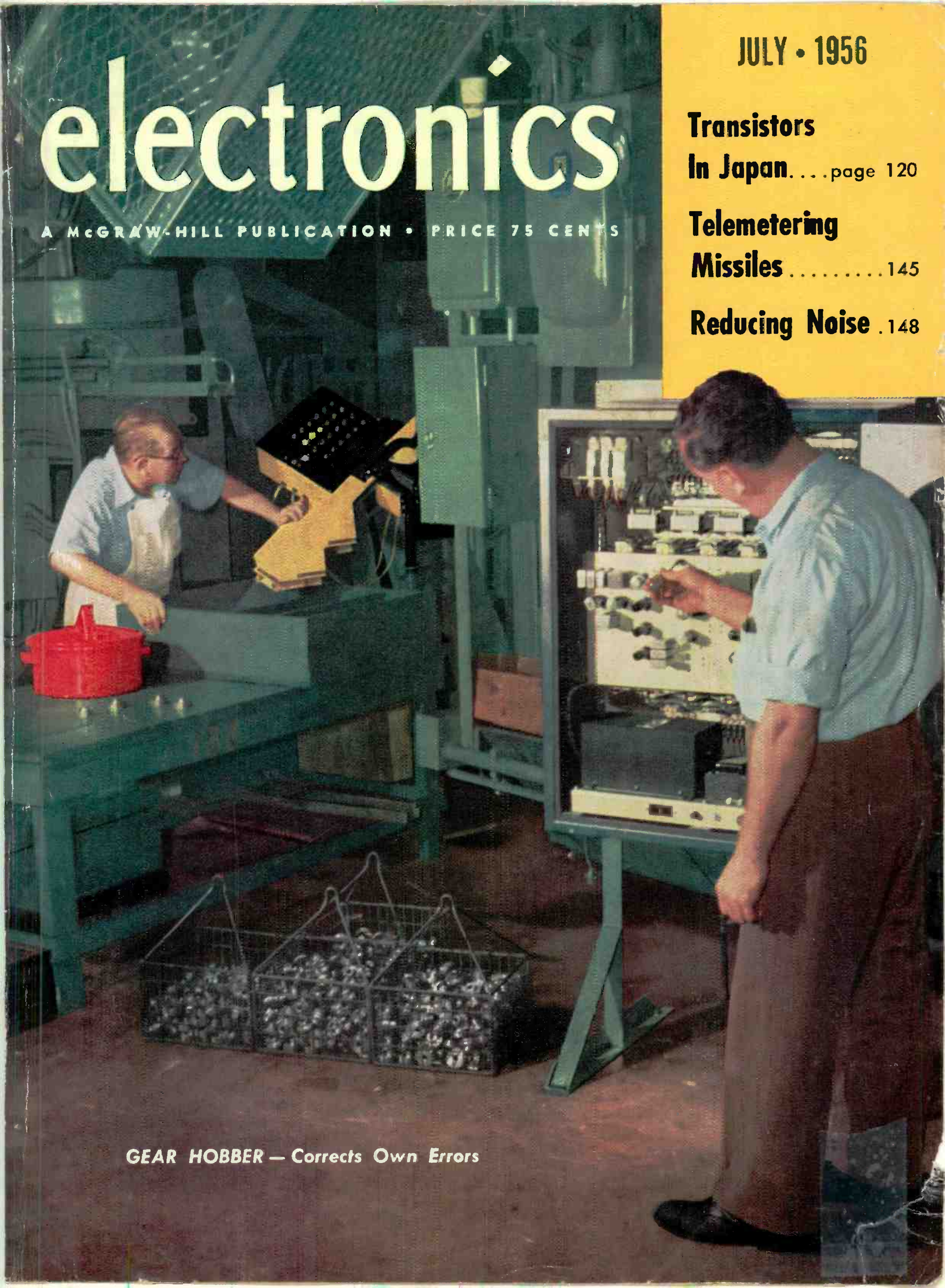
electronics

A McGRAW-HILL PUBLICATION • PRICE 75 CENTS

JULY • 1956



GEAR HOBBER — Corrects Own Errors

NEW HERMETIC POWER COMPONENTS

HIGHEST RELIABILITY FOR MILITARY AND INDUSTRIAL USE

Listed below are just a few of the 50 new **stock items** in the United hermetic power series. These MIL-T-27 power components add to the 200 other hermetic stock items of filter, audio, and magnetic amplifier types. Through the use of proven new materials and design concepts, an unparalleled degree of life and reliability has been attained, considerably exceeding MIL-T-27 requirements. Test proved ratings are provided, not only for military applications but for **industrial, broadcast, and test equipment service (55°C. ambient).**

For complete listing of these new items, write for Catalogue #56.

MIL-T-27 RATINGS IN REGULAR TYPE — **INDUSTRIAL RATINGS IN BOLD TYPE**

TYPICAL POWER TRANSFORMERS, PRI: 115V., 50-60 cycles.

Type No.	HV Sec. C.T.	Approx* DC volts	DC MA	Fil. Wdg.	**Approx* DC volts**	**MA DC**	**Fil. Wdg.**	**MIL Case**
H-81	500	L 180	65	6.3VCT-3A	**L 170**	**75**	**6.3VCT-3A**	**HA**
		C 265	55	5V-2A	**C 240**	**65**	**5V-2A**	
	550	L 200	60		**L 190**	**70**		
		C 300	50		**C 280**	**60**		
H-84	700	L 255	170	6.3V-5A	**L 240**	**210**	**6.3V-6A**	**KA**
		C 400	110	6.3V-1A	**C 360**	**150**	**6.3V-1.5A**	
	750	L 275	160	5V-3A	**L 260**	**200**	**5V-4A**	
		C 420	105		**C 380**	**140**		
H-87	730	L 245	320	6.3V-6A	**L 210**	**420**	**6.3V-6A**	**NB**
		C 390	210	6.3V-2A	**C 350**	**310**	**6.3V-2A**	
	800	L 275	300	5V-4A	**L 245**	**400**	**5V-4A**	
		C 440	200		**C 400**	**300**		
H-93	1000	L 370	280	6.3V-8A	**L 340**	**340**	**6.3V-10A**	**OA**
	1200	L 465	250	6.3V-4A	**L 455**	**300**	**6.3V-5A**	
				5V-6A			**5V-6A**	

*After appropriate H series choke. L ratings are choke input filter, C ratings are condenser input.

United "H" series power transformers are available in types suited to every electronic application. Proven ratings are listed for both high voltage outputs . . . condenser and choke input filter circuits . . . military and industrial applications.

United "H" series filter reactors are extremely flexible in design and rating. Listings show actual inductance at four different values of DC. Bold type listings are industrial application maximums.

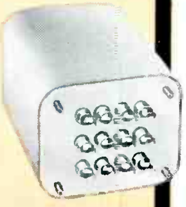
A FEW TYPICAL LISTINGS OF FILTER REACTORS.

Type No.	Ind. @ Hys.	MA DC	Ind. @ Hys.	MA DC	**Ind. @ Hys.**	**MA DC**	**Ind. @ Hys.**	**MA DC**	Res. Ohms	Max. DCV* Ch. Input	Test V. RMS	MIL Case
H-71	20	40	18.5	50	**15.5**	**60**	**10**	**70**	350	500	2500	FB
H-73	11	100	9.5	125	**7.5**	**150**	**5.5**	**175**	150	700	2500	HB
H-75	11	200	10	230	**8.5**	**250**	**6.5**	**300**	90	700	2500	KB
H-77	10	300	9	350	**8**	**390**	**6.5**	**435**	60	2000	5500	MB
H-79	7	800	6.5	900	**6**	**1000**	**5.5**	**1250**	20	3000	9000	9x7x8

*Based on maximum ripple voltage across choke in choke input filter circuit, in terms of DC output voltage.

TYPICAL FILAMENT TRANSFORMERS, PRI: 105/115/210/220V., 50-60 cycles.

Type No.	Sec. Volts	Amps. (MIL)	**Amps. (Ind)**	Test Volts RMS	MIL Case
H-121	2.5	10	**12**	10000	JB
H-124	5	3	**3**	2000	FB
H-127	5	20	**30**	21000	NA
H-131	6.3CT	2	**2.5**	2500	FB
H-132	6.3CT 6.3CT	6 6	**7** **7**	2500	JA
H-136	14, 12, 11CT	10	**14**	2500	LA



United "H" series filament transformers have multi-tapped primaries, good regulation, and are rated for industrial as well as military service.

United "H" series plate transformers incorporate dual high voltage ratings and tapped primaries to provide versatile units for a wide range of military and industrial electronic applications. Large units have terminals opposite mounting for typical transmitter use.

TYPICAL PLATE TRANSFORMERS, PRI: 105/115/210/220V., 50-60 cycles.

No. Type	Sec. V. C.T.	Approx.* DC volts	MA DC	Choke No.	**MA DC**	**Choke No.**	Case
H-110	1050 1200	380 465	275 250	H-75 H-75	**385** **350**	**H-77** **H-77**	MB
H-113	2500 3000	1050 1275	280 250	H-77 H-76	**340** **300**	**H-77** **H-76**	5¼ x 6 x 7
H-115	3500 4400	1500 1900	265 225	H-77 H-77	**350** **300**	**H-77** **H-77**	8¾ x 6½ x 8
H-117	5000 6000	2125 2550	900 800	H-79 H-79	**1100** **1000**	**H-79** **H-79**	13½ x 11 x 14½

*After filter choke. All ratings are for choke input filter.

UNITED TRANSFORMER CO.

150 Varick Street, New York 13, N. Y. • EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y.

CABLES: "ARLAB"

electronics

A McGRAW-HILL PUBLICATION

JULY • 1956

GEAR HOBBER CORRECTS OWN ERRORS—Machine designed at Airborne Instruments Laboratory checks gears for pitch diameter and root fillet buildup and automatically adjusts to compensate for tool wear in Plymouth engine plant (see p 140) . . . . COVER

FEATURES

CONTINUED ON NEXT PAGE

contents

continued

SHOP

▶ COMMUNICATIONS . . . Editors on ELECTRONICS staff have one advantage over the editors of many other publications—they can pursue their editorial interests at home as a hobby.

Half the staff currently hold FCC licenses, mostly amateur, and nearly all have at some time or another held ship and broadcast operator licenses.

The publishing business being what it is, the amateurs on the staff do not spend much time operating. They do, considerable experimenting, though, some of it on amateur equipment.

Seven editors have commercial communications receivers, several have more than one. We exclude Command sets from this category, but there are two dozen of these scattered throughout the staff.

There are five tape recorders and two wire recorders in editors' homes. These have had an increasing amount of use in the past year or two and there has been some duplicating of tape for other editors.

Television sets average 2.4 per editor. Sizes range very widely and include 3, 5, 7, 10, 12, 16, 17, 19, and 21-inch picture tubes. Two are the proud possessors of color sets.

Table model radio receivers, with and without clocks, average 3.1 per editor.

Ten f-m receivers, or tuners and amplifiers, are used by ELECTRONICS editors.

electronics

JULY, 1956 Vol. 29, No. 7

Member ABC and ABP

TALK

Some rather odd pieces of gear turned up in our survey. These came from surplus which, right after the war, was a boon to those of us who admire odd pieces of electronic gear. Included are two radio teleprinters.

Three of us admit that, although we have no practical use for them, it was because of purely academic interest and admiration that we picked up Gibson Girls.

► DISTANCE NO PROBLEM . . . A subscriber in Durban, South Africa floored us last month. He wrote that he noticed in December *Shoptalk* the troubles faced by another reader packing and moving his 120 copies of ELECTRONICS from the east to the west coast.

He, J. W. Orner, states, "I am up against much the same trouble as I have a collection dating back to mid 1948 and am leaving South Africa for the U. S. shortly. In my case the problem seems to be a bit tougher and I have not yet succeeded in solving the first of his two troubles, convincing my wife that the issues are really going with us."

► CHIROGRAPHY . . . Editors are often called upon to interpret foreign letters (sometimes in the original non-English) because of their technical knowledge that helps clarify individual words from their context. Recently, however, a different technique was necessary.

ELECTRONICS Washington editor Gladys Montgomery handles our affairs with the various agencies in the nation's capital but has never been in New York when photos of the staff were taken for Shoptalk. She appears at left, in the photo above. It was taken at the annual dinner of the Women's National Press Club and includes Mrs. Eisenhower, other members of the club and President Eisenhower

An English-speaking author sent in some typed copy that was obviously very much garbled. After a moment of headscratching, the editor decided that a typist had put down what she saw instead of what the author meant when he scribbled it down.

Fortunately, he was familiar with the author's writing. So he scribbled "nook" in a simulated hand, and sure enough, the letters also looked like "mask".

The word fitted the context most perfectly!

► NO END TO NOISE . . . "Reducing Noise in Communications Systems", page 148 this issue, concludes Bill Bennett's series on electrical noise. This is not the last word ELECTRONICS has to say on the subject, however. We will continue to follow the subject closely and to publish other worthwhile articles in future issues.

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Single copies 75¢ for United States and possessions, and Canada: $1.50 for Latin America; $2.00 for all other foreign countries. Buyers' Guide $3.00 Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years. Canada, $10.00 a year; $16.00 for two years. Other western hemisphere countries and the Philippines, $15.00 a year; $25 for two years. All other countries $20.00 a year; $30.00 for two years. Three-year rates, accepted on renewals only, are double the one-year rate. Entered as second-class matter August 29, 1936, at the Post Office at Albany, N. Y., under act of Mar. 3, 1879. Printed in U.S.A.

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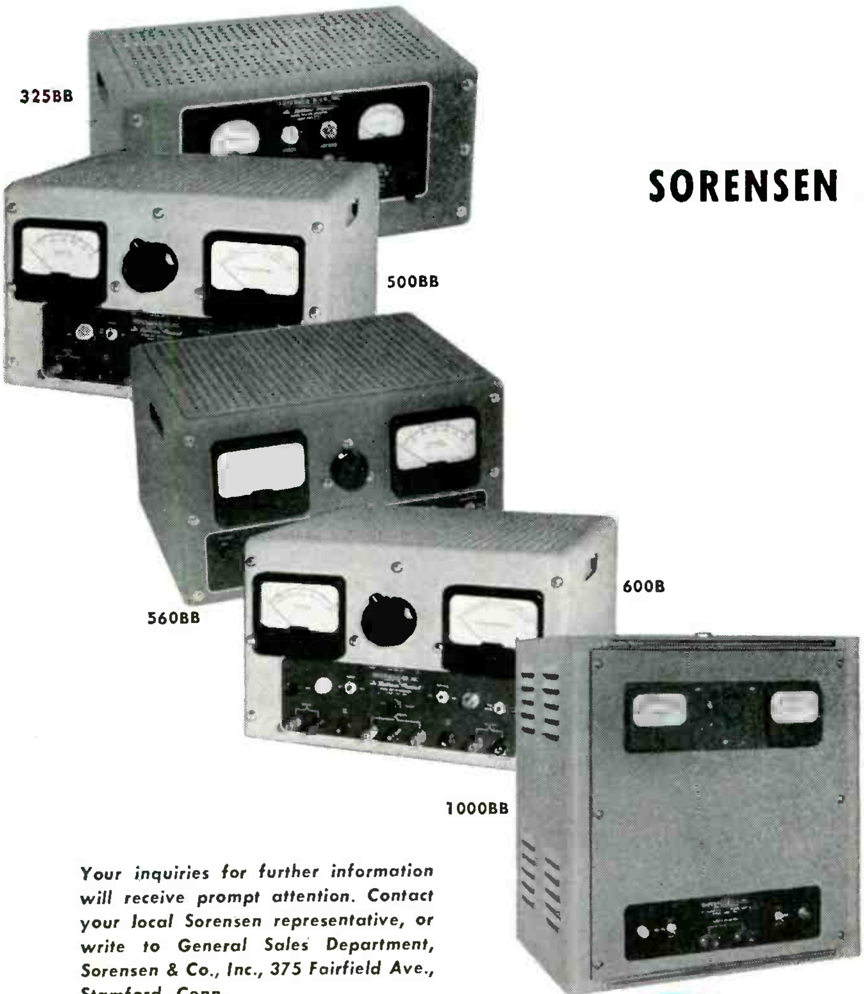
CHECK ALL B SUPPLIES

YOU WILL CHOOSE

SORENSEN B-NOBATRONS*

PERFORMANCE • DEPENDABILITY • PRICE



SORENSEN B-NOBATRONS (B Power Supplies) were designed specifically to provide an economical answer for a very wide range of technical requirements.

Look them over. Five catalog models, available from stock, give you choice of outputs from 0-325, 0-500, 0-600, and 0-1000 VDC, accurately regulated. High grade engineering, high grade materials, and Sorensen's unequaled know-how in designing and manufacturing regulated power equipment combine to assure you top performance, dependability, and fair price.

*Reg. U.S. Pat. Off.

DC POWER SUPPLY SPECIFICATIONS

Model	325BB	560BB	500BB	600B	1000BB
AC input range (50-60 cps, 1Ø)	105-125	105-125	105-125	105-125	105-125
Output range (VDC)	0-325	0-500	0-500	0-600	200-1000
Output current (Ma)	0-125	0-200	0-300	0-500	0-500
Regulation accuracy	±0.5%	±0.5%	±0.5%	±0.25%	±0.5%
Ripple (MV-RMS)	5 max.	5 max.	5 max.	3 max.	20 max.
Bias supply (VDC at 0-5Ma)	0-150	0-150	0-150	0-150	——
Internal impedance (max.)	2 ohms	2 ohms	2 ohms	2 ohms	2 ohms
AC voltage (C.T., unreg.)	6.3 at 10 amp.	6.3 at 10 amp.	6.3 at 10 amp.	6.3 at 15 amp.	——
Max. bias circuit impedance	25000 ohms	25000 ohms	25000 ohms	50000 ohms	

Your inquiries for further information will receive prompt attention. Contact your local Sorensen representative, or write to General Sales Department, Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn.

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Hourly Stability Better than ±0·02%

NO IDLE BOAST—this is the normal performance of the D-695 MUIRHEAD-WIGAN decade oscillator

Other outstanding features of this unique instrument include . . . .

Extreme Simplicity of Control

just set the frequency dials and adjust to the required level on the output meter

Frequency Accuracy

±0·2% and better, within five minutes of switching on

204

THE D-695 MUIRHEAD-WIGAN DECADE OSCILLATOR

Low Harmonic Content

obtained by using controlled negative feedback in the oscillatory section

PUBLICATION 4718 sent on request

SPECIFICATION

FREQUENCY RANGE
10 c/s-31 200 c/s (continuously variable) in two ranges (× 1 and × 10)

FREQUENCY ACCURACY (within 5 minutes of switching on).
±0·2% (or better) above 100 c/s, decreasing to ±0·3 c/s at 10 c/s

HOURLY STABILITY Better than ±0·02%

RESETTING ACCURACY 0·1 c/s on × 1 range : 1·0 c/s on × 10 range

HARMONIC CONTENT AT AN OUTPUT LEVEL OF 10 mW
30 c/s-30 kc/s 0·2% into 600 ohm balanced or unbalanced; 0·5% into 10 k ohm unbalanced.
Below 30 c/s Increasing gradually to about 0·6% in the two unbalanced conditions and about 4% in the 600 ohm balanced condition at 10 c/s

HUM LEVEL WITH RESPECT TO 10 mW
—70dB (0·03% of the output voltage at 10 mW)

VARIATION OF OUTPUT LEVEL WITH FREQUENCY
50 c/s-10 kc/s Flat within ±0·1dB
20 c/s-30 kc/s Flat within ±0·5dB
Below 30 c/s ±1dB

MAXIMUM UNDISTORTED OUTPUT POWER 10 mW

POWER SUPPLY
190-250V, 50 c/s (D-695-A) 95-125V, 60 c/s (D-695-A/100)

OVERALL DIMENSIONS
17½ in. wide × 12½ in. high × 8 in. deep (44·5 cm × 31·8 cm × 20·3 cm)

WEIGHT 37 lbs (17 kg)

MUIRHEAD

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FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month Apr. '56	Previous Month Mar. '56	Year Ago Apr. '55
Television sets, total	549,632	680,003	583,174
With UHF	74,102	82,805	103,088
Color sets	nr	nr	nr
Radio sets, total	992,982	1,360,113	1,099,755
With F-M	nr	833	13,894
Auto sets	299,253	478,272	567,876

RECEIVER SALES

(Source: RETMA)	Apr. '56	Mar. '56	Apr. '55
Television sets, units	347,630	544,411	411,748
Radio sets (except auto)	471,193	527,649	367,841

RECEIVING TUBE SALES

(Source: RETMA)	Apr. '56	Mar. '56	Apr. '55
Receiv. tubes, total units	35,184,000	42,525,000	35,426,153
Receiv. tubes, value	$28,616,000	$34,849,000	$26,779,586
Picture tubes, total units	830,902	848,055	788,317
Picture tubes, value	$15,141,461	$15,714,365	$14,620,075

INDUSTRIAL TUBE SALES

(Source: NEMA)	Quarterly Figures — Latest Quarter 4th '55	Previous Quarter 3rd '55	Year Ago 4th '54
Vacuum (non-receiving)	$9,967,411	$9,027,845	$9,338,181
Gas or vapor	$3,251,621	$3,438,835	$3,498,123
Magnetrons and velocity modulation tubes	$13,726,323	$10,998,967	$15,249,651
Gaps and T/R boxes	$1,578,767	$1,421,138	$1,788,780

MILITARY PROCUREMENT

(Source: Defense Dept.)	1st '56	4th '55	1st '55
Army	$40,490,000	$48,477,000	$2,833,000
Navy	$28,700,000	$20,378,000	$43,147,000
Air Force	$124,828,000	$131,938,000	$133,503,000
Total—Electronics	$194,018,000	$200,793,000	$179,483,000

BROADCAST STATIONS

(Source: FCC)	Latest Month May '56	Previous Month Apr. '56	Year Ago May '55
TV stations on air	495	489	454
TV stations CPs—not on air	112	114	124
TV stations—new requests	41	29	16
A-M stations on air	2,890	2,872	2,711
A-M stations CPs—not on air	118	118	103
A-M stations—new requests	273	275	217
F-M stations on air	532	534	540
F-M stations CPs—not on air	15	13	12
F-M stations—new requests	4	6	4

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Apr. '56	Mar. '56	Apr. '55
Aeronautical	46,739	45,488	42,045
Marine	55,530	55,175	49,261
Police, fire, etc.	20,339	20,216	17,827
Industrial	28,946	28,454	24,045
Land transportation	9,001	8,849	7,499
Amateur	148,648	146,699	134,720
Citizens radio	17,046	16,262	11,193
Disaster	327	327	313
Experimental	690	666	600
Common carrier	2,219	2,185	1,917

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Mar. '56	Feb. '56	Mar. 55
Prod. workers, comm. equip.	378,300-p	385,400-r	352,300
Av. wkly. earnings, comm.	$75.14 -p	$74.93 -r	$70.80
Av. wkly. earnings, radio	$72.00 -p	$70.84 -r	$68.68
Av. wkly. hours, comm.	40.4 -p	40.5 -r	40.0
Av. wkly. hours, radio	40.0 -p	40.0 -r	39.7

SEMICONDUCTOR SALES ESTIMATES

	Mar. '56	Feb. '56	Jan. '56*
Transistors, Units	707,817	616,818	572,674

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	May '56	Apr. '56	May '55
Radio-tv & electronics	424.0	450.0	471.4
Radio broadcasters	492.1	524.0	537.0

p—provisional r—revised nr—not reported

*1955 not available

FIGURES OF THE YEAR

	TOTALS FOR FIRST FOUR MONTHS 1956	1955	Percent Change	1955 Total
Television set production	2,394,264	2,771,426	—13.6	7,756,521
Radio set production	4,525,225	4,739,919	— 4.5	14,894,695
Television set sales	2,036,808	2,355,740	—13.5	7,421,084
Radio set sales (except auto)	1,984,915	1,609,182	+23.3	6,921,384
Receiving tube sales	155,604,000	152,762,000	+ 1.9	479,802,000
Cathode-ray tube sales	3,469,405	3,427,745	+ 1.2	10,874,234

INDUSTRY REPORT

electronics—July • 1956

RETMA Sees Increased Volume

Predicts rise of $250 million in equipment sales this year, higher military and radio sales

DURING the 1955-56 RETMA fiscal year ending in August, electronics manufacturers will sell equipment valued at $5.5 billion as against $5.25 billion during 1954-55 fiscal year, according to estimates by F. W. Mansfield of Sylvania, chairman of RETMA's statistics committee. The total billing of the industry should exceed $10 billion with distribution, service, installation and broadcast revenue.

The total factory sales of all amusement devices (radios, television sets, phonographs, etc) was estimated at $1.434 billion compared with $1.495 billion in the last fiscal year. Industrial and commercial products are up from $625 million to $775 million. Military products exceed $2.5 billion versus $2.375 billion in the preceding fiscal year. Replacement parts reach $780 million this year compared with sales of $725 million.

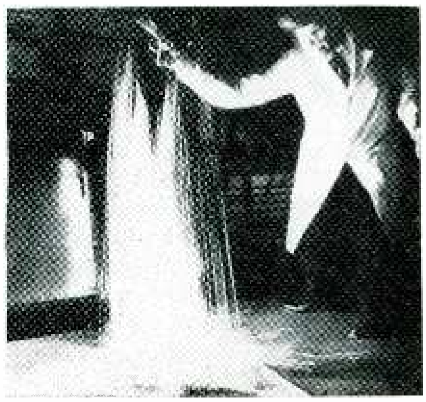
▶ **Units**—Radios gain 14 percent with 14,300,000 units sold by factories during 1955-56 compared with the 12,576,138 in 1954-55. Auto radios account for 6,400,000 units versus 5,704,983 for a gain of 12 percent. Factory sales of all other radios were estimated at 7,900,000 versus 6,871,155, a 15-percent growth.

Television set factory sales show a decline of 6 percent, from 7,959,389 to 7,450,000 units.

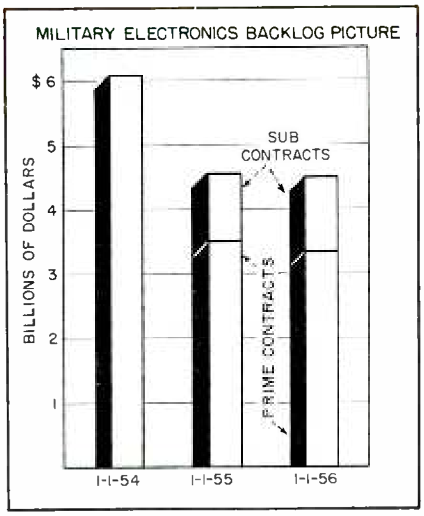
▶ **Multiple Ownership**—According to the RETMA report, it is to be expected that the television industry is on the threshold of a new upswing even though 75 percent of American households have one or more television sets and 91 percent may have them by 1960. Multiple set ownership and replacement sales will account for the rise. During 1954, the number of television sets sold to those already having at least one set in working order was 925,000. During 1955, another 1,700,000 were sold as second sets.

In 1950, replacement television sales were only 102,000. Last year, they were 2,366,000. By 1960, it is estimated that annual television sales to replacement buyers will be 6,100,000.

Magnet Material Burns



PURIFIED manganese-bismuth ignites when exposed to air. Expected to yield powerful permanent magnets, it has been perfected by Westinghouse for the Air Research and Development Command. Resistance to demagnetization is about ten times greater than present magnets



FROM peak in 1954 . . .

Military Backlogs Hold Up

Companies have big business on the books and orders are increasing

MANY firms are well set for a big year in the military electronics business. This is indicated by the industry's military backlog. Individual firms report sharp increases in unfilled orders.

At the beginning of 1956, the industry had a total military backlog of $4,503.5 million representing a decline of only $23 million from the $4,526.4 million a year earlier. Recent reports for individual firms indicate that by the beginning of 1957, the backlog of military orders may approach the total of 1954.

▶ **Rise**—One company reports that its current $58-million backlog is the highest month-end total since December, 1954. Reports from other firms indicate increases ranging from 25 percent to 100 percent over backlogs of a year ago. For ten companies, backlogs, on the average, are some 60 percent higher than they were a year ago.

▶ **Why**—Increased emphasis on guided missile and other aircraft procurement this year is an important reason for the rising backlog. Some manufacturers who planned to deemphasize military business in favor of civilian sales have changed plans and are staying with military electronics.

The Navy's survey of electronic production capabilities (ELECTRONICS, June, p 8, 1956) showed that this year 99 companies of those surveyed plan 100 percent military production compared to 73 in 1955. However, the number of companies who planned 100-percent civilian production also increased, from 79 in 1955 to 97 at the beginning of 1956.

CAA Budgets for Electronics

Program calls for $250 million expenditure for equipment in the next five years

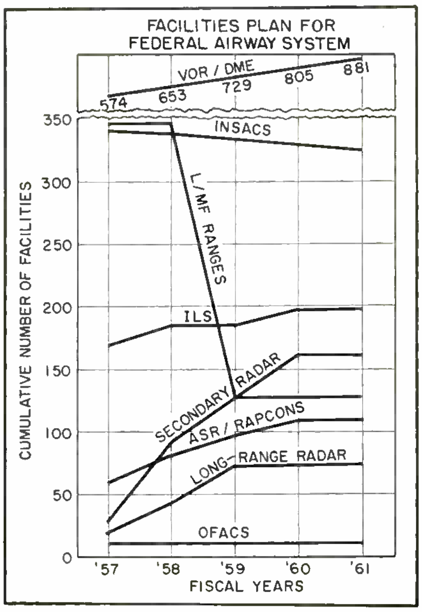
ELECTRONICS looms large in CAA plans to provide adequate air navigation, communications and traffic control for the nation's growing aircraft population. For electronics manufacturers the program may mean new business in the next five years of close to $250 million.

▶ **Major Units**—Airport Surveillance Radar (ASR) with a range of 50 to 60 miles will be increased by an additional 44 locations through fiscal 1961 bringing the total number to 89. As of June 30, 1955, a total of 45 had been planned with 31 commissioned and 14 under installation.

By 1957 the CAA hopes to have 13 Radar Approach Control (RAPCONS) units in operation increasing to 20 by 1958. Cost for the program through 1961, excluding maintenance and operation, would be about $19.6 million.

▶ **Long-Range Radar**—This equipment, for obtaining information on aircraft en route rather than in terminal areas, is to be increased by 51 additional installations through fiscal 1961 at a total establishment cost of $42.2 million.

▶ **Secondary Radar**—Used to detect and identify aircraft within a range of 200 miles, secondary radar or ATC Radar Beacon System depends on transmitted replies from aircraft.



A total of 162 is contemplated through 1961 of which 28 will be furnished by the military. This will mean expenditure of $15.2 million for the equipment during the period.

▶ **VOR/DME**—This equipment provides track guidance and position information for air navigation. As of June 30, 1955 214 DME's had been commissioned for use with VOR's, 141 more had been installed but not commissioned, 73 installations were under way and 4 projects were unassigned. There has not been a DME establishment program since fiscal 1955.

Federal agencies on the Air Coordinating Committee agreed last year on military implementation of a tactical air navigation system (TACAN) and the continued use of VOR/DME until some succeeding "common system" has been adopted and installed.

If TACAN is adopted, VOR would continue in use until 1965 and DME until 1960. However, if VOR/DME continue as part of the overall "common system" CAA estimates that 383 additional VOR/DME facilities will be required through 1961 with a $49.7 million establishment cost. If TACAN is adopted an estimated 814 TACAN units will be required through 1961.

▶ **ILS**—An additional 28 instrument Landing Systems will be required through 1961. As of June 30, 1955, 170 were programmed, 157 commissioned, 5 unassigned and 8 underway. New ILS will cost about $11.4 million to establish.

▶ **Other**—Other equipment planned that may provide additional business for electronics manufacturers includes INSACS or interstate airway communications systems and OFACS, overseas-foreign aeronautical communications stations.

Broadcasters Get Set For 1956 Politics

Elaborate tv facilities are planned by networks for convention coverage

THREE tv networks will have tons of equipment on hand for coverage of the Republican National Convention in San Francisco Aug. 21-24 and the Democratic National Convention in Chicago Aug. 13 to 20.

▶ **ABC** — American Broadcasting plans to build two 14-room units, one in San Francisco and one in Chicago.

The network will use 25 cameras in addition to five pool cameras. ABC newsmen will be equipped with portable tv cameras, two-way communications sets and thirty magnetic paging receivers will be available. (ELECTRONICS, p 210,

(Continued on page 10)

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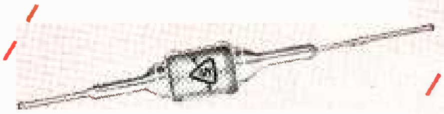

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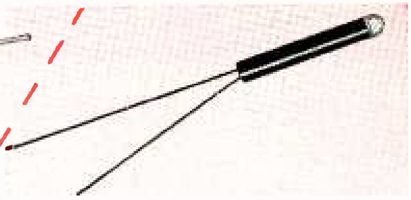

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Newsman for NBC-TV's convention coverage holds experimental RCA transceiver, left, and a portable tv camera powered by a pack on his back

June 1956). Three mobile units will operate in each convention city.

▶ CBS—Approximately 22 tons of equipment will be used by CBS to cover the Chicago convention. It will then be moved to San Francisco for the Republican convention. High-speed computers, new two-way radios weighing about 5 pounds each and a new tv camera will be included in the equipment.

The network also hopes to have Ampex video recorders available for convention coverage. (ELECTRONICS, p 7, May, 1956).

▶ NBC—Staffs at each convention for NBC will number close to 400 persons. Three mobile units and over 40 cameras will be used at each site. On the convention floors, a team of reporters will be equipped with two-way radios. Roving mobile units and portable one-man cameras will be used. Film units equipped with high-speed developing equipment will be on the scene.

The network will use Porto-Vision, portable tv receivers that will enable politicians to see each other by split-screen techniques while they talk to each other. The tv audience will have a view of the conversation at the same time. Hip pocket wire recorders with tie-clasp microphones will also be used.

FCC Actions

▶ **Announced** reception of 50 comments overwhelmingly in favor of proposed unlimited remote control for a-m and f-m stations. Present rules allow remote control of non-directional a-m and f-m of 10 kw or less.

▶ **Stayed** arc welding rules until further information is available about the characteristics of radio-frequency arc stabilizers that cause interference to communications.

▶ **Amended** tv rules to permit operation of uhf translator stations in channels 70 to 83 to serve areas without good tv signals. Translators will pick up programs from existing stations and rebrodcast them with an effective 100 watts. More than one remotely controlled translator can be used per program, but each on a different channel with its own call letters.

▶ **Created** a Domestic Radio Facilities Division in the Common Carrier Bureau to handle radio services and facilities of domestic common carriers.

▶ **Established** the radio-frequency band 10,500 to 10,550 mc for land and mobile radio-positioning stations using c-w emission.

▶ **Sought** information to formulate rules for experimental tropospheric over-the-horizon "scatter" assignments, which Commission believes may replace or supplement conventional radio systems.

▶ **Received** Stromberg-Carlson petition to establish selective radio paging service for certain industrial radio users.

▶ **Deferred** to Dec. 1 the requirement that field intensity measurements of spurious radiation be submitted with requests for equipment type acceptance.

Test Equipment Volume Triples

Value of shipments nears $190 million with oscilloscopes showing biggest gain

MANUFACTURERS of test equipment for electrical, radio and communication circuits shipped over $188.1 million worth of products in 1954, according to an advance report on the 1954 Census of Manufacturers by the Commerce Department. The total represents more than a threefold increase over 1947 shipments worth $54.8 million.

▶ **Types**—Four types of test instruments registered the largest percentage gain in shipments during the 7-year period between 1947 and 1954. Oscilloscopes (high frequency types) rose from $766,000 to $7.0 million during the period, followed by radio-frequency measuring equipment which increased from $1.8 million in 1947 to $13.7 million in 1954. Electronic volt-ohm-milliammeters registered a gain of $2.9 million in annual dollar volume of

(Continued on page 12)

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HERE ARE THE SMALLEST *aluminum electrolytic capacitors ever made to Sprague's rigid quality standards.* Add to that their low leakage current, high reliability, and moderate price, and you have a new series of *miniature* electrolytic capacitors ideal for use in transistorized pocket radio receivers, wireless microphones, personal-style wire recorders, and similar equipment.

Their ultra-low leakage current is particularly important for it means minimum drain and long battery life when used in filtering applications across a battery, and excellent circuit performance when used in coupling applications.

Sprague Littl-Lytics are available in a full range of capacitance ratings from 1 to 110 mf, and in standard working d-c voltages of 1, 3, 6, 10, 12, and 15. Sizes range from 3/16"D x 1/2"L to 3/8"D x 3/4"L. Maximum operating temperature of the new Type 30D capacitors is 65°C.

Performance and size data on metal encased, hermetically sealed Littl-Lytics, in more ratings than ever before, are all provided in NEW Engineering Bulletin 320A, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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μF		3	60
Leakage Current (μA Max.)		2.0	3.0
Can Size	D"	3/16	3/8
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shipments, going from $723,000 in 1947 to $3.6 million in 1954. Signal generator shipments rose from $3.7 million to $15.1 million.

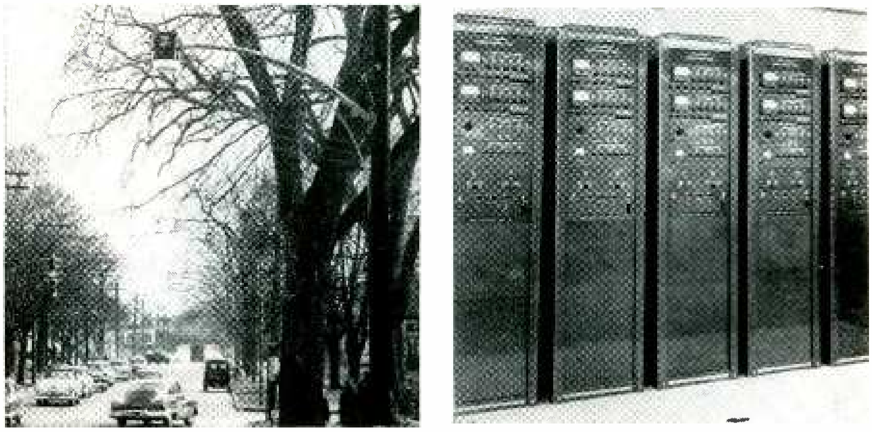
▶ **Leaders**—Shipments for five types of test equipment exceeded $10 million in 1954, according to the Census. They are engine analyzers and auxiliary equipment, $23.1 million; oscilloscopes and oscillographs other than high-frequency types, $16.4 million; signal generators, $15.1 million; radio-frequency measuring equipment $13.7 million; parts for test equipment sold separately, $11.3 million.

▶ **Other**—Volume of shipments for other types of test equipment listed in the Census breakdown in order of value is as follows: microwave test equipment $8.4 million; oscilloscopes (high-frequency types), $7.0 million; receiving tube testers, $5.8 million; electrical volt-ohm-milliammeters, $4.4 million; electronic volt-ohm-milliammeters, $3.6 million; resistor, capacitor and inductor measuring equipment, $3.2 million; broadcast transmitter test equipment, $1.6 million.

Overall volume of shipments for other types of test equipment not listed in the breakdown totaled $73.7 million.

Hot Tube Made For Automatic Circuits

ONE of a new series, the Eimac ceramic receiving tube shown in the photograph is being made as a dual triode and pentode. Such a tube can withstand 15-g acceleration at frequencies up to 2,000 cycles. The tube is undamaged at envelope temperatures up to 300 C. Electrical terminals in the form of flat tabs facilitate incorporation of the tube as part of automatically produced circuit modules



RADAR hanging from stanchion, left, detects cars approaching intersection and sends count to computer, right, that controls traffic lights when . . .

Tubes Clear Highway Traffic Jams

Traffic control systems range from downtown grids to isolated intersections

WITH nearly 62 million registered motor vehicles and new ones rolling off the assembly lines at about nine million annually, traffic congestion has become a serious problem. Engineers working towards more efficient handling of highway traffic are getting help from electronic devices including radar and computers.

▶ **Vehicle Detection**—One way to count cars approaching an intersection is an overhead doppler radar set about the size of a wastepaper basket. Its cone-shaped beam covers one approach. The set emits a pulse each time a vehicle passes through the beam.

Other ways to detect approaching vehicles are pressure or magnetic detectors set in the road. Some engineers prefer radar because it does not require digging up the pavement when it is installed.

▶ **Computers**—Pulses from the vehicle detectors go to preset counters that establish the traffic-signal cycle. At the traffic signal, electron tubes control the green-amber-red light cycle.

At so-called semiactuated intersections, two detectors on side-road approaches count vehicles while the traffic signal is set to favor traffic on the arterial highway. At fully actuated intersections four or more detectors count vehicles approaching in all directions and allocate green time on the traffic signal to favor the heaviest traffic flow. It costs from $3,000 to $15,000 to control an intersection depending upon the equipment required and the problems arising in installing cables and detectors.

▶ **Master Control**—In downtown areas master units controlling many lights automatically set up signal patterns to favor the heaviest traffic flow. In Philadelphia, for example, there will be five master units. On Broad St., three units will control about 60 intersections.

Baltimore plans to control more than 300 intersections. About two dozen cities including Atlanta, Denver, Houston, Los Angeles and New Orleans have some form of electronic traffic signal control. In five years, an estimated 1,000 cities will have electronic control systems.

The radar detector and master control unit shown are made by Eastern Industries, Norwalk, Conn.

▶ **Speed Control**—Doppler radar is doing a big job helping police tag speeders. About 1,500 units are in use.

Another application is a radar unit installed on Connecticut's Merritt Parkway that tells officers at State Police headquarters the speed of vehicles passing the monitor. Police can thus foretell impending con-

(Continued on page 14)

Antenna on fire chief's car controls traffic signals

gestion, get to the scene and get traffic moving again.

▶ **Emergency Vehicles**—The device shown in the photograph allows emergency vehicles to turn traffic signals red on side roads while speeding along a highway. The antennas radiate a 200-ft beam. Made by Standard Coil Products, the equipment consists of a transmitter in the vehicle and receiver in each traffic-signal control box.

Business Failures Up In Electronics

Slight increase in number of failures is offset by decrease in total liabilities

DURING the year ending in April, 29 manufacturers of electronic equipment or products failed in business compared with 26 in the previous year. Total liabilities of the 29 companies were approximately $11,055,000 as against $14,460,000 for the 26 firms a year ago, according to RETMA's credit committee.

▶ **Types**—Twenty of the troubled companies are continuing in business under the supervision of creditors' committees and nine have gone out of business completely with little or no recovery to creditors.

Seventeen of the firms were producers of components; eight were manufacturers of electronic equipment; two manufactured phonographs; one produced recorders, and one manufactured electronic organs.

Electronics Aids Weather Bureau

Radar for hurricane and tornado warning grows as $10 million is programmed for more equipment

HURRICANE season which started in June and reaches its height in September will be under closer watch this year than ever before. The U.S. Weather Bureau now has 42 radar units in operation in the U. S. representing an investment of nearly $500,000.

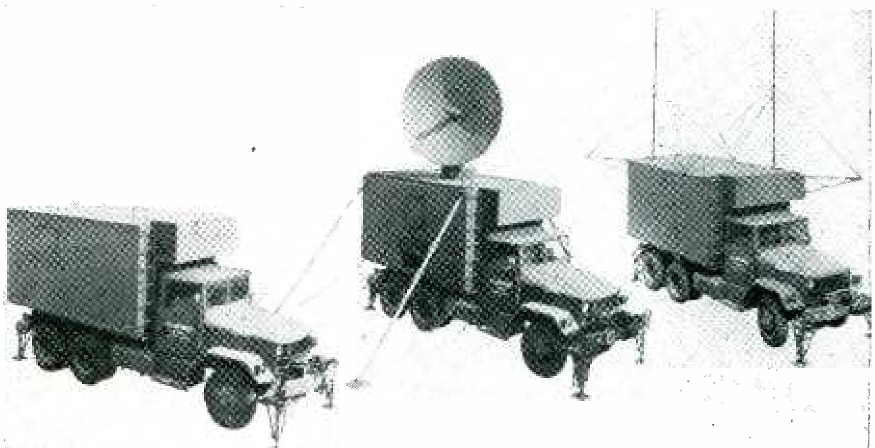
Two years ago the Bureau had 22 radar units in operation mainly for use in a tornado picket line in Texas where a line of 14 radar units was established.

▶ **Equipment**—Most radars now operating are APS 2 or 13 surplus radars turned over to the Bureau by the military. With the units a range of 200 miles is possible.

Soon, however, the Weather Bureau will have new radar units especially designed for its use. Bids are being received for the units which will range in price from $100,000 to $250,000. A contract will be let soon covering about 36 units. The Bureau hopes eventually to have approximately 100 radars in operation throughout the country for storm coverage.

Its overall equipment buying program calls for the expenditure of some $10 million through 1959 of which about $2.5 million has already been approved. A large percentage of the total amount will be used for electronics including the new weather radars, automatic visibility equipment and automatic ceiling cloud height recorders of which more than 100 are planned.

▶ **Computers**—For the past year the Weather Bureau, in conjunction with the Air Force and Navy, has been using an electronic computer for weather predictions. Ultimately the Bureau hopes to extend its use to tie in with automatic weather observers (ELECTRONICS, p 196, May '56) which will obtain the weather information, transfer it by teletype to a central point where the information will be converted to punched cards for compilation and analysis.



Computer, radar and radio vans, left to right, can go by plane as . . .

Air Force Gets New Radar System

ELECTRONIC close-support ground guidance radar system, designed and built by Reeves Instrument Corp., subsidiary of Dynamics Corp. of America, at a cost of about $40 million, has been delivered to the Air Force.

▶ **Parts**—The system, designated MSQ-1A Close-Support Control Set, consists of three basic vans: radar, computer and communications. The radar tracks friendly aircraft and furnishes continuous data to the

(Continued on page 16)

computer van for evaluation.

The computer analyzes, interprets and issues all necessary command instructions for tactical guidance of the aircraft. It also provides a continuous plot of the location of any and all airborne weapon systems.

Proper functioning of the system can be checked by a series of built-in automatic test problems and test operations.

Tube Testers Invade Supermarkets

Test-them-yourself stands in 12,000 stores become factor in tube sales

MANUFACTURERS of tube testers of the special quick-setup type have sold a total of 12,000 units, close to $3 million worth, since 1953. The testers go into supermarkets, drugstores and hardware stores for use by customers, and often get the same rough treatment as pinball machines.

▶ **Acceptance** — Though looked upon by many as a fad, the business has taken hold solidly in the west, southwest and southeast. In some areas it accounts for up to 50 percent of all replacement tube sales. The estimated national average of self-service replacement tube sales is around 10 percent.

▶ **Techniques**—Special testers on floor stands, foolproof and easy to operate, are installed in stores without charge by route operators. A favored location is near the liquor counter in a grocery store, because there is usually a clerk to assist with tests and unlock the tube storage rack in the tester base. Some setups carry as many as 125 different tube types. Tubes are checked out and paid for along with groceries.

A location is usually serviced once a week by the owner of the tester. Although many tester routes are owned by parts jobbers and radio servicemen, the majority are owned by pinball and jukebox route operators.

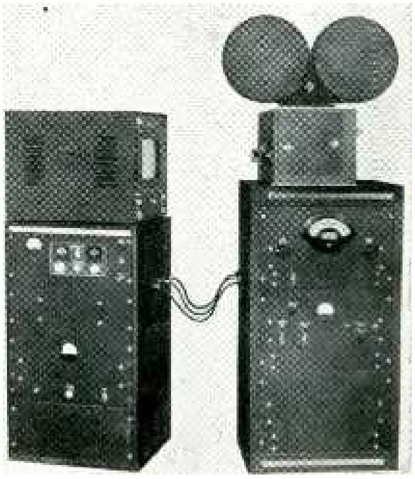
▶ **Profits**—Testers cost from under $200 to around $350. In the best southern California locations, monthly sales can run as high as $1,000 per tester, with average monthly sales per tester hitting $350. The national average of supermarket tube sales is reported to be about $70 per month per outlet.

A consignment contract between the store and the route operator usually gives the location around 25 percent of gross sales. Even with this, the monthly return on the operator's investment runs 15 to 20 percent. After half a year or so, a well-developed route can be sold at profit of 100 to 200 percent, taxed at capital gain rates.

▶ **Manufacturers** — Firms making special tube testers for this market include American Scientific Development Co. of Ft. Atkinson, Wis. and U-Test-M Mfg. Co. of Milwaukee. Initial response to units installed in 1953 in Milwaukee was slow, partly because of antagonism of local servicemen and tube jobbers, but sales picked up in 1954.

Largely resigned to sharing tube sales profits, servicemen in some areas pay as much as $20 a month for the privilege of painting their name on the tester door to get the repair business when a new tube won't fix the set.

Typical grocery supermarket installation. Multiple sockets minimize control settings needed for test



New video film recorder enters market as . . .

Bright Future Seen for Kinescope Recorders

Announcement of video-tape recorder does not appreciably affect film-recorder market

NO SLUMP in sales of video film recorders is anticipated because of a recently announced video tape recorder according to a spokesman for General Precision Laboratory, a supplier of kinescope recording equipment.

▶ **Prices**—Ampex is taking orders for its vtr at $45,000 a unit. Film recorders with optical sound tracks are quoted by GPL at $23,000 and with magnetic-sound-track units for as low as $19,700.

▶ **Other Companies** — Most recently, Univox Eastern made a bid for part of the film recorder market. It is taking orders for a kinescope recorder (see photo). The equipment consists of two units which can be transported, and setup for operation within a few minutes. Current price is $25,000.

(Continued on page 20)

COURTESY GENERAL ELECTRIC CO

. . . it's G-R Type 970 Potentiometers
where performance and reliability count

The recently announced Carboloy Machinability Computer promises to make the life of the tool engineer much less complicated. This compact instrument provides quick, simple answers to specific metal-cutting problems. Seventeen variables, including cutting speed, depth of cut, tool life, feed, metal removal rate and horsepower, can be determined accurately through use of the Computer.

Every part and component built into this "machining computer" had to meet stringent electrical-performance standards. In particular, General Electric engineers had to be certain that all known quantities would be correctly conveyed to the computer input circuits. That is why General Radio Type 970 Precision Potentiometers were specified for all fifteen of the panel function controls used to establish the input conditions.

Dependable, trouble-free operation is of necessity high on the list of specifications for any computer. Precision G-R Potentiometers are suited for computer use: because, they are sturdy and versatile . . . have superior resistance characteristics...feature a-c performance which is substantially better than that found in higher-precision types...and finally, they are very low in cost for value received.

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from 2 to 500,000 ohms
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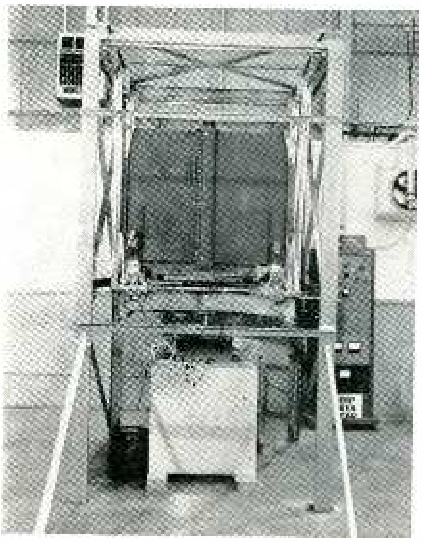
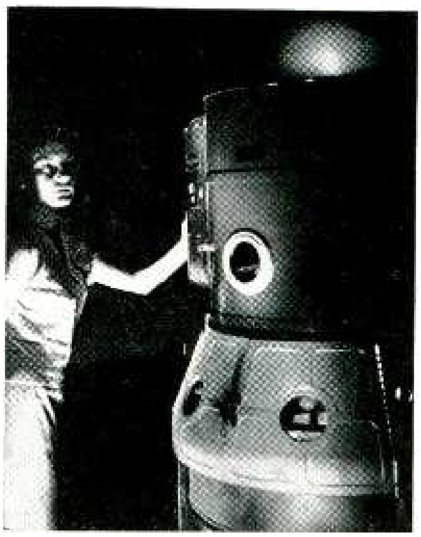




EARTHQUAKE Ernie, left, is the name given to Northrop Aircraft's new electronic shaker (arrow). Robot like device, right, is used at GE to simulate desert heat and glare as . . .

Environment Creates Big Business

More companies buy equipment to meet new extremes in operating conditions

EVER increasing military requirements for electronic equipment that will operate within even wider limits of heat, temperature, humidity, pressure, and other climatic and operating conditions, have boosted the importance of environmental test equipment to the industry.

▶ **Contracts** — Nearly every electronics firm holding military contracts has environmental testing equipment available. One of the largest companies in the environmental field estimates that electronics firms, alone, account for about $10 million in equipment sales a year.

▶ **Equipment**—Depending on the units, many of which are custom made, prices range anywhere from $1,000 to $150,000 per system. Size of the units range from one cu ft dry ice chambers to walk-in rooms, and giant facilities, such as those at an Air Force base where an aircraft hangar has been set up for environmental testing of complete aircraft.

▶ **Range**—Whereas the temperature range for much equipment was from −100 to 350 F, today the range may go from −150 to 500 F, and up to 1,000 C in some special installations.

Temperature and altitude chambers are the biggest sellers but companies supply equipment for nearly every condition, including baths, sand and dust, explosions, fungus, fog and vibration.

▶ **Firms** — There are about two dozen companies that manufacture environmental equipment, according to the Environmental Equipment Institute, although about 15 companies do the bulk of the business. In addition, a number of electronics manufacturers build their own equipment. But as specifications and requirements increase, more firms are buying ready-made equipment.

▶ **Product**—General Dynamics and Consolidated Electrodynamics have set an agreement in which Consolidated will manufacture and market Convair's dynamic shock-testing machine. The device simulates shock experienced by equipment in actual use. It is capable of applying widely varying accelerating and decelerating forces for controlled periods of time. It will be used in shock-testing electronic equipment for missile and aircraft applications. The cylindrical device is no larger than a golf-bag, whereas drop towers now used for shock tests require much more space.

A new midget shake-test device has been developed by Northrop Aircraft. Less than one cubic foot in size, the device can apply a force of 55 g's to guided missile electronic components weighing more than 1,000 pounds. It produces vibrations ranging from 5 to 600 cps. Prime mover is a vibration exciter composed of the two-stage electrohydraulic servo valve and the hydraulic system. An amplifier-like exciter transmits electronic impulses to the valve's pilot spool. This controls the movements of the piston rod to shake the specimen.

RESEARCH of petroleum is aided by RCA unit at Atlantic Refining as . . .

Electron Microscopes Keep Gaining

Applications widen as industrial and biological research activities increase

BETWEEN 1,000 and 1,200 electron microscopes are in use throughout the world.

▶ **Market**—RCA estimates that it has produced about 600 units. Many have been manufactured abroad. About two dozen foreign firms are active.

Countries in which the devices

(Continued on page 22)

BARRY ADDS NEW WEST COAST FACILITY

Occupies Plant in Burbank

With its purchase of all physical assets of the United States Sheet Metal Products Company in Burbank, California, Barry Controls Incorporated establishes a Western Division for improved service to the aircraft and missile industry. Operations of the Western Division will include an engineering design section, a shock and vibration test laboratory, a model shop, and production of special designs.

The metal-working facilities of this plant will be used to produce prototypes of vibration-isolating mounting bases and for short-run production of special mounting bases. Stocks of standard isolators will also be maintained here. Barry's present West Coast engineering office will become part of the engineering section of the Western Division.

With the availability of on-the-spot engineering consultation and local model-shop facilities, design and development of complex mounting systems for missiles and jet aircraft will be speeded and valuable lead-time gained for production of prototypes.

CHIVERS TO HEAD WESTERN DIVISION

A. S. Chivers, Sales Manager of Barry Controls Incorporated, has been appointed General Manager of the new Barry Western Division. A graduate of Massachusetts Institute of Technology, Chivers joined Barry in 1952 as administrative assistant with the sales department. He was made Assistant Sales Manager in 1953 and Sales Manager in 1955. As General Manager of the Western Division, he will be responsible for the direction of all its activities.

Want more information? Use post card on last page.

are produced include Holland, Switzerland, France, Sweden, Germany, Great Britain and Japan. There are some 12 or 13 different brands of electron microscopes made in Japan. Russia claims that it has several models available.

Industrial and biological research represent large markets for electron microscopes. More than 20 companies in the chemical and processing field have installed the devices. The petroleum and railroad fields also rank high in importance along with the metal fabricators and industrial research institutes.

▶ **Use**—Atlantic Refining Co. recently installed an RCA unit at its research labs. It is being used in research and development of lubricating greases, waxes and catalysts. According to Atlantic, grease technology is being advanced by electron microscopic study of the effects of processing variables such as composition, temperature and degree of mechanical work on the structure and quality of greases.

The electron microscope played a part in the development of the Salk polio vaccine. It is capable of making polio virus visible. It is also aiding law-enforcement agencies. With the device it is said to be possible to detect the origin of incendiary material.

▶ **Power**—Early electron microscopes provided direct magnification of about 20,000 diameters.

North American Philips and Seimens & Halske have models that provide direct magnification up to 100,000 diameters. With photographic enlargement, useful magnification can be extended up to 300,000 diameters.

Prices range from about \$9,000 to \$45,000, depending on power and auxiliary services.

Control board of new nuclear reactor for industrial research is inspected as . . .

Industry Gets Private Nuclear Reactor

Unit for industrial research goes into operation at Armour Research Foundation

PRIVATE nuclear reactor for industrial research goes into operation at a new \$1.2 million physics and electrical engineering research building being constructed by Armour Research Foundation of the Illinois Institute of Technology in Chicago. It was built by Atomics International, a division of North American Aviation. The reactor is a neutron and gamma source and is not intended for the generation of electrical power, nor for research on reactors themselves.

▶ **Use**—Probably the most frequent use of the ARF research reactor will be in the production of radioactive samples. The reactor makes possible, structure analysis potentially more powerful than the standard x-ray diffraction techniques.

▶ **Electronics** — The instrumentation consists of circuits which monitor reactor power and the performance of the gas-handling and cooling system. There is provision for area radiation monitoring and similar instrumentation.

▶ **Firms** — Twenty-four industrial companies are participating in the nuclear reactor research program

(Continued on page 24)

Wire Makers Size Up Future

Communications equipment accounts for high volume but printed circuits are gaining

WIRE and cable for communications, ranging from wire used in radio and tv sets to railroad signal wire and coaxial cable, account for over 20 percent of the total value of insulated wire and cable produced in the U. S. An estimated \$1.5 billion worth of insulated wire and cable was produced and shipped last year with between \$300 million and \$400 million dollars worth going for communications equipment. In 1953 communications wire and cable shipments totaled about \$300 million.

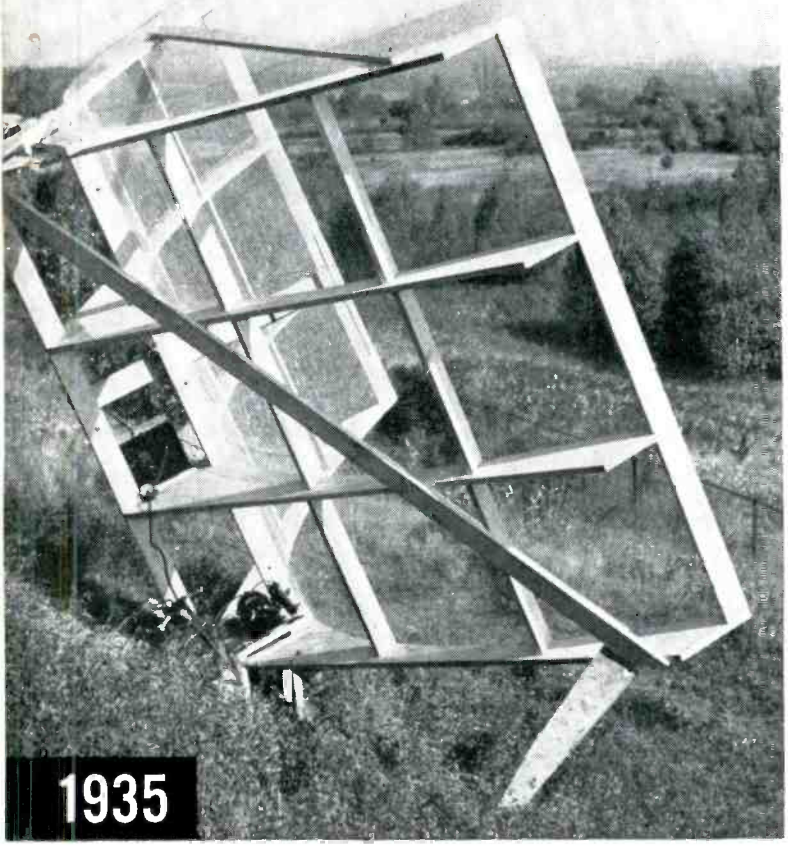
▶ **Sets**—Radio and tv set makers have been major markets for some wire manufacturers. About 20 companies are members of RETMA's wire section.

Last year an estimated 400 million feet of wire, mainly Awg. No. 18, 20 and 22, were used in tv sets. At current prices this represents about \$2 million. Add to this, wire used in 14 million radios, computers and military equipment.

▶ **Insulation**—According to a 1955 survey by the Department of Agriculture, the communications wire industry purchased 72 million pounds of plastics material, 35.5 million pounds of paper, 28 million pounds of rubber, 9.6 million pounds of cotton and about 5 million pounds of acetate, asbestos and fibrous glass.

▶ **Printed Circuits**—Increasing use of printed circuits has cut the volume of hookup wire sold for electronics. This year an estimated 70 percent of all radios will use printed circuit boards and some 6 million sq ft of printed circuit boards will be produced for tv sets. In all, a total of 8 million sq ft of printed circuit board may be produced in 1956.

RCA's new color and monochrome sets will use up to six printed circuit boards in each chassis. In the new color sets from 80 to 90 percent of the circuits are on printed circuit boards compared to about 20 percent in previous color sets.



EARLY RESEARCH AND DEVELOPMENT EXPERIENCE with electronic location equipment at G.E. began in 1935 when this first system, with an output of 1½ watts, located planes up to five miles away.

IN USE TODAY, this huge nodding height finder was designed and developed by General Electric to be used with powerful search radar systems and is a major contribution to long-range aircraft location.

How G.E.'s 20-year antenna background can help make your radar system more effective

6 examples show experience in all areas of land- and ship-based antenna work

To give you an outstanding source for reliable, precision radar antenna equipment, General Electric backs modern facilities with the know-how that comes from many years of research, engineering, and manufacturing experience.

For example, early research in electronic location equipment at G.E. began in 1935 and engineering and manufacturing experience includes these six major areas:

1. **Stabilized bases** to compensate for ship pitch and roll were built in large quantity with Navy antennas in World War II.
2. **Small, portable systems** for weather balloon tracking were developed and produced for the Army and Navy in 1948.
3. **Powerful heightfinding antenna,** FPS-6XW1, developed by G.E. for USAF in 1949, was an advancement in long-range detection.
4. **Giant shipboard search antenna,** largest in use today, was G-E developed and produced for Navy early-warning ships.
5. **Long-range search antennas** (FPS-7) were designed and built by G.E. using advanced construction techniques.
6. **One of the first combination antennas** (allows both search and elevation detection), the Navy's SPS-8 was designed and produced to give a precise beam pattern.

This extensive background enables clearer perception of special engineering and manufacturing problems. It is the element that helps give G-E precision antenna equipment the efficiency and reliability to help make your radar system more effective. For more information, contact your G-E Apparatus Sales Office or use coupon below.

Mail to: General Electric Company, Section J223-2
Schenectady 5, N. Y.

Please send me these two bulletins:

GEA-6279, Radar Antennas, Mounts, Components, and Accessories

GED-2494, G.E.'s Naval Ordnance Department Offers *Complete* Engineering and Manufacturing Services

☐ For immediate project. ☐ For reference only.

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GENERAL ELECTRIC

at ARF. At least six of the firms are active in the electronics field.

Each firm is contributing $20,000 toward the construction and initial operation of the $700,000 reactor facility. ARF is providing the remaining funds. The companies will share in the benefits of a three-year program aimed at the application of atomics to industrial problems.

TV Industry Pushes Color

More tv broadcasters add color facilities. Two color set makers break $500 prices

NUMBER of tv stations that get network color service over Bell System facilities reached 203 stations in 141 cities as of June 1. At the beginning of the year only 190 stations in 101 cities had the facilities available. At the end of 1954, AT&T cross-country tv routes had been reengineered to carry color to 139 stations in 101 cities.

CBS reports that it now has 117 stations equipped to rebroadcast its color shows. It has 32 stations equipped with color slide equipment, 30 with color film equipment and 8 with color film, slide and studio equipment.

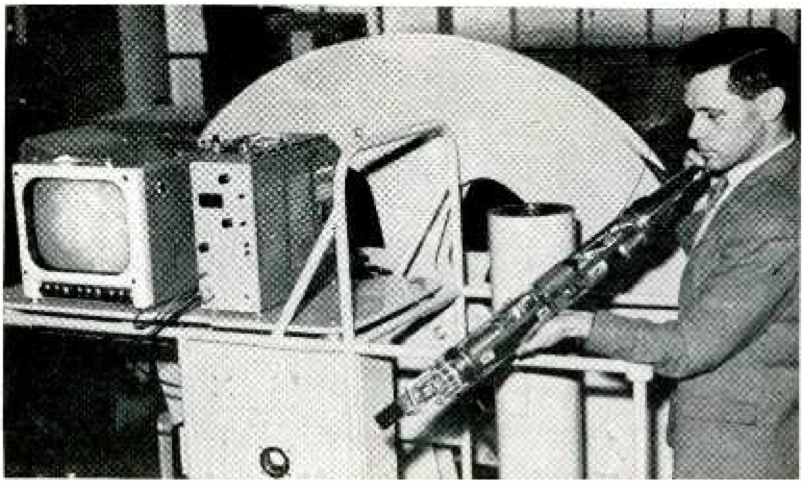
At the beginning of the year 32 NBC affiliates had slide-film equipment and 11 were fully equipped for originating live color shows. The network is surveying its stations for an up-to-date picture of its color facilities.

ABC still holds to its announced policy of not equipping its owned stations for color until color set circulation is sufficient.

▶ **Expansion**—CBS is expanding its color facilities on the West Coast. It is adding two color studios to its tv city in Hollywood and converting an existing studio for color tv. The net now has four color studios in Hollywood.

▶ **Sets**—Admiral and RCA, have broken the $500 color tv price barrier with new color tv table models for the fall market. Admiral's set will sell for $499.95. RCA has established a price of $495 for its model. It is expected that nearly every major tv set manufacturer will have color tv in new fall lines and that some will also offer sets below $500.

Industrial TV Inspects Reactors



Interiors of nuclear reactors at England's Calder Hall atomic power station are inspected by special industrial-tv camera made by Pye, Ltd. Shown with its stainless-steel casing removed, camera has remotely controlled rotatable mirror that permits all-around viewing and four small bulbs at front that provide sole source of illumination. A similar camera is made by Grundig-Radio-Werke of Bavaria for boiler inspection. Only 47 mm in diameter and 150 mm long, the camera is blown by compressed air through steam pipes and smoke flues

Noise Measuring Gear Has Brisk Sales

Eight-year period produces seven-fold sales increase. Future looks even brighter

IN the past five years noise has been recognized at a deterrent to efficient output and a possible cause of impaired hearing. Some states have laws making impairment of hearing subject to workmen's compensation procedures. Such cases are increasing. In Wisconsin during 1953, 381 workers received a total of $650,373 as compensation for impaired hearing caused by industrial noise.

▶ **Sales** — Noise-measuring equipment sales including sound-level meters, audiometers and related equipment have soared from about $700,000 in 1947 to over $3,000,000 in 1955. Sales of one sound-level meter are more than 20 percent above those for a similar period last year.

Prices of noise-measuring equipment range from $900 to $1,100 while audiometers are available from $350 to $700.

▶ **Latest**—Combining the functions of sound-level meter, octave-band analyzer and narrow-band analyzer, the Soundscope, made by Mine Safety Appliances Co., Pittsburgh, Pa., is a self-contained portable unit.

It can measure from 24 to 150 db and filters the noise into any of eight octave-bands covering the frequency range of 75 to 19,200 cps.

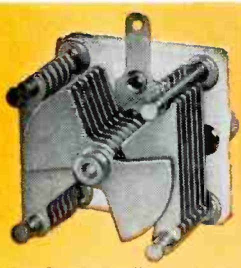
Financial Roundup

First quarter earnings for many firms in the industry were lower than in 1955

NET income of 25 firms in the radio-tv electrical equipment field for the first quarter of 1956 is off 31 percent from the first three months of 1955 and 32 percent from the last quarter of 1955 according to a survey by the First National City

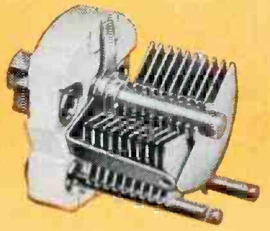
(Continued on page 26)

For VARIABLE CAPACITORS...

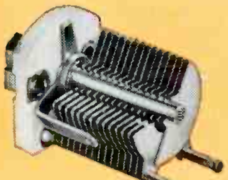


"BFC" butterfly-type capacitor with isolated rotor, very low minimum capacity and low inductance. For VHF applications as series capacitor with no rotor connection.

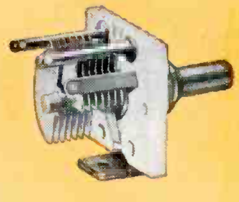
"MAC" Low minimum capacity and very low inductance. Ideal for VHF-UHF applications. Designed for use in miniaturization. Also available as butterfly type "MACBF".



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

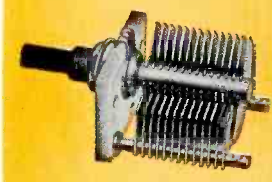


"MAPC" A scaled down version of the "APC". Designed to fill the needs of miniaturization. Suitable for VHF use.

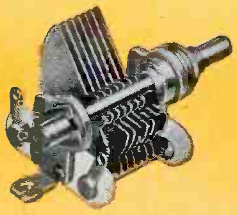


"HF" A high frequency design featuring extra long sleeve bearing and positive contact nickel-plated phosphor bronze wiper. Also available as a dual unit.

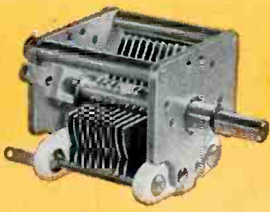
naturally,



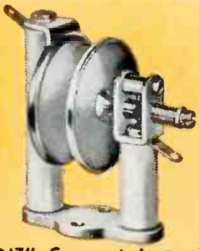
"HFA" Similar to "HF" model, but with larger air gaps for higher breakdown ratings. Used for high-frequency, low-power transmitting. Also available as dual unit.



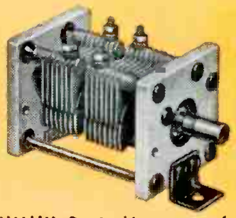
"MC" Designed for maximum versatility in mountings, connections and capacity characteristics. Rotor stop permits 180° clockwise rotation with increasing capacity. Also available as dual unit.



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



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



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

it's HAMMARLUND

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

● *Send for your copy of Bulletin E 756*

HAMMARLUND MANUFACTURING COMPANY, INC.
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Bank of New York. Total net profit in the first quarter was $55.2 million compared to $80.6 million in the first quarter of last year and $81.0 million in the fourth quarter of 1955.

Following are the net profit reports of companies in the electronics field, as reported in the past month for the fiscal periods indicated plus a roundup of security transactions:

Company	Net Profits 1956	1955
Am. Electronics 3m	$82,216	$81,408
Am. Cable & Radio 3m	318,977	211,446
Amphenol 3m	262,985	204,451
Beckman Inst. 9m	1,144,888	872,082
Clevite 3m	738,000	1,175,000
Du Mont 3m	79,000	27,000
T. A. Edison 3m	382,575	320,457
Electronic Eng. 3m	20,781	14,942
Garret 9m	3,410,810	2,707,309
Gen. Prec. Equip. 3m	346,973	961,986
Hoffmann 3m	467,994	309,996
Magnavox 9m	2,639,000	2,110,000
Minn. Mining 3m	8,632,518	7,452,172
Motorola 3m	2,012,876	2,153,038
Olympic 3m	159,464	82,631
RCA 3m	12,727,000	12,568,000
Siegler 9m	896,276	774,571
Standard Coil 3m	615,285*	116,599
Stewart-Warner 3m	1,718,528	1,116,064
Sylvania 3m	4,323,086	3,247,655
Texas Instruments 3m	540,000	391,000
Van Norman 3m	264,660	107,289
Westinghouse 3m	18,575,000*	12,782,000
Zenith 3m	1,831,165	2,074,960

*loss

▶ **Securities** — Mohawk Business Machines offered 167,000 shares of common stock, par 10 cents, at 75 cents a share. Proceeds will be used for additional working capital and general corporate purposes.

Norden-Ketay obtained a $6.5 million V-loan and has sold $1 million of debentures. Funds will be used to meet working capital needs arising from increased production demands. The V-loan is guaranteed by the Navy. The $1 million 5-percent convertible, subordinated debentures, are convertible into common stock at a price of $13.33 1-3 per share.

General Electric placed on the market $300 million in 20-year 3.5-percent debentures due May 1, 1976. The debentures are priced at 100.5 percent and accrued interest to yield about 3.47 percent to maturity. Proceeds will be used for retirement of outstanding short-term borrowings, for the replenishment of funds spent in the firm's expansion program and for the improvement, replacement and expansion of plant and other facilities.

FUTURE MEETINGS

AUG. 20-21: National Telemetering Conference, IRE, AIEE, IAS, ISA, Biltmore Hotel, Los Angeles, Calif.

AUG. 21-24: 1956 Western Electronic Show and Convention, Pan-Pacific Auditorium, Los Angeles, Calif.

AUG. 22-SEPT. 1: The 23rd Annual British National Radio Show, Earls Court, London.

AUG. 24-26: Seventeenth Annual Summer Seminar, IRE, Emporium, Pa.

SEPT. 10-12: Information Theory Symposium, IRE, MIT, Cambridge, Mass.

SEPT. 11-12: Second RETMA Conference on Reliable Electrical Connections, University of Pennsylvania, Philadelphia.

SEPT. 14-15: Sixth Symposium, Mellon Institute, Pittsburgh.

SEPT. 17-21: Eleventh Annual International Instrument-Automation Conference and Exhibit, ISA, New York Coliseum, New York, N. Y.

SEPT. 24-25: Industrial Electronics Conference, IRE, AIEE, Hotel Manger, Cleveland, Ohio.

SEPT. 26-30: New York High Fidelity Show, New York Trade Show Building, New York.

OCT. 1-3: IRE Canadian Convention, Automotive Bldg. Exhibition Park, Toronto.

OCT. 1-3: Twelfth Annual National Electronics Conference, Hotel Sherman, Chicago.

OCT. 1-4: Semiconductor Symposium, Electrochemical Society, Statler Hotel, Cleveland, Ohio.

OCT. 8-9: Second National Symposium on Aeronautical Communications, IRE, Hotel Utica, Utica, N. Y.

OCT. 9-10: Third Annual Computer Applications Symposium, Armour Research Foundation, Chicago, Ill.

OCT. 10-11: Engineering Convention of the Central Canada Broadcasters Association, Seaway Hotel, Toronto.

OCT. 10-12: Symposium On Applications of Optical Principles to Microwaves, IRE, George Washington University, Washington, D. C.

OCT. 15-17: Radio Fall Meeting, IRE, RETMA, Hotel Syracuse, Syracuse, N. Y.

OCT. 16-18: Conference On Magnetism & Magnetic Materials, IRE, AIEE, APS, AIMME, Hotel Statler, Boston, Mass.

OCT. 18-19: Third Annual International Meeting of the Institute of Management Sciences, Statler Hotel, Los Angeles, Calif.

OCT. 25-26: Second Annual Technical Meeting of the IRE Professional Group on Electronic Devices, Shoreham Hotel, Washington, D. C.

OCT. 29-30: Third Annual East Coast Conference On Aeronautical & Navigational Electronics, IRE, Fifth Regiment Armory, Baltimore, Md.

NOV. 7-9: Conference on Electronics In Medicine & Biology, IRE, AIEE, ISA, Gov. Clinton Hotel, New York, N. Y.

Industry Shorts

▶ **Mobile Radio** service contracts will be accepted by General Electric in its own name for the first time under a new sales policy. Authorized service stations will be continued and expanded.

▶ **Transistor** production is now at an annual rate of 10 million units and will reach 300 million units a year by 1965. Of the 300 million, about 25 million of them will be of the medium and large-power types, according to Minneapolis-Honey-

▶ **Color** tv service contracts, announced by RCA, range in price from $39.95 for installation maintenance and service for 90-days, to $99.50 for one-year coverage with unlimited service and parts.

▶ **Mullard** Ltd. was one of the British firms that provided a color tv receiver for the demonstration to CCIR delegates during their visit to London. (ELECTRONICS, p 14, May, 1956)

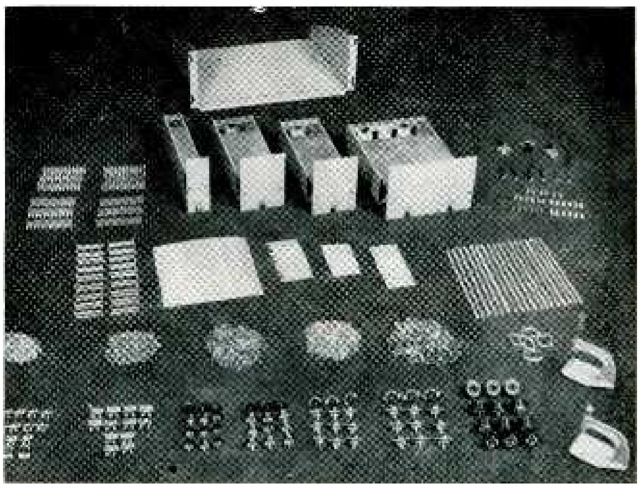
▶ **Average** "middle management" executive (those between the policy-making level and that of general foreman or first-line supervisor) was paid $11,347 last year, an overall increase of about 5 percent over the previous year, according to AMA.

▶ **Canadian** tv and radio set sales totaled 747,988 and 545,590 respectively during the fiscal year ending in April, 1956. During the previous year 679,344 tv sets and 420,632 radios were sold, according to Canadian RETMA.

Want more information? Use post card on last page.

Electronic Packaging System . . .

Simplifies Circuitry Packaging, Cuts Assembly Costs, Minimizes Servicing Problems



All necessary components to package your electronic circuitry using principles of Plug—in Units Construction are included in this Alden Kit #37.

SUMMARY—"Building Block" plug-in chassis system organizes circuits by function, provides for plug-in replacement and fast servicing by non-technical personnel.

DESCRIPTION

A complete system of integrated terminal card sub-chassis elements designed to snap into plug-in chassis now makes it simple for designers to take full advantage of the new mass production techniques of printed wiring and modular construction in the manufacture of custom-designed systems.

Alden Products Company of Brockton, Mass., is the developer of this system which is based upon standardized pre-punched mounting cards with associated terminals, tube sockets and holding devices which accept resistors, condensers, tubes and other components. The cards may be snapped into place in plug-in chassis units.

This eliminates the usual "rat's nest" point-to-point wiring and facilitates access for assembly and repair.

The terminal cards arrange all the components on sub-chassis in "planes of circuitry" which can be housed in standardized 2", 4", 8" or 17" Alden Basic Chassis. Each chassis contains all the sub-chassis associated with a single electronic function. "Tell-Tale" monitor lights mounted on the plug-in chassis front panel can be employed to give instant indication of service failure.

Plug-in chassis units are arranged in modular metal cabinets called Uni-Racks to make up and house complete systems.

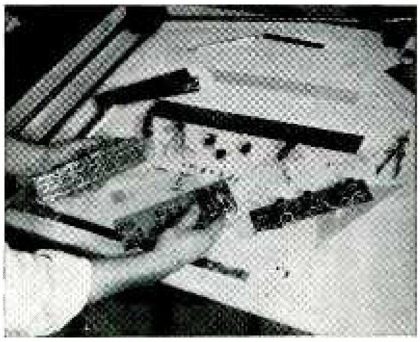


Fig. 1. Circuitry laid out using terminal card mounting system.

ADVANTAGES

There are a number of primary benefits associated with the Alden System. Fundamentally, the break-down of the circuitry by **function** and the modular assembly concept of components and terminal cards means that even complicated electronic-electrical problems are reduced to relatively simple mechanical assembly problems once the theoretical design stage is passed.

The need for prototypes is eliminated since breadboard layouts can be lifted directly onto the terminal card system with the aid of planning sheets furnished by the manufacturer.

The finished system is easy to keep in service—even for non-technical personnel. "Tell-tale" monitors instantly locate functioning chassis elements and non-technical personnel can replace them with spare plug-in units. The faulty unit can then be repaired and returned to service. In addition, provision for numbered and color-coded in-out leads conveniently grouped at the back of each chassis by Alden Back Connectors enables laymen to make accurate first-level checks.

Fig. 2. Easy First Level Checks By Non-Technical personnel

APPLICATIONS

A leading research institute received an unexpected order for a computer. Using this Basic Chassis System for housing the circuitry as plug-in units, they assembled the computer so rapidly that more than seven weeks was saved in design time and in the packaging and mechanical engineering phase. Moreover, the flexibility of the system permits periodic up-dating of the computer with more modern circuits as these are developed.

Another important advantage lies in the shortening of required lead time on delivery dates. One manufacturer supplying electronic test gear to the Naval Ordnance Bureau on irregular schedules is able to quote extraordinarily fast delivery on custom equipment because the units go together so fast. This firm starts with a series of standard functions to which are added specialized circuit functions. The chassis are then housed in Uni-Racks and rushed to the job.

In addition to speed, costs are held to a level far lower than is usual for special or custom built equipment and one or a hundred can be produced at little cost variance.

"ELECTRONIC PACKAGING" ELEMENTS

Terminal Cards: These cards are pre-cut to size, in lengths up to 3 feet. They are pre-punched with 0.101" holes on ¼" centers for maximum flexibility in circuitry layout.

Mounting Sockets: Available in 7 and 9-pin miniature and octal, sockets mount directly either to the edge or to the side of the terminal card in piggy back or side saddle fashion.

Miniature Ratchet Terminals: Stake into terminal card and provide positive grip for feed-through or single-end connections for all pigtail 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.

Plug-In Chassis Units: Built on the modular principle allow organization of circuitry by function and provides housing in replaceable units.

Portable Units: Plug-in Chassis can be carried or shipped conveniently in specially designed padded carrying cases.

SIMPLE TO GET STARTED

Alden Products Company offers a low cost "get started" chassis and terminal card assortment kit containing all components to mount, house, fasten and monitor electronic circuitry—including materials for experimental etched circuitry. (Kit #37 shown above, price $249.50).

This kit will enable you to determine quickly the advantages this system holds for your product development and production.

The Alden Handbook, "Ideas, Techniques, Designs" is supplied with each kit and contains a complete description of the Alden System.

To order your kit or to get further information write to Mr. N. Hearn, Alden Products Co., 7127 N. Main St., Brockton, Mass.

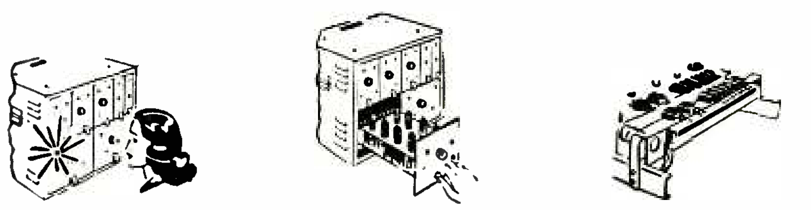
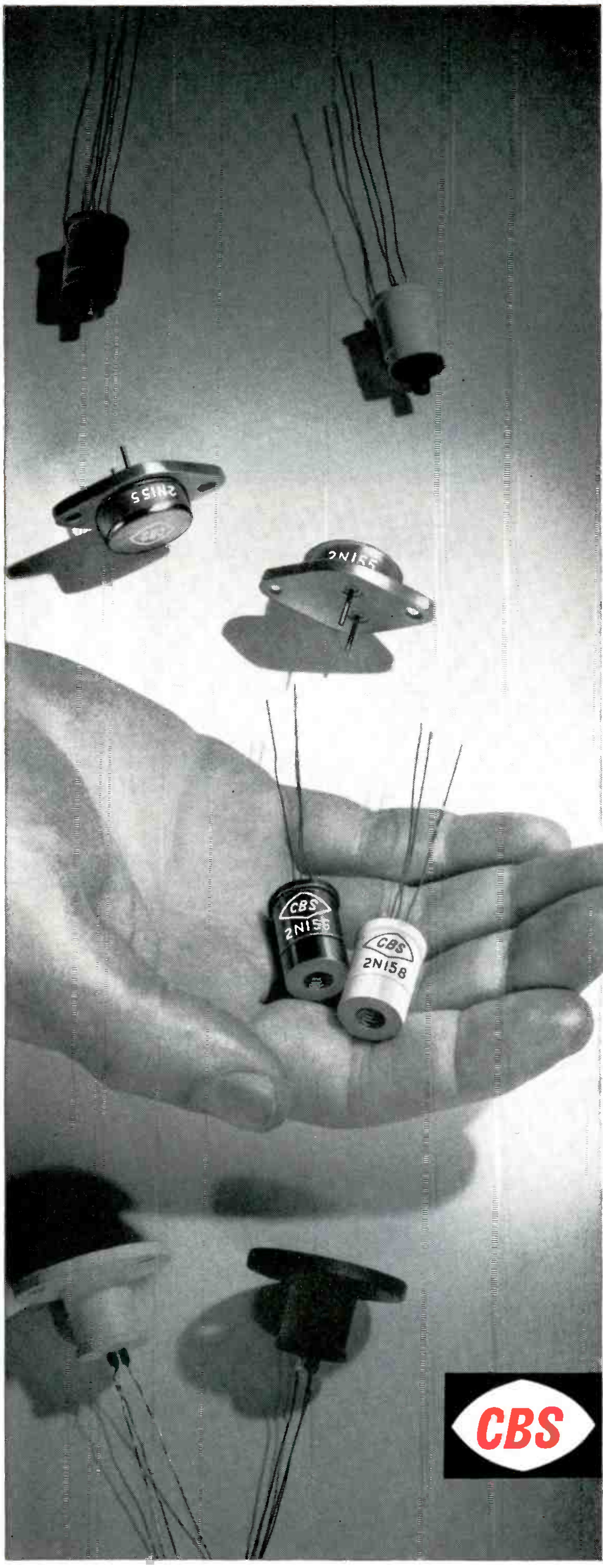


Fig. 3. Circuitry subdivided, function by function into attractive plug-in units. Laymen can plug in replacement spare in 30 seconds. Tiny tell-tales spot trouble instantly, eliminate need for trained technicians on spot. All leads are at a single accessible point, numbered and color-coded so layman can make first-level tests.



CBS

POWER TRANSISTORS

with uniform characteristics

in mass production

Whether your requirements are for a dozen or a million . . . for standard or special types . . . CBS is prepared to supply you with power transistors. And in a variety of metal cases designed to solve problems of mounting and heat dissipation.

The many advanced-engineering features of the CBS 2N156 (12-volt) and CBS 2N158 (28-volt) are ideally suited to high-power audio amplifiers, servo amplifiers, power converters, and low-speed switches. The CBS type 2N155 is especially designed for optimum performance in single-ended audio output stages of automobile radios.

Note the many features of these PNP junction transistors. Write for free bulletin E-259 giving complete data. Let us help you also with your circuit designs for these versatile and dependable CBS power transistors.

FEATURES OF CBS PNP JUNCTION POWER TRANSISTORS

1. High current gain at high current
2. High power-handling capabilities
3. High peak-back voltages
4. Stable, uniform characteristics (special selection unnecessary)
5. Low input impedance
6. Low saturation voltage
7. Low saturation current
8. Choice of hermetically sealed designs

Reliable products through Advanced-Engineering

CBS semiconductors

CBS-HYTRON
Semiconductor Operations, Lowell, Mass.
A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.

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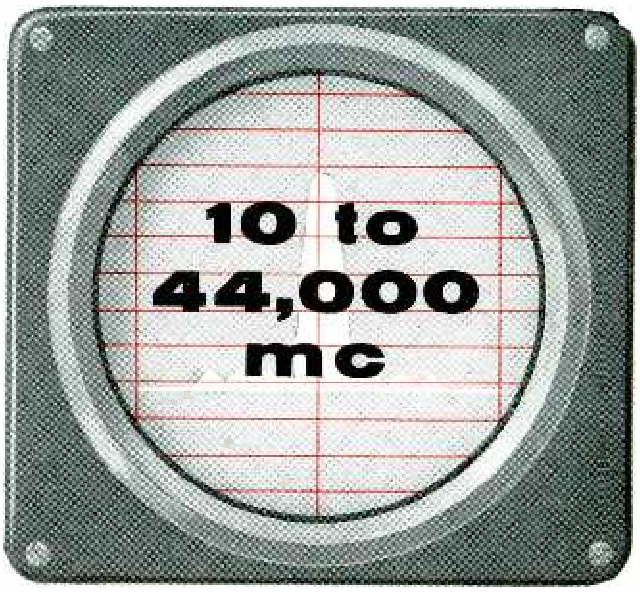
POLARAD
PROVEN RELIABILITY

DIRECT READING SPECTRUM ANALYZER



UNI-DIAL CONTROL

Years of day-in, day-out field operation by most exacting users, have proven the Polarad Model TSA Spectrum Analyzer to be a versatile test instrument of highest reliability and accuracy for both laboratory and production applications.

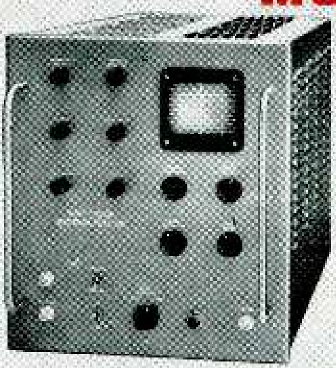
It is a broadband instrument with greatest pulse sensitivity over the band—10 to 44,000 mc. And each of its five interchangeable RF tuning heads operate with utmost simplicity and frequency stability. All tuning is by Uni-Dial control. Frequencies are read with 1% accuracy right on the linear dial as the set is tuned. No mode charts or interpolations necessary.

The Polarad Model TSA has been designed to save engineering manhours. Its 5 inch CRT display of the RF spectrum is bright and easily defined. And its 1 cycle sweep speed makes for fine resolution. For detailed specifications, contact your nearest Polarad Representative, or write directly to the factory.

APPLICATIONS

- Transmitter characteristics tests
- Broadband receiver for AM, FM, CW, MCW, and pulse modulated signals
- Component tests
- Frequency measurements
- Leakage, interference and radiation measurements
- Bandwidth measurements
- Modulation tests
- Adjacent signal channel tests
- Attenuation measurements
- Filter measurements
- Standing wave measurements

MULTI-PULSE SPECTRUM SELECTOR



MODEL SD-1

Increases the versatility of Polarad Spectrum Analyzers. It displays and allows selection for analysis of a specific train of microwave pulses, as well as any one pulse in the train; selects and gates a group of pulses up to 180 μsec. in length; and is designed to work with fast, narrow pulses; can be adjusted to gate any pulse including the first at zero time. Special circuitry discriminates automatically once pulses have been selected. Operates at any of the frequencies accepted by Polarad Spectrum Analyzers.

FEATURES:

Continuously variable sweep widths; 15 to 180 μsec. • Continuously variable gate widths for pulse selection; 0.4 to 10 μsec. • Continuously variable gate delays for pulse selection; .3 to 180 μsec. • Automatic gating of spectrum analyzer during time of pulse consideration. • Intensified gate (brightening) to facilitate manual pulse selection. • Triggered sweep on first pulse in any train. • No sweep in absence of signal.

SPECIFICATIONS:

Maximum Pulse Train Time 180 μsec. • Pulse Rise Time .05 μsec. Minimum • Minimum Pulse Separation .2 μsec. • Repetition Rate 10—10,000 pps. • Minimum Pulse Width .1 μsec. • Input Power 95 to 130 volts, 50/60 cps., 325 watts. • Input Impedance 50 ohms. • Output Impedance 50 ohms (to match TSA Spectrum Analyzer).

BROADBAND SPECTRUM ANAL

FEATURES

- Greatest signal sensitivity over entire frequency band.
- Single frequency control with direct-reading dial accurate to ±1%.
- Complete frequency coverage from 10 mc to 44,000 mc.
- Internal RF attenuator (RF Tuning Unit Models STU-1, STU-2A, STU-3A).
- Adjustable frequency display from 400 kc to 25 mc.
- Frequency differences as by means of adjustable 1 variable amplitude.
- 25-kc resolution for all b
- Stable klystron oscillato plungers to insure longe
- No klystron modes to set.
- 5-inch CRT display.
- Portable and completely self-contained.

MODEL TSA

SPECIFICATIONS

Model No.	Equipment
Model Du......	Spectrum Display and Power Unit
Model STU-1...	RF Tunning Unit 10-1,000 mc
Model STU-2A.	RF Tuning Unit 910-4, 560 mc.
Model STU-3A.	RF Tuning Unit 4,370-22,000 mc.
Model STU-4	RF Tuning Unit 21,000-33,000 mc.
Model STU-5...	RF Tuning Unit 33,000-44,000 mc.

SPECIFICATIONS:

Frequency Range: 10 mc to 44,000 mc.

Frequency Accuracy: ±1%

Resolution: 25 kc.

Frequency Dispersion: Electronically controlled, continually adjustable from 400 kc to 25 mc per one screen diameter (horizontal expansion to 20 kc per inch)

Input Impedance: 50 ohms—nominal

Sensitivity:*

STU-1 10-400 mcs—89 dbm
400-1000 mcs—84dbm

STU-2A 910-2,200 mcs—87 dbm
1,980-4,560 mcs—77 dbm

STU-3A 4,370-10,920 mcs—75 dbm
8,900-22,000 mcs—60 dbm

STU-4 21,000-33,000 mcs—55 dbm

STU-5 33,000-44,000 mcs—45 dbm

Overall Gain: 120 db

Attenuation:
**RF Internal 100 db continuously variable,
IF 60 db continuously variable

Input Power: 400 Watts

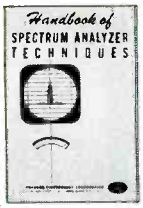
*Minimum Discernible Signal

**STU-1, STU-2A, STU-3A

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

Consult us on your Spectrum Analysis Problems



Write for your copy of the Polarad "Handbook of Spectrum Analyzer Techniques". 50c per copy. Includes discussion of Spectrum Analyzer operation, applications and formulae for analysis techniques.

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in 11 colors

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BH Flextrude-105 is 100% extruded vinyl. It has served in many transformer applications without contaminating the oil and with unusual oil resistance. Additional advantages are high cut-thru resistance and heat-aging resistance.

Now, from Bentley, Harris it is possible to fill all your tubing and sleeving needs — extruded vinyl, braided Fiberglas*, braided Fiberglas coated with vinyl or silicone. Only you can really tell which is best for your product. We'll be glad to send data sheets and production testing samples. A few facts would help — temperatures to be encountered, physical conditions to be met — then we'll send along the BH Tubing or Sleeving to answer your particular problem.

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	TRANSPARENT	BLACK
WHITE	GREEN	ORANGE
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*TM Owens-Corning Fiberglas Corp.

specify

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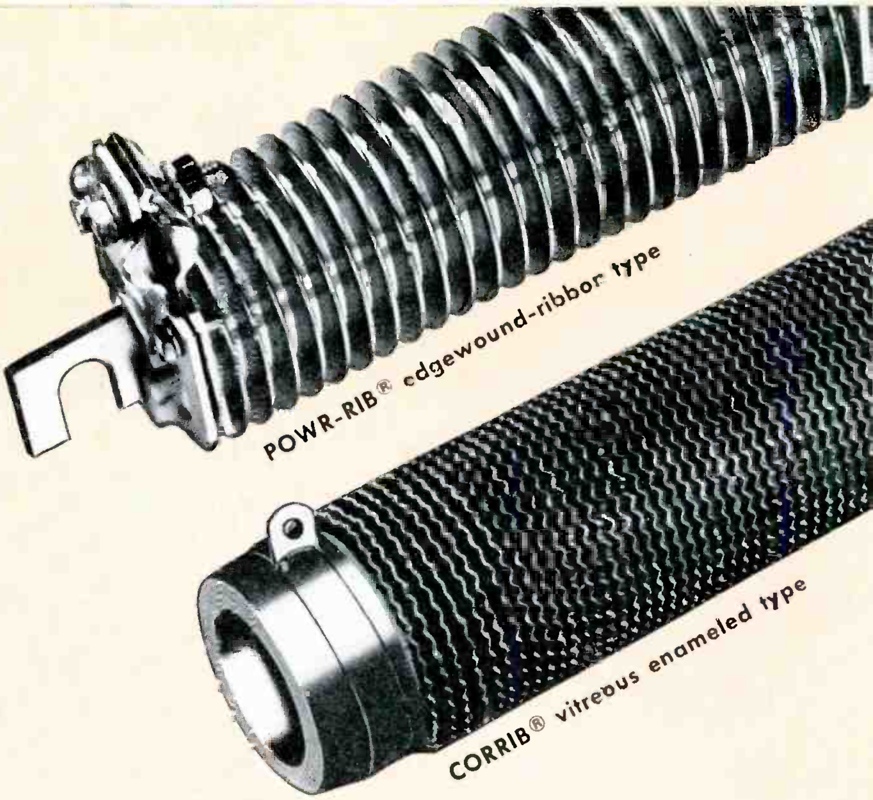
Power Type

RESISTORS

for high current low resistance applications—



The Ohmite line of specialized CORRIB and POWR-RIB resistors solves your high-current, low-resistance problems. The four basic types of Ohmite units (shown below) handle a wide range of special power resistor needs. They are designed for continuous or intermittent duty and provide dependability for heavy-duty applications. Available in Fixed or Adjustable "DIVIDOHM®" Types.

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IN STOCK—26 Powr-Rib Resistance Values in 5 Section Size (17⅞" long).

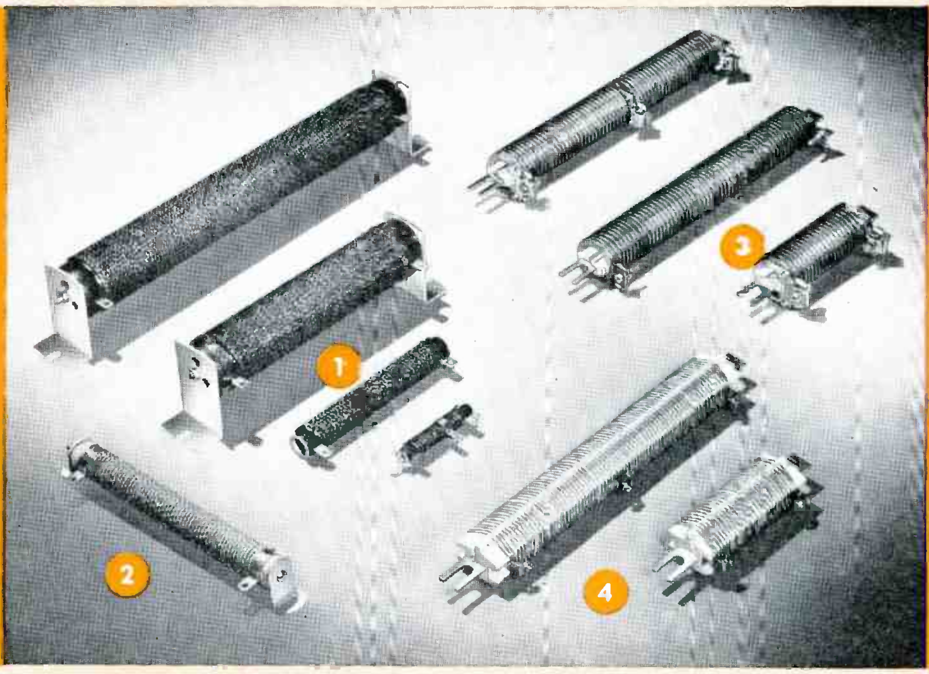
Write for Bulletin 144

1 CORRIB® vitreous-enameled corrugated-ribbon type
Fixed, tapped, and adjustable types in 25 sizes, 90 to 1500 watts. Resistances from .04 to 110 ohms.

2 CORRIB® bare threaded tube type
For continuous or intermittent operation at higher than normal 375°C temperature rise. In two sizes, from 0.36 to 4.25 ohms.

3 POWR-RIB® edgewound-ribbon type
Has ceramic core, sectionalized to resist shock. Four sizes. Values .043 to 1.6 ohms; 24 to 95 amps.

4 POWR-RIB® round-wire type
Has sectionalized core similar to ribbon type. Four sizes. Values from .69 to 25 ohms; 5.1 to 18.4 amps.



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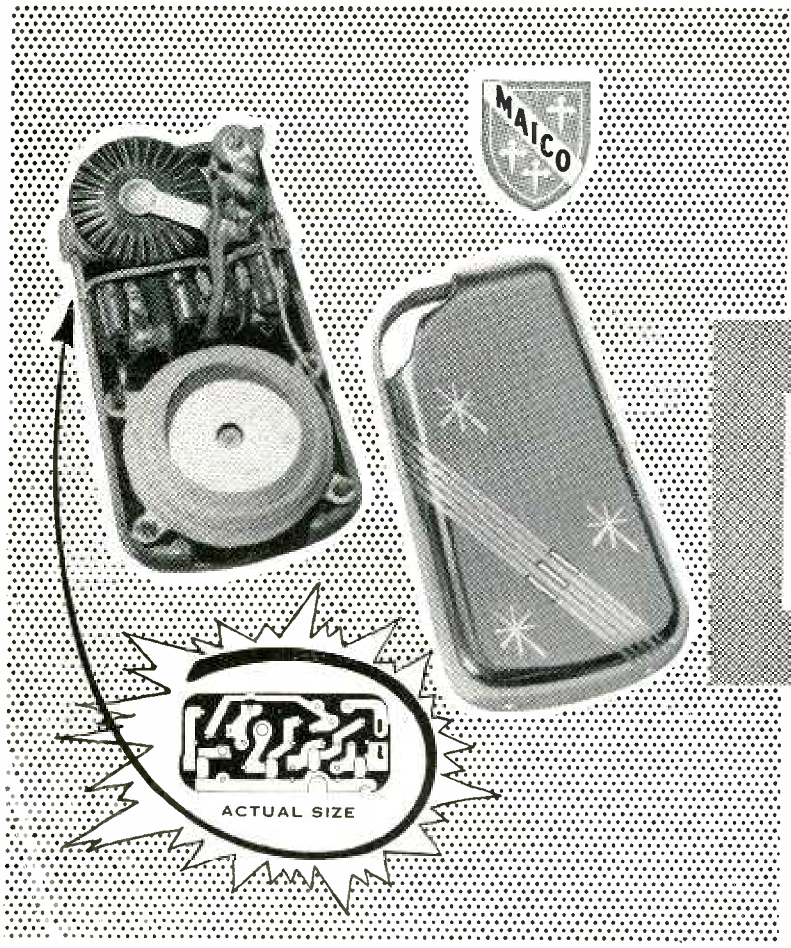

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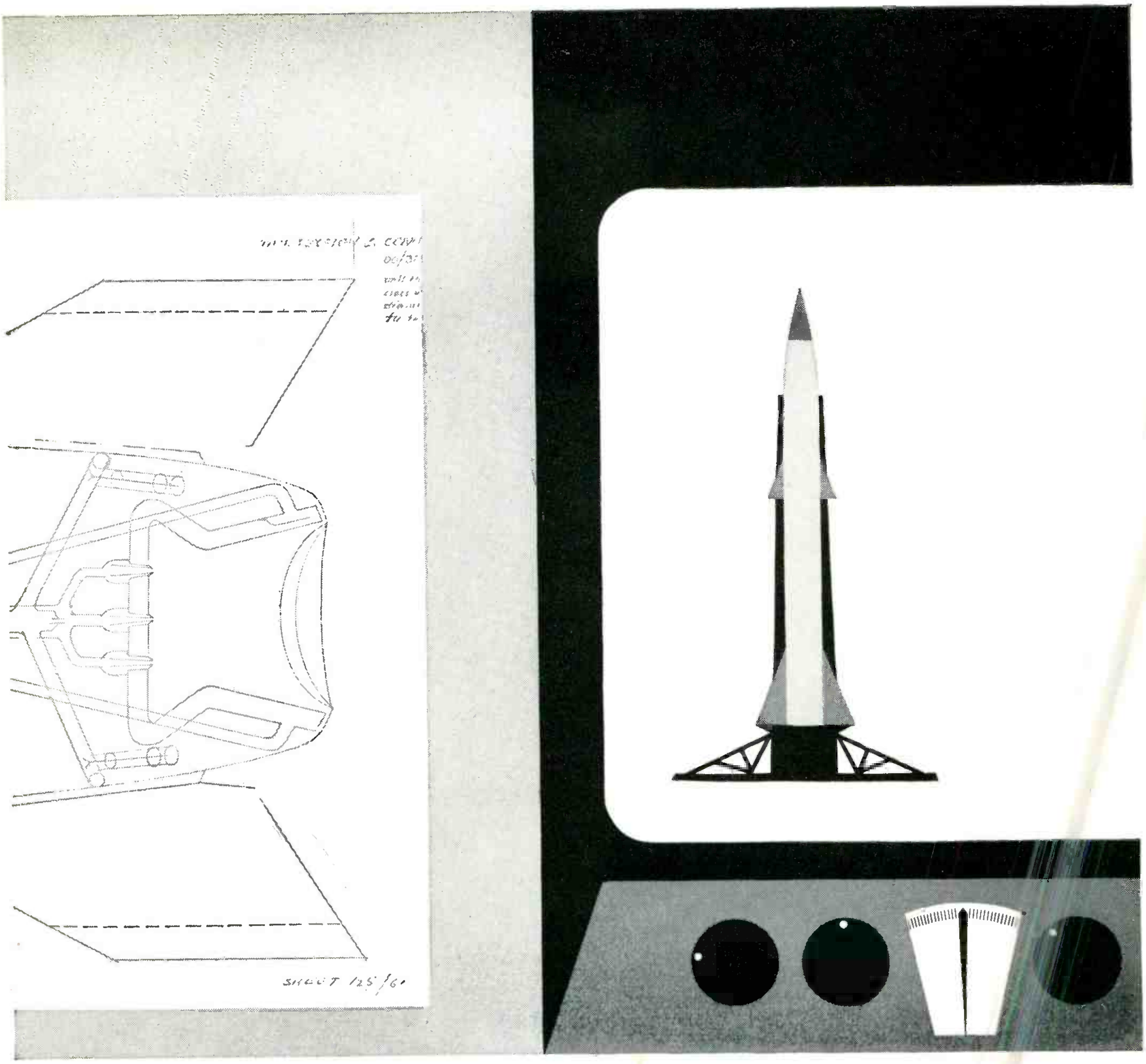

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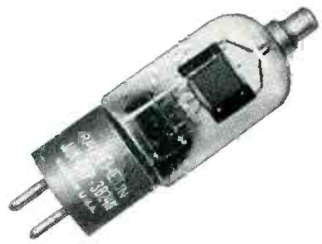
Magnetic Deflection Type
Resolution—400 lines

6116

Klystron
Ruggedized
Thermally Tuned
Frequency—
8500 to 9660 mc
Power Output—
35 mw

RK3B24W

Half Wave-High Vac.
Diode Rectifier
Max. Peak
Inverse Voltage—
20,000
Max. Peak
Current—300 ma

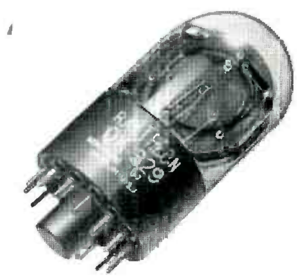


QK518

Backward-Wave
Oscillator
Frequency Range—
2000 to 4000 mc
Voltage Tunable
Power Output—
0.1 to 1.0 watts

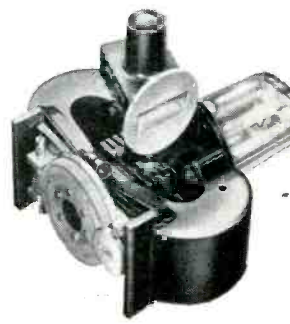
QK329

Square Law Tube
Function Multiplier

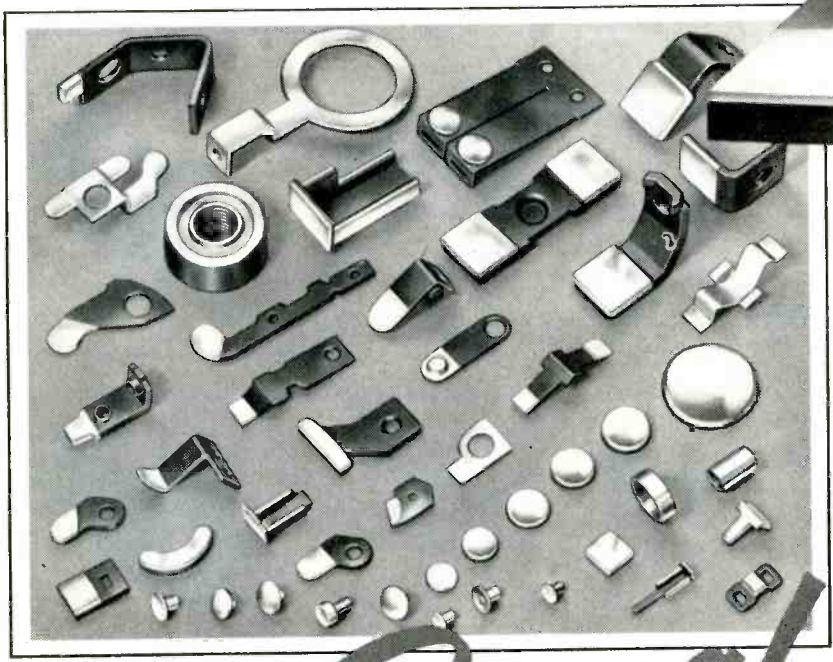


RK2J51A

Magnetron
Tunable—
8500 to 9600 mc
Peak Pulse Power—
40 kw min.



Speaking of Cutting Costs



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COMPOSITE METAL CONTACTS

Save Money and Improve Performance, too!

That's right — time and time again General Plate Division has been able to cut electrical contact costs for customers — while improving product performance.

At General Plate Division customers with contact questions deal directly with a top notch team of Engineers, Production people, and Cost Analysts who specialize in contact activities.

Result? Savings — savings by design for alert customers — with improved performance in the bargain.

Here's what's behind it —

Drawing on forty years of metal cladding experience, General Plate Engineers have developed superior bonded metals which combine the best electrical and mechanical properties of two or more separate metals for greatest contact efficiency and economy.

General Plate Production people have developed the finest facilities available for the manufacture of all kinds of contacts from these materials.

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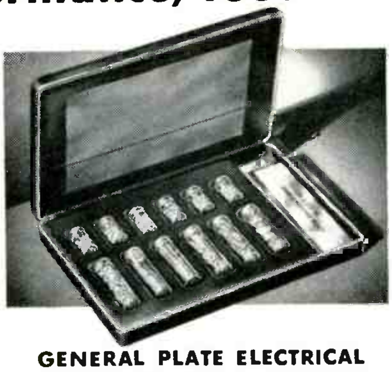


GENERAL PLATE ELECTRICAL CONTACT KIT FOR LABORATORY AND DEVELOPMENT USE

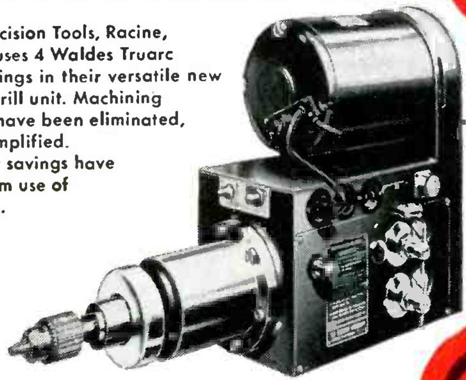
Kit K11 contains a wide assortment of silver rivet contacts; Kit K12 has representative standard button contacts. Also included are metal strips for fabrication of contact parts. These kits are available at nominal cost. Bulletin available.

You can profit by using General Plate Composite Metals

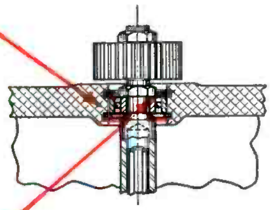
4 Waldes Truarc Rings Cut Costs Drastically, Increase Versatility of Precision Automatic Drill

Dumore's New Automatic Drill

Dumore Precision Tools, Racine, Wisconsin, uses 4 Waldes Truarc Retaining Rings in their versatile new automatic drill unit. Machining operations have been eliminated, assembly simplified. Great labor savings have resulted from use of Truarc rings.

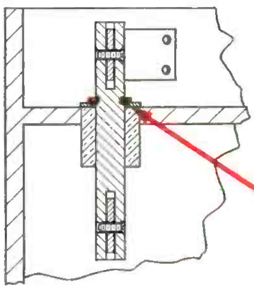


Drive Spindle Assembly



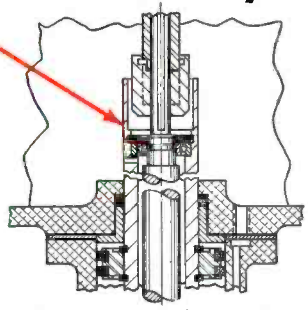
Bearing is held in position by two Waldes Truarc Rings—Standard (Series 5000) and Bowed (Series 5001). Two grooves are turned and housing rough bored in one operation. Alternate method would require at least two additional machining operations. Bowed Truarc ring takes up accumulated tolerances resiliently.

Actuator Lever Shaft Assembly



A Single Waldes Truarc External Retaining Ring (Series 5100) acts as shoulder, holds the lever in position. Labor savings are tremendous—a simple groove cutting operation replaces turning a shoulder, grinding and polishing.

Piston Assembly



Easy assembly is assured by use of one Waldes Truarc Bowed Ring (Series 5001) to lock the bearing to the piston assembly. When unit is to be used in tapping applications, entire spindle assembly can be removed without disassembly.

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.

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

Send for new catalog supplement

WALDES
TRUARC®
RETAINING RINGS

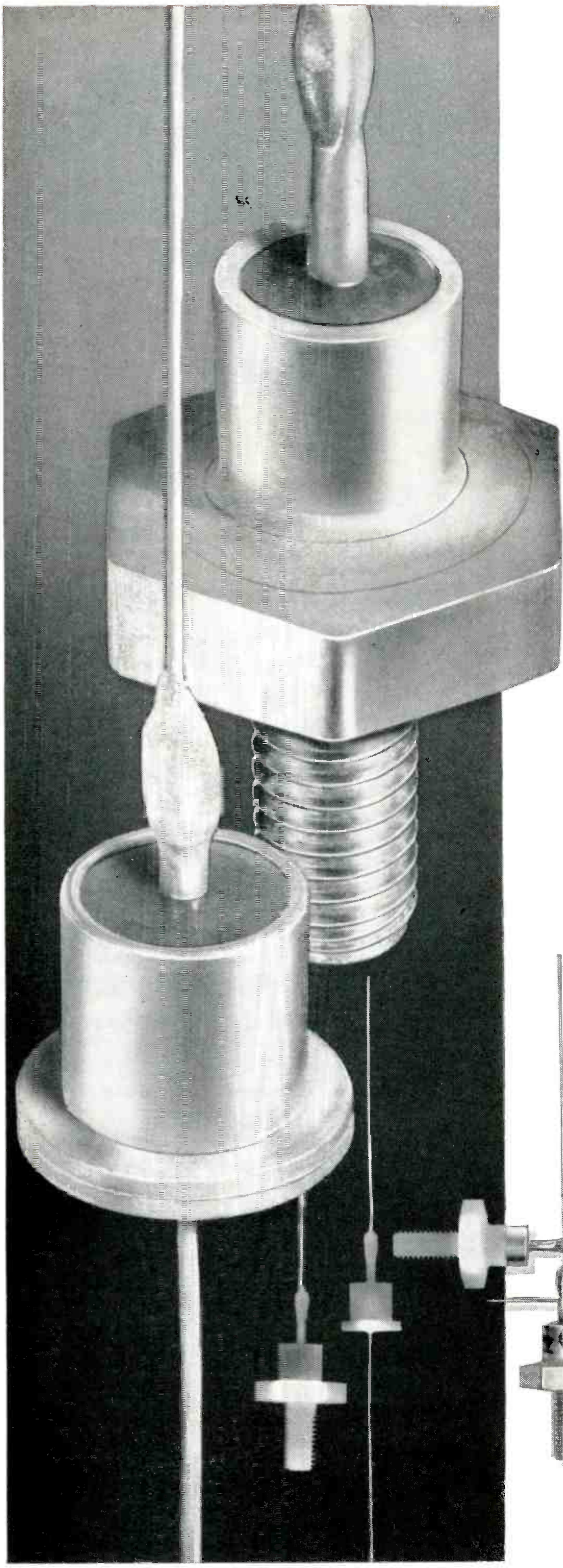
Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name ....
Title ....
Company ....
Business Address ....
City .... Zone ...... State ......

E 078

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.



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High peak inverse voltages . . . extremely low reverse current

The Westinghouse XP-5052 fused-junction silicon diode can handle 500 ma continuous d-c current at peak inverse voltages from 50 to 600 volts.

Leakage at rated voltage is extremely low . . . result is increased efficiency and temperature ranges never before attainable.

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For more information on the XP-5052, or any other silicon rectifier requirements, regardless of voltage and current, call your nearest Westinghouse apparatus sales office, or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-09001

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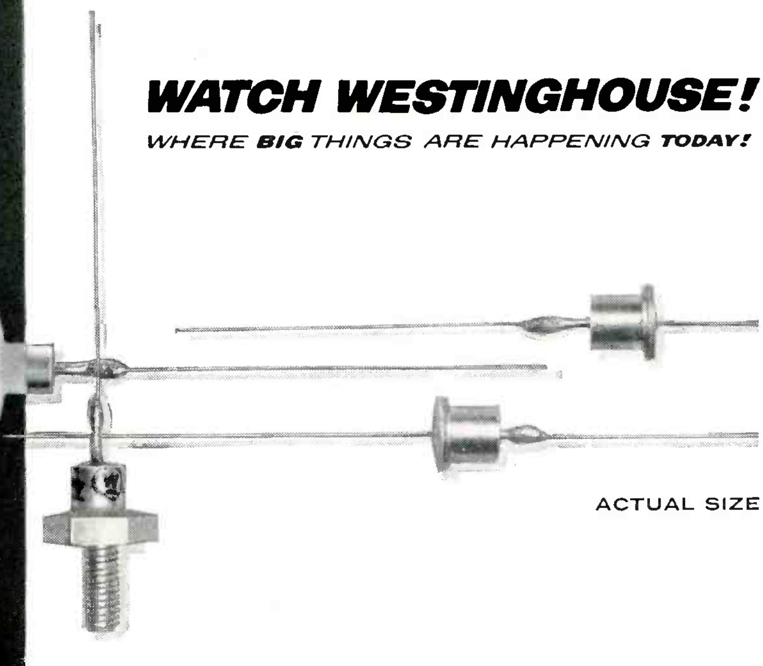
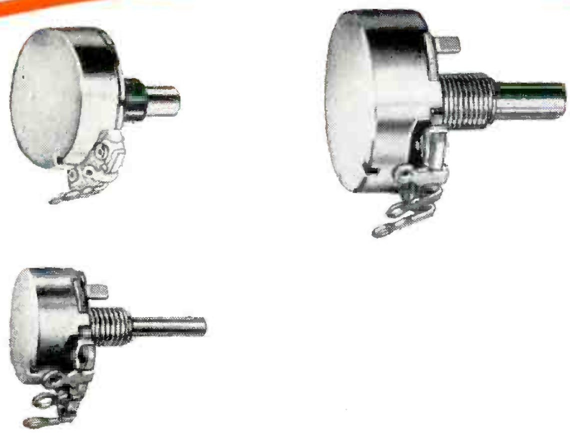
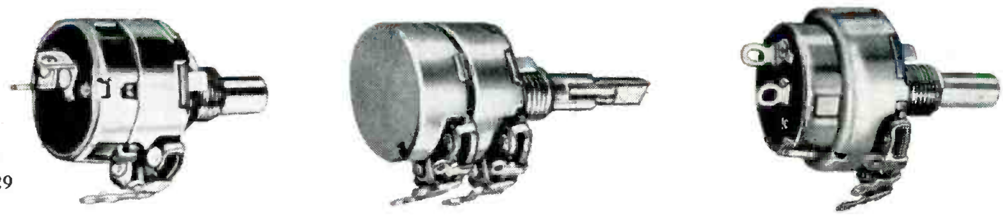


ACTUAL SIZE



VARIABLE RESISTORS



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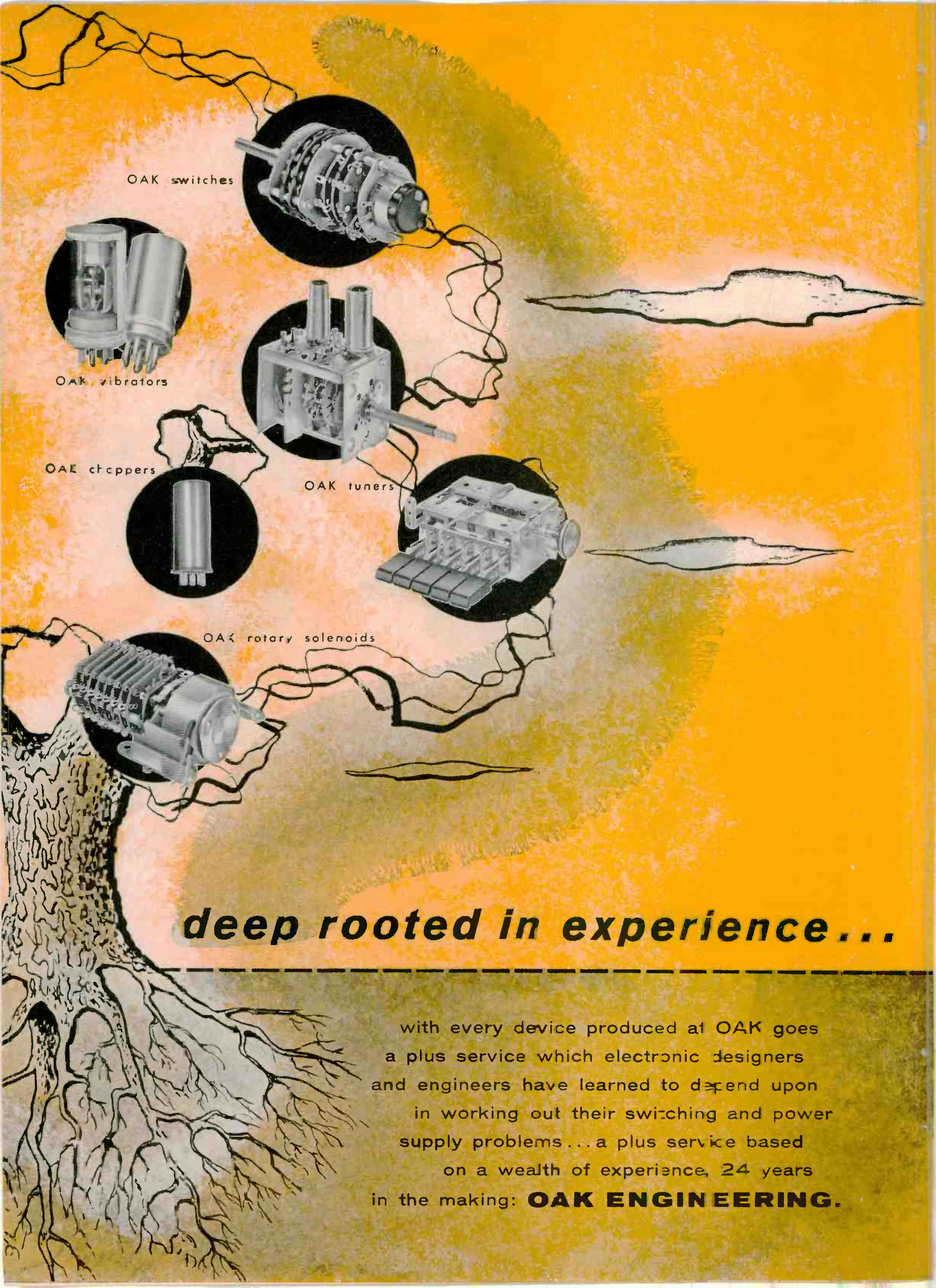
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in working out their switching and power
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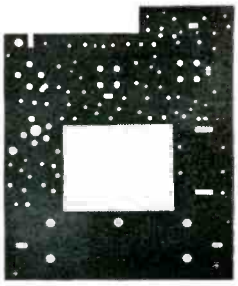

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INSULATED CIRCUITS, INC., WEST CALDWELL, N. J.

Your printed circuitry is off to a good start when you specify one of C-D-F's Metal-Clad Dilecto grades. Base materials are uniform, almost homogeneous—therefore easier to punch, drill, form...with less waste of expensive time and materials.

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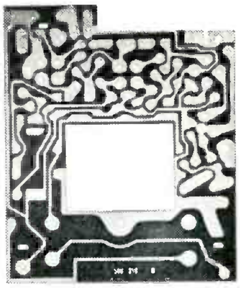
The closely bonded foil can be etched cleanly and dipped in hot solder to 220°C. (428°F.) for ten seconds with a guarantee of no blistering or separating. HIGH BOND STRENGTH is an all-important virtue of C-D-F Metal-Clads.



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FOUR FEATURES YOU GET WITH C-D-F METAL-CLAD LAMINATES

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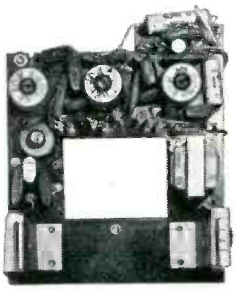
Automatic or hand assembly is speeded when printed circuits are on dimensionally stable C-D-F Dilecto. Minimum warp and twist. Unlike many materials, Dilecto can be dropped, jammed into tight chassis, treated roughly in assembly and service.



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As manufactured by
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Manufacturers, like I.D.E.A., Inc., whose Regency transistor radio is pictured, find C-D-F a big, reliable source of supply. C-D-F delivers high-quality laminates on time, to meet exacting production schedules. Result: better products, made and sold at lower costs!

C-D-F Metal-Clad Dilecto

A laminated plastic with copper or aluminum sheet bonded tightly to one or both surfaces. Base materials: paper or woven glass fabric. Resins: phenolic, epoxy, or Teflon*. Good deliveries; expert engineering and fabricating service.

Write for *new* Metal-Clad Technical Bulletin, samples of all grades. The name and address of C-D-F sales engineer nearest you are listed in both Electronics Buyers Guide and Product Design File (Sweet's). *DU PONT TRADEMARK

improves design . . . simplifies purchasing . . . speeds production!

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CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.
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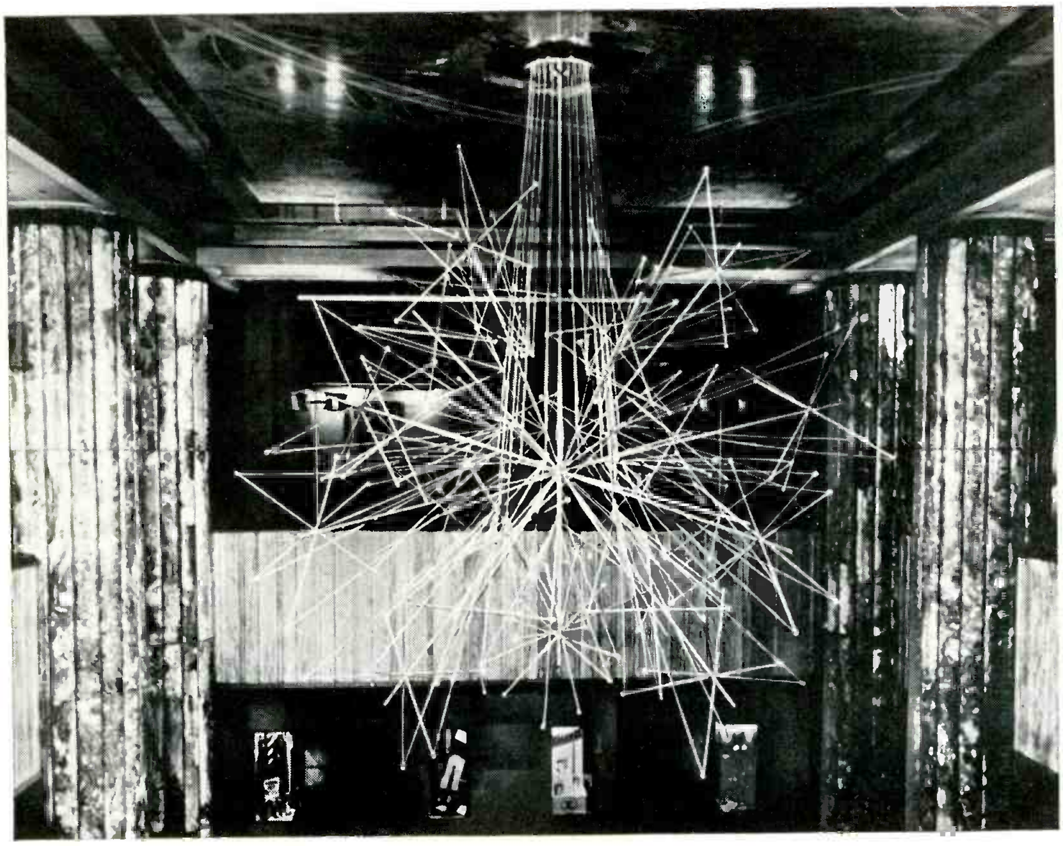


What carries the current in the wireless chandelier of New York City's Barbizon-Plaza Hotel? The fixture is constructed of gleaming Inco Nickel tubing in an intricate pattern — and the tubing carries the current! Nickel tubing is light and rigid, too — so the chandelier can be slowly rotated from above. The chandelier was designed by Richard Kelly and fabricated by Edison Price — both of New York City.

A chandelier without wires!

. . . and three other unique designs in Inco Nickel Alloy *tubing*

There's a similarity in all four tubing applications here.

In each, a needed *combination* of useful properties is provided by Inco Nickel or an Inco Nickel Alloy. For example, in the chandelier above: electrical conductivity *plus* rigidity and light weight. Or in the radar antenna lens at the right: electrical properties *plus* strength and corrosion resistance *plus* brazing facility.

