electronics

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APRIL 1956

4/5/56

TELEMETERING
Electronic Data Transmission

28-page SPECIAL REPORT on latest techniques

Systems Development

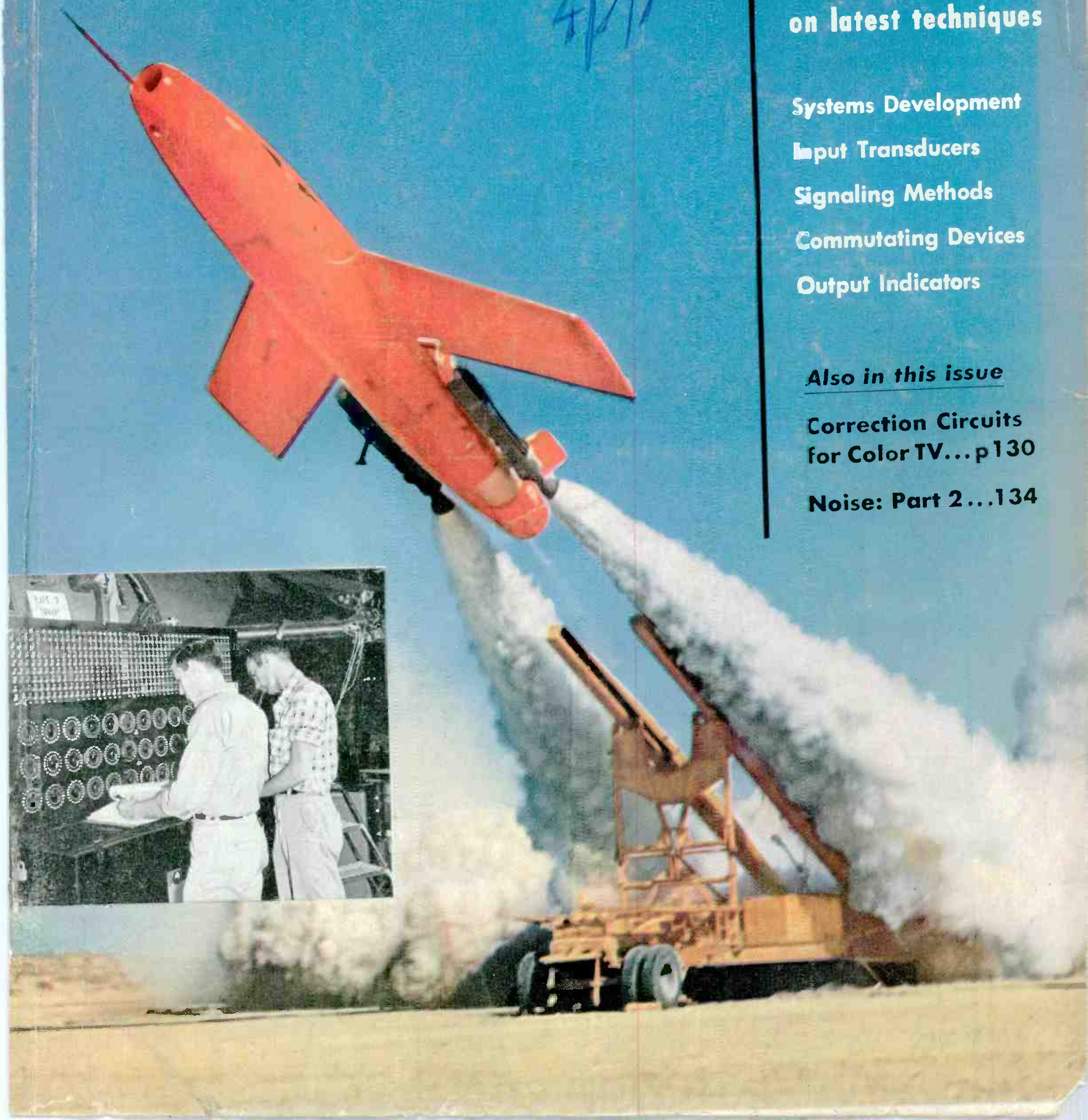
Input Transducers

Signaling Methods

Commutating Devices

Output Indicators

Also in this issue



LEADERS IN MINIATURIZATION FOR OVER 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.

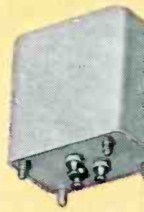
Dimensions . . . 1/2 x 11/16 x 29/32 . . . Weight .8 oz.

TYPICAL ITEMS

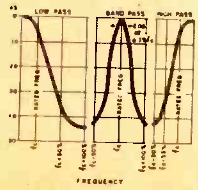
Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri MA	Response ±2 db (Cyc.)	Max. level dbm
H-30	Input to grid	TF1A10YY	50*	62,500	0	150-10,000	+13
H-31	Single plate to single grid, 3:1	TF1A15YY	10,000	90,000	0	300-10,000	+13
H-32	Single plate to line	TF1A13YY	10,000*	200	3	300-10,000	+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 interstage 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.

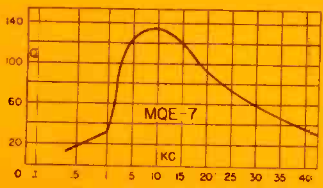


HERMETIC MINIATURE HI-Q TOROIDS

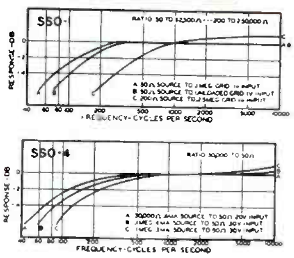
MQE units provide high Q, excellent stability and minimum hum pickup in a case only. 1/2 x 1-1/16 x 17/32 . . . weight 1.5 oz.

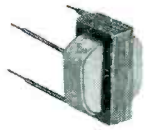
TYPICAL ITEMS

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





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.						
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.

OUNCER (WIDE RANGE) 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

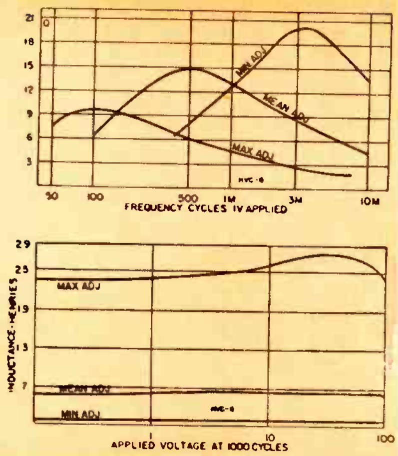
Type No.	Application	Pri. Imp	Sec. Imp
0-1	Mike, pickup or line to 1 grid	50, 200/250, 500/600	50,000
0-4	Single plate to 1 grid	15,000	60,000
0-7	Single plate to 2 grids, D.C. in Pri.	15,000	95,000
0-9	Single plate to line, D.C. in Pri.	15,000	50, 200/250, 500/600
0-10	Push pull plates to line	30,000 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		

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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electronics

A McGRAW-HILL PUBLICATION

APRIL • 1956

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

FEATURES

CONTINUED ON NEXT PAGE

contents

continued

SHOP TALK

▶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.

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

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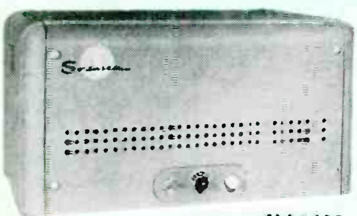
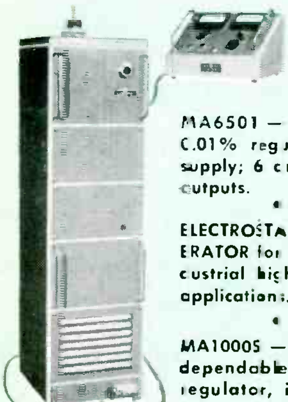


MA6501



MA6501 — tubeless 0.01% regulated DC supply; 6 and 2 volt outputs.

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ELECTROSTATIC GENERATOR for lab or industrial high-voltage applications.

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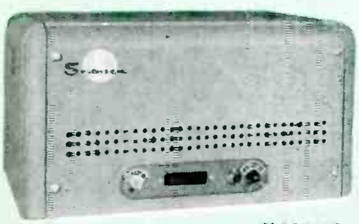
MA1000S — tubeless, dependable 1000VA regulator, ideal for unattended installations.



MA1000S

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MR3215 5-32VDC AT 0-15 AMPS
new, tubeless, magnetic amplifier

WIDE RANGE REGULATED DC POWER SUPPLY

for versatile, trouble-free performance in countless design & test applications

Different outside . . . and *inside!* The latest design in magnetic amplifier regulation. A silicon diode is used as reference element and a transistor amplifier provides the control current for the magnetic amplifier. Wide range, continuously adjustable voltage at high current. Regulation ±0.5% against line or load, ripple 1% RMS. Versatile, dependable, rugged, economical.

Write today for detailed specifications, performance data, and quotations.

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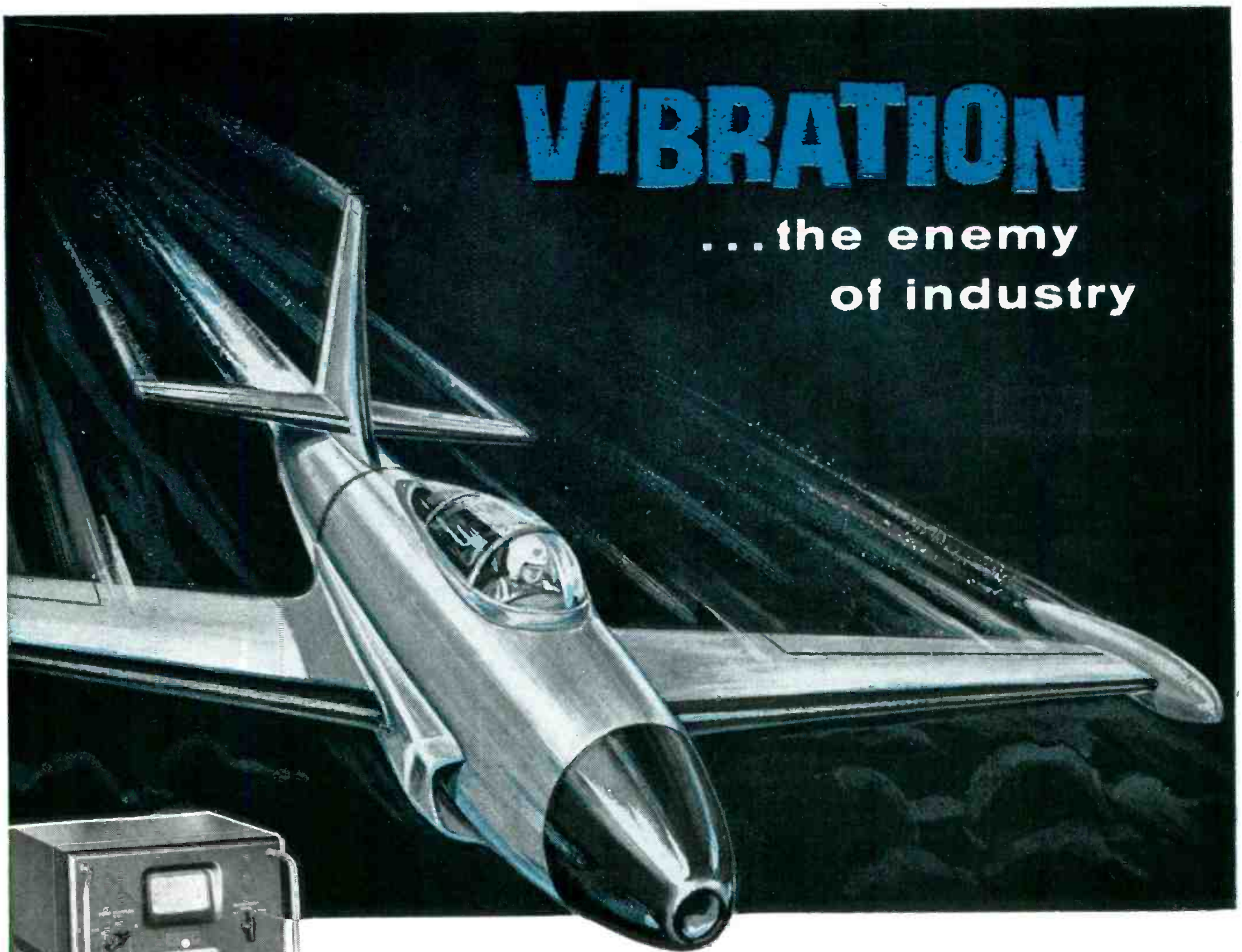


Mechanical vibration waveforms can now be measured and analyzed with the greatest accuracy, using the revolutionary MUIRHEAD-PAMETRADA Model D-489 Wave Analyzer. Complex vibration waveforms can now be isolated and measured within a wide frequency range, overcoming amplitude and frequency fluctuation 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.

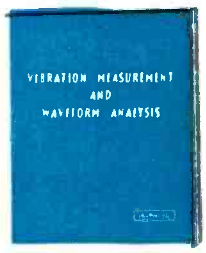
This highly versatile instrument has a wide diversity of applications in many industries: aviation, automotive and manufacturing, shipbuilding and electric power generation, to name only a few.

FEATURES

- No internal oscillator—eliminates drift
- R/C-tuned circuits—reduces hum and noise pickup
- Choice of 4 bandwidth characteristics: In-tune High, In-tune Medium, Narrow Band and ⅓ Octave.
- High selectivity characteristic (1% bandwidth for greatest discrimination)
- Auxiliary pre-amp permits use of high-impedance pickups or transducers.

SPECIFICATIONS

- Frequency range—19 c/s to 21 kc (extendable down to 2 c/s)
- Frequency Stability—± 0.3% over most of range
- Measurement Accuracy— ± 1 db over several days
- 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—12¾" x 13½" x 17½"
- Weight—55 pounds



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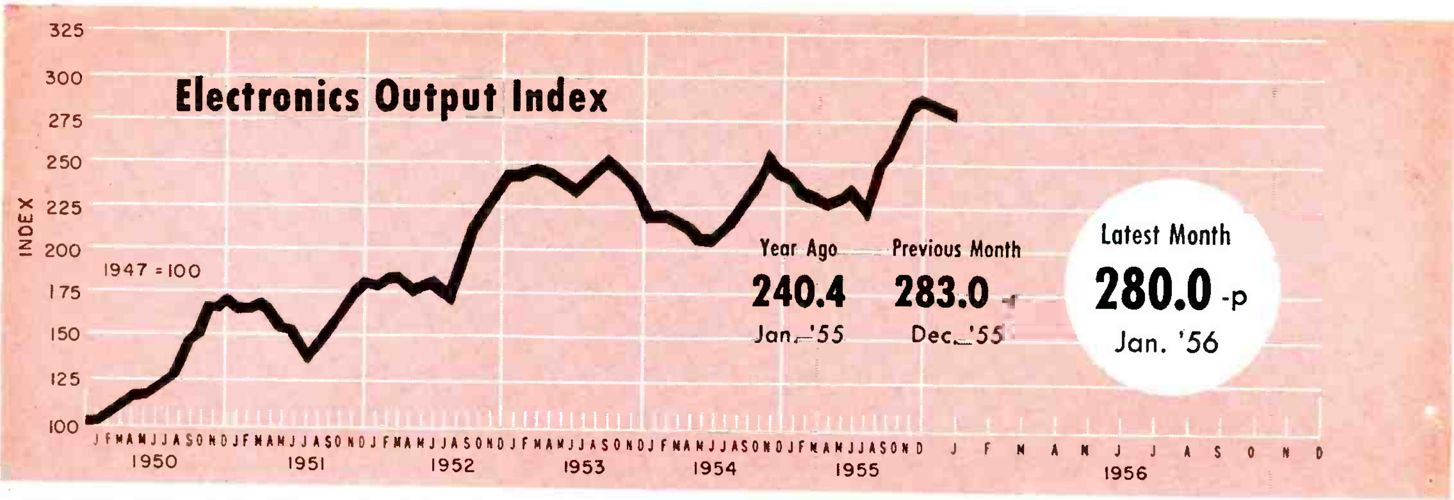


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)

	Latest Month	Previous Month	Year Ago
	Jan. '56	Dec. '55	Jan. '55
Television sets, total	588,347	604,626	654,582
With UHF	82,107	89,606	117,095
Color sets	nr	nr	nr
Radio sets, total	1,078,624	1,786,330	1,068,146
With F-M	nr	40,305	16,568
Home sets	nr	396,535	280,121
Clock radios	nr	343,330	166,885
Portable sets	nr	182,204	47,303
Auto sets	519,648	864,261	573,837

RECEIVER SALES

(Source: RETMA)

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

RECEIVING TUBE SALES

(Source: RETMA)

	Jan. '56	Dec. '55	Jan. '55
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

SEMICONDUCTOR SALES ESTIMATES

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

INDUSTRIAL TUBE SALES

(Source: NEMA)

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

BROADCAST STATIONS

(Source: FCC)

	Latest Month	Previous Month	Year Ago
	Feb. '56	Jan. '56	Feb. '55
TV stations on air	485	484	448
TV stations CPs—not on air	106	105	130
TV stations—new requests	22	26	17
A-M stations on air	2,841	2,834	2,692
A-M stations CPs—not on air	123	120	101
A-M stations—new requests	247	242	186
F-M stations on air	539	538	542
F-M stations CPs—not on air	13	16	11
F-M stations—new requests	4	3	5

COMMUNICATION AUTHORIZATIONS

(Source: FCC)

	Jan. '56	Dec. '55	Jan. '55
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

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)

	Dec. '55	Nov. '55	Dec. '54
Prod. workers, comm. equip.	404.0 -p	406.0 -r	379,000
Av. wkly. earnings, comm.	$75.53-p	$75.53-r	$70.70
Av. wkly. earnings, radio	$71.81-p	$71.81-r	$69.49
Av. wkly. hours, comm.	41.5 -p	41.5	40.4
Av. wkly. hours, radio	40.8 -p	40.8 -r	40.4

STOCK PRICE AVERAGES

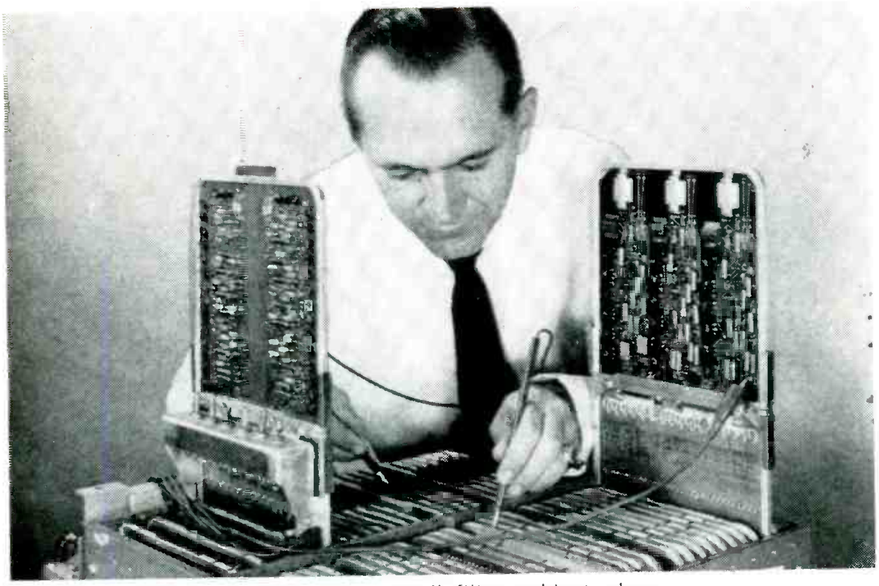
(Source: Standard and Poor's)

	Feb. '56	Jan. '56	Feb. '55
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

	TOTALS FOR FIRST MONTH 1956	1955	Percent Change	1955 Total
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.

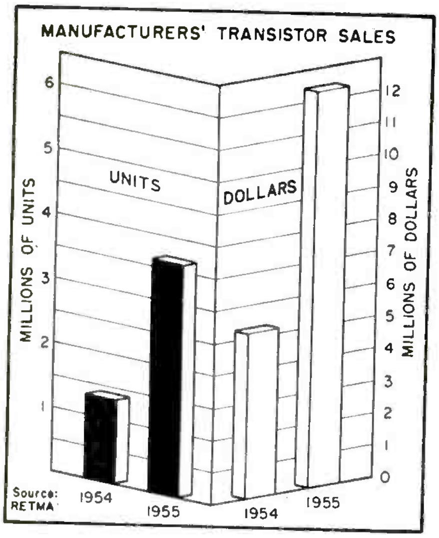
Transistor Shipments In Sharp Rise

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 communications 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 ¾ 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.

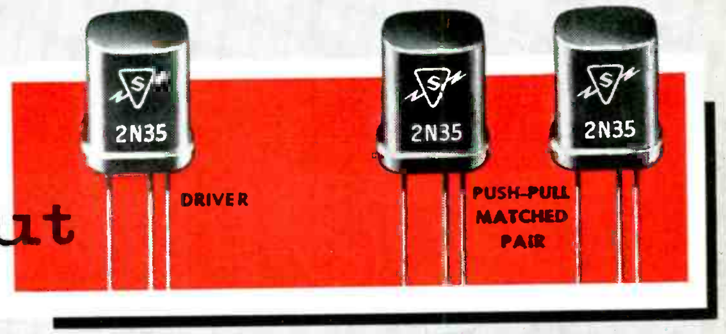
▶ **Equipment** — The new Philco package includes a transmitter, monitoring equipment, high-gain antenna and transmission line and local program originating facili-

(Continued on page 10)

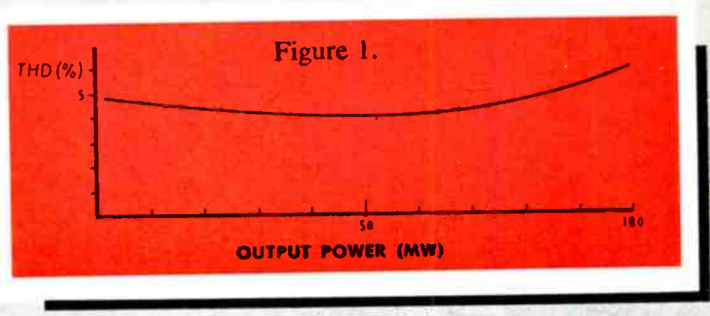
Sylvania NPN transistors

MATCHED

for high audio output



with low distortion



Whatever the front-end design in your transistor audio circuits, Sylvania offers a highly efficient audio transistor line-up for driver and push-pull stages. Controlled driver characteristics and a matched push-pull pair assure maximum power output with minimum distortion.

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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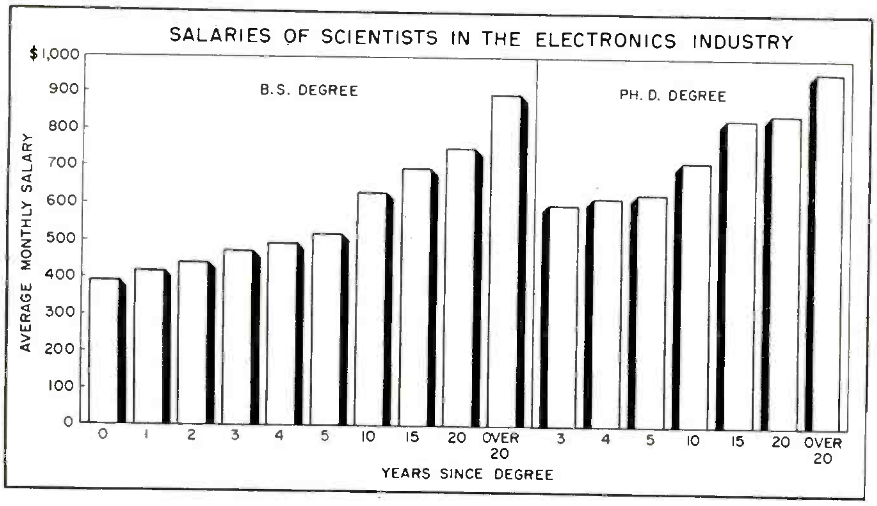
LIGHTING • RADIO • TELEVISION • ELECTRONICS • ATOMIC ENERGY ties for transmission of slides, films and local live shows.

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.

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 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.

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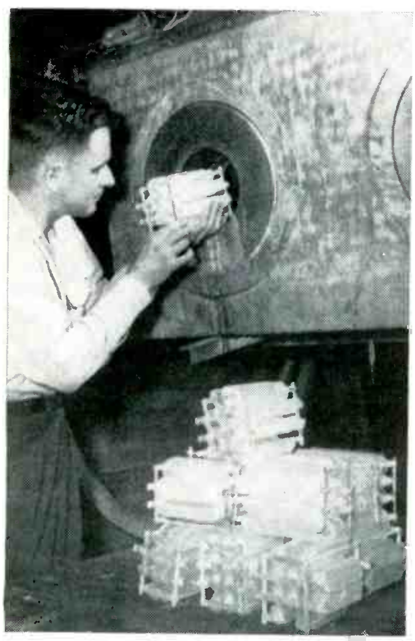
an almost perfect material having few flaws for discard. The synthetic bars are grown to practically the exact cross-section of the resonators being cut, minimizing cutting waste.

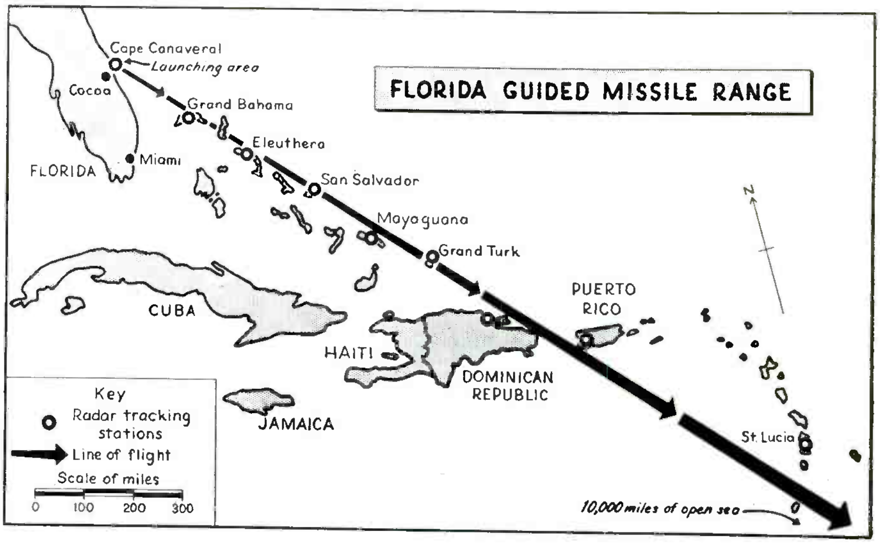
The crystals are grown in exactly the desired orientation, so that the cutting saw travels a shorter distance through the material; this permits use of a thinner saw without reducing cutting accuracy, thereby giving more plates per crystal.

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)

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 Antropology 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 accounting 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

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.

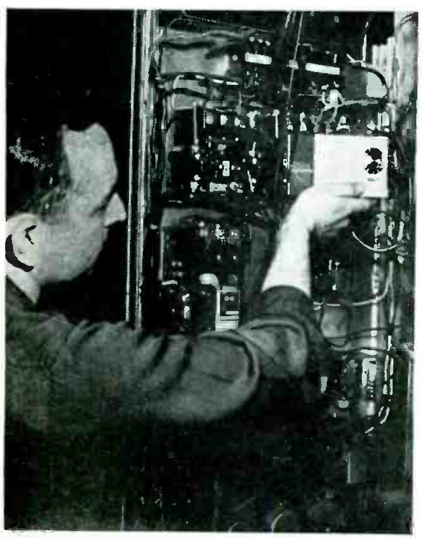
Although some manufacturers recommend only 1 or 2 mathematicians and engineers, Franklin Life, which does its own maintenance, employs a chief engineer and senior engineer, both with previous computer experience, 2 junior engineers and 4 technicians. Franklin has 10 programmers but feels the company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

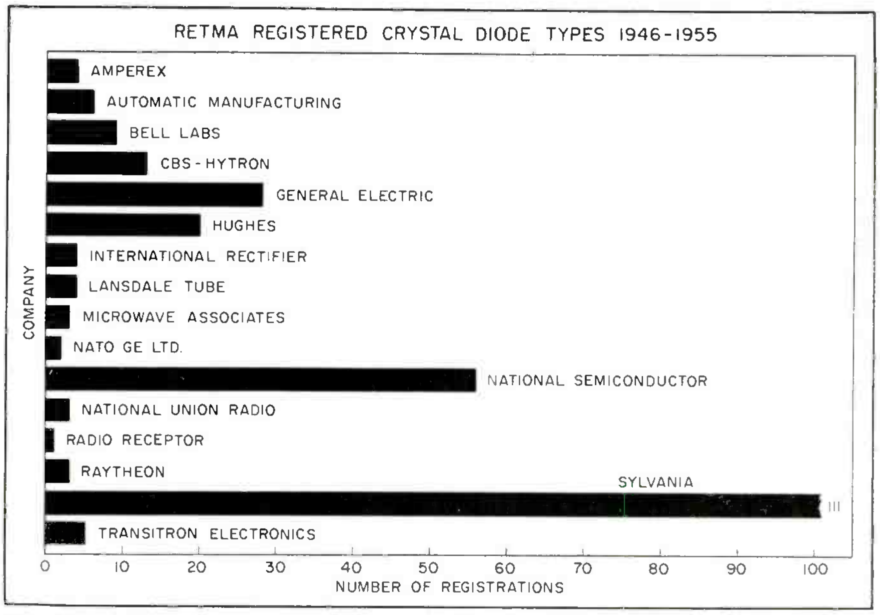
▶ **Outlook**—One major change that computers may cause is shift work for white collar workers. Another is creation of a new profession, the information engineer, as programmers have been called. They organize the sequence of control of information and understand operation of the machine. Within the 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 registered 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 thermosetting plastics. Such sealing units

(Continued on page 20)

All in One Package!

Millivoltmeter
Micro-microammeter
Mega-megohmmeter

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

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 ±3 x 10^{-13} amp d-c, full scale — accuracy, 3% of full scale from ±1 ma to ±3 x 10^{-9} amp and 10% to ±3 x 10^{-13} amp.

Sixteen Resistance Ranges: direct reading 300 kΩ to 10 MMΩ, full scale; 5 x 10^{14}Ω at smallest meter division — accuracy, 3% from 3 x 10^{5}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 x 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.

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

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-P_1 Component Shield at $40 provides a fully shielded chamber for measurement of very high resistance components.

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FIRST PLACE for TRANSISTORS . . . .

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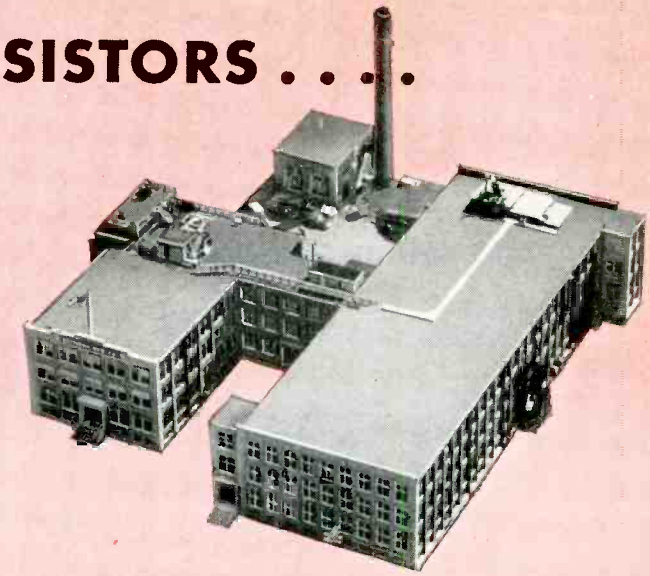
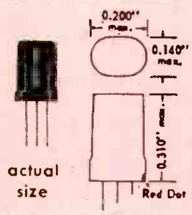


Raytheon's three million dollar Semiconductor Division plants devote 180,000 square feet (over 4 acres) of floor space exclusively to semiconductor research, engineering and manufacturing. Raytheon's semiconductor operations employ 1500 people, including over a hundred scientists and engineers.

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.

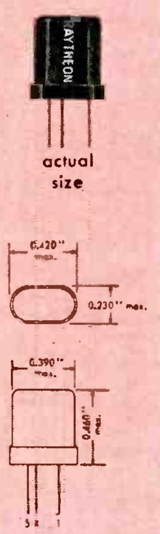
SUBMINIATURE LOW FREQUENCY TRANSISTORS



Type	Collector Volts	Collector Meg. ohms	Collector Cutoff μA	Emitter Current mA	Base Resistance ohms	Base Current Ampl. Factor	Max. Noise Factor db	Alpha Freq. Cutoff mc.
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 Volts	Collector Meg. ohms	Collector Cutoff μA	Emitter Current mA	Base Resistance ohms	Base Current Ampl. Factor	Max. Noise Factor db	Alpha Freq. Cutoff mc.
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 Volts	Collector Cutoff μA	Emitter Current mA	Extrinsic Base Resis. ohms	Base Current Ampl. Factor	Alpha Freq. Cutoff mc.	Collector Capacity μμf	Gain (max. available) at 455kc db	Gain (max. available) at 2 mc db	Grounded Emitter Switching Ib = −1ma, Ic = −20 ma. Rise time μsec.	Storage time μsec.	Decay time μsec.
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 Collector μA (max.)	Reverse Current at −20v Emitter μA (max.)	Beta	Base Resistance ohms	Collector Resistance kilohms	Noise Factor db (max.)	Collector Capacity μμf	Alpha Freq. Cutoff KC
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

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RAYTHEON TRANSISTORS

more in use than all other makes combined

the prime source of

special tubes

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America's Largest Special Tube Manufacturer

CK5783WA

Subminiature Voltage Reference Tube featuring extraordinary stability.

CK6611
CK6612

Filamentary Subminiature Tubes for low battery drain plus high transconductance.

6AN5WA

Reliable Miniature Tube combining high perveance 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.

RAYTHEON manufacturing co.

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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 Thermatron 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.

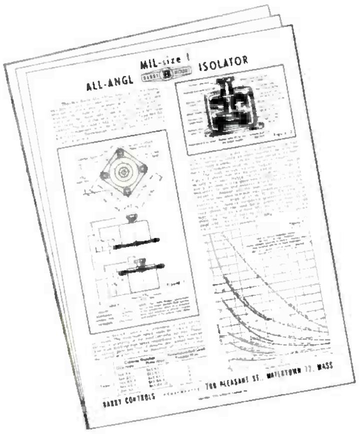
(Continued on page 22)

Advertisement

HOW to CHOOSE VIBRATION MOUNTS

For Jet and Missile Applications

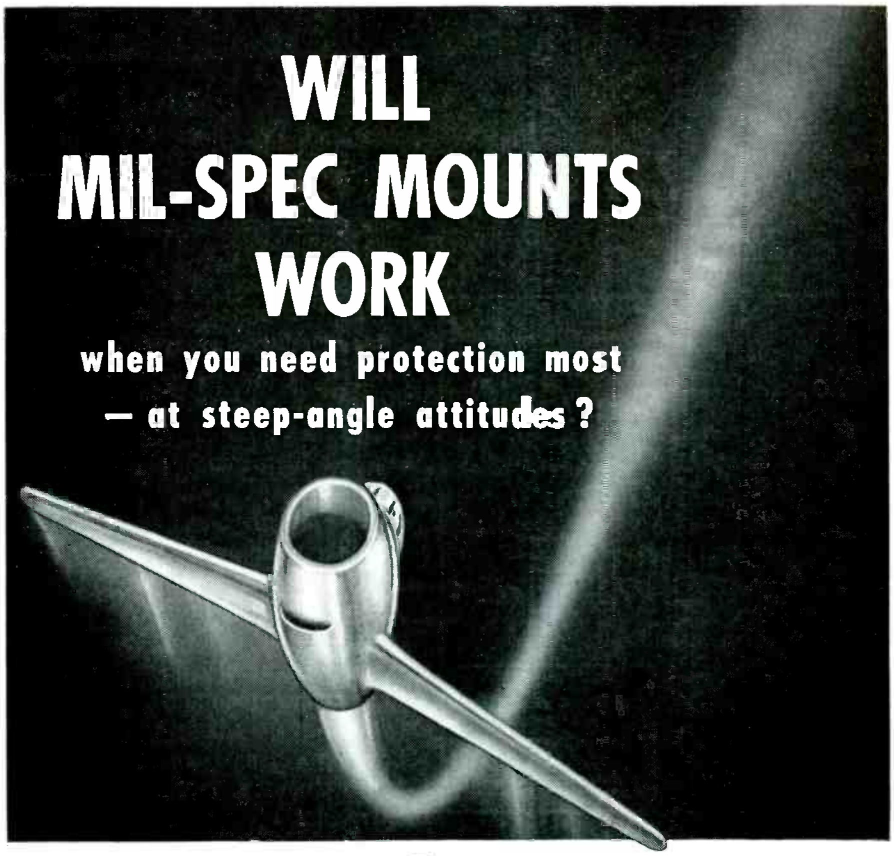
Use our free engineering data sheets on ALL-ANGL Barrymount® Isolators. They describe and illustrate the operating principle of the ALL-ANGL Barry Mount, telling how it works to control shock and high-frequency vibration. They give



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.

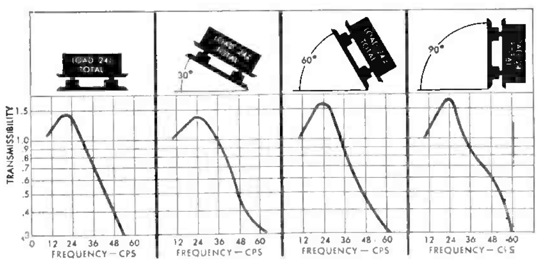


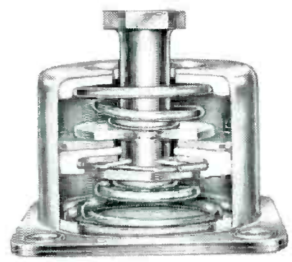
ALL-ANGL BARRY B MOUNT ISOLATORS

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

BARRY B MOUNT

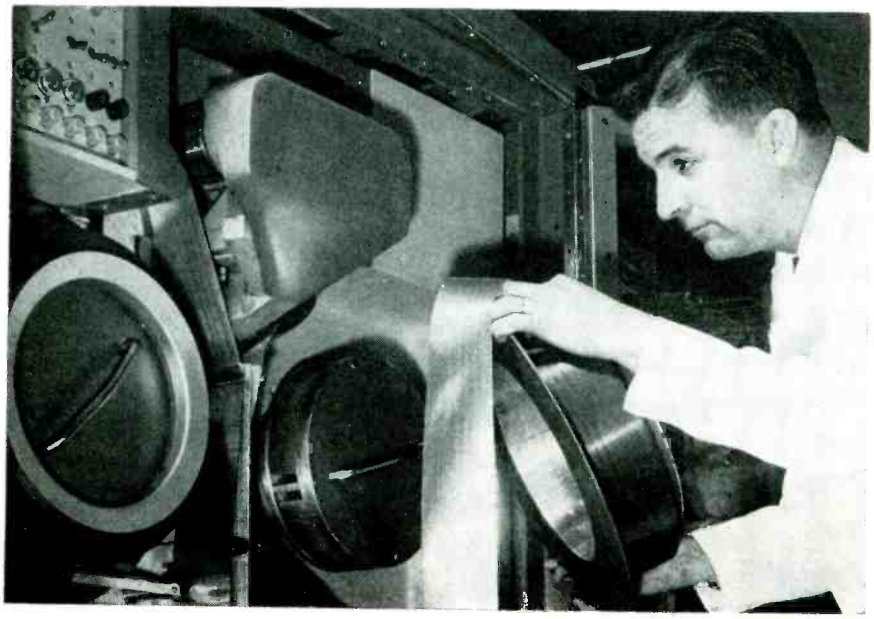
SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

707 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

Want more information? Use post card on last page.

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 imaged 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.



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 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. Teleregister 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

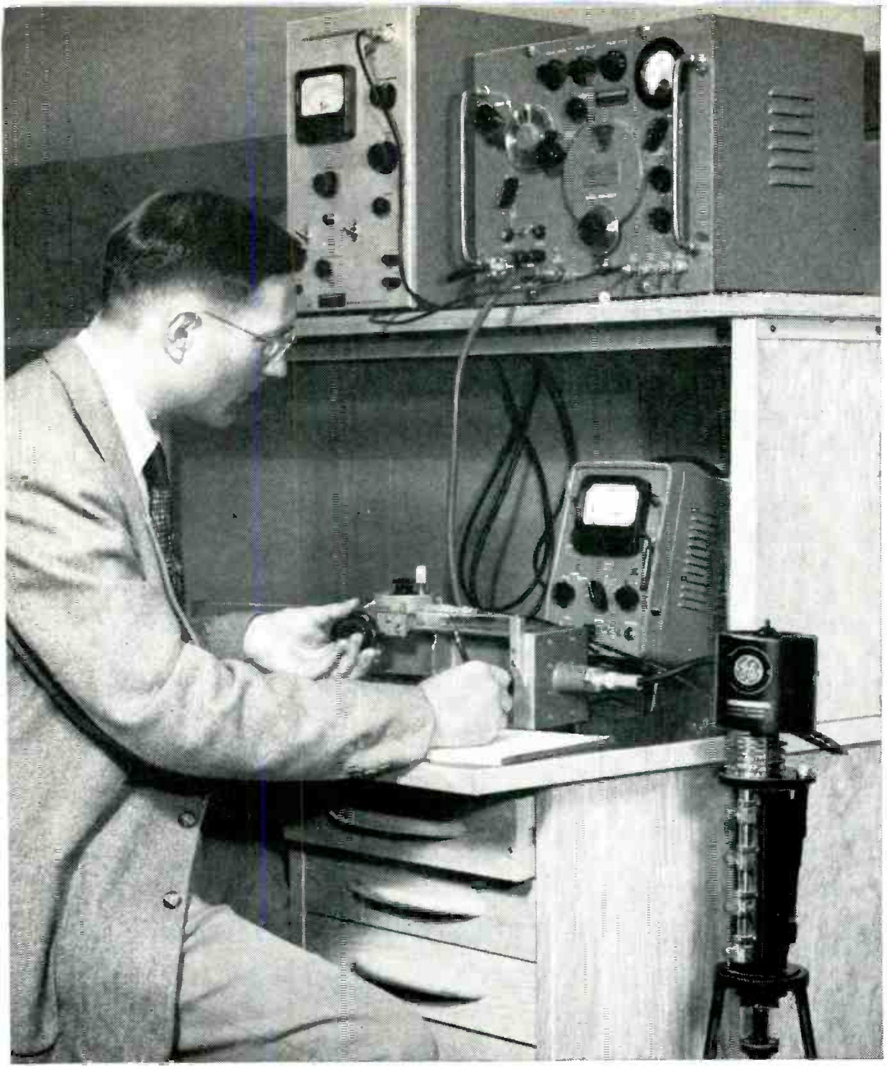
One refiner to enter supply market by mid-1956. Others may join in soon after

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.

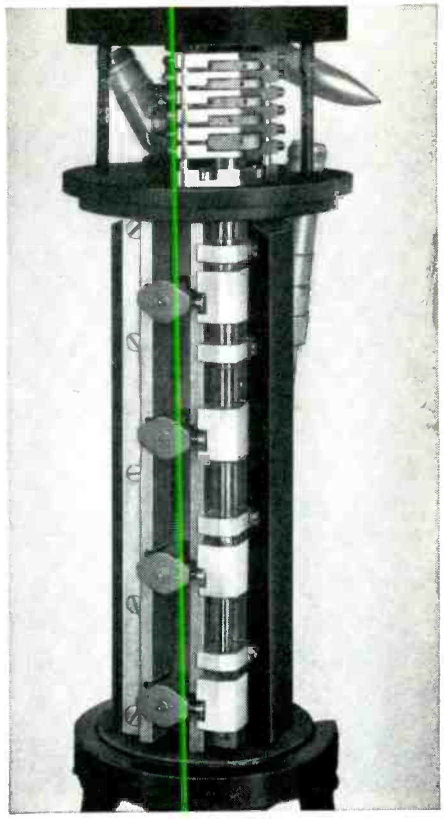
▶ **Prices**—Since November 1954, high-purity silicon has been selling for \$380 a pound. Before that time, the price was \$430 a pound. These high prices are partially attributed to the fact that silicon production has been and is today on a semi pilot-plant basis.

▶ **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 10^6

(Continued on page 24)



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

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GENERAL ELECTRIC

162-1B3

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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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 andIndustry, 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.

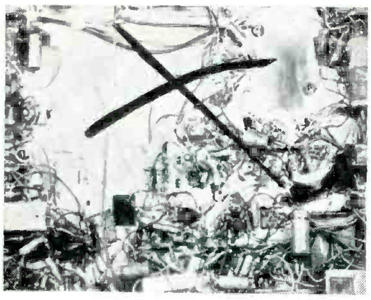
▶ **Navy** awarded a $22.7 million contract to Westinghouse for the Aero 13 fire-control system to be installed in the Douglas F4D Skyray.

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

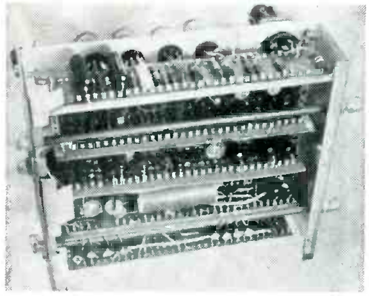
▶ **Estimated** 1,100 tons of metal powder was used for magnetic cores in 1955.

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 precut 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 standard 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.

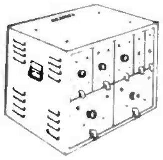
WHEN YOU USE THE ALDEN SYSTEM, you enable your production organization to build "custom" products on a true mass-production basis. Production planning is simplified, for at the design stage it becomes natural to break down equipment into simple sub-assemblies of extreme accessibility and ease of manufacture. 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.

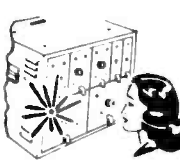
Sub-contracting becomes simpler because you can farm out your work, specifying Alden techniques or supplying Alden parts, and be sure of getting sub-units of satisfactory quality.

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

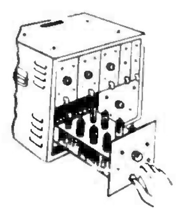
Electronic Construction and Servicing Are 4 Ways Better



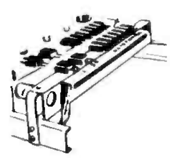
Circuitry subdivided, function by function into attractive plug-in units.



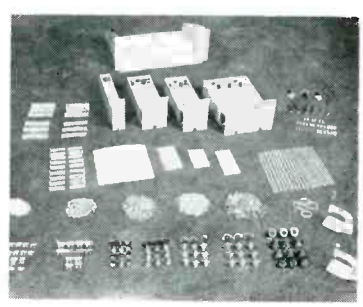
Tiny tell-tales spot trouble instantly, eliminate need for trained technicians on spot.



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.

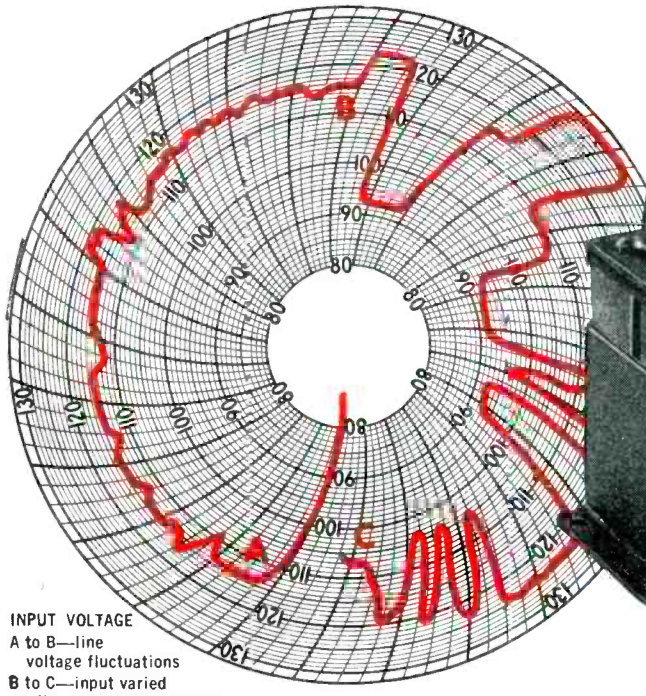


WANT TO TRY THE ALDEN SYSTEM? Send for this complete basic assortment of Alden Circuit Packaging Components. Includes all the elements you'll need to assemble a variety of complete chassis based on the Alden Terminal Card System. Price—$249.50. Ask for Kit #37.

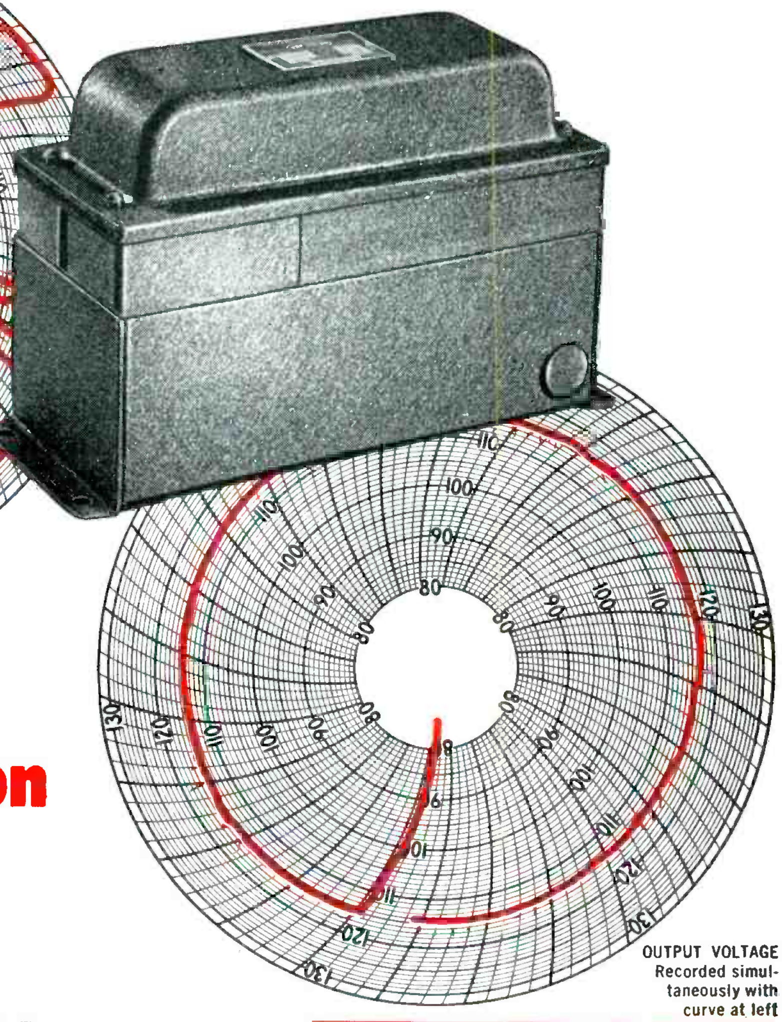
ALDEN PRODUCTS COMPANY

Manufacturing Product Engineers

Brockton, Mass.



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



OUTPUT VOLTAGE
Recorded simultaneously 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.

CHECK THESE IMPORTANT FEATURES

- Guaranteed stabilization to ± ½ %
- 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

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.

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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.

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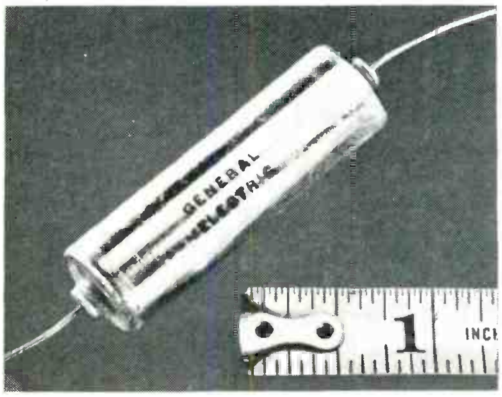
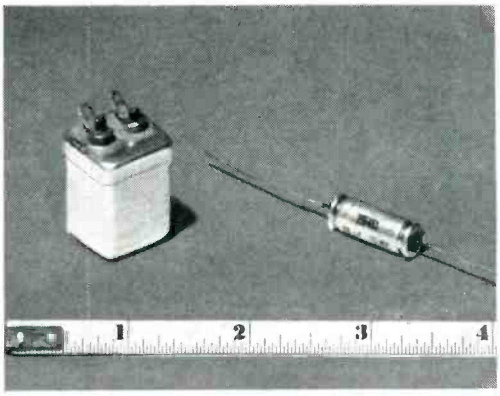
A FULL LINE OF CAPACITORS FOR THE ELECTRONICS INDUSTRY

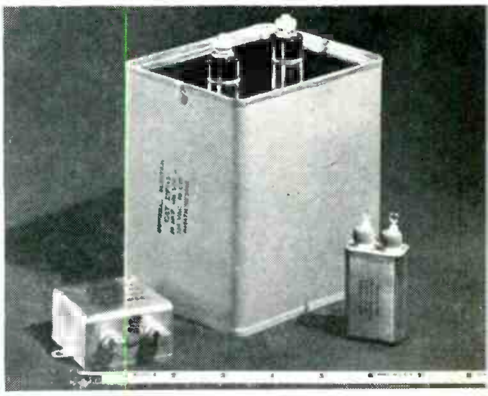


METAL-CLAD TUBULAR CAPACITORS for all d-c uses where utmost reliability is required. Ratings: .001 to 1.0 uf, 100-600 v. d-c. Tol: ±5%, ±10%, or ±20%. Temp. range: −55 C to +125 C with solid impregnant: −55 C to +85 C with mineral oil. Write for GEC-987.

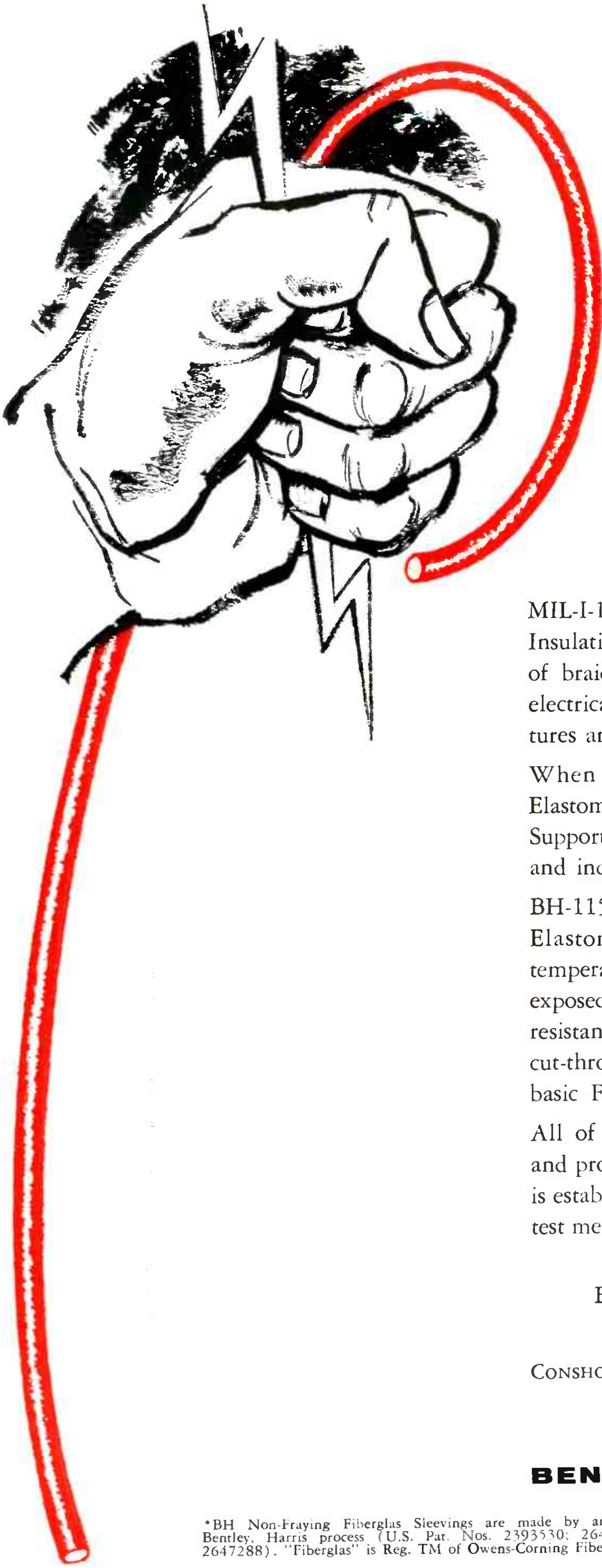


125 C TANTALYTIC* CAPACITORS—for high speed aircraft and missile systems where quality, long life, and small size are main requirements. In plain or etched foil, and rectangular or tubular designs. Ratings: .25 to 180 uf, 10 to 100 volts. Tolerance: +20% (plain foil), −15 to +75% (etched). Temp. range: −55 C to +125 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 C, and −55 C to +125 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.

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*BH Non-Fraying Fiberglas Sleevings 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.

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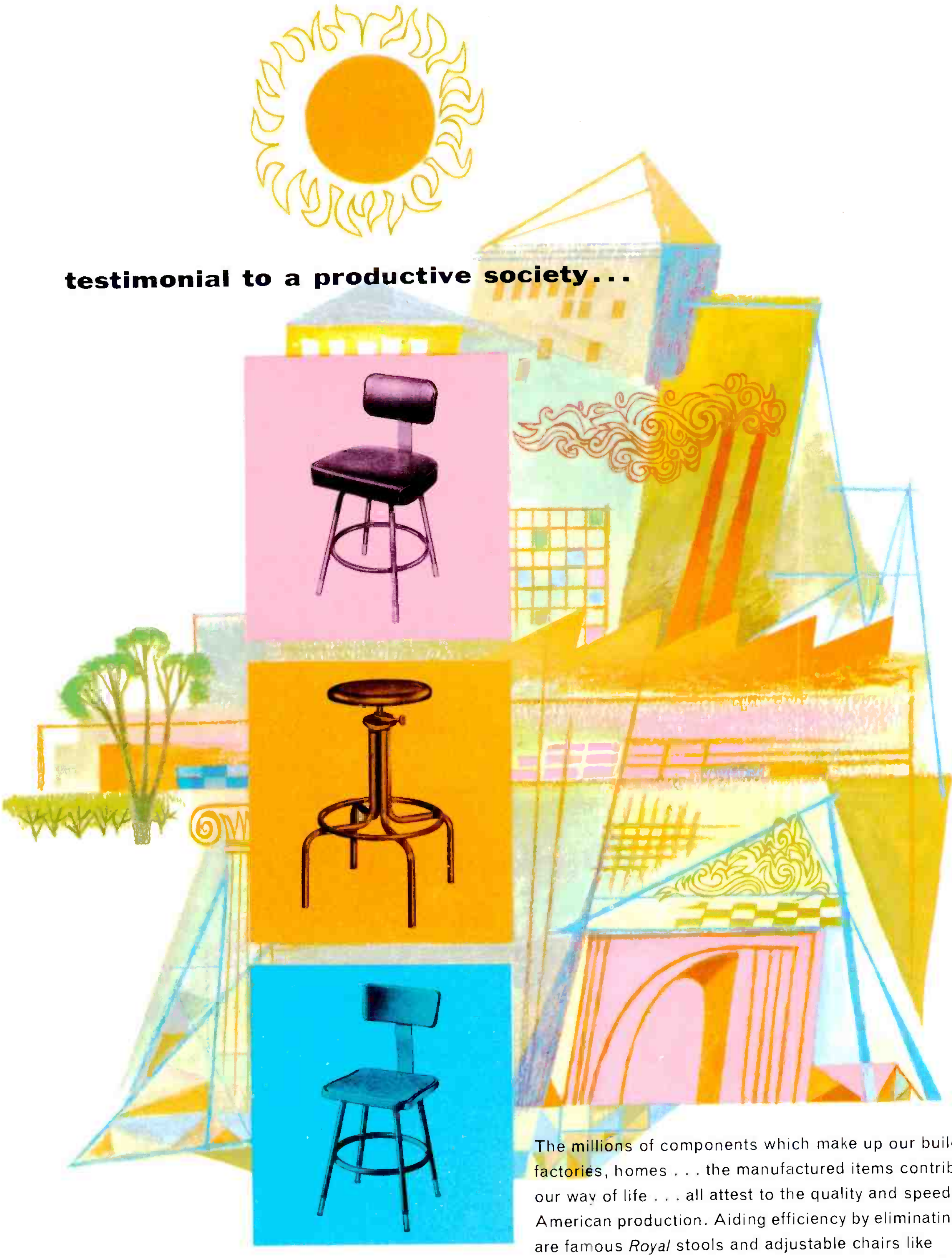

The millions of components which make up our buildings, factories, homes . . . the manufactured items contributing to our way of life . . . all attest to the quality and speed of American production. Aiding efficiency by eliminating fatigue, are famous *Royal* stools and adjustable chairs like these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

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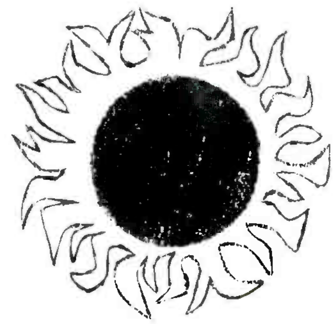

Shown on the other side of this page, are the 535-S Adjustable Chair, 621-T Stool and the 515-S Adjustable Chair.

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(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″.

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(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″.

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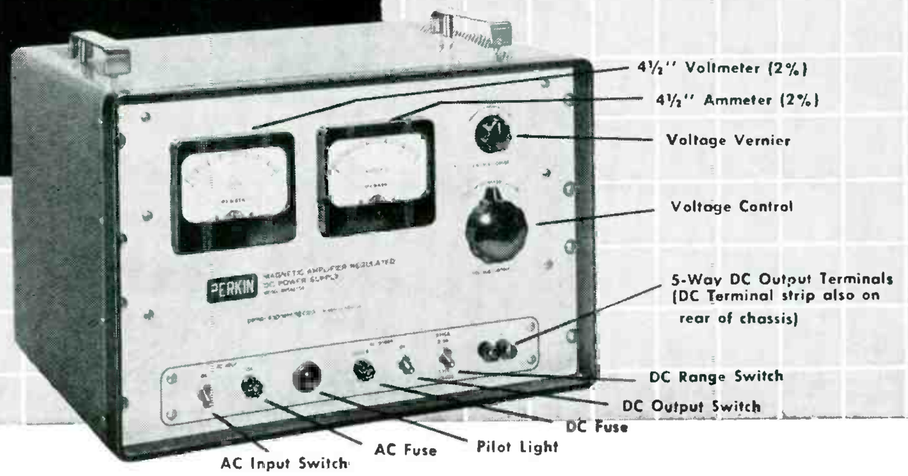

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Specifications . . . .

REGULATION: 5-32V Range: ± ½% for combined line changes of 105-125VAC and load of 0-15A. DC.
2-5V Range: ± 2% for combined line changes of 105-125VAC and load changes of 0-15A. DC.
32-36V Range: ± 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: 19½" wide x 15½" deep x 13¼" high with cabinet. (19" wide x 14¾" deep x 12¼" high rack panel construction)

FINISH: Gray Hammertone WEIGHT: Approx. 135 lbs.

OTHER STANDARD MODELS AVAILABLE:

VOLTS	AMPS	REG.	MODEL
0-32	25	±1%	M60V
24-32	10	±½%	28-10WX
24-32	30	±½%	28-30WX
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24-32	100	±½%	100 XA

Ripple on all above models: 1% rms 6, 12 and 115 V models also available. Write for complete specifications on all models listed above.

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5 PULSE POWER 50 watts peak

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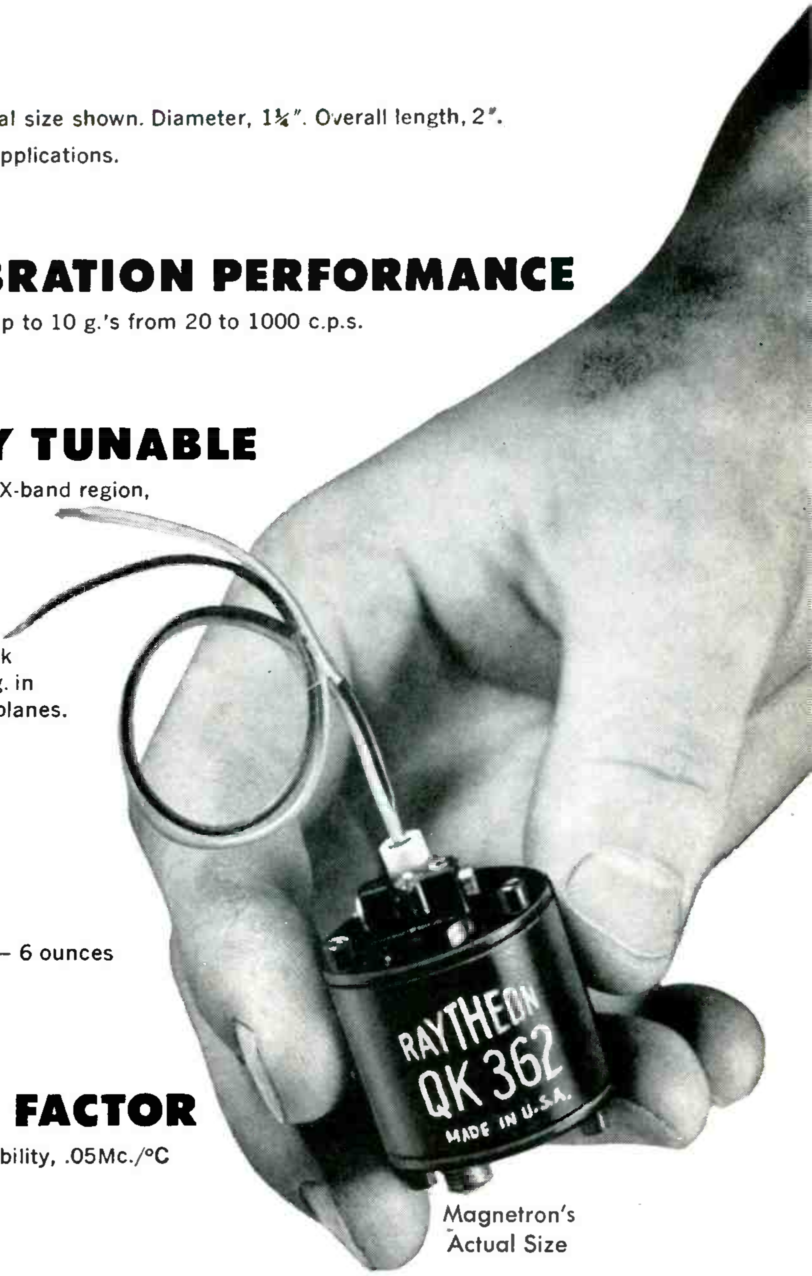

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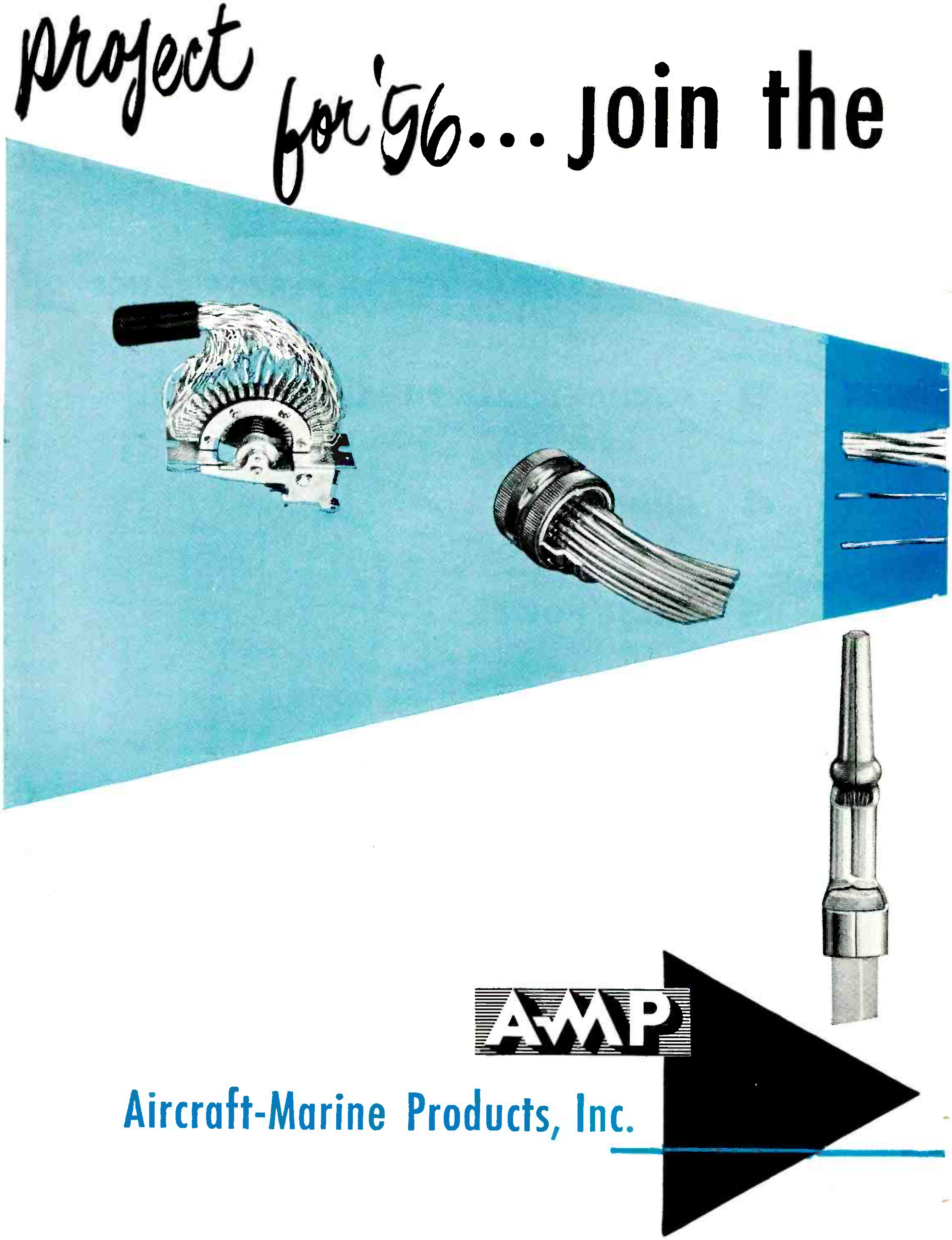
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Are you in step with the more progressive manufacturers of BUSINESS MACHINES—AIRCRAFT—GUIDED MISSILES—ELECTRONIC EQUIPMENT—who have approved and are profiting by the use of A-MP TAPER TECHNIQUE?

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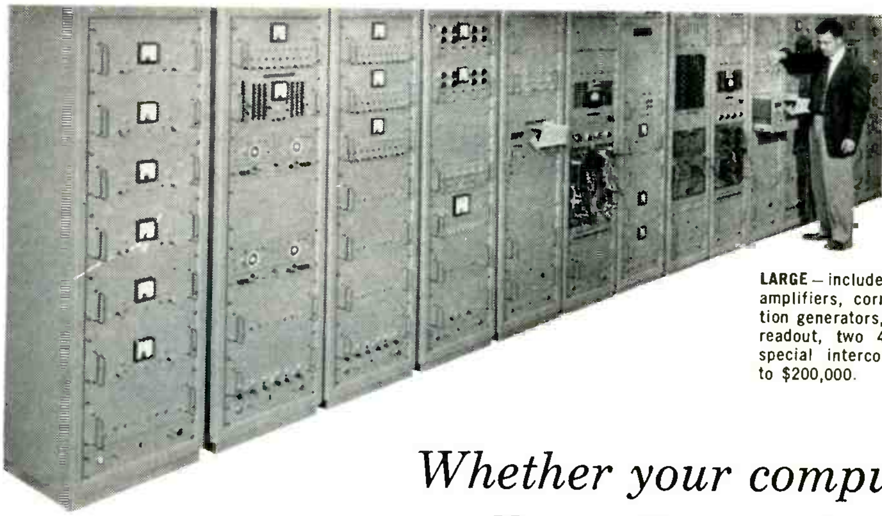

LARGE — includes two control units with 200 pots, 80 amplifiers, corresponding number of multipliers, function generators, etc., plus digital voltmeter with printed readout, two 4-channel recorders, timing matrix and special interconnecting panel. Price range, $100,000 to $200,000.

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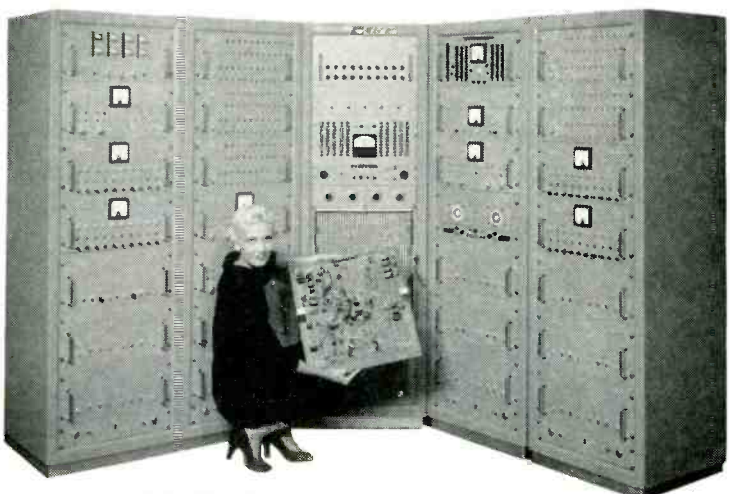
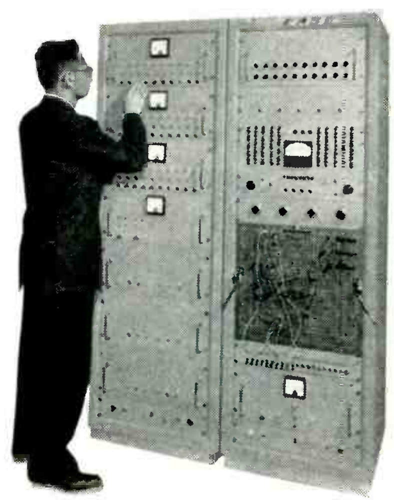


MEDIUM — includes control unit with 100 pots, 40 amplifiers, 14 electronic multipliers, function generator set-up unit with 1 pushbutton and 5 manual set generators, 2 servo multipliers, preset timer control unit, power supplies. Price range, $30,000 to $65,000.



SMALL — includes control unit with 50 pots, 30 amplifiers, 2 electronic multipliers, 10 initial condition voltage sources, power supplies. Price range, $12,000 to $25,000.

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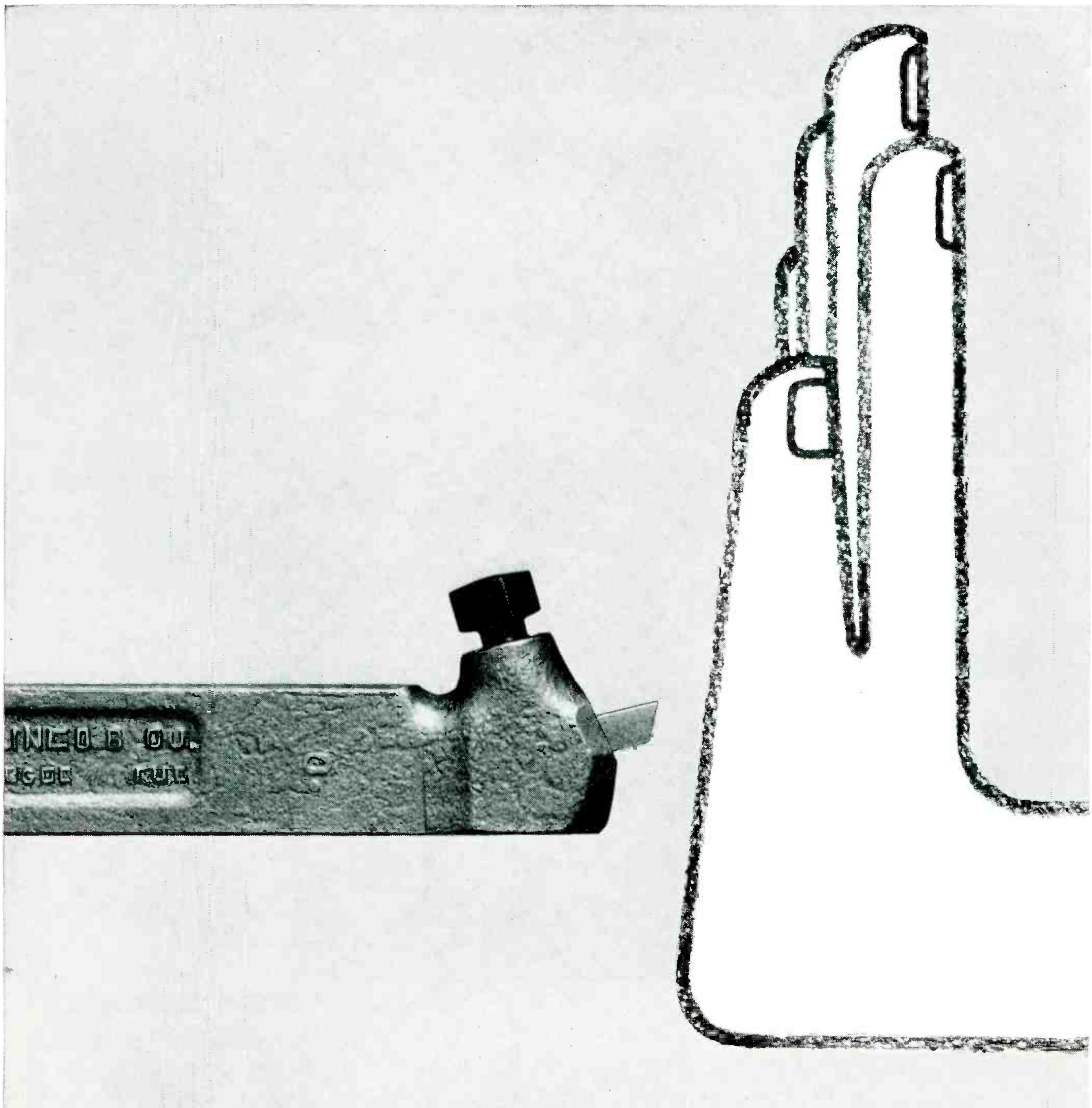

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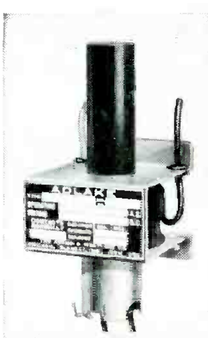

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For more information about Adlake Relays, write The Adams & Westlake Company, 1171 N. Michigan, Elkhart, Indiana.

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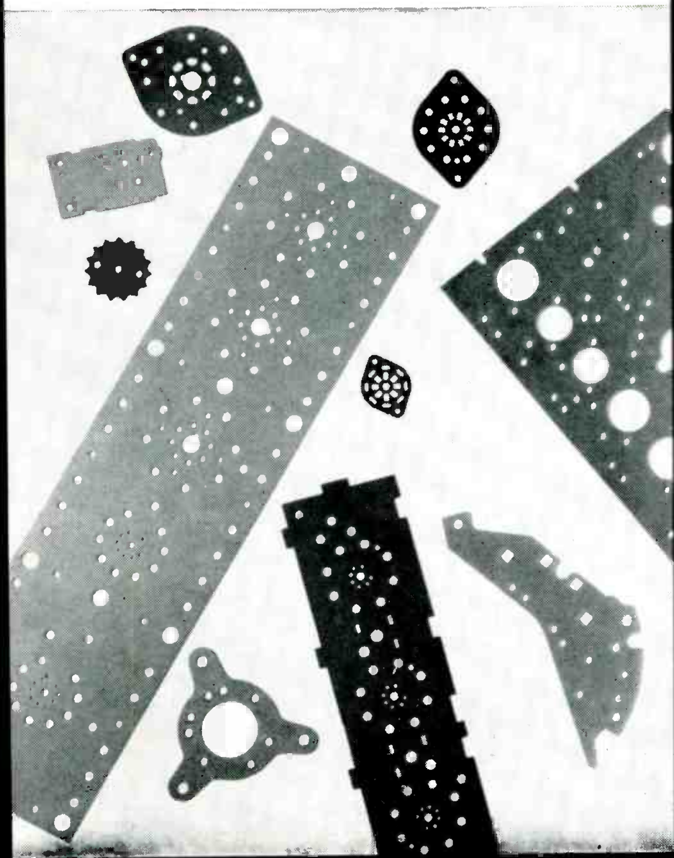

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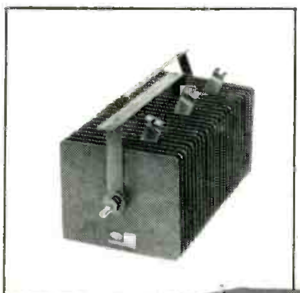

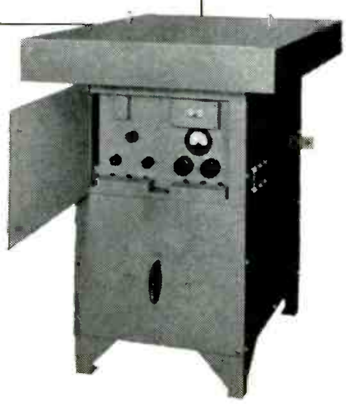

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Huge aircraft carriers like the USS Saratoga and Forrestal demand complete reliability from a vast network of men, machines and components working together under all kinds of stress. Aboard these new fleet giants are power conversion units made by our customer, Ther Electric and Machine Works, Chicago, Ill. . . . and key component in each unit is a Radio Receptor Selenium Rectifier.

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4096 word memory

SPECIFICATIONS:

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Serial, one address
Program Storage:
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Access time:
8.5 ms av. 2 ms min.
Transfer time:
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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.

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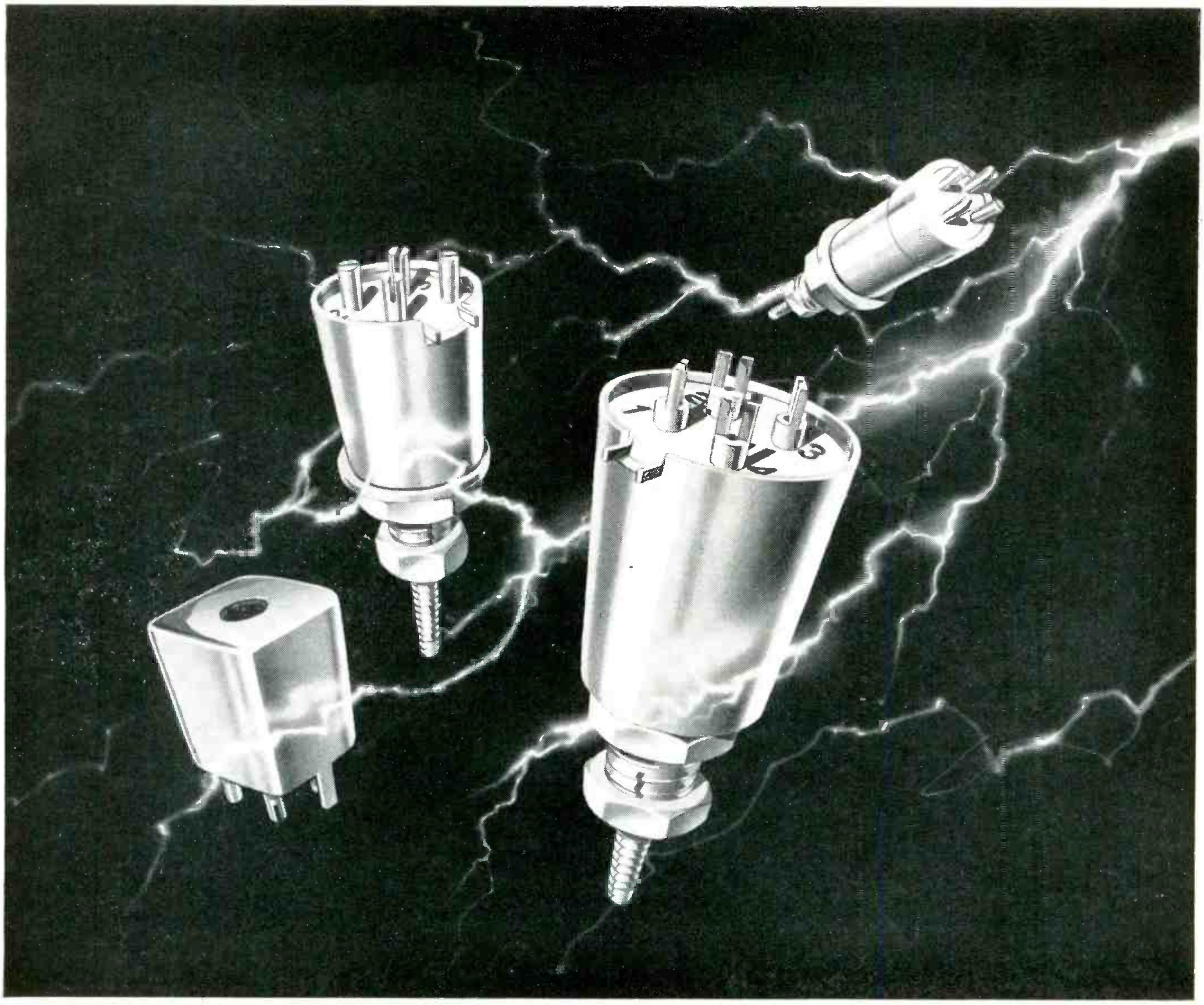


Four sizes of shielded coil forms cover a wide range of design requirements. Dimensions when mounted, including terminals, are: LS-12 (square type for printed circuits), ½" x ½" x ½"; LS-9, 7/16" diameter x ½" high; LS-10, 5/8" x 15/16"; LS-11, 15/16" x 17/32". Each form mounts by a single stud. Windings may be universal or wound to your specifications.

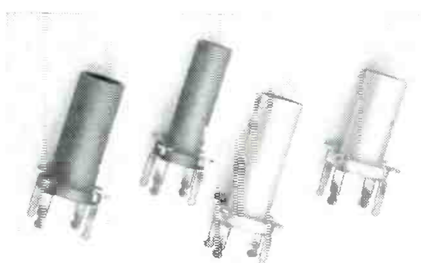
Where shock treatment doesn't work

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: ¾" high when mounted, in diameters of .219" and .285". Ceramic forms: ¼" diameter, in mounted heights of 5/8" and 13/16", with 10/32" powdered iron core, and collars of silicone fibreglas. 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.



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makers of guaranteed electronic components
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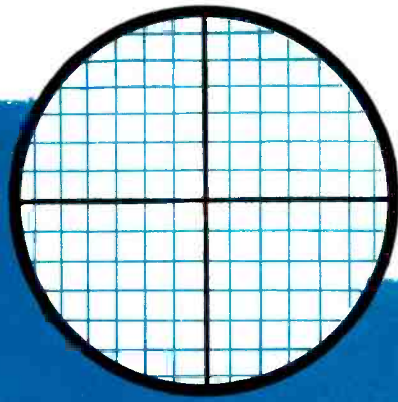
-hp- announces 2 all new OSCILLOSCOPES



-hp- 130A Low Frequency Oscilloscope

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

-hp- 150A High Frequency Oscilloscope

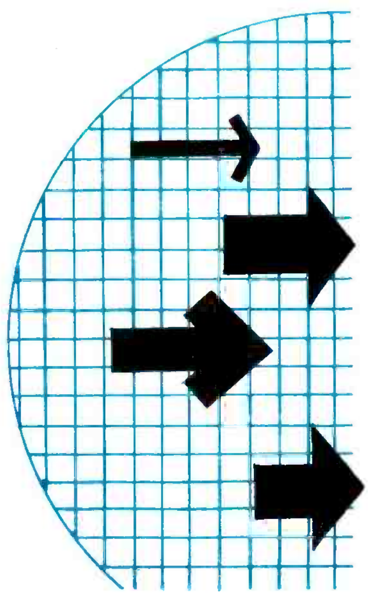
Dc to 10 MC. Plug-in preamplifiers.
Sweeps 0.02 μsec/cm to 15 sec/cm.

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.

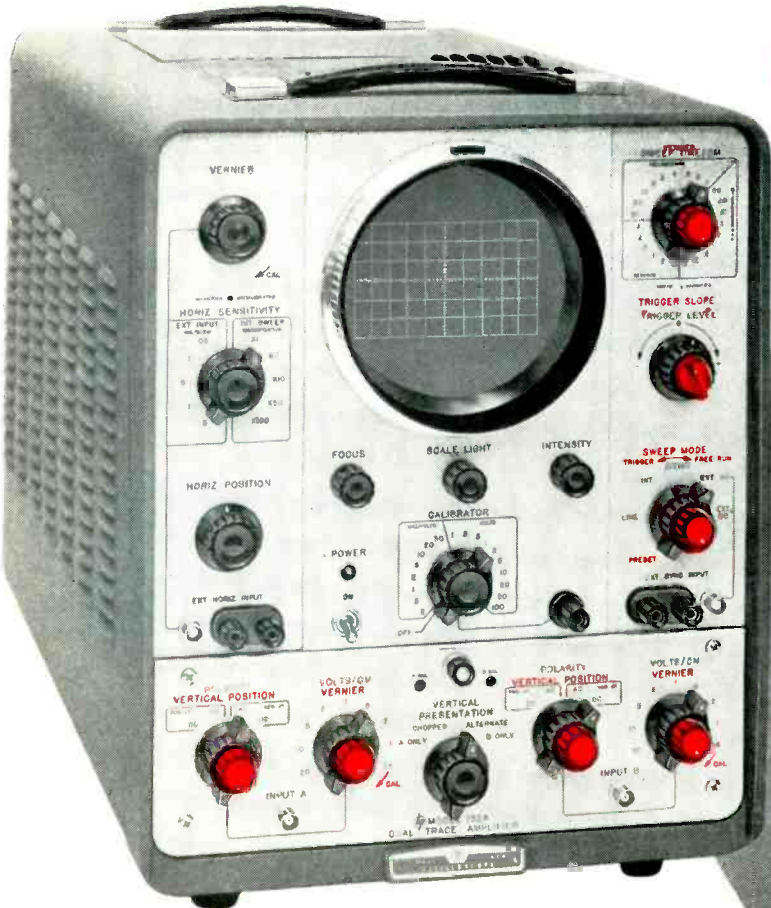
Both oscilloscopes have a "universal" automatic triggering system wherein one preset adjustment provides optimum triggering for almost all conditions.



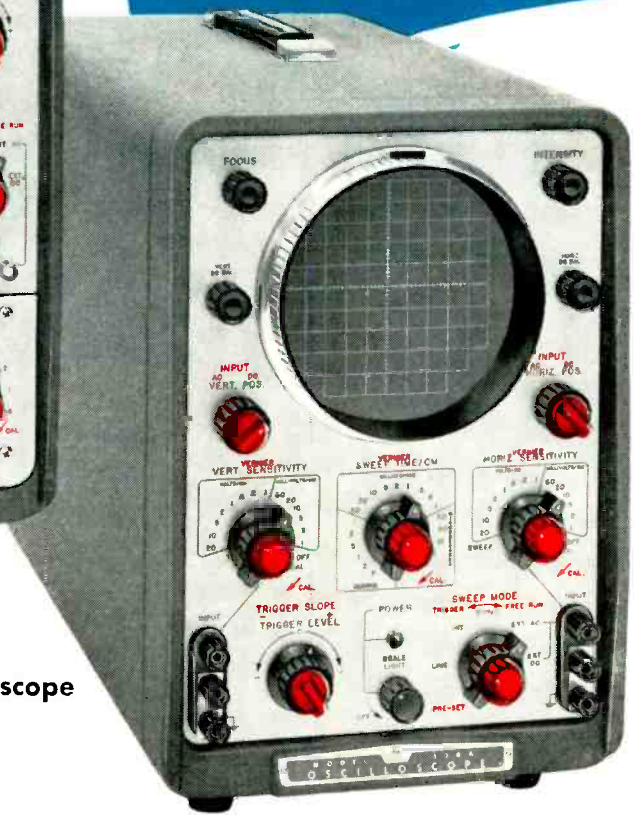
Truly, with these two instruments, *-hp-* adds to the oscilloscope field the two new dimensions of CONVENIENCE and RELIABILITY!

Want more information? Use post card on last page.

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 μsec/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 μsec/cm to 15 sec/cm.
Calibration: 21 sweeps: 1-2-5-10 sequence, 1 μsec/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 μsec/cm to 15 sec/cm.
Calibration: 24 sweeps: 1-2-5-10 sequence, 0.1 μsec/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, hp means "Complete

last!

Real Dependability day after day!

-hp- 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 μsec rise time, pass band dc to 10 MC. A 0.25 μsec 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.

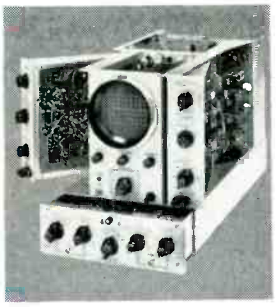
The instrument's horizontal amplifier provides sweep magnification of 5, 10, 50 and 100 times. "Reminder" lamps indicate when the circuit is in use, or the combination of sweep time and magnification exceeds the maximum calibrated sweep time. The amplifier's sensitivity is 50 mv/cm to 25 v/cm, pass band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

Vertical Amplifier: Pass band dc to 10 MC. Optimum transient response and rise time less than 0.035 μsec. Signal delay of 0.25 μsec 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 μsec.

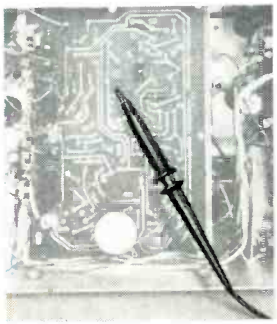
Prices: *-hp-* 150A High Frequency Oscilloscope, $1,000.00.
-hp- 151A High Gain Amplifier, $100.00.
-hp- 152A Dual Channel Amplifier, $200.00.

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 $\mu\mu$f capacitance probe has exclusive clip-on nose; 10 megohm input impedance.

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Coverage" in electronic test instruments!

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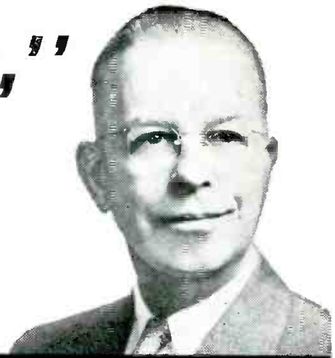
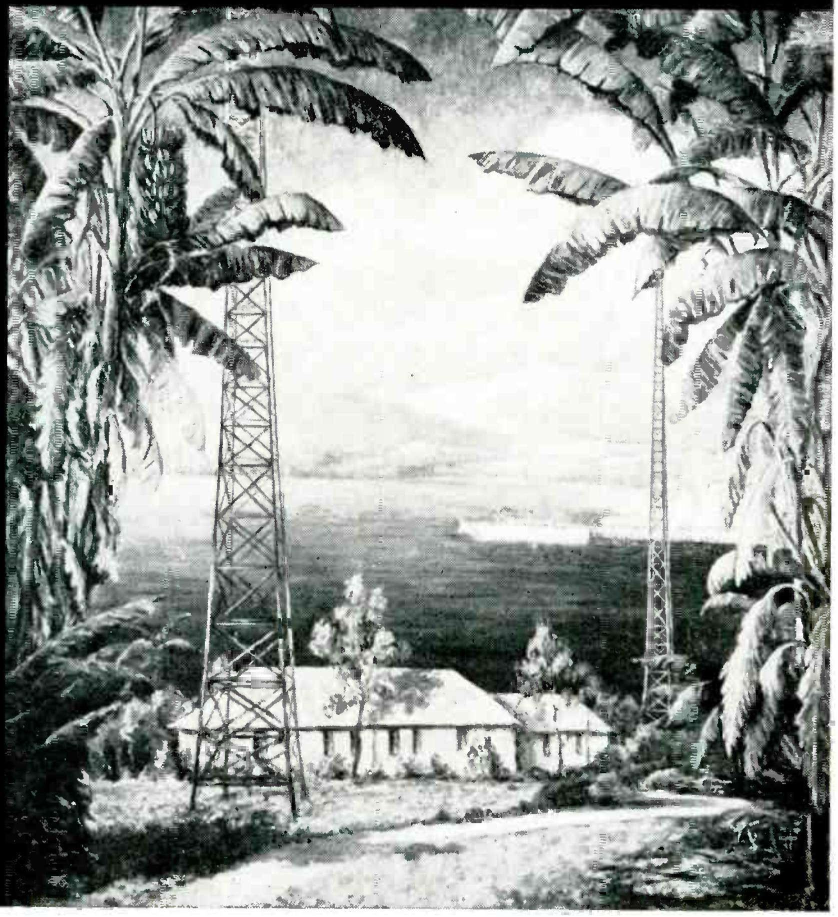
"Reliability where it counts,"

says C. C. Harris,
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 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."*

6ET-4106

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RELIATRON® TUBES

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, N. Y.

ELECTRONIC DIVISION

from the 102-year world leader in elevatoring . . .

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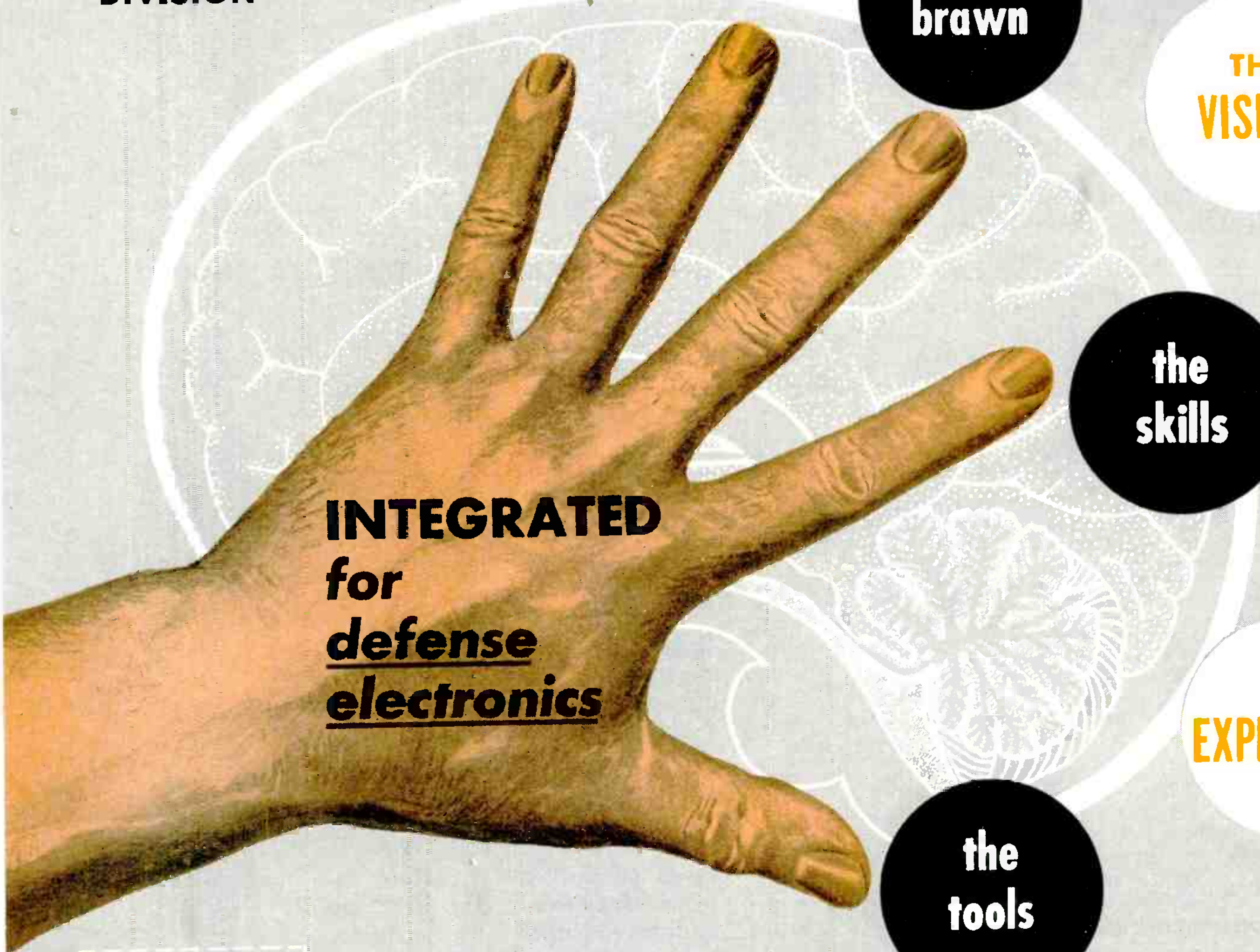
the brawn

THE VISION

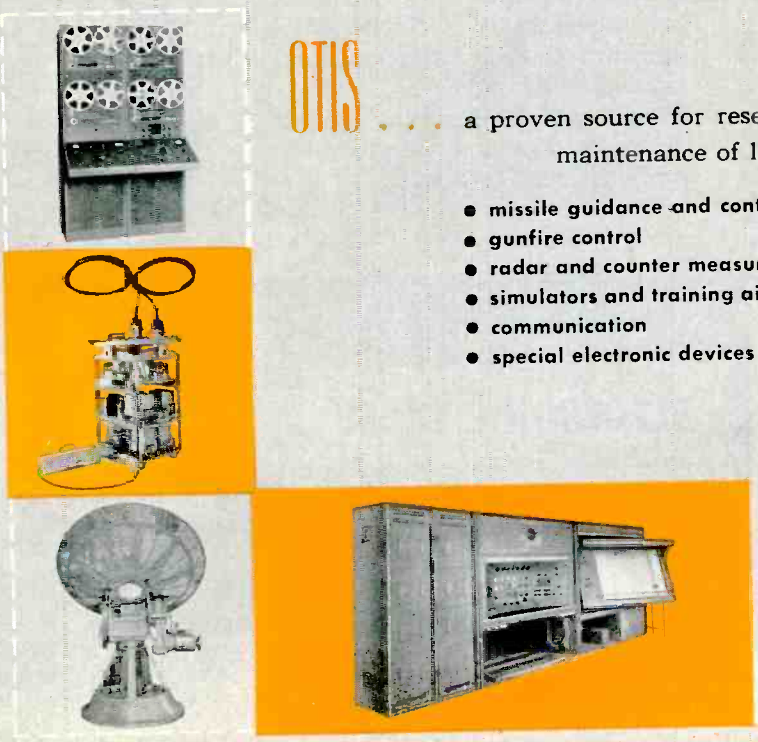
the skills

THE EXPERIENCE

the tools



INTEGRATED for *defense electronics*



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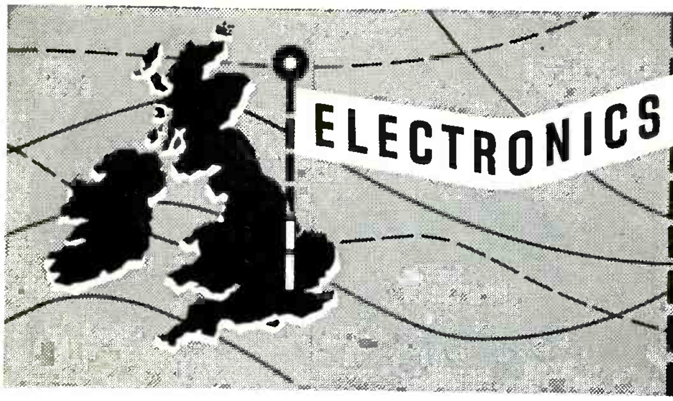


ELECTRONICS *in Britain*

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 μmhos

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 1.5μV. Over a bandwidth of 25 to 1,000c/s equivalent noise input approximates 2 μV.

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.

