easily be slid along a metal-top bench. Each finished face of the cabinet in turn is rolled past the roller-grain units mounted

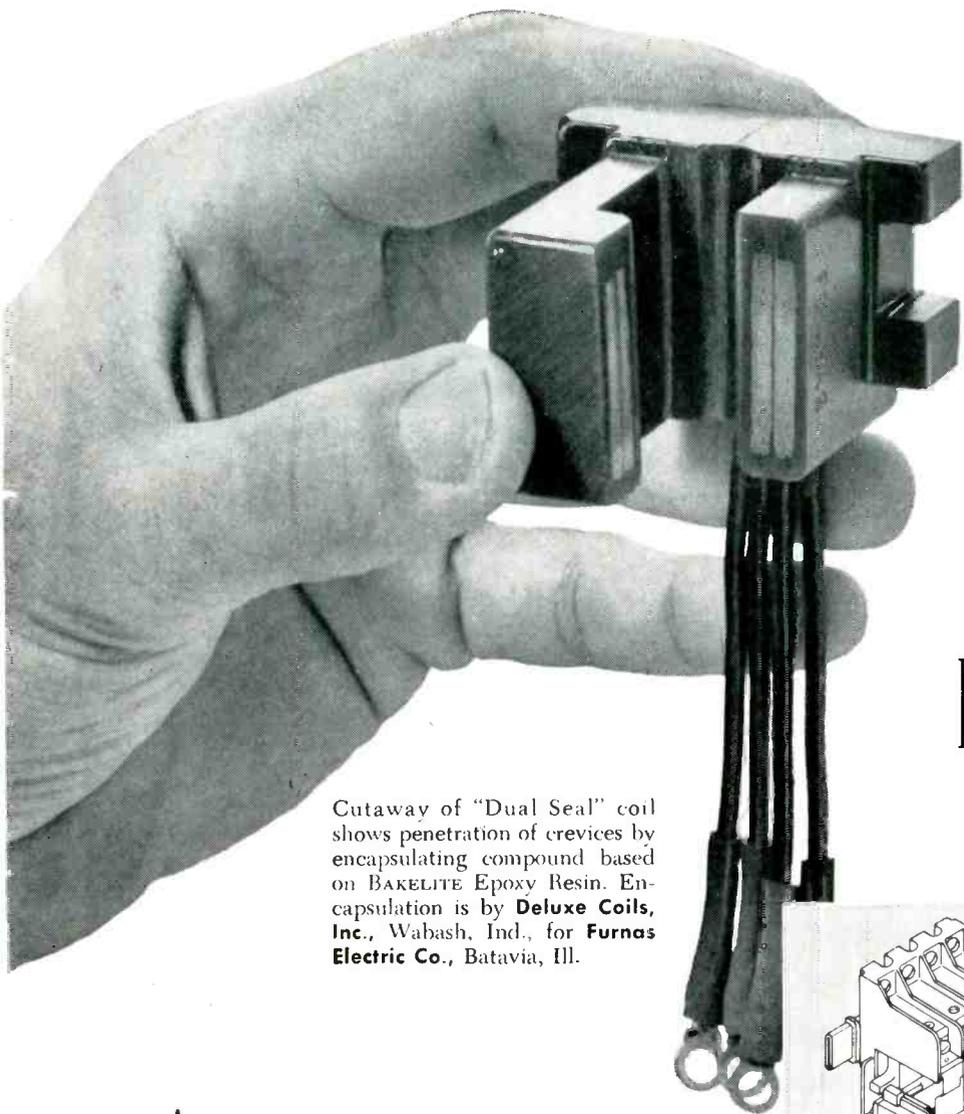


Applying roller-grain finish to metal cabinet shelves

vertically at the rear of the bench, for application of the simulated

wood finish to the metal panels forming the sides of the cabinet.

► **Spray Disk**—After draining, the metal cabinet shells are loaded on another overhead conveyor for transport through a Ransburg electrostatic paint station, to receive a clear scuff and stain resistant finish. The shells travel around this room in a circular path on the conveyor while the rotating-disk painting fixture moves up and down in the center of the room. As the paint comes out of the center of the rotating disk, it is electrostatically charged to a high positive potential. The centrifugal force of the disk combined with the attraction of the



*Encapsulated
in epoxy resin*

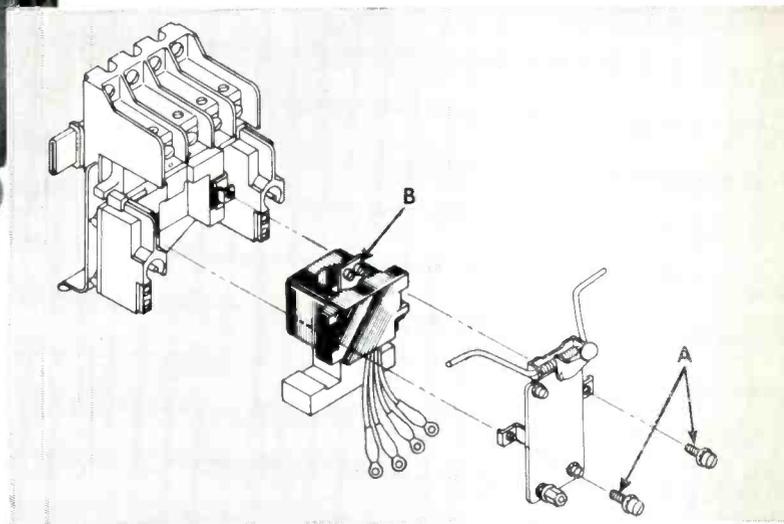
One coil replaces six!

Cutaway of "Dual Seal" coil shows penetration of crevices by encapsulating compound based on BAKELITE Epoxy Resin. Encapsulation is by **Deluxe Coils, Inc.**, Wabash, Ind., for **Furnas Electric Co.**, Batavia, Ill.

A single 220-440 volt dual voltage coil encapsulated in BAKELITE Brand Epoxy Resin takes the place of six coils usually needed in 3, 7½, and 10 hp. starters. It virtually eliminates coil changing, reduces stocking of coils and starters.

The BAKELITE Epoxy Resin encapsulation is extremely tough. It resists moisture, fungus, and aging; cuts moisture-caused burn-out almost to zero. The tough resin prevents damage by vibration or impact. It withstands temperatures from -90 to +250 deg. F, and results in a motor that runs eight per cent cooler. Dielectric strength of the resin is high.

Encapsulation with BAKELITE Epoxy Resin is effected by mixing the liquid resin with its liquid hardener and pouring the mixture into place. It penetrates every crevice, then hardens into a tough, dimensionally stable mass that holds each element of the assembly firmly in position.



New coil design has stretched mechanical life of starter more than 50%. Extracting two bracket screws "A" and loosening of cross arm screws "B", as shown in exploded drawing, make coil removal easy.



Designed for



Application

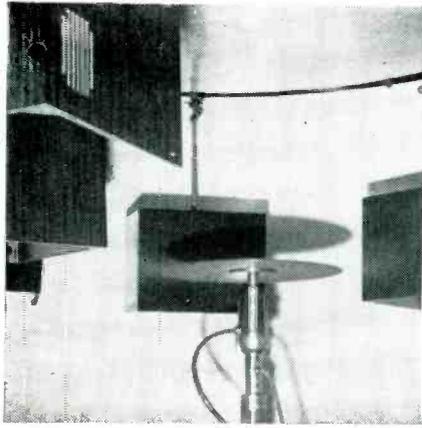


**The No. 90901
One Inch
Instrumentation Oscilloscope**

Miniaturized, packaged panel mounting cathode ray oscilloscope designed for use in instrumentation in place of the conventional "pointer type" moving coil meters uses the 1" 1CP1 tube. Panel bezel matches in size and type the standard 2" square meters. Magnitude, phase displacement, wave shape, etc. are constantly visible on scope screen.

**JAMES MILLEN
MFG. CO., INC.**

MAIN OFFICE AND FACTORY
MALDEN
MASSACHUSETTS



Electrostatic spray room, showing disk



Matching wood and metal finishes

grounded cabinet shells serves to give an even coating over the entire outside surface of the shells.

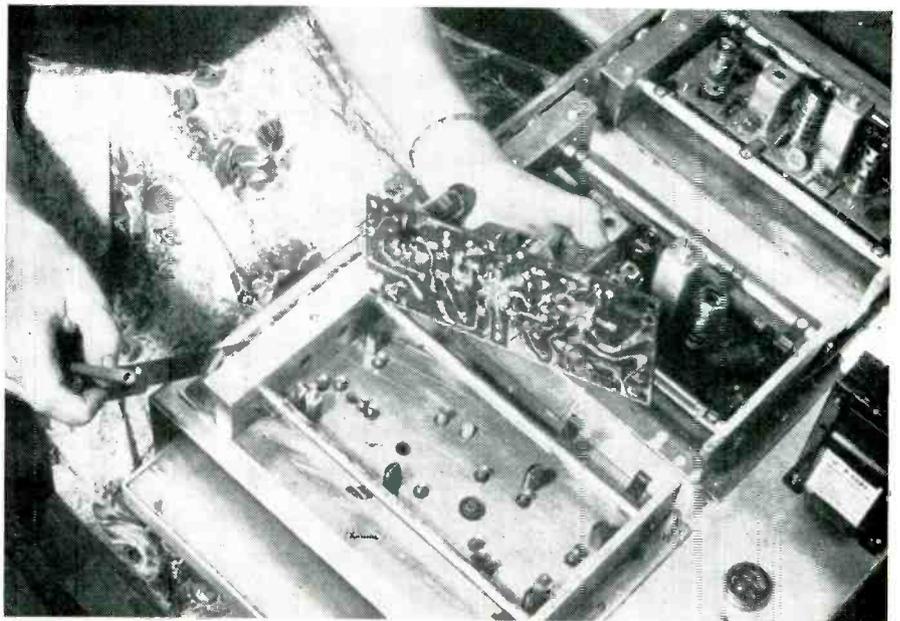
► **Shading**—After the wood front frame has been attached to the metal cabinet shell, final shading insures that the finish on the wood will match the simulated finish on the top and sides. This detailed

spray painting operation is performed with a hand-held spray gun in a spray booth while the cabinets move past on a roller conveyor. The pallets used are large enough to hold two cabinets back-to-back. A large cog arrangement serves to turn the pallets automatically so that the painter can easily process both sides of the wood frame.

Gear-Operated Video I-F Alignment Setup

AFTER dip soldering, tv boards are tested and aligned in semi-automatic setups at RCA's Indianapolis and Bloomington plants. Three positions are usually provided, to give preheating time. The boards are placed over spring-loaded con-

tacts positioned to meet with the desired terminals on the etched wiring. A lever is then used to actuate a train of four gears. These move spring holding fingers down over the board to press it against the contacts. When the board is in



Placing board on empty position while tubes are warming up preparatory to alignment at other two positions

UNITED ANNOUNCES

NEW DC-6A CARGOLINERS

Five new DC-6A Cargoliners® are joining the United Air Lines fleet — increasing our all-cargo space by nearly 70%! Each of the new DC-6As carries up to 30,000 pounds of cargo, at 300 miles an hour . . . and accommodates single pieces up to 76" x 81" x 115", and up to 8000 pounds.

Each is equipped with radar, a United cargo-plane "exclusive" for smoother flight and better on-time performance—plus many other improvements of special interest to shippers.

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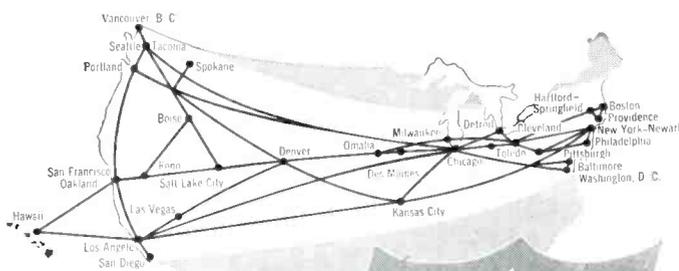


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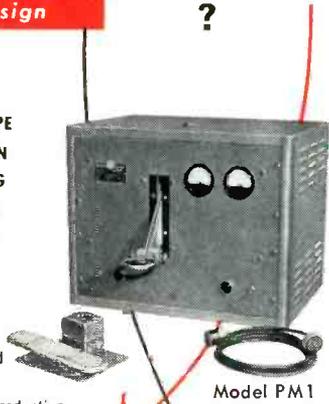


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position it holds down the nylon button of a master switch that applies plate voltages to the circuits of the board.

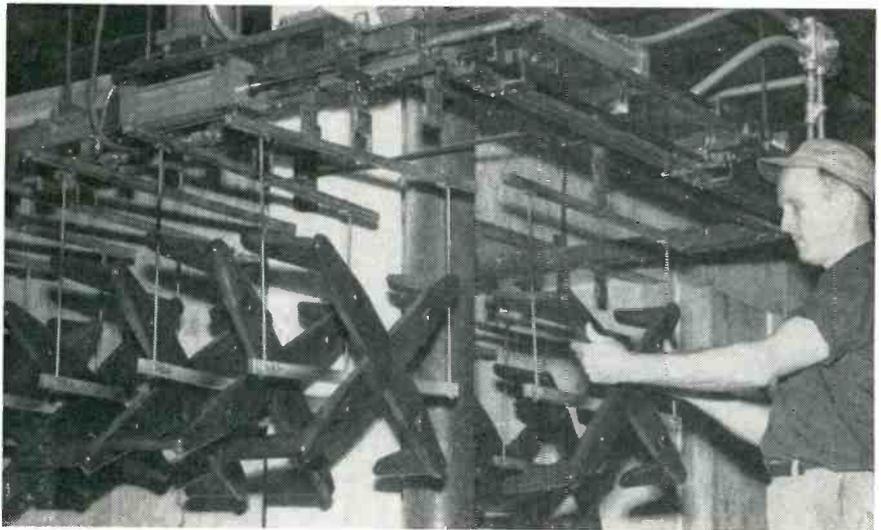
Anvils support the board under transformers requiring adjustment, to prevent breakage of the board under pressure of the adjusting tool. Other chromium-plated anvils are located directly under the spring hold-down springs so as to give good ground connections for the etched wiring.

When adjustments must be made below a board, captive screwdrivers are mounted under the test bench.



Moving lever to rotate gear train that brings spring clips into position to push wiring board down over contacts

Square-Corner Conveyor Saves Floor Space



Square-corner conveyor transfer setup at output of drying tunnel for spray-finished bases

AFTER WOOD swivel-base sections for television receiver cabinets travel through a curing tunnel for drying of their finish coats, a hydraulically operated shifting device automatically transfers each carrier in turn transversely to a parallel conveyor running back to the input of the tunnel. Use of this square-corner conveyor technique saved 75 percent of the space that would otherwise be required for this operation at the G-E Rock-

ford, Ill. television cabinet plant.

Air cylinders actuated by trip-lever valves make the transfer operation completely automatic. When a conveyor hanger reaches the end of the line, it trips the first air cylinder. This pushes the hanger onto the transverse track and moves it to the end of this short track. The hanger then trips the valve of the other cylinder, and this in turn pulls the hanger onto the long return conveyor line.

Solenoids Connect Etched Wiring Board

SOLENOIDS tripped by snap-action switches make all connections and apply all voltages automatically when an operator slides a sweep board into position at a special

test and alignment setup in the Metuchen, N. J. television plant of Westinghouse Electric Corp. Interlocking switches insure that action cannot start until the board has

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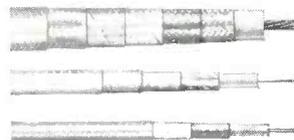
If your cable problems involve heat, space or weight, it will pay you to consider Federal's new "Teflon" insulated cables. For information, write Dept. D-913A

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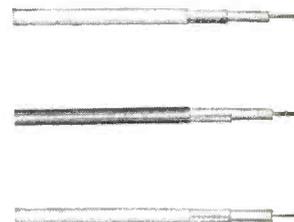


"TEFLON" MINIATURE COAXIAL CABLES

K-256 50 ohms; 29 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 13 db/100 ft. Atten. at 400 mc; 0.095 O.D. dielectric; 7/30 silver-plated Copperweld conductor; 0.135 O.D. jacket.

K-257 70 ohms; 21 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 14 db/100 ft. Atten. at 400 mc; 0.095 O.D. dielectric; 7/34 silver-plated Copperweld conductor; 0.135 O.D. jacket.

K-258 93 ohms; 16 mmf/ft. Cap; 72% V.P.; 850 V rms Corona; 15 db/100 ft. Atten. at 400 mc; 7/38 silver-plated Copperweld conductor; 0.135 O.D. jacket.



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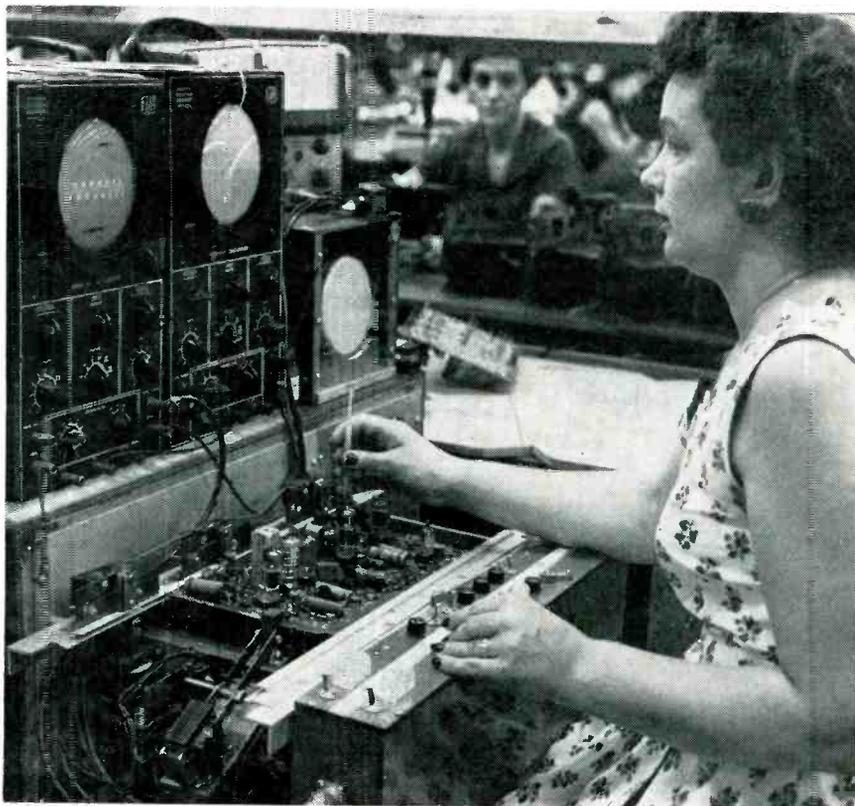
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Adjusting transformer on sync board. All connections are made automatically by solenoids after operator slides board into position on test stand

been pushed all the way in between the two aluminum slides. Solenoids on opposite ends of the board then operate to lock the board rigidly in position, after which other solenoids bring a bank of spring-loaded

contacts up against the bottom of the board and apply operating voltages. The operator can then proceed with test and alignment, using the automatically connected scopes as indicators.

Take-Apart Spools for Magnetic Telemetry Tape

By W. D. ISBELL

*Flight Test Engineer
 Convair (San Diego)*

A Division of General Dynamics Corp.



New take-apart spool, at left, being disassembled from airborne tape recorder. Extra sleeve appears in center foreground. Spool at right is older solid type that cannot be taken apart

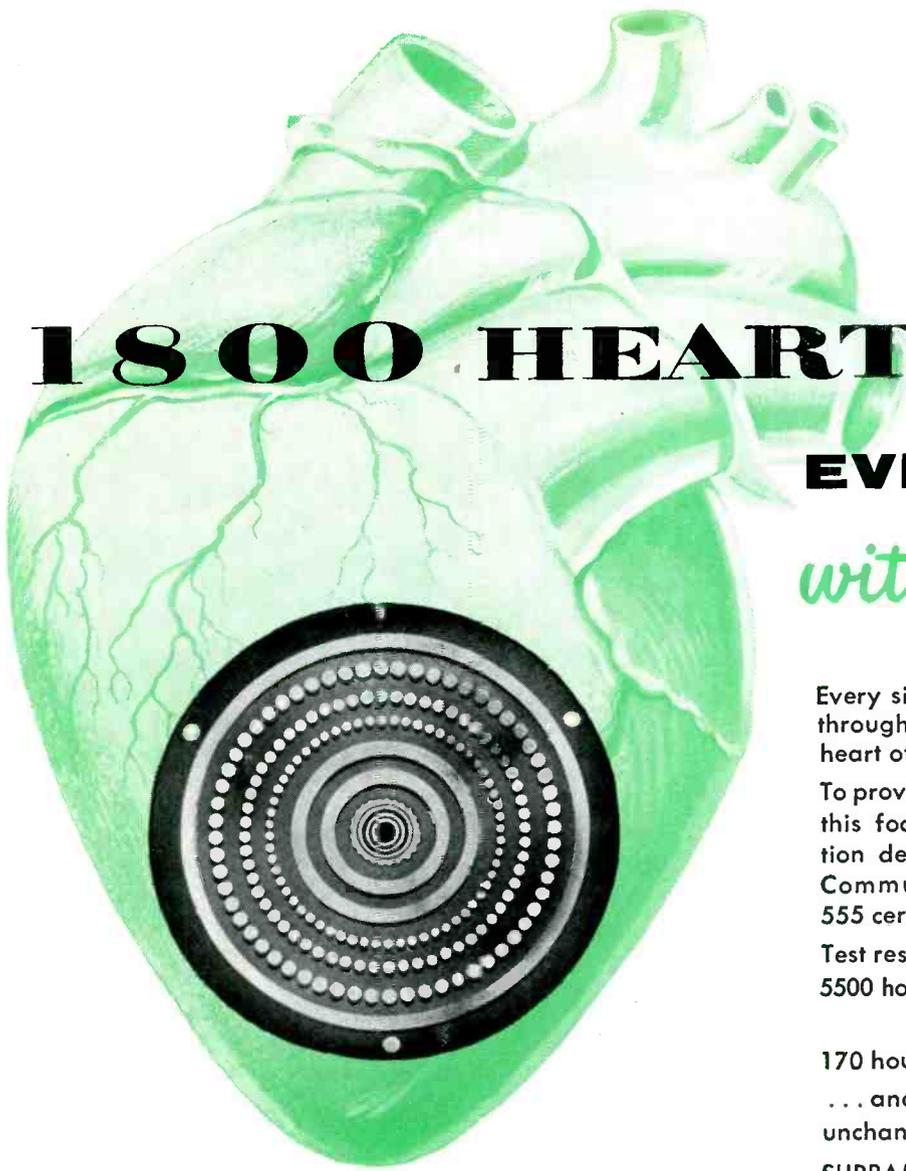
FLIGHT test programs for planes like Convair's new delta-wing supersonic interceptor involve handling of a tremendous volume of magnetic tape for airborne recorders. In this instance, the tape was used at Edwards Air Force Base Test Center in the arid Mojave wastelands near Muroc, California, then shipped to the data-reducing facility at San Diego.

► **The Problems**—Extremely low humidity, which makes magnetic tape brittle, prevented quantity storage of tape at the test center. The San Diego Division was shipping the tape on recorder spools as needed, but damage to spools and tape in shipping was proving costly because the spools are not repairable and valuable

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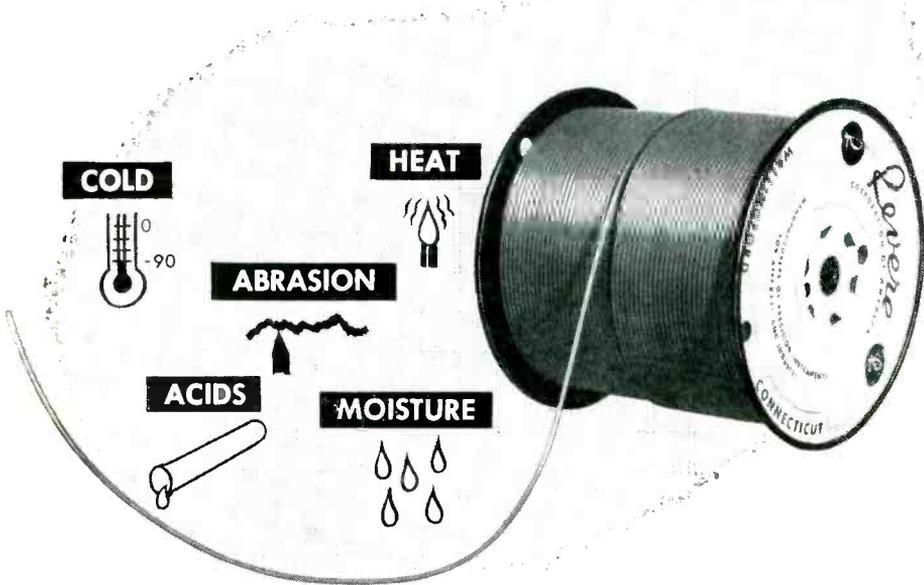


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Prompt delivery of standard stock wires. Write for samples and literature on specialty hook-up or thermocouple wire.



Components of 5-inch take-apart spool



Components of 10 1/2-inch spool

test data was often being lost.

To further complicate the processing, it soon became evident that the space needed to store the spools and used tape after data reduction would assume staggering proportions. It takes approximately 80 spools of tape to service one recorder for six months. Another problem involved the cost of spools which could be used only once and then stored for an indefinite period. The spools range in price from \$20 for the 5-inch reel to \$35 for the 10 1/2-inch size.

► **The Answer** — A satisfactory solution to these problems was achieved by designing and building take-apart spools that could be used over and over again. These new spools incorporated sleeves upon which the tape is wound, so that the tape-loaded sleeve can later be removed and stored.

Cans formerly used for the ship-



Components of shipping container assembly for 5-inch reels. Pads of rubberized hair hold tape snug

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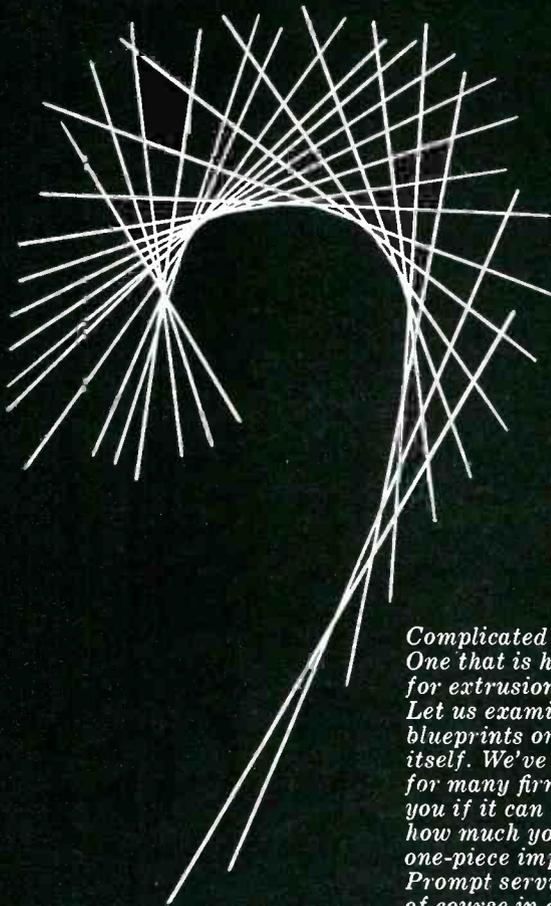
GET THE FACTS: Send for your copy of the detailed specifications and applications notes on the EPSCO high-speed DATRAC Series B Converters.



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1. Voltage-to-digital conversion time: 22 microseconds
2. Digital-to-voltage conversion time: 2 microseconds
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4. Minimum full scale input voltage: ± 10 mv
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Shipping container ready for shipment to data reduction station, with identifying data marked on side with grease pencil

ment of instruments were found to be ideal for conversion to tape shipping containers. The tape is first transferred from the manufacturer's large supply spools to one of the take-apart spools. The spool is then disassembled and the tape removed with its sleeve and placed in the container. Each container will hold three of the 5-inch rolls of tape. The can is then sealed at San Diego, which boasts an ideal humidity, and shipped to Edwards.

Upon receipt of the tape, ground crews at Edwards can rearm the planes' recorders without removing the take-apart spools from the aircraft. After a flight the tape is removed and returned to the San Diego data-reducing station.

The new spools as built by Convair cost about three times that of standard production reels, but it now takes only two spools to service one recorder indefinitely. The spools are fabricated from 75 ST aluminum. The sleeves, on which the tape is transported, can be made of any nonmagnetic rigid material such as aluminum, Micarta or molded plastic.

Plug-Assembly Conveyor

PLUG and wire assemblies for aircraft electronic systems are now made at Martin on an assembly-line conveyor. The first wire of an assembly is identified, cut to length on

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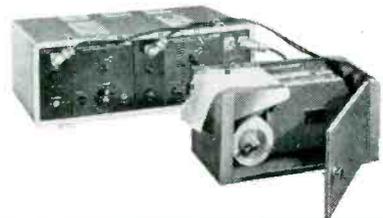
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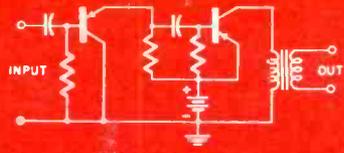


Type P Portable Dynograph. Single and Dual Channel Units—performance specifications identical to those of the console model—Chart speeds from 1 to 100 mm. per second.



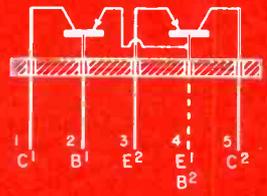
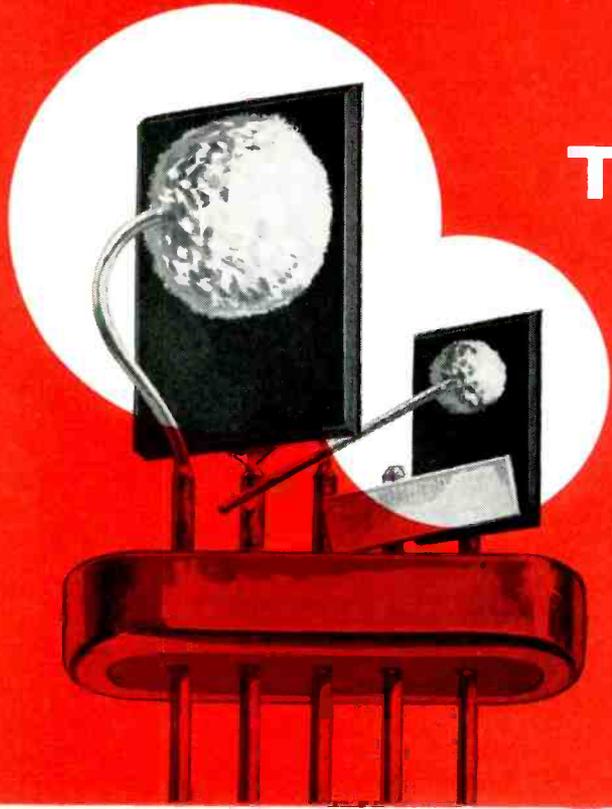
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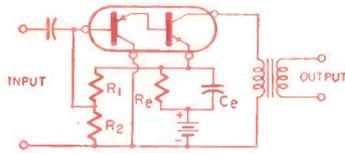


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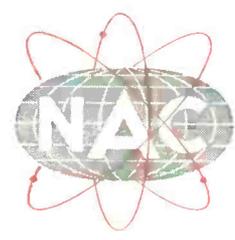
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ELECTRONICS — April, 1956

PRODUCTION TECHNIQUES

(continued)



Conveyor runs at rear of long, narrow assembly bench for aircraft electronic cables and plugs

a semiautomatic machine and put on the conveyor belt with the plugs and fittings. It travels to the next worker who removes a portion of the nylon jacket and adds Vartex identification sleeves. Part of the braided shield around the wire is made into a pigtail for a subsequent ground connection. One end is then stripped, tinned and soldered to the pretinned plug terminal. Other wires belonging to the assemblies are prepared singly and placed upon the conveyor, going in sequence to the workers who solder them to the plugs.

The braided shield pigtails are soldered to a common grounding ring. Vartex identification sleeves are tied temporarily in place and the assembly is visually inspected. The wires are bundle-laced at intervals and the assembly is tested electrically before potting. In the final operation, the Vartex identification sleeves are adjusted to suit contract requirements and the wire assembly is ready for installation. As many as sixty plugs can be assembled simultaneously on this belt-conveyor.

Etched Wiring Boards Have Resistivity Problem

By L. J. MARTIN and M. J. VAVRA
*Weapon Systems Development Laboratories
Hughes Aircraft Co.
Culver City, Calif.*

A WIDE range of resistivities has been observed in preliminary tests of laminates for etched wiring boards, as shown in Fig. 1. Among the phenolics, one showed lower resistivity when dry than three others showed after three days at 98-percent relative humidity. The best material, when dry, had resistivities above 10^{15} ohms per square for all four samples, but its resistivity dropped by five orders of magnitude following humidity

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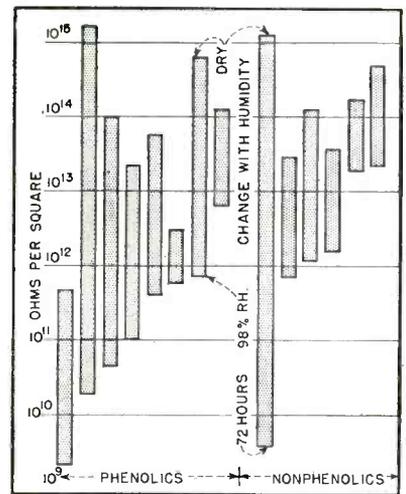


FIG. 1—Apparent surface resistivity of copper-clad plastic materials. Lengths of vertical bars represent change in resistivity; upper end of each bar is dry value and lower end is value after 72 hours at 98-percent humidity

exposure, at which time its resistivity was next to the lowest. The material which seemed next to the poorest in its dry state maintained its resistivity phenomenally after humidity exposure, showing the third highest wet resistivity. The best phenolic, according to these tests, showed 10^{14} ohms per square dry and nearly 10^{18} ohms per square when wet, a performance only slightly exceeded by two of the nonphenolics. One is forced to conclude that phenolics can be good or poor insulators and that their insulating properties shouldn't just be accepted on faith.

Turning to the nonphenolics, one manufacturer's glass-base silicone laminate showed the highest dry resistivity, above 10^{15} , but dropped well below 10^{10} after humidity exposure, a greater change than for any of the phenolics. The remaining nonphenolics included diallylphthalates, epon-glass, Teflon-glass and epon-orlon. Their resistivities were well clustered, with dry values similar to the better phenolics and generally with less deterioration of resistivity following humidity exposure.

Short-Run Cable Machine

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How General Electric Permanent Magnets help designers miniaturize products by supplying constant magnetic field energy in a fraction of the space required by electromagnets

WHERE constant magnetic field energy is necessary, powerful G-E Alnico permanent magnets offer the designer many advantages no electromagnet can match.

The most important of these advantages — from the designer's viewpoint — is the permanent magnet's superior volumetric efficiency. An Alnico permanent magnet can supply a given magnetic field in a fraction of the space required by even the best designed electromagnet.

Since miniaturization has become so vital in the electrical and electronics industries, it is important to see just why and how a permanent magnet utilizes space so much more effectively.

Figure 1 shows a typical magnetization curve of an electromagnet with a flux density of 20,000 gauss, when the polarizing force is 200 oersteds. (The curve has been displaced into the magnetizing quadrant for comparison purposes.)

In a well-designed electromagnet, approximately half the total area is occupied by conductors, and half is flux-conducting core material.

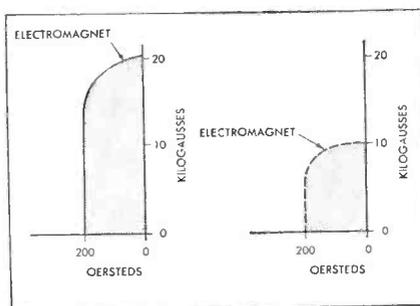


FIGURE 1

FIGURE 2

Therefore, to make the comparison valid, the residual induction of the electromagnet must be reduced to 10,000 gauss (Figure 2).

The area under the curve now represents the approximate external field energy available on a volume basis. When the equivalent demagnetization curve of Alnico 5 is plotted against the corrected electromagnet

curve (Figure 3), the true capabilities of each type of magnet become immediately apparent.

The area under the Alnico 5 curve is about three times the area under the electromagnet curve. Thus, to produce a given field requirement, the permanent magnet will occupy a volume one-third that of an equivalent electromagnet.

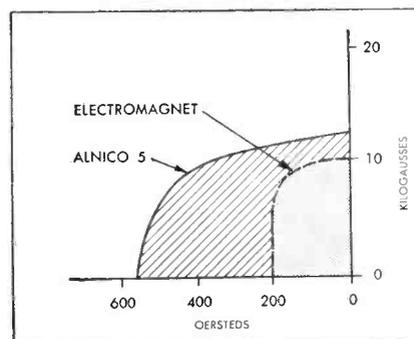


FIGURE 3

The above comparison is somewhat theoretical; under many circumstances, permanent magnets will show to even greater advantage. For example, consider the two TV-tube focusing magnets in Figure 4, at the top of the next column.

At the left, is the electromagnet previously used. It weighed 2 lbs. 13 ounces, and took up 16.35 cubic inches. At right, is the G-E Alnico 5 permanent magnet which replaced it. The new magnet weighs just 15 ounces, and occupies only 1.30 cubic inches — a space saving of 87%!

These savings in size and weight result from permanent magnets' inherent volumetric superiority. In addition, permanent magnets provide equally impressive savings in both initial and service costs because of four other inherent advantages.

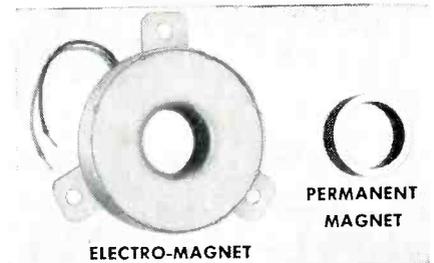


FIGURE 4

First, no power source is required with permanent magnets, because no energy is consumed. Once magnetized, the field is permanently retained.

Second, permanent magnets operate continuously. There can be no interruptions of the field due to power failure.

Third, permanent magnets are extremely stable under changing temperature conditions. They are unaffected by conditions ruinous to electromagnet installations.

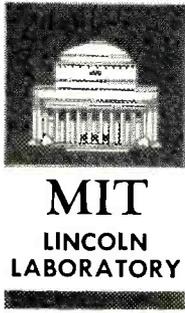
Fourth, permanent magnet assemblies are easier to install, and cost nothing to maintain. There are no moving parts to break down, no wiring to burn out, no costly, time-consuming repairs to make.

These are but a few of the many reasons why designers are turning to G-E Alnico magnets for products for which only electromagnets had been previously considered.

If you have a problem where constant magnetic field energy is required, one of the G-E Alnico compositions may well be your solution. For more design data or technical assistance from our magnet engineers, write: *Carboloy Department of General Electric Company, 11137 E. 8 Mile Street, Detroit 32, Michigan.*

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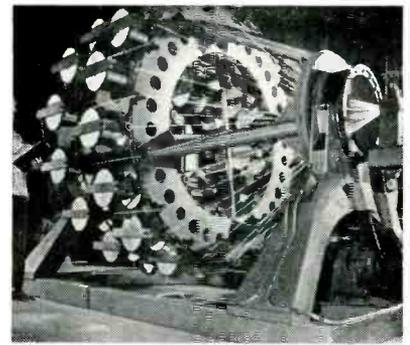
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Mounting Wiring Boards on Color-TV Chassis

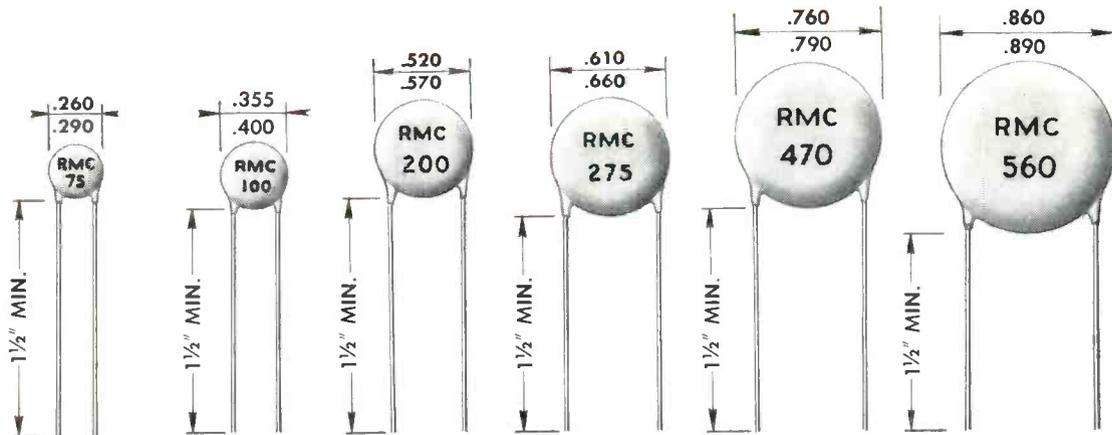
Two etched wiring boards used in RCA's new 26-tube color television receiver are both fastened to the chassis at one work position with the aid of an air gun and an efficient work handling arrangement in



Driving mounting screw into sound circuit board of color-tv set. The board already installed directly behind serves as the picture i-f section

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N- 75	2- 14	15- 27	28- 56	57- 68	69-110	111-150
N- 150	2- 15	16- 30	31- 68	69- 75	76-140	141-150
N- 220	3- 15	16- 30	31- 75	76- 90	91-130	131-190
N- 330	3- 15	16- 30	31- 75	76-100	101-150	151-190
N- 470	3- 20	21- 40	41- 80	81-120	121-200	201-240
N- 750	5- 29	30- 68	69-150	151-180	181-300	301-350
N-1500	15- 50	51-120	121-200	201-250	251-330	331-560
N-2200	47- 75	76-150	151-200	201-275	276-470	471-560

SPECIFICATIONS

POWER FACTOR: Over 10 MMF less than .1% at 1 megacycle. Under 10 MMF less than .2% at 1 megacycle.

WORKING VOLTAGE: 1000 V.D.C.

TEST VOLTAGE (FLASH): 1750 V.D.C.

CODING: Capacity, tolerance and TC stamped on disc.

INSULATION: Durez phenolic-vacuum waxed.

INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms.

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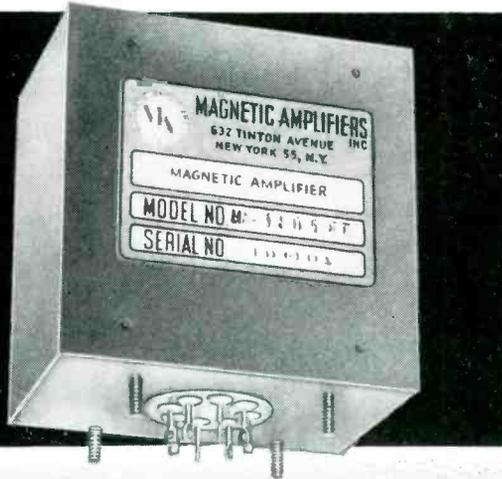
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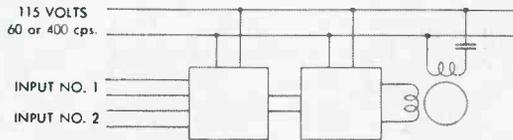
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Fast response at high gain
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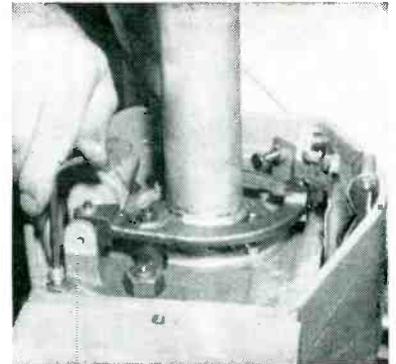
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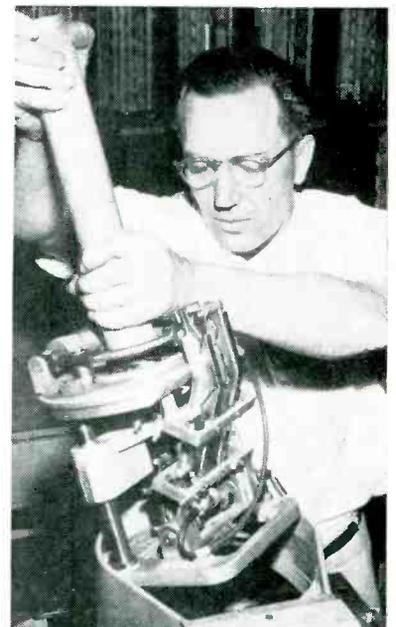
the firm's Bloomington, Ind. plant. The operator places each finished board in turn over its punched opening in the steel chassis, then anchors each board with six self-tapping screws taken from a bin directly in front of the bench. Each screw in turn is put into the magnetic chuck of the wrench, a washer is pushed over the screw, and the combination is driven through the previously punched holes in the wiring board and the chassis.

Changing Insertion Heads On Assembly Machine

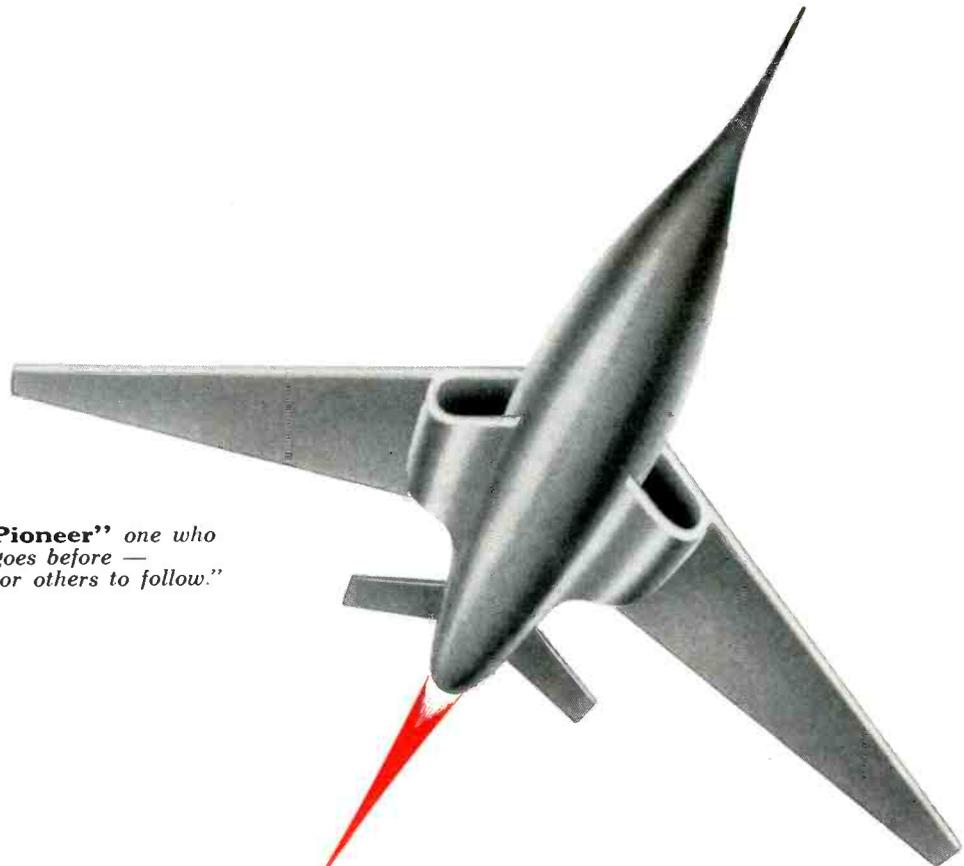
QUICK changing of setups on the General Mills automatic assembly machine is achieved by using a standard housing at all stations and having a variety of inter-



Loosening one of the two bolts that hold the insertion head in its housing. Magazine feed turret, which fits over vertical shaft, is removed first



Removing insertion head

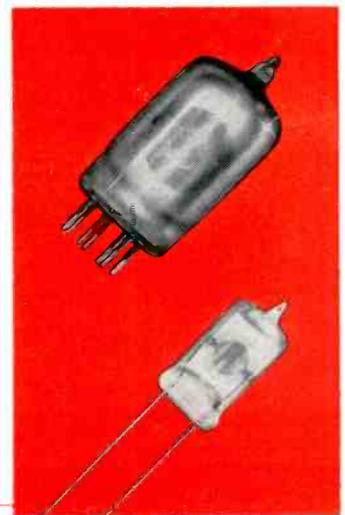
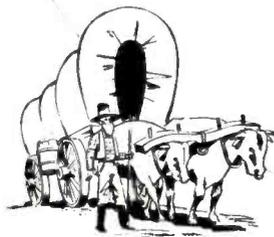


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Sierra 193A Ionization Gauge has a monel-encased interaction space with case near ground potential. A nichrome wire anode at 2.5 Kv is centered inside the case. An insulated out-gassing heater is mounted nearby. An insulated kovar tube is provided for connection to the vacuum line. Permanent magnets in the shell provide the magnetic field, with the shell serving as a return magnetic path, connection block, envelope and heater oven. Electrical connections are made to external binding posts. The tube weighs 22 oz., measures 7" x 5" x 3 1/2".

Sierra 192A Ionization Gauge Amplifier consists of a high voltage rf power supply, voltmeter, heater transformer and self-regulating low voltage power supply. It provides range switches, a special leak-check range for full scale meter deflection at any pressure, built-in calibrating circuits, and a heater switch for out-gassing the gauge tube. The instrument operates on 115 v 60 cycle power, measures 10" x 8" x 8" and weighs 17 1/2 lbs.

Specifications subject to change without notice

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changeable insertion mechanisms that fit into the housings of all stations. In addition, two simple wrench adjustments change the position of the entire housing at a station.

Two bolts anchor the head in its housing. When these are removed with a small Allen wrench, the 24-



Method of repositioning insertion head laterally, after first loosening bolts of locking clamp just below transverse screw

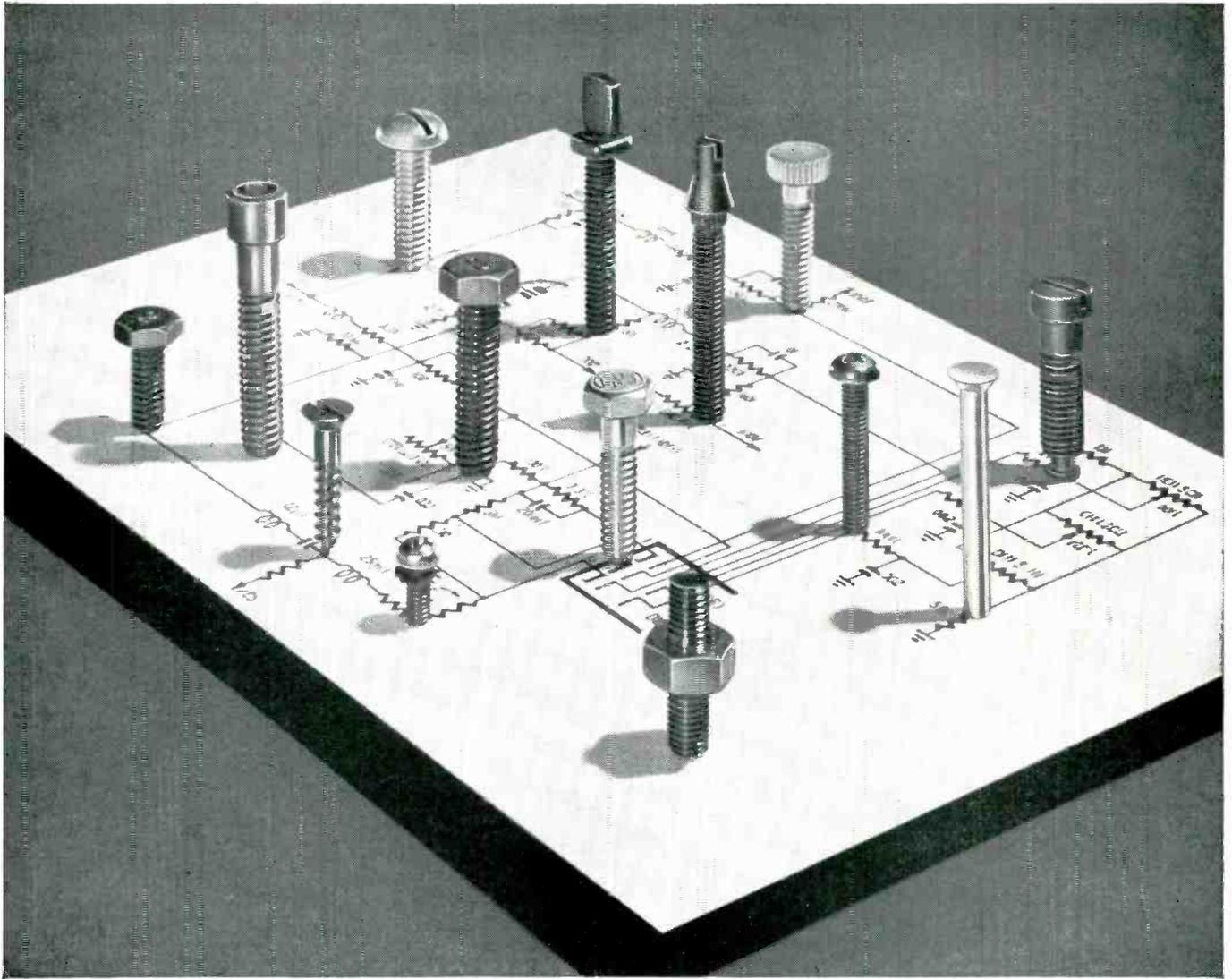
pound head can easily be lifted out by one man after disconnecting one air line and one cable connection. Actually, heads are changed in this manner only rarely because repositioning of standard heads is usually sufficient to accommodate a change in etched wiring boards.

Checking Linearity of Shaped Resistor Cards

RESISTANCE elements wound on shaped flat cards are checked for linearity and for shorted turns at taps with a special calibrating fixture in the Hicksville, N. Y. plant of Fairchild Controls Corp. A small and inexpensive cathode-ray



Linearity checking setup, with resistance card on fixture in front of B battery. Contact arm running over card is moved by stainless steel belt going over shaft of master potentiometer in front of operator



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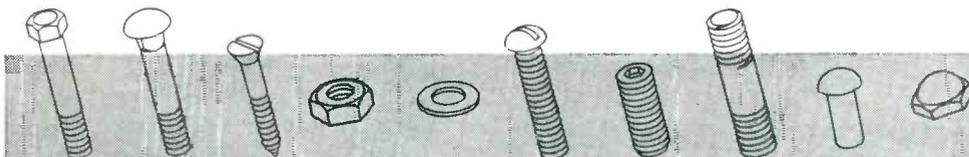
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oscilloscope is used as an indicator for obtaining the high-precision check of calibration that is required for precision potentiometers.

For a test, the operator hooks the card over pegs on a holding fixture at the left of the calibrating wheel. One peg is rigid and is used for the card end from which measurements are made. The other holding peg is spring-loaded to keep the card under tension. A wiper contact mounted on a stainless steel belt is set to the start of the resistance winding and the large indicator dial of the master potentiometer is set to zero. The steel belt runs over the shaft of the master unit, so that the wiper on the card moves as the master is rotated.

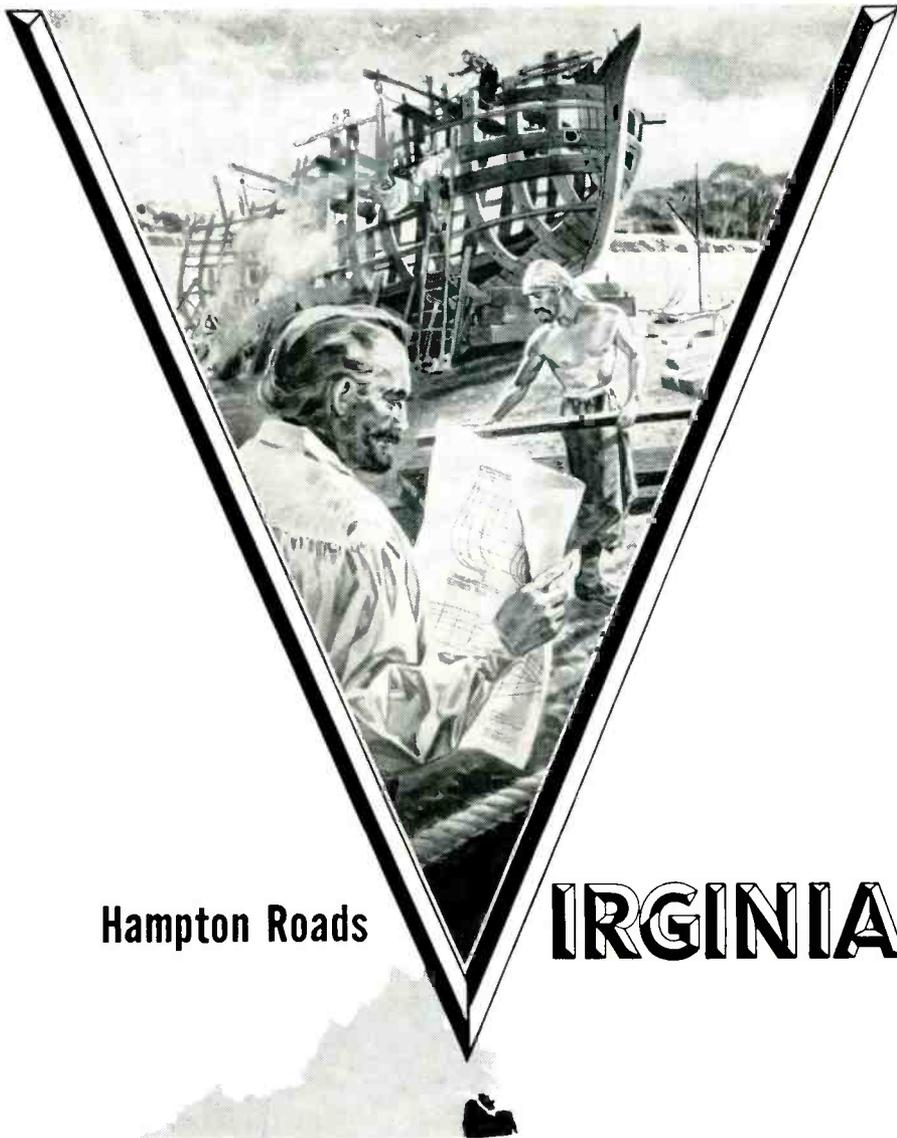


Holding fixture for resistance card

After the card is located in the fixture and the leads are connected to the ends of the winding, a reference point of the particular function is selected to set up the checking equipment (scope, dial plate and master pot).

The master pot is set to the reference percent output (selected either by the customer or the manufacturer) by adjusting the vernier dial of the master potentiometer to the required value. The wiper is moved over the winding by rotating the dial plate until a null appears on the scope. The wiper is then locked in place and the dial plate is loosened to permit setting it at the desired angular location corresponding to the reference output. The dial plate is then locked in place and the wiper loosened, permitting it to traverse the winding again.

The linearity is then checked by rotating the dial plate to the angles specified on a function check sheet. The percent output corresponding to each angular setting is recorded from the master pot vernier after a null appears on the scope, for comparison with the theoretical percent output. The difference between



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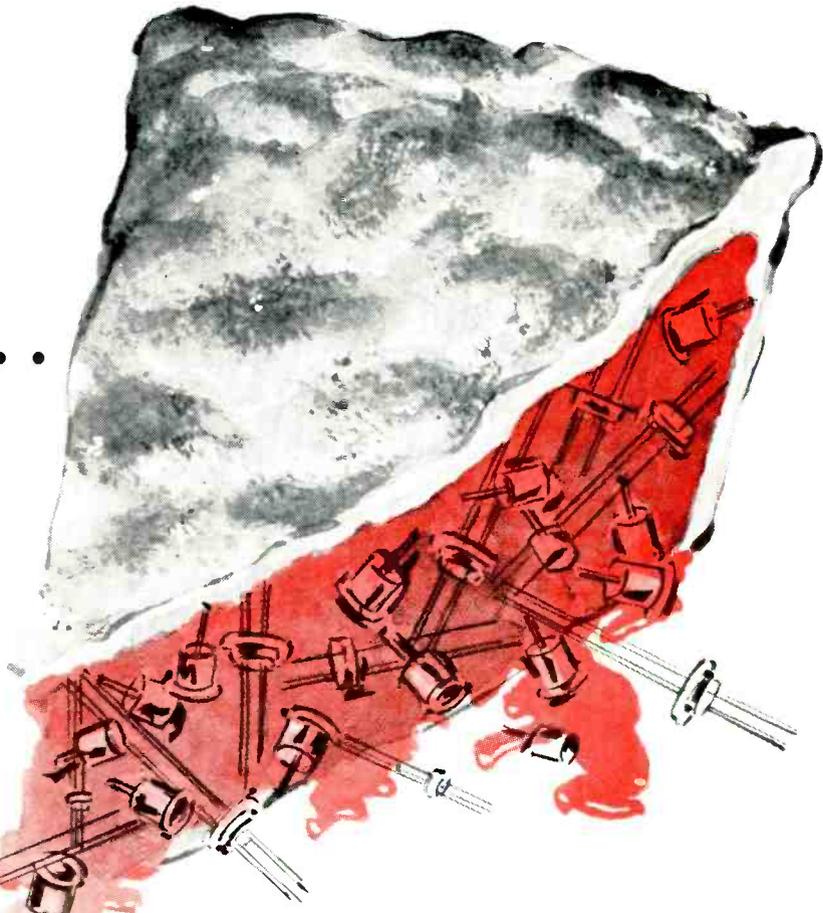
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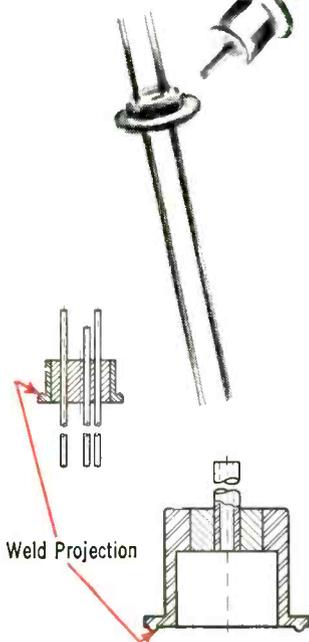
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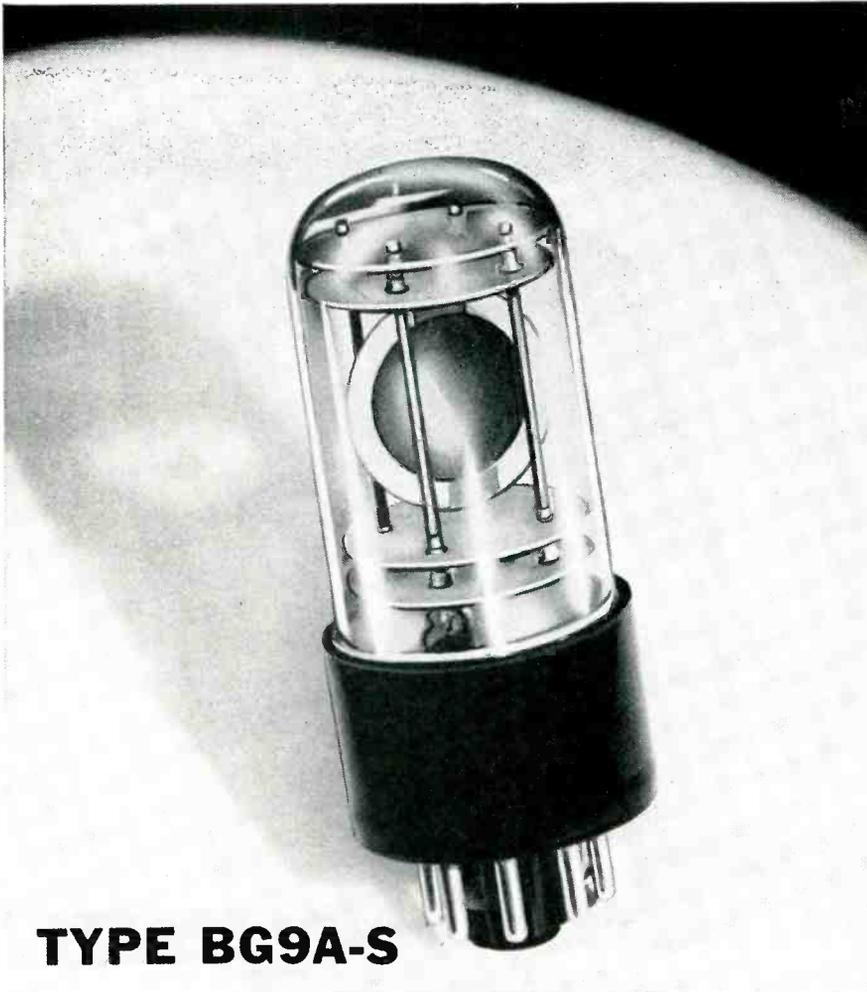
California Associate: Glass-Solder Engineering, Pasadena



SERVICE AND
ELECTRONICS — April, 1956

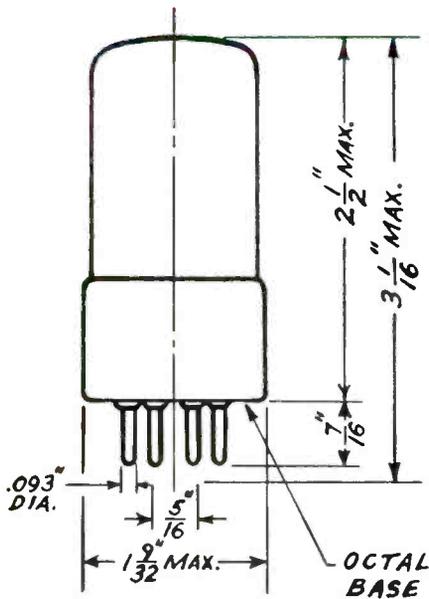
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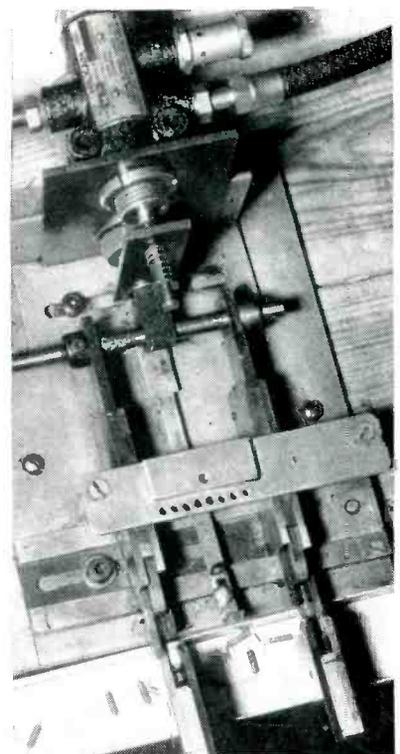
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the actual and the theoretical is the error. The error must be within tolerance to pass inspection.

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The operator grasps each component in turn by the end of one lead and holds it against a stop between the cutting jaws. After the leads have been cut and formed, the unit is dropped into the chute below. The chute is designed so it can

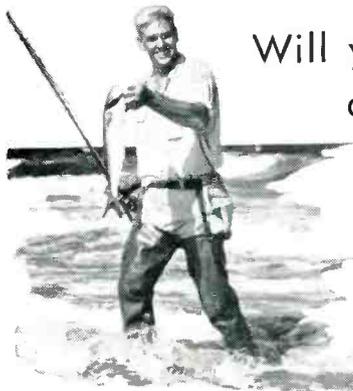


Machine for cutting and forming leads of axial-lead components. Continuously operating air cylinder at rear is made by The Climax Rock Drill & Eng. Works Ltd., Carn Brea, Cornwall, England

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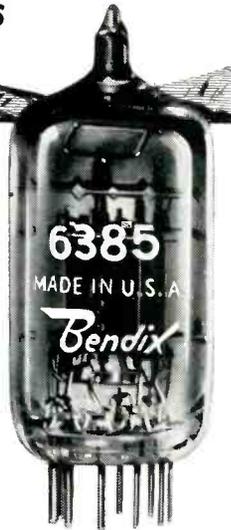


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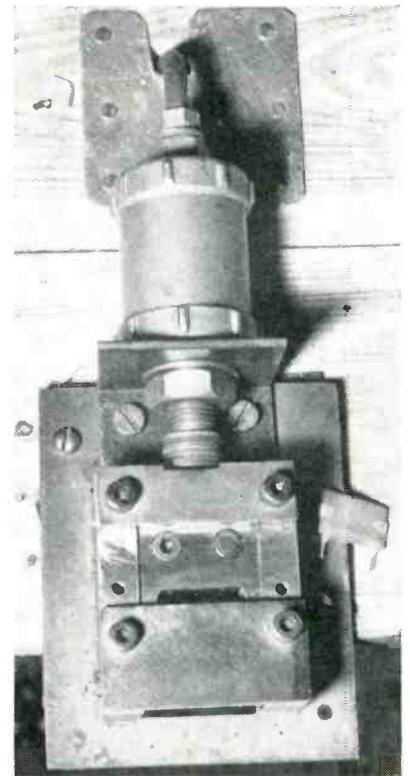
TUBE TYPE	5838	5839	5852	5993	6106	6754
Type	6X5	6X5	6X5	6X4	5Y3	412A
Prototype	TE-3	TE-2	TE-5	TE-10	TE-22	TE-36
Bendix No.	Full Wave Rectifier					
Class	Octal T-9	Octal T-9	Octal T-9	9-Pin Miniature	Octal T-9	9-Pin Miniature
Base and Bulb						
TYPICAL OPERATING CONDITIONS						
Heater Voltage	12.6	26.5	6.3	6.3	5.0	6.3
Plate Volts Per Plate	350	350	350	350	350	350
mA Load	70	70	70	70	100	100

Type	5992	6385
Prototype	6V6	2C51, 5670
Bendix No.	TE-8	TE-21
Class	Beam Power Amplifier	Double Triode
Base and Bulb	Octal T-9	9-Pin Miniature
Heater Voltage	6.3	6.3
Plate Voltage	250	150
Screen Voltage	250	—
Grid Voltage	—12.5	—2.0
Gm	4000	5000
Plate Current	45mA	8mA
Power Output	3.5W	—

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HARD GLASS TUBES			
Type	6094	6384	6754
Prototype	6AQ5, 6005	6AR6	412A
Bendix No.	TE-18	TE-27	TE-36
Class	Beam Power Amplifier	Beam Power Amplifier	Full Wave Rectifier
Base and Bulb	9-Pin Miniature	Octal T-9	9-Pin Miniature
Heater Voltage	6.3	6.3	6.3
Heater Current	0.6 Amp.	1.2 Amp.	1.0 Amp.
Plate Voltage	250	250	350
Plate Current	45mA	77mA	—
Screen Voltage	250	250	—
Grid Voltage	—12.5	—22.5	—
Gm	4100	5400	—
Power Output	4.5W	8.5W	—
Load Current	—	—	100mA

The above three tubes incorporate hard glass bulbs for high-temperature operation (maximum bulb temperature 300°C).



Air-actuated lead chopper for ceramic components

be lifted out when full and transferred to the assembly line for use as a dispenser bin.

Leads of ceramic disk capacitors and coupling plates are chopped to length by air-powered jaws under foot-valve control. This assembly is mounted on the front of the workbench, so that cut leads can drop into a bin below.

Components are inserted manually without clinching, with the aid of trolley cars that support wiring boards on a pass-along assembly line. The car is much like a chassis equipped with four rubber wheels, having in its top a framed rectangular hole to receive the wiring board. The trolley-car wheels run in semi-circular channels cut into an ordinary wood-top bench. At each work station is a spring-loaded catch for holding the trolley while parts are being inserted in the wiring board.

After assembly is completed, the boards are removed for transfer to the dip soldering machine. The empty trolleys are placed on a sloping shelf at the back of the bench for gravity return to the start of the line.

Component storage bins are open and mounted on a slant to give gravity feed. A protruding lip at





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SOLENOID BANK ASSEMBLY



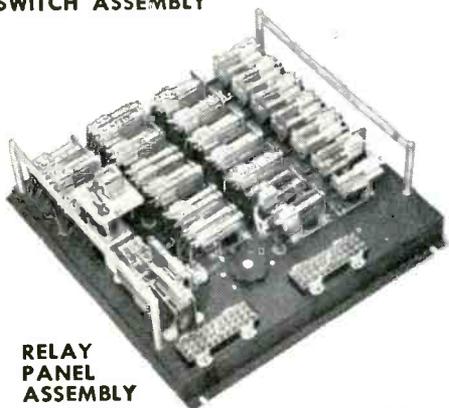
CONTROL BOX TESTER



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PUSH-BUTTON SWITCH ASSEMBLY



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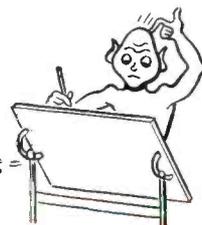
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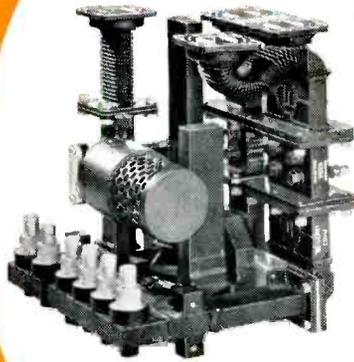
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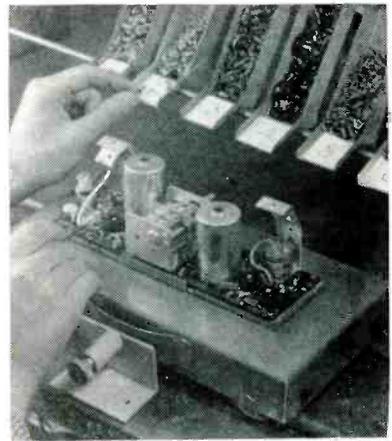
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Work station on trolley-car assembly line, showing open gravity-feed dispenser bins. Spring-loaded clip holds car steady as components are inserted in wiring board. Rubber wheels of car run in channels cut into wood bench

the bottom of each bin facilitates pickup. The lip of the bin is above the bench; a component is removed with the left hand by placing the thumb under the lip and the forefinger on top to draw a component to the edge and grab it.

Each component to be assembled is assigned a number in sequence. This is written on a tape tab placed on the lip of each dispenser bin. Corresponding numbers are screen-printed on the top of the wiring board, between lines going to the holes in which the particular component is to be inserted. This technique minimizes assembly errors and cuts down training time when starting up a line for a new design.

Intensity Markers Aid Television Alignment

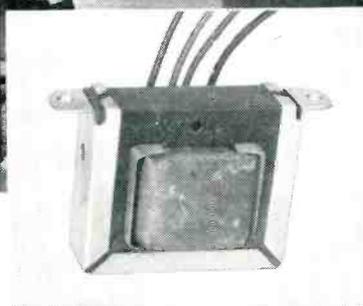
By L. W. DIXON

*Test Equipment Design
Radio Corporation of America
Television Division
Bloomington, Indiana*

ALIGNMENT OF TELEVISION receivers on a production test line can often be made more efficient by the simultaneous presentation of negative and positive intensity markers to sweep signals being viewed on an oscilloscope. This is accomplished in the i-f section of chassis alignment by the use of a sweep generator feeding all i-f alignment positions on the production line. The sweep generator output is simultaneously fed into a sampling cir-



New Leeson No. 108 Coil Winders (foreground) in the plant of Ram Electronics, Inc., Irvington, N. Y., where Leeson Winders have become "standard equipment." These were added as best winders for producing short runs of stick-wound coils of varying specifications. (Inset) Ram has built an excellent reputation for winding quality coils and transformers used in radio and TV equipment.



RAM standardizes on Leeson coil winders...adds No. 108 machines

These winders help maintain highest quality standards . . . with good production performance

Ram Electronics, Inc. (Irvington, N. Y.) earned its fine reputation by adhering to unusually high quality standards.

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"We have come to count on Leeson Coil Winders to assure the high quality coils we insist upon for our products. That's why any additions to our present installation will be Leeson winders."

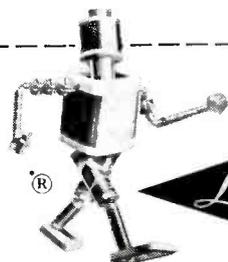
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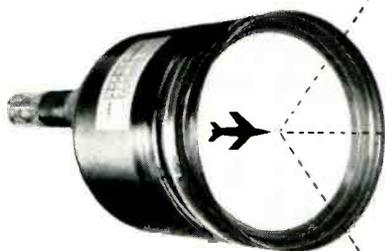
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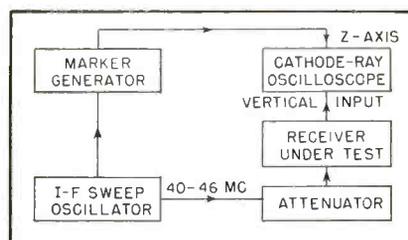


FIG. 1—Sweep generator and marker generator connections to equipment

cut containing crystals which become resonant as their frequencies are swept through, as in Fig. 1.

► **Method of Use** — Rectification and amplification of the output from the crystals results in pulses which are fed through a common cable to the Z axis of the oscilloscope for intensity modulation purposes. Positive pulses, appearing as bright dots on the i-f response curve displayed on the oscilloscope, are used to identify the frequencies used for peaking the i-f stagger-tuned stages, as in Fig. 2A and 2B. Negative pulses, identified by blanked portions of the trace as in Fig. 2C, are used as curve reference markers.

In operation the aligner feeds the i-f sweep signal into the chassis, peaks each stagger-tuned stage for maximum rise from the base line of the corresponding bright dot, then touches up the alignment by referring to the negative-blanked curve positions to obtain the proper position of the reference markers.

► **Advantages**—When master signal systems are used, this method has many advantages. The aligner

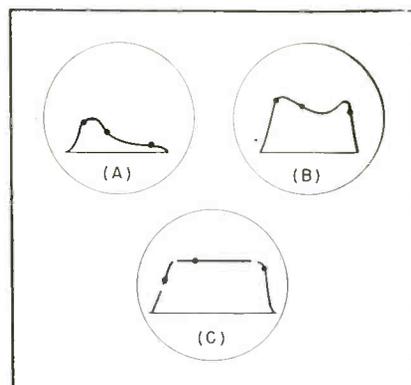


Fig. 2—Positive pulses as they appear before alignment (A), curve shape after positive pulse peaking (B) and i-f response after touchup (C) using negative pulses as reference markers

New Resistor Stands Higher Overloads... Without Crazing!



The "Blue Ribbon", resistor with a higher wattage rating per unit space requirement. Made by Hardwick, Hindle, Inc., Newark, N. J.

because of DRIVER-HARRIS 146 ALLOY



Here is a resistor really new and different . . . the compact Hardwick, Hindle "Blue Ribbon," which stands remarkably high overloads and excessive heat without crazing.

Special design features which make this possible are: an aluminum thru-bar extending through the center of the elliptical ceramic core, which insures a more even distribution of heat to prevent "hot-spots;" and a thermo-shock-proof enamel coating which eliminates crazing.

Heretofore, crazing, which occurred mostly at terminal areas, shortened resistor life and limited the safety factor. To prevent this, an alloy with three hard-to-find qualities was needed: (1) It had to have a coefficient of expansion to match all integral parts; (2) it had to be free of gas; (3) it had to form a perfect bond with the enamel.

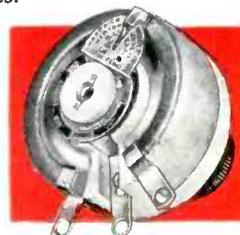
A large order, indeed. But Driver-Harris filled it

by developing #146, a glass-to-metal sealing Alloy. This alloy now makes it possible to operate resistors and rheostats at hitherto dangerous overloads, with no risk of breakdowns in the enamel coatings.

146 Alloy is one of 4 Driver-Harris Alloys which cover most glass-to-metal sealing needs—available as rod, wire, strip, sheet foil, and in special shapes. Today the makers of the "Blue Ribbon" use 146 Alloy for the terminals in all of their resistors and rheostats as well. They also use Nichrome*, Advance*, and other gas-free resistance alloys made by Driver-Harris in winding the cores.

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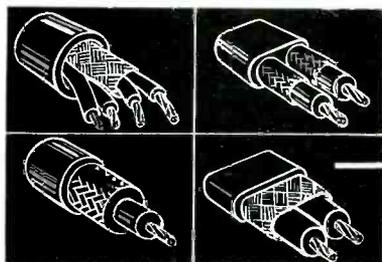
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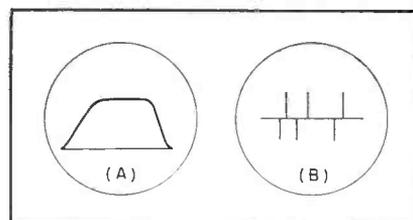


FIG. 3—Vertical (A) and Z-axis (B) inputs to cathode-ray oscilloscope

is required to select only one signal at the attenuator. Considerably less hookup time is required. The aligner can simultaneously observe the i-f response characteristics while making specific frequency adjustments. Relatively few distribution cables and transformers are required. Model change-over time is reduced to a minimum.

The overall analysis of the method indicates a substantial reduction in alignment time and a general improvement in the quality of alignment, resulting in better overall performance.

Turn-Finding Welder for Potentiometer Taps

TAPS of hair-size wire are welded to precisely the correct turn on the resistance element of a precision potentiometer with an electronically controlled capacitor discharge welder that allows welding current to flow only at the exact turn that gives the desired resistance value. Tweezers connected to the welder are used to hold the short piece of wire used for the tap. The welding operation is observed with the aid



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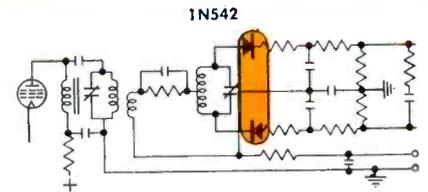
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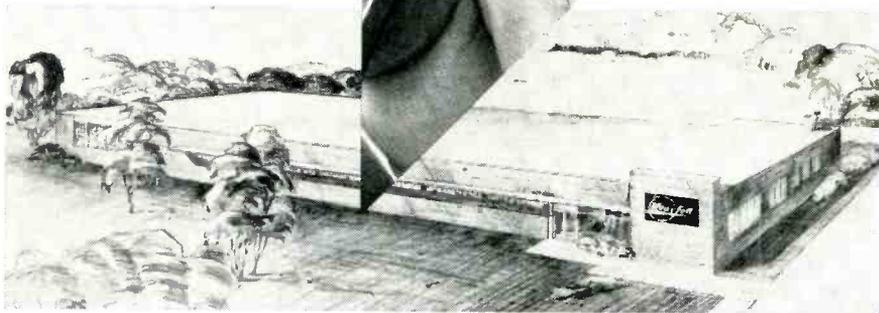
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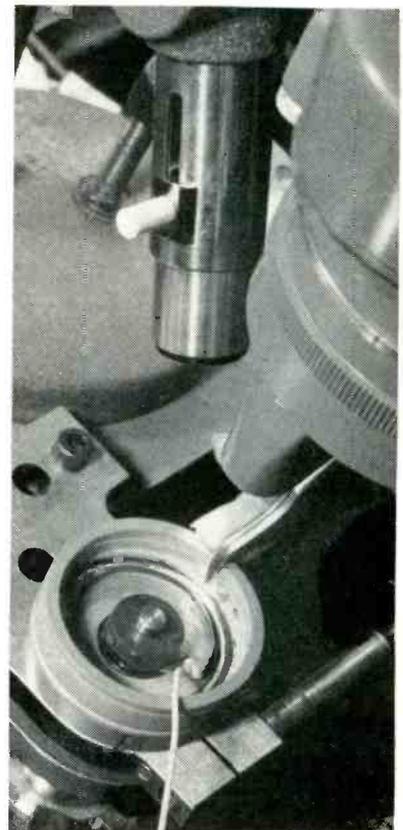
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Closeup of welding operation, showing light source mounted at rear of stereo microscope

of a 20-power stereo microscope, using a spotlight mounted on the assembly fixture to give adequate illumination for this critical operation.

The other terminal of the welder is connected to the wiper arm of the potentiometer, which is set to the desired tap position. With the aid of a calibrating chart, the welder controls are set to a value corresponding to the ohms per turn of the particular potentiometer unit being welded. Sufficient weld current then flows only when the tap wire is on the same turn as the wiper. This technique is used in the Hicksville, N. Y. plant of Fairchild Controls Corp.

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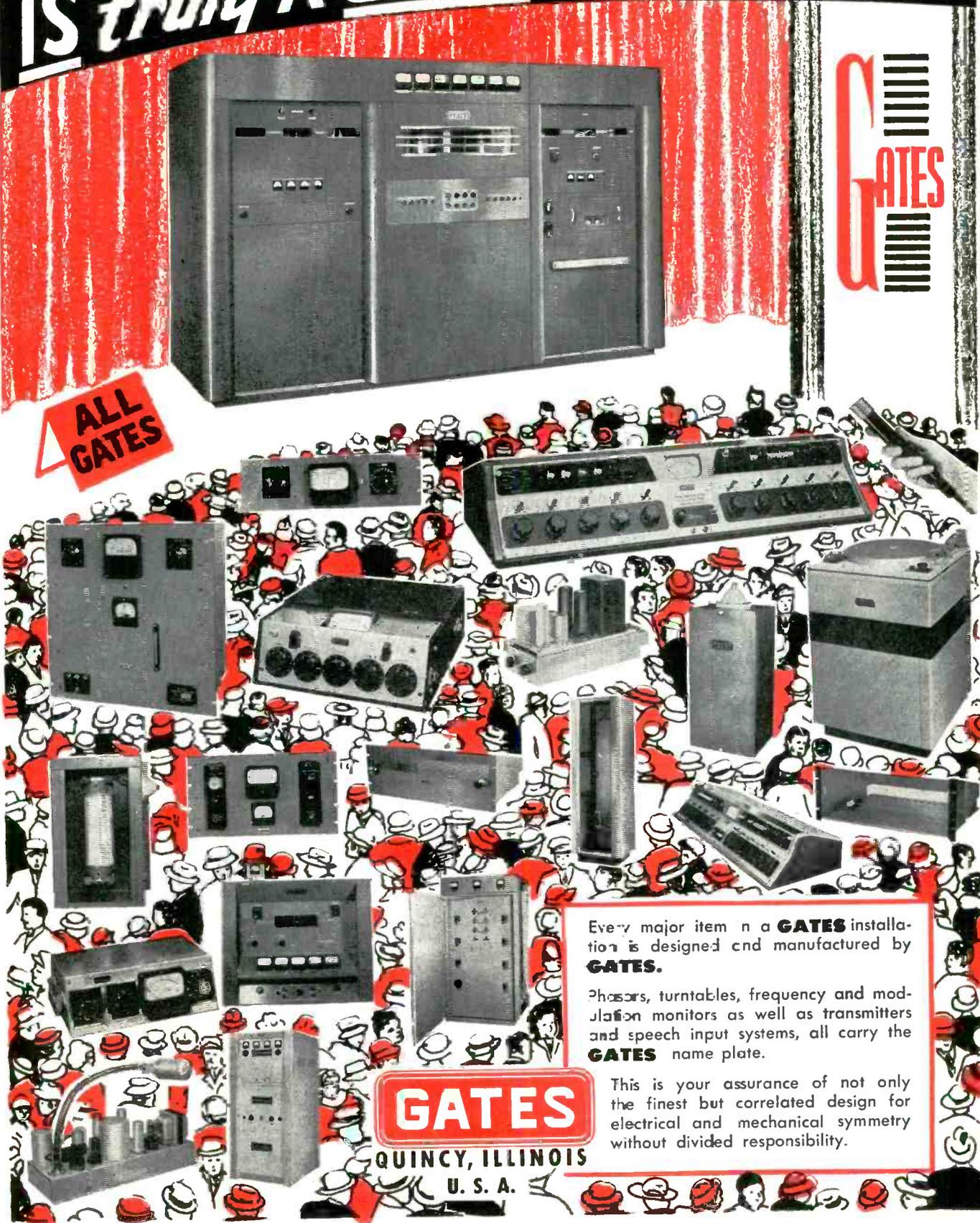
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The cyclotron shown above is one of the many types of advanced research equipment in use at Los Alamos. This variable energy machine is designed to accelerate high intensity beams of all the hydrogen and helium isotopes.

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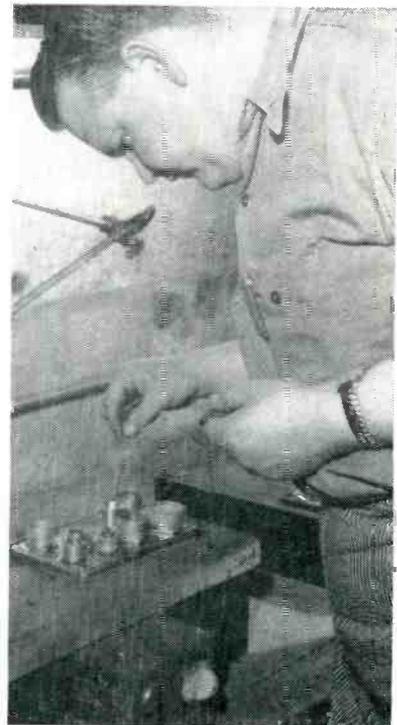
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Placing cover plate over connectors loaded into positioning jig



Touching up soldering on hot plate

milled-out block of heavier stock.

Alongside each hex hole is stamped the number of the connector. Colored dots are applied at appropriate locations to show the relationship of alignment keys to the plate. Solder preforms are placed over the connectors before the cover plate is put on. The assembly is then placed in an oven for melting of the solder.

After oven soldering, the cover with its connectors is placed on an 800 F hot plate for visual inspection and manual addition of solder as required. The plate is then turned over and three tacks of

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$L_{bm}^2 L_{bm}^1$

$G_R = G_2^+$

20 Lc

$P_e =$

$V =$

$\theta = \frac{d}{R}$

$P_R = \frac{P_r}{4\pi(d/2)^2} \cdot L$

$\sqrt{x_3^2 + y_3^2}$

x^2

$P_w = \frac{A_w}{A_o} \cdot 2$

$\frac{\gamma^2}{4\pi(d/2)^2} \cdot 2G$

$V = 2 \left(\frac{b}{2} \cdot \epsilon \right)^{\frac{3}{1}} \theta$

Photograph of the earth from 100 mile altitude — Courtesy U. S. Air Force

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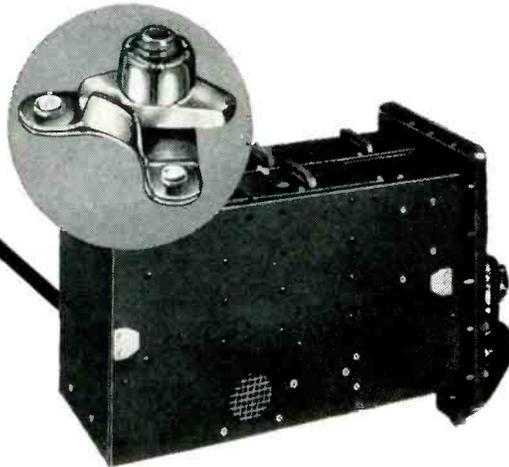
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The next 135 words of this advertisement taken from Bell Engineers' letters

S. W. Esmond, Product Engineer:

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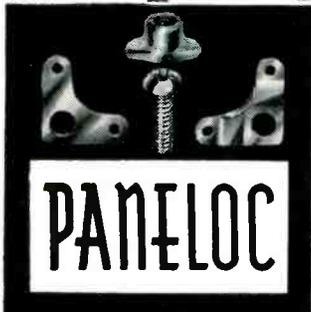
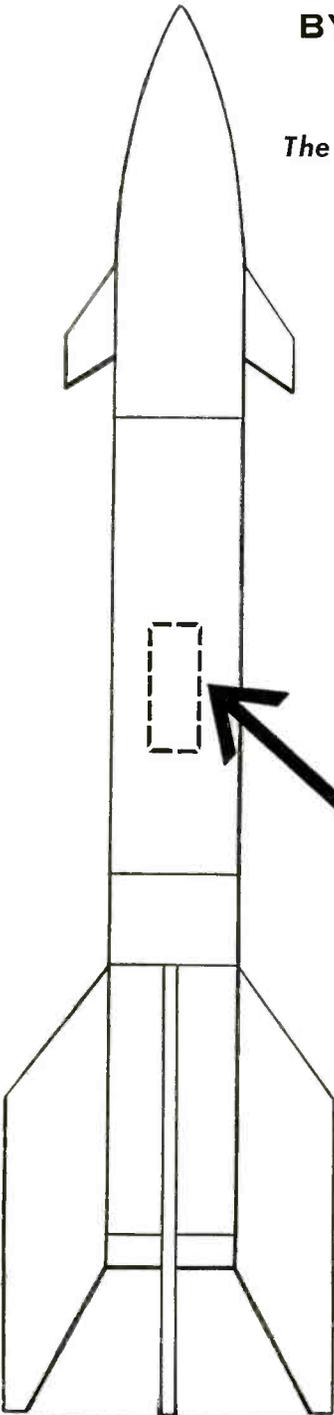
F. P. Bassett, Project Engineer:

- Rotary Latch selected for use on cowl access doors on Bell's latest vertical-rising (VTOL) aircraft.
- The new PANELOC Rotary Latch is excellent for hinged doors and applications where maximum access and opening are important design considerations.
- Its simplicity, vibration resistance, ease of installation and cost are other factors that resulted in Bell's adoption of this new fastener.
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PRODUCTION TECHNIQUES (continued)

solder are placed on each nut used on the other side of the cover to prevent loosening from vibration during use. This technique is used in the Long Island City, N. Y. plant of Ford Instrument Co.

Spraying Molten Metal on Resistance Cards



Spraying resistance card with molten metal to form end connections, using combination mask and holding fixture

END connections and shorted sections are produced on wound cards and mandrels for precision potentiometers by masking with a holding fixture and then spraying with molten precious metals in a production setup in Fairchild's, Hicksville, N. Y. plant.

Spraying is done in a metal-lined chamber that catches oversprayed metal. The Metco gun is mounted on the bench at the front of this chamber. The part being sprayed is held by the operator and moved about to insure adequate buildup of metal in the desired areas.

Horseshoe Bends in Pass-Along Lines

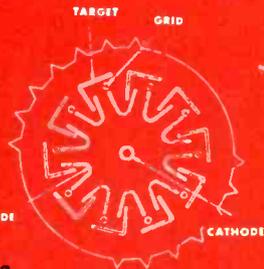
A LONG pass-along assembly line for television i-f amplifiers was set up in an essentially square area in Emerson's Jersey City plant by using six horseshoe bends. The line



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BURROUGHS CORPORATION RESEARCH CENTER

BEAM SWITCHING TUBE...

AVAILABLE NOW IN PRODUCTION QUANTITIES



Cross Section showing
Cathode, Grids,
Spades and Targets for
10 position switching.

The beam switching tube offers a new basic device to the engineer of electronic equipment. Versatility of the basic ten-position tube is such that any desired type of sequential, simultaneous or random switching of any number of positions may be obtained. The simplicity of the tube design and associated required circuitry results in a new standard of reliability. It reduces the total number of tubes required in a circuit, space, weight, and heat in control and switching systems.

Perfect by the Burroughs Research Center... rigidly tested and accepted by key electronic plants and communications labs throughout the world... this revolutionary new tube is now precision-manufactured in production quantities with complete accuracy and dependability by the Haydu tube division, specialists in the electronic industry.

The simplicity and reliability of this new basic building block have been demonstrated in applications performing the following functions:

- DISTRIBUTING
- SAMPLING
- FREQUENCY DIVIDING
- COUNTING
- CODING
- MODULATING
- GATING
- TIMING
- CASCADING
- MULTIPLEXING
- MATRIXING
- OSCILLATING

HAYDU

BROTHERS OF NEW JERSEY

PLAINFIELD, NEW JERSEY

Subsidiary of Burroughs Corporation



An Applications Engineering Department, offering engineering service and consultation, has been set up to assist you in taking full advantage of this device. For further information, contact:

APPLICATIONS ENGINEERING DEPARTMENT
HAYDU BROTHERS OF NEW JERSEY
c/o BURROUGHS RESEARCH CENTER
PAOLI, PENNSYLVANIA

Here's the fastest way to produce finished wire leads!



Allen-Bradley Co., producers of motor controls, use several Artos CS-6 automatic wire cutting and stripping machines in their Milwaukee plant.

**high speed ARTOS
AUTOMATIC MODEL CS-6**

3000 STRIPPED WIRE LEADS in one hour ... each precision-cut with both ends perfectly stripped. That's the speedy pace set by the Artos CS-6 in producing wire leads up to 15 inches in length! Production rates vary in proportion to the length cut.

Highly accurate machine operation reduces work spoilage to an absolute minimum. Errors due to the human element are eliminated. *There is no cutting of strands or nicking of solid wire.*

PROVED PERFORMANCE

Time-consuming hand stripping jobs which once were a bottleneck in many plants are gone forever. As a result, Artos automatic wire strippers are paying their way in the mass production of television and radio sets, electrical appliances, motor controls and instruments of all kinds.

Plan now to cut wire stripping costs in your plant... with the high speed, automatic Artos CS-6.

CS-6 CAPACITY

Finished Wire Leads Per Hour:
lengths to 15", 3000; 64"-97" lengths, 500.
Stripping Length: 1½" max. both ends.
Cutting Length: max., 97"; min., 2"; special, ¾".

WRITE FOR BULLETIN

Descriptive technical sheet tells how the Artos CS-6 can save you money, manpower and time.



**MEASURES,
CUTS and
STRIPS
wire, cord
and cable
at speeds up to
3000
pieces per hour**

- 2-Conductor Twisted Wire
- Single Conductor Solid Wire
- 2-Conductor Parallel Stranded Wire
- 300 Ohm Television Wire
- SJ Cord
- Heater Cord
- Braided Cord With Rubber Jacket

doubles back and forth across the available area, with an average of six working positions on each of the seven straight sections. The metal panels of this subassembly slide on angle-iron rails, with the rear rail appreciably higher to hold the panel at a more convenient working angle for assembly.



Method of using pliers to push a panel around the bend

When the operator at the end of each straight section completes her work on a panel, she gives it a push with her fingers or with a pair of pliers to send it around the bend to the next operator. Considerable experimentation was required to achieve exactly the right positioning of the angle-iron rails and the sheet metal side fences around each bend, to insure that panels would move smoothly around the bends without jamming or flying off the track.

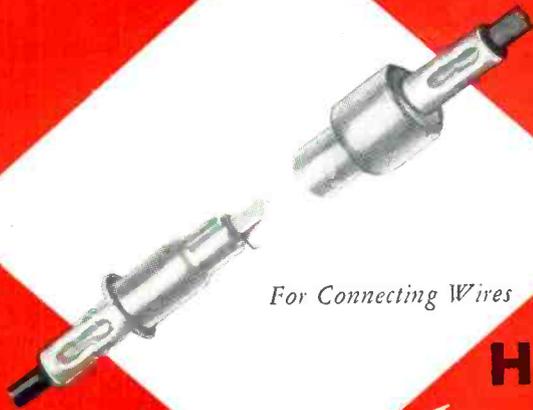


Folded assembly line for i-f subassemblies, showing one of the six pass-along bends in the two-track line

ARTOS ENGINEERING CO.

