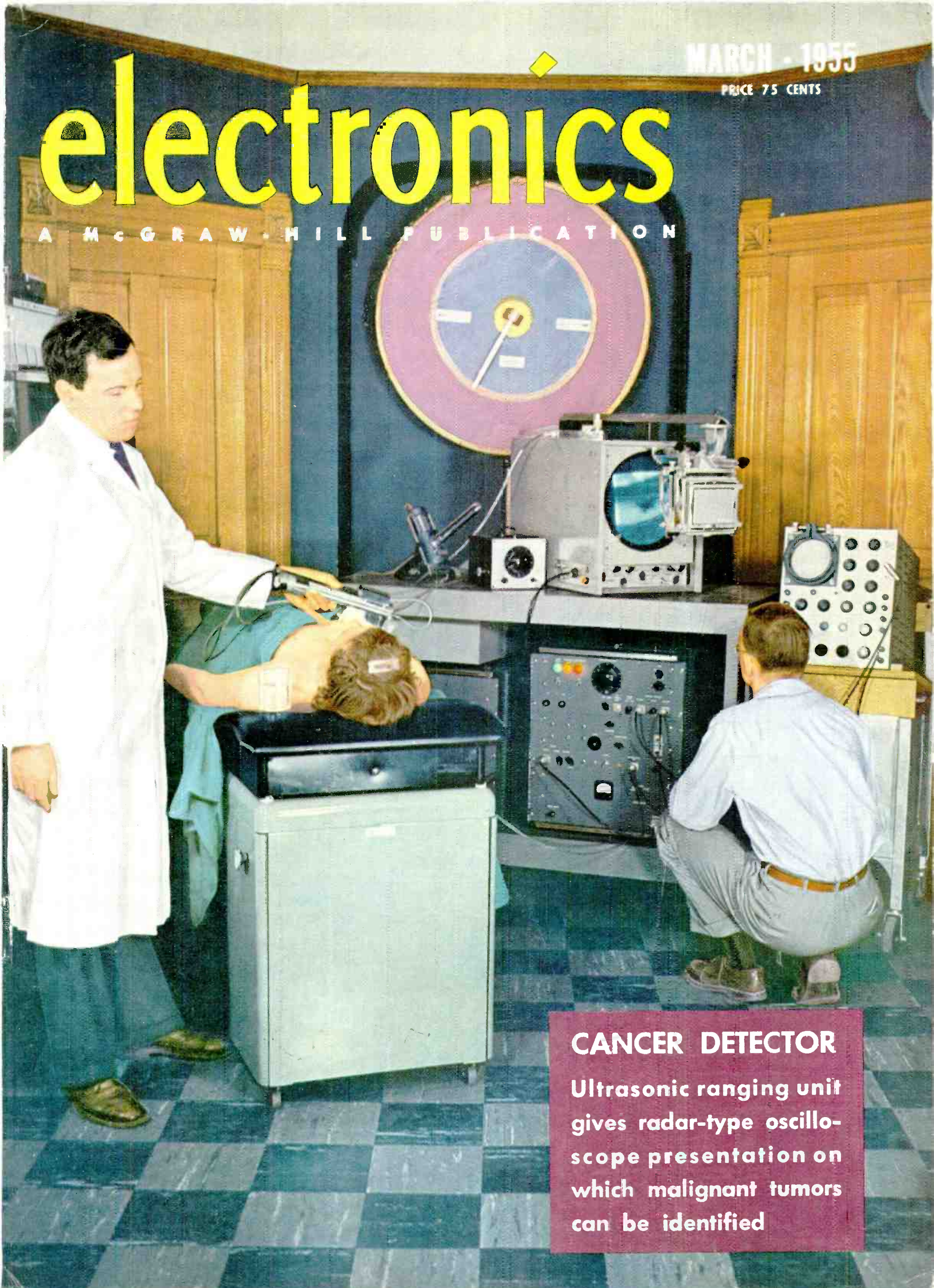
MARCH · 1955
PRICE 75 CENTS

electronics

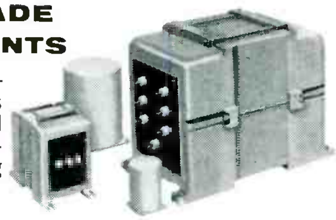
A McGRAW-HILL PUBLICATION



CANCER DETECTOR

Ultrasonic ranging unit gives radar-type oscilloscope presentation on which malignant tumors can be identified

COMMERCIAL GRADE POWER COMPONENTS



CG power components are conservatively designed for long, continuous duty, life. Their rugged mechanical structure is matched by high insulation safety factors permitting 250% applied voltage tests.

Type No.	Application	High Volt.	DC Volt.	DC ma.	Filaments
CG-301	Plate	580-530-300-0 -300-530-580	475/425/ 250	420	
CG-302	Plate	950-750-0-750-950	760/610	360	
CG-308	Plate	3500-3000-2400-0 -2400-3000-3500	3000/2500 2000	500	
CG-315	Bias Tapped for any DC voltage from 15 to 100 volts within 6%-250ma				
CG-422	Power & Bias	435-365-0 -365-435 125-0-125		125 25	5V-3A, 5V-2A, 6.3VCT-3A 2.5VCT-5A
CG-33	Filament	2000V Test	500V working		6.3VCT-4A

Type No.	Application	Induct. Henries at rated DC ma.	DC Resist. Ohms	DC ma.	Test Voltage
CG-40	Filter Choke	10	110	200	1750
CG-44	Filter Choke	30	400	100	1750
CG-48C	Filter Choke	50	2200	50	1750

COMMERCIAL GRADE AUDIO COMPONENTS

UTC CG audio units provide exceptional reliability at moderate cost. Units are fully compound sealed in rugged drawn cases and cover all audio applications from hum bucking input units to high level modulation transformers.

Type No.	Application	Pri. Imped.	Sec. Imped.
CG-131	Interstage, 1 plate to 1 grid	15,000	135,000 3:1 ratio
CG 132	Interstage, 1 plate to 2 grids	15,000	135,000 CT 3:1 ratio overall
CG-134	Input, line to 1 grid humbucking	50, 200, 500	80,000
CG-137	Mixing	50, 200, 500	50, 200, 500
CG-140	Low Level Output,Triode plate to line	15,000	50, 200, 500
CG-19	Output, 6V6, Triode:6L6, 5881 20 watts max.	6,000/10,000	500, 200, 16, 8, 5, 3, 1.5
CG 2L6	Output, 6L6's, AB1, 5881 30 watts max.	9,000	500, 200, 16, 8, 5, 3, 1.5
CVP-1	Varimatch outputs for P.A. 12 watts	3000, 5000, 6000, 7000, 8000, 10 000, 14,000	500, 200, 16, 8, 5, 3, 1.5
CVP-2	Varimatch output for P. A. 30 watts	3000, 5000, 6000, 7000, 8000, 10,000, 14 000	500, 200, 16, 8, 5, 3, 1.5
CVM-0	Varimatch modulator, 12 watts	500 to 20,000	30,000 to 300

FROM STOCK

. . . These items and 650 others in our catalog B

RUGGED, RELIABLE **TRANSFORMER COMPONENTS** FOR

INDUSTRIAL APPLICATIONS

STEPDOWN TRANSFORMERS

These autotransformers are a convenient means for adapting 110/120 volt appliances to 220/240 volt circuits. Units come with 6′ cord and female receptacle.

Type No.	Application	L	W	H	Wgt. Lbs.
R-41	85 watt capacity	2⅝	2⅝	3⅛	4
R-42	125 watt capacity	3	3	3½	5
R-43	175 watt capacity	3¼	3¼	3⅞	5½
R-44	250 watt capacity	3⅞	3¼	3⅞	6½
R-45	500 watt capacity	4⅛	3⅞	4⅝	12
R-46	1200 watt capacity	6⅜	3⅞	4⅝	18
R-64	2500 watts, no cord	10½	4¾	6¾	30

LINE VOLTAGE ADJUSTERS WITH METER

The perfect answer to abnormal or fluctuating line voltage. Adjust switch so meter reads at red line and you know your equipment is working at correct voltage.

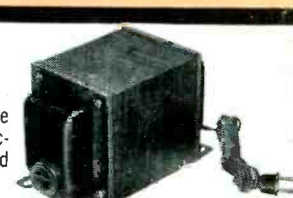
Type No.	Primary Voltages	Sec. Volts	Watts	L	W	H	Wgt. Lbs.
R-78	60, 70, 80, 90, 100, 110, 120, 130, 140	115	150	7	4	4¾	6
R-79	60, 70, 80, 90, 100, 110, 120, 130, 140	115	300	7	4	4¾	9
R-80	60, 70, 80, 90, 100, 110, 120, 130, 140	115	600	10¼	4	4¾	13
R-81	60, 70, 80, 90, 100, 110, 120, 130, 140	115	1200	10¼	4	4¾	21
R-83	160, 170, 180, 190, 200, 210, 220, 230, 240	230	150	7	4	4¾	6
R-84	160, 170, 180, 190, 200, 210, 220, 230, 240	230	300	7	4	4¾	9
R-85	160, 170, 180, 190, 200, 210, 220, 230, 240	230	600	10¼	4	4¾	13
R-86	160, 170, 180, 190, 200, 210, 220, 230, 240	230	1200	10¼	4	4¾	21

VOLTAGE BOOSTERS for TV and AIR-CONDITIONERS

Ideal means for accommodating units to low line voltage conditions. Complete with cord and receptacle . . . boosts line voltage 10%.

Type No.	Rating		L	W	H	Wgt. Lbs.
R-87	3A.	350 W.	3⅜	2	2¾	2
R-88	18A.	2 KW.	3⅞	4⅛	4⅝	12

ISOLATION TRANSFORMER



Excellent units for isolating line noise, AC-DC sets, etc. Full electrostatic shielding . . . 6′ cord and female receptacle.

Type No.	Rating	L	W	H	Wgt. Lbs.
R-72	40 watts	2¾	2⅛	3⅛	4
R-73	100 watts	3⅜	3¼	3⅞	6
R-74	250 watts	4⅜	3⅞	4⅝	12
R-75	600 watts	6⅞	3⅞	4⅝	20
R-76	1200 watts	8⅜	4½	5⅞	30
R-77	2500 watts (no-cord)	12	7	9	70

SPECIAL UNITS TO YOUR NEEDS . . . *SEND US YOUR SPECS., FOR PRICES.*

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

MARCH • 1955

CANCER DETECTOR—Equipment developed by Dr. J. J. Wild and John M. Reid of St. Barnabas Hospital, Minneapolis, under sponsorship of U. S. Public Health Service (See p 174) .... COVER

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CONTINUED ON NEXT PAGE

contents continued

SHOP

SILVER ANNIVERSARY — In April, Electronics begins its 26th year of publication. Charter subscribers have received 300 regular issues and 9 *Buyers' Guides* through March.

Checking our own bound volumes we find that some pages or sections have been omitted. Because of this, an exact count of total pages is not easy to make.

Placed on one shelf, however, our volumes extend to a length of 11 feet, 2 inches. We wonder how this compares with other complete libraries.

Comments will be welcome.

NICE SUMMARY—A number of readers contacted this month in our continuing survey of subscriber likes and dislikes ask for a one-paragraph abstract right at the beginning of featured papers. We're attempting to meet such requests in our own way, as contrasted with the association journal approach.

The bank or deck head set in fairly large type near the title or headline is as descriptive of what is in a paper as ELECTRONICS' editors know how to make it. Authors are asked for additional illustrations in many cases and we try to make the pictures and drawings and diagrams tell the story. Finally, where a subject is particularly complex you will often find that boxes or panels of type point it up.

No pointing up whatever was required for a recent headline ap-

electronics

MARCH, 1955 Vol. 28, No. 3

Member ABC and ABP

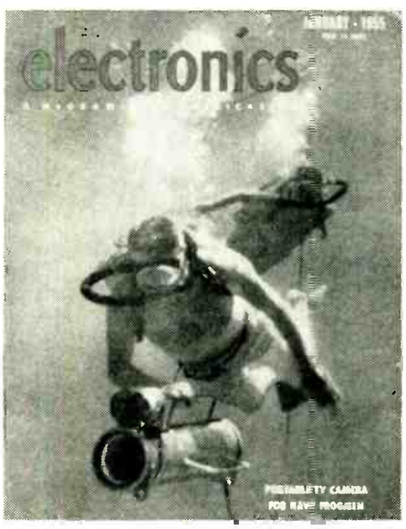
TALK

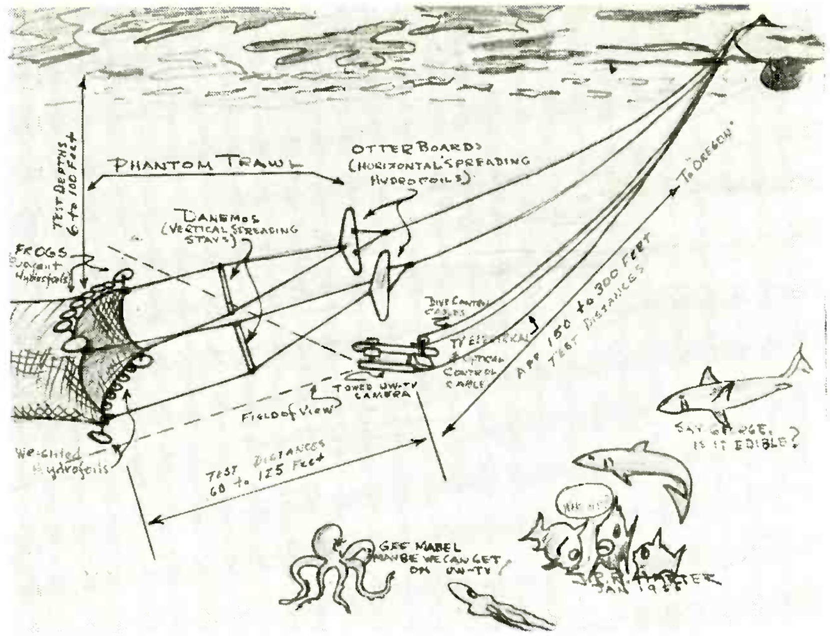
pearing in one of our departments. It read: "Shape Factor as a Criterion of Skirt Selectivity."

SUBMERGED ARTIST—When we received the story on underwater television for testing efficiency of fish nets (p.26, this issue), a drawing illustrating the technique accompanied the material. The artist's signature, being examined by three finny denizens of the deep, and the words "Who he?" puzzled us.

Checking with Washington editor Gladys Montgomery, we found that the artist is J. R. R. Harter, engineer with BuShips, U. S. Navy. He did the sketch while talking to her. His original drawing is reproduced on this page.

Readers have met him before, under water, right on the front cover for January. But we don't blame anyone for not recognizing him.





Electronics and Experimental Diving Groups at BuShips used tv and fishing equipment shown above for rating nets (see p 26). We have added "frogs", "danemos" and "otter boards" to our lexicon

PERFECT TIMING—Art Hungerford, television manager at General Precision Labs, tells us he phoned all over the country to track down a flat television picture tube. He was told by a west coast contact that such a tube was described in ELECTRONICS.

It was (p 7, Feb. 1955), in the issue sitting right on his desk, delivered a few moments before.

FEEDBACK—Newspapers report that the Air Force is working on a crash beacon and triangulation system to bring help to planes that crack up.

One of our readers (p 414, May, 1953) pointed out the need for such equipment and made a few suggestions concerning its design.

Newspapers might note that, after location, a rescue boat can be dropped by an airplane, engine started and boat steered to men in water by remote control from the plane. (ELECTRONICS, p 130, Mar. 1954)

ACCESSORY PROBLEM—Photographs of the laboratory model transistor radio receiver (p 159, this issue) were taken in our own studio while the set was in transit between Raytheon's laboratory in Newton, Mass. and the manufacturing plant in Chicago.

We managed to borrow the receiver for a few hours, persuaded our 30th floor receptionist to pose with it, and matched the pose and appearance of the picture supplied to us of the production receiver. (See p 10, Feb.)

We did not, however, attempt to match the pose and photo that some newspapers ran. Designed to accent safety of battery operation, it showed the set being tuned by a girl in a bathtub.

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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; $25.00 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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Model E-6-15A Nobatron

. . . WHEN YOU NEED

PRECISELY REGULATED DC — SPECIFY NOBATRON*

accurate • dependable • economical

For more than ten years, Sorensen NOBATRONS have provided regulated, low-voltage, high-current DC in thousands of laboratory and industrial applications. Their users have chosen them for their ±0.2% regulation accuracy, their convenience of use compared with battery installations or other sources, their dependability, their easy maintenance.

Nobatron circuits usually employ only three tubes. They are easily accessible for replacement when required. The characteristics listed below are conservative and tell you why you should specify Nobatron.

Models available (numbers indicate voltage & current) E-6-5A, E-6-15A, E-6-40A, E-6-100A, E-12-5, E-12-15, E-12-50, E-28-5, E-28-10, E-28-30, E-28-70, E-28-150, E-48-15, E-125-10, E-200-5.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 50-60 cycles. 120/208, 3ϕ, 4-wire wye for the E-28-150. The E-28-70 requires 190/260, 1ϕ power.
Reg. accuracy	±0.2% against line, ±0.2% against load.
Ripple	Varies to 1% RMS max. under worst conditions.
Load range	1/10 to full load.
Output range	Adjustable ±10%; down to 20% at lesser accuracy.
Recovery time	0.2 seconds on all models up to 1 KW rating, increasing to 0.5 seconds at 10 KW.

Note: "A" models output either 6 or 7 volts.

*Reg. U.S. Pat. Off.

Model SR2

NOBATRON-RANGERS

Your interests may best be served by an instrument with electrical characteristics similar to the standard Nobatron, but with stepless, continuously adjustable output. If so — find out more about Sorensen's line of Nobatron-RANGERS.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 50-60 cycles for SR30 and SR100. 190-260 VAC, 1ϕ, 50-60 cycles for the SR2.		
Reg. accuracy	±0.25% at any voltage setting.		
Ripple	1% RMS max.		
Output: Model	SR100	SR30	SR2
VDC	5-135	5-30	100-300
Amps	1-10	3-30	1-10

TUBELESS NOBATRONS

Sorensen is aware of the advantages of tubeless circuitry, and manufactures a line of tubeless supplies, also.

ELECTRICAL CHARACTERISTICS

Model	MA65	MA640	MA2850
Input, VAC, 60~	105-125, 1ϕ	105-125, 1ϕ	190-230, 3ϕ, 4-wire, wye
Output, VDC	6, adj. ±10%	4.5-7.7 adj.	23-32 adj.
Load range	0-5 amp.	0-40 amp.	0-50 amp.
Ripple	1% max.	1% max.	3% max.
Reg. accuracy	±1.0% for any combination of line and load.		
Recovery time	0.2 sec.	0.15 sec.	0.5 sec.

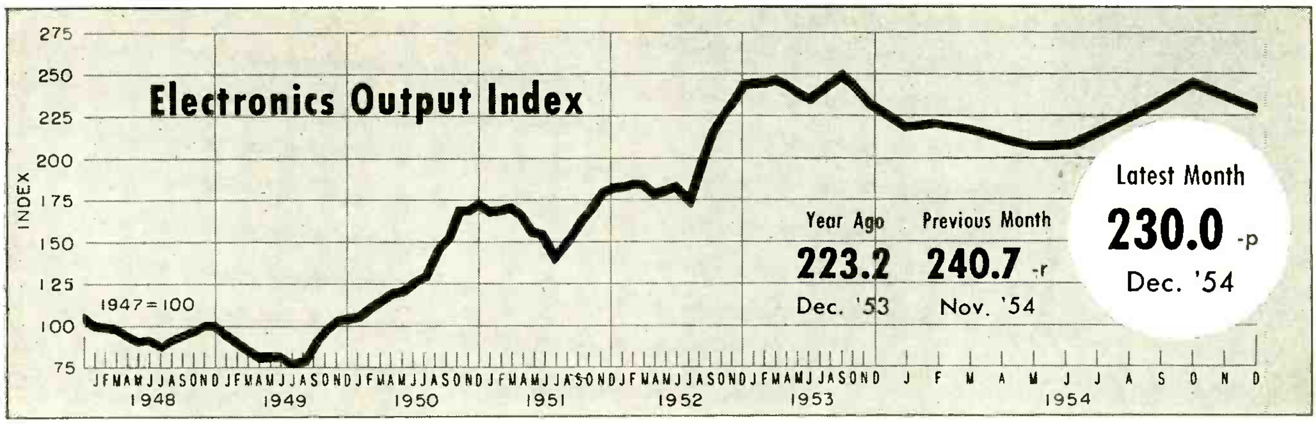
Model MA640

Catalogs available describing the complete line of Sorensen instruments. Write for free copies today.

SORENSEN

SORENSEN & CO., INC., 375 FAIRFIELD AVENUE, STAMFORD, CONNECTICUT

Want more information? Use post card on last page.



FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month	Previous Month	Year Ago
	Dec. '54	Nov. '54	Dec. '53
Television sets, total	833,423	858,501	449,787
With UHF	129,181	168,563	139,657
Color sets	N.R.	N.R.	......
Radio sets, total	1,261,575	1,098,725	1,101,115
With F-M	22,055	17,364	39,171
Home sets	300,023	327,973	514,428
Clock radios	312,967	272,583	117,672
Portable sets	109,001	93,716	103,931
Auto sets	539,584	404,453	365,084

RECEIVER SALES

(Source: RETMA)	Dec. '54	Nov. '54	Dec. '53
Television sets, units	1,093,702	779,105	774,856
Radio sets (except auto)	1,158,588	669,166	1,456,008

RECEIVING TUBE SALES

(Source: RETMA)	Dec. '54	Nov. '54	Dec. '53
Receiv. tubes, total units	37,908,894	38,781,863	23,404,026
Receiv. tubes, value	$27,391,916	$27,618,868	$17,832,387
Picture tubes, total units	1,009,398	1,157,866	644,287
Picture tubes, value	$20,521,562	$27,140,693	$14,801,856

SEMICONDUCTOR SALES

	Nov. '54	Oct. '54	Nov. '53
Germanium diodes, units / Silicon diodes, units	1,494,314	1,506,611	733,029

INDUSTRIAL TUBE SALES

(Source: NEMA)	Quarterly Figures — Latest Quarter	Previous Quarter	Year Ago
	3rd '54	2nd '54	1st '54
Vacuum (non-receiving)	$8,803,740	$8,971,335	$10,400,000
Gas or vapor	$3,570,586	$4,589,239	$3,300,000
Phototubes	N.R.	N.R.	$700,000
Magnetrons and velocity modulation tubes	$13,112,244	$16,135,274	$10,500,000
Gaps and T/R boxes	$1,476,407	$1,517,426	$1,700,000

TV SETS INSTALLED

(Source: NBC Research Dept.)	Latest Month	Previous Month	Year Ago
	Dec. '54	Nov. '54	Dec. '53
Total sets	32,996,000	32,262,000	26,973,000

BROADCAST STATIONS

(Source: FCC)	Dec. '54	Nov. '54	Dec. '53
TV stations on air	439	434	356
TV stations CPs—not on air	137	141	211
TV stations—new requests	19	18	172
A-M stations on air	2,669	2,650	2,521
A-M stations CPs—not on air	105	112	115
A-M stations—new requests	172	174	4
F-M stations on air	552	554	560
F-M stations CPs—not on air	7	11	20
F-M stations—new requests	8	3	178

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Nov. '54	Oct. '54	Nov. '53
Aeronautical	40,737	39,873	42,667
Marine	48,255	48,116	43,455
Police, fire, etc.	16,757	16,546	14,478
Industrial	22,742	22,579	19,564
Land transportation	7,127	7,071	6,380
Amateur	126,021	124,563	114,665
Citizens radio	9,116	8,945	4,070
Disaster	306	306	254
Experimental	636	627	495
Common carrier	1,771	1,737	1,392

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Nov. '54	Oct. '54	Nov. '53
Prod. workers, comm. equip.	386,800-p	300,800-r	414,300
Av. wkly. earnings, comm.	$70.99-p	$70.88-r	$67.26
Av. wkly. earnings, radio	$69.02-p	$69.32-r	$66.23
Av. wkly. hours, comm.	40.8 -p	40.5	39.8
Av. wkly. hours, radio	40.6 -p	40.3	39.9

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Jan. '55	Dec. '54	Jan. '54
Radio-tv & electronics	413.4	409.3	273.4
Radio broadcasters	463.7	449.0	274.3

p—provisional; r—revised
N.R.—not reported

FIGURES OF THE YEAR

TOTALS FOR THE YEAR

	1954	1953	Percent Change
Television set production	7,346,715	7,215,827-r	+ 1.8
Radio set production	10,400,530	13,368,556	—22.2
Television set sales	7,317,034	6,370,571-r	+14.8
Radio set sales (except auto)	6,430,743	7,031,293-r	— 8.5
Receiving tube sales	385,089,458	437,091,555	—11.9
Cathode-ray tube sales	9,913,504	9,839,138-r	+ 7.5

INDUSTRY REPORT

electronics—March • 1955

OVER 700 electronic engineering exhibits, at least 100 more than in 1954, will be on display in New York when . . .

IRE's 1955 Convention Opens For Biggest Meeting

Attendance of more than 40,000 is expected at this year's technical sessions and displays

ENGINEERS will again be able to take stock, first hand, of the growth, technical advances and problems of the electronics industry when they attend the 1955 IRE National Convention on March 21 to 24.

Technical sessions are scheduled for the Waldorf-Astoria and Belmont-Plaza hotels in New York City and Kingsbridge Armory in the Bronx. Exhibits will be displayed at Kingsbridge Armory and, for the first time, at Kingsbridge Palace, located 1½ blocks from the Armory.

This year's show is expected to draw nearly 5,000 more people than last year's event. At least 100 more exhibits have caused the overflow to Kingsbridge Palace.

▶**Sessions**—A total of 55 technical sessions made up of more than 250 individual papers are scheduled. Last year there were 50 sessions and in 1953 only 43. A quick guide to the subject, time and place of each session is given on page 8. The complete technical program with titles of individual papers is given in this issue, beginning on page 440.

▶**Changes**—Sessions on Automatization and on Remote Control of Space Stations are scheduled for the first time this year and are expected to be highlights of the meeting. Growing importance of the engineering management side of the business is apparent with three sessions devoted to the subject compared to two last year and one in 1953.

Ultrasonics is also stressed this year with two sessions planned. In 1953 there were none. Other subjects receiving increased attention are microwave, component parts and magnetic recording.

The annual meeting of the IRE to be held on Monday morning, March 21 at the Waldorf will feature a talk by A. V. Loughren of Hazeltine.

At the Annual IRE banquet Wednesday evening at the Waldorf, Gen. Matthew B. Ridgway will be the principal speaker.

▶**Guide**—To aid engineers in scheduling and covering all activities that relate to their particular field of interest or specialization, the technical sessions guide at the top of the following page groups, in alphabetical order, the 55 meetings according to main topic to be discussed. Last minute changes in the present scheduling plan can be checked at show headquarters in the Waldorf.

Technical Sessions Guide For 1955 IRE Show

Morning sessions: 10 am to 12:30 pm
Afternoon sessions: 2:30 pm to 5 pm
Night sessions: 8 pm to 10:30 pm
* Session ends at 12:00 Noon

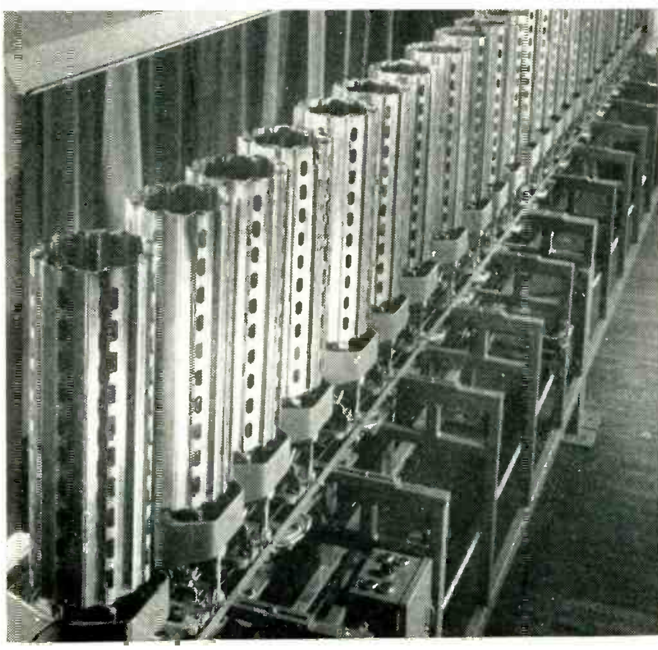
Session	Time	Place
Aeronautical And Navigational Electronics		
Part I	Tues. Morn.	Waldorf
Part II	Tues. Aft.	Waldorf
Part III	Thurs. Aft.	Armory
Antennas And Propagation		
Part I	Mon. Aft.	Waldorf
Part II	Tues. Morn.	Waldorf
Part III	Wed. Morn.	Armory
Part IV	Wed. Aft.	Armory
Audio		
Part I	Tues. Morn.	Waldorf
Part II	Tues. Aft.	Waldorf
Part III	Tues. Night	Armory
Automatic Control		
Part I	Mon. Aft.	Armory
Part II	Tues. Night	Waldorf
Production Techniques	Wed. Morn.	Waldorf
Broadcast And Television Receivers	Wed. Aft.	Waldorf
Broadcast Transmission Systems		
Part I	Tues. Morn.	Waldorf
Part II	Tues. Aft.	Waldorf
Circuit Theory		
Part I	Mon. Aft.	Armory
Part II	Wed. Morn.	Armory
Part III	Wed. Aft.	Armory
Communications Systems	Mon. Aft.	Waldorf
Also see Microwave Communications		
Component Parts		
Part I	Thurs. Morn.	Waldorf
Part II	Thurs. Aft.	Waldorf
Electronic Computers		
Part I	Wed. Morn.	Waldorf
Part II	Wed. Aft.	Waldorf
Part III	Thurs. Morn.	Armory
Electron Devices		
Part I	Tues. Morn.	Armory
Part II	Tues. Aft.	Armory
Part III	Thurs. Morn.	Waldorf
Part IV	Thurs. Aft.	Waldorf
Engineering Management		
Part I	Tues. Aft.	Waldorf
Part II	Thurs. Morn.*	Waldorf
Part III	Thurs. Aft.	Waldorf
Industrial Electronics	Mon. Aft.	Waldorf
Information Theory		
Part I	Tues. Morn.*	Waldorf
Part II	Thurs. Morn.	Waldorf
Part III	Thurs. Aft.	Waldorf
Instrumentation		
Part I	Mon. Aft.	Belmont-Pl.
Part II	Tues. Aft.	Belmont-Pl.
Instrumentation And Nuclear Science	Wed. Morn.	Waldorf
Instrumentation And Telemetry And Remote Control	Tues. Morn.	Armory
Medical Electronics		
Part I	Thurs. Morn.	Belmont-Pl.
Part II	Thurs. Aft.	Belmont-Pl.
Microwave Theory And Techniques		
Part I	Wed. Morn.	Waldorf
Part II	Wed. Aft.	Waldorf
Part III	Thurs. Morn.	Armory
Microwave Communications And Systems	Thurs Aft.	Armory
Also see Communications Systems		
Mobile Communications	Mon. Aft.	Waldorf
Nuclear Science	Thurs. Morn.	Waldorf
Also see Instrumentation And Nuclear Science		
Quality Control And Reliability Studies Of Electronic Tubes And Systems	Wed. Aft.	Waldorf
Spurious Radiation Symposium	Wed. Morn.	Waldorf
Telemetry And Remote Control		
Part I	Mon. Aft.	Waldorf
Part II	Tues. Morn.	Belmont-Pl.
Part III	Tues. Aft.	Armory
Also see Instrumentation And Telemetry		
Ultrasonics		
Part I	Wed. Morn.	Belmont-Pl.
Part II	Wed. Aft.	Belmont-Pl.

Mechanized Assembler Builds Air Force Computers

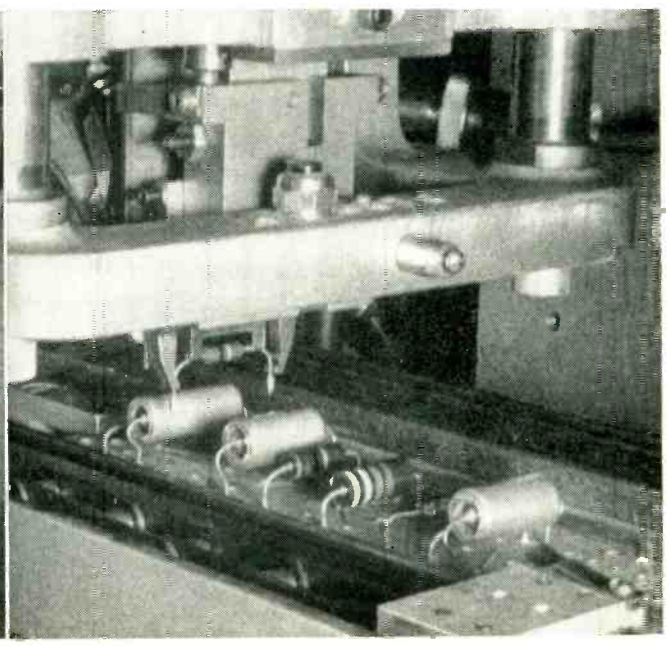
New 24-head machine inserts all components in printed-circuit panels at high speed

EVEN FOUR-LEAD pulse transformers are automatically inserted in punched holes of printed-circuit panels by the new production robot built by General Mills for IBM. The machine will be used for complete assembly of the many different types of subassemblies required in giant ground-station early-warning radar computers being built for the U. S. Air Force. It can turn out up to 200,000 panels per month.

▶ **Features**—In this mechanized assembly system use is made of cone-shaped metal wrap-around sleeves on the ends of all leads. These serve to give good mechanical joints before soldering, and also permit positioning all components a fixed distance off the panel as re-



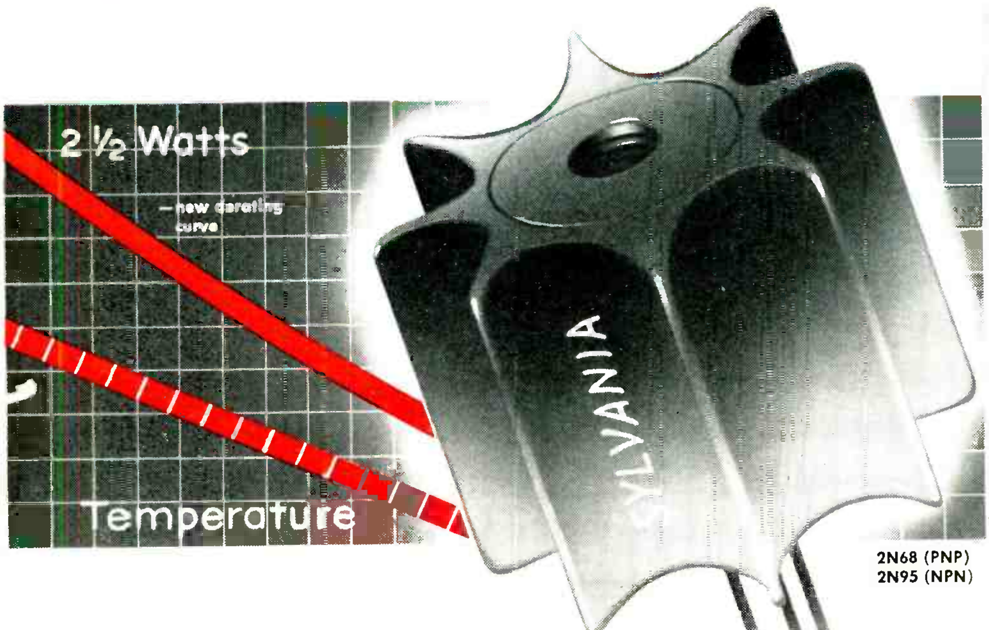
Autofab 24-head machine delivers complete panels at lower left, ready for dip-soldering



Resistor-inserting position, showing how conical sleeves on leads are pushed into panel holes

(Continued on page 10)

Sylvania Power Transistors...



2N68 (PNP)
2N95 (NPN)

...now with increased ratings

dissipate 2½ watts in free air, have low thermal inertia

NEW Sylvania design developments achieve low thermal inertia and increased ratings in the Sylvania Power Transistors 2N68 and 2N95. Dissipation of 2½ watts in free air reflects a full watt increase over previous ratings. Power dissipation up to 5 watts is possible with an external heat sink.

With Sylvania's new design heat is conducted quickly away from active elements. Resulting low thermal inertia improves performance stability over a wider range of operating temperatures. Operated as a Class A amplifier the 2N68 or 2N95 provides a minimum power gain of 20 db.

"Another reason why it pays to specify Sylvania"
SYLVANIA ELECTRIC PRODUCTS INC.
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Sylvania Transistors — for military, industrial, and commercial applications. Available in commercial quantities.

High-Gain, Low Frequency—2N35 (NPN)—2N34 (PNP)—low to medium power—use as a high-gain audio amplifier—gains up to 40 in grounded emitter circuit.

High-Power, Low Frequency—2N68 (PNP)—2N95 (NPN) increased power ratings—use for high current, low voltage applications (6-24 volts power supplies).

High Frequency—2N94 (NPN)—2N94A (NPN)—high alpha (over 0.95)—low base resistance and collector capacitance—typically 1500 ohms uufd—gains up to 40 db.

Also available in commercial quantities

Silicon Junction Diodes—1N137A—1N138A and allied types—high back resistance at high operating temperatures.

Silicon Point-Contact Diodes—1N193, 1N194, 1N195, 1N196—specifically designed for computer and high temperature general purpose applications. Excellent transient response (0.1 u sec.)

For your semiconductor requirements, check Sylvania first. Use this convenient form to indicate your interests and address it to Department C20R.

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Sylvania Electric Products Inc.
1740 Broadway, New York 19, N. Y.
Gentlemen: Please forward additional information on the items checked below:

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☐ High Frequency

Silicon Diodes
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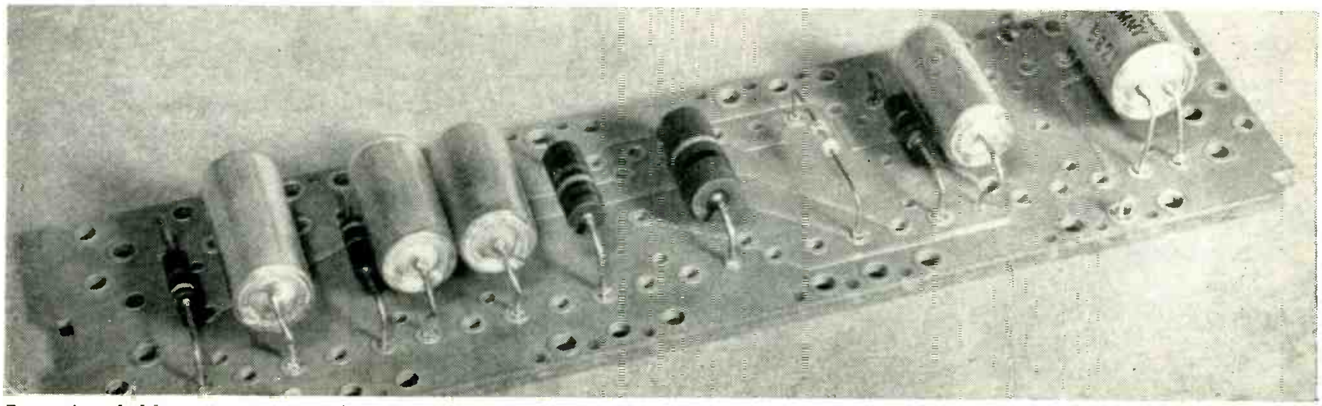


Example of 11-component panel assembled by machine, with four-lead pulse transformer at right. Extra punched holes permit use of same panel with different printed wiring for other circuits of computer, cutting panel-punching costs

quired when printed wiring is on both sides.

A preparation machine straightens and cuts leads of components, then crimps on the sleeves with sufficient force to cut through dirt and oxide. The components then drop into magazines, ready for use on the Autofab machine.

Panel holes are much larger than usual, to accommodate the sleeves. The dies of the inserting heads push down on the sleeves, jamming them against the etched wiring surrounding the holes.