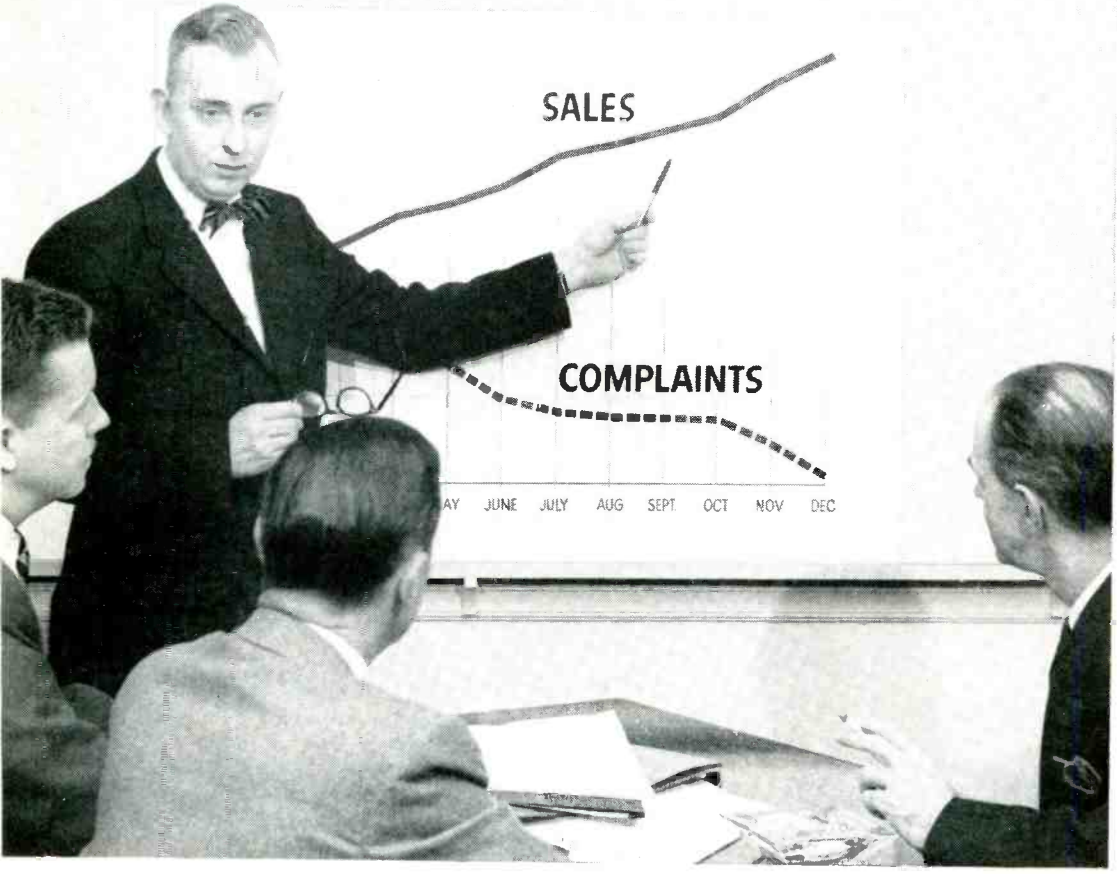
Mullard ELECTRONIC TUBES

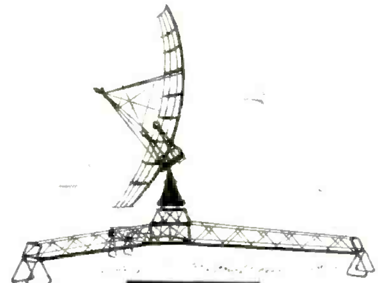
used throughout the world

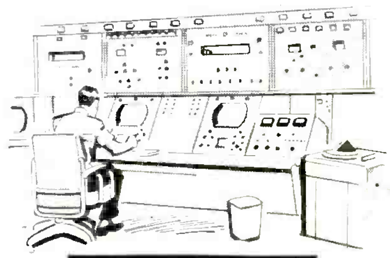
MULLARD OVERSEAS LTD., CENTURY HOUSE, SHAFTESBURY AVE., LONDON, ENGLAND

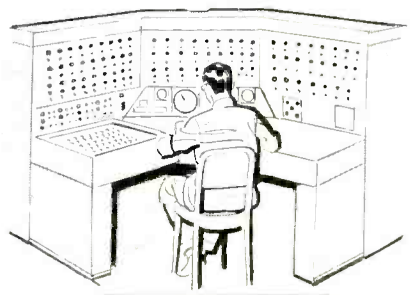
MEV 34

INDUCTROLS*
profitable industrial voltage regulation




RADAR


COMMUNICATIONS

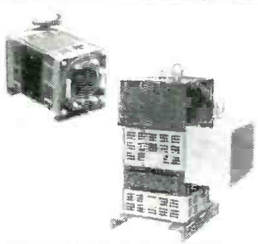

COMPUTERS

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 substation 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.

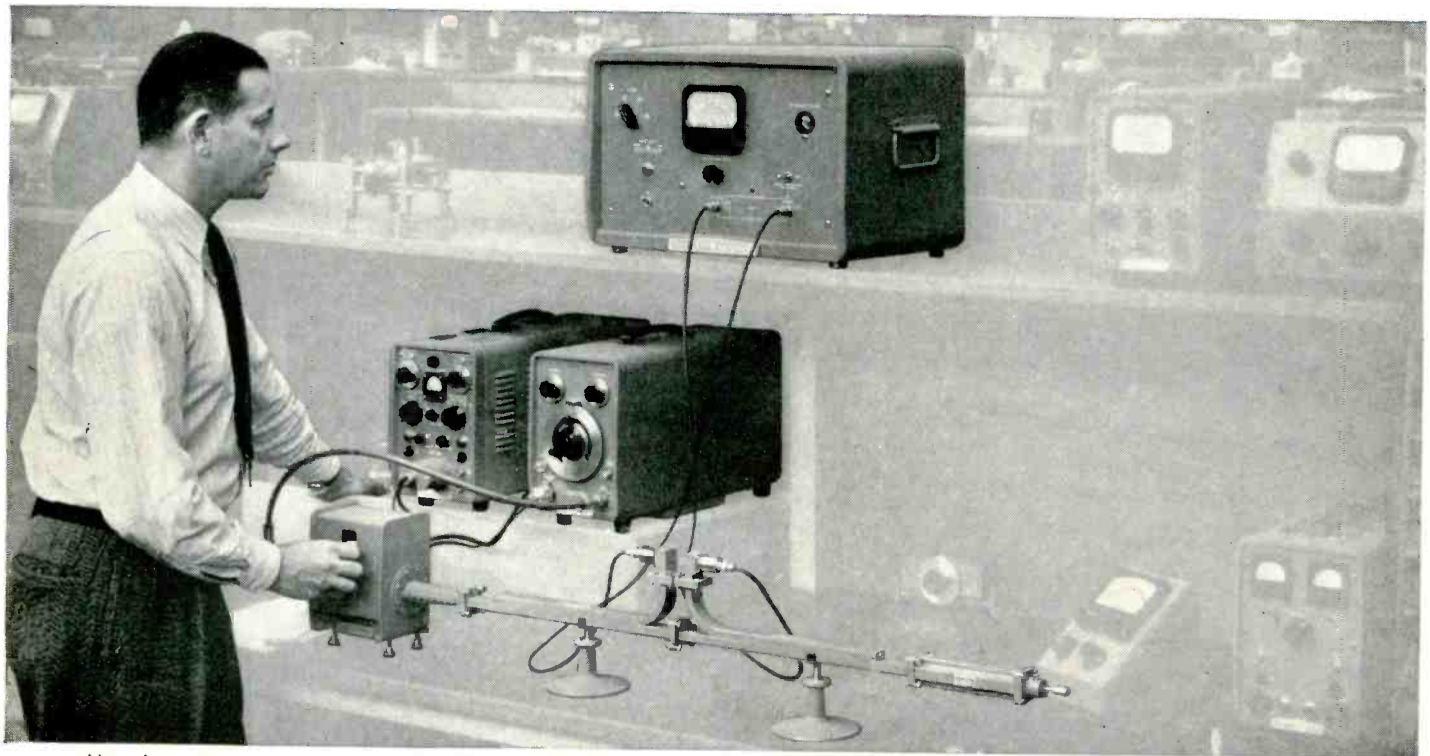
For complete information and application assistance, contact your nearest General Electric Apparatus Sales Office, or write Section 425-2, General Electric Company, Schenectady 5, N. Y.

*G-E Induction Voltage Regulators

Progress Is Our Most Important Product

GENERAL ELECTRIC

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: ±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 ±0.1% output voltage change for ±10% variations from 115-volt line. (b) Less than ±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 ±0.05% change for ±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 ±45° 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 x ½
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.

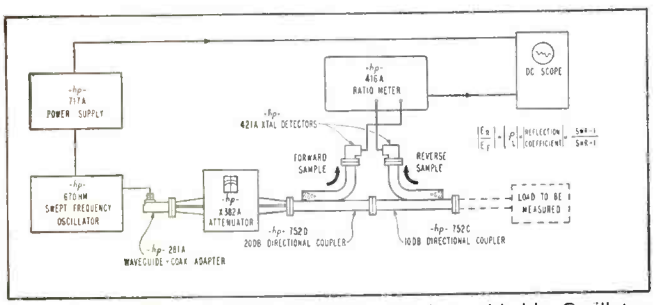


Figure 1. Reflectometer system. Swept rf power is provided by Oscillator. Directional Couplers sample forward and reverse power. Waveguide Detector Mounts terminating both Couplers demodulate power and present a 1,000 cps signal to Ratio Meter. Oscilloscope presents continuous visual study of reflection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

***-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 repellor, 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.

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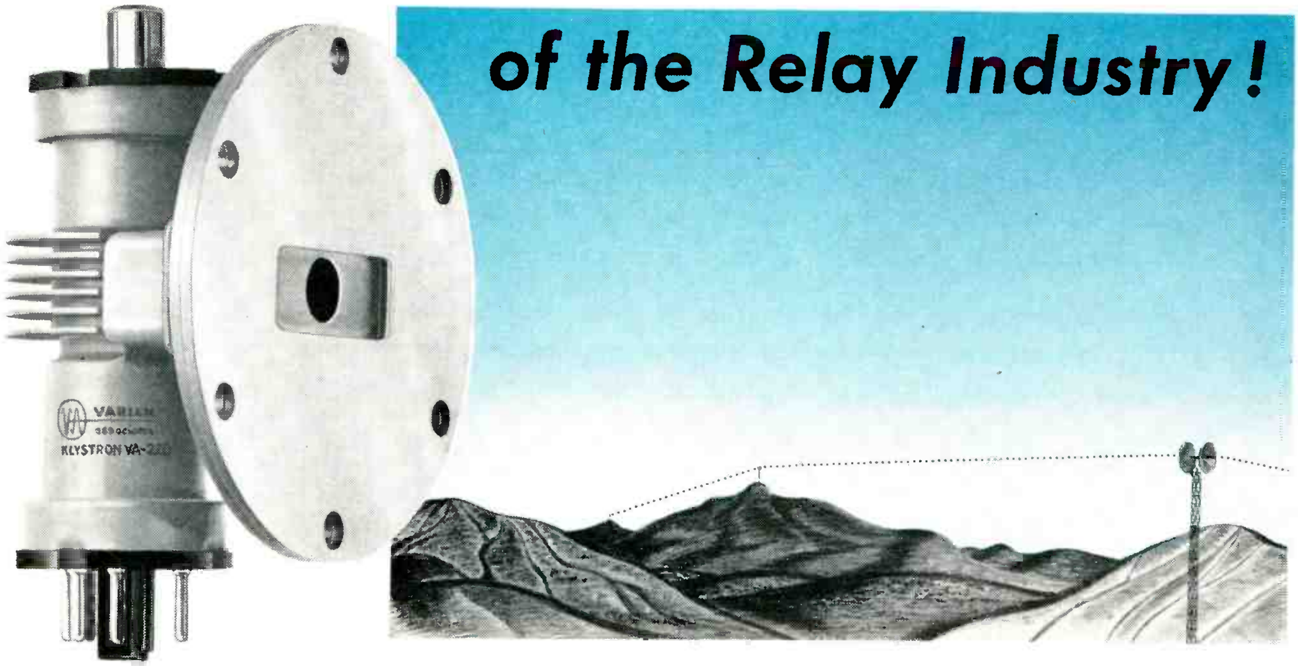

Varian's high performance relay klystron

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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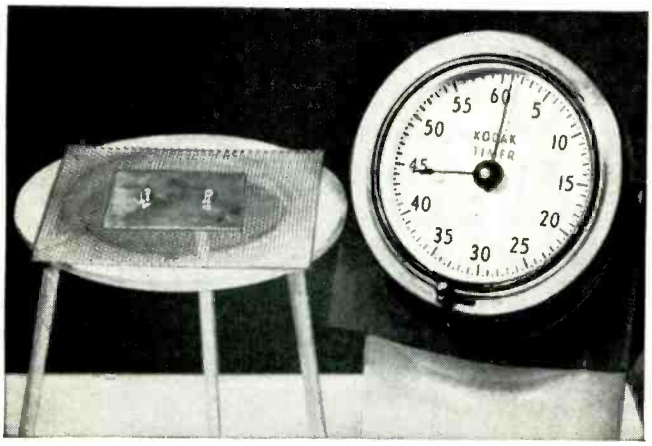
Want more information? Use post card on last page.

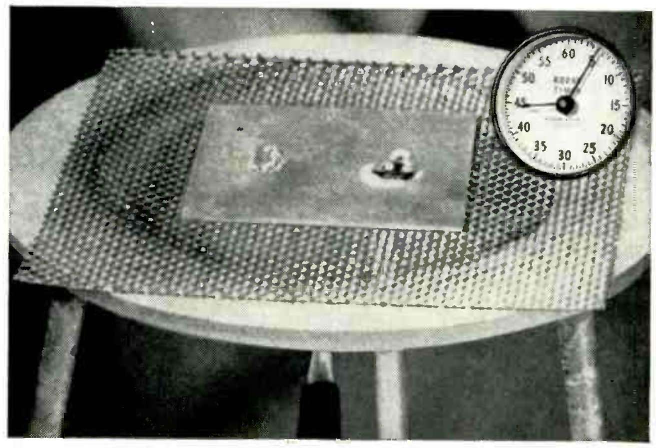
Make this test yourself

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

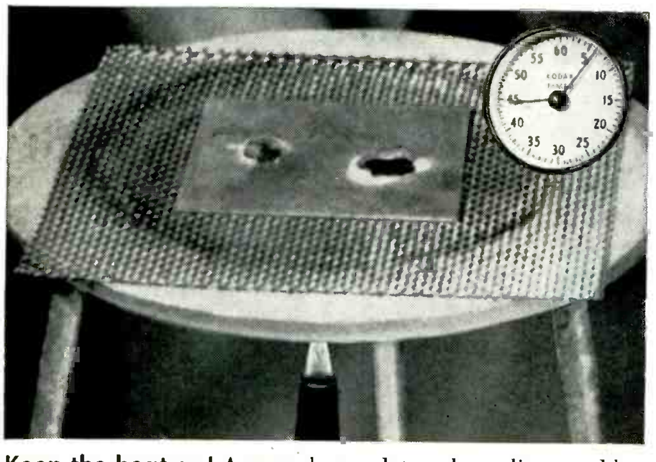
50-100% faster soldering
50-60% more soldering "mileage"



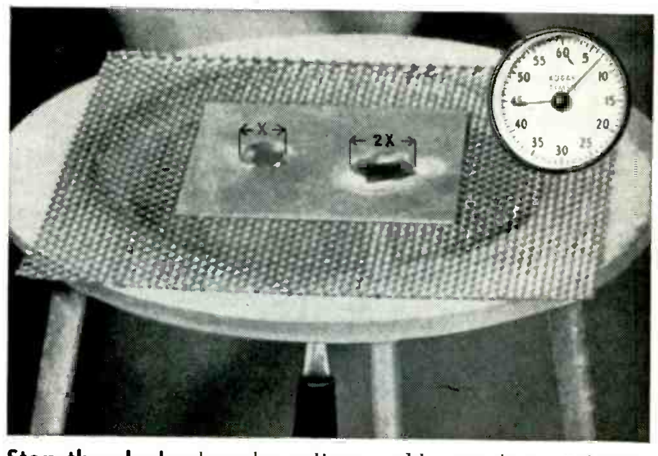
Set test up like this! Place one-inch, doubled-up samples of ordinary rosin core and "Dutch Boy" *activated* rosin core solders on sheet of clean copper. (In these pictures, "Dutch Boy" sample is on your right.)



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.

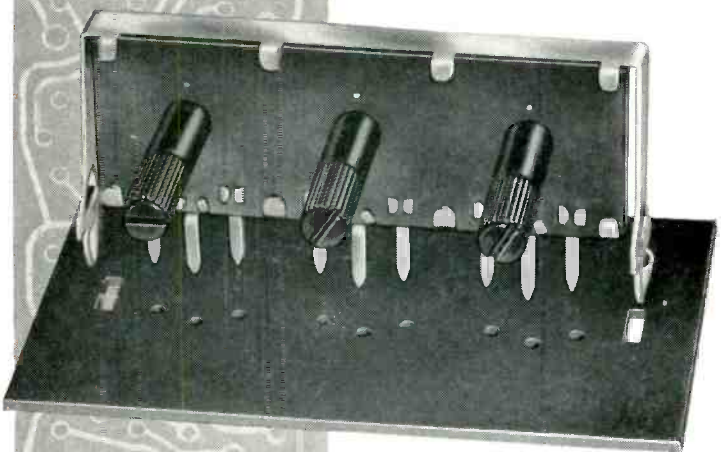
But don't take *anybody's* word for it. Try it yourself. Send for free samples. Write National Lead Company, 111 Broadway, New York 6, N. Y.

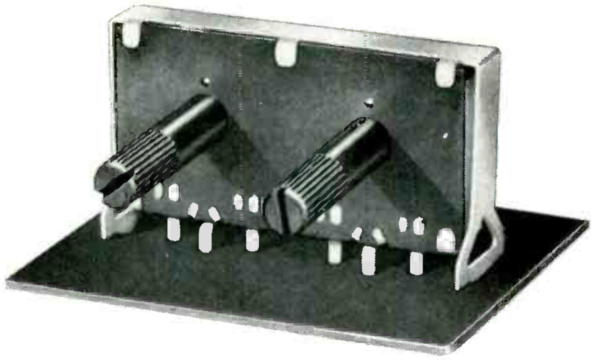
"Dutch Boy" solders and fluxes

NOW!

designed specifically for PRINTED CIRCUITS

SNAPS INSTANTLY INTO PLACE—REMAINS FIRMLY LOCKED





Illustrations are actual size—note compact multiple units

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A NEW TOTALLY FUNCTIONAL DESIGN CONCEPT

1. Snaps instantly into place with full length sturdy spring supports that lock control rigidly to printed panel.
   Wide shoulders provide rugged support.
   No mounting hardware, no separate support needed.
2. Compact multiple units conserve panel space, reduce handling costs and number of automatic assembly stations.
3. The only variable resistor with external contour designed specifically for mechanized handling and feeding into a printed panel.
4. Exclusive clip-off mounting supports and terminals for easy removal by service man without a solder pot.
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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The Exclusive Specialists in Precision Mass Production of Variable Resistors

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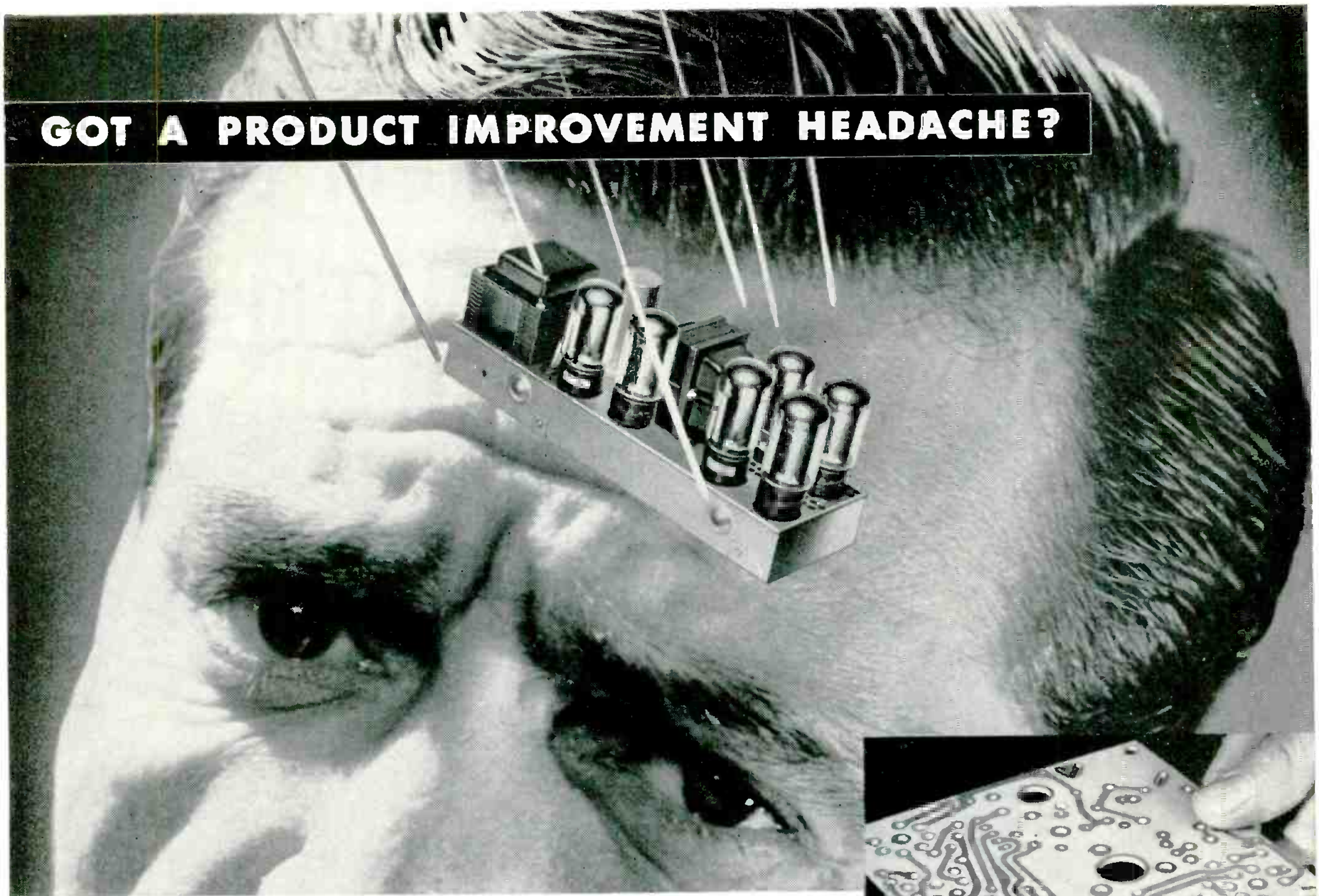


LOOK TO G-E "THRU-CON" PRINTED CIRCUIT BOARDS FOR FAST, SURE RELIEF

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

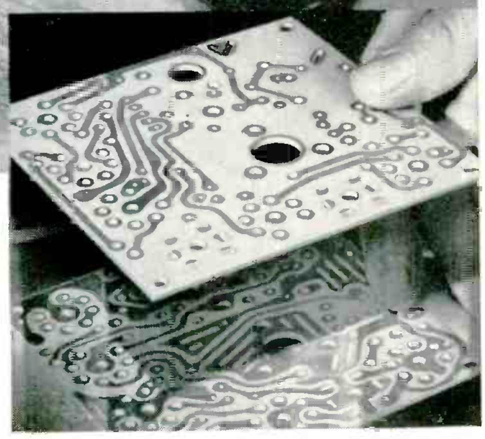
Two-sided boards eliminate heavy metal parts, make miniaturization possible. Product is improved by simpler construction and more compact assembly design.

Printed Circuits Now In Many Products

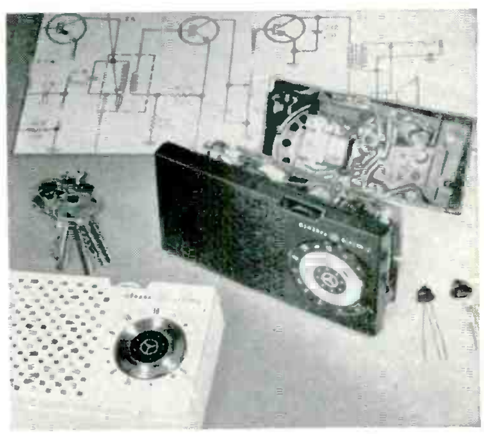
G-E "Thru-Con" Boards are being used now in lamps, fans, street lighting systems, kitchen appliances, radios, television, and control equipment of many kinds. In addition, General Electric engineers are working with other industries in the development of design improvements with "Thru-Con" Boards.

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.

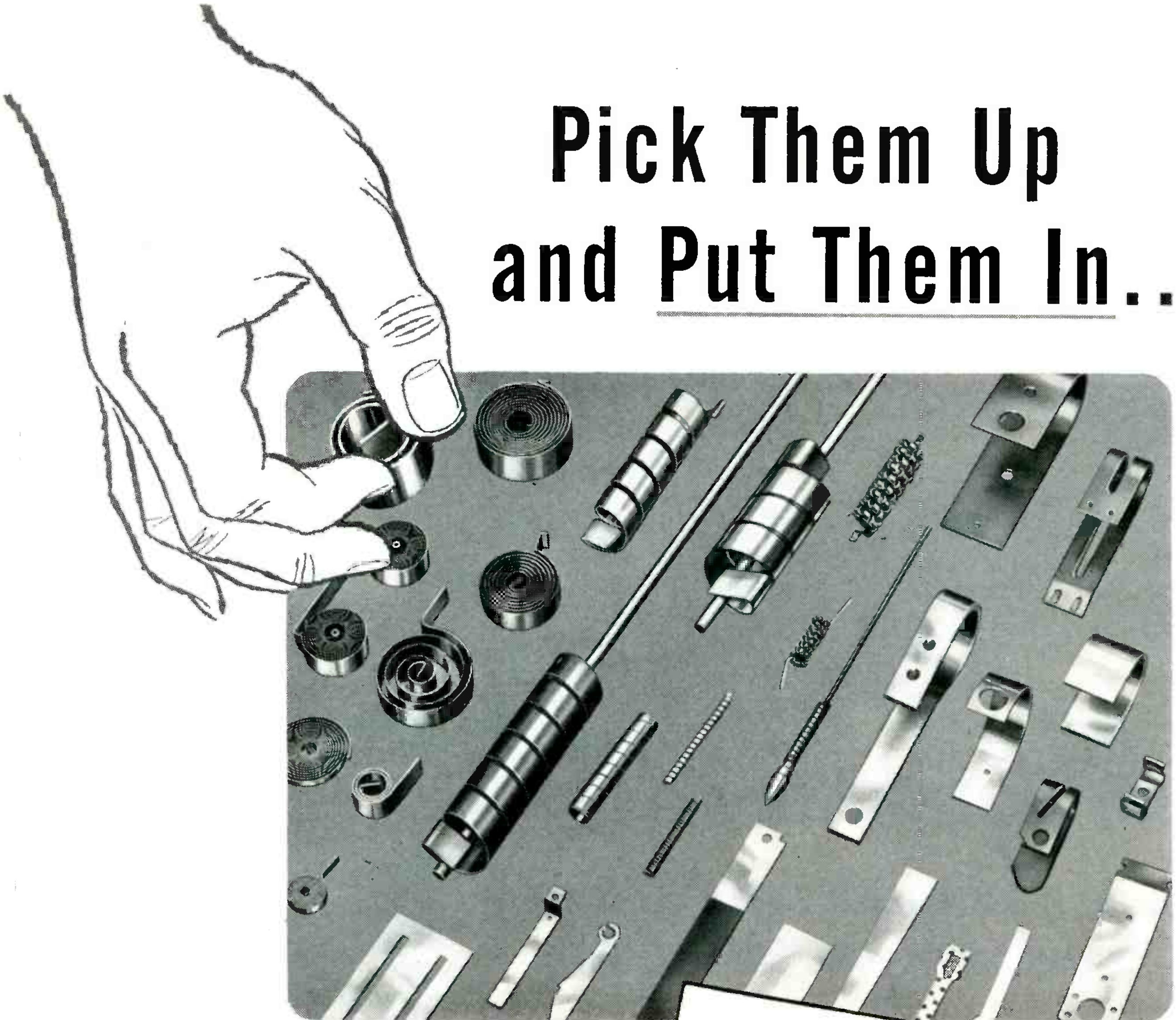


Positive Proof. This new transistorized portable radio features a full printed circuit using a General Electric "Thru-Con" Board. Combining other advances in electronics with a "Thru-Con" circuit makes possible sweeping changes in size, weight, and styling.

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

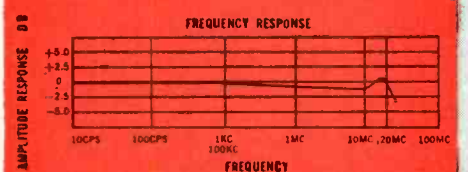
TV EQUIPMENT FOR STUDIO and LABORATORY

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 ±1½ 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

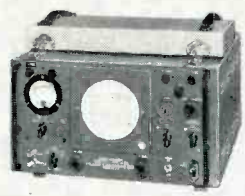
TV STUDIO MONITOR

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

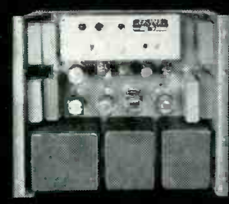
EXCELLENT FOR SUBCARRIER MEASUREMENTS

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	150-23[illegible] 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 VDC; 20 ma	—150V DC; 10 ma
Filament Supply	a. 6.3V @ 12 a b. 6.3V @ 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 Dual power unit, each side provides:	Model PT-112
Output Voltage	250-300 V DC	250-300 V DC
Output Current	100-400 ma	150-800 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	105-125V, 50/400 cps	105-125V 50/400 cps
Series Operation Output Power	500-600 Volts 100-400 ma	
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.

POLARAD PROVEN RELIABILITY

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

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Want more information? Use post card on last page.

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

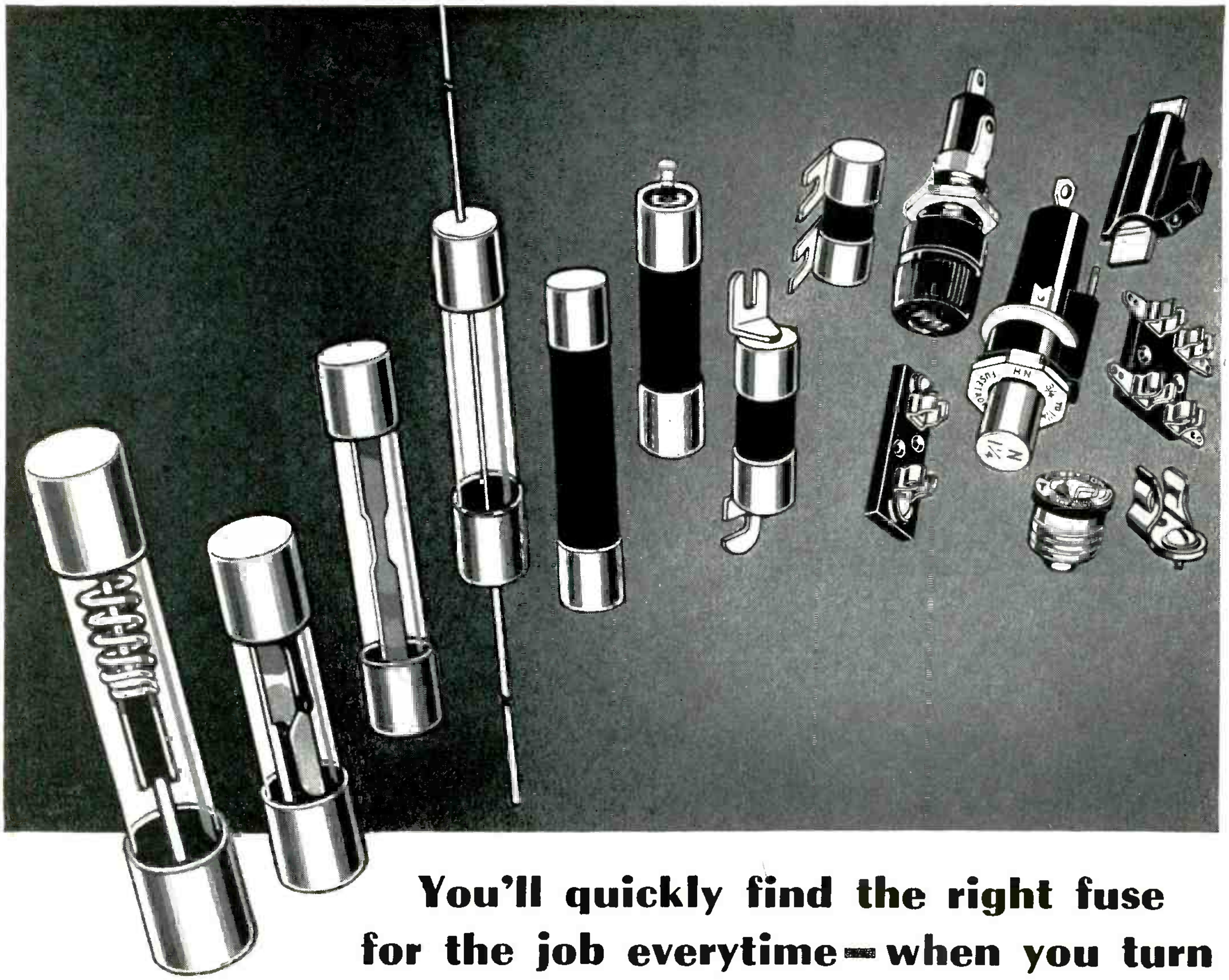
Today abundance so completely prevails in the United States that it has been conservatively estimated that as much as a third of everything offered for sale falls in the realm of "optional consumption." That is, consumers can "take it or leave it" without any immediate personal inconvenience. But if 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.

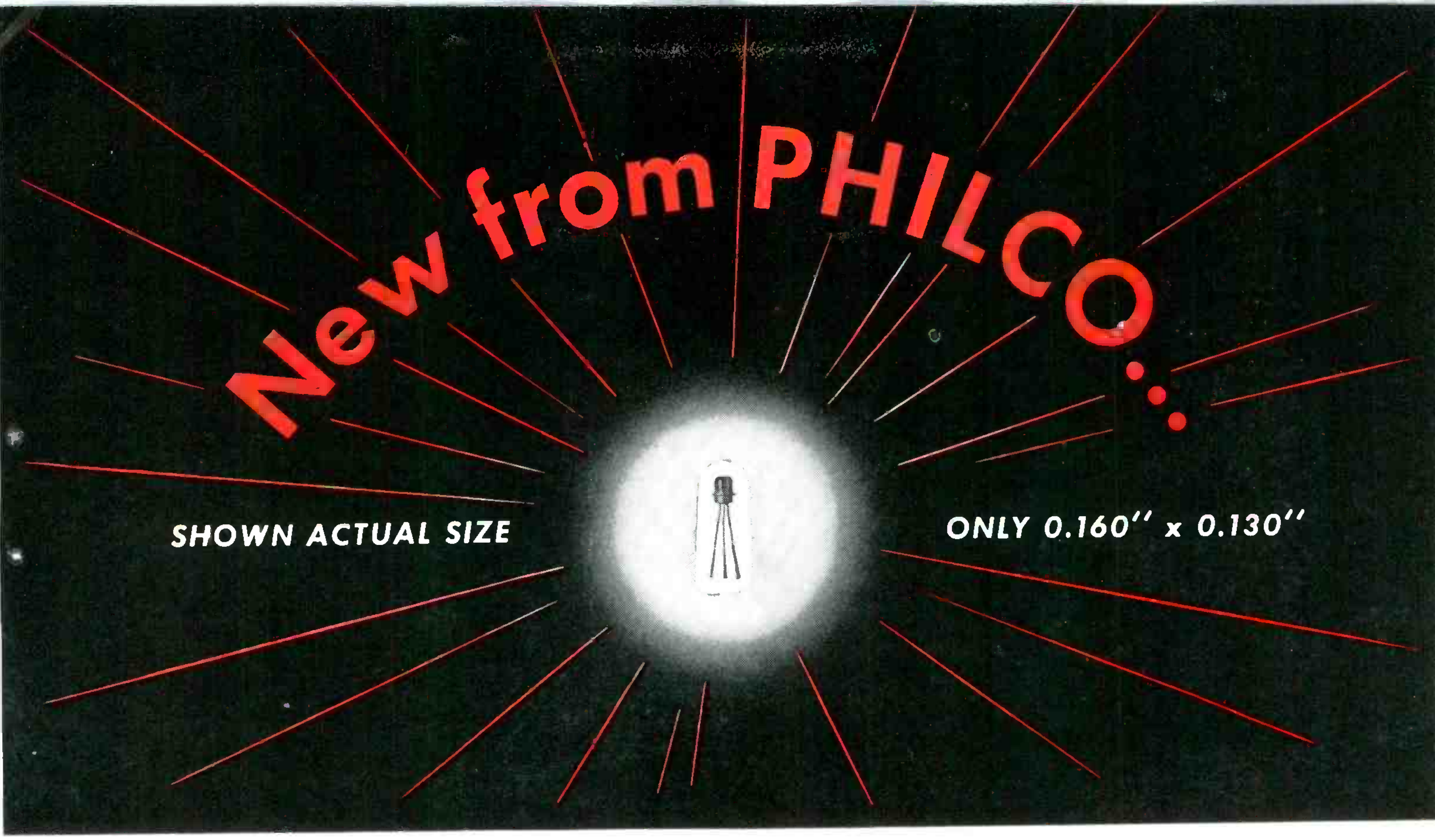
In performing its key role in past years, American advertising never realized its full potential. It successfully promoted sales. But it never was called upon to promote an overall economic stability as a direct outgrowth of increased sales.

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.





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
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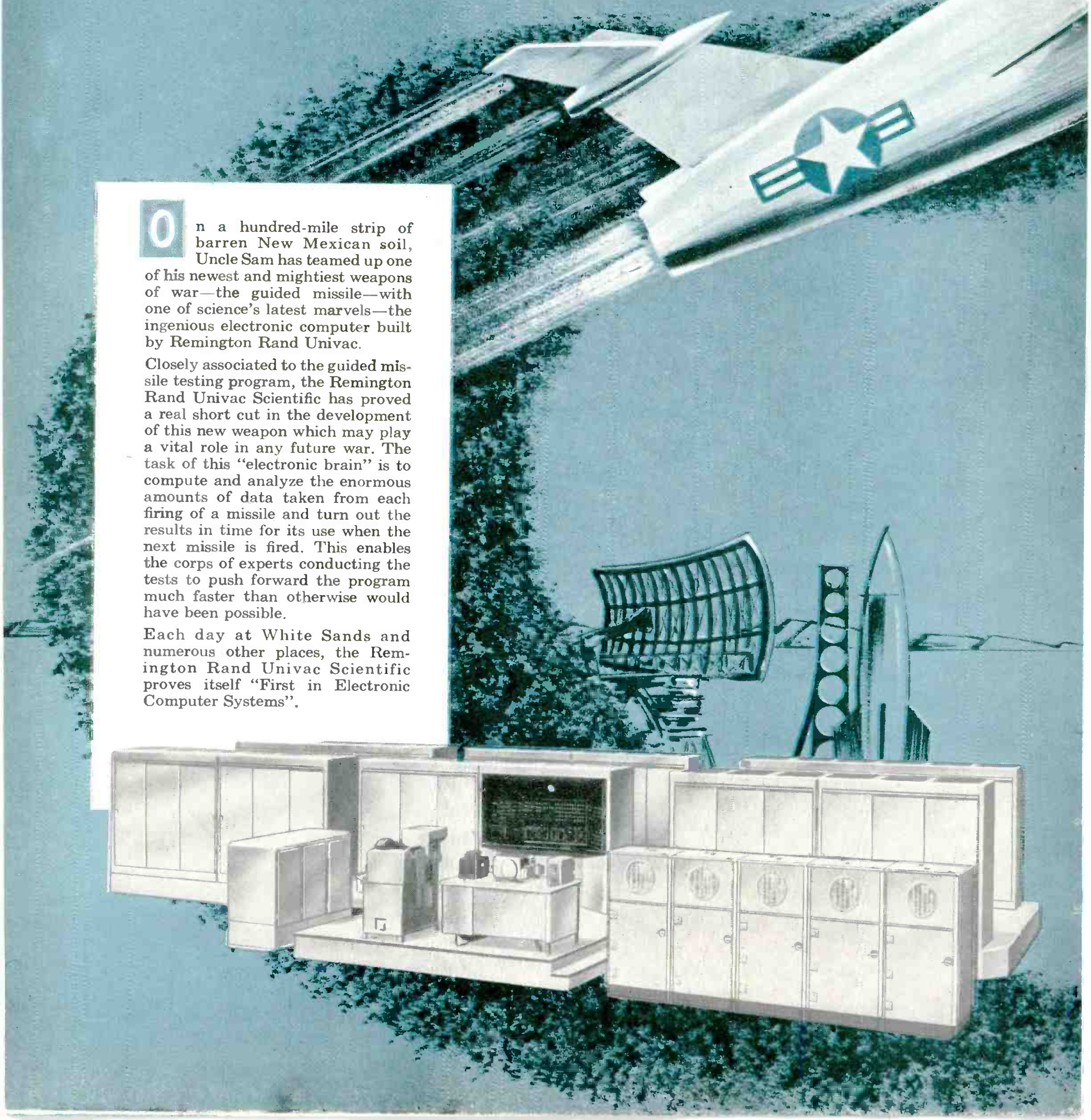
univac

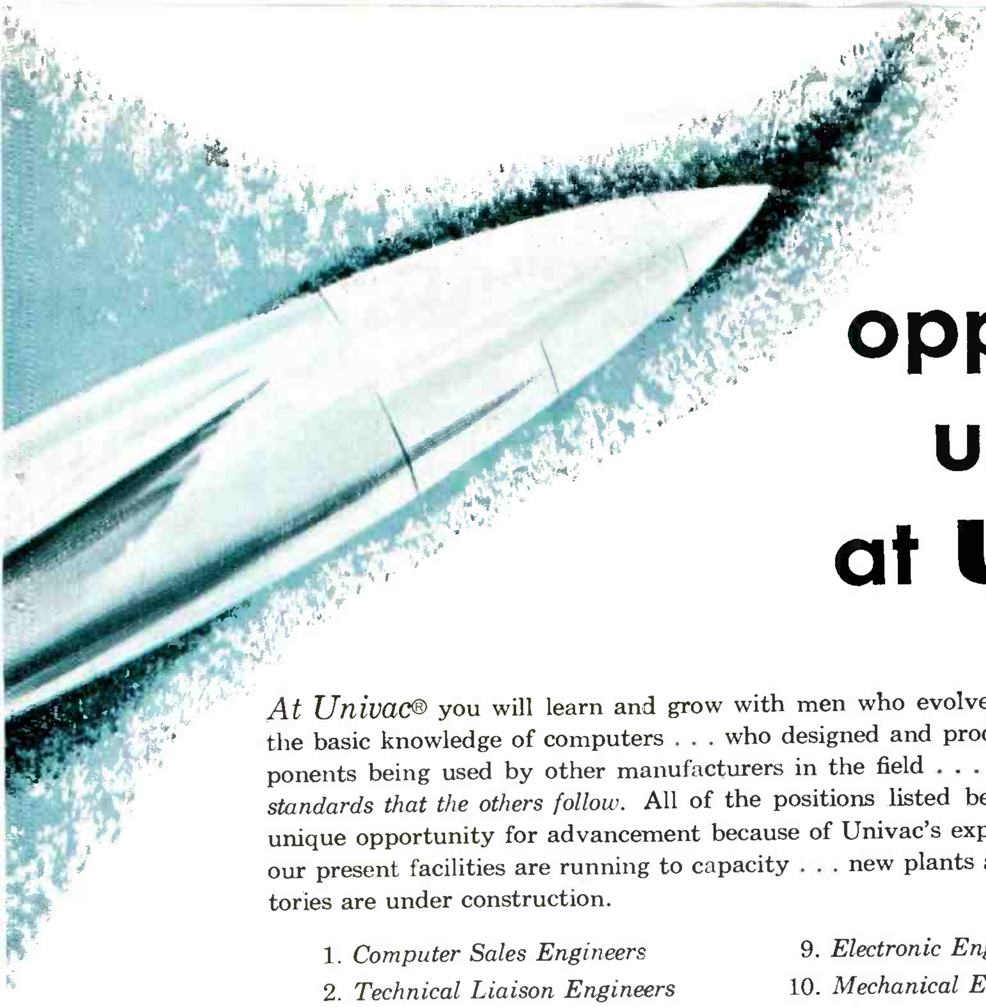
proves itself at White Sands



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".



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FOR THE JUNE GRADUATE

FOR THE EXPERIENCED ENGINEER

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5. *Product Planning Engineers*
6. *Field Location Engineers*
7. *Contract Administration Engineers*
8. *Instrumentation and Component Sales Engineers*
9. *Electronic Engineers*
10. *Mechanical Engineers*
11. *Mathematicians*
12. *Physicists*
13. *Programmers*
14. *Logical Designers*
15. *Production Engineers*

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.

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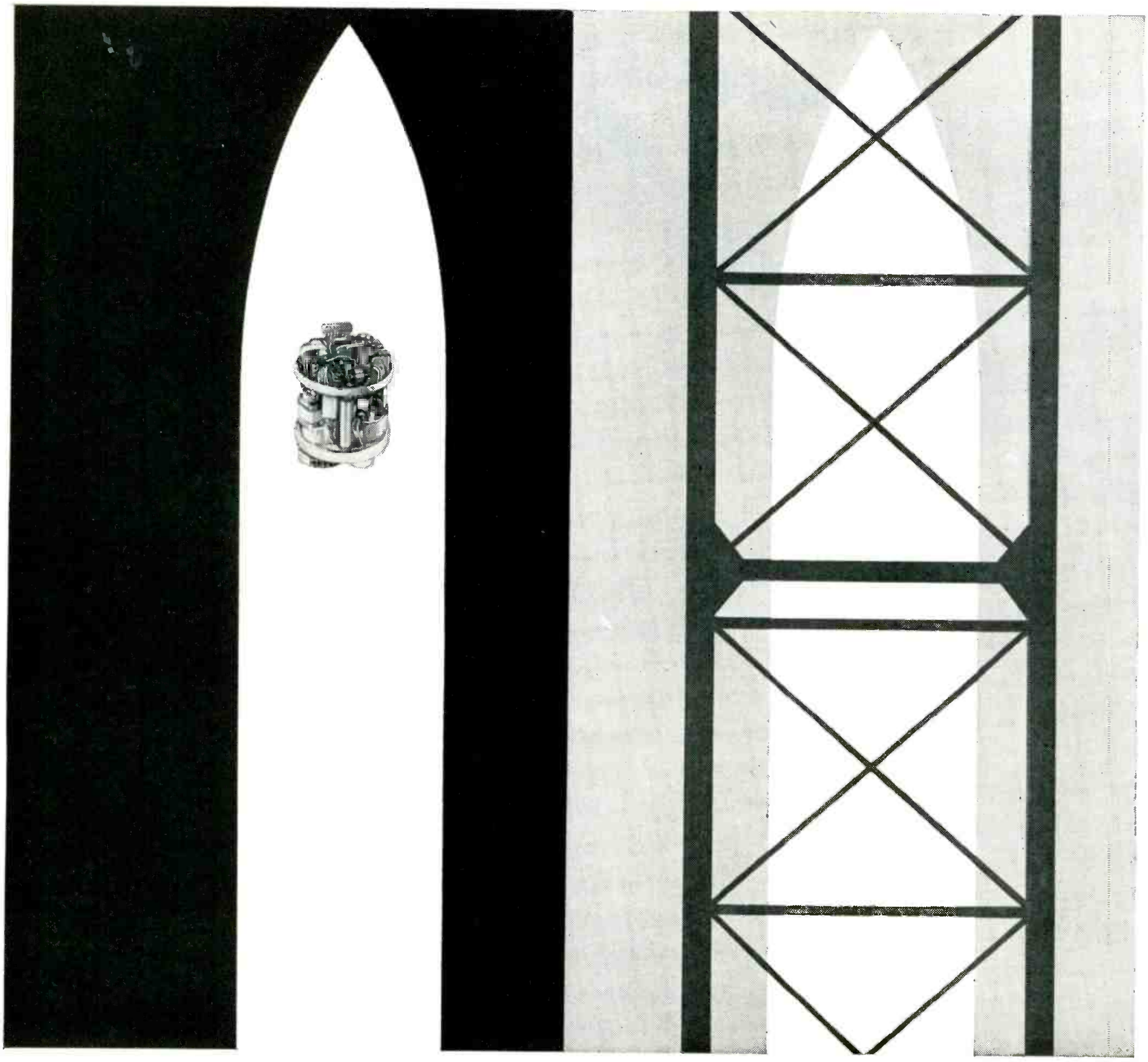

From sensitive components to brawny launchers . . .

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*

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Defense Products Group
AMERICAN MACHINE & FOUNDRY COMPANY
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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 6x10^{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.

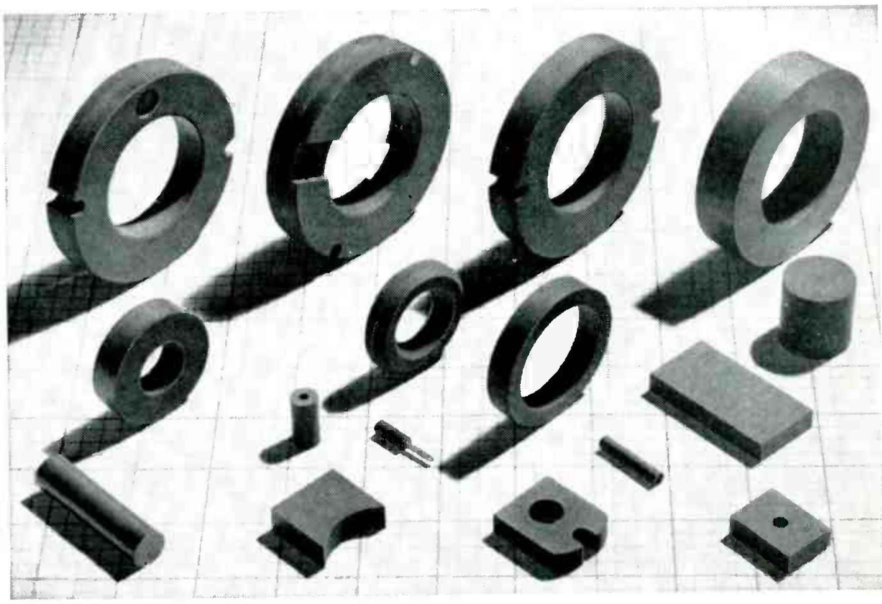
Unaffected by Strong Opposing Fields

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, couplings, magnetic seals, motors, small generators, H-F alternators, magnetos, ion traps and others.

*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.

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/cm^3.

Although the energy product (0.915x10^6 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.**

Want more information? Use post card on last page.

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.*

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manufactured by the Components Division of

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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!

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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 Type	4	50 @ -50V 10 @ -10V	80	Hi Temperature Diode

Want more information? Use post card on last page.

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

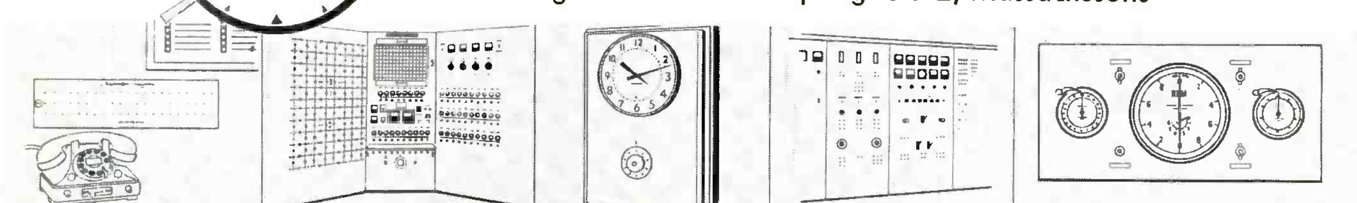
In almost every research and testing laboratory the information needed to obtain a specific end result depends upon knowing, to an accurate degree, the speed of revolving shafts, motors, governors or other rotating equipment.

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

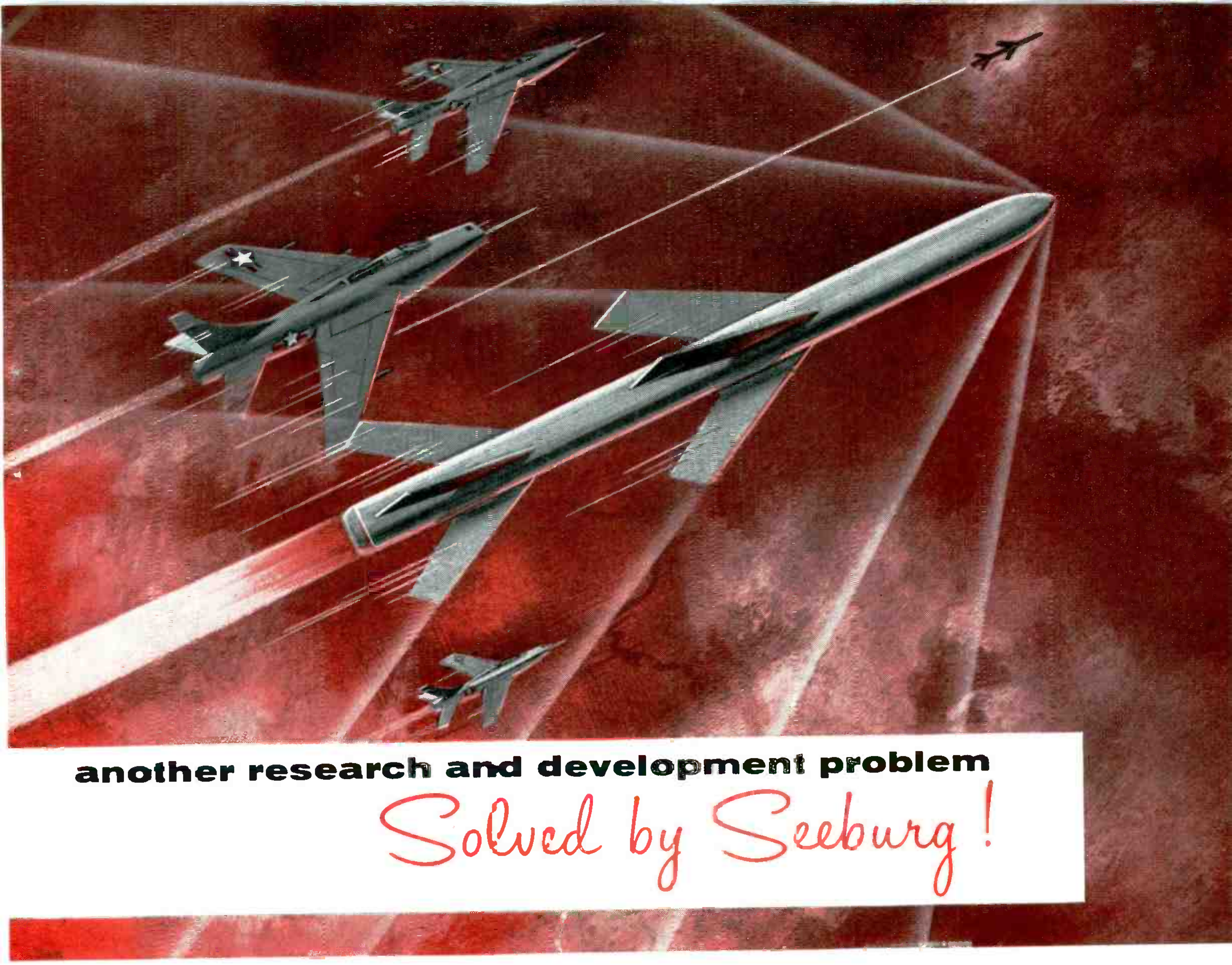
That's why the Standard Chrono-Tachometer plays such an important role in so many industrial, governmental and educational laboratories. Built for *continuous* service, it is a test instrument of extreme accuracy, invaluable wherever the precise measurement of speed of rotation is required.

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 opportunites in our engineering division.

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

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Micro Wave Equipment
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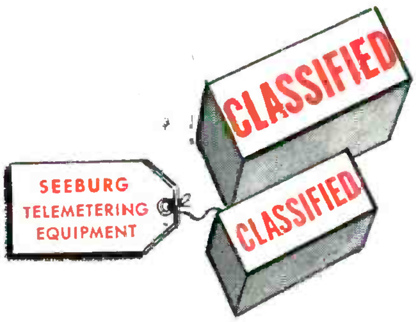
Telemetric Equipment
Electronic Computers
Music Systems



WORLD'S LEADING MANUFACTURERS OF AUTOMATIC MUSIC SYSTEMS

THE Heiland® 119 AMPLIFIER SYSTEM FOR OSCILLOGRAPHIC RECORDING

COMPARE THESE FEATURES WITH SIMILAR SYSTEMS:

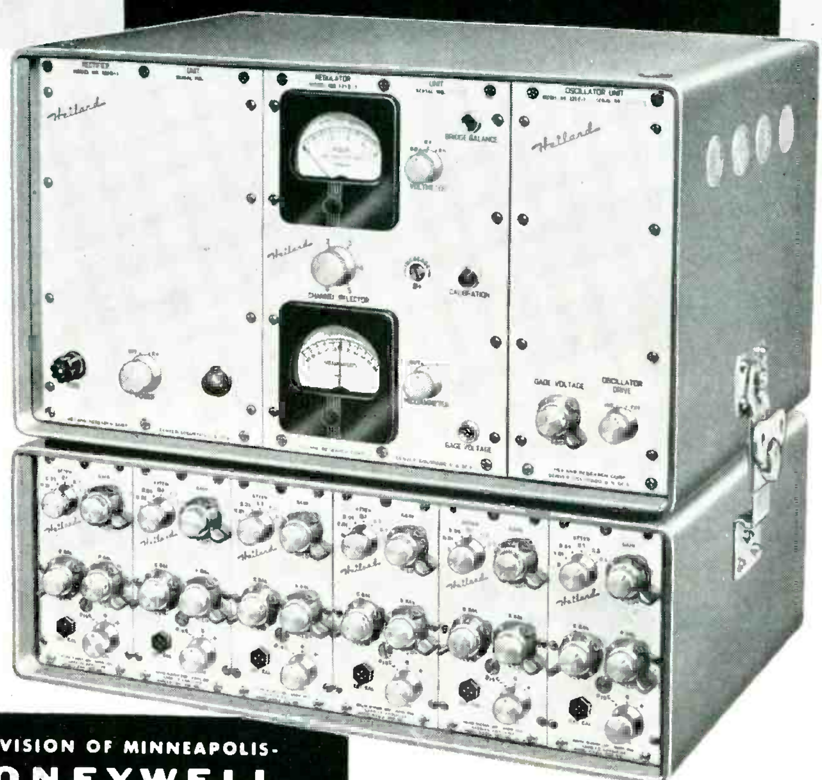
TWICE THE SENSITIVITY—½ millivolt for full current output

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® HONEYWELL
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.

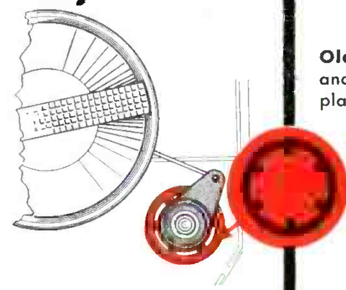
In addition, linear-integrate and carrier units are interchangeable within the system case.

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

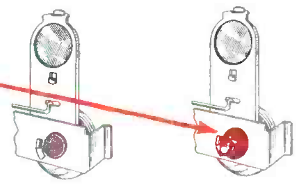
Key Shaft



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

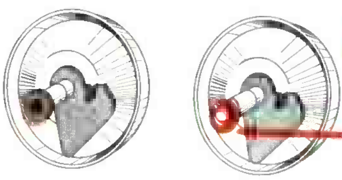
Old way: Knob with plastic shaft used washer and heat forming operation that flattened the plastic pin and locked the pivot in position.



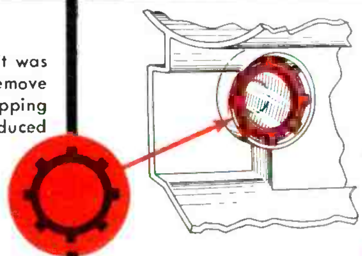
Truarc way: Molded plastic knob with pin is easily and quickly held by a Truarc self-locking ring (series 5105). No groove is necessary. Washer is eliminated and it is possible to remove ring if necessary without damage to knob.

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.

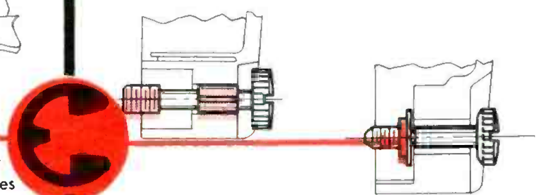


Rear Lens

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.

Ansco, 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 controlled 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.

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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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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.

Want more information? Use post card on last page.

ALLIED'S

HERMETICALLY SEALED RELAYS

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

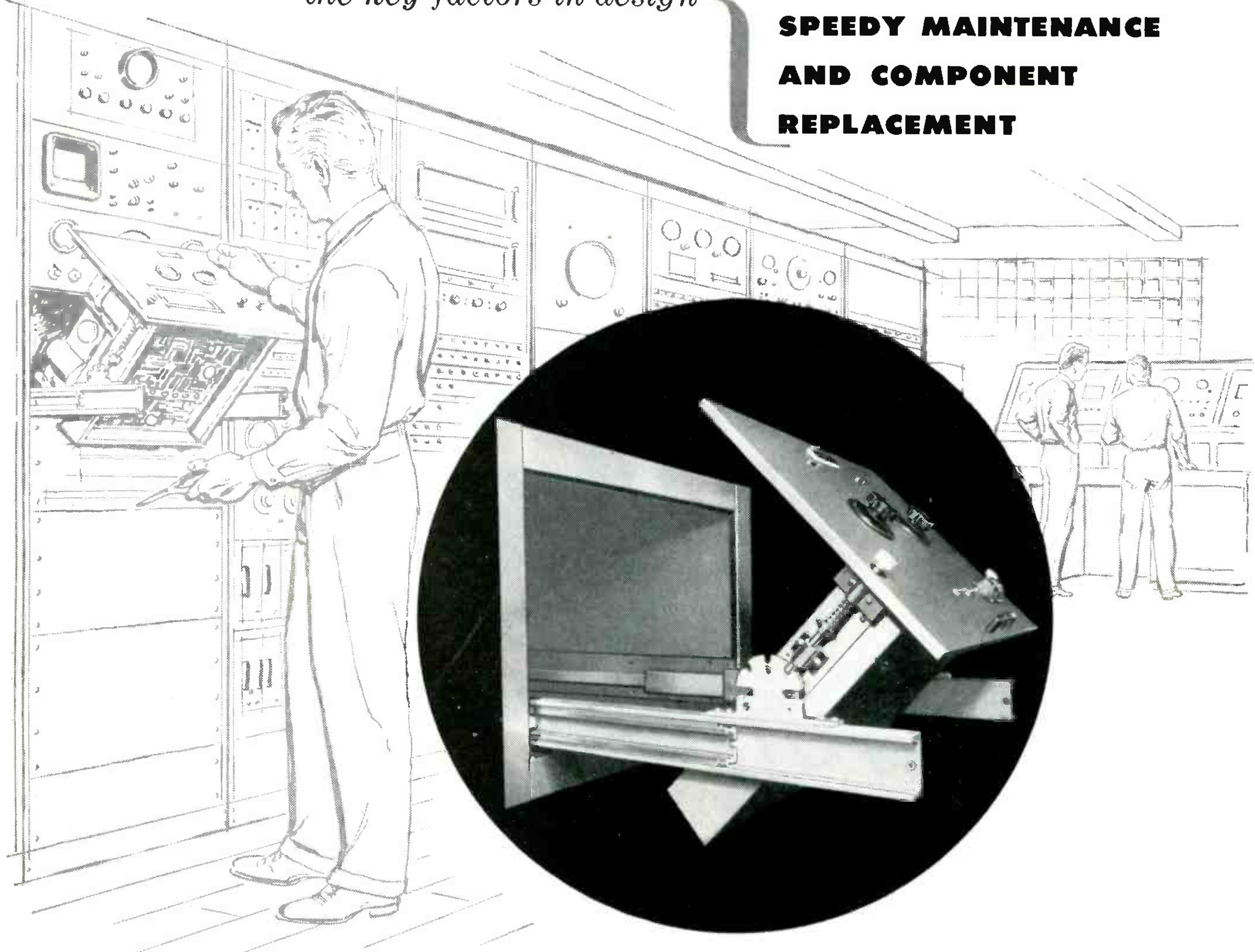
MECHANICAL SPECIFICATIONS										ELECTRICAL SPECIFICATIONS			
ALLIED TYPE	TYPE OF TERMINAL	OUTLINE DIMENSIONS AA	A	B	C	WT. (OZ.)	MOUNTING DIMENSIONS D	E	TYPE MOUNTING	CONTACT RATING (AMPS.)	CONTACT FORM MAX.	COIL DATA MAX. D.C. OHMS	OPERT.
ASH	SOLDER	2 7/16	2 1/16	1 5/8	1 7/16	3.5	.938	1.187	(3)#6-32 Studs	5	SPDT	3500 3485	AC DC
ASHO	PLUG-IN	3	2 7/16	1 5/8	1 7/16	4			Octal Plug-in	5	SPDT	3500 3485	AC DC
BJHR	SOLDER	3 3/32	2 23/32	1 59/64	1 11/32	7.5	.875	1.625	(3)#6-32 Studs	5	DPDT	3700 5000	AC DC
BJHRO	PLUG-IN	3 5/8	3 1/16	1 59/64	1 11/32	7.5			Octal Plug-in	5	DPDT	3700 5000	AC DC
BOH	SOLDER	3 11/32	2 31/32	2 3/16	DIA.	7.5	1.856	1.856	(4).206 Dia. Holes	10	DPDT	2675 5000	AC DC
BOHO	PLUG-IN	3 9/16	3	2 3/16	DIA.	8			Octal Plug-in	5	DPDT	2675 5000	AC DC
BOHR	SOLDER	3 1/16	2 11/16	1 49/64	1 41/64	8.5	1.250	1.250	(3)#8-32 Studs	10	DPDT	2675 5000	AC DC
BOHRO	PLUG-IN	3 17/32	2 31/32	1 49/64	1 41/64	8.5			Octal Plug-in	5	DPDT	2675 5000	AC DC
BOYH	SOLDER	3 11/32	2 31/32	2 3/16	DIA.	8.5	1.856	1.856	(4).206 Dia. Holes	10	DPDT	10,000	DC
BOYHO	PLUG-IN	3 9/16	3"	2 3/16	DIA.	8.5			Octal Plug-in	5	DPDT	10,000	DC
BOYHR	SOLDER	3 1/16	2 11/16	1 49/64	1 41/64	8.5	1.250	1.250	(3)#8-32 Studs	10	DPDT	10,000	DC
BOYHRO	PLUG-IN	3 17/32	2 31/32	1 49/64	1 41/64	8.5			Octal Plug-in	5	DPDT	10,000	DC
CNAH	SCREW	4 1/2	3 5/16	2 17/32	2 21/32	22	1 7/8	2"	(3)#10-32 Studs	50	SPST	600 4460	AC DC
DSH	SOLDER	3 21/32	3 13/32	3 1/2	1 7/8	13	1.375	3.125	(4).206 Dia. Holes	5	DPDT	8,000	DC
DSHR	SOLDER	3 3/8	3 1/16	2 1/4	1 13/32	9.5	.687	1.750	(3)#8-32 Studs	5	DPDT	8,000	DC
KH-3-1D	PLUG-IN	1 5/64	55/64	23/64	49/64	0.33			7 Pin Plug-in	1/2	SPDT SPST NO	1,500	DC
KH-3-2D	PLUG-IN	1 5/64	55/64	23/64	49/64	0.33			7 Pin Plug-in	1/2	SPDT SPST NC	1,500	DC
KH-6D	PLUG-IN	1 7/64	57/64	396	.800	0.33			8 Pin Plug-in	1/2	DPDT	5,000	DC
LKH-6C	SOLDER	3 9/16	3 3/16	1 7/8	1 7/8	8.5	1.375	1.500	(3)#6-32 Studs	2	6PDT	11,000	DC
LKH-4C	SOLDER	3 1/16	2 11/16	1 5/8	1 7/16	6	.938	1.187	(3)#6-32 Studs	2	4PDT	11,000	DC
LKHO	PLUG-IN	3 9/16	3"	1 5/8	1 7/16	5.5			Octal Plug-in	2	DPDT	11,000	DC
MEH-6	SOLDER	2 3/32	1 23/32	1 3/8	1"	3	.672	1.047	(3)#6-32 Studs	5	DPDT	1330 2930	AC DC
MEHG	PLUG-IN	2 7/32	1 27/32	1 3/8	1"	3.5	.750	1.125	Note 1 (3)#6-32 Studs	5	DPDT	1330 2930	AC DC
MEHX	SOLDER	2 5/8	2 1/16	1 5/8	1 7/16	5.3	.938	1.187	Note 2 (3)#6-32 Studs	5	4PDT	7260	AC DC
MH-6D	SOLDER	1 53/64	1 23/64	41/64	DIA.	1	CTR/CTR	.875	(2) Holes 125 Dia.	2	DPDT	15,900	DC
MH-12	SOLDER	1 25/32	1 23/64	1 3/64	DIA.	2.5	CTR/CTR	1.406	Note 3 (2)#6-32 Studs	2	4PDT	16,000	DC
MH-18	SOLDER	1 25/32	1 23/64	1 3/16	DIA.	4	CTR/CTR	1.562	Note 3 (2)#6-32 Studs	2	6PDT	22,100	DC
MHT-12	SOLDER	2 1/8	1 13/16	1 3/64	DIA.	3	CTR/CTR	.625	Note 3 (2)#6-32 Studs	2	4PDT	16,000	DC
MHT-18	SOLDER	2 1/8	1 13/16	1 3/16	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 3/64	DIA.	3.5	.938	1.187	(3)#6-32 Studs	2	4PDT	16,000	DC
MHUO-12	PLUG-IN	1 3/4	1 23/64	1 3/64	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 23/64	1 3/64	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 23/64	1 3/16	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 23/64	1 3/16	DIA.	4.0	CTR/CTR	1.687	Note 4 (2)#10-32 Thd.	2	6PDT	22,100	DC
*MHJ-12	SOLDER	1 25/32	1 23/64	1 3/64	DIA.		CTR/CTR	1.406	(2)#6-32 Studs	2	4PDT	16,000	DC
*MHJ-18	SOLDER	1 25/32	1 23/64	1 3/16	DIA.		CTR/CTR	1.562	(2)#6-32 Studs	2	6PDT	22,100	DC
MHY-6	SOLDER	1 13/16	1 23/64	1 3/64	DIA.		CTR/CTR	1.406	(2)#6-32 Studs	10	DPDT	16,000	DC
MHY-12	SOLDER	1 63/64	1 23/64	1 3/16	DIA.		CTR/CTR	1.562	(2)#6-32 Studs	10	4PDT	22,100	DC
PBHW-6	SOLDER	2 5/8	2 1/4	1 49/64	1 41/64	6	CTR/CTR	1.468	Note 3 (2)#6-32 Studs	10	DPDT	380 4800	AC DC
PBH-6	SOLDER	2 5/8	2 1/4	1 49/64	1 41/64	6	1.218	1.218	(4)#6-32 Studs	10	DPDT	380 4800	AC DC
PBH-9	SOLDER	2 27/32	2 1/4	1 49/64	1 41/64	6	1.218	1.218	(4)#6-32 Studs	10	3PDT	380 4800	AC DC
PBH-12	SOLDER	2 27/32	2 1/4	1 49/64	1 41/64	6.5	1.218	1.218	(4)#6-32 Studs	10	4PDT	380 4800	AC DC
PBHN-6	PLUG-IN	3 5/32	2 5/32	1 49/64	1 41/64	9	Note 3		"AN" CONNECTOR	10	DPDT	380 4800	AC DC
PBHN-9	PLUG-IN	3 5/32	2 3/32	1 49/64	1 41/64	9	Note 3		"AN" CONNECTOR	10	3PDT	380 4800	AC DC
PBHN-12	PLUG-IN	3 5/32	2 1/8	1 49/64	1 41/64	9.5	Note 3		"AN" CONNECTOR	10	4PDT	380 4800	AC DC
PDH-6	SOLDER	2 11/16	2 1/16	1 5/8	1 7/16	6	.938	1.187	(3)#6-32 Studs	2	DPDT	475 4800	AC DC
PDH-9	SOLDER	2 11/16	2 1/16	1 5/8	1 7/16	6	.938	1.187	(3)#6-32 Studs	2	3PDT	475 4800	AC DC
PDH-12	SOLDER	2 11/16	2 1/16	1 5/8	1 7/16	6.5	.938	1.187	(3)#6-32 Studs	2	4PDT	475 4800	AC DC
PDHG	PLUG-IN	2 9/16	2 3/16	1 5/8	1 7/16	6.5	Note 1		14 Pin Plug (3)#6-32 Studs	2	4PDT	475 4800	AC DC
POHR-9	SOLDER	3 19/32	3 7/32	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 29/32	3 17/32	2 1/4	2 1/8	13.5	1.625	1.812	(3)#8-32 Studs	10	4PDT	870 5000	AC DC
POHRO-12	PLUG-IN	4 1/16	3 1/2	2 1/4	2 1/8	13.5			14 Pin Plug-in	5	4PDT	870 5000	AC DC
PRH	SOLDER	3 5/32	2 27/32	3 1/8	1 13/32	9.5	CTR/CTR	2.687	(2) .161 Dia. holes	10	4PDT	620	DC
RSH-3D	SOLDER	2 7/64	1 41/64	3/4 DIA.		2.0	CTR/CTR	.973	(2).125 dia. clearance holes	2	SPDT	14,000	DC
RSH-6D	SOLDER	2 7/64	1 41/64	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 13/64	1 41/64	3/4 DIA.		2.0	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 55/64	3/4 DIA.		2.0			7 Pin Plug-in	2	SPDT	14,000	DC
SKH	SOLDER	2 5/8	2 1/16	1 5/8	1 7/16	4.5	.938	1.187	(3)#6-32 Studs	2	4PDT	4,500	DC
SKHO	PLUG-IN	3	2 7/16	1 5/8	1 7/16	5			Octal Plug-in	2	DPDT	4,500	DC
SKHW	SOLDER	2 5/8	2 1/16	1 5/8	1 7/16	4.5	.938	1.187	Note 3 (3)#6-32 Studs	3	4PDT	4,500	DC
SKHG	PLUG-IN	2 5/8	2 7/32	1 5/8	1 7/16	5	Note 1		14 Pin Plug-in(3)#6-32 Studs	2	4PDT	4,500	DC
SKHN	PLUG-IN	3 5/32	2	1 5/8	1 7/16	6.8	Note 3		"AN" CONNECTOR	2	4PDT	4,500	DC
SWHO	PLUG-IN	2 11/16	2 1/8	1 5/8	1 7/16	5.5			Octal Plug-in	2	DPDT	13,800	DC
SWH	SOLDER	2 7/16	2 1/16	1 5/8	1 7/16	5.5	.938	1.187	(3)#6-32 Studs	2	DPDT	13,800	DC
7RH	SOLDER	5 15/16	3	5	4 11/32	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.

Grant INDUSTRIAL SLIDES FOR

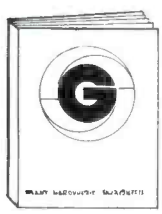
the key factors in design

ACCESSIBILITY
COMPACTNESS
PROVISION FOR EASY, SPEEDY MAINTENANCE AND COMPONENT REPLACEMENT



Grant Industrial Slides are essential to the solution of most problems centering on these design factors—so highly emphasized in this automation era. Grant Slides provide skillfully developed, competently engineered sliding, pivoting mountings for nearly all types of assemblies—electronic, hydraulic, pneumatic, mechanical.

Grant engineers and representatives are located in all important industrial centers—their valuable store of specialized experience is yours for the asking.



More Than 100 Pages of Important Working Data

The Grant Industrial Slide Catalogue—on the press—outlines principles, details, of more than 100 standard and custom-made slides. A working manual on built-in accessibility. Ask us to reserve your free copy.

Grant INDUSTRIAL SLIDES

Grant Pulley and Hardware Corporation
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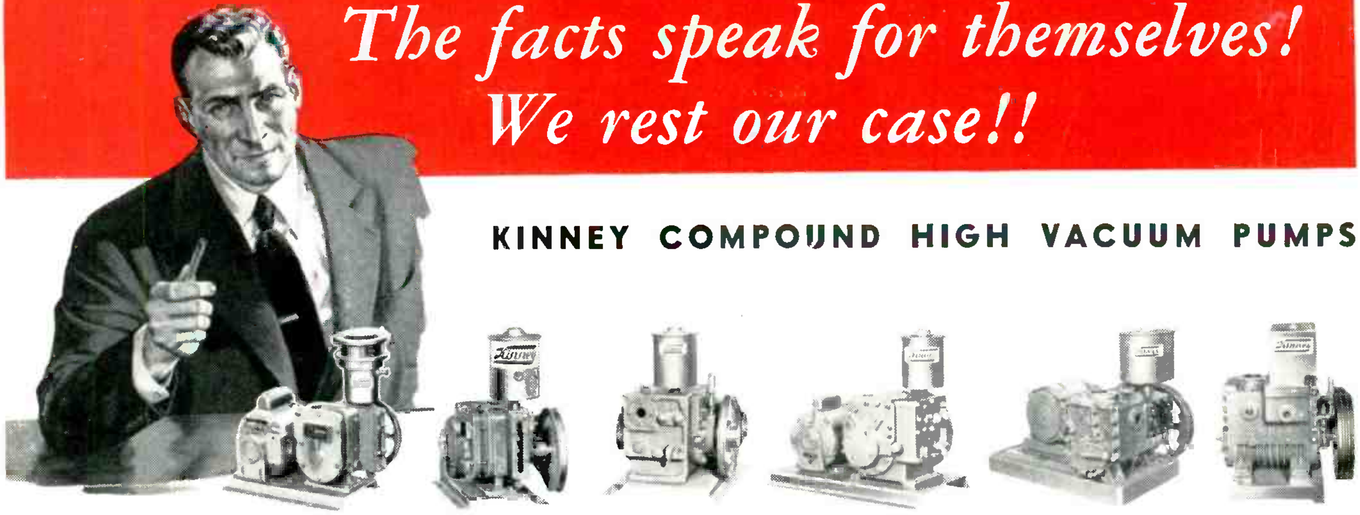
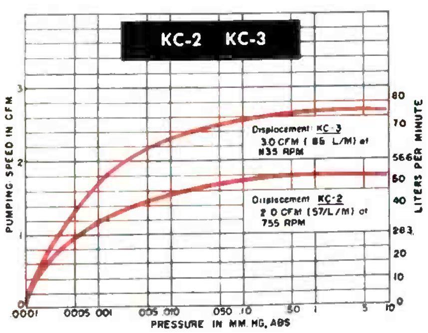
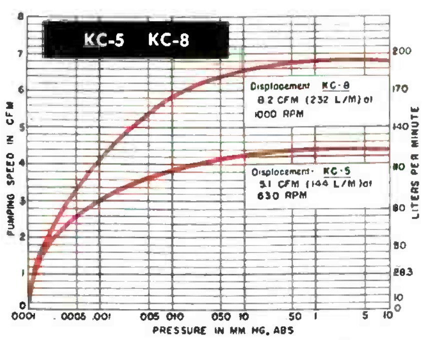
The facts speak for themselves! We rest our case!!

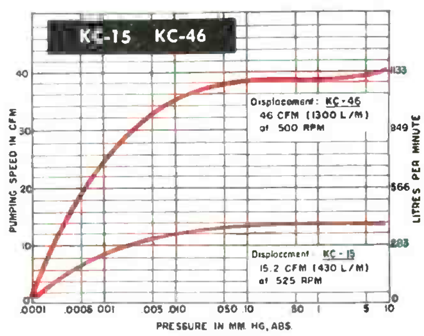


KINNEY COMPOUND HIGH VACUUM PUMPS

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.	¼	⅓	⅓	½	1	3
Motor RPM (syn.)	1800	1800	1800	1800	1800	1800
Oil Capacity	6 oz.	6 oz.	1⅓ pt.	1⅓ pt.	2 qt.	1 gal.
Shaft Diam.	¾"	¾"	¾"	¾"	¾"	1⅛"
Inlet Connection	¾" Screwed	¾" Screwed	1" Screwed	1" Screwed	2" Screwed	3" Screwed
Outlet Connection	None	¾" Screwed	1" Screwed	1" Screwed	1¼" Screwed	1½" 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

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THE NEW YORK AIR BRAKE COMPANY
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• Please send Bulletin 403 giving complete data on Kinney Compound Pumps
Our vacuum problem involves ....
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a VOM ...plus a VTVM when you need it.

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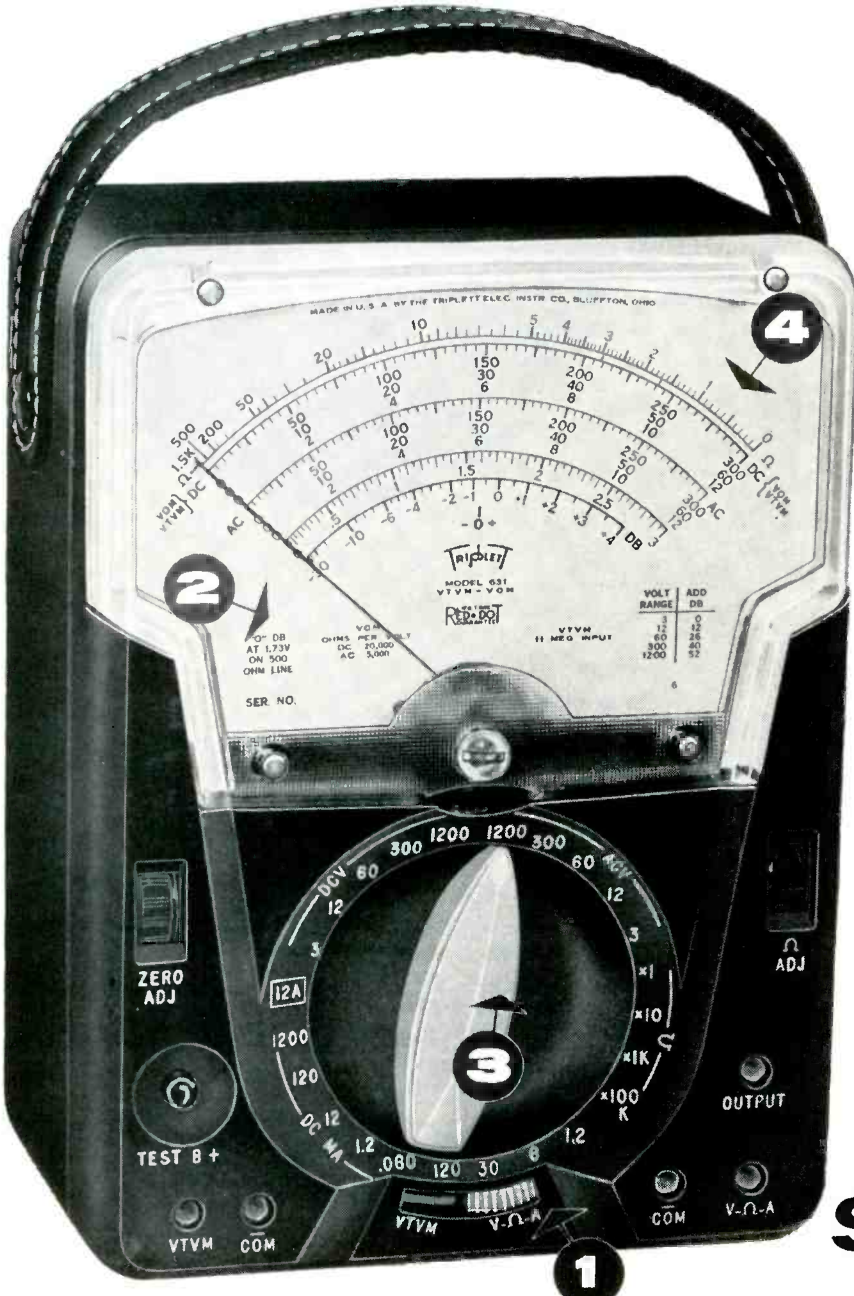
TRIPLETT MODEL 631—In one year accepted as the standard COMBINATION VOM-VTVM



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1 Just flip the switch.

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4 Extra long scales —unobstructed visibility.

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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.
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Triplett design and development facilities are available for your special requirements for meters and test equipment.

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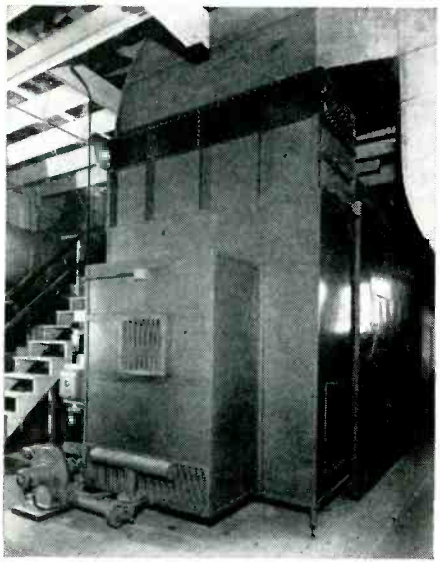
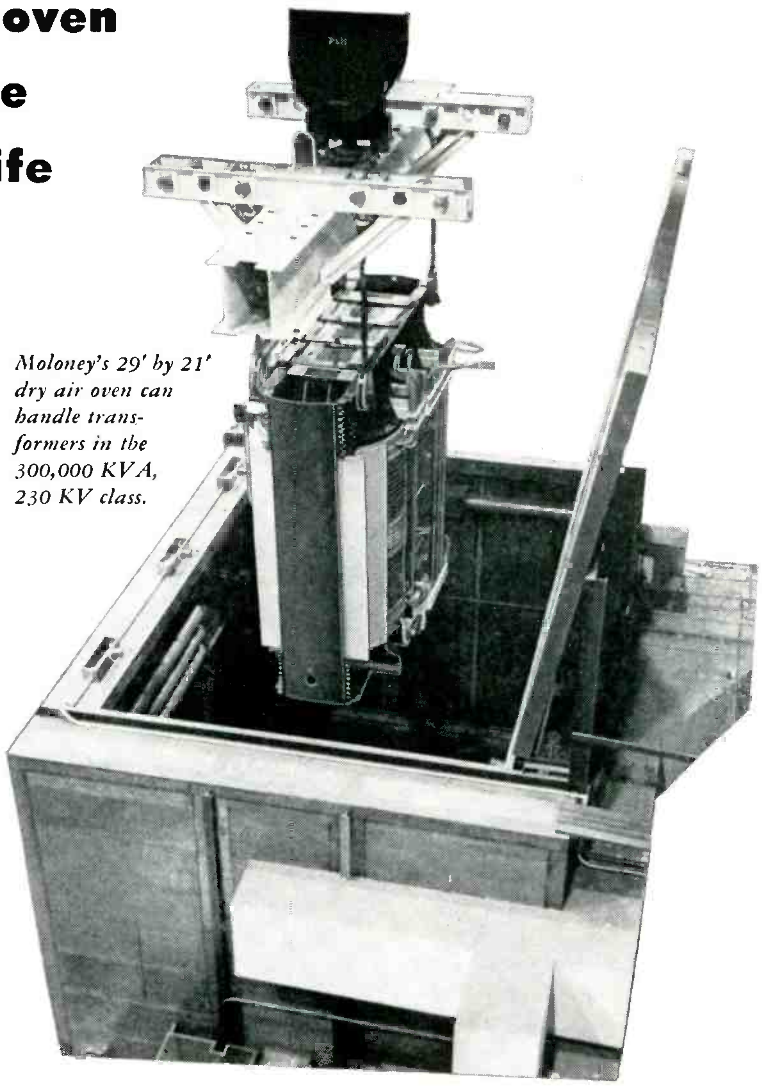
Moloney power transformers are dried in new controlled atmosphere oven to further improve performance and life



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.

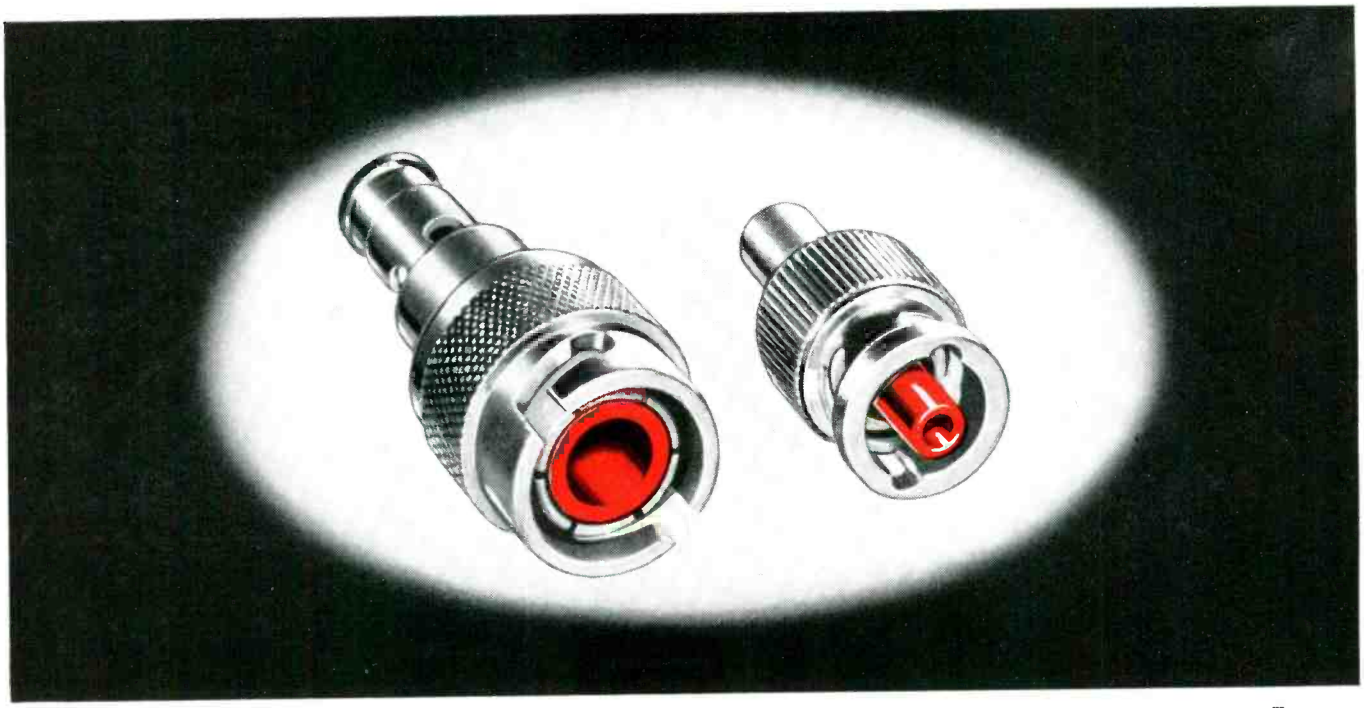
Lectrodryers are being used elsewhere in the electrical industry to equal advantage, speeding production, safeguarding materials in storage, improving quality. Some of the newer precision electronic products couldn't be made without the extreme DRYness provided by Lectrodryers. For advice on where you 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.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

* REGISTERED TRADEMARK U S PAT OFF.



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.

M KELLOGG W

Subsidiary of Pullman Incorporated

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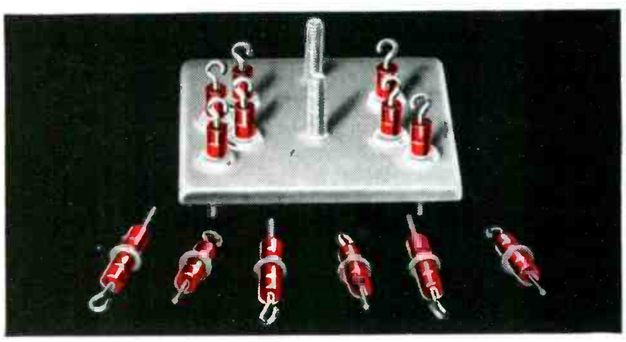
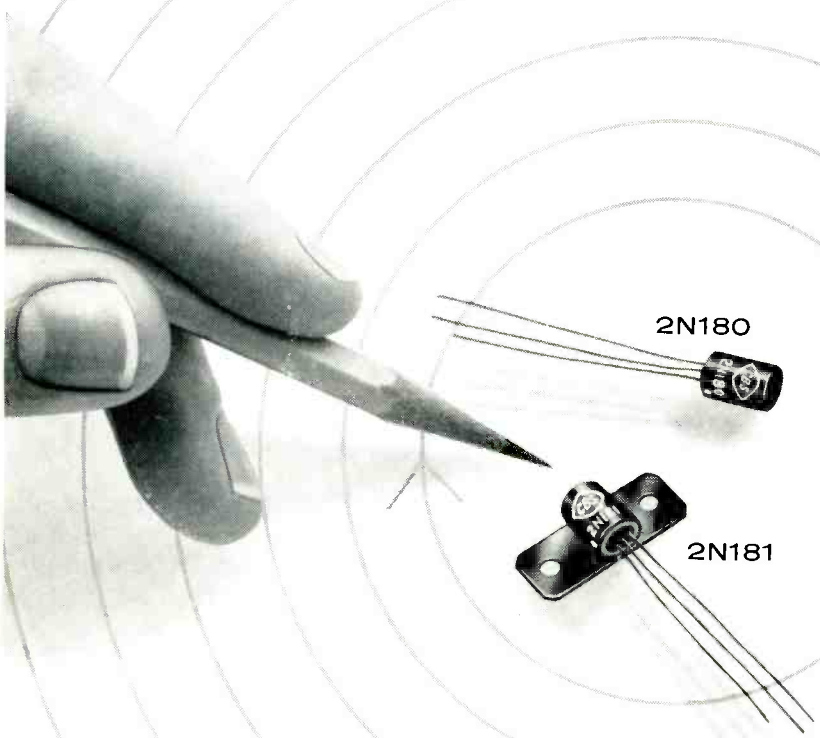


HERMETICALLY-SEALED TERMINALS with KEL-F plastic insulation handle high voltage without flash-over or tracking. Won't shrink, swell, age or lose hermetic seal at high and low operating temperatures. Can be used in contact with highly corrosive chemicals.

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.

Want more information? Use post card on last page.

Two new general-purpose 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.

CBS semiconductors

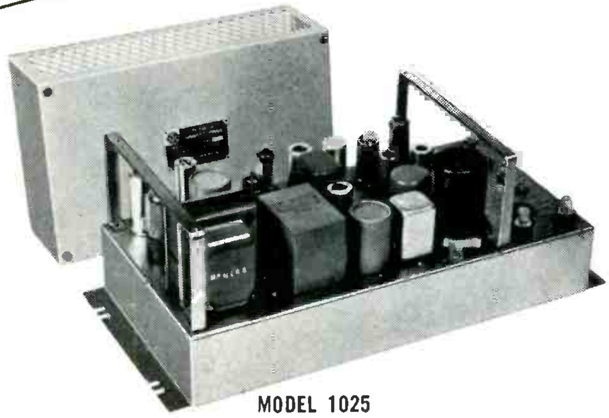
Reliable products
through Advanced-Engineering

CBS-HYTRON, Danvers, Mass.
A Division of Columbia Broadcasting System, Inc.

Telemetering and Telegraph Terminals

Frequency Type Telemeter Terminal

NEW



MODEL 1025

Model 1025

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

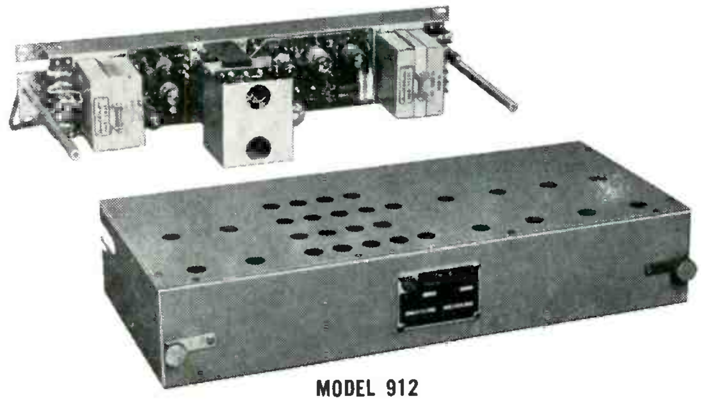
APPLICATION

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 Telemetering 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 transceiver, 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.

MODEL 995

Comtel Telegraph Terminal

POWER SOURCE
115 v ±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

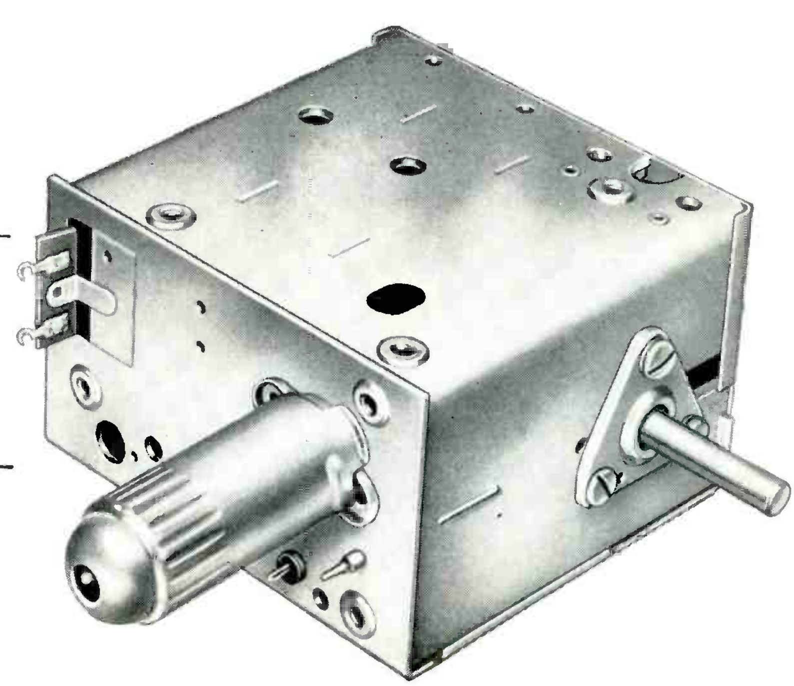
Each equipment contains its own power and loop supply and is available in either transceiver, dual transmitter or dual receiver. The unit is completely electronic and requires no relays. All essential controls such as transmitter output level, receiver input level, and bias are included.

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

UHF



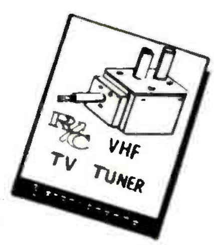
how we cut tuner costs without cutting quality corners

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.

The result is evident in the T-90 uhf TV tuner illustrated. Double-circuit tuned, it features oscillator radiation fixes . . . meets all RETMA spurious radiation requirements. Performance is just what you would expect from Radio Condenser, *but the T-90 costs you far less than any previous R/C uhf tuner!*

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

R/C

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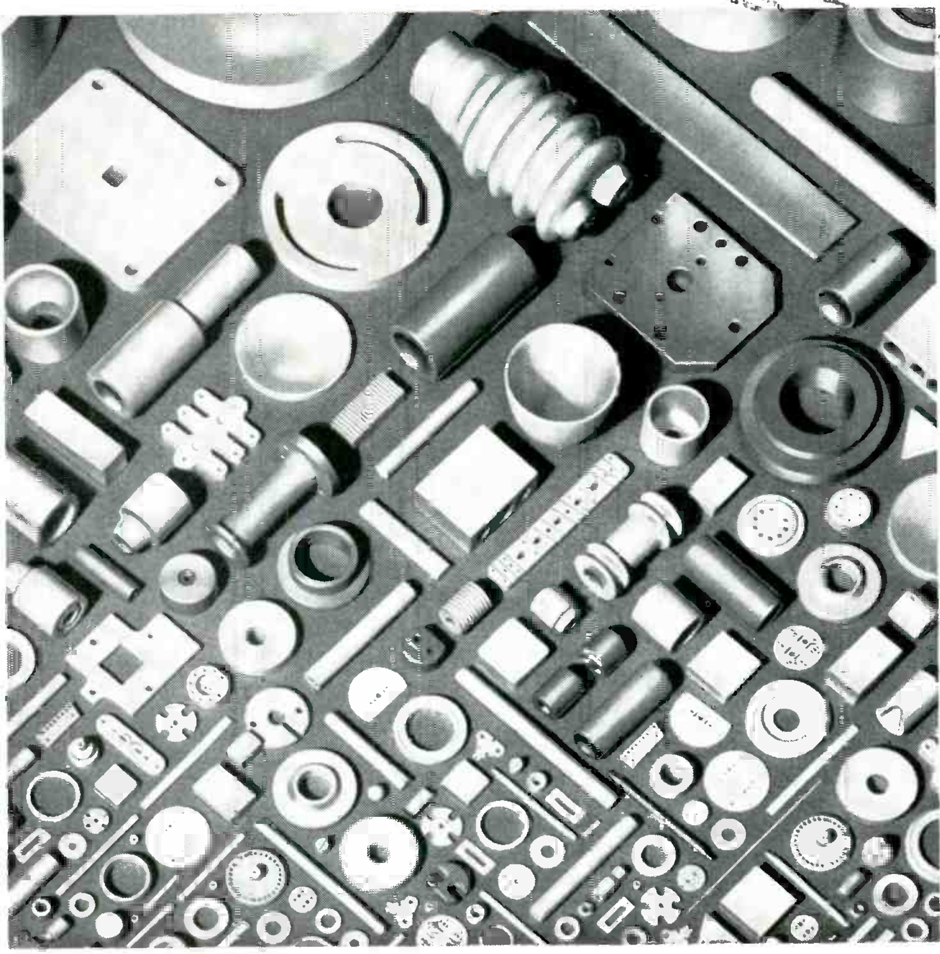
Improve your product with AlSiMag®

ALUMINA CERAMICS



STRENGTH. High compressive, flexural and tensile strengths.

STABILITY. Successfully withstand radiation bombardments and elevated temperatures without producing contaminants.

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.

RUGGEDNESS. Resist mechanical shock, vibration and high ambient or operating temperatures.

CHEMICAL INERTNESS. Will not rust, corrode or deteriorate with time.

PRECISION TOLERANCES. Can be fabricated to extremely close tolerances on dimensions. Parts as thin as .009" are practical in production quantities.

SURFACE FINISHES. Surfaces may be ground or polished to 10 micro-inches RMS or better.

HEAT SHOCK RESISTANCE. Not affected by elevated temperatures. Withstand repeated hot-cold shock.

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.

PLANTWIDE VACATION
First two Weeks of July

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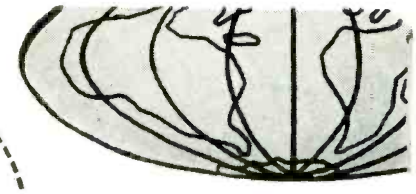
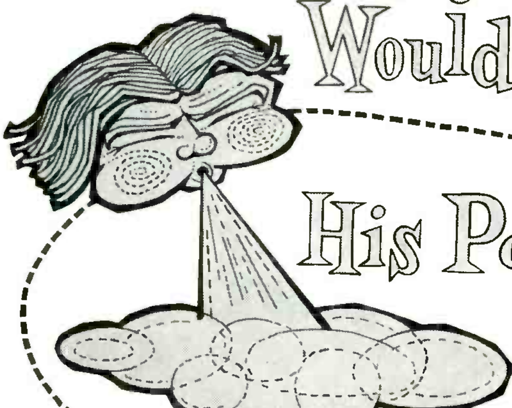
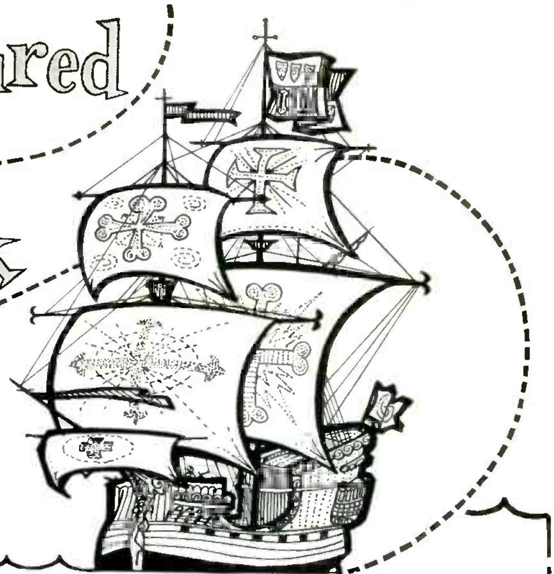
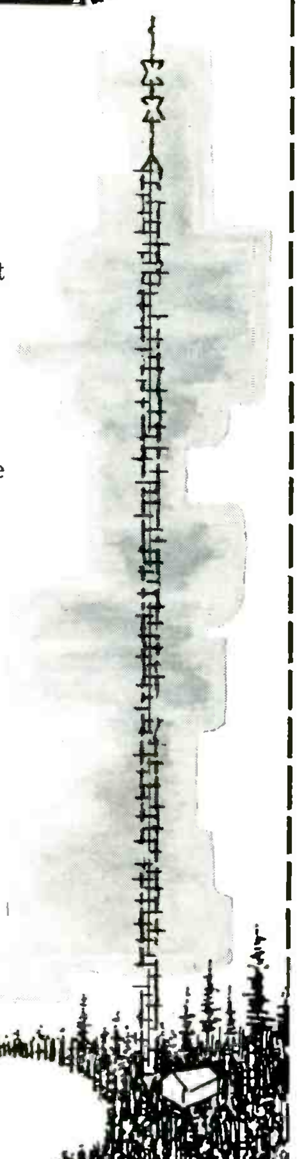




Magellan Would'a Fractured His Poopdeck



. . . matching TOWER'S Log!



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.

Write for free illustrated booklet

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Better Things for Better Living
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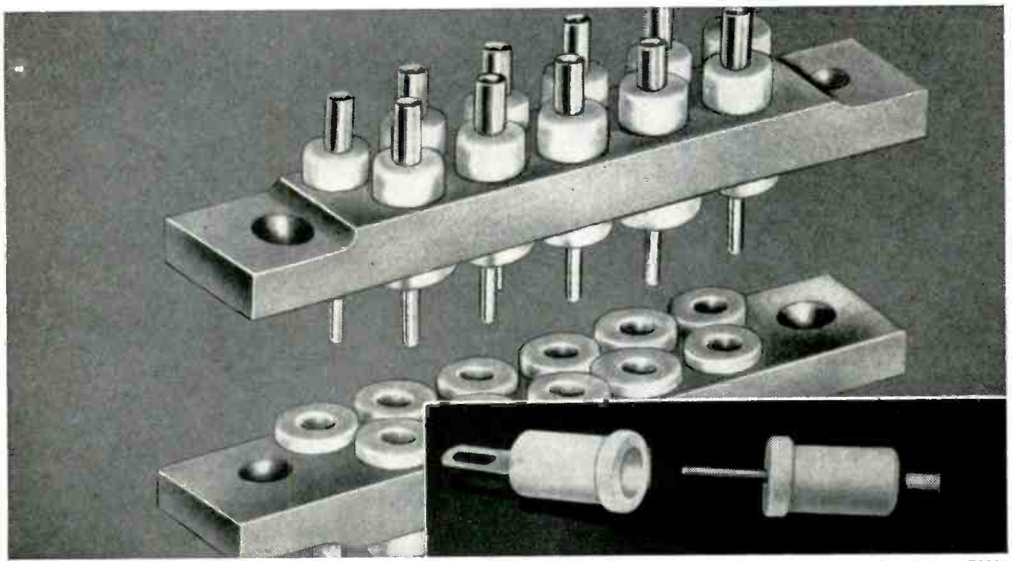
ELECTRONIC DESIGN NEWS

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

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.)