Automatic Wire Cutting and Stripping

2743 South 28th Street • Milwaukee 46, Wisconsin



For Connecting Wires



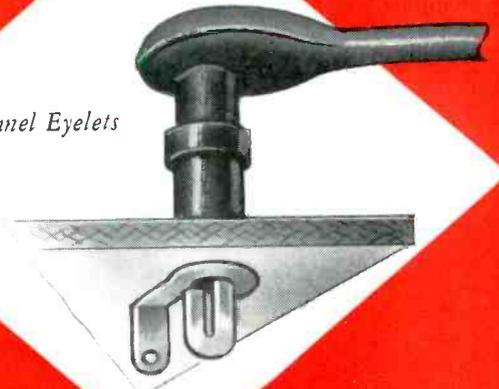
In Terminal Strips

HUBBELL
Interlock
TRADE-MARK
AUTOMATIC LOCKING — QUICK DISCONNECT
PLUGS and CONNECTORS

For Printed Circuits
 (Type "C")



In Panel Eyelets



Insulated



Non-Insulated



Insulated



Non-Insulated

**TYPE "B" MINIATURE
 PLUGS AND CONNECTORS**

Current Capacity: 5 Amperes
 Wire Sizes: #18 to #22

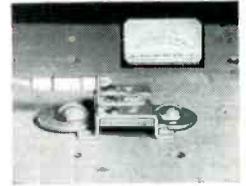
**TYPE "C" SUB-MINIATURE
 JACKS AND CONNECTORS**

Current Capacity: 1 Ampere
 Wire Sizes: #20 to #22

**TYPE "A"
 PLUGS AND CONNECTORS**

Current Capacity: 10 Amperes
 Wire Sizes: #14 to #18

VIBRATION PROOF!



Left: With an Interlock Plug and Jack securely mounted, test begins with platen vibrating at 10 cycles per second. Right: at 50 cycles per second, camera stops motion to show plug still locked in its jack! Tested for 18 hours at an amplitude of .06 inch and at a varying frequency from 10 to 50 to 10 cycles per second, conductive quality remained steady with no current interruption during vibration.



For Further Information, Write Dept. C:

HARVEY HUBBELL, INC.
 Interlock Electronic Connector Dept., Bridgeport 2, Conn.



New Products

Edited by WILLIAM P. O'BRIEN

80 New Products and 34 Manufacturers' Bulletins Are Reviewed

. . . Control, Testing and Measuring Equipment Described and

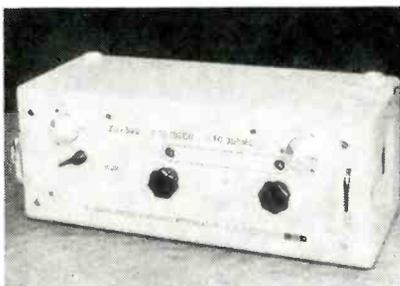
Illustrated . . . Recent Tubes and Components Are Covered

VHF ATTENUATOR

for accurate, easy operation

FEDERAL TELEPHONE AND RADIO Co., 100 Kingsland Road, Clifton, N. J. Precise measurement of attenuation in electrical elements over a frequency range from d-c to 300 mc may be easily carried out by means of type FT-DTR vhf standard attenuator.

► **Performance** — The instrument



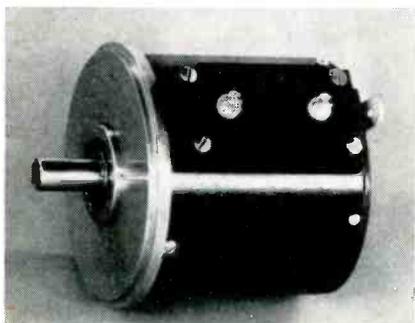
provides accurate attenuation from 0 to 100 db in 1-db steps, with ease of operation equal to or better than that usually associated with l-f attenuators. It is ideal for attenuation comparison checks and serves also for the attenuation of known voltages where fractional outputs are needed.

The unit weighs 24 lb and measures 19 $\frac{3}{4}$ in. long, 7 $\frac{1}{4}$ in. high and 10 $\frac{1}{4}$ in. deep. It has a characteristic impedance of 50 ohms.

ULTRAPRECISION POT

features high linearity

LITTON INDUSTRIES, Components Div., 336 North Foothill Road,



Beverly Hills, Calif. The new 10-turn 2-in. o-d ultraprecision potentiometer provides independent linearity as close as 0.01 percent or better. High stability combined with extra rugged construction assures highest accuracy even under severe environmental conditions.

► **Construction and Specifications** —The resistance coil is externally wound on a nonhydroscopic ceramic core which is chemically inert, di-

mensionally stable, and has a low coefficient of expansion. Rugged metal-to-metal traveling nut stops withstand static torque of 500 in.-oz. The wiper arm is independent of the stops and, to minimize wear, only the wiper touches the resistance element. The 2-in. diameter cover is precision-machined aluminum. Electrical angle is 3,600 deg with 90 deg overtravel at each end. All tapes are welded to a single turn of wire. Resistance values of 1K to 100K can be supplied; other values on customer order.

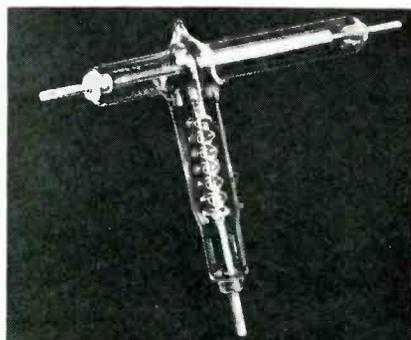
VACUUM SWITCH

is high-current type

PENTA LABORATORIES, INC., 312 N. Nopal St., Santa Barbara, Calif. The PL-169 high-current vacuum switch was developed specifically for switching between spectrograph arc and spark sources, but has numerous other uses where a compact, sealed spdt relay capable of handling 30 amperes at voltages up to 250, or low current at voltages up to 22,000, or both, is required.

► **Highlights**—The PL-169 features large contact surfaces, large ter-

minal leads, and a heavy flexible shunt to carry current around the



armature. High-vacuum exhaust allows it to withstand a voltage of 22,000 v across the open contacts, even though contact spacing is only 0.020 in.

DIODE CURVE TRACER

gives large display

WATERS MFG., INC., P.O. Box 368, South Sudbury, Mass. Completely independent display of forward and reverse characteristics of all common types of diodes, on the scope

—in Sylvania "Gold-Brand" subminiatures



"donut-ridge"

Button Header

—builds in extra reliability and versatility



Here's a simple reliability test you can make yourself to demonstrate important advantages of Sylvania's "donut-ridge" button header. When you bend the tube leads as shown, ordinary headers will flake, chip, or crack: but leads bend cleanly around the "donut-ridge" header in Sylvania "Gold-Brand" subminiatures.

THE "DONUT-RIDGE" is an original Sylvania refinement in button header design: you'll find it on all Sylvania T-3 premium subminiature tubes. By preventing sharp angle bends in the leads the "donut-ridge" eliminates header cracking and chipping —leads can be clipped short for tight component spacing.

These reliability "extras" are added to the basic advantages of button header design. Greater protection against mechanical shock and vibration; wider lead spacing to retard electrolysis for more stable operation at high temperatures; heavier leads and less lead fatigue; more rigid seating in socket applications; these are just a few of the benefits the button

header has over pressed stem construction.

And only the button header accommodates eight external leads which make possible the twin triode with separate cathode connections. Pioneered by Sylvania, the twin triode broadens subminiature application and provides greater versatility in subminiature circuit design.

Standardize your reliable equipment designs with Sylvania "Gold-Brand" subminiatures. There's a "donut-ridge" button header type to meet all your subminiature needs and Sylvania offers you the most complete line. 39 types are detailed in the "Sylvania Gold-Brand Subminiatures" brochure. Write for it. Address department D20P.



SYLVANIA[®]

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.,
University Tower Bldg., Montreal

LIGHTING • RADIO • TELEVISION • ELECTRONICS • ATOMIC ENERGY

face of the model 1003B diode curve tracer, gives an image four times the size of that obtained with earlier models. Dual inputs permit convenient comparison or differential testing of diodes and resistors. This facilitates application of the

instrument to production testing in addition to its use in laboratory work and as a maintenance tool.

► **Specifications**—Accuracy is ± 5 percent for measurement of forward characteristics at the in-

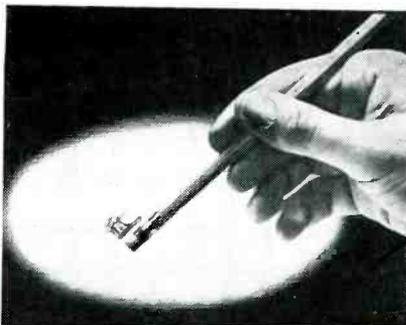
creased sensitivity of 2 v per in. and current ranges of 10, 20 and 50 ma per in., and of reverse characteristics at 50, 100 and 250 v per in. and current ranges of 1, 10, 100 and 1,000 μ a per in. Voltage is adjustable from 0 to 500 v.

PISTON CAPACITORS

used in printed circuitry

JFD MFG. Co., INC., 6101 Sixteenth Ave., Brooklyn, N. Y., has introduced a new series of subminiature piston capacitors designed primarily for use in printed circuitry and automation.

► **Two Models**—The VC9G (\$3 list) and VC10G (\$2.50 list) feature glass dielectrics and invar silver-plated rotors. The VC10G measures



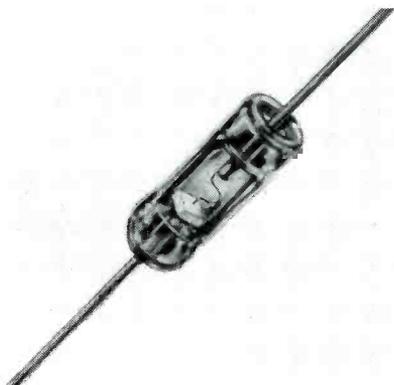
$\frac{5}{8}$ in. in length; model VC9G, $\frac{3}{8}$ in.

Temperature range of both goes from -55 C to $+125$ C and their dielectric strength (d-c volts) is greater than 1,000 v d-c. Adjustment torque is approximately 1 in. oz. Both midget trimmers have a 2-56 internal screw thread, with a 0.118 diameter screw head.

Capacitance range of the VC10G is 1 μ f to 4.5 μ f, and weight is 2 grams. The VC9G has a capacitance range of 0.5 μ f to 8.5 μ f; weighs 3 grams.

H-F DIODES

are silicon bonded



TRANSITRON ELECTRONIC CORP., Melrose 76, Mass. The new silicon diodes, now being produced in a subminiature glass case, exhibit excellent high frequency and fast switching characteristics. They are intended for use in detector, discriminator or pulse circuits where high temperature performance is important.

► **Highlights**—The bonded silicon diodes offer low shunt capacitance

(0.8 μ f average), high inverse resistance and moderate forward conductance with a high degree of electrical and mechanical ruggedness. Types such as the 6SG are particularly useful in 30-to 60-mc i-f strips for video detectors, clamps or clipping diodes. Their fast pulse recovery time is of particular importance for computer circuits as well.

Extremely small size and ability to operate at high ambient temperatures are important advantages when they are used for aircraft and missile applications.

MAGNETRONS

ruggedized, pulse type

MICROWAVE ASSOCIATES, INC., 22 Cumington St., Boston, Mass., has developed two new ruggedized pulse-type magnetrons for continuous operation under extreme conditions of shock and vibration. Both tubes, identical physically, are especially suited for short pulse operation in extremely high-definition radars for airborne and mobile use.

► **Simplification**—The MA-200 and MA-206 feature much improved form factor packaging with a total weight reduction of 2 lb, simplified mounting requirements and a more

compact design than standard 5789. Long life is achieved by use of the dispenser type impregnated tungsten cathode.



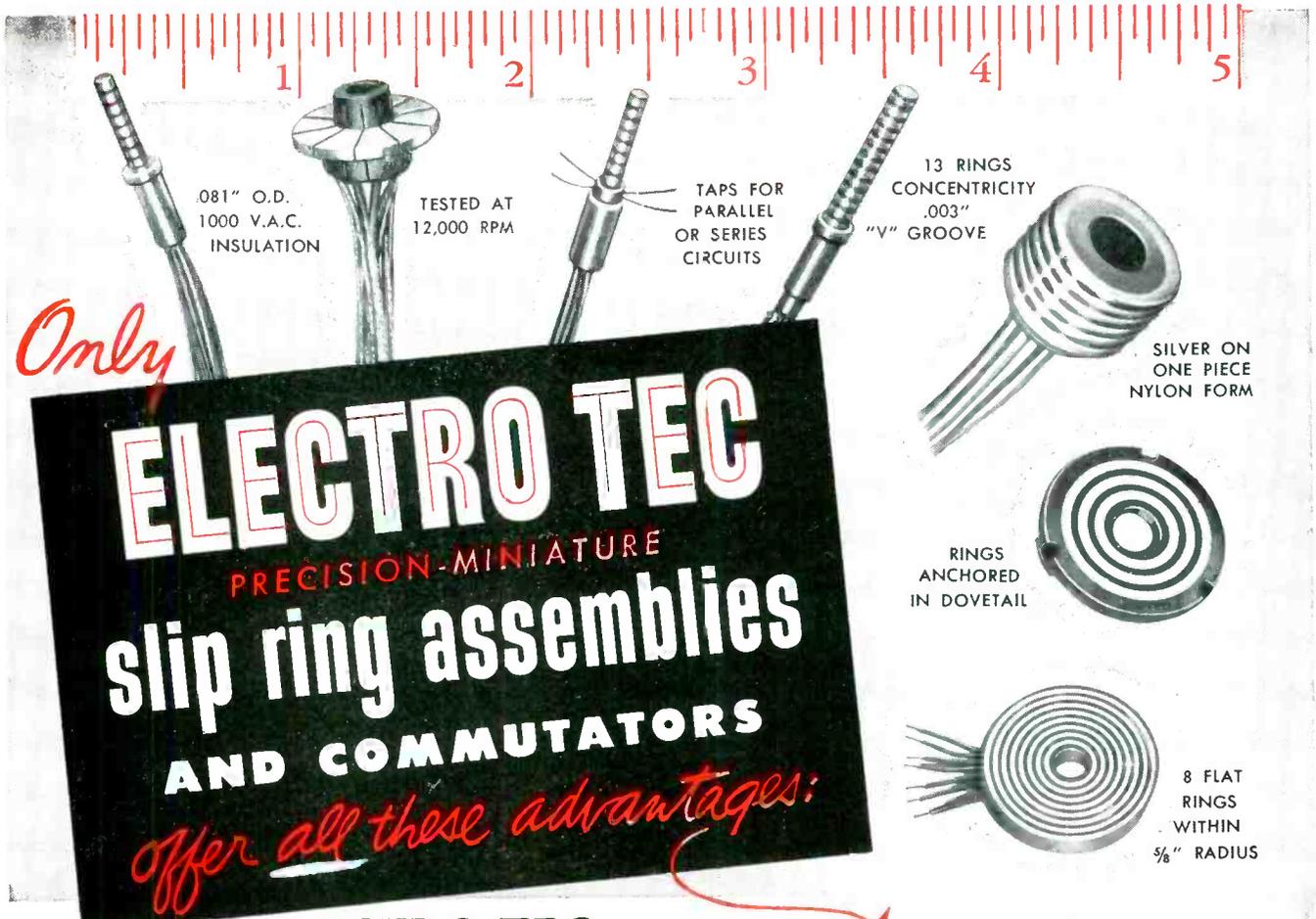
The MA-200 is a pulsed-type fixed-tuned magnetron generating approximately 40 kw peak power at 35 kmc. Its r-f spectrum is unchanged when subjected to vibration conditions of 15 g at 1,000 cycles.

The MA-206 is a low-power counterpart of the above generating 20-kw peak power at 35 kmc.

A-F OSCILLATOR

30 cps to 30 kc output

AMERICAN METRIX CORP., Box 179, Upper Darby, Pa. Type 816 a-f service oscillator gives an output



Only

ELECTRO TEC

PRECISION-MINIATURE

slip ring assemblies

AND COMMUTATORS

offer all these advantages:

EXCLUSIVE* ELECTRO TEC TECHNIQUES

insure closer tolerances, absolute uniformity, and the ultimate in miniaturization

Electro Tec units are the product of an exclusive manufacturing technique that results in accuracy unattainable by conventional fabricating methods. In this process a plastic is moulded around the wire leads. Accurate machining reduces this blank to the proper shape, complete with grooves. Hard silver is deposited into the grooves by electroplating to produce the required rings. Final machining insures concentricity and dimensional accuracy. The result is one-piece, unitized construction with conducting rings of 70 to 95 Brinell hardness.

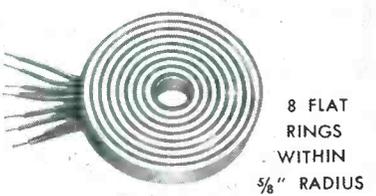
Diameters of these assemblies range from .045" to 24" cylindrical or flat. Cross-sections may range from .005" to .060" or more. Rings are polished to a jewel-like finish and can be held to 4 micro-inches or better. Even the smallest sizes withstand a 1000 V.A.C. breakdown test. Most types easily withstand rotational speeds up to 12000 rpm.

ELECTRO TEC Assemblies are Specified by the Nation's Leading Precision Instrument and Equipment Manufacturers for Proven Greater Dependability, Longer Life, Smoother Functioning.

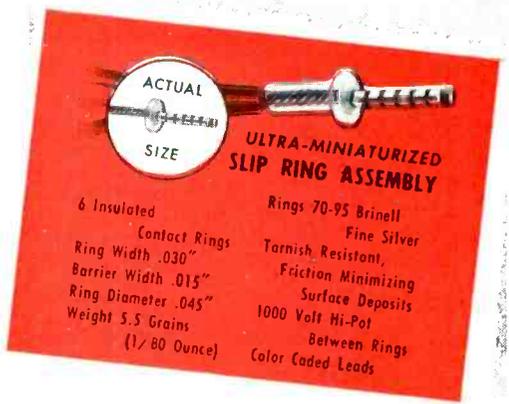
The uniformly superior performance of Electro Tec slip ring and commutator assemblies in thousands of industrial and governmental applications has resulted in wide adoption of these component units by most leading manufacturers of precision instruments and equipment. Although these products provide improved performance and extra dependability, prices are strictly competitive. Write today for fully illustrated literature.

ELECTRO TEC CORPORATION
 SO. HACKENSACK NEW JERSEY

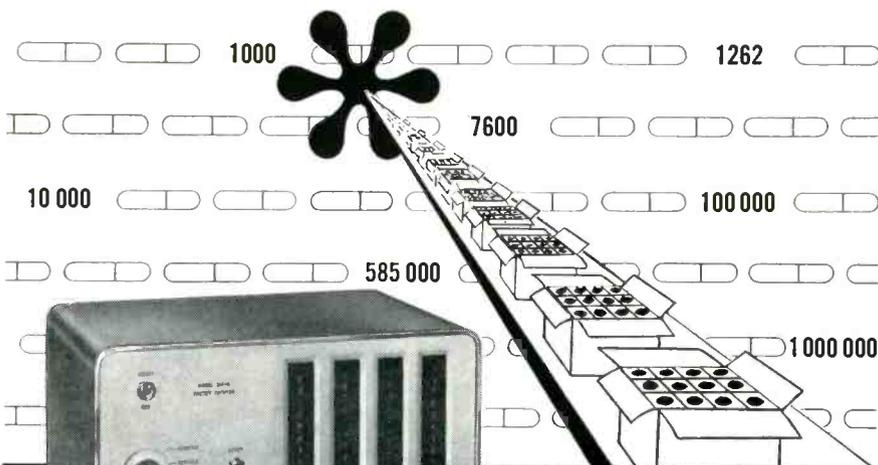
PRODUCTS OF PRECISION CRAFTSMANSHIP BY A NEW AND REVOLUTIONARY PROCESS



- ONE PIECE, UNITIZED CONSTRUCTION
- ABSOLUTE MINIMUM TORQUE FRICTION
- DIAMETERS FROM .045" TO 24.0"
- MINIMUM 1000 V.A.C. HI-POT INTER-CIRCUIT
- UNIFORMLY HARD SILVER RINGS PLATED INTO GROOVES ON PRECISION MACHINED ONE PIECE PLASTIC FORM
- SPECIAL SURFACE DEPOSITS PREVENT TARNISH, MINIMIZE FRICTION, BRUSH NOISE AND PRACTICALLY ELIMINATE WEAR



*PAT. NO. 2,696,570



Model 314A \$495.00

Automatically count and control to 1,000,000 events

Advanced Design

ELECTRONIC PRESET CONTROLLER

The CMC Model 310 Series Preset Controllers are designed as high speed direct reading electronic counters of the coincident type which will control any operation or activate an alarm after a preselected total count has been reached.

*A few of the many applications are batching and packaging of pills, bottles, bottle caps, canned goods, pen points, machine parts, electronic com-

ponents, etc., in exact preselected quantities; controlling the exact length of stock in cutting operations; and control of high speed machinery. Any electrical, mechanical or optical events which can be converted into electrical impulses can be counted and controlled. Devices to effect this conversion may be photocells, magnetic coils, switches, and suitable transducers for pressure, temperature, velocity, acceleration, displacement, etc.

SPECIFICATIONS					FEATURES
	312A	313A	314A	315A		316A
Decades	2	3	4	5	6
Count Capacity	100	1000	10,000	100,000	1,000,000
Counts per Second	0 to 100,000 (as totalizing counter)				
Recycling Rate	50,000 counts per second (as preset counter)				
Input Sensitivity	0.05 volts rms: 10-100,000 cps 0.07 volts rms: 1-10 cps Positive Pulse Rise Time: 1/2 volt or more per sec.				
Input Impedance	0.5 megohm, 50 mmf				
Accuracy	Absolute				
Output	60 volt positive pulse, 10 microseconds duration (negative pulse optional)				
Output Relay Contacts	5 amps, 117 volts, non-inductive load Normally open or normally closed (with indicator lamp) Can be switched out				
Relay Hold Time	Automatic: Continuously variable from 0.1 to 1 second Manual: Lock until release				
Auxiliary Power	6.3 volts ac @ 3 amps; ±225 volts dc regulated @ 50 ma; -150 volts dc regulated @ 5 ma.				
Power Requirements	117 volts ± 10% 50-60 cycles 100-150 watts depending on model				
Dimensions	13" W x 8 3/4" H x 13" D 16 1/4" x 8 3/4" x 13"				
Net Weight	20 to 28 lbs. depending on model				
Finish	Panel: Light grey baked enamel Case: Dark grey baked enamel				

- COINCIDENT TYPE
- ABSOLUTE ACCURACY
- DIRECT SETTING
- DIRECT READ-OUT
- EXCEPTIONAL VERSATILITY
- HIGH SPEED
- RELIABLE
- RUGGED
- ECONOMICAL
- SMALL SIZE

Data Subject to Change Without Notice

The direct reading Model 101A Preset Decade Counting Unit is designed to provide an output pulse at a selected number at rates in excess of 50,000 counts per second. They are capable of counting at a 100,000 cps rate if reset is not required. These units are readily connected in cascade in order to emit a pulse at any desired count. Typical applications are batching, sorting, packaging, automatic counting and control, frequency division, generation of precise delays, etc.



Model 101A \$75.00

Write for complete catalog and prices.

Computer-Measurements Corporation

5528 Vineland Avenue, North Hollywood, Calif. Dept. 78-D



from 30 cps to 30 kc which largely covers the acoustic frequency range. It is intended for adjustments of a-f amplifiers and measurements at audio and acoustic frequencies. Output level is adjustable from 10 μv to 10 v by an accurate attenuator system. An automatic regulation circuit keeps the output level constant with changes in frequencies.

► Further Technical Data — Frequency accuracy is 2 percent ±2 cps. Output impedance is less than 5,000 ohms. Distortion from 30 to 50 cps is 3 percent; above 50 cps, 2 percent. Power supply is 115 to 220 v, 50/60 cps. Dimensions are 10 1/2 by 7 1/2 by 7 1/2 in. Weight is 12 lb, 2 oz.



MERCURY BATTERY for electronic devices

P. R. MALLORY & Co., INC., Battery Div., North Tarrytown, N. Y., has developed a mercury cell so designed that a number of them can be stacked together to provide required voltage in a variety of physical shapes. The design permits full automation in the construction of the basic cell and in the assembly of the cells into battery stacks, with substantial economies in production costs. Thus the long shelf life and constant

CAN *Ampli*FILM DO THIS?

Many times we have been asked if Ampli-Film Dielectric can be curved. We had anticipated applications in which Ampli-Film would be made in shapes other than flat . . .

Yes, *Ampli*FILM can be formed in unusual shapes

The size and shape of some electronic gear require that components be manufactured in unusual shapes. Dielectrics must, in turn, be formed to fit. Ampli-Film meets the requirement. The curved Capitron® Wafer Capacitor pictured is an example. A truly remarkable versatility in a dielectric.



*Ampli*FILM the all-purpose dielectric, is insoluble, incompressible and inert . . . undergoes no distortion from heat or pressure . . . can be bonded by adhesives . . . is free from pinholes and flaws . . . is easy to handle and fabricate.

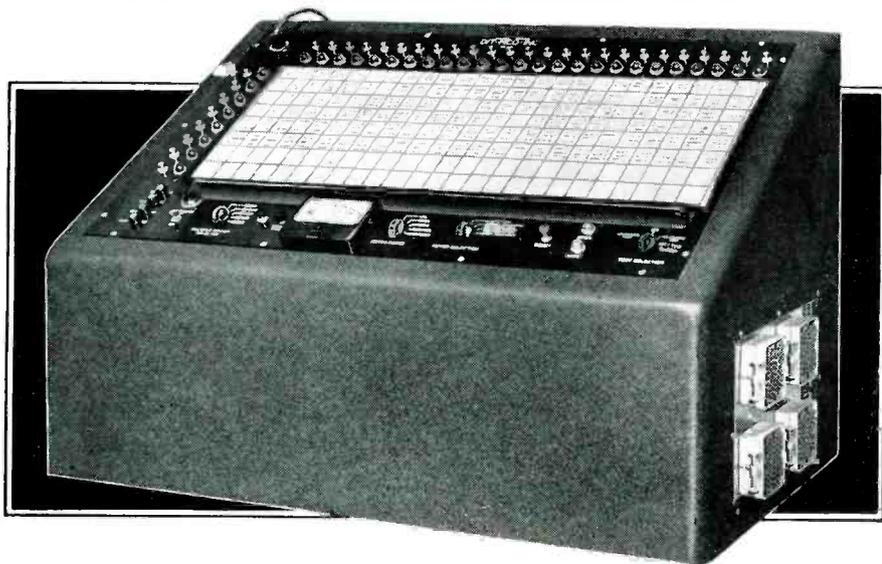
AIRCRAFT-MARINE PRODUCTS, INC.

Chemicals and Dielectrics Division • 155 Park Street, Elizabethtown, Pa.



A-MP of Canada, Ltd., Toronto, Canada • Aircraft-Marine Products (G.B.) Ltd., London, England
A-MP—Holland N.V., 's-Hertogenbosch, Holland • Societe A-MP de France, Courbevoie, Seine, France

ONE DIT-MCO AUTOMATIC CIRCUIT ANALYZER...



... CAN MAKE
THE EQUIVALENT OF 35,800
SEPARATE HAND TESTS IN
LESS THAN A MINUTE...AND
NON-TECHNICAL PERSONNEL
CAN DO THE WORK...MORE
ACCURATELY THAN WAS EVER
BEFORE POSSIBLE BY ANY
HAND OR MACHINE METHOD!

*If your product involves complex electrical
circuitry, DIT-MCO can help you make it
better and faster, at less cost. Write
today for full details.*

DIT-MCO INC., ELECTRONICS DIVISION

Box 04-15, 911 Broadway, Kansas City, Mo. • Phone: HARRISON 1-8484

Partial List of DIT-MCO Users:

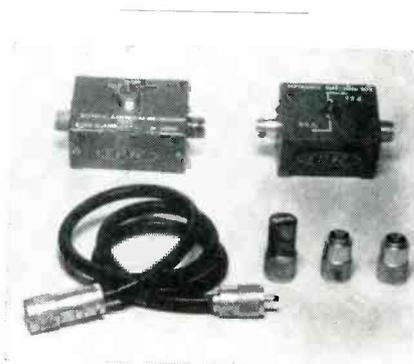
Bell Aircraft Corporation, Texas Div. • Bendix Aviation Corporation, Sidney, New York • Boeing
Airplane Company, Seattle, Washington and Wichita, Kansas • American Bosch Arma Corporation
• Douglas Aircraft Company, Tulsa, Oklahoma • Fairchild Aircraft Division • Goodyear Aircraft
Corporation • Martin, Baltimore • Naval Ordnance Laboratory, White Oaks, Maryland • Northrop
Aircraft, Inc. • Motorola, Inc. • Temco Aircraft Corporation • Trans World Airlines • Convair •
Chance Vought Aircraft • Servomechanisms, Inc. • Radio Corporation of America • Pacific Mercury
Television Mfg. Corp.

NEW PRODUCTS

(continued)

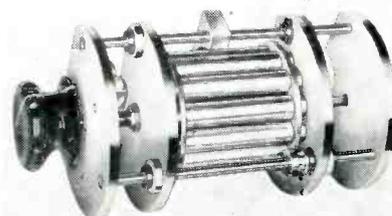
voltage output inherent in the mercury battery system are available at lower prices.

► **Specifications** — The new batteries are available in standard miniature sizes for 15, 22.5, and 45 v. The basic individual cell is 0.490 in. in diameter, with an overall height of 0.280 in. When cells are nested together, the net height of each is 0.210 in.



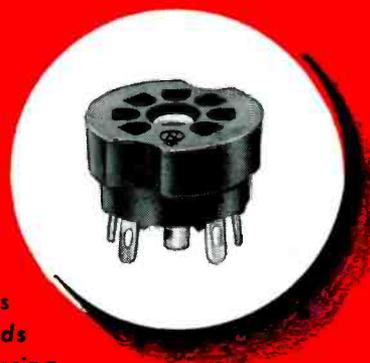
PULSE EQUIPMENT for wideband transmission

ELECTRICAL AND PHYSICAL INSTRUMENT CORP., 4219 27th St., Long Island City 1, N. Y. A new line offers most equipment needed for wide-band pulse transmission problems from d-c to 1 millimicrosecond rise time pulses (0 to 350 mc), standard coaxial cables prefabricated to any desired length with any desired standard connectors and coaxial line terminations for any impedance from 50 to 200 ohms. Impedance matching boxes for joining different impedance lines, and pulse splitters-mixers, pulse attenuators, and variable pulse delay boxes are included.



UHF ATTENUATOR uses coaxial networks

EMPIRE DEVICES PRODUCTS CO.,
38-15 Bell Blvd., Bayside, N. Y.
Model AT-104 is a 12-position uhf



molded printed circuit sockets

IMMEDIATE DELIVERY AND FINEST QUALITY
make ***nattfab*** the fastest growing line
of printed circuit sockets

- ★ available in 7 or 9 pin types
- ★ with or without center shields
- ★ above or below board soldering
- ★ in mica-filled or black phenolic material
- ★ with or without ground straps



WRITE for illustrated or technical literature
Samples available upon request

NATIONAL FABRICATED PRODUCTS

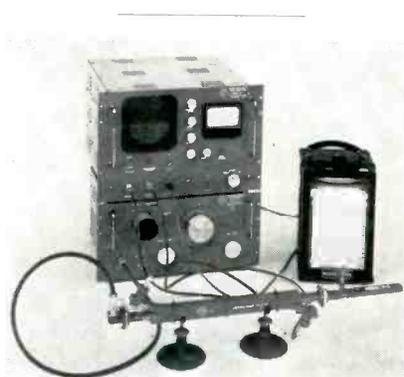
2650 West Belden Avenue • Chicago 47, Illinois

Division of **Hoffman** ELECTRONICS CORPORATION

attenuator using resistive coaxial networks.

► **Specifications**—The attenuators are used in both narrow-band and broadband circuits within the frequency range from d-c to 4,000 mc. The vswr is better than 1.1 to 1 at all frequencies to 3,000 mc, better than 1.2 to 1 at all frequencies to 4,000 mc. Rated power is 1 w continuous, 1 kw peak. Accuracy is $\pm \frac{1}{2}$ db. Normal impedance is 50 ohms, with special impedance values supplied on request.

Designed to withstand mechanical shock and vibration, the AT-104 is expected to be widely used both as a laboratory test device, and a production component where flexibility coupled with accuracy is required.

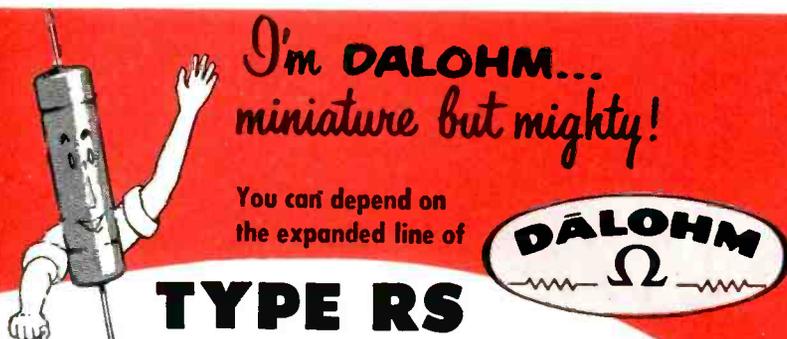


MEASURING SYSTEM plots vswr vs frequency

COLOR TELEVISION INC., 935 San Carlos Ave., San Carlos, Calif. Permitting instant observation and/or recording of vswr vs frequency, model 125-A sweep-frequency vswr measuring system offers the speed and accuracy of a ratiometer system using a bidirectional coupler. Overall accuracy is within 2 percent.

► **Uses**—The instrument is ideal for wideband tuning operations both in the laboratory or on the production line. Also, where desired, it can be used in single-frequency operations.

Both a built-in oscilloscope and direct-reading meter are provided for direct observation. Where permanent records are required a recorder is available as an accessory. A 203-B klystron with 1,000-cps square-wave modulation is used as an r-f source. The system includes a load calibrated at 4 vswr read-



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For all applications where the equipment must survive the most severe environmental, shock, and vibration conditions.

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RS-2A, 2 watts; RS-2B, 2 watts; RS-2, 2 watts;
RS-5, 5 watts; RS-7, 7 watts; RS-10, 10 watts.

- Temperature coefficient 0.00002/Deg. C
 - Ranges from 0.05 ohm to 55,000 ohms, depending on type
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- Conform to applicable JAN and MIL Specifications

Write for Bulletin R-23A

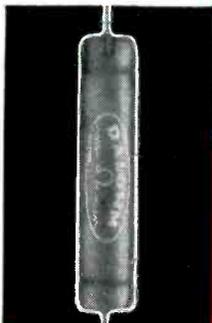
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RELAYS



LONG BRANCH, N. J.

Notable Achievements at JPL

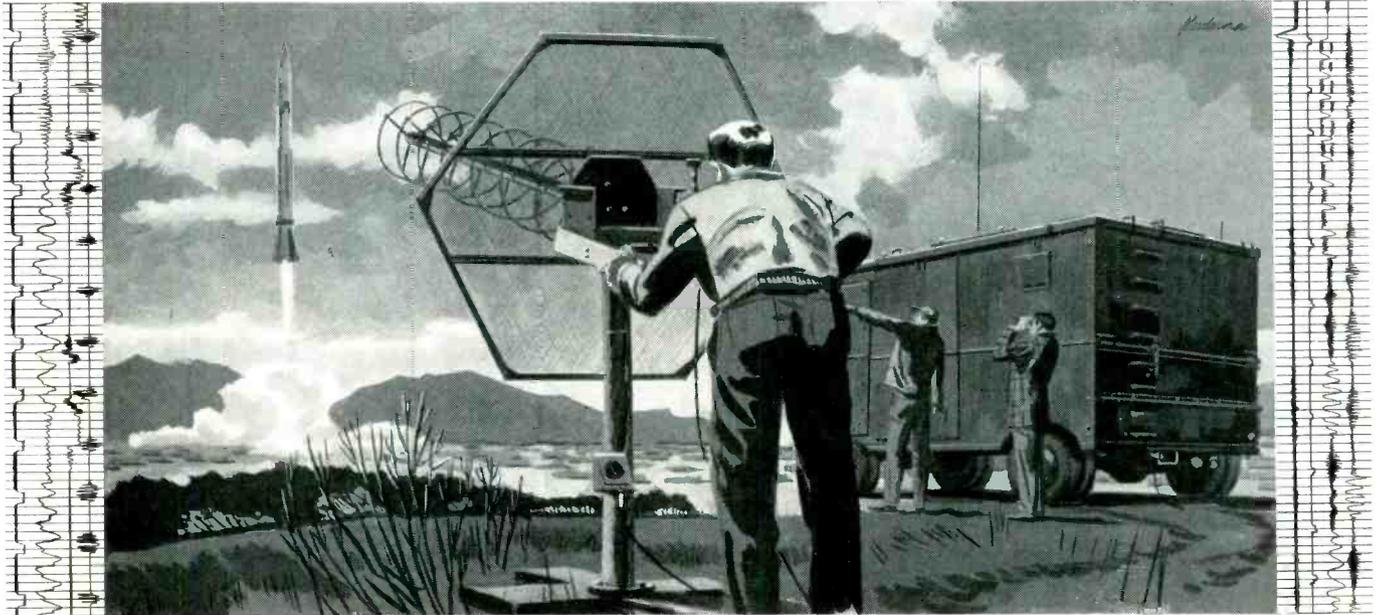
FIRST TO FLY FM-FM TELEMETERING... From JPL's 3-band FM-FM telemetering System flown in 1944, to its present extremely versatile, compact, transistorized 18-band system, telemetering has been an important factor in the successful development of JPL guided missiles.

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The success of the Corporal and other JPL guided missile programs is dependent on constantly improved instrumentation techniques. Development, a major portion of the Telemetering Group activity, is directed toward improving system flexibility, accuracy and reliability. This activity is tailored to both immediate and long range instrumentation requirements of the many Laboratory missile programs.

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Thermostatic **DELAY RELAYS** 2 to 180 Seconds

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- SPST only — normally open or normally closed.

Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from -55° to $+70^{\circ}$ C. Heaters consume approximately 2 W. and may be operated continuously. The units are most compact, rugged, explosion-proof, long-lived, and — inexpensive!

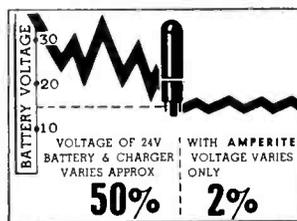
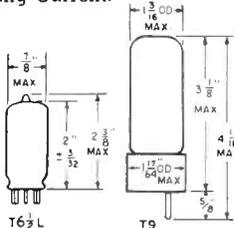
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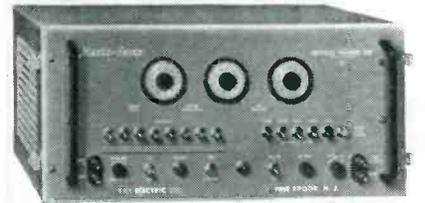
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Individual inspection and double-checking assures top quality of Amperite products.

ings for each of 3 different frequencies.

► **Price**—The complete system including indicator, oscillator, bidirectional coupler and calibrated load is \$4,950.



SWEEP OSCILLATOR priced at \$695

KAY ELECTRIC Co., Pine Brook, N. J. The Marka-Sweep model Video 50, a new sweeping oscillator with marks, provides both a 50-mc sweep which includes the low end of the video spectrum, and a continuously variable i-f sweep, enabling the operator to look at the complete spectrum to 50 mc or any 4-mc part over the range.

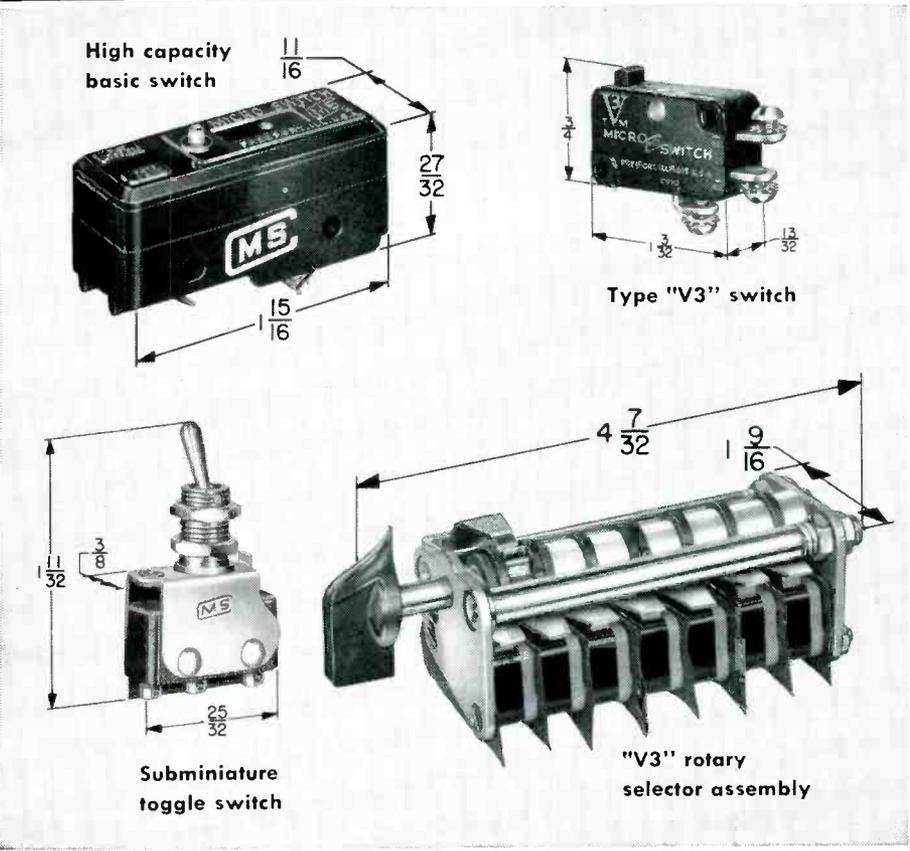
► **Specifications**—Range is 50 kc to 50 mc, continuously variable; r-f output, 1.0 v peak to peak into 75 ohms, flat within ± 0.5 db over widest sweep; sweep width, linear sweep continuously variable 4 mc to 50 mc; sweep rate, variable around 60 cps, locks to line frequency; attenuators — individually switched 20, 20, 10, 6 and 3 db plus continuously variable 6 db; markers — both internal and external crystal controlled pulse type, individually selected at 10, 20, 30, 40 and 50 mc.

ELECTROLYTICS are ultraminiature type

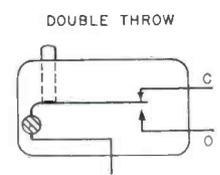
BARCO, INC., Box 1222, Milwaukee 1, Wis. Particularly advantageous for the transistor application where size is of prime importance, these ultraminiature electrolytics are now available in 42 types. Capacitance range is from 0.15 μ f to 160 μ f, voltage ratings from 1.5 v dew to 70 v dew, and diameters from $\frac{1}{8}$ in. to $\frac{3}{16}$ in. The tiny units are hermetically sealed and are inherently

MICRO precision switches

...THEIR USE IS A PRINCIPLE OF GOOD DESIGN

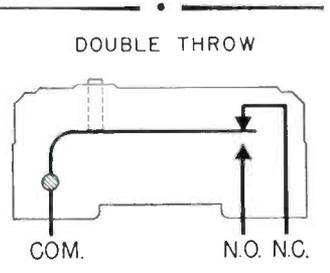


Circuit Arrangements



Type V3 Switch

This switch has a single-pole, double-throw contact arrangement. Electrical rating is: 10 amperes, 125 or 250 volts a-c; 1/2 ampere, 125 volts d-c; 1/4 ampere, 250 volts d-c.

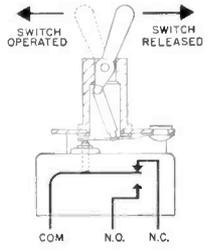


High Capacity Basic Switch

Standard switches are single-pole, double-throw. Electrical rating is: 20 amperes 125, 250 or 460 volts a-c; 1/2 ampere 125 volts d-c; 1/4 ampere 250 volts d-c; 1 H. P. 115 volts a-c; 2 H. P. 230 volts a-c; 10 amperes 125 volts when controlling tungsten filament lamp loads on a-c circuits.

Subminiature Toggle Switch

Contact arrangement is single-pole, double-throw. Double-pole, double-throw assembly, using two subminiature switches is available. Electrical rating is: 5 amperes 125 or 250 volts a-c. The 30 volt d-c rating is, inductive—3 amperes at sea level and 2.5 amperes at 50,000 feet, resistive—4 amperes at sea level and 4 amperes at 50,000 feet, maximum inrush is 15 amperes.



A continuous flow of Precision Switch developments anticipates designer's needs

Whatever the design requirement—whether it calls for unusually small size, unusually high electrical capacity or unusual actuation and circuit arrangement—there is a MICRO precision switch to meet it. That is why designers have long made it standard policy to check with MICRO SWITCH as new needs develop.

Shown here are just a few small, compact switch designs that are typical of MICRO SWITCH development. Each is one of a whole "family" of extremely reliable switches.

Type "V3" Switch. The MICRO SWITCH "V3" line switches have the highest electrical capacity for their size of any switch available. They have been developed to meet the exacting requirements of designers for an extremely small, compact switch without sacrifice of quality. Actuators are available to permit their actuation by cams, slides and other mechanical motion not in line with the switch plunger motion. (Send for catalog 74).

"V3" Rotary Selector Assembly. These assemblies are available with from one to eight switching units and from two to eight detent positions. Light in weight and small in size, these assemblies are well suited for use in electronic and aircraft applications. Many as-

semblies are available with various camming sequences. (Send for catalog 74).

High Capacity Basic Switch. This switch combines high electrical rating with high inrush capacity. The steady state current rating is 20 amperes, with inrush capacity of 75 amperes on voltages up to 460 volts a-c. These switches are especially useful for handling high inrush currents of solenoids, motors and tungsten lamps. (Send for catalog 62).

Subminiature Toggle Switch. This is one of a number of subminiature toggle switch designs developed for subminiature assemblies. The toggle switch illustrated consists of one MICRO subminiature switch riveted into the stainless steel toggle bracket. The assembly is for single-pole, double-throw service. Double-throw switches can be used "normally open" or "normally closed" by wiring to either the normally open or normally closed terminals. (Send for catalog 75).

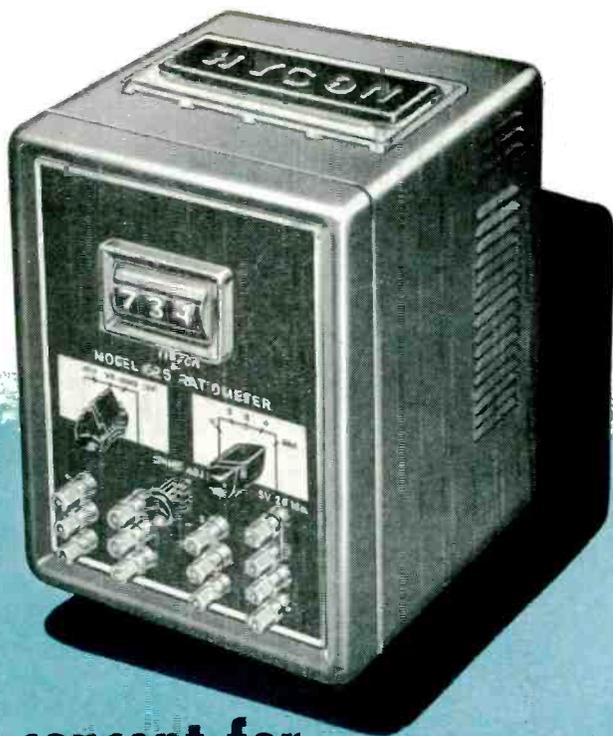
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**MODEL 615
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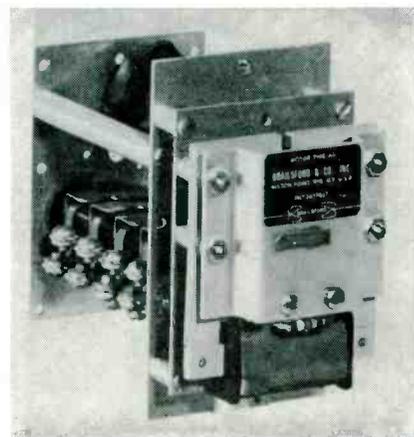
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low in leakage current. An operating temperature range of -30°C to $+60^{\circ}\text{C}$ is standard. List price is \$1.

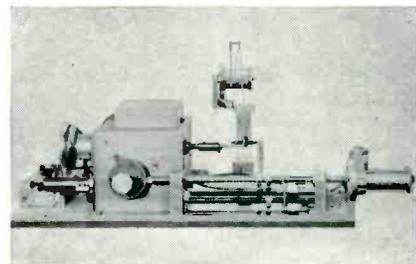


REPEAT CYCLE TIMER operates on less power

BRAILSFORD & Co., INC., Milton Point, Rye, N. Y. Model AGS-4 repeat cycle timer was developed primarily for balloon instrumentation. It has 4 spdt switching circuits. Overall dimensions are: 3 in. deep; $2\frac{1}{4}$ in. high; $1\frac{1}{2}$ in. wide. Weight is 6 oz. Operating current is 8 ma at 6 v d-c. The governor will hold speed to within 1 percent with as much as 50 percent voltage shift, either plus or minus from rating.

It is also available with 1, 2 or 3 circuits and in any required output speed.

Although primarily designed for semiexpendable applications, units now incorporate a new brush assembly to give normal service life of better than 3,000 hours continuous operation.



COIL WINDER variable pitch space

GEO. STEVENS MFG. Co., INC., Pulaski Road at Peterson, Chicago 30, Ill., has available a new variable pitch space winder designed for

sub-miniature MODULAR AMPLIFIERS

REL-18 ISOLATION AMPLIFIER

A Sub-miniature 400 cycle power amplifier, having adjustable voltage gain from unity to 70 with 100 MW power output. The circuit uses triodes with negative feedback reducing the output impedance, phase shift and distortion to a minimum.

REL-19 SUMMING AMPLIFIER

Special purpose sub-miniature 400 cycle amplifier with multiple inputs and single output. The signal output is the vector sum of the input signals times the gain of the amplifier. 14 channel summing accuracy within 2½%. Low output impedance, low phase shift and high stability are achieved by use of negative feedback.

REL-20 SERVO AMPLIFIER

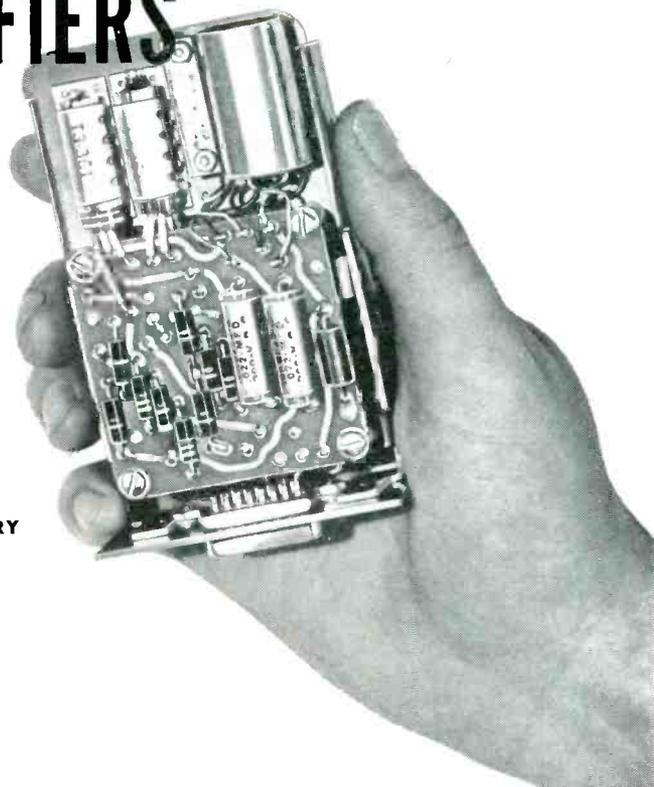
High gain sub-miniature servo-amplifier utilizing push pull output and feedback. 100 MW power output, low phase shift and high stability. Designed to operate into a chopper demodulator.

* **PROVEN RELIABILITY**

* **REDUCE OVERALL SYSTEM COST**

* **MINIMUM SPACE AND WEIGHT**

* **DESIGNED TO MILITARY SPECIFICATIONS**



REL-102 GENERAL PURPOSE WIDE BAND AMPLIFIER

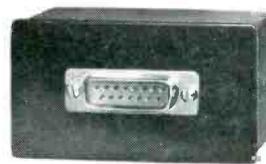
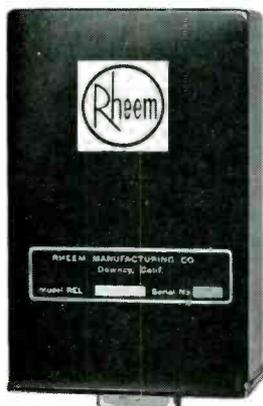
Maximum gain 300. Four course gain ranges with each range continuously variable $\pm 10\%$. High input and low output impedance.

REL-103 GALVANOMETER AMPLIFIER

For amplifier piezo electric or low level transducer signals to drive High Frequency Fluid Damped Galvanometers. 70 MA peak to peak into 30 ohm galvanometer.

REL-104 ACCELEROMETER AMPLIFIER

For amplifying piezo-electric accelerometer signals to drive sub-carrier oscillator and similar devices. High input impedance and low output impedance. Gain of 10 continuously variable $\pm 10\%$.



REL-09
Miniature Telemetering Power Amplifier designed to withstand extreme shock and vibration. 2 watts nominal power output.

for further information call:

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Because of the unique Shallcross method of encapsulating windings, "P" type resistors have greater maximum resistances, longer leakage paths, and higher wattage ratings.

Shallcross "P" type resistors are available in six MIL-R-93A lug-type styles and five axial lead styles with wattage ratings ranging from .500 to 3.5 watts. All styles meet and exceed JAN-R-93A, Characteristic A.

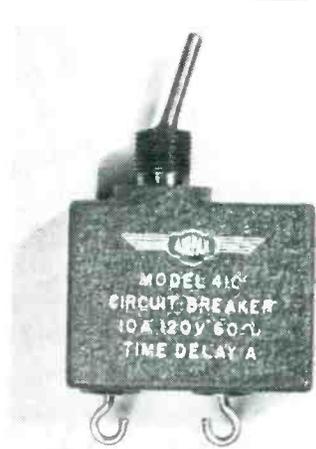
Complete information on sizes, ratings, and test results of Shallcross "P" type precision wirewound resistors is available in Engineering Bulletin L-30. Write for your copy today.

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522 Pusey Avenue, Collingdale, Pa.

long production runs. It features the electric heel-and-toe pedal which starts the machine and resets the cam for each new winding, permitting the operator to have full use of both hands at all times.

A new time-saving self-resetting automatic counter requires no handling or resetting until turns count is changed, saving much valuable time during long production runs.

Model 518-AM winds variable pitch single layer coils up to 3 in. long by 3 in. o-d. Wire sizes range from 18 to 46. One tension, one gearing set-up, magnetic brake and custom built motor are supplied. Windings speed is up to 2,100 rpm. Complete job changeover takes only 5 to 10 min. Output end of spindle is $\frac{5}{8}$ in., flatted shaft, accommodating chucks or mandrel adapters.



CIRCUIT BREAKER for operation to 1,200 cps

AIRPAX PRODUCTS Co., Middle River, Baltimore 20, Md. Type 410 miniature magnetic circuit breaker is now rated for operation from 60 to 1,000 cps. This compact series breaker is thus applicable to a wide variety of airborne installations operating at 400 cps even if the power is subject to wide variations in frequency.

► **Specifications** — Occupying little more than a cu in. of volume and weighing less than 2 oz, this all-magnetic inverse time delay breaker is available in ratings from 1.0 to 10 amperes, 120 v. The hermetically sealed unit is designed for a minimum life of 10,000 on-off operations, resists over 50 g shock and 0.06 in. total excursion of vibration from 1.0 to 55 cps in all

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TC 75E

SYSTEMS RAKSCOPE

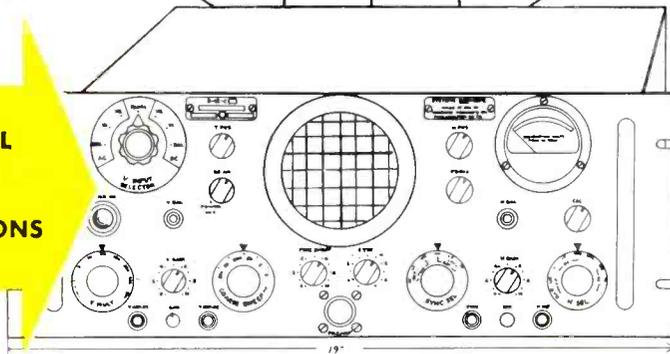
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MODEL S-12-C

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7" HIGH
10" DEEP



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The S-12-C series of Systems RAKSCOPES have been developed for the dual purpose of monitoring and troubleshooting of rack-mounted equipment. These oscilloscopes obtain a new degree of flexibility with the multiple input selector making possible selection of different signal sources. This optional vertical input selector, with built-in attenuators, selects either front panel connectors for troubleshooting or rear mounted connectors for systems monitoring. This permits the omission of an entire switching panel from an overall system resulting in circuit and space economies. A ruggedized construction philosophy has been carried throughout. Vertical and horizontal amplifiers are identical, each having a frequency response from dc to 700 kc (-2 db). Their sensitivities are 50 and 72 millivolts rms per inch of deflection. Signal amplitude calibration employs a direct reading meter. The time base is operative in either trigger or repetitive modes with a range from $\frac{1}{2}$ -cycle to 50 kc. Synchronization is independent of polarity. Sync. lockout circuits are employed for stable operation over wide range of writing speeds and amplitudes. A unique plug-in elliptical sweep network makes frequency calibrations more simplified. Power requirements: 105-125 volts, 50 to 400 cycles. Accessory probes available; attenuator and amplifier types.

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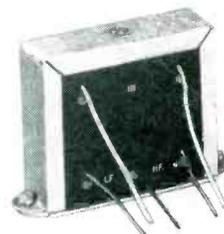
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directions and maintains its trip level constant from -0 to $+100$ C.

Because it mounts with a standard switch shank, type 410 trip-free circuit breaker serves both as power on-off control and as circuit protector to simplify equipment wiring and maintenance.



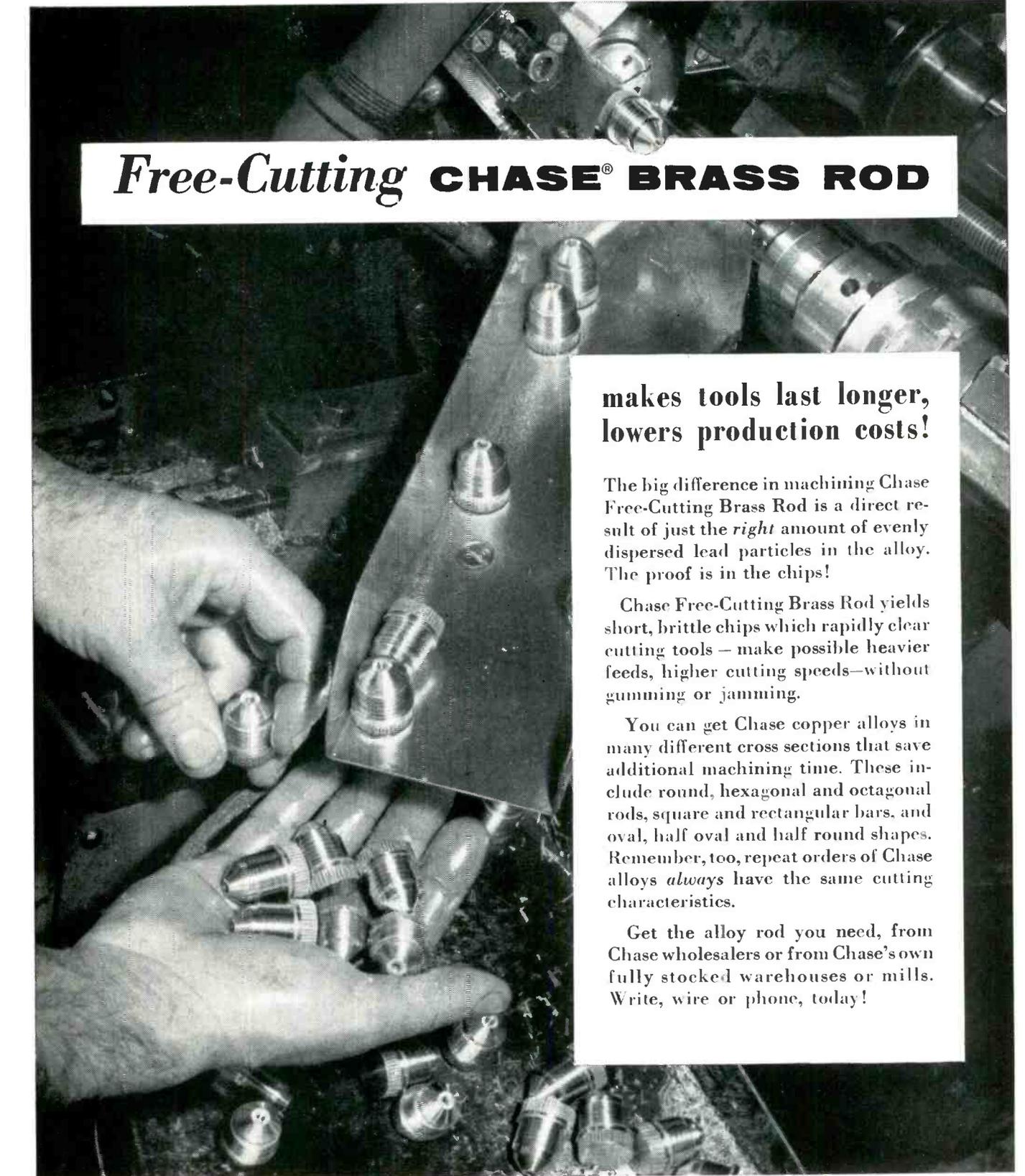
L-F CROSSOVER priced at \$13.95

BEAM INSTRUMENTS CORP., 350 Fifth Ave., New York 1, N. Y. The CX500 predetermines the crossover frequency at 500 cps, and has output connections providing l-f from 0 to 500 cps and h-f from 500 cps upwards. Input and both output impedances are 15 ohms. Weight is approximately 1 lb. Dimensions are 4 in. by 3 in. by 1 in.



SINE-WAVE GENERATOR uses etched circuits

DONNER SCIENTIFIC Co., 2829 Seventh St., Berkeley 10, Calif. Model 1200 sine-wave generator generates pure sinusoids from 1 cps to 1 mc (plus overlap) in 6 decade ranges. Distortion is less than 0.1 percent for any frequency or amplitude. Low output impedance of 600 ohms is constant for any setting of the amplitude control. The signal, 0 to 8 v rms, contains no d-c component. Stable amplitude, freedom from



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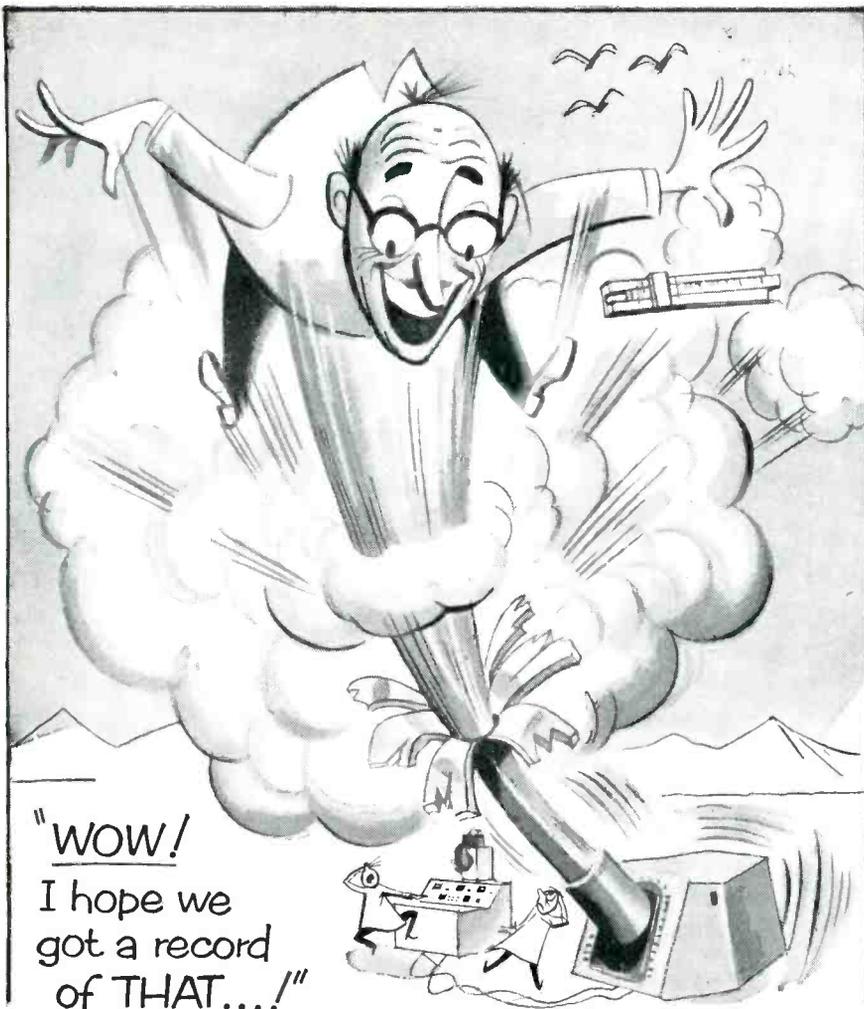
NEW CHASE ROD and WIRE MOVIE "IN THE CHIPS"

Contact your nearest Chase Warehouse or Sales Office now to arrange for a loan of this informative film for showing in your own organization. Write on your Company letterhead.

The Nation's Headquarters for Brass & Copper (sales office only)

Atlanta	Chicago	Denver	Indianapolis	Minneapolis	Philadelphia
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Boston	Cleveland	Grand Rapids†	Los Angeles	New Orleans	Providence
Charlotte†	Dallas	Houston	Milwaukee	New York	Rochester†
	St. Louis	San Francisco	Seattle	Waterbury	

Want more information? Use post card on last page.



"WOW!
I hope we
got a record
of THAT...!"

COSTLY DESTRUCTION TESTS DEMAND THE RELIABILITY OF A FAIRCHILD OSCILLO-RECORD CAMERA

Of course, you can always get another piece of equipment to test, set up your instruments, repair your personnel, relandscape the grounds and start all over . . . but it's really easier and less expensive to get the data the first time. Barring a cataclysm like the one above, the Fairchild Oscillo-Record Camera is your best bet for getting accurate records of the test data you want . . . the first time.

Since Fairchild built the first camera specifically designed for oscilloscope recording, more *Oscillo-Record* cameras have been used than all other continuous motion oscilloscope recording cameras combined. The *Oscillo-Record* camera has several design features which contribute to its outstanding reliability and trouble-free operation in obtaining accurate test data. It is ruggedly constructed; its sprocket film drive eliminates slippage, even at high speeds. Rigid, top-of-scope mounting safeguards it against accidental upsetting, maintains the camera in focus at all times and leaves oscilloscope controls unobstructed. Other features include the electronically-controlled continuously variable film speed which permits the selection of the exact rate of film transport for optimum performance.

For any wave pattern . . . continuously varying, stationary or single transient, at all speeds from 1 to 3600 inches per minute, (7200 in/min on special order) the Fairchild Oscillo-Record camera is the reliable means of photographing scope patterns. Industrial Camera Division, Fairchild Camera & Instrument Corp., 88-06 Van Wyck Expressway, Jamaica, L. I., N. Y., Dept. 120-25A2.

FAIRCHILD

OSCILLOSCOPE RECORDING CAMERAS

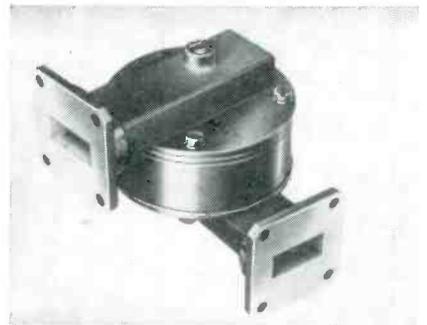
NEW PRODUCTS

(continued)

drift, and high calibration accuracy are insured by a fully regulated power supply and generous negative feedback.

► **Other Features**—The instrument utilizes a frequency-generator circuit requiring only two vacuum tubes. No wave filter or complex distortion-reducing device is needed. Use of etched circuits and miniaturized components has cut the weight to 23 lb and the size to 7½ by 10½ by 13½ in.

Model 1200 has application wherever high-quality sine waves are essential, as in communications, audio and laboratory testing. Price is \$265.



MICROWAVE JOINT for 1.00 by 0.50 waveguide

AIRTRON, INC., 1103 W. Elizabeth Ave., Linden, N. J., has developed a microwave rotary joint with a peak power rating exceeding 400 kw at atmospheric pressure. The high-power waveguide rotary joint is used with 1.000 by 0.500 waveguide and is available in both unsealed or pressured versions.

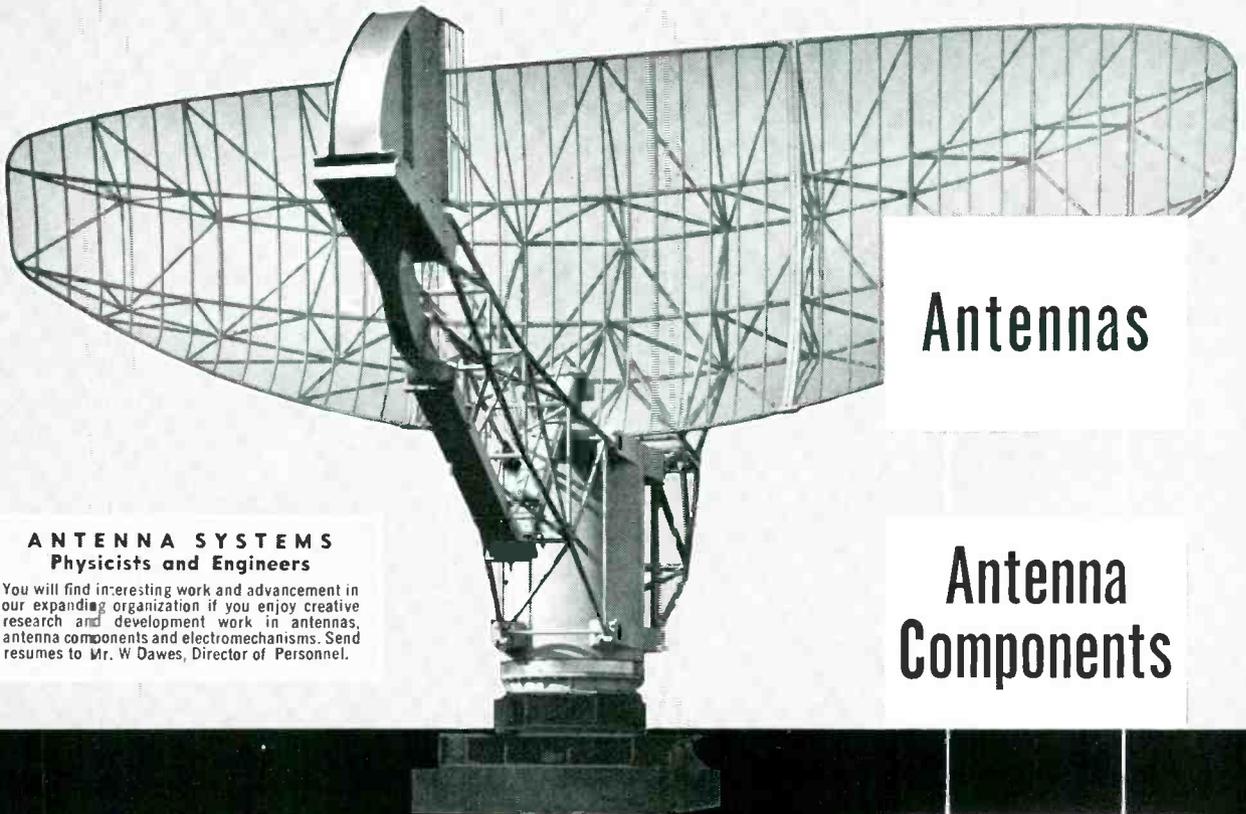
Characteristics include a maximum vswr of less than 1.25 over the 8,500-9,600 mc range and a vswr of less than 1.10 when tuned for narrow-band operation. Variation of vswr with rotation is negligible throughout the total angular travel.

► **Further Data**—Rated for 30 psi pressurization, the rotary joint retained 60 psi without leakage, after rotation at 170 rpm for 10 million revolutions. Mechanical design features assure stability of electrical characteristics throughout the life of the high power joint.

Lasting accuracy of rotation is maintained by large diameter pre-loaded ball bearings. These bear-

electronics →

Gabriel



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Components**

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You will find interesting work and advancement in our expanding organization if you enjoy creative research and development work in antennas, antenna components and electromechanisms. Send resumes to Mr. W Dawes, Director of Personnel.

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FOR EVERY MICROWAVE APPLICATION

. . . Gabriel can furnish antenna equipment of proved efficiency and reliability. The experience and facilities of Gabriel laboratories offer prompt solutions to your antenna problems. And the manufacturing skills and equipment of Gabriel Electronics Division assure scheduled production to the laboratories' performance specifications.

For analysis of your antenna or microwave problems, write us or telephone NEedham 3-0005 (through Boston).

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THE GABRIEL COMPANY



NEEDHAM HEIGHTS 94, MASSACHUSETTS
NEedham 3-0005 (thru Boston)

New 2-TERMINAL

SERIES L-6600

Only $1\frac{5}{64}$ " long from lens to terminals, this new Hetherington light gives wide-angle visibility in both standard and edge-lit panels. Uses 6, 14 or 28 volt AN-3140 lamps in a unique mounting so light is "piped" evenly throughout the long plastic lens. Lamp circuit insulated from case to meet the needs of electronic equipment. Mounts in $1\frac{5}{32}$ " diameter hole. Can be supplied with "taper tab" terminals. Also available with 1-terminal, case ground, as Series L-6000.



2

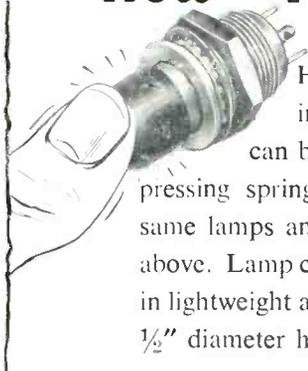
smaller

INDICATOR LIGHTS

for compact Aviation and Industrial Assemblies

New "PRESS-TO-TEST"

SERIES L-3200



Here's added safety for critical warning light jobs. Lamp and its circuit can be "checked out" before take-off by pressing spring-mounted plastic lens cap. Uses same lamps and lens assembly as L-6600 shown above. Lamp circuits insulated from case. Housed in lightweight anodized aluminum case. Mounts in $\frac{1}{2}$ " diameter hole.

OTHER INDICATOR LIGHTS . . . including Hetherington-originated switches with Built-in Lights are regularly produced in a variety of standard and special styles. *Write for Bulletin L-2.*

HETTERINGTON, Inc.

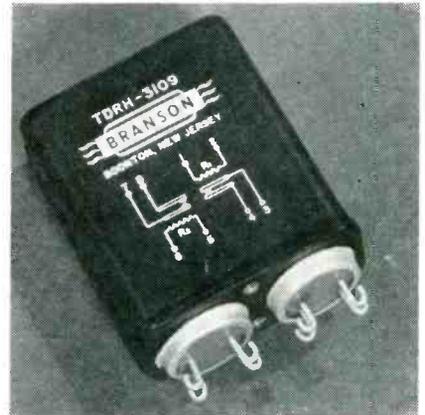
SHARON HILL, PA.

West Coast Div.:
139 Illinois St.
El Segundo, Calif.

HETTERINGTON

INDICATOR LIGHTS • SNAP-ACTION SWITCHES
SWITCHES WITH BUILT-IN LIGHTS
HIGH-IMPACT RELAYS • COILS • SOLENOIDS

ings are a permanently lubricated, sealed type which eliminate dirt contamination problems over the life of the bearing.



TIME DELAY RELAY has 2-in-1 feature

BRANSON CORP., Boonton, N. J. The new type TDRH thermal time delay relay uses only 1.531 by 0.844 chassis space and contains two thermal relays which may be completely independent or interwired in various ways to provide special voltage compensated delays as well as other unique results.

► **Operation** — The TDRH is hermetically sealed and can be operated in ambient temperatures from -65 C to $+125$ C. It will operate properly under the various shock and vibration requirements encountered in high speed military aircraft.

The time delays may be operated at voltages up to 120 v. They require 2 to 4 w of control power depending upon the particular requirements. Normally open or normally closed contacts are available. Standard delays may be anywhere from 1 sec to 1 minute.

EPOXY COMPOUND for potting, encapsulating

HOUGHTON LABORATORIES, INC., 322 Houghton Ave., Olean, N. Y., have available a new epoxy compound, Hysol 6600, especially developed for use in potting and encapsulating large metal masses such as transformers for electronics, instrument transformers, power bushings and related equipment. It has been

**Available now
to Engineers and Designers!**

NEW! OVER 100 PAGES!

E-I HANDBOOK and CATALOG

INCLUDES COMPLETE DATA Contains full electrical and mechanical data on over 500 standard types with a helpful discussion of accepted installation techniques.

REQUEST YOUR FREE COPY NOW This authoritative brochure will be particularly useful for design, production and purchasing staffs for specifying, installing and ordering service-proven E-I glass-to-metal seals. To obtain your copy, just write E-I on your company letterhead. A copy will reach you promptly!



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Terminals



Multi-lead
Headers



E-I
End Seals



Plug-in
Connectors



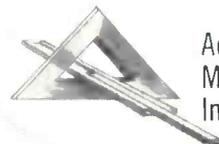
Diode and
Transistor
Closures



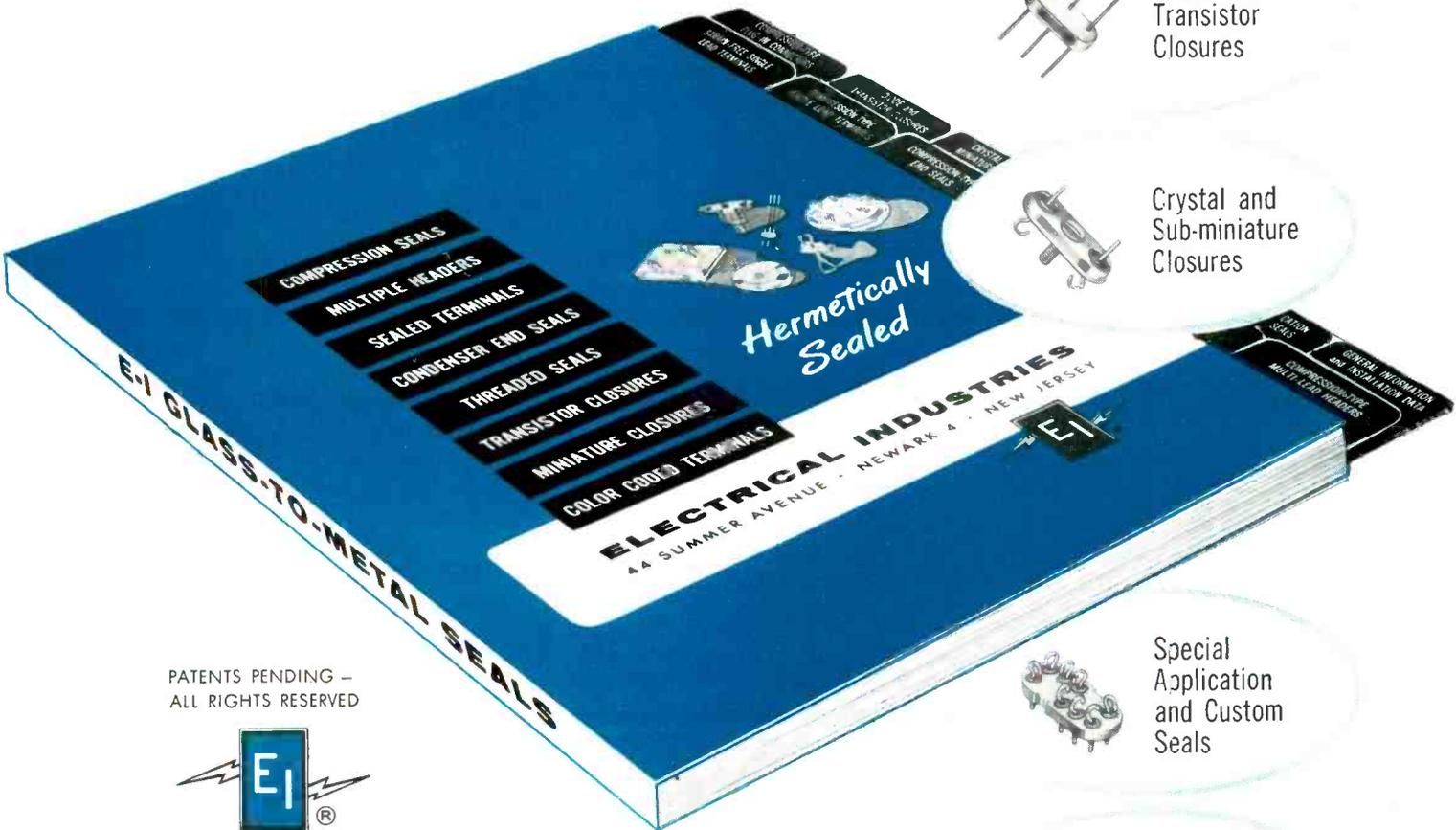
Crystal and
Sub-miniature
Closures



Special
Application
and Custom
Seals



Accepted
Methods of
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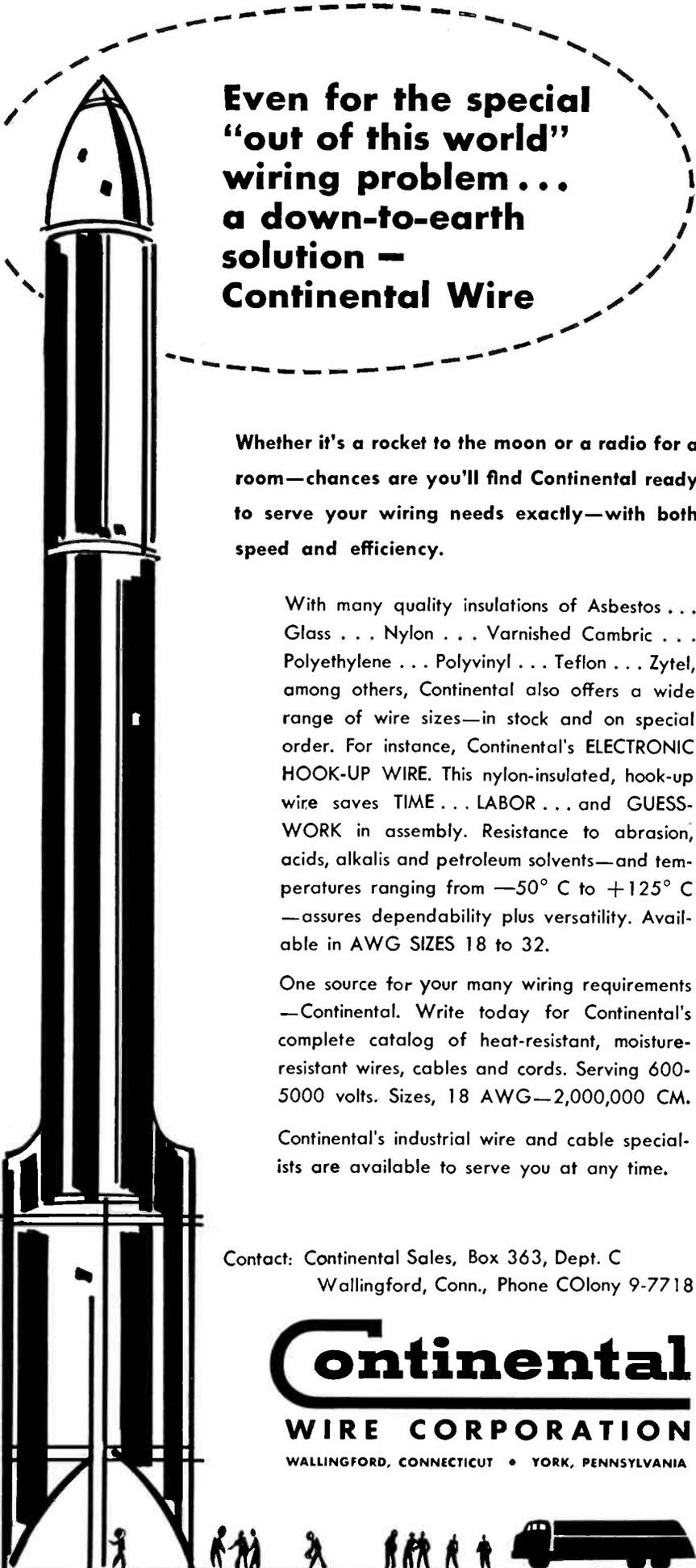


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ELECTRICAL INDUSTRIES

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Whether it's a rocket to the moon or a radio for a room—chances are you'll find Continental ready to serve your wiring needs exactly—with both speed and efficiency.

With many quality insulations of Asbestos . . . Glass . . . Nylon . . . Varnished Cambric . . . Polyethylene . . . Polyvinyl . . . Teflon . . . Zytel, among others, Continental also offers a wide range of wire sizes—in stock and on special order. For instance, Continental's ELECTRONIC HOOK-UP WIRE. This nylon-insulated, hook-up wire saves TIME . . . LABOR . . . and GUESS-WORK in assembly. Resistance to abrasion, acids, alkalis and petroleum solvents—and temperatures ranging from -50°C to $+125^{\circ}\text{C}$ —assures dependability plus versatility. Available in AWG SIZES 18 to 32.

One source for your many wiring requirements—Continental. Write today for Continental's complete catalog of heat-resistant, moisture-resistant wires, cables and cords. Serving 600-5000 volts. Sizes, 18 AWG—2,000,000 CM.

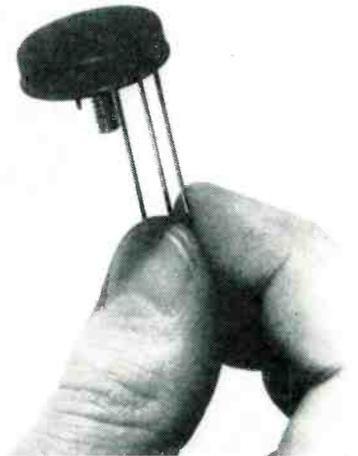
Continental's industrial wire and cable specialists are available to serve you at any time.

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used in transformers which must meet the requirements of MIL-T-27A specification.

Hysol 6600 is a filled epoxy base supplied in the form of a soft solid which melts to an easily handled, low viscosity liquid. A resilient, heat-resistant, tough casting is obtained when this base is processed with Hysol Hardener D.



**SILICON TRANSISTOR
for power amplification**

GENERAL ELECTRIC Co., Syracuse, N. Y. A power *mp* alloy junction silicon transistor, the ZJ16 is capable of dissipating 8 w at 85 C and 4 w at 120 C. Maximum storage temperature is rated at 200 C. Maximum collector voltage is rated at 75 v. Alpha cutoff is 100 kc.

► **Applications** — The device will find application in guided missiles, jet igniters, servomechanisms, switching and general amplifier circuits.

It is expected that the ZJ16 will ultimately be the company's answer to the need for reliable power amplification in automobile radios.

**TEST JACKS
for printed circuit use**

RAYTHEON MFG. Co., 100 River St., Waltham 54, Mass. The new test jacks are miniature units designed specifically for printed circuit application. Consisting of a nylon insulator, a beryllium copper spring pin contact, and a gold-plated contact sleeve, these units are readily mounted in panels up to $\frac{1}{4}$ in. thick.

Eight colors are available and the

"WE LIKE THE CONSISTENT QUALITY OF RICHARDSON PLASTICS"

SAYS....

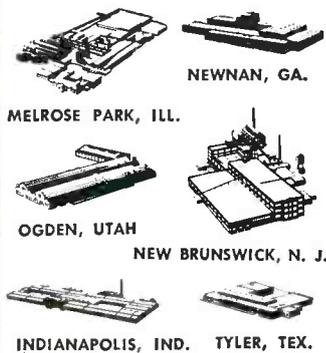


CHICAGO TELEPHONE SUPPLY
Corporation



Exploded view shows a CTS control—a concentric shaft tandem variable resistor with switch. Arrows indicate laminated parts made with Richardson plastics.

SIX PLANTS



**RICHARDSON
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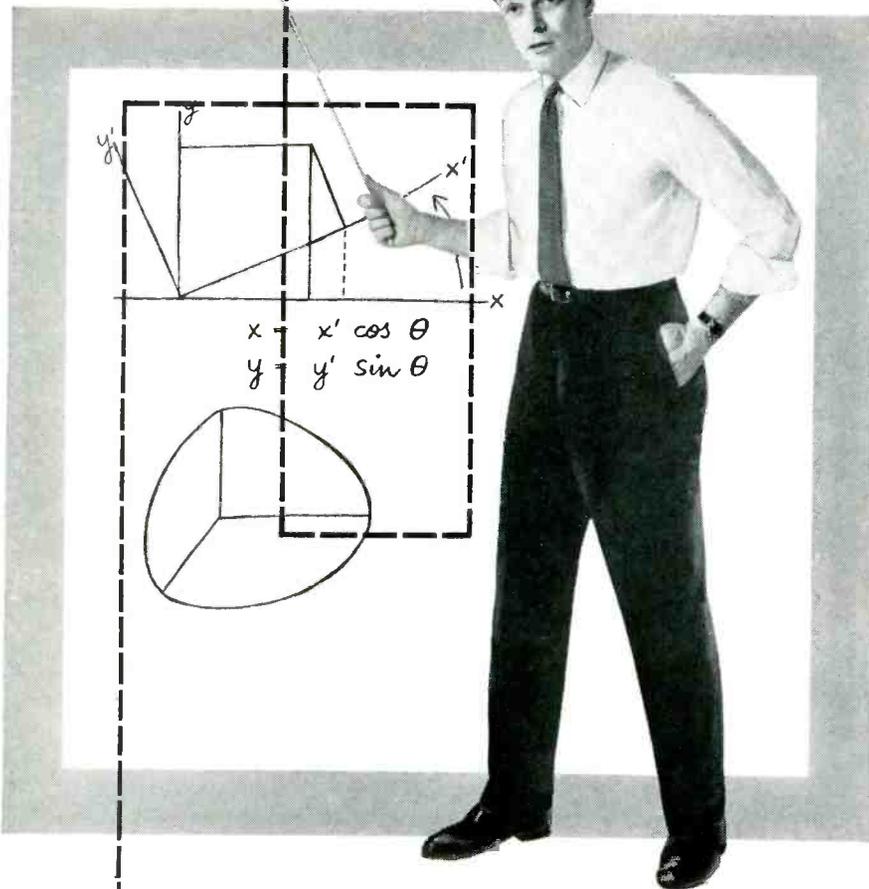
Chicago Telephone Supply Corporation is the world's largest producer of variable resistors. To achieve this position, they have stressed *quality*—both in their manufacturing operations and in their sources of supply. For many years, The Richardson Company has supplied the Chicago Telephone Supply Corporation with laminated and molded plastic products which meet their high standards for insulating and electrical properties—a testimonial to Richardson's own quality-mindedness.

If you are looking for a plastic supplier who can give you what you need, contact Richardson. Their complete laminating and molding facilities permit volume production with consistent high quality and accuracy. Write or phone today for complete information.

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RAPID, PRECISE TRIGONOMETRIC OPERATIONS FOR AUTOMATION

Norden-Ketay high-quality resolvers provide you with accurate solutions to problems encountered in:

- High precision phase shifting
- Data Transmission
- Industrial process controls
- Rectangular to polar coordinate transformations
- Rectangular coordinate rotations

These precision resolvers are available to standard sizes (10, 11, 15 or 23) or may be ordered to your specifications.

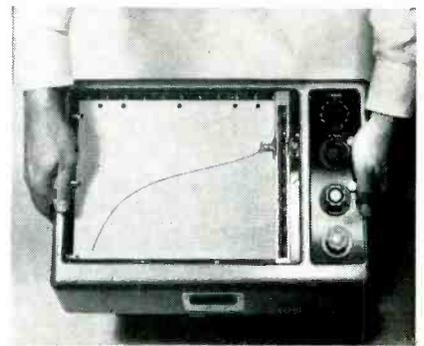
For full details write for data file # 113.



NORDEN-KETAY CORPORATION

WESTERN DIVISION:
13210 Crenshaw Blvd., Gardena, California
PRECISION COMPONENTS DIVISION:
555 Broadway, New York 12, New York

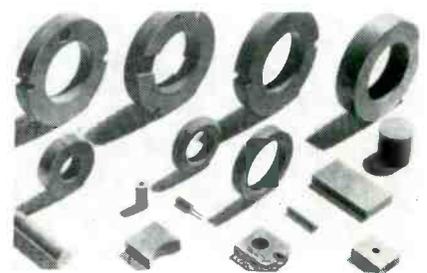
jacks accommodate standard 0.080 in. diameter test prods.



X-Y RECORDER is light and compact

F. L. MOSELEY Co., 409 N. Fair Oaks Ave., Pasadena 3, Calif. Ideal for desk-top use, the model 3 Autograf X-Y recorder presents standard notebook size graph paper on a flat bed, fully visible to the observer during recording operations. Independent servo drives, actuating a drafting machine type recording mechanism, provide 0.25 percent accuracy and resolution at speeds up to $\frac{1}{2}$ sec for full scale travel, each axis. Inputs are independent and transformer isolated from ground; sensitivity is adjustable in steps from 0.5 mv per in. up to 50 v per in. Zero set and full scale zero offset on both axes allow recording in any desired quadrant.

Completely self-contained, the model 3 Autograf measures 17 in. by 11 in. by 6 in. and weighs about 25 lb. Price is \$1,175.



CERAMIC MAGNETS are highly permanent

STACKPOLE CARBON Co., St. Marys, Pa. A low-cost, ceramic p-m material combines adequate energy product with high coercive force, low residual induction, virtually 100-percent electrical resistivity and exceptional resistance to demagnetization. The Ceramagnet perma-

... *Where reliability counts most.*

Up here
Almost 'Good enough'
won't do!

Up here, performance must be swift... precise... predictable. "Almost good enough" could mean disaster.

Today, at Norden-Ketay, experienced engineers are meeting missile quality demands in instrumentation for guidance, computers, data transmission, automatic control, components and other vital functions. The same skill and inventiveness responsible for the high level effectiveness of the AN/ASB-1 all weather Bomb Director System, for example, is currently engaged in the development of the most advanced systems for military and commercial use. With the wide range of facilities at their disposal... with the ability to develop completely new components where needed... Norden-Ketay is particularly suited to carry out major projects in instrumentation — from development to volume production.

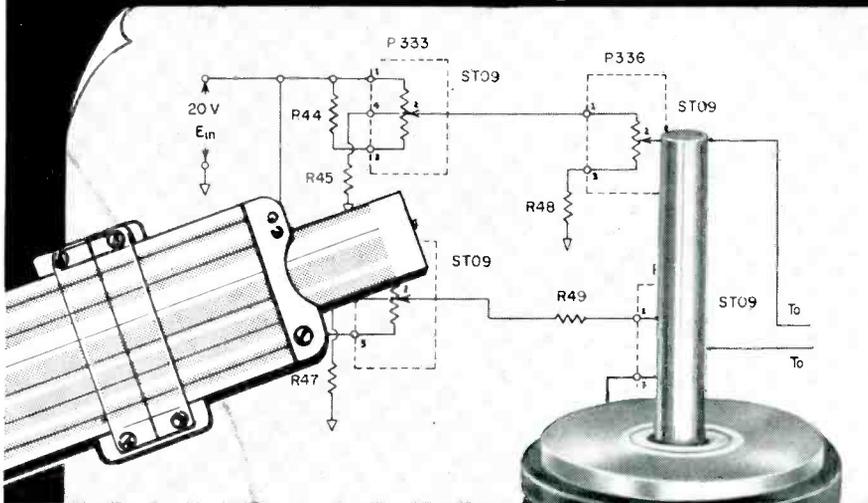
NORDEN-KETAY CORPORATION

99 Park Avenue, New York 16, New York

SERVOMECHANISM COMPONENTS • PRESSURE GAGES
AIRCRAFT INSTRUMENTS • AUTOMATIC CONTROL
SYSTEMS • RADAR • COMPUTERS

This picture of southwestern U. S. and Mexico is an official United States Navy photograph made from the research rocket, Viking 12, at an altitude of 143.4 miles.

Where specs are tight...



SPECIFY SUPERIOR BALL-BEARING POTENTIOMETERS BY



Designed for those applications where less than the best means failure . . . by the world's first and leading manufacturer of precision single-turn wire-wound potentiometers. Advanced production and quality-control techniques by the pioneer in mass production of precision potentiometers offer unequalled delivery . . . of prototype and production quantities.

All models of the TIC Ball-Bearing Series are designed to the latest industrial dimensions. Servo mounting is AIA standard. Stainless-steel ball-bearing construction is used for low-friction . . . low-torque operation. Other precision mechanical features include precious-metal slider contacts . . . centerless-ground stainless-steel shaft . . . and one-piece stainless-steel clamp ring developed by TIC for simple, precise phasing of individual units of ganged assemblies.

Designed for precision applications in automatic control systems, the subminiature ST09, for example, features standard independent linearity of $\pm 1\%$ (0.3%, special) of the total resistance, and $\pm 5\%$ standard total resistance accuracy. High resolution . . . equivalent noise resistance less than 140 ohms . . . wide standard temperature range (-55°C to 80°C) increases application versatility. ST09 is available in standard resistances of 100, 200, 500, 1K, 2K, 5K, 10K, and 20K.

Full specification on the ST09 and other units of the TIC precision ball-bearing series available upon request.

TECHNOLOGY INSTRUMENT CORP.

533 Main Street, Acton, Mass., COLonial 3-7711
West Coast Mail Address, Box 3941, No. Hollywood, Calif., POplar 5-8620

ment magnets retain their energy even when used without keepers or under other closed-circuit conditions, and in the presence of strong opposing fields.

Ceramagnet magnets are practically nonconductors. Electrical resistivity is 6 by 10^{10} ohms per cm^2 , making them ideally suited for h-f and h-v circuits. Temperature characteristics are linear, including retrace, to 400°C .

Units are available in practically any size or shape. Complete engineering data including graphs of essential properties appear in bulletin RC-10A.

POWER SUPPLY a precision power source

A-V MFG. CORP., 730 Fifth Ave., New York 19, N. Y. The new precision frequency power supply type 120A is a precision 60-cycle power source with accuracy of 0.01 percent over the temperature range of 0 to 75°C .

The internal precision frequency source is a hermetically sealed 480-cycle tuning fork whose frequency is divided by eight to provide the 60 cycles which drives the unit's power amplifier.

Size is 19 in. wide for rack mounting, height $10\frac{1}{2}$ in. and depth 13 in. Weight is 60 lb net. Input power is 105-130 v, 300 v-a, 50-400 cycles.