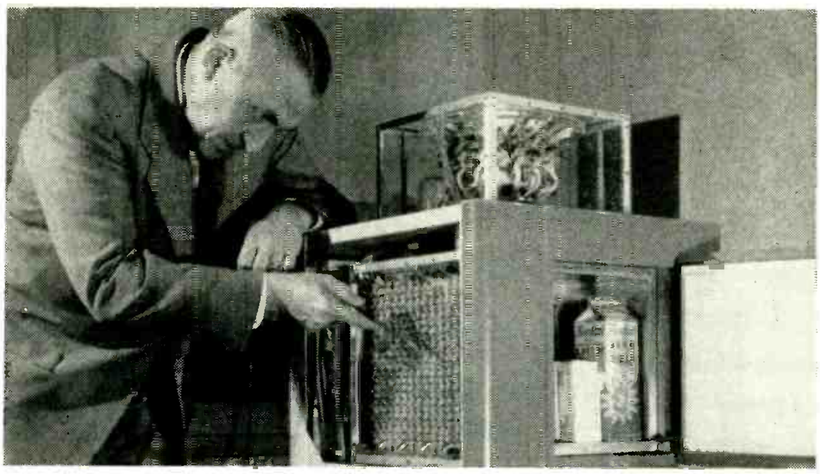
▶ **Operation**—Use of eight magazines per insertion head gives an average capacity of 600 components per head. When one magazine is empty, the magazine turret advances automatically. Empty magazines can then be filled at leisure while the machine is running. If a head exhausts its supply or a jam occurs, a warning light flashes and the entire machine stops, so that no defective panels are produced.

▶ **Flexibility**—The machine can be adjusted to take printed-circuit plates ranging from 2 to 10 inches in width and in length. The plates ride directly on the precisely controlled conveyor, eliminating need for pallets. Insertion heads are easily moved or changed since each is held in position by two bolts and weighs only 25 lb.

With other adjustments, parts can be inserted conventionally without sleeves for mounting directly on the panel. Leads can be inserted in holes spaced closer together than the length of the component.

Components can be purchased in bulk from a variety of suppliers since all special processing is done right at the machine. When polarity is unimportant, components are simply dumped into the hopper of the preparation machine, where a Syntron vibrator lines them up for processing.

The machines were developed in Minneapolis by the Mechanical Division of General Mills, under the supervision of Dr. Cledo Brunetti, director of engineering research and development. Work is progressing on an automatic dip-soldering section.



SCIENTIST inspects electrothermal junctions as . . .

Electronic Cooler Makes Progress

IN THE YEAR 1834, Jean Charles Peltier, French physicist, discovered that when an electric current passed through a junction of dissimilar metals, the junction was either heated or cooled, depending upon the direction of the current across the boundary.

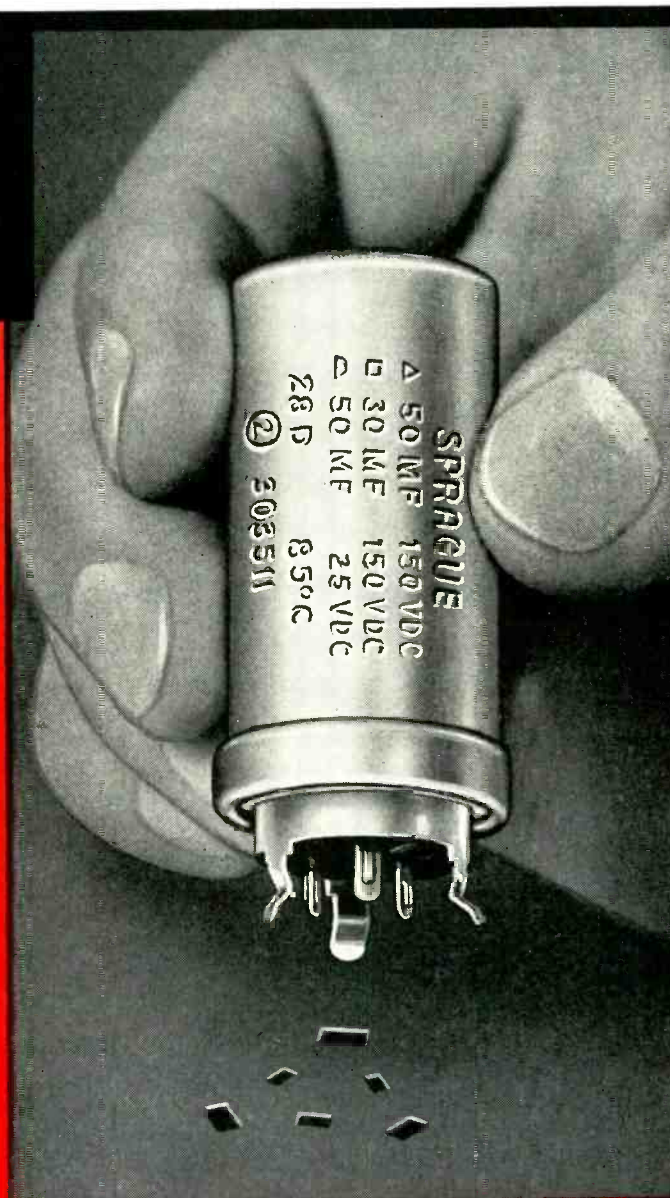
The cooling or heating is a direct function of the current and in this respect differs from the kind of heating that results when current is passed through a copper wire or other conductor. This heating increases with the square of the current. There is no cooling effect produced.

Some 120 years after Peltier, Nils E. Lindenblad of RCA Laboratories has successfully employed the famed physical effect to refrigerate food and freeze ice cubes, describing the development as a progress report in unwritten form. Lindenblad is chary about describing the superior materials and techniques used because he says that they have

(Continued on page 12)

A SNAP FOR WIRING BOARD ASSEMBLIES

NEW Sprague Type 28D Push-Lok* Electrolytic Capacitors Give Fast, Fool-Proof Mounting



HERE'S THE BEST APPROACH yet to electrolytic capacitors for printed wiring board assemblies.

It's Sprague's new Type 28D Push-Lok Electrolytic. Just insert the connecting lugs through the slots in the wiring board, and the capacitor is held securely in place until the chassis is ready for dip soldering . . . so securely that solder gaps are eliminated. Spring action of the Push-Lok lugs is strong enough to hold relatively heavy capacitors in place, even when the board is carried sideways, or upside-down on a conveyor. Tab connections are always in close contact with the printed conductors. Yet, unlike other designs, no secondary operations are required for this fast and secure mounting.

Other advantages include:

Fool-Proof Positioning—A Push-Lok can only be inserted the right way. A wide index terminal is provided in the mounting ring to index the assembly on the chassis or other surface if desired.

The Ability to Print Wiring Boards on Both Sides—Shoulders on the Push-Lok lugs plus additional prongs keep the capacitors clear of the chassis.

Safety—Circular shield conforms with suggestions of Underwriters' Laboratories, Inc. Tools cannot be inserted easily between the bottom of the capacitor and the chassis.

FOR COMPLETE INFORMATION on these new Type 28D Push-Lok electrolytic capacitors, write for Engineering Bulletin to Sprague Electric Co., 35 Marshall Street, North Adams, Massachusetts.

**Push-Lok is a Trademark of the Sprague Electric Company*

Sprague, on request, will provide you with complete application engineering service for optimum results in the use of electrolytic capacitors.

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already been improved.

▶**Materials and Power**—The electronic refrigerator does not use bismuth and antimony (commonly employed in college laboratories to demonstrate the effect) as such, although they form part of the ingredients. Nor is the junction material necessarily a semiconductor. From such guarded reports, it appears that there is more than one approach. Lindenblad states that there are no limitations in theory to the economic feasibility of the electronic method.

Whereas the cooling junctions (some 200 of them in the experimental cold box) require direct current of about 25 amperes at 20 volts or less, this current can easily be supplied by a commercial rectifier built into the unit and plugged into the wall socket. Power consumption will be about the same for electronic or conventional units.

A trickle of tap water was used to remove the heat absorbed by the experimental cooling unit. Nonmechanical methods known, but not yet employed, are promised.

In the prototype, there are actually two types of cooling junctions. For freezing water, the thermojunctions are in direct contact with the vessel in which ice is made, whereas the cooling compartment is a double-walled structure within which water circulates. Thermal junctions mounted on panels cool the water. For the same amount of cooling, it takes more thermocouples for the cooler than for the freezer.

NAM Wants In Mobile Radio

PERMISSION to share unassigned f-m broadcast frequencies between 92 and 108 mc is asked by Committee on Manufacturers Radio Use of the National Association of Manufacturers. Claiming no interference with existing broadcasting stations if assignments are made on a noninterference basis, the group feels this move will pave the way for expansion of radio use by all safety and industrial services.

The manufacturers, who are now included in the Special Industrial Radio Service, state they have increased the number of stations 800 percent in the last five years, while f-m stations decreased 25 percent.

Finder Accelerates Tetrode Transistor Production

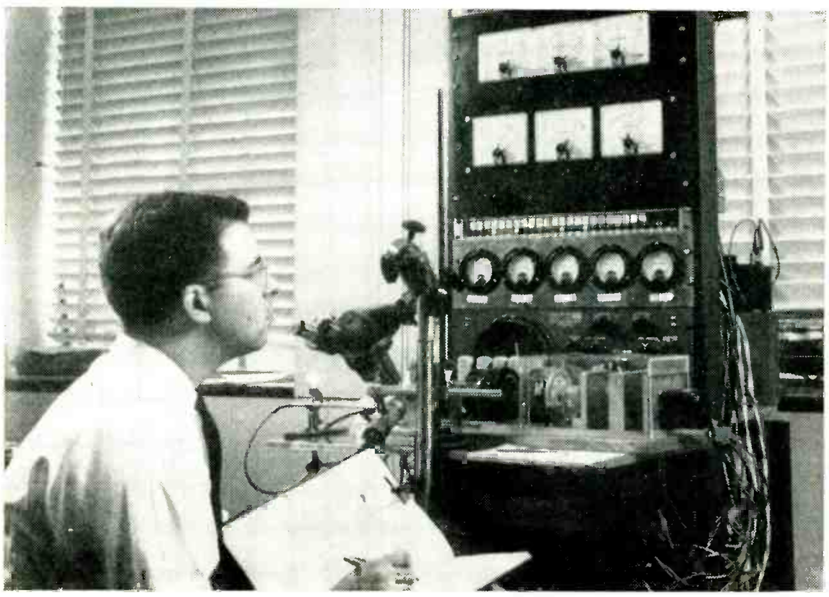
TRANSISTORS, like most other products, will be more reliable, more available and will cost less only after means have been found to turn them out in production quantities. Rejects will have to be reduced to a small fraction of total output.

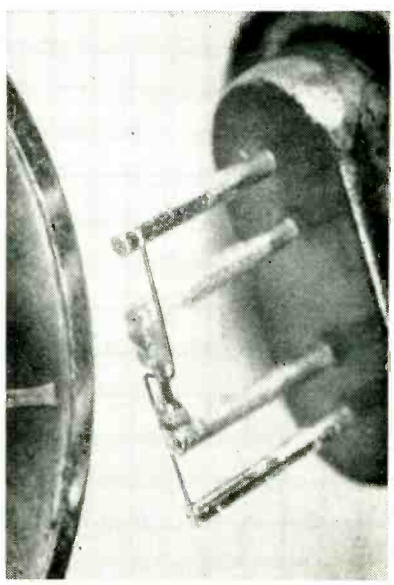
Scientists at Bell Labs have found a way to mechanize one of the most difficult steps—attaching electrodes to the semiconductor bar—that bottlenecks their own experimental production. Unwilling themselves to forecast the effect of their development, the physicists showed conclusively that machinery can eliminate a watchmaking technique and cut production time by some 80 percent.

▶**Finding the Spot**—The machine, dubbed Mr. Meticulous by his human builders, accepts a semiconducting bar the length of a match head and nearly as thin as a human hair. A fine gold wire is lowered onto the surface and the bar is moved along in steps of 50 millionths of an inch.

Somewhere near the middle of the bar is a wafer of critical material 1/20,000 inch wide. The machine stops the gold wire on the center of this wafer and a welded connection is made.

The bar is then reversed, end for end, and the process repeated. When the tetrode transistor is completed, the machine automatically makes a





Automatic electrode-attaching machine under the watchful eye of R. P. Riesz of Bell Labs displays colored lights and meter readings that monitor progress of junction. Gold wires attached between junction and output terminals (right) shown magnified many times and compared with edge of a coin

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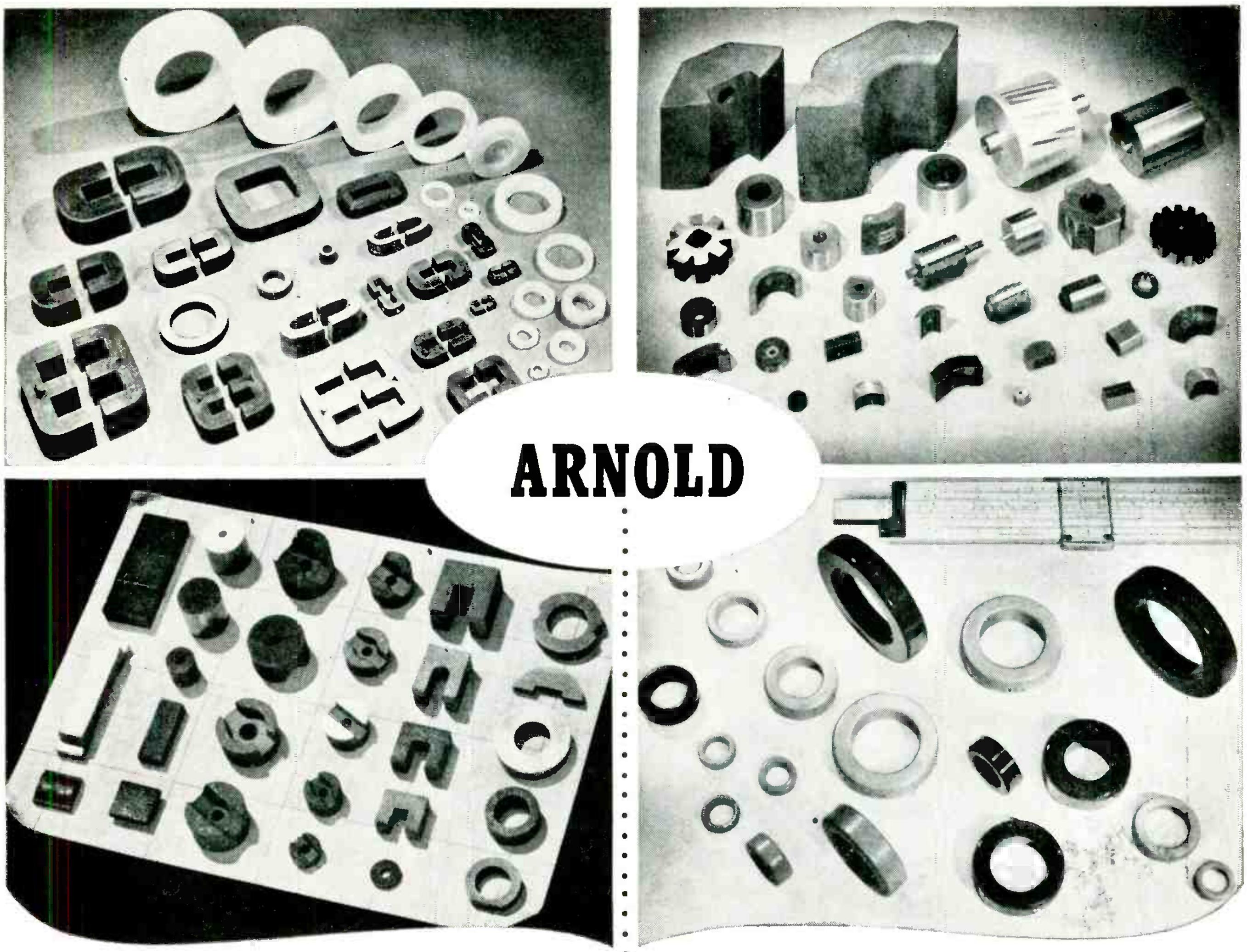

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In other words, Arnold magnetic materials can answer *any* requirement you may have. It is the *only* complete line in the industry; and in addition, Arnold maintains complete control over every production step from raw materials to finished products. Such a source can bring you advantages in long experience and undivided responsibility, and in unequalled facilities for quality production and control. ● ***Let us supply your needs.***

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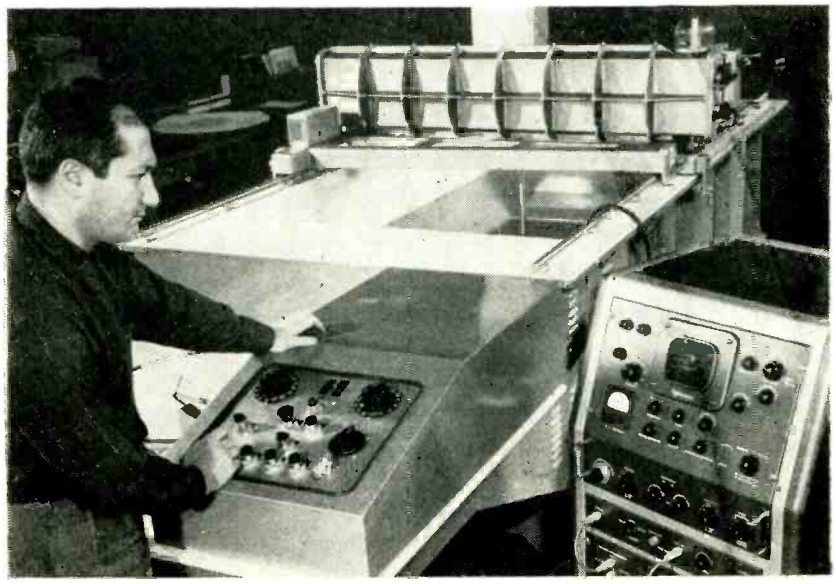
test run on its characteristics, displaying results on three meters. The technique can likewise be employed in the manufacture of triode types.

▶ **Practical Applications**—The device shown in the laboratory is not a machine into which raw materials can be poured—it is just one important step in a manufacturing process. In the factory, where it is sure to go, and soon, it can be combined with material-handling equipment to speed production of finished transistors. There will still be some rejects, but their cause will not depend upon fatigue of personnel laboriously assembling minuscule parts under a microscope.



JET engine makers use audio generating gear as . . .

Ultrasonics Gains Sound Footing

HIGH-FREQUENCY sound is shaking up things in fields varying from jet engine manufacture to beer production. Recent showings have introduced new equipment for applications in these fields as well as for medicine, parts cleaning and nondestructive testing.

A $50,000 immersion-type flaw detector for examination of jet engine rotors has been designed and built by Sperry Products Inc. for Westinghouse. Using a quartz crystal probe on a motor-driven mount, the operator can examine the entire rotor casting without leaving the control panel. Flaw indications are presented on a cathode-ray tube and on a chart.

A similar unit built for the Allison Engine Co. has the motion of the pick-up probe controlled by a digital computer. A punched tape for each rotor shape in production operates the probe drive to cover the entire area of the piece. The $300,000 unit has stepped up inspection speed from two rotors per day using manual checking to 20 to 25 per day with the computer-controlled ultrasonic scanner.

Another industrial unit inspects welded steel tubing at rates up to 125 feet per minute, automatically marking defective pipe sections.

▶ **Food Field**—A homogenizing unit for chocolate and an extractor for hops are two ultrasonic devices for food processing introduced by Curtiss-Wright Corp. The chocolate homogenizer is claimed to increase the flavor of chocolate without the use of chemical additives.

The hop extractor provides a means of obtaining a 90 to 94-percent yield of the bitter substance of hops used in the making of beer.

Specialized Computers Perform Varied Tasks

When versatility isn't required special-purpose and tailor-made machines take over

MILLION-DOLLAR computers of the large general-purpose variety are valued for their versatility in programming. The machines can be set up to do a great many different data-handling jobs.

However, in many businesses the same operation must be performed over and over. A computer tailored to the particular operation can often save money both in capital investment and personnel training. These cost $20,000 to $500,000, depending upon their data-handling capacity. Here are a few of the things specialized computers do:

▶ **Compute** and record automatically the weight of iron ore in transit from the Mesabi Range to the Great Northern railroad's ore docks on Lake Superior. Great Northern handles 32 million tons of ore a year and during the rush season, 180 ore cars leave the gathering point at two-hour intervals.

As cars pass the computer operator at the rate of 3½ per minute, he enters the car number and the computer does the rest *(Remington Rand)*.

▶ **Handle** the proof and sorting of bank checks for the Bank of America. Pilot installation is to be made in two months *(International Telemeter)*.

▶ **Tally** orders for 12,000 different catalog items and accommodate approximately 100,000 orders a day at John Plain Co., Chicago mail-order house *(Remington Rand)*.

▶ **Determine** the availability of seats on 1,000 airplane flights for a 10-day period. If all seats are gone on the desired flight the machine provides an alternative booking. Information is fed to the machine directly from the agent's set *(Teleregister)*.

▶ **Receive** aircraft flight plans from several points by teleprinter,

(Continued on page 16)

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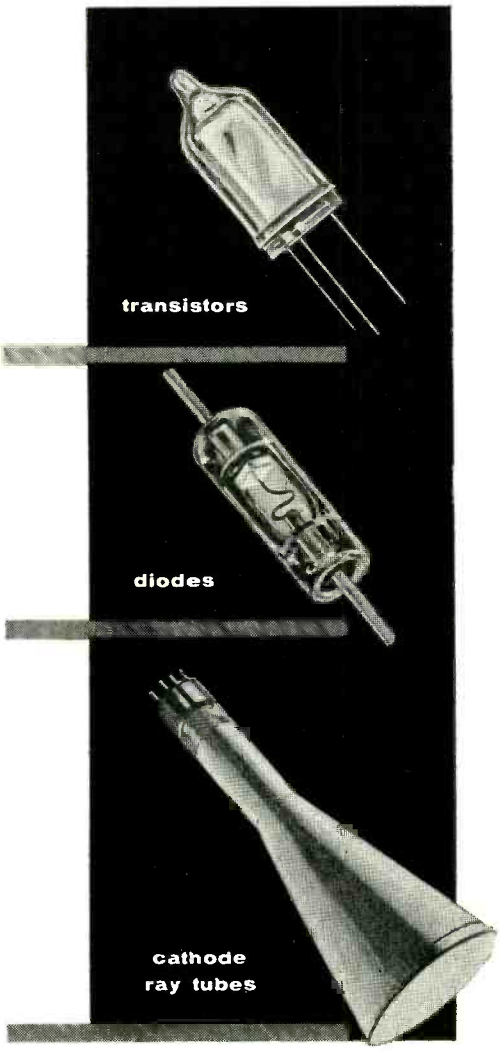
profitable
automatic production...

call on KAHLE



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If you're making (or plan to make) *diodes, transistors, sub-miniature, miniature, cathode ray tubes, or other electronic tubes or component parts,* take full advantage of Kahle's invaluable experience.

With Kahle methods and "know-how" you're sure of getting exactly the right machinery to produce exactly what you want...accurately, dependably, profitably.

For more than a quarter of a century the leaders in the electronics field have relied on Kahle for production machinery. Typical production steps automatically performed by Kahle equipment include sealing, bulb making, stem making, exhausting, grid winding, filament coil winding, lead wire welding.

Write today for additional details, equipment specifications, production data, and quotations.

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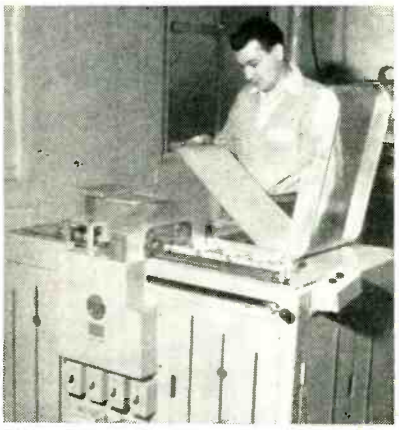
check them and file up to 2,000 for immediate access for the Civil Aeronautics Administration in Indianapolis (*Remington Rand*).

▶ **Provide** $4\frac{1}{2}$ stock quotations per second for 600 stocks on Toronto Stock Exchange to serve 200 brokers. Operator on stock exchange floor enters price changes *(Teleregister)*.

Tape Controls Panel Hole Pattern



AN automatic programmed-production machine that promises time-and-cost savings in printed-circuit manufacturing has been developed by Radio Corporation of America. The machine is expected to sell for \$14,500 and should be on the market in six months.

▶ **How It Works**—A glass-based cloth tape contains master holes for any combination of component holes in printed-circuit panels. When the control tape is fed into the machine, its punches are precisely and uniformly triggered in the pattern dictated in the tape.

It takes approximately four hours to prepare the tape and about three minutes to install it in the machine.

▶ **Specifications** — The holes punched are 0.052 inch in diameter at 0.10-inch grid intersections. Panel material can be glass-based or paper-based-laminate boards of $\frac{1}{16}$ or $\frac{3}{32}$-inch thickness. Pattern sizes on the panels can be as large as 6×17.6 inches.

Transistor Quality Improves

PERFORMANCE of transistors in hearing aids after a year of use indicates that the operation of transistors is as good as, and in some cases better than, comparable tubes.

Return rate on transistorized hearing aids, under a one-year service guarantee, is reported to be about the same as for tube units by Sonotone Corp. of Elmsford, N. Y. In the case of a four transistor high-gain model for severe hearing loss, returns are considerably lower than the previous tube model.

Improvement in the quality of transistor production is indicated by the fact that the first models of a three-transistor unit had a higher return rate than the tube model it superseded. Later production of the same model gradually decreased in return rate until present returns are now the same as for the tube model.

▶ **Gain**—Using the earlier transistors, preproduction sorting divided the transistors into three groups with a 12-db spread in gain permitted in each group. Closer control in transistor manufacture has permitted the reduction of the spread to 6 db. This spread in gain is comparable to that found in tube production.

Quality control of transistors purchased from a number of manufacturers shows that the main causes for rejection are high noise level and high collector current. The main cause for returns from the field are intermittent operation and completely inoperative transistors.

TV Output Mushrooms In Canada

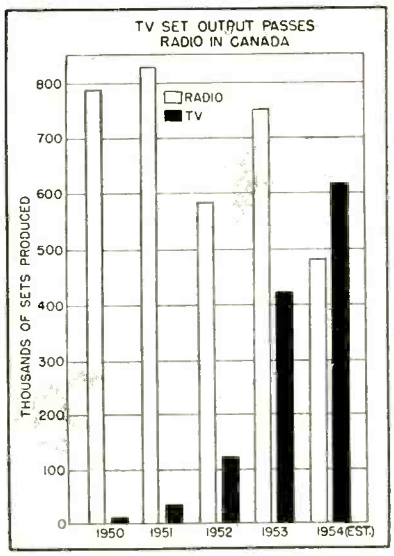
Radio shows marked decline but tv set output surges ahead with continued vigor

CANADIAN television set manufacturers broke previous production records in 1954 with an output of 620,000 sets, nearly 200,000 more than were produced in 1953.

Radio set production declined, however, from some 750,000 sets in 1953 to below 500,000 last year. For the first time, tv set output surpassed that of radio in the Dominion.

▶ **Trade**—A sizeable number of radio and tv sets continue to be imported into the country. Last year nearly 35,000 sets were imported, mostly from the U. S. In 1953, over 58,000 sets were imported and in 1952 set imports totaled over 82,000.

Canadian exports of tv and radio sets also declined last year as domestic sales increased. An estimated 17,500 receivers were exported during the year compared to over 22,000 in 1953 and 33,000 in 1952.

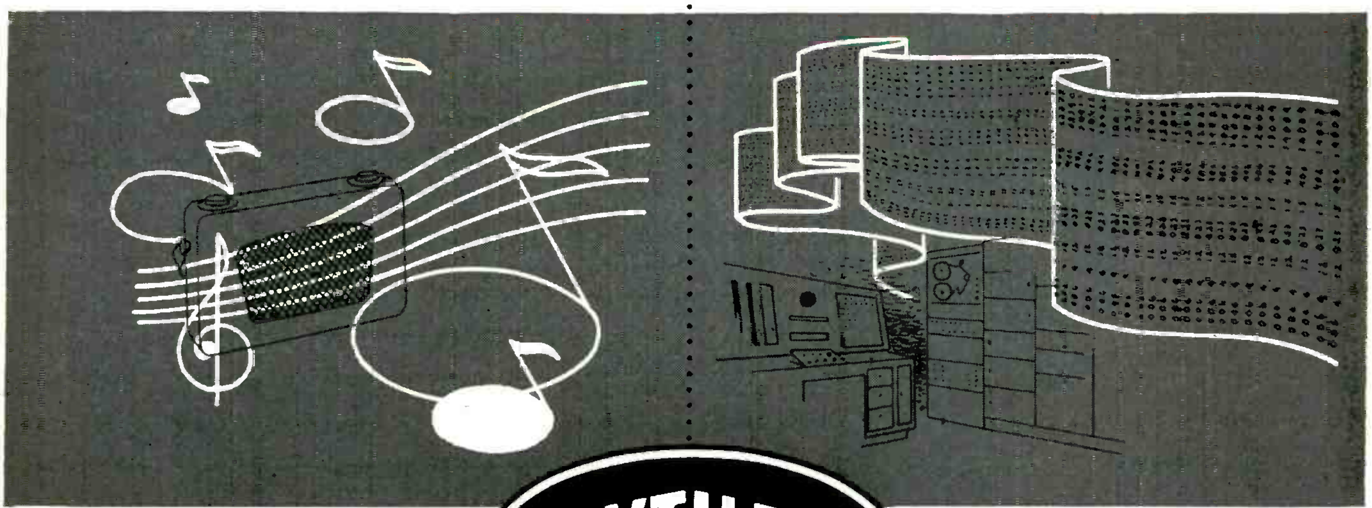


▶ **Prices**—Factory prices of television sets made in Canada have experienced a decline in the past few years similar to that which has taken place in the U. S. Last year the average value of sets shipped from Canadian factories was approximately \$350, more than \$50 below the 1953 average of \$406. In 1952, the price average was \$442. Despite these drops, Dominion tv

(Continued on page 20)

for your product

whether it PLAYS or COMPUTES



RAYTHEON

RF TRANSISTORS

RADIO APPLICATION

Raytheon RF Transistors create a whole new concept of portable radio convenience, performance and economy — portable radios that run for 500 hours on ordinary, low cost universally available flashlight batteries, and that *really* outperform most tube portables.

	CK760	CK761	CK762
Gain in db at 455 Kc.	32	33	33
Gain in db at 2000 Kc.	18	20	22

COMPUTER APPLICATION

Raytheon RF Transistors combine high alpha cutoff, fast rise time, the desired dissipation and voltage ratings and excellent base current amplification. They mark a milestone in computer development, design and progress.

	CK760	CK761	CK762
Rise time (μsecs)	0.05	0.04	0.02
Decay time (μsecs)	0.06	0.05	0.03

(measured in circuit which will be supplied on request)

	CK760	CK761	CK762
Alpha frequency cutoff (megacycles)	5	10	20
Collector capacitance ($\mu\mu$fd)	15	15	15
Extrinsic base resistance (max. ohms)	125	125	125

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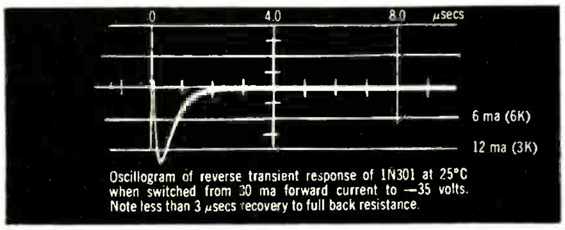
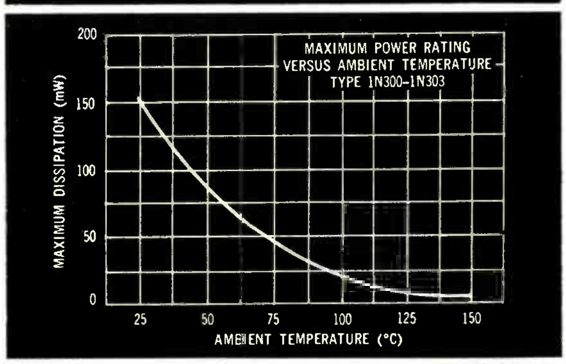
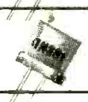
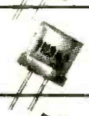
SILICON DIODES

Charted here are some of the performance characteristics and features of four of these Silicon Diodes. Other characteristics can be supplied to your requirements. Other Raytheon Silicon, Gold Bonded Germanium and Point Contact Germanium Diodes are available. Complete data is yours for the asking.





		RATINGS AT 25°C AMBIENT						RATINGS AT 100°C AMBIENT		
Diodes Shown Actual Size	Type	Minimum Forward Current @ +1.0 volt (mA)	Maximum Continuous Reverse Voltage (Volts)	Minimum Zener Voltage (@ 100μA) Volts	Maximum Reverse Current @ —10V (μA)	Maximum Average Dissipation (mW)	Maximum Average Forward Current (mA)	Maximum Reverse Current @ —10V (μA)	Maximum Average Dissipa-tion (mW)	Maximum Average Forward Current (mA)
	1N300 (CK735)	8.0	12	15	0.001	150	40	0.01	20	15
	1N301 (CK736)	5.0	60	70	0.01	150	35	0.2	20	12
	1N303 (CK738)	3.0	115	125	0.01	150	30	0.2	20	10
	1N302 (CK737)	1.0	215	225	0.01	150	25	0.2	20	8

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For application information write or call the Home Office or: 4935 West Fullerton Avenue, Chicago 39, Illinois, NAtional 2-2770

589 Fifth Avenue, New York 17, New York, PLaza 9-3900 ● 622 South La Brea Ave., Los Angeles 36, California, WEbster 8-2851

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set prices are approximately $100 above the average price of tv sets sold at retail in the U. S.

▶ **Companies**—Although the basic reason for the rise in tv production in Canada is the growth in its number of tv stations, another important reason has been the increasing number of U. S. set manufacturers that have established plants there. At present, there are about a dozen U. S. set makers with plants in the country representing nearly half of Canada's set industry. In addition, an increasing number of U. S. component manufacturers are establishing or expanding production facilities across the border.

Parts Makers Try New Packaging

Bulk packs for hopper feed compete with magazine packs and reels of tape-belted units

MACHINES for inserting parts in printed-circuit panels make news today. As the automatic machines evolve in a variety of forms, each with different feed systems, the need for standardization on packaging of components becomes more and more evident.

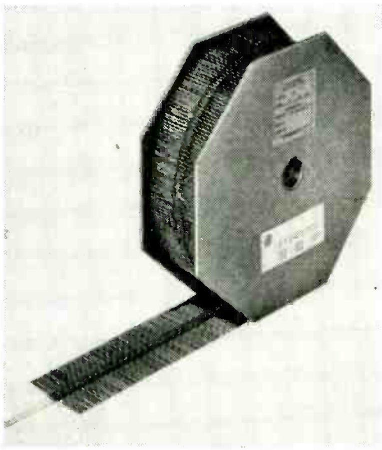
The big question is whether component manufacturers will continue to use conventional bulk packaging, or whether they will have to make up special packs to meet input requirements of the various machines.

▶ **Reels**—Allen-Bradley now puts up fixed resistors in expendable 12-inch reels holding 5,000 half-watt units. Belting is achieved by pressure-sensitive tape that runs across the resistor bodies. A 12-inch leader precedes the first resistor, for loading into the machine and for splicing to the belt of an emptying reel.

United Shoe uses four lengths of tape to make up a belt that supports parts by their leads. The tape lengths, facing each other in pairs with the leads between, go into scrap with the lead ends as parts go through the cutting dies of the machine.

Stackpole Carbon is preparing to sample the trade with two or more types of reel or tape packaging. At present it uses a corrugated cardboard strip pack suitable for some types of automatic feed.

▶ **Magazines** — Although expendable magazines are a possibility, the trend at present is toward use of accessory magazine-loading machines right in the assembly plant. Here bulk-packed parts of any form are dumped loosely into a hopper for orientation by a Syntron vibrator that feeds to the magazines being loaded. Special vendor packaging or hand loading is required only for parts having polarity requirements, such as crystal diodes.



Single tape on resistor bodies forms belt for Allen-Bradley reel package

▶ **Bulk Packs**—A special carton holding 2,500 half-watt resistors, packed with straight leads for convenient hopper-feed into magazines or moving racks, is IRC's fundamental approach to the problem. By designing around conventional straight leads and the cheapest and most compact shipping container for all customers, they are able to mass-produce a half-watt 20-percent tolerance insulated resistor selling to the end- equipment manufacturer at 1.2 cents each in quantities of 5,000 and over.

In general, engineers favor the bulk pack, with any special magazine- loading or belt- forming equipment located in the assembly plant.

Moving Engine X-Rayed with ITV and Betatron

Big industrial x-ray machines make news as NBS develops new system

PISTONS and rods moving up and down inside the cylinders of engines in actual operation can now be seen on television screens, by means of an x-ray televising system developed by the National Bureau of Standards.

The x-ray beam from a betatron is directed through the engine onto a special fluorescent screen made from a thallium-activated sodium iodide crystal that may be up to 7 inches in diameter and 1 inch thick. The visual image on this screen is picked up by a remotely controlled industrial television camera, which transforms the image to a safer locale and intensifies as well as enlarges it for viewing on a closed-circuit tv monitor.

Addition of a timing mechanism permits x-ray stroboscopic studies. For thicker-walled engines, the NBS synchrotron can be used.

U. S. Budget Jets Electronics Spending

Firms in the field will get more defense business in fiscal 1956 from allied equipment

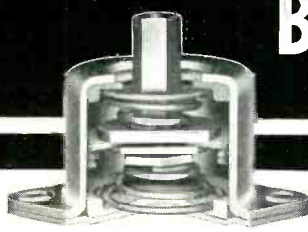
DESPITE the fact that the electronics-communications expenditure figure of $653 million in the proposed U. S. budget for fiscal 1956 is some $145 million lower than the amount to be expended by the end of fiscal 1955, Defense Department officials expect that electronics expenditures, taken as a whole, will move upwards during the period. This is based on increased expenditures for electronics, in such equipment as aircraft, ships and parts of missiles, which is not included in the electronics-communications figure.

▶ **Changes**—In the President's budget message, he indicated that about two-thirds of the projected Defense Department expenditures

(Continued on page 22)

NEW

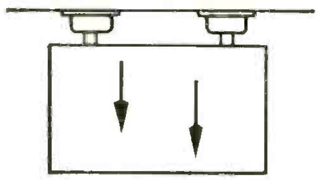
ALL-ANGL BARRY MOUNT

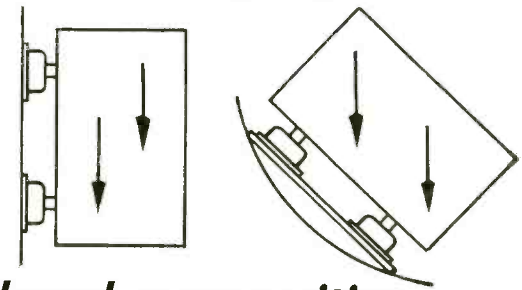


Works at any angle

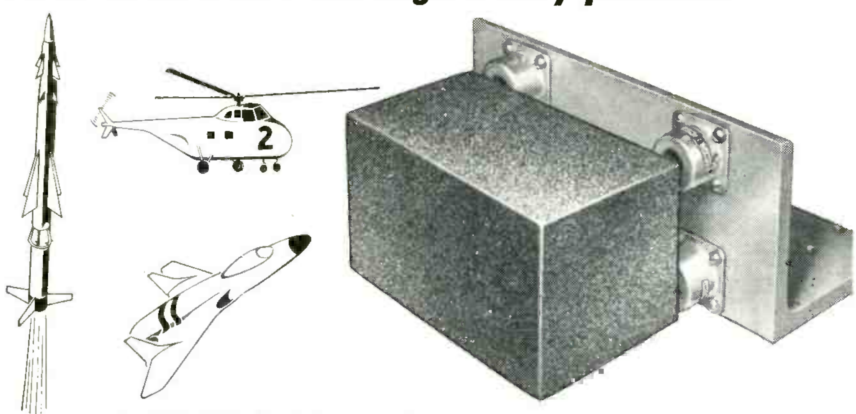
ALL-ANGL **BARRY MOUNT**

Cup diameter ....1 inch
Maximum load ....3 pounds
Weight ....less than 1 ounce





...in maneuvers through every position



...with HIGH DAMPING in all directions

Now you can forget all limitations on mounting positions for delicate apparatus. You can design for easiest installation and best space utilization, because the new Barry ALL-ANGL vibration isolator works in any position. Upside down, on a bulkhead, at any slant—position means nothing to this new BARRYMOUNT.® Damping is exceptionally high in all directions; transmissibility at resonance is less than 3. The ALL-ANGL mount is interchangeable with other miniature BARRYMOUNT isolators.