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.

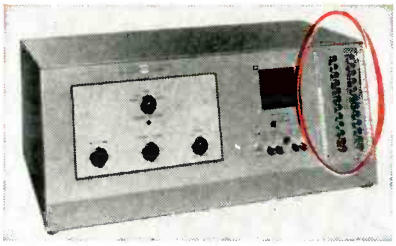
"Teflon" is nonflammable and will not carbonize under arcing; it has good dielectric strength. Resiliency of "Teflon" enables the insulation to expand to original diameter after it is pressed into the hole—and locks the connector securely and permanently in place.

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.

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.



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.)

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.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department
Room 224 Du Pont Building, Wilmington 98, Delaware.
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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 ________

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versatile

Multi-channel -- telegraph Al or telephone A3.

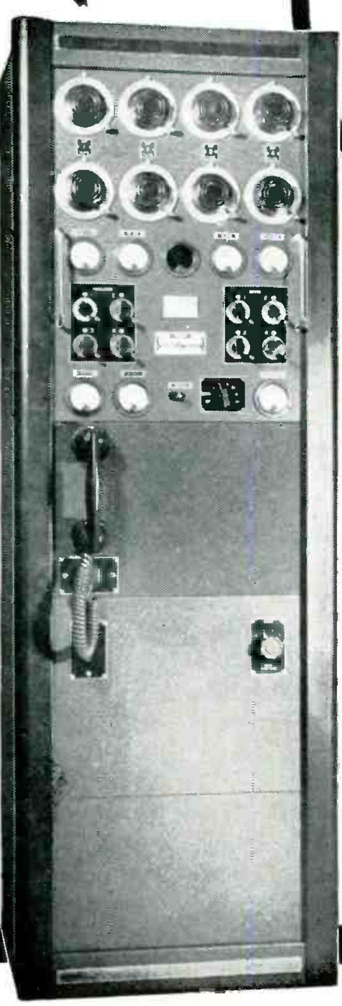
FROM GROUND TO AIR OR POINT TO POINT

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!

AER -O- COM

3090 DOUGLAS ROAD MIAMI 33, FLA.

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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

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

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

See Bulletin TE1335 for additional types and complete specifications.

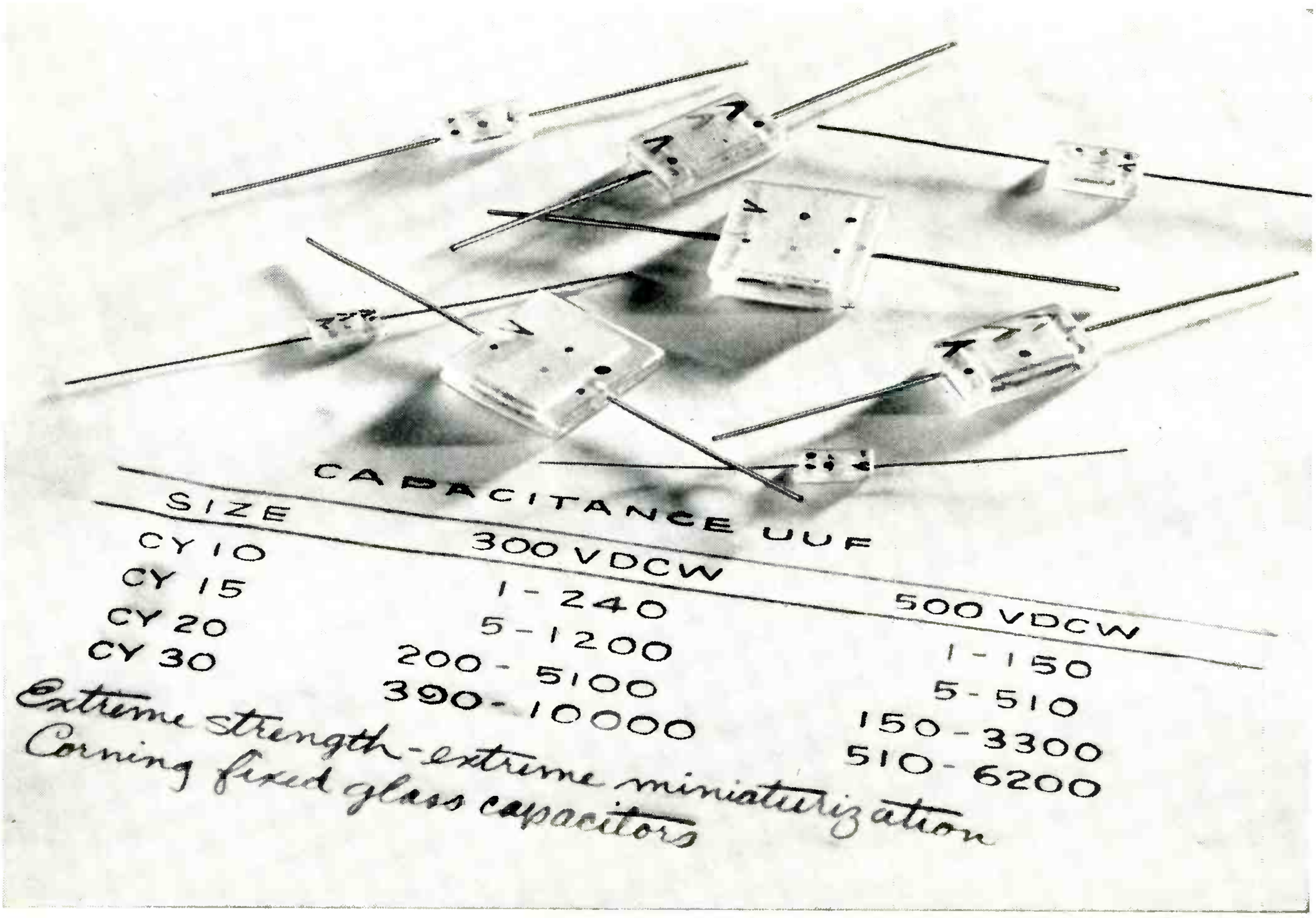
RATINGS AT 100°C AMBIENT

	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 TE1338 for additional types and complete specifications.

* JAN types

Transitron
electronic corporation melrose 76, massachusetts



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 temperatures 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:

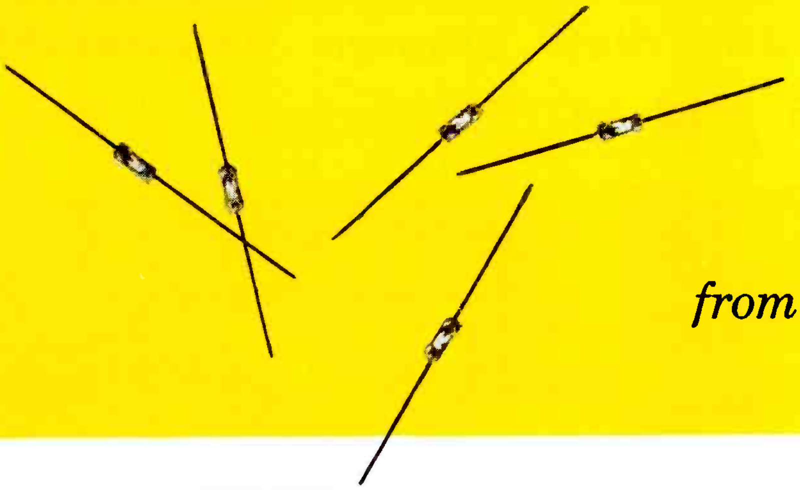
Fixed Glass Capacitors*, Transmitting Capacitors, Canned High-Capacitance Capacitors, Subminiature Tab-Lead Capacitors, Special Combination Capacitors, Direct-Traverse and Midget-Rotary Capacitors*, Metallized Glass Inductances, Resistors.

**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.

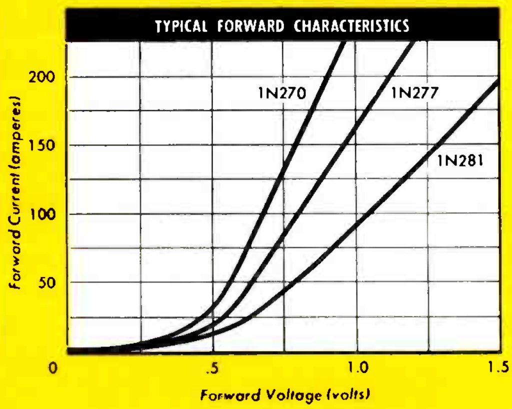
Transitron's gold bonded diodes are characterized by reliability under the most severe operating conditions. This is achieved by rugged construction and 100% testing of electrical and mechanical characteristics.

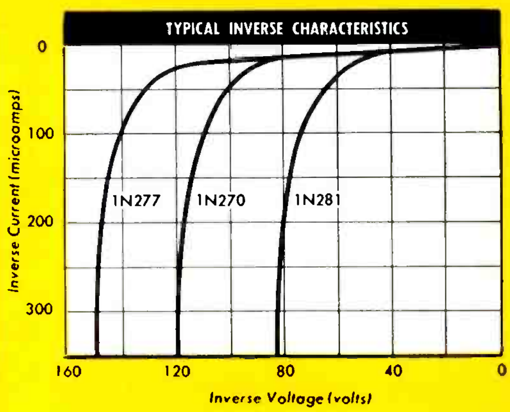
WRITE FOR BULLETIN TE-1319.

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

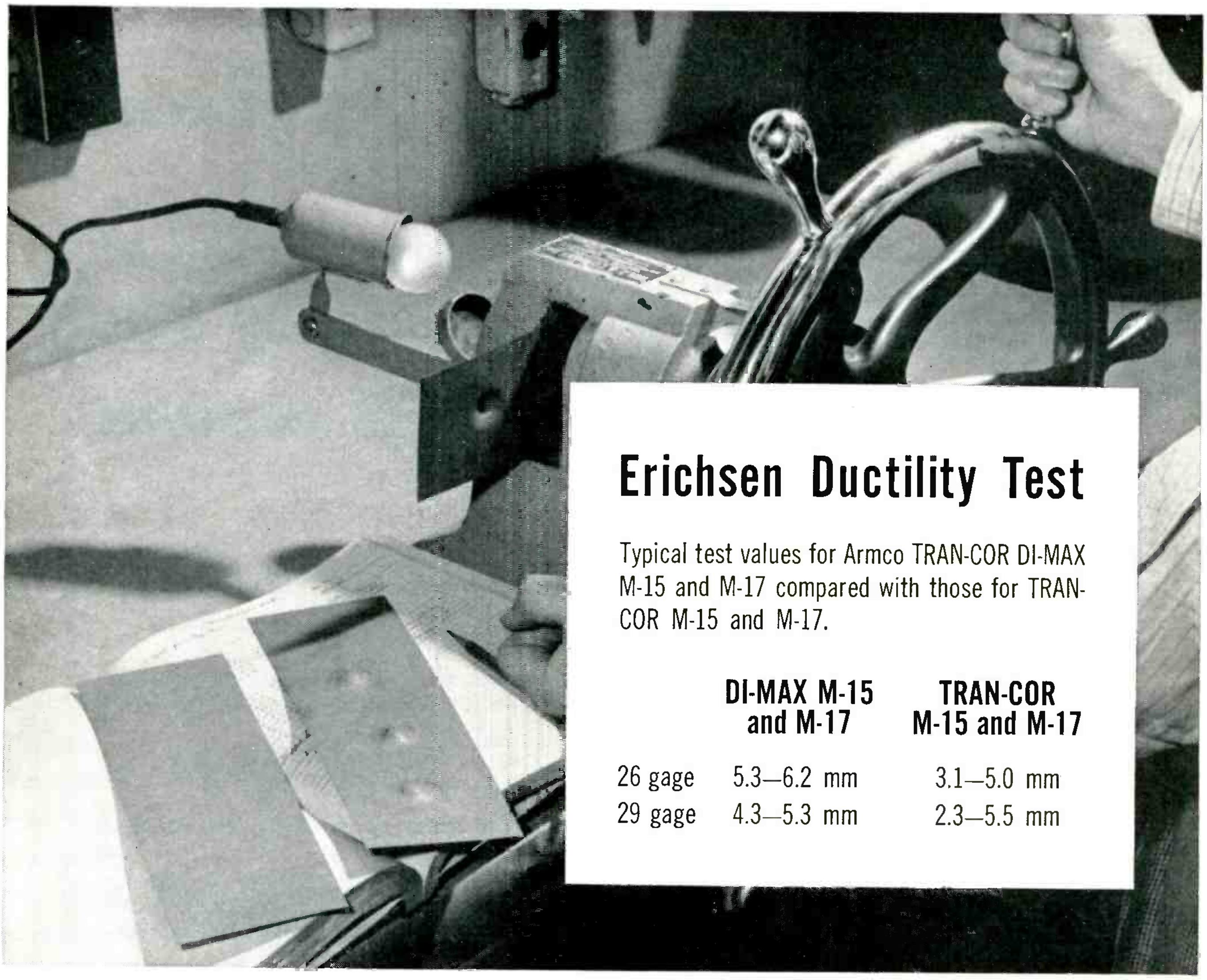
***JAN types**





Transitron
electronic corporation melrose 76, massachusetts

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.

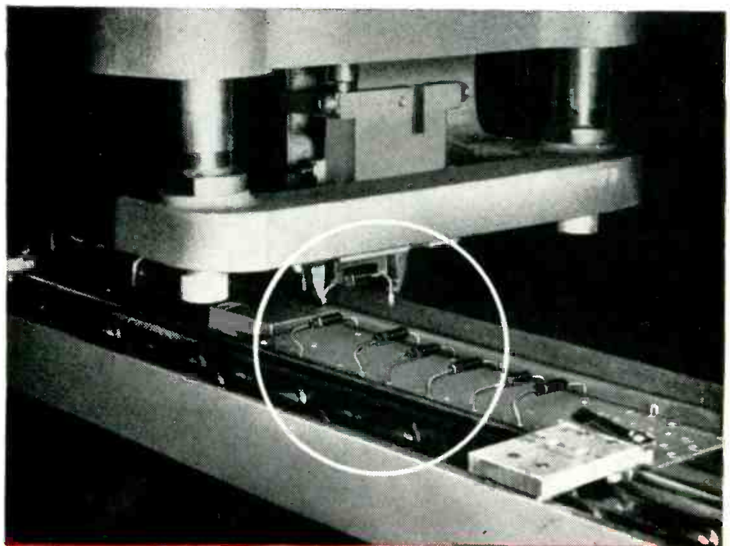
ARMCO STEEL CORPORATION

1146 CURTIS STREET, MIDDLETOWN, OHIO

ARMCO ®

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

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

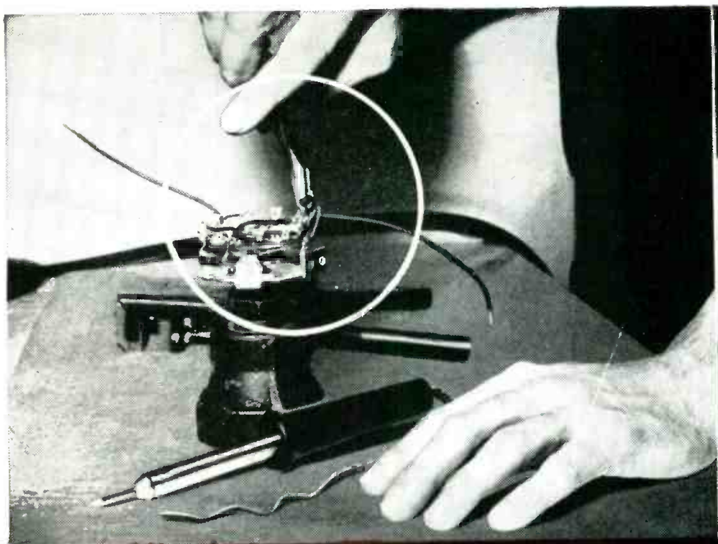
Leads of IRC Type BT Resistors are so securely joined to the element that even the unmolded assembly exceeds the standard 5-lb. pull requirement. For still greater strength, leads have a crimped collar which provides a tooth-and-notch effect when the assembly is molded as a unit.

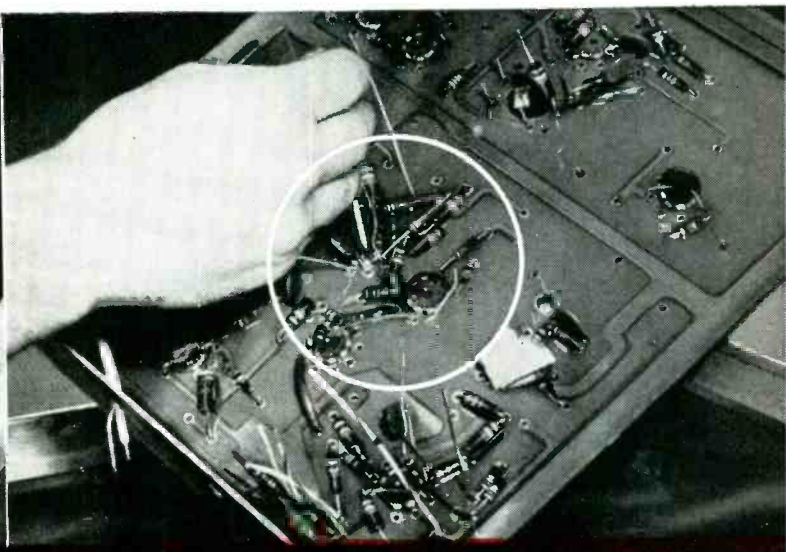
Straight Leads Speed Automation

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.

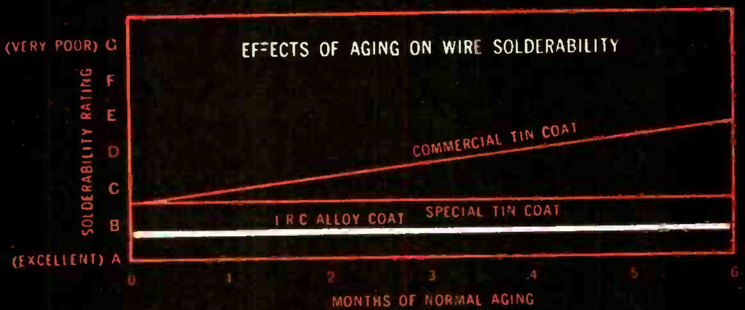
Because they can be bent up to resistor body, IRC leads solve special "fit" problems and simplify production and soldering operations.

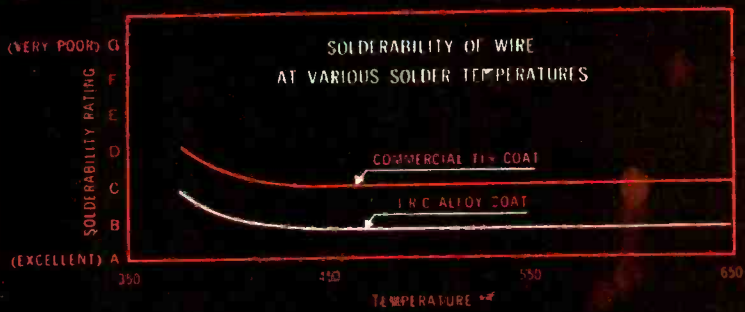
New alloy surface on leads overcomes tendency of copper to migrate toward coating. This assures superior solderability by any method, with low or varying temperatures.



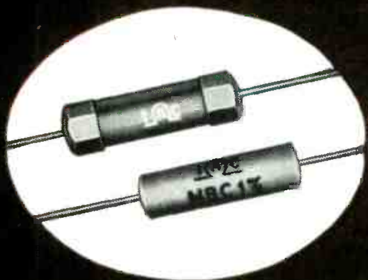


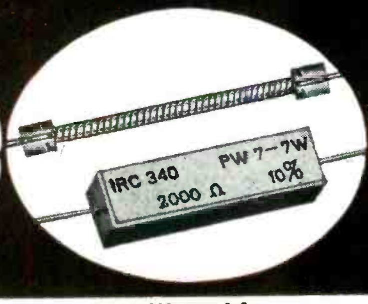
here's how much IRC's new alloy coating improves solderability

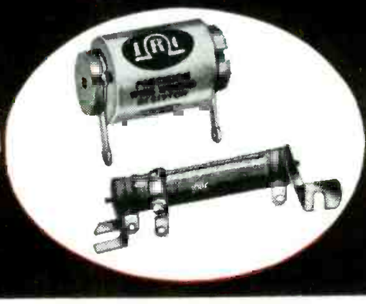


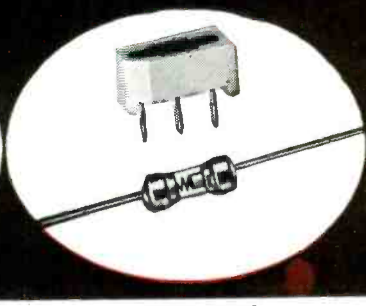


EXTRA TERMINAL SECURITY ALSO FEATURES OTHER IRC RESISTORS









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

IRC

Precision Wire Wounds • Ultra HF and Hi-Voltage Resistors • Selenium Rectifiers • Insulated Chokes • Hermetic Sealing Terminals

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Los Angeles, California
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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____________________

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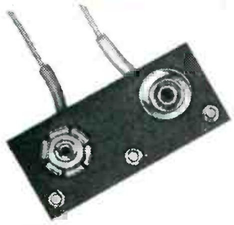
City____________ State________

Ucinite Electrical Assemblies



BATTERY CONNECTORS

Wired snap-on 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

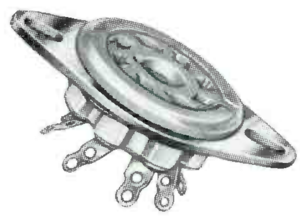
Offered in several sizes — brackets and durometer of rubber bushings can be varied. With threaded Teenuts or plain bushings. Insulated versions if needed.

ANODE CONNECTORS

Plug button contacts for positive firm connections. Corona resistant neoprene or silicon shields in straight or right angle types. Wiring to customers 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.

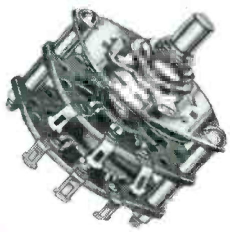


TUBE SOCKETS

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.

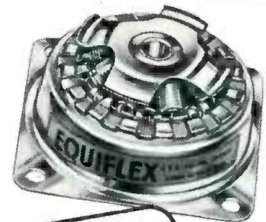


SNAP SWITCHES

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.

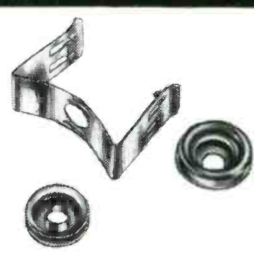


VIBRATION ISOLATORS

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.



ELECTRICAL ASSEMBLIES
Ucinite
RADIO AND AUTOMOTIVE

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

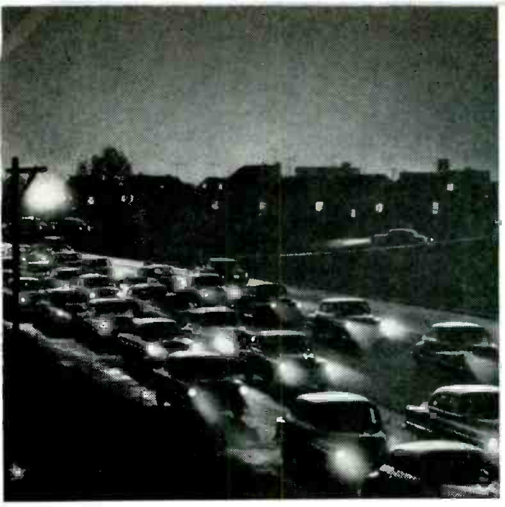
DIVISION OF UNITED-CARR FASTENER CORP.

Newtonville 60, Massachusetts

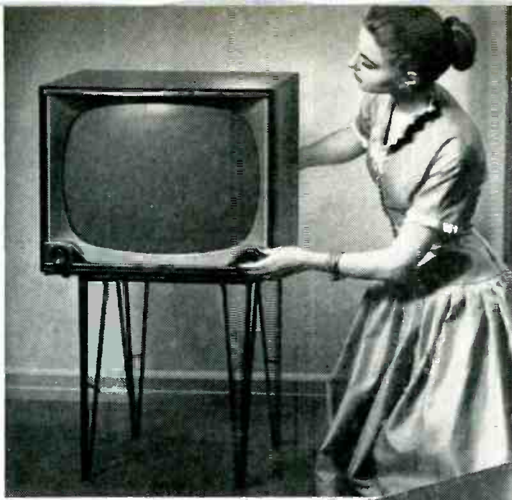
Picture flutter from planes flying overhead is greatly reduced.

In fringe-reception areas, there is less picture roll.

Lightning will not materially affect sync—cause picture distortion.



Passing automobiles leave the picture steady, free from distortion and jitter.

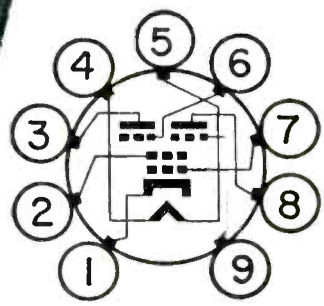


◀ **ALSO** . . . . . no more bothersome "both-hands" tuning of the set! The distance switch can be eliminated—another 6BU8 plus and cost-saver. When choosing programs, viewers no longer need manipulate two controls: tuning knob and distance switch. One control knob will tune in *all* stations, near and 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.

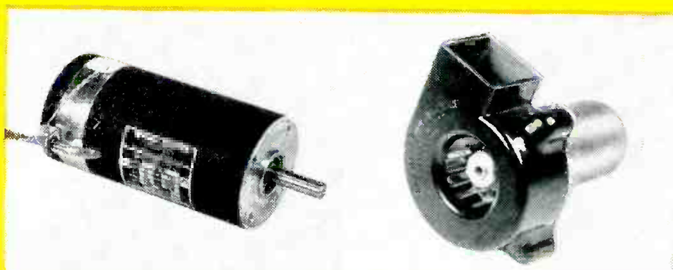


Progress Is Our Most Important Product

GENERAL ELECTRIC

162-1A3

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*

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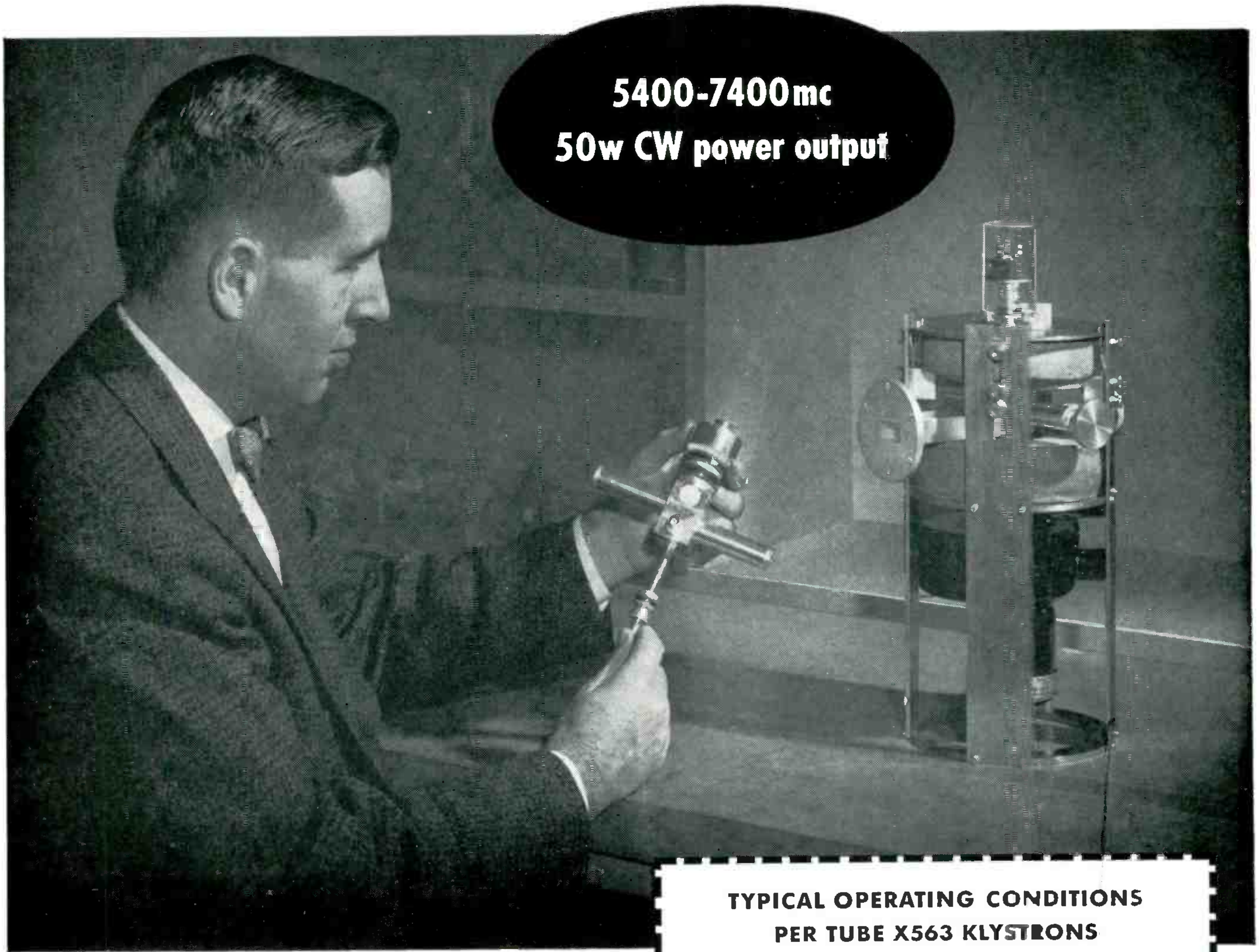
PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON — REPRESENTATIVES IN ALL PRINCIPAL CITIES

EIMAC Klystrons bring new power to another frequency range...



Eimac X563E, 5900-6400mc, and amplifier circuit assembly.

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

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 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.*

Eimac

EITEL-McCULLOUGH, INC.
SAN BRUNO • CALIFORNIA
The World's Largest Manufacturer of Transmitting Tubes

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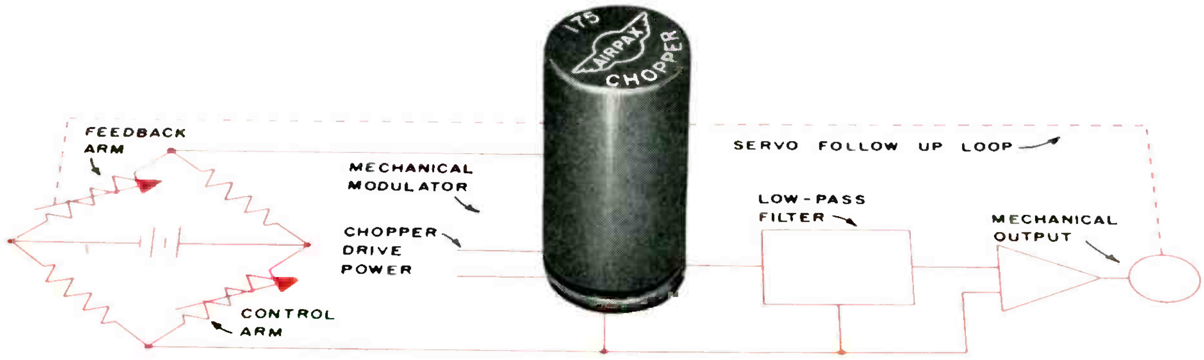
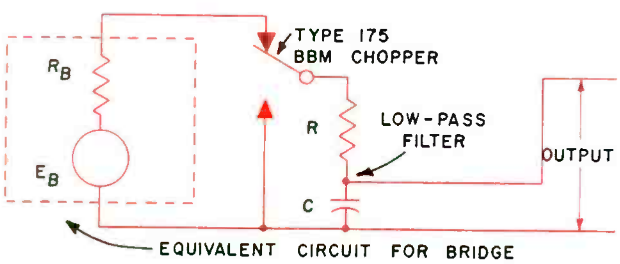
HIGH IMPEDANCE MODULATOR



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 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.



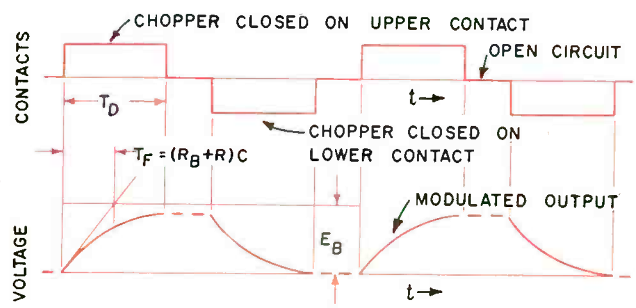
In basic modulator circuit, chopper alternately connects filter across bridge and then shorts filter

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 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.



Upper diagram shows timing of chopper action, lower one shows effect of low-pass filter on output

For further recommendations on the chopper best suited to your particular requirements, write to

AIRPAX PRODUCTS COMPANY

DESIGNERS — ENGINEERS

MIDDLE RIVER — BALTIMORE 20, MD.

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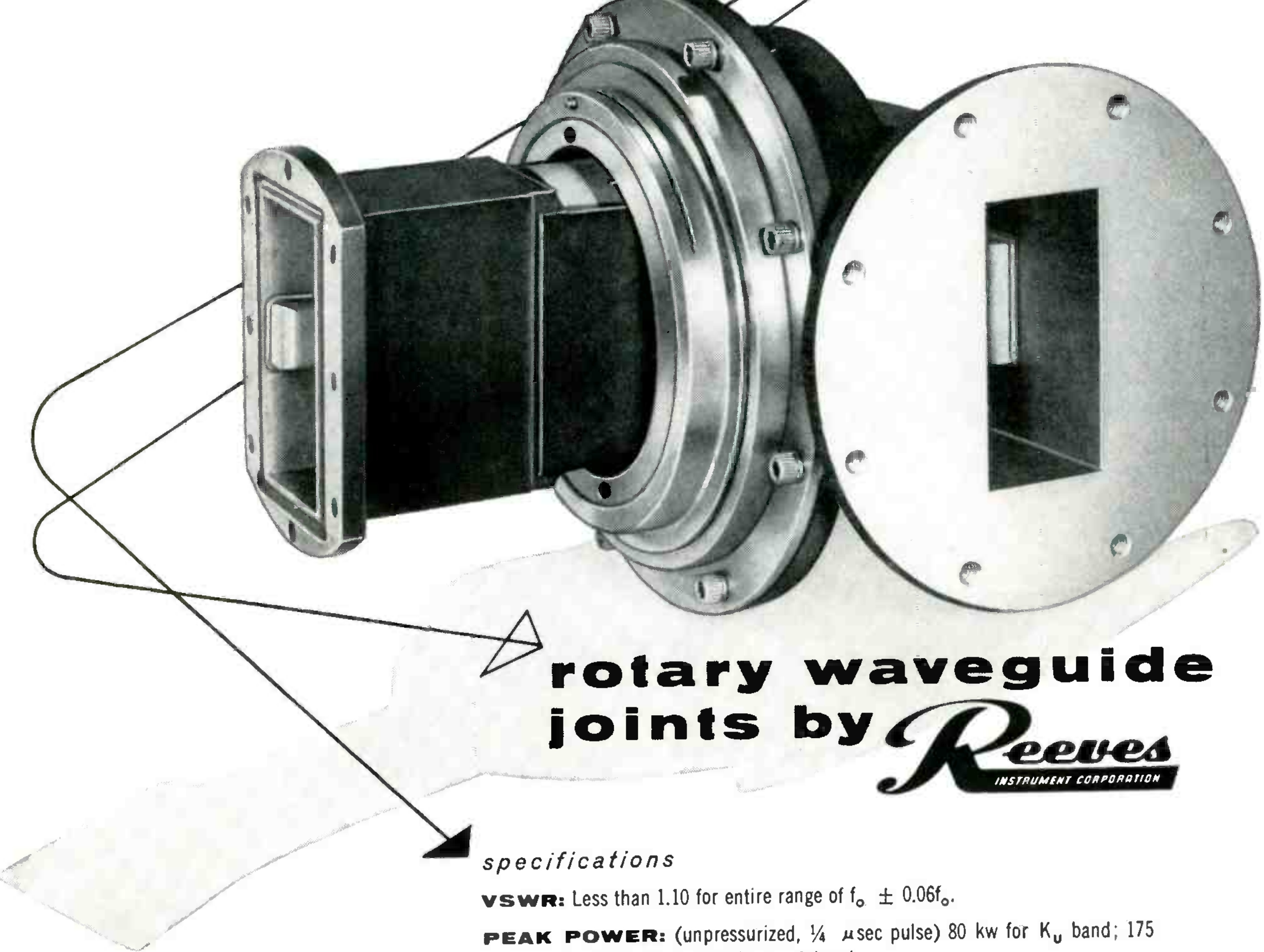
low VSWR
compact
high speed...



rotary waveguide joints by Reeves

INSTRUMENT CORPORATION

specifications

VSWR: Less than 1.10 for entire range of $f_o \pm 0.06f_o$.

PEAK POWER: (unpressurized, ¼ μsec pulse) 80 kw for K_u band; 175 kw for X band; 1500 kw for S band.

PEAK POWER: (pressurized, ¼ μsec pulse) approximately proportional to square of the absolute pressure.

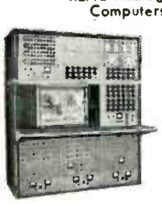
HIGH ROTATIONAL SPEEDS: Center conductor supported in oilite bearing; main housing supported on ball bearing.

LOW LEAKAGE: RF chokes incorporated to prevent leakage.

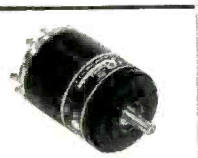
MEETS MIL SPECS: Including weatherproofing for outdoor use.

NO WOW: Coaxial design eliminates amplitude changes with rotation.

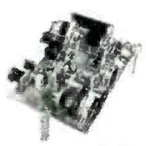
REAC Analog Computers



Precision Floated Gyros



Precision Resolvers and Phase Shifters



Servo Mechanical Parts

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.

Write for complete details and operational data and curves.

Reeves
INSTRUMENT CORPORATION

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A Subsidiary of Dynamics Corporation of America
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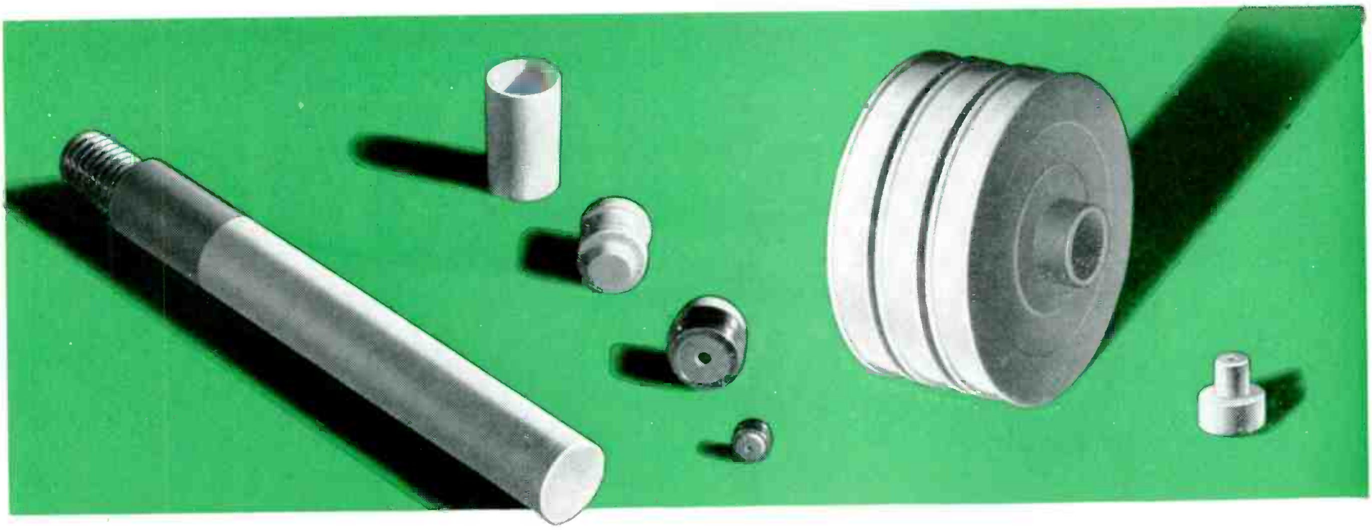


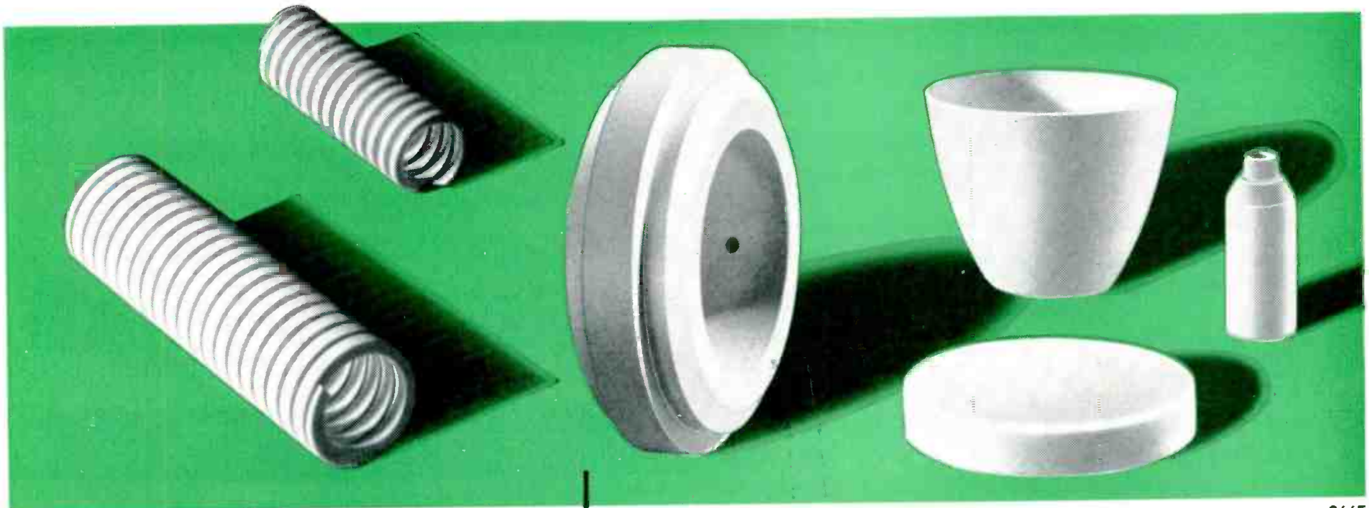
What properties of ALITE will serve you best?

- *Its diamond-like hardness?*
- *Its electrical resistivity?*
- *Its high temperature characteristics?*

Alite is a sintered metallic oxide with decidedly interesting properties. It is so hard, for example, that only a diamond can scratch it. It maintains excellent dielectric properties from power frequencies throughout the entire spectrum into the super high frequency range. It retains its high mechanical strength at temperatures even beyond 2000°F. In its resistance to chemical attack it is comparable to fine quality chemical porcelain.

How is it used? In such mechanical applications as rotating seals, pump plungers, slide valves, cutting tools, sleeve bearings, bushings, extrusion dies. In electronic applications as tube envelopes, as insulating supports. It can be joined to itself or to unrelated materials with a vacuum type bond.

Certainly, any engineer concerned with material specification in mechanical, electronic, or nucleonic design problems should be thoroughly familiar with Alite and its possibilities. Bulletin A-7 tells the story. It is free on request. Write for it today.



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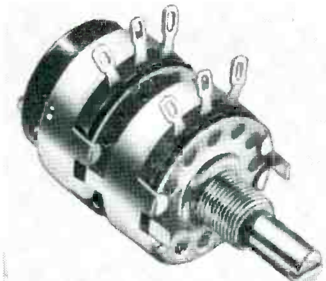
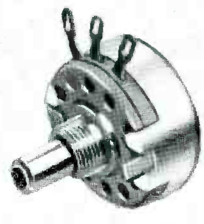
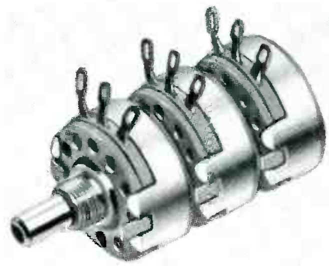
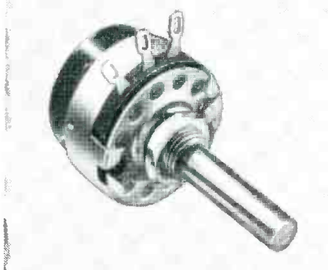
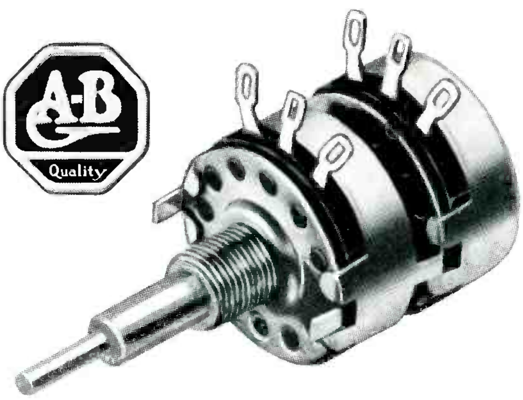

Type J dual control with line switch


Type J resistor with short shaft and lock-type bushing

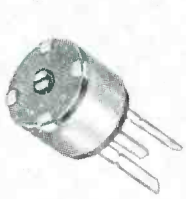

Type J single-unit resistor with plain, short shaft

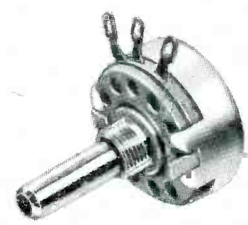

Type J triple-unit resistor


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


Type J single-unit variable resistor with long shaft

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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—½ watt—½ inch in diameter. Type GP units have long terminals for printed circuit applications.

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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 when our hindsight is pretty dim. Take the age-old standard-versus-custom argument, for example.

As everyone knows by now (we grow hoarse repeating it) we offer by far the longest, most diversified list of catalog power supplies in the industry—over 500 models, and hundreds of "quickie" stock variations.

Every month, in addition, we design and build about $100,000 worth of custom power supplies . . . and every time we complete 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 of different people, we begin to worry . . . does it belong in the regular catalog? Maybe not, but we're going to try a compromise:

We've selected about 200 of the most-frequently-requested custom supplies, and prepared a Custom-Design File, which we'd like to send you. Here are a few samples:

VOLTAGE RANGE	CURRENT RANGE	[illegible]	[illegible]	TYPE	MODEL	PRICE
200-2000	0-200 ma	1 volt	1% line, or load	Series-tube reg.	CS-3308	$1200.00
0-350	0-3 amp.	10 mv	0.25% L or L (or 0.08 volts)	"	CS-3443	1300.00
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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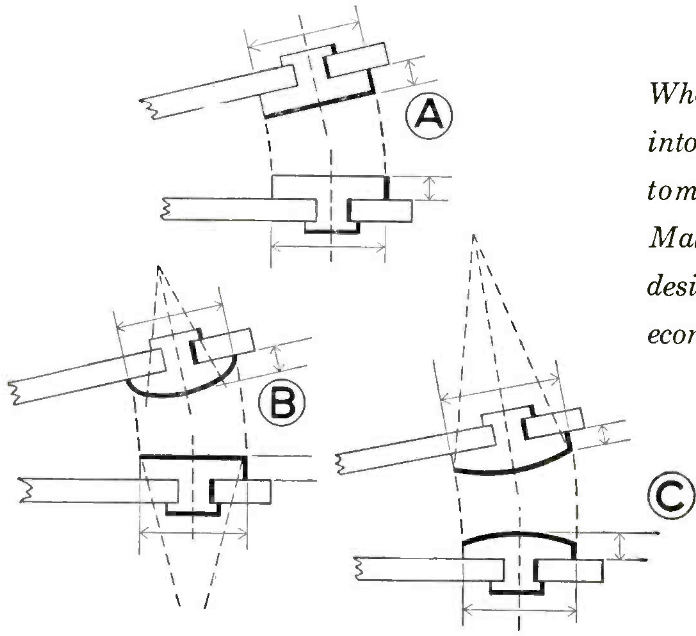

When Original Design A ran into alignment trouble, the customer proposed design B. Mallory engineers recommended design C as the most efficient and economical solution.

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2. **The most economical contact design . . .** for your purchasing, production and product needs.
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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.

There's a good chance that you can realize comparable savings on your own contact applications, by bringing your problems to Mallory specialists. The complete engineering job that our staff can undertake will assure you of gaining the maximum in performance . . . at the peak of economy . . . for your specific requirements. For a consultation, write or call Mallory today.

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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

By JOHN BETHKE

Applications Engineering Department
Haydu Brothers of New Jersey
Plainfield, New Jersey
Subsidiary of Burroughs Corp.

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.

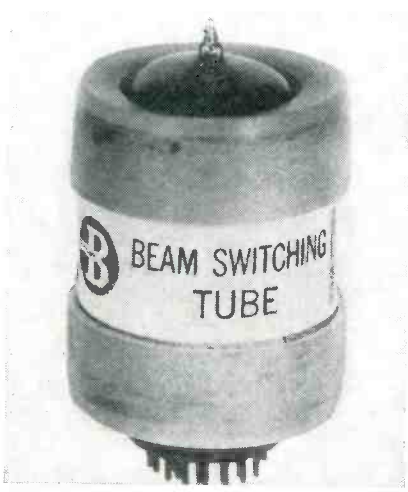
With the tube initially in this cut-off or cleared condition, the static voltage-current characteristic of an individual spade is represented by curve 1 of Fig. 2.

The dynamic spade characteristic, represented by curve 2, is obtained with the lagging spade at 0 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 would not intersect the static curve 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_s, 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

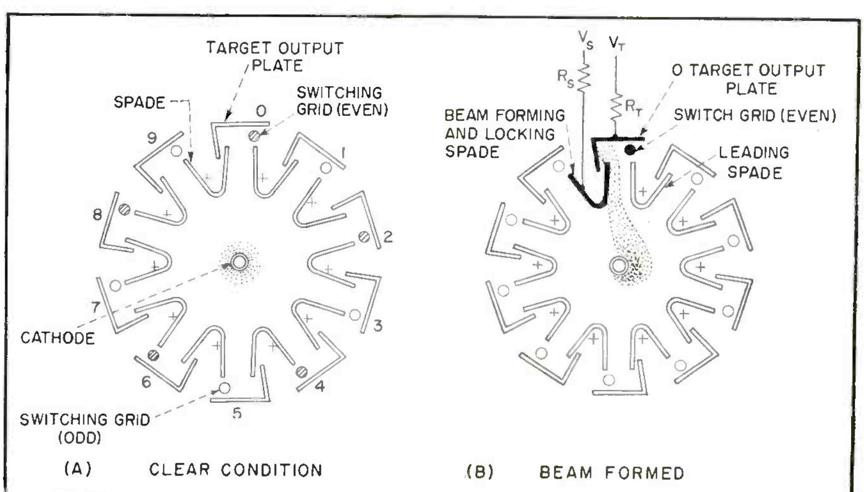


FIG. 1—Electron beam in 450-gauss axial magnetic field serves as equivalent of contact arm in switching from one to another of the ten target output plates under control of spade and grid potentials. Tube designation is now type 6700 (formerly type MO-10)

Beam Switching Tubes

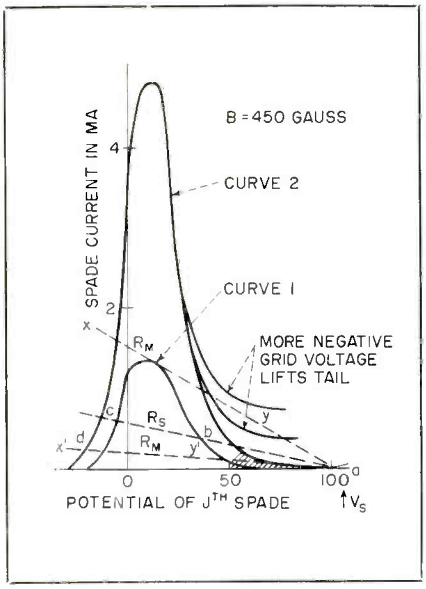


FIG. 2—Spade characteristic curves

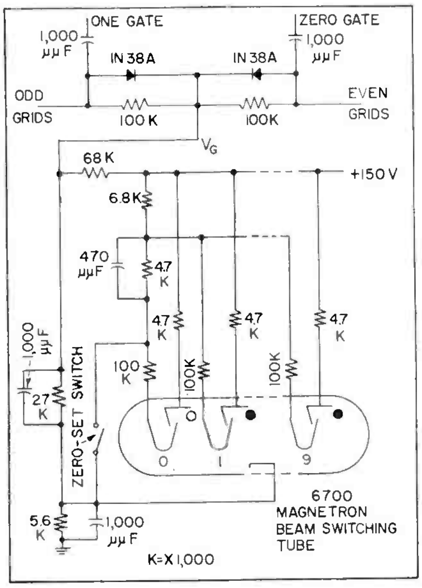


FIG. 3—Basic switching circuit

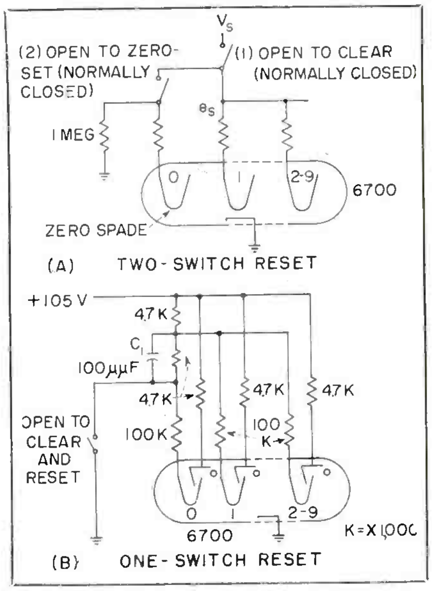


FIG. 4—Resetting circuit arrangements

lowering the potential of the respective spade from point *a* to where the negative charactertistic 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 potential of the switching grids. Making the grids more negative raises the right-hand portion of the dynamic characteristic so that load line R_s 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 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

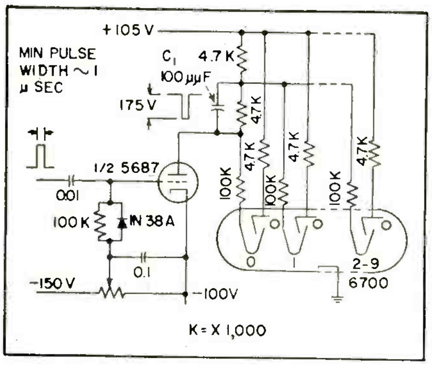


FIG. 5—High-speed clear and reset circuit using direct coupling

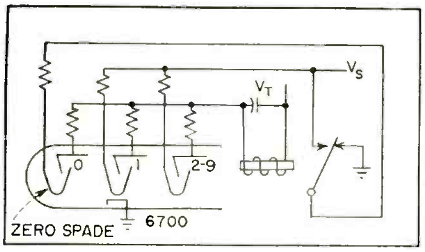


FIG. 6—Automatic zero reset circuit

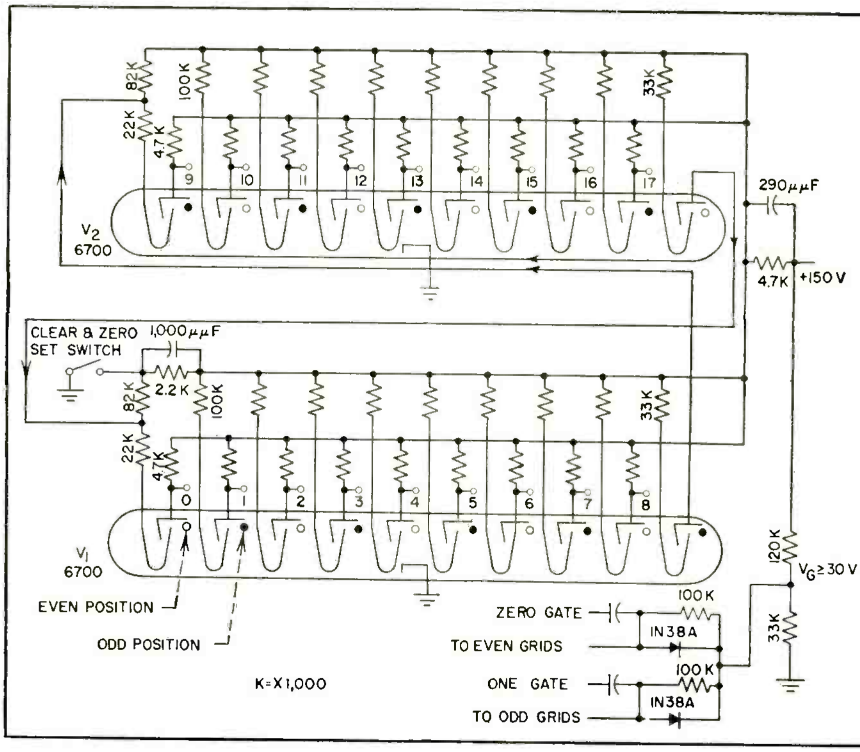


FIG. 7—Multiposition distributor using two type 6700 magnetron beam switching tubes

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 and is slowed in its recovery by C_1, 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 termination of the pulse, when the voltages begin to recover to B+, the 0 spade voltage recovery is retarded by C_1. Thus, when the spade bus recovers, the beam will form to the spade with the low potential.

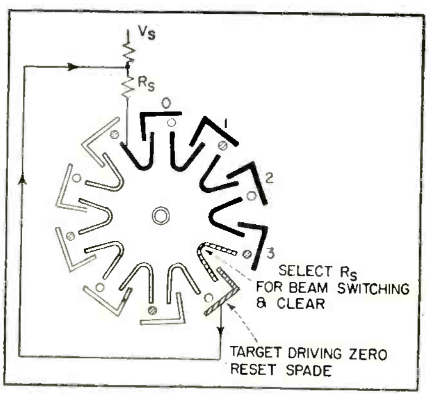


FIG. 8—Tube interconnection for four-position indication

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 scalers 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

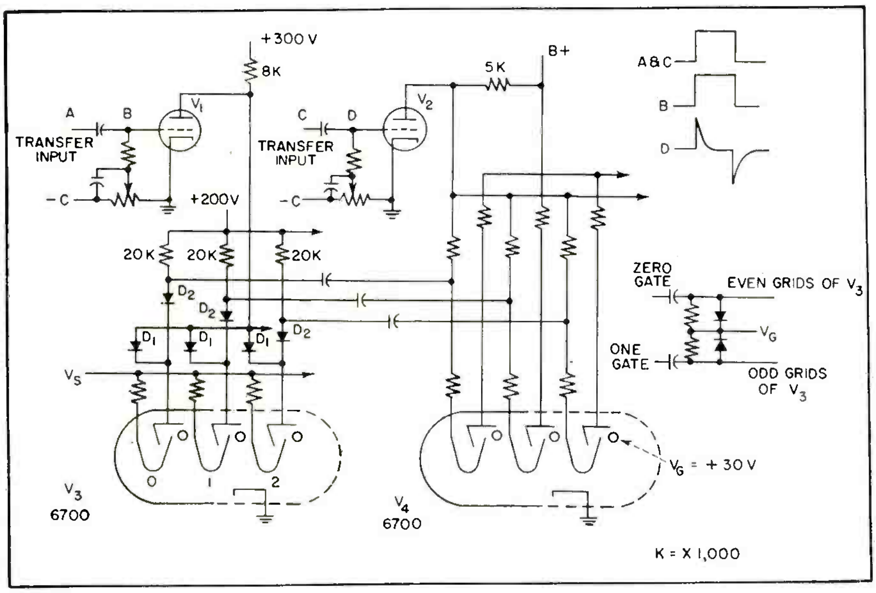


FIG. 10—Transfer-storage circuit using two switching tubes

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 9*N* 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

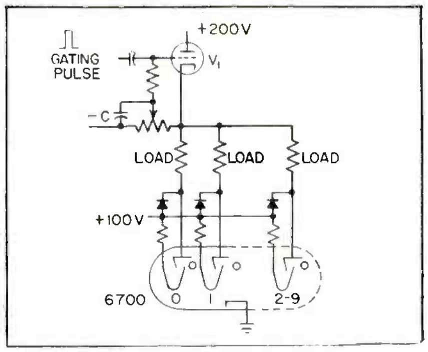


FIG. 9—Single-triode gating circuit

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

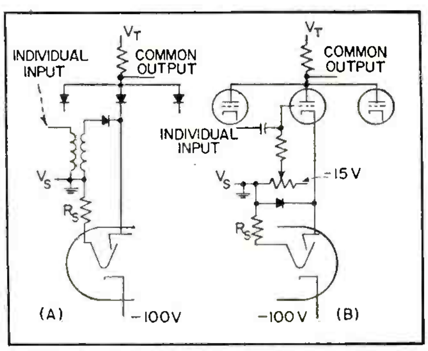


FIG. 11—Beam-gated sampling circuits

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_4 to spades

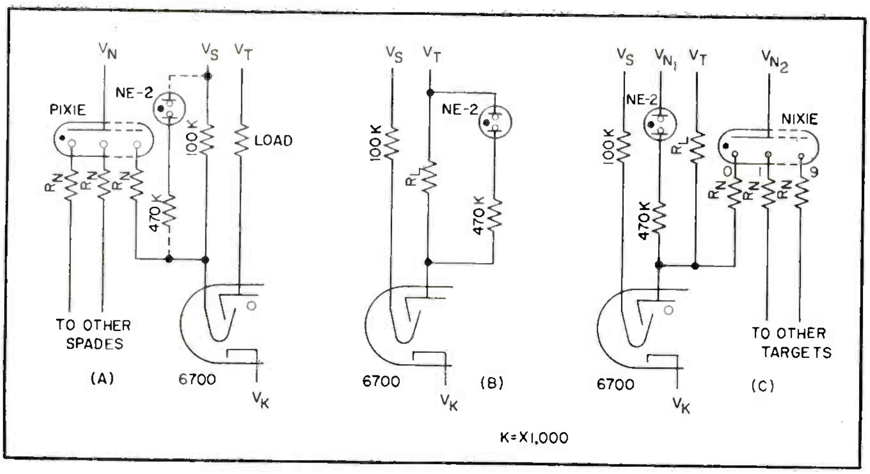


FIG. 12—Three methods of obtaining visual read-out

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.

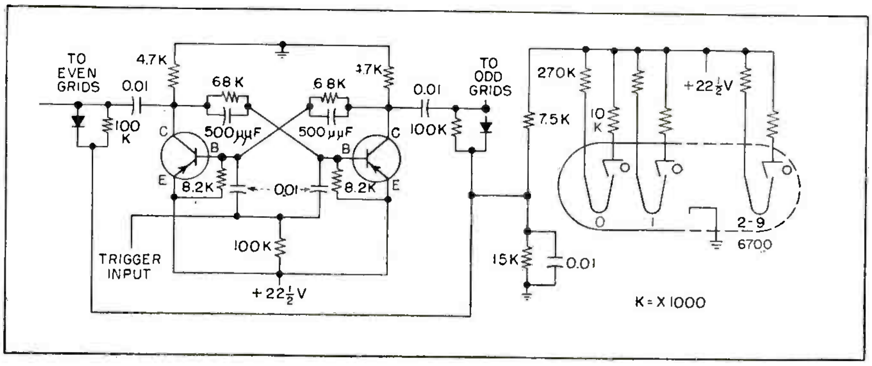


FIG. 13—Transistor driver used with low-voltage version of beam switching tube. One switching tube can do all the functions of approximately twenty transistors

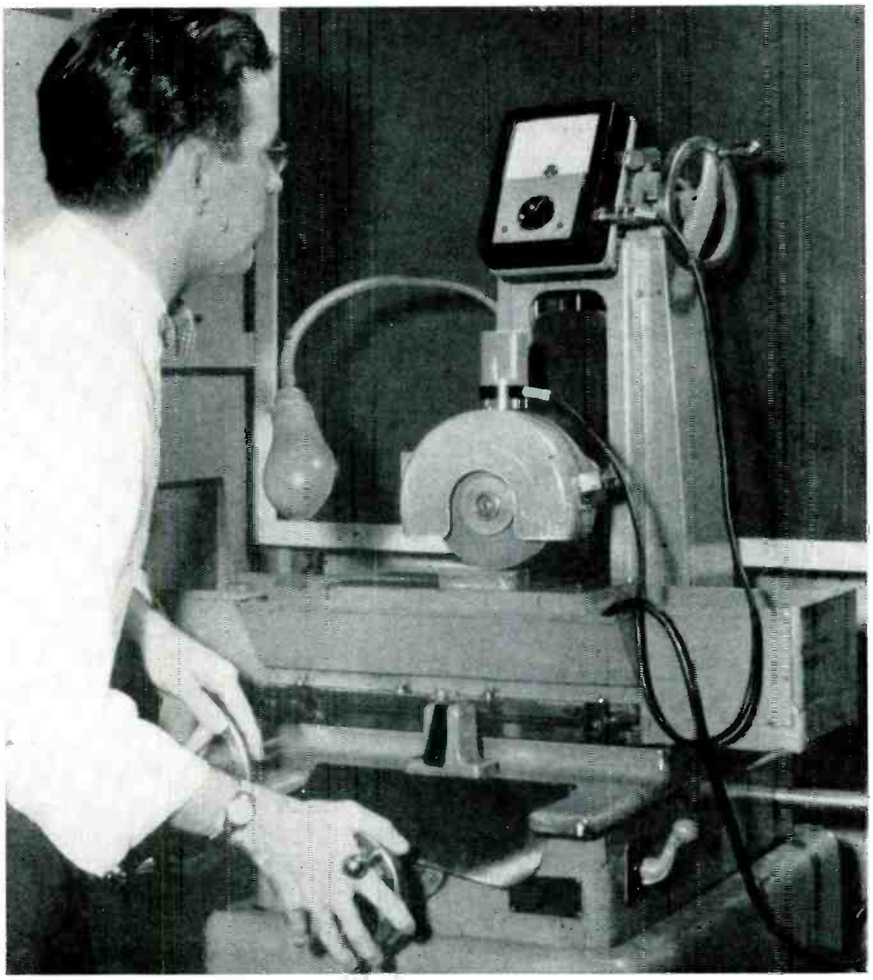
VIBRATION METER Uses Transistors

By JOHN F. KINKEL and M. CARR WILSON

Consolidated Electrodynamics 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.



Engineer uses transistor vibration meter to check performance of grinding machine

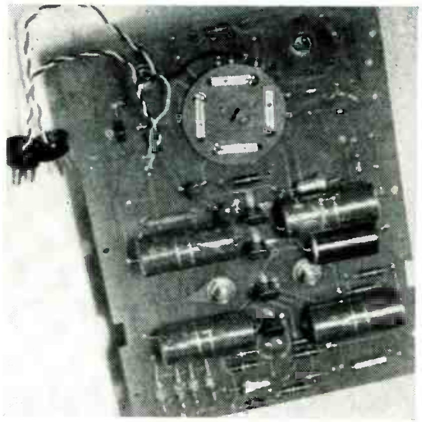
Vibration in machine tools can substantially reduce tool life and adversely affect quality. Vibrations of only 0.00006 in. amplitude in a grinding machine can produce marked degradation in the quality of a ground surface.[1,2] The shift from propeller-driven to jet aircraft has produced a significant 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]

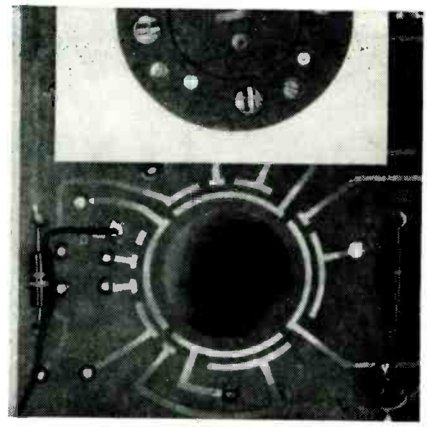
Design Requirements

Portability of vibration-measuring equipment is important in preflight 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





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 vibration 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-frequency 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-μf 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

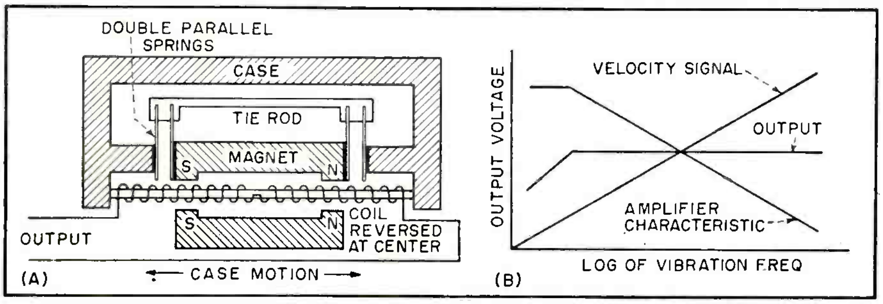


FIG. 1—Electromagnetic vibration transducer used as pickup (A) and voltage-frequency transfer characteristics of system (B)

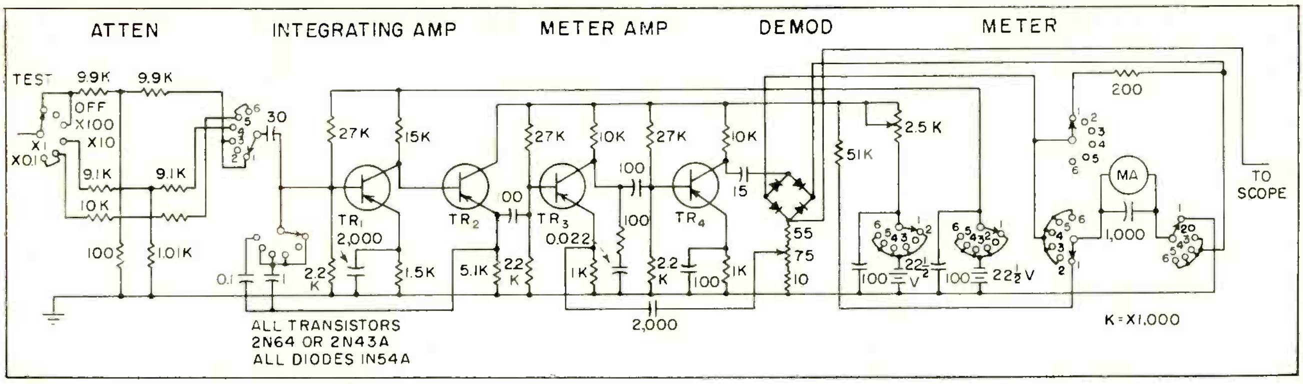


FIG. 2—Integrating amplifier uses one grounded-emitter and one grounded-collector stage. Meter amplifier uses two grounded-emitter stages. Range switch controls input attenuator

diode forward-current characteristics for normal small diode back-current values. Feedback voltage appears across the 75-ohm potentiometer in the output of TR_4. The potentiometer acts as a gain control.

The fourth-stage output is available at a jack and can be observed with an oscilloscope or a recorder having an input impedance in excess of 10,000 ohms.

The overall frequency response referred to 100 cps is given in Table I. A significant factor in frequency performance is the temperature sensitivity of the electrolytic bypass capacitors. Increase in internal series resistance at low temperatures increases degeneration in stages 1, 3 and 4.

Another significant temperature effect is the variation in collector current cutoff I_{co} of the transistors. The biasing networks have been designed to stabilize the circuit against variations in this parameter over the temperature range.

Current drain from the two batteries differs in a ratio of roughly 3 to 1. Hence the internal resistance of one will increase more rapidly than the other. The voltage of the battery having the greater drain is checked by the test-battery circuit and is adjusted by the 2,500-ohm resistor. Since the useful voltage to the predetermined endpoint of 15 v is governed by internal resistance, the batteries can be interchanged once to obtain greater useful life from both.

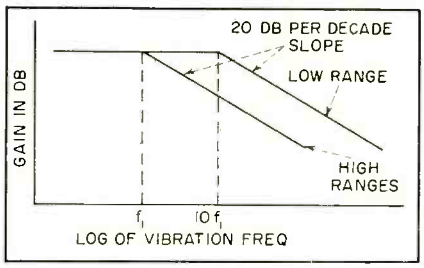


FIG. 3—Frequency response of meter on low and high frequency ranges

Design Features

The circuit lends itself to etched wiring. However, the geometry required for instrument compactness and the size of the special low-temperature capacitors require a two-sided etched board. All mounting and through connections on the board are eyeletted. The use of a two-sided board and the sensitivity of several components to soldering temperatures precluded dip-soldering. All heat-sensitive components are soldered using heat-sink pliers as a precaution.

All electronic components, including the meter, are mounted on the etched board, which is in turn assembled on the upper half of the die-cast case. Connection to the input and output jacks is by solderless sleeve-and-pin elements.

The two-sided etched board permits use of an etched equivalent to a conventional eight-pole six-position wafer switch. A detail of four poles is shown in a photograph. Switch elements and wipers are gold-plated. Switching is accomplished by wipers which short the inner races to the desired outer contacts. By proper orientation of the switch circuits on opposite sides of the board, it was possible to make both wiper disks identical.

The selector-switch knob and the indexing mechanism are integral with the case. The mechanical driving connection between the knob and wiper disks is a flatted bar which slides into the slot in the wiper disks. The indexing mechanism has a spring return action in the test-battery position, returning the switch to OFF upon release to reduce battery drain.

The carrying handle can be pivoted to form a supporting stand holding the instrument at 30 deg.

The authors acknowledge the contributions of R. L. Sink and Norton W. Bell for origination and development of the instrument and F. Walsh for styling and design.

Table I—Overall Frequency Response

Range	Frequency in cps	Tolerance in percent	Temperature in deg F
×0.1	50–1,000	± 5	−20 to +120
×1, ×10, ×100	10–1,000	± 5	0 to +120
×1, ×10, ×100	20–1,000	± 5	−20 to +120
×1, ×10, ×100	10–1,000	±10	−20 to +120

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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 neccesary 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.

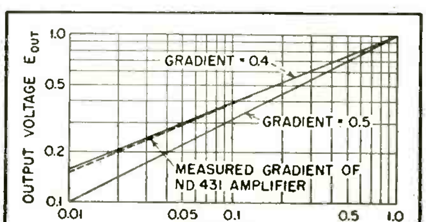

FIG. 1—Measured transfer characteristic of gamma correction amplifier

It has been shown[2] 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

Color TV Transmitters

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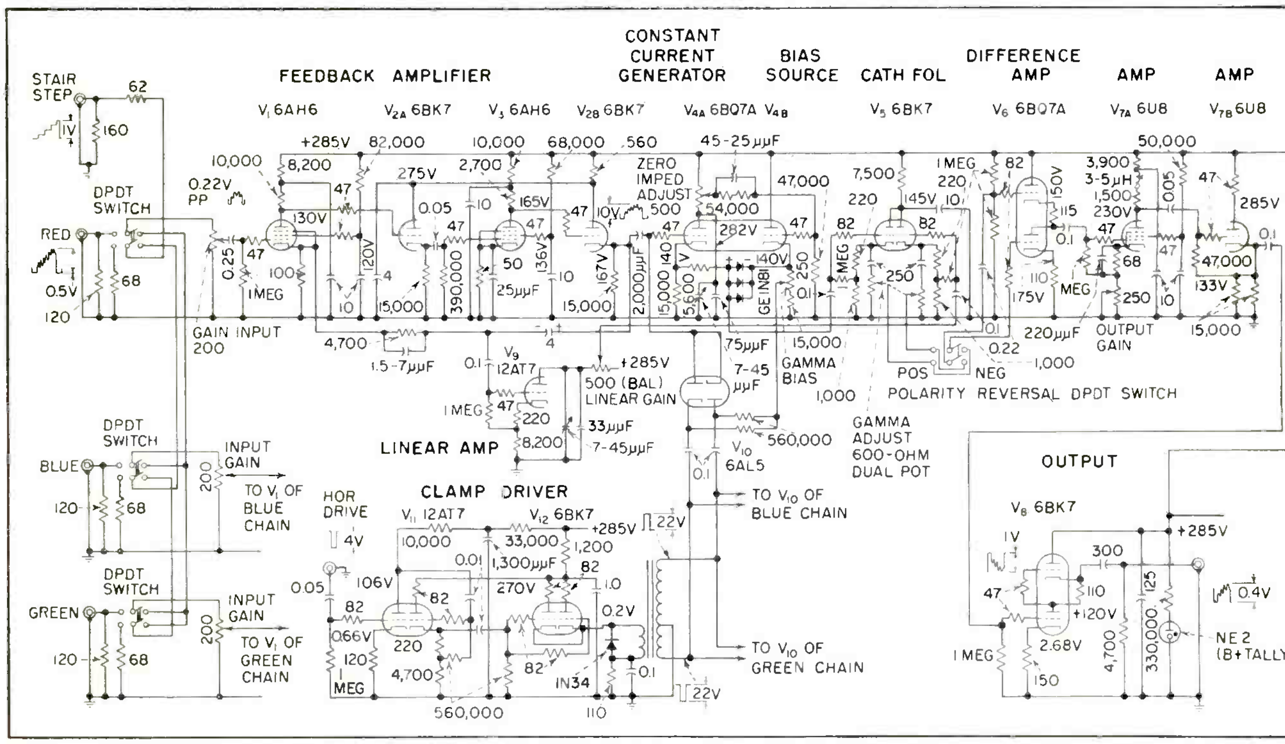


FIG. 2—Red-channel gamma or gradient correction amplifier. Blue and green channels are identical

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

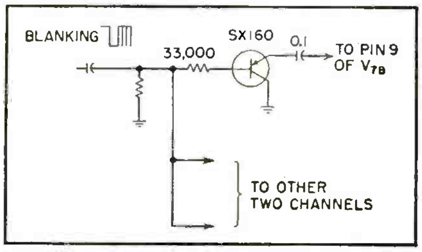


FIG. 3—Noise reduction circuit for blanking in gamma correction amplifier

* Now with Radio Corporation of America, New York, N. Y.
** Now with CBS Laboratories, Inc., New York, N. Y.

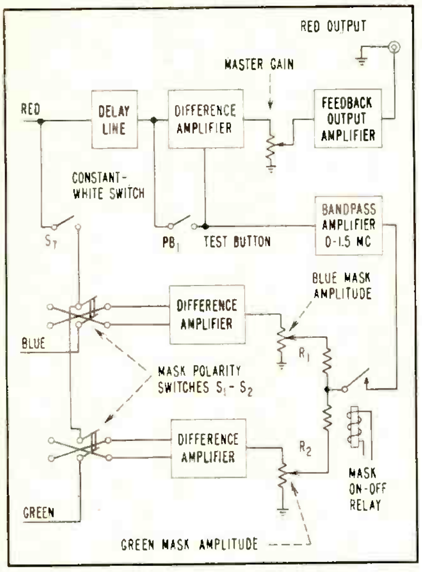


FIG. 4—Matrix amplifier for red channel

function[5] 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_{4B}. 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 follower used to provide ganged variable gain control of the linear signal from V_9 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 minimizing 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[7] 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

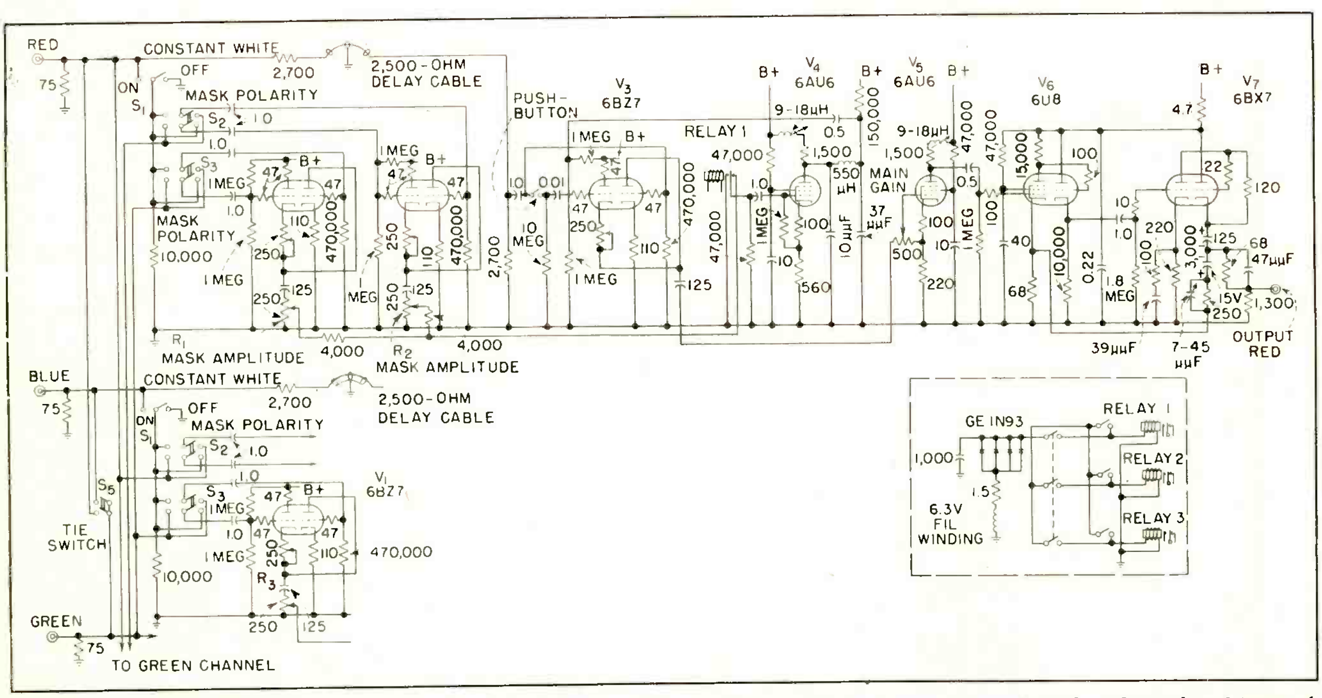


FIG. 5—Complete red-channel circuit for universal or matrix masking amplifier, with first stage of identical blue channel and input of identical green channel

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 paralled.

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.

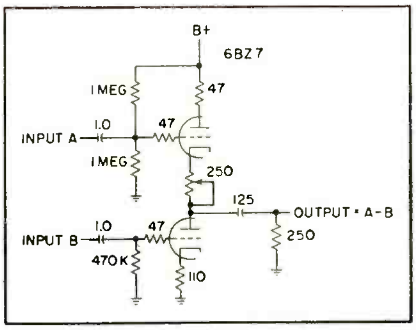


FIG. 6—Simplified diagram of difference amplifier used in each masking amplifier channel

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.

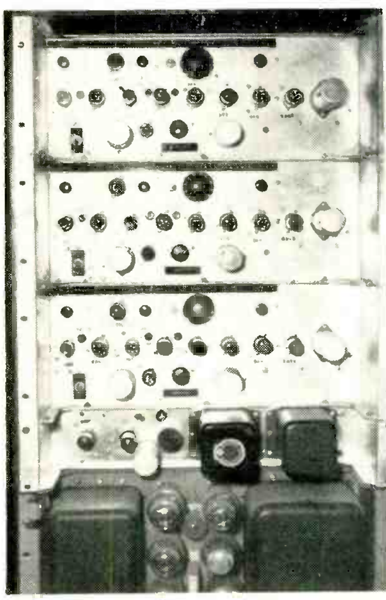
Difference Amplifiers

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 unusuable.

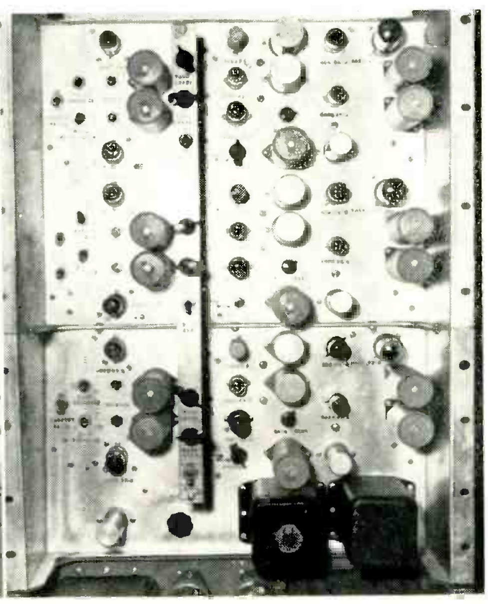
Pushbutton switches S_1 in each channel in Fig. 5 connect together the difference amplifier inputs for initial setup of the amplifiers. With signal applied and the buttons pushed, the balance potentiometers are adjusted for a null at the difference amplifier outputs. An additional switch S_2 ties all 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 combinations[3] 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.



Complete three-channel gamma correction amplifier



Complete matrix amplifier, with power supply below

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noise

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-dependent distortion observed in magnetic recording.

Previous Article

Characteristics and Origins of Noise, p 154, March 1956

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. Applications[5-6] 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

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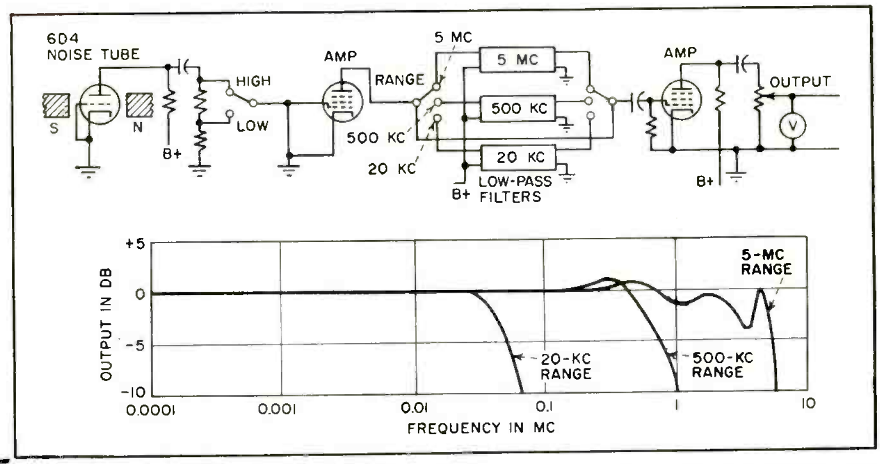

FIG. 1—Circuit (A) and spectral density (B) of noise generator using hot-cathode arc

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 demonstrated[8-10] 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 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.

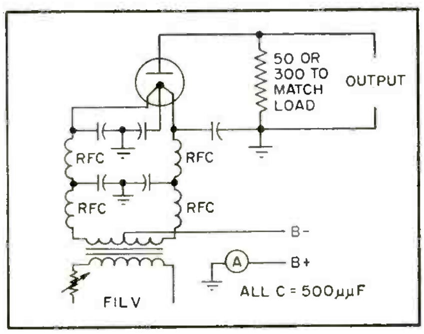

FIG. 2—Noise diode and its circuit

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 cathode[6] 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 diode[13] 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

$$n = [(e I_0 b R/2) + k T b]/ k T b = 20 I_0 R + 1$$

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 diode[11] 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 diode[10] is shown in Fig. 3B. A coaxial structure similiar 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-

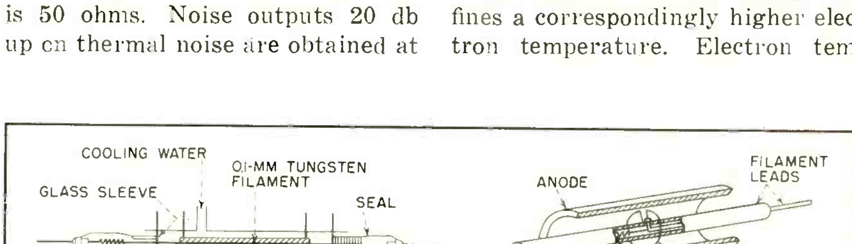

FIG. 3—Disk-seal coaxial noise diode (A) and coaxial-line noise diode (B)

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 energized from a d-c source were outside the guide and were surrounded by cylindrical metal shields which formed waveguides 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 ¼ 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.

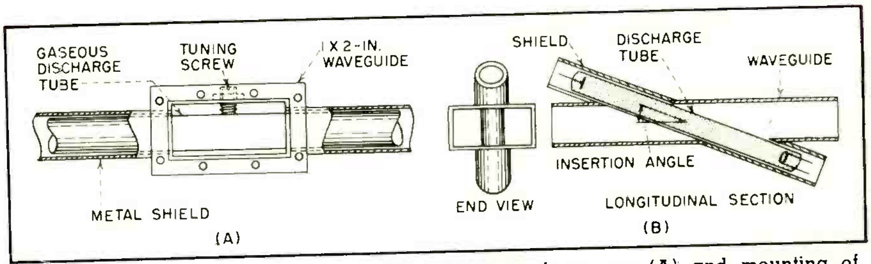

FIG. 4—Glow-discharge noise source for microwave frequency (A) and mounting of small-bore tube to generate shf noise (B)

Further Investigation

The constancy with frequency extends over an even wider range 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 Deremer[18] 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-deg 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.[10]

Earlier work on standards for microwave noise measurements made use of nonoscillating klystrons, 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 function). 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

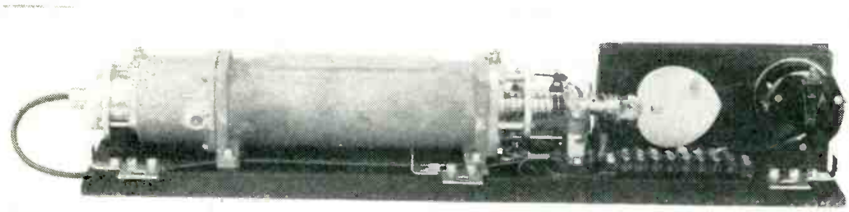
In the automatic search condition, a voltage of constant amplitude and phase is applied to the control phase of the motor. The cam rotates in one direction only, and the oscillator frequency sweeps through the band cyclically.

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

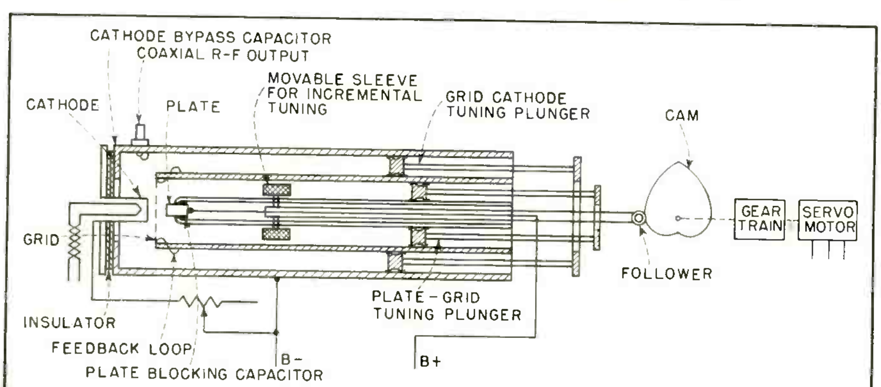


FIG. 1—Cross-section of stable L-band local oscillator

Mechanical Tuning

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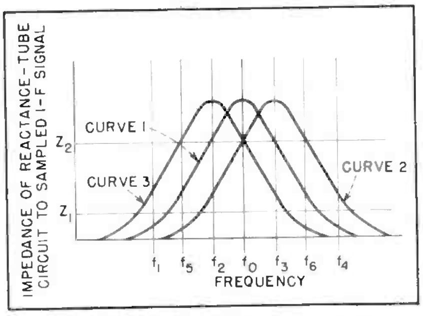
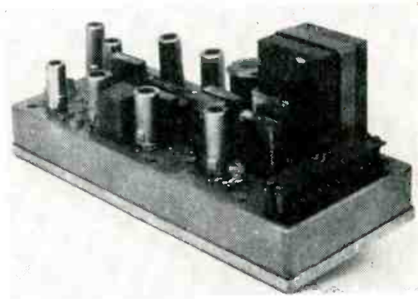


FIG. 2—Variation of impedance-frequency characteristic of resonant circuit



Control circuits and servo amplifier are combined on one chassis

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 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 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 varitaion 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 multivibrator[2] 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 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.

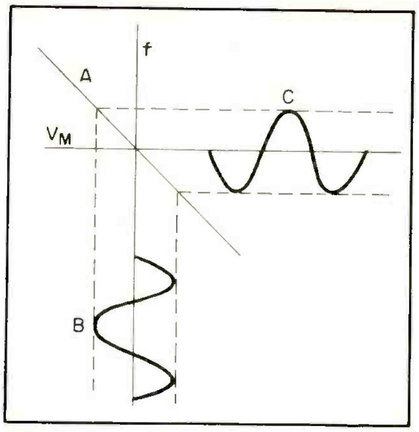


FIG. 3—Transfer characteristic of reactance-tube circuit

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 reinstituted. 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

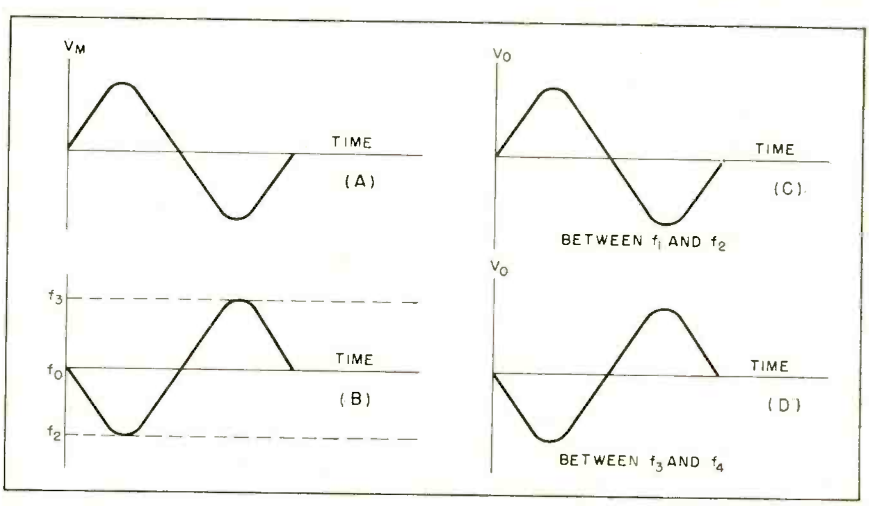


FIG. 4—Phase comparison between modulating voltage (A), reactance-tube resonant frequency (B) and servo output (C) and (D)

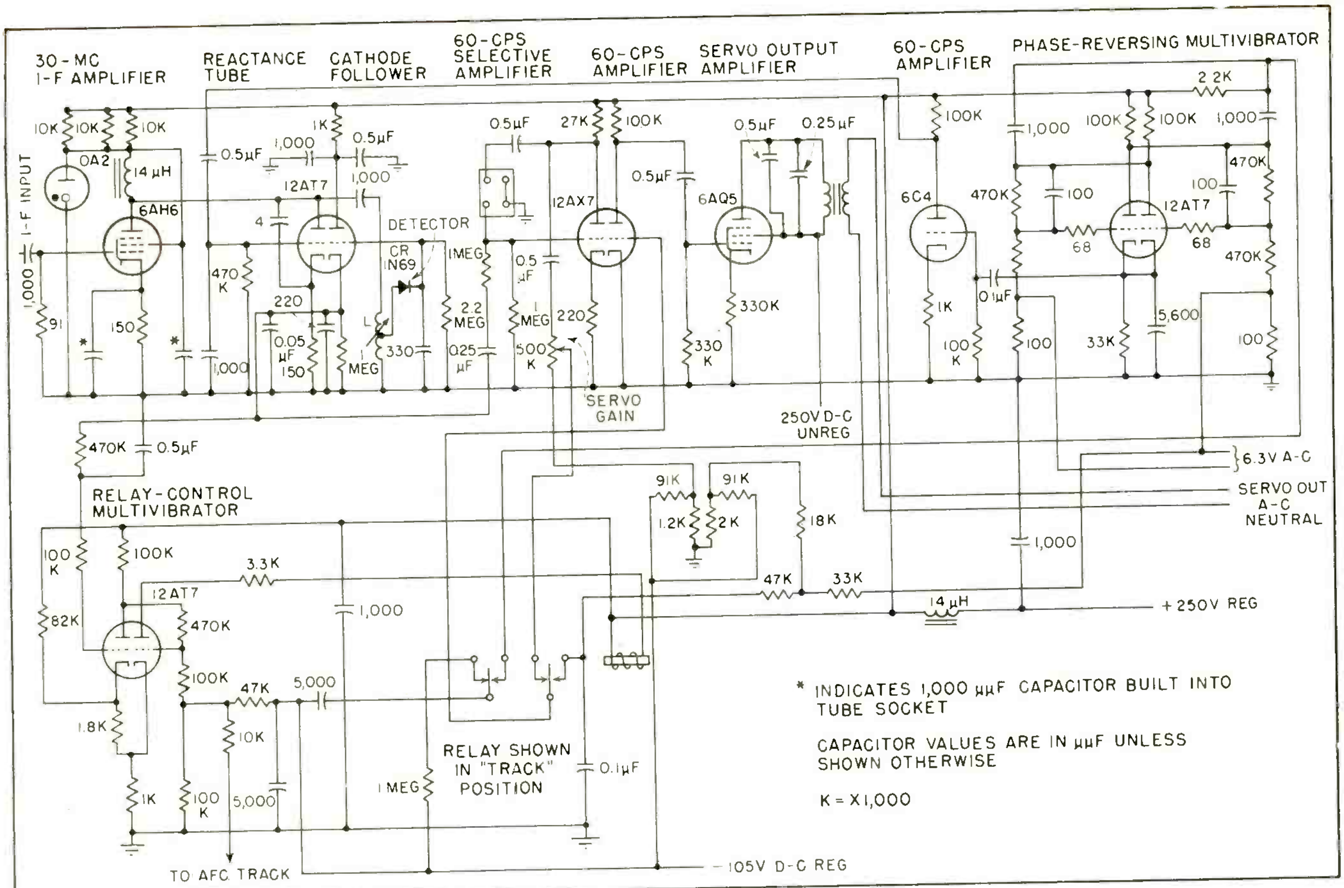


FIG. 5—Complete circuit provides frequency deviation detection and electronic control over search-afc transition

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-μsec 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 circuit will develop an output voltage of about 20 to 40 volts at midfrequency. The exact value depends on the input signal, the resonant 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.

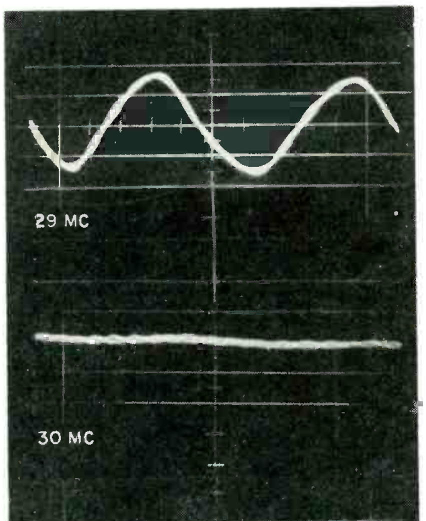


FIG. 6—Servo amplifier output waveforms at null and at either side of null

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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TESTING HARDNESS with

SUMMARY — Electronic hardness tester incorporating second-harmonic flux gate magnetometer accurately measures magnetic retentivity of steel tubing in which this characteristic is proportional to hardness. Readings are independent of surface conditions

MEASUREMENT of permeability, as a basis for hardness testing of ferrous metals, has had considerable application in industry.

Most methods employ an inductor or transformer into which a part is inserted for testing. Since alternating currents are employed in this procedure, only the metal near the surface of the object to be tested exerts an influence on the test results. At 60 cps, the flux penetration is only about 0.2 inch for a typical steel, according to the formula $S = 1.98 \sqrt{\rho/\mu f}$, where S is depth of current penetration in inches (where current is $1/e$ times that at surface), ρ is resistivity in microhm-centimeters, μ is relative permeability and f is frequency in cps.

When the part to be tested is perfectly homogeneous, this characteristic offers no particular difficulty. This is also true if only the surface properties of the test piece are of interest. Unfortunately, many steel parts have a surface condition which, while it may be only slight, can affect the permeability measurements out of all proportion to the part of the total mass which it represents, thus giving erroneous and inconsistent test results.

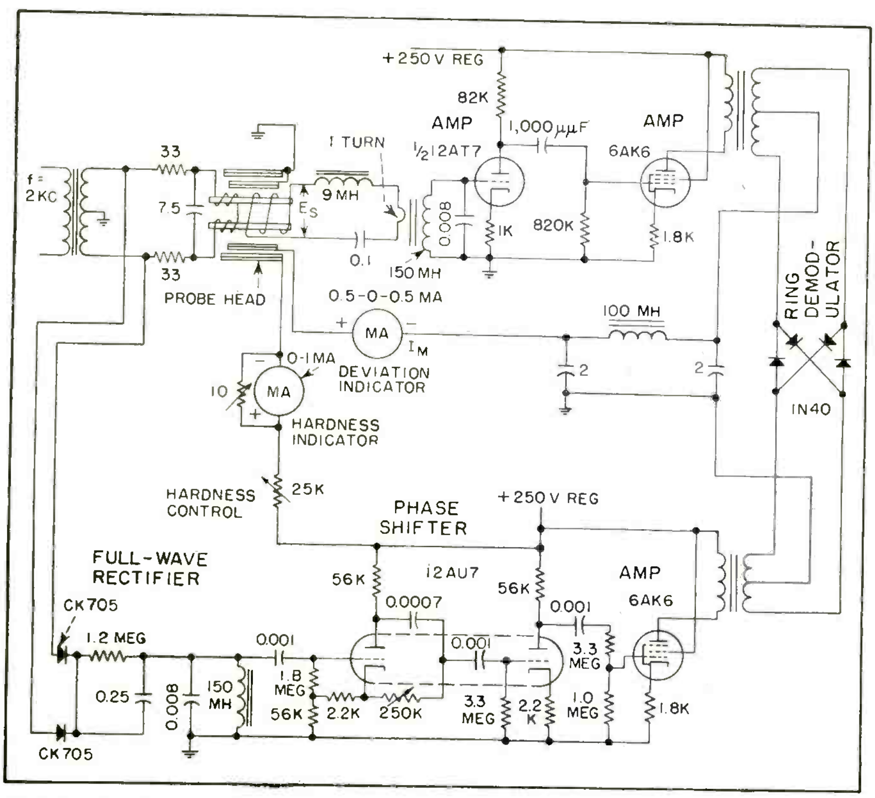

FIG. 1—Circuit of hardness tester. Readings proportional to hardness are obtained from either meter, depending on technique of use

New Method

An electronic hardness tester has been developed to overcome, on special applications, some of the limitations noted above. It could be termed a d-c tester as it operates on the principle that with certain magnetic materials, magnetic retentivity is proportional to hardness.

In the method under discussion, the metal part to be tested is first placed in a coil and magnetized. Discharging a large bank of capacitors through the coil saturates the part magnetically so that results are consistent in this respect. The magnetic field created by the part is then measured with a flux gate magnetometer. There is generally no relative movement between the part and the magnetometer probe during the test.

Operating Principle

The unit described is called a second-harmonic flux gate magnetometer. The basic circuit is shown in Fig. 1. The cores are two identical high-permeability elements in the form of rods. The primary windings are wound directly on the individual cores and connected to a 2-kc signal generator. The secondary winding is wound over both cores, and delivers voltage E_s having the frequency $2f$, where f is the 2-kc input. The output current I_M, derived from a phase-sensitive rectifier circuit in the amplifier, is measured by an

Flux Gate Magnetometer

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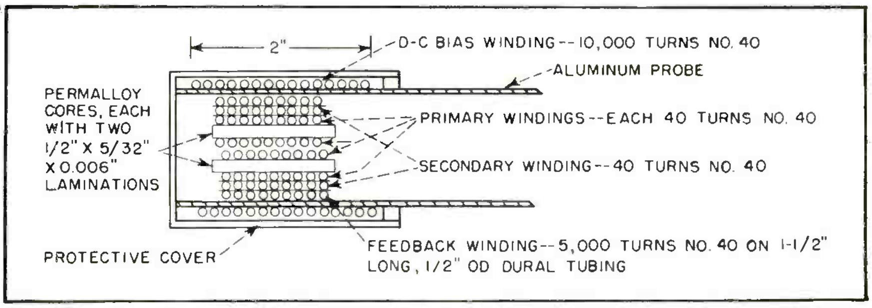

FIG. 2—Probe construction details. Spacings and insulating techniques are critical

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.