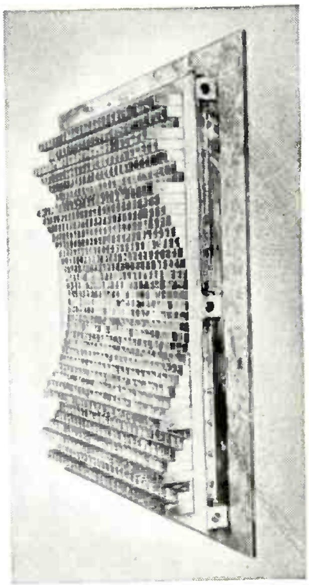
Perhaps *your* design requires a hard-to-find combination of electrical properties with others such as thermal conductivity, non-magnetic properties, resistance to corrosion, or to vibration, shock, and fatigue. With these alloys you also get the advantages of fabricability, high strength-to-weight ratio, hardness, rigidity, or other properties.

So for help in selecting the alloy that fits your needs, call on Inco's Technical Service Section.

And, remember, you can get Inco Nickel Alloy tubing in all useful sizes from your distributor — or from redrawers who supply it as fine as 0.012″ O.D.

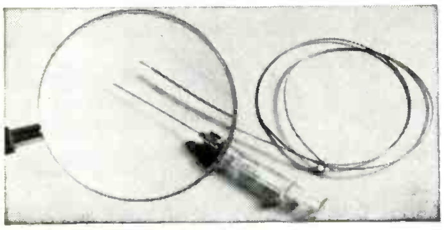
The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCO Nickel Alloys
TRADE MARK



Radar antenna lens uses square seamless tubing of Monel* nickel-copper alloy. Superior Tube Company, Norristown, Pa., recommended Monel to I-T-E Circuit Breaker Company, of Philadelphia, for strength, corrosion resistance, electrical properties, and brazing facility. *Registered Trademark

Aircraft fire detector's 0.065-in. diameter Inconel tube encloses two Inconel wires. A special ceramic between them becomes conductive when heated — closes the circuit. The box flashes a warning. Walter Kidde & Company, Inc., Belleville, N. J., uses Inconel nickel-chromium alloy because it withstands temperatures up to 2000°F., resists vibration and shock.



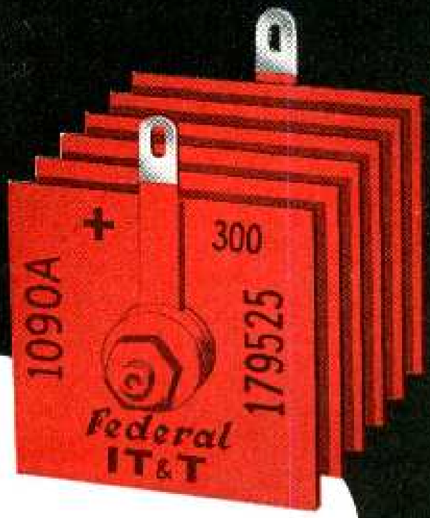
Nuclear reactors' temperatures measured—Inconel* nickel-chromium alloy tube, almost as thin as a hypodermic needle, is both thermocouple unit and thermocouple protection tube. The Inconel tube resists oxidation, which might set up a heat barrier and interfere with accuracy of the reading. Photo courtesy of Argonne National Laboratory, Lemont, Ill.

Want more information? Use post card on last page.

Federal

THE SELENIUM RECTIFIER WITH THE GREATEST

Manufacturer Acceptance



More design and component engineers in the radio-TV industry have placed their approval on Federal Selenium Rectifiers than any other make—

And HERE'S why— point by point:

- **LONGER LIFE** . . . 5,000 hours life expectancy in approved applications.
- **HIGHER OUTPUT VOLTAGE** . . . 3 to 6½ higher B+ output volts than competitive selenium rectifiers in conventional doubler circuits.
- **LOWER TEMPERATURE RISE** . . . 2° C to 10° C lower average operating temperature than competitive selenium rectifiers.
- **SUPERIOR HUMIDITY RESISTANCE** . . . passes 1,000-hour life test in 95% relative humidity at 40° C.
- **PROVEN MECHANICAL CONSTRUCTION** . . . brass eyelet or aluminum stud construction used exclusively. Patented "dead-center" construction allows stack to be tightened until rigid, without affecting the pressure-sensitive selenium characteristic.
- **UNDERWRITERS LABORATORY ACCEPTANCE FOR 85° C OPERATION** . . . Federal's popular radio-TV types have been tested and accepted by UL for operation at cell temperatures of 85° C.
- **CONSERVATIVE RATINGS** . . . rectifiers offered to the industry are rated only after exhaustive temperature rise and aging tests on minimal grade units to insure full value and satisfaction.
- **MORE UNIFORM QUALITY** . . . Federal rectifiers are automatically 100% tested and inspected to meet standard forward and reverse current specifications, as well as for dielectric strength.
- **LARGEST PLANT CAPACITY** . . . production facilities to satisfy any quantity requirement.
- **MORE ENGINEERING KNOW-HOW** . . . the research and design facilities of the world-wide, American-owned International Telephone and Telegraph Corporation assure continued product leadership.

Federal

A DIVISION OF IT&T

FEDERAL TELEPHONE & RADIO FTR

For full information, write Dept. F-613

Federal Telephone and Radio Company

A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
COMPONENTS DIVISION • 100 KINGSLAND ROAD • CLIFTON, N. J.

In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., New York

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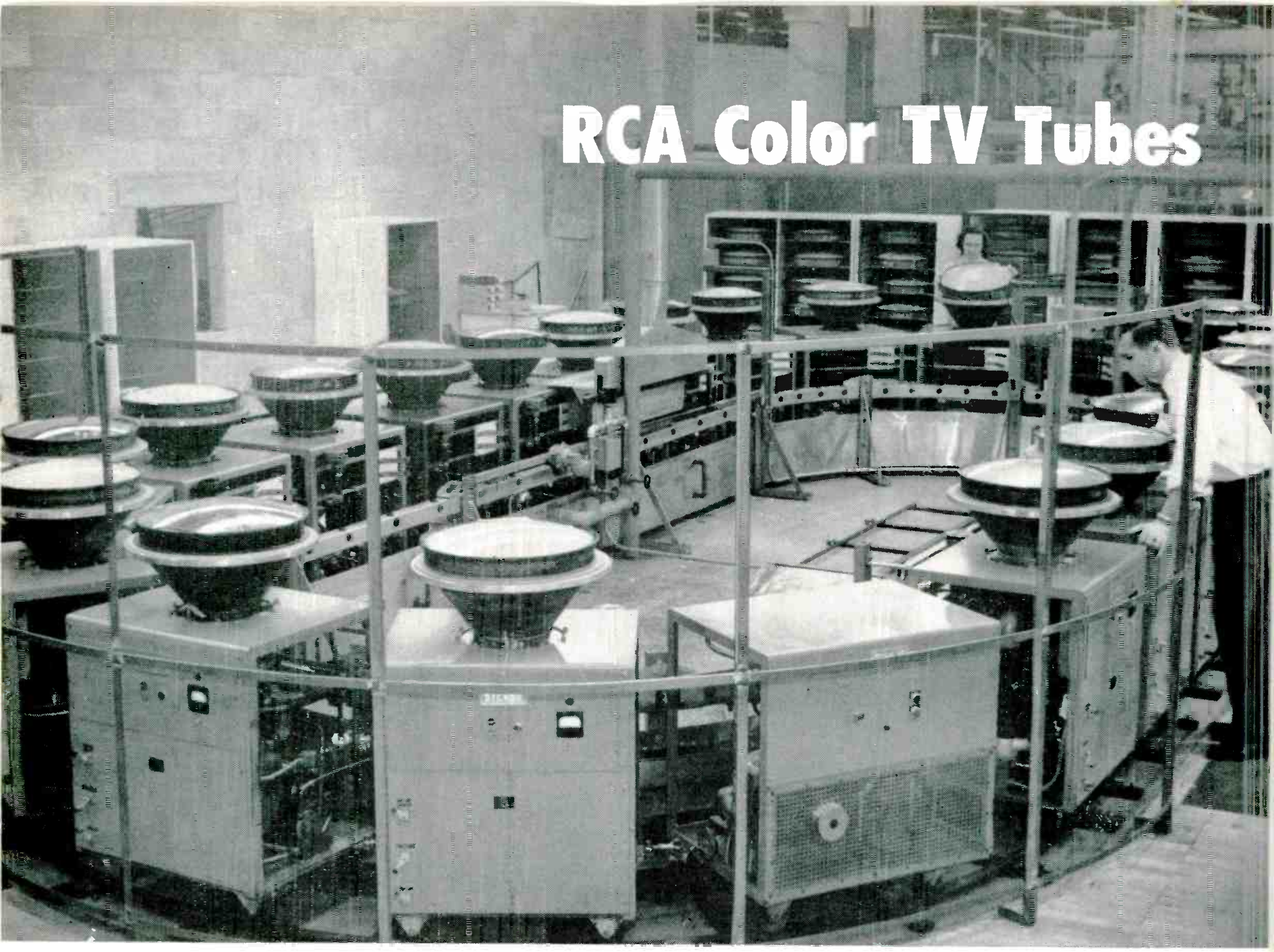
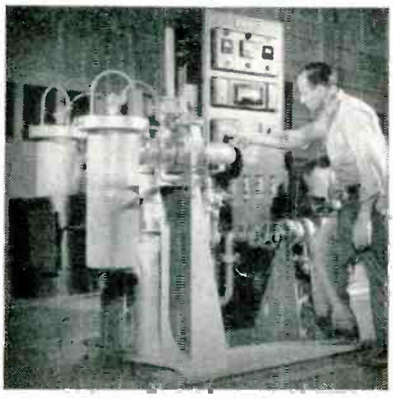
RCA Color TV Tubes

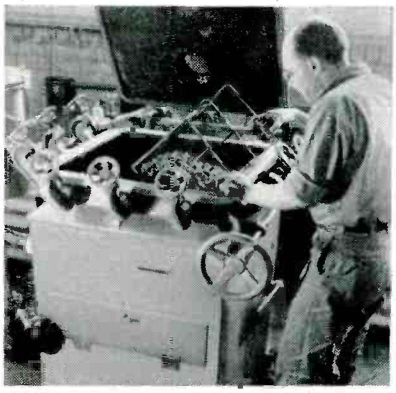


Automatic production at high output per man-hour is obtained from this complete in-line Stokes aluminizing system, used for color TV tube face plates at the RCA tube plant, Lancaster, Pa.

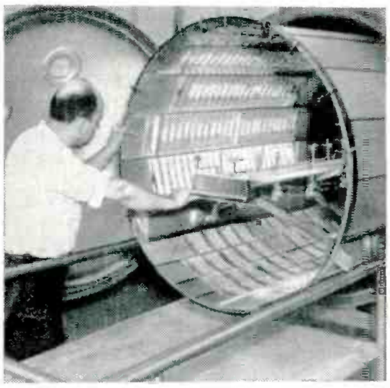
Electronic equipment manufacturers are profiting from other Stokes Vacuum Equipment . . .



Vacuum Metallizers. Stokes manufactures a complete line of vacuum metallizing equipment to plate selenium rectifiers, printed circuits and other conductive coatings on non-conductive materials.

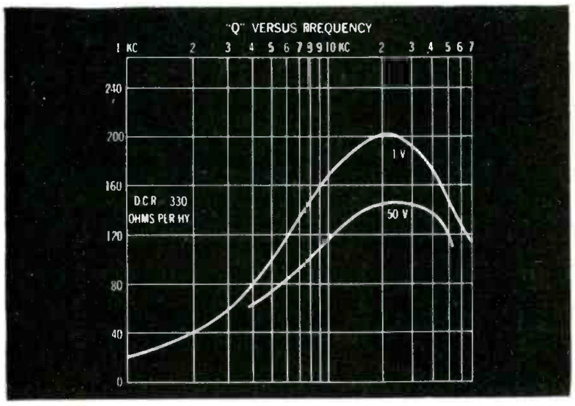


Vacuum Impregnators. Manufacturers of electronic equipment use Stokes vacuum impregnation systems for obtaining improved characteristics of coils, capacitors and other components.



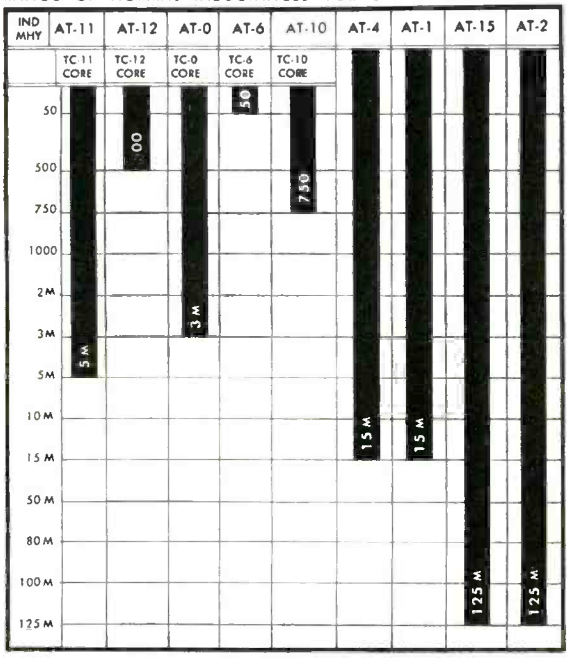
Vacuum Furnaces. Stokes melting and heat-treating furnaces permit electronic manufacturers to pre-process raw and semi-finished materials with less contamination for increased life and performance.

variable "L" by BURNELL



Typical Q vs. frequency characteristics of Adjustoroids.

RANGE OF NORMAL INDUCTANCES FOR STOCK ADJUSTOROIDS



For nominal D. C. R. values refer to Burnell catalog No. 103.

COMPLETE TECHNICAL INFORMATION UPON REQUEST
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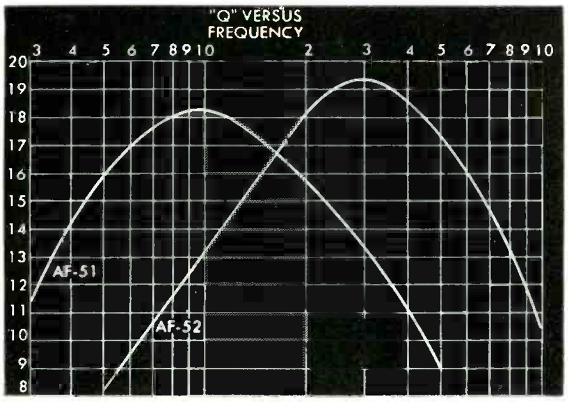


Typical Q vs. frequency characteristics of Variable Inductors.

ADJUSTOROIDS

The Adjustoroid, a low cost adjustable toroid, exclusively developed by Burnell & Company, Inc., contains an actual complete toroid with all the excellent characteristics of the non-adjustable types. Adjustment is obtained by a completely stepless function with magnetic biasing.

The nominal inductance value for an Adjustoroid is the **maximum** value, and the inductance range is the nominal value minus approximately 10%.

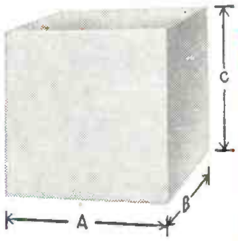
Hermetically sealed to meet Government MIL specifications. Many types of networks in tuned circuits are being produced which employ the Adjustoroid in completely hermetically sealed packages.

Intermediate inductance values as well as special taps and extra windings available on special order with minimum delay.

For additional technical data on Adjustoroids, refer to equivalent toroid in catalog.

AT-0, AT-6, AT-10, AT-4

AT-1, AT-2, AT-11, AT-12



ADJUSTOROID & VARIABLE INDUCTOR DIMENSION CHART

	A—LENGTH	B—WIDTH	C—HEIGHT
AT-O, AT-6	1-1/16"		1"
AT-10, AT-4	1-19/64"		1-1/4"
AT-15	1-31/32"		1-7/8"
AT-11, AT-12	45/64"	45/64"	3/4"
AT-1	1-3/4"	1-3/4"	1-1/4"
AT-2	2-3/4"	2-3/4"	2-1/4"
AF-51, AF-52	1-19/64"		2"

and now ...

VARIABLE INDUCTORS

AF-51 AF-52

(20-500 cycles)
Maximum Q at 100 cycles

(50-1000 cycles)
Maximum Q at 250 cycles

Burnell Variable Inductors have the similar characteristics to the Adjustoroid except they are especially designed for low frequency applications or for conditions where high inductance values are required. Variable Inductors are available in all inductance values up to 1000 Hys.

BURNELL & CO., INC.

YONKERS 2, NEW YORK Teletype: Yonkers, N. Y. 3633
Pacific Division: 720 Mission St., S. Pasadena, Calif.

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You get dependable electrical protection – under all service conditions – with BUSS FUSES

To assure top quality and proper operation, — BUSS fuses are electronically tested. A sensitive device automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

BUSS fuses, by their unfailing dependability, help safeguard the reputation of your product for quality and service.

When there is an electrical fault, BUSS fuses clear the circuit in time to prevent further damage to equipment. And just as important, BUSS fuses eliminate needless blows.

Users of your equipment get protection yet — they are not plagued with irritating, useless shutdowns caused by faulty fuses blowing needlessly.

With a complete line of "trouble-free" BUSS fuses available in all sizes and types, — it is just good business to standardize on BUSS fuses.

If your protection problem is unusual, you can save engineering time by letting the BUSS fuse engineers help you select the fuse or fuseholder best suited to your needs.

Be sure to get the latest information on BUSS and FUSETRON small dimension fuses and fuseholders . . . Write for bulletin SFB.

Bussmann Mfg. Co.

(Div. of McGraw Electric Co.)

UNIVERSITY AT JEFFERSON, ST. LOUIS 7, MO.

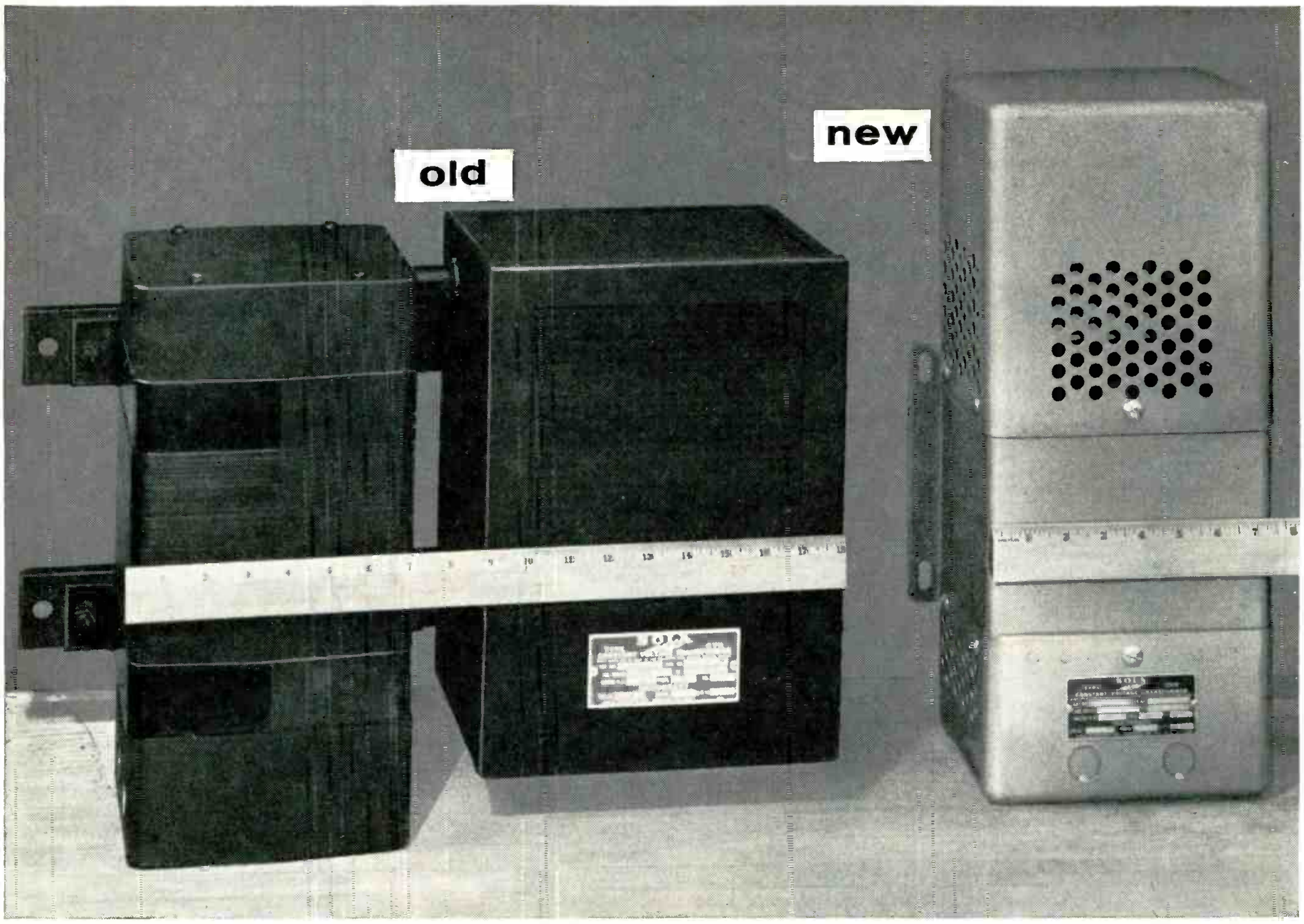
ELRC 756

FUSETRON

TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION

BUSS

Makers of a complete line of fuses for home, farm, commercial, electronic, automotive and industrial use.



SMALLER SIZE, LIGHTER WEIGHT *of the new Sola Type CVH regulating transformer design is shown by the comparison of 1000va units shown above. The new unit shown at the right utilizes a single, rectangular housing that replaces the core-and-coil-assembly and separate neutralizer component. Also available in the new design are 250 and 500va capacities. Finish is gray hammerloid.*

New Sola Harmonic-Neutralized Constant Voltage Transformers greatly reduced in size and weight

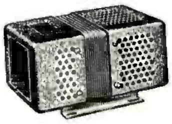
Now the valuable performance features of the Sola Harmonic-Neutralized Constant Voltage Transformer (Type CVH) are offered in a new unit design that provides up to 60% reduced size and 54% lighter weight. In addition to significant size and weight reductions, the new Sola Type CVH regulator design provides the lowest external field of any stock static-magnetic stabilizer available.

Essentially, electrical characteristics of the new Type CVH regulator are unchanged. Stabilization is ±1% regardless of primary voltage swings over a newly-expanded range of 95-130 volts. Sinusoidal output is delivered with less than 3% harmonic distortion at rated load. The nominal output rating has been raised to 118 volts to correspond with similar input reratings of electronic and other equipment.

Sola harmonic-neutralized regulators may be used for the most exacting applications with equipment having elements which are sensitive to power frequencies harmonically related to the fundamental. They are especially suitable for input to a rectifier when close regulation of the dc output is required.

New design Sola Type CVH regulators are available in three capacities — 250, 500, and 1000va. For specific advice on your particular application, consult your Sola representative listed below.

SOLA *Constant Voltage* **TRANSFORMERS**



Request Explanatory Circular

SOLA ELECTRIC CO.
4633 W. 16th Street
Chicago 50, Illinois

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*

Bendix-Pacific airborne radar systems represent advancement. Highly complex systems are designed into extremely small lightweight units to meet rigid environmental conditions.

This Bendix-Pacific arch-type sub-assembly for a new radar system represents a maximum utilization of space.

Rely on Bendix-Pacific for your airborne radar system requirements. Qualified radar systems engineers are available to call on you at your convenience.

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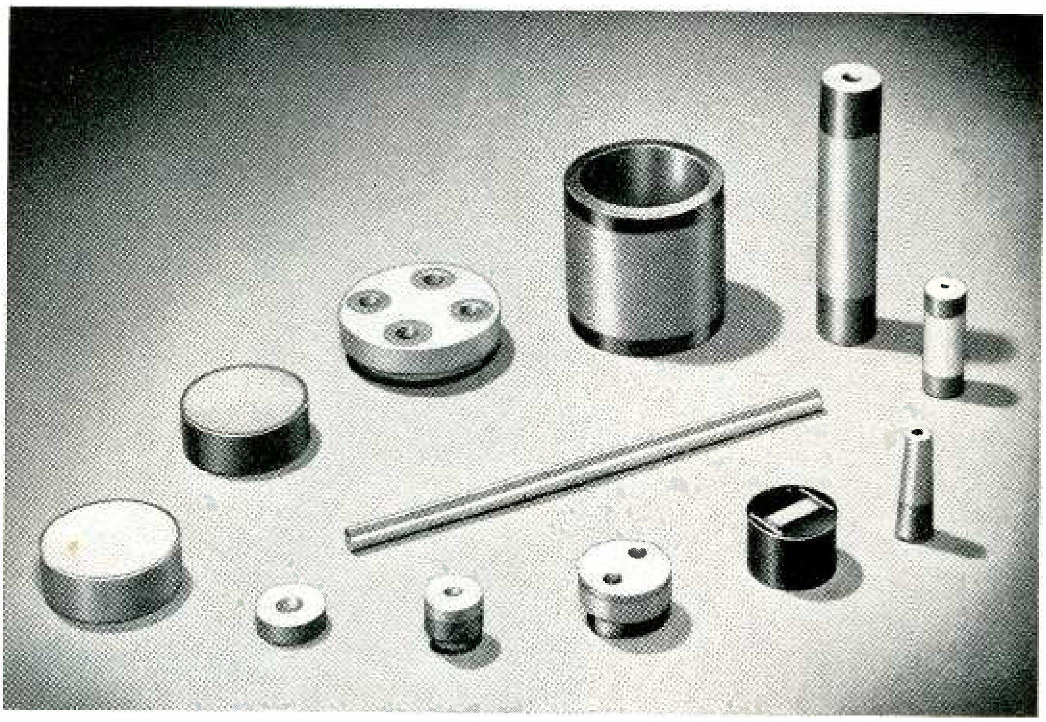
another first!

MOLCOTE *metallized ceramic coating*

for use with all types of hard solders!



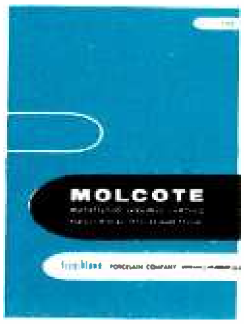
HERE'S *another first* from Frenchtown . . . a firmly bonded metal-to-ceramic coated surface to which a metal or metallized ceramic may be *hard soldered* up to 2200° F.

MOLCOTE, applied to ceramic bodies by a special Frenchtown process and fired at high temperature, offers distinct advantages over existing coatings. Its versatility permits use in a wide latitude of high temperature assembly manipulation. And, its extreme refractory qualities defy the attack of solders of the copper-silver, silver, and pure copper types.

With MOLCOTE, no expensive preliminary processing is required. You may use it immediately for any high temperature solder operation.

MOLCOTE's solder bonds are exceptionally strong to the point of fracture of the ceramic, making it ideal for such applications as vacuum type ceramic envelope electronic equipment assemblies, support insulators, condenser shafts, hermetic seals, wave guide windows and a host of others. We'd like you to know more about the unlimited possibilities of MOLCOTE. Bulletin 1155 contains complete engineering details. Write for your free copy.

Bulletin 1155 contains complete engineering data on MOLCOTE, Frenchtown's metallized ceramic coating for use with all types of hard solders. Write for your copy.



CALIFORNIA REPRESENTATIVE:
Edwin E. Starr,
4101 Rhodes Ave.,
North Hollywood,
Cal. STanley 7-5879

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SALES OFFICES: ATLANTA, COLUMBUS, CULVER CITY, DALLAS, DENVER, DETROIT, MELROSE PARK (ILL.), NEWARK, SEATTLE
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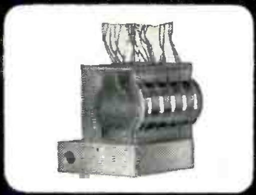
BK-3300, BK-3500, BK-3700—ultimate in precision made multichannel heads.

BK-1300, BK-1500 series—up to 25 interlaced channels per inch.



BK-1605 series—simple mounting and adjustment, ideal for drum computers.

BK-1501 series—compact, wafer-thin, permit individual adjustment.

BK-900, BK-1000, BK-1200 series—variety of types for single channel applications.

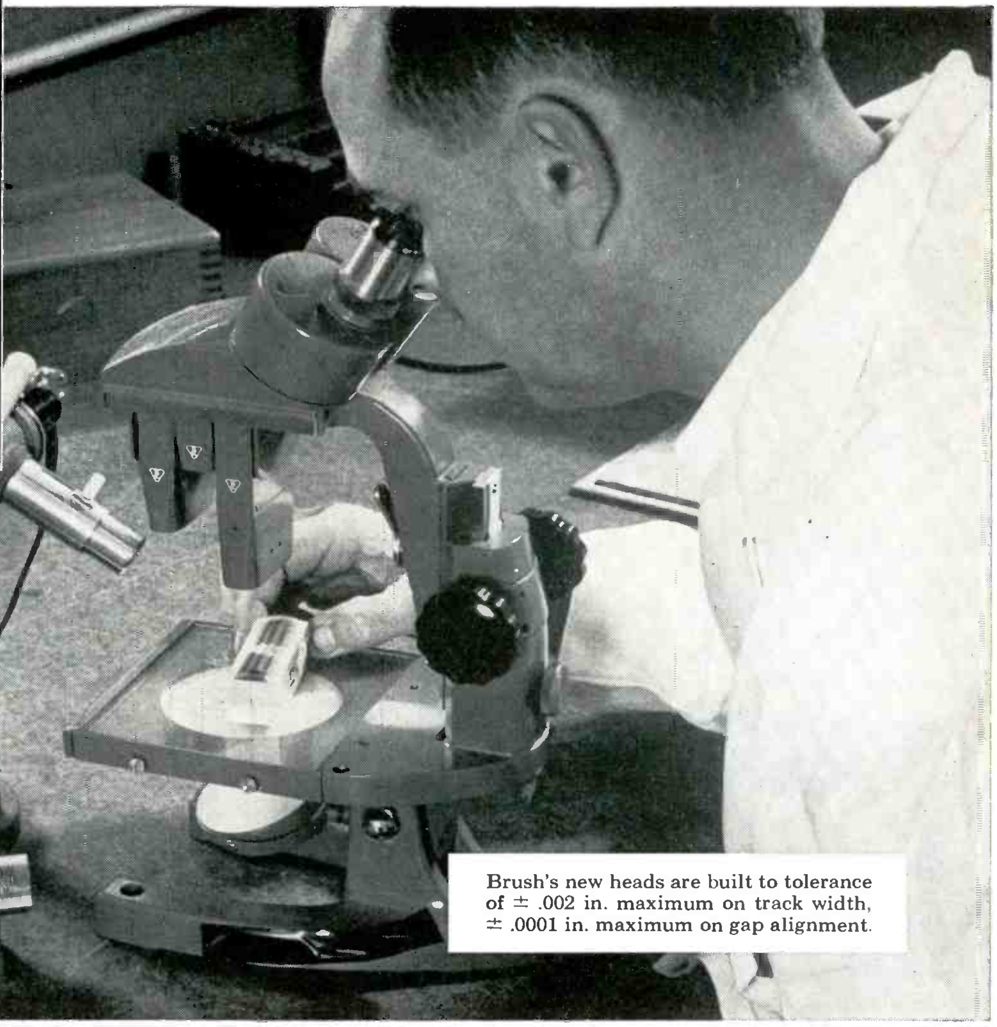
How Brush Magnetic Heads improve product performance

Microscopic inspection is a familiar tool in Brush's manufacturing of magnetic heads. Track width and gap alignment must be held to ten-thousandths; pole faces and tips must be lapped to a surface finish of better than 8 microinches.

This craftsmanship improves product performance. Precision gap alignment assures perfect time phase accuracy. Close tolerances permit greater pulse packing, increased storage capacity, uniform output and frequency response.

Get the facts on Brush's complete line of magnetic heads, including the new precision multichannel heads. Write Brush Electronics Company, Dept. K-60, 3405 Perkins Avenue, Cleveland 14, Ohio.

BRUSH ELECTRONICS COMPANY
3405 Perkins Avenue, Cleveland 14, Ohio
DIVISION OF CLEVITE CORPORATION



Brush's new heads are built to tolerance of ± .002 in. maximum on track width, ± .0001 in. maximum on gap alignment.

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CAMERA PICK-UP TUBES FROM WESTINGHOUSE

Image Orthicon (WL-5820), left

Vidicon (WL-6198), right

For superlative tube performance in your television cameras, you'll find this worth remembering.

The same fine quality you have learned to count on in all other Westinghouse Tubes is available to you in the Vidicons and Image Orthicons that are in production today at Westinghouse. Improved versions for military and industrial applications are under development.

Born of Westinghouse experience and workmanship, these precision-built TV pick-up tubes are absolutely unexcelled for clarity and brightness of image and for long, economical life.

Whether you build TV cameras or use them —for commercial, industrial or defense applications—we invite your inquiries. Simply write our Commercial Engineering Department at the address below.

ENGINEERS! For challenge, security, growth potential, investigate career opportunities now being offered by Westinghouse Electronic Tube Division. Write Technical Placement Director today.

Westinghouse RELIATRON® Tubes

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PHONE OR WRITE *for complete information regarding component type Tuning Fork Resonators, or variously packaged Tuning Fork Frequency Standards.*

PHILAMON LABORATORIES INC.
90 Hopper Street, Westbury, Long Island, N. Y. **ED***gewood* **3-1700**

Doelcam

PROPORTIONAL AMPLIFIERS

OFFER GREATEST VERSATILITY FOR LOW LEVEL D-C SIGNAL MEASUREMENTS

D-C INDICATING AMPLIFIER
Model 2HLA-3
Write for Bulletin 1A-7

- COMPARATIVE RESISTANCE MEASUREMENTS
- TEMPERATURE INDICATION AND CONTROL
- INSULATION AND DIELECTRIC TESTING
- PHOTOELECTRIC MEASUREMENTS
- STRAIN GAGE MEASUREMENTS
- NULL DETECTION

Wherever low level d-c signals corresponding to minute chemical or physical changes must be accurately measured, the Doelcam D-C Indicating Amplifier Model 2HLA-3 is ideally suited. This versatile instrument may be used as either a multi-range microvoltmeter or a null indicator in the laboratory and on the production line. The exclusive Doelcam Second Harmonic Magnetic Converter is used in the input stage instead of a mechanical chopper for all around improved performance.

PERFORMANCE CHARACTERISTICS

SENSITIVITY: *4×10^{-15} watt*
HIGH GAIN: *10^4 for Model 2HLA-3*
10^5 for Model 2HLA-4
LINEAR AMPLIFICATION: *Better than 1% on all ranges.*
HIGH STABILITY: *Zero drift less than 10 microvolts.*
RUGGED: *Withstands over-range inputs up to 1500 times full scale range.*
FREQUENCY RESPONSE: *Greater than 20 cps.*
INPUT IMPEDANCE: *One megohm/volt.*
HIGH POWER OUTPUT: *Drives most commercial pen motor or galvanometer recorders.*

SELECTIVE RANGE D-C AMPLIFIER
Model 2HLA-4
Write for Bulletin SRA-7

Doelcam Model 2HLA-4 is a Selective Range D-C Amplifier with provisions for the following interchangeable range plug-in units: 0-0.1 MV, 0-0.3 MV, 0-1 MV, 0-3 MV, 0-10 MV, 0-30 MV, and 0-100 MV. Model 2HLA-4 is designed for bench mounting and rack mounting as a component part of a control or measuring system.

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A DIVISION OF MINNEAPOLIS-HONEYWELL
1400 SOLDIERS FIELD ROAD
BOSTON 35, MASSACHUSETTS

Instruments for Measurement and Control

Synchros • Gyros • Accelerometers • Amplifiers • Microsyns • Servo Motors

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Now LARGE WAVEGUIDE

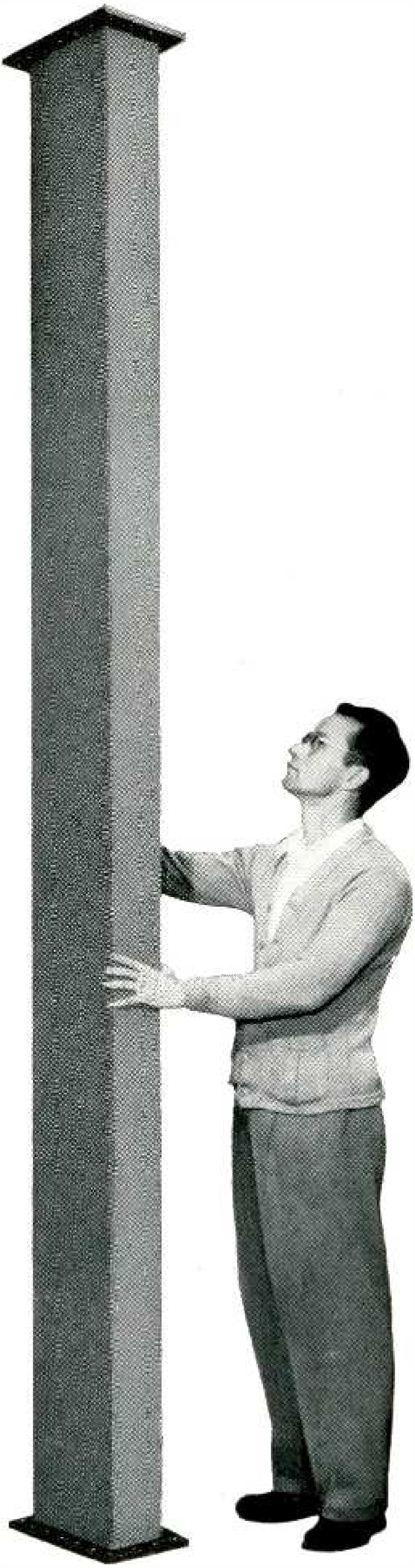
For multi-megawatt radar and scatter communications equipment

You can have early delivery on any large waveguide size from WR-770 up. Available in straight runs, H-plane and E-plane bends, S-bends and other shapes.

This new I-T-E waveguide is now being specified for both commercial and military applications. Accepted for major critical defense programs.

Treated aluminum construction resists corrosion. Waveguide is sealed against all types of weather and is capable of pressurization. Has superior ability to handle highest powers with low attenuation. VSWR 1.03 peak over entire range for straight sections—proportionately low for other configurations. Available with fully engineered waveguide test equipment, plus accessories and hardware. Competitively priced.

Write for complete technical details. I-T-E Circuit Breaker Company, Special Products Division, 601 East Erie Avenue, Philadelphia 34, Pa.



One of the smaller "large" waveguide sizes. Others measure up to 21 in. major dimension.

I-T-E CIRCUIT BREAKER COMPANY
Special Products Division

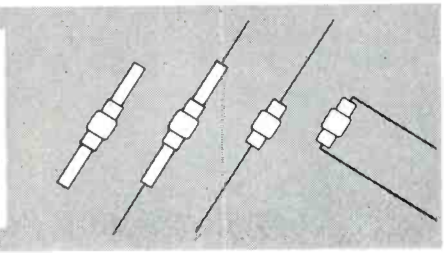
L. C. Clevenger, Manufacturing Manager, explains below the method used in maintaining lot homogeneity at PSI.

FAMILY HISTORY OF DIODE LOT NO. 273

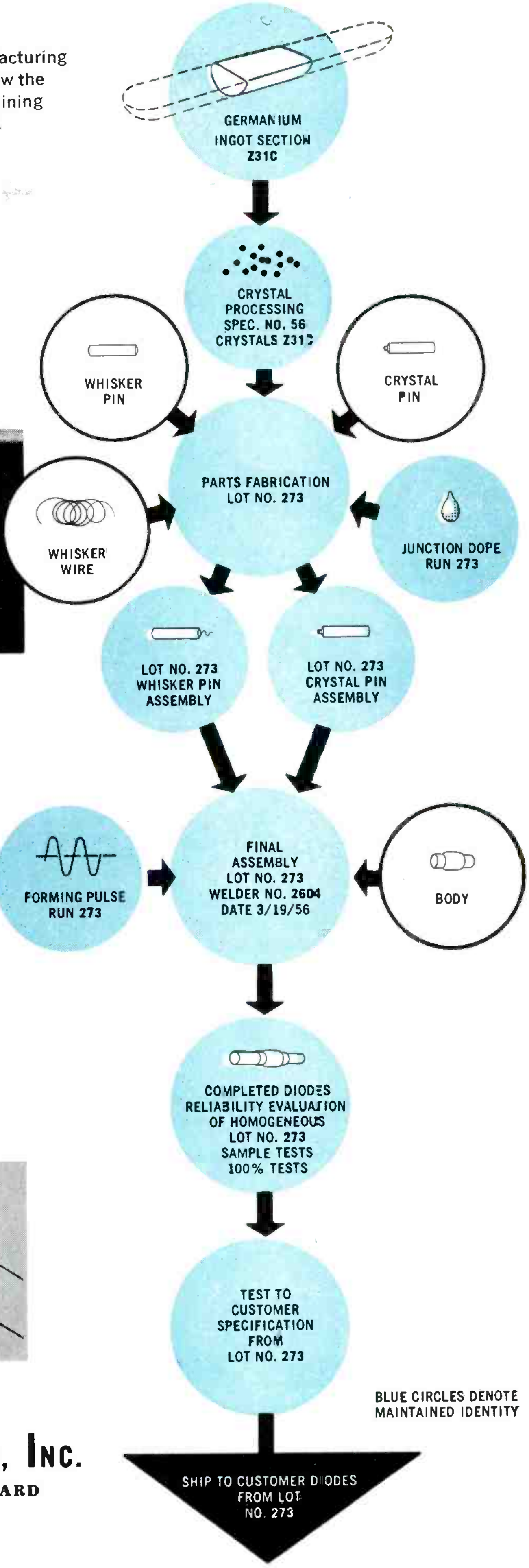
"At PSI, lot identity is maintained so strictly throughout manufacturing, testing and shipping that, if required, we can trace a diode all the way back to the original semiconductor ingot, as indicated in the accompanying diagram.

"In each serialized production lot, every input parameter is kept unchanged; only one semiconductor ingot section is used, and production time is limited to a specified interval. There is one set of material-input limits, one junction-dope concentration, one prescribed forming pulse.

"Sampling tests of diodes from each lot, particularly life tests under electrical load, are used to qualify a lot for shipment. Maintenance of lot identity and homogeneity assures that control samples are *truly* representative, and that all diodes from the lot will meet PSI's exacting standards of reliability."



PSI offers both germanium and silicon diodes (here, actual size) with four basic lead arrangements. Construction permits lead bending with complete safety and without harm to the hermetic seal. WRITE FOR DATA.



PACIFIC SEMICONDUCTORS, INC.

10451 WEST JEFFERSON BOULEVARD

CULVER CITY, CALIFORNIA

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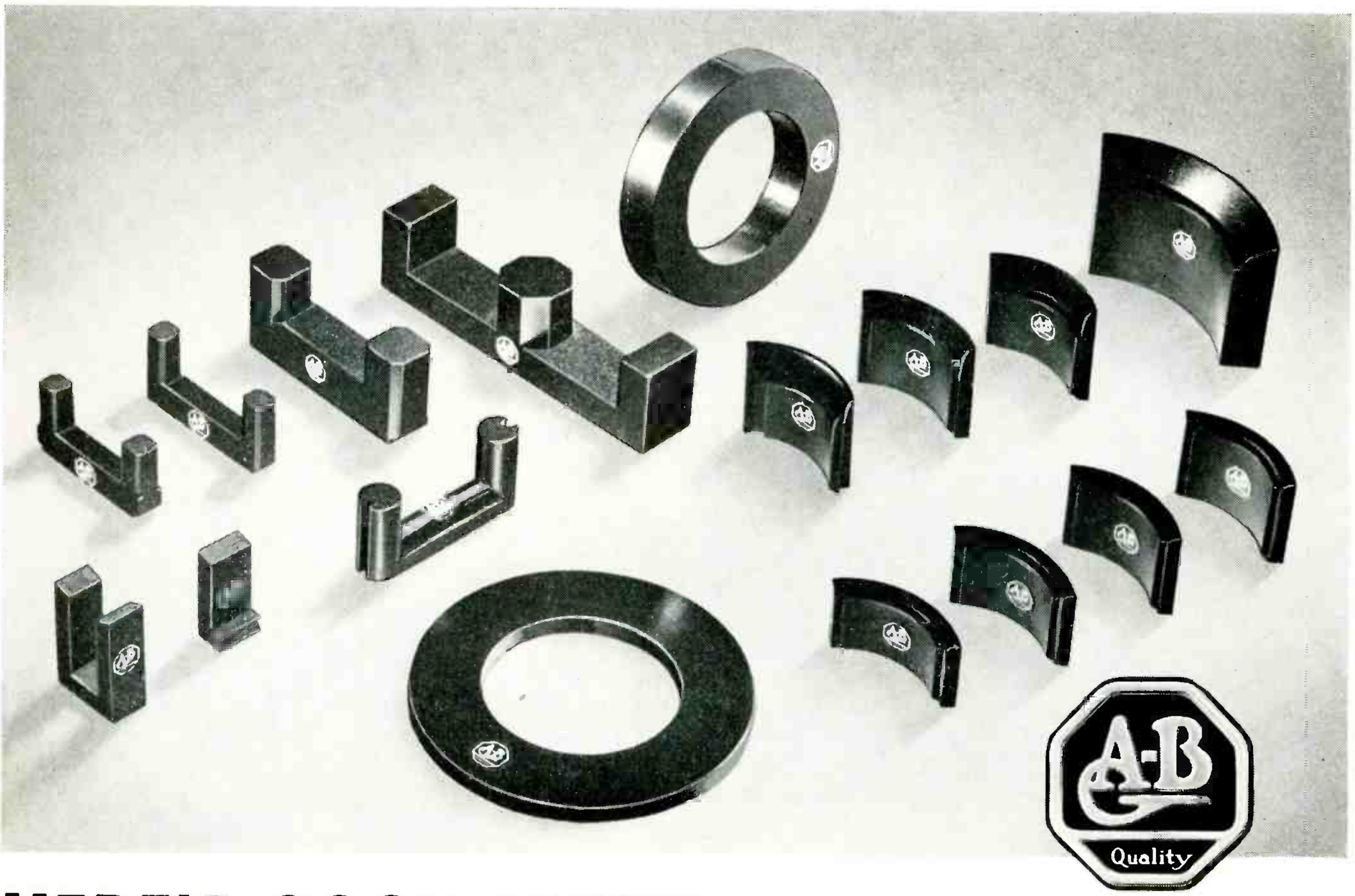

HERE'S GOOD NEWS

about ALLEN-BRADLEY FERRITES!

Allen-Bradley ferrites have been discovered to be superior for deflection component applications in television receivers. As a result, the demand has kept Allen-Bradley in delivery troubles—a situation that has been annoying to both customers and ourselves. Therefore, you will be glad to learn that Allen-Bradley's production capacity has been considerably expanded—our shipment problems should be a thing of the past.

Comprehensive tooling for practically every size and shape of ferrite core currently being used in both black and white and color television receivers, makes Allen-Bradley an ideal source for your ferrite core requirements.

Use Allen-Bradley Class WO-1 ferrites for deflection yoke application and Class WO-3 ferrites for flyback transformer applications and enjoy superior TV receiver performance.

Uniform dimensions of Allen-Bradley ferrites enable low-cost, efficient assembly. Uniform magnetic characteristics eliminate necessity of individual adjustments or compensations.

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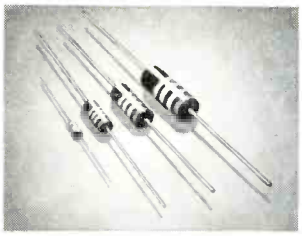
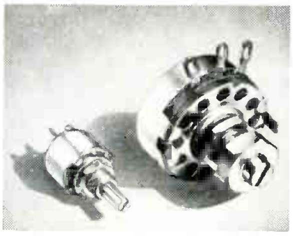
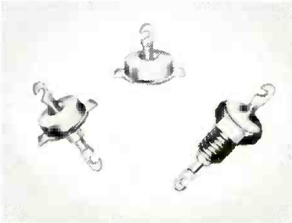


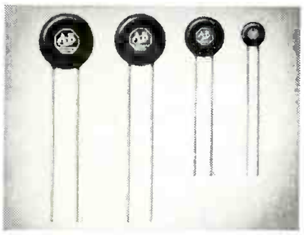
Fixed Molded Resistors
1/10, 1/2, 1 & 2 watt



Variable Molded Resistors
1/2 & 2 watt



Stand-off and Feed-thru capacitors



Ceramic Dielectric Capacitors for by-pass and filtering

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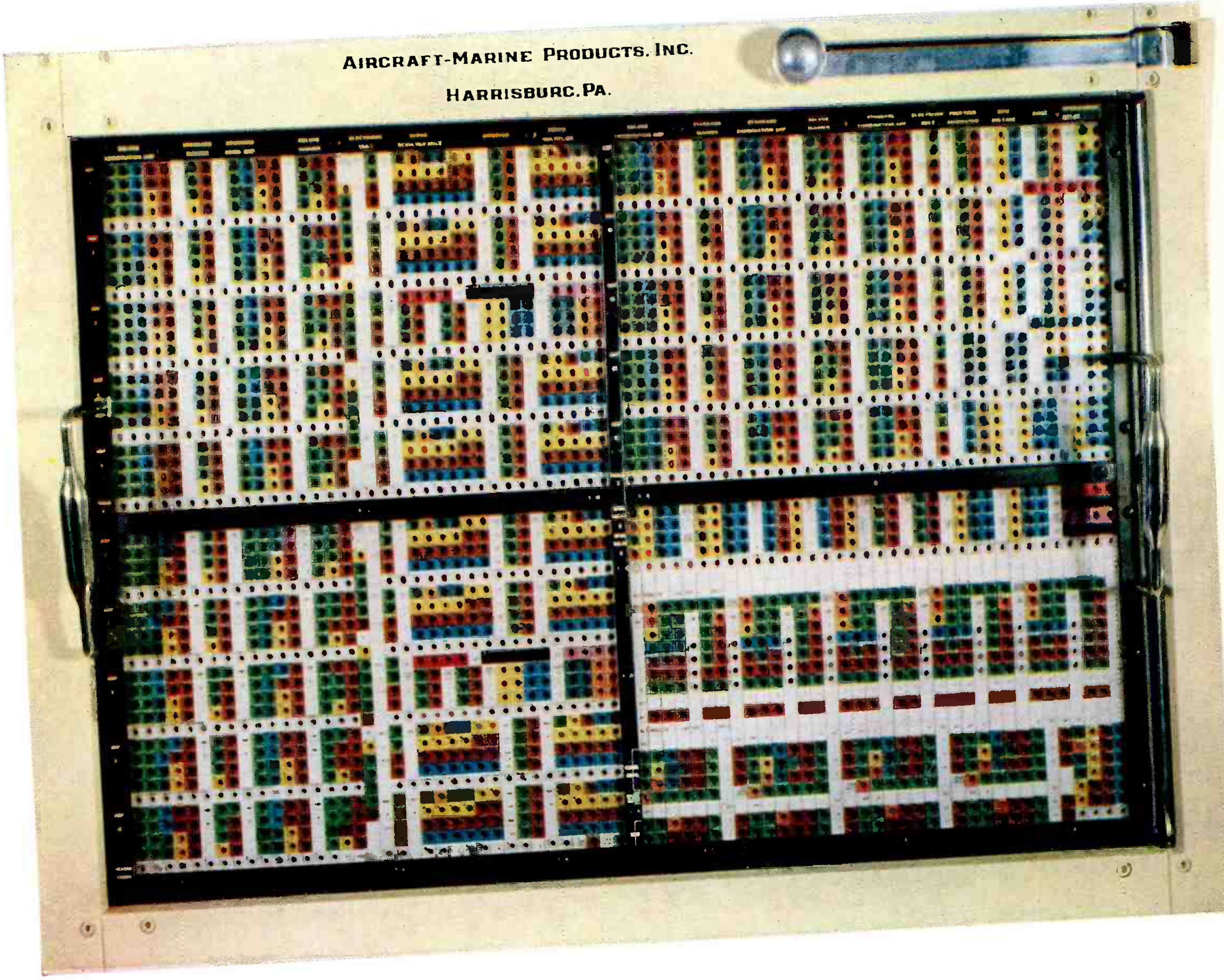

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2W-2084	1.650 dia. Size 17	.002 HP	6500 RPM	30 FLD 27 1/2 ARM	.05	REV.	CONT.	Servo	D.C. Servo
BU 380 MOD 1	1.672 dia. Size 17	.03 HP	7000 RPM	27	1.75	C.C.W.	CONT.	Series	
BHG 375 MOD 6	1.687 dia. Size 17	.01 HP	5490 RPM	27 1/2	1.2	C.W.	CONT.	Shunt	Governor Controlled Speed to ± 1%
CU 306 MOD 4	1.937 dia. Size 20	.01 HP	7000 RPM	27 1/2	7	C.W.	CONT.	Series	
QH 312 MOD 6	2.312 dia. Size 24	.1 HP	10,000 RPM	27 1/2	4	C.W.	CONT.	Shunt	
2N 2103	3.920 dia. Size 40	.5 HP	4000 RPM	27 FLD 60 ARM	10	REV.	CONT.	Compound	Has 27 V.D.C. BRAKE
2P 2104	4.670 dia. Size 47	1.0 HP	4000 RPM	27 FLD 60 ARM	16.5	REV.	CONT.	Compound	Has 27 V.D.C. BRAKE

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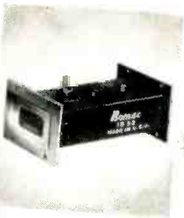
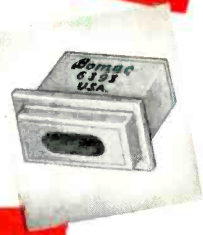


ATR



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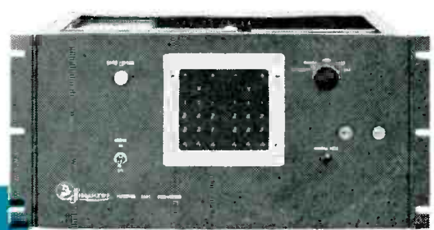

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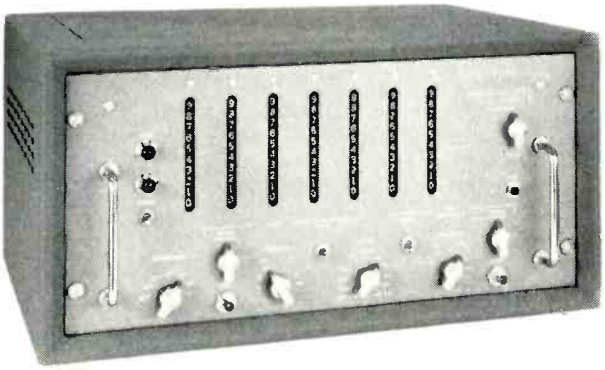
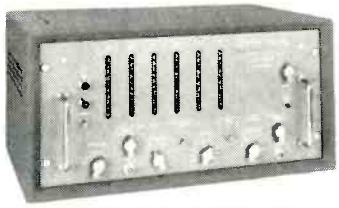


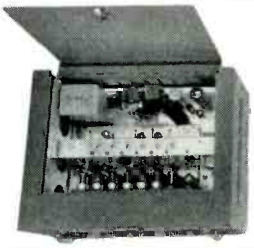
MODEL 7360 — 0 cps to 1 mc range



MODEL 7350 — 0 cps to 100 kc range

MODEL 5916 IN-LINE REMOTE READOUT offers large illuminated in-line figures all on one plane which can be read from any angle. Reduces error and fatigue; ideal for remote observation of data.

MODEL 1452 DIGITAL PRINTER prints data on standard adding machine tape. 7000-Series instruments also drive data converters to operate card punches or electric typewriters.



Accessibility is an important feature of BERKELEY 7000-Series instruments. Modular chassis design permits rapid checking or replacement of components and sub-assemblies.

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1. *0.1 v rms sensitivity*
2. *Step attenuators; trigger-adjusted noise discriminators*
3. *More stable frequency dividers*
4. *Electronic (not relay) reset*
5. *External frequency standard input connection*
6. *AC or DC coupling of all input circuits; 10 megohm input impedance*
7. *Multivoltage accessory socket to power photocells, etc.*
8. *Binary-coded output with direct connection to digital printers, data converters, inline readouts, etc.*
9. *Crystal-controlled time marker output*
10. *Unitized modular design*
11. *Larger, brighter readout numbers*
12. *Modern-styled all-aluminum cabinets*

BRIEF SPECIFICATIONS

	Model 7350	Model 7360
Ranges—Frequency:	0 cps to 100 kc	0 cps to 1 mc
Time Interval:	10 μ sec to 10^6 sec	1 μ sec to 10^7 sec
Period:	0 cps to 100 kc	0 cps to 1 mc
Time Bases:	10μ sec to 10 sec	1 μ sec to 10 sec
Accuracy:	± 1 count, ± crystal stability	
Crystal Stability:	± 3 parts in 10^6 per week	±3 parts in 10^7 per week
Input Requirements:	0.1 v rms, 10 megohm impedance, dc or ac — coupled	
Display Time:	Adjustable, 0.1 to 5 seconds (automatic reset). Manual reset also provided.	
Dimensions:	10¼"H x 20¾"W x 16½"D (cabinet mount; rack mount available)	
Price: (f.o.b. factory)	$890.00	$1,175.00

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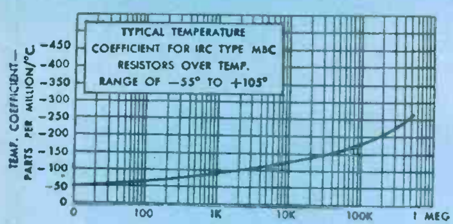

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IRC's winding skills and automatic assembly equipment provide precision windings to exacting standards. Continuous inspections at every stage of manufacture assure maximum reliability in each finished resistor. Available in 7 sizes including tiny Type WW10J—13/32'' x 9/32''. Standard tolerance ±1%; minimum tolerances are shown below.

Minimum Tolerances

Resistance	Types WW2, 3, 4, 5, 8 and 11J	Type WW10J
10 ohms & up	0.1%	
5 ohms & up	0.25%	
1 ohm & up	0.5%	
1500 ohms & up		0.1%
200 ohms & up		0.25%
65 ohms & up		0.5%

Encapsulated Wire Wound

Series "PH" Encapsulated resistors are produced to IRC's high standards and represent many years' experience in the development and manufacture of precision wire-wound resistors. Available in many types and styles, including types for use in printed wiring assemblies and subminiature Type 128A. Standard tolerance ±.1%. Also, ±1%, 0.5%, .25% and .05% can be supplied. Series "PH" offers the most complete selection of Encapsulated precision wire-wound resistors available . . . all designed to meet MIL-R-93A specifications.

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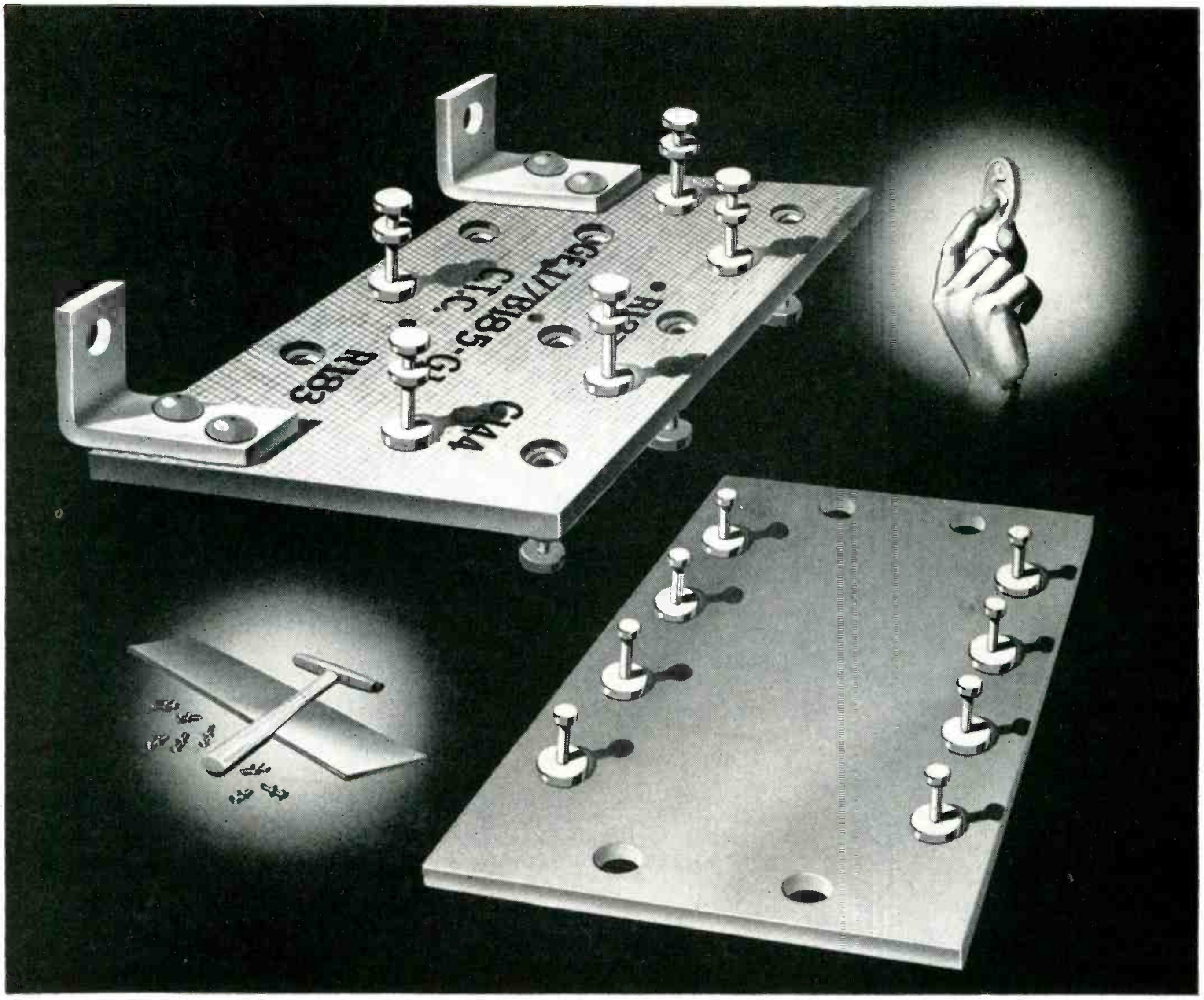

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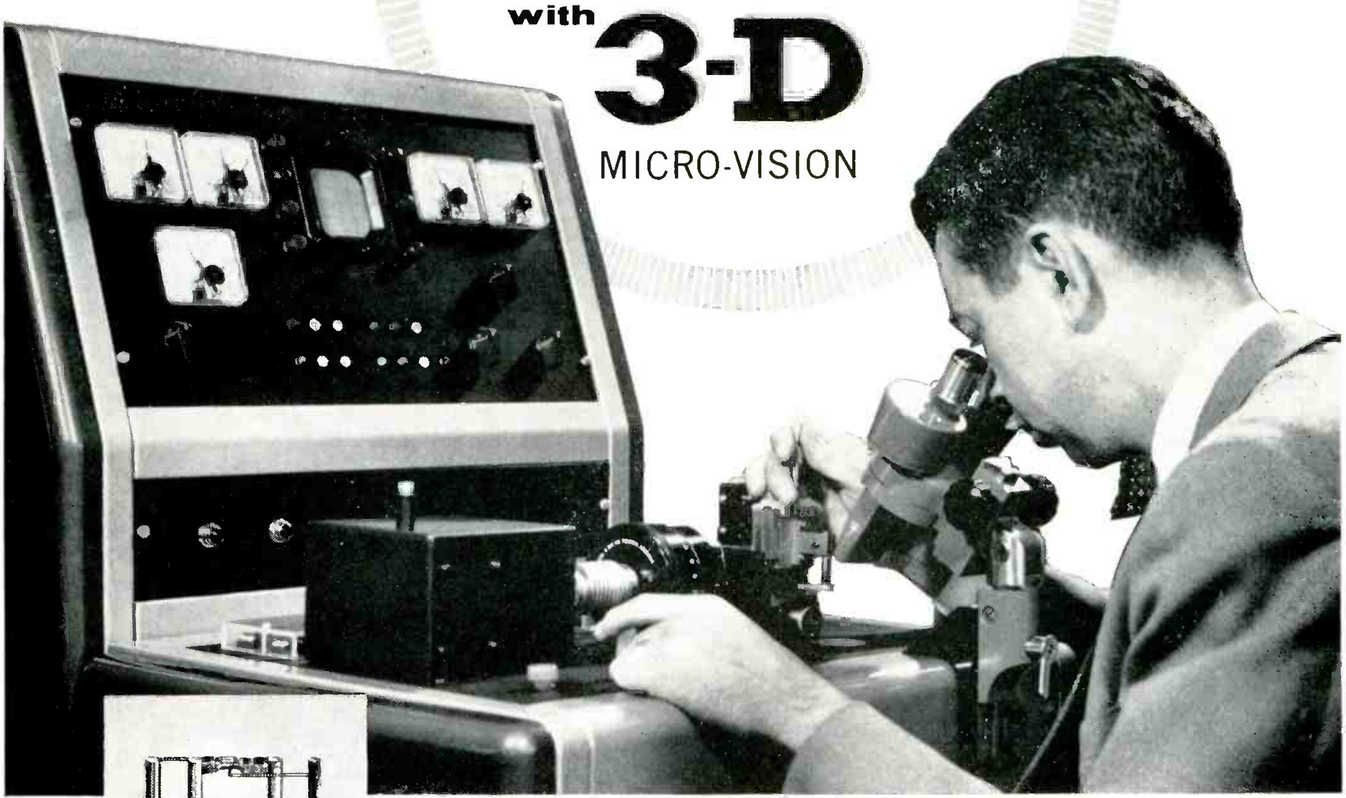

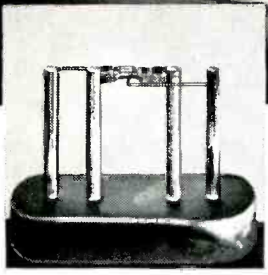

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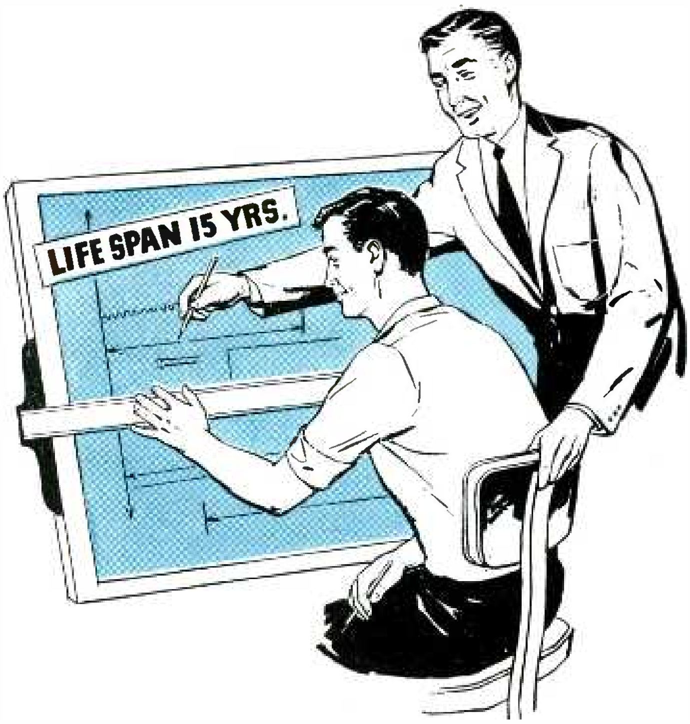

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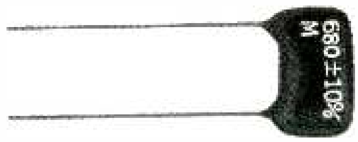

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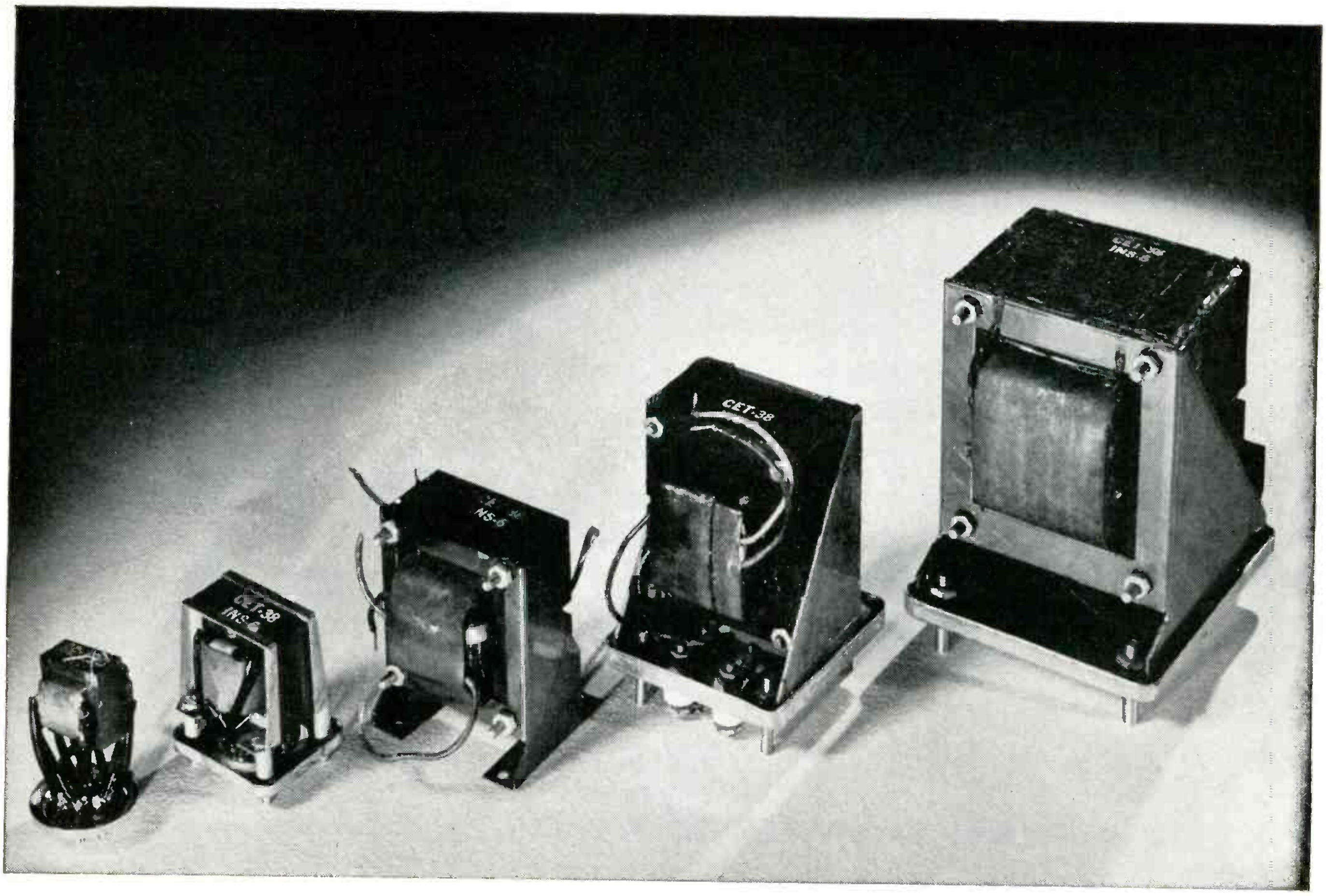

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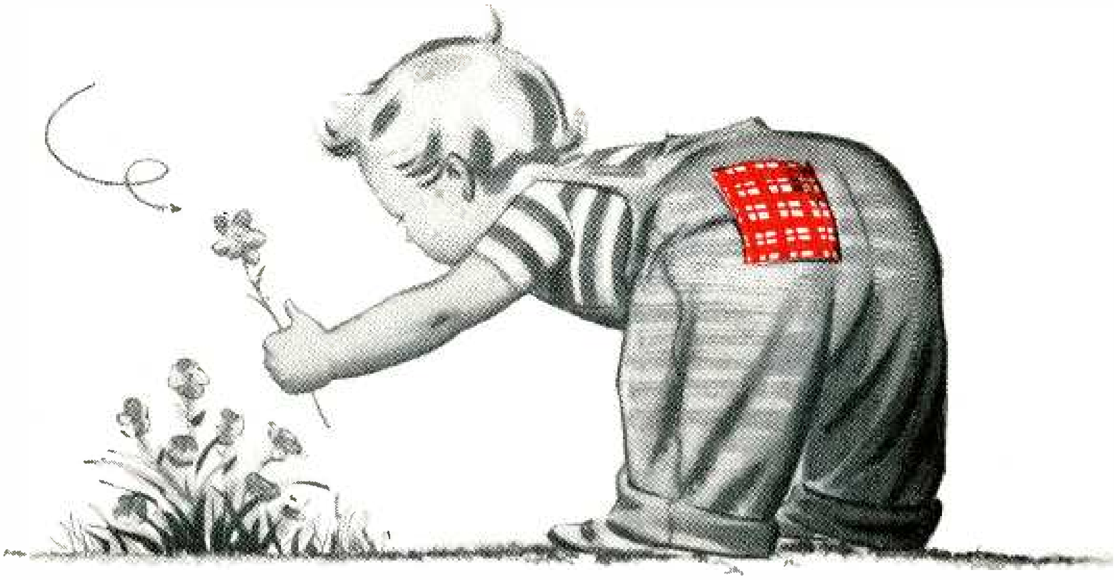

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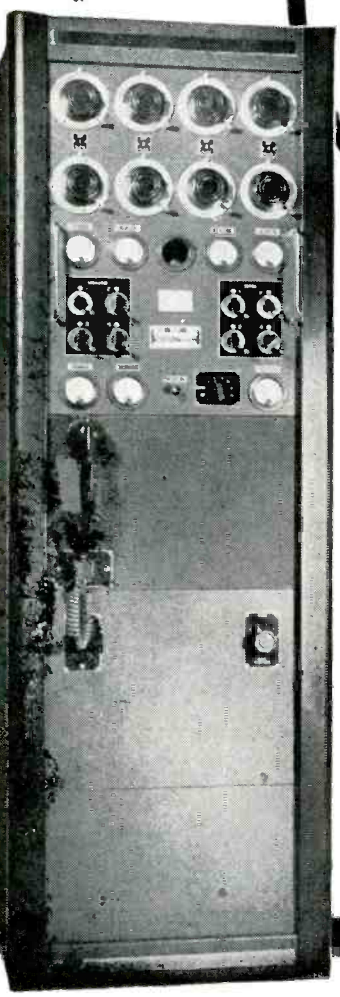

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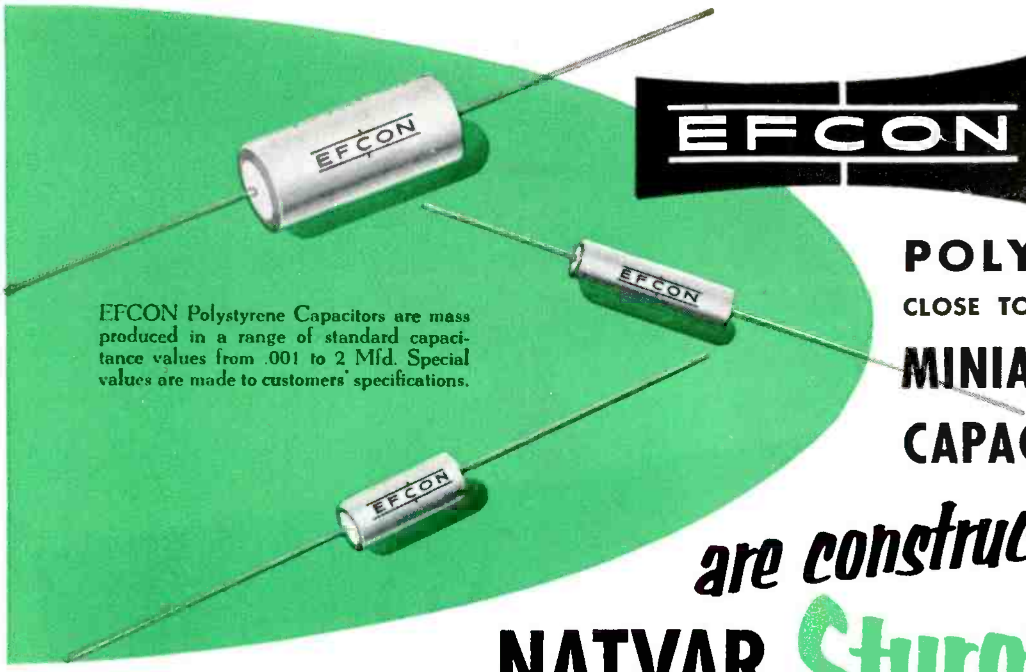

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are constructed with
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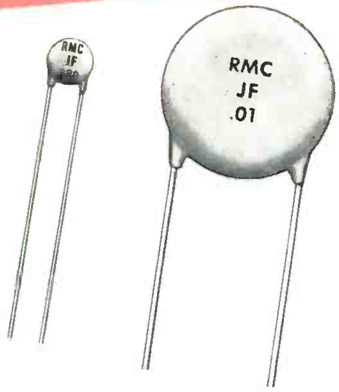
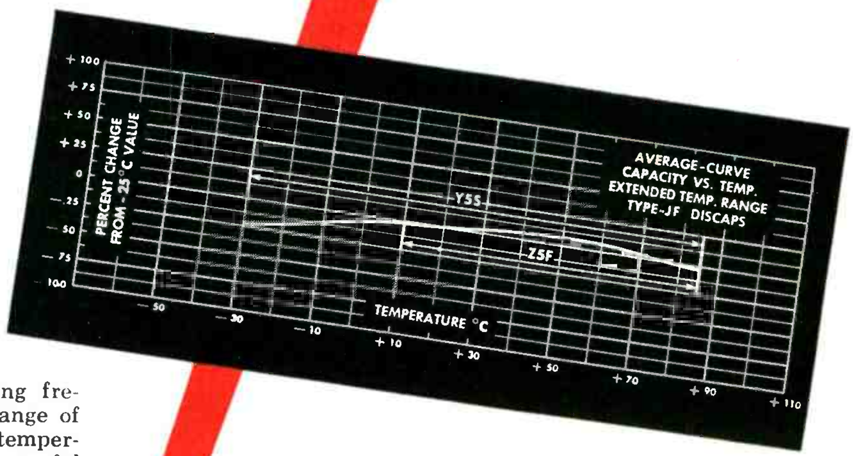
RMC DISCAPS

for frequency and temperature stability

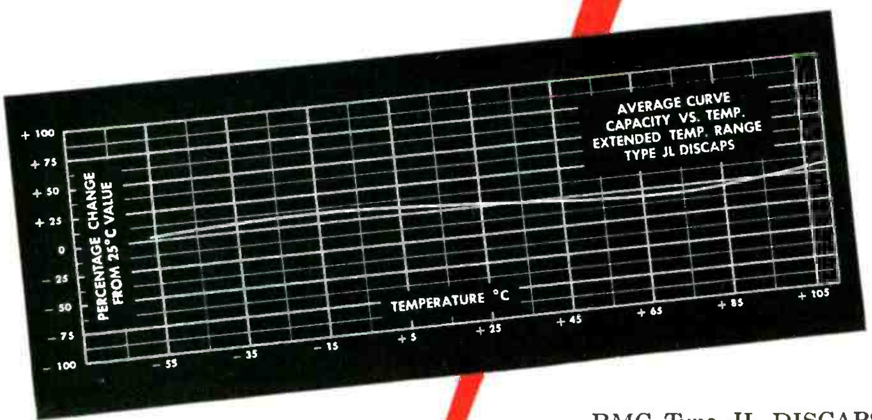
Type JF

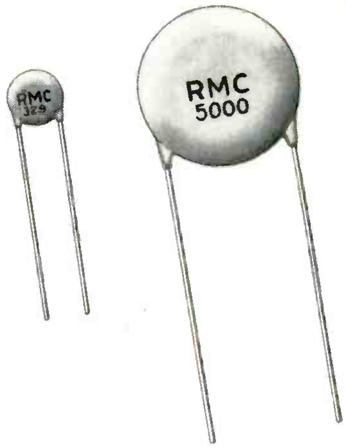




Type JF DISCAPS have outstanding frequency characteristics over a wide range of capacities and incorporate desirable temperature properties over an extremely useful range. Manufactured in capacities from 150 MMF to 10,000 MMF, Type JF DISCAPS extend the range of the RETMA Z5F capacitor between +10°–+85°C and meet Y5S specs from −30° to +85°C. (See graph)

Type JL



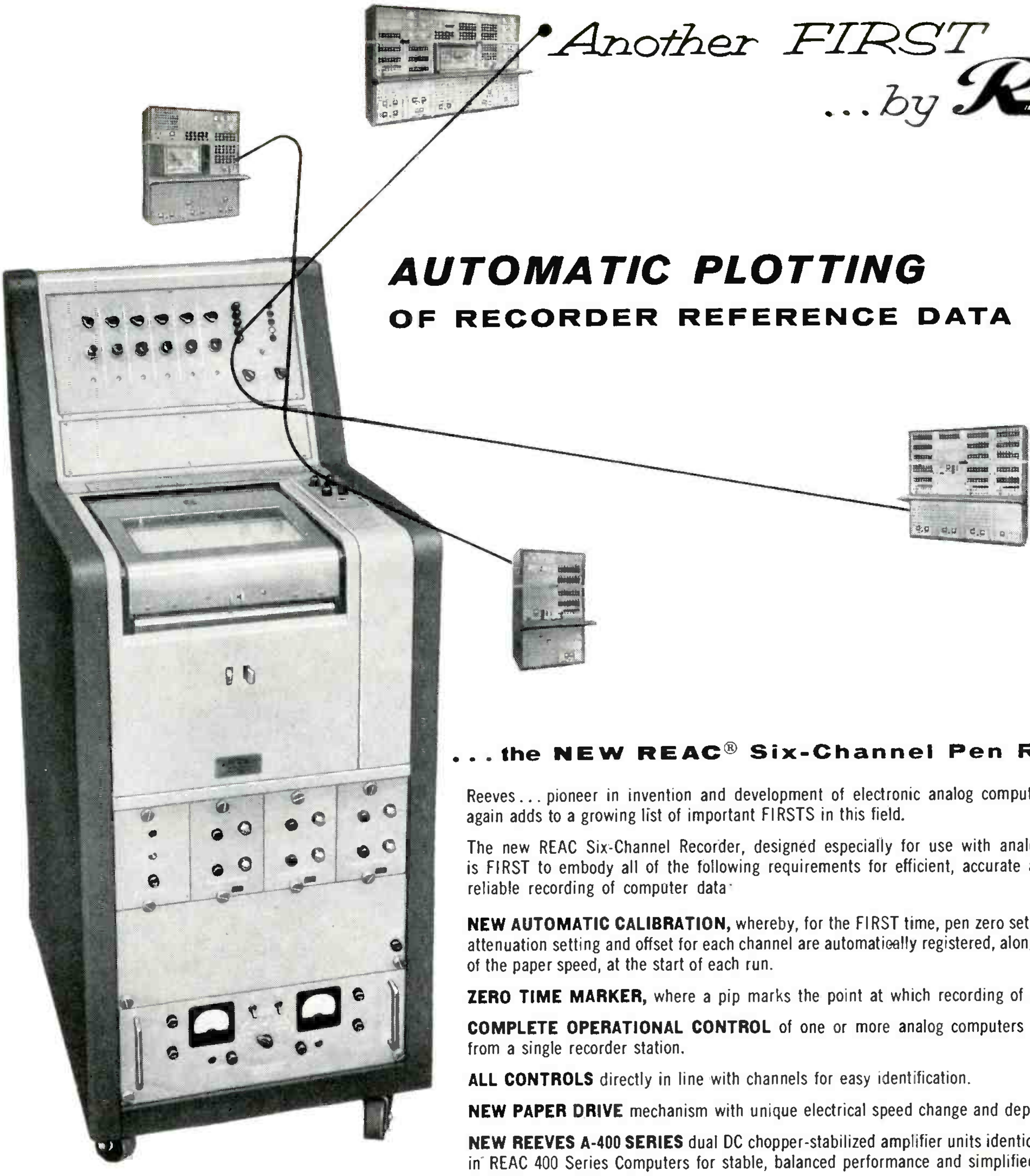


RMC Type JL DISCAPS feature exceptional temperature stability over an extended range. The maximum capacity change between −60° and +110°C is only ±7.5% of capacity at 25°C. With a standard working voltage of 1000 V.D.C., Type JL DISCAPS are the ideal cost saving replacement for paper and general purpose mica capacitors.

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.



Another FIRST ...by Reeves

AUTOMATIC PLOTTING
OF RECORDER REFERENCE DATA

... the NEW REAC® Six-Channel Pen Recorder

Reeves ... pioneer in invention and development of electronic analog computers ... again adds to a growing list of important FIRSTS in this field.

The new REAC Six-Channel Recorder, designed especially for use with analog computers, is FIRST to embody all of the following requirements for efficient, accurate and reliable recording of computer data·

NEW AUTOMATIC CALIBRATION, whereby, for the FIRST time, pen zero set, attenuation setting and offset for each channel are automatically registered, along with a record of the paper speed, at the start of each run.

ZERO TIME MARKER, where a pip marks the point at which recording of each run begins.

COMPLETE OPERATIONAL CONTROL of one or more analog computers from a single recorder station.

ALL CONTROLS directly in line with channels for easy identification.

NEW PAPER DRIVE mechanism with unique electrical speed change and dependable accuracy.

NEW REEVES A-400 SERIES dual DC chopper-stabilized amplifier units identical with those used in REAC 400 Series Computers for stable, balanced performance and simplified maintenance.

SELF-CONTAINED independent plug-in power supply.

Provision for slaving one recorder to another where required, and for control of any number of computer units from one recorder.

A range of special optional accessories, such as electric writing pens, event markers for random phenomena, and Arabic-numeral-coded run designations.

Write for detailed specifications and additional information.

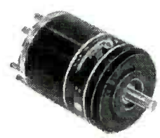
15RV56

Reeves INSTRUMENT CORPORATION

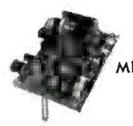
REEVES INSTRUMENT CORPORATION
A Subsidiary of Dynamics Corporation of America
201 East 91st Street, New York 28, New York

REAC Analog Computers

Precision Floated GYROS



Precision RESOLVERS and PHASE SHIFTERS



SERVO MECHANICAL PARTS

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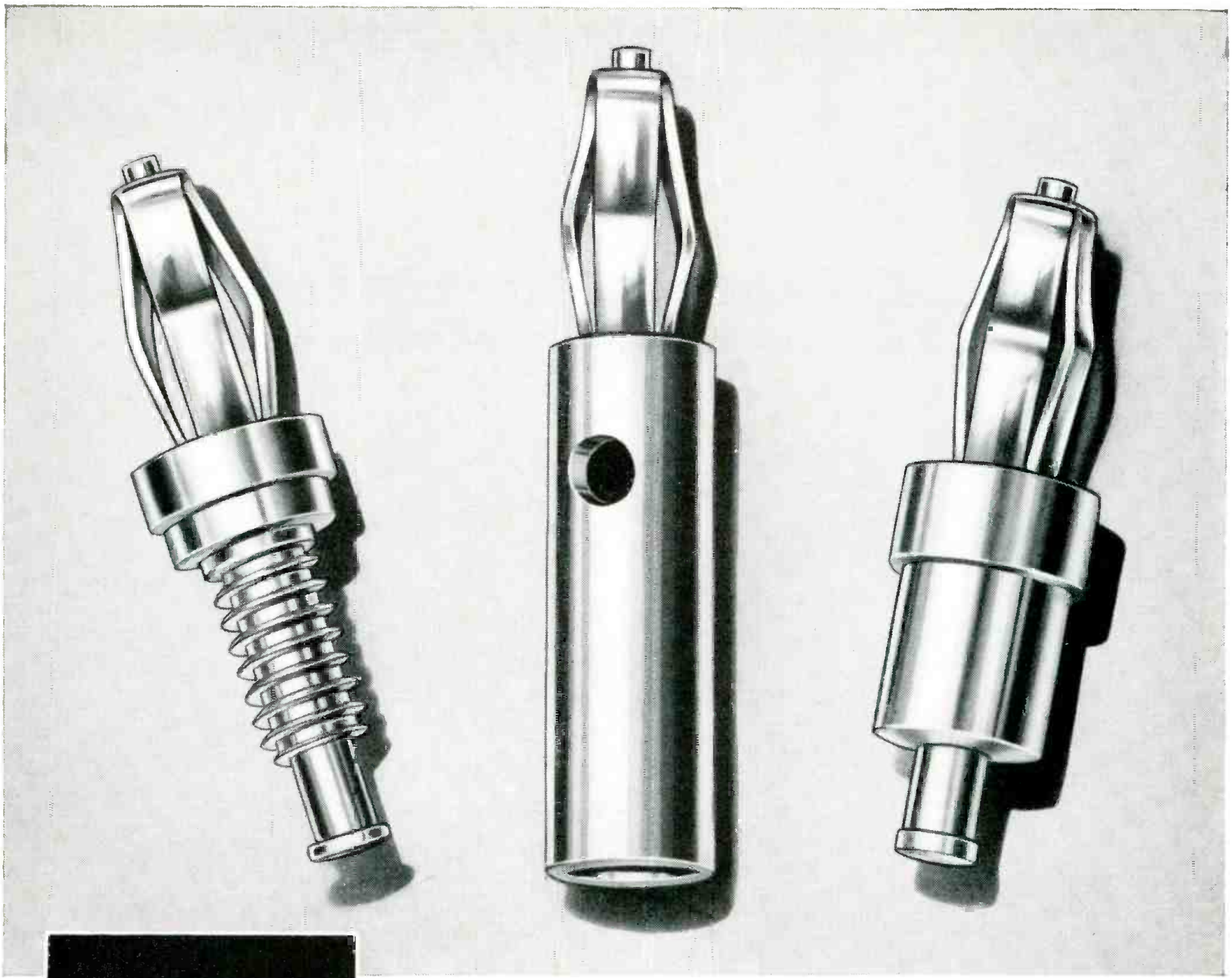
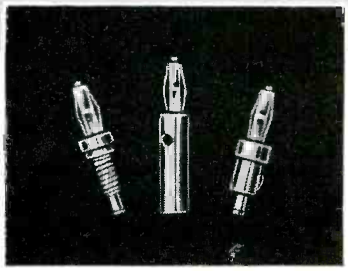


6 times enlargement



Actual size

Ucinite Miniature Banana Pins

Heavy resistance to torque is a big feature of Ucinite miniature banana pins. The springs are mechanically riveted over and the large area around the tip of the pin is bonded by solder.

Pins are available in a variety of types, for assembly by staking . . . with nuts and washers . . . with soldered tails . . . with multiple plug-in features. Springs are designed to fit .093 sockets.

Built to withstand rough usage, Ucinite miniature banana pins are available in cadmium, silver or gold plate.

For further information, call your nearest United-Carr representative or write directly to us.

ELECTRICAL ASSEMBLIES Ucinite RADIO AND AUTOMOTIVE

The UCINITE CO.
Newtonville 60, Mass.
Division of United-Carr Fastener Corp.

Specialists in
ELECTRICAL ASSEMBLIES, RADIO AND AUTOMOTIVE

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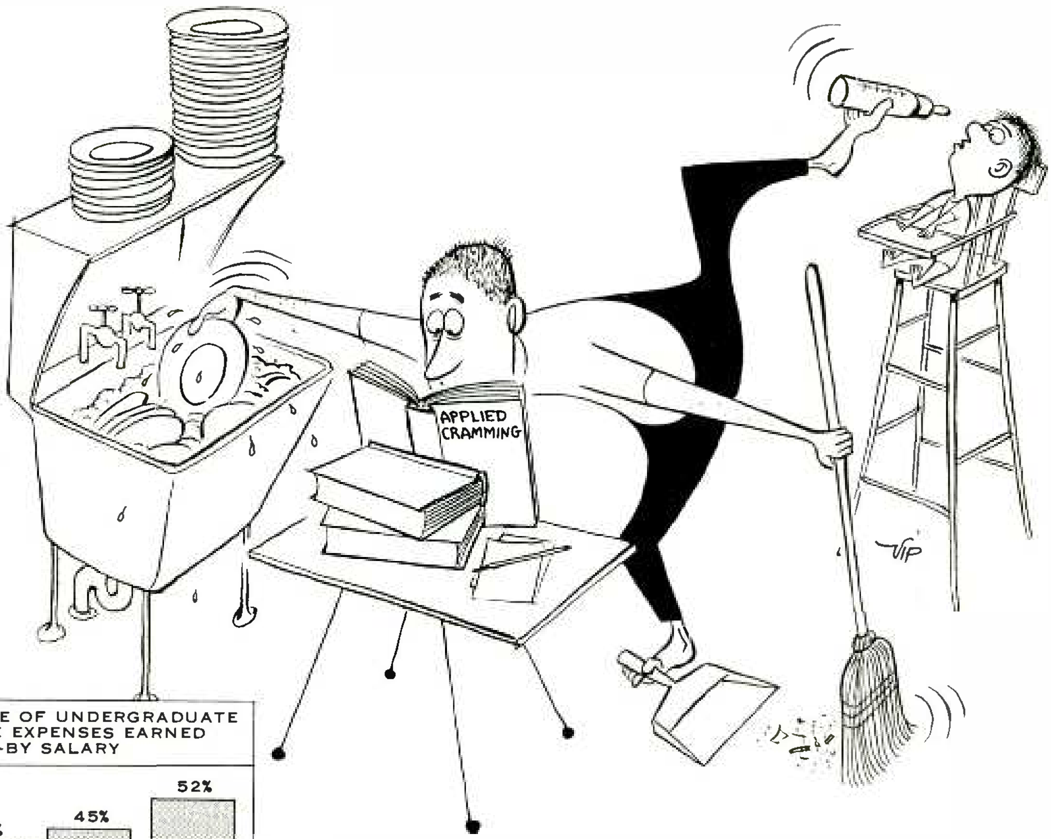
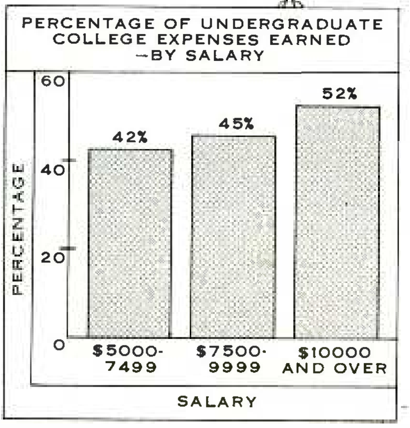
SIDELIGHTS ON THE SCIENTISTS *number* **5** *of a series*





Data obtained from a 20% random sample of the 2400 professional engineers and scientists on the staff of Hughes Research and Development Laboratories.

How to make $10,000 *(and up)*

Here at Hughes we have been analyzing the files of personal data regarding our scientists and engineers. Together with some additional facts cheerfully contributed by individuals, the findings reveal some interesting—and sometimes surprising—group characteristics and relationships. In this series we shall chart and attempt to interpret the results for you.

College Expenses Earned . . . and Present Salaries

The chart shown here represents the percentage of undergraduate college expenses earned—by present salaries at Hughes. The net result of this comparison is, that the higher the present salary of the individual—the more he earned while an undergraduate. College jobs included baby-sitting, "hashing", collecting laundry, lawn-mowing, car-washing, etc., etc. One scientist included in his list of college jobs—"Walking the Dean's rheumatic bulldog."

In the Hughes laboratories more than half of the engineers and scientists have had one or more years of graduate work; one in four has his Master's; one in 15 his Doctorate. Our research program is of wide variety and scope, affording exceptional freedom as well as superior facilities for these people. From every standpoint, it would be difficult to find a more exciting and rewarding climate for a career in science. Too, we are continually stepping up projects which will insure success in commercial as well as military work.

Hughes is pre-eminent as developer and manufacturer of the electronic armament control system now standard equipment on all Air Force all-weather interceptors. Our program also embraces ground systems radar, the Hughes Falcon and other guided missiles, automatic control, synthetic intelligence. Projects of broader commercial and scientific interest include research in and manufacture of semiconductors; electron tubes; digital and analog computation; data handling; navigation; production automation.

Scientific Staff Relations

HUGHES

The Laboratories now have positions open for all phases of work on ground and airborne digital computers—from logical design to production engineering. Why not write us?

RESEARCH AND DEVELOPMENT LABORATORIES
HUGHES AIRCRAFT COMPANY
Culver City, Los Angeles County, California

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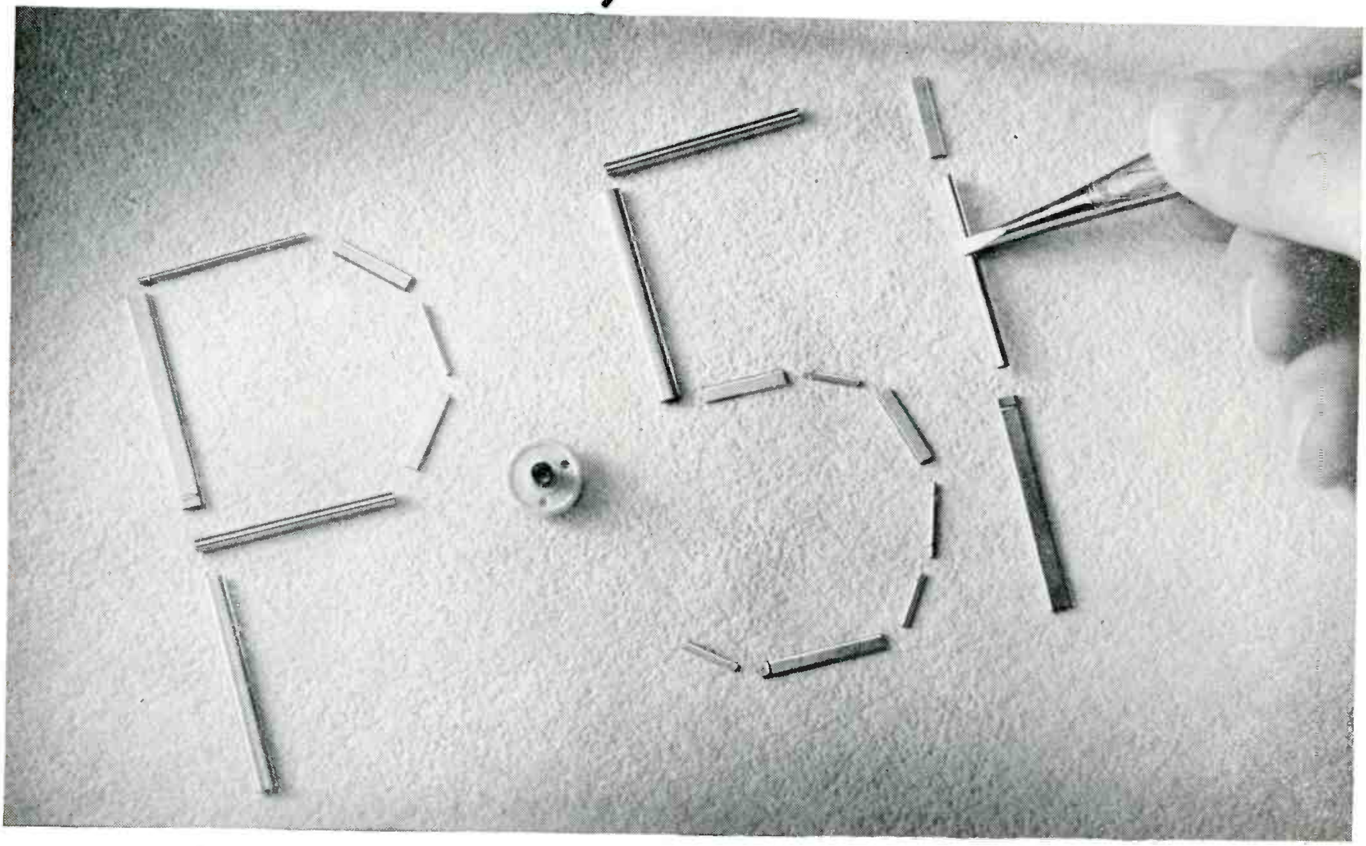
Now-Stronger Passive Cathodes!



Superior announces Cathaloy P-51

— a new passive cathode material

- *100% stronger than Cathaloy P-50, ideal for ruggedized tubes*
- *Free of sublimation and grid emission troubles; low interface impedance*
- *Available in seamless, Weldrawn® and Lockseam* forms*

Latest addition to Superior Tube's family of Cathaloys is Cathaloy P-51 —a passive cathode material with entirely new properties.

NEW INGREDIENT

Cathaloy P-51 is similar to Cathaloy P-50 in chemical composition and electrical characteristics. But the addition of approximately 4% tungsten greatly increases its strength.

HIGH HOT STRENGTH

Tests prove that Cathaloy P-51 is twice as strong as Cathaloy P-50 at operating temperatures. This means it is especially useful in ruggedized tubes. In all tubes, it reduces the risk of failure from shock and of bowing. As with all Cathaloys, the composition of Cathaloy P-51 is carefully controlled by Superior. Every melt is checked in an electron tube before being approved for production.

UPGRADE YOUR TUBES

Cathodes made from Cathaloy P-51 are available in either seamless, Weldrawn or Lockseam form, and can be fabricated to your exact dimensional specifications. Write for technical information. Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.

*Manufactured under U.S. patents.

NOTE. Cathaloy is a trademark of Superior Tube Co., Reg. U.S. Pat. Off.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N. Y.—an affiliated company making precision metal stampings and deep-drawn parts

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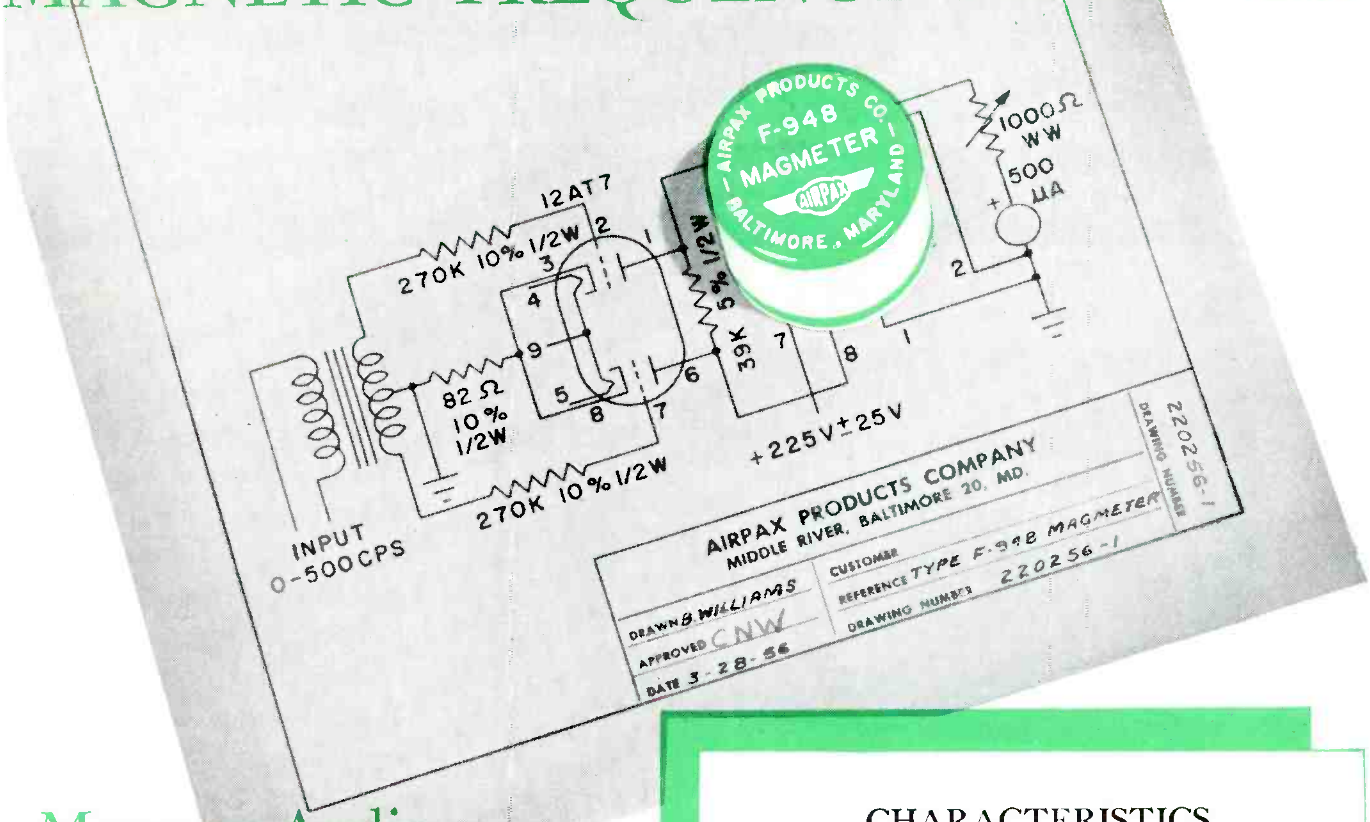
MAGNETIC FREQUENCY DETECTOR



Measures Audio Frequencies Directly

Magmeter is an entirely new product—the result of Airpax leadership in developing magnetic components. The Magmeter produces an output signal directly proportional to the input frequency.

In the circuit shown, the 12AT7 dual triode drives the Type F-948 Magmeter over the rated frequency range of 0 to 500 CPS. A 0-500 microampere meter, connected to the Airpax Magmeter, indicates frequency directly. A resistor in series with the meter calibrates the circuit when it is installed. Once adjusted, the Magmeter holds the calibration for long periods of time to at least 2% of full scale.

The Magmeter is completely contained in a can 1¼ inches high and 1½ inches in diameter with a standard octal base. This compact component weighing only 3.4 oz. can be used wherever frequency is measured: in test equipment, AC servos, speed indicators and controls, and power frequency regulators.

You probably have an application in which this one component can replace considerable circuitry. We have a detailed data sheet ready for you, just write to

CHARACTERISTICS

RANGE: 0 to 500 CPS (other ranges available on special order)

ACCURACY: ±2% of full scale plus temperature variation of 500 ppm/C

WAVEFORM SENSITIVITY: less than 1% change in indication for sine, triangular, and square waves of same rectified average value

SHOCK: 30g shocks of 11± 1 milliseconds duration in each plane, case clamped

VIBRATION: 10g in each plane at 10 to 55 CPS, case clamped

TEMPERATURE: —55C to +72C operate; —65C to +85C storage

LIFE: comparable to that of a well made transformer

ENCLOSURE: hermetically sealed

AIRPAX

DESIGNERS ENGINEERS

MIDDLE RIVER BALTIMORE 20, MD.

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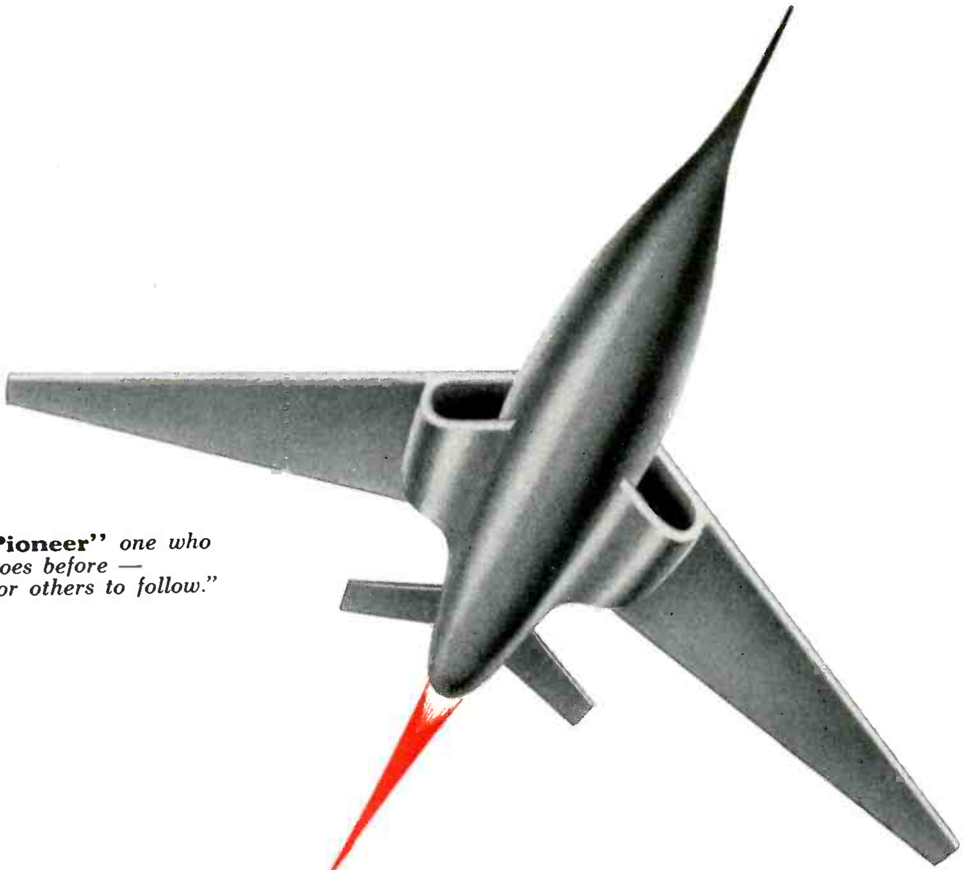
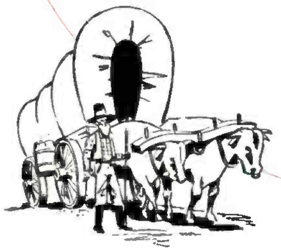


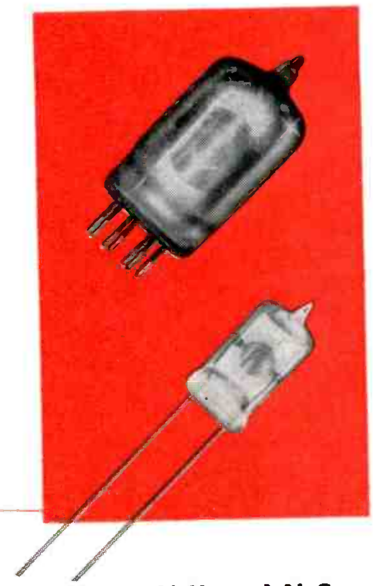
"**Pioneer**" *one who goes before — for others to follow.*"

IF WEBSTER IS RIGHT —
Then Midland Has Done It Again, this time with

glass holders for crystals!

Permanent high vacuum attainable only with glass, isolates the crystal from atmospheric factors detrimental to dependable performance. Truly, here are crystals designed with the future in mind — future requirements of application and design as well as the long life of the unit far into the future.





Midland MANUFACTURING COMPANY, INC.
3155 Fiberglas Road • Kansas City 15, Kansas
World's Largest Producer of Quartz Crystals

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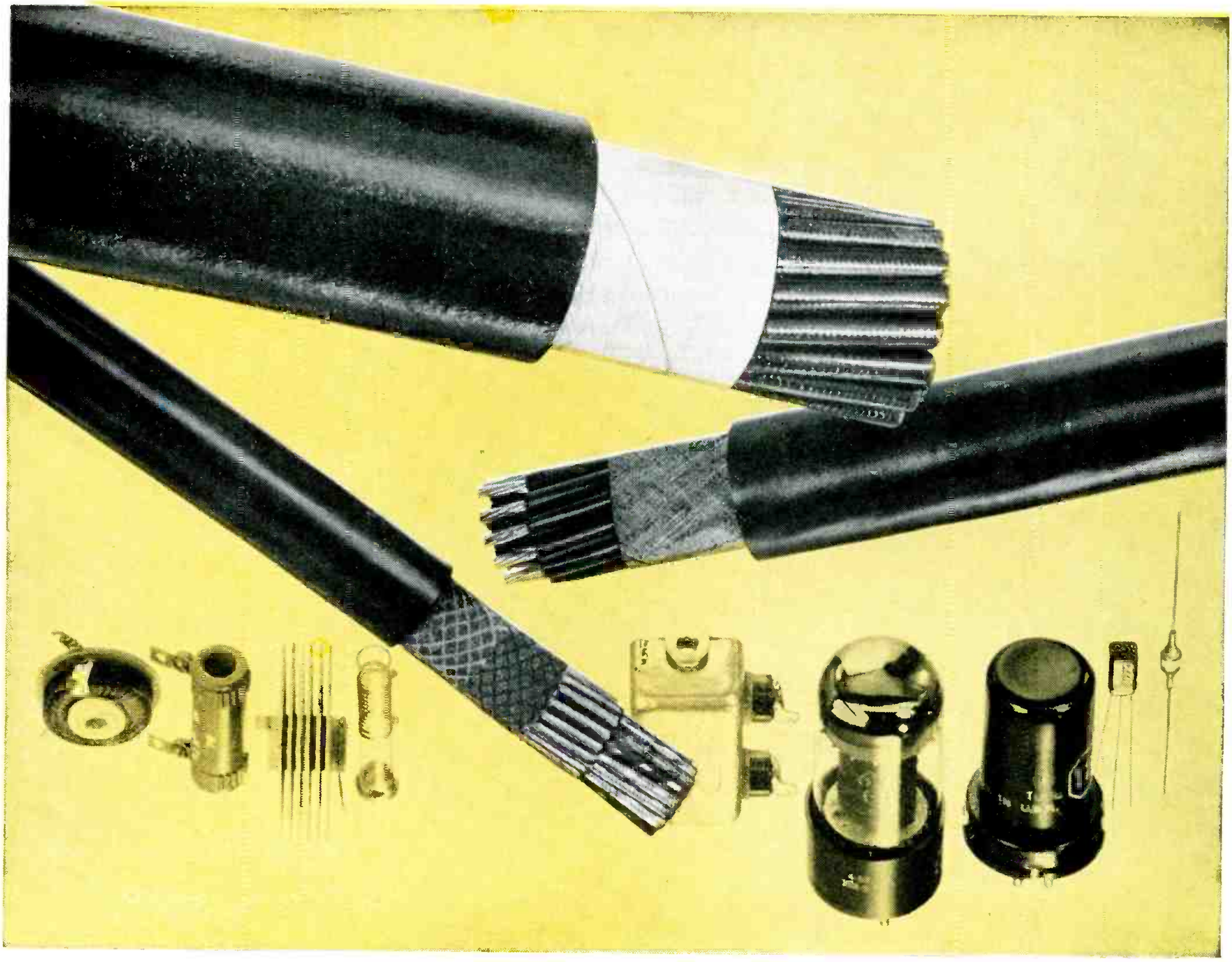


In electronics... **cables are basic**

Proper choice of wiring material for electronic equipment involves a critical decision. As a component, it may well "make or break" product performance or design. Fortunately, there are guide posts to help you in the selection of a qualified supplier.

Look for essentials

Look, first, for *high quality*. Look for such essentials as full-sized copper, uniformly annealed and precisely stranded. Look, too, for insulations and coverings which have been proven to provide good workability and long-lived dependability.

Then, look . . . as *your* customers presumably do . . . for a supplier of responsibility. To qualify, such a supplier should have (1) a thorough knowledge of electronic wiring problems, (2) engineering and research ability in the development of special cable constructions and (3) complete manufacturing facilities of modern design for the production of specification or custom-built cables.

Rome Cable has all of these things

For some 20 years we have served the electronic industry with complete satisfaction. Rome's high product quality and engineering ability have gained wide recognition wherever exacting standards of performance are a requisite.

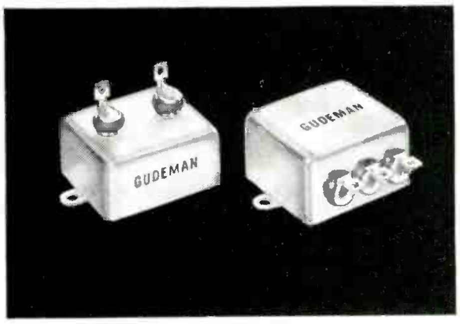
Fully approved

Rome Cable products, commercial and military, are manufactured in strict compliance with the requirements of approval agencies.

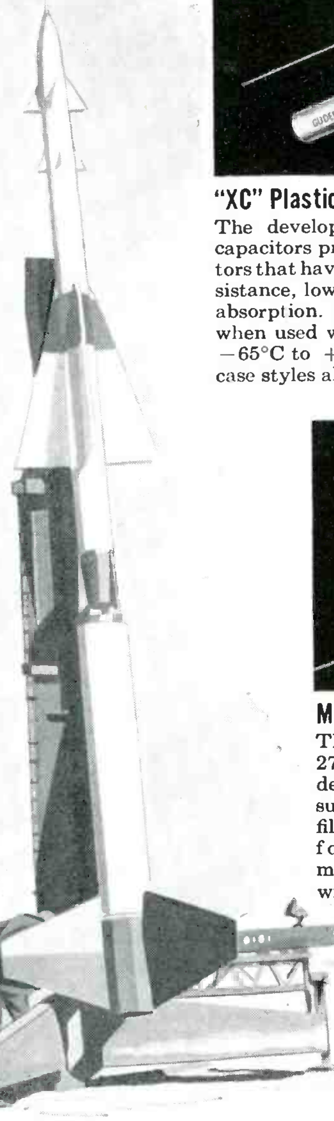
With Rome engineering and manufacturing experience, you get full value from your electronic cable dollar. *We will be happy to serve you.* For more details, write for Bulletin TR-5.

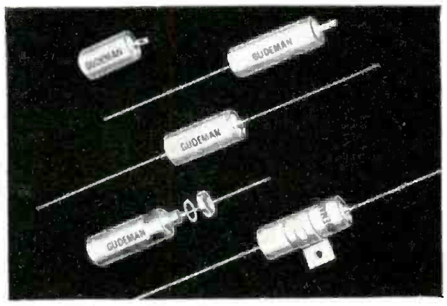
ROME CABLE Corporation
ROME · NEW YORK
and
TORRANCE · CALIFORNIA

GUDEMAN *Capacitors*

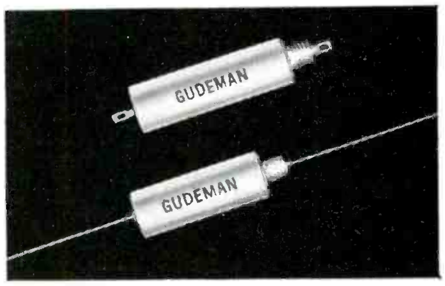


Bathtub Type Military Capacitors
MIL-C-25 Types
CP53, CP54, CP55 Case Styles
Temperature Ranges:
−55°C to +85°C
−55°C to +125°C



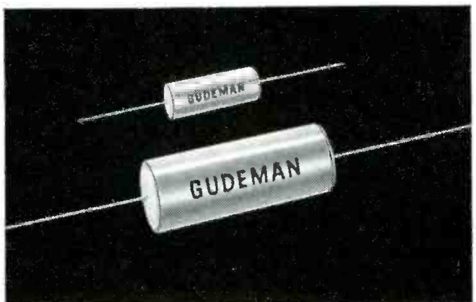


"XC" Plastic Film Dielectric Capacitors
The development of the Gudeman "XC" capacitors provides high temperature capacitors that have exceptionally high insulation resistance, low power factor and low dielectric absorption. No voltage derating is required when used within a temperature range from −65°C to +165°C. Bathtub and rectangular case styles also are available.



Miniature Feed-Through Capacitors
The Gudeman Feed-Thru Capacitor, Types 271 and 272 is a three-terminal component designed to be used for R. F. Interference suppression in a manner similar to a low pass filter. The typical insertion loss characteristics for these Feed-Thru Capacitors when measured in a 50 ohm line are in accordance with MIL-Standard 220.

Military Capacitors
MIL-C-25 Types
CP70 Case Styles
Temperature Ranges:
−55°C to +85°C
−55°C to +125°C



Tubular Laminated Cardboard Capacitors
The 633 series gives extra protection in extremely high humidity applications.
Paper Dielectric: Wax or Oil Impregnated
Resin End Seals
Temperature Range: −40°C to +85°C

Dry Electrolytic Capacitors
MEand Printed Circuit Types
High Purity (99.99%) Aluminum Foil
Low Leakage
Temperature Range:
−30°C to +85°C

THE **GUDEMAN** COMPANY

Write for latest technical data **Main Plant & General Offices**
340 West Huron St., Chicago 10, Illinois, Dept. C256
Mfg. Branches: Chelsea, Mich.; Sunnyvale and Monrovia, Calif.; Terryville, Conn.
Manufacturers of Electronic Components for Military and Commercial Applications.

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PERHAPS WE'LL HAVE TO ADD A PINCH, FOR YOU . . .

Just ask us for an alloy we haven't got — we'll be delighted.

Because that's how each of the more than 112 resistance and electronic alloys Driver-Harris makes had its beginning. Each of these highly specialized alloys is custom-made . . . produced exactly to the specifications of our customers.

The physical and chemical properties of an electrical resistance alloy can be altered greatly by a minute difference in its constituents. Often just a few ounces to the ton can make the difference you need.

One thing you can always rely on in any Driver-Harris alloy: it is made to the most precise metallurgical checks and controls known to the industry. It is these exclusive quality controls that have made Nichrome V and Nichrome* the standard for over 50 years by which all other electrical resistance alloys are measured.

Perhaps in a sense Nichrome is *too* well known. For we don't want people to forget that we make many other resistance alloys of sustained high quality to meet other special needs. And that, as we said at the outset, our engineers will be more than delighted to start afresh tomorrow to devise a new one, custom-made for you. Just tell us as exactly as you can what you wish to accomplish.

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

NICHROME V and NICHROME are manufactured only by

Driver-Harris Company

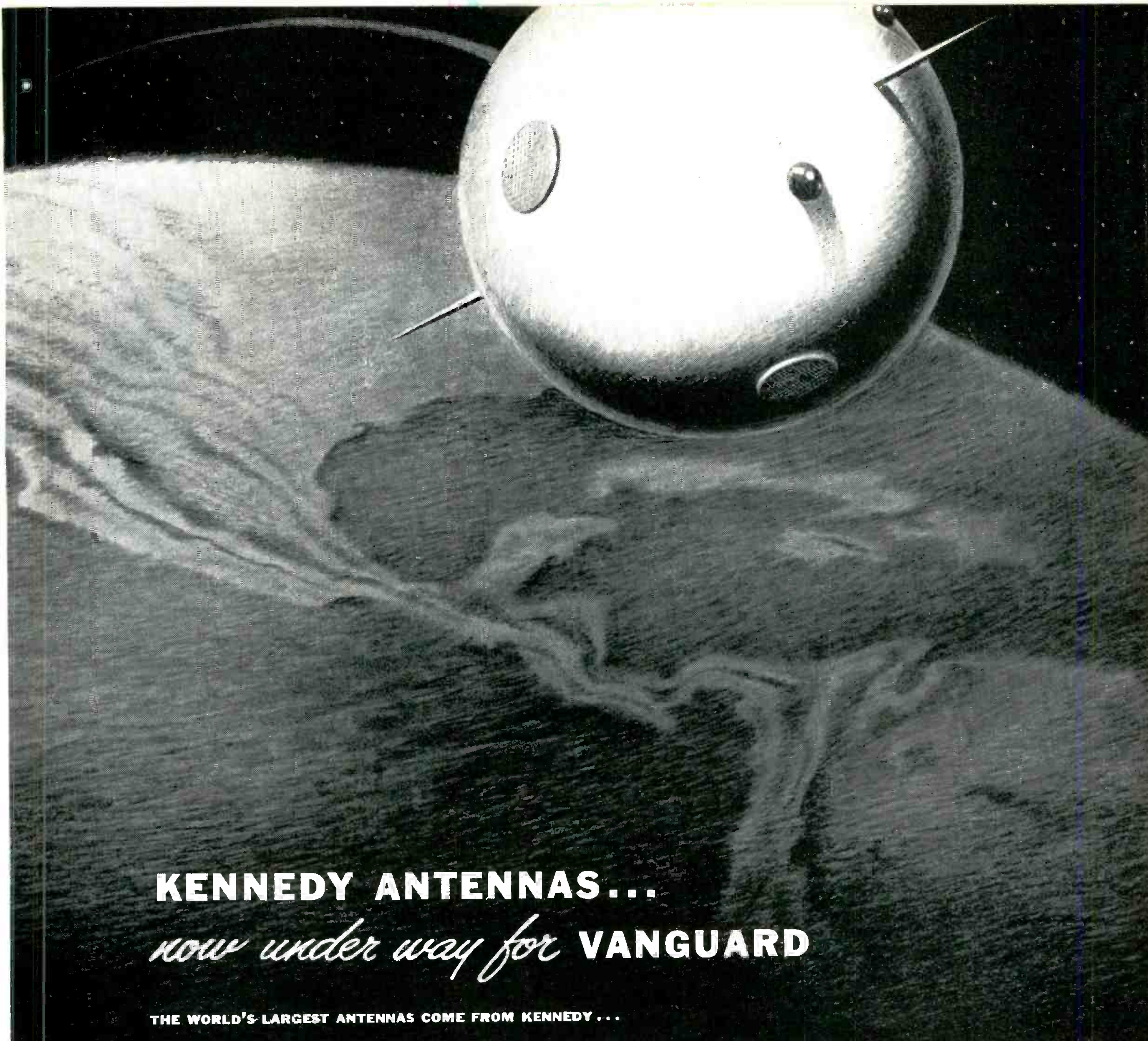
HARRISON, NEW JERSEY

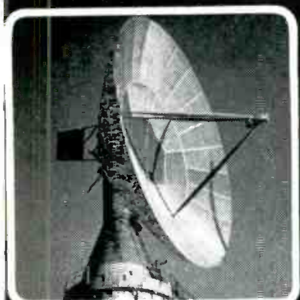
BRANCHES: Chicago, Detroit, Cleveland, Louisville, Los Angeles, San Francisco

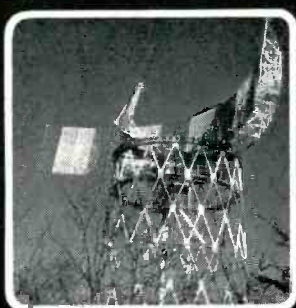
In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario.

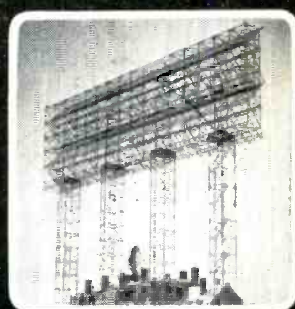
*T. M. Reg. U. S. Pat. Off.

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









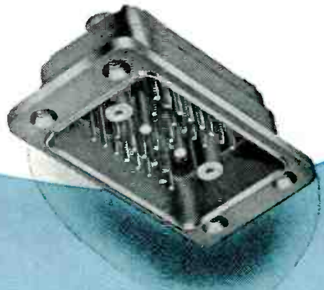
TRACKING ANTENNAS .... RADIO TELESCOPES .... RADAR ANTENNAS .... TROPOSPHERIC SCATTER ...... IONOSPHERIC SCATTER

Even as you read these words, Kennedy is already building the antennas whose mission it will be to track the earth satellite on its epoch-making trip through space.
When launching day arrives, these mighty electronic sentinels will be ready to play their vital role in this most momentous adventure of modern times.

ANTENNA EQUIPMENT
D. S. KENNEDY & CO.
COHASSET, MASS. — TEL: CO4-1200

"A connector for practically every application"
. . that's why Cannon Electric is *first in connectors.*
More than 26 lines in 20,000 different assemblies and countless
"specials." Only a pioneer multi-contact connector
manufacturer and the largest exclusive connector
designer and builder in the world could make this claim.

Mil-Spec

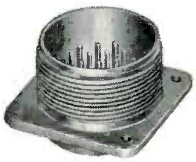


Rack/Panel/Chassis

Audio

THREE OF TWENTY-SIX SERIES

cannon connects



Mil-Spec

Rack/Panel/Chassis

Audio

FIREPROOF • MINIATURE • MIL SPEC • EXTERNAL POWER
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SWITCHING PLUGS • TEST JACKS

CANNON PLUGS

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Please Refer to Dept. 120

Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif. Factories in Los Angeles; East Haven; Toronto, Can.; London, Eng.; Melbourne, Australia. Licensees in Paris, France; Tokyo, Japan. Representatives and distributors in all principal cities...see your Telephone Yellow Book.

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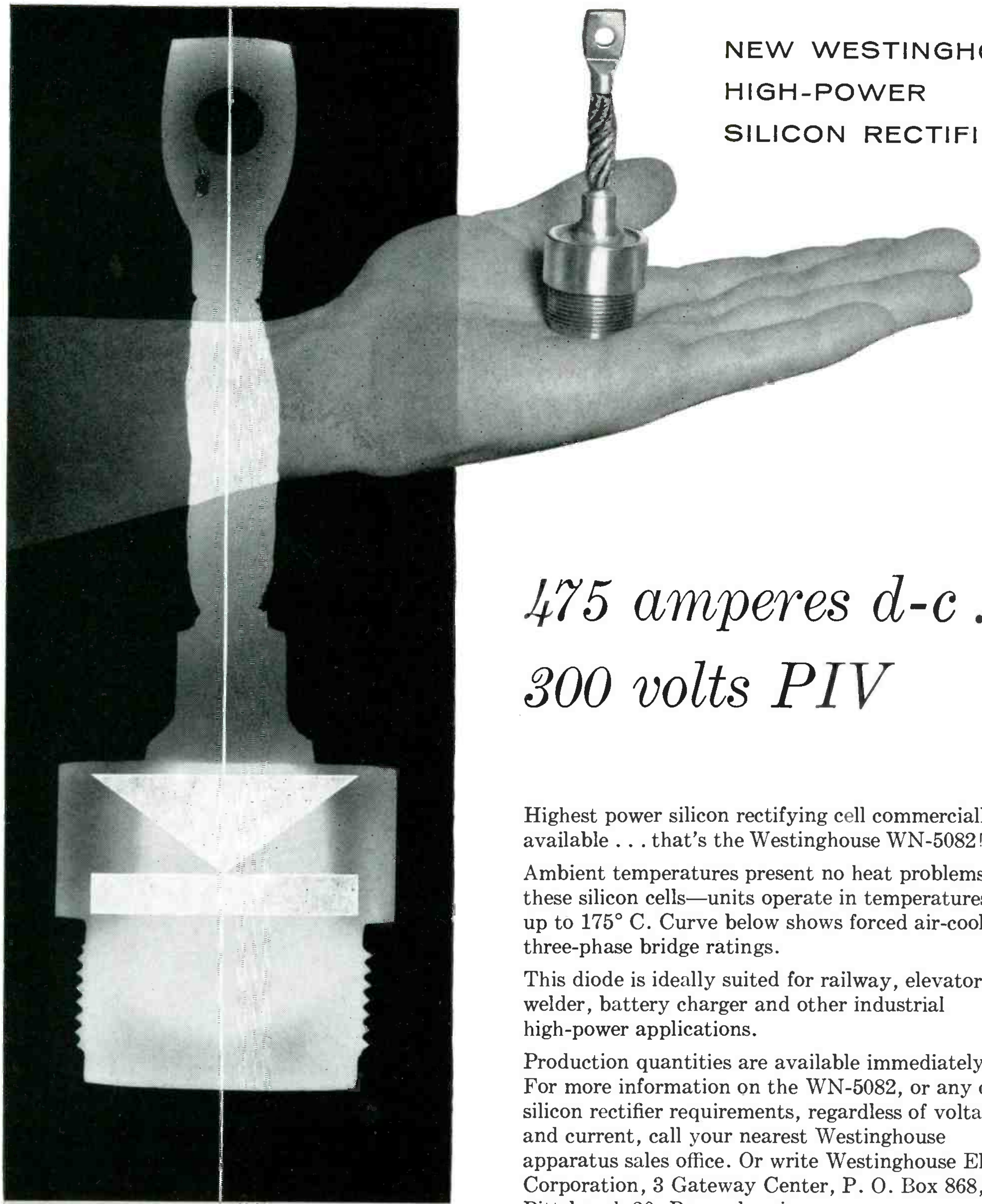


NEW WESTINGHOUSE HIGH-POWER SILICON RECTIFIER

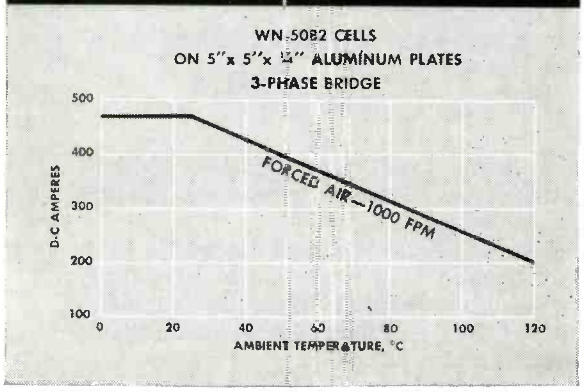
475 amperes d-c . . .
300 volts PIV

Highest power silicon rectifying cell commercially available . . . that's the Westinghouse WN-5082!