This isolator is the answer to your toughest vibration-protection problems. Let us show you what it will do for you — at the New York I. R. E. Show; or write for Bulletin.

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in fiscal 1956 will be devoted to air power and related programs, which include electronics. Expenditures for ground communications is expected to go down and stay down for some time. On the other hand, it has been indicated that electronics research and development spending for the overall defense program will remain at about the same level.

▶ **Trend**—Here is the way the electronics communications expenditures by the defense department have run in the past few fiscal years: 1956, $653 million; 1955, $798 million; 1954, $826 million; 1953, $1,001 million; 1952, $597 million and 1951, $193 million.

Total defense department expenditures were broken down among the Army, Navy and Air Force during these years as shown in the table:

Fiscal Year	Army	Navy	Air Force
1956 (Est.)	$113	$120	$420
1955 (Est.)	183	243	372
1954	231	274	320
1953	512	235	254
1952	266	121	210
1951	53	50	90

▶ **Hidden Business** — Electronics items that are not included in the electronics-communications budget are: equipment in aircraft, ships, combat vehicles, artillery, guided missiles, ammunition, weapons and maintenance and replacement items.

Hollow Tubes Carry Conversations

Section of copper waveguide through which a Bell Labs engineer is peering will simultaneously carry tens of thousands of conversations and hundred of tv programs. For technical details, see p 212

Yachtsmen Boost Electronics

Radiotelephones increase as manufacturers probe markets for related equipment

MANUFACTURERS of marine electronic equipment plan to carve out an increasingly large slice of the $800-million yachting and boating market as owners install more and more electronic gear aboard their vessels.

▶ **Radiotelephone**—Most popular item is a radio telephone transmitter-receiver. More than 40,000 of these sets are licensed. Manufacturers view every owner of a boat over 30 ft long as a potential customer. There are over 200,000 such vessels. Radiotelephones range in power from 12 to 150 watts and cost between $300 and $2,000 installed.

▶ **Other Equipment**—Some currently available loop-type direction finders sell for about $300. A portable d-f set to sell for $170 is under development. A recently announced small-boat d-f features dial tuning. When a station is tuned in a needle automatically indicates its direction.

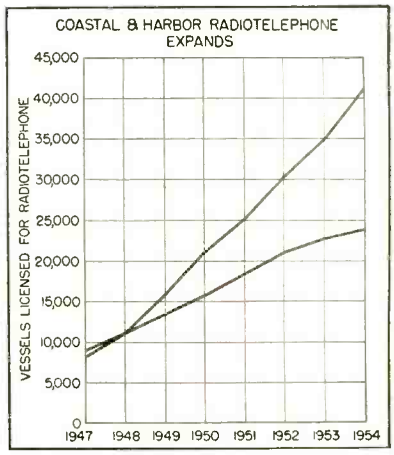
Some interest is shown in sonar equipment and depth finders although this type of gear finds greatest use aboard commercial fishing boats. Equipment for locating schools of fish costs $2,200 and up. However, for the pleasure craft owner there is an oscillographic depth recorder that sells for $625.

Few pleasure craft except ocean-going yachts need loran. A direct-reading loran set sells for about $3,000.

▶ **Radar**—Commercial marine radar sets sell for $10,000 and up. More than 2,400 ships are licensed for radar. Annual sales run about 400 sets.

Progress has been made towards light-weight radar gear suitable for small craft. An X-band set with 10-in. scope sells for $3,200-3,800. The equipment mounting on the mast weighs 105 lb.

A small boat radar selling for $2,995 has recently been announced.



Equipment mounting on the mast weighs only 40 lb. The manufacturer has built 12 developmental units and production is scheduled to start in 60 days.

Air Force Plans Parts Handbook

AS PART of a multipronged campaign to improve reliability of military electronic equipment, the Air Force, through Wright Air Development Center, has entered into a contract with the Technical Writing Service of the McGraw-Hill Book Co. for development of a complete and up-to-date Components Handbook.

The purpose of the book is to provide design engineers with all types of information which will enable them to select, specify and use components in such a way that greater equipment reliability will be secured.

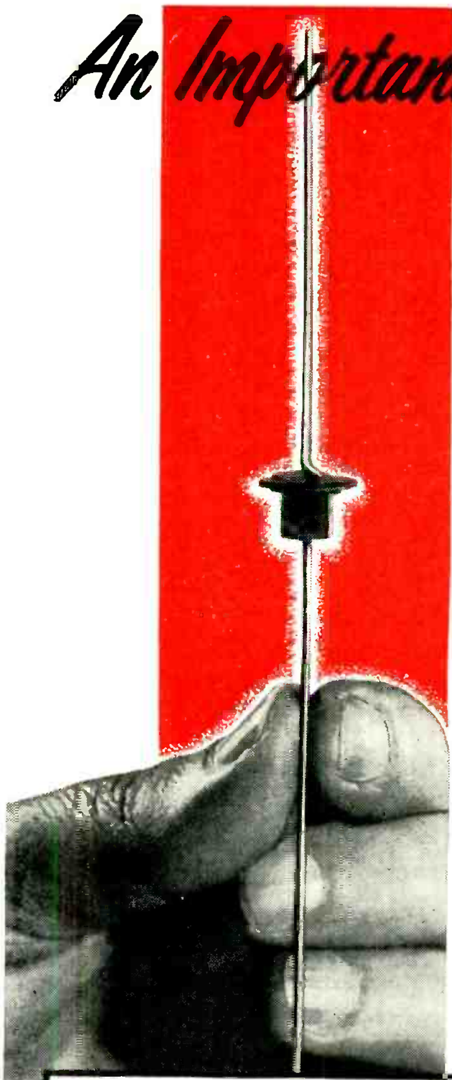
▶ **Causes**—It has been determined that the greater part of present lack of reliability in complex military electronic equipment arises from deterioration and failure of components, including tubes. Of the many causes for these troubles, the most prevalent are: poor circuit design so that failure or change in characteristic of one component causes the failure of several other components; improper selection of

(Continued on page 24)

An Important Announcement to Industry

SILICON POWER RECTIFIERS

AVAILABLE FOR THE FIRST TIME IN PRODUCTION QUANTITIES

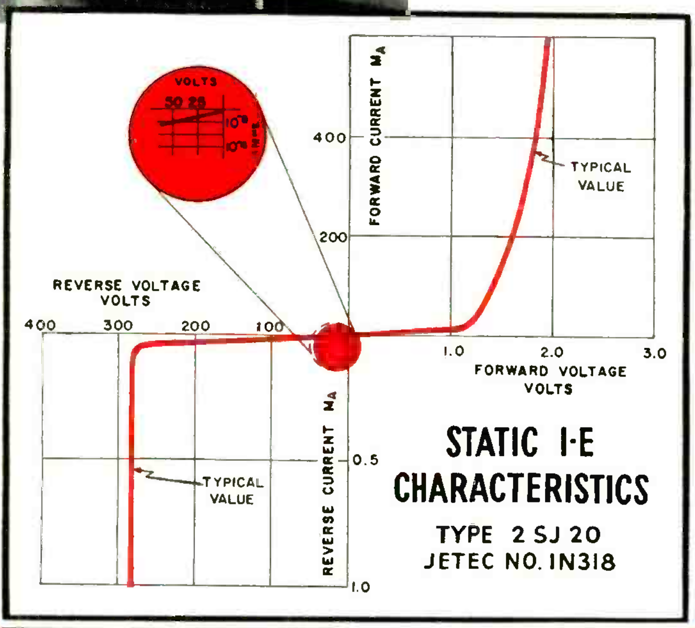


PRECISION ELECTRICAL EQUIPMENT
Bogue
SINCE 1892

★ These units are ideally suited for aircraft and guided missile requirements. Other typical applications that can benefit from their superior characteristics are power rectifiers in commercial equipment, magnetic amplifiers, clipping, meter protection and counter circuits. Anxiety over temperatures is completely eliminated when they are used in digital computers. Automation and control engineering suggest additional fields.

Performance:

1. Rectification Efficiency Over 99%
2. Forward Voltage Drops Averaging 1.5 Volts at 200 MA
3. Peak Inverse Voltages to 1,000 Volts
4. Operates Continuously up to 200°C.
5. Leakage Current as Low as 10-10 amperes
6. Rectification Ratios as High as 10°
7. Practically Flat Zener Characteristics



Characteristics:

1. HIGHEST EFFICIENCY
2. HIGH CURRENT
3. HIGH VOLTAGE
4. HIGH AMBIENT OPERATION
5. HERMETICALLY SEALED
6. SMALL IN SIZE
7. LIGHT IN WEIGHT
8. RUGGED—ALL WELDED
9. LOW FORWARD DROP
10. LOW LEAKAGE

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Jetec No.	TYPE	Forward Drop @ 200 MA	Forward Current Continuous	Power Current Peak	Peak Inverse
IN 316	2SJ5	2V Max	200 MA	2A	50V
IN 317	2SJ10	2V Max	200 MA	2A	100V
IN 318	2SJ20	2V Max	200 MA	2A	200V
IN 319	2SJ30	2V Max	200 MA	2A	350V
IN 320	2SJ50	2V Max	200 MA	2A	500V

Units with peak inverse rating of 850 volts available in sample quantities.

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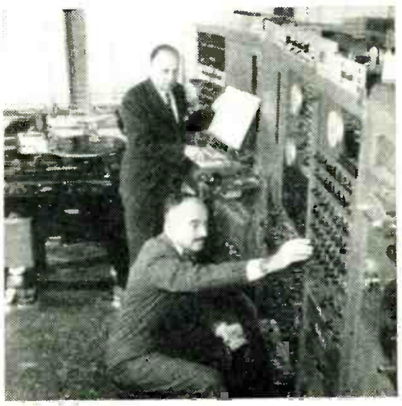
components for rigorous environment of present-day military apparatus due to lack of sufficient information on the ability of components to stand up under these stringent conditions; poor workmanship in production of equipment; poor mounting, ventilation, placement, voltage regulation; and necessity of purchasing and using mass-production low-cost component parts.

The Components Handbook will be a three-year combined Army-Navy-Air Force project and will be published and available to design engineers through the McGraw-Hill Book Co.

► **Design**—For the Rome Air Development Center, McGraw-Hill is completing a book "Reliability Factors for Ground Electronic Equipment" covering general design principles with particular emphasis on mechanical, electrical and human engineering factors, statistical aids to quality control and related subjects. The first volume of the handbook will be ready early in 1956.

Tubes Play Tunes In Music Synthesizer

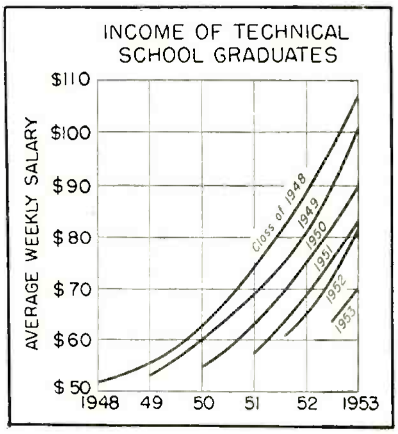


EXPERIMENTAL electronic instrument to synthesize familiar sounds and to create an unlimited range of tone variations and rhythms, developed and recently demonstrated by RCA, is operated by H. F. Olsen, rear, and Herbert Belar of the firm's research center in Princeton, New Jersey.

Supply Of Technicians Remains Short

Tech school graduates decrease; lack of aides aggravates engineer shortage

THERE are still not nearly enough electronics engineers to go around. Whether you judge from your own experience in trying to hire one, count the ads in the *Searchlight* section of ELECTRONICS or draw a comparison with things in Soviet Russia, the supply is indeed short.



During 1953, U. S. engineering schools graduated 24,164 engineers in all curriculums. More than 40,000 could have been profitably employed. Meanwhile the Russians acquired over 100,000 new engineers.

► **Technicians**—Not only are professional engineers scarce but they are also handicapped by shortage of trained assistants. Ideally, each engineer should have about four technical aides to carry out his more routine duties.

During 1953 technical institutes turned out only 1,859 technicians trained in electronics, television or radio. This was down from the 1952 figure of 2,591.

Lack of technical aids not only cuts down the productivity of engineers but also requires that many younger engineers work at routine tasks below their level of education.

► **Remuneration** — As the chart shows, a technician's career can be quite profitable. The chart is based on data reported periodically by technical graduates of Long Island Agricultural and Technical Institute. Salaries range between $50 and $110 a week as average figures. This can be compared with salaries from $57 to $96 for government technicians.

A recent survey showed around 3,000 technicians working for the government. Fifty percent work for the Commerce Department which encompasses the Civil Aeronautics Administration and the National Bureau of Standards. The Navy Department employs one fourth of the total.

Financial Roundup

PROFITS reports and security transactions made in the past month by companies in the electronics field indicate the state of the business on the financial front. The following companies issued profit statements for the fiscal periods indicated:

Company	Net Profit 1954	1953
AT&T 12m	$480,460,000	$421,485,570
Bendix Aviation 12 m	25,537,771	17,352,710
Daystrom 9m ..	997,070	821,268
Int'l Resistance 40w	368,322	421,165
Packard-Bell 3m	217,236	
Remington Rand 9m	11,636,465	8,470,556

► **Securities**—Audio & Video Products filed with SEC covering 450,000 shares of common stock, par one cent, to be offered at 30 cents per share. Net proceeds are to be used to reduce accounts payable, to manufacture new tape recording machines and for working capital.

Electronic Specialty Co. of Los Angeles filed with SEC covering 100,000 shares of capital stock, par 50 cents, to be offered at $3 per share. Net proceeds are to be used for working capital.

Olympic Development filed with SEC covering 299,698 shares of common stock to be offered at par, $1 per share, to stockholders on a 1 to 6 basis. Proceeds are to be used to retire short-term notes and for general working purposes.

(Continued on page 26)

CENTRALIZED OPERATIONS CONTROL...

- **Telemetering**
- **Control**
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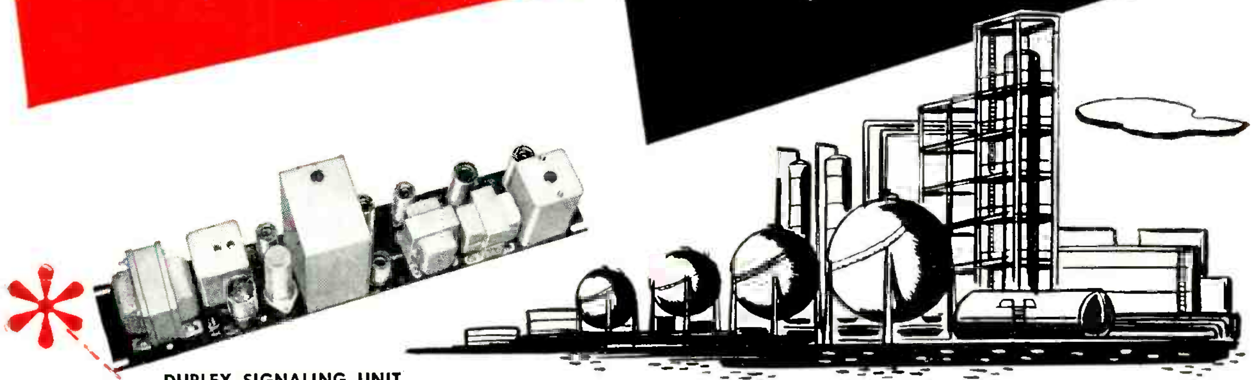
On One Circuit



DUPLEX SIGNALING UNIT

Centralized Operations Control is the Hammarlund proven method for remote supervisory control and metering of all your plant operations over a single circuit — telephone line, carrier, radio or microwave. All remote operations can be controlled from one or more main offices.

The system can be built into a new plant or used to modernize existing facilities. You can buy a custom-built COC system, open-ended to meet future requirements, or you can build one yourself using Hammarlund components. And, most important, *full use can be made of all existing instruments.*

Our growing list of satisfied customers in the petroleum, chemical, transportation, metal working, public utility and other fields reflects and proves the versatility of COC.

No matter which method you select, you take advantage of the Hammarlund COC building-block components that are engineered and built to give long, dependable, trouble-free service. An example of the type of components built by Hammarlund for COC service is the DSU described below.

For further information on COC, write to The Hammarlund Manufacturing Co., Inc., 460 West 34th Street, New York 1, N. Y. Ask for Bulletin E-3.

* The DSU is an audio tone generator and frequency receiver in a single package unit that transmits and receives signaling, dialing, telemetering, teleprinting, supervisory controls and other information. It operates over wire lines, telephone or power line carrier, and radio or microwave communications circuits.

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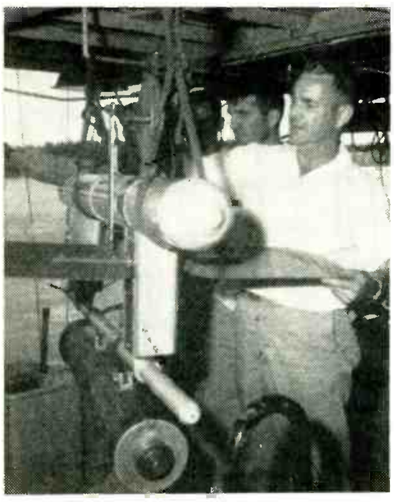
Submarine TV Checks Fish Nets



Camera buoy monitored fish and net in action

UNDERWATER television was used recently to evaluate new equipment for the fishing industry. At the request of the Department of Interior's Fish and Wildlife Service, the Navy's Bureau of Ships used tv to test a midwater trawl used for herring, sardines and other fish.

The net is a Swedish development and its original model has expensive component parts and requires several men to handle it. Experiments were conducted to ascertain whether an adapted form, constructed at lower cost and requiring fewer men to operate, would be as effective. The net, about 150 feet long, has a 40-foot square mouth, an extensive field of view.

To monitor the net while it caught fish, a television camera was attached to a towed buoy which permitted control of depth while in tow. An image orthicon unit designed for underwater use was used.

The camera is 5 inches in diameter and 42 inches long without the pressure housing. It is capable of picking up scenes having a considerably lower light level than most conventional tv equipment. Change of focus, aperture and lens are accomplished by remote control from the surface operating position.

As a result of the tests it was determined that the modified version performed as well or better than the more complicated original net.

MEETINGS

MARCH 1–3: Joint Western Computer Conference and Exhibit sponsored by IRE, AIEE, ACM; Statler Hotel, Los Angeles, Calif.

MARCH 21–24: 1955 IRE National Convention, Waldorf Astoria Hotel & Kingsbridge Armory, New York, N. Y.

APRIL 5–7: Radio Technical Commission for Aeronautics, Spring Assembly Meeting IRE, Los Angeles, Calif.

APRIL 13–15: Symposium On Modern Network Synthesis, II sponsored by Polytechnic Institute of Brooklyn, Engineering Societies Bldg., New York, N. Y.

APRIL 15–16: Ninth Annual Spring Technical Conference, Cincinnati IRE; Engineering Society Bldg., Cincinnati, Ohio.

APRIL 19–21: Twelfth British Radio Components Show, Grosvenor House, London.

APRIL 27–29: Seventh Regional Technical Conference and Trade Show, IRE, Westward Ho Hotel, Phoenix, Ariz.

APRIL 29–30: New England Radio-Electronics Meeting, IRE, Sheraton Plaza Hotel, Boston, Mass.

MAY 2–5: Third Annual Semiconductor Symposium of the Electrochemical Society, Cincinnati, Ohio.

MAY 3–5: URSI Spring Meeting, National Bureau of Standards, Washington, D. C.

MAY 13: Automation, Engineering For Tomorrow, Symposium, Engineering School, Michigan State College, East Lansing, Mich.

MAY 16–19: Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago.

MAY 18–20: Annual National Telemetering Conference and Exhibit sponsored by IRE, AIEE, IAS, ISA; Hotel Morrison, Chicago, Ill.

MAY 19–21: Global Communications Conference, sponsored by AFCA; Hotel Commodore, New York, N. Y.

MAY 24–26: Ninth Annual NARTB Broadcast Engineering Conference, Washington, D. C.

MAY 26–27: Electronic Components Conference, Los Angeles, Calif.

JUNE 2–3: IRE Materials Symposium, Convention Hall, Philadelphia, Pa.

JUNE 3–5: ARRL Hudson Division Convention and Amateur Radio Equipment Show, Hotel Adelon, Long Beach, N. Y.

JUNE 6–8: Fourth Annual Convention and Trade Show, National Community Television Association, Park Sheraton Hotel, New York, N. Y.

JUNE 20–25: Symposium on Electromagnetic Wave Theory sponsored by URSI and the University of Michigan, Ann Arbor, Mich.

AUG. 23–SEPT. 3: British National Radio Show, Earls Court, London.

AUG. 24–26: 1955 WESCON, Civic Auditorium and Fairmount Hotel, San Francisco, Calif.

AUG. 26–SEPT. 4: Great German Radio, Gramophone and TV Exhibition, Dusseldorf, Germany.

Industry Shorts

▶ **Highway** trucking rules made effective March 15 by FCC provide for more liberal use of radio within cities by interurban truckers of property.

▶ **Some** 6,000 electronic engineers are employed by the nation's airframe manufacturers and the number is expected to nearly double by 1959, according to S. F. Arn of Packard-Bell.

▶ **Increasing** use of automatic production techniques will increase the nation's maintenance expenditures by one billion dollars in 1955, approximately 9 percent higher than last year's outlay, according to GE.

▶ **United** Air Lines has purchased $1 million worth of aircraft radio equipment from Collins Radio consisting of 224 vhf receivers and the same number of vhf transmitters.

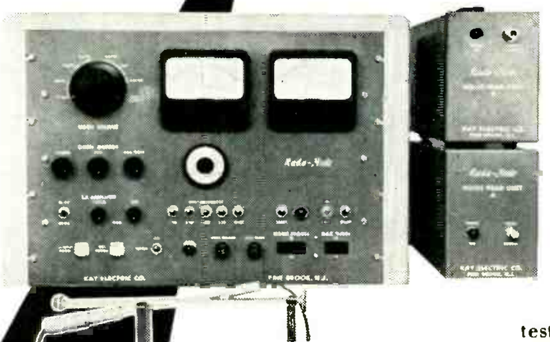
▶ **Time** for submission of tenders for the supply and installation of transmitting and studio equipment for the proposed Australian national tv stations in Sydney and Melbourne has been extended to April 14.

▶ **Investment** per job in plant and property in the communications equipment industry averages $3,704.

▶ **Mica** strike in North Carolina may yield 1,500 pounds of block mica per day.

KAY

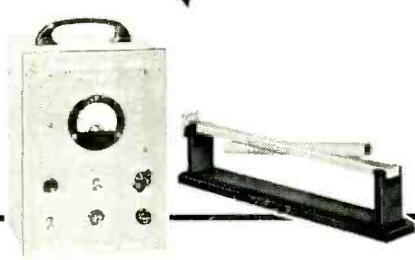
PRECISION PACKAGED NOISE MEASUREMENT IN EVERY RANGE



There's a Kay instrument to answer most needs in noise testing—with good measure! Each *Mega-Node* type affords accurate measurement of noise figure and receiver gain in a specific frequency range, while the *Kada-Node* can be obtained with all elements required for complete noise figure measurement, 5 mc to 26,500 mc, including power supplies. Thus you may trust your noise test work to one precision line of uniform high quality.

KAY *Kada-Node* *(Illustrated)*

Complete radar noise figure measuring set for IF and RF, including attenuators, detector and noise sources. Provides production and lab measurement of noise figure and receiver gain. Complete with power supplies. *Freq. Range*: 5-26,500 mc. *Noise Figure*: Range. 0-21 db, accurate to ±0.25 db. Prices on request.



KAY *Microwave Mega-Nodes*

Calibrated random noise sources in the microwave range, used to measure noise figure and receiver gain and to calibrate standard signal sources in radar and other microwave systems. Available in the following waveguide sizes to cover the range of 1200-1400 mc and 2600-40.000 mc:

RG-69/U, RG-48/U, RG-49/U, RG-50/U, RG-51/U, RG-52/U, RG-91/U, RG-53/U

Available with fluorescent or inert gas (argon or neon) tubes. Noise output fluorescent tubes 15.8 db ±.25 db; argon gas tubes 15.2 db ±.1 db*; neon tubes 18.0 db ± .5 db*.

**Noise output of inert gas tubes. independent of operating temperature.*

RG-69/U	$500
RG-48/U	295
RG-49/U	295
RG-50/U	295
RG-51/U	295
RG-52/U	295
RG-91/U	350
RG-53/U	350

ALL PRICES INCLUDE POWER SUPPLY

KAY *Mega-Node*

Calibrated random noise source reading direct in db, for measurement of noise figure, receiver gain, and for indirect calibration of standard signal sources. *Freq. Range*, 5-220 mc. *Output impedances*: Unbalanced—50, 75, 150, 300, Infinity. Balanced—100, 150, 300, 600, Infinity. Noise Figure Range: 0-16 db at 50 ohms; 0-23.8 db at 300 ohms. $295.00 f.o.b. factory.

KAY *Mega-Node-Sr.*

Same uses as *Mega-Node*. *Freq. Range*, 10-3000 mc. *Output Impedance*: 50 ohms unbalanced into Type N Connector. Noise Figure Range: 0-20 db. $995.00 f.o.b. factory.

KAY ELECTRIC COMPANY

Dept. E-3 14 Maple Ave. Pine Brook, N. J.

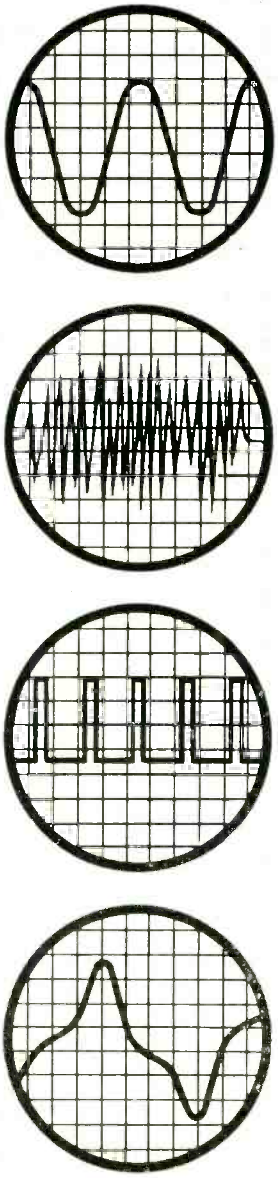
Write for Technical Data Sheets and copy of Kay 1954-55 Catalog.

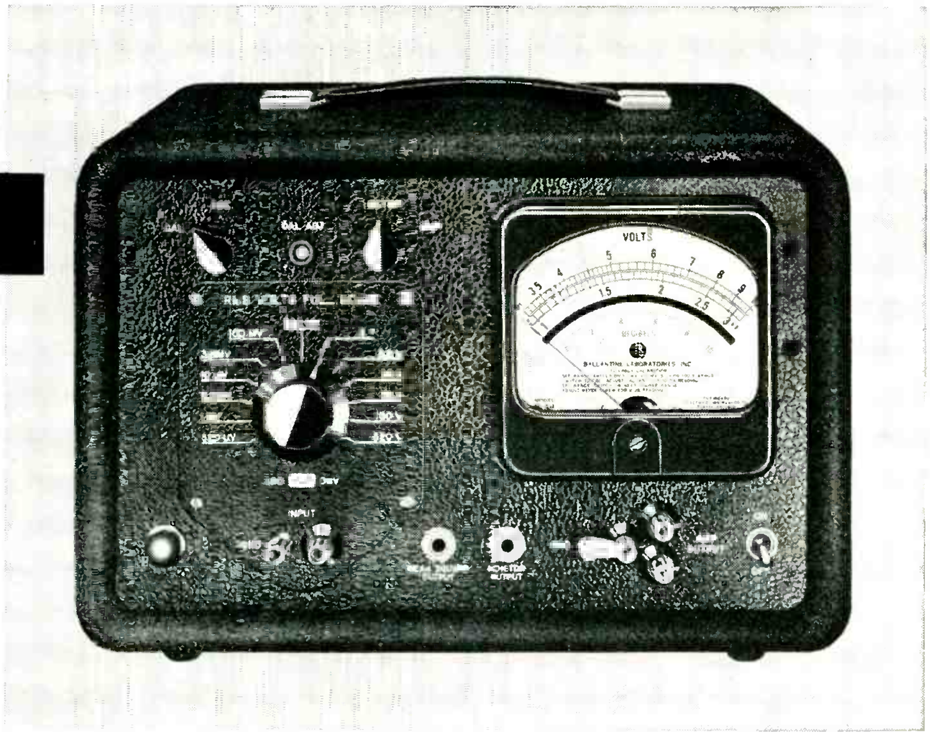
NOW *Measure* TRUE RMS

from 100 microvolts to 320 volts REGARDLESS OF WAVEFORM

WITH THE

BALLANTINE MODEL 320 VOLTMETER





REPRESENTING:

A distinctly new departure in VTVM design.

FEATURING:

A built-in calibrator; — easily read 5-inch log meter; — immunity to severe overload; — useful auxiliary functions.

BRIEF SPECIFICATIONS:

VOLTAGE RANGE:	100 microvolts to 320 volts
DECIBEL RANGE:	—80 dbv to +50 dbv
FREQUENCY RANGE:	5 to 500,000 cycles per second
ACCURACY:	3% from 15 cps to 150KC; 5% elsewhere Figures apply to *all* meter readings
MAXIMUM CREST FACTORS:	5 at full scale; 15 at bottom scale
CALIBRATOR STABILITY:	0.5% for line variation 105-125 volts
INPUT IMPEDANCE:	10 M Ω and 25 μμf, below 10 millivolts 10 M Ω and 8 μμf, above 10 millivolts
POWER SUPPLY:	105-125 volts; 50-420 cps, 75 watt Provision for 210-250 volt operation
DIMENSIONS: (Portable Model)	14 3/8" wide, 10 1/8" high, 12 3/8" deep Relay Rack Model is available
WEIGHT:	21 lbs., approximately

PRICE: $325.

Write for the New Ballantine Catalog describing this and other instruments in greater detail.

BALLANTINE LABORATORIES, INC.

100 FANNY ROAD, BOONTON, NEW JERSEY

Want more information? Use post card on last page.

Bradley LABORATORIES, INC.

Rectifiers now available for continuous operation at 150°C

"Hellishly High" is used in a comparative sense, of course. But the fact remains: Bradley's SS series of high-vacuum processed Selenium Rectifiers was developed to *perform as rated* at ambient temperatures of 150° C.

Life tests have passed 4200 hours at 150° C without any indication of cell deterioration. The units undergoing tests comprise four Bradley SS series R-cells, experimentally rated at 13 volts, operating with an a-c input of 52 volts under a resistive load of 50 milliamperes. Available cell sizes range from 3/16" diameter to 5" x 6" plates.

Our representative will be glad to discuss the application of Bradley High Temperature Rectifiers to your application. Curves showing test results are available upon request. Please write for them.

SEE US AT I.R.E. NATIONAL CONVENTION BOOTH #722 ● SOUTHWEST I.R.E. CONVENTION BOOTH #13

VACUUM-PROCESSED — FOR PERFORMANCE AS RATED

Manufacturers of Metallic Rectifiers and Photoelectric Cells

Bradley LABORATORIES, INC.

BRADLEY LABORATORIES, INC. • 168E Columbus Ave., New Haven 11, Connecticut

NOW YOU CAN USE *Heldor*

RIVET TYPE
LOCK-IN TERMINALS

in ALL applications!

- ***Outperforms any other terminals made today.***
- ***Costs less, installed, than solder seal terminals.*** ✱

YOU can show marked cost reductions and improve the performance of your components by using these new HELDOR rivet type, lock-in terminals *in place of those you now use.* They will not crack or leak. They meet the MIL-T-27 Twist Tests. When you let HELDOR stake in these terminals in can covers you'll effect further economies.

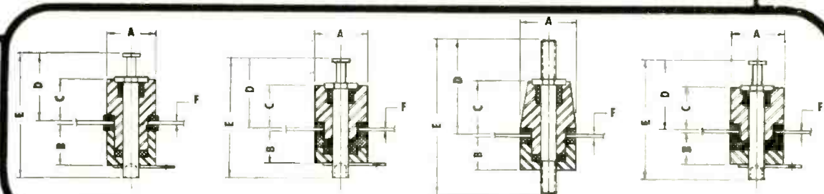
Cost-conscious, quality-minded manufacturers now use HELDOR for terminals, drawn cans, sheet metal fabrication of cans and covers, cabinets, brackets and a complete assembly service. Heldor can save you money. Send in your specifications or prints for a quotation.

Do it now!

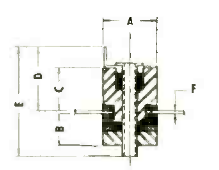
HELDOR LOCK-IN TERMINAL SPECIFICATIONS

TERMINAL	STYLE NO.	A	B	C	D	E	*F	RMS VOLTS	AMPS	HEX. MTG. HOLE	TORQUE
5218	2	15/64	11/64	3/16	3/8	5/8	.019-.025	4000	10	9/64	▼
5312	2	5/16	3/16	13/64	7/16	3/4	.020-.032	5000	15	3/16	▼
5312-C&C	4 or 5	5/16	3/32	15/64	17/32	11/16	.020-.032	3000	●	3/16	▼
5312-C&C	4 or 5	5/16	3/32	15/64	7/16	5/8	.020-.032	3000	●	3/16	▼
5375	1	3/8	5/16	7/16	23/32	1 3/16	.032-.048	6000	20	1/4	▼
5375-C&C	5	3/8	3/32	11/64	17/32	11/16	.025-.037	4000	●	1/4	▼
5375-C&C	4	3/8	3/32	17/64	31/64	11/16	.025-.037	4000	20	1/4	▼
5500	1	1/2	7/16	7/16	23/32	1 5/16	.032-.048	10000	35	5/16	8"#
5500-C&C	1	1/2	9/32	7/16	23/32	1 1/8	.032-.037	7000	35	5/16	8"#
5875	3	7/8	19/32	1 3/32	1 5/16	2 1/2	.037-.062	12000	45	1/2	15"#
5-1125-C&C	3	1 1/8	11/32	1 9/16	2 5/32	3 1/16	.037-.062	5000	45	3/4	18"#
5-1125-3/4	3	1 1/8	27/32	1 9/16	2 5/32	3 3/16	.037-.062	16000	45	3/4	18"#
5-1125-1 1/16	3	1 1/8	1 3/32	1 9/16	2 5/32	3 1/2	.037-.062	19000	45	3/4	18"#

● Depending on style. ▼ Must be staked securely.
Insulation Resistance at 45% relative humidity at Sea Level over 500,000 Megohms.
* If other panel thickness required, please state thickness when ordering.



STYLE #1 STYLE #2 STYLE #3 STYLE #4

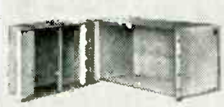


STYLE #5

WRITE FOR NEW TERMINAL DATA BULLETIN!

✱ of equivalent rating

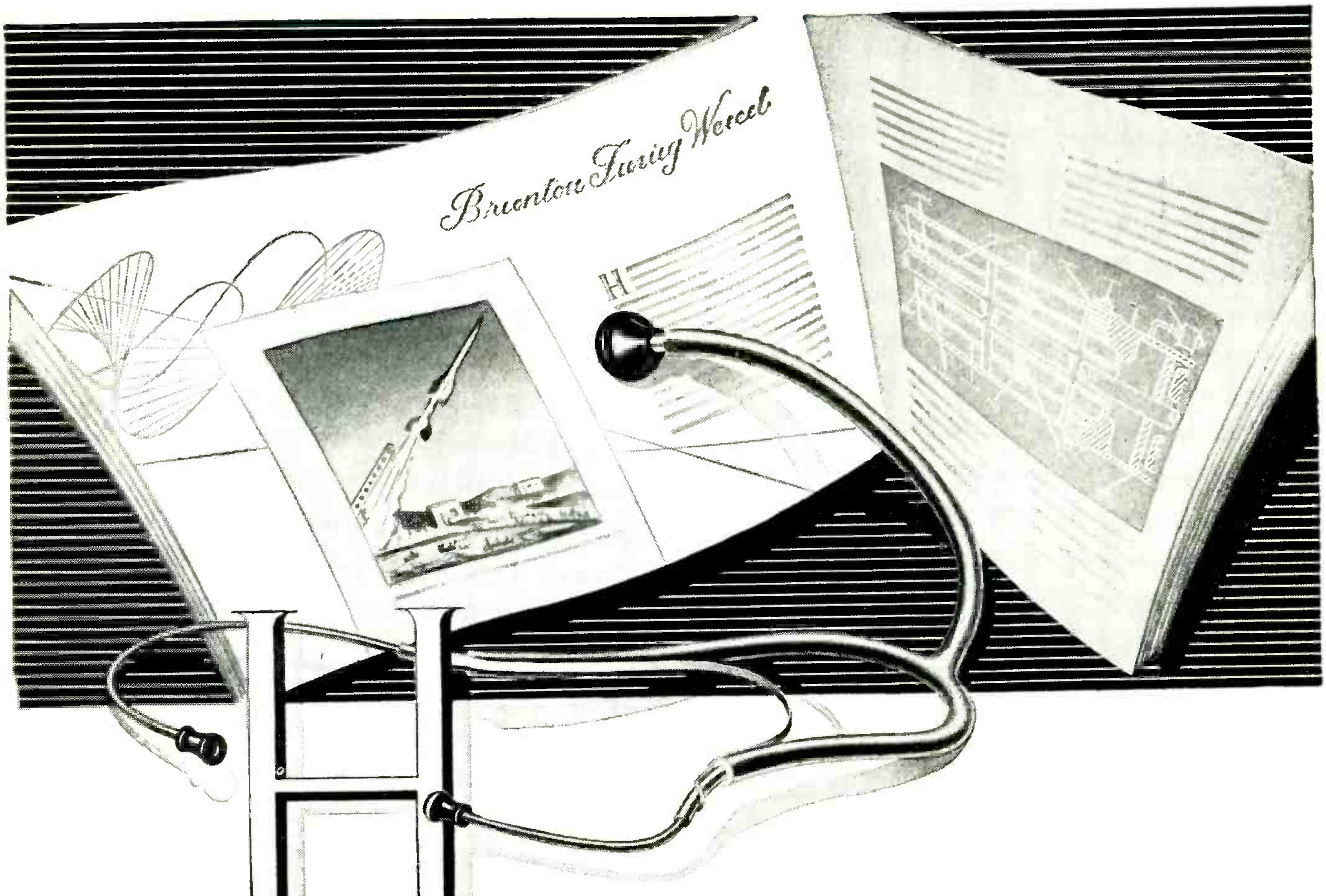
other *Heldor* products



- CANS and COVERS
- CABINETS
- ASSEMBLY SERVICE
- BUSHINGS
- HOT TINNING SERVICE

HELDOR MANUFACTURING CORPORATION
HELDOR HERMETIC SEAL COMPANY, INC.
238 Lewis Street • Paterson, N. J.

VISIT BOOTH #863 AUDIO AVENUE, I.R.E. SHOW, MARCH 21-24, 1955.



HOW ARE YOUR COMMUNICATIONS ?

Do the booklets, pamphlets, and manuals you use really *work* for you? Are these vital publications, that tell the story of your products and your company, as effective, readable, well designed and illustrated as they can be? Today more than ever, your entire operation is judged by each annual report, employee manual, and public relations piece that you produce. Have you examined your communications lately? If you have any doubt as to the impact of your instructional and promotional literature, remember . . .

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For a good many decades McGraw-Hill has stood for complete coverage in the business literature field. Now the McGraw-Hill TECHNICAL WRITING SERVICE offers a new approach to your publication problems – an *integrated* writing, editing, illustrating, and printing service for the *custom* production of: INSTRUCTION MANUALS, PRODUCT BULLETINS, TRAINING AIDS, INDUSTRIAL RELATIONS LITERATURE, ANNUAL REPORTS, COMPANY HISTORIES, PROCEDURAL GUIDES and other collateral literature. More than 150 editorial and graphic experts are at your disposal, ready to prepare high-quality material to your own or government specifications. Save time, save money . . . and make your communications work! Let *our* staff be your staff for technical and business publications.