Complete details are given in bulletin 120B.



LINEAR TRAVEL POT in $\frac{1}{2}$ -in. diameter case

GENERAL COMPONENTS Co., 801 Eighth St. Southeast, Minneapolis 14, Minn., announces a new, miniaturized linear travel potentiometer. Either single or dual pots are available in a $\frac{1}{2}$ -in. diameter case. Ball type mounting provides



MISSILE WEAPONS SYSTEMS PLANNING

The successful development of advanced missile weapons systems demands a high order of creative planning and coordination between scientists and engineers in virtually every field. Individual efforts must fit smoothly into group progress covering a span of years.

At Lockheed Missile Systems Division, regular planning conferences coordinate the progress of weapons systems development—from initial operations research and systems analysis to operational use.

Significant new activities at Lockheed have created openings for those able to contribute to group efforts of the utmost importance.

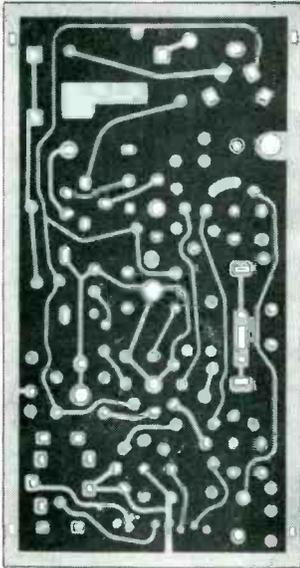
Systems Analyst Jobe Jenkins (standing) discusses planning on a new weapons systems project with research and development personnel involved in initial development activities. From left to right: E. A. Blasi, antenna; G. D. Schott, flight control; W. D. Van Patten, command guidance; Jenkins; H. R. Senf, electronic research; W. F. Main, radar; J. J. Dulin, electronics systems analysis; E. V. Stearns (back to camera), advanced systems design.

Lockheed

MISSILE SYSTEMS DIVISION
research and engineering staff

LOCKHEED AIRCRAFT CORPORATION
VAN NUYS, CALIFORNIA

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High Pressure PLASTIC LAMINATES for PRINTED CIRCUITS

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This much-wanted grade of paper-based plastic laminate is now available in substantial quantity. Through exercise of our special skills and manufacturing facilities, rigid U.S. Government and NEMA Standards are met, and are exceeded in every instance. Present users of our P-630B laminate report excellent results, particularly in significant reduction of manufacturing costs. Use the coupon below to learn more about . . .

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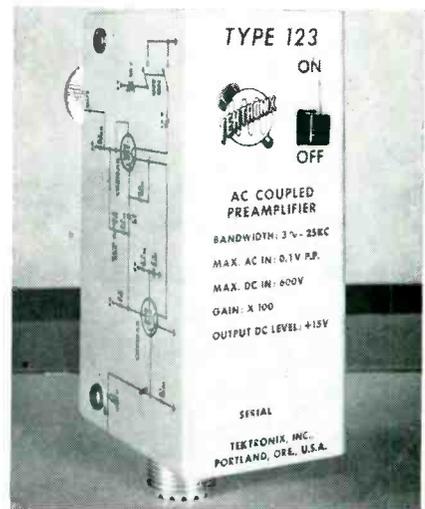
FIRM _____

ADDRESS _____

universal alignment. Resistance values are up to 60,000 ohms per in., total travel up to 6 in.

► **Performance**—Dual wipers are on each element for minimum noise and longer life. Resolution can be as low as 0.0008 in., with single turn taps. It has O-ring sealed construction to meet environmental requirements of MIL-E-5272A.

Unique design permits complete preassembly and testing before insertion in case.



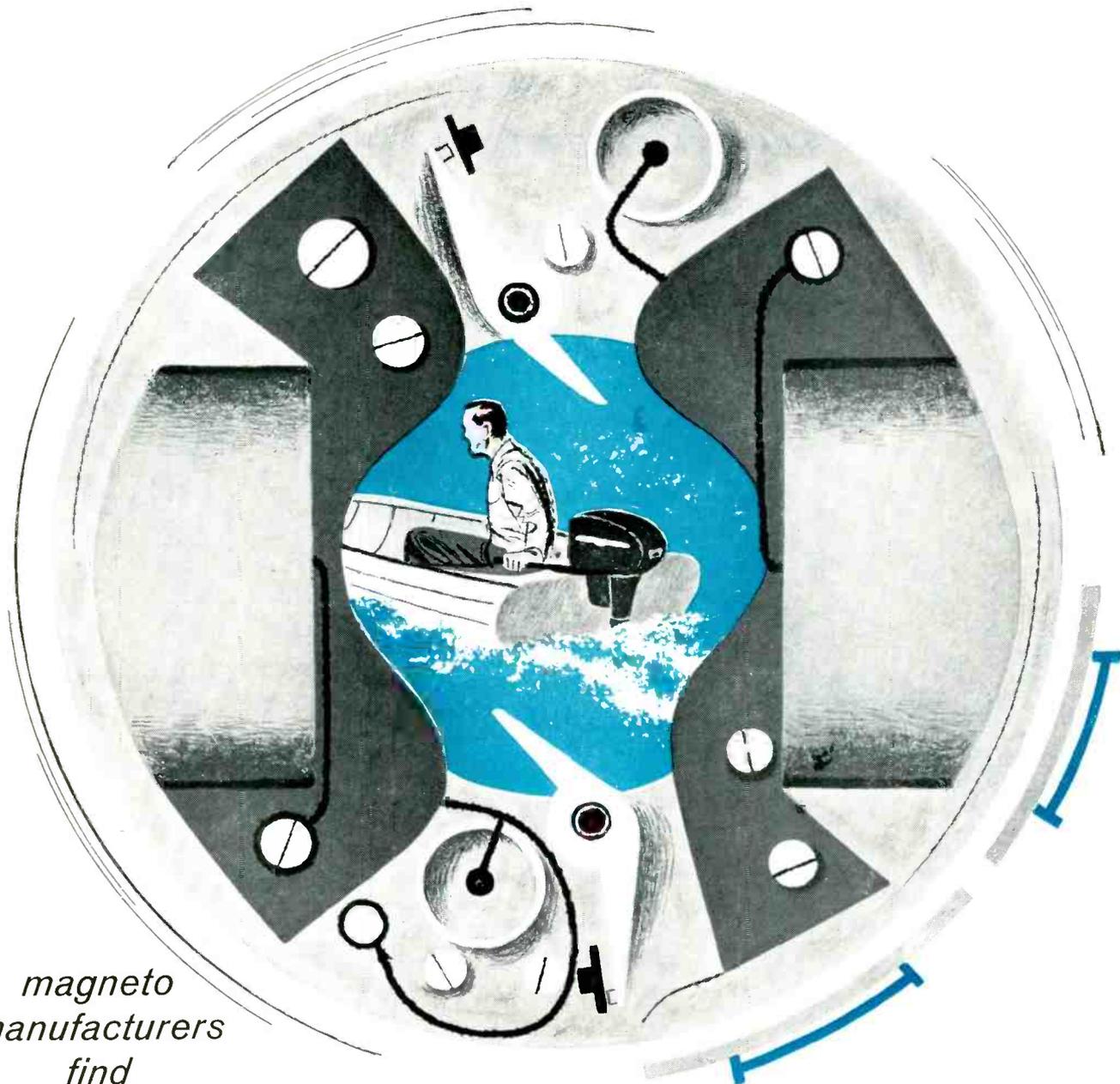
PREAMPLIFIER battery-powered, a-c coupled

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon. Type 123 is a battery-powered a-c coupled pre-amplifier with a voltage gain of 100. Passband is within 3 db from 3 cps to 25 kc, within 2 percent from 15 cps to 6 kc. Maximum input signal is 0.1 v peak-to-peak.

► **Other Features**—It is fitted with coaxial input and output connectors, permitting mounting on an oscilloscope or other instrument, or mounting to a cable for use as a probe. Dimensions are 3½ in. high, 1½ in. wide, 2¼ in. deep, not including connectors. Weight is only 10 oz. Price, including batteries, is \$50.

SPECTRUM ANALYZER for h-f use

MARCONI INSTRUMENTS, 44 New St., New York 4, N. Y. The OA1094 spectrum analyzer gives a visual



*magneto
manufacturers
find*

CRUCIBLE PERMANENT MAGNETS

provide maximum energy... minimum size

The *consistently higher* energy product of Crucible Alnico permanent magnets enables manufacturers to use smaller, more powerful magnets in the magnetos of outboard motors, power mowers and other gasoline-powered equipment.

In fact, ever since Alnico alloys were first developed, Crucible has been supplying them to manufacturers of permanent magnet magnetos, generators and motors and all types of magnet-equipped devices.

Pioneers in magnet design and production, Crucible's magnet division is backed by a half-century of fine special steelmaking. So when you have a magnet application it will pay you to call Crucible. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE

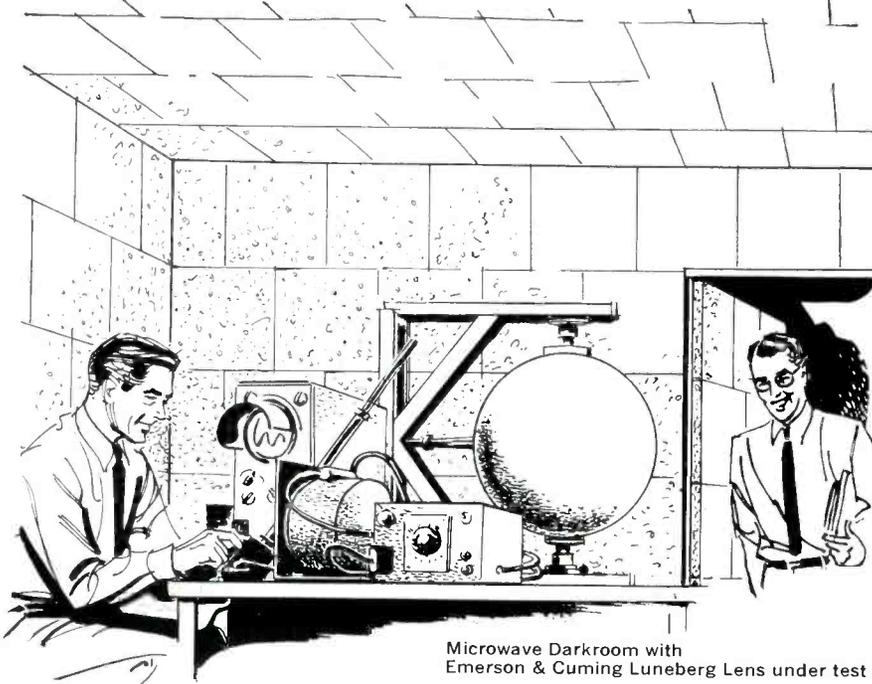
first name in special purpose steels

Crucible Steel Company of America

Eccosorb CH

Microwave Absorber

for Darkrooms



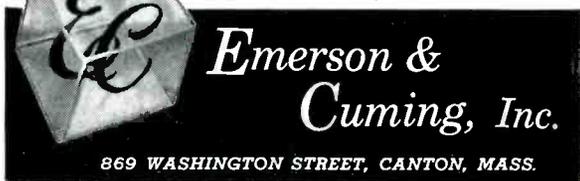
Microwave Darkroom with Emerson & Cuming Luneberg Lens under test

Eccosorb CH is a series of broadband absorbers reflecting less than 2% of the energy incident upon its surface. It is composed of enmeshed, rubberized fibers and made in sheets 2 feet by 2 feet in various thicknesses. Eccosorb CH is light weight and flexible. It is easily mounted and its natural, white surface color gives good light reflection.

Free Space Rooms are easily and economically built for indoor antenna measurements. Reflections are eliminated for all practical purposes. You can build your own microwave dark room or we offer you a complete Free Space Room ready to use. Emerson & Cuming engineers design and build special types for unusual conditions. Send us your specifications.

Another absorber, ECCOSORB HF comes in rods, sheets or molded shapes in several volume resistivities for waveguide terminations and similar uses. If you have a problem write for information on . . .

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CASTING RESINS
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AND SHEET STOCK
MICROWAVE ABSORBERS

NEW PRODUCTS

(continued)

presentation on a crt of the frequency spectra of a-m signals in the 3 to 30-mc band. Bandwidth can be switched to either 6, 30 or 150 cps and the sweep amplitude can be varied from 0 to 30 kc and scanning time from 0.1 to 30 sec. Using a two-stage measurement technique, relative signal amplitude levels of 60 db can be measured.



CENTRIFUGAL BLOWERS

cool electronic equipment

TRADE-WIND MOTORFANS, INC., 7755 Paramount Blvd., Rivera, Calif. Series PA-361 blowers are being used in cabinets and other housings for ventilating electronic equipment. Compact in design, they employ centrifugal blower wheels and produce up to 130 cfm with shaded pole motors. Overall dimensions are approximately 7 in. in length, width and depth.



S-W INDICATOR

speeds component testing

MARCONI INSTRUMENTS, 44 New St., New York 4, N. Y. The TF1081 automatic standing-wave indicator provides rapid and accurate vswr measurements by means of a motor driven waveguide probe. The unit includes a modulated klystron oscillator, and the output from the probe is amplified and displayed on

when does

$$\Delta\phi_1 = \Delta\phi_2?$$

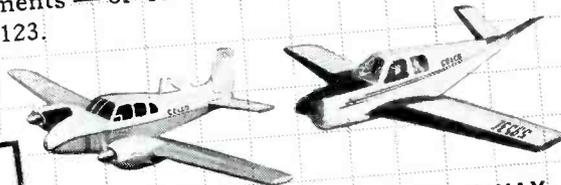
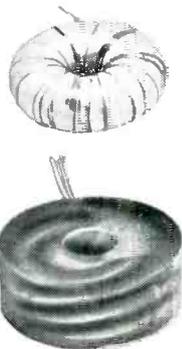


when magnetic amplifier cores are matched by **Celco**

If the hysteresis loops of two toroidal cores shown in the sketch above, are identical in all respects, and identical windings are placed on the cores, then many magnetic amplifiers might operate as predicted, i.e. $\Delta\phi_1 = \Delta\phi_2$.

However, even if the above assumptions were true, then subsequent handling, impregnation, encapsulation and electrical history of the assembly must be carefully controlled in order to maintain the original performance characteristics. Here at Celco, a considerable amount of development and production experience is available for application to your particular magnetic amplifier problems.

We shall be happy to quote on your magnetic amplifier component requirements — or for immediate action — call RAMsey, N. J., 9-1123.



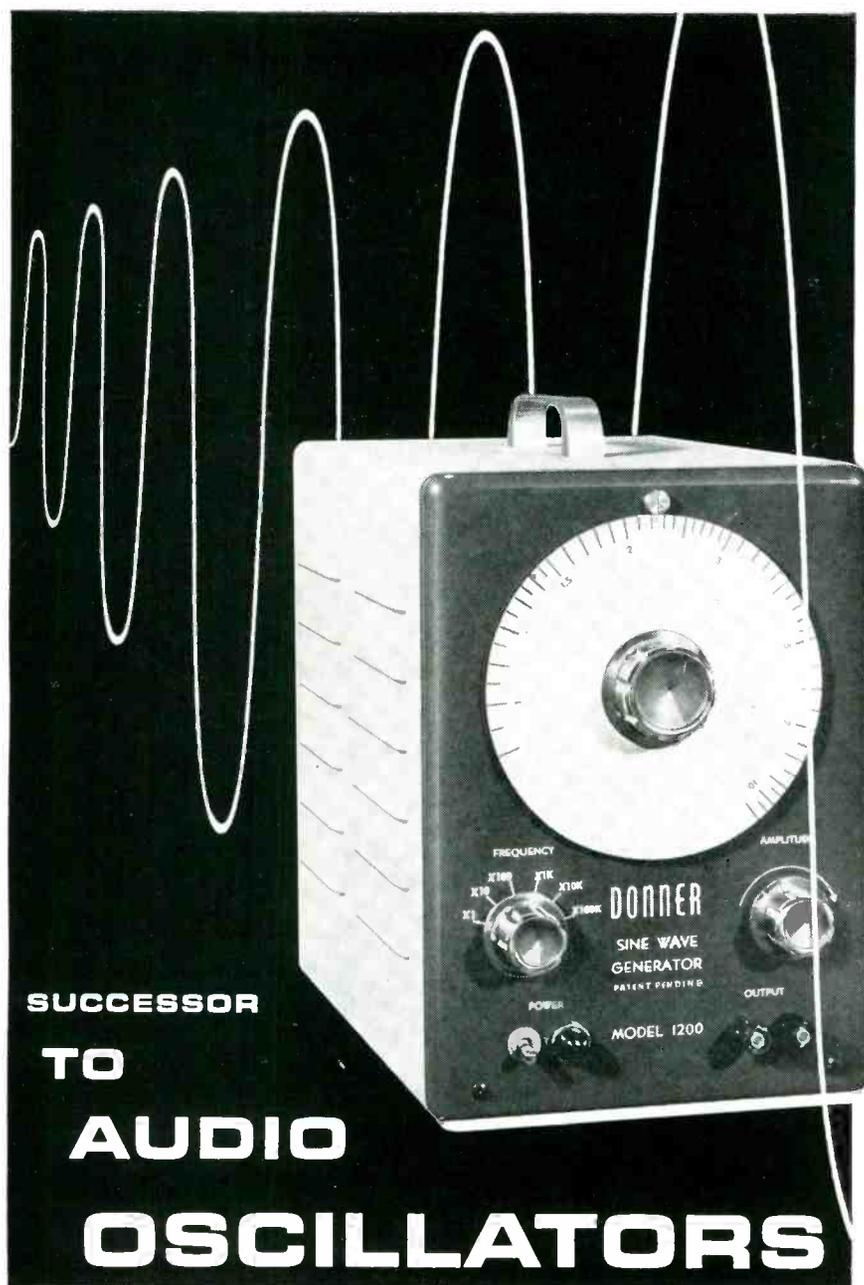
Celco

YOUR PLANT IS ONLY HOURS AWAY
FROM MAHWAH BY THE CELCO AIR FLEET

Constantine Engineering Laboratories Co.

Island Avenue, Mahwah, New Jersey — RAMsey 9-1123

Manufacturers of precision aircraft and missile electronic components: ★ Radar Yokes ★ Motor Stators, Armatures Rotors ★ Transformers



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AUDIO
OSCILLATORS**

**DONNER MODEL 1200
SINE WAVE GENERATOR**

Less than 0.1% distortion, any amplitude or frequency
1 cps to 1 mc in 6 decades, plus overlap

600 ohms constant output impedance

Many other exceptional features

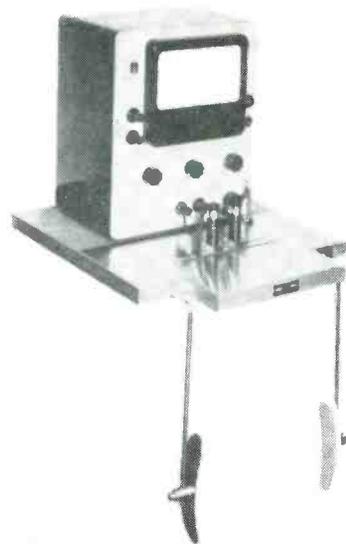
Small, portable — 23 pounds

\$265.00, FOB Factory

DONNER SCIENTIFIC
COMPANY

2808 Seventh St.
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Complete data
on request.

the synchronized crt. Frequency range is from 8,500 to 9,500 mc and the accuracy of vswr measurement is 0.5 percent. Minimum discernible vswr is 0.995.



**TEST BRIDGE
fast impedance comparator**

BRUSH ELECTRONICS Co., 3405 Perkins Ave., Cleveland 14, Ohio, has introduced a new addition to the line of deviation test bridges, extremely fast direct-reading impedance comparison instruments.

► Uses—The instruments are used primarily for production inspection, inspection of resistance, capacitance and inductance. They are designed to accurately and quickly present a comparison against a standard impedance indicating both percentage impedance deviation and phase angle deviation in radians on a 6-in. illuminated scale.

The new deviation test bridge model BL-1506 has a 100-kc bridge frequency for the test ranges 10 to 50,000 ohms resistance, 25 μf to 0.1 μf capacitance, and 20 μh to 80 mh inductance.

For automatic inspection the meter can accommodate 4,000 units per hour.

**KNOB LOCK
for electronic controls**

RAYTHEON MFG. Co., Waltham 54, Mass., has announced a new locking device for use on potentiometers and other electronic controls. De-

For greater economy...

wider design flexibility...

UNEXCELLED PERFORMANCE!



Single Phase Bridge
Cartridge Rectifiers

Also available,
Voltage-Doubler &
Full Wave Center Tap



Half-Wave Cartridge Rectifiers



Hermetically Sealed
Cartridge Rectifiers



Miniaturized Hi-Voltage

QUALITY CARTRIDGE RECTIFIERS BY

International

Manufactured under the
United States Army Signal Corps
Reduced Inspection
Quality Assurance Program
RIQAP



A WORLD OF DIFFERENCE

THROUGH RESEARCH

The higher voltage ratings of International selenium rectifier cells result in a 30% shorter length cartridge! These miniature-size rectifiers permit greater design freedom where space is at a premium. They are available in numerous terminal types, circuits, cell sizes and protective coatings to meet your specific needs. International—leader in the field—sells more selenium cartridge rectifiers than all other manufacturers combined! As a result, your special cartridge rectifier requirements may be standard at International. A wire, letter or phone call will bring immediate and experienced recommendations for your application.

International Rectifier

C O R P O R A T I O N

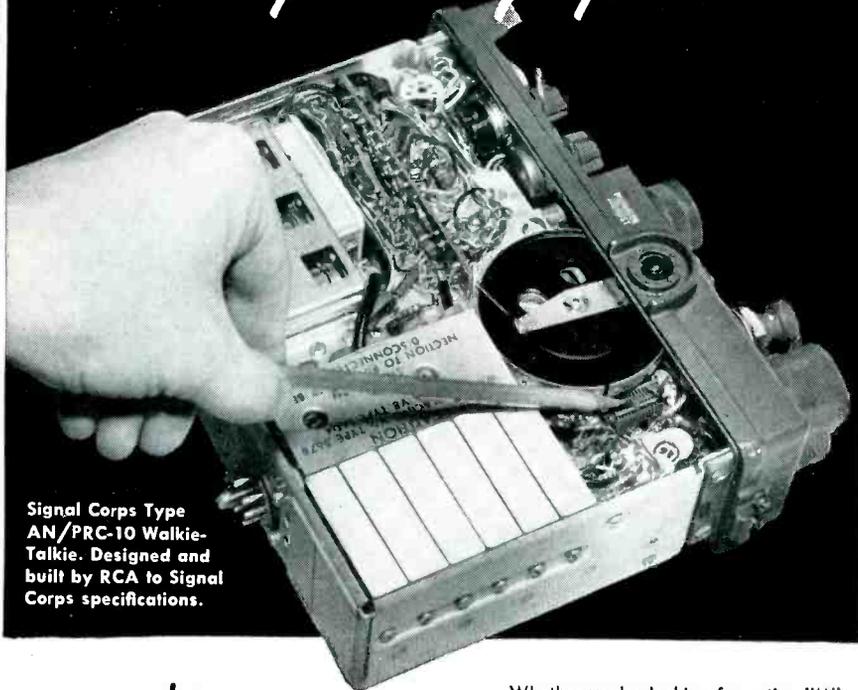
EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA · PHONE OREGON 8-6281

NEW YORK: 132 E. 70TH ST., TRAFALGAR 9-3330 · CHICAGO: 205 W. WACKER DR., FRANKLIN 2-3889
IN CANADA: ATLAS RADIO CORP., LTD., 50 WINGOLD AVE. W., TORONTO, ONTARIO, RU 1-6174

THE WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS

ELECTRONICS — April, 1956

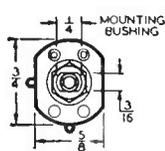
Save valuable space in compact equipment



Signal Corps Type AN/PRC-10 Walkie-Talkie. Designed and built by RCA to Signal Corps specifications.

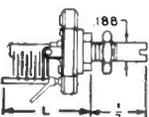
a complete line of JOHNSON variable capacitors

Whether you're looking for a tiny "M" capacitor similar to the one shown above, or a rugged air variable rated to 11,000 volts, you're sure to find it in the Johnson line. All Johnson Variable Capacitors are designed to permit high standards of workmanship, yet costs are low.



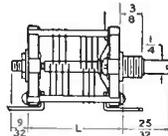
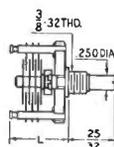
TYPE "M" CAPACITORS

Extremely compact and rugged—requires $\frac{5}{8}$ " x $\frac{3}{4}$ " panel mounting area. Soldered brass plates. Low inductance bridged stator terminals. Heavy beryllium copper rotor contact nickel plated. Steatite end frames, DC-200 impregnated. Heavy nickel plating, standard—other platings available.



TYPE "L" CAPACITORS

Excellent for applications requiring extreme stability and rigidity—tie rods soldered directly to ceramic (steatite) end frames. Plates and metal parts, brass—plating is heavy nickel—other platings available. Requires $1\frac{3}{8}$ " x $1\frac{3}{8}$ " panel mounting area.



Johnson also makes a complete line of



SHAFT COUPLINGS • FLEXIBLE SHAFTS • PANEL BEARINGS

Flexible and rigid shaft couplings available for $\frac{1}{4}$ " to $\frac{1}{4}$ ", $\frac{1}{4}$ " to $\frac{3}{8}$ ", and $\frac{3}{8}$ " to $\frac{3}{8}$ ". Types available for adjustment to both axial and angular shaft misalignment.

Flexible shafts are phosphor bronze with $\frac{1}{4}$ " nickel plated brass hubs. Permit out-of-line or up to 90 degrees angular control with minimum backlash.

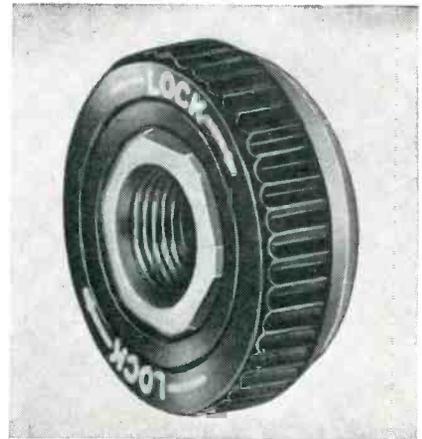
Panel bearings are nickel plated brass—for $\frac{1}{4}$ " shaft and up to $\frac{3}{8}$ " panels. Types available with 3" and 6" nickel plated brass shafts—standard $\frac{3}{8}$ "-24 nut furnished.

For complete information and specifications on Johnson Air Variable Capacitors or other Johnson electronic components, write for your copy of components catalog 976a.

E. F. JOHNSON COMPANY

2304 SECOND AVENUE SOUTHWEST • WASECA, MINNESOTA

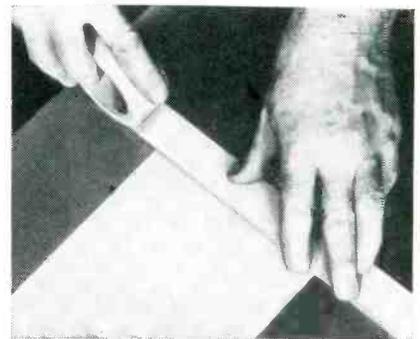
CAPACITORS • INDUCTORS • KNOBS • DIALS • SOCKETS • INSULATORS • PLUGS • JACKS • PILOT LIGHTS



signed for application with Raytheon standard control knobs, the knob lock mounts on the control bushing replacing standard mounting hardware and provides a simple means of maintaining critical control settings under conditions of shock or vibration.

It takes up little more panel area than the knob itself. An eighth-turn of the fluted skirt forces a circular neoprene shoe against the inner face of the control knob, locking the knob firmly without affecting the angular position of the control shaft.

The knob lock is available in three sizes for use with series 70, 90 and 125 round Raytheon standard control knobs.



TEFLON TAPE now in cementable form

THE UNITED STATES GASKET CO., Camden 1, N. J., is producing Teflon tape—treated for cementing with any commercial adhesive, to metal, glass, wood, plastics or any other surface. Pull test is approximately 45 lb.

► Applications — Thin section (down to 5 mil) inexpensive applications of this material can be made for many purposes where



what's the

veridicality

*of a DeMornay-Bonardi
standing wave detector?*

Verily, it's high. Since you want true readings from a slotted line, we've produced an instrument abounding in "truthfulness."

First we massacred the causes of mismatch. The D-B waveguide block, for example, is precision-formed in one piece to give it high internal uniformity. This pays off in an even path for the measured waves. Also, it minimizes residual VSWR. To wipe out warp-age, we make the block of non-distorting, stress-free aluminum, precision-milled to assure absolute alignment with the probe carriage. Three leveling screws support the instrument without rocking.

Do we stop there? Not by your transverse travel! We use a 5-point kinematic carriage suspension which assures maximum linearity of probe motion. The carriage rides on stainless steel ball bearings, precision ground and spring loaded to keep perfect alignment. A large knob controls the carriage motion from a restful stationary position, leaving eyes

free to watch the indicator. Knob speed is continuously variable from "vernier" to "fast," allowing you to speed up the quick measurements.

Your budget buys more. For a modest amount, you can equip any D-B instrument to handle another frequency band. Merely use a different size waveguide block and probe. Nine sizes of each are available—all interchangeable in 30 seconds, without loss of accuracy. Thus one instrument will measure from 12.4 KMC to 90 KMC and another from 5.8 KMC to 12.4 KMC.

Who needs tuning? D-B broad band probes with calibrated depth adjustment need no tuning over the allocated waveguide band, and yet are efficient at all frequencies. There's a special built-in miniature coaxial cable that flexes freely with the carriage motion, eliminating 95% of cable noise. Many more refinements in addition. Complete data sent on request.



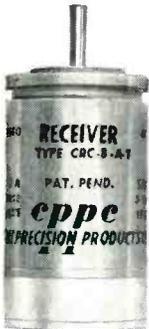
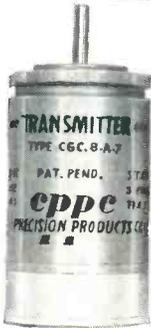
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Want more information? Use post card on last page.

ACTUAL SIZE

Where
ACCURACYSIZE
WEIGHT
RELIABILITY
Count
Most

FOR AC SYSTEMS SPECIFY CPPC SYNCHROS



Let Clifton Size 8's take the place of larger synchros at very significant savings in weight and bulk, yet at no sacrifice in accuracy or reliability.

In airborne equipment, why load on unnecessary weight?

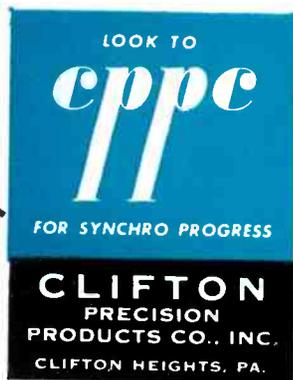
By the early introduction of our Size 8 Synchro Series, we figure to have saved the Air Arm 1 Ton of dead weight in 1956 alone.

Samples from stock, quantities from the production line.

Write for complete electrical data.

cppe SIZE 8 SYNCHROS

ACCURACY 7 MINUTES
WEIGHT 32 GRAMS



Teflon's extremely anti-hesive sanitary surface, zero water absorption, chemical inertness, broad service temperature range and unusual dielectric qualities are desired. Teflon tape, treated for adhesion on both sides and laminated to another dielectric for rigidity, also offers excellent possibilities for printed circuit production.

Cementable Teflon tape, 5 mil to 60 mil in thickness is available in continuous rolls up to 12 in. wide. Sheets are also available in $\frac{1}{2}$ -in. thickness in sizes up to 24 by 24 in. and in $\frac{1}{8}$ -in. thickness, up to 48 by 48 in.



SMALL RECTIFIER for printed circuits

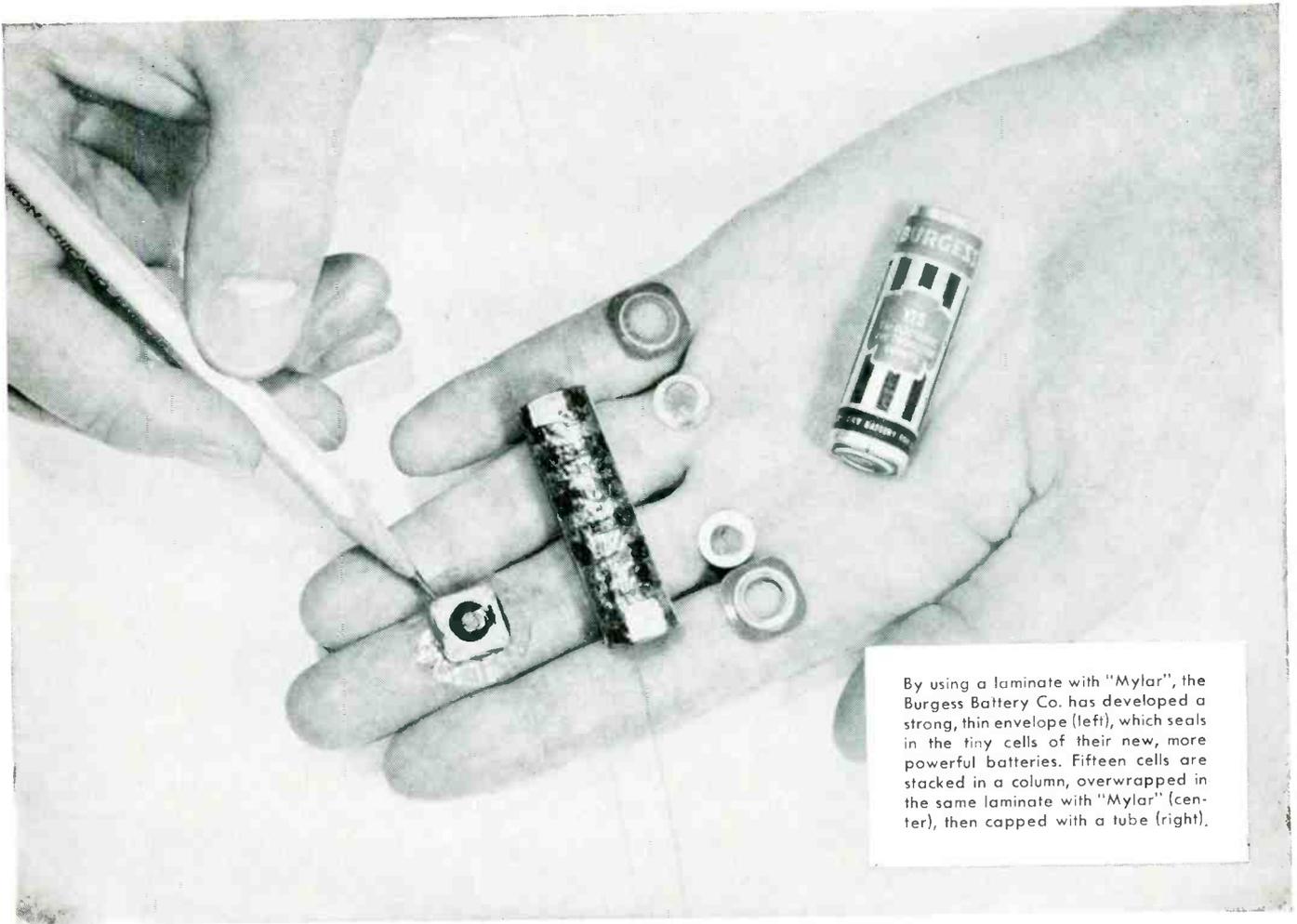
RADIO RECEPTOR Co., Inc., 251 W. 19th St., New York 11, N. Y., has announced a new miniature selenium rectifier with special snap-in terminals designed for printed wiring boards. The terminals will snap into the printed board easily, but with sufficient mechanical rigidity to hold the rectifier firmly in place, making soldering necessary only for good electrical contact.

► Ratings—The new rectifiers are the half-wave stack types 8Y1B and 8J1B, rated at 30 ma and 65 ma, respectively, at off the line voltages, with a capacitive load in an ambient temperature of 45 C.

Both stacks mount in $\frac{3}{8}$ diameter holes spaced on $\frac{3}{4}$ centers.

AMPLIFIER light-weight, small space

SERVO CORP. OF AMERICA, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y. Model 1124 Servoflex amplifier is designed to meet the light-weight, small space and



By using a laminate with "Mylar", the Burgess Battery Co. has developed a strong, thin envelope (left), which seals in the tiny cells of their new, more powerful batteries. Fifteen cells are stacked in a column, overwrapped in the same laminate with "Mylar" (center), then capped with a tube (right).

Du Pont MYLAR[®] helps Burgess obtain smaller, more powerful batteries

"Smaller than your finger tip, yet a third more powerful than conventional cells . . . that's the story of improvement on our line of dry-cell batteries", reports the Burgess Battery Company, Freeport, Ill. "We achieved this improvement by using a laminate with 'Mylar'* formed into an envelope to seal in tiny dry cells. Because the lamination is extremely thin, we saved valuable space for more energy-producing materials.

"By using this same laminate with 'Mylar' as the insulating cell-stack wrap, the old problem of holes appearing in the overwrap after heat sealing has been completely eliminated. High chemical resistance and strength make it possible to heat-mold each cell into a permanent

locked position to preserve the intercell connection. What's more, the transparent material permits maximum quality control . . . inspectors can see into each cell-stack to insure perfect stacking and wrapping."

This is only one example of the way versatile Du Pont "Mylar" polyester film, used alone or in combination with other materials, is making possible superior performance for a variety of electrical products.

For more information on how "Mylar" can help you improve product performance, or solve knotty problems, send in the coupon below. Be sure to indicate the type of application you have in mind.

* Mylar is a registered Du Pont trademark for its brand of polyester film.



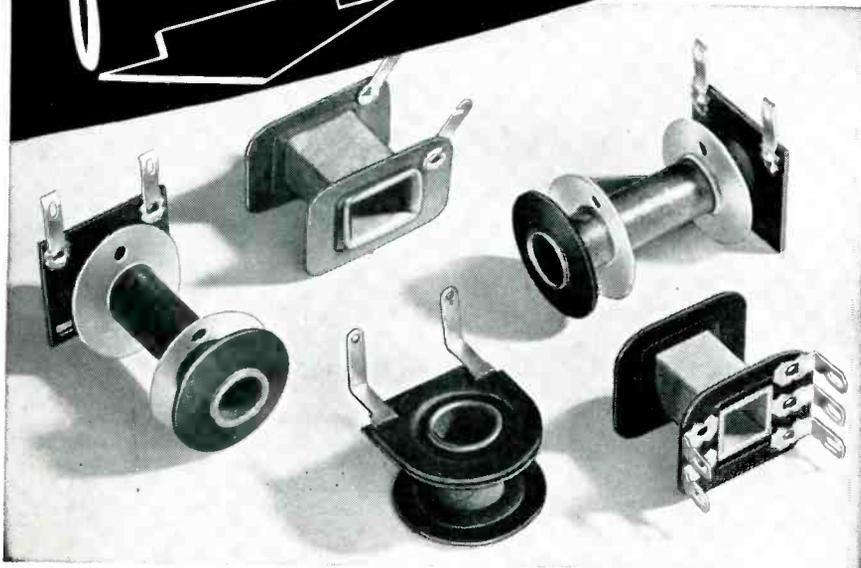
BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY



E. I. du Pont de Nemours & Co. (Inc.)
 Film Dept., Room E-4, Nemours Bldg., Wilmington 98, Del.
 Please send the new booklet (MB-4) listing properties, applications and types of "Mylar" available.

Application _____
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 Company _____
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Here is the IDEAL COIL BOBBIN for Printed Circuits



**FURNISHED WITH ANY NUMBER OF LUGS
ATTACHED AT A NEW LOW IN UNIT COST**

Low-cost coil bobbins can now be furnished to your specifications with any number of lugs attached. Through the development of special high production automatic equipment, Precision has eliminated the expense and difficulty of attaching terminals... especially as encountered with molded type bobbins.

The attached lug feature especially adapts these bobbins to printed circuit applications. Equally important, they can be insulated from the coil winding by washers as an integral part of the assembly. This latter advantage not only improves insulation, but greatly facilitates easier and faster production of the finished coil.

Coil bobbins with lugs attached are available in any size . . . with round, square or rectangular cores . . . flanges of all shapes. Cores are wound from dielectric kraft, fish paper, acetate or combinations, including DuPont Mylar. They can also be supplied Resinite impregnated.

Write, wire or phone for full information

Sales Representatives in:

Illinois; Indiana; Iowa; Wisconsin; Missouri; Minnesota: Chicago, Illinois, ARmitage 6-5200.
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 New England: Framingham, Massachusetts, TRinity 3-7091.
 Delaware; Washington, D. C.; Maryland; New Jersey; Metropolitan New York; Eastern Pennsylvania; Virginia: Jersey City, New Jersey, Swarthmore 5-2480.
 Upper New York: Syracuse, New York, Syracuse 4-2141.
 CANADA: Montreal, Quebec, Canada, Walnut 0337.
 MEXICO: Mexico 6, D. F., Telephone: 35-06-18.



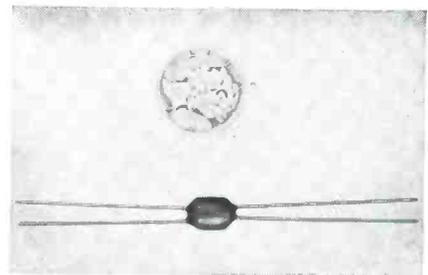
PRECISION PAPER TUBE CO.

2041 W. CHARLESTON ST. • CHICAGO 47, ILL.

Plant No. 2: 79 Chapel St., Hartford, Conn.

quality performance of operation in high altitude servo systems. As such, it complies with MIL-E-5400 requirements. A 3-legged transformer acts as a combined power supply and output transformer in the reluctance amplifier circuit.

► **Other Features** — With instantaneous response the 1124 accepts a single d-c input or takes the difference between two such inputs and a built-in 400-cycle synchronous chopper modulates the d-c signal to an a-c signal. It will drive any 115 v 400-cycle servo motor rated at 8 w or less. The present model features a voltage gain of approximately 25,000 (rms v out/d-c v in).



VOLTAGE DIVIDER tiny, 3-section d-c type

THE DAVEN CO., 530 West Mt. Pleasant Ave., Route 10, Livingston, N. J., has available a new, miniature, 3-section d-c voltage divider. Composed of three resistance sections with four output terminals, this unit is completely encapsulated, providing protection against saltwater immersion, and extremes of humidity and temperature (-55 C to +125 C).

► **Specifications**—Measuring $\frac{1}{4}$ in. in diameter by $\frac{3}{8}$ in. in length, the voltage divider is available with a maximum of up to 100,000 ohms per section. Standard resistor accuracy is ± 0.5 percent. Wattage dissipation is $\frac{1}{2}$ w at room temperature and 0.25 w at 125 C.

SMALL RELAY for control circuits

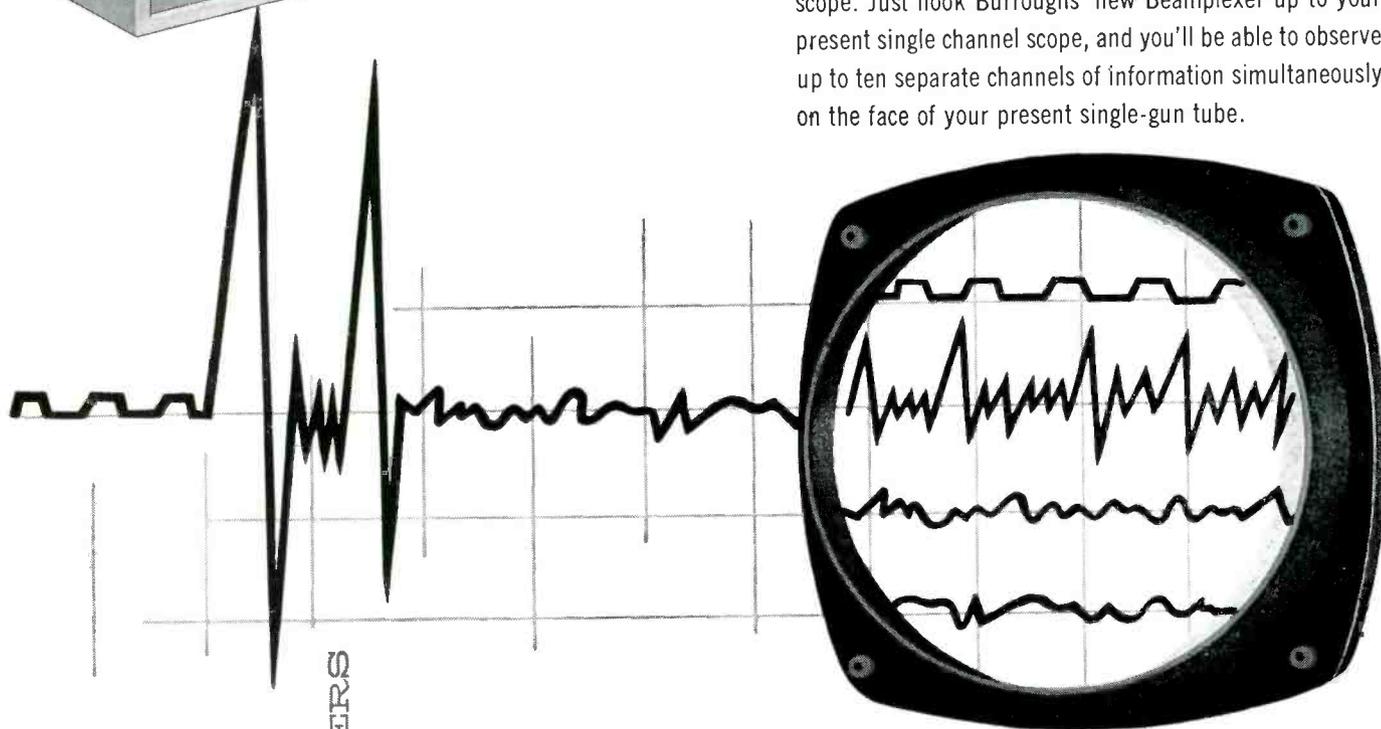
KURMAN ELECTRIC CO., INC., 35-18 37th St., Long Island City, N. Y., has manufactured a new miniature telephone relay, designed for motor control, mobile radio and many other control circuits where there

make your scope multi-channel

NEW BURROUGHS BEAMPLEXER

displays up to 10 separate signals on a single-channel scope simultaneously

Now you can have the advantages of multi-channel oscillography at a fraction of the cost of a multi-channel oscilloscope. Just hook Burroughs' new Beamplexer up to your present single channel scope, and you'll be able to observe up to ten separate channels of information simultaneously on the face of your present single-gun tube.



TOOLS FOR ENGINEERS



BURROUGHS CORP. • ELECTRONIC INSTRUMENTS DIVISION
Department C • 1209 Vine Street • Philadelphia 7, Penna.

HPB 4B-103

The Beamplexer is actually a fast electronic switch. Its heart is the Burroughs Beam Switching Tube which acts as a gate, picking the ten parallel input signals off in sequence, at adjustable speeds ranging from push button to 100 kc, and putting them out on one line. Each signal can be located on the scope as desired, and even superimposed on another, through individual position and amplitude controls for each channel. Other controls include separate amplification for each channel.

Power consumption is 120 volts a-c, 60 cps, single phase, 0.73 amps, with the entire unit self-contained for cabinet or standard relay rack mounting.

Full details on how the Beamplexer can make your scope more useful . . . make your time more efficient . . . are given in Technical Bulletin 346 available for the asking. Write for your copy.

ELECTRONICS ENGINEERS

Link Aviation, Inc., one of the world's leading manufacturers of analog computing equipment, has built over \$100 million worth of computer-actuated devices in the past five years. Most of this electronic computing equipment has been custom-designed to meet the highly specialized requirements of complex military training devices.

Our development activity embodies the fields of flight and radar simulators, missile and gunnery trainers, special purpose computers for laboratory and industrial applications, electronic laboratory instrumentation and specialized optical devices.

In a recently established program to develop top-flight technical men for management positions, we are seeking electronics engineers with the following qualifications:

1. **Advanced degree in E. E., Engineering Physics or Applied Science.**
2. **One or two years' experience since attainment of advanced degree.**
3. **Training, experience, and interest in feedback systems, analog computation, vacuum tube or transistor circuitry (with particular emphasis on low-frequency or instrumentation applications), instrument servomechanisms.**

The men we seek are making rapid progress in their present jobs, but are interested in greater opportunities unrestricted by age, seniority, rigid salary structures, formalized tables of organization, and other administrative obstacles. Our high order of dependence upon key technical men creates a challenging opportunity for superior engineers which we feel is unusually attractive.

Please send full details of your qualifications to:
MR. JOHN M. HUNT, Manager of Engineering



LINK AVIATION, INC., BINGHAMTON, N. Y.

PIONEER AND WORLD'S LARGEST PRODUCER OF JET FLIGHT SIMULATORS

A subsidiary of General Precision Equipment Corp.



NEW PRODUCTS

(continued)



is need for a small relay to handle heavy currents of up to 5 amperes —125 v a-c.

The 7MS relay is $\frac{3}{4}$ in. by $1\frac{1}{8}$ in. by $1\frac{1}{4}$ in. high and has a life of 100,000 operations minimum under the contact load mentioned, with increased life under lesser load. A fast acting d-c relay with 100-mw minimum operating power, maximum coil dissipation of 1.5 w and maximum coil resistance of 6,000 ohms, it will meet MIL-R-5757B class A. Enclosed snap-action contacts are UL approved.

Special features include impregnation and tropicalization, hermetic sealing, replaceable switch assembly and a-c operation.



MAGNETIC AMPLIFIER is voltage regulated

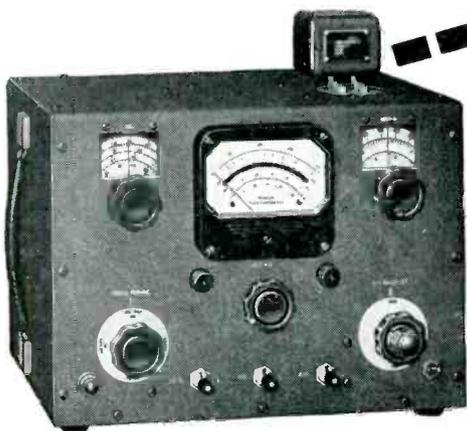
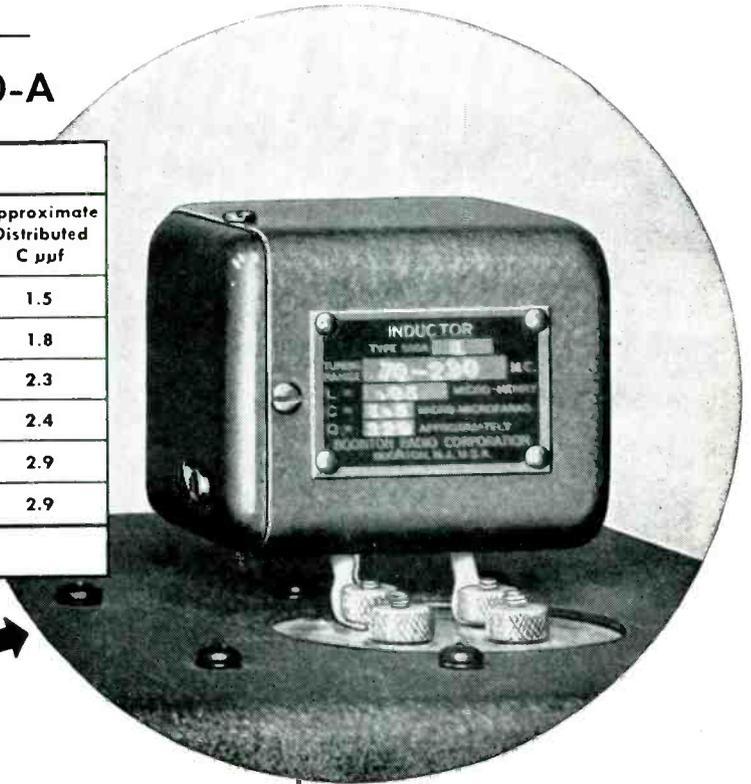
RAPID ELECTRIC Co., 2881 Middletown Road, New York 61, N. Y. A regulated 14/28 v, 200/100 ampere d-c power rectifier is designed to meet Air Force specifications MIL-P-8194 and MIL-P-6457A. Operating on 220/440 v, 3 phase, 50-60 cycles, the output voltage

Q Meter Inductors for measurements up to 260 mc!

**INDUCTORS Type 590-A—
accessories to Q Meter Type 190-A**

TYPE 590-A INDUCTORS					
Type	Inductance μ h	Capacitance μ uf	Approximate Resonant Freq. mc	Approximate Q	Approximate Distributed C μ uf
590-A1	0.05	8.0 — 95.0	70 — 230	320	1.5
590-A2	0.1	10 — 100	50 — 160	350	1.8
590-A3	0.25	8.0 — 80.0	30 — 100	310	2.3
590-A4	0.5	7.5 — 80.0	25 — 70	340	2.4
590-A5	1.0	7.5 — 65.0	20 — 50	300	2.9
590-A6	2.5	9.0 — 25.0	20 — 30	300	2.9

PRICE: \$10.00 each F.O.B. BOONTON, N. J.



Q METER Type 190-A

This new 190-A Q Meter measures an essential figure of merit of fundamental components to better overall accuracy than has been previously possible. The VTVM, which measures the Q voltage at resonance, has a higher impedance. Loading of the test component by the Q Meter and the minimum capacitance and inductance have been kept very low.

SPECIFICATIONS—TYPE 190-A

FREQUENCY RANGE: 20 mc. to 260 mc.

RANGE OF Q MEASUREMENT:

Q indicating voltmeter	50 to 400
Low Q scale	10 to 100
Multiply Q scale	0.5 to 3.0
Differential Q scale	0 to 100
Total Q indicating range	5 to 1200

PERFORMANCE CHARACTERISTICS OF INTERNAL RESONATING

CAPACITANCE: Range—7.5 mmfd. to 100 mmfd. (direct reading).

POWER SUPPLY: 90-130 volts — 60 cps (internally regulated).

Type 190-A Price: \$625.00 F.O.B. Factory

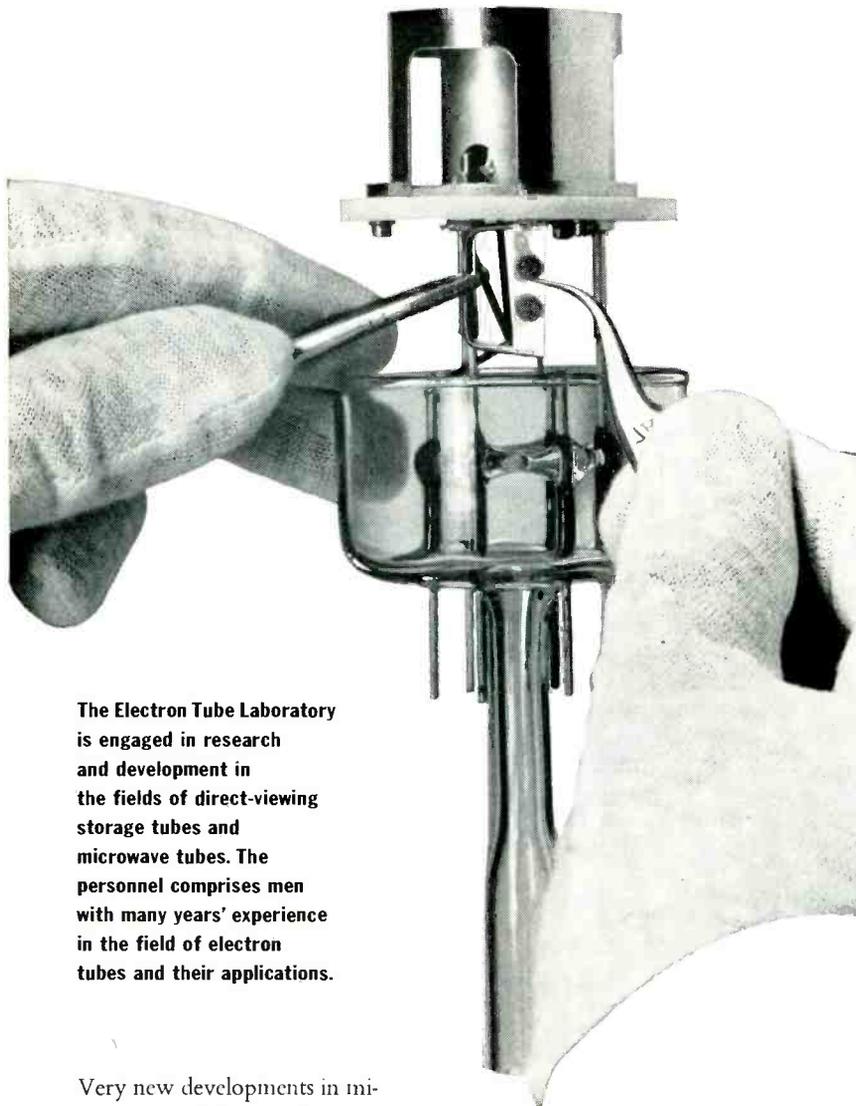
Inductors Type 590-A are designed specifically for use in the Q Circuit of the Q Meters Type 170-A and 190-A for measuring the radio-frequency characteristics of condensers, resistors, and insulating materials. They have general usefulness as reference coils and may also be used for periodic checks to indicate any considerable change in the performance of the Q Meters.

Each inductor Type 590-A consists of a high Q coil mounted in a shield and is provided with spade lugs for connection to the coil terminals of the Q Meters. The shield is connected to the lugs which connect to the Low Coil terminal in order to minimize any changes in characteristics caused by stray coupling to elements or to ground.

BOONTON RADIO
BOONTON · N · J · U · S · A · Corporation



for **ELECTRON TUBES**



The Electron Tube Laboratory is engaged in research and development in the fields of direct-viewing storage tubes and microwave tubes. The personnel comprises men with many years' experience in the field of electron tubes and their applications.

Very new developments in microwave and display tubes have created a number of openings at the research and development level for Laboratory Assistants. At Hughes, engineers, scientists and technicians develop their ideas from inception to quantity production. Thus, assistants working with electron tube products have unlimited scope for applying their talents and skills to a wide range of military and commercial uses.

You should qualify in any **3** of the following areas:

- Electron Circuitry and Test Equipment Construction**
- Mechanics and Benchwork Skills**
- Tube Fabrication Techniques**
- High Vacuum Techniques**
- Microwave Testing**
- Tube Chemistry**
- Precision Assembly**

SCIENTIFIC STAFF RELATIONS

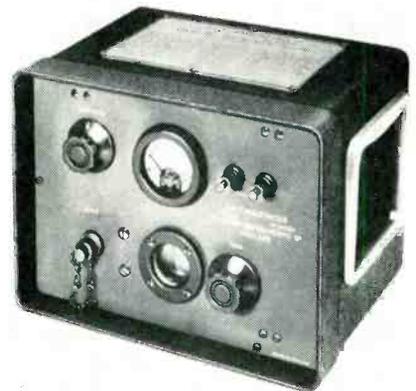
HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

regulation from no load to full load is held within 0.5 v, including a variation of ± 10 percent of the rated input voltage.

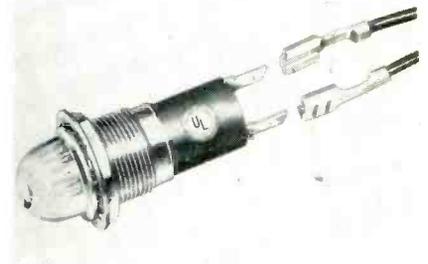
► **Maintenance** — Periodic air-cleaning of selenium rectifier stacks is all the maintenance required. Self-lubricating fan-motor bearings eliminates lubrication.



SHF WAVEMETER covers 4,000 to 10,000 mc

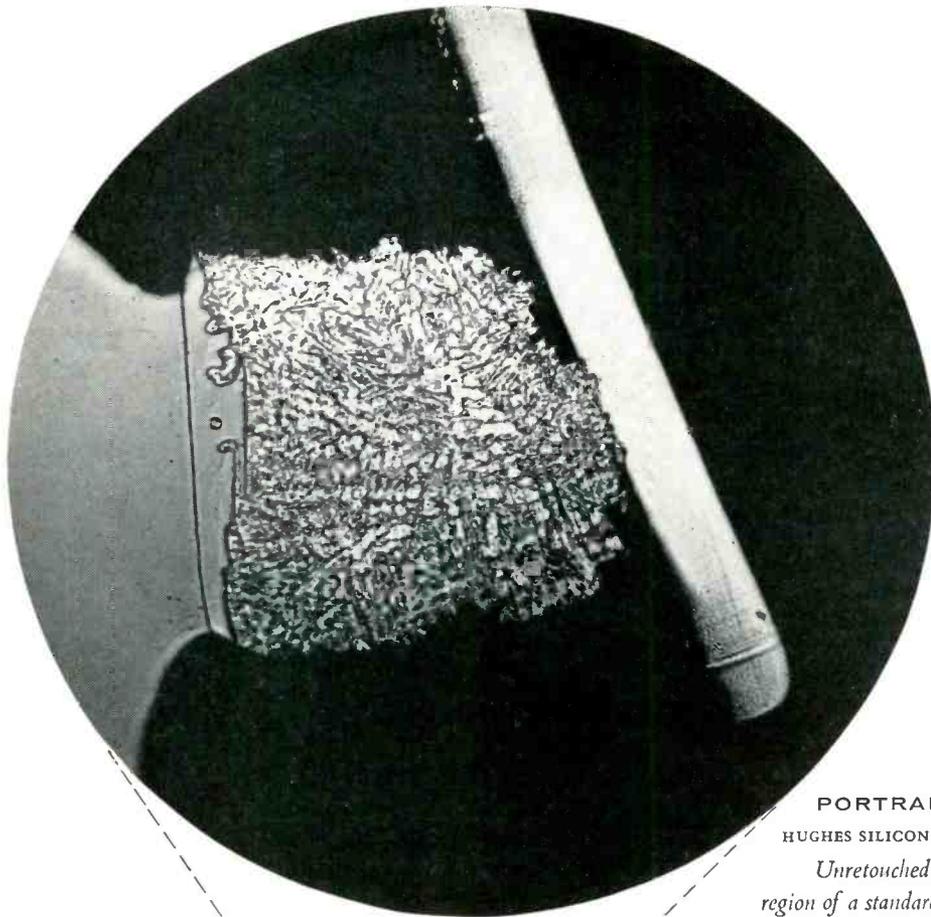
MARCONI INSTRUMENTS, 44 New St., New York 4, N. Y. The TF1059 shf wavemeter covers the wide band of 4,000 to 10,000 mc by use of a cavity resonator operating in a hybrid mode. It is tuned by a $2\frac{1}{2}$ in. precision micrometer and is totally enclosed, the micrometer being viewed via a low power lens.

► **Highlights** — Its features are high Q and an accuracy of 0.05 percent. Discrimination at the worst point is 0.03 percent. Power required is 1 mw.



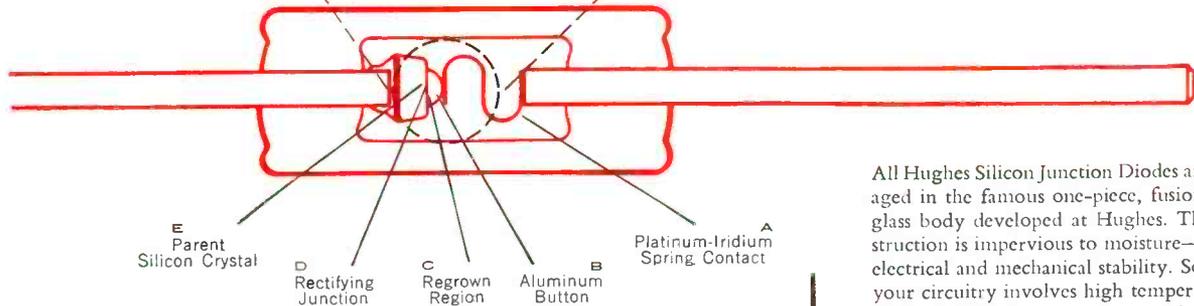
PILOT LIGHTS with spade terminals

DIALIGHT CORP., 60 Stewart Ave., Brooklyn 37, N. Y., now offers its series of indicator lights, which accommodate bayonet type miniature lamps, with spade terminals. These terminals are the matching male



PORTRAIT OF RELIABILITY
HUGHES SILICON JUNCTION DIODES

Unretouched photomicrograph of the junction region of a standard Hughes Silicon Junction Diode.



E Parent Silicon Crystal
 D Rectifying Junction
 C Regrown Region
 B Aluminum Button
 A Platinum-Iridium Spring Contact

RELIABILITY YOU CAN SEE

In this cross section (made from a standard, non-selected production specimen), renowned Hughes quality is clearly visible. (A) The platinum-iridium whisker makes firm, positive contact with the aluminum button. (D) The rectifying junction is clean, sharp, and straight. (E) The parent silicon crystal is free from strain-induced cracks, fissures or blemishes around the junction. Such meticulous workmanship gives microscopic evidence that, in semiconductors, HUGHES QUALITY means HIGHEST QUALITY.

**Characteristics rated at 25° C and at 150° C.
 Ambient operating range, -80° C to +200° C.*

Actual size

***Dimensions, diode glass body: 0.265-inch by 0.105-inch, maximum.*

HUGHES PRODUCTS

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

All Hughes Silicon Junction Diodes are packaged in the famous one-piece, fusion-sealed glass body developed at Hughes. This construction is impervious to moisture—ensures electrical and mechanical stability. So, when your circuitry involves high temperature or high back resistance requirements, be sure to specify *Hughes* Silicon Junction Diodes. Available now, at lower prices, in nine different standard and several special types. And, as always, they are First Of All... For RELIABILITY!

FEATURES:

- High Temperature Operation**
- Extremely High Back Resistance*
- Very Sharp Back Voltage Breakdown*
- Excellent Forward Conductance*
- Subminiature Size***
- Exceptionally Stable Characteristics*

For descriptive product information, please write:

HUGHES



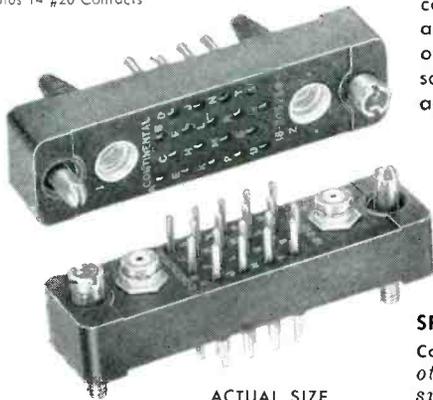
SEMICONDUCTORS
HUGHES PRODUCTS

*International Airport Station
 Los Angeles 45, California*

Continental Connectors adds coaxial contacts to series "20" miniature connectors



Single Coax Contact
plus 14 #20 Contacts



2 Coax Contacts
plus 14 #20 Contacts

ACTUAL SIZE

Now you can specify a connector that combines 50-ohm matched impedance coaxial contacts in a special insert arrangement with standard pin contacts for #20 AWG wire. Design is particularly adaptable to miniaturized equipment requiring extremely compact components. "Series 20" is available with coax contacts, a variety of pin arrangements, plus polarizing screwlocks* to protect against accidental disconnection.

SPECIFICATIONS:

Contacts: 14 and 18 (as illustrated) plus other contacts and arrangements on special order.

Contact Pins (brass) and Sockets (spring temper phosphor bronze) silver and gold plated for low contact resistance.

Terminals: Solder cup or turret type.

Moldings: Choice of Mineral-filled Melamine, Plaskon reinforced (glass) Alkyd 440A, or Orlon-filled Diallyl Phthalate.

ELECTRICAL RATINGS:

Voltage Breakdown:

At Sea Level.....2100 Volts RMS

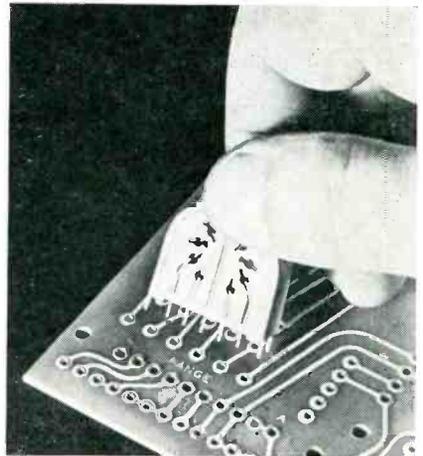
At 60,000 Ft.....750 Volts RMS

Current Rating5 Amps.

Additional information on these connectors, and special designs requiring the use of subminiature, printed circuit, hermetic seal, pressurized, high voltage, or power connectors are available on request. Write today for free catalog.

part for the convenient quick-connect type wire terminals. The connection is positive with triple spring action and, in many situations, their use makes a cost-saving contribution to the manufacture or maintenance of equipment.

The T-3 $\frac{1}{4}$ incandescent bulbs which are used may be had in 2 to 55-v ratings. With Dialco's built-in resistor these pilot lights may be used on voltages of 105-125 v or 210-250 v. Simple external resistors can be provided for all higher voltages.



RIGHT-ANGLE SOCKETS for printed wiring

AEROVOX CORP., Pacific Coast Division, 2724 South Peck St., Monrovia, Calif., has announced right-angle tube sockets that provide marked reduction in height and depth of printed-wiring assemblies. They are equally adaptable to hand-or machine-insertion methods. Terminals are of adequate length to slip into printed wiring holes and be dip soldered. Silver-plated contacts are engineered to provide nonfatiguing contact pressure with suitable insertion and withdrawal pressures. Metal parts and mounting hardware are plated to meet salt-spray test specifications.

► **Four Types**—These components are available in 7- and 9-pin sockets and in 4 different versions. Type A is for general-purpose applications where extra rigidity and resistance to vibration and shock are not important factors; type AX, for special applications requiring extra rigidity; type B, same as A, but with tube shield added; and type

you're sure with*

DeJUR

ELECTRONIC SALES DIVISION
DeJUR-Amsco Corporation
45-01 Northern Blvd.
Long Island City 1, N. Y.

*Pat. Pending

TAYLOR

Laminated Plastics
Vulcanized Fibre

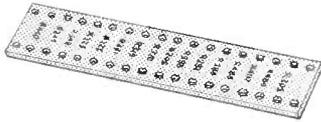
Shop Talk

TAYLOR FIBRE CO.

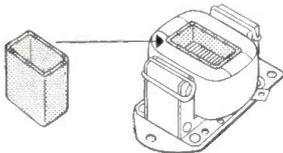
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

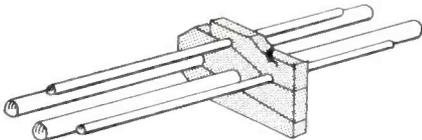
Tips for designers



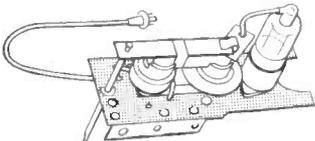
Terminal strips for high-precision electronic instruments benefit from the excellent insulating properties of Taylor XXXP-301 hot-punch laminate.



Coil forms for this solenoid have to operate at high temperatures . . . an ideal application for Taylor glass melamine laminate.



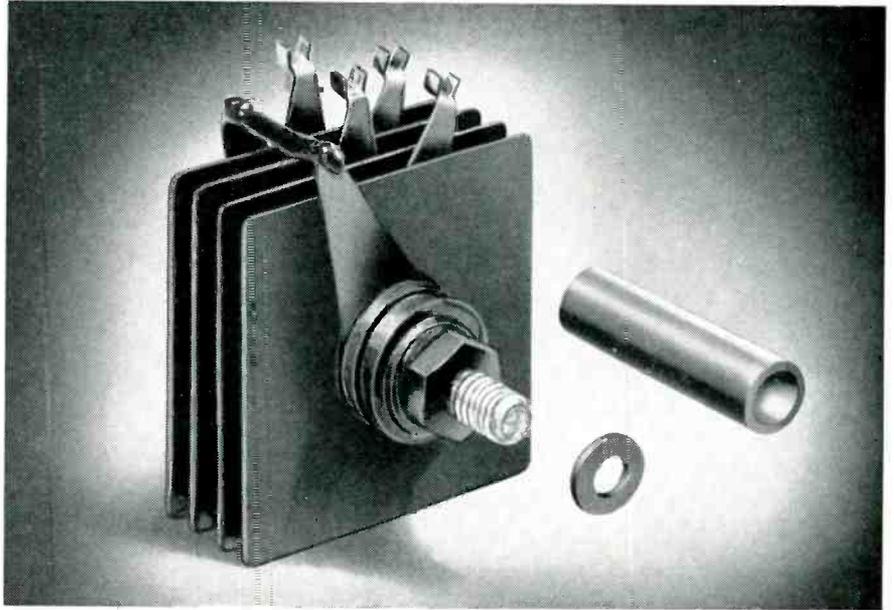
Fuel line clamp for a fighter airplane's "pipe-line" system is machined from Taylor fabric base laminate which has high mechanical strength and resists extreme temperature and humidity.



Base plate for high-voltage TV component, punched from Taylor canvas melamine laminate, has high dielectric strength and arc resistance.

TAYLOR FABRICATING FACILITIES

Your production problems can often be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts of vulcanized fibre and laminates to your specifications. Efficient, modern facilities are ready to serve you. Write to Taylor about your specific requirements.



Low-flow under physical load is an important characteristic of the Taylor Grade 353 washer used in this selenium rectifier. The Taylor Grade XX-10 tube provides dependable, long-lasting insulation for the current-carrying plates.

Electrical and physical stability recommend Taylor laminates

Dozens of different grades of Taylor laminates offer the designer and the production man a variety of combinations of electrical and physical properties for a wide range of product applications.

And very important . . . but often overlooked . . . is the degree to which these Taylor laminates maintain their original characteristics, over long periods of time and under severe operating conditions. You can have performance to fit your requirements . . . performance with stability . . . when you use Taylor laminates.

Included in this broad selection of materials are paper, fabric and glass bases . . . phenol, melamine, silicone and epoxy resins. Within

the complete line there is the combination you need, to improve the performance of your present product or to help move a new product into practical and economical production.

They are available in several forms, too, which make for greater fabrication efficiency . . . sheets 49" by 49", and tubes and rods in a wide range of sizes.

Whenever you are looking for a laminate . . . and particularly when the specifications include stability . . . it will pay you to check with Taylor first. To help you in your selection, Taylor offers the services of its engineering staff as well as the facilities of its fabricating division. Call on Taylor for a consultation on your specific requirements.

UNIQUE SENSITIVE RELAY

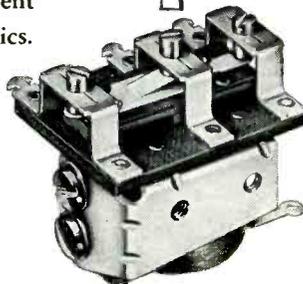
incredibly small,
lightweight and
adjustable!

ADVANCE "SO" SERIES

Here for the first time is a sensitive relay only 1-7/32" x 1-1/8" x 1-1/4"... weighing only 1-1/2 ounces, and adjustable over a wide range. You get much more latitude with this relay in designing for tiny areas.

The Advance "SO" is set at the factory to operate on 10 milliwatts. User can adjust it down to 2 milliwatts, or any desired pick-up or drop-out, by means of fine screw contacts. A balanced armature provides extremely sensitive operation. The unit is highly efficient, ruggedly built, and offers excellent shock and vibration-resistant characteristics.

Contact arrangement is SPDT. Coil resistances: 4000, 6500 and 10,000 ohms. Life expectancy: 250,000 operations. Available in open types... dust-tight or hermetically sealed enclosures. Now in quantity production. Advance "SO" relays are priced amazingly low. Write for literature.



Coil Resistance	Pick Up Voltage	Pick Up Current	Drop Out Voltage	Drop Out Current	Max. Coil Voltage for Continuous Duty	Overtravel	Contact Gap
4000	6.4 V	1.6 MA	3.2 V	.8 MA	110 V	.0015	.002/.003
6500	8.1 V	1.25 MA	3.9 V	.6 MA	140 V	.0015	.002/.003
10,000	10 V	1 MA	5 V	.5 MA	175 V	.0015	.002/.003

BX, same as AX, but with tube shield added.



POWER METER

d-c to 500 mc

MARCONI INSTRUMENTS, 44 New St., New York 4, N. Y. The TF-1152/1 measures true power from d-c to 500 mc with an accuracy of 5 percent up to 250 mc. It has ranges of 10 and 25 w maximum and a parallel-plate line matched to the cracked carbon load resistor insures a pure input impedance of 50 ohms throughout its entire frequency range.

Since it reads true power, modulation depth can be easily calculated. Calibration can be readily checked at d-c or 60 cps.



TUBE CHECKER

checks international types

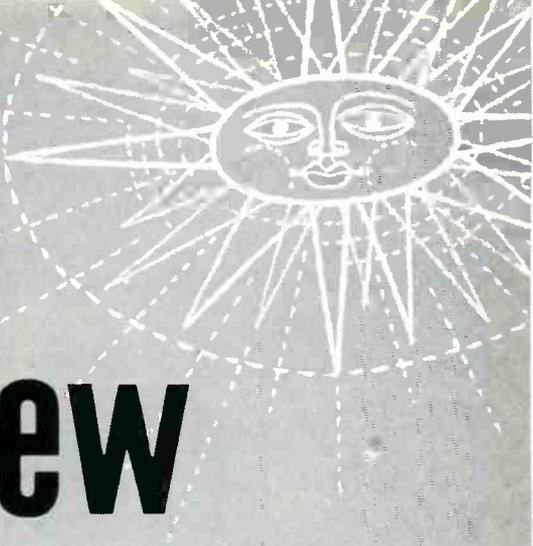
AMERICAN METRIX CORP., Box 179, Upper Darby, Pa., The type 310 will rapidly make a series of checks and measurements on receiving tubes, at one of several points on the static characteristic chart, in conditions similar to normal working conditions. It checks filament con-



ELECTRONICS DIVISION

ELGIN NATIONAL WATCH COMPANY

FOR RELAYS: 2435 N. Naomi Street, Burbank, California



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under the sunny skies of colorado!

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A NEW engineering project

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DENVER, the capitol of Colorado, is the site of Martin's new multi-million dollar plant where development work has begun in new fields of engineering.

To enhance this project, Martin is offering the finest in laboratory and production facilities; salary levels commensurate with experience and ability; association with people of extremely high technical competence; opportunities of advancing oneself professionally . . .

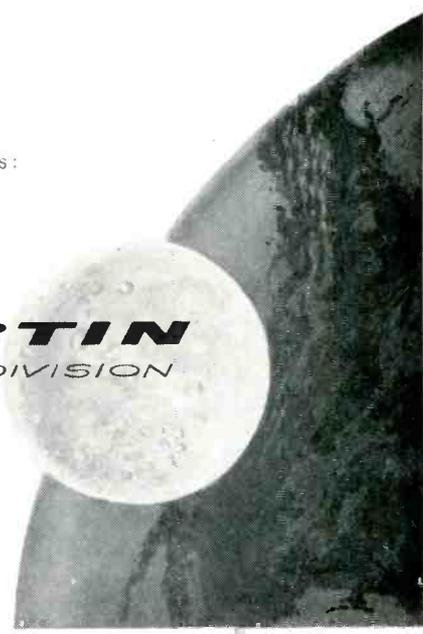
PLUS, a higher standard of living . . . and a way of life that is unhurried, stimulating, and completely enjoyable.

The Glenn L. Martin Company's **NEW DENVER DIVISION** in the heart of the Colorful Colorado Rockies will put you on the threshold of a career that has no limit.

We invite you to inquire about positions now open in the following fields:

POSITIONS:

Circuit Design & Anal.	Servo Design
Auto. computations	Instrumentation
Mathematicians	Physicists
Electronics Engineering	Electronic Systems
Systems Analysis	Communications



MARTIN
DENVER DIVISION

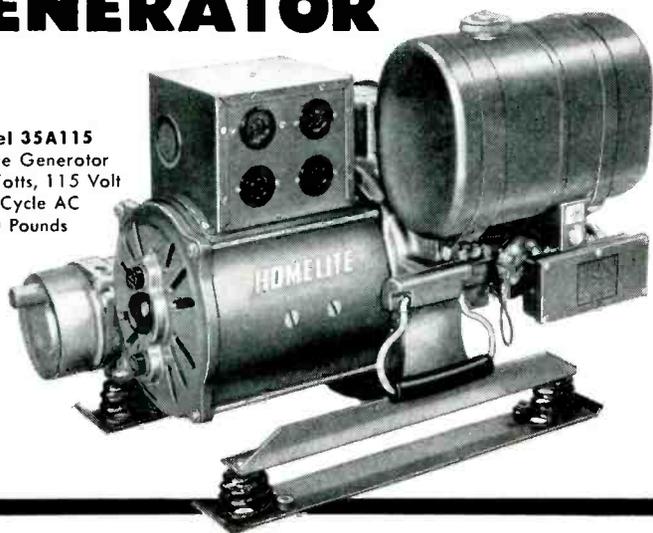
Address inquiries to: *Emmett E. Hearn, Employment Director,
Box 179, Dept. H, Denver, Colorado*

ALL NEW DESIGN!

Simple... Foolproof... Low Cost

1500 WATT HOMELITE GENERATOR

Model 35A115
Homelite Generator
1500 Watts, 115 Volt
60 Cycle AC
90 Pounds



1. New Money-Saving features... No DC brushes; just two easy-to-get-at collector ring brushes... No commutator or DC windings... No intermediate couplings; armature keys directly to shaft. Fewer parts to wear out — longer trouble-free generator service.

2. Constant Voltage... less than 4% change from no load to full 1500 watt capacity... assures long service life for your electrical requirements... guarantees top performance at all times.

3. Overload Capacity... 1500 watt continuous duty with generous overload capacity prevents stalling under heavy loads... insures uninterrupted service even when starting loads exceed operating loads.

4. Compact and Lightweight... one man can easily carry this generator wherever you need electricity to power time-saving electronic and communications equipment. No need for long, hazardous power-consuming cables.

SAVE EVEN MORE!

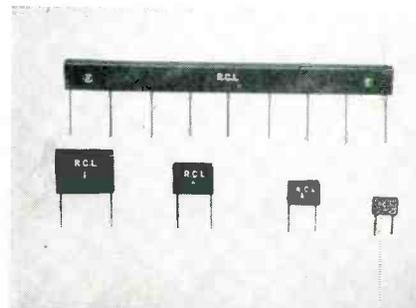
New Homelite idle control unit, available as optional accessory, runs engine at idle speed when no current is drawn... automatically brings engine to full speed when load is applied.

HOMELITE

A DIVISION OF TEXTRON AMERICAN, INC.
6804 RIVERDALE AVE., PORT CHESTER, N.Y.

Manufacturers of Carryable PUMPS
GENERATORS • BLOWERS • CHAIN SAWS

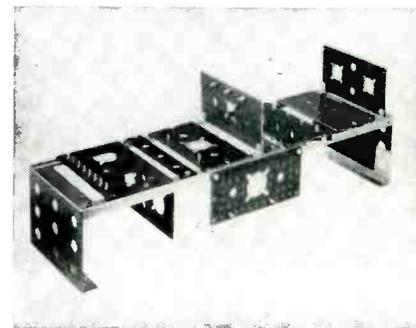
tinuity, hot and cold interelectrode short circuits, and filament-cathode insulation, and will measure plate current and mutual conductance anywhere on the characteristic chart. An overload cutout protects the instrument against faulty usage.



PRECISION RESISTORS encapsulated, wire-wound

R. C. L. MFG. Co., P. O. Box No. 25, Riverside, N. J. Series 3030 encapsulated wire-wound precision miniature and subminiature resistors are designed and built to withstand wide temperature ranges with ambients up to 125 C, humidity, salt water immersion, corrosion and shock without deterioration. They will withstand all test requirements of MIL-R-93; and can be supplied in radial and axial lead styles.

► **Technical Information** — Standard tolerances are 1 percent, available to 0.05 percent. Temperature ranges are -70 C to +125 C. Wattage is 0.1 to 0.750 w. Range is from 1 ohm to several megohms.

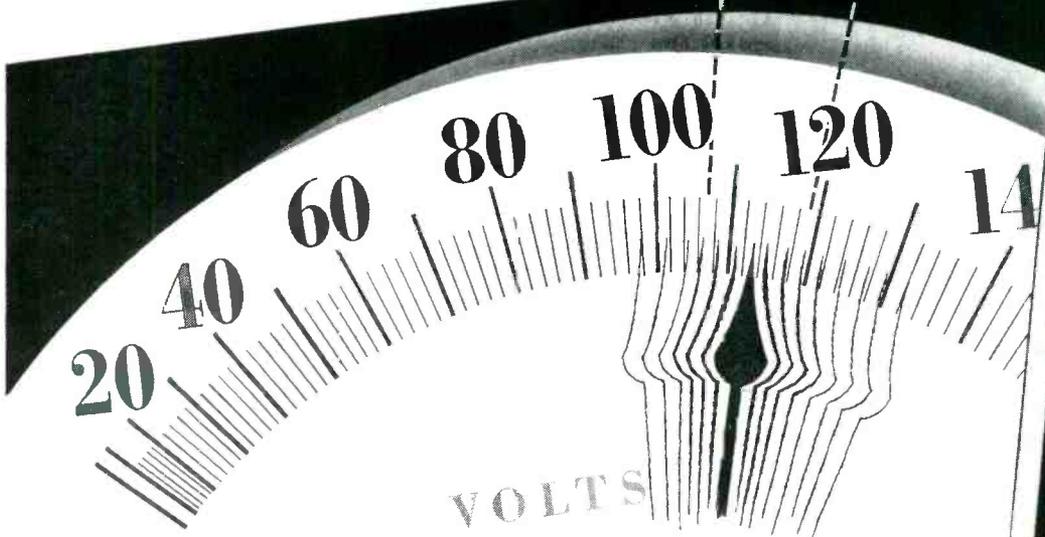


CHASSIS KIT for prototype models

PRECISION METAL PRODUCTS Co., 41 Elm St., Stoneham 80, Mass. The 3-D chassis kit is designed to provide complete flexibility to the design and development engineer in the construction of prototype mod-

END "ALLOWABLE" VOLTAGE VARIATIONS

→ ALLOWABLE VOLTAGE VARIANCES ←



THESE ARE SO-CALLED VARYING VOLTAGE TROUBLES



SHORTER LIFE FOR MOTORS



TOO MANY REJECTS



PROCESS RECYCLING



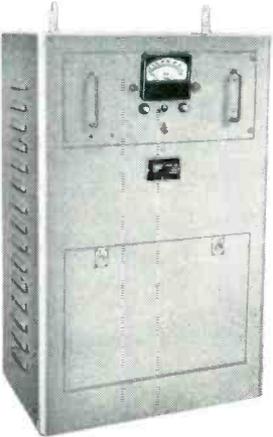
INSPECTION GEAR GOES OFF STANDARD



ELECTRONIC TUBES GO FASTER



FLUORESCENT TUBES BURN OUT TOO FAST



STABILINE type EM6220Y

Electrical equipment is designed to operate at a specified voltage. It is obvious that equipment will perform best . . . last longer if the specified rated voltage is maintained.

Voltage is supplied to your plant within certain "allowable" limits. Even if the voltage reading at your doorstep is right on the button, voltage variations occur within the plant.

STABILINE* Automatic Voltage Regulators end voltage variation headaches. They maintain constant specified voltage to voltage-sensitive equipment regardless of line voltage fluctuations or load changes. There is a STABILINE to fulfill the needs of most applications. Let us give you more facts.

*Trade Mark Reg. U. S. Pat. Off.

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A Long Step FORWARD in—

PRECISION FREQUENCY SYNTHESIS...



the
MANSON
Series 182

CRYSTAL SYNTHESIZER

- ★ **STABILITY** ... 1 in 10^7
- ★ **RESETABILITY** ... zero error
- ★ **READABILITY** ... zero error
- ★ **SPURIOUS SIGNALS** ... down 80 db

20,000 precisely-selectable, exact frequencies are at your fingertips in this disciplined incremental oscillator. It is the black-box equivalent of 20,000 crystals . . . and offers setability, readability and stability approaching the theoretical limits. Unskilled personnel can take immediate advantage of its designed-in simplicity, versatility and precision, and it meets JAN Specifications for electrical, mechanical and environmental performance.

PULL-IN and **HOLD-IN** are equal and automatic through a new Discriminator* without moving parts . . . **DIGITIZED DIAL*** gives direct readings of frequency . . . **READOUTS** are both mechanical and electrical . . . **AUTOMATIC RESET** to exact frequency after power failure . . . **REMOTE OPERATION*** available . . . **ALL-ELECTRONIC** design with simplified circuitry and construction for fast, easy maintenance . . . and many other unique features.

*Patents Applied For.

Three Models cover the range from 18 mc to 410 mc, with increments providing from 2000 to 20,000 discrete frequencies in each portion: Model **182-A** for the **HF** spectrum — **182-B** for **VHF** — and **182-C** for **UHF**. The Manson Series 182 Crystal Synthesizers are outstanding for use as:

Transmitter Exciters — Frequency Standards — Ultra-Stable Signal Generators and Frequency Meters—Low-Power AM and FM Transmitters—and as Master and Beat-Frequency Oscillators with Double and Single Side-Band Receivers.

.....Write for Bulletin 182

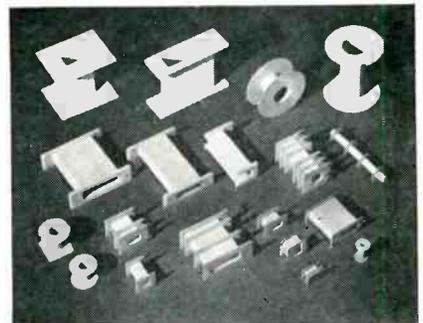
Manson offers to Engineers and Technicians a rewarding present and attractive future in suburban Connecticut.



els. It consists of: end brackets, side channels, terminal strips, miniature and octal tube socket plates, component mounting boards, mounting brackets, double-end press-in terminals, self-tapping screws, potentiometer mounting boards, and rack mounting plates.

► **Materials Used**—Plastic used in all mounting boards is laminated, paper base, XXXP (MIL-P-3115), type PBE. This material has low dielectric losses and excellent insulation resistance. Its $\frac{3}{32}$ -in. thickness provides excellent strength. The silver-plated solder terminal lugs, type PMP No. 1602, are lacquered to prevent tarnishing.

Overall size of the chassis kit is 5 in. wide, 16 $\frac{1}{8}$ in. long and 3 $\frac{1}{2}$ in. high. Capacitors, controls and components are easily mounted through the many holes provided. Two or more kits may be joined together for more complex prototypes.



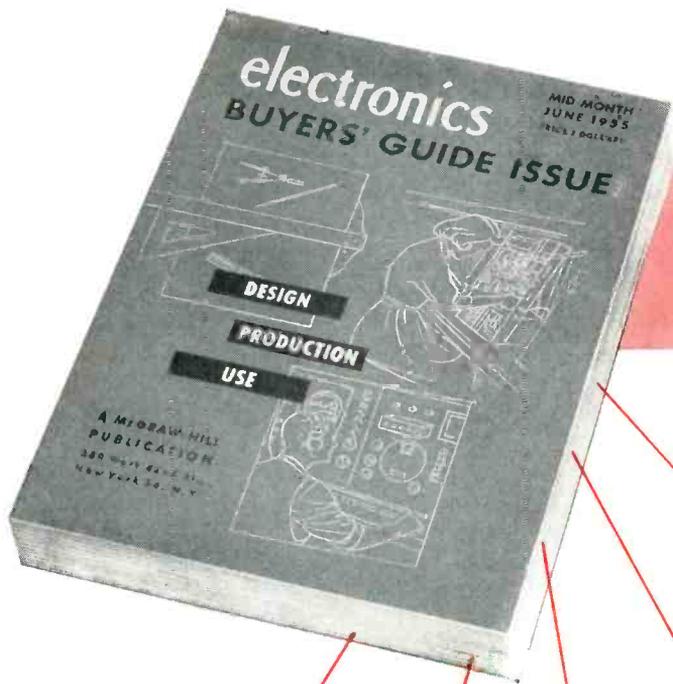
GLASS CLOTH BOBBINS laminated silicone type

SILICONE INSULATION, INC., 567 Third Ave., New York 16, N. Y. A silicone glass cloth bobbin laminated into a unified structure is finding a most needed application in high-temperature transformers, solenoids, relays and other coil-using equipment. The new spool maintains both mechanical and dielectric strength at the joints.

The bobbins include round and rectangular units with two or more flanges, with irregular flanges, protrusions, core extensions, or metal inserts.

► **Thin Walls** — Their thin rigid walls save valuable winding space. Wall thickness of 0.030 in. are most frequent, but walls of 0.020 in. or 0.015 in. are common, while some

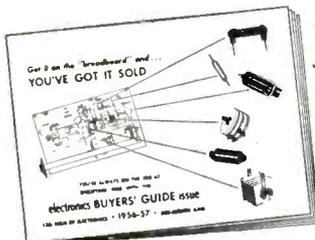
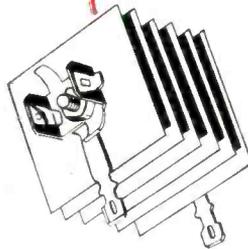
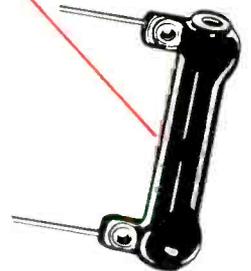
MANSON LABORATORIES 207 Greenwich Avenue
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STAMFORD • CONNECTICUT
Design and Production of Specialized Electronic Equipments



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6.8-billion dollar
electronic market
is thru the ...
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For the complete story on how the BUYERS' GUIDE can sell electronic components, equipment, materials . . . send for the free booklet titled: **GET IT ON THE "BREADBOARD" AND . . . YOU'VE GOT IT SOLD!**

electronics BUYERS' GUIDE

330 WEST 42ND STREET  A MCGRAW-HILL PUBLICATION  NEW YORK 36, N. Y.

modernization

For the benefit of those to whom marking pulses and spacing pulses are only assorted bauds—the top illustration represents a venerable, familiar and respected telegraph relay made by one of the great corporations. For a long time it has been common in Teletype communication equipment; and, as with the DC-3 airplane, its "bugs" are pretty well domesticated.

Then, in a 1946 development contract, the Signal Corps asked for a small equivalent — hermetically sealed against the tropics and G. I. fingers. Ironically enough, when it came time to try and sell the result (Sigma Series 7 ) nobody had any way of using it unless it fitted existing sockets and cover clamps.

This led to the preposterous but effective arrangement in the second illustration.

There was only one trouble. It had been the custom with the predecessor relay to clean and adjust contacts at infrequent intervals during a long service life. Hermetic sealing, besides somewhat impairing contact life, makes service and adjustment quite impractical. (Some will recall previous mention of the Air Force Captain and his dramatic "small hole treatment." The story was true.) So the verdict on the Series 7 was confused: Good in "tactical" situations, i. e., foxholes; also good in some commercial equipment, but n. g. in other.

A private attempt to end all such attempts — with a good Sigma telegraph relay once and for all — led to the Series 72 . In order to be sure of no distortion at 100 word-per-minute speeds, it was made capable of acceptable behavior at 1000 w. p. m. Not only was it made with a detachable cover, but the wearing parts were made replaceable like phonograph needles. (It was our good fortune that the "72" turned out, in addition, to be a rather decent relay on a great many other counts, which means business outside the telegraph field.)

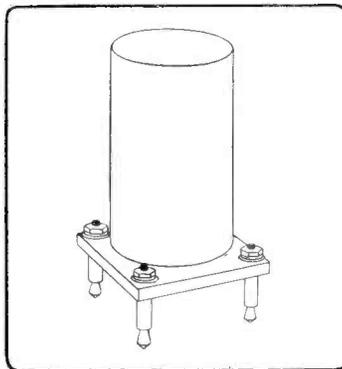
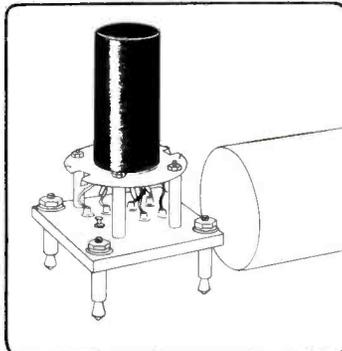
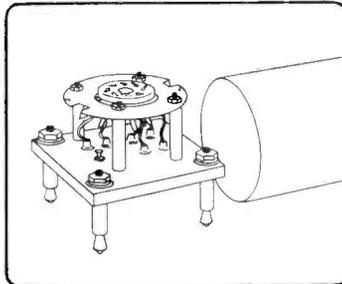
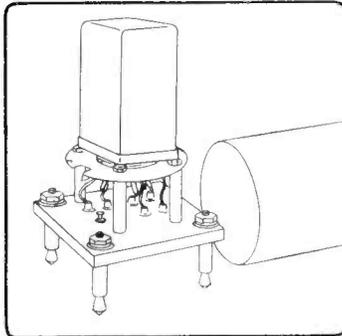
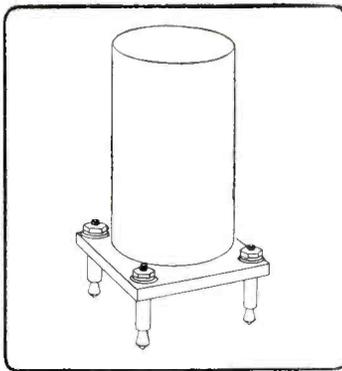
Now, of course, there may be some devil-may-care individuals actually designing future equipment of this type with octal sockets. The AB-37 Adaptor is still around, however, for those who must look before they leap.



**SERIES 72
HIGH SPEED
RELAY**

Outstanding Specifications

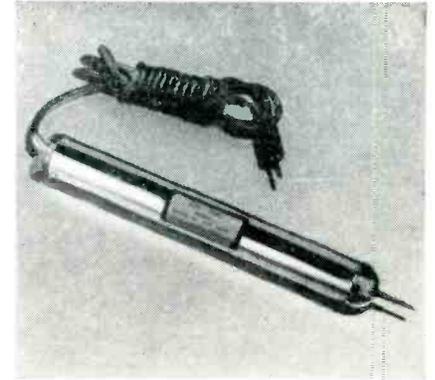
Pulse Relaying	500 per second at 75% efficiency
Life under Load	About 500 million operations without adjustment. (110 V 60 ma. DC simulated printer)
Maintenance	Bias, Sensitivity adjustable; contacts, armature easily replaceable
Vibration Immunity	15 g to 500 cps even unenergized



have been made as low as 0.010 in.

Close dimensional tolerances can be maintained— ± 0.005 in. is normal while ± 0.001 in. is possible. These tolerances are largely a function of the tooling.

Laminated silicone glass cloth bobbins meet and exceed class H temperature requirements.



VOM PROBES are rugged and accurate

FUTURAMIC Co., 2500 W. 23rd St., Chicago, Ill. Model 261 high-ohms probe extends the ohmmeter range of the vom by a factor of 10. It permits measurement of resistance values up to 200 megohms. The probe can be used with any 20,000 ohms-per-volt vom having a center-scale indication of 12 ohms, and an internal ohmmeter battery of 7.5 v.

► **Other Features**—It is ruggedly constructed, highly accurate, and has a gold-plated steel housing with color-coded Lucite end pieces. The probe is put into operation by simply plugging into meter in place of conventional test lead.