Ambient temperatures present no heat problems for these silicon cells—units operate in temperatures up to 175° C. Curve below shows forced air-cooled, three-phase bridge ratings.

This diode is ideally suited for railway, elevator, arc welder, battery charger and other industrial high-power applications.

Production quantities are available immediately. For more information on the WN-5082, or any other silicon rectifier requirements, regardless of voltage and current, call your nearest Westinghouse apparatus sales office. Or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-09004



WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***


Otis
ELECTRONIC DIVISION
from the 102-year world leader in elevatoring . . .
THE BRAINS
the brawn
THE VISION
the skills
THE EXPERIENCE
the tools
INTEGRATED for defense electronics
OTIS . . . a proven source for research, development, manufacture and maintenance of large-scale equipment and systems in the fields of:
• missile guidance and control
• gunfire control
• radar and counter measures
• simulators and training aids
• communication
• special electronic devices
• computers
• ultrasonics
• servomechanisms
• magnetic amplifiers
• testing instrumentation
• electro-mechanical components
For engineering achievements, rely on engineering-minded management—rely on Otis.
Write on your letterhead for 32-page history and facilities report.
OTIS ELEVATOR COMPANY
35 RYERSON STREET, BROOKLYN 5, N. Y.
ELECTRONIC DIVISION

Gilfillan pays off on ability, not adaptability

MEMO TO EXPERIENCED ELECTRONIC ENGINEERS

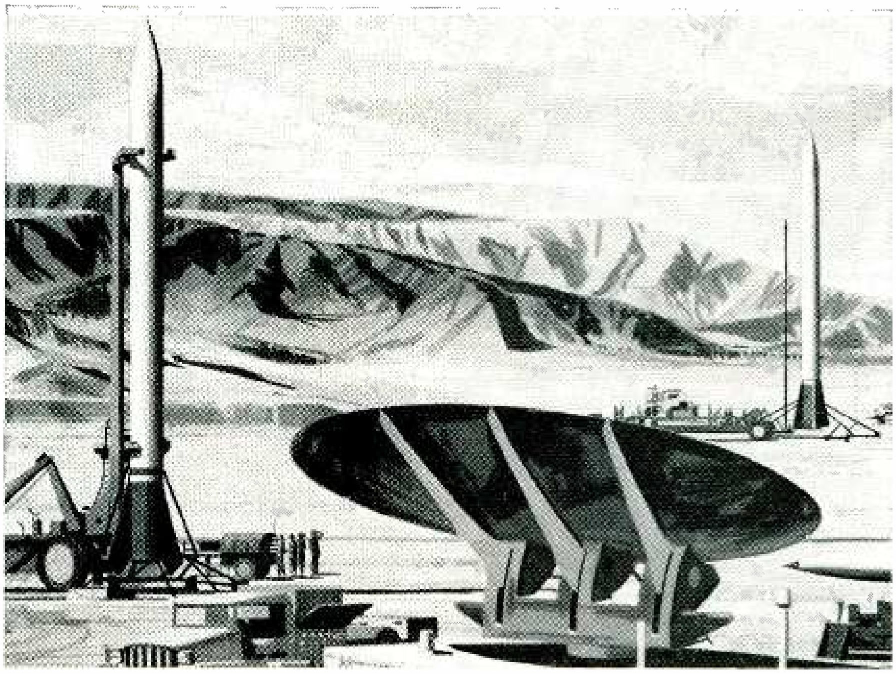
Gilfillan needs both experienced engineers and recent graduates. The significance of Gilfillan advantages will be most apparent to engineers who have experienced a static corporation system.

For example, Gilfillan does not have a rigid hierarchy of juniors, seniors, supervisors and project engineers that changes only at fixed intervals, like musical chairs.

On the contrary, Gilfillan maintains a dynamic organization, with operations under constant modification to meet current research needs. Capable engineers advance from junior to senior to supervisor to project engineer status more rapidly at Gilfillan because this fluid, changing operation means emphasis is placed on ability--rather than on adaptability to a rigid system.

Gilfillan pays higher salaries because, with emphasis on doing rather than on diplomacy, the individual is literally worth more, from the start.

You probably know Gilfillan's reputation for developing practical, simplified solutions to complete systems problems, on time. It is directly due to this Gilfillan method of operating on a basis of professional freedom, rather than under ordinary business methods.



THE ARMY'S CORPORAL: Prime contract for Basic Research and Development —Jet Propulsion Laboratory of California Institute of Technology. Prime contracts for Development (improvement and simplification of ground and airborne electronic systems); and Production (ground guidance systems and airborne electronics)—Gilfillan.

A man who stands still too long at the same job level is moving...backwards. Find out how you can move ahead--and have the satisfaction of working with whole problems, all the way through to production--at Gilfillan.

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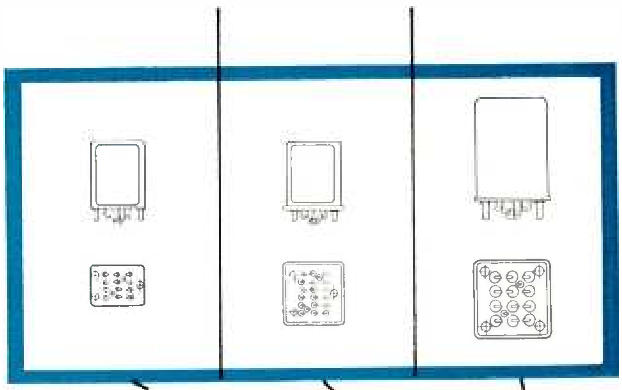

	9220	9226	9230
Contact arrangement	4PDT	6PDT	4PDT
Operating voltage	18-30 VDC	18-30 VDC	18-30 VDC
Contact rating at 28 VDC Resistive Inductive	 5 amp 1.5 amp	 5 amp 1.5 amp	 10 amp 7 amp
Coil resistance	250 ohms	200 ohms	150 ohms
Duty	Continuous	Continuous	Continuous
Weight	.25 lb.	.25 lb.	.5 lb.
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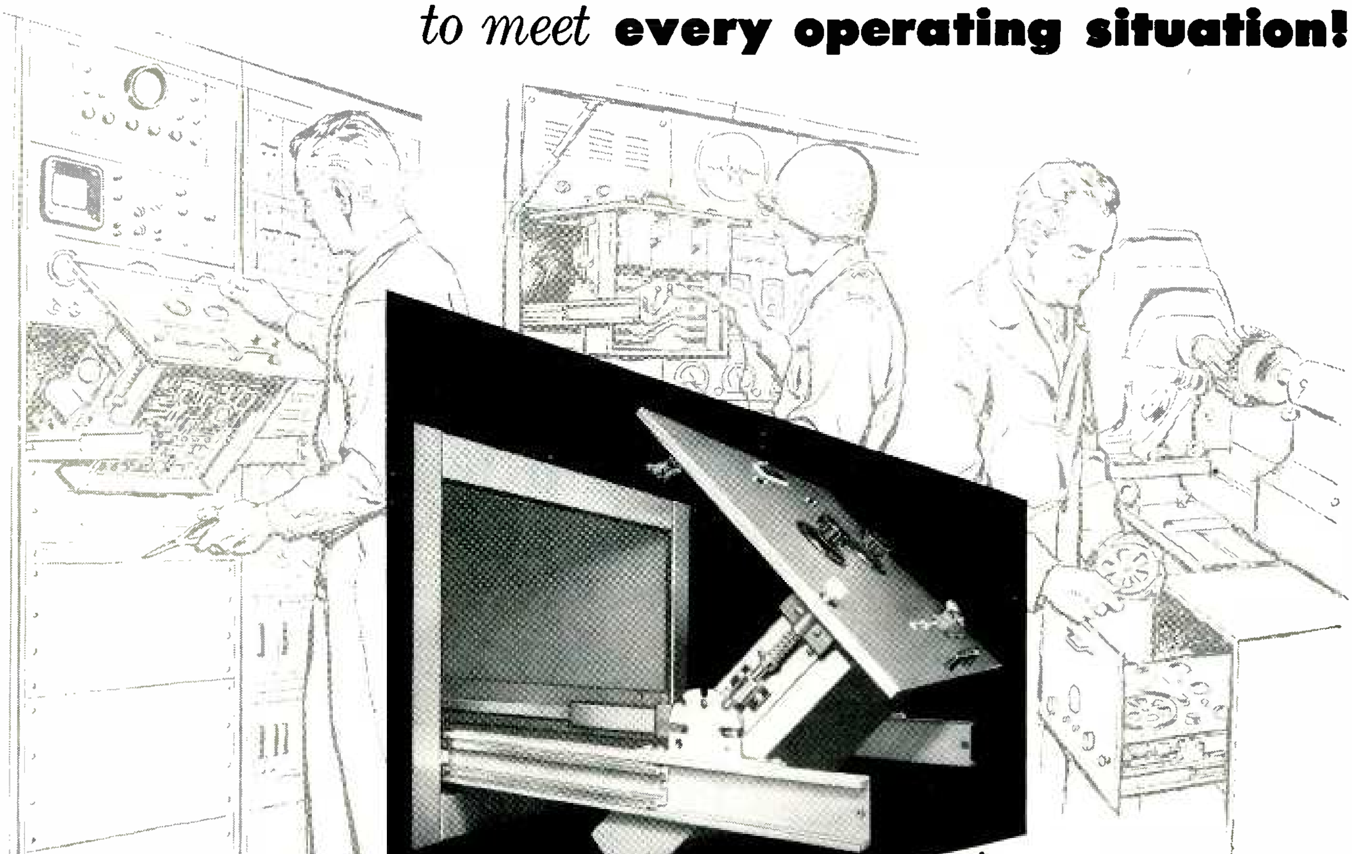

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- Multi-Stable Work Horse: By employing a non-linear load, new circuit permits two transistors to do the work of ten. IBM Bulletin No. 200.
- Self-Complementary: New Gas Tube Counter subtracts by adding. IBM Bulletin No. 201.
- The Soft Touch: Ultrasonic cutting at IBM permits devices to be cut from hard, brittle materials within 0.0002″.

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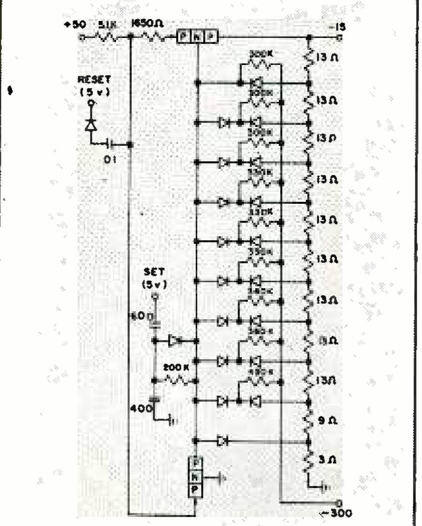
Multi-Stable Work Horse

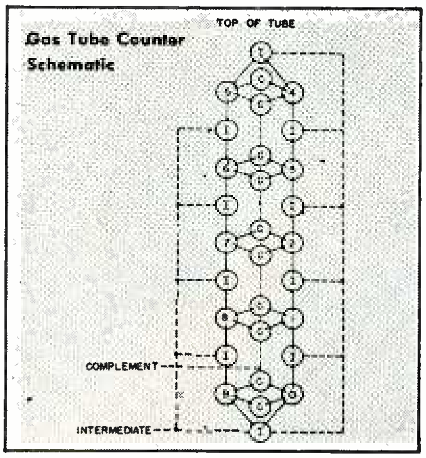
As the size and complexity of IBM products increase, we are faced with growing numbers of components—which means increased cost. As part of our continuous search for improvement and ways to reduce the number of components, Robert Henle, one of our Transistor Circuit Research people, undertook to get more work out of a given number of transistors. The result is a two-transistor, multi-stable circuit employing feedback controlled by a non-linear load. Junction transistors are naturally suited to this new kind of circuit.



10 Stable State Circuit

A full report on this new idea from IBM contains eight full-page circuit diagrams in addition to mathematical analyses of the operation of the circuit. Write for your copy of IBM Bulletin No. 200.

Gas Tube Counter Schematic



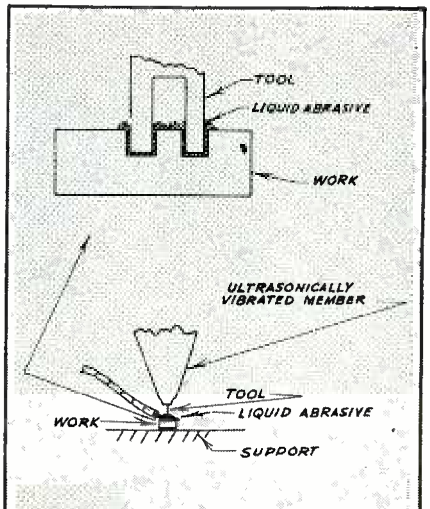
Self-Complementary

Accounting machines these days must be able to do everything—even make decisions. In order to get a machine to do more in a day's time with little or no increase in operating cost, IBM Component Research people studied the idea of using a multi-cathode gas tube. It's good news that they came up with an attractive approach, which Robert Koehler, of our Device Development Group, then reduced to practice; it operates faster than its electro-mechanical predecessor and, furthermore, with simple circuitry, can subtract by adding. It can read out in true number form both positive and negative balances. This is possible because a number stored in the tube may be transposed to its 9's complement (i.e., value subtracted from nine) by a single electrical pulse.

If you'd like more information on the basic principle, physical arrangement of parts, and typical problems solved, write for IBM Bulletin No. 201. If you are fascinated by the theory of numbers, we recommend this Bulletin.

The Soft Touch

In some of our studies of new components, at the IBM Research Laboratories at Poughkeepsie, it is necessary to make many different, small and intricately shaped parts from brittle materials. Following the conventional approach, each of these parts would require laborious and costly machining and fabrication. We turned to ultrasonic cutting; with this tool we can make any shape or size component in approximately a minute—with an accuracy five times greater than previously possible! The ultrasonic cutter has helped us progress faster in our development of new devices. RESEARCH at IBM means IDEAS at work.



Schematic of Impact Grinder

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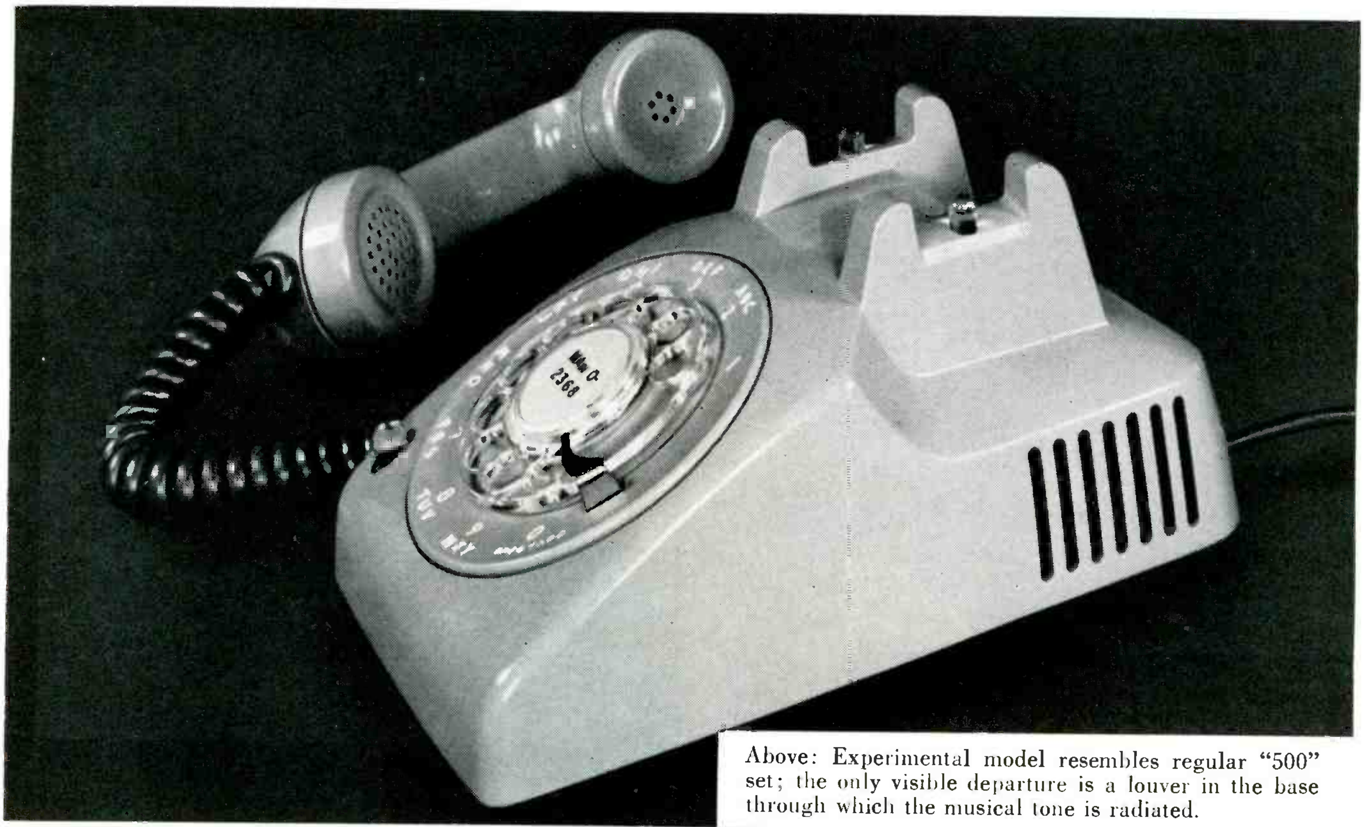
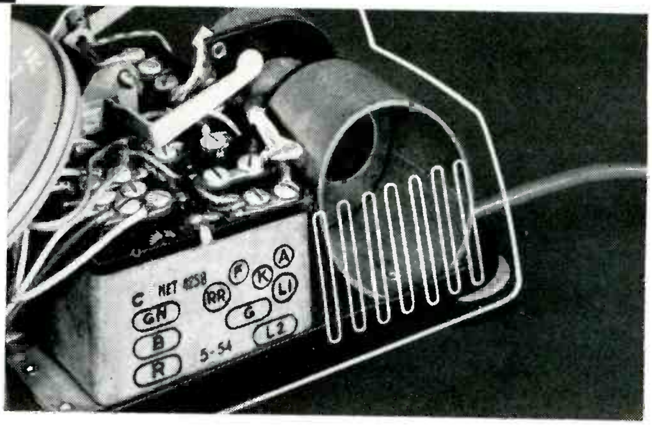
Transistorized telephone summons you with a mu𝄞ical tone



Above: Experimental model resembles regular "500" set; the only visible departure is a louver in the base through which the musical tone is radiated.



Bell scientists have developed a new musical tone device which may some day replace the telephone bell, if it meets technical standards and customers' approvals.

Because the musical tone equipment uses transistors, the tones will be transmitted with the same amount of power required to transmit a telephone conversation — considerably less than is needed to make a telephone bell ring.

The experimental telephone sets resemble the current "500" sets; the only external difference is a louver at the side of the base through which the tone is radiated by a small loudspeaker mounted inside the telephone's base.

Tests have shown that the musical tone can be heard at great distances. It stands out above general room noise and can be distinguished from such sounds as ringing of doorbells, alarm clocks, and home fire alarms.

This new low-power signaling technique is expected to play an important part in the electronic switching system now under development at Bell Laboratories.

Above: Bell ringer has been displaced by a small loudspeaker in transistorized telephone. Left: L. A. Meacham heads the team of engineers that developed the musical tone ringer. Mr. Meacham holds a B.S. in Electrical Engineering from the University of Washington, Class of '29. He became affiliated with Bell Labs a year after his graduation. In 1939 Mr. Meacham won the "Outstanding Young Electrical Engineer" award of Eta Kappa Nu.

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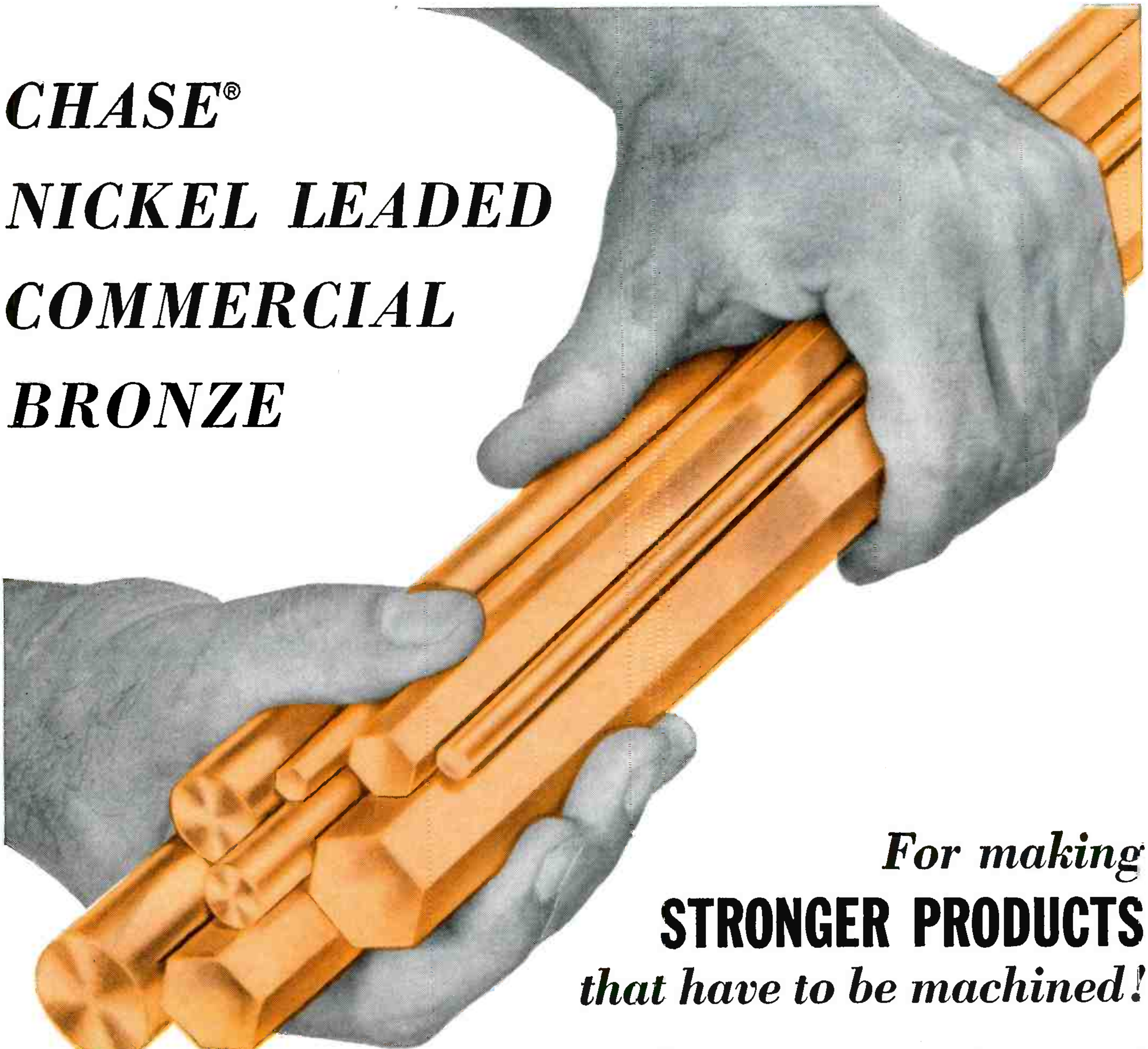

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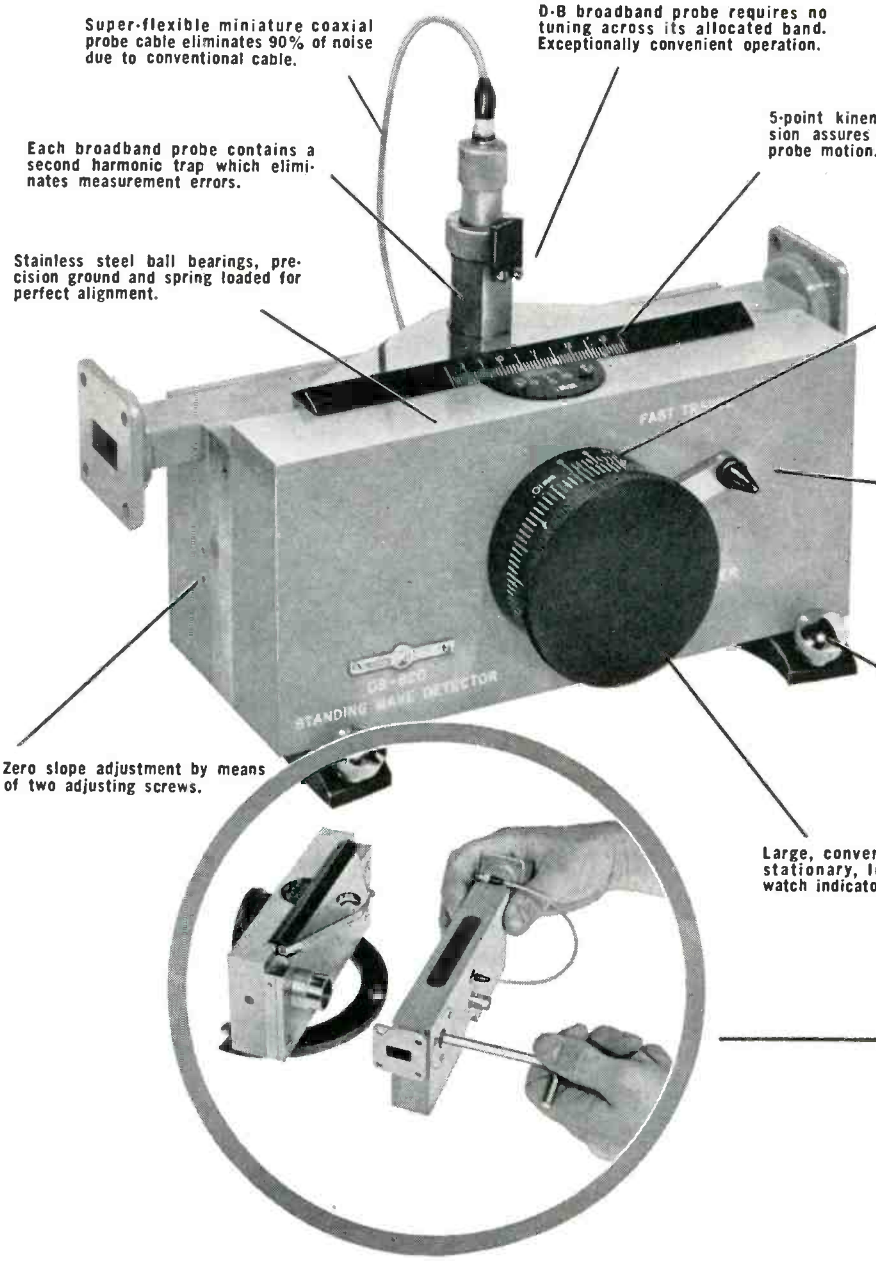

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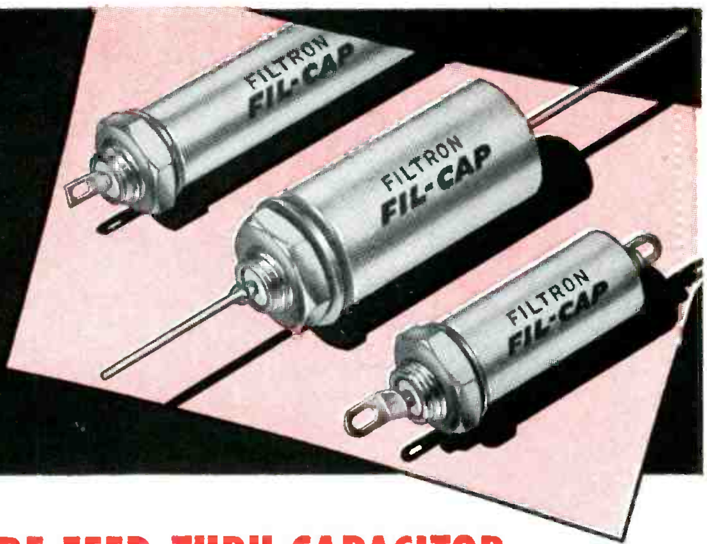

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SETS A NEW STANDARD OF RF ATTENUATION PERFORMANCE

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2 **Advanced internal circuit design . . . specially processed impregnant**

3 **Meets Spec MIL-C-11693 (proposed) for suppression capacitors**

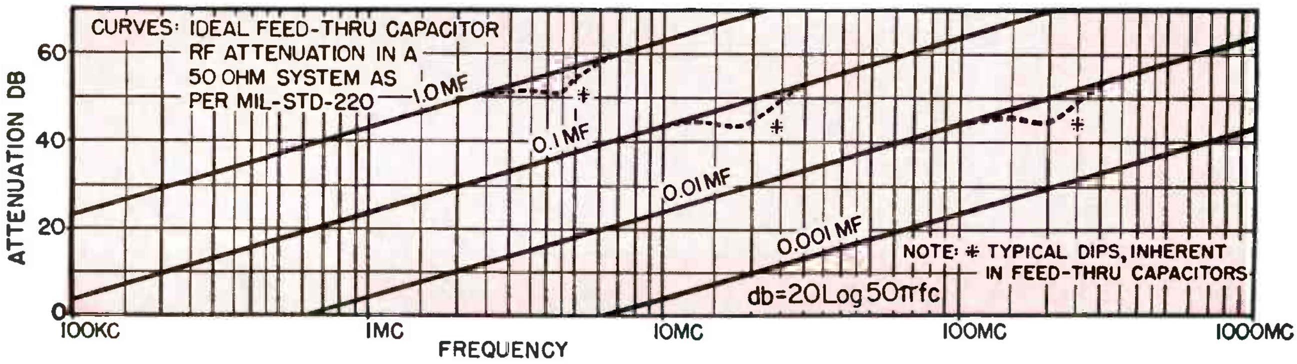
4 **Closely matches theoretically ideal attenuation characteristics**

An unusual internal circuit arrangement, precision mechanical components, and a specially processed silicone impregnant combine to afford outstanding electrical characteristics and stability—unobtainable in conventional feed-thru capacitors ordinarily used for interference suppression in electronic equipment.

Basically, FIL-CAPS are a four-terminal network inserted in the current-carrying line. The power line to be filtered must be broken, and each end connected to an insulated terminal of the capacitor. The feed-thru ground-plane mounting prevents mutual impedances between input and output terminals. The FIL-CAP design includes compression glass insulated terminals, and milled flats on the threaded mounting neck, to prevent rotation during installation and under service conditions.

Type FV is rated for 5 amps AC-DC continuous operation, and Type FX is for 10 amps AC-DC continuous operation. Both types are available in operating voltages of 100, 200, 300, 400 and 600 volts DC; 125 and 250 volts AC; 0 to 400 cycles.

All FIL-CAP subminiature feed-thru capacitors are 100% tested and inspected before shipment.



If your requirements call for greater attenuation than is obtainable with feed-thru capacitors, Filtron also manufactures a complete line of RF interference filters. More than 5000 filter types are offered for military, industrial, nuclear and commercial applications. Filtron is the world's largest manufacturer of RF interference filters. Details and literature furnished on request.

For complete engineering data and installation diagram, ask for Filtron Catalog FV, and FV Supplement for FIL-CAP equivalents to MIL-C-11693 military designations.

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Flying-Spot Cathode-Ray Tubes . . . RCA-5AUP24, -5WP15, -5ZP16 . . . all feature fine spot, high resolution, aluminized screen, electrostatic focus, magnetic deflection; for film, strip, sheet, or card reading. **Transcriber Kinescope . . . RCA-5WP11** especially designed for use in kinescope film recording.

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Radechon . . . RCA-6499 . . . barrier-grid storage tube . . . for use in variety of information-processing systems . . . digital or analogue information may be stored for periods controllable from microseconds to minutes . . . "read-out" rate same as or different from "write-in" rate.

Graphechon . . . RCA-6896/1855 . . . electrostatic charge storage tube . . . for use in scan-conversion equipment . . . writing gun . . . reading gun . . . magnetic deflection . . . electrostatic focus.

Computer Storage Tube . . . RCA-6571 . . . single beam type for use in binary-digital computer systems . . . electrostatic focus and deflection.

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Resistance ranges are compensated for greatest accuracy over wide battery voltage variation.

33 RANGES:

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		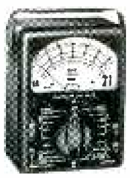						
631 Combination V-O-M—VTVM	**630-NA** For Best Testing Around the Lab, Production Line or Bench	**630** The Popular All-Purpose V-O-M	**630-A** A Good Lab and Production Line V-O-M	**310** The Smallest Complete V-O-M with Switch	**630-T** For Telephone Service	**666-HH** Medium Size for Field Testing	**625-NA** The First V-O-M with 10,000 Ohms/Volt AC	**666-R** Medium Size with 630 Features

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3. **The most economical backing material** . . . from a group of Mallory alloys developed for this use.
4. **The most economical backing member design**. . . in relation to contact and product design requirements.
5. **The most economical method of assembly** of contact and backing member.

By coordinating *all* these important elements of contact design, Mallory can help you put into effect a long-range plan for cutting contact cost and assuring peak performance.

CONTACTS can be *too good* for their intended service. Detailed study of a contact application, by Mallory engineers, often uncovers ways to design more closely to actual requirements . . . at substantial savings to the customer.

The contact pictured above is a typical example. Intended for use in a circuit breaker for utility distribution lines, it originally was designed with contacts made of heavy-duty silver ELKONITE®. At first glance, this exceptionally long-wearing, high conductivity metal appeared ideal to meet the customer's original specifications. But further investigation by Mallory contact engineers revealed that while contacts had to operate with absolute dependability, they did not have to function *frequently*.

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Chances are that consultation by Mallory on your own contact applications can prove the source of interesting savings for you. Mallory engineers are well qualified by years of experience to analyze your requirements, to recommend materials from the extensive line of Mallory alloys, and to assist in overall design of contacts and assemblies. For a discussion, write or call Mallory today.

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CROSS TALK

▶ **CONSTRUCTIVE** . . . Manufacturers have become very adept at shifting engineers from somebody else to themselves. Migration has been encouraged with every trick in the bag, and particularly the alleged advantages of one geographical area or community over others.

We're realistic enough to know that individual companies must protect themselves against a manpower shortage, even at the expense of other plants. And some engineers do indeed find greater opportunity and a better way of life by moving. But it should be remembered that mere shifting adds nothing to the industry's engineering pool. Like electrons flowing into a circuit and then back to a battery, there is no increase in number by the action.

Several good plans which would permit educational institutions to turn out more engineers have been suggested. Some companies are using technicians to fill jobs formerly held by engineers, and upgrading the engineers. Steps such as these hit the shortage where it needs hitting.

▶ **QUOTES** . . . AIEE's Morris D. Hooven says engineers were considered palace nobility in the time of the Pharoahs, notes that they are now being invited into an "intellectual aristocracy."

He notes also that 68 percent of all engineering students pass Selective Service deferment tests as against a 53 percent national average, that less than 2 percent are divorced as against the national average of 25 percent and that there are currently no electrical or electronic engineers in jail in the State of New Jersey.

▶ **EXPORT** . . . One of the first needs of underdeveloped nations of Asia, Africa and South America in moving toward an industrial economy and higher standard of living is adequate communications. Inhospitable terrain rules out telephone cable in many cases. One answer is radio-relay networks.

American firms should, at least initially, find a ready market here for equipment. We have had a good deal of experience with such things as multiplexing, scatter, uhf and microwaves, and these all lend themselves ideally to the problem.

▶ **TRANSITION** . . . To those who as boys wound wire on oatmeal boxes, the world of waveguide modes and fittings will always be a little alien. And the transition from lumped to distributed constants is still by no means over.

A ferrite plate with "hen scratchings" fired into it may turn out to be the circuit of a distributed-constant phase-shift oscillator. Piezoelectric zirconate slabs laid side by side may become a transformer if driven by magnetostriction.

It is a wise engineer who can pick up a missile component and guess its function.

▶ **COLONELS AND CONTRACTORS** . . . Walk into the Kittyhawk Bar of the Hotel Biltmore in Dayton any cocktail hour and you will feel right at home.

The air is full of conversation containing such phrases as "cathode follower" and "output impedance."

LOOKING AHEAD . . . new materials*

Ceramics flexible enough to be used as insulation between coil layers show experimental promise

Plastic mixed with ceramic and then boiled away during firing produces an interesting new end product

Powdered metal wedded in an unusual way to plastic may provide readily moldable permanent magnets

Silicones and epoxy resins in combination with still unpronounceable materials expand the horizon for insulation

*We're working on a Special Report

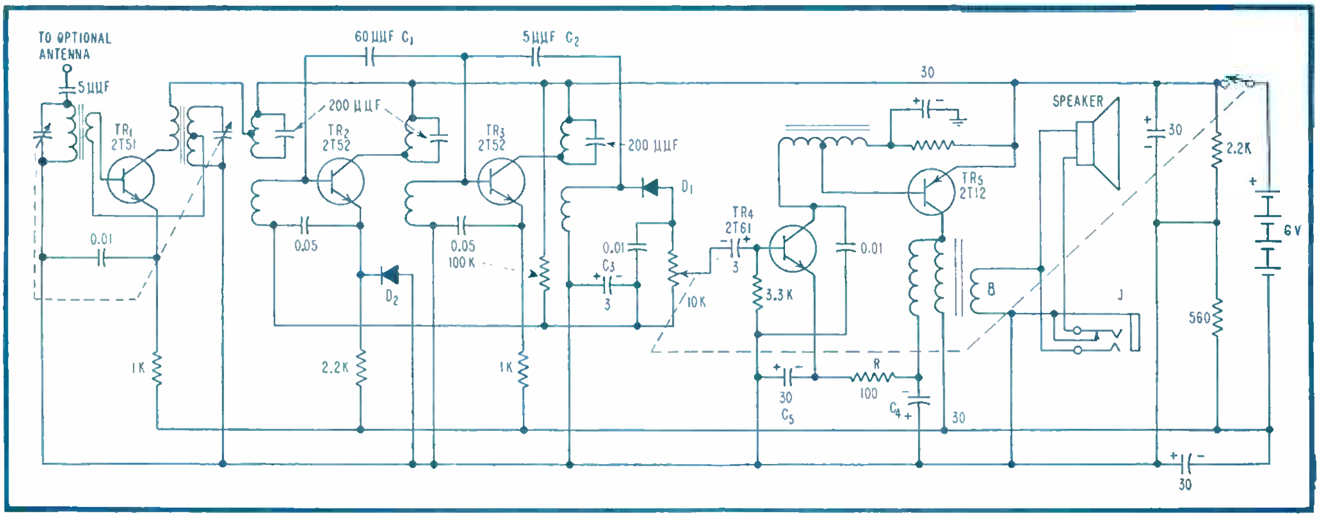
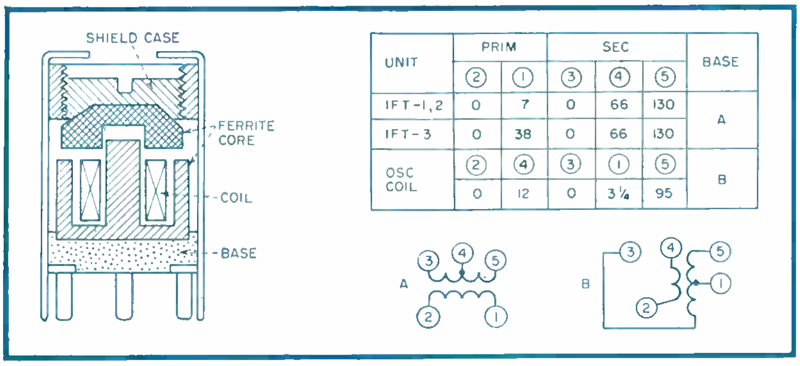
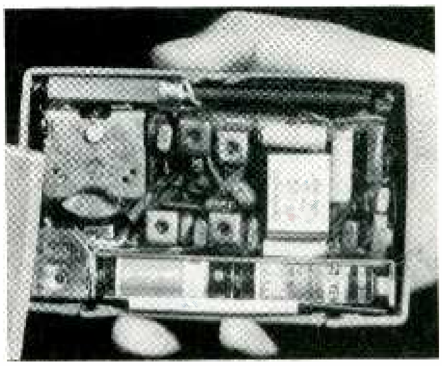


FIG. 1—Complete circuit of portable five-transistor Japanese receiver



UNIT	PRIM		SEC			BASE
	②	①	③	④	⑤	
IFT-1,2	0	7	0	66	130	A
IFT-3	0	38	0	66	130	
OSC COIL	②	④	③	①	⑤	B
	0	12	0	3¼	95	

FIG. 2—Construction of i-f transformers and oscillator coil



Rear view of Sony TR-55 portable

TRANSISTOR

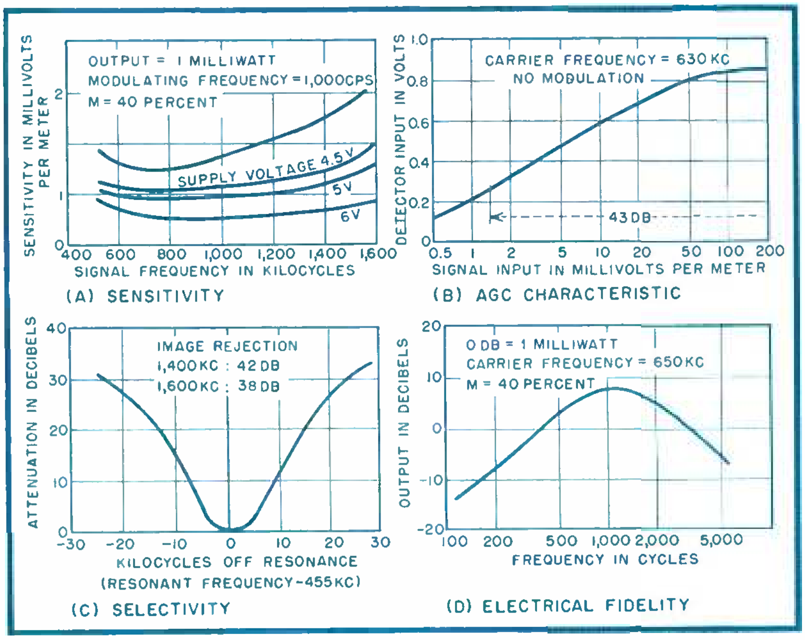


FIG. 3—Characteristics of the five-transistor receiver

ADVENT of transistorized radio receivers occurred at almost the same time in the United States and Japan. Engineering developments and techniques in both hemispheres have paralleled to an appreciable degree, but there are differences in details.

Last fall, ELECTRONICS editors were privileged to examine one of the first foreign broadcast receivers using transistors to enter this country. It was made in Japan by Tokyo Tsuchin Kogyo Ltd., a licensee of

Transistorized products include a table-model receiver, battery-operated tape recorder, superheterodyne pocket receiver, regenerative pocket receiver and hearing aid. The portable receiver on facing page is not shown above

CIRCUITRY in Japan

SUMMARY —— Characteristics of transistors, circuit designs of four different types of broadcast receivers using from two to seven transistors, a portable tape recorder and a hearing aid are disclosed

Western Electric. Some details of the receiver and circuit were published in October (p 12) and December (p 174) issues.

More details of the design of this portable receiver have now been made available by Kazuo Iwama, director of the transistor division of the company, and by J. Yasuda of the engineering staff.

Five junction transistor and two diodes are used in the "Sony" TR-55 portable. The r-f and i-f stages employ three *npn* junction transistors. The audio stages contain an *npn* alloy-type junction transistor and a conventional alloy-type *pnp* junction transistor.

The main tuning dial is a friction-type vernier. In production, all components are mounted on a printed-circuit board and all the connections are soldered in one dipping operation.

The complete circuit of the TR-55 is shown in Fig. 1. Transistor TR_1 serves as the converter and oscillator, while TR_2 and TR_3 are the first and second i-f stages respectively. Diodes, D_1 and D_2 are small germanium types. One is employed as the second detector and the other as the complement gate of the agc circuit.

Transistor TR_4 and TR_5 comprise the audio stages. The characteristics of these transistors are shown in Table 1.

The intermediate frequency is 455 kc to obtain good image and i-f responses.

The tuned winding of the ferrite-

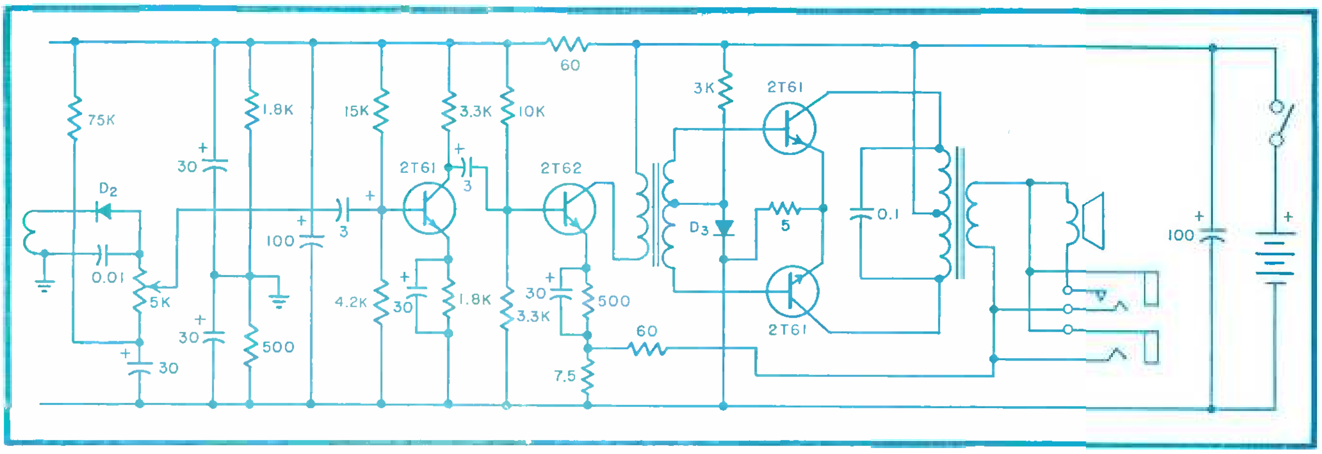


FIG. 4—Audio circuits of the seven-transistor receiver differ materially from those of the portable model

core antenna consists of approximately 80 turns of 0.08 Litz wire. The unloaded Q is about 150 at 1 mc.

The ferrite core is identified by the type number Ferrinver 503, the permeability of which is approximately 400 with its $\mu o/\tan\delta$ approximately 3×10^{-5} at 1 mc. The core is formed as a flat strip 12 cm long. It is 1.8 cm wide and 0.4 cm thick.

The five-turn secondary of the antenna coil matches the high impedance of the tuned primary to the low input impedance of the converter. This winding is adjacent to the primary and is dsc 0.2 mm wire.

The antenna is so located in the cabinet as to reduce feedback of i-f and harmonics from the i-f output stage and second-detector circuits. The two windings occupy less than half the length of the core.

Converter Circuit

The converter transistor performs the functions of both mixer and oscillator. The collector current is held at about 1 ma by the 1,000-ohm resistor in the emitter circuit which returns to the −1 volt battery line.

The turn ratio of the oscillator collector winding to the base tap winding has been determined experimentally to obtain near-optimum injection voltage over the band. This ratio is preferably tailored for each transistor. The optimum injection voltage is about 0.1 to 0.2 at the converter base.

I-F Stages

The i-f transformers are of the single-tuned type. These use a Ferrinver 403 ferrite pot core, the permeability of which is about 600 with its $\mu o/\tan\delta$ about 2.5×10^{-5} at 500 kc.

The coils are enclosed in a copper shield case whose dimensions are about 1.2 cm square by 1.65 cm high. The primary unloaded Q is about 100 and loaded Q about 30 at 455 kc. Construction of the transformers, and coil data, are given in Fig. 2.

Sensitivity of the receiver is shown in Fig. 3A.

The two i-f stages are connected in neutralized common-emitter circuits. Capacitors C_1 and C_2 are used for neutralizing.

The first i-f stage is controlled by agc. This voltage is derived from the output of the second detector, filtered by resistance of the volume control and electrolytic capacitor C_3, and then supplied to the base of transistor TR_2 through the secondary winding of the first i-f transformer.

The collector current of the first i-f stage is about 0.5 ma with no signal. It decreases with increasing signal and the gain of this stage is lowered as a result. The agc characteristic is given in Fig. 3B.

Diode D_1 complements the agc, so that the emitter potential of TR_2 may be grounded when the input signal level becomes large enough to make the potential of base lead

Table I—Transistor Characteristics

Type Description	2T51 NPN Grown Converter	2T52 Junction I-F Stage	2T61 NPN Alloy Junction Audio	2T12 PNP Alloy Junction Audio
Collector voltage......	6	6	4.5	−4.5
Emitter current.......	−1	−1	−1	1
Cutoff freq (mc)...... fα Vc = 6 volts	4	2.5	.....	0.7
Collector C..........	5	5	40	40
Ext base res.........	150	100	.....	.....
Current ampl α.......	...	...	0.97	0.95
Collector cutoff current Vc = 10 volts	10	10	10	10
Noise figure in db.....	...	...	10	.....
Maximum rating (25C)				
Vc (v).............	25	...	25	25
Ic (ma)...........	5	...	10	10
Pc (mw)..........	40	...	50	50

of TR_2 less than ground potential.

The output transformer matches the 600-ohm impedance of the output transistor to an 8-ohm voice coil impedance. The resistance of the primary winding is about 90 ohms, and this is employed as the stabilizing resistance of this stage.

Bypass capacitor C_4 should be about 200 μf, but physical size would be large. The small RC filter circuit, C_4, C_5 and R, is employed instead. This audio stage gain is about 60 db at 1,000 cycles.

The second detector output feeds a two-stage audio amplifier employing *npn* and *pnp* transistors in a cascade connection which operates class A, so that the source voltage may be effectively used. The stability factor is good and the undistorted maximum output is about 14 mw.

Four penlight cells in series provide 6 volts and the total current drain is about 14 milliamperes. The life of the battery is estimated at more than 100 hours.

Deluxe Model

The table model receiver shown in the photographs operates from three flashlight D cells. The battery operating cost is estimated to be less than 1/15 cent per hour.

This receiver contains seven transistors, two diodes and one varistor. The intermediate frequency is 455 kc.

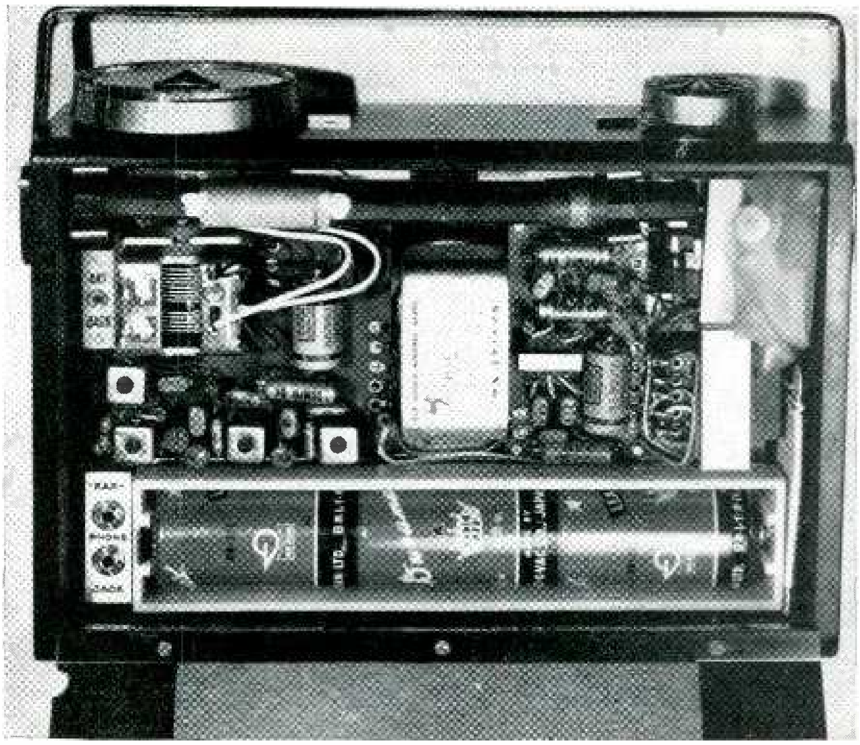
Class B push-pull audio output is used. At maximum rated output, the total drain is approximately 30 ma. Idling current is 8 ma.

Two printed circuits boards are employed, one for the audio circuits and the other for the high-frequency circuits.

Sensitivity of the receiver is approximately 500 microvolts per meter. Adjacent-channel attenuation is about 12 db. Image-frequency interference at 1,400 kc is approximately 25 db and intermediate frequency interference at 600 kc is about 20 db.

Undistorted maximum output is 50 milliwatts. The loudspeaker is a 4 by 6-inch elliptical type.

The first three transistor stages contain *npn* triode grown-junction transistors for the mixer-oscillator and two i-f stages. The audio signal is handled by *pnp* alloy-type junc-



Components in table model receiver are mounted on two printed-circuit boards, one for audio and the other for r-f circuits

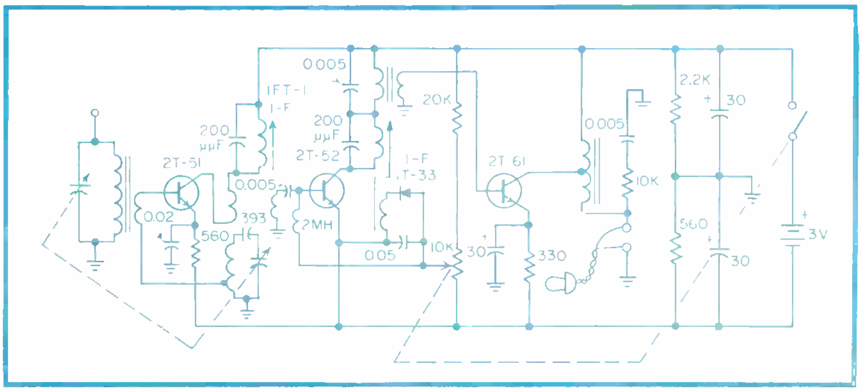


FIG. 5—Pocket superheterodyne has circuit arranged so one transistor handles both i-f and audio signals

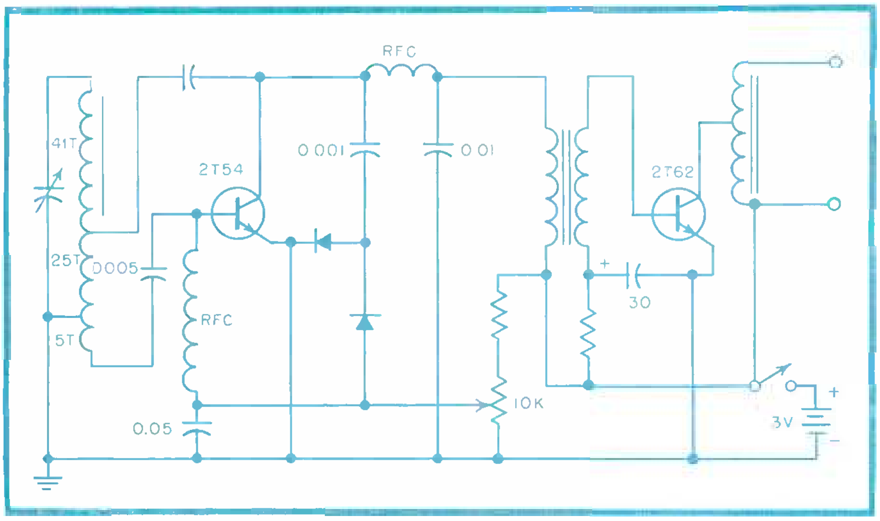


FIG. 6—Regenerative circuit used in two-transistor pocket receiver

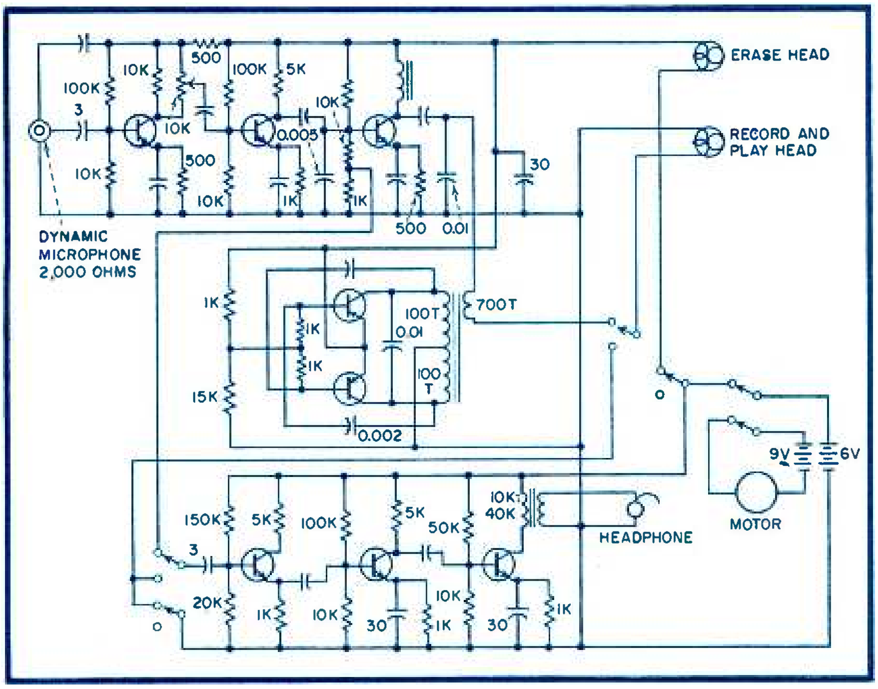


FIG. 7—Complete circuit of battery-operated tape recorder called "Babicorder"

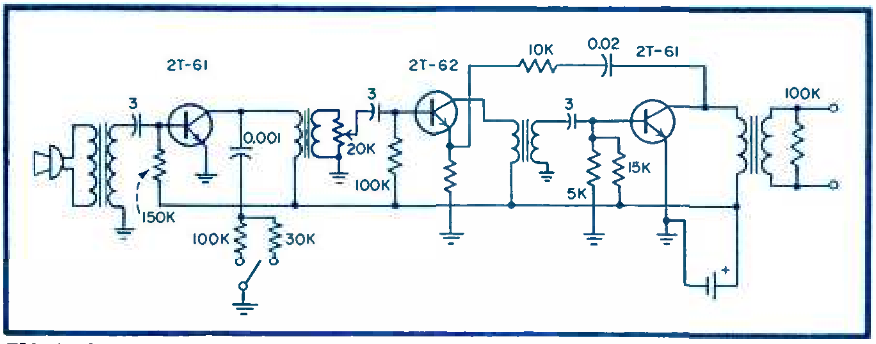


FIG. 8—Single penlight cell powers circuit of hearing aid

tion transistors. Two diodes are used for the second detector and complement of the agc circuit. A varistor is used for improvement of the source voltage effect and thermal variation effect of the output circuit.

The antenna consists of a ferrite-cored loop made of two cemented ferrite rods 180 cm long 1 cm in diameter. The effective height of this antenna is greater than that of a core loop antenna. The winding ratio between the large antenna coil and the converter base input winding is approximately 10:1.

The circuits of converter and i-f stages are similar to those of the TR-55 portable radio. The additional circuitry from the second detector to the loudspeaker is shown in Fig. 4 for the TR-72 model.

Audio output of the detector is applied through a capacitor to the base of the first audio amplifier 2T61, then amplified and applied to an audio driver stage having a 2T62. This drives a class B push-pull output stage having two 2T61 transistors.

Pocket Receivers

Quite small in size, two Japanese receivers contain novel circuits that seem to be high in signal-handling efficiency. Both performed well without any external antennas in New York City.

One of these, a superheterodyne, contains only three transistors. Its sensitivity rating is about 1 or 2 millivolts per meter. Output to hearing-aid type earphone is 1 milliwatt.

Positive feedback in the i-f stage and reflexing seem to be the secrets of operation. The circuit is shown in Fig. 5. The i-f is 260 kc. The receiver sells for about $30 in Japan.

The second pocket receiver employs two transistors. One is a regenerative r-f stage and the other an audio amplifier. As shown in Fig. 6, two diodes handle demodulation.

Unlike many tube regenerative stages, hand capacitance effects were barely noticeable, an attribute of the inherent low-impedance circuits involved with transistors. Sensitivity is about 5 millivolts per meter. Output is about 1 mw.

Current drain at 3 volts is 2.5 ma. This set is selling for about $15 in kit form.

Midget Recorder

A transistorized tape recorder is designed for voice recording and uses standard $\frac{1}{4}$-inch tape in a special magazine. The circuit is shown in Fig. 7.

The motor provides two tape speeds, $1\frac{7}{8}$ and $3\frac{3}{4}$. At the slower speed, one hour of operation is achieved. Nine volts of battery supply the motors and six volts feed the transistor amplifier. Six transistors are used in the amplifier.

The bias oscillator contains two transistors in push-pull. High frequency bias is 25 kc.

The overall signal to noise ratio of the amplifier is 45 db at 1,000 cycles. Input is from a small dynamic microphone and the output feeds a crystal earphone.

Hearing Aid

Three transistors are employed in a low-priced hearing aid. The stages are transformer coupled and negative feedback is used. Input is from a moving-coil microphone and the output feeds a crystal earphone. The complete circuit is given in Fig. 8.

The sound pressure gain is above 40 db and maximum undistorted acoustic power is 120 db. Output level of the microphone is 78 db, with 0 db = 1 volt per dyne per cm^2 at 1,000 cycles.

Operating power is obtained from one penlight cell whose life is estimated at 300 to 400 hours.—V.Z.

Speed of disk recorder used in tests was cut in half by using special pulley for belt

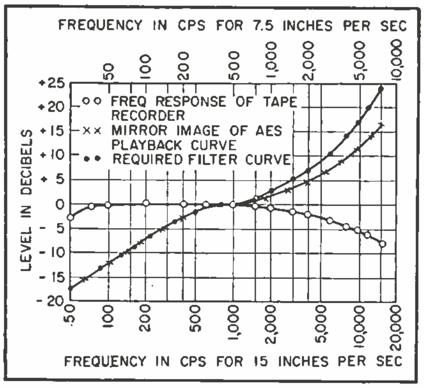


FIG. 1—Frequency response and filter compensation curves for combination tape-disk recording technique. Tape-recorder curve indicates frequency response obtained by recording at 15 inches per second (lower frequency scale) and playing back at 7½ inches per second (upper frequency scale). Use upper scale also for mirror-image of AES playback curve

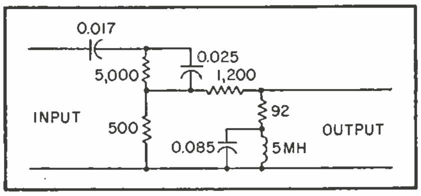


FIG. 2—Filter circuit for solid-circle curve

TAPE Doubles Response of DISK RECORDERS

SUMMARY —— Signals recorded on magnetic tape at 15 inches per second are played back at half speed to ordinary cutting head of disk recorder modified to run at 16 2/3 rpm. Playback at 33 1/3 rpm then gives full fidelity

By W. E. GILSON

University of Wisconsin Medical School Madison, Wisconsin

THE ADVENT OF high-quality tape recording equipment makes it possible to bring the entire audible range of frequencies within the capabilities of the ordinary disk recorder cutting head. Assume that a signal having a 15,000-cps component is to be recorded on disk. This signal is recorded on a magnetic tape traveling at 15 inches per second. When this tape is played back at 7½ inches per second, all frequencies will have been cut in half. Thus the original 15,000-cps component will now be 7,500 cps. This may easily be recorded by an ordinary cutter. To transfer the signal to the disk at the proper frequency, it is necessary only to rotate the disk-recorder turntable at one-half the desired playback speed. When the disk is played back at its normal speed, all signal frequencies will again be as they were originally.

When a 15-inch-per-second tape recording is played back at half this speed there is a moderate loss of the higher frequencies, as shown in Fig. 1. The drop at 7,500 cps on the upper scale, which was 15,000 cps on the lower scale when recorded, is approximately 8 db with the Magnecord No. 90 and Minnesota Mining tape. The circuit in Fig. 2 compensates for this 8-db loss at 15,000 cps and also provides a mirror image of the AES playback curve for disk recordings. The approximation to this curve has a variation of less than 2 db.

It was found essential to use a tape recorder with a minimum of wow and flutter.

DESIGNING Storage-

SUMMARY —— Special cathode-ray tubes for storing information are useful in frequency-bandwidth conversion, mti radar and data storage and analysis. High-voltage power supply, video amplifiers, sweep and blanking generator, focus-current regulator and staircase raster generator used with storage tube are described. Typical use is tv transmission over telephone lines

ABILITY of recording storage tubes to record pictures or other data with over 400-line resolution and full dynamic range has encouraged their use in many applications including frequency or bandwidth conversion, improved radar moving-target indication, data integration and analysis to determine energy distribution curves of atomic radiation, and rapid storage of changing pictures to stop motion and permit recorded information to be analyzed.

Tube Characteristics

The recording storage tube is a special cathode-ray tube available with either magnetic or electrostatic focus and deflection. Since the high voltage, normally 3,000 volts, is lower than for most tv picture tubes, the deflection sensitivity is somewhat greater and the susceptibility of the tube to inhomogeneities of the focus field and external magnetic fields is more of a problem than with most other cathode ray tubes.

The output when reading a stored pattern is an a-m current with a peak value up to 0.5 microampere. For circuit design this output is treated as a high-impedance source shunted by an effective capacitance of about 20 micromicrofarads.

To operate the tube through its write, read, erase and prime modes it is necessary to switch voltages to the storage element and control grid. The speed of mode switching is limited only by circuit considerations. Switching can be accomplished within a few milliseconds with electronic switches or fast-acting relay. A typical storage-tube circuit to write and read at different scan speeds is shown in Fig. 1.

Voltage Supplies

The voltages for the tube elements, although interdependent, can often be based upon the amplifier B+ supply. The high-voltage supply should deliver approximately nine times the maximum voltage from the amplifier supply.

With a B+ supply of 325-v, the high-voltage supply should be 3,000 v. Since the optimum voltage for the decelerator and signal electrode will normally be between 8 and 10 percent of anode voltage, a bleeder output can be taken from the B+

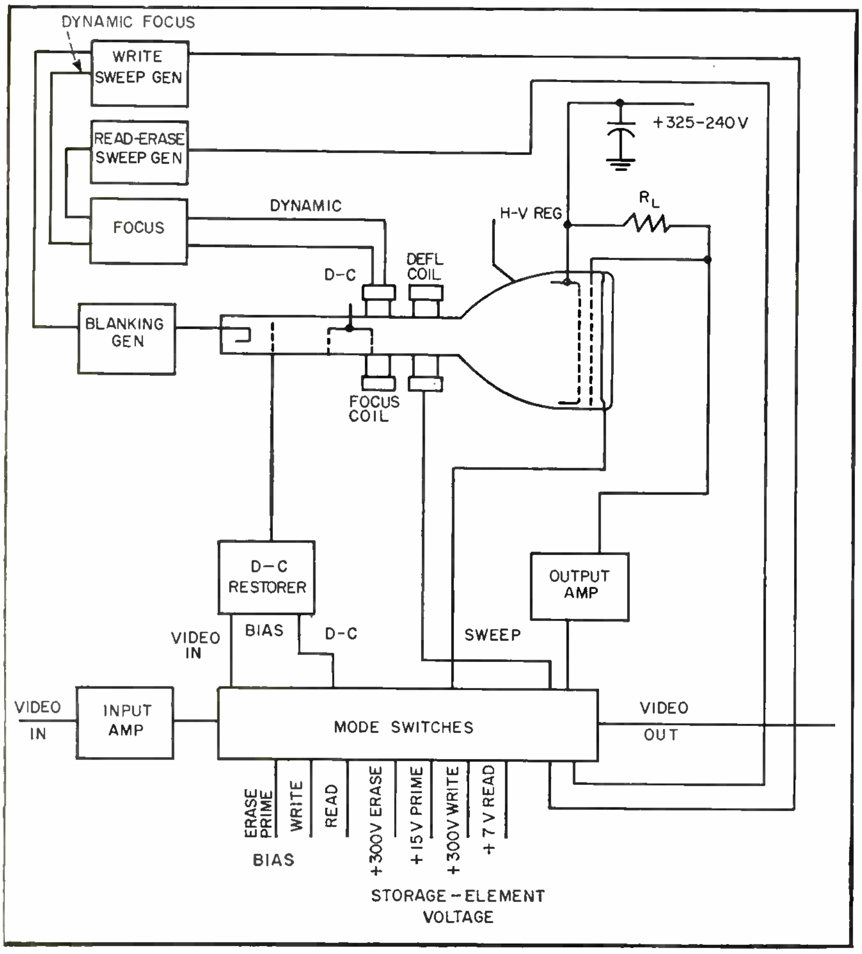
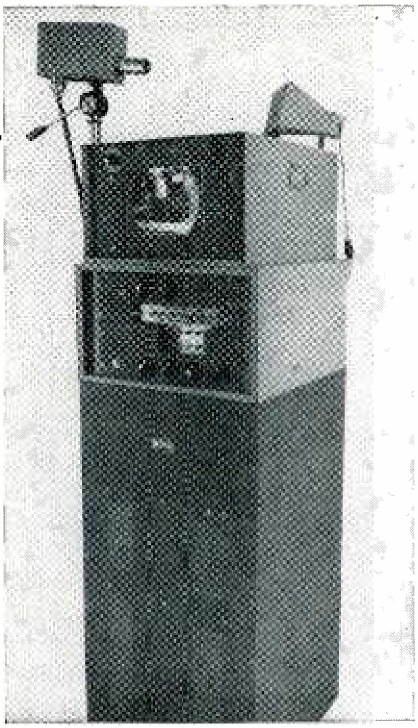


FIG. 1—Read, write and erase circuits used with recording storage tube

Tube Equipment

By J. A. BUCKBEE and A. S. LUFTMAN

Chief Circuit Engineer *Senior Project Engineer*
Raytheon Manufacturing Company
Waltham, Massachusetts



Industrial television system with stored picture on monitor

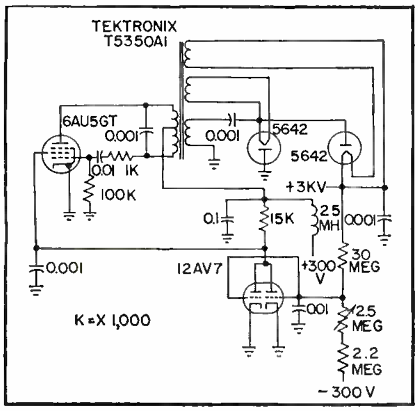


FIG. 2—Regulated high-voltage supply for storage-tube anode

supply which will be variable between 240 and 325 v.

The storage screen potential determines the operating mode of the tube at any instant. Typical voltages would be: for erase, decelerator screen potential; for prime, 15 volts; for read, between 6 and 10 volts; and for high scanning speed writes, the same voltage as for erase. Where slow scanning speeds will be used during write or where the tube will be used to integrate many write scans, the screen voltage for this mode should be decreased to as low as 80 volts.

Bias Level

The bias supply controls the storage-tube beam current and is a reference for the high-voltage supply. It should be well regulated and ripple-free. Besides the reference voltage to the r-f supply, normally −150 v or −300 v, three interdependent outputs with controllable ranges between 0 and −150 v are fed to the storage tube mode-switching unit.

For read, the bias level is such that the storage-tube cathode current will be approximately 3 to 5 microamperes. The write bias is adjusted for storage-tube beam current cutoff. The erase-prime bias is set for between 10 and 50 microamperes storage-tube cathode current depending upon the length of time the storage tube will be in these modes. If the storage tube will be in the erase and prime modes for a combined time greater than one minute, no more than 25 microamperes should be used.

The high-voltage supply must minimize ripple or hum and should provide good voltage stability with line-voltage fluctuations. Since the tube should never be operated with cathode current exceeding 1 milliampere, a low-current r-f supply may be used. Figure 2 illustrates a typical r-f voltage supply.

The method of control compares the high-voltage output with a reference voltage across a bleeder and uses an amplified error signal to control the screen voltage of an r-f oscillator. The oscillator output is rectified and filtered to provide the hum-free high-voltage output.

Table I—Time Allocation for Ten-to-One Band Compression

Mode	Time in Milliseconds	
	Tube 1	Tube 2
Write	0-1,000	1,000-2,000
Switch	1,000-1,050	2,000-2,050
Preread	1,050-1,150	2,050-2,150
Switch	1,150-1,200	2,150-2,200
Read	1,200-1,300	2,200-2,300
Switch	1,300-1,350	2,300-2,350
Erase	1,350-1,500	2,350-2,500
Switch	1,500-1,550	2,500-2,550
Prime	1,550-1,950	2,550-2,950
Switch	1,950-2,000	2,950-3,000
Write	2,000-3,000	3,000-4,000

Auxiliary Components

The deflection coil is dependent on the type of scanning and the frequencies. Where raster scan and sweep frequencies comparable to or less than television standards are used, good quality cosine television yokes are acceptable.

However, when it is necessary to track scan lines between write and read, the effective impedance of the yoke to the input deflection signal must be identical for the two sweep rates or compensated externally. Low-reactance deflection coils approximate the desired condition. High-quality radar ppi yokes and push-pull balanced deflection raster yokes are frequently used for special applications.

In low-electron-velocity cathode-ray tubes the beam is sensitive to inhomogeneities in the focus field. Therefore a focus coil with a homogeneous Swedish iron shell is normally used. Typical coils have two sets of windings. One is composed of approximately 17,500

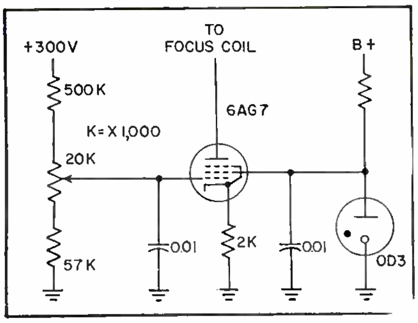


FIG. 5—Focus-current regulator

focus field so generated that the focal length of the lens is increased as the beam is deflected toward the periphery of the storage area.

In a radial scan system a sawtooth in synchronism with the sweep may approximate the desired dynamic focusing although a parabolic curve would be more accurate. For raster scans the dynamic focus correction must include components due to displacement from both the X and Y axes. The circuitry for such dynamic focus is similar to that used in color television equipment.

Mode-Switching

The mode-switching circuits switch voltages at the storage tube and, in some instances, permit alternating between fast and slow scan deflection speeds. The switching can be controlled by an electronic timing circuit or by synchronizing pulses from a master timer which will control the time intervals to be allotted to the read, erase, prime and write modes. It may be manually operated when automatic timing is undesirable or unnecessary.

Tubes in Tandem

A four-mode storage cycle makes impossible a continual flow of input and output from a single storage tube. Where the time cycle for operation is proper, two or three recording tubes operating sequentially in the various modes can provide the desired continuity of intelligence.

For a 10-to-1 band compression where the complete cycle of operation is allotted 2 seconds and where a continuous flow of input information must be recorded, a planned time allocation cycle may be set up as illustrated in Table I.

One of the two storage tubes is always recording incoming information. This information is transmitted in a compressed form during the third 1,000-millisecond period after the start of each cycle, following which the tube is prepared for the next write mode.

A fifth mode, preread may be useful. Conditions are identical to read except that the output signal is not transmitted. Prereading is not necessary if the signal will be read out many times and used for a visual presentation, but may be desirable where a single read-out of high quality is required. The prereading permits overwritten stored signals to stabilize and also permits charge redistribution to reduce spurious noise peaks.

Design Problems

A typical application for storage tubes is to transmit television signals over telephone lines or over a microwave channel with a frequency bandwidth far less than the desired 4 to 4.5 mc. The tube is used for bandwidth compression at the transmitter and expansion at the receiver. The television signal normally transmitted in 1/60 second is slowed down so that the transmission time is 6 seconds and the frequency components in the signal are 1/360 of their initial value.

The circuitry for the compressor is in general identical with that described with the exception that the storage tube output amplifier must be capable of passing frequencies well below 1 cps. The sweep generator for the low-speed scan may cause design problems since the vertical sweep is equivalent to one cycle in 6 seconds.

Burst Transmission

The storage-tube application using tubes in tandem requires that in the transmitter a continuous flow of information be time-compressed into short bursts of higher-speed information. In the receiver these bursts are time-expanded to form a continuous flow of information. In both the transmitter and receiver, storage-tube units were developed to perform the band compression and/or expansion. Each storage unit contains two storage tubes alternately switched between fast and slow sweep speeds and between modes of storage-tube operation. In the transmitter, each tube is written for a fixed period, for example 1 second. During the alternate 1-second periods the signal is read out in a rapid burst and the tube is erased and primed so that it is again ready to write.

A staircase raster eliminates retrace gaps and simplifies circuitry. A 100-line raster is generated from sync pulses at the desired line frequency in a manner similar to that shown in Fig. 6.

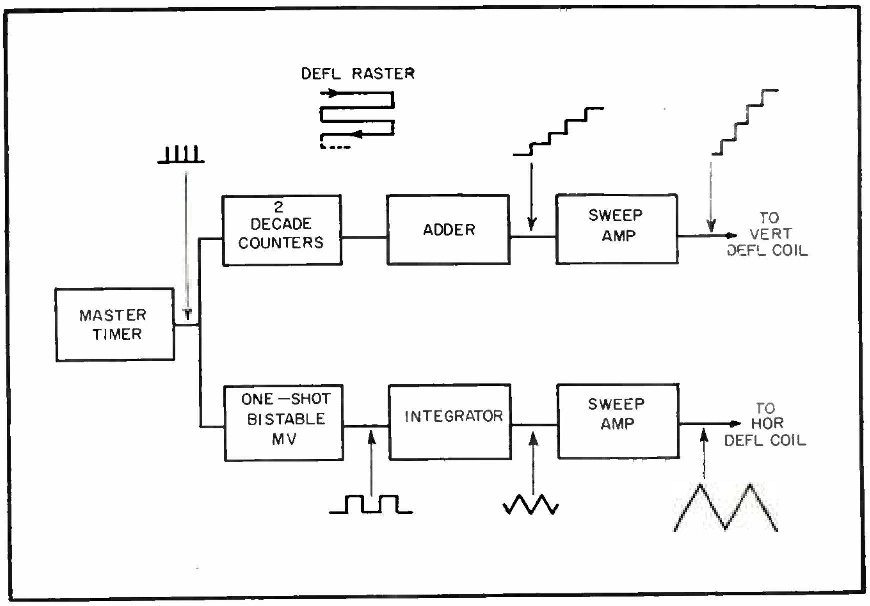


FIG. 6—Staircase raster generator for transmitting information in fast bursts

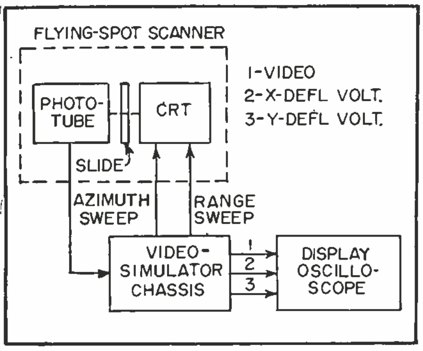


FIG. 1—Complete radar display system for three-dimensional presentation

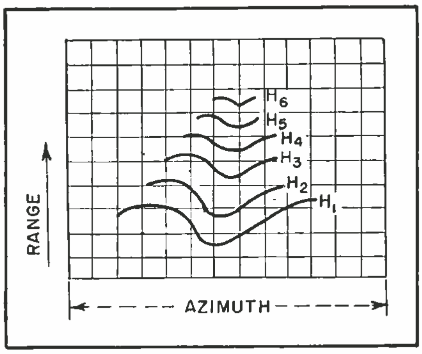


FIG. 2—Typical terrain-contour-line slide for flying-spot scanner

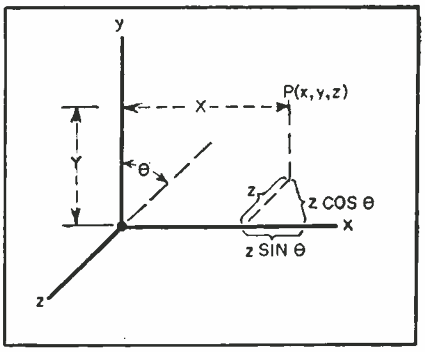


FIG. 3—Coordinate system for developing simulated-video signal

Three-Dimensional Radar VIDEO SIMULATOR

SUMMARY —— Terrain-clearance radar data is presented as three-dimensional oscilloscope display by using simulated-video generator and conventional flying-spot scanner. Equipment permits study of displays under realistic, but controllable, conditions

By PETER PIELICH
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CONVENTIONAL RADAR DISPLAYS are restricted to a two-dimensional representation of a three-dimensional situation despite the general availability of range, azimuth and elevation data, which provide three-dimensional point coordinates.

An investigation to determine the feasibility of displaying terrain-clearance radar data in three-dimensional form established that mechanization of such a display is a relatively simple matter.

System

Picture video which provides a reasonable approximation of a three-dimensional radar display may be generated by the equipment shown in Fig. 1. A conventional television flying-spot scanner, modified to operate at radar scanning rates (1-cps azimuth scan rate and 3-kc range sweep rate), is used to scan a slide on which is represented the terrain to be reproduced, as in Fig. 2.

The terrain is described by six contour lines. Each contour line defines the range and azimuth of the terrain at a particular height level. The H_1 line describes the terrain at the lowest level. The H_n line describes the terrain at the sixth or top level.

The video obtained by scanning the slide is converted to simulated radar video in the video-simulator chassis. This simulated radar video is then used to intensity-modulate a cathode-ray tube oscilloscope to obtain a projection of the scanned terrain. The X and Y oscilloscope deflection voltages are obtained by combining the x, y, and z sweep voltages generated in the video-simulator chassis.

Video-Simulation Theory

If electrical data representing the coordinates of the points of a solid are available, a two-dimensional pictorial projection of the solid can be generated on a cathode-ray oscilloscope screen.

The relation between the projection coordinates, X and Y, and the three-dimensional rectangular coordinates x, y and z of point P of Fig. 3 is given by

$$X = x + z \sin \theta,\ Y = y + z \cos \theta \quad (1)$$

Since the viewing angle θ between the x and z axes of the plane projection is a constant,

$$X = x + K_1 z,\ Y = y + K_2 z \quad (2)$$

The equations

$$E_X = E_x + K_1 E_z,\ E_Y = E_y + K_2 E_z \quad (3)$$

therefore give the simple electrical relations between the projection voltages E_X, E_Y and the rectangular coordinate voltages E_x, E_y, E_z. If E_X and E_Y are applied as X and Y cathode-ray tube deflection voltages, point P will appear as shown in Fig. 3, in the correct relation to the X and Y projection axes.

If voltages E_x, E_y, E_z of Eq. 3 represent the instantaneous coordinates of a surface or solid, deflection voltages E_X and E_Y will trace the projection of the solid on the cathode-ray tube screen, generating

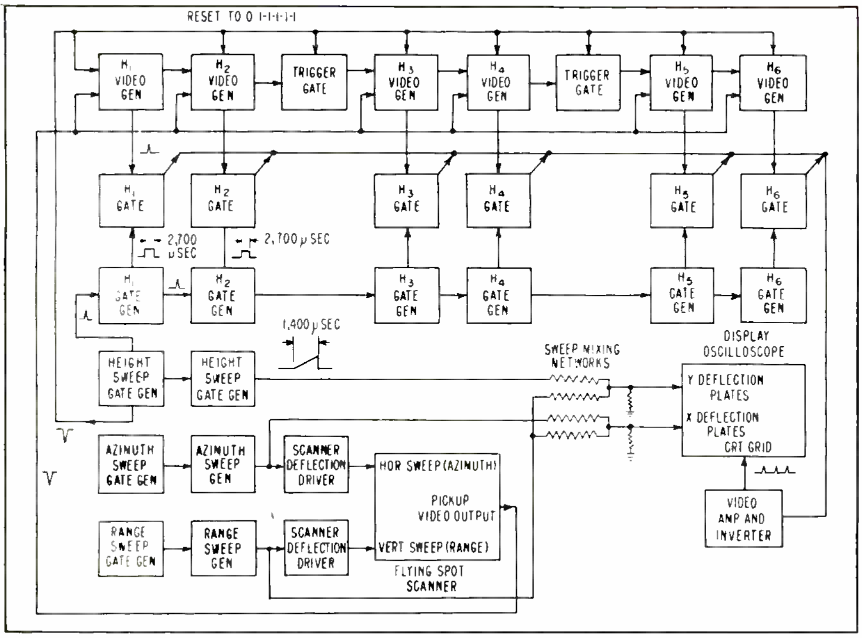


FIG. 4—Block diagram of radar-video simulator equipment

a three-dimensional picture.

The block diagram of the video simulator is shown in Fig. 4 and the circuit diagram in Fig. 5. Figure 6 is the circuit of the flying-spot-scanner range and azimuth sweep chassis.

Three astable multivibrator sweep gates generate three sawtooth sweeps. The azimuth sweep, in the sweep chassis, has a duration of one second and represents the radar-antenna azimuth sweep. The height sweep, in the simulator chassis, is 1/60 second in duration and corresponds to the vertical component of the antenna scan. The range sweep, in the sweep chassis, is approximately 100 microseconds in duration and provides a time base equivalent to 10 miles of radar range.

Video Generation

As the slide (Fig. 2) is scanned by the moving spot, a video output pulse is obtained whenever a line is intercepted. The pickup video output appears as shown in Fig. 7 if six lines are intercepted by the spot in one range interval.

The range (time) position of

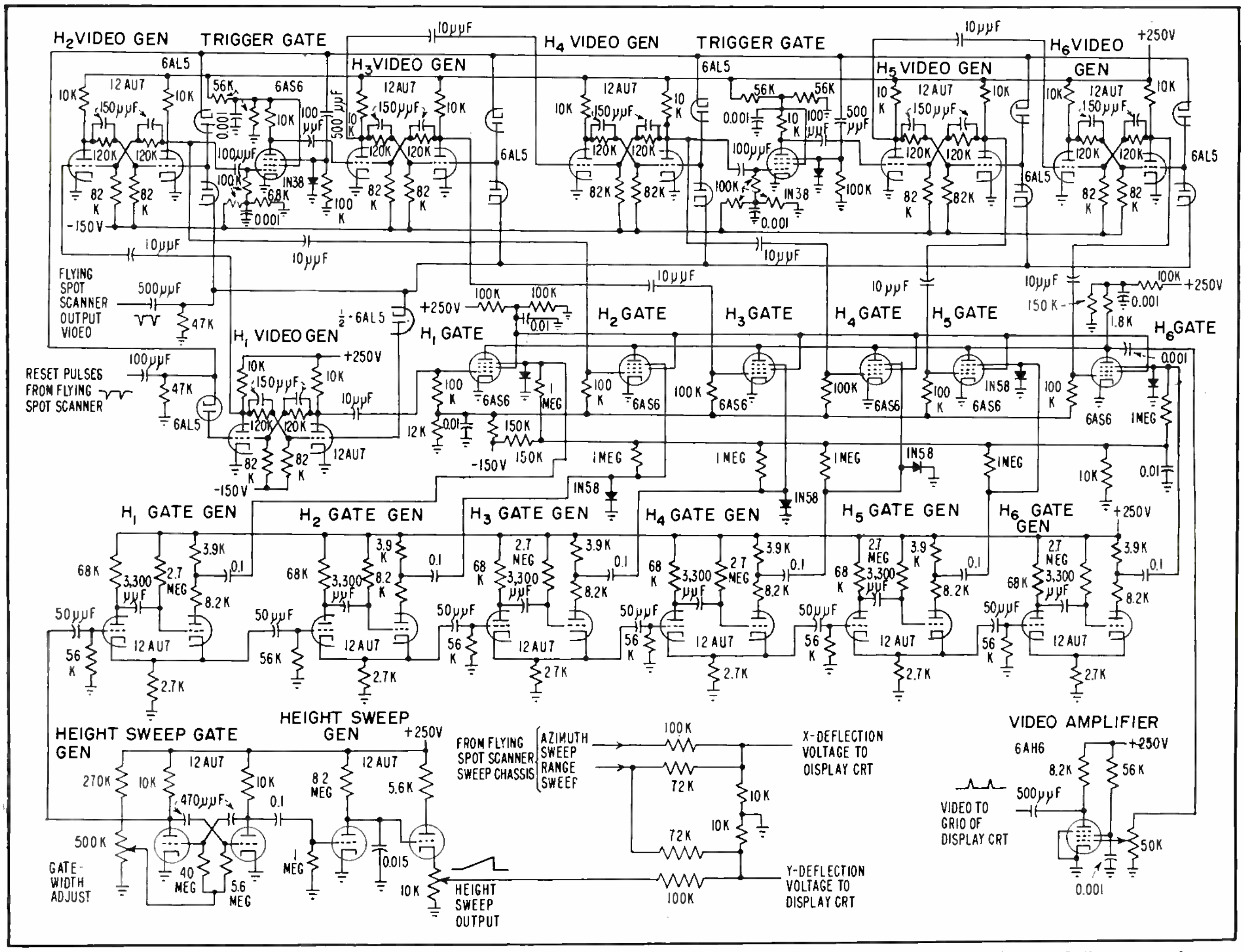


FIG. 5—Video simulator provides video signal for grid-modulation of crt and height-sweep-signal component of Y-deflection voltage

each pulse is determined by the position of the lines on the slide. As the azimuth sweep moves successive range sweeps across the slide, the range position of the video pulses will vary in accordance with the range positions of the corresponding lines.

The pickup video is applied as a parallel input to a series-coupled bistable multivibrator chain comprising video generators H_1 to H_6. Coupling within this chain is such that a multivibrator may be triggered only if it has been enabled by a trigger pulse from the preceding stage.

The H_1 multivibrator is enabled by the reset pulse so an output, a positive excursion of the output plate, is obtained in response to the first video input pulse (H_1 pulse). The corresponding negative output of the opposite plate of the H_1 multivibrator is used to enable the following stage, the H_2 multivibrator.

The second video input pulse triggers the H_2 multivibrator and enables the H_3 multivibrator, which then can be triggered by the third input pulse. The remaining multivibrators are successively enabled and triggered in this manner, each thereby responding to only one specific input pulse.

The action of the chain in response to a train (one range interval) of input pulses is diagrammed in Fig. 7. The trailing edges of the output plate wave forms are differentiated to form positive pulse inputs to pentode gating stages H_1 to H_6.

Height Gate Generation

The H_1 to H_6 height gate generators comprise a series-coupled chain of monostable multivibrators. The first is triggered in coincidence with the beginning of the height sweep.

Each of the following is triggered in succession by the end of the preceding gate waveform, so six 2,700-μsec-height gates are generated within each height sweep interval as shown in Fig. 8.

The H_1 to H_6 height gates thus generated enable gating stages H_1 to H_6 respectively. The pulse inputs to these gating stages are the

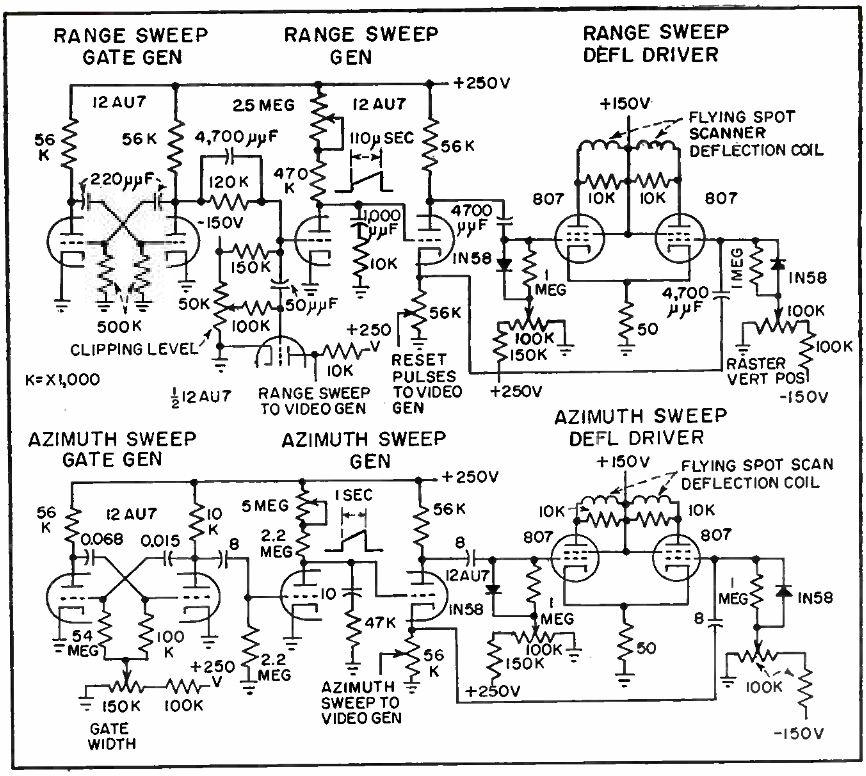


FIG. 6—Flying-spot-scanner sweep chassis generates range and azimuth sweeps

respective H_1 to H_6 video pulses generated by the video-generator chain. The output at the common plate load of the gating stages is therefore a series of video pulses, which are gated in time sequence.

The H_1 video pulses appear only during the H_1 height gate interval, the H_2 (second) video pulses only during the H_2 height gate interval and so on. The video pulses appear

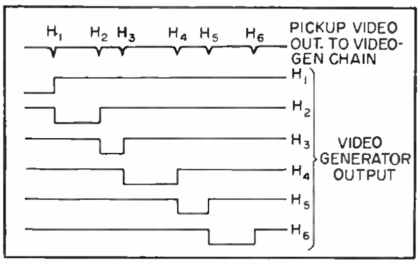


FIG. 7—Video generator chain output

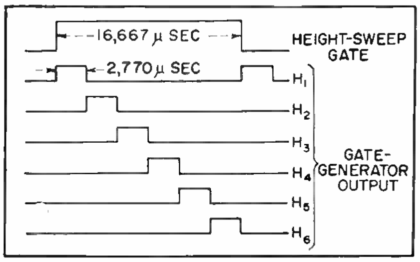


FIG. 8—Height gate generator output

distributed in height in accordance with their relative positions on the range sweep. As the height sweep moves the indicator cathode-ray tube spot upward, these video pulses appear as intensity modulations distributed along the y or height axis.

The trigger gates shown between pairs of bistable multivibrators are disabled by the reset pulse during the reset-pulse interval. If this buffer action is not provided, a multivibrator that may have been enabled but not triggered during one cycle will, when reset, enable the following stage, which will then be triggered by the first input pulse of the succeeding cycle. The trigger gates eliminate this possibility by isolating the critical stages during reset time.

The maximum number of height steps obtainable is limited only by the resolving time of the bistable multivibrators in the video-generator chain. This resolving time must be smaller than the separation in microseconds between contour lines on the slide.

The operation of this equipment permits the study of displays under realistic, yet controllable, objective and subjective conditions.

AUTOMATIC TUNING for

SUMMARY — Frequency-selecting dial operates servo system which tunes transmitter stages and adjusts loading of final stage. Combination of wide and narrow band discriminator circuits pulls servos into critical tuning position over wide frequency range

TO MAINTAIN communications in the high-frequency spectrum, it is often necessary to have transmitting equipment capable of quick frequency change. In the transmitter shown in the photographs, a new frequency is selected by setting the desired frequency on a counter dial and pushing a button. Phase-operated servo systems and automatic controls direct the adjustment of the transmitter and within thirty seconds the equipment is ready for transmission on the new frequency.

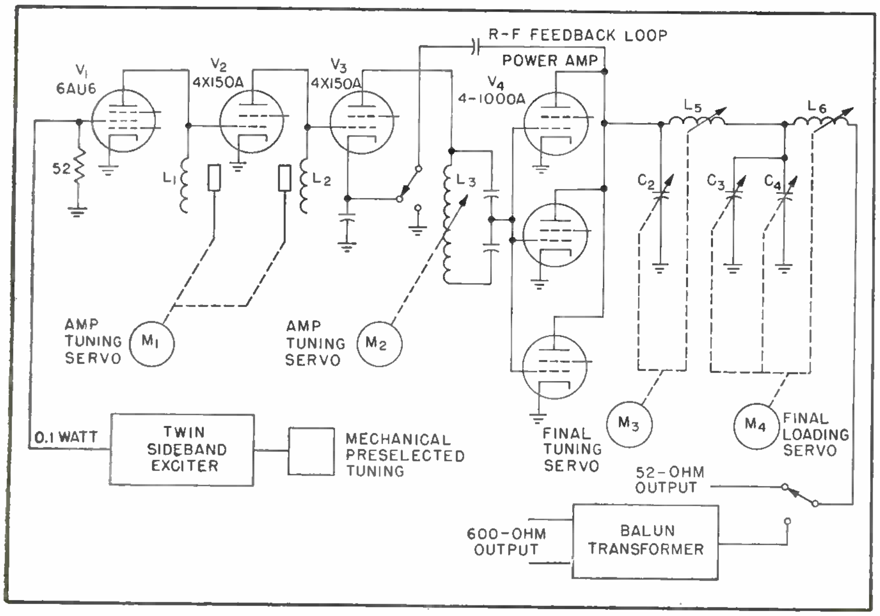


FIG. 1—Simplified diagram of r-f amplifier shows stages tuned by servo system

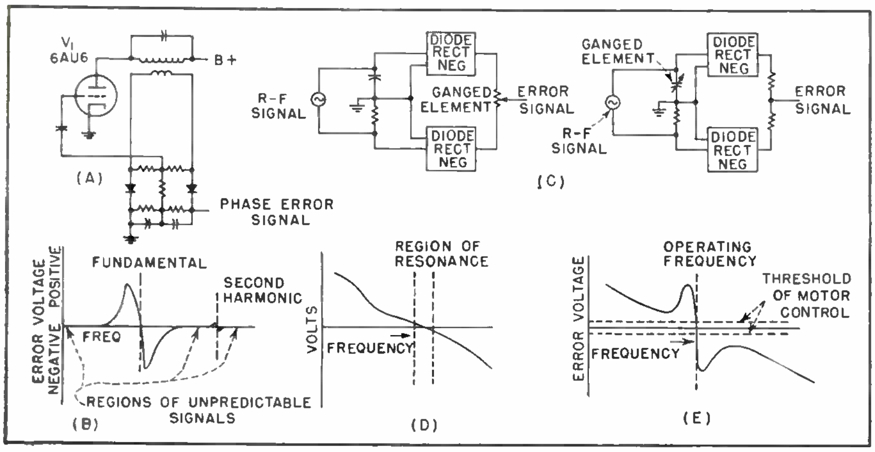


FIG. 2—Discriminator (A) with sharp response curve (B) is combined with R-C discriminator (C) with broad response (D) to obtain wide range with critical null (E)

The exact frequency, which has a stability of 1 part in 10^8 per day, is displayed on a counter dial. Output of the final amplifier is 4 kw peak envelope power for twin-sideband operation c-w, 5 kw a-m or c-w, in a frequency range from 1.5 to 30 mc.

Tuning Cycle

A tuning cycle begins when the operator either turns the exciter control dial to a new frequency or selects any one of ten previously dialed frequencies by setting a channel switch. Channel selection positions, by direct mechanical linkage, all the tuned circuits in the exciter including the stabilized master oscillator, mixer and variable-gain r-f amplifier circuits.

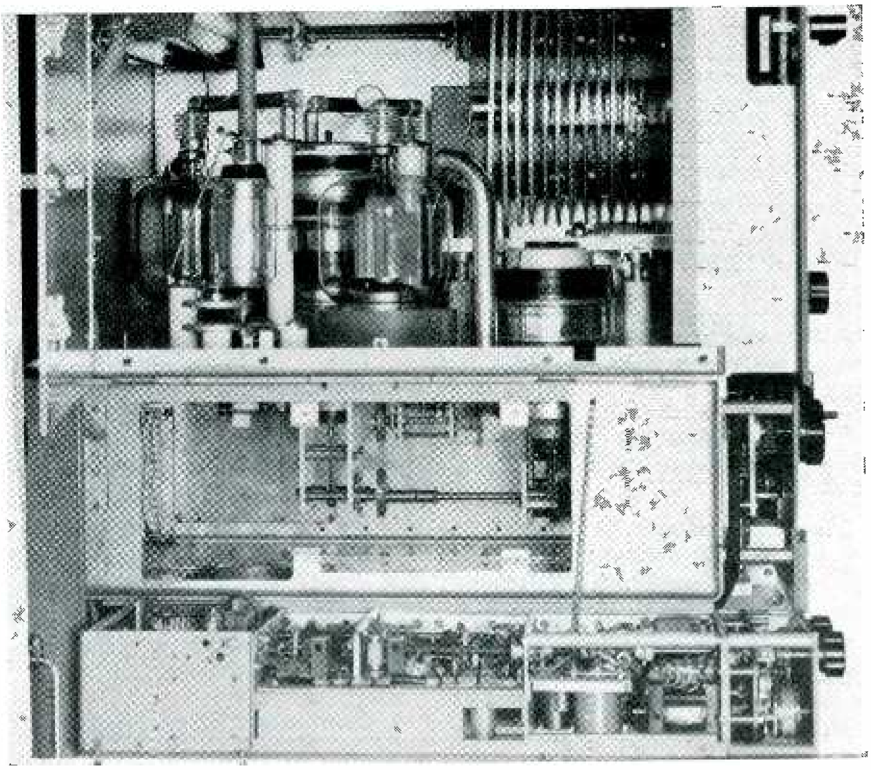
While the automatic tuner is in motion, a contact causes a tuning relay to energize. This relay reduces plate and screen voltage to protect the high-level amplifier tubes from over-dissipation. The tuning relay also operates the carrier reinsert circuit in the twin-sideband exciter to supply a signal on carrier frequency for the amplifier to tune. An additional contact on the relay ungrounds the grid of a differential amplifier allowing rectified d-c from the power-amplifier-tuning and loading-rate generators to be applied to the grid of a differential relay.

Upon reaching the new frequency, the automatic tuner shuts off and the reinserted carrier of proper frequency is applied to the amplifiers. A sample of this signal is rectified and compared with a rectified r-f sample of opposite polarity from the

High-Power Transmitter

By V. R. DeLONG

Collins Radio Co.
Cedar Rapids, Iowa



Twin-sideband transmitter is automatically tuned by setting exciter control to desired frequency

final amplifier. Since the amplifier is not tuned yet, no signal is available from the power amplifier. The resulting net signal from the comparing circuit is applied to the differential amplifier causing the differential relay to operate and lock the transmitter in tuning position until the tuning cycle is complete.

By coarse-positioning and discriminator circuits, the four tuning controls simultaneously proceed to seek the proper tuning positions for resonance. Once resonance is approached a rectified r-f signal is available from the power amplifier that allows the differential amplifier to deenergize the tuning relay and switch to full power before all the circuits are accurately tuned. To avoid this condition, the differential amplifier is fed with a rectified signal from the power-amplifier-tuning and loading-rate generators. Thus the transmitter remains in tune until the power amplifier tuning requirements are satisfied.

Once all tuning requirements have been satisfied the rectified rate signal applied to the differential amplifier decays to zero and the tuning relay is allowed to de-energize. This action turns off the carrier reinsert, makes the two audio channels ready for use and turns on a light on the front panel. Within thirty seconds the transmitter is on frequency with 5 kw available at the antenna.

Exciter Tuning

Due to the extremely low power levels involved, the twin-sideband exciter uses receiver-type construction. Tuning is continuous across the frequency range from 1.7 to 32 mc using a bandswitch and ganged permeability-tuned coils. Output from the exciter is fed into a terminated coaxial cable to drive the final string of linear amplifiers.

Figure 1 is a simplified schematic of the r-f circuits. The first stage, a miniature-receiver type pentode with a permability-tuned coil, drives a larger tetrode which also uses a permeability-tuned coil. These two stages comprise tuning control M_1. The second tetrode stage is resonated by a small roller coil actuated by control M_2. This stage has allowances to receive r-f feedback from the final amplifier in single-sideband operation to improve the linearity of the amplifiers. A motor-driven bandswitch changes tank-circuit capacitors in the first three tuned stages.

The final amplifier is resonated by control M_3 and loaded by control M_4. Tuning elements are continuously variable and consist of vacuum capacitors and large screw coils. These elements, partially visible in the photographs of the r-f chassis, are ganged to cover from 1.5 to 30 mc without switching.

Discriminator Circuits

In the vicinity of resonance, the information for positioning of controls M_1, M_2 and M_3 can be obtained from the Foster-Seeley type phase discriminator shown in Fig. 2A.[1] As the error curve of Fig. 2B indicates, this discriminator supplies adequate information for operating the servo system only when the tuning control is near resonance.

This phase discriminator also gives a response to second harmonic tuning. Were this the only information available, the transmitter might tune to a multiple of the desired frequency. It might even fail to tune at all, should the control stall in the region of unpredictable signal which is in general below the threshold to servo control. To overcome these difficulties, the coarse frequency discriminators shown in Fig. 2C are employed. These circuits are a simple series R-C network fed with a small amount of

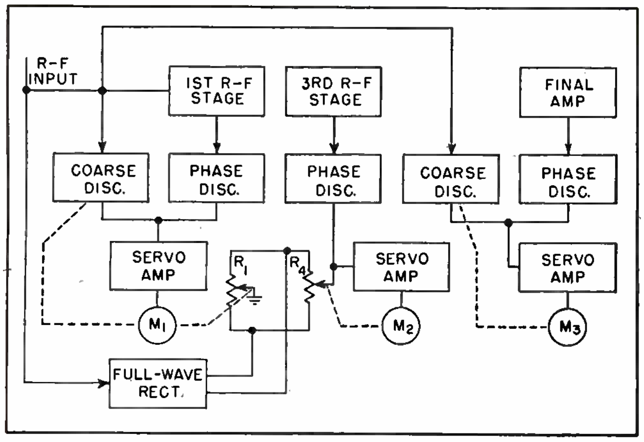


FIG. 3—Method of combining outputs of coarse and fine discriminators to obtain wide range servo drive signal

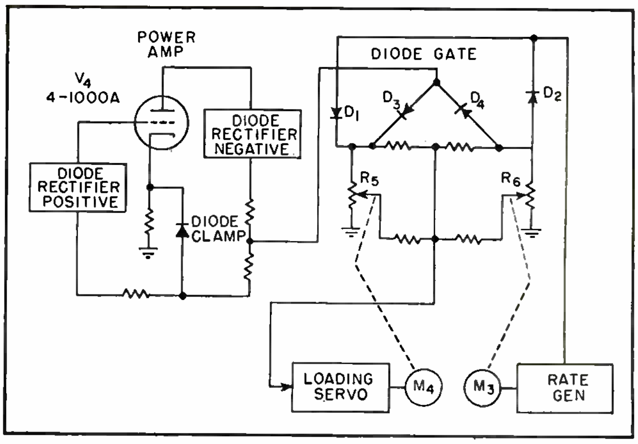


FIG. 4—Diode gate prevents loading-servo from operating until amplifier stages have been tuned

r-f voltage from the exciter and having a response curve as shown in Fig. 2D.

One discriminator uses a potentiometer output ganged to the control requiring positioning information. The servo system searches for a null from the potentiometer. Position of the null changes with frequency due to the change in capacitive reactance that switches the balance of the bridge circuit. The null function so generated may be matched to the mechanical tuning curve of the control shaft by nonlinear potentiometers, tailoring of R-C circuit constants or both. The potentiometer version of this discriminator was found to lend itself well to the band-switched amplifier circuits. Various values of capacitance were switched into the R-C circuit for each of five bands.

Use of a variable capacitor is shown in the second version of this circuit. The circuit with the capacitor as the variable element was found to be more easily tracked to the final tank circuit.

In combining the two discriminator outputs, use was made of the fact that the phase discriminator has a rather high gain in the vicinity of resonance, as indicated by the steep slope of the error curve, while the coarse discriminator has a constant gain throughout the entire shaft travel. Addition of the two curves in the proper gain relationship yields a curve similar to Fig. 2E.

The phase discriminator and coarse discriminator error signals are both a function of the r-f driving voltage. This allows the system to resonate on varying amplitude signals as will be obtained from the exciter in single-sideband service. It is also necessary that these servos do not drift in a no-signal condition. This requires that all noise in the servo circuits be held well below the threshold of motor control.

Combining Error Signals

Figure 3 is a simplified block diagram indicating how the coarse and fine information is combined. A coarse discriminator connected to the r-f input plus a phase discriminator connected around the first r-f stage yields information to position control M_1. Servo M_1 indicates its position to M_2 by setting potentiometer R_1. Coarse positioning for M_2 is obtained by a follow-up potentiometer system involving R_1 and R_4. Source voltage for this scheme is developed directly from the r-f input signal with a full-wave diode rectifier.

Since both the coarse and fine error signals are obtained from the r-f signal, the control of M_2 meets the requirement of proper position error signal whether the r-f be modulated or even reduced to zero potential for periods of time.

Final Tuning

As indicated in Fig. 3, the M_3 coarse discriminator obtains its information directly from the r-f exciting voltage. This allows the final tank circuits to do their rough positioning simultaneously with the driver circuits, hence, reducing the overall tuning time. Once again both types of servo control voltage, coarse and fine, are obtained from the r-f signal voltage resulting in proper position error voltages regardless of the type of modulation applied to the r-f signal.

Final Amplifier Loading

Loading the final amplifier for proper tube operation presents different problems than the tank-circuit tuning. Figure 4 is an outline of the basic circuits employed. For linear operation the ratio of the output from linear diode rectifiers connected by dividers to the plate and grid of the final amplifier will give an indication of the amount of plate loading. However, when the stage is driven into distortion or operated class C, the grid-diode

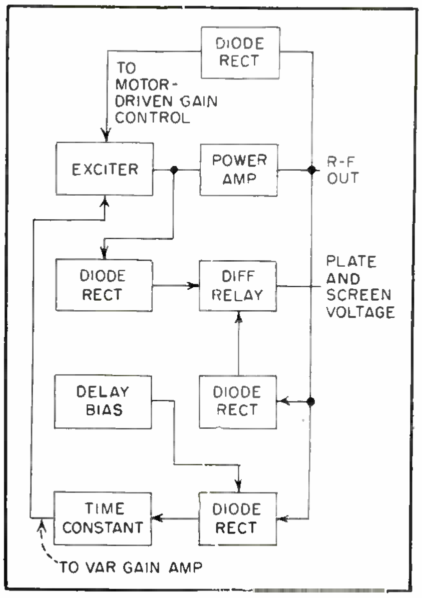


FIG. 5—Automatic load control and differential relay section of automatic tuner r-f section of automatically tuned high-power transmitter

voltage will increase faster than the plate-diode voltage. A diode clamp was added to prevent the rectified grid voltage from exceeding a value of voltage proportional to the plate current of the amplifier.

Proper adjustment of rectified plate voltage, rectified grid voltage and plate current sample, yields a loading-error voltage source that gives a null indication for the proper value of loading regardless of the operating conditions of the final tubes.

Unfortunately, the error signal from this composite detector-comparing circuit is correct only when control M_3 has the plate tank circuit tuned to resonance and a method is required to shut off the loading signal when it is in error. Since the loading signal would be incorrect whenever control M_3 is in motion, a gate circuit is operated from voltage obtained from the rate generator bus of control motor M_3. Diodes D_1 and D_2 rectify this 60-cps voltage creating equal negative and positive sources of voltage which bias-off diodes D_3 and D_4 blocking the incorrect error signal that originated in the loading comparator circuit. Nulling of control M_3 yields zero rate voltage allowing the gate to open and pass the now correct loading signal to the amplifier.

It is necessary to supply coarse position information to the loading servo. As the loading comparator does not give an S-shaped curve, it is not possible to directly add coarse information to obtain sufficient positioning accuracy. In addition, the loading-control position varies with different antenna impedances, a factor which makes tracking of a directly added coarse information circuit impossible. Hence, a coarse position system was devised whose signal decays to zero whenever good fine-position information is present.

The voltages developed by the M_3 rate generator and rectified by gate blocking diodes D_1 and D_2 are used to power a follow-up potentiometer system connecting the tuning and loading controls. Whenever the final tuning control operates, it causes the loading fine signal to be disabled and the loading coarse-position system to be actuated. In this condition, the loading control follows the tuning control. Once resonance has been reached, M_3 stops, disabling the follow-up potentiometer system, and control M_4 completes its task using the now correct fine-position signal.

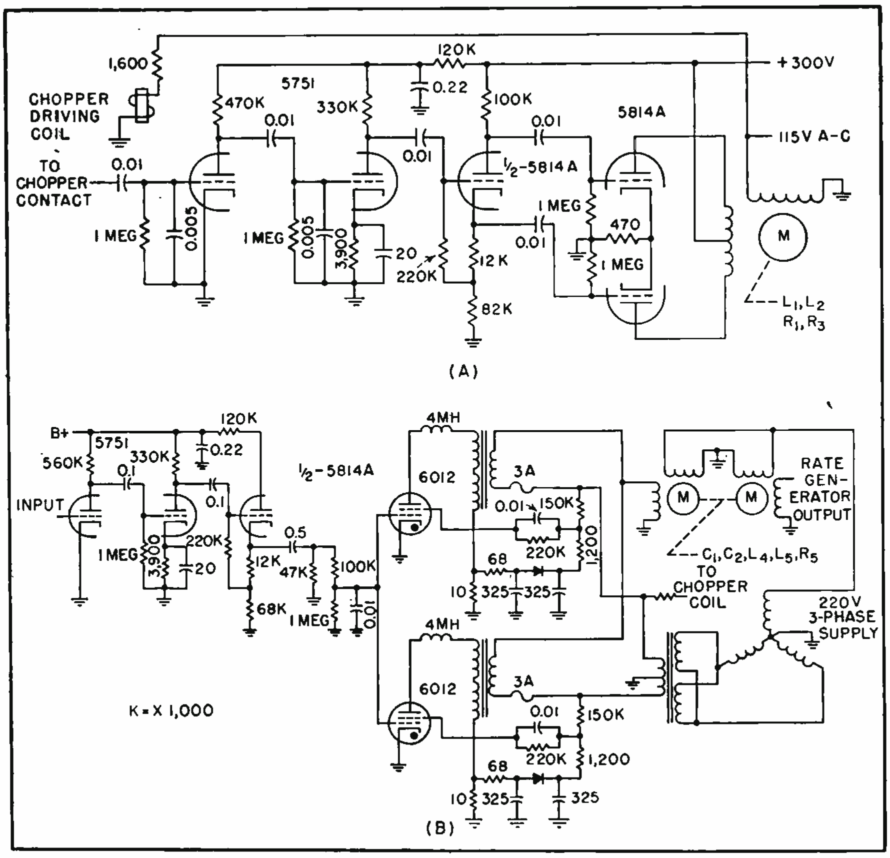


FIG. 6—Circuits of 1½-watt (A) and 25-watt (B) servo amplifier systems

Tube Protection

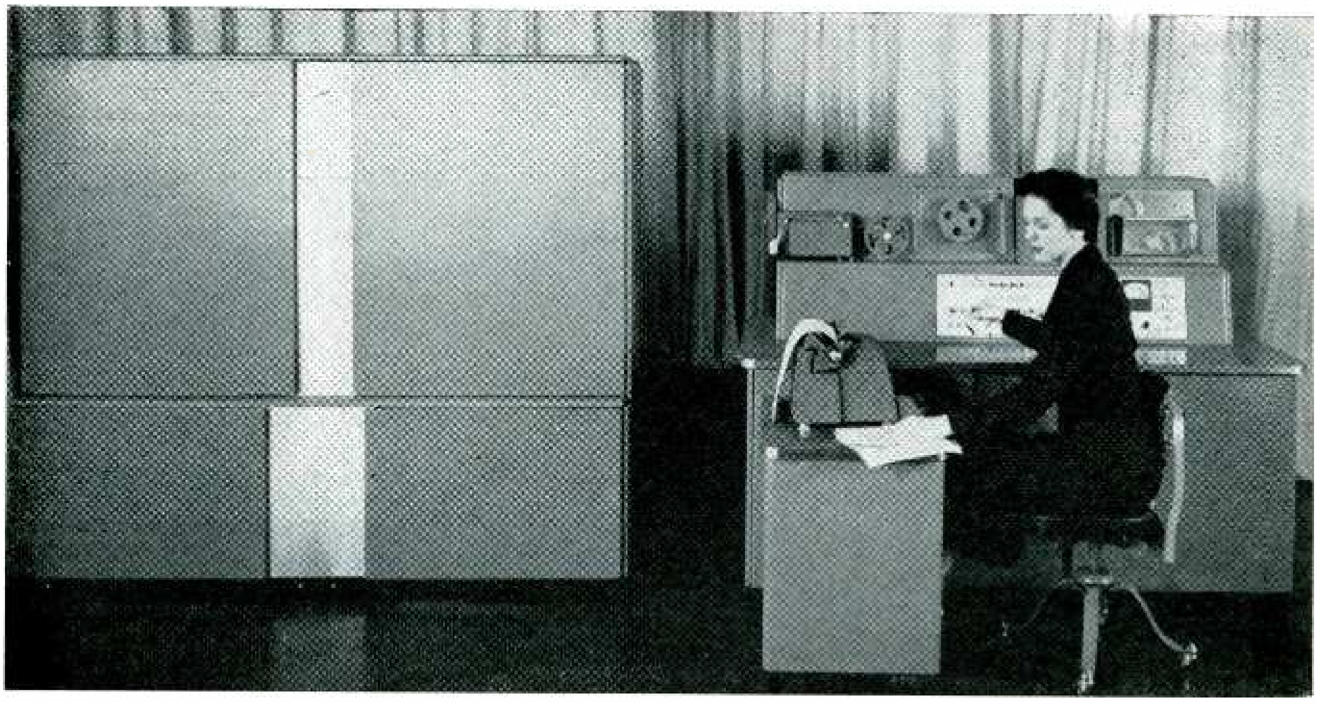
During periods of mistuning, protection must be given to the high-power tubes. When amplifier gain falls below a minimum level, a differential relay circuit comparing input and output r-f signals operates to reduce the plate voltage and screen voltage on the power tubes.

In single-sideband service, it is necessary to maintain overall circuit gain constant from the audio input to the antenna. Utilizing a motor as an infinite integrator, a constant gain is maintained from the antenna to a point in the low-level exciter (in this particular case to the 100-kc output of the balanced modulators) by comparing diode-rectified r-f signals from the low-level stages and the final amplifier, amplifying the result and using it for motor control.

It was found possible to maintain gain to about 1 db for various frequencies in the operating range. Following this degree of adjustment, a more dynamic control of the gain is effected with the automatic load-control circuit of Fig. 5.[2] This is a diode-rectifier circuit with delay voltage adjusted to hold conduction off until an r-f signal is encountered which would ordinarily drive the linear amplifier beyond its peak envelope power rating. These peaks cause the automatic-load-control diode to conduct and supply a negative signal on the alc bus. This control voltage feeds a variable-gain amplifier strip in the exciter, reducing the overall gain to a satisfactory level. This gain control is done ahead of the motor-driven gain adjuster in the exciter to prevent interaction and is tempered by a fast-attack, slow-delay time-constant circuit.

Figure 6 displays the circuits of the 1½ and 25-watt motor servo-amplifier systems.

Work done on the equipment described was in connection with Signal Corps Contract DA36-039-sc-36524.



Installation comprises cabinet and desk-sized console. Input/output includes punched paper tape, typewriter and remote line

USAF Computer Uses

USE OF HIGH-SPEED pulse-type magnetic amplifiers provides an alternative to use of transistors as replacements for electron-tubes in digital computers.

A high-speed general-purpose engineering computer recently described by Remington Rand Univac engineers illustrates how magnetic amplifiers can be used in computing circuitry. The computer described was developed by Sperry Rand for the Air Force Cambridge Research Center.

The computer can add two 10-digit numbers in 90 microsec or multiply them in from 0.3 to 1.7 millisec. Its magnetic drum memory stores 2,000, 10-digit words plus sign. Average access time is 1.8 millisec.

About 1,500 magnetic core devices are used. The computer also contains about 9,000 germanium diodes, 15 electron tubes and several transistors.

Input and output for the computer can be from punched paper tape, typewriter or a remote line. A significant feature of the computer is that it is designed to operate in real time. This may indicate that it is to be used in connection with an aircraft warning system.

The computer occupies one 6 by 6 by 1.5-ft cabinet which is air cooled. Control is accomplished from a 4.5 by 6 by 3-ft desk-like console. The computer requires 5 kva of power. The entire computer installation is shown in a photograph.

Computing Circuitry

Basically the computer is a two-address, decimal-serial, binary-parallel machine. It operates at a master clock frequency of 660 kc. The clock utilizes electron-tube circuits and is of the two-phase type. Output is a square wave.

Diode logic is used throughout the computer. There is one basic diode configuration for both AND and OR circuits. How a circuit functions depends upon the master clock phase fed to it. The computer provides seven transfer functions, four arithmetic functions, seven logical functions and output instructions.

Computer operation is in three basic modes. The machine can run continuously. It can be made to stop before each instruction, display the instruction in lights and print it out if the operator desires. This mode of operation is useful for debugging problems. The computer can also be made to stop before each branching instruction to provide a type of manual operation.

Magnetic Amplifiers

Power gain is achieved by magnetic amplifiers. After each logical operation, the pulse is amplified. The arrangement is: amplifier—diodes—amplifier.

As illustrated in Fig. 1A, the amplifiers are of the serial type. The electron-tube master clock acts as the power source. Input pulses in the control winding saturate the core and allow the master clock pulse to pass to the load.

The amplifiers and other circuits are packaged in 600 plug-in units mounted on printed-wiring panels. Two photographs show several plug-in pacakages arranged in the

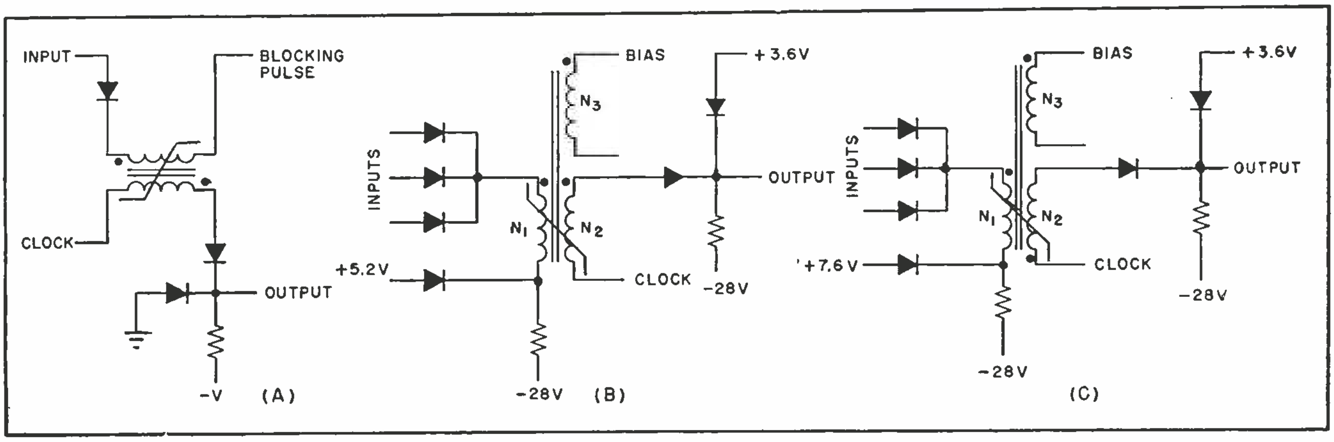


FIG. 1—Basic magnetic circuit is serial amplifier (A) which is used in complementing (B) and noncomplementing (C) amplifiers

SUMMARY —— Electron tubes work compatibly with transistors and magnetic amplifiers in high-speed computer which ties into remote line for real-time operation. Tape-wound cores on stainless-steel bobbins overcome frequency limitation of magnetic devices. Computer has 660-kc clock frequency

Magnetic Amplifiers

computer and one of the packages. Two magnetic amplifiers with cases open are shown at the bottom of this photograph. There are 17 basic circuit types used in the computer.

Both complementing, Fig. 1B, and noncomplementing, Fig. 1C, magnetic amplifiers are employed. The essential difference is in the polarity of the output winding.

Double-power amplifiers are used to some extent in the computer as are special amplifiers to drive the output buffer. Mechanical computer components are controlled by electromechanical relays which are controlled by magnetic amplifiers.

Three registers used in the arithmetic section of the computer—the A, L and X registers—consist of recirculating strings of magnetic amplifiers. There is also a 44-bit input buffer register and a 26-bit buffer shift register which feeds the output line when the computer is used in real-time operations.

The magnetic amplifiers utilize alloy tap cores wound on stainless-steel bobbins.

Magnetic amplifiers of the type used in this computer have functioned satisfactorily in pulse operations at information rates up to 2.5 mc.

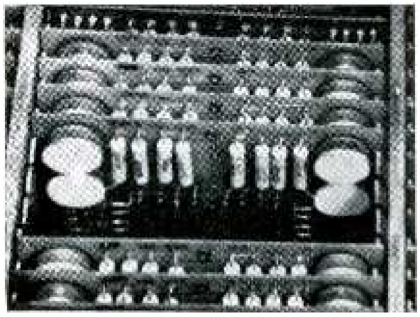
The magnetic drum that provides the storage function in the computer is made from aluminum plated with nickel-chrome alloy. It is 5 in. in diameter and 3 in. long. It spins at 16,500 rpm. The drum is mounted in a gas-tight helium-filled housing to prevent corrosion.

Drum Memories

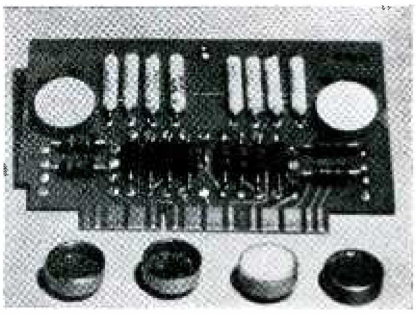
The drum has 200 word bands each with five tracks. Words are read serially. There is a timing band of five tracks and a single-track sprocket channel. The timing channel produces synchronizing pulses to control the master clock frequency.

A rapid-access memory of 400 words capacity is provided on the drum. Access time is 450 microseconds.

Rapid access is achieved by using four read-write heads for each track of the rapid-access portion of the drum. The heads are spaced 90 deg apart around the drum periphery.—J.M.C.



Rack of printed circuit modules typifies internal appearance of computer



Circuit cards hold magnetic elements in pill boxes at left and right

GEAR GAGE CONTROLS AUTOMATIC HOBBER

SUMMARY — Probes attached to cores of linear variable-differential transformers measure pitch diameter and root fillet of automobile transmission gears, to generate signals for logic and control memory circuits that automatically adjust depth setting of hobbing cutter or shift cutter laterally to replace dull cutting surface

THE ELECTRONICALLY-CONTROLLED hobbing machine installation at Plymouth's automobile transmission plant involves six-spindle gear-cutting machines, each of which has six essentially independent hobbing cutters mounted on a rotating platform. Each spindle discharges a completed gear as it passes a common discharge point. A single control unit measures and sorts the gears from all six spindles, controlling the spindles individually by means of six sets of control circuits.

Other installations of this electronic control have been made on single-spindle hobbers. For simplicity, the control equipment will be described in terms of a typical single-spindle installation.

Inspection Requirements

Each gear is automatically inspected as it comes from the hobber. This inspection includes measurement of pitch diameter and root fillet build-up, the latter being indicative of the extent of hob wear. Gears are sorted physically as being acceptable or unacceptable, and appropriate control signals are supplied to the hobbing machine. These control signals include demands for adjustments to correct pitch-diameter errors observed in the gears, shift the hobbing cutter laterally as a means of replacing dull cutting surfaces and shut down the hobbing machine when attempts to adjust it prove unsuccessful.

In the interests of good hobbing-machine control, measurements on the gears employ two sets of tolerances for each gear characteristic of interest. One set of tolerances, symmetrical about the nominal dimensions, is used principally as the basis for physical sorting of the gears. A narrower set of tolerances, also symmetrical, provides the basis for controlling the hobbing machine to limits that are somewhat smaller than the allowable manufacturing tolerances on the gears. By use of these two sets of tolerances, production of gears exceeding the manufacturing tolerances is kept to an absolute minimum.

Control Requirements

Control of the hobbing machine, as regards both pitch diameter adjustment and automatic hob shift, is in fixed increments. Consequently, the electronic control equipment is required only to operate the appropriate set of relay contacts in order to energize the adjustment mechanisms that are

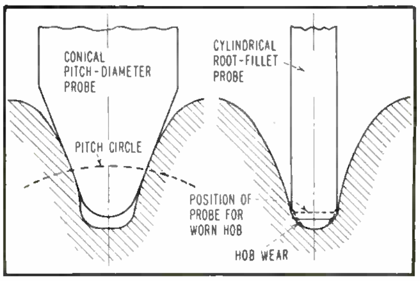


FIG. 1—How probes measure gear teeth

an integral part of the hobbing machine.