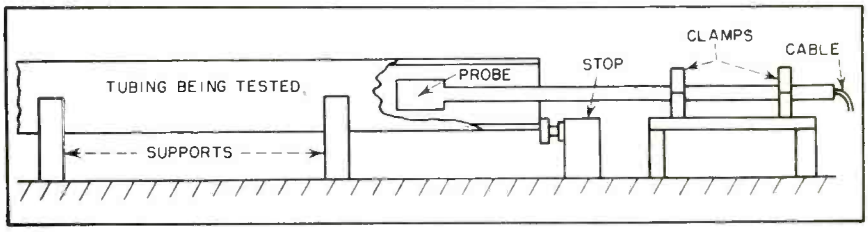

FIG. 3—Method of using probe for testing hardness of steel tubing

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 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-

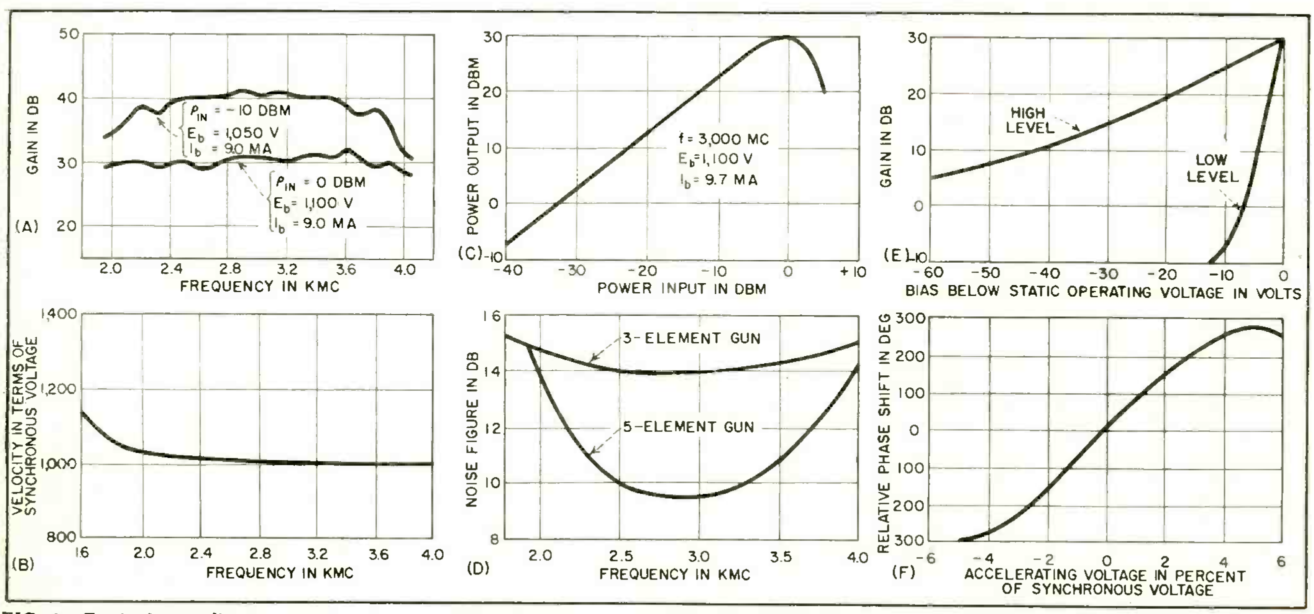
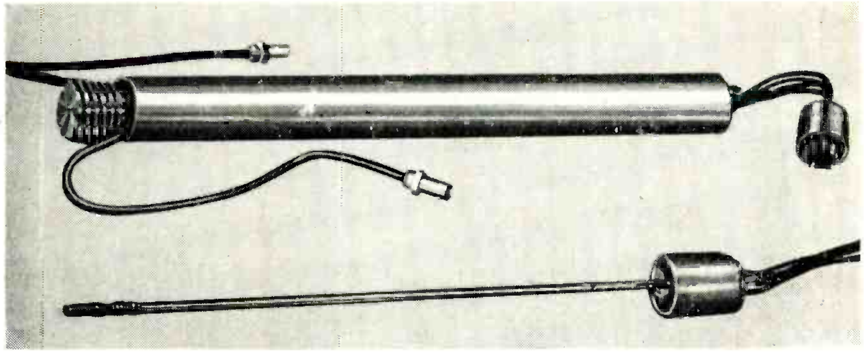


FIG. 1—Typical traveling-wave tube characteristics show value of tube in wide variety of applications described in text

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 amplitude 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 40 λ, 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.

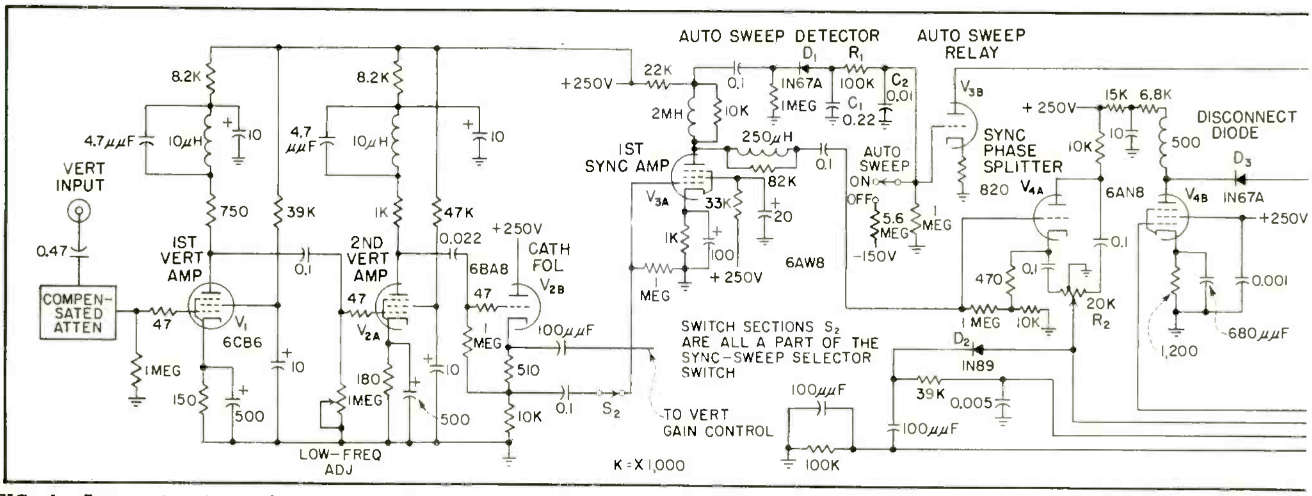


FIG. 1—Automatic triggered sweep circuit as used in Hycon model 622 oscilloscope, with conventional unmodified stages of

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

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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_4. 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_{13} or C_9 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_{6B} is held cut off by the gate supplied from the plate of V_{5A} through R_5. When the gate duration is terminated, V_{6B} conducts, discharging the sawtooth-forming capacitor and thus creating the retrace or flyback time.

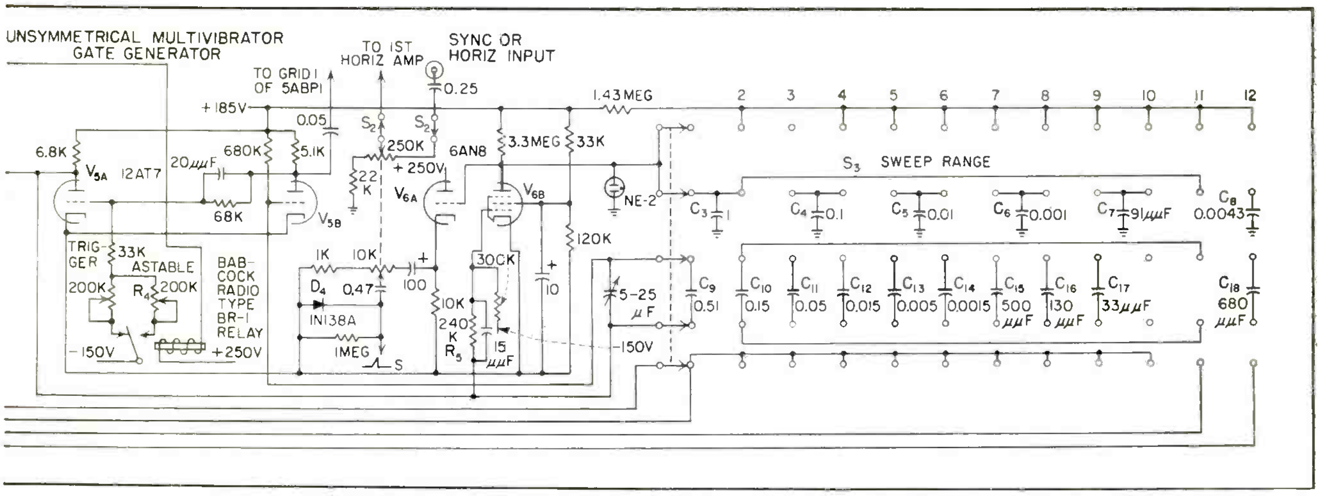
A signal present at the vertical input terminals of the oscilloscope passes through a compensated attenuator to first vertical amplifier V_1. From there it progresses to second vertical amplifier V_{2A} and cathode follower V_{2B}. The path to the vertical deflection plates of the cathode-ray tube continues from the cathode of V_{2B}.

Tapped down on the cathode of V_{2B}, a 0.1-μf 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-μf 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 sufficently 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_2 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

pensated 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.

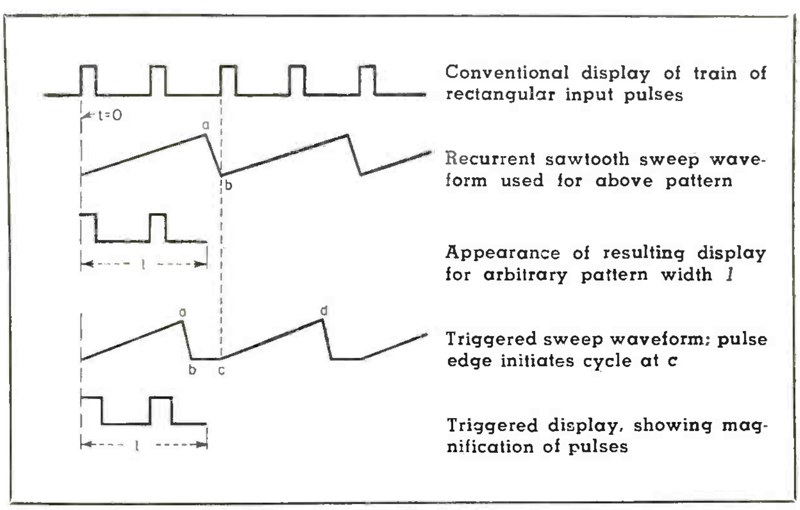
If the phenomenon to be observed is nonrecurrent and has too low an energy content to actuate the mode transfer of the sweep circuits, part of the waveform at the start of the trace may be missed or a stationary pattern may not be achieved. For such situations, front-panel AUTO SWEEP switch S_4 may be 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

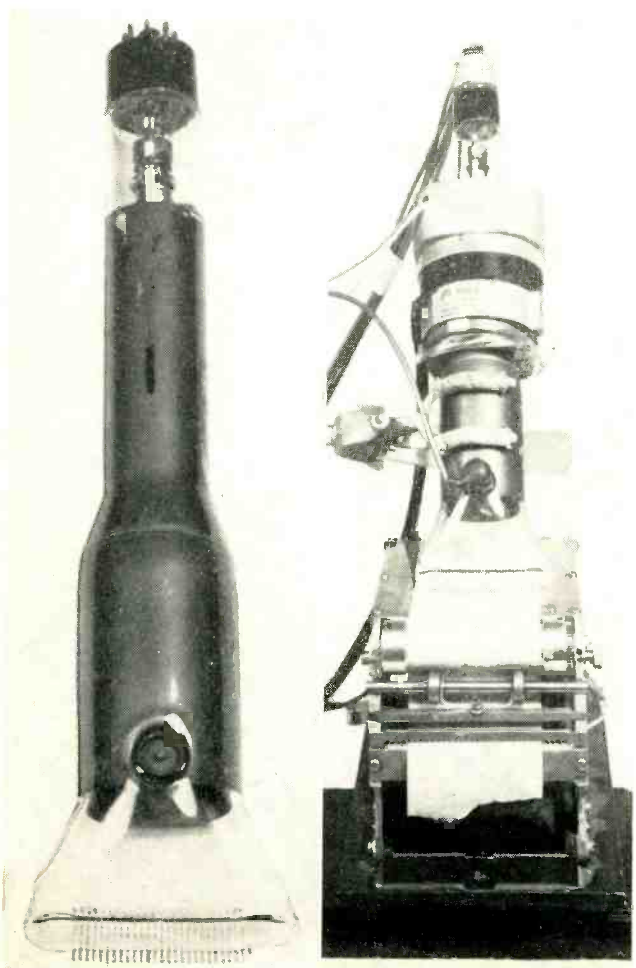
IN THE RECORDING system to be described, a virtually inertialess electron beam serves as the writing element for producing permanent markings on electrographic paper. The recorder resembles a modified cathode-ray tube, as shown in Fig. 1. At the upper end of the tube, coplanar closely spaced targets are sealed into the face of the tube, with the external portions serving as styli. Electrosensitive 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 electrosensitive paper and produce 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



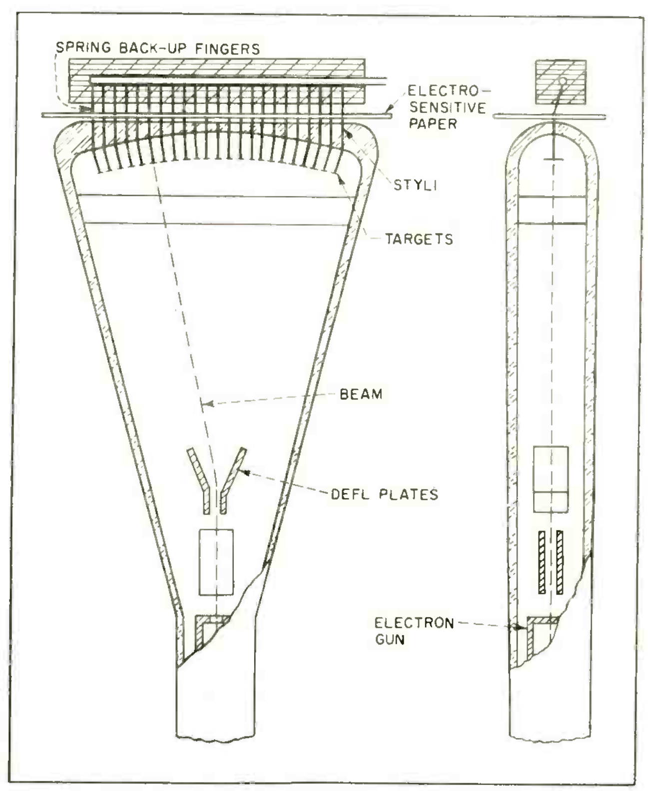


FIG. 1—Original concept of recorder tube, as shown by front and side views in patent application. Recording paper is pulled across face of tube by drive mechanism

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 inversely 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

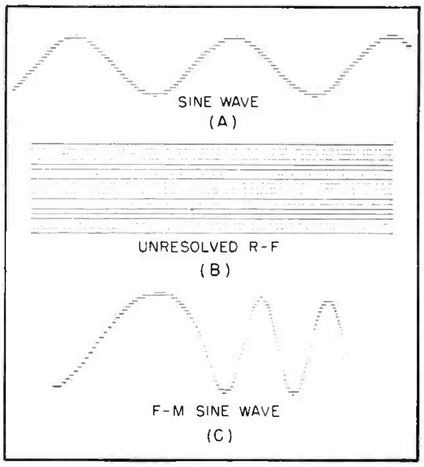

FIG. 2—Examples of traces obtained

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

By GLENN H. BROWNING
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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 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 $\mu\mu$f in a total of 2,000 $\mu\mu$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 $\mu\mu$f in 5,000 $\mu\mu$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

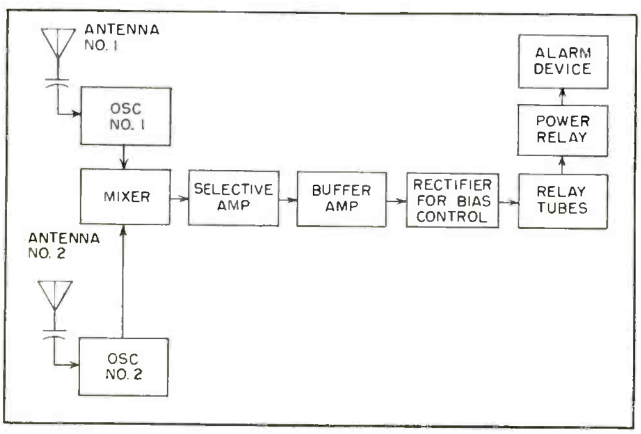


FIG. 1—Elements of complete electrostatic intrusion alarm

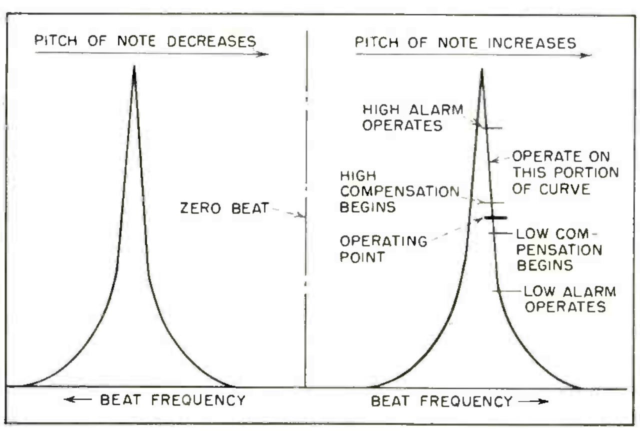
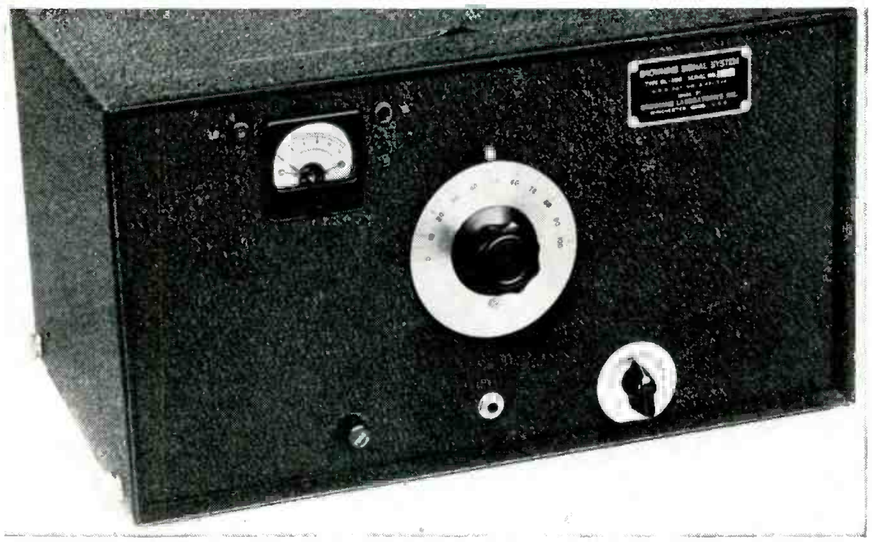
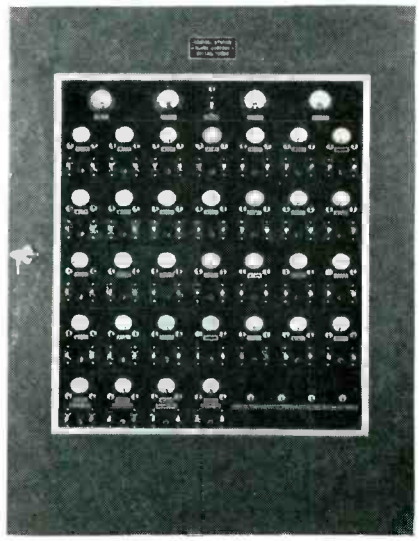


FIG. 2—Curves used for slow differential corrective system

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

$$\frac{f_1}{f_2} = \sqrt{\frac{L_2C_2}{L_1C_1}} = \sqrt{\frac{L_2}{L_1}}$$

$$\frac{L_2}{L_1} = \frac{16}{9} = 1.78$$

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 $500 = N_1f_1 - N_2f_2$, 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

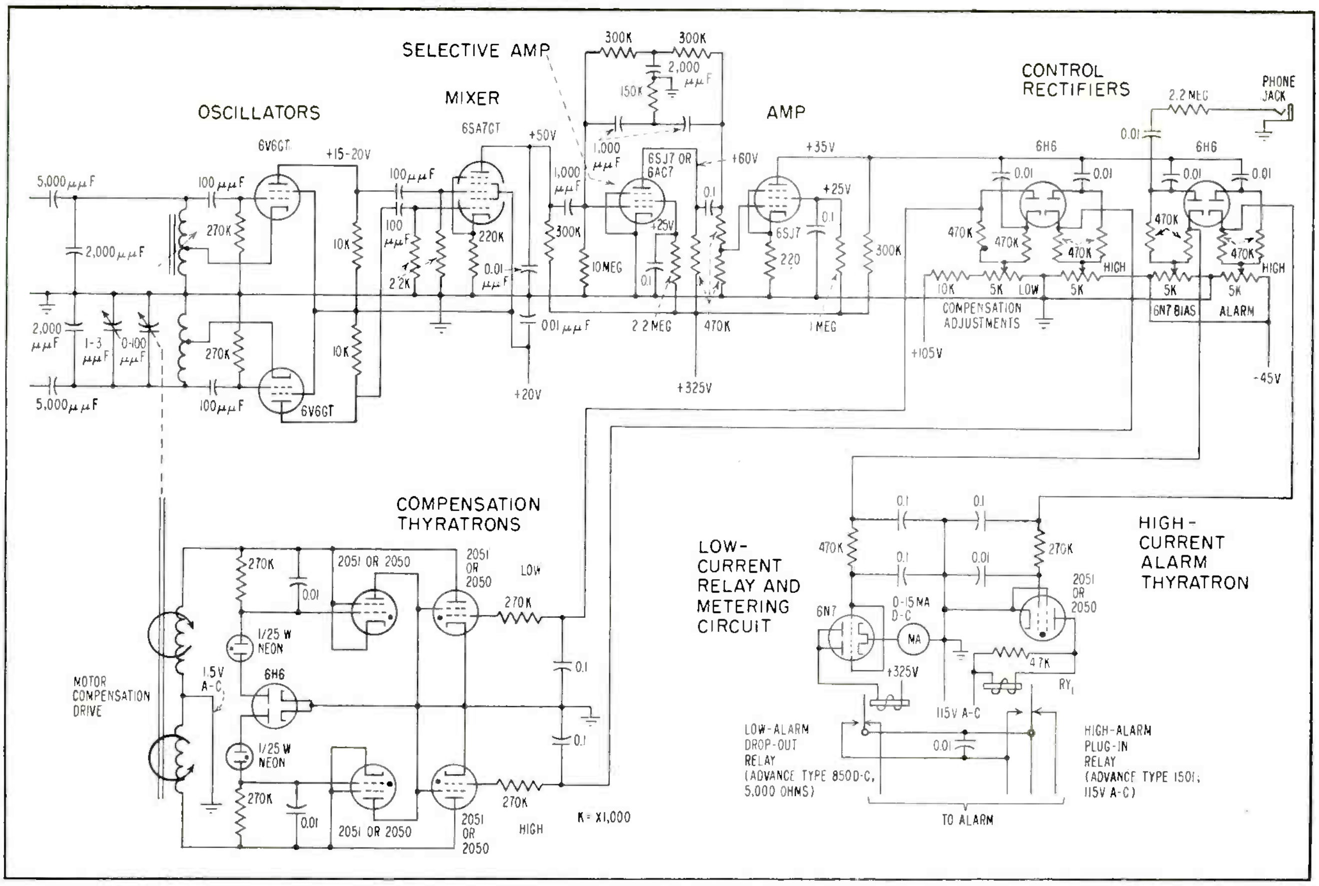


FIG. 3—Complete control circuits of Browning model BL-300 alarm signal system. Power supply is conventional

using insulated wires 2 and 4 feet from the ground on metal supports close to the barbed wire fence, false alarms were common. The capacitance of the antennas was changed by the wind swaying the barbed wire. Rain changed the capacitance materially. Rain drops would collect on the antenna wires and when a gust of wind blew them off, a false alarm resulted. The rain also changed the capacitance to the metal arms supporting the antennas.

When the antennas were placed about 3 feet from the fence, the trouble from the wind on the fence was eliminated and the apparent sensitivity was greatly increased. With 1-$\mu\mu$f equipment sensitivity, the detection range of a person was about 1 foot when the antennas were close to the fence, but with the antennas 3 feet from the fence a person was detected about 4 feet away.

Changing to a powdered mica insulating covering for the antenna wire allowed practically no moisture droplets to collect, but rain still gave false alarms. When porcelain insulators on wooden arms were used to support the antenna wires, the trouble with rain disappeared.

The final antenna layout is shown in Fig. 4. It consists of a three-wire system. The lower wire is 18 inches from the ground, the second is 2 feet and the third is about 6 inches below the top of the fence. Detection range is up to 7 feet, depending on the sensitivity setting. Each control unit covers 500 linear feet (250 feet each half) and is on guard night and day, reducing manpower requirements for guards to a minimum. So far as is known, this system has never been penetrated without sounding an alarm.

The system is essentially insusceptible to external jamming, as the selective circuit is well isolated from the antenna circuit. Plug-in selective circuits of different operating frequencies could be used for even greater difficulty in jamming, by giving three unknowns—the two harmonics and the frequency of the selective circuit.

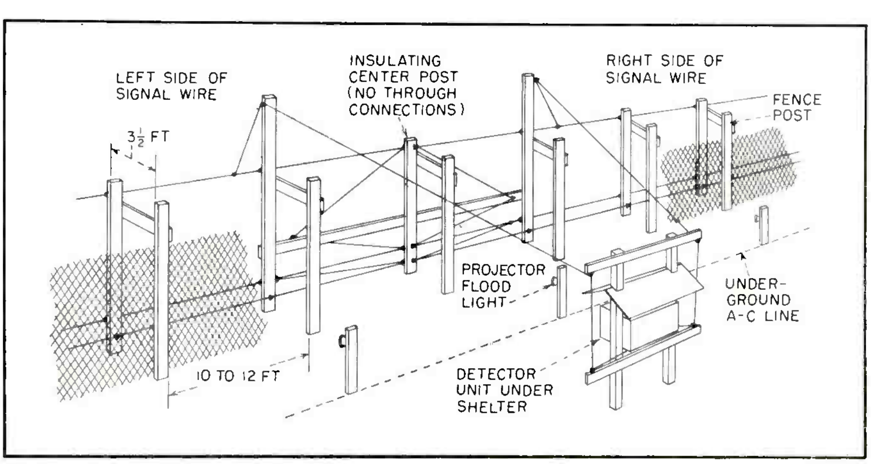


FIG. 4—Example of antenna system and lead-in for woven-wire fence

Systems Development

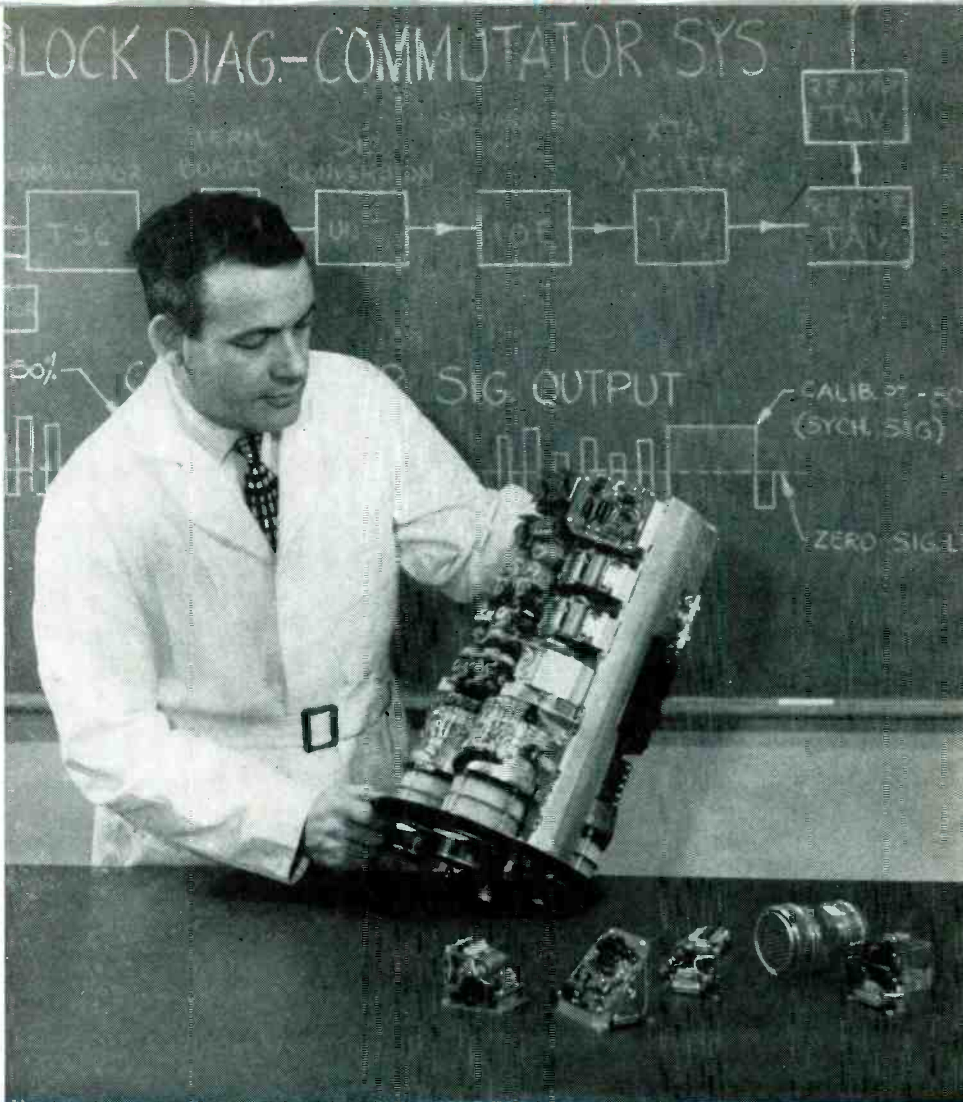
Input Transducers

Signaling Methods

Commutating Devices

Output Indicators

and Bibliography



BENDIX-PACIFIC TELEMETER EQUIPMENT FOR LONG-RANGE MISSILES

Telemetering

Electronic Data Transmission

By ALEXANDER A. McKENZIE *Associate Editor*

and HAIG A. MANOOGIAN *Assistant Editor*

An **electronics** Special Report

APRIL • 1956

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

Telemetering 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 telemetering of many kinds mandatory

PATENTS issued in 1885 in the United States described electrical telemetering 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 telemetering 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 antiaircraft 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 ballistics missile (ICBM). Telemetering 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 telemetering. Because of the tremendous activity here, standards were set up for certain aspects of missile telemetering. While these standards (reproduced here) have been outgrown, they are still used where possible.

The field of telemetering 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 telemetering 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 telemetering system is shown

Table I—Teleprinter 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					•				•			•			•

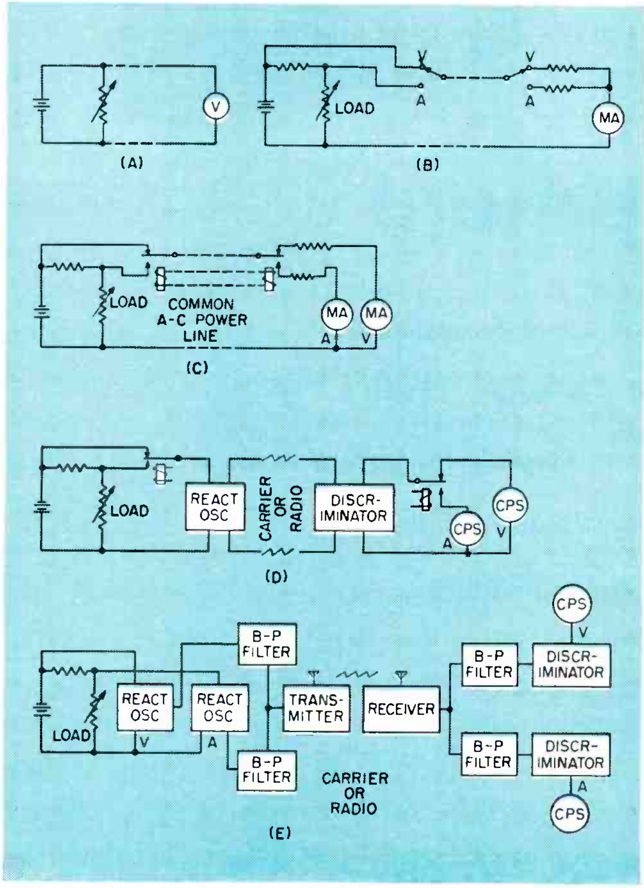


FIG. 1—Development of time-division and frequency-division telemetering systems. Means of computing power at a distance using wire line, radio or carrier is shown

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

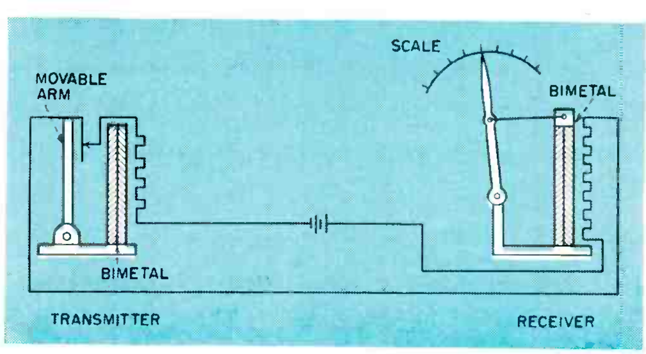


FIG. 2—Simple telemeter that depends upon the heating of bimetallic strips. Position of the movable arm determines height on scale to which pointer will rise

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	●	

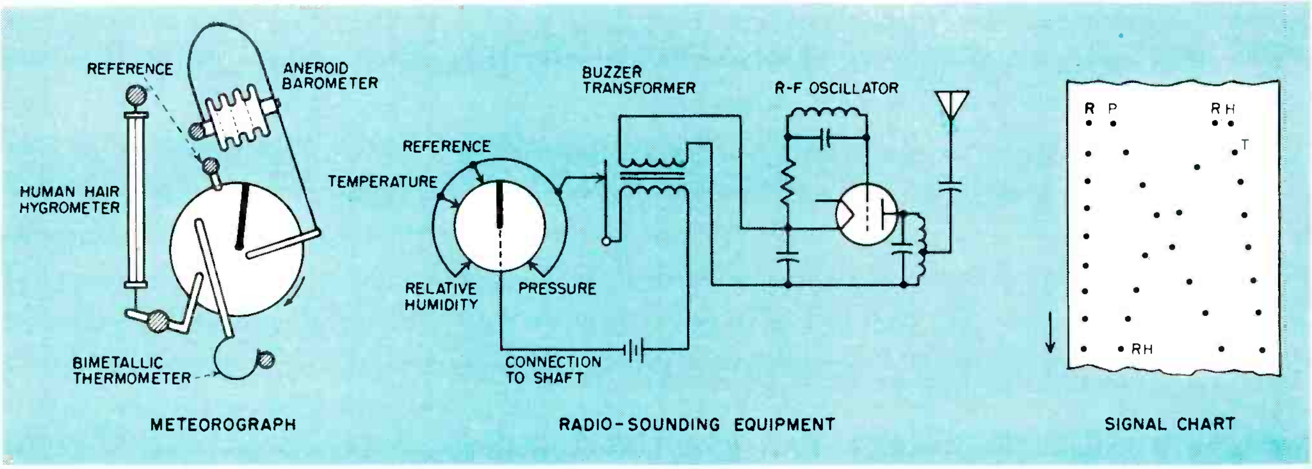


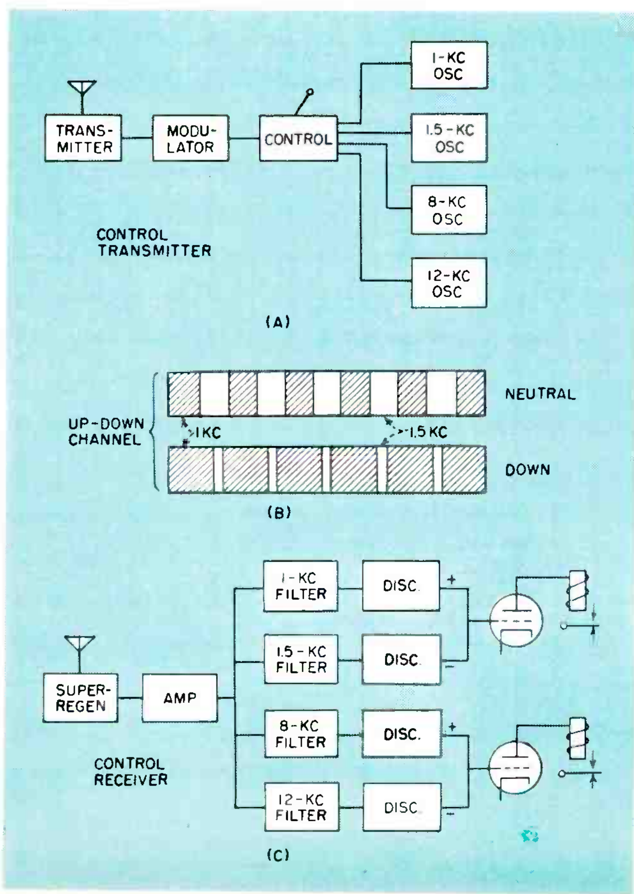
FIG. 3—Elements of a radiosonde based upon the Olland sampling principle. Relative displacement of elements is shown by a series of short dashes on moving chart paper at ground station

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.



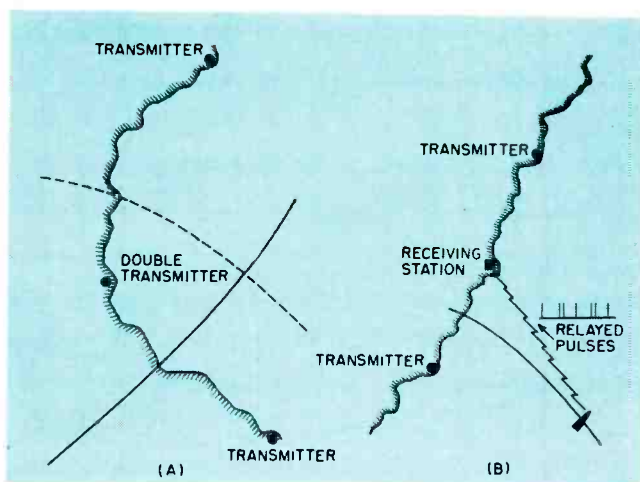


FIG. 5—Data transmission in position-finding system often depends upon time of propagation. A standard hyberbolic fix from two pairs of transmitters is shown at (A). A relayed line of position comes from the lifeboat at (B)

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-

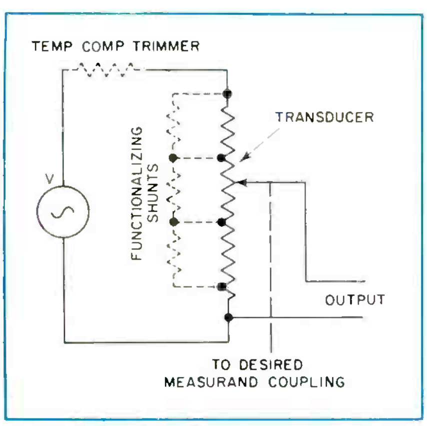


FIG. 6—Typical potentiometer-transducer circuitry. Dashed-line components may be added as needed

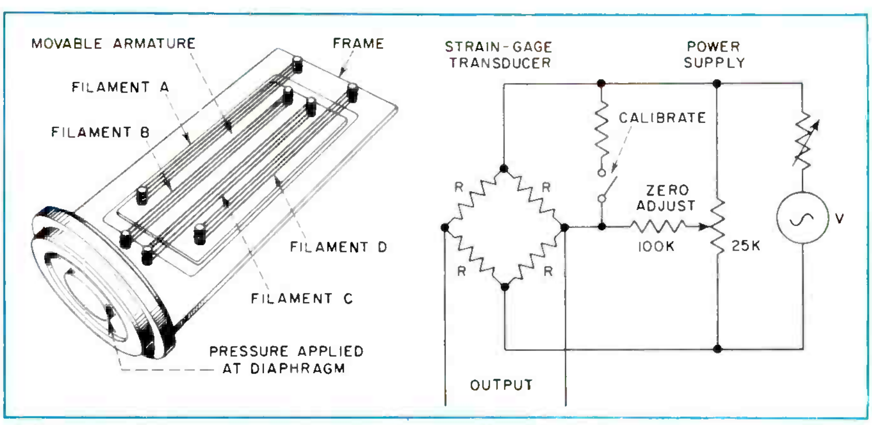


FIG. 7—Unbonded strain-gage pressure transducer has diaphragm mechanically coupled to movable armature. Pressure variations cause armature to move and change tension of wire filaments. Typical circuit is shown at right; source voltage can be a-c or d-c

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 $\mu\mu$f capacitive	50 $\mu\mu$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	½ 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

eter 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 subcarrier 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.

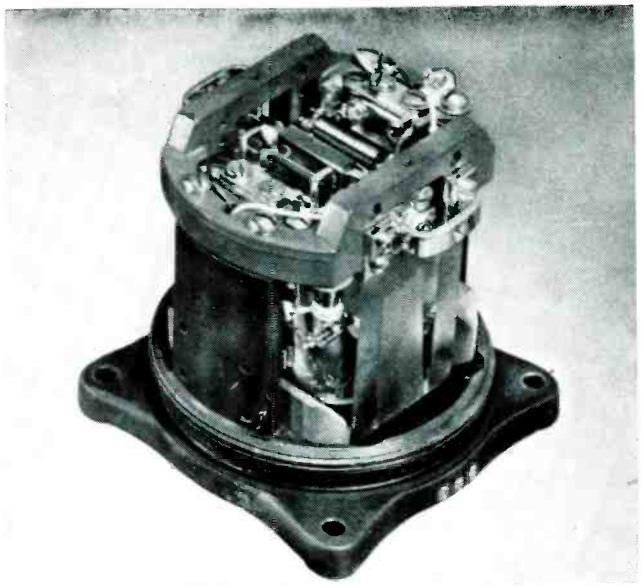
In contrast with metals, which often have small positive temperature coefficients of resistance, some semiconductors have relatively large, nonlinear negative temperature coefficients. Thermistors are probably the most widely used semiconductors. They are usually a sintered mixture of ceramic materials 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

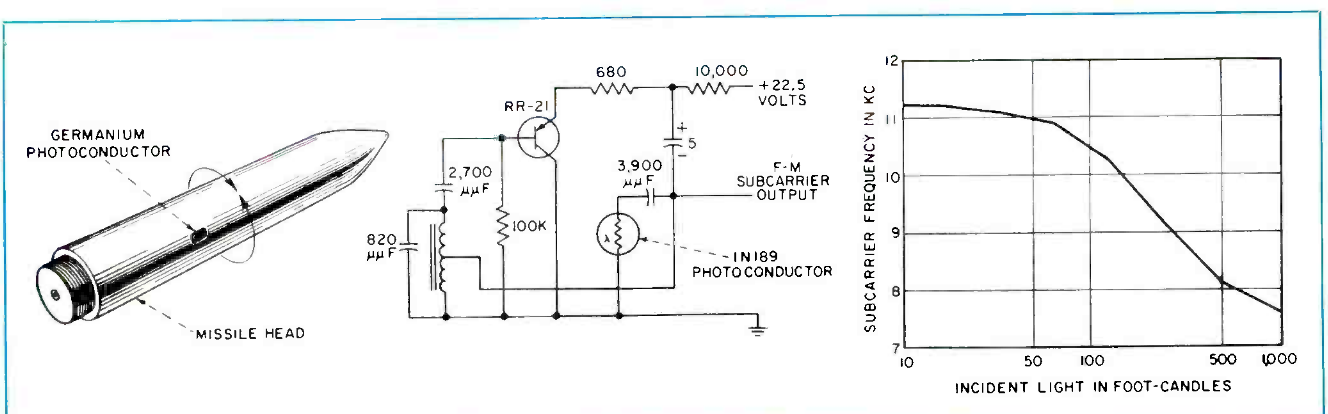


FIG. 8—Test-missile head contains germanium photoconductor which is employed as frequency-determining element of transistor f-m subcarrier oscillator. Spinning of missile causes light falling on photoconductor to vary and in turn vary subcarrier frequency

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

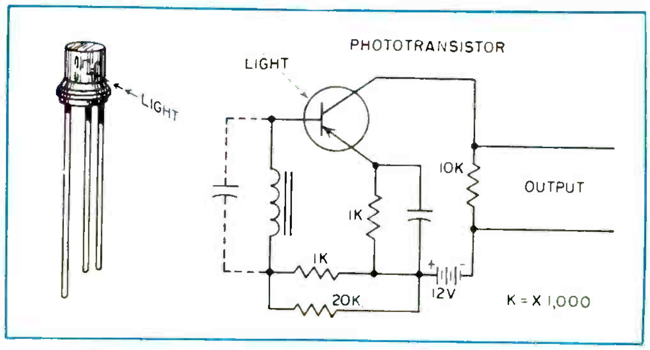


FIG. 9—Typical Radio Receptor *pnp* germanium-junction phototransistor and circuit for modulated-light use. Base inductance is tuned to light-modulation frequency for best signal-to-noise ratio

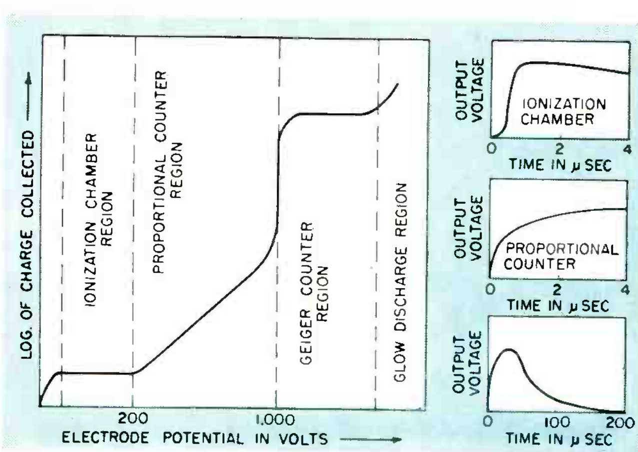


FIG. 10—Operating regions of various nuclear radiation detection instruments and shapes of output-voltage pulses. Waveshapes shown are for infinite input time constants

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 $\alpha/(1\text{-}\alpha)$, where α 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.

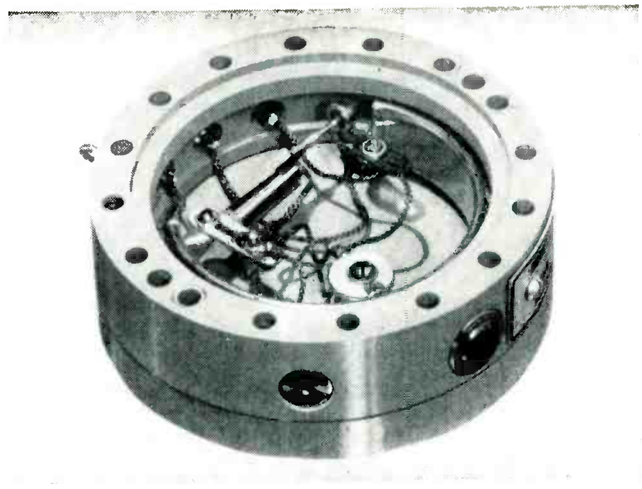
Commercially available photovoltaic cells are either copper-copper oxide, silicon *pn*-junction or iron selenide-silver. All of these devices have outputs which are proportional to the area exposed to radiant energy. A 1¾-inch diameter silicon-junction cell will generate 0.25 v across 10 ohms in sunlight. Other cells ordinarily produce outputs in the milliampere 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 semicylindrical 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

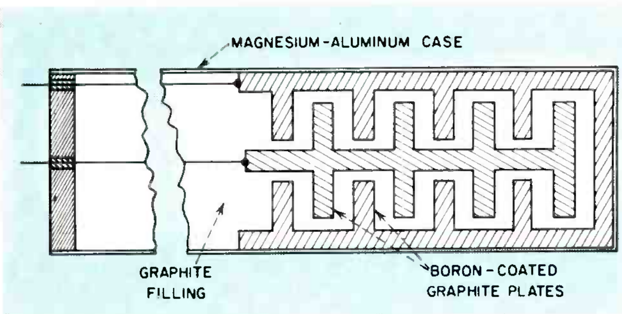


FIG. 11—Parallel circular-plate ionization chamber has boron-coated electrodes for detection of slow neutrons. Wire leads are of lead and are coated with quartz

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.

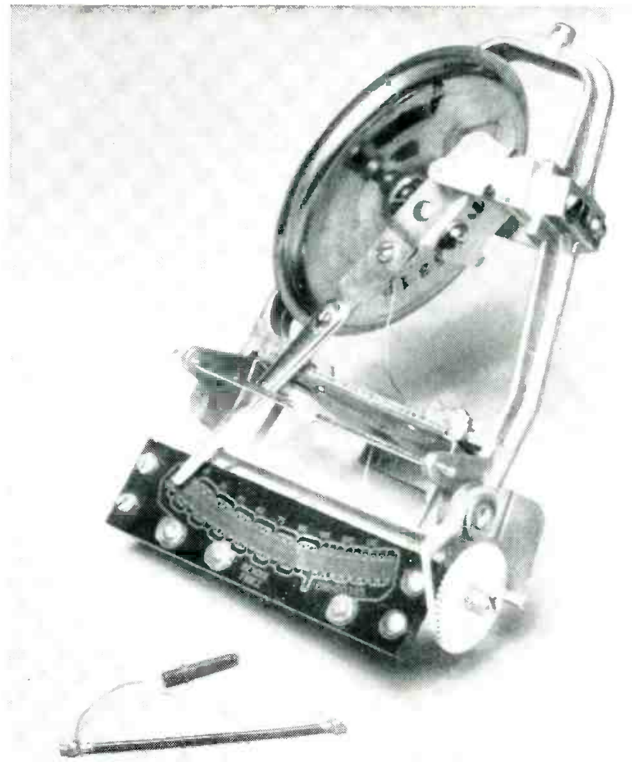
At very low voltages the ions move so slowly that many recombine before reaching the electrodes; charge collected increases with plate voltage. Increasing the voltage, a point is reached where the ions move sufficiently fast that they are all collected before they can recombine. Continuing to increase 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^{-5} to 10^{-3} 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 trifloride, 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 trifloride.

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 scaled to the input voltage.

These devices are analogous to resistance potentiometers. 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.

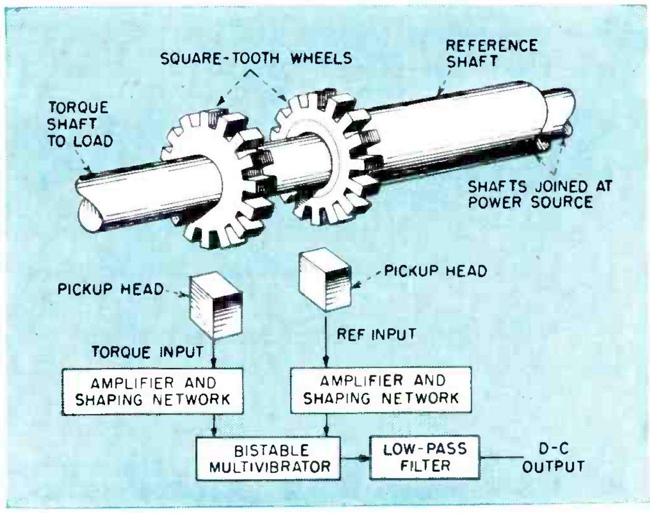


FIG. 12—Phase shift between signals from two pickup heads is proportional to amount of twist between torque-carrying shaft and reference shaft and gives indication of dynamic torque

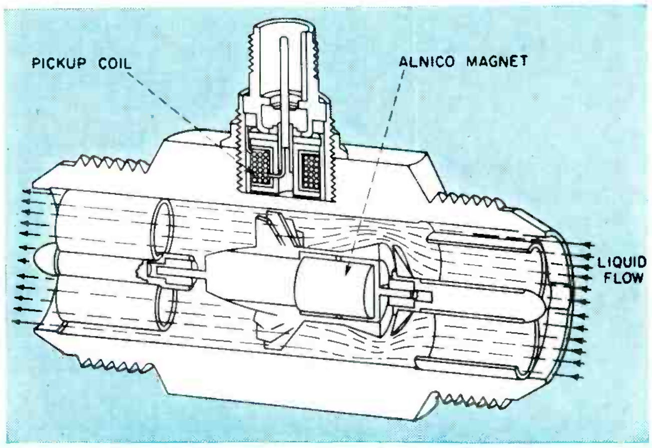


FIG. 13—Permanent magnet in hub of hydraulically suspended Potter flow meter induces signal in pickup coil. Signal frequency is proportional to flow rate; total pulses are proportional to total flow

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.

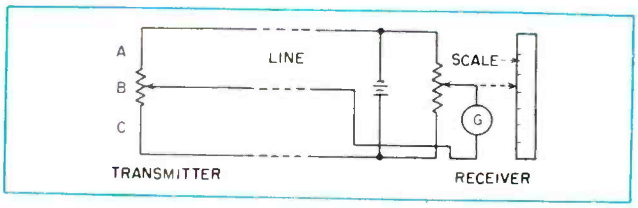


FIG. 14—Elementary bridge system requires manual operation at receiver but is easily adapted to servo balancing control

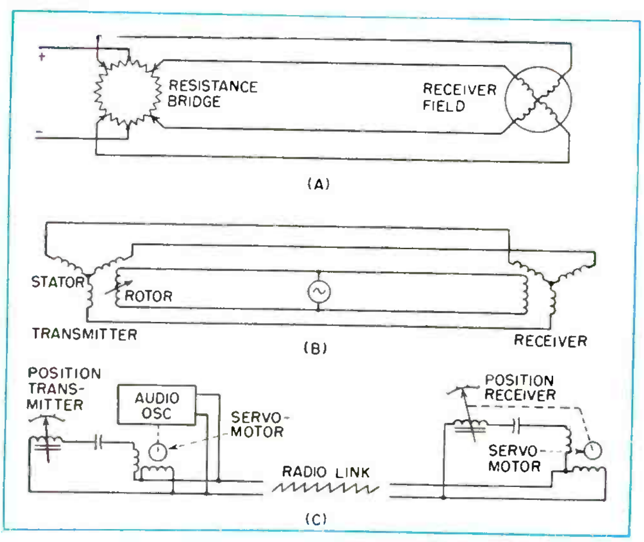


FIG. 15—Remote dial reading systems. So-called d-c synchro (A), conventional a-c synchro (B), and tuned audio system (C)

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 components 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.

Table VI—Subcarrier Bands

	Subcarrier Band			Subcarrier	Nominal	Maximum
Band	Lower limit in cps	Center freq in cps	Upper limit in cps	Deviation in percent	Intell freq in cps	Intell 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

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.

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.

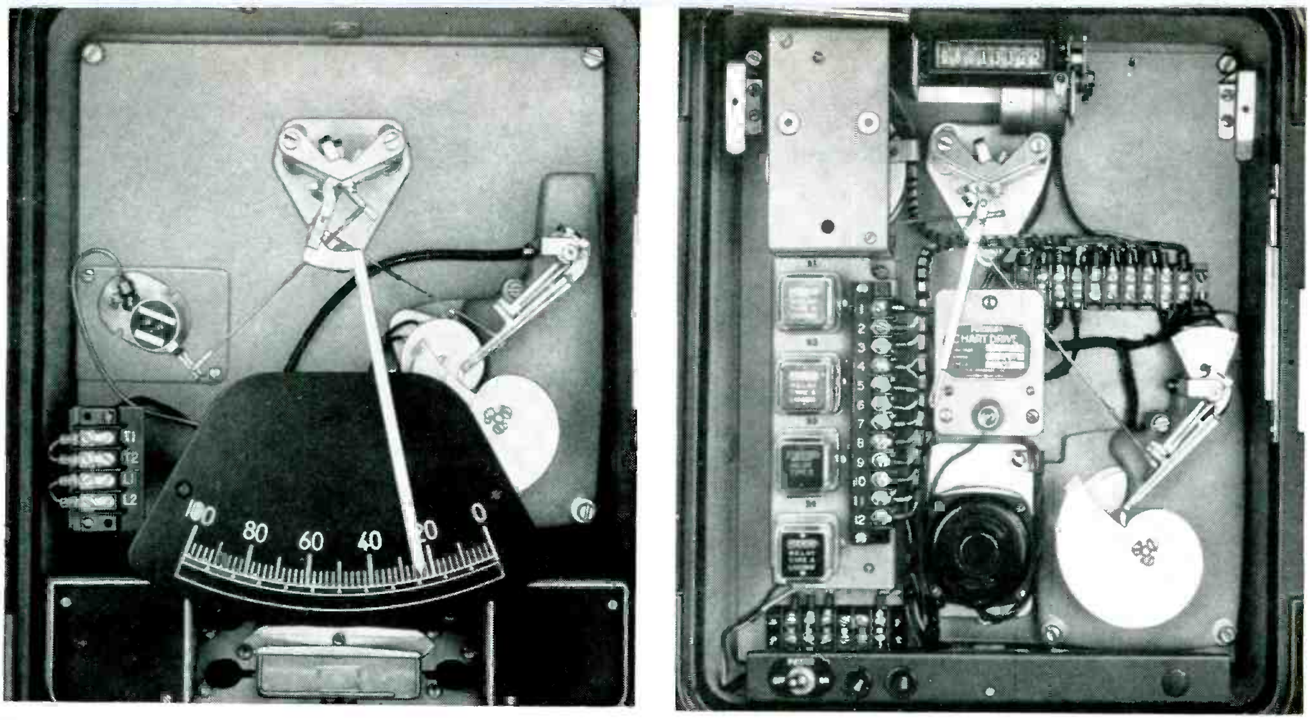
Zero indication is accomplished using a constant-torque element driven from a constant-voltage transformer. This torque adds directly to that of the primary detector. When there is no output to the primary detector, the constant torque causes the light modulating disk to revolve at such speed as to result 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 milliampere 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

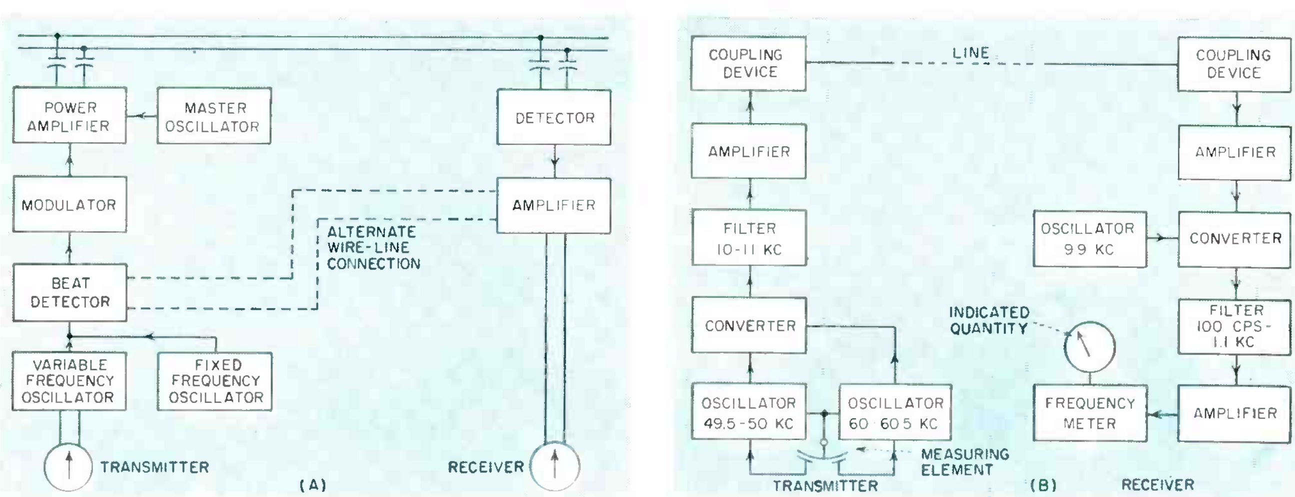


FIG. 16—Frequency telemetering system depends upon transmission of audio tone (A). Variation of the system uses two oscillators whose frequencies are varied in opposite directions (B)

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 of pulse code modulation systems in terms 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

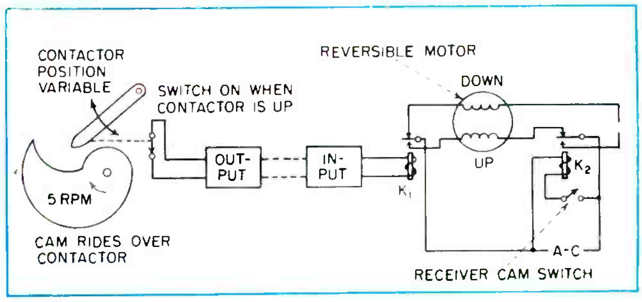


FIG. 17—Position of mechanical contactor arm relative to rotating cam is compared with a similar cam that controls direction of rotation of motor to move receiver dial in the Foxboro telemeter

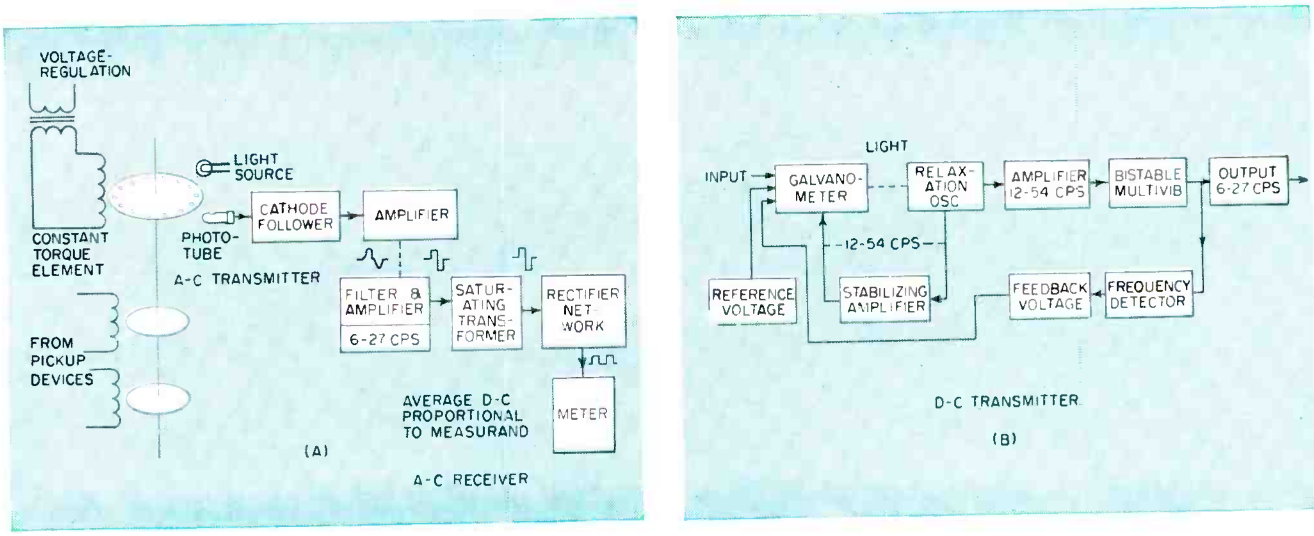


FIG. 18—Power-line telemetering system sends low-frequency pulses derived from rotation of disk between light and phototube caused by variation in a-c parameters (A). Information derived from d-c is transmitted by equipment (B)

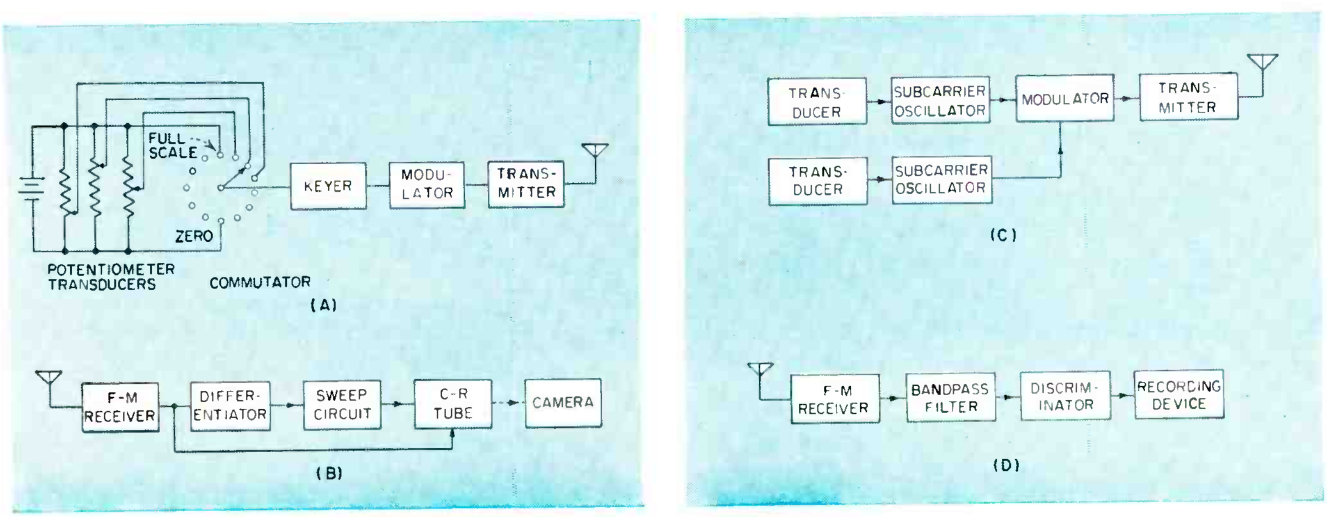


FIG. 19—Basis of pulse-width modulation of a frequency modulated carrier (pwm/f-m) transmitter (A) and receiver (B). Two-channel f-m/f-m transmitter (C) and receiver (D)

Table VII—Bandwidth and Noise

MODULATION METHOD	TRANSMISSION BANDWIDTH	SIGNAL-NOISE
AMPLITUDE (a-m)		
double sideband and carrier	$2\,f_m$	$(S/N)f_m = (C/N)f_t$
single sideband and carrier	f_m	
single sideband	$\Delta\,f_m$	
FREQUENCY (f-m)		
wideband ($f_m < f_d$)	$2\,f_d$	$(S/N)f_m = \sqrt{3}\,(C/N)f_t\,(f_d/f_m)$
narrowband ($f_m > f_d$)	$2\,f_m$	
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		
PHASE (p-m)		
double sideband and carrier	$2\,f_m$	$(S/N)f_m = \phi\,(C/N)f_t$
$m_p < 60°$		
$m_p > 60°$	Required transmission bandwidth increases greatly as depth of modulation is increased beyond about 60 degrees	
single sideband and carrier $m_p < 60°$	f_m	
PULSE		
height..........(phm)	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	$(S/N)f_m = m_w t_p\,(C/N)f_t$
width..........(pwm)		
rate............(prm)		
number........(pnm)		
displacement....(pdm) (pulse displaced either in position or time)		$(S/N)f_m = t_m f_t\,(C/N)f_t$
PULSED		
amplitude (pam)	$8\,f_m$	Inferior to unpulsed modulations of like type unless pulse rate is very high and transmitted bandwidth is very wide
frequency (pfm)		
phase (ppm)		

$(C/N)f_t$ 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.

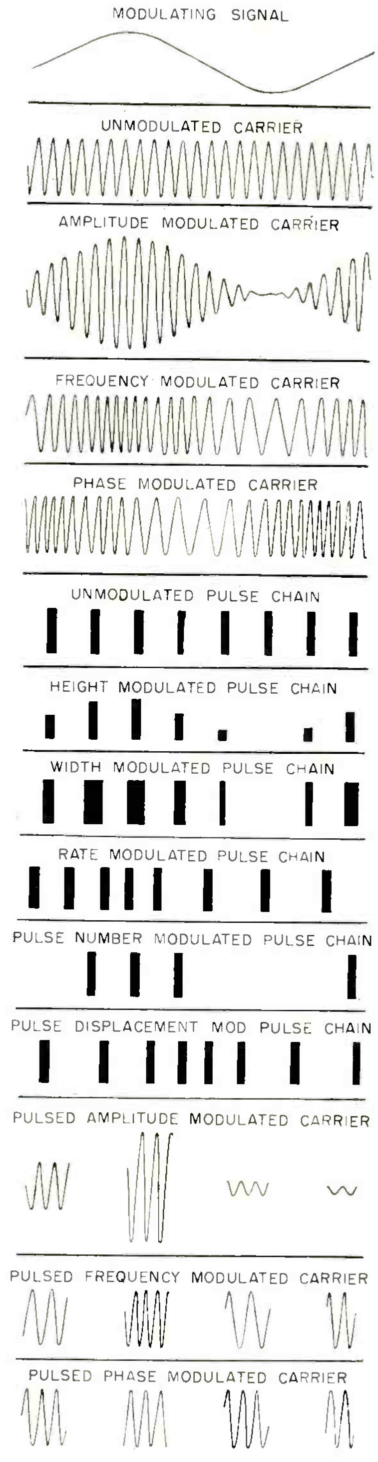


FIG. 20—Comparison of various types of modulation useful in telemetering data

and the bandwidth of the information to be transmitted.

Beacon Telemetering. 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 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.

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

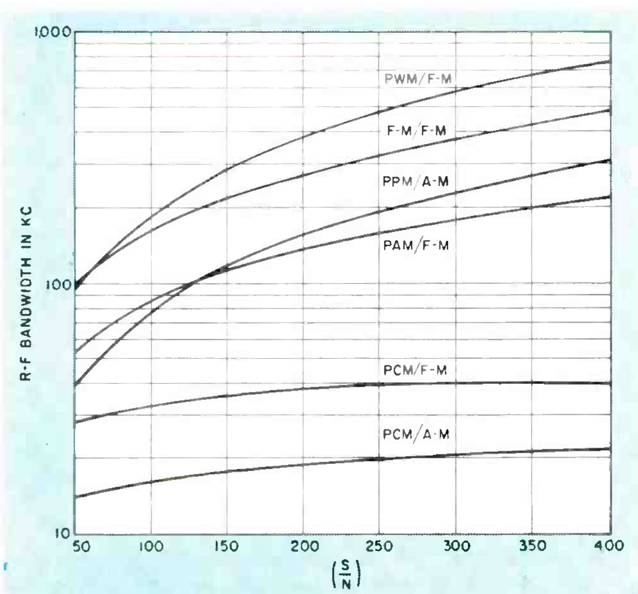
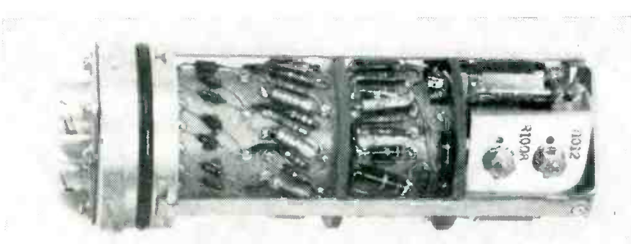


FIG. 21—Pulse-code signaling systems compared with other types on the basis of signal-noise ratio and bandwidth

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



Signal Corps telemetering unit designed by Stavid Engineering

Subcarrier discriminator built by Electro-Mechanical Research (right)

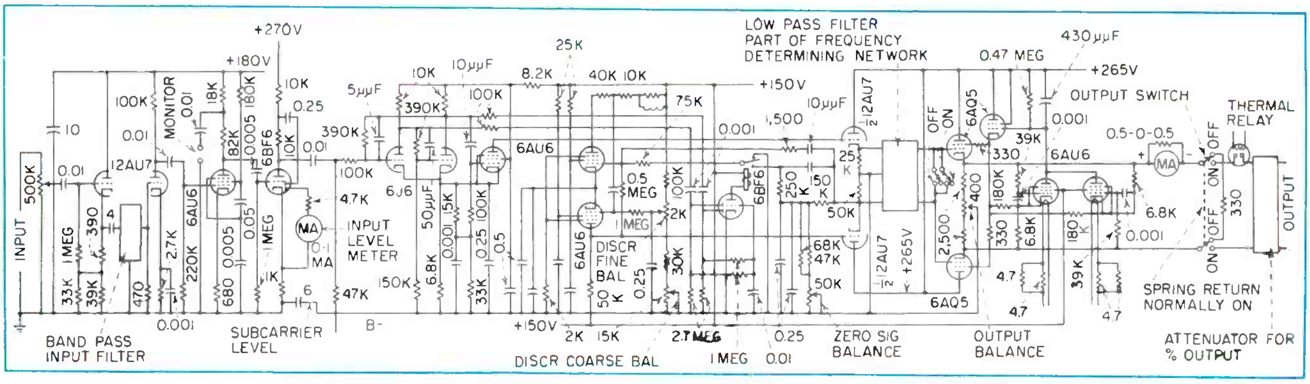


FIG. 22—Circuit diagram of linear multivibrator type of subcarrier discriminator. Plug-in filters permit use on any of the standad channels. Output limiting circuit protects the load (such as recording galvanometer) if output becomes unbalanced in excess of ± 150 percent full scale

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 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.

Receiving station for liquid level pulse code telemetering system

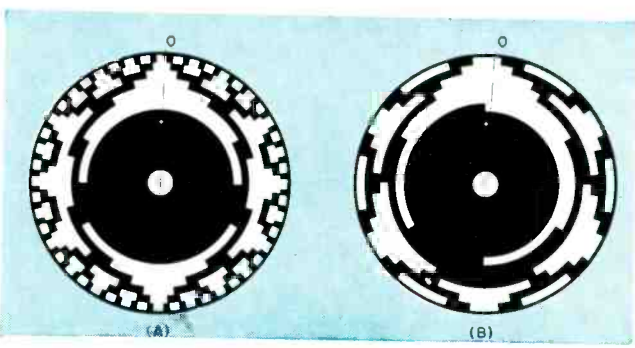


FIG. 23—Binary code disks used to sense fluid level and convert it to pulse code. Disk (A) measures inches and (B) measures feet

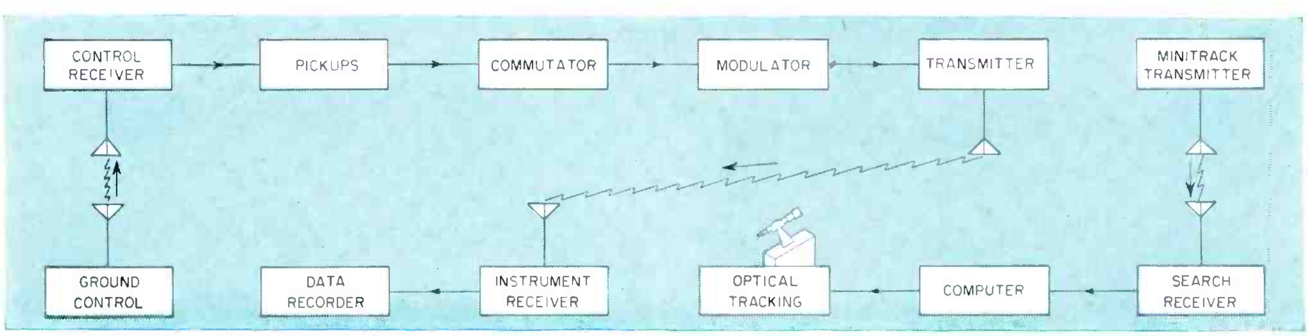


FIG. 24—Possible arrangement of tracking and telemetering equipment to observe phenomena between 200 and 300 miles above the earth from the Vanguard satellite on its orbit about the earth

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

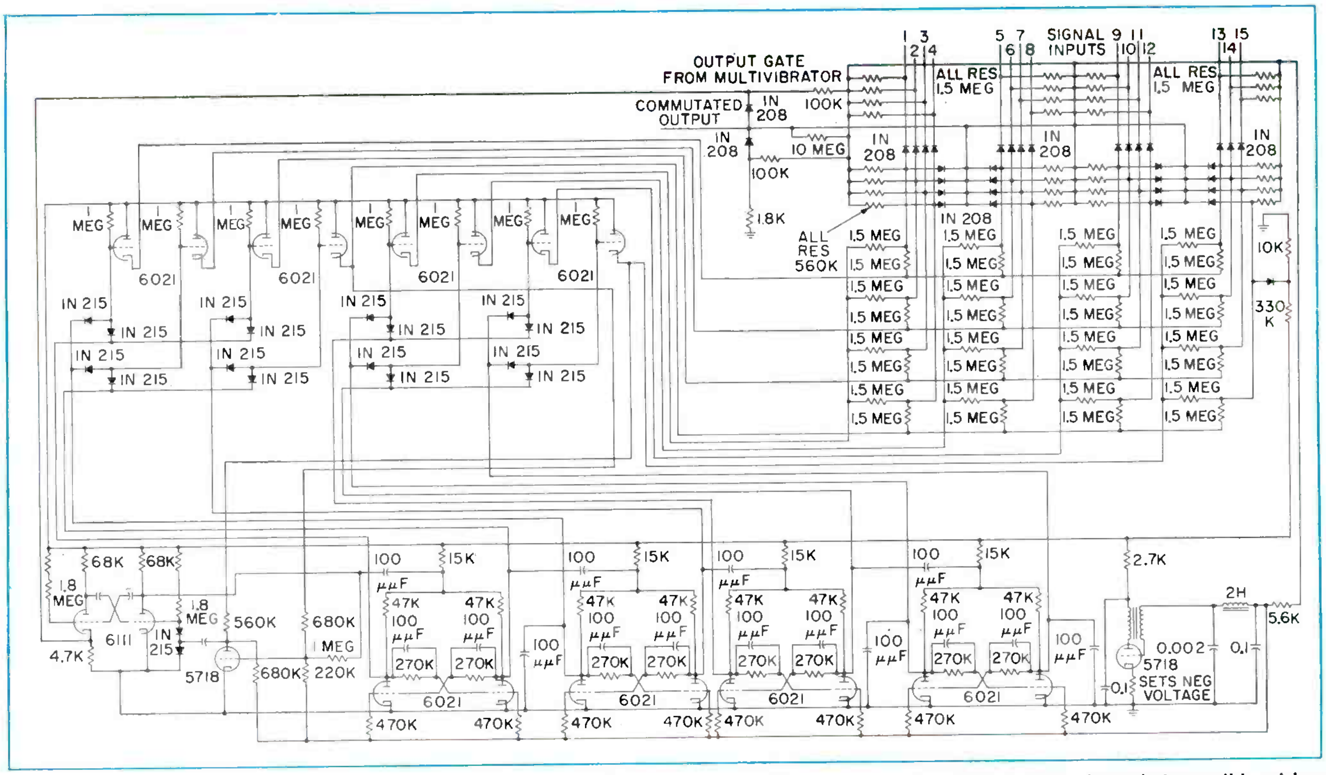
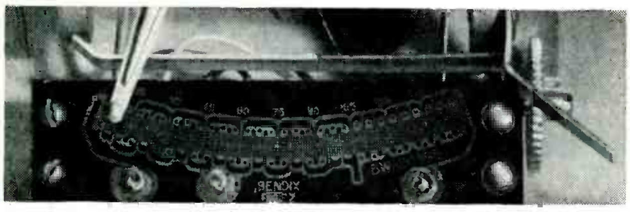


FIG. 25—Circuit diagram of an electronic commutator using tubes and diodes. Time sharing of radio-frequency channels is possible without use of rotating devices when fifteen channels are employed. Equipment is built by Electro-Mechanical Research



Baroswitch operated by the variation of atmospheric pressure in weather sounding radio telemeter switches the signal elements

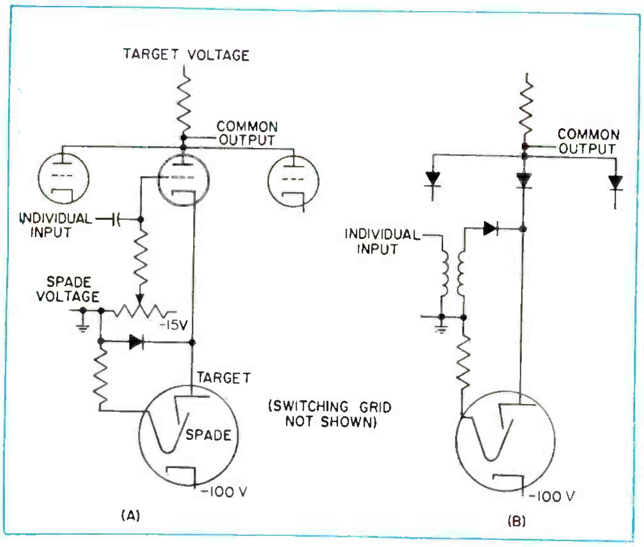


FIG. 26—Typical beam-gated sampling circuits using the Burroughs magnetron beam switching tube built by Haydu.

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).

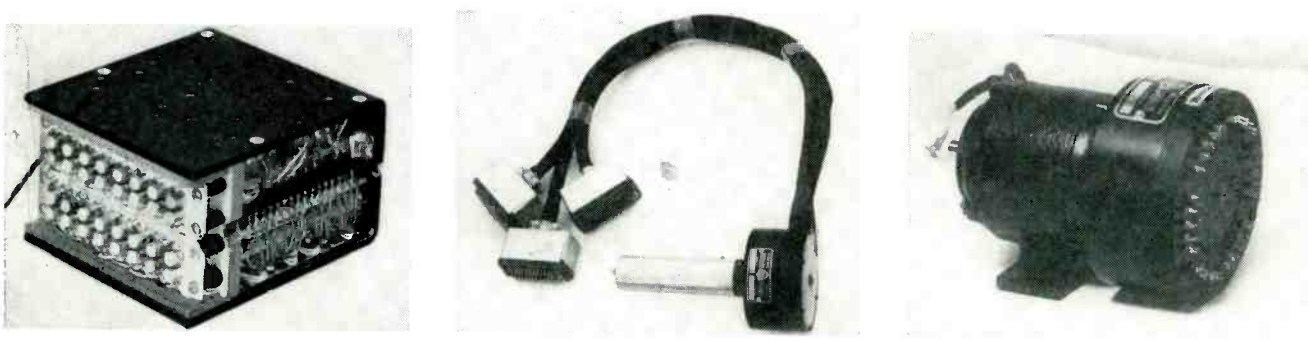
Tube Switches. Electron tube devices are being used in the field of military telemetering. One electron-beam tube, manufactured by Haydu Brothers, uses a switching grid, a spade and a target output plate as its basic electrodes. The switching grid is designed to initiate high-speed sequential switching 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

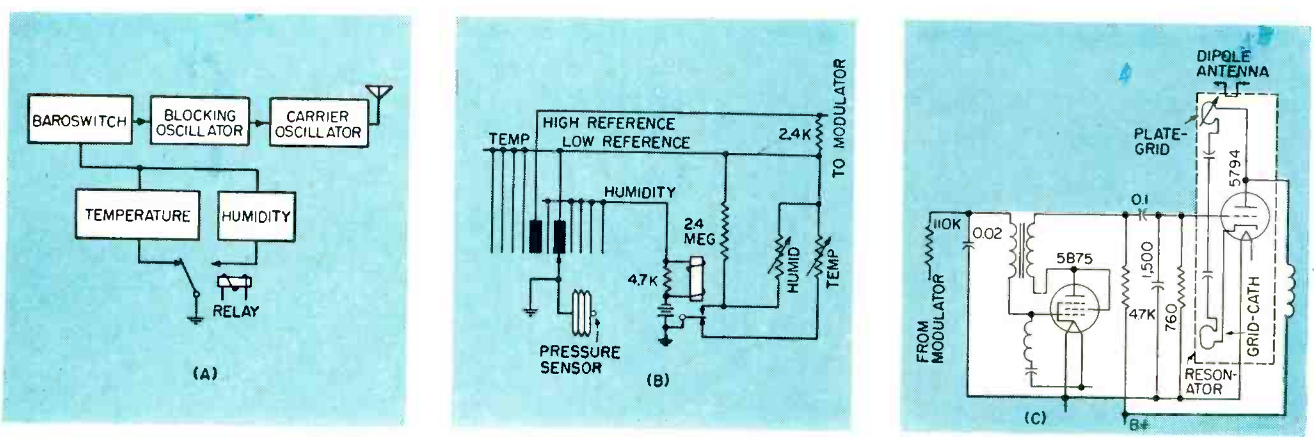


FIG. 27—Elements of a modern weather radiosonde (A) that show dependence upon the commutating system (B). Modulator and r-f transmitter shown at (C) transmit tones representing weather measurements

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

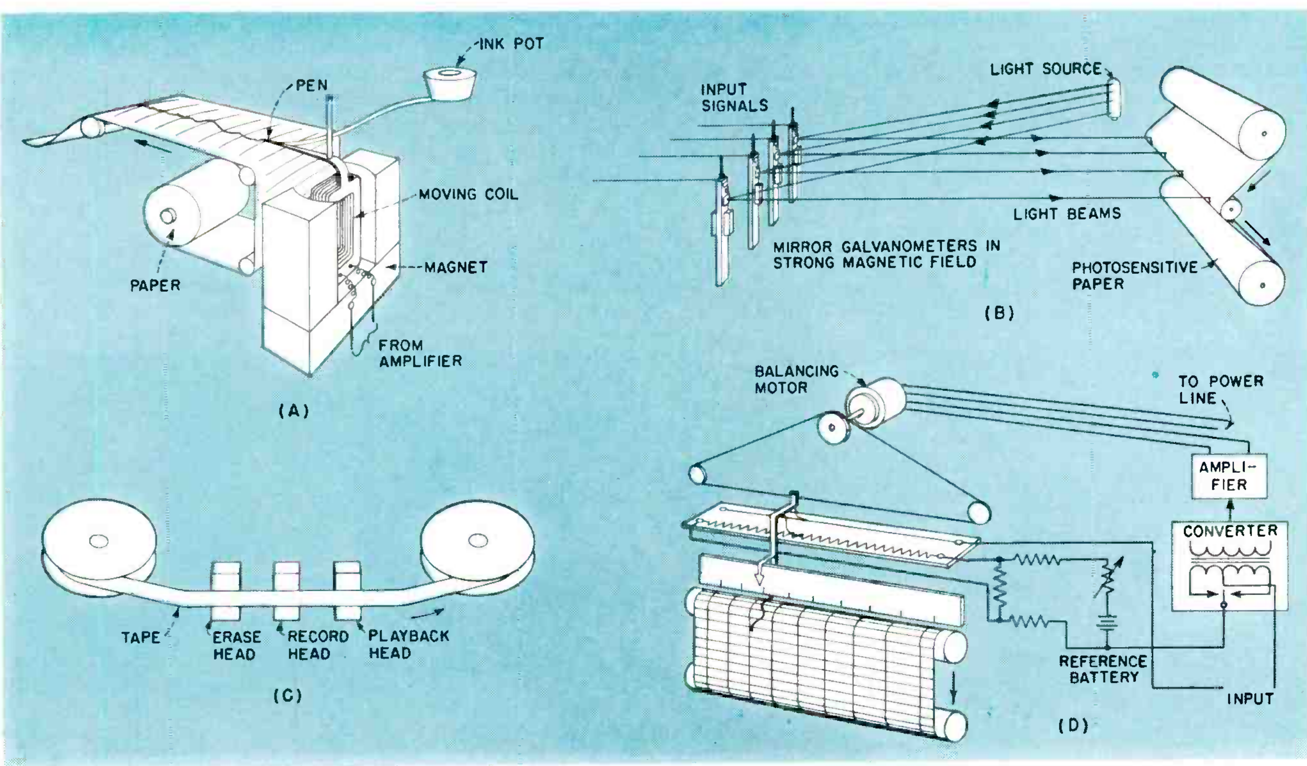
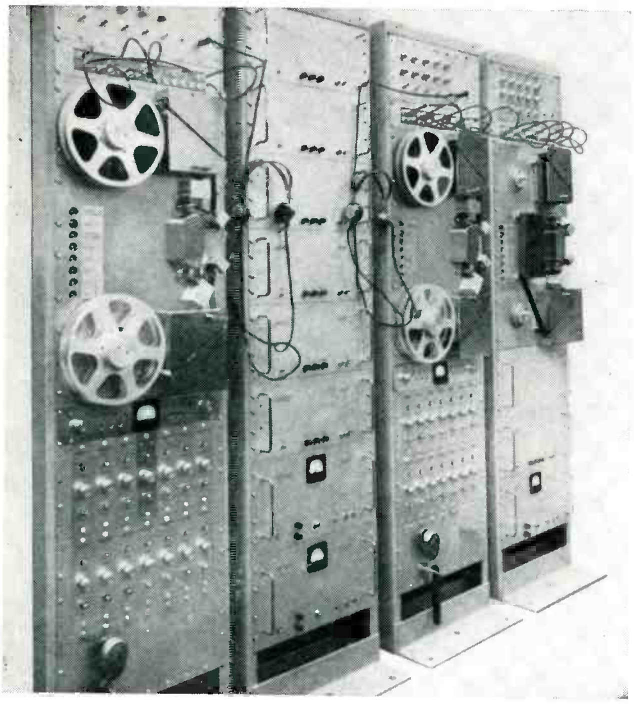


FIG. 28—Typical data recording devices include direct-writing oscillograph (A), galvanometer oscillograph (B), magnetic-tape recorder (C) and self-balancing recorder (D). Telemeter signals are usually stored on tape then played back, processed and recorded on one of other types of recorders. Information 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 oscillographs 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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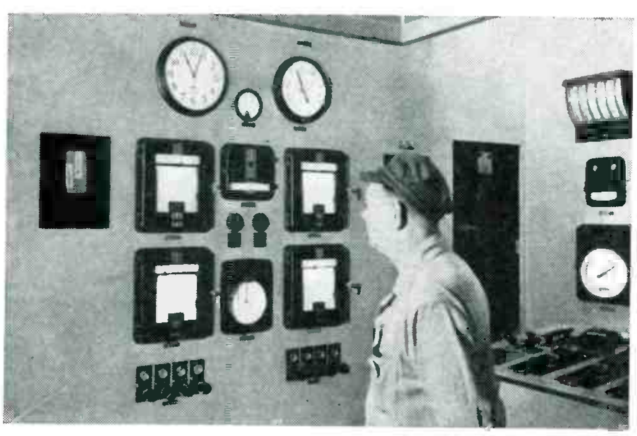
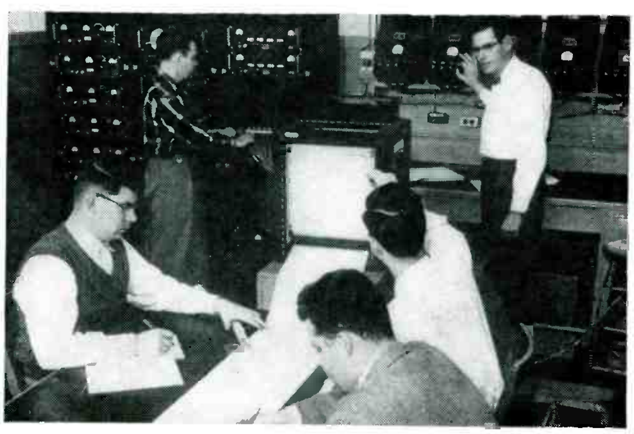


Indicating panel of power station has linear and circular self-balancing recorders to record steam-gas and air, feedwater and other temperatures on continuous basis



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 Telemetering 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—telemetering 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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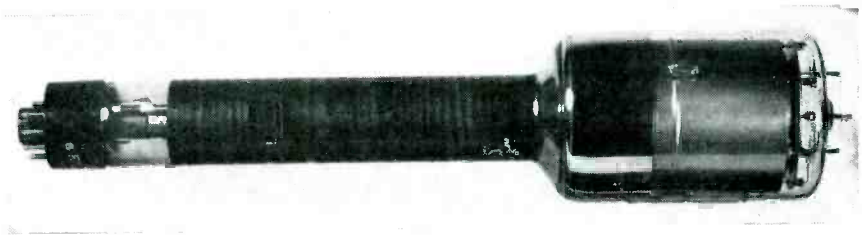

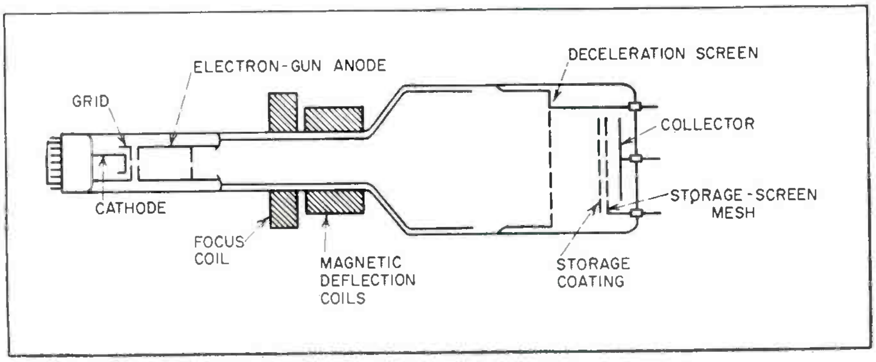

Appearance and structure of type QK-464 storage tube

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

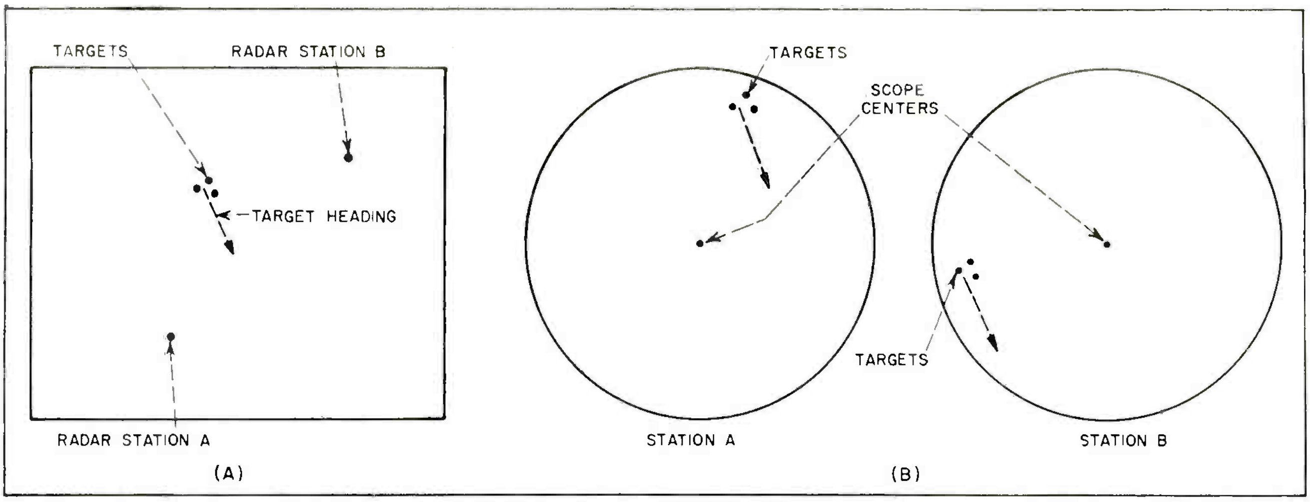

FIG. 1—Configuration of targets and radar stations (A) and simulated ppi presentations (B)

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

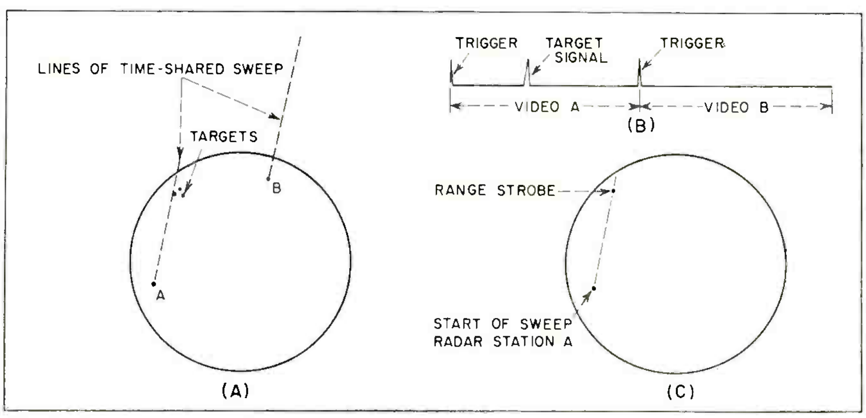

FIG. 2—Target pattern (A), video output (B) and method of writing targets on storage tube (C)

Y off-centering is determined by potentiometers that set the d-c potentials on the clamping tube.

The output gates of the flip-flop are connected to gated video amplifiers. The video output from the gated video *A* channel occurs when the sweep is off-centered to correspond to position *A*. This sequence occurs for one sweep line. The start of the next sweep on the storage tube occurs from position *B*, and the gated video *B* amplifier is activated.

The video connected to indicator *A* will show the targets as seen from *A*. On the other indicator the targets will be displayed as though detected from *B*. A schematic diagram of the output circuits of the storage tube, the video amplifier and the gated video amplifiers is shown in Fig. 4.

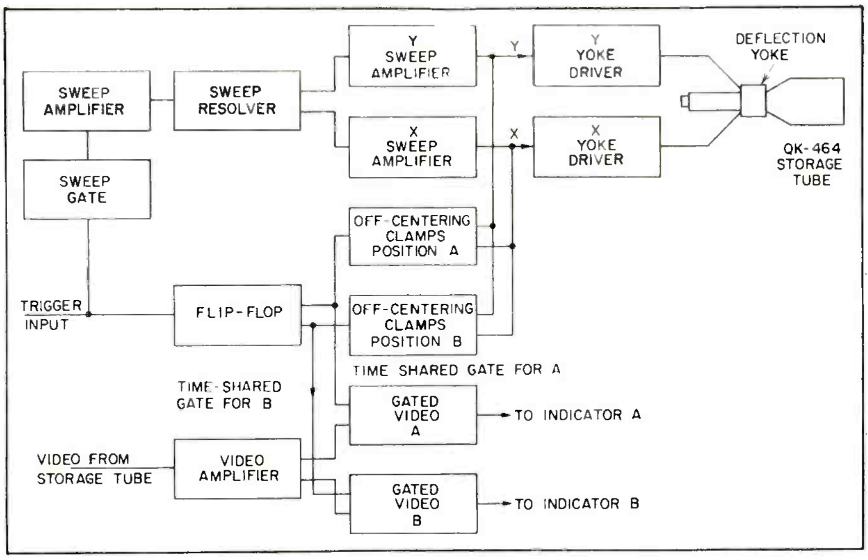

FIG. 3—Time-shared sweep permits alternate display on two radar indicators

A simulation of moving targets has been devised by connecting points *X* and *Y* in Fig. 3, to a non-time-shared, variable d-c voltage. This may be obtained from a motor-driven potentiometer and adds a variable displacement to both time-shared off-centered voltages. The targets though fixed in location on the screen, will actually appear on indicators *A* and *B* as moving targets. This is due to the translation of the centers of both sweeps.

The authors acknowledge the cooperation of A. S. Luftman and J. Buckbee of Raytheon Manufacturing Company, who assisted in the technical problems concerned with optimum preformance of the storage tube.

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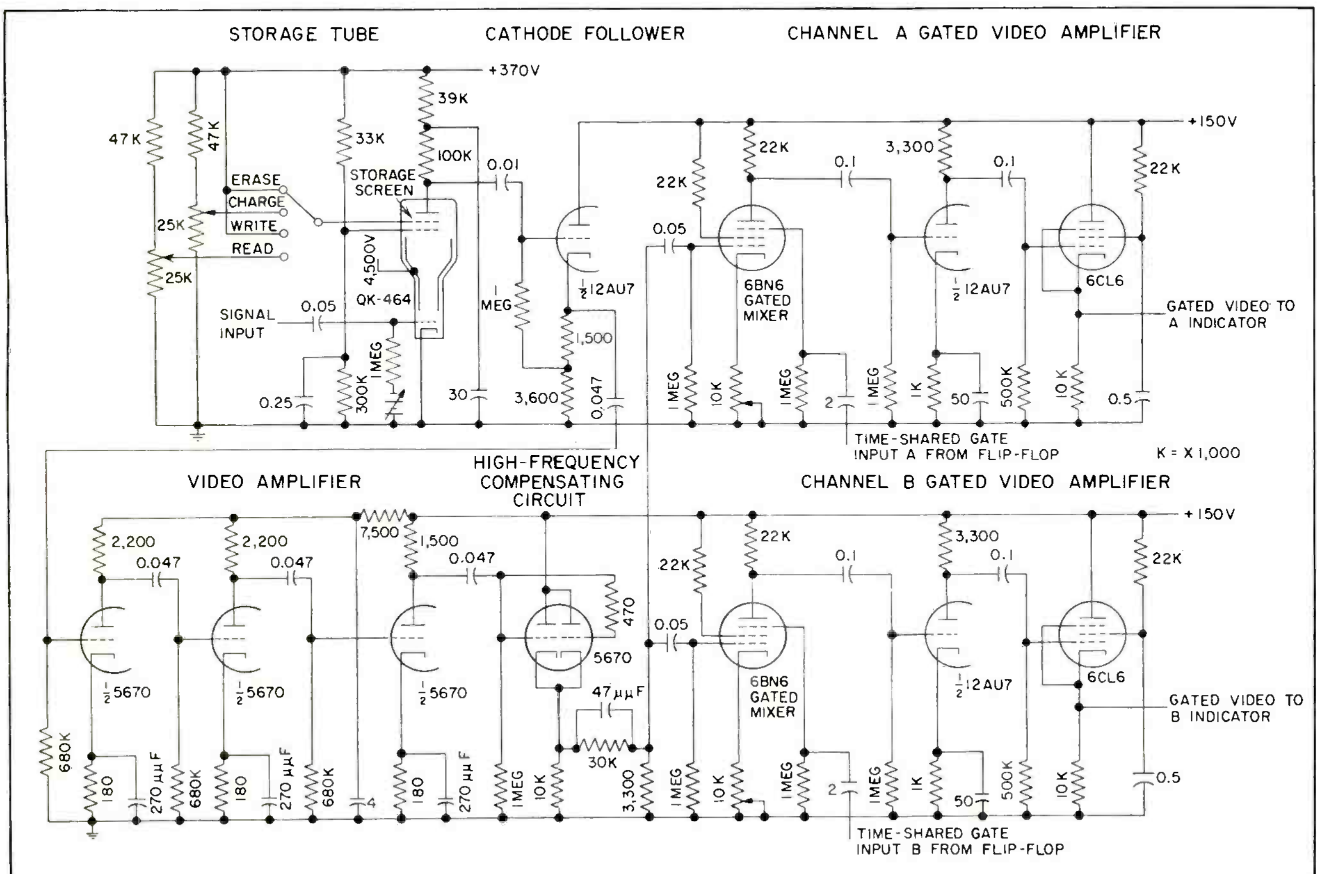

FIG. 4—Storage tube circuits, video amplifier and gated video circuits constitute heart of radar simulator

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

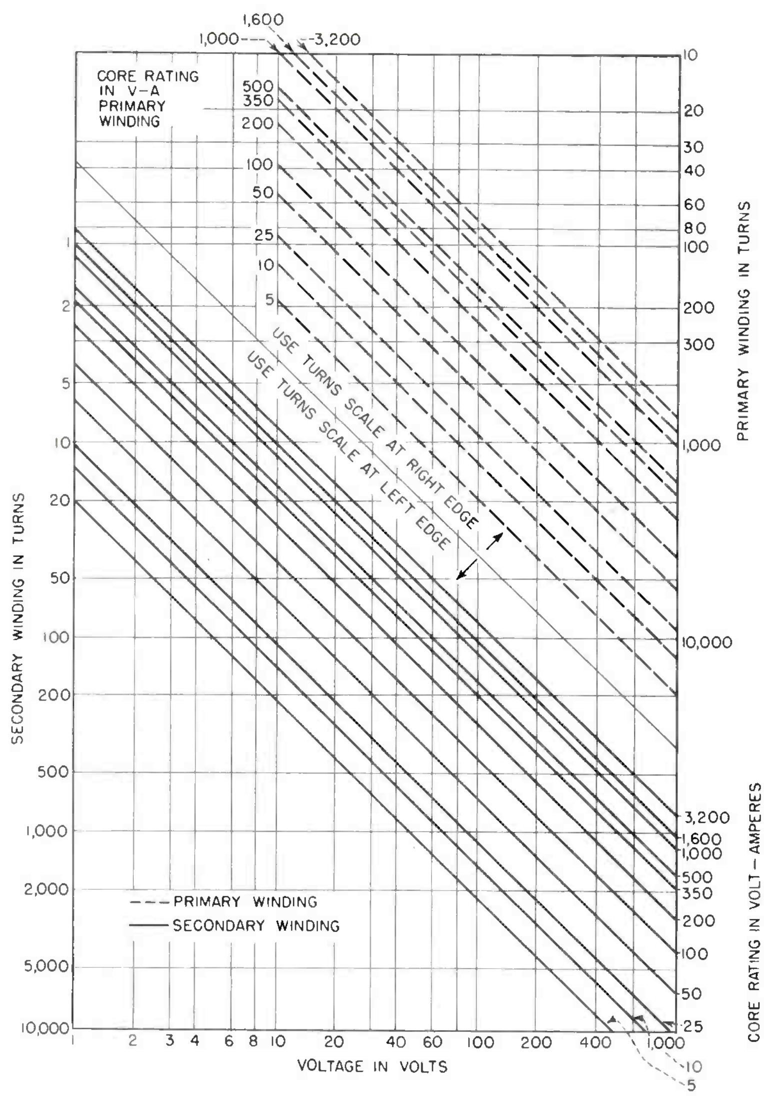

FIG. 1—Primary and secondary winding turns as determined from core volt-ampere rating

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)

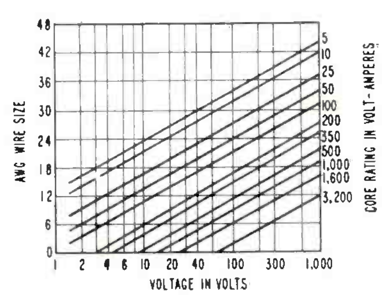

FIG. 2—Winding wire size in relation to voltage and core rating

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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 1.

(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 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) × $\sqrt{\text{temperature rise}/40\text{ C}}$.

(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.