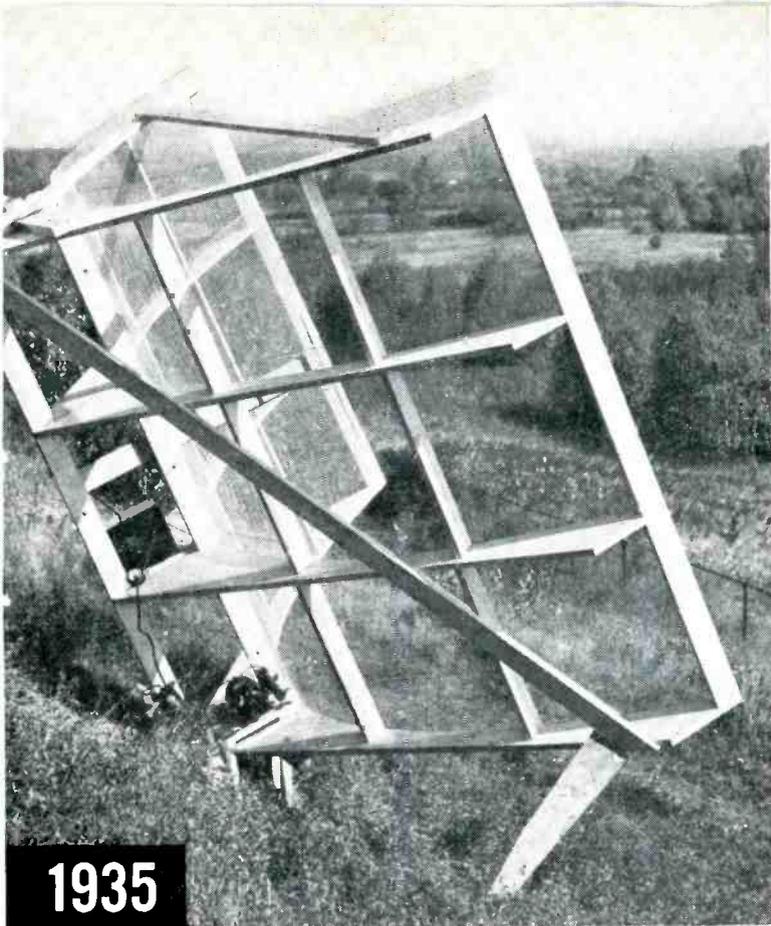
Price is \$9.95.

R-F PREAMPLIFIER features small size

APPLIED SCIENCE CORP. OF PRINCETON, P. O. Box 44, Princeton, N. J. Model APA-2 r-f preamplifier greatly improves the signal-to-noise ratio of a typical radio receiver in the 215-235 mc frequency band, resulting in a better reception of low-strength signals. Addition of the preamplifier to a typical receiving installation utilizing a receiver with a typical 10-db noise figure

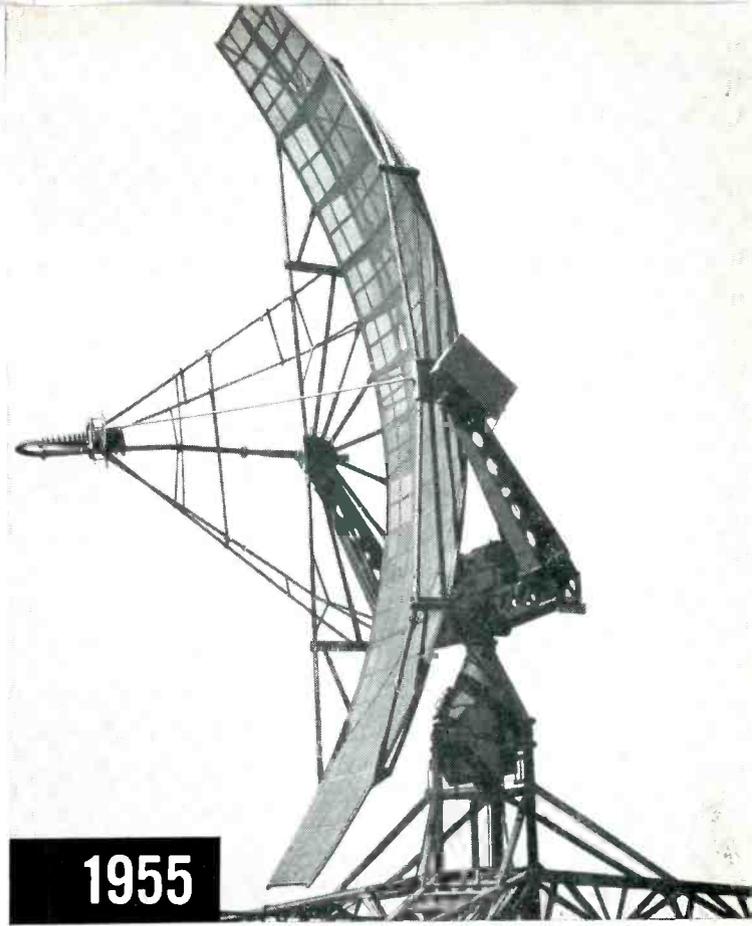
SIGMA

SIGMA INSTRUMENTS, INC., 62 Pearl Street, So. Braintree, Boston 85, Massachusetts



1935

EARLY RESEARCH AND DEVELOPMENT EXPERIENCE with electronic location equipment at G.E. began in 1935 when this first system, with an output of 1½ watts, located planes up to five miles away.



1955

IN USE TODAY, this huge nodding height finder was designed and developed by General Electric to be used with powerful search radar systems and is a major contribution to long-range aircraft location.

How G.E.'s 20-year antenna background can help make your radar system more effective

6 examples show experience in all areas of land- and ship-based antenna work

To give you an outstanding source for reliable, precision radar antenna equipment, General Electric backs modern facilities with the know-how that comes from many years of research, engineering, and manufacturing experience.

For example, early research in electronic location equipment at G.E. began in 1935 and engineering and manufacturing experience includes these six major areas:

1. **Stabilized bases** to compensate for ship pitch and roll were built in large quantity with Navy antennas in World War II.
2. **Small, portable systems** for weather balloon tracking were developed and produced for the Army and Navy in 1948.
3. **Powerful heightfinding antenna**, FPS-5XW1, developed by G.E. for USAF in 1949, was an advancement in long-range detection.
4. **Giant shipboard search antenna**, largest in use today, was G-E developed and produced for Navy early-warning ships.
5. **Long-range search antennas** (FPS-7) were designed and built by G.E. using advanced construction techniques.

6. **One of the first combination antennas** (allows both search and elevation detection), the Navy's SPS-8 was designed and produced to give a precise beam pattern.

This extensive background enables clearer perception of special engineering and manufacturing problems. It is the element that helps give G-E precision antenna equipment the efficiency and reliability to help make your radar system more effective. For more information, contact your G-E Apparatus Sales Office or use coupon below.

Mail to: General Electric Company, Section F 223-2
Schenectady 5, N. Y.

Please send me these two bulletins:

GEA-6279, Radar Antennas, Mounts, Components, and Accessories

GED-2494, G.E.'s Naval Ordnance Department Offers Complete Engineering and Manufacturing Services

For immediate project. For reference only.

Name
Position
Organization
Address

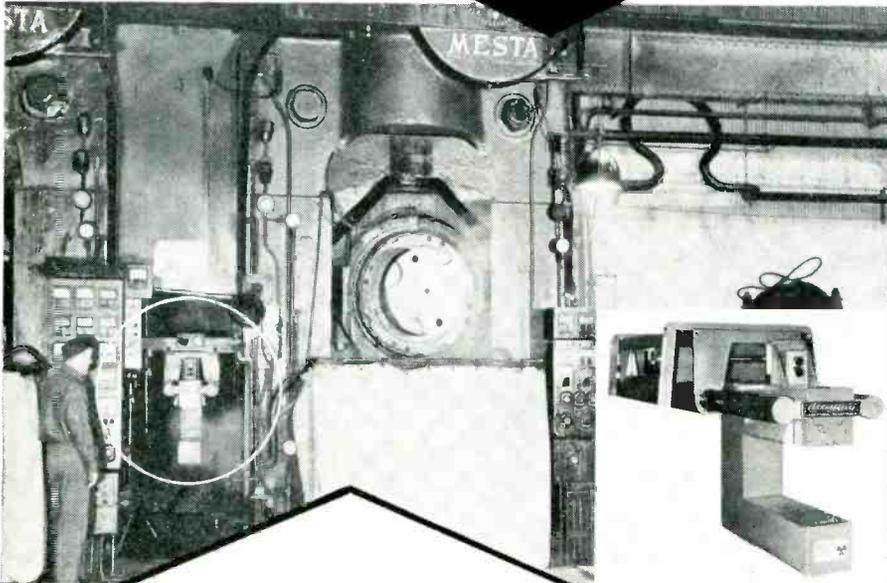
Progress Is Our Most Important Product

GENERAL  ELECTRIC

A CHICAGO
Stock
Transformer



**SAVED 8 WEEKS
DELIVERY TIME ON
THIS AccuRay® AUTOMATIC
PROCESS CONTROL
EQUIPMENT**



CONTROL UNIT

Industrial Nucleonics Corporation of Columbus, Ohio, needed the finest of dependable, high quality transformers in this equipment used to control steel strip thickness in the cold rolling of sheet steel. Units of another manufacturer did not fully meet required specifications. New, redesigned transformers would have required at least eight weeks delivery time.

Chicago Transformer PSC205 provided the ruggedness and reliability required for this equipment and was available from stock for immediate delivery. Thus Industrial Nucleonics was able to maintain its production and delivery schedules on this important equipment. PSC205 has been used continuously in the production of AccuRay® automatic process control equipment ever since.

Write for the free Chicago Standard catalogs listing over 1110 stock transformers.

**USE CHICAGO
STANDARD STOCK
TRANSFORMERS
TO ELIMINATE
YOUR
TRANSFORMER
BOTTLENECKS**

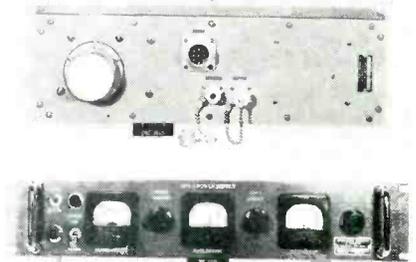


CHICAGO STANDARD TRANSFORMER CORPORATION
3501 ADDISON STREET • CHICAGO 18, ILLINOIS

Export Sales: Roburn Agencies, Inc., 431 Greenwich St., New York 13, N.Y.

NEW PRODUCTS

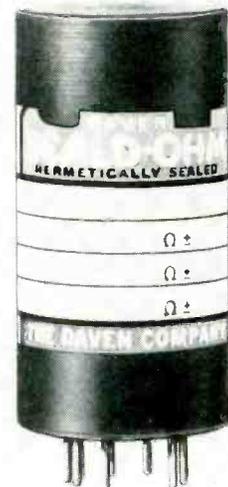
(continued)



produces an improvement in signal-to-noise ratio equal to that which would result from a five-fold increase in transmitter power, or an antenna gain increase by a factor of 5.

► **Size**—The preamplifier is 17½ in. long by 6½ in. wide by 5¾ in. high and weighs 12½ lb. By virtue of its small size it can easily be mounted at the antenna in most cases.

The separate power supply furnished with each preamplifier mounts in a standard 19 in. relay rack and may be placed at a remote point with respect to the preamplifier.



RESISTOR NETWORK
plug-in type

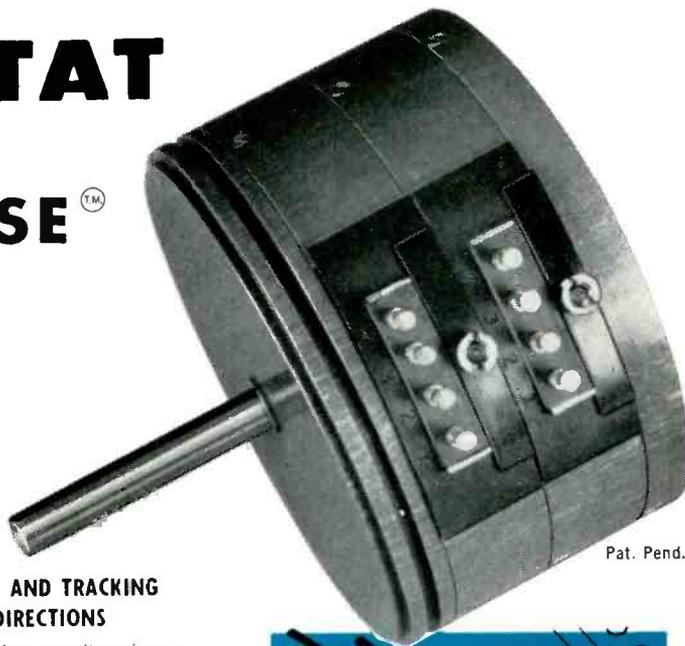
THE DAVEN Co., 530 W. Mt. Pleasant Ave., Livingston, N. J., has developed a new plug-in resistor network, type 1299. The unit is epoxymolded, hermetically sealed and measures ¼ in. in diameter and 1½ in. in length. Its base fits a standard 9-pin miniature socket.

► **Specifications**—The plug-in resistor network can accommodate up to 8 individual resistors with a

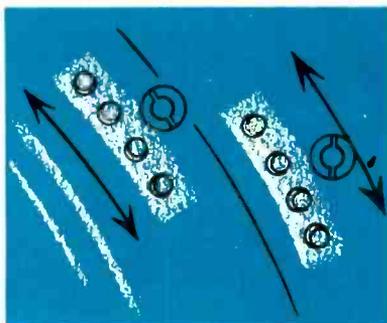
A **new** and **better**
variable-phase, single-turn
precision potentiometer

CLAROSTAT


VARI PHASE™

Pat. Pend.

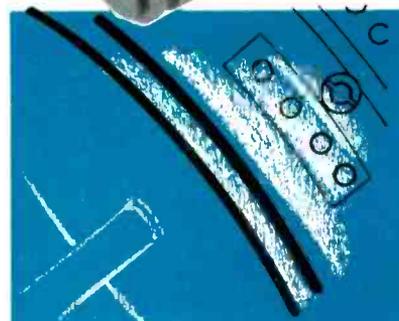
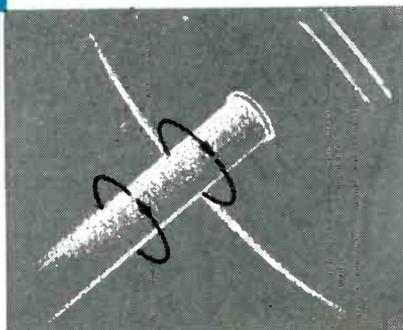


EQUAL TORQUE AND TRACKING IN BOTH DIRECTIONS

Unique contact design permits micrometer tension adjustment at factory and assures equal torque and tracking in either direction at all times.

NO CLAMPING RINGS

Simplified phasing—External independent phasing of each cup without affecting the relationship of the others.—To phase, loosen clamping nut, move terminal board in desired direction, tighten clamping nut and it's done. Speedy phasing saves time and money. Reduced overall diameter by elimination of clamping rings.



STANDARD A. I. A. MOUNTING

Mounting per A.I.A.* standards—others available. Meets or exceeds electrical and mechanical A.I.A. requirements.

Materials selected for lightest weight possible. Design assures highest performance.
Five sizes available—7/8", 1-1/16", 1-5/8", 2" and 3" diameters.

Another **CLAROSTAT** first. A product of advanced imagineering.

WRITE FOR
COMPLETE ELECTRICAL
AND MECHANICAL
SPECIFICATIONS.



CLAROSTAT MFG. CO., INC.
DOVER, NEW HAMPSHIRE

*In Canada: Candian Marconi Co., Ltd., Toronto 17, Ont.
Manufactured under license in Great Britain by
A. B. Metal Products Ltd., 17 Stratton St., London W. 1,
Concessionaires for British Commonwealth except Canada.*

*Aircraft Industries Associated.

The Curtiss-Wright "SNAPPER"

NEW CONCEPT... ADVANCED DESIGN

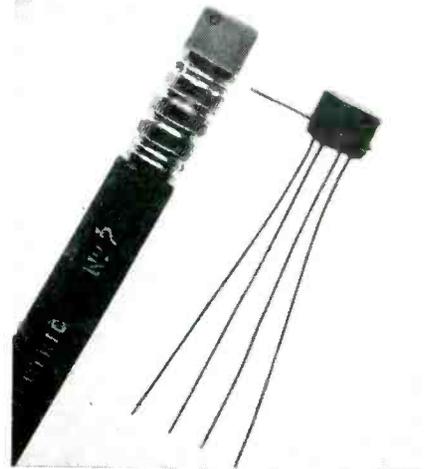


Designed for high performance and long life, the Curtiss-Wright "SNAPPER" Thermal Time Delay Relay is proving itself in countless applications involving time delay in electrical circuits. Such applications include circuits to provide definite on-off time intervals to delay the application of high voltage until after warm-up period and for over and under voltage protection with simultaneous fault indication. These relays have single-pole double-

- throw contact action, high ambient temperature range, freedom from chatter and arcing, and are small in size. The "SNAPPER" thermal time delay relays
- are factory pre-set from 3 to 120 seconds. They are available in metal envelope, miniature (7 and 9 pin) or octal (8 pin) and in a glass envelope in 9 pin only. Curtiss-Wright manufactures the High-Low "SNAPPER" Differential Thermostat with high precision characteristics. Write for full data.

total resistance of 6 megohms. Individual resistor tolerances can be held to ± 0.05 percent. It is operable from -55 C to $+125$ C. Each resistor can dissipate 0.5 w.

This new assembly can be supplied for other standard sockets or connectors, if required. It can also be furnished with modifications of physical size depending upon the number of resistors and their values.



TRANSISTOR germanium tetrode type

GENERAL ELECTRIC Co., Syracuse, N. Y., has announced a new germanium tetrode transistor produced by the company's melt-back process. It combines rugged construction and substantial power handling capabilities with high frequency performance.

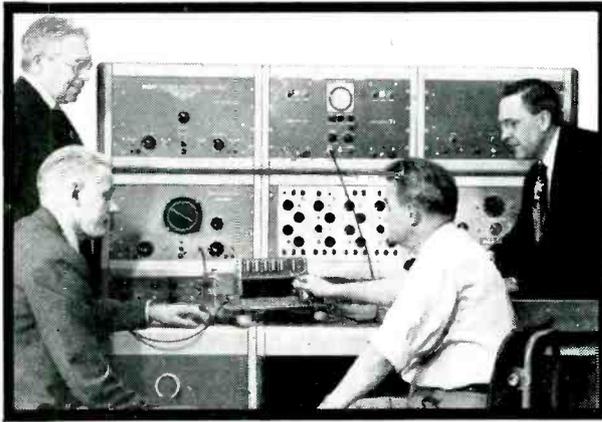
► **Specifications** — Typical alpha cutoff of the new device is 50 mc at 85 C. It is rated at a minimum of 10 db power gain at 30 mc at 25 C with a 2-mc bandwidth. It is capable of dissipating 50 mw at 25 C and has a rise and fall time of 0.02 μ sec.

FILTER CHOKES new hermetic series

UNITED TRANSFORMER Co., 150 Varick St., New York 13, N. Y. A new concept in filter choke design and ratings is effected in the hermetic series recently released. Designed to provide exceptional reliability through low temperature rise and high insulation safety factors, these

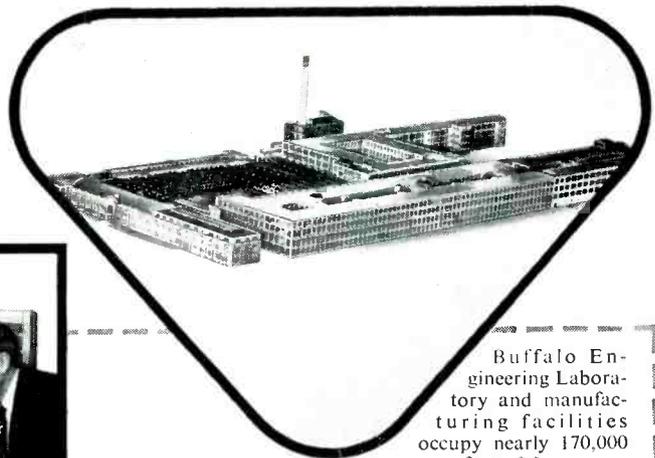
ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.

**The right people
with the right facilities
produce the
right solutions**

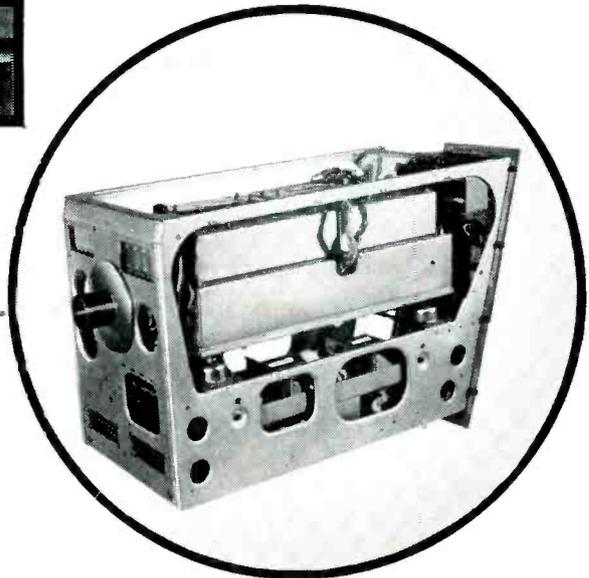


Observing measurement of circuit parameters in the Electronic Systems Division's Buffalo Engineering Laboratory. From left: *H. C. Tuttle*, Manager—Buffalo Operations; *M. C. Scott*, Manager—Buffalo Engineering Laboratory; *R. W. Ferry*, Assistant Product Engineering Manager and *A. W. Puttick*, Product Engineering Manager.

Component of Airborne Countermeasure System.



Buffalo Engineering Laboratory and manufacturing facilities occupy nearly 170,000 square feet of floor space in this industrial center at 175 Great Arrow Ave., Buffalo 7, New York.



**“Packaged”
to deliver top performance —
anywhere**

THIS “PACKAGE” CAN GO anywhere, any time, in modern, high-performance aircraft, and deliver effectively in America's defense. It is an electronic countermeasure system. Designed, engineered, and “packaged” for minimum weight, the equipment provides maximum reliability and top performance under extreme conditions of humidity, altitude, shock, vibration, and temperature differential.

Engineered in the Buffalo Engineering Laboratory of Sylvania's Electronic Systems Division, this highly advanced elec-

tronic system employs subminiature tubes, transistors, and printed circuits in a package which is itself subminiaturized. Despite its complexity of design and purpose, it is engineered for quantity production in the Division's Buffalo plant.

In all of Sylvania's Electronic Systems Division installations, the right people work with the right facilities, within a sound managerial environment. That is why they have produced the right solutions to a variety of problems, and have made such important contributions in the fields of aviation electronics, guided

missiles, countermeasures, communications, radar, computers and control systems. Whether the problem is military or industrial, Sylvania's business is to come up with electronic solutions that are *producible*.

In addition to its Buffalo Engineering Laboratory and manufacturing facilities, the Electronic Systems Division has installations at Waltham, Mass., and Mountain View, Calif., staffed with top-ranking scientists and engineers, and backed by Sylvania's extensive resources in the electronics field.

—SYLVANIA IS LOOKING FOR ENTERPRISING ENGINEERS—

Sylvania has many opportunities in a wide range of defense projects. If you are not now engaged in defense work, you are invited to contact

Edward W. Doty, Manager of Personnel, Electronic Systems Division, Sylvania Electric Products Inc., 100 First Avenue, Waltham 54, Mass.



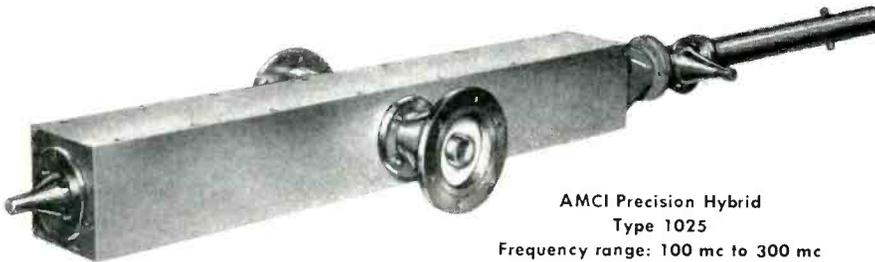
SYLVANIA



SYLVANIA ELECTRIC PRODUCTS INC.

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

NEW TOOLS for R-F MEASUREMENTS



AMCI Precision Hybrid
Type 1025
Frequency range: 100 mc to 300 mc

PERMITS DETECTION OF SWR'S AS LOW AS 1.002

THE TYPE 1025 PRECISION HYBRID is a five-terminal, high-frequency network built with particular attention to stability and accuracy of construction. It makes possible the *measurement* of quantities that have been, normally, only estimated. For example: this device can be used to measure at about 200 mc. a reflection coefficient as low as 0.01, with a precision of ± 0.001 in magnitude and $\pm 5^\circ$ in phase angle.

VERY LOW SWR's can be measured by using the Type 1025 Hybrid with a suitable receiver and signal generator. With additional equipment, the phase angle also can be obtained, permitting point-by-point plotting of impedance curves like the one shown at the right.

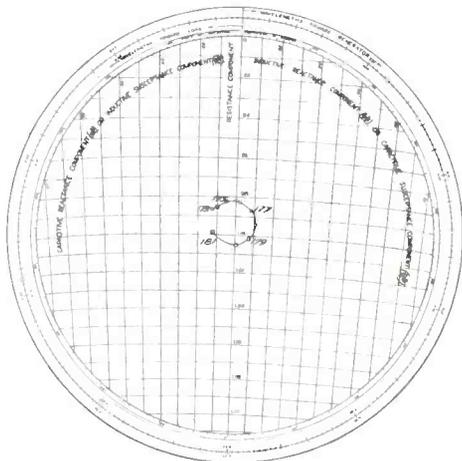
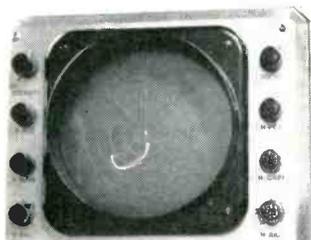
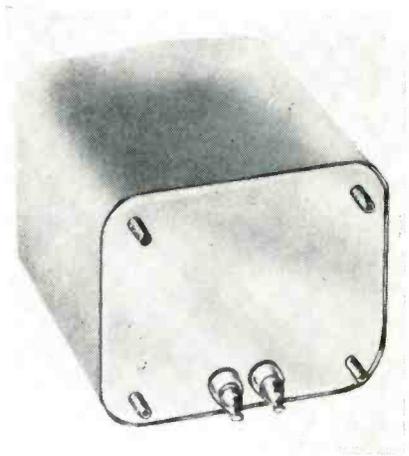


CHART FULL SCALE=1.10



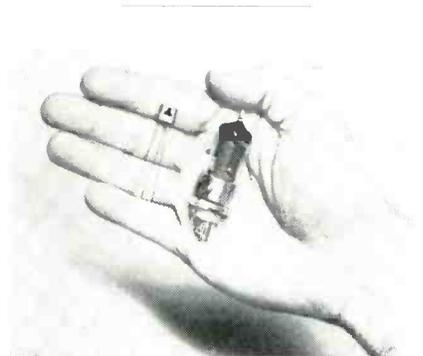
DIRECT DISPLAY OF IMPEDANCE can be obtained by using the Type 1025 Hybrid in conjunction with the AMCI type 1028 Polar Display Unit (frequency range 120 mc to 240 mc) together with a standard d-c oscilloscope and suitable swept oscillator. A typical display is shown in the unretouched photograph at the left.



hermetic filter chokes exceed MIL-T-27 specification requirements.

► **Features**—Four inductance-vs-current ratings for each unit provide maximum versatility in application. The ten units in the H series cover current values from 20 ma to 1,250 ma, with voltage ratings up to 3,000 v d-c.

These units also have industrial ratings for high reliability, broadcast, test equipment and similar service.



SILICON TRANSISTORS in large-scale production

BOGUE ELECTRIC MFG. Co., 52 Iowa Ave., Paterson 3, N. J., has available a complete line of precision durable silicon grown junction transistors. They will operate at peak efficiency under a wide range of operating conditions, including high temperatures.

► **New Characteristics**—Three important new characteristics in design are: high input operating voltage, higher collector operating voltage and decreased collector series resistance. These will permit silicon transistors to operate efficiently in the large signal applications necessary in magnetic

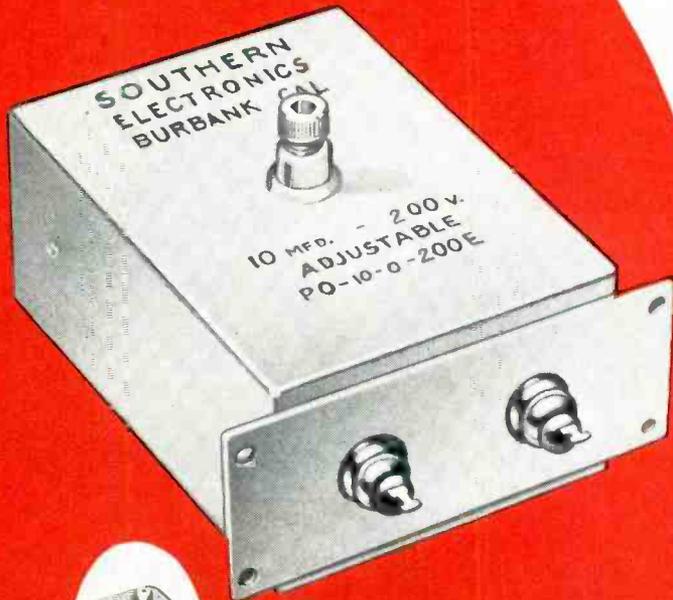


ANTENNA SYSTEMS - COMPONENTS - AIR NAVIGATION AIDS - INSTRUMENTS

ALFORD

Manufacturing Co., Inc.

299 ATLANTIC AVE., BOSTON, MASS.



**NOW AVAILABLE FROM
0.1 M.F.D. to 10 M.F.D.**

Check these outstanding features:

- Accuracy in the order of 0.1% or better!
- Long Time stability in the order of 0.03%!
- I.R. — @ 25° C-10¹² OHMS
- Dielectric Absorption — .015%
- Dissipation Factor — .0002
- Temp. Coeff. (—20° to 140° F.) 100 P.P.M. per °C

Excellent for Computer Integration, Test Equipment or Secondary Standards.

America's electronic leaders specify Southern Electronics' polystyrene capacitors for their most exacting requirements. Goodyear Aircraft, Beckman Instruments, Reeves Instrument Corp., Electronic Associates, Inc., Convair, M.I.T., Calif. Inst. of Tech., and many others. Make sure you're getting the finest—always specify S.E.C.!

Wire, write or phone for complete catalog today!

ADJUSTABLE
precision
polystyrene
capacitors

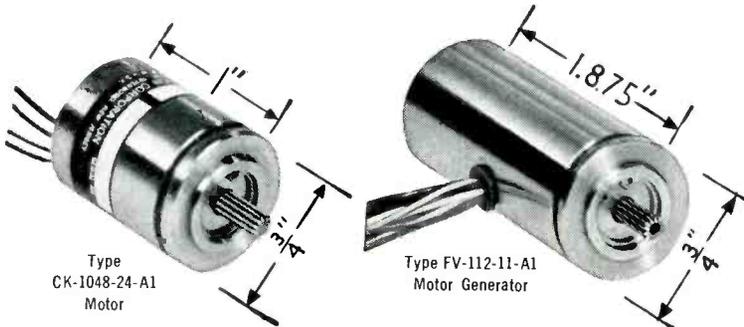
... WITH PERFECT
HERMETIC SEAL TO
INSURE EXTREMELY
LOW LEAKAGE!



SOUTHERN ELECTRONICS
Corporation

239 West Orange Grove Ave., Burbank, California

Need a sub-miniature low-inertia Servo Motor or Servo Motor Generator?



Here are two brand-new ones

by **Bendix**

TYPICAL MOTOR CHARACTERISTICS

	CK-1048-24-A1	FV-112-11-A1
Frame Size	8	8
Voltage: Fixed Phase	18 volts	18 volts
Control Phase	18 volts	18 volts
Frequency	400 cps	400 cps
Current*: Fixed Phase	.095 amp.	.095 amp.
Control Phase	.095 amp.	.095 amp.
Impedance*: Fixed Phase	190 = 158 + j104 ohms	190 = 158 + j104 ohms
Control Phase	190 = 158 + j104 ohms	190 = 158 + j104 ohms
Power Input* (Total)	3 watts	3 watts
Stall Torque	.15 oz-in	.15 oz-in
No Load Speed	6300 rpm	6300 rpm
Rotor Moment of Inertia	.5 gm-cm ²	.8 gm-cm ²
Torque to Inertia Ratio	21,000 rad/sec ²	13,000 rad/sec ²
Weight	1.5 oz.	2.5 oz.
Operating Temperature Range	-55°C to +100°C	-55°C to +100°C

*At stall with rated voltage applied to each phase

TYPICAL GENERATOR CHARACTERISTICS

Voltage: Input	18 volts
Output	.250 volts/1000 rpm
Frequency	400 cps
Linearity	1/2 of 1% up to 3000 rpm
Input Impedance	178 = 135 + j115 ohms
Recommended Output Loading	100,000 ohms
Power Input	1.5 watts
Null Voltage	15 millivolts max.

These latest additions to the Eclipse-Pioneer line are now in initial production. They're another forward step in the continuing development of Bendix components to meet modern space, accuracy and weight requirements. For full details, write stating your specific needs. DEPARTMENT A, ECLIPSE-PIONEER DIVISION, BENDIX AVIATION CORPORATION, TETERBORO, N. J.

Let "by Bendix" be your guide to **BUY BENDIX**

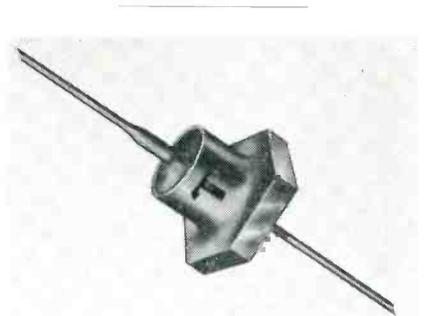
West Coast Office: 117 E. Providencia Ave., Burbank, Calif.

Export Sales and Service: Bendix International Division, 205 E. 42nd Street, New York 17, N. Y.



amplifier, computer and servo applications.

The new transistors are currently available in two categories, one with emitter voltage of 2 v and the other, the "A" category with emitter voltage of 5 v. Four types of transistor in each series cover a wide range of special operating requirements.



SILICON RECTIFIERS axial lead types

TRANSITRON ELECTRONIC CORP., Melrose 76, Mass., has available axial lead silicon power rectifiers which offer versatile mounting arrangement for printed circuits or standard terminal boards.

► **Specifications**—They are available with peak inverse voltage ratings up to 600 v, and maximum average forward currents to 500 ma at 100 C. They feature both high forward conductance and low leakage current for high operating efficiency.

Small size (less than 1/4 cu in. total volume) and hermetic sealing ideally suit these rectifiers for use in military equipment or similar applications where miniaturization and reliability are of importance. Complete information is given in bulletin TE-1335.

LAB TEST DEVICE gas analyzer, vacuum pump

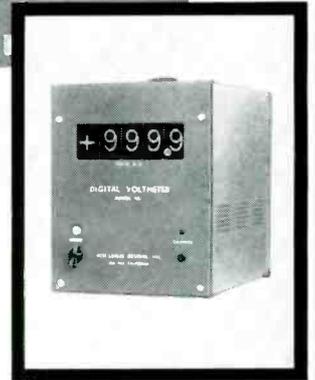
BARRY ELECTRONICS CORP., 512 Broadway, New York 12, N. Y. Model 1 is a combination leak tester, gas analyzer and vacuum pump. The unit includes built-in vacuum pump, vacuum gages, all necessary control valves and a gas analyzer cell for identification of system leaks. This test apparatus is self-contained in a single top-of-

MODEL 451



RACK MOUNT STYLE — 5¼" high by 18" wide by 15⅞" deep

PORTABLE STYLE — 10⅞" high by 8⅞" wide by 15⅞" deep



Now! Accurate automatic measurements for varied industrial applications...

NOW EVERY FEATURE you want in a precise, automatic Digital Voltmeter is available in these new Non-Linear Systems models. Their *performance* features automatic measurement from zero to ± 999.9 volts DC with high accuracy and resolution. *Fast readings* are presented in a brilliant, in-line luminous numerical display. *Automatic features* simplify operation, enable you to use non-technical employes. Assured *long life* results from exclusive NLS *oil-sealed* stepping switch system, plus top-quality components. Thorough *quality control* ensures reliable operation. And unitized construction means *simplified maintenance*, saving you time and money.

Yet NLS Model 451 Digital Voltmeters are priced far below instruments offering only a fraction of these advantages! These low costs are possible because NLS, as originators of the Digital Voltmeter, has the advantage of pioneering design and production techniques. Furthermore, NLS quantity production results in additional savings.

You can save time and money, and assure automatic accuracy in precision measuring, with an NLS

Digital Voltmeter. Mail coupon today for more information on how these quality instruments can assist your operations.

YOU GAIN THESE ADVANTAGES

- Automatic operation** — Simple operation plus brilliant numerical readout and recording allows use of non-technical personnel.
- Exhaustive quality control** — Sustained accuracy assured by systematic testing procedure throughout all engineering, production phases.
- Unitized, standardized construction** — Each instrument can be quickly disassembled into three functioning subassemblies.
- Quality components**, including mercury-cell reference standard, stepping switches built to NLS specifications, precision resistors and other high standard components.
- Oil-sealed stepping switch subassembly** cuts maintenance, boosts switch life, ensures reliability under all operating conditions.
- Long-life stepping switches** — Life tests corresponding to 21,000,000 readings completed, with switches still operating!

Simplified maintenance, resulting from unitized construction, saves you time and money.

No-lost-time service — Interchangeable subassemblies and complete instruments available promptly.

Automatic recording by electric typewriter, printer, summary punch.

Low initial cost, based on NLS integrated, efficient production methods, and on advanced engineering developments.

New! Automatically-standardized reference power supply eliminates manual adjustment; available instead of internally-mounted mercury-cell battery pack.

APPLICATIONS

Automatic measurement, digital display and recording of DC voltages for:

Manufacturing — Development, production and process control testing.

Laboratories — Precision standardization procedures.

Special test equipment — Analog computers, missile components, control systems.

Many more! Our application engineers are available to work with you.



NON-LINEAR SYSTEMS

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ORIGINATORS OF THE DIGITAL VOLTMETER

Digital Ohmeters • AC-DC Converters • Digital Readouts
Data Reduction Systems • Peak Reader Systems
Digital Recording Systems • Binary Decimal Converters

NON-LINEAR SYSTEMS, INC.

Dept. B-456, Del Mar Airport, Del Mar, California
Send new '56 catalog on complete line of precision instruments, and current price list.

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COMPANY _____

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CITY _____ STATE _____

vital tests?
lots of data?

Here's the acknowledged peak of recording oscillograph development — CEC's Type 5-119, usable for over 90% of all static-dynamic tests, regardless of their complexity. An unusual group of *built-in* safeguards against data loss has proved especially valuable in aircraft flight testing and in missile testing, where conditions are often impossible to duplicate and lost data can mean tens of thousands of dollars. In the air or on the ground, you can be *sure* when you use the CEC 5-119.



bench cabinet with all controls and gages conveniently located on the front panel. The portable, versatile instrument is suited for altitude test chambers, evacuation of tubes, and leak detection of mechanical and electrical components.



C-R-A-M UNIT widely versatile instrument

RADIO FREQUENCY LABORATORIES, INC., Boonton 3, N. J. Model 1051 C-R-A-M (calibrator-receiver-amplifier-mixer) is intended for use (1) as a secondary frequency standard of 0.0005-percent accuracy, (2) for the reception of standard time and frequency broadcasts from WWV, (3) as a moderate gain audio amplifier for general use, and (4) as a mixer to compare two external signals to each other or to compare one external signal to one of the harmonics or subharmonics of its 10-mc crystal oscillator.

The unit has a self-contained regulated power supply. Overall dimensions are 10 in. wide by 11 in. high by 9 in. deep. Weight is approximately 24 lb.

TANTALUM CAPACITOR featuring high stability

FANSTEEL METALLURGICAL CORP., Rectifier-Capacitor Division, North Chicago, Ill. Type STA tantalum capacitor has favorable characteristics over a temperature range from -70°C to $+85^{\circ}\text{C}$. From room temperature to -70°C , capacitance

then try
CEC's 5-119
recording
oscillograph



Also, the 5-119R, especially engineered for vertical installation. Effectively shock mounted, using little space, it's ideal for both stationary and mobile rack mounting... tilts forward easily for loading and adjustment.

The 5-119 records up to 50 channels on records 12"x250 ft at speeds from 0.1 to 100 inches per second. *Instant* speed change of 10:1 is effected through a simple switch control. It uses standard CEC Galvanometers, with linear frequency response from 0 to 3000 cps. All controls and warning lamps are located on the front panel.

*For complete information
about the 5-119 oscillograph,
write today for CEC 1536B-X3.*

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formerly Consolidated Engineering Corporation

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SMALLER AND LESS EXPENSIVE

The G-E Vac-u-Sel rectifier stack (in red) gives the same life, current capacity, and performance as the larger, ordinary selenium stack. Low-cost Vac-u-Sel rectifier stacks are ideal for such applications as coin-operated machines.

DESIGNED TO HELP YOU MEET PRICE COMPETITION . . .

G-E *Vac-u-Sel** Rectifiers Cost You Up to 30% Less

Here is a component rectifier stack that will out-perform ordinary selenium stacks, and yet cost you up to 30% less!

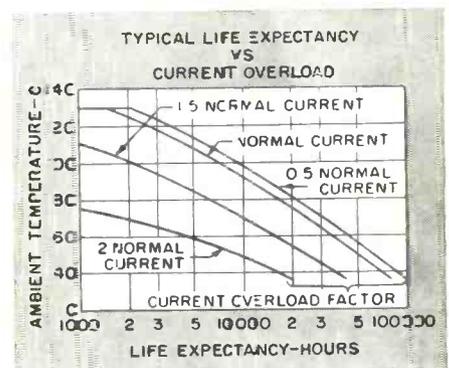
INITIAL COST IS OFTEN 30% LOWER: G-E Vac-u-Sel rectifiers can be made up to 30% smaller for any given application, due to the greater current-carrying capacity of the individual cells. Smaller size means a lower cost to you. These cells are produced by a unique G-E sphere-type vacuum-evaporation process that enables us to accurately predict the output and life characteristics of any model number. We are thus able to give you a stack with the exact life you require. You don't pay for more life than you need.

PICK THE LIFE YOU WANT: You can select a Vac-u-Sel rectifier that will last up

to 80,000 hours—or more. But if your application calls for shorter life, we can give you a smaller, less expensive stack, which operates at greater than normal-rated current. You will find that even when overrated these top-quality G-E Vac-u-Sel rectifier stacks will perform with greater predictability than ordinary selenium. So, by tailoring each stack to meet your exact requirements, you receive the benefit of top quality at lower cost.

Contact your G-E Apparatus Sales Office, or write for Bulletin GEA-6273 to: Section 461-41, General Electric Co., Schenectady 5, N. Y.

* Vac-u-Sel is a trade-mark of the General Electric Co. It designates top-quality selenium rectifier cells manufactured by a unique sphere-type vacuum-evaporation process by the Rectifier Department, Lynn, Mass., headquarters for silicon, germanium, selenium, and copper-oxide component rectifiers.



LONG LIFE is provided by G-E Vac-u-Sel rectifier stacks—even at high operating ambients and better than normal-rated current.

Progress Is Our Most Important Product

GENERAL  ELECTRIC



size: $1\frac{1}{4}'' \times 1\frac{1}{2}'' \times 2\frac{3}{8}''$
weight: less than 7 oz.

LOW-LEVEL MAGNETIC D. C. SIGNAL AMPLIFIER

*for thermocouple and strain gage
applications in telemetering systems*

RUGGED, ALL-MAGNETIC construction assures exceptional stability under the most severe conditions. No moving parts, no fragile elements. Unit withstands extreme vibration and shock without introducing spurious noise, and delivers reliable performance in high environmental temperatures. Produces 5 VDC output from 1 millivolt DC input, with exceedingly high gain stability. Used in all major aircraft and missile instrumentation projects as well as for temperature and strain measurements in industrial and medical applications.

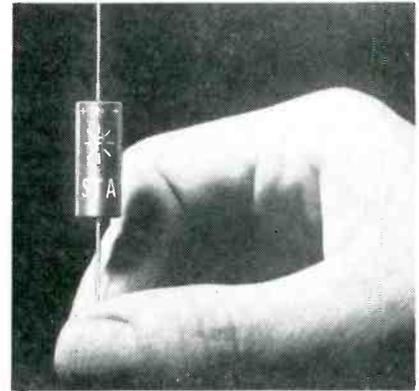
FEATURES

- Gain change of less than 2% for temperature change of 100° C.
- Gain change of less than 1/2% for line voltage changes from 105 to 125 volts.
- High DC voltage gain, ripple-free. 5 VDC output from 1 millivolt DC input.
- Responds only to DC; signal sensitivity 10-12 watts
- No pickup — no lead shielding required.
- All magnetic — maintenance-free.
- Response time 40 milliseconds.
- No tubes — no warm-up time, generates no heat.
- Power requirements less than 10 milliwatts.
- Temperature compensated control circuit.
- Hermetically sealed in thermosetting plastic.
- Magnetically shielded.
- Long life, extremely rugged and reliable.
- Operates from standard 400-cycle supply.

for further information, write for Bulletin EB-201-A

MAGNETIC RESEARCH CORP.
200 CENTER STREET • EL SEGUNDO, CALIFORNIA

*Mfrs. of Magnetic Amplifiers and Converters, Magnetically
Regulated DC Power Supplies, Magnetic Pulse Generators.*



and power factor are practically constant.

The capacitor will operate more satisfactorily at higher frequency than conventional electrolytic capacitors.

► **Makeup**—The new STA uses a porous sintered tantalum anode with an electromechanically formed tantalum oxide dielectric, which provides large capacitance in small pace with exceptional chemical and electrical stability.



ITV EQUIPMENT new remote control type

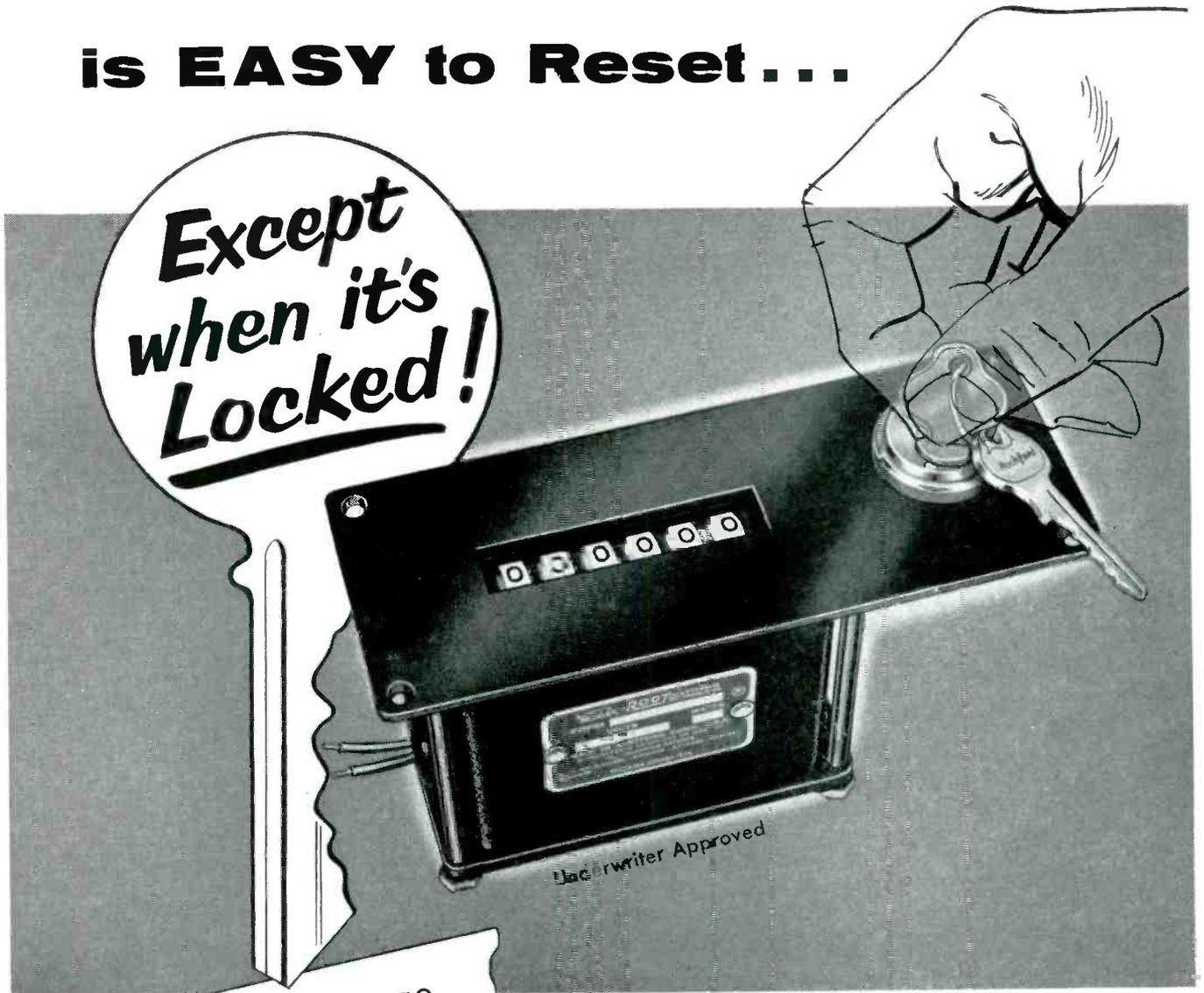
GENERAL PRECISION LABORATORY INC., Pleasantville, N. Y., has announced new remote control of its closed-circuit industrial and institutional equipment including camera, lens iris and focus, indoor and outdoor pan and tilt, and weatherproof housing.

► **Remote Operation** — The equipment is highly suitable for surveillance work and remote monitoring of operations. Full 360-deg camera viewing and 90-deg tilt are obtainable with both indoor and outdoor mountings.

Two restyled camera control

This **NEW** Magnetic Counter is **EASY** to Reset...

*Except
when it's
Locked!*



Added Evidence
that —

Everyone Can Count on **VEEDER-ROOT**

Designed for panel mounting where remote indication is required, this electrically operated counter is a compact package 5.5" long, 2.1" wide, 2.7" high. Capacity: 1,000 counts per minute. Power consumption, 8 watts. Stocked in 110 and 220 AC and DC. Easy to reset, except when locked . . . then the sturdy tumbler-lock* puts the damper on tampering. Yet one

turn of the key resets all 6 figures to zeros.

This new Magnetic Counter is one of the thousands of Veeder-Root standard and special counters . . . electrically, mechanically and manually operated . . . in daily use throughout the world in industry, business, science and medicine. You, too, can count on Veeder-Root . . . to help you count anything you need.

*National Lock Co. Lock No. 68-4837; Key D-428

Stocked at
Hartford 2, Conn. • New York 19, N. Y.
Greenville, S. C. • Chicago 6, Ill.
Montreal 2, Canada
Offices and Agents in Principal Cities

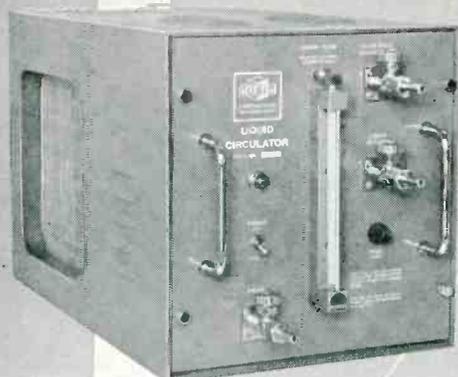


VEEDER-ROOT
"THE NAME THAT COUNTS"

MICROWAVE POWER MEASUREMENT FROM DEGREES...

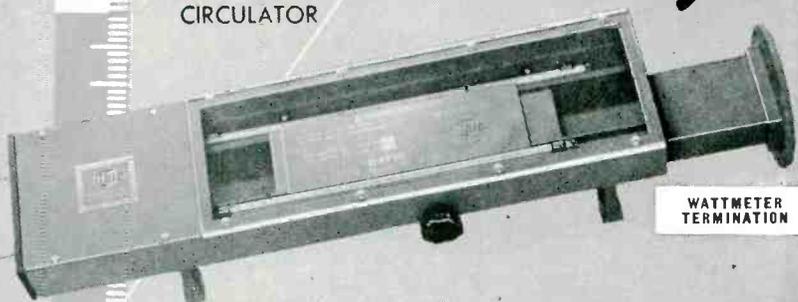
SPECIFICATIONS

Av. Power 0-600 watts
 Peak 600 KW
 VSWR 1.1 max.
 Freq. range
 Basic unit 2.6 to 3.95 kmc
 With Adapters 2.6 to 18.0 kmc



CIRCULATOR

...TO WATTS directly!



WATTMETER TERMINATION

CUBIC'S 2-UNIT CALORIMETRIC WATTMETERS

... for obtaining direct power readings in testing electronic equipment—without guessing!

Three of the world's largest producers of electronic equipment have recently made CUBIC Calorimetric Wattmeters standard test equipment in their laboratories and plants. For very good reason. No other instrument designed for power measurement gives you direct power readings... with such precision, and yet so simple in its application.

The model shown is the MC-1B for power measurement from 2600 to 26,500 MC. Also available are the models MCX-1A (coaxial type) for power measurement from 100 to 3000 MC, and MCL-1A (L-Band waveguide type) for power measurement from 1120 to 2600 MC.

Whether checking field equipment, developing or making acceptance tests on new equipment or magnetrons in the lab, or in production, one of CUBIC'S Calorimetric Wattmeters will be an invaluable addition to your test equipment. Standard laboratories calibrate secondary power devices, especially bridge type bolometer instruments. Exact calibration is provided month to month.

Write for more information, and ask for our catalog of other test equipment and waveguide components. Or if you have a problem in development or engineering, CUBIC offers the services of its engineering staff and facilities in its solution.

units, portable and wall-mounted, are also available with plug-in control panels which may be removed to provide remote operation of beam, focus, target, blanking and gain.

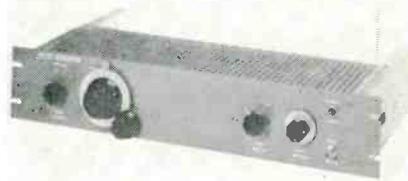


ELECTRICAL CABLE 200 percent expandable

UNITED CABLE CORP., Division of Mutual Electronic Industries Corp., Beechwood Ave., New Rochelle, N. Y., has announced Elasticable, an expandable electrical cable constructed of braided 21-strand conductor with a covering of rayon, nylon or rubber.

► Sizes—One to six conductors finished with spade terminals, alligator clips or jacks are available in stock sizes of 2, 3 or 4-ft relaxed lengths; other sizes to order.

Expansion is over 200 percent. Voltage insulation is 1,000; current twin conductor, 4 amperes. Prices of the cables are determined by length, quality of cover, number of conductors and type of terminal.



H-F PULSE GENERATOR designed for rack mounting

BURROUGHS CORP., 1209 Vine St., Philadelphia 7, Pa. The No. 1050 pulse generator is designed for

CUBIC CORPORATION ELECTRONIC EQUIPMENT RESEARCH...DEVELOPMENT
 2481 CANON STREET, SAN DIEGO, 6, CALIFORNIA



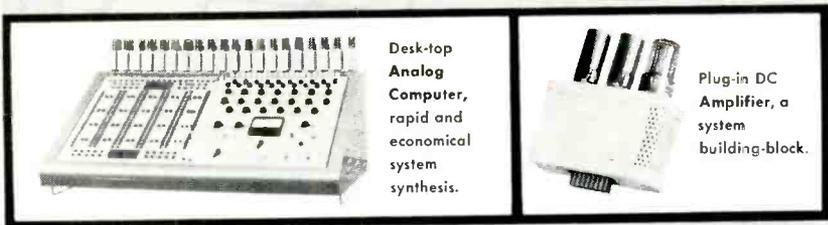
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***Ideas That Become
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You can expect intelligent solution of your design problems, with fast processing to finished product, when you use the completely integrated development and production facilities of Hall-Scott Electronics. Advanced electronic engineering, manufacture, and assembly—including precision sheet metal work—are all carried on under one roof in an ultra-modern plant. Hall-Scott laboratories include advanced condition, simulation, electrical and mechanical testing equipment. The shops are tooled for efficient production of the most complex electronic equipment.

You can also expect the same high standards that have made the name Hall-Scott synonymous with dependability in research and development for industry and government over the past 40 years.

No matter what your electronic project may be, write for complete information on how Hall-Scott Electronics can assist you...
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Desk-top
Analog
Computer,
rapid and
economical
system
synthesis.

Plug-in DC
Amplifier, a
system
building-block.

Work now in process includes Ground Control Components for Missiles, Sensing Devices, Electronic Analyzers, Transistorized Power Packages, Plug in DC Amplifiers, Pre-flight Test Equipment, and Analog Computers.



Hall-Scott Motors Company, Electronics Division

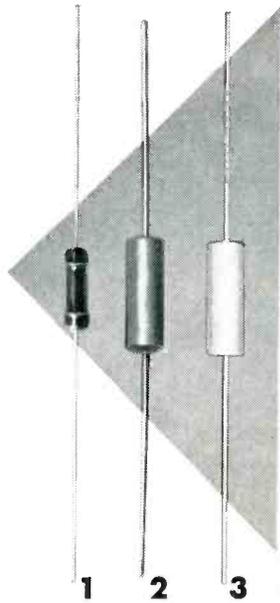
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7-3000

ELECTRA

Your Best Source For All Types of
DEPOSITED CARBON RESISTORS

1. Standard
2. Molded
3. Hermetically Sealed



Electra, a pioneer manufacturer, offers you a *complete line* of precision Deposited Carbon Resistors. Chances are your firm has modified its designs to specify deposited carbon resistors. No matter what your needs, you'll find the right resistor among the 16 physical sizes in Electra's complete line. Available in $\frac{1}{8}$ watt to 3 watt capacities and resistance ranges of 2 ohms to 50 megohms.

STANDARD

Manufactured to meet or exceed specification MIL-R-10509A, Electra's standard resistors offer you the largest capacity in the *smallest physical size*. Available in 8 sizes, this resistor gives you accuracy and stability plus Electra's improved, exclusive insulation at the *lowest possible cost*.

MOLDED

Give you every advantage of Electra's standard resistor, *and more!* Molded plastic case gives you *extra* mechanical protection, *longer* load life, *better* insulation against electrical shock and humidity. Meets or exceeds specification MIL-R-10509B (Proposed).

HERMETICALLY SEALED

Designed to meet the roughest, most rigid requirements. Sealed in impervious ceramic sleeve with special silver alloy solder. Maximum protection against rough handling, temperature extremes, humidity, exposure to chemicals. Meets or exceeds specification MIL-R-10509B (Proposed).

NEW PRODUCTS

(continued)

testing, information handling, and control wherever extra high frequencies are required. Output is $\frac{1}{2}$ sine wave pulse, with adjustable width from $0.03 \mu\text{sec}$ to $0.07 \mu\text{sec}$ in 5 bands. Frequency range is from 1.6 mc to 10.4 mc in 4 overlapping bands. The generator utilizes the same standard voltages as all other Burroughs pulse control equipment.

Designed for rack mounting, the unit measures 19 in. by $3\frac{1}{2}$ in. by 10 in. with amateur notches.



SENSITIVE RELAY features different design

STERLING ENGINEERING, Princeton, Ind., announces a new low-cost sensitive relay which, due to its unusual mechanical design, provides 15 percent more winding space than similar conventional design. Results are high contact pressures and high resistance to vibration.

► Specifications—Sensitivity is 40 mw; coil resistance, up to 22,000 ohms; operating shock, 25 g; vibration over 10 g, 10 to 60 cycles; weight, only $1\frac{1}{8}$ oz.

POTENTIOMETERS smaller size, lighter weight

THE GAMEWELL Co., Newton Upper Falls 64, Mass. Model RVG-14 is a $\frac{3}{8}$ in. diameter, $\frac{3}{4}$ oz precision potentiometer specifically designed to meet the increasing demand for smaller size and lighter weight with good linearity. It features dependable performance, particularly where severe vibrations and

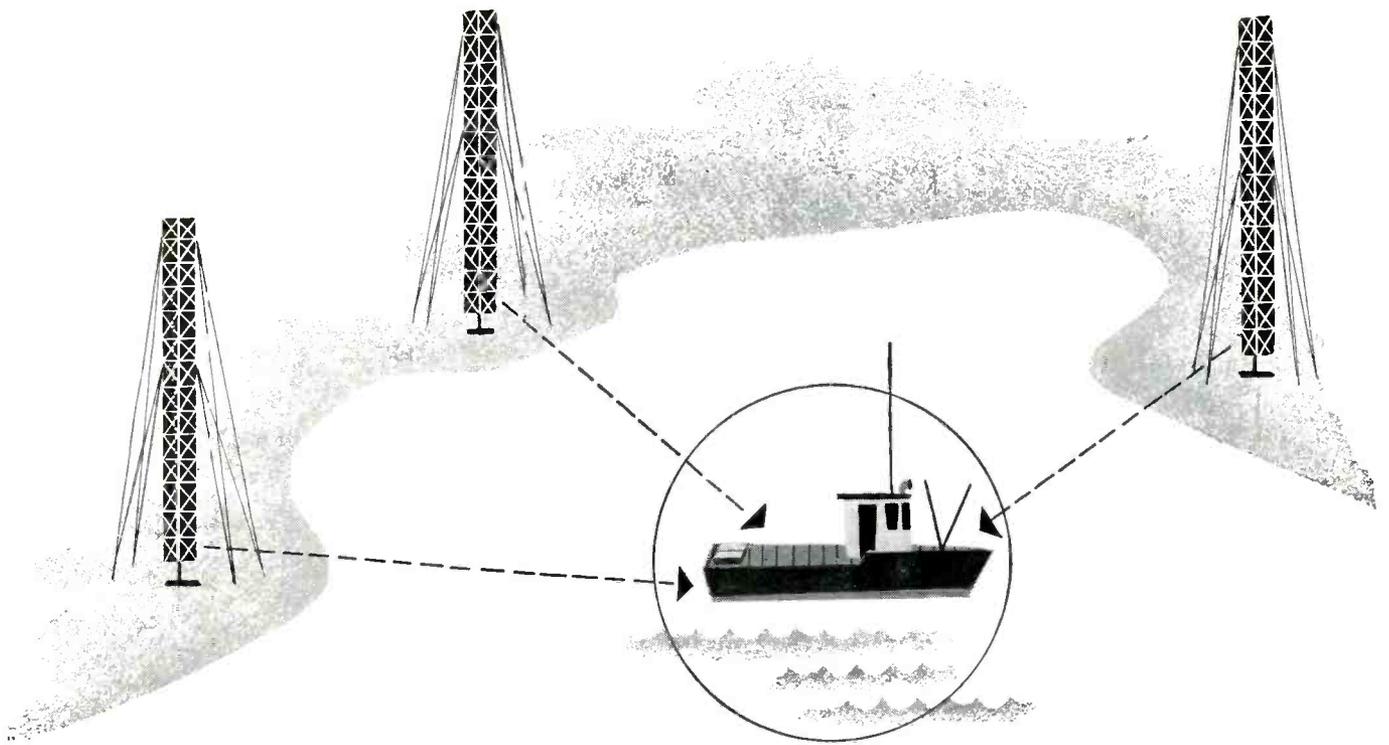
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**MANUFACTURING
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4051 Broadway WE 1-6864
Kansas City, Missouri

FILL OUT THIS COUPON TODAY!

Please send me the following catalog specification sheet(s).
Standard Bulletin 50 . . . Molded Bulletin 70 . . . Hermetically Sealed Bulletin 60 . . .

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how Transicoil servos help LORAC

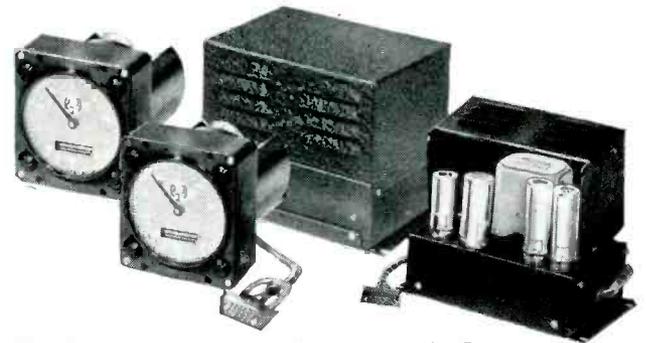
bring off-shore navigation to accuracies within yards

LORAC (LONg Range ACcuracy), one of the newest methods of close tolerance navigation, is now providing pin-point positioning for ships at sea, well away from land or other navigational markers. Developed by the Seismograph Service Corporation, this novel system compares the phase relationship of three sets of radio signals to fix position.

Lorac accuracy depends on the ship's receiver having laboratory type dependability and precision under extreme corrosive atmosphere and rough handling. Yet the servo phase resolver and indicator can spot position to within a matter of yards.

This all-important servo indicator-package was designed and built by Transicoil to meet the specific requirements of shipboard use.

When coupled to the electronic section of the receiver, this unit continuously measures the phases of the incoming signals by comparing the phase of the beat frequency with a modu-



The Transicoil servo assembly used in the Lorac receiver. Components include a 400 cycle oscillator supply for two indicators and two servo amplifiers. System is built on separate chassis to permit the indicators and amplifiers to be located in separate parts of the ship.

lated reference signal, and presents the position information on the counter-pointer type dial face.

The Lorac system is typical of the way in which Transicoil can solve your servo problems to bring new measures of accuracy and dependability. Transicoil will develop and manufacture a complete "package" servo system to conform to your individual requirements. You pay only for results—on a fixed fee basis for equipment delivered and functioning properly.

Write today for further information, outlining your servo problem.



TRANSICOIL CORPORATION
Worcester, Montgomery County · Pennsylvania

"PRINTED CIRCUIT OUTPUT UPPED *when we switched to HUNT R.C.E.*"

(RAPID CIRCUIT ETCH)

—the FASTEST ETCHING SOLUTION for PRINTED CIRCUITS

Here indeed is good news for all makers of etched printed circuits. Philip A. Hunt Company, world-famous makers of photographic and photo-engraving chemicals, now offers Hunt R.C.E. Solution, a special etching solution with these BIG advantages, guaranteed:

1. Controlled rapid etching speed, permitting standardization of a high production etching schedule
2. Instant and uniform etching over entire circuit
3. Maximum etching capacity
4. Full protection of tops

Contact your nearest Hunt branch, or write us at Palisades Park, N. J., today for full information on Hunt R.C.E. Solution.

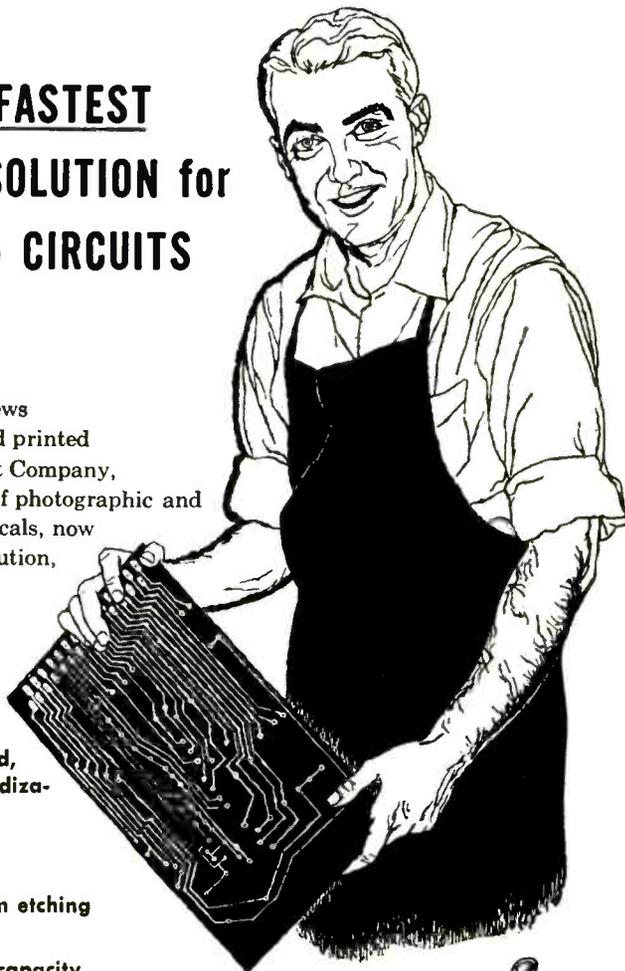
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Solution is
supplied in
145 lb. rubber
drums*



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NEW PRODUCTS

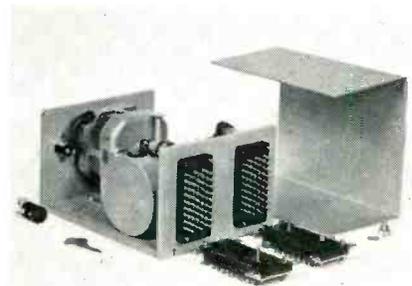
(continued)



high operating temperatures are encountered.

This metal-housed potentiometer is available in single as well as multigang construction, with sleeve or ball bearings.

► **Specifications**—Winding resistances from 25 to 45,000 ohms may be had with minimum resolution of 0.06 percent and optimum linearity of 0.25 percent where specified. Maximum continuous operating temperature is 150 C, and the units meet MIL-E-5272A specification as they apply.



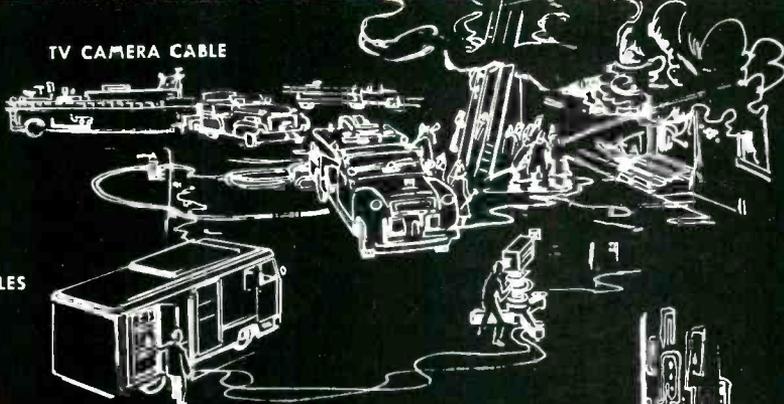
COMPENSATION SWITCH handles computer drift

THE APPLIED SCIENCE CORP OF PRINCETON, P. O. Box 44, Princeton, N. J. The new computer drift compensation switch is primarily for use in electronic analog computers to connect a single a-c compensating amplifier in sequence to a number of d-c computing amplifiers for zero drift or offset compensation. It may also be used in other applications where a rotary compensator of high quality is required.

► **Specifications**—The switch has two poles and is available with 60 or 80 make-before-break contacts per pole at sampling speeds ranging from 3.5 to 4 rps. The



BROADCAST AUDIO CABLES



TV CAMERA CABLE



TV TRANSMISSION WIRE



TV STUDIO CABLE



INTERCOM CABLE



SOUND SYSTEM CABLES



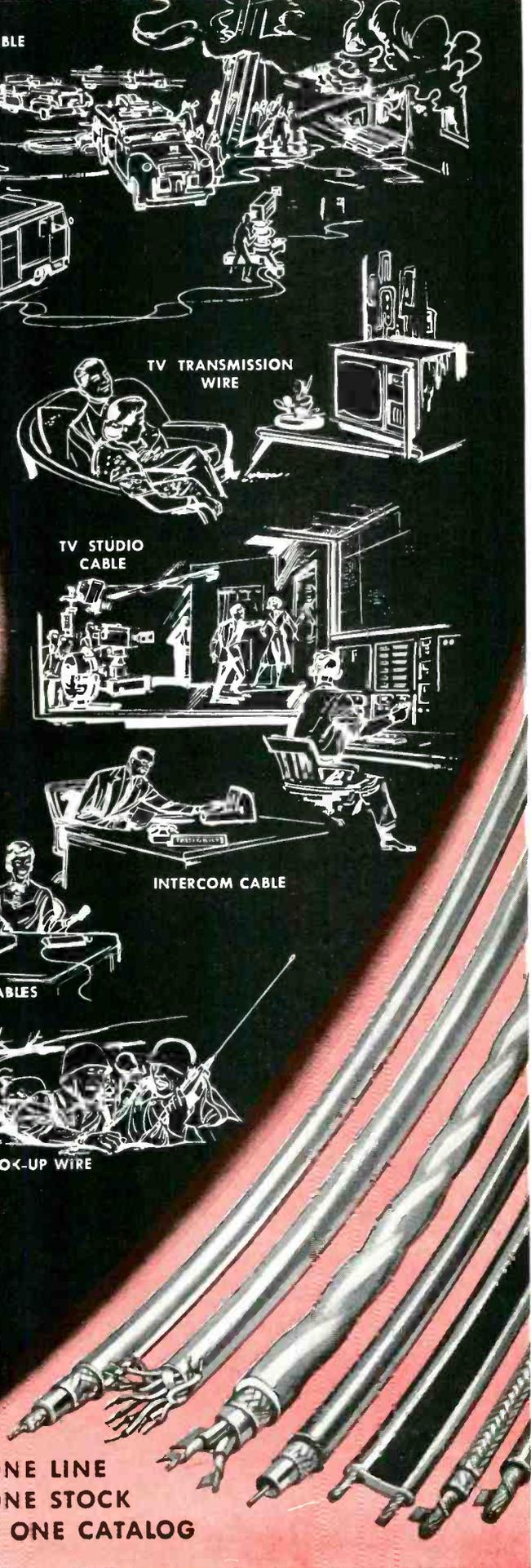
MAGNET WIRE—HOOK-UP WIRE

Belden

WIREMAKER FOR INDUSTRY
SINCE 1902



MICROPHONE CABLE



ONE LINE
ONE STOCK
ONE CATALOG

I-8

WHAT'S NEW AT BRISTOL...



BRISTOL'S SYNCROVERTER SWITCH is made to fit 7-pin miniature tube socket (left) or 3/8-in. diameter chassis hole (right). Covered by patents.

"Most reliable miniature chopper we've tested!"

That's the playback we're getting from electronic engineers all over the country on the high-performance Bristol Syncroverter® switch. One engineer writes:

"In seven years of experience in applying similar devices, we have not found a chopper as reliable . . . after our tests no deterioration in performance was found, and we believe there is no equivalent meeting our requirements."

Another electronics engineer comments on his life-tests:

"The switch has passed the 1000-hour mark without the slightest degradation of the wave form."

The Syncroverter switch has a normal *operating life of thousands of hours*. It's a polarized, SPDT, non-resonant switch that provides break-before-make action in synchronism with a sine or square-wave driving current anywhere in the frequency range of 0 to 2000 cps. In addition to reliability and long life, it's noted for light weight (only 1.7 ounces) low noise level, and clean wave form.

Write today for free bulletin on the high-performance Syncroverter switch. The Bristol Company, 152 Bristol Road, Waterbury 20, Conn. 6.10

TYPICAL OPERATION

	400 cps	500 cps
Coil voltage	6.3V sine, square, pulse wave	6.3V sine, square, pulse wave
Coil current	55 milliamperes	45 milliamperes
Coil resistance	85 ohms	85 ohms
*Phase lag	55° ± 10°	65° ± 10°
*Dissymmetry	less than 4%	less than 4%
Temperature	-55°C to 100°C	-55°C to 100°C
*Switching time	15° ± 5°	15° ± 5°

Mounting—Any position—fits 7-pin miniature socket

*These characteristics based on sine wave excitation

BRISTOL FINE PRECISION INSTRUMENTS
FOR OVER 60 YEARS

phasing between poles is adjustable. This switch is 5½ in. long by 7 in. wide by 4½ in. high and weighs approximately 9½ lb.



SILICON DIODE for X-band mixer use

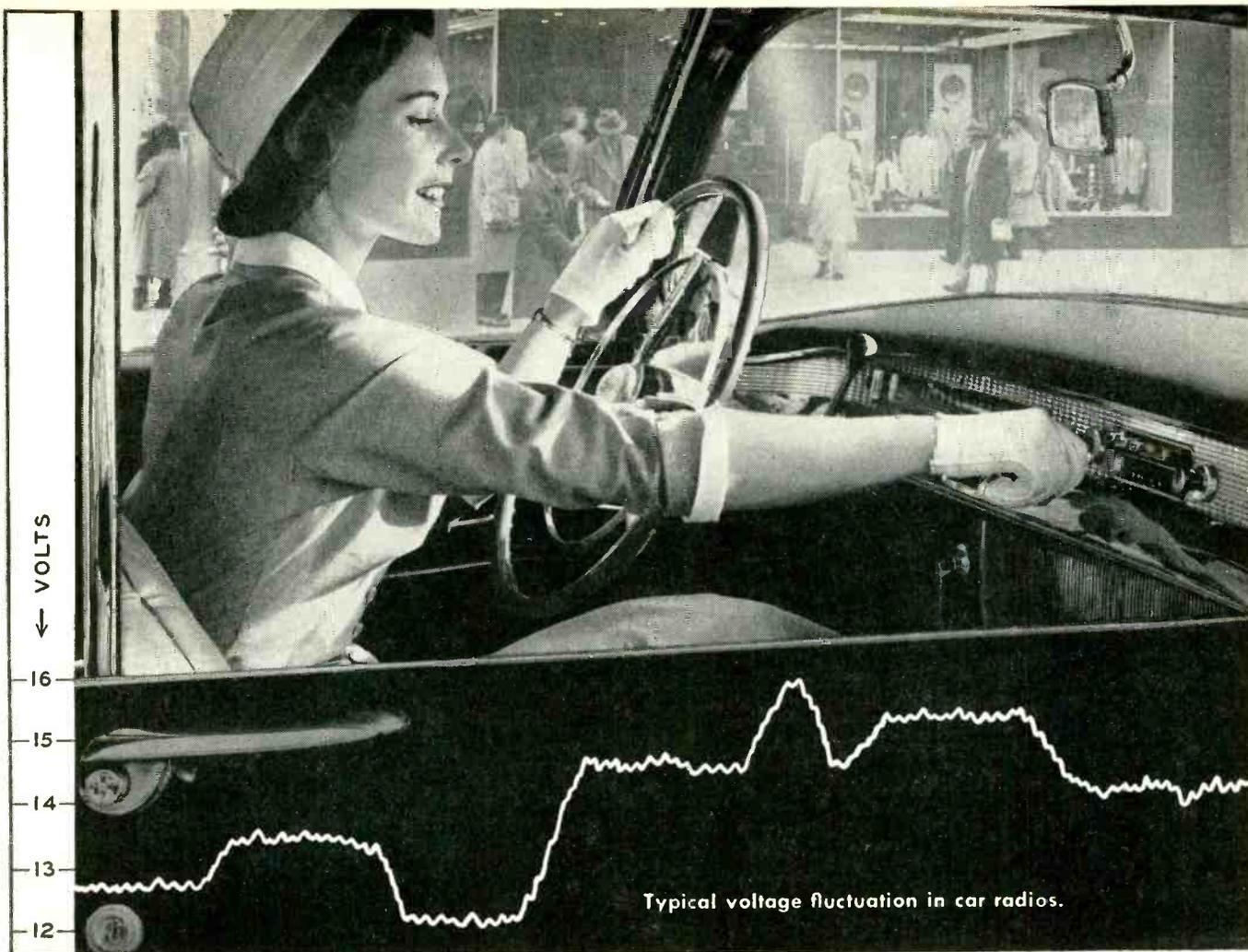
BOMAC LABORATORIES INC., Beverly, Mass. The 1N23D high sensitivity silicon diode can lower the overall system noise down to 7.5 db in a system with well-designed plumbing. It is designed for X-band mixer use in superheterodyne receivers where low overall noise and minimum conversion loss are required. These characteristics enable the systems engineer to design for both maximum receiver sensitivity and maximum output signal to noise ratio.

► **Other Uses**—With proper mounting and circuitry these diodes may also serve as low-level detectors and measuring devices in the X-band region.

Both normal and reversed polarity are available.

DUAL D-C SOURCE for transistor biasing

ELECTRONIC RESEARCH ASSOCIATES, INC., 67 E. Center St., Nutley, N. J. Model 310 is a regulated dual output high current tubeless supply specially designed to power both high and low-current transistors. Other applications include computer magnetic memory devices, d-c filament supply, solenoid and magnetic-clutch operation, and all types of regulated, d-c high-current lab-



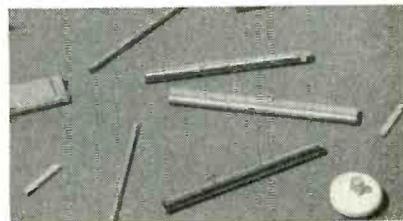
FOUND: a Cathode alloy that prolongs tube life under fluctuating voltage

CATHALLOY* A-31 IDEAL FOR CAR RADIO TUBES. This discovery was made in actual car radio installations. Heater supply voltages were found to vary up to 25% above specification. And the tubes using Superior's new Cathaloy A-31† consistently outlasted others.

These findings prompted car radio manufacturers to insist on longer-life tubes in car radio service. Specifications stipulate several hundred hours at approximately 25% overvoltage. No cathode alloy can match Superior's Cathaloy A-31 in meeting these requirements.

OTHER ADVANTAGES. Cathaloy A-31, with its 4% tungsten, is probably the strongest cathode material at high temperatures that is commercially available today. Hence it qualifies especially for use in ruggedized tubes. In addition, its special composition reduces the twin problems of sublimation and interface impedance.

SEND FOR FREE CATALOG. Contains complete technical information on Cathaloy A-31 and other cathode alloys and on electronic tubular parts. Write Superior Tube Co., 2500 Germantown Ave., Norristown, Pa.

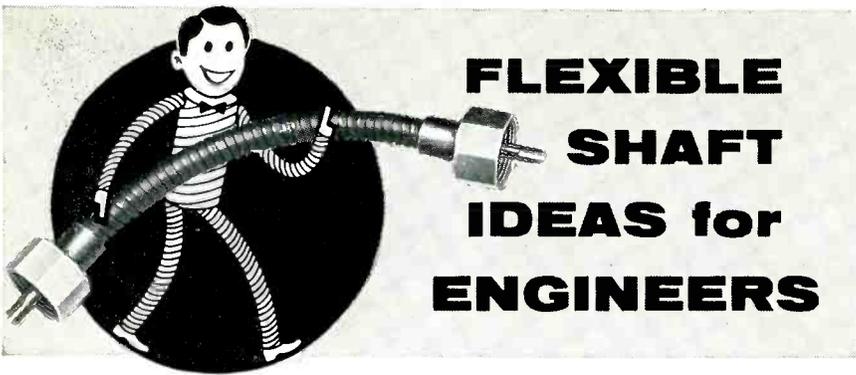


Cathodes made from A-31 are available in Weldrawn, Lockseam † and disc cathodes.*

*T.M. Reg. U.S. Pat. Off., Superior Tube Co.
†Manufactured under U.S. patents.

Superior Tube

The big name in small tubing
NORRISTOWN, PA.



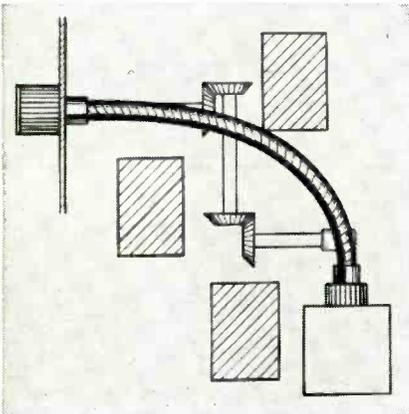
One part does the work of many when you use a flexible shaft

Design simplification is one of the reasons why it pays to use S.S.White "Metal Muscles"®

IT'S A DESIGNER'S AXIOM that simplification is one of the most effective ways of reducing product costs. By so doing, you save weight, you eliminate a number of unnecessary parts and you reduce assembly time and costs.

Eliminating Parts

When it's a question of transmitting rotary power or providing remote control, especially where turns or alignment are involved, an S.S. White flexible shaft is an efficient cost-saving solution. The illustration below demonstrates why this is so.



One flexible shaft is all it takes to do a job that might otherwise require an entire system of bevel gears, straight shafts, universals, etc. Added to this is the fact that installation is greatly simplified and alignment problems are eliminated.

F6-2

S.S. White **FIRST NAME**
IN FLEXIBLE SHAFTS

S. S. WHITE INDUSTRIAL DIVISION, DEPT. E, 10 EAST 40th ST., NEW YORK 16, N. Y.
Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

90% Cost Reduction

Actual cost figures on a control set-up for a large dual hydraulic power system dramatize how effectively flexible shaft simplification can cut costs.

In this case, 35 parts including universal rods and bevel geared elbows were being used to transmit control from two handwheels to a motor control unit and thence to two hydraulic motors.

Without any necessity of redesigning the equipment, 4 standard S.S. White flexible shafts were used in place of the original control system. The result was a 90% savings — and, incidentally, 100% improved performance.

What About Your Application?

Perhaps your own designs cannot realize benefits as outstanding as this. But the chances are good indeed, that, if you are not now using them, you'll be able to handle many remote control and power drive applications better and at less cost with an S.S. White flexible shaft.

USEFUL FLEXIBLE SHAFT DATA

Bulletin 5601 has concise information on how to select and apply flexible shafts. Send for a copy.



laboratory and industrial power requirements.

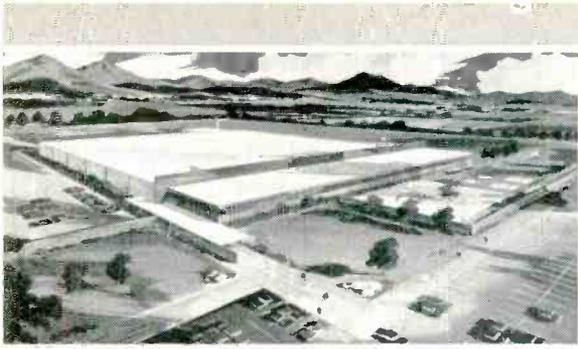
► **Specifications**—The supply operates from a 95-125 v a-c, 60-cps source. Either output can provide singly or simultaneously 0-30 v d-c at a maximum current of 1.5 amperes. Ripple is less than 0.05 percent. Input regulation is better than ± 1 percent, and the internal d-c resistance is less than 3 ohms. The shunt a-c impedance is less than 0.02 ohm at 60 cps. In addition to the d-c outputs, line regulated a-c output 0-130 v a-c is also provided.



INDICATOR LIGHTS two-terminal subminiatures

HETHERINGTON INC., Sharon Hill, Pa., has announced fully insulated, two-terminal indicator or warning lights in the smallest sizes consistent with the dependability required for aviation and critical industrial applications. They are available in two basic styles—series L660, a subminiature design measuring $1\frac{1}{8}$ in. long by $\frac{3}{8}$ in. in diameter; and the L-3200, $1\frac{1}{2}$ in. long by $\frac{1}{2}$ in. in diameter with a built-in press-to-test circuit for ultracritical warning light applications. The lamp circuit is fully insulated from the case in both types.

Miniature AN-3140 lamps are mounted deep inside a long plastic lens. An inside leveling of the lens serves to pipe the light



Denver manufacturing plant now under design



Infrared laboratory



Instrumentation laboratory

At Ramo-Wooldridge today there exists a wide range of projects intended to aid aircraft in navigating to the vicinity of targets, finding the targets, destroying them, and returning safely to base. Work is under way in such fields as infrared and microwave detection, information display, communication and navigation, and analog and digital computing. Some projects are in the laboratory development stage, some in the flight test stage, some in pilot production.

Good progress is being made in the establishment of facilities and operational patterns that are well tailored to the unique requirements of advanced electronic systems work.

AIRBORNE ELECTRONICS AND WEAPON CONTROL SYSTEMS



Initial unit of flight test facility



Communications pilot line production



Simulators in computing center

Positions are available for scientists and engineers in these fields of current activity:

- Communications Systems
- Digital Computers and Control Systems
- Airborne Electronic and Control Systems
- Electronic Instrumentation and Test Equipment
- Guided Missile Research and Development
- Automation and Data Processing
- Basic Electronic and Aeronautical Research

The Ramo-Wooldridge Corporation

5730 ARBOR VITAE STREET LOS ANGELES 45, CALIFORNIA

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

BuAir—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-A SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA • Hollywood 4-9294

throughout the entire periphery, thereby assuring maximum visibility from all angles. The heavy lens is over 1/2 in. long so the lights may be used equally well with either standard or edge-lit panels.



HEAT EXCHANGER used in liquid circuits

ROTRON MFG. Co., Schoonmaker Lane, Woodstock, N. Y. Recommended for use in closed-system liquid circuits, the model A heat exchanger has 3-kw capacity and finds application in radio transmitters, oscillators, dielectric heating apparatus, and similar devices incorporating liquid-cooled vacuum tubes.

► **Capacities**—The exchanger, weighing 12 lb, is available in either type 1-3000 having liquid flow capacity of 4 gpm or type 2-3000 having liquid flow capacity of 8 gpm. Heat capacity is the same for each type.

The fan motor is of the shaded-pole type and connects to a 1-phase, 115-v, 60-cps supply line. Catalog sheet 80201-1 is available.

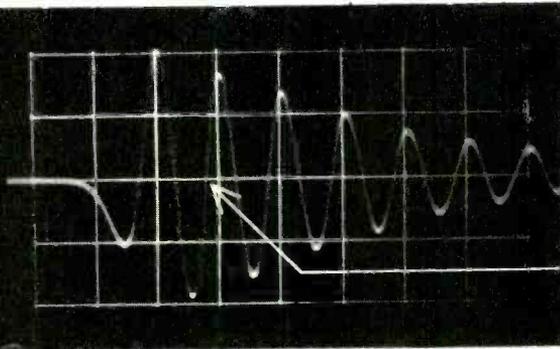
CONTROLLED WARMUP TUBES feature high perveance

GENERAL ELECTRIC Co., Schenectady 5, N. Y. A new horizontal deflection amplifier tube, the 12DQ6, has been added to the company's line of 600-ma controlled warmup tubes. Also now available is the 6-v version, the 6DQ6.

Both tubes have extremely high perveance, permitting the design of



1100-cm/ μ sec writing rate!



Arrow indicates 1100-cm/ μ sec writing-rate point on 100-mc damped oscillation, displayed on single 0.01 μ sec/cm sweep of Type 517A Oscilloscope with T54P11H crt. Recorded on 35-mm TRI-X film at f 1.9 with 4.2 to 1 reduction, developed 26 minutes in D-19 at 68° F.

The Tektronix Type 517A Cathode-Ray Oscilloscope has the high writing rate, faithful transient response, fast sweeps, and dependable stability necessary for accurate analysis of single high-speed occurrences. Improvements in several performance areas, made possible by the development of a new Tektronix high-voltage cathode-ray tube, make the Type 517A even more useful than its famous predecessor, the Type 517. Sensitivity of the Type 517A is double that of the Type 517, both sweep and vertical linearity are improved, and the viewing area is increased to a full 4 cm by 8 cm. An automatic duty-cycle limiter prevents accidental damage to sweep-circuit components. The exceptional performance characteristics and accurate display of the Type 517A can speed up progress in work involving high-speed transients.

Price \$3500

f.o.b. Portland (Beaverton), Oregon

Includes indicator unit, power-supply unit, scope-mobile, cathode-follower probe, 7-step attenuator unit, viewing hood, bezel, 170-ohm cable.

Complete specifications and information on demonstration schedules are available from your local Tektronix Field Office or Representative, or from...

Tektronix, Inc.

P. O. BOX 831, PORTLAND 7, OREGON
Cypress 2-2611 • Cable: TEKTRONIX

Transient Response — Risetime seven millimicroseconds. No overshoot or ringing.

Maximum Sensitivity — 0.05 v/cm.

Sweep Range — Eleven calibrated sweeps from 0.01 μ sec/cm to 20 μ sec/cm. Each can be adjusted to the accuracy of an external standard.

Regulated Accelerating Potential — 24 kv on T54P11H Tektronix metallized precision cathode-ray tube.

Low Displacement Error — Less than 1% of 8 cm horizontal, less than 2% of 2 cm vertical.

Rate Generator — 15 to 15,000 cycles, accurate within 5% of full scale.

Amplitude Calibrator — Pulse-type, accurate within 4% of full scale.

Regulation — All dc supplies electronically regulated. Indicator-unit heater voltages regulated.

Calibrated Horizontal-Position Vernier



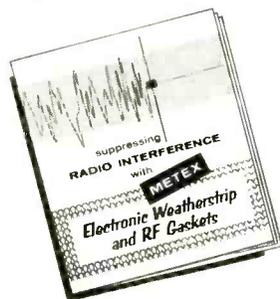
Where dependability is vital...

METEX RF SHIELDING CONTROLS RADIO NOISE!

In radar systems — as in all types of noise-sensitive electronic devices — more and more design engineers are turning to METEX RF Shielding Products as the most practical and effective method of suppressing radio noise.

METEX Shielding Materials are formed from *knitted*, metallic wire for maximum *conductivity*. The inherent *resiliency* of the knitted structure provides a continuous line contact between imperfect mating surfaces with minimum contact impedance. The countless, interlocked loops, formed from continuous wire strands, impart maximum *cohesion* with no loose strands or frayed fibres.

This unique combination of electrical and mechanical properties not only re-establishes electrical conductivity across joints, but conforms to wide irregularities in mating surfaces with minimum closing pressure.



METEX Electronic Weatherstrip, RF Gaskets and Combination Fluid and RF Sealing Gaskets are available in a wide variety of types and sizes to solve your RF noise problems. Write for full information *today!*

Send for your copy of this fact-filled METEX Handbook NOW!

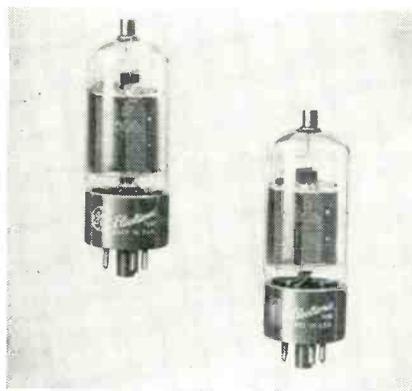
ELECTRONICS DIVISION

METAL TEXTILE CORP.
ROSELLE • NEW JERSEY

6-063

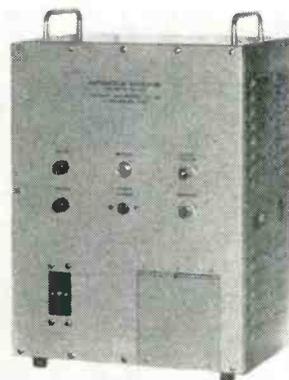
NEW PRODUCTS

(continued)



high-efficiency 90-deg deflection systems without the necessity of using an expensive deflection amplifier tube.

► **Other Technical Data**—They incorporate 6,000-v pulse capability, a 15-w dissipation rating and a large bulb for increased reliability. The 6DQ6 heater is rated at 6.3 v and 1.2 amperes. The 12DQ6 has a 12.6-v rating at 600-ma current with an 11-sec warmup time.



A-C REGULATOR dual-voltage automatic type

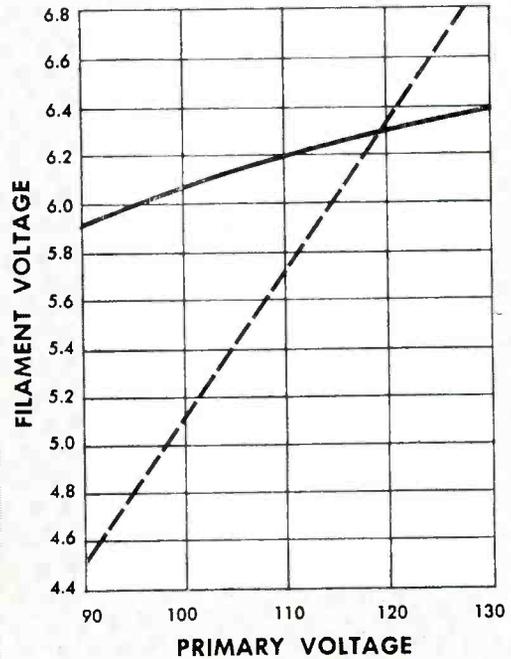
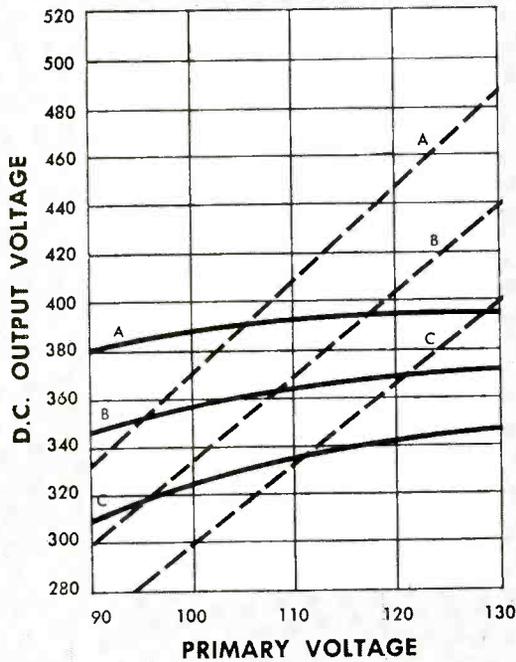
ELECTRONIC MEASUREMENTS Co., Lewis St., Eatontown, N. J. Model 260-A automatic a-c regulator operates for either 115 or 230-v mains without derating. Voltage change-over is accomplished in the field by simple switching devices requiring only seconds to operate.

► **Specifications**—The control tolerance is better than 1 percent; and power rating is 6 kva, and input range is 100 to 130 or 200 to 260 v at line frequencies from 47 to 63 cycles.

The unit also features a monitor which warns of improper operation plus a fail-safe arrangement to prevent over-voltage. Wall or floor-

A: 50% Load
 B: 100% Load
 C: 150% Load

———— SOLA CONSTANT VOLTAGE TRANSFORMER
 - - - - CONVENTIONAL POWER TRANSFORMER



These curves contrast the plate and filament supply voltages obtained from a Sola and a conventional power transformer when line voltage is varied from 100v to 130v.

Improve Performance of electronic products with built-in regulating power transformer

You can make sure your product will always receive correct plate and filament voltages by building in a Sola Constant Voltage Power Transformer (Type CVE) in place of a conventional, non-regulating power transformer.

The Sola CVE provides $\pm 3\%$ regulation of plate and filament supply, with line voltage variations of 100 to 130 volts. Regulation is completely automatic, continuous and substantially instantaneous (1.5 cycles or less). Sola CVE stabilizers have no moving parts or tubes, require no manual adjustments or maintenance, and are self-protecting against short circuits.

Three stock units (all with high voltage ct, 5.0v and 6.3v regulated windings) are stocked by your electronic distributor. You can order production quantities of special units manufactured to your specification. We invite your inquiry.

TYPICAL STOCK UNIT: Sola Electronic Power Transformers are made for chassis mounting. They are furnished complete with separate capacitors and capacitor mounting brackets.