Although the control equipment is capable of detecting minute differences in gear dimensions, random variations in the hobbing machine output can result in individual gears that do not truly represent the need for hobbing machine adjustment. Consequently, the hobbing machine control signals are based on trends rather than on individual gears.

In the case of pitch diameter errors, three successive gears must fall outside the narrow tolerance limits before the control equipment calls for readjustment of the hobbing machine. In the case of apparent hob wear, a hob shift signal results each time two successive gears show root fillet build-up in excess of the narrow tolerance limits. If a single small

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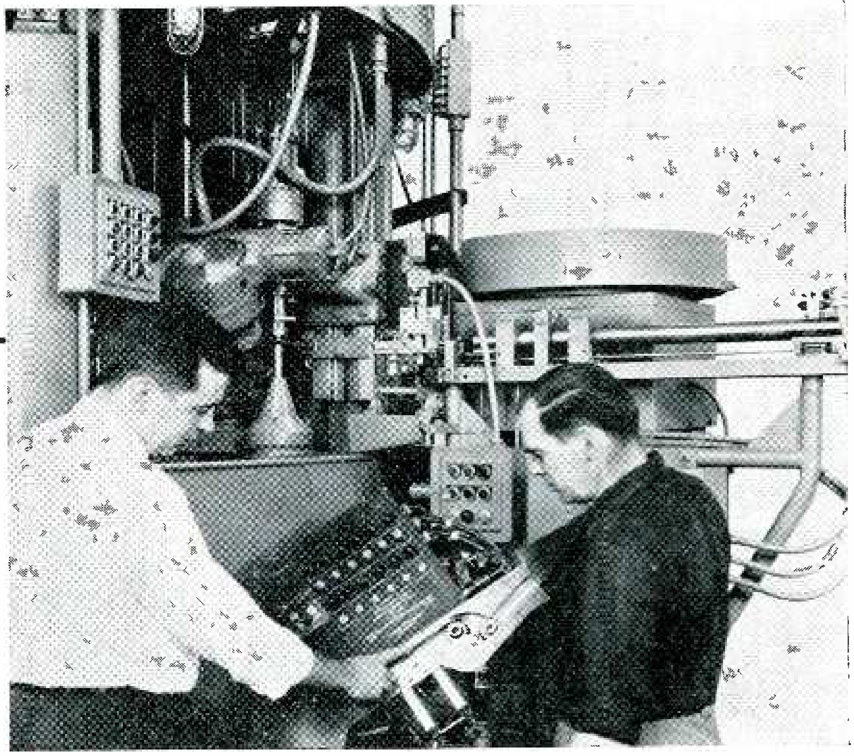


THE FRONT COVER—Method of mounting gear gage at output position of six-spindle Lees-Bradner rotary hobber for automotive transmission gears. Man at left points to position of one of gaging probes in chute down which gears slide

shift does not correct the root fillet build-up, additional shifts are made after each pair of gears with excessive build-up.

After calling for hobbing machine readjustment, the control equipment continues to count successive gears with the same type of error. If the count reaches ten, without at least one gear falling within the narrow tolerance limits, it is assumed that the hobbing machine requires human attention. The control equipment then opens a pair of contacts that removes operating power from the hobber.

Gears are automatically fed to two gaging stations at which pitch diameter and root fillet build-up are measured successively. After leaving the second gaging station, the gear exits through one of three sorting chutes, depending on actual gear dimensions as compared to the production tolerance limits.

Figure 1 shows enlarged cross-sections of gear tooth spaces, illustrating how the gaging probes make physical contact with the gear. The conical measuring probe contacts the gear at the pitch circle, which is a hypothetical circle approximately midway between the root and crown of the gear teeth; its diameter is the pitch diameter of the gear. Any variations from nominal pitch diameter are apparent as displacement of the measuring probe along the radius of the gear.

The method used to detect hob wear is also illustrated in Fig. 1. The solid lines show the shape of the gear tooth space and the position of the cylindrical measuring probe when the gear has been cut with a sharp hob. When the hob begins to wear, the effects are evident as growth of the root fillet of the gears. The broken lines illustrate such growth, and show the resulting displacement of the root-fillet measuring probe.

The mechanical portion of the control equipment includes a set of cam-operated switches that provide the necessary sequencing and timing signals for the electronic circuits.

Gaging Heads

The electronic measuring system is shown in Fig. 2. The gaging transducers are a pair of linear variable differential transformers, one each for the pitch diameter and root fillet measurements.

Each differential transformer

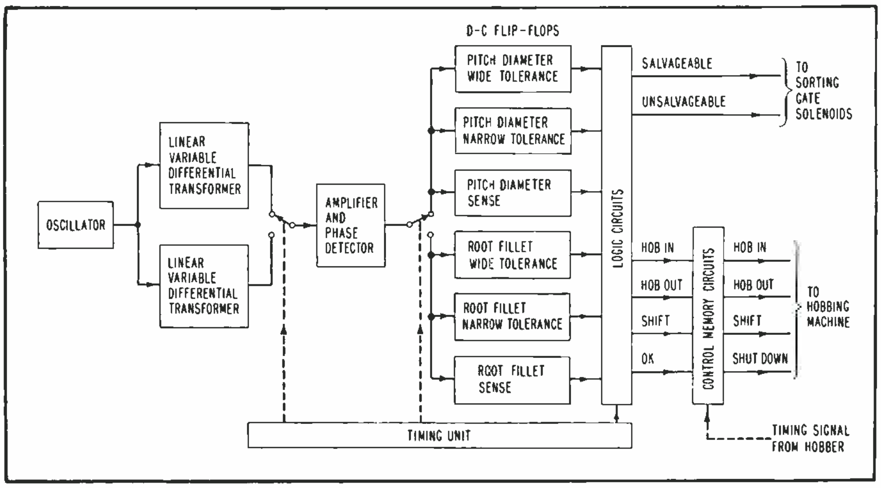


FIG. 2—Probes act on linear variable differential transformers of control system

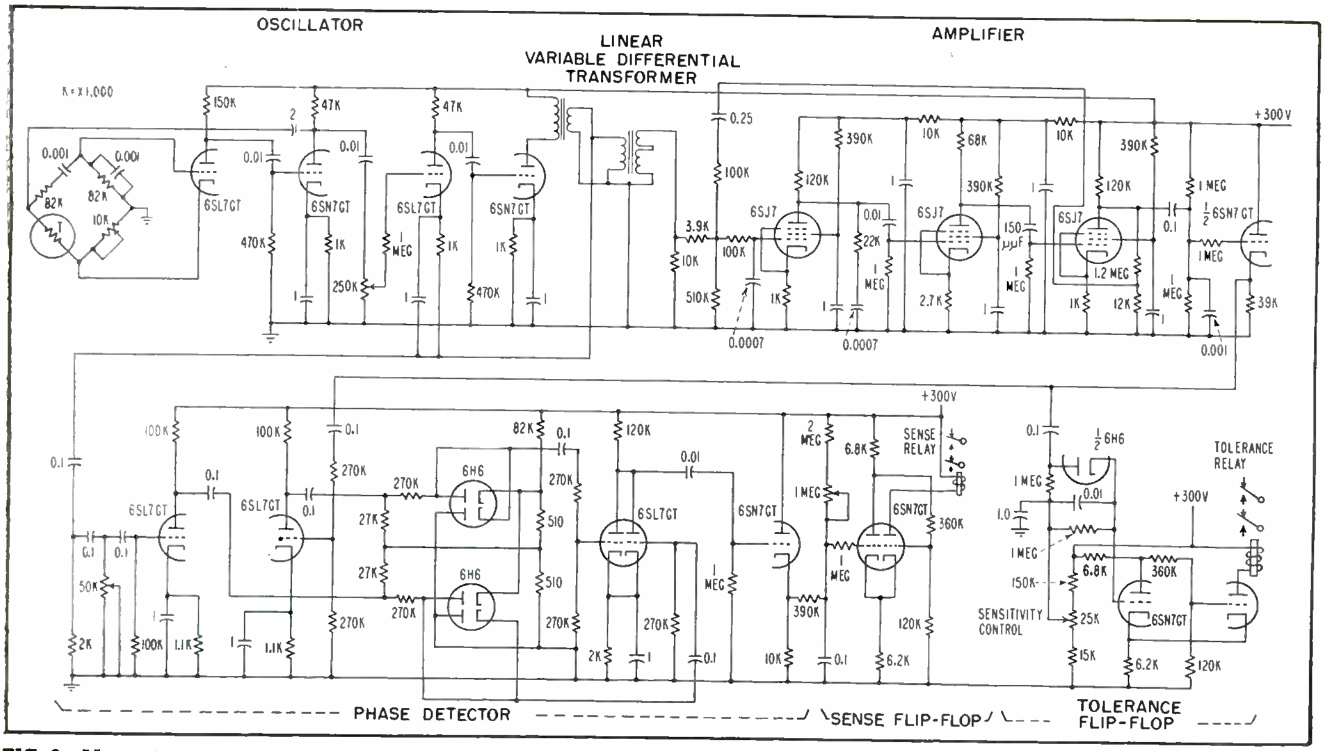


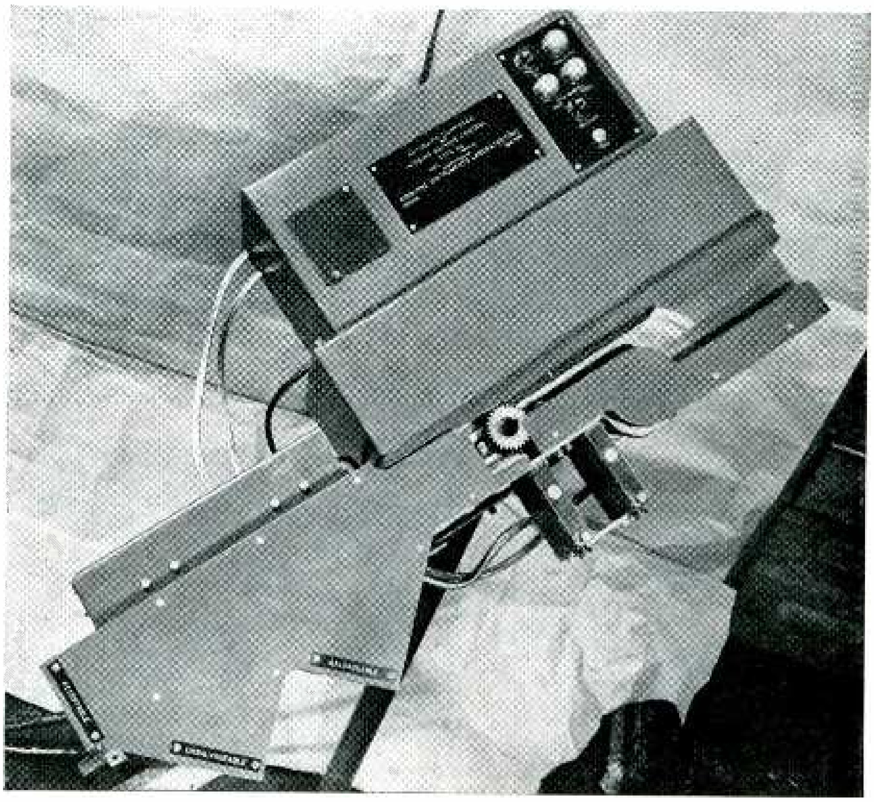
FIG. 3—Measuring circuit and two tolerance flip-flops. Other four tolerance flip-flops and other two sense flip-flops are identical

consists of a single primary winding and a pair of secondaries connected in opposition and symmetrically disposed about the primary. A movable magnetic core, mechanically connected to the gaging probe, varies the coupling between the primary and the two secondaries. Thus, when the primary is excited, the net output voltage from the two secondaries is proportional to the distance between the actual core position and its null position. The phase of the output voltage is a function of the direction of core movement from null. The result is a null-type measuring system with excellent linearity, good sensitivity and freedom from moving contacts with the resulting tendency to wear. Typical units have sensitivities of the order of a millivolt per 0.001 inch per volt excitation.

Measuring Circuits

The two differential transformers are driven by a common oscillator. Their outputs are applied, through relay contacts controlled by the timing unit, to a common amplifier and phase detector as shown in Fig. 3. Relay switching functions have been omitted from this schematic for simplicity.

The oscillator is a bridge-stabilized type, supplying 2,000-cps drive at about 3 volts to the differential transformer primaries. The amplifier and phase-detector circuits are conventional, including



Sensing unit and sorting chutes of gear gage. Cables make interconnections with remotely located electronic control panel. Gear is in position for checking root fillet build-up. The three output chutes, for ACCEPTABLE, UNSALVAGEABLE and SALVAGEABLE gears, are at lower left

the use of negative feedback in the amplifier. The primary purpose of this feedback is to stabilize operation against such factors as power supply variations and tube characteristic changes.

Although gear-sorting and hobbing-machine control operations are both of an incremental nature, the measuring circuits operate on an analog basis. The reasons include the advantages obtained from use of the differential transformers, which are basically analog devices, and the ease with which adjustable tolerances can be obtained in an analog system as compared to a digital system.

The conversion from analog to digital measurement information takes place in a set of six direct-coupled flip-flops following the amplifier and phase detector. The four tolerance flip-flops are driven by the amplifier, while the two sense flip-flops are driven by the phase detector. In all cases, relay switching is employed to activate the particular flip-flops corresponding to the gear characteristic being measured.

In the schematic diagram of Fig. 3, one tolerance flip-flop and one sense flip-flop are shown. The four tolerance flip-flops are identical, as are the two sense flip-flops.

The four tolerance flip-flops each include a sensitivity control calibrated directly in thousandths of an inch tolerance. This facilitates adjustment of the equipment even by inexperienced operators.

Logic Circuits

Pitch diameter and root fillet measurements are made sequentially, but logical decisions as to gear sorting and hobber control must be based on both measurements. Consequently, the three logic relays associated with pitch diameter measurement include electrical locking circuits. Lock-up is automatic at the time pitch diameter is measured; unlocking is controlled by the timing unit and takes place at the end of the operating cycle of the control equipment.

With the aid of the wide tolerance and sense flip-flops, gears are physically rejected if they fall outside the manufacturing tolerance limits. Rejected gears are further segregated as either salvageable or unsalvageable. A salvageable gear is one that has been left with pitch diameter and/or root fillet above manufacturing tolerance limits. An unsalvageable gear is one that has been left with pitch diameter below manufacturing tolerance limit; there is no significance to a gear whose root fillet build-up is excessively small.

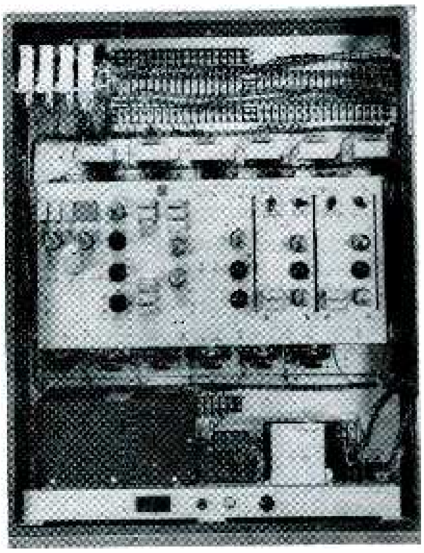
From the standpoint of hobbing-machine control, logic requirements are somewhat more complex. If the hobbing machine is taking a cut that is either too deep or too shallow, the gears will have incorrect pitch diameter and readjustment of the hob in-out mechanism is indicated. Unfortunately, such a condition also has the basic symptoms of excessive fillet build-up resulting from wear of the hob cutting surfaces.

Similarly, actual wear of the hob affects pitch diameter of the gears to some extent. Fortunately, incorrect adjustment of the hob in-out mechanism has effects of equal magnitude on both pitch diameter and root fillet build-up, while hob wear affects root fillet build-up by several times the effect on pitch diameter.

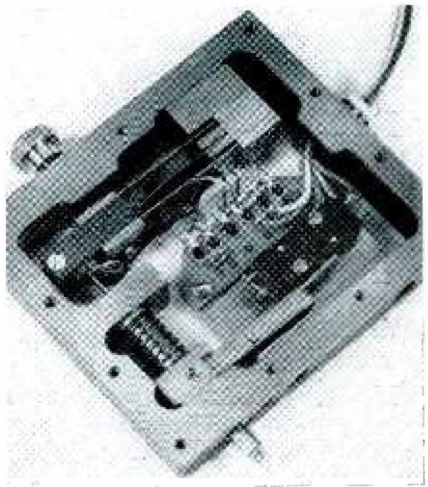
Classification of Gears

Consequently, the logic circuits classify each gear according to the magnitude and sense of its departure from nominal values of both pitch diameter and root fillet. This classification takes place in the manner indicated by the diagram of Fig. 4. The origin at the center of the classification diagram corresponds to nominal values of both pitch diameter and root fillet. Vertical departure from the origin represents an error in root fillet, while horizontal departure from the origin represents an error in pitch diameter.

Normally, all gears fall within the first or third quadrant of the diagram. Because the resulting pitch diameter and root fillet errors are of equal magnitude, an error in adjustment of the hobbing machine in-out mechanism places gears on a line at approximately 45 degrees to the axes of Fig. 4.



Electronic control cabinet. Hinged chassis at center drops forward to expose relays at rear. Main power supply is at bottom of cabinet



Interior of one of gaging heads. Probe is mounted on shaft projecting at bottom, which goes up to linear variable differential transformer mounted in plastic block supported by cantilever spring arrangement. Large knurled screw is zero adjustment for block

Distance along this 45-degree line depends on the magnitude of the error, while direction from the origin depends on the sense of the error.

In the case of hob wear, the root fillet is affected more than the pitch diameter, and gears will fall on a line that may be typically 30 degrees from the vertical axis. Deviation from the origin is always toward the first quadrant for hob wear, never toward the third quadrant.

The wide and narrow tolerances on both pitch diameter and root

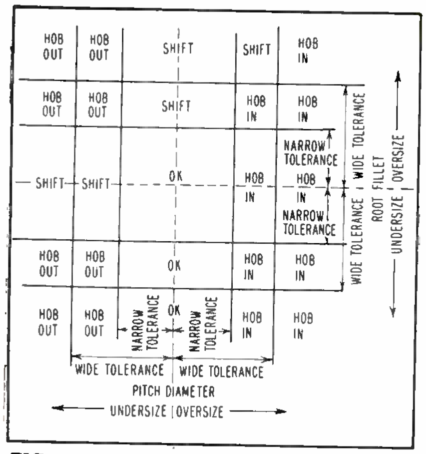


FIG. 4—Classification diagram showing method of classifying hobbing-machine errors according to observed defects

fillet are employed, in the logic circuits, to divide the complete area of the classification diagram into 25 subareas. With proper adjustments of the tolerance controls in the flip-flop circuits, each of these 25 areas corresponds to one of the following four conditions: (1) OK—gear within both sets of narrow tolerance limits so no hobbing machine adjustment is required; (2) HOB IN—pitch diameter (and perhaps root fillet) oversize, requiring hob-in adjustment; (3) HOB OUT—pitch diameter undersize, requiring hob-out adjustment; (4) SHIFT—root fillet oversize, requiring hob shift.

In certain areas of the diagram, the relation between the observed errors in the gears and the needed hobbing machine adjustment may not be immediately obvious. In some cases, the reason lies in the possibility of simultaneous errors in both in-out adjustment and hob wear; here the necessary adjustments will be made successively during the course of production and measurement of several gears. As the effect of each adjustment becomes apparent on the next gears hobbed, classification of gears will proceed from one area of the diagram to another, until finally gears are produced that fall within one of the OK areas.

The second and fourth quadrants of the classification diagram are of little or no practical importance. Consequently, some of the classifications in these quadrants are established as much from the standpoint of convenience and circuit simplicity as from the standpoint of control logic.

Control Memory Circuits

There are two reasons for using control memory circuits rather than controlling the hobbing machine directly from the logic circuits. First, the control memory circuits permit controlling the hobbing machine from observed trends in the gears, rather than supplying control signals based on measurement of a single gear. Second, some sort of control signal memory is required because the hobbing machine is capable of accepting adjustment signals only during a specific portion of its cycle. Thus, the logic information must be stored in some manner at least until the hobber is capable of responding to a demand for adjustment. The control memory circuits thus perform the dual function of determining trends and storing control signals until they can be transmitted to the hobber.

The control memory circuits involve principally a set of three stepping relays. Each of these relays has 10 positions in addition to a zero position, and each relay corresponds to one of the three possible hobbing machine adjustments, namely hob in, hob out and shift.

At the time each gear is being measured for root fillet build-up, the timing unit supplies a register pulse to the logic circuits. Depending on the positions of the six flip-flop relays, this register pulse then appears on one of four buses to the control memory circuits.

The HOB IN, HOB OUT, and SHIFT buses each operate one of the three stepping relays, causing the relay to advance one step each time a register signal appears on the associated bus. A signal on the OK bus, on the other hand, resets all three stepping relays to their zero positions. Further, each time one of the stepping relays steps forward, it automatically resets, to the zero position, either of the other two relays that may have previously advanced off zero. Consequently, each stepping relay counts only the successive gears showing the need of the related hobbing machine adjustment.

Each time the hobbing-machine cycle reaches a point such that it can accept an adjustment signal, an interrogating signal is supplied from the hobbing machine to the stepping-relay contacts. If either the HOB IN or HOB OUT stepping relay has counted three successive gears, or if the SHIFT relay has counted two successive gears, the interrogating signal passes through the stepping relay contacts to an associated power relay. Operation of the power relay then supplies the desired adjustment signal to the hobbing machine.

If one of the stepping relays counts ten successive gears, the interrogating pulse operates a shut-down relay. This relay removes operating power from the hobber and locks up until it is manually reset.

Other Features

The timing unit with its six cam-operated switches is a separate subassembly, chain-driven from the main camshaft of the mechanical handling apparatus. For ease in setting up the timing relationships, the six switch cams are on separate splined sections of the timing-unit camshaft.

Of the six switches, two accomplish the transfer of the amplifier-phase detector between pitch diameter and root fillet measuring functions, two provide register signals to actuate the sorting gate solenoids and the control memory relays through the logic circuits and two reset the locking circuits of the sorting solenoids and the logic relays.

In addition, there are two switches that operate in response to the actual presence of a gear in the mechanical handling portion of the equipment. These prevent false actuation of the control memory circuits during operating cycles in which no gear is actually being measured.

Indicator lights give the hobbing machine operator a visual indication of the classification of each gear as it is inspected.

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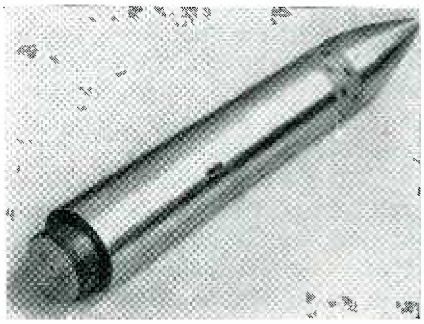
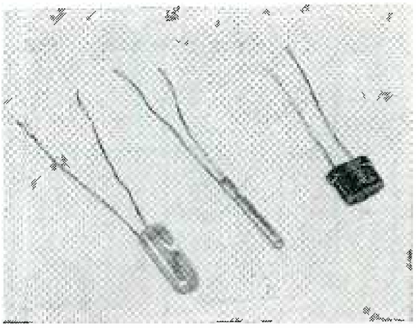
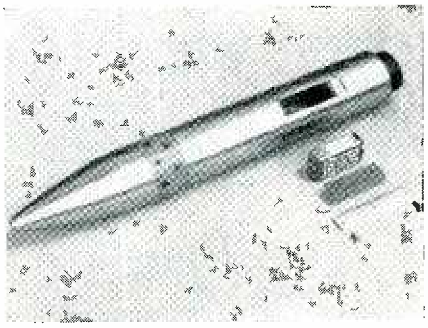


Hearing-aid battery powers encapsulated telemeter unit



Photoconductive devices. One at far left was selected



Hole in case admits light to photocell. Plastic section isolates nose-cap antenna

Transistors Telemeter Small Missiles

BY CECIL M. KORTMAN

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SUMMARY —— Germanium photocell used with three-transistor f-m/f-m telemeter counts revolutions of two-inch diameter missile in flight. Other channels measure acceleration and pressure conventionally. Point-contact transistor furnishes vhf carrier

USE OF TRANSISTORS has made possible more complete instrumentation of small projectiles and rockets than heretofore. In the past practically the only information that could be obtained from a small missile was its rate of spin.

This was obtained by a spin sonde, a simple radio-frequency transmitter driving a loop antenna with the plane of the loop passing through the longitudinal axis of the missile. A receiving station located to one side of the flight path of the missile received a signal of varying intensity as the missile spun about its axis. Two maximums and two minimums occurred for each rotation.

In the system to be described, continuous monitoring of a pressure and an acceleration on two subcarrier channels made it necessary to maintain a relatively uniform radio-frequency field intensity. This required that the spin information be placed on a third subcarrier channel of an f-m/f-m system.

A 2-inch diameter test vehicle containing the complete system is shown in the photograph at the left above. The hearing-aid battery will operate the system satisfactorily for at least fifteen minutes and in some cases has run for more than two hours, with reduced power output. The plastic section isolates the nose-cap antenna.

Radio-Frequency Link

The radio-frequency link operates in the 44 to 50-mc region. The transmitter employs a 2N33 point-contact transistor with the parallel resonant circuit in the base lead, as shown in Fig. 1A. Variable capacitor C_1 permits a small frequency adjustment without appreciably affecting the output coupling. The composite subcarrier output is applied in the base circuit to frequency-modulate the carrier.

Instrumentation

Depending upon the individual transistors, output power of the order of 1 to 5 milliwatts can be obtained into a resistance load. Working into the nose-cap antenna, it is possible to transmit a usable signal for a distance of several hundred feet.

Most of the instrumentation consists of straightforward applications of telemetry and transistor practices. The pressure and acceleration pickups are standard variable reluctance types, of mini-

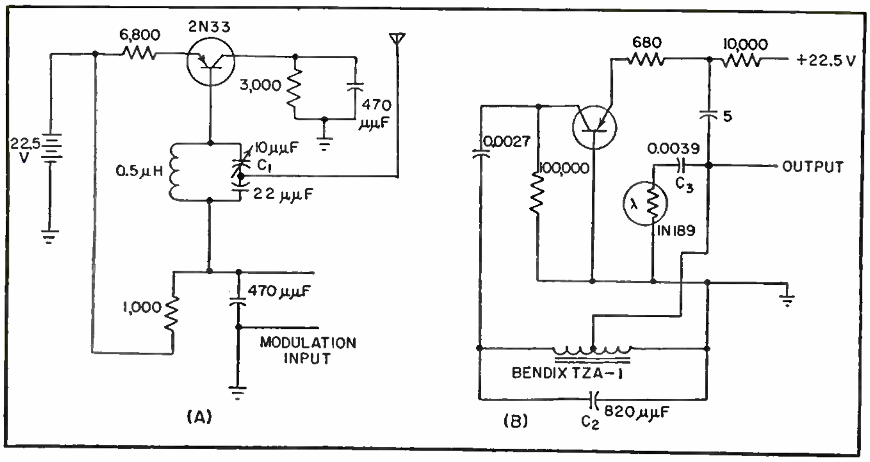

FIG. 1—Point-contact transistor r-f oscillator (A) and light-modulated subcarrier oscillator (B)

mum size and weight. The subcarrier oscillators are of the Hartley type, using junction transistors, with a variable reluctance pickup in the tuned circuit so that changes in the input stimulus are converted to changes in subcarrier frequency. Although the circuit shown in Fig. 1B is for the spin counter, it is essentially the same as those used for the other subcarrier channels.

For the pressure and acceleration measurements, the 1N189 photocell and C_3, the series capacitor, are removed from the circuit. The variable reluctance pickups are substituted for the TZA-1 coil shown in Fig. 1B. Capacitor C_2 is adjusted to give the desired frequency of oscillation.

Spin Counter

The spin-counting device presented an especially interesting problem. The requirements were for a device capable of sensing spin rates of hundreds of revolutions per second, of modulating an audio-frequency oscillator in accordance with f-m telemetry practices, ±7.5-percent bandwidth, and a device compatible with the weight, space and power-supply limitations of the small missile. These limitations eliminated mechanical devices such as angular accelerometers.

However, some of the larger missles, employing electron-tube circuits for instrumentation, have used a standard photocell to sense the variation in light intensity as it faced a light source, such as the sun, or was shielded from the light by the body of the missile. These variations occur with each rotation of the missile and may be used to determine the spin rate. Because of the size and weight limitations of the small projectile, this appeared to be the most feasible approach for the all-transistor system.

Photo Devices

The center photograph shows some of the photosensitive devices investigated. The one finally selected is at the far left and consists of a bar of germanium having leads attached to each end and encapsulated in transparent plastic. Essentially, this is a variable resistor with the instantaneous resistance dependent upon incident light intensity and temperature.

In the spin-counting application the temperature will be, at most, a uniformly varying quantity, so any cyclic variations will be entirely due to changes in light intensity. Being a resistance element, the device operates as effectively in a-c circuits as in d-c, and introduces no distortion such as might be caused by clipping in a photodiode or phototransistor.

In Fig. 1B the photocell is placed in series with a capacitor across the coil tap of the Hartley oscillator. The variation in resistance causes a frequency change in the oscillator. The series capacitor is chosen so that the difference between total darkness and bright sunlight will deviate the oscillator from the upper band limit to the lower band limit, based upon ±7.5-percent bandwidth. This method of modulation produces considerable a-m as well as f-m, but this is not objectionable in this application.

Table I—Test Data for Small-Missile Telemeter

Lighting Conditions	Subcarrier Frequency (in cps)
Dark	11,153
Deep shade	11,030
Missile shadow	10,214
Bright sun	9,800

10.5-kc band ±7.5 percent; upper band limit = 11,288 cps; lower band limit = 9,712 cps

Performance

The radio-frequency transmitter, although operating out of the regularly assigned telemetering bands, performed much like the standard transmitters except for the reduced power output. Deviations of ±30 to ±50 kc per subcarrier channel were easily obtained. With suitable receiving equipment, line-of-sight transmission was possible for distance approaching one mile. However, any obstructions in the transmission path will reduce the operating distance.

The pressure and acceleration measuring channels were completely analogous to the electron-tube circuits. In fact, the pickups were first calibrated using a standard electron-tube test fixture. Then the calibrations were checked using the transistor oscillators. Agreement was within the accuracy of measurement over the complete range of input stimulus.

Although absolute light intensity was of no concern in this application, Fig. 2A shows the sensitivity that can be obtained under one set of conditions.

Sensitivity

It is possible to adjust the sensitivity over a wide range by changing the capacitance in series with the photocell. Figure 2B shows the variations that can be obtained. To check the oscillator linearity and to provide a means of determining the effective a-c resistance of the photocell, a decade resistor was substituted for the 1N189 shown in Fig. 1B. Figure 2C is a plot of frequency against decade resistance value for three different values of series capacitance, C_3.

As the capacitance increases the frequency variation increases, as does the nonlinearity. A capacitance of 0.0051 μf appears to be a reasonable compromise between sensitivity and linearity. Returning to Fig. 2B, it is found that 0.0051 μf in series with the photoconductor gives a frequency shift from 10,250 to 9,360 cps for a change in light intensity from zero to 100 foot-candles.

From Fig. 2C, this change in frequency is found to correspond to a change in resistance from 3,300 to 2,000 ohms. In the circuit shown in Fig. 1B, it was necessary to reduce the sensitivity by reducing the series capacitance to 0.0039 μf which also made the frequency variations more linear with resistance change, as is shown by Fig. 2C.

Frequency Response

To check the frequency response of the photocell, a squirrel-cage blower wheel was used as a light chopper with a 100-watt lamp as a source. The subcarrier output frequency was fed directly to a telemetering discriminator which converted frequency changes into changes in d-c level. The output of the discriminator was monitored on a d-c oscilloscope. The chopper frequency was found to be nearly 850 cps, and the peak-to-peak output of the discriminator was roughly half the change obtained between steady conditions of light off and light on. This proved that the device was capable of responding at rates far in excess of the requirements.

To determine the effects of temperature, the photocell circuit was placed in an oven with a 100-watt lamp. The lamp power was supplied through a variable transformer so that intermediate light levels could be obtained. Figure 2D shows the variations of frequency for temperature between -10 and 52 C for three light intensities.

For the curves labeled dark and medium, the frequency remains nearly constant to around room temperature, where it begins to decrease rapidly. This may be attributed to intrinsic conduction as the thermal energy becomes sufficient to create more hole-electron pairs and thus decrease the effective resistance. However, the curve labeled bright does not exhibit this trend.

This indicates that the light energy effectively saturates the germanium so that the relatively small increase in thermal energy has little effect. For the spin-counter application, the results shown in Fig. 2D are acceptable since the frequency shift with light intensity remains large over the complete temperature range.

The trend of the curves is such that, if the circuit is adjusted to keep the frequency within band limits at room temperature, it will remain within limits over the complete range even though there is a decrease in sensitivity at the higher temperatures.

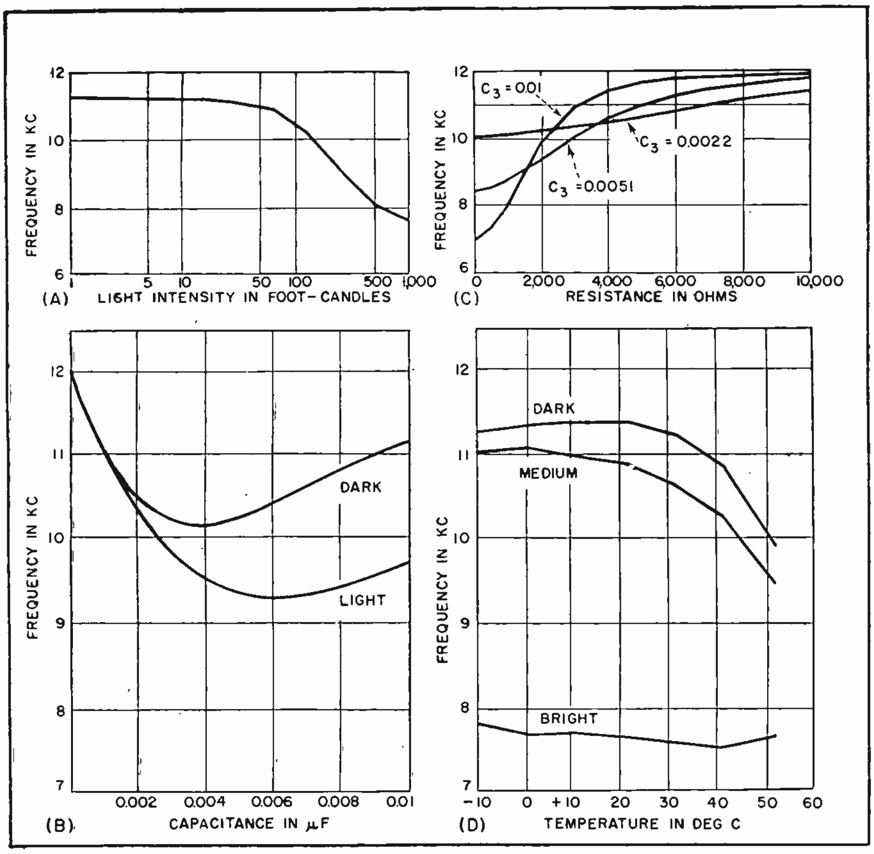

FIG. 2—Performance of subcarrier oscillator with frequency plotted against light intensity (A), capacitance in series with photocell (B), resistance of photocell (C) and temperature (D)

Operating Data

Following these tests the circuit was packaged in the 2-inch diameter test vehicle. The photocell is mounted in the small window near the center of the cylindrical metal portion of the missile shown in the third photograph. Actual firing performance data is not available on the test vehicle.

However, Table I shows the frequency variations obtained under possible operating conditions. Both the dark and bright sun frequencies lie within the ± 7.5-percent bandwidth of the 10.5-kc channel. The full bandwidth was utilized since drift or distortion of the peaks at either end would not effect the count.

The important information is that the frequency shift obtained by rotating the missile 180 degrees from having the bright sun shining directly onto the photocell is nearly 400 cps, or roughly 25 percent of bandwidth. This is more than enough information to give a clear record of each rotation of the missile in flight.

Acknowledgement is due to R. E. Colander for his contribution to the development of the entire system and to W. J. McMaster for his assistance in developing the spin counter and in building the test vehicle.

REDUCING NOISE in

Part V

SUMMARY — Transmitting information through noise can be accomplished by exchanging excess bandwidth for improved signal-to-noise ratio. Pulse-code modulation does this efficiently and permits regenerating pulses that have become distorted. Error detecting and correcting codes offer additional advantages

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PRACTICAL communications systems must prevent noise from disturbing the essential information to be transmitted. There may be considerable variation as to what is essential depending on the type of message and the needs of the user.

At one extreme, there is a luxury zone in which cost is no deterrent. At the other, there are situations in which it is difficult to provide even meager message service.

An example of the first case is the high-fidelity music system. Since the objective is personal satisfaction, not measurable in dollars and cents, low-noise components should be used and signal power should be high enough to make negligible the effect of any noise other than that inherently present in the source. To cheapen the system by allowing even a small noise defect would make the hobby frustrating rather than rewarding.

An example of the other extreme involves providing communications when the only available medium is so noisy and interference-ridden that great skill and luck are needed to get information through. Here it is imperative to strip the message to its barest essentials.

Overriding noise by high-level signal power is the straightforward luxury approach to communication over a noisy channel. If the noise level is unduly high, the cost may be prohibitive. If part of the noise is interference from other channels, the method may fail because interchannel interference is a mutual problem for all channels.

If one transmitter is operated at higher power to overcome interference, more interference is produced in the other channels. This calls for more transmitted power in the other channels and more interference in the first.

A similar argument applies in a noise situation caused by fluctuations in signal level in beyond-the-horizon transmission and by mode-transfer echoes in waveguide. Noise is proportional to signal and increase in signal power increases noise power in the same ratio.

Frequency-Modulation

A more subtle approach uses excess bandwidth to augment the signal-to-noise ratio when extra bandwidth is available. The first success of this method was with frequency modulation.[1]

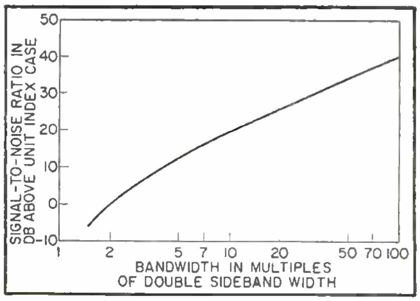

FIG. 1—Exchange of excess bandwidth for improved signal-to-noise ratio with frequency modulation

The signal magnitudes are converted at the transmitter into proportional variations in carrier frequency at constant amplitude. If these variations in frequency are large, the frequency perturbations of the carrier caused by noise become negligibly small provided the ratio of mean carrier power to mean total power in the r-f band is above a modest threshold value.

To make room for the wide frequency swing, the recommended spacing of mean carrier frequencies is 200 kc instead of the 10 kc allotted in a-m broadcasting. The ratio of rms signal to rms noise in the detected f-m output varies directly with the rms frequency swing imparted by the signal up to a point where the mean total noise power in the widened r-f band becomes comparable with the mean carrier power.

Figure 1 shows how f-m systems

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Communications Systems

exchange bandwidth for signal-to-noise ratio. The r-f bandwidth is the double sideband width plus the peak-to-peak frequency swing. The carrier power is constant and above improvement threshold for all bandwidths. Noise power is uniformly distributed throughout the r-f band. The test signal is the same throughout and the reference condition that in which frequency deviation equals baseband width.

Pulse-Code Modulation

Frequency modulation is not the most efficient way of exchanging bandwidth for signal-to-noise ratio. The ultimate bargain is reached by pulse-code modulation. Instead of direct proportionality of rms signal-to-noise ratio with bandwidth, pcm gives an exponentially increasing improvement with bandwidth.

The signal is sampled at a rate at least twice the highest frequency in the signal and the samples are quantized to the nearest of a set of discrete magnitudes. The quantized samples are transmitted by code sequences. Greatest noise tolerance is obtained with a binary code.

In transmitting binary pcm, two conditions are used which may be *plus* and *minus* or *off* and *on*. The stepped magnitudes are assigned binary numbers. If 128 steps give a sufficiently accurate representation of the signal, the levels may be represented by the 128 possible seven-digit binary numbers

0 = 0000000
1 = 0000001
2 = 0000010
3 = 0000011
4 = 0000100
. . . .
127 = 1111111

The code groups can be transmitted by c-w using carrier off to represent 0 and carrier on to represent 1. Sufficient bandwidth must be provided to transmit pulses at a rate equal to seven times the sampling rate. The bandwidth is proportional to the pulse rate.

Figure 2 illustrates the exchange of bandwidth for signal-to-noise ratio in binary pulse-code modulation. The signal-to-noise ratio is the ratio of mean power in a full-load test tone to mean quantizing noise power in the signal band. Carrier power is large enough to make transmission errors negligible.

Sampling rate is 2.5 times signal bandwidth which increases the signal-to-noise ratio 1 db over the minimum sampling rate. The reference bandwidth for one pulse a sample depends on the tolerable margins against intersymbol interference. Ideally it can be made equal to signal bandwidth but is usually more to ease transmission requirements.

In pcm, the pulses are correctly received if the carrier peaks and noise peaks can be distinguished. Ideally, the system is error-free if the carrier peaks slightly exceed twice the noise peaks. In gaussian r-f noise, the noise peaks cannot be precisely defined but an upper limit of about four times the rms value is exceeded so rarely as to make consideration of higher peaks unnecessary.

By operating the pcm system at a sufficient carrier power level above noise to make errors in recognition rare, the pulses can be decoded to represent exactly the original quantized signal levels. The only noise present is quantizing noise caused by differences between the sampled magnitudes and the discrete representations.

Pulse Regeneration

Pulse-code modulation has the advantage that the pulses can be regenerated in both magnitude and time. A pulse train which has been distorted by noise and interference can be examined at equally spaced intervals and a determination made as to whether or not a pulse is present. If the answer is *yes*, a clean properly timed pulse can be sent on to the next repeater; if the answer is *no*, a clean blank can be sent.

Figure 3 shows input and output of a regenerative pulse repeater. The code sequence is 100111. The input is accompanied by interference and distortion. Nonsynchronous interference produces the blurred trace. There is a phase reversal between input and output while the small ripple visible in the output is a result of the timing wave.

Because of pulse regeneration there can be no accumulation of error in a chain of repeaters provided the effects of noise, distortion and interference in any one link are sufficiently small to prevent a pulse

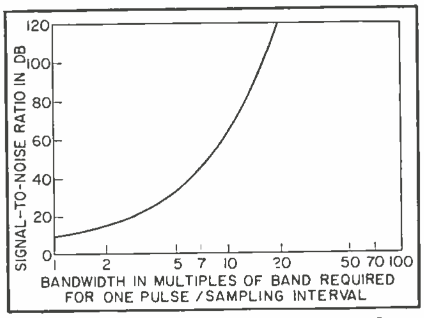

FIG. 2—Pulse-code modulation provides exponential signal-to-noise improvement with bandwidth

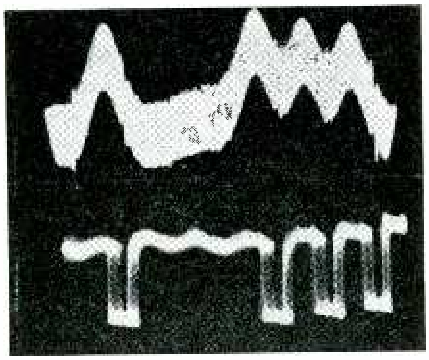
FIG. 3—Pulse-code modulation sequence before (above) and after (below) regeneration

from being mistaken for a space. An important feature is that this exploitation of bandwidth for noise suppression does not imply high-fidelity low-noise bandwidth, but only bandwidth of moderate quality to enable on-off pulses to be recognized accurately.

Repeater Circuit

The transistorized regenerative repeater depicted in Fig. 4 has been used to obtain the results shown in Fig. 3.[2] The second stage is a blocking oscillator that delivers an output pulse when the sum of the input signal and timing waves exceeds threshold.

The timing wave is derived by shock exciting a parallel resonant circuit with the output pulse train. A clamping diode establishes the positive peak of the timing wave. A small part of the pulse output is fed back to the input to cancel stretching of input pulses caused by inadequate low-frequency response of the transformers.

With the noncritical input equalizing network shown, this repeater operated successfully at 672 kc over 2.3 miles of No. 19 Awg paper-insulated cable pair.

Frequency-modulation, pcm and related schemes such as pulse-position modulation, pulse-duration modulation and pulse-frequency modulation are of the improvement-threshold type. A minimum ratio of signal power to noise power is required in the transmission medium to obtain noise suppression. The improvement threshold reaches its most lenient value in binary pcm where the theoretical requirement is only a factor of two between carrier and noise peaks.

Table I—Code for Single-Error Correcting and Double-Error Detecting

Decimal Number	Position in Sequence 1	2	3	4	5	6	7	8
0	0	0	0	0	0	0	0	0
1	1	1	0	1	0	0	1	0
2	0	1	0	1	0	1	0	1
3	1	0	0	0	0	1	1	1
4	1	0	0	1	1	0	0	1
5	0	1	0	0	1	0	1	1
6	1	1	0	0	1	1	0	0
7	0	0	0	1	1	1	1	0
8	1	1	1	0	0	0	0	1
9	0	0	1	1	0	0	1	1
10	1	0	1	1	0	1	0	0
11	0	1	1	0	0	1	1	0
12	0	1	1	1	1	0	0	0
13	1	0	1	0	1	0	1	0
14	0	0	1	0	1	1	0	1
15	1	1	1	1	1	1	1	1

If instead of c-w, a video pulse transmission system is used, the binary values can be sent as positive and negative pulses, the detector becomes a polarity indicator and the threshold is reduced to equal signal and noise peaks. In practice, an additional margin should be allowed for variation.

In improvement-threshold systems, when the noise breaks through the threshold barrier the system favors the strongest component and is indifferent to whether it is signal or noise. If the strongest component is noise, the suppression works in reverse and pure noise is registered in the output.

Filtering and Repetition

There exist systems for reliable transmission at small ratios of signal-to-noise power. The key to success is a decrease in the signaling rate to give time to make decisions which discriminate between signal and noise.

An example applicable to noise uniformly distributed over the frequency range is the use of narrow-band filters. This cuts down the amount of noise power accepted by the receiver. The signal power is concentrated in the narrow band to obtain a margin over noise.

Since the narrow-band system can not follow rapid changes in waveform, the signaling rate must be reduced. Practical limitations are: the cost of highly selective filters, the stability requirements imposed on carrier oscillators and the transmission delay.

Radar operation with a low signal-to-noise ratio is related to the narrow-band filter technique. The repeated pulse pattern reflected from an object stands out through the nonrecurrent grass produced by noise. Repetition is a form of integration and integration is a form of low-pass filtering.[3] The poorer the signal-to-noise ratio, the more repetitions are required.

Controlled Redundancy

A systematic approach based on controlled redundancy is offered by error-detecting and error-correcting codes. As an example, consider the 2-out-of-5 code in which the code groups are sequences of five intervals in which only two pulses are sent.

The ten allowed sequences are 11000, 10100, 10010, 10001, 01100, 01010, 01001, 00110, 00101, 00011. If choice were not restricted there would be 32 sequences available. Also, it would be possible to obtain 16 sequences from four intervals. This cuts the signaling rate to less than $\frac{4}{5}$.

If more or less than two pulses are received in a five-interval frame, it is known that there must have been at least one error. Occurrence of two errors in a frame may not be detected, for if one pulse is changed to a space and one space to a pulse, the 2-out-of-5 condition remains. Single error detection is most effective when the probability of error in one pulse is small. The probability of two errors in a frame becomes approximately the square of a small quantity and may be negligible.

To correct single errors in a frame it is necessary to restrict the meaningful sequences to a set differing individually in at least three places. If the minimum number of differences is increased to four, double-error detection as well as single-error correction is possible. The total number of meaningful sequences out of a given number of pulse intervals shrinks rapidly as higher numbers of errors are detected and corrected.

It is not possible to detect a number of errors up to and including the number of pulse intervals, for this would yield only one allowed sequence.

Parity Checks

Table I illustrates a coding plan in which 16 meaningful sequences are obtained from the 256 possible sequences in eight intervals.[4] If the correcting and detecting features were not used, the same information could be sent in four intervals, so the penalty is halving the transmission rate.

Columns 3, 5, 6 and 7 give the message pulse values and represent, in binary notation, the numbers 0, 1, 2, . . . 15. Columns 1, 2 and 4 are check-pulse values for single-error correction. Column eight gives check-pulse values for double-error detection. The checking is done on a parity basis in selected subgroups.

The parity of a set of 1's and 0's is determined by counting the 1's. If the number of 1's is even or zero, the parity is even. Each check value is chosen to make the parity of its subgroup even.

At the receiver, four parity checks are made: pulses 1, 3, 5 and 7; pulses 2, 3, 6 and 7; pulses 4, 5, 6 and 7; pulses 1, 2, 3, 4, 5, 6, 7 and 8. If a parity check gives an even number or zero, the result is 0. If an odd number is obtained, the result is 1. If no errors are made, all four checks give 0.

If a single error is made, the fourth parity check gives 1 and the results of the first three checks in the order 3, 2, 1 form a binary number indicating which position is in error. If this number is 000, the error is in position 8. The offending value may then be corrected by changing 1 into 0 or 0 into 1.

If two errors are made, the result of check 4 is 0 and at least one of the other checks gives 1. The location of the errors cannot be found.

Information Theory

Error correction and detection reduce the probability of error from noise but cannot guarantee freedom from error. Operations which take account of statistical differences between the possible message sequences and the noise can under ideal conditions assure errorless transmission through noise up to a maximum signaling rate which is a property of the system.

The fundamental theorem is[5]

$$C = W \log [1 + (S/N)]$$

where C is the maximum number of units of information a second which can be received without error, W is the bandwidth of the system in cps, S is the average signal power and N is the average noise power. The number of units of information is the logarithm of the number of choices between possible messages. If the base of the logarithm is two, the unit is called the bit. When the logarithm is taken to the base 10, the unit is called the hartley.[6] When natural logarithms are used, the unit has been called the nit.

Bandwidth W is that of an ideal filter—a linear filter with no loss in a band of width W, infinite loss at all other frequencies and constant delay in the transmission band. The noise is assumed to be white and gaussian.

White gaussian noise has maximum interfering effect for a given mean noise power. Hence, if the noise is nongaussian, the maximum possible rate of errorless transmission of information is at least as great as given by the formula and is in general greater.

The information rate is the product of $2W$ and $\log [1 + (S/N)]^{\frac{1}{2}}$. This means that $2W$ independent samples a second can be unambiguously recognized in the output of an ideal filter of width W and the number of recognizable distinct magnitudes a sample is

$$[1 + (S/N)]^{\frac{1}{2}}$$

Application of the theorem postulates an equivalent ideal filter obtained by equalization of the amplitude-frequency curve to flat response over the band utilized and high loss outside. Also equalization of the phase-frequency curve to a straight line with effectively zero intercept. Many transmission systems do not need to meet these requirements and the theorem indicates only what their channel capacities could approach if extensive modifications were made.

A typical voice channel is designed for transmission of human speech and performs this function well when the amplitude-frequency curve is flat from 300 to 3,300 cps. The phase-frequency curve is not critical.

Ideal Transmission

Given a channel consisting of an ideal filter perturbed by white gaussian noise, the theorem assures that errorless transmission at the rate C is possible and errorless transmission at any rate greater than C is not possible. The proof does not show how the ideal rate can be obtained, but indicates a direction in which to go.

The maximum rate is approached

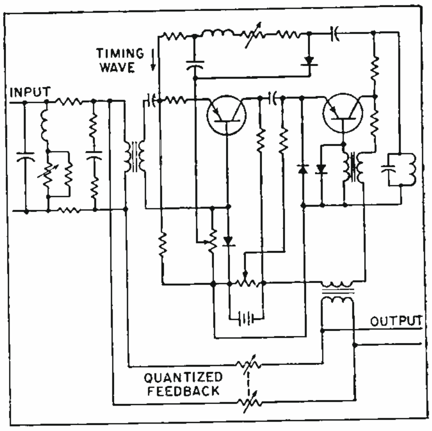

FIG. 4—Transistorized regenerative repeater produces results shown in Fig. 3

by using long messages and applying statistical treatment to the complete response of the system. Identifications of individual elements are postponed until the complete message has been received.

This implies a long delay since no part of the message can be obtained until it has all been decoded. As the ideal rate is approached the delay becomes indefinitely large. The ideal condition is approached analogously by drawing sets of code values for long messages at random from a gaussian distribution of numbers.[7]

One decoding plan is to compare the actual response of the system to the long message plus noise with the individual noise-free responses which would be obtained from each message code separately. Identification of the actual message sent is made on the basis of the best match in accordance with some criterion such as the least integrated squared difference. Since the number of possible messages increases exponentially with the message length, the complexity of the decoding apparatus does likewise.

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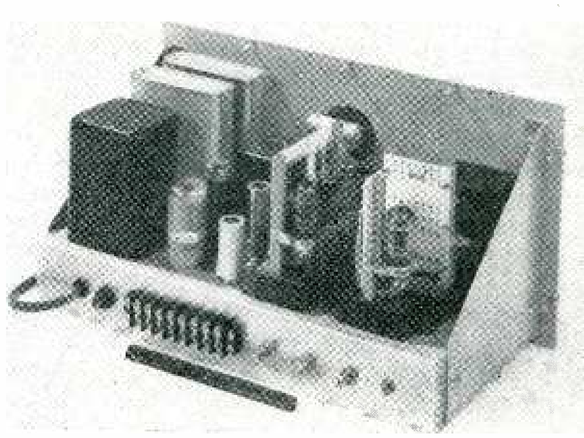
Meter indicates flutter and wow using 3,000-cps signal


Construction of wow meter makes use of plug-in units

SUMMARY — Test instrument for tape recorder transport mechanisms measures speed variations from 0.01 to 5.0 percent at rates from 1 to 450 cps. Simple system uses f-m discriminator to detect change in recorded signal

WIDE RANGE METER

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SINCE the basic function of a tape transport mechanism is to drive the magnetic tape over the head at a constant speed, it is often necessary to determine how well this basic requirement is being met.

Defective parts can be found by comparing the rhythmic pattern of the flutter or wow with the rotational speeds of the various components in the transport mechanism.

Basic System

Two basic systems are used to measure flutter and wow. Both systems utilize a sinusoidal signal which has been recorded on magnetic tape. In one system, the recorded signal is squared and differentiated to convert the sine waves into pips. These pips are used to intensity modulate an oscilloscope. Another set of pips from a precision oscillator supplies timing reference markers to the horizontal plates of the oscilloscope. The instantaneous time difference betwen the reproduced and the reference pips is proportional to flutter and wow. The scope face is photographed to provide a permanent record. This system is complex and expensive, but provides measurements over a wide range of flutter rates.

Another system is based on the fact that the instantaneous frequency of the reproduced signal is proportional to the instantaneous tape speed. The reproduced signal from the tape is applied to a f-m discriminator which provides an output voltage proportional to the flutter and wow. This output drives a meter which directly indicates the percent flutter and wow. In addition the output from the discriminator can be sent to a pen recorder for a permanent record.

This sytem is simple and inexpensive, but small flutter amplitudes usually can not be measured over a wide range of flutter rates; it is satisfactory where extreme precision is not required. This article describes a simple instrument which utilizes the second system. The instrument is capable of detecting flutter and wow from 0.01 to 5.0 percent at rates from 1 to 450 cps.

Circuit

Figure 1 shows an overall schematic of the flutter and wow meter.

The 3-kc band-pass filter prevents the meter from responding to harmonics of the recorded signal and tape noise. This filter is of the constant-k type with 1-kc and 6-kc signals being attenuated more than 55 db.

A limiter prevents erroneous meter readings caused by amplitude variations in the recorded signals. These variations are mainly caused by defects in the magnetic tape rather than in the transport mechanism. The limiter allows only a 1-db change in output amplitude for a 35-db change in input amplitude. Waveform remains symmetrical over this range.

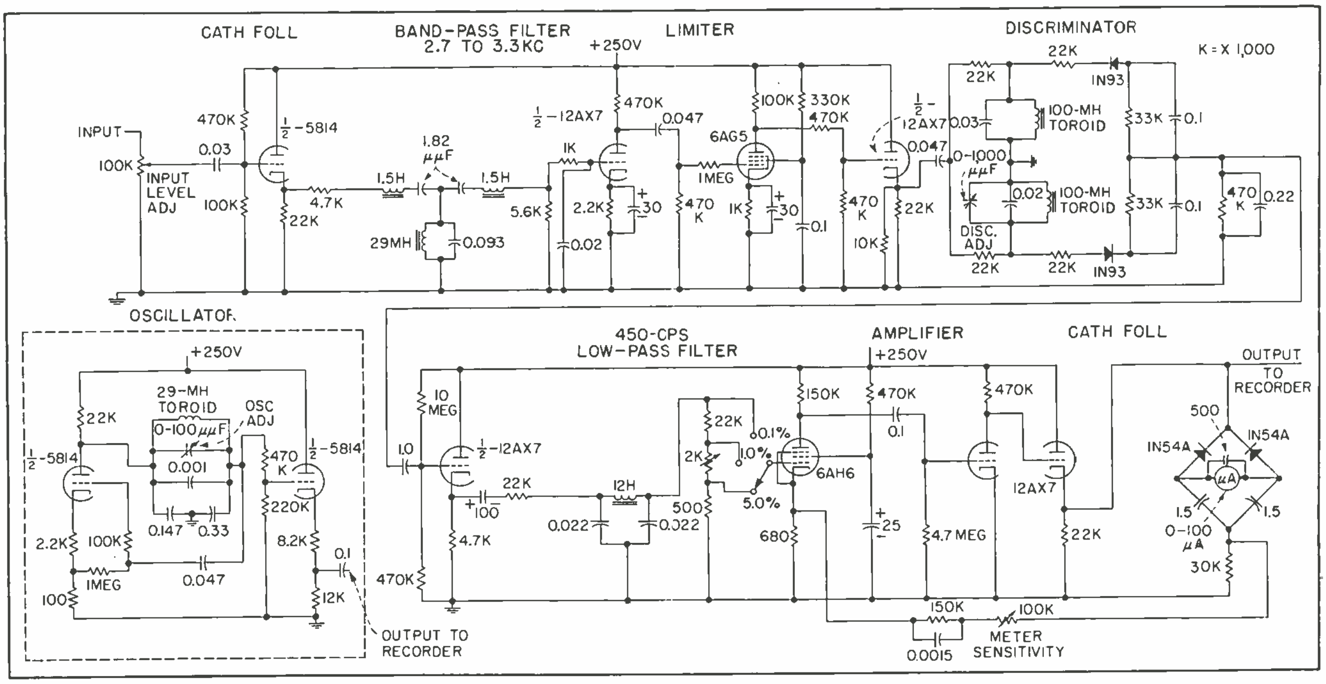

FIG. 1—Flutter and wow meter uses dual-tank discriminator with tanks tuned 300-cps on either side of 3,000-cps center frequency

Measures Flutter and Wow

The discriminator used detects flutter and wow over a 500-to-1 range from 0.01 percent to 5.0 percent. The circuit is essentially a dual tank in which each tank is tuned approximately 300 cps off the center frequency of 3,000 cps. The components were arranged so that heat would not cause the discriminator to drift. The output characteristic, shown in Fig. 2, can be observed directly on an oscilloscope, a pen recorder or used to activate a direct-current meter.

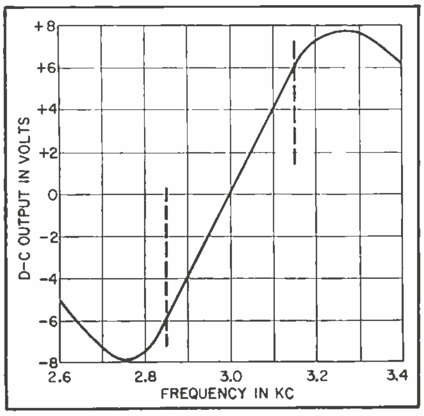

FIG. 2—Characteristic of dual-tank discriminator

A low-pass filter between the discriminator and meter amplifier prevents erroneous meter readings by the residual 3-kc signal and noise produced by the discriminator diodes. This filter is a single-section low-pass filter of the constant-k type with high-frequency cutoff at 450 cps. The 3-kc signal is attenuated over 50 db. If desired, the low-pass filter can be replaced with narrow band-pass filters to obtain a spectrum analysis of the flutter and wow.

Meter Circuit

Scale switching is accomplished by a calibrated voltage divider in the grid circuit of the meter amplifier. The high-gain meter amplifier is direct-coupled to a cathode follower which drives the meter.

Diodes in the meter circuit should have a linear voltage-current characteristic in the vicinity of the origin so that the meter deflection will be linear over a wide dynamic range. Three types of diodes, 1N54A, 1N137 and 1N-138 proved satisfactory in this circuit. Overall feedback is used to insure linearity. Feedback is increased in the high-frequency region to reduce the effects of pickup of the 3-kc oscillator signal in the meter circuit.

Test Oscillator

The test signal to the recorder is supplied by a 3,000-cps oscillator. An ordinary variable R-C oscillator does not have sufficient stability, especially if it is supplied from an unregulated power source. Any variation of the test oscillator frequency at a rate between 1 and 450 cps is sufficient to cause false meter readings.

The oscillator is a Colpitts type operated class A. Long-term stability of the signal is about 0.3 cps and warm-up time is less than five minutes.

A regulated power supply is used as the power source. This adds to the stability of the oscillator circuit and the meter amplifier gain.

Four-Place Timer Codes

SUMMARY —— Timing generator creates pattern that indicates time on oscillograph record in increments of 0.001 from 0 to 9.999 seconds before repeating itself. Coding produces tenth, hundredth and thousandth-second markers on single trace

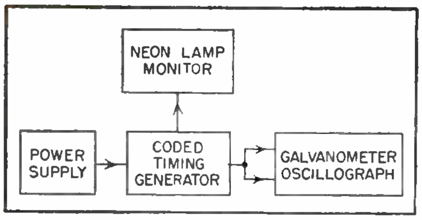

FIG. 1—Principle units of timing system

TIMING INFORMATION can be introduced into an oscillograph record by one or more timing traces containing pips or markers onto which the timing information is coded. However, if the timing display utilizes too many traces, or if assessment of the data contained in the timing traces is made difficult by tedious measurements or lengthy counting of markers, the value of the data is reduced.

The two timing traces derived from the timing generator described in this article create a pattern which indicates time directly down to 0.001 second. With the simple method of calibration recommended, the pattern reads from zero to 9.999 seconds before repeating itself, with a maximum of ten markers to be counted for each data point.

The complete system is portrayed in Fig. 1. The timing generator drives two type 7-216 galvanometers in a Consolidated oscillograph. A monitoring neon lamp, which flashes at a rate of one flash per second, provides remote indication that the system is on and in operation.

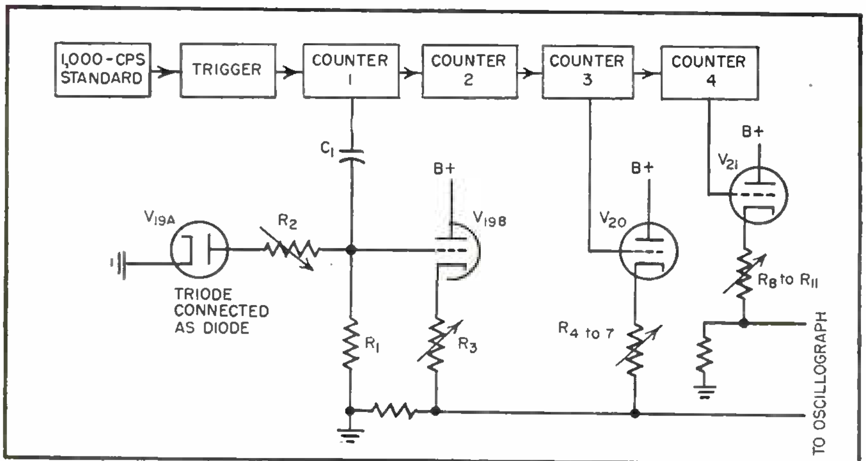

FIG. 2—Simplified diagram of timing generator; component designations correspond with complete circuit diagram, Fig. 3

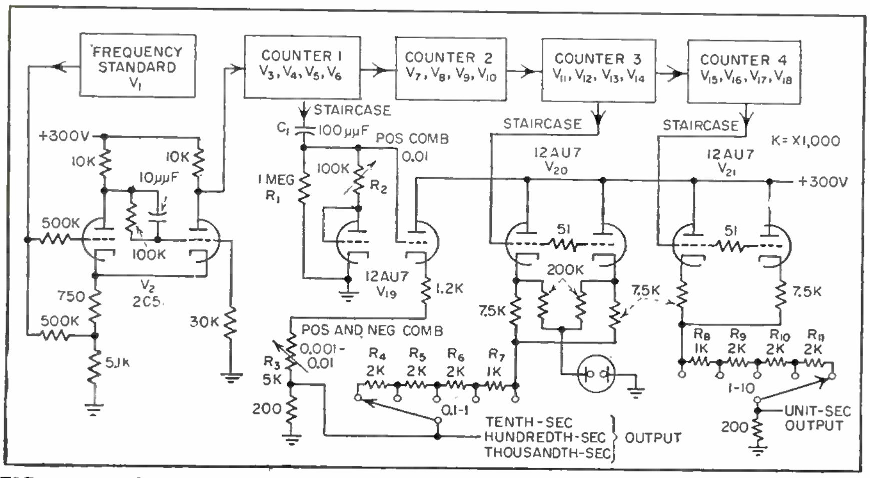

FIG. 3—Complete circuit of timing generator. Frequency standard and decade counters, represented by blocks, are commercially available plug-in units

Timing Generator Unit

A block diagram of the timing generator is given in Fig. 2 and the complete schematic in Fig. 3. The design is centered around commercially available plug-in type units.

The 1,000-cps frequency standard feeds through a trigger circuit into a chain of four decade counter units, which have staircase outputs in addition to their normal output circuits. These staircase outputs are differentiated and limited as required, fed through cathode followers, attenuated, combined and fed into the oscillograph to form the time pattern.

The frequency standard, an American Time Products type 2007W, is a dual-triode, inductively coupled, temperature-compensated tuning-fork oscillator which de-

Oscillograph Recordings

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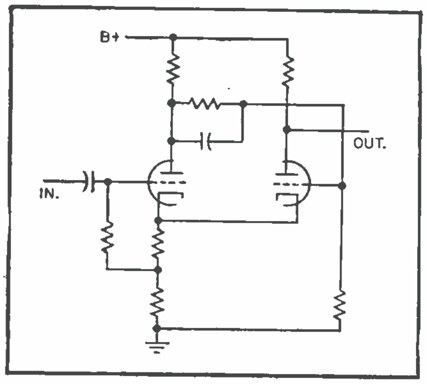
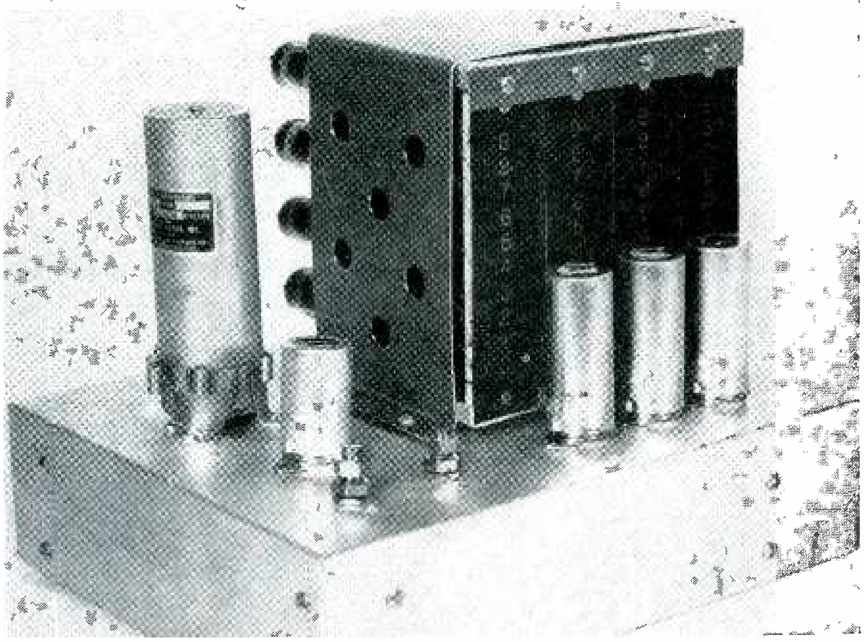


FIG. 4—Schmitt-type trigger used in timing generator



Timing generator uses commercial plug-in counters and frequency standard

livers approximately five volts at 1,000 cps into a 200,000-ohm load. The unit has an accuracy of 0.001 percent. It is furnished as a complete entity with an octal plug for making the necessary connections of power input and signal output.

The trigger, or signal shaper, diagrammed in Fig. 4, is very similar to a Schmitt trigger except that bias for both grids is obtained from conduction through the cathode resistors. It generates rectangular waves with steep, negative-going trailing edges, the type of signal best suited to drive the decade counter, a Hewlett-Packard type AC-4A.

Staircase Waveform

This counter has the advantage of a staircase output. The circuit is represented symbolically in Fig. 5A; neon lamps and their resistor matrix are omitted from this diagram. The staircase-forming resistors, R_A, R_B, R_C and R_D, are connected to points A, B, C and D, each of which is a plate of its flip-flop not being used to drive the succeeding flip-flop.

Figure 5B shows idealized wave forms of the voltages at A, B, C and D of Fig. 5A. These voltages are summed through resistors R_A, R_B, R_C and R_D, which are proportioned to produce the staircase output shown in Fig. 5C. The staircase signal can be differentiated into the comb-like timing signal shown in Fig. 5D.

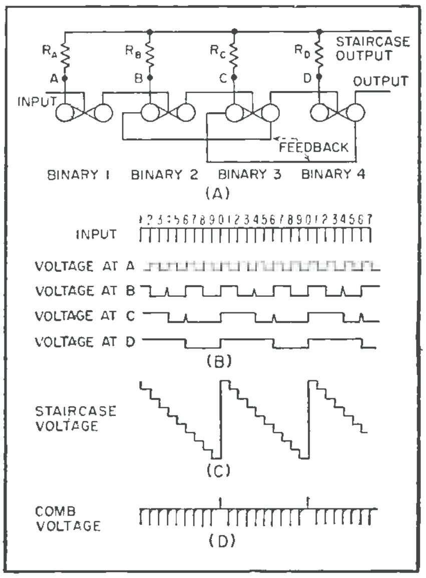


FIG. 5—Basic configuration of counter decade with staircase output (A) and waveforms (B, C and D)

Comb Signal

Referring to Fig. 2, the staircase output of the first counter is differentiated by capacitor C_1 and resistor R_1 to form the comb signal of Fig. 5D. The positive pulses of Fig. 5D are limited by potentiometer R_2 and V_{19A}. The diode conducts through R_2 only on the positive portions of the differentiated signal. Cathode follower V_{19B} serves as driving amplifier for the comb signal.

In the comb, the negative pulses are the 1,000-cps indications and the positive pulses are the 100-cps indications. Potentiometer R_3 serves as amplitude control of the comb signal.

The staircase output of the second counter is not used. The staircase-voltage output of the third counter is amplified by cathode follower V_{20}, controlled in amplitude by switched resistors $R_{4 \text{ to } 7}$, and mixed with the comb signal to provide indications of tenth-seconds, hundredth-seconds and thousandth-

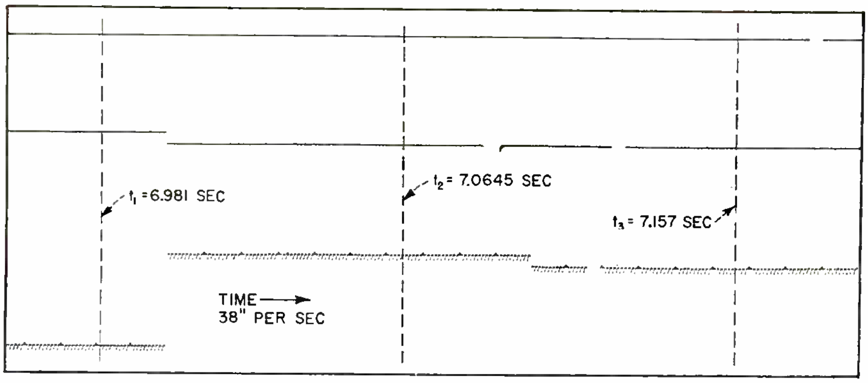


FIG. 6—Section of oscillograph record taken during test

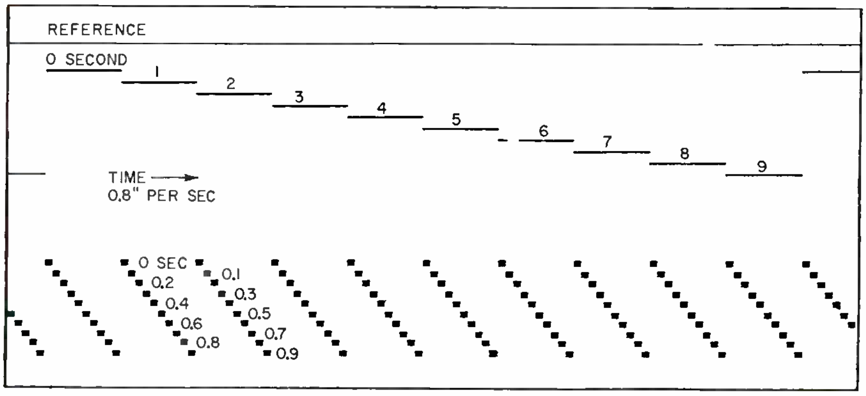


FIG. 7—Section of oscillogaph record taken during calibration run of test

seconds, all recorded on the same trace of the oscillograph. The staircase output of the fourth counter is amplified by cathode follower V_{21}, controlled by switched resistors $R_{8 \text{ to } 11}$ and fed into another galvonometer element on the oscillograph, giving indications of unit-seconds in ten-second groups.

Oscillograph Record

Prints of sections of the oscillograph record, taken during a test run of the timing system, are shown in Fig. 6 and 7. All identifying markers have been deleted from the record except for a single reference trace and the occasional blanks which serve as trace identifiers. The speed of the film in Fig. 6 is approximately 38 ips, which is close to the expected operating speed of the oscillograph. In Fig. 7, the speed has been reduced to about 0.8 ips. This is too slow to be of practical value in recording of data, but serves to illustrate the maximum timing pattern of the system of 10 seconds and is valuable for calibration purposes.

In Fig. 6, the thousandth-second indications are the negative pips appearing in groups of nine, each in comb-like fashion. The hundredth-second indications are the positive pips interspersed among the thousandth - second combs. Tenths of seconds are represented by the steps in the staircase upon which the pips are superimposed. Unit-seconds are represented by the steps in the staircase of the other trace. Portions of three tenth-second and two unit-second steps are shown.

The time scale is so reduced in Fig. 7 that the thousandth-second and hundredth-second pips are run together and are therefore unreadable. However, this view is well adapted to the calibration procedures because complete staircases of tenth-second and unit-second steps are available.

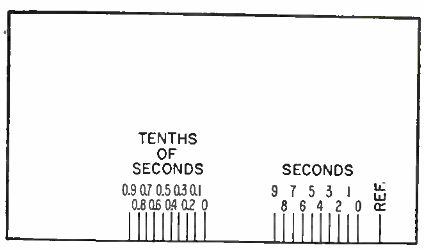


FIG. 8—Card used for calibration

For calibration in any test and subsequent reading of time it is desirable to run at least 20 seconds of film in the oscillograph with the timing generator on and with very slow film speed, as was done for Fig. 7. This makes certain that, when an assessment is started, there will be at least one full staircase of unit-second steps.

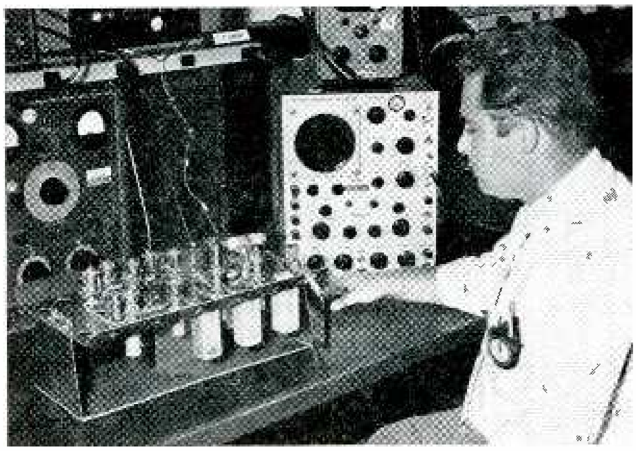
Calibration

To calibrate, a 3 by 5 inch card is held so that one of its long edges bridges the two timing traces and the reference line on the slow oscillograph record. The point on the edge where reference line crosses is marked. The card is then slid along the film, keeping the reference mark of the card on the reference trace; the points of crossing of the zero-second step, the one-second step, the two-second step and so on through the nine-second step are marked. The same is done with the tenth-second steps, marking the card as shown in Fig. 8. It is not necessary to number individual steps on the film. This was done in Fig. 7 for clarity.

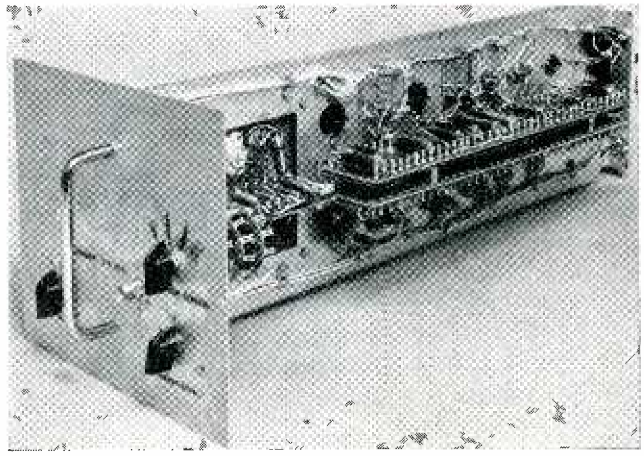
Example

To illustrate the use of the calibrating card, three arbitrary times are marked on Fig. 6. These times are indicated by the dash lines and the letters t_1, t_2 and t_3. In determining t_2, for example, the marked edge of the calibrating card was held on the dash line of t_2 so the reference mark on the card coincided with the reference trace at the crossing of the dash line. The units trace indicated 7 and the tenths trace indicated 0. Hundredth-second pips were counted and indicated 6 from the last step of the tenth-second staircase. Thousandth-second pips were counted in the comb with an indication of 4 pips and half a space. This made the number 7.0645, as shown in Fig. 6. Times t_1 and t_3 were found in similar fashion.

These time numbers are relative. There is no absolute zero time in this timing system. What is determined is time difference obtained by subtraction of two indicated values. Where time differences cross from one unit-second staircase into the next, 10 seconds must be added to the second reading.



Experimental frequency shifter and demodulator undergoing test



Final design for rack mounting uses terminal board construction

Telemetering Demodulator for Wide-Band F-M Data

SUMMARY —— Translating wide-band f-m subcarrier to lower frequency permits recording modulating signal at lower tape speed. Demodulator converts f-m to pfm for pulse averaging recovery of signal

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In the design of a telemetry system, demodulation of 12 video range (1.0-4.0 mc) f-m subcarrier oscillators characterized by 60-kc deviation at 20 cps to 20 kc intelligence rates was required. In addition, magnetic-tape recording of the f-m signal before demodulation was desirable to minimize amplitude errors encountered in direct amplitude magnetic recording. Further study indicated that to keep the recorder tape speed and response requirements from becoming excessive, frequency translation of the subcarrier would be necessary.

The video subcarriers are translated, by selection of the proper beat-frequency oscillator, to 150 kc with ±60 kc deviation, at rates up to 20 kc.

The problem of demodulating the wide-band f-m wave of 150 kc ±60 kc deviation is successfully solved by converting the f-m to pulse-frequency modulation in which a narrow pulse, compared to the period, is generated for every cycle of the translated subcarrier wave. This signal is then demodulated by pulse-averaging techniques. Figure 1 is a block diagram of the system and the circuit is shown in Fig. 2.

Frequency Translator

The experimental circuit was designed to process a typical subcarrier channel of 1.0-mc center frequency. The modulated subcarrier is fed to the control grid of the 6AS6 mixer V_2. The output of the 1,150-kc beat-frequency oscillator V_3 is fed to the mixer suppressor grid. When F_c is 1.0 mc and F_{BFO} is 1,150 kc, the translated frequency F_T is 150 kc.

The minimum value of F_T is determined by the number of lower sidebands generated in the modulation process. The equation for

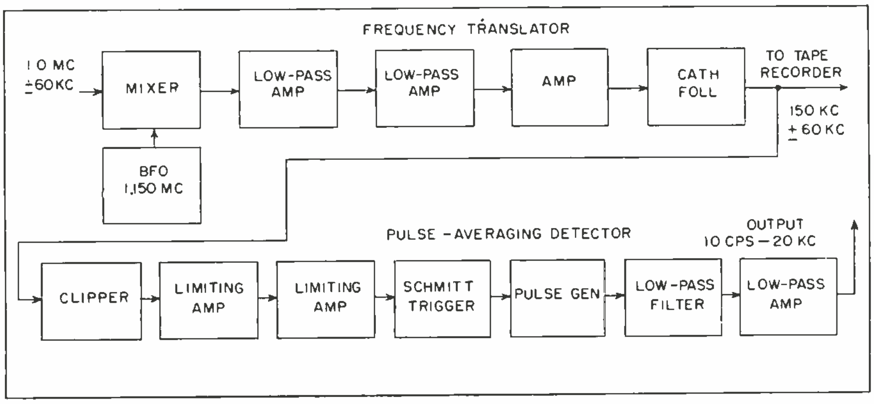


FIG. 1—Subcarrier translator and demodulator for tape recording of telemetered data

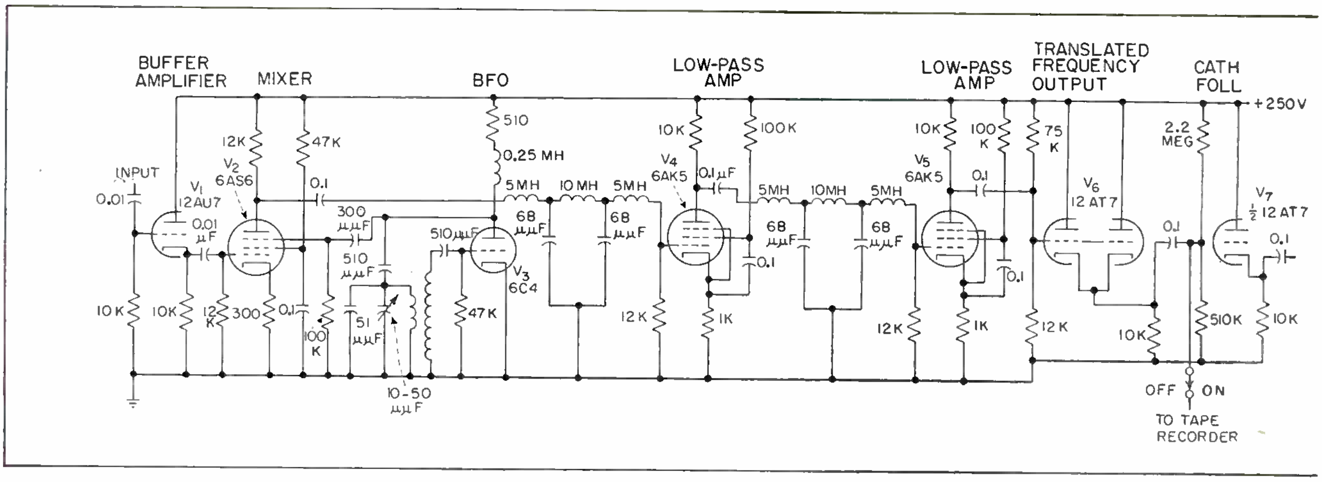


FIG. 2—Frequency-shifter provides undistorted modulation signal on lower frequency carrier for tape recording. Pulse averaging

an f-m wave is

$$e = A \sin (\omega T + M_F \sin \omega st) \quad (1)$$

where:

A = carrier-wave amplitude
ω = carrier angular velocity
F_{dev} = frequency deviation
F_{mod} = modulation frequency
M_F = F_{dev}/F_{mod}
T = time
ωs = $2\pi F_{mod}$

A trigometric expansion of the right hand side of Eq. 1 will yield an expression which contains the sideband frequency components and amplitude relations in terms of the Bessel functions. The significant sideband components for a given modulation index may be found from a table of Bessel functions.

An approximate relation of the minimum value of F_T determined by experimental data is

$$F_{T min} = (F_{dev} + 2F_{mod}) \quad (2)$$

for $F_{dev} = 60$ kc and $F_{mod} = 20$ kc, $F_{T min}$ will be 100 kc.

The instantaneous value of F_T is

$$F_T = F_T \pm (F_{dev} + 2\, F_{mod}) \quad (3)$$

If the value of $F_{T min}$ is not maintained according to Eq. 2 severe distortion will result because the lower sidebands will not be transmitted with phase and amplitude fidelity.

Tubes V_4 and V_5 are low-pass selective amplifier stages designed to pass only the different frequency components of the F_c and bfo signals. The response limits of the filter may approximately be determined by Eq. 3. For example when:

F_T = 150 kc
F_{dev} = ± 60 kc
F_{mod} = 20 kc
F_T lower = 150 − [60 + 2(20)] = 50 kc
F_T upper = 150 + [60 + 2(20)] = 250 kc.

Figure 3 is a response curve of the selective amplifier stages. This curve includes the amplifier and the low-pass filter characteristics. Figure 4 is an oscillogram taken at various stages of the translation process. The output of cathode follower V_6 is 15v peak-to-peak.

Pulse Frequency Demodulator

The extremely wide-band f-m output of the frequency translator presents demodulation problems. Tuned-circuit discriminator techniques were not considered feasible due to difficulties in obtaining linear operation over the wide deviation percentages employed. The percent deviation is

$$\text{Percent dev} = \frac{F_{dev}}{F_T}(100) = \frac{60 \text{ kc}}{150 \text{ kc}}$$

$$(100) = \pm 40 \text{ percent} \quad (4)$$

The demodulation is accomplished by converting the translated f-m wave to pulse frequency modulation. This process is indicated by the oscillograms in Fig. 5.

A 1.0-microsecond pulse of fixed duration and amplitude is generated for every cycle of the translated f-m wave. Hence, the intelligence information is contained in the instantaneous pulse frequency.

In the circuit diagram, Fig. 2, the translated f-m wave F_T is directed to the cathode-follower driver tube V_7. Each cycle of the wave is symmetrically clipped by the resistor and biased diode networks. The input to the amplifier stages is a symmetrically clipped wave of 3v peak-to-peak amplitude. The rise time of this signal is related to the frequency and amplitude of F_T.

These rise-time variations are a source of standard-pulse jitter and therefore must be minimized by additional limiting which is provided by V_8 and V_9. Each of these stages symmetrically amplify and limit the clipped signal so that the output of V_9 is a square wave of 100 v peak-to-peak amplitude and 0.2 microsecond rise time. This signal is used to drive V_{10} which is a Schmitt-trigger type square-wave generator circuit.

The output of the Schmitt trigger is differentiated by C_1 and R_1. The negative spike of the differentiated wave is shunted to ground by the 1N38 diode.

The remaining signal is a +10 v spike of 0.02-microsecond rise time which is sufficient to trigger the standard-pulse generator.

The standard pulse is generated by a cathode-coupled one-shot multivibrator, V_{11}. The output of this stage is a 1.0-microsecond pulse of fixed duration and constant amplitude of +40 volts. The 10-to-90 percent rise time of this pulse is less than 0.10 microsecond. Due to the large deviations employed, the standard-pulse duration t_0 must be less than half the period of the highest frequency encountered to

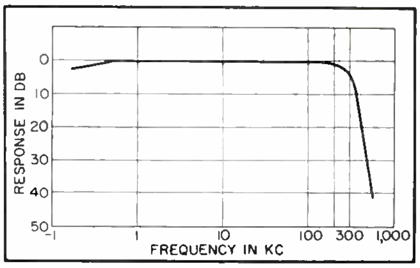
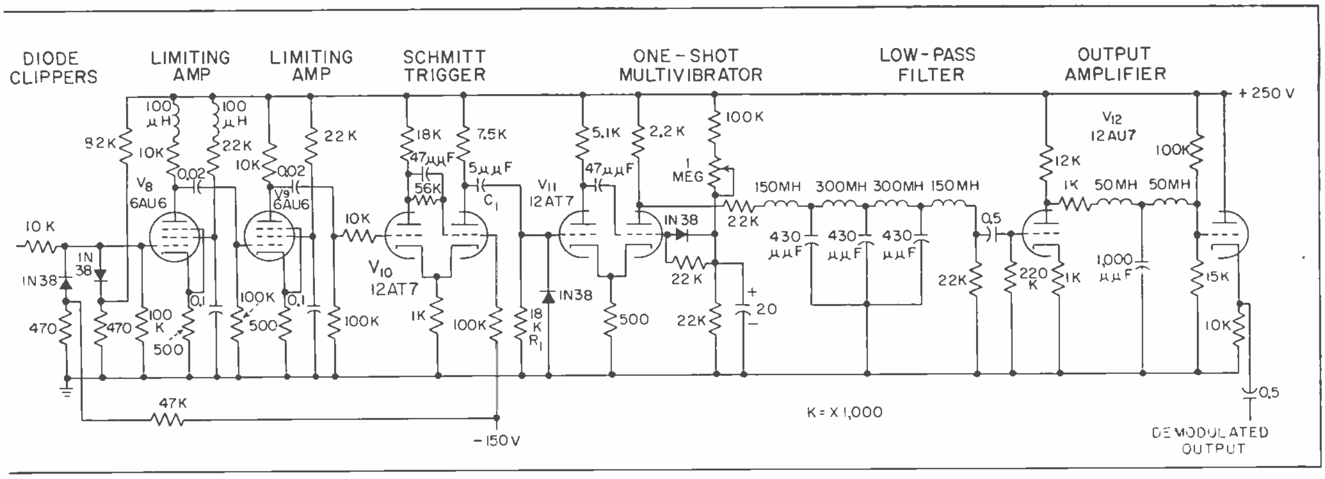


FIG. 3—Response of selective amplifier stage with low-pass filter



method is used in demodulator to give output signal from 10 cps to 20 kc for frequency-modulated tape recording

allow sufficient recovery time. Hence,

$$T_{max} = \tfrac{1}{2} F_t$$

$$T_{max} = \frac{1}{2(250\times10^3)} = 2.0\times10^{-6}\text{ sec} \quad (5)$$

Experimental data indicated that a 1.0-microsecond pulse duration was suitable for operation of the standard-pulse generator.

Energy of Wave

The energy of the wave is proportional to the duty cycle; this relation is Energy $= t_0/_T(K)$.

Where t_0 is the pulse duration, T is the period and K is a constant. Since changes in T contain the intelligence, and $T = \frac{1}{F_t}$

$$e_{out} = \frac{t_0}{\frac{1}{F_t} \pm \frac{(1)}{(F_{dev})}}(K) \quad (6)$$

The value of K is dependent upon the pulse amplitude and the integrator characteristic.

For a given value of K the integrated voltage output is directly proportional to the value of the instantaneous pulse frequency. To demodulate the pfm wave to the original modulating signal it is necessary to integrate the pulses by means of a low-pass filter network.

Either L-C or R-C low-pass filters may be successfully employed. An L-C T-section filter as shown in Fig. 2 was used to demodulate the pfm waveform. The ripple component appearing on the demodulated signal is less than 0.5 percent. Since d-c response was not required, a-c coupled amplifier and cathode-follower stages V_{12} were added. This provided a more suitable output signal level. The overall deviation sensitivity was increased to 0.1 volt per kc.

The frequency deviation against demodulator output voltage plot is linear to better than 1-percent of the deviation bandwidth. Dynamic tests indicate the overall distortion due to processing to be less than 1 percent.

Fig. 6 is an oscillogram of the demodulator response to a 500-cps square wave and a 20-kc sine wave.

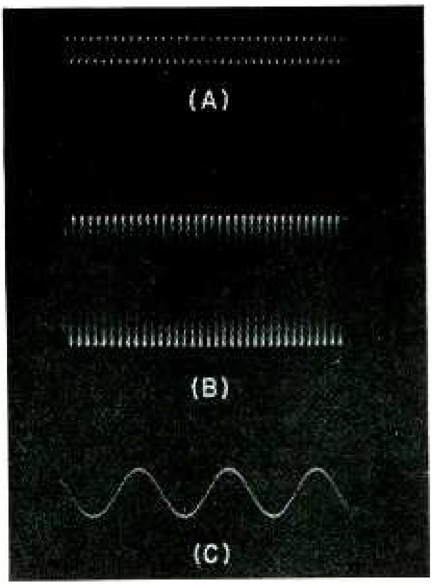


FIG. 4—Unmodulated subcarrier (A) is combined with bfo output (B) to give translator output (C) for frequency-modulation magnetic-tape recording

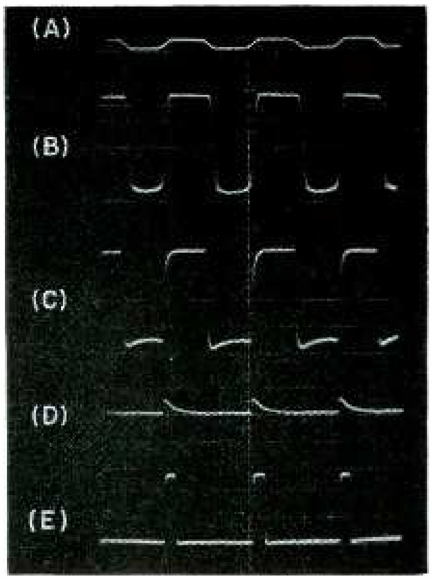


FIG. 5—Circuit waveforms at output of clipper (A), limiting amplifier (B) and trigger circuit (C). Pulse generator trigger (D) provides standard-pulse output (E)

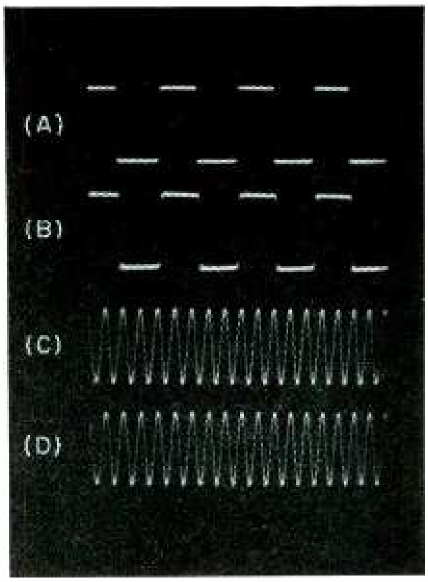


FIG. 6—Waveform of 500 cps signal before (A) and after (B) demodulation. Waveforms of 20-kc sine wave before (C) and after (D) demodulation

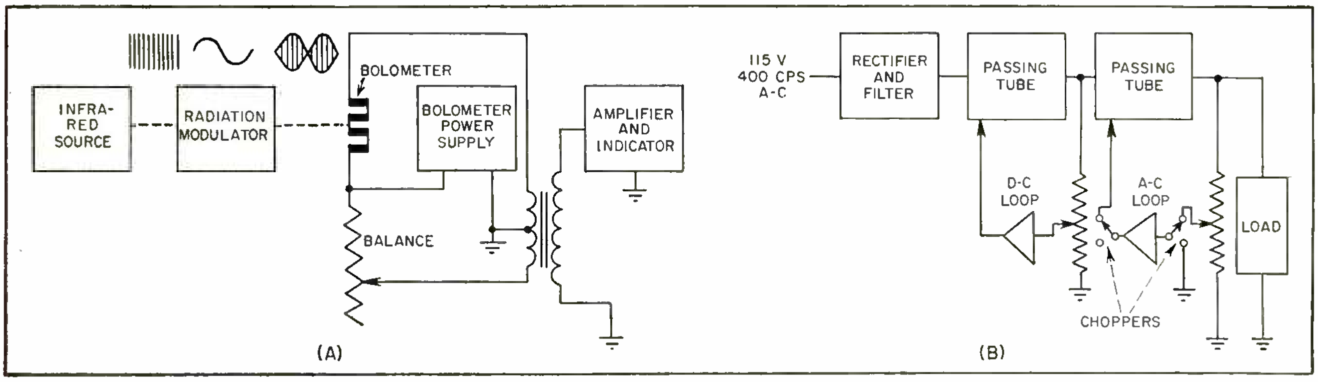


FIG. 1—Block diagram of test setup for infrared detector (A) and elements of the double-regulation power supply for bolometer (B)

Regulator Stabilizes

BOLOMETERS used for detection of infrared radiation require the application of d-c voltages that are devoid of noise and fluctuations. The power source used must also be capable of supplying high current at low voltage. These requirements generally indicate the use of a battery. For an aircraft installation where batteries are not permissible as equipment power supplies, there was developed a supply adequate for bolometer requirements.

Detector Construction

In this application, the bolometer comprises a group of blackened nickel strips, one micron in thickness with a surface area of half a square centimeter each. The strips absorb the infrared radiation, from a flame or other source, on their surfaces. The strips, connected in series, heat up, consequently change their resistance slightly and thus produce a small output voltage across a load. Since the strips are thin, their mass is small and the time required for the strips to heat is short.

Thermal lag in the bolometer heating process is small. Therefore, if the radiation varies in intensity at a rate corresponding to frequencies in the subaudio or low audio range up to 25 cycles, a usable output voltage of the same frequencies is produced. Thus the bolometer gives an electrical analog of the variation in the intensity of radiation with time. The output amplitude is in the microvolt region. The theory of infrared bolometer performance[1,2] is given in mathematical form in the literature.

A test set-up used to examine bolometer performance without use of an actual flame is shown in Fig. 1A. A source of steady infrared radiation, such as a light bulb, is placed in front of a modulator. The latter consists of a motor-driven metallic disk with notches in its periphery. When the disk rotates, infrared radiation is interrupted at a frequency dependent on the rate of motor rotation and the number of notches.

The bolometer, power supply, transformer and balancing potentiometer are connected in a bridge circuit. The voltage appearing at the secondary winding of the transformer is a replica of the intensity variation. It is amplified by a low-frequency a-c amplifier and observed on an oscilloscope.

Because of the extremely small amplitudes of the signals, a high-gain amplifier is used. Variations at subaudio and audio frequencies in the voltage source used to supply the bolometer bridge circuit are likewise amplified, especially if the bridge does not entirely cancel them. Fluctuations comparable to the desired signal may be falsely detected as such. Hum reduction and long-term voltage stability are of secondary importance. The former has little effect since the lowest hum component, the second harmonic of the supply frequency, is 800 cycles and outside the passband of the detector amplifier. Long-term voltage changes affect the sensitivity of the system only slightly. The sensitivity need not be accurately controlled for this application, since qualitative rather than quantitative results are observed.

Double Regulation

After a number of more conventional approaches failed to yield a voltage output sufficiently free from low-frequency variations, the design of Fig. 1B was evolved. As shown in Fig. 2 this uses an a-c loop as well as a d-c loop. The reference voltage of −5 volts is derived, by a stage of gas-tube regulation consisting of an 0A3 and associated components, from an ordinary −180-volt regulated power supply.

In the a-c loop, the 5,000-ohm potentiometer is connected between the output terminal and the reference voltage and it is adjusted to vary the output voltage. A type A-300 miniature 400-cycle mechanical chopper driven from 6.3 volts has its moving contact on the potentiometer arm during part of a cycle and on ground during the other part. This gives a 400-cycle carrier modulated by variations in the output voltage.

Since the chopper gives sup-

SUMMARY —— Bolometer-type infrared detectors used on aircraft give ambiguous indication at intensity variation rates up to 25 cycles unless power supply is well regulated. Chopper-derived a-c loop supplements more conventional d-c regulation in cutting variations to less than a millivolt

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INFRARED DETECTOR

pressed-carrier modulation, only the sidebands are present. The modulated signal is amplified by one section of the 12AX7 and then synchronously rectified by a second chopper. It is finally filtered, to give a grid voltage for one of the 6AS7 passing tubes, which has its two sections connected in parallel. Use of choppers for similar purposes[3,4,5] is discussed in the references.

If the extremes of the frequencies of the variations in the output voltage are denoted by F_1 and F_2, where both F_1 and F_2 are considerably below 400 cycles, the chopper converts the band F_1 to F_2 to the bands $400 - F_2$ to $400 - F_1$ and $400 + F_1$ to $400 + F_2$. The 12AX7 stage was found to generate considerable noise at the lower frequencies, F_1 to F_2.

A-C Amplifier

The amplifier in the a-c loop is designed to pass only frequencies in the neighborhood of 400 cycles and attenuate greatly any low-frequency components. The low-frequency disturbances are not amplified. Tube noises near 400 cycles are small and can cause disturbances only to the extent that they appear as sidebands by modulating the carrier. This effect is slight. Improvement in regulation of the output voltage is thus obtained in the a-c loop that could not be obtained in a d-c loop.

To supply the a-c regulating loop with a reasonably clean voltage so excessive gain is not required of it, a second loop is employed. This is a d-c loop, since here only coarse regulation is needed. A 25,000-ohm potentiometer is connected in a voltage divider used between the 6AS7 plate voltage and the −180-volt reference power supply. From the arm of the 25,000-ohm potentiometer, voltage variations are fed to a section of the 12AX7, amplified and applied to a second 6AS7 passing tube.

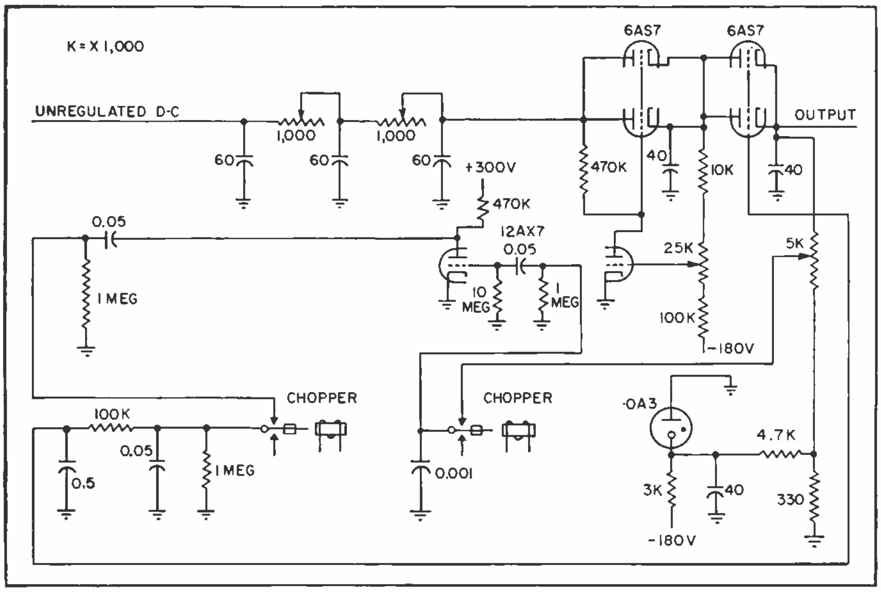

FIG. 2—Circuit diagram shows choppers used to generate and rectify a-c signal that compensates low-frequency variation

Loop Supply

The d-c loop is, in turn, supplied by a standard circuit utilizing a transformer, a 5U4 full-wave rectifier and a filter composed of two resistors and three electrolytic capacitors.

The output voltage is 3 to 6 volts with current capacity of 250 ma. Hum at 800 cps is under one millivolt rms and low-frequency variations are less than a millivolt.

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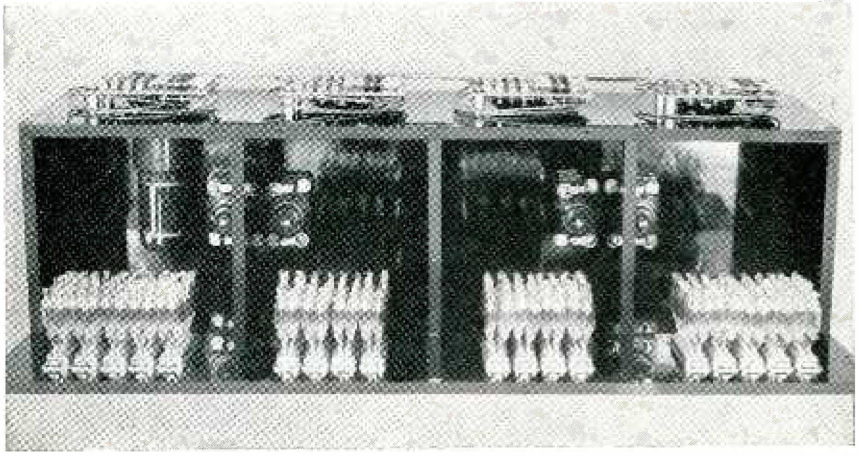

Memory matrix with light-tight cover open. Only one multiplier phototube is shown

DIGITAL STORAGE

SUMMARY —— Inexpensive storage for digital data is provided by neon-tube matrix. Less power is required than with coincident-current memories such as a core matrix. Memory uses multiplier-phototube read out. Flasher lamp prevents complete deionization of neon tubes

NEON STORAGE unit uses the presence or absence of a small neon tube as the memory element. The memory consists of rows and columns of wires with neon tubes connected to appropriate intersections.

The neon tube detects a coincident voltage at the intersection and its light output is converted to voltage by a phototube. Since the phototube will pick up the light of any of the neons, it also acts as the logical OR gate which is necessary in memories.

Operation of Matrix

Figure 1 shows a corner of a neon matrix and operating waveforms. The selection of the corners of the matrix is accomplished by a coincident voltage. Once the correct voltage is present, the neon tube will fire and draw a small amount of current (about 0.2 milliamp). This current, however, can normally be supplied by any circuit having a reasonable output impedance without seriously affecting the output voltage level.

The sets of vertical and horizontal wires have the property that at all times only one wire from each set has the selecting voltage on it. The magnitude of this selecting voltage is about one-half the firing voltage of the neon tubes.

On the voltage waveforms at time t_1, wire 3 is selected but none of the hundred series wires is selected (one in another part of the matrix is chosen). Even though there are neons at corners c and d, the voltage applied to them is lower than their firing point and they remain off.

Extinguishing Neon Tubes

The neon tubes are NE-2's. These are small tubes with wires extending from the glass seal. In manufacture, no measures have been taken to hold the gas pressure and the spacing of the electrodes uniform between tubes.

The firing voltages of new tubes can be from 65 to 90 v, and the maintaining voltages from 55 to 65 v. As the tubes age, these voltages will increase.

The amplitude of the half-selecting voltages is about plus or minus 55 from ground. This will insure the firing of any tube when coincidence occurs. A resistor in series with one line will drop the voltage applied to the neon to the maintaining value after the tube fires.

However, when one selecting voltage is removed, there will still be 55 v available which may prevent the neon from extinguishing. This can be overcome by adding an R-C network in series with the vertical or horizontal wires as shown in Fig. 2.

As the neon fires and starts to draw current, capacitor C charges

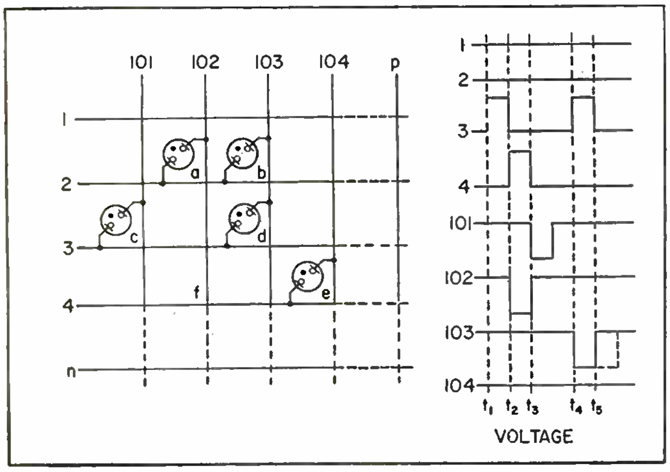

FIG. 1—Section of neon-tube matrix and firing waveforms

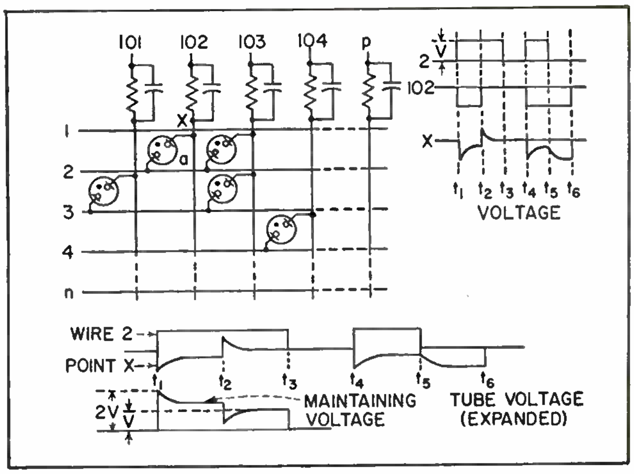

FIG. 2—Section of matrix and extinguishing waveforms

Using Neon Tubes

and the voltage across the tube drops to the maintaining voltage level. When one selecting voltage is removed, the voltage across the neon drops to about 10 volts for the short time before *C* discharges. It is long enough, however, to extinguish the neon.

When the neon tubes are in an area which has normal illumination, 110 v or so across the neon tube when there is a coincident voltage would be enough to fire the tube reliably. The light in the area would prevent the neon gas from deionizing completely, thus making it easier fully to ionize or fire the tube.

The neons of the matrix, however, must be installed in a light-tight enclosure to allow the phototube to pickup the on-off condition. In a dark area, there is practically complete deionization about 30 millisec after the maintaining voltage is removed. Since each neon bulb in the matrix must be addressed as often or as infrequently as desired, no restriction based on the 30-millisec interval can be tolerated.

In a dark area, the neons may not fire for periods greater than 20 millisec after a voltage much in excess of their normal firing voltage is applied. This is in contrast to a neon in a lighted area which will fire within a few microseconds. Since the neons can be held from deionizing by light, a flash of light, at intervals in the normally dark area would ionize the tubes partially. In particular, if a neon lamp were flashed, the emitted light would cause the most activity in the neon lamps of the storage matrix.

The flasher neon is normally flashed at the time a new corner in the matrix is chosen. A new neon which must fire is thus given the activation when the coincident voltage is applied. Since the flasher neon is fired each time a new location is pulsed, it normally fires many times a second and there is no possibility of this tube becoming fully deionized.

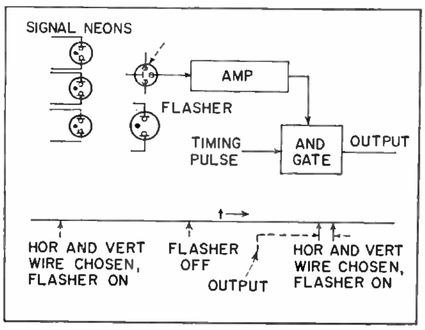

FIG. 3—Output circuit and timing cycle

Matrix Output

Both the light from the signal neons and the flasher neon will be picked up by the multiplier phototube. Whether a signal neon is on or not, an output indication could result at the time the flasher neon is on. It is therefore necessary to look for the output after the flasher is turned off.

This can be accomplished by the circuit shown in Fig. 3. The output of the multiplier phototube passes through an amplifier to increase the voltage swing available and change the d-c output level. The output of the amplifier and the timing pulse are gated to produce the output. Immediately after this output, another location is chosen for the next output.

The delay between the turning off of the flasher and the output is necessary to allow the light output of the flasher neon to decay to a low level. The multiplier phototube and amplifier are designed to have no greater bandwidth than is necessary to follow this decay.

Where the memory is to be used

to generate a certain function it will always be read in the same order. A simple way of reading which would cover all corners of the memory would be to select one horizontal wire and then sequentially select all the vertical wires. The next horizontal wire would then be selected and all the vertical wires would be selected again. This process then would be repeated until all the horizontal wires were selected.

With this method of selection, it is always known which corner will be the next one selected. Therefore the circuit can remain one step ahead of the input and also have an instantaneous output instead of waiting for the flasher neon and slow decay. A circuit which will perform in this manner is illustrated in Fig. 4.

To scan the matrix in a sequential order, two four-stage counters and decoding circuits are included. The four-stage binary counter has 2^4 or 16 possible configurations. Each configuration can be recognized by the decoding circuit as being distinct.

It will therefore energize one of its 16 output lines according to the four inputs it receives from the counter. These output lines form one set of wires to go to the neon tubes.

The second counter and decoder form the second set of wires to the neon matrix. Since the second counter is fed by the overflow of the first, all 16 lines of the first will be selected while the second set remains fixed. The overflow will then cause another line in the second set to be chosen and the first set will sweep through again.

It is necessary that one of the two sets of outputs from the decoders have a positive selecting voltage and the other be negative. Since it is generally desirable to make all counter stages the same, this difference in circuitry is in the cathode followers and the decoding circuits.

Pulse Input

The positions of the neon tubes are set up initially so that the corner of the matrix which is energized when the counters are reset contains the information to be read out at the time of the first pulse. When the first pulse comes in, it is regenerated by the blocking oscillator and fed to the AND gate. The other input to this gate before the pulse came was the information from the matrix at the reset position.

Since this input is designed to have a long time constant, it will only start to change at the time of the pulse and the previous in-

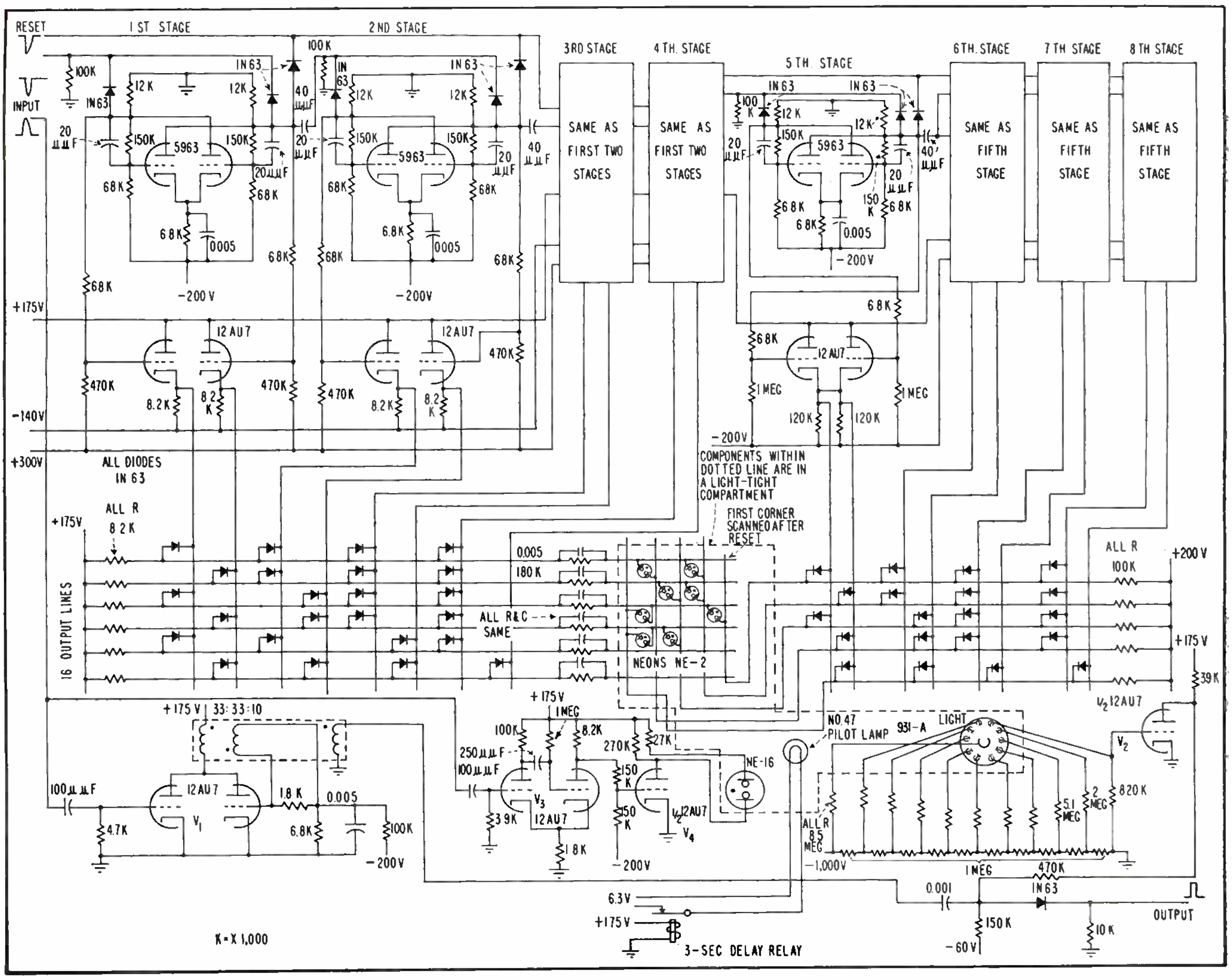

FIG. 4—Schematic diagram of neon-memory function generator

formation will be the control on the gate. The output is therefore directly available.

The input pulse also steps the counter and triggers the monostable multivibrator which in turn fires the flasher neon. This sets the matrix at the next corner and the neon at that corner, if any, will light. The multiplier phototube picks up the light and slowly changes the input to the AND gate. When the next input pulse arrives, the second output is immediate and the matrix is set for the third position.

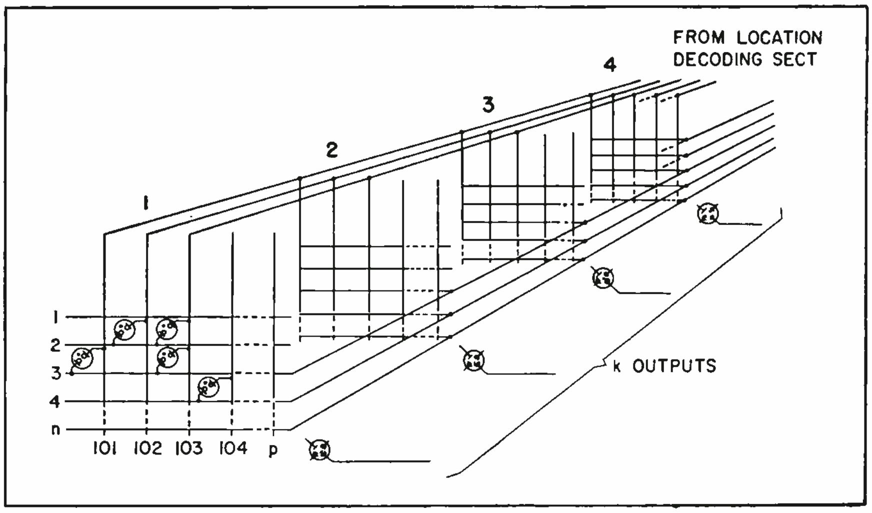

FIG. 5—Neon-tube matrix memory with four-bit output

Circuit Operation

The decoded output to the neon matrix from the first four stages is a positive gate from the zero-reference level. The d-c output level of the counter flip-flops is raised by the dividers to the grids of the cathode followers and the polarity of the diodes in the decoding matrix provides for the positive output gate. The d-c level of the fifth to eighth counter flip-flops is lowered by the dividers to their cathode followers to obtain a negative gate from the zero reference level. The outputs of these flip-flops are reversed to obtain correct sequencing of the negative output gates.

The positive input pulse is brought to blocking oscillator V_1 for reshaping and amplification. The positive output of V_1 is gated with the d-c level from multiplier-phototube amplifier V_2. Since the amplifier and gate have a slow response to the d-c level change, the output information is based on the past output of the neon matrix.

The flasher neon is ignited immediately after the input pulse by monostable multivibrator V_3 and amplifier V_4. To be certain that the flasher neon is partially ionized when the equipment is put into operation, a pilot lamp is included in the light-tight compartment. This lamp is turned off by the thermal relay about three seconds after B+ is applied. This delay allows the equipment to start its operation and insures initial firing of the flasher neon.

The circuit shown was designed for equipment requiring a maximum read-out rate of 200 cps and no attempt was made to attain maximum speed from the memory unit. The unit as constructed has a maximum read-out rate of about 2 kc. This is due to some portions of the circuitry and the mechanical layout of the decoding and neon matrixes. To work at higher speeds, the capacitance between all matrix wires must be reduced to improve rise times and reduce crosstalk.

Multidigit Output

The circuit provides one bit of output information at the time of each input. Many applications, however, require more bits per input pulse. Each bit will require a separate neon matrix but most of the equipment can be common. The layout of the matrixes for a four-bit output word is shown in Fig. 5.

Corresponding wires of each matrix are connected together and driven from the same source. The counters, cathode followers, decoding circuitry, monostable multivibrator and blocking oscillator need not be repeated. All that is necessary for each additional bit is a matrix, multiplier phototube and amplifier, AND gate and flasher.

The additional power required is negligible. For memories which require a different number of locations than 16 by 16 or 256 positions, a different counter configuration can be used or the counters can be reset before they reach full capacity.

The life of the components is normally no problem. The counters, cathode followers and decoding circuitry need not be high-speed units. Therefore they can operate with relatively low current and reasonable rise times. This speed also allows the crystal diodes in the decoding circuits to operate in circuits which are relatively insensitive to variations between diodes. The NE-2's have a rated life of about 25,000 hours. Since the tubes are on only a fraction of the time and are operating at about $\frac{1}{3}$ rated current due to the large gain available from the multiplier phototube, the neon life is no problem.

Construction

The physical layout of a typical memory matrix is shown in the photograph. The cover holding the neons is tipped up. This unit has four output bits per input pulse therefore four light-tight compartments, each with the memory neons, flasher neon and multiplier phototube. The neon memory tubes, rather than being physically located at the intersections of cross wires, are bunched in a group to illuminate the multiplier phototube uniformly.

The access time for the neon memory is about 100 microsec and the consecutive read-out time is the same. About 25 tubes and 128 diodes are needed for the 4-bit 256-word consecutive read-out memory. Sixteen tubes are counters and cathode followers.

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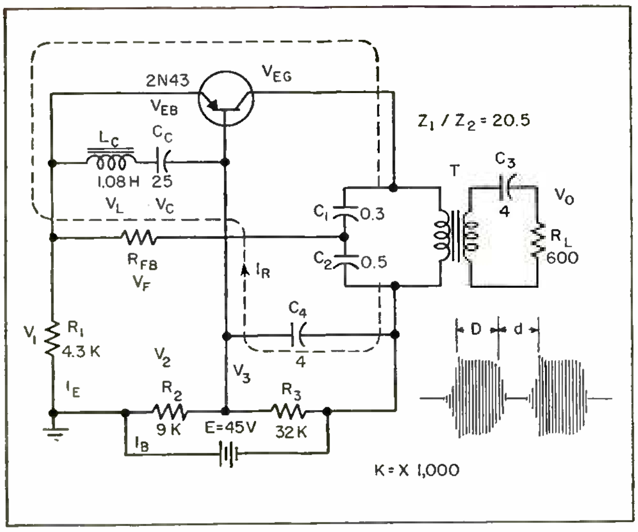

FIG. 1—Self-quenching superregenerative oscillator circuit uses junction transistor. Point contact may also be used

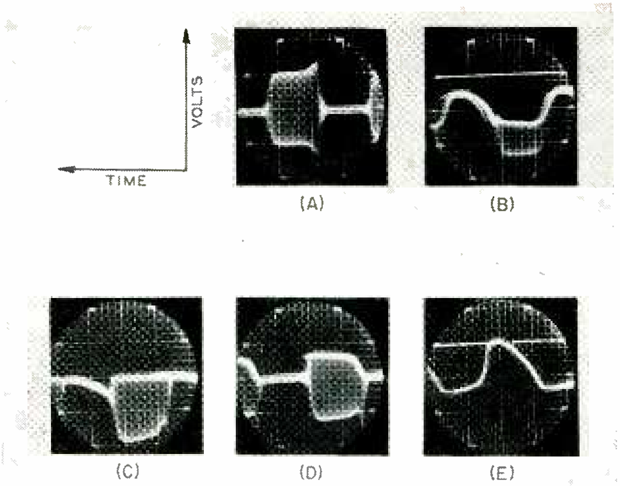

FIG. 2—Waveforms show circuit voltages V_o (A), V_1 (B), V_{eb} (C), V_l (D) and V_c (E) corresponding to circuit diagram

SUPERREGENERATIVE

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SUMMARY — Equal on-off intervals of 500-cps audio frequency are obtained at a rate of 7 cps using junction transistor in basic self-quenching oscillator circuit. Effects of circuit parameter variation on oscillator performance are given. Operation is possible at higher frequencies

PULSES OF AUDIO-FREQUENCY tone produced at a slow rate from 5 to 10 cps are useful in providing alarm controls and in performing identification and supervisory functions in signaling systems.

This article describes a simple transistor circuit that produces equal on-off intervals of 500-cps tone at a rate of 7 cps. The circuit requires one junction transistor and provides 23 milliwatts of pulse power to a 600-ohm load. Operation at higher frequencies and the use of point-contact transistors in this circuit is possible.[1, 2]

The circuit diagram of the self-quenched oscillator is shown in Fig. 1.

Figure 2A is the output signal, Fig. 2B is the voltage across the resistor R_1 in the emitter circuit, Fig. 2C is the emitter-to-base voltage and Fig. 2D and 2E are the voltages across L_c and C_c respectively.

Operation

To obtain some insight into the circuit operation, assume that self-quenched oscillation takes place. Suppose that the off period has just been completed and the on period is about to begin. Thus the emitter-to-base voltage will be slightly positive (for a *pnp* unit), the current through the *LC* combination will be small, the emitter-to-base resistance will be low and C_c will be charged positively.

Capacitor C_c will discharge rapidly through L_c and the emitter-to-base resistance. The voltage across L_c will increase, opposing the change in current, and the voltage across the *LC* combination will adjust itself to maintain a small positive voltage across emitter and base. Oscillations will build up rapidly toward some limiting value. Owing to transistor nonlinearity these oscillations produce a rectified current I_R, with a fundamental frequency of 7 cps, that flows through the inductance-capacitance combination along the assumed path shown in Fig. 1.

This current reduces the voltage across C_c until V_{eb} becomes so small that oscillation ceases. The emitter-to-base resistance is now high and C_c begins to charge through L_c, R_1 and the bias network R_2, R_3, C_4 and E. The resultant rapid change in the direction of current through L_c causes the voltage across the coil to decrease rapidly and drive the emitter diode further below cutoff.

The emitter-to-base voltage now increases toward the bias voltage V_2 as C_c charges. When V_{eb} becomes slightly positive, the emitter diode again becomes a low resist-

*Formerly with Bell Telephone Laboratories

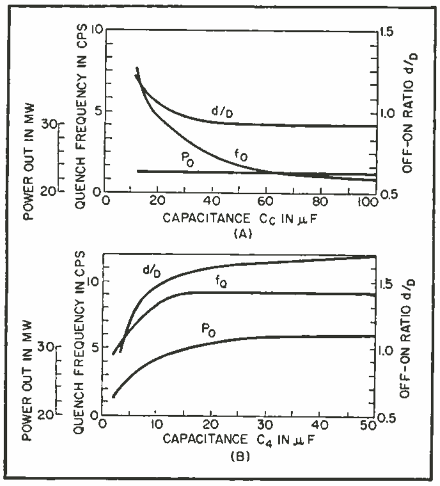

FIG. 3—Circuit performance with variation in quench capacitor C_Q (A) and bypass capacitor C_4 (B)

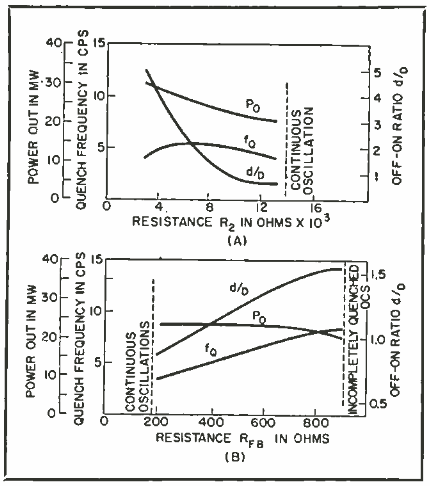

FIG. 4—Effect of changes in bias (A) and feedback (B) on circuit performance. Sum of R_2 and R_3 held constant in (A)

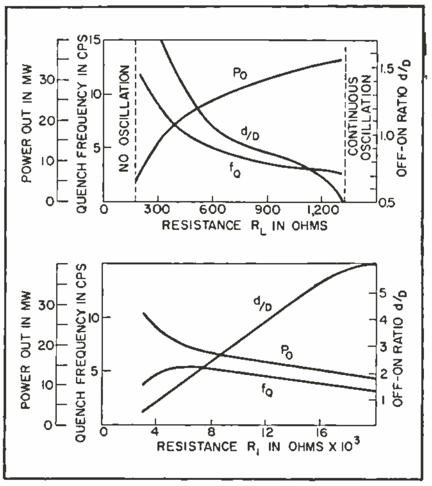

FIG. 5—Effect of changes of load resistance (A) and emitter resistance (B) on circuit performance

Transistor Oscillator

ance across the LC combination and the cycle repeats itself.

Choke L_c also serves to prevent a short circuit across the emitter and base at the fundamental oscillator frequency.

Experimental Results

Circuit performance was measured with a fundamental oscillator frequency of 500 cps, a quench frequency of 7 cps and a off to on ratio, d/D, of unity.

Only one significant element at a time was varied. The pulse power dissipated in R_L and P_o is taken as $A^2/2R_L$.

Performance as a function of the quench circuit capacitance C_Q is shown in Fig. 3A. The power output and the off-on ratio d/D, do not vary appreciably for values of $C/_Q$ above 25 μf. Quench frequency f_Q varies hyperbolically with C_Q. An empirical relation for f_Q is $(8.8 \times 10^{-3} C_o)^{-1}$.

This variation suggests that quenching is controlled by a time constant rather than by a resonance phenomenon since the resonant frequency for the L_cC_c circuit is 33 cps. Since C_Q chiefly affects f_Q, it can be used as the primary control for the quench frequency.

Effects of varying bypass capacitor C_4 values are shown in Fig. 3B. Above a value of 15 μf, d/D, f_Q and P_o change slightly indicating that R_3 is effectively bypassed at the quench frequency.

Figure 4A shows the effects of changing the bias by varying R_2 while keeping the sum of R_2 and R_3 constant at 41,000 ohms. As R_2 is increased beyond 14,000 ohms quenching of the 500-cps signal stops owing to reduced collector voltage. As R_2 is decreased toward zero d/D increases rapidly because of reduced quiescent emitter current. Values of P_o and f_Q are less critically related to the value of resistance than d/D; thus R_2 and R_3 can be used as a fine control for d/D.