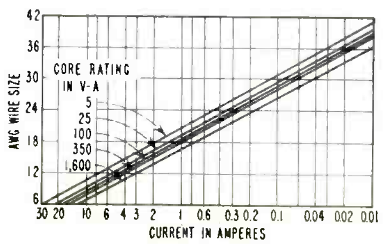

FIG. 4—Relation of winding wire size to current

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	1¾ × 1¾ × 1¾
2	10	15	0.68	1⅞ × 2⅜ × 1¾
3	25	10	1.2	2¼ × 2⅞ × 2¼
4	50	10	2.2	2½ × 3⅛ × 2½
5	100	8	3.8	3⅛ × 3¾ × 3
6	200	6	6.4	3⅞ × 4¾ × 3⅝
7	350	4	11.0	4⅜ × 5⅜ × 4
8	500	3	15	5⅛ × 6⅛ × 5
9	1,000	2.2	24	5⅞ × 6¾ × 6⅛
10	1,600	1.8	36	7¼ × 8¼ × 7½
11	3,200	1.2	75	9¾ × 12¾ × 8

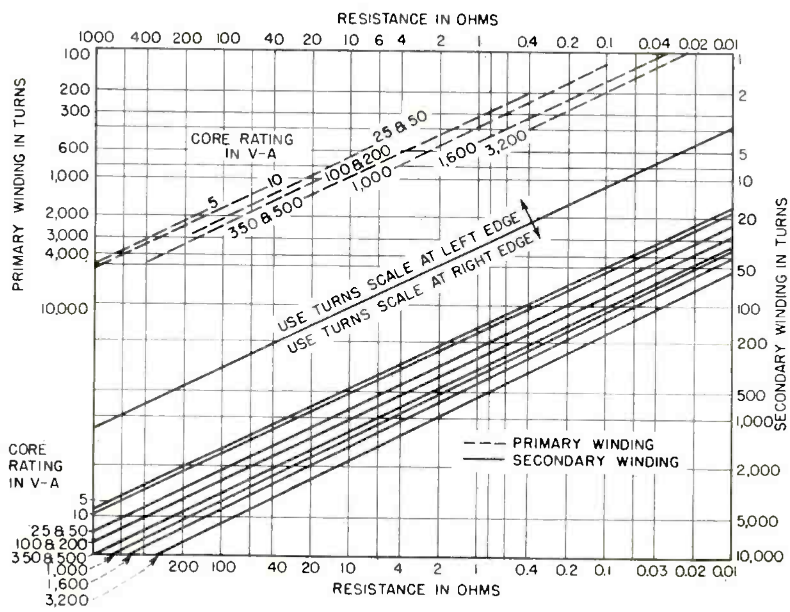

FIG. 3—Resistance of primary and secondary windings for type-C cores

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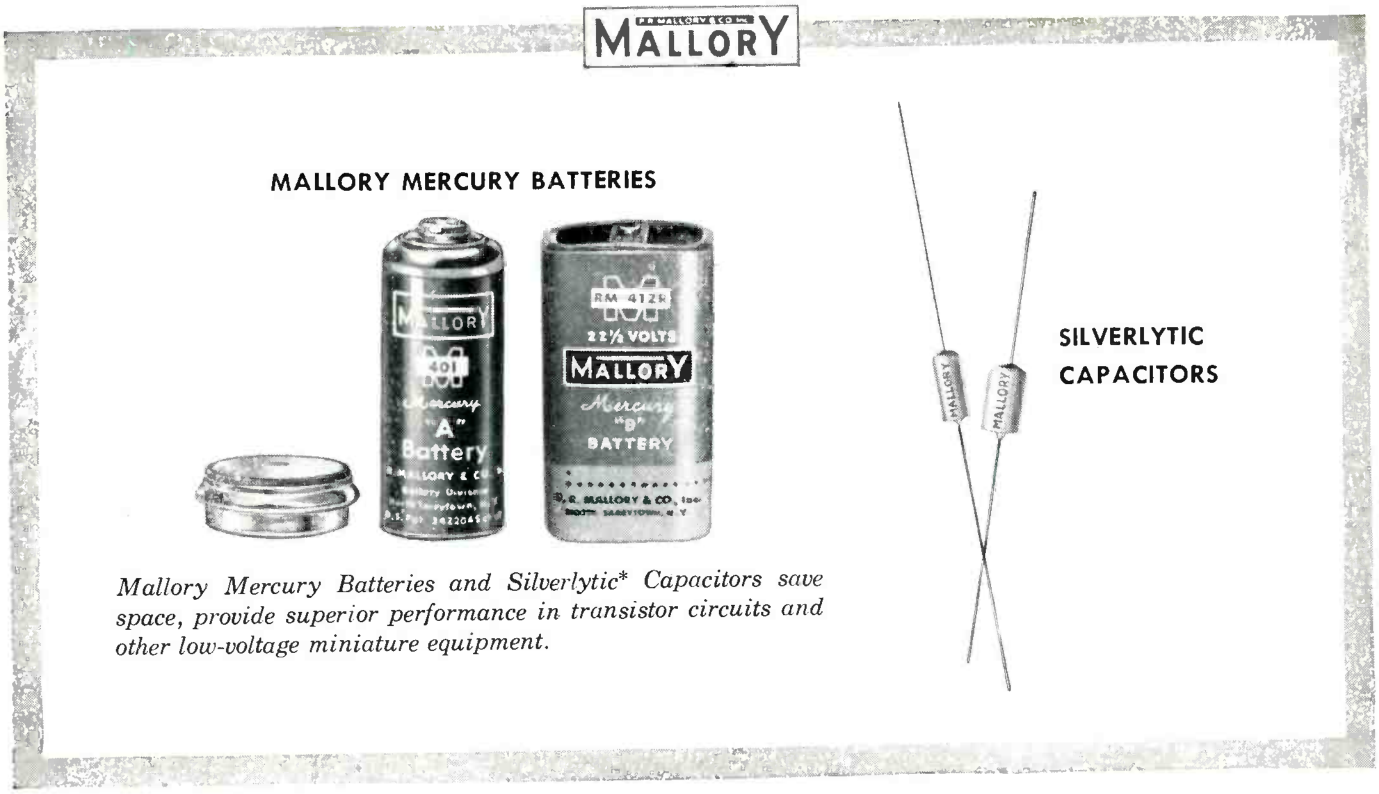

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To power transistor circuits, Mallory Mercury Batteries are now manufactured by a unique "snap together" construction† that makes higher voltage ratings available at hourly operating costs even lower than conventional batteries. The new design comes in standard 15, $22\frac{1}{2}$ and 45 voltages . . . can be produced in other ratings on order. A unique power source pioneered by Mallory, mercury batteries offer high energy content in small volume . . . far longer life in service and in storage. Service life up to three times that of usual dry batteries can be expected in transistor radios. Their constant discharge characteristic is ideally suited for transistor operation.

*Trademark

†Patent applied for

Subminiature Silverlytic Capacitors give maximum rating in small size. Type TAP, $\frac{7}{32}$" in diameter by $\frac{3}{8}$" long, operates from —55° to +85° C; values up to 30 mfd. at 6 volts, and in higher voltages as well. Even smaller is Type TAW—only .145" in diameter by $\frac{3}{8}$" long. Five basic capacitance values for Type TAW, from 1 mfd. at 24 volts to 6 mfd. at 4 volts. Each capacitance value is also available at lower voltage ratings at slightly lower cost.

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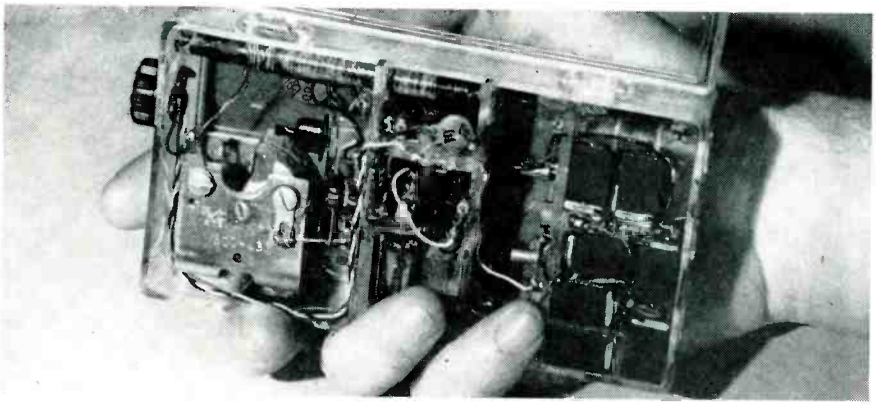
Electrons At Work

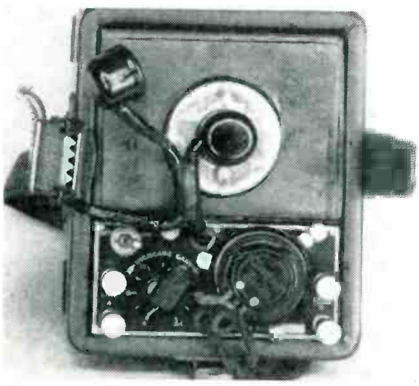
Edited by ALEXANDER A. McKENZIE

Transistor Receiver Powered By Sun

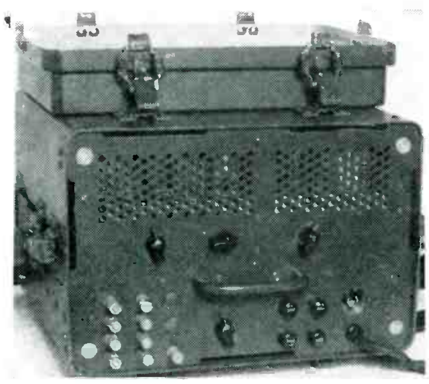


Weighing only 10 ounces, the receiver shown is said by General Electric engineers to be capable of working two hours a day for more than eight months in total darkness although solar powered. A miniature storage battery is charged by seven solar cells contained in the transparent plastic case. Artificial 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.

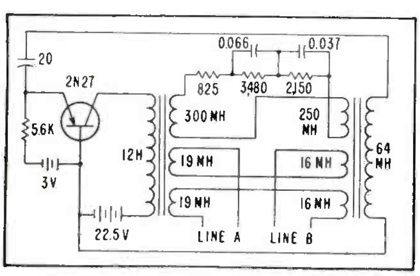
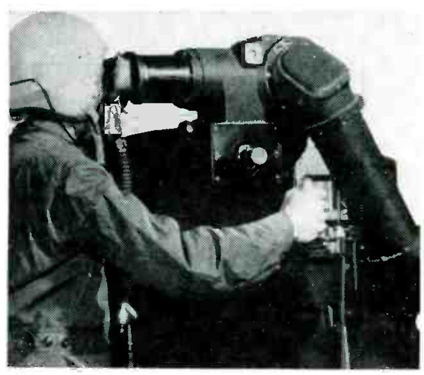


FIG. 1—Transistor negative-impedance telephone line repeater

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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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.

30 MODELS AVAILABLE FROM STOCK. COMPLETE CATALOG ON REQUEST

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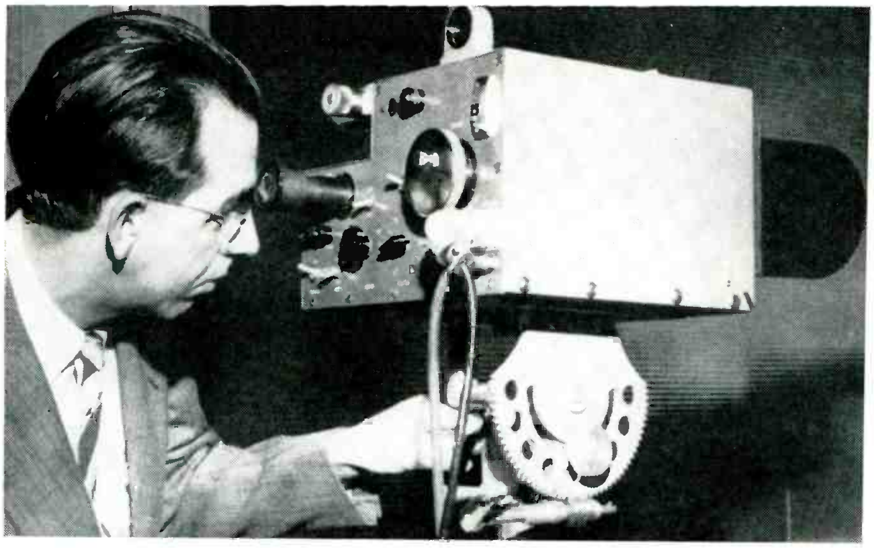
131-38 SANFORD AVENUE • FLUSHING 55, N.Y. • INDEPENDENCE 1-7000 many applications. The latter unit weighs 65 pounds.

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 distant can be seen in total darkness.

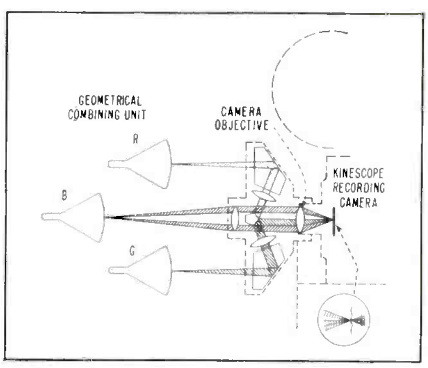
In operation, the evaporograph collects radiation emitted from an object and focuses it as an image upon an oil film. The oil evaporates from point to point at rates varying with the amount of radiation received at each point. Viewed in reflected light, the differences in oil-film thickness appear as different 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 represented 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

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 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.

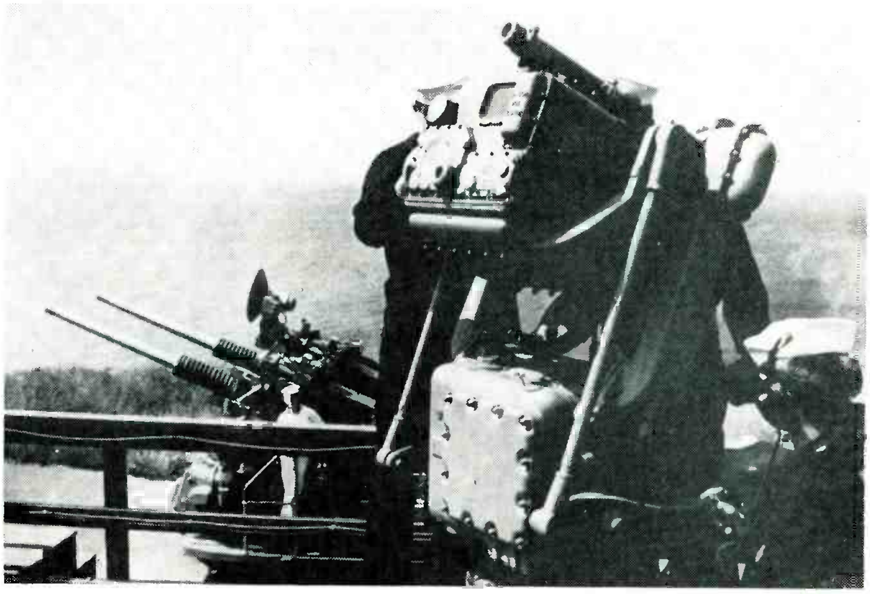
A suitable optical system for use with Vidicons is essentially the reverse of the geometrical combining unit used in recording. In this case, the film as it passes through the projector gate is illuminated from the emulsion side. Light transmitted by the various black-and-white color-separation images 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.

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

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 $\mu\mu$f) 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 $\mu\mu$f and an attenuation of only 2-to-1.

Input capacitance of a triode-connected cathode-follower is

$$C_{IN} \approx C_{gp} + (1 - G)\, C_{gk}$$

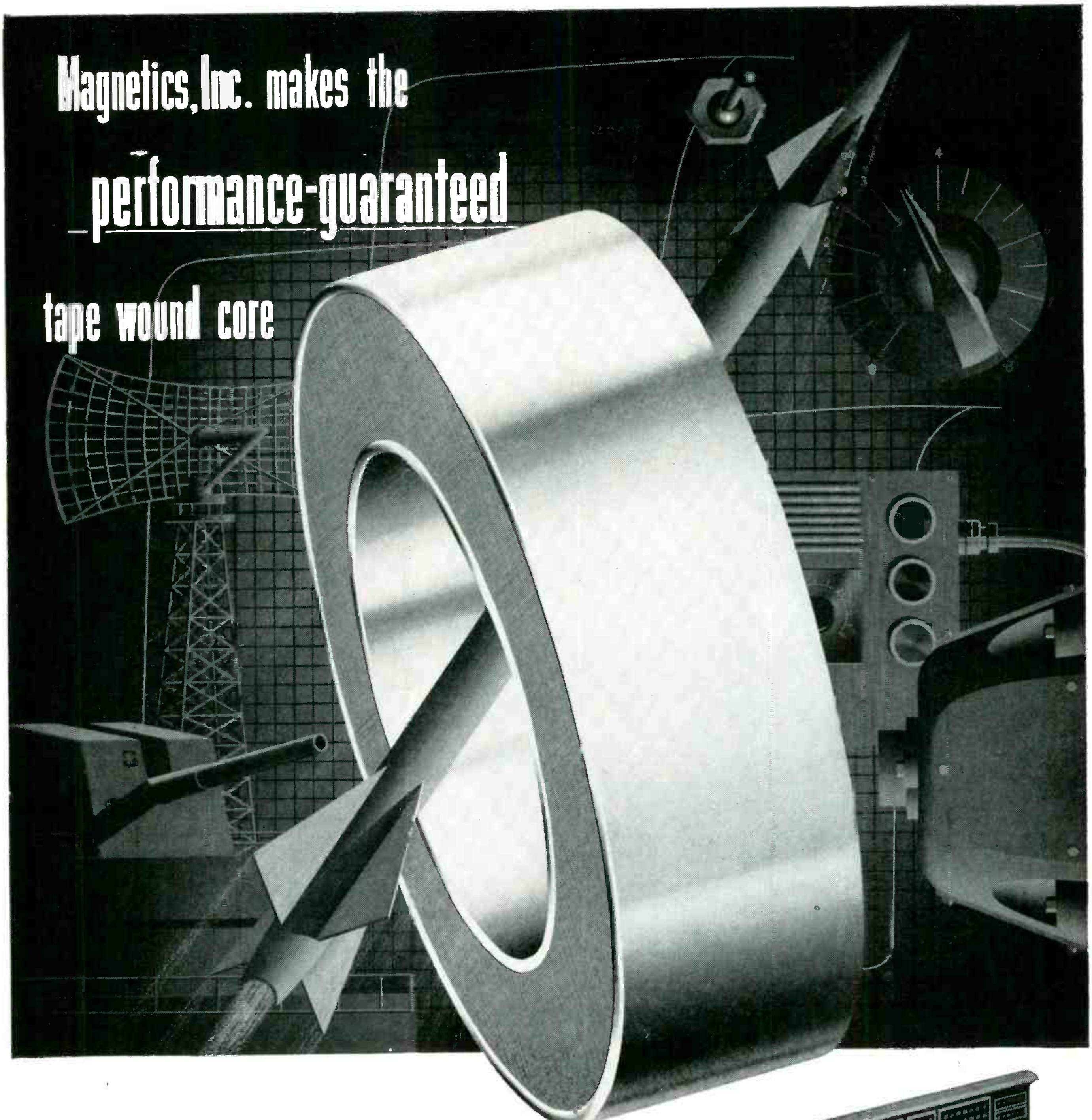
where C_{gp} is the grid-plate capacitance, C_{gk} is the grid-cathode capacitance of the triode and G is the gain of the cathode-follower.

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

$$C_{IN} \approx (1 - G)\,(C_{gk} + C_{gs})$$

where C_{gs} is the grid-screen capacitance of the pentode.

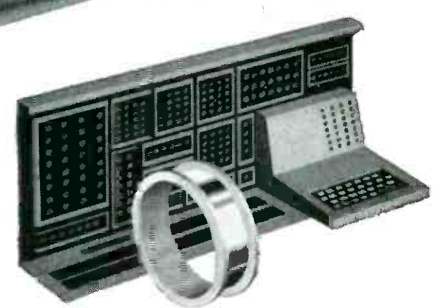
Total input capacitance for a given tube, disregarding wiring capacitance, now depends upon the



Core quality is no longer your worry—it's ours, for we guarantee performance of our tape wound and bobbin cores to mutually agreed upon specifications. What's more, you can specify a host of extra Magnetics, Inc. exclusive features. These include the Aluminum Core Box*, to withstand the rigors of temperatures to at least 450°F., vacuum impregnation, heavy winding stresses and vibration—and the color-coded bobbin core, for error-free handling in storage and assembly.

Why not write today for your copy of Catalog TWC 100-A? And if you have an application problem, our sales engineers are ready to provide you with expert assistance. *Magnetics, Inc., Dept. E-29, Butler, Pennsylvania.*

**Patent Pending*



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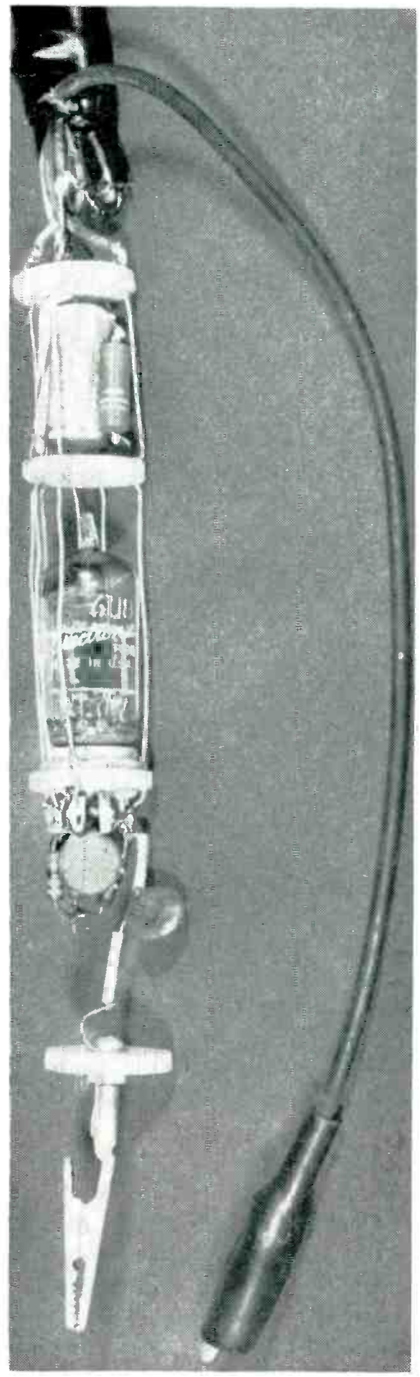
CABLE: Magnetics

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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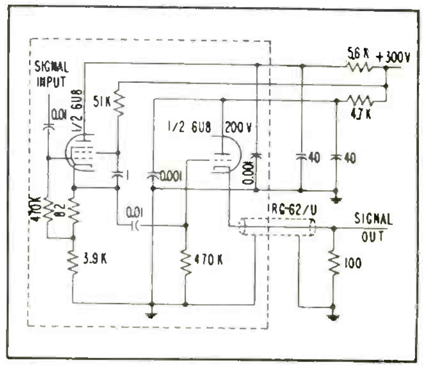
to reduce the input capacitance.

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.

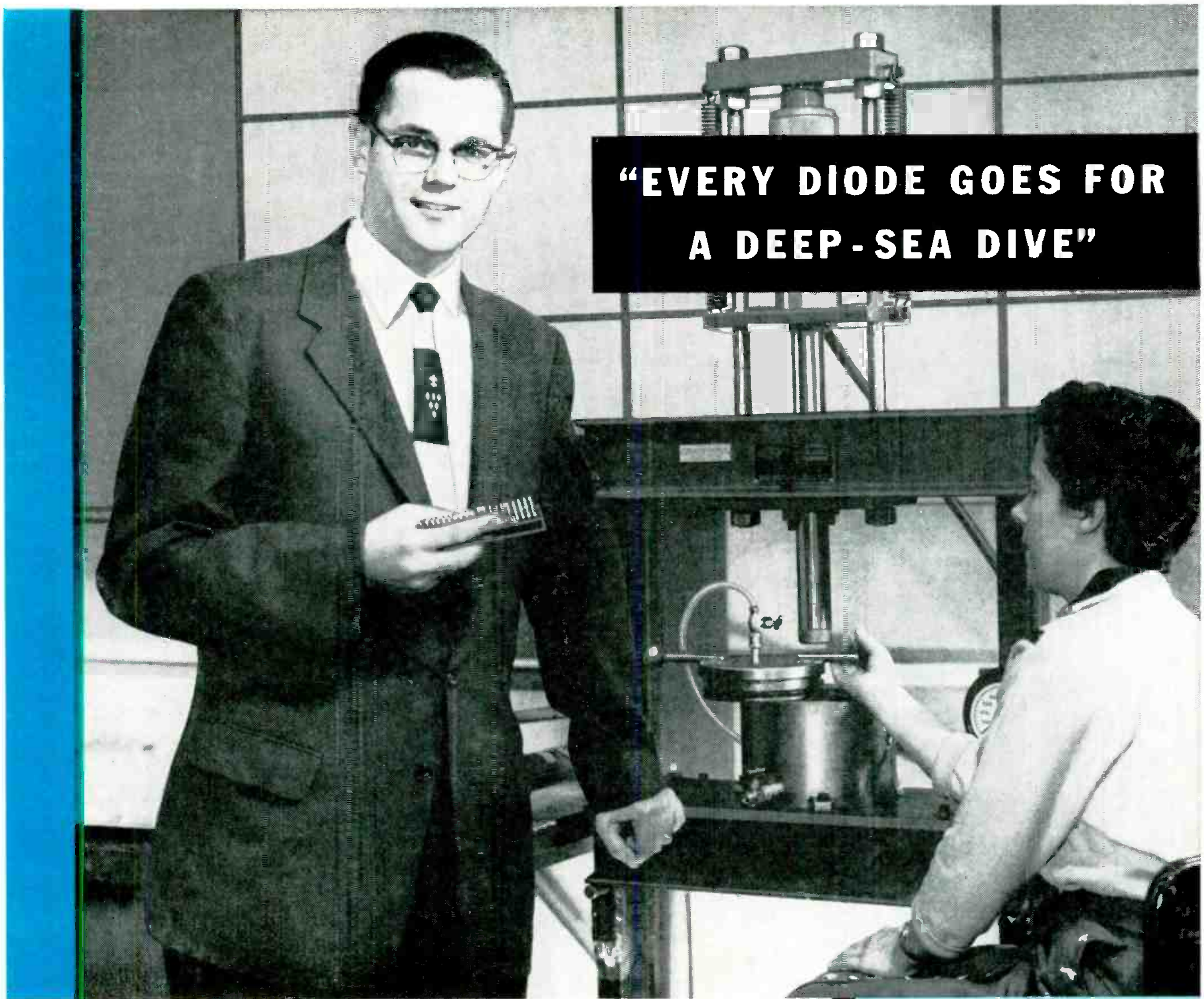


Tandem cathode-follower probe has attenuation of only 2 to 1 with input capacitance of less than 3 $\mu\mu$f

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 reponse.

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 $\mu\mu$f, the calculated input capacitance for the cathode-follower circuit is 0.25 $\mu\mu$f.

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-



"EVERY DIODE GOES FOR A DEEP-SEA DIVE"

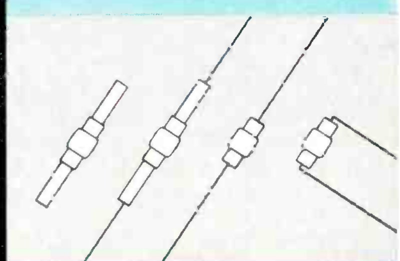
Morgan McMahon, Head of Engineering Services, is in charge of PSI's product applications and manufacturing engineering. Here he holds diodes prior to subjecting them to 1000 p.s.i. hermetic seal test.

"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."

COMPARE IT YOURSELF!

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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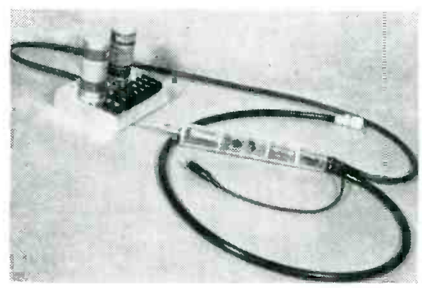
cathode bias, the input resistance is $R_g \left[\frac{e_1}{e_1 - e_2}\right]$ Here, e_2 is equal to $0.95e_1$ so that the input resistance is calculated to be 9.4 megohms.

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

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 voltagewise 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

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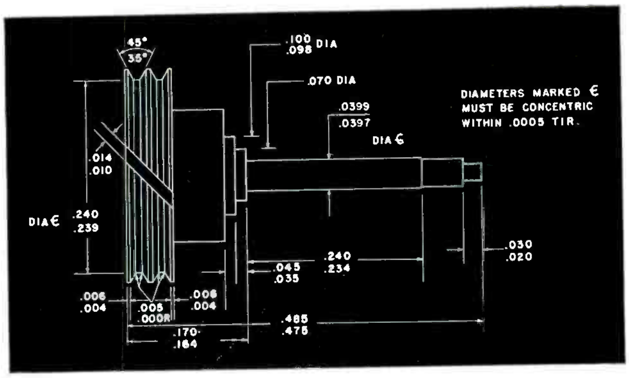
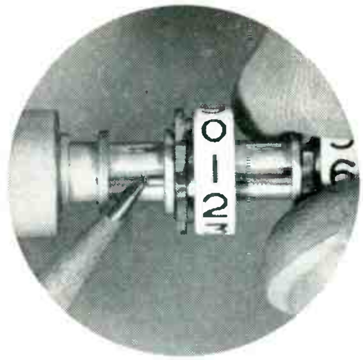


Inspection of incoming precision shafts took 10 to 15 minutes each by mechanical gaging—involved concentricity, diameters, shoulder locations, and other tough-to-measure dimensions to tolerances of .0002". Doing the work on a Kodak Contour Projector cut time to 2 to 3 minutes per shaft.



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 ¼ 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.
2. *Ease of operation*—Kodak Contour 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.

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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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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

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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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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.

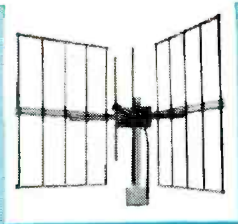
FIG. 1—Trailer carrying tower is located at desired spot. Outriggers keep unit steady while tower is raised in about three minutes

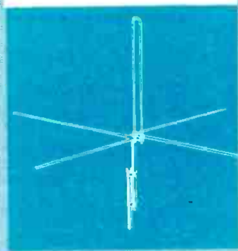
Telescopic shafts are used with this mechanism so that the tower can be raised or lowered to any level without any adjustment to the shafts.

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.

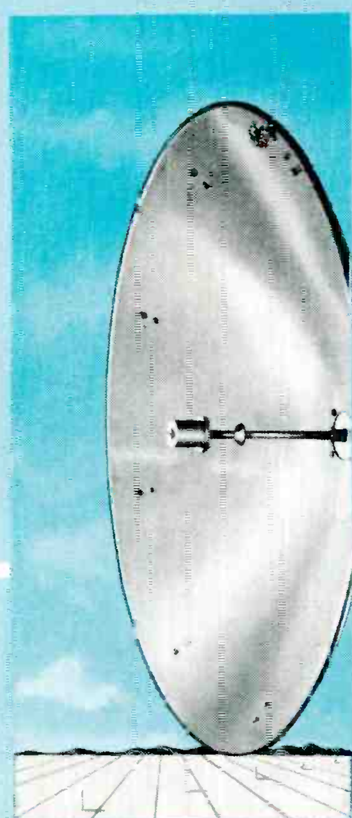
One of the less expensive components in a radio communications installation is the antenna. Yet the antenna, which usually represents less than ten per cent of the total equipment cost, can multiply the effective power of every transmitter in the system *several hundred per cent*. Equally true, a poorly designed or inappropriate antenna can waste the power produced by the costly equipment behind it.

Manufacturers of the UNIPOLE, High Gain, Corner Reflector, Parabolic and Yagi Antennas

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 adaptions of standard models are readily made to order.

Write or phone Andrew for a dollars-and-cents evaluation of the type of antenna that can give your installation the greatest bargain in power.



Andrew CORPORATION
363 EAST 75th STREET · CHICAGO 19

OFFICES: NEW YORK • BOSTON • LOS ANGELES • TORONTO 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.

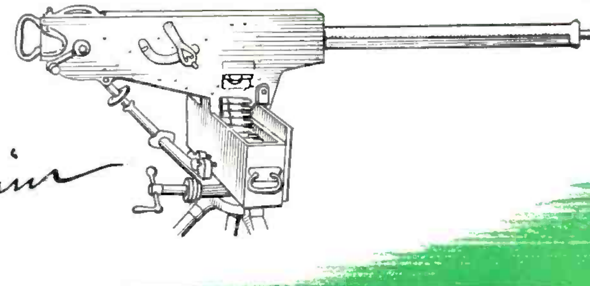
An image of the scene to be televised is formed by a special lens on a transparent photocathode. Photoelectrons emitted are deflected by both an electric and a magnetic field. They strike points on a mica target corresponding to the image points from which they were emitted. On the target is produced 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

. . . packaged for efficiency

Hiram Maxim devised the first single-barrel, fully automatic machine gun. It embodied the best features of other firearms and Maxim's own refinements. With this automatic, well-packaged gun, one man has the fire power of dozens of individual riflemen.



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.
Type No. N771B: 1900 to 4000 Mc/s.
Direct Reading Frequency Dial Accuracy: ± 1%*
Power Output: 50 mw (average) over the band.
Internal Modulation: CW, Square Wave and Pulse (400 to 1800 cps)
External Pulse Modulation and Reflector Modulation (FM) through Front Panel Input Jacks.

*When greater accuracy is required, the FXR Type No. N410A Direct Reading Coaxial Frequency Meter will provide ± 0.1% accuracy from 1000 to 4000 Mc/s.

N410A

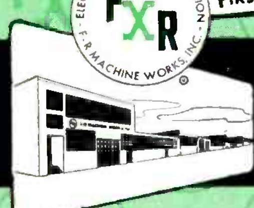
Convenience is the "big gun" of the FXR *all-in-one* Signal Sources. Into one compact package has been built a power supply, klystron, klystron cavity, modulator, variable rf attenuator and an automatic reflector voltage tracking system. These Signal Sources are as easy to use as your home radio. The 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.

Write today for a complete catalog of FXR PRECISION MICROWAVE TEST EQUIPMENT.

FXR ELECTRONICS & X-RAY DIVISION F-R MACHINE WORKS, INC.

FIRST BY FAR

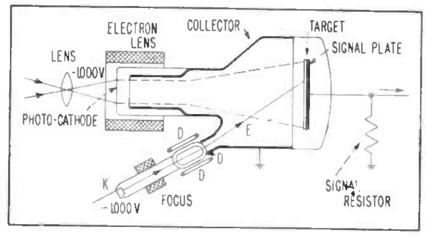


Electronics & X-Ray Division

F-R MACHINE WORKS, Inc.

26-12 BOROUGH PLACE, WOODSIDE 77, N. Y. • ASTORIA 8-2800 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 scannings, 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.



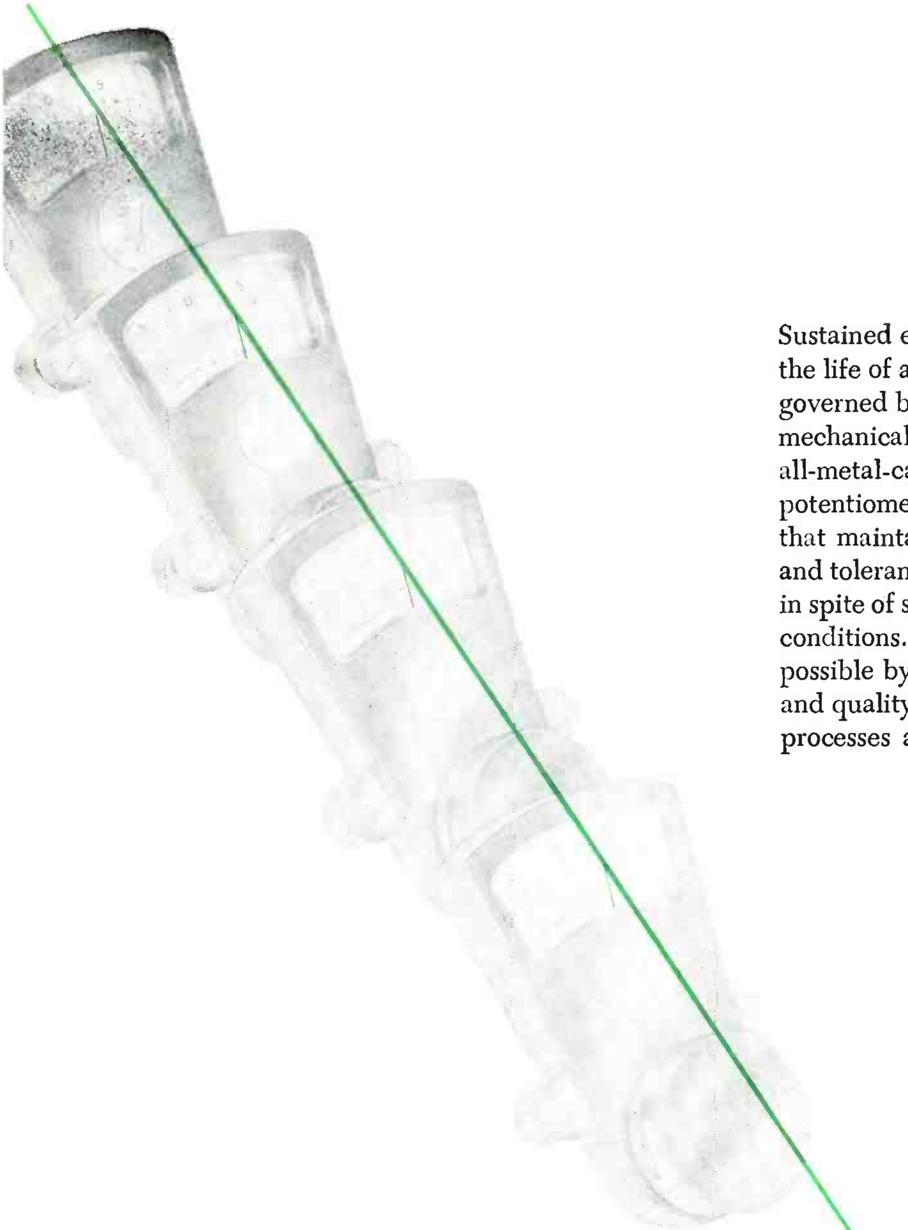
Cross-section of image iconoscope showing deflection coils *D* and scanning beam *E*. In the new tube, the insulated mica target plate is replaced by a conducting glass plate

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 scannings, 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,



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.

SUSTAINED ACCURACY

through mechanical rigidity

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 ½ the diameter and ⅓ the weight of usual standards. It is the Fairchild Standard Type 920. Its 24½" coil length assures linearities of ±0.25% in a resistance range of 1,000 to 200,000 ohms, with ±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 the 48 states! They're all solved for us by Air Express! And Air Express has never failed us!

"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¢!"

Air Express

GETS THERE FIRST *via U.S. Scheduled Airlines*

CALL AIR EXPRESS . . . *division of* RAILWAY EXPRESS AGENCY 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.

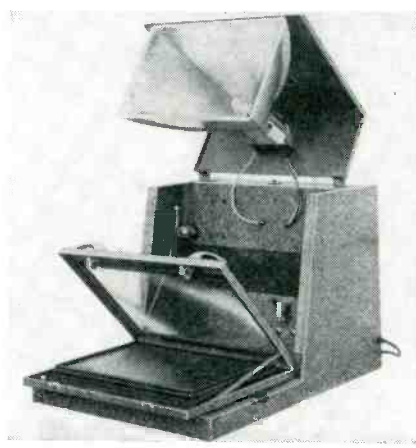
Inquiries can be made by telephone. Written requests should be addressed to C. P. Marsden, Chief, Electron Tubes Section, National Bureau of Standards, Washington 25, D. C.

Microammeter Measures Frequency

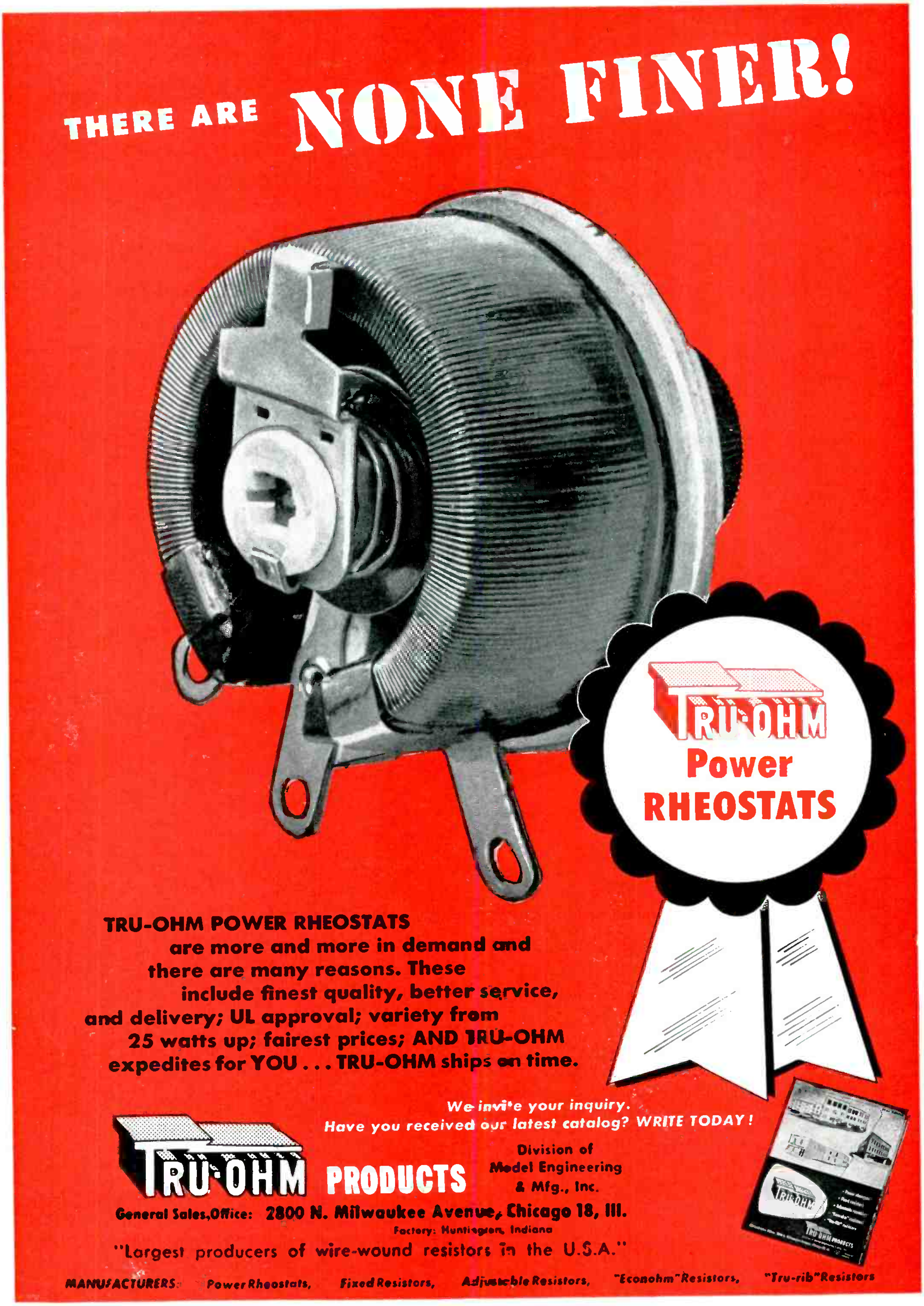
AUDIO-FREQUENCY measurements can be made with considerable precision at the lower end of the spectrum using a saturable reactor and a rectifier. A plug-in unit that has been developed recently combines components and requires only a suitable source of voltage and a microammeter to give direct frequency 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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Power
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TRU-OHM POWER RHEOSTATS are more and more in demand and there are many reasons. These include finest quality, better service, and delivery; UL approval; variety from 25 watts up; fairest prices; AND TRU-OHM expedites for YOU . . . TRU-OHM ships on time.
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MANUFACTURERS: Power Rheostats, Fixed Resistors, Adjustable Resistors, "Econohm" Resistors, "Tru-rib" Resistors

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.

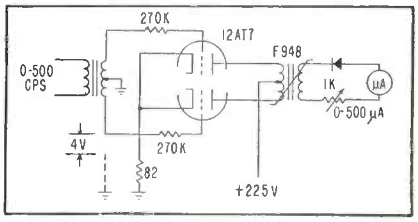


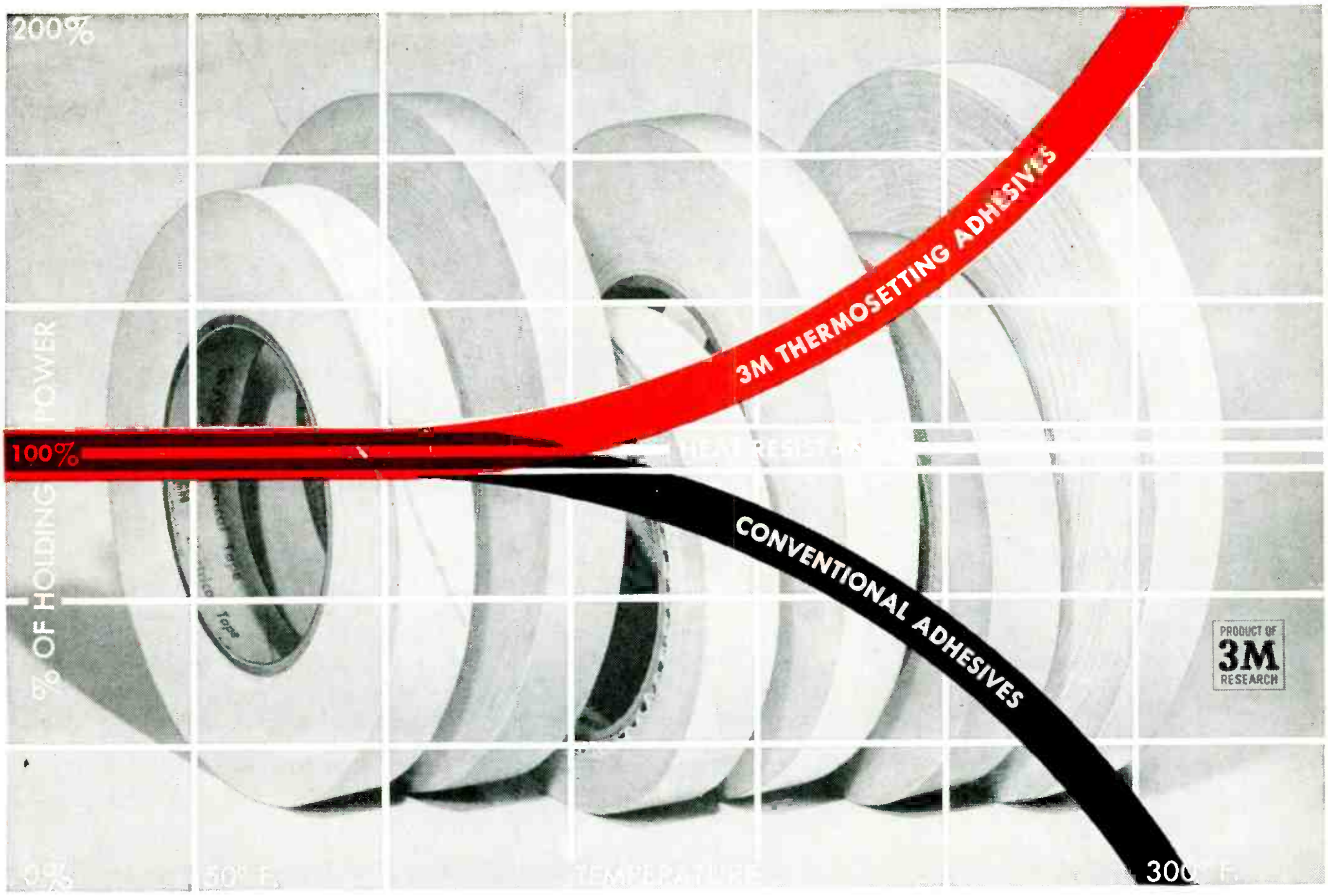
FIG. 1—Reactor and rectifier count cycles

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 letterhead 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.

The first true thermosetting adhesive . . . still the industry standard . . . found only in . . . **SCOTCH** BRAND **Electrical Products**

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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 $3\frac{1}{2}$ 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 $3\frac{1}{2}$ 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

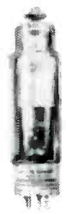
Consult CHATHAM for all four

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.

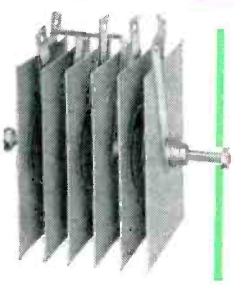
CHATHAM TYPE 5948/1754

Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 12.5 megawatts.

CHATHAM TYPE VC-1257

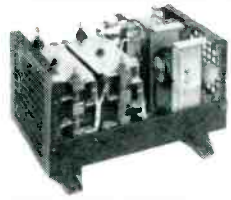
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of pulse power up to 33 megawatts.

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.
Regulation — 25 to 31 volts
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.

4 CUSTOM-DESIGNED EQUIPMENT

CHATHAM specializes in the development, design and production of equipment built to customers' needs. Our engineers will supply estimates on receipt of your drawings and specifications.

High power Radar modulators built to government specifications.

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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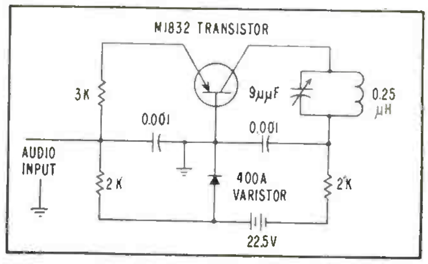


Circuit of simple f-m transistor transmitter originally described in ELECTRONICS, p 130, Feb. 1954

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.

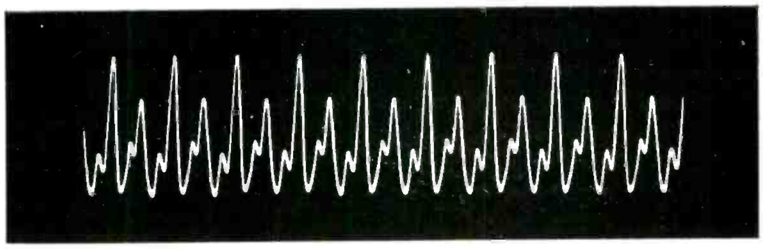
An intrstng exprmnt in spch

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.

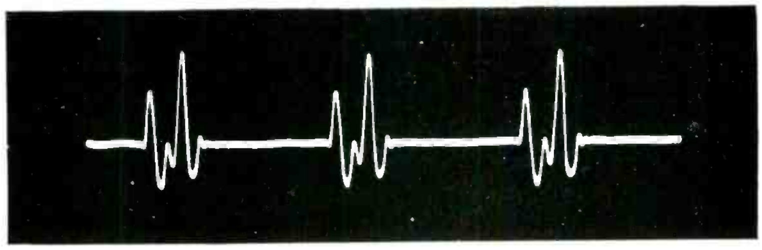
This is but one of many transmission techniques that Laboratories scientists are exploring in their search for ways to make Bell System wire and radio channels serve you more efficiently. It is another example of the Bell Telephone Laboratories research that keeps your telephone the most advanced on earth. *The oscilloscope traces at right show how the shorthand technique works.*

BELL TELEPHONE LABORATORIES

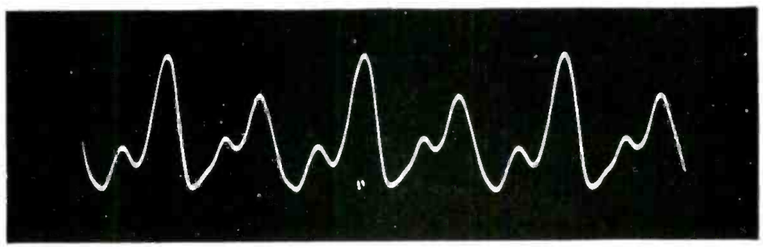
World center of communications research
Largest industrial laboratory in the United States



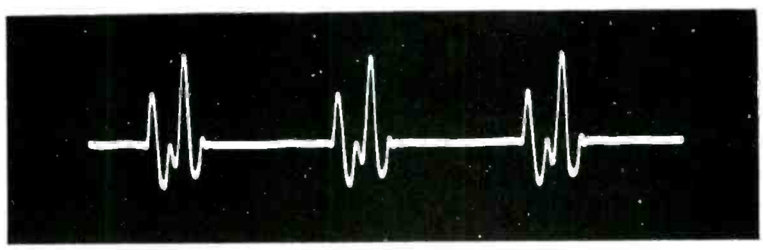
Vibrations of the sound "or" in the word "four." Pattern represents nine of the "pitch periods" which originate in puffs of air from the larynx when a word is spoken.



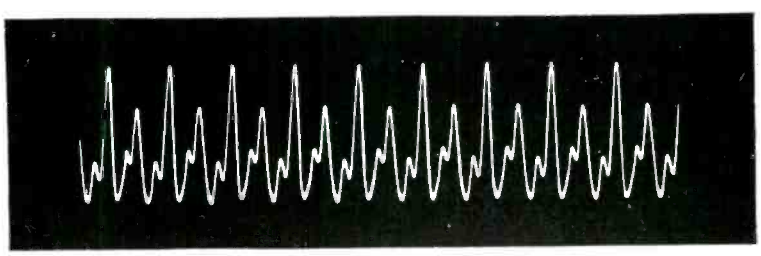
An electronic sampling of the "or" sound. One "pitch period" in three has been selected for transmission. This permits great naturalness when voice is rebuilt. Intelligible speech could be sent through a 1 in 6 sampling.



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.



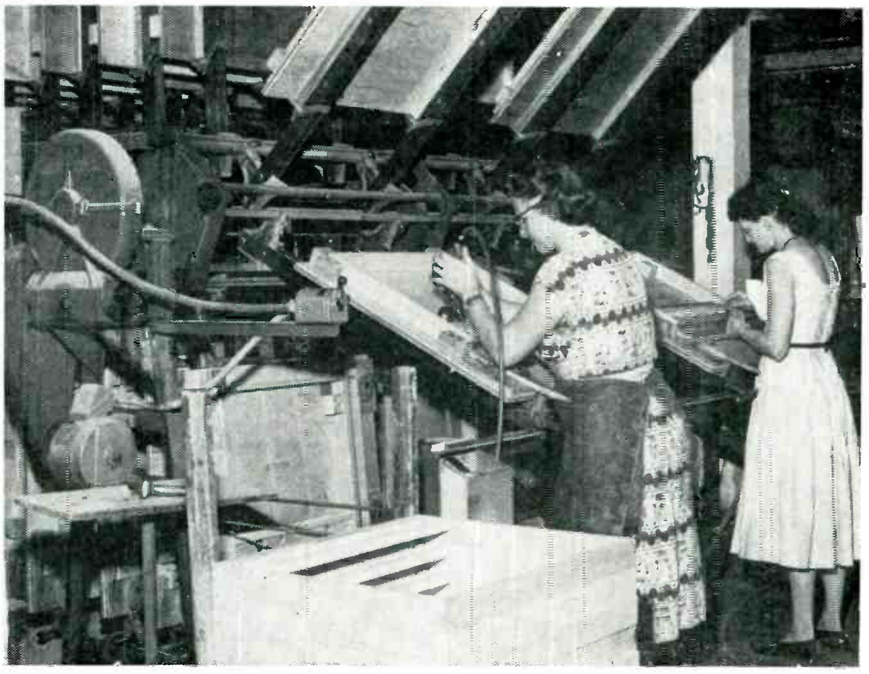
The receiver fills in gaps between samples, recreating total original sound. Under new system, three or four voices could travel at once over a pair of wires which now carries only one—and come out clearly at the end!

Production Techniques

Edited by JOHN MARKUS

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.

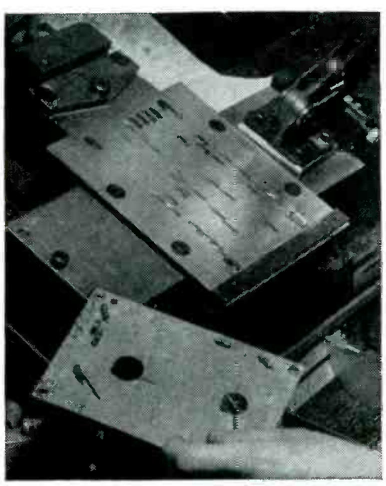


Installing screws after loading glued frames onto carriers of horizontal endless-chain clamping and drying machine. Crank handles of clamps are at outer ends of carriers

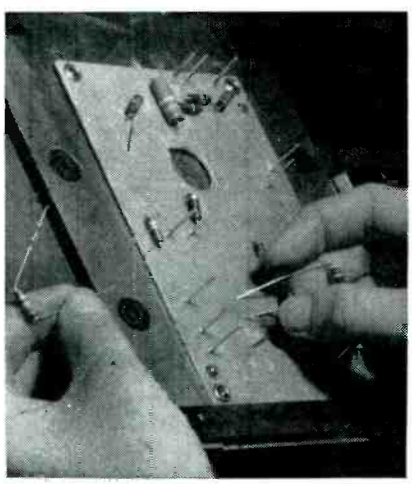
Cutting and Clinching Machine for Etched Wiring Boards

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 inserts 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!

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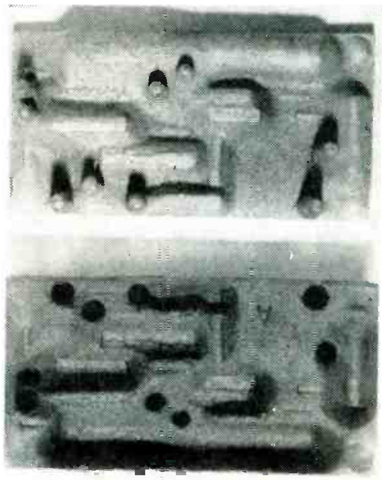
one station to the next by a conveyor belt that runs under the cut-and-clinch machines. Taking a board off the belt, the operator places it over positioning pegs on the machine, then loads in her assigned components one by one. Next, with her right hand she brings up a lever that presses a rubber-cushioned 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

Initial method of contouring pressure plate by glueing carved pieces of sponge rubber in position

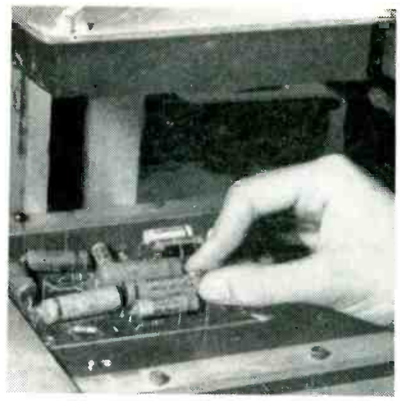


Aluminum mold (top) and sponge rubber pressure pad made from it for use in holding components down on wiring board while cutting and clinching leads

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 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.



Setup using overhead pressure pad having its own air cylinder

Finishing Techniques for Wood-Metal TV Cabinets

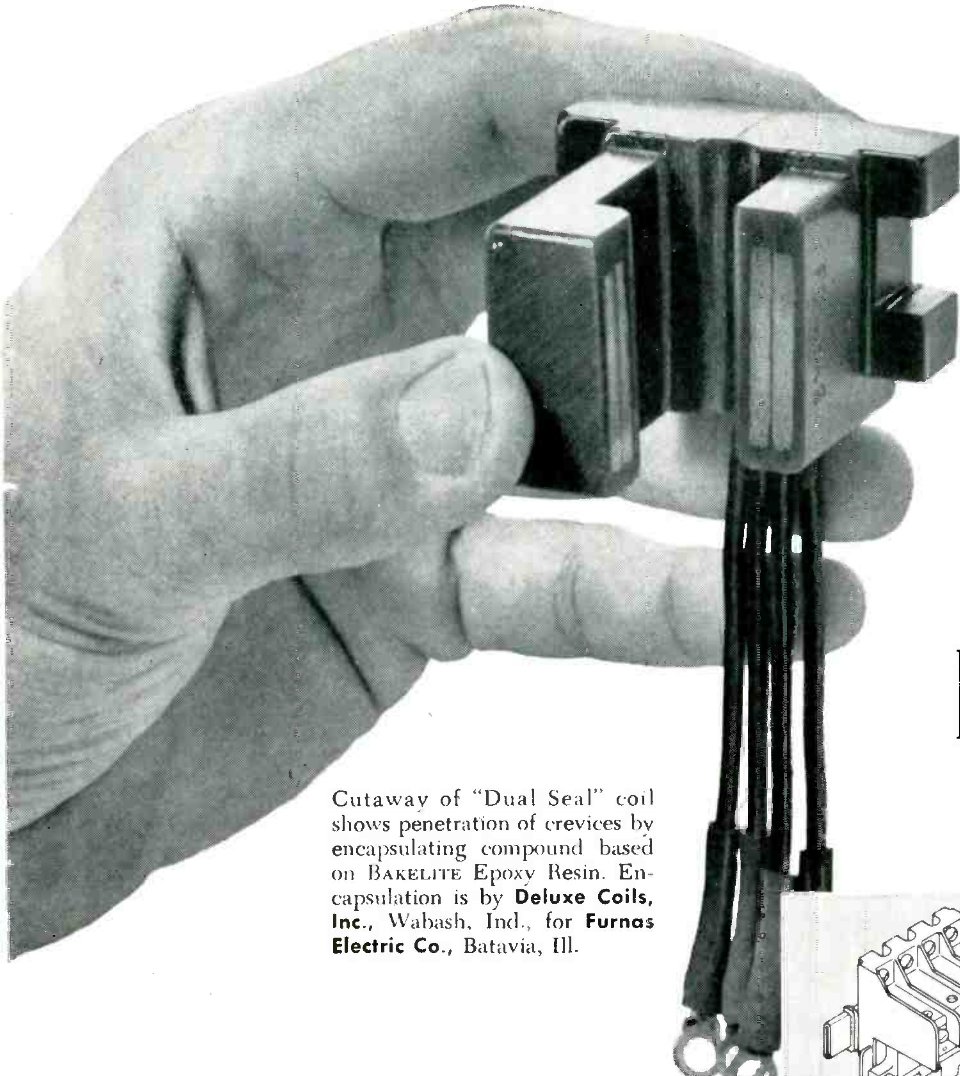
ACCURATE MATCHING of simulated and actual wood finishes on combination wood-metal television receiver cabinets is achieved at the G-E Rockford, Ill. cabinet plant, by combining roller-graining and electrostatic painting with final hand spray gun touchup.

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

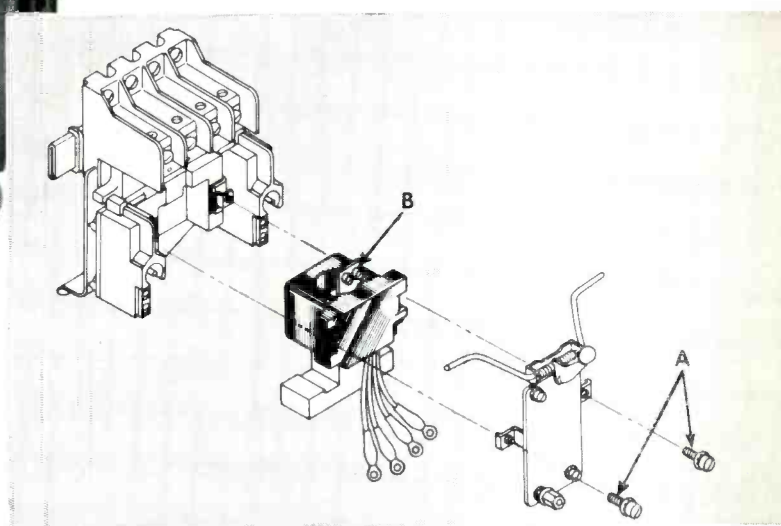
One coil replaces six!

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 burnout 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.

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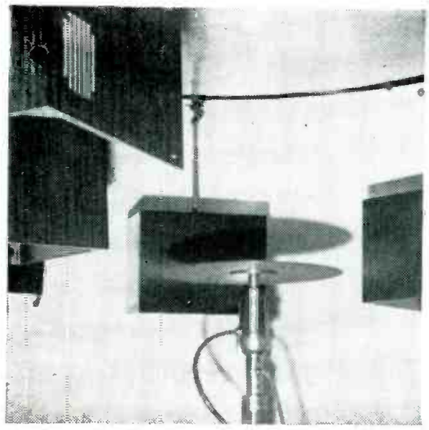
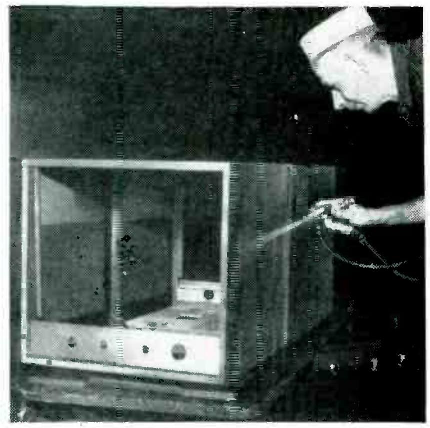

Electrostatic spray room, showing disk

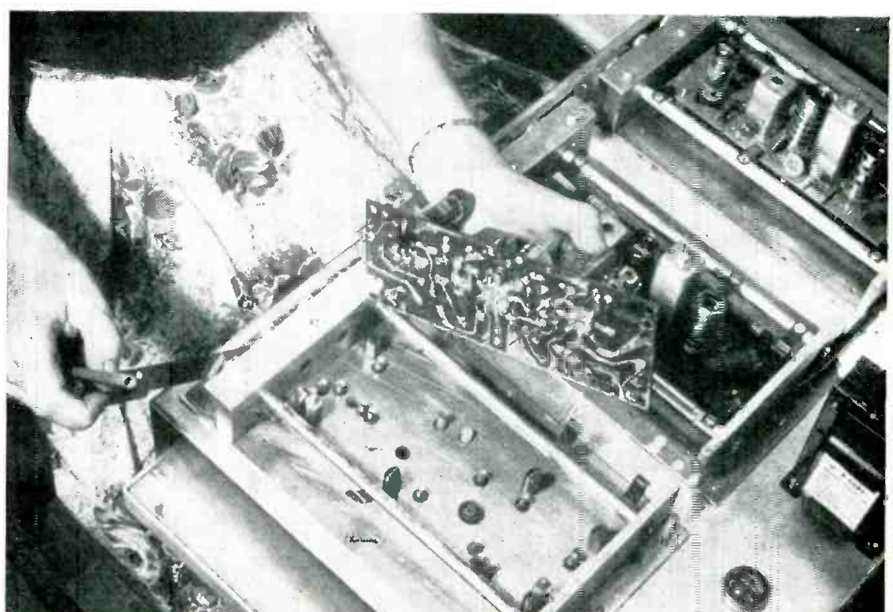

Matching wood and metal finishes

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 contacts 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

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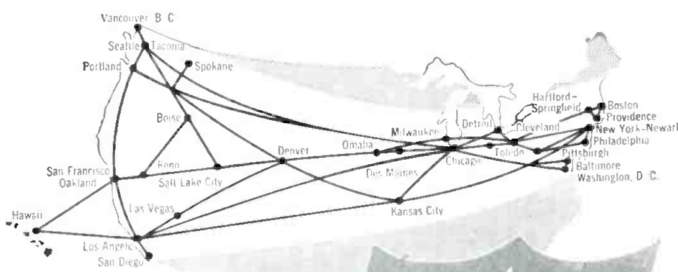

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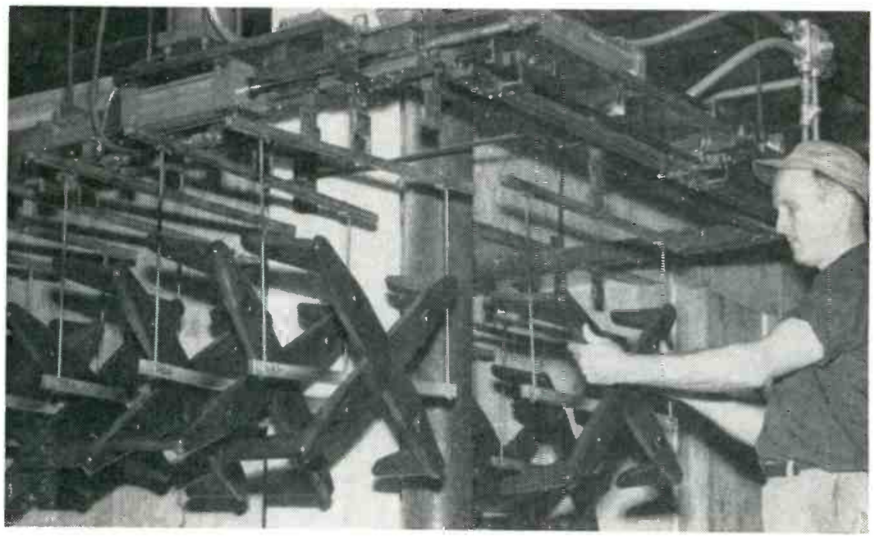
position it holds down the nylon button of a master switch that applies plate voltages to the circuits of the board.

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



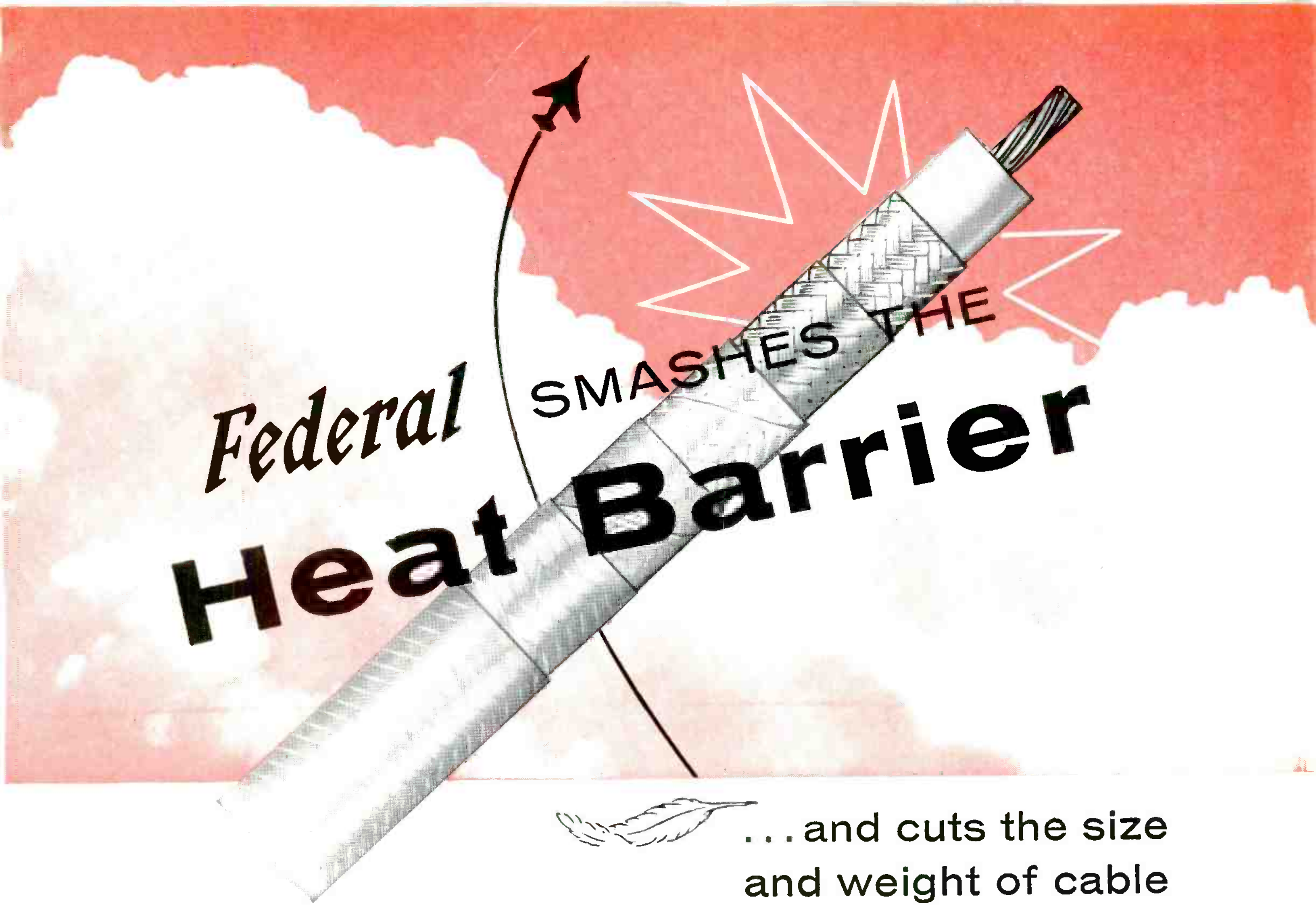
Square-corner conveyor transfer setup at output of drying tunnel for spray-finished bases

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 Rockford, 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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RG-141/U 50 ohms; 69.5% V.P.; 29.0 mmfd/ft. Cap; 1,500 operating volts.

"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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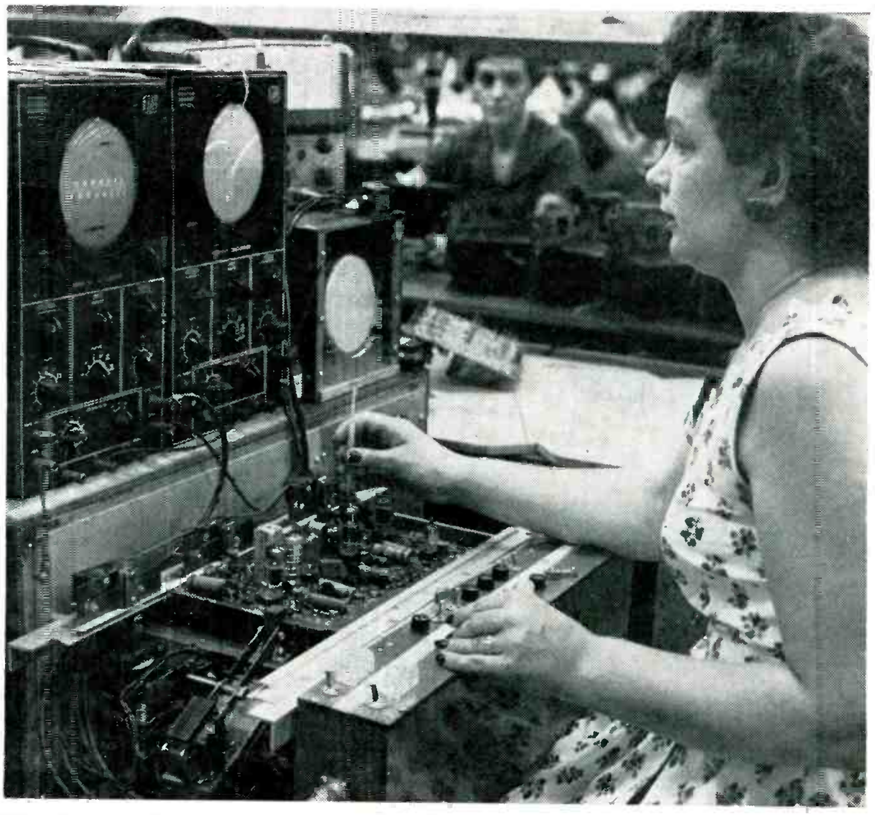

Adjusting transformer on sync board. All connections are made automatically by solenoids after operator slides board into position on test stand

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 Telemetering 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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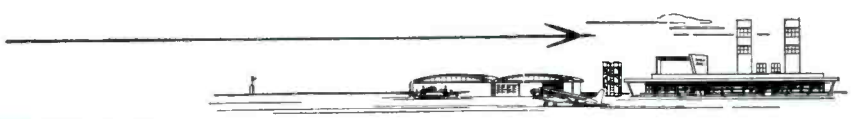
*600 RPM Operation



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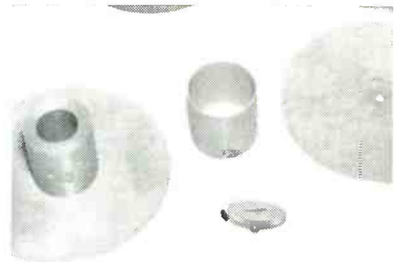


Components of 5-inch take-apart spool

Components of 10½-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 10½-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

Shipping container ready for shipment to data reduction station, with identifying data marked on side with grease pencil

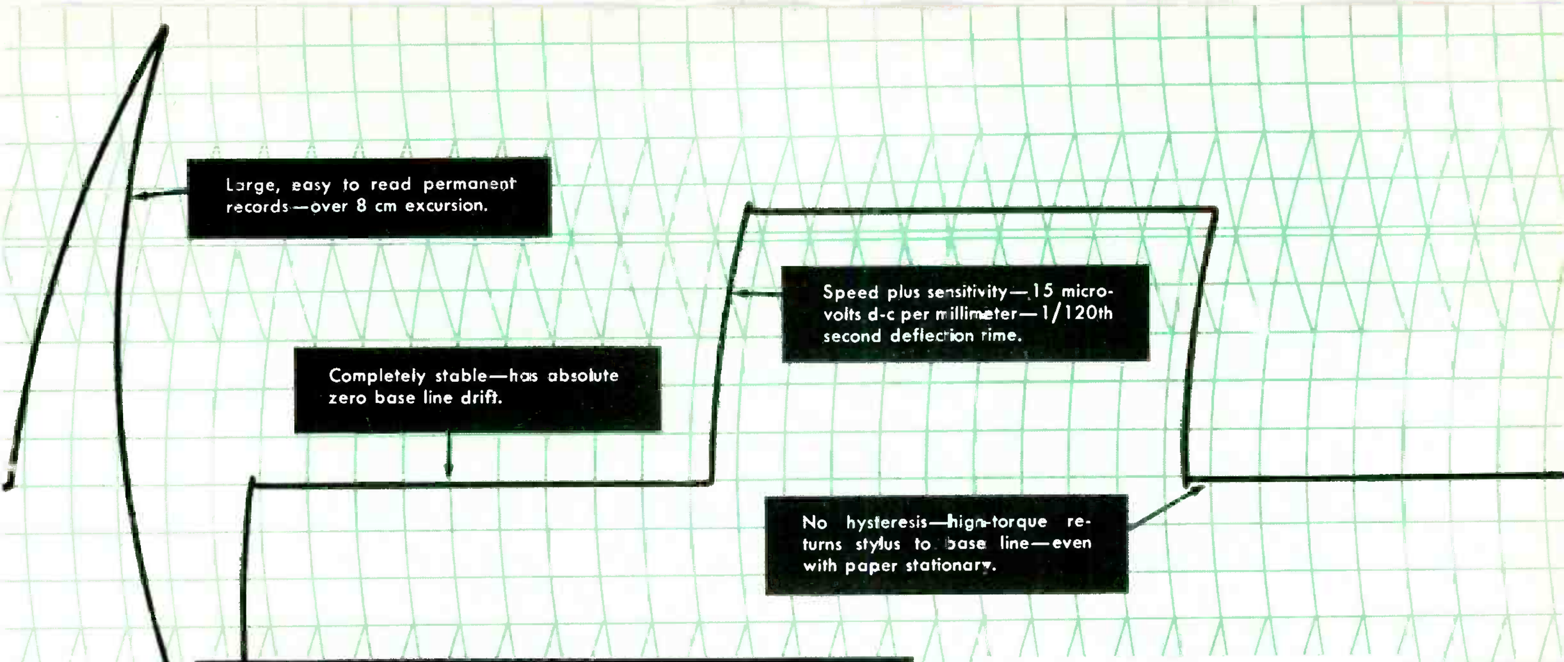
ment of instruments were found to be ideal for conversion to tape shipping containers. The tape is first transferred from the manufacturer's large supply spools to one of the take-apart spools. The spool is then disassembled and the tape removed with its sleeve and placed in the container. Each container 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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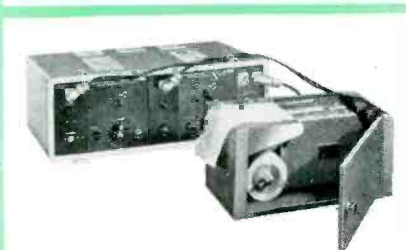
Type M Console. *Accommodates up to six recording channels with specialized input couplers, for a wide variety of applications—eight chart speeds, 1 to 250 mm. per second.*



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.*

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

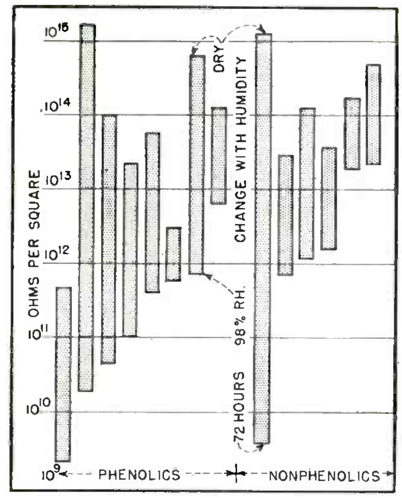


FIG. 1—Apparent surface resistivity of copper-clad plastic materials. Lengths of vertical bars represent change in resistivity; upper end of each bar is dry value and lower end is value after 72 hours at 98-percent humidity

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^{13} 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

A NEW planetary cabler, designed and built by Douglas Roesch, Inc., 2200 S. Figueroa St., Los Angeles, offers a solution to the problem of

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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 gausses, 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.

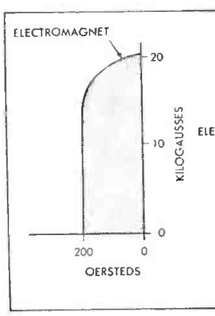

FIGURE 1

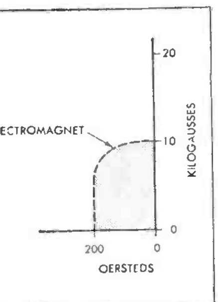

FIGURE 2

Therefore, to make the comparison valid, the residual induction of the electromagnet must be reduced to 10,000 gausses (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.

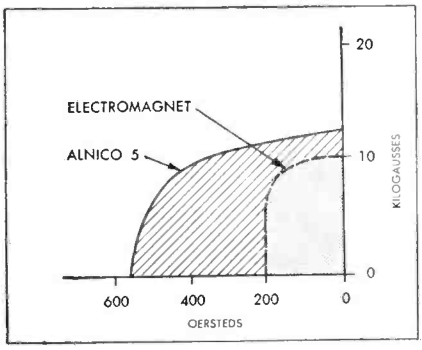

FIGURE 3

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.

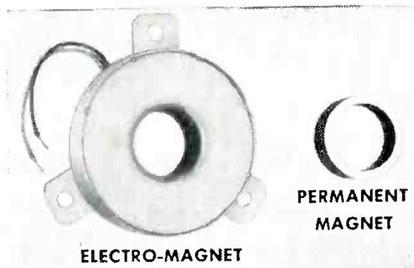

FIGURE 4

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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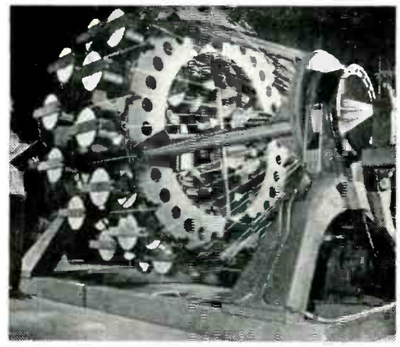

Cable-maker for short-run orders can be easily changed over for producing wide variety of cables

supplying custom electronic cable in prototype or production runs. The new machine has successfully fabricated intricate multiple-conductor cables, delicate coaxial circuits, precision balanced quads and power leads into one manageable cable length. Quality can be compared favorably to mill-run, catalog power cable, despite the highly specialized nature of the short-run components.

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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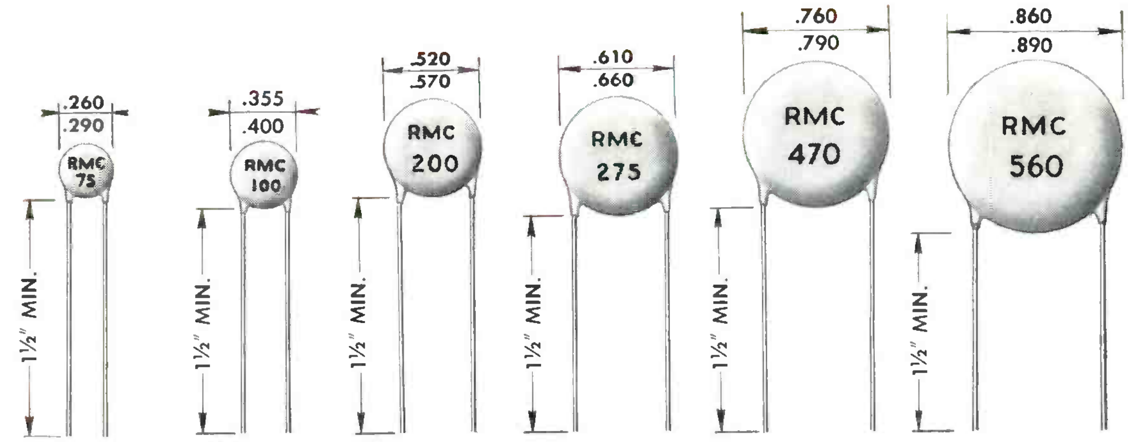

TC	1/4 Dia.	5/16 Dia.	1/2 Dia.	5/8 Dia.	3/4 Dia.	7/8 Dia.
P-100	1- 3 MMF	4- 9 MMF	10- 20 MMF	—	—	—
NPO	2- 13	14- 29	30- 69	70- 85 MMF	86-115 MMF	116-150 MMF
N- 33	2- 13	14- 29	30- 56	57- 62	63-100	101-150
N- 75	2- 14	15- 27	28- 56	57- 68	69-110	111-150
N- 150	2- 15	16- 30	31- 68	69- 75	76-140	141-150
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

Temperature coefficients up to N-5200 available on special order.

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.

AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms.

LEADS: No. 22 tinned copper (.026 dia.).

TOLERANCES: ±5% ±10% ±20%

These capacitors conform to the RTMA specification for Class 1 ceramic condensers.

The capacity of these condensers will not change under voltage.

Type C DISCAPS are available in a wide range of capacities and temperature coefficients and the millions used over the years prove them to be the ideal replacement for tubular ceramic and mica capacitors.

Their smaller size, greater stability, and greater mechanical strength are features that leading manufacturers of electrical and electronic products have found advantageous. Rated at 1000 working volts, Type C DISCAPS cost no more than ordinary 600 volt capacitors.

If your applications involve printed circuits, Type C DISCAPS are available with plug in leads.

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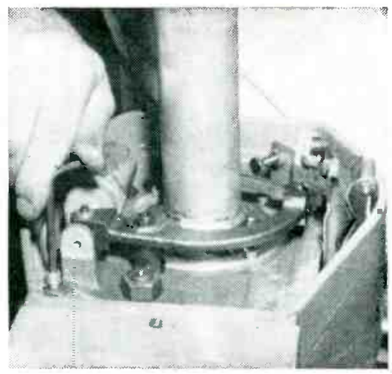
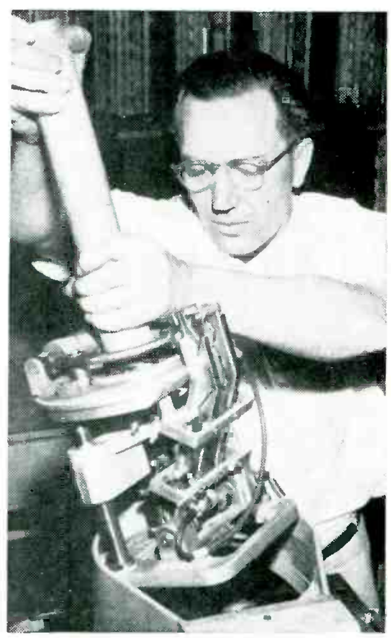
the firm's Bloomington, Ind. plant. The operator places each finished board in turn over its punched opening in the steel chassis, then anchors each board with six self-tapping screws taken from a bin directly in front of the bench. Each screw in turn is put into the magnetic chuck of the wrench, a washer 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

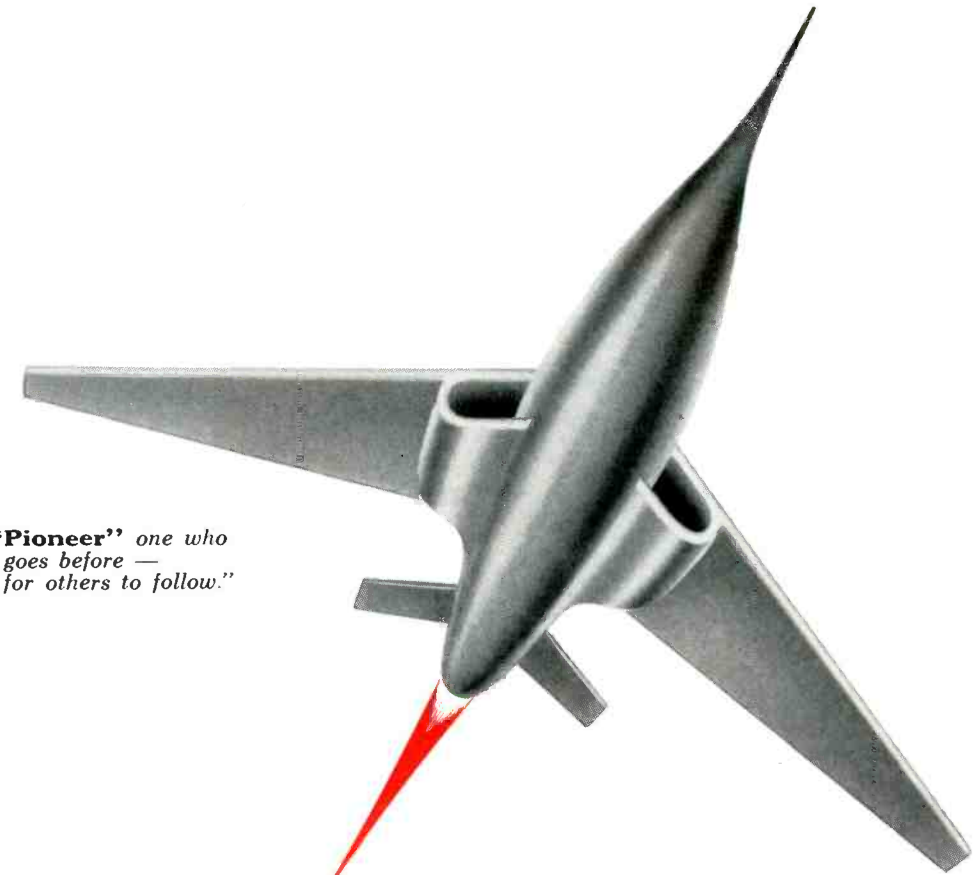
QUICK changing of setups on the General Mills automatic assembly machine is achieved by using a standard housing at all stations and having a variety of inter-



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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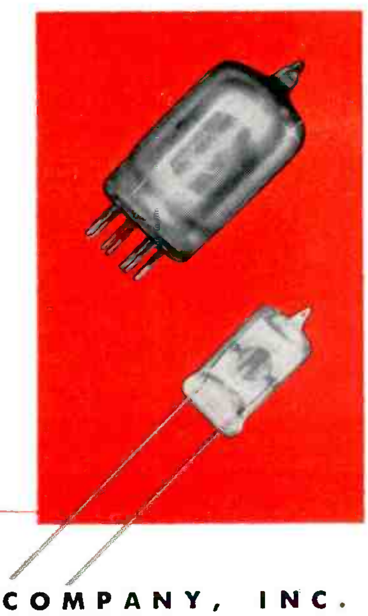

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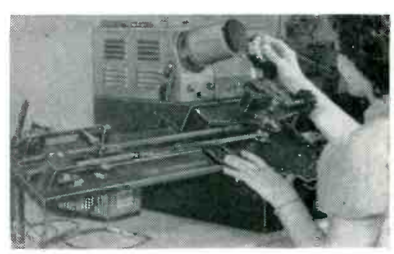
changeable insertion mechanisms that fit into the housings of all stations. In addition, two simple wrench adjustments change the position of the entire housing at a station.

Two bolts anchor the head in its housing. When these are removed with a small Allen wrench, the 24-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.

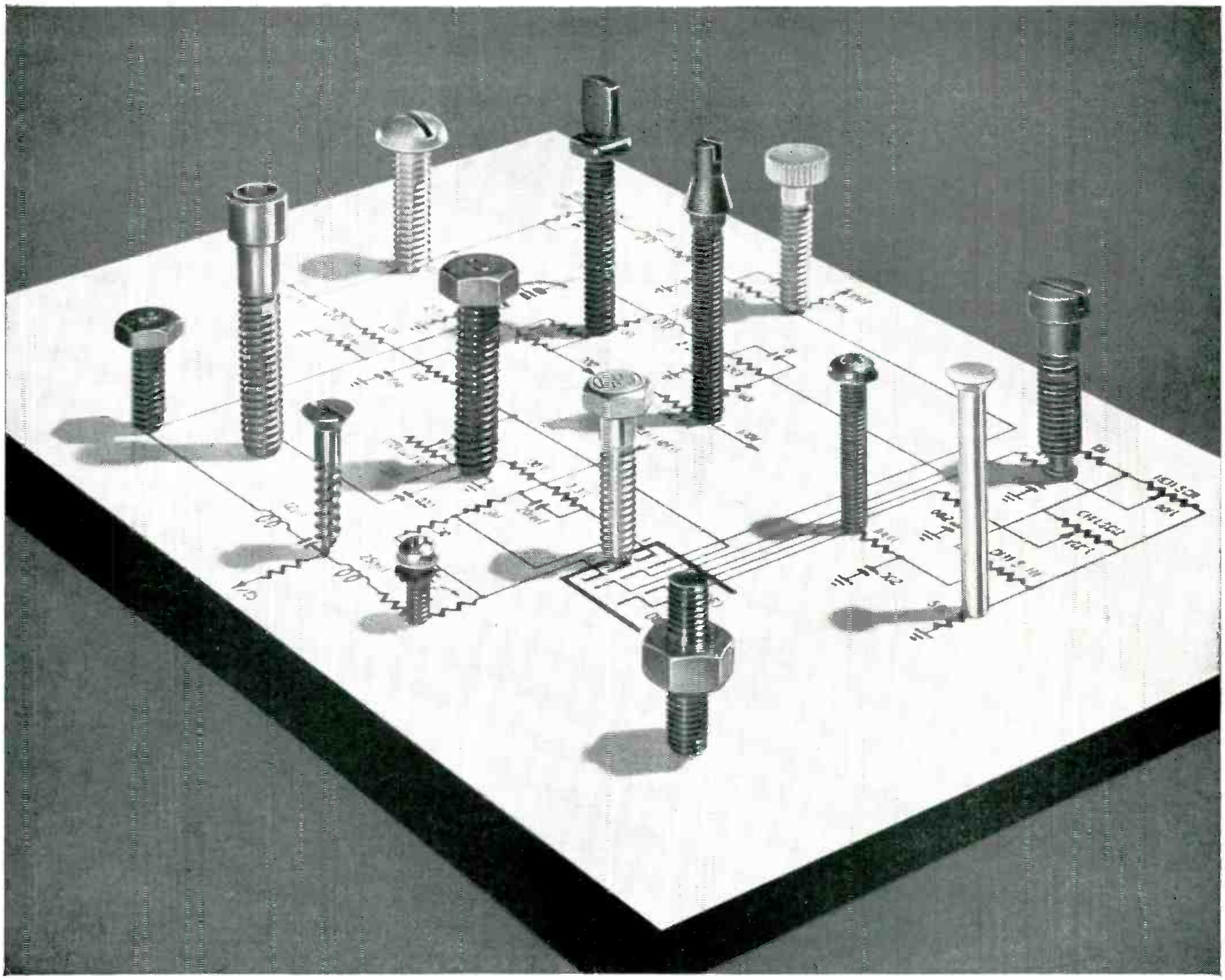
Method of repositioning insertion head laterally, after first loosening bolts of locking clamp just below transverse screw

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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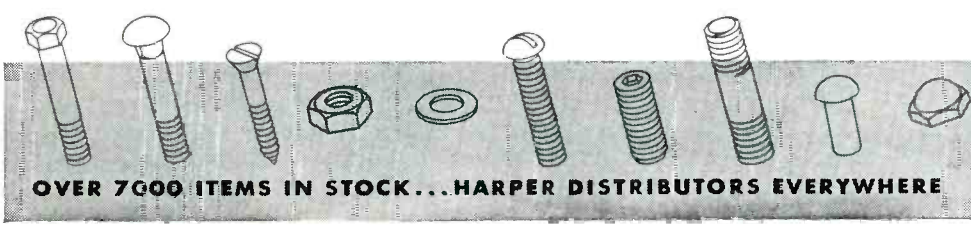

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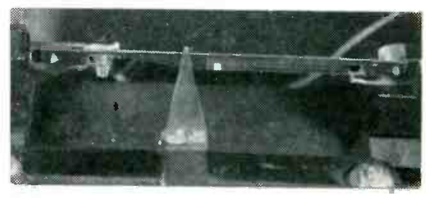
oscilloscope is used as an indicator for obtaining the high-precision check of calibration that is required for precision potentiometers.

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.

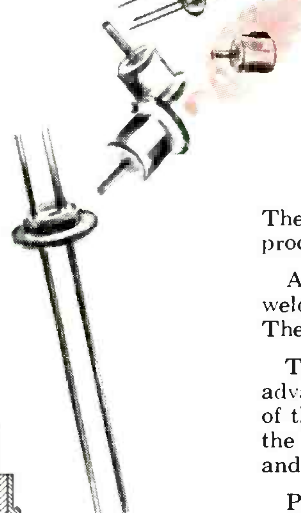

Holding fixture for resistance card

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

easy as . . .



to assemble Hermetic Diode and Transistor Housings

These small, durably constructed units furnish the solution to assembly and procurement problems confronting design engineers and purchasing agents.

A variety of diode and transistor housings are available from Hermetic with weld projections and special metallic finishes to simplify assembly techniques. These units eliminate costly soldering steps—they result in man-hour savings!

The advanced design of Hermetic Transistor Housings provide additional advantages to the engineer and purchasing agent. The internally exposed areas of these parts are of all-glass construction. This construction feature prevents the contamination of a transistor wafer when closure is made after mounting and assures reliable transistor performance, as well as longer shelf life.

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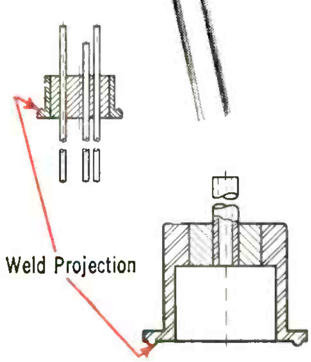

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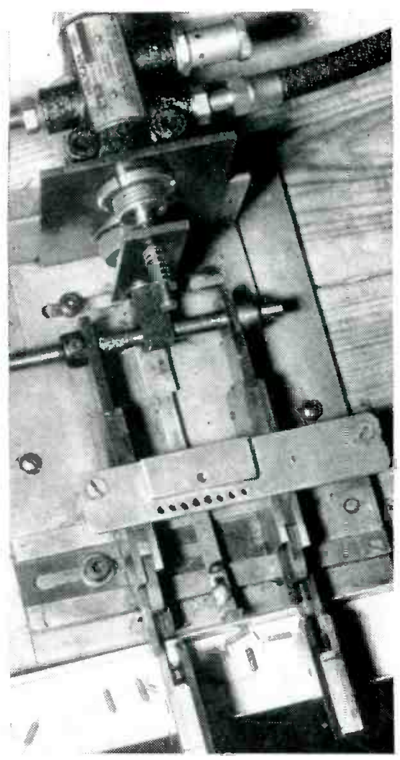
the actual and the theoretical is the error. The error must be within tolerance to pass inspection.

Cutting and Forming Leads

RESISTOR and capacitor leads are cut and formed by an air-actuated machine that can be fed by hand at rates up to 1,500 components per hour, in the Cambridge Radio Works of Pye Ltd. Once the air is turned on, the machine operates automatically, at a speed which can be set to suit the operator. Positions of the cutting and forming blades are continually adjustable to leave any desired length of wire on each lead. Adjustment is made by loosening Allen screws and sliding the entire cutting and forming members sideways.

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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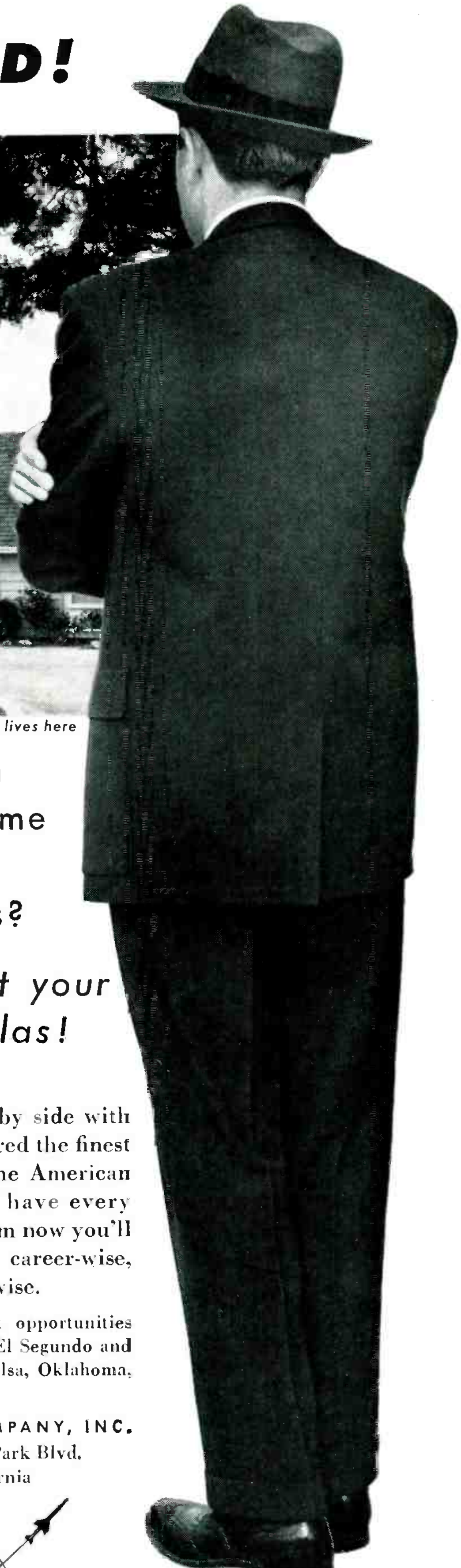

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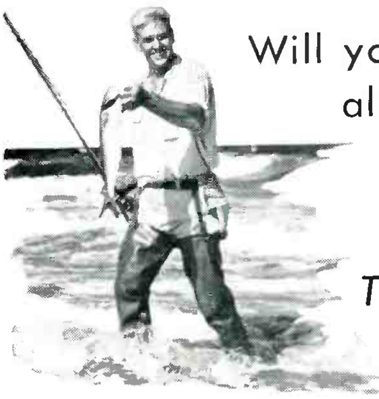

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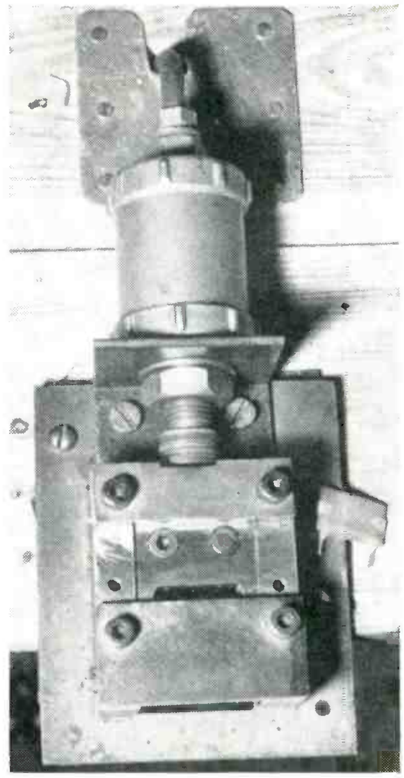

Air-actuated lead chopper for ceramic components

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 semicircular 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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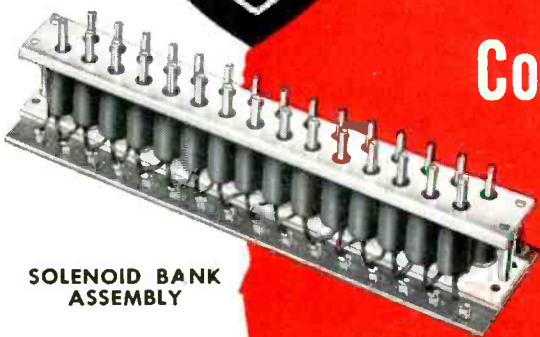
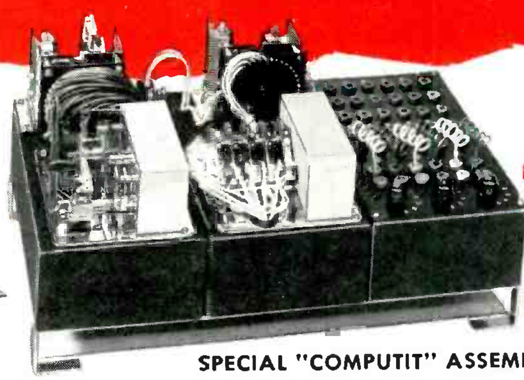


SOLENOID BANK ASSEMBLY

CONTROL BOX TESTER



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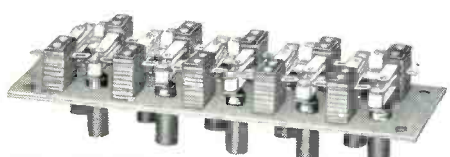
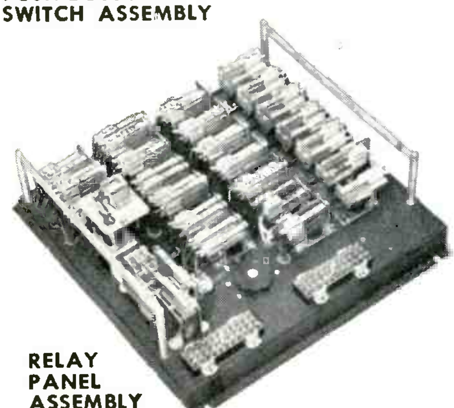


PUSH-BUTTON SWITCH ASSEMBLY

Units shown here typify the wide range of Complete Control Assemblies *designed, engineered* and *produced* by GUARDIAN. With absolutely dependable controls such as these, GUARDIAN engineers have solved seemingly insurmountable problems for both the military and commercial industry.