Automatic, Maintenance-Free Voltage Stabilization

SOLA *Constant Voltage* TRANSFORMERS



SEND FOR FOLDER:
 Please write for folder which gives complete data.
 Ask for **CIRCULAR 7D-CVE-195**

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • **LIGHTING TRANSFORMERS** for All Types of Fluorescent and Mercury Vapor Lamps. • **SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Blshop 2-1414** • **NEW YORK 35: 103 E. 125th St., TRafalgar 6-6464** • **PHILADELPHIA: Commercial Trust Bldg., Rittenhouse 6-4988** • **BOSTON: 272 Centre Street, Newton 58, Mass., Bigelow 4-3354** • **CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400** • **KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382** • **LOS ANGELES 23: 3138 E. Olympic Blvd., ANgelus 9-9431** • **TORONTO 17, ONTARIO: 102 Laird Drive, Mayfair 4554** • *Representatives in Other Principal Cities*

potter

AC DRAWN OVAL Capacitors

For Air Conditioning, Refrigeration, Fan Motors, etc.



236, 330 or 440 volts, 60 cycles, A.C.

...save space, weight and cost!

LEAK PROOF CONSTRUCTION:

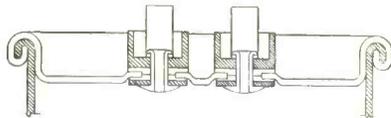
Cases are seamless, and tops (see drawing) are joined to cases via a double-rolled seam which provides not only a perfect and permanent seal but also incorporates exceptional mechanical strength. No solder is needed or used.

SPECIAL IMPREGNANT:

Cases are filled with Chlorinated Diphenol Resin—an impregnant which is non-flammable and has high dielectric qualities. It has exceptional stability and long life, even at high operating temperatures.

CHOICE OF TERMINALS:

Three types of terminals, (see illustration) to fit your particular needs—speed connecting time whether you prefer mechanically joined or soldered leads.

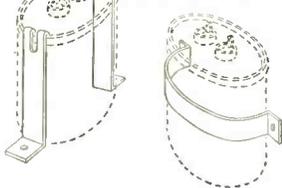


WIDE RANGE OF SIZES:

Available for 236, 330 and 440 volts A.C., 60 cycles. Conventional or barrier type terminal mounting. Two types of mounting brackets.

Write for Bulletin 237 A

MOUNTING BRACKETS FOR THE
AC DRAWN OVAL
CAPACITORS



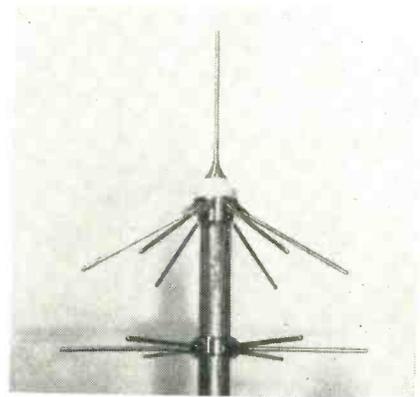
THE potter COMPANY

Specialists in Fixed Paper Capacitors Since 1925
1950 SHERIDAN ROAD, NORTH CHICAGO, ILL.

NEW PRODUCTS

(continued)

mounted it is 18½ in. high by 13 in. wide by 8¾ in. deep overall. A rack unit is also available having dimensions of 19 in. by 8¾ in. by 13 in. deep. The weight is 90 lb.



NEW ANTENNA for communications purposes

THE HERB KRECKMAN ANTENNA Co., 124 Greenwood Drive, Massapequa, N. Y., announces a new series of communications antenna designed to mount directly on 1½ in. support pipe. The DGP-155 is an all-brass duo-ground plane which has 6 radials for improved impedance to frequency characteristics.

Also in the new series are coaxial, co-plane and a 4-element stacked coaxial for the 108 to 470-mc range; and coaxial, co-plane, ground plane and duo-ground planes for the 25 to 50-mc range.

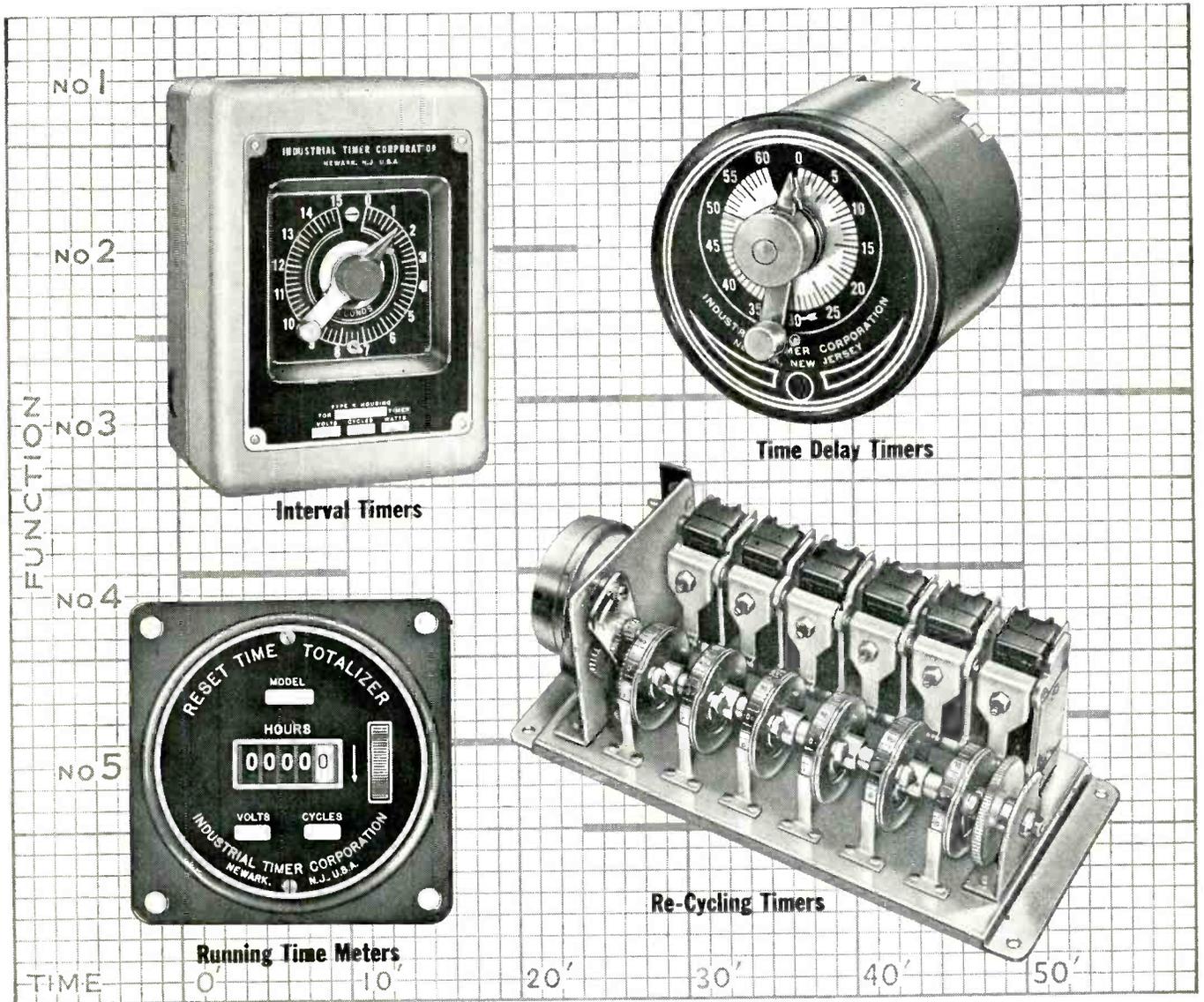
At 40 mc the new series of coaxials and ground-planes will withstand winds in excess of 100 mph.

SECONDARY STANDARDS available in 38 ranges

PHAOSTRON INSTRUMENT AND ELECTRONIC Co., 151 Pasadena Ave., South Pasadena, Calif. A new line of completely self-contained, ready-to-use, portable laboratory instruments (secondary standards) are available in 38 standard ranges. Rated accuracy is either 0.5 percent or 1 percent of full scale deflection. An incorporated overload network provides meter protection up to 500 times full scale value for short periods.

► Switch—Multirange portable instruments are available which pro-

YOUR "SPECIAL" TIMER may be one of our 721 STANDARD UNITS!



We have 20 years of experience in developing new timers to meet our customers' widely varying requirements. Our Engineering Department not only originates new designs, but also develops modifications for that purpose. That's why most requests for special timers can be filled without delay—by one of the 721 combinations we've developed so far from our 17 basic types of timers. But if we don't have what you want on hand, we'll welcome the chance to design and make it for you! And quickly too!

We manufacture a complete line of timers in these 4 broad classifications:

**INTERVAL TIMERS • TIME DELAY TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS**

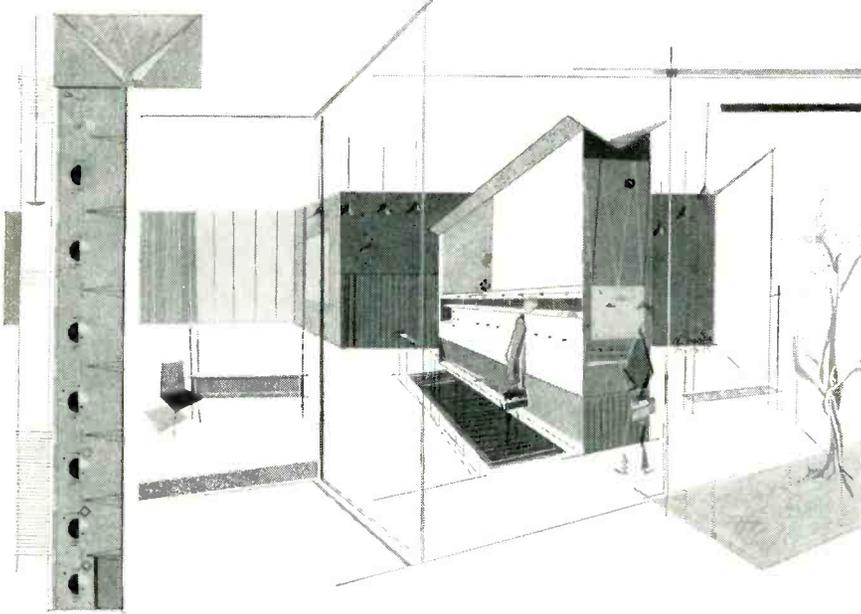
Our large stock assures you of rapid deliveries—even when we have to create a brand new timer for your special needs. Ask us first—you may save yourself much lost motion...and your inquiry will receive prompt attention.

*Timers that Control
the Pulse Beat of Industry*



INDUSTRIAL TIMER CORPORATION

1409 McCARTER HIGHWAY, NEWARK 4, N. J.



chef-less restaurant

This concept of Sue Vanderbilt, Pratt industrial-design graduate now designing GM auto interiors, would assemble a whole meal and cook it by microwave in a few seconds. Customer would merely check picture menu, insert money, push buttons. By the time he reached the far end of the counter the meal would be waiting, piping hot. All components already exist.

Many designs that will make news tomorrow are still in the "bright idea" stage today. No one knows which 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, EXEXB 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.
HACKENSACK, NEW JERSEY

at all good engineering and drawing material suppliers



vide up to 6 ranges with a multiplier switch. This switch also protects the meter movement when set in transit position by damping the meter movement and thereby giving additional protection during storage and transit.

Specifications, including leather carrying case, are: height, 7½ in.; width, 6½ in.; and depth, 3¼ in.



H-V RECTIFIER TUBE cuts tv manufacturing costs

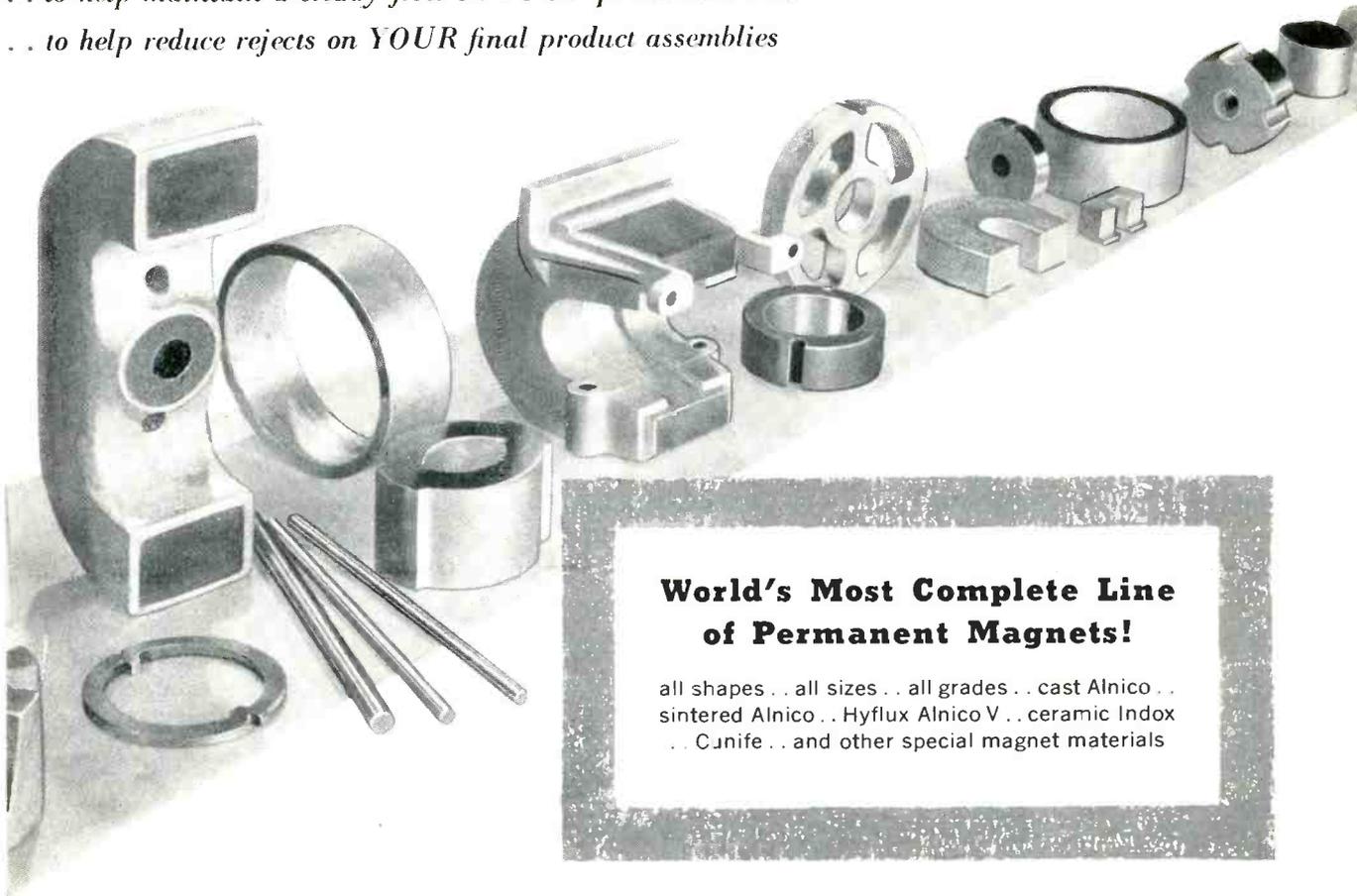
GENERAL ELECTRIC Co., Schenectady 5, N. Y. The 2B3-GT h-v rectifier tube promises to cut tv set manufacturing costs and give longer life.

► **Specifications**—It has a filament rating of 1.75 v at 0.25 ampere as compared with the 1.25-v and 0.2-ampere rating of the 1B3-GT. The tube can be operated directly from the flyback transformer without a filament dropping resistor—thus saving the manufacturer the cost of the resistor, associated wiring and assembly expense.

The 2B3-GT has a new type of filament construction which promises to give longer life and greater

Indiana Permanent Magnets undergo **13** quality and uniformity tests!

.. to help maintain a steady flow on YOUR production line
.. to help reduce rejects on YOUR final product assemblies



World's Most Complete Line of Permanent Magnets!

all shapes .. all sizes .. all grades .. cast Alnico ..
sintered Alnico .. Hyflux Alnico V .. ceramic Indox
.. Cunife .. and other special magnet materials

Yes, Indiana Permanent Magnets undergo a wide range of tests .. Spectrograph tests .. chemical analyses .. Zygo tests .. 13 tests in all to assure precise magnetic characteristics, sound structure, exact physical dimensions .. in short, to assure uniformity and high quality.

Maintaining the high quality of Indiana Permanent Magnets is not just a one-man or one-department responsibility. Teams of physicists, engineers, technicians and experienced craftsmen supervise and keep a constantly critical eye on all stages of production. Quality control is this group's most important single job .. by far!

To be sure of better permanent magnets, take advantage of the experience of permanent magnet specialists. Indiana maintains the World's largest staff of engineers devoted solely to the design and application of permanent magnets .. the World's largest and most complete research and production facilities.

Indiana engineers, with almost a half century of experience in "tailoring" permanent magnets for more than 35,000 designs, will welcome the opportunity to work with your technical men in the development of your permanent magnet designs.

We invite you to contact your nearest Indiana sales engineer .. in Boston, HANcock 6-2323 .. in Chicago, FRanklin 2-1114 .. in Cleveland, CHerry 1-4163 .. in New York, VANDerbilt 6-1898 .. in Los Angeles, DUNkirk 4-0465 .. in Philadelphia, KINGSley 5-2036 .. in Rochester, HAMILton 8990.

Write, today, for your copy of magnet catalog #11-A4. This 8-page booklet details the wide range of Indiana cast permanent magnets available for immediate delivery in sample quantities.

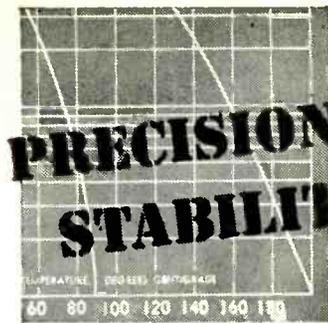


.. Manufacturers of permanent magnets for the electronics,
electrical, instrument and communications industries

THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA

World's Largest Manufacturer of Permanent Magnets

**INDIANA
PERMANENT
MAGNETS**



Signposts of Quality that make F.C.I. Capacitors ideal for exacting applications.



POLYSTYRENE and TEFLON CAPACITORS

For applications where the ultimate in low power factor, low saakage, high IR, and high capacitance stability are of vital importance. Voltage ranges from 100 V up; operating temperatures to 85° C for Polystyrene; to 200° C for Teflon.



ADJUSTABLE CAPACITORS

Designed for circuits requiring large capacitances at close tolerance. They provide instantaneous capacitance changes without subsequent drift. Adjustments can be made within ±1.5% of nominal value. Non-inductive windings minimize power factor and soakage. Electrical characteristics same as fixed polystyrene capacitors.



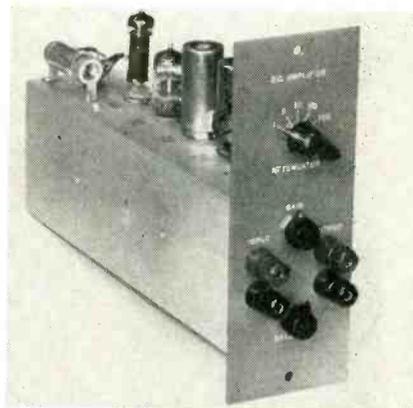
HIGH VOLTAGE CAPACITORS

Employ a "high-breakdown" plastic film producing capacitors remarkably smaller and lighter than previously available. Operation at temperatures to 125° C, with voltages from 2 to 60 KV. Hermetic glass tube housings with wire leads or threaded stud mountings.



MINIATURE CERAMIC CAPACITORS

Mylar* dielectric capacitors housed in ceramic jackets with thermosetting plastic end fill. Specially impregnated to minimize temperature coefficient. Insulation resistance is maintained under the most severe conditions of temperature and humidity. *Du Pont trademark



D-C AMPLIFIER for lab and portable use

THE RALPH M. PARSONS Co., 135 W. Dayton St., Pasadena, Calif., has designed a d-c amplifier to meet the exacting requirements of data recording in both laboratory and portable applications. Gain is adjustable to a maximum of 400 with drift not exceeding 2 in. in any half-hour period.

The amplifier is free of oscillations regardless of the gain balance or compensator setting. A control is provided to compensate for the response characteristics of the recorder which may be used. Any standard pen or graphic recorder may be used.

For further information write for bulletin 119.

ELECTRICAL CHARACTERISTICS

	POLYSTYRENE	TEFLON	H.V.	MINIATURE MYLAR
Operating Temp. Range	-55°C to +85°C	-55° to +200°C	-55°C to +125°C	-55° to +125° C
Voltage Range, D.C.	100 to 30,000	100 to 30,000	600V to 80KV	100-600V
Capacitance Range	.001 to 20 MF	.001 to 20 MF	.0001 to 0.1 MF	.0001 to 1.0 MF
Power Factor	.02% @ 1KC	.02% @ 1 KC	0.3% @ 1 KC	0.3% @ 1 KC
Dielectric Absorbtion:	.01%	.01%	0.1%	0.1%
Voltage Operating at 85°C	none	none	30%	none
Voltage Derating at 125°C	not operable	none	66%	30%
Voltage Derating at 150°C	not operable	none	not operable	not operable
Voltage Derating at 200°C	not operable	33%	not operable	not operable
Temperature Coefficient	-100 PPM/°C	-100 PPM/°C	+500 PPM/°C	+60 PPM °C up to 70° C
I.R. at Room Temperature	10 ¹⁰ megohms/MF	10 ¹⁰ megohms/MF	10 ⁸ megohms/MF	10 ⁸ megohms/MF
Capacitance Stability	0.1%	0.1%	0.5%	0.2%

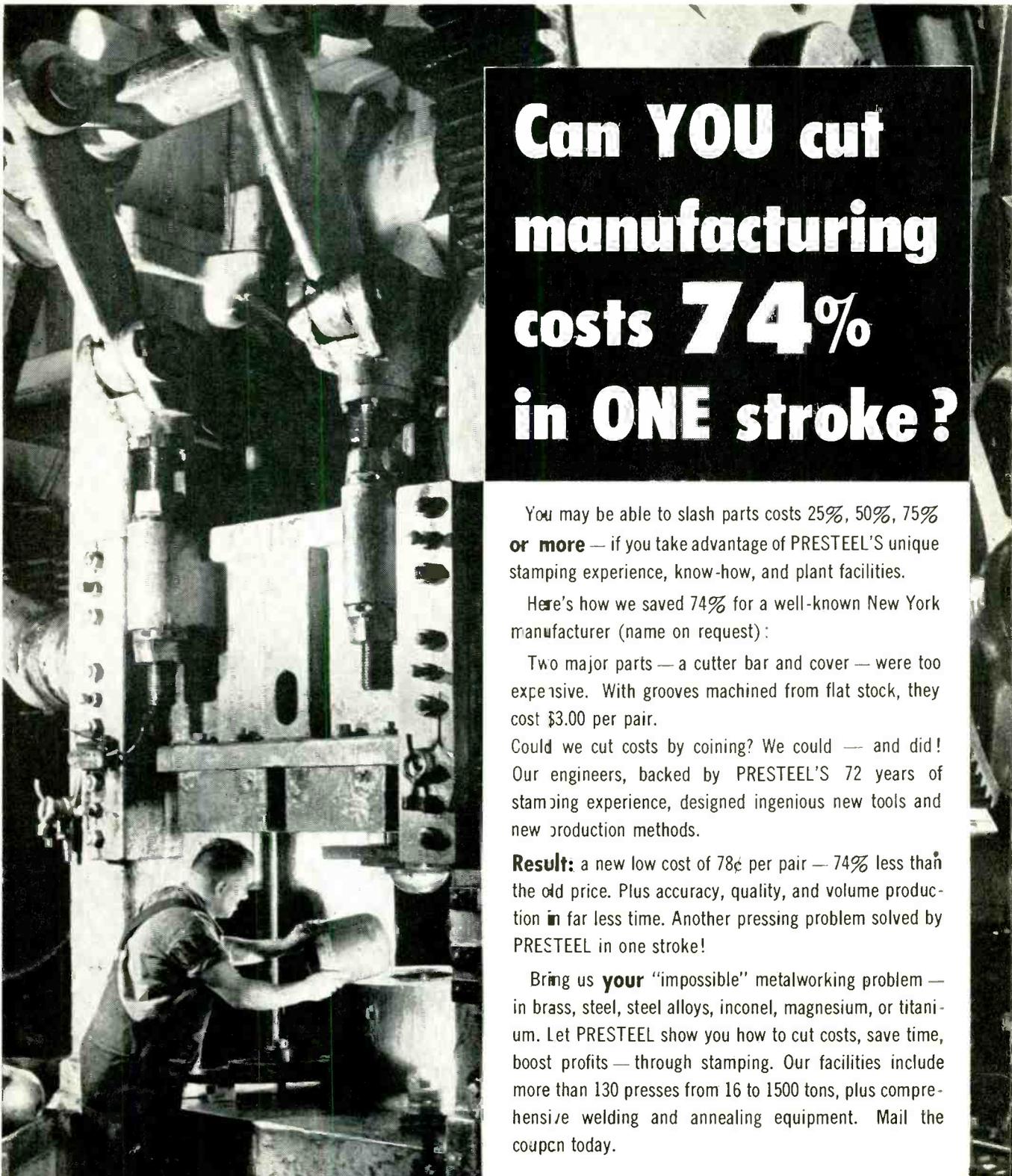


SERVO GEAR TRAIN weighs only 6.875 oz

JOHN OSTER MFG. Co., Racine, Wis., has available a new size 11 servo gear train weighing only 6.875 oz and consisting of a single

When your industrial capacitors specs. call for precision and stability, specify FCI. Excellent delivery on standard or special types—Capacitors made to your specifications. For more complete technical data, write for catalog.

fci film capacitors, INC. 3400 Park Avenue, N.Y., N.Y. • Telephone CYpress 2-5180



Can YOU cut manufacturing costs **74%** in **ONE** stroke?

You may be able to slash parts costs 25%, 50%, 75% or more — if you take advantage of PRESTEEL'S unique stamping experience, know-how, and plant facilities.

Here's how we saved 74% for a well-known New York manufacturer (name on request):

Two major parts — a cutter bar and cover — were too expensive. With grooves machined from flat stock, they cost \$3.00 per pair.

Could we cut costs by coining? We could — and did! Our engineers, backed by PRESTEEL'S 72 years of stamping experience, designed ingenious new tools and new production methods.

Result: a new low cost of 78¢ per pair — 74% less than the old price. Plus accuracy, quality, and volume production in far less time. Another pressing problem solved by PRESTEEL in one stroke!

Bring us **your** "impossible" metalworking problem — in brass, steel, steel alloys, inconel, magnesium, or titanium. Let PRESTEEL show you how to cut costs, save time, boost profits — through stamping. Our facilities include more than 130 presses from 16 to 1500 tons, plus comprehensive welding and annealing equipment. Mail the coupon today.

WORCESTER PRESSED STEEL COMPANY



FREE!

from Worcester Pressed Steel, this handsome, practical ashtray — an example of PRESTEEL craftsmanship — is yours for the asking. Attach the coupon to your business letter head.



Get a quote from the leader — PRESTEEL!

101-D Barber Ave., Worcester 6, Mass.

Please send me a PRESTEEL ashtray and brochure illustrating facilities and products.

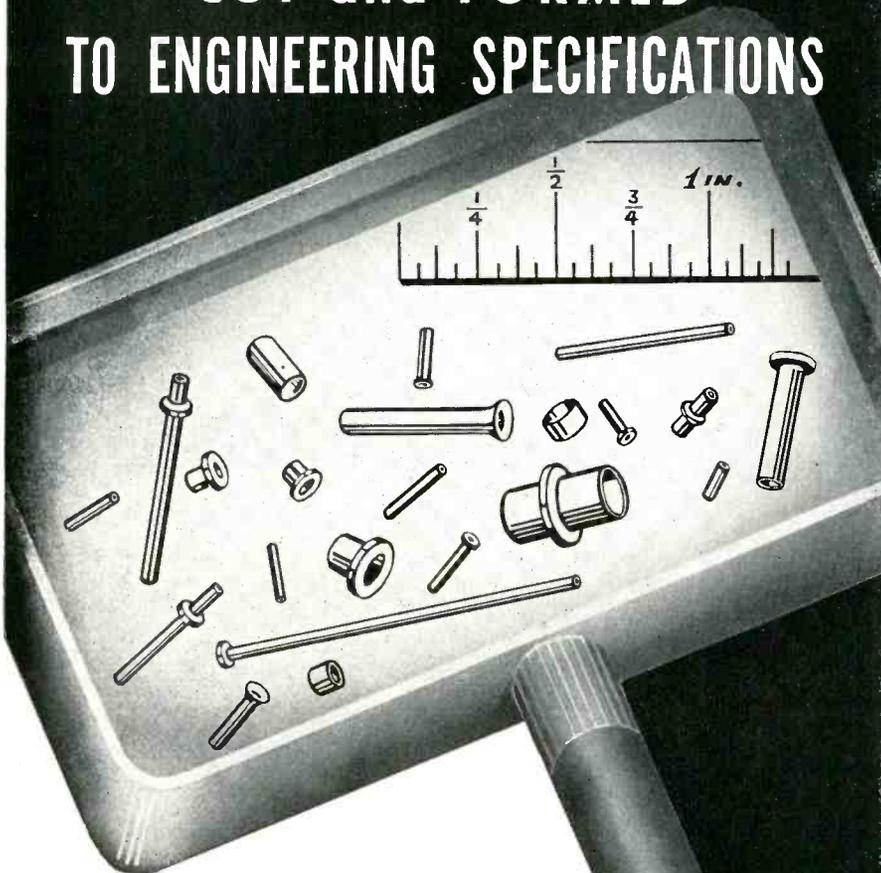
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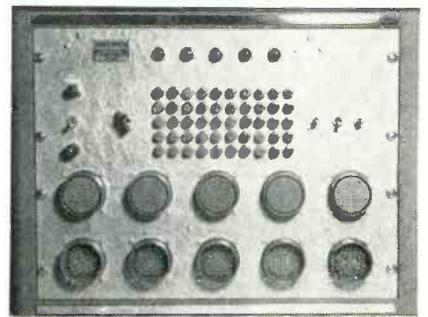
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P. O. BOX 185, DUNELLEN, NEW JERSEY

homogeneous unit instead of two separate parts. Type 2LR-3265 is designed to meet military requirements and can be built to operate 150 C ambient. Both the motor section and the gear train section are extremely versatile and are designed to cover a great range of applications. For example, the motor can be made to operate as a 2, 4, 6 or 8-pole motor. Windings can be made to operate on 60 or 400 cycle, 26 to 115 v.

The gear train operates with load torques up to 25 in.-oz and maximum momentary load torques of 75 in.-oz. Backlash is 35 minutes minimum. Gear ratios may be varied in convenient steps from 12 to 1 to 4,000 to 1. A slip clutch is available if desired. Units have been made with windings to load output transformers of amplifiers or to be connected directly to the output tubes or transistors.



CONTINUITY TESTER used on production lines

CENTURY ENGINEERS, INC., Burbank, Calif. Up to 200 conductors in groups of 50 in any given cable or harness assembly can be checked automatically with the new continuity tester.

► **Operation**—The tester uses stepping switches of the telephone variety to provide automatic switching from one circuit to another. The read-out is positive. Six volts d-c is used for test voltage. The tester, with appropriate patch cables, will check cables and harnesses.

The instrument is provided with the following front panel controls: power light, switch and fuse, momentary start switch and reset switch, 50 numbered lights for circuit identification, a ready light to

**From 3 to 20 times
the usual plotting area**



... combined with considerably simplified operation



Direct plotting on the face of a 22-inch indicator is now possible through the use of our AN/SPA-23 (XN-1) indicator.

Developed for the Navy Department, this indicator uses a 22-inch flat-faced (250-inch radius) cathode ray tube permitting parallax-free observation and plotting. Through its size, several operators may be accommodated.

Incorporating a high degree of flexibility, ranges from 4 to 300 miles are provided and input repetition rates of 60 to 3000 PPS are accepted. All contents have been "human-engineered" for operator convenience and minimum fatigue.

Designed for maximum reliability and ease of maintenance, the unit may be completely serviced from the front with all components readily accessible and replaceable.

This indicator is but one of the many products designed and developed by Stromberg-Carlson for the defense of our country.

In military or civilian products of the highest order—there is nothing finer than a Stromberg-Carlson.

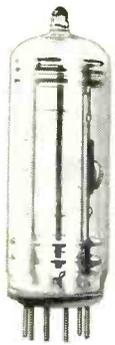


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Miniaturized Precision Crystals, in a range from 1000 cycles to 150 mc, combining minimum size with maximum stability.



JK H-3

"Thermystal", an advance design frequency control unit that combines plug-in simplicity with extreme precision. Calibration accuracy: \pm (cycle \pm .0001%). Temperature stability: 30 to 900 kc \pm .0001% 1000 kc to 150 mc .00005%.



JK-THERMYSTAL



Precision "G-line" Crystals over a complete range of 800 cycles to 5 mc including the JK G-12A with a proven stability of one part in one billion per day at 1000 kc.

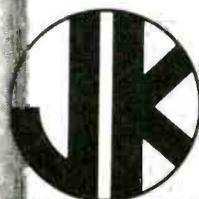
JK G-12A

These recent JK product developments indicate the wide range of experience available to bear on your frequency management problems. Can you take advantage of these advanced James Knights developments? They are now available on a production basis.

THE JAMES KNIGHTS COMPANY

Crystals for the Critical

SANDWICH, ILLINOIS



PRODUCTS

indicate the starting position of the tester, lights 1 through 4 to indicate which group of 50 circuits is under test, positional selector switch to select the bank of 50 circuits to be tested.



TINY POTENTIOMETER flexible or turret terminals

CIRCUIT INSTRUMENTS INC., P.O. Box 355, 1927 First Ave. South, St. Petersburg, Florida. Model HM-100 miniaturized multiturn potentiometer is available with either flexible or turret-type terminals. These potentiometers have a 1-oz-in. maximum starting torque, while net weight is only 1.2 oz.

► **Technical Data**—The unit is rated at 2 w at 40 C, and standard linearity is ± 0.5 percent. Resistance values are from 500 to 100,000 ohms. Standard tolerance is ± 5 percent; however, tolerances as low as ± 0.5 percent can be obtained.

PRINTED CIRCUIT RECEPTACLE

in single or double rows

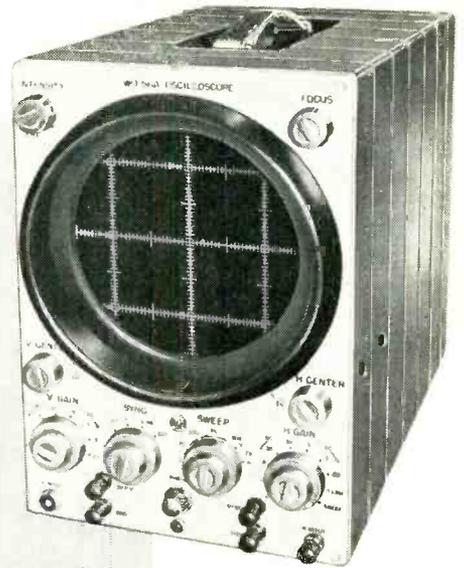
DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. The 28-contact printed circuit receptacle (PCSC28) has a center barrier as part of the molding to provide extra strength and prevent warping. Gold-plated phosphor bronze contacts are available in single or double rows to accommodate up to 56 connections.

Exclusive Bellows-type contact with coil-spring action grip clasps board firmly over the entire printed circuit board contact area. It retains tension and allows use of



**General-Purpose
DIRECT-COUPLED
5" 'SCOPE, WO-88A**

Low in cost, yet high in quality—for general laboratory applications, production-line alignment, testing, troubleshooting—built-in voltage-calibrating facilities permit simultaneous waveshape display and peak-to-peak voltage measurements; sync polarity instantly reversible; only 10 μf input capacitance with probe. Price.....\$169.50*



**Identical "V" & "H"
Amplifiers
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Invaluable for phase measurements or vector display—7" screen plus trace expansion of 3 times screen diameter provide unusually large waveshape display for distant viewing or close examination of minute portions of waveshapes; frequency-compensated voltage-calibrated attenuators in both "V" and "H" amplifiers. Price.....\$274.50*



**Economy-Priced
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Excellent for general laboratory, or production-line for waveshape observation and measurement, signal tracing, and alignment of chrominance circuits and wide band amplifiers—voltage-calibrated input step-attenuators and calibrated graph screen make possible direct voltage readings as easily as with a VTVM. Price.....\$229.50*



**Engineer's Choice
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Recommended to and chosen by engineers requiring a 'scope with extra-sensitivity and extended-frequency response—utilizes flat-faced cathode-ray tube with post-deflection acceleration; automatic sync limiting; push-button for calibration checking; excellent phase characteristics; full screen deflection over entire rated frequency range. Price.....\$425.00*

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accurate, reliable instruments designed to operate with minimum maintenance under production conditions!

RCA Oscilloscopes and other superior-quality RCA Test Instruments are available through your RCA Distributor. See him now for early delivery. For detailed technical data, write RCA, Commercial Engineering, Sector D-19-W, Harrison, N. J.



TEST EQUIPMENT
Radio Corporation of America, Harrison, N. J.

SPECIFICATIONS	WO-91A	WO-78A	WO-88A	WO-56A
FREQ. RESPONSE: Wide-Band Positions	10 cps to 4.5 Mc (±1 db)	3 cps to 4.5 Mc (-1 db)		
High-Sensitivity Positions	10 cps to 500 Kc (-1 db) 10 cps to 1.5 Mc (-6 db)	3 cps to 500 Kc (-3 db)	0 cps to 500 Kc (-3 db) 0 cps to 1 Mc (-10 db)	0 cps to 500 Kc (-2 db) 0 cps to 1 Mc (-6 db)
SENSITIVITY Wide-Band Positions	0.053 (rms) v 0.15 (p-p) v	0.035 (rms) v 0.1 (p-p) v		
High-Sensitivity Positions	0.018 (rms) v 0.05 (p-p) v	0.0035 (rms) v 0.01 (p-p) v	0.025 (rms) v 0.07 (p-p) v	0.01 (rms) v 0.03 (p-p) v
RISE TIME ("V" Amp.)	0.1 μsec. (4.5 Mc) 0.5 μsec. (1.5 Mc)	0.1 μsec. (4.5 Mc) 0.7 μsec. (1.5 Mc)	0.5 μsec.	0.35 μsec.
SWEEP FREQ.	10 cps to 100 Kc Plus preset "H" & "V"	10 cps to 100 Kc Plus preset "H" & "V"	15 cps to 30 Kc	3 cps to 30 Kc Plus preset "H" & "V"

*voltage/in. beam deflection measured at "V" amplifier input terminals.
*User Price (Optional). All instruments supplied with probes, cables, green graph screens, instruction booklets.

For Miniature Helical Potentiometers

Call...
CIRCUIT
INSTRUMENTS INC.

NEW PRODUCTS

(continued)



TYPES H-150 and H-155

Miniature 1½" diameter size. Turret type terminals. Rotation: Type H-150 3600, -0 +4°; Type H-155 1800, -0 +4°. Power rating 6 watts and 5 watts respectively. Patented stop mechanism completely separate from element and brush.



TYPE H-151

Only 1½" diameter x ¾", exclusive of shaft and turret terminals. Continuous rotation; stops available on special order. Standard linearity ±0.5%. Power rating 3 watts. Standard resistance values from 50 to 15,000 ohms. Weight 2 ounces.



TYPES H-100 and H-105

Slim 1" diameter. 5 and 10 turn types. Rotation: Type H-100 3600, -0 +4°; Type H-105 1800, -0 +4°. Power rating 4 watts and 3 watts respectively. Flexible silver plated terminals or rigid turrets available.



TYPE H-101

Tiny 1" diameter by ¾", exclusive of shaft and turret terminals. Weight is 1 ounce. Power rating 1½ watts. Standard resistance values from 50 to 10,000 ohms. Continuous rotation; stops available on special order.



TYPES H-750 and H-755

Ultra-thin ¾" diameter size. Type H-750 3 watts, standard resistance values from 250 to 50,000 ohms. Type H-755, standard resistance values from 125 to 25,000 ohms. Either flexible silver plated terminals or rigid turrets available.



TYPE H-751

Small ¾" diameter by ¾" body size, exclusive of shaft and turret terminals. Weight 1 ounce. Power rating 1 watt. Standard resistance values from 100 to 10,000 ohms. Continuous rotation; stops available on special order.

Note: Linearities (independent) can be supplied to ±0.1% for most resistance values.



undersized or oversized board while maintaining low contact resistance.

► **Special Design**—The PCB20 printed circuit receptacle is a special design type with center mounting and two sets of five double row contacts. It accommodates two printed circuit boards, each with 10 connections.

These connectors can be supplied in mineral filled Melamine, Plaskon reinforced (glass) alkyd type 440A and Orion filled diallyl phthalate molding compounds.



COLOR TV TUBESCOPE checks pattern accuracy

EDMUND SCIENTIFIC CORP., Barrington 3, N. J. The color tv tubescope is a microscope designed to assist and simplify alignment of the dot pattern on the picture tube during manufacture and field servicing. It checks the accuracy and concentricity of the pattern where unaided vision is unsatisfactory, inadequate and time consuming.

► **Parts**—The instrument consists of two parts, a main chrome-plated optical body housing a cemented

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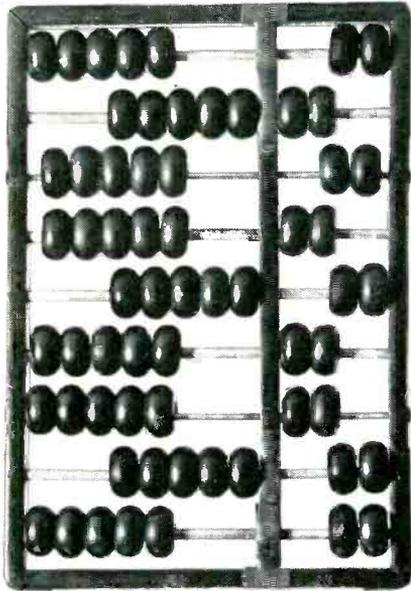
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The most powerful force known to science is that of a new idea.

Anon.

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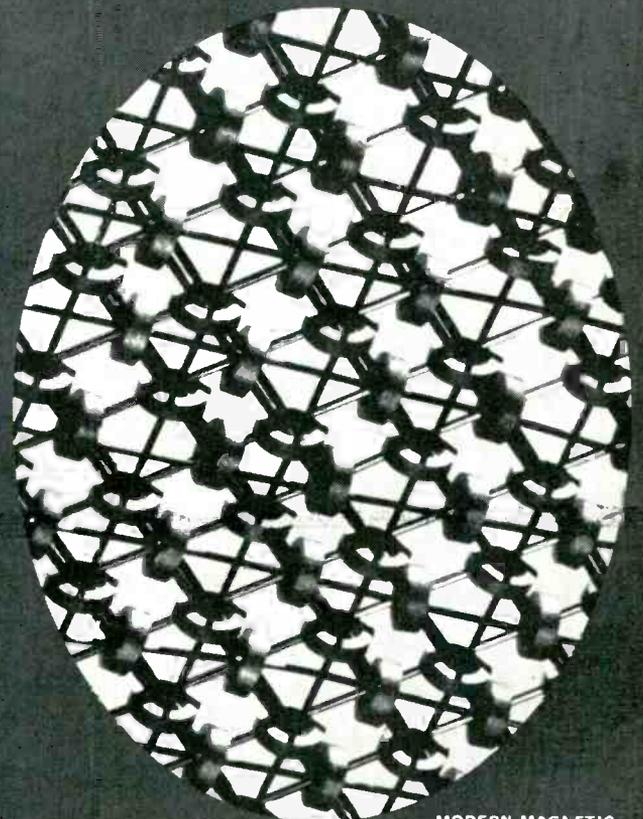
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BIRD Model 43 *Thurline* DIRECTIONAL WATTMETER

Reads Directly . . . WATTS FORWARD
WATTS REFLECTED... *In 50 Ohm Coaxial Lines*

Measures POWER into the antenna in the actual operating circuit. Continuous monitoring if desired.

Measures reflected power, direct reading. In antenna matching work, results show directly in lower reflected power.

Ideal for mobile equipment.

Tests 50 ohm r-f lines, antenna connectors, filters—quickly. ACCURATE because of high directivity and small frequency error.

DIRECT READING—no calibration charts, no full scale meter adjustments needed. Meter scale reads directly for all ranges and is expanded for better down-scale reading.

CONVENIENT—does not require reversal of r-f connections. No auxiliary power required.

Negligible power loss and insertion VSWR.

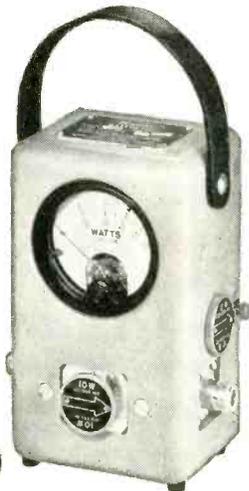
Full scale power range and frequency range are determined by the selection of plug-in elements from the following list.

Frequency Range—25-1000 megacycles in five ranges vis. 25-60 (A), 50-125 (B), 100-250 (C), 200-500 (D), 400-1000 (E).

Power Range—10, 25, 50, 100, 250, and 500 watts full scale. Available in most frequency ranges.

Accuracy—5% of full scale.

Write for literature.



Model 43 with front element in operating position. Dimensions: 7" x 4" x 3" Weight, 4 pounds. SO239 jacks for PL259 plugs available.



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ELECTRONIC CORP.
1800 EAST 38TH ST., CLEVELAND 14, OHIO
TERMALINE Coaxial Line Instruments

VAN GROOS
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Sherman Oaks, Cal.

NEW PRODUCTS

(continued)

achromatic objective lens with the eyepiece, and the outer black anodized felt-lined aluminum barrel for focusing.

A working distance of 4½ in. is ample to view the periphery of the tube, and make it unnecessary to remove the safety glass shield thereby protecting technicians from the high potential on the tube.

Five different eyepieces are available and can be easily interchanged to give powers from 10X to 33X. The instrument is 7½ in. long with outside diameter of 1½ in.



POST AMPLIFIER for measuring noise figure

RS ELECTRONICS CORP., 435 Portage Ave., Palo Alto, Calif., announces a post amplifier for study of i-f amplifiers. It is particularly useful for making noise figure measurements in conjunction with the company's noise generator.

The unit features an input cathode follower terminating in a 3-db attenuator (utilizing 1-percent precision resistors) actuated by a spring-return switch, with provisions for simultaneously controlling the noise generator. A panel switch permits selection of two separate amplifiers. An integral vtvm, with a 4-in., 0 to 50 μ a movement, serves as an amplitude comparator.

Literature

Microvolt Generator. The Hickok Electrical Mfg. Co., 10514 Dupont Ave., Cleveland 8, Ohio. A 4-page folder illustrates and describes model 295X universal, all-band

J-V-M

MICROWAVE COMPONENTS



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Cavities, duplexers, couplers, feed horns, mixers, rotating joints and other complex mechanical assemblies built to your specifications . . . Engineering service available . . . prompt quotations and deliveries.

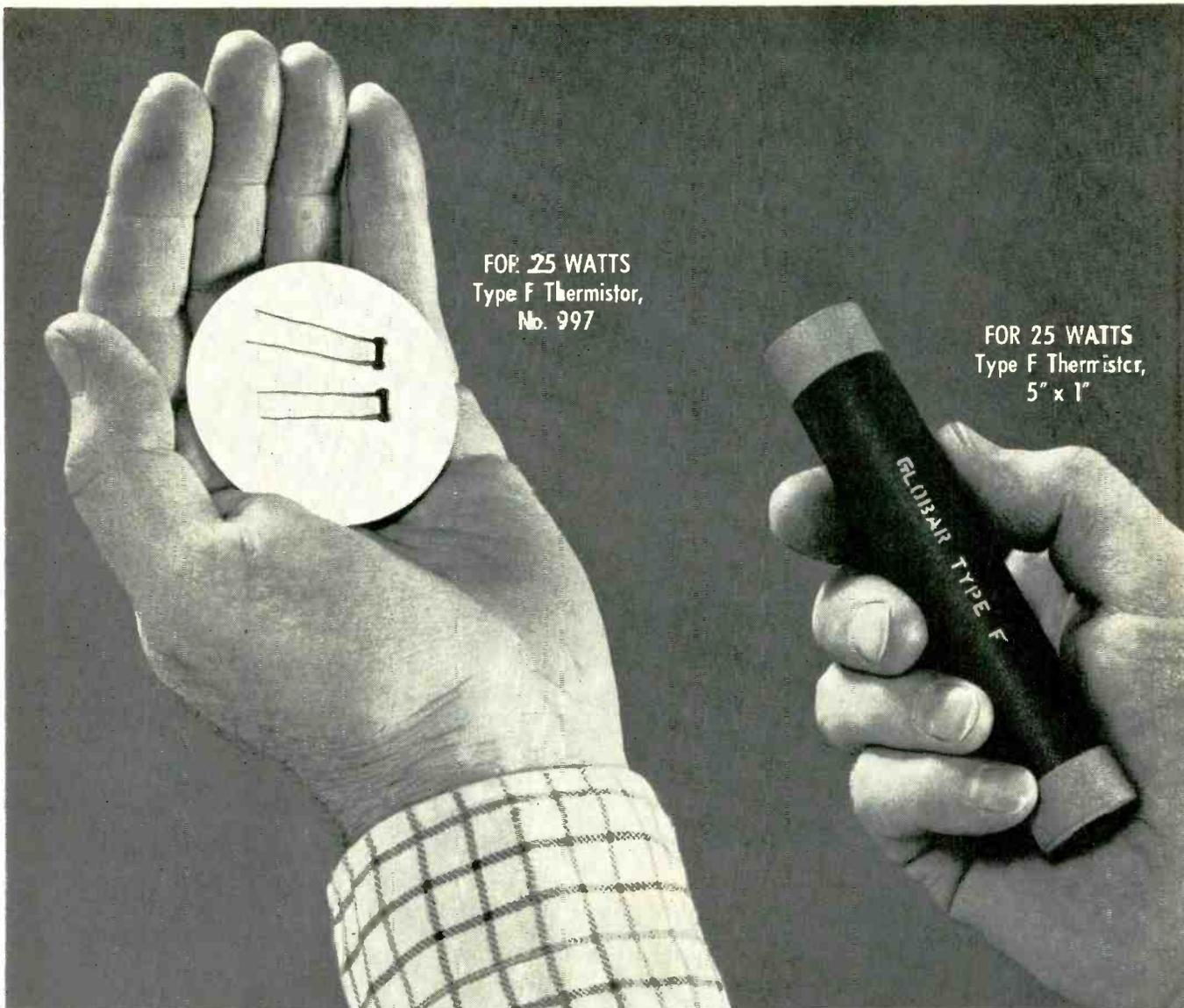
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Type F Thermistor,
No. 997

FOR 25 WATTS
Type F Thermistor,
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THESE TWO EXTREMES in thermistors were designed by GLOBAR[®] engineers to meet specific circuit requirements of two of our customers. Chances are that your particular application will not require either of them... but will fall somewhere in between. But our experience in working out difficult design problems like these, plus our flexibility in production, is your assurance that a GLOBAR[®] Thermistor design will satisfy your requirements best.

GLOBAR[®] THERMISTORS are available with temperature coefficients ranging from .3% per degree C at 25° C up to 4.5% per degree C at 25° C, and in a broad range of body sizes for special electronic packaging. Both thermistor sizes shown above, while originally custom-designed, are still in production and currently available.

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Ceramic Resistors

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microvolt and crystal-controlled generator. Information on outstanding range and accuracy, specifications and applications are included.

Unitized Chassis. Instrumentation Devices, Box 319, Buchanan, N. Y., has available a circular describing a chassis design of unitized construction without special wiring methods. Conventional wiring and components can be used to build circuits on the shelves of the chassis described. Unit chassis dimensions are illustrated.

Printed Circuit Connector. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 2-color engineering data sheet on printed circuit 22-contact connector series 4 PCSC gives detailed description and specifications plus mounting and clearance dimensions. Write for technical bulletin 44C.

Variable Inductances. Superex Electronics Corp., 4-6 Radford Place, Yonkers, N. Y., has available a 4-page folder illustrating and describing a line of r-f chokes and coil forms. An industrial price schedule may also be had for the asking.

Transformer Products. United Transformer Co., 150 Varick St., New York 13, N. Y. Catalog 56 A covers a complete line of transformers, filters, and high Q coils for military, industrial, broadcast, amateur, laboratory and replacement purposes. Included are an index and net price list, illustrations and specifications.

Ultraminiature Electrolytic Capacitor. Barco, Inc., Box 1222, Milwaukee, Wisc. Catalog CS-33 is a complete listing of the 42 types of ultraminiature electrolytic capacitors. Including test charts and a cross-reference table, the brochure details these units in their range from 0.15 μ f to 160 μ f, 1½ v dcw to 70 v dcw, and ½ in. diameter to 23/64 in. diameter.

Resistance Standards. Consolidated Resistance Co. of America, Inc., 44 Prospect St., Yonkers, N. Y. Data sheet No. 128 describes Vari-Plug and pushbutton resistance

NEMS-CLARKE Special Purpose Receivers are designed for optimum performance in telemetering, guided-missile monitoring and radiosonde reception and many other applications calling for superior performance. These Receivers are now in use by most of the leading aircraft companies.

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SMALL PARTS

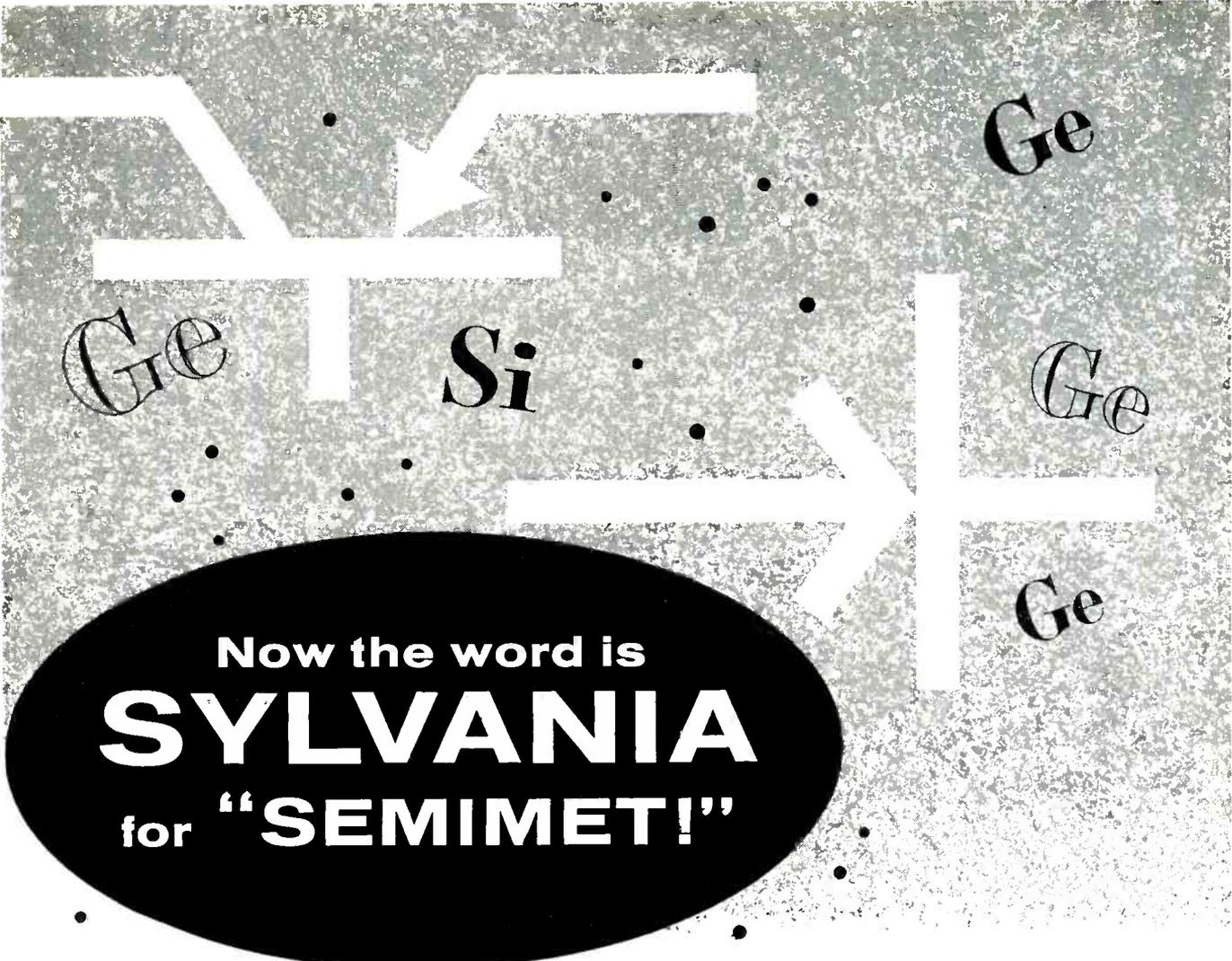
Cost less when made by

MULTI-SWAGE

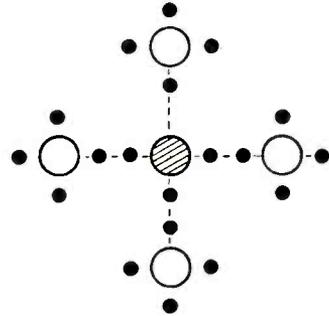
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Examine the tubular metal parts shown here twice size. If you use anything similar . . . in large quantities . . . important savings can be yours. Send us the part and specs. Our quotation will show why the Bead Chain Company's MULTI-SWAGE Process has long been known as the most economical method of making electronic tube contact pins, terminals, jacks and sleeves. And, why more and more users of mechanical parts (up to ¼" dia. and to 2" length) employ our facilities. WRITE for Data Bulletin.

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Sylvania has long been a primary refiner of high-purity germanium. Now, newly completed facilities for the production of high purity silicon are operating on a pilot plant basis, producing the semimetal in needle or densified form, of spectrographic purity. Full production is expected in the spring. At present, transistor-grade samples are available for your testing on a letterhead request basis.

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HYSOL 6000 EPOXIDE RESINS



The Electro Tec Corp. selected HYSOL 6000 Series tubes to make slip ring assemblies. That's because the outstanding electrical, thermal and mechanical properties of HYSOL 6000 epoxide compounds provided an ideal material for precise machining, intricate silverplating and ease of handling. The ability to withstand wear contributed heavily to its use in a mechanism for the transfer of electrical current from a stationary to a rotating mechanism.

Houghton Laboratories, Inc., supplies HYSOL 6000 Series tubes in certain sizes to Electro Tec Corp. and also furnishes the basic resin compound for formulating tubes in varying sizes. The 6000 Series includes a complete line of easily machined sheets, tubes and rods, room temperature and heat curing potting and casting compounds and coating and laminating varnishes.

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standards. Included are specifications, prices and information on optional equipment. Chief features and illustrations are shown.

Receiving Tubes. Radio Corp. of America, Harrison, N. J., has published a revised edition of the technical booklet, "RCA Receiving Tubes for A-M, F-M, and Television Broadcast." The 28-page booklet gives the characteristics of more than 600 RCA receiving tubes including picture tubes. Picture tube information is presented in a chart which lists and describes 75 types. Base and envelope connection diagrams are supplied for all tube types.

A classification chart is arranged to permit quick determination of the type designations of RCA receiving tubes according to their functions and filament or heater voltages. The company's picture tubes are listed according to their envelope size, focus method and deflection method.

The booklet carries a list price of 20 cents a copy.

Silicon Rectifiers. Sarkes Tarzian Inc., Rectifier Division, 415 North College Ave., Bloomington, Ind. An 8-page booklet covers a line of silicon rectifiers which will fill military requirements and many commercial applications. Included are information on efficiency, operating temperatures, size, construction, voltage and current ratings, series and parallel operation, typical applications, specifications and illustrations.

Magnetic Tape Recorders. Amplifier Corp. of America, 398 Broadway, New York 13, N. Y. The VU Magnemite series, portable, battery-operated, spring-motor magnetic tape recorders, with built-in-v-u meter is described in a 4-page folder.

The brochure completely describes in detail, features of 14 models, all of which were especially designed for field applications. A variety of single, two, three and four speed models are available and listed with their respective recording characteristics tabulated for easy reference or selection.

The various mechanical and electrical components are fully de-

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POWER TRANSISTORS

High Current Gain— Maintained at Large Collector Currents

New Westinghouse XD-5081 transistor is characterized by high current gain throughout its operating range. Distortion is cut to a minimum.

THERMAL DISSIPATION. Large copper base provides an ample heat dissipating area.

LONG LIFE — RELIABLE OPERATION. Hermetically sealed in glass and metal to exclude moisture, prevent atmospheric contamination.

TYPICAL APPLICATION. Ideally suited for audio output stages and switching applications.

Performance data on the XD-5081:

*Large signal current gain . . . 70 at $I_c = 1$ ampere;
55 at $I_c = 2$ amperes*

*Large signal frequency cutoff
(common emitter) . . . >10 kc*

Maximum voltage (V_{ce}) . . . 35 volts

Maximum current (I_c) . . . 2 amperes

*Saturation characteristic (V_{ce})
. . . <1 volt at $I_c = 1$ ampere*

Thermal drop . . . 3.5°C per watt from junction to case

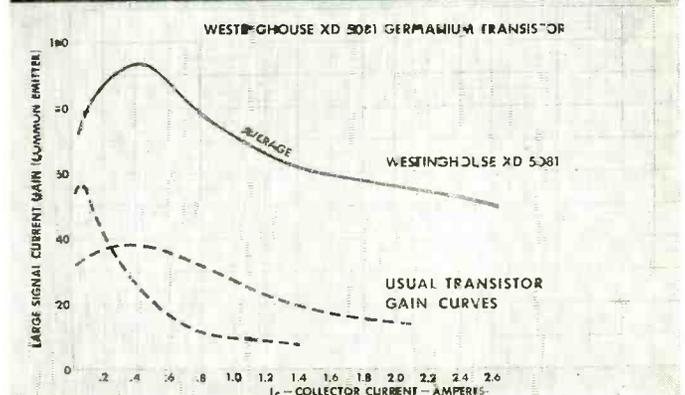
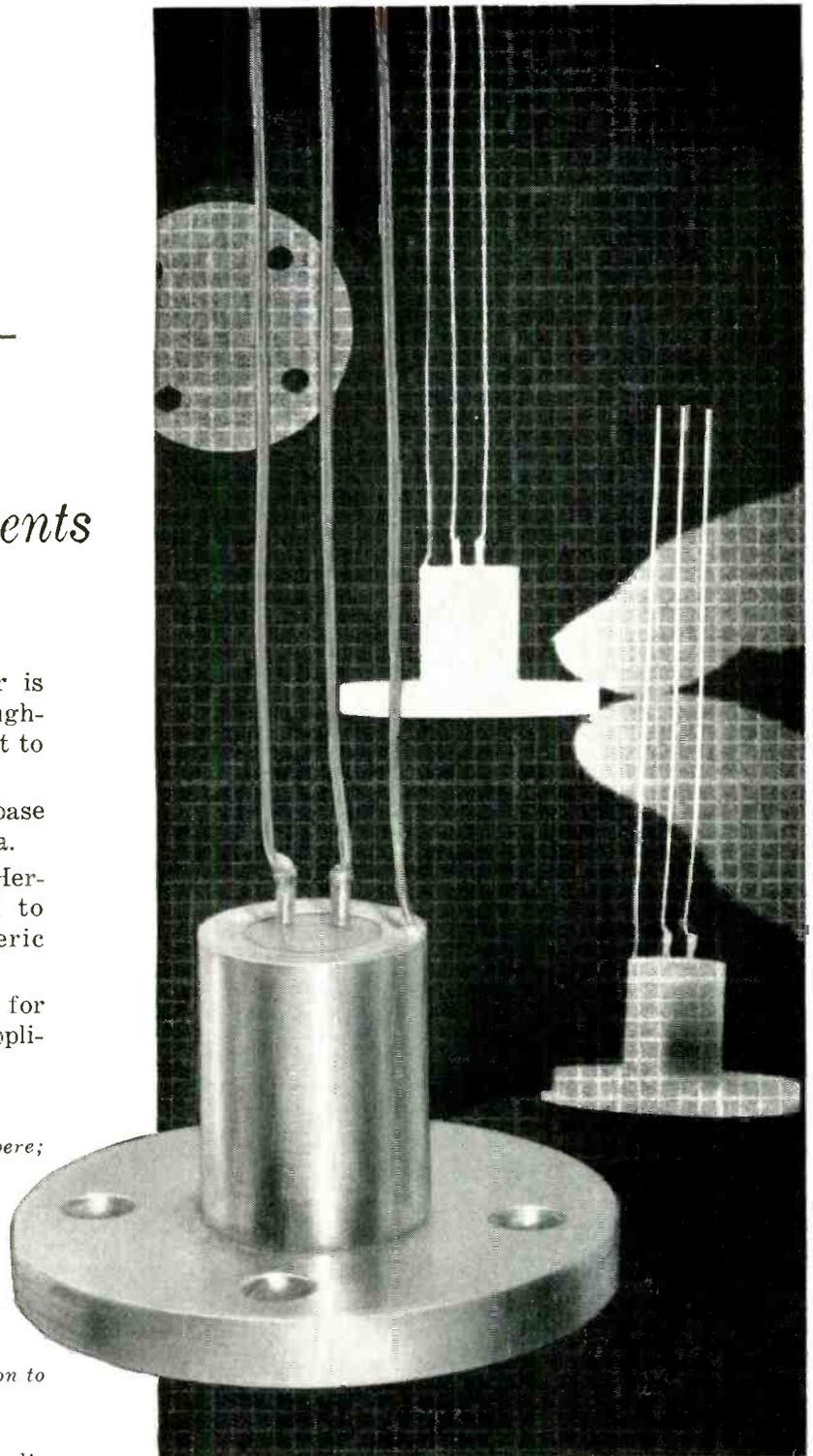
Maximum junction temperature . . . 100°C

Sample quantities are available immediately. Contact your nearest Westinghouse district sales office or write, Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-09002

YOU CAN BE SURE...IF IT'S

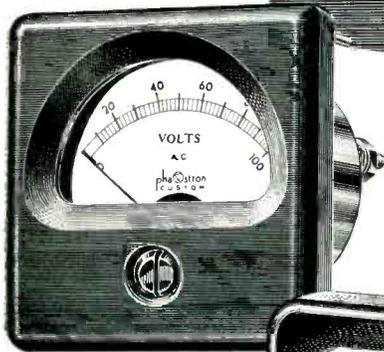
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PHAOSTRON

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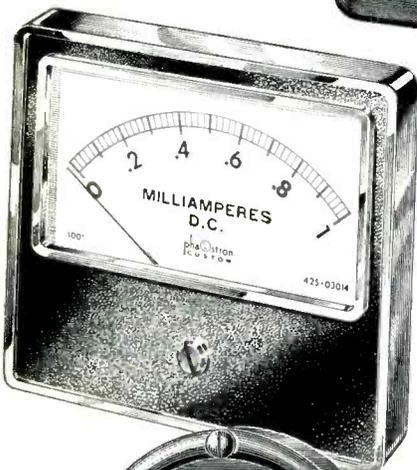
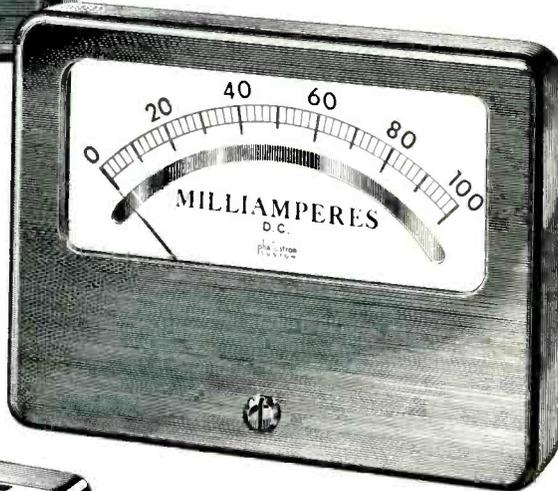
CUSTOM PANEL METERS



2 1/2" or 3 1/2" Square

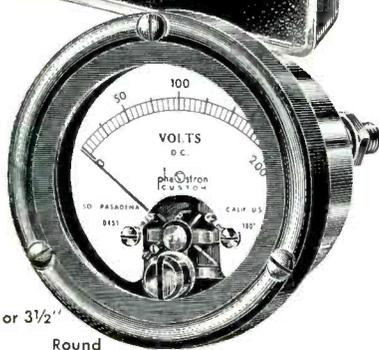
4" x 6" Rect.
with Mirrored Scale

4 1/2" Rect.
Chrome or Black
also available
illuminated



2 1/2" or 3 1/2"

Round



The appearance of your equipment will be enhanced by PHAOSTRON meters with their high style, die cast bezels and large easy-to-read scales.

You can depend upon 2% accuracy because these meters are calibrated to within 1% of full-scale deflection with controlled, certified standards.

Continuous accuracy is assured by the UNITIZED METER MOVEMENT ASSEMBLY which provides integral mechanical stability. The aged alnico magnet of the meter is protected from the effects of stray magnetic fields by the steel case.

These units are also equipped with insulated zero adjustments.

Nine Types in 77 Standard Ranges are available at your Parts Distributor. If you have a special requirement, write to the Product Development Department for a practical recommendation.

PHAOSTRON INSTRUMENT AND ELECTRONIC COMPANY
151 PASADENA AVE., SOUTH PASADENA, CALIF.

scribed and individually illustrated. The recorders' operations are concisely explained and complete technical specifications, recommended accessories, as well as direct factory prices are included.

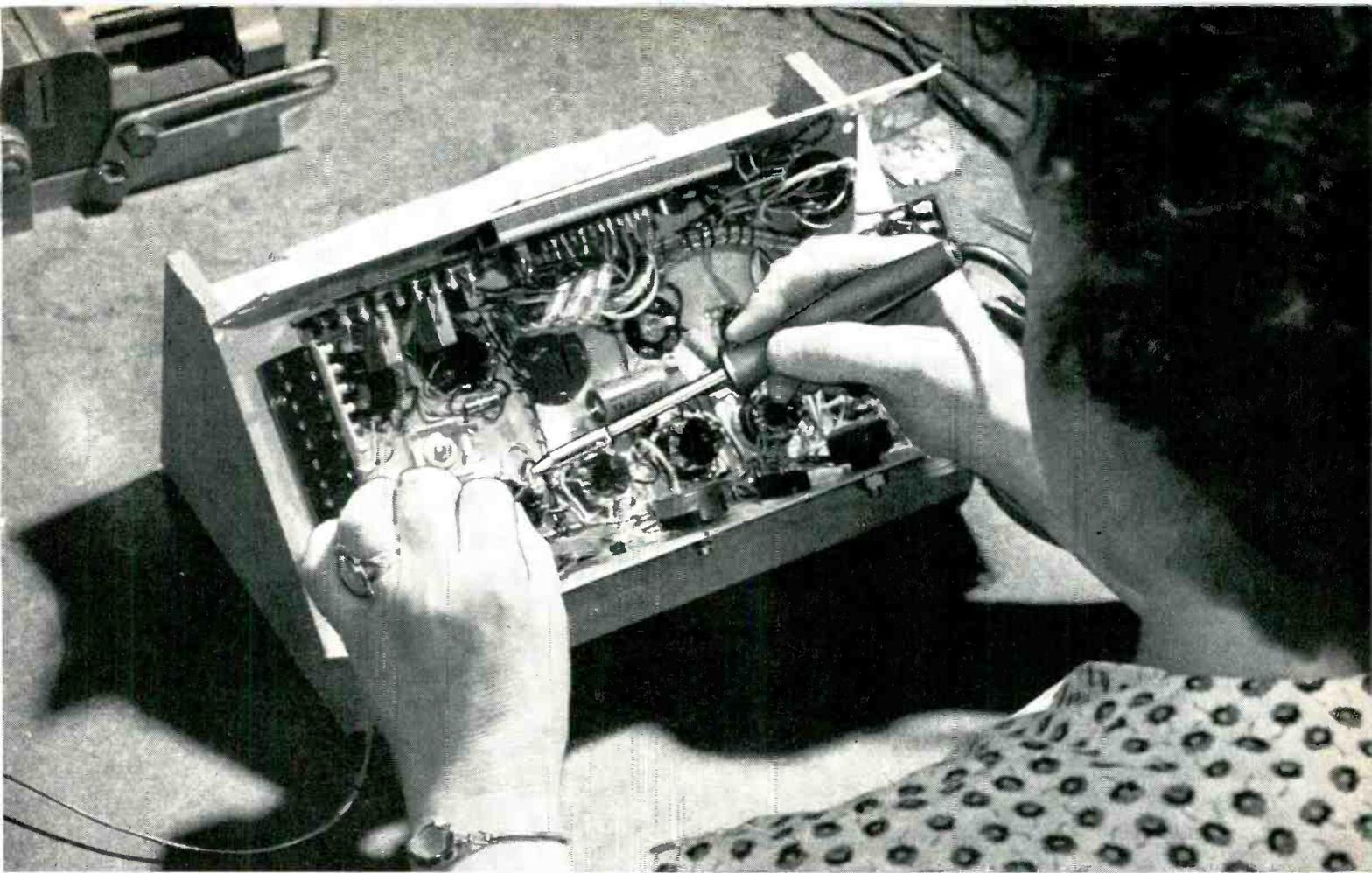
TWT Amplifiers. Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. Volume 7, No. 5 of the *Journal* covers new twt amplifiers which feature provision for simulating special microwave signals. The amplifiers described operate over the 4-8 and 7-12.4 kmc ranges with gains of 25 db or more and with maximum power outputs greater than 10 and 5 mw, respectively, at 50-ohm input and output levels. Illustrations and specifications for models 492A and 494A are included.

Tubeless D-C Power Supply. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif., has available a new bulletin describing the model 28-10 WX, 28-v \pm 10 percent at 10 amperes magnetic amplifier tubeless regulated d-c power supply. The unit illustrated and described in the bulletin features regulation of 0.5 percent and ripple of 1-percent rms. All characteristics and specifications on this unit are shown.

Cavity Wavemeters. DeMornay-Bonardi, 780 S. Arroyo Pkwy, Pasadena, Calif. A 4-page folder covers type DB-715 precision, broad-band cavity wavemeters. Features, applications, description, specifications and ordering information are included.

Analog Computer. Weber Aircraft Corp., 2820 Ontario St., Burbank, Calif. A 6-page folder fully illustrates and describes a low-cost general purpose analog computer which is complete within one basic unit. Applications and specifications are listed.

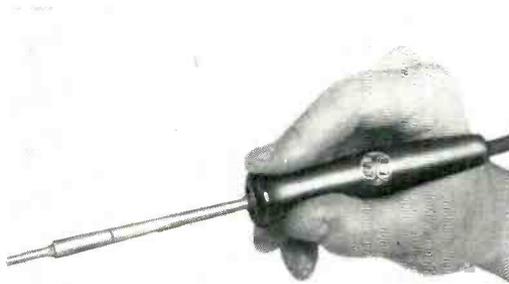
Connectors and Cable. Gulston Mfg. Corp., 212 Durham Ave., Metuchen, N. J., has announced a 6-page folder describing the new subminiature C-21 connectors and cable. It gives complete information concerning features, construction and applications of these Glennite C-21 subminiature connectors which oc-



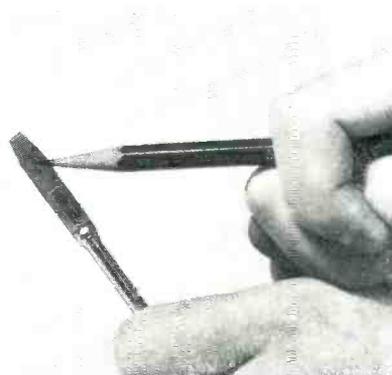
HARD-TO-REACH JOINTS in Sanborn Co.'s electro-cardiographs are soldered quickly with the fine-point G-E Midget iron—with no damage to adjacent parts. Weight of iron—less

than 2 ounces—helped increase output by reducing operator fatigue. The Midget's ironclad-copper tip saves Sanborn ½ hour cleaning and tinning time daily, per operator station.

Sanborn speeds assembly 13% with G-E Midget iron, a small soldering iron with big-iron efficiency



HANDLES LIKE A PENCIL—Weighing less than a package of cigarettes, the General Electric Midget soldering iron speeds production by reducing operator fatigue.



RAPID HEAT TRANSFER is achieved by locating the heater directly in the ironclad-copper tip. Result—the G-E Midget iron's heat efficiency is 90%.



THREE-IN-ONE IRON with 1/8", 1/4", 3/16" tip sizes gives you greater versatility to meet your soldering requirements. Tips can be changed in only 5 seconds.

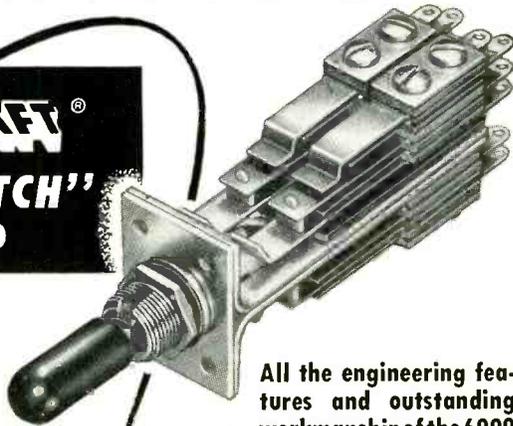
For more information write for GED-2263, G-E Midget Soldering Iron, Section 724-2, General Electric Co., Schenectady 5, N. Y.

GENERAL  **ELECTRIC**

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SWITCHCRAFT
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"TELEVER SWITCH"
SERIES 16000

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Single-Hole
Mounting**



All the engineering features and outstanding workmanship of the 6000 Series "Telever Switch" are retained in this new switch.

Single hole mounting provided by 15/32" threaded bushing 3/8" long; slotted bushing and a special washer provide a convenient non-turn device. 2-position and 3-position types; locking and non-locking. A unique feature is that conversion from a non-locking

action to a locking action can be made by removing a simple stamping supported by 2 screws.

Contact are welded cross bar palladium—standard. Fine silver (in various sizes) on special order.

Write for details and price

1336 N. Halsted St., Chicago 22, Ill.

Canadian Representative:

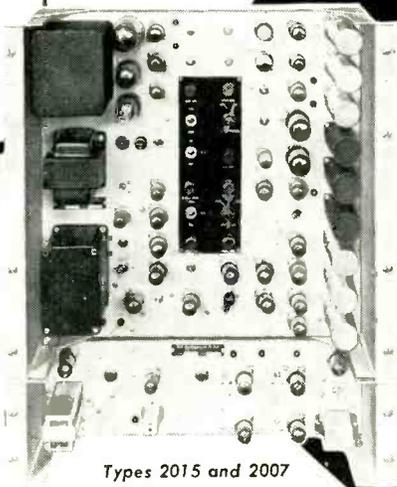
Atlas Radio Corp. Ltd., 50 Wingold Ave., Toronto, Canada

SWITCHCRAFT
INC.

COLOR SIGNAL CHECKING have you SPINNING?

use **TIC'S** NEW
Type 2015
**DIFFERENTIAL GAIN &
PHASE MEASURING GENERATOR**
and **Type 2036**
**DIFFERENTIAL GAIN
& PHASE ANALYZER**

Now you can conveniently measure small values of differential gain and phase with no more than a 5cm scope deflection! Differential gain can be read at 2% / cm. Differential phase at better than 0.5% / cm. The test signal contains the measurement signal, sync, color burst and front and rear porches. The measurement signal is a saw or 10-step, with 5% to 20% superimposed RF. Color certification tests are made to $\pm 1\%$ with the continuously variable, calibrated phase shifter. Type 2007 Sync Signal Simulator is available as attachment.



Types 2015 and 2007
illustrated

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COMPLETE
INFORMATION



Tel-Instrument
ELECTRONICS CORP.

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copy only one-quarter the volume of standard AN connectors and can withstand up to 100 g shock. Handy scale and actual size cutaway diagrams, easy-to-use ordering data, and specific technical information are all prominent features in the folder.

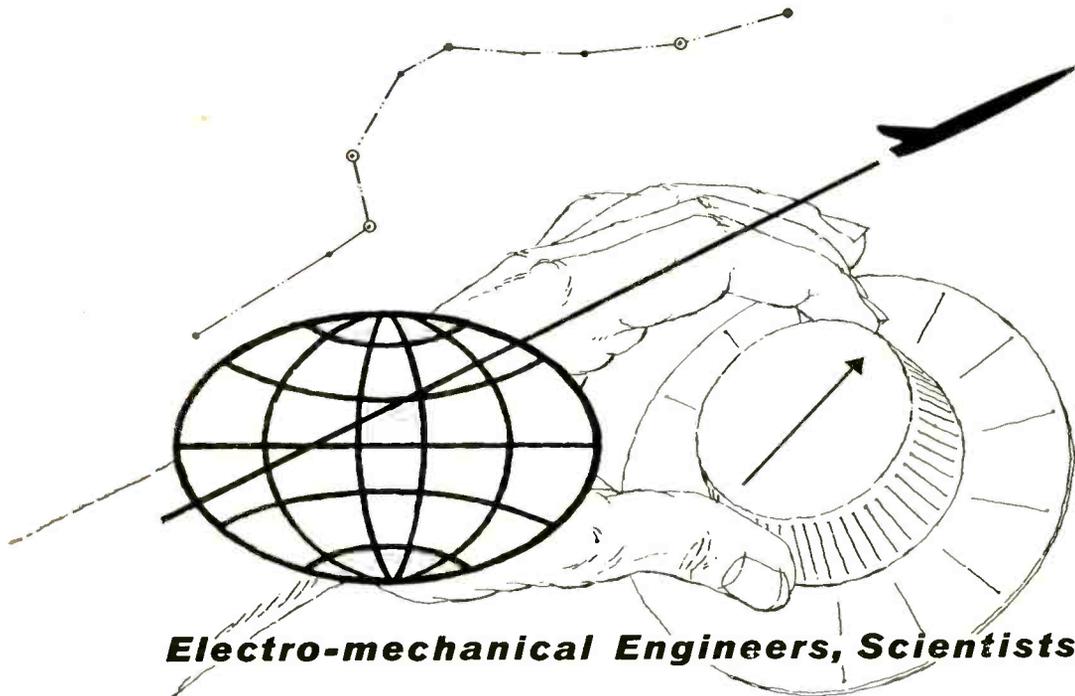
Silicon Junction Rectifiers. National Semiconductor Products, 930 Pitner Ave., Evanston, Ill. Bulletin TIB 22-55 covers high power silicon junction rectifier types NS-PI and NS-PIR (reversed polarity version of NS-PI). Tentative ratings, mechanical and electrical data and physical characteristics are included.

High-Power Dummy Load. A. R. F. Products, Inc., 7627 Lake St., River Forest, Ill., has available a bulletin on its model ADA-1 high-power dummy load which is used to replace the antenna in a radio transmitter when it is desired to keep the equipment operating for testing or alignment purposes. Application information, description, illustration and typical test results are included.

Static Control Systems. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa. The new Cypak static control systems are discussed in a new booklet entitled "The Whys and Wherefores of Cypak." Illustrated with photographs, drawings and circuit diagrams of actual equipment, booklet B-6584 covers the systems from four points of view: the need for static industrial controls, what they are, how they operate and where they can be used.

Time Delay Relays. A. W. Haydon Co., Waterbury, Conn., has available a new bulletin describing operation and specifications of the 6400 series d-c, 11400 a-c, and 24300 series 400-cycle time delay relays with proportional delayed reset for delaying application of plate voltage in gas and vacuum power tubes until filaments or heaters have reached the proper temperature.

Bulletin TD402 describes standard delayed reset units, reclosure time, tolerance, operation and special application of proportional de-



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THE MODEL T-1/E LABORATORY-PRECISION

Q-METER

■ The new ADVANCE LABORATORY Q-METER, Model T-1/E, is the first instrument of its kind incorporating an overload-proof VTVM indicator, and at a price below what you would expect to pay. This instrument provides a convenient method for making RF measurements of Q, Inductance, Capacitance and Power Factor at frequencies between 100 Kc and 100 Mc — in six frequency ranges, accurate to $\pm 1\%$. Calculation of Inductance and Impedance is simplified by the use of a variable capacitor, calibrated in three scales: (1) in mmfd from 40 to 550, accurate to 2%. (2) in Zf from 4,000 to 300 (ohms, Mc) and (3) in Lf from 600 to 50 (microhenrys, Mc.) There is a vernier capacitor of ± 2.5 mmfd. Q is read directly in two scales: 10-100 and 40-400, accurate to $\pm 5\%$. Rugged aluminum front panel; polished, grey enamel finish. Rhodium-plated terminals throughout. Power supply for 110-125V, 40-60 Cy., AC. SIZE: 15½" wide, 10½" high, 6½" deep. WEIGHT: 14 pounds.

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Sole U.S. Agents: FISHER RADIO SALES CO., Inc., 21-39 44th Dr., L. I. City 1, N. Y.

layed reset time delay relays, available for civilian and military requirements.

Ceramic Transducers. Gulton Mfg. Corp., Metuchen, N. J., has available a comprehensive 12-page brochure covering the use of piezoelectric ceramic transducers. The 2-color booklet outlines the many applications of ceramic transducers including ultrasonic shock and vibration, medical and underwater sound equipment, in addition to presenting complete physical and electrical properties and specifications for the ceramic materials. Other features covered include a discussion of resonant frequency characteristics and detailed tables outlining standard sizes and shapes of transducers available.

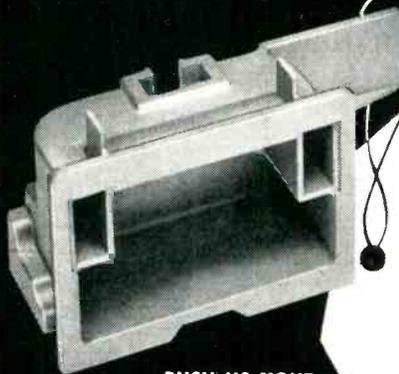
Miniature Feed-Through Capacitors. The Gudeman Co., 340 W. Huron St., Chicago 10, Ill. A 4-page engineering bulletin (No. 271-2) illustrates and gives complete technical data on miniature paper dielectric hermetically sealed feed-through capacitors designed for use in r-f interference suppression. Included are capacitance listings, dimensions and voltages, dimensional drawings and engineering specifications on test voltage, life test, insulation resistance, power factor and military environmental requirements.

Miniature Connector. DeJUR-AMSCO Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 2-color, 2-page technical bulletin gives description, specifications, enlarged views, mounting and clearance dimensions of the new series 20 miniature Continental connector with coaxial contacts. Write for bulletin 16C.

F-M-Carrier Recording Equipment. A-V Mfg. Corp., 730 Fifth Ave., New York 19, N. Y., has issued a new bulletin illustrating and describing its type 6 f-m-carrier recording system. Recording data from d-c to 10,000 cps, the basic system described consists of five building blocks. Fourteen tracks can be included in one system and A-V building block units can be

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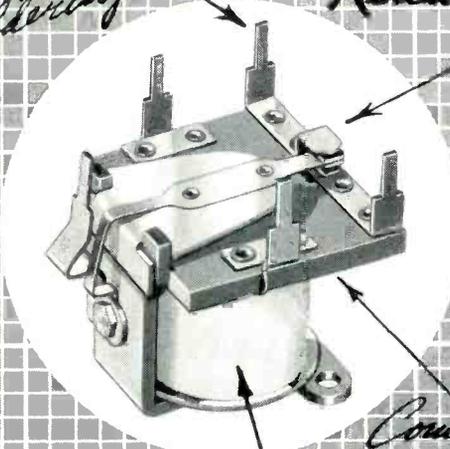
SUBJECT
**MINIATURE SENSITIVE
RELAY (TYPE MS)**

(IDEAL FOR PRINTED CIRCUITS)

*Note desired RBM
features will cut our
assembly costs*
M.S.

*Self locking
Terminal position
Relay before
Soldering*

*X-Bar Contacts
insure ultimate
in Circuit Switching
Reliability*



*Compact
size*

*Coil Construction
meets unusual
climatic conditions*

Construction—Printed circuit terminals are designed with snap-in feature which holds relay in printed circuit board without lugging prior to solder dip.

Other versions of MS relay available with standard solder type terminals and insulating base, where required. Also with 4 N.O. isolated circuits having common make.

While not yet in production, extra-sensitive version has been developed. Maximum coil resistance 18,000 ohms, nominal sensitivity .030 watt, maximum sensitivity .020 watt, overall height 1-9/16". All other details same as standard MS relay.

Application—Type MS is an ideal relay for any application requiring a compact, highly reliable single pole D. C. device, where a low cost solution is required because of volume usage and competitive problems.

The fact that industry has already used over a million units of this design is your assurance that the R-B-M Type MS relay will meet your most exacting requirements.

Contacts used in Type MS are of the cross bar type, which offer the ultimate in reliability throughout the life of the relay. Molded bobbin design has eliminated coil failure on sensitive applications under severe climatic conditions.

OTHER VERSIONS



SOLDER TERMINALS
4 isolated circuits with
common make contact.



INSULATED BASE
Solder terminals mounted
on insulating base.



**EXTRA SENSITIVE
VERSION**

ENGINEERING DATA

ENGINEERING DATA	
Specifications	Miniature Sensitive Relay Type MS
Contact Form	S. P. D. T.
Contact Rating	1 amp. 32 V.D.C. non-inductive
Coil Resistance	Up to 10,000 ohms
Nominal Sensitivity (Coil Input)	.060 Watt
Maximum Sensitivity	.040 Watt
Approx. Dimensions	1 1/8 x 1 1/8 x 1 1/2"



Send for Descriptive Bulletin MS-1

RBM DIVISION
ESSEX WIRE CORPORATION, Logansport, Indiana

Shasta

INSTRUMENTS

designed for the user!

MODEL 1201A WWV RECEIVER

Features:

- ★ Coverage of all WWV and WWVH frequencies; 2.5, 5, 10, 15, 20 and 25 mc
- ★ Individual crystal for each frequency
- ★ High sensitivity and selectivity
- ★ Compact, reliable construction

Description:

This high-quality instrument is designed to provide laboratories and industries with a reliable, accurate means of utilizing primary standard times and frequencies supplied through the National Bureau of Standards' radio stations WWV and WWVH. Every feature for convenient operation and dependable performance is included.



Brief Specifications:

Frequency Coverage: 2.5, 5, 10, 15, 20 and 25 mc

Sensitivity: Better than 1 microvolt for 3 db signal plus noise-to-noise

Selectivity: 1 kc at 3 db down

Dimensions: 19" W x 5 1/4" H x 9-5/16" D; relay rack mounting

Weight: 17 lbs.

Price: \$495 f.o.b. factory

Write today for Technical Bulletin 1201-A; please address: Dept. SG-4

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Expanded Scale Frequency Meters and Voltmeters
Audio Oscillators • AC Voltmeters • Power Supplies
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Bridges • WWV Receivers
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NEW PRODUCTS

(continued)

plugged together to provide both direct and f-m type recording. Ask for bulletin 107.

Components and Accessories. Herman H. Smith Inc., 2326 Nostrand Ave., Brooklyn 10, N. Y. A new 32-page catalog features an expanded line of plugs and jacks, all with schematic diagrams and detailed technical specifications. Printed in 2 colors throughout, catalog No. 56 is an important reference work for everyone connected with the design and production of electronic equipment.

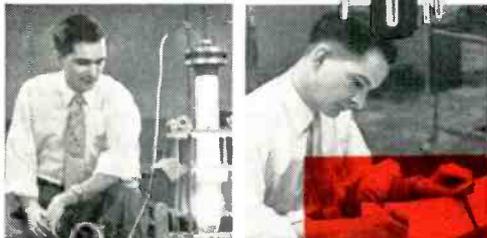
Antenna Catalog. Andrew Corp., 363 E. 75th St., Chicago 19, Ill., has produced a comprehensive catalog on antennas, antenna systems and transmission line. The 100-page catalog contains the product description and engineering data of over 500 products. Twenty pages are devoted to system engineering data and related information that engineers specializing in this field of electronics will find informative.

Ceramic Capacitors. Cornell-Dubilier Electric Corp., South Plainfield, N. J. A comprehensive 20-page catalog (616) covers all standard or popular ceramic capacitors—disk, tubular, slug-types and special types—manufactured by the company.

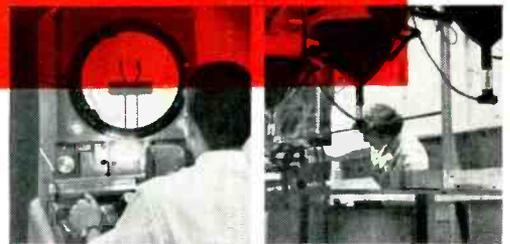
The illustrated, 3-color catalog consolidates an extensive variety of ceramic capacitors available to meet any precise applications. These include single and dual capacitance disks, tubulars, printed circuitry and automation disks, h-v slug types and special design types. The Tiny Mike line is also described.

Resin Booklet. Ohio-Apex Division, Food Machinery & Chemical Corp., Nitro, West Virginia. A 6-page booklet describes Dapon, a new material developed to fill a need for a solid prepolymer of diallyl phthalate. Included are information on applications, resin blends, laminates, and technical data on properties and solution properties.

Terminal Blocks. Marathon Electric, Wausau, Wisc. The complete line of Controlead heavy-duty terminal blocks is illustrated and



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**FREE
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**HOW TO APPLY
THERMAL RELAYS**

Based on 10 years experience in the design, manufacture and engineering application of thermal relays, this booklet contains diagrams and recommendations to save you hours of engineering time. Here is data on thermal relays with specifics on their use in high-power electron tube circuits, automatic controls and other applications. The booklet discusses design factors that influence the time delay, instantaneous and saturation values, re-operate and recovery periods... gives information on contact protection, how to eliminate contact chatter, temperature compensation and vibration problems. For your free copy of "How to Apply Thermal Relays"* write:

*Reprinted from "Electrical Manufacturing"

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described in a 4-page folder. Included are specifications on the series 1000 solderless connector block, series 2000 direct wiring block, series 3000 stud terminal block, series 6000 screw terminal block, series 6000-SC short circuiting block, and series 6000-H hinged cover block.

Ultraviolet Microscope. Norden-Ketay Corp., Snow & Union Sts., Boston, Mass. A 4-page illustrated bulletin deals with the automatic color translating ultraviolet microscope which is available for accurate structure determination and indication of absorption spectrum. Bulletin 370 describes applications and operating principles. A bibliography of experimental results obtained with the microscope is given. Prices are included.

Alternators. Leece-Neville Co., 1374 E. 51st St., Cleveland 3, Ohio, has released 2 new 4-page folders illustrating and describing two new models of its standard line of alternators, models 5368-G3 and 5370-G6. Designed to replace d-c generators on passenger cars, light and medium trucks, school busses and the like, the models described are also particularly suited for such specific types of vehicles with two-way radio or telephone as police cars, highway patrol, taxicabs and utility trucks. A transformer may be attached to the alternator discussed to give up 800 w of 110-v portable power.

The folders are illustrated with photos, charts and engineering drawings. Specifications, application and installation information are likewise featured.

Soft Soldering by Induction Heating. McDowell Electronics Inc., 117 Woodside Ave., Metuchen, N. J. Bulletin 561 is a 4-page folder that tells how soft soldering by induction heating can increase production output, cut labor costs, decrease production rejects, eliminate cold solder joints and assure uniform penetration. Illustrations and design notes are included.

Variable Delay Line. Helipot Corp., 916 Meridian Ave., South Pasadena, Calif. Data sheet No. 54-74 covers

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CONTROL INSTRUMENTS
require **MAXIMUM** Performance
MINIMUM Size - Weight - Power Drain

BRAILSFORD AGS TIMERS ARE UNMATCHED IN THESE BASIC REQUIREMENTS

IF YOU HAVE A TIMING PROBLEM WHERE SIZE, MASS AND POWER DRAIN ARE CRITICAL READ THESE

SPECIFICATIONS
Model AGS-4

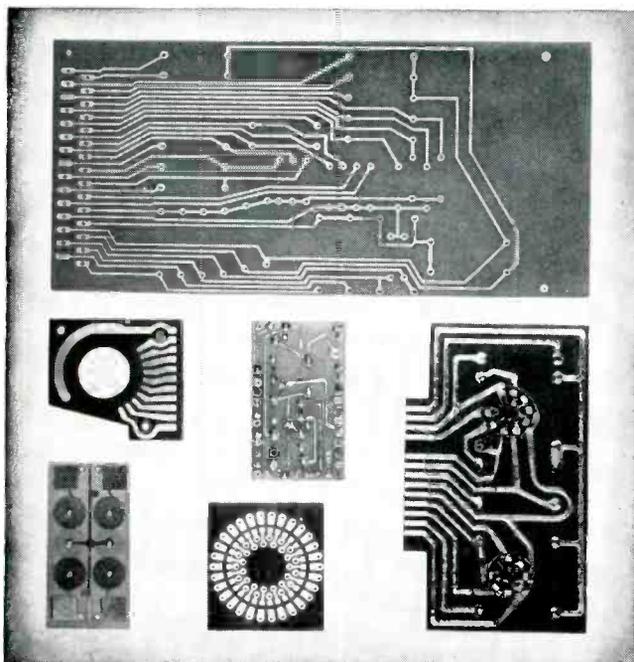
NUMBER OF CIRCUITS—4 SPDT
WEIGHT—6.1 OZ.
SPEED REGULATION $\pm 1.0\%$ @ $\pm 50.0\%$ VOLTAGE SHIFT

SIZE—3 IN. X 2 1/4 IN. X 1 1/4 IN.
POWER INPUT—008 AMP. @ 6 V.D.C.
ALSO AVAILABLE 1-2 OR 3 CIRCUITS

WRITE FOR LITERATURE
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ENGINEERING DEVELOPMENT MANUFACTURING
SUB FRACTIONAL WATT D.C. MOTORS **BRAILSFORD** SIGNALLING SYSTEM COMPONENTS

For the most dependable printed circuits, you need the high bond strength, workability, heat-resistance of C-D-F DILECTO[®] METAL-CLAD LAMINATES



Printed circuits based on C-D-F materials are being used with great success in military electronic equipment, commercial television and radio sets, telephone switchboards—even sub-miniature radiosonde equipment and hearing aids.

Photos courtesy of Photocircuits, Inc., Glen Cove, N. Y.

HIGH BOND STRENGTH—C-D-F's special adhesive for metal-clad Dilecto bonds the copper foil to the plastic without affecting the laminate's superior electrical properties. Heat-resistance, dissipation factor, dielectric constant, dielectric strength, and insulation resistance of the Dilecto base remain unaffected. The closely-bonded foil can be etched cleanly and dipped in hot solder to 220°C. (428°F.) for ten seconds with a guarantee of no blistering or separating. Metal-Clad Dilecto can be punched or machined either before or after etching.

EXCELLENT WORKABILITY—On all five Dilecto metal-clad grades, you can solder, punch, saw, and assemble components either by hand or automatically. Thanks to the inherently superior workability of the plastics laminate over that of ceramic-type materials, Dilecto can be dropped, jammed into tight chassis, and otherwise treated roughly on the assembly line and in service.