The effect of the feedback resistance, R_{FB}, is shown in Fig. 4B. Within the operating region both d/D and f_Q vary moderately so that R_{FB} can be used as a fine control for the 7-cps quench signal as well as a control over the basic 500-cps frequency.

Figure 5A shows that variation in R_L has a marked effect on the circuit performance. Improvement may be obtained by using a more suitable output transformer, a pad in the secondary to reduce the load variation seen by the circuit or a buffer amplifier in the output circuit.

Effects of variation in R_1 are shown in Fig. 5B. The important property here is that d/D can be controlled by R_1, with only small changes in f_o and f_Q, in the range of 4,000 to 16,000 ohms.

Although the sum of $R_2 + R_3$ was not varied, it was found that for a value of 10,000 ohms instead of 41,000 ohms, the quench frequency increased about 40 percent with some increase in d/D. This change increased the battery drain from 4 ma to 8 ma.

A resistor placed in series with L_C and C_C decreased d/D as the resistance was increased, and quenching stopped when the sum of the value of this resistor and the resistance of L_Q reached approximately 200 ohms. An increase in the value of L_C lowered the quench frequency.

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(2) R. U. Endries and R. P. Moore, Jr., Transistor Oscillators, RCA Lab. Report LB-865, p 9, May 23, 1952.

Regulating Amplifier

SUMMARY — Servocontrol automatically adjusts gain to accommodate changes in attenuation in long open-wire telephone lines. Slope, or unequal attenuation as a function of frequency, in 12-channel carrier systems is likewise compensated. Pilot-tone pairs of 40 and 80 kc with 99 and 150 kc are employed to control gain

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MULTICHANNEL CARRIER telephone systems require compensation for variations in line attenuation caused by weather changes.

The device described is used in a new 12-channel carrier telephone system to correct automatically not only for changes in attenuation but also slope—the change of attenuation over a range of frequencies—that occur in open-wire telephone lines.

The telephone system uses frequencies from 40 to 88 kc in one direction of transmission and 99 to 150 kc in the other direction. Over these frequency ranges, differing weather conditions cause large changes in the attenuation characteristics of a line.

Figure 1 shows the attenuation characteristics of a typical 33-mile long telephone line. Under dry weather conditions, the average attenuation of the line is about 8 db and the change in attenuation from 99 to 150 kc is only 2 db. During a sleet storm, however, the attenuation at 99 kc may increase to 38 db and the attenuation at 150 kc may increase to 60 db.

The difference between these two values of attenuation (22 db) is the slope across the transmitted band of frequencies. Under different weather conditions, attenuation and slope may be anywhere between the dry-weather and sleet-storm extremes.

The regulator compensates for any attenuation in the range covered in Fig. 1. This includes lines so short that instead of providing variable amounts of gain, the regulator must provide varying amounts of loss. For long lines, the regulator will provide up to 48 db gain at 99 kc or 72 db gain at 150 kc. The regulation error under most conditions does not exceed ± 1 db.

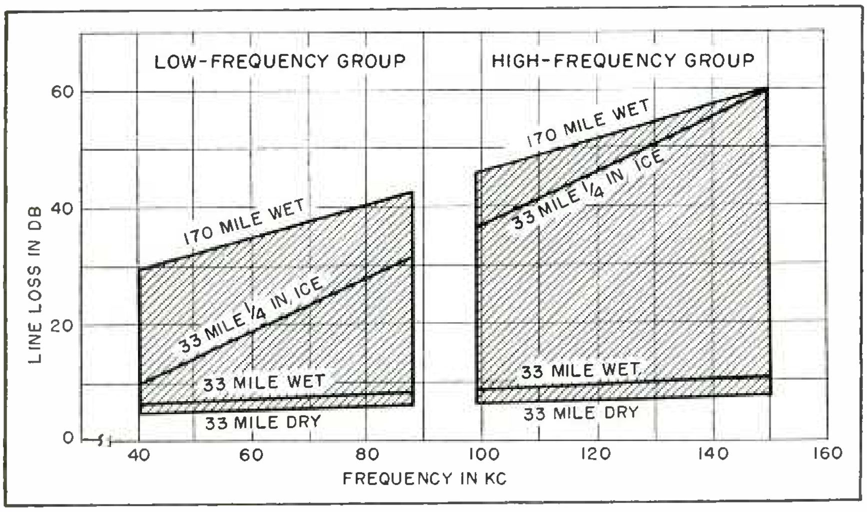

FIG. 1—Attenuation characteristics of open-wire line. Shaded portions show range of regulation of the equipment described in text

Design Considerations

Two general approaches, either electromechanical or electronic, can be taken in the design of regulators for open-wire carrier systems.

Electromechanical regulators are possible because attenuation changes occur slowly enough to be adequately compensated by a mechanical device. In fact, slow regulator response is necessary to prevent wide swings in system gain resulting from momentary line shorts or induced transients.

One type of electromechanical regulator now used in carrier system is a servomechanism consisting of motor-driven attenuators and slope-correcting networks. The motors of these devices are driven by a system of amplifiers, relays and filters to insert the necessary characteristics in the line. Such regulators, although they perform satisfactorily, are large physically and include expensive components.

Another design approach makes use of electronic circuits to take advantage of miniature components now available. An electronic regulator is smaller, more efficient and can be inexpensively manufactured.

To correct for wide range line-

Corrects Slope and Level

loss and slope conditions, precise attenuation and slope information must be conveyed to each regulator in the system. This information is obtained by sending two pilot frequencies in each direction of transmission. Pilots of 150 kc for slope control and 99 kc for flat-gain control are transmitted in the high-frequency direction. Tones of 80 kc for flat-gain control and 40 kc for slope control are transmitted in the low-frequency direction.

The regulator can be considered a closed-loop electronic servo system. The characteristics of this system are controlled by the level of the pilot tones at each end of the transmitted band.

A block diagram of the regulator circuit is shown in Fig. 2. In operation, the regulator attempts to maintain both pilot tones at a constant preset level at point *B*. This level is determined by the amplifier gains existing within the feedback loop, indicated by β.

The received band of frequencies, including the message and the pilot tones, is transmitted from input *A* to output *B* of the regulator. The pilot tones present in the output are then separated from the message frequencies and returned through a feedback loop to control the flat-gain and the slope-compensating amplifiers.

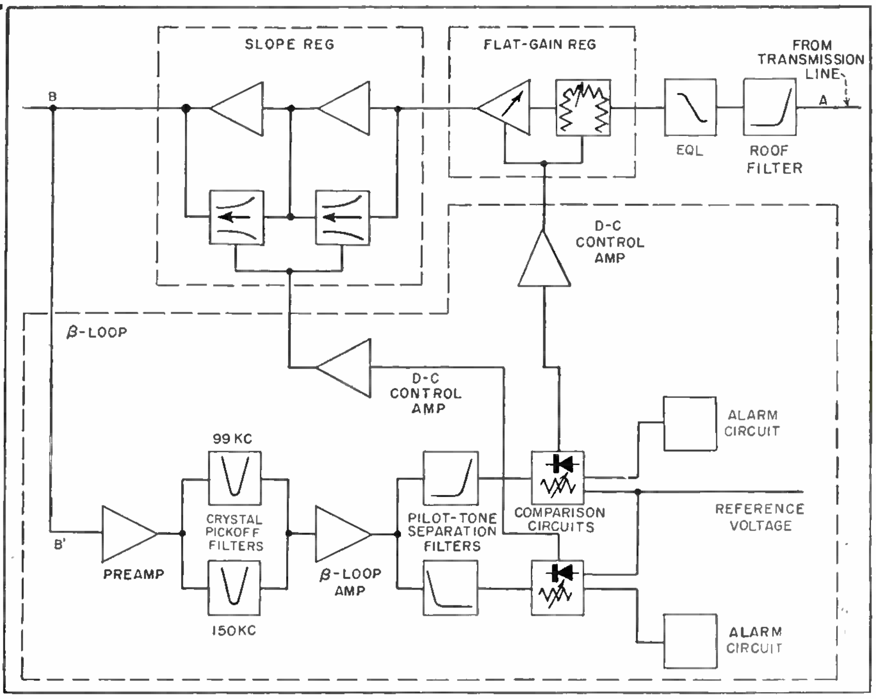

FIG. 2—Block diagram shows signal and pilot-tone paths

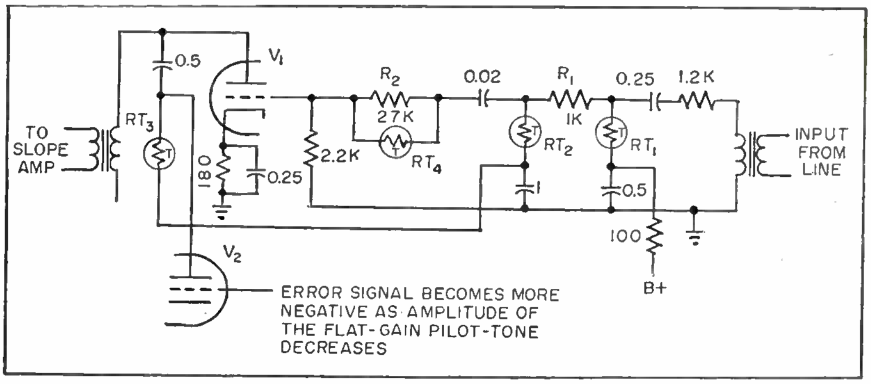

FIG. 3—Flat-gain regulator uses four thermistors

The line-equalizer section of the *A-B* path contains a low-pass roof filter to suppress out-of-band crosstalk and noise and a fixed equalizer to provide a moderate amount of preliminary equalization.

The flat-gain section maintains the overall gain of the regulator constant. This section consists of a pi-network in which attenuation depends upon the resistance of thermistors in its shunt arms and an amplifier with gain controllable by a thermistor in parallel with the load resistor. The overall gain or loss of the flat-gain section is determined by a direct current flowing through the thermistors.

Slope correction follows the flat-gain correction and is provided by two cascaded amplifiers with slope-equalizing networks in their feedback circuits. The frequency response of these amplifiers is controlled by varying the characteristics of the equalizer networks. As in the flat-gain regulator, this is accomplished by thermistors whose resistance is varied by d-c control. The output of the second slope amplifier is also the output of the regulator.

Feedback Loop

A portion of the regulator output is applied to the β-loop to control the gain characteristics of the flat-gain and slope-correcting amplifiers. In this loop, a pair of very sharp crystal band-pass filters separate the two pilot tones from the message frequencies. After further amplification, the pilot tones are separated from each other by a low-pass and high-pass filter combination, individually rectified and compared with d-c reference voltages.

The two error voltages obtained by the comparison depend upon the level of the pilot tones at the regulator output and are used to determine the output of the d-c control tubes. These tubes supply current to the flat-gain and slope-correcting

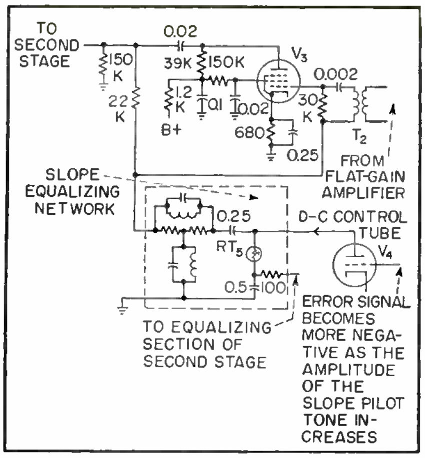

FIG. 4—Two slope-correcting amplifiers are used in cascade

networks. An output pilot level change of ±1.0 db swings these control currents through their complete operating range.

Any change in the amplitude of a pilot tone at point *B* will cause the characteristic of the flat-gain or slope-correcting networks to vary in a direction that creates a compensating change in gain or slope.

To prevent the regulator from responding to transient phenomena such as swinging shorts on the telephone line or momentary interruptions from maintenance procedures, the time constants of the d-c control circuits are made long. If signals are completely lost, alarm circuits that monitor the error signals will be operated after about five seconds delay. The loss of either or both of the pilot tones will cause audible or visual indication.

A simplified schematic of the flat-gain regulating circuit is shown in Fig. 3. The input transformer provides an impedance step-up necessary to obtain optimum performance from a pi-section attenuator. Resistance R_1 and the two thermistors, RT_1 and RT_2 form the attenuator. The thermistors have a resistance characteristic that decreases as the current through them increases.

By varying the current through the thermistors, the attenuation of the pi-network can be changed to the desired value. The current is controlled by an error voltage applied to the grid of d-c amplifier tube V_2.

The plate-current path of the control tube contains a third thermistor RT_3, which is in series with RT_1 and RT_2 as far as the d-c control current is concerned. To the incoming signals, however, RT_3 is part of the load on the flat-gain amplifier tube V_1.

Therefore, any changes in control-tube plate current will also cause the resistance of the thermistor to modify the amplifier load impedance. This alters the gain of the amplifier in the same direction as the pi-network and provides additional attenuation compensation.

Thermistor RT_4 and resistor R_3 provide temperature compensation. They form a voltage divider that controls the input to the flat-gain amplifier as a function of ambient temperature. Temperature compensation is necessary because the thermistors that control the flat-gain or loss of the regulator are sensitive to changes in the ambient temperature as well as to changes in control current.

Since thermistor RT_4 is not in the d-c path of the other thermistors and does not carry appreciable current, its resistance is dependent only on ambient temperature. Its effect on the gain of the regulator is opposite to the effects of temperature change on thermistors RT_1, RT_2 and RT_3

Slope Control

A simplified diagram of one of the two slope-correcting amplifiers is shown in Fig. 4. Signals from the flat-gain regulating stage are stepped up in voltage and impedance by the interstage transformer and applied to the grid of a pentode amplifier connected in a conventional *RC* arrangement with voltage feedback.

The feedback voltage of this amplifier is developed across a two-terminal *RLC* network in which impedance to ground varies linearly with frequency. By changing the resistance of RT_5 in the *RLC* network the impedance variation with frequency can be made to increase or decrease.

By passing plate current from d-c control tube V_4 through this thermistor, a means is provided for varying the slope of amplifier V_3 as a function of the error voltage applied to V_4. To keep the reactive elements in the slope-correcting networks within practical limits, two slope-correcting amplifiers are cascaded. Overall performance characteristics of the regulator are shown in Fig. 5.

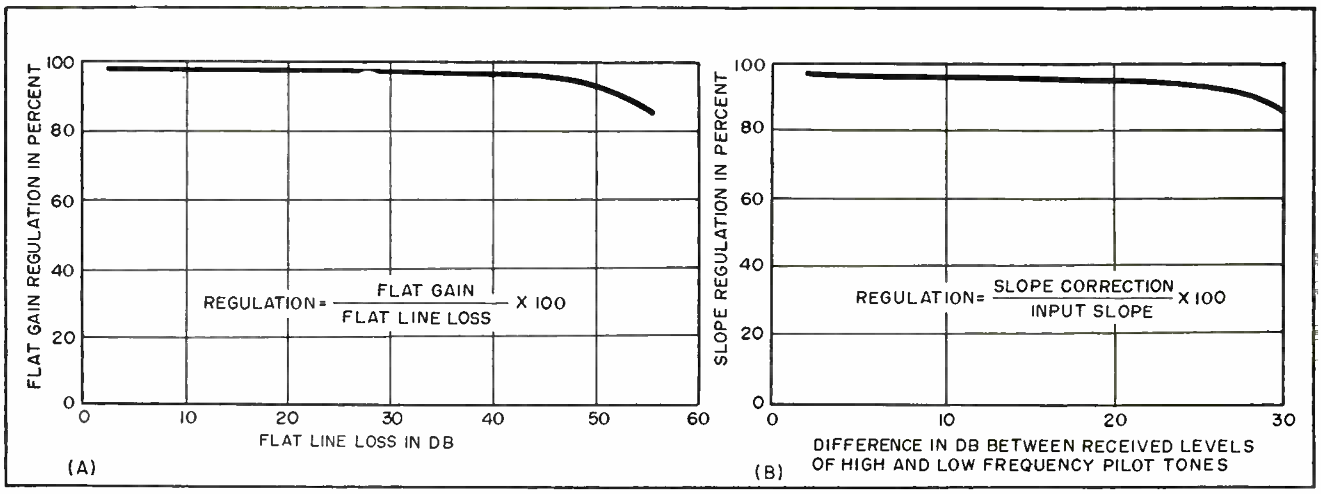

FIG. 5—Flat-gain regulation (A) and slope regulation (B) characteristics. Complete plug-in regulator comprises main chassis and four plug in units

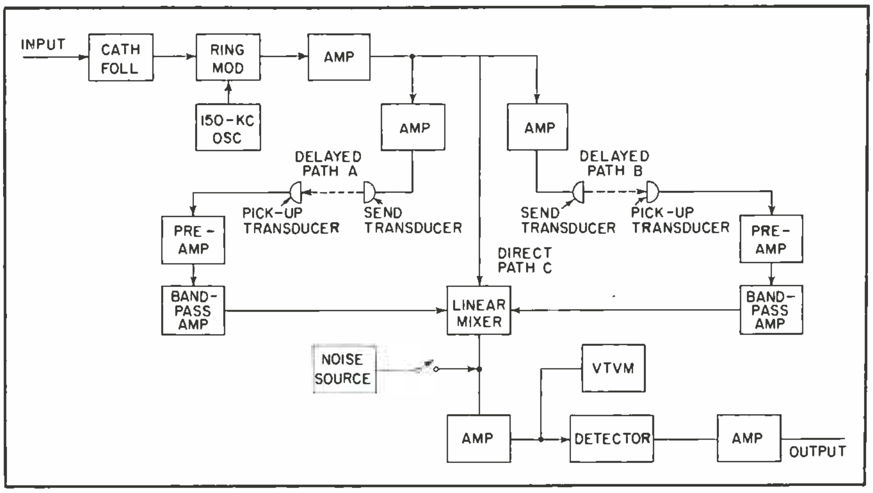

FIG. 1—Two ultrasonic paths through artificial ionosphere are compared with direct line signal in linear mixer

Multipath Simulator Tests Communications

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SUMMARY —— Ultrasonic artificial ionosphere uses crystal transducers at 150 kc operating in air. Heat and fans simulate fading in two air-path signals which are compared with direct wire path

DEVELOPMENT of long-range communications equipment requires an ionosphere simulator capable of duplicating in the laboratory radio-signal test conditions corresponding to actual field conditions.

The multipath simulator described here is a discrete path type employing three paths, two of which are atmospheric. These paths provide for adjustable differential delays up to about 5 milliseconds. It differs from previous simulators in that the path delay takes place after modulation and that both amplitude and phase of the delayed signals can be varied dynamically and simultaneously. Fading is random and frequency selective.

The path delay point is important for double-sideband amplitude modulation for, if the signals were delayed in advance of carrier modulation, the system would not be realistic. The frequency selective nature of the fading simulates the actual nature of radio fading and distorts the two sidebands in different fashion.

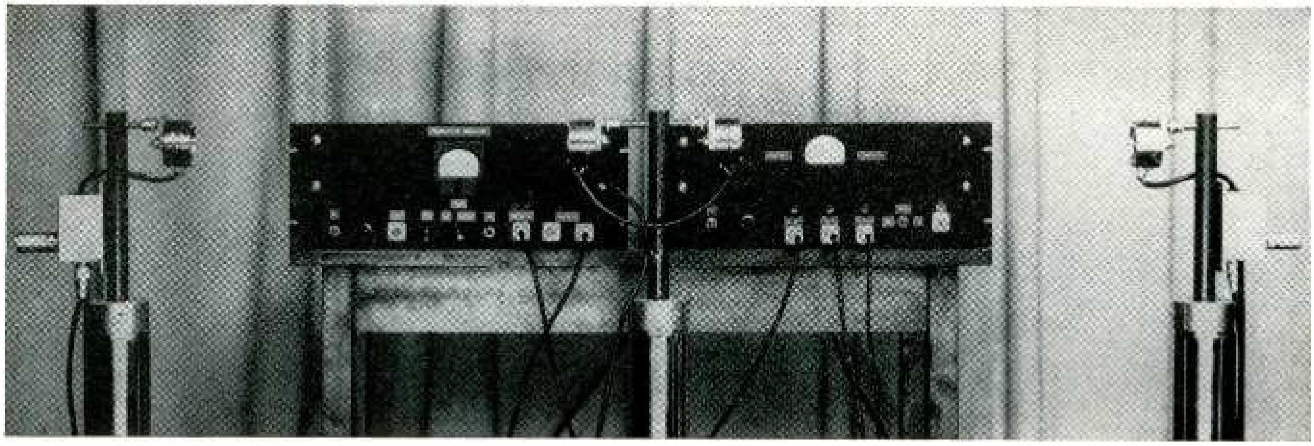
To account for the fading patterns observed, both the phase and amplitude of the delayed signals must vary. Fading due to multipath is random in nature and follows the Rayleigh distribution law.

Transducers

The simulator employs acoustic transducers operating in air at a frequency of 150 kc. The high frequency is necessary since the signals are delayed after modulation. The transducers are made up of 14 ADP crystals. Since the ratio of the diameter of the transducer diaphragm to the wavelength of the 150-kc signal in air is large, the transducers have a sharp beam pattern. This makes it possible to operate them in an ordinary room without taking special precautions against spurious reflections. The transmitting and receiving transducers are identical. They are mounted on stands and are aligned by swivel joints. The arrangement is shown in a photograph.

The distance between transducers determines the delay, and the distance for each path can be independently adjusted. Since the velocity of sound in air is 1,119 feet per

* Formerly with Hogan Laboratories.



Multipath simulator with transducers spaced for delay of about two milliseconds. Transmitting transducers are on stand at center and the receiving transducers are on stands at left and right

second at 20 C, the delay is 0.9 millisecond per foot. The third or reference path is a direct wire transmitted signal traveling from the transmitter simulator to the receiver simulator.

A block diagram of the system is shown in Fig. 1. The transmitter consists essentially of a cathode-follower current amplifier which amplifies the modulation signals and supplies the current to a ring modulator. The 150-kc oscillator signal is amplitude modulated and amplified to drive the transmitting transducers. A small part of the amplified signal is taken as the direct signal.

The receiver portion of the simulator consists of the receiving transducers which furnish the input signals for preamplifiers mounted on the transducer stands. These preamplifiers feed band-pass amplifiers terminated by level controls. The signals are monitored by a vtvm and are combined, amplified, detected and further amplified for recording. Considerable amplification and careful shielding are required because the signal level out of the receiving transducers is on the order of a fraction of a millivolt. The low output of the transducers is due to the necessity of providing damping to increase bandwidth.

Although the system as described provides for only double-sideband a-m transmission, provision is made to incorporate single-sideband transmission. Provision is also made for adding a noise signal.

Transmitter

Figure 2 is a schematic of the transmitting unit of the multipath simulator. The carrier frequency of 150 kc is generated by one-half of a 12AT7 in a series tuned *L-C* oscillator circuit. The other half of the 12AT7 is operated as a cathode-follower buffer amplifier which drives the diode-ring modulator. Carrier amplitude is adjusted so that the modulated carrier output is linear with the modulating signal well past 100-percent modulation.

With perfectly matched diodes, the diode ring is balanced for both the carrier and the modulating signal so neither appears in the output unless the other is present. Therefore, no component of the modulating signal will appear in the output except as a modulation of the carrier. This is desirable when the highest modulating frequency is close to the carrier frequency.

The output voltage is proportional to the current flowing in the center-tap circuit with matched diodes and with a sine-wave carrier input that is sufficiently high in level to be clamped to essentially a square wave by the forward conductance of the diodes.

The ring in the transmitter simulator is operated with a steady-state direct current in the modulator to obtain the quiescent carrier. The voltage differential between the cathode of V_4, the modulator tube, and the tap from the 150-v plate supply causes this residual direct current flow through the modulator. Operation of V_4 against a positive direct voltage source instead of against ground is necessary for linearity when the modulation approaches 100 percent.

Output of the modulator appears at the grid of V_2 and is amplified by the 12AT7 two-stage *R-C* coupled amplifier. This amplified modu-

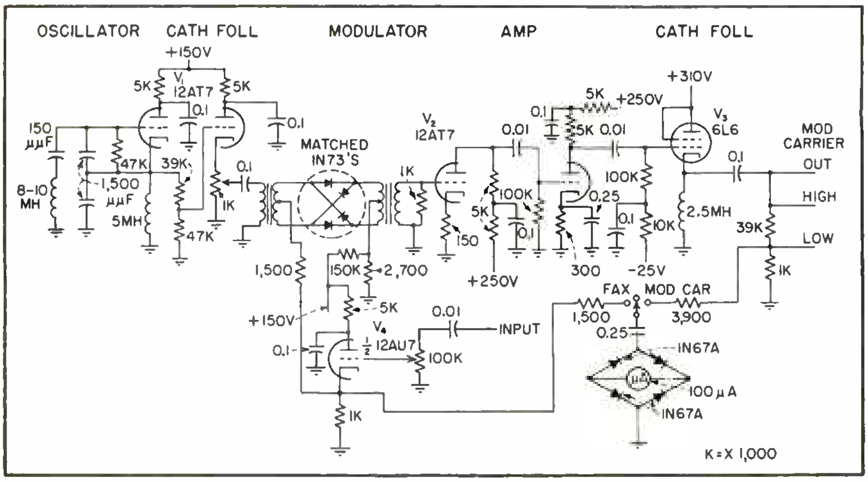
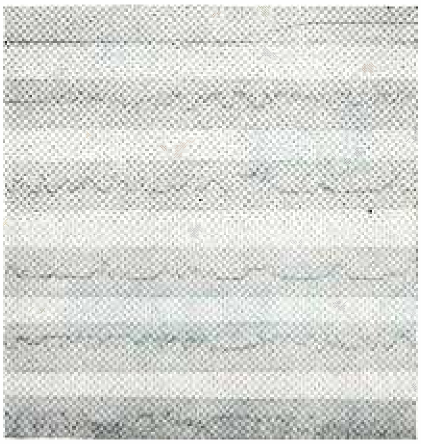


FIG. 2—Transmitter simulator provides modulated carrier output to drive sending transducer



Combined carrier signal through simulator with paths perturbed by electric fan

lated 150-kc carrier drives the cathode-follower connected 6L6 output tube. Back bias is used so that impedance coupling may be employed to obtain a reasonable power output. This output is capacitively coupled to the transducers.

The bridge-type a-c meter indicates the amplitude of the modulating signal or the amplitude of the modulated output carrier. In the modulated carrier position this meter may be employed as a simple overmodulation indicator. With the balanced modulator used in this system, overmodulation will be indicated by a pronounced upward carrier shift.

The modulating signal may lie anywhere within the audio-frequency band from approximately 200 to 6,000 cps.

Figure 3 is a schematic of the preamplifier and band-pass amplifier for the receiving transducers. Two such systems are employed, one for each of the delayed path received signals. The preamplifiers are mounted in the small boxes on the transducer stand. The preamplifier has a double-tuned band-pass filter input with a bandwidth of approximately 14 kc. Overall voltage gain of the preamplifier is 25.

A two-stage band-pass amplifier using 6AH6 pentodes raises the level of the signal from the preamplifier to a peak value of approximately 1 volt. A separate amplifier is employed for each of the delayed signal inputs. Since the direct signal is obtained by a wire connection, no band-pass amplifier is required for this third circuit.

In the linear mixer, shown in Fig. 4, the composite output signal from the two delayed channels and the direct signal channel is developed across the resistor in the grid circuits of the 6AK6 amplifier.

A 6H6 is used for full-wave detection of the composite amplitude-modulated carrier. A simple *L-C* filter section removes the carrier components from the output of this detector. Parallel resonance in the filter effectively suppresses the carrier fundamental frequency.

A 6C4 cathode follower provides a low-impedance output stage for transmission of the recovered information signals to the recorder.

A separate vtvm circuit using a cascade-connected 12AT7 is provided for setting the relative amplitudes of the various input channels. Inverse feedback is employed in this amplifier to stabilize gain.

In the equipment shown the bandwidth, and hence the highest permissible modulation frequency, is determined by the band-pass circuits employed. The transducers themselves have an essentially flat bandwidth of 20 kc and so are not the limiting elements in the system.

Fading Effects

The velocity of sound in air changes with temperature about 2 feet per sec per degree C. At a frequency of 150 kc a small temperature differential will change the velocity sufficiently to produce a considerable change in phase. A change of about 0.9 deg C over a 2.24 foot beam path would change the phase π radians. This effect is made use of in obtaining random change of phase. A small heat source is placed between the transducers and under the beam. Random convection currents intercept the beam over a part of its travel and cause two effects, the phase is changed in a random manner due to the change in velocity and the amplitude is changed in a random manner due to refraction.

Fading rates can be somewhat controlled by increasing heat intensity.

Oscillograph records were made of the instantaneous value of combined carrier signals through the simulator. The delayed path was perturbed by an electric fan, causing rapid fading of the resultant carrier corresponding to rates on the order of 25 to approximately 500 per minute. The records are strikingly similar to oscillograms of actual radio transmissions.

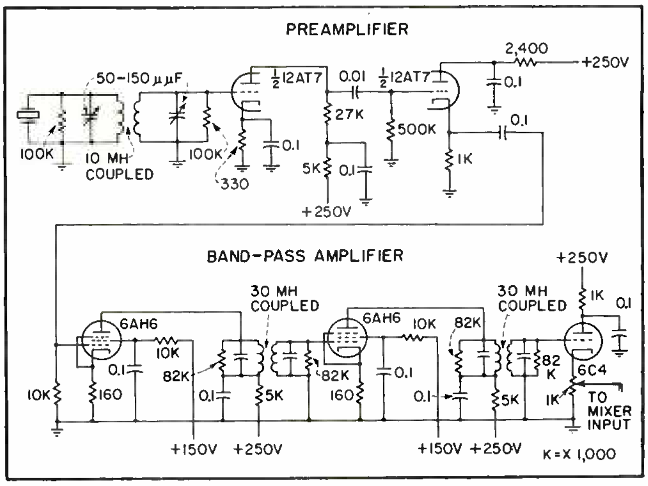


FIG. 3—Preamplifier-bandpass amplifier circuit for each delayed path boosts signal to 1-volt for mixing

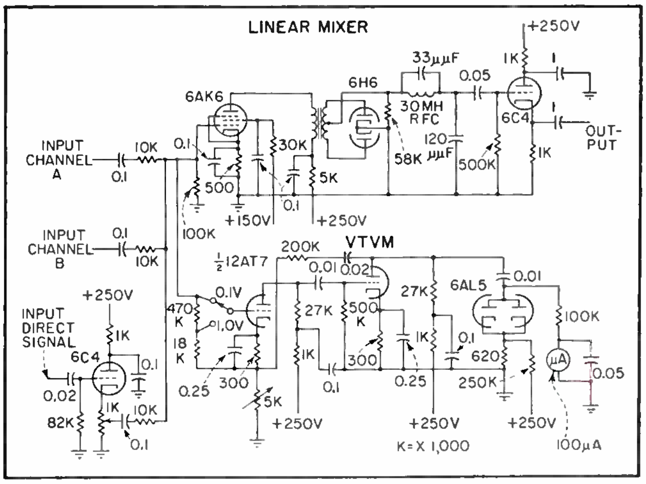


FIG. 4—Inputs from two delayed paths and direct path are combined and demodulated to drive recorder

Design Chart for Selective Cathode Traps

By K. HILLMAN
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SUMMARY — Equations for determining attenuation introduced at trap frequency and at other desired frequency used with chart speed determination of values for R, L and C for cathode trap. Graph can also be used to determine bandwidth of trap

IN DESIGNING cathode traps of the type shown in Fig. 1, attenuation must be introduced at a trap frequency, f_o, without greatly affecting the gain at some other frequency, f.

It is useful, therefore, to consider how the gain at f relative to the gain at f_o varies with trap Q, normalized frequency spacing δ, and the increased loss at f due to the presence of the trap. A cathode resistor R_k has been included in the circuit, but may be set to zero or bypassed, if desired.

Chart Construction

In obtaining the expression from which the chart is plotted, the following assumptions are made: grid-cathode and cathode-ground capacitances are negligible, the tube is a constant-current generator ($i_p = g_m e_{gk}$) and the trap may be represented by a parallel combination of R, L and C.

An actual coil has, of course, series resistance. A parallel representation is exact, however, if the Q of the coil as a function of frequency is constant.

Let $|r_1| \equiv$

$$\frac{\text{gain reduction factor at } f \text{ with trap}}{\text{gain reduction factor at } f \text{ or } f_0 \text{ without trap}}$$

$$= \frac{\left|1 + g_m\left[R_k + \dfrac{R}{1 + jQ\delta\dfrac{(2+\delta)}{(1+\delta)}}\right]\right|}{1 + g_m R_k}$$

and $r_2 \equiv$

$$\frac{\text{gain reduction factor at } f_0 \text{ with trap}}{\text{gain reduction factor at } f_0 \text{ or } f \text{ without trap}}$$

$$= \frac{1 + g_m(R + R_k)}{1 + g_m R_k}$$

It can then be shown that

$$\frac{r_2}{|r_1|} = \left[\left(Q\delta\frac{(2+\delta)}{(1+\delta)}\right)^2\left(\frac{|r_1|^2 - 1}{|r_1|^2}\right) + 1\right]^{1/2}$$

The ratio

$$\frac{r_2}{|r_1|} = \frac{\text{gain reduction factor at } f_0 \text{ with trap}}{\text{gain reduction factor at } f \text{ without trap}}$$

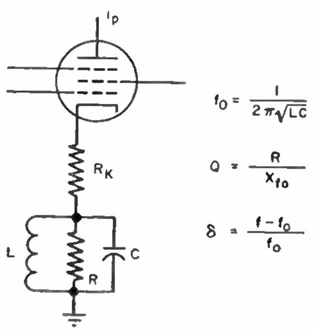


FIG. 1—Basic cathode trap circuit with design equations

has been plotted against $Q\,|\delta(2+\delta)/(1+\delta)|$ for various values of $|r_1|$. In addition, contour lines indicating levels where the value of r_2 remain constant are shown on the chart.

Example

An example of a typical design problem will show how the chart can be used to obtain component values and aid in gaging the trap bandwidth.

It is desired to reduce the gain at 10 mc by a factor of 20 relative to the gain at 7 mc.

The gain at 7 mc is to be decreased by no more than five percent. The circuit constants are $R_k = 0$, $g_m = 5{,}000$ μmhos. Find R, L and C.

The intersection of $r_2/|r_1| = 20$ and the curve corresponding to a value of $|r_1| = 1.05$ occurs for an abscissia corresponding to

$$Q\left|\delta\frac{(2+\delta)}{(1+\delta)}\right| = 66$$

since

$$\left|\delta\frac{(2+\delta)}{(1+\delta)}\right| = (0.3)\frac{1.7}{0.7} = 0.73,$$

$$Q = \frac{66}{0.73} \cong 90$$

(Continued on page 176)

The CINCH-JAN Shield Insert

—FOR INCREASED COOLING EFFICIENCY

ENDS OF INSERT

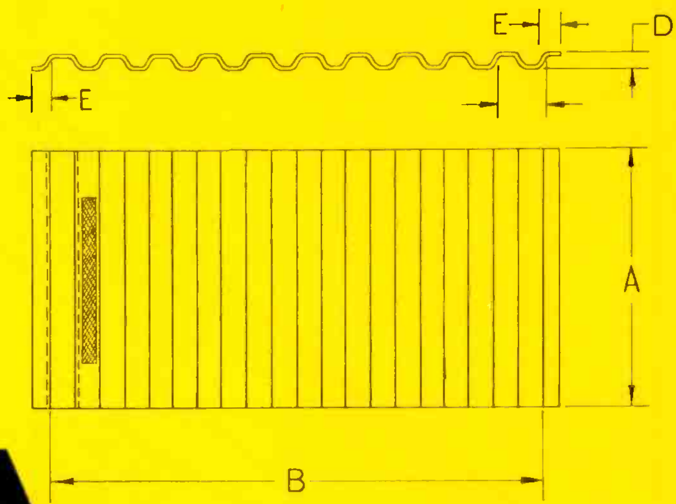
. . . aids in maintaining lower operating tube temperatures . . . equipments have fewer failures, greater reliability, less maintenance and tube replacement costs.

ENDS OF INSERT

Six sizes of the corrugated inserts are necessary to fit the six sizes of miniature tubes. The seven-pin tubes require a certain corrugation height and three widths: for the small, medium, and large sizes. The nine-pin tubes require a different corrugation and three different widths: for small, medium and large tubes.

CINCH corrugated inserts are made from 0.003 inch cadmium-plated brass shim stock with black matte finish; bent into a circular shape, the ends fitted together, and then inserted into the proper shield. The insert makes contact with the glass bulb on one side and the shield on the other, distributing the hot-spot on the tube and conducting the heat to the shield with a greater radiating surface.

Part No.	Shield	B	A	D	E	For Shield Number
20K22591	7 pin Small	2 13/32	.750	.049	3/32	TS 102U01
20K22592	Medium	2 13/32	1.000	.049	3/32	TS 102U02
20K22593	Large	2 13/32	1.500	.049	3/32	TS 102U03
20K22594	9 pin Small	2 15/16	.860	.068	1/32	TS 103U01
20K22595	Medium	2 15/16	1.200	.068	1/32	TS 103U02
20K22596	Large	2 15/16	1.500	.068	1/32	TS 103U03



These inserts may be adapted to operating equipments presently in use with no chassis modification or additional space requirements.

Centrally located plants at Chicago, Shelbyville, Pasadena and St. Louis.

Cinch ELECTRONIC COMPONENTS

CONSULT CINCH

CINCH MANUFACTURING CORPORATION

1026 South Homan Ave., Chicago 24, Illinois

Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

(Continued from page 174)

Also, $r_2 = 1.05\ (20) = 21 = 1 + g_mR = 1 + 0.005R$ so that
$R = 4{,}000$ ohms

$$X_{10\ mc} = \frac{R}{Q} = \frac{4{,}000}{90} = 44 \text{ ohms}$$

from which

$L \cong 0.7\ \mu h$

$C \cong 360\ \mu\mu f$

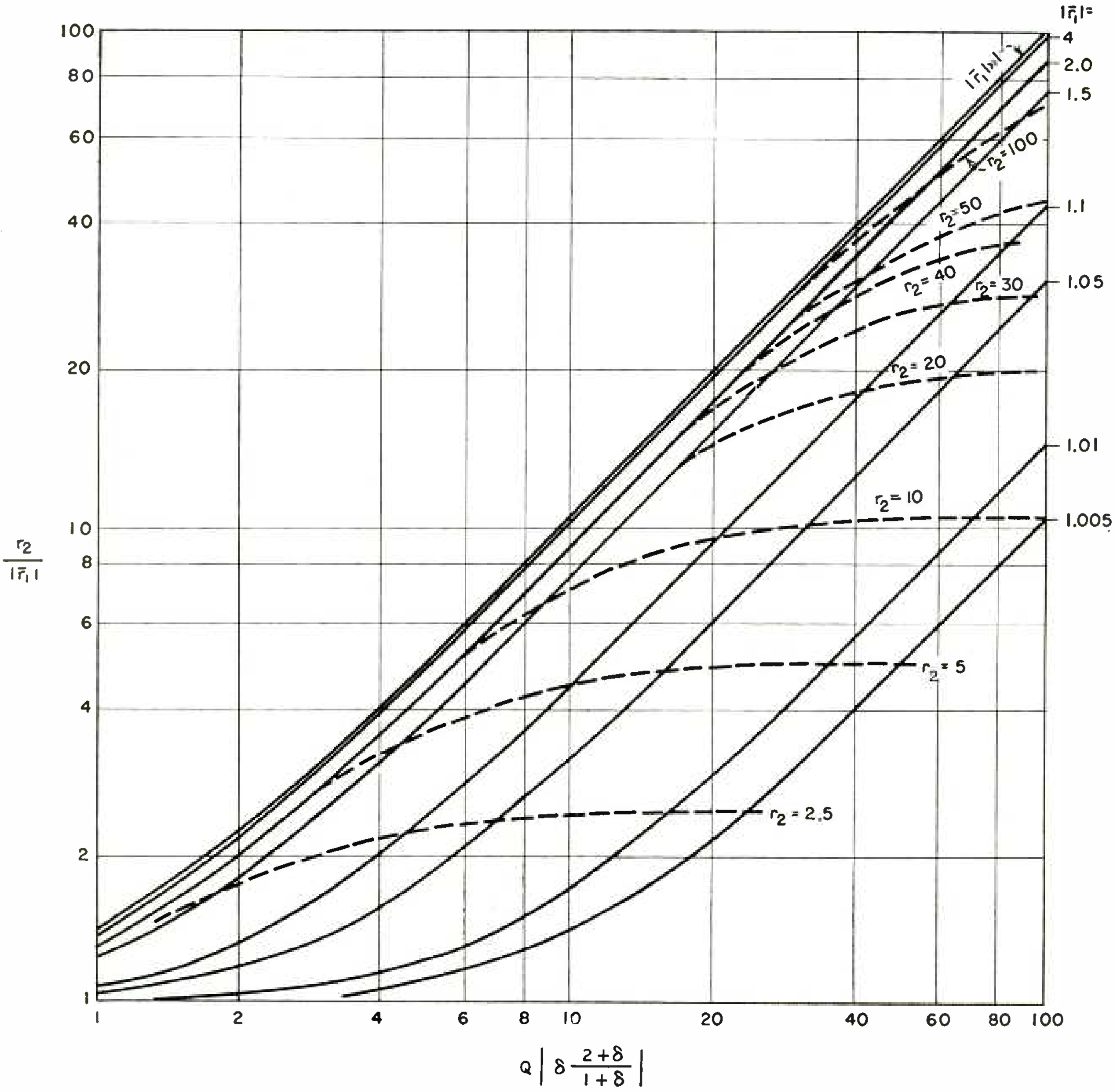
Suppose a 0.7-μh coil is now made and found to have a Q>90. Let the measured value be Q = 130. The chart shows that the intersection of $r_2 = 1 + 20\ 130/90 = 30$ and $Q|\delta(2 + \delta)/(1 + \delta)| = 94$ occurs for value of $r_2/|r_1| \cong 28.5$ and for $|r_1| = 1.05$.

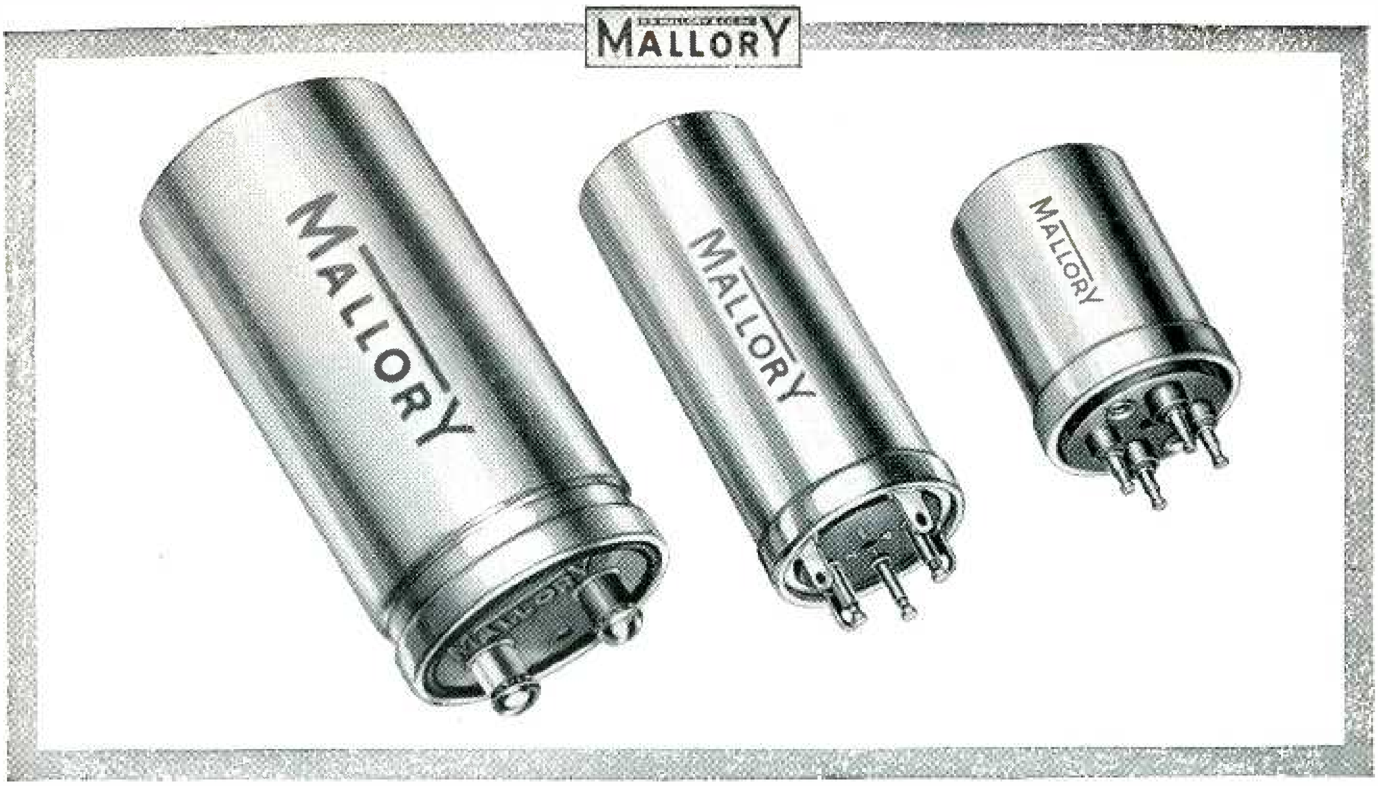
If desired, the inductance may be reduced, assuming the coil Q is held constant, so that $r_2/|r_1| = 20$ is again obtained but at a value of $|r_1| < 1.05$.

Trap Bandwidth

Sometimes a band of frequencies rather than a single frequency is to be attenuated. The chart may be used to gage the trap bandwidth. In the preceding example, the range of frequencies where the gain relative to 7 mc is decreased by a factor of ten or more can be found.

Since $r_2 = 21$, for $|r_1| \geq 10$ (1.05 = 10.5, then $r_2/|r_1| \leq 2$. The intersection of $r_2/|\bar{r}_1| = 2$ with the curve $\bar{r}_1 >> 1$ occurs at about $Q|\delta(2 + \delta)/(1 + \delta)| \cong 2\ Q|\delta| \cong 1.7$, so that $2|\delta| \cong 1.7/90 \cong 0.019$. Hence the trapping bandwidth (as defined) is 0.019 (10) or 0.19 mc.





For Extra Capacitor Life and Reliability—Mallory Telephone and Computer Grades

Certain types of electronic equipment demand the ultimate in reliability and long life in all components . . . either because replacement would be highly expensive or because complex circuits require extreme stability. For applications of this sort, beyond the range of standard commercial products, Mallory manufactures electrolytic capacitors known as telephone and computer grade. These capacitors have premium characteristics obtained by special techniques in processing.

To assure highest quality, extra precautions are observed in the selection of materials, and in manufacturing . . . even beyond the extreme care normally practiced in making Mallory commercial grade capacitors. Special electrical processing operations produce exceptionally low leakage current and series resistance. Rigid pretesting assures as much as twenty years' life on a statistically high percentage of capacitors of this grade.

This extra measure of performance is available in three different series of Mallory capacitors:

- Units manufactured to conform in appearance and construction with current telephone standards.
- Capacitors of telephone grade performance, but with physical design other than that called for in telephone applications.
- Units similar to telephone grade but with recommended voltage ratings lower in relation to anode forming voltages: particularly useful for high stability and low leakage in computer circuits.

Mallory capacitor specialists will be glad to consult with you on the selection and application of special grades for your special circuit requirements.

For all capacitor needs . . . see Mallory first!

For the great majority of civilian and military electronic circuits, Mallory supplies a complete line of commercial and JAN grade electrolytic capacitors. All can be counted on to render superior performance at economical cost. Mallory also manufactures the famous FP—the pioneer fabricated plate capacitor rated for continuous duty at 85° C.; also miniature and subminiature electrolytics, tantalum capacitors, motor starting capacitors. Write or call for complete data.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Tuning Devices • Vibrators
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Parts distributors in all major cities stock Mallory standard components for your convenience.

Expect more . . . get more from

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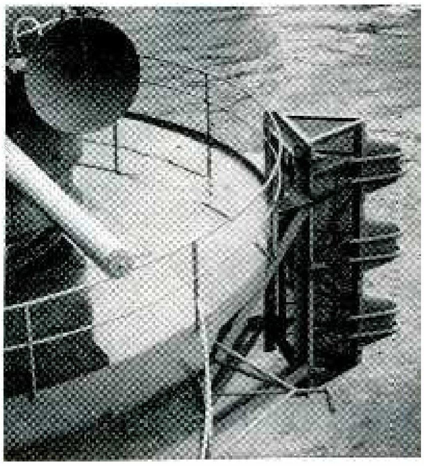
Electrons At Work

Edited by ALEXANDER A. McKENZIE

New Carrier Communications and Radar



Newly commissioned *U. S. S. Saratoga* uses the latest electronic devices to improve detection and fire control besides furnishing navigational signals and communications to aircraft. Barrel-shaped structure at top of mast (left) is enclosed Tacan navigation-aid antenna, used with system developed by Federal Telecommunication Labs. Antennas for uhf communications are visible at the corners of the flight deck. Detail of similar antenna mounted on gun tub is shown at right. Eight antennas provide 360-degree cover

Shock-Velocity Measurement

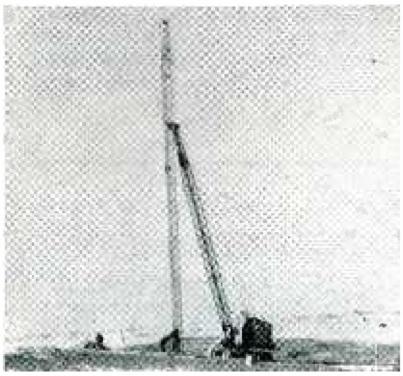
AN ACCELEROMETER that conveniently produces shock-damage data previously unavailable may eventually lead to design changes and improvements in the shock-load performance of aircraft and shipboard equipment. It was developed by T. A. Perls and C. W. Kissinger at the National Bureau of Standards.

Conventional velocity meters comprise a heavy mass, spring-mounted to a rigid frame attached to the test structure. When the test structure and frame are accelerated, the mass remains fixed in space for a small fraction of the natural period of the spring-mass system. For this short time, displacement of the mass relative to the frame is equal and opposite to the absolute motion of the frame.

This relative motion causes a pick-up coil to cut lines of force of a constant magnetic field, generating a voltage. Such voltage is proportional to the relative velocity between the mass and the frame and, for a short time, it is proportional to the absolute velocity of the frame.

These conventional velocity meters have an undesirable low-frequency resonance between 3 and 5

Construction Of DEW Line In Far North



Temporary Air Force communications tower is erected at early-warning location

Module-type housing being erected near air strip for radar-communications use

Mobile unit transports Western Electric personnel in vicinity of radar stations

kepco

VOLTAGE REGULATED POWER SUPPLIES

for powering electronic equipment

KR SERIES

with ***NEW-IMPROVED FEATURES***

★ ***FAST*** RECOVERY TIME

★ ***GOOD*** STABILITY

★ ***LOW*** OUTPUT IMPEDANCE

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

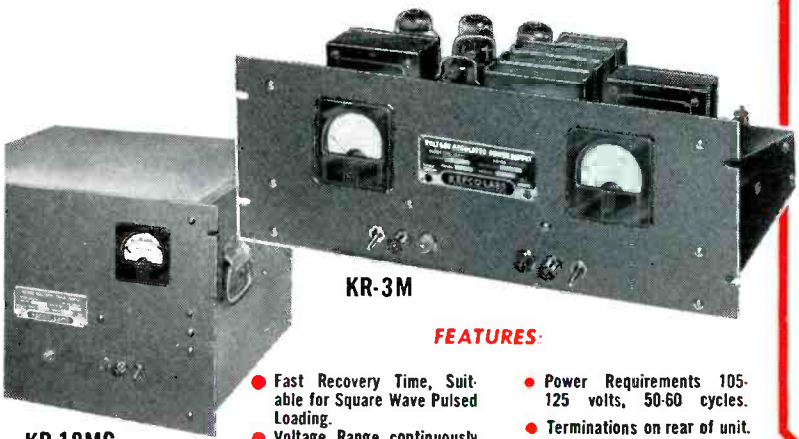
REGULATION: Less than 0.2 volts for line fluctuation from 105-125 volts and less than 0.2 volts for load variation from 0 to maximum current.

RIPPLE: Less than 3 mv. rms.

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

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

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



KR-3M

KR-18MC

FEATURES:

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

All models available for 400 cycle operation on special order.

1.5 Amp. KR SERIES

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

600 ma. KR SERIES

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

300 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount W	H	D	Price
KR 12	0-150	Each supply	19"	7"	11"	$270
KR 3	100-200	has two	19"	7"	11"	$180
KR 4	195-325	5 Amp.	19"	7"	11"	$180
KR 10	295-450	outputs	19"	7"	11"	$190

125 ma. KR SERIES

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

To Include 3" Current and Voltage Meters, Add M to Model number (e.g. KR 16-M) and Add $30.00 to the Price.
To include Dust Cover and Handles for Table Mounting, Add C to Model number (e.g. KR16-C) and Add $10.00 to the Price.
To Include Meters, Dust Cover and Handles, Add MC to Model number (e.g. KR-16 MC) and Add $40.00 to the Price.

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A LINE OF 50 MODELS

Available from Stock - Catalog on Request

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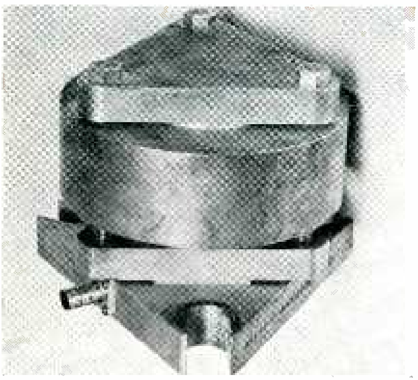


Large barium titanate velocity meter is bolted to structure being shock tested. It acts as a transducer to convert shock into an electrical signal

cps and are impossible to adjust more than approximately under conditions of movement, such as a rolling ship. Large errors may be introduced if the instrument is used with its sensitive axis other than vertical.

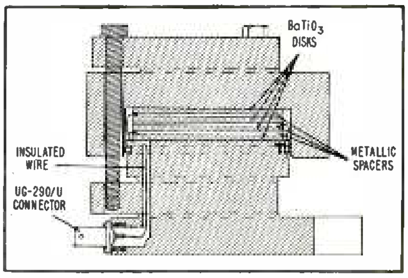
The new device is a barium titanate velocity meter operating on a different principle. It is essentially an integrating accelerometer. The sensing element is a group of four piezoelectric transducers, each 3 inches in diameter and $\frac{1}{8}$-inch thick.

Sensitivity of the device is such that an applied acceleration of one gravity unit will produce electrical output of approximately 200 millivolts. Linear range is better than ± 300 g.

Acceleration output from the barium titanate element must be integrated to obtain a velocity signal, which can be done using a simple R-C integrator. A velocity sensitivity of 4 millivolts per foot per second might be available at the amplifier recorder.

With commercially flat crystals, the resonant frequency of the meter is 6,900 cps. Optically ground crystals increase resonant frequency to 10,200 cps. To achieve highest possible resonant frequency, the velocimeter base, the barium titanate disks and the loading mass must be in contact over their entire mating surfaces. The assembly then acts as a compression spring.

The force exerted by the bolts that hold the assembly together must be so applied that the surfaces bearing against the piezoelectric disks are not distorted. Contact in the present instrument is established by machining three ears on the loading mass and on the base and providing an undercut. The force exerted by the three assembly bolts is applied relatively uniformly around a circle of smaller diameter than that of the barium titanate disks.



Cross-section drawing shows the four barium-titanate wafers that are the heart of the electromechanical transducer that was recently developed at NBS

With the device mounted on a heavy object, theoretical resonant frequency should be 0.7 times the unmounted resonant frequency, assuming perfect coupling. Such coupling can be obtained using a $\frac{1}{16}$-inch lead mounting shim that has proved not to flow appreciably during six days.

Tesla Centenary Honors High-Frequency Pioneer

Nikola Tesla, in 1922, experiments with high frequencies in his laboratory

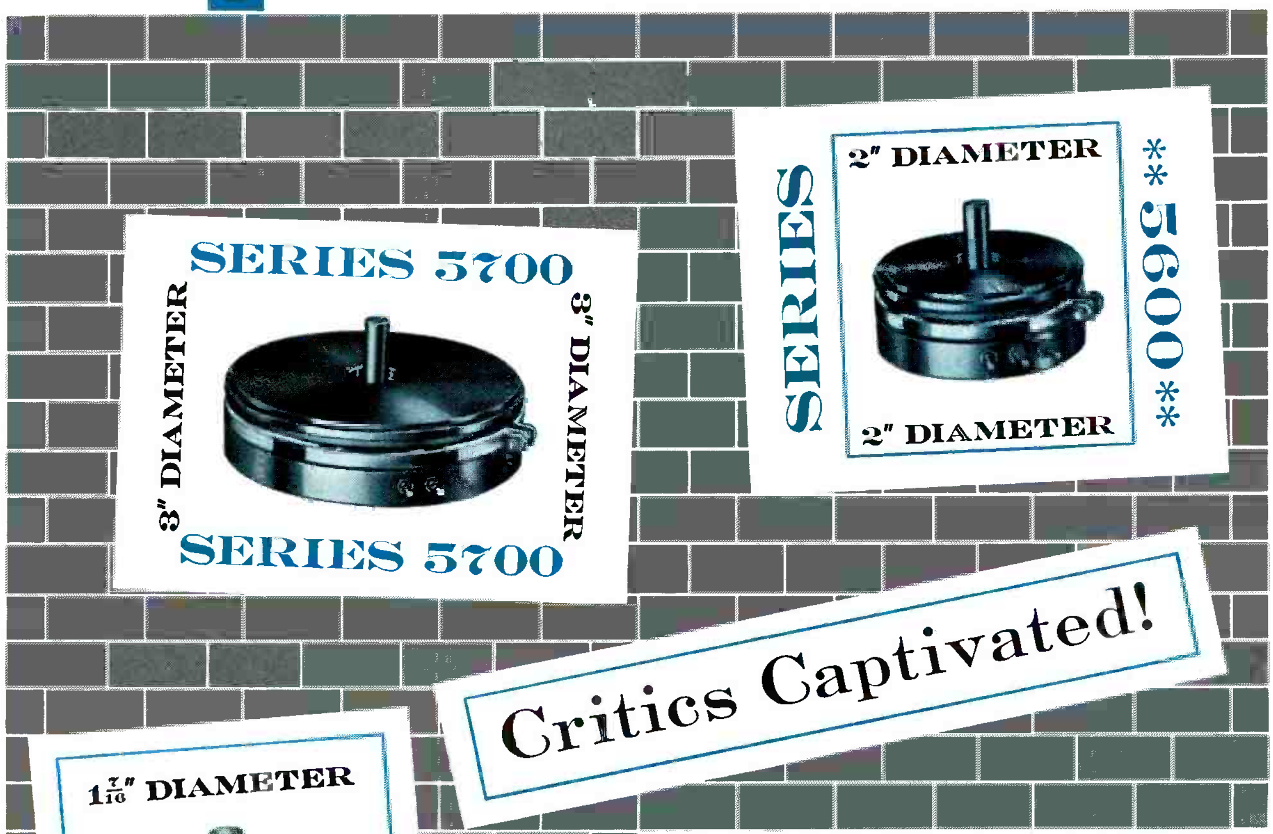
ACCORDING to the best available information, Nikola Tesla was born in what is now Jugoslavia on July 10, 1856. He died in New York City on January 7, 1943. He was about 28 years old when he came to America, but the young man brought with him the idea of a new alternating-current power distribution system based upon the polyphase induction motor. Current electrical power practice bears witness to the importance of his ideas.

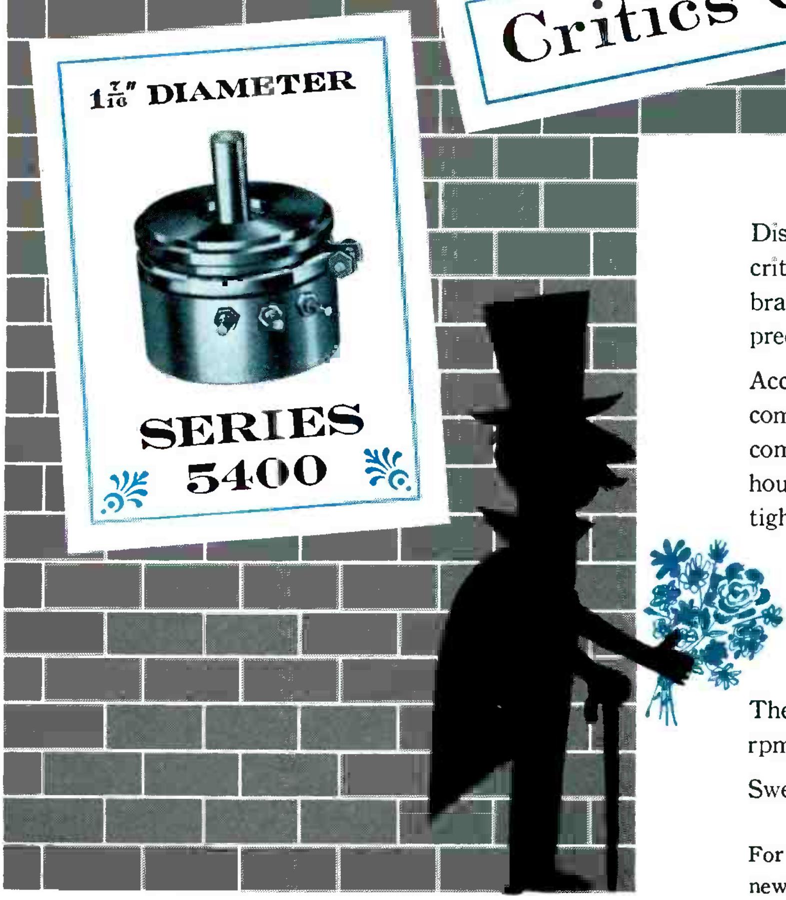
Despite his latter-day flamboyant pronouncements in the press, Tesla did not ever achieve a like measure of success in high-frequency radio communications or—a pet project—wireless transmission of power.

Writing about Tesla's contribution to high frequency, L. P. Wheeler in 1943 pointed out that a perusal of pertinent patent specifications indicated Tesla's superior grasp of three ideas. While they were not effectively exploited for communications purposes, his ideas appear to have been clearer than those of his contemporaries.

He understood the idea of inductive coupling between driving and working circuits; he saw the importance of tuning both circuits (the idea of an oscillation transformer); and he had the idea of a capacitance-loaded open-secondary

Another product *surprise* from Helipot!





Discriminating engineers, the world's toughest critics, applaud the brilliant performance of Helipot's brand new trio - - series 5400, 5600 and 5700 single-turn precision potentiometers.

According to the program notes, these three virtuosi come in a choice of five mounting-and-bearing combinations. A one-piece, dimensionally-stable plastic housing eliminates a separate rear lid. There are tighter tolerances on linearity and mechanical run-out.

A new rotor design reduces mass . . . permits lower contact pressure . . . results in decreased coil wear, more reliable operation, greater life expectancy. Incidentally, torque is lower.

They're a quiet trio, too. Maximum noise, at 100 rpm, with 1 milliamp of slider current, is 100 millivolts.

Sweet music to any electronic designer's ear!

For complete information and specifications on these three new HELIPOT* precision potentiometers, write for data file 701.

Helipot®

first in precision potentiometers
Helipot Corporation, South Pasadena, California
Engineering representatives in principal cities
a division of Beckman Instruments, Inc.

708 *REG. U. S. PAT. OFF.

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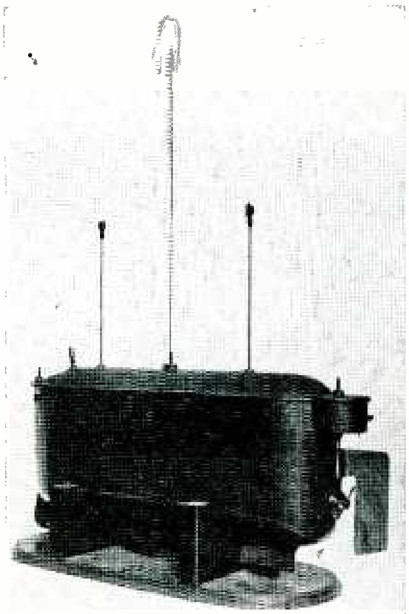
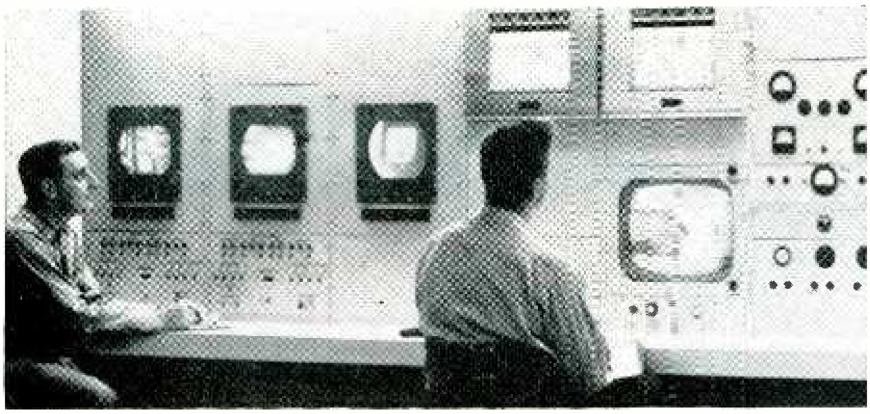
circuit. All this was presented in lectures or patent disclosures prior to 1894.

Tesla's great body of unworkable or unworked ideas was not so limited, however. For example, the late E. H. Armstrong wrote, a few months before his own death, ". . . in my 'Appreciation' of the work of Tesla which came during wartime (1943), there was much research under way toward reducing the Tesla concept of the guided weapon in various laboratories—I considered it inadvisable to draw attention to the subject by reference to Tesla's early concept of the matter. So far as I know, the credit for the concept rests entirely with him."



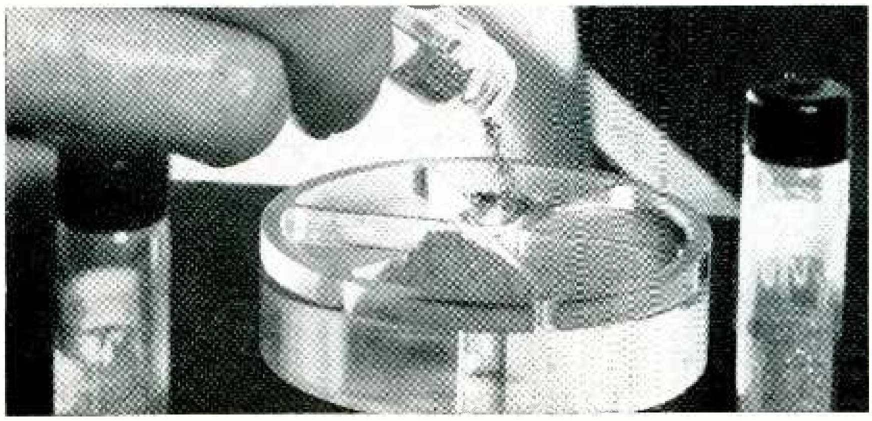
Wireless-controlled boat (1897)

New Wind Tunnel Depends On Television



Three strategically placed RCA television cameras in the new 10-by-10 foot supersonic wind tunnel located at Lewis Flight Propulsion Laboratory, Cleveland, permit safe observation of tests. Monitors shown are installed at the tunnel control room

Man-Made Industrial Diamonds



Production of man-made diamonds in 1954 by scientists of the General Electric Co. is commemorated in an exhibit of 100 carats of small industrial crystals at the Smithsonian Institution. The stones were made since 1954 using pressures of 2.7 million pounds a square inch at temperatures above 5,000 F. They are not commercially available

Radio Paging Eliminates Public Address

DISADVANTAGES of public-address paging or sound-signaling systems can be overcome by radio systems provided equipment is not too complex or expensive for all those required to use the service. Various systems have been suggested or used varying from the Hollywood closed-loop cueing system to selective signaling devices that can be operated many miles from the central transmitter.

In Great Britain, according to *McGraw-Hill World News*, British Communications Corp. of Wembley, England, is producing a Radiopage equipment that uses transistors in a receiver that picks up energy from a closed wire loop encircling the building in which communication is desired.

The frequency band includes 75

to 87 kc and each receiver is allocated a frequency 250 cps from its neighbor, allowing a total of 50 channels. Signals picked up by a ferrite rod antenna go through a stage of r-f amplification and are rectified by a germanium diode. Selectivity is obtained with a crystal filter tuned to one of the 50 different carrier frequencies of which the transmitter is capable.

A gating transistor controls application of high voltage to the audio stages so that only when a signal of correct frequency arrives does the gate open and the a-f stage operate. Audio power to the loudspeaker is about 5 milliwatts. When the receiver (illustrated) is not carried in the pocket but laid

A COMPLETE LINE OF DEPENDABLE ENCAPSULATED RESISTORS

PRECISION WIREWOUND RESISTORS FOR 85C AND 125C AMBIENTS

For applications requiring accurate resistance values at 85C and 125C operating temperatures—in units of truly small physical size—select the precise resistor you want from one of the 46 standard Permaseal designs in tab or axial lead styles.

Winding forms, resistance wire and embedding material are matched and integrated, resulting in long term stability at rated wattage over the operating temperature range. The embedding material is a special plastic that extends protection well beyond the severe humidity resistance specifications of MIL-R-93A and Proposed MIL-R-9444 (USAF).

These high-accuracy units are available in close resistance tolerances down to ± 0.1%. They are carefully and properly aged by a special Sprague process so that they maintain their accuracy within the limits set by the most stringent military specifications.

SPRAGUE

FOR COMPLETE DATA WRITE FOR COPY OF SPRAGUE ENGINEERING BULLETIN NO. 122A

SPRAGUE ELECTRIC COMPANY • 35 MARSHALL ST. • NORTH ADAMS, MASS.

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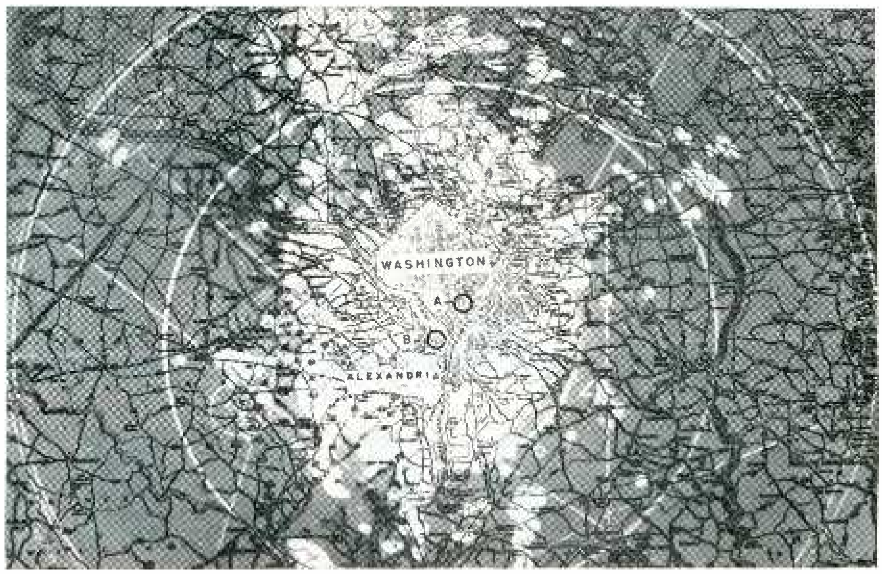
flat on a table, a mercury switch turns off the unit.

▶ **Transmitter Unit**—With a power output of 25 watts, the transmitter is considered adequate to cover an area of some 30 acres. A control unit contains 50 crystals. Signals from the control unit pass through a limiter and are then amplified sufficiently to drive a push-pull output stage. Amplitude modulation is used on both plate and screen. Output impedance can be adjusted between 50 and 300 ohms.

A loop Q up to 10 can be expected and as the frequency of the transmitter is varied with the selector switch, tuning capacitors are switched in each time transmitter frequency is changed by an increment of 2.5 kc. It is necessary to tune the transmitting loop by the addition of series capacitors so that a resistive load is presented to the transmitter.

Siting Communications Stations



Ground clutter, the generally unwanted signal return from hills, trees and other low objects, has been put to use by the Signal Corps. Propagation maps, showing possible uhf signal paths, can be prepared by superimposing radar reflections upon terrain maps. The light areas shown above indicate good communications paths from a 147-foot tower at Washington National Airport

Army Meteorologists Study Duct Effects

Instruments mounted on the 200-foot tower measure changing meteorological conditions during correlation tests on propagation ducts

ATMOSPHERIC conditions that cause ducting, or propagation of ultra-high frequency radio signals far beyond the optical horizon are recognized but quantitative data are lacking. The phenomenon is important to the military since transmissions thought to be private have sometimes been heard at distances great as compared with the location of the desired receiver.

Special Studies Branch, Plans and Programs Division, Aviation and Meteorological Dept., Army Electronic Proving Ground, Fort Huachuca, Arizona, is currently using airborne electronic equipment

Officer checks wind direction, velocity and humidity at base of 200-foot tower. Recorder at left is connected to wind vane, the center recorder indicates velocity of an anemometer. Motor operated psychrometer and recorder are at right

to analyze effects of temperature and humidity changes on microwave transmissions.

A duct is a layer of atmosphere, based either at the earth's surface or aloft. Ducts may be anywhere from 10 to 100 feet high. Some have been measured from 100 to 500 feet.

With a normal lapse rate in the atmosphere, temperature and humidity decrease with altitude. When the temperature, instead, increases with height and humidity decreases at a rate faster than normal, conditions are ideal for the formation of ducts. The greater the vertical dimension of a surface base duct, the greater the range of frequencies affected.

When a duct is aloft, its base above the transmitting and receiving stations, only those transmitted beams forming an angle of less than a degree with the base of the duct are deflected back and extend beyond the line of sight.

Helium-filled Kytoon is a nylon covered balloon with a stabilizing tail section. A Wiresonde picks up meteorological information and sends it back down the wire to the ground in tests being conducted at Gila Bend, Ariz.

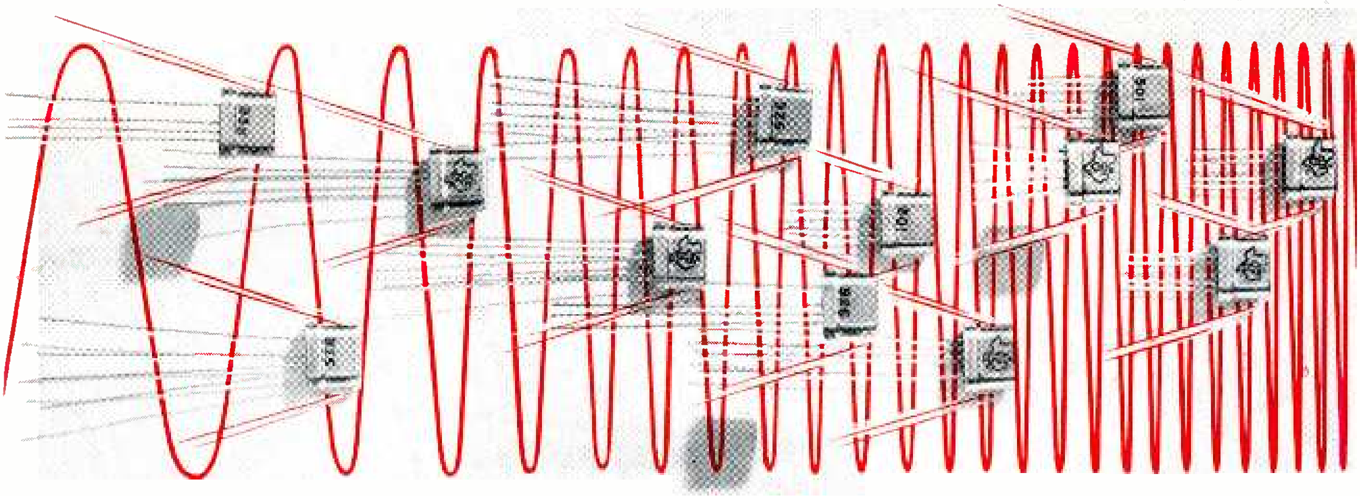
Transhorizon Utilization

IN NOTICE of proposed rule making, FCC says, "There is no question but that the technique (of over-the-horizon transmission) may prove to be economical and feasible with respect to short-haul international fixed circuits and there appears to be a great number of applications where the techniques might possibly be useful for the domestic fixed service perhaps, in some instances, replacing or supplementing conventional systems".

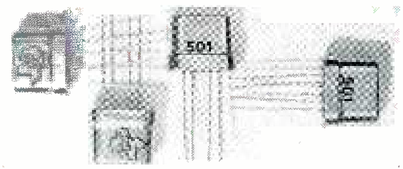
▶ **Information Needed**—Desired by July 1 is specific information as to whether tropospheric transhorizon fixed circuits can share with conventional circuits the bands above 940 mc. Also wanted is data showing anticipated use of tropospheric circuits, state of the art in techniques and equipment and evalua-

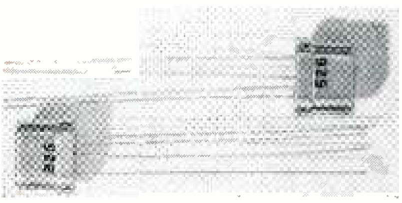
TEXAS INSTRUMENTS PROGRESS REPORT ON HIGH FREQUENCY

VHF transistors NOW!



NEW 'GROWN-DIFFUSED' TYPES COMMERCIALLY AVAILABLE IN PRODUCTION QUANTITIES





HIGH GAIN VHF TRANSISTORS with usable power levels and band widths are now immediately available from Texas Instruments . . . another first for the leading producer of silicon and germanium transistors. Your design horizons are now extended to include all-transistor TV, FM, and VHF receivers . . . and transistorized amplifier, oscillator, or switching applications in communications, telemetering, or radar.

NEW VHF GERMANIUM TRANSISTOR

OSCILLATING FREQUENCY IS ABOVE 250 MEGACYCLES . . . alpha cutoff frequency is 200 mc. Typical gain is 12 db at 100 mc (unregenerative). This performance in a production transistor was unheard of prior to perfection of the "grown-diffused" method – an exclusive Texas Instruments technique.

NEW HF SILICON TRANSISTORS

FREQUENCIES TO 30 MEGACYCLES, rated 30 volts and 125° C, make these "grown-diffused" units ideal for high temperature military and commercial applications. They increase to 10 the types of silicon transistors now available from Texas Instruments, and represent the continual improvement in frequency, gain, and power made by the pioneer producer of silicon transistors.

OTHER NEW SEMICONDUCTOR DEVICES FROM TI

NEW HIGH POWER TRANSISTORS – 12-watt dissipation germanium power transistor and 8.75-watt dissipation silicon power transistor. NEW HIGH VOLTAGE RECTIFIERS – full wave and single junction half wave 1500-volt silicon units stable to 150° C. NEW HIGH CONDUCTANCE DIODES – 4 types of axial-lead silicon junction diodes with 100 ma forward currents and 0.1 μa back currents.

All these devices in production and available immediately. Write today!

LOOK TO TI FOR: GERMANIUM VHF, POWER, RADIO, & GENERAL PURPOSE TRANSISTORS ● SILICON HF, POWER, & SMALL SIGNAL TRANSISTORS ● SILICON RECTIFIERS AND DIODES

TEXAS INSTRUMENTS
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6000 LEMMON AVENUE DALLAS 9, TEXAS

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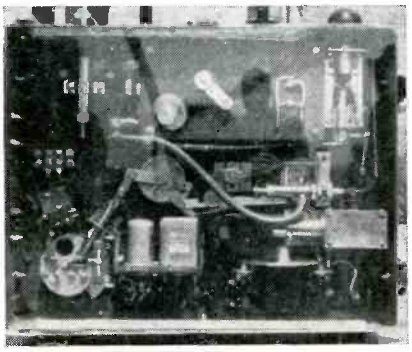
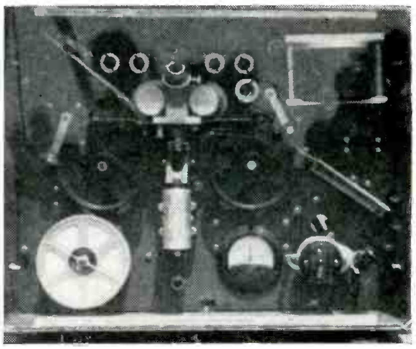
tion of relative spectrum utilization efficiency as compared with conventional line-of-sight systems.

The questions concern only tropospheric propagation, having a present practical range of about 200 miles using frequencies generally above 100 mc. Unmentioned is the technique of ionospheric forward scatter, which customarily operates in the frequency region of 30 to 50 mc over distances between about 500 and 1,500 miles. Circuits are experimental or military now.

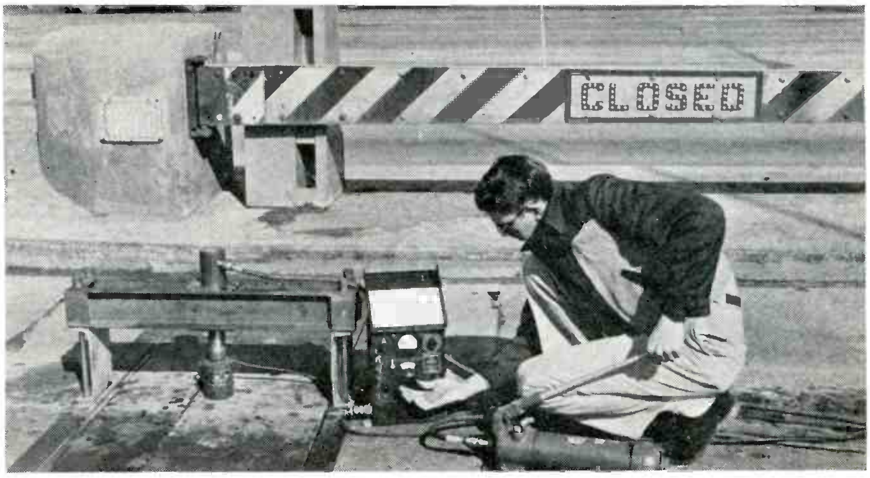
Photoelectric Sampler Detects Nerve Gas





Back (left) and front (right) of a nerve gas detector built by RCA for Army Chemical Corps. In principle, a chemically treated paper tape is drawn past a photocell. Then it is wetted and exposed to ambient air pumped through the unit. Hazardous industrial or commercial gases react with the impregnated paper to change its color, which is sensed by a second photocell. If the before and after colors do not balance, an alarm is sounded

Toll Highways Check Vehicle Scales



Accuracy of the electronic weighing mechanism used to determine load of trucks on turnpikes is tested with a hydraulic jack and load cell similar to that employed under scale platform. A series of weight readings obtained with the Baldwin-Lima-Hamilton SR-4 load cell is checked with those recorded in the toll booth

Research Publication

MILLIONS of dollars are being spent in tax-supported institutions for research that should benefit industry. To make the results of its scientific contribution available, Naval Research Laboratory has adopted the expedient of publishing regular monthly reports, beginning January 1956.

Priced at $1.25 each, these reports are available from Office of Technical Services, U. S. Depart-

ment of Commerce, Washington 25, D. C. Each bulletin contains 50 to 60 pages and carries articles by members of the NRL staff.

There is a list of problems accepted and a number of problem notes in electricity, optics, radio, sound and other fields allied to that of electronics.

A list of published reports (available from OTS) and papers appearing in scientific journals and patents issued is also given.

Higher Pentode Gain

By Lester Levy
Engineering Consultant
Brooklyn, N. Y.

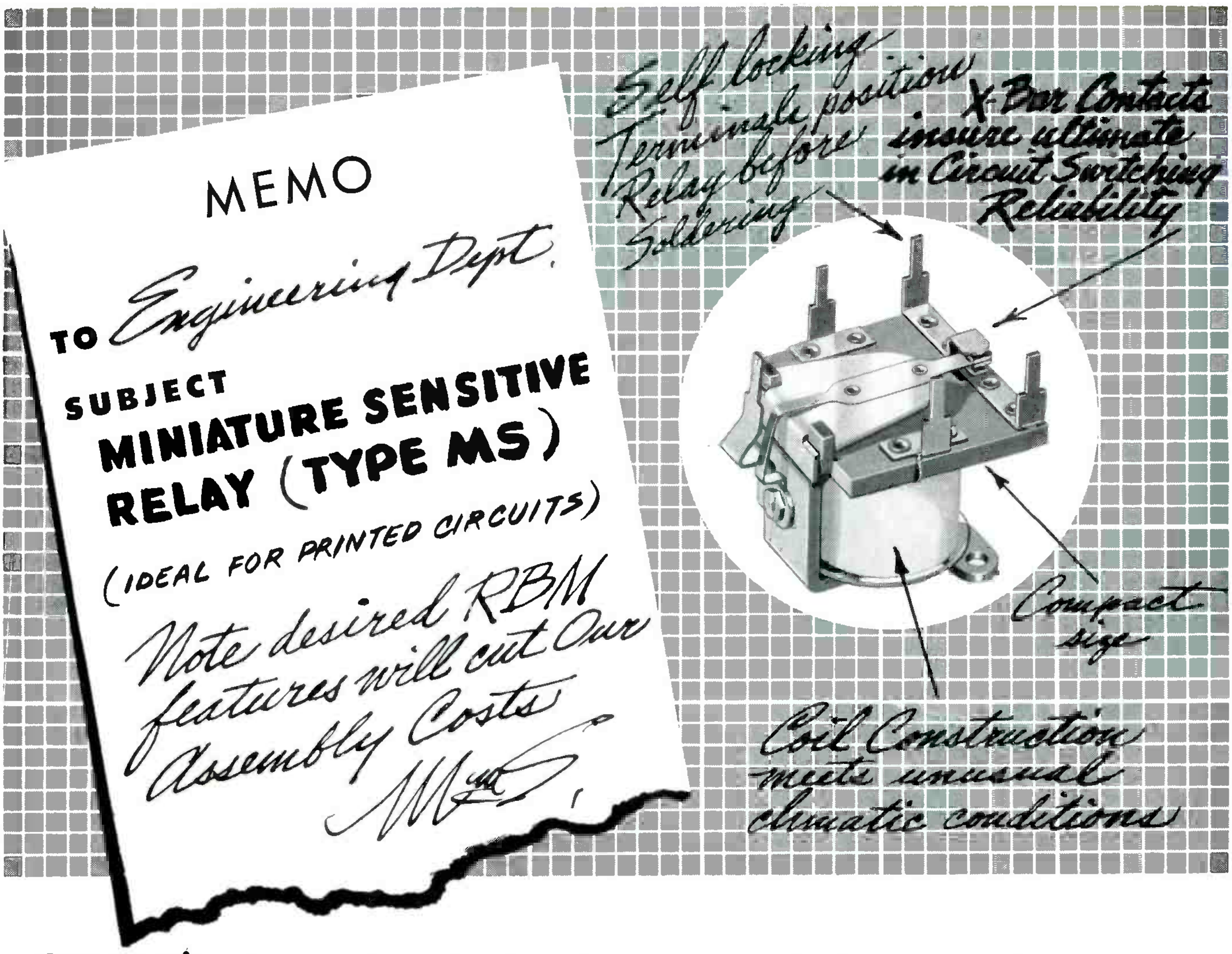
When employing triodes in amplifying circuits, little difficulty is encountered in realizing amplifications approaching the μ of the tube. This is because it is relatively simple to load the plate circuit with impedances that are five or more times the internal plate impedance of the tube.

For pentodes, the internal plate impedance is in the order of a megohm. To realize amplifications approaching the μ of the tube, a load of several megohms is needed. Even with resonant circuits it is not usual to realize amplifications much in excess of 200.

For broadband characteristics at audio frequencies, it is customary to use resistive, inductive or transformer loading. Unfortunately, inductances and transformers are expensive, weighty and bulky. In obtaining high amplification through the use of higher primary impedances, the expense, weight and bulk are also increased.

While the resistor has the advantages of being small, light and inexpensive, it has the serious drawback of limiting the available electrode voltages and currents. The μ or the g_m decreases with decreasing plate current so that resistance coupling limits the available amplification, with reasonable power supplies, to about 200.

One means of increasing the gain of a pentode is to use another pentode as the load impedance on the amplifying pentode. This is illustrated in Fig. 1A. Inductances



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.

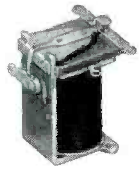
The fact that industry has already used over a million units of this design is your assurance that the R-B-M Type MS relay will meet your most exacting requirements.

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	1⅛ x 1 1/16 x 1 1/32″

Send for Descriptive Bulletin MS-1

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and transformers have the advantage of relatively low d-c voltage drops, owing to relatively low d-c resistance, while maintaining high impedances. The small d-c voltage drops permit the amplifier tube to operate at high current and high g_m with the consequent high gain. In the case of the pentode used as a load on the amplifier pentode, the fact that the internal plate impedance is much higher than the d-c resistance of the tube is used. In such a circuit it should be possible to realize about half the μ of the tube if identical tubes are used.

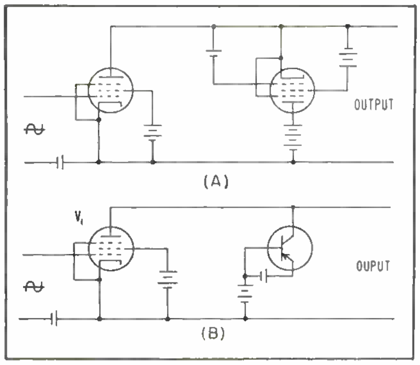

FIG. 1—Pentode gain increased (A) by using another as load impedance. Pentode load is replaced by transistor (B)

Use of a pentode as a load on another presents a few difficulties. The load-tube cathode is several hundred volts above ground and its filament winding must be floating. Tube cost is much higher than that of a resistor. The tube requires additional capacitors and resistors, in addition to a floating screen supply.

Transistors have collector internal impedances of the same order of magnitude as those found in pentodes. The collector impedance is a function of both collector current and emitter external circuit impedance, among other factors.

A simple theoretical circuit, using a *pnp* transistor, is shown in Fig. 1B. The circuit between collector and emitter serves both as the d-c path for the plate current of V_1 and as the high impedance load on V_1. Since the d-c voltage drop is small, being of the order of 20 volts or less, there is no problem with regard to uneconomical power supplies.

A practical circuit is shown in Fig. 2. Tube V_2 is not essential to the circuit. This tube was added as

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STANDARD UNITS		ROTOR						STATOR						IMPEDANCE								
SYNCHRO FUNCTION	CPPC TYPE	Input V400cy	Input Amps	Input Watts	Ohms (DC)	Output Rotor	Sensitivity (MV/deg.)	Output Volts	Sensitivity (MV/deg.)	Input Volts	Input Amps	Input Watts	Ohms (DC)	Zro	Zso	Zrss	Phase Shift R-S	Phase Shift S-R	Nulls (MV)	Possible Error	Spd.	Length in inches
Torque Transmitter	CGC-8-A-7	26.0	100	.5	37	—	—	11.8	200	—	—	—	12	54+j260	12+j45	76.4+j19.6	8°	—	30	7′	14′	1.240
Control Transformer	CTC-8-A-1	26.0	.050	.25	143	24	410	11.8	200	11.8	.090	.23	25	220+j740	28+j110	246+j60		8.5°	30	7′	14′	1.240
Control Transformer	CTC-8-A-4	—	—	—	381	24	410	—	—	11.8	.037	.09	60	508+j1680	67+j270	640+j190	—	9.2°	30	7′	14′	1.240
Control Differential	CDC-8-A-1	—	—	—	36	11.8	200	—	—	11.8	.085	.21	25	38+j122	27+j120	48.6+j13.8	—	9°	30	7′	14′	1.240
Electrical Resolver	CSC-8-A-1	26.0	.039	.43	230	23.2	400	10.6	180	11.8	.084	.27	27	280+j600	38+j136	70+j136	20°	11°	30	7′	14′	1.240
Torque Receiver	CRC-8-A-1	26.0	.100	.50	37	—	—	11.8	200	—	—	—	12	54+j260	12+j45	85.1+j20.4	8°	—	30	30′	30′	1.240
Vector Resolver	CVC-8-A-1	1-26	.057	.34	78	—	—			11.8	.294		27	103+j444	28.8+j27.9		10.2°	—	1MV/V			1.240

TYPICAL SYSTEM MEASUREMENTS

SYSTEM	Input V400cy	Input Amps	Input Watts	Output Volts	Sensitivity (MV/deg.)	CPPC TYPES	Input Z	Output Z	Phase Shift	Nulls (MV)	REMARKS
Transmitter→C.T.	26	.110	.74	23.6	408	CGC-8-A-7→CTC-8-A-4	58+j226	626+j233	19°+	50	Hi Z Load on CT
Transmitter→C.T.	26	.111	.75	23.3	407	CGC-8-A-7→CTC-8-A-4	58+j226		19°	50	50K Load on CT
Transmitter→C.T.	26	.111	.83	20.8	363	CGC-8-A-7→CTC-8-A-4	64+j221		17°	50	5K Load on CT
Transmitter→4 Parallel CT's	26	.145		21.8	381	CGC-8-A-7→4 ‖ CTC-8-A-4			28°	40	CT Interaction ½° Max.
Transmitter→Differential→C.T.	26	.134	1.78	19.5	340	CGC-8-A-7→CDC-8-A-1→CTC-8-A-4		748+j364	40°	40	CT Output to Hi Z
Series Vector→Electrical Resolver	1→26	.103	.67	4.9	85	CVC-8-A-1→CSC-8-A-1	55+j230	32+j68	32°	40	$E_o = .19\ E_1 \sin\theta_1 \sin\theta_2$
Series Vector Resolvers	1→26	.110	.55	5.2	91	CVC-8-A-1→CVC-8-A-1			20.2°	40	$E_o = .2\ E_1 \sin\theta_1 \sin\theta_2$
Transmitter→Receiver	26	.200	1.0	—	—	CGC-8-A-7→CRC-8-A-1			—	—	Torque 2400 mg.mm/deg.

LOOK TO CPPC FOR **cppc** *SYNCHRO PROGRESS*

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a cathode follower that permits relatively heavy loading by the measuring instrument while giving a good measure of the a-c voltage being belivered by the transistor-loaded pentode. Resistor R_1, the external emitter circuit resistance, is chosen high enough to have negligible effect upon the collector impedance. Resistor R_2 controls the base current, helping to determine the operating point of the transistor. The plate current of V_1 passes through

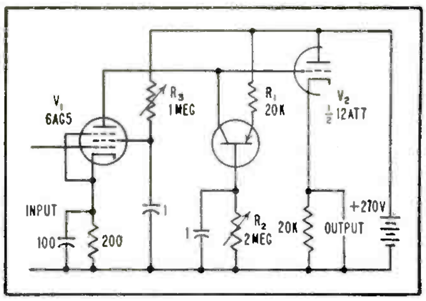

FIG. 2—Practical amplifier circuit uses transistor load stage followed by cathode follower

power supply, R_1 and the collector.

For a particular collector current and emitter external circuit resistance, there is a discrete base current that yields the maximum gain. Inasmuch as V_1 will have its greatest g_m with the greatest plate current, it is necessary to adjust its plate current and base current of the transistor until maximum amplification is obtained. Since the collector impedance seems to drop with rising collector current it is necessary to strike the optimum combination depending upon the particular tube and transistor used. Resistor R_3 permits adjustment of plate current by adjustment of the screen voltage.

With the particular tubes and transistors used, the maximum amplification was obtained with collector current in the range of 4 to 6 milliamperes. In general, transistors with high alpha gave highest amplification. For V_1, a type 6AG5 tube was used, although there is no reason to believe that other tubes giving reasonable g_m at lower plate currents might not give better results. This may be expected since maximum collector impedance rises with decreasing collector current.

A value of 10,000 ohms has al-

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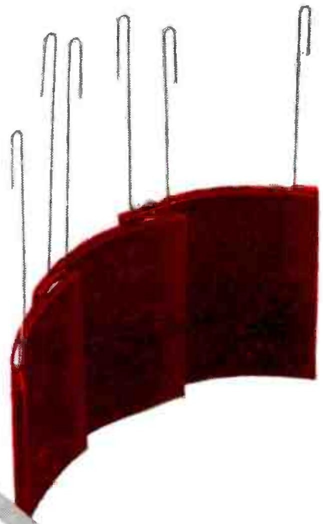

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ready been tried successfully for R_1. Probably even less can be used. This would result in lower voltage requirement in the power supply, since R_1 produces an appreciable voltage drop.

With transistors having high alpha values R_2 became ineffective at higher resistance values. This might indicate that the static operating point of the transistor was being controlled by either or both of the two components of I_{co}. These two components are the normal saturation current and surface leakage currents. Transistors with improved characteristics along these lines should give still higher amplification.

Frequency response, noise and distribution characteristics have not been evaluated.

Magnetic Storm Alarm

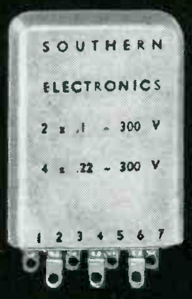
ACCORDING to *McGraw-Hill World News*, Askania-Werke in East Germany has produced an instrument called the H-Magnetograph for giving automatic warning of magnetic storms. It consists of an H-unit with torsion fiber and magnetic system, photocell attachment, switching box and line recorder with contact operating at a prearranged amplitude.

By this means, any kind of visual or audible alarm can be actuated, indicating the outbreak of a magnetic storm. Detailed ionospheric observations can then be carried out immediately upon such warning.

This instrument has been developed following the recommendation of a special committee for the International Geophysical Year, that equipment for giving automatic warning of great geophysical events such as magnetic storms, should be developed.

Cadmium Oxide Cover Electrodes

COVER ELECTRODES for photocells should be as transparent as possible. The greatest amount of light energy must reach the active cadmium



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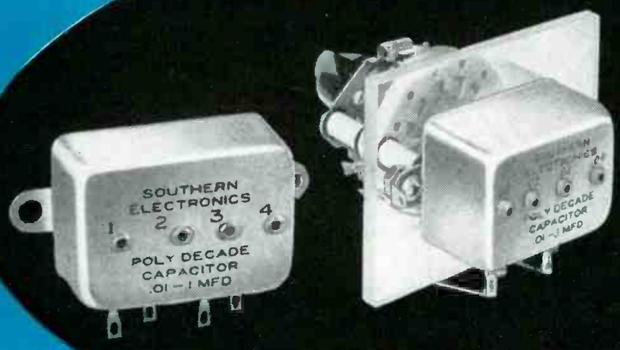

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selenide layer of a selenium photocell to have maximum effectiveness. Such a cover electrode should likewise have minimum electrical resistance. *McGraw-Hill World News* reports that Wilfred Berger of Electrocell GmbH, Berlin-Steglitz has recently developed a selenium photocell using cadmium oxide as a cover. Whereas cadmium of 60 percent transparency has a resistance of 1,000 ohms, the cadmium oxide layer under the same conditions has a resistance of 10 ohms.

Video Tape Recorder

TECHNICAL details of the new Ampex video tape recorder show its differences from conventional sound recorder-reproducers. Designed for broadcast service, the new unit has two input connections, one for video and the other for audio. The output signal is said to meet RETMA standards for video to transmitter.

Relative timing of any two scanning lines in any group of 20 adjacent lines is reproduced on any machine to an accuracy of 1 part in 600. Horizontal instability is not detectable on a studio monitor of RCA 630TS synchronizing circuitry. Field-to-field stability is held to a degree equivalent to no more than 10-percent error of interlace on the reproduced picture.

Much of the operational stability of the machine results from a refined version of a power-line lock-in drive described in 1950. A control track is continuously recorded on the tape at a frequency that corresponds to that of the power line.

Small variations are thus recorded for future reference. During playback, an electronic servo compares power-line frequency recorded with that being supplied and issues a correction signal to the tape-drive mechanism.

▶ **Response Levels** — Video level changes between record input and playback output, owing to differences in output among the four revolving heads, are more than 40

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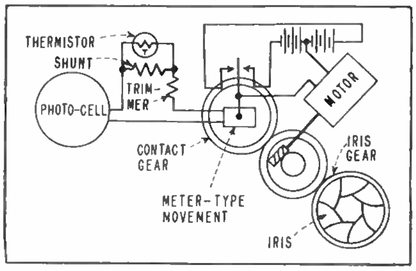
nongovernment fixed and mobile (as further defined in Part 2 of the Rules).

Frequencies between 13,200-13,225 mc are nongovernment fixed and mobile; and 13,225-16,000 is assigned to government use.

Camera Exposure Adjusts Automatically

LIGHT striking a photocell is measured by a meter to which is affixed a moving contact arm. A pair of fixed contacts shown in the drawing is mounted on a gear ring and so connected that the motor tends to center these contacts on the moving contact. The camera iris is



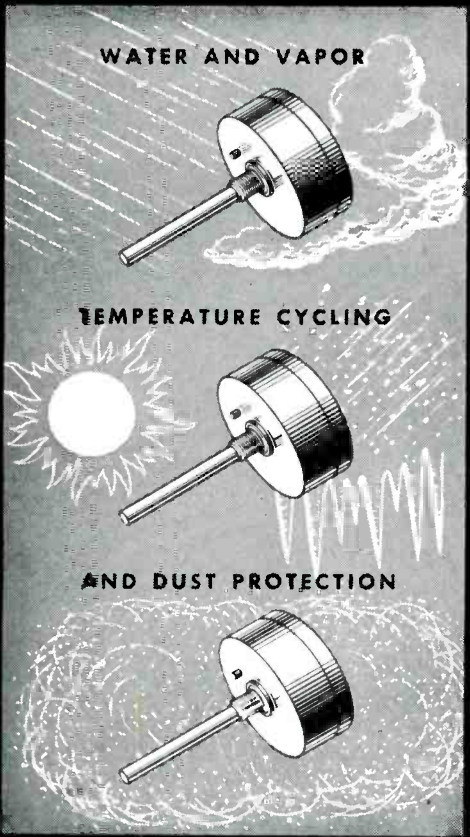
Circuit diagram of the photocell-actuated iris

Bottom view shows motor and mercury-cell battery

Transistors Under Test

Electrical performance tests on Philco M-1 transistors that operate in the audio-frequency range. Hermetically sealed units can withstand acceleration rates up to 20,000 g

BUILT-IN PROTECTION



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"POTPOT" means potted or encapsulated potentiometers. Either in wire-wound or carbon types, including **Clarostat** Series 48M, 49M, 43, 37, 51, 58, and 10 controls. New encapsulating material means water- and vapor-tight molded enclosures imbedding entire unit with exception of external shaft assembly and terminal tips. Special water-tight assembly for shaft bushing.

Designed specifically to meet MIL-STD-202 Test Specification. Incorporating necessary salt-spray, humidity and temperature cycling requirements of MIL-E-5272 climatic standards. Excellent shelf life. Electrical specifications are those of given **Clarostat** control type.

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likewise geared into the system with the result that strong ambient light tends to close the iris, while weak light opens it.

▶ **Home Movies** — Application of this system has been made in a Bell & Howell camera designed for amateur use. Six mercury cells are used to drive the actuating motor.

Phase Detector for Synchro Alignment

By G. S. Copper
Supervisor
Test Equipment Design Section
Bell Aircraft Corp.
Tonawanda, N. Y.

THE PHASE DETECTOR described here is the result for the need of a simple and inexpensive in-line production tool to be utilized during the assembly of synchros into servo systems.

The construction of the angle-indicating synchro is shown in Fig. 1A. A single winding is rotated so that it couples in varying amounts with three fixed stator windings.

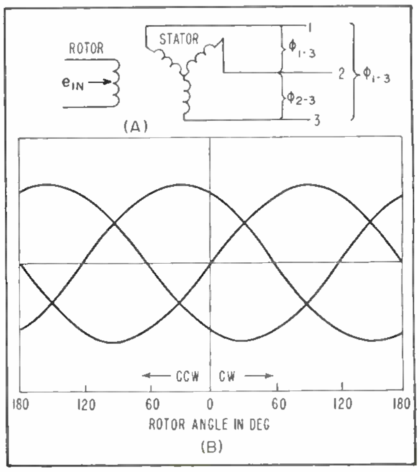
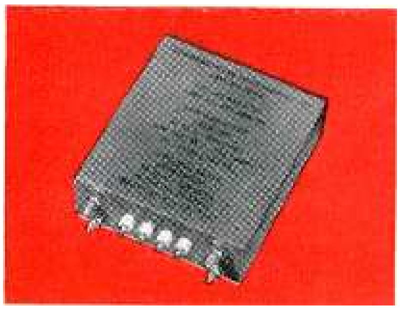
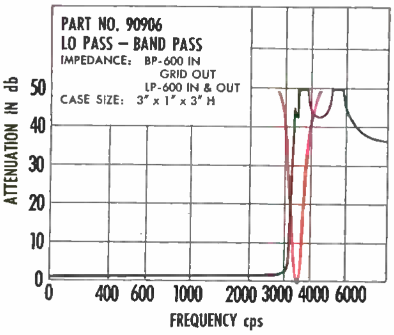


FIG. 1—Winding arrangement of synchro motor (A) provides 3-phase output (B) when sinusoidal signal is applied

The stator windings are oriented 120 degrees apart in space. Signals induced in these stator windings are essentially in time phase but are 120 degrees apart in space phase.

If a sinusoidal voltage is applied to the rotor windings of the synchro, the induced output voltages between phase 1 and 2, phase





L-C FILTERS

L-C filters utilizing high Q toroidal inductors and high quality capacitors are the heart of these frequency selective components. Recent developments of magnetic materials and highly stable capacitors have extended the useful frequency and temperature range of electrical wave filters. Use of impedance transformations, near unity coupling, and other applications of advanced network theory result in high performance units in small volume packages.

Low pass, high pass, band pass and band stop filters can be designed covering sub audio to over 500kc range. Line, interstage or other impedances can be specified. Filters can be designed for direct paralleling where required. High permeability cases and the closed toroidal form assure low hum pickup. Temperature stabilization on the order of 0.1% frequency can be attained through use of negative TC compensation to offset slightly positive coil and capacitor characteristics.

Depicted response curve is for an integrally packaged low pass—band pass filter employing the latest design and production procedures. This unit uses less chassis area and is an excellent example of subminiature coil usage, impedance transformations, and printed circuitry. Hermetically sealed to meet the military specifications.

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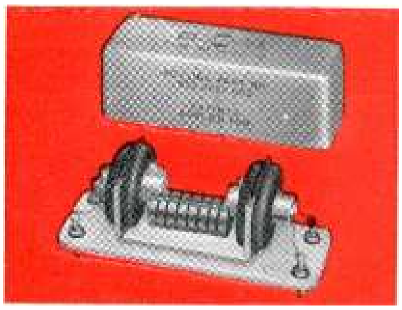

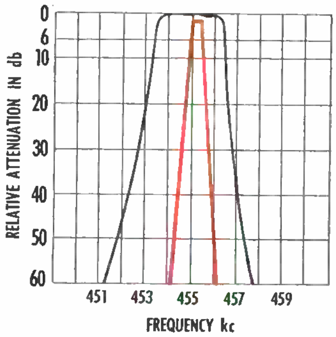

MECHANICAL FILTERS *(Developed and mfd. by Collins Radio Co.)*

The Mechanical Filter provides far better bandpass selectivity in one small sealed unit than a series of bulky conventional IF transformers. Excellent characteristics allow closer spacing of information channels, lower adjacent-channel interference and improved signal to noise ratios. These Filters have been proven in thousands of military and commercial receivers, transmitters and microwave multiplex systems.

Units are designed for center frequencies of 60 to 600kc and various 6db bandwidths from 300cps to 16kc. In general, bandwidth is limited to 10% of the center frequency. In many types, the 60db bandwidth is only twice the 6db bandwidth. Filters have a frequency shift with temperature of + 10ppm/°C. Normal insertion loss for the filters is 6 to 8db. Most types comply with Mil-E-5400 on shock and vibration.

In receiver IF amplifier design the Mechanical Filter replaces one of the usual IF transformers and is fixed tuned. Preceding or following stages may be coupled with subminiature toroidal transformers using fixed tuning. Variable selectivity is obtained by using two or more Filters and switching connections.

Catalogs on Individual Components are Available on Request.

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2 and 3, and phase 1 and 3 are amplitude-modulated signals, as shown in Fig. 1B, proportional to the angular displacement of the rotor. Negative values of induced output voltages indicate a 180-deg phase reversal with respect to the rotor input voltage.

Two null points exist as the rotor is turned through 360 degrees and phase reversal is in opposite directions. For example, if the rotor is adjusted to null at zero degrees and the rotor is turned through 180 degrees in a counterclockwise direction, the phase of the output stator voltage (phase 1 and 3) will be 180 degrees out-of-phase with respect to the rotor input voltage.

If the rotor is then turned to its other null position (180 mechanical degrees), clockwise rotation from its new null position will produce an output voltage whose phase is 180 degrees with respect to the rotor input voltage. Counterclockwise rotation through null will produce an output voltage which is in phase with the rotor input voltage.

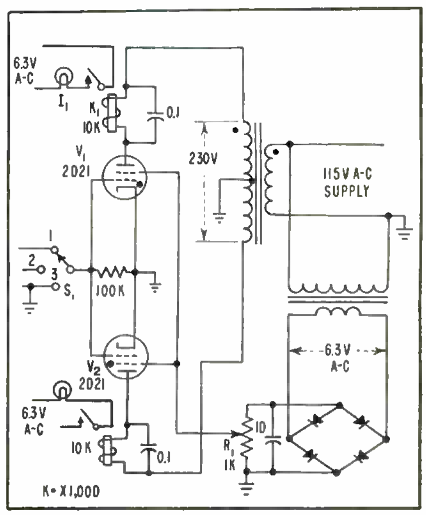

FIG. 2—Phase detector for determining independent null points in synchro alignment

The circuit shown in Fig. 2 may be used to select, as a go no-go detector, the two independent null points in order properly to align the synchro in an angle-error detection system. A feedback signal resulting from a false null position of the synchro would add to rather

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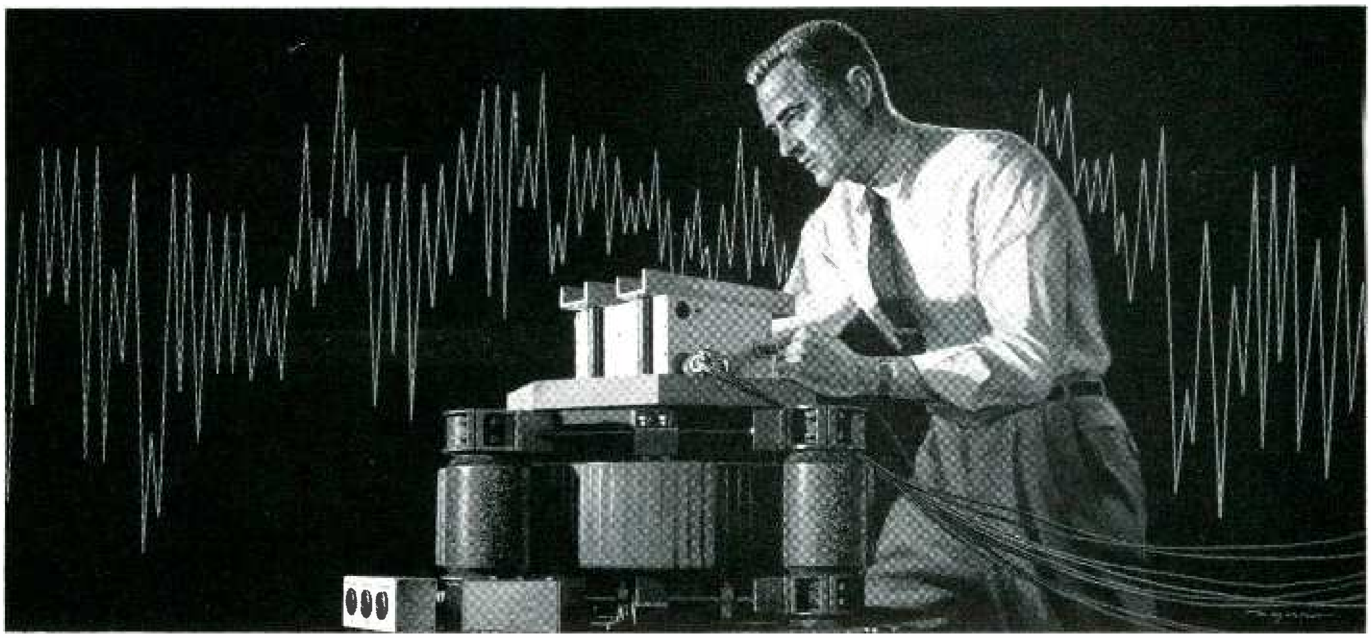

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than reduce the angular error.

Essentially, the circuit consists of two thyratrons whose plate voltages are 180-degrees out of phase with respect to each other, a bias supply and two indicating lamps, each connected across the contacts of the plate-load relays, of the thyratrons. A calibrating a-c input voltage, approximately ten times the rms value of the synchro null voltage is applied simultaneously to the control grids of V_1 and V_2.

Bias potentiometer, R_1 is adjusted until indicator lamps I_1 and I_2 are extinguished. If the phase 1 and 3 stator winding of the synchro is connected to switch 1 and the rotor displaced from null in a clockwise direction to induce a stator voltage equal to or greater than the calibrating voltage, V_1 or V_2 will conduct, lighting I_1 and I_2 respectively. For example, if synchro stator phase 1 and 3 is in phase with the supply voltage, then V_1 will conduct each half cycle and I_1 will light. Tube V_2 will be in a nonconducting state since the control grid and plate voltages are 180 degrees out of phase.

Conversely, if phase 1 and 3 is 180 degrees out of phase (counterclockwise rotation) with the supply voltage, then V_2 will conduct, I_2 will light and I_1 will be extinguished.

If the synchro rotor be mechanically rotated 180 degrees to its other null position, a clockwise displacement of the rotor would produce an out-of-phase voltage, lighting I_2. Conversely, a counterclockwise displacement would produce an in-phase voltage, lighting I_1.

This circuit lends itself easily to production line go no-go alignment of correct null points for synchros. After the lighting sequence has been established, refinement of null adjustment may be made with a vacuum-tube voltmeter.

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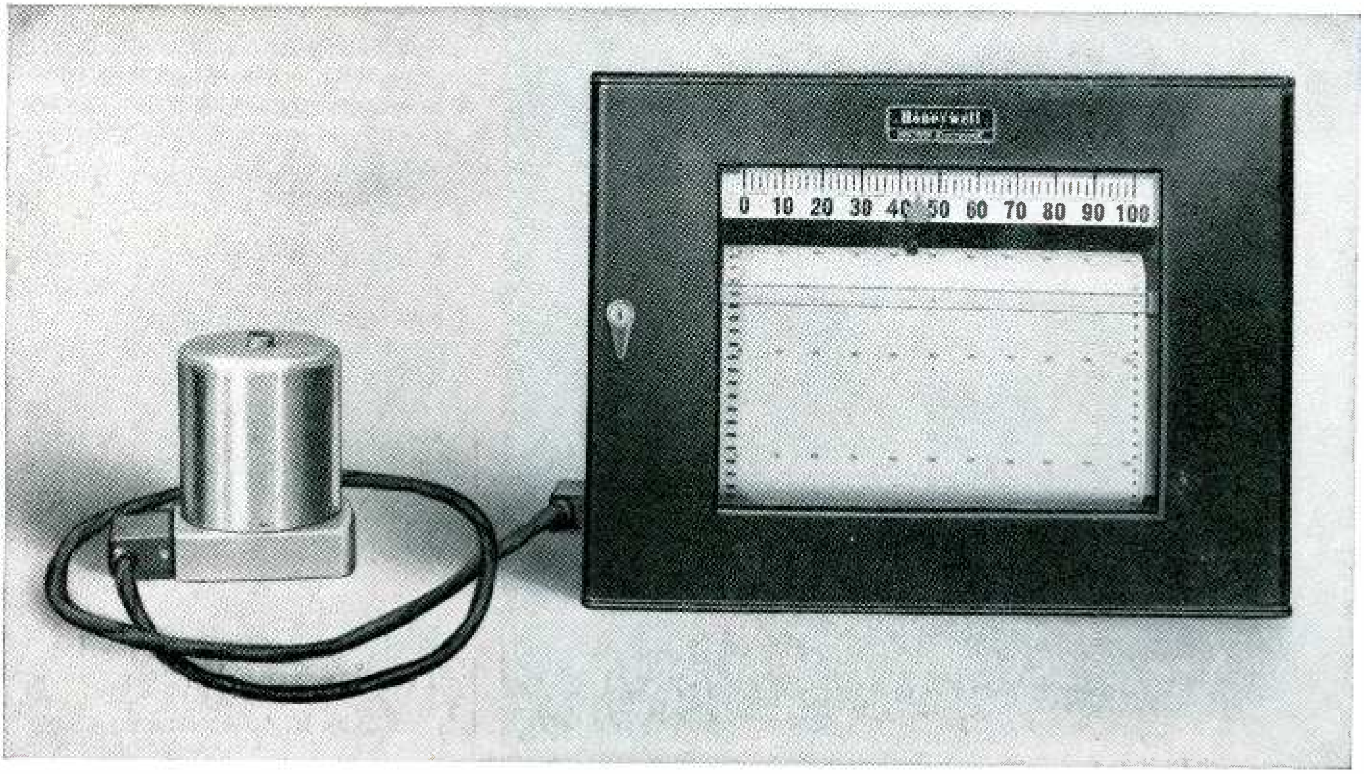

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Bistable Circuits Using Triode-Pentodes

by H. L. ARMSTRONG
Pacific Semiconductors, Inc
Culver City, California

TRIODE-PENTODE tubes make possible several interesting multivibrator-type circuits that use only one tube envelope. Oscillators working

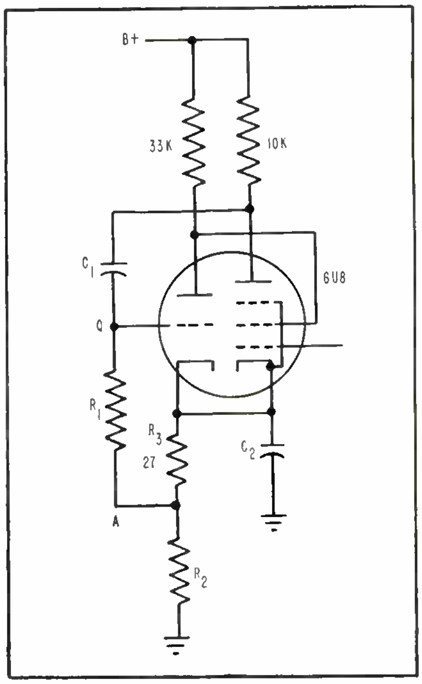

FIG. 1—Basic multivibrator-type circuit. Component values for free-running, one-shot and Schmitt trigger circuits are given in text

on the same principle are also possible.

Figure 1 shows a basic circuit; it is like a conventional multivi-

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TYPE	FREQUENCY RANGE	WAVEGUIDE
Models 8211— 3	8200 to 11500 MC	RG-52/U
Models 7010— 3	7000 to 10000 MC	RG-51/U
Models 5882—1, 2, 3	5800 to 8200 MC	RG-50/U
Models 4458—1, 2, 3	4400 to 5800 MC	RG-49/U

Frequency Standards
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brator except that one feedback path is from the triode plate to the pentode screen by having the two directly connected.

A free-running circuit uses the following numerical values: B+ = 150 volts, $C_1 = 300\ \mu\mu f$, $R_1 = 100{,}000$ ohms, $C_2 = 50\ \mu f$, $R_2 - 0$ (point A was grounded directly) and the grid of the pentode section went to ground through a 10,000-ohm resistor. Figure 2 shows the waveforms at the pentode plate, triode plate and triode grid.

On the upper two waveforms, the scales are 20 volts per cm and 1 μsec

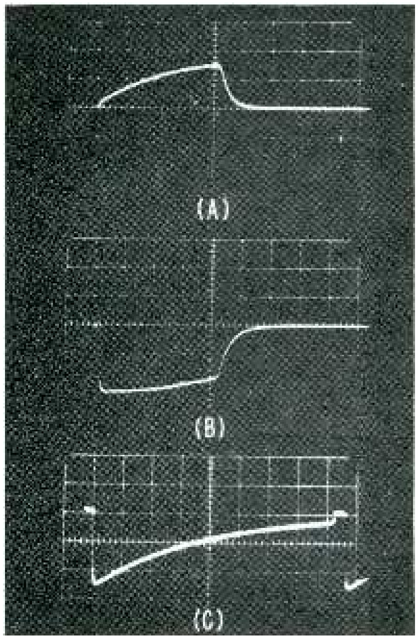

FIG. 2—Waveforms present at pentode plate (A), triode plate (B) and triode grid (C) in free-running circuit

per cm. (the squares are one cm); on the bottom one they are 10 volts per cm and 10 μsec per cm. Thus the frequency of this circuit was about 12 kc, and the length of the main pulse about 4.5 μsec.

A one-shot circuit was also tried, using values of B+ = 300 volts, $C_1 = 0.0015\ \mu f$, $R_1 = 100{,}000$ ohms, $R_2 = 2{,}200$ ohms, $C_2 = 100\ \mu f$. The pentode grid was again returned to ground through a 10,000-ohm resistor and the triggering pulses, which were derived from a neon bulb relaxation oscillator, were applied to it.

Figure 3 shows the resulting waveform at the triode plate. Here the scale is 40 volts per cm and 10

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μsec per cm, and the operating frequency about 800 cps.

A Schmitt-type circuit, which switches from one stable state to the other when the input voltage exceeds a certain level,[1,2] was also built. For this circuit, B+ = 300 volts, R_1 = 1 megohm, and C_1 was replaced by a 1.8-megohm resistor. Point *A* was connected to ground

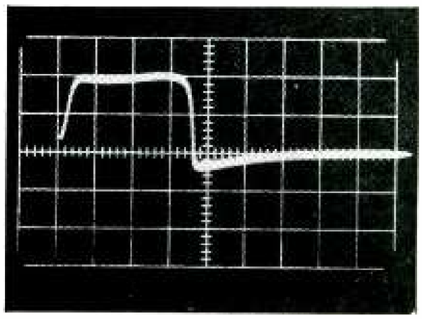


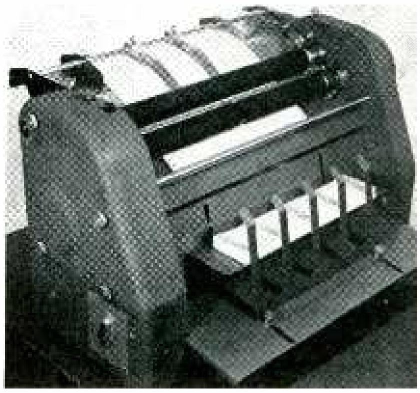
FIG. 3—Triode plate waveform for one-shot multivibrator-type circuit

but C_2 and R_3 were omitted and the cathodes connected directly to +80 volts.

When the voltage applied to the pentode grid exceeds about 80 volts, the circuit changes from state 1 (triode conducting, pentode nonconducting) to the other state. This causes a rise of about 50 volts at the triode plate, which is the output.

For this use, the present circuit has some advantage over the cath-

Forms Burster



Office forms of varying length can be quickly processed using a forms burster that separates sections along a perforated line. Twenty-three different lengths from 3 to 22 inches can be selected by electronic timing in a machine recently developed by Standard Register

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ode-coupled multivibrator in freedom from feed-through effects for rapidly rising inputs. It shares this advantage with other circuits[3, 4] recently described, but is simpler.

A bistable circuit would also be possible, but it would seem to have no advantage over the conventional flip-flop.

This basic circuit has also been applied to sine-wave oscillators. One type makes C_1 fairly large and replaces R_1 by a parallel-resonant tank circuit. Another makes a resistance-capacitance oscillator in replacing C_1 by a resistor and capacitor in series and R_1 by the same value of resistor and capacitor in parallel. Thus the latter is similar to some other oscillators[5] recently described.

The R-C oscillator gave good results with B+ voltages as low as 25 volts. With these, as with other oscillators, the amplitude must be limited for a good waveform.

These examples show how plate-to-screen feedback can be applied to produce several interesting circuits that require only one tube envelope and leave one grid free for triggering, gating or modulation.

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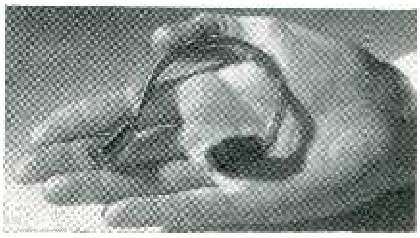
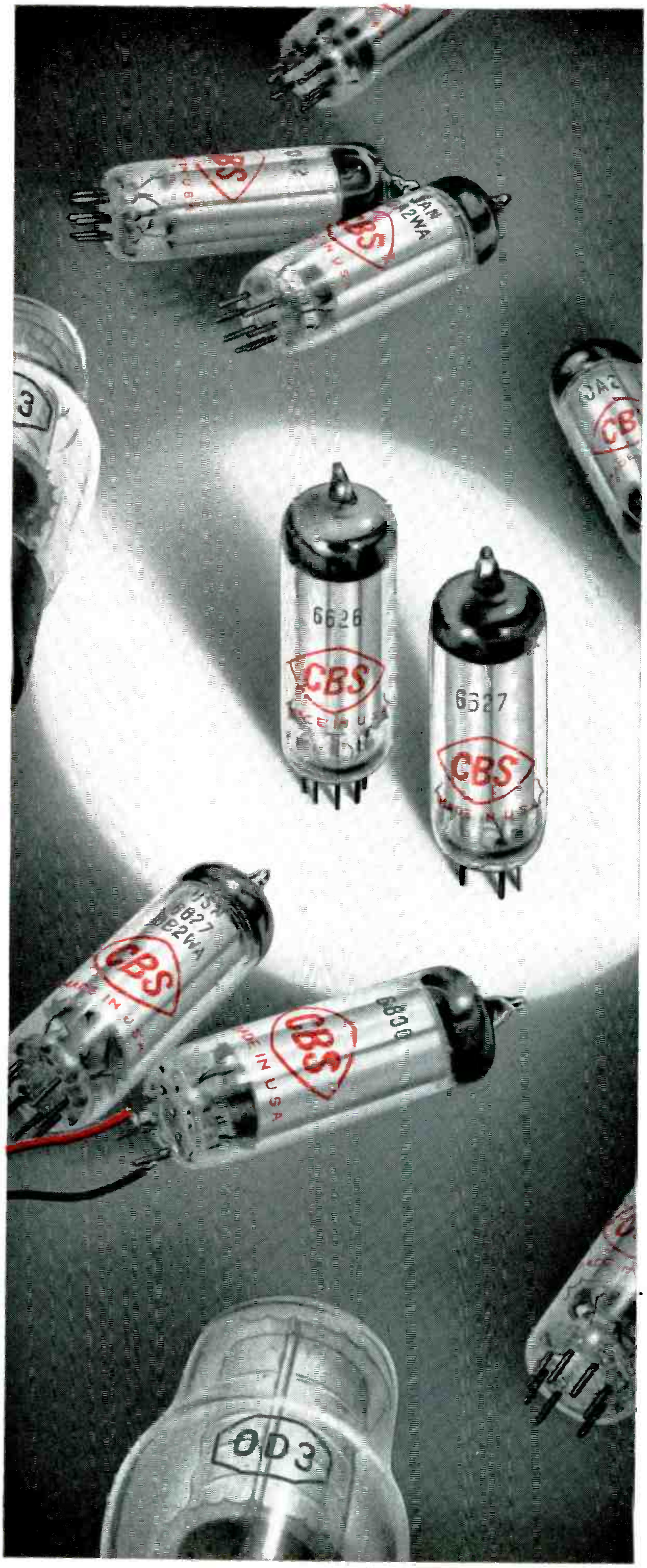
(2) W. C. Elmore and M. Sands, "Electronics", McGraw-Hill Book Co., New York, 1949.
(3) W. M. Grimm and A. B. Van Rennes, *Rev Sci Inst*, 23, p 563, 1952.
(4) H. L. Armstrong, *Rev Sci Inst*, 24, p 551, 1953.
(5) H. L. Armstrong, ELECTRONICS, p 234, July, 1953.

Color Tape Head



Magnetic tape recorder head used by RCA to record and reproduce, monochrome, color and sound. It is claimed that the unit can handle ten times more information per inch of tape than is possible with conventional techniques. The five-element assembly can record more than 20,000 cycles an inch at rates up to 4 mc on half-inch tape



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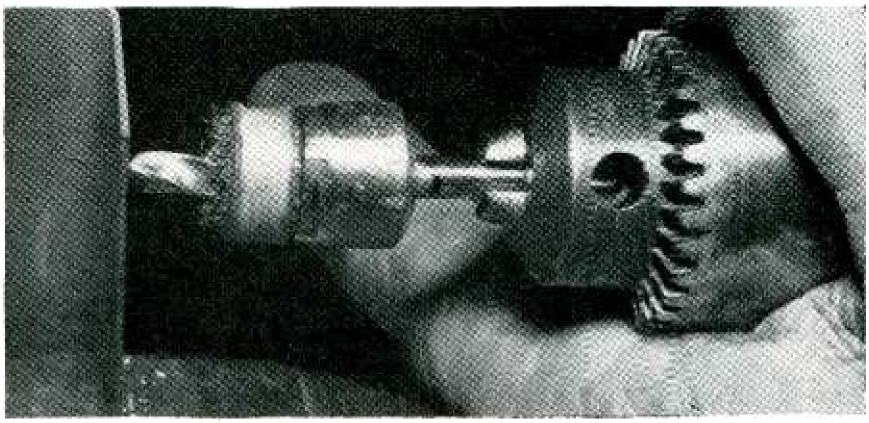
Production Techniques

Edited by JOHN MARKUS

Wire Brush on Drill Cleans Metal for Good Grounding



A COMBINATION drill and wire brush developed by Martin serves to drill holes and remove aluminum cladding from duralumin in one operation. This insures positive electrical connections when grounding airborne electronic equipment to aircraft structures, without need for an extra cleaning operation. The drill is mounted in the center of a standard wire brush.