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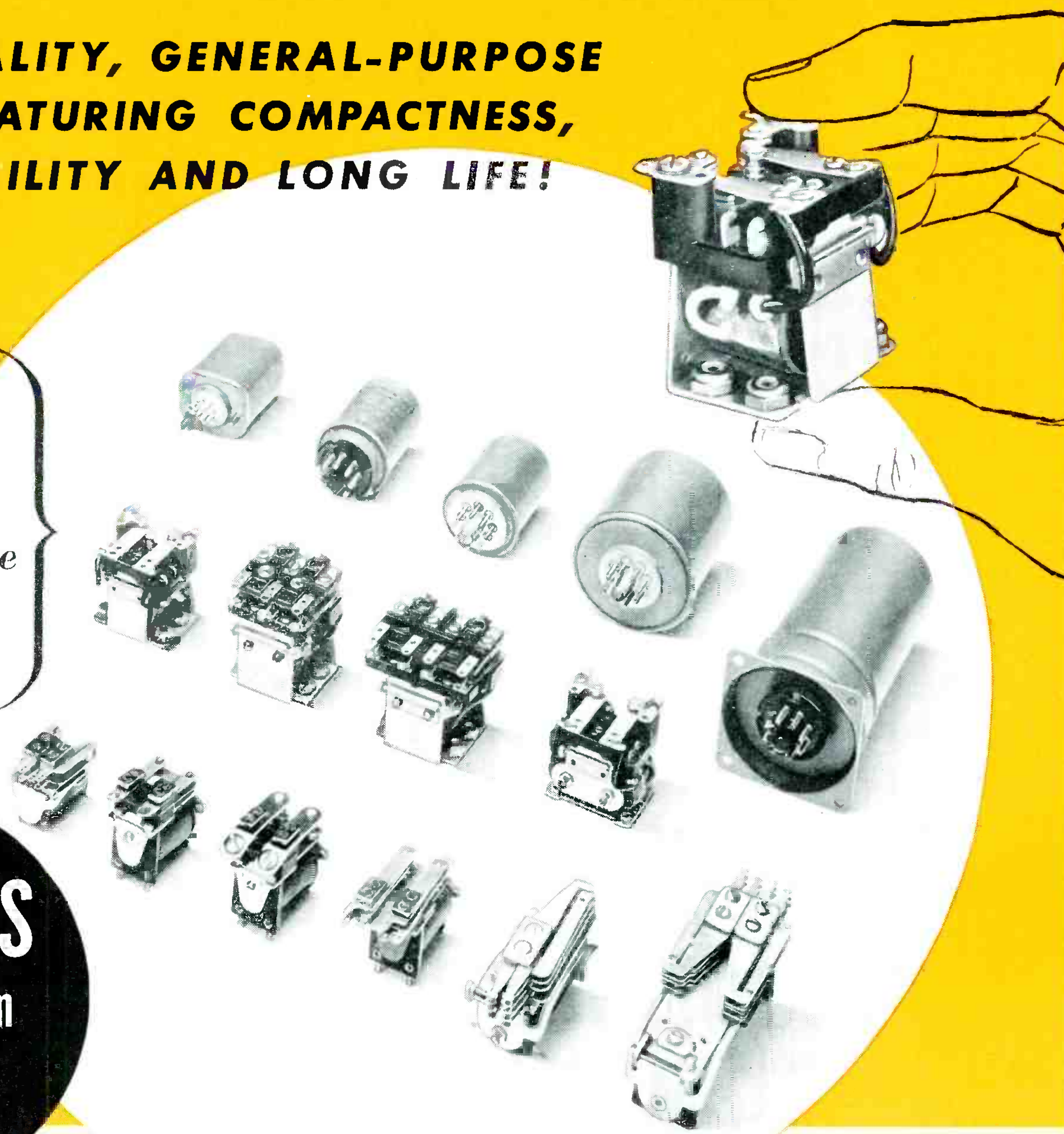
OHMITE AMRECON® Relays

HIGH QUALITY, GENERAL-PURPOSE RELAYS FEATURING COMPACTNESS, DEPENDABILITY AND LONG LIFE!

hermetically sealed or dust-protective enclosures



30 TYPES available from STOCK

Current ratings up to 25 amp, AC or DC

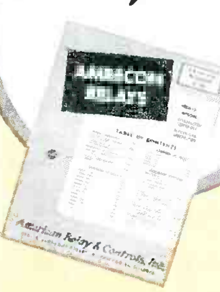
When you want the utmost in relay dependability, investigate the Amrecon line. Amrecon relays are designed, produced, and tested in the new, air-conditioned Ohmite plant.

These ruggedly built relays have the ability to handle power loads usually requiring larger, heavier units. They are built to meet rigorous aircraft relay standards, and are particularly adapted to mobile equipment where severe shock and vibration are encountered.

Amrecon relays are available with screw, plug, or solder-wire terminals; in a variety of contact arrangements; with hermetically sealed or dust-protective enclosures. Order from the 30 stock types, or let Amrecon's engineers help you work out special relay applications.

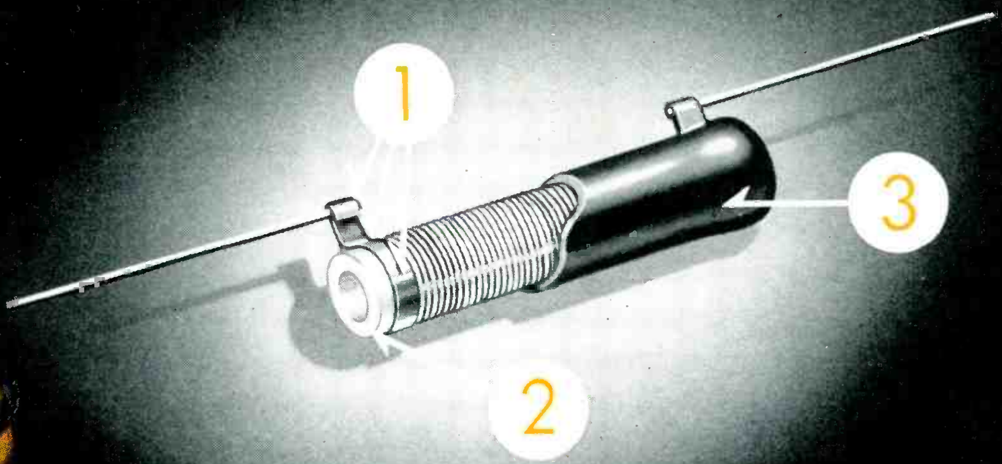
AMERICAN RELAY & CONTROLS, Inc.
3610 Howard St., Skokie, Illinois (Suburb of Chicago)
a subsidiary of
OHMITE®
MANUFACTURING COMPANY

Send for Catalog R-10



OHMITE "Brown Devil"®

RESISTORS have BALANCED THERMAL EXPANSION!



High-quality resistors for your *tough* jobs!

When you want a resistor that will stand up under high temperatures, specify Ohmite Brown Devils. They have been carefully designed to provide "balanced thermal expansion." All parts—core, resistance wire, vitreous enamel coating, and terminal band—have a thermal expansion that has been carefully matched. As a consequence, "Brown Devil" resistors expand and contract as a unit. This eliminates cracking of the enamel, keeps terminals firmly anchored, and prevents the entrance of moisture.

For many years, these superior Ohmite resistors have proved their reliability under the toughest service. Specify them on your next job.

1 PATENTED WELDED TERMINALS

Ohmite welded terminals provide a perfect and permanently stable electrical connection that is unaffected by vibration or high temperature.

2 HIGH TEMPERATURE STEATITE CORE

This strong, rugged steatite core has excellent electrical characteristics, and a coefficient of thermal expansion that matches the other resistor materials.

3 EXCLUSIVE HIGH TEMPERATURE VITREOUS ENAMEL

This special-formula enamel was developed by Ohmite after extensive research. Its thermal expansion is properly related to that of the steatite core, terminal, and resistance wire.

30th Anniversary 1925-1955

OVER 100,000,000 SOLD!

Be Right with **OHMITE**® RHEOSTATS RESISTORS TAP SWITCHES

OHMITE MANUFACTURING COMPANY, 3610 Howard Street, Skokie, Illinois (Suburb of Chicago)

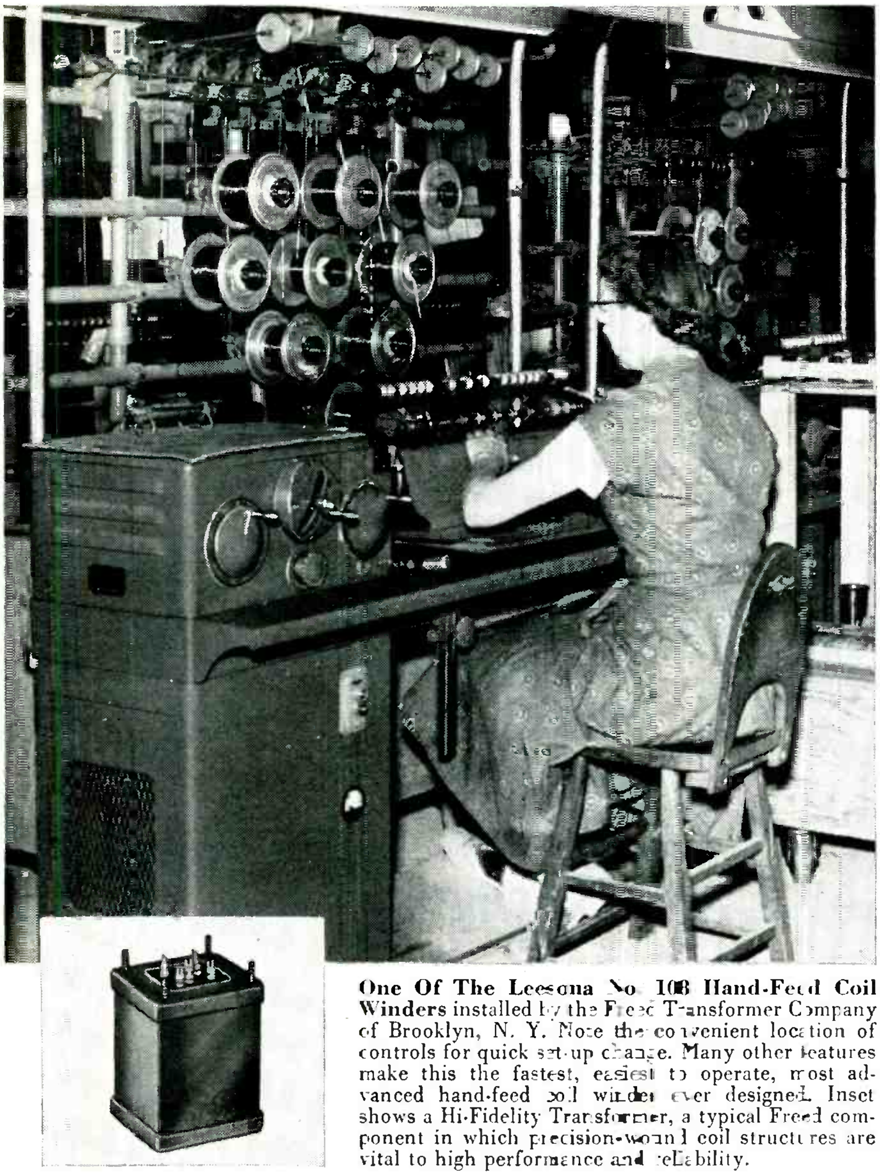
I.R.E. NATIONAL CONVENTION · RADIO ENGINEERING SHOW

BOOTHS 560 and 562 COMPONENTS AVENUE

KINGSBRIDGE ARMORY
KINGSBRIDGE PALACE
WALDORF-ASTORIA NEW YORK CITY
MARCH 21-24, 1955

At FREED... Leesona coil winders cut production time and costs

Executive praises performance of No. 108 Machines



One Of The Leesona No. 108 Hand-Feed Coil Winders installed by the Freed Transformer Company of Brooklyn, N. Y. Note the convenient location of controls for quick set-up change. Many other features make this the fastest, easiest to operate, most advanced hand-feed coil winder ever designed. Inset shows a Hi-Fidelity Transformer, a typical Freed component in which precision-wound coil structures are vital to high performance and reliability.

At the Freed Transformer Company, well known manufacturers of electronics components, Leesona No. 108 Hand-Feed Coil Winders have replaced obsolete winding equipment. Here's what the president of Freed reports about the new installation:

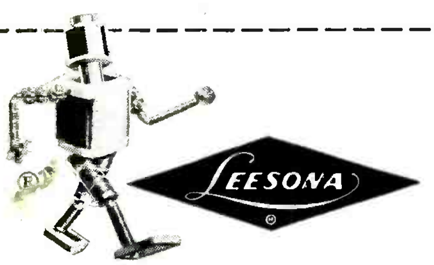
> **"In our winding operations, accuracy comes first. Our new Leesona No. 108 Winders, besides being tops for accuracy, have brought us many other production advantages. Their quick set-up changes, simple operation, and easy insertion of paper sheets are saving us time and money. We're more than pleased that we changed over to these speedy, versatile Leesona 'Coil Winders.'"**

Many other plants report similar benefits as a result of modernizing with Leesona No. 108 Hand-Feed Coil Winders. The most accurate, flexible and economical machines of their type ever developed, Leesona No. 108's wind four to thirty paper-insulated coils in stick form simultaneously, reduce set-up time considerably, and speed up production on long or short runs.

Use The Coupon

to get complete facts on how Leesona No. 108 Coil Winders can bring new efficiency and economy to your own coil winding operations. And note the additional helpful coil winding information listed on the coupon. Why not send for all the facts today?

23B.4.5



FOR WINDING COILS
IN QUANTITY...
ACCURATELY...USE
LEESONA WINDING MACHINES

UNIVERSAL WINDING COMPANY

P. O. BOX 1605, PROVIDENCE 1, RHODE ISLAND, Dept. 13

Please send me

- ☐ Bulletin on the Leesona No. 108 Hand-Feed 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.

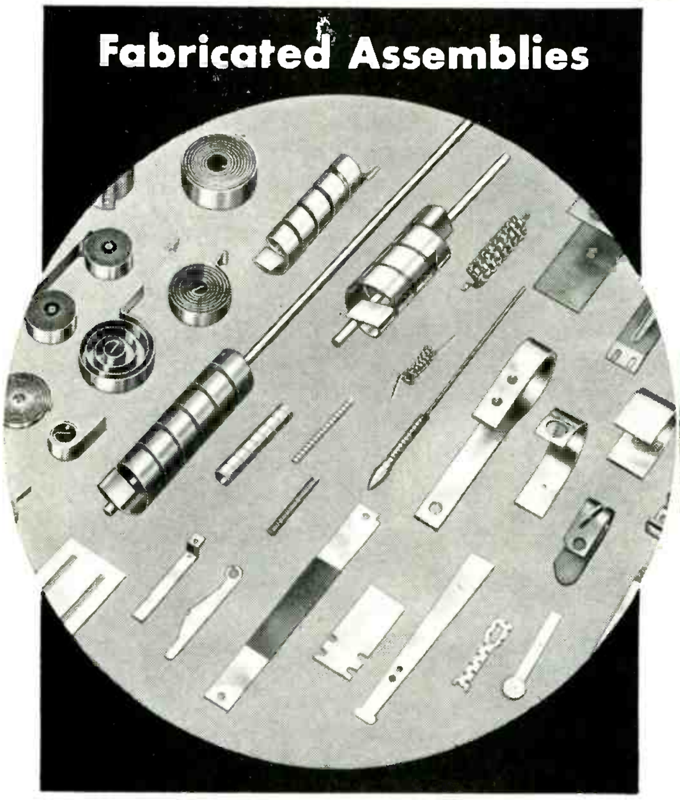
Name..*Title*......................

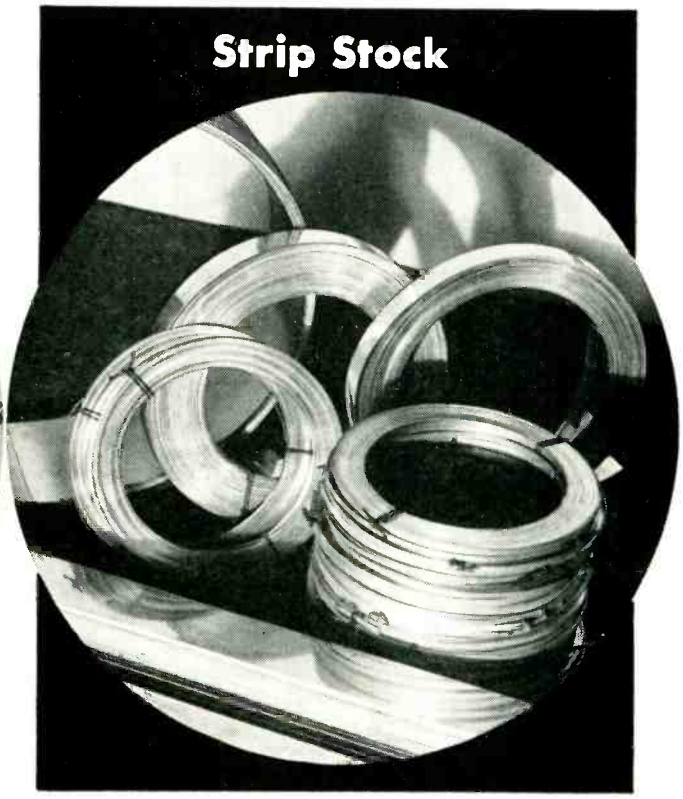
Company..

City..*Zone*....*State*..................

Want more information? Use post card on last page.

In Any Form





General Plate TRUFLEX® Thermostat Metals

Give Accurate Temperature Response . . . Cut Costs

General Plate *Truflex* Thermostat Metals provide a sure way to get reliable performance and at the same time cut costs of products requiring temperature control, indication or compensation.

Advanced General Plate production methods coupled with the best equipment available insure close tolerances on all properties and dimensions. This maintains positive consistency in thermal, mechanical, and electrical performance. With no variation from lot to lot rejects are eliminated, costly adjustments are minimized.

General Plate *Truflex* fabricated assemblies are engineered and manufactured to your specifications, ready for installation into your products. They eliminate costly fabrication problems . . . needless special equipment . . . experimental work and expensive calibration.

However, if you prefer to make your own assemblies, General Plate *Truflex* Thermostat Metals are available as strip in extra long coils or flat cut lengths manufactured to your material specifications.

Write for information and engineering assistance.

You can profit by using General Plate Composite Metals!

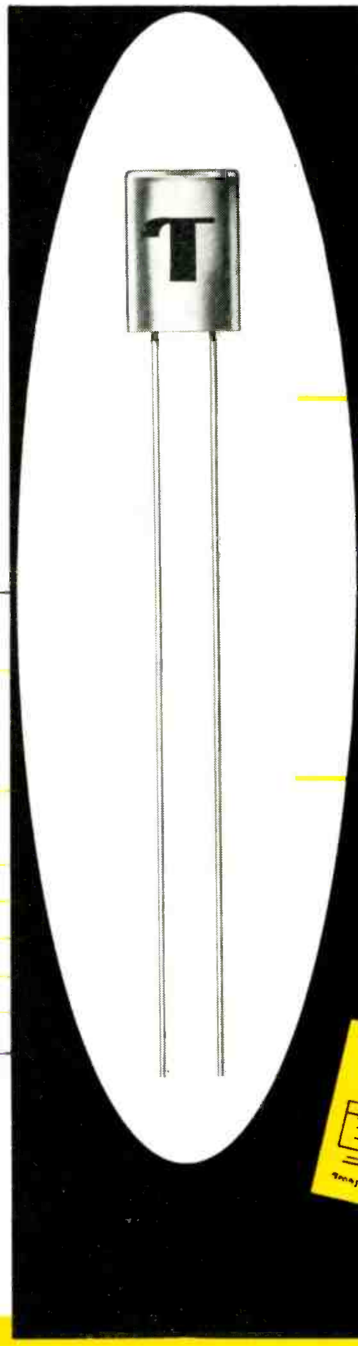
METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
33 FOREST STREET, ATTLEBORO, MASS.

NOW . . . FROM **Transitron**

SILICON JUNCTION DIODES WITH SUPERIOR FORWARD CONDUCTANCE

- **Operation up to 150°C**
- **Low Inverse Current**
- **Sharp Zener Break**
- **Hermetic Sealing**

Transitron silicon junction diodes are specifically designed to meet exacting high temperature requirements. Combining high forward conductance with very high inverse resistance, they provide improved circuit performance in many applications. Reliability is assured through welded hermetic sealing.



ACTUAL SIZE

SPECIFICATIONS AND RATINGS

TYPE	Forward Current at +1.0 Volt (ma)	Inverse Current at Specified Voltage (μa) at 25°C	Inverse Current at Specified Voltage (μa) at 125°C	Maximum Reverse Working Voltage (volts)
1N137A	3	.03 at 20V	—	36
1N138A	5	.01 at 10V	—	18
1N137B	20	.03 at 20V	5 at 20V	36
1N138B	40	.01 at 10V	2 at 10V	18
1N350	20	.03 at 60V	5 at 60V	70
1N351	8	.03 at 100V	5 at 100V	120
1N352	5	.05 at 150V	10 at 150V	170
1N353	3	.10 at 200V	20 at 200V	225
1N354	1	.10 at 300V	20 at 300V	325

Types 1N200 through 1N222 as well as special types, including Zener regulators, are also available. Your inquiries are invited.

SEND FOR BULLETIN TE1322

VISIT BOOTH 580 AT THE I.R.E. SHOW, MARCH 21-24

Transitron electronic corporation
melrose 76, massachusetts

Glass Diodes | Silicon Diodes | Germanium Diodes | Transistors | Silicon Rectifiers

Want more information? Use post card on last page.

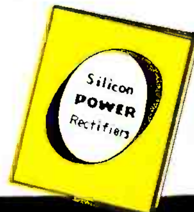
- **Reliability at High Temperatures**
- **High Power Handling Ability**
- **Negligible Leakage Current**
- **No Forward Aging**
- **High Conductance**
- **Miniature Size**
- **Hermetic Sealing**

Transitron's silicon rectifiers meet the long felt need for reliable and efficient power rectification at high temperatures.

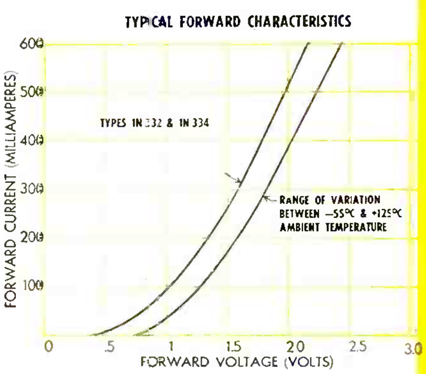
Overcoming the basic limitations of selenium, germanium, and the vacuum tube, they provide trouble-free operation over wide ambient temperature ranges.

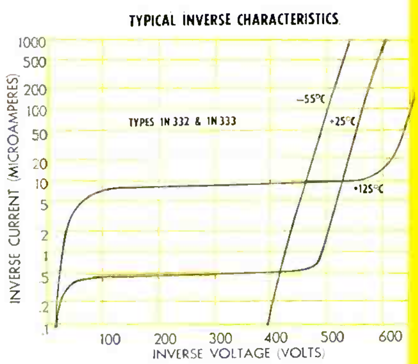
These rugged rectifiers offer major savings in both size and weight in any high temperature application.

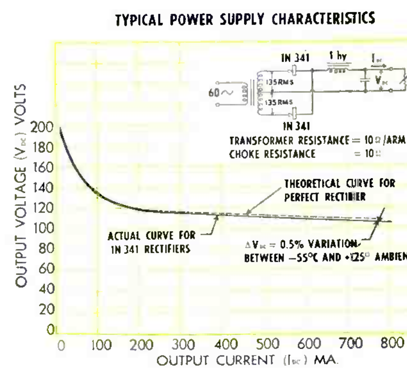
VISIT BOOTH 580 AT THE I.R.E. SHOW, MARCH 21-24



SEND FOR BULLETIN TE1321







SPECIFICATIONS AND RATINGS AT 125°C

POWER SUPPLY TYPES					MAGNETIC AMPLIFIER TYPES				
TYPE	Peak Recurrent Inverse Voltage (volts)	Maximum Average Forward Current (ma)	Maximum* Average Forward Voltage (volts)	Maximum* Average Inverse Current (ma)	TYPE	Peak Recurrent Inverse Voltage (volts)	Maximum Average Forward Current (ma)	Maximum* Average Forward Voltage (volts)	Maximum* Average Inverse Current (ma)
1N341	400	400	3.0	.5	1N332	400	400	1.5	.10
1N342	400	200	3.0	.5	1N333	400	200	3.0	.10
1N343	300	400	3.0	.5	1N334	300	400	1.5	.10
1N344	300	200	3.0	.5	1N335	300	200	3.0	.10
1N345	200	400	2.5	.5	1N336	200	400	1.3	.05
1N346	200	200	2.5	.5	1N337	200	200	2.5	.05
1N347	100	1000	1.0	.5	1N338	100	1000	1.0	.10
1N348	100	400	2.5	.5	1N339	100	400	1.3	.05
1N349	100	200	1.0	.5	1N340	100	200	2.5	.05

Special silicon rectifiers, or combinations, are available to meet specific requirements. Your inquiries are invited.

*Averaged over one cycle for full wave choke input circuit with Rectifier operating at full rated forward current.

Glass Diodes

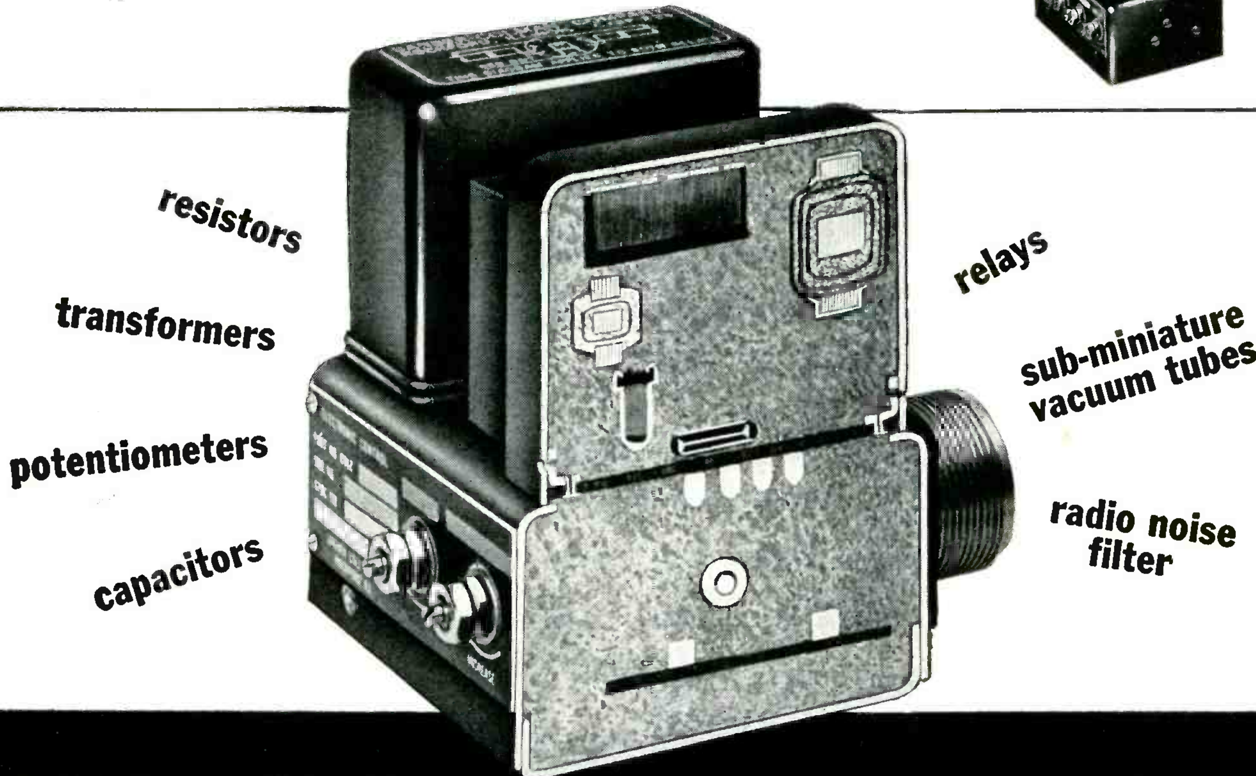
Silicon Diodes

Germanium Diodes

Transistors

Silicon Rectifiers

What's inside this Aircraft Temperature Control?...



BARBER-COLMAN protects these from shock, vibration, humidity with NOPCO® LOCKFOAM

Barber-Colman Company, Rockford, Ill., is well known for its varied line of aircraft temperature and positioning control systems, actuators, air valves, and other accessory equipment. In designing the electronic temperature control shown here, they required a potting material to protect the fragile components and the connecting wiring. It was necessary that the material be both light and strong, have good electrical insulation properties, and be impervious to salt spray and humidity. Curing temperature was not to exceed 250° F., and after curing had to withstand ambient temperatures up to 220° F.

Their search for the right material ended when they tried one of the 50 different formulations of Nopco Lockfoam. "By using Nopco Lockfoam as the potting material," states Barber-Colman, "we were able to meet environmental operating requirements with an economy in manufacturing and assembly time."

These properties of Nopco Lockfoam are finding new applications almost daily—and they are by no means limited to electronics or aviation. Since Nopco Lockfoam is poured-in-place, it exactly fills the configurations you wish to fill. It is consistent and reproducible.

One of the many formulations of Nopco Lockfoam may be the means of improving some product of yours, or even of bringing into being a product that so far exists only on your drafting board. Send for the free informative booklet today.

Plastics Division

NOPCO
CHEMICAL COMPANY
Harrison, New Jersey
4858 Valley Blvd., Los Angeles 32, Calif.

NOPCO — EVOLVED THRU RESEARCH

SIMPLER MICROWAVE MEASUREMENTS TO SAVE ENGINEERING MANHOURS

MEASURES MICROWAVE POWER WITH ONLY ONE PROBE ...NO BURNOUTS

POWER METER MODEL P-2
DC TO 11,000 MC

Over the entire frequency range DC to 11,000 MC, Polarad's new Micro Power Meter utilizes only **one** power probe, supplied as an integral part of the instrument. This unique power probe will sustain severe overloads without burnout since it does not contain hot wire barreters or other delicate components.

This new rugged and stable instrument reduces microwave power readings to the simplicity of everyday low frequency measurements. It is a true rms milliwatt indicating meter accurately measuring CW and pulse power, in milliwatts and dbm. Insensitive to line voltage changes.

Because of its wide band coverage, the Polarad Model P-2 is outstanding as a general lab and field instrument, available for power measurements at all commonly used frequencies. P-2 can be completely calibrated from its own self-contained DC source.

Features and Specifications:

- Single power probe for all frequencies.
- 150% overload without burnout.
- Direct reading.
- Broadband Coverage .... DC to 11,000 mc continuous in single mount.
- Multi-Power Range .... 0-1 mw, 0-10 mw, 0-100 mw. 0 dbm, + 10 dbm, + 20 dbm.
- Impedance .... 50 ohms coaxial.
- VSWR .... Less than 1.4:1 from 0 to 5000 mc. Less than 2:1 from 5000 to 11,000 mc.
- Accuracy .... ± 1.0 db.
- Connector .... Type N plug.
- Input Power Required .... 115v ± 10%, 60 cps.
- Dimensions .... 10″ x 8″ x 8″.
- Weight .... 14 lbs.

TESTS ALL KLYSTRON TUBES

MODEL K-100
KLYSTRON TUBE TESTER

Now, for the first time, you can test all commercially available klystron tubes, built-in cavity types as well as those requiring external cavities, just as easily as you make tests on vacuum tubes.

Polarad's new Model K-100 Klystron Tube Tester provides complete metering facilities and control adjustments with a tube data chart to determine settings. Safety features protect personnel at all times when testing tubes requiring high voltages.

Features:

- Performs the following basic tests:
  - **a.** Filament continuity.
  - **b.** Short circuit tests between all elements.
  - **c.** Static d-c tests—measurement of rated d-c currents and voltages.
  - **d.** Life test—relation of cathode current versus reduced filament voltages.
  - **e.** Dynamic test—provision is made for external modulation so that klystrone tubes may be dynamically tested with external r-f measuring equipment.
- Special adapter mount for all commercial types of klystrons.
- Safety features protect personnel during tests.
- Protective devices prevent misadjustment and save tubes from accidental burnout.
- Built-in heavy duty blower provides forced air cooling of the klystron tubes.
- Tester designed to be adapted for future tubes.
- Built-in Universal Power Supply may be used for klystron testing purposes outside the instrument.

AVAILABLE ON EQUIPMENT LEASE PLAN
FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

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NEW SYMBOL FOR SEMICONDUCTOR LEADERSHIP

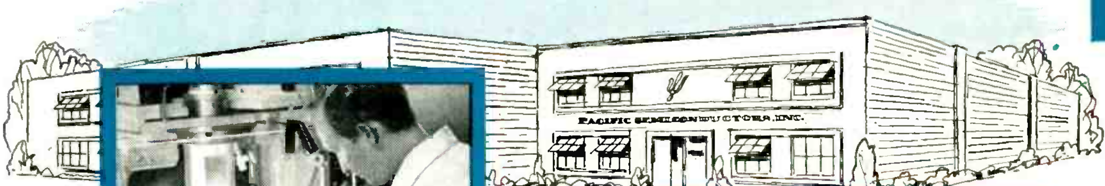
now... from Pacific Semiconductors

new designs

new techniques

new performance

Back of Pacific Semiconductors' new diode design is a fresh approach based on experience . . . over 145 man-years professional experience in the field of semiconductor electronics. Starting where others have left off, these pioneers in one of the decade's most promising electronic fields have developed a series of truly *new* semiconductor devices uniquely suited to the demands of today's airborne and computer circuitry. Experienced personnel and a thorough, continuing research and development program are your assurance of the most advanced design, combined with *proven* performance at levels heretofore unobtainable. Pioneering at PSI is not mere guesswork; it is based on thorough knowledge of each product and of the conditions under which that product is used. In the months and years to come, look to PSI . . . Pacific Semiconductors, Inc. . . . for your requirements of gold bonded germanium diodes, silicon junction diodes and other important semiconductor devices. Inquiries are invited for both standard units and for the special characteristics constantly called for by advances in electronic design.



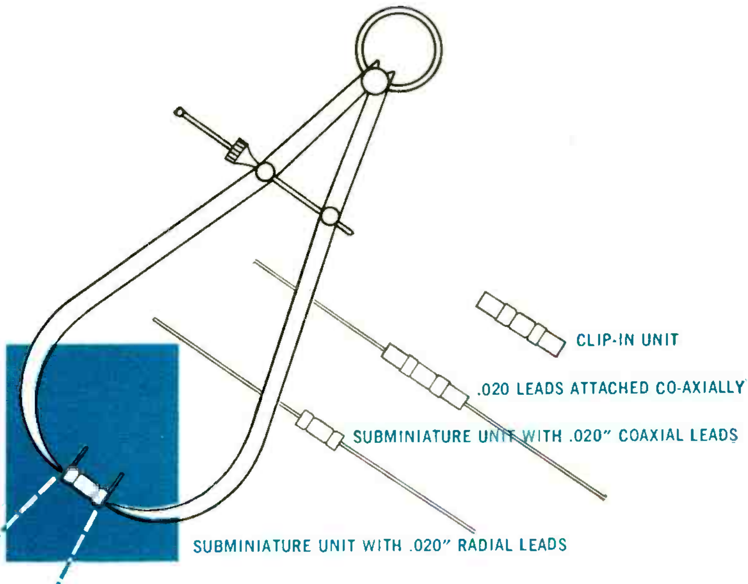
High-purity silicon crystals are drawn in PSI's high frequency induction furnaces.

X-ray diffraction orients crystals prior to slicing wafer for silicon junction diodes.

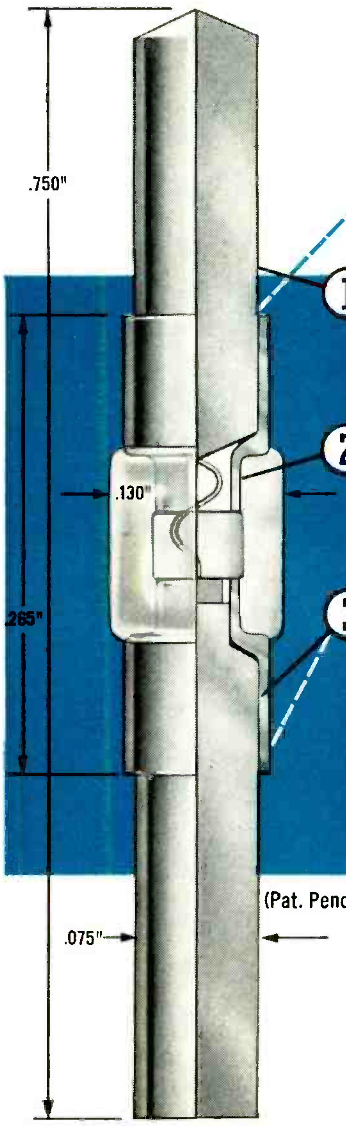
NOW AVAILABLE

- GERMANIUM GOLD BONDED DIODES
- SILICON JUNCTION DIODES

in the new ***PSI diode package...***
designed around user requirements



PSI's revolutionary new package, with advantages not found in any other commercially available diodes, was designed only after an exhaustive survey of user requirements. Space limitations, environmental demands, even assembly procedures became factors in the final design. The result: diodes with demonstrably superior performance, greater versatility, top all-around utility.



(Pat. Pending)

*CHECK THESE BENEFITS...

1. VERSATILE LEAD ARRANGEMENT... for maximum adaptability, diodes may be obtained in a variety of configurations.

2. GLASS-TO-METAL SEAL... for positive moisture resistance, PSI uses a true **fusion** seal.

3. WELDED CONSTRUCTION... for greater strength and freedom from contamination; no low melting point solders are used.

and **your** net benefit from all these features...

NEW STANDARDS OF RELIABILITY AND STABILITY

Typical PSI Gold Bonded Diode Characteristics @ 25°C

Forward Current @ 1v (ma)	Inverse Current (μa)	Inverse Working Voltage (volts)
100	100 (−20v)	35
35	10 (−50v)	80
15	25 (−50v) 200 (−200v)	220

Typical PSI Silicon Junction Diode Characteristics

E_s/E_t (volts)	Forward Current @ 1v (ma)	Back Current	
		at 25°C	at 150°C
30/29	80	.01μa (−15v)	5μa (−15v)
55/53	40	.01μa (−30v)	5μa (−30v)
150/145	15	.01μa (−75v)	5μa (−75v)
300/290	5	.01μa (−150v)	5μa (−150v)

a: The saturation voltage (E_s) is measured at 500μa; the transition voltage (E_t) is measured at 20μa.
b: Recovery time: after switching from 5ma forward current to −40v for all these types, back resistance reaches or exceeds 50K in 1μsec.

For complete product specifications, address inquiries to Dept. S-1

PACIFIC SEMICONDUCTORS, INC.
10451 WEST JEFFERSON BOULEVARD
CULVER CITY, CALIFORNIA

From Original Engineering...

From Original Engineering... and from its half-century of specialized skills and experience, Machlett once again creates new criteria of electron tube performance for high power electronics.

Machlett is first again to offer significant, original design for high power triodes. It was six years ago that Machlett perfected a heavy duty power tube series—the first from any manufacturer. Accepted at once by equipment manufacturers, now universally used, these tubes were also *paid the compliment of imitation.*

With the New Machlett Triodes
COSTS GO DOWN

Because filament power is reduced—
up to 60% (enough, in many cases, to pay for the tube).

Because tube life is longer—
increases of over 100%, compared to conventional types.

Because maintenance is cut—
replacement minimized; cleaning simplified.

Because handling costs are low—
weight down 60 to 70% for air cooled types.