HIGH HEAT-RESISTANCE—Metal-Clad Dilecto Laminates are made of phenolic, epoxy, or Teflon* resin for various conditions of service and assembly, and have either cellulosic paper or woven glass-fabric base. All are ideally suited to printed-circuit applications in which heat-dissipation is a major problem. Continuous exposure to high ambient operating temperatures in enclosed electronic equipment has no significant effects on Dilecto's electrical and physical properties.

UNLOAD YOUR HEADACHE HERE! C-D-F, a big, reliable source of supply, can help you get the most for your printed-circuit money by reducing rejects, lowering fabrication costs, assuring dependable quality every time. Send us your print or problem, and we'll gladly supply appropriate test samples free. See our catalog in the Product Design File (Sweet's) or send for the new 20-page Dilecto catalog. Let your nearby C-D-F sales engineer (listed in Sweet's) help you right from the design stage!

TYPICAL PROPERTY VALUES

	Copper-Clad PHENOLIC (Grade XXXP-26)	Copper-Clad PHENOLIC (Grade XXXP-24)	Copper-Clad EPOXY (Grade GB-116E)	Copper-Clad EPOXY (Grade GB-181E)	Copper-Clad TEFLON* (Grade GB-116T)
BOND STRENGTH—0.0014" foil (Lbs. reqd. to separate 1" width of foil from lam. mate)	5 to 8	5 to 8	8 to 12	8 to 12	5 to 8
MAXIMUM CONTINUOUS OPERATING TEMP. (Deg. C.)	120	120	150	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil.)	800	800	700	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90% RH	50,000	50,000	30,000	20,000	Over 10 ⁶ megohms
DIELECTRIC CONSTANT 10 ⁶ Cycles	4.20	4.20	4.90	4.95	2.85
DISSIPATION FACTOR 10 ⁶ Cycles	0.026	0.026	0.019	0.018	0.0006
ARC-RESISTANCE (Seconds)	10	10	60	80	180
TENSILE STRENGTH (psi.)	16,000 x 13,000	14,000 x 11,000	46,000 x 42,000	48,000 x 44,000	23,000 x 21,000
FLEXURAL STRENGTH (psi.)	21,000 x 18,000	19,000 x 16,000	60,000 x 55,000	75,000 x 65,000	13,000 x 11,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.40 x 0.35	0.40 x 0.35	6.5 x 6.0	13.5 x 11.5	6.0 x 5.0
COMPRESSIVE STRENGTH flatwise (psi.)	28,000	27,000	60,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Cotton rag paper	Cotton rag paper	Fine-weave, medium-weight glass cloth	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural greenish	Natural Brown	Natural	Natural	Natural

All these standard grades are available with 0.0014", 0.0028", 0.0042", or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

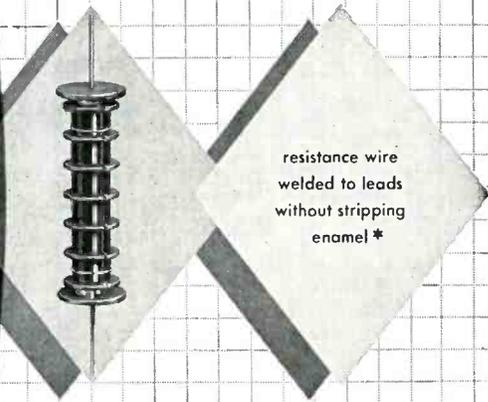
*DuPont Trademark



CONTINENTAL DIAMOND FIBRE
CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.

NEWARK 16, DELAWARE

TERMINATE PRECISION RESISTORS WITH SPEED AND RELIABILITY



resistance wire
welded to leads
without stripping
enamel*

precision stored-energy welding

WELDMATIC MODEL 1012 TWEEZER TYPE WELDER
welds fine wire to leads or tabs while resistor is on winder.

Enamel stripping and flux contamination eliminated,
with production time halved. Welded connection
is very positive, stable, and rugged.

*Made by Ircal Industries
a subsidiary, TRC

Unitek
WELDMATIC

UNITEK CORPORATION
259 Halstead Avenue • Pasadena 8, California
Write for Complete Technical Information
on Stored Energy Welding

the 1- μ sec Helidel variable delay line that has a longer total delay than in the 0.2- μ sec and 0.3- μ sec units. Delay in the unit described is adjustable in increments of 0.04 millimicroseconds; rise time, 0.08 μ sec maximum; frequency response, from 0 to 4.5 mc. Overshoot and phase distortion are negligible.

The 1- μ sec Helidel described is a 10-turn unit with mechanical rotation of 3,600 deg +5 deg -0 deg. Other applications include use in laboratory electronic measuring devices in color telecasting and high-speed computers. It is useful for measurement of potentiometer phase shift at 400 cycles; 360-deg phase shift at 1 megohm, and 1,800 deg at 5 megohms.

The unit described is also valuable as a memory circuit in the development of high-speed computers because of the relatively long, distortion-free delay.

Gear Boxes. Southwestern Industries Inc., 5880 Centinela Ave., Los Angeles 45, Calif., has issued an illustrated catalog sheet describing in detail a series of flexible, precision-made gear boxes for use in actuators, computers and small electronic components. Designated series 145 and 167, the gear boxes described provide maximum torques from 150 oz in. to 200 oz in. with high efficiency and low backlash.

Units discussed are designed for mounting directly to small electric motors, and can be supplied with an input shaft if desired. Ball bearings are used throughout to provide maximum operating efficiency. Complete specification tables are included in the catalog sheet.

D-C Power Supplies. Universal Electronics Co., 1720 Twenty-Second St., Santa Monica, Calif., has released an 8-page catalog (BF56), describing an expanded line of regulated d-c power supplies. The catalog includes approximately 125 models under the headings: Standard, Precision, Ultra-Precision, For Transistor Research, Unireg (Mag-Amp), Fixed Voltage, Constant Current and Custom Designs.

A COMPLETE SPINNING SERVICE

FOR THE

ELECTRONIC INDUSTRY

Metal Spinning

FROM 10' PARABOLA TO THIMBLE-SIZE CASE

Metal Fabrication

COMBINES SPINNING WITH FABRICATION,
WELDING and ANNEALING TO PRODUCE A
FINISHED PART. (Gov't. certified welders)

Mu Metal Shields

ANNEALED IN OUR OWN HYDROGEN ATMOSPHERE OVEN



COMMITMENTS SOLICITED. SEND FOR OUR BROCHURE
WE ARE A JOB SHOP — WE HAVE NO PRODUCT OF OUR OWN



TEINER *engineering corporation*

115-E Madison Street, Malden 48, Mass.



—the modern
successor to the
galvanometer

Research and production tests speeded with the *Electronik* Null Indicator

Design your servo circuits
around these Brown components



Brown Converters

Long-lived, low-noise, thoroughly shielded "choppers" for d-c to a-c conversion in radar, computers, servo and balancing circuits. SPDT switching action. Applicable to voltages as small as 1×10^{-6} . For 25, 40, 60 and 400 cycles. Prices from \$35.75. For full characteristics, write for Data Sheets No. 10.20-1 and 10.20-5.



Brown Servo motors

2-phase reversible motors ideal for servomechanisms, remote positioning, null circuit balancing, computers. High torque . . . fully enclosed, self-lubricating. No-load speeds of 27, 54, 167, 333 and 1650 rpm available. Operate from 115-volts, 60-cycles. Numerous variations in pinion, shaft, leadwires and materials are available for special requirements. Prices from \$40.50. Write for Data Sheet 10.20-2c.

JUST about anything a galvanometer can do . . . in laboratory or production line testing . . . the *Electronik* Null Indicator can do better, easier and faster. A completely electronic null detector, it can be used with any d-c bridge or potentiometer circuit. It is unaffected by vibration . . . needs no leveling or special mounting. It has plenty of sensitivity for the most accurate measurements. It's fast . . . indicates in less than $\frac{1}{2}$ second. It takes heavy overloads without damage . . . eliminates delays from "loss of spot" that hamper use of spotlight galvanometers. Just plug into any 115-volt, 60-cycle line, and it's ready to use. Look at these characteristics—then order one now for your own test work!

Period—less than $\frac{1}{2}$ second
Current sensitivity—.001 microamp/mm
Voltage sensitivity—1 microvolt/mm
Input impedance—1000 ohms at max. sensitivity
Overload rating—1 volt at max. sensitivity
Stability—less than 1 mm zero shift/hour
Damping—critically damped. Independent of external resistance.
Terminals—input and ground, for spade, pin, or banana plugs

PRICE—only \$175.00 net, f.o.b. Philadelphia

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4591 Wayne Avenue, Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS



First in Controls

Prices and specifications subject to change without notice

Electronics manufacturers continue to build new plants and expand existing facilities through acquisitions. Engineers are promoted to new positions, join new companies. Industry associations elect new officers, plan 1956 activities

Missile Firms Plan Extensive Expansions On The West Coast

LOCKHEED Aircraft will move its missile systems division from Van Nuys, Calif. to new expanded headquarters in the San Francisco area by the end of 1956.

An initial outlay of \$7 million will be spent for construction of two 51,000 sq ft research laboratories on a 22-acre site at Stanford University, and a 96,000 sq ft manufacturing facility on a 275-acre site, in Sunnyvale, 7 miles from the campus. Construction is scheduled to begin immediately on the two research labs, with work on the Sunnyvale plant to begin shortly. The labs are expected to be ready by fall and the plant by the end of the year.

The initial construction will be part of a \$20 million expansion program to take place over the next three years.

► **Boeing** — After revealing plans for an \$8.5 million manufacturing and office facility of 558,000 sq ft at Renton, Wash., the Boeing Airplane Co. announced plans for a \$21 million developmental center near its main plant in nearby Seattle.

The developmental center, south



Louis N. Ridenour, center, of Lockheed indicates site of the firm's new research buildings to Dr. F. E. Terman, right, and D. B. Adams of Stanford University

of the present plant and adjacent to Boeing Field, will include four main buildings and minor supporting structures which will add 1,021,000 sq ft of covered area to the Boeing operations. Certain phases of the Bomarc project (guided missiles), physical research, structural

testing and experimental activities are among the functions which will occupy the area.

Largest of the new buildings will have a total floor area of 754,000 sq ft. The buildings are expected to be completed and in operation by the fall of 1957.

Beckman Instruments Establishes Shockley Semiconductor Lab.

BECKMAN INSTRUMENTS has established the Shockley Semiconductor Laboratory near Stanford University to develop and produce transistors and other semiconductor devices in the field of advanced electronics for automatic production techniques.

Headed by Dr. William Shockley, pioneer in the development of the junction transistor, as director, initial lab members include Drs. G. Smoot Horsley, formerly of Motorola and Bell Laboratories; Leo B. Valdes, formerly of Pacific Semiconductor and Bell Laboratories; William W. Happ, formerly



William Shockley

of Raytheon and Sylvania and R. V. Jones.

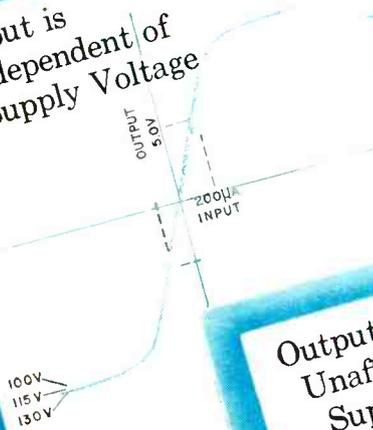
Quartered temporarily in Mountain View, Calif. the group will move into the new \$500,000 research and development center Beckman is building in Stanford Industrial Park for its Spincor division and the Shockley Semiconductor Laboratory.

Completion of the facility is scheduled for August.

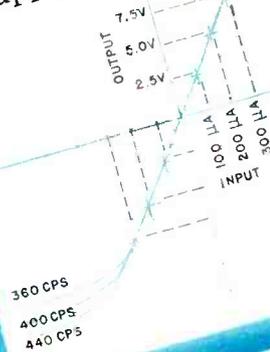
Dr. Shockley said that recent developments in physics and chemistry indicate great future expansion for semiconductors. "We have found corresponding phenomena in tran-

STABLE MAGNETIC AMPLIFIER

Output is
Independent of
Supply Voltage



Output is
Unaffected by
Supply Frequency



FERRAC

A FERRomagnetic Amplifier
for Analog Computers

Ferrac, a self-contained amplifier, is now available for use in computers and controls. Initial stand off error (current into one control coil necessary to accurately zero the output) and null error (current into control coil to re-zero the Ferrac during changes in environmental and operating conditions) do not exceed ± 5 microamperes.

CHARACTERISTICS

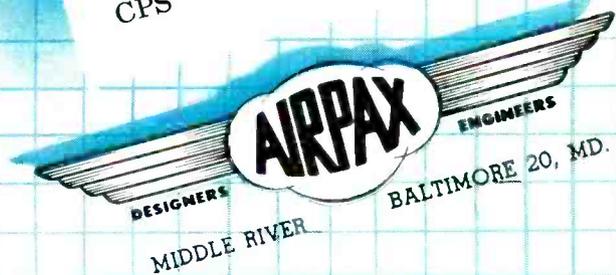
INPUT: Two fully isolated 120-ohm control coils, DC polarity reversible.

OUTPUT: Unfiltered DC linear to 7.5 volts into 1000-ohm load.

GAIN: 2.5 volts output per 100 microamps into either control coil, externally adjustable by feedback.

ENVIRONMENT: Operating range -55 to +85 C, meets MIL-T-27A requirements.

POWER: 115 volts at 400 CPS



MIDDLE RIVER

BALTIMORE 20, MD.

sistor and vacuum tube electronics which suggest ways in which transistor counterparts may be made for a wide variety of vacuum tubes now in use", he said.

General Radio Selects New President

CHARLES C. CAREY has been named president of the General Radio Co. of Cambridge, Mass. succeeding Errol H. Locke, recently retired.

Carey joined the company's production department in 1927 and has been its vice-president for manufacturing since 1944.

The following directors were re-elected: Harold B. Richmond, chairman; Charles C. Carey; Donald B. Sinclair; Arthur E. Thiessen and Frank L. Tucker.

Lenkurt To Build New Engineering Building In California

ARCHITECT Frank Lloyd Wright has been retained by the Lenkurt Electric Co. of San Carlos to design a new administration and engineering building for the electronics firm.

The building will have about 90,000 sq ft of floor space and will be located near the center of Lenkurt's 55-acre plot in the San Carlos industrial area.

Neither the exact site nor the timetable for construction of the administration and engineering building is definite yet and it may be several more months before plans are complete and building starts.

Offices and engineering development laboratories that will go into the new Lenkurt building now occupy about one-third of the company's present 167,000 sq ft of floor space. The firm recently broke ground to add another 6,000 sq ft

Sprague Constructs Transistor Plant

CONSTRUCTION of a new plant for Sprague Electric Co. to manufacture surface-barrier transistors will begin shortly at Concord, N. H. The new building will occupy 20,000 sq ft adjacent to the Concord Airport.

It is expected that production will be well under way by fall of 1956 with about 200 persons employed.

Temporary manufacturing quarters in Concord will probably be utilized by Sprague beginning this spring while the new plant is being built.

Sprague was recently licensed to produce surface-barrier transistors under Philco patents.

General manager of the firm's Concord operation will be Jesse Ault, who recently retired as works manager of the Haverhill and Andover, Mass. plants of the Western Electric Co. John Puppolo, who has been associated with Sprague for the past 22 years and is presently production superintendent of the firm's tantalum electrolytic capacitor operations at North Adams, will be factory manager in charge of production. The Concord plant will be Sprague's twelfth for the manufacture of electronic components.

The company presently employs over 6,000 persons in the manufacture of various types of electronic components.



Frank Lloyd Wright, center, and president L. G. Erickson, right, and executive v-p K. E. Appert of Lenkurt Electric

factory building wing.

During the past six years the number of Lenkurt employees has increased from 125 to the present

total of 1,600 and the company's monthly business volume has jumped from \$100,000 to \$1,500,000.

Magnavox Acquires Two Businesses, Appoints Engineers

THE MAGNAVOX Co. and Sentinel Radio Corp. signed a contract for the sale of substantially all the assets, properties and goodwill of Sentinel as a going business to Magnavox.

Magnavox expects the acquisition of Sentinel to facilitate its planned long-range expansion program. Operations at the Sentinel plant in Evanston, Ill., are expected

to continue and be expanded in the near future. Leonard F. Cramer, vice-president and general manager of the television-radio-phonograph division of Magnavox, will be responsible for the Sentinel operation.

Richard S. Lawton, present secretary-treasurer of Sentinel, will continue in an executive capacity. The business will continue without

interruption and production will be accelerated in the near future. Magnavox also plans to build a 100,000 sq ft plant at Urbana, Ill. with provision for eventual expansion of this operation to 400,000 sq ft. It is to be completed by the latter part of 1956.

Magnavox also completed the acquisition of the Sparks-Withington radio-television business as

STAR PERFORMER

GOOD-ALL Capacitors

contribute to the stable performance of many types of electronic equipment. Not all are as large and impressive as a TV transmitter, but their requirements for capacitor stability may be many times more exacting.

Engineers have come to rely on Good-All Mylar capacitors for their small capacity change during life. This feature, together with small size, low power factor and excellent IR, is responsible for the rapid increase in demand for our various MYLAR* types.

**DuPont's Trademark for Polyester Film*

CLOSE TOLERANCE

The use of close tolerance capacitors becomes practical when there is assurance that later shifts will not wipe out the advantage of initial precision. Good-All Mylar types are widely applied in tolerance of 1%, 2% and 5%. Our engineers are ready to work with you on any capacitor problem.

MYLAR Capacitor Applications

Computers . . . Military and Commercial
Seismic Instrumentation
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Critical TV Circuits
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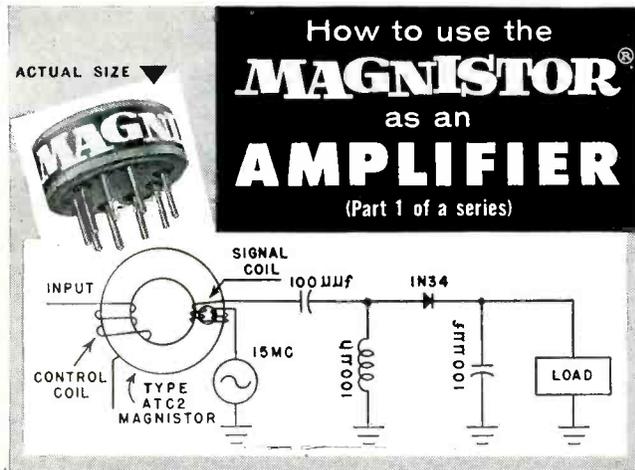


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**GOOD-ALL
ELECTRIC MFG. CO.**

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- LOW NOISE
- LONG LIFE
- RUGGEDNESS
- SMALL SIZE

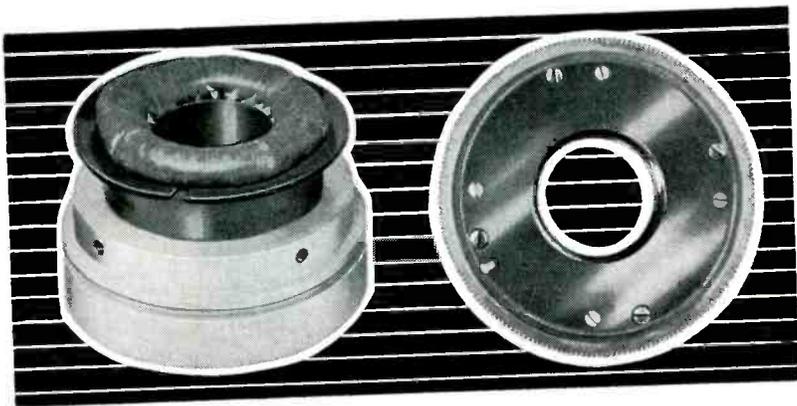
... high power gain and dependability are only a few advantages of Magnistor amplifiers for low-level signals from d-c to rf frequencies. The typical circuit illustrated will deliver a 25-volt signal at 20 ma, with an output noise level equivalent to less than 2 microvolts applied to the input, and an input impedance of 50 ohms.

Using other Magnistor types and circuits, considerably higher gains can be attained. For complete information on Magnistors, their circuits and applications, write to:



POTTER INSTRUMENT CO., INC.
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DEFLECTION YOKES



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Celco

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Constantine Engineering Laboratories Co.

Island Avenue

Mahwah, N. J.

part of a planned program to increase the company's sales volume to the \$100 million mark in its next fiscal year. The Magnavox Company volume for the last six months ended December 31, 1955 was \$34 million. It is anticipated that the sales volume to be gained from the acquisition of the Spartan business will add from \$15 million to \$20 million in radio-phonograph-television annual business.

None of the manufacturing facilities of Sparks-Withington were acquired. Only certain movable assets associated with the manufacture and conduct of the Spartan radio-television business were purchased. A line of instruments will be manufactured by the Magnavox Company in its own plants and sold under the brand name of Spartan through the sales personnel previously associated with the Sparks-Withington.

Lt. Col. John J. Slattery was appointed assistant to the vice-president and general manager of the government and industrial division of Magnavox.

Prior to joining the firm, he was vice-president and director of engineering of Sterling Precision Instrument Corp., instrument division.

Colonel Loren E. Gaither, Signal Corps, USA (RET), has been appointed director of engineering of the government and industrial division of Magnavox. He was formerly with the Evans Signal Laboratory of the Signal Corps engineering laboratories of which he was director from 1951 to 1955.

Bendix Names Transistor Head

WALLACE C. CALDWELL has been appointed to head a new department for expanded research into and production of transistors at the Red Bank division of Bendix Aviation Corp.

Dr. Caldwell, who has been chief engineer of the division's electron tube plant in Eatontown, N. J. for the past four years, will direct an engineering and manufacturing program geared to the market for transistors and other semi-conductor devices.

Before joining Bendix, Caldwell

was associated with the department of physics of Iowa State College and also served as a consultant to Bendix. During World War II he conducted research and development on radar systems and radar tubes at MIT.

John H. Wyman had been named to succeed Dr. Caldwell as chief engineer for electron tubes at the Red Bank division. Wyman has been with Bendix for seven years, serving most recently as chief project engineer for special-purpose electron tubes.

Bendix also announced that Richard M. Somers has been appointed director of engineering for the Kansas City division.

Prior to his appointment he was assistant director of engineering of the division, which is engaged in the production of instruments and electronic devices as a prime contractor for the Atomic Energy Commission.

He joined Bendix as a staff engineer of the Eclipse-Pioneer division, Teterboro, N. J.

Somers succeeds Howard K. Morgan who has been named director for commercial aviation systems of the corporation.

Fairchild Formally Opens New Plant



Left to right, S. M. Fairchild, Lee Griswold, J. M. Case

FAIRCHILD Camera and Instrument Corp. formally opened a new plant in California primarily built to provide new west coast production, engineering, sales and office facilities for the potentiometer division of Fairchild Controls Corp., a wholly-

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TUBING...MOLDED OR MACHINED PARTS?

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"Made of Teflon by JOHN CRANE" has become practically a standard specification for parts and components subject to severe electrical, corrosive, thermal, mechanical or atmospheric abuse. Whatever your requirements in Teflon . . . sheet, rod, tubing, packings, gaskets, bellows, insulators, sealing discs or non-stick parts . . . "John Crane" can supply them!

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Hamilton, Ont.



* **TEFLON** DuPont trademark

Advantages:

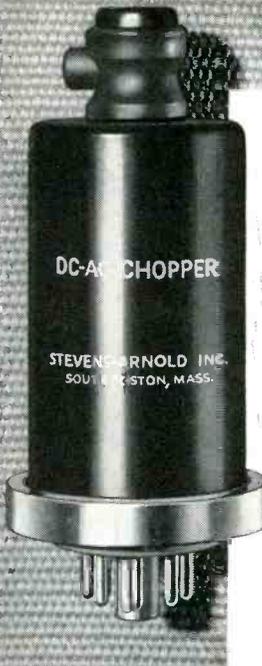
- CHEMICAL**—Completely inert
- ELECTRICAL**—Extremely low power factor
Very high dielectric strength
- THERMAL**—Temperature range
—300°F. to +500°F.
- MECHANICAL**—Strong, flexible
Weather resistant
- LOWEST COEFFICIENT OF FRICTION**
- ABSOLUTELY NON-STICK**

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CRANE PACKING COMPANY

OFFICES IN ALL PRINCIPAL CITIES

38 YEARS
INDUSTRIAL PROGRESS



DC-AC CHOPPERS

For 60 Cycle Use

Built to rigid commercial specifications.

Twenty-two types, both single and double pole.

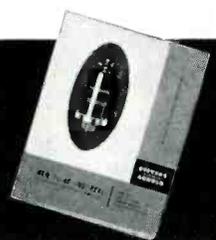
Long life.

Low noise level.

Extreme reliability.

Write for Catalog 370.

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S/A-10

owned subsidiary. The 25,000 sq ft structure also provides office facilities for the reconnaissance systems division and Fairchild graphic equipment Corp., another wholly-owned subsidiary. The plant is situated on a seven acre tract to provide ample room for future building additions.

Fairchild executives on hand for the event included in addition to Sherman M. Fairchild, board chairman, L. T. Eliel, president of Fairchild Aerial Surveys; John M. Case, executive vice-president of FCI; Richard Hodgson, FCI vice-president, and president of the subsidiary Fairchild Controls Corp.; Erwin Hale, vice-president of Fairchild Controls and general manager of the potentiometer division; E. F. Richardson, director of organization and control; Lee Griswold, manager, potentiometer division west coast; Milton A. Chaffee, director of electronics and systems research and James B. Moore, director of public relations.

Fairchild also announced that Leonard S. Hermelin was appointed executive assistant to Richard Hodgson, vice president of Fairchild and general manager of the reconnaissance systems division.

He was formerly assistant manager of the division's systems projects department.

Prior to joining the company in 1953, he was chief engineer, guided missiles division, Fairchild Engine and Airplane Corp.

New Radio-TV Firm Established In Mexico

A NEW company known as Electronica Mexicana has been organized in Mexico City by Sears Roebuck & Company and two of its suppliers; Warwick Manufacturing Corp., and Pacific Mercury of California.

Pacific Mercury and Warwick have jointly operated a factory in Mexico since July 1955.

The redesigned plant occupying 40,000 sq ft, which will make electronic components in addition to tv and radio sets, can be expanded as the need for additional manufacturing and office space arises.

The plant has a conveyORIZED

Borg 900 Series Micropots offer everything you want in a potentiometer



- 1 Versatility — 1 to 5 gang models, single or double shaft, servo or bushing mount.
- 2 Permanent Accuracy — Resistance element integrally molded within housing. Leads, taps and terminals firmly encapsulated.
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Borg 1100 Series Micropots

Accurate, dependable, long-lived. Has 9 inch coded leads for easy installation. Offers your products a competitive price advantage.

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BORG EQUIPMENT DIVISION
GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN




Built by Borg

About a Sawtooth, Clamping and your Efficiency...

Let's look at it this way—What features should an instrument incorporate to make your job easier, help prevent costly mistakes? Take the case of the new PRD Klystron Power Supply. Should we incorporate a sawtooth rather than a sine wave modulation? It's easier to put in a sine wave. However, a sawtooth has the definite advantage of eliminating phasing and blanking problems when the frequency response of a transmission device is to be studied. So, in goes the sawtooth. It's easy enough to get hold of some sine wave modulation which can be applied through the external modulation input.

As for preventing mistakes—consider switching from cw to square wave modulation. Suppose you forget to readjust the reflector voltage . . . Sure, you'll catch the mistake later, but time is lost. The new PRD Klystron Power Supply has an electronic clamping circuit which locks the top of the square wave to the previously chosen reflector voltage. No readjustments to think about, no mistakes.

Want to modulate with pulses—use the external input. The rise time degradation of your pulses will be less than .1 microsecond!

Another point, good regulation! Here's an example: a $\pm 10\%$ line change or any load change will cause a reflector voltage change of only $\pm 0.1\%$.

Compare . . . chances are that you'll send in your order for the PRD Type 809, too.

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The New PRD KLYSTRON POWER SUPPLY



HERE'S WHAT THE TYPE 809
CAN DO FOR YOU —

- Powers most low and medium voltage klystrons — up to 600 V. beam supply
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- Has square wave, sawtooth and provision for external modulation for pulses
- Affords exceptional stability and regulation at modest cost
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Miniaturized CAPACITORS FOR TRANSISTORIZED ASSEMBLIES

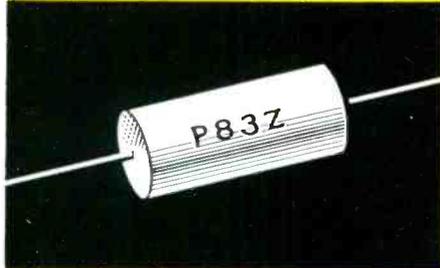
P-82 and P-92ZN CAPACITORS

Metallized-paper units—P-82, cardboard sleeve with metal end-caps and extended foil construction. Operating temperature range from -40°C to $+70^{\circ}\text{C}$.; P-92ZN, high temperature capacitor in paper case with plastic end-fill. Operating range from -30°C to $+100^{\circ}\text{C}$.



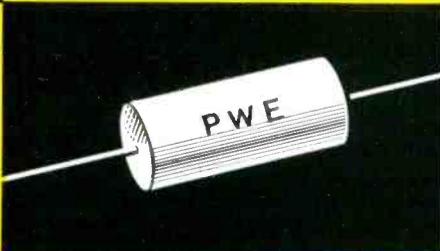
P-83Z CAPACITORS

Sub-miniature molded metallized-paper units in humidity-resistant molded thermoplastic case. Particularly applicable to replacement of low-capacitance paper units now in use. Operating temperature range from -15°C to $+85^{\circ}\text{C}$. In 200-volt ratings from .005 to .04 mfd. Sizes, $\frac{3}{16}$ " d. x $\frac{3}{16}$ " l., to $\frac{1}{4}$ " d. x $\frac{3}{16}$ " l.



PWE CAPACITORS

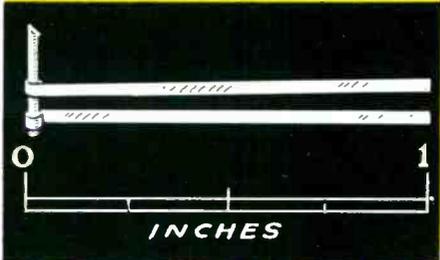
Steatite-cased miniature aluminum-foil electrolytics, offering relatively high capacitance at low voltages. Size, only $\frac{1}{4}$ " d. x $\frac{3}{4}$ " l. Operating temperature range from -30°C to $+50^{\circ}\text{C}$. Exceedingly low leakage currents.



CERAFIL* CERAMIC CAPACITORS

Newest and positively the smallest capacitors available anywhere. Rugged ceramic-dielectric units for operation from -55°C to $+85^{\circ}\text{C}$. Ultra-miniature size in .001 mfd. unit is .060" d. x .290" l. Capacitances of .001 to .1 mfd. Miniature ceramic disk capacitors also available.

*Trade-mark



Transistorized assemblies demand miniature components. In some instances conventional capacitors prove adequately small; in others, new designs and materials have had to be developed. Aerovox application engineering, always in step with electronic trends, now offers a wide choice of miniaturized capacitors.

GET THE FACTS...

Complete engineering details available by writing TECHNICAL SALES DEPT., Aerovox, New Bedford, Mass.



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heating tunnel for the production of tv and radio cabinets. Because of the altitude, drying initially presented a difficult problem.

Dynamics Expands Reeves Instrument

REEVES INSTRUMENT CORP., a subsidiary of Dynamics Corp. of America, has taken over a \$5,000,000 plant and added facilities at Roosevelt Field in Mineola, N. Y. The addition increases the company's plant space by more than 30 per cent.

The 280,000 sq ft plant will bring together under one roof Reeves research, development and production programs previously located in a number of buildings at Roosevelt Field. It will accommodate more than 3,000 employees, as compared with 1,300 in the old facilities.

The new plant will increase Reeves Instrument's total factory and office space in Mineola and New York City to approximately half a million sq ft.

Radio Club Elects Officers



Frank A. Gunther

THE Radio Club of America elected Frank A. Gunther president of the organization for 1956. Serving with him are Walter A. Knoop, Jr., vice-president; O. James Morelock, corresponding secretary; Joseph J. Stantley, treasurer, and John H. Bose, recording secretary.

Directors for the coming year include: Ernest V. Amy, Ralph R. Batcher, George E. Burghard, Paul F. Godley, Harry W. Houck, Fred

A. Klingenschmitt, O. F. Masin, Renville H. McMann, Jr., Jerry B. Minter, Harry Sadenwater, Francis H. Shepard, Jr., Joseph J. Stantley, Jr. and Craig Walsh.

Frank A. Gunther is vice-president of Radio Engineering Laboratories in Long Island City.

Walter A. Knoop is a professional engineer in the firm of Gawler-Knoop Co. O. James Morelock is a radio consultant in Millington, N. J. Joseph J. Stantley is with Continental Sales Co., Inc., of Newark, N. J. John H. Bose is engaged in research at the electronics research laboratories of Columbia University.

GE Appoints Three Engineers

GEORGE G. GABEL has been appointed manager of the General Electric semiconductor products manufacturing operation in Syracuse, N. Y.

He joined GE in 1929 at Schenectady and transferred to Syracuse in 1944 as assistant superintendent of aircraft gas turbine manufacturing operations.

Immediately prior to his latest appointment, Gabel was manager of manufacturing engineering at the Clyde, N. Y., semiconductor products plant, a position he assumed in 1954.

James W. Nelson, Jr. was appointed manager, and William A. Edson, consulting engineer of GE's microwave laboratory at Stanford Industrial Park, Palo Alto, Calif.

Nelson succeeds H. R. Oldfield, Jr. who has been manager of the micro-



J. W. Nelson, Jr.

CIRCUIT NO.	CIRCUIT TYPE	INPUT	OUTPUT	OPERATING RANGE	TUBE	POWER
B 1001	300V DC REGULATOR	150 VDC MINIMUM	NEGATIVE PULSE	NEGATIVE PULSE	6080 5751 5651	6 V @ 2.8 AMPS
F 1001	VIDEO LIMITER	NEGATIVE PULSE	POSITIVE PULSE	4.2V LIMITING LEVEL	6AK5	-150 VDC @ 14 MA 6 V @ 175 MA
P 1002	LOW LEVEL CATHODE FOLLOWER	POSITIVE PULSE	POSITIVE PULSE	MAXIMUM LEVEL 4.2V IN	2C51 OR 5670	150 VDC @ 22 MA 150 VDC @ 1 MA 6 V @ 300 MA
P 1003	DUAL CATHODE FOLLOWER OR VIDEO MIXER	POSITIVE PULSE	POSITIVE PULSE	75% OF INPUT	2C51 OR 5670	+150 VDC @ 1 MA 6 V @ 300 MA
P 1004	INTERMEDIATE VIDEO AMPLIFIER	POSITIVE OR NEGATIVE PULSES	POSITIVE OR NEGATIVE PULSES	MAXIMUM SIGNAL 5 VOLTS FOR CASCADING STAGES -2.3 TO +2.2 VOLTS FOR SINGLE STAGE	2C51 OR 5670	+150 VDC @ 1 MA 150 V @ 1 MA 6 V @ 300 MA
P 1005	VIDEO DRIVER AMPLIFIER	POSITIVE PULSES	NEGATIVE PULSES	2 TO 15 VOLTS INPUT MAXIMUM OUTPUT 83 VOLTS	2C51 OR 5670	+150 VDC @ 1 MA 150 V @ 1 MA 6 V @ 300 MA
1001	MULTIVIBRATOR			280 VOLTS EXCLUDING ANY NEGATIVE OVERSHOOT	12AU7	+150 VDC @ 8 MA 6 V @ 300 MA

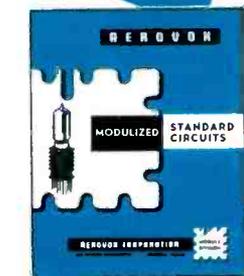
Available Now... AEROVOX MODULIZED STANDARD CIRCUITS

For the first time, the design engineer, experimenter, prototype technician and special-equipment builder can enjoy the advantages of basic circuit assemblies in the form of neat, compact, high-reliability modules. Instead of gathering, designing, wiring and testing the various components that go into basic circuitry, the user now has all that work done for him with these handy plug-in AeroVox modules, thereby permitting better utilization of time and talents towards more creative design requirements.

Selecting the most popular basic circuits with corresponding sub-assemblies, AeroVox now offers, through its parts distributors, seven standard-circuit modules. As a further convenience in selecting and connecting these modules, AeroVox makes available a 12-position printed-wiring breadboard with connection jacks and bus bars.

Individual standard-circuit modules, mounting sockets, breadboard, may be purchased separately. Complete kit containing seven standard-circuit modules, breadboard, banana plugs and instruction manual, in handsome plastic box, available at special introductory price.

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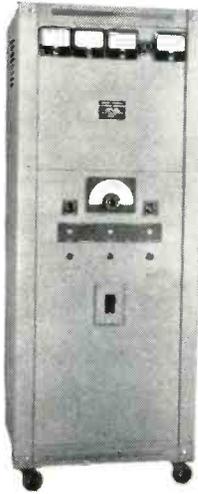
THREE PHASE VARIABLE FREQUENCY POWER SUPPLY

CONTINUOUSLY VARIABLE FROM 360 TO 440 CPS

CML's Model 1450 Electronic Generator has a power output of 750 volt-amperes with output voltage regulation of better than 2% from no load to full load. Harmonic content is below 3% at full load.

Model 1450 is also available as a fixed frequency unit employing a tuning fork oscillator to give a frequency accuracy and stability of 1 part in 50,000. This stability is independent of line voltage or frequency.

Catalogue sheet "P" describes the Model 1450 and is available for the asking.



COMMUNICATION MEASUREMENTS LABORATORY, INC.

350 LELAND AVE., PLAINFIELD, N. J.

wave laboratory since it was established in late 1954. Oldfield was recently promoted to general manager of a newly-established industrial computer section in Syracuse, N. Y.

Prior to his new appointment, Nelson was manager of electron tube research of the microwave laboratory. He has been with the company's electronics division since 1946, and was a member of the management team which established the Laboratory.

As consulting engineer, a new position in the microwave laboratory, Dr. Edson will be responsible for advice and counsel on technical aspects including planning for the future. He has been manager of microwave techniques at the laboratory since August, 1955, when he joined General Electric.

He came to the laboratory from Stanford University where he was acting professor of electrical engineering. Prior to this he was director of the school of electrical engineering at Georgia Institute of Technology.

Ramo-Wooldrige Plans Expansion

RAMO-WOOLDRIDGE CORP. plans the erection of a major electronics manufacturing plant in the Denver area.

It exercised an option on 640 acres of industrial land near Littleton, Arizona. Ground will be broken in May or June on the first structure of 172,000 sq ft, with allowance for future expansion of the site, if needed.

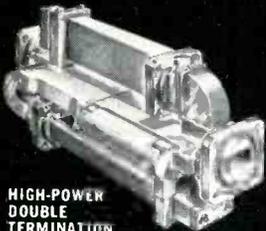
Original production in the new factory will be electronic systems for military customers, such as fire control systems for military aircraft, radar systems, electronic computers, or advanced communications equipment. Later, the company expects to produce automation and data processing equipment for commercial clients, as well.

The facility will accommodate 1,500 employees, with annual sales of \$25 million.

Buildings currently occupied or under construction by Ramo-Wooldrige in the Los Angeles International Airport area total 300,000 sq ft.

Employment has grown from

FERRITE COMPONENTS



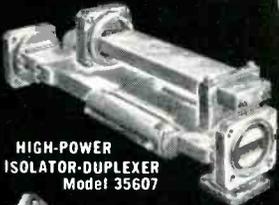
HIGH-POWER
DOUBLE
TERMINATION
LOAD ISOLATOR
Model 34305



HIGH-POWER
DIFFERENTIAL ABSORBER
Model 35776



HIGH-POWER
SINGLE TERMINATION
LOAD ISOLATOR
Model 34304



HIGH-POWER
ISOLATOR-DUPLEXER
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DOUBLE
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POLARIZATION
CIRCULATOR
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Experience, skill and technical know-how has made Canoga Corp. a leader in the microwave field. The components illustrated and described are representative of Canoga's continuing progress in research and design... dedicated to serving and benefiting the microwave engineer

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Delco Radio, first organization to develop and use Hi-Power transistors for automotive application, now offers permanent employment opportunities to men of highest caliber.

Some of these opportunities are for men experienced in solving problems of semiconductor processing, development, or application. Other positions exist for persons experienced in semiconductor or related research.

These are challenging jobs where professional knowledge will be utilized to the highest degree. Qualified persons will be rewarded with personal satisfaction, recognition and stimulating companionship with other eminent scientists, and will also receive liberal compensation and benefits as important members of the General Motors organization.

If you are capable of assuming the responsibility of leadership and are experienced in transistor, diode, photo cell or other semiconductor projects, write to Personnel Director, Department B. Your inquiry will be held in confidence.

**WORK WITH THE MEN WHO FIRST MADE HI-POWER
TRANSISTORS AVAILABLE IN AUTO RADIOS!**

Relocation expenses are paid to pleasant Indiana community where you'll make congenial associations with men of recognized standing in the field of semiconductors.



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DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA



TELEX Mini-Mike[®]

- Tiny, precision speaker-microphone.
- Quality, dynamic performance.
- For use in dictating machines, transceivers, other electronic equipment where "ruggedness" is important.

Model 100 PRECISION DESIGN Wt. approx. 1½ oz.; Size 1"x1"x¾"; Impedance 10 ohms

TELEX Boom-Type Headset

NEW

For airline reservation boards, telephone operators, television floormen.

- Lightweight . . . adjustable tone arms . . . no ear muffs.
- Available with single, double receivers, split phones.



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Electro-Acoustic Division, Telex Park, St. Paul 1, Minnesota

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Representatives in Principal Cities

PRODUCTIMETERS
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150 in July, 1954, to nearly 1,400 currently. By December, 1956 employment is expected to exceed 2,300.

Sales for the company totalled \$10,000,000 in 1955 vs. \$2,000,000 in 1954. Sales this year are expected to exceed \$20,000,000.

Philco Names New President

JAMES H. CARMINE will retire as president of Philco Corp. when his term ends in April. He plans to continue as an active member of the company's board of directors and finance committee and to serve as special consultant on sales and merchandising. He joined Philco in 1923 as a battery salesman.

William Balderston, who has been associated with Philco for 25 years, is to be re-elected chairman of the board. James M. Skinner, Jr., who is now a director and vice-president and general manager of the television division, is to become president.

Skinner, son of the late James M. Skinner, who was president of Philco from 1929 to 1939, joined the company in 1934.

Gunderson Receives Amateur Award



Left to right, J. Milton Lang of GE, under secretary of state Herbert Hoover, Jr., Robert W. Gunderson

ROBERT W. GUNDERSON, a blind New York City radio amateur, was presented with the Fourth Annual Edison Radio Amateur Award for outstanding public service.

He received the trophy and \$500 check for designing electronic test

BRUSH ...complete systems for noise or vibration measurement

21 seconds to make complete noise or vibration analysis!

This chart record produced by the Brush Spectrum Recorder presents a complete frequency and noise level analysis for an electric motor. It is an example of the way Brush instrumentation can aid your analysis of noise or vibration:

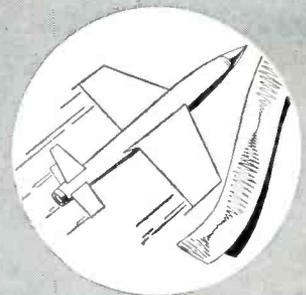
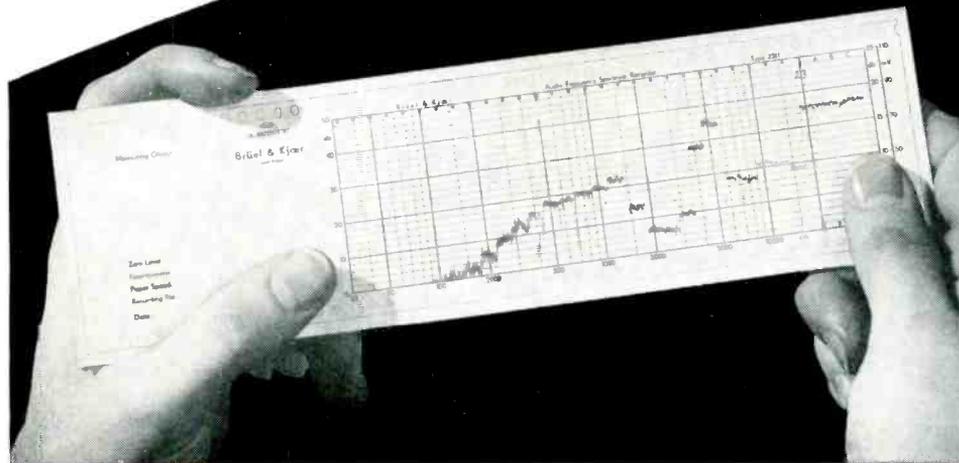
- All sounds from 14 cycles to 36,000 cycles per second automatically scanned and recorded by the Brush Spectrum Recorder to eliminate laborious plotting of data.
- Measurements made in one-third octave steps, to positively identify frequencies.

How leading companies use this Brush instrumentation

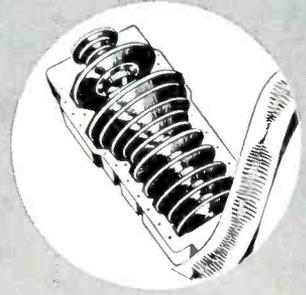
- engine vibration analysis
- aircraft noise reduction
- accelerometer calibration
- missile testing
- jet engine noise measurements
- appliance noise reduction
- automotive vibration analysis
- tape recorder readout
- plant noise studies
- evaluating acoustic materials

- Complete recording through the complete frequency range made in 21 seconds, to save valuable engineering time.

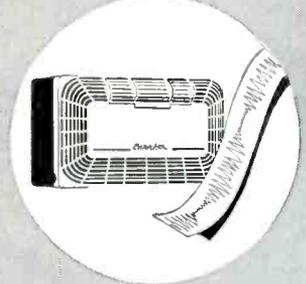
The Spectrum Recorder is one unit in the most complete line of noise and vibration instrumentation available (manufactured in Denmark by Bruel & Kjaer). Thus Brush can offer you matched systems, and offer application assistance on complete projects. For complete information call your Brush representative, or write Brush Electronics Company, Dept. K-4, 3405 Perkins Avenue, Cleveland 14, Ohio.



LOCKHEED ... uses Spectrum Analyzer for data reduction of telemetered information ... and to measure noise transmission through aircraft fuselage wall panels.



GENERAL ELECTRIC ... uses Frequency Response Recorder to check mechanical resonance points of both steam and jet turbines when blades are magnetically vibrated.



CARRIER ... uses Spectrum Recorder for production quality control checks of room air conditioning units.



SPECTRUM RECORDER is integrated system for noise and vibration recording in one-third octave steps.

BRUSH ELECTRONICS

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

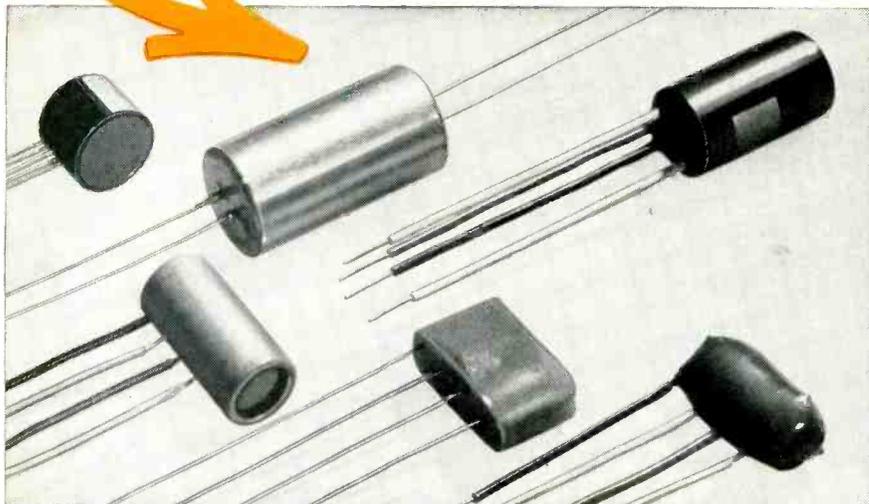


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UNION

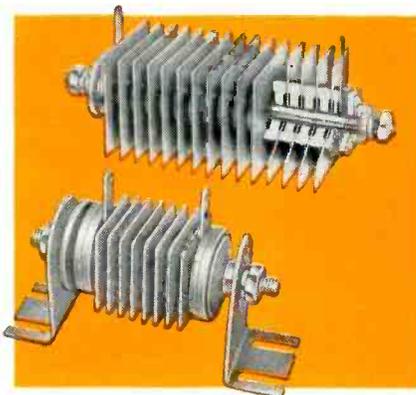
SELENIUM RECTIFIERS fitted to your application



SPECIALLY DESIGNED COMBINATIONS of standard UNION selenium rectifier cells range in size from $\frac{1}{8}$ " to $\frac{1}{2}$ " diameter rated from 2.5 to 40.0 milliamperes per cell on a single-phase full-wave bridge basis.



"SELENIUM SLIMS" in five ratings ranging from 1.25 to 20.0 milliamperes and maximum peak inverse voltages from 36 to 9360 with condenser input filter. Available in diameters from $\frac{1}{8}$ " to $\frac{1}{2}$ ".



POWER RECTIFIERS with solid stack assembly range in size from 1" x 1" to 5" x 6" and with convection cooling are rated from .80 to 10.0 amperes per cell on a single-phase full-wave bridge basis.

Our engineers can help you in designing the best rectifier for your applications. Write for catalog.

GENERAL APPARATUS SALES

UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

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PENNSYLVANIA

PLANTS AND PEOPLE

(continued)

instruments which operate by sound instead of visual meters. The annual award is granted each year by General Electric Co. for ingenuity and sacrifice displayed in employing amateur radio in the public interest.

Speakers at the award banquet in Washington, D. C. included Herbert Hoover, Jr., the undersecretary of state, himself a licensed radio amateur.

Gunderson is editor of The Braille Technical Press, an electronics magazine for the blind, and has translated electronics reference books into Braille.

Mallory To Acquire General Dry Batteries

P. R. MALLORY plans to acquire the business of General Dry Batteries.

General Dry is to operate as a Mallory division under its present management. In addition to president Walter A. Onorato, General Dry's officers include Fielder Israel, executive vice-president, and Dudley Thomas and Frank J. Wisinger, vice-presidents.

Motorola Extends Arizona Expansion

A \$3 million plant expansion for its Phoenix, Ariz., research and production facilities is planned by Motorola.

The new plant site is on 160 acres 2 miles southeast of Scottsdale, resort center about 9 miles west of Phoenix.

The additional 150,000 sq ft of production and laboratory space will bring total plant space of Motorola's three Phoenix facilities to 300,000 sq ft.

Work in the new plant will be devoted to research, development, and production of military electronic equipment. This plant will parallel production of one of the two other Motorola divisions in Phoenix. The company's third plant, a \$1.5 million structure, produces transistors for military and civilian use.

When completed, the new facility will employ a work force of 1,000—divided into about 400 engineers and physicists and about 600 as-

sembly and production workers. Motorola now employs 2,000 at its two other facilities at Phoenix.

When all three plants are in production, the company payroll will top \$1.5 million a month making it one of the largest in the state.

Westinghouse Promotes Five Engineers

GILBERT C. LARSON has been appointed assistant general manager of the television-radio division of Westinghouse.

He was employed by the Colonial Radio Corp. in 1935 as supervisor of the production engineering laboratory. From 1940, he was with the Hazeltine Electronics Corp. as a project engineer on iff gear, and later, as engineer in charge of the New York licensee laboratory. He joined Westinghouse in December 1947. Prior to his new appointment, he was manager of engineering for the television-radio division.

Norman S. Kornetz has been appointed manager of engineering of the division. He was formerly manager, engineering sub-division, where he had direct responsibility for all television engineering.

He was a radio receiver design engineer with the Colonial Radio Corp. from 1938 through 1942. In 1942 he became a captain in the U. S. Signal Corps and was in charge of the government's administrative radio communications at Calcutta, India, until 1945.

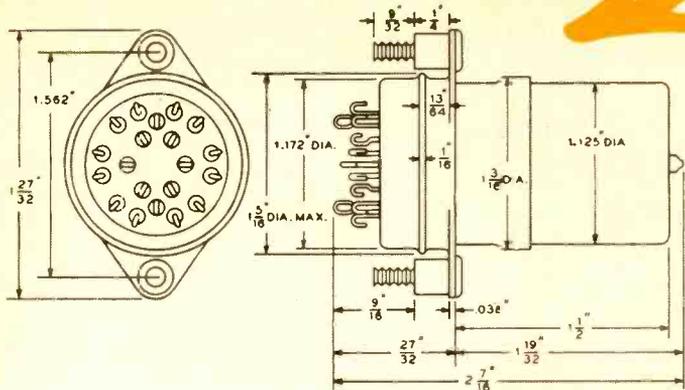
He joined Westinghouse in 1945 as manager of television engineer-



Norman S. Kornetz

UNION

MINIATURE RELAY Plate Circuit 10,000 OHMS



THIS NEW UNION 10,000 ohm, current-sensitive relay picks up at a nominal value of 8 milliamperes throughout the entire temperature range of -65°C to $+125^{\circ}\text{C}$, while maintaining the excellent shock and vibration characteristics inherent in our standard design. It can withstand 200 volts across the coil continuously.

These current-sensitive relays have a life expectancy of 100,000 operations. They meet or exceed all requirements of Mil-R-5757-B and withstand shock up to 50G's, vibration through 1500 cycles at 15G's.

The relays are available in 6PDT or 4PDT models, all the usual mountings and with plug-in or solder-lug connections.



DRY CIRCUITRY APPLICATIONS

In grid switching applications where the relay contacts must operate at low-voltage, low-current levels, special gold-alloy contacts have proved highly reliable. They maintain their low resistance through hundreds of thousands of operations. They are available on the complete line of UNION miniature relays.

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To users of ceramic parts...

is THERMAL SHOCK giving you trouble?

Stupakoff offers a number of ceramic bodies providing exceptional resistance to thermal shock, the most outstanding being STUPALITH, which has withstood over a hundred cycles from 2000° F to liquid air without harm.

are HIGH TEMPERATURES your problem?

Components formed of selected Stupakoff Ceramic Materials will withstand extremely high and prolonged temperatures, without deterioration, even in the presence of many corrosive gases and materials.

would PRECISION-MADE CERAMICS help speed your production?

Stupakoff specializes in the mass-production of precision-made ceramic parts and components. Tolerances of ± 0.001 in. are not unusual. Their use in assemblies of electrical and electronic equipment sharply reduces assembly costs, and assures correct functioning of the equipment in service. This precision is particularly valuable in miniaturized assemblies.

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The CARBORUNDUM Company

ing, a position he held until his new appointment.

Three other promotions were made in the engineering department of the television-radio division of Westinghouse.

J. P. Van Duyne was appointed as manager, engineering sub-division. In his new position he will have responsibility for all television engineering. He was formerly in charge of color television engineering. He has been with the company since 1953.

O. H. Fernald was appointed supervising engineer in charge of color television engineering. He has been with Westinghouse since 1951. He will report to Van Duyne.

A. S. Goldsmith was appointed as supervising engineer in charge of all radio engineering. He has been with the firm since 1949. He will report directly to N. S. Kornetz.

Olympic Radio Acquires Bogen

OLYMPIC Radio & Television purchased for cash all of the outstanding stock of David Bogen Co., of New York, N. Y.

The Bogen Company, for its fiscal year ended June 30, 1955, reported net sales of \$4,583,895, and a net profit, after taxes, of \$157,222.

The present management of Bogen will continue in charge of its operations and the brand name, sales organization and the pattern of distribution will remain intact.

Western And AB-PT Expand In Electronics

WESTERN UNION and American Broadcasting-Paramount Theatres each plan to acquire a 22 per cent interest in Technical Operations of Arlington, Mass., a manufacturing, research and development organization. Both firms are to have options to increase their individual stock interest up to 25 per cent each.

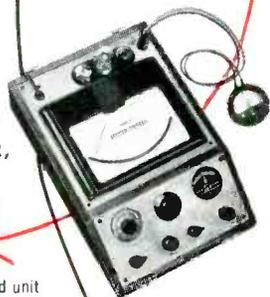
Technical Operations is engaged in the application of nucleonics, operations research, chemistry, physics and electronics to industry and government uses.

Last April the telegraph company purchased a one-third interest

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 advancement
 in instrument
 design

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 ABOUT IT**

... with the
 versatile
**MULTI-RANGE
 METER TESTER,**
 Power Supply,
 and
 Limit Bridge



Precise, self-contained unit for laboratory and production use. For DC instrument calibration from 25 μ a full scale to 10 ma full scale, and 0-100 V DC; sensitivity and resistance measurement; DC current-voltage source; limit or Wheatstone bridge measurements from 0-5000 ohms. Regulated Power supply. Stepless vacuum tube voltage control. Accuracy exceeds 1/4% (current), 1/2 ohm or 1/2% (resistance). For 115 V, 60 cycle AC. Complete — needs no accessories.



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**New ILLINOIS TYPE SMT
 SUB-MINIATURE
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Where space is at a premium—and absolute reliability is a must—there you will find ILLINOIS type SMT sub-miniature electrolytic capacitors.

- Immune to shock and vibration.
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If your application is a "tough one", specify ILLINOIS Type SMT for complete dependability. Wide range of capacities and voltages.



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PLANTS AND PEOPLE

(continued)

out of the college less than 10 years in recognition of outstanding technical accomplishments and meritorious service in the interests of his fellowmen.

Honorable mentions were made to J. N. Grace of the Westinghouse Atomic Power Division; H. R. Johnson of Hughes Research Laboratories; D. B. Shuster of the Sandia Corporation and Glen Wade of the Stanford University Applied Electronics Laboratory.

With Henry R. Chope and George B. Foster, Chope founded the Industrial Nucleonics Corp. in 1950 to develop peace-time industrial uses of atomic energy. Starting with three men and zero sales, this company now employs close to 300 people and is a multi-million dollar corporation.

North American Selects Two Engineers

NORMAN F. PARKER has been appointed assistant chief engineer of autonetics, a division of North American Aviation.

Prior to his appointment, Dr. Parker served for four years as assistant chief of the division's guidance section. He first joined the company in 1948.

He was appointed supervisor of the theoretical analysis unit in 1950 and in 1951 was promoted to group leader, autonavigator systems group. He held the latter position



Norman F. Parker

until 1952 when he was named assistant chief of the guidance section.

Prior to joining North American he was employed as an engineer at the University of California radia-

3 ANSWERS TO POWER PROBLEMS



More flexible shafts are being used in the electronic field today because they offer an economy in time, space, and costs.

There are three types of flexible shafts available, each having certain advantages of its own.

The FIRST type of flexible shaft is power drive, which transmits power between two points where, due to position, solid shafts cannot be used. The power drive flexible shaft provides for rotation either clockwise or counter-clockwise with the wire wound according to the direction rotation in order to strengthen the cable while the assembly is in use.

SECOND is the remote control flexible shaft which offers the advantage of rotation both clockwise and counter-clockwise and may function in either a continuous or an intermittent operation. The remote control flexible shaft has proven its value many times where the driven element required only a fraction of a turn or many complete turns and where both rotation and reciprocation were required.

The THIRD type of flexible shafting is the coupling which is an added application of the remote control flexible shaft and is most useful to control the movement of parts within a piece of equipment. There are no alignment problems to contend with because the flexibility of the coupling compensates for any difference in alignment between the drive and the driven elements.

For complete information and a better understanding of flexible shafting write F. W. Stewart Corporation, 4311 Ravenswood Ave., Chicago 13, Illinois.

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Frenchtown Metallized Terminals!

Here is Frenchtown's improved line of Annulated Type NICOTE Metallized Hermetic Terminals for use in controls, relays, transformers, capacitors, motors, and heater units. Custom-engineered of HIGH ALUMINA CERAMICS and metallized with our exclusive NICOTE, these terminals are available in six varying sizes with a choice of terminal hardware to fit any exacting application. Write for Engineering Bulletin 1055.

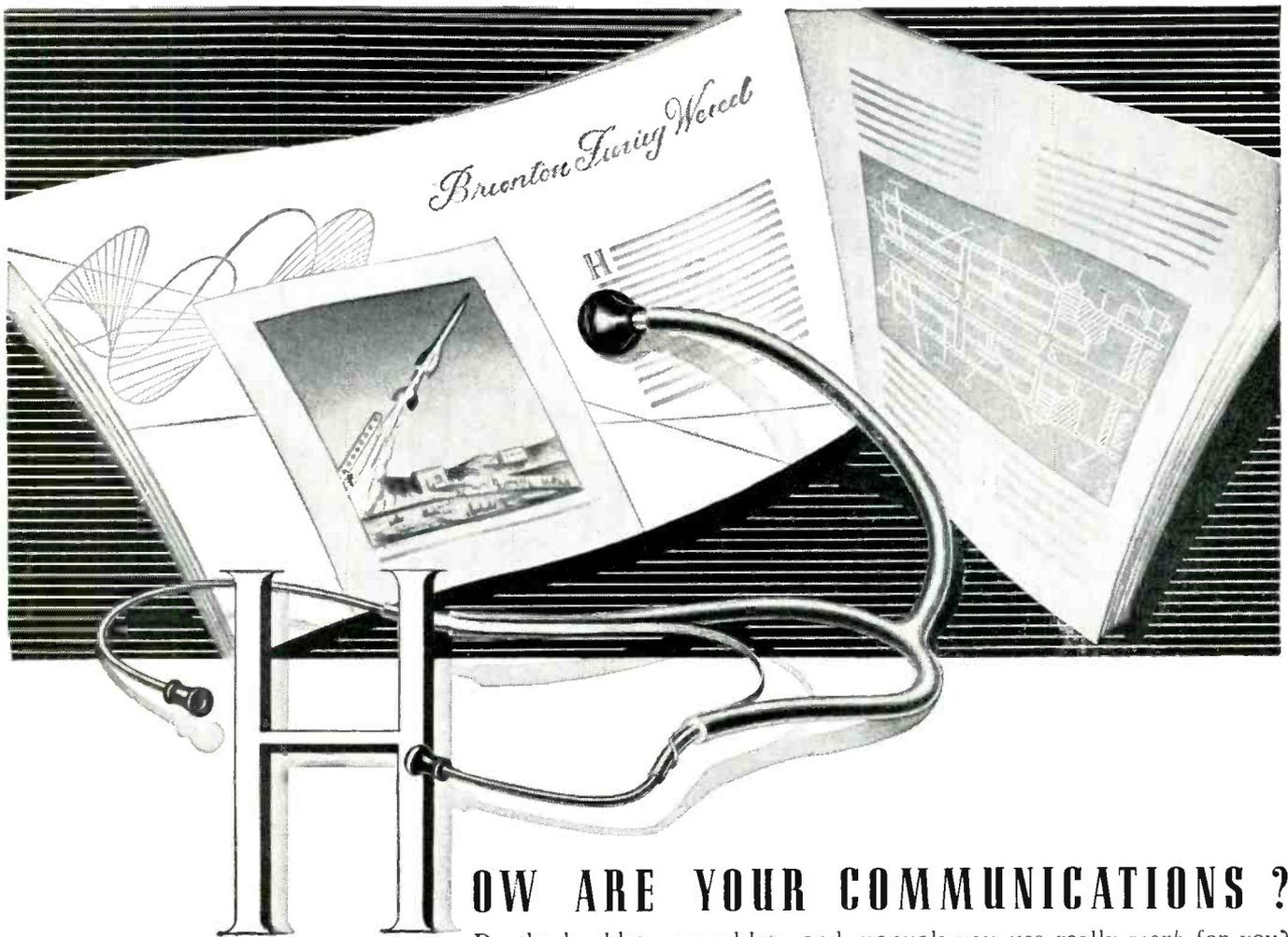
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April, 1956 — ELECTRONICS



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Do the booklets, pamphlets, and manuals you use really *work* for you? Are these vital publications, that tell the story of your products and your company, as effective, readable, well designed and illustrated as they can be? Today more than ever, your entire operation is judged by each annual report, employee manual, and public relations piece that you produce. Have you examined your communications lately? If you have any doubt as to the impact of your instructional and promotional literature, remember . . .

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tion laboratory at Oak Ridge, Tenn.

D. B. Duncan has been appointed assistant chief of the guidance section, succeeding Parker.

Dr. Duncan first joined auto-netics in August, 1950 as a research engineer in the guidance section's investigation unit. In August, 1954 he was promoted to group leader of the guidance analysis group. Due to a reorganization, he became group leader of the section's research group in July, 1955 and held that position until his recent appointment.

Servomechanisms Promotes Kasindorf

IRA L. KASINDORF has been appointed chief development engineer of Servomechanisms eastern components division in Westbury, N. Y.

Prior to his appointment, he was a staff engineer at the company's eastern division for three years, where he was engaged in the development of analog computers and associated electronic and electro-mechanical components.

Telecomputing And Whittaker To Merge

TELECOMPUTING CORP. plans to acquire all of the outstanding stock of Whittaker Gyro, in exchange for 900,000 shares of authorized but unissued Telecomputing stock.

Telecomputing will specialize in scientific data processing equipment, commercial products and military products for guidance and control systems.

Telecomputing Corp. was formed in 1947 by Ward Beman and other associates. Whittaker Gyro and predecessor companies have been in business since 1938.

The management of Telecomputing Corp. will consist of Ward Beman as chairman of the board and Joseph Globig as president. Globig was formerly president of Whittaker Gyro.

Telecomputing's plant facilities consist of approximately 146,000 sq ft and total personnel of about 800.

Current backlog of the combined companies is approximately \$9,000,000.

Wm. R. Whittaker Co., Ltd.,



★ ULTRA LOW capacitance & attenuation

WE ARE SPECIALLY ORGANIZED TO HANDLE DIRECT ORDERS OR ENQUIRIES FROM OVERSEAS
SPOT DELIVERIES FOR U.S. BILLED IN DOLLARS—SETTLEMENT BY YOUR CHECK CABLE OR AIRMAIL TODAY

TYPE	μμ F/ft	IMPED.Ω	O.D.
C1	7.3	150	.36'
C11	6.3	173	.36'
C2	6.3	171	.44'
C22	5.5	184	.44'
C3	5.4	197	.64'
C33	4.8	220	.64'
C4	4.6	229	1.03'
C44	4.1	252	1.03'



NEW 'MX and SM' SUBMINIATURE CONNECTORS
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① Check the outstanding engineering design of this modern printed circuit Scope. Designed for color TV work, ideal for critical Laboratory applications. Frequency response essentially flat from 5 cycles to 5 Mc down only 1½ db at 3.58 Mc (TV color burst sync frequency). Down only 5 db at 5 Mc. New sweep generator 20-500,000 cycles, 5 times the range usually offered. Will sync wave form display up to 5 Mc and better. Printed circuit boards stabilize performance specifications and cut assembly time in half. Formerly available only in costly Lab type Scope. Features horizontal trace expansion for observation of pulse detail — retrace blanking amplifier — voltage regulated power supply — 3 step frequency compensated vertical input — low capacity nylon bushings on panel terminals — plus a host of other fine features. Combines peak performance and fine engineering features with low kit cost!



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MODEL TS-4
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parent company to Whittaker Gyro, will be the principal stockholder of Telecomputing Corp.

Ballard Joins Hall-Scott Motors

ALBERT N. BALLARD, has joined Hall-Scott Motors Co. as factory manager of the firm's electronics division in Burbank, Calif.

For 17 years he served in supervisory capacity for Convair Corp. In January, 1952, he became aircraft division manager of the White Motor Co. and later that year returned to Convair as chief industrial engineer.

Stanford Research Annoints Two

Improved regulation



Oregon Electronics
MODEL B3

The Model B3 Variable Voltage Regulated Power Supply is an improved version of the standard time-tested Model A3.

REGULATION: against load 15%
against line .3%

CONTINUOUSLY VARIABLE, 0 to 350 volts DC.

CURRENT: 200 milliamperes.

RIPPLE less than 3 millivolts peak to peak at any current or voltage. Either positive or negative output terminal may be grounded

VARIABLE stabilized bias supply.

Continuously Variable... without switching



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MODELS
5-2V & 5-4V

Models 5-2V and 5-4V Variable Voltage Regulated Power Supplies provide extremely well filtered and regulated direct current output which may be varied continuously without switching from zero to 500 volts. Maximum current output of the instruments may be drawn at any voltage setting.

REGULATION: against load .15%
against line .3%

CONTINUOUSLY VARIABLE, 0 to 500 volts without switching

CURRENT: 200 milliamperes (any voltage setting) (5-2V).
400 milliamperes (any voltage setting) (5-4V)

EITHER POSITIVE OR NEGATIVE output terminal may be grounded.

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communication and navigation equipment and direct the studies in system engineering.

He has worked with the airlines company 20 years. In Denver since 1946, he supervised the development of telecommunication requirements, procedures and policy involving air navigation and traffic control.

Donner Scientific Plans Expansion

DONNER SCIENTIFIC COMPANY plans to build a new plant on a 10 acre site it recently purchased in Concord, Calif. The new 22,000 sq ft plant, scheduled for completion in June, will house the company's engineering laboratories, manufacturing facilities and administrative offices, now headquartered in Berkeley, Calif.

The first building will cost \$125,000 and an additional \$125,000 will be invested in machinery, equipment and fixtures. The setting will be arranged to permit expansion to 100,000 sq ft of floor space when required. Donner manufactures electronic test equipment, general purpose analog computers and aircraft control systems for inertial guidance of missiles and stabilization of aircraft.

The company was organized in August 1953 by W. K. Rosenberry, president, who also founded Berkeley Scientific Co. in 1946 and which was merged with Beckman Instruments in 1952. Under Rosenberry, Berkeley Scientific grew from a one-man operation, with an initial investment of less than \$10,000, into an instrument firm with annual sales of \$2,000,000 and 300 employees. Donner Scientific has increased its personnel 50% during the past 4 months and expects to be employing 500 persons by the end of 1957.

Donner also announced that Robert E. Krueger has been named marketing manager of the company.

Before joining Donner, Krueger was sales manager for Unitek Corp. in Pasadena, also before that chief mechanical engineer at Rutishauser Corp. in the same city. He was a staff member at Los Alamos Scientific Laboratory and

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Tubular Electric Heating Units that fit around or clamp to vessels, tanks, pipes, etc. for contact heating of metals, oils, air and water . . . especially where little space is available and considerable heat is needed.



Can be bent into almost any shape.

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or made to your requirements.

See 8-page Vulcan catalog in Swetz's Product Design File for 1955.

earlier was associated with Beckman Instruments and Douglas Aircraft in engineering capacities.

Thompson Products Names Gardiner

ROBERT A. GARDINER has joined Thompson Products of Cleveland to head research and development work of the company's electronics division in aircraft and missile controls, sub-systems and components.

He was formerly for 12 years with the Langley Aeronautical Laboratory of the National Advisory Committee for Aeronautics at Langley Field, Va. Earlier he was associated with Airborne Instrument Laboratories, of Mineola, N. Y. and General Industries Co. of Elyria, Ohio.

Stock Board Tours Packard-Bell Plant



ROBERT S. BELL, left, executive vice-president and Herbert A. Bell, right, of the Packard-Bell Co. team up to explain methods of mass producing television receivers to F. E. Naley, second from right, president of the board of governors of the Los Angeles Stock Exchange, during a tour of the firm's main plant by the group. Locking in is Dr. N. Jacoby, dean of the UCLA School of Business and a member of the board of Packard-Bell. Stock exchange members inspected the technical products division, color television research laboratory, cabi-

New high-vacuum pump

*heats faster
cools faster*

for faster cycling



CVC's KS-200 oil diffusion-ejector pump.

You can complete more process cycles an hour and cut maintenance costs with this new CVC oil diffusion-ejector pump.

The KS-200 is designed especially for TV tube aluminizing, vacuum-arc melting of metals, and other repetitive processes that require pressures in the 1 to 10 micron Hg range.

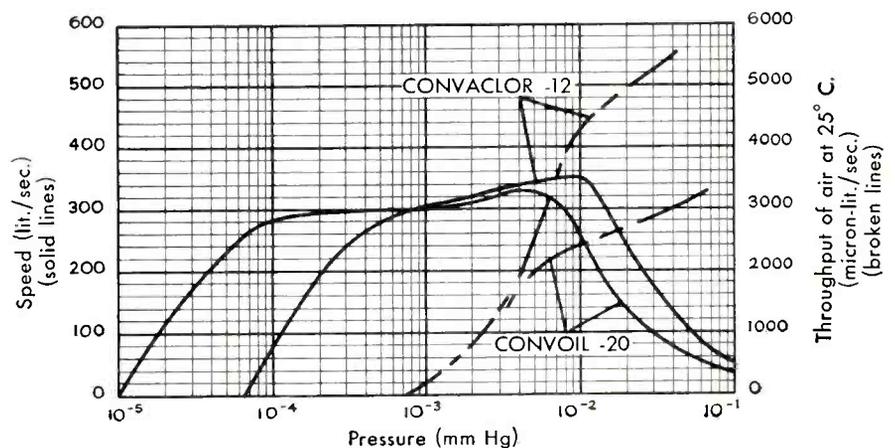
Faster heating. Four heaters (combined capacity, 2000 watts) heat the pump's fluid from a cold start to operating temperature in only seven minutes.

The heaters sit in cylindrical wells that jut up into the pump fluid from the bottom of the boiler—an arrangement that combines the low heat loss of an internal-immersion heater with the easy maintenance of a heater mounted externally.

Faster cooling. An internal coil in direct contact with the pump fluid cools it enough for safe exposure to atmosphere in only one minute, a saving of four to five minutes over old designs.

No valves needed. Convaclor-12 pump fluid gives you shorter warm-up and cool-down times with the KS-200. The saving offsets the longer cycling required by most high-vacuum pumps when used without valves.

With Convaclor-12 fluid the pump's ultimate pressure is 6×10^{-5} mm Hg. You can reach 1×10^{-5} mm Hg with Convoil-20 fluid, but speed and throughput become slower in the 1 to 10 micron range. See graph below.



Consolidated Vacuum Rochester 3, N. Y.

a division of CONSOLIDATED ELECTRODYNAMICS CORPORATION, Pasadena, California

Sales Offices: Albuquerque • Atlanta • Boston • Buffalo • Chicago • Dallas • Detroit
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net shop and production, testing and quality control sections of the Packard-Bell plant.

Mutual Electronics Firm Formed

A NEW company, Mutual Electronic Industries Corp. has been organized and will begin operations in a modern plant in New Rochelle, N. Y.

MEI will coordinate the manufacturing and licensing activities of Universal Aviation Corp., Essex Connector Corp. and United Cable Corp. It will also operate a research and development department for the design, evaluation and engineering of new and improved components in the electronic and allied fields.

The operations of MEI will be conducted, under R. W. McKirdy, president, by vice-presidents A. S. True, research and development; J. W. Schmidt, production, and James L. Risk, sales. B. B. McAlpin, partner of Laird & Co., is chairman of the board and Bradford S. Magill, an attorney and partner of Naylor, Foster, Dean, Shepard & Aronson, is secretary and treasurer.

M.I.T. Appoints Claude Shannon

DR. CLAUDE E. SHANNON, research mathematician at the Bell Telephone Laboratories in Murray Hill, N. J., has been appointed visiting professor of electrical communications at M.I.T.

While at M.I.T. during the spring term, Dr. Shannon will continue as an active member of the Bell Laboratories staff.

He will also be associated with the M.I.T. Research Laboratory of Electronics.

Computer Firm Elects Officers

COMPUTER CONTROL Co. of Wellesley, Mass., designers and manufacturers of digital computing and control equipment, announced a new slate of officers. Robert W. Brooks has been promoted from vice-president to president. Franklin R. Dean is vice-president in



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PL-6549

BEAM POWER PENTODE

This rugged, versatile power package, when used as a class C amplifier, delivers 60 watts at 600 volts... 110 watts at 1000 volts... with driving power less than 3/4 watt. An efficient modulator, amplifier or oscillator. Provides distortion-free, high peak power for class AB, single sideband service. Beam pentode construction offers a combination of peak power and linearity unattainable with conventional tetrodes. Rugged—ideal for all mobile applications.

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Filament—Thoriated Tungsten

(quick heating)

Voltage	6.0 volts
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Plate Current, Max.	150 ma.
Screen Voltage, Max.	600 volts
Plate Dissipation, Max.	75 watts

PENTA offers a complete line of power diodes, triodes, tetrodes, pentodes for many a-f and r-f applications, hydrogen thyratrons and vacuum relays. For power tube information, write for data file 203.



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ACME ISONEL WIRE

Plus Acme #150 VARNISH
Equals Class B
Equals MIL-T-27A Class S

Freed Transformer Co., Inc., Brooklyn, N. Y., a leader in engineering and manufacturing of transformers and reactors for the electronics industry, has found in the above equation the solution to the manufacturing and performance problems of Class B (MIL-T-27A, Class S) Commercial and Military units.

Acme Isonel Wire is a Class B (MIL-T-27A Class S) wire. However, optimum insulation system performance can only be achieved when this wire is impregnated with a compatible varnish. Acme #150 is that varnish.

Acme #150 Varnish does not require a high temperature cure. It has excellent resistance to oils.

Acme #150 Varnish meets all the requirements of specifications MIL-V-1137A, Class CB, Type M for government equipment. In fact, it exceeds the heat resistance requirements of this specification by 50%.

Acme #150 Varnish improves thermal stability, while maintaining dielectric strength when used in Class B (MIL-T-27A Class S) windings.



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NEW HAVEN, CONN.

MAGNET WIRE • COILS
VARNISHED INSULATIONS
INSULATING VARNISHES
AND COMPOUNDS



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charge of east coast operations and chief engineer. Kenneth M. Rehler is vice-president in charge of west coast operations. Other officers are Robert L. Massard, treasurer and William P. Horton, clerk of the corporation.

Brooks was one of the original founders of the company in 1952. Prior to the forming of CCC, he was in the computer department of Raytheon. He served as overall systems coordinator during the construction of the RAYDAC computer. He was also project engineer at Barber-Colman Co.

IBM Maps Western Expansion

IBM PLANS a multimillion dollar expansion of its west coast operations. The program includes:

A new 13-story office building and data processing center of advanced design in Los Angeles. Construction will start in mid-1956 and occupation by 600 people will get underway in mid-1957.

A six-story office building now nearing completion in San Francisco. Occupation by nearly 300 people will begin later this month.

New manufacturing, engineering and education facilities at San Jose. Approximately 400,000 sq ft will be built during 1956 and occupied by 1,500 employees beginning in the fall.

A new office building in Santa Monica. Over 150 people moved into this two-story structure in mid-January.

Data processing centers in Portland and Seattle. These facilities will be installed in Portland in March, in Seattle in June.

Byron Jackson Builds New Plant

THE Byron Jackson division of Borg Warner Corp. has begun construction on a 65,000 sq ft electronics plant in Santa Ana, Calif. Total cost of the project for property, buildings and equipment will be \$1 million.

Construction, to be completed in June, will include a 45,000 sq ft

NOW YOU CAN AVOID THE MAKESHIFT NECESSITY OF USING PREMIUM CULLS FROM MIXER DIODES FOR VIDEO DETECTION.

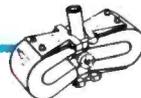
New MA408 and 408A video detector diodes are specifically designed for high performance replacement of older 1N23B and 1N23C crystals!

- ★ Vastly improved sensitivity. The MA 408 insures a consistent minimum improvement in sensitivity in excess of 2 db over the older 1N23C.
- ★ When operated in the MA 611 X-Band crystal mount which is specifically designed and "mated" to the 408 diodes, a minimum figure of merit at 9000 mc is 16C.
- ★ Users report up to 6 db improvement in signal-to-noise ratio.
- ★ Minimum theoretical tangential sensitivity of the new 408 crystal is -50 dbm, and for the extra sensitive 408A, it is -51 dbm for a receiver bandwidth of 10 mc/s.
- ★ Excellent broad band performance is exhibited in video applications from 1000 through 12,400 mc in terms of optimum signal-to-noise ratio and accurate reproduction of short pulses.

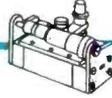
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Silicon Diodes



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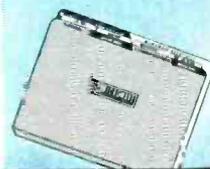
22 Cummington St., Boston 15, Mass.
OO 7-7577



The MA 611 X-Band Crystal Mount is designed to mate the MA408 diode to insure maximum performance.

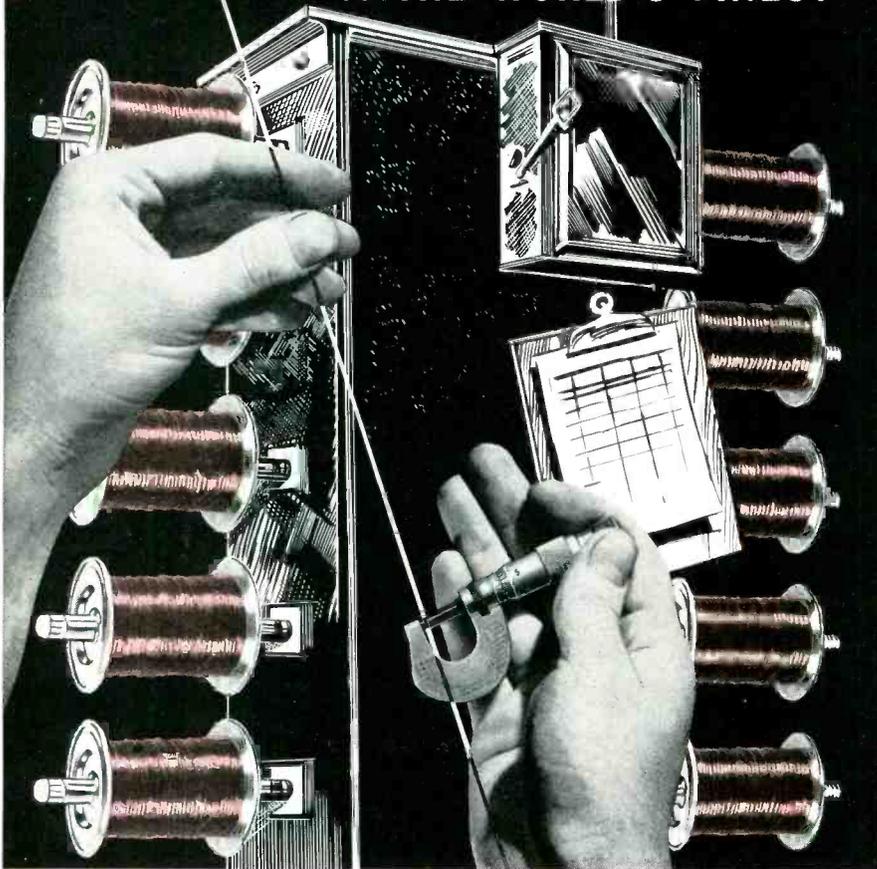
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Hitemp's Teflon insulated products offer: low loss factor, low dielectric constant, high volume resistivity, non-flammable, low coefficient of friction, unaffected by moisture, tough . . . yet flexible, completely inert to all known commercial solvents.

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building to house the main plant and offices, and a 20,000 sq ft testing laboratory. The main plant will eventually be enlarged to 100,000 sq ft.

The new facilities will consolidate Byron Jackson's electronic facilities currently handled in four separate plants in Pasadena, Calif.

Linear Equipment Changes Name

THE corporate name of Linear Equipment Laboratories of Copiague, New York, has been changed to LEL Inc. This was brought about by the sale of the Linear Instruments division to the Measurements Corp. of Boonton, N. J., subsidiary of Thomas A. Edison. Linear Instruments will move to Boonton. The sale included all instruments, trade marks, good will and the trade name "Linear." The Linear line of instruments will be marketed through the present Linear sales representatives retained by the Measurements Corp. LEL will devote its entire efforts to the i-f amplifier division. It will manufacture i-f strips and transistorized products.

Construction has been started on a new building adjacent to the present manufacturing plant which will double manufacturing area.

Harry R. Clark was elected president of LEL Sales Corp. of Copiague, New York. He will also continue as vice-president and general sales manager of LEL Inc. LEL Sales Corp. will market the firm's wrist radio on a national basis.

Nebraska Electronics Firm Established

J. J. JENSEN has been appointed general manager of Nebraska Electronics Manufacturing Co.

Nebraska Electronics is a new corporation formed jointly by Good-All Electric Mfg. Co. and Radio Industries, Inc., for the manufacture of ceramic disc capacitors. The company's plant is located in Ogallala, Nebraska. All sales will be handled by the distri-

bution organization of Good-All Electric.

Jensen had previously served as an assistant to the president of Good-All on staff assignments.

Penn-Texas Division Gets New Name

THE PLASTIC division, Colt's Manufacturing Co. of Hartford, Conn., a subsidiary of Penn-Texas Corp. of New York, N. Y., has changed its name to Manufactured Products Corp. The firm is a custom molder of plastics for packaging and industrial uses.

Two Engineers Join Bomac



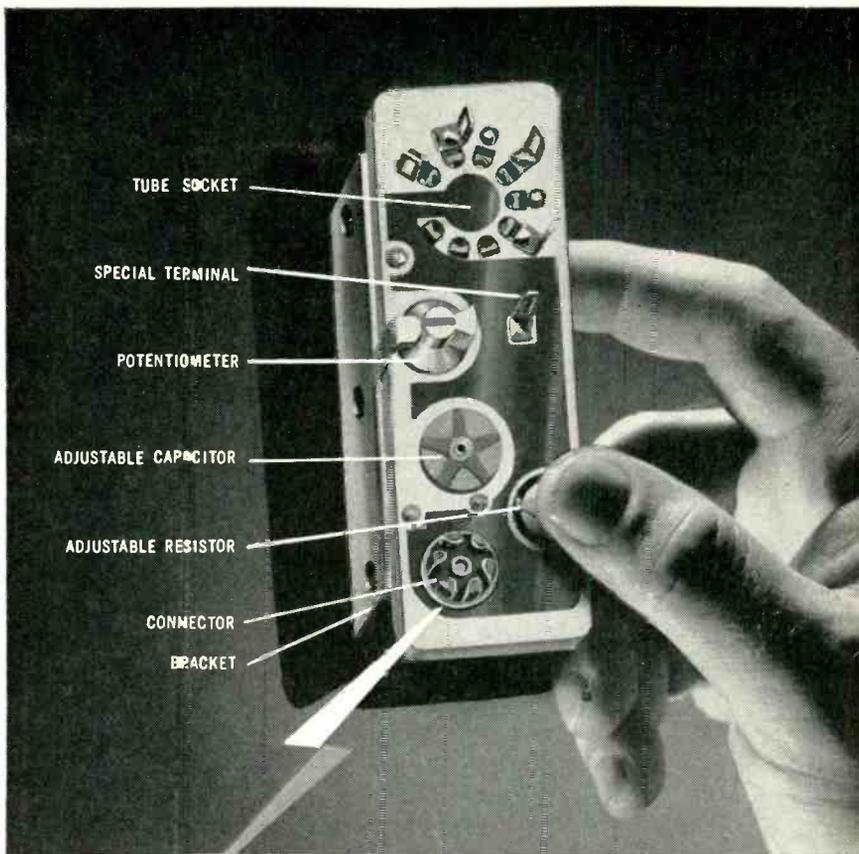
Louis W. Roberts

LOUIS W. ROBERTS joined the staff of Bomac Laboratories in Beverly, Mass. He will be in charge of a newly formed theoretical section which will function as a consulting group to other sections of the engineering department.

He comes to Bomac from Microwave Associates, where he was one of the founders and director of research. His background also includes consulting work for M.I.T. engineering manager for Sylvania and professor of physics.

Donald R. Lester joined the staff of Bomac as an electronic engineer. He will be in charge of klystron development.

He has been associated with Raytheon and Trans-Sonics, Inc., where



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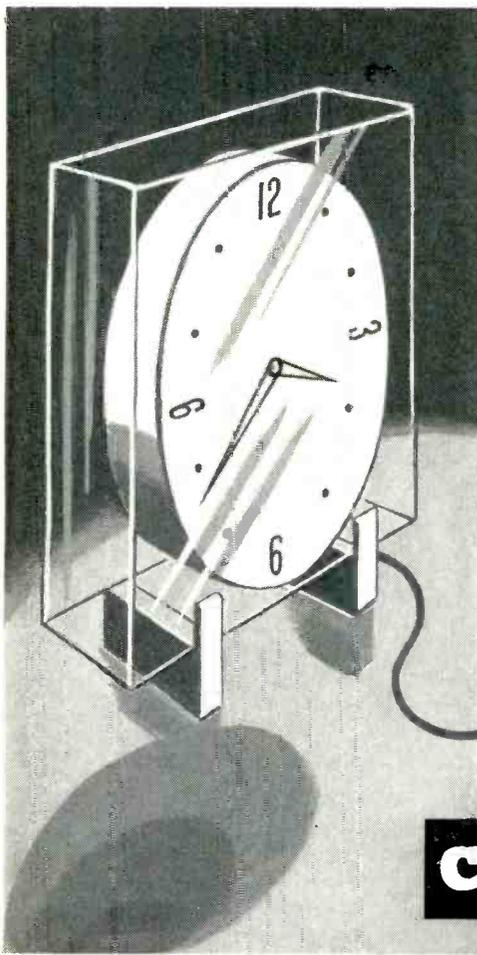
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This is a miniaturized unit of advanced design which provides four voice channels on a frequency-division basis above a voice-frequency order-wire channel. Each of these five channels is provided with a 4-wire 2-wire termination and a voice-frequency ringing circuit for d-c or 20-cycle signals. Adjustable attenuators are provided in the 4-wire side of all channels, and a built-in test oscillator and meter permit complete line-up, maintenance and trouble-shooting checks to be made. Channel levels are from -9 to 0 dbm and line levels from -30 to 0 dbm. Channel width is 300 to 3500 cycles within 1 db.

This unit is only 5 1/4" high by 19" wide by 14" deep. It mounts on a standard rack and operates from 115 volts 50-60 cycles a.c.

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CABLES RADENPRO, MONTREAL

he was an electronics engineer. His experience has been mainly in the research and development of klystrons and magnetrons.

Hycor Appoints Engineering Head

PHILIP R. GEFFE has been appointed engineering director of Hycor Co. of North Hollywood, Calif. He was chief filter engineer at Triad Transformer Corp. for three years, and joined Hycor last year as director of research.

American Instrument Names Chief Engineer

JAMES M. KLASSE has been appointed chief engineer of American Instrument Co. of Silver Spring, Md., manufacturers of scientific laboratory apparatus. He was with W. & L. E. Gurley of Troy, N. Y. as sales manager of the industrial division and as chief engineer.

He was formerly chief seismologist of Beers & Heroy, consulting geophysicists of Dallas, Texas and Troy, N. Y., supervising physicist with the U. S. Naval Ordnance Laboratory and supervisory electronic scientist, Office for Atomic Energy, Headquarters, U. S. Air Force.

Vactron Builds Plant In Texas

VACTRON CORP. is building a 15,000 sq ft plant in Mansfield, Texas to house its office, factory, laboratory and warehouse facilities. The plant will remanufacture television picture tubes. Production of other electronic devices is planned.

Don Houghton and Silas A. Mayfield are president and vice-president, respectively of the firm. Ken E. Westenhover is secretary-treasurer.

Siegler Buys Hufford Electronics

THE SIEGLER CORP. of Chicago and Long Beach, Calif., manufacturer of space heating equipment and electronic devices, has purchased for cash the assets of Hufford Electronics Company of West Los

Angeles, Calif. Hufford has contracts on hand for production of guided missile components which will be administered by Siegler's Hallamore electronics division in Long Beach, Cal.

Siegler acquired the business of the Hallamore Electronics Co. last year.

Axel Expands Electronics Division

AXEL BROTHERS electronics division moved to a recently purchased five-story plant in Jamaica, N. Y., the former Fairchild Camera & Instrument Corp. plant.

Axel also expanded and re-organized its design and development engineering staff, under the direction of Manuel L. Matnick, chief electrical engineer. The enlarged staff will concentrate on the design and development of electronic components

Du Mont Consolidates, Promotes Executives

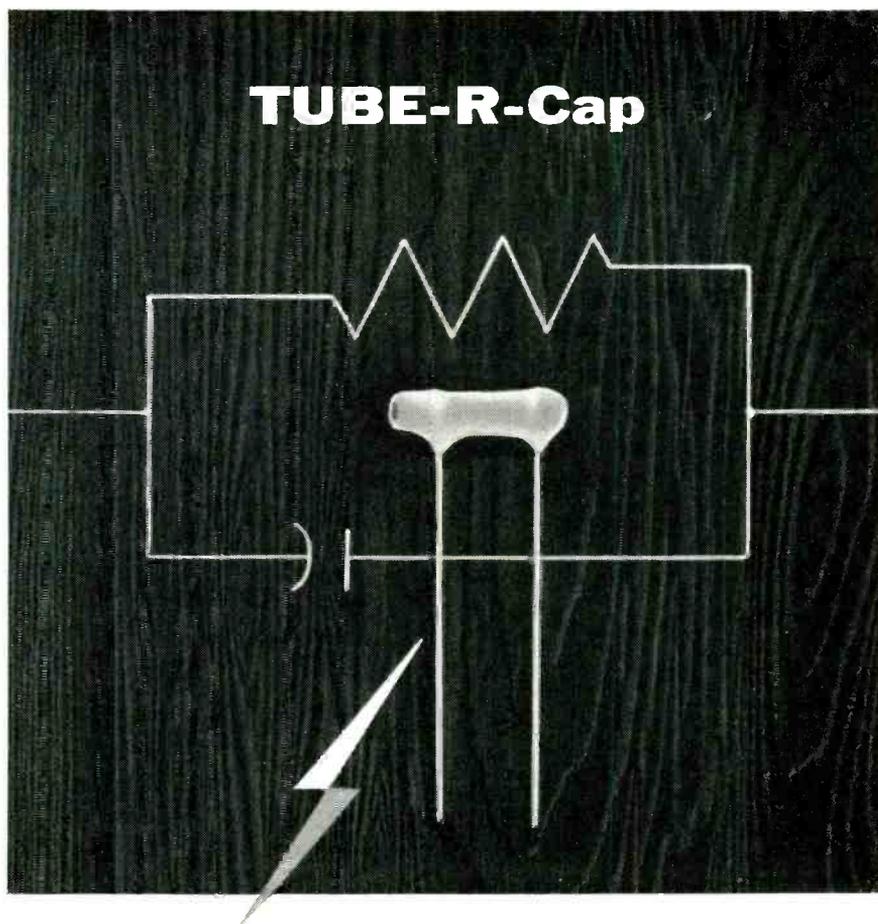
DU MONT LABORATORIES has consolidated all government manufacturing, engineering and sales operations into one division under Thomas T. Goldsmith, Jr., as vice-president and general manager of the government and research divisions.

Dr. Goldsmith has been head of Du Mont's research division since 1936. He will continue to direct the company's research division which also engages in extensive commercial programs and electronic applications.

Dr. Goldsmith joined Du Mont in 1936 as director of research, and he has been vice-president, research, since 1953.

Irving G. Rosenberg was appointed vice-president and general manager of the technical products division which embraces electronic instrument, broadcasting equipment and mobile communications operations. He has been with the company since 1942, and has served in various management capacities. He has been a vice-president since 1953.

William H. Kelley has been elected a director of the company



New RC Antenna Coupling Network

built to U/L specifications

Centralab Tubular Resistor-Capacitor Combination

There's nothing else like it!

Combines a high-quality, ceramic capacitor and a built-in fixed resistor in the space of a capacitor alone.

Costs you less than an equivalent combination of individual resistor and capacitor (not to mention installation cost)

Radial lead construction; Durez coated; stamped with capacity and resistance value.

Sets using TUBE-R-Cap have been approved by Underwriters' Laboratories.

Resistance
 $\frac{1}{2}$ meg. nominal.

Capacity
470 mmf. GMV tol.

Tested at 1500 V.A.C.,
in accordance with
U/L requirements.

Maximum size
.312" diameter,
.300" length.

Write for Technical Bulletin EP-76.

Centralab

A DIVISION OF GLOBE-UNION INC.

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In Canada: 804 Mt. Pleasant Road, Toronto, Ontario



VARIABLE RESISTORS

ENGINEERED CERAMICS

SWITCHES

PACKAGED ELECTRONIC CIRCUITS

CERAMIC CAPACITORS

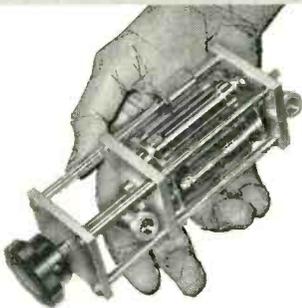
PRECISION ATTENUATION to 3000 mc!

SINGLE "in-the-line" ATTENUATOR PADS and 50 ohm COAXIAL TERMINATIONS



PROTECTED UNDER STODDART PATENTS

This new group of pads and terminations features the popular Types C and N connectors, and permits any conceivable combination of the two styles.



PROTECTED UNDER STODDART PATENTS

six-position TURRET ATTENUATOR

- Frequency Range: dc to 3000 mc.
- Characteristic Impedance: 50 ohms.
- Available Attenuation: Any value from 1 db to 60 db.
- Accuracy: ± 0.5 db.
- Power Rating: One watt sine wave power dissipation.

STODDART
Aircraft Radio Co., Inc.
6644-A SANTA MONICA BLVD.
HOLLYWOOD 38, CALIF. • HO 4-9294

Want more information? Use post card on last page.

and vice-president and general manager of consumer products.

He joined Du Mont in 1954 as vice-president, marketing. As a director, he succeeds Stanley F. Patten who just recently assumed the office of treasurer, and now holds the dual office of vice-president and treasurer.

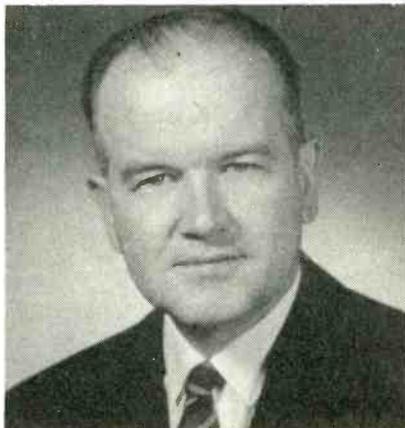
Kelley will direct the operations of the firm's receiver division and the cathode-ray tube division.

Arthur Israel, Jr., was elected secretary and Bert L. Graham as assistant secretary.

Israel has been assistant secretary. He succeeds Bernard Goodwin, who has resigned.

Graham was formerly controller, then special assistant to the president before succeeding Israel as assistant secretary.

Philips Selects Research Head



John A. Hipple

JOHN A. HIPPLE has been elected vice-president and director of research of North American Philips Co. He will succeed O. S. Duffendack as director of the Philips laboratories at Irvington-on-Hudson.

Dr. Duffendack, who has reached retirement age, will continue for this year as a member of the board of directors and as a consultant.