Method of using tool for drilling duralumin held in vise

Lamps Indicate Errors During Wiring of Harness Boards

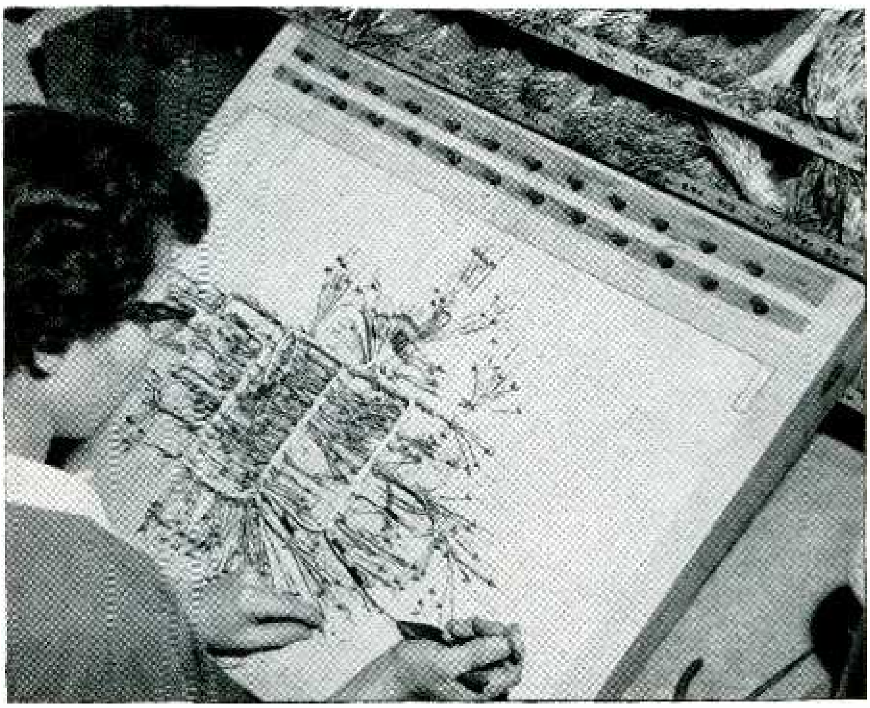
UP TO 7,000 man-hours per year are saved by using automatic checkout on wiring harness boards for airborne electronic equipment in the Los Angeles plant of Packard-Bell Co. The holding clips for wires on the board are connected underneath to indicating lamps in such a way that a lamp lights to indicate satisfactory installation of a group of up to ten wires.

Combining of inspection with production actually saves still more time through elimination of the human error factor in inspecting harnesses after conventional assembly. Errors that get past inspectors involve costly and time-consuming corrections once wired into actual equipment.

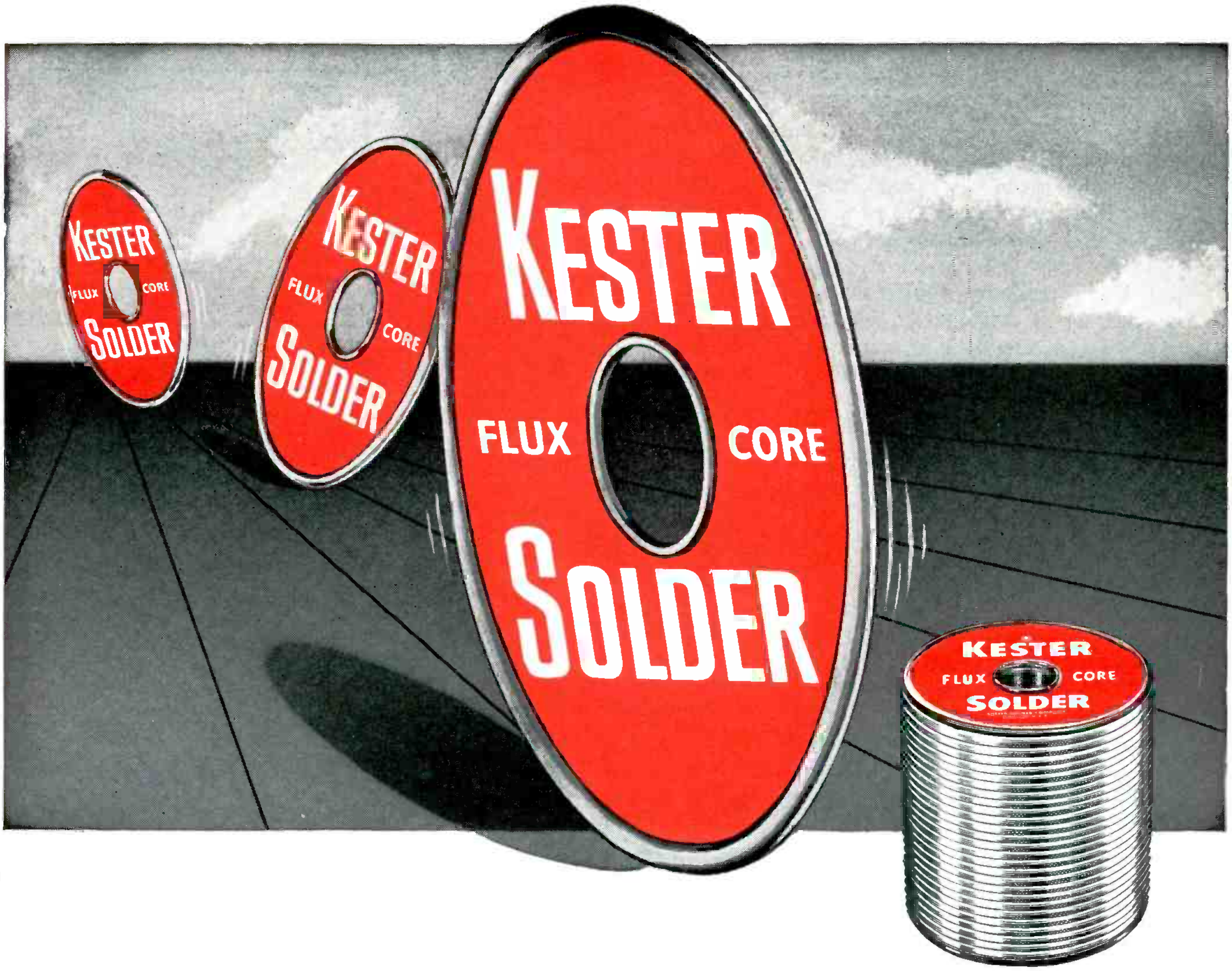
▶ **Construction**—Ordinary cotter pins are used as combination terminals and anchors for the wires. The pins are installed with the split ends up and slightly spread apart, so stripped ends of wires can easily be inserted. The eyes of the cotter pins project under the board. The pins are driven into under-sized holes so they cannot rotate out of position once the ends are spread apart above the board.

Connecting leads are soldered to the eyes under the board to achieve the self-inspecting feature. These interconnections serve to place an average of seven wires in series with an indicating lamp across the low-voltage secondary of a small power transformer. The lamps can then light only when all of the wires are correctly positioned to complete the series circuit.

The wiring board serves as the upper surface of a box about 6



Installing wire lead on self-checking harness board. Each of 24 lamps across top of board indicates correct installation of an average of seven wires, installed in a prescribed sequence



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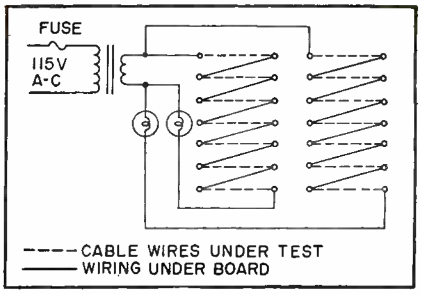
inches high, to give protection for the terminals underneath.

▶ **Identification**—For each job, the worker is given an instruction sheet that specifies the size and type of wire to be used at each position, the color code, length and installation directions. Positions are specified by a combination of letters and numbers much as on maps, with corresponding letters running vertically down the side of the board and corresponding numbers running from left to right across the bottom of the board. The approximate position of a starting cotter pin can thus be determined quickly. Each pin also has a code number on the instructions and on the board, corresponding to the name of a city on a map.

▶ **Circuit**—The low voltage used for this automatic checkout system eliminates the possibility of shock to the operator. A fuse in the primary of the power transformer provides further protection, even though the lamps are all in one leg of the secondary so it is impossible to produce a direct short.

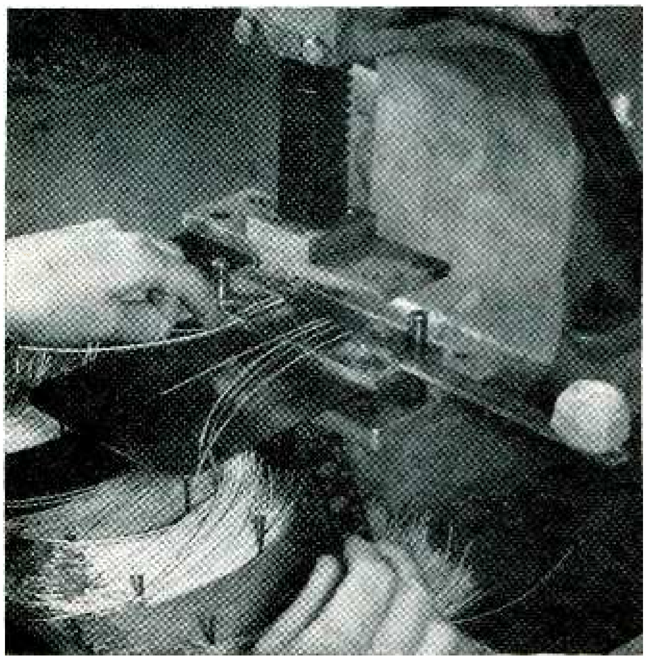
A typical wiring harness, such as that used as the main cable of the integrated communication system for Douglas and Chance-Vought fighter aircraft, involves installation of 152 wires, and takes



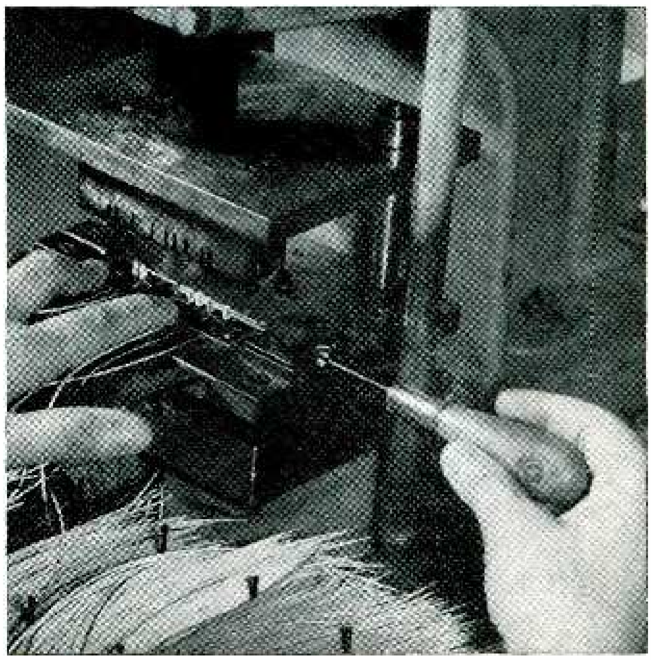
Twelve circuits identical to this are installed on board. Use of only two lamps per transformer permits use of small and inexpensive transformers under board

approximately $3\frac{1}{2}$ hours to complete. Initial planning and wiring of such a harness board circuit takes just about a full week of a technician's time.

Anchoring Leads in Terminal Strip with Nylon Rods



Loading wires into press. Stripped ends of wires go into holes at rear of slots in floating bed of press. Padded handle at right moves pointed steel rod used for spreading loops



Spreading loops with pointed steel rod on handle. The seven different colors of insulated wire leads used are kept separated by long finishing nails driven into the bench

TWO DIFFERENT TYPES of work setups are used at Radio Condenser Co., Camden, N. J., to push seven loops of insulated wire through punched slots in a Bakelite strip simultaneously and thread a length of nylon rod through the loops for anchoring all leads at once without using eyelets.

In one setup, the operator loads the leads one by one into machine grooves in the bed of a Dake arbor press, places a strip over the leads, then operates the lever to bring down the head of the press. This has a contoured rubber block with slots at each lead position. Downward pressure of the rubber block pushes the strip and the spring-supported false bed of the press down over seven upward-projecting metal studs that push a loop of wire up into each punched hole of the strip.

Next, the operator retracts the press and holds the strip in position with her left hand while she pushes a metal rod through each of the seven loops that now project up through the strip. This rod is guided by a clamp bolted to one side of the false bed, and has a pointed end so that it can easily enter and spread apart each loop. The rod is pulled entirely out from the press and a solid nylon rod of

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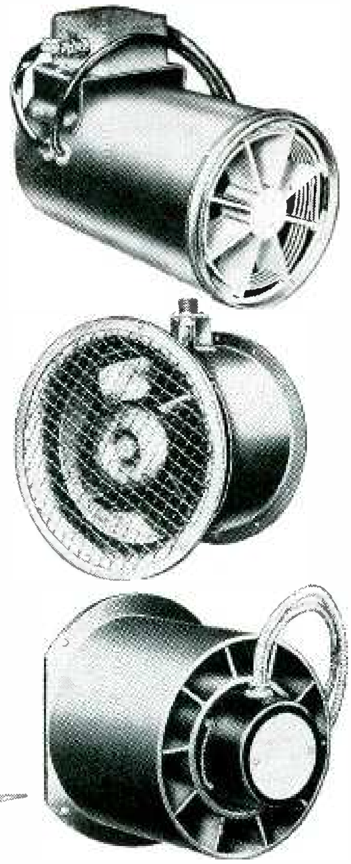

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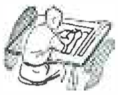

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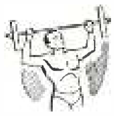

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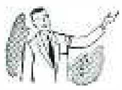

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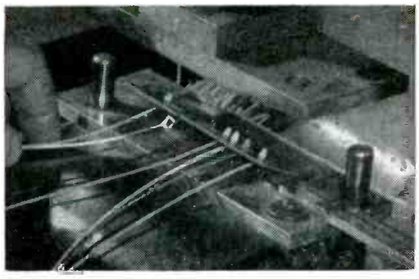
slightly smaller diameter is pushed through the loops. Cement is then applied to several of the loops to anchor the rod.

▶ **Variation**—A slightly modified version of this press setup employs a captive needle to spread open the loops. This slides in a metal outrigger projecting to the right from the floating bed of the press. After the holes have been spread, the piece is lifted out and held in the left hand while the nylon rod is pushed through the loops with the right hand. Production rate is about the same as on the other press.



Removing finished strip from press

Motorized Solder Wheel for Capacitor Leads

Swaging and soldering leads to paper-wound bathtub capacitors. Knurled, tin-plated steel wheels turning vertically in asbestos-enclosed electric solder pots bring hot aluminum solder to the slots in the tops of the asbestos boxes. Soldered units go down slide onto conveyor belt

A MOTORIZED SOLDER WHEEL that simplifies the assembly of certain paper-wound bathtub capacitors is used in the capacitor department of Lenkurt Electric Co.

The capacitors are swaged at each end and the leads are soldered in place simultaneously. Previously, these operations were accomplished by placing a number of capacitors in a jig and swaging and assembling each with an ordinary soldering iron. The new system obviates use of a soldering iron and is more nearly like dip soldering, except that a tin-plated wheel carries hot aluminum solder from the pot to the capacitors.

▶ **Construction** — Two of the knurled wheels are mounted vertically on a horizontal shaft powered by a small electric motor (Lee Engineering Co., Milwaukee; maximum current 3.5 amp; speed range 1,000 to 10,000 rpm). The bottom portion of each wheel is immersed in an electric solder pot (DEE

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No. 7, 1956

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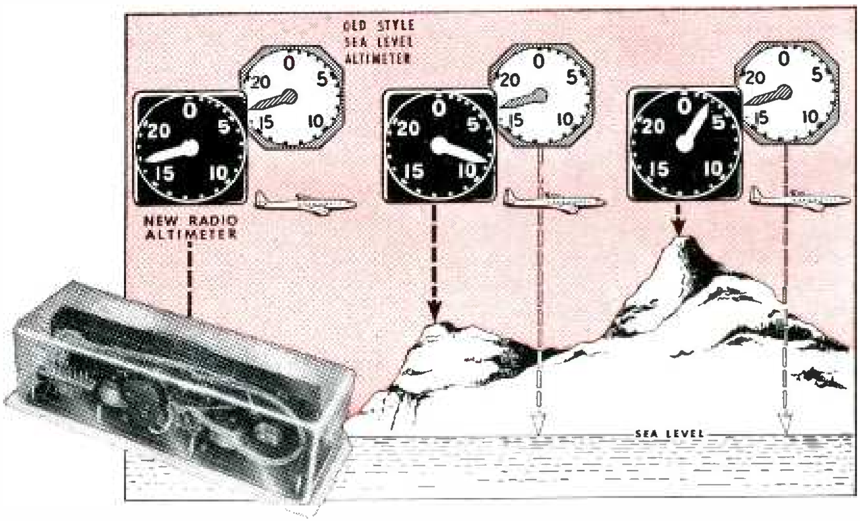

TEFLON tetrafluoroethylene resin is used as cable insulation in this new radar altimeter. One of these cables carries microwave energy from the magnetron oscillator tube to the antenna. The other cable provides interconnection within the transmitter-receiver unit. (Cable used in this altimeter is manufactured by Surprenant Mfg. Co., Clinton, Massachusetts.)

A new radar altimeter, made by the Raytheon Manufacturing Company, Waltham, Massachusetts, furnishes continuous terrain-clearance information and flashes a warning light when a preset minimum is reached. Du Pont TEFLON was selected as the insulation for cabling in this altimeter because of its ability to perform under the wide range of temperatures encountered in the aviation field.

TEFLON tetrafluoroethylene resin is used in electronics equipment as molded components, tape, and extruded insulation. The excellent dielectric properties of TEFLON, even at ultrahigh frequencies, and its moisture resistance are particularly important in the electronics field. Heat resistance is frequently essential, too, especially with the present trend to miniaturization of electronics equipment, which results in increased operating temperatures.

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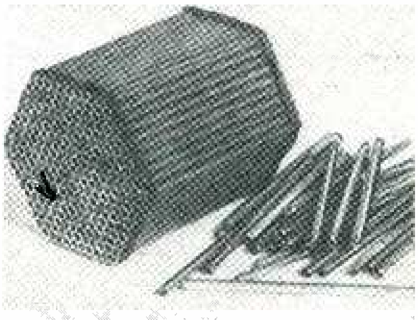
Electric Co., Chicago; model 61; 700 watts; temperature range 600 F to 1,000 F). Pots and wheels are enclosed in asbestos shielding. In the top of each shielding box is a stainless plate with a slot through which about 1/16 inch (adjustable) of the wheel protrudes. The knurled wheel picks up solder from the pot and presents it at the slot. The operator rubs the end of the capacitor, with the lead wire held in place, over the slot to make the solder junction.

Ultrasonic Dicing of Germanium

STAINLESS STEEL tubes are preventing warpage from brazing and increasing the life of tools made by the Cavitron Equipment Corp., Long Island, N. Y. for ultrasonic dicing of germanium.

The type 304 stainless steel tubes were adopted, after consultation with engineers of Superior Tube Co., Norristown, Pa., to replace carbon steel tubes in the Sheffield-Cavitron ultrasonic machine tool.

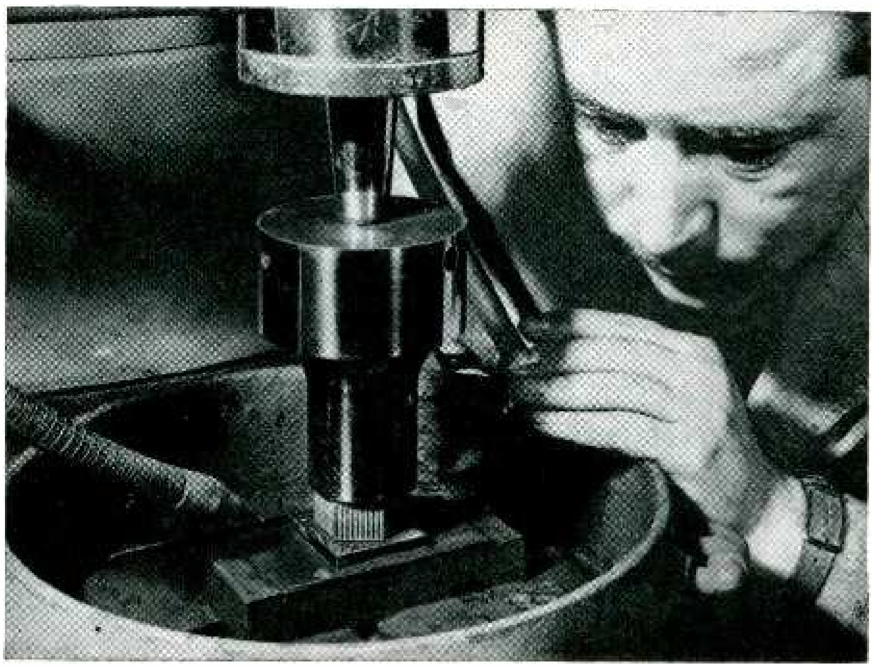


Construction of stainless steel cutter

▶ **Brazing**—Usually a number of tubes are brazed together into a bundle of the same shape as the cut to be made. With carbon steel tubing, the tubes frequently warped at brazing temperature and the tool was rejected. Replacement with type 304 stainless tubing eliminated the warping and gave longer tool life on the production line.

Long tool life is particularly important because of the time required to make the complex bundles of tubing, which are also used to slice and dice quartz crystals and to drill and form ceramic electronic tube spacer elements.

▶ **Dicing**—The tool tip used to dice germanium in the mass pro-



Dicing 271 disks of germanium from thin slab in one operation, using stainless steel cutters on ultrasonic machine tool. Abrasive particles in water suspension are directed across work by two hoses

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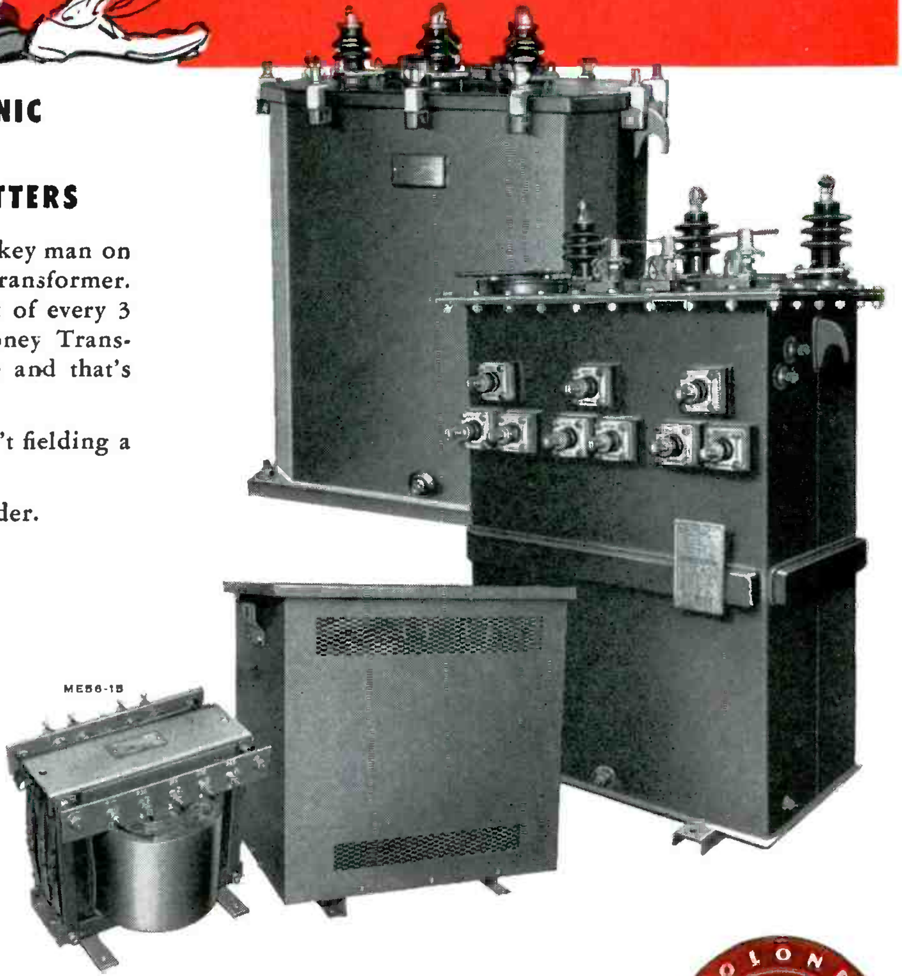

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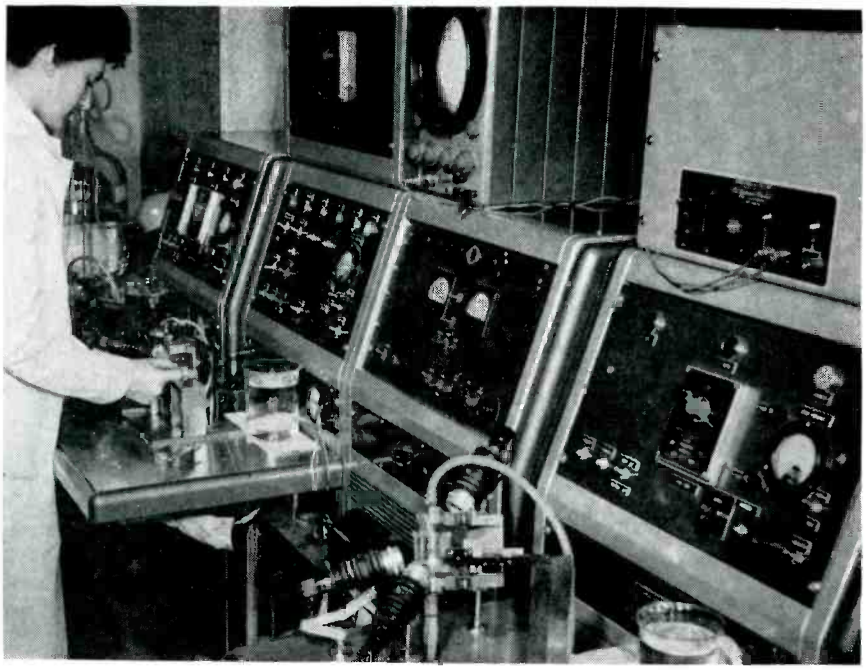
duction of transistors consists of 271 2-inch lengths of 19-gauge type 304 needle tubing. These are silver-brazed into a hexagon-shaped bundle resembling a honeycomb. After the bundle is formed it is cut in half to give two complete tools, each ⅛-inch deep.

The tubes are assembled with such precision that tolerances well below 0.0005 inch are held. This would not be possible if the tubing warped. The ability of the stainless tubing to hold a sharp clean edge also contributes to the quality of the work.

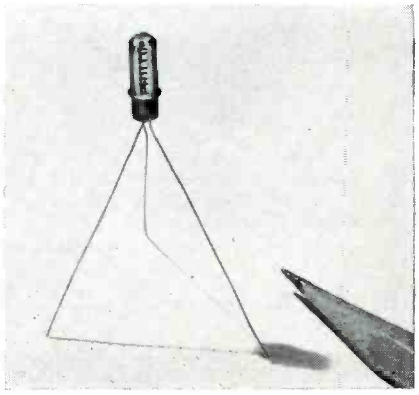
Automatic Etching of Transistor Pellets



Battery of automatic etching machines producing surface-barrier transistors. Operator merely transfers work carriers from one setup to the next. These machines automatically etch concentric holes on opposite sides of the germanium pellet so the hole thickness remaining between them is less than 0.0002 inch, then plate the holes with indium

GERMANIUM OR SILICON pellets mounted on stems of surface-barrier transistors are electrochemically etched with jets of acid under photoelectric control in the Lansdale, Pa. plant of Philco Corp. Precisely machined work carriers make possible the accurate positioning required for mechanization of the sequence of operations involved in producing concentric holes on opposite sides of the tiny germanium pellets.

▶ **Washing** — A unique jet-type washer is used to direct a stream of high-purity water at the pellet after it has been soldered into position on its lead in preparation for etching of holes. The washer is also used between the various stages of etching and plating. The operator merely places the work carrier in the groove of a tilted slide and allows it to drop down against a stop inside the washer. This automatically positions the pellet directly in the path of circu-



Example of transistor now in mass production, with pencil shown alongside for size comparison

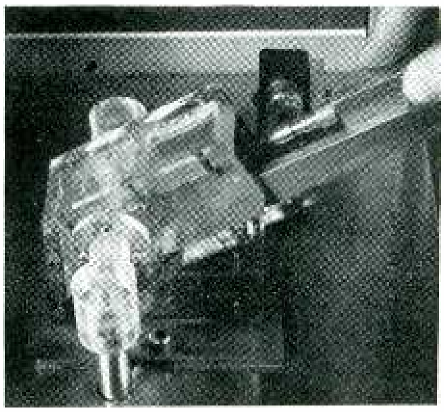


FIG. 1—Sliding work carrier into jet-type washer

lating water spray. The washer is constructed entirely from transparent plastic pieces, as shown in Fig. 1.

▶ **Rough Etching**—After washing, the work carrier that holds the transistor stem is transferred directly to the positioning blocks of the rough etching setup and pushed into position as shown in Fig. 2, so the pellet is in a horizontal plane. Here tiny streams of chemicals are directed at the pellet from above and below to etch out roughly the desired depressions on the sides. The rough etching is done on a time basis, with occasional visual monitoring through the transparent plastic housing of the etcher. Strong flood lamps illuminate the etcher from both sides to increase the rate and uniformity of etching.

The etchant is a 5-percent solu-

FIG. 2—Rough etching position, with operator pushing transistor between opposing jets inside transparent plastic cage

tion of sulphuric acid. For this electrochemical etching the work carrier serves as one electrode and the other electrodes are inserted in the acid lines.

The etching liquid comes from large glass bottles behind the etching console. Air pressure in the bottles produces the required pressure at the jets. When a bottle empties to a certain point, a snap-action switch is tripped by the re-

FIG. 3—Precision etching head, showing operator pushing work carrier into position. Outer housing has been removed for clarity

duced weight of the bottle. This in turn starts a pump that refills the bottle.

The pumping action is stopped automatically by another weight-sensing switch when the bottle is nearly filled again. Used acid is collected in separate containers, because recirculation of acid would introduce diminishing acid strength as an uncontrolled variable.

► **Precision Etching**—After rough etching and washing, the carrier goes to the precision etching setup of Fig. 3, where the underside is etched by a single upward-aimed jet. This jet comes up through an intense beam of light that is focussed on the hole being etched. The

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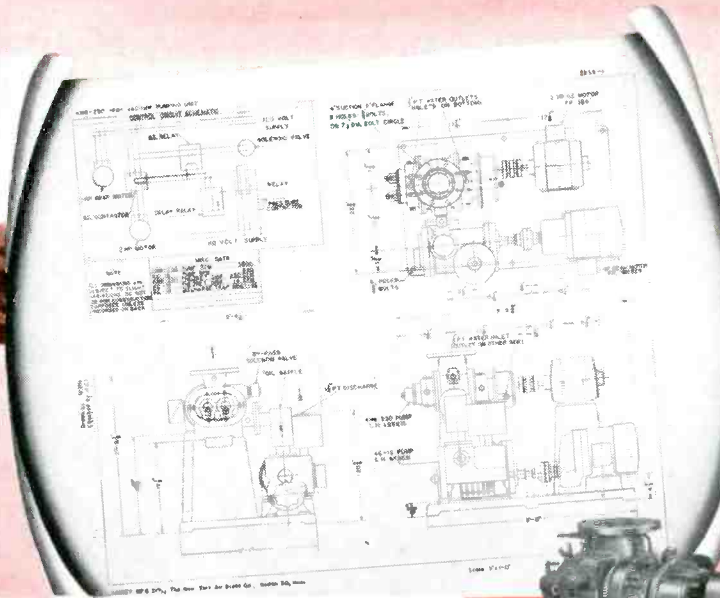

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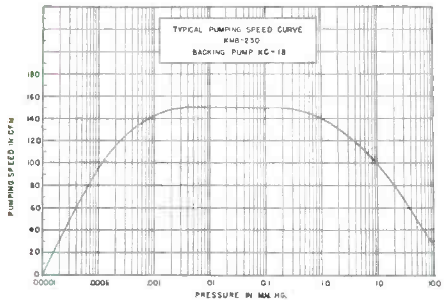
Model KMB-230 Two Stage Mechanical Booster Vacuum Pump

Ultimate Pressure (McLeod Gauge)	0.1 Micron
Free Air Displacement	230 CFM
RPM	3600/640
Motor H.P.	2 and 1
Oil Capacity	5 Pints
Cooling	Water
Shaft Seal	Mechanical
Shaft Diameter	3/4-3/4
Inlet Connection	4" Flanged
Outlet Connection	1¼" Screwed
Net Weight, Complete	1010 lbs.



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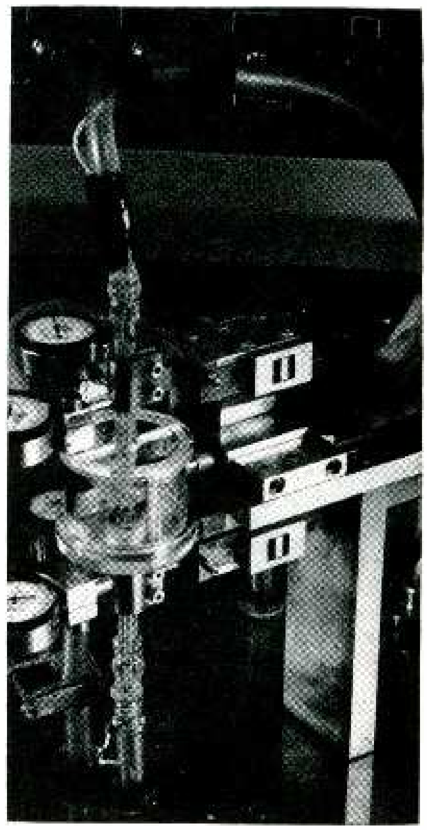


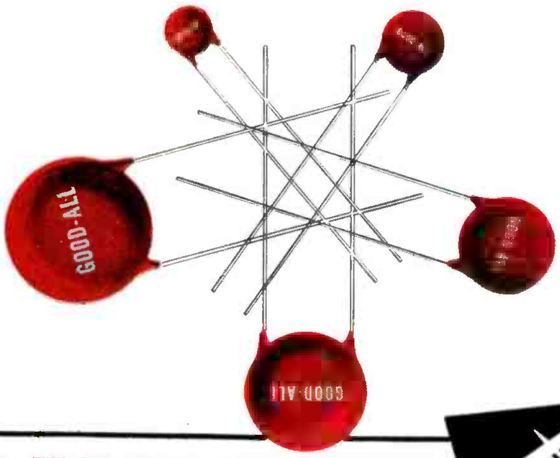
FIG. 4—Precision indium plating setup using jets for plating indium in etched holes on germanium. Dial gages serve for making precision head adjustments

light activates the germanium, so that more carriers are released and etching is correspondingly speeded up. The light also concentrates the etching action in a smaller hole for this final precision etch.

Aspirator tubes on each side of the germanium draw off the etchant after use, so that none is recirculated by the jet in this critical operation.

A small phototube mounted directly over the germanium monitors the amount of light that comes through as the emitter hole is deepened by the etching action. When this transmitted light reaches a certain intensity that has previously been correlated with the desired thickness of material remaining between the holes, the phototube triggers a solenoid valve that automatically stops the flow of etchant.

A stream of air is blown down onto the top surface of the germanium, past the phototube lens system, to prevent accumulation of etchant in the upper rough-etched



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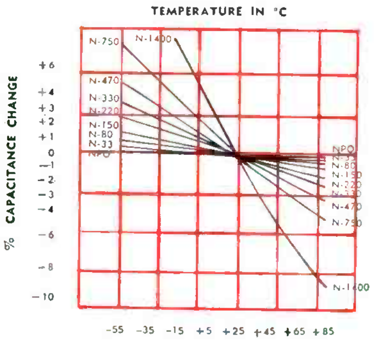
Good-All has designed a full line of TC discs in accordance with RETMA specification REC-107-A (class 1). These units are well suited for resonant circuits or other applications where HIGH Q and STABILITY of capacitance is essential. Small size gives an inherent advantage in VHF and UHF applications.

SPECIFICATIONS—Working Voltage: **600 VDC** • Flash Test Voltage: **1500 VDC** • Power Factor: **Less than .1% @ 1 MC** • Leakage Resistance: **Greater than 10,000 megohms** • Leads: **#22 gage tinned copper wire** • **Capacity Tolerance: ±5%, ±10%, ±20%**

MAXIMUM DIAMETER

Temperature Coefficient	1/4	5/16	1/2	5/8	3/4
P-100	1-3 mmf	4-9 mmf	10-30 mmf	......	......
NPO	2-12	13-22	28-60	61-75 mmf	76-110 mmf
N-33	2-15	16-27	28-60	61-75	76-110
N-80	2-15	16-27	28-60	61-75	76-110
N-150	2-15	16-30	31-60	61-75	76-110
N-220	3-15	16-30	31-75	76-100	101-140
N-330	3-15	16-30	31-75	76-100	101-140
N-470	3-20	21-40	41-80	80-120	121-170
N-750	5-25	26-50	51-150	151-200	201-290
N-1400	15-50	51-100	101-200	200-250	251-470
N-2200	47-75	76-100	101-200	201-275	276-470

CAPACITANCE CHANGE VS. TEMPERATURE IN °C



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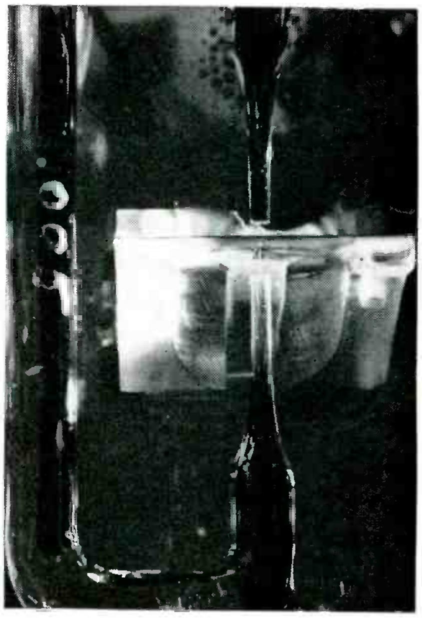
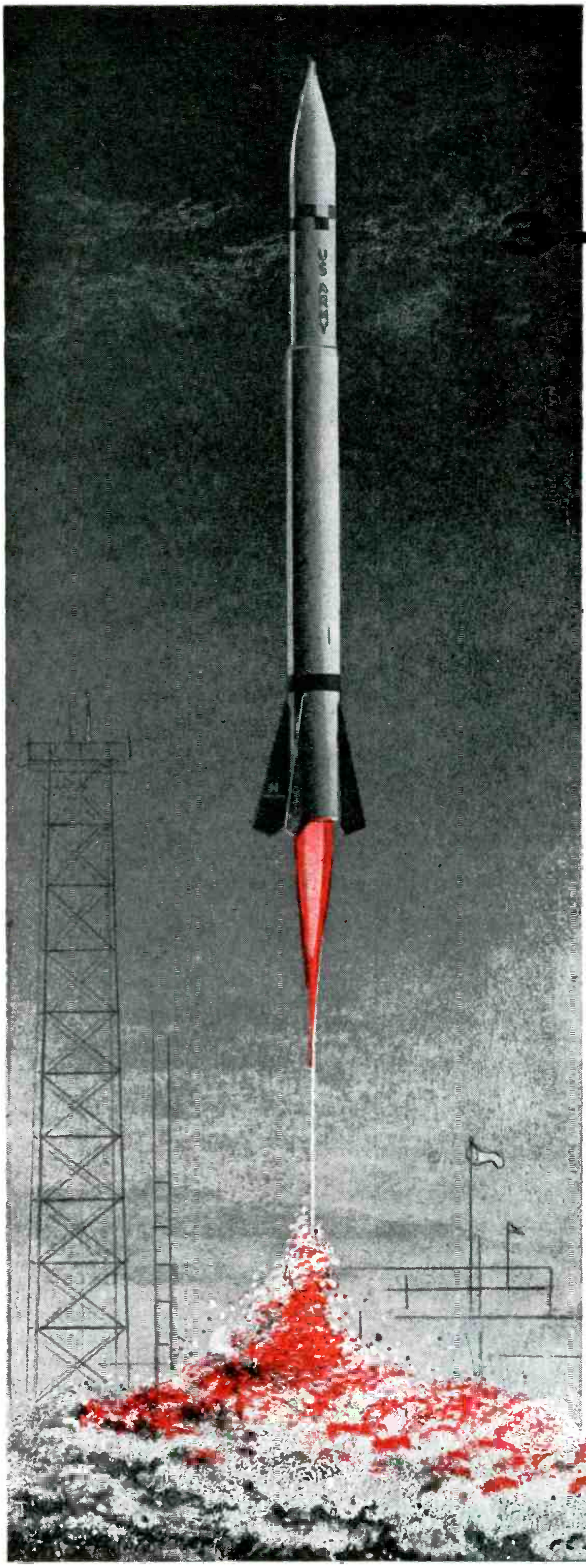


FIG. 5—Highly magnified view of jets used for electroplating indium on germanium pellet

hole, since this would interfere with thickness monitoring.

▶ **Plating** — After another wash, the work carrier goes to the indium plating setup of Fig. 4. Here both sides of the germanium are plated simultaneously with indium from a solution of indium sulphate. Again the jets are positioned above and below the pellet, as in Fig. 5. Electrodes are located in etchant lines just as for etching and aspirators are positioned alongside to

FIG. 6—Optical setup for checking concentricity of etched holes in germanium pellet. Required precision of alignment increases with operating frequency of transistor. Production and inspection controls are now adequate for at least 100-mc transistors



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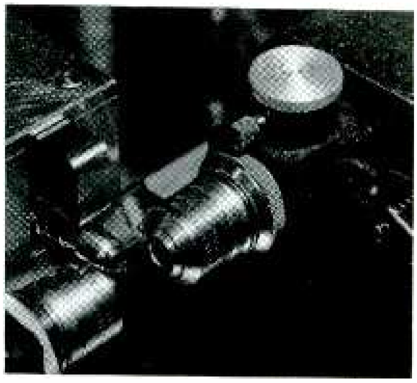


FIG. 7—Transistor in position between dual microscope lenses of concentricity checker

draw up the electroplating liquid.

The jets are initially turned on for a fraction of a second with the electric current in the etching direction, to produce a virgin surface for plating. When the current is reversed at the end of this interval, indium is plated onto the germanium to form electrodes.

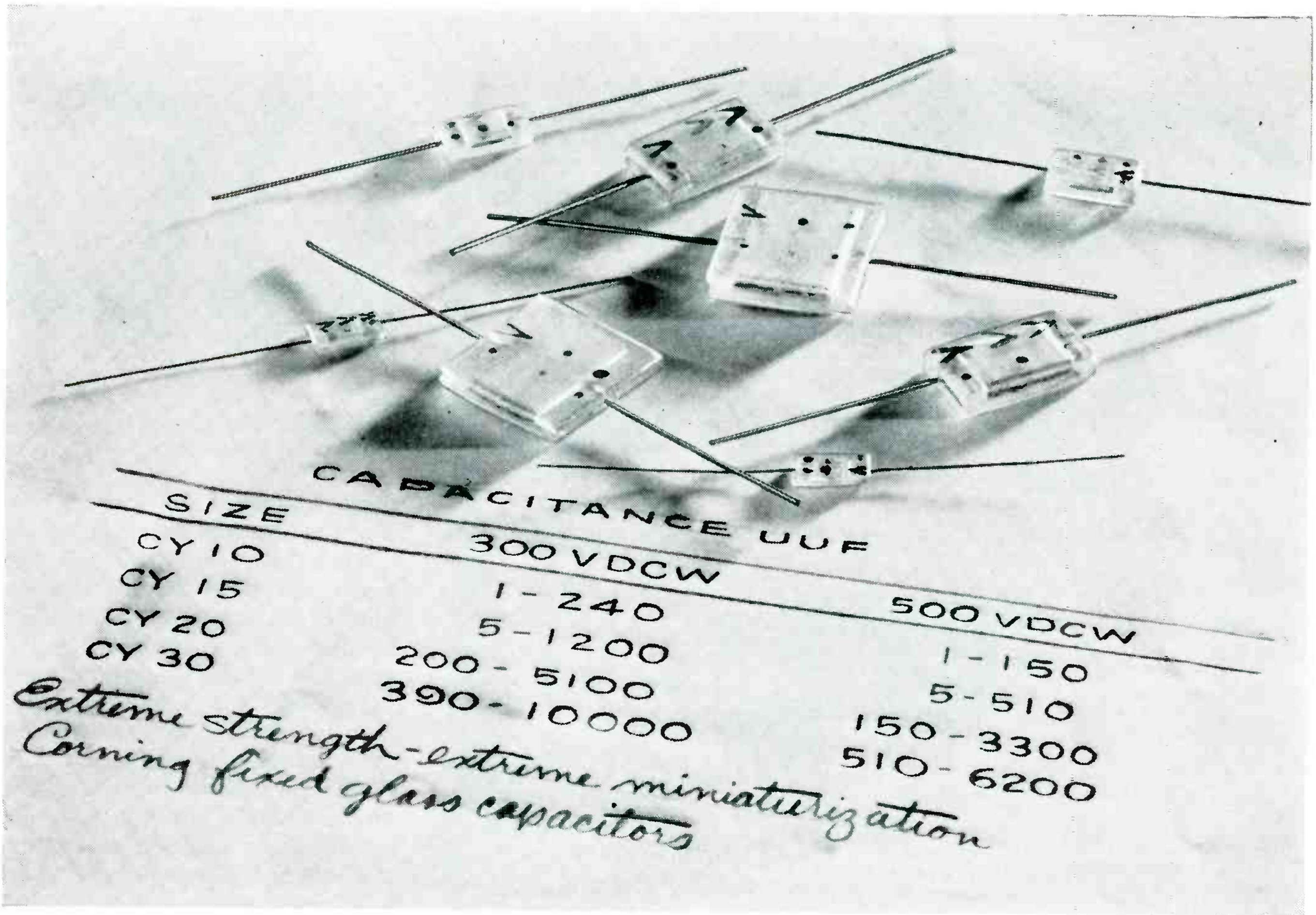
▶ **Concentricity Checking** — After indium plating, concentricity of the etched holes on opposite sides of the germanium pellet is checked in the dual optical setup shown in Fig. 6. The work carrier is placed in the holding fixture of the comparator with the germanium pellet in a vertical plane and is moved into position between the lenses of two microscopes as in Fig. 7.

The work carrier is racked in and out until the etched hole on one side of the germanium is exactly centered in one microscope. The operator can then read the amount of deviation from concentricity on a graduated scale in the other microscope.

Coining Saves $74,000 on Waveguide Flanges

REDESIGN OF A waveguide flange to permit production by coining reduced machining to one simple grinding operation at Lord Machine Co., Waltham, Mass., and thereby saved up to $74,000 a year for one user of this component.

The part originally was made from a piece of steel machined all over. In another run, the flange was made from a drop-forged



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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.

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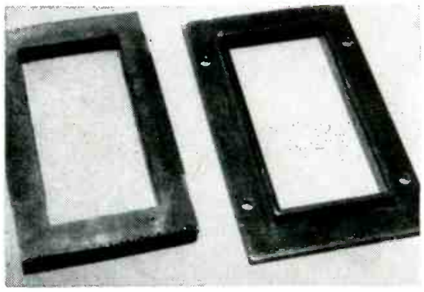

Finished steel waveguide flange for radar t-r tubes used for low-frequency scanning, at right, was coined in heavy presses from blank shown at left

blank, machined and broached, but this also proved costly.

An attempt to draw the part from a flat strip was unsuccessful, but led to the idea of coining it in heavy presses. Coining, derived from the ancient process of striking coins, is a squeezing operation used by stampers to force cold metal into shapes of different thicknesses and with sharp corners. This proved highly satisfactory. No machining is required except that the back is ground to provide a flat surface. Tolerances of 0.005 inch are held with high surface finish.

The 1956 John Woodman Higgins Redesign Award, annually donated by the Worcester Pressed Steel Co. of Worcester, Mass., was awarded to owner Francis B. Lord for his design for coining.

Ultrasonic Unit Combines Stripping and Soldering

POLYVINYL ACETAL ENAMEL insulation is removed and wire is soldered to coil terminals in a single fast operation through use of high-power ultrasonic soldering equipment developed by Aeroprojects Inc., West Chester, Pa. Without stripping and without the use of flux, the ends of the wire are securely soldered to the pretinned copper terminals.

▶ **Advantages** — Besides reducing direct labor cost, this method also reduces the normally high rejection losses resulting from nonuniformity accompanying a hand stripping and wrapping operation.

By the hand stripping method, the stripped part of wire is often

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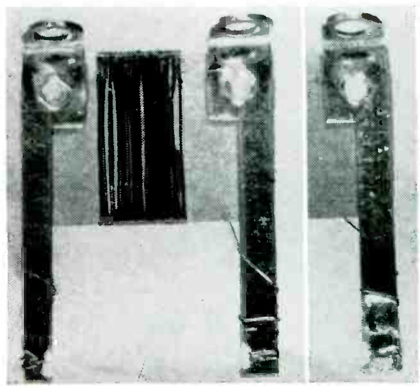
Setup for hand dipping of unstripped polyvinyl acetal enamelled wire in molten solder on hot plate, with ultrasonic unit immersed in solder



Method of wrapping unstripped coil leads around terminals preparatory to soldering and appearance of one terminal after soldering

not even wrapped around the terminal; instead, the insulated wire is placed in contact with the terminal. Then, by normal soldering methods, a bad joint would usually result.

By ultrasonic soldering with equipment powerful enough to remove the insulation, the soldered joint can be made successfully every time because the human element has been eliminated. The wire is stripped and soldered where the connection is required.

▶ **Technique**—After wrapping the wire around the terminal, the assembly is dipped into a soldering pot containing 60-40 or 50-50 tin-lead solder at approximately 650 F. The terminal ends are brought up close to the tip of an S-3-H-55-8 Sonobond unit. This ultrasonic soldering head, in conjunction with a

CHATHAM ELECTRONICS AT WORK

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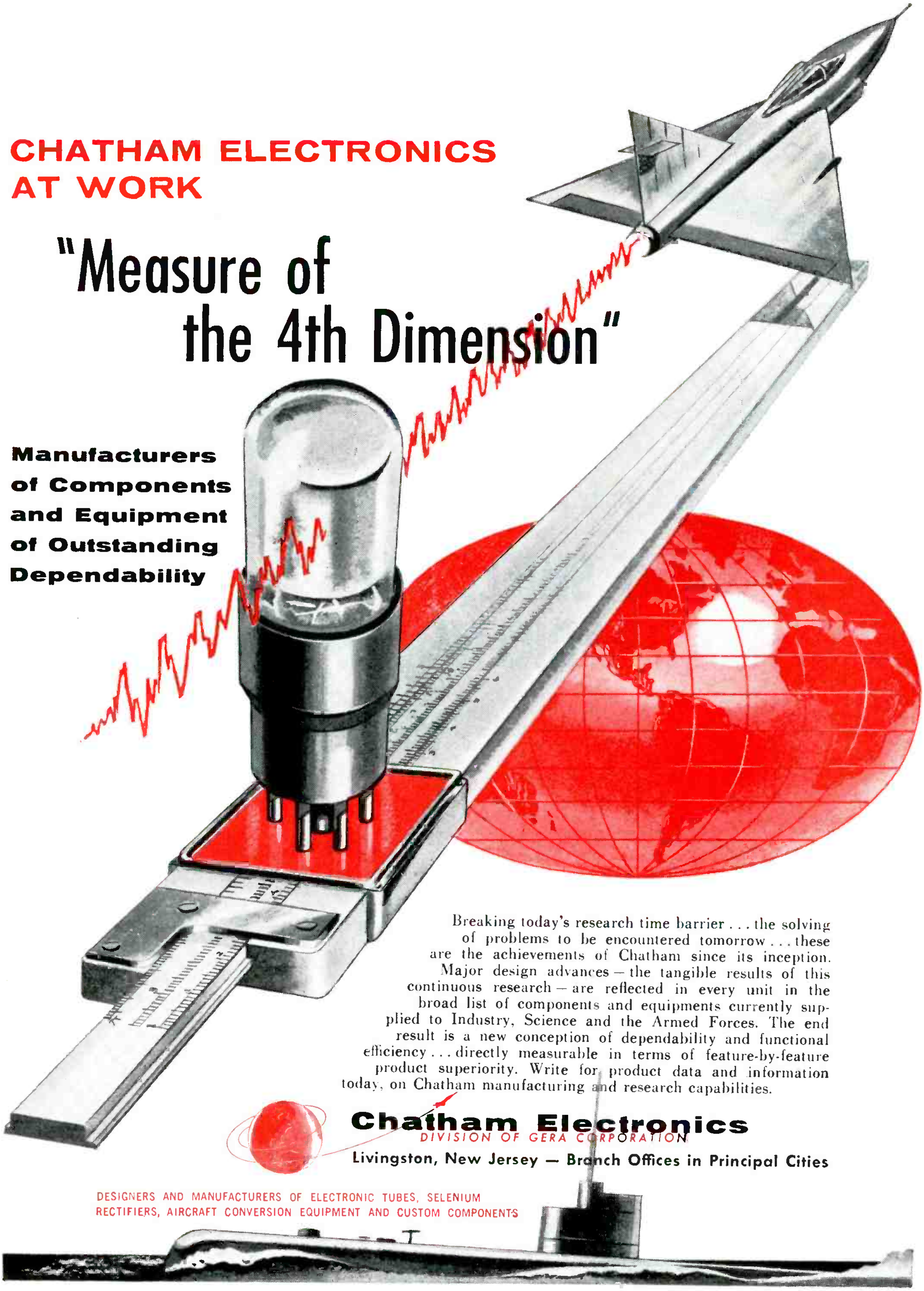

Breaking today's research time barrier . . . the solving of problems to be encountered tomorrow . . . these are the achievements of Chatham since its inception. Major design advances — the tangible results of this continuous research — are reflected in every unit in the broad list of components and equipments currently supplied to Industry, Science and the Armed Forces. The end result is a new conception of dependability and functional efficiency . . . directly measurable in terms of feature-by-feature product superiority. Write for product data and information today, on Chatham manufacturing and research capabilities.

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DESIGNERS AND MANUFACTURERS OF ELECTRONIC TUBES, SELENIUM RECTIFIERS, AIRCRAFT CONVERSION EQUIPMENT AND CUSTOM COMPONENTS

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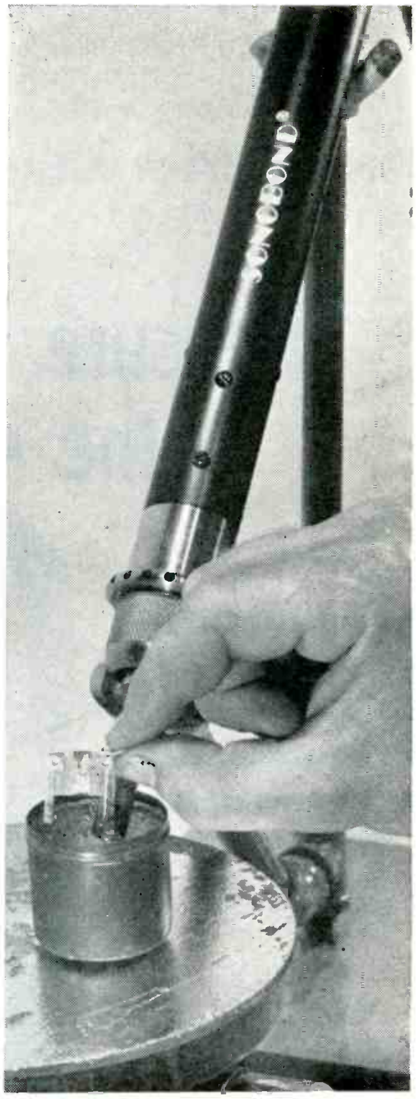

Each terminal of coil in turn is held against ultrasonic soldering head immersed in solder

specially designed tip, delivers the ultrasonic energy where it is most effective to do this operation. In less than 2 seconds, the two terminals are stripped and soldered. The operation is acomplished at a temperature which insures a good connection yet not so high as to damage the wire.

Tube Printer

A NEW IMPRINTING machine can apply company names, contract numbers or any other imprint to cylindrical objects including vacuum tubes up to 12 inches in diameter and 7 inches long.

Operation requires no skill on the part of the operator. The dies

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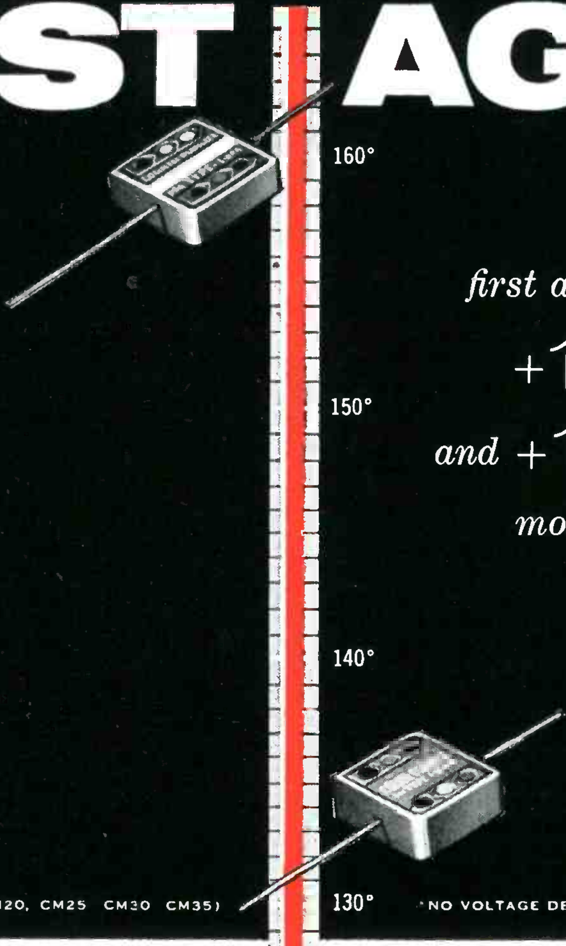

first and only

+160°C

and +130°C*

molded mica capacitors

(EQUIVALENT TO MIL SIZES CM15, CM20, CM25 CM30 CM35)

*NO VOLTAGE DERATING EVEN AT MAXIMUM TEMPERATURES

TO SOLVE your high temperature component requirements count on these unique new C-D capacitors, outstanding result of many thousands of man-hours of engineering, development, and 45 years of priceless capacitor manufacturing experience. Write or wire collect for engineering samples and new Bulletin 422-4 on this outstanding C-D EXCLUSIVE. Cornell-Dubilier Electric Corporation, Dept. K-76, South Plainfield, N. J.

FULL RATED VOLTAGE AT HIGH TEMPERATURE EXTREMES—No voltage derating required over respective operating temperature ranges −55°C to +160°C (HX types) and −55°C to +130°C (H types).

EXCELLENT CAPACITANCE-TEMPERATURE STABILITY—In all characteristics up to and including characteristics F (0 to +70 ppm/°C.).

ABSOLUTELY WAX-FREE. No internal or external wax impregnation or other meltable coating material used in these units.

RUGGEDIZED, electrically, mechanically. New moisturetight seal, developed specifically by C-D for high temperature operation. Will withstand vibration, impact, high ambient temperatures.

IN 300v and 500v DC working, up to and including 7500 mmf. in 160°C (HX types) and 15,000 mmf. in 130°C (H types).

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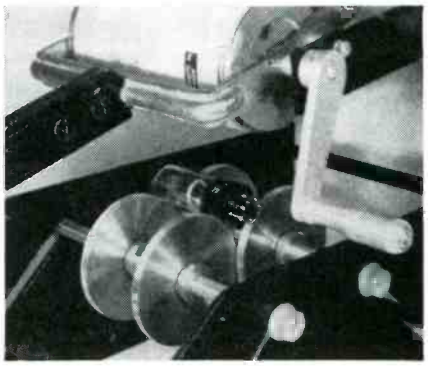
THERE ARE MORE C-D CAPACITORS IN USE TODAY THAN ANY OTHER MAKE



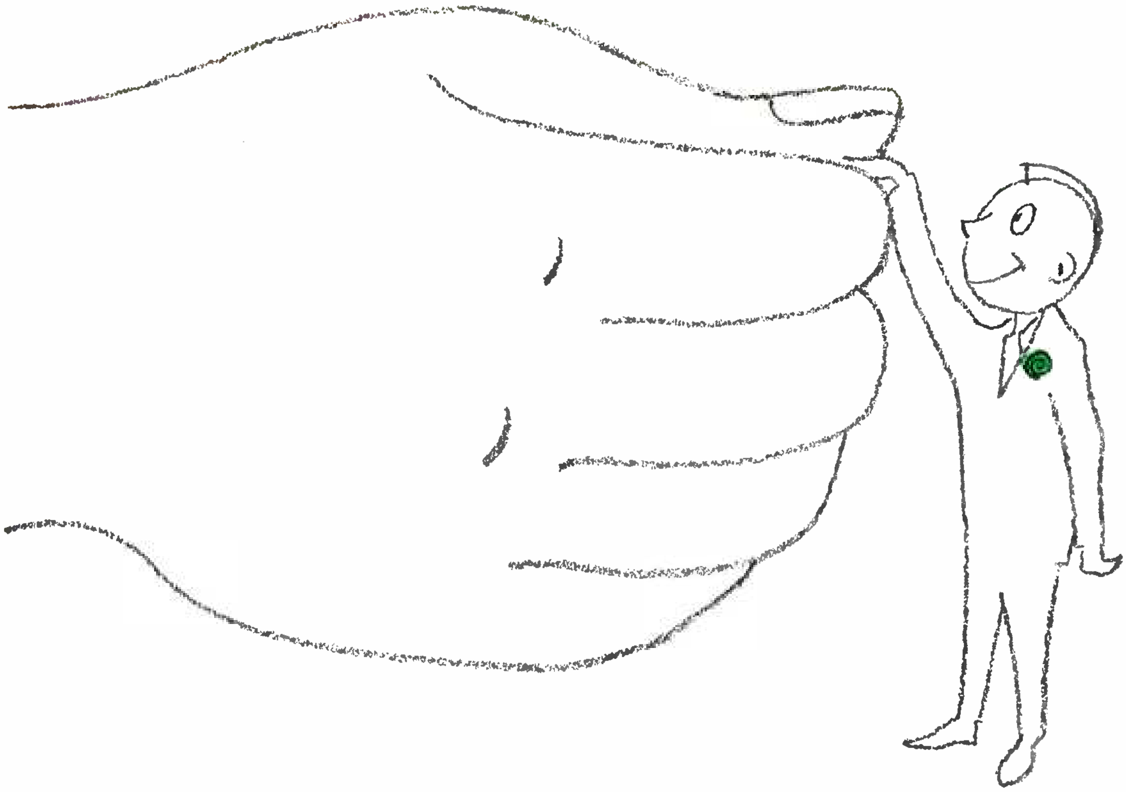
Tube to be imprinted is placed on free-turning disks, cylinder holding inked rubber type is lowered and crank is turned to place desired imprint neatly on tube base

used are the same conventional inexpensive rubber type used in office stamps and are easily changed. Make-ready takes but a few seconds. Up to 400 pieces can be imprinted in one hour. This Murco Midget imprinter is made by Murco Mfg. Co., Delray Beach, Florida.

Winding Focus Coils With Aluminum Foil

A NEW TECHNIQUE for winding focus coils involves coating aluminum foil with a thin layer of aluminum oxide and then winding this foil without additional insulation. The oxide film, though only a few

Test setup for foil coating and winding. Power supply for producing anodic coating is on overhead rack



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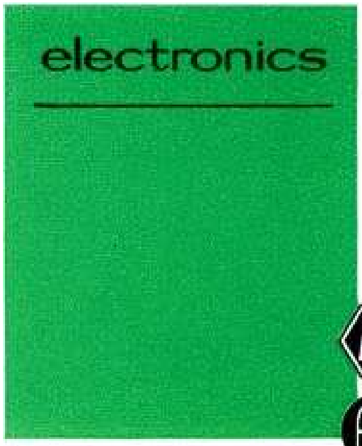

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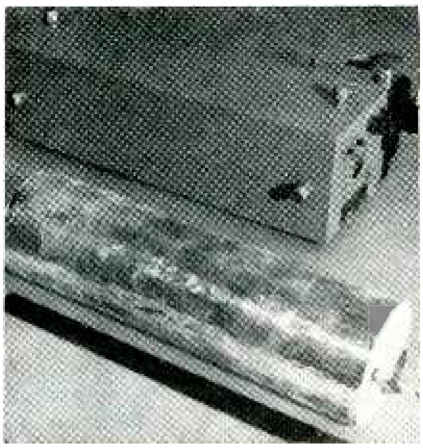
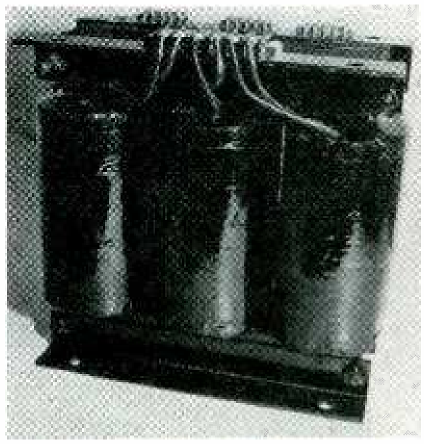
millionths of an inch thick, is able to withstand usual turn-to-turn voltages. Since this film is so thin, a tightly wound coil is nearly a solid block of aluminum.

▶ **Heat Problems**—In foil windings with plastic layer insulation, some attempts have been made to get the heat out of the coil through the ends of the coil. This is quite successful if the coil is a short solenoid. If the length of the coil is great enough so that an appreciable temperature gradient exists down the axis of the solenoid, some trouble may be experienced due to the nonuniform current distribution in the sheet of foil. Since the center portion of the solenoid is hotter than the ends, more current per unit length flows in the portion



Aluminum-foil solenoid producing 850 gauss for focusing traveling-wave tube. At rear is solenoid housing complete with magnetic shield and cooling blower. Coil alone here is 12¾ inches long and weighs 12 lb



Experimental three-phase transformer wound with aluminum foil. On overload test, winding temperature reached 350C without damage

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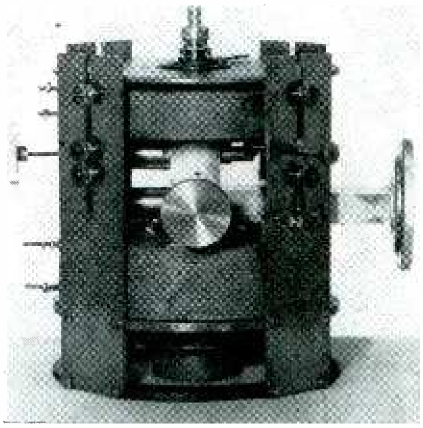
of the winding near the ends than at the center.

In some applications, such as focus coils for traveling wave tubes, it may be found that a tube will focus when the focus coil is cold but will not focus properly when the coil reaches operating temperature.

▶ **Getting Rid of Heat**—It now appears that the best way to remove the heat from a winding is to remove it from the outer surface of the winding. There is more surface available for cooling by water or forced air. The field can also be made to remain more uniform. By using such an extremely thin film for insulation between layers, the thermal insulation between the winding hot spot and the outside is almost nonexistent. Also, aluminum oxide appears to have a much higher thermal conductivity than the organic materials usually used for layer insulation.

▶ **Temperature**—Aluminum oxide melts at 2,050 C and retains its insulating qualities well past the 660 C melting point of aluminum. Practical considerations such as start and finish insulation and solder for termination currently set the tentative limit for continuous operation at 350 C, however. Coils have been run at this temperature continuously, and cycled from this temperature to very low temperatures. Others have been heated to this temperature and then placed in a pan of water. None of these



Aluminum-foil focus coils in use on Eitel-McCullough klystron here have less weight and lower power requirements than equivalent copper-wire coils

All Hughes diodes resemble each other—externally. Germanium point-contact or silicon junction, they are all glass-bodied* and tiny (actual dimensions: 0.265 by 0.123 inch). But minute, meticulously controlled variations in the manufacturing process impart individual characteristics to the diodes, make them just right for specific applications. This gives you the opportunity of selecting from a line which includes literally hundreds of diode types.

So, when your circuitry requires varying combinations of such characteristics as . . . high back resistance . . . quick recovery . . . high conductance . . . or high temperature operation, *specify Hughes*. You will get a diode with mechanical and electrical stability built in. You will get a diode which was manufactured first of all for reliability.

*Nowhere else have glass packaging techniques been developed to a comparable extent, for the Hughes process has many unique aspects. They are difficult to duplicate, yet are instrumental to the manufacture of diode bodies which are completely impervious to contamination and moisture penetration.

For descriptive literature please write: HUGHES

SEMICONDUCTORS

HUGHES PRODUCTS

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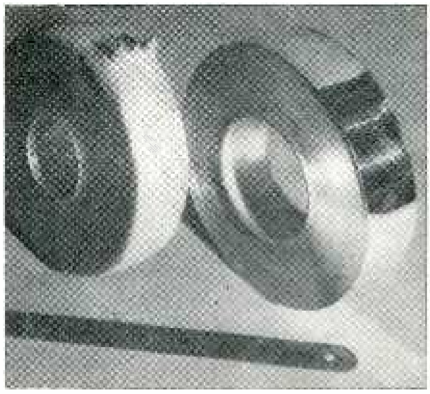


Aluminum-foil focus coils for klystron, before and after encapsulation with epoxy resin

abuses have any effect on the coils that can be observed.

▶ **Space Factor**—In sharp contrast to the 65-percent space factor of a conventionally insulated wire-wound coil, use of a microscopically thin film of aluminum oxide on strip aluminum can result in space factors better than 95 percent. In a typical case, the total size of a foil winding may be very near to that of a copper winding for the same amount of power consumed, when provisions for cooling are taken into account.

In some cases the winding size may be somewhat smaller for the same amount of power consumed due to a lower temperature rise and thus less resistance change as the wire reaches operating temperature. Figure 1 compares equivalent wire-wound and foil-wound coils where the foil coils actually consumed less power. The

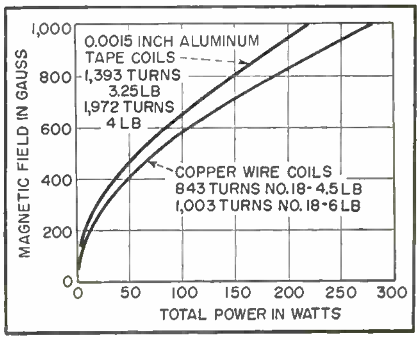
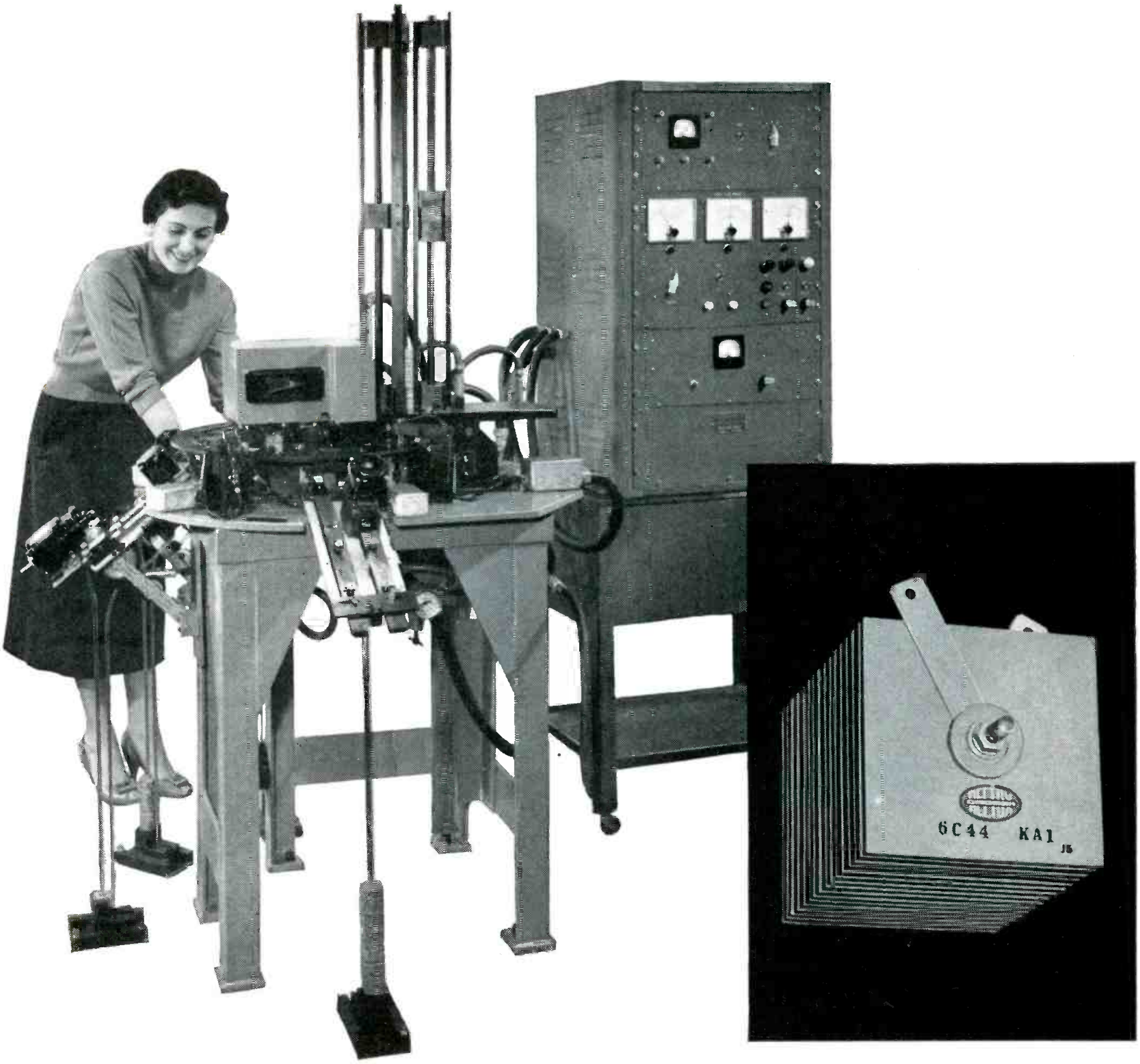


FIG. 1—Comparison of power requirements for copper-wire and aluminum-foil coils used for focusing a klystron. Data for curves was obtained in laboratory of Eitel-McCullough, Inc. Power saving with aluminum is due to better thermal conductivity within the aluminum coil



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Typical of the precision controls employed in the manufacture of Westinghouse selenium cells is the automatic cell tester shown above. This ingenious machine tests electrical characteristics of every cell, eliminating all human errors and assuring uniformity of the finished product.

Automatic controls are also employed at all other possible points in the process, reducing variability to a minimum. Contamination of the process is eliminated by air conditioning and precipitron cleaning.

These are reasons why Westinghouse selenium stacks are the highest quality rectifiers available today.

For all the facts, call your Westinghouse sales engineer. He'll show you why Westinghouse selenium stacks have the lowest forward aging rate in the industry.

J-21948

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size was the same in both cases.

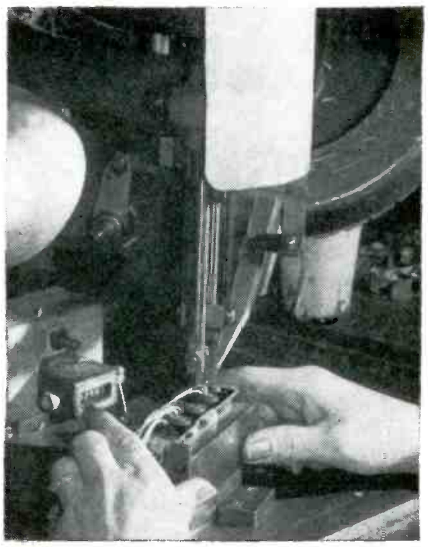
Since the size of an aluminum foil winding is nearly the same as for copper and the density of aluminum is much less than that of copper, the weight of a typical coil can be greatly reduced. The ratio of density of copper to aluminum is about 3, but the aluminum is packed much more tightly so the actual gain in weight will be closer to two to one. Many things will affect this, such as the type of impregnating varnish in a copper-wire coil and the exact space factors achieved by the two methods.

▶ **Future**—Some work has already been done on techniques for winding small aluminum-foil transformer and relay coils at high speed to compete with wire-wound coils in large-quantity production.

Assembling Coil Strip With Automatic Screwdriver

SELF-TAPPING SCREWS are fed and driven automatically in a setup used at Radio Condenser Co., Camden, N. J., for anchoring a three-coil Bakelite strip to its die-cast single-piece coil shield.

A pivoted holding fixture swings out from under the Detroit power



Loaded work fixture is in assembly position, with automatic power screwdriver bringing down next screw to be driven. Pivot for fixture is at left of operator's left hand

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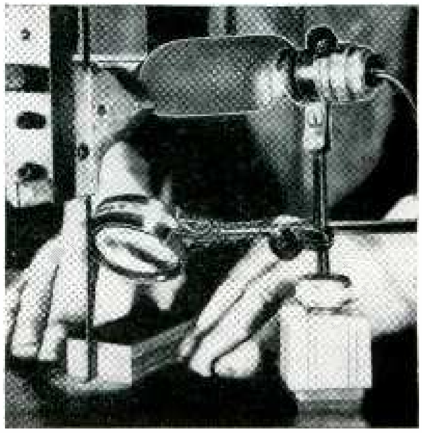
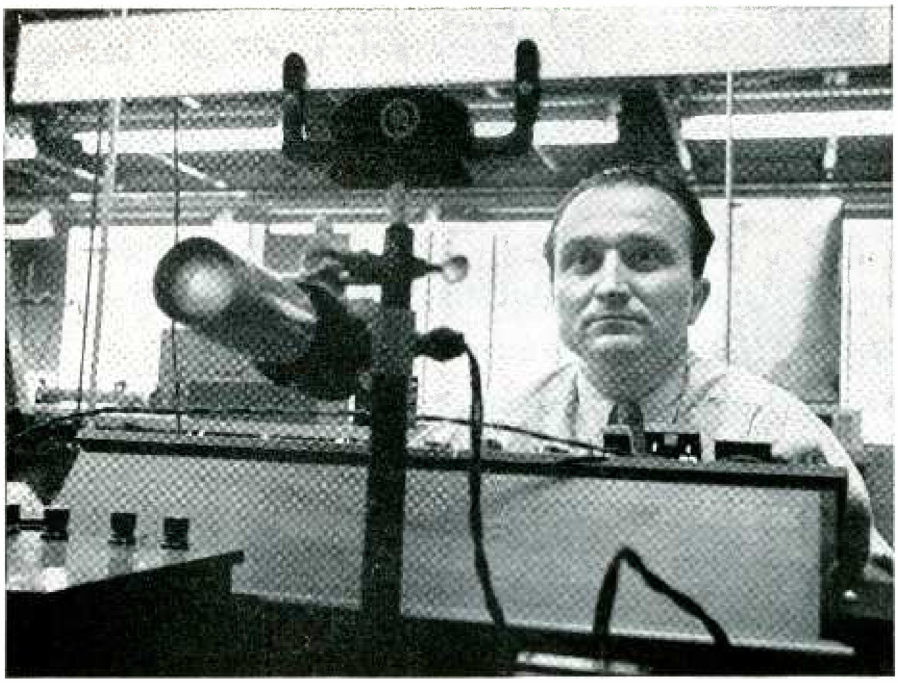
screwdriver for loading. The operator first drops in the three-coil shield, then drops the coil assembly into the shield. The coil forms slide over projecting metal studs that come up from the fixture through the coil shield. The strip itself is positioned by smaller studs at the ends of the fixture. After loading, the operator swings the fixture into position and pushes a foot pedal to initiate driving of the first screw. Three more screws are driven in rapid succession, swinging the fixture to the new position each time. This technique is possible because the screw holes are positioned on the arc of a circle having the same radius as the pivoted fixture.

Magnetic Base Holds Lamp and Magnifier



New production aid mounted on band saw helps operator follow fine scribed line precisely when cutting aluminum block

A FIVE-POWER magnifying glass mounted on the same adjustable magnetic-base holder as a lamp reduces rejects when drilling prototypes of etched-wiring boards or performing other delicate machine operations on electronic components. The base mounts equally well on flat or curved surfaces and provides a magnetic pull of 65 lb. A knurled aluminum locknut permits setting the upright at any desired angle quickly. Another adjustment permits rotating the 2-inch magnifying lens at any angle or plane. The tiny lamp is made by Enco Mfg. Co., 4520 W. Fullerton, Chicago.



Scientist at control box of a Sanford-Bennett High-H-Permeameter measures hysteresis loop of Indox ceramic magnet.

How temperature affects magnets

An interview with Dr. Rudolf K. Tenzer, scientist, The Indiana Steel Products Company

BECAUSE PERMANENT MAGNET remanence changes, resulting from varying temperatures, often necessitate corrections, compensations, or allowances, Dr. Tenzer undertook a series of studies on the subject. Some of the data used by him in answering the questions posed below resulted from work sponsored by the Wright Air Development Center of the U. S. Air Force. Reprints of an article by Dr. Tenzer on the subject are available by writing The Indiana Steel Products Co., Dept. A-7, Valparaiso, Ind.

Question: How does the remanence of permanent magnets vary with temperature?

Answer: Normally, remanence decreases with an increase in temperature . . . becoming zero at the Curie point, where all ferromagnetic properties vanish.

Question: Does a change in temperature result in a permanent change in remanence?

Answer: Not necessarily. Investigations which we have conducted show that temperature effects on ferromagnetic materials reveal both non-reversible and reversible variations.

Question: Can the result of these influences be evaluated?

Answer: Proper measuring techniques will evaluate the non-reversible variations as well as the reversible variations.

Question: Are non-reversible variations permanent changes in the remanence of a magnet?

Answer: Non-reversible variations are permanent until the initial remanence is restored by remagnetizing. This effect is not the same as irreversible metallurgical changes which prevent restoration of initial remanence by remagnetizing.

Question: What are reversible variations in remanence?

Answer: When a magnet has been stabilized for a certain temperature range, remanence variations within this temperature range are reversible.

Question: How are magnets stabilized for a given temperature range?

Answer: The magnet is exposed to repeated temperature cycling over a given range until the non-reversible variation becomes zero and remanence at room temperature remains the same for each additional cycle.

Question: Can the amount of remanence variation with temperature be predicted?

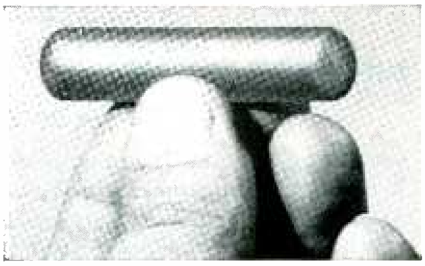
Answer: Our experiments in this field have produced quantitative results which can be used in predicting both the reversible and the non-reversible variations in remanence resulting from temperature change.

Question: Over what temperature range can these measurements be applied?

Answer: Our initial work in this field has been carried out in the temperature range from −60°C to 350°C.

Indiana expands research and production facilities

Currently under construction at Valparaiso, Ind., is a half-million dollar addition to the main plant of The Indiana Steel Products Co. The new structure will provide facilities for expanded research of magnetic materials, and increased production of Indox ceramic permanent magnets.



"Cattle Magnets" protect Bossie from stomach-aches

Cows often consume nails, staples and wire with their food. This causes a disorder called "hardware disease." To prevent it, you can feed Bossie an Indiana "Cattle Magnet." The magnet remains in her first stomach, gathering the stray metal. This keeps it from passing to her other stomachs (she has four, you know) where it can cause great distress.

THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA
WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS

INDIANA PERMANENT MAGNETS

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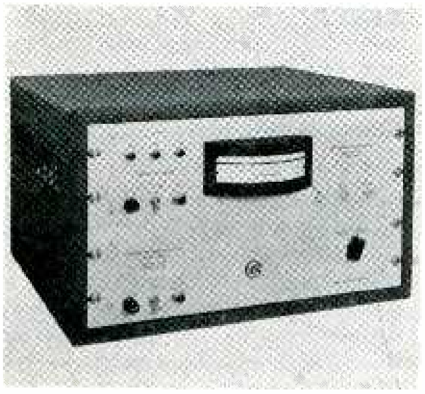
New Products

Edited by WILLIAM P. O'BRIEN

76 New Products and 67 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

FREQUENCY METER

features high accuracy



VARO MFG. CO., INC., 2201 Walnut St., Garland, Texas, announces the model 6503 frequency meter featuring accuracy of better than 0.01 percent. Frequency range is 397 to 403 cps. A switch permits using the meter to measure any frequency in the range 370 to 430 cps to an accuracy of better than 0.1 percent.

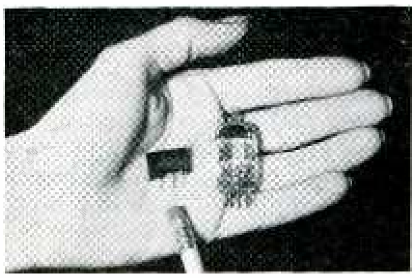
The meter is completely insensitive to waveform. It will accurately measure the repetition rate of voltage spikes, sawtooth waveforms, or badly distorted sine waves. It will measure frequency of any input signal voltage between 6 and 250 v without need for adjustment.

Model 6503 consists of a model 6600 frequency deviation multiplier and a model 6505A frequency meter. The frequency deviation multiplier multiplies by 10 the difference between the measured frequency and 400 cps. Thus, a 399-cps input applied to the input appears at the output as a 390-cps signal. This frequency is measured to 0.1 percent accuracy by the 6505A frequency meter.

MINIATURE RECTIFIER

for tv applications

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has announced a new twin diode, miniature Vac-u-Sel rectifier for use as a horizontal phase detector in place of 6AL5 tubes in tv sets. The new semiconductor is especially adapted for automatic assembly operations using printed circuits.



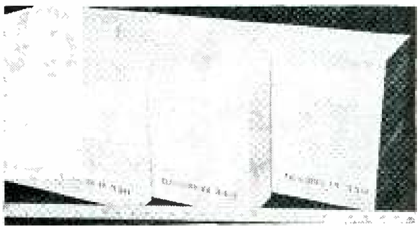
It is built to withstand prolonged exposure at 90 percent humidity, is capable of operation at high ambient temperatures, and has rugged tinned leads.

▶ **Characteristics**—The rectifier features a minimum forward current of 25 μa at -20 v. The characteristic capacitance per section is approximately 50 $\mu\mu$f, with negligible unbalance.

MICROWAVE ABSORBER

for free space rooms

EMERSON & CUMING, INC., 869 Washington St., Canton, Mass., has announced a new series of broadband microwave absorbers for use in free space rooms. Designated Eccosorb FR, the absorbers are rigid foam blocks which reflect less than 2 percent of incident energy. The material will not burn, making it ideal for use at indoor antenna test locations. It will not absorb moisture and therefore is also useful out of doors.

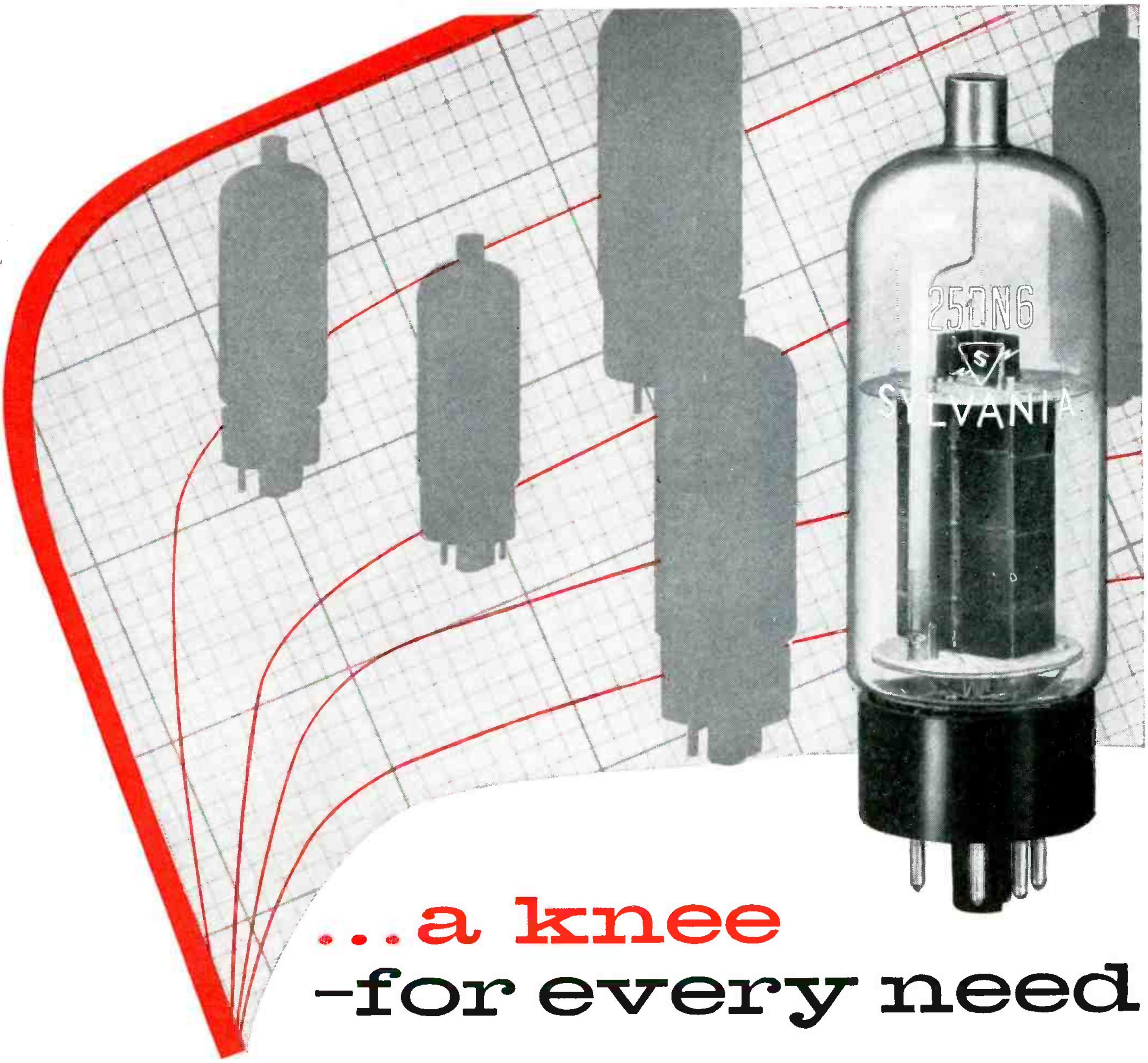


Available in three types, dependent upon the frequency range to be covered, Eccosorb FR is easily installed in the microwave darkroom. It is white surfaced for good light reflection. A special type which can be walked upon is supplied for floors.

DIGITAL RATIOMETER

high speed precision unit

FRANKLIN ELECTRONICS INC., East 4th St., Bridgeport, Pa. High speed



...a knee —for every need

—including low B+ deflection

Peak plate currents are checked in production on universal dynamic testing equipment built by Sylvania engineers.

For all your TV designs, Sylvania offers a complete line of deflection amplifier tubes with proper plate knee characteristics to meet every deflection need.

And Sylvania offers you the Sylvania-originated type 25DN6 designed to deliver high peak currents for proper deflection in low B+TV designs.

All Sylvania deflection tube types are tested under an exhaustive dynamic testing program. Critical parameters are checked 100% in production and double checked in destructive life tests in universal equipment specially designed by Sylvania engineers to simulate circuit conditions existing in the modern television receiver.

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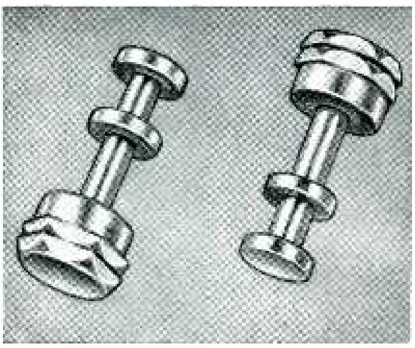
electronic digitizing is employed in this 4 digit ratiometer which is useful in many automatic control applications, such as digital indication of mechanical position, process data logging, checking of precision resistance components and control of resistance winding machines.

Model 330 ratiometer provides a discrete 4-digit indication of the ratio between two voltages or resistances stable to 0.01 percent. The ratiometer measurements are independent of reference excitation accuracy. Readings take less than 10 milliseconds and up to 60 channels may be scanned per sec. In addition to a visual display, provisions are included for a digital readout to printers or card and tape punches.

MOUNTING TERMINALS

require no riveting



CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass., announces the first of a series of three new barbed and press mount terminals. These press mount solder terminals, designated series PM do not require riveting or swaging. They are designed to be press mounted into snug holes in all kinds of material, including laminated or cast material of 3/32 in. thickness or more.

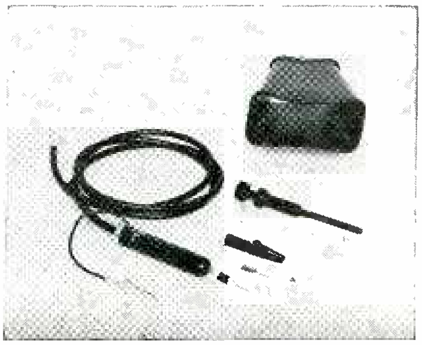
Once inserted the new terminals have great holding power and will not come loose even under extreme shock or vibration. Ideal for mounting in blind holes or flush mounting in through holes, series PM sizes correspond to the dimensions of the following terminals: 1724, X2034 and X1558. When mounted the PM-1724 terminal is 23/64 ths, the PM2034 is 9/32 nds and the PM-1558 is 7/32 nds.

Complete specifications, information and prices are available by writing the company.

TEST PROBE & HOOD

for use with cro's

ALLEN B. DUMONT LABORATORIES, INC., 760 Bloomfield Ave., Clifton, N. J., has available a fixed-ratio test probe which permits observation of signals in circuits with high source impedance without loading the circuit. Together with the new probe, the availability of a 3-in. rubber viewing hood for cro's has been announced.



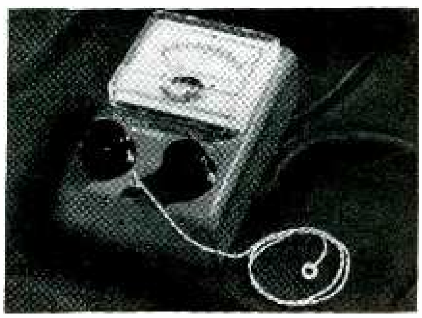
▶ **Specifications**—Offering 10 megohms input impedance, type 2613 fixed-ratio test probe is a general purpose, attenuator probe, which has a frequency range from d-c to 10 mc. The attenuation ratio is 10 to 1. A capacitive trimmer adjustment on the probe permits frequency compensation by matching input impedances of oscillographs having inputs within the range of 10 to 80 $\mu\mu$f.

The type 2621 three-in. rubber viewing hood is furnished with a mounting clip for fastening to the panel bezel of an oscillograph.

POWER TRANSISTOR THERMOMETER

with high thermal impedance

B&B ENGINEERING ASSOCIATES, RFD No. 1, Concord, N. H. Model 1 power transistor thermometer is a compact, battery powered instrument for measuring temperature. The sensing element is normally mounted with the same screw (or stud) as the power transistor being observed, with the power transistor on one side of the heat dissipator and the sensing element on the other side. The high thermal impedance and small physical size of the sensing element minimizes heat conduction and radiation from the transistor mounting.

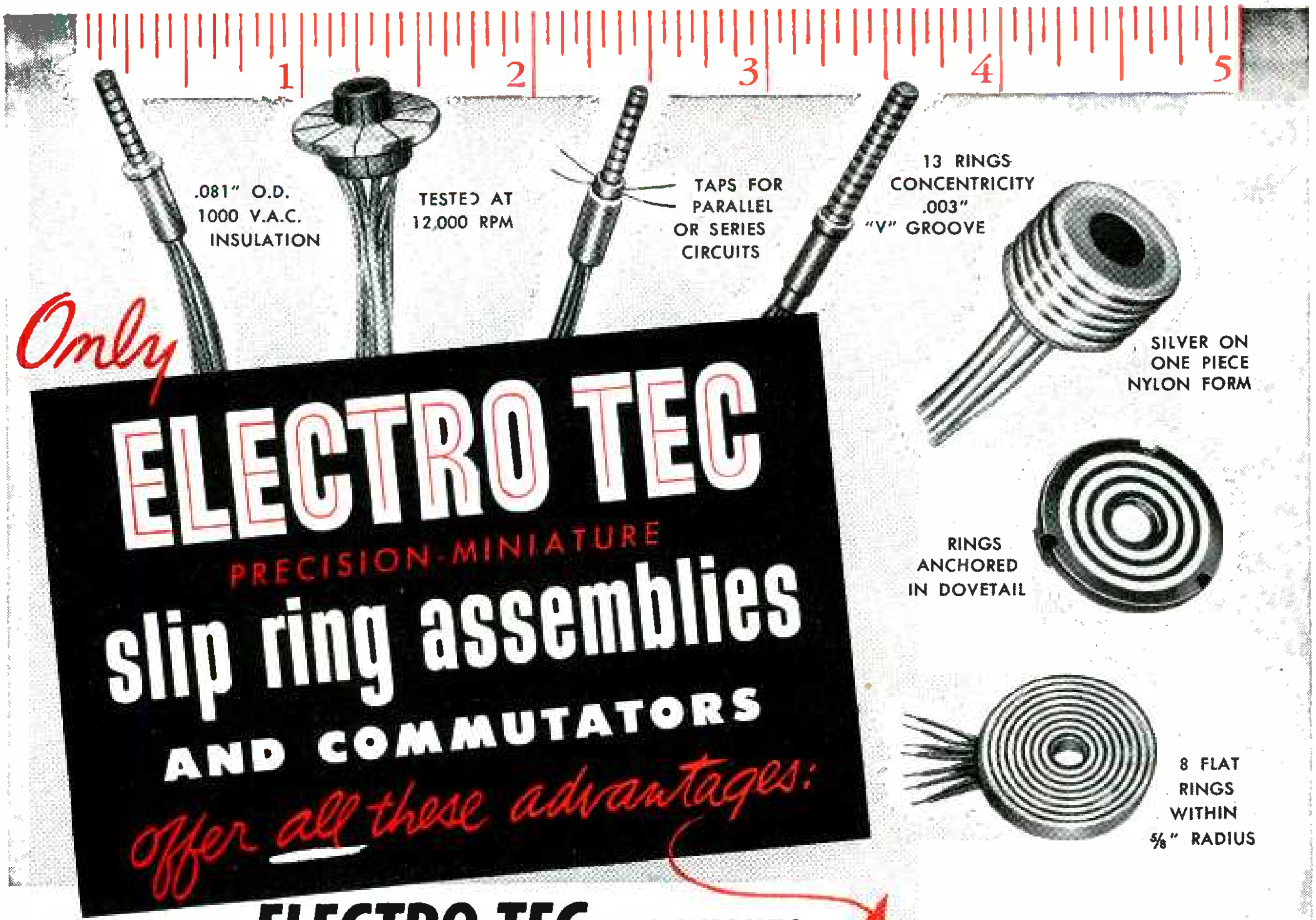


▶ **Specifications**—Scale ranges are 35 to 85 C and 95 to 185 F. Accuracy is ± 1 deg C with measuring unit within normal room temperatures. Battery life is approximately 250 hr. Weight is 1$\frac{3}{8}$ lb. The unit is 4 in. wide by 6 in. long by 2$\frac{5}{8}$ in. high. Sensing element is $\frac{3}{8}$ in. diameter by 5/64 in. thickness. Hole diameter is 0.196 in. Price is $87.50 complete with sensing element and battery.

PARALLEL T FILTERS

for printed circuit uses

THE NEWTON CO., 55 Elm St., Manchester, Conn., announces a new line, the series L. G. filters. These filters are parallel networks which are used for nearly complete elimination of 30, 60 or 120 cps frequencies. Design has made them



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.

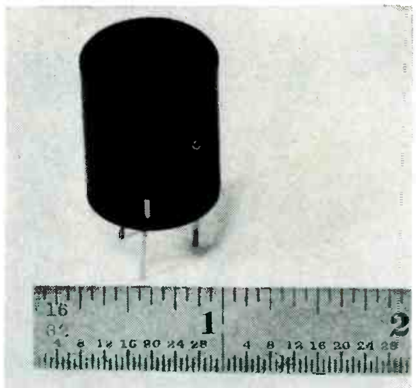
- ONE PIECE, UNITIZED CONSTRUCTION
- ABSOLUTE MINIMUM TORQUE FRICTION
- DIAMETERS FROM .045" TO 24.0"
- MINIMUM 1000 V.A.C. HI-POT INTER-CIRCUIT
- UNIFORMLY HARD SILVER RINGS PLATED INTO GROOVES ON PRECISION MACHINED ONE PIECE PLASTIC FORM
- SPECIAL SURFACE DEPOSITS PREVENT TARNISH, MINIMIZE FRICTION, BRUSH NOISE AND PRACTICALLY ELIMINATE WEAR

*PAT. NO. 2,696,570

ELECTRO TEC CORPORATION
SO. HACKENSACK NEW JERSEY

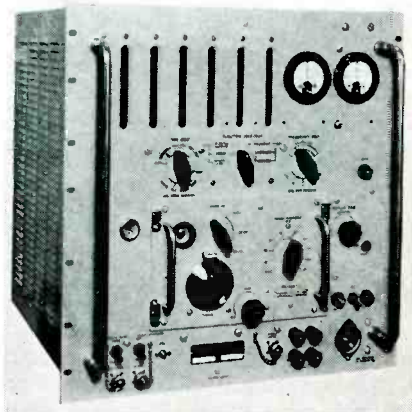
PRODUCTS OF PRECISION CRAFTSMANSHIP BY A NEW AND REVOLUTIONARY PROCESS

Want more information? Use post card on last page.



especially adaptable for printed circuit applications in that there are three leads which may be inserted with printed circuit boards and dip soldered.

It has available a wide range of impedances and voltage ratings. The filters give a minimum of 45-db attenuation at the null frequency.



FREQUENCY METER
displays in digital form

NORTHEASTERN ENGINEERING, INC., Manchester, N. H. Frequency counter No. 14-20 FM, a commercial version of the military type AN/USM-26, is a precision direct reading type frequency meter which displays the measured frequency automatically in digital form. Frequencies measured may be periodic or random; 10 cps to 220 mc. The counter may also be used to measure time intervals, pulse length, frequency drift and total events.

Basic feature of the unit is a precision time base generator, operating from a crystal-controlled 100-kc precision oscillator, which opens and closes a gating circuit. Period or time intervals are measured by reversing the roles of the time-base generator and the signal

Want more information? Use post card on last page.

under measurement.

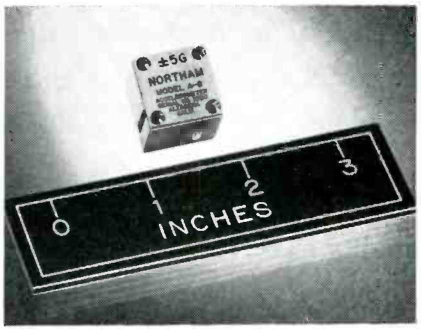
Complete technical characteristics are available from the company.

ELECTRONIC LOAD
compact and easy to operate

BRISTOL ENGINEERING CORP., Bristol, Pa. Model 102 electronic load is a precision device which combines in a single, compact unit all of the conventional instrumentation required for the complete testing of regulated and unregulated power supplies.

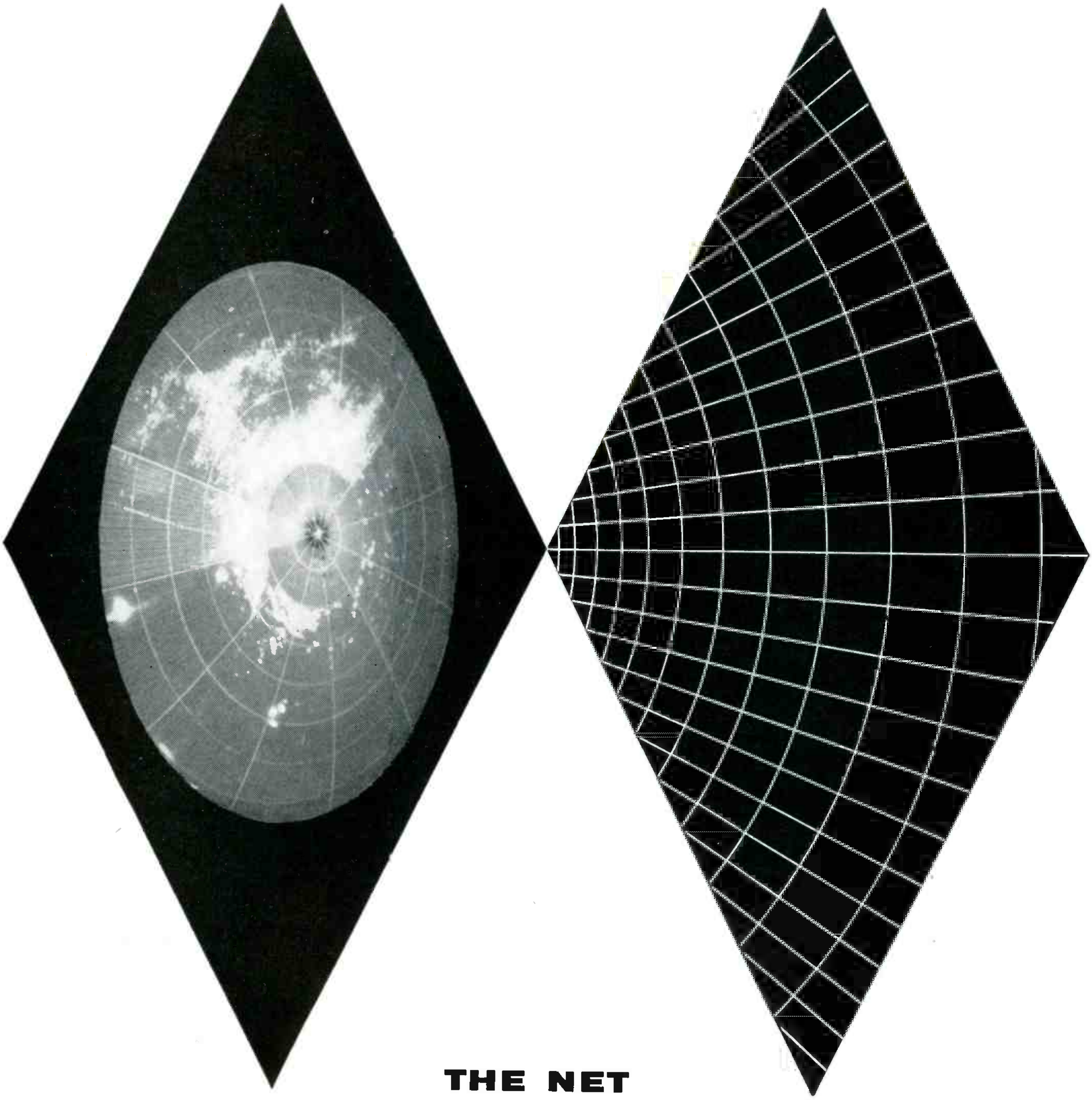
▶ **Makeup**—The unit comprises a group of paralleled power tubes, a wide-band modulation amplifier, a variable bias supply, a mechanical keying device, and an a-c vtvm.

Physical size, compactness, ease of operation and reliability in continuous use make the unit suitable for field production testing as well as for laboratory use.



TINY ACCELEROMETER
variable reluctance type

NORTH AMERICAN INSTRUMENTS, INC., 2420 N. Lake Ave., Altadena, Calif. Model A-8 miniature accelerometer of the variable reluctance type was developed primarily for flight test application. The



THE NET

America's most potent protective weapon has been announced by the Army.

It is the new Martin Missile Master, the country's first electronic system designed to coordinate and control an integrated network of radar surveillance, target detection and anti-aircraft missile battery operation.

Now fully proved out and ready for installation, Missile Master offers pushbutton protection for whole cities and strategic areas.

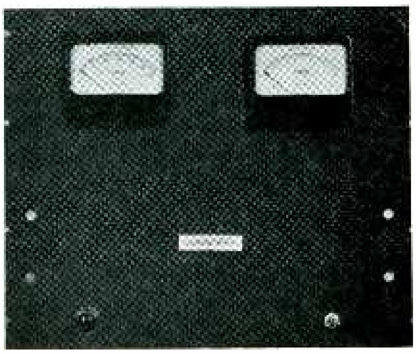
The system collects information on the position, identity and flight data of all aircraft entering the network. This data is stored electronically and distributed to display consoles in the Operation Center and at the missile batteries.

Thus, the activity of Nike batteries and other advanced weapons in the system are centrally coordinated and controlled.

This important new weapon system is one of the great defense developments of our time.

MARTIN

dozen is $43.20; $38.40, if bought in 6 dozen lots.

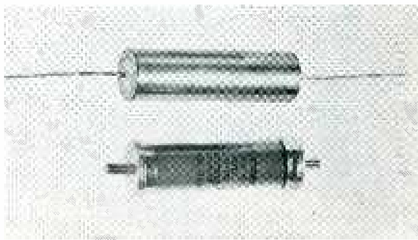


D-C POWER SUPPLY uses silicon rectifiers

STATOR ELECTRIC CORP., 46-25 58th St., Woodside 77, N. Y., has announced a new d-c power supply using silicon rectifiers. Input is 208-220 v, 60 cycles, 3 phase; and output, 220 v d-c, 5 amperes.

▶ **Other Features**—Regulation is 5 percent for 20 percent to full load. Ripple is 50 mv. Ambient temperature is −55 C to +85 C. Dimensions are 19 in. wide by 15¾ in. high.

Unit price is $975. The same unit magnetically regulated is $1,175.



TEFLON CAPACITORS for high-temperature usage

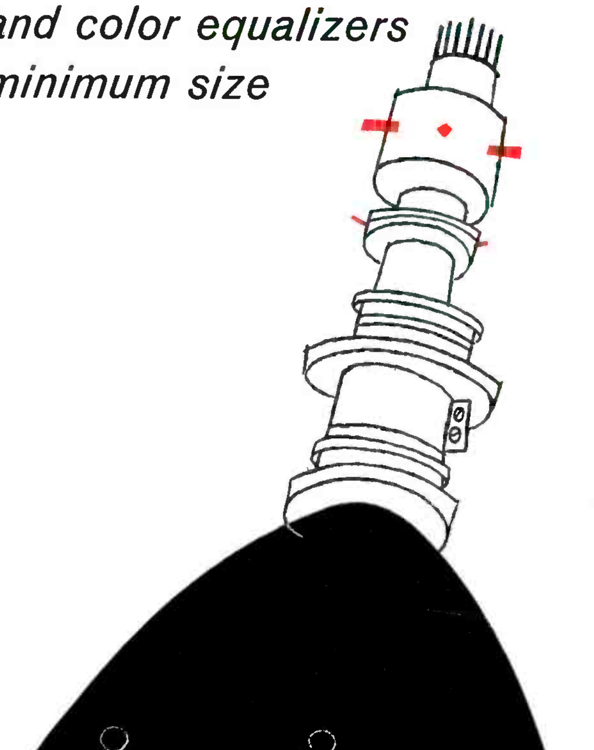
CONDENSER PRODUCTS CO., 140 Hamilton St., New Haven, Conn., has introduced two new Teflon dielectric capacitors specifically designed for high temperature usage in guided missiles and other airborne applications. They are smaller than others designed to give the same electrical characteristics at temperature ranges of from −70 C to +200 C. They equal or exceed requirements of MIL-C-25. These capacitors were developed for applications where small dielectric absorption and capacitance changes are necessary.

Capacitance range is from 0.001

in color tv, too

CRUCIBLE PERMANENT MAGNETS

for beam correctors, color purifiers and color equalizers
give maximum energy . . . minimum size



Designers of electronic and control equipment can count on a *consistently higher* energy product with Crucible alnico magnets. *It means greater power from a minimum size magnet!*

And they're available in practically any size you want—from a fraction of an ounce to several hundred pounds. What's more, Crucible alnico permanent magnets can be sand cast, shell molded, or investment cast to your exact size, shape, or tolerance requirements.

Crucible has been a leading producer of these permanent magnets ever since alnico alloys were developed. And their manufacture is backed by over a half century of fine steelmaking experience. That's why so many magnet applications begin at Crucible.

Crucible Steel Company of America,
The Oliver Building, Mellon Square,
Pittsburgh 22, Pa.

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

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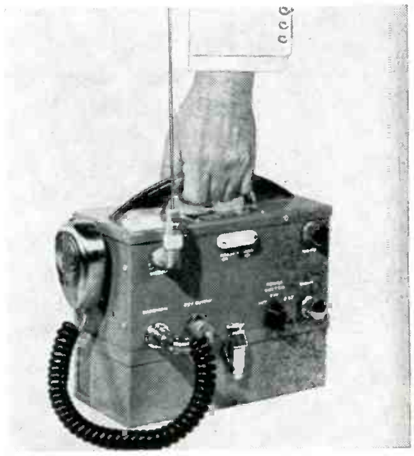
μf to 1.0 μf. Standard capacitance tolerance is ±20 percent.

One of the new capacitors, the TACM type, is hermetically sealed in tubular brass shells. The other, type TAG, is glass encapsulated. Type TACM operates at temperatures up to and including 200 C. Type TAG operates up to and including temperatures of 170 C.



LIGHT 2-WAY RADIO
meets FCC and FCDA demands

INDUSTRIAL RADIO CORP., 428 N. Parkside Ave., Chicago 44, Ill., has announced a 2-way portable radio measuring only 10 by 4½ by 9¾ in. and weighing only 11 lb complete with long-life batteries. Model H/M Pak-Fone features loudspeaker operation, relay operated squelch system, volume control and an on-off indicator light.

A power cable connector is also provided for an external power supply, such as the UPC-100 which operates from 6, 12 and 24-v storage batteries and 117 v a-c.

Performance meets all FCC and FCDA requirements for municipal and industrial portable radios.

HOOK-UP WIRES
available in varied colors

REVERE CORP. OF AMERICA, Wallingford, Conn., is now manufacturing Permacode hook-up wires, combining high temperature operating characteristics with permanent and positive identification. The new wires, insulated with extruded duPont Teflon suitable for continuous operation up to 210C, are available in 15 solid colors and any combina-

tion of 2, 3 or 4 colors.

The wires are available in nominal 0.010 in. or 0.015 in. wall thicknesses, and are constructed to meet requirements of military specification MIL-W-16878/A, types E and EE.

TINY POTENTIOMETER
operates to 150 C

ACE ELECTRONICS ASSOCIATES, 103 Dover St., Somerville 44, Mass., announces the X-500 Acepot, a $\frac{1}{2}$-in. subminiature, precision wire-wound potentiometer which operates in the temperature range from —55 C to a high of 150 C.

▶ **Specifications**—Resistance range is 200 ohms to 250,000 ohms ±2 percent; linearity, ±0.3 percent; weight, $\frac{1}{4}$ oz. It is available in threaded bushing, servo, flush tapped hole, or flange mountings and up to 6-gang units. It meets applicable portions of JAN specs and MIL-E-5272A standards.

MEMO-SCOPE
stores traces indefinitely

ADVANCED ELECTRONICS MFG. CORP., 2025 Pontius Ave., Los Angeles 25, Calif. The MemoScope 103, a storage oscilloscope, forms and retains

for LOW-DISTORTION *amplification of* WIDE-BAND *signals . . . use* SIE DIRECT-COUPLED AMPLIFIERS

When your signals include frequencies from below 1 cps to above the audio range, a true direct-coupled amplifier gives the FLATTEST response over the WIDEST range with the LOWEST noise, distortion, and phase shift.

For voltage gain from transducers of all kinds, use the Model D-1. It will drive a 'scope, direct-writer, oscillograph, or magnetic recorder.

SIE MODEL D-1
Direct Coupled Amplifier

Input Impedance: 10 megohms or open grid, single ended or differential.

Noise: Less than 10 microvolts, wide-band.

Gain: 80,000, ± 1db, 0 to 50 kc.
1,000, ± 1db, 0 to 120 kc.

Drift: Less than 3 millivolts per hour, referred to input.

Maximum Output Signal: 80 volts into high impedance, 25 ma. into 1000 ohms. (Distortion less than 1%)

Price: **$515**

For power gain — to drive Helmholtz coils, servo motors, or small shakers — use the Model B.

SIE MODEL B
Direct Coupled Amplifier

Input Impedance: 500,000 ohms.

Voltage Gain: 2.5. *Power Gain:* 30,000.

Power Output: 6 watts into 100 ohms.

Frequency Response: 0 to 20,000 cps ± 1 db.

Output: 25 volts RMS at 250 milliamperes.

Price: **$575**

You can use the D-1 to drive the B — they rack-mount together perfectly!

SOUTHWESTERN INDUSTRIAL ELECTRONICS COMPANY

SIE

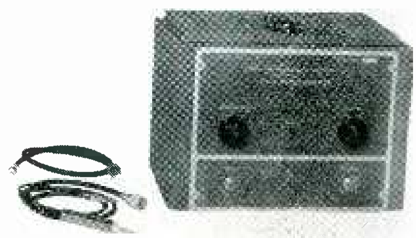
Industrial Instruments Division

P. O. BOX 13058 • 2831 POST OAK ROAD • HOUSTON 19, TEXAS traces at a constant intensity until they are deliberately erased by the operator. This feature permits the study of transient electrical phenomena as short as 10 μsec in duration, presentation of tube or transistor characteristics without the necessity of repetition, display of frequency response curves without the need of a sweep generator, spectrum analyses and the like.

Plug-in vertical amplifier units allow new amplifier characteristics as different units become available, increasing the range of application. For comparison purposes, a number of traces may be written and stored on the 103. The stored trace, immediately visible and of constant high brightness, is readily seen in a brightly lighted room, and may be easily photographed.

▶ **Other Features**—The unit offers a vertical amplifier sensitivity of 10 mv d-c; sweep speeds up to 100 sec full-scale; and direct reading calibrations of amplitude and time.

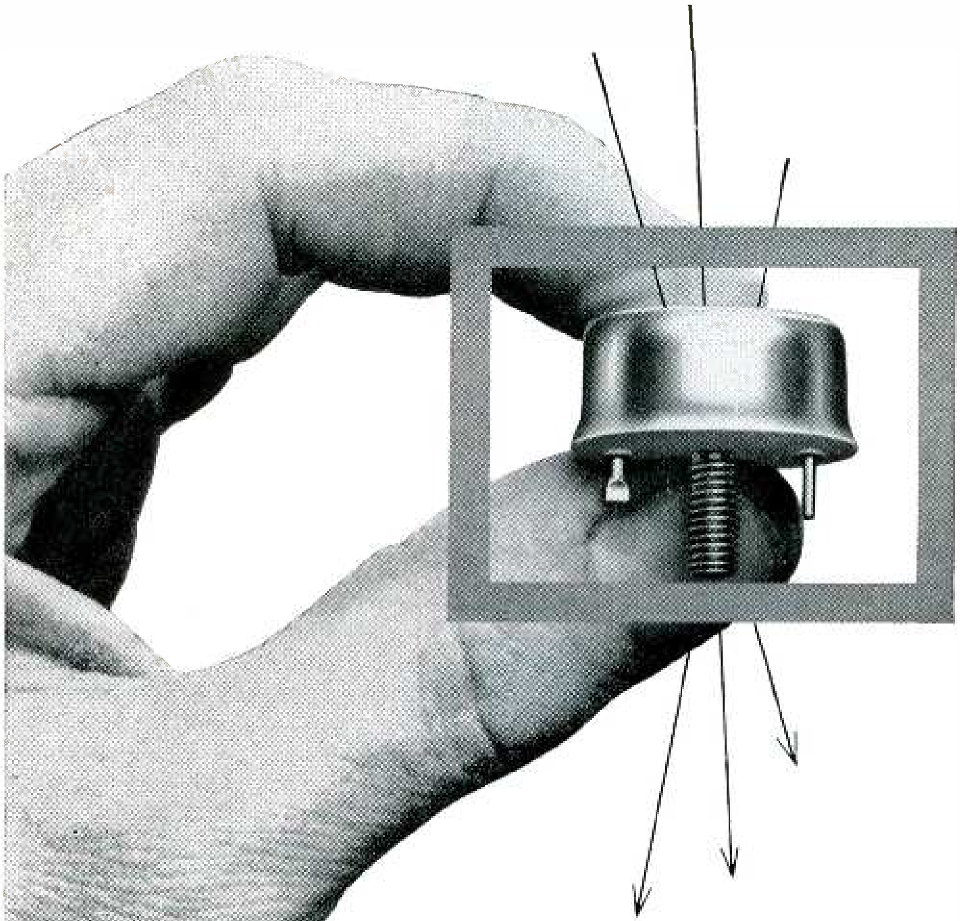
Complete specifications and prices are available.



OSCILLOPROBE
and video amplifier

LINEAR EQUIPMENT LABORATORIES, INC., Intervale Road, Boonton, N. J., is marketing a low-capacitance oscilloprobe and video amplifier designed to extend the utility of oscilloscopes for making accurate observations of waveforms. The instrument consists of a shielded, low capacitance (1.5 to 2 $\mu\mu$f) probe and an associated video amplifier with a gain of 40 to compensate for the probe attenuation. The overall bandwidth is within 3 db from 5 cps to 12 mc. The amplifier may be used separately to provide a gain of 40, or with the probe to provide attenuations of $\times 1$, $\times 0.1$ and $\times 0.01$.

Used with an oscilloscope, the

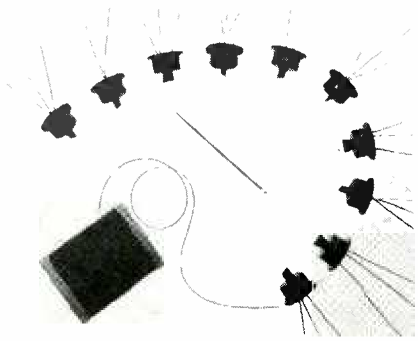


HF-3A oscilloprobe permits observation of signals in a circuit with negligible resultant loading or detuning, or otherwise affecting the normal performance of the circuit.

LARGE COAX
for high power uses

ANDREW CORP., 363 E. 75th St., Chicago, Ill., announces a 9-in. rigid coaxial transmission line for very high power application at frequencies up to 550 mc. The new line can handle average powers of 300 kw at 150 mc, and peak power of 3.0 megawatts. It has a 50-ohm characteristic impedance, and attenuation of 0.042 db per 100 ft at 150 mc.

The line comes in 20-ft sections and features a quick-assembly flange using only 1 bolt, instead of the many bolts required by conventional flanges. A complete complement of elbows, gas barriers, adaptors, power dividers, tuners, slotted lines, hangers and other associated equipment have been designed and are available for prompt delivery.



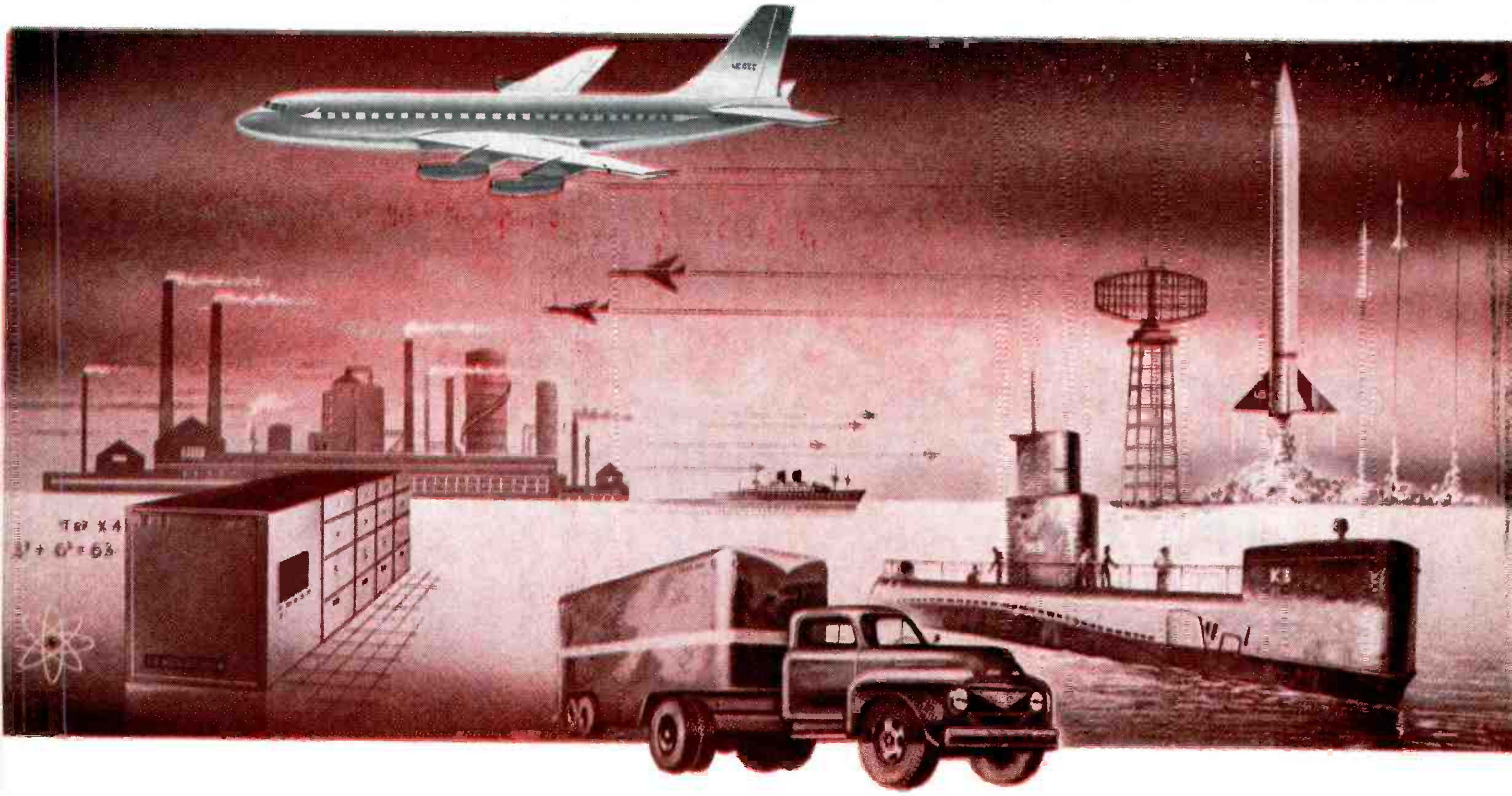
TRANSISTORS
for audio amplifier uses

GENERAL ELECTRIC CO., Syracuse, N. Y., has announced ten new *pnp* transistors made of germanium and produced by the alloy junction process. They include 6 different types for the output stage of an audio amplifier and 4 types for the driver stage.

▶ **Specifications**—Current gain of the output type is maintained at an essentially constant value for collector currents from 1 ma to 200 ma. The 2N186A, 2N187A and 2N188A are rated at a 180-mw power collector dissipation at 25 C. Types 2N186, 2N187 and 2N188 are rated

BEAM SWITCHING TUBES *Simplify* CIRCUITRY

IN UNLIMITED APPLICATIONS



GREATLY REDUCE THE TOTAL NUMBER OF RESISTORS, CONDENSERS, TUBES, SOCKETS AND OTHER COMPONENTS.

The Beam Switching Tube has introduced new standards of simplicity and reliability in the design of most electronic systems. It is so versatile that any desired type of sequential, random switching or distribution of any number of positions can be obtained. Design engineers now have available new high levels of speed, reliability and economy in solving difficult instrumentation problems in unlimited applications such as:

- COUNTING
- GATING
- TIMING
- DISTRIBUTING
- SAMPLING
- CASCADING
- MULTIPLEXING
- MATRIXING

Send for latest circuit information on the Beam Switching Tube.

LIFE TESTS INDICATE A LIFE SPAN OF 50,000 HOURS.

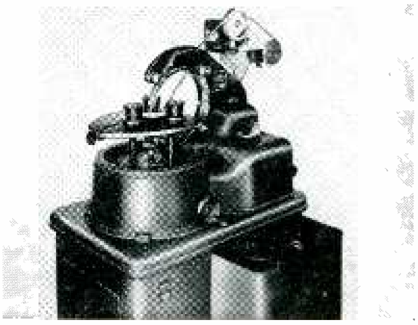
For further information write

HAYDU

BROTHERS OF NEW JERSEY

PLAINFIELD, NEW JERSEY   SUBSIDIARY OF BURROUGHS CORPORATION at a maximum power collector dissipation of 75 mw at 25 C. The 4 driver types (2N189, 2N190, 2N191 and 2N192) in a class A operation have a minimum power gain rating of 37 db, 39 db, 41 db and 43 db respectively at 1 mw power output. Typical base current gains are 24, 36, 54 and 75 respectively. All 4 are rated at a maximum power collector dissipation of 75 mw at 25 C. They have a maximum storage temperature rating of from —55 C to 85 C.

Prices of the 10 new audio amplifier transistors in quantity lots to equipment manufacturers range from $1.40 each to $2.35 each.