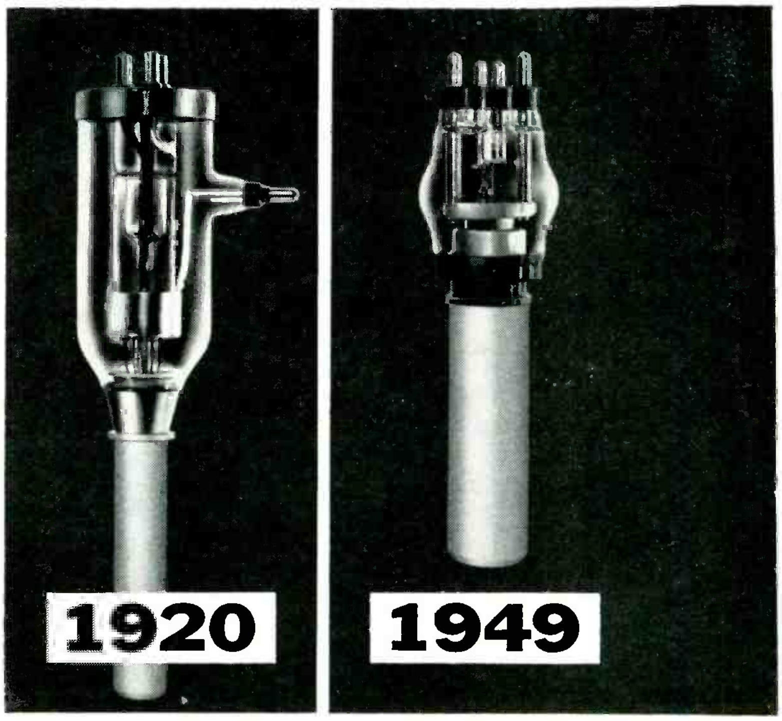
With the New Machlett Triodes
PERFORMANCE GOES UP

Because plate and grid ratings are higher—
broader range of operation is possible.

Because safety margins are usefully increased—
for thermal, mechanical and electrical ratings.

Because lead inductances are very low—
circuit parasitics are reduced by as much as 10-to-1.

Because transconductance is high—
plate efficiency is increased, grid drive reduced, stable performance assured over broadest loading range.



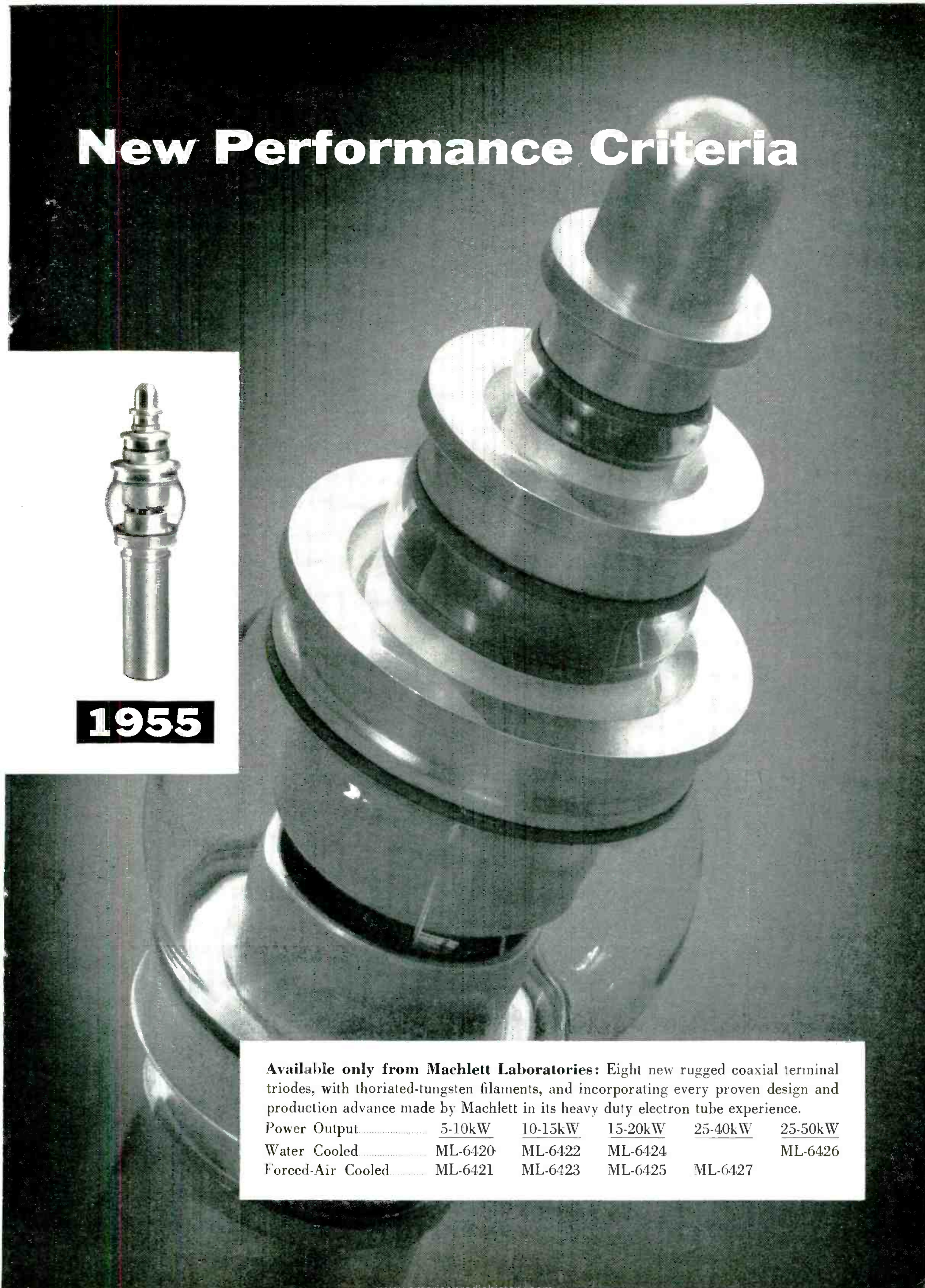
The above tubes portray progressive evolution in electron tube design. Left, Type 892, uses long, high inductance electrode leads and large glass envelope—a design now over 35 years old. Center, Machlett developed, electrical equivalent, industrial ML-5668, has stronger, less inductive internal structures, short glass envelope and sturdier seals, thicker anode with double heat dissipation capacity. Right, most modern tube, Machlett's new ML-6422, uses cylindrical electrode supports for lowest inductance, great stability; large contact area terminals for great seal strength; close-spaced, precisely-aligned electrodes for low drive and high efficiency; thick-wall anode for cool tube operation, high overload capacity; stress-free thoriated-tungsten filament for high load current, low heating power, and longer life.

MACHLETT

And Your First Cost is Only One Postcard—that's all it takes to write Machlett Laboratories for the full story of these premium design, rugged, coaxial triodes. Learn now what to expect of a modern power triode.

MACHLETT LABORATORIES, INC.
1063 Hope Street, Springdale, Connecticut

New Performance Criteria

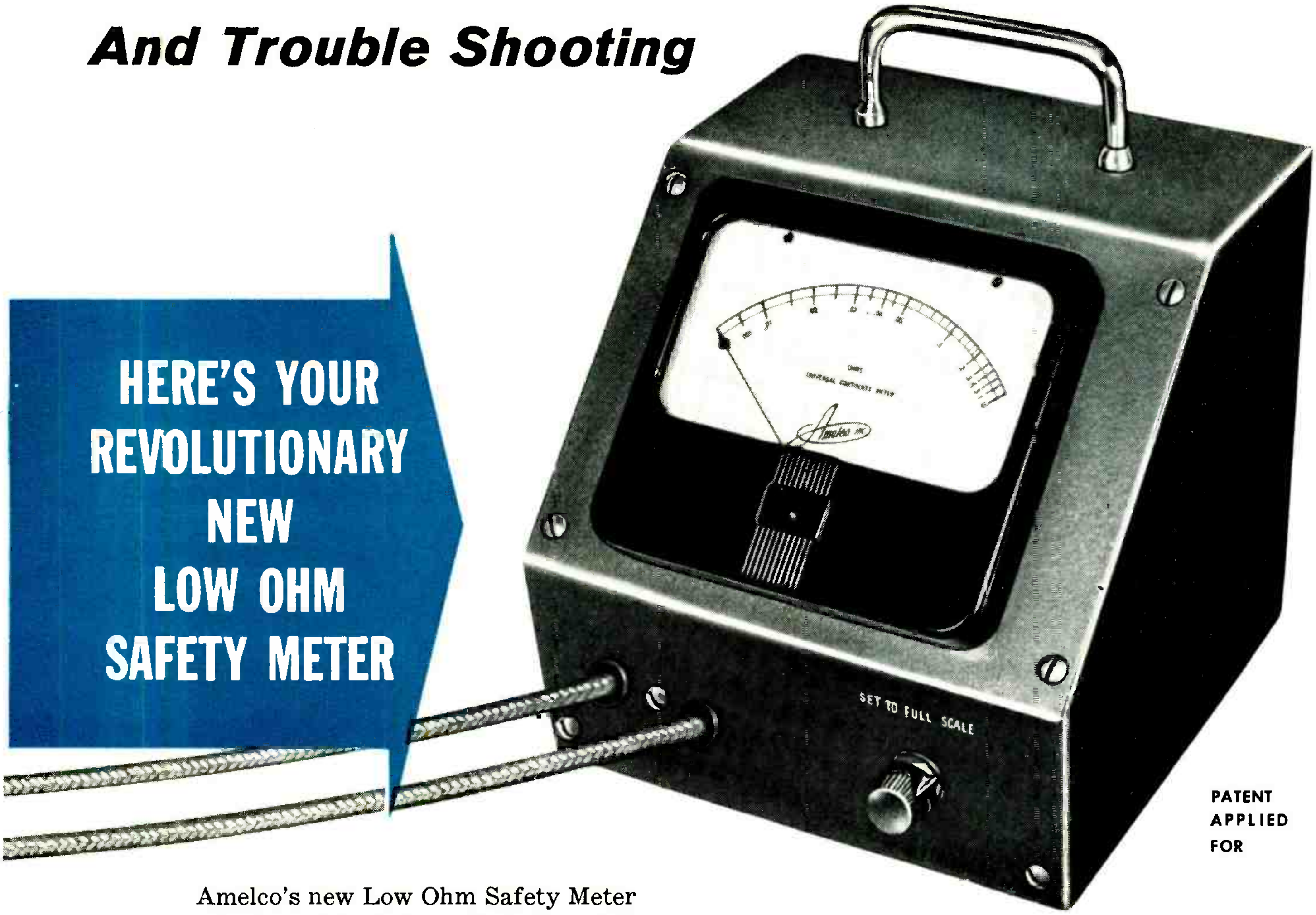


1955

Available only from Machlett Laboratories: Eight new rugged coaxial terminal triodes, with thoriated-tungsten filaments, and incorporating every proven design and production advance made by Machlett in its heavy duty electron tube experience.

Power Output	5-10kW	10-15kW	15-20kW	25-40kW	25-50kW
Water Cooled	ML-6420	ML-6422	ML-6424		ML-6426
Forced-Air Cooled	ML-6421	ML-6423	ML-6425	ML-6427	

And Trouble Shooting



PATENT APPLIED FOR

Amelco's new Low Ohm Safety Meter checks the original wiring, including high current filament circuits, etc., which cannot be reliably checked with any other production instrument. More important the Low Ohm Safety Meter saves hours and hours of trouble shooting.

Thousands of tests prove there is no damage to meters and delicate parts when a unit is being checked with this meter. Why? Because of its low operating voltage. Nothing else like it on the market!

THE AMELCO "SAFETY METER" WILL PERFORM THE FOLLOWING PRODUCTION AND TEST REQUIREMENTS NOT POSSIBLE WITH ANY OTHER "PRODUCTION" TYPE OF INSTRUMENT

1. **Will not damage delicate components**
2. **Will differentiate between legs of high current filament circuits**
3. **Will indicate potential sources of trouble in switches, relay contacts and connectors**
4. **Locate incomplete electrical bonding**
5. **Save hours of time locating shorts in B+lines, signal grounds, etc.**
6. **Detect unsoldered and "cold" soldered connections**
7. **Eliminate possibility of a good continuity indication through a mis-connected part**

ORDER NOW!

Performance guaranteed.

Price Complete

$75.00

Amelco "Safety Meter" justifies its initial cost every time it indicates trouble sources

AMELCO, INC.
2040 Colorado Avenue
Santa Monica, California

Rush a UNIVERSAL CONTINUITY METER to us C.O.D.

NAME ____________

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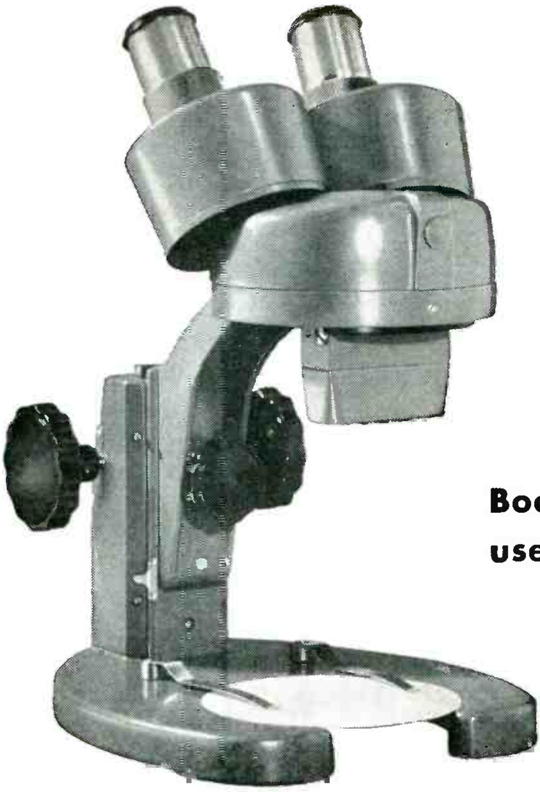
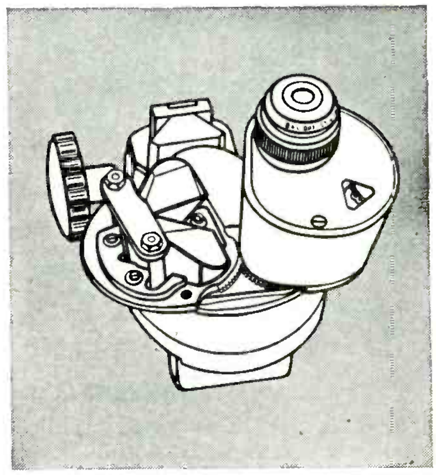
CITY ____________ ZONE ____ STATE ____

Want more information? Use post card on last page.



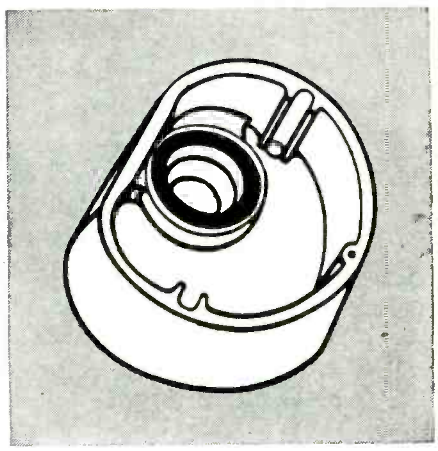
Full 3-D detail for FASTER, EASIER ASSEMBLY and INSPECTION

Boost production... save on lifetime trouble-free use... with a Bausch & Lomb Stereomicroscope



SHOCKPROOF . . . for lifetime dependability

Ready whenever you need it . . . in the lab, or mounted in machines or fixtures . . . because prisms *can't* jar loose despite the punishment of year-after-year practical use. Double support locks them into lifelong alignment . . . clamps at the top, gibs at the bottom.



DUSTPROOF . . . for bright, detailed images

Even on production lines, you get "laboratory clean" images. Patented Neoprene ring inside prism housing fits flush on prism surface, seals out contaminants . . . one of the reasons why B&L Stereomicroscopes are *dustproof for life.*

BAUSCH & LOMB

SINCE B&L 1853

WRITE for Catalog D-15 and demonstration. Bausch & Lomb Optical Co., 61439 St. Paul Street, Rochester 2, N. Y.

STEREOMICROSCOPES

RECOMMENDED APPLICATIONS, NEW GL-6442 TRIODE

	R-f power amplifier and oscillator, Class C telegraphy:	Plate-modulated r-f power amplifier and oscillator, Class C telephony:	Plate-pulsed r-f power amplifier and oscillator, Class C telegraphy:	Frequency multiplier, Class C (inquire about ratings for this service):
BEACONS	Yes	—	Yes	Yes
COMMUNICATIONS	Yes	Yes	—	Yes
LOW-POWER RADAR	Yes	—	Yes	Yes
MICROWAVE RELAYS	Yes	Yes	Yes	Yes
NAVIGATION	Yes	Yes	Yes	Yes
SPECIAL TEST EQUIPMENT	Yes	Yes	Yes	Yes
TELEMETERING	Yes	Yes	Yes	—

MAXIMUM RATINGS AND TYPICAL OPERATION

MAX RATINGS, ABSOLUTE VALUES

As r-f power amplifier and oscillator, Class C telegraphy, to approx 2500 mc:

	CCS
D-c plate voltage	350 v
D-c plate current	35 ma
D-c grid current	15 ma
Plate power input	12 w
Plate dissipation	8 w
Peak heater-cathode voltage:	
heater negative to cathode	90 v
heater positive to cathode	90 v

As plate-modulated r-f power amplifier and oscillator, Class C telephony, to approx 2500 mc:

	CCS
D-c plate voltage	275 v
D-c plate current	35 ma
D-c grid current	15 ma
Plate power input	9.5 w
Plate dissipation	6 w
Peak heater-cathode voltage:	
heater negative to cathode	90 v
heater positive to cathode	90 v

As plate-pulsed r-f power amplifier and oscillator, Class C telegraphy, to approx 4000 mc:

Peak positive-pulse plate-supply voltage	3,000 v
Peak negative-pulse grid-bias voltage	100 v
Peak plate current from pulse supply	2.5 amp
Peak rectified grid current	1.25 amp
D-c plate current	0.0025 amp
D-c grid current	0.00125 amp
Plate dissipation	7.5 w
Pulse duration	2 microseconds
Cathode heating time	60 seconds (min)
Peak heater-cathode voltage:	
heater negative to cathode	90 v
heater positive to cathode	90 v

TYPICAL OPERATION

As plate-pulsed oscillator at 3500 mc:

Duty factor	0.001
Peak positive-pulse plate-supply voltage	3,000 v
Peak negative-pulse grid-bias voltage	75 v
Peak current from pulse supply	2.5 amp
D-c plate current	2.5 ma
Useful power output at peak of pulse, approx	2 kw
Pulse duration	1 microsecond
Pulse repetition rate	1,000 pulse per second
Heater voltage	6 v

For further information, phone or write the G-E tube regional office nearest you, listed below.
Tube Department, General Electric Company, Schenectady 5, New York.

General Electric Company
Tube Department
200 Main Avenue, Clifton, N. J.
Telephone: GRegory 3-6387
(For direct connection in N. Y. C.
dial WIsconsin 7-4065, 6, 7, 8)

General Electric Company
Tube Department
3800 North Milwaukee Avenue
Chicago 41, Illinois
Telephone: SPring 7-1600

General Electric Company
Tube Department
11840 West Olympic Boulevard
Los Angeles 64, California
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ARizona 9-7765

Progress Is Our Most Important Product

GENERAL ELECTRIC

162-1B2

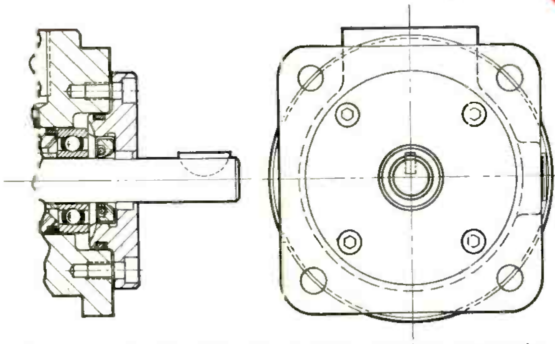
One Waldes Truarc Ring Saves a Pound in Weight
Replaces Cast Retainer Plate and Four Screws

Denison Vane Type Pump/Motor

The Denison Engineering Company of Columbus, Ohio uses a Waldes Truarc Beveled Retaining Ring (Series 5002) in their pump/motor to achieve a simpler, lighter, more easily assembled unit and to cut both material costs and production time.

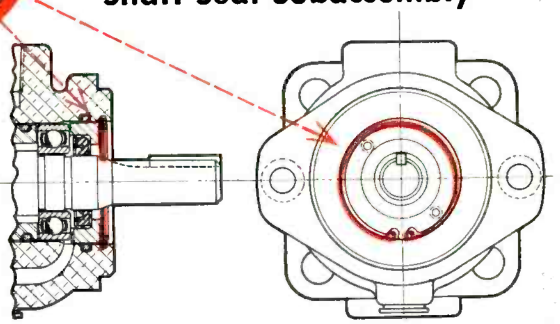
This vane-type power package operates as either a fluid pump or motor without alterations of any kind. Built for 2000 psi continuous duty, rugged construction was essential.

Shaft Seal Subassembly



Experimental Way: One cast retainer plate plus four socket head cap screws hold unit together. Assembly requires skilled labor, machinery, time-consuming careful adjustment.

Shaft Seal Subassembly



Truarc Way: Waldes Truarc beveled retaining ring (internal 5002) retains shaft and bearings, takes up accumulated tolerances rigidly, prevents leakage around shaft. Unit is one pound lighter. Assembly is quick and easy, more economical.

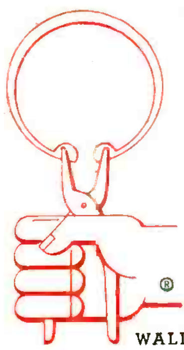
Wherever you now use machined shoulders, bolts, snap rings, or cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Truarc Rings are precision engineered, quick and easy to assemble and disassemble.

More than 5,000 stock-sizes of the different Truarc ring types available. Ninety stocking points throughout U. S. A. and Canada.

Find out what Waldes Truarc Retaining Rings can do for you toward reducing costs and improving your product. Send your blueprints to Waldes Truarc Engineers for individual attention without obligation.

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

Send for new catalog supplement



WALDES
TRUARC®
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

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.
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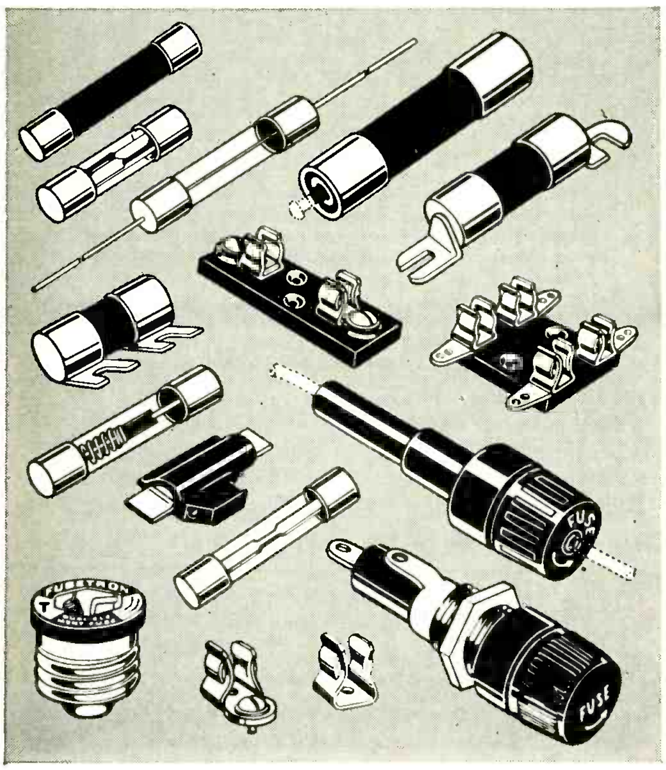
E037

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.

. . . dependable BUSS FUSES help protect the Product and your Reputation



BUSS fuses are made to protect — not to blow needlessly. A sensitive electronic device tests every BUSS fuse normally used by the Electronic Industries. Any fuse not correctly calibrated, properly constructed and right in all physical dimensions is automatically rejected.

This careful testing is your assurance that BUSS fuses will open and protect equipment against damage when there is trouble on the circuit. If a poorly made fuse doesn't open when it should on an electrical fault, something else will burn out.

BUSS fuses also safeguard your good-will by eliminating needless blows. A useless shutdown caused by a faulty fuse blowing when trouble doesn't exist can be most irritating to your customer. It could jolt his confidence in you.

Surely it is wise to rely on fuses that help you avoid troubles by offering dependable protection under all service conditions.

Then, why not be sure your buying and stock records specify BUSS and FUSETRON fuses . . . you'll find it convenient to use BUSS as the one source for all your fuse needs.

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

BUSSMANN MFG. CO. FUSETRON (Division of McGraw Electric Co.) ELRC 355

TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION

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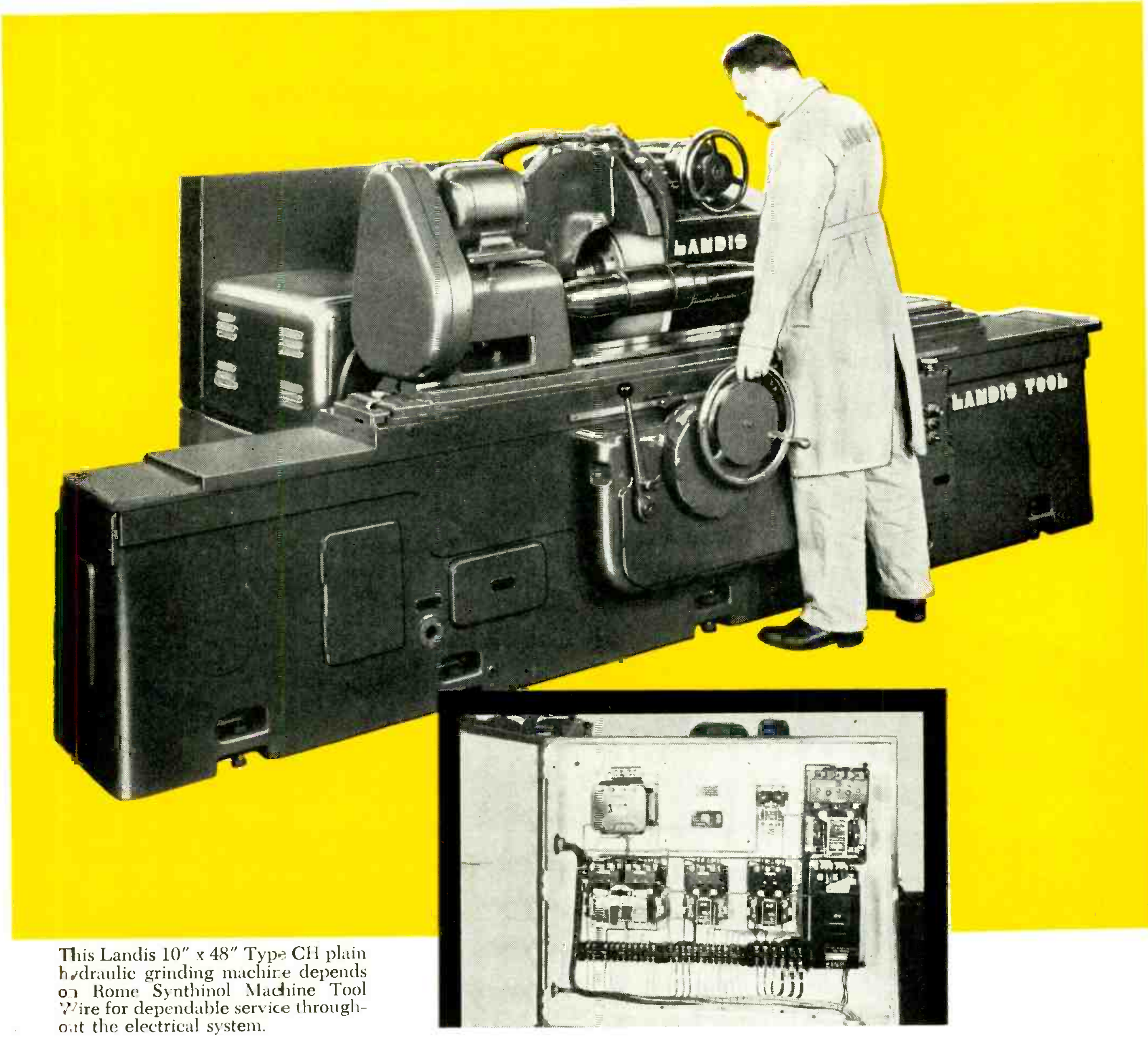

This Landis 10" x 48" Type CH plain hydraulic grinding machine depends on Rome Synthinol Machine Tool Wire for dependable service throughout the electrical system.

How Landis Tool **builds long life** *into the electrical circuits of these large precision grinders*

Oils and coolants—two liquids necessary in the operation of these large Landis grinders—can be pretty rough on ordinary insulated wires.

That's one of the reasons why the Landis Tool Company in Waynesboro, Pennsylvania, specifies Rome Synthinol® Machine Tool Wire for their line of precision cylindrical grinders. Other reasons: Rome's fast service and expert assistance to help solve wiring problems.

Synthinol, the thermoplastic insulation used in these Rome Machine Tool Wires, is specially compounded to resist moisture, heat, flame, acids, oils, and cutting solutions.

Uniformly small diameters and bright colors for easy identification make Rome Synthinol Machine Tool Wire a good choice for multiple circuit wiring like that on the Landis Type CH plain hydraulic grinding machine shown above.

Next time you're ordering machine tool wire, specify Rome for long life and trouble-free service in your product. Further information will be given promptly on request.

It Costs Less to Buy the Best

ROME CABLE ROME, N.Y.

ROME CABLE *Corporation*
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One of a series telling
how the producing companies of
General Precision Equipment Corporation
are contributing to America's progress.

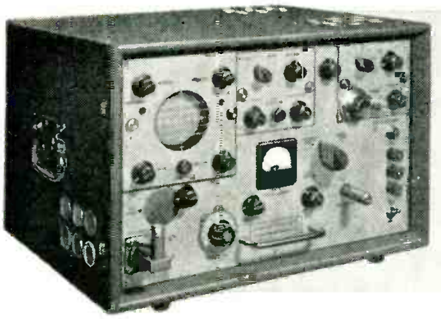
precision technology

GPE Coordinated Precision Technology is the basic GPE operating policy which inter-relates the research, development and manufacturing facilities, techniques and capabilities of the producing companies of General Precision Equipment Corporation. Thus each company's specialization in its particular areas of competence is supplemented by the application of the resources of the other companies, wherever relevant. A diversified line of advanced precision equipment of superior design and performance has resulted from this application of the newest and most advanced techniques possessed among the companies in every technical capacity.

e.g. in ELECTRONICS

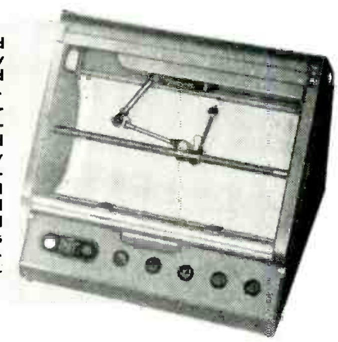
Ten of the GPE Producing Companies work in this important field. These companies were "born in electronics" and pioneered in its development before the word was coined. Their work covers every phase of electronics and GPE coordination relates each new electronic problem to the specialized knowledge and experience which is most valuable. This secures the optimum solution for the customer with minimum expenditure of time and money.

GPE Producing Companies have been responsible for the research, development and manufacture of a wide range of electronic precision components, equipment and systems, including Theatre Sound Systems, Sonar Equipments, Flight Simulators, Industrial Control Systems, Analogue Computers, Digital Computers and Components, Industrial and Studio Television, Navigation Systems—both airborne and marine. GPE systems, in most instances, are advanced concepts, often employing components specifically developed for the purpose by one of the GPE companies. Of the great number, two are shown.



Kearfott X-band Test Set, frequency range 8,500 to 10,000 MC; a unique all-purpose portable radar test set, comprising a power monitor, spectrum analyzer, wavemeter and signal generator which supplies an accurately calibrated signal of known level with variable amplitude and pulse-width combinations. Also provides FM, square wave and CW output.

Librascope X-Y Plotter and Recorder; automatically displays data derived from punch cards, mechanical or electronic computers or sensing elements; features rapid graphic 2-axis display with provision for 10-fold scale expansion and zero suppression. Used in aero-dynamic and electronic research, as well as in mass data reduction systems for business and industry.



Most advanced technological products which utilize electronics also call for other advanced technological skills. Though space allows only for an outline of GPE's work in electronics, both the capacities chart on the facing page and most of the products mentioned above serve to suggest the broad coordination of technical capacities in all fields which exists as a result of GPE Coordinated Precision Technology.

Address inquiries to: **GENERAL PRECISION EQUIPMENT CORPORATION**
92 GOLD STREET, NEW YORK 38, NEW YORK

AMPRO CORPORATION
CHICAGO

LINK AVIATION, INC.
BINGHAMTON, N. Y.

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BLUDWORTH MARINE
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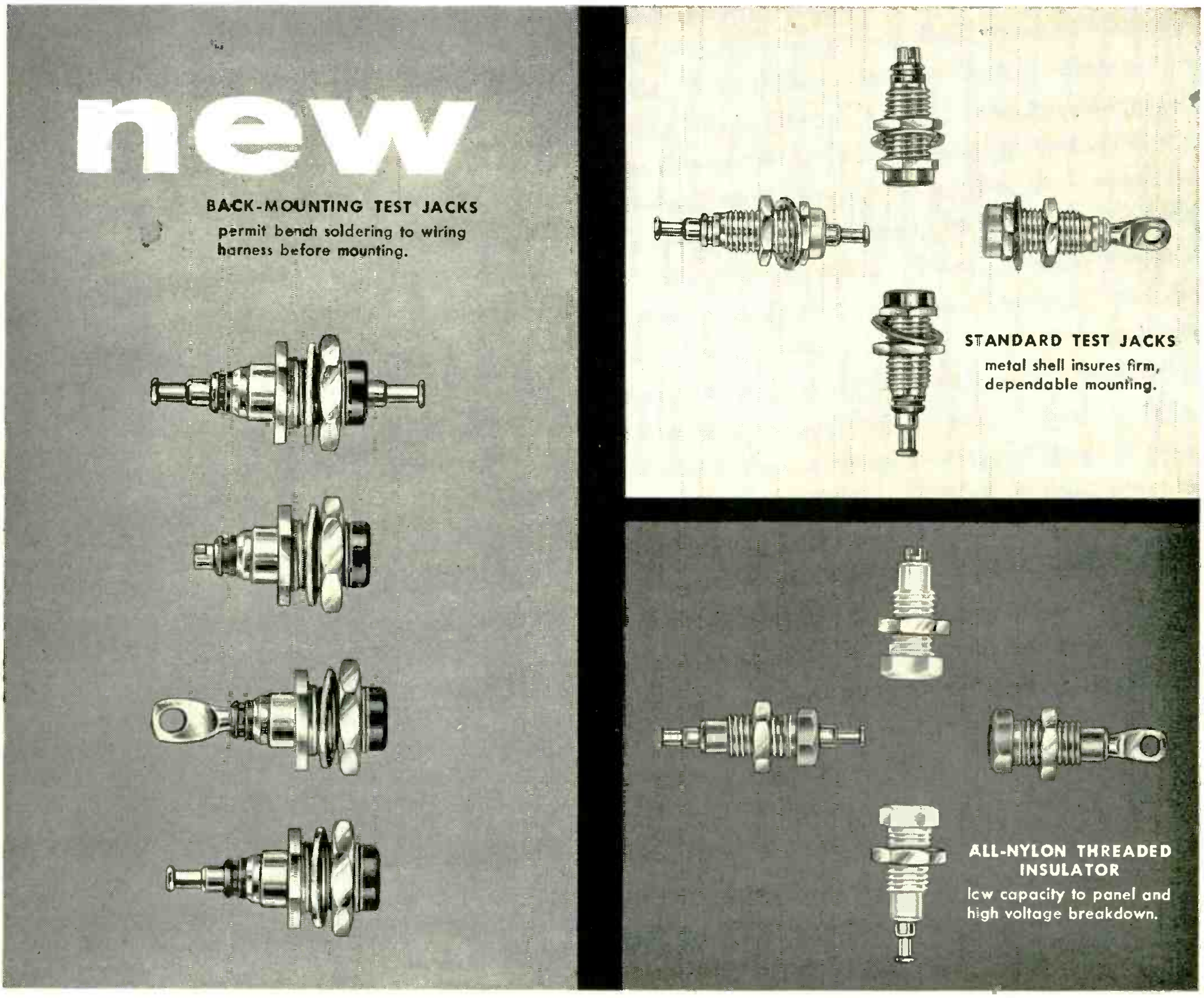


Test Jacks by Ucinite

The introduction of Ucinite's back-mounting jacks makes available for the first time a *complete* line of *high quality* test jacks suitable for use in equipment where long life and dependability are essential.

Ucinite Test Jacks, designed for standard .080 phone tips, are available in a variety of colors ideally suited to coded application. Silver-plated, heat treated beryllium copper contact is made in one piece with large terminal ends for easy soldering. The feed through type is provided with a one-piece brass terminal stud, tin-plated.

The specialized abilities and experience of Ucinite's own staff of design engineers are available for work on new and unusual problems. Volume production facilities ensure fulfillment of the largest requirements.

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

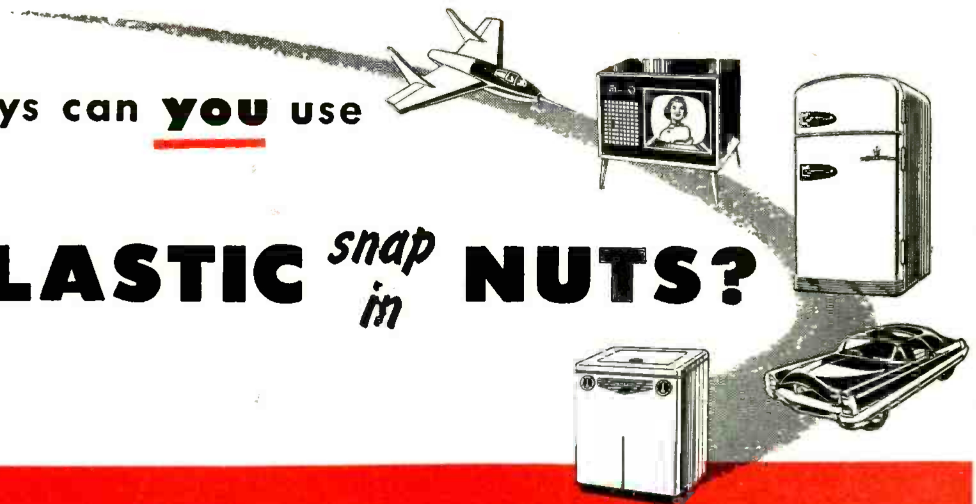
ELECTRICAL ASSEMBLIES
Ucinite
RADIO AND AUTOMOTIVE

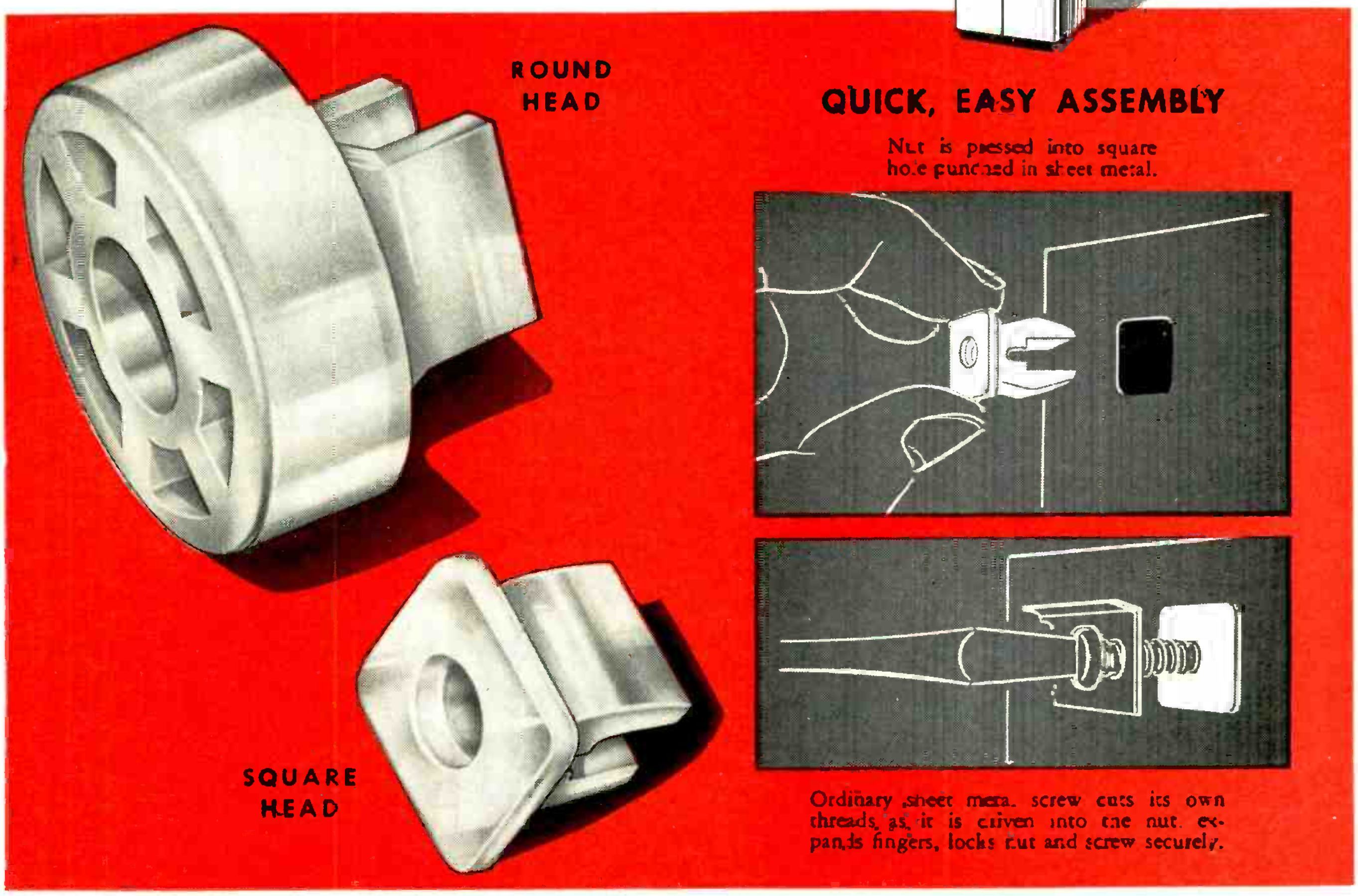
The UCINITE CO.
Newtonville 60, Mass.
Division of United-Carr Fastener Corp.