Let GUARDIAN'S 25 years of engineering experience help you save money, conserve space and prevent costly rejects. Whether you require relay banks, solenoid banks, control box testers, "Computit" assemblies, push-button switch systems—or an entirely different "package" control—Guardian has complete facilities to design and produce them.



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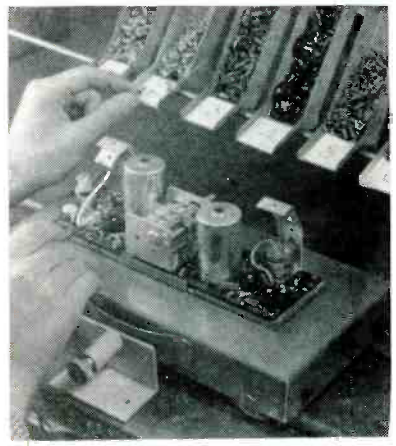

Work station on trolley-car assembly line, showing open gravity-feed dispenser bins. Spring-loaded clip holds car steady as components are inserted in wiring board. Rubber wheels of car run in channels cut into wood bench

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-

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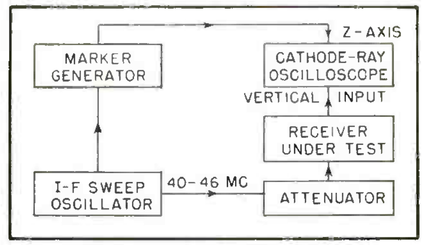


FIG. 1—Sweep generator and marker generator connections to equipment

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

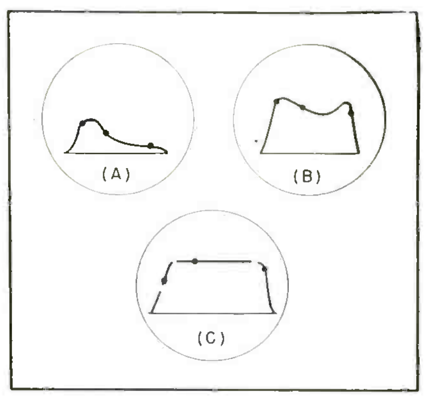


Fig. 2—Positive pulses as they appear before alignment (A), curve shape after positive pulse peaking (B) and i-f response after touchup (C) using negative pulses as reference markers

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.

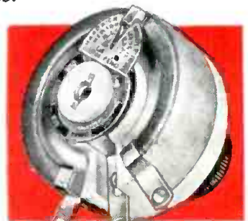
Special design features which make this possible are: an aluminum thru-bar extending through the center of the elliptical ceramic core, which insures a more even distribution of heat to prevent "hot-spots;" and a thermo-shock-proof enamel coating which eliminates crazing.

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.

What you can learn from this is clear. If you also need a special purpose alloy, send us your specifications. Our engineers with 48 years of experience are at your service.



One of a new line of "H" Series high wattage rheostats made by Hardwick, Hindle, using Driver-Harris Alloys.

*T. M. Reg. U. S. Pat. Off.

Nichrome and Nichrome V are made only by

SPECIAL PURPOSE ALLOYS SINCE 1899
D H
TRADE MARK REG. U. S. PAT. OFF.

Driver-Harris Company HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Louisville, Los Angeles, San Francisco

In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

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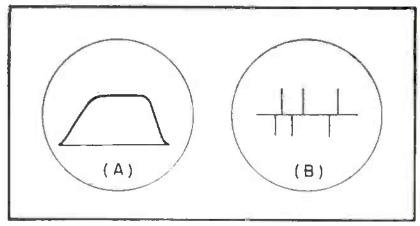


FIG. 3—Vertical (A) and Z-axis (B) inputs to cathode-ray oscilloscope

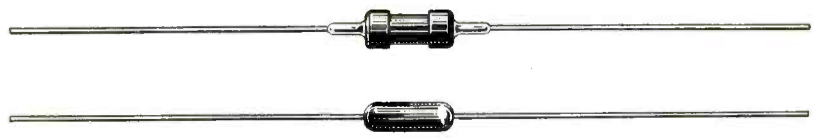
is required to select only one signal at the attenuator. Considerably less hookup time is required. The aligner can simultaneously observe the i-f response characteristics while making specific frequency adjustments. Relatively few distribution cables and transformers are required. Model change-over 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

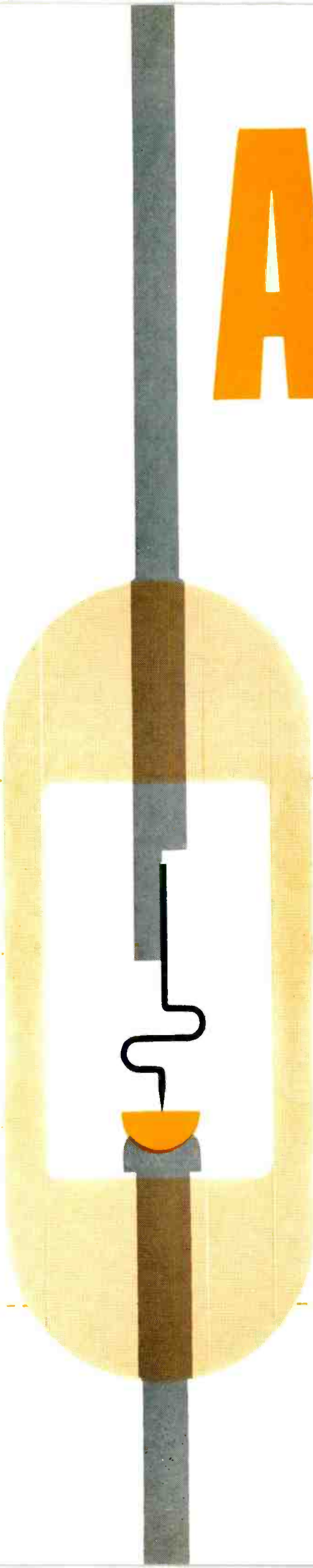
Automatic welding setup used for welding tap on precisely the correct turn of a precision potentiometer



Amperex®

all-glass GERMANIUM DIODES

a complete line by a world leader in electron tubes and semiconductors

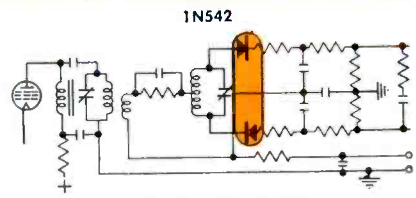


STABLE • UNIFORM • TIGHT-TOLERANCE

Each AMPEREX germanium diode is all-glass . . . fusion sealed . . . and available in both a clip-in ('GA') and a solder-in ('G') version.

Preferred
ENTERTAINMENT DIODES

- video detector types 1N60G, 1N87G, and OA73
- DC restorer type 1N88G
- AGC and AM detector type 1N541
- matched-pair ratio detector for TV and FM receivers — type 1N542



RATIO DETECTOR

COMPUTER DIODES

- recovery-time and high-temperature tested types
- tight-tolerance, point-contact, high-temperature guaranteed types.

	DIODE TYPE			DIODE TYPE
Solder-In	1N480	1N490	Recovery Tested	1N476 & 1N478
Clip-In	1N119	1N120		1N477 & 1N479
Back Resistance at —20 to —50 volts at 55°C.	400K	200K		Min. and Max. characteristic limits specified at both 25°C. and 60°C. Replace most point-contact types.
Forward Current	5 ma at +1 volt			

GENERAL PURPOSE and REPLACEMENT DIODES

- 100 volt types
- high back-resistance types
- 1 megohm back types
- video detector types

including . . .

1N34G	1N54G	1N63G	1N68GA
1N34GA	1N54GA	1N63GA	1N87GA
1N38G	1N58G	1N67G	1N89G
1N38GA	1N58GA	1N67GA	1N89GA
1N48G	1N60GA	1N68G	1N90G
1N48GA			1N90GA

. . . and other specially tested types

AMPEREX also has available a complete line of audio and switching *transistors* of all-glass construction.

For detailed data or applications-engineering consultation, write to
Semiconductor and Special Purpose Tube Department

Amperex ELECTRONIC CORP.

230 DUFFY AVENUE, HICKSVILLE, LONG ISLAND, N. Y.

AMPEREX

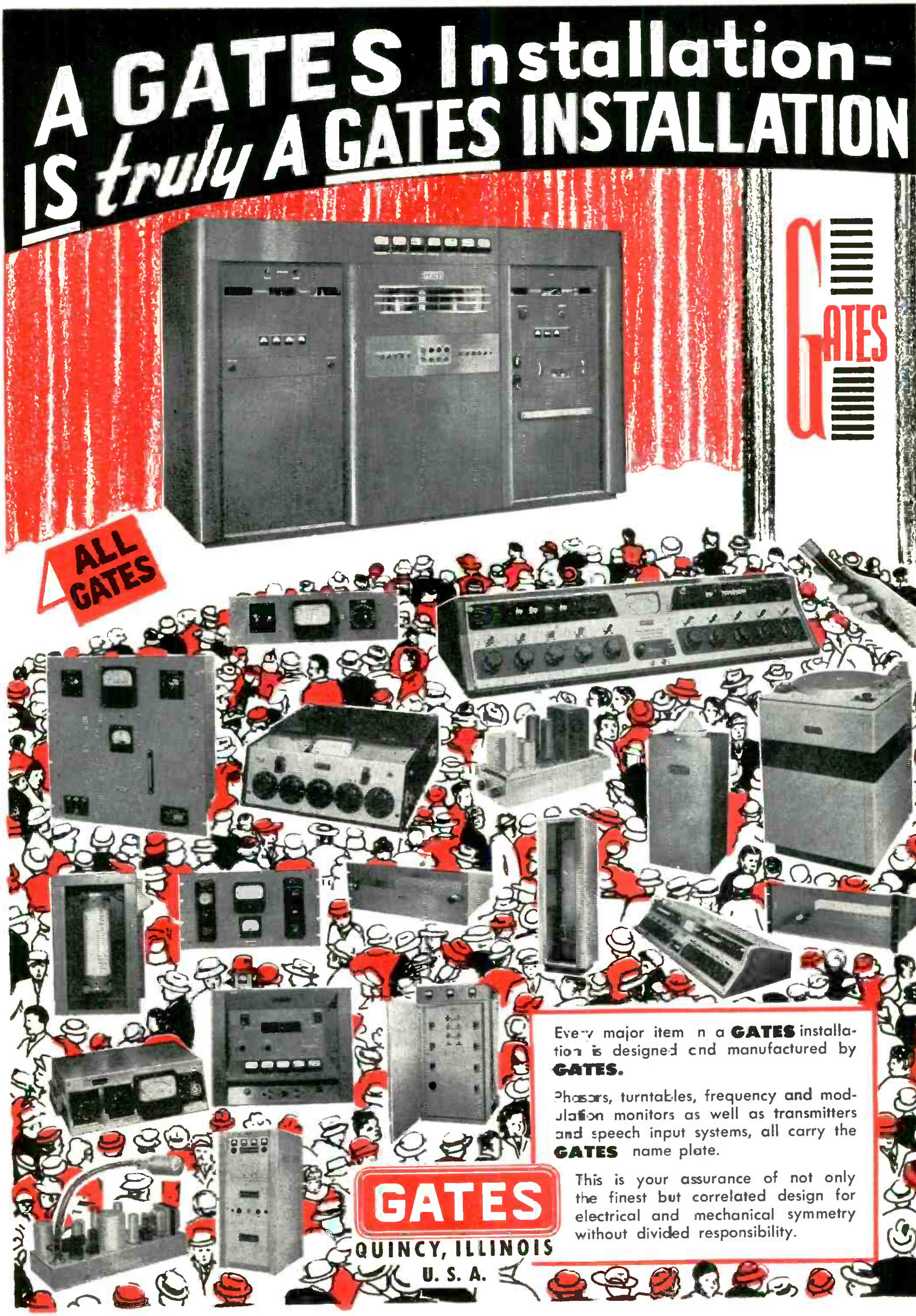
Closeup of welding operation, showing light source mounted at rear of stereo microscope

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.

Connector Assembly Jig

SOLDERING of nine connectors in correct orientation on the cover of a hermetically sealed airborne electronic control unit is expedited through use of a simple metal jig. A thin sheet of steel having hex holes in the correct positions for the connectors is attached to a



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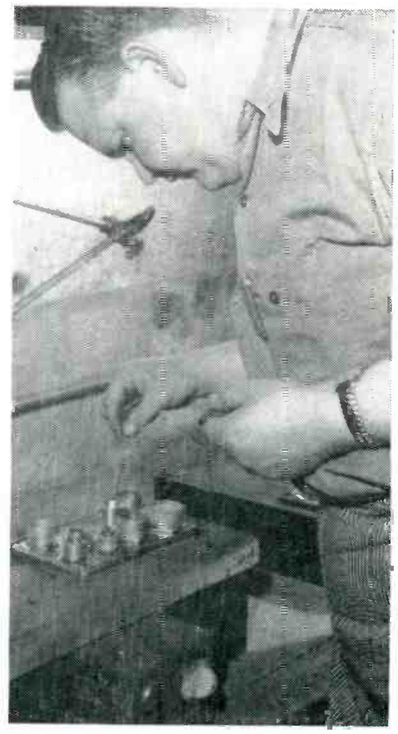
Placing cover plate over connectors loaded into positioning jig



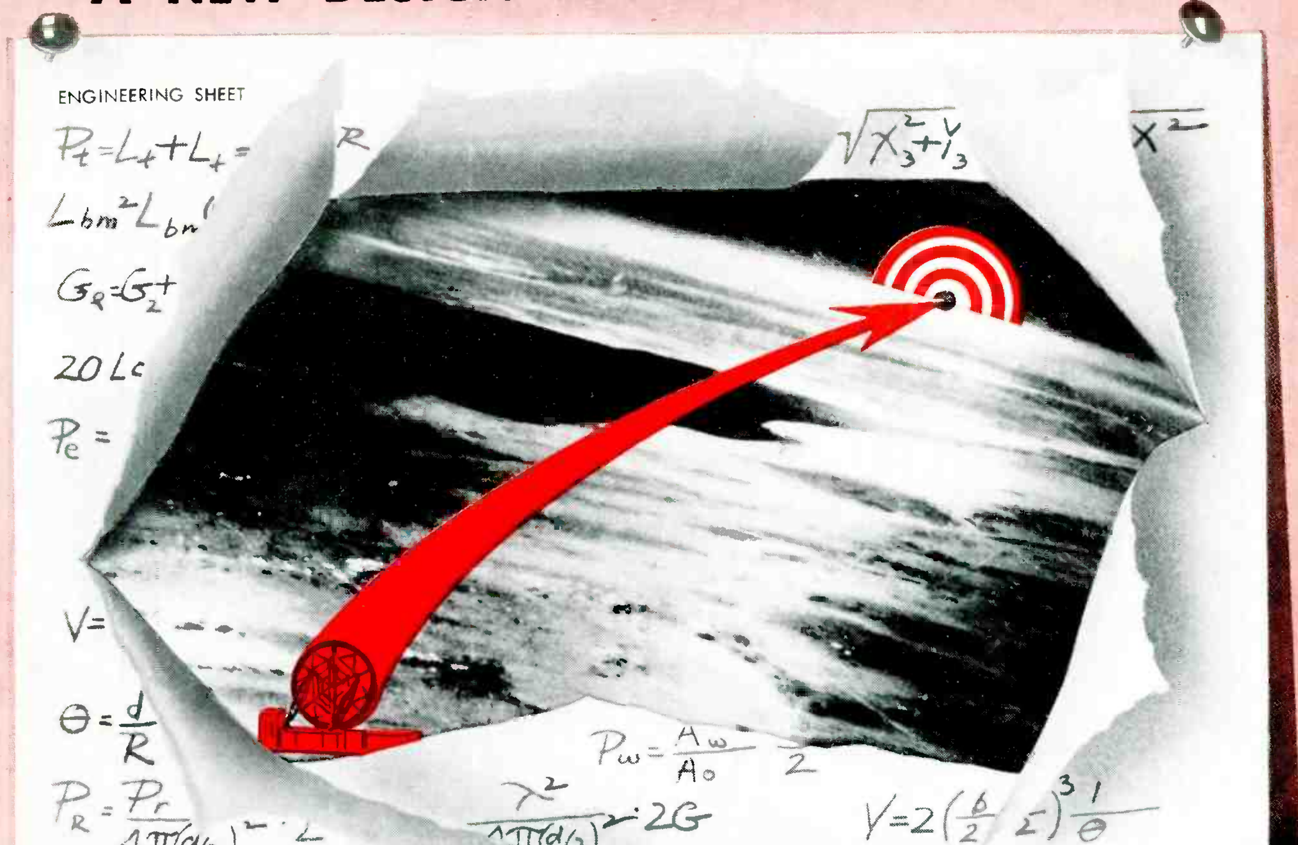
Touching up soldering on hot plate

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

A NEW DESIGN APPROACH...



Photograph of the earth from 100 mile altitude — Courtesy U. S. Air Force

... BEYOND-THE-HORIZON TRANSMISSION

BEYOND-THE-HORIZON TRANSMISSION

The newest military and commercial long-range communications systems are turning towards the advantages of "scatter" transmission. By transmitting *directly* to stations well beyond the horizon, scatter transmission systems eliminate the construction and maintenance of intermediate microwave stations and avoid cables and repeaters of wire systems, while retaining the wide bandwidths available at high frequencies. This *direct* transmission can span water or inaccessible terrain while giving predictably high signal reliability and freedom from interference.

A NEW APPROACH . . . CONTROLLED SYSTEM DESIGN

A complete analysis including the effects of climate, multipaths, modulation, diversity and prolonged equipment operation combined with an exclusive experimental method of simulating every proposed link enables Hycon Eastern, Inc. to *hit the performance target more precisely*. We can reduce the expense of a large margin for error and eliminate the possibility of costly site relocations by careful assessment of each customer's needs and operating conditions that will provide him with an optimum design.

HYCON EASTERN OFFERS AN INTEGRATED SERVICE

Within the areas of Hycon Eastern, Inc. and its associated companies can be found complete facilities not only to design, engineer and specify equipment for Beyond-the-Horizon Transmission Systems, but to design Central Offices, Connecting Wire Networks, perform Communication Traffic Density Surveys, Aerial Surveys and Mapping to determine the most efficient routes for land lines and for various radio links such as UHF/SHF line of sight. After the necessary facts have been gathered there further exists the experience to evaluate them and to specify practical equipment with complete independence of judgment necessary to create a complete communications system that will fulfill present and projected needs.

HYCON EASTERN, INC.

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Affiliated with HYCON MFG. COMPANY, Pasadena, California

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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 Resista nce 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.

Hoseshoe 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

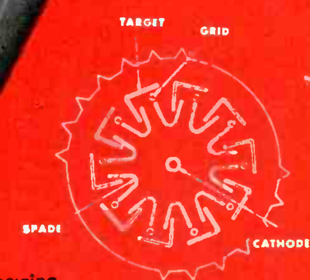
Newest ELECTRONIC CONCEPT BY
BURROUGHS CORPORATION RESEARCH CENTER

BEAM SWITCHING TUBE...

AVAILABLE NOW IN PRODUCTION QUANTITIES

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.

Perfected 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.



Cross Section showing Cathode, Grids, Spades and Targets for 10 position switching.

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:

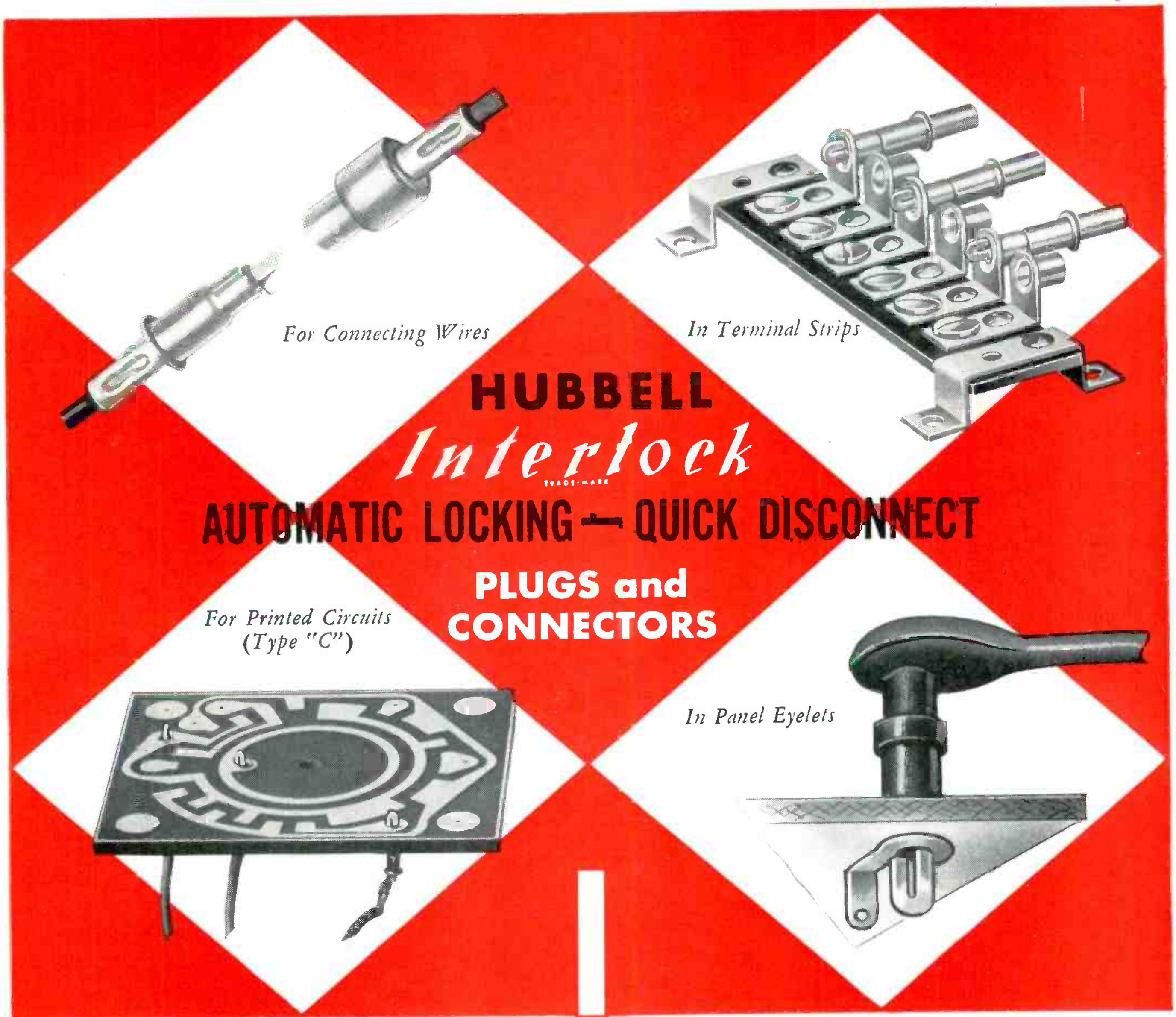
APPLICATIONS ENGINEERING DEPARTMENT
HAYDU BROTHERS OF NEW JERSEY
c/o BURROUGHS RESEARCH CENTER
PAOLI, PENNSYLVANIA

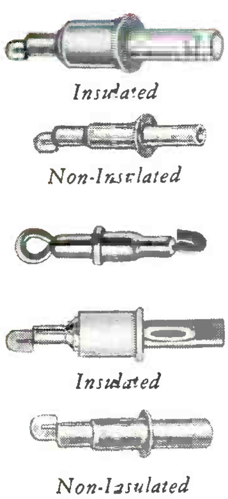
doubles back and forth across the available area, with an average of six working positions on each of the seven straight sections. The metal panels of this subassembly slide on angle-iron rails, with the rear rail appreciably higher to hold the panel at a more convenient working angle for assembly.

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





TYPE "B" MINIATURE PLUGS AND CONNECTORS

Current Capacity: 5 Amperes
Wire Sizes: #18 to #22

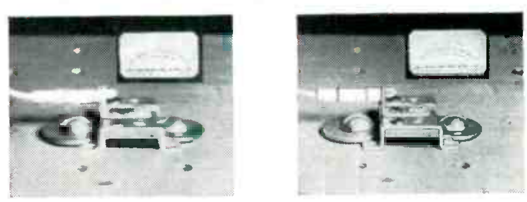
TYPE "C" SUB-MINIATURE JACKS AND CONNECTORS

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.

HUBBELL REG. U.S. PAT. OFF.

SELF-LOCKING CONNECTORS
Pats. & Pdg. Pats.

For additional information on all items on this page, use post card on last page.

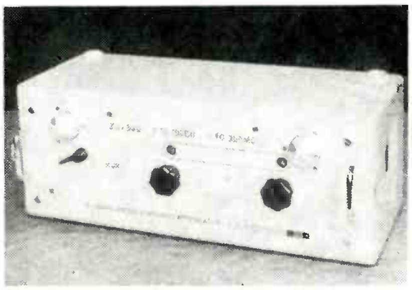
New Products

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.

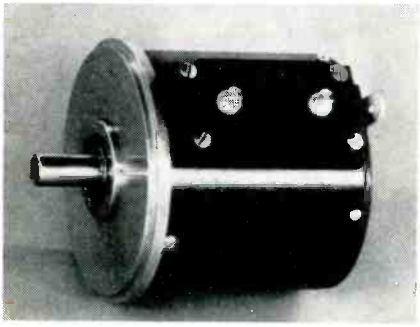


▶ **Performance** — The instrument provides accurate attenuation from 0 to 100 db in 1-db steps, with ease of operation equal to or better than that usually associated with l-f attenuators. It is ideal for attenuation comparison checks and serves also for the attenuation of known voltages where fractional outputs are needed.

The unit weighs 24 lb and measures 19¾ in. long, 7¾ in. high and 10¼ 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.

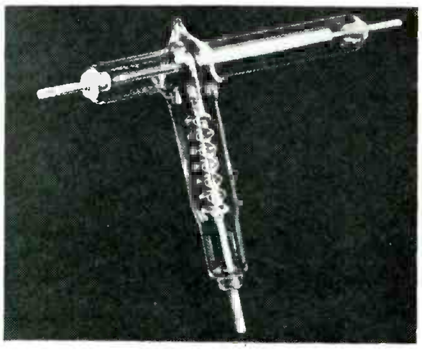


▶ **Construction and Specifications** —The resistance coil is externally wound on a nonhydroscopic ceramic core which is chemically inert, dimensionally stable, and has a low coefficient of expansion. Rugged metal-to-metal traveling nut stops withstand static torque of 500 in.-oz. The wiper arm is independent 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 terminal 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

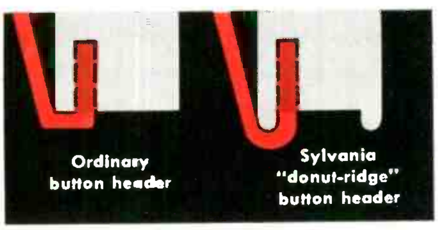
WATERS MFG., INC., P.O. Box 368, South Sudbury, Mass. Completely independent display of forward and reverse characteristics of all common types of diodes, on the scope

—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

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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 increased 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 μa per in. Voltage is adjustable from 0 to 500 v.

PISTON CAPACITORS
used in printed circuitry

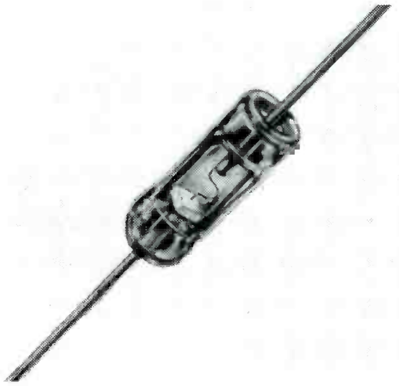
JFD MFG. CO., INC., 6101 Sixteenth Ave., Brooklyn, N. Y., has introduced a new series of subminiature piston capacitors designed primarily for use in printed circuitry and automation.

▶ **Two Models**—The VC9G ($3 list) and VC10G ($2.50 list) feature glass dielectrics and invar silver-plated rotors. The VC10G measures $\frac{5}{16}$ in. in length; model VC9G, $\frac{9}{16}$ 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 $\mu\mu$f to 4.5 $\mu\mu$f, and weight is 2 grams. The VC9G has a capacitance range of 0.5 $\mu\mu$f to 8.5 $\mu\mu$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 $\mu\mu$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 Cummington 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.

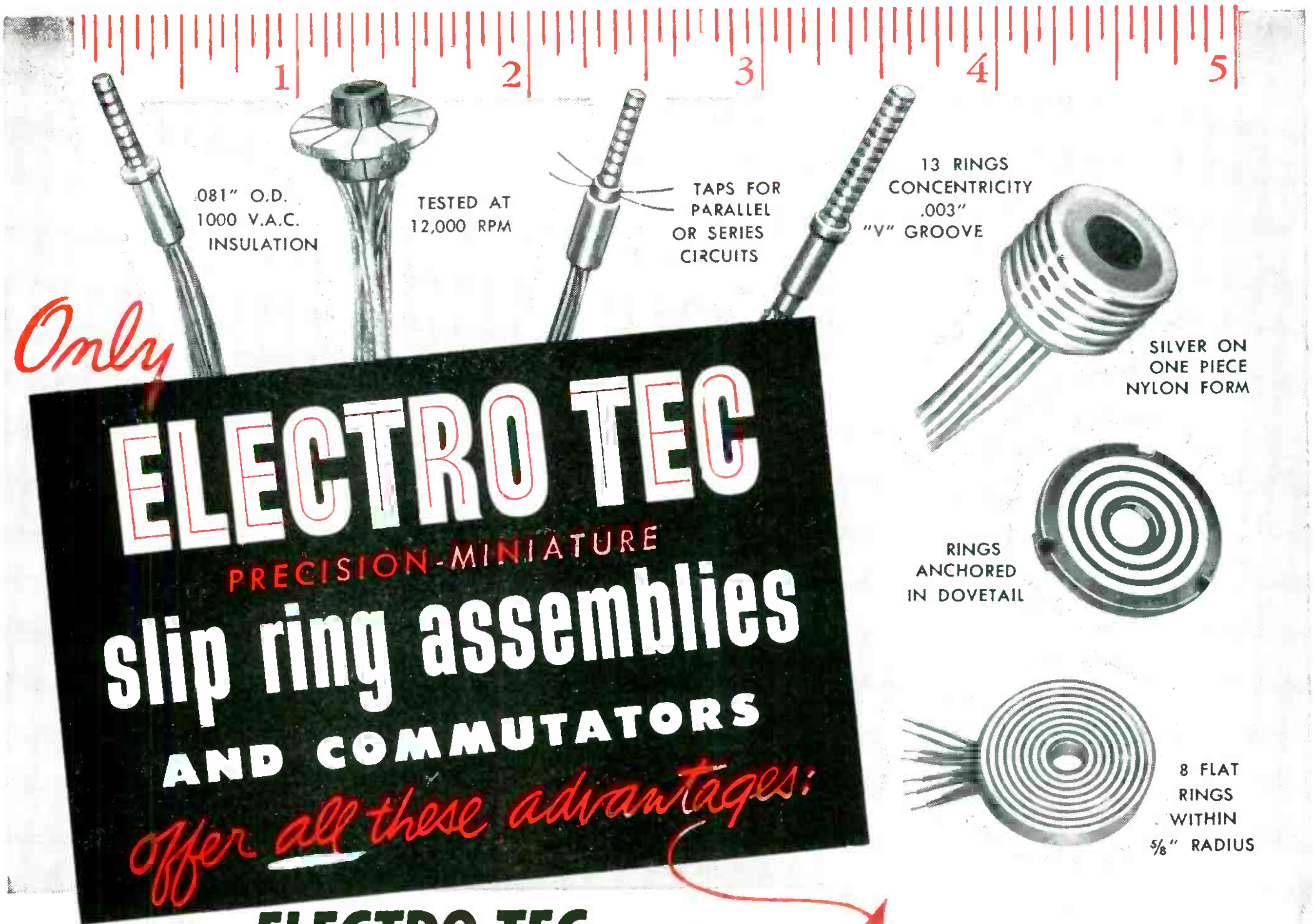
▶ **Simplification**—The MA-200 and MA-206 feature much improved form factor packaging with a total weight reduction of 2 lb, simplified mounting requirements and a more compact design than standard 5789. Long life is achieved by use of the dispenser type impregnated tungsten cathode.

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



- 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

EXCLUSIVE* ELECTRO TEC TECHNIQUES

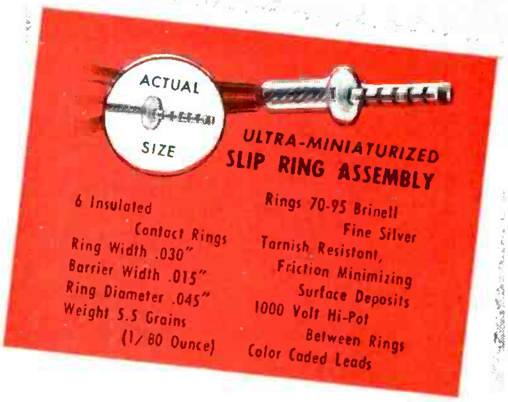
insure closer tolerances, absolute uniformity, and the ultimate in miniaturization

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

*PAT. NO. 2,696,570

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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 10⅛ by 7⅝ by 7½ in. Weight is 12 lb, 2 oz.

MERCURY BATTERY for electronic devices

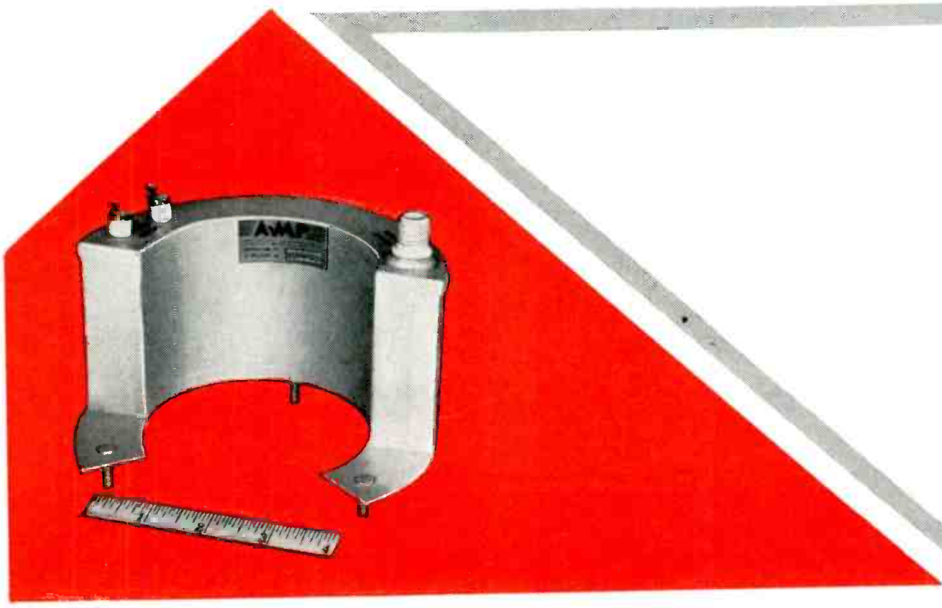
P. R. MALLORY & CO., INC., Battery Div., North Tarrytown, N. Y., has developed a mercury cell so designed that a number of them can be stacked together to provide required voltage in a variety of physical shapes. The design permits full automation in the construction of the basic cell and in the assembly of the cells into battery stacks, with substantial economies in production costs. Thus the long shelf life and constant

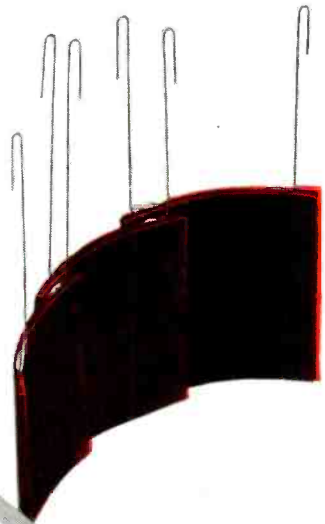
CAN AmpliFILM DO THIS?

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, AmpliFILM 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.





AmpliFILM ***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.

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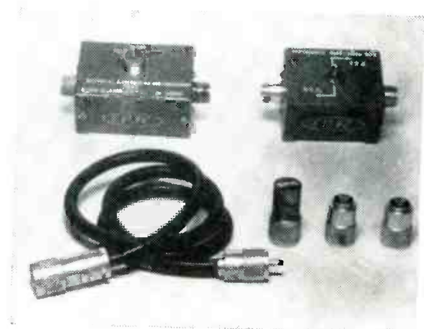
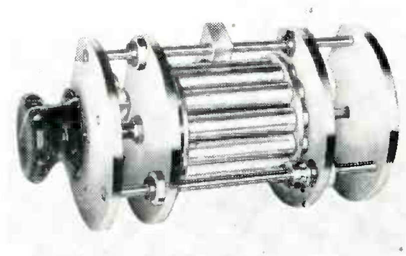
voltage output inherent in the mercury battery system are available at lower prices.

►**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.



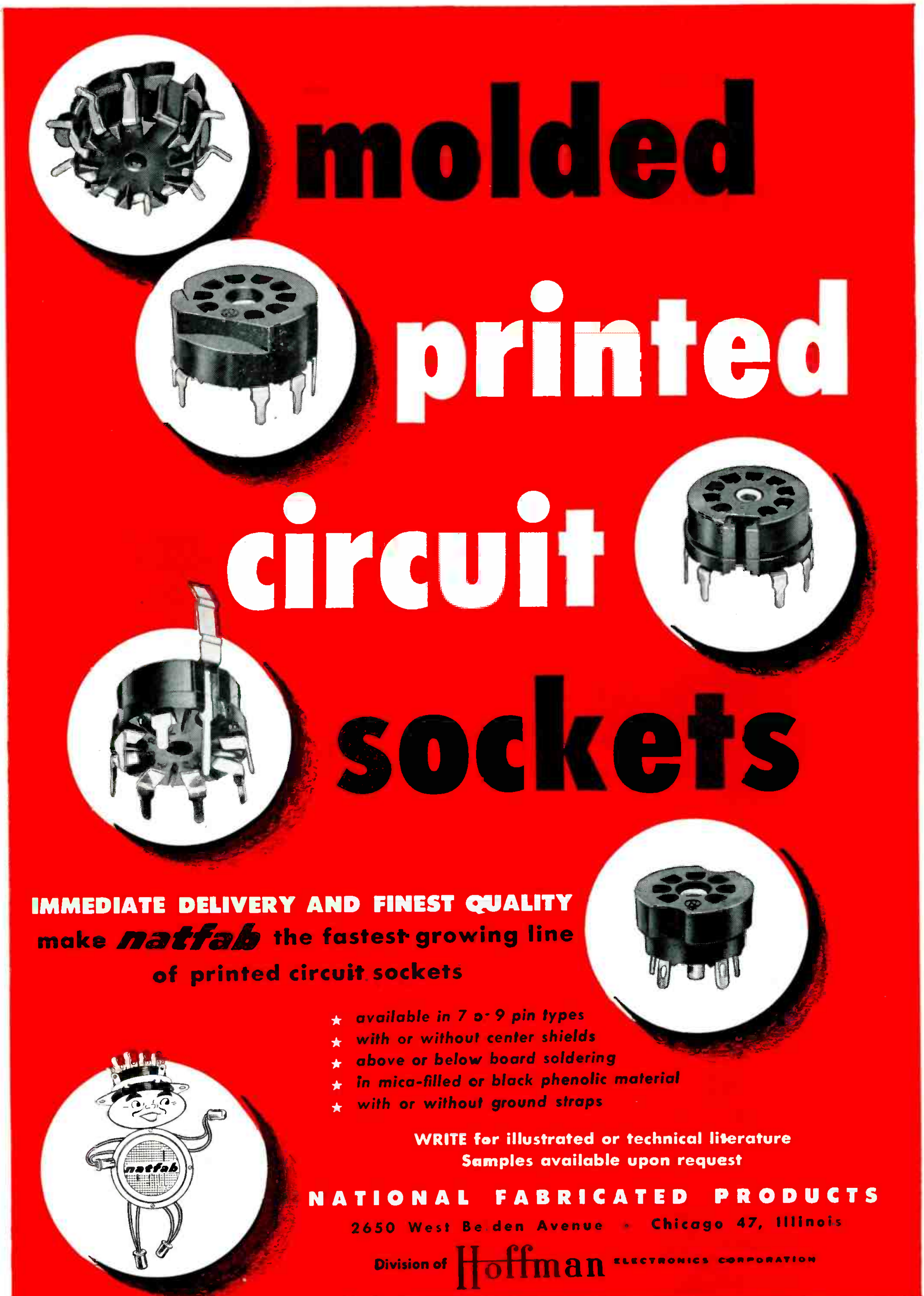
PULSE EQUIPMENT for wideband transmission

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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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.

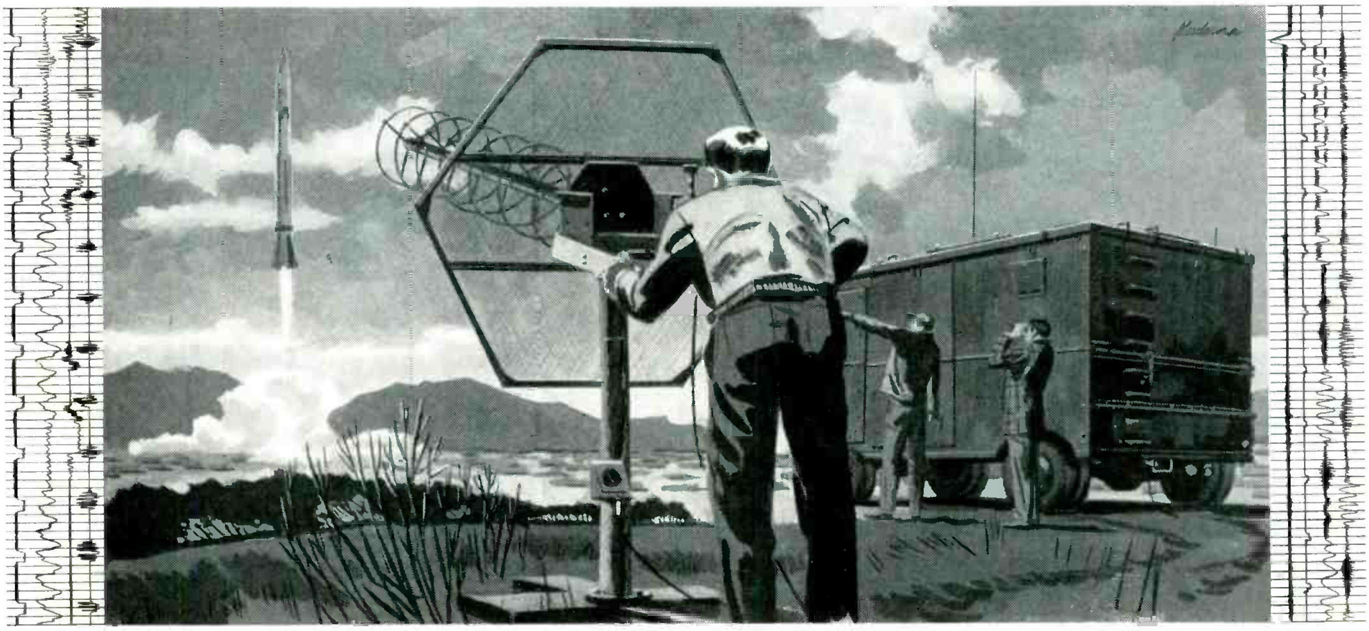
▶ **Uses**—The instrument is ideal for wideband tuning operations both in the laboratory or on the production line. Also, where desired, it can be used in single-frequency operations.

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-

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.

Significant firsts in this field are:
In 1948, a 10-band FM-FM System with 15 measurements.
In 1953, an 18-band FM-FM System with 36 measurements.
In 1954, a 14-band FM-FM System with all audio circuits transistorized.



Pioneers in Telemetering Development

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INERTIAL GUIDANCE
TELEMETERING
PHYSICS
PACKAGING
MECHANICAL ENGINEERING
AERONAUTICAL ENGINEERING

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.

The use of transistors and modern magnetic elements, together with progressive packaging techniques developed from intensive JPL studies, result in greatly improved reliability in missile-borne and ground-recording equipment. In addition, advanced communication studies are being utilized in the design of advanced telemetering equipment to the constant improvement of this art. An example of applied theory, is the use of tracking filter techniques in the communication link—resulting in a significant improvement in telemetering data accuracy.

The size and character of the "Lab" fosters a personal contact and close relationship between data-user and telemetering engineer. This close telemetering support is a basic reason for the development of better ways of measuring drag for the aerodynamicist, motor pressures for the propulsion expert, stresses for the missile designer and of monitoring complex electronic circuits which are the responsibility of the guidance specialist. This close cooperation has become a prime factor in the growth of the laboratory into one of the most successful guided missile development centers in the world.

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CALTECH jpl **JET PROPULSION LABORATORY**

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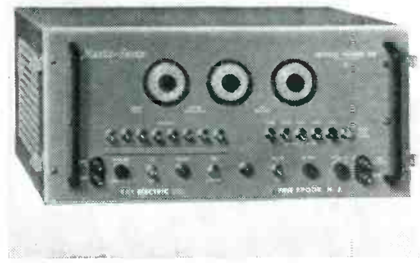
ings for each of 3 different frequencies.

▶ **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.

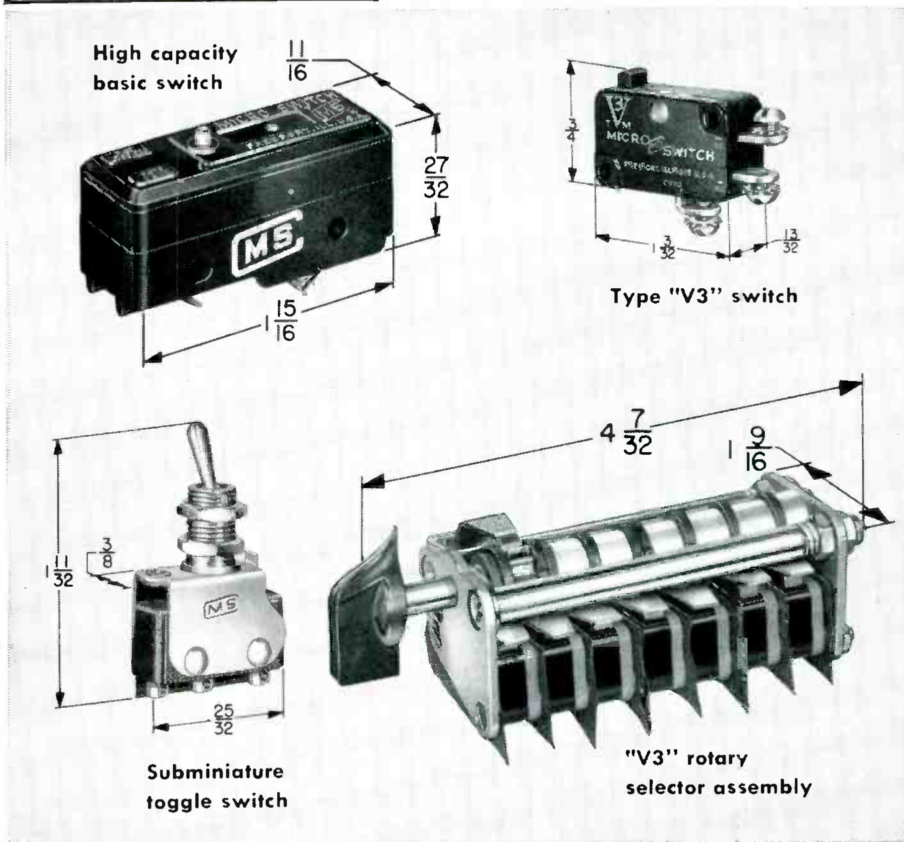
▶ **Specifications**—Range is 50 kc to 50 mc, continuously variable; r-f output, 1.0 v peak to peak into 75 ohms, flat within ±0.5 db over widest sweep; sweep width, linear sweep continuously variable 4 mc to 50 mc; sweep rate, variable around 60 cps, locks to line frequency; attenuators — individually 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, Wisc. 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 μf to 160 μf, voltage ratings from 1.5 v dcw to 70 v dcw, and diameters from ⅛ in. to 3/4 in. The tiny units are hermetically sealed and are inherently

MICRO precision switches

...THEIR USE IS A PRINCIPLE OF GOOD DESIGN



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).

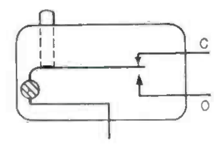
"V3" Rotary Selector Assembly. These assemblies are available with from one to eight switching units and from two to eight detent positions. Light in weight and small in size, these assemblies are well suited for use in electronic and aircraft applications. Many assemblies are available with various 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).

Circuit Arrangements

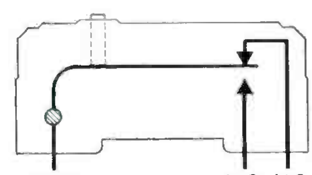
DOUBLE THROW



Type V3 Switch

This switch has a single-pole, double-throw contact arrangement. Electrical rating is: 10 amperes, 125 or 250 volts a-c; ½ ampere, 125 volts d-c; ¼ ampere, 250 volts d-c.

DOUBLE THROW

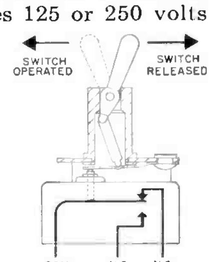


High Capacity Basic Switch

Standard switches are single-pole, double-throw. Electrical rating is: 20 amperes 125, 250 or 460 volts a-c; ½ ampere 125 volts d-c; ¼ 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.



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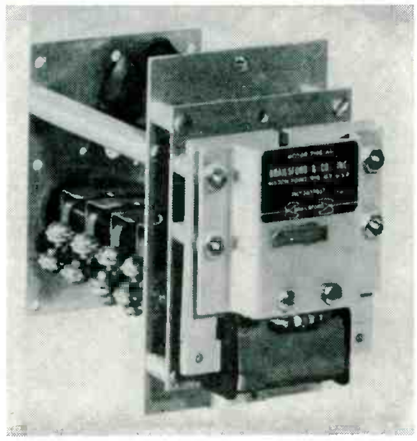
low in leakage current. An operating temperature range of −30 C to +60 C is standard. List price is $1.

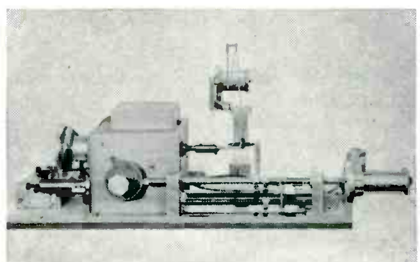


REPEAT CYCLE TIMER
operates on less power

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; $1\frac{3}{4}$ 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.

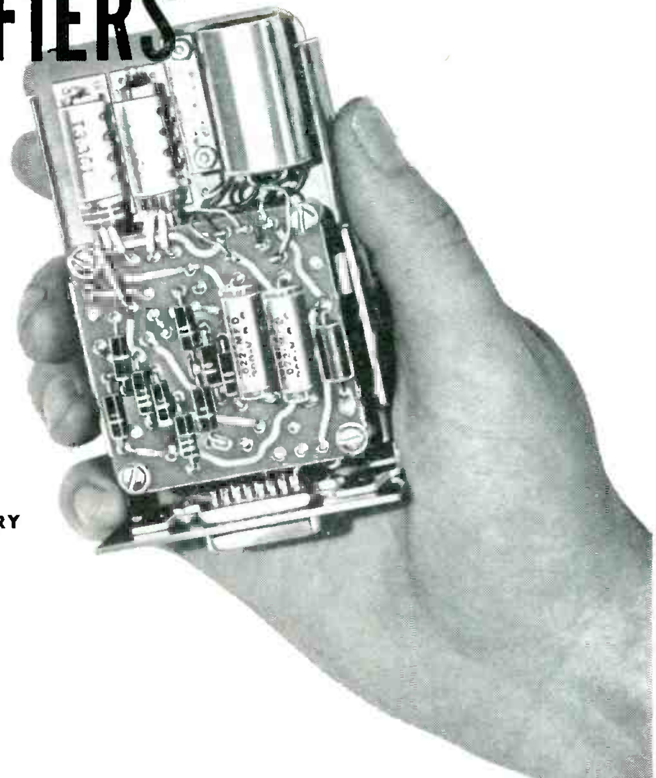
Although primarily designed for semiexpendable applications, units now incorporate a new brush assembly to give normal service life of better than 3,000 hours continuous operation.



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.

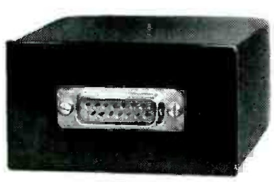
- **PROVEN RELIABILITY**
- **REDUCE OVERALL SYSTEM COST**
- **MINIMUM SPACE AND WEIGHT**
- **DESIGNED TO MILITARY SPECIFICATIONS**

REL-102 GENERAL PURPOSE WIDE BAND AMPLIFIER

Maximum gain 300. Four course gain ranges with each range continuously variable ± 10%. High input and low output impedance.

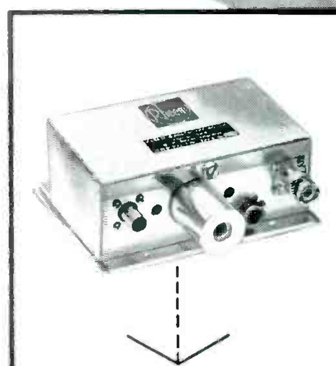
REL-103 GALVANOMETER AMPLIFIER

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 ± 10%.



REL-09

Miniature Telemetering Power Amplifier designed to withstand extreme shock and vibration. 12 watts nominal power output.

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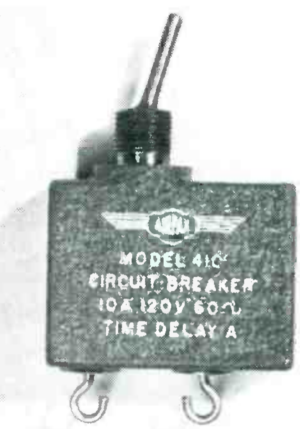
long production runs. It features the electric heel-and-toe pedal which starts the machine and resets the cam for each new winding, permitting the operator to have full use of both hands at all times.

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

F.M./A.M. SIGNAL GENERATOR
TYPE TF 1066

Carrier Frequency Range: *10 to 470 Mc.* • No spurious sub-multiple outputs; *r.f. oscillator generates direct at carrier frequency on all bands.* • F.M. monitored and variable *up to 100 kc deviation.* • A.M. monitored and variable *up to 80% depth.* • Output Level variable *from 0.2 microvolt to 200 millivolts.* • Precision Incremental Tuning *with frequency change indicated on a directly-calibrated meter.*

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TC 75E

directions and maintains its trip level constant from —0 to +100 C.

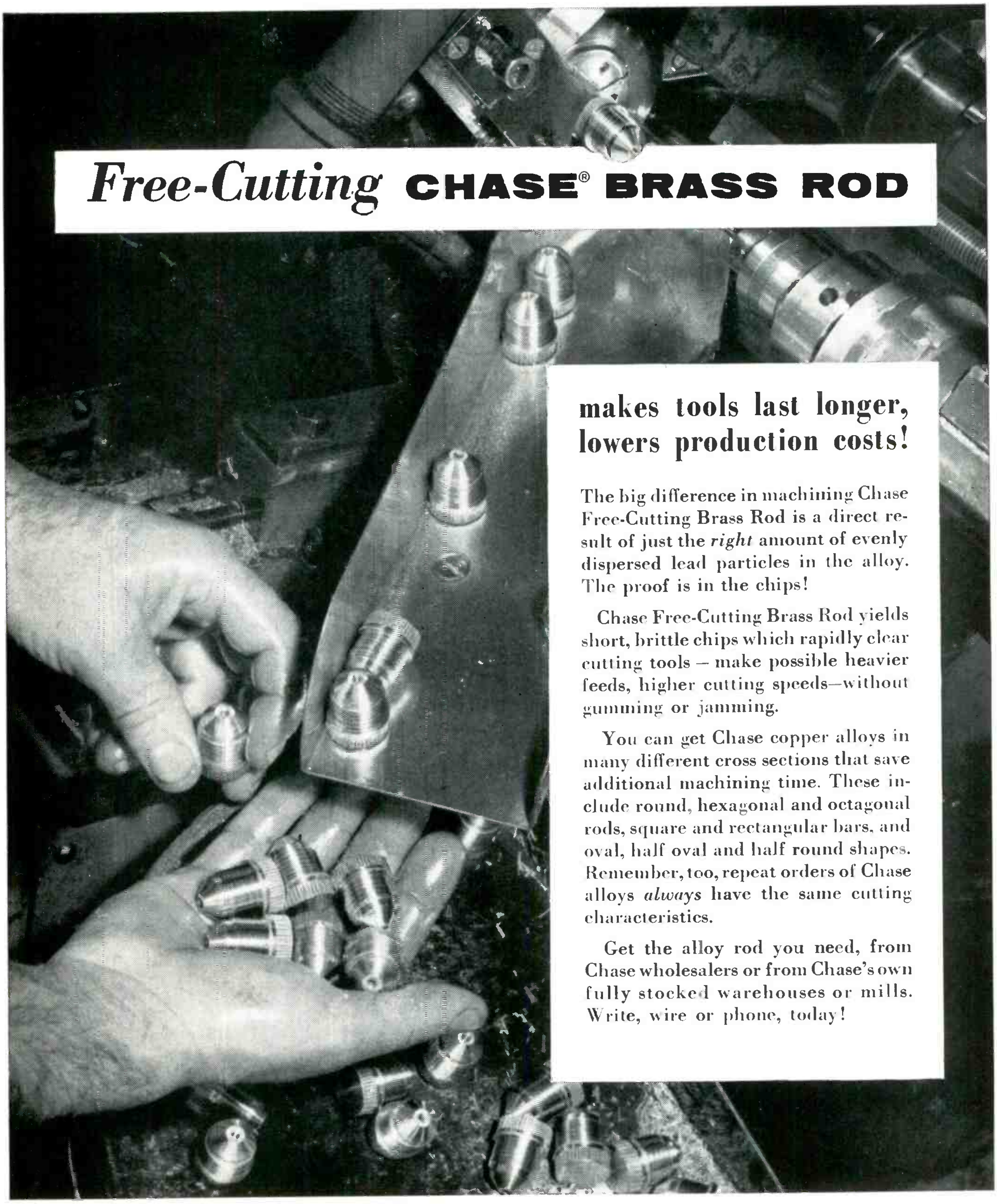
Because it mounts with a standard switch shank, type 410 trip-free circuit breaker serves both as power on-off control and as circuit protector to simplify equipment wiring and maintenance.

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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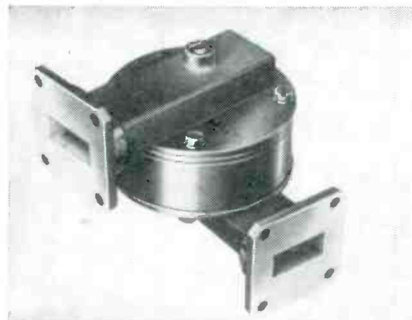
drift, and high calibration accuracy are insured by a fully regulated power supply and generous negative feedback.

▶ **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.

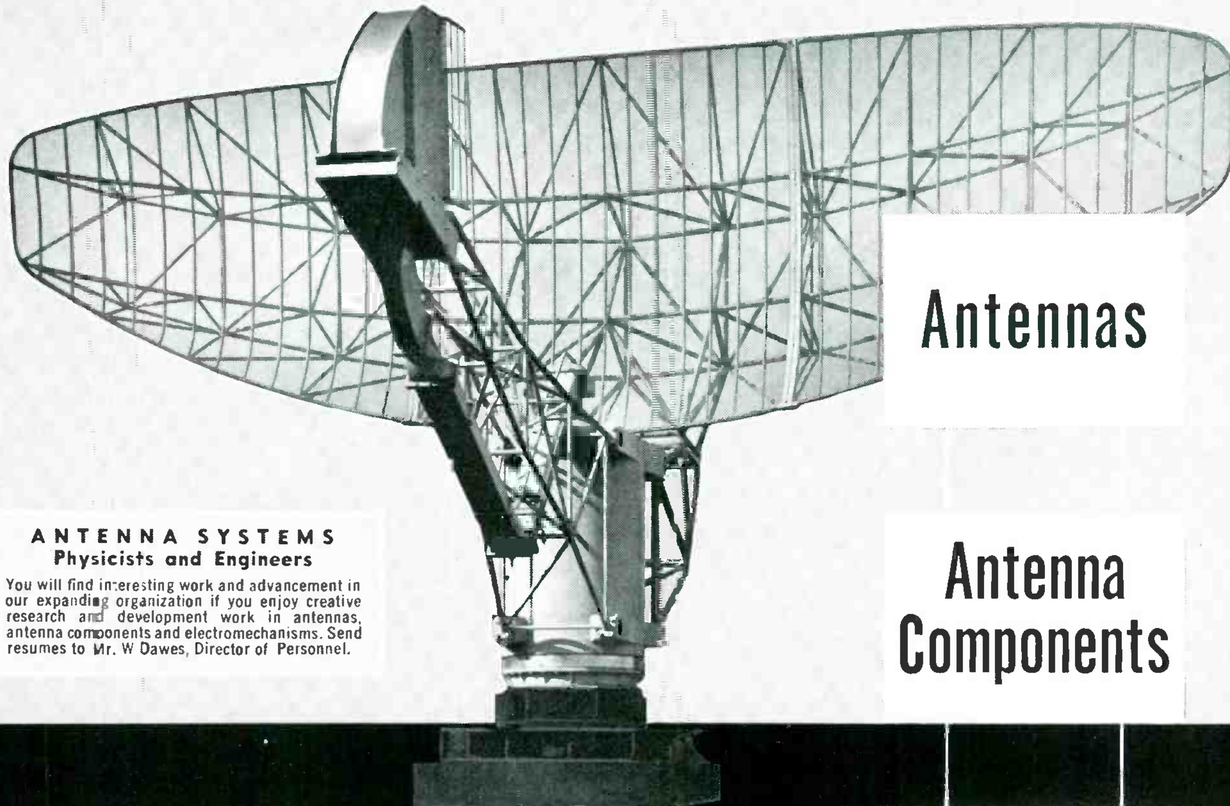
Characteristics include a maximum vswr of less than 1.25 over the 8,500-9,600 mc range and a vswr of less than 1.10 when tuned for narrow-band operation. Variation of vswr with rotation is negligible throughout the total angular travel.

▶ **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 preloaded ball bearings. These bear-

electronics →

Gabriel



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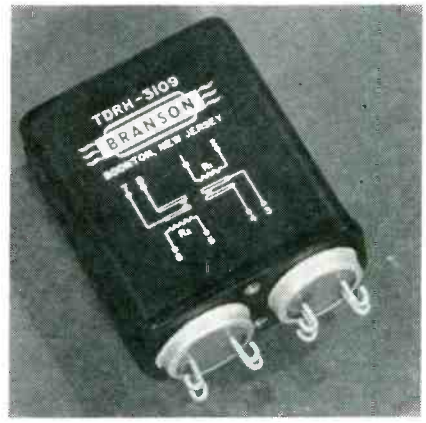
ings are a premanently lubricated, sealed type which eliminate dirt contamination problems over the life of the bearing.



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

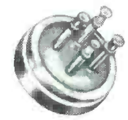
INCLUDES COMPLETE DATA Contains full electrical and mechanical data on over 500 standard types with a helpful discussion of accepted installation techniques.

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!

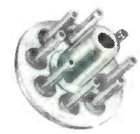
ELECTRICAL INDUSTRIES

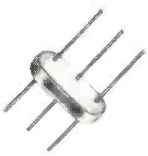
44 SUMMER AVENUE, NEWARK 4, NEW JERSEY


Single-lead Terminals


Multi-lead Headers

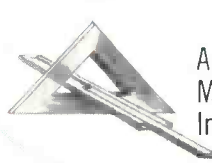

E-I End Seals


Plug-in Connectors


Diode and Transistor Closures

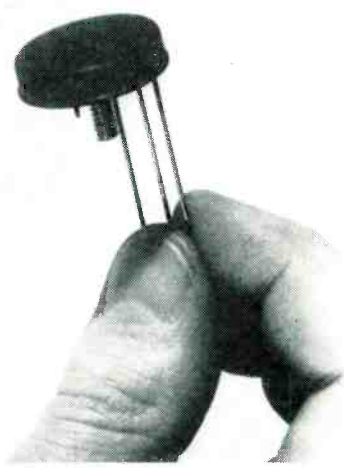

Crystal and Sub-miniature Closures


Special Application and Custom Seals


Accepted Methods of Installation

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 *pnp* 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

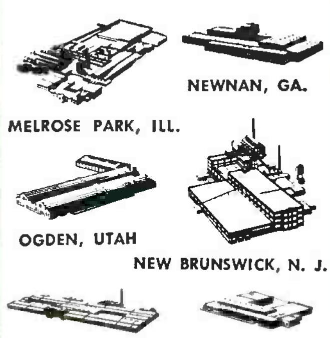
"WE LIKE THE CONSISTENT QUALITY OF RICHARDSON PLASTICS"

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
LAMINATED and MOLDED PLASTICS

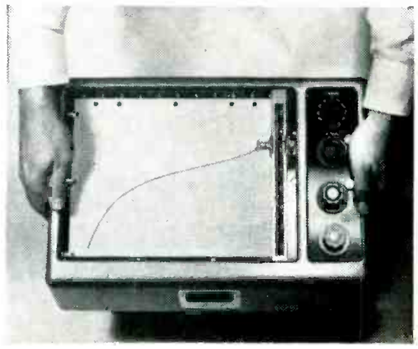
Chicago Telephone Supply Corporation is the world's largest producer of variable resistors. To achieve this position, they have stressed *quality*—both in their manufacturing operations and in their sources of supply. For many years, The Richardson Company has supplied the Chicago Telephone Supply Corporation 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.

The RICHARDSON COMPANY
FOUNDED 1858
2797 Lake St., Melrose Park, Illinois (Chicago District)
SALES OFFICES IN PRINCIPAL CITIES

Want more information? Use post card on last page.

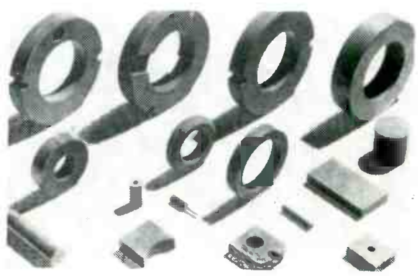
jacks accommodate standard 0.080 in. diameter test prods.



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 ½ 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, computors, 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

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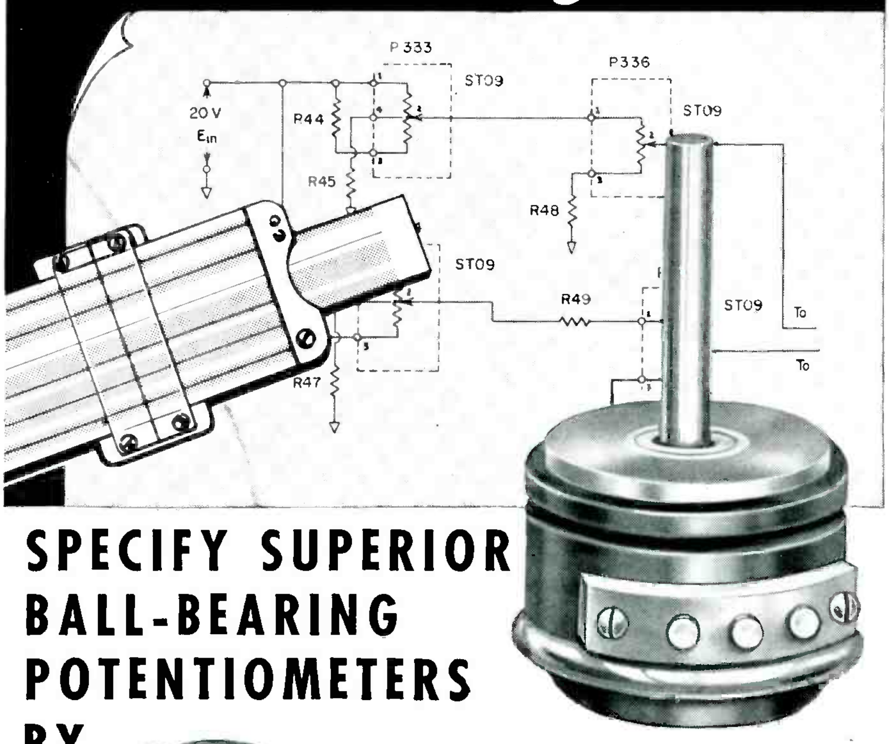
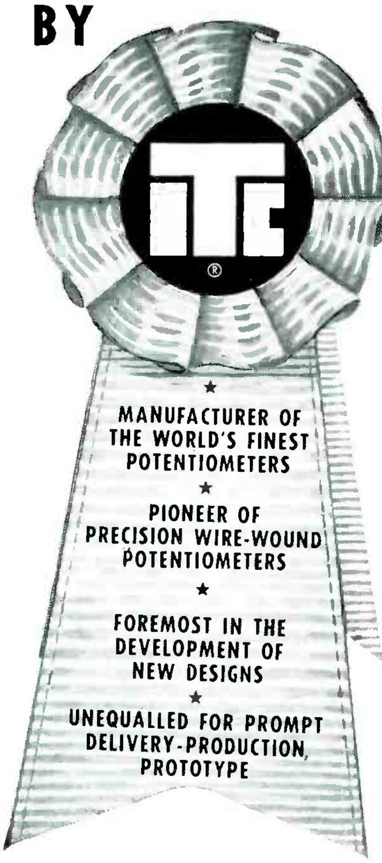
SYSTEMS • RADAR • COMPUTORS

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 ±1% (0.3%, special) of the total resistance, and ±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

nent 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^3, 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.

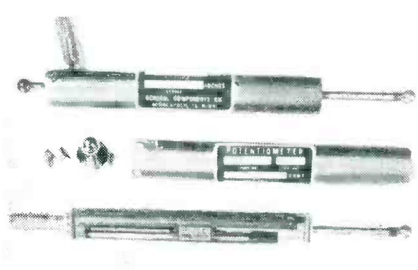
POWER SUPPLY
a precision power source

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 10½ 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 ½-in. diameter case

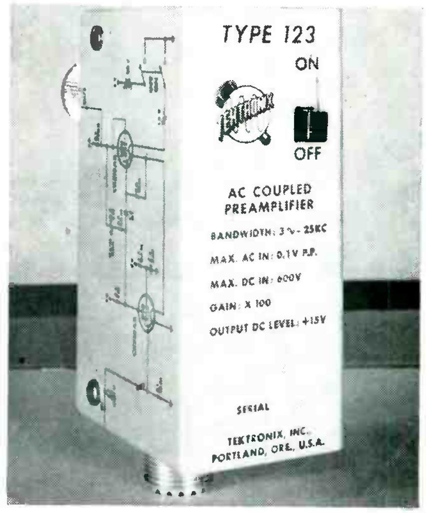
General Components Co., 801 Eighth St. Southeast, Minneapolis 14, Minn., announces a new, miniaturized linear travel potentiometer. Either single or dual pots are available in a ½-in. diameter case. Ball type mounting provides

EAPON SYSTEM DEVELOPMENT PLAN
FLIGHT TEST
OPERATIONS
WEAPON SYSTEM
OPERATIONAL CONCEPT
TACTICS

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 preamplifier 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 $3\frac{5}{8}$ in. high, $1\frac{1}{2}$ in. wide, $2\frac{1}{16}$ 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

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 centifugal blower wheeels 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
$\Delta\phi_1 = \Delta\phi_2$?
$\Delta\phi_2$
MATCHED CORES
CELCO
$\Delta\phi_1$
when magnetic amplifier cores
are matched by Celco
If the hysterisis 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.
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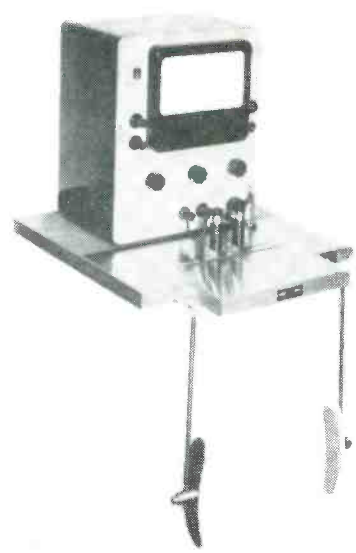
the synchronized crt. Frequency range is from 8,500 to 9,500 mc and the accuracy of vswr measurement is 0.5 percent. Minimum discernible vswr is 0.995.



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 $\mu\mu$f 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!

Miniaturized Hi-Voltage

QUALITY CARTRIDGE RECTIFIERS BY

International

Manufactured under the
United States Army Signal Corps
Reduced Inspection
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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

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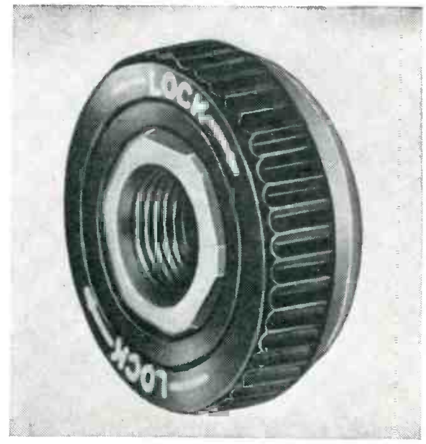
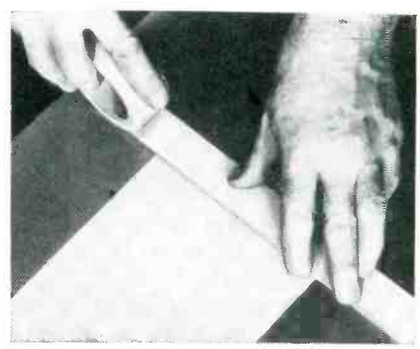
THE WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS



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 warpage, 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.

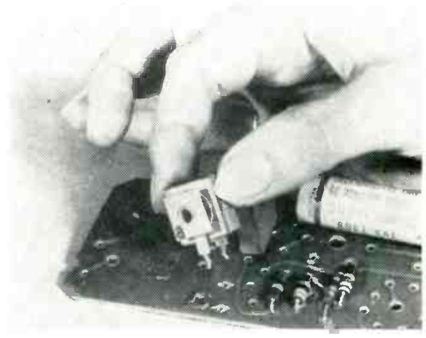
DE MORNAY BONARDI

DE MORNAY-BONARDI • 780 SOUTH ARROYO PARKWAY PASADENA, CALIFORNIA

Want more information? Use post card on last page.

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 $\frac{1}{32}$-in. thickness in sizes up to 24 by 24 in. and in $\frac{1}{16}$-in. thickness, up to 48 by 48 in.



SMALL RECTIFIER
for printed circuits

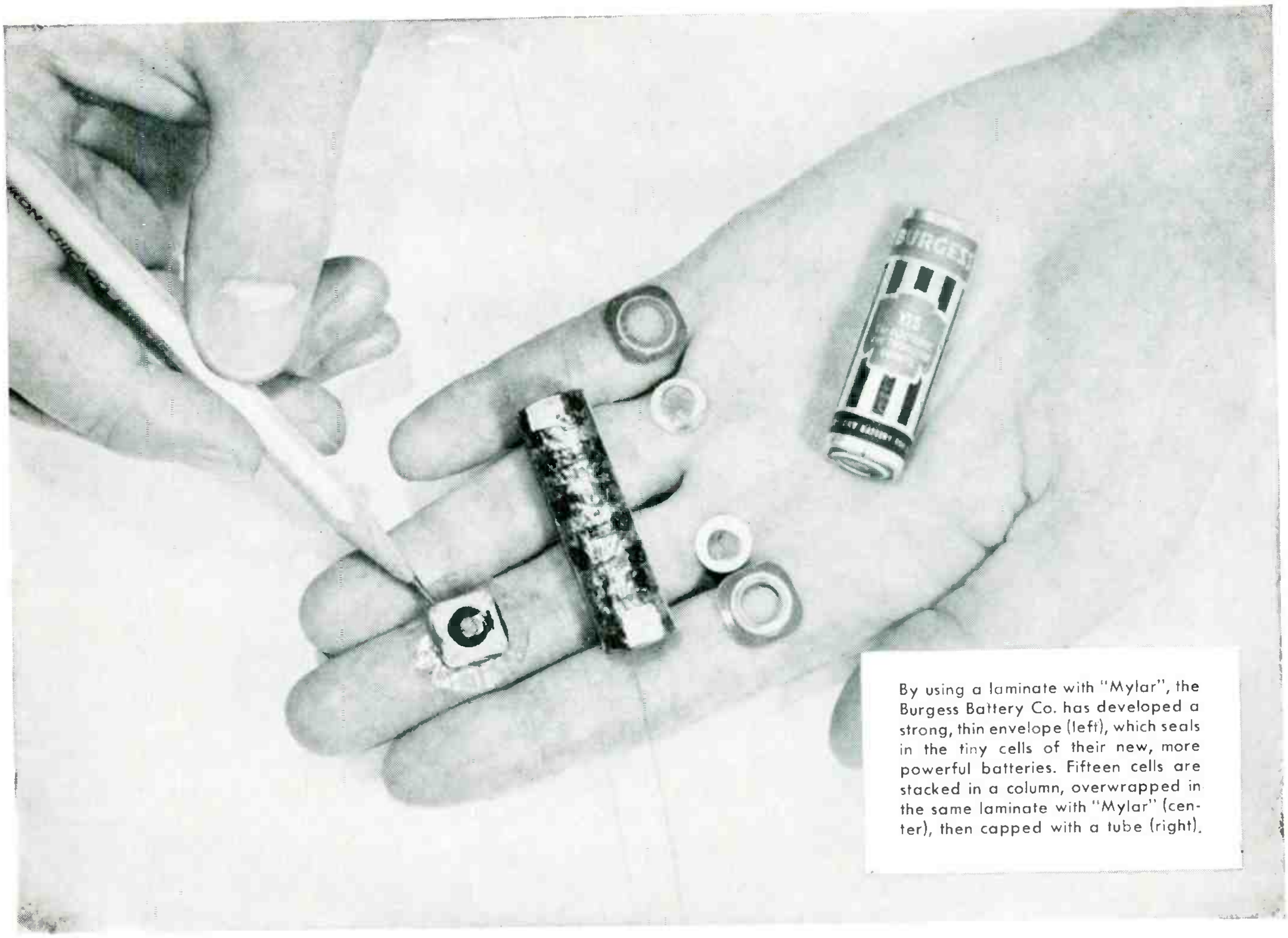
Radio Receptor Co., Inc., 251 W. 19th St., New York 11, N. Y., has announced a new miniature selenium rectifier with special snap-in terminals designed for printed wiring boards. The terminals will snap into the printed board easily, but with sufficient mechanical rigidity to hold the rectifier firmly 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 $\frac{3}{32}$ 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.*

DU PONT

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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 ____________________

Name ____________________

Company ____________________

Address ____________________

City ____________________ State ____________

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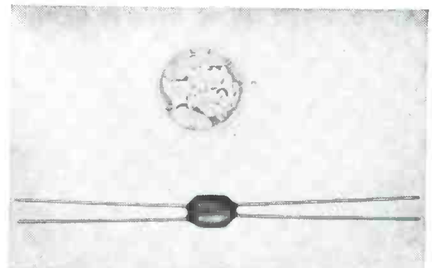
quality performance of operation in high altitude servo systems. As such, it complies with MIL-E-5400 requirements. A 3-legged transformer acts as a combined power supply and output transformer in the reluctance amplifier circuit.

▶ **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

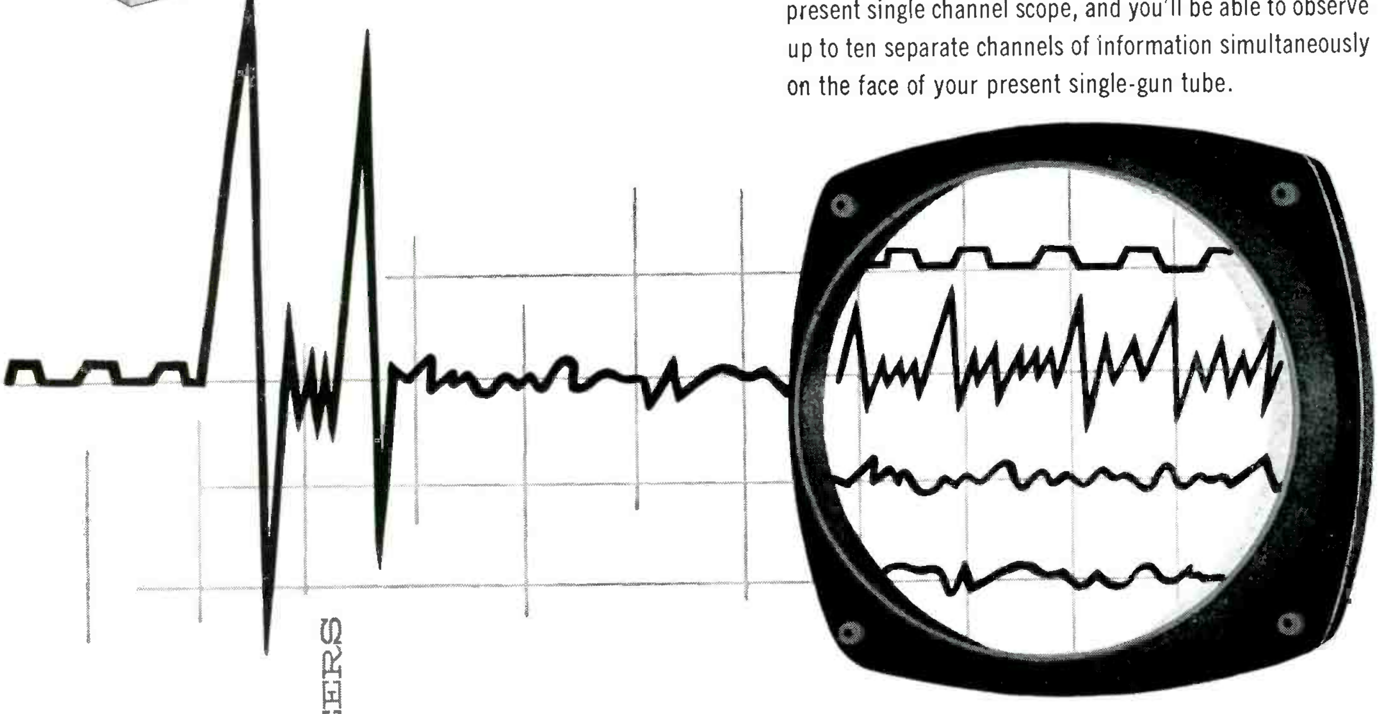
KURMAN ELECTRIC CO., INC., 35-18 37th St., Long Island City, N. Y., has manufactured a new miniature telephone relay, designed for motor control, mobile radio and many other control circuits where there

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

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.

Burroughs

BURROUGHS CORP. • ELECTRONIC INSTRUMENTS DIVISION
Department C • 1209 Vine Street • Philadelphia 7, Penna.

HPB 4B-103

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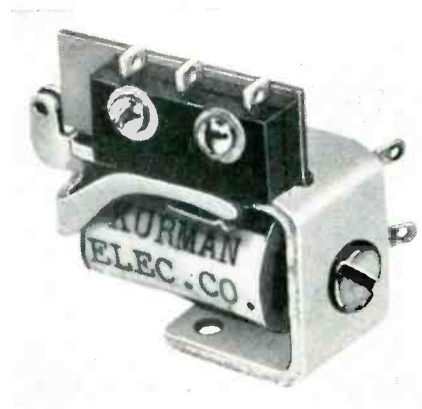


is need for a small relay to handle heavy currents of up to 5 amperes —125 v a-c.

The 7MS relay is $\frac{55}{64}$ in. by $1\frac{3}{8}$ in. by $1\frac{23}{64}$ 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.

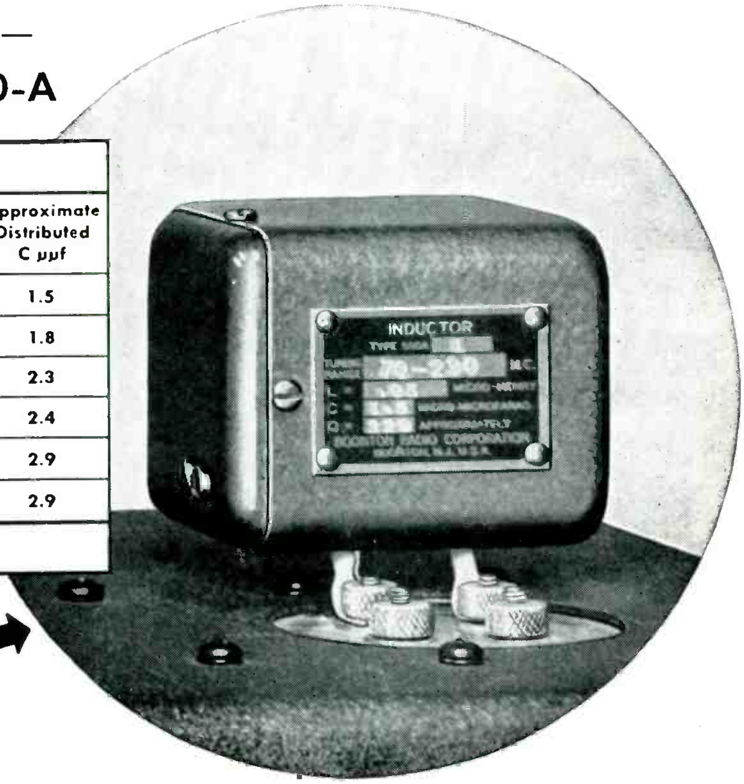
MAGNETIC AMPLIFIER is voltage regulated

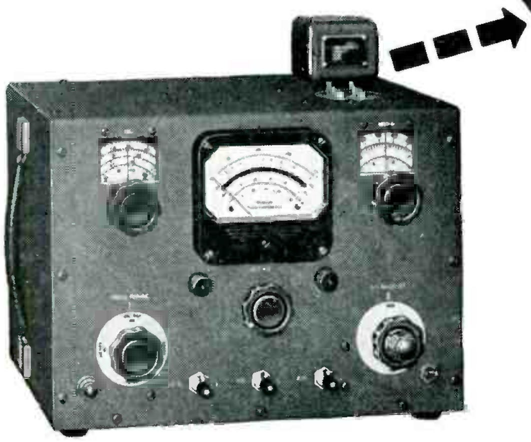
RAPID ELECTRIC CO., 2881 Middletown Road, New York 61, N. Y. A regulated 14/28 v, 200/100 ampere d-c power rectifier is designed to meet Air Force specifications MIL-P-8194 and MIL-P-6457A. Operating on 220/440 v, 3 phase, 50-60 cycles, the output voltage

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 µh	Capacitance µµf	Approximate Resonant Freq. mc	Approximate Q	Approximate Distributed C µµf
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 Corporation
BOONTON · N · J · U · S · A ·

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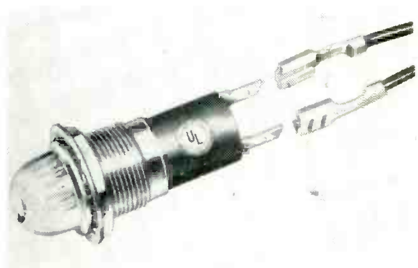
regulation from no load to full load is held within 0.5 v, including a variation of ± 10 percent of the rated input voltage.

▶ **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

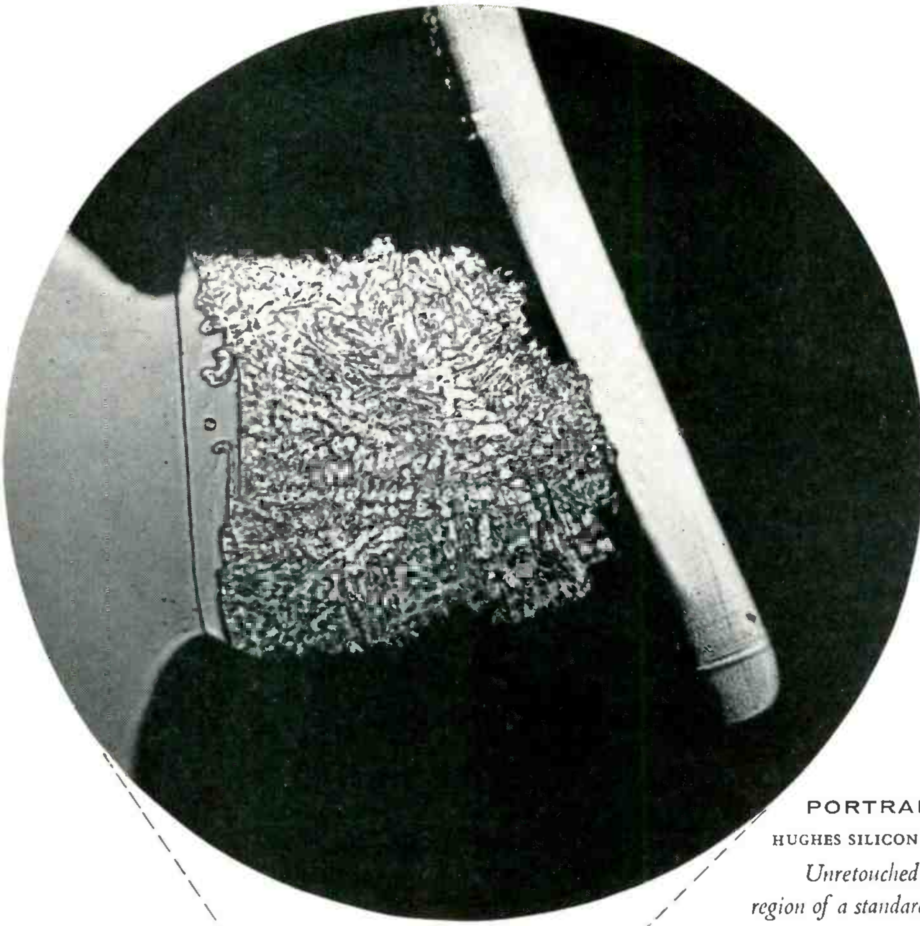
MARCONI INSTRUMENTS, 44 New St., New York 4, N. Y. The TF1059 shf wavemeter covers the wide band of 4,000 to 10,000 mc by use of a cavity resonator operating in a hybrid mode. It is tuned by a 2½ in. precision micrometer and is totally enclosed, the micrometer being viewed via a low power lens.

▶ **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

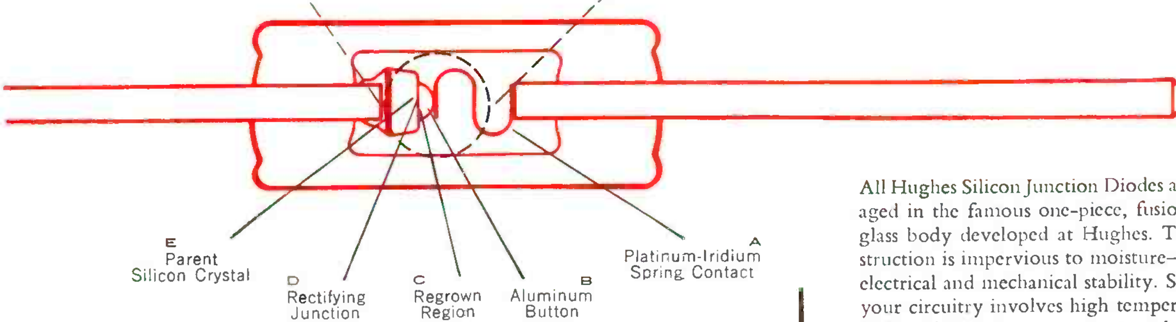
DIALIGHT CORP., 60 Stewart Ave., Brooklyn 37, N. Y., now offers its series of indicator lights, which accommodate bayonet type miniature lamps, with spade terminals. These terminals are the matching male



PORTRAIT OF RELIABILITY

HUGHES SILICON JUNCTION DIODES

Unretouched photomicrograph of the junction region of a standard Hughes Silicon Junction Diode.



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.*

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

HUGHES PRODUCTS

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

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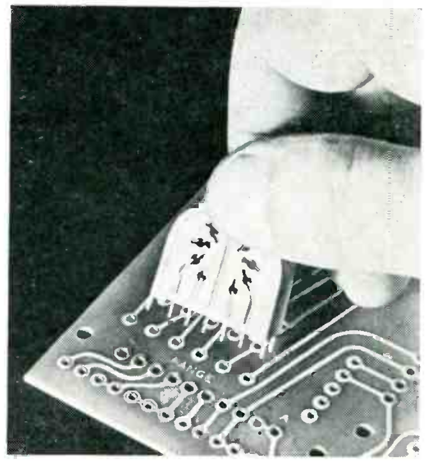
part for the convenient quick-connect type wire terminals. The connection is positive with triple spring action and, in many situations, their use makes a cost-saving contribution to the manufacture or maintenance of equipment.

The T-3¼ 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

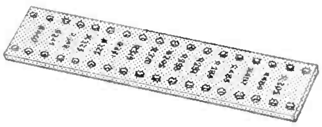
TAYLOR
Laminated Plastics
Vulcanized Fibre

Shop Talk

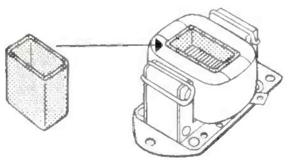
TAYLOR FIBRE CO.
Plants in Norristown, Pa. and La Verne, Calif.

PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

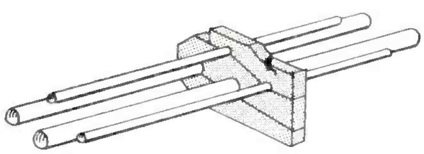
Tips for designers



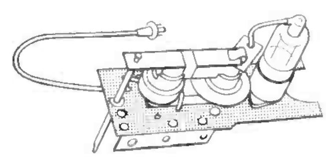
Terminal strips for high-precision electronic instruments benefit from the excellent insulating properties of Taylor XXXP-301 hot-punch laminate.



Coil forms for this solenoid have to operate at high temperatures . . . an ideal application for Taylor glass melamine laminate.



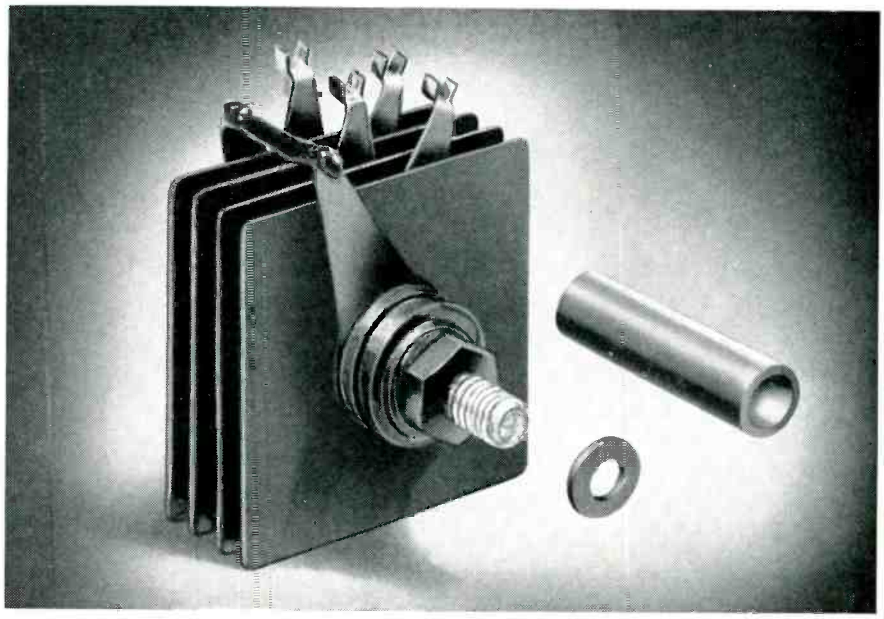
Fuel line clamp for a fighter airplane's "pipeline" system is machined from Taylor fabric base laminate which has high mechanical strength and resists extreme temperature and humidity.



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.

Want more information? Use post card on last page.

BX, same as AX, but with tube shield added.

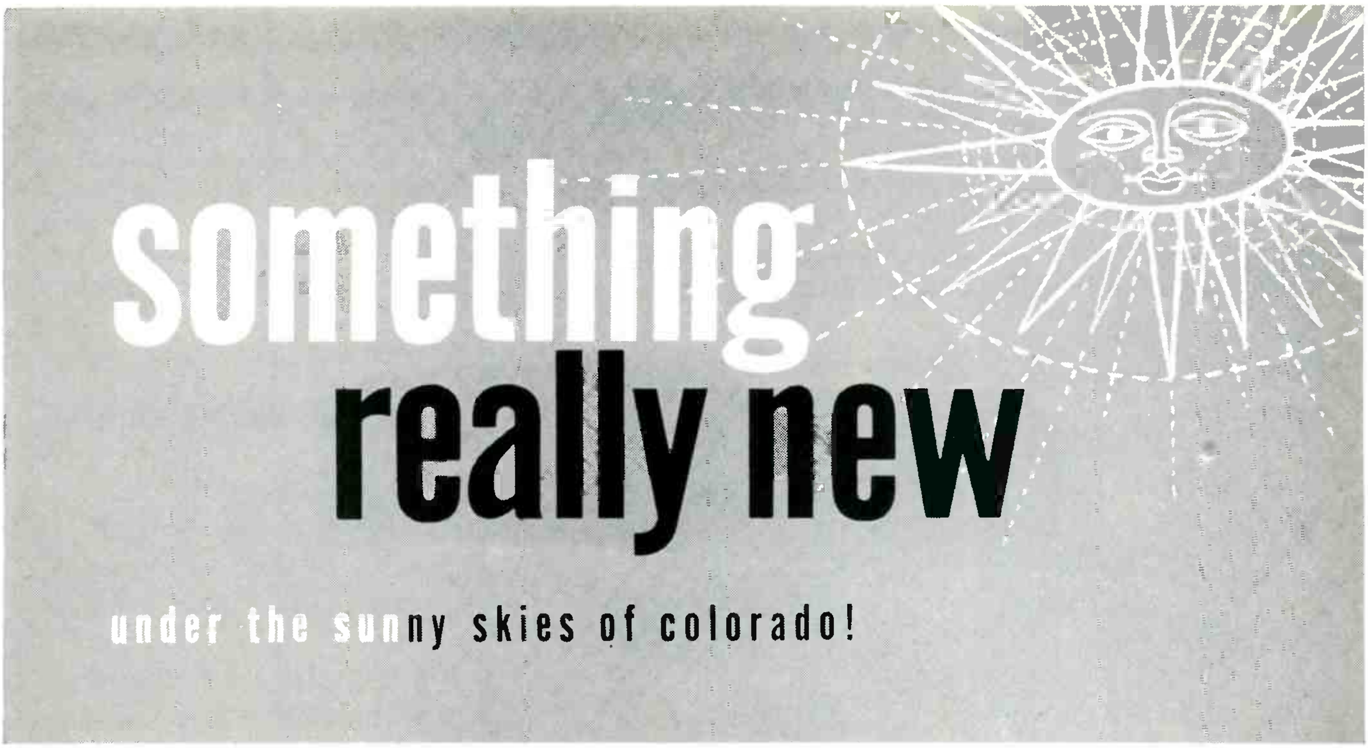
POWER METER
d-c to 500 mc

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-



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A NEW engineering project

A NEW technical challenge

A REALLY new way of life for engineers and scientists in the wonderland of Colorful Colorado

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 . . .

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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.
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Circuit Design & Anal.	Servo Design
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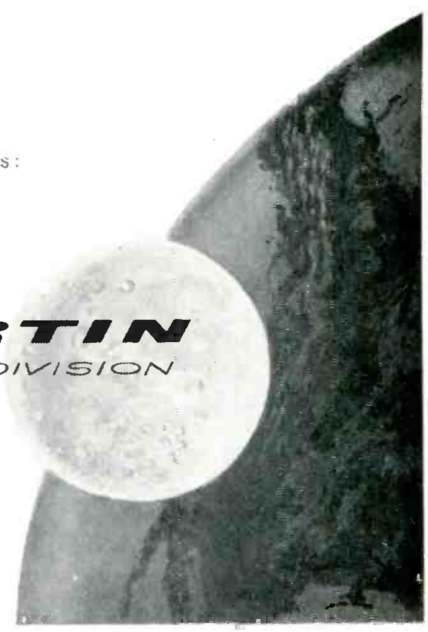
Electronics Engineering	Electronic Systems
Systems Analysis	Communications



MARTIN
DENVER DIVISION

Address inquiries to: Emmett E. Hearn, Employment Director, Box 179, Dept. H, Denver, Colorado

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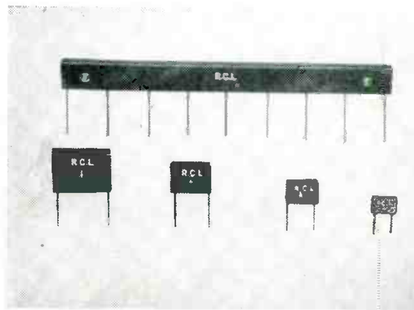
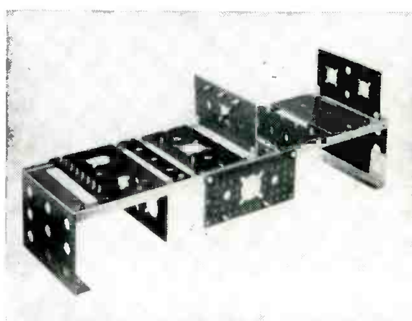
tinuity, hot and cold interelectrode short circuits, and filament-cathode insulation, and will measure plate current and mutual conductance anywhere on the characteristic chart. An overload cutout protects the instrument against faulty usage.



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.

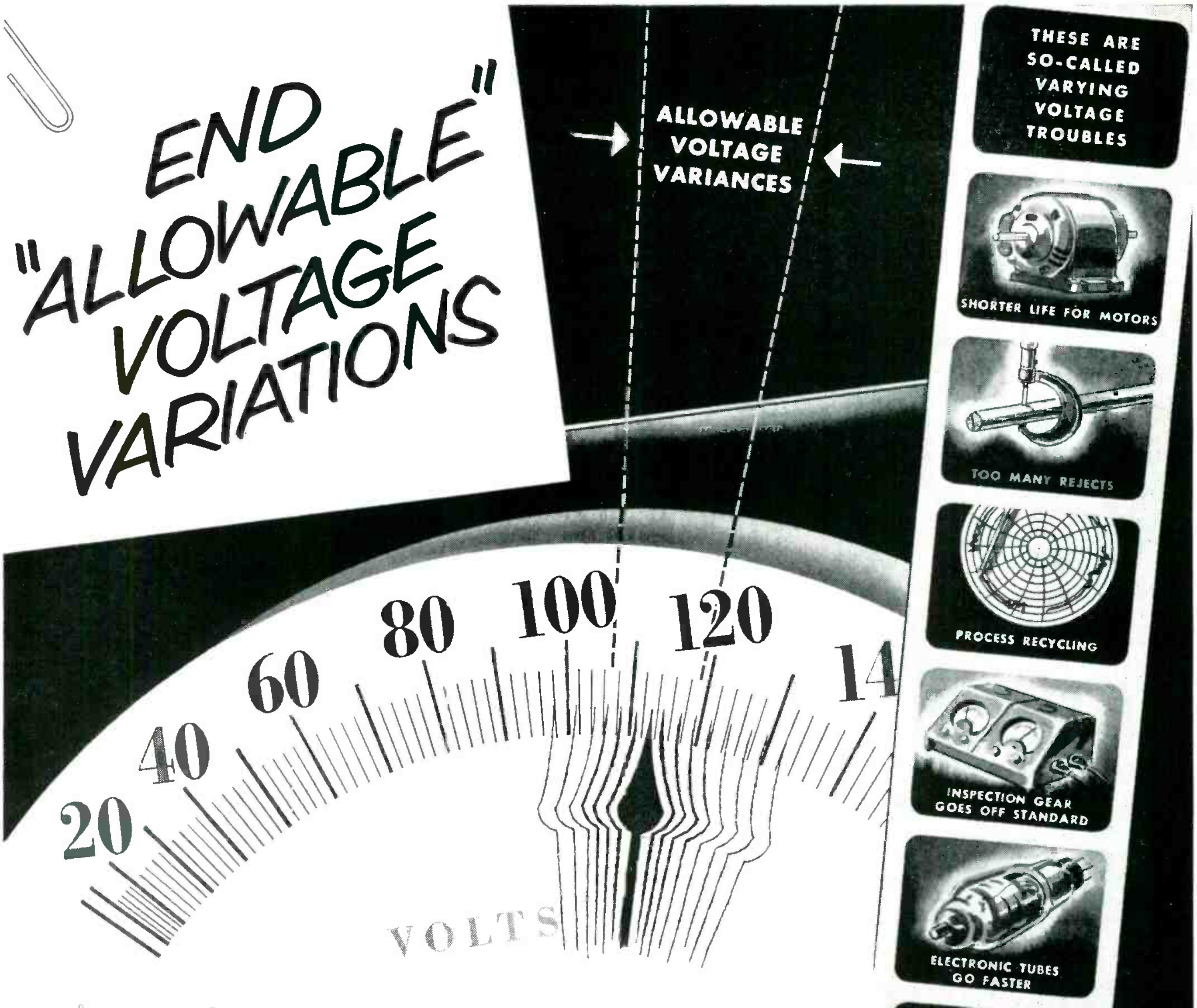
▶ **Technical Information** — Standard tolerances are 1 percent, available to 0.05 percent. Temperature ranges are −70 C to +125 C. Wattage is 0.1 to 0.750 w. Range is from 1 ohm to several megohms.