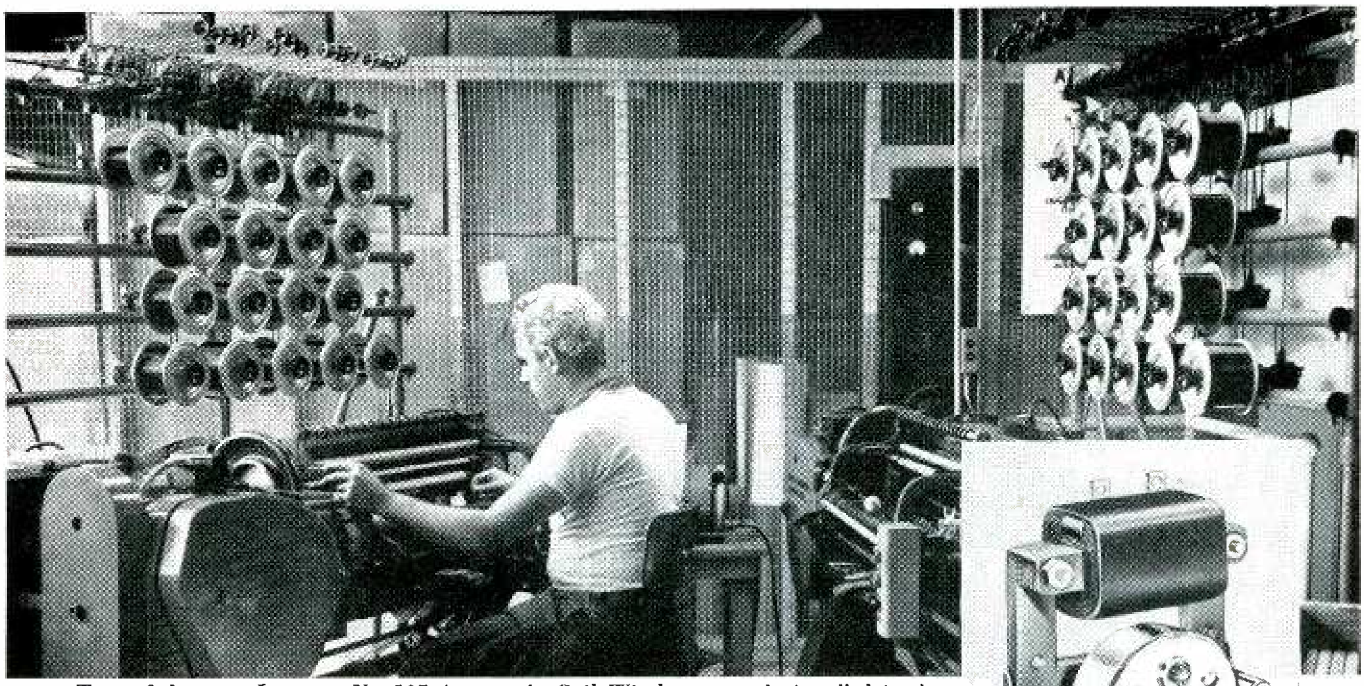
TAPE WINDERS
for toroidal coil field

UNIVERSAL MFG. CO., Hillside, N. J., announces a new series of automatic tape winding machines for the toroidal coil field. The new tape winders offer revolutionary operational and performance features including core turning table with automatic feed and variable pitch control, automatic tape cutting device and special manual feeding attachment for hand winding when desired.

Series incorporates 3 models, U-9, U-14 and U-20, to wind tape from $\frac{3}{8}$ in. to 1 in.

CIRCUIT MODULES
and breadboard kit

AEROVOX CORP., New Bedford, Mass., has announced a new concept in electronic circuitry and assembly, in the form of standard-circuit modules and handy breadboard for simplifying and speeding up experimental and prototype assemblies. Engineers can work up breadboard layouts by simply



Two of the new Leesona No. 107 Automatic Coil Winders recently installed in the Clock and Timer Department of the General Electric Company, Ashland, Mass. The last word in automatic coil winder design, No. 107's wind paper-insulated coils in stick form. Automatic operation eliminates human error, reduces wire breakage to a minimum, cuts production time and costs. Inset shows a Type H3 Synchronous Motor, one of many Telechron timing units with coils precision-wound on Leesona No. 107 machines.

Clock and Timer Department, General Electric Company selects Leesona Coil Winders as standard equipment

General Electric Department adds No. 107 machines for proved production advantages

The synchronous timing motors made by the Clock and Timer Department of the General Electric Company are famous for accuracy and dependability.

One reason why is the high efficiency maintained by this department of the General Electric Company, in its wide range of coil winding operations. Leesona Coil Winders are standard equipment at General Electric Telechron plants — and during a recent expansion of production facilities, Leesona No. 107 Automatic Coil Winders were important new additions.

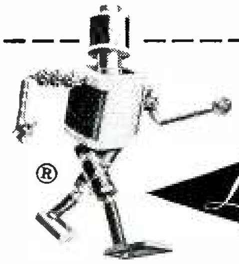
Leesona No. 107 machines are fully automatic. Every feature is designed to produce compact, uniform, paper-insulated coils — in fastest time — with minimum operator attention — at lowest cost. This General Electric department reports:

"The Short Paper Attachment on our Leesona No. 107 Coil Winders is a big advantage. Allowing an initial paper insert of $1\frac{7}{16}''$, it eliminates the usual $2\frac{3}{4}''$ insert when starting winding. On these particular coils the result is considerable savings in wire."

Get the Whole Story

on how Leesona No. 107 Automatic Coil Winders can bring new, profit-boosting efficiency to your own coil winding production. For complete details on this advanced machine — and other helpful coil winding information — check and mail the coupon today.

B.5.4



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FOR WINDING COILS
IN QUANTITY...ACCURATELY
...AUTOMATICALLY...USE
UNIVERSAL WINDING MACHINES

UNIVERSAL WINDING COMPANY

P. O. BOX 1605, PROVIDENCE 1, RHODE ISLAND, Dept. 127

Please send me

- ☐ Bulletin on the Leesona No. 107 Automatic Coil Winder.
- ☐ Condensed catalog of Leesona Winders.
- ☐ Bulletin on the new Leesona *Pay-As-You-Profit Plans* for purchasing or leasing modern coil winding machinery.

Name...*Title*......................

Company...

City....................................*Zone*....*State*..................

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plugging in complete basic-circuit modules in the breadboard sockets, and completing the necessary connections with banana-plug jumpers plus the basic bus-bar wiring of the breadboard.

▶ **Modules**—These commercialized modules are now available in seven circuits or block diagrams. Each module includes all necessary components on the stacked wafers wired together by the riser conductors and provided with base prongs for plugging into a socket.

▶ **Kit**—The complete introductory kit includes seven standard-circuit modules; one 12-position module breadboard; 50 banana plugs. A module catalog and instruction manual go with the kit.

SWITCH
is acceleration-sensitive

Maxson Instruments, Division of the W. L. Maxson Corp., 47-37 Austel Place, Long Island City 1, N. Y. This acceleration-sensitive switch has a snap-acting switch element capable of being set precisely, in manufacture, to open or close when the desired level is reached.

▶ **Data**—These switches are rated at 30 v, one ampere inductive or two amperes resistive load. They can be furnished to operate at any level from 2.5 to 15 g absolute with precision of ± 0.2 g; higher g ratings are available on special order. Frequency range is 0 to 10 cps; shock resistance is 25 g for 11 millisec, on all 3 axes. These switches are designed to function through a temperature range of -60 to $+180$ F and to withstand 100-percent humidity at 160 F.

▶ **Uses**—Typical applications are: g-limiting switch for autopilots,

FOR ELECTRONIC AND ELECTRICAL APPLICATIONS . . .

only one insulation

Combines

ALL THESE ADVANTAGES

- ***TOTAL*** **Permanent Dimensional Stability**
- **Continuous Hi-Temperature Performance: to 950° F.**
- **Moldability to ±.001″ Tolerances**
- **Thermal Expansion Matching Steel**
- ***POSITIVE*** **Bonding and Permanent Anchorage of Inserts**
- **Resistance to Radiation, Water or Oil**
- **High Dielectric Strength: 400 Volts/mil**
- **Excellent Arc Resistance: 250 Seconds ASTM**
- **Extremely Low Loss Factor: 1 meg — 0.014**

SUPRAMICA® 555 CERAMOPLASTIC . . .

. . . has many **important** properties that will significantly **improve** your product's performance! No need to choose or balance insulation advantages . . . specify SUPRAMICA* 555 for the most **nearly perfect** combination. This unique formulation of high quality electrical glass and pure synthetic mica has the built-in versatility to surpass extra-stringent performance requirements. For complete technical information about SUPRAMICA 555 ceramoplastic insulation, and MYCALEX design and custom precision-molding services, write to Department 224.

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MOLDED OF SUPRAMICA 555 CERAMOPLASTIC FOR BETTER PERFORMANCE

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THE FIRST SUPRAMICA® CERAMOPLASTIC

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LOS ANGELES
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WASHINGTON

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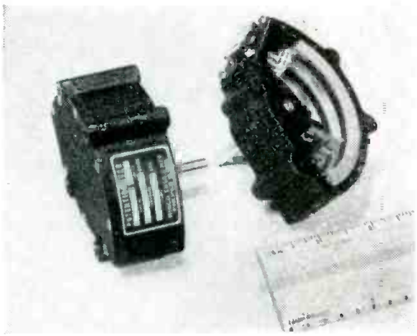
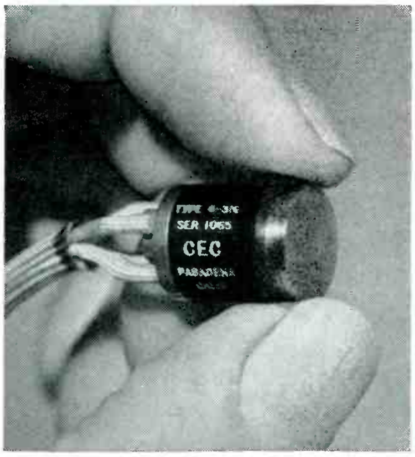
WORLD'S LARGEST MANUFACTURER OF GLASS-BONDED MICA AND CERAMOPLASTIC PRODUCTS control of g-warning light, safety devices based on sensing dangerous levels of acceleration or vibration and controls in guided missiles.



PRECISION POT
a rugged device

MINCO ENGINEERING AND MFG., 801 8th St., S. E., Minneapolis 14, Minn. A rugged precision potentiometer adapted to flight test, servo feedback and telemetering applications is announced. Housed in a cast aluminum case, this rotary sector pot is designed to withstand up to 40 lb side load on the shaft while operating. It is also gasket and O-ring sealed against immersion to 15 psi.

▶ **Other Data**—Additional specs are: dual element, 4,800 ohms each element; dual wipers each element and pickoff; up to 2 w dissipation per element; 110 deg active travel, 5 deg over-travel each end; and resolution 1/17 deg.



PRESSURE PICKUP
for high temperature use

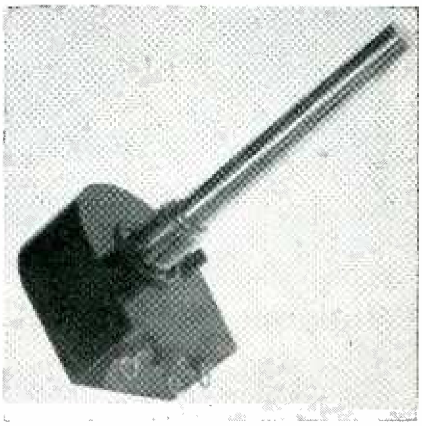
CONSOLIDATED ELECTRODYNAMICS CORP., 300 N. Sierra Madre Villa,

Pasadena, Calif. Type 4-316 pressure pickup operates continuously up to 600 F. It is available in both gage and differential types.

The new unit is ½ in. in diameter, ¾ in. long and weighs 15 grams with its 30 in. of insulated, permanently attached, 4-conductor cable.

Unbonded strain-gage windings connected in a four-arm bridge comprise the sensing elements of this variable-resistance-type transducer.

New fabricating techniques, centering about an all-welded internal construction, suit the pickup to such applications as static and dynamic flight-load testing, engine studies, and supersonic-speed tests where external cooling methods are impractical.

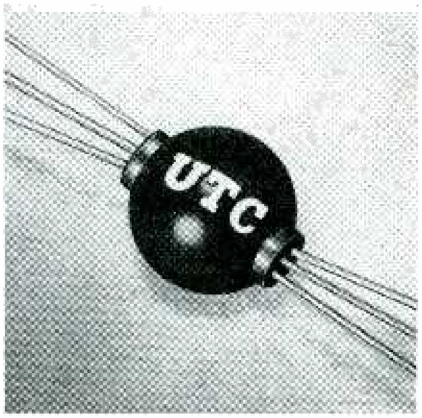


POTTED POTS
in several types

CLAROSTAT MFG. CO., INC., Dover, N. H., has available a line of potted or encapsulated potentiometers. These "Potpot" units may be had in both wire-wound and composition-element types, including the series 48 and 49 miniature controls, the 43, 37 and 51 medium-sized controls, and again the larger 58 and 10 wire-wounds. The neatly molded, smooth, green-colored encapsulating material means water- and vapor-tight molded enclosures, embedding the entire unit with the exception of the external shaft assembly and terminals. A special water-tight assembly for the shaft bushing completes the sealing.

Designed specifically for MIL-STA-202 test specification, the units also meet the necessary salt-spray, humidity and temperature cycling

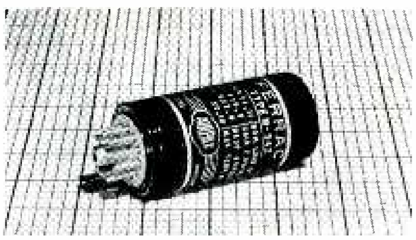
requirements of MIL-E-5272 climatic standards. They feature excellent shelf life. Electrical specifications are those for the given Clarostat control type.



PULSE TRANSFORMERS have varied applications

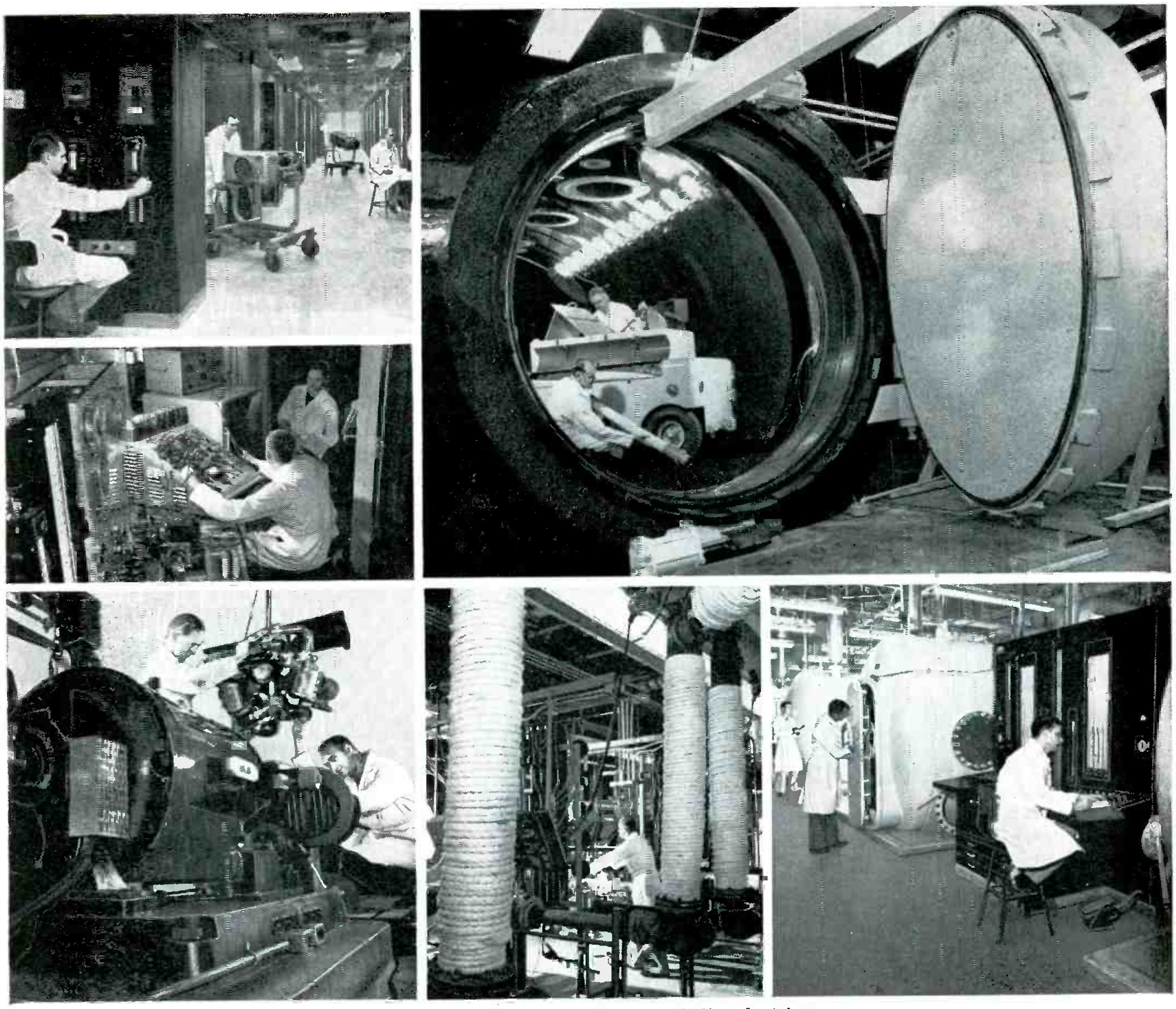
UNITED TRANSFORMER CO., 150 Varick St., New York 13, N. Y., has released a new series of miniature pulse transformers hermetically sealed by the vacuum mold epoxy process. These units are suited to a wide variety of blocking oscillator, interstage, and low level modulator applications.

▶ **Service**—They are designed for service from —70 to +130 C and fully meet MIL-T-27 specifications. Thirteen types cover the range from 0.05 to 25-μsec pulse width with exceptionally low rise time. All units are three winding 1:1:1 for maximum flexibility of application.



MAGNETIC AMPLIFIER for analog computers

AIRPAX PRODUCTS CO., Middle River, Baltimore 20, Md. The Ferrac amplifier is a ferromagnetic amplifier for analog computers. It is a d-c to d-c amplifier powered directly from a 115-v, 400-cps line. Full linear output of $\pm$7.5 v is obtained with $\pm$300 μa input. The



New AiResearch Production Test Laboratory in Phoenix, Arizona

Finest production test facilities

prove aircraft system compatibility

Testing of critical aircraft components and systems is now performed on a precision production basis in these completely equipped laboratories.

Here, in more than 75 test cells and test stands, finely-engineered AiResearch products are given every test necessary to insure perfect operation.

Altitudes are simulated from 1,000 feet below to 75,000 feet above sea level; pressures up to 1,000 psi; temperatures from −80° F to +1,000° F; air flow up to 1410 pounds per minute.

Units tested include gas turbine engines, air turbines, air turbine starters, pneumatic controls, cabin pressure regulators, valves, refrigeration turbines, heat transfer equipment and complete systems employing these and additional components.

These unsurpassed test facilities are another reason why you can rely on the performance of AiResearch products.

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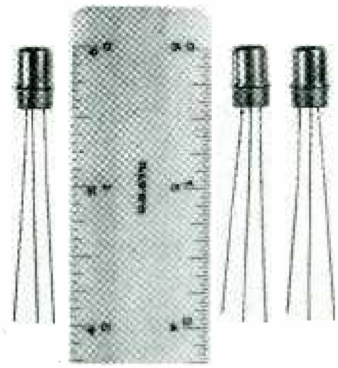
amplifier is so stable that null balancing windings and auxiliary circuits are unnecessary. Bandwidth is at least 8 cps per each 1,000 ohms in a control loop.

► **Further Information**—Two independent control windings enable the Ferrac amplifier to be used in summing and multiplying circuits. Lead and lag networks can be introduced as readily as with electronic amplifiers. Two signals can be mixed in a Ferrac amplifier even though they have no common ground. Complete analog computers, simulators and automatic controls can be assembled using Ferrac amplifiers as basic building blocks.



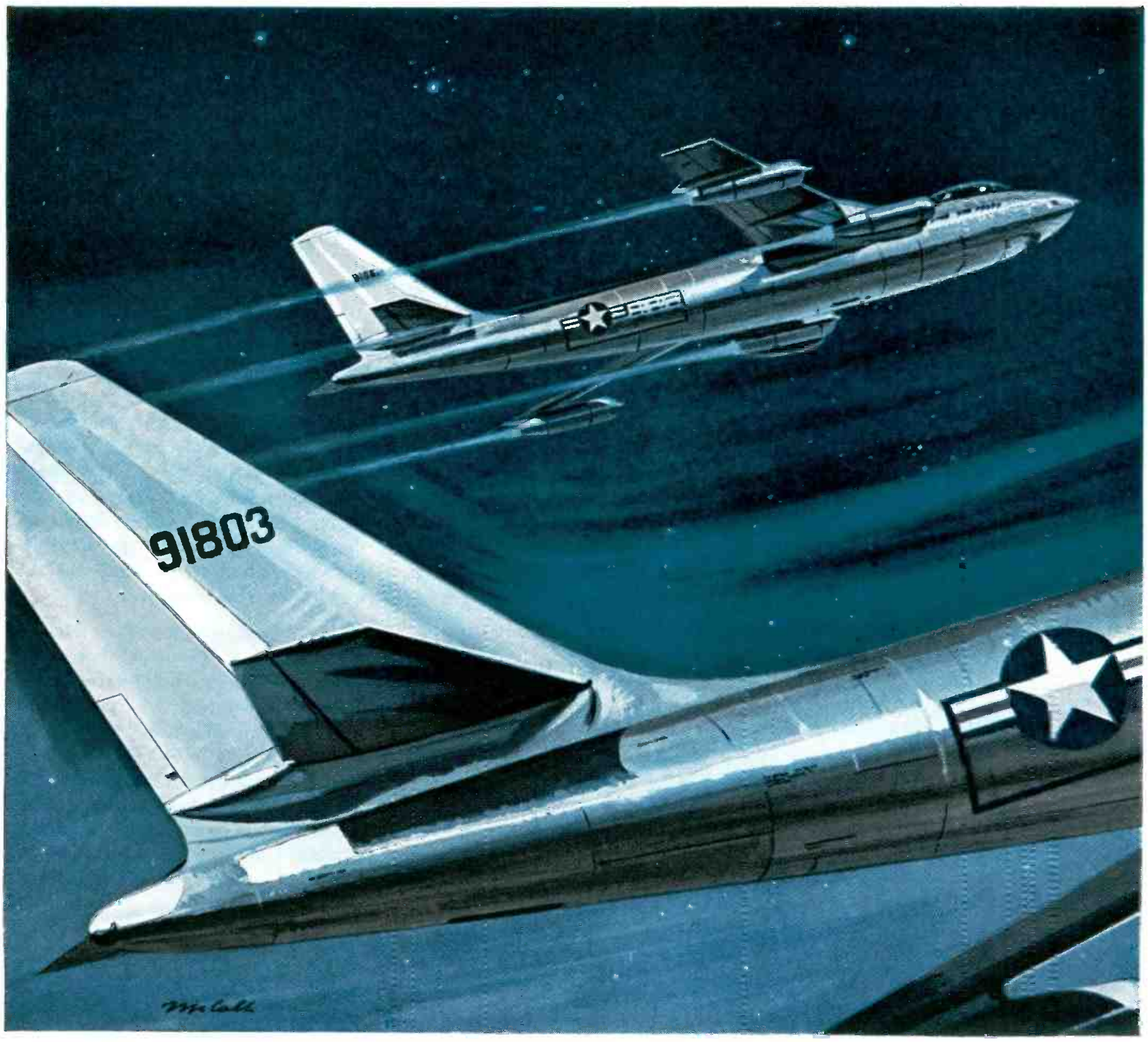
TRANSISTORS
designed for audio stages

PHILCO CORP., 4700 Wissahickon Ave., Philadelphia 44, Pa. The 2N223, 2N226 and 2N224 medium-power transistors are specifically designed for the audio stages of transistorized radios. In driver and class B push-pull operation, these hermatically sealed, *pnp* transistors provide up to 300 mw audio output at battery supply voltages of 3 to 12 v.

Extremely linear d-c amplification up to 100 ma of collector current assures minimum distortion. Output transistors 2N226 and 2N224 can be made available in matched pairs. They are available in production quantities.

DIGITAL MAGNETIC TAPE HANDLER
features new design

KEY ELECTRIC CORP., 287 Post Ave., Westbury, L. I., N. Y. Increased



OLIN ROLL-BOND GOES 8 MILES UP WITH THE STRATEGIC AIR COMMAND

Packed into the sleek fuselage of the B-47 is several million dollars worth of electronic equipment essential to its mission. Some of the most delicate and vital units are housed in cases made of Olin Roll-Bond to ensure that exactly the proper temperature will be maintained regardless of external conditions.

Only one method will do the job perfectly—seamless tubes that are an integral part of the case wall itself. Olin Roll-Bond, proved in hundreds of thousands of refrigerator evaporators, embodies this principle and is equal to the task.

If *your* job calls for a system of tubing for the purpose of heat exchanging, a call to Olin is the first step to a better product made more efficiently.

PAT. NO. 2,690,002

The Original Patented Process

Olin ROLL-BOND

a product of the Metals Division

Raytheon Manufacturing Company supplies vital electronic equipment used in the all-weather B-47. When selecting a material for the temperature regulating cases, Raytheon turned to Olin, the largest supplier of bonded evaporators to the refrigeration industry.

OLIN MATHIESON CHEMICAL CORPORATION

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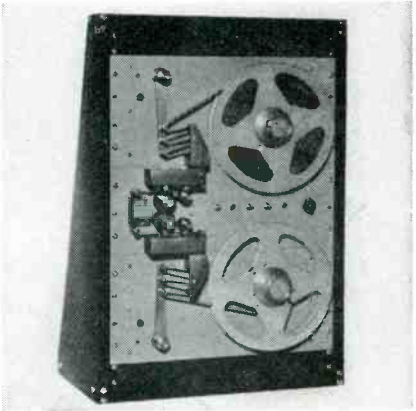
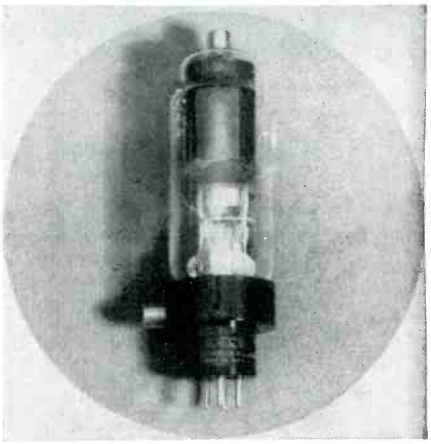


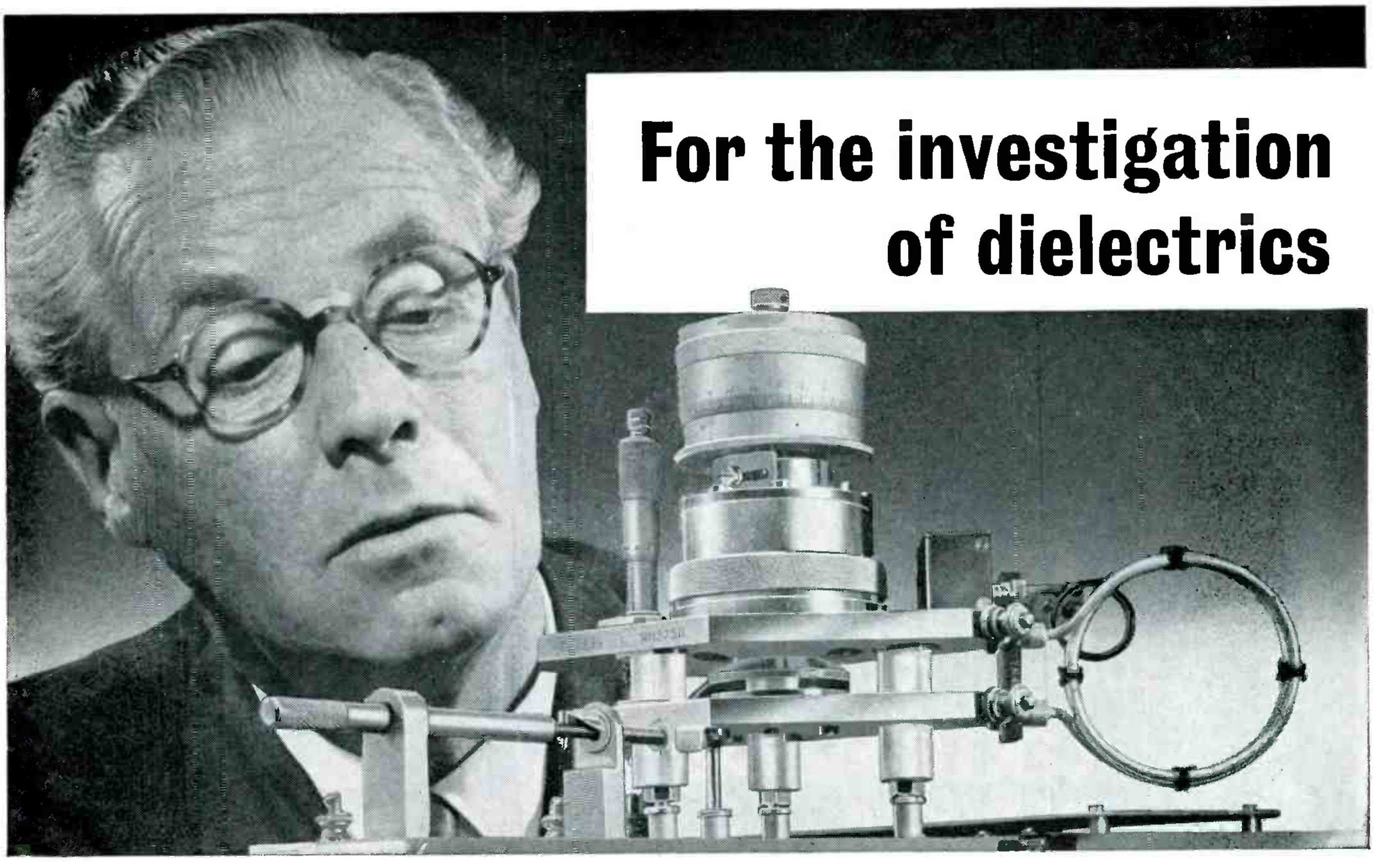
reliability for digital computing and data processing systems is provided by model 101 digital magnetic tape handler. Magnetic amplifier reel servos provide improved dependability, greater power output, and smaller size than the v-t amplifiers they replace.

▶ **New Design**—In this design, depth behind the panel has been reduced to 9 in., a 25-percent reduction in volume over previously available digital tape transports. Start-stop time is less than 5 milliseconds; and complete remote control of start, stop, reverse, and speed change functions is provided. Standard models have either 6 or 8 tracks, and dual tape speeds of 60/15 or 30/15 ips.



THYRATRON
mercury-vapor type

NATIONAL ELECTRONICS, INC., Geneva, Ill. A new 2.5-ampere d-c thyratron has been added to the company's line of industrial tubes. The tube, designated as the NL-632B, is a mercury-vapor shield grid thyratron. It is designed and



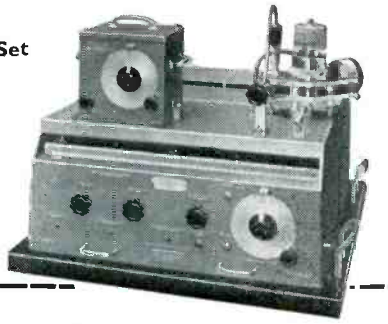
The MARCONI Dielectric Test Set *Type TF 704B*

The Marconi TF 704B Dielectric Test Set allows precise evaluation of the permittivity and phase defect of dielectric materials in the frequency range 50 kc to 100 Mc.

The principle of measurement is to introduce the sample under test into a tuned circuit and then, by means of a square-law voltmeter with high-discrimination mirror galvanometer, note the changes in circuit conditions.

The heart of the Test Set is the jig holding the sample under test. There is one jig for solid specimens and another for liquids. The jigs are masterpieces of the instrument maker's art; their high-quality construction is a blend of precision and ruggedness, which ensures accuracy and stability.

Dielectric Test Set Type TF 704B
The equipment includes two interchangeable oscillator units and a full range of jig loading coils.



In addition to the investigation of dielectrics, the high-frequency performance of resistors, capacitors, cables, etc., can be determined over a wide range.

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TC81

specially tested for use in frequency-changer type resistance welders.

▶ **Technical Data** — Ratings are: filament volts, 5; filament current, 4.6 amperes; anode current, 2.5 amperes d-c; peak anode current, 30 amperes; peak inverse and peak forward volts, 1,500; and maximum averaging time, 15 sec.

POWER TRANSDUCER
in a variety of sizes

CEDAR ENGINEERING INC., 5806 W. 36th St., Minneapolis 16, Minn., has announced a servomechanism that translates lateral force to direction and speed regulation with 200 to 1 mechanical power amplification.

This power transducer is available in a variety of fractional h-p sizes with a wide selection of gear train assemblies whereby the direction and speed of the servo can be controlled in proportion to displacement of the input shaft. It can be used in proportional open-loop systems, or can be arranged with feedback for a closed-loop system.

REFERENCE CAVITIES
for X-band applications

MICROWAVE ASSOCIATES, INC., 22 Cummington St., Boston, Mass., has developed the MA-318 series of temperature compensated reference cavities for use in automatic frequency control applications and as fixed frequency stabilizers in radar beacons and other microwave systems.

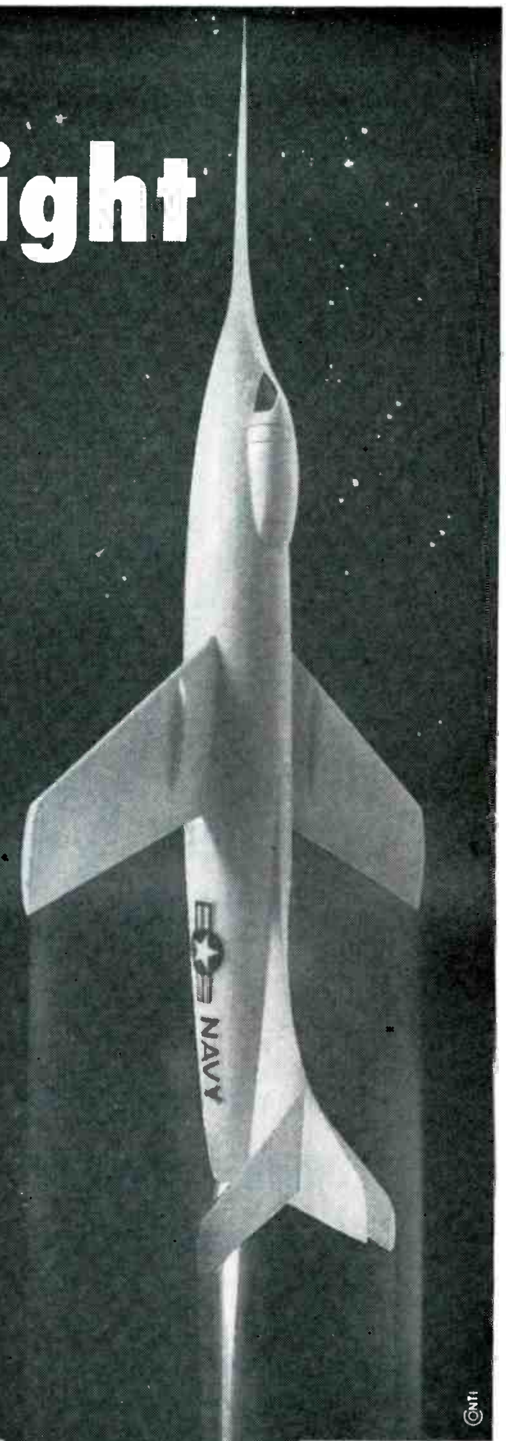
▶ **Improved Form**—Because of improved form factor packaging and extra rugged construction, the cavities are ideally suited for airborne

supersonic flight

. . . NATURE'S SEVEREST TEST

PROVES *Constantin*

glass-to-metal seal quality



Tomorrow's aircraft must be built to withstand great extremes of temperature, pressure and vibration — every component must perform its functions accurately and dependably at speeds of 2,000 miles per hour or more.

Constantin vacuum-tight, glass-to-metal seals were developed to meet the great extremes of operating conditions that lie ahead. Never-ending research and development are carried on by Constantin's resourceful design engineering staff to insure maximum performance and non-leakage. This quality control and development make Constantin units *ideal* for use with complex systems or miniaturized components.

This long experience in the design and manufacture of thousands of types of glass-to-metal seals will solve the most difficult vacuum-sealing problems.

Write today to find out how this experience and design versatility will help you.

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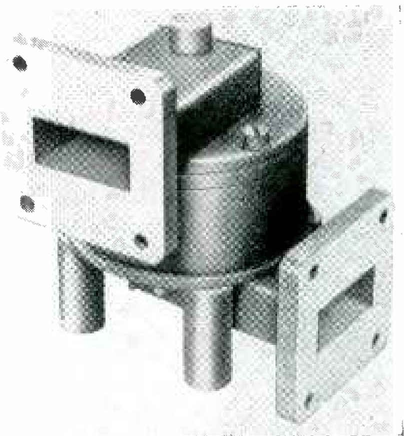
radar beacon applications where weight, space, pressure extremes and vibration considerations are of paramount concern. The cavities require no matching and are available for use at fixed frequencies from 9,250 to 9,350 mc.

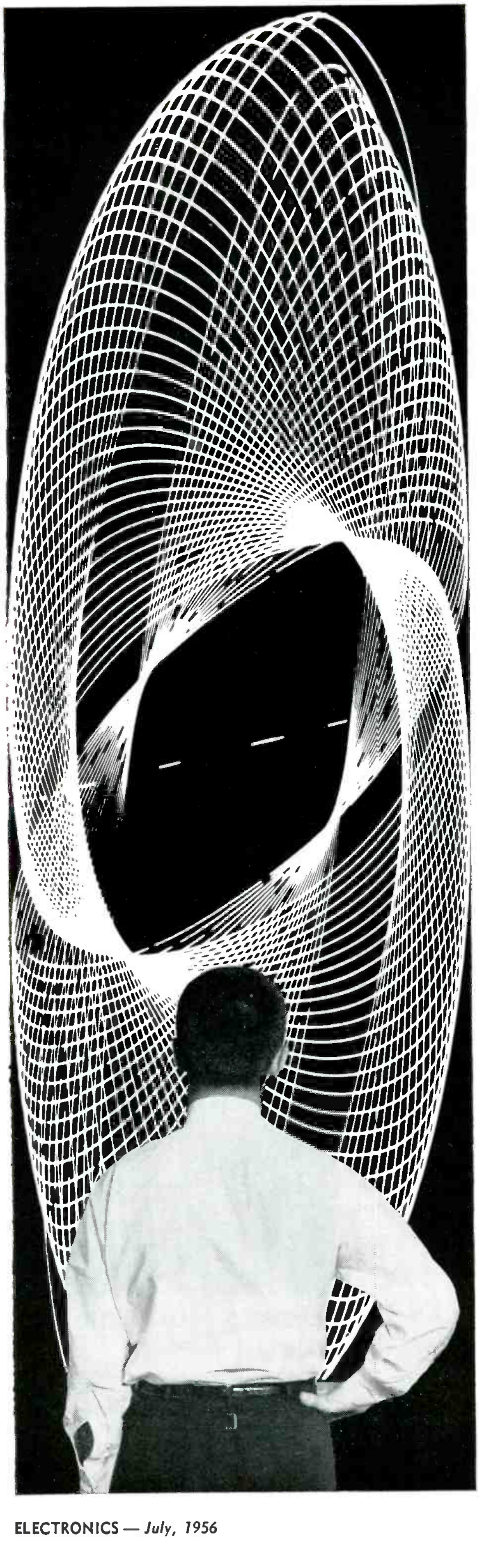


ROTARY JOINT
for airborne equipment

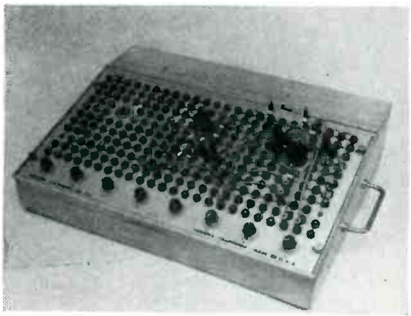
AIRTRON INC., 1103 W. Elizabeth Ave., Linden, N. J. The RE 51/U is a new microwave rotary joint with a peak power rating exceeding 600 kw at atmospheric pressure. Available in both unsealed or pressurized versions, it is used with 1.250 by 0.625-in. waveguide.

Other characteristics include a maximum vswr of less than 1.10 over the frequency range of 8,500 to 9,600 mc. Variation of vswr with rotation is negligible throughout the total angular travel. Operating life is in excess of 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 bearings. Pressurization is



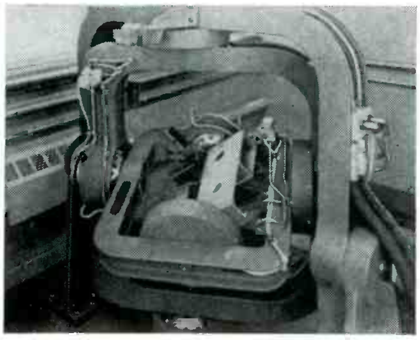
accomplished by an O-ring gasket located on the weather side of the bearings. This protects the latter from corrosion due to atmospheric conditions as well as eliminating dirt contamination problems during the life of the bearing.



CIRCUIT DESIGNER
with reuseable components

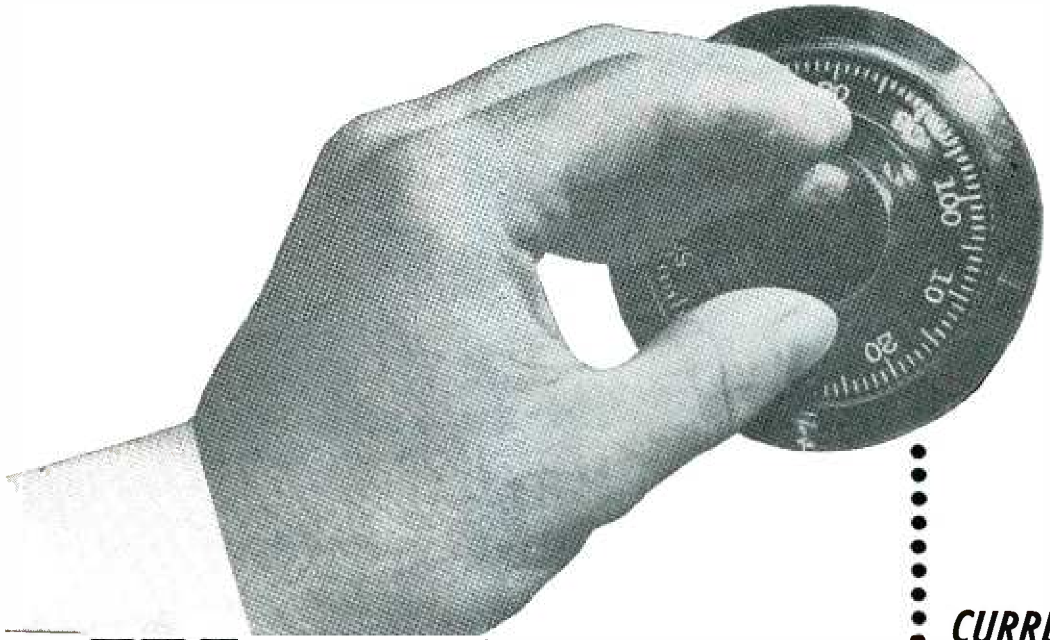
POMONA ELECTRONICS CO., INC., 1126 W. Fifth Ave., Pomona, Calif. A new circuit designer provides quick positive facilities for rapidly synthesizing and testing innumerable circuits without consuming an inch of solder or drilling a single hole. Every component is reuseable again and again.

▶ **Other Features**—All connections are visually traceable with color coded leads, plugs and jacks. Where temporary special instrumentation is required, the unit is especially advantageous, since the rapidity of circuit set-up and dismantling reduces to a minimum the time and equipment tied up in the test.



FLIGHT SIMULATOR
three-axis type

COLOR TELEVISION INC., 935 E. San Carlos Av., San Carlos, Calif. Equivalent flight conditions of modern high-performance aircraft in pitch, roll and yaw can be repro-



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A convenient interview can be arranged during your vacation. Naturally, reasonable expenses between your home and Baltimore would be reimbursed by Westinghouse. We will be happy to send further details.

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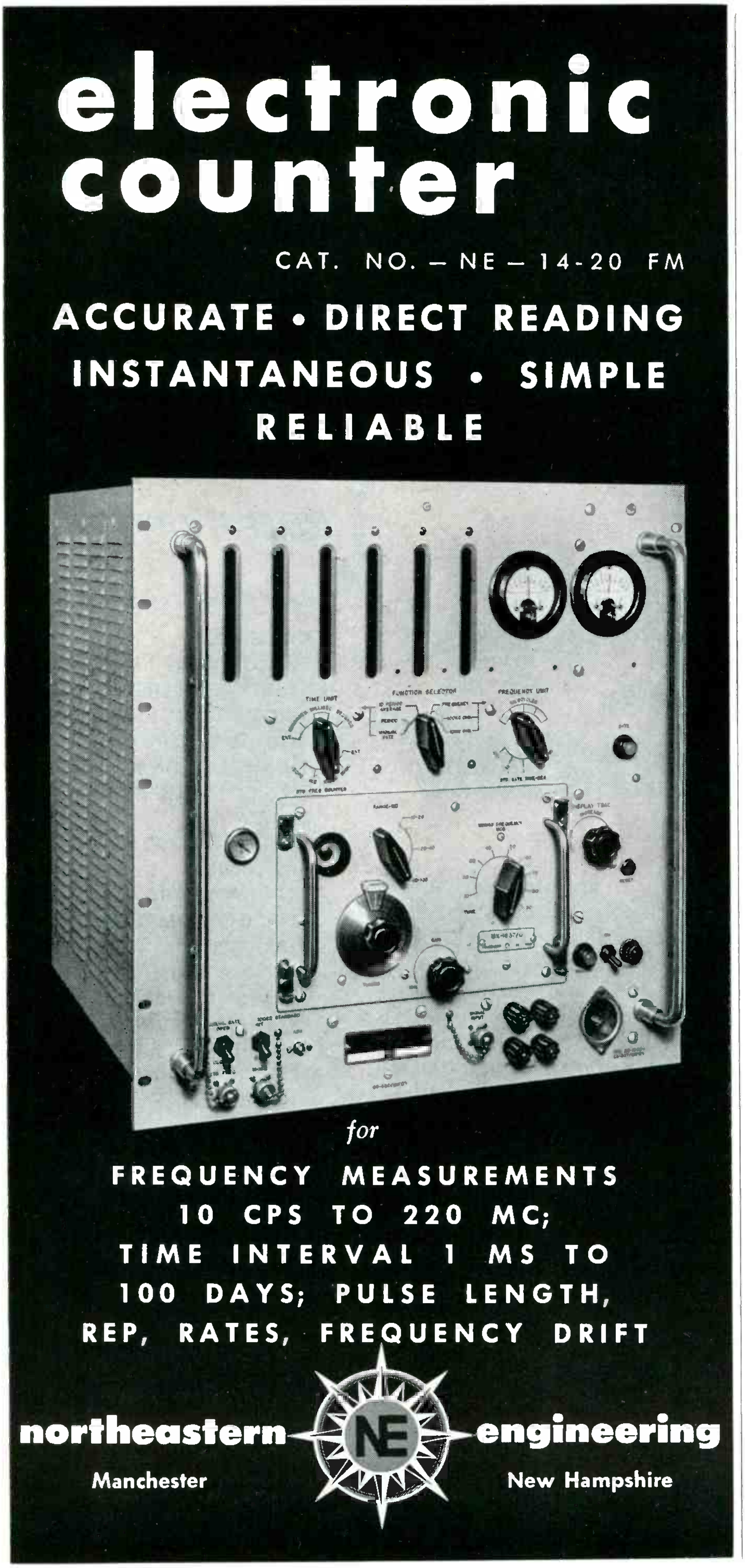


duced rapidly by this 3-axis flight simulator. Voltage analogs of the vectors representing these factors are fed as individual command signals to the flight table. The instrument can operate directly from the output of a computer such as the REAC.

▶ **Performance**—Specifications include the following: In roll, approximate maximum acceleration is 40,000 deg per sec^2 and approximate maximum velocity is 250 deg per sec. While maximum displacement is ± 120 deg, the table can be shifted to provide motion of 210 deg in one direction and 30 deg in the other.

In pitch, approximate maximum acceleration is 20,000 per sec^2 and approximate maximum velocity is 150 deg per sec. Maximum displacement is ± 90 deg. In yaw, the maximum acceleration is 8,000 deg per sec^2 and the approximate maximum velocity is 125 deg per sec. Maximum displacement is ± 90 degrees.

AMPLIFIER
high power, low distortion

ALTEC LANSING CORP., 9356 Santa Monica Blvd., Beverly Hills, Calif. The 260A is a 260-w amplifier of low distortion and wide frequency range intended for p-a and industrial control applications where long life and minimum maintenance are paramount.

▶ **Specifications** — Power is available continuously at 2 percent or less distortion over full frequency range of 40 to 15,000 cps.

Output connections provide for low-impedance speaker loads and 70-v line; also a 65-ohm tap for 140 v line or 117-125 v to operate

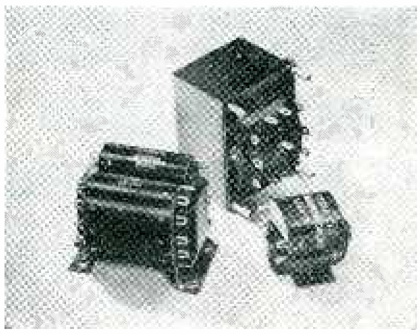
motors at various frequencies. Protection is by thermal cutout. Filament warmup period, controlled by delay relay, permits remote full on-off control.

DIGITAL VTVM
designed for rack mounting

HYCON ELECTRONICS, INC., 321 So. Arroyo Parkway, Pasadena, Calif. Model 615R digital vtvm is a direct-reading unit. A 3-digit counter eliminates interpolation and parallax errors, makes accurate readings easy, and avoids multiple-scale confusion.

▶ **Features**—Standard features include an automatic off-scale indicator and illuminated decimal-point and polarity signs. One-millivolt sensitivity is provided on the low scale, and accuracy is 1 percent on d-c and resistance, 2 percent on a-c.

Special accuracy of 0.1 percent, as well as complete facilities for automatic print-out, are available on special order. Price of the unit is $397.

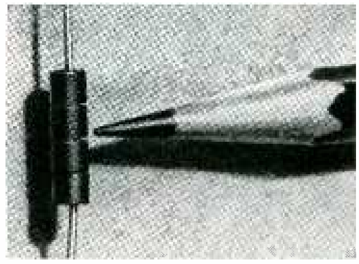


TRANSFORMERS
new encapsulated type

ELECTRO ENGINEERING WORKS, INC., 401 Preda St., San Leandro, Calif. Epseal, a new transformer encapsulation process in combination

with unique coil construction, offers reduced temperature rise in miniature size transformers, built to operate in higher ambient temperatures required for aircraft and missile applications.

Temperature rise as low as 50 per cent of that for comparable units has been achieved in units employing the Epseal process, enabling the use of ambient temperatures as high as 125 C without penalty on size.



SHIELDING BEADS of nickel-zinc ferrite

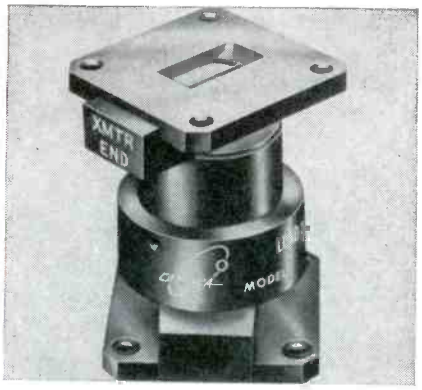
FERROXCUBE CORP. OF AMERICA, 35 E. Bridge St., Saugerties, N. Y. Supply leads in radio, tv and radar sets often form an easy path along which an h-f, i-f or pulse signal can be carried from the output stage back to the input. A simple capacitive decoupling of the lead will not always be satisfactory, due to possible parasitic resonances. For the same reason, an extra series self-inductance will not in all cases give the desired effect.

Parasitic resonances may be prevented by introducing an ohmic damping in this inductance. Stringing Ferroxcube shielding beads on leads increases the lead inductance so that the lead will act as a h-f choke and at the same time damp any signals above a cutoff frequency, dependent upon the material because of the high losses in the ferrite.

Complete data are given in engineering bulletin FC-5112A.

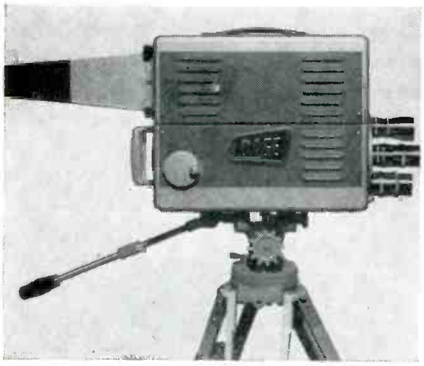
FERRITE ISOLATOR is an X-band circulator

CANOGA CORP., Van Nuys, Calif. Model 6332 Ferrite isolator is a nonreciprocal waveguide device used to isolate medium power klystrons and magnetrons from their



loads. It is essentially a modified polarization circulator employing permanent magnets and containing two sets of integral external dummy terminations. The external loads are capable of handling higher powers than internal types and also make possible the short length of 2.25 in.

▶ **Specifications**—The isolator may be pressurized to 30 psi absolute and will handle 25 kw peak, 25 w average power over the 8.5 to 9.6 kmc band. The isolation is 10 db minimum, the insertion loss is 0.5 db maximum and the vswr is 1.35 maximum over the band. Isolation over a 7-percent band is 20 db.



STUDIO TV CAMERA priced at $3,500

DAGE TELEVISION DIVISION, Thompson Products, Inc., Michigan City, Ind. Model 320-A studio tv camera features a 4-unit, hinge-mounted chassis and plug-in hinge-secured amplifier strips, providing easy accessibility to all components without the need for tools.

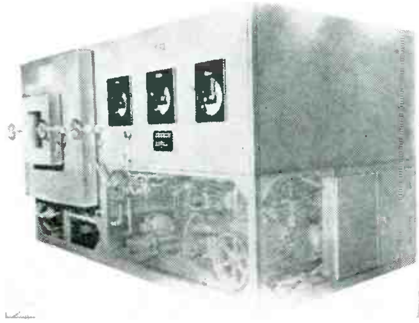
Provision is made for 4 lenses which may be quickly interchanged from the operator's position.

Adaptable to film use, model 320-A is suited for closed-circuit

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

tv applications in addition to broadcast use.

List price is $3,500.

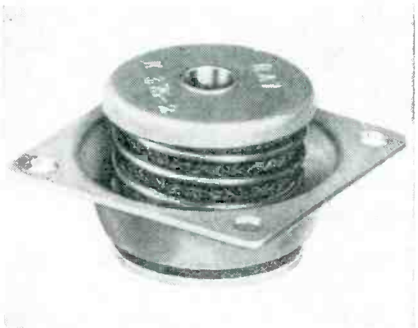


TEST CHAMBER
altitude simulation type

THE AMERICAN RESEARCH CORP., 11 Brook St., Bristol, Conn., has built an altitude simulation test chamber with a temperature range of from —100 F to +500 F, without modification.

The chamber incorporates a 64-cu ft test space. It includes completely automatic operation, air circulation, mercury manometer calibrated in thousands of feet, and a safety thermostat to protect heaters against accidental burnout.

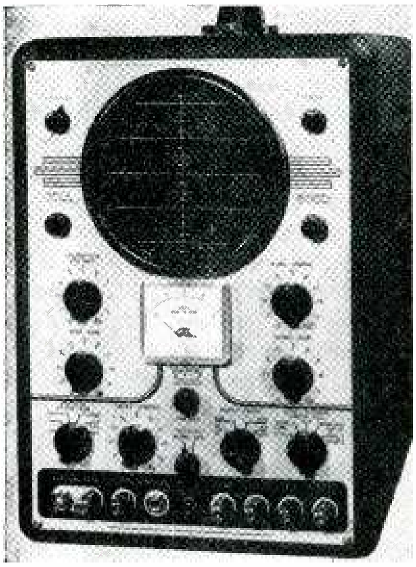
The chamber provides accurate simulation of atmospheric conditions at high altitude under ultrasonic velocities, and the controls are designed to duplicate the results of rapid changes in acceleration.



METAL UNIT MOUNT
for vibration protection

ROBINSON AVIATION, INC., Teterboro, N. J. The K375 all-metal, lightweight unit mount has been engineered for vibration protection of all airborne electronic equipment used in jet aircraft and winged missiles. With a low natural frequency of 6 to 9 cps, this versatile mount is readily adaptable to many applications in which outdated mounts of the AN8008 type have been used in the past.

Vibration isolation efficiency is 90 percent at 30 cps and improves at higher frequencies. Met-L-Flex resilient cushions are constructed of stainless steel and are unaffected by temperature extremes, solvents, oil, sunlight and ozone. A nonlinear spring rate and the highest damping is inherent in the all-metal construction of the mount.

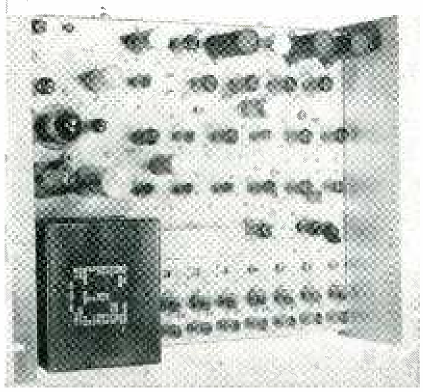


CRO
priced at $249.50

THE TRIPLETT ELECTRICAL INSTRUMENT CO., Bluffton, Ohio, has introduced a new cro, model 3441-A. It bears a U.S.A. dealer net price of $249.50. A general description of the model 3441-A along with its outstanding features and technical information will be found in available data sheets.

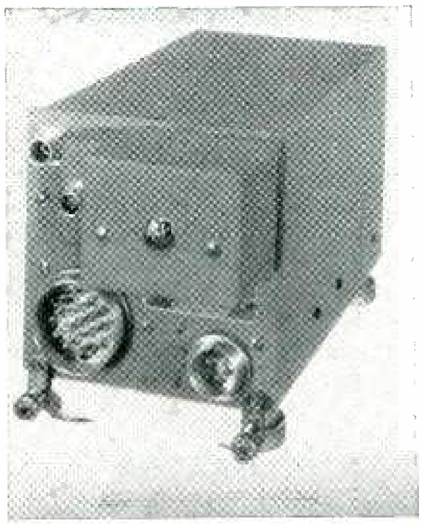
SYNC GENERATOR
uses phantastron counters

KAY LAB, 5725 Kearney Villa Road, San Diego 12, Calif. The APG-4 RETMA sync generator utilizes phantastron counter circuitry. The unit provides horizontal drive, vertical drive, mixed blanking and composite sync. Phantastron counters, which have been used for many years in precision timing applications and military radar equip-



ment, assure reliable and continuous trouble-free operation.

All critical pulse widths are delay-line controlled thus obviating any possibility of any incorrect sequence since all are derived from the same source. The entire composite sync signal is formed in one circuit. All rise and fall times are identical as equalizing, sync and serrated vertical sync pulse since all are generated by the same new bistable multivibrator. The generator may be locked to line, locked to internal crystal or triggered externally. Phase control is provided on the line locked position. The unit is available for either rack mounting or as a portable unit.

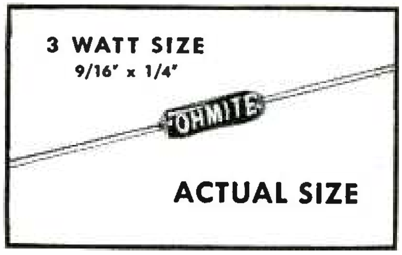


ADF UNIT weighs only 19.1 lb

AIRCRAFT RADIO CORP., Boonton, N. J., has announced a miniature automatic direction finder or radio compass, weighing 19.1 lb. Type 21 adf unit is a 3-band superheterodyne receiver, complete with power unit, receiver, control unit, indicator, loop, loop housing, and all connectors. It is designed for use in all types of aircraft.

▶ **What It Does**—The type 21 provides reception of and direction on l-f range and broadcast stations in the 190 to 1,750 kc spectrum. A hermetically sealed loop assembly which penetrates only 1¾ in. beyond the skin of the aircraft is used. The unit has provisions for compensation of as much as 25 degrees of compass error from local field distortion. Installations may be single or dual.

The new adf was designed for reliability, serviceability, power drain and stability under adverse environmental conditions and power supply voltage change.



TINY RESISTORS
the 3-w axial-lead type

OHMITE MFG. CO., 3677 Howard St., Skokie, Ill. The tiny 3-w axial-lead vitreous enameled resistor is now available in a wide range of resistance values, from 1 to 10,000 ohms. It is only ¼ in. in diameter and 9/16 in. long.

▶ **Other Features**—These resistors are simple to mount by their tinned wire leads and occupy small space because of the absence of mounting brackets. Axial-lead resistors, particularly the small sizes, are especially suited for printed circuits, terminal board, and point-to-point wiring applications.

The small resistors are wire-wound units with steatite cores and a special-formula, vitreous-enamel coating. The resistance wire and terminal lead are both welded to the end cap, thus assuring perfect and permanently stable electrical connections.

All parts of the resistors are thermally balanced, so as to expand and contract as a unit. This enables the resistors to stand up

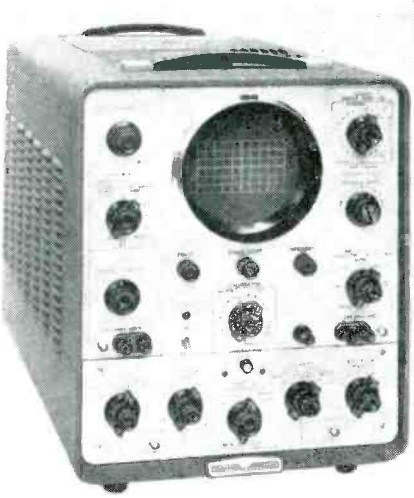
For additional information on all items on this page, use post card on last page.

under high operating temperatures without loosening of terminals or cracking, and subsequent entrance of moisture.

GENERATOR delivers random pulses

UNIVERSAL ATOMICS CORP., 19 E. 48th St., New York 17, N. Y. Model 422 completely transistorized, portable random pulse generator is designed for use in radiation and electronic laboratories, and for field testing of radiometric equipment. The 6-lb unit delivers random pulses at a controlled rate from 10 to 1,000 pps. It operates for over 100 hr from 4 standard $1\frac{1}{2}$-v flashlight batteries, at 5 mv to 5 v output, from a 100-ohm impedance source.

The random pulse generator comes in a 9-in. by 7-in. by 6-in. case and the price is $199.50.



H-F OSCILLOSCOPE magnifies 100 times

HEWLETT-PACKARD CO., 395 Page Mill Road, Palo Alto, Calif., has announced model 150A, a new 10-mc oscilloscope that magnifies 100 times. The d-c to 500 kc horizontal amplifier provides sweep magnifications of 1, 5, 10, 50 and 100 times, which together with the special horizontal position control offer a means of fine adjustment and examination of any 10-cm portion of the magnified range. Full sweep range is 0.02 μsec per cm to 15 sec per cm.

▶ **Other Details** — Triggering may be internal, external, or from the line voltage on positive or negative level and slope. Sweep circuit may also be set for a triggered-single sweep.

The main vertical amplifier has a pass band from d-c to 10 mc with optimum transient response and rise time less than 0.035 μsec. A fixed delay of 0.25 μsec permits viewing the leading edge of the signal triggering the sweep. The vertical amplifier is driven by plug-in vertical preamplifiers of shallow drawer construction for optimum accessibility and maintenance.

C-BAND MAGNETRON
miniature type

BOMAC LABORATORIES, INC., Beverly, Mass. The BL206 miniature C-band magnetron is ruggedly built and will withstand shock stresses of 10,000 g longitudinally and 1,000 g laterally. Tuning is adjustable by a set screw to produce high precision tuning throughout the frequency range. The tube is manufactured as a complete package unit —no accessory equipment is required. Frequency drift is less than 0.05 mc per deg C. Operating time is 7 sec; weight, 6.5 oz; dimen-

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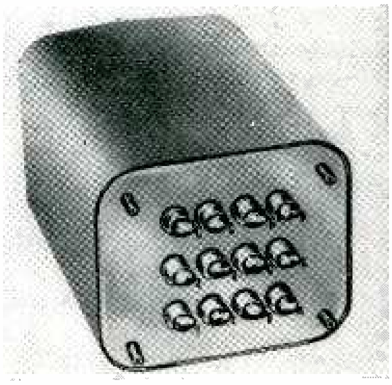
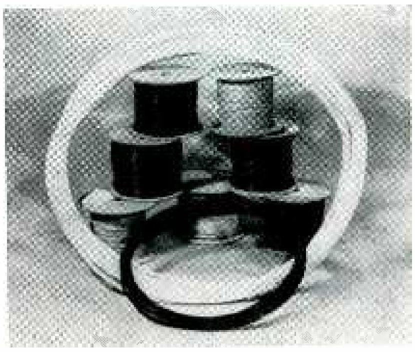
sions, 3⅜ in. high and 1¼ in. in diameter.



TRANSFORMERS in standard MIL cases

UNITED TRANSFORMER CO., 150 Varick St., New York 13, N. Y. Seventeen new hermetic sealed filament transformers are conservatively designed to exceed MIL-T-27 specifications and to provide a maximum of reliability through low temperature rise and high insulation safety factors. For maximum versatility in application, these units are provided with 105/115/210/220 v primaries as well as bearing both military and industrial ratings. Units range from 6.3 v, 0.6 ampere output to 5 v at 75 amperes and from 1,500 to 21,000 v test.



SPAGHETTI TUBING made from Teflon

PENNSYLVANIA FLUOROCARBON CO., INC., 1115 N. 38th St., Philadelphia 4, Pa. A wide range of sizes of spaghetti tubing made from Teflon is now being offered. It has good dielectric strength (500 to 1,000 v per mil); lowest dielectric constant (2.0) and dissipation factor (0.0002) of any solid dielectric; and no change of electrical properties with temperature (−100 C to +250 C) or frequency (60 cps to 100 mc). The tubing is not affected by moisture.

The spaghetti made from Teflon is used for instrument tubing, sheathing for several wires, and with bare wire as a replacement for hook-up wire insulated with Teflon. Assembly of aircraft and communication electronic equipment is speeded up when Teflon is used because it simplifies the soldering technique since Teflon is not harmed by the hot barrel of the soldering iron.

MICROWAVE LINK
for color television

LAMBDA - PACIFIC ENGINEERING, INC., 14725 Arminta St., Van Nuys, Calif., has available a new color tv microwave link, convertible from 0.1 w to 1.0 w. It is a companion to the widely used 1.0-w Lambda link. It has a frequency range from 5.9 to 7.2 kmc, and is available with program channel. Further information is available from the manufacturer.

POWER SUPPLY
for high-power klystrons

LEVINTHAL ELECTRONIC PRODUCTS, INC., 2760 Fair Oaks Ave., Redwood City, Calif. Developed as a bombarder power supply for high-power klystrons, this unit provides up to 3 amperes at 4,000 v with 0.1-percent ripple. The d-c supply is isolated 50 kv above ground. Voltage is continuously variable

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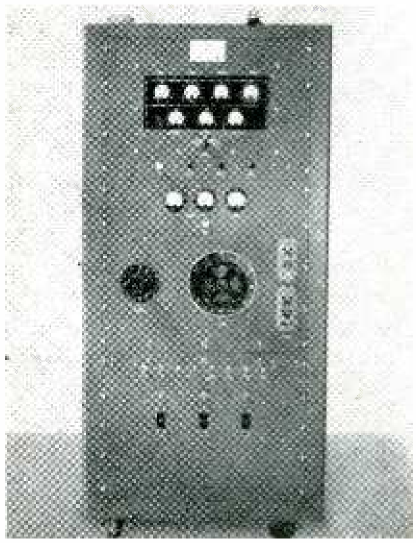
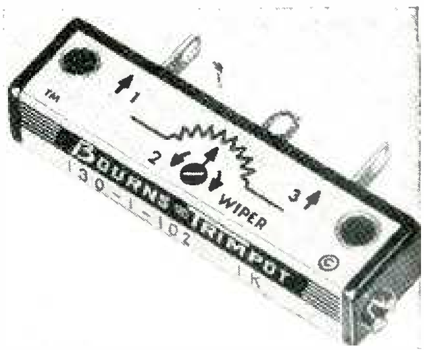


over the 0 to 4-kv range.

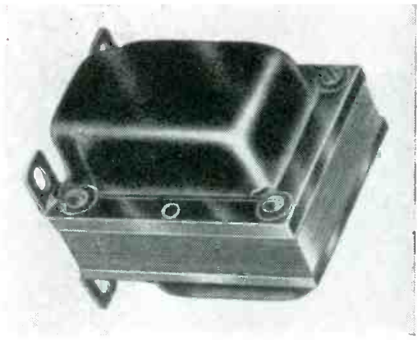
Included in the supply is provision for filament power to 6 filaments each insulated at 50 kv from ground and each variable up to 6 v a-c at 70 amperes.

Also included are facilities both to meter and control remotely a 50-kv d-c power supply for providing beam voltage to the tube. The unit is completely interlocked and designed for interlocking with auxiliary external units. Power input is 230 v, 3-phase, 60 cps at about 5 kw per phase.



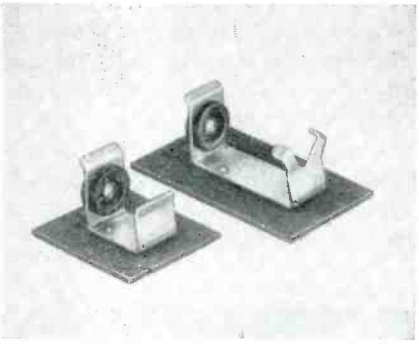
TRIMMING POT
with solder-lug terminals

Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif., has announced the model 130 subminiature Trimpot with solder-lug terminals and a high usable potentiometer range of at least 98 percent. Designed for use where wire-to-wire splicing is not convenient or practical, it permits wiring direct to the instrument, using simple soldering or dip-soldering techniques. The unit is screwdriver adjusted over 25 turns. It is available in 11 standard resistances from 10 to 20,000 ohms in resolutions ranging from 2.0 to 0.02 percent.



TRANSFORMERS
used with power supplies

STERLING TRANSFORMER CORP., 297 North 7th St., Brooklyn, N. Y., has available a line of transformers for use with electronically regulated power supplies. These transformers are especially designed to allow for the drop across the series regulator tube. They and their associate filter chokes are available hermetically sealed for military application as well as in commercial end-bell versions.

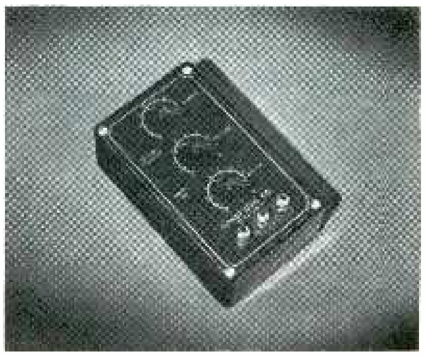


BATTERY CLIPS
for transistor circuits

CAMBRIDGE THERMIONIC CORP., Cambridge, Mass., has announced two new silver-plated battery clips for use with transistorized circuitry. They have been designed to lock simply yet stand up and remain secure even under extremely rough handling. They feature a positive low resistance contact. The silver plating resists corrosion even under battery leakage.

The clips mount simply with only

two rivets or eyelets, and are primarily intended for use on one or two cell mercury batteries. Their ready application to transistor circuits, printed or otherwise, provides the answer to many battery-securing problems.

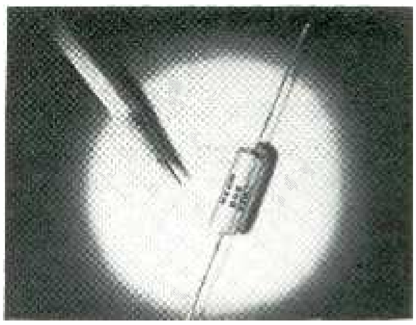


DECADE INDUCTOR
high in performance

COAST COIL CO., 5333 W. Washington Blvd., Los Angeles 16, Calif. Relatively small in size, reasonable in price, but high in performance, the model 100 decade inductor will serve as a convenient circuit element wherever a variable inductor is needed.

Covering the inductance range of 10 mh to 9.99 henries in steps of 10 mh, it measures only 2 by 3¾ by 6¼ in. (excluding knobs and terminals). The high Q inductors used in the decade inductor are adjusted to a tolerance of ± 2 percent.

Complete specifications, which include a-c and d-c ratings as well as typical Q curves are available on request.



MINIATURE RESISTOR
ceramic shell type

REON RESISTOR CORP., 117 Stanley Ave., Yonkers, N. Y., has in production a silicone-sealed ceramic shell type resistor. The miniature precision power unit, compact and self-supporting, is resistant to humidity and salt spray military tests.

▶ **Advantages**—Ideal for terminal board or printed circuit mounting, the ceramic shell offers uniform outer dimensions and is unaffected by abrasion and rough handling. It can be close mounted while the outer shell is completely insulated and has high dielectric strength. The component is also sealed in non-hygroscopic military grade steatite shells.

▶ **Specifications** — Also featured are: low temperature coefficient of ±0.00002 C, wide ohmic range of 0.1 to 55,000 ohms, tolerance of 5 percent to 0.05 percent, and it exceeds MIL-R-26B characteristic G specifications.

Unusual stability is achieved by special design and for maximum environmental protection Reon employs a silicone seal of special flexible formulation.

UNIVERSAL POT speeds readings

LEEDS & NORTHRUP CO., 4934 Stenton Ave., Philadelphia 44, Pa. Type K-3 universal potentiometer has a reading window that centralizes 3 or 4 dial readings into one single row of digits plus a scale value. Used for measurement of d-c voltage, the instrument has applications in precise temperature measurement, calibration of meters, calorimetry and precise voltage measurements.

▶ **Other Features**—The instrument circuit is guarded against static, leakage and effects of high humidity. Thermals usually generated during measurement are eliminated

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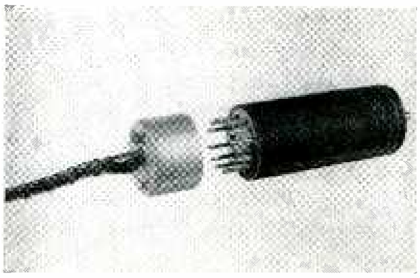
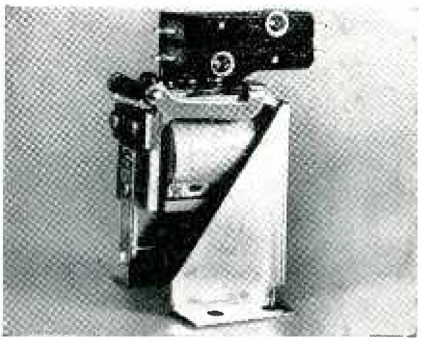
by the use of a new measuring circuit. An auxiliary potentiometer circuit and connections provide selection of reference potentials to permit use as double potentiometer.



RESOLVER
for missile guidance

DIEHL MFG. CO., Finderne Plant, Somerville, N. J. A new, size 11, high accuracy induction resolver with a total functional error of 0.05 percent has been announced. Designed to meet the environmental requirements of the Armed Forces, the new resolver is completely machine wound. When both the rotor and the stator are machine wound the uniformity of the product yields high performance quality. Further, the resolver has a high input impedance, permitting an excitation voltage of 110 v a-c at 400 cps.

The new resolver can function at a 70,000-ft altitude without pressurization. To enable design engineers to easily adapt it to their applications, the component is provided with a pin-type base and mating connector.



TIME DELAY RELAY
offers high capacitance

E. V. NAYBOR LABORATORIES, 30 Manorhaven Blvd., Port Washington, N. Y. Type TD310 offers a high capacitance time delay relay. Maintaining all the high resistance advantages of the company's air dashpot time delay relays, the unit affords spdt, contact rating of 10 amperes at 125/250 v a-c or 30 v d-c inductive. Contact ratings are in accordance with MIL-S-6743 and MIL-S-6744. Life, under certain conditions, can be offered to exceed 10 million operations.

▶ **Other Specifications** — Physical dimensions are 1½ by 2 by 2½ in. high for open chassis mounting. Weight is less than 4¼ oz.

This unit is also available hermetically sealed in dry nitrogen to withstand altitudes to 70,000 ft. Standard temperature range —55 C to +85 C, but units are available in the range of —65 C to +125 C.

A-C VTVM

a low-frequency instrument

SHASTA DIVISION, Beckman Instruments, Inc., P. O. Box 296, Station A, Richmond, Calif. Model 204 a-c vtvm is designed specifically for accurate measurements of a-c voltages from 0.03 to 300 v full scale in the l-f range of 2 cps to 300 kc.

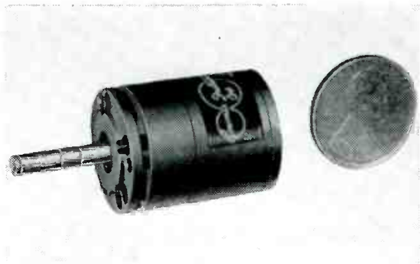
▶ **Features** — It has a regulated power supply, a large easy-to-read 6 in. meter which provides an effective scale length of 8¾ in., an illuminated range selector switch which displays only the range that the operator is using, and a unique mechanical construction.

▶ **Specifications**—Accuracy is ±½ db from 2 to 3 cps; ±2 percent, 3 cps—150 kc; ± 3 percent, 3 cps—250 kc; ± 5 percent, 2 cps—300 kc. Input impedance is 10 megohms, 3 v to 300 v; 2.6 megohms, 0.03 v to 1 v. Output impedance is less than 25,000 ohms. Price is $175.

RATIO TRANSFORMER
features high accuracy

GERTSCH PRODUCTS, INC., 11846 Mississippi Ave., Los Angeles 24, Calif., has introduced a new series of standard ratio transformers known as the Radiotran model 10, with a terminal linearity of 0.001 percent. Model 10 has improved accuracy over previous Gertsch standard ratio transformers, plus reduced size (a 3½-in. by 19-in. rack panel).

Ease of read-out and both front and rear input and output terminals are featured. Model 10 operates over the frequency range of 50 to 3,000 cps.



GEAR HEAD
used with size 8 motors

BOWMAR INSTRUMENT CORP., 2617 Pennsylvania St., Ft. Wayne, Ind., has announced an ultraminiature precision motor gear head weighing 1⅛ oz. The 750-GH gear head, designed for adaptation to size 8 motors, measures 0.750 in. in diameter, and, in its solid-type model, is 1 in. long.

Four through-bolts make it adaptable to specially tapped size 8 motors without the use of adapter plates or other accessories, thus eliminating extra weight and removing another variable from the electromechanical assembly using it. Assembly operations may also be simplified when the direct mounting method can be employed.

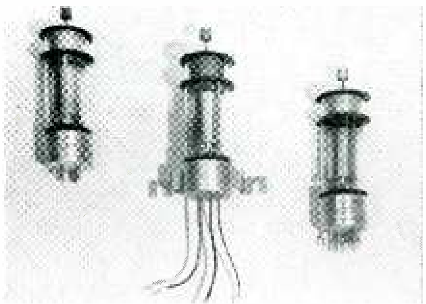
► **Uses**—Principal applications include missile control systems, where weight, performance and size are critical; servomechanisms; aircraft control equipment; indicating devices; computers and other precision electromechanical instrument applications.

PRECISION RESISTOR
completely encapsulated

EASTERN PRECISION RESISTOR CORP., 677 Barbey St., Brooklyn, N. Y. Designed to meet the requirements of MIL-R-93 characteristic A, this subminiature precision resistor is completely encapsulated. It measures 0.150 in. in diameter, ⅜ in. in length.

► **Design**—A new method of mechanically attaching the axial leads to the winding form eliminates the possibility of leads being pulled out during use. This new design also allows for a much greater winding area.

Values up to 500,000 ohms are available with tolerance as close as 0.01 percent. Resistor style NS-6AV will dissipate 0.1 w at 125 C with no derating.



CONTROL THYRATRON
with 3 different bases

GENERAL ELECTRIC Co., Schenectady 5, N. Y., has available 3 new types of its 6.4-ampere negative control characteristic thyratron—

GL-6807, GL-6808 and GL-6809. All incorporate element and envelope construction designed to provide maximum cooling to eliminate major causes of inoperation resulting in loss of factory time and possible damage to equipment.

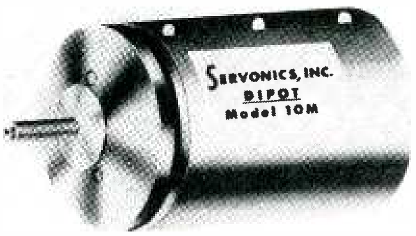
▶ **Base Connections**—The GL-6807 has a pin-type base and can be used interchangeably with the GL-5545. The GL-6808 has flexible flying leads and the GL-6809 is made with spade lug terminals extending from the base.

Because they carry high commutation factor ratings they are particularly suited to motor control and other inductive load circuits without cushioning. Their ability to operate over a wide ambient temperature range (—55 to +70 C) and a quick-heating cathode (1 minute) are useful features in industrial applications.

Maximum average cathode current is 6.4 amperes and fault current, 1,120 amperes. Maximum negative control grid voltage before conduction is —250 v; and during conduction, —10 v. Maximum positive control grid current is 0.20 ampere with the anode positive and 0.10 ampere with the anode negative.

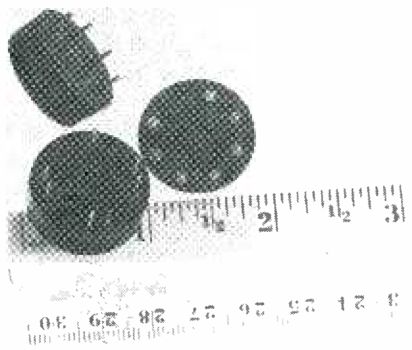
PRODUCTION TOOL
for connector soldering

AMELCO, INC., 2040 Colorado Ave., Santa Monica, Calif., announces the Connex, a production tool for faster and more efficient soldering. In use, the connector is snapped quickly and firmly to the Connex, permitting the operator to solder fast from any angle. There is no danger of slips and far less chance for burns. Connex reduces costs by increasing production performance on all production lines where soldering is involved. Price is $7.00 ($7.50 east of the Rockies).



PRECISION POT
a multiturn unit

SERVONICS, INC., 834 N. Henry St., Alexandria, Va. The Dipot is a high precision multiturn potentiometer which subdivides voltages obtained from matched resistors with a vernier porentiometer. It is effectively an "automized" Kelvin-Varley circuit. The Dipot may be continuously rotated without adverse effects. Through the use of pie wound resistors, instead of a helical coil, phase shift is greatly reduced. A brochure is available telling how it works, giving specifications and applications.



TRANSFORMERS
for printed circuit cards

TECHNITROL ENGINEERING CORP., 2751 North Fourth St., Philadelphia 33, Pa. Designed especially for printed circuit cards, the type P transformers offer a flat profile with sturdy, accurately spaced solder pins.

Both units are 11/32 in. high by 15/16 in. in diameter and are completely encapsulated. Type PE units feature a pin arrangement similar

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

to the standard 7 pin miniature, but with the pins on an 11/16 in. diameter. Type PA features an arrangement of pairs of pins, so located that the pins fall at the intersections of a 1/10 in. center grid.

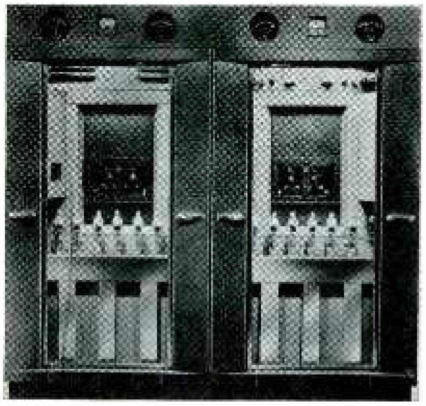
Featuring ferrite cores, this series of transformers can be wound to cover pulse widths ranging from 0.1 μsec to over 2.5 μsec and incorporating a wide variety of turn ratios.

INTERVERTER
power conversion device

THE INTERELECTRONICS CORP., 2432 Grand Concourse, New York 58, N. Y., has announced the Interverter, a voltage regulated d-c to d-c semiconductor power transformer. The $\frac{3}{4}$ w and 50 w series are illustrated. A miniature, standard and high-power series are available, ranging from $\frac{3}{4}$ w to 1 kw. A specially designed, high efficiency toroidal core structure is used, powered by the gating generator, and almost any voltage or voltages can be secured. Conversion efficiencies up to 90 percent are obtained. Input voltages of 1.5 v to 60 v may be used. Voltage regulation up to 0.1 percent is available.

► **Advantages**—It uses no moving parts, slip rings, brushes or commutators and maintenance is completely obviated. It withstands the extreme shock, vibration and acceleration encountered in military equipment, and operates over a wide temperature range.

► **Applications**—The miniature series are designed primarily to furnish plate and bias power from the filament battery for missiles, fuzes, telemetering, beacons and other miniaturized equipment. Among the uses of the high-power series are in high-power transmitters, radar and aircraft.



VHF TV AMPLIFIER
for channels 2-6

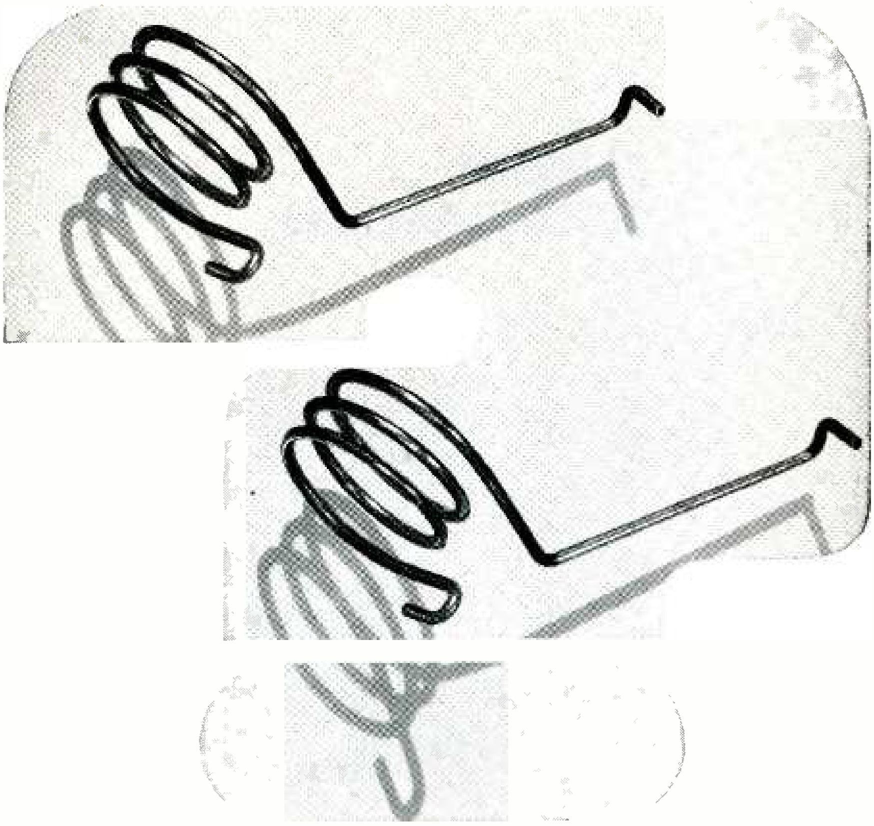
STANDARD ELECTRONICS CORP., 285 Emmet St., Newark 5, N. J., has developed a compact 25-kw tv amplifier for channels 2-6. Model AL-634 amplifier, priced at $50,000, includes the following characteristics: diminished floor space requirements, 2 cabinets occupying a total of 235 sq ft; reduced weight, 4,000 lb total; low power consumption, 63 kw at 90-percent power factor at black level; and it exceeds all applicable FCC requirements for monochrome and color transmission.

► **Adaptability** — As a result of self-contained, unitized design, where all components are housed in the two amplifier cabinets, the equipment is adaptable to any station layout; thereby providing maximum flexibility and minimum building alterations.

The rectifier unit, in both visual and aural amplifier cabinets, supplies high plate voltage by means of a 3-phase full-wave circuit which utilizes 6 mercury vapor rectifier tubes. A complete system of interlocks, overload circuits and relays, time delays and safety switches protects the equipment from overloads and power transients.

RESISTORS
are highly stable

PHYSICS RESEARCH LABORATORIES, INC., 507 Hempstead Turnpike, W. Hempstead, N. Y., has introduced the complete line of Otto Wolff of



Berlin standard resistors. All resistors have accuracies of 0.01 percent and in the air-cooled models may be obtained in power ratings of 1, 10, or 25 w.

The l-w models come in 9 different values, ranging from 100,000 ohms to 0.001 ohm. The temperature coefficient is smaller than 25×10^{-6} ohm per C. The variation in stability is less than 5 parts in 100,000 over a period of one year.

POWER TRANSISTORS
handle up to 20-w input

CLEVITE TRANSISTOR PRODUCTS, 241 Crescent St., Waltham 54, Mass., has announced 6 new germanium power transistors for handling up to 20-w input. They are *pnp* power junction type, and were originally developed to meet U. S. Signal Corps specifications.

Types are available for nominal 12 and 28-v operation, making them suitable for direct use in battery powered equipment. They are particularly suitable for class A operation in the audio output stage of automobile radios. The collector is electrically connected to the metal housing, but where it must be insulated from the chassis, a large mounting flange permits rapid heat flow through the insulating material.

A brochure is available listing complete specifications and performance characteristics.

Literature

Wire-Wound Resistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Catalog data bulletin D-1a covers MIL type precision wire-wound resistors. It contains comprehensive data on winding techniques, testing, tolerance, inductance, insulation, terminals and temperature coefficient.

Microwave Components and Mechanical Assemblies. J-V-M Engineering Co., 8846 W. 47th St., Brookfield, Ill. A wide range of standard and custom-engineered microwave components and complex mechanical assemblies are featured in an illustrated technical catalog. The microwave components described range from d-c to 40,000 mc and include cavities, adapters, bends, attenuators, loads, tees, twists, directional couplers and similar components and waveguide accessories. Mechanical components and services cover tools, dies, general machining, screw machine and sheet metal.

Snap-Action Switches. Micro Switch, Freeport, Ill., has published a 16-page booklet titled "Micro Tips Digest", containing 43 illustrated descriptions of uses for snap-action switches. The booklet is a compilation of the best ideas for applications of this type of switch, now widely used throughout industry.

Complete with photographs and drawings, the 43 switch application stories describe a wide variety of industrial and commercial uses for snap-action switches to provide improved safety, to lower costs, to increase production and to make electrically operated equipment more automatic.

Simulation Theory and Practice. Berkeley Division, Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Calif. Data File 121 gives a simplified short course in the basic theory and practice of analog computers. It explores the various aspects of simulation and describes its convenient implementation with analog computers for solving great varieties of problems in systems design, engineering and industry.

Mathematical background is fully explained, and the data file features a complete presentation on electronic analog simulation equipment. It includes references and bibliography.

Precision Instruments. Advance Electronics Lab., Inc., 451 Highland Ave., Passaic, N. J. A 4-page folder illustrates and describes a line of phase measuring instruments, delay lines and electronic counters. Specifications, prices are given.

Titanium Corrosion Resistance. Mallory-Sharon Titanium Corp., Niles, Ohio. A new bulletin con-

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tains currently available data on the corrosion resistance of titanium, and suggests to the product designer where this new metal can be applied to overcome corrosion problems. Various uses of titanium, based on its corrosion resistance, are described, and the booklet contains corrosion ratings for titanium when exposed to many common types of corrosive agents.

Servo Literature. John Oster Mfg. Co., Avionic Division, Racine, Wisc. Four catalog pages, each illustrating and fully describing a type of low inertia servo motor, are now available. Each sheet includes two graphs, dimensional drawings, average characteristics and complete electrical data.

The four servos described are a size 10 servo designed for operation in a special 250-cycle square-wave system; a size 10 designed for use in servo systems where instant response to input signal is a prime requisite; a high performance servo which conforms dimensionally with Navy BuOrd size 10; and a high performance servo which conforms dimensionally with Navy BuOrd size 15.

Frequency Limit Trips. Arga Division, Beckman Instruments, Inc., 220 Pasadena Ave., South Pasadena, Calif. Data sheet El presents the company's line of frequency limit indicators which are designed to monitor supply lines where frequency is critical. The bulletin describes the operation of the unit which comes in two forms: one operates when the frequency is higher than critical; the other when the frequency is lower than critical. They are available packaged together.

Technical data presented include: input voltage (115), nominal frequency (400 cps), l-f warning point (390 cps), h-f warning point (410 cps), accuracy ±1 cps at 400 cps, input power (10 w), harmonic and voltage coefficients (input voltage harmonics of 5 percent or changes of input voltage of ±10 percent), ambient temperature limits (—55 C to +55 C).

Beryllium Copper Springs. The Beryllium Corp., Reading, Pa. A 4-page technical bulletin describes the use and advantages of Berylco beryllium copper as the heart of a new vibration damping device for mounting electronic components in aircraft.

This case study covers damping units manufactured by the K. W. Johnson Co., Dayton, Ohio. Included in the bulletin are complete data on metal requirements for the Berylco alloy wire mesh springs, as well as design and fabrication considerations. The springs protect equipment under shock load conditions up to 30 g. In addition, the metal must withstand temperatures ranging from —65 to +200 C, high salt spray concentrations, extreme humidity and long storage life.

Molding Compounds. Plastics & Resins Division, American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N. Y., has published a 50-page technical manual entitled "Melamine Molding Compounds."

Subjects covered include descriptions of molding compounds, characteristics of molding compounds, storage and handling, preforming, preheating, molds, design of molded parts, molding procedures, molding variables, finishing, and typical applications of Melamine molding compounds. Individual data sheets on all of the company's Cymel Melamine molding compounds are included.

Solenoids. Comar Electric Co., 3349 Addison St., Chicago 18, Ill. Bulletin No. 200 is a 6-page folder illustrating and describing a line of solid frame a-c and d-c solenoids. Four types of laminated a-c solenoids are covered. Charts, and size and mounting data are included.

Geiger Counter. Nuclear Instrument and Chemical Corp., 229 W. Erie St., Chicago 10, Ill., has available a brochure describing the model 2612L portable Geiger counter for uranium prospecting. Chief features, circuit details and calibration information are included. Price of the unit described is $250.

Magnetic Storage Elements. Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass., has available engineering data sheets on its low power, medium frequency, subminiaturized magnetic storage elements, suitable for mounting on etched wiring boards. Specifications and dimensional drawings are included.

Resistivity System. Houston Technical Laboratories, a subsidiary of Texas Instruments Inc., 2424 Branard, Houston 6, Texas. Bulletin E-401 illustrates and describes new lightweight portable instruments (signal generator bank and voltmeter bank) for the electrical resistivity method of geophysical prospecting.

Explosion Chamber. Tenney Engineering, Inc., 1090 Springfield Road, Union, N. J., has available a 4-page folder giving complete information concerning design features, construction and test procedures involved with the use of a new explosion chamber. Illustrative photographs, handy reference arrows and simplified ordering data are all prominent features of the folder. An entire range of specifications is included for factual evaluation.

Product Brochure. Gulton Industries, Inc., Metuchen, N. J., has available a 12-page, illustrated guide to the products of its five associated companies: Gulton Mfg. Corp.; Glenco Corp.; Vibr-Ceramics Greibach Instruments Corp.; Thermistor Corp. of America. Included is useful technical information about over 65 diversified advanced Gulton Industries' product lines. Also shown are interesting photographs of individual manufacturing processes involved in the production of these products.

High Temperature Insulation. Insulation and Wires Inc., 1534 Swinney Ave., Fort Wayne 6, Ind. A new 4-page brochure describes and lists a line of class H silicone electrical insulating materials for high-temperature use. A chart compares class A, B, H and C insulations.

Products included are silicone resin insulating varnish, silicone bonded mica-glass cloth and tape, silicone treated glass cloth and tape, silicone-glass laminate, silicone-treated asbestos cloth and tape, silicone rubber insulated lead wire, silicone rubber-glass tape, silicone resin and rubber-treated glass tubing and sleeving, and silicone bonded glass magnet wire.

TV Picture Tubes. CBS-Hytron, Salem, Mass., is offering the third edition of its reference guide for tv picture tubes. Revised and brought up to date, it provides pertinent data for 258 magnetically deflected picture tubes. Ask for bulletin PA-2.

Resistor Catalog. The Daven Co., 538 W. Mt. Pleasant Ave., Livingston, N. J., has available a 12-page encapsulated wire-wound resistor catalog. Newly developed products, new plastic formulations, new encapsulating techniques, in addition to other improved design and manufacturing features, are presented in detail.

The catalog includes: temperature-sensitive resistors; card-type resistors, miniature d-c voltage divider and d-c networks, toothpick resistors; miniature resistors, subminiature resistors; axial lead types; lug types; MIL types and Daven equivalents.

Magnetic Counters. Sprague Electric Co., 35 Marshall St., North Adams, Mass. Data on the application of magnetic shift register assemblies in magnetic counters is given in engineering bulletin 551. The bulletin gives data on the operation of two types of standard Sprague counters and illustrates a typical decimal counter decade circuit.

Printed Circuit Tolerances. Photocircuits Corp., Glen Cove, N. Y. Technical bulletin P-9 is a 2-page publication entitled "Standard Printed Circuit Tolerances."

Included in the bulletin are such items as diameter tolerances of unplated and plated holes, location tolerances between holes, hole to pattern tolerances, alignment (front to back) tolerances, circuit pattern to outside dimension tolerances, overall dimension tolerances, holes to outside dimension tolerances, line width and spacing tolerances, plating tolerances and others—all hav-

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

ing to do with design and production specifications of printed circuitry for lowest cost.

Coaxial Tuner. Jasik Laboratories, 61 Second St., Mineola, N. Y. A single-sheet bulletin illustrates and describes type 224 coaxial E-H Tuner, an impedance matching device of novel design which is highly useful for effecting impedance transformation in coaxial line circuits.

The tuners discussed are available in several models. Model 224-A (2,700 to 10,000 mc) is priced at $92; model 224-C (950 to 10,000 mc), $98. When a crystal mount is desired in place of one of the type N fittings, price is $15 extra.

Analog Computers. George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass., has released a 16-page, fully illustrated catalog describing its complete line of electronic analog computers.

Complete descriptions are presented on: areas of application in industry, military and business; modular concept of building new or expanding existing installations; the company's electronic graph paper for instantaneous and automatic calibration of both voltage and time on the oscilloscope and simultaneous display and precise comparison of as many as five variables; K3 series of analog computing components (both linear and nonlinear) for rapid set up of problem where operator has minimum knowledge of electronic circuitry; central signal components; regulated power supplies; K2 series of plug-in components offering the most computing per dollar invested; new function of two variables component; delay line synthesizer and other miscellaneous computing equipment.

Polyester Laminates. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill., has published two illustrated booklets on polyester electrical insulating products.

An 8-page catalog on Conolite glossy surface polyester laminates provides technical data, suggested applications, and ordering information for rolls, coils and sheets. Glass cloth, cotton cloth and paper base combinations are described, as well as a wide variety of fabricated products that may be made from these plastic materials.

The 12-page catalog on Haysite reinforced plastics tells of the exceptional dielectric and physical properties of this inorganic mat-reinforced polyester sheet insulation. Tables and charts describe the properties of the standard grades, and bar graphs compare the physical properties of these reinforced polyester laminates with other electrical insulating laminates. Fabricated and molded parts are described, as well as suggestions for cutting, shearing and machining.

Transmitting and Special-Purpose Tubes. CBS-Hytron, Salem, Mass., has available new reference data for transmitting and special-purpose tubes. Conveniently indexed, the catalog includes data for small transmitting pentodes, triodes and rectifiers, gaseous voltage regulators and reference tubes, and special receiving and military tubes. Ask for bulletin PA-5.

TV Amplifier Specifications. Standard Electronics Corp., 285 Emmet St., Newark 5, N. J., has produced a new tv amplifier specifications bulletin, describing both low and high band 25 kw vhf tv amplifiers. The bulletin contains photographs of the standard electronic amplifiers, a complete explanation of how the equipment operates, 2 pages of illustrations and descriptions of major design features, electrical and mechanical specifications, a tube list, and block diagrams of both aural and visual amplifiers.

Mercury Plunger Relay. Ebert Electronics Corp., 212-26 Jamaica Ave., Queens Village 28, N. Y. Complete description, technical data, and illustrations on the midget Minirelay mercury plunger relay are now available in a new bulletin. The bulletin fully covers operational and construction details, load ratings and typical features.

The Minirelay is rated and proven in use for all loads up to 20 amperes at 115 v a-c and may be had either normally open or normally closed. Actuating coils are

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

available in most standard operating voltages.

Instrument Catalog. Allen B. DuMont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J. A 12-page folder offers a quick reference instrument catalog. Included are illustrated detailed descriptions and prices for a line of h-f and l-f instruments, accessory instruments, recording equipment and accessory equipment, cro's and accessory equipment.

Mobile Electronics Laboratory. Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill. The Electronics Systems Division of the company, in *Newsletter* No. 1, Vol. 7, illustrates and describes the mobile electronics laboratory that was custom engineered and equipped for the Airborne Instrumentation and Standards Branch, Electro Mechanical Laboratory of the Army at White Sands Proving Ground. The lab described is an example of the company's ability to design, fabricate and deliver a unit meeting or exceeding customers' specifications.

Subminiature Connectors. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif., has issued a complete new engineering bulletin on the type D subminiature connectors, code D-6.

The connectors described are designed for miniature equipment and components requiring rack and panel chassis construction in electronics, radio, aviation, automation, instruments and other fields.

The 8-page, 2-color bulletin contains actual size photographs of D miniatures; dimensional data, soldering, mounting and shell deviations; standard assemblies and variations, also several application photographs.

Controller for H-F Induction Heating. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. Complete information about a small-target high-speed Rayotube detector and Speedomax G controller for h-f induction heating is now available in a 2-page data sheet. The sheet describes how this equipment is being used on continuous, batch and selective induction heating processes.

Included is a full description of the 8891-C Rayotube and the Speedomax G controller. Specifications and standard ranges for both are conveniently tabulated. Ordering instructions are included.

Ask for process data sheet 620 (2).

Relay Specification. American Machine & Foundry Co., 261 Madison Ave., New York 16, N. Y., has available a 12-page article on specifying relays by James F. Rinke. It covers the various factors that should be considered in selecting an electrical relay for a given application. These factors include circuit characteristics, type of switching, actuation power, operating speed, duty cycle, life expectancy, environmental conditions, physical requirements and cost.

Transformers. Sterling Transformer Corp., 297 North 7th St., Brooklyn, N. Y., has available bulletin 2K covering a line of transformers designed to be used for electronically regulated power supplies.

The bulletin provides a tested circuit, and application information that permits construction of a high-performance regulated power supply. Complete electrical and physical ratings of the transformers are listed.

Ferrite Cored Inductors. Aladdin Radio Industries, Inc., Nashville 2, Tenn., has available a new engineering bulletin on ferrite cored inductors. The bulletin contains several new product lines, including the company's Tiny-L inductors, which cover the range from 0.33 to 6.8 microhenries. The company has adopted RETMA increments for the inductance values of all units in the lines described in this bulletin.

Thermistors and Varistors. Victory Engineering Corp., 101 Springfield Road, Union, N. J., has published its sixth edition of a technical catalog describing VECO thermistors, varistors and assemblies.

The catalog will assist engineers and buyers in selecting proper thermistor or varistor units for their purposes.

Electronic Digital Computer. Logistics Research Inc., 141 Pacific Ave., Redondo Beach, Calif. An 8-page folder illustrates and describes the ALWAC III-E general purpose electronic digital computer designed for a wide range of application to the problems of scientific-engineering-research and business-industrial-financial organizations. Specifications, features and information on operations are given.

Midget Mica-Dielectric Capacitors. Cornell-Dubilier Electric Corp., South Plainfield, N. J. Bulletin No. 422-4 illustrates and describes the molded midget mica-dielectric capacitors now available in three operating temperature ranges: —55 C to 130 C, —55 C to 160 C and the original —55 C to 85 C. Dimensional diagrams, characteristics description, characteristics availability chart and electrical mechanical features are included.

Automatic Controls for Aerodynamic Testing. Hagan Corp., 323 Fourth Ave., Pittsburgh 30, Pa. A 20-page booklet, MSP-133, describes the company's PowrAmp series of components, a high-speed, high-powered line of precision electrical and electronic automatic control equipment for all standard variables. The series discussed is designed for use in aeronautical testing and other facilities requiring exact performance. Typical applications include the control of surge, altitude and mass flow in all types of wind tunnels—subsonic, transonic and supersonic.

Brief descriptions of each device's function and method of operation, essential specifications, photographs and schematic drawings are features of the brochure. Highlighted are transducers, amplifiers, converters, controllers, signal shapers, computers, electrohydraulic pilot valves and other associated components.

TV Amplifier. Standard Electronics Corp., 285 Emmet St., Newark 5, N. J., has published a new 4-page tv amplifier specifications bulletin which describes high-band 50-kw vhf tv amplifiers. The bulletin contains photographs of the company's amplifiers, an explanation of how the equipment operates, 2 pages of illustrations and descriptions of major design features, electrical and mechanical specifications, a tube list, and block diagrams of both aural and visual amplifiers.

Contact Connectors. Alden Products Co., 117 North Main St., Brockton 64, Mass. A new 4-page brochure, "What's New at Alden's," shows a whole new series of rugged, compact single and multicontact contact connectors. The IMI (integrally molded insulation) connectors discussed feature perfect strain relief, a natural sealing against dust and moisture trapping, shorter leakage paths and greater reliability. The IMI technique is described in detail and illustrations and application of these connectors and unit cables are shown.

Multiple Switch. Switchcraft, Inc., 1328 N. Halsted St., Chicago 22, Ill., has issued a catalog supplement No. S-560 covering their new Multi-Switch. The switch described features a choice of switching functions; flexible tools make it practical to make in any multiple from 2 to 12 stations; choice of mounting centers; plungers—0.050 in. by 0.187 in.—so designed to accept standard push-on buttons; stack switches mounted on a separate plate. Up to 4 stacks can be operated by each button, providing innumerable circuit possibilities.

The bulletin covers illuminated and nonilluminated and ganged assemblies of intercoupled rams of Multi-Switches. Full details and specifications are given.

Magnetic Recording Tape. Audio Devices, Inc., 444 Madison Ave., New York 22, N. Y., has issued a new bulletin on type EP Audiotape, extra precision magnetic recording tape for telemetering, electronic computers and other specialized applications.

The folder lists the physical characteristics and magnetic properties of type EP Audiotape which is made on a base material of cellulose

acetate or Mylar polyester film. The publication also includes a price list of reels of various lengths, widths of tape and thickness of base material.

Teflon Tubing. Sparta Mfg. Co., Dover, Ohio. Form No. 564 is a 4-page illustrated bulletin covering the company's new flexible thin-walled and spaghetti tubing made of Teflon. Properties, characteristics, suggested end uses and complete price lists are included.

Electronic Gear. Alden Products Co., 117 North Main St., Brockton 64, Mass. A new bulletin, "Ideas, Techniques, Designs," shows application photos and stories on electronic gear packaged with the company's plug-in components.

Included is a detailed description of two new kits containing all the necessary plug-in components. The kits described permit the user to begin construction and assembly immediately of a piece of electronic gear. In addition, they enable him to evaluate quickly the use of unitized design and construction for his equipment.

Printed Circuitry. Croname Inc., 3701 Ravenswood, Chicago 13, Ill. A 4-page brochure outlines the company's facilities for producing printed circuits by its laboratory approved process, and offers recommendations on the basic steps necessary for exact circuit duplication. Information on quotation and orders is included.

Tiny Metal-Ceramic Receiving Tubes. General Electric Co., 1 River Road, Schenectady, N. Y., has available a 20-page booklet containing additional data on the company's micro-miniature metal-ceramic receiving tubes. Design and construction innovations of the tube are described in the booklet which also contains additional application data, operating characteristics and construction features. Illustrations show the extensive facilities, advanced equipment and the engineering and technical skills employed in the manufacture of the tubes. Ask for booklet ETD-1212-A.

Diffractometer. New Brunswick Scientific Co., P.O. Box 606, New

Brunswick, N. J. A 4-page folder illustrates and describes the double crystal x-ray diffractometer, a new research tool for metallurgy, the quartz industry, the production of transistors, the precise determination of lattice parameters and studies of precipitation hardening. Specifications are included.

Meters and Timers. Berkeley Division, Beckman Instruments Inc., 2200 Wright Ave., Richmond 3, Calif. A 4-page folder covers the 7000 series of Eput, frequency, and time interval meters and universal Eput meters and timers. Included are descriptions, applications, specifications and prices.

Magnetic Tape Handler. Key Electric Corp., 287 Post Ave., Westbury, N. Y., has available a specification sheet on the model 101 digital magnetic tape handler. Illustrations, features, description and specifications are included.

Regulated D-C Power Supplies. Lambda Electronics Corp., 11-11 131 St., College Point 56, N. Y. A 6-page folder contains an illustrated description and specifications for the 200 MA series power supply which saves panel space. Prices of the units described range from $149.50 to $189.50.

Features of the power supplies discussed are: fuse failure indicators, transient-free operation, hermetically-sealed transformers and chokes, and service accessibility.

D-C P-M Motors. Barber-Colman Co., 1400 Rock St., Rockford, Ill. Catalog F4344-3 describes a line of fractional h-p d-c p-m motors as well as gearheads, centrifugal blowers and tachometer generators. All are designed for aircraft or industrial applications with many combinations of voltage, output and speed. The motors discussed are available with voltages from 6 to 115 v d-c with outputs up to 1/10 h-p and speeds from 5,000 to 20,000 rpm.

Custom Molding Services. Molded Fiber Glass Co., 4403 Benefit Ave., Ashtabula, Ohio, announces a 16-page catalog descriptive of the com-

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

pany's custom molding services. It is intended as a guide for designers interested in the application of molded fiber glass to specific products.

Printed in two colors and illustrated with photographs, line sketches and charts, the catalog describes the molded fiber glass molding process and lists various mechanical, electrical and chemical properties of molded fiber glass. It also lists the fabricating operations which can be performed on this material, and illustrates a number of finished molded fiber glass products.

Room Temperature Bonding. Rubber & Asbestos Corp., 225 Belleville Ave., Bloomfield, N. J., has released an 8-page, profusely illustrated booklet describing application techniques and precautions, advantages and limitations of adhesive bonding at room temperature.

Particular emphasis in the booklet is placed on the new epoxy based adhesives which need neither heat cure nor pressure, and which offer new, high-strength fastening possibilities for plastics, metals and other components.

Also included are helpful tables, charts, photos and data on how to attain longest pot life from two-part formulations; information as to how to speed cures with moderate applications of heat; data on strength vs temperature for epoxy adhesives; cost of heat resistance, and the like.

Voltage Regulator. North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y., has available a new engineering bulletin, with data on a new Norelco 3-kva a-c voltage regulator for use with x-ray diffraction equipment. Illustrated with photographs, the literature covers characteristics, including line voltage, output load, output voltage, output current, regulation, load power factor, harmonic distortion and time constant.

Temperature Controller. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Specifications sheet S1010-1 describes the model 077 electronic temperature controller. The unit discussed is a nonindicating device which operates on the balanced bridge principle. It can be supplied as a single point controller, using a single bulb; as a differential controller, for control on the temperature difference between two bulbs; or for cascade control, using two bulbs.

Control-Resistor Catalog. Clarostat Mfg. Co., Inc., Dover, N. H. Just about every type and size control or resistor for the usual run of applications can be found in catalog No. 56. Among the listings are composition-element and wire-wound controls in several sizes including miniaturized versions, convenient field-attached shafts and switches, power rheostats, sound-system controls, precision or laboratory-grade controls, wire-wound fixed and adjustable resistors, precision deposited-carbon resistors, ballasts, line-voltage regulators, fuse-type resistors, power resistor decade box and the like.

Panel Instruments and Accessories. General Electric Co., Schenectady 5, N. Y. Bulletin GEC-368H is a 12-page booklet describing the features, application, construction, dimensions and other data of 2½, 3½ and 4½ in. sizes. Photographs, diagrams and prices are included.

Thermocouple Circuit Restorer. The Peerless Electric Co., Electronics Division, W. Market St., Warren, Ohio. Catalog R-26 describes the thermocouple circuit restorer, a device for renewing proper electrical conductivity through thermocouples and thermocouple circuits used in heat-treating, melting and other processing operations.

Diagrams, installation photos and recorder chart reproductions illustrate how the Restorer monitors couples and thermocouple circuits transmitting emf to temperature indicators, recorders and controllers.

Magnetic Bobbin Cores. Burroughs Corp., 1209 Vine St., Philadelphia 7, Pa. A new 4-page folder describes the development, characteristics, applications and services available in connection with the line of Bi-

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

Mag tape-wound magnetic bobbin cores. Materials, widths, thicknesses and bobbin sizes are listed for standard cores of Molypermalloy and Orthonik. The company points out that these cores feature unusual uniformity to assist the design engineer in the application of magnetic cores as a working component in electronic systems.

Angular Position Encoders. The Electronics Division, The Baldwin Piano Co., 1815 Gilbert Ave., Cincinnati 2, Ohio, has published a comprehensive 8-page bulletin describing new 13-digit and 16-digit optical-type analog to digital angular position encoders.

Well illustrated, the bulletin gives detailed information on the operation and construction of the two models and describes the manufacture of Baldwin binary and other type code disks. Encoder and code disk specifications are included.

Magnetic Shielding. Perfection Mica Co., 20 North Wacker Drive, Chicago 6, Ill. Release 103 describes how to protect tape recordings from various low and high intensity magnetic fields by storing or carrying in Fernetic and Co-Netic protective cans. Typical dimensions and prices are given on Fernetic, Co-Netic, Fernetic-Co-Netic, and Co-Netic-Fernetic rectangular cans, flat sheets, cylinders, crt shields, transformer cans and tachometer shields.

Data sheet 103-A gives terminology and example sheet from laboratory test reports on shielding high, medium and low intensities with Fernetic and Co-Netic magnetic shielding materials.

Digital Pulse Generators. The Jacobs Instrument Co., Bethesda 14, Md., has available a bulletin announcing the Digipulsers, a series of instruments which emit a continuous train of equally spaced pulses. The Digipulsers measure $4\frac{1}{4}$ by $6\frac{1}{4}$ by 7 in. and weigh $8\frac{1}{2}$ lb.

The units described, fitted for laboratory and industrial use, may be used as lightweight precision intervalometers in the field or in aircraft. Characteristics are outlined.

Thermocouple Data. Barber-Colman Co., Rockford, Ill. Bulletin F-

5228-3, a 40-page booklet, discusses construction and application of thermocouples and radiation detectors as used on industrial control applications. Included is information on how to check thermocouples, how to make thermocouples, how to select and size thermocouples, plus other useful information for instrument men.

Also given are standard thermocouple temperature-millivolt equivalents with temperatures being expressed on the international temperature scale of 1948. The electromotive force is expressed in absolute units.

H-V Pressurized Connectors. DeJUR-AMSCO Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. The 2-color, 2-page bulletin 46C on the new h-v pressurized precision Continental connectors in 2 and 3 contacts for AN24 shell includes description, specifications, actual size illustrations, mounting and clearance dimensions and electrical ratings.

Soldering Instruments. Adcola, Gauden Road, Clapham, London, S.W. 4, England, has available literature on its soldering instruments and allied equipment designed to accelerate production and reduce manufacturing costs. Included are illustrated data on a quick-heating solder pot, the Secundus electric soldering instrument, the P.V.C. electric stripper and a soldering instrument shield.

Rotating Components. Norden-Ketay Corp., 555 Broadway, New York 12, N. Y. Bulletin 376 is a 4-page folder giving the characteristics of over 138 synchros, servo motors and resolvers. The bulletin was prepared to provide engineers with an easy guide for the selection of rotating components.

Glass-Sealing Alloys. Driver-Harris Co., Harrison, N. J. A 4-page folder contains a description, properties listing and thermal expansion chart for 4 alloys (Therlo, 142 alloy, 152 alloy and 146 alloy) for glass-to-metal sealing of both hard and soft glass. The alloys described are available as rod, wire, strip, sheet foil—and in special shapes.

Plants and People

Edited by WILLIAM G. ARNOLD

Industry plant and facility expansions continue at rapid rate as more manufacturers enlarge production space. Changes in engineering and executive personnel are announced by major companies. More acquisitions and mergers are completed.

RCA Unveils New Missile Plant Addition In New Jersey

TO PROVIDE the design, engineering, and manufacturing space for the 'Talos' guided missile project, RCA has completed one phase of an enlargement program which more than doubles the engineering space and laboratory facilities of its Moorestown, N. J. missile and surface radar engineering plant. The new building, which joins the original construction, was opened officially by General David Sarnoff and other officers of RCA with the unveiling of a plaque at the dedication ceremonies.

The original plant comprised 145,000 sq ft of total building space and provided employment for approximately 600 people, compared with today's building space of 264,000 sq ft and employment of more than 1,500 persons.

Following the dedication ceremonies, military guests attended a special program which reviewed the firm's defense electronic products activities and achievements.


General Sarnoff, left, and H. R. Wege, manager of missile and surface radar operations

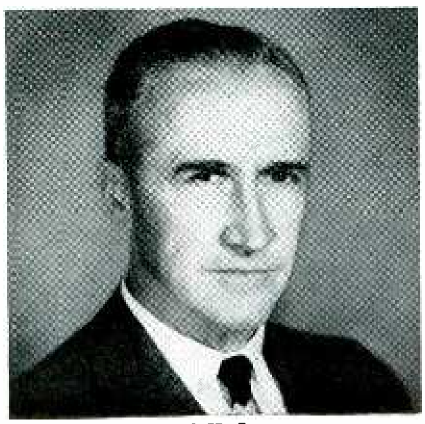
▶ **Tubes**—RCA also announced that Leonard Gillon, manager of manufacturing in the television picture tube section of the plant in Marion, Indiana, has been appointed plant manager. He succeeds W. T. Warrender, who has been named general manager of the newly formed components division, with headquarters in Camden, N. J.

Gillon joined the company in 1929 as a machine attendant at Harrison, N. J. In 1940 he was appointed general foreman of the miscellaneous parts department at the company's plant in Indianapolis, Ind., and for 14 years held successive positions there as manager, materials and production controls; superintendent, and then manager, glass receiving tube manufacture.

IT&T Elects President, Sells Capehart, Appoints Engineers

EDMOND H. LEAVEY has been elected president of IT&T, filling the top executive position held by the late William H. Harrison.

Elected a vice-president of IT&T in 1952, he became president of the corporation's central research division in the U. S., Federal Telecommunication Laboratories in Nutley, N. J. in 1953, and president of International Standard Electric Corp. in 1954. He is a director and officer of numerous other IT&T companies.


Edmond H. Leavey

He has traveled extensively for IT&T in connection with its worldwide operations and, prior to joining the corporation, had extensive experience in both the operational and administrative fields of engineering. He was chief of the logistics division of Supreme Headquarters of the Allied Powers in Europe (SHAPE) before his retirement from the Army with the rank of Major General in 1952.

▶ **Sale**—The television, high-fidelity phonograph and radio business of IT&T's Capehart-Farnsworth Co. has been sold to the Ben Gross Corp.

of New York City. Gross will be licensed on a non-exclusive basis under certain U. S. patents based on inventions of Capehart-Farnsworth employees. Ownership of these patents will be retained by IT&T.

The Ben Gross Corp. has indicated that it will continue with the manufacture of high quality products under the trademark name of Capehart.

Disposition of present inventory and other details are to be determined.

▶ **Appointments**—Robert S. Caruthers has joined the executive staff of IT&T as director of telephone systems research and development. He will coordinate all the work in this field currently being carried on both in the United States and abroad by IT&T and its associated companies.

Caruthers' business career started with the U. S. Bureau of Standards in Washington, D. C., and in 1929 he joined the technical staff of Bell Telephone Laboratories in New York. Later, when operations at Murray Hill were expanded, he was transferred to that point. He joined Lenkurt Electric in 1952 as chief development engineer. He holds more than 20 patents.

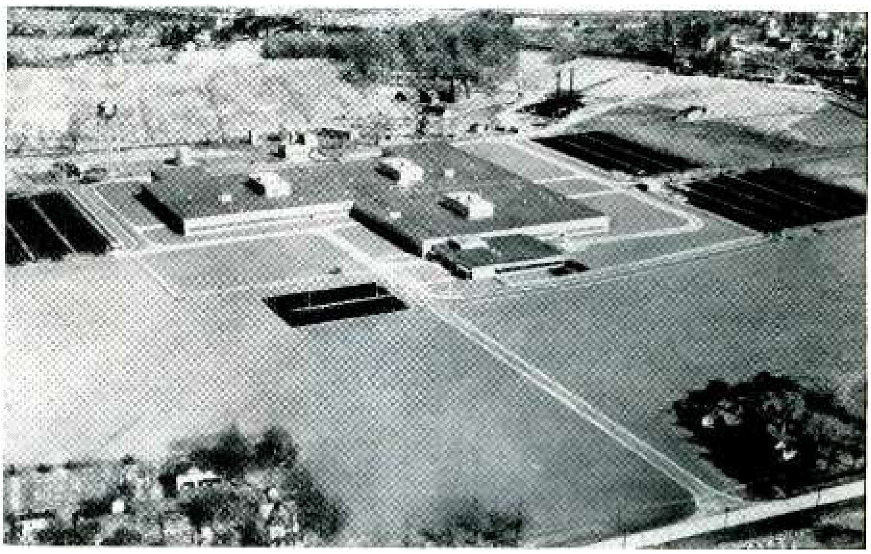
Frank M. Viles, Jr., has been appointed technical director of the components division of IT&T's Federal Telephone and Radio Co. in Clifton, N. J. He comes to Federal from Litton Industries, where he was administrative assistant to the general manager.

Leeds & Northrup Opens New Instrument Factory

Leeds & Northrup Co. officially opened its new instrument plant in North Wales, Pa. Land and buildings cost about $4 million; inventory and equipment about $7 million more.

The manufacturing and office areas provide over 6 acres of floor space and are set in a 129-acre tract.

There will be about 1,300 employees at North Wales, including not only some of the firm's manufacturing people but also some from the departments of engineering, industrial engineering, personnel, accounting and maintenance. The L&N headquarters, and all manufacturing of laboratory instruments, furnaces and certain other products, will remain at the long-established company location in Philadelphia. Products to be produced at the new plant include recorders, combustion controls and other automatic instrumentation.



Leeds & Northrup instrument plant in North Wales, Pa.

GE Organizes Industrial Laboratory, Plans Florida Plant

General Electric is organizing a new laboratory to concentrate on development of new products, techniques and systems for the industrial electronics field, a business expected to double in size in the next five years.

Donald E. Garr was appointed manager of the new unit in GE's laboratories department in Syracuse.

Garr currently is heading a study team formulating plans for the laboratory, including initial work projects and size and location of a permanent laboratory facility. He previously was manager of electrical engineering at the firm's general engineering laboratory. He joined General Electric in 1936.

Donald E. Garr

G. L. Haller, manager of the laboratories department, said that over twenty GE departments outside the company's electronics division currently have a vital interest either in the manufacture of industrial electronics products or in the sale of systems which lean heavily on such products.

Dr. Haller said that the industrial electronics laboratory will start operations during the early summer with a small nucleus of engineers working at Syracuse and Schenectady until a permanent headquarters facility is established. He

expects about 50 people to be on the technical staff by year's end.

▶ **Florida** — GE also announced plans to establish an electronics plant in the St. Petersburg-Clearwater area, the firm's first manufacturing facility to be constructed in Florida.

The proposed plant will produce electronics equipment for Sandia Corp. of Albuquerque, N. M., prime contractor to the Atomic Energy Commission. The General Electric x-ray department will operate the new facility.

The new plant will employ from 600 to 700 people and will have an annual payroll of about four million dollars. A. F. Persons has been named plant manager. Ground will be broken for construction late in May. It is planned to have the plant in operation by December 30, 1956.

There will be 150,000 sq ft of floor space in a one-story manufacturing building and an attached two story office building.

A small number of key employees will be transferred from the headquarters of the x-ray department at Milwaukee, Wisconsin.

NCR Dedicates Electronics Division

New National Cash Register electronics plant in California

THE NATIONAL CASH REGISTER Co. dedicated its new electronics division in Hawthorne, Calif.

The 52,000 sq ft structure is devoted to research and design activity in advanced electronic computers and auxiliary equipment for business systems. Management at the division includes D. E. Eckdahl, division manager; D. J. Daugherty, manager of engineering department; Marc Shiowitz, manager of product development department; Alfred Doig, manager of special projects department; and R. J. Valenti, manager of engineering services department.

The division has 225 employees, consisting principally of engineers, mathematicians and scientists.

General Instrument Buys Micamold

GENERAL INSTRUMENT CORP. has reached an agreement to purchase all outstanding capital stock of Micamold Electronics Manufacturing Corp. The acquisition is subject to shareholder approval.

Under terms of the agreement, all Micamold's outstanding stock is to be purchased at the approximate book value of its shares on December 31, 1955, $2,494,000 payable 20 percent in cash and the balance in long-term notes maturing annually over a five-year period from March 1, 1958, to March 1, 1962, along with options for the purchase of 210,000 General Instrument shares.

Micamold and its subsidiary report for 1955 combined sales of

$7,350,000 and earnings of $293,000 before taxes. The firm has plants at Brooklyn, N. Y. and Tazewell, Va.

Loral Electronics Builds New Plant

LORAL ELECTRONICS CORP. broke ground for its new plant in New York City on Bronx River Avenue.

The plant will be one story high and three city blocks long. It will occupy 100,000 sq ft of space on five acres.

Leon Alpert, president, stated that this is the first in a series of expansion moves presently being planned.

Texas Instruments Consolidates Divisions

THE semiconductor products and components divisions of Texas Instruments have been combined to improve customer service and to increase production efficiency.

The new semiconductor-components division is headed by vice-president Mark Shepherd, Jr., formerly in charge of the semiconductor products division. J. P. Rodgers, Jr., formerly general manager of the components division, has been appointed assistant vice-president and marketing manager of the new division. Other divisional appointments include: W. E. Love, sales planning manager; Z. W. Pique, sales manager and Leslie King, products manager.

The divisional consolidation has altered the construction plans for the new plant on the recently acquired 250-acre tract near Richardson, Texas. Plans originally called for a 150,000 sq ft plant, but consolidation of the two divisions will increase the new plant size to over 200,000 sq ft. Construction will begin this year, with completion scheduled in 1957.

▶ **Apparatus**—TI also announced new appointments in its apparatus division. They include: Cecil L. Covington, controller; R. E. Houston, personnel director; W. H. Owen, chief industrial engineer; and Ingram Lee II, production manager. In the apparatus division engineering department, W. R. Bailey and Ronald F. Keener have been appointed assistant chief engineers, reporting to assistant vice-president H. J. Wissemann.

All those concerned have been with Texas Instruments for several years. John A. F. Gerrard is now director of geophysical research in the central research division of Texas Instruments. He is in charge of basic and exploratory research into technique and instrumentation for geophysical exploration for petroleum and minerals.

Dr. Gerrard was formerly director of geophysical research for Houston Technical Laboratories. He replaced Dr. Hal J. Jones, who is now chief engineer of HTL.

Prior to his coming with the TI companies in 1954, Gerrard was a vice-president of Electro-Technical Laboratories, Houston, and before that was a technical supervisor with Northwest Seismic Surveys, Calgary, and a geophysicist with California Standard Company of Canada.

Simpson Aids U. S. Assistance Program

A. J. Milewski, left, of Simpson in Chicago and N. R. Das Gupta of National Instrument in Calcutta

Nirode Ranjan Das Gupta of India recently made a three-day study of the Simpson Electric Company's Chicago plant to learn more about mass production and specifically about mass production of electrical measuring instruments. He is making a six-month tour of the U.S. as part of the U.S. Technical Assistance Program. His job back in Calcutta is supervisor of repairs at the National Instrument factory.

Simpson also announced formation of an avionics division, headed by Dudley Hansen. It will produce aircraft-indicating instruments.

Ford Motor Company Moves Into Missiles

Ford Motor Co. formed a subsidiary company which will span advanced scientific and technological operations ranging from guided missile systems to possible exploration of outer space. Ford's initial commitment for the new firm of $10 million will go for research and development facilities. Total investment in such facilities is expected to run around $14 million.

Called Aeronutronic Systems, Inc., the subsidiary will have its headquarters in California. Construction of research and development facilities for the new firm is expected to start by the end of 1956 and be completed in 1958. Between 1,000 and 2,000 people may eventually be employed in the facility. For production facilities the company will either build new plants or use some of the facilities that Ford has located in the U.S.

Nucleus of the new company will

be a group of scientists and engineers who formerly were organized under the name of Systems Research Corp., a Los Angeles firm engaged in research and development in the design of weapons systems. It was formed by scientific personnel who were formerly with Lockheed's missile systems division.

A seven-member board of directors includes Henry Ford, E. R. Breech, president and board chairman of Ford, respectively; Gerald J. Lynch, director of Ford's office of defense products and governmental relations; Ernst H. Krause and Montgomery H. Johnson of the SRC group and Andrew Kucher, director of the Ford scientific laboratory. A chairman and a seventh member will be announced later.

Lynch, who is resigning his present position with Ford to become president of the subsidiary, said:

"We expect to take a missile or other project and see it through from its very conception to its manufacture, and possibly even to its utilization and maintenance."

"And when the new corporation gets to the point where it is ready to start production, it either will build new plants or use some of the modern, highly versatile facilities which Ford Motor Company has located strategically in all parts of the country."

▶ **Personnel**—Dr. Krause, formerly president and board chairman of SRC, has been named vice-president—research and development, and Dr. Johnson, who was director of SRC's physics and nucleonics division, has been appointed director of research and development.

In another key assignment, Dr. Joseph V. Charyk, who was vice-president and director of SRC's aerophysics division, has been named head of the aerodynamics and propulsion division.

A former associate director of research at the Naval Research Laboratory in Washington, D. C., Krause was with Lockheed Aircraft before forming SRC.

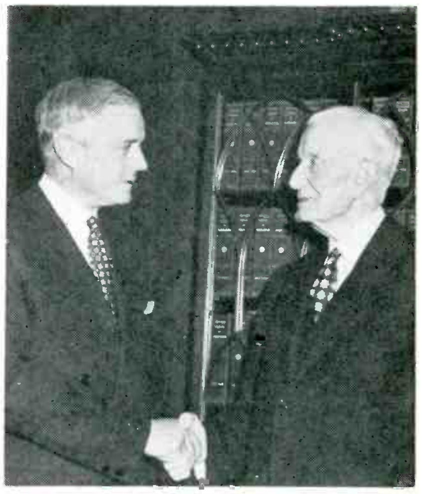
Johnson also is a former staff member of the Naval Research Laboratory and Lockheed. He is a former faculty member at New York University and the University of Maryland.

Charyk has also served with

Want more information? Use post card on last page.

Lockheed and was on the faculties of California Institute of Technology and Princeton University. He has been associated with the Advisory Group of Aeronautical Research and Development of the North Atlantic Treaty Organization.

IBM Elects Chief Executive



Thomas J. Watson, Jr., left, and Thomas J. Watson, Sr.

THOMAS J. WATSON, JR., has been elected chief executive officer of IBM.

He has been president of the company since January, 1952, and will continue in that office. Thomas J. Watson, Sr. will continue as board chairman.

U. S. Telecommunications Advisory Board Set

A TELECOMMUNICATIONS Advisory Board, under Office of Defense Mobilization chairmanship, was established by Defense Mobilization order.

Primary function of the board is to advise the director of defense mobilization on the effective use of telecommunications programs in over-all government mobilization activities.