Specialists in
ELECTRICAL ASSEMBLIES,
RADIO AND AUTOMOTIVE

How many ways can **you** use

DOT PLASTIC *snap in* NUTS?





United-Carr's new self-locking, plastic nut is designed for blind application and can be used with all types of metal finishes without scratching or chipping the surface. Its plastic fingers provide rigid anchorage yet will not mar paint, polished metals or even porcelain.

Inexpensive sheet metal screws cut their own threads and expand the nut's fingers as they are driven, locking both nut and screw tightly in place. Screws can be removed and replaced several times without damage to the nut.

DOT plastic snap-in nuts are electrically non-conductive and provide a high degree of insulation against heat transfer. For all practical purposes, they also provide an effective vapor seal.

Available in several styles and sizes. Write for full information and samples or contact your nearest United-Carr representative.

UNITED-CARR FASTENER CORP.

CAMBRIDGE 42, MASSACHUSETTS

MAKERS OF DOT FASTENERS

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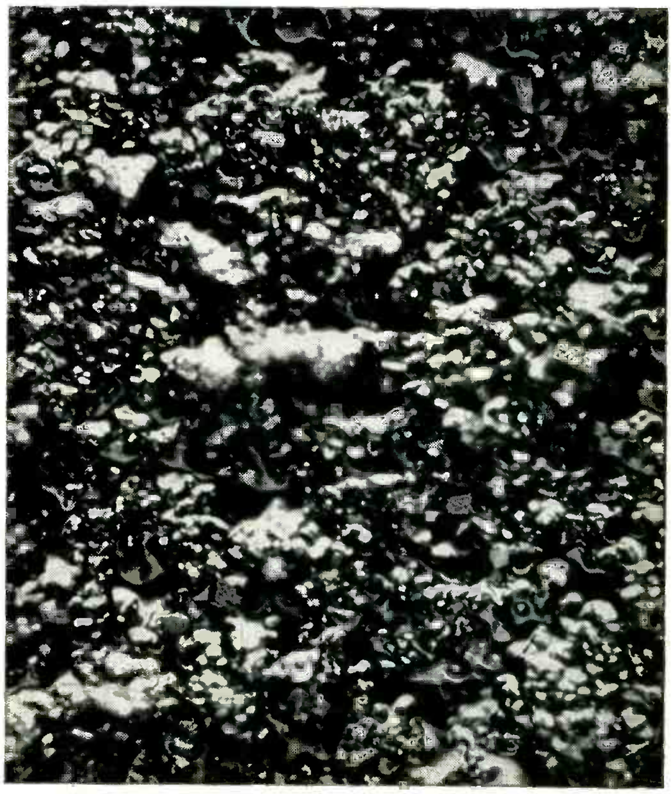
Which Aluminized Picture Tube is Best?



COMPETITIVE TUBE — This photomicrograph magnifies the inside reflective surface of an aluminized picture tube 200 times. You can see clearly its uneven "hill-and-valley" coating which causes some light to be lost within the tube, cuts down on brightness.

WESTINGHOUSE TUBE — Here's a photomicrograph of the Westinghouse aluminized tube manufactured with the exclusive Westinghouse "Flow-Filming" process, taken under the same conditions. Note the smoother, more even aluminum coating. It means you get maximum reflection, sharper, more detailed images.

Here's New Proof of Westinghouse Superiority!

For the first time, here's actual *proof* of the superiority of Westinghouse "Flow-Filmed" aluminized picture tubes.

In a dramatic comparison test of a Westinghouse aluminized picture tube against the tube of another well-known manufacturer, it was proved, beyond any doubt, *by photomicrography — not guess work* — that the Westinghouse aluminized picture tube was superior. Here's what the comparison shows:

WESTINGHOUSE ALUMINIZED TUBE — Look at the photomicrographs. The one on the right is smoother, more even. The aluminum layer has been applied to produce maximum reflection; it provides the viewer more light — *usable light* — that gives an image more brilliance, more clarity. This superior aluminized screen is a result of the *exclusive* Westinghouse "Flow-Filming" process of manufacturing.

COMPETITIVE TUBE — Notice the high peaks and crevices on the competitive tube (left). Light gets lost among them, is reflected backward and toward the sides, not toward the face of the tube. The Westinghouse aluminized tube's coating "caps" every exposed phosphor crystal, makes it an almost perfect reflector and directs the light onto the viewing area. This produces more detailed images, better contrast.

"Flow-Filming" is simply a *better* way of making aluminized picture tubes. It drastically reduces emission failures, caused by chemical residues, which occur under other manufacturing methods. "Flow-Filming" also virtually eliminates the "mottled" or "spotted" effect common to other brands of aluminized picture tubes.

WHAT CAN "FLOW-FILMED" WESTINGHOUSE ALUMINIZED PICTURE TUBES MEAN TO YOU? Just this: Fewer line rejects in your plants. Fewer field rejects. And — in the final analysis — a better, lower cost, easier-to-sell television set. You'll want to know more about Westinghouse aluminized picture tubes. So see your Westinghouse representative or drop a note today to the address below.

ET-95067

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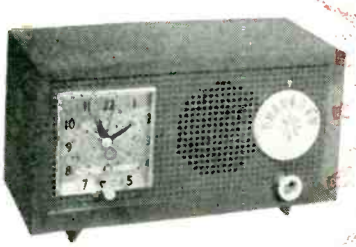

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El Menco Dur-Mica DM20
1 to 3900 mmf. at 500vDCw
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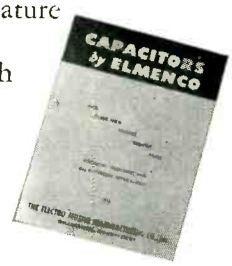

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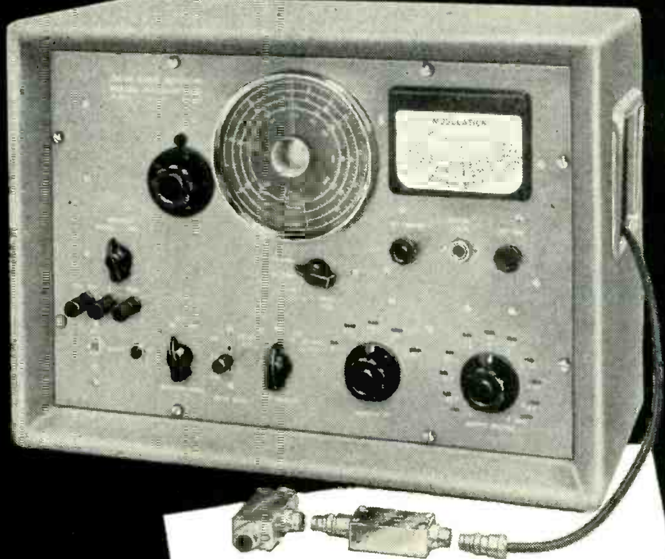

above
TYPE TF 995A/1
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TYPE TF 801B
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c.w. and a.m.

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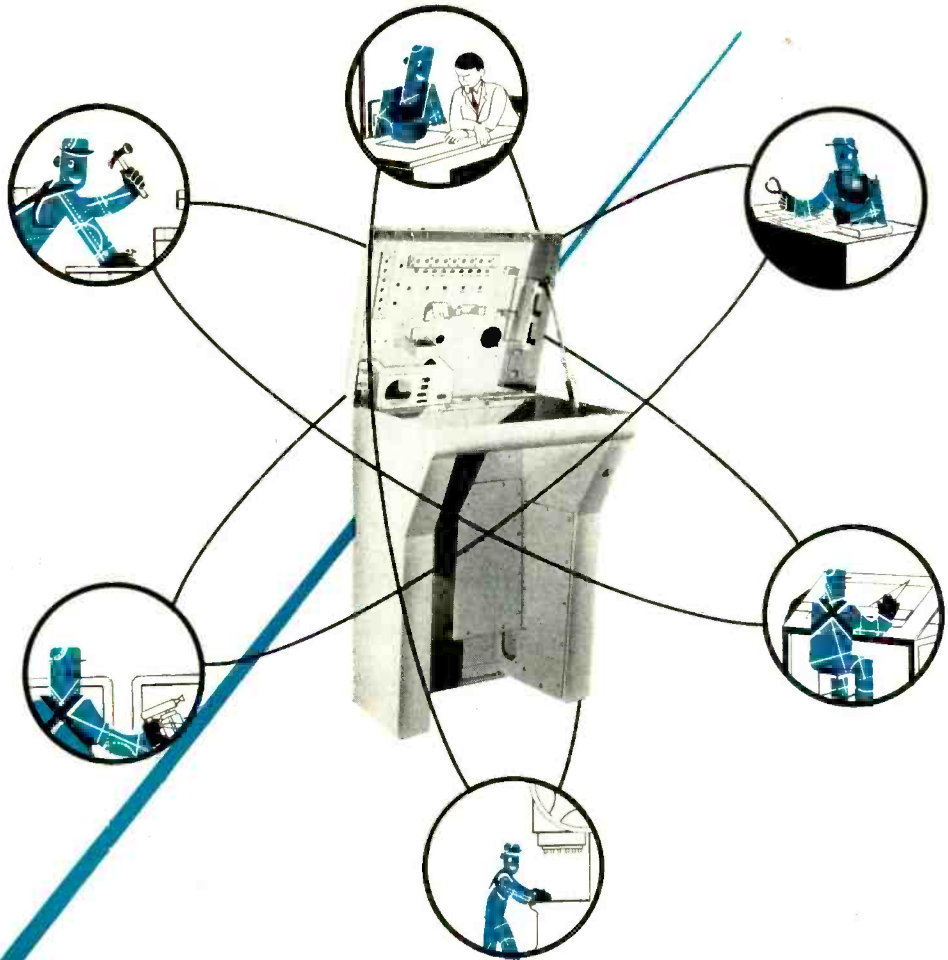

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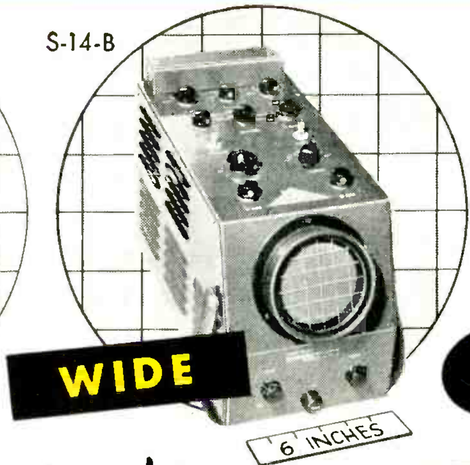
Waterman POCKETSCOPE

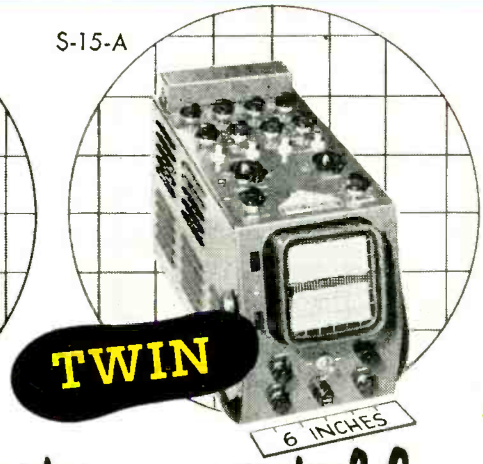
The Pocket-Size Oscilloscope

S-14-A

S-14-B



S-15-A



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Featuring small size, light weight and outstanding performance the HIGH, WIDE and TWIN POCKETSCOPES have become the "triple threat" of the oscilloscope field. Their incomparable versatility, reliability and accuracy have skyrocketed this team of truly portable instruments into unparalleled demand. Each oscilloscope features DC coupled amplifiers in both vertical and horizontal channels.

HIGH

The S-14-A HI-GAIN POCKETSCOPE provides the optimum in oscilloscope flexibility for analysis of low-level electrical impulses. Extremely light weight (12¾ lbs.), compact in size (12 x 5¾ x 7 in.), dependable and accurate in performance. Vertical and horizontal channels: 10mv rms/inch with response within 2DB from DC to 200 KC and pulse rise of 1.8 μs . . . non-frequency discriminating attenuators and gain controls with internal calibration of trace amplitude . . . repetitive or trigger time base with linearization from ½ cycle to 50 KC with ± sync or trigger.

WIDE

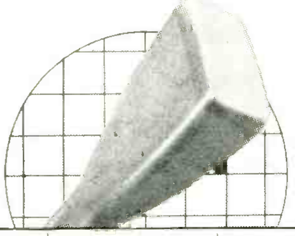
The S-14-B WIDE BAND POCKETSCOPE is ideal for investigations of transient signals, DC signals, aperiodic pulses or recurrent waveforms. Vertical channel: 50 mv rms/in. within —2DB from DC to 700 KC . . . pulse rise time of 0.35 μs. Horizontal channel: 0.15v rms/in. within —2DB from DC to 200 KC . . . pulse rise of 1.8 μs. Attenuators and gain controls are non-frequency discriminating . . . trace amplitude calibration . . . repetitive or triggered time base from ½ cycle to 50 KC . . . ± sync or trigger . . . trace expansion, filter graph screen and many other features . . . 14 lbs. . . . 12 x 6 x 7 inches.

TWIN

The S-15-A POCKETSCOPE is a portable, twin tube, high sensitivity oscilloscope with two independent vertical as well as horizontal channels. It is indispensable for investigation of electronic circuits in industry, school and laboratory. Vertical channels 10 mv rms/in. with response within—2DB from DC to 200 KC and pulse rise time of 1.8 μs . . . horizontal channels 1v rms/in. within —2DB from DC to 150 KC . . . non-frequency discriminating controls . . . internal signal amplitude calibration . . . linear time base from ½ cycle to 50 KC, triggered or repetitive, for both horizontal channels.

S-11-A

The S-11-A INDUSTRIAL POCKETSCOPE is a small, compact (5x7x11 inches), and lightweight (8¾ lbs.) instrument for observing electrical circuit phenomena. The flexibility of the POCKETSCOPE permits its use for AC measurements as well as for DC. The vertical and horizontal amplifiers are capable of reproducing within —2DB from DC to 200 KC with a sensitivity of 0.1v rms/in. . . . repetitive time base from 3 cycles to 50 KC continuously variable throughout its range . . . variations of input impedance, line voltage or controls do not "bounce" the signal—the scope stabilizes immediately.



RAYONIC CATHODE RAY TUBES BY WATERMAN

TUBE	PHYSICAL DATA		STATIC VOLTAGE		DEFLECTION*		LIGHT OUTPUT**
	FACE	LENGTH	A3	A2	VERT	HOR	
3JP1	3″	10″	3000	1500	111	150	352
3MP1	3″	8″		750	99	104	33
3RP1	3″	9.12″		1000	61	86	44
3SP1	1.5x3″	9.12″		1000	61	86	44
3XP1	1.5x3″	8.875″		2000	33	80	218

*Deflection in volts per inch.
**Light output of an element of a raster line (one mm long and not exceeding .65 mm in width) in microlumens.

The basic properties of the cathode ray tube that concern the designer or the user are: deflection sensitivity, unit line brightness, line width, static voltage requirements and physical size. A comparison between cathode ray tubes manufactured by Waterman Products Company is shown in the table adjoining. These tubes are available in P1, P2, P7 and P11 phosphors. 3JP1, 3JP7, 3SP1 and 3XP1 are available as JAN tubes.

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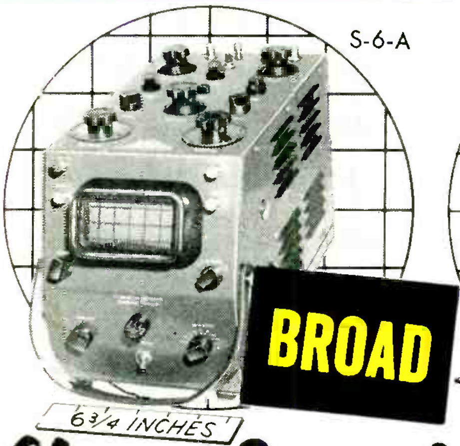
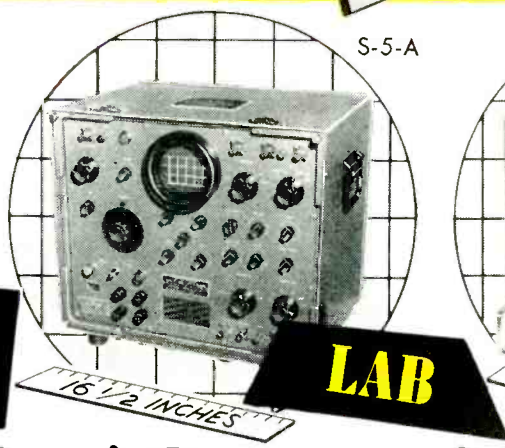
PULSESCOPE by Waterman

The Oscilloscope that Portrays the Pulse





Classic Examples of Precision Engineering...

The PULSESCOPES are cathode ray tube oscilloscopes that portray the attributes of the pulse: shape, amplitude, duration and time displacement. All PULSESCOPES have internally generated markers with the basic difference that in the SAR PULSESCOPE the markers initiate the sweep while in the others the sweep starts the markers.

BROAD

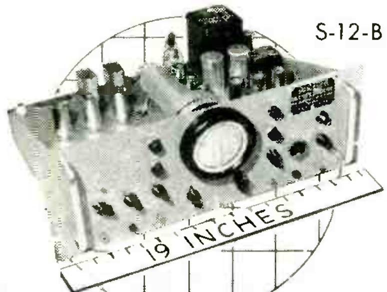
The S-6-A BROAD BAND Scope is a PULSESCOPE in performance, POCKETSCOPE in size. The instrument measures DC as well as AC signals. Unique DC calibration methods permit rapid measurements of either positive or negative, AC or DC signals. Vertical amplifier sensitivity of 0.2v rms/inch, and response to 5 mc within 3DB . . . pulse rise time of 0.1 μs . . . internal markers from 1 to 1000 μs . . . repetitive or trigger sweep from 5 cycles to 500 KC with 5X sweep expansion . . . sweep, marker and DC calibrating voltage available externally. Size 8½ x 6¾ x 13¾ in. Weight 22 lbs. Operates from 50 to 400 cycles at 115 volts AC.

LAB

The S-5-A LAB PULSESCOPE is a JANized (Gov't Model No. OS-26) portable, AC, wide band-pass, laboratory oscilloscope ideal for pulse as well as general purpose measurements. Internal delay of 0.55 μs permits observation of pulse leading edge. Includes precision amplitude calibration, 10X sweep expansion, internal trace intensity time markers, internal trigger generators and many other features. Video amplifier 0.1v p to p/inch . . . pulse rise time of .035 μs or response to 11 mc. 1.25 to 125,000 μs triggered or repetitive sweep . . . internally generated markers from 0.2 to 500 μs . . . trigger generator from 50 to 5000 pps. for internal and external triggering. Operates from 50 to 400 cycles at 115 volts AC.

SAR

The S-4-C SAR PULSESCOPE is a JANized (Gov't Model No. OS-4) portable instrument (31.5 lbs.) for precision pulse measurements for radar, TV and all electronic measurements. Portrays all attributes of the pulse . . . internal crystal controlled markers of 10 and 50 μs available for self-calibration . . . in R operation a small segment of the A sweep is expandable for detailed observation with a direct-reading calibrated dial accurate to 0.1%. Video amplifier band-pass up to 11 mc . . . optional video delay 0.55 μs . . . pulse rise and fall time better than 0.07 μs . . . R pedestal (sweep) 2.4 to 24 μs . . . video sensitivity of 0.5v. p to p/inch. Easily convertible from μs to yards. Operates from 50 to 400 cycles at 115 volts AC.



RAKSCOPE

Because the panel is only 7″ high and fits any standard rack, the S-12-B RAKSCOPE admirably fills the need for a small oscilloscope of wide versatility. With all the features of the S-11-A POCKETSCOPE, the RAKSCOPE is JANized (Gov't Model No. OS-11), and has many additional advantages; the sweep, from 5 cycles to 50 KC, is either repetitive or triggered . . . vertical and horizontal amplifiers are 50 mv rms/inch with band-pass from 0 to 200 KC . . . special phasing circuitry for frequency comparison.

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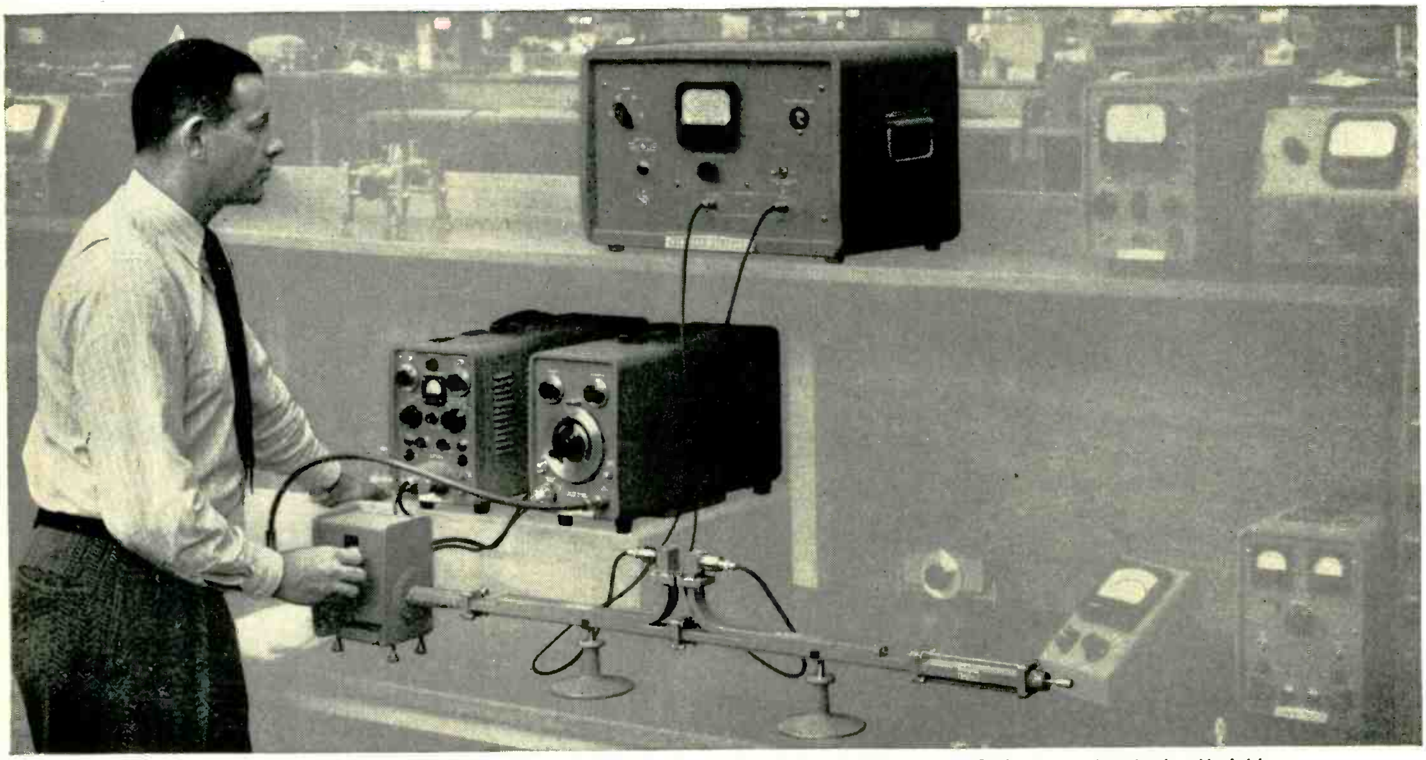

New -*hp*- reflectometer system comprises Klystron Power Supply, Swept Frequency Oscillator and Ratio Meter (rear) plus Variable Attenuator, Directional Couplers, Waveguide Crystal Detectors and Load (simulated by Short).

SPECIFICATIONS

-hp- 416A RATIO METER

METER PRESENTATION: (a) As a Reflectometer: Percent reflection (magnitude of reflection coefficient). Four ranges, full scale values of 100%, 30%, 10%, 3% reflection. (1.00, 0.30, 0.10, 0.03 reflection coefficient.) (b) As a VSWR Indicator Voltage Standing Wave Ratio. Four ranges, 1 to 3, 3 to 10, 10 to 30, 30 to 100 VSWR. (c) Decibel scale for either application: 0 to 10 db, 40 db total, ranges spaced exactly 10 db.
ACCURACY: ±3% of full-scale value for 20 to 1 range of incident or reference r-f power.
CALIBRATION: Square-law, for use with Crystal Detectors or barretters.
FREQUENCY: 1,000 cps. ±40 cps.
INPUT VOLTAGE: Incident or Reference Channel: 3 mv to 100 mv rms. Reflected or Probe Channel: 0.3 mv to 100 mv rms. (Square-wave or sine-wave).
INPUT IMPEDANCE: Approximately 75 K ohms.
EXCESS COUPLER LOSS: Provision made for increasing sensitivity of the Incident Channel by 10 db for reflectometer setups employing couplers with different coefficients. Under certain circumstances, accuracy can be improved by this procedure.
OUTPUT: Connectors for oscilloscope and recorder.
ADJUSTMENTS: "Set to Full Scale" control for initial calibration with 100% reflection, or at VSWR peak.
INTERNAL CHECK: "Eye" tube continuously monitors input amplitude (and frequency indirectly) to assure proper operating range for instrument and for crystal detectors.
PRICE: $365.00.

-hp- 670HM shf OSCILLATOR

FREQUENCY RANGE: 7.0 kmc to 10.0 kmc.
OUTPUT POWER: Approximately 10 mw entire frequency range.
ATTENUATOR RANGE: 100 db.
MODULATION: (a) Grid Modulation for optimum swept-frequency performance. (b) Reflector Modulation for optimum single-frequency performance. Modulating signals must be provided from external source (normally the -hp- 717A Power Supply). Pulses as short as 3 microseconds can be produced.
MECHANICAL SWEEP: Fully adjustable to cover any 10% or larger portion of the 7.0 kmc to 10.0 kmc spectrum. Sweep rate approximately 12 to 60 complete cycles per minute depending on swept frequency range. (Special sweep rates available at additional charge.)
SWEEP VOLTAGE PROVIDED: Linear voltage proportional to mechanical sweep. (Approximately 50 volts change provided for 7 to 10 kmc swept frequency range.)
PRICE: $850.00.

-hp- 717A KLYSTRON POWER SUPPLY

BEAM SUPPLY:
VOLTAGE RANGE: 800 to 1,000 volts.
CURRENT: 25 ma, maximum.
REGULATION: (a) For constant load, less than ±0.1% output voltage change for ±10% variations from 115-volt line. (b) Less than ±1% output voltage change for output currents from 0 to 25 ma.
HUM: Less than 10 millivolts.
REFLECTOR SUPPLY:
VOLTAGE RANGE: 0 to 600 volts in 3 ranges.
CURRENT: 1 ma maximum; source resistance approximately 300 K ohms.
REGULATION: For constant load, less than ±0.05% change for ±10% variations from 115-volt line.
HUM: Less than 10 millivolts.
SQUARE WAVE MODULATION: (a) Amplitude adjustable 0 to 60 volts peak-to-peak. (b) Rise and decay times less than 10 microseconds. (c) Frequency adjustable from 400 to 1,000 cps.
SINE WAVE MODULATION FOR FM'ing: (a) Amplitude adjustable from 0 to 300 volts peak-to-peak. (b) Frequency: line voltage frequency. (c) Oscilloscope horizontal sweep voltage: 15 volts peak-to-peak, phase adjustable ±45° with respect to modulating voltage.
EXTERNAL: Terminals available for applying external modulating voltage. System will pass 3 microsecond pulses.
GRID SUPPLY:
VOLTAGE RANGE: 0 to +30 volts, open circuit, referred to cathode potential.
SQUARE WAVE MODULATION: (a) Amplitude adjustable 0 to 60 volts peak-to-peak. (b) Rise and decay times less than 10 microseconds. (c) Frequency adjustable from 400 to 1,000 cps.
EXTERNAL: Terminals available for applying external modulating voltage. System will pass 3 microsecond pulses.
FILAMENT SUPPLY: 6.3 volts ac., 2 amps.
PRICE: $375.00.

-hp- X421A CRYSTAL DETECTOR

FREQUENCY RANGE: 8.2 kmc to 12.4 kmc.
SENSITIVITY: Approximately 1 mv/0.01 mw (average value).
VSWR: Less than 1.5 entire frequency range.
FREQUENCY RESPONSE: Flat within ±2 db entire frequency range.
PRICE: $75.00. (Includes 1N26 Silicon Diode and matched video-load resistor.)

-hp- 752 DIRECTIONAL COUPLERS

COUPLING: X752C = 10 db coupling
X752D = 20 db coupling
WAVEGUIDE SIZE (in.): 1 x ½
FREQUENCY RANGE (kmc): 8.2 - 12.4
DIRECTIVITY: Better than 40 db full range.
PRICE: $100.00

All prices f.o.b., Palo Alto, California
Data subject to change without notice

See reflectometer and other new *hp* **INSTRUMENTS**

reflectometer system for impedance measurement

Reflection coefficient or SWR measured instantly over wide frequency range

Direct, continuous swept-frequency oscilloscope presentation

Higher accuracy than slotted lines for single frequency measurement

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

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

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

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

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

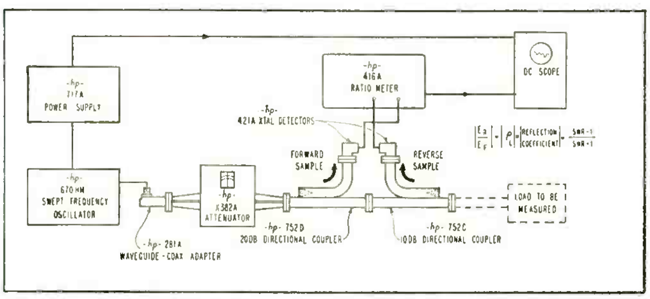

Figure 1. Reflectometer system. Swept rf power is provided by Oscillator. Directional Couplers sample forward and reverse power. Waveguide Detector Mounts terminating both Couplers demodulate power and present a 1,000 cps signal to Ratio Meter. Oscilloscope presents continuous visual study of reflection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

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

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

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

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

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

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Magnetic Amplifiers are designed for use in Servo Systems employing two phase low inertia induction motors. They require no external tubes or separate bias, and operate directly from a line supply. They employ the latest half-wave self-saturating circuitry, insuring low response time, high gain and compactness. The half wave reset mode of operation of these units supplies very desirable quadrature rejection. These Magnetic Amplifiers are noted for long life, ruggedness, and dependability.

RESOLVER AMPLIFIERS

Resolver Amplifier Systems are made for precision resolver applications where accuracy, isolation, and reliable operation under severe environmental conditions is paramount. Subminiature packaging techniques, preferred type tubes and quality components assure reliability, compactness and long life. Two basic system types are standard: a system connection employing summing resistors; the other, where the input signals are series summed with the compensating winding signal and fed to the grid of the high gain amplifier.

SERVO AMPLIFIERS

Dual Channel Servo-Amplifier, Type SEA 4-310, is made for servo-systems using miniature two-phase servo motors. Each amplifier channel is capable of accepting input error information, either in-phase or 90 degrees out of phase with the line of reference. Separate input terminals are provided for these inputs. For in-phase signals, the amplifier circuits provide the required 90 degrees phase shift for operation of the servo motor. Hence, the motor fixed field can operate without external phasing capacitors. Tuning capacitors for motor control fields are provided as integral part of each amplifier for power factor correction.

CONTROL DEVICES

Many control devices, designed and developed by Norden-Ketay engineers, are being produced in mass quantities. Custom engineered units, featuring resistance to humidity, corrosion and high temperatures, or having special configuration and other non-standard characteristics, will be made to meet the needs of your particular application.

Norden-Ketay designs and manufactures a large variety of airborne instruments for engine and flight operation, for many aircraft, missile, marine, ordnance and civilian applications. Included are many special designs insuring a high level of performance, while meeting limitations of space and operating conditions. Norden-Ketay research laboratories are staffed and equipped to co-operate with engineers that find a need for electronic control devices in their particular project.

NORDEN-KETAY CORPORATION

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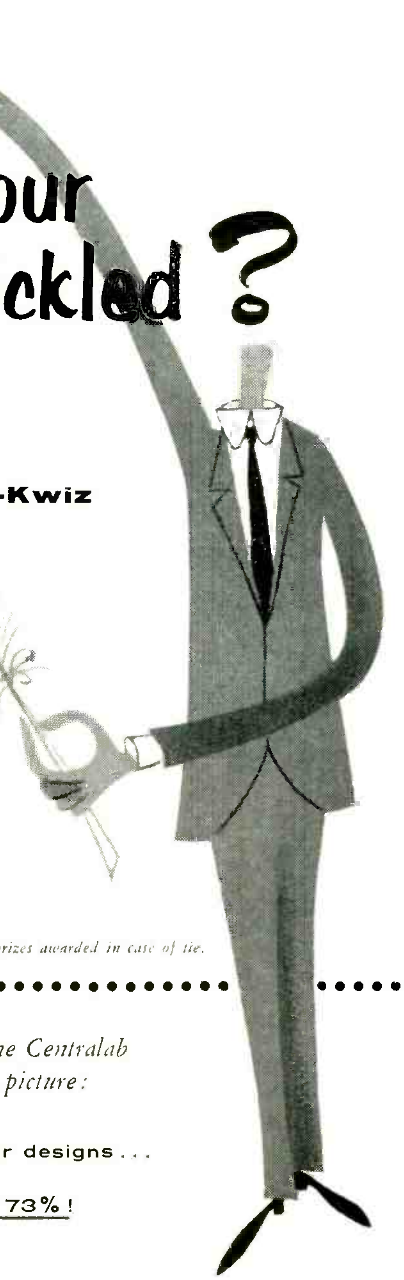


Like to have your brain tickled?

Then Centralab's new monthly Electroni-Kwiz is your dish — for fun and prizes*

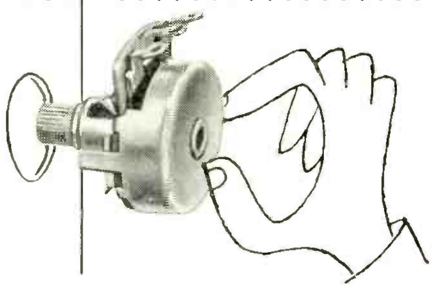
Answer the Electroni-Kwiz question in 50 words, more or less (who counts?), and you're eligible to win a prize.

Now, we're not giving away any oil wells (a big national advertiser beat us to that), but we do promise awards well worth your time and effort. This month's major prize is a wardrobe of fine men's shoes. A leading editor in this field will pick the winner.

Here's this month's question: If you were to make like Webster, how would you define *"automation"?*

Sharpen that pencil — flex those mental muscles — and mail your entry to us before March 30.

**Nothing to buy. Employees of Centralab and their advertising agency not eligible. Duplicate prizes awarded in case of tie.*

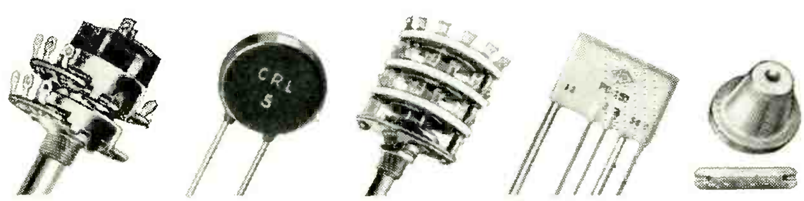


Speaking of automation, here's one Centralab component that fits right into the picture:

When manufacturers worked Centralab's Snap-Tite into their designs . . . they cut the cost of installing rear-end controls as much as 73%!

More proof that if it's a job for electronic components, it's a job for Centralab

Centralab's creative engineering and production methods pay off for many users of standard and special electronic components



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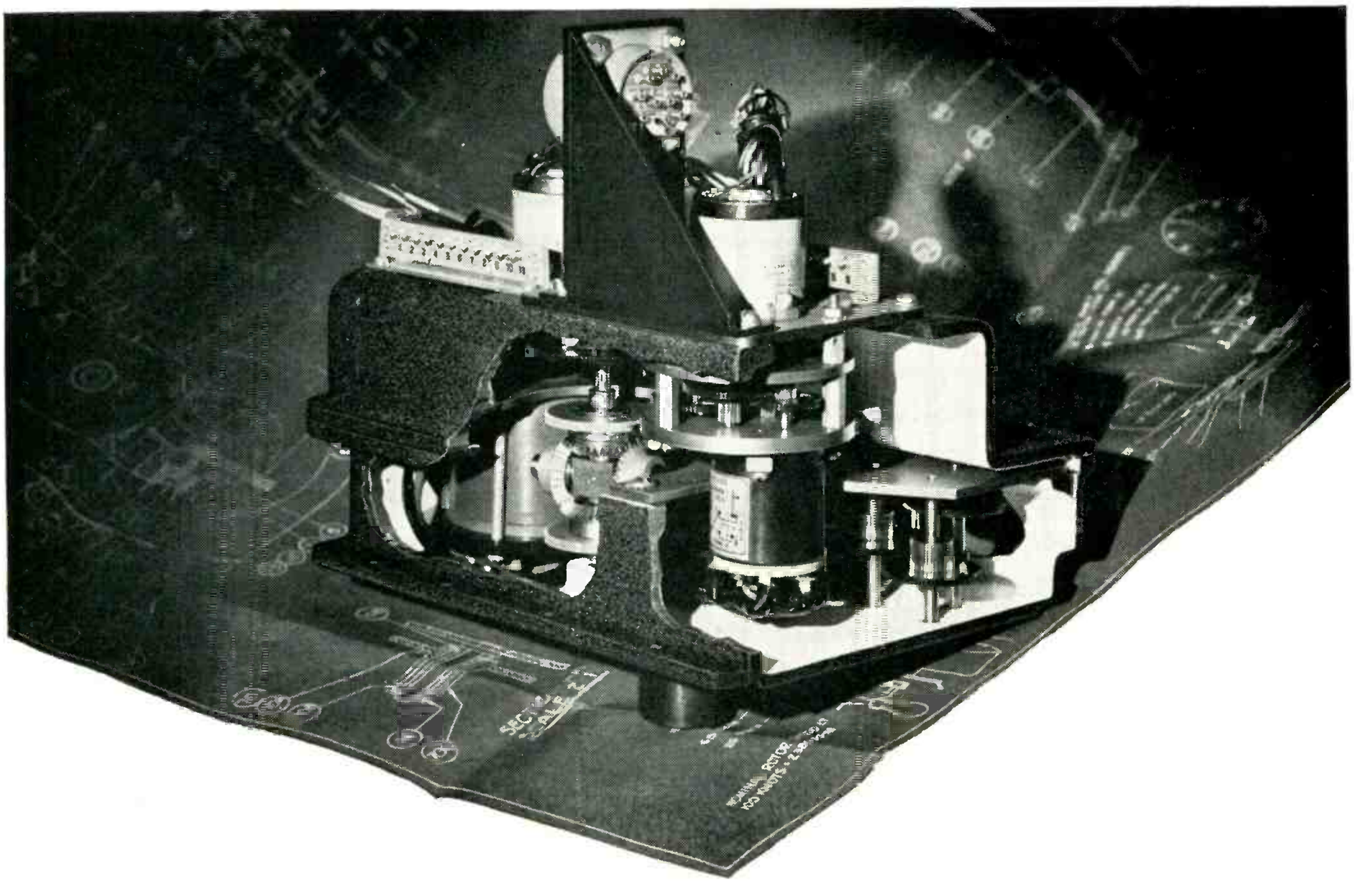

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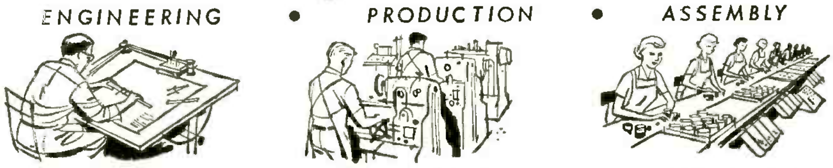
Here's how Atlas helps you develop new assemblies and components for radar and sonar systems, computers, and other electro mechanical devices.