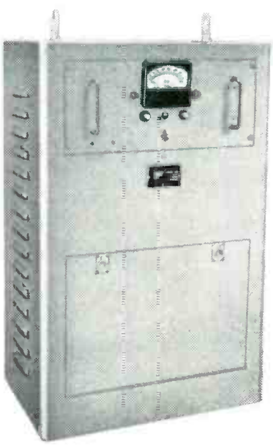


CHASSIS KIT
for prototype models

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





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.

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Send STABILINE Bulletin S351 ☐

Name ....
Company Name ....
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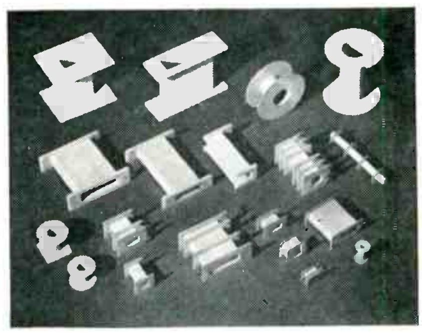
els. It consists of: end brackets, side channels, terminal strips, miniature and octal tube socket plates, component mounting boards, mounting brackets, double-end press-in terminals, self-tapping screws, potentiometer mounting boards, and rack mounting plates.

▶**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, $16\frac{7}{8}$ 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.

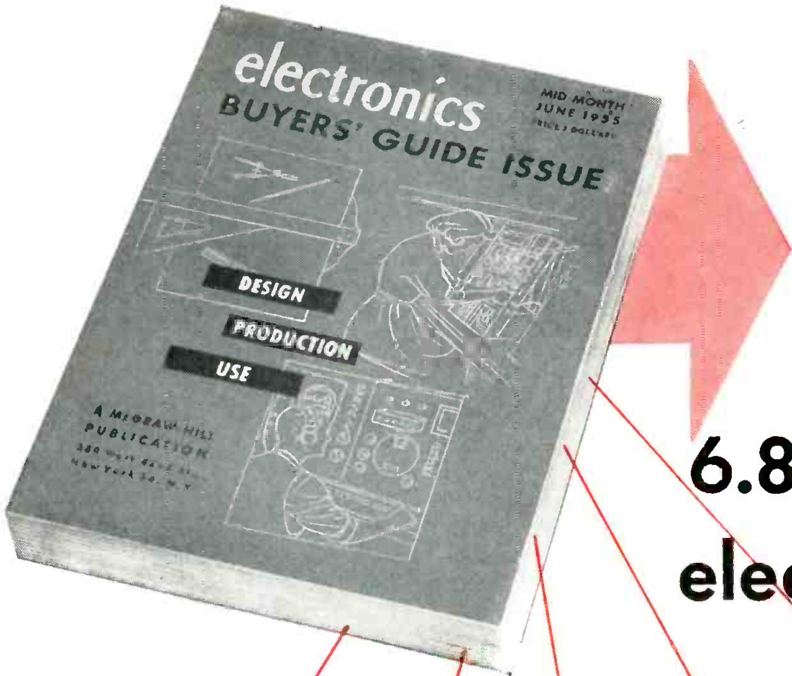


GLASS CLOTH BOBBINS
laminated silicone type

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



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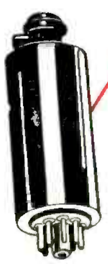

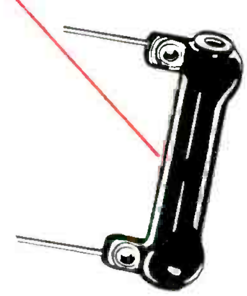

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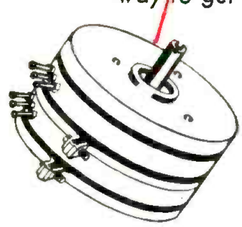

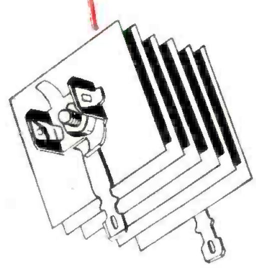

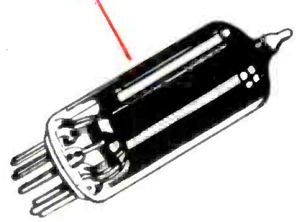

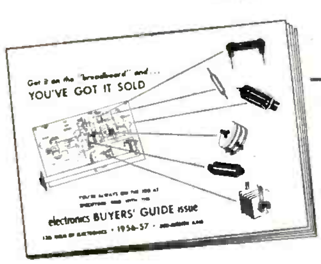

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electronics BUYERS' GUIDE

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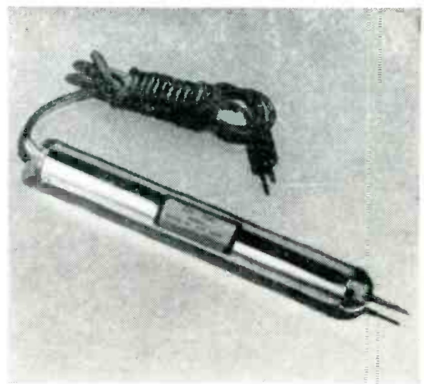
have been made as low as 0.010 in.

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

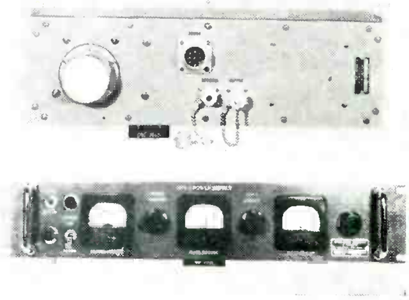
FUTURAMIC Co., 2500 W. 23rd St., Chicago, Ill. Model 261 high-ohms probe extends the ohmmeter range of the vom by a factor of 10. It permits measurement of resistance values up to 200 megohms. The probe can be used with any 20,000 ohms-per-volt vom having a center-scale indication of 12 ohms, and an 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 load.

Price is $9.95.

R-F PREAMPLIFIER
features small size

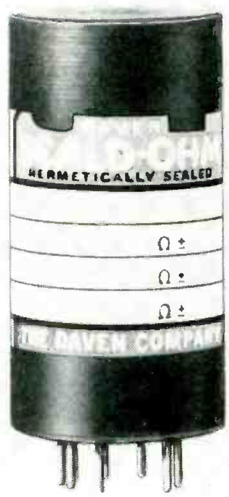
APPLIED SCIENCE CORP. OF PRINCETON, P. O. Box 44, Princeton, N. J. Model APA-2 r-f preamplifier greatly improves the signal-to-noise ratio of a typical radio receiver in the 215-235 mc frequency band, resulting in a better reception of low-strength signals. Addition of the preamplifier to a typical receiving installation utilizing a receiver with a typical 10-db noise figure



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 6¼ in. wide by 5 29/32 in. high and weighs 12¼ 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

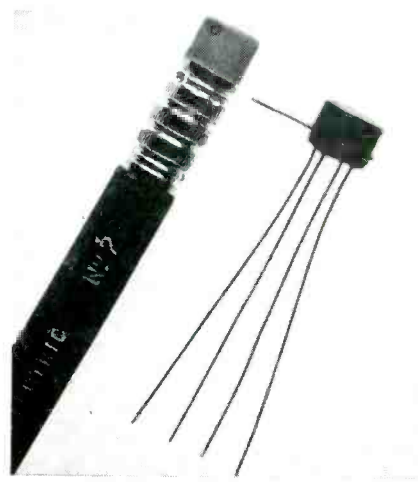
THE DAVEN CO., 530 W. Mt. Pleasant Ave., Livingston, N. J., has developed a new plug-in resistor network, type 1299. The unit is epoxymolded, hermetically sealed and measures ⅞ in. in diameter and 1¾ in. in length. Its base fits a standard 9-pin miniature socket.

▶ **Specifications** — The plug-in resistor network can accommodate up to 8 individual resistors with a

Want more information? Use post card on last page.

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 μsec.

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

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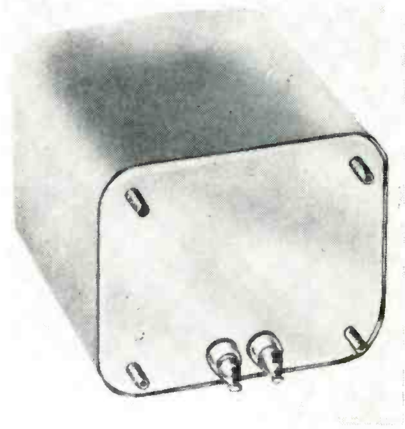
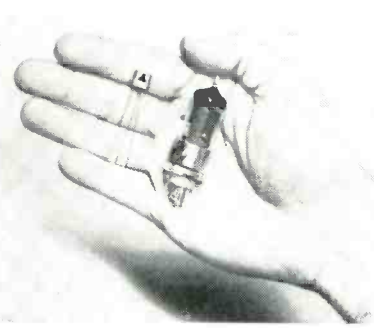


hermetic filter chokes exceed MIL-T-27 specification requirements.

▶ **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.

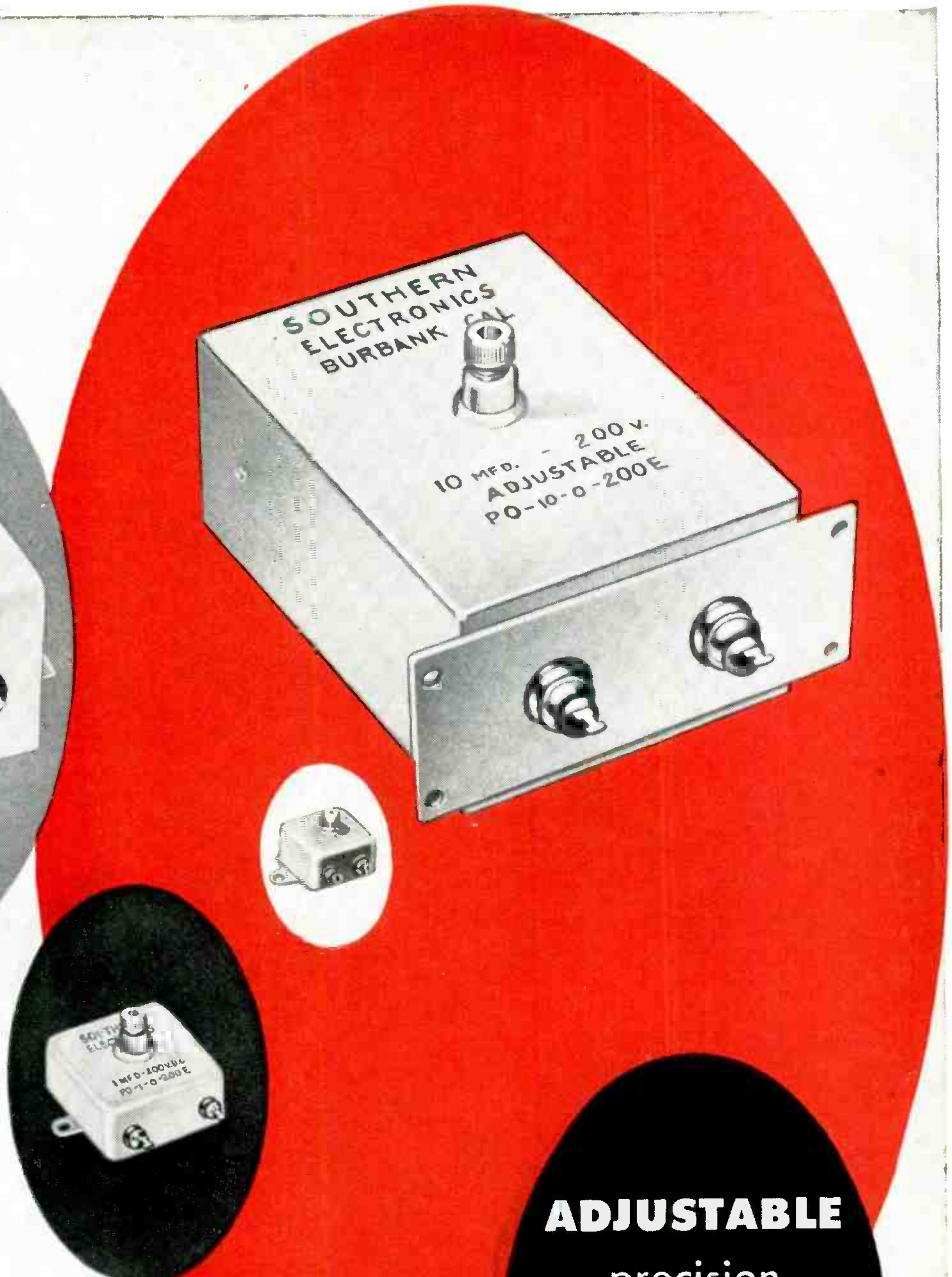
These units also have industrial ratings for high reliability, broadcast, test equipment and similar service.



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



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Excellent for Computer Integration, Test Equipment or Secondary Standards.

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ADJUSTABLE
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. . . WITH PERFECT HERMETIC SEAL TO INSURE EXTREMELY LOW LEAKAGE!

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SOUTHERN ELECTRONICS *Corporation*

239 West Orange Grove Ave., Burbank, California

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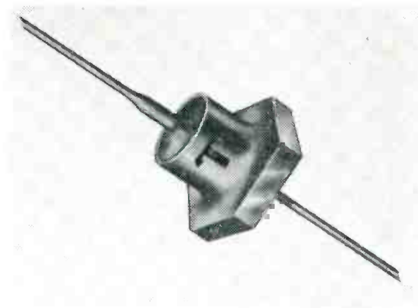
amplifier, computer and servo applications.

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.

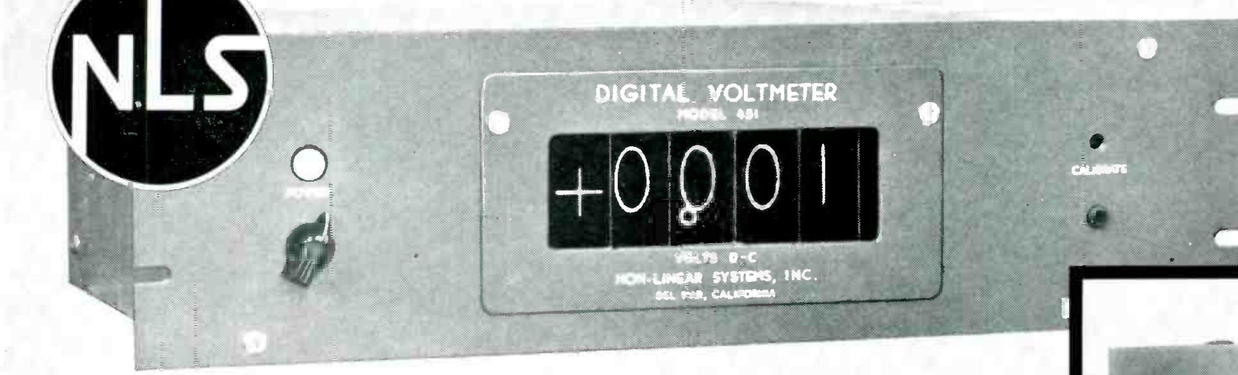
▶ **Specifications**—They are available with peak inverse voltage ratings up to 600 v, and maximum average forward currents to 500 ma at 100 C. They feature both high forward conductance and low leakage current for high operating efficiency.

Small size (less than ¼ 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

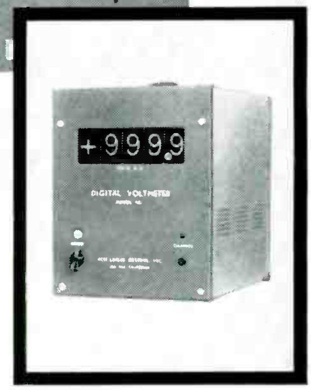
BARRY ELECTRONICS CORP., 512 Broadway, New York 12, N. Y. Model 1 is a combination leak tester, gas analyzer and vacuum pump. The unit includes built-in vacuum pump, vacuum gages, all neecssary control valves and a gas analyzer cell for identification of system leaks. This test apparatus is self-contained in a single top-of-

MODEL 451



RACK MOUNT STYLE – 5¼" high by 18" wide by 15⅛" deep

PORTABLE STYLE – 10⅞" high by 8⅜" wide by 15⅛" 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.

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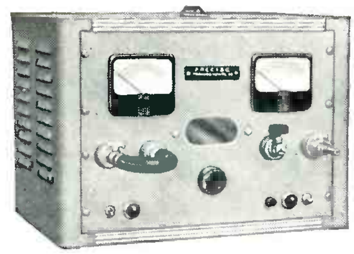


bench cabinet with all controls and gages conveniently located on the front panel. The portable, versatile instrument is suited for altitude test chambers, evacuation of tubes, and leak detection of mechanical and electrical components.

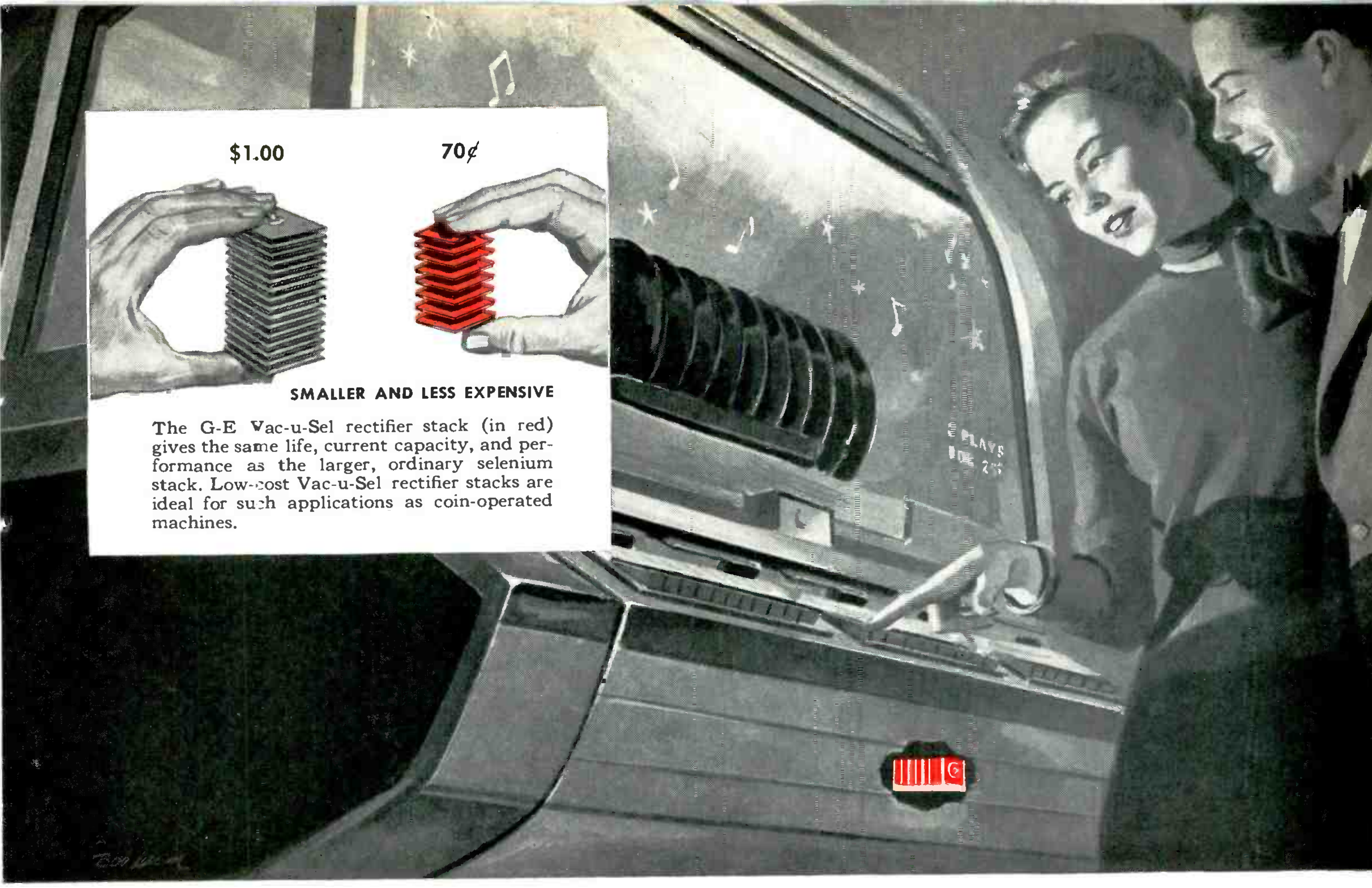
C-R-A-M UNIT
widely versatile instrument

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 C. From room temperature to −70 C, capacitance



DESIGNED TO HELP YOU MEET PRICE COMPETITION . . .

G-E *Vac-u-Sel** Rectifiers Cost You Up to 30% Less

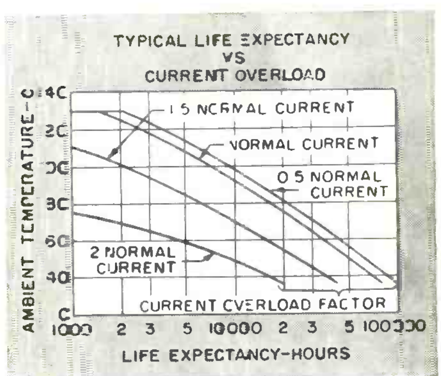
Here is a component rectifier stack that will out-perform ordinary selenium stacks, and yet cost you up to 30% less!

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.

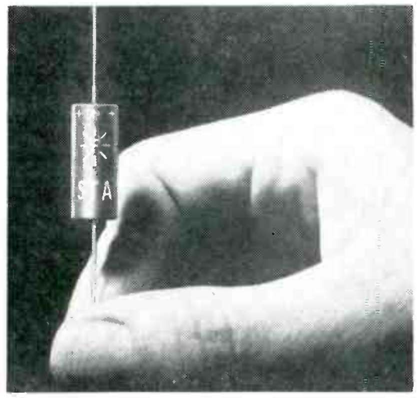
*Vac-u-Sel is a trade-mark of the General Electric Co. It designates top-quality selenium rectifier cells manufactured by a unique sphere-type vacuum-evaporation process by the Rectifier Department, Lynn, Mass., headquarters for silicon, germanium, selenium, and copper-oxide component rectifiers.



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



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...

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

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"THE NAME THAT COUNTS"

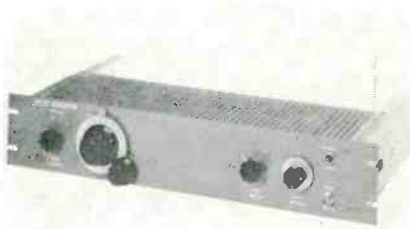
units, portable and wall-mounted, are also available with plug-in control panels which may be removed to provide remote operation of beam, focus, target, blanking and gain.

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

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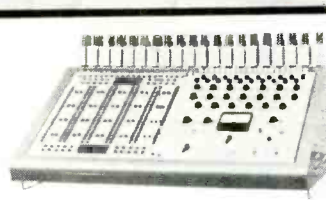

Desk-top **Analog Computer,** rapid and economical system synthesis.

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 Since 1909

Hall-Scott Motors Company, *Electronics Division*

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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 μsec to 0.07 μsec 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.

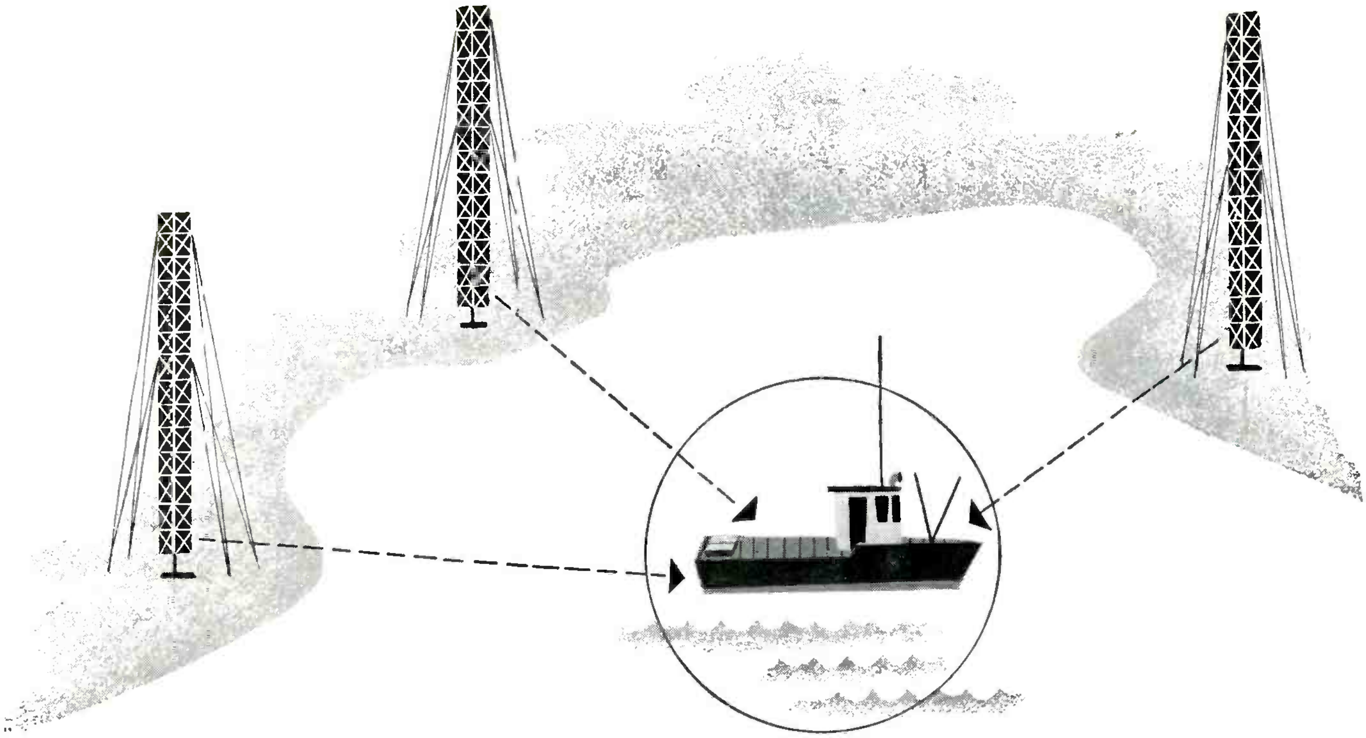
SENSITIVE RELAY features different design

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 $1\frac{1}{16}$ oz.

POTENTIOMETERS smaller size, lighter weight

THE GAMEWELL CO., Newton Upper Falls 64, Mass. Model RVG-14 is a $\frac{7}{8}$ 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



how Transicoil servos help LORAC

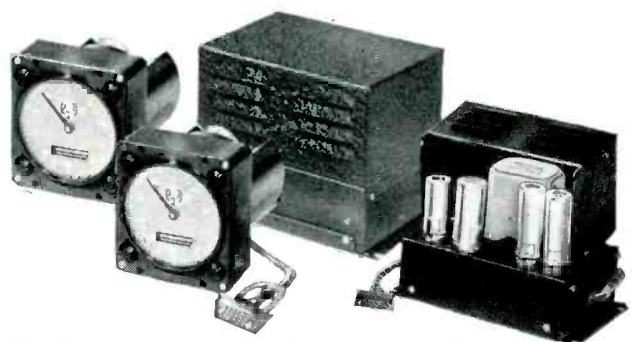
bring off-shore navigation to accuracies within yards

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 modulated reference signal, and presents the position information on the counter-pointer type dial face.



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.

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

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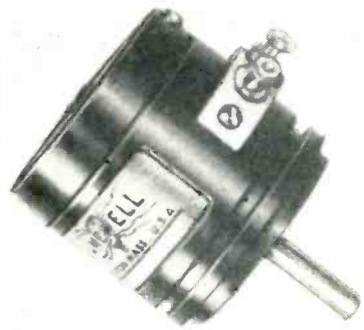
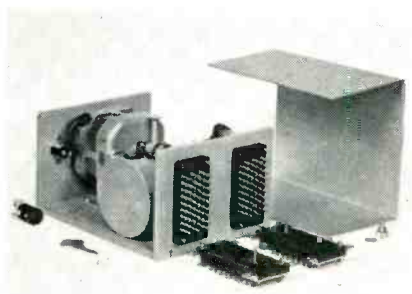


high operating temperatures are encountered.

This metal-housed potentiometer is available in single as well as multigang construction, with sleeve or ball bearings.

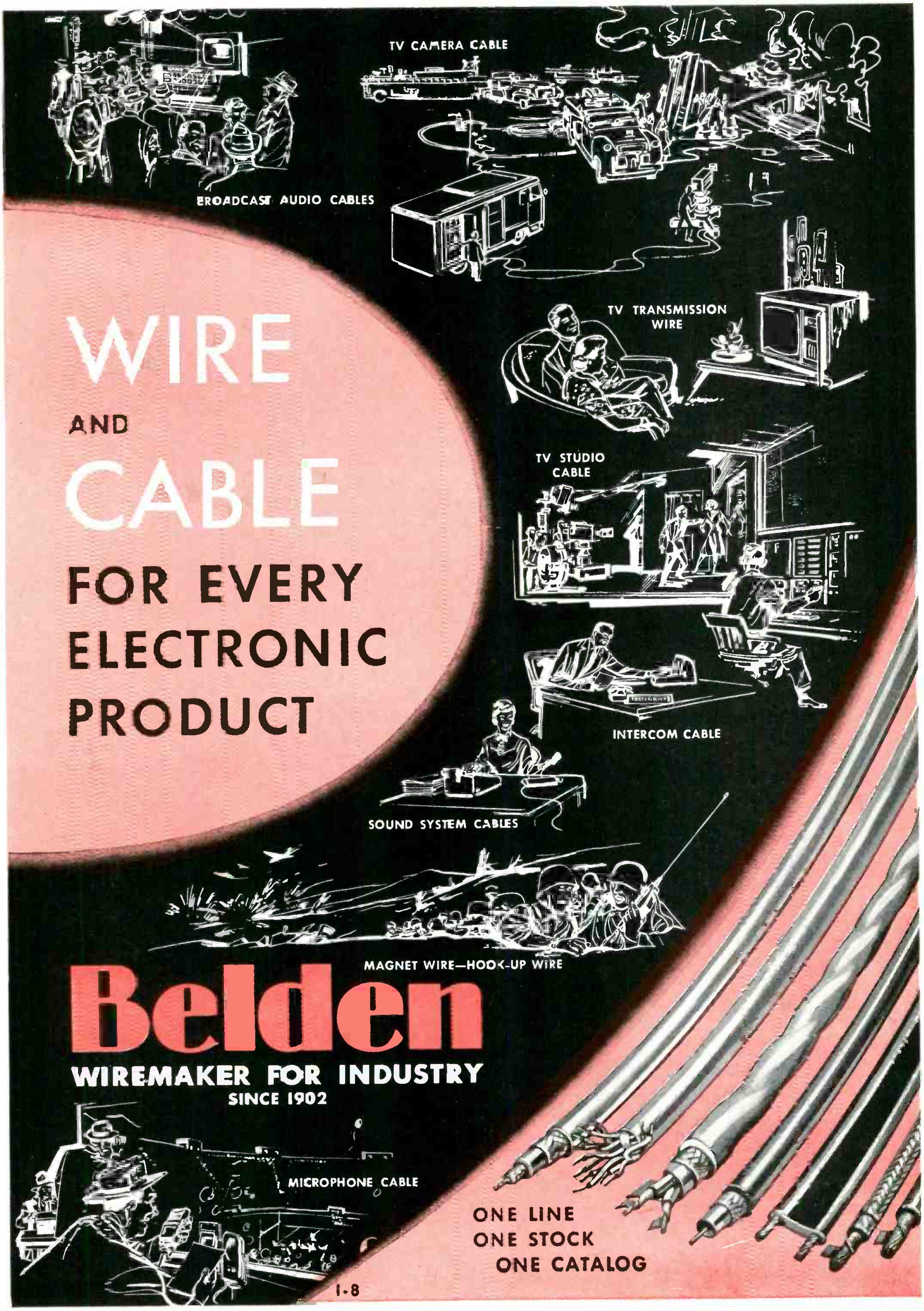
▶ **Specifications**—Winding resistances from 25 to 45,000 ohms may be had with minimum resolution of 0.06 percent and optimum linearity of 0.25 percent where specified. Maximum continuous operating temperature is 150 C, and the units meet MIL-E-5272A specification as they apply.



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


TV CAMERA CABLE
BROADCAST AUDIO CABLES
TV TRANSMISSION WIRE
WIRE
AND
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INTERCOM CABLE
SOUND SYSTEM CABLES
MAGNET WIRE—HOOK-UP WIRE
Belden
WIREMAKER FOR INDUSTRY
SINCE 1902
MICROPHONE CABLE
ONE LINE
ONE STOCK
ONE CATALOG
1-8

phasing between poles is adjustable. This switch is 5¾ in. long by 7 in. wide by 4⅛ in. high and weighs approximately 9½ lb.

SILICON DIODE
for X-band mixer use

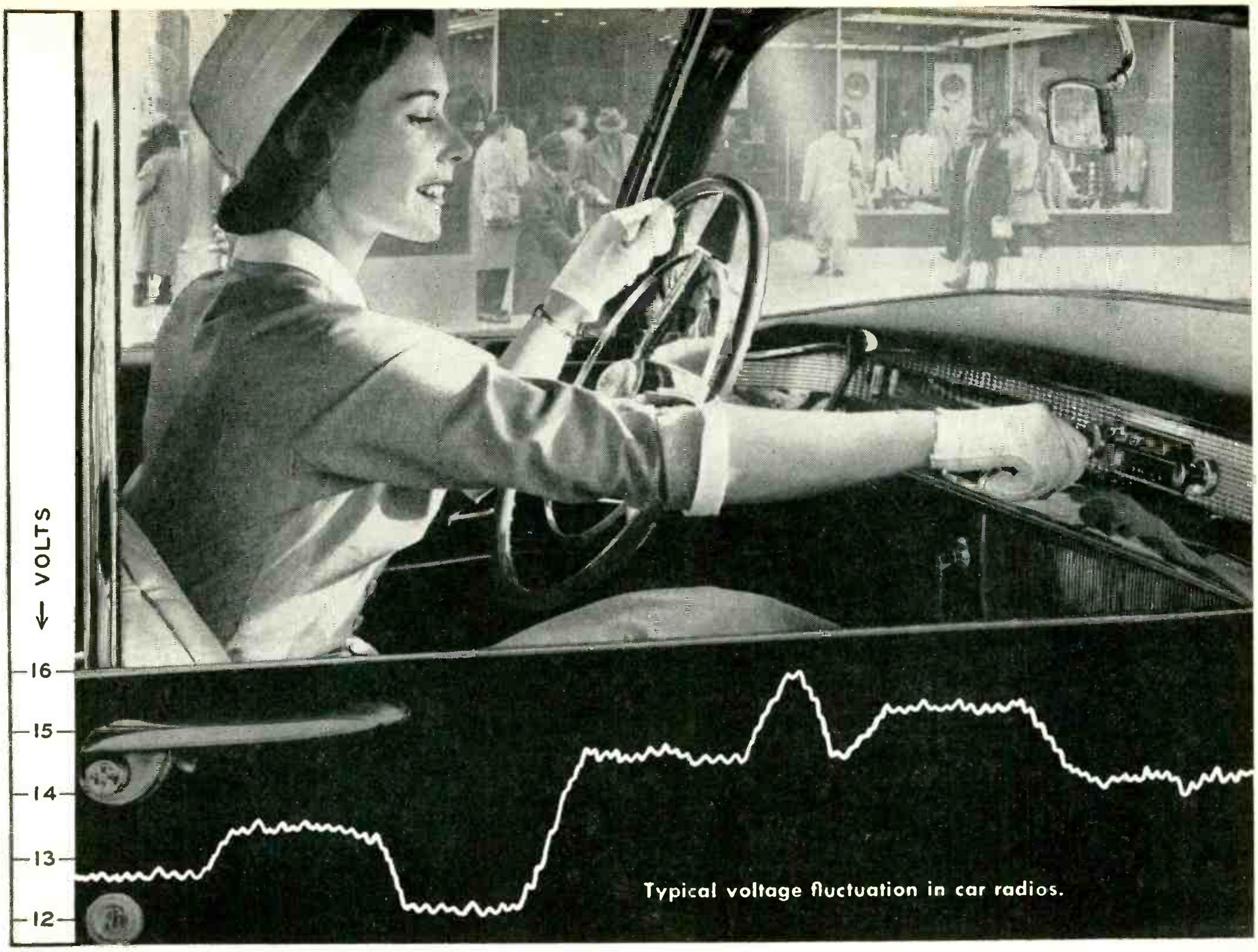
Bomac Laboratories Inc., Beverly, Mass. The 1N23D high sensitivity silicon diode can lower the overall system noise down to 7.5 db in a system with well-designed plumbing. It is designed for X-band mixer use in superheterodyne receivers where low overall noise and minimum conversion loss are required. 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-



Typical voltage fluctuation in car radios.

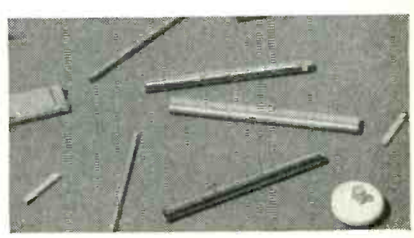
FOUND: a Cathode alloy that prolongs tube life under fluctuating voltage

CATHALOY* 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

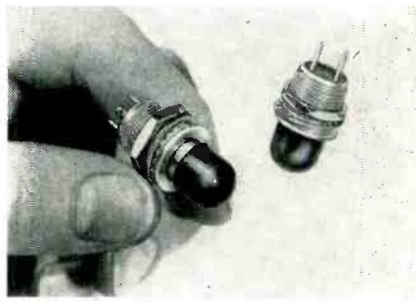
The big name in small tubing

NORRISTOWN, PA.

Want more information? Use post card on last page.

oratory 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

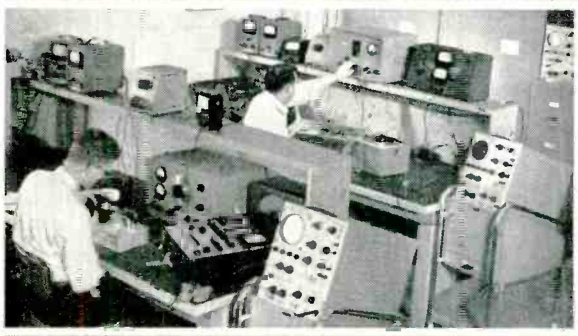
HETHERINGTON INC., Sharon Hill, Pa., has announced fully insulated, two-terminal indicator or warning lights in the smallest sizes consistent with the dependability required for aviation and critical industrial applications. They are available in two basic styles—series L660, a subminiature design measuring 1 15/64 in. long by 15/32 in. in diameter; and the L-3200, 1 9/32 in. long by ½ 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

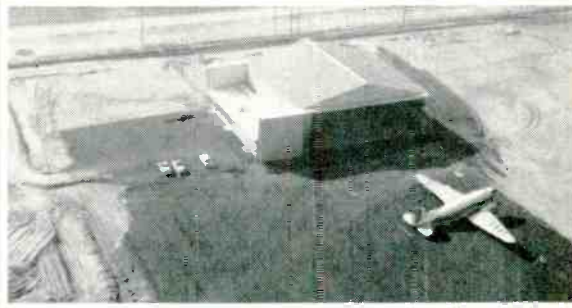
AIRBORNE ELECTRONICS
AND
WEAPON CONTROL SYSTEMS

Denver manufacturing plant now under design

Infrared laboratory



Instrumentation laboratory



Initial unit of flight test facility

Communications pilot line production

Simulators in computing center

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.

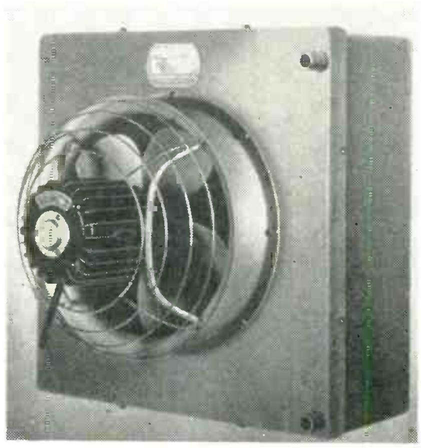
Good progress is being made in the establishment of facilities and operational patterns that are well tailored to the unique requirements of advanced electronic systems work.

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 throughout the entire periphery, thereby assuring maximum visibility from all angles. The heavy lens is over $\frac{13}{32}$ 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.

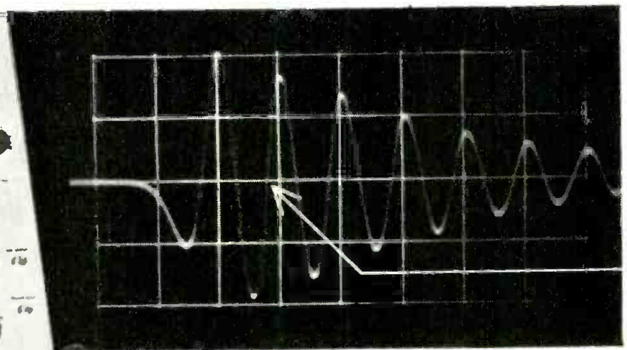
The fan motor is of the shaded-pole type and connects to a 1-phase, 115-v, 60-cps supply line. Catalog sheet 80201-1 is available.

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/μsec writing rate!



Arrow indicates 1100-cm/μsec writing-rate point on 100-mc damped oscillation, displayed on single 0.01 μsec/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.

Transient Response — Risetime seven millimicroseconds.
No overshoot or ringing.

Maximum Sensitivity — 0.05 v/cm.

Sweep Range — Eleven calibrated sweeps
from 0.01 μsec/cm to 20 μsec/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.

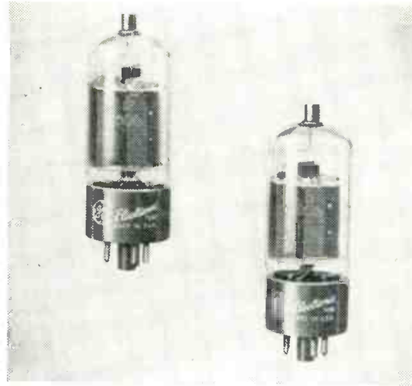
Calibrated Horizontal-Position Vernier

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

Want more information? Use post card on last page.



high-efficiency 90-deg deflection systems without the necessity of using an expensive deflection amplifier tube.

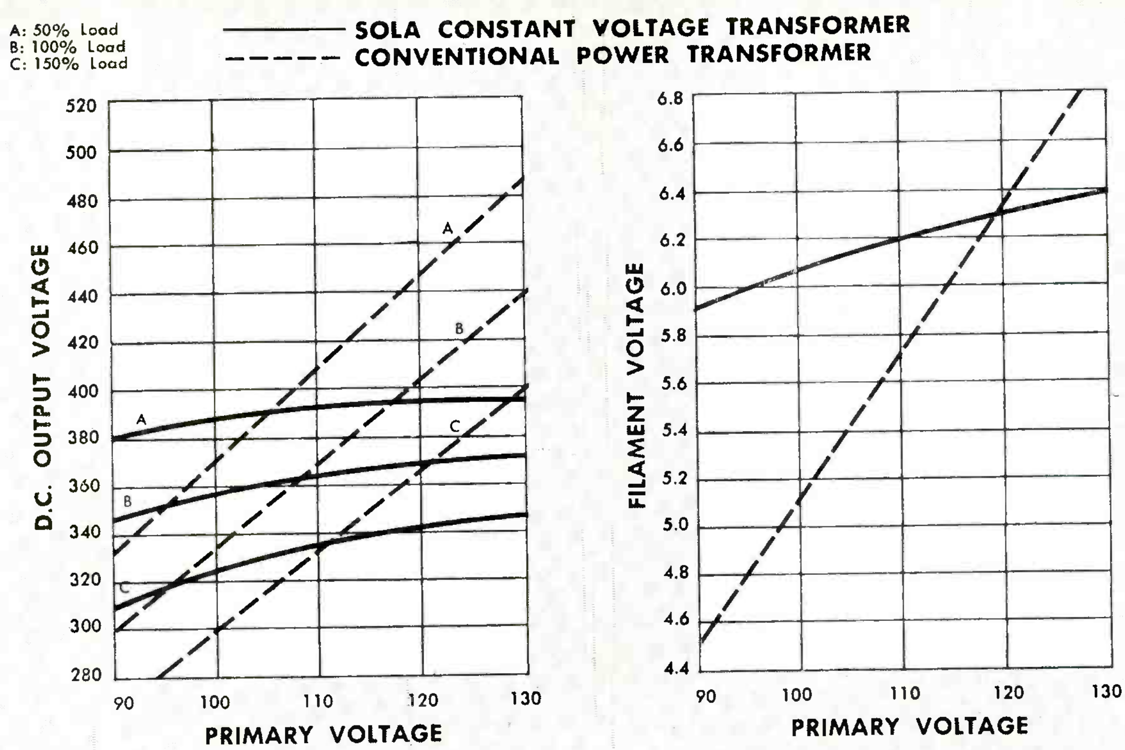
►**Other Technical Data**—They incorporate 6,000-v pulse capability, a 15-w dissipation rating and a large bulb for increased reliability. The 6DQ6 heater is rated at 6.3 v and 1.2 amperes. The 12DQ6 has a 12.6-v rating at 600-ma current with an 11-sec warmup time.

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 changeover 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-



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.

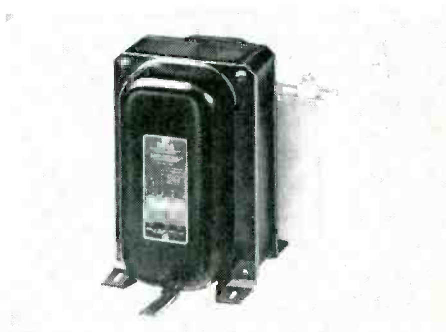
Improve Performance of electronic products with built-in regulating power transformer

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 ±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.

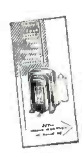
Three stock units (all with high voltage ct, 5.0v and 6.3v regulated windings) are stocked by your electronic distributor. You can order production quantities of special units manufactured to your specification. We invite your inquiry.

TYPICAL STOCK UNIT: Sola Electronic Power Transformers are made for chassis mounting. They are furnished complete with separate capacitors and capacitor mounting brackets.



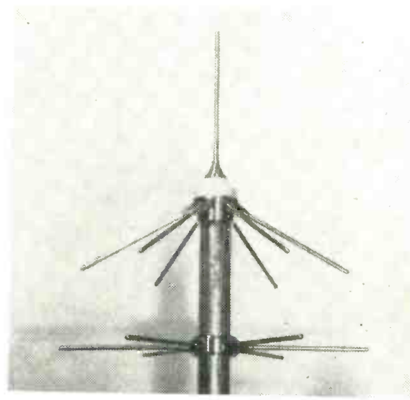
Automatic, Maintenance-Free Voltage Stabilization

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, Bishop 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* mounted it is $18\frac{1}{2}$ in. high by 13 in. wide by $8\frac{3}{4}$ in. deep overall. A rack unit is also available having dimensions of 19 in. by $8\frac{3}{4}$ 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 $1\frac{1}{4}$ 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-

Want more information? Use post card on last page.

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, 6⅝ in.; and depth, 3¾ 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 . . Spectograph tests . . chemical analyses . . Zyglo tests . . 13 tests in all to assure precise magnetic characteristics, sound structure, exact physical dimensions . . in short, to assure uniformity and high quality.

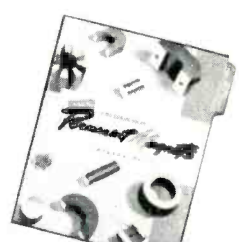
Maintaining the high quality of Indiana Permanent Magnets is not just a one-man or one-department responsibility. Teams of physicists, engineers, technicians and experienced craftsmen supervise and keep a constantly critical eye on all stages of production. Quality control is this group's most important 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 Philadephia, 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.

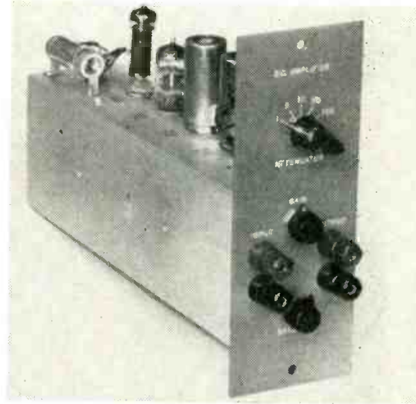


. . Manufacturers of permanent magnets for the electronics, electrical, instrument and communications industries

THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA
World's Largest Manufacturer of Permanent Magnets

INDIANA PERMANENT MAGNETS

dependability. Other ratings and pin connections remain the same as the 1B3-GT.



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.

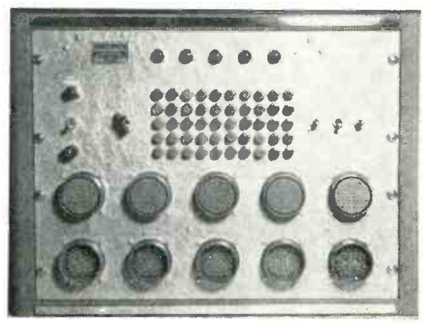
SERVO GEAR TRAIN
weighs only 6.875 oz

JOHN OSTER MFG. CO., Racine, Wisc., has available a new size 11 servo gear train weighing only 6.875 oz and consisting of a single

Want more information? Use post card on last page.

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.



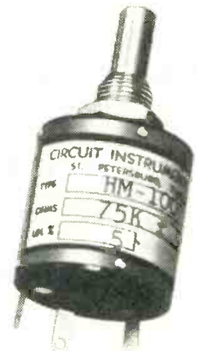
CONTINUITY TESTER
used on production lines

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

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.

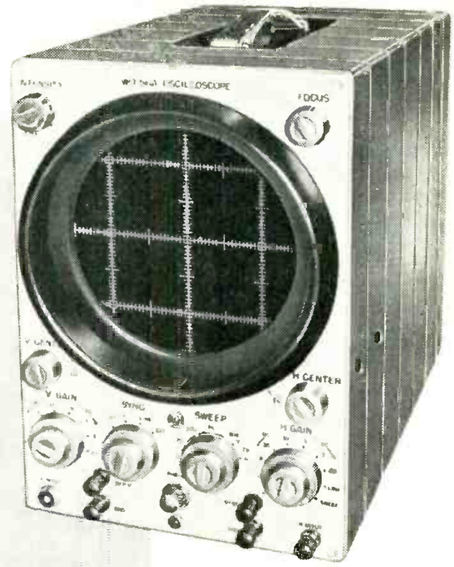
Exclusive Bellows-type contact with coil-spring action grip clasps board firmly over the entire printed circuit board contact area. It retains tension and allows use of

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 μμf input capacitance with probe.
Price **$169.50***

Identical "V" & "H" Amplifiers DIRECT-COUPLED 7" 'SCOPE, WO-56A

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 DUAL-BAND 5" 'SCOPE, WO-91A

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 DUAL-BAND 5" 'SCOPE, WO-78A

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***

CHOOSE FROM FOUR OF THE FINEST...

RCA OSCILLOSCOPES...

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, Section D-19-W, 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"

†volt/in. beam deflection measured at "V" amplifier input terminals.
*User Price (Optional). All instruments supplied with probes, cables, green graph screens, instruction booklets.

RCA®

TEST EQUIPMENT

Radio Corporation of America, Harrison, N. J.

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undersized or oversized board while maintaining low contact resistance.

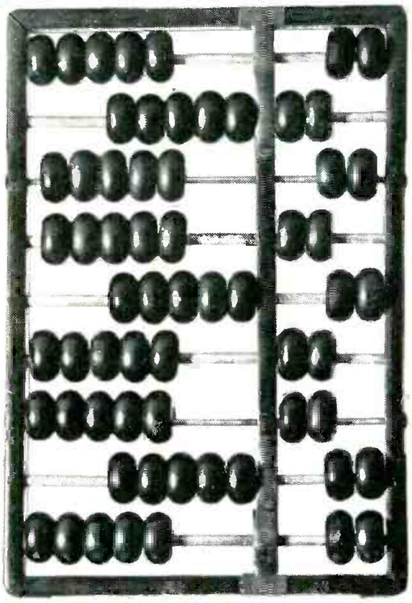
▶**Special Design**—The PCB20 printed circuit receptacle is a special design type with center mounting and two sets of five double row contacts. It accommodates two printed circuit boards, each with 10 connections.

These connectors can be supplied in mineral filled Melamine, Plaskon reinforced (glass) alkyd type 440A and Orlon 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



EARLY CHINESE ABACUS

The most powerful force known to science is that of a new idea.

Anon.

• If you, as an engineer, have a profound respect for new ideas

. . . if your search for them carries you beyond the arbitrary boundaries of your specific assignment

. . . and if, above all, you believe deeply in the irresistibility of the impact of ideas—

IBM's creative leadership in digital computer development, design and manufacture offers you a means to tremendous professional satisfaction.

For the specifics of the opportunity IBM offers you, write, outlining your background and interests, to:
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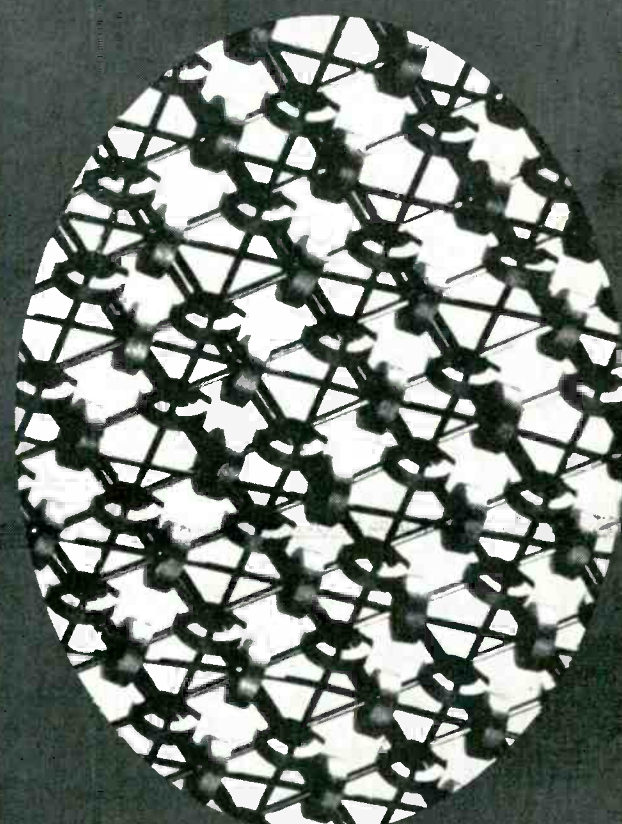

MODERN MAGNETIC CORE MEMORY

IBM®

INTERNATIONAL BUSINESS MACHINES CORPORATION

DATA PROCESSING · ELECTRIC TYPEWRITERS · TIME EQUIPMENT · MILITARY PRODUCTS

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achromatic objective lens with the eyepiece, and the outer black anodized felt-lined aluminum barrel for focusing.

A working distance of $4\frac{1}{4}$ 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 $7\frac{1}{2}$ in. long with outside diameter of $1\frac{1}{2}$ in.

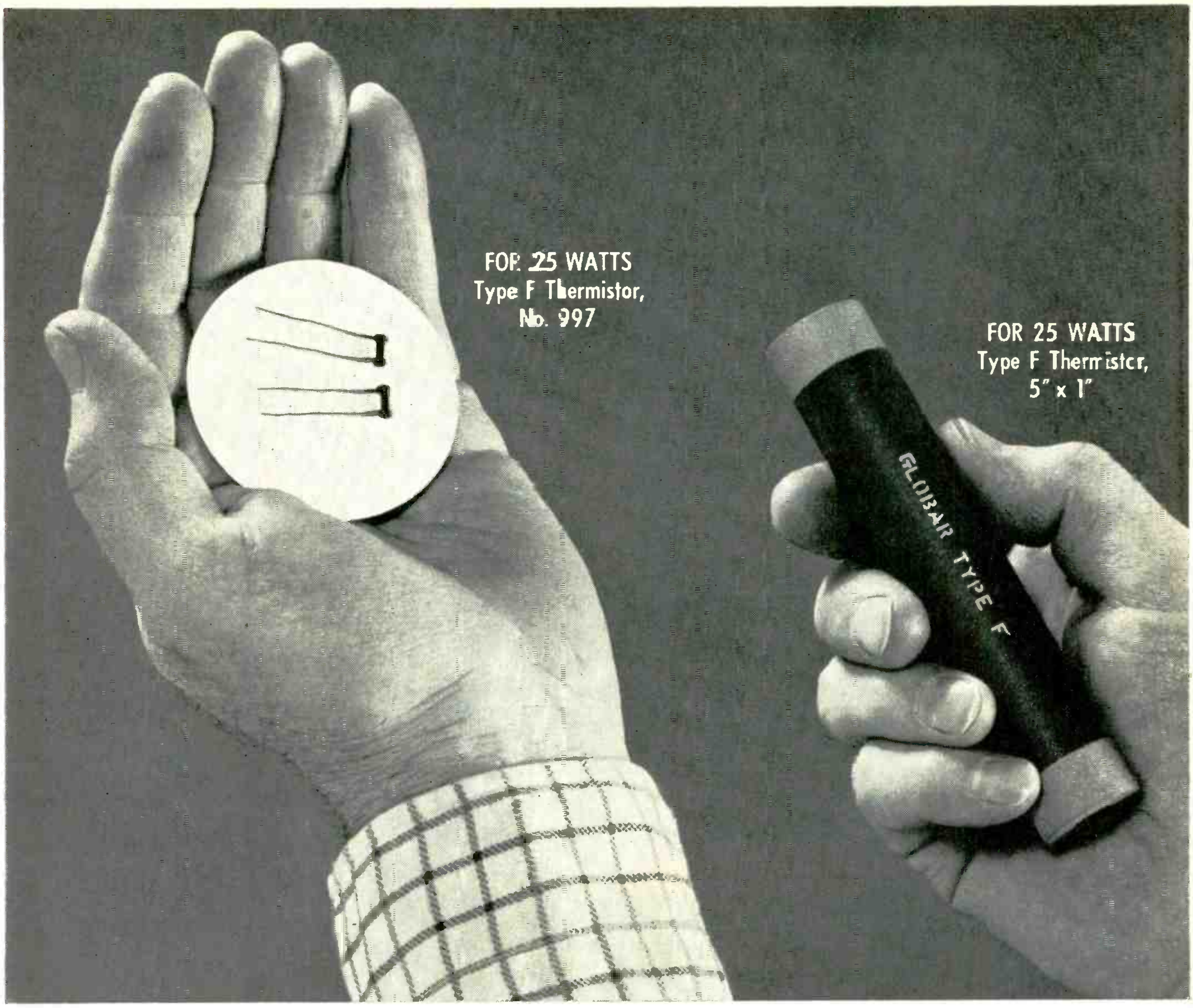
POST AMPLIFIER
for measuring noise figure

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 μa 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



Only **GLOBAR**® Ceramic Resistors can give you design **FLEXIBILITY** like this!

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.

FREE ENGINEERING BULLETIN gives detailed information on uses and specifications of all three types of GLOBAR® Thermistors — F, B and H. Ask for Bulletin GR-3 — and, if you have a circuit problem, send us the basic details. Our engineers will assist you, without obligation. Write The Carborundum Company, Dept. E 87-68, Niagara Falls, N. Y.

GLOBAR® Ceramic Resistors

by **CARBORUNDUM**

REGISTERED TRADE MARK

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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.

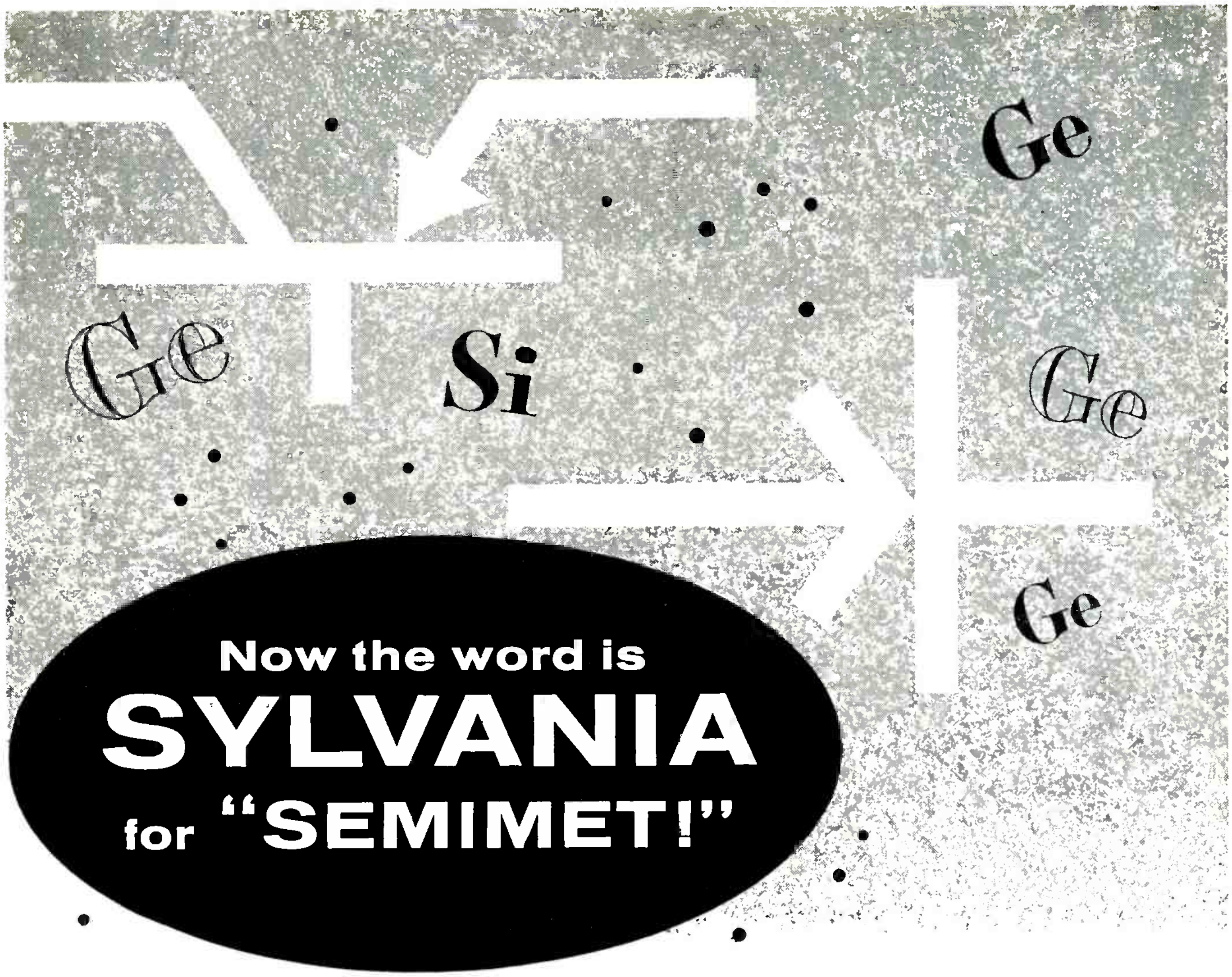
Printed Circuit Connector. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 2-color engineering data sheet on printed circuit 22-contact connector series 4 PCSC gives detailed description and specifications plus mounting and clearance dimensions. Write for technical bulletin 44C.

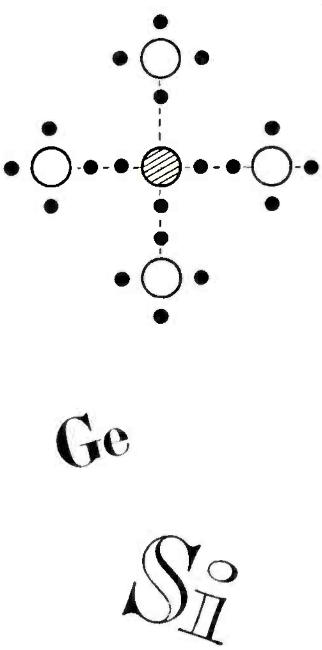
Variable Inductances. Superex Electronics Corp., 4-6 Radford Place, Yonkers, N. Y., has available a 4-page folder illustrating and describing a line of r-f chokes and coil forms. An industrial price schedule may also be had for the asking.

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 μf to 160μf, 1½ v dcw to 70 v dcw, and ⅛ 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





...your single source for both transistor-grade silicon and germanium

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.

Specifications for Sylvania germanium dioxide and semimetal include ingot as-reduced (guaranteed 5 ohm cm resistivity) and polycrystalline ingot (guaranteed minimum 30 ohm cm resistivity). Whichever grade you prefer, you can be sure of continuing high quality and uniformity when you order from Sylvania.

If you use semimetals in your products . . . or plan to in the future . . . write for technical specifications and quotations on Sylvania silicon and germanium. Remember, too, that our engineering staff is always ready to help you solve semimetal application problems.

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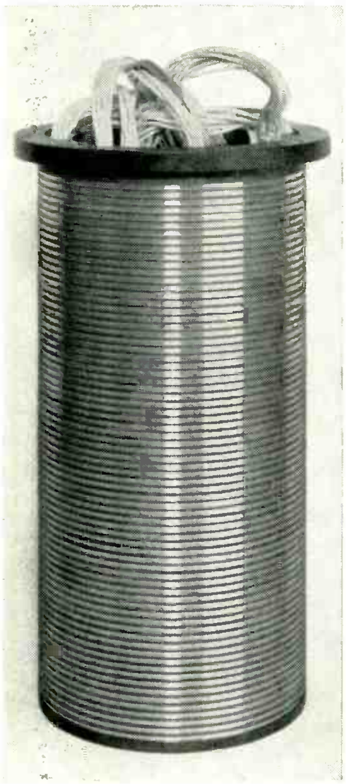

standards. Included are specifications, prices and information on optional equipment. Chief features and illustrations are shown.

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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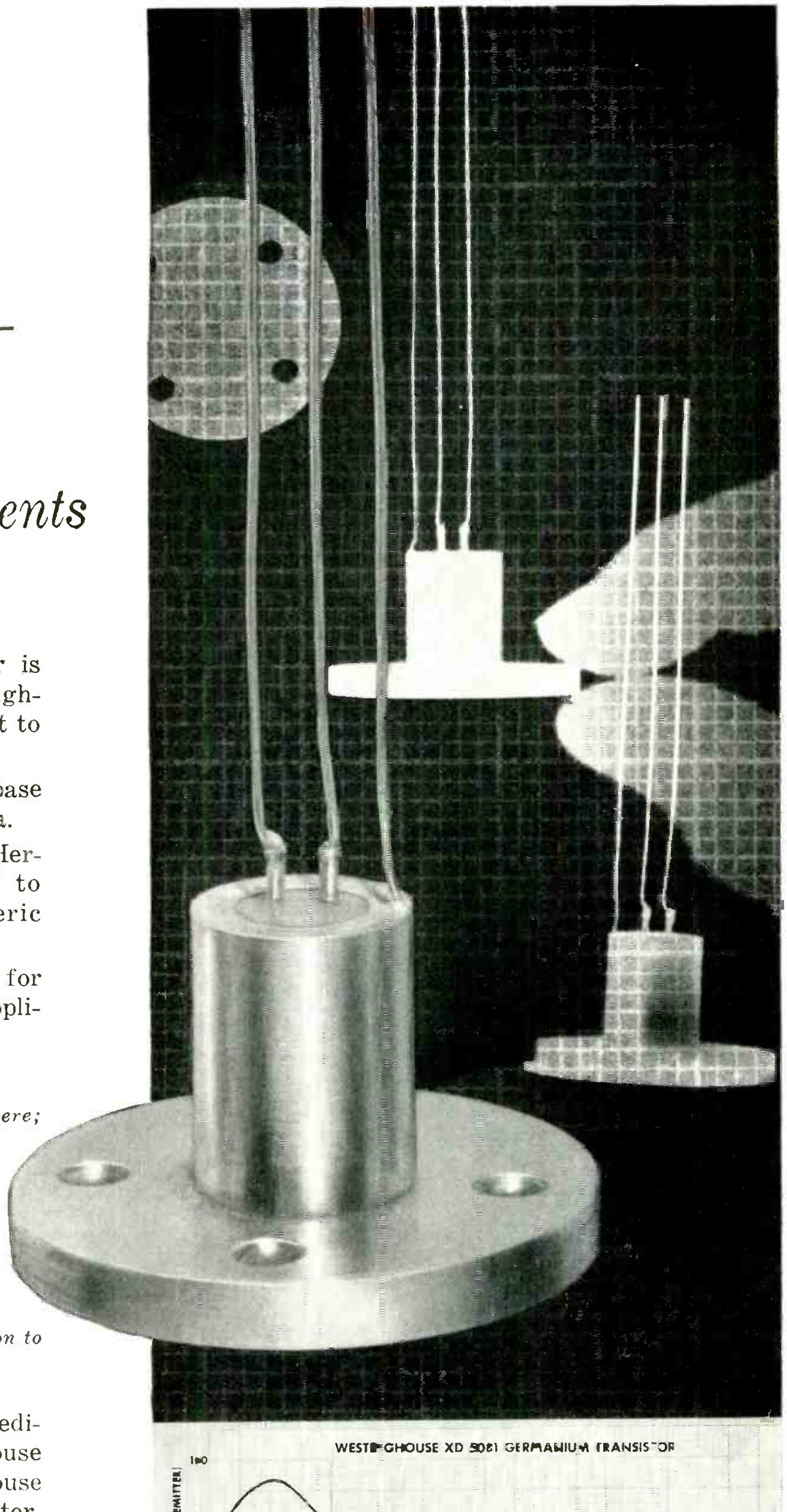
2-AMP GERMANIUM

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 Ic = 1 ampere; 55 at Ic = 2 amperes

Large signal frequency cutoff (common emitter) . . . >10 kc

Maximum voltage (Vce) . . . 35 volts

Maximum current (Ic) . . . 2 amperes

Saturation characteristic (Vce) . . . <1 volt at Ic = 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

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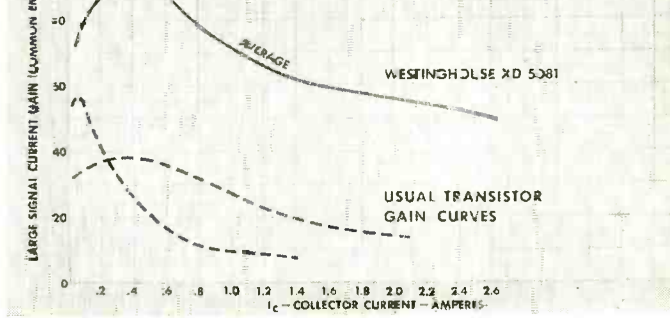
Westinghouse



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scribed and individually illustrated. The recorders' operations are concisely explained and complete technical specifications, recommended accessories, as well as direct factory prices are included.

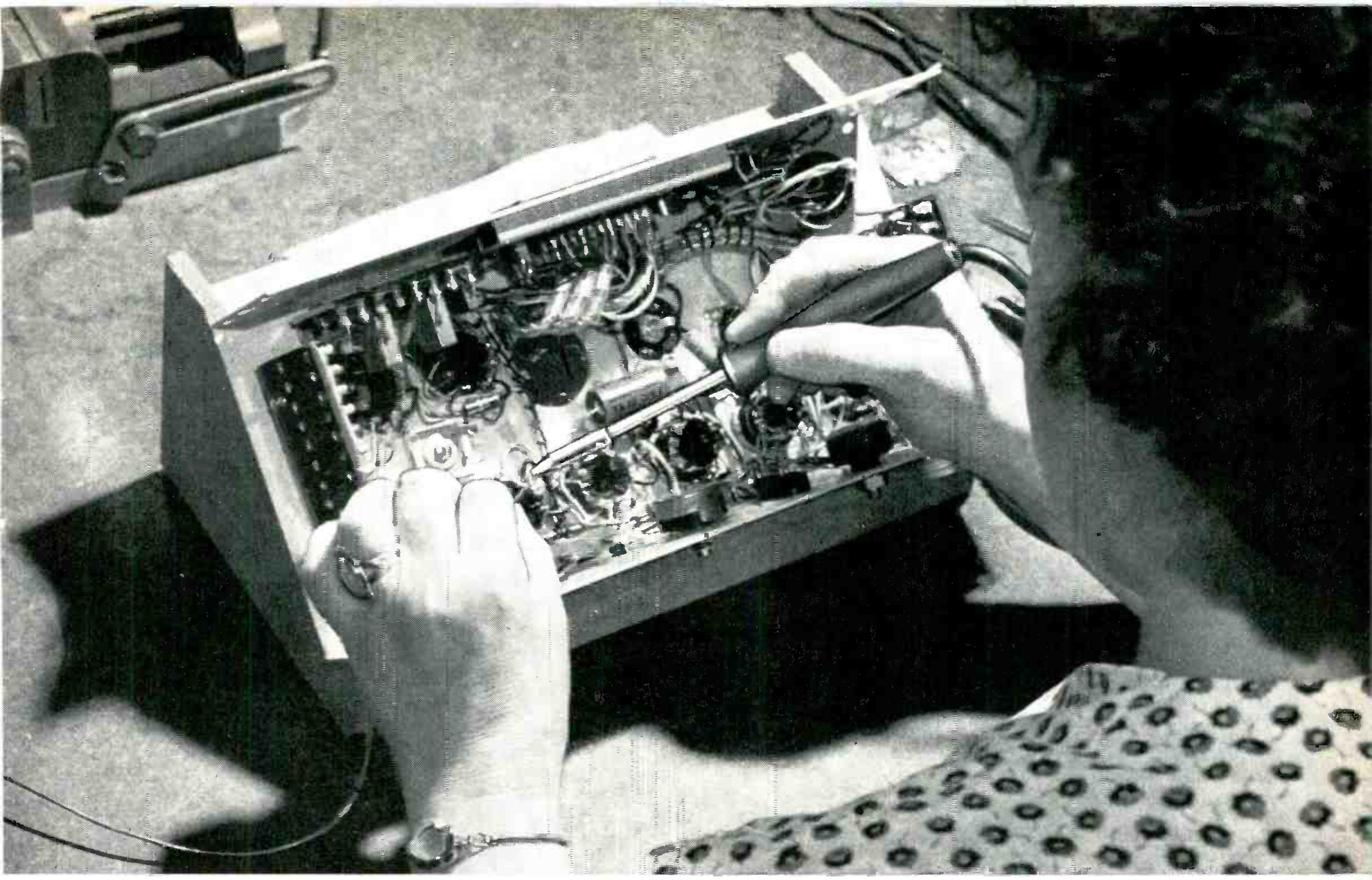
TWT Amplifiers. Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. Volume 7, No. 5 of the *Journal* covers new twt amplifiers which feature provision for simulating special microwave signals. The amplifiers described operate over the 4-8 and 7-12.4 kmc ranges with gains of 25 db or more and with 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 ± 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 Pkway, Pasadena, Calif. A 4-page folder covers type DB-715 precision, broad-band cavity wavemeters. Features, applications, description, specifications and ordering information are included.

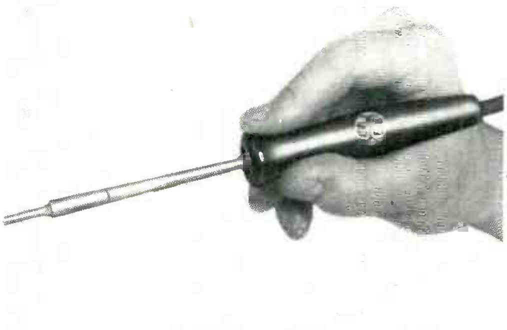
Analog Computer. Weber Aircraft Corp., 2820 Ontario St., Burbank, Calif. A 6-page folder fully illustrates and describes a low-cost general purpose analog computer which is complete within one basic unit. Applications and specifications are listed.

Connectors and Cable. Gulton 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-

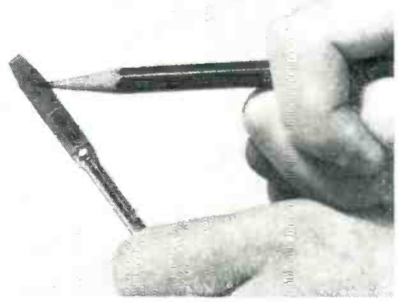


HARD-TO-REACH JOINTS in Sanborn Co.'s electro-cardiographs are soldered quickly with the fine-point G-E Midget iron—with no damage to adjacent parts. Weight of iron—less than 2 ounces—helped increase output by reducing operator fatigue. The Midget's ironclad-copper tip saves Sanborn ½ hour cleaning and 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 ⅛", ¼", $\frac{3}{16}$" 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

cupy 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.

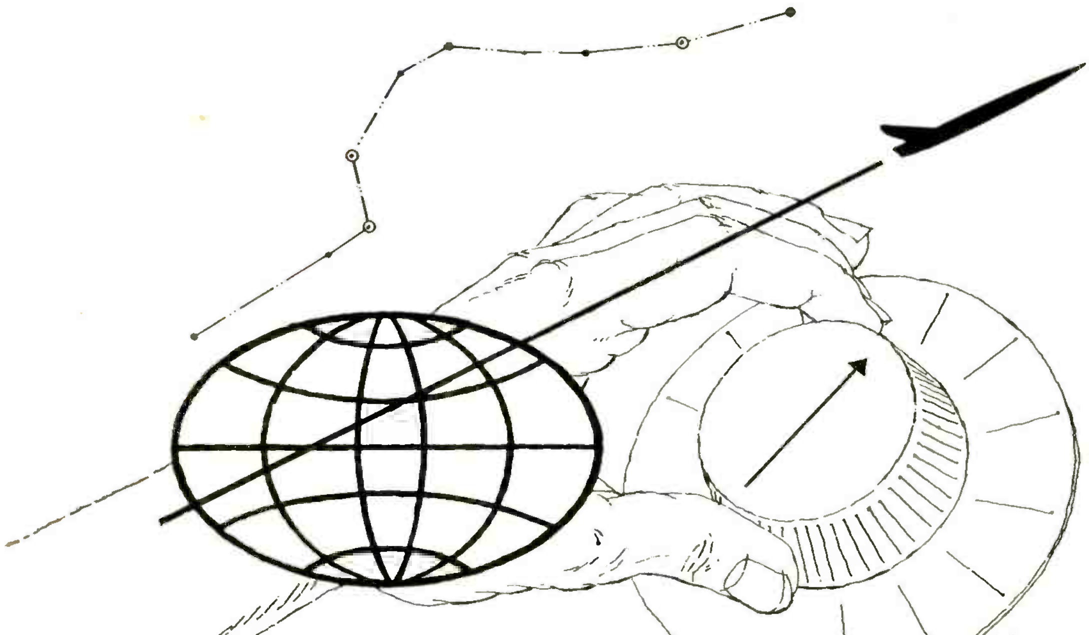
Silicon Junction Rectifiers. National Semiconductor Products, 930 Pitner Ave., Evanston, Ill. Bulletin TIB 22-55 covers high power silicon junction rectifier types NS-P1 and NS-P1R (reversed polarity version of NS-P1). Tentative ratings, mechanical and electrical data and physical characteristics are 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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IN TODAY'S ELECTRONIC ACHIEVEMENTS LIE TOMORROW'S CAREERS

Your work in advanced guidance and control systems and components at AUTONETICS today is excellent assurance of *long-range* opportunity. Problems like heat resistance, weight reduction and sub-miniaturization in electro-mechanical devices for missiles and manned aircraft have a direct application to non-military industry.

The work at AUTONETICS is challenging and professionally rewarding. Nearly 100 projects are now underway—most of which have not yet been printed in journals or texts. This diversity means good opportunity to find the field that is best for your particular talent, training and desires.

In developing and designing precision electro-mechanical equipment, you will use the finest digital and analog computers and other advanced research and test facilities at AUTONETICS.

In addition to all the physical advantages at AUTONETICS, you will welcome the professional attitude of your colleagues here. You can expect to be informed about your personal progress, have your ideas listened to.

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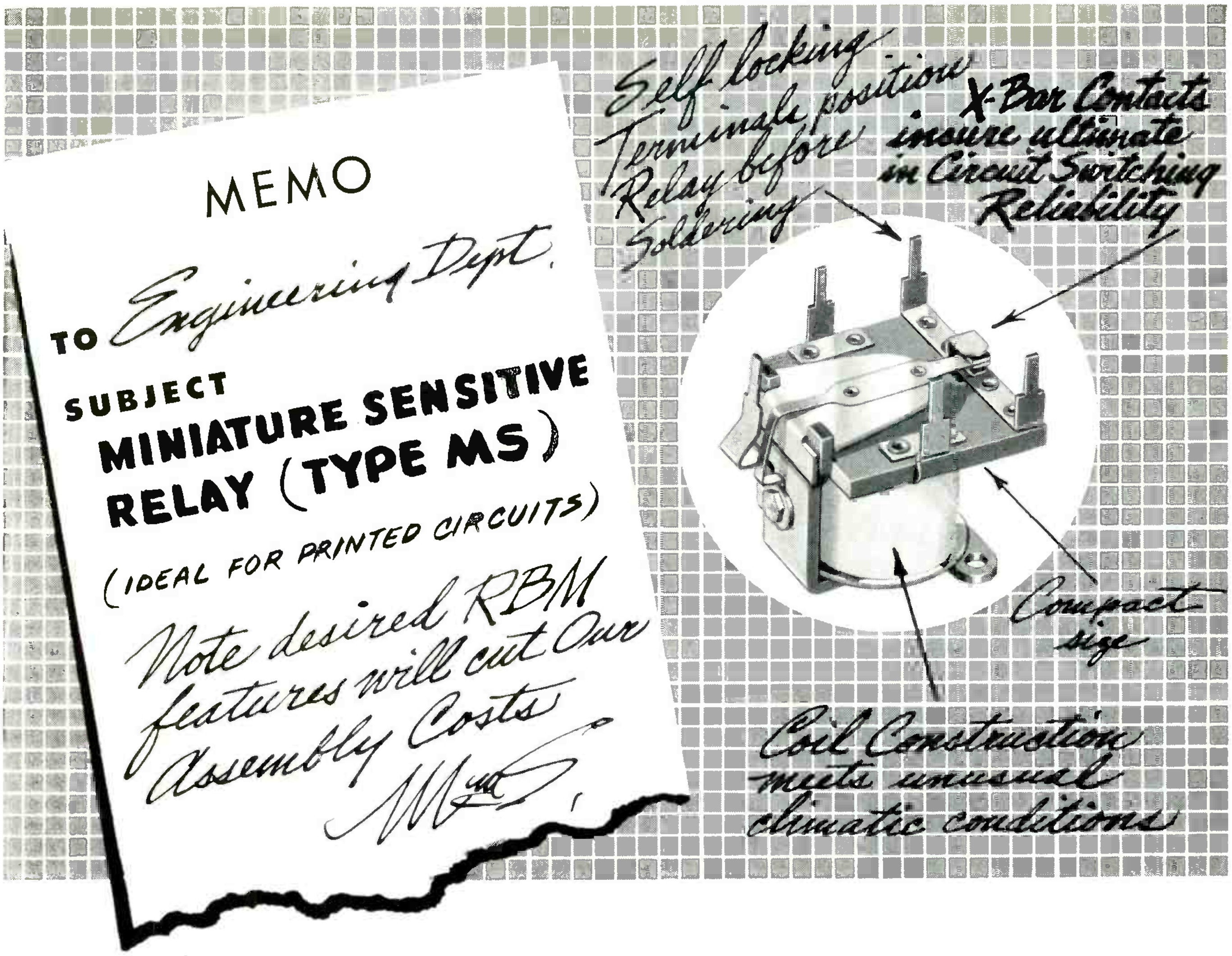
layed reset time delay relays, available for civilian and military requirements.

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



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.

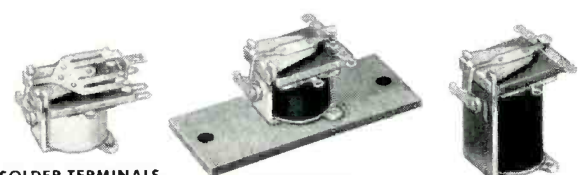
While not yet in production, extra-sensitive version has been developed. Maximum coil resistance 18,000 ohms, nominal sensitivity .030 watt, maximum sensitivity .020 watt, overall height 1-9/16″. All other details same as standard MS relay.

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	
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 1/16 x 1 1/32″

CORD SETS
WIRE HARNESSES
MAGNET WIRE
OTHER PRODUCTS

Send for Descriptive Bulletin MS-1

RBM DIVISION

ESSEX WIRE CORPORATION, *Logansport, Indiana*

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.

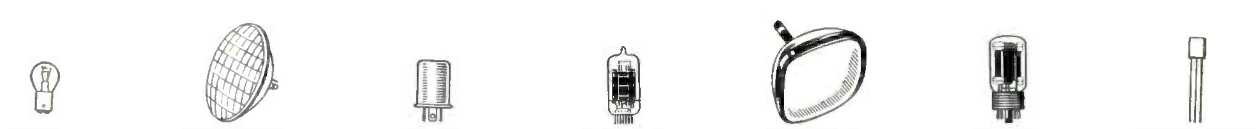
The illustrated, 3-color catalog consolidates an extensive variety of ceramic capacitors available to meet any precise applications. These include single and dual capacitance disks, tubulars, printed circuitry and automation disks, h-v slug types and special design types. The Tiny Mike line is also described.

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

TUNG-SOL ELECTRIC INC., Newark 4, N. J.

SALES OFFICES: ATLANTA, COLUMBUS, CULVER CITY, DALLAS, DENVER, DETROIT, MELROSE PARK (ILL.), NEWARK, SEATTLE



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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.

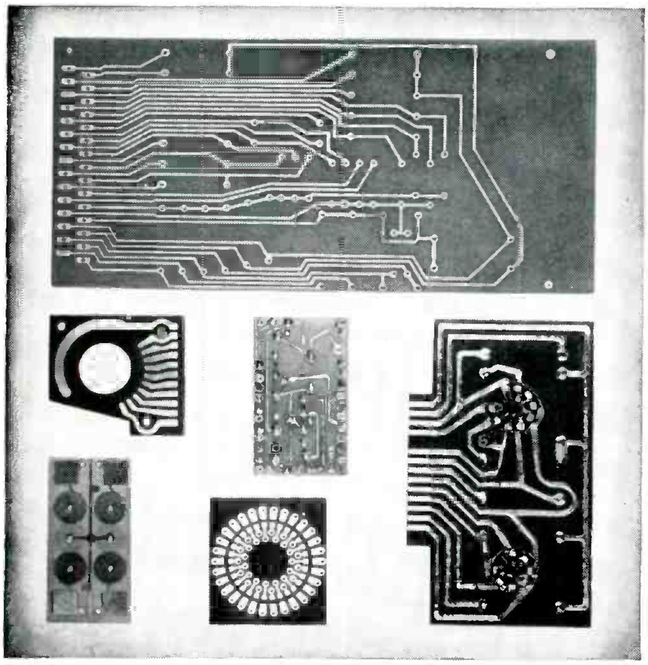
Alternators. Leece-Neville Co., 1374 E. 51st St., Cleveland 3, Ohio, has released 2 new 4-page folders illustrating and describing two new models of its standard line of alternators, models 5368-G3 and 5370-G6. Designed to replace d-c generators on passenger cars, light and medium trucks, school busses 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

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 laminate)	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

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the 1-μsec Helidel variable delay line that has a longer total delay than in the 0.2-μsec and 0.3-μsec units. Delay in the unit described is adjustable in increments of 0.04 millimicroseconds; rise time, 0.08 μsec maximum; frequency response, from 0 to 4.5 mc. Overshoot and phase distortion are negligible.

The 1-μsec 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.

Want more information? Use post card on last page.

Plants and People

Edited by WILLIAM G. ARNOLD

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.

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

▶ **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 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 of Raytheon and Sylvania and R. V. Jones.

William Shockley

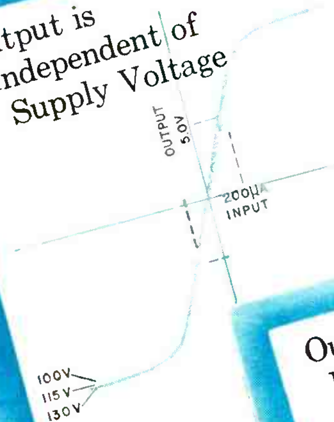
Quartered temporarily in Mountain View, Calif. the group will move into the new $500,000 research and development center Beckman is building in Stanford Industrial Park for its Spinco division and the Shockley Semiconductor Laboratory.

Completion of the facility is scheduled for August.

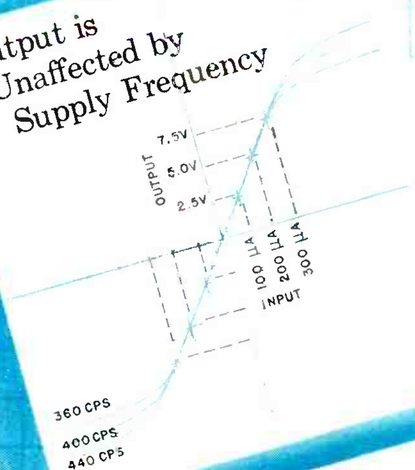
Dr. Shockley said that recent developments in physics and chemistry indicate great future expansion for semiconductors. "We have found corresponding phenomena in tran-

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 out-put) 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

AIRPAX

DESIGNERS ENGINEERS

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.

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.

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 factory building wing.

Frank Lloyd Wright, center, and president L. G. Erickson, right, and executive v-p K. E. Appert of Lenkurt Electric

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.

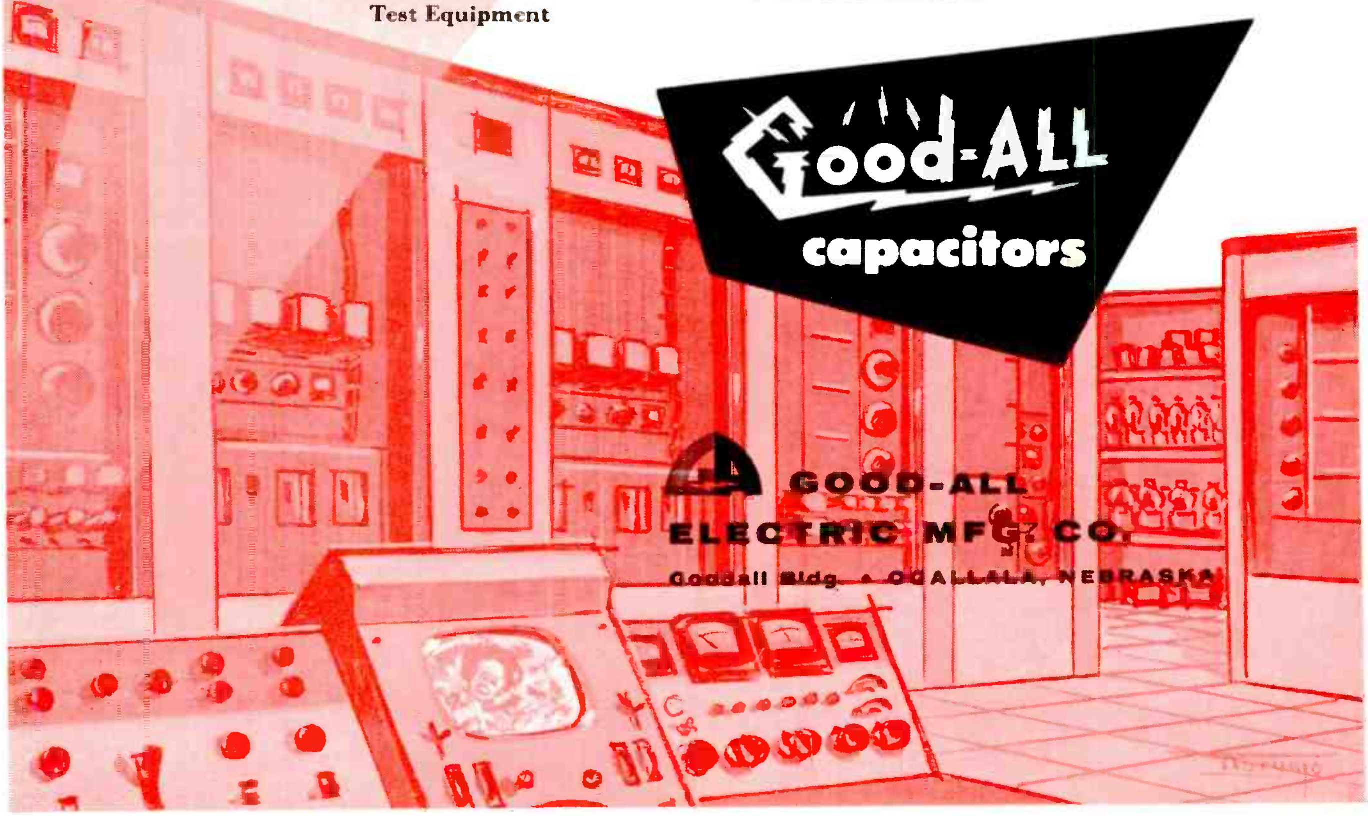
*DuPont's Trademark for Polyester Film

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
Electronic Control Systems
Guidance Systems
Critical TV Circuits
Test Equipment



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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 Sparton 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-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

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 ±10% line change or *any* load change will cause a reflector voltage change of only ±0.1%.

Compare . . . chances are that you'll send in your order for the PRD Type 809, too.

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
- Has electronic readjustment of reflector voltage when changing from cw to square wave modulation—no errors due to forgetfulness
- Has square wave, sawtooth and provision for external modulation for pulses
- Affords exceptional stability and regulation at modest cost
- Price $350.00 F.O.B. New York

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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.

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-Wooldridge 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-Wooldridge in the Los Angeles International Airport area total 300,000 sq ft.

Employment has grown from

Semiconductor engineers find new opportunities at Delco Radio!

Delco Radio, first organization to develop and use Hi-Power transistors for automotive application, now offers permanent employment opportunities to men of highest caliber.

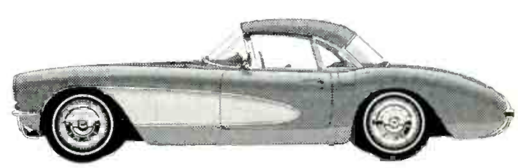
Some of these opportunities are for men experienced in solving problems of semiconductor processing, development, or application. Other positions exist for persons experienced in semiconductor or related research.

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.



GM GENERAL MOTORS

Delco Radio

DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA

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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.**
- **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.

How leading companies use this Brush instrumentation

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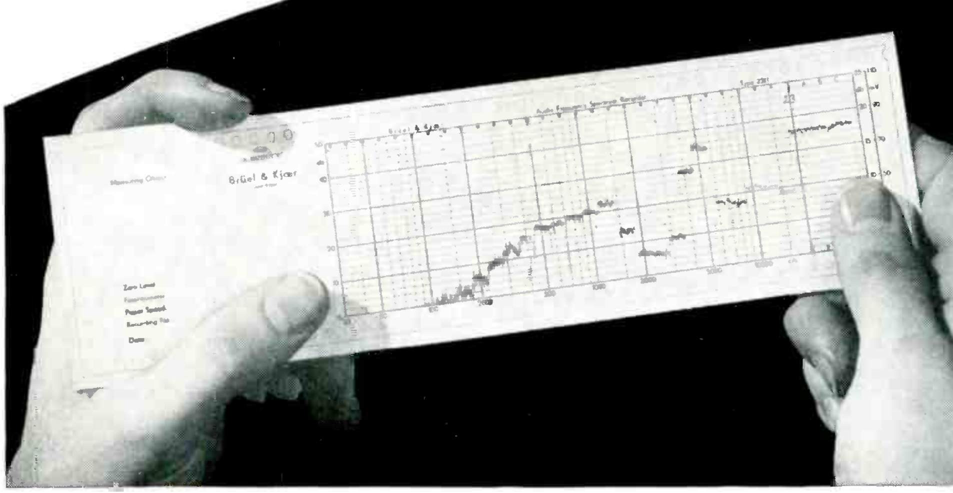
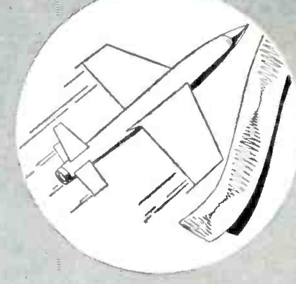
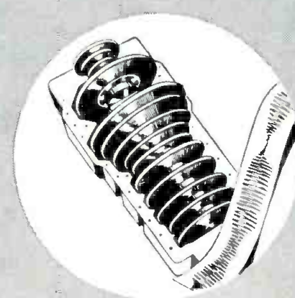
- **aircraft noise reduction**
- **accelerometer calibration**
- **missile testing**
- **jet engine noise measurements**
- **appliance noise reduction**
- **automotive vibration analysis**
- **tape recorder readout**
- **plant noise studies**
- **evaluating acoustic materials**

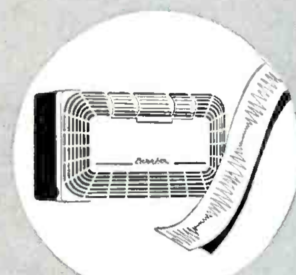




LOCKHEED. . . uses Spectrum Analyzer for data reduction of telemetered information . . . and to measure noise transmission through aircraft fuselage wall panels.



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 COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

BRUSH ELECTRONICS

Division of Clevite Corporation

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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 assembly 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

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 in Microwave Associates, of Boston. AB-PT previously was associated with Microwave and presently has a one-third interest in that company.

Technical Operations was formed in March, 1951. Its officers include three of the original founders: Dr. Frederick C. Henriques, Dr. Eric T. Clarke and Dr. Marvin G. Schorr.

Burroughs Appoints Engineering Director

Thomas M. Butler

THOMAS M. BUTLER has been appointed to the new post of director of engineering for Burroughs Corp. He was formerly chief development engineer.

He assumes responsibility for the administration of all engineering functions at the home office in Detroit. In addition he will be responsible for functional engineering coordination of product engineering in all divisions and subsidiaries.

Butler has been with the corporation for 37 years. He joined Burroughs in 1919 as a tool design apprentice under its apprentice program.

Chope Named Outstanding Engineer

WILBERT E. CHOPE, president of Industrial Nucleonics Corp. of Columbus, Ohio has been named the "Outstanding Young Electrical Engineer of 1955" by the jury of award of Eta Kappa Nu, electrical engineering honorary fraternity.

This award is made annually to an electrical engineer under 35 and 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.

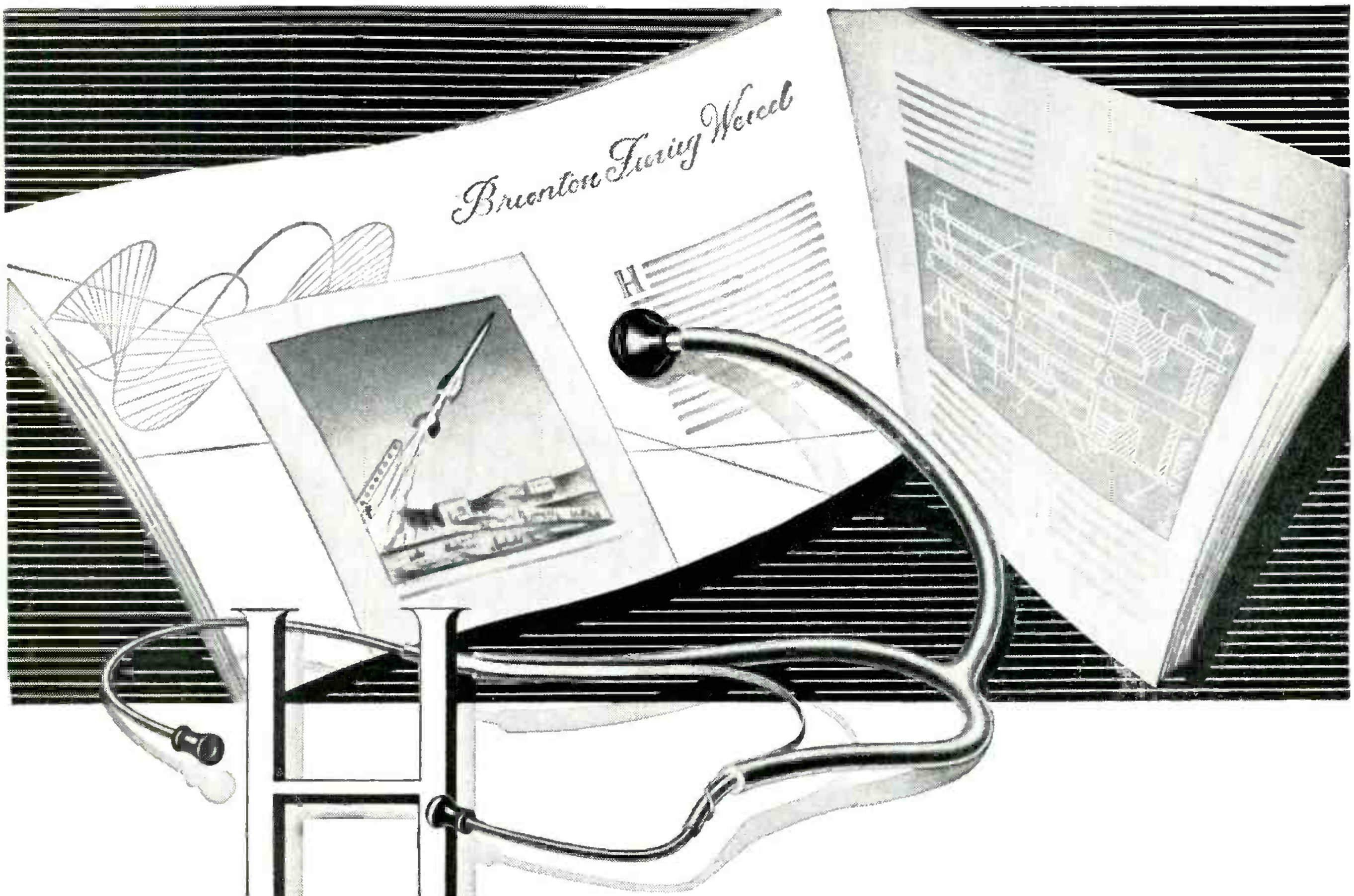
Prior to his appointment, Dr. Parker served for four years as assistant chief of the division's guidance section. He first joined the company in 1948.

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-



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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 autonetics 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 electromechanical 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.,

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 Appoints Two

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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 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. Looking on 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-

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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 Naylon, 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 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

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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 distribution 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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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. KLAASSE has been appointed chief engineer of American Instrument Co. of Silver Spring, Md., manufacturers of scientic 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. Westenhaver 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 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 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

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

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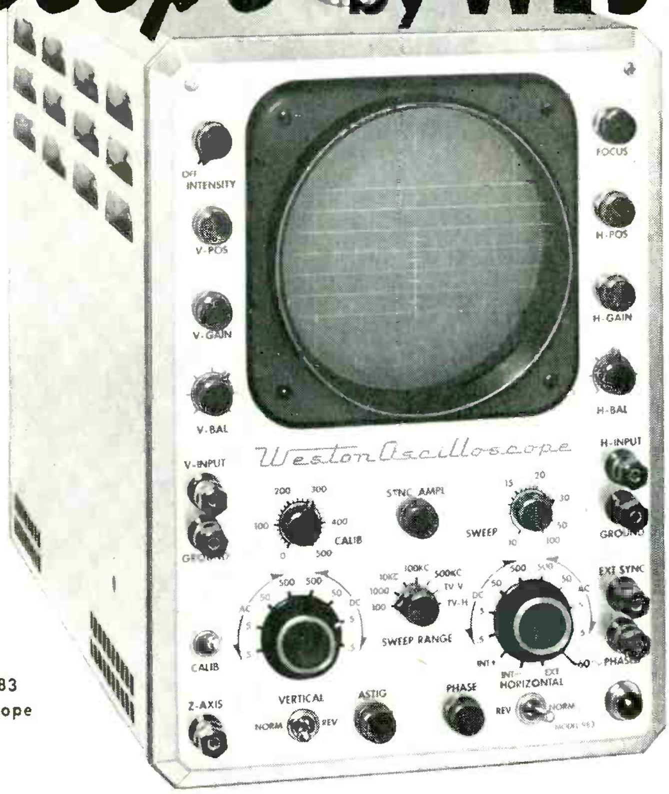


Weston
Model 983
Oscilloscope

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.

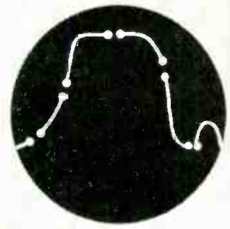
The 'scope contains identical vertical and horizontal push-pull amplifiers with a choice of AC or DC coupling without affecting either sensitivity or band width. Both amplifiers have compensated step attenuators and cathode follower input. *It has excellent square wave reproduction with overshoot of 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.

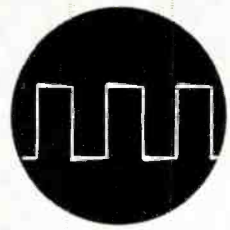
WESTON *Instruments*

WAVEFORM ANALYSIS



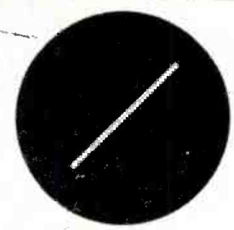
Response curves accurately displayed. Ideal for use with Weston intensity marker display. A fast, retrace sweep circuit with cathode follower output prevents pattern distortion.