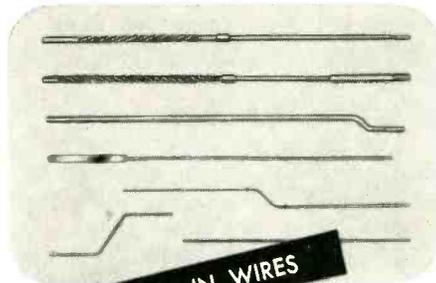
Since 1953, Dr. Hipple has been director of the Mineral Industries Experiment Station and assistant dean of the College of Mineral Industries at Pennsylvania State University. He was chief of the atomic

Specify



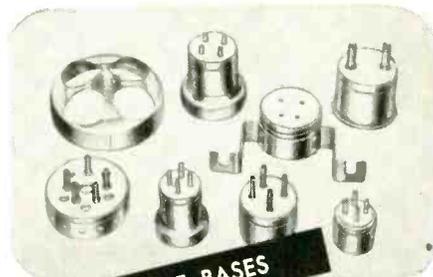
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ALLOYS, KOVAR



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Quality controlled throughout production with Tungsten hard glass leads produced under General Electric Timing Control. Each tungsten lead is microscopically inspected for flaws. DKE offers highest quality and LOW PRICES. Send drawings for quotations and let us prove the economy of our prices.



• DKE TUBE BASES

The Engineering Company can give you immediate delivery on following bases: 50 Watt, 3303B, 412 Industrial Base, Giant 7 Pin Bayonet, 4310 Four Pin Jumbo, Tetrode, Hydrogen Thyatron Bases in both Aluminum and Copper up to 6.50 dia. etc. All bases to JAN-1A/MIL-E-1B and subjected to weights and strength tests.

DKE HYDROGEN THYRATRON TUBE BASES



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ON YOUR SPECIFIC REQUIREMENTS

THE **engineering** co.

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physics section of the National Bureau of Standards from 1947 to 1953.

Association Elects New Officers

ELECTRONICS MANUFACTURERS ASSOCIATION elected the following officers: president, I. A. Mitchell of United Transformer Co.; treasurer, Hyman Winograd of Presto Recording Corp.; secretary, Allan C. Bernstein of Adams Laboratories.

Elected to the board of directors were David Wald of Dewald Radio Mfg. Co. and United Scientific Laboratories; I. Walter Wyckoff of Pilot Radio Corp.; Lloyd Hammarlund of Hammarlund Mfg. Co. and Arthur Blumenfeld of University Loudspeakers.

Texas Instruments To Acquire Burlington

TEXAS INSTRUMENTS plans to purchase the business and assets of the Burlington Instrument Co. in a cash transaction.

Burlington Instrument, 20-year-old manufacturer of electrical indicating instruments, is located in Burlington, Iowa. The entire operation will be integrated with the TI components division and transferred to Dallas as soon as possible. Manufacturing space has been leased near the firm's main Dallas plant for the expansion of the components division.

Burlington product sales have totalled well over a million dollars per year.

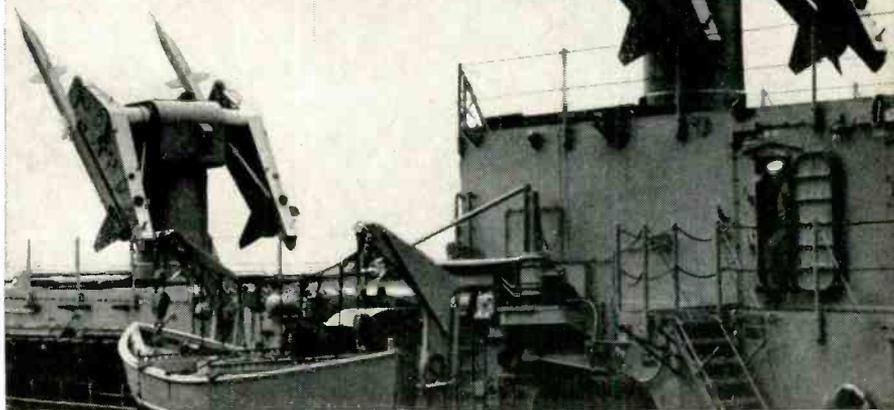
Varian Associates Name Patterson

HOWARD R. PATTERSON, formerly vice-president and general manager of Chromatic Television Laboratories of Oakland, Calif. has joined Varian Associates as manager of the production engineering department.

The former department head, B. C. Gardner, has been promoted to head the product engineering division.

Patterson served as chief engineer of the television and pickup tube factories of RCA at

speaking of systems engineering...



OFFICIAL U. S. NAVY PHOTOGRAPH

THE USS Boston, recently commissioned as the first guided missiles warship in history, carries the newest and most powerful weapons afloat.

Vitro Laboratories takes pride in the Navy's "well done" for its part in the systems engineering of the missiles installation and launching system on the Boston.

Another first in the important new field of systems engineering is the comprehensive multiple-range timing system conceived, developed, installed and operated by Vitro for armament testing at the Air Force Armament Center in Florida. By means of pulse electronics, a time signal generator establishes base "central" time measured in 10,000ths of a second. The system transmits time signals to remote ground and airborne stations for precision command timing and time identification of action photographs.

These are but two of many examples of Vitro's role in systems engineering of the most advanced kind. They are forerunners of significant new systems applicable across a broad industrial spectrum.

Vitro Laboratories is now building a million-dollar laboratory to make its staff and facilities available for new industrial and governmental projects.

Write for detailed information to

VITRO LABORATORIES, 962 Wayne Avenue, Silver Spring, Md.

A Division of

Vitro CORPORATION of AMERICA
261 Madison Ave., New York 16, N.Y.

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| ☞ Research, development, weapons systems | ⊗ Uranium mining, milling, processing, refining |
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For Resistors and Capacitors. For Machine or Hand Application.

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PART NO 10

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L. A. PHILLIPS, President

PHILLIPS PROCESS CO. INC.

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ROCHESTER 14, N. Y.

Lancaster, Pa., as chief production engineer in the Chicago cathode-ray tube factory of Rauland Corp. and as chief engineer of the cathode-ray tube department of Raytheon before joining Chromatic in 1951.

Daystrom Realigns Three Executives

SAMUEL J. CHILDS has been appointed vice-president and general manager of Weston Electrical Instrument Corp., a subsidiary of Daystrom, Inc. Childs, who was formerly president of Daystrom furniture division, will be in charge of all manufacturing and production at Weston.

He was president and treasurer of the Friend Manufacturing Co. in Gasport, N. Y. and of the Bennett Manufacturing Co. in Alden, N. Y. before joining Daystrom.

George J. Parker was appointed vice-president of Daystrom in charge of its Washington office. He was formerly president of the Daystrom Instrument division at Archbald, Pa. Walter W. Slocum, recently promoted to vice-president of operations of Daystrom, will assume current responsibility for the operation of the instrument division.

Air Associates Appoints Harries



Wolfgang Harries

WOLFGANG HARRIES has joined the staff of the research and development division of Air Associates.

Dr. Harries came to the United

Another PRESTO precision instrument



Model 100

M · S · F · S*

The Presto Model 100 *Microwave Secondary Frequency Standard is a versatile, inexpensive test signal generator. In the laboratory or on production test bench, the Model 100 together with microwave receiver and auxiliary signal generator, will provide rapid measurement of frequencies from 50 to 11,000 mc, with $\pm .005\%$ accuracy.

The Presto Model 100 will

- perform functions of expensive primary standards
- calibrate standard signal generators
- establish standard frequencies
- calibrate and align receivers
- test radar or microwave installations
- provide markers for panoramic displays

This unique and valuable instrument weighs only 8½ pounds and comes complete with 4 foot RG-58/U cable with UG-260/U connectors, Presto XH microwave crystal holder with Type N male plug and 8 foot power cable.

Price: \$265.00 f.o.b. Paramus, N. J.

Write for complete information and specifications.

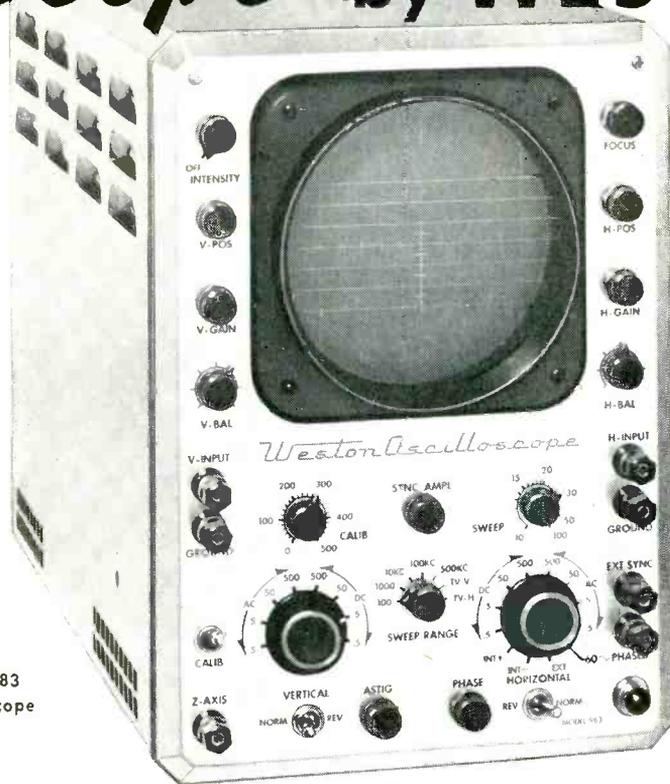


RECORDING CORPORATION
Specialty Products Division
Paramus, New Jersey

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April, 1956 — ELECTRONICS

NOW...the All-purpose 'Scope by WESTON



Weston
Model 983
Oscilloscope

Model 983 is a high gain, wideband Oscilloscope designed to accurately reproduce waveforms comprising a wide band of frequencies. High sensitivity of 15 millivolts per inch RMS makes this "scope ideal for—**SETTING RESONANT TRAPS... SIGNAL TRACING IN LOW LEVEL STAGES... AS A GENERAL NULL INDICATOR... for PHASE CHARACTERISTIC MEASUREMENT IN INDUSTRIAL APPLICATIONS... and for SWEEP FREQUENCY VISUAL ANALYSIS.**

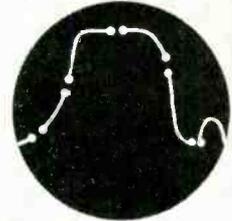
The 'scope contains identical vertical and horizontal push-pull amplifiers with a choice of AC or DC coupling without affecting either sensitivity or band width. Both amplifiers have compensated step attenuators and cathode follower input. *It has excellent square wave reproduction with overshoot of only 2 to 5%, with a rise time of 0.1 microsecond. The 'scope response is essentially flat throughout the specified range of 4.5 mc and is usable to 6 mc.*

The unit has provisions for internal calibration, internal phased sine wave, and Z-axis intensity modulation. Reversal of polarity of both horizontal and vertical signals is easily accomplished by means of toggle switching. *Tube replacements are non critical, and etched circuitry facilitates quick and rapid maintenance.*

The Model 983 Oscilloscope is now available through local distributors. For complete literature write WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

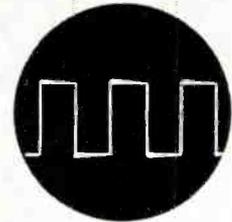
WESTON Instruments

WAVEFORM ANALYSIS



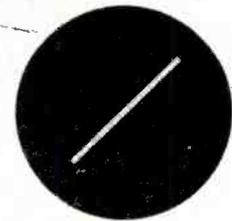
Response curves accurately displayed. Ideal for use with Weston intensity marker display. A fast, retrace sweep circuit with cathode follower output prevents pattern distortion.

SQUARE WAVE RESPONSE



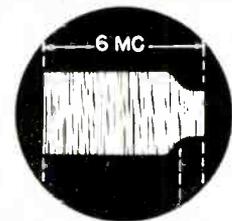
Overshoot is only 2 to 5%. Rise Time is 0.1 Microsecond. Square wave depicted 250 kc.

PHASE MEASUREMENTS



Phase shift between horizontal-vertical amplifiers, 0-500 kc-0°, to 1 mc within 2°; by internal adjustment with gain controls at max 0° phase shift possible on any specific frequency to 6 mc.

RESPONSE CHARACTERISTIC



Note flatness throughout specified range; to 3.6 mc down 1.5 db, at 4.5 mc down 3 db, at 6 mc down 6 db.

NEW Jewel-bearing "LO-TORK"



ACTUAL SIZE

0.01 ounce-inches

PRECISION *wire-wound* POTENTIOMETER

Jewel bearings for lowest torque, and superior seal against surroundings that contain abrasive dust, make this new, Model LLT 7/8 Waters pot the ideal unit for high-reliability service where minimum torque is essential. With torque low enough to permit actuation by a Bourdon tube or a bimetallic thermal element, this potentiometer offers new advantages in sensitive-instrument applications as well as in computer, servo, and selsyn uses. Check your needs with these specifications:

Maximum torque:0.01 ounce-inch
 Dissipation:one watt at 80° Centigrade
 Resistances:100 ohms to 100,000 ohms
 Weight:1/2 ounce
 Outside diameter: 0.885 inch Body depth: 7/8 inch
 Linearity: 0.5% standard; on special order, 0.25%
 Winding angle: 354° standard; on special order, 360°
 Ganging: to six decks with no increase in diameter.

Where the features of a ball-bearing potentiometer are desirable, specify Waters Model LT 7/8 "Lo-Tork" potentiometer.

Write for data sheets on jewel-bearing and ball-bearing precision wire-wound potentiometers.

Do you ever need pots that are "just a bit different"?
 Maybe we can help you — by modifying a standard
 Waters design or by taking a bold, new approach. Tell
 us your need and we'll tell you what we can do.

WATERS MANUFACTURING, inc.
 Wayland, Massachusetts
 Mail address: P.O. Box 368, So. Sudbury, Mass.
 APPLICATION ENGINEERING OFFICES IN PRINCIPAL CITIES



States from Germany in 1951. He was formerly chief engineer for Matawan Electronics Co., a subsidiary of Lavoil Laboratories, where he was responsible for the development of automatic calibrators and testers for electronic equipment.

CBS Names Quality Chief

DAVID S. BLACKWELL has been named manager of quality control for CBS-Columbia.

He was formerly chief production engineer for the Warwick Manufacturing Corp. and director of quality for Capehart-Farns worth.

Kearfott Plans New Plant

KEARFOTT Co., GPE subsidiary, plans a new engineering-sales building to be constructed opposite the present home offices and production plants in Little Falls, N. J.

The target date for completion of the building is early 1957.

Kearfott's present engineering forces will provide the majority of the 1,500 persons expected to be employed in the new building. More than 500 additional engineers, technicians and production specialists are being added.

The new building, which will contain 240,000 sq ft of floor space, will increase the total facilities of Kearfott to 600,000 sq ft.

Hughes Aircraft Appoints Two Engineers

HUGHES AIRCRAFT Co. appointed J. W. Clark and S. W. Lichtman to the scientific staff of its research and development laboratories.

A specialist in high power microwaves and nuclear electronics, Dr. Clark will serve as a staff scientist reporting directly to Dr. A. V. Haefl, vice-president and director of research.

Lichtman, associated with guided missile and rocket research, heads the missile reliability effort of the Hughes systems engineering department.

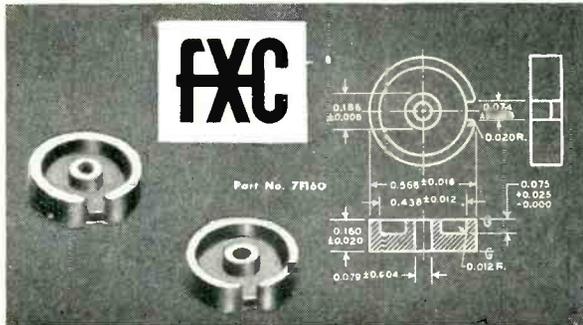
Dr. Clark was most recently with Litton Industries where he was

⚡ HIGH- μ FERRITE POT CORES FOR EFFICIENT MINIATURIZATION

Versatile Ferroxcube pot cores permit construction of miniature coil assemblies having moderate inductance values with relatively high Q. Shielding is excellent, stray fields are minimized. Cores can be placed close together or even stacked, with negligible coupling between adjacent coils.

Ferroxcube Pot Cores are available in 3 high permeability ferrite formulations.

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FERROXCUBE CORPORATION OF AMERICA

A Joint Affiliate of Sprague Electric Co. and Philips Industries
Managed by Sprague

35 EAST BRIDGE STREET • SAUGERTIES, NEW YORK

NEW! DOUBLE-RANGE Incremental-Inductance BRIDGE

For production and laboratory testing of coils with d-c and a-c magnetization.

This new, two-in-one instrument provides fast, easy measurement of inductance from zero to five and five to 180 henries, with superimposed d-c from one to 500 milliamperes, in inductors up to 750 ohms resistance. Accuracy $\pm 3\%$.



FEATURES

- 1 Direct reading of inductance on large, balance-control dial calibrated for 60 - 400 - 1000 cps, and for use at any intermediate frequency.
- 2 Three-inch 'scope shows phase-difference nulls.
- 3 Panel instruments read direct current and a-c volts.
- 4 Continuous and independently adjustable control of a-c voltage, 0-135 v., and direct current supply, 0-500 ma.
- 5 External-frequency input for measurements at frequencies between 60 and 1000 cycles.

The double-range calibration of the Model 1002-C Incremental Inductance Bridge permits high accuracy in the measurement of low values. Its rapid, simple operation and rugged construction make it equally suitable for production-line and laboratory use. For detailed information, write for bulletin EL-4.

Price \$895.00 complete, net F.O.B. Wayland, Mass.

WATERS
MANUFACTURING, inc.



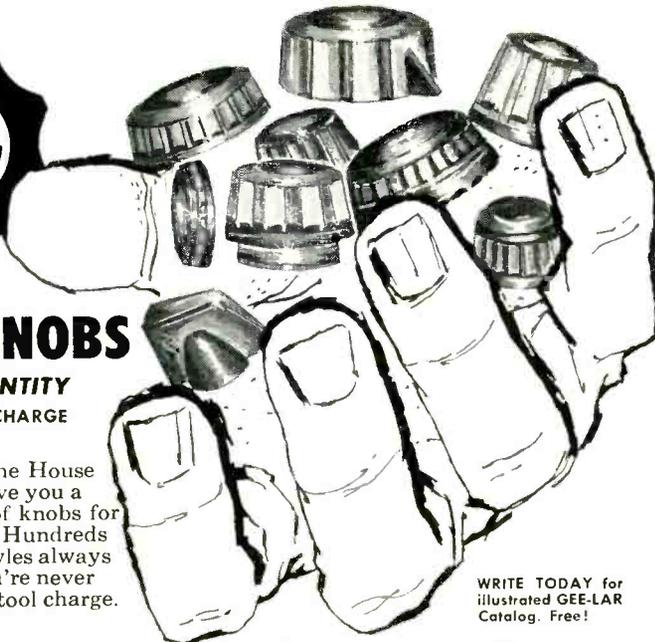
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P.O. Box 360, So. Sudbury, Mass.APPLICATION ENGINEERING OFFICES IN PRINCIPAL CITIES



STOCK KNOBS

IN ANY QUANTITY
NEVER A MOLD CHARGE

GEE-LAR—The House of Knobs—can give you a wide selection of knobs for every application. Hundreds of patterns and styles always in stock, and you're never concerned with a tool charge.



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GUDEMAN

NEW MINIATURE FEED-THRU CAPACITORS

Paper Dielectric — Hermetically Sealed
Gudeman Impregnant #257
Types 271 and 272



The Gudeman Feed-Thru Capacitor, Types 271 and 272, is a three-terminal component designed to be used for R.F. Interference suppression in a manner similar to a low pass filter. The typical insertion loss characteristics for these Feed-Thru Capacitors when measured in a 50 ohm line are in accordance with MIL-Standard 220.

The internal construction of these Feed-Thru Capacitors is designed so as to minimize the inherent inductance; therefore, these units perform functionally as nearly as possible to an ideal capacitor.

NEW RADIO INTERFERENCE FILTERS



- Screw neck mounting
- Hermetically sealed tubular construction
- Glass compression or ceramic solder seal terminals
- High insertion loss from .15 to 1000 MC
- Ratings range from 1 to 20 amps at 125 V.A.C. (0-400 cycles) or 400 V.D.C.
- Operating temperature range: -55° C. to + 85° C.

THE **GUDEMAN** CO.
340 W. Huron, Chicago 10

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director of the nuclear electronics division. Lichtman was head of the missile laboratory division of the Naval Ordnance Laboratory, Corona, Calif.

Astron Buys Skottie Electronics

ASTRON CORP. of East Newark, N. J., manufacturers of capacitors and r-f noise interference filters, bought all of the outstanding stock of Skottie Electronic Corp. of Peckville, Penna. The purchase includes the plant buildings and production facilities.

Skottie manufactures ceramic capacitors and also supplies sub-miniature units designed specifically for transistorized and printed circuits.

Steps are being taken to expand the firm's production facilities.

Eitel-McCullough Selects Hall & Heil



James L. Hall

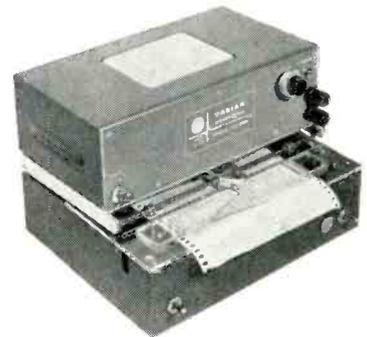
JAMES L. HALL has been named group leader of the ceramic receiving tube group for Eitel-McCullough of San Bruno, Calif., manufacturer of electron-power tubes.

Dr. Hall has assumed the duties of Paul Williams who has moved to the position of special assistant to the director of research. Hall came to Eimac as an electronic research engineer in July, 1953 from the Stanford Research Laboratory. He was made assistant department

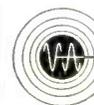
have you ever seen a graphic recorder with . . .

- ⊙ **PORTABILITY**... weighs less than 15 pounds, measures 10" x 7 1/8" x 8".
- ⊙ **VERSATILITY**... can be used as recording millivoltmeter or —with appropriate transducers — to record measurement of physical quantities.
- ⊙ **RECTILINEAR** trace representation.
- ⊙ **FULL CHART** zero positioning.
- ⊙ **HIGH INPUT** impedance and high allowable signal source impedance.
- ⊙ **PANEL** damping control for optimum stability.
- ⊙ **CHART DRIVE** extension for synchronization with other equipment.

**THE VARIAN G-10 GRAPHIC
RECORDER HAS ALL THESE
FEATURES AND MORE... IS
PRICED AT \$295**



WRITE TODAY FOR COMPLETE TECHNICAL DATA ON THIS REMARKABLE NEW INSTRUMENT AND ITS FULL ACCESSORY LINE.



Special Products Division

VARIAN associates
PALO ALTO 8 CALIFORNIA

Representatives in all principal cities
MICROWAVE TUBES — INSTRUMENTS

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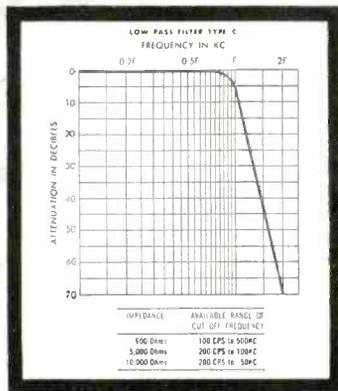
Clarify all types of Audio Frequencies

Available in a wide variety of types, frequency characteristics and impedance matches.

Boehme Communication Filters Especially designed . . .

- for minimum "ringing" or "tailing" (transient response)
- for optimum results under dynamic conditions

Write for data sheets, today!



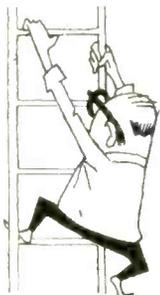
H.O. Boehme, Inc.

Designers and Manufacturers Communication Equipment Since 1917

Precision Electro-Mechanical Apparatus

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GOING
AS AN



ELECTRONIC ENGINEER?

If you're a qualified electronic engineer with ability, ambition, and imagination, your best chance for professional growth is with Electronic Engineering Company of California.

You can exercise your initiative and versatility on the wide variety of projects that form our increasing backlog. And you will be assured of recognition, security, excellent facilities, and the finest possible working conditions.

How far you go is up to you!

Send a resume of your background to Bob Lander

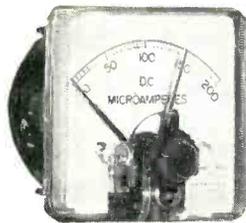
Electronic Engineering Company
of California



180 SOUTH ALVARADO STREET
LOS ANGELES 57, CALIFORNIA

METER-RELAYS

For Sensitive and Accurate Control



RANGES:

- 0/20 Ua. to 0/50 A.
- 0/5 Mv. to 0/500 V.

The trip point is adjustable to any point on the scale arc.

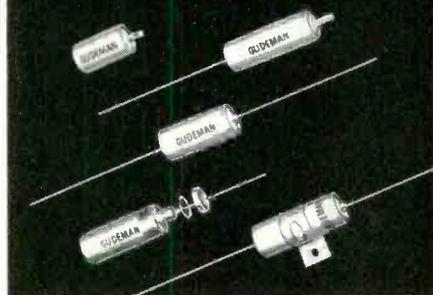
These meter-relays are sensitive to changes of as little as 1%. One contact is carried on moving pointer. The other is on a semi-fixed pointer. When two pointers meet contacts close and lock. Holding coil is wound directly over moving coil. Reset can be manual or automatic. Spring action in contacts kicks them apart forcefully. Three sizes of clear plastic case models, 2½, 3¾ and 4½ inches (all rectangular). Two ruggedized and sealed models, 2½ and 3½ inches (round metal cases). Contact arrangements: High Limit Single, Low Limit Single or Double (both high and low). Contact rating is 5 to 25 milliamperes D.C.

Suggested circuit for meter-relays and complete specifications including prices are covered in new 16-page Bulletin G-6, which you can get by writing Assembly Products, Inc., Chesterland 4, Ohio.

GUDEMAN

NEW "XC" PLASTIC FILM DIELECTRIC CAPACITORS

Hermetically Sealed (Glass to Metal)
Tubular Cased



The development of the Gudeman "XC" capacitors results in a new line of high temperature capacitors that has exceptionally high insulation resistance, low power factor and low dielectric absorption. The case sizes were selected whereby no voltage derating is required when the capacitors are used within a temperature range from -65° C. to +165° C.

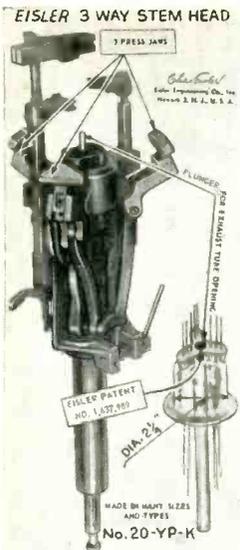
The Gudeman "XC" capacitors as shown are hermetically sealed, tubular, oil filled (Gudeman Impregnant #258), plastic film dielectric. Other case styles such as bathtub and rectangular types are available.

NEW MINIATURE DRY ELECTROLYTICS



- Gudeman "EMM" Type
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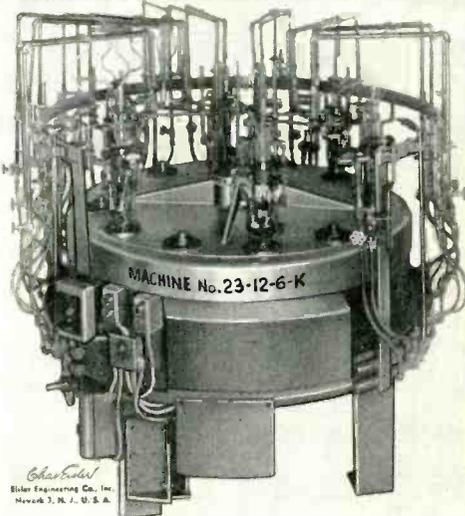


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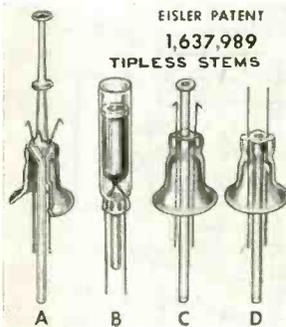
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head of the receiving tube group at Eimac in December, 1954.

Oskar Heil has joined the firm as group leader of the advanced research group recently formed in the research laboratory.

He comes from Wright Air Development Center at Wright Patterson Air Force Base, Ohio. He will direct research work on new types of tubes and theoretical study of electron beams.

Roger White Expands Plant

ROGER WHITE ELECTRON DEVICES of Ramsey, N. J. acquired a new plant in Haskell, N. J. The firm manufactures microwave equipment for both commercial and military uses.

The new plant triples previous facilities and will be devoted to the production of microwave equipment including traveling wave tubes, backward wave oscillators, gas control tubes and test equipment.

Heli-Coil Buys Towle And Son

HELI-COIL CORP. of Danbury, Conn., manufacturers of wire thread inserts, purchased the entire manufacturing facilities of the Towle and Son Co. of Conshohocken, Penna., precision manufacturers in the aircraft and electronic fields.

Heli-Coil will move all Towle equipment to Danbury and combine the facilities of both organizations, with Towle as a division of the Heli-Coil Corp.

Defiance Executives Acquire Interest

ANDREW A. CIROLIA and Percy E. Goodwin, executives and principals of Defiance Engineering & Microwave Corp. and Defiance Microwave Corp., have, individually, acquired an interest in and are now associated with Union Electronics & Machine Corp. of Georgetown, Mass. as president and treasurer, respectively. Union

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**Will this blot
spread...
or shrink?**



NOTHING STRIKES so brutally at human lives as a slum.

Yet of America's many millions of homes, the blot that is a slum covers more than 1 out of every 10... and nearly one-half of all our homes are urgently in need of repair and basic improvements.

Will the blot go on spreading? Or will a concerted, nationwide attack on the causes of slums shrink it, year by year, until it is wiped out? Today, this is a challenge to every American... a challenge that *must* be met.

Your community . . . your problem!

A slum reaches across blocks, across miles, to sit on your doorstep and demand a price.

You pay it in the threat of crime and juvenile delinquency to your family. You pay the price in higher personal property taxes to fight the disease and crime and poverty that are slum-bred. You pay personally when the value of your home sinks as community deterioration takes another step closer.

Your *firm* pays when the community where you do business goes downhill. Slums automatically mean lower purchasing power and less effective labor.

Good citizenship is good business

It's good citizenship and good business both for your firm to join efforts to check housing decay... to stop slums before they start. In fact, it's the *responsibility* of every business, as it is of every other good citizen, to support community improvement efforts.

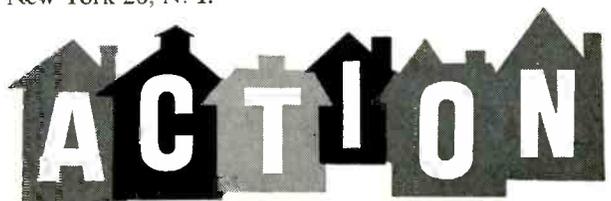
Some slums are beyond repair. They should be torn down and a fresh start made. Others can be remodeled, made to conform to better living standards. So it is up to you to get behind every sound program which seeks to provide adequate housing for all our people.

Adding your support to the efforts of the millions already attacking the problem, your firm can help stop slums cold and put America's housing standards at a new height.

How to get into action

A group of Americans from every walk of life has formed a new, non-profit organization to help combat home and community deterioration — The American Council To Improve Our Neighborhoods . . . A.C.T.I.O.N.

Send for a free copy of "ACTION." It explains what A.C.T.I.O.N. is and proposes to do. It also lists booklets, research reports, check-lists, and other material which can help you protect the housing health of your community. Address P. O. Box 500, Radio City Station, New York 20, N. Y.



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- Flat from DC to 4.5 mc to reproduce 3.58 mc sync burst and oscillator signals in color TV sets.
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Astatic Names Engineering Director



Fred Gluck

FRED GLUCK has been appointed as director of engineering of The Astatic Corp. of Conneaut, Ohio. He was formerly chief engineer of Fada Radio & Electric Co. He will direct and coordinate the various engineering activities at Astatic.

While at Fada, Gluck was responsible for all engineering activities involved in the design and manufacture of tv and radio receivers, and with that company's military electronics program. He was previously in engineering and sales administration with the Radiart Corp. of Cleveland.

New Missile Firm Formed

SYSTEMS RESEARCH CORP., a new company formed by a group of former Lockheed scientists who resigned last December following a policy dispute, began operations at its Van Nuys, Calif. headquarters.

Heading the company is Dr. Ernst Krause, former director of Lockheed's missile systems research laboratories branch. Dr. John L. Barnes, former director of Lockheed's computer and control laboratory, is serving as vice-president of the new company and Dr. Montgomery Johnson, former di-

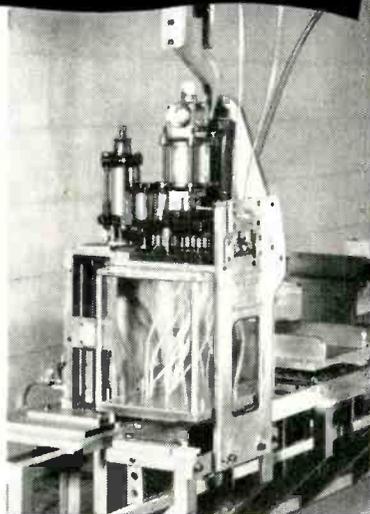
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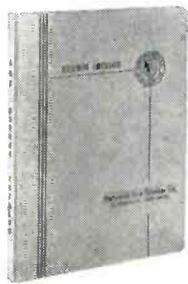
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3. DX-2252. Length 4-9/32". 22 contacts, spaced 5/32". For boards 0.060" to 0.071" thick.
4. DX-2842. Length 4-9/32". 28 contacts, spaced 5/8". For boards 0.060" to 0.071" thick.
5. DY-4453. Length 4-9/32". Double row, total of 44 contacts, spaced 5/32". For printed circuit boards 0.062" to 0.100" thick.



**Nylon plastic shells...
gold plated contacts**

DX contacts of phosphor bronze; DY of beryllium copper. All contacts "grip" the board, which enters to a depth of approximately 11/32". Each rated at 5-amp. Polarization studs provided. Flashovers 2000 and 2500 v. 60 cps ac rms.

Single-row types for boards printed on one side only, or both sides common. Double-row type for boards printed both sides having different circuits, not common.

Please refer to Dept. 120

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rector of Lockheed's nuclear physics laboratory, is the corporation's secretary-treasurer.

The new company expects to devote some of its energies to projects dealing with specific missile parts, but its primary aim is research and development work on the entire missiles system.

Narda Establishes Manufacturing Subsidiary

THE Narda Manufacturing Corp. has been formed as a wholly owned subsidiary of The Narda Corp.

The new company will manufacture uhf and microwave test equipment and detecting elements for The Narda Corp. In addition, the firm will engage in government contract and sub contract work relating to electronic test equipment.

Officers of the new corporation are: president, Dr. John C. McGregor; vice-president, William Bourke; vice-president in charge of engineering, Stuart Casper; vice-president in charge of manufacturing, James McFarland.

Oxford Division Appoints Plant Head

FRED BOECKER has been appointed plant manager of Oxford Electric's transformer division.

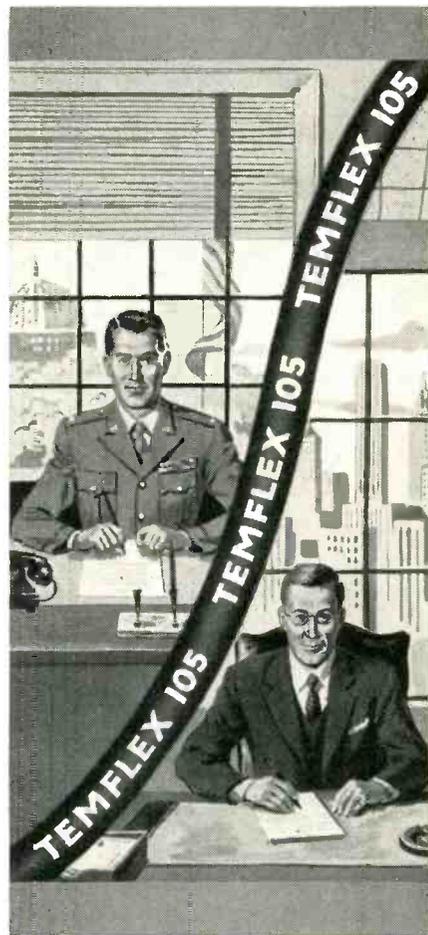
He comes to Oxford from the Rola Company of Cleveland, Ohio, where he was in charge of transformer operations. Prior to that, was in charge of transformer operations at Utah Products of Chicago.

Marvelco Names Design Director

CLARENCE B. KNUDSON has been appointed director of the newly formed product and applications design section of Marvelco Electronics division of National Aircraft Corp.

Knudson comes to Marvelco from Hoffman Laboratories where he was manager of the new products development engineering division. He has been vice-president in charge of engineering, Vantool, Inc.; director of engineering, Wash-

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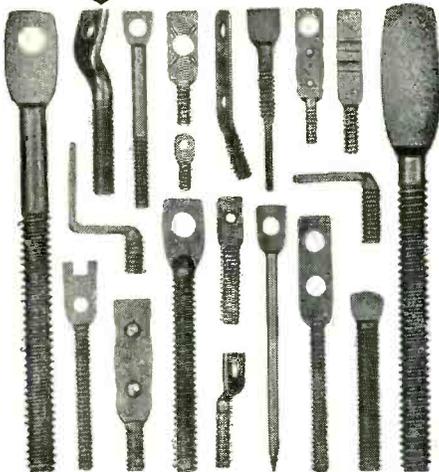


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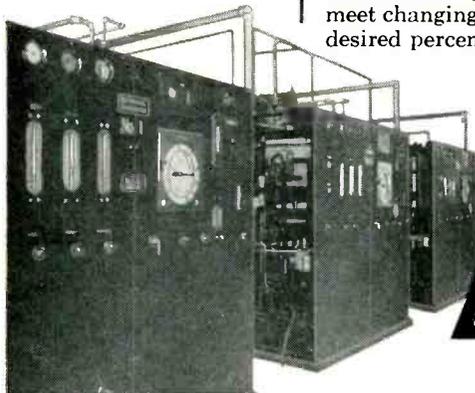
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ington Institute of Technology; section head, American Bosch Corp. and electronics engineer at Westinghouse.

Hewlett-Packard Plans Expansion

HEWLETT-PACKARD Co. of Palo Alto, Calif., has leased a 40-acre site in the Palo Alto area to build new manufacturing facilities. The property, owned by Stanford University, was leased for 99 years. The company hopes to begin construction in a year. The present plant and offices will be retained.

Infra Selects Chief Engineer



Fenimore Fisher

FENIMORE FISHER was promoted to chief engineer of the motor and generator division of Infra Electronics Corp.

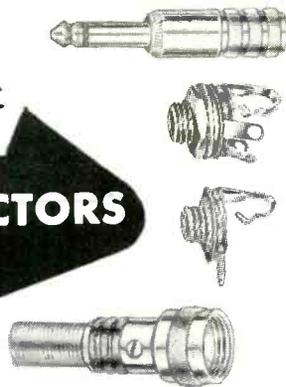
He formerly was senior engineer in the servo motor laboratory of the firm at the design level. Prior to joining Infra over five years ago, he was employed as design engineer by the Naval Aircraft Instrument Laboratory in Philadelphia.

Signal Engineering Changes Its Name

WHEELOCK SIGNALS, INC. is the new name of Signal Engineering & Mfg. Co., makers of relays, fire alarm systems, audible signals, code call system and auxiliary equipment.

The change, made to simplify the

tiny
ELECTROCRAFT
PLUGS·JACKS·CONNECTORS
in true miniature
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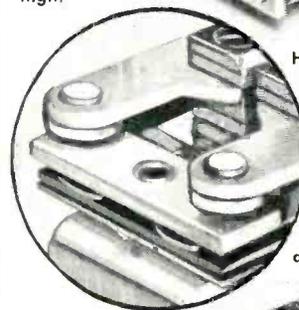
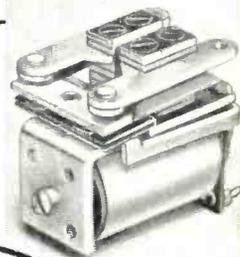
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New Miniature
RELAYS
 switch 20 amps.
reliably

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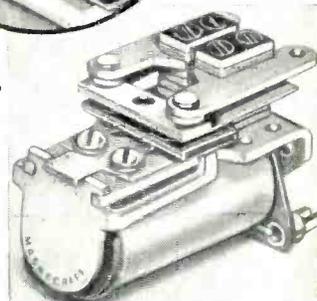
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AC or DC



For AC operation to 440 V. or DC to 230 V. Minimum operating power, 1/2 watt. 2-1/16" long, 1-1/16" wide, 1-9/16" high.

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\$150

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- Beta: 0-50 0-150
 or as calibrated
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 0-150 microamperes
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 2 megohms

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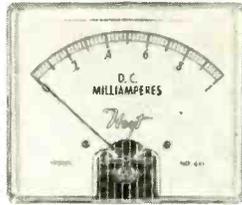
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corporate name, is a change in name only and the business will be continued as heretofore by the present personnel with the same ownership, products and policies which have characterized the company over the past forty years.

The change of name follows the firm's recent move to larger and new plant facilities and offices at Long Branch, N. J. The company was previously located in New York City.

Zenith Establishes West Coast Lab

ZENITH Radio Research Corp. of California, subsidiary of Zenith Radio, established a research laboratory in Redwood City, Calif.

Winfield W. Salisbury will be director of research of the lab.

The laboratory will be concerned with electronic developments in areas outside the household radio and television field which may lead to diversification of the company's activities.

Jerrold Electronics Opens New Laboratory

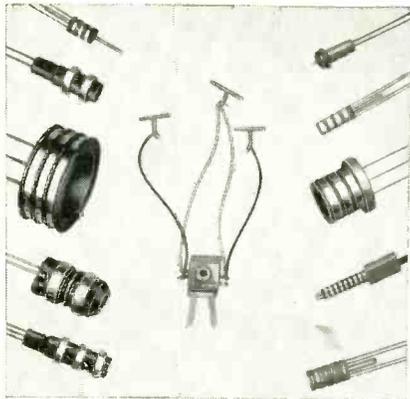
JERROLD ELECTRONICS CORP. dedicated its new 10,000 sq. ft research laboratory in Huntington Valley, Pa. In addition to the electronic research facilities, it includes a machine shop, plastic molding shop and two model shops for assembling prototype models.

Clary Names Two Engineering Heads

CLARY CORP. has appointed two assistant chief engineers to head new development programs for its electronic and data-processing equipment and for business machines.

Kenneth F. Oldenburg and Milton Scozzafava were promoted to the newly-established offices of assistants to Robert E. Boyden, chief engineer. Both have been engineering supervisors since 1952.

Oldenburg will continue in charge of the electronic and data-



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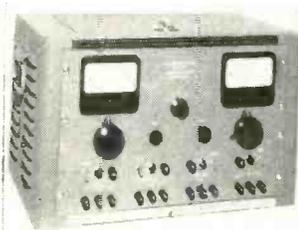
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Vib.: 10 G at 5 to

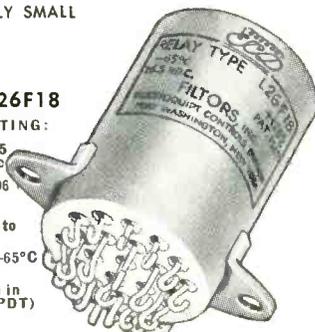
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Actual Size

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Vib.: 10 G at 5

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426

PLANTS AND PEOPLE

(continued)

handling equipment department
and Scozzafava of the business ma-
chines department.

Oldenburg joined the engineering
department as a designer in 1946
and for the past few years has been
in charge of the data-processing
laboratory.

Consolidated Sets Up Data Laboratory



Robert L. Sink

CONSOLIDATED Electroynamics
Corp. has established an advanced
electronic data laboratory.

The lab will undertake develop-
ment of advanced equipment in the
magnetic-tape data-processing field
under contract to governmental and
private agencies.

Named to head the Laboratory,
which will be located in Pasadena,
was Robert L. Sink, former assist-
ant director of engineering for
Consolidated.

He joined Consolidated in 1945
as chief electrical engineer. Previ-
ously, he had held engineering posi-
tions with Litton Engineering,
Hewlett-Packard and GE.

General Controls Acquires Division

GENERAL CONTROLS Co. of Glendale,
Calif., acquired the precision pot-
entiometer division of Electro
Circuits of Pasadena.

The new division is to operate
as an independent unit with all
Electro personnel continuing with

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For many years, Stromberg-Carlson pro-
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the independent telephone industry.

Last year, we became a division of
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million-dollar expansion program is un-
der way and one result is already in-
creased relay manufacturing facilities,
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These relays—proven by years of re-
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are designed to operate under extreme
ranges of temperature and humidity.
They are made in many types of which
these are typical.

Type A is a general-purpose relay espe-
cially adapted to the control of switch-
ing operations.

Type B is a gang-type relay which can be
equipped with three times the number
of spring combinations as the "A" type.

Type C. Two relays on the same frame;
mounts in same space as the "A" type.
It is particularly effective where small
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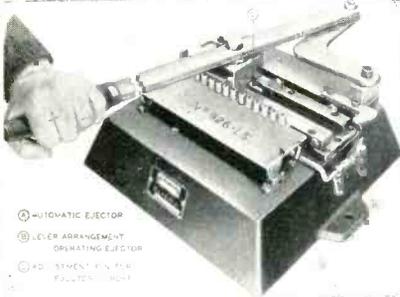
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April, 1956 — ELECTRONICS

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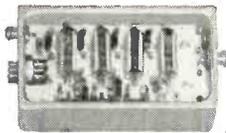
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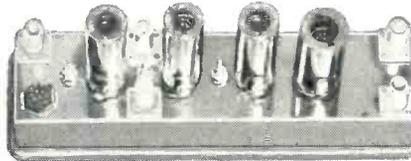
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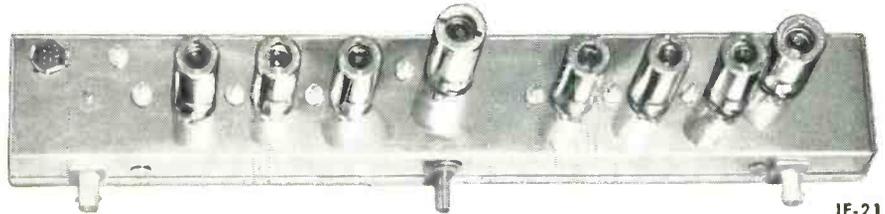
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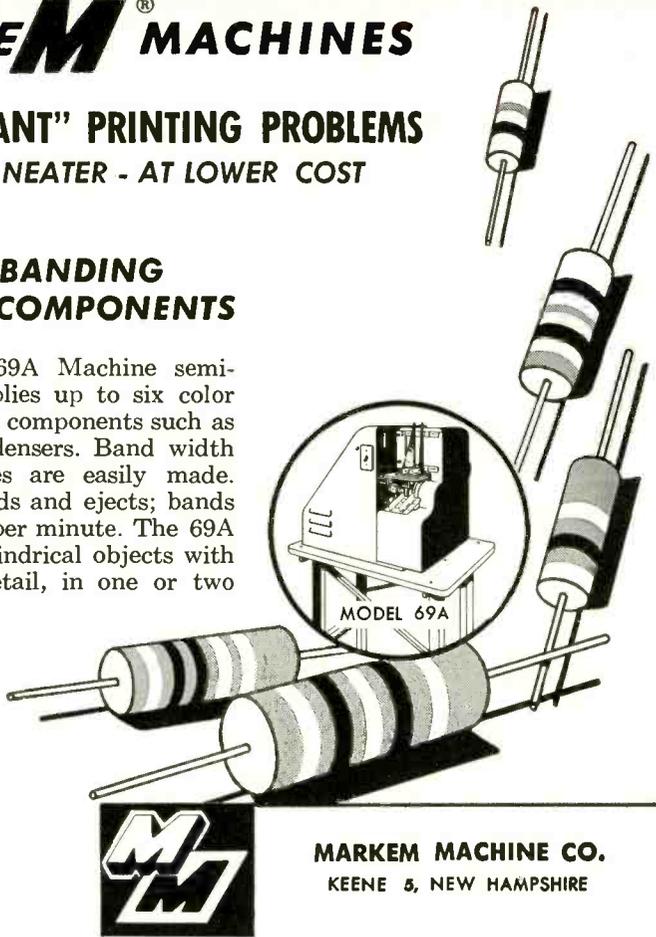
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Other Markem machines available for marking electrical parts and products of all sizes and shapes. Write for detailed information.



PLANTS AND PEOPLE

(continued)

the division under the direction of Bruce Grimm, chief engineer.

Raytheon Elects New Treasurer

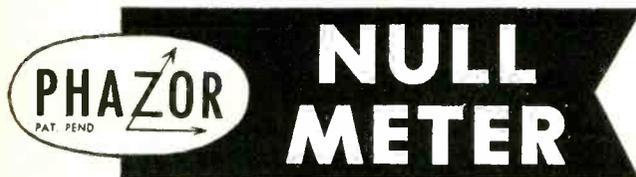
ALLEN E. REED has been elected treasurer of Raytheon. He has served as comptroller of the firm for the past nine years and will continue in that capacity in addition to the office of treasurer.

As treasurer of Raytheon, Reed succeeds D. T. Schultz, who joined Allen B. DuMont Laboratories as president.

Central Transformer Doubles Space

CENTRAL TRANSFORMER Co. doubled its manufacturing space by leasing additional space at its present location in Chicago.

M. R. Whitman is president and chief engineer; L. G. Shore is secretary-treasurer and general manager and F. J. Gallagher is manager of sales.



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WHEREIN NOISE
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**Other Electronic
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Feedback Controls Appoints President

WILLIAM M. PEASE has been appointed president of Feedback Controls, Inc. He formerly held the position of vice-president and general manager of the firm. He was v-p and manager of the electronic division of Ultrasonics Corp. and director of the servomechanisms lab at M.I.T., previously.

Lewyt Expands In Electronics

THREE Lewyt corporations will spend \$10 million during the next 5 years in an expansion program.

The program started last July with the \$2 million purchase of the Ford Instrument plant in Long Island City, N. Y. from the Sperry-Rand Corp. The newly acquired building has 315,000 sq ft of manufacturing space, but 43,000 more sq ft are being added. The expansion program will triple research and development facilities and double production capacity. In the

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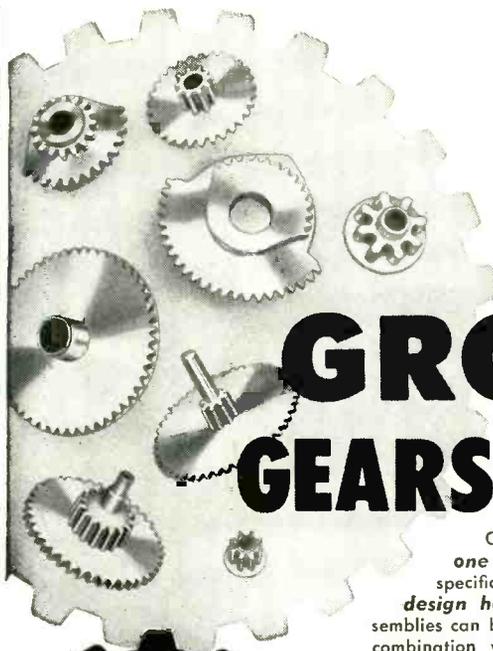


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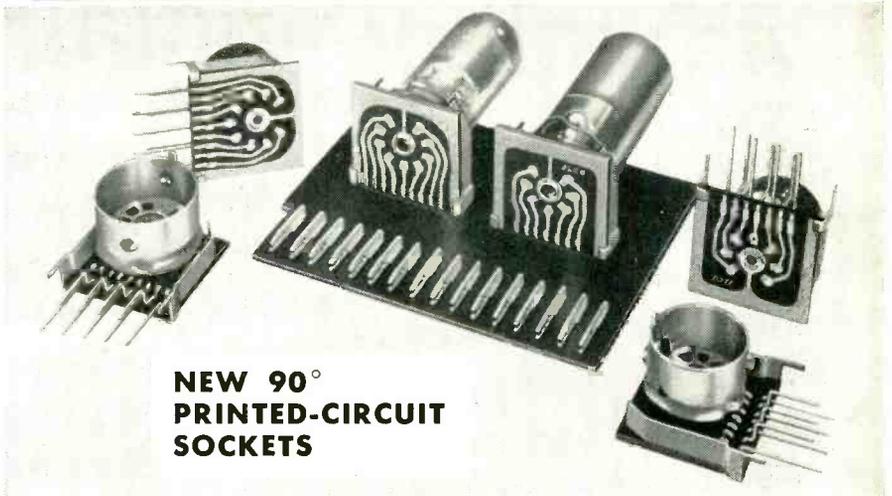
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near future the firm will have manufacturing and assembly facilities for over 6,000 employees.

Each of three companies has been allocated a good slice of the \$4 million expansion pie for the coming year.

The Lewyt Manufacturing Corp., makers of electronic and electro-mechanical equipment for the military and private industry, plans a new research and development laboratory, new test chambers, new vibration and shock test equipment and new plating gear.

Crosby Labs Promotes Coffman

BARTON C. COFFMAN has been named chief engineer of Crosby Laboratories of Hicksville, N. Y. He joined the firm in 1951 as senior engineer. He was later advanced to the post of research associate.

Lambda Electronics Pushes Output



Lambda Electronics plant

LAMBDA Electronics Corp., manufacturers of power supplies, is in full production at its new plant at 11-11 131 st. in College Point, N. Y.

ESC Appoints Production Chief

ESC CORP., of Palisades Park, N. J., manufacturer of delay lines, appointed Melvin Traum as production manager.

Previous to his appointment at ESC, Traum was associated, for twelve years, with the guided missile division of Federal Telecommunication Laboratories.

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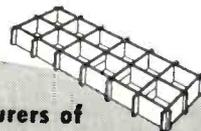
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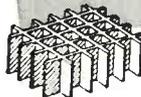
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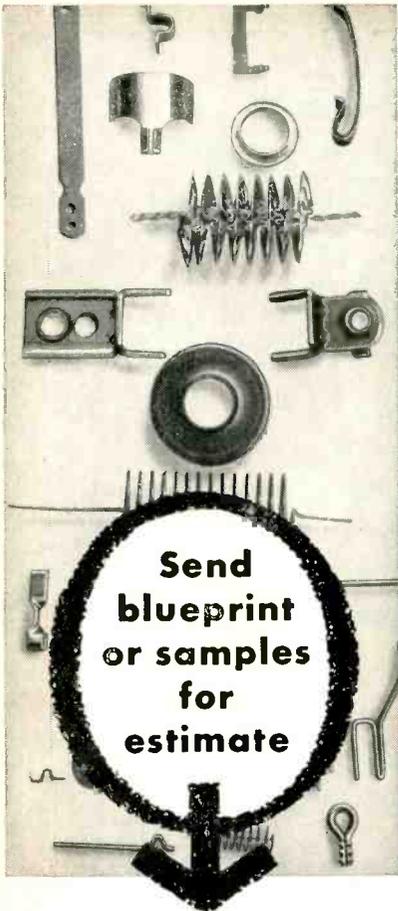
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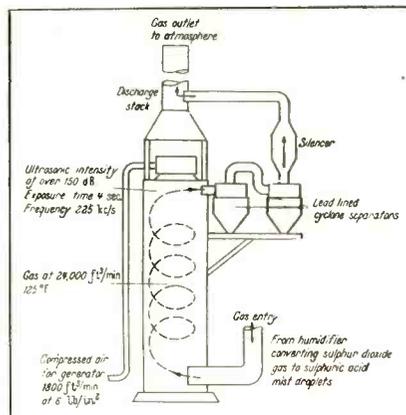
Ultrasonic Engineering

By A. E. CRAWFORD
Academic Press Inc., New York,
1955, 344 p, \$8.00.

THE contents of this book deal with a subject which has been rapidly increasing in importance over the past decade, although a large percentage of engineers are totally unfamiliar with it. The object of the book is to present and correlate data on the applications and effects of ultrasonic waves and to cover some basic methods of generation of ultrasonic energy. Emphasis is placed on the practical aspects of ultrasonics and not on mathematical analysis.

The book is divided into sections covering: theory, generation and applications.

► **Basic Theory**—In the first section the author discusses basic ultrasonic theory including types of waves, standing waves, energy and frequency measurement, and the phenomenon of cavitation. The properties of absorption, reflection, refraction and beaming of ultrasonic waves are described. Basic equations are presented. These equations although brief, are informative. A group of tables of velocity of sound, specific acoustic impedance and density of a large number of liquids, solids, gases and metals are included which are helpful in designing ultrasonic generators.



Schematic arrangement of acid fog precipitation using sonic agglomeration

► **Generators**—The second section deals with the generation of ultra-

sonic energy using piezoelectric, magnetostrictive and electromagnetic transducers. Also included is an interesting chapter on ultrasonic generation by high-velocity jets of liquids and gases. The theory of operation and practical design considerations of the various types of transducers mentioned are adequately discussed including forms of coupling and methods of mounting.

► **Applications**—The third section, which occupies more than half the book, is concerned with practical high-power applications of ultrasonic energy in the fields of chemistry, metallurgy, and medicine. In addition descriptions are given of instruments employing ultrasonic waves for drilling, soldering, dust precipitation and equipment for use in underwater applications. Excellent qualitative information on the actual processes involved in applying ultrasonic energy to perform various tasks and descriptions of commercially produced laboratory and industrial instruments are contained in this section.

The excellent graphs, tables, photographs and drawings help to a large extent in making this book a fine introduction to the field of ultrasonics for engineers unfamiliar with the subject. It is also a valuable source of information to those interested in familiarizing themselves with the capabilities of ultrasonic energy for the purpose of possibly converting their standard methods of processing to ultrasonic methods with the object being improved efficiency and economy, among other things.—S. A. GITLIN, Dept. of Electrical Eng. Electronics Research Labs, Columbia University, New York

Linear Feedback Analysis

By J. G. THOMASON. McGraw-Hill Book Co., New York, 1955, 348 p, \$8.50.

"LINEAR Feedback Analysis" is an introductory, analytical treatment of feedback-circuit analysis, which emphasizes stability theory and design techniques for stabilizing feedback amplifiers. The book is written at a level which should be readily understood by seniors or graduate

electronics engineers:



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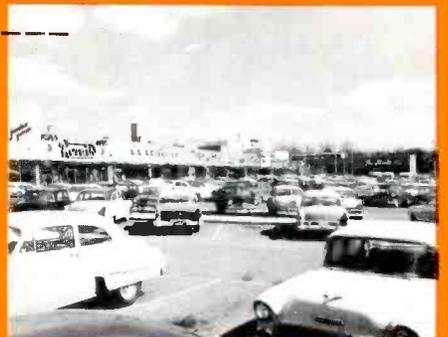


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438

NEW BOOKS

(continued)

book seems to be a definite contribution in the dissemination of the basic ideas of stabilization.

In this sense, the book closely parallels a number of servo books, such as G. J. Thaler's "Elements of Servomechanism Theory," except of course that in Thomason's book the examples are drawn from the feedback-amplifier field rather than the servo field.

► **Feedback**—There are a number of fundamental aspects of the feedback-amplifier subject which the author chooses not to discuss in order to emphasize the basic techniques of stabilization. For example, there is practically no real utilization of transform methods in design, once the Nyquist criterion is established.

Perhaps more important, there is only a very brief discussion of the effects of feedback on sensitivity, impedances, distortion, etc. The especially brief treatment of sensitivity (the return difference is not included in the index) is unfortunate in the reviewer's opinion, since stabilization is really necessary in the majority of cases only because of the desire for low sensitivity. Likewise, there is essentially no clear distinction between negative resistance and instability and only a hurried disposition of conditionally stable systems.

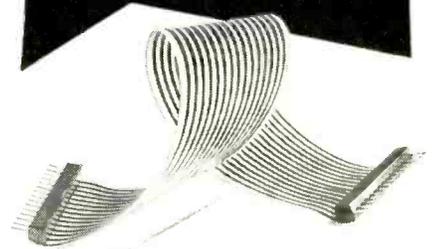
Comment on these omissions is unjust, however, since the author is not trying to present feedback theory, but rather the basic, commonly used techniques for the design and stabilization of feedback amplifiers, and in this direction he has succeeded admirably with a book which is easily read, replete with interesting examples, relatively free of errors, and in a comparatively under-published field—
JOHN G. TRUXAL, *Associate Professor, Polytechnic Institute of Brooklyn, Brooklyn, New York*

The Physics of the Ionosphere

THE PHYSICAL SOCIETY.
London, England, 406 p, 1954, 40 shillings (paper).

THIS BOOK is the report of the Physical Society conference held

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April, 1956 — ELECTRONICS

at the Cavendish Laboratory, Cambridge in September 1954. It contains 50 papers, 45 of which are in English with 3 in German and 2 in French.

The report is in four parts: the lowest ionosphere, 10 papers; irregularities and movements in the ionosphere, 17 papers; the ionosphere F2 layer, 9 papers; the mathematics of wave propagation through the ionosphere, 14 papers.

Arrangement

Each section is introduced by a survey article to bring the reader up to date on present knowledge in the field. An addendum to each survey article summarizes the major points brought out during the conference. The four survey articles provide a good introduction to the subject of ionospheric radio propagation.

The paper Scattering at Oblique Incidence from Ionospheric Irregularities by D. K. Bailey of NBS reports transmissions of 1,200 km on frequencies on the order of 50 mc by forward scattering from irregularities in the E or D regions, the power of the transmitter being about 30 kw. This sort of phenomenon has assumed considerable importance in military uhf point-to-point communications.

The Ionospheric F2 Region by R. J. Havens, H. Friedman and E. O. Hulburt of NRL reports on composition and temperatures in the upper atmosphere. The data was obtained during rocket flights that attained altitudes up to 219 km. —J.M.C.

Microwave Spectroscopy

By C. H. TOWNES and A. L. SCHAWLOW

McGraw-Hill Book Co., Inc., New York, 1955, 698 p, \$12.50.

YET another book of the same title to come out within a couple of years. The first, by Walter Gordy et al, was published by John Wiley in 1953, and the second, a Methuen Monograph by M. W. P. Strandberg, in 1954. Both books were reviewed in ELECTRONICS (October 1953 and June 1954, respectively). In reviewing the latter, the re-

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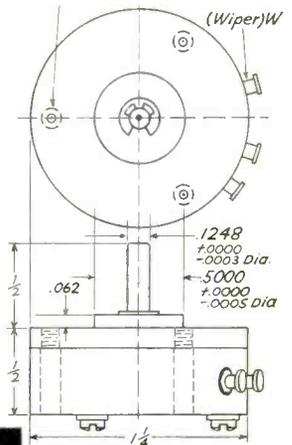
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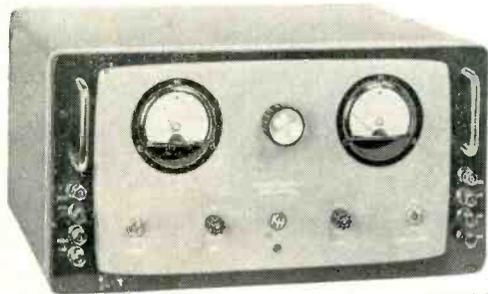
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viewer pointed out that among American universities, Columbia, Duke and M. I. T. were perhaps the foremost in the field of microwave spectroscopy. Duke and M. I. T. having made their contribution, it now behooves Columbia University to bring forth the present volume, which is perhaps the most all-encompassing yet, not only because it is more recent, but also because of the exhaustive treatment: the book draws on a bibliography of some 1,200 items, with information to match.

► **Molecules**—But this is no mere compendium of tables, graphs, and other information of the handbook type. Rather, the treatment starts with a consideration of the simple diatomic molecules, followed by the increasingly complex cases of linear polyatomic molecules, symmetric-top molecules, and asymmetric-top molecules. The authors go on to discuss some of the fine and hyper-fine effects, the study of which has been made possible by the use of microwave technique for the first time.

Of the book's eighteen chapters only three are concerned directly with instrumentation: one on microwave circuit elements and techniques, one on microwave spectrographs, and one on methods of measuring and controlling frequency. There is also a short chapter on the production of millimeter waves, a topic on which the Columbia group is particularly competent to report, since they have made some notable contributions to this field.

► **Impact**—There are few instances in which electronics has had such a profound influence upon related fields as microwave spectroscopy has had on physics and chemistry (and promises to have on chemical analysis). The authors speak of the "furious activity" that has made their task especially difficult, both because of the huge amount of results becoming available all at once, and because of the rapid development of ideas and techniques that is sure to make any published survey obsolete quickly. They have addressed themselves to this task with a result that is certainly im-

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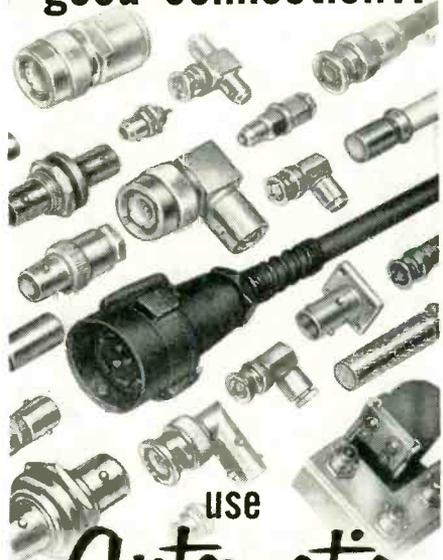
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ELECTRONICS — April, 1956

pressive, producing a book that is both timely and likely to remain a standard work for some time to come.

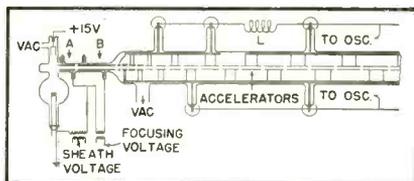
C. H. Townes is Professor of Physics at Columbia University, and A. L. Schawlow, formerly also associated with Columbia, is a member of the staff of the Bell Telephone Laboratories. They are to be commended for undertaking to write such a major work, and to be congratulated as to the extent of their success in accomplishing their avowed intent "to discuss the material critically, systematically, and in the simplest way consistent with some completeness in a single volume."—CHARLES SUSSKIND, *University of California, Berkeley, Calif.*

**Introductory Nuclear
Physics**

By DAVID HALLIDAY. *John Wiley & Sons, Inc., New York, 1955, 493 p., \$7.50.*

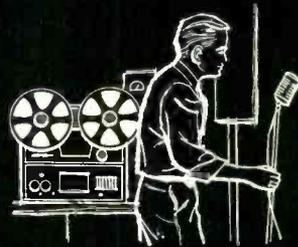
INSTRUMENTATION for studying nuclear phenomena and for controlling reactions depends heavily upon electronic circuitry. This puts the electronic engineer into the nuclear energy business and it behooves him to have more than a nodding acquaintance with this new, complex and rapidly moving science.

This book is designed as an introductory text on the undergraduate level. Nevertheless, the material presented in small type and the appendixes contain material sufficient for a course on the first-year graduate level.



Halliday linear accelerator for heavy ions

► **Content**—The book covers radioactive decay and alpha emission, gamma radiation and internal conversion, behavior of gamma rays, beta decay, detection of charged particles. Also: neutrons, nuclear



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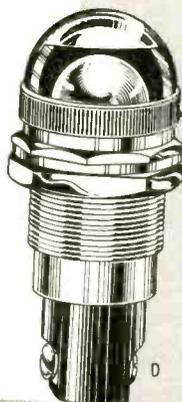
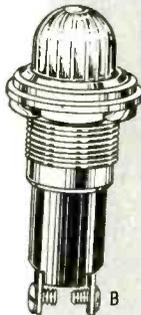
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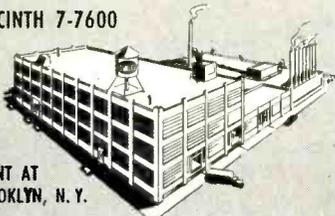


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NEW BOOKS

(continued)

masses, structure, reactions, fission and spin, particle accelerators, cosmic rays and subnuclear particles.

Chapter II presents the more elementary concepts of quantum mechanics with more detailed material in the appendix. The quantum mechanical approach is used in presenting subsequent material.

► **Electronics**—The chapter on particle detection describes the operation of several electronic instruments including cloud chambers, electroscopes, scintillation counters, amplifiers, scalars and coincidence detectors. Also described are proportional counters and the mass spectrometer.

Under the heading of accelerators the reader can discover the principles of electrostatic generators, linear accelerators, cyclotrons, betatrons and proton synchrotrons.

Other sections of the book treat electronic instrumentation used in nuclear experimentation such as the pair spectrometer for gamma-ray energies, the beta-ray spectrometer, molecular-beam magnetic resonance apparatus and r-f equipment for studying nuclear spin. Also covered are electronic equipments for studying nuclear reactions, cosmic rays and subnuclear particles.—J.M.C.

Thumbnail Reviews

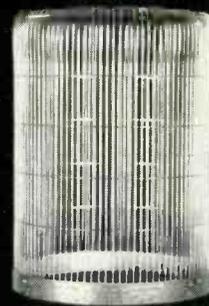
Partial Differential Equations of Mathematical Physics. A. G. Webster. Dover Publications, Inc., New York, 1955, 440 p, \$1.98 (paper). Reprint edition of 1927 work. Covers fields of mathematics particularly useful in electromagnetic studies.

ASTM Standards on Plastics. American Society for Testing Materials, Philadelphia, Pa., 1955, 790 p, \$5.75 (paper). Presents specifications, methods for testing including electrical tests, recommended practices and definition of terms relating to many materials in wide use in the electronics industry.

Peaceful Uses of Atomic Energy, Vol. III, Power Reactors. Columbia University Press, New York, 1955, 389 p, \$7.50. Proceedings of international conference held at Geneva in August 1955. This volume contains informa-

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tion on every central-station power reactor throughout the world. Discussion of many of the reactors includes material on instrumentation.

Table of the Descending Exponential. National Bureau of Standards. Superintendent of Documents, Washington, D. C., 76 p, \$50 (paper). Useful in applied electronic physics. Table extends from $x = 2.5$ to 10 at intervals of 0.001 to 20 decimal places.

Table of Hyperbolic Sines and Cosines. National Bureau of Standards. Superintendent of Documents, Washington, D. C., 81 p, \$55 (paper). Covers from $x = 2$ to 10 at intervals of 0.001 to nine significant figures.

Bulletin of the Academy of Sciences of the USSR. Columbia Technical Translations, White Plains, New York, single issues: \$20; annual subscription: \$110. Present copy, No. 3, Vol. 18, 1954 is 112 p, paperbound. It includes fifteen papers dealing with properties of ferrites. For example: Rotation of the Plane of Polarization of Centimeter Waves By a Ferrite Disk.

Broadcasting Stations of the World. Foreign Broadcast Information Service. Superintendent of Documents, Washington, D. C. (paper). Lists all known radio and television broadcasting stations except domestic stations within continental U. S. Published in four parts: Part I (\$1.25) indexes stations according to country and city; Part II (\$1.25) indexes according to frequency; Part III (\$1.00) indexes by call letters or slogan; Part IV (\$.60) deals with f-m and tv stations.

The Mathematical Analysis of Electrical and Optical Wave Motion. H. Bateman. Dover Publications, New York, 1955, 168 p, \$1.60 (paper). Reprint of 1914 book on mathematical analysis of electromagnetic wave phenomena using Maxwell's equations.

Arbeitsverfahren und Stoffkunde der Hochvakuumtechnik Technologie der Elektronenrohren. H. Steyskal. Physik Verlag, Mosbach, Germany, 1955, 183 p, DM 14.40 (paper). Characteristics of materials and techniques used in the fabrication of electron tubes.

Techniques for Application of Electron Tubes in Military Equipment. Rex S. Whitlock. Office of Technical Services, Washington, D. C., 1955, 271 p (paper). Air Force technical report presents data on electron tubes intended for military applications. Gives essential tube properties and relates them to circuit design. Bulk of book consists of numerical data and design considerations for specific tube types.

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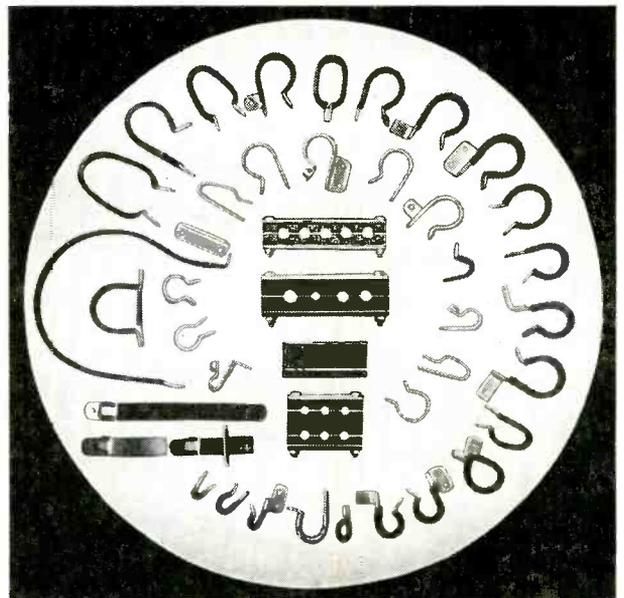
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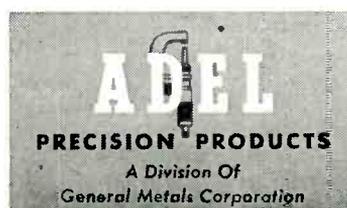
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Backtalk

Tubes Plus Diodes

DEAR SIR:
CONCERNING the circuit shown on page 192 of Nov. *ELECTRONICS* ("Electronic D-C Amplifiers", by I. Barditch), no apparent purpose is served by the diodes in series with the plates of the 12AT7. The diodes present a high impedance to reversal of current, but the tubes already possess an infinite impedance to reversal of current, so the diodes appear to be superfluous.

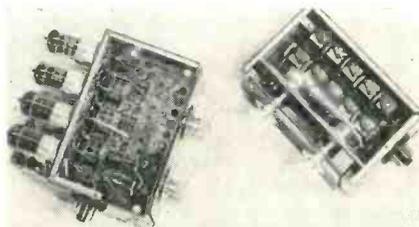
ROBERT HEPPE
Nutley, New Jersey

DEAR SIR:
MR. HEPPE is probably not aware that tubes subjected to a high negative voltage on the plate exhibit a phenomenon known as "back emission". This is fully discussed in a Sylvania Engineering Information pamphlet Vol. I, No. 10, May 1954 in an article entitled "Effects of AC Plate Voltages on Tube Performance". It is pointed out therein that back emission can vary with temperature and from tube to tube, so that different tubes will perform differently in the same circuit.

The diodes prevent this from occurring. So, while it is possible the diodes can be omitted for economy, they do provide a measure of "design margin" that is desirable.

IRVING BARDITCH
Baltimore, Maryland

Magnetic Amplifier For Counters



Two decimal counting units shown in the photograph use tubes (left) and ferristors (right). Reduced size results from using a 50-year old principle in development of a modified magnetic amplifier (*Electronics*, p 128, Oct. 1955). The particular application is that of Beckman Instruments, Inc.

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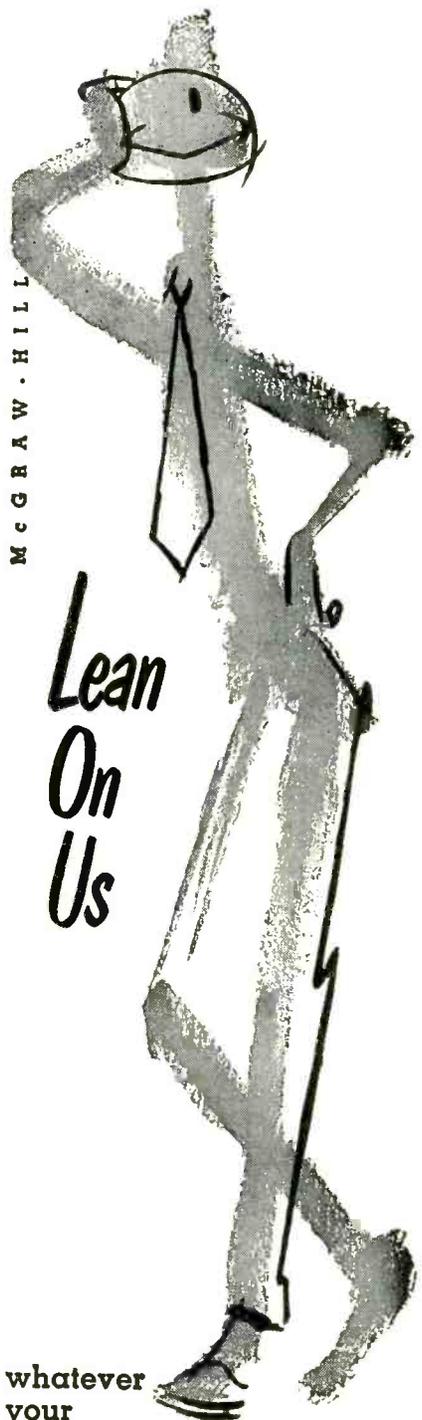
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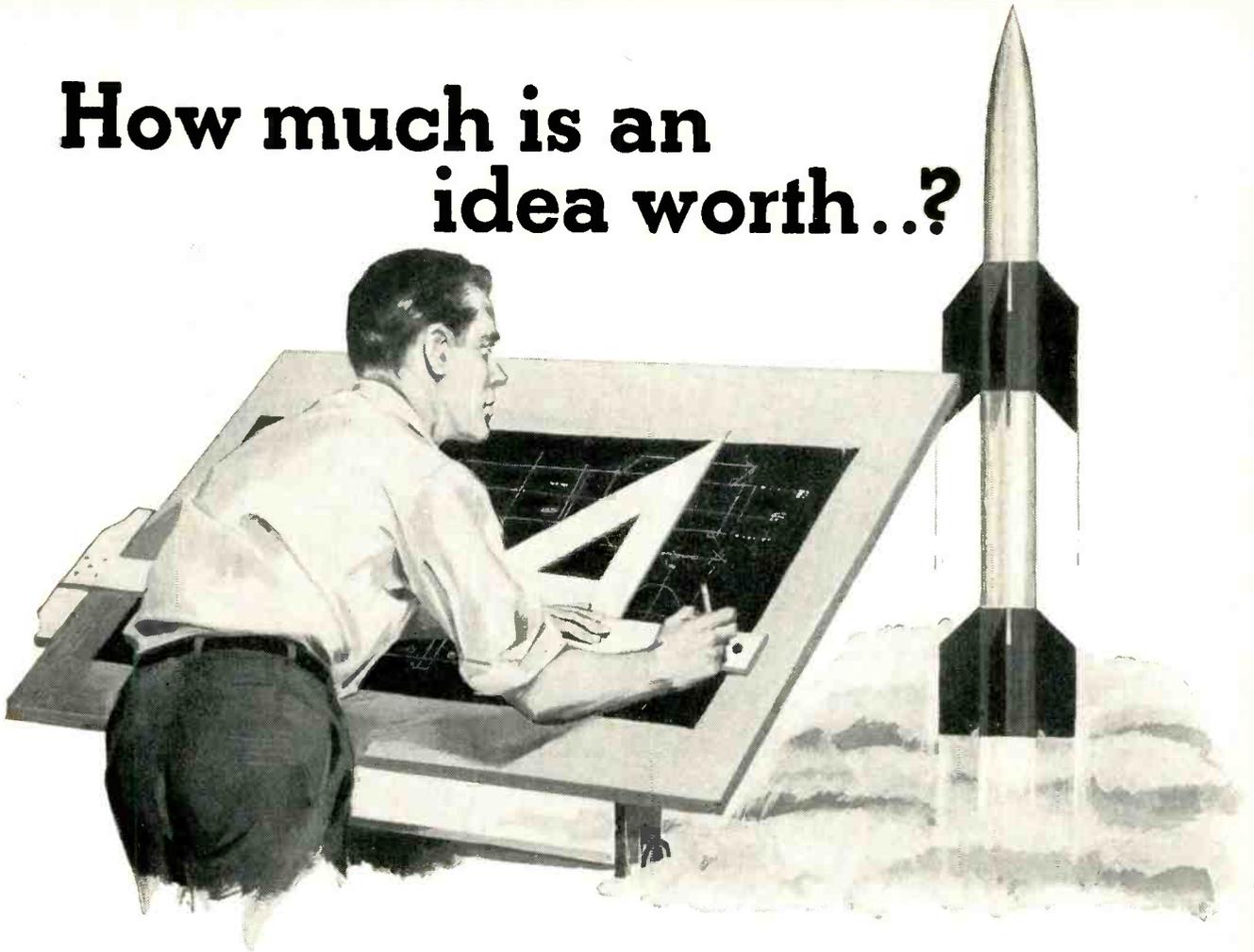


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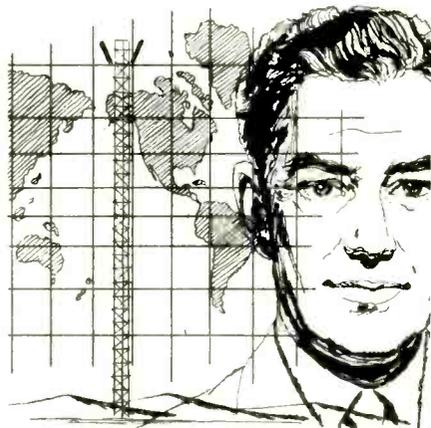
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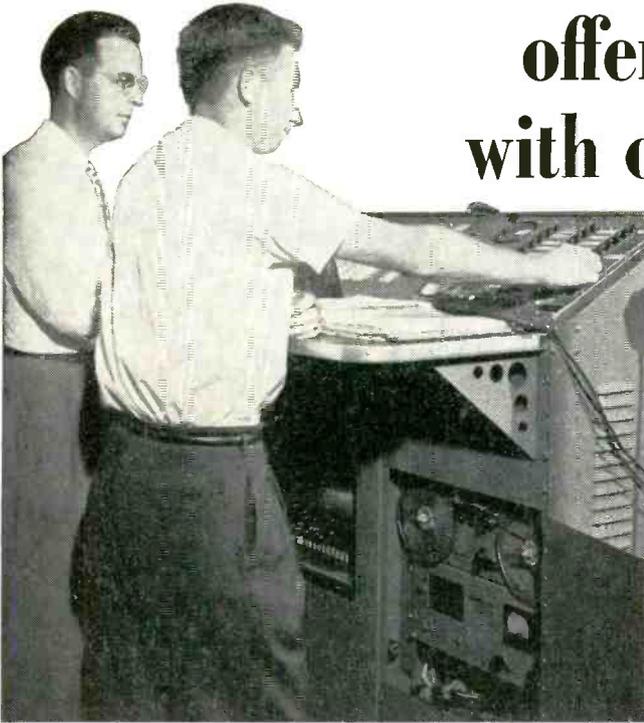
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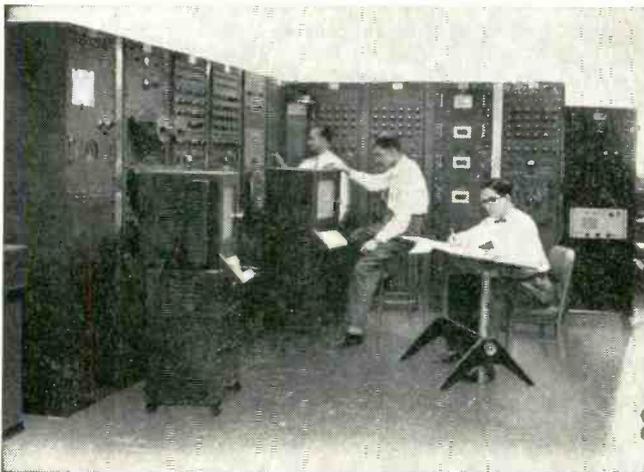
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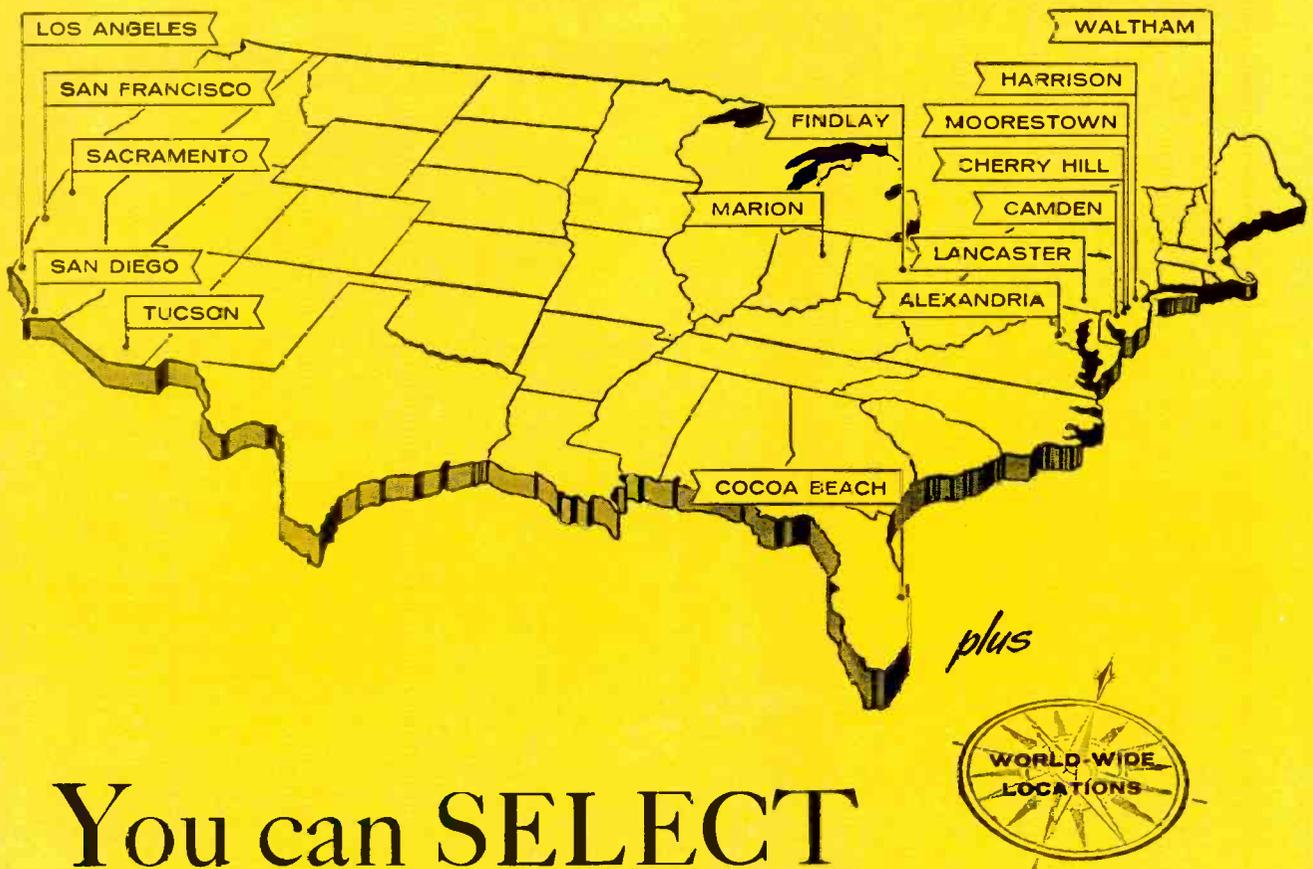
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FIELDS OF ENGINEERING ACTIVITY		M A N A G E R S	TYPE OF DEGREE AND YEARS OF EXPERIENCE PREFERRED													
			Electrical Engineers			Mechanical Engineers			Physical Science			Chemistry Ceramics Glass Technology Metallurgy				
			0-2	2-3	4-15	0-2	2-3	4-15	1-2	2-3	4-15	1-2	2-3	4-15		
• SYSTEMS (Integration of theory, equipments and environment to create and optimize major electronic concepts.)	AVIATION ELECTRONICS - CONTROLS			W	W						W	W				
	DIGITAL DATA HANDLING DEVICES	M	C	M	M			C	C			C	C			
	MISSILE ELECTRONICS • RADAR	M	W	M	M		M	M		M	M	W	W			
	INERTIAL NAVIGATION	W			W			W				W				
	COMMUNICATIONS				C							C				
• DESIGN • DEVELOPMENT																
KINESCOPES (B & W and COLOR), OSCILLOSCOPES —Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photosensitive Materials and Glass to Metal Sealing)			L	L	L		L	L	L		L	L	L		L	L
RECEIVING TUBES —Tube Design—Test and Application Engineering—Chemical and Physical Development—Methods and Process Engineering—Advanced Development			H	H	H		H	H		H	H		H	H		H
SEMI-CONDUCTORS —Transistors—Semi-Conductor Devices—Materials			H	H	H		H	H		H	H		H	H		H
MICROWAVE TUBES —Tube Development and Manufacture (Traveling Wave—Backward Wave—Magnetron)		H		H	H		H	H		H	H		H	H		H
GAS, POWER AND PHOTO TUBES —Photosensitive Devices—Glass to Metal Sealing—UHF and VHF—Power			L	L	L		L	L		L	L		L	L		L
AVIATION ELECTRONICS —Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Automation—Transistorization		W	C	W	W		W	W		W	W		W	W		W
COMPUTERS —Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming			C	C	C		C	C		C	C		C	C		C
RADAR —Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control—Information Handling—Displays		M	C	M	M		M	M		M	M		M	M		M
COMMUNICATIONS —Specialized Military Systems—Microwave—Aviation—Audio—Propagation Studies			C	C	C		C	C		C	C		C	C		C
MISSILE ELECTRONICS —Systems Planning and Design—Radar—Fire Control—Shock Problems—Servo Mechanisms		M	M	M	M		M	M		M	M		M	M		M
COMPONENTS —Transformers—Coils—TV Deflection Yokes (Color or Monochrome)—Resistors—Ferrites (Material and Parts)			C	Z	Z		C	Z		C	Z		C	Z		C
• SYSTEMS APPLICATION (Evaluation and Planning—Design and Development—Modification—Specification)																
MISSILE TEST INSTRUMENTATION (Data Acquisition and Processing)—Radar—Telemetry—Timing—Communications—Optics—Computers		F	F	F	F		F	F		F	F		F	F		F
RADAR —Airborne—Surface—Shipboard—Sonar—Fire Control		F	F	F	F		F	F		F	F		F	F		F
COMMUNICATIONS —Radio—HF—VHF—UHF—Microwave—Telephone—Teletype—Telegraph Terminal Equipment—Wave Propagation		F	F	F	F		F	F		F	F		F	F		F
• MACHINE DESIGN Mechanical and Electrical—Automatic or Semi-Automatic Machines			L	L			L	L		C			L	L		

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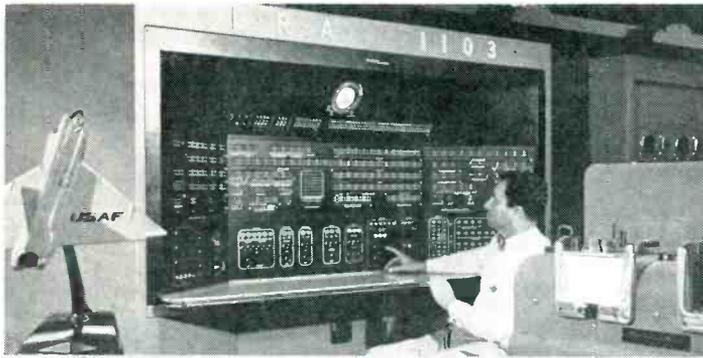