You bring your designs to us. Atlas experienced production and methods engineers layout the job using new cost-cutting methods, improved processing techniques. Atlas toolmakers build dies and fixtures to implement these plans. Atlas skilled mechanics and assemblers produce prototypes to your exact specifications. Atlas metallurgical and electronic technicians test your product. Your next step is when your plant or Atlas takes over for volume production.

Atlas furnishes the practical engineering step between idea and production line. We've been "precision-eering" on a contract basis for many years. May we work with you? Write for booklet "Precisioneering Electro Mechanical Equipment." ATLAS Precision Products Co., Phila. 24, Pa. (*Division of Prudential Industries*).

"From Drawing Board . . . to Production Line"

ENGINEERING • PRODUCTION • ASSEMBLY



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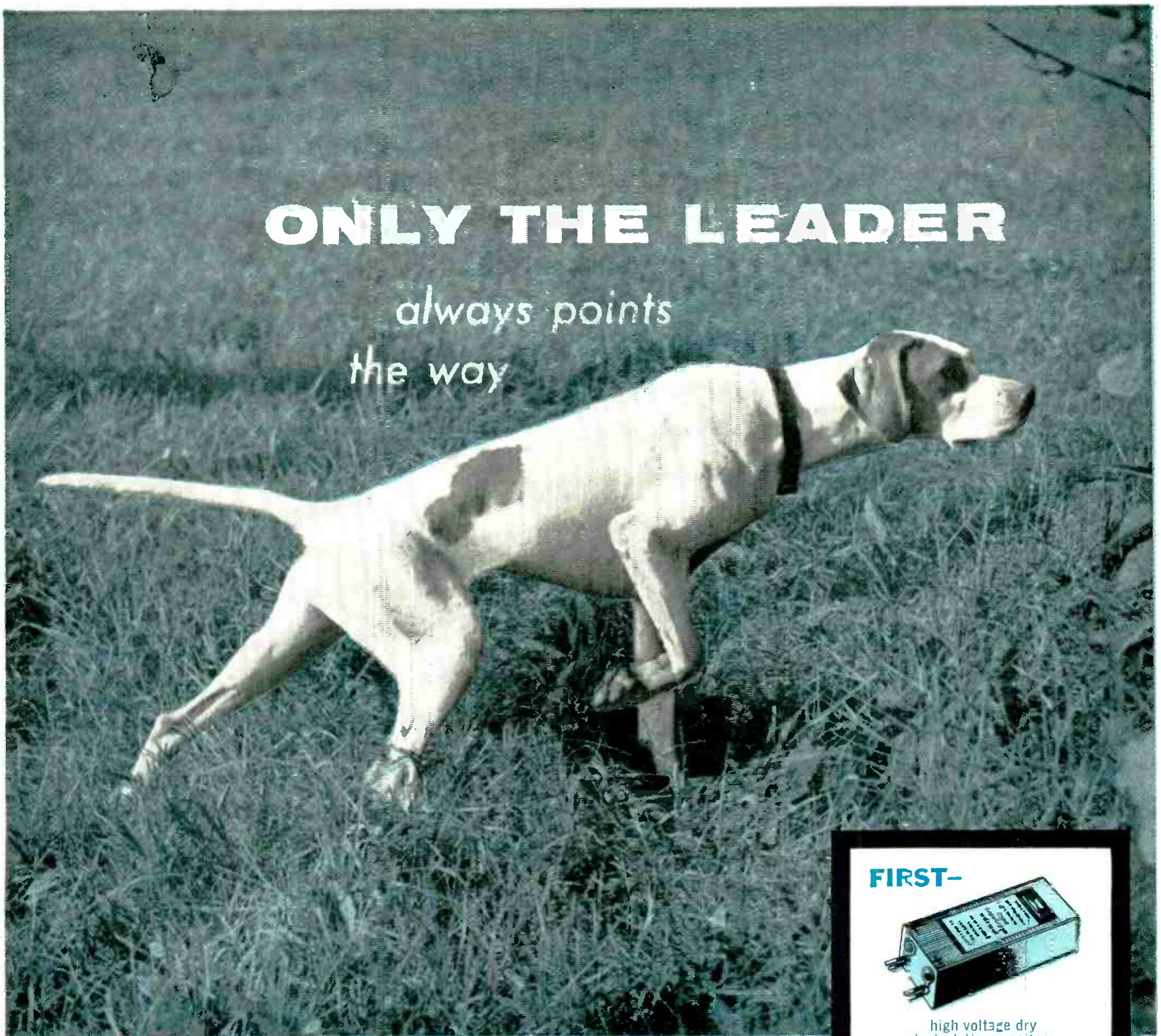
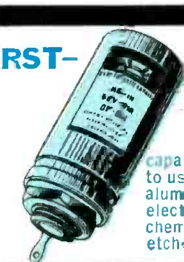


FIRST–

high voltage dry electrolytic capacitors.

FIRST–



capacitor to use anodic aluminum foil electro-chemically etched.

FIRST–

miniature, metal-cased electrolytic capacitors.

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Typical of these "famous firsts" are the three examples shown here . . . *proof* that whatever your capacitor requirements may be, your needs can be filled by C-D. Write to Cornell-Dubilier Electric Corp., Dept. K-35, South Plainfield, N. J.

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PLUS LFE's New PLUG-IN feature which greatly increases the number of applications which can be serviced by one instrument. More X-axis flexibility and unmatched versatility — at lower overall cost.

Specifications

X-AXIS PLUG-IN ADAPTERS

Model(s) 1400, BASIC, with 500 to 5000 cps trigger generator.
1401, SWEEP DELAY, continuously variable from .5 μ sec. to .1 sec.
1402, VIDEO SWITCH
1403, GATED MARKER GENERATOR, 01 to 10000 μ sec.
1404, TV TRIGGER SHAPER, triggers on composite video signal.
1405, LONG SWEEPS, from .1 μ sec. /cm. to 10 sec. /cm.

BASIC SCOPE

Y-Axis Amplifier

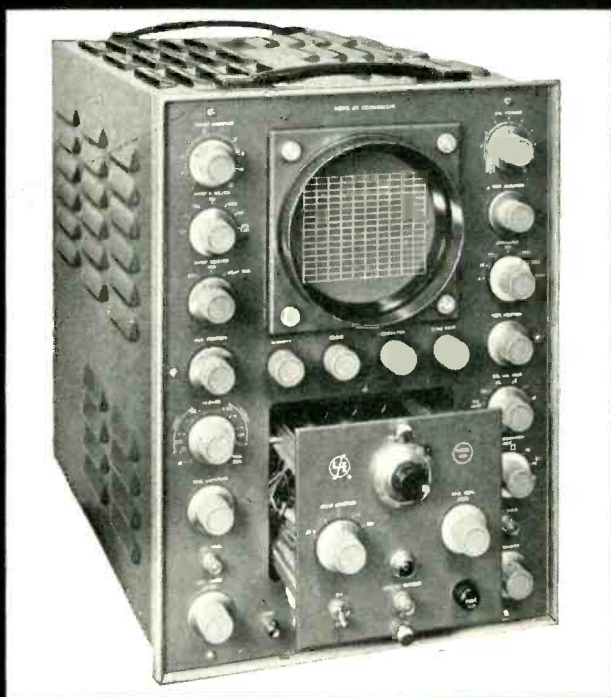
Deflection Sensitivity — 15 mv. /cm. p-p for both d-c and a-c (max.)
Max. Signal Voltage — 500 volts, peak.
Frequency Response — d-c to 10 mc /sec. (3 db point)
Transient Response — Rise time (10%-90%) — 0.035 μ sec.
Linearity of Deflection — Max. deflection, 5". At 2.5" unipolar deflection, maximum compression is 10%.
Signal Delay — 0.25 μ sec.
Input Termination — 53, 72, or 93 ohms.
Input Impedance — 1 megohm, 30 μμf.

X-Axis

Sweep Time Range, calibrated — .1 μ sec. /cm. to .1 sec. /cm.
External Sweep Sensitivity — 2 volts /cm., p-p.
Frequency Response — DC to 1 Mc., (3 db. point)
Triggers — Internal or External to 10 mc., 60 cps
DC Blanking.

OTHER FEATURES

Flat-face CRT Type 5-ABP1 (P7 or P11 optional) — Accelerating Potential 3000 - 4000 volts.
Deflection Plates Accessible.
Power Requirements: 105-125 V., or 210-250 V., 50-60 cycles, 385 watts.
Dimensions: 13" w, 17¾" h, 21" d.



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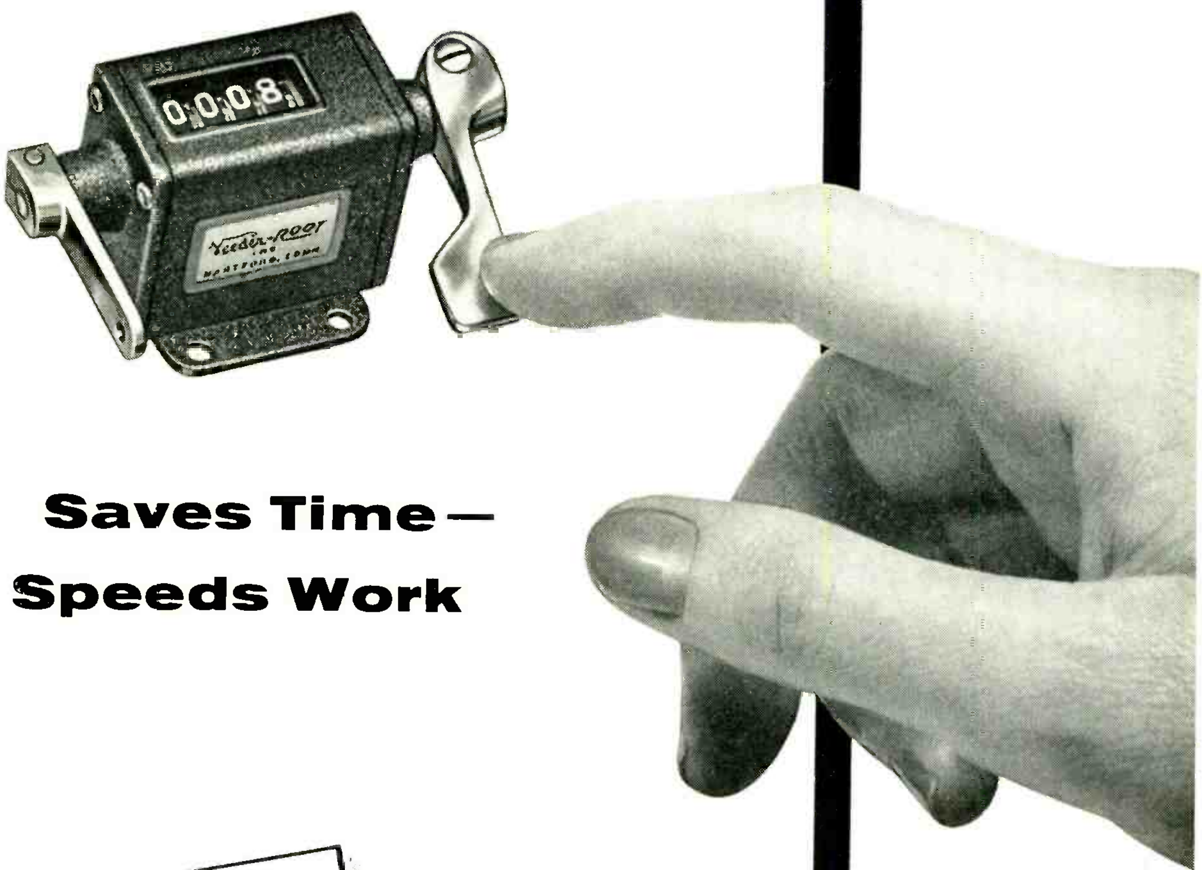

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Where time consumed in resetting is at a premium . . . on short machine-runs, inspection, military equipment and other applications . . . this new time-tested Quick-Reset Ratchet Counter is exactly the time-saving device you need. Just flick the easy-acting lever on the right side . . . *all 4 figures reset instantly to zeros*. And a thumb-lever may be used on the left side also if the counter is to be operated manually.

This compact, standard counter, now readily available from stock, is one of scores of Veeder-Root Counters (both standard and special) for manual, mechanical and electrical operation in every field from electronics to atomics. Just name what you want to count . . . and "The Name that Counts" will help you do the job. Write:

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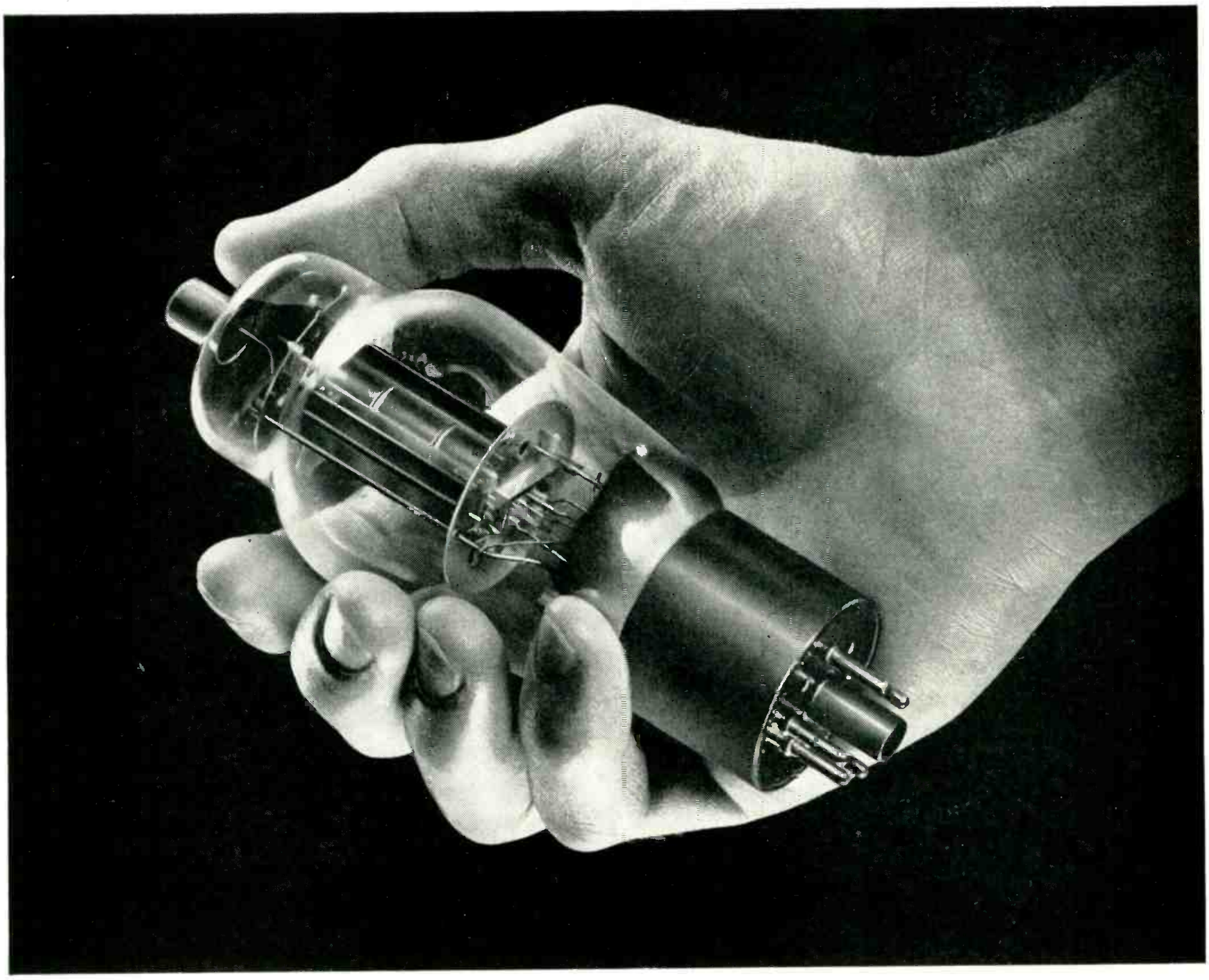

vacuum-melted components give long, reliable performance . . .

Vacuum-melted metals are the answer to the engineer's search for more *reliable* materials. In vacuum tube components, for example, these superior metals mean longer tube life . . . *stable* electrical characteristics even after repeated heatings. For vacuum-melting *removes* undesirable gases *before* they are put in the tube.

Vacuum-melting literally sucks gaseous impurities and inclusions from the molten metal. You get high-purity, gas-free metals that far outperform conventional air-melted metals. Cathode nickel alloys, iron, and alloys for metal-glass seals are held to *uniformly* close standards of composition. Purity and soundness of *any* metal is improved.

Vacuum Metals Corporation, pioneer in development and leading producer of vacuum-melted and cast metals, has available a wide range of these unique metals designed for electrical and electronic uses. If you believe they might improve your product, please write, giving full details. Our engineers will give them careful attention. *Vacuum Metals Corporation, P. O. Box 977, Syracuse 1, N. Y.*

VMC

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COLOR BAR GENERATOR — MODEL PT-203

A complete instrument with a color bar pulse forming unit, a complete colorplexer unit and regulated B+ and filament supplies. Provides NTSC color TV test signals, for receivers, transmitters, networks and components. Internal switching provides 19 different test patterns in the form of a composite NTSC video signal. Special self-balancing colorplexer provides exceptional stability over long periods of operation without readjustment, with "I" and "Q" outputs. (See colorplexer details.)

AUTO-SELF-BALANCED COLORPLEXER MODEL PT-205

Incorporated in the Model PT-203 Color Bar Generator, available as a separate chassis for rack mounting. Designed for high stability and negligible drift, this unit replaces old encoder units of early design. This instrument multiplexes three simultaneous color video signals (R, G, B) and properly encodes them into color information and then combines them with sync pulses and color sync signals to form a standard NTSC color TV signal. Pulse or video signals to drive colorplexer may be obtained from special (R, G, B) pulse generators, color camera or color slide scanner. Subcarrier balance is stable and dynamically independent of signal level changes over long periods of operation. Driving signals are Subcarrier, Blanking, Sync and Vertical pulses. Full bandwidth "I" and "Q" modulation is used in the chrominance channel of the colorplexer. "I" and "Q" or "B-Y" and "R-Y" video test signals are available for receiver and monitor matrix alignment. Both positive and negative polarity signals are available at high and low impedance.

POLARAD

COLOR

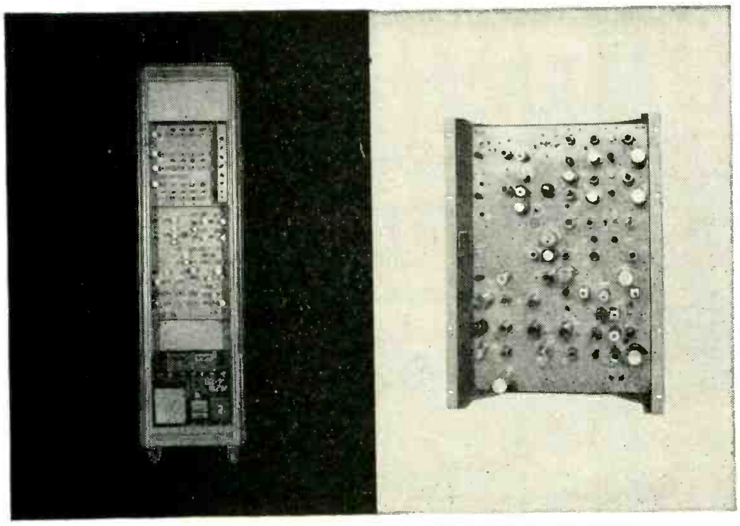
TV

AN INTEGRATED LINE OF EQUIPMENT FOR STUDIO AND LABORATORY

Fully integrated units that combine ease of operation with maximum stability. No additional accessories or power units required for operation.

Especially designed for:

- Testing receivers, transmitters, and terminal equipment.
- Laboratory test standards for development of color TV equipment.
- Checking components used for color TV.
- Alignment and adjustment of colorplexers or encoders.
- Testing convergence of tri-color kinescopes.



COLOR BAR GENERATOR— MODEL PT-203

Output Signals: NTSC Composite Video 2 Outputs 0—1.4 v. pk-pk
Output Signal Information:
Color Bars—6 Bars of Color (R, G, B, C, Y, M) plus Blk/Wht
Gamma Bars—10 step grey scale Black to White
Dots—White dots on a black field
External Video—Positive or negative (Provision for mixing ext. video with above).
System Bandwidth: Luminance Channel 6 mc
Chrominance: "I" and "Q" Channel per NTSC standard
Subcarrier balance stability: Drift not greater than 6 mv (1.4 v. pk-pk signal), 8 hour operation.
Residual Subcarrier Unbalance: 1% Signal Level
Power Requirements: AC 105-125 volts 7 amps., 60 cps.

COLORPLEXER-MODEL PT-205

Output Signals: NTSC Composite Video 2 Outputs 0—1.4 v. pk-pk
Available Test Signals: I, Q, Y, R-Y, B-Y, (Neg. and Pos.) Video
Input Signals: Subcarrier 20-30 v. pk-pk, 3-579545 mc
Sync 3.0 v. pk-pk, negative
Vertical Drive 3.0 v. pk-pk negative, R, G, B; 1 v. pk-pk
System Bandwidth: Luminance Channel 6 mc
Chrominance: "I" and "Q" Channel per NTSC standard
Subcarrier Balance Stability: Drift not greater than 6 mv (1.4 v. signal), 8 hour operation
Power Requirements: AC 6.3 v. @ 12 amps., DC 280 v. @ 425 ma

POLARAD PROVEN RELIABILITY **ELECTRONICS CORPORATION**

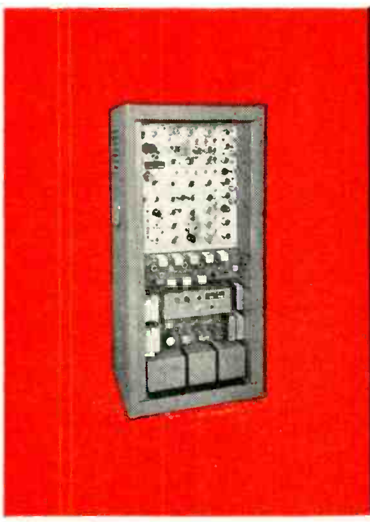
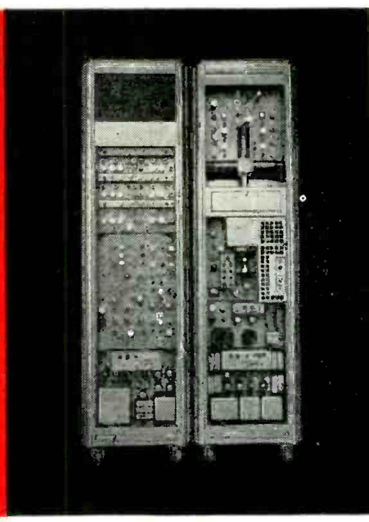
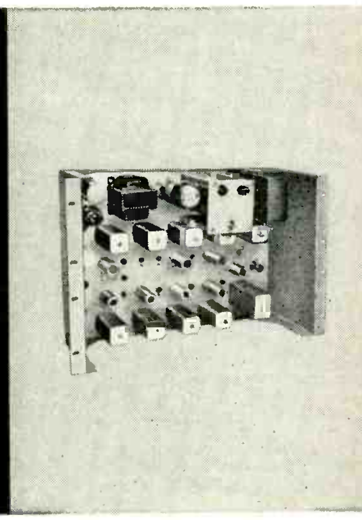
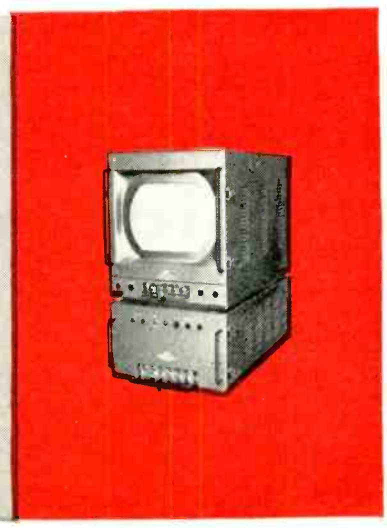
SYNCHRONIZING GENERATOR — MODEL PT-201
Compact unit provides RTMA standard driving, blanking and synchronizing pulses, as well as a composite video signal comprising vertical and horizontal dots for receiver tests (positive and negative). Used to drive color bar generators, or any other NTSC color TV generating equipment. Utmost stability assured through use of delay lines and by driving all pulses from leading edge of a crystal controlled oscillator. Unit may also be locked to synchronize with 60 cps line. External drive input jack permits operation with Color Subcarrier Generator. Complete with power supply.

COLOR SLIDE SCANNER — MODEL PT-210
A complete equipment integrated into only two racks which provides a high resolution NTSC composite color video signal obtained from standard 2 x 2 (35mm) transparencies. Designed for maximum stability and high signal to noise ratio. The optical head is complete with lenses employing V-type dichroic mirrors and Fresnel condensing lenses. The R, G, B signals obtained from three channel photo amplifiers are gamma corrected to give proper rendition to high lights and shading. Utilizes a highly stabilized colorplexer. (See complete description of Model PT-205 Colorplexer above.)

The scanning kinescope has fine resolution and is combined with the deflection and high voltage unit. The remaining chassis components contain a regulated low voltage power unit, a regulated filament power unit and a regulated photo multiplier power supply.

COLOR SUBCARRIER GENERATOR AND FREQUENCY DIVIDER UNIT — MODEL PT-202. This rugged unit complete with regulated B+ and filament power provides standard NTSC subcarrier frequency with dual outputs and includes a frequency divider to provide a sync generator driving signal (31.5 KC) to convert standard B/W sync generators for color TV use. High stability achieved by temperature controlled crystal oscillator. All adjustments accessible at front of unit. Adapts any sync generator to NTSC color operation.

COLOR TV VIDEO MONITOR — MODEL M-200
Two portable units supplied with brackets for standard rack mounting. High definition color picture with exceptionally good color rendition is displayed on a 15 inch tri-color kinescope. Excellent for checking the quality of NTSC color video signals in the studio, on transmission lines or in the receiver factory. Special test jacks and switches are provided for analyzing R, G, B signals, matrixing and phase of color signals. Exceptionally good synchronizing capabilities over a wide range of signals. Special convergence circuits are employed to give maximum utilization of color kinescope. Model M200 has good color stability and is relatively insensitive to line voltage changes. Excellent dynamic circuit linearity assures good color stability over a wide range in signal level.

SYNCHRONIZING GENERATOR— MODEL PT-201

Output Signals: Sync. (Neg. and Pos.) 4 v. pk-pk across 75 ohms
Blanking (Neg. and Pos.) 4 v. pk-pk across 75 ohms
Horiz. Drive (Neg. and Pos.) 4 v. pk-pk across 75 ohms
Vert. Drive (Neg. and Pos.) 4 v. pk-pk across 75 ohms
Composite Video Output (Neg. and Pos) 1.4 v. pk-pk across 75 ohms
Internal Dot Pattern or External Video—1.4 v. pk-pk across 75 ohms
Input Power: 105-125 v. 4.5 amps., 60 cps.

COLOR SLIDE SCANNER— MODEL PT-210

Output Signals: NTSC Composite Video 2 Outputs 0—1.4 v. pk-pk
Optical Head: Lens—F. 2.0 50 mm, Xenon lens in tractica mount
V-type dichroic mirrors
Color Slide 2 x 2 color Transparencies
Gamma Amplifier:
Three Channels (R, G, B)
Input Signal—1.4 v. pk-pk across 75 ohms
Output Signal—1.4 v. pk-pk across 75 ohms
Colorplexer: (See Model PT-205 above)
Deflection and High Voltage Unit, Kinescope type 5AUP24;
Operating Voltage: 27 KV
Linearity: 2% across raster Horizontal and Vertical
Photomultiplier Power Supply: Electrically regulated. Filament Supply—AC line Regulated
Input Signals: Hor. Drive—3 v. pk-pk Ver. Drive—3 v. pk-pk. Blanking Drive—3 v. pk-pk Sync. 3 v. pk-pk
Power Requirement: AC 105-125 v., 10 amp., 60 cps.

COLOR SUBCARRIER GENERATOR AND FREQUENCY DIVIDER UNIT—MODEL PT-202

Subcarrier Frequency Dual Output: 3.579545 mc/sec. ± 0.0003% with maximum rate of frequency change not exceeding 1/10 cps./sec.
Subcarrier Output Voltage: 25 to 40 volts
Frequency Divider Output: 31,468 cps.
Divider Output Voltage: 0 to 100 volts
Ambient Temperature: 40° F. to 110° F.
Power Requirements: AC 105-125, 2A, 60 cps.

COLOR VIDEO MONITOR—MODEL 200

Input Video Signal: 0.25 to 2.0 volts, pk-pk
Signal Polarity: Pos., Neg., Bal.
Input Impedance: 66 mmf across 2.2 megohms or 75 ohms
Resolution: 250-300 lines min. (Full utilization of NTSC Color Signal Bandwidth)
Linearity: (Hor. and Vert.) 2% across raster
Tricolor Kinescope: 15″
Focus: Electro Static
Net Weight: 175 lbs.
Power Requirements: 105-125 v., 4 amps., 50/60 cps.

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WILL FIT YOUR ELECTRONIC APPLICATION

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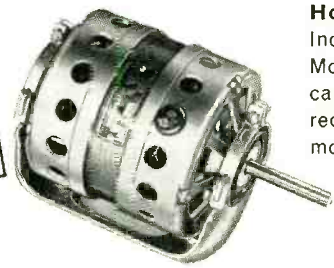
Induction motor.
For facsimile equipment, tape recorders, blowers—used by many leading manufacturers.



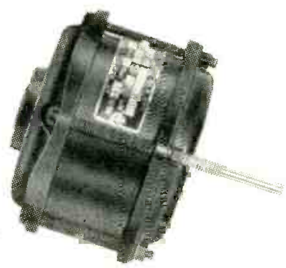
Howard 3700
Induction motor.
Movie projectors, TV cameras, tape recorders—Resilient mounted.

Howard 2500
Induction Motor.
For instruments, tuning devices, light switching, metering devices, recordiographs, damper controls, telefax equipment and a host of other applications.

Howard 512 Universal Motor. Widely used in business machines, projectors, automatic tuning equipment, photo developing and printing, automatic pilots, photo copy machines.

Howard 100 & 200
Universal & D. C. Motors.
For blowers, radio and radar equipment, aircraft pumps, aircraft cooling fans.

Lots of power in a small package.



Howard 2400
Capacitor or 2-Phase Servo Motor. Used in servo type applications—tuning, instruments, meters, controls, etc.

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UNIVERSAL AND D. C. MOTORS
1/1000 to 1/2 h.p.

SHADED POLE MOTORS
1/2000 to 1/8 h.p.

INDUCTION MOTORS
1/1400 to 1/4 h.p.

Here are just a few of the many fractional h.p. motors Howard can offer you for your quantity applications. To date, Howard motors have been used by leading manufacturers in more than 85,000 applications. Chances are there's a specification in our file that will work for you and at the right price. If you use fractional h.p. motors, write and tell us your needs today. We'll handle your inquiry promptly.

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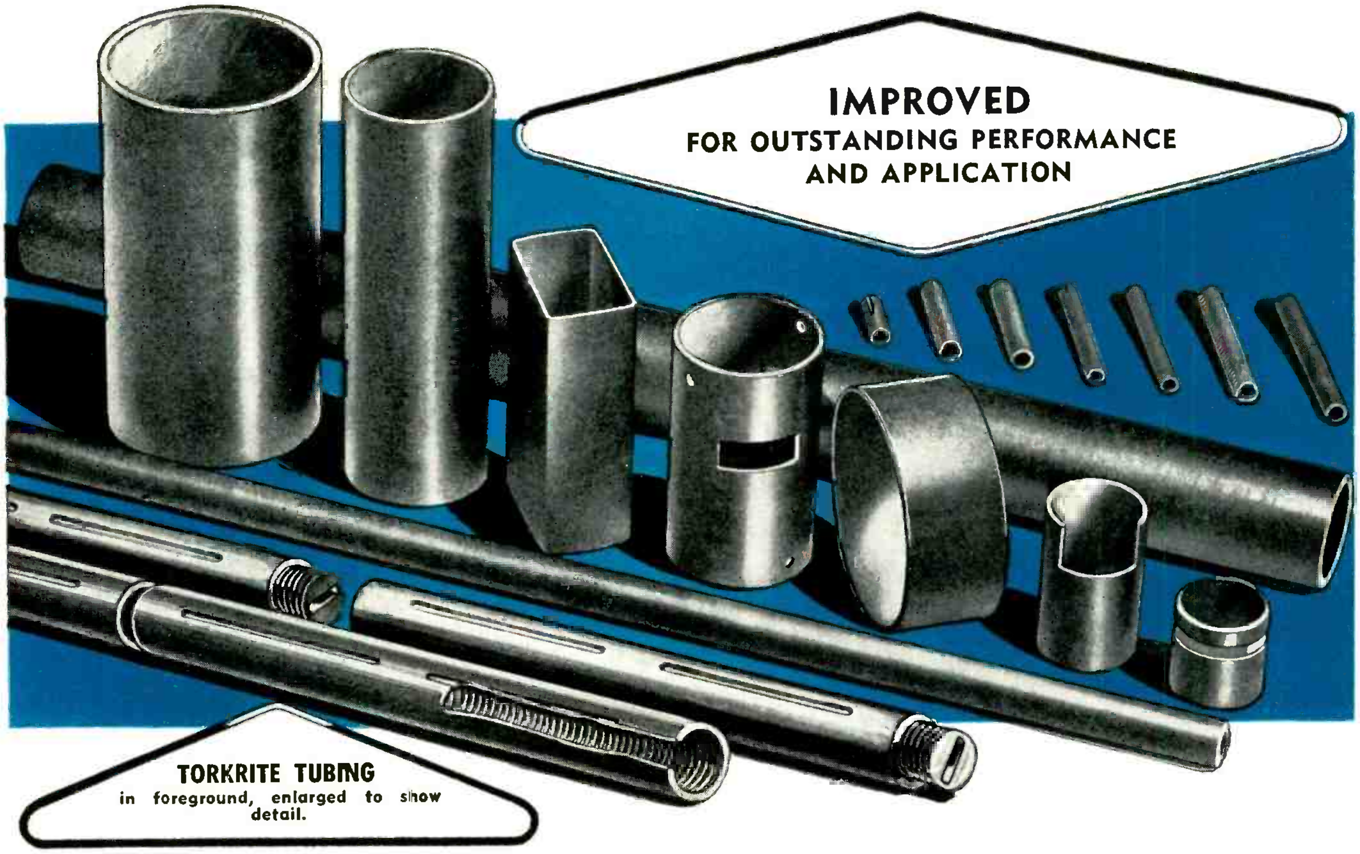

★ ★ ★

TORKRITE POSSESSES MANY ADVANTAGES

Torkrite affords unmatched recycling ability. After a maximum diameter core has been recycled in a given form a reasonable number of times, a minimum diameter core can be inserted and measured at 1" oz. approximately.

Torkrite has no hole or perforation through the tube wall. This eliminates the possibility of cement leakage locking the core or cores.

Torkrite permits use of lower torque as it is completely free of stripping pressure.

With Torkrite, torque does not increase after winding, as the heavier wall acts to prevent collapse and core bind.

Improved new Torkrite is now available in various diameter tubes. Lengths from 3/4" to 3-1/8", are made to fit 8-32, 10-32, 1/4-28 and 5/16-24 cores.

★ ★ ★

Visit our Exhibit #519 at the Radio Engineering Show in New York City, March 21-24.

CLEVELITE*

LAMINATED PAPER BASE PHENOLIC TUBING

In seven specific grades, Clevelite is one of the finest and most complete lines of tubing available to the electronic and electrical industries.

Grade	Application
Grade E	Improved post-cure fabrication and stapling
Grade EX	Special grade for TV yoke sleeves
Grade EE	Improved general purpose
Grade EEX	Superior electrical and moisture absorption properties
Grade EEE	Critical electrical and high voltage application
Grade XAX	Special grade for government phenolic specifications
Grade SLF	Special for very thin wall tubing having less than .010 wall

High performance factors, uniformity and inherent ability to hold to close tolerances, make Clevelite outstanding for Coil Forms, Collars, Bushings, Spacers and Cores.

Competent Research and Engineering facilities are always available to aid in solving those tough and stubborn design and fabrication problems. May we help you?

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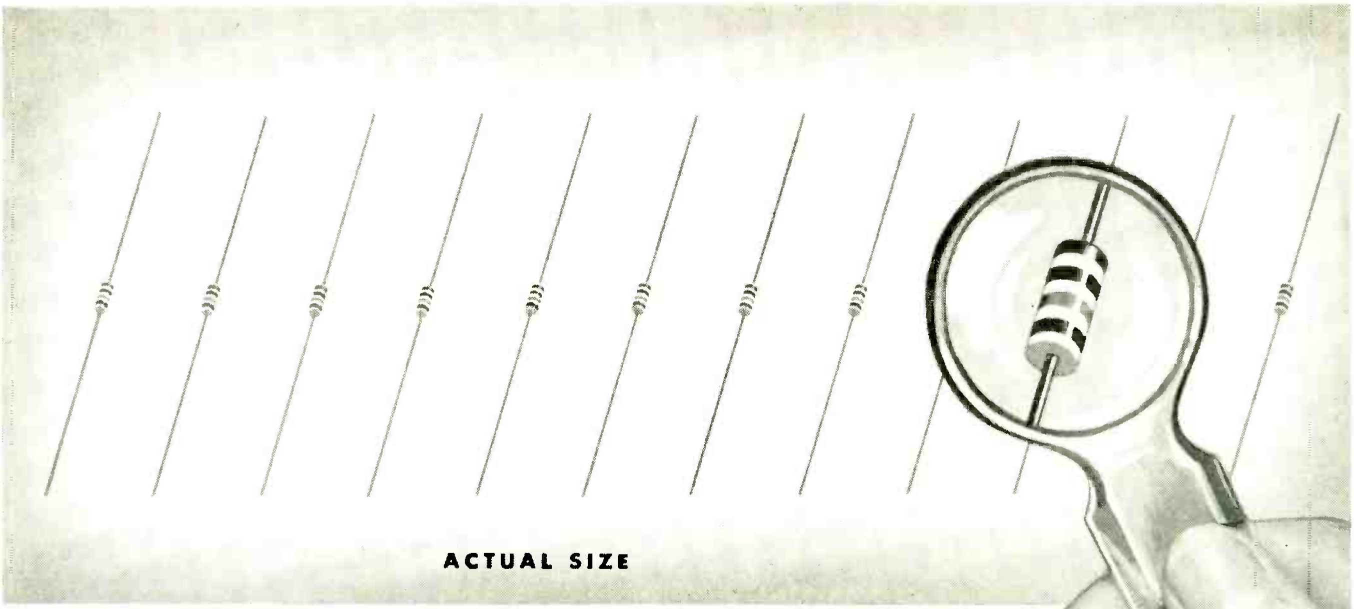


Type TR "tiny" resistors shown in natural size—One unit is magnified to show color-code bands

NEW! TINY ALLEN-BRADLEY FIXED RESISTORS

Type TR—Length—0.140 in. Diameter—0.067 in. 1/10th Watt—In all RETMA values and tolerances.