SQUARE WAVE RESPONSE



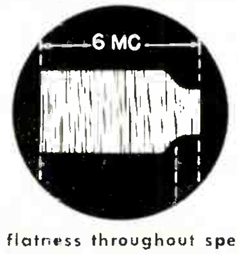
Overshoot is only 2 to 5%. Rise Time is 0.1 Microsecond. Square wave depicted 250 kc.

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.

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States from Germany in 1951. He was formerly chief engineer for Matawan Electronics Co., a subsidiary of Lavoi Laboratories, where he was responsible for the development of automatic calibrators and testors 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-Farnsworth.

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. Haeff, 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

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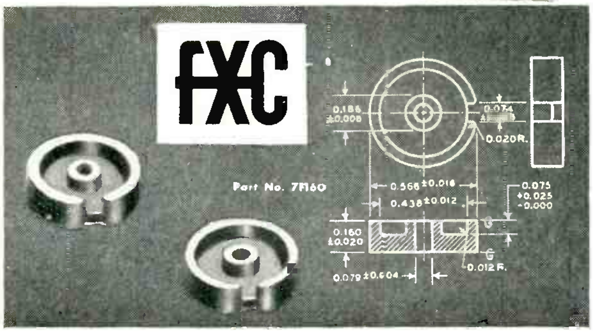

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This new, two-in-one instrument provides fast, easy measurement of inductance from zero to five and five to 180 henries, with superimposed d-c from one to 500 milliamperes, in inductors up to 750 ohms resistance. Accuracy ± 3%.

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1 Direct reading of inductance on large, balance-control dial calibrated for 60 - 400 - 1000 cps, and for use at any intermediate frequency.

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4 Continuous and independently adjustable control of a-c voltage, 0-135 v., and direct current supply, 0-500 ma.

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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.

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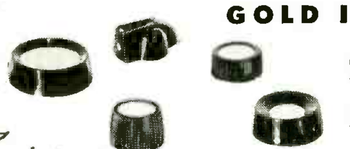

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director of the nuclear electronics division. Lichtman was head of the missile laboratory division of the Naval Ordnance Laboratory, Corona, Calif.

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 subminiature units designed specifically for transistorized and printed circuits.

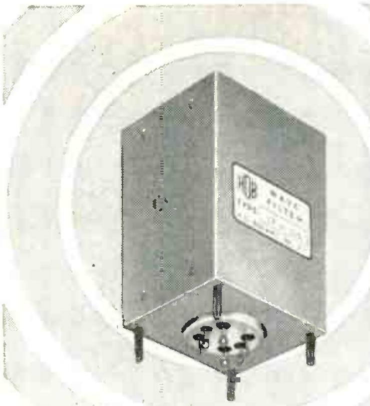
Steps are being taken to expand the firm's production facilities.

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



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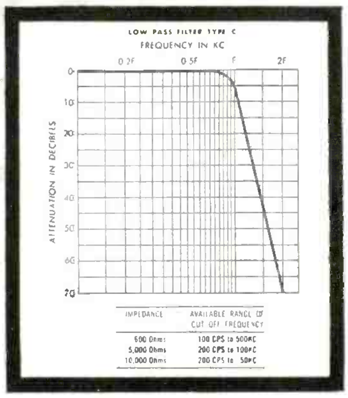

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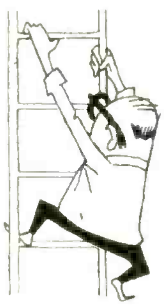

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If you're a qualified electronic engineer with ability, ambition, and imagination, your best chance for professional growth is with Electronic Engineering Company of California.

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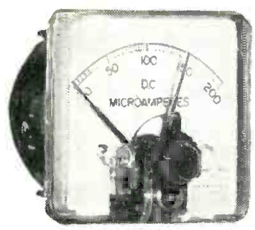
METER-RELAYS

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 circuits 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.

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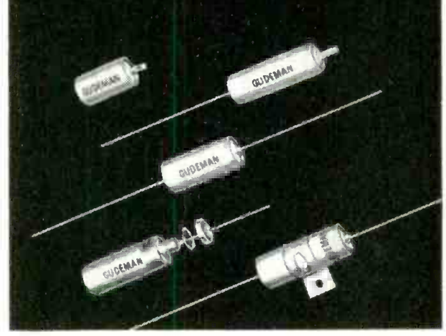
NEW "XC" PLASTIC FILM DIELECTRIC CAPACITORS

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
- Size Range 3/16" to 3/8" diameter ½" to 1" long
- Capacity Range: 1 MFD to 100 MFD
- Voltage Range: 3 V.D.C. to 50 V.D.C.
- Operating Temperature: 65°C.
- Hermetically Sealed
- 99.99% Purity Foil
- Low Leakage Current
- Low Equivalent Series Resistance

THE GUDEMAN CO.
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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

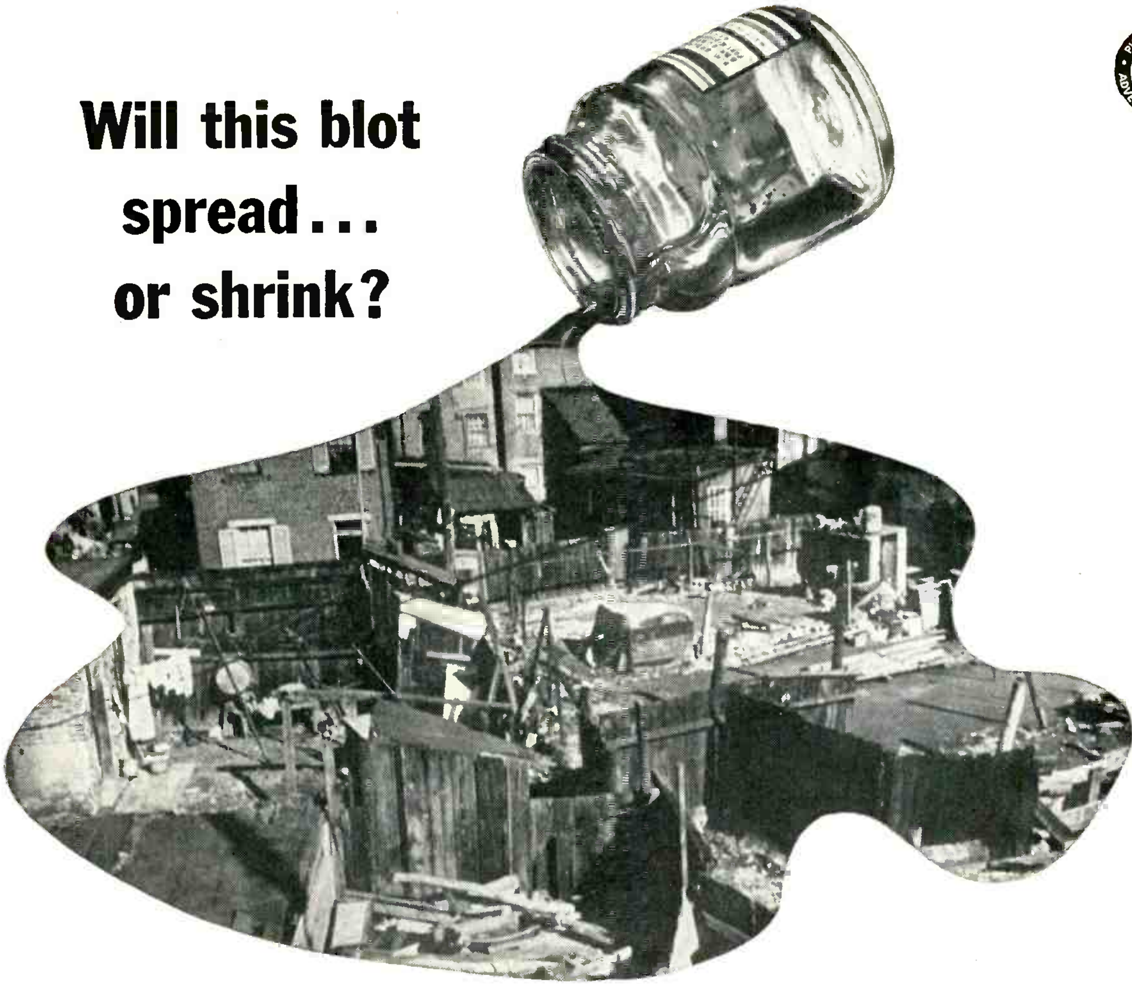
HELI-COIL CORP. of Danbury, Conn., manufacturers of wire thread inserts, purchased the entire manufacturing facilities of the Towle and Son Co. of Conshohocken, Penna., precision manufacturers in the aircraft and electronic fields.

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

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.

ACTION

American Council To Improve Our Neighborhoods

Electronics & Machine designs and manufactures standard and special types of r-f co-axial connectors.

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-

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-

Want more information? Use post card on last page.

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

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.

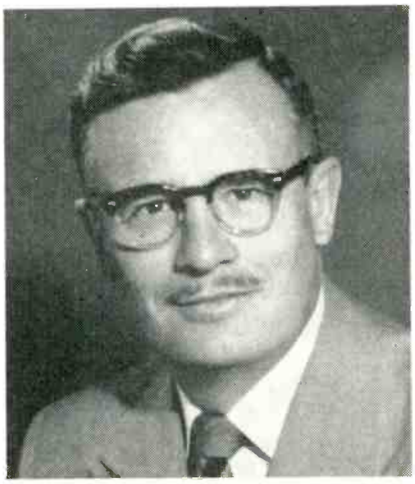
Oldenburg will continue in charge of the electronic and data-

 Want more information? Use post card on last page.

handling equipment department and Scozzafava of the business machines 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 Electrodynamics Corp. has established an advanced electronic data laboratory.

The lab will undertake development 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 assistant director of engineering for Consolidated.

He joined Consolidated in 1945 as chief electrical engineer. Previously, he had held engineering positions with Litton Engineering, Hewlett-Packard and GE.

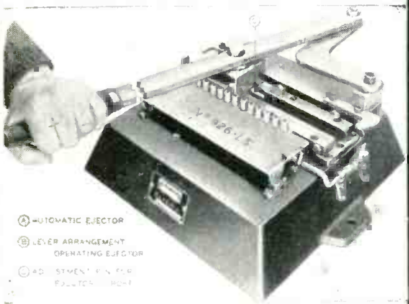
General Controls Acquires Division

GENERAL CONTROLS Co. of Glendale, Calif., acquired the precision potentiometer division of Electro Circuits of Pasadena.

The new division is to operate as an independent unit with all Electro personnel continuing with

MARK 12 CAPS at one time with this machine

To meet the need for a small bench style marking machine that would provide quantity production at a specific point in an assembly line, this machine was developed.



Ask for literature and prices of the ACROMARK Model 926-LS Machine and send our Engineers a blue print or sample of parts marking you need for their recommendation of proper equipment.

The ACROMARK Company

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"The Original Marking Specialists"

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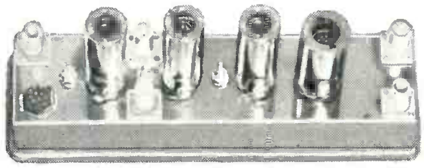

IF-31

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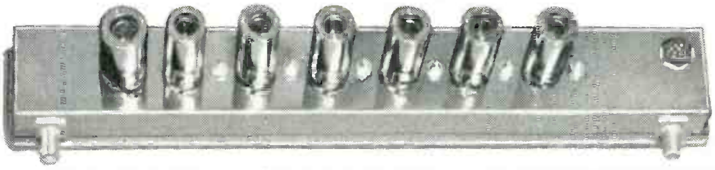
Frequencies: 5 to 100 MC & Higher

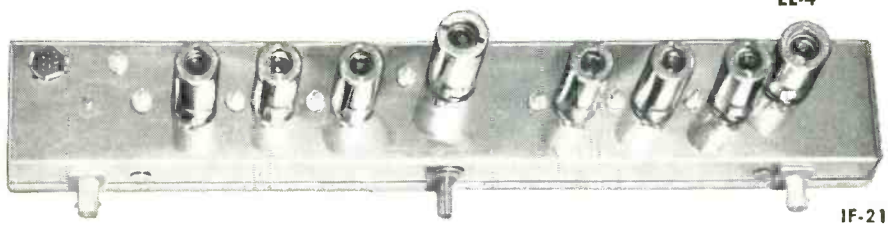
Write for literature and quantity prices —or submit specifications for units to meet your specific application.



IF-30

FULL DETAILS Catalog EL-4

• STANDARD • MINIATURE • SUBMINIATURE •



IF-21

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- Improved Socket Contacts — 4 individual flexing surfaces. Positive contact over practically their entire length.
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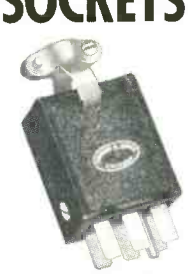
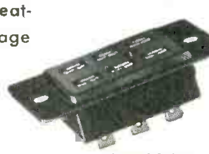
- Interchangeable with 400 Series.



P-2406-CCT



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Send for complete Catalog No. 20. Plugs, Sockets, Terminal Strips.

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SUBSIDIARY OF UNITED-CARR FASTENER CORP.

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  To permit easy winding of Potentiometers and Coils.
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  Platinum Content provides unsurpassed resistance to corrosion . . long shelf life.
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  of Electrical Characteristics. Available Bare or Enameled as small as .0004" diameter to as large as required. Resistance to 2500 ohms/ft.

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SINCE 1901

SIGMUND COHN CORP.

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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.

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

STAVOLT POWER RECTIFIERS

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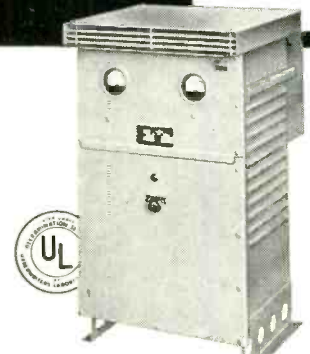

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- For Factories and Labs

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15 to 1500 amps

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save time . . .
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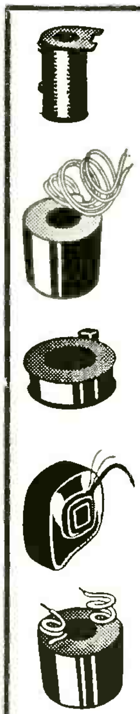

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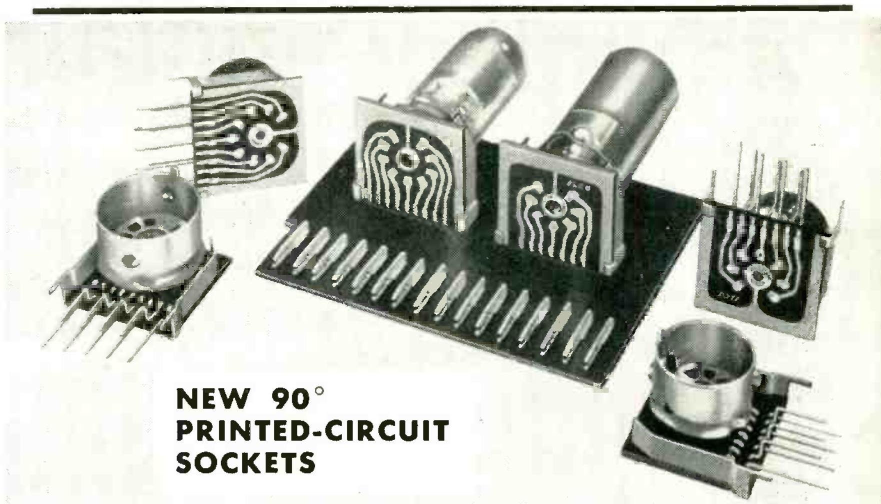


NEW 90° PRINTED-CIRCUIT SOCKETS

Newsworthy and newsmaking are Elco's new 90° Printed Circuit Sockets for 7-pin and 9-pin miniature tubes. These Elco quality components permit installation of the tubes in a position parallel to the printed-circuit chassis, thus conserving space where height is limited. The new sockets carry the same characteristics as standard miniature tube sockets. Furthermore, mounting brackets are designed to maintain rigidity and cannot be loosened from the chassis. For further information, please address your inquiry on your company's letterhead.

ELCO CORPORATION, M STREET BELOW ERIE, PHILA. 24, PA., CU 9-5500

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 electromechanical 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.

New Books

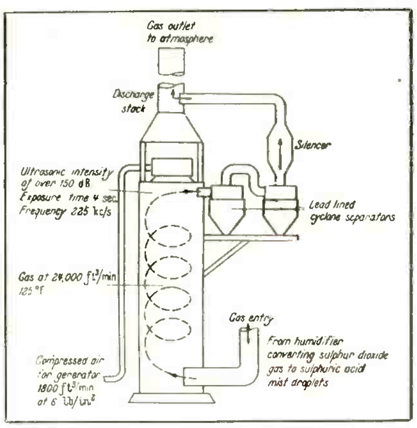
Ultrasonic Engineering

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 ultrasonic 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

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Expansive "Downtown" facilities, plus the convenience of modern suburban shopping centers. Well planned home developments and individual homes, built to meet any desired budget.

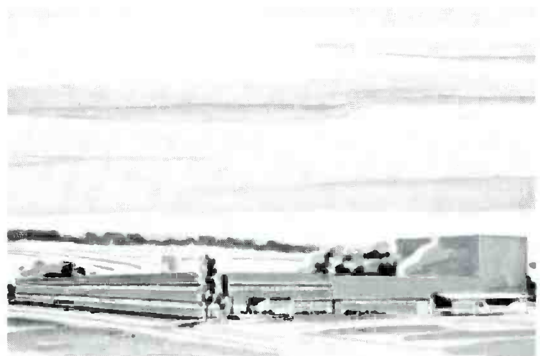
FOR YOU:

At the Baltimore Divisions of Westinghouse . . . Liberal relocation allowances, advanced education at Company expense, excellent employee benefits, interesting projects in association with recognized leaders in the industry, together with truly *unlimited opportunity*.

This is Westinghouse in Baltimore

AIR ARM DIVISION:

Pioneer in airborne electronics, developer of the world's *first* automatic electronic airborne fire control system. Today's advanced projects will win still more respect for this outstanding division . . . and *you* can share in its future!



ELECTRONICS DIVISION:

Chief supplier of transmitting and radar equipment for the Navy during World War II, this division is today engaged in challenging projects covering the entire scope of ship and landborne electronic equipment. At this writing, work is progressing on the construction of an ultra-modern plant to house advanced military electronics projects.

Westinghouse Baltimore Divisions are proud of their achievements in electronics, and proud, too, of the men who have made them possible. The past success of the Divisions offers to all qualified engineers an assured future . . . in the most modern of plant facilities, and with an established *leader* of the electronics industry.

Visit us during your VACATION

Because Maryland *is* a state of scenic, recreational and historical importance, you and your family would enjoy a summer vacation in this area. We will be happy to forward an illustrated historical map of the State upon request.

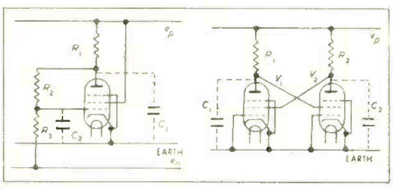
Better yet, send us your resume *now* . . . so that a convenient interview may be arranged during your vacation. Naturally, we *would expect to reimburse you for reasonable expenses incurred between your home and Baltimore.*

electrical engineers.

The first third of the book is devoted to the mathematics basic to stability analysis, with chapters on a-c circuit analysis, Laplace transforms, and examples of transform analysis.

The middle section, of five chapters, is devoted to amplifier analysis and design, with detailed descriptions of the design and stabilization of biasing and coupling circuits for vacuum-tube feedback amplifiers. Primary emphasis is on the gain-phase analysis, and the discussion leads to a presentation of common stabilizing networks.

▶ **Circuits**—The final section of the book includes discussions of a number of typical, linear feedback amplifier circuits, particularly drawn from the field of nuclear instrumentation, but of rather general interest. Circuits discussed include the cathode follower, various operational amplifiers (in considerable detail), a current amplifier for an ionization gage, a pulse amplifier as used in counting instruments, an audio amplifier with transformer-speaker load, and several electronically regulated power supplies.



The stability of feedback systems. Two lags, negative feedback; two lags, positive feedback

▶ **Theory**—The middle chapters represent the core of the design theory, as the author presents the concept of Nyquist diagrams and then turns to gain and phase plots. The gain-phase relations are discussed, the limitations on gain and phase are considered, and the stabilization problem is presented largely in terms of the gain-phase plots.

The discussion of theory is consistently clear and presented in terms of concrete, easily followed examples. Thus, although the theoretical development only rarely goes beyond and usually does not go as far as Bode's bible in the field, the 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 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 compostion 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 reviewer 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 hyperfine 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 impressive, producing a book that is both timely and likely to remain a standard work for some time to come.

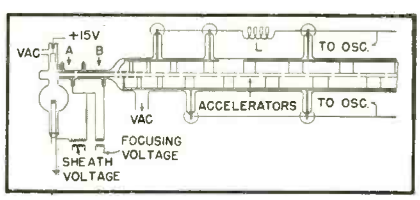
C. H. Townes is Professor of Physics at Columbia University, and A. L. Schawlow, formerly also associated with Columbia, is a member of the staff of the Bell Telephone Laboratories. They are to be commended for undertaking to write such a major work, and to be congratulated as to the extent of their 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 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, scalers 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, bevatrons 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 eletronic 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 defination 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 information 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 Hocvakuumtechnik Technologie der Elektronenrochren. 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.

Backtalk

Tubes Plus Diodes

DEAR SIRS:

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

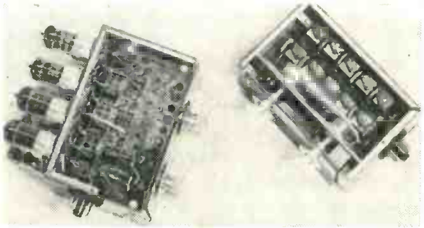
DEAR SIRS:

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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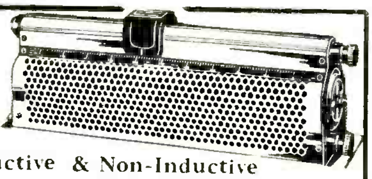

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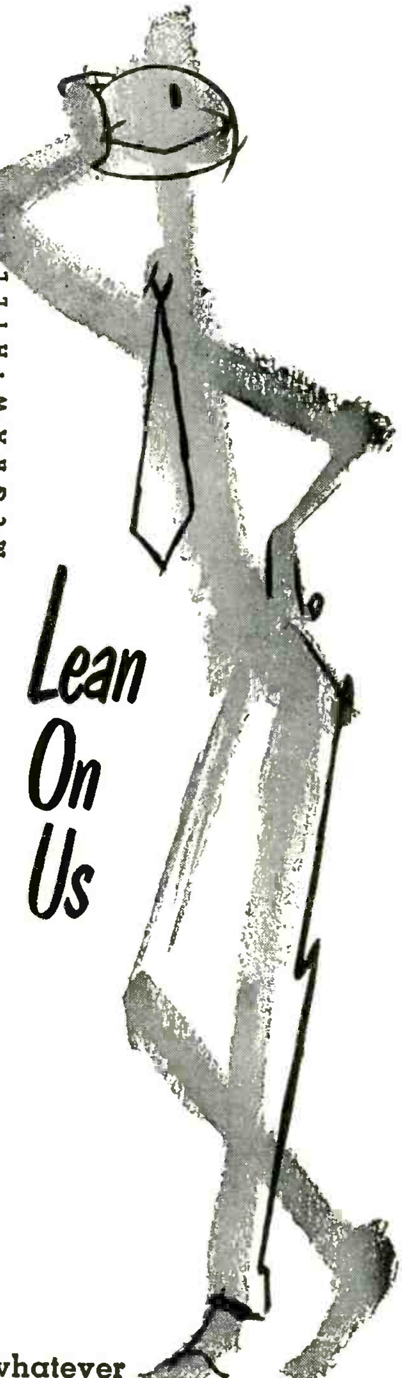

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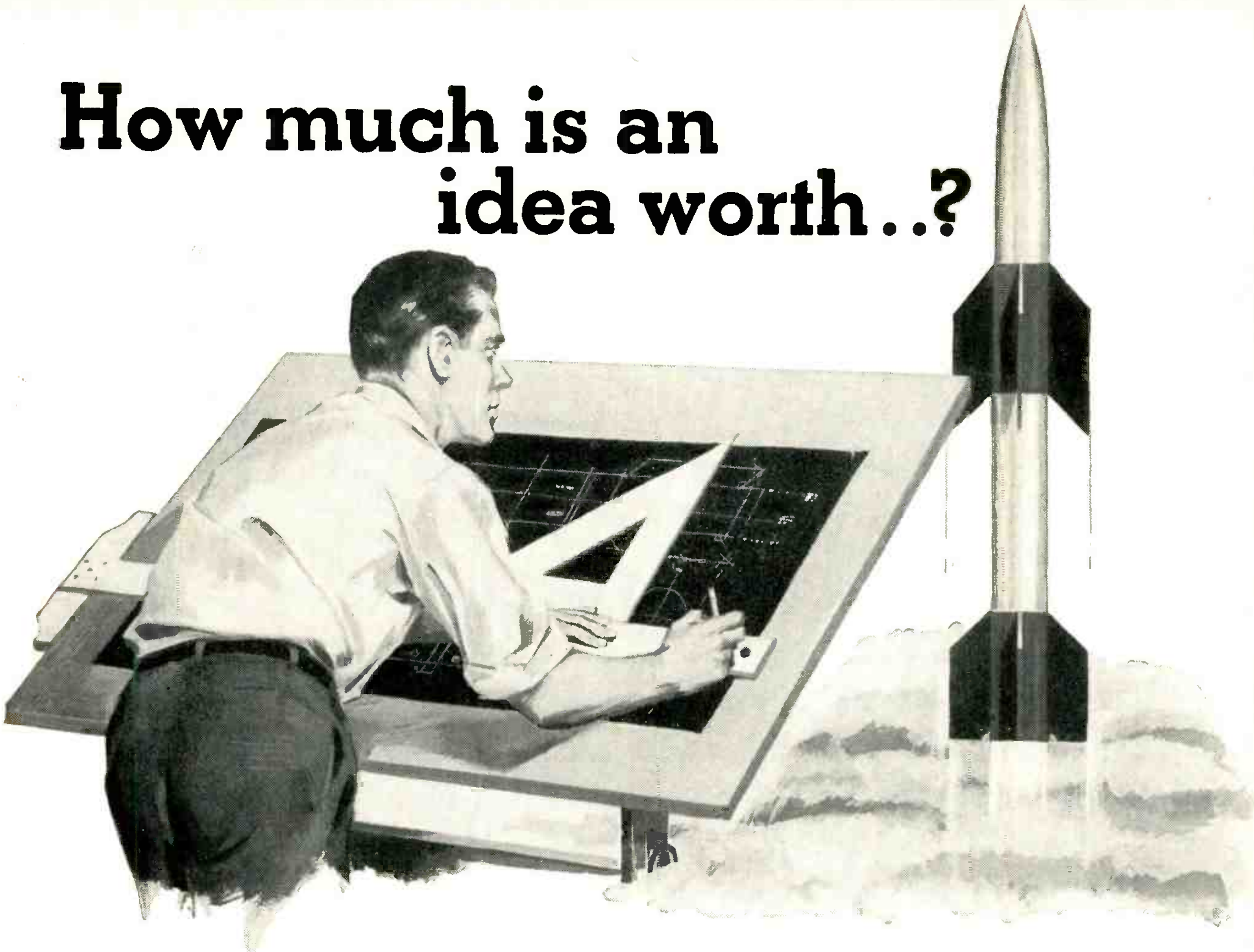

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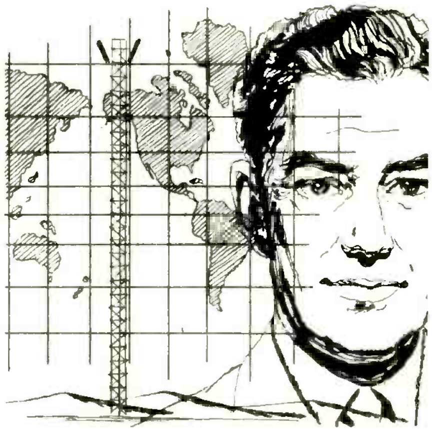
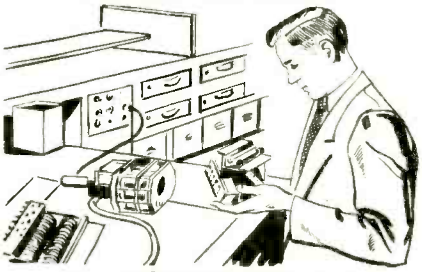


or just the details?



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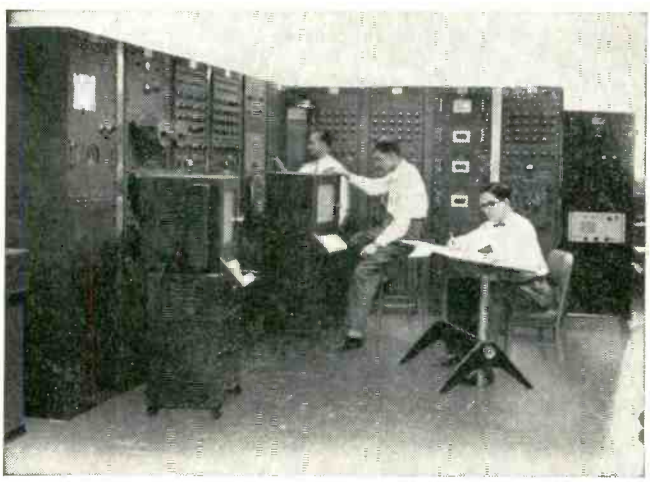

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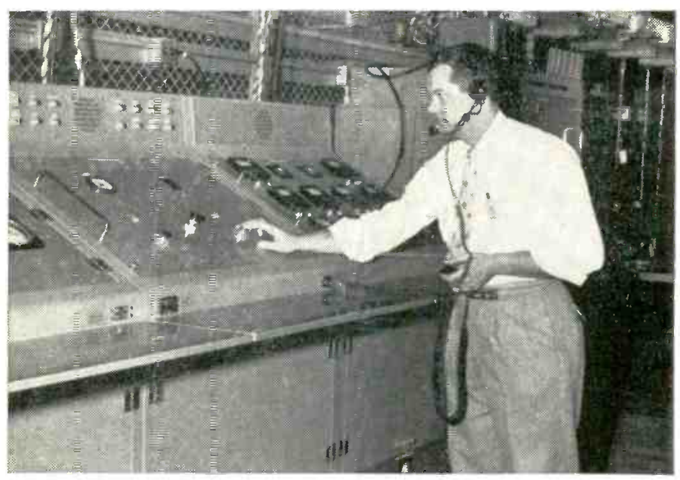

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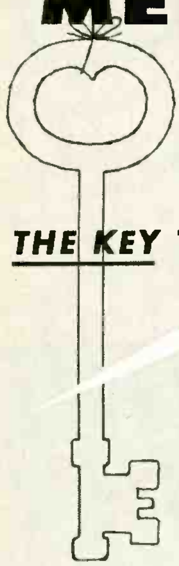

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To do original work on the design and development of horizontal and vertical deflection components and circuitry for both monochrome and color receivers.

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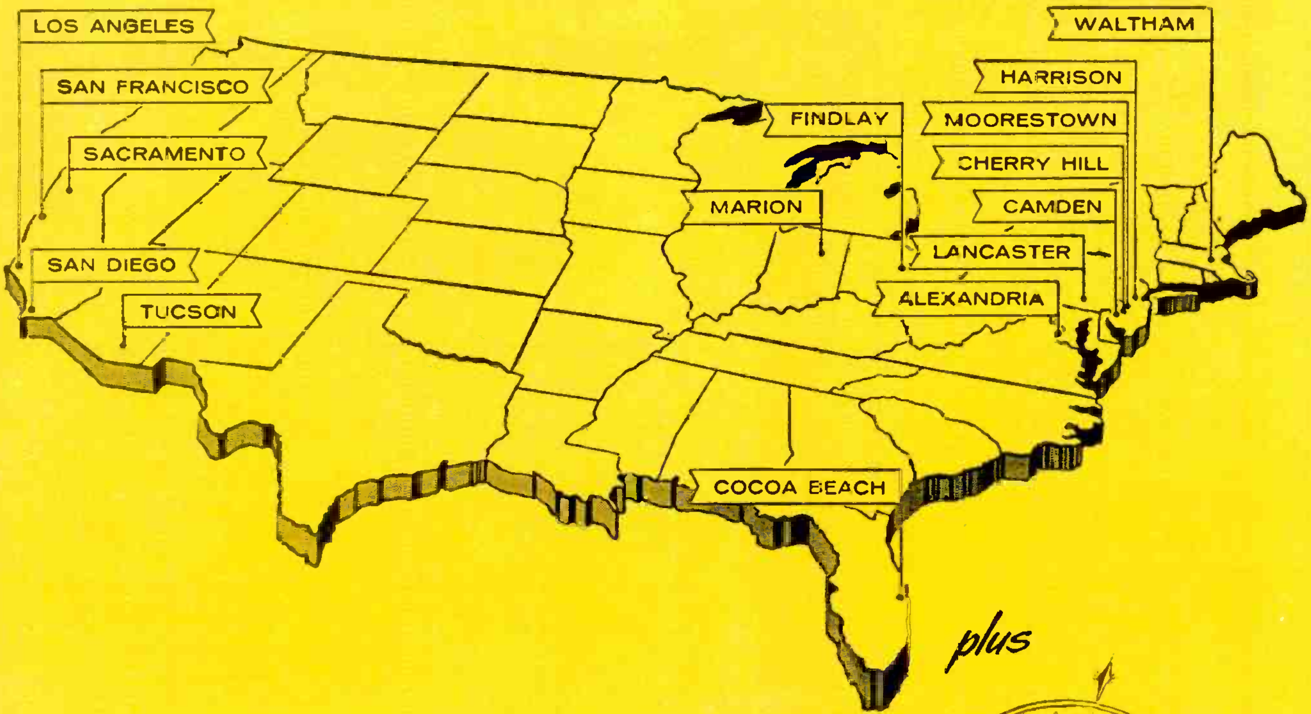

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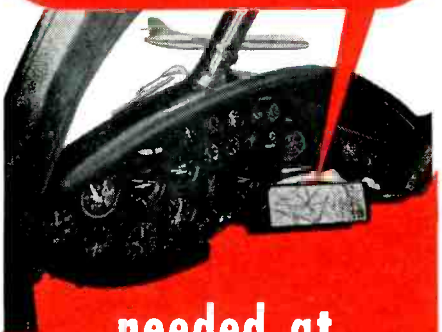

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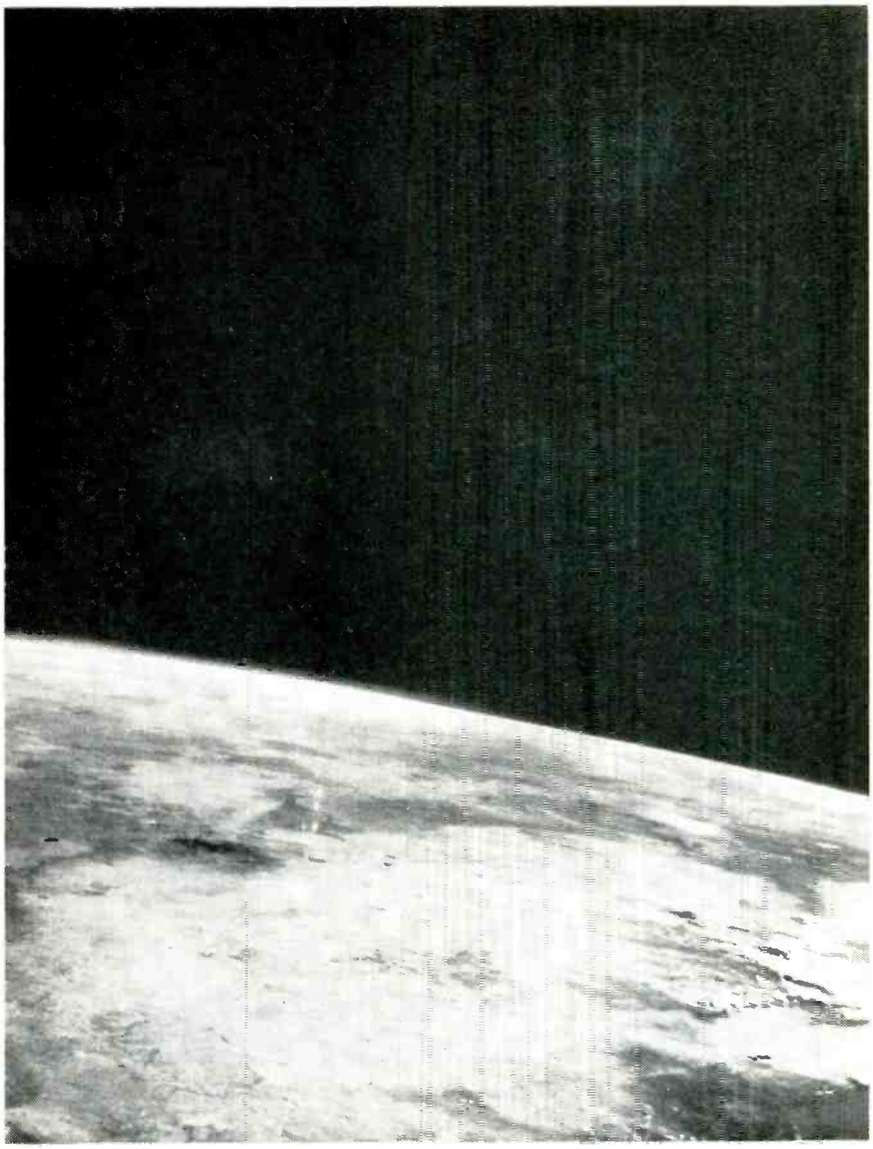

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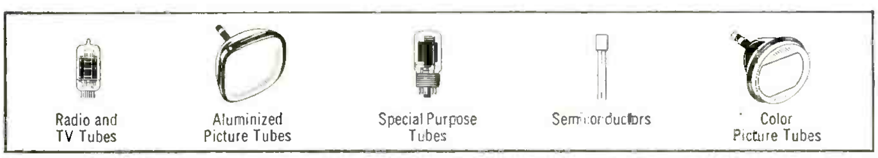

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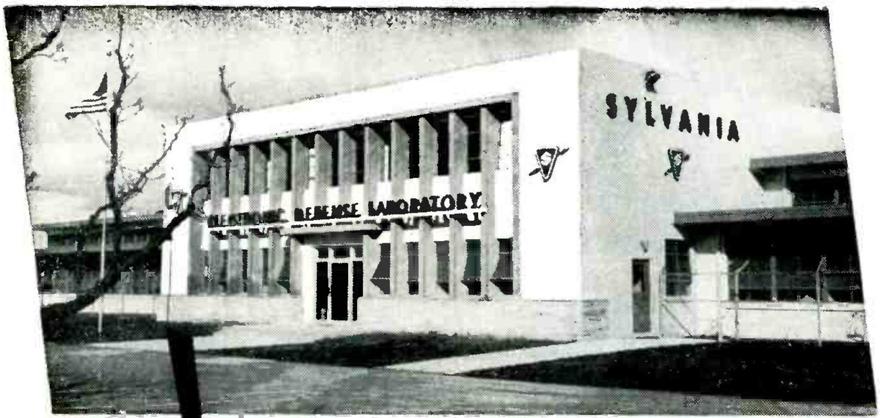

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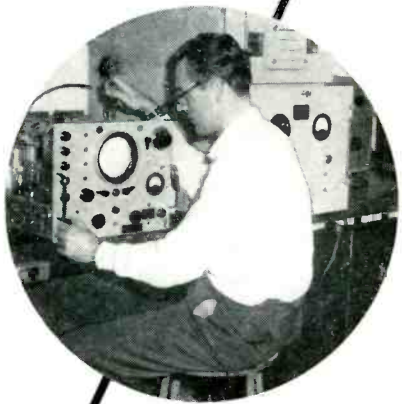

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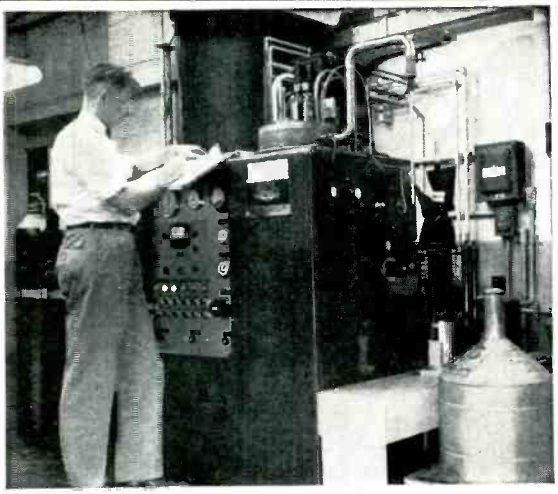
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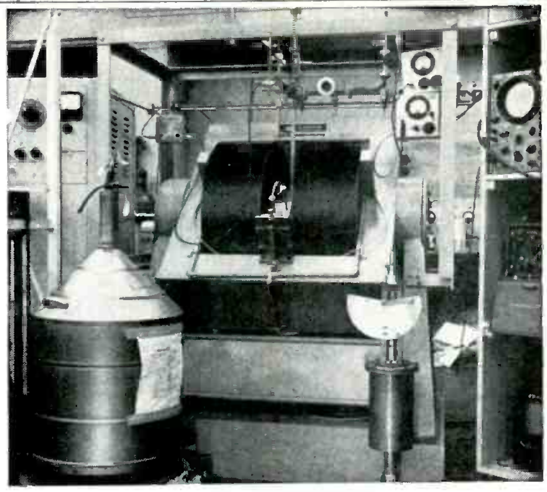
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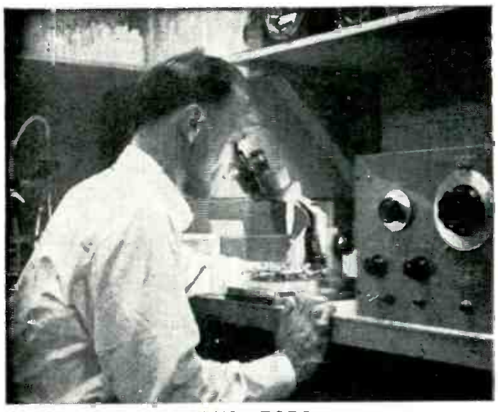
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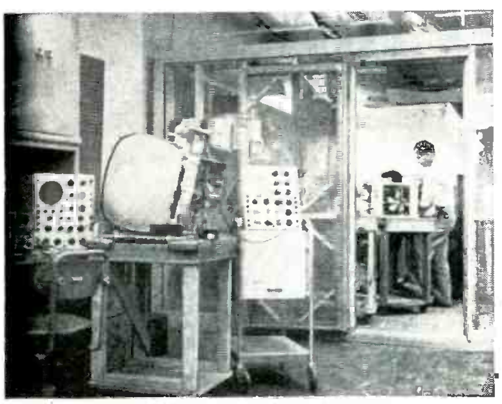
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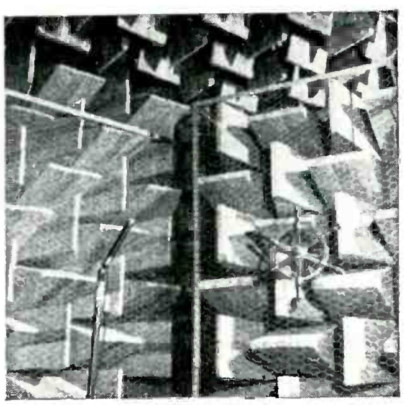
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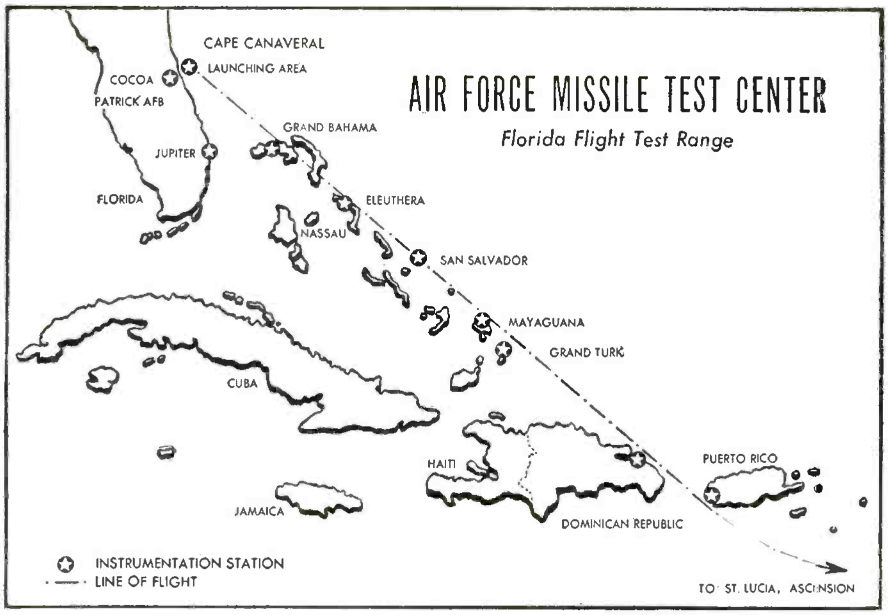

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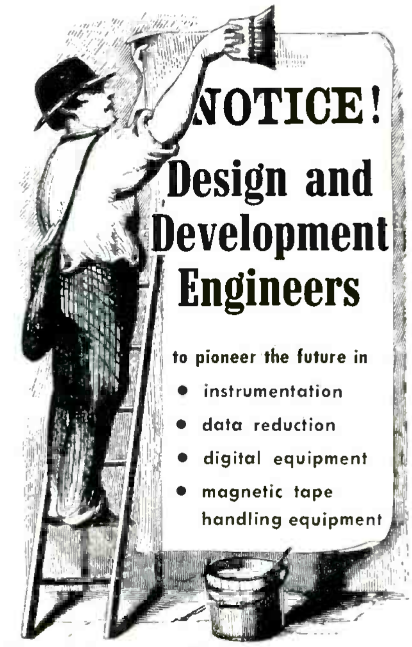

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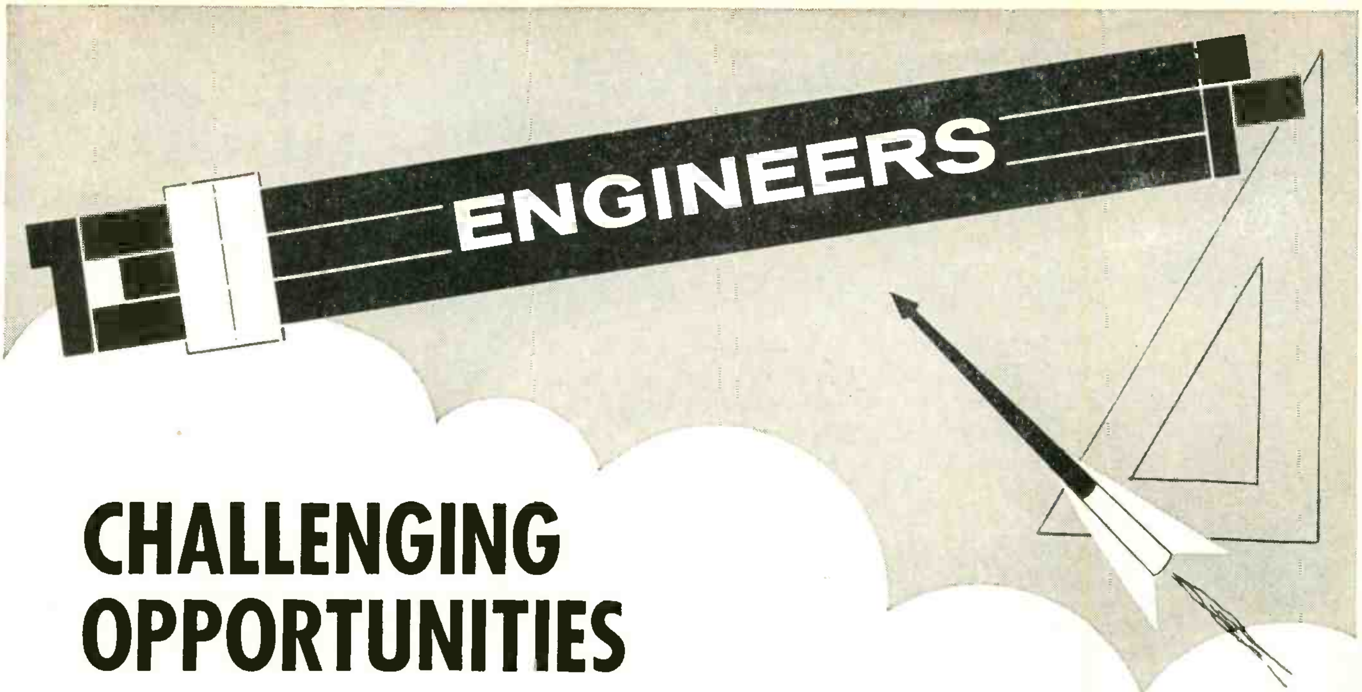

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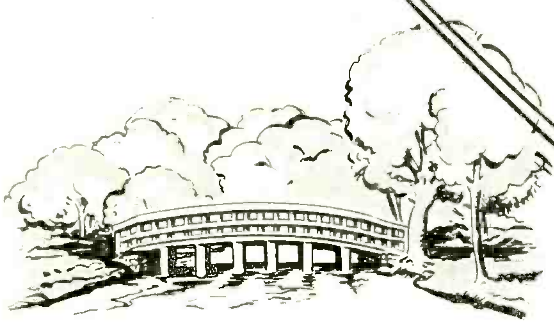

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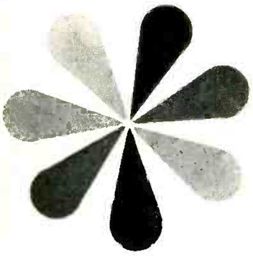

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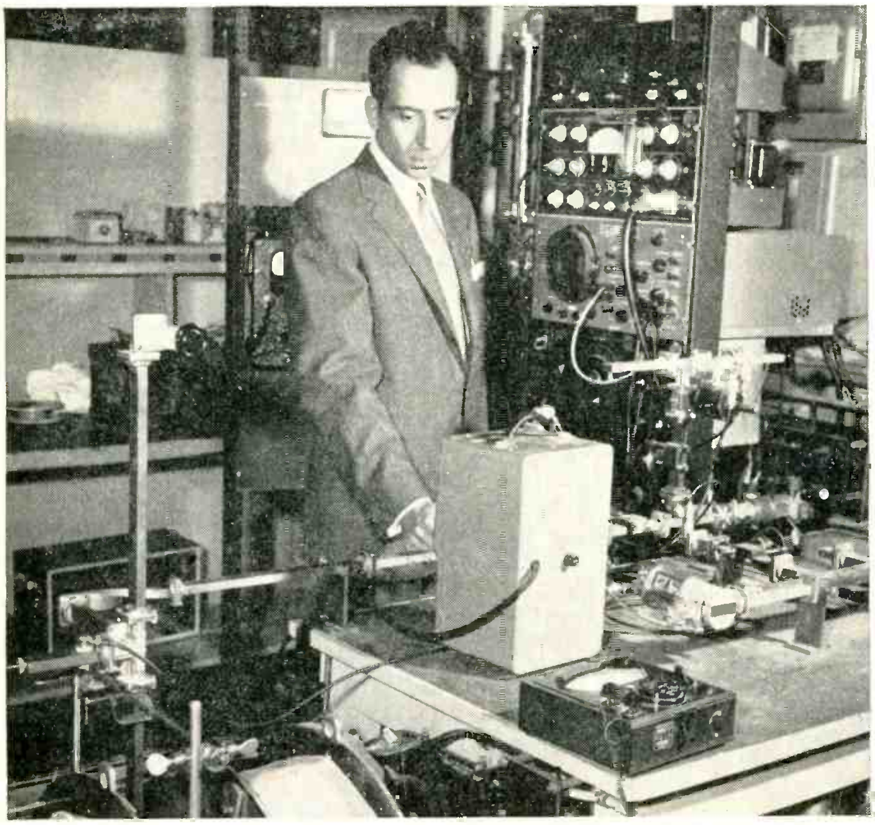

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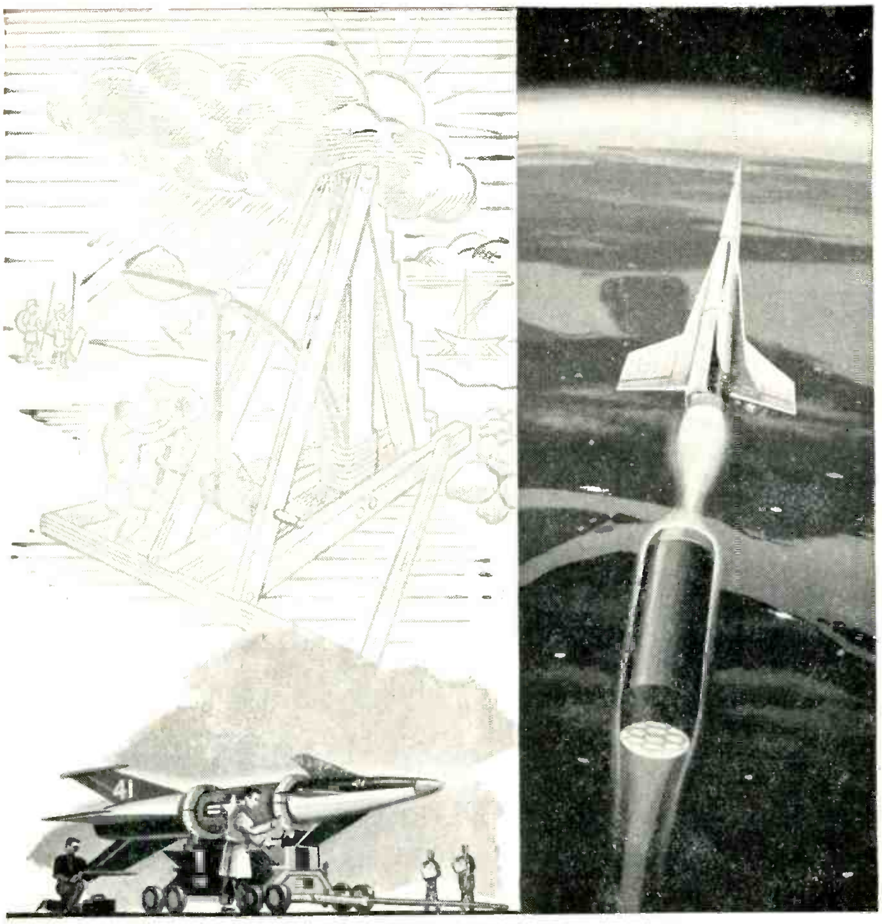

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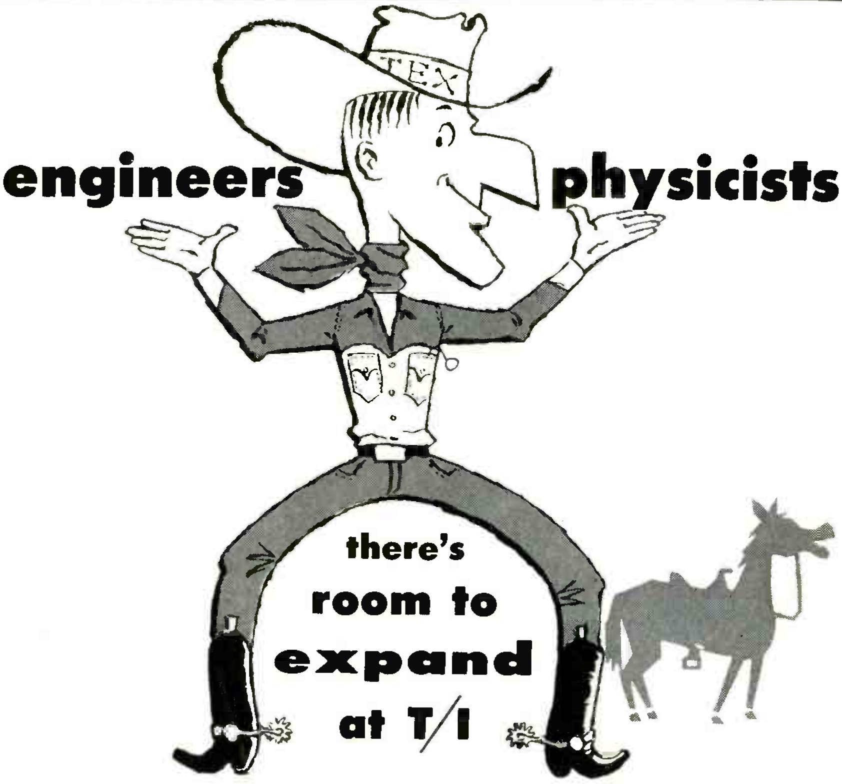

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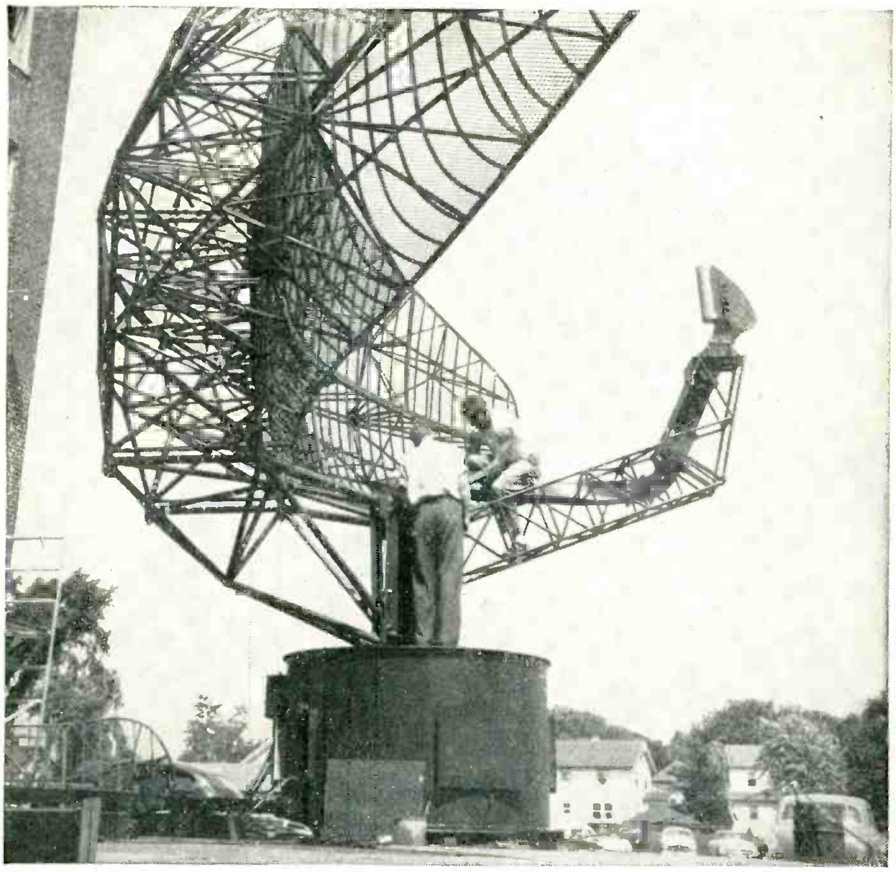

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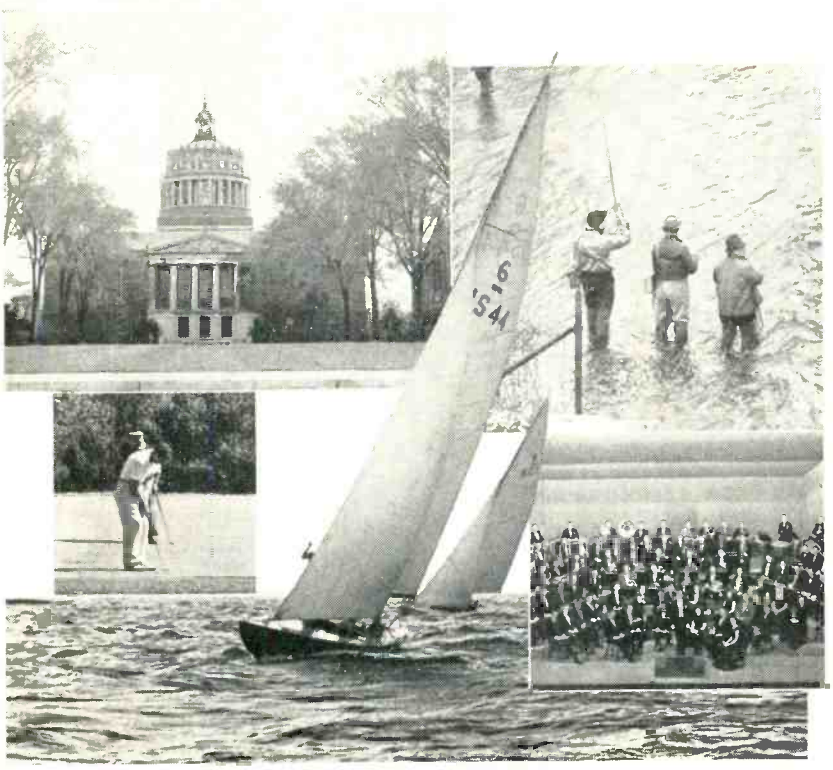

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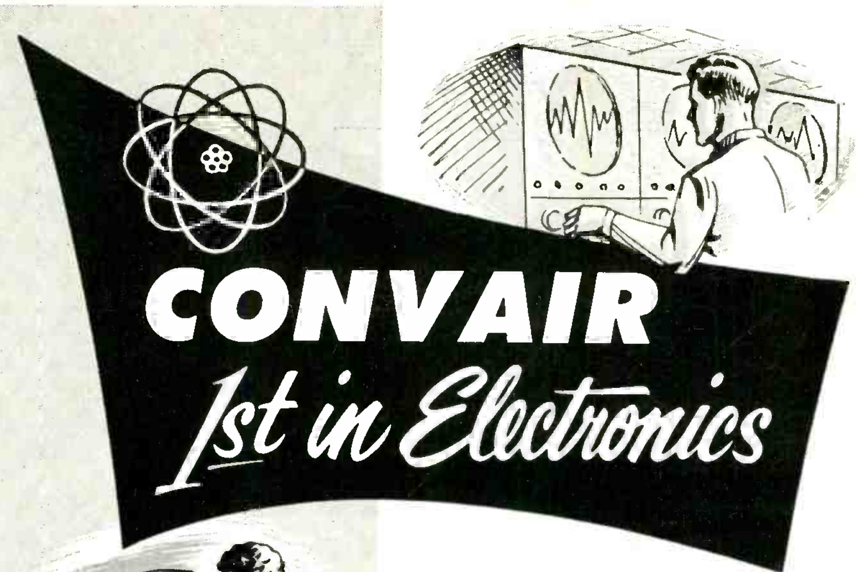

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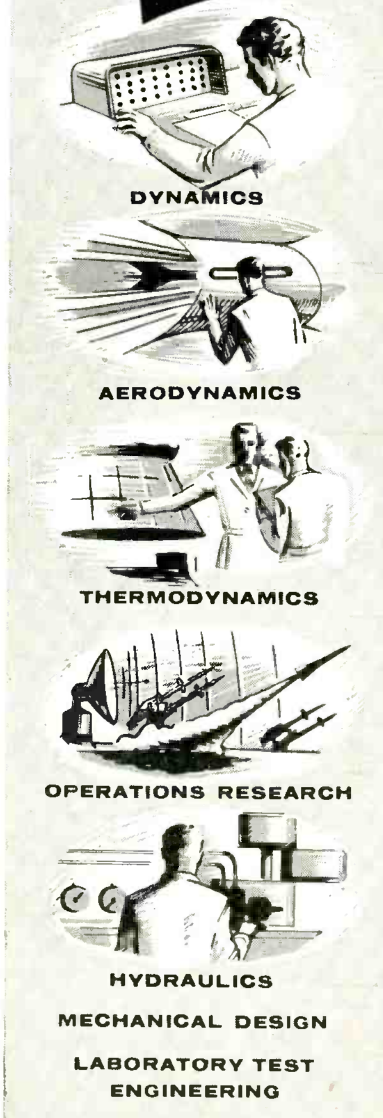

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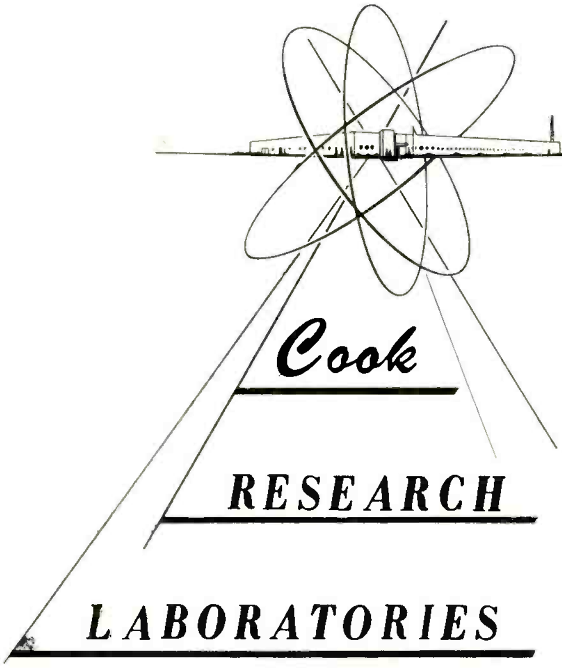

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Electron Tube Engineer. Now serving in executive capacity. Wide experience in development and research. Background cathode ray, color, photo sensitive, fluorescent, thyratron, high vacuum, etc. Glass and metal techniques. PW-1044, Electronics.

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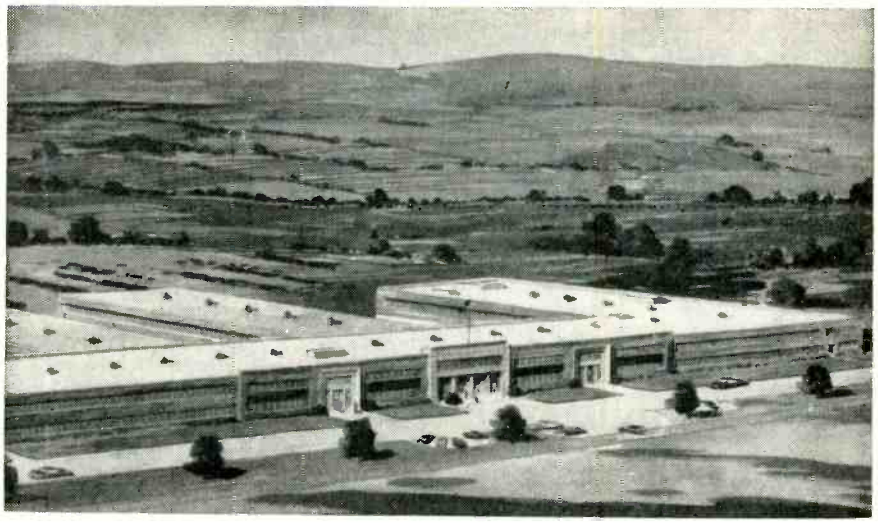

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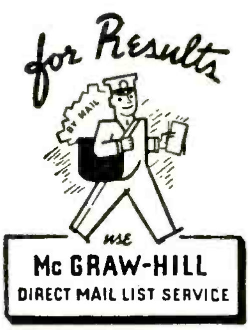

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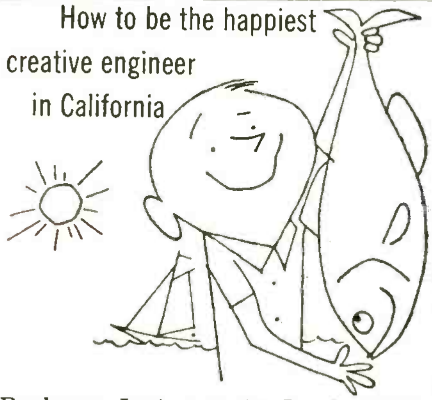
Subsidiary of General Precision Equipment Corporation

How to be the happiest creative engineer in California



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*We're pacing the commercial electronics field ($3,000,000 sales in 1949 to $21,000,000 sales in 1955) and we'll be disappointed if you don't grow with us.

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Employment Opportunities
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electronic & mechanical

engineers

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Mr. Richard Parvin

THE MAGNAVOX CO.
FORT WAYNE 4, INDIANA

INDEX TO THE SEARCHLIGHT SECTION ADVERTISERS

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200 VDCW 500 VDCT
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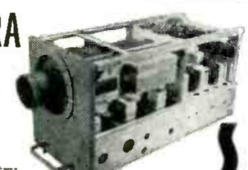

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2J61A; 2J62A; 2K22; 2K23; 2K25; 2K26; 2K28; 2K29; 2K30; 2K33A; 2K39; 2K41; 2K42; 2K43; 2K44; 2K45; 2K46; 2K47; 2K48; 2K50; 2K54; 2K55; 2K56; 2X2A; 3AP1; 3B4; 2B24; 3B24W WA; 3B25; 3B26; 3B28; 3B29; 3C22; 3C23; 3C33; 3C45; 3D6; 3D21A; 3D22; 3D24; 3DP1, S2; 3E29; 3EP1; 3FP7A; 3GP1A; 3J31; 3K21; 3K22; 2K23; 3L54; GA-4; SN-4; 4-65A; 4-125A; 4-250A; 4-400A; 4-1,000A; 4B22; 4B23; 4B24; 4B25; 4B26; 4B27; 4B28; 4B31; 4B32; 4B36; 4C22; 4C27; 4C28; 4C35; 4C36; 4D21; 4D32; 4E27; 4J31; 4J33; 4J34; 4J42; 4J50; 4J51

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6SK7W; 6SL7W GT; 6SN7W GT; 6S117 GTY; 6X4W; 7AK7; 7BP7, A; 7CP1; 7UP7; 7YP2; 8D21; 9LP1; 9LP7; 10E/13; 10E/222; 10KP7; 10KP17; A-11; 12AT7 WA; 12AU7 WA; 15E; FG17; RX21; HK24; 24G; RK20A; RK25; 25T; 25Z6W GT; 26Z5W; 28D7W; 31Z; RK-34; 35T, TG; RK-39; T-40; TZ-40; RX-47; RK-49; V-50; 52HAP7; RK-65; HY-65; HY-69; RK-72; RK-73; RK-75; 75T, TL; BR-90; CV-92; C-100A; HF100; 100TH, TL; 101D; FG105; F-124A; FG154; WE121A; VT127, A; 151N; 152TH; QK155; 183; QK202; 203A; 204A; 207; 211D; 212D; 217C; 218; 220B, C; RX233A; 235A; 492A, B, C

250TH, TL; 252A; 253A; 258A; 259A; 266B; 274B; QK284; 290A; HF300; 300B; 304B, L, TH, TL; GG305; CE306; 307A; 310A; 311CT; 314A; 316A; ML-322; T327A; C-33S; 337A; 342A; 348A; 349A; 350A, B; 354C, F; 359A; 371A, B; ML381; 388A; 393A; 395A; 397A; 401A; 403A, B; 404A; 407A; 408A; 409A; 412A; 415; 416A, B; 417A/5842; 418A; 419A; 420A; 421A; 422A; 423A; 427A; 428A; 429A; 431A; 438A; 446A, B; ZP-449; 450TH, TL; 451A; 454H; 464A; 471A; 502A; 506AX; 507AX; 508; 510; 511X; 512AX; 518AX; 522AX; 526AX; 527; N-531; 532A; 533AX; 535AX; 551AXA; 559; 571AX

572AX; 574AX; 575A; 592; 615; KU627; 631-P; 648-P1; HK654; 700B; 703A; 704A; 705A; 706 SERIES; 707A, B; 708A; 710A; 713A; 714A, AY; 715A, B, C; 717A; 719A; 720 SERIES; 721A; CE-722A; CK-722; 723A/B; 724B; 724A; 726A, B, C; 728 SERIES; 750TL; 800; 801A; 802; 803; 804; 805; 806; 807, W; 808; 809; 810; 811, A; 812, A; 813; 814; 815; 816; 825; 826; 828; 829B; 830B; 832A; 833A; 834; 836; 837; 838; 841; 843; 845; 845W; 850; 851; 852; 854; 857B; 858; 860; 862A; 864; 865; 866A; 868; 869B; 872A; 874

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5896; 5899; 5902; 5915; 5931; 5932; 5933; 5948; 5949; 5962; 5963; 5965; 5977; 5980; 5987; 5993; 5995; 5998; 6002; 6095; 6012; 6021; 6028; 6044; 6045; 6050; 6073; 6074; 6080; 6082; 6087; 6088; 6096; 6097; 6100; 6101; 6110; 6111; 6112; 6136; 6140; 6141; 6146; 6147; 6143; 6161; 6186; 6188; 6189; 6199; 6201; 6205; 6216; 6246; 6247; 6249; 6280; 6293; 6336; 8002; 8005; 8008; 8011; 8012, A; 8013, A; 8014A; 8016; 8020; 8025A; 9001; 9002; 9003; 9004; 9005; 9006; AX9903; 38111A; D96475; D164696; D178461; 199698; 8651860G1

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6AS6W	1.50
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6J4WA	3.50
6J6W	1.50
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6SN7W	1.50
6SU7GTY	2.00
6X5W	1.25
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7CP1	10.00
7EP4	10.00
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12DP7	17.50
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35T	3.00
35TG	2.50
VX-41	5.00

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T-55	3.50
RK-60/1641	1.35
RK-61	3.00
HY-65	1.35
RK-65/5D23	7.50
FG-67	9.00
HY-69	2.75
RK-72	.50
RK-73	.50
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75TL	7.50
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100TH	5.50
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F-123A	5.00
WE-123A	2.50
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F-128A	15.00
F-129B	150.00
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FG-166	14.00
FG-172	25.00
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FG-190	7.50
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FG-258A	100.00
WE-262B	5.00
267B	5.00
WE-268A	7.50
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WE-285A	5.00
WE-286A	6.00
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323B	4.00
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WE-337A	7.50
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WE-347A	3.00
WE-350A	2.65
WE-350B	2.65
WE-352A	15.00
WE-355A	12.00
WE-356B	5.00
WE-368A/AS	2.00
371B	1.50
WE-388A	1.50
WE-393A	4.50
394A	1.85
WE-396A	2.90
WE-403A	1.10
WE-404A	12.50
GL-415	25.00
WE-417A	12.50
WL-417	2.50
WE-418A	15.00
WE-421A	7.00
GL-434A	10.00
446A	.40
446B	1.50
464A	2.15

CK-510AX	.50
GL-546	2.00
559	.45
575A	7.50
631-P1	6.00
WL-632A	17.50
WL-652/57	40.00
WL-655/58	100.00
WL-681/86	25.00
WE-701A	2.50
703A	1.25
WE-704A	.70
WE-705A	.70
706AY-GY	12.50
707B	3.50
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WE-714AY	20.00
715B	3.50
715C	11.50
717A	.35
WE-719A	12.50
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721B	7.00
723A/B	8.50
WE-724B	1.00
WE-725A	5.00
WE-726A	5.00
WE-726B	25.00
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WE-730A	7.00
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SA-782B	2.00
WL-786	14.00
801A	.50
802	2.00
803	2.00
804	8.50
805	5.00
807	1.10
807W	2.00
808	1.00
809	2.75
810	10.00
811	2.90
811A	3.50
812	2.90
813 (RCA)	12.00
814	1.50
815	1.00
816	1.00
826	.50
SD-828A	6.50
SD-828E	6.50
828	9.50
829	5.50
829B	8.50
830B	.50
832	3.00
832A	5.00
833A	35.00
SD-834	3.75
834	7.50
836	1.50
837	1.10
838	1.00
842	1.85
845	4.00
845W	7.50
849	20.00
851	9.00
860	2.75
866A	1.20
866 JR.	1.00
869B	35.00
872A	1.25
884	.95
885	.95
902A/P1	2.00
913	20.00
SD-917A	3.75
917	2.00
918	1.50
922	2.00
923	1.40
927	.95
931A	2.50
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SN-948D	6.50
954	.30
955	.35
SN-956B	1.00
956	.35
957	.35
958A	.35
959	1.35
SN-974B	8.50

SN-976D	8.50
991/NE-16	.30
CK-1005	.30
CK-1006	2.50
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CK-1007	.60
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SC-1016C	6.50
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1603	3.50
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1619	.30
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1846	50.00
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5528	5.00
5550	25.00
5551	40.00
5553	100.00
5556/PJ-8	6.75
5557	3.75
5558	5.00
5560	17.50
5610	1.00
5632	8.50
5634	6.50
5637	3.75
5638	6.50
5640	8.50
5642	1.00
5644	6.50
5645	8.50
5650	85.00
5651	1.35
5654	1.20
5656	6.50
5670	1.45
5672	1.15
5676	1.25
5678	1.00
5687	2.00
5691	4.25
5692	4.25
5693	3.50
5696	1.00
5703	1.00
5720	15.00
5725	1.50
5726	.55
5727	1.35
5728	9.00
5734	9.00
5740	35.00
5750	2.50
5763	1.35
5800	7.50
5801	5.00
5803	7.50
5819	30.00
5827	5.00
CK-5829	1.50
5842	12.50
5847	12.50
5915	1.00
5932	4.00
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5963	1.40
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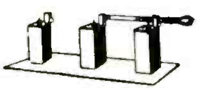

Square D Antenna change switch Bakelite base

2x8x¼ ★49¢

Mu Switch	RC-1P	norm. closed	.59
Mu Switch	RO-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
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ST 50 R DPDT		on-momen. on	.89
ST 40 G SPDT		momen.-off-momen	.44

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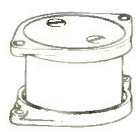

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10KV	00015	*5.95
6KV	00024	4.95
2KV	03	10.95
1KV	04	4.95

3KV	0063	*.99
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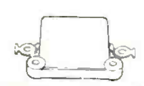
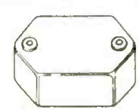
3KV	0002	.99
2KV	02	1.29
2KV	015	1.29
2KV	00015	.99
1KV	.1	1.39
600V	.4	1.39





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1200WV	01	.59
1200WV	0051	.49
600WV	01	*.32
600WV	02	*.45
600WV	001	.19

2500WV	005	.89
2500WV	0036	*.69
2500WV	001	.44
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General Electric Type IRT. 1.64 Kva. Filled with 9 gal. oil. Primary 208 volts. Brand New, Limited Quantity. Special $90.00

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ohms	watts	bush.	shaft	each
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3000	50(J)	3/8	9/16	*.79
2	25(H)	3/8	1/8 sl.	.79
8	25(H)	3/8	1″	.79
100	25(H)	3/8	7/16	.79
150	25(H)	3/8	7/16	.79

POTENTIOMETERS
2 Watts Types JU and JLU

ohms	type	bush.	shaft	each
50	JU	1/2	1/2	.54
1000	JU	1/4	3/16sl.	*.49
500K	JU	1/4	1/2	.59
2000	JLU	lock	3/16sl.	*.44
3000	JLU	lock	3/16sl.	.54
10000	JLU	lock	3/16sl.	.59

RELAYS

Amperite 6NO-110 time delay relay, octal tube base 6V Heater, normally open. Contacts rated 3A ★99¢

Allied BO 13D35 SPST Double break normally open 24V DC. Coil Silver contacts each rated 15 Amp @ 24V DC or 115V AC ★98¢

Autelco Jr Type 16 115V AC coil DPDT Snap Action contacts rated 15 Amp 115V, 5 Amp 230V 2.95

Cook #773 Standard Telephone Relay 900 ohm DC coil double arm 14 contacts 1A-1B-1C-1D 4″Lx1½W x2½H ★1.09

COAXIAL CABLE & CONNECTORS

RG 9 B/U ★15.00 C FT

PL 259 Plug ★29¢

Amphenol 83-1AP Angle Adaptor ★18¢

ALL PRICES F.O.B. OUR WAREHOUSE
TERMS: Net 10 days to firms rated well in D.B. Others deposit or cash with order balance C.O.D. Please include postage.

RUXUR ELECTRONICS CORP.
623 Hudson St., New York 14 WA 4-7260

COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

10 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 Recvr. Uses 2C40, 2C43, 1B27, Tunable APX 2400-2700 MCS. Silver Plated $15.00

BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. 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

McNALLY KLYSTRON CAVITIES for 707B or 2K28, 2700-2900 MC....$4.00

HOLMDELL-TO-TYPE "N" Male Adapters. W. E. #D167284....$2.75

BEACON ANTENNA AS31/APN-7 in Lucite Ball. Type "N" feed....$22.50

ANTENNA, AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed....$12.50

"E" PLANE BENDS. 90 deg. less flanges....$7.50

K-Band, X-Band Eqpt. 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-601E: Azimuth Rotating Joint....$15.00

Z-911: Long Rt. Angle Bend, 90 Deg....$4.50

Z-910: Short Rt. Angle Bend with pressure fitting $3.50

X BAND - 1" x ½" WAVEGUIDE

AT-68/UP 3 CM Horn with type N. feed for receiver measurements, etc. New (as shown)....$7.45

PARABALOID DISH, 18" diam. Spun Aluminum, 8" Focus. For AN/APS-6 $4.95

3 CM. DIPOLE and Feed Assembly. (May be used with above dish.) 8 inches long....$5.00

FLEXIBLE SECTION 9 in. long. Cover-to-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, 1¼" x ⅝" W.G. W.E. Flanges. **"E" Plane**....$3.50

3 CM ANTENNA ASSEMBLY: Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 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 6" 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 5' 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 15 lb. gauge....$10.00

Directional Coupler. UG-40/U Take off 20db....$17.50

MAGNET AND STABILIZER CAVITY For 2J41 Magnetron....$24.50

90 degree elbows, "E" or "H" Plane 2½" radius..$8.50

ADAPTER, waveguide to type "N", UG 81-U, p/o TS 12, TS-13, Etc....$7.50

ADAPTER. UG-163/U round cover to special BTL. Flange for TS-45, etc....$2.50 ea.

APS-1S SPARE PARTS

CU-73/APS-15A. SCS #2Z3265-73 right angle bend. E plane. 6½" x 10", with directional coupler on 6½" 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 press. fitting....$6.50

Z-614: Philco 756-1142. CG124/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....$4.50

Z-609. Philco 348-1629. 13½" run. with bend & 90 deg. twist (on 3½" 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 6½"....$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 40A/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-ATR-Section Choke to cover....$4.00

Flexible Section 1" 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 .825-1.175 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	1600V/2MA., 6.3V/.6A, 2.5V/1.75A	4.95
CT-127	900V/25MA PK. 5V/2A. 2V/7.5A	2.79
CT-006	350-0-350V/120MA. 5VCT/3A, 2.5VCT/12.5A, 2.5VCT/3.5A	4.39
CT-965	78V/0.6A, 6.3V/2A	1.95
CT-004	350-0-350V/90MA. 5VCT/3A. 2.5VCT/12.5A	4.60
CT-002	350-0350V/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-07	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	37.5/40V AT 750 MA	2.15
PT-87P	860VCT/230MA DC	4.75
PT-876	1500-0-1500V./400MA	12.75
PT-151	2060VCT/0.175A	18.50

FILAMENT—115V/60~INPUT

FT-157	4V/16A. 2.5V/2.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25A/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	2.5H/700 MA, 2.5 KV Test 18 Ohms	5.75
CG-044	8.5H/350 MA, 3.5 KV Test 50 Ohms	3.25
CH-291	O-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-344	1.5H/145MA/1200V Test	2.35
CH-366	20H/300 MA	6.95
CH-999	15HY/15 MA—400 ohms DCR	1.95
CH-445	0.5HY/200 MA, 32.2 ohms, 3000 V.T.	1.39
CH-170	2x0.5H/380 MA, 25 ohms	2.79
CH-124	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 R-55/ARQ-9	1.35
KS9608	1233/.35MA, 1140VCT/.07A	5.79
352-7102	6.3V/2.5A	1.45
M-7472426	1450V/1.0MA, 2.5V/.75A, 6.4VI/3.9A, 5V/2A. 6.5V/.3A. P/O ID-39/APG-13	4.95
352-7039	640VCT @ 380MA, 6.3V/.9A, 6.3V6A 5V/6A	5.49
702724	9800/8600 @ 32MA	8.95
KS9584	5000V/290MA, 5V/10A	22.50
KS9607	734VCT/.177A, 1710VCT/.177A	6.79
352-7273	700 VCT/350MA, 6.3V/0.9A. 6.3V/25A, 6.3V/.08A, 5V/CA	6.95
352-7070	2x2.5V/2.5A (2KV TEST) 6.3V/2.25A, 1200/100/750V, & .005A	7.45
352-7136	1140/1.25MA. 2.5V/1.75A, 2.5V/1.75A—5KV TEST	3.95
352-7176	320VCT/50MA. 4.5V/3A, 6.4V/CT 20A. 2x6.3VCT/6A	4.75
RA6400-1	2.5/1.75A, 6.3V/2A—5KV Test	2.39
901692	13V/9A	2.49
901699-501	2.77V.@4.25A—10KV Test	3.45
901698-501	900V/75MA, 100V/.04A	4.29
Ux8855C	900VCT/.067A, 5V/3A	3.79
RA6405-1	800VCT/95MA, 5VCT/3A	3.69
T-48852	700 VCT/806MA, 5V/3A, 6V/1.75A	4.25
352-7098	2500V/6MA, 300VCT/135MA	5.95
M-7474319	6.3V/2.7A, 6.3V/.66A, 6.3VCT/21A	4.25
KS8984	27V/4.3A, 6.3V/2.9A, 1.25V/.02A	2.95
52C080	650VCT/50MA, 6.3VCT/2A, 5VCT/2A	3.75
32332	400 VCT/35MA, 6.4V/2.5A, 6.4V/.15A	3.85
68G631	1150-0-1150V 2MA	2.75
80G198	6VCT/.00006 KVA	1.75
302433A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5/3.5A	4.85
KS 9445	592VCT/18MA, 6.3V/8.1A, 5V/2A	5.39
KS9685	6.4/7.5A, 6.4V/3.8A, 6.4/2.5A	4.79
70G30G1	600VCT/36MA	2.65
M-7474318	2100V/.027A	4.95
352-7069	2-2.5V Wdgs at 2.5A, Each Lo-Cap., 22Kv Test	5.95
352-7096	2.5V/1.79A, 5V/13A, 6.5V/6A, 6.5V/1.2A, D/O BC800	4.95

DYNAMOTORS

	INPUT		OUTPUT		
TYPE	VOLTS	AMPS	VOLTS	AMPS	PRICE
BDAR83	14	...	375	.150	$6.50
35X-059	19	3.8	405	.095	4.35
DM33A	28	7	540	.250	3.95
B-19	12	9.4	275 500	.119 .050	6.95
DA-3A*	28	10	300 150 14.5	2.6 .010 5.	3.95
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....5.95

Navy type CAJO-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 5½ x 10½. 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/AP. Input: 28 vdc/160A. Output: 115 VAC, 400~. 1ϕ. 500 VA., 21.6 Amp Volt. and Freq. Reg. Used. Exc....$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. Dual 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

4P37: Primary. 50 Ohms 730V. .001 Duty. Sec. 15KV. 1000 Ohms Impedance Bifilar 12.6V/2.5A....$32.50

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC. 16KV-16 AMP DUTY RATIO: 001 400 CYCLE FIL. TRANS. "BUILT-IN"....$22.50

WECO: 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. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar 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 @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar: 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

54J318-1—3 wdgs. Ratio: 1:1:1. 1.10 uh. /wdg., 2.5 ohms DCR....$3.50

UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 30 ohms DCR....$5.00

UTAH X-150T-1: Two sections, 3 Wdgs. per section. 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg....$5.00

K-904695-501: Ratio 1:1. Pri. Imp. 40 Ohm. Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.65 usec rise....$8.95

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. M.O. OR CHECK. ONLY SHIPPING SENT C.O.D. RATED CONCERNS SEND P.O. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK OR RAILEX.

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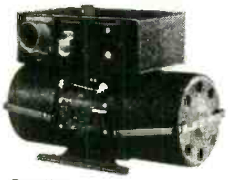
ESTERINE ANGUS RECORDER

Model AW 0-1 MA

DC Milliameter permanent magnet moving coil type. Spring clock duel speed drive (hour and minute). Instructions including connection diagrams and instrument data sheet with each instrument. Portable case $200.00

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, 3½" 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
2J5F1 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
5CT Cont. Trans. 90/55V 60 cy.	34.50
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
5SDG 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
R200-1-A Kearfott Cont. Trans. 26/11.8V 400 cy.	15.00
R210-1A 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.	20.00
C69405-2 Type 1-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 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.	17.50
FPE-25-11 Diehl Servo Mtr. 75/115V 60 cy.	22.50
FPE-43-1 Resolver 400 cy.	25.00
FJE-43-9 Resolver 115V 400 cy.	25.00
999-0411 Kollsman 26V 400 cy.	15.00
1377-0410 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

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 7⅛" high by 3" wide. Priced at **$8.95 each.**

SMALL DC MOTORS

(approx. size overall 3¾" x 1¼" 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 1⅝" x 3½"	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 1¼" in dia. 2" long overall	4.00

SAVE ON TUBES BRAND NEW TUBES GUARANTEED TUBES

OA2	.75
OA3	.90
OB2	.65
OB3/VR90	.85
OC3/VR105	.65
OD3/VR150	.65
ELC1B	1.50
1AD4	1.25
1B23	2.75
1B24	5.50
1B24A	12.50
1B26	1.25
1B27	10.00
1B35	4.50
1B36	4.00
1B40	2.00
1B42	4.00
1B47	6.50
1B51	6.75
1B62	4.00
1B63A	22.00
1N21	.60
1N21B	1.25
1N23	.60
1N23B	1.50
1N23BM	3.50
1N23C	2.50
1N25	3.00
1N26	3.75
1N28	5.00
1N31	3.00
1N34A	.50
1N38A	.65
1N42	8.00
1N52	.65
1N63	1.75
1N69	.40
1P21	30.00
1P22	6.50
1P28	9.00
1W5	1.00
1Z2	1.75
2AP1	4.00
2C33	.75
2C35	2.50
2C36	30.00
2C37	30.00
2C39	4.95
2C39A	10.00
2C42	10.00
2C43	9.00
2C44	.50
2C46	6.00
2C51	3.00
2C52	3.00
2C53	10.50
2D21	.60
2D21W	1.25
2E26	3.25
2E27	.60
2E32	1.00
2J31	15.00
2J32	12.50
2J33	14.50
2J34	14.50
2J36	15.00

2J42	60.00
2J48	35.00
2J49	40.00
2J50	35.00
2J55	35.00
2J56	50.00
2J61	15.00
2J62	6.50
2K22	14.50
2K23	14.50
2K25	12.00
2K26	45.00
2K28	25.00
2K33	90.00
2K33A	50.00
2K33B	110.00
2K34	85.00
2K35	175.00
2K39	100.00
2K41	100.00
2K42	125.00
2K43	110.00
2K45	40.00
2K46	200.00
2K47	110.00
2K48	75.00
2K50	150.00
2K54	7.00
2K56	50.00
2X2A	1.00
3AP1	2.95
3BP1	2.00
3B24	1.00
3B24W	5.00
3B26	2.50
3B28	5.00
3B29	5.50
3C22	60.00
3C23	5.00
3C27	1.00
3C31	1.50
3C33	8.00
3C45	7.00
3DP11A	7.50
3D21A	3.00
3DP1S2	5.00
3E29	8.50
3FP7A	2.50
3J30	35.00
3K22	150.00
3K23	150.00
3K30	100.00
4-65A	14.00
4B23	5.00
4B24/3C	4.00
4B31	22.00
4C27	5.00
4C28	25.00
4C35	13.50
4E27	8.75
4J22	35.00
4J29	35.00
4J31	65.00
4J34	50.00
4J42	25.00
4J50	99.50

4J52	50.00
4X150A	22.50
4X500A	55.00
5BP2A	5.00
5CP1A	8.00
5CP7A	8.00
5CP11A	9.50
5C22	29.50
5C30/C5B	1.00
5JP2	7.00
5JP4	7.00
5JP5	7.00
5JP11A	9.50
5MP1	3.95
5NP1	5.00
5R4GY	.90
5R4WGY	2.75
C6J	6.50
6AK5W	1.00
6AN5	2.00
6AR6	1.25
6AS6	1.25
6BL6	35.00
6BM6	25.00
6F4	3.25
6J4	1.95
6J4WA	3.50
6K4	2.25
6Q5G	3.25
6L6WGB	2.75
6SK7W	2.00
6SN7W	2.00
6SU7GTY	2.75
6X4W	1.00
6X5WGT	1.30
7C22	50.00
7C24	90.00
FG-17	2.95
RX-21	4.00
HK-24	3.00
RK-28A	2.50
HK-54	2.00
D-42	40.00
QK-60	25.00
RK-60/1641	1.35
RK-61	2.50
QK-62	25.00
HY-65	1.00
RK-65/5D23	7.50
FG-67	12.00
HY69	3.00
RKR-72	.50
RKR73	.50
ML-100	50.00
100TH	6.50
FG-105	11.00
F-123A	2.95
F-124A	Q
F-128A	13.00
FG-154	15.00
VT158	9.75
FG-166	15.00
FG-179	20.00
HF-200	10.00
QK-181	20.00
WL-200	75.00

203A	3.00
204A	25.00
207	25.00
211/VT4C	.50
212E	15.00
WL-218	15.00
RX-233A	.75
FG-235A	25.00
QK-249	150.00
WE-249B	2.50
WE-249C	3.00
250-R	4.00
250-TL	15.00
WE-251A	39.50
WE-252A	7.95
WE-254A	3.75
FG-258A	90.00
FG-271	25.00
271A	10.00
WE-274B	1.00
WE-282A	6.00
WE-282B	6.00
WE-285A	5.00
287-A	2.50

WE-394A	3.00
WE-396A	3.00
403/5591	2.75
WE-403A	1.50
WE-404A	11.00
GL-414	99.50
WE-416B	45.00
417A	2.75
WE-417A	12.50
WE-423A	8.50
446B	2.00
WL-456	59.50
464A	2.25
527	22.50
ML-531	4.00
KU-610	3.50
KU-627	10.00
KU-628	10.00
648P1	5.00
WL-652	20.00
HK-654	25.00
681/686	25.00
WE-701A	1.85
702A	.50

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5" DUAL GUN TUBE

Long persistency face, P7 screen. Value at $200.00. This tube has been rejected for military use.

Tested Before Shipped & Fully Guaranteed. Only **$17.95**

VACUUM CAPACITORS

6 mmfd. 30 KV 9.00
50 mmfd. 32 KV 9.00
75 mmfd. 20 KV 12.50

Also Other Values!

HF-300	15.00
WE-300B	5.00
GB-302	5.00
304TH	8.00
304TL	8.95
WE-305A	3.00
307A/RK75	1.00
WE-308B	15.00
WE-310B	3.00
WE-312A	2.00
WE-315A	20.00
WE-316A	.50
327A	3.50
WE-336A	5.00
WE-338A	5.00
WE-348A	6.00
WE-349A	6.00
WE-350A	2.75
350B	2.00
354C	5.00
356B	6.50
WE-359A	2.00
368AS	2.00
WE-388A	1.20
WE-393A	4.50

WE-703A	1.25
WE-704A	.75
WE-705A	.75
706AY-GY	15.00
707A	3.50
707B	4.50
WE-708A	.75
714A	12.50
715A	1.75
715B	4.00
715C	12.00
717A	.50
720AY-EY	50.00
721A	.75
721B	7.25
722A	.75
723A	5.00
723A/B	8.50
725A	3.50
726A	7.00
726B	20.00
726C	20.00
730A	7.50
750TL	40.00
WL-759	3.25

800	1.50
801A	.50
802	2.25
803	1.40
804	9.00
805	6.00
806	7.50
807	1.20
807W	3.00
808	1.25
809	2.25
810	10.00
813	11.00
814	1.75
815	1.50
826	.75
829	6.00
829B	8.50
830B	.75
832	4.00
832A	6.00
836	1.50
842	2.00
845	5.00
849	17.50
851	10.00
852	4.00
858	Q
860	3.00
861	15.00
872A	1.35
884	1.00
GL-889	50.00
GL-889A	65.00
889RA	110.00
902A	3.00
902P1	3.00
905	2.00
917	2.00
919	2.00
927	1.00
931A	2.50
935	4.00
954	.35
955	.35
956	.35
957	.35
958A	.35
959	1.25
991	.35
CK-1005	.35
CK-1006	2.75
CK-1007	.55
1603	3.00
1620	3.25
1623	1.75
1624	1.00
1625	.30
1626	.25
1636	.75
1641	1.35
1642	.50
1945	65.00
2000T	150.00
2050	.90
2051	.65
ZB-3200	69.50

5517	1.75
5551/FG271	25.00
5553/FG258A	90.00
5559/FG57	10.00
5586	125.00
5591/403B	2.75
5611	65.00
5634	7.00
5636	2.25
5647	5.00
5651	1.40
5654	1.25
5656	7.00
5657	125.00
5663	1.50
5667	125.00
5670	1.50
5687	3.00
5691	4.75
5702	1.75
5702WA	6.00
5703	1.10
5718	3.00
5719	2.50
RK-5721	150.00
5725	1.50
5726	.60
5727	1.30
5744	1.90
5750	3.10
5763	1.30
CK-5787	4.95
5814	1.00
5814WA	3.50
5819	25.00
5825	7.95
5829	1.40
5829WA	8.00
5837	70.00
5840	4.50
5844	3.00
5851	4.00
5876	11.50
5894	18.00
5896	5.00
5899	5.00
5901	6.50
5905	8.95
5908	7.95
5932	4.00
5933/807W	4.00
6005	1.75
6021	4.50
6044	30.00
6045	Q
6046	.75
CK-6050	2.00
6096	1.75
6100/6C4WA	2.25
6111	6.50
6147	3.00
6177	49.50
6246	Q
6764	Q
8005	4.95
8012	1.00
8025A	2.00
9001	.85
9002	.55
9004	.85
9005	1.50

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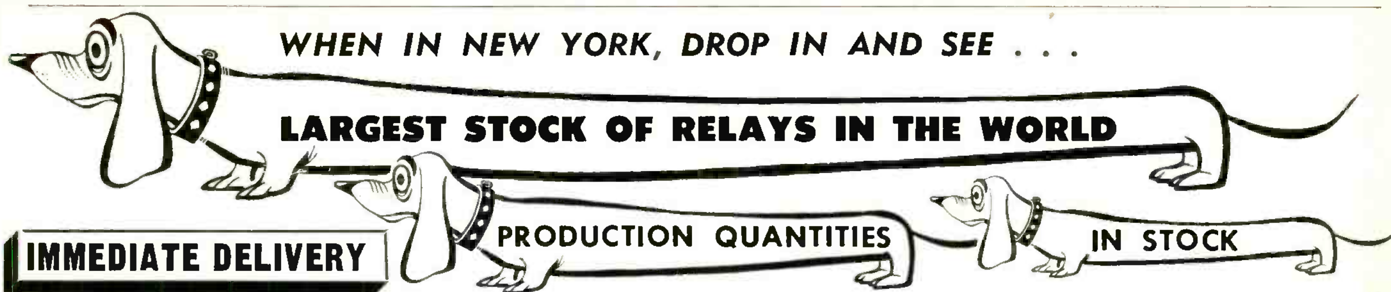
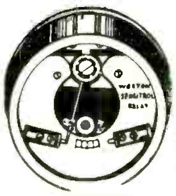
All prices F.O.B. Los Angeles, subject to change without notice. Minimum order $5.00. Check with us for items not listed.



IMMEDIATE DELIVERY

WESTON Type 705 SENSITROL



#R561

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 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.

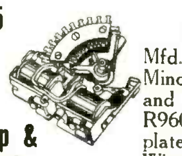
Double contact with Solenoid Reset; Sensitivity 7.5 Microamps; Reset coil 6-24 VDC or 24 VAC; Makes contact on increasing or decreasing values; Contacts; "Twintacts", Capacity 100 ma at 110 volts; Nickel plated brass cover; Weston Model 705 Type 6 #R560 ..... **18.75; 10 for 170.00**

Same as #R560 but with glass face; Weston Model 705 Type 6 #R561 .... **19.75**
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 #R523 .... **17.75 10 for 160.00**

Same as #523 with Brass Cover Weston Model 705 Type 4 #R523N......... **16.75**
10 for 150.00

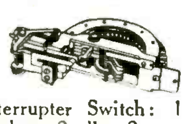
SS5 STEPPING SWITCHES



Step & Reset

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.

	Each	Lots 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	Lots of 10
#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

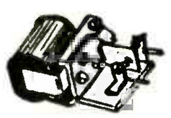
CLARE TYPE 20 "Homing" type; Step in one direction; 20 position; 180° wipers, one bridging and remainder non-bridging; Interrupter Switch: 1 break. #R891; 24-36VDC; 3 levels; Clare #SD19. . **12.95 each**

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: 3¼", overall diameter: 1-3/16" #R1021........ **6.95 ea.**
10 for 65.00 100 for 625.00

SIGMA SENSITIVE



SIGMA 4F8000S; 1 ma; SPDT (1C); 8000 ohm; #R425 .... **3.95 ea.**
3 for 10.00 10 for 30.00

SIGMA 5F16000S; 0.5 ma; SPDT (1C); 16000 ohm; #R627............. **5.95 ea.**
10 for 50.00 100 for 450.00

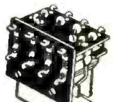
HERMETICALLY SEALED

ALLIED SMHX-1; 24-VDC; 6PDT(6C); 10 Amp contacts; 230 ohm; Solder lug header; #271.......... **6.50 ea.**

ALLIED SKHXCC; 24 VDC; DPDT(2C) 425 ohm; Solder lug header; #R85. . .**4.95 ea.**

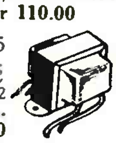
ALLIED SKHXCCCC; 24 VDC; 4PDT(4C); 425 ohm; Solder lug header; #R86 **5.50 ea.**

A-C RELAYS



ALLIED PO12A115: 115V 50-60 cyc; 4PDT; 10 Amp contacts; #R1025.......... **4.50 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: 1½ lb; #T120 .... **1.50 ea.**
10 for 13.00 100 for 100.00

LATEST SUBMINIATURE TYPE

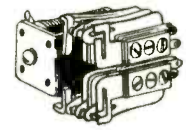
ALLIED 50G MH-12; MIL-R-5757A; 24-29 VDC; 4PDT; 300 ohm; Herm. Sealed; Solder Lug Header; 2.9 oz; Operate time 8 millisec; 1-1/16" dia. × 1-5/16" H; #R1138.......... **5.50 ea.**

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; #R1145..... **6.00 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	R1132	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

Cook & RBM

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

Automatic Electric Mfg. Co.

12	200	2C	R921	1.50
6	50	2C	R922	1.50

Miscellaneous Types

Mfgr' & No.	Volts	Ohms	Contacts	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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Universal general corp.

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Model 6RC89F16. Input 115v., 60 cy., 1 ph. Output 115v. dc. @ 10 amps. Consists of a metal cabinet 41 x 21 x 21 inches containing a transformer, copper-oxide rectifier, secondary reactor, ventilating fan, control circuits and aux. equipment. Transformer and reactor tapped to vary output. A 0-15 amp DC meter on front of cabinet. A useful piece of equipment for testing in lab or shop where 115 vdc. at 10 amps is needed. Also will charge a 54 cell emergency storage battery. Unused surplus. Only a few of these available. Special....$97.50
Shpg. Wt. approx. 300 lbs.

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Westinghouse. PRI: 115, 60 cy. Sec: 15,000V C.T., @ .060A, C.T. ungrounded. Excellent for high-potting tests. Size OA 12H x 8½W x 9¼D. Weight 67 lbs. Fully enclosed steel case. Price....$29.50

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SO-1 (10CM) assembly with reflector, waveguide nozzle and drive motor. New $279.50

SO-3 (3CM) Surface Search type with reflector and drive motor, but less plumbing. New in original cases. $149.50

SO-13 (10 CM) Complete assembly with 24" dish, dipole, drive motor and gearing. New $39.50

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Clare octal base 75 ohm coil. 115 V. 60 Cy. Makes two breaks one. New....$1.95

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TYPE CR-28/U. 200 Kc. mounted crystals. New. Price....$1.65

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.025	50	17.95
.025/.025	50	24.50
.1/.1	4.5	3.50
.135	7.5	6.95
.2	50	39.50
.25	15	9.95

SPECIAL
1 MFD. 7500 Volt Pyranol Filled
$6.95

Mfd.	KV	Price
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.25	50	54.50
.5	25	39.50
1.	7.5	6.95
1.	15	29.50
1.	20	42.50
1.	25	49.50
2.	5.5.	9.50

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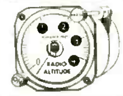

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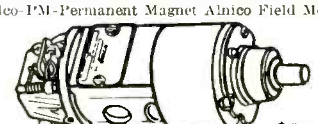

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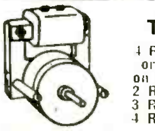

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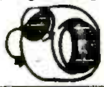

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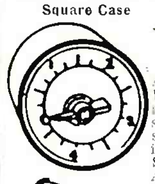

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AN/SPR-1
AN/TRM-3
AN/URM-1
AN/URM-23
AN/URM-43
AN/URM-67
AN-USM-24
AN-USM-45
AN/USM-50
AS-23/AP
AS-251/AP
AT-49/APR
AT-48/UP
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BC-650A
BC-905A
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BC-1066B
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I-122B
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I-203A
I-208
I-212
I-223A
I-233
IE-17E
IE-21A
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OBU-2
OBU-3
OS-8/U

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TFX-13GA
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TS-2/TG
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TS-6/AP
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TS-12/AP
TS-13/AP
TS-15/AP
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TS-186/UP
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TS-192/AP
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TS-305/AP
TS-319/URM
TS-320/URM
TS-322/URM
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TS-338/U
TS-343/U
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