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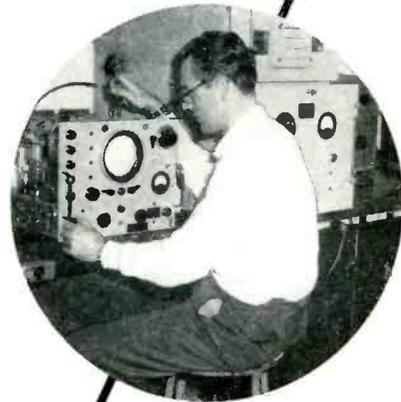
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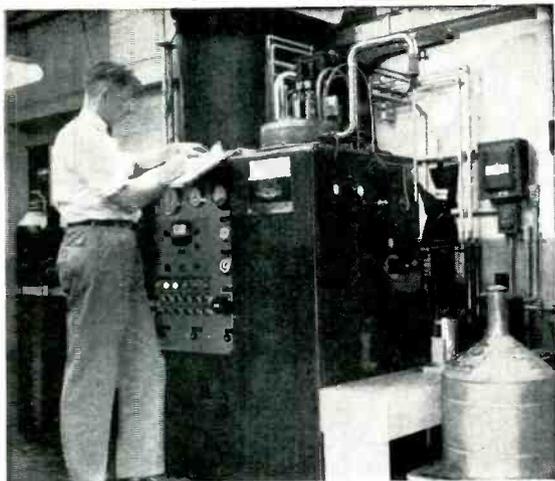
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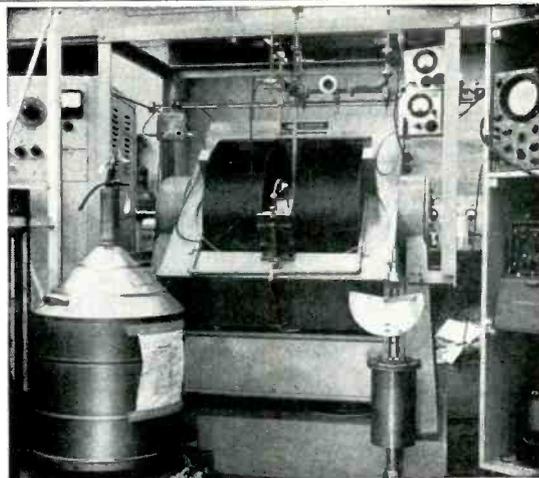
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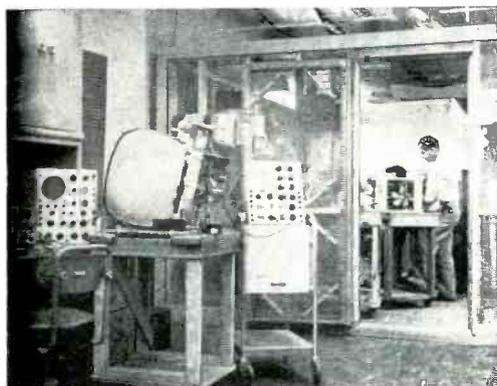
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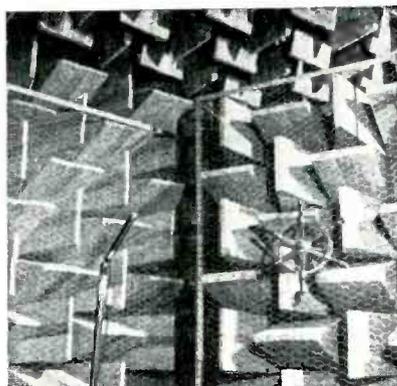
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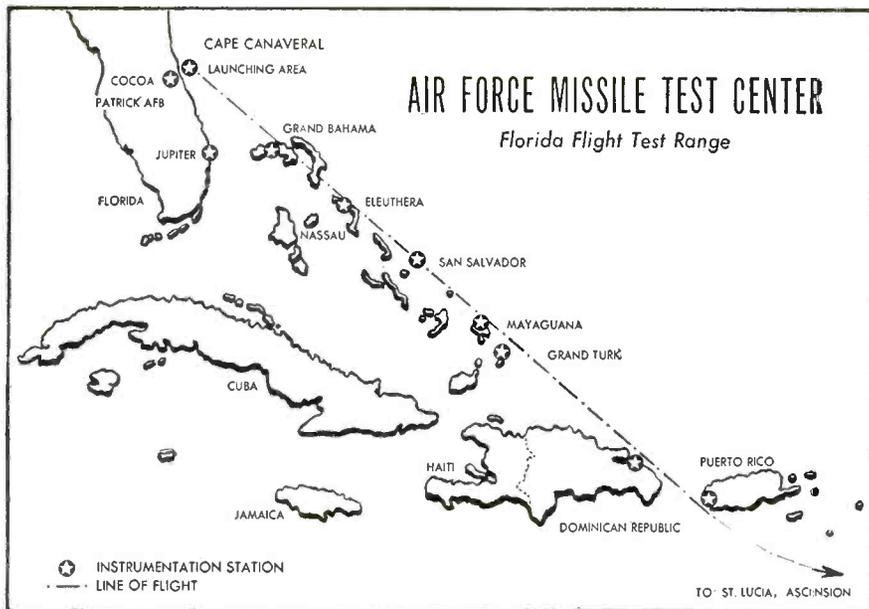
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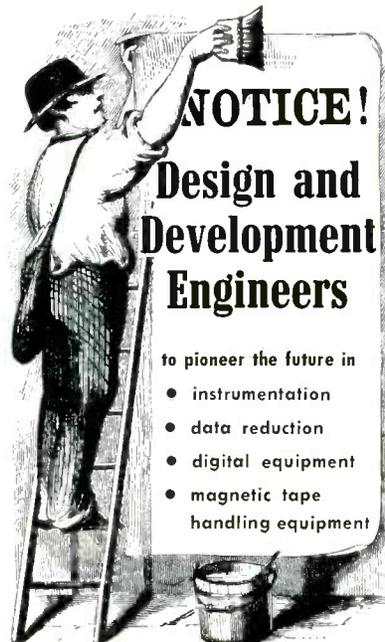
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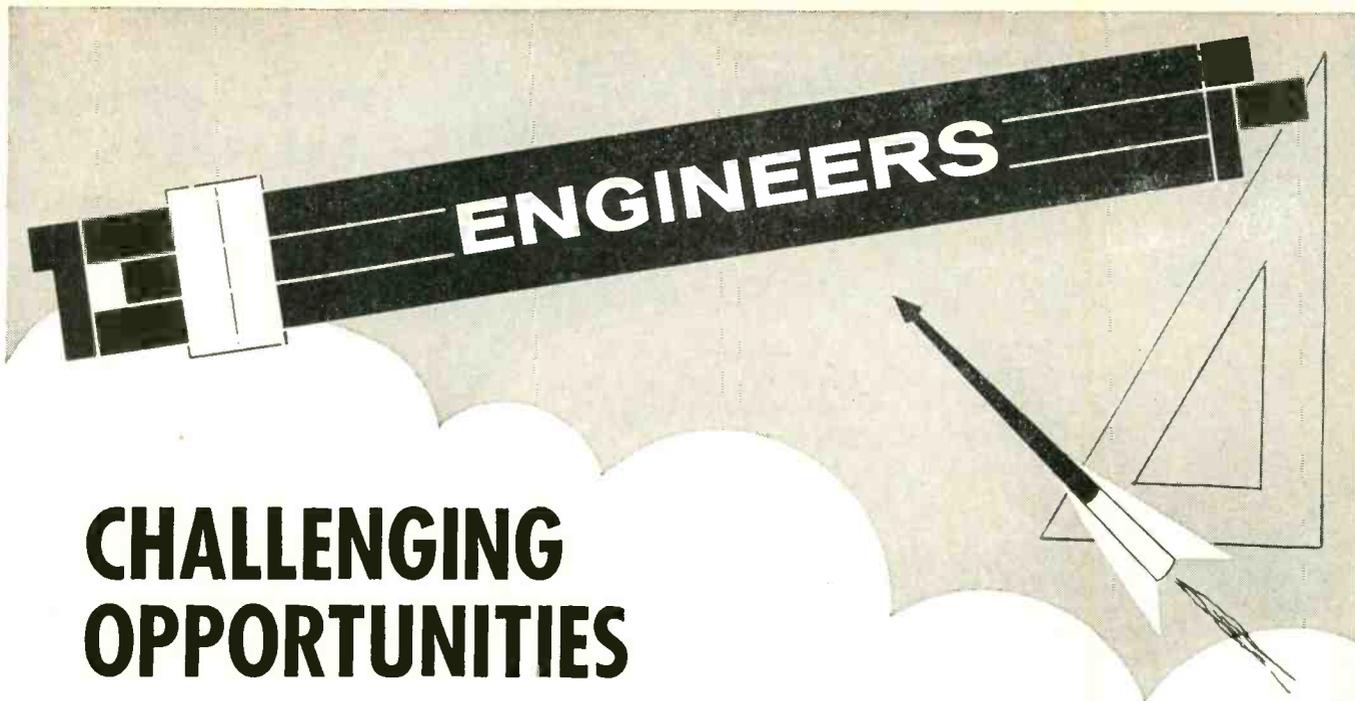
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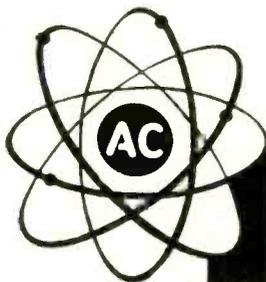
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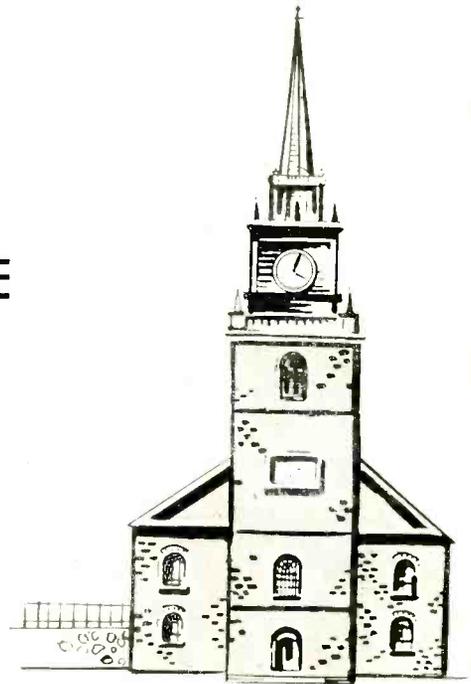
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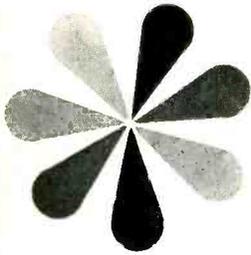
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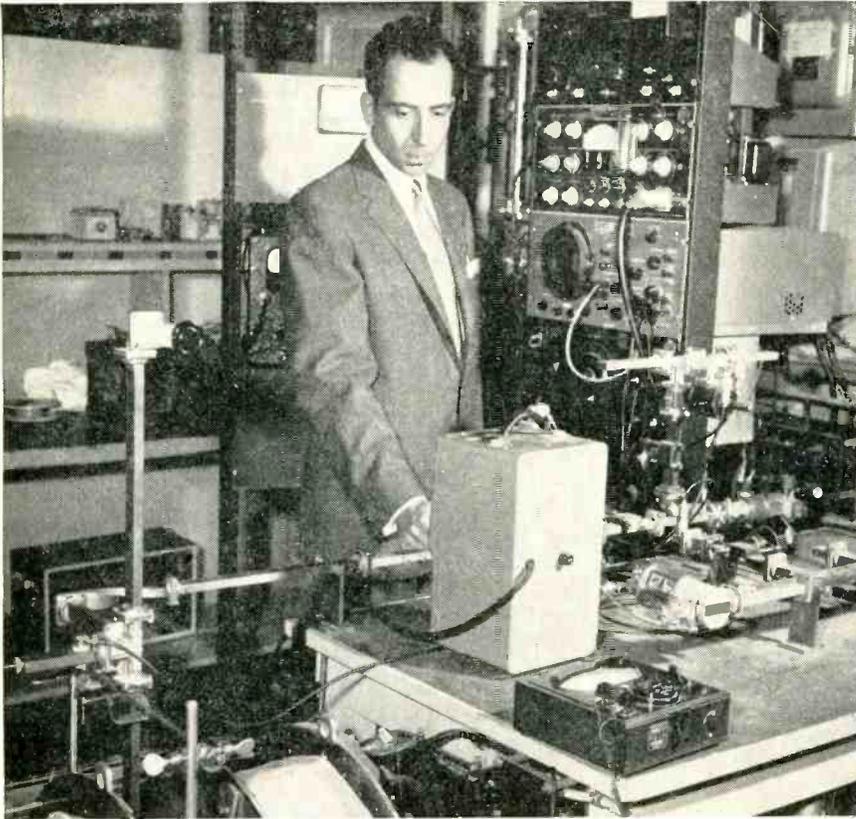
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K. F. Umpleby
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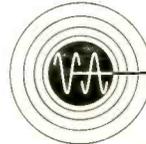
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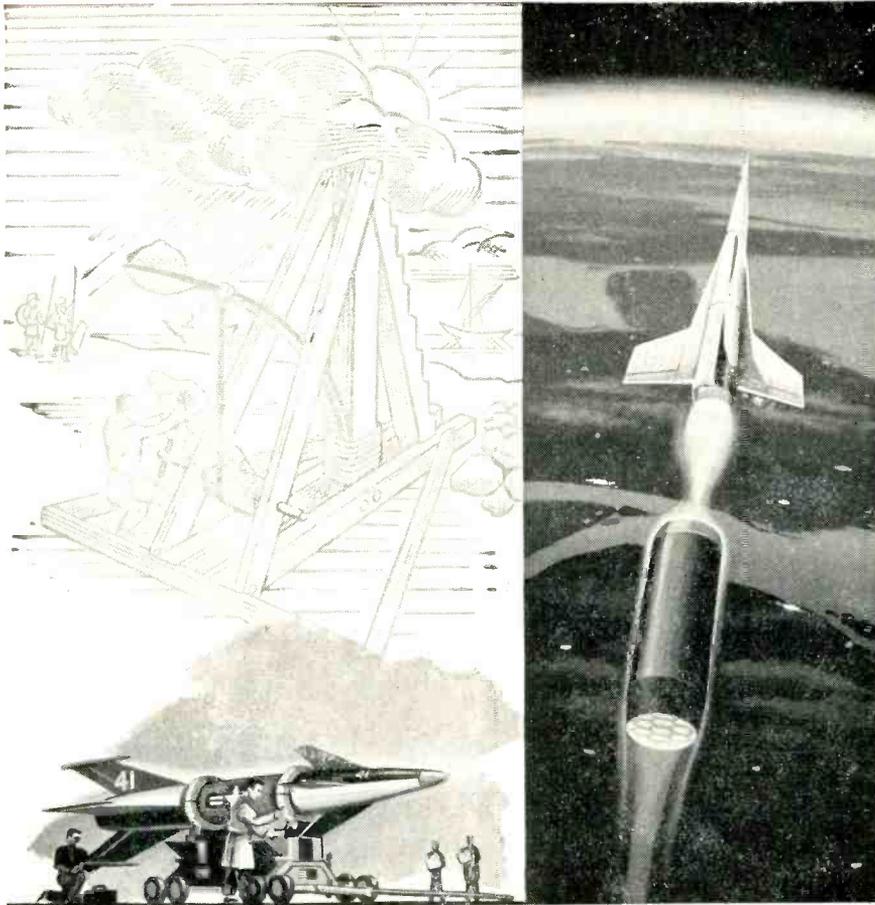
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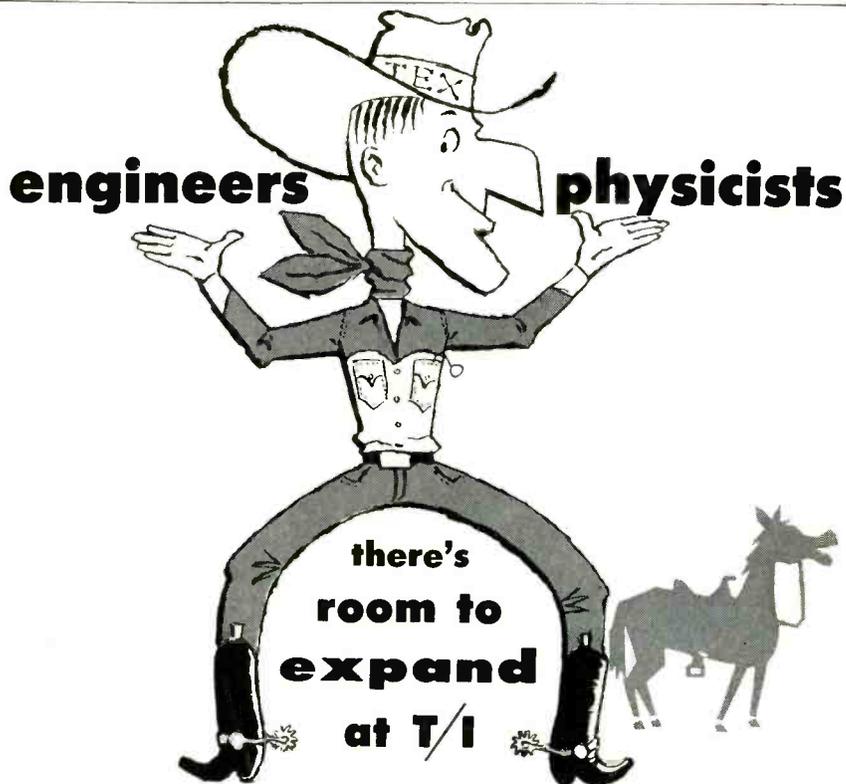
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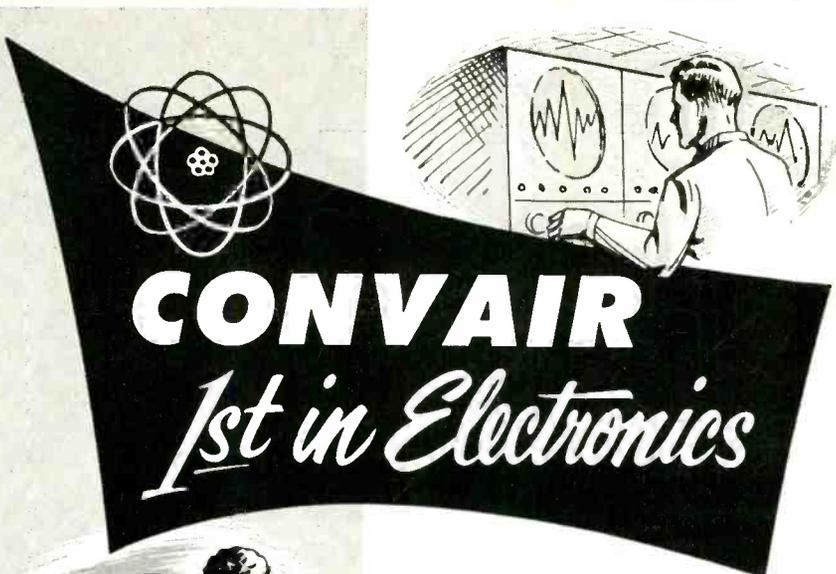
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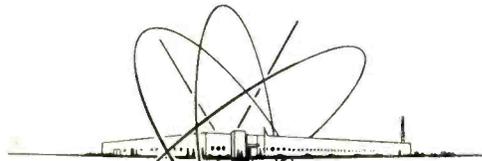
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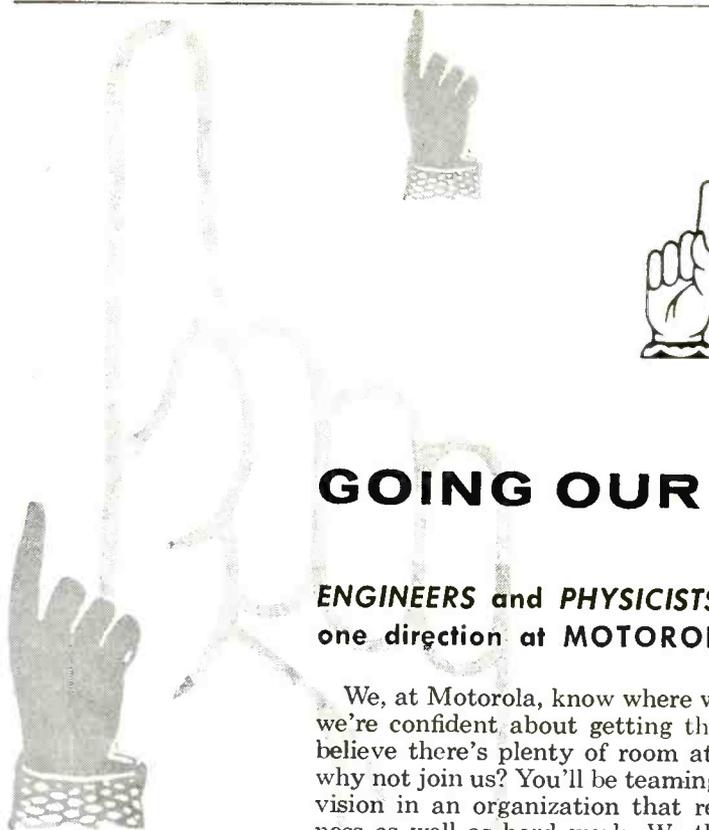
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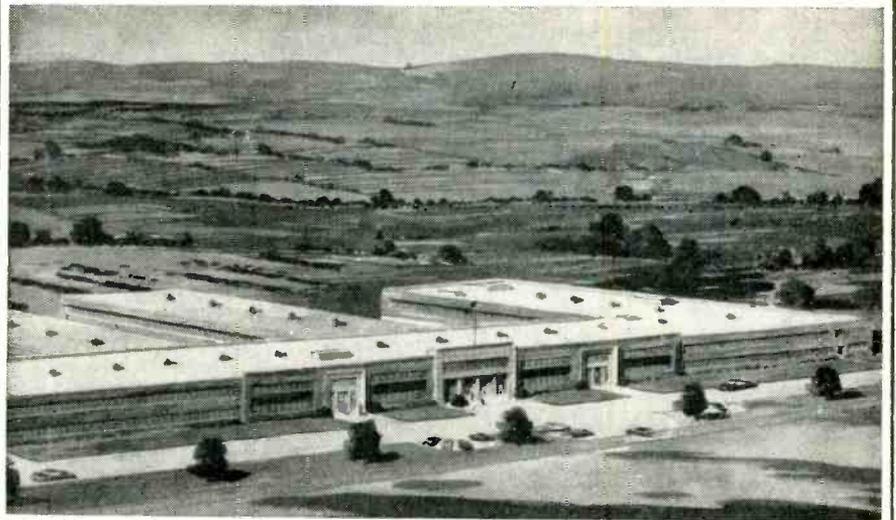
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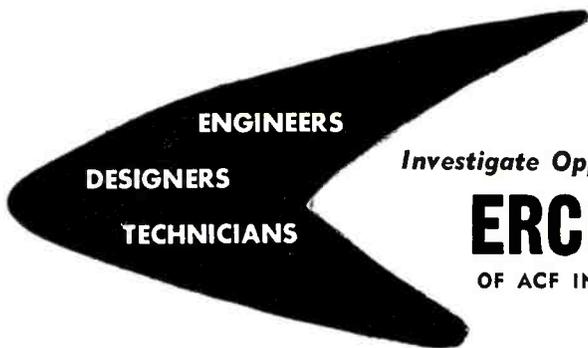
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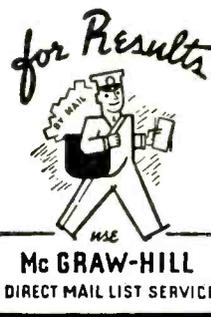
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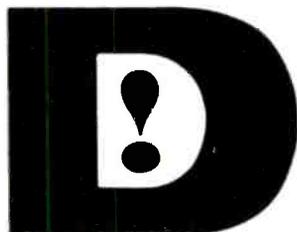
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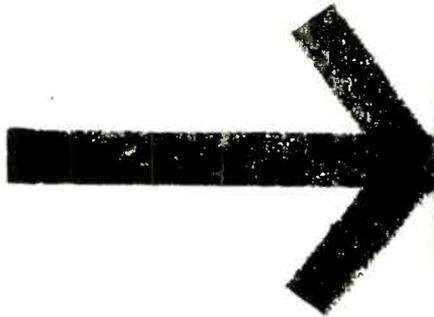
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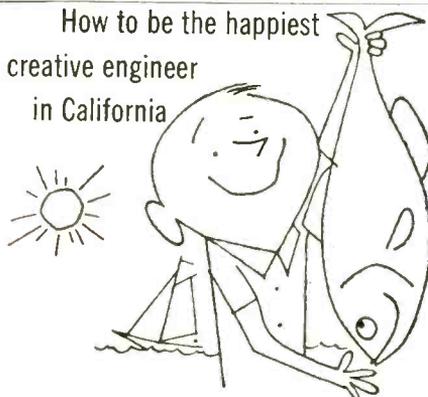
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2C53	10.00	5HP1	9.00	203A	2.50	SA-759	12.50	5610	1.00
2D21	.75	5J29	7.50	207	35.00	SA-782B	2.00	5632	8.50
2D21 W.	1.35	5J30	5.00	WE-211C	10.00	WL-786	14.00	5633	3.75
2D29	2.00	5J32	10.00	WE-211D	8.00	801A	.50	5638	6.50
2E22	3.00	5J31	12.50	WL-218	15.00	802	2.00	5640	8.50
2E24	1.95	5J32	6.25	232CH	100.00	803	2.00	5642	1.00
2E26	3.00	5J34	6.25	CE-235A	5.00	804	8.50	5642	6.50
2E29	1.00	5J35A	6.25	WE-242C	7.00	805	5.00	5644	8.50
2E36	1.25	5J311	9.00	WE-244A	7.50	807	1.10	5645	6.50
2J21A	2.75	5LP1	7.50	WE-245A	7.50	807W	2.00	5650	85.00
2J26 & 27	4.00	5LP1A	20.00	WE-249R	2.50	808	1.00	5651	1.35
2J29	15.00	5NP1	2.00	WE-249C	2.50	809	2.75	5654	1.80
2J30	35.00	5R4GY	.85	250R	3.75	810	10.00	5656	6.50
2J31	12.50	5R4WGY	2.50	250TH	17.50	811	2.90	5670	1.45
2J32	10.00	5X3	3.00	250TL	14.50	811A	3.50	5672	1.15
2J33	17.50	5X3P1	75.00	WE-251A	45.00	812	2.90	5678	1.25
2J34 & 36	12.50	5Z2P7	50.00	WE-252A	9.50	813 (RCA)	12.00	5678	1.00
2J37	4.00	5Z4P11	100.00	WE-253A	2.50	814	1.50	5687	2.00
2J38	10.00	EL-C6J	6.25	WE-254A	3.50	815	1.00	5691	4.25
2J39	7.50	EL-C6L	5.00	WE-257A	3.00	816	1.00	5692	4.25
2J40	15.00	EL-C6 4B25	8.00	FG-258A	100.00	826	.50	5693	3.50
2J51	125.00	6ACT7W	1.00	WE-262B	5.00	SD-898A	6.50	5696	1.00
2J52	50.00	WE-6AK5	1.10	267B	5.00	SD-828E	6.50	5703	1.00
2J54	35.00	6AK5W	1.20	WE-268A	7.50	828	9.50	5725	1.50
2J55	50.00	6AL5W	.55	FG-271	40.00	829	5.50	5726	.55
2J56	75.00	6AN5	2.75	WE-274B	.90	829B	8.50	5727	1.35
2J61	15.00	6AR6	1.25	WE-276A	7.50	830B	.50	5728	9.00
2J62	7.50	6AS6	1.25	WE-282A	6.00	832	3.00	5734	9.00
2K92	15.00	6AS6W	1.50	WE-283A	3.50	832A	5.00	5740	35.00
2K95	11.50	6AS7G	2.50	WE-285A	5.00	833A	35.00	5750	2.50
2K30	100.00	6C21	17.50	WE-286A	6.00	SD-834	3.75	5763	1.35
2K33A	50.00	6J4	2.00	287A	2.50	834	7.50	5800	7.50
2K34	85.00	6J4WA	3.50	HF-300	25.00	836	1.50	5801	5.00
2K39	125.00	6J6W	1.50	WE-300B	5.00	837	1.10	5803	7.50
2K41	85.00	6L6WGB	2.50	304TH	7.50	838	1.00	5819	30.00
2K47	125.00	65K7W	1.50	304TL	12.50	842	1.85	5827	5.00
2K54	7.50	65N7W	1.50	WE-305A	2.85	845	4.00	CK-5829	1.50
2K55	5.00	65U7GTG	2.00	307A	.85	845W	7.50	5842	12.50
2P21 (I. O.)	25.00	6X5W	1.25	WE-310A	4.00	849	20.00	5847	12.50
2X3G	1.25	7BP7	3.50	WE-313C	3.00	851	9.00	5915	1.00
2X2A	.90	7CP1	10.00	316A	.50	860	2.75	5932	4.00
3A4	5.00	7EP4	10.00	WE-323A	7.50	866A	1.20	5933	9.00
3A5	2.00	12AP7	50.00	323B	4.00	866 JR.	1.00	5948	1754. 200.00
3AP1	2.00	12DP7	17.50	WE-328A	3.50	869B	35.00	5962/BS-101	6.50
3AP11A	5.00	12GP7	17.50	WE-337A	7.50	872A	1.25	5963	1.40
3B21	3.50	LM-15 (I. O.)	50.00	WE-339A	7.50	884	.95	5979/BS-1	15.00
WE-3B24	1.00	FG-17	3.75	WE-347A	3.00	885	.95	5980/BS-2	10.00
3B24W	4.75	RK-20A	7.50	WE-350A	2.65	902A/P1	20.00	5981/5650	85.00
3B25	3.00	TZ-20	1.50	WE-350B	2.65	913	2.00	5998	7.00
3B26	2.85	RK-23	2.50	WE-352A	15.00	SD-917A	3.75	6328	12.50
3B27	3.00	HK-24	3.00	WE-355A	12.00	917	2.00	8002R	15.00
3B28	4.85	HK-24G	2.00	WE-356B	5.00	918	1.50	8005	4.75
3BP1	2.00	CE-25A/B	1.00	WE-368A/AS	2.00	922	2.00	8012	1.00
EL-3C/4B24	5.00	RK-25	2.25	371B	1.50	923	1.40	8012A	3.50
EL-3CJ	8.50	25E6WG	4.00	WE-388A	1.50	927	.95	8013	9.50
3C23	4.50	25T	3.00	WE-393A	4.50	931A	2.50	8013A	3.50
3C24	2.50	25TG	2.50	394A	1.85	SN-947C	6.50	8020	1.50
3C33	7.50	FG-97A	13.00	WE-403A	1.10	SN-947D	8.50	8025	1.25
3C45	5.85	28D7W	1.50	WE-404A	12.50	SN-948B	6.50	8025A	9.00
3D22	9.75	FG-32	5.00	GL-415	25.00	SN-948D	6.50	PD-8365	50.00
3DP1	3.00	VX-32B	7.50	WE-417A	12.50	954	.30	9001	.60
3DP1A	7.50	FG-32	5.00	WL-417	2.50	955	.35	9002	60
3E29	8.50	FG-33	5.00	WE-418A	15.00	SN-956B	1.00	9003	1.25
3EP1	2.00	VX-33A	5.00	GL-434A	10.00	956	.35	9004	.35
3FP7	2.00	35T	3.00	446A	.40	957	.35	9005	1.40
3FP7A	2.50	35TG	2.50	446B	1.50	958A	.35	9006	.25
3GP1	2.00	VX-41	5.00	464A	2.15	959	1.35	9903	20.00
3HP7	3.00					SN-974B	8.50		
3J21	50.00								

Bargains in Brand New Surplus

★ Starred Items Available in Production Quantities at Special Prices

These are only a few of our specials; write us your requirements

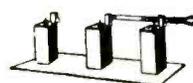
OIL FILLED CAPACITORS

VOLTS	MFD	Price	VOLTS	MFD	Price
25KV	1.0	*49.95	1000	28.0	5.50
25KV	0.5	*39.95	1000	2.0	.69
25KV	0.1	14.95	1000	0.5	1.19
7.5KV	0.5	4.25	600	10	1.29
6KV	0.25	1.09	600	8	1.19
3KV	0.5	1.59	600	4	*.69
3KV	0.1	*1.19	600	2	*.39
2.5KV	2.0	*2.95	600	1	*1.19
2KV	5.0	2.95	660AC	5	2.99
2KV	.25	.89	330AC	5	1.25

PULSE NETWORK SPECIAL

Sprague 15-1-400-50 15 Kv ★\$2.95
1.0 usec 400 P.P.S. 50 ohm Z

SWITCHES



Square D Antenna change switch Bakelite base

2x8x1/4 ★49¢

Mu Switch RC-1P	norm. closed	.59
Mu Switch RC-1P	norm. open	.59
Mu Switch RD-1P	double-throw	.69
Micro Switch WZ-RQ1	norm. closed	.69
Micro Switch YZ-RQ1	norm. open	.79
Micro Switch WZ-RL8	norm. closed	.49
Micro Switch BZ-R	double-throw	.49
Micro Switch G-R32	norm. open	.34
ST 50 R DPDT	on-momen. on	.89
ST 40 G SPDT	momen.-off-momen.	.44

COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS TO CM.—RG48/U Waveguide

POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" connectors. \$12.50

LHTR. LIGHTHOUSE ASSEMBLY. Parts of RT39 APG 5 & APG 15. Receiver and Trans. Cavities w/ assoc. Tr. Cavity and Type N CPLG. To Recv. Uses 2C30, 2C43, 1B27, Tunable APC 2400-2700 MCS. Silver Plated. \$15.00

BEACON LIGHTHOUSE cavity p/o UTN-2 Beacon 10 cm. MGR. Bernard Rice, each. \$27.50

MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplexer Cavity, gold plated. \$31.50

721A TR BOX complete with tube and tuning plungers. \$12.50

MINIALLY KLYSTRON CAVITIES for 707B or 2K28, 2700-2900 Mc. \$12.50

HOLMDELL-TO-TYPE "N" Male Adapters. W.E. #1167284. \$2.75

BEACON ANTENNA AS31 APN-7 in Lucite Ball. Type "N" Feed. \$22.50

ANTENNA AT49A/APR. Broadband Conical, 300-3500 MC Type "N" Feed. \$27.50

"E" PLANE BENDS. 90 deg. less flanges. \$12.50

K-Band, X-Band Enpt. Available. Send for List

APS-2 SPARE PLUMBING

Z-601C: Elevation Joint. \$9.50

Z-601B: Transmission Line from El. Jt. to antenna feed. \$4.50

Z-601A: Antenna and Dipole feed assy. \$12.50

Z-911: Azimuth Rotating Joint. \$15.00

Z-911: Long Rt. Angle Bend, 90 deg. \$14.50

Z-910: Short Rt. Angle Bend with pressure fitting. \$3.50

X-BAND - 1" x 1/2" WAVEGUIDE

AT-68 "P" 3 CM Horn with type N feed for receiver measurements, etc. Not face shown. \$7.45

PARABOLOID DISH. 18" diam. Spun Aluminum, 8" Focus. For AN/AP-6. \$4.95

3 CM. DIPOLE and Feed Assembly. (May be used with above dish) 18 inches long. \$5.00

FLEXIBLE SECTION. 9 in. long. Covers Cover. \$5.50

ROTARY JOINT (APS-6) Sperry PT #658275. 180 deg. rotation, choke to choke. Has "Built-in" Di-Coupler, 20 DB. with "N" Takeoff. \$22.50

3CM. DIPOLE FEED. 15" L. for APS-15. \$14.50

MITRED ELBOW. Cast aluminum, 1 1/4" x 5/8" W.G. W.F. Flanges. "E" Plane. \$3.50

3 CM ANTENNA ASSEMBLY. Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern 7 deg. in both Azimuth and elevation. Sector Scan; over 160 deg. at 35 scans per minute. Elevation Scan; over 2 deg. Tilt. Over 24 deg. \$35.00

Cross-Guide Directional Coupler. UG-40 output flange. Main Guide is 8" Long, with 90 Deg. "E" Plane bend at one end and is fitted with Std. UG 39/UG 40 flanges. Coupling figure: 20 db Nominal. \$22.50

RG52/U Waveguide in 1/2 lengths, fitted with UG 39 flanges to UG40. Silver plated. per length \$5.00

Rotating Joints supplied either with or without deck mountings. With UG40 flanges. each \$17.50

Bulkhead Feed-thru Assembly. \$15.00

Pressure Gauge Section with 1 1/2 lb. gauge. \$10.00

Directional Coupler. UG-40 T Take off 20db. \$17.50

MAGNET AND STABILIZER CAVITY For 2F41 Magnetron. \$24.50

90 degree elbows. "E" or "H" Plane 2 1/4" radius. \$8.50

ADAPTER. waveguide to type "N". UG 81-U. p/o TS-12. TS-12. Etc. \$7.50

ADAPTER. UG-149/T round cover to special BFL Flange for TS-45, etc. \$2.50 ea.

APS-1S SPARE PARTS

CU-73/APS-15A. SCS #223265-73 right angle bend. E plane. 6 1/2" x 10". with directional coupler on 6 1/2" arm. type "N" takeoff 20 db coupling. \$12.50 each

Z-607 Dwg. Symbol. Approx. 150 degree bend with 90 deg. twist. One end pick-up loop with pressure fitting. \$6.50

Z-614: Philco 756-1142. CG24/APS-15A. Wave-selector; approx. 16" L. with 15 deg. bend at center (E-plane) 20 db coupling. \$12.50

Philco 348-1425. 180 deg. bend. with pressure fitting. \$6.50

Z-604: Philco 348-1629. 13 1/4" run. with bend 50 deg. twist (on 3 1/4" section). \$6.75

Z-606: 8" run with 30 deg. bend (E-plane) one end \$4.50

Philco 348-1427 E plane bend 11" x 6 1/2" \$6.50

CG1/APS-3 Philco 358-5212. S-curve 16" L. with round contact flanges. \$5.75

WAVEGUIDE FLANGES

UG 39/U	\$1.20	UG 51/U	\$1.65
UG 40/U	\$1.35	UG 52/U	\$3.40
UG 10A/U	\$2.00	UG 52A/U	\$3.40

"K-BAND" WAVEGUIDE

Right Angle Bend E or H Plane, specify combination of couplings desired. \$12.00

Mitred Elbow. cover to cover. \$4.00

TR-ATF Section Choke to choke. \$4.00

Flexible Section U choke to choke. \$5.00

"S" Curve choke to cover. \$4.50

THERMISTORS

D-164699 Bead Type DCR: 1525-2550 Ohms @ 75 Deg. F. Coefficient: 2% Per Deg. Fahr. Max. Current 25 MA AC/DC. \$1.00

D-167332 Bead Type. DCR is 1525-2550 Ohms. Rated 25 MA at 825-1175 VDC. \$1.00

D-167613 Disk Type. DCR: 355 Ohms @ 75 Deg. F. P.M. 2.5%. 1 Watt. \$1.00

D-166228 Disk Type 7120 Ohms @ 60°F. 4220 Ohms @ 80°F. 2590 Ohms @ 100°F. 1640 Ohms @ 120°F. \$1.00

POWER TRANSFORMERS COMBINATION—115V/60~INPUT

CT-518	160-0-160V/70MA, 6.3V/2A, 2.5V/1.75A.	\$2.15
CT-375	160V/2MA, 6.3V/6A, 2.5V/1.75A.	4.95
CT-127	90V/25MA P/O 5V/2A, 2V/7.5A.	2.79
CT-806	350-0-350/120MA 5VCT/3A, 2.5VCT/12.5A, 2.5VCT/3.5A.	4.39
CT-965	78V/0.6A, 6.3V/2A.	1.95
CT-804	350-0-350V/90MA, 5VCT/3A, 2.5VCT/12.5A.	4.60
CT-802	350-0-350V/50MA, 5VCT/2A, 2.5VCT/7.5A.	3.65
CT-479	7000V .018V, 2.5V/5A/17,800 V. Test.	22.50
CT-403	350VCT .026A 5V/3A.	2.75
CT-931	585VCT .086A 5V/3A, 6.3V/6A.	4.25

PLATE—115V/60~INPUT

PT-87	400VCT/4.0 AMPS For RA43	17.50
PT-034	125V45MA (For Preamp)	1.15
PT-133	3140/1570V, 2.36KVA	85.00
PT-521	7500V .06A, Half Wave	59.50
PT-913	2500V12 MA H/SLD	4.95
PT-38-2	37.5V/40V AT 750 MA	2.15
PT-87P	86VCT/230MA D.C.	4.75
PT-876	1500-0-1500V, 400MA	12.75
PT-1751	2060VCT 0.175A	18.50

FILAMENT—115V/60~INPUT

FT-157	4V/16A, 2.5V/2.75A.	2.95
FT-301	6V/.25A	.79
FT-924	5.25V/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 1.2V/7A, 6.4V/10A, 6.4V/2A.	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A.	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A.	8.95
FT-38A	6.3V/2.5A, 2x2.5V/7A 5KV TEST.	2.79
FT-650	2.5V/10A/3KV TEST LO-CAP.	7.50
FT-025	2.5VCT/10A, 10KV TEST.	6.95
FT-650	2.5V/40A, 3KV TEST.	7.50

FILTER CHOKES

Stock	Description	Price
CH-914	12HY/250 MA 2500 V. Test.	\$3.25
CH-CEC	117: 9-60H/.05-400 MA, 10 KV TEST.	14.95
CH-113	25H/700 MA, 2.5 KV Test 18 Ohms	5.75
CG-044	8.5H/350 MA, 2.5 KV Test 50 Ohms.	3.25
CH-291	0-1H, 12 A. DCR: 0.3 Ohms	12.50
CH-322	.35H/350 MA—10 Ohms DCR	2.75
CH-141	Dual 7H/75 MA, 11H/60 MA	4.69
CH-69-1	Dual 120H/17 MA	2.35
CH-776	1.28H/130 MA/75 ohms	2.25
CH-324	1.3H/150 MA/1200V Test	2.35
CH-366	20H/300 MA	6.95
CH-599	15HY/15 MA—400 ohms DCR	1.95
CH-495	0.5HY/200 MA, 32.2 ohms, 3000 V.T.	1.39
CH-170	2x0.5H/380 MA, 25 ohms.	2.79
CH-200	5H/200 MA, 3KV Test	3.25
CH-189	12H/300 MA, 3KV Test	4.65
CH-88C	Swing 5-20H/0-300 MADC	5.25

400 CYCLE TRANSFORMERS

(All Primaries 115V 400-1200 Cycles)

KS13101	6.3V/15A, 6.3V/0.9A, 6.3V/0.4A, 6.3V/0.2A	\$3.85
KS13104	1450VCT/0.283A, 1050VCT/0.217A	7.50
KS9318	6.3V/4A, P/O 75-55/ARQ-9	1.35
KS9626	32.5V/35MA, 1140VCT/.07A	5.79
352-7102	6.3V/2.5A	1.45
M-7472426	1450V/1.0MA, 2.5V, 75A, 6.4V/1/3.9A, 5V/2A, 6.5V/3A, P/O (D-39)	4.95
352-7039	APG-13 640VCT @ 380MA, 6.3V/.9A, 6.3V/6A 640VCT @ 32MA 9800/8600 @ 32MA 5000V/290MA, 5V/10A 734VCT/177A, 1710VCT/177A 70V VCT/350MA, 6.3V/0.9A, 6.3V/2.5A, 6.3V/0.8A, 5V/CA	5.49 8.95 22.50 6.79
352-7273	70V VCT/350MA, 6.3V/0.9A, 6.3V/2.5A, 6.3V/0.8A, 5V/CA	6.95
352-7070	2x2.5V/2.5A, 2KV TEST, 6.3V/2.25A, 1200/100/750V, &.005A, 1140/1.25MA, 2.5V/1.75A, 2.5V/1.75A—5KV TEST	7.45
352-7136	320VCT/50MA, 4.5V/3A, 6.4V/CT 20A, 2x6.3VCT/6A	3.95
352-7176	2.5-1.75A, 6.3V/2A—5KV Test	4.75
RA6400-1	13V/9A	2.39
901692	2.77V @ 4.25A—10KV Test.	2.49
901698-501	900V/75MA, 100V/.04A	3.45
Ux9855C	900VCT/.067A, 5V/3A	4.29
RA6405-1	800VCT/95MA, 5VCT/3A	3.79
T-48852	700VCT/806MA, 5V/3A, 6V/1.75A, 2500V/6MA, 300VCT/135MA	3.69
352-7098	6.3V/2.7A, 6.3V/.66A, 6.3VCT/21A, 27V/4.3A, 6.3V/2.9A, 1.25V/.02A	5.95
M-7474319	650VCT/50MA, 6.3VCT/2A, 5VCT/2A/6A	2.95
KS8984	400 VCT/35MA, 6.4V/2.5A, 6.4V/.15A	3.75
52C080	1150-0-1150V 2MA 6VCT/.0006 KVA 6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5V/1.75A	3.85 2.75 2.75
68C631	592VCT/18MA, 6.3V/8.1A, 5V/2A	4.85
80C196	6.4V/7.5A, 6.4V/3.8A, 6.4/2.5A	5.39
302433A	600VCT/36MA 2100V/.027A	4.79 2.65
KS 9445	2-2.5V Wdgs at 2.5A, Each Lo-Cap.	4.95
KS9685	2.5V/1.75A, 5V/13A, 6.5V/6A, 6.5V/1.2A, D/O BC800	5.95
70C30G1		4.95
M-7474318		
352-7069		
352-7096		

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	PRICE
BDAR83	14		375	.150	\$6.50
35K-059	19	3.8	405	.095	4.35
DM33A	28	4.0	540	.250	3.95
B-19	12	9.4	275	.119	6.95
DA-3A*	28	10	500	.050	
			300	2.6	3.95
			150	.010	
			14.5	5.	
PE 73 CM	28	19	1000	.350	17.50
BD 69	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	2.50
BDAR 93	28	3.25	375	.150	5.75

* Less Filter. * Replacement for PE 94.
† Used, Excellent.
PE 94, Brand New. \$9.95
Navy type CAJ0-211444. Input: 105 to 130 VDC. Output: either 26 VDC at 20 amps, or 13 VDC at 40 amps. Radio filtered and complete with line switch. New \$69.50

INVERTERS

800-1B input 24 vdc, 62 A. Output: 115 V, 800 cy. 7A. 1 phase. Used, excellent. \$18.75

PE-218H: Input: 25/38 vdc, 92 amp. Output 115V 300/500 cy. 1500 Volt-ampere. NEW \$32.50

PE206: Input: 28 vdc, 36 amps. Output: 80 V 800 cy. 500 volt-amp. Dim. 13 x 5 1/2 x 10 1/2. New. \$22.50

EICOR—ML 3011-5. Input: 13.75 V; 18.4A. Output: 115 V/400—, 3φ, 0.95 PF. 100 VA. New. \$59

PU 7/A.P. Input: 28 vdc/160A. Output: 115 VAC. 400—, 1φ, 500 VA., 21.6 Amp Volt. and Freq. Reg. Used. Ex. \$75

D.C. RELAYS*

CR2792B116A3

SPST—50 Amp Contacts. Operates from 22-30 VDC. Coil Res. 200 Ohms. Completely enclosed in transparent plastic case, which may be removed for adjustments. \$1.15

GE #CR2791B116W3

Same as above, except additional terminal brought out from contact arm. \$1.30

GE #CR2791-F100D3

Differential: OPST. Norm. open. Oual coil, 1500 ohms per coil — 25 MA. Operating Current. Contact: 20 Amp. \$1.85

GE #CR2791F100G3

Same as above, except has extra 1A contact. Rated 5 Amp. \$1.95

GE #CR2791-D101F3

All Ceramic Insulation, DPDT. Coil — 12VDC, 100 Ohms DCR. Contacts designed for fast operation. Rated at 5 Amps. \$1.00

GE #CR2791B106J3

SPDT, 5 Amp contacts. Coil rated 22-30VDC, 150 Ohms DCR. Contacts are designed for fast operation, and enclosed by clear plastic cover. \$1.10

GE #CR2791B106C3

SPDT, Dual Contacts will handle 20 Amps. Coil: 18-28 VDC 125 Ohms DCR. \$1.25

*THESE RELAYS AVAILABLE IN MFRS. QUANTITIES

PULSE TRANSFORMERS

*P37: Primary, 50 Ohms 750V, .001 Duty. Sec. 15KV, 1600 Ohms Impedance Billar 12.6V/2.5A. \$32.50

RAYHEON WX 4298E: Primary 4KV, 1.0 USEC. SEC 16KV-16 AMP DUTY RATIO: 001 400 CYCLES. FIL. TRANS. "BUILT IN" \$22.50

WECCO: D-163247 For Modulator of SCR 720. \$22.50



GE #K-2449A
Primary: 9.33 KV, 50 ohms Imp.
Secondary: 28 KV, 450 ohms.
Pulse length: 1.05/5 usec @ 635/120 PPS. Pk Power Out: 1.740 KW.
Bifilar: 1.5 amps (as shown). \$62.50

GE #K-2748-A. 0.5 usec @ 2000 Pps. Pk. Invt. out is 32 KV Impedance 40-100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Billar rated at 1.3 Amp. Fitted with magnetron well. \$24.50

K-2745 Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse length: 0.25/1.0 usec @ 600/800 PPS. Pk. Power 200/150 KW. Billar: 1.3 Amp. Has "built-in" magnetron well. \$32.50

K-2461-A. Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar 1.3 Amp. Fitted with magnetron well. \$29.50

UTAH X-151T-1: Dual Transformer, 2 Wdes. per section 1:1 Ratio per sec 13 MH impedance 30 Ohms. \$5.00

UTAH X-150T-1: Two sections, 3 Wdes. per section. 1:1 Ratio, 3 MH, 6 ohms DCR per Wdg. \$5.00

K-901695-501: Ratio 1:1, Pri. Imp. 40 Ohm. Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.65 usec rise. \$8.95

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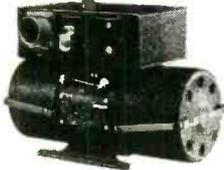
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INVERTERS

- 10042-1-A Bendix
DC Input 14 volts; output: 115 volts; 400 cycles. 1-phase; 50 watt **\$35.00**
- 12116-2-A Bendix
Output: 115 VAC; 400 cyc; single phase; 45 amp. Input: 24 VDC, 5 amps. **\$35.00**
- 12117 Bendix
Output: 26 volts; 400 cycles, 6 volt amperes, 1 phase. Input: 24 VDC; 1 amp. **\$15.00**
- 12121 Bendix
Input: 24 volt D.C. 18 amp. 12000 r.p.m. Output: 115 volts, 400 cycle, 3-phase, 250 volt amp, 7 pf. **\$49.50**
- 12123 Bendix
Output: 115 V; 3-phase; 400 cycle; amps .5 Input: 24 VDC; 12 amp. **\$49.50**
- 12126-2-A Bendix
Output: 26 volts; 3 phase; 400 cycle; 10 VA; .6 PF. Input: 27.5 volts DC; 1.25 amps. **\$24.50**
- 12130-3-B Bendix
Output: 125.5 VAC; 1.5 amps. 400 cycles single phase, 141 VA. Input: 20-30 VDC, 18-12 amps. Voltage and frequency regulated. **\$49.50**
- 12133 Bendix
Input: 26/29 volt D.C., 28 amps Output: 115 volt, 3 phase, 400 cycle, 250 volt amp., .8 pf. **\$59.00**
- 12143-2-A Bendix
Output: 115 volts; 400 cycles; 250 VA; single phase pf. 9-1. DC Input: 26-29 VDC; 25-22 amp; voltage & frequency regulated **\$49.50**
- 778 Bendix
Output: 115 volt, 400 cycle; 190 VA; single phase and 26 volt, 400 cycle, 60 VA, single phase. Input: 24 VDC. **\$37.50**
- 10285 Leland
Output: 115 volts AC; 750 VA, 3 phase, 400 cycle, .90 pf and 26 volts. 50 VA, single phase, 400 cycle, .40 pf. Input: 27.5 VDC, 60 amps. cont. duty, 6000 rpm. Voltage and frequency regulated. **\$59.50**
- 10339 Leland
Output: 115 volts; 190 VA; single phase; 400 cycle; .90 pf. and 26 volts; 60 VA; 400 cycle, .40 pf, Input: 27.5 volts DC, 18 amps cont. duty, voltage and freq. regulated. **\$49.50**
- 10486 Leland
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 pf. Input: 27.5 DC; 12.5 amps; cont. duty. **\$70.00**
- 10563 Leland
Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 pf. Input: 28.5 VDC; 12 amps. **\$35.00**
- PE109 Leland
Output: 115 VAC, 400 cyc; single phase; 1.53 amp; 8000 rpm. Input: 13.5 VDC; 29 amp. **\$50.00**
- PE218 Leland
Output: 115 VAC; single phase pf 90; 380/500 cycle; 1500 VA. Input: 25-28 VDC; 92 amps; 8000 rpm; Exc. Volts 27.5 BRAND NEW. **\$30.00**
- MG149F Holtzer-Cabot
Output: 26 VAC @ 250 VA; 115 V. @ 500 VA; single phase; 400 cycle; Input: 24 VDC @ 36 amps. **\$40.00**
- MG153 Holtzer-Cabot
Input: 24 VDC; 52 amps. Output: 115 volts - 400 cycles, 3-phase, 750 VA. Voltage and frequency regulated. **\$95.00**
- DMF2506M Continental Electric
24-30 volts input; 5.5-45 amps; cont. duty. Output: 115 volts; .44 amps; 400 cyc; 1 phase; pf 1.0; 50 watts. **\$39.50**

ROTARY JOINT

Contains 4 slip rings; rated at 3 amps at 110 VAC. Model No. RPJ-E-11. Manufactured by Selectar Mfg. Corp. Approximately 2" in diameter, 3 1/2" long. Priced at \$3.00 each.

SELSYNS-SYNCHROS

- | | |
|---|----------------|
| 1CT Cont. Trans. 90/55V 60 cy. | \$37.50 |
| 1DG Diff. Gen. 90/90V 60 cy. | 37.50 |
| 1F Syn. Mtr. 115/90V 60 cy. | 37.50 |
| 1G Gen. 115V 60 cy. | 37.50 |
| 1SF Syn. Mtr. 115/90V 400 cy. | \$12.50 |
| 2J1F1 Gen. 115/57.5V 400 cy. | 7.50 |
| 2J1F3 Gen. 115/57.5V 400 cy. | 10.00 |
| 2J1FA1 Gen. 115/57.5V 400 cy. | 7.50 |
| 57.5/57.5V 400 cy. | 5.00 |
| 2J1H1 Diff. Gen. 57.5V 400 cy. | 7.50 |
| 2J5D1 Cont. Trans. 105/55V 60 cy. | 17.50 |
| 2J5T1 Cont. Trans. 105/55V 60 cy. | 17.50 |
| 2J5H1 Gen. 115/105V 60 cy. | 17.50 |
| 2J15M1 Gen. 115/57.5V 400 cy. | 17.50 |
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| 5D Diff. Mtr. 90/90V 60 cy. | 34.50 |
| 5DG Diff. Gen. 90/90V 60 cy. | 34.50 |
| 5F Syn. Mtr. 115/90VAC 60 cy. | 34.50 |
| 5G Syn. Gen. 115/90VAC 60 cy. | 34.50 |
| 5HCT Cont. Trans. 90/55V 60 cy. | 42.50 |
| 5SD8 Diff. Gen. 90/90V 400 cy. | 12.50 |
| 6DG Diff. Gen. 90/90V 60 cy. | 25.00 |
| 6G Syn. Gen. 115/90VAC 60 cy. | 34.50 |
| 7G Syn. Gen. 115/90VAC 60 cy. | 42.50 |
| R110-2A Kearfott Cont. Mtr. 115V 400 cy. | 17.50 |
| R20C-1-A Kearfott Cont. Trans. 26/11.8V 400 cy. | 15.00 |
| R21C-1A Kearfott Trans. 26/11.8V 400 cy. | 15.00 |
| R235-1A Kearfott Resolver 26/11.8V 400 cy. | 22.50 |
| C56701 Type 11-4 Rep. 115V 60 cy. C69405-2 Type 1-1 Transm. 115V 60 cy. | 20.00 |
| C69436 Syn. Transm. 115V 60 cy. | 20.00 |
| C69436-1 Type 11-2 Rep. 115V 60 cy. | 20.00 |
| C76156 Volt. Rec. 115V 60 cy. | 10.00 |
| C78248 Syn. Transm. 115V 60 cy. | 12.50 |
| C78249 Syn. Diff. 115V 60 cy. | 5.00 |
| C78863 Repeater 115V 60 cy. | 7.50 |
| C79331 Transm. Type 1-4 115V 60 cy. | 20.00 |
| 851 Bendix Autosyn Mtr. 32V 60 cy. | 7.50 |
| 403 Kollsman Autosyn Mtr. 32V 60 cy. | 7.50 |
| CK5 Bendix Mtr. 2 phase 26V 400 cy. FPE-25-11 Diehl Servo Mtr. 75,115V 60 cy. | 17.50 |
| FPE-43-1 Resolver 400 cy. | 22.50 |
| FJE-43-9 Resolver 115V 400 cy. | 25.00 |
| 999-0411 Kollsman 26V 400 cy. | 15.00 |
| 1377-3410 Kollsman 26V 400 cy. | 10.00 |
| 1515E-0410 Kollsman 26V 400 cy. | 20.00 |
| 10047-2-A Bendix 26V 400 cy. | 12.50 |
| 2900 Transicoil 115V 400 cy. | 15.00 |

**ESTERINE ANGUS RECORDER**
Model AW 0-1 MA

DC Milliammeter permanent magnet moving coil type. Spring clock dial speed drive (hour and minute). Instructions including connection diagrams and instrument data sheet with each instrument. Portable case **\$200.00**

**APG 15 INDICATOR**

Easily converted to a MODULATION INDICATOR. Unit contains a 2AP1 tube with shield; also 9006 tube, miscellaneous potentiometers and resistors. Brand new.....**\$5.00** each Conversion data to miniature modulation indicator with schematic.....**\$1.50**

TEMPERATURE and HUMIDITY INDICATOR

(Hair actuated) Manufactured by Freez Instruments. Model No. 181-1. Approximately 7 1/2" high by 3" wide. Priced at **\$3.95** each.

SMALL DC MOTORS

- (approx. size overall 3/4" x 1 1/4" dia.)
- | | |
|--|----------------|
| 5069600 Delco PM 27.5 VDC 250 rpm | \$12.50 |
| 5069230 Delco PM 27.5 VDC 145 rpm | 15.00 |
| 5068750 Delco 27.5 VDC 160 rpm w/brake | 6.50 |
| 5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2") | 5.00 |
| 5069625 Delco 27.5 VDC 120 rpm w/governor | 15.00 |
| MM A-11 Globe PM 24 VDC | 7.50 |
| 5BA10AJ18 GE 24 VDC 110 rpm | 10.00 |
| 5BA10AJ37 GE 27 VDC 250 rpm reversible | 10.00 |
| 5BA10AJ52 27 VDC 145 rpm reversible | 12.50 |
| 806069 Oster series reversible 1/50 h.p. 10,000 rpm 27.5 VDC 1 1/2" x 3 1/2" | 5.00 |
| C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm | 3.00 |
| 7100-B PM Hansen 24 VDC 160 rpm | 7.50 |
| SSFD-6-1 Diehl PM 27.5 VDC 10,000 rpm | 4.00 |
| 6-volt PM Mtr. mfgd. by Hansen 5,000 rpm 1 1/4" In dia. 2" long overall | 4.00 |

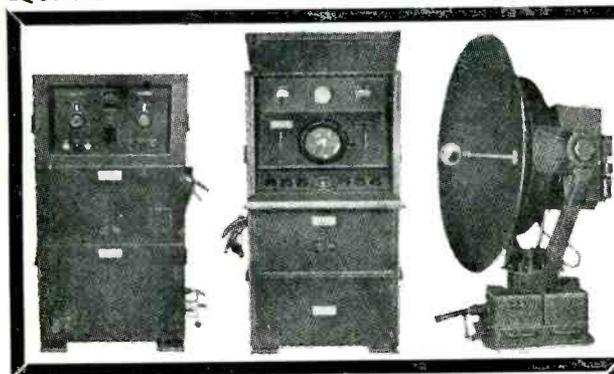
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RT-66, 67, 68, 69, 70 GRC
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**AN/ASQ-1
Airborne Magnetometer**

This is an airborne chart recording magnetometer. The set consists of an amplifier, oscillator, detector head, chart profile recorder, power supply, etc. The equipment has a sensitivity of 2 gamma or better. The AN/ASQ-1 records on an Esterline Angus recorder disturbances in the earth's magnetic field caused by an ore deposit or a sunken boat or submarine. An indicator is provided that gives a bearing on a magnetic disturbance. Power input is 28v DC. Weight about 130 lbs.

REMOTE P.P.I.s

- VD 7" Upright Mount
- VE 7" Table Mount
- VF 9" Upright Mount
- VG 24" Plotting Table
- VJ 12" Upright Mount
- VK 12" Upright Mount
- VL 12" Upright Mount

**SCR-682-A SEARCH
AND WEATHER RADAR**

This is a 10cm high power search and weather radar, using a 7" P.P.I. These sets will give excellent SERVICE IN A TORNADO OR STORM WARNING NETWORK, OR AT AN AIRPORT for surveillance to 135 miles. The set consists of three units. 1—The paraboloid antenna which includes the pedestal, reflector, dipole and RF section. 2—Modulator. 3—Desk type P.P.I. indicator, units have pilot light decks that enable the set to be serviced without being taken out of operation and are fully safety interlocked.

Technical Specifications:

- 1—Operating freq.—3000cm 10mc.
- 2—Power output—225kw.
- 3—Pulse width—1 micro second.
- 4—Ranges—500-240,000 yds in four ranges. 10,000 yds., 40,000 yds., 160,000 yds., and 240,000 yds.
- 5—360 scan.
- 6—azimuth accuracy 1°.
- 7—7" P.P.I. indicator.
- 8—Antenna beam width 1°.
- 9—110. 60 cyc power input.

**THE SCR-682-A IS AVAILABLE
IN OPERATION BY APPOINTMENT.**

**AN/APN-3 - AN/CPN-2
SHORAN**

The AN/APN-3 and AN/CPN-2 are airborne and ground. Precision distance measuring installations. This equipment operates on 225 mc. The range is 250 miles with an accuracy of 25 feet. This is the most accurate distance measuring equipment built to date. The AN/APN-3 used with the K-1 computer (also available) will permit taking a photograph up to 250 miles from the CPN-2 beacons completely automatically. The AN/APN-3 can be fed into the aircraft auto pilot to fly it to the drop point. This equipment is very widely used by geological survey companies for oil prospecting and mapping. Power input is 110v 100cyc and 28v DC. COMPLETE SETS AND SPARES ARE AVAILABLE.

OTHER EQUIPMENT

- AN/URC-4 Airsea rescue set
- AN/ARC-12 and up
- AN/APG-15 and up
- AN/APS-19 and up
- AN/APR-4, 5, 6 and up
- AN/CPN-6, 8, 17 Beacons
- AN/UPN-1, 2, 3, 4, Radar Beacons
- SCR-399, 499
- SCR-536
- SCR-300
- SCR-506
- SCR-508, 608
- Test Sets TS-1 to TS-700
- "If it is Or Was Made We Can Supply It"

AN/PRC-8, 10 WALKIE-TALKIE

The PRC series are the new F.M. high freq. back pack walkie-talkies. These sets are miniaturized and weigh 18 lbs. complete. The PRC-8 covers 20-27.9 mc. PRC-10 covers 38-54.9 mc. The set has 16 tubes. The receiver is A.F.C. controlled and has a sensitivity of .5 microvolts. The transmitter output is 1 watt F.M. A crystal calibrator is provided to calibrate the set. The receiver is equipped with a squelch control. Complete sets and parts available.

AN/GRC-3 thru 8

The GRC series are the new field and mobile military communications sets. These sets cover 20-58.4 mc. The transmitter output is 15 watts. The transceivers are tuneable or fixed. Input is 12 or 24v DC. Components are miniaturized. Complete installations are avail. Also parts.

SCR-616—BC-1269

F.M. & A.M. 145-600mc communications receiver. The receiver is a superhet covering the 145-600mc in 2 bands. The dial is calibrated in megacycles. F.M., or A.M. reception is offered. Input is 110v 60 cyc. This is one of the nicest receivers designed.

**RECEIVER—TRANSMITTER
FM 20—28 MC**

BC-603 RECEIVER: 20-28 MC variable tuning, 10 Pre-Set push button channels, squelch circuit, 4" speaker; 10 Tubes: 2/12SG7, 2/6EL7, 1 6X6, 1/6X5, 3/6AC7, & 1/6116. Prices: USED: \$29.95

PLUG for rear of Receiver. USED: \$1.00

DYNAMOTOR: 12 V input; Output 220 V 80 MA. DM-24. NEW: \$4.95. REISSUE: \$2.95

BC-604 TRANSMITTER: 20-28 MC, 30 Watt, companion to BC-603 Receiver. Crystal control, 10 Pre-Set channels, interphone communication; 8 Tubes: 7/16J9 & 1/1624. USED: \$18.95

PLUG for rear of Transmitter. USED: \$1.00

DYNAMOTOR: 12 V input; Output 625 VDC 225 MA. DM-35. NEW: \$12.95. REISSUE: \$8.95

FT-237 BASE for mounting Receiver & Transmitter (No plug required) USED: \$9.95

BC-500 RECEIVER TRANSMITTER: FM Crystal Control on 5 channels, 100 KC separation 20-28 MC. Transmitter: 25 Watt output, 7 Tubes: 1/1625, 1/12A6, 3/12S47, & 2/12SA7. Receiver: 11 Tubes: 1/12S47, 2/12A6, 3/12SA7, 3/12116, 2/12K5, & 1/12S7. Dynamotor Supply; Receiver 28 VDC 1.2 A input; output 250 VDC 60 MA. Transmitter 28 VDC 4.1 A input; output 550 V 120 MA. Control Panel: For Local Control & outlets for Remote also. Heavy duty 5" speaker. Size: 12" x 25" x 9". NEW: \$59.50 Weight: 65 lbs. Price: USED: \$39.95

TELEPHONE EQUIPMENT

EE-8 Field Telephone—Ideal for private telephone system for two or more phones, up to 17 miles, hand ringer generator with handset, carrying case, uses two flashlight batteries. USED, Checked: \$14.95 New Equipment, Used Cases: \$18.95

RM-13 Remote Control Unit for telephone & radio equipment. Telephone unit same as EE-8. Radio remote, pre-amplifier, 115 V 60 cycle with input & output jacks, DF Meter, one tube amplifier with TS-9 handset. USED: \$19.95 — NEW: \$24.95

SOUND POWERED HEAD & CHEST SETS USED, Checked: \$3.95

TS-9 HANDSETS. NEW: \$6.95 — USED: \$3.95

TS-13 HANDSETS w/PL-55 & PL-68. USED: \$5.95

INVERTERS & GENERATORS:

GENERATOR—115 V, 400 Cycle, 1400 Watt, Single Phase, 28.5 VDC 400 Watt. USED: \$89.50

GENERATOR: Motor 3 HP, 115/230 60 cycle single phase; Generator 115 Volt 400 cycle single phase 1400 Watt & 28.5 VDC 400 Watt. Belt Drive. Reconditioned. \$195.00

115 V. 60 CYCLE BLOWERS:

At Left: 115 VAC 60 Cycle SINGLE TYPE — 100 CFM — 2-1/4" intake; 2" outlet. Complete size: 5" x 6" — No. 1C939. \$8.95
115 VAC 60 Cycle DUAL TYPE — 100 CFM — 4" intake; 2" Dis. Each Side. Complete size: 8" x 6" — No. 1C880. \$13.95

115 VAC 60 cycle COMPACT TYPE—108 CFM; Motor built inside squirrel cage; 4-1/2" intake; 3-5/8" x 3" Dis. Complete size: 4-1/2" W x 8-3/8" H x 8-3/8" D—No. 2C067. \$14.95

115 VAC 60 cycle FLANGE TYPE—140 CFM; 3-1/2" intake; 2-1/2" Dis. Complete size: 7-1/2" W x 7-1/2" H x 6-3/4" D—No. 1C807. \$13.95

115 VAC 60 cycle FLANGE TWIN—275 CFM; 4-1/2" intake; 3-3/4" x 3" Dis. Complete size: 11-3/4" W x 2-3/4" H x 8-1/16" D—No. 2C069. \$21.95

115 VAC 60 Cycle BLOWER—200 CFM; 4" intake; 2" x 2" outlet. Overall size: 8" x 7" x 6". Bodine Motor NSI-33. Removed from New Equipment. \$14.95

115—VAC 60 Cycle BLOWER—100 CFM; 3-3/4" intake; 2" outlet; Rd. Flange with Flap Director. Overall size with bracket: 8" L x 6-1/2" W x 7" H. Removed from New Equipment. Diehl Motor FB-2106-6 No. FDBL-2106. \$6.95

Same as above, but with 12" Curved Director. No. CDBL-2106. \$7.95

OTHER BLOWERS:

12/24 VDC—AC CAST ALUMINUM BLOWER—100 CFM; 3" intake; 2" outlet. Shunt Motor 4" x 2", 3000 RPM @ 24 VDC. \$5.95

6 VDC SINGLE—100 CFM—No. 6100. USED: \$4.95

24 VDC DUAL—20 CFM—Min—No. 2420. \$7.95

10 CFM BLOWER—27.5 VDC; 1/100 HP; 7000 RPM; Oster Motor C2BP-1A; L-R Mfg. Co. Bakelite Blower #2. Overall Size: 3-1/2" x 4-1/2". \$5.95

Price Same as Above, 12 VDC operation — \$5.95

115 V. 100 CYCLE—10 CFM—Eastern Air Devices Motor J31A—7200 RPM, 1/100 HP, L-R #2 Blower Assy. Overall Size: 4-1/2" x 5-1/2". No. 3110. \$5.95

10 CFM BLOWER—28 VDC, 6 A; 5000 RPM. Pioneer Motor SS-2345. Aluminum Blower Housing — Overall Size: 4-1/2" x 5-1/2". \$5.95

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**VARIABLE
VOLTAGE**

AMERTRAM TRANSFORMER. 115 KVA. Input 115 V., 60 cycles. Output continuously variable 0 to 115 V. up to 100 amperes. Easily re-connected for input of 230 V., with output of 0-230 V., 50 amperes. Brand new. Special \$99.50

GERMANIUM DIODES

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1N70, JAN, New and Clean!

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Stock up while they last! Extremely high (100) inverse volts. So only 8 are needed to make a full-wave 115 V. bridge (2 in series in each leg, with high safety factor, instead of the usual 3 per leg.) 30 ma average. Also, greatly reduced reverse current: only 300 uA at -50 V! Normally, a very high priced unit, so this is a terrific buy! Next price break is: 1,000 for \$325.00.

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FAIR RADIO SALES • 132 SOUTH MAIN ST LIMA, OHIO

SAVE ON TUBES BRAND NEW TUBES GUARANTEED TUBES

OA2	.75	2J42	60.00	4J52	50.00	203A	3.00	WE-394A	3.00	800	1.50	5517	1.75
OA3	.90	2J48	35.00	4X150A	22.50	204A	25.00	WE-396A	3.00	801A	.50	5551/FG271	25.00
CB2	.65	2J49	40.00	4X500A	55.00	207	25.00	403 5591	2.75	802	2.25	5553	
OB3 VR90	.85	2J50	35.00	5BP2A	5.00	211 VT4C	.50	WE-403A	1.50	803	1.40	FG258A	90.00
OC3 VR105	.65	2J55	35.00	5CP1A	8.00	212E	15.00	WE-404A	11.00	804	9.00	5559 FG57	10.00
OD3 VR150	.65	2J56	50.00	5CP7A	8.00	WL-218	15.00	GL-414	99.50	805	6.00	5586	125.00
ELC1B	1.50	2J61	15.00	5CP11A	9.50	RX-233A	.75	WE-416B	45.00	806	7.50	5591/403B	2.75
1A04	1.25	2J62	6.50	5C22	29.50	FG-235A	25.00	417A	2.75	807	1.20	5611	65.00
1B23	2.75	2K22	14.50	5C30/C5B	1.00	QK-249	150.00	WE-417A	12.50	807W	3.00	5634	7.00
1B24	5.50	2K23	14.50	5JP2	7.00	WE-249B	2.50	WE-423A	8.50	808	1.25	5636	2.25
1B24A	12.50	2K25	12.00	5JP4	7.00	WE-249C	3.00	446B	2.00	809	2.25	5647	5.00
1B26	1.25	2K26	45.00	5JP5	7.00	250-R	4.00	WL-456	59.50	810	10.00	5651	1.40
1B27	10.00	2K28	25.00	5JP11A	9.50	250-TL	15.00	464A	2.25	813	11.00	5654	1.25
1B35	4.50	2K33	90.00	5MP1	3.95	WE-251A	39.50	527	22.50	814	1.75	5656	7.00
1B36	4.00	2K33A	50.00	5NP1	5.00	WE-252A	7.95	ML-531	4.00	815	1.50	5657	125.00
1B40	2.00	2K33B	110.00	5R4GY	.90	WE-254A	3.75	KU-610	3.50	826	.75	5663	1.50
1B42	4.00	2K34	85.00	5R4WGY	2.75	FG-258A	90.00	KU-627	10.00	829	6.00	5667	125.00
1B47	6.50	2K35	175.00	C6J	6.50	FG-271	25.00	KU-628	10.00	829B	8.50	5670	1.50
1B51	6.75	2K39	100.00	6AK5W	1.00	271A	10.00	648P1	5.00	830B	.75	5687	3.00
1B62	4.00	2K41	100.00	6AN5	2.00	WE-274B	1.00	WL-652	20.00	832	4.00	5691	4.75
1B63A	22.00	2K42	125.00	6AR6	1.25	WE-282A	6.00	HK-654	25.00	832A	6.00	5702	1.75
1N21	.60	2K43	110.00	6AS6	1.25	WE-282B	6.00	681 686	25.00	836	1.50	5702WA	6.00
1N21B	1.25	2K45	40.00	6BL6	35.00	WE-285A	5.00	WE-701A	1.85	842	2.00	5703	1.10
1N23	.60	2K46	200.00	6BM6	25.00	287-A	2.50	702A	.50	845	5.00	5718	3.00
1N23B	1.50	2K47	110.00	6F4	3.25					849	17.50	5719	2.50
1N23BM	3.50	2K48	75.00	6J4	1.95					851	10.00	RK-5721	150.00
1N23C	2.50	2K50	150.00	6J4WA	3.50					852	4.00	5725	1.50
1N25	3.00	2K54	7.00	6K4	2.25					858	Q	5726	.60
1N26	3.75	2K56	50.00	6Q5G	3.25					860	3.00	5727	1.30
1N28	5.00	2X2A	1.00	6L6WGB	2.75					861	15.00	5744	1.90
1N31	3.00	3AP1	2.95	6SK7W	2.00					861	15.00	5750	3.10
1N34A	.50	3BP1	2.00	6SN7W	2.00					872A	1.35	5763	1.30
1N38A	.65	3B24	1.00	6SU7GT	2.75					884	1.00	CK-5787	4.95
1N42	8.00	3B24W	5.00	6X4W	1.00					GL-889	50.00	5814	1.00
1N52	.65	3B26	2.50	6X5WGT	1.30					GL-889A	65.00	5814WA	3.50
1N63	1.75	3B28	5.00	7C22	50.00					889RA	110.00	5819	25.00
1N69	.40	3B29	5.50	7C24	90.00					902A	3.00	5825	7.95
1P21	30.00	3C22	60.00	FG-17	2.95					902P1	3.00	5829	1.40
1P22	6.50	3C23	5.00	RX-21	4.00					889RA	110.00	5829WA	8.00
1P28	9.00	3C27	1.00	HK-24	3.00					902A	3.00	5837	70.00
1W5	1.00	3C31	1.50	RK-28A	2.50					902P1	3.00	5840	4.50
1Z2	1.75	3C33	8.00	HK-54	2.00					905	2.00	5844	3.00
2AP1	4.00	3C45	7.00	D-42	40.00					917	2.00	5851	4.00
2C33	.75	3DP11A	7.50	QK-60	25.00					919	2.00	5876	11.50
2C35	2.50	3D21A	3.00	RK-60/1641	1.35					927	1.00	5894	18.00
2C36	30.00	3DP152	5.00	RK-61	2.50					931A	2.50	5896	5.00
2C37	30.00	3E29	8.50	QK-62	25.00					935	4.00	5899	5.00
2C39	4.95	3FP7A	2.50	HY-65	1.00					954	.35	5901	6.50
2C39A	10.00	3J30	35.00	RK-65/5D23	7.50					955	.35	5905	8.95
2C42	10.00	3K22	150.00	FG-67	12.00					956	.35	5908	7.95
2C43	9.00	3K23	150.00	HY-69	3.00					957	.35	5932	4.00
2C44	.50	3K30	100.00	RKR-72	.50					958	.35	5933 807W	4.00
2C46	6.00	4-65A	14.00	RKR73	.50					958A	.35	6005	1.75
2C51	3.00	4B23	5.00	ML-100	50.00					959	1.25	6021	4.50
2C52	3.00	4B24/3C	4.00	100TH	6.50					991	.35	6044	30.00
2C53	10.50	4B31	22.00	FG-105	11.00					CK-1005	.35	6045	Q
2D21	.60	4C27	5.00	F-123A	2.95					CK-1006	2.75	6046	.75
2D21W	1.25	4C28	25.00	F-124A	Q					CK-1007	.55	CK-6050	2.00
2E26	3.25	4C35	13.50	F-128A	13.00					1603	3.00	6096	1.75
2E27	.60	4E27	8.75	FG-154	15.00					1620	3.25	6111	6.50
2E32	1.00	4J22	35.00	VT158	9.75					1623	1.75	6147	3.00
2J31	15.00	4J29	35.00	FG-166	15.00					1624	1.00	6177	49.50
2J32	12.50	4J31	65.00	FG-179	20.00					1625	.30	6246	Q
2J33	14.50	4J34	50.00	HF-200	10.00					1626	.25	6764	Q
2J34	14.50	4J42	25.00	QK-181	20.00					1636	.75	8005	4.95
2J36	15.00	4J50	99.50	WL-200	75.00					1641	1.35	8012	1.00
										1642	.50	8025A	2.00
										1945	.65	9001	.85
										2000T	150.00	9002	.55
										2050	.90	9004	.85
										2051	.65	9005	1.50
										ZB-3200	69.50		

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Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AB/150	\$1.99	OB2	.89	2K28	29.50	5BP1	2.49	12AT7	.85	274B	1.79	703A	1.90	815	1.99	5703	1.19
C3J	6.35	1B22	1.69	2K33A	59.95	5BP1A	8.99	12AU7	.76			704A	1.59	816	1.05	5725	1.99
C6J	7.99	1B24	5.99	2K41	72.50	5BP4	2.99	15E	1.25	282A	6.49	705A	1.25	826	.75	5835	1.29
CRP RK-72	.49	1P30	1.99	2K54	8.95	5CP1	3.99	26A7/GT	2.99	287A	6.61	706B	14.50	829B	8.99	1626	.29
EC1	1.99	2AP1	3.99	2K55	9.50	5CP1A	12.49	26C6	1.19	304TH	10.00	706C	17.50	830B	2.99	1630	.79
EF-50	.89	2AP1A	6.44	2X2	1.34	5CP7	9.99	28D7	.99	304TL	12.00	707A	2.55	832A	7.45	1632	.79
E1148	.29	2BP1	5.99	3A5	.89	5CP11A	14.99	78P7	6.25	307A	1.85	707B	4.45	833A	31.50	1641	1.88
EM-3GA	39.50	2BP11	7.99	3A5	.89	5D21	6.99	91P7	5.00	310A	3.99	708A	2.99	837	1.99	1642	.39
F123A	5.99	2C21	.49	3A5	.89	5FP7	3.99	10V	.39	316A	.69	709A	1.69	838	1.50	180P1	4.99
F128A	19.00	2C22	.39	3AP1	3.99	5HP1	2.49	18C	.29	327A	3.35	714AY	24.95	841	.59	2050	.95
FG-105	12.99	2C26	.39	3B22	1.49	5HP4	2.49	24C	1.89	329A	4.69	715A	2.65	843	.49	2050W	2.40
FG-154	14.99	2C26A	.49	3B24	2.99	5J31	16.99	32K3	1.59	316A	.69	715B	6.45	845	6.49	2051	.76
HF-100	7.49	2C33	.79	3B24W	4.99	5J33	7.99	35T	4.99	350B	2.99	715C	14.50	851	16.50	5651	1.39
HK-24	3.69	2C39	4.99	3B25	3.99	5LP1	13.99	35TG	7.25	356B	7.45	717A	.49	861	3.49	5654	1.40
HK-54	3.95	2C39A	11.50	3B27	3.49							18A/CV	29.75	864	.69	5670	2.20
HY-114B	.69	2C40	9.99	3B28	4.69	CRYSTAL DIODES						EY/DY	29.75	865	.49	5686	1.79
KU-610	5.99	2C42	9.75	3BP1	1.88	1N21	.19	1N23B	1.10	719A	14.65	866	.49	869	1.19	5687	2.69
HY-65	1.70	2C43	10.99	3BP1A	5.15	1N21B	.99	1N27	.69	721B	8.45	869B	30.00	5702	1.49	5702WA	3.10
REL-21	1.00	2C44	1.35	3C22	64.95	1N23A	.49	1N34A	.61	722	1.99	GL-872A	2.49	5726	1.00		
RK-34	.39	2C46	7.49	3C23	5.99					723A/B	8.99	872A	1.29				

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RK-59	1.88	2C53	9.90	3C24	1.50	5NP1	6.99	53A	2.29	371B	1.29	724A	1.15	874	.69	5744	.31	
RK-60	1.99	2D21	.69	3C33	8.99	6C21	19.95	89V	.15	388A	1.49	724B	1.45	878	1.00	5751	2.10	
RK-61	3.50	3D21W	1.39	3C45	6.25	6ACT	1.64	100TH	3.99	393A	4.35	725A	3.99	884	1.00	5763	1.25	
RK-65/5D23	14.99	2G22	2.29	3CP1	2.25	6AG7	.79	205B	1.99	1.99	726A	9.50	9.3	.69	5879	1.10		
RK-73	.69	2J21	2.99	3D23	4.99	6AJ5	1.19	205D	3.99	48.50	GL-434A	6.66	726C	24.50	902P1	2.99	5933	2.95
RZ-233A	.69	2J22	4.99	3DP1	1.88	6AK5	.54	207	.72	446A	1.49	730A	7.95	927	1.45	5964	.74	
VT5/215A	.69	2J27	5.99	3E29	10.25	6AK5W	1.19	211	.49	446B	1.79	800	1.29	931A	2.99	6077	2.89	
VT25/30	.49	2J30	14.50	3EP1	1.88	6ANS	2.12	215A	3.49	439	801A	.42	955	.29	6080W	3.90		
VT25A/10V	.39	2J31	14.50	3CP1	1.88	6AR6	1.49	217C	3.99	439	802	2.89	956	.25	8002R	18.50		
VT67/30 Spec	.26	2J32	13.50	4-125A	26.50	6AS6	1.19	221A	3.99	1.19	CK-502AX	1.10	803	2.69	901	3.49		
VT-158	17.50	2J33	13.50	4-151	4.49	6AST/G	2.49	221A	3.99	527	14.50	804	9.99	958A	.39	8012	1.85	
VD-111	.19	2J34	13.50	4AP10	4.99	6BM6	39.50	242C	3.99	527	14.50	805	4.90	959	1.40	8013	2.50	
VB52/52A	.99	2J38	11.00	4B25	6.49	6C4W	2.99	249B	2.99	527	14.50	807W	3.25	CK1005	.46	8020	1.33	
QK-59	29.50	2J49	39.50	4B36	4.69	6F4	2.99	250TH	24.95	532A	.99	808	1.79	CK1006	1.97	8025	1.99	
QK-61	32.00	2J61	16.40	4C27	8.95	6J4	2.50	250R	4.99	532A	.99	809	1.50	1500T	94.50	9021	7.95	
QK-185	99.00	2J62	9.60	4C28	6.49	6J4W	3.75	258B	4.49	532A	.99	810	9.95	1608	.29	9002	.69	
VR-78	.89	2K22	14.50	4C35	12.95	6K4	3.99	264C	3.90	E	10.99	811	3.19	1613	.95	9003	1.10	
VR-90	.79	2K23	16.50	4E27	9.95	6X4W	1.49	271A	12.59	701A	4.99	913	11.49	1614	1.49	9006	1.49	
VR-105	.79	2K24	16.50	5AP1	3.95	12A6	.39	274A	1.49	702A	2.25	814	2.25	1616	.59	9006	.19	

Type	Price	Type	Price	Type	Price	Type	Price
1N21	.19	1N23B	1.10				
1N21A	.55	1N26	3.55				
1N21B	.99	1N27	.69				
1N23A	.49	1N34A	.61				

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WESTON Type 705 SENSITROL



Stationary contact is a small powerful permanent magnet and movable contact is iron "rider" mounted on pointer which travels over relay scale. Operating torque moves pointer into magnetic field of stationary contact

#R561 which draws movable contact and holds it firmly. Contacts remain closed until reset. Will operate directly from a photocell or a group of thermocouples. Net weight 14 oz.

Double contact with Solenoid Reset; Sensitivity 7.5 Microamps; Reset coil 6-24 VDC or 24 VAC; Makes contact on increasing or decreasing values; Contacts; "Twintacts", Capacity 100 ma at 110 volts; Nickel plated brass cover; Weston Model 705 Type 6 #R56018.75; 10 for 170.00 Same as #R560 but with glass face; Weston Model 705 Type 6 #R56119.75 10 for 180.00

Single contact (Normally Open), Solenoid Reset; Sensitivity; 10 Microamperes; Reset coil; 6-24 V DC or 24 V AC; Contact; "Twintact", capacity 100 ma at 110 volts; Glass Face; Weston Model 705 Type 4 #R52317.75 10 for 160.00 Same as #523 with Brass Cover Weston Model 705 Type 4 #R523N16.75 10 for 150.00

STEPPING SWITCHES

SS5



Mfd. by Western Electric Minor Switch 10 steps and off Contacts: #'s R960, 975, 976 Gold plated brass; Bridging Wiper; others non-bridging; Net. Wt. 1 lb.

Step & Reset

Each of 10
#R960; Single Level; 6 to 12 VDC. 9.50 8.00
#R975; Single Level; 24 to 36 VDC. 10.50 9.00
#R976; Single Level; 48 to 60 VDC. 11.50 10.00
#R977; Two Level; 6 to 12 VDC. 10.50 9.00
#R978; Two Level; 24 to 36 VDC. 11.50 10.00
#R979; Two Level; 48 to 60 VDC. 12.50 11.00

SS6 Mfd. by Western Electric Co.; 22 step; 5 levels; Bridging Wipers; Contacts; Gold plated brass. Interrupter Switch; 1 Break-Make; Net Weight: 2 lb. 2 oz.



"Homing" Type; 180° Wipers; Step in One Direction

#R926; 6 to 12 VDC.13.75 11.50
#R980; 24 to 36 VDC.14.75 12.50
#R981; 48 to 60 VDC.15.75 13.50

SS7 Mfd. by Western Electric Co.; 44 step; 2 Levels; Bridging Wipers; Contacts: Gold plated brass; Interrupter Switch; 1 Break-Make; Net Weight 1 lb. 14 oz.

"Homing" Type; 360° Wipers; Step in One Direction

Each of 10 Lots
#R927; 6 to 12 VDC.13.75 11.50
#R982; 24 to 36 VDC.14.75 12.50
#R983; 48 to 60 VDC.15.75 13.50

CLARE TYPE 20 "Homing" type; Step in one direction; 20 position; 180° wipers, one bridging and remainder non-bridging; Interrupter Switch: 1 break. #R891; 24-36VDC; 3 levels; Clare #SD19. 12.95 each

WESTERN ELECTRIC MERCURY CONTACT

Pressure Sealed; Octal Plug Base D171584; (Equivalent to 275B); SPDT; 1 coil of 4500 ohms plus 24V Heater. Operating current: 8.0 ma, release current: 5.2 ma. Overall length: 3/4", overall diameter: 1-3/16" #R10216.95 ea. 10 for 65.00 100 for 625.00



SIGMA SENSITIVE



SIGMA 4F8000S; 1 ma; SPDT (1C); 8000 ohm; #R4253.95 ea. 3 for 10.00 10 for 30.00

SIGMA 5F16000S; 0.5 ma; SPDT (1C); 16000 ohm; #R6275.95 ea. 10 for 50.00 100 for 450.00

HERMETICALLY SEALED



ALLIED SMHX-1; 24-VDC; 6PDT (6C); 10 Amp contacts; 230 ohm; Solder lug header; #2716.50 ea. ALLIED SKHXCC; 24 VDC; DPDT (2C) 425 ohm; Solder lug header; #R854.95 ea. ALLIED SKHXCCC; 24 VDC; 4PDT (4C); 425 ohm; Solder lug header; #R86 5.50 ea.

A-C RELAYS



ALLIED PO12A115; 115V 50-60 cyc; 4PDT; 10 Amp contacts; #R10254.50 ea. 10 for 40.00 100 for 350.00 GUARDIAN 150; 115V, 50-60 cyc; SPDT, 3 Amp contacts; #R1029 1.50 10 for 12.50 100 for 110.00

24 VOLT TRANSFORMER; 1.5 Amp; Pri; 115V; 50-60 cyc; Double shielded; Net wt: 1 1/2 lb; #T1201.50 ea. 10 for 13.00 100 for 100.00



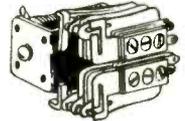
LATEST SUBMINIATURE TYPE

ALLIED 50G MH-12; MIL-R-5757A; 24-29 VDC; 4PDT; 300 ohm; Herm. Sealed; Solder Lug Header; 2.9 oz; Operate time 8 millisec; 1-1/16" dia. × 1-5/16" H; #R11385.50 ea. STRUTHERS DUNN 220XFX100; Same as Allied above but 6PDT; 300 ohm; Herm. Sealed; Solder Lug Header; 3 oz; 1-3/16" dia. × 1-11/16" H; #R11456.00 ea.



MINIATURE RELAYS

Automatic Electric Sales, Class S



Twin Code 0, 20 ga Contacts

Volts D. C.	Ohms	Contacts†	Stock No.	Price Each
24	300	3A	R340	1.25
24	640	1C, 1B	R640	1.25
2.5 ma	10000	1C, 1A	R1133	2.00
8 ma	5000	5A	R1133	2.00
24	600	1C	R318	1.15
24	600	2A	R319	1.15
24	600	1A, 1C	R336	1.25
24	600	1A, 1B, 1C	R337	1.35
24	250	4C	R1161	2.75
24	250	6C	R1162	3.25

Clare Type K

24	300	1A	R344	1.00
24	300	2C	R331	1.25
24	300	1C	R345	1.15
3-S	17	1A	R339	1.00
6	30	2C	R1134	1.25
48	1300	2C	R1135	1.50
24	300	1A, 1B, 1C	R1163	1.50
24	250	1B, 2C	R1136	1.50
24	300		R1137	.80

Coil and Frame actuator only (No contacts).

Allied Type TSL

24	300	1A	R346	1.00
24	300	1C	R347	1.00
24	300	2C	R348	1.15
12	150	1A	R338	1.00

Allied Type SK

24	300	1C	R349	1.00
24	300	2C	R67	1.15
24	300	4C	R525	2.25

Allied Type STK

24	300	1A	R350	1.00
24	300	1C	R330	1.00
24	300	2A, 1C	R403	1.25

Allied Type F & Price 1150

6-12	120	1A	R394	1.00
12	100	2A, 1C	R395	1.25
8 ma	3000	1A	R916	1.25

Advance Type 1504 & 1604

24 AC	45	2A	R334	1.00
3	14.5	2C	R650	2.00
12	450	1H	R396	1.50
12	450	2A	R397	1.50

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24	250	3A	R317	1.25
24	500	2C	R918	1.50
10 ma	6500	4A	R802	2.00
12 ma	5000	1A, 4C	R1164	3.75

Anti-Capacity Types

12-32	500	1A	R106	.90
24	300	1C	R134	1.50
24	300	2C	R351	1.50

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12	200	2C	R921	1.50
6	50	2C	R922	1.50

Miscellaneous Types

Mfg'r & No.	Volts	Ohms	Con-tacts	Stock No.	Price Each
Kurman	24	1500	1C	R1139	1.00
Leach P3 Series	.02		1C	R1141	.80
Leach P3	6	150	1C	R173	.80
Price TB302	24	300	2A, 1C	R404	1.35

†A=SPST, normally open; B=SPST, normally closed; C=SPDT; H=SPST, double make.

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.025	50	17.95		.5	25	39.50
.025/.025	50	24.50		1.	7.5	6.95
.1/.1	4.5	3.50		1.	15	29.50
.135	7.5	6.95		1.	20	42.50
.2	50	39.50		1.	25	49.50
.25	15	9.95		2.	5.5	9.50

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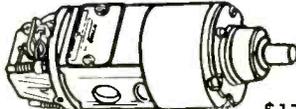
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1B24A	15.00	2K55	15.00	EL6CF/4B25	8.00	QK155	255.00	387A	4.00	709A	1.75	1684	2.20	5704	1.50	6021	1.50
1B26	1.25	3B23/RK22	3.30	FD21	7.75	FG172	15.50	391A	3.50	715B	3.00	5551/FG271	37.50	5718	1.50	6022	1.65
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1B35	3.50	3B25	5.00	6SN7W	1.50	QK202	255.00	403B/5501	2.75	723A/B	9.00	5637	8.00	5721	15.00	6097	1.50
1B36	3.75	3B27	3.50	7C30	65.00	203A	2.50	404A/5F47	12.50	726B	20.00	5734/SDF28E	7.00	5725/6A56W	2.75	6098	1.90
1B63A	20.00	3B29	5.50	8D21	200.00	207	45.00	411R/3K30	55.50	726C	20.00	5636	3.50	5726/EAL5W	.60	6099	1.40
1N21E	1.25	3B31	1.00	12CB	.20	213/VT4C	.50	412A	3.50	800	.90	5637	5.50	5727/2D21W	1.40	6100	4.75
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1N34	.45	3C31/C1B	1.40	T-40	2.25	FT231	12.50	416F/6210	50.00	805	5.00	5639	9.50	5744	1.25	6161 (RCA)	70.00
1N34A	1.50	3C31	7.05	V-45	700.00	245A	15.00	417A	8.00	806	7.50	5640/SN947	6.50	5749	1.50	6162	2.50
1N48	.40	3D21A	3.95	246A	10.00	249A	3.50	417B	8.00	807	1.20	5751	5.75	5751	1.50	6189/12AU7W	2.50
1N54	.55	3DP1	3.30	249A	3.50	251A	45.00	417C	8.00	807W/5933	2.25	5763	1.20	6197	1.35	6211	1.40
1N56	.85	3J36	30.00	251A	45.00	266R	45.00	418A	10.00	808	2.25	5764	1.85	6211	1.40	6223	12.00
1N67	.70	3K21	200.00	266R	45.00	272A	9.00	418A	10.00	812A	3.50	5765	1.85	6264	12.00	6350	10.00
1N65	.85	3K30/410R	115.00	272A	9.00	272A	9.00	418A	10.00	816	1.00	5765	1.85	6264	12.00	6350	10.00
1N65	.85	4-65A (Surp)	18.50	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
1N69	.60	4B24	3.50	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
1N70	1.20	4B25/EL6CF	8.00	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
1N81	.30	4E27	8.50	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
1P23	1.90	4J21	77.50	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
1P30	1.25	4J30	39.50	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
1P41	1.50	4J36	75.00	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
1P23	1.90	4J21	77.50	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
1P30	1.25	4J30	39.50	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
1P41	1.50	4J36	75.00	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
1S21	2.50	4J50	99.50	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
CL-7	19.90	4X150A	25.00	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
2C15	2.50	4 (Surp)	22.50	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
2C39A	9.00	4X150G	25.00	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
GL-2C39B	27.50	4X150G (Surp)	32.50	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
2C51/396A	4.50	4X50A	50.00	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
2C53	10.25	4X500F	65.00	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
2D21W	1.40	5B1P (Surp)	65.00	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
2E30	1.95	5B1P	2.50	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
2E35	1.95	5B1P	3.95	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
2J49	40.00	5C22	27.50	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
2J54	45.00	5D21	7.95	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
2J61A	35.00	5F7	1.20	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00
2K25	12.00	5J23	20.00	272A	9.00	272A	9.00	418A	10.00	825B	8.50	5765	1.85	6264	12.00	6350	10.00

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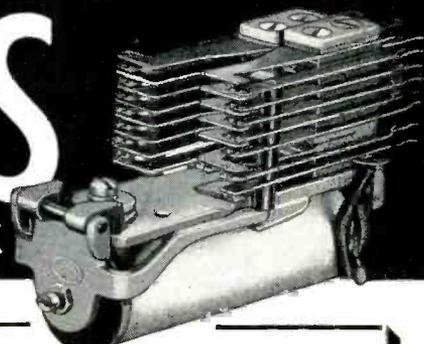
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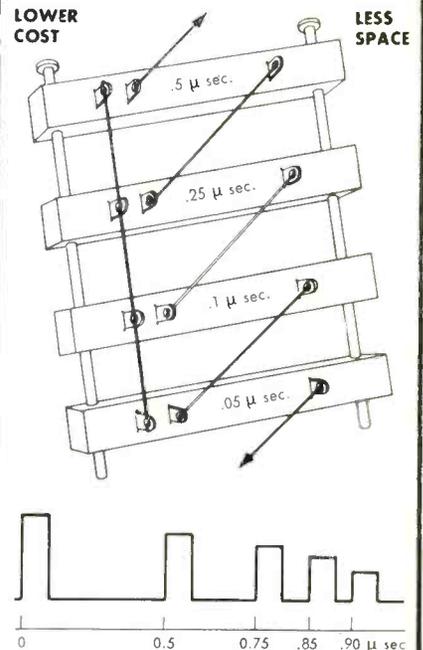
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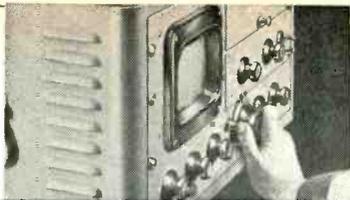
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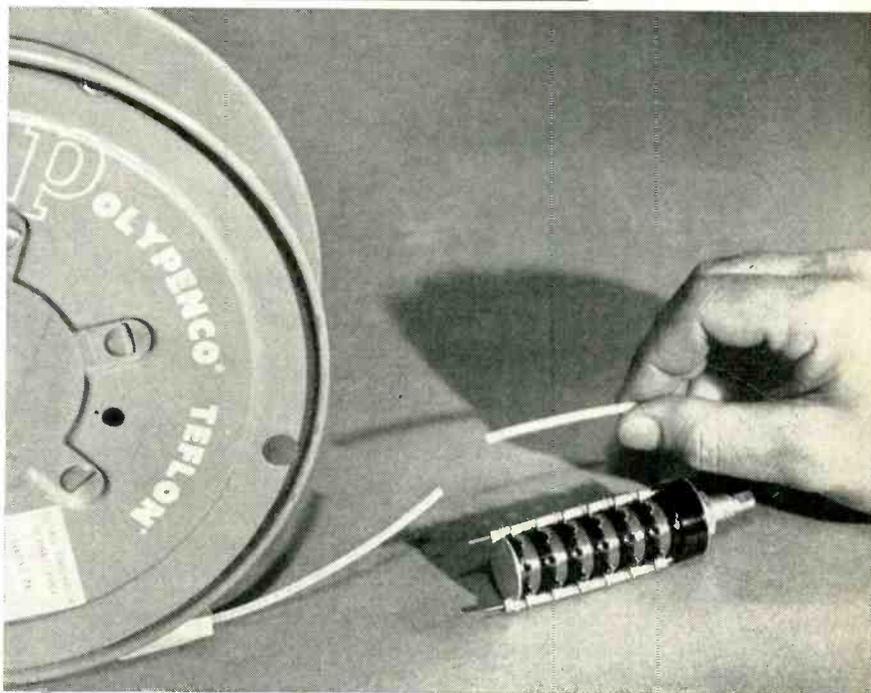
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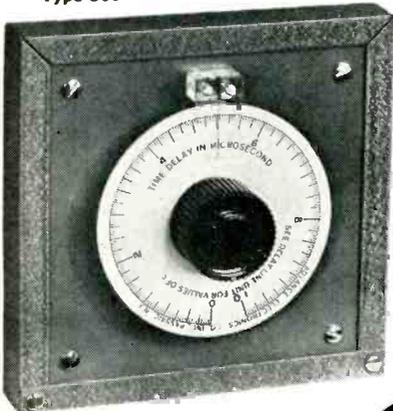
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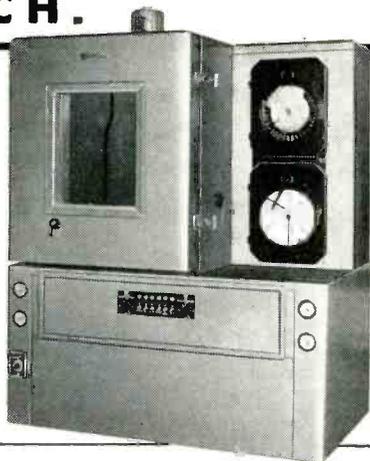
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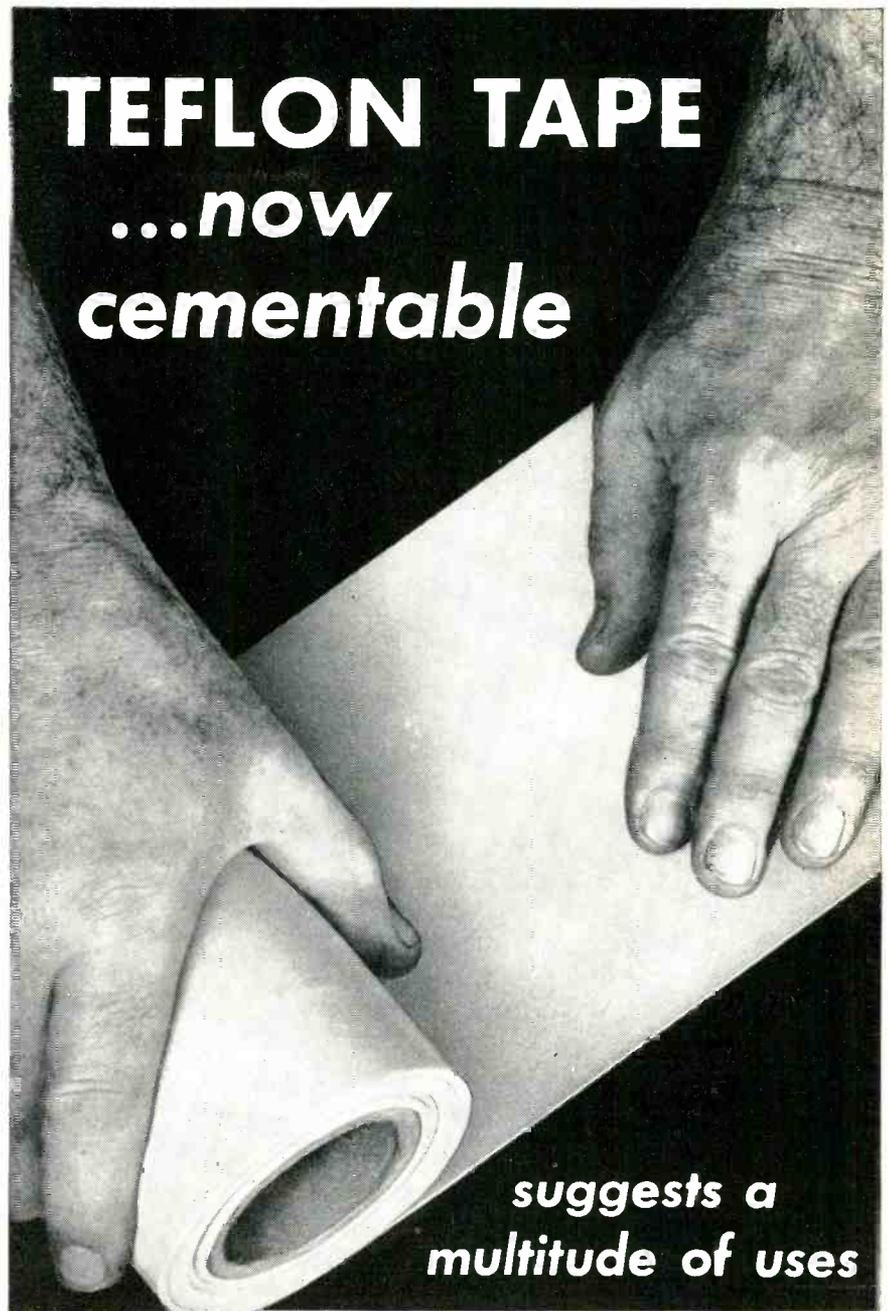
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Model ES-550 Deluxe: (Illustrated) In custom-styled, blue-grey ripple finished steel cabinet; 2 color satin-brushed aluminum panel and contrasting dark blue control knobs. Case Dimensions 8¼ x 14½ x 18½ inches. Complete with all tubes, including 5CP1/A CR tube. Comprehensive Instruction Manual.

Net Price \$235.00

Model ES-550 Standard: Electrically identical to above but in standard black cabinet with black anodized aluminum panel. Case Dimensions 8¼ x 14½ x 18½ inches. Complete as above.

Net Price: \$230.00

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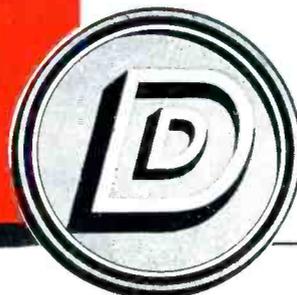
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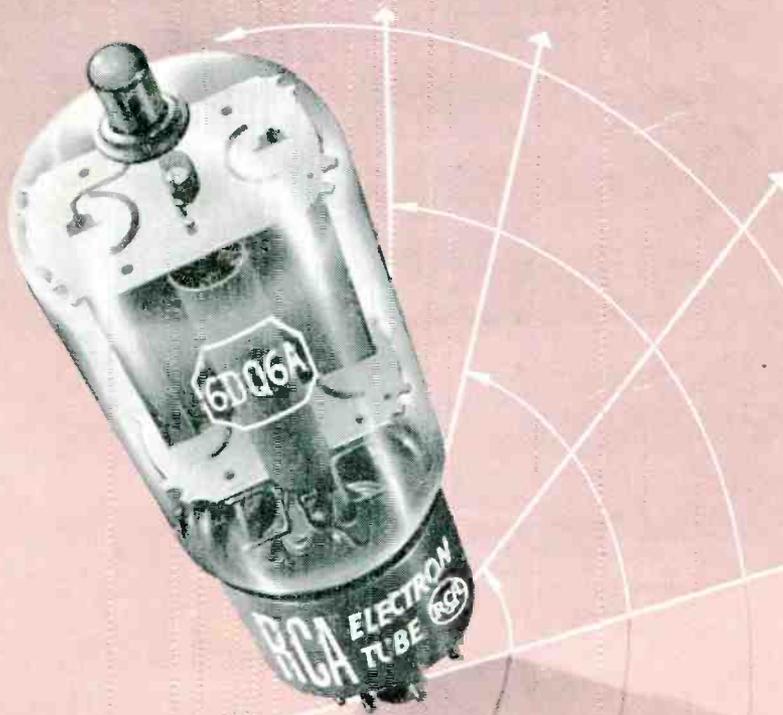
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