The board, to be headed by Major General Jerry V. Matejka, USA, (Ret.), ODM assistant to the director for telecommunications, will be made up of representatives from the Departments of State, Defense and Commerce, the Central Intelligence Agency, Federal Civil Defense Administration and the Federal Communications Commission. Edward Webster will be the FCC representative on TAB.

Audio-Video Names Chief Engineer

IRVING KAUFMAN has been appointed vice-president in charge of engineering at Audio-Video Recording Co. He has been chief engineer of the company since 1955 and will supervise all engineering personnel and facilities.

He joined the firm in 1951 as senior studio engineer. In 1954 he became studio supervisor and was promoted to the position of chief engineer in 1955. In 1956, he was made responsible for all engineering activities.

Prior to joining the company, he was chief engineer at another New York studio for six years.

Sylvania Expands For Microwave, Promotes Six

SYLVANIA plans to expand it microwave tube laboratory by adding a new wing devoted to increased research and development in traveling-wave tubes and other microwave devices. Total of 18,000 sq ft will be added to the present 40,000 sq ft. Construction is to begin this summer for fall occupancy.

The laboratory, built in 1952, is producing traveling-wave tubes under government contracts. Gerald C. Rich is manager of the laboratory.

At least 15,000 sq ft of the new wing will be used for engineering laboratories and offices, while 3,000 sq ft will be devoted to experimental tube construction.

►Lab — Earlier Sylvania announced that a microwave physics laboratory had been established in Mountain View, Calif. Activities will be carried out in rented space until permanent facilities are established.

Henry Lehne, general manager of the electronic systems division, said the new laboratory would conduct research and advanced development in the uses of new magnetic materials and gaseous media for microwave electronic control devices and systems for radar, communications and electronic countermeasures.

The new laboratory is the third Sylvania electronics laboratory to be located at Mountain View. The company's microwave tube laboratory was established there in 1952, and the electronic defense laboratory in 1954.

Osmund T. Fundingsland, who has been directing research and development in these fields, will head the new laboratory. Prior to joining Sylvania in 1953, he was with the Air Force Cambridge Research Center. Since 1953 he has been serving as consultant on the Atomic Energy Commission's Project Sherwood at the University of California's Radiation Laboratory.

Arthur L. Aden will be assistant manager of the new laboratory. Since 1953, he has been leading specialized applied physics research for Sylvania.

▶ **Promotions**—Arthur L. Chapman has been appointed vice-president of manufacturing. A vice-president of the firm since 1950, he most recently had been a vice-president of operations, in charge of the radio and television division.

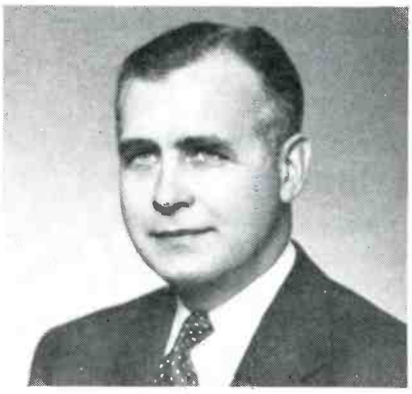
Arthur L. Chapman

Charles W. Hosterman has been appointed general manager of the electronics division of Sylvania. He has been assistant general manager of the division since 1954. He joined the company in 1943.

Bennett S. Ellefson has been appointed vice-president-engineering and research, and Marion E. Pettegrew has been appointed vice-president-tungsten-chemical and parts operations, of Sylvania.

Dr. Ellefson is responsible for planning and coordinating broad aspects of engineering and research on a company-wide basis. He previously had served since November, 1954, as technical director of Sylvania.

Pettegrew, as a vice-president, will continue to have over-all responsibility for the parts division and tungsten and chemical division. He also continues to have responsibility for parent company supervision of the operations of two wholly-owned subsidiaries, Sylvania Electric of Puerto Rico, and Produtos Eletricos de Mica in Brazil.



Bennett S. Ellefson

Dr. Ellefson joined the Sylvania organization in 1937 as a research chemist, specializing in work on fluorescent materials and glass. He served in various engineering capacities until 1946, when he was appointed director of the central engineering laboratories in New York.

National Semiconductor Selects Research Head

Morton B. Prince has been appointed to the new position of director of research and development for National Semiconductor division of Hoffman Electronics Corp.

Dr. Prince comes to National Semiconductor from Bell Laboratories where he has done developmental work on silicon devices including solar energy converters and power rectifiers. Prior to joining

Bell in 1951, he was research assistant at the research laboratory of electronics at MIT.

Canadian RETMA Elects President

JOHN D. CAMPBELL was elected president of RETMA of Canada.

He is general manager of the consumer products group of the Canadian Westinghouse Co. in Hamilton, Ont. He joined the company in 1934, working on time study and methods engineering. In 1937 he moved into the consumer products sales department, first in Hamilton and, in 1939, in Toronto.

He was appointed manager of the appliance and electronic division in 1951 and later was made general manager of the consumer products group.

Canadian RETMA has 118 member-companies.

Fisher Plans To Build In California

PLAN for a new firm in Sunnyvale, Calif., that will manufacture electronic aviation equipment was revealed when a 21 acre plant site was purchased by Gerhard R. Fisher.

Dr. Fisher, president of Fisher Research Laboratory, of Palo Alto, Calif., said he is organizing a new company, unnamed as yet, to manufacture direction finders, radio equipment and other navigational aids and test gear.

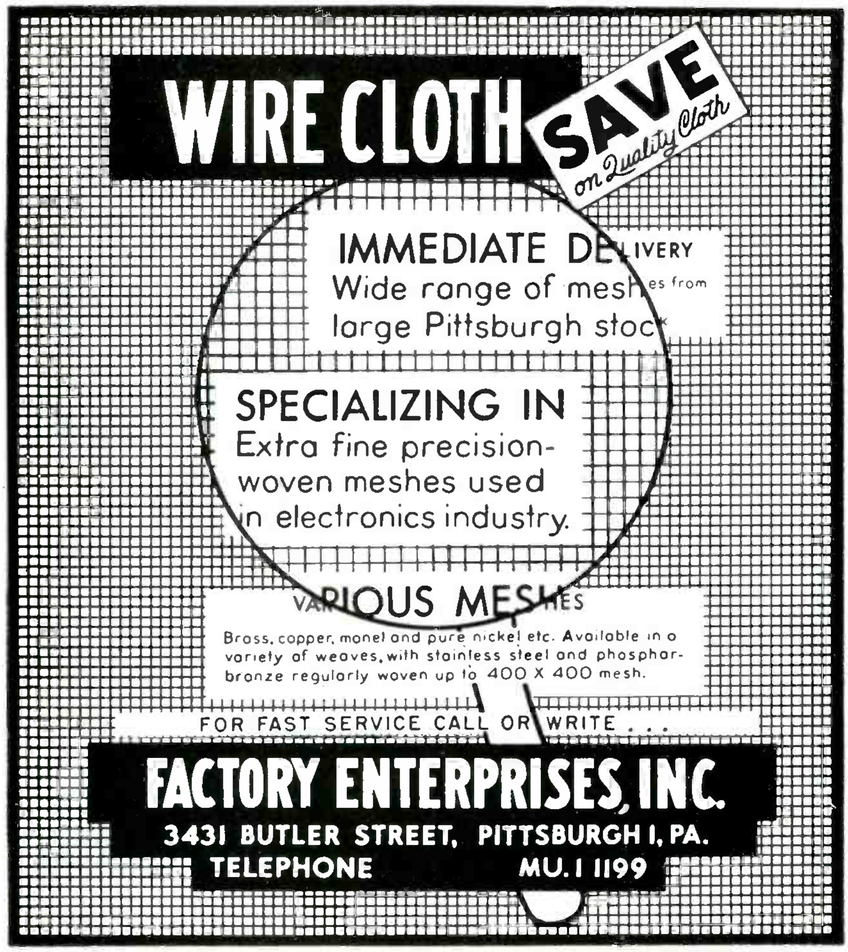
Construction of a \$1 million plant will get under way by end of this year, and it is to be in operation by February.

Prospective customers for Fisher will be the Lockheed missile facility and the General Motors assembly plant to be built in Sunnyvale.

Fisher's Palo Alto firm manufactures electronic equipment in the geophysical field.

Weston Laboratories Moves To New Plant

WESTON LABORATORIES has moved its operations from Harvard, Mass., to Bolton, Mass. The new plant comprises a 10,000 sq ft



building on a forty-seven acre tract. The former building in Harvard, Mass., has now been leased to the Civil Defense Administration.

Westinghouse Elects Four Vice-Presidents

FOUR executives of Westinghouse have been elected vice-presidents of the company.

They are:

Frank W. Godsey, Jr., 16 years with the firm and the manager since 1951 of the electronics x-ray and air arm divisions, all in Baltimore, Md. He will continue to direct these divisions.

A. M. Kennedy, Jr., 15 years with the company. He will continue to administer the purchases and traffic department from the company's headquarters.

F. M. Sloan, 24 years with the firm, and the general manager of the lamp division since 1953. He will continue to direct the lamp division.

W. Waits Smith, for three years the manager of the company's aviation gas turbine division at Kansas City, Mo., which he will continue to direct.

Godsey joined the Westinghouse new products department in 1940 and was named manager of that department in 1945. In 1951 he was placed in charge of the electronics and x-ray divisions at Baltimore and soon after the air arm division.

Alto Scientific Names Engineers

STANLEY J. FRONT has been appointed mechanical engineer for Alto Scientific Co. Palo Alto, Calif. electronic design and manufacturing firm.

He has served as aircraft and automobile engine designer for Vickers, Ltd., and heavy equipment designer with Northwest Engineering Co. and Skagit Steel & Iron Works. Most recently he was chief development engineer for the Willamette Iron & Steel Co. in Portland, Oregon.

The company also announced that two new engineers, David A. Geddes

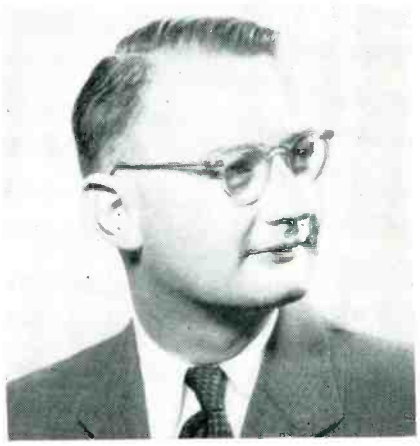
Want more information? Use post card on last page.

and John W. Witcosky, have joined the engineering staff.

Geddes was formerly associated with the Washington Institute of Technology and a West Coast electronics instrument firm. For the past 5 years he has been engaged in developing carrier frequency and low frequency equipment.

Witcosky was formerly with Beckman Instruments, Stanford Research Institute and Lynch Carrier Systems.

Melpar Appoints Chief Engineer



Robert S. Butts

ROBERT S. BUTTS has been appointed chief engineer of Melpar, of Falls Church, Va. He joined the firm in 1947 as a senior engineer. In prior assignments, he was engaged in the design and development of subminiaturized equipment for piloted aircraft and guided missiles.

Emerson Reorganizes Operating Structure

OPERATING structure of Emerson Radio and Phonograph Corp. has been changed from a horizontal to a vertical basis, with the establishment of autonomous divisions, the radio-television-phonograph division and the government contracts division.

Dorman D. Israel, executive vice-president and a member of the board of directors, will head the radio-television-phonograph division. Morton P. Rome, vice-president in charge of government contracts, will head the government contracts division. The management of existing subsidiaries, Quiet Heet Manufacturing Corp., manufacturer of air conditioners and oil burners, Jefferson-Travis, manufacturer of cabinets, and Plastimold Corp., custom moulder of plastics, will remain unchanged.

Perfection Mica Opens Indiana Plant

A NEW PLANT was opened in Rochester, Indiana by magnetic shield division of Perfection Mica Co. of Chicago. The 15,000 sq ft plant has new modern equipment for manufacturing magnetic shielding material designed to attenuate both high and low magnetic fields. The firm's Chicago plant will continue to produce shielding as well as "K" gauged mica.

Transistor Applications Formed In Boston

A NEW COMPANY, Transistor Applications Co., has been formed in Boston, Mass. for the research, development and production of transistorized products only.

Seymour Schwartz, formerly staff member of Lincoln Laboratory and transistor engineering consultant, is president and general manager.

Operations of the new company include research, development and pre-production on miniaturization and transistorization of both military and commercial equipment. The company also conducts evaluations of transistor circuits and devices.

Mack Steps Further Into Electronics

MACK ELECTRONICS, a new division of Mack Trucks, Inc., has been formed and will be located in Boston, Mass. It will supplement the facilities of the present electronics operation located at the Mack plant in Plainfield, N. J.

All phases of engineering will be under the direction of Paul Travers, formerly chief engineer at Ultrasonic Corp. and, before that, with the Servomechanisms Laboratory of MIT. Glenn H. Roundy, also formerly connected with Ultrasonic Corp. as vice-president, will direct sales.

Mack acquired, in 1955, two electronic companies, White Industries and Radio Sonic Corp., now known as Mack electronics division.

Production of military and commercial electronic equipment will be continued at the Mack plant in Plainfield, N. J., under the directon of Robert Edwards, recently appointed manager.

Electro Engineering Names Halloran

JAMES J. HALLORAN has been elected secretary-treasurer of Electro Engineering Works in San Leandro, Calif. He is also vice-president in charge of engineering for the firm. He replaces Alex W. Fry, who has moved to New York and a new field.

Halloran has been a member of the executive staff of the company for the past six years.

Sell Heads AMF Electronics

WENDELL B. SELL has been appointed general manager of the electronics division of American Machine & Foundry Co.

He formerly was project engineer with the pilotless aircraft di-


Wendell B. Sell

vision of Boeing Aircraft for two years. Prior to joining Boeing, he was a member of the anti-aircraft and guided missile board, Fort Bliss, Texas from 1950 to 1954.

In 1947 he worked in the Applied

Physics Laboratory at Johns Hopkins on guided missiles, and in 1948 at the Ballistics Research Laboratory, Aberdeen, Maryland on large-scale digital computers.

Dr. Sell served as chief of the radar branch, G-3 Section, Army Ground Forces, where he established a graduate level training program for military personnel in electronics and radar.

Lockheed Speeds Missile Plant

LOCKHEED AIRCRAFT broke ground for its missile systems division's new Sunnyvale, Calif. plant to be completed by mid-1957.

The division has decided to keep its present Van Nuys, Calif. plant open and to build the additional facilities on the 275-acre Sunnyvale site sooner than it had previously expected.

The building program calls for construction of four separate buildings with a total floor space of more than one quarter of a million sq ft.

This includes a 48,000 sq ft administration building; a 96,000 sq ft manufacturing building; a 96,000 sq ft engineering building and a 20,000 sq ft cafeteria.

The manufacturing building's factory area is designed to incorporate high-speed precision machinery and specialized shops for rapid production line operations. The engineering building will house such functions as general engineering offices and engineering test laboratories.

Utah Radio Buys Electronics Division

THE electronics division of Utah Radio Products Co. has been sold to the Utah Radio Products Corp. of Huntington, Ind., a locally organized company that plans to continue operations without interruption. The division produces radio and tv loudspeakers and other electrical and electronic assemblies.

Frank L. Pyle, vice-president in charge of Utah's electronics division for the past seven years, heads the new company as president.

Work in process has been trans-

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ferred to the new corporation and operations are to continue without change.

Northeastern Elects Two Directors

JOHN E. MOSSMAN and O. P. Harwood have been elected members of the board of directors of Northeastern Engineering of Manchester, N. H.

John Mossman is president of Monitor Controller of Rockland, Mass. and Ashdee Products of Homewood, Ill.

Harwood has been identified with the aviation industry for 40 years. He was regional administrator of the Civil Aeronautics Administration from 1929 to 1945.

Sperry Expands, Names Engineers

SPERRY GYROSCOPE CO. plans to build a West Coast research facility, the Sunnyvale Development Center, in Sunnyvale, Calif. Operations are scheduled to begin this summer.

Advanced research and development projects of the western group will be in the specific fields of radar, fire control, servomechanism and guided missile systems. This work will be under the direction of the main engineering division of Sperry Gyroscope Co. and L. L. Wheeler, chief engineer at Lake Success.

E. B. Hammond, former engineering head for Airborne Weapon Systems, will be manager of the new center.

Immediate plans are limited to two 10,000 sq ft buildings.

Under present plans, the Sunnyvale group will initiate development work on new weapons systems and carry these projects to completion of workable production designs based on thoroughly-tested prototypes. Manufacture of equipment will be performed at established Sperry manufacturing facilities.

► **Research**—Sperry also organized a new microwave electronics division.

Manager of the new division is Eugene J. Venaglia who formerly directed Sperry's surface armament engineering department. He joined the firm in 1942 as a research laboratory technician.

Eugene J. Venaglia

The new division will employ more than 800 persons, including 200 engineers. It will supply weapon support systems, test equipment, antennas, and precision components requiring specialized engineering and production techniques. The division will also reorganize and expand operations for additional instrumentation and standards for advanced research laboratories, special radar systems, and target simulators, computers, and evaluators.

▶ **Ford**—The Ford Instrument Co., division of Sperry Rand Corp announced that Charles R. Burrows, director of Cornell University's school of electrical engineering, will join the firm in July. He will become vice-president for engineering, heading all engineering, development and research.

Dr. Burrows has been associate chief scientist of GE's advanced electronics center. During World War II, he was chairman of the radio wave propagation committee of the National Research & Development Council, coordinating all research work in this field affecting the war effort.

Gamewell Selects Chief Engineer

THE GAMEWELL CO. of Newton Upper Falls, Mass. appointed Edward S. Ruth chief engineer, replacing Frank R. Bridges, who has resigned from the firm.

Ruth joined Gamewell in 1954. For many years he was director of research, engineering and development for Edwards Co. in Norwalk, Conn.

Electromation Buys Cado Manufacturing

ELECTROMATION Co. of Burbank, Calif. purchased the patents, tooling inventory, corporate structure and name of the Cado Manufacturing Co. of Santa Monica, microwave manufacturers.

Donald H. Lanctot, vice-president and chief engineer of Cado, will continue in the same capacity under the new ownership. Formerly with RCA Victor as a project engineer in the radar development field, he later was affiliated with Transco Products Corp., as project engineer in development of microwave and associated products.

Raytheon Adds Space For Military Output

RAYTHEON exercised its option to lease with a further option to buy, the Shawsheen Mill properties in Andover, Mass. from Textron.

By the move, the firm acquired more than a million sq ft of manufacturing, office and warehouse space.

Raytheon will use its new facilities to produce military equipment it is now developing for the Army Ordnance Corps.

Textron is to vacate the mill, built in 1923, in June. Conversion of the mill for electronics production will be started as soon as possible after that.

The firm contemplates a buildup during the first year of occupancy, to about 1,000 employees. During the next five years, employment at Shawsheen could rise to as much as 6,000 provided necessary government contracts, presently planned for, are secured.

Feedback Controls Appoints Heuchling

FEEDBACK CONTROLS appointed T. P. Heuchling as chief engineer. He was formerly section head for analog computers and controls at Ultrasonic Corp. and a project engineer at the M.I.T. servomechanisms laboratory.

Clifton Precision Promotes Hayes

Arnold E. Hayes

ARNOLD E. HAYES has been elected secretary and appointed general manager of Clifton Precision Products. Hayes has been with the Clifton Heights, Pa. firm for the past four years in the position of chief applications and service engineer.

Previously he was a technical advisor, aeronautical division of Minneapolis-Honeywell and with the National Bureau of Standards in Washington, D. C. as a gyro engineer. During World War II, he was with Bendix Aviation engaged in the design and manufacture of aircraft instruments.

Burr-Brown Research Company Formed

A NEW ELECTRONICS FIRM, the Burr-Brown Research Corp., has been formed by R. Page Burr and Thomas R. Brown, Jr.

Burr was formerly a supervising engineer in the research department of the Hazeltine Corp. where he was responsible for development work in television transmitting and receiving apparatus. He has made contributions to the development of color television.

Brown has been an instructor in electronics and treasurer and board member of a residential development corporation in Tucson, Arizona.

The new firm will specialize in the design, development and manufacture of transistorized electronic circuits and equipment. It will be active in the New York area near Cold Spring Harbor, Long Island,

R. Page Burr

and in the Southwest at Tucson. Burr will be responsible for the technical operations and Brown will supervise the business activities of the organization.

Mueller Joins Packard-Bell

GEORGE J. MUELLER has been appointed chief engineer for the technical products division of the Packard-Bell Co. He will have a major role in guiding the firm in its national defense work and more specifically in the projected expansion of its guided missile program.

Dr. Mueller most recently headed

George J. Mueller

the test support department of the guided missile research division of the Ramo-Wooldridge Corp.

For 15 years he worked in various capacities at the Army's Picatinny Arsenal in Dover, N. J.

In 1950, he left the Arsenal to become supervisory physicist at the Air Force Missile Test Center in Florida.

In 1952 he began work on the development of operational test equipment for the Navy Bureau of Aeronautics' guided missile program as technical director of the Allen B. DuMont Laboratories' project.

Completing the project in 1953, he became an engineering and physics consultant for two years.

Concord Control Starts Operations

A NEW COMPANY, Concord Control, of Cambridge, Mass. has been formed to develop and manufacture numerical control equipment for machine tools and industrial processes. The firm's staff includes engineers who played a part in the development of numerically controlled machine tools at the M.I.T. servomechanisms laboratory. Newly-elected officers of the company are James O. McDonough,

Left to right, H. P. Grossimon, J. O. McDonough, R. W. Lawrie

president; Herbert P. Grossimon, vice-president in charge of engineering and Richard W. Lawrie, vice-president in charge of sales. Other officers are Robert H. Gregory, comptroller and treasurer and

Charles M. Ganson, clerk of the corporation.

McDonough had been project engineer for the numerical control projects at M.I.T. since 1951.

Marchant Research Promotes Martin

WILLIAM L. MARTIN, for the past ten months director of engineering of Marchant Research in Oakland, Calif., has been appointed vice-president of the firm.

The firm authorized a broadening of the Marchant Research program

William L. Martin

to include development of most of the major types of equipment required in a complete electronic data processing system for business applications. Martin will direct and supervise all of the research and engineering development work.

Underwood Names Top Engineers

JOHN H. HOWARD has been named director of research and engineering for Underwood Corp. and Albert A. Auerbach was appointed chief engineer of the electronic computer division.

Howard will also direct the business machine company's development activities. He will have complete responsibility for research and development of typewriters and other business machines as well as integrated data processing equipment and electronic computers.

Before joining Underwood, Howard was manager of engineering

John H. Howard

services for the Burroughs Corp.

He was director of development for Engineering Research Associates, project engineer for the Sperry Gyroscope Co. and later spent a year in private engineering practice as a consultant.

Auerbach has been associated with the company as a project engineer since Underwood acquired the Electronic Computer Corp., of Brooklyn, in 1952.

Previously he had been with the advanced development section of RCA at Camden, N. J., and with the Eckert Mauchly Computer Corp. of Philadelphia, as project engineer.

Hycon Plans New Plant

HYCON MFG. CO. of Pasadena, Calif., will move into new plant facilities in La Verne, Calif., before the end of the year.

Trevor Gardner was elected president following the resignation of Alden E. Acker as president and a member of the board. Gardner, former Assistant Secretary of the Air Force, will continue to serve as chairman of the board and chief executive officer of Hycon. Robert G. Taylor, secretary of the company, was elected to the board post vacated by Acker.

Hycon will start construction of the building within six weeks. The company is investing more than $1,250,000 in buildings and facilities. The 136,000-sq ft facilities will house the main manufacturing operations and executive offices. Some subsidiary and division operations will continue in Pasadena.

Want more information? Use post card on last page.

New Books

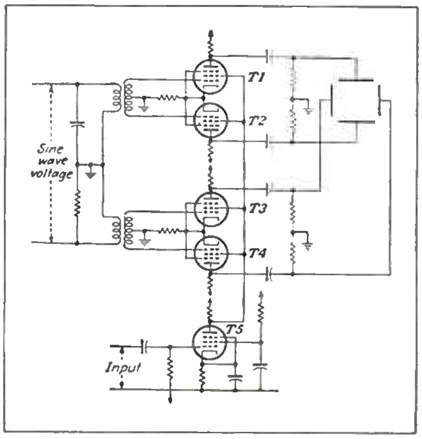
Electronic Engineering

By Samuel Seely
McGraw-Hill Book Co., New York, 1956, 525 *p*, $8.00

This book deals with the application of electron tubes and transistors in nonradio circuits. "Electronic Engineering" and a companion volume "Radio Electronics" (now in press) constitute a revision and extension of the material in Professor Seely's book "Electron-Tube Circuits" published in 1950. By leaving the treatment of radio circuitry to a separate volume, the author has been able to enlarge his treatment of such subjects as feedback in amplifiers and electronic computing circuits, and to add a short section on cathode-ray tubes and two chapters on solid-state theory and on transistors as circuit elements. As much as a third of this book is new material; the rest is unchanged from the earlier text, although there is some rearrangement in presentation.

▶ **Circuits**—The book is apparently intended for use as a text in a college course covering electronic circuits not classified as radio circuits. The analysis of various types of circuits is carefully developed, and there are numerous problems designed to supplement and emphasize the text. The material covered includes characteristics of electron tubes, basic amplifier principles, untuned amplifiers, oscillators, relaxation circuits, sweep generators, rectifiers, regulated power supplies, electronic instruments and transistor circuitry.

The new material on solid-state physics and transistors is covered in fifty pages. The electron theory of metals and the rectification and amplification effects in semiconductors are discussed by energy-level diagrams. The small-signal theory of transistors is treated in terms of four-terminal-network theory and various types of transistor circuitry are shown. A brief discussion of the duality of the electron-tube and the transistor is



A circular—sweep generation circuit

included. The treatment is as comprehensive as can be expected in the space allotted and should afford a useful introduction to this branch of electron devices.

▶ **Errors**—There were few errors noted in examining this work, but two misstatements have been carried over from the previous book that the reviewer as a tube engineer dislikes to see perpetuated. On p 25, a variable-mu tube is not so called because the mutual conductance changes with bias, as the text states, but because the mu-factor varies markedly with control-grid bias. On p 387, vacuum diodes used as rectifiers in capacitor-input filters are not insensitive to excess peak currents as the text states; but may readily be damaged by arcing when peak-current ratings are exceeded, particularly when oxide-coated cathodes are used.

The choice of the title for this work is a little confusing. Is the object to set up "electronic engineering" as a term applicable only to nonradio electronics? One notes the same implication in the title of Professor Terman's new book "Electronic and Radio Engineering". Although it is unfortunate that there is no generally accepted name for nonradio electronics, any move to restrict the meaning of "electronic engineering" to only part of its present general meaning is surely to be deplored. If such a limited meaning were adopted, we should then be faced with the problem of devising an appropriate name to cover both radio and nonradio electronics.

This textbook should prove to be useful in a college curriculum that allows sufficient time for a course on the circuits of nonradio electronics and for a companion course in radio electronics. The division of the subject matter is of necessity somewhat arbitrary and a balanced training will require both courses. The book is primarily for undergraduate study, and is not suitable as a reference book for the practicing engineer.—T. J. HENRY, *Radio Corporation of America, Tube Division, Harrison, N. J.*

Color TV Servicing

BY WALTER H. BUCHSBAUM
Prentice-Hall, Inc., New York, 258 p, $6.35

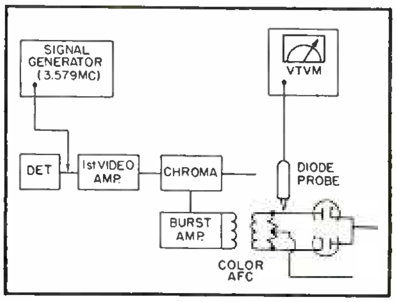
THIS book is of little interest to the engineer since it is directed at the tv serviceman. The most significant contribution of this book is a series of color plates illustrating the effect of maladjustments and internal troubles as they appear on the color picture-tube face. Other than this it is doubtful if the typical serviceman will find it as useful as some other recent texts on this subject.

The book begins with a brief comparison of monochrome and color tv. The second chapter sets forth the principles of colorimentry, including color plates of a color diagram and color triangle. The makeup of color tv signals is described in Chapter 3 which also attempts to explain the principles of vectors.

A color-tv transmitting-receiving system is explained, using block diagrams, in Chapter 4; Chapter 5 describes the construction and operation of three-gun tv color picture tubes, but omits any mention of the single-gun Lawrence tube which in some ways is substantially superior and may become a competitor.

Deflection circuits unique to color

picture tubes are covered in Chapter 6, and again in Chapter 11. A detailed block diagram and description of color tv receiver circuits are presented in Chapter 7 and expanded in the following four chapters.



Color afc adjustment

Installation is covered briefly in Chapter 12 while alignment and back-of-the-set color adjustments are described in the next three chapters. The final four chapters are concerned with troubleshooting, and it is in this section that the color pictures of the tube face are included. Some different troubles illustrated by color pictures contained in recent other texts do not appear here.—J. R. McDermott, *Product Engineering, N. Y.*

Electronique Industrielle

By G. Goudet
Eyrolles, Paris, 1955, 635 *p*

This text book has been written primarily to provide students in electrical engineering with a modern and basic knowledge of that part of electronics which is progressively invading all fields of industry. This book is, however, well adapted to a wider class of readers.

In the theoretical part, the accent has been placed on the development of sound and modern concepts that will lead to a better understanding of modern electronic theories: electronic structure of the solid state, ionization of gas, application of quantum mechanics to the theory of conductors, semiconductors and dielectrics, circuit theory, electron optics etc. The mathematics used in the book are at the level of graduate work in any kind of engineering. The Fourier series, Fourier transform and Laplace transform are briefly but clearly presented.

▶ **Tube Applications**—The theoretical part occupies two thirds of the book and the other third is devoted to applications: cathode-ray tubes, electron microscope, mass spectrometer, induction heating, photoelectric cells, ultrasonic waves, and servomechanisms.

In those applications there is no emphasis on components or equipments. In each case, the author is primarily concerned with the necessary relations between theory and engineering practice. The possibilities and limitations of each technique are thoroughly investigated.

As a result of this approach, the engineers can become acquainted with the determining factors which should help him to make his own decisions concerning the choice of available tools for particular applications.

▶ **Format**—The book is divided into six sections, each section containing from 3 to 6 chapters according to the importance of the subject.

In the first chapter of the first section, the advantages of the rationalized MKS system of units, which is exclusively used in the book, are clearly presented in relation to the other systems of units. The other chapters of the first section are devoted entirely to the theory of circuits and transmission lines.

The second section deals with electron tubes, electronic theory of the solid state and the ionization of gas.

The third section serves to acquaint the reader with the theory and technique of amplification, including the amplifier stability and noise theory.

The fourth section pertains to production and detection of oscillations.

The fifth section includes the principles of electron optics and their application to cathode-ray tubes, the electron microscope, electron diffractor and mass spectrometer.

The last section presents in six chapters the industrial applications mentioned above: induction heating, photocells, ultrasonics and servomechanisms.

The author's pertinent commentaries concerning each subject make interesting reading and serve to stimulate the reader to further investigation among the 185 references listed in the bibliography—J. B. LAIR, *Federal Telecommunication Labs., Nutley, New Jersey*

Thumbnail Reviews

Hi-Fi Loudspeakers and Enclosures. Abraham B. Cohen. John F. Rider Publisher, New York, 1956, 368 p, $4.60. Written for the hi-fi enthusiast and audio technician, this book explains basic loudspeaker principles, multispeaker design and cross-over networks. Baffles and enclosures of all types are discussed with build-it-yourself data given.

Introduction to Color Television. Milton Kaufman and Harry E. Thomas. John F. Rider Publisher, New York, 1956, 160 p, $2.70 (paper). Presents fundamentals of color for television and the NTSC color television system. Tricolor picture tubes described include the CBS aperture-mask color tube, the RCA three-gun shadow mask tube and the single-gun Chromatron or Lawrence tube. General design for color television receivers is discussed. Important circuits are illustrated schematically.

An Active Filter. G. K. Jenssen and J. E. McGeogh. Office of Technical Services, Washington, D. C., 1955, 10 p, $0.50 (paper). Discusses filter with 0.01-cps passband. Filter consists of phase detector, low-pass filter, reactance tube, local oscillator and polylock feedback loop.

The Transosonde — A New Meteorological Data-Gathering System. Albert D. Anderson, Henry J. Mastenbrook and Henry D. Cubbage. Office of Technical Services, Washington, D. C., 1955, 21 p, $0.75 (paper). Describes transoceanic sondes used to gather weather data. Concept is based on use of controlled altitude balloons by the Japanese during World War II.

Thermal Power From Nuclear Reactors. A. Stanley Thompson and Oliver E. Rodgers. John Wiley & Sons, New York, 1956, 229 p, $7.25. Discusses the use of nuclear reactors in the production of thermal power. Subjects treated include nuclear considerations, reactor equations and kinetics, shielding problems, and thermal power cycles.

Radio Philatelia. Herbert Rosen. Audio-Master Corp., New York, 1956, $2. Information for the collector on postage stamps dealing with radio and electronics.

Peaceful Uses of Atomic Energy, Vol. II. Columbia University Press, New York, 1956, 471 p, $8. Second volume of the proceedings of the International Conference held in Geneva in August 1955 discusses research reactors. Some of the United States papers describe instrumentation used in control reactor operations. The paper on the Brookhaven reactor gives a detailed description of electronic instrumentation.

Spheroidal Wave Functions. J. A. Stratton, P. M. Morse, L. J. Chew, J. D. C. Little and F. J. Corbato. John Wiley & Sons, New York, 1956, 613 p, $12.50. Mathematical tables prepared on Whirlwind I at MIT make it possible for the electrical engineer and physicist to handle wave problems in spheroidal coordinates.

Alternating-Current Circuit Theory. Myril Reed. Harper & Brothers, New York, 1956, 587 p, $6.50. Undergraduate textbook on alternating-current theory deals with sine waves, circuit elements, parallel and series circuit, Fourier series, transients, mesh and node systems and transmission lines and filters. The material in this edition includes elementary topology, matrix algebra and the *m*-derived approach to filter design.

Germanium Diodes. S. D. Boon. Elsevier Press, Inc., Houston, Texas, 92 p, $1.95 (paper). Covers characteristics and behavior and circuit applications of germanium diodes of the signal rectifier type. The specific diodes described are manufactured by Phillips.

The Economic Almanac, 1956. Prepared by the research staff of the National Industrial Conference Board, Thomas Y. Crowell Co., New York, 1956, 688 p, $3.95. Brings together data often needed on current economic problems. The 1956 revision contains new information on saving and liquid assets of individuals, federal, state and local finance, stock ownership and additional information about Canada. It covers statistics on electronic engineering salaries, operating ratios of communications equipment firms, production, sales, employment, earnings, output per man hour, tax payments, installment credit, stock ownership, of radio, tv and broadcasting segments of the electronics industry.

Legal Problems in Engineering. Melvin Nord. John Wiley & Sons, New York, 1956, 391 p, $7.50. Elementary textbook on civil law aimed specifically at the professional engineer, covering basic legal concepts, also specific subjects such as engineering ethics, professional registration, controls and specifications, government regulations, patents, copyrights and trademarks, and air and stream pollution.

Backtalk

Gravity Hypothesis

Dear Sirs:

As another curbstone physicist I was prompted by Mr. Littell's letter and your footnote (ELECTRONICS, p 500, March 1956) to consider again the nature of gravity.

Mr. Littell's extension of the expanding universe to the subatomic is to me a new concept. Macroscopically, an expanding universe or at least galactic system is ponderable: an expanding photon, neutron or void? Void forsooth! Still, why not an expanding photon, for it is just as much a source of our packet of electromagnetic wave energy as it is a corpuscle.

We shall have to wrestle again and again with Mr. Littell's hypotheses, as apparently he has.

Anent your own conjecture it seems to me that there would be wide variations in the gravitational constant, g, particularly at antipodal loci. How test it?

If at long intervals standard gravity were measured simultaneously at the McGraw-Hill Building, at a few hundred miles off the coast of Western Australia and at other analogous points, should there not be indications of the "combination—of forces from outer space"? Parenthetically, all three measurements can be made conveniently by overseas telephone calls.

Presently my view is that g may be the resultant of all forces within neutron, atom, molecule, planet or nebula.

Anyway, curbstone Manhattan Project might get to the bottom or perhaps center of the matter.

C. H. Tewksbury
N. J. Bell Telephone Company
Bridgeton, N. J.

More Shoddy Gear

Dear Sirs:

You recently ran editorials supplicating more engineers with a conscience! One can only hope that the industry throughout the U.S.A. will take these pleas seriously.

We have purchased three medium-power broadcast transmitters from the U.S.A. over the past ten years, two of them quite recently. It is discouraging to note the degradation of quality, especially in the little details. These are all of a first-line manufacturer from whom one could, years back, order a new model sight unseen.

Now one gets equipment which has never been set up on test and actually run under load on frequency. A prototype has apparently been built and checked on a single frequency for a short time. Then production takes over and the subchasses are shipped to the field.

In overseas territories, at least, station personnel with notable exceptions are not as skilled nor as well paid as in the States. Nor are they always fitted to cope with subtleties of design errors such as parasitic oscillations, harmonic filter deficiencies that let through spurious radiations to the detriment of other services, quasiparasitics in class B stages, developing only after audio components begin to deteriorate. These things the factory designers should have cleaned up.

Nor is it any less disconcerting to find cold soldered joints, omission of lockwashers or two of same to every nut, rusty steel washers on 100-ampere circuit breakers, transformers design of which has been farmed out to subcontractors of dubious reputation.

Nor is the trouble confined to standard broadcasting equipment. Many airlines in these countries have turned to building their own ground communications equipments as the only solution. They are tired of high-priced factory-built transmitters having failed due to the use of a ½-watt resistor in a circuit where a 10-watt oversized unit would have eliminated the trouble forever. So, they build their own, not as pretty construction perhaps, but more reliable.

One's inevitable reaction to this trend of U.S.A. engineers content to ride the present boom of high salaries and dollars of easy morality and dubious permanent value, is, in

self defense, to look towards Europe for merchandise. We are now buying there at 25-percent higher prices. The equipment is not so laden with latest gadgetry but they do take time to solder the joints and use heavier gage metal. Back home we *still* need engineers with a conscience!

R. H. AXTELL
Chief Engineer
Radio Continente
Caracas, Venezuela

Another Rental Plan

DEAR SIRS:

UPON glancing through the March 1956 issue of ELECTRONICS, I noticed an article regarding the rental of equipment in the *Backtalk* section, p 500.

Polarad has had an equipment rental plan for sometime, and it is satisfactory both to us (the manufacturer), and to the customer.

ALFRED A. GOLDBERG
Polarad Electronics Corp.
Long Island City, New York

Editor's Note: We are glad to pass the word along, hope that others who rent equipment will advise us.

Human Resistance

DEAR SIRS:

I RESPECTFULLY call your attention to a statement on page 153 of the March issue of ELECTRONICS, under your "Reminder" paragraph, which can conceivably be misinterpreted in a dangerous fashion.

You state, "On the average, man is a 0.25-megohm, one-watt resistor". You then continue to give data relevant to current values that are perceptible, "freezing", and fatal. The values of currents stated are those generally accepted, and are conservative.

However, the statement concerning the average resistance of man is quite misleading, in that this value holds true *only* at *low voltage*, with measurements taken on an ordinary "ohm-meter".

If one were to use the average figure of 0.25 megohm, and the 1-milliampere figure, one would conclude that, using Ohm's Law, the voltage necessary for shock perception is 250 volts. We know from experience that such a voltage is extremely hazardous, and most conditions can be fatal if the power-carrying leads are firmly seized.

Further, if one were to employ the same formula with the 10-ma-ampere "let go" figure that you give, one would conclude that at 2,500 volts one would merely "freeze" to the power lines. You may be well aware of the fact that electric chairs employed at Sing Sing and other prisons operate from 2,200 volts so that the 10-ma figure in conjunction with the 0.25-megohm data is dangerously misleading.

The error is your use of the phrase "on the average". What average is being referred to? The average to be found when employing an ordinary ohm-meter? I should imagine that your phrase "the average" should refer to the condition that would exist if a person should get across an "average" type of power source, namely, household lines, stepped-up voltage sources in electronic equipment, etc. Under these circumstances, the skin resistance, which, when dry, (an average condition) constitutes the main component of the 0.25-megohm value quoted, breaks down under the voltage applied, and becomes very low.

In an excellent article by Prof. Dalziel of the University of California, it is shown that the "average" resistance that should be used for "average" computation of hazards is closer to 500 ohms. Under these circumstances, the empirically established value of 50 volts as being conceivably fatal is more accurately determined. . .

We agree that "engineers are already in short supply" and we therefore recommend that statistics concerning safety be issued and interpreted only by experts in the field, who specialize in high voltage, and who devoted time to the analysis of high-voltage problems and the minimizing of high-voltage hazards.

VICTOR WOUK
Engineering Director
Beta Electric Corp.
New York City, N. Y.

Punched Tape, Not Magnetic

DEAR SIRS:

WE enjoyed the article by Mr. Findlay on page 122 of the February 1956 issue of ELECTRONICS concern-

PROFESSIONAL SERVICES

Consulting—Patents—Design—Development—Measurement
in
Radio, Audio, Industrial Electronic Appliances

ing electronic controls for machine tools.

This article gave an excellent summary of the automatic control problem and a good outline of the methods currently available for application to machine tool control.

One item mentioned in this article has caused some confusion and embarrassment with Bendix customers.

In Table 1 on page 124, you indicate that Bendix has under development for Martin Aviation Corporation a magnetic tape, phase modulation, machine control unit.

The system we are developing for The Martin Company uses a punched plastic tape and works in a manner similar to the procedure outlined for the Bendix Cam Milling Machine as described in Mr. Findlay's article.

The Martin Company is procuring from Bendix a Numerically Controlled Milling Machine System under an Air Force prime contract. Bendix has spent considerable time and effort in selling this punched tape system and the indication in the article has created confusion both with the Air Force and with The Martin Company.

W. A. MARA

Director
Bendix Aviation Corp.
Detroit, Michigan

Editor's Note: We regret the error in the table, but hope that the description of the punched tape equipment in the text helped.

Electronic Printing

DEAR SIRS:

WITH reference to your comments on electronic printing, on page 20 of the April 1956 issue of ELECTRONICS, I thought that you might be interested in basic patents No. 2, 409, 454 and 2,549, 546.

You will notice that these patents contemplate direct printing as a result of electronic or particle bombardment. I have done some experimental work and believe that this method of making reproductions is definitely possible but much development work needs to be done.

A. G. THOMAS

Industrial Controls Corp.
Chattanooga, Tennessee

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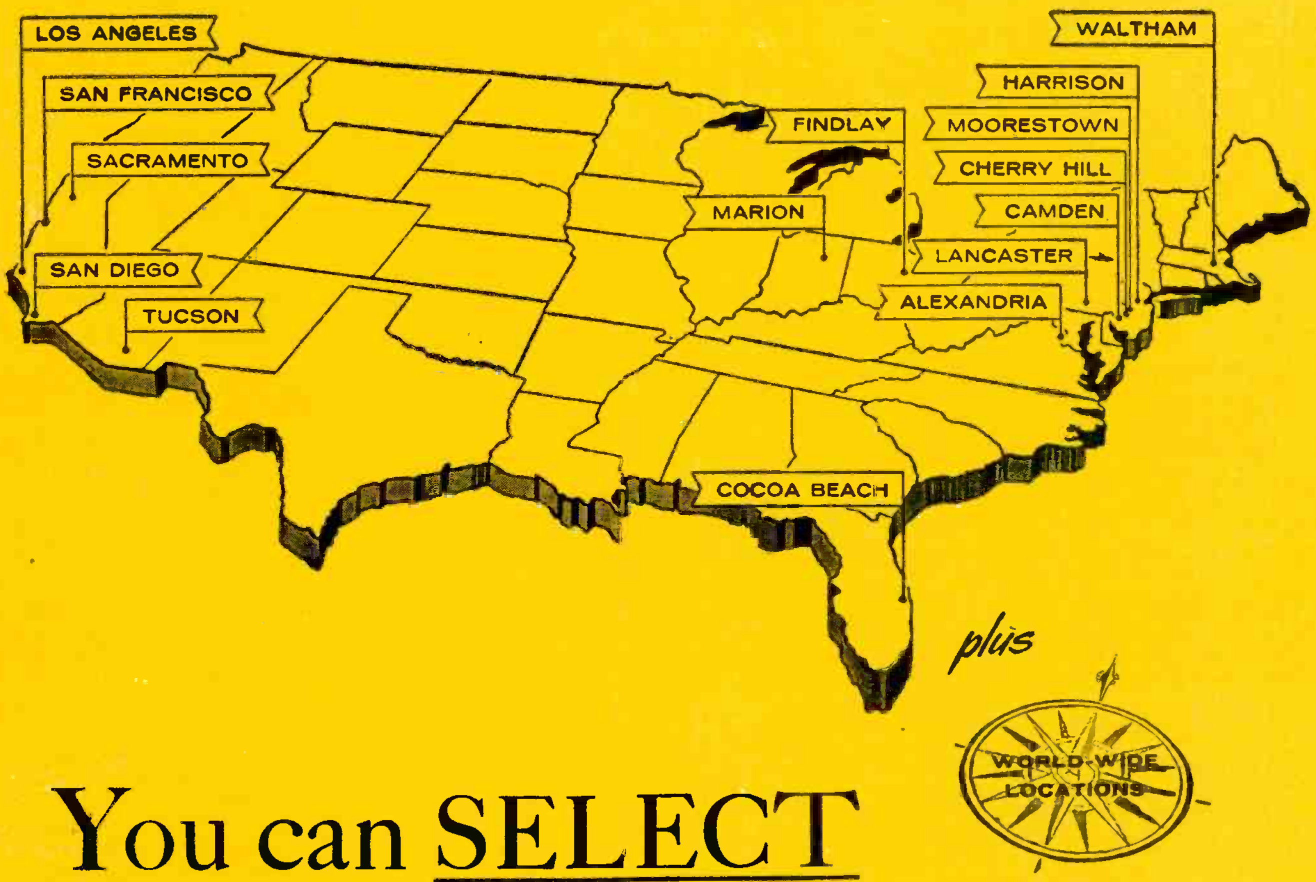

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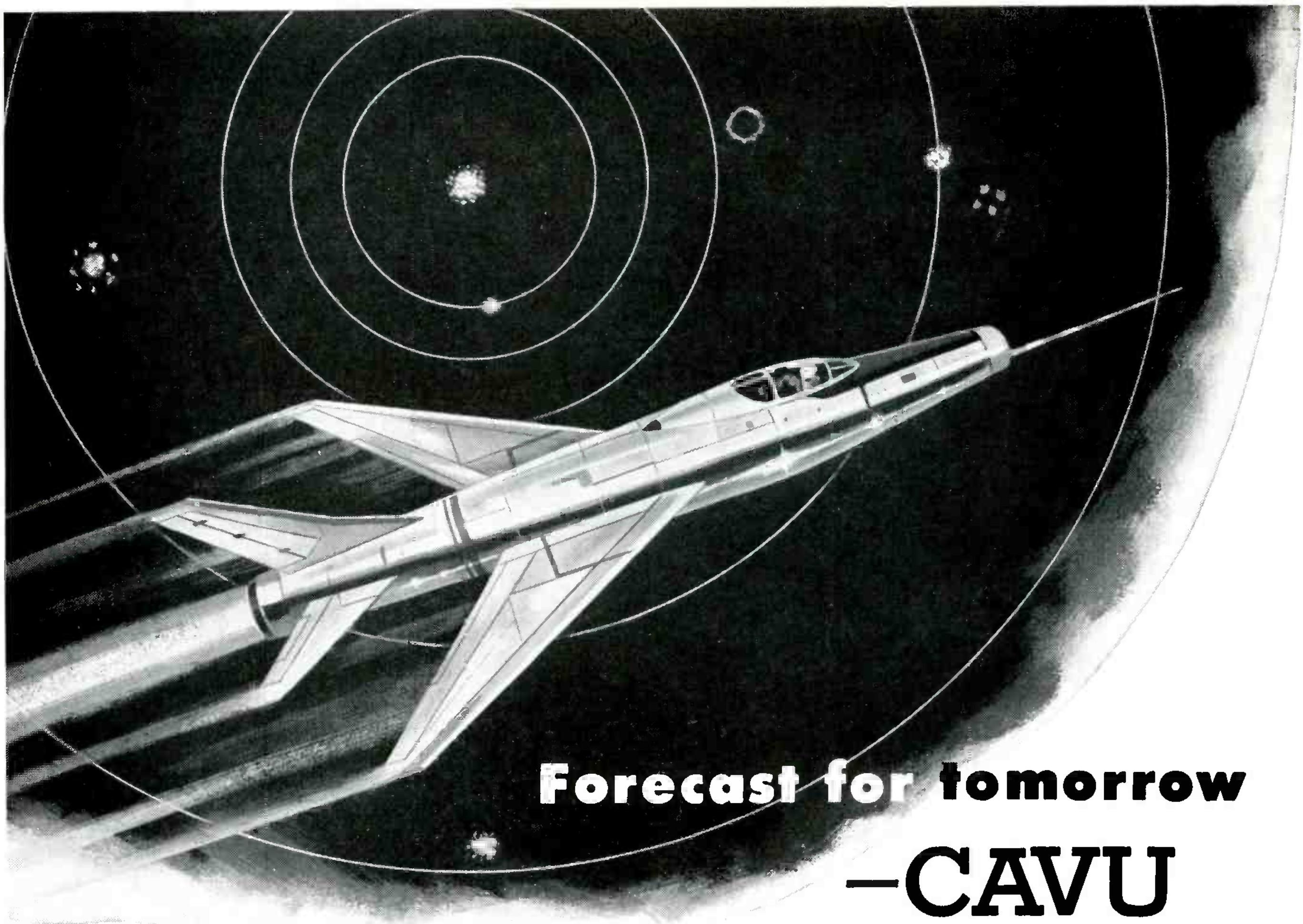

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For here is a place where you can grow. Here, your imagination and ingenuity will provide the raw materials for transforming your ideas into realities that pay off. And to help put your ideas to work, we have the most modern facilities available, including one of the largest computer laboratories in the world. At Goodyear Aircraft, every idea is a prime commodity and is given a chance to mature.

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This is only one ... the reasons why most of
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stay...wire the wife to start packing...
knowing she will love the living part of it.

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The attached clipping will give you a brief
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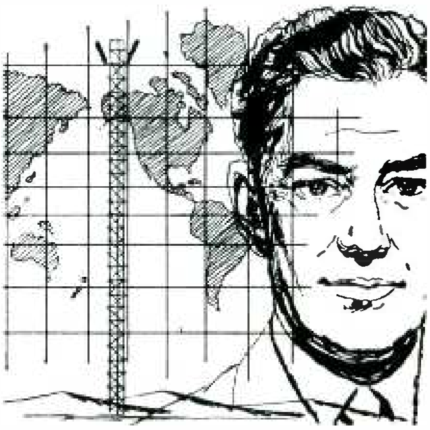
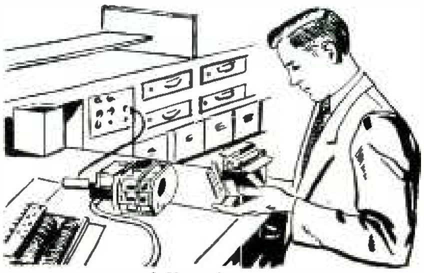
do you see...
the over-all picture...



or just the details?



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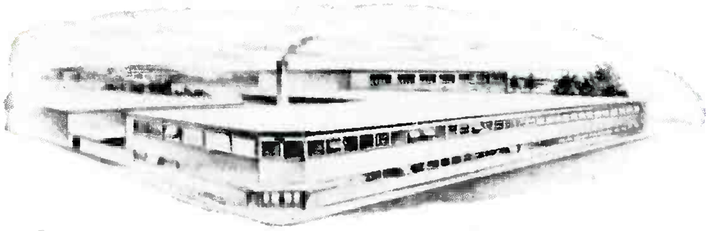

Today Transitron employs over 750 people in a modern plant of 65,000 square feet at Melrose, Massachusetts.

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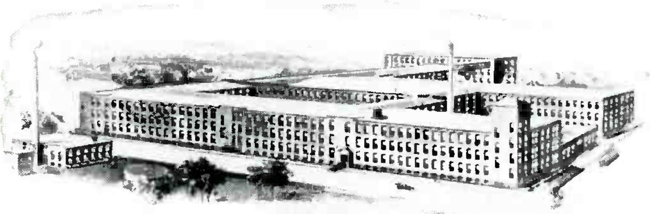

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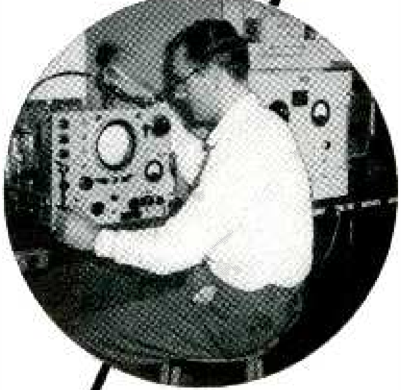

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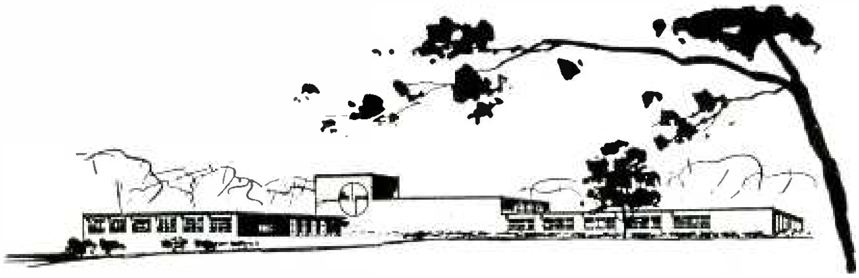

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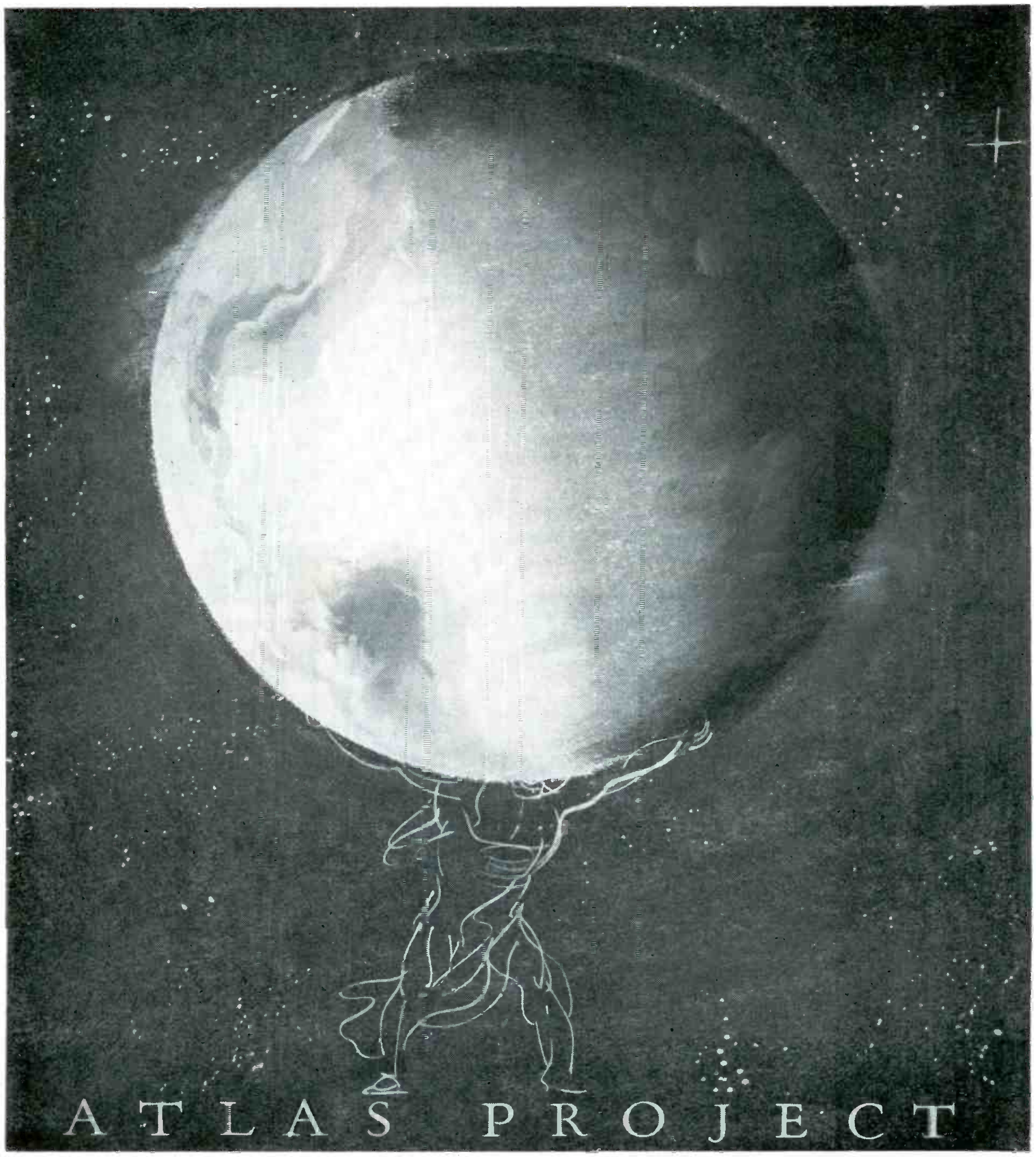

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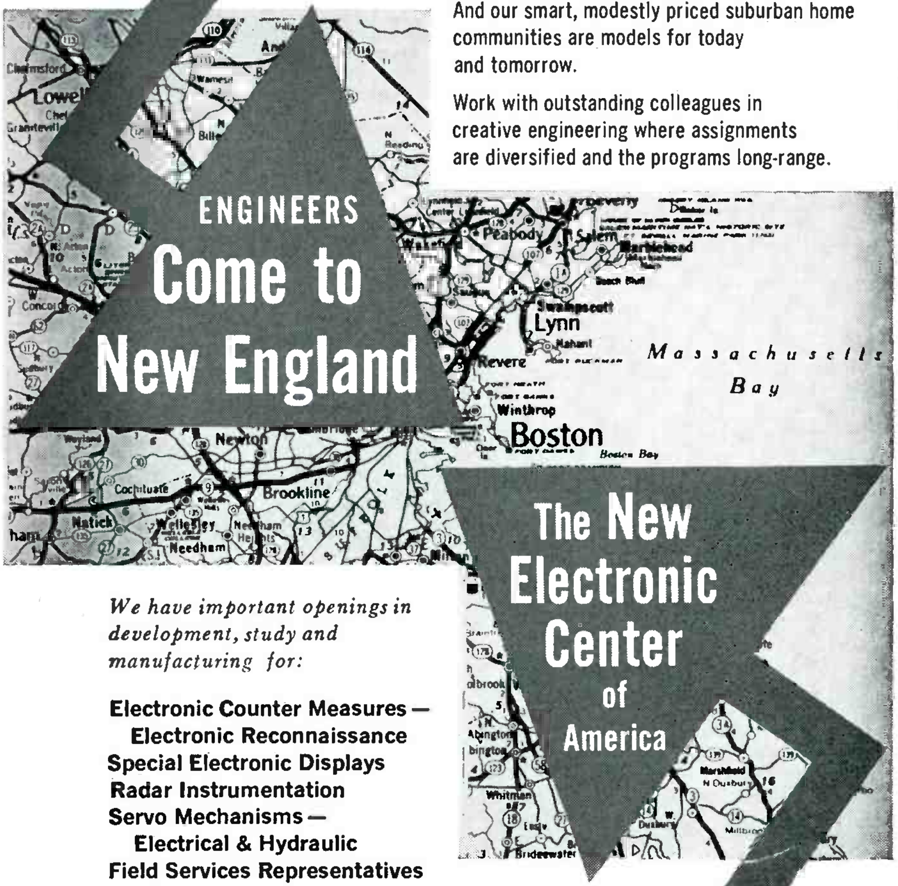

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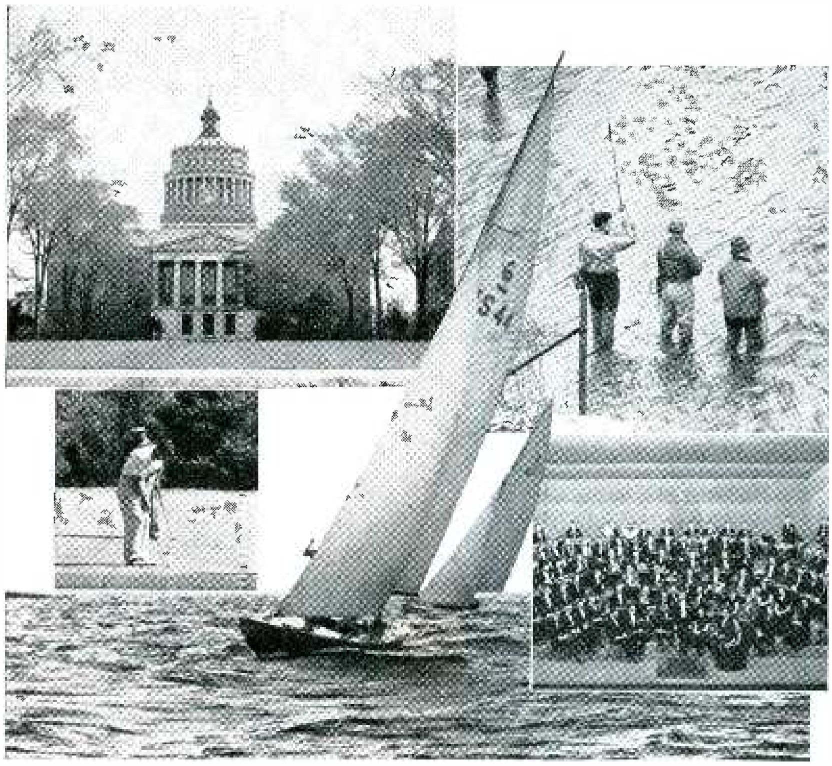

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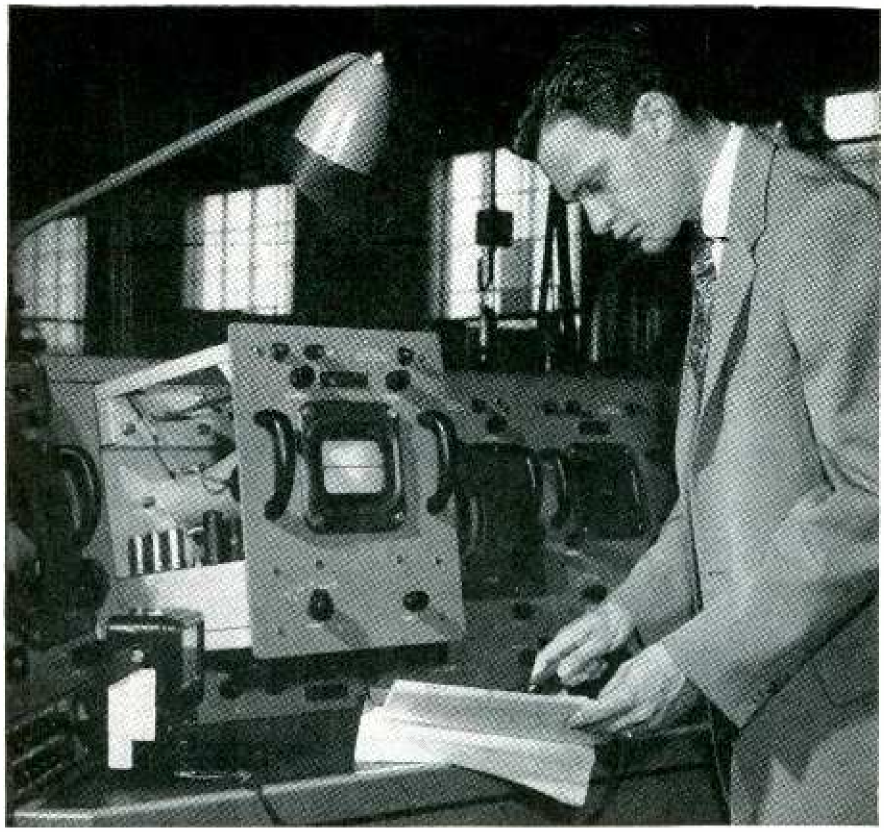

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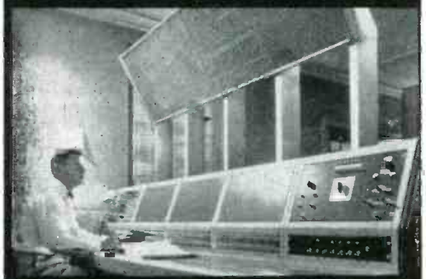
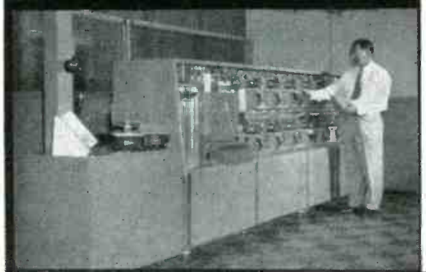
ERMA

electronic recording machine accounting





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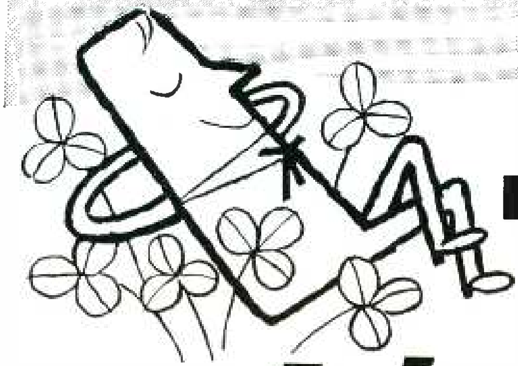

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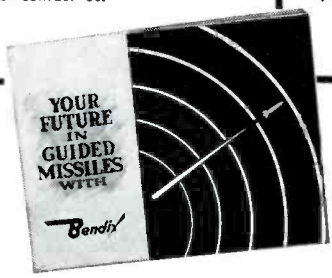

At Bendix Products Division—Missiles Section, qualified engineers have the advantages of a compact, hard-hitting organization backed by all the resources of the nation-wide Bendix Aviation Corporation. If you can accept a challenge, want an opportunity to grow with a rapidly expanding technical business, and can accept the responsibilities that go with opportunity, I would like to hear from you personally—W. L. Webb, General Manager, BENDIX PRODUCTS DIVISION—MISSILES, 403A, Bendix Drive, South Bend, Indiana.

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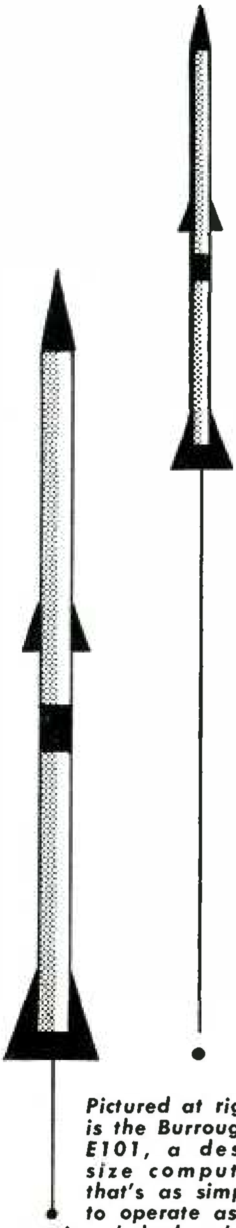

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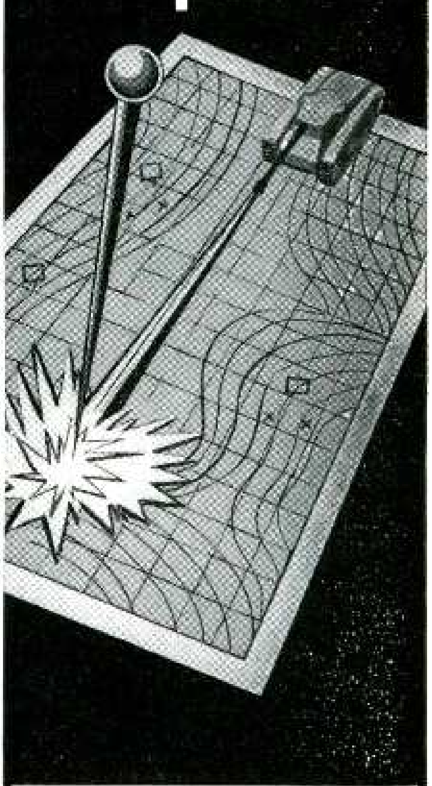

This field experiment by the Combat Operations Research Group involved time required for armor to locate and bring under fire anti-tank gun emplacements before being themselves hit . . . a typical example of vital problems challenging Technical Operations scientists at CORG.

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Chief Engineer, Instrument Division

Tracerlab Keleket

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It was good to hear from you and learn that you might be interested in changing jobs.

You mentioned that you had a few offers and were "sort of shopping around". If that's what you're doing Ken, very frankly, we're not interested.

Let's not kid ourselves. Although there are plenty of jobs around, good ones are still hard to find. The really important factors that make for job satisfaction, can't be found everywhere. Sure, the "ads" all talk about opportunity, challenge, frontiers to conquer, special benefits, etc., etc., but...

If you're sincere about a career opportunity, we want you to consider the possibility of joining Tracerlab. Ours is one company (I'm sure there are others) where the atmosphere is right. We're a first-name, shirt-sleeve company. We're not chained by tradition or by static thinkers. If you have an idea, and it's a good one, you'll see it as a finished product.

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Just a word about openings, Ken. We have only a few (not hundreds), and they're important ones. Most critical is our need for a Senior Electronic Engineer to supervise a small development group, working on some pretty complex electronic systems. To back him up, we'd like to find a couple of top-flight Engineers with some background in pulse techniques. A Mechanical Engineer to work as a consultant on all mechanical problems will round out the team.

That's it! Let me know what you think, and pass the word along to any good men you might know.

Best Regards,

Fred

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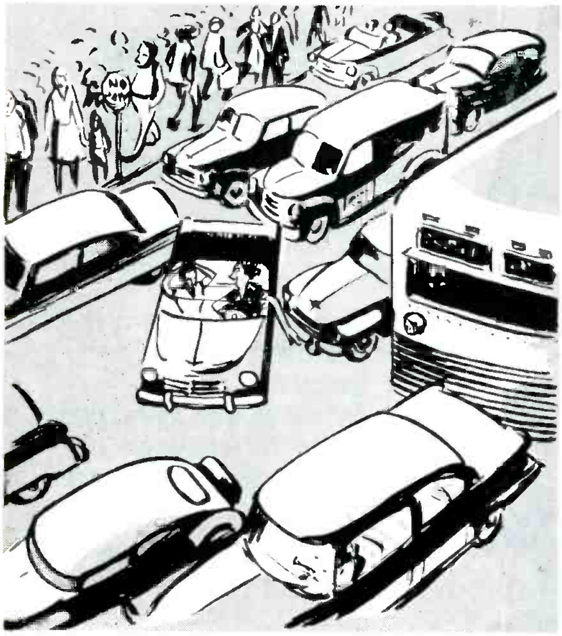

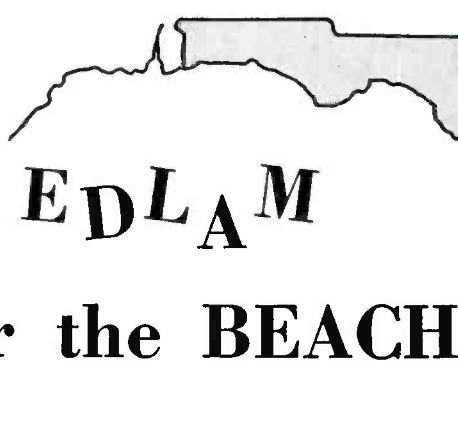

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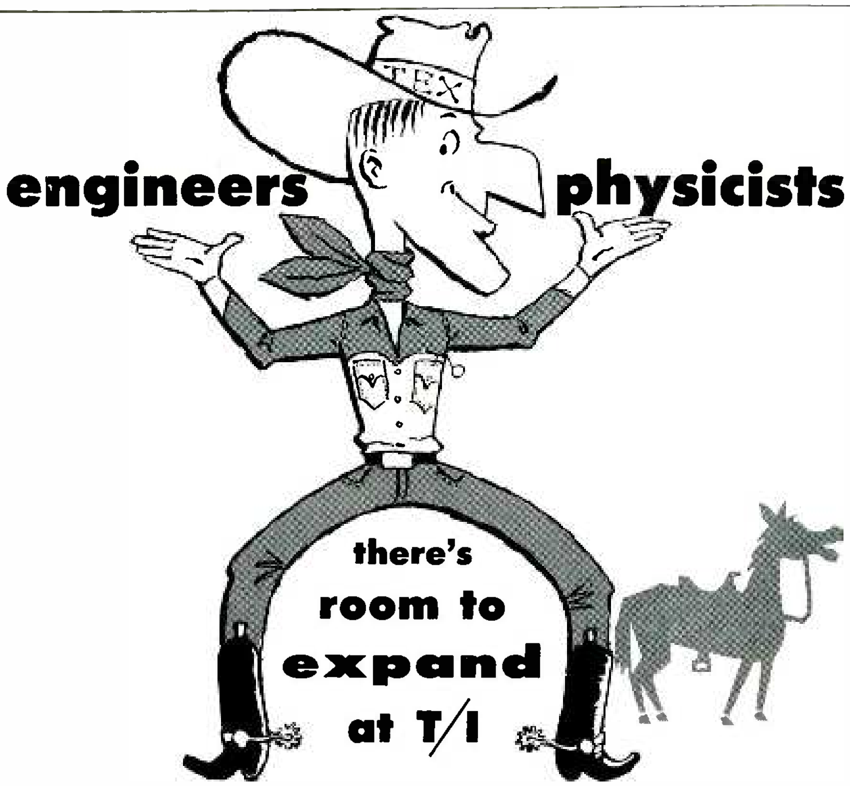

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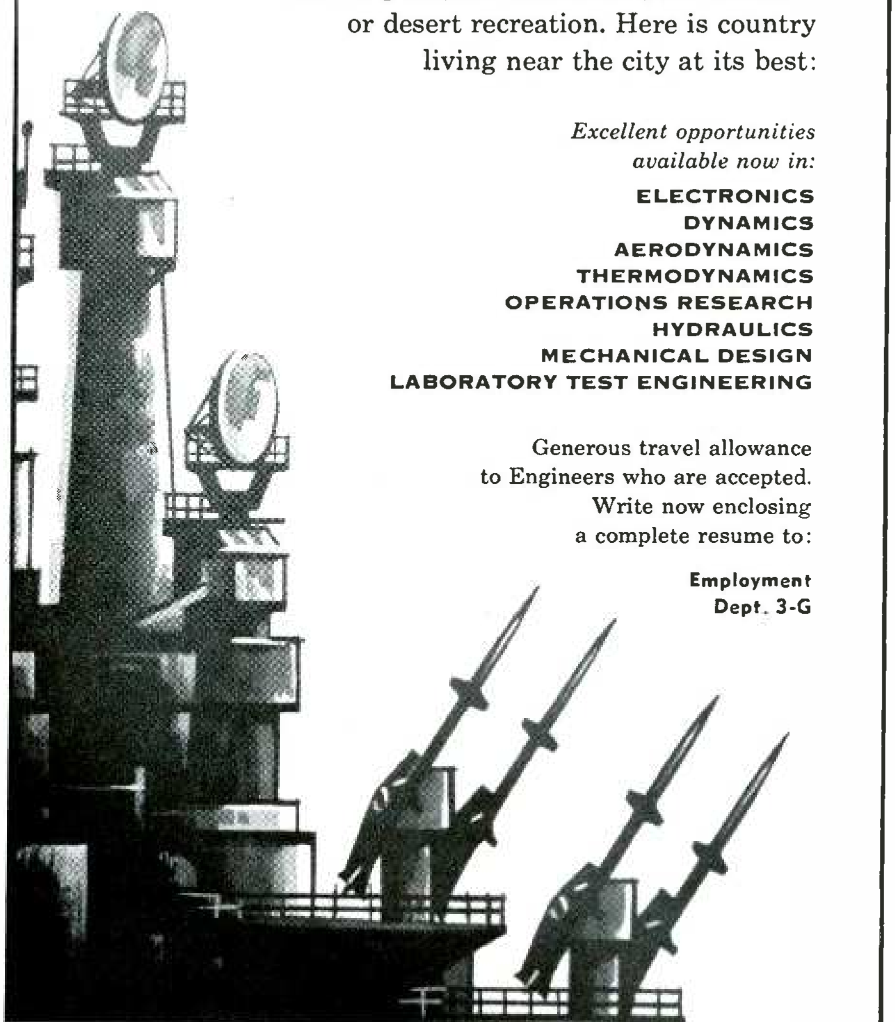

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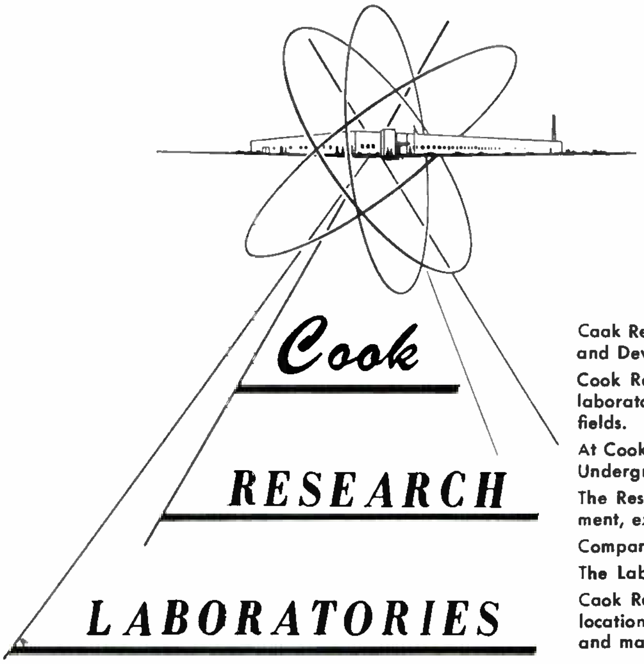

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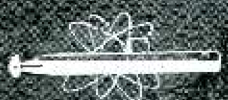

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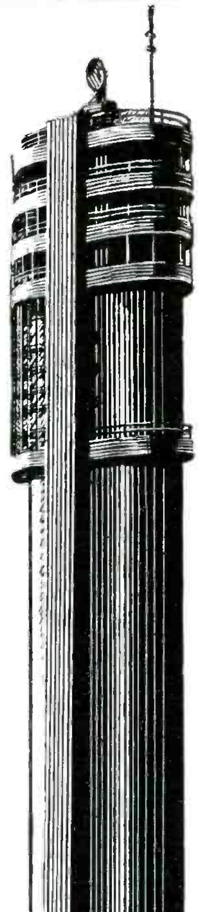

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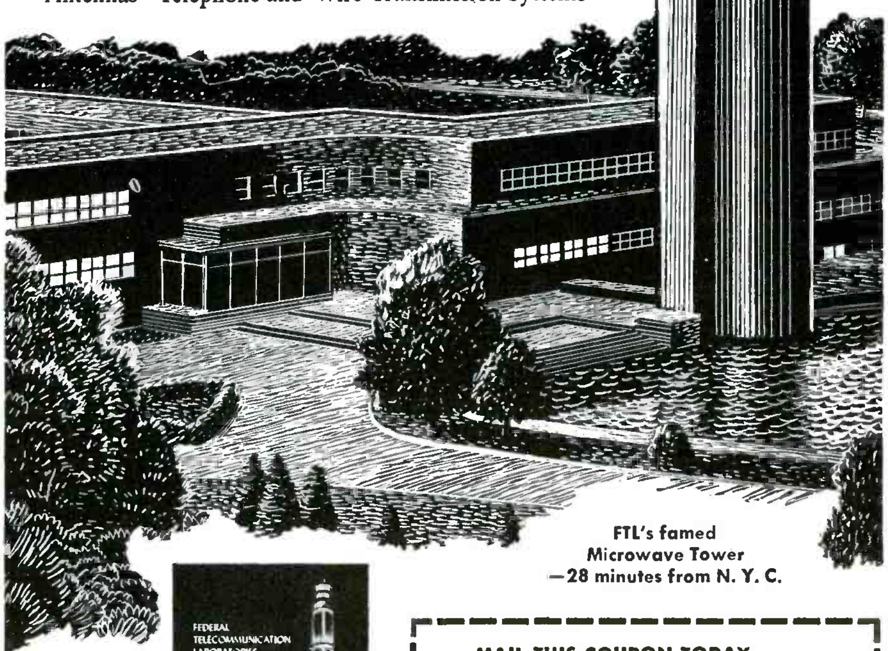

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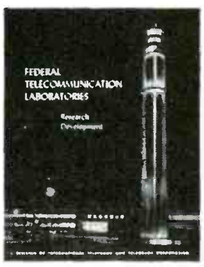

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— Radar Guidance & Fire Control Systems
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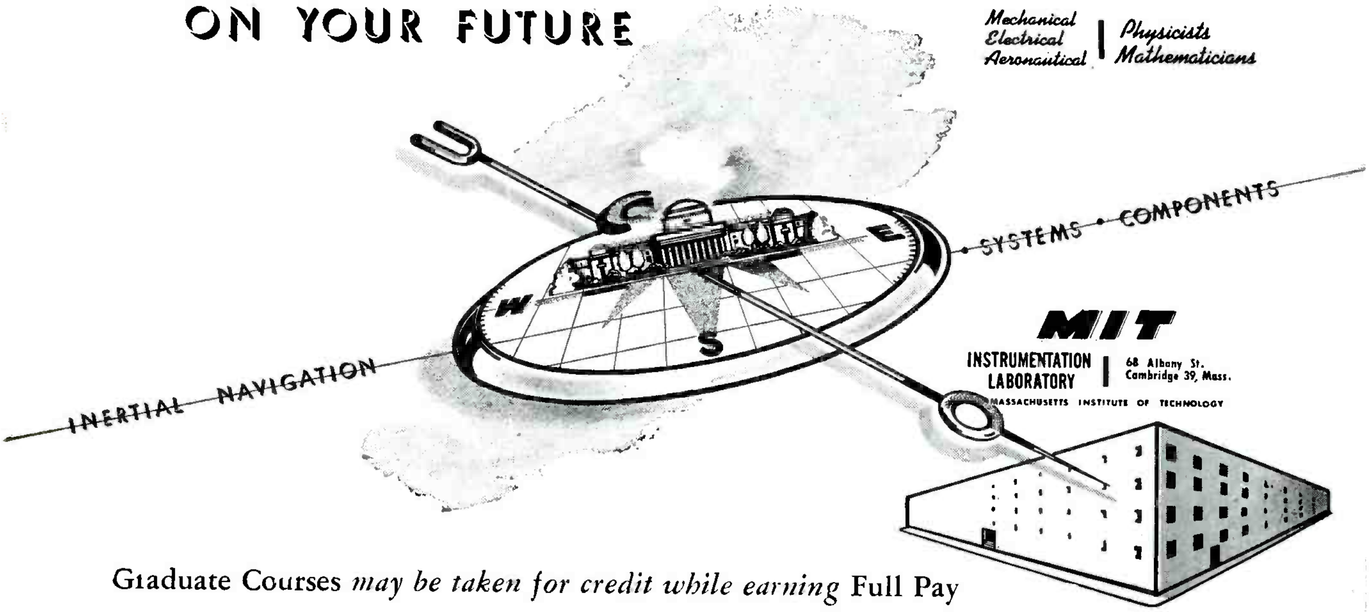

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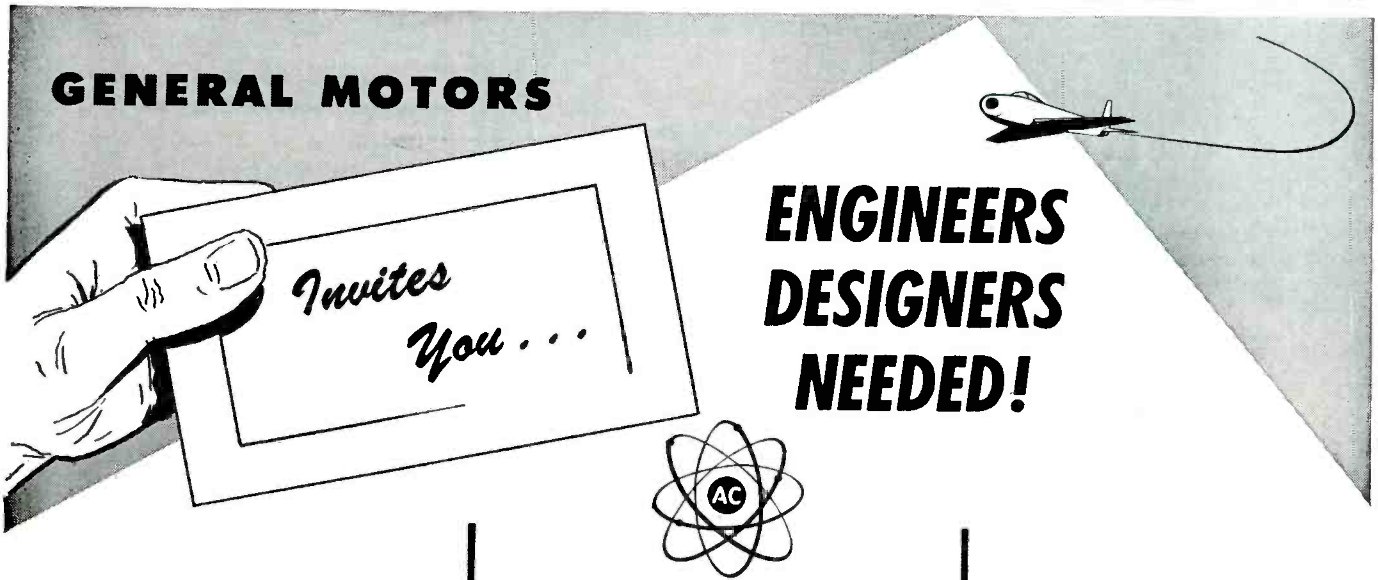

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Both with E.E. or M.E. degrees from recognized institutions.

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- Midwest location.

Salary open.

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(Continued on pages 418-428)

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Wanted Advertisements

on page 426

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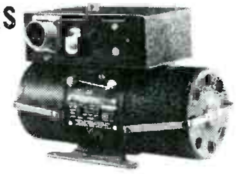

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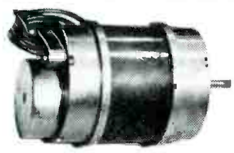

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C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm	3.00
7100-B-PM Hansen 24 VDC 160 rpm	7.50
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COMPONENTS OF AN/GRC
EQUIPMENT

Radalab Inc.

87-17 124TH ST. RICHMOND HILL 18, NEW YORK, N. Y.

Phone Virginia 9-8181-2-3
TWX-NY-4-4361

SCR-508

10 Channel FM Receiver and Transmitter. Frequency Range 20-27.9 mc. Receiver is manually tuned, transmitter is crystal controlled. Consists of 2 BC-603 Receivers, BC-604 Transmitter, FT-237 mount. Box 89 xtals BC-606 Control, A-62 Phantom Ant., Headsets, mike, and antenna. Input 12v. D.C. SCR-608 also available.

SCR-291A GROUND AUTOMATIC DIRECTION FINDER

1.5-30 mc. automatic direction finder. This equipment used to take bearings on transmitters. Complete equipment available comprising the following: BC-1147A Rec., PN 31, Power Panel, BC-1159, automatic bearing goniometer. RC-223 antenna system consisting of 5 masts with legs, MC-412, MC-413 phase inverters calibrating transmitter. 110 v 60 cyc.

SCR—536 HANDI-TALKIE

Freq. range 3.7-5.5mc crystal controlled battery operated handitalkie. The range of this equipment is approximately 2 miles. We can supply these sets to your specified freq. Completely reconditioned and guaranteed. Large quantity available.

REMOTE P.P.I. REPEATER INDICATORS

VD-7" P.P.I. Upright Mount.
VE-7" P.P.I. Table Mount.
VF-5" B Scope 5" P.P.I. Upright.
VG-24" Plotting Table P.P.I. Repeater. This unit just installed in new air control center at Idlewild Airport, N. Y. Very Elaborate System.
VJ-12" P.P.I. Upright Mount.
VK-12" P.P.I. Upright Mount.
VL-12" P.P.I. Upright Mount.

RADIO TELETYPE TERMINALS

AN/SGC-1 Very Compact. Late Model.
AN/CV-60/URR All Miniaturized. Late Model.
FRA, FRR, FRF.
AN/FGC-1.

SCR-682-A SEARCH AND WEATHER RADAR

Technical Specifications:
1—Operating freq.—3000 mc.-10CM.
2—Power output—225kw.
3—Pulse width—1 micro second.
4—ranges—500-240,000 yds. in four ranges. 10,000 yds, 40,000 yds, 160,000 yds, and 240,000 yds.
5—360 scan.
6—azimuth accuracy 1°.
7—7" P.P.I. indicator
8—Antenna beam width 1°. Parabolic.
9—110v 60 cyc power input.

AN/ASQ-1 AIRBORNE MAGNETOMETER

This is an airborne chart recording magnetometer. The set consists of an amplifier, oscillator, detector head, chart profile recorder, power supply. The equipment has a sensitivity of 2 gamma. The AN/ASQ-1 records on an Esterline ANgus recorder disturbance in the earth's magnetic field caused by an ore deposit or a sunken boat or submarine. An indicator is provided that gives a bearing on a magnetic disturbance. Input is 28v DC. Weight about 130 lbs.

AN/APN-3-AN/CPN-2 SHORAN

The AN/APN-3 and AN-CPN-2 are airborne and ground. Precision distance measuring installations. This equipment operates on 225 mc. The range is 250 miles with an accuracy of 25 feet. This is the most accurate distance measuring equipment built to date. The AN-APN-3 used with the K-1 computer (also available) will permit taking a photograph up to 250 miles from the CPN-2 beacons completely automatically. The AN-APN-3 can be fed into the aircraft auto pilot to fly it to the drop point. This equipment is very widely used by geological survey companies for oil prospecting and mapping. Power input is 110v 400cyc and 28v DC. COMPLETE SETS AND SPARES ARE AVAIL.

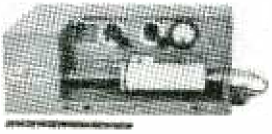
AN/APR-4

38-4000 mc precision receiver consists of receiver and five tuning units to cover the full range. Each tuning unit is calibrated directly in mc. Input 115v-60 cyc.

AN/APG-3 AIRBORNE GUN LAYING AND AIR SEARCH RADAR

This is a late X-band airborne search and gun laying automatic tracking radar. The set uses an antenna mounted to scan forward to search for aircraft and to provide gun fire presentation. The set consists of an indicator with a 5" B and C scope for radar operator, and a 3" indicator for the pilot for gun firing, a control stick firing grip, antenna. RF unit modulator, servos amplifier, radar central, etc. A modification of this set is the AN/APG-33 which is used in the F-89 and F-94 jet interceptors. Complete sets available. POR

RC-120 FACSIMILE TRANSCEIVERS



This is a page printing facsimile set using either direct or photographic recording paper. The set will send and receive a 7" x 7½" page of printed matter or a picture in 7 minutes on a radio or wire circuit. This equip. is completely portable. The set will operate from 6v DC or 110v 60 cyc. POR

SCR-399-499

Mobile and fixed station high power radio sets: the SCR-39 is mounted in a HO-17 shelter. The SCR-499 is transported in carrying cases to be set up for operation. Freq. of the sets is 2-18mc. pwr output is 350w. Phone and C.W. 2 communication receivers are provided. Input is 110v 60 cyc. POR

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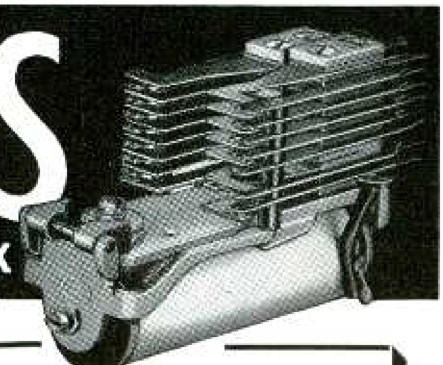

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TN-1/APR-1 TUNING UNIT
Receives and converts 38-80 MC RF to 30 MC IF. Requires only 250 V. B+ and 6.3 VAC for heaters. Hand calibrated tuning chart. Originally used for radar countermeasures, receiver, but also ideal for noise and spectrum analyses. Brand new in storage case, with carton of spare tubes and other parts. A terrific value at only **$24.50**

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115 V., 50-800 cy. power supply. In freq. meter section, crystal oscillator beats VFO. Osc. section puts out sine or pulse modulated RF. With tubes, headset, cords, adapters, radiators, etc. and INSTRUCTION BOOK.
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3C27	1.00
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3E29	8.50
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4B31	20.00
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275A 3.50
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348A 4.95
350A 3.00
350R 2.75
355A 15.00
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359A 1.75
371B/VT166 ..... .90
373A 3.00
374A 4.00
387A 4.00
391A 3.50
394A 2.50
356A/2C51 ..... 3.00
403A (WE-6AK5) 1.25
403B/5591 ..... 2.75
404A/5847 ..... 12.50

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450-TH
(Surp)
$47.50
★★★★★★★★★

410R/2K30 ..... 95.00
416A 36.70
416B/6280 ..... 50.00
417A (Klystron) 2.75
417A/5842 ..... 12.50
418A 16.00
420A/5755 ..... 5.25
421A/5998 ..... 7.00
422A 10.00
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559 ..... .50
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UE577 ..... 22.00
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GL673 ..... 13.00
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705A ..... .85
CK707 ..... 1.15
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707B 4.00
708A 2.00
709A 1.75
715B 3.00
717A ..... .35
719A 11.00
721A ..... .75
723A/B 7.85
726B 20.00
726C 20.00
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803 ..... 2.00
805 ..... 5.00
806 ..... 7.50
807 ..... 1.20
807W/5933 ..... 2.85
809 ..... 2.25
811 ..... 3.00
815 ..... 1.50
816 ..... 1.00
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927 ..... 1.50
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932 ..... 1.75
SN947/5640 ..... 6.50
958A ..... .35
CK-1007 ..... .75
CK1026 ..... 2.35
CK-1301 ..... 1.75

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750-TL
(Surp)
$50.00
★★★★★★★★★

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1680 ..... 2.50
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5963 ..... 1.50
5965 ..... 1.60
5977A 4.50
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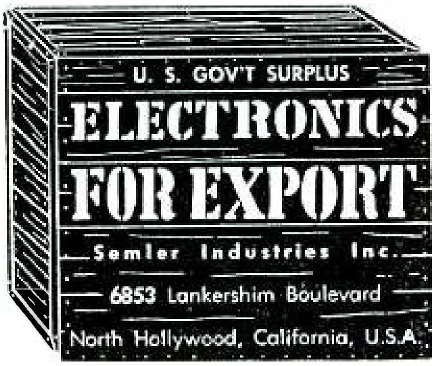

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MICROWAVE EQUIPMENT

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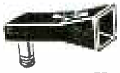

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MICROWAVE ANTENNAS

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
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2C21	.35	C5B/5C30	1.10	705A	.75
2C22/7193	.07	7C4/1203A	.18	706A	9.75
2C26A	.25	9GP7	3.45	706D	14.75
2J21A	2.90	10Y	.10	706EY	9.75
2J22	2.50	15R	.45	706CY	9.75
2J26	2.50	39/44	.15	708A	.65
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2J39	8.25	227A	2.50	843	.19
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4J33	85.00	WL531	2.75	1625	.20
4J42	35.00	532/1B32	1.25	1619	.15
5FP7	1.10	GL559	.75	8012	.75
5GP1	4.50	700B	8.75	9004	.65

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TEST OSCILLATOR TS-47/APR, 40-2000+ Mc. Fundamental coverage 40-500Mc in two ranges. Harmonics above 2000 Mc. Provides a calibrated (dial accuracy ±0.7 per cent) H.F. source for testing receiving equipment. Output 3MW or more up to 400 Mc. less on harmonics. C.W., mod. pulse or sine wave output. Operates on 115/230 60 Cy. or batteries. Part of APR countermeasures equipment. New....$120
TS 13/AP. Signal source 9305-9445 mc. 50 microwatts. Comes with a wavemeter, thermistor-bridge power meter, and calibrated attenuator. Oscillator is a klystron type 723/a-b which may be internally (self-synch) or externally pulsed. Controls are provided for FM operation, variable pulse delay, pulse width and phasing. Operates from 115 v, 60-800 cps. New...$375
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TS-56A/AP TEST EQUIPMENT. Slotted line test equipment designed for operation over a frequency of 500-675 MC. Has impedance of 51 ohms. Ideal test set for matching antennas, measurement of characteristics of transmission line. With instructions manual. New. Shipping wt.: 41 lbs....$95.50

POWER TRANSFORMERS

PLATE—115/60~INPUT

PT-766	15KV/30MA	$47.50
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
PT-403	Autotrans.—70V/2A	1.75
PT-078	300V/.05MA	1.85
PT-599	40V/10A.CT	6.15
PT-823	220VCT/75 WATT	2.95
PT-973	160V/100MA	2.15

COMBINATION—115V/60~INPUT

CT-518	160-0-160V/70MA, 6.3V/2A, 2.5V/1.75A.	$2.15
CT-875	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	350-0-350V190MA, 5VCT/3A, 2.5VCT/12.5A	4.60
CT-002	350-0350V/50MA, 5VCT/2A, 2.5VCT/7.5A	3.65
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CT-403	350VCT .026A 5V/3A	2.75
CT-931	585VCT .086A 5V/3A, 6.3V/6A	4.25
CT-349	24VCT/1A, 175VCT/50MA, 600VCT/90MA	3.25
CT-159	2-2.5VCT/3A, 2-22.5V/100MA, 27V/50MA, 40V/50MA	2.35
CT-913A	4.5V/3A, 5.5V/3A, 650VCT/75MA	2.65
CT-607 ‡	2.3V/2A, 85V/.1ACT, 400VCT/1A	3.95
CT-616 †	3V/10A, 10.5V/.1A, 45V/.1A, 60V/.1A, 140V/100MA	$3.75

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WECO: D-163247 For Modulator of SCR 720....$22.50
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54J318-1—3 wdgs. Ratio: 1:1:1, 1.10 uh. /wdg., 2.5 ohms DCR $3.50
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UTAH X-150T-1: Two sections, 3 Wdgs. per section, 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg....$5.00
68G711: Ratio: 4:1 Pri: 200V, Sec. 53V, 1.0 usec Pulse @ 2000 PPS, 0.016 KVA $4.50
TR1049 Ratio 21 Pri. 220 MH, 50 Ohms, sec. 0.75 H. DCR 100 Ohms $6.75
K-904695-501: Ratio 1:1, Pri. Imp. 40 Ohm. Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise $8.95

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H-615 10KV, 0.85 usec., 750 PPS, 50 ohms imp..$27.50
KS9623 CHARGING CHOKE: 16H @ 75 MA, 380 Ohms DCR, 9000 Vac Test....$14.95
H-605: 25 KV, "E" CKT. 1.5 usec. 400 PPS. 50 Ohms Impedance, 5 sections....$62.50
7-5E3-1-200-67P, 7.5 KV "E" Circuit, 1 microsec. 200 PPS, 67 ohms impedance 3 sections....$7.50
7-5E4-16-60. 67P, 7.5 KV "E" Circuit, 4 sections 16 microsec. 60 PPS. 67 ohms impedance....$15.00
7-5E3-3-200-67P, 7.5 KV. "E" Circuit, 3 microsec. 200 PPS, ohms imp. 3 sections....$12.50
H-616 10KV, 2.2 usec., 375 PPS, 50 ohms imp...$27.50
H-615 10KV, 0.85 usec., 750 PPS, 50 ohms imp..$27.50

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT 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	.119	6.95
			500	.050	
DA-3A*	28	10	300	.260	3.95
			150	.010	
			14.5	5.	
PE 73 CM	28	19	1000	.350	17.50
BD 69	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	2.50
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HK-54	3.99
HY-114B	.69
KU-610	3.49
HY-65	1.70
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RK-34	.39
RK-59	1.88

Type	Price
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1B24	5.99
1B29	9.95
1P30	1.99
2A4/G	1.10
2AP1	3.99
2AP1A	6.44
2B22	1.89
2BP11	7.99
2C21	.49
2C22	.39
2C26	.39
2C26A	.49
2C33	.69
2C39	4.99
2C39A	11.50
2C40	10.99
2C42	9.75
2C43	10.99
2C44	1.35
2C46	7.49
2C53	9.90
2D21	.69

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2K41	72.50
2K45	32.50
2K54	8.95
2K55	9.50
2V3/G	1.39
2X2	.34
2X2A	.89
3A5	.69
3AP1	5.95
3B22	1.49
3B23	3.25
2B24	2.99
3B24W	4.99
3B25	3.99
3B27	3.49
3B28	4.69
3BP1	2.99
3BP1A	6.15
3C21	1.29
3C22	64.95
3C23	5.99

Type	Price
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5CP1A	12.49
5CP7	9.99
5CP11A	14.99
5D21	6.99
5FP7	3.99
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5J33	7.99
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282A	6.49
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286A	7.50
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304TL	13.95
307A	1.85
310A	3.99
316A	.69
329A	4.69
347A	3.88
350B	2.99
354C	14.95
388A	1.49
394A	2.99
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Type	Price	Type	Price
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1N21A	.55	1N26	3.55
1N21B	.99	1N27	.69
1N22	.49	1N34	.41
1N23A	.49	1N34A	.64

Type	Price
706DY	35.00
707A	3.55
707B	3.95
708A	2.99
709A	1.69
713A	.96
714AY	24.95
715A	2.65
715B	6.45
715C	14.50
717A	.49
718AY/CY/EY/DY	29.75
719A	14.65
720CY/DY/EY	29.75
721A	1.49
721B	8.45
722	1.99
723A/B	8.99
724A	1.15
724B	1.45
725A	3.99
726A	9.50

Type	Price
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830B	2.99
832A	7.49
833A	31.50
836	1.99
837	1.99
838	3.50
841	.59
843	.49
845	6.49
851	16.50
860	3.49
861	19.00
864	.69
865	.49
866A	1.19
869B	30.00
GL-872A	2.49
872A	1.29
874	1.25
876	.99
878	.90
884	1.00
885	1.10

Type	Price
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1632	.59
1641	1.88
1642	.39
1644	.48
1806P1	4.99
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2050W	2.40
2051	.76
5651	1.39
5654	1.40
5656	3.25
5670	2.20
5686	1.79
5687	2.69
5702	1.49
5702WA	3.10
5703	1.19
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5744	.91
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1B32/532A	.99
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QK-61	32.00
QK-185	99.00
VR-78	.89
VR-90	.89
VR-105	.79
VR-150	.79
OA2	.74
OB2	.89

Type	Price
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3D21W	1.39
2G22	2.29
2J21	2.99
2J21A	4.95
2J22	4.99
2J26	2.50
2J27	5.99
2J30	14.50
2J31	14.50
2J32	13.50
2J33	13.50
2J34	13.50
2J38	14.00
2J39	11.00
2J49	39.50
2J61	16.40
2J62	9.60
2K22	14.50
2K23	16.50
2K25	18.99
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Type	Price
3C24	1.50
3C28	5.95
3C33	8.99
3C45	6.25
3CP1	2.25
3D23	4.99
3DP1	1.88
3E29	10.25
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3GP1	3.95
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4C27	8.95
4C28	35.50
4E27	9.95
5AP1	3.95
5BP1	2.49
5BP1A	8.99
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Type	Price
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6AK5W	1.35
6AN5	2.12
6AR6	1.49
6AS6	1.19
6AS7/G	2.49
6BM6	39.50
6C4	.49
6D4	2.99
6F4	2.99
6J4	2.50
6J4W	3.75
6J6W	1.29
6K4	3.99
6X4W	1.49
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Type	Price
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205B	1.99
205D	3.99
207	49.50
211	.72
215A	3.25
217A	2.99
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233A	1.19
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446A	1.49
446B	1.79
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471A	1.25
CK-508AX	1.10
CK-521AX	1.10
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WL-530	19.50
WL-531	6.25
532A	.39
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701A	4.99
702A	2.25
703A	1.90
704A	1.59
705A	1.25
706A	6.75
706B	14.50
706C	17.50

Type	Price
726B	25.00
726C	24.50
728AY/BY/CY/DY/FY/GY	35.00
730A	7.95
800	1.29
801A	.42
802	2.89
803	2.69
804	9.99
805	4.90
807	1.25
807W	3.25
808	1.79
809	3.15
810	9.95
811	3.19
913	11.49
814	2.49
815	1.99
816	1.05
826	.75

Type	Price
9-3	.69
902P1	2.99
918	1.99
927	1.45
931A	2.99
954	.19
955	.29
956	.25
957	.33
958A	.39
959	1.40
991	.39
CK1005	.46
CK1006	1.97
1500T	94.50
1608	2.99
1613	.95
1614	1.49
1616	.59
1619	.92
1625	.29
1626	.29
1629	.29

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5933	2.95
5963	1.19
5964	.74
5977	3.89
6080	2.99
6080W	3.90
8002R	18.50
8005	4.50
8012	1.85
8013	2.50
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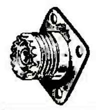

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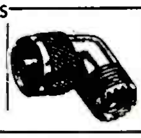

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OD3/VR-150	.60	4C27	5.00	VX-55	6.00	575A	6.00	SN-1007A	6.50
EL-C1B/3C31	1.00	4C35	17.50	RK-60/1641	1.25	631-P1	5.00	SN-1007B	8.50
1AD4	1.15	4E27/8001	7.50	RK-61	2.50	WL-632A	17.50	CK-1009/BA	3.00
1AF4	2.50	4J34	25.00	HY-65	.75	WL-652/57	40.00	SC-1016C	6.50
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1B22	1.25	4J39	100.00	FG-67	9.00	WL-681/86	25.00	CK-1026	2.90
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1B35	4.50	4J61	175.00	RK-72	.50	703A	1.25	SC-1156A	6.50
1B38	25.00	4X100A	15.00	RK-73	.50	WE-705A	.70	1500T	100.00
1B46	1.75	EL-C5B/5C30	1.00	RK-75/307A	.75	706AY-GY	7.50	1603	3.50
1B47	5.00	5AP1	2.00	75TL	7.50	707B	2.50	1614	1.50
1P21	30.00	5B21	1.00	FG-81A	3.50	WE-714A	7.50	1619	.30
1P22	5.50	5BP1	2.00	FG-95	17.50	WE-714AY	25.00	1624	1.00
1P28	7.50	5BP1A	4.00	100R	3.50	715B	3.00	1625	.30
1P29 & 30	1.50	5BP2A	4.00	100TH	5.00	715C	10.00	1846	50.00
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2-01C	10.00	5C22	25.00	F-123A	5.00	WE-719A	7.50	ZB-3200	100.00
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2AS15	5.00	5CP7	6.00	VXR-130	1.65	721B	7.00	5550	25.00
2C38	6.50	5CP7A	8.00	HK-154	4.00	723A/B	7.50	5551	40.00
2C39	4.00	5CP12	10.00	FG-166	7.50	WE-725A	3.00	5553	80.00
2C39A	10.00	5D21	7.50	FG-172	20.00	WE-726A	5.00	5556/PJ-8	6.75
2C40	10.00	5FP7	1.50	QK-181	12.50	WE-726B	15.00	5557	3.50
2C42	10.00	5FP14	7.50	FG-190	7.50	WE-726C	15.00	5558	5.00
2C43	10.00	5GP1	4.00	HF-200	8.50	WE-730A	6.50	5560	17.50
2C44	.45	5HP1	2.00	CE-203	3.50	750TL	40.00	5610	1.00
2C46	6.00	5J29	10.00	203A	3.50	SA-728B	2.00	5632	8.50
WE-2C51	3.00	5J30	10.00	207	25.00	WL-786	12.50	5634	6.50
2D21	.75	5J32	7.50	WE-211C	10.00	801A	.50	5637	3.75
2D21W	1.00	5JP1	10.00	WE-211D	8.00	802	2.00	5638	6.50
2D29	1.00	5JP2	5.00	WL-218	15.00	GL-803	2.00	5640	8.50
2E22	3.00	5JP4	5.00	232CH	100.00	804	8.50	5642	1.00
2E24	2.35	5JP5A	5.00	CE-235A	5.00	805	5.00	5644	6.50
2E26	3.00	5JP11	7.50	WE-242C	7.00	807	1.10	5645	8.50
2E29	.75	5LP1	7.50	WE-244A	7.50	807W	2.00	5650	85.00
2E36	1.25	5NP1	2.00	WE-545A	7.50	808	1.00	5651	1.35
2J21A	2.50	5R4GY	1.25	WE-249B	3.00	809	2.25	5654	1.00
2J26 & 27	2.50	5R4WGY	3.50	WE-249C	2.50	810	10.00	5656	5.50
2J29	10.00	5X3	2.75	250R	3.50	811	2.75	5670	1.45
2J30	35.00	5X3P1	75.00	250TH	17.50	811A	3.50	5672	1.15
2J31-40	10.00	5Z2P7	50.00	250TL	14.00	812	2.75	5676	1.25
2J51	100.00	5Z4P11	100.00	WE-251A	75.00	813 (RCA)	12.00	5678	1.00
2J52	50.00	EL-C6J	7.50	WE-252A	7.50	814	1.25	5687	2.75
2J54	25.00	EL-C6L	5.00	WE-253A	2.50	815	1.00	5691	4.00
2J55	35.00	EL-6C/4B25	8.00	WE-254A	3.50	816	1.00	5692	4.00
2J56	50.00	6AC7W	1.00	WE-257A	3.00	826	.50	5693	3.50
2J61	15.00	6AD4	2.50	FG-258A	80.00	SD-828A	6.50	5696	1.00
2J62	5.00	WE-6AK5	1.00	WE-262B	5.00	SD-828E	6.50	5703	1.00
2K22	15.00	6AK5W	1.00	267B	5.00	828	8.50	5720	15.00
2K25	10.00	6AL5W	.50	WE-268A	5.00	829	4.50	5725	1.50
2K30	100.00	6AN5	2.00	FG-271	40.00	829B	8.50	5726	.50
2K33A	50.00	6AR6	1.25	WE-271A	7.50	830B	.50	5727	1.25
2K34	85.00	6AR6WA	3.75	WE-274B	.90	832	2.75	5728	9.00
2K39	100.00	6AS6	1.15	WE-276A	7.50	832A	4.75	5734	9.00
2K41	85.00	6AS6W	1.50	WE-282A	5.00	833A	35.00	5740	35.00
2K45	30.00	6AS7G	2.75	WE-283A	3.50	SD-834	3.75	5750	2.50
2K47	100.00	6BA5	2.50	WE-285A	5.00	834	5.00	5763	1.25
2K54	5.00	6C21	15.00	WE-286A	6.00	836	1.50	5800	7.50
2K55	5.00	6J4	1.75	287A	2.50	837	1.00	5801	5.00
2P21 (I.O.)	25.00	6J4WA	2.50	WE-300B	5.00	838	1.00	5803	6.00
2V3G	1.25	6J6W	1.50	304TH	7.50	842	1.50	5819	30.00
2X2A	.90	6L6WGB	3.50	304TL	10.00	845	3.50	5827	5.00
3A4	.50	6SK7W	1.00	307A	.75	845W	7.50	CK-5829	1.25
3A5	.60	6SN7W	1.50	WE-310A	4.00	849	17.50	5842	12.50
3AP1	1.50	6SU7GTY	2.00	WE-313C	3.00	851	7.50	5847	12.50
3AP11A	5.00	6X4WA	2.00	316A	.50	860	2.50	5915	.75
3B21	3.50	6X5W	1.25	WE-323A	10.00	866A	1.15	5932	3.75
WE-3B24	1.00	7BP7	3.50	323B	6.00	866 JR	1.00	5933	2.00
3B24W	4.85	7CP1	10.00	WE-328A	3.50	869B	30.00	5948/1754	250.00
3B25	3.00	7EP4	10.00	WE-337A	6.00	872A	1.25	5949/1907	125.00
3B26	2.50	7HP7	10.00	WE-339A	7.50	884	.95	5962/BS-101	6.50
3B27	3.00	10KP7	25.00	WE-347A	3.00	885	.95	5963	1.40
3B28	4.00	12AP7	50.00	WE-350A	2.50	902A/P1	2.00	5979/BS-1	10.00
3BP1	1.50	12DP7	17.50	WE-3503	2.00	913	17.50	5980/BS-2	8.50
EL-3C	5.00	12GP7	17.50	WE-352A	15.00	SD-917A	3.75	5981/5650	85.00
EL-3CJ	8.50	LM-15 (I.O.)	50.00	WE-355A	12.00	917	1.75	5998	7.00
3C23	4.50	FG-17	3.50	WE-356B	3.50	918	1.50	6098	3.75
3C24	2.50	RK-20A	7.50	WE-368A/AS	1.75	922	2.00	6328	12.50
3C33	7.50	TZ-20	1.50	371B	1.50	923	1.40	8002R	15.00
3C45	6.50	RK-23	2.50	WE-388A	1.50	927	.75	8005	4.75
3D22	9.75	HK-24	3.00	WE-393A	4.50	931A	2.35	8012A	3.50
3DP1	3.00	HK-24G	2.50	394A	2.00	SN-947C	6.50	8013	2.50
3DP1A	7.50	RK-25	2.25	WE-396A	3.00	SN-947D	8.50	8013A	3.25
3E29	8.50	25E6WG	3.00	WE-403A	1.00	SN-948B	6.50	8020	1.50
3EP1	2.00	25T	3.00	WE-404A	12.50	SN-948D	6.50	8025	1.25
3FP7	1.50	25TG	2.50	WE-409A	1.10	954	.25	8025A	2.00
3FP7A	2.50	FG-27A	12.00	GL-415	25.00	955	.35	PD8365	50.00
3GP1	2.50	28D7W	1.25	WE-417A	12.50	SN-956B	1.00	9001	.85
3HP7	3.00	FG-32	5.00	WL-417A	2.50	956	.35	9002	.50
3J21	50.00	VX-32B	7.50	WE-418A	15.00	957	.35	9003	1.25
3J31	45.00	FG-33	15.00	WE-421A	7.00	958A	.35	9004	.35
3K27	150.00	VX-33A	5.00	GL-434A	10.00	959	1.25	9005	1.40
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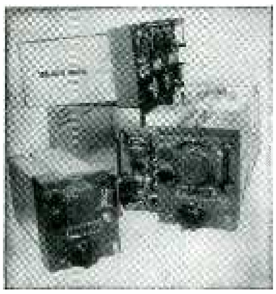

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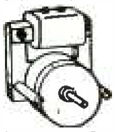

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4 RPM on 50 cy or 4¾ RPM on 60 cy. . .$2.85	3.6 RPM . .$3.15
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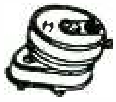

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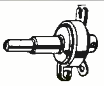

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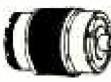

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Special...$2.98 @; 4 for $10
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.01	1200	35c; 100/$30
.001	1200	20c; 100/$15
.002	1200	35c; 100/$30
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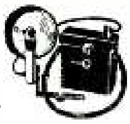
.002	2500	45c; 100/$40

NEW "TABLITE" ELECTRONIC PHOTOFLASH KITS

Portable Units—AC & Battery Inbuilt In One Camera Case



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KITS ASSEMBLED, additional.........@ $10
*Two (2) 240V BATTERIES..............@ $10
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COND-525MFD/450VDC/53 Watt sec'ds.
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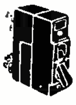

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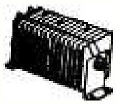

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3	2.90	4.10	5.75	7.80	12.70	37.00	3.05	20.00	49.50
4	3.50	6.40	11.25	14.30	25.00	45.00	3.40	21.70	55.75
6	3.95	7.70	12.75	17.25	29.65	59.00	3.70	24.00	59.90
10	5.85	11.35	19.40	24.75	41.25	85.00	5.45	42.40	94.25
12	7.20	14.25	22.00	29.50	43.85	100.00	6.80	48.15	113.50
20	13.00	25.00	37.00	48.00	78.00	161.00	9.15	58.50	164.75
24	15.00	28.50	44.25	57.50	80.65	191.00	11.45	103.35	241.00
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*Dual Pri 115 & 220V 60cy.

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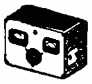

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T28V5A*	0-28 WVDC at 5 Amp	$50
T28V5ACC	5 Amp (1 % Ripple)	$85
T28V5A2CC	5 Amp 0.01 % Ripple	$145
T28V12A	0-28 VDC at 12 Amp	$125
T28V12ACC	12 Amp (1 % Ripple)	$160
T28V12ACC	12 Amp 0.01 % Ripple	$220
T28V24A†	0-28 VDC at 24 Amp	$155
T28V24ACC†	24 Amp (1 % Ripple)	$225
T28V24A2CC†	24 Amp 0.01 % Ripple	$310
T28V50A†	0-28 VDC at 50 Amp	$285
T28V50ACC†	50 Amp (1 % Ripple)	$410
T28V100A†	0-28 VDC at 100 Amp	$500
T28V100ACC†	100 Amp (1 % Ripple)	$700

Variable 75 to 135 VDC Completely Built. Ready to go. Includes F. W. Selenium Bridge Rectifier 4" Rectangular Volt & Ammeter.
Specify for 115 or 230 VAC 1 phase, 60 cy Input.

T120V5AC	75 to 135 WVDC at 5 Amp	$190
T120V5ACC	5 Amp (1 % Ripple)	$240
T120V10AC	75 to 135 VDC at 10 Amp	$245
T120V10ACC	10 Amp (1 % Ripple)	$295

*2" Meters; All Others 4" Meters
POWER SUPPLIES TO YOUR SPECS.
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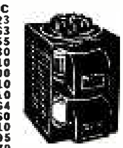

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0-132V-1.25A...............$7.23
0-135V/3A..................10.63
Cased 0-135V/7.5A..........19.55
Uncased/0-135V/7.5A........15.30
Cased/0-270V/3A............22.10
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Cased/0-270/9A.............39.10
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230 to 115 V Autoformers

For 220v/50cy Input. To 110-120V or Step up. †With Cord. Plug & Receptacle.
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TPA075/75W.†.......... 3.65
TPA100/100W.†......... 4.00
TPA200/200W.†......... 5.75
TPA250/250W.†......... 6.75
TPA500/500W.†......... 8.25
TPA750/750W.†..........................11.79
Model TPA1000 Watts: 1 kw.†............16.95
TPA1500/1500W.†..$22.50; TPA2000/2KW..$34
* Less Cord, Plug & Receptacle

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"TAB" TESTED *INSPECTED* GUARANTEED!!!

OA2	$ .74	3C45	7.00	394A	1.85	1201	.75	5819	33.00
OA3	.89	3D21A	2.95	434A	2.75	1612	1.25	5820	45.00
OB2	.64	3D23	5.09	446A	.69	1613	1.00	5829	.99
OB3/VR90	.84	3K23	125.00	446B	1.85	1616	.49	5841	7.98
OC3/VR105	.74	3X2500A	100.00	450TH	65.00	1619	.25	5842	11.00
OD3/VR150	.65	4-65A	16.50	512AX	1.35	1620	3.00	5844	.85
1AD4	1.24	4-125A	19.09	531DX	1.89	1625	.30	5851	3.50
1AG4	1.35	4B23	6.00	536AX	1.55	1626	.15	5879	1.15
1AX2	1.25	4B27	2.50	538DX	.98	1629	.30	5881	2.70
1B3	.65	4C35	15.00	439DX	2.50	1632	.63	5910	.43
1B22	1.25	4J52	50.00	544DX	2.50	1633	.98	5932	3.95
1B24	4.94	4X150A	22.25	571AX	4.45	1642	.50	5965	1.50
1B32	2.94	5C22	29.45	608CX	.97	1644	.99	6080	5.99
1B35	3.49	5D21	7.45	HY615	.46	1680	2.00	6082	4.50
1B46	1.88	5U4G	.45	703A	1.20	1850A	65.00	6099	1.55
1B63A	21.95	6AG5	.45	704A	.74	2050	.98	6146	4.87
1D21	3.49	6AN5	2.61	705A	.74	2050W	2.48	6199	45.00
1LN5	.70	6AS6	1.20	707B	3.95	2051	.68	7193	.25
1Q23	150.00	6AS7G	2.35	710A	1.68	5514	4.69	8005	3.85
1X2A	.60	6BQ6	.90	715A	3.85	5516	5.51	8008	3.50
2C22	.25	6J6	.45	717A	.29	5517	2.10	8012	1.09
2C26	.20	6SN7	.55	721A	72.00	5651	1.40	8013	2.70
2C39A	7.95	6X4	.40	723AB	8.00	5654	1.25	8020	2.95
2C40	7.22	8D21	79.00	724A	.84	5656	6.00	8025A	2.00
2C43	6.90	12AU7	.50	724B	.80	5663	1.06	9001	.80
2C51	2.85	12AX7	.55	725A	2.00	5670	2.24	9002	.57
2D21	.59	FG17	2.70	726A	4.25	5672	1.55	9003	1.25
2E22	1.89	19BG6	1.38	801A	.42	5686	2.99	9006	.15
2E26	3.25	24G	2.70	807	1.19	5687	3.59	3BP1A	5.55
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2G21	1.95	REL26	.49	814	2.48	5692	5.00	3DP1	2.75
2J30	15.00	RK34	.24	815	1.90	5693	4.75	3DP1A	6.50
2J42	59.00	35Z5	.45	826	.70	5694	3.70	3EP1	2.40
2K22	14.00	TZ40	3.33	829B	8.49	5697	3.70	3FP7	1.91
2K25	11.95	50L6	.55	832A	5.00	5702	2.50	3FP7A	3.00
2K28	28.00	HY69	5.49	836	1.49	5704	2.25	3GP1	1.91
2K29	29.50	QK155	250.00	837	1.95	5718	3.00	5BP1	1.95
2K30	100.00	QK202	250.00	864	.34	5719	2.50	5CP1A	9.00
2K33	100.00	203A	3.50	866A	1.25	5727	1.77	5HP1	3.55
2K39	100.00	215	10.35	872A	1.29	5732	2.85	5JP1	14.95
2K41	90.00	233A	2.92	874	.59	5744	1.85	5JP2	5.00
2K42	125.00	250R	10.95	884	1.38	5749	1.49	5LP1	7.00
2K43	110.00	250TH	35.00	885	1.19	5750	3.10	5SP7	50.00
2K48	80.00	304TH	15.00	927	.90	5751	1.45	7BP4A	7.50
2K50	125.00	304TL	15.00	954	.10	5783	4.25	7BP7	4.50
2P23	89.00	316A	.48	955	.34	5787	4.95		
3B24W	5.00	349A	5.00	956	.29	5794	5.99		
3C22	75.00	371B	.90	957	.34	5812	1.49		
3C24	3.98	388A	1.15	1005	.35	5814	.79		

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1% ACCURACY GTD
SPECIAL 15c EA.
10 OF ONE VALUE 10¢ ea
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IN23B Crystal Diode

"TAB" SPECIAL 75¢ ea; 10 FOR $7
IN21...............6 FOR $1

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INFRARED SNOOPERSCOPE SEE IN DARK TUBE

Selected GTD Image-Converter Tube Hi-Sensitivity simplified design 2" dia. Willemite screen—Resolution up to 350 lin'in Tube & Data "TAB" Special.$3.90; 2/$7.50
New Snooperscope Power Supply
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"TAB" 89¢ ea; 6/$5

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DUAL CKT, 105° F & 32° F. Extremely sensitive & accurate for most exacting requirements—Research. Fire Prev., Freeze, Pt Control, or Max Min Temp Control. Brand New. w/data & ckt. Regularly over $20.00· EA. 98c; 12 for $10.00

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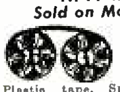

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1. Products advertised in this issue
2. New Products and Literature covered in the editorial section of this issue

This direct method prevents loss of time in remailing your request from publication to manufacturer.

THESE POST CARDS ARE FOR YOUR USE

and

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1. Fill in with ink or typewriter your name, company, address and title.

2. Then fill in the name of the specific product and the page number on which it appears.

3. Place a check mark in the box or boxes applicable to your needs.

4. Tear out the postcard on the perforated lines and address it to the manufacturer(s) whose products you are interested in. Place a stamp in the box indicated and drop into the mail.

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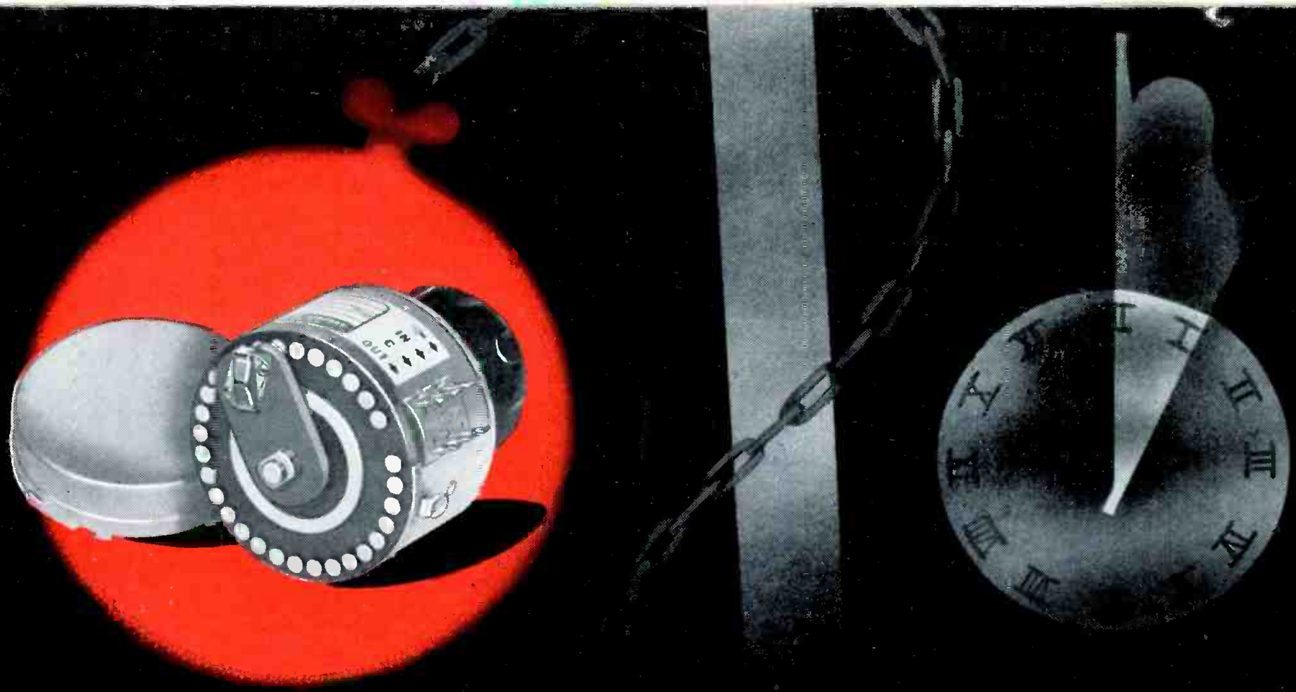

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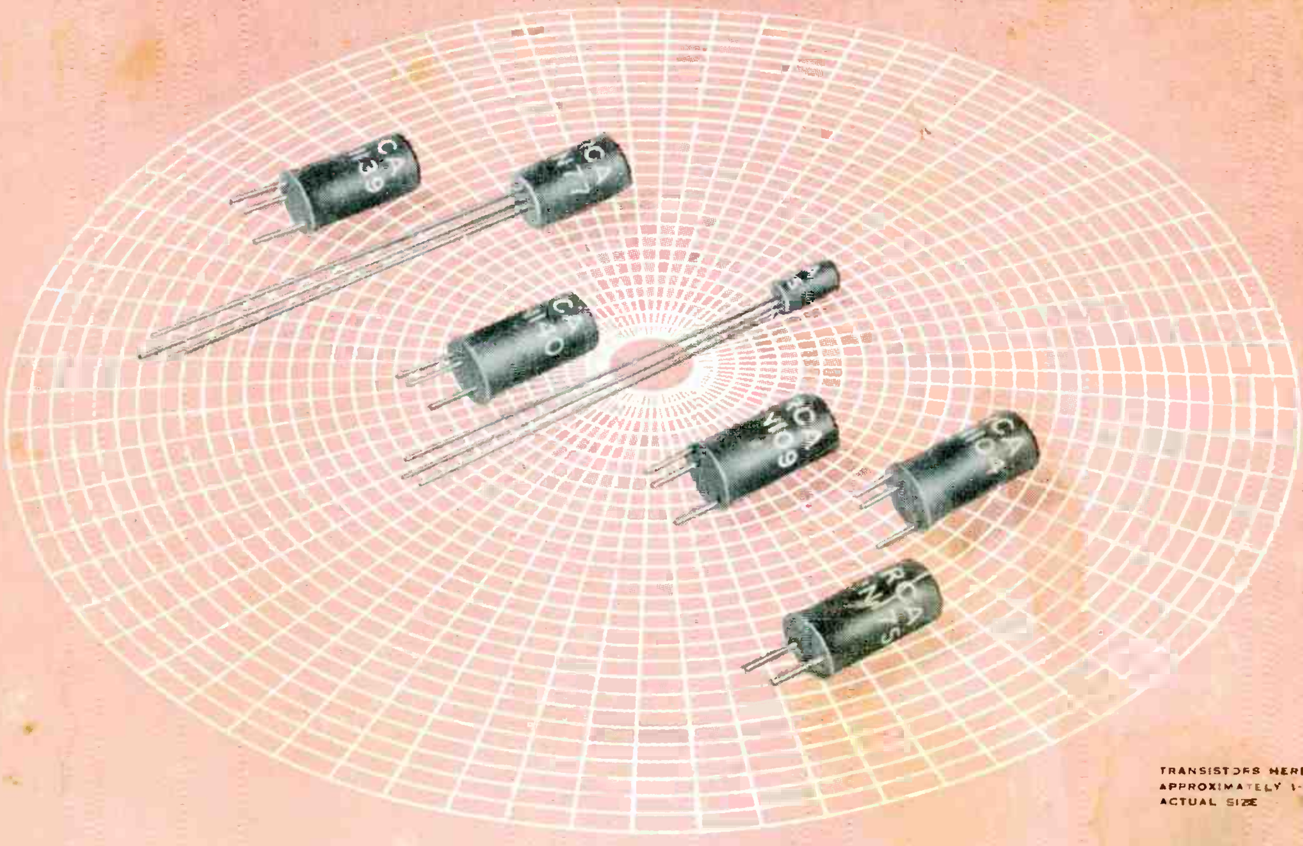

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