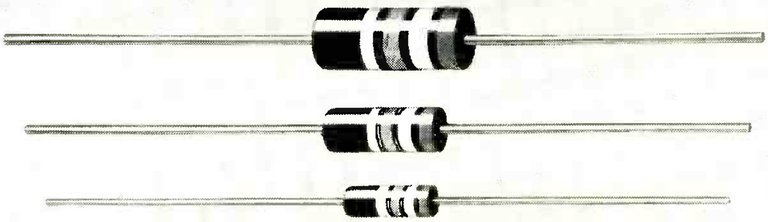
For electronic applications, where small size is a major consideration, the new Allen-Bradley Type TR "tiny" resistors are the ideal answer. While these 1/10th watt, miniaturized resistors are extremely small in size, they are a QUALITY product in construction and performance.

Because of their low noise level, they are especially suited for hearing aids and compact, portable receivers.

Type TR resistors have an insulating coating which affords a conservative insulation strength of 200 volts DC for continuous operation. These tiny resistors can be supplied in all standard RETMA, JAN-R-11A, and MIL-R-11A resistance values from 10.0 ohms to 22.0 megohms, inclusive in 5%, 10%, and 20% tolerances. If you build miniaturized electronic equipment, take advantage of Allen-Bradley Type TR QUALITY resistors.

A-B Quality

The Sign of QUALITY



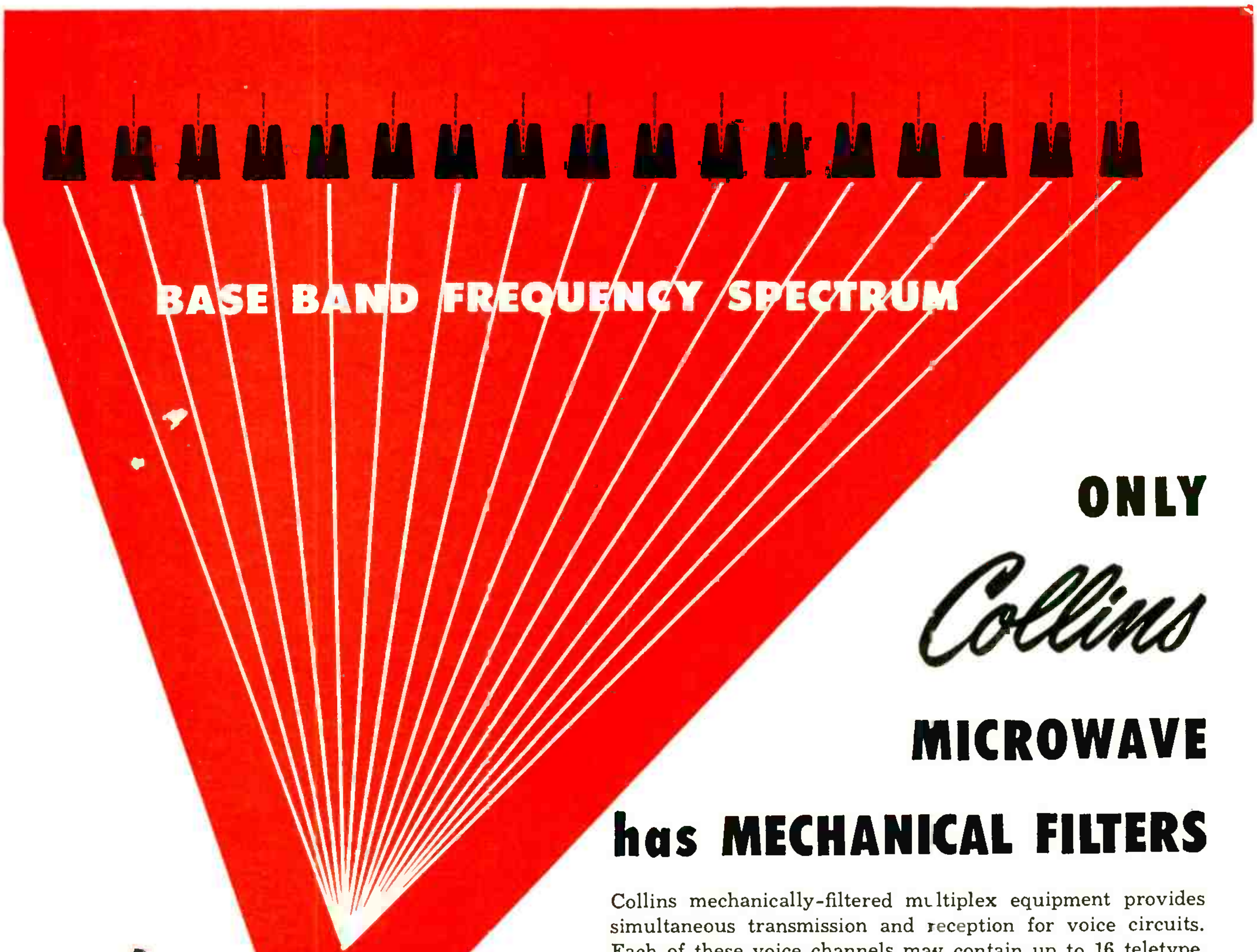
Allen-Bradley Types HB (2-watt), GB (1-watt), and EB (½-watt) solid molded fixed resistors are shown actual size in the above illustration.

See *Allen-Bradley exhibit at IRE Engineering Show — Booth 794*

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Limited, Galt, Ont.

ALLEN-BRADLEY

RADIO, ELECTRONIC AND TELEVISION COMPONENTS



ONLY *Collins* MICROWAVE has MECHANICAL FILTERS

Collins mechanically-filtered multiplex equipment provides simultaneous transmission and reception for voice circuits. Each of these voice channels may contain up to 16 teletype, telemetering and supervisory control channels. The system employs proven bi-lateral, single sideband suppressed carrier transmission. Intelligence is transmitted only when a circuit is in use, thereby permitting statistical loading of the system to achieve a maximum signal-to-noise ratio on each channel. This method of multiplexing is simplified and made economical by the use of the Collins Mechanical Filter. The steep skirt attenuation of this filter permits use of upper and lower sidebands with suppressed carrier to be employed for transmission of two separate channels.

Collins microwave engineering staff is ready to assist you in planning and installing your microwave system.

Visit Collins Booth at the New York IRE Show March 21-24

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COLLINS

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R/M "TEFLON" is blazing many trails that few people thought would ever open up. Daily it is instrumental in improving old products and processes, in developing new ones, and in effecting unheard-of economies. In the form of tape and other component parts, R/M "TEFLON" has already licked many electrical and electronics problems once thought unsolvable. So turn to R/M if you have a problem that "TEFLON" might possibly solve. We can fabricate to your specifications or supply you with "TEFLON" in the form of rods, sheets, tubes or tape. For complete information, write today.

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High dielectric strength • Moisture absorption zero • Unaffected by weather • Excellent heat stability up to 500°F. in continuous operation • As tape, leaves no carbon residue along discharge path • High impact resistance • Nonadhesive • Stretches easily • Tensile strength 1500-2500 psi

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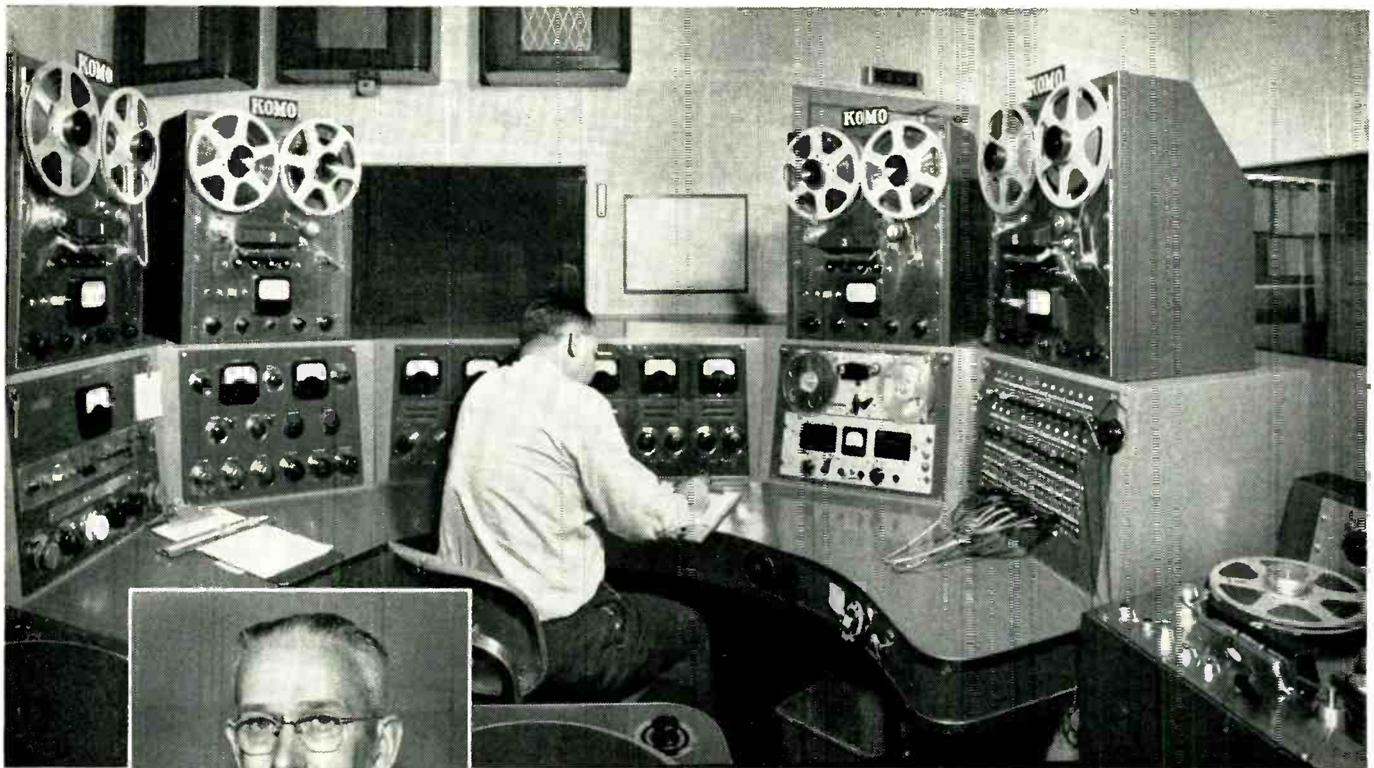

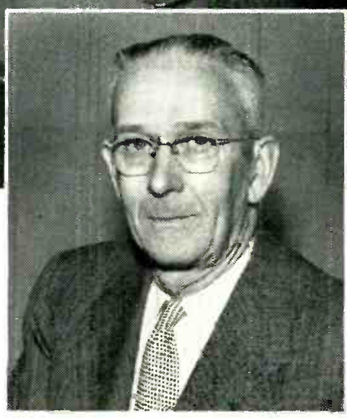

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says Francis Brott, Chief Engineer, KOMO, Seattle

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Write today for further information and complete specifications, Dept. E-1880

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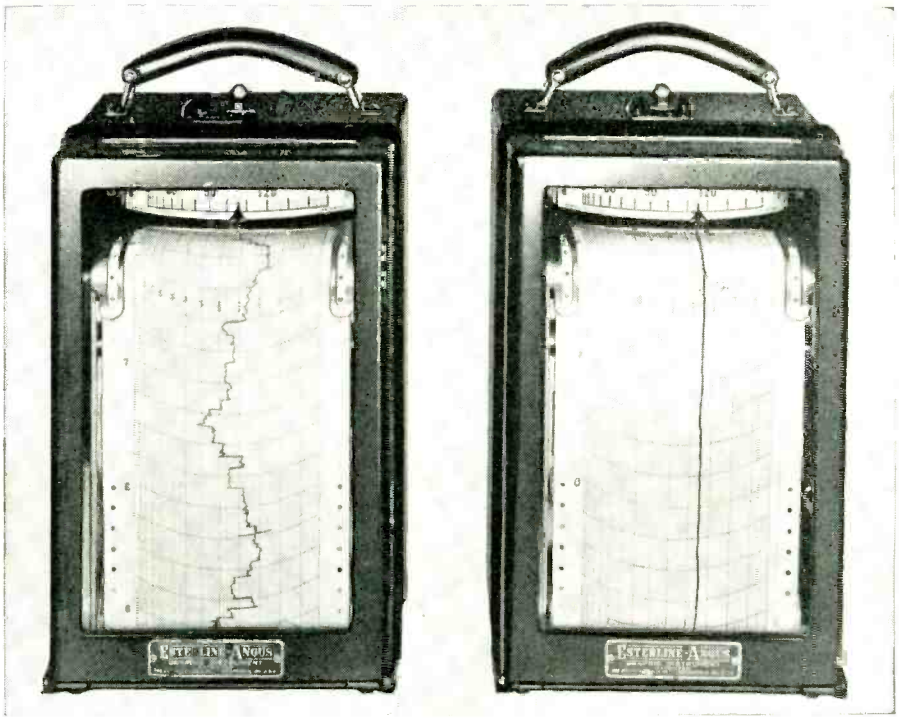
±1% stable voltage in face of 30% line variations



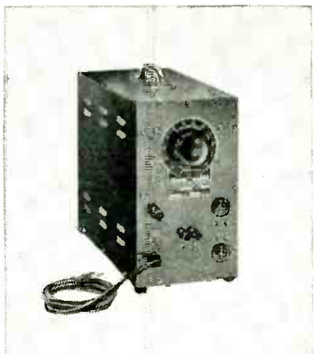
TYPICAL EXAMPLE OF SOLA VOLTAGE REGULATING ACTION. The recording on the left represents a fairly common condition of voltage fluctuation on a 115v line. The chart on the right was made at exactly the same time from the same line. The primary of the Sola regulator was fed the voltage charted on the left, the voltage charted on the right represents its secondary output, regulated to within ±1% of 115v.

Voltage-sensitive electrical and electronic equipment can not operate to performance specifications under conditions of voltage fluctuation. A source of constant voltage can be easily supplied with a Sola Constant Voltage Transformer . . . built-in as a component, or used externally as an accessory.

Among the chief advantages of Sola regulators are: dependable, automatic operation (static-magnetic regulation) . . . substantially instantaneous response (1.5 cycles or less) . . . no maintenance (no moving or expendable parts) . . . and immediate availability (40 stock units in a wide variety of ratings).

STANDARD TYPE CV
Twenty-nine units from 15va to 10kva in a common power line and filament voltage ratings . . . regulation ±1% or less with a total primary variation of 30% . . . for electronic and electrical equipment requiring close regulation.

HARMONIC-NEUTRALIZED TYPE CVH
Six units from 60va to 2kva . . . input range 95-125v, output 115v . . . all the features of the Standard Type CV plus a harmonic neutralizer circuit . . . ±1% regulated voltage with less than 3% harmonic distortion.



ADJUSTABLE, HARMONIC-NEUTRALIZED TYPE CVL
Two ac voltage supply units, 250va and 500va . . . input range 95-125v, output range adjustable from O-130v . . . regulated ±1%, harmonic distortion less than 3% . . . for general lab work, testing and other applications.

PLATE AND FILAMENT TYPE CVE
Three units in popular power supply ratings . . . a single, compact source of filament and plate supply voltages . . . regulated to within ±3% or less with line voltage variations of 100-130 volts . . . supplied with separate capacitor for chassis mounting.

SOLA *Constant Voltage* **TRANSFORMERS**

VISIT SOLA'S I.R.E. BOOTH. See the latest in REGULATED DC POWER SUPPLY units. Booth 537, I.R.E. Show, New York, March 21.

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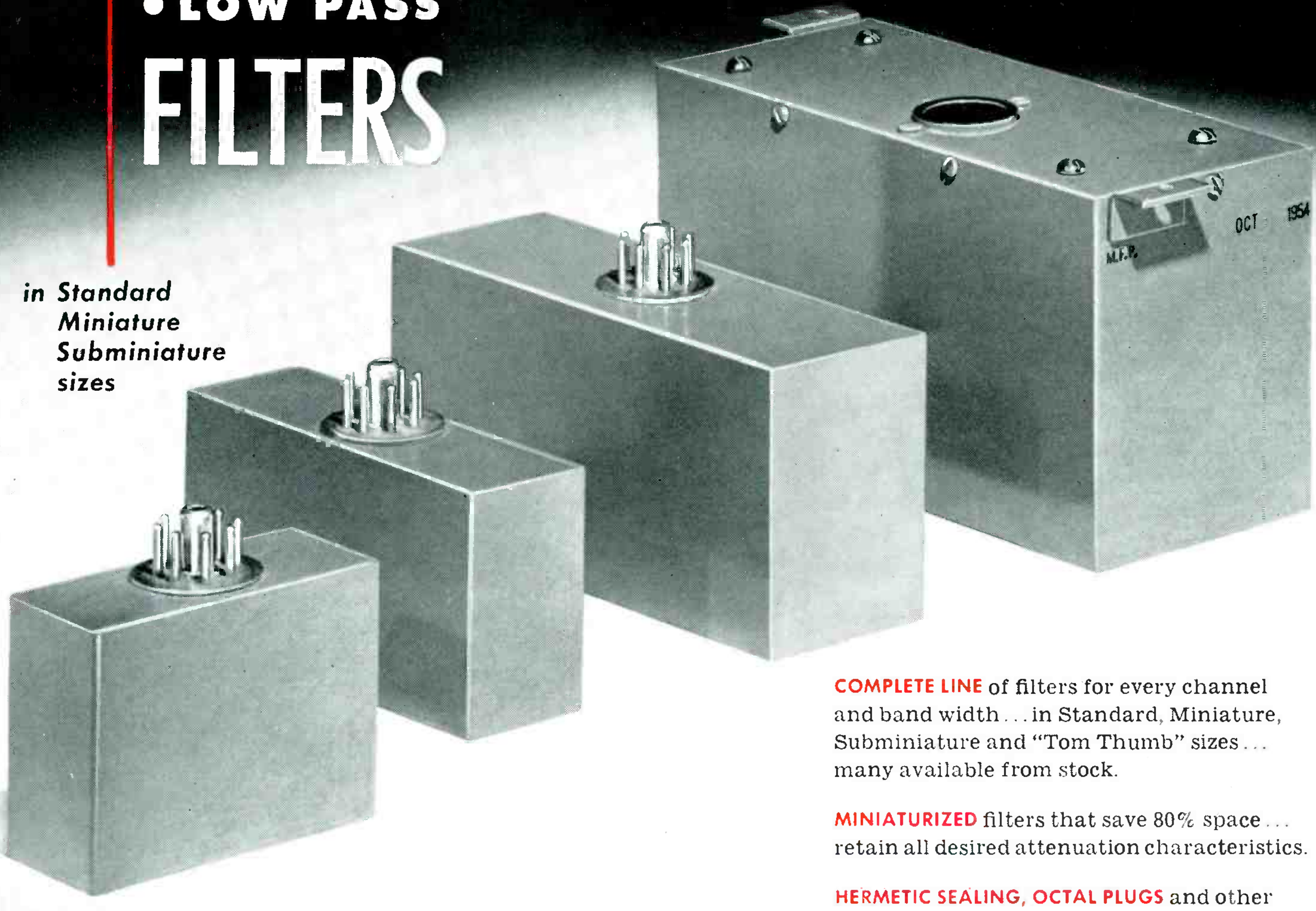
FIRST IN TOROIDS AND RELATED NETWORKS

TELEMETERING

• BAND PASS
• LOW PASS

FILTERS

in Standard Miniature Subminiature sizes



COMPLETE LINE of filters for every channel and band width . . . in Standard, Miniature, Subminiature and "Tom Thumb" sizes . . . many available from stock.

MINIATURIZED filters that save 80% space . . . retain all desired attenuation characteristics.

HERMETIC SEALING, OCTAL PLUGS and other new features.

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SPECIAL PHASE LINEARITY characteristics to conform to new concepts of high accuracy telemetering practice.

SPECIFICALLY DESIGNED for telemetering, these filters have found great utility in a wide variety of communications and control applications.

APPLICATION ENGINEERING service plus complete technical literature. Write Dept. . . . . , for Catalog 102A.

PARTIAL LISTING OF MINIATURE TELEMETERING BAND PASS FILTERS

Channel Freq.		15% Band Width	30% Band Width	Case Size	Approx. Weight	Attenuation	
		Type No.	Type No.	W- L- H-		15% B. W.	30% B. W.
400	CPS.	S-15456		2 x 6 x 2¾	3 lbs.	4DB — 15% 20DB — 23% 40DB — 27%	4DB — 30% 20DB — 46% 40DB — 54%
560	"	S-15457	S-15477				
730	"	S-15458	S-15478				
960	"	S-15459					
1300	"	S-15460		1⅜ x 4½ x 2¼	1 lb. 7 oz	3.5DB — 15% 20DB — 23% 40DB — 27%	3.5DB — 30% 20DB — 46% 40DB — 54%
1700	"	S-15461					
2300	"	S-15462					
2570	"	S-15463		1⅜ x 3 x 2¼	9¾ oz.	3DB — 15% 20DB — 23% 40DB — 26%	3DB — 30% 20DB — 46% 40DB — 52%
3000	"	S-15464					
3900	"	S-15465	S-15479				
4500	"	S-15466					
5400	"	S-15467	S-15480				
7350	"	S-15468	S-15481				
10500	"	S-15469	S-15482				
12300	"	S-15470	S-				
14500	"	S-15471	S-15483				
22000	"	S-15472	S-15484				
27000	"		S-15485				
30000	"	S-15473	S-15486				
40000	"	S-15474	S-15487				
52500	"	S-15475					
70000	"	S-15476	S-15488				

OPTIMUM OPERATING IMPEDANCES — SOCKET TERMINAL CONNECTIONS

INPUT		OUTPUT	
Terminals 1 & 2	500 ohms	Terminals 1 & 6	500 ohms
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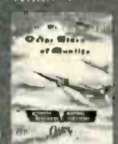

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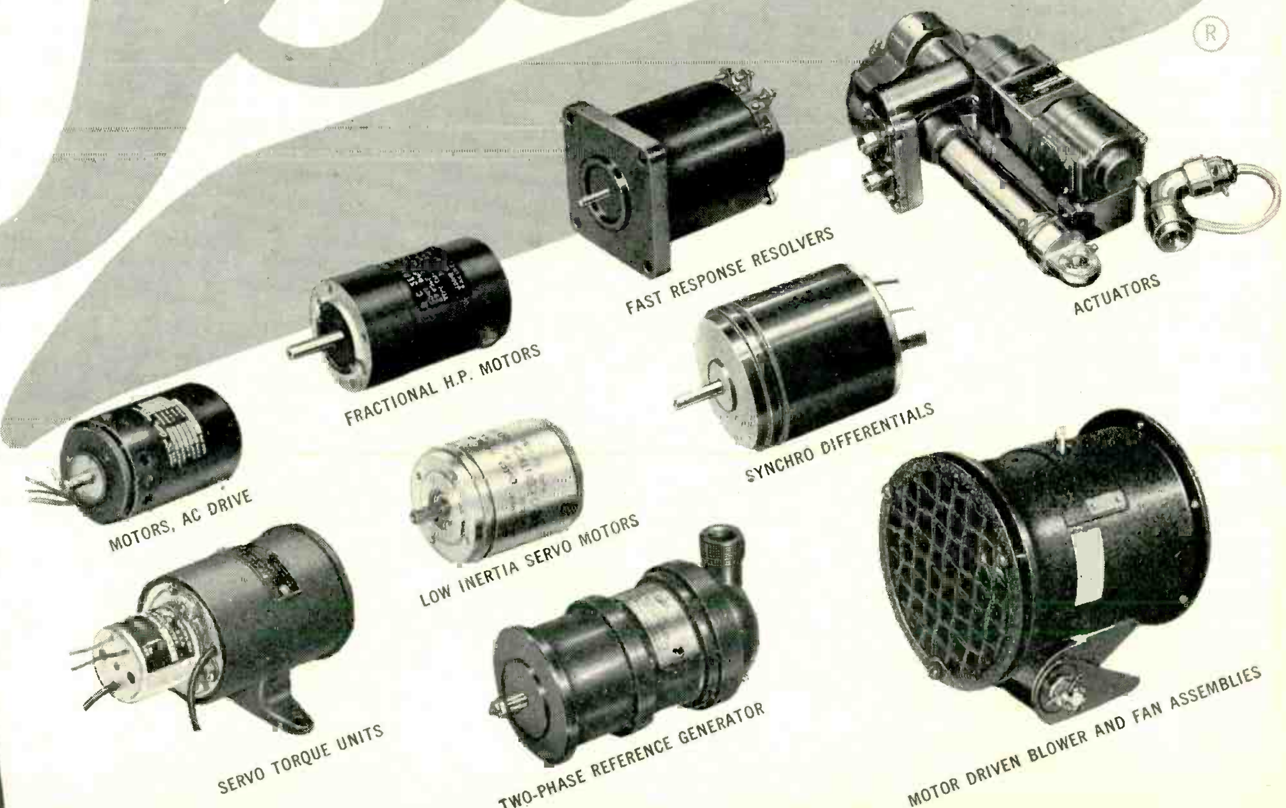


Here's an exciting new development in metallized ceramics!

NICOTE METALLIZED CERAMIC COATING

for use with both hard and soft solders!

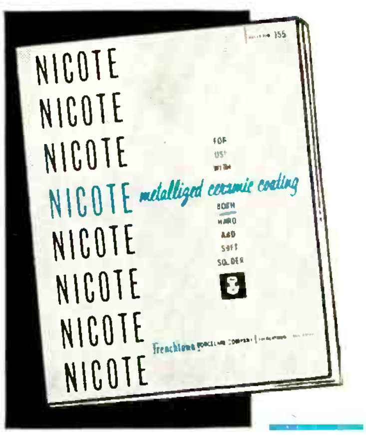
Here is Frenchtown's revolutionary answer to a problem that has baffled industry for years . . . a satisfactory *single* metallic coating for refractory ceramic bodies which provides a surface for applying solders with melting points between 275° and 1600°.

NICOTE, applied to refractory ceramic bodies by high temperature firing, in most applications requires no expensive preliminary processing such as buffing, electroplating, or tinning to form a strong, firmly-adhering bond with either *hard* or *soft* solders.

Whether the problem requires the fastening of a metal part or other metallized ceramic parts to its surface, NICOTE offers distinct advantages over ordinary silver soft receptive coatings as well as molybdenum and tungsten hard solder coatings. It will withstand molten soft soldering *indefinitely* . . . it's less costly to produce . . . requires no expensive processing.

NICOTE'S mechanical bond to the refractory ceramic body approximates ceramic strength, making it ideal for hermetic seals, high strength mechanical seals, and vacuum type applications.

Like to know more about the amazing possibilities of NICOTE Metallized Ceramic Coating for your product? Bulletin 155 contains complete engineering details. Write for a free copy today. There's no obligation, of course.



This idea starter is free for the asking . . . contains complete facts and details about NICOTE . . . Frenchtown's new **single metallic coating** for use with **both** hard and soft solders. Ask for Bulletin 155.

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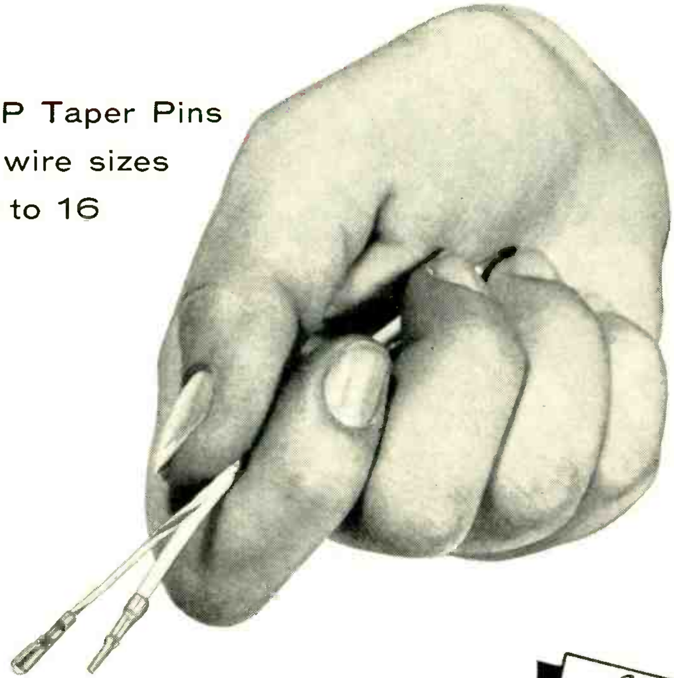
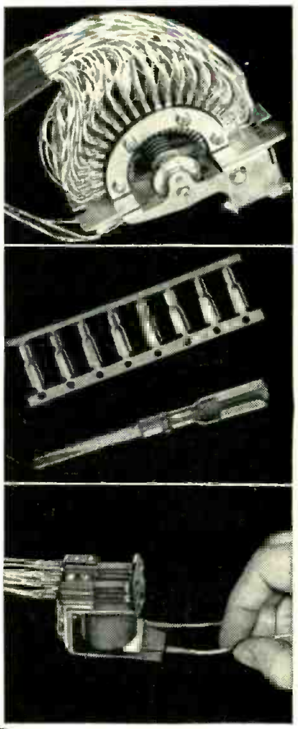
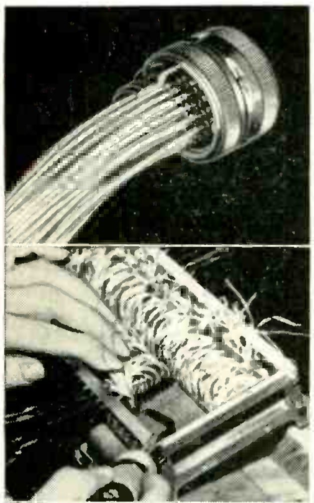
AMP Taper Tab
receptacles for wire
sizes 26 to 18

AMP Taper Pins
for wire sizes
26 to 16







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Cubic restrictions have brought about a whole new concept of wire termination. The AMP Taper Technique with AMP taper pins, tab receptacles, blocks and modified miniature components will help you take full advantage of small wire, small insulation and small space for your wire terminations.

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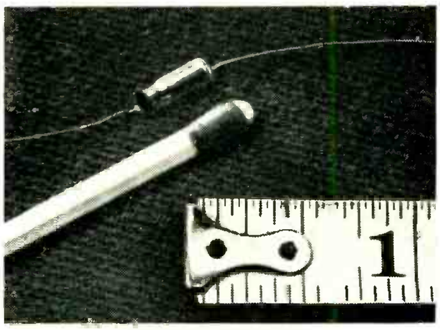
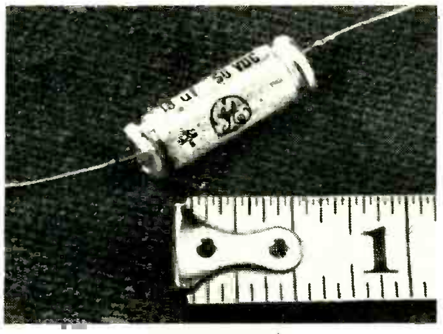


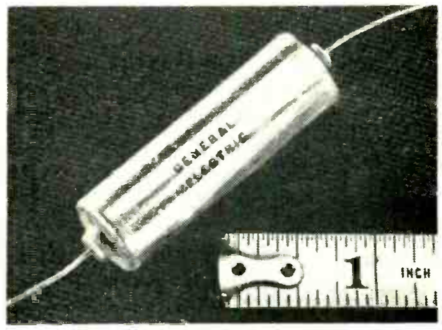
MICRO-MINIATURE

For low voltage d-c miniaturized electronic equipment (hearing aids, walkie-talkies, paging systems). Ideal for transistorized assemblies. **Ratings** 1-8 uf at 4 v. d-c, 1 uf at 8 v. d-c, 0.5 uf at 16 v. d-c. **Tolerance** −0 to +200%. **Temp. range** −20 to +50° C. BULLETIN GEA-6065.



TANTALYTIC*

For electronic equipment requiring small size, low leakage current, long shelf life, wide temperature range. Plain or etched foil, and polar or non-polar types, suitable for a-c or d-c. **Ratings** 0.25−580 uf, 3.75−150 v. **Tolerance** ±20% (plain foil), −15 to +75% (etched). **Temp. range** −55 to +85° C. BULLETIN GEC-808.

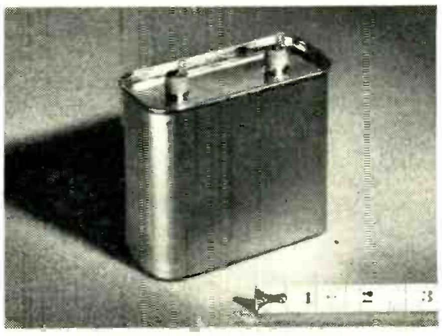


METAL-CLAD TUBULAR

For d-c uses where reliability under severe operating conditions is required (military electronic equipment). **Ratings** 0.001−1 uf at 100, 200, 300, 400 and 600 working v. d-c. (Can be applied to a-c circuits with adequate derating.) **Tolerances** ±5, ±10, or ±20%. **Temp. range** −55 to +125° C. BULLETIN GEC-987.

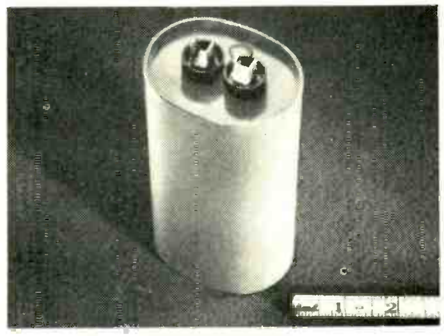
PERMAFIL-IMPREGNATED

Designed to meet requirements of MIL-C-25A, characteristic K specifications, and are suitable for high-temperature operation. **Ratings** 0.05−1 uf at 400 v. d-c. **Tolerance** ±10%. **Temp. range** −55 to +125° C. BULLETIN GEC-811.



STANDARD COMMERCIAL

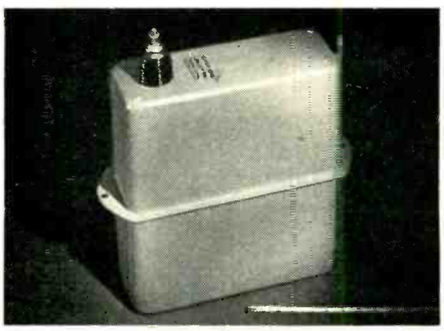
For motors, filters, communication equipment, luminous-tube transformers, industrial control. **Ratings** dual rated units (a-c or d-c) rated at 0.01−50 uf, at 236-660 v. a-c, 400-1500 v. d-c. Single rated units also available. **Tolerance** ±10%. **Temp. range** −55 to +85° C. BULLETIN GEC-809.



DRAWN-OVAL

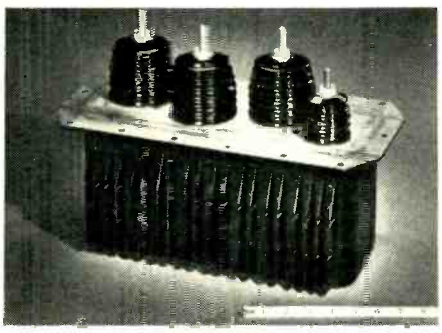
For air conditioning and refrigeration equipment, fluorescent lamp ballasts, business machines, voltage stabilizers. Single, dual or triple-section types. **Ratings** 1−20 uf at 236-660 v. a-c, and 1-15 uf at 600-1500 v. d-c. **Tolerance** ±10%. **Temp. range** −30 to +70° C. BULLETIN GEA-5777.

Reg. trademark of General Electric Company.



ENERGY STORAGE

For use in high magnetic fields and high intensity arc discharge. **Ratings:** may be built as high as 2000 joules (watt-seconds). **Tolerance** ±10%. BULLETIN GEA-4646.



NETWORK

For guided missiles, aircraft, radar equipment. **Ratings:** built to user specifications. **Temp. range** −55 to +125° C, or to user specifications. BULLETIN GEA-4996.

NOTE: All capacitance tolerances are given at +25° C.

SEND COUPON BELOW for complete information about G-E capacitors.

General Electric Co.
Section A442-25
Schenectady 5, N. Y.

Please send me capacitor bulletins checked below.

- ☐ GEA-4646 ☐ GEC-808
- ☐ GEA-4996 ☐ GEC-809
- ☐ GEA-5777 ☐ GEC-811
- ☐ GEA-6065 ☐ GEC-987

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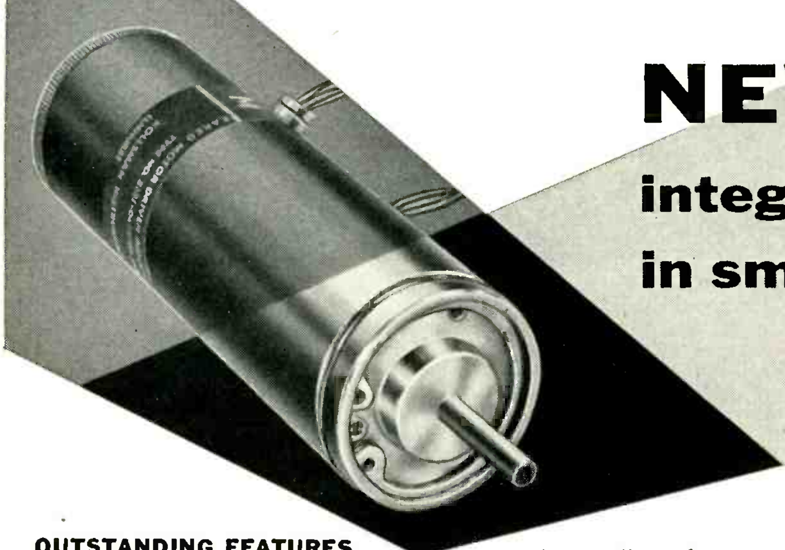
GENERAL ELECTRIC

COMMON CHARACTERISTICS OF ALL TYPE 2131 GEARED MOTOR GENERATOR UNITS

O.D. of Case	1.000 inch	No. of Poles (Motor)	6
Case Length	3.301	*No Load Speed (Min.)	6500 rpm
Weight	7.5 ounces	Rotor Inertia	1.1 gram-cm²
Frequency	400 cycles		

*Motor Speed at input to gear train



NEW

integral gear head in small servo motors

OUTSTANDING FEATURES OF TYPE 2131 GEARED MOTOR GENERATOR

- New methods of manufacture result in high efficiency
- High torque to inertia ratio to give fast response
- Available for 115 volt—115 volt two phase or single ended tube operation
- High impedance winding for direct plate to plate operation available
- High generator output voltage with excellent signal to noise ratio
- Zero degree phase shift in generator
- All metal parts corrosion resistant
- Extremely wide operating temperature range

Other models of one inch O.D. units

TYPE NO.	DESCRIPTION
2103	Induction Motor
2101	Geared Induction Motor
2028	Motor Generator

A new line of units has been added to the Kollsman "Special Purpose Motors" family combining precision machining, advanced electrical design and the latest in new materials. An unusual feature of the new line is the integral gear head unit. Contained within a single case is the gear train and motor; or gear train, motor and generator. Gear ratios as high as 300:1 can be supplied.

This new line consists of Induction Motors and Induction Generators supplied separately or combined in a single case one-inch in diameter. The new motors have been designed to give the maximum torque per watt ratio with the minimum rotor inertia. The generators have been designed to give the maximum output voltage with the minimum residual voltage and phase shift.

One of the principal features of the Kollsman "Special Purpose Motors" is the interchangeability of parts which permits numerous electrically different combinations of motor and generator windings within the same case.

INPUT PER PHASE ONLY 1.8 WATTS

ELECTRICAL CHARACTERISTICS OF TYPICAL TYPE 2131 GEARED MOTOR GENERATORS

TYPE NO.	MOTOR EXCITATION FIXED	MOTOR EXCITATION CONTROL	MOTOR INPUT PER PHASE	MOTOR STALL TORQUE	MOTOR Theoretical Acceleration At Stall	GENERATOR EXCITATION FIXED	GENERATOR INPUT	GENERATOR OUTPUT PER 1000 rpm
2131-0411110	26	26	2.3	0.4	25600	26	1.8	.51
2131D-0412120	26	26	4.0	0.6	38500	26	2.2	.68
2131D-0413120	26	26	1.8	0.3	19200	26	2.2	.68
2131-0460600	115	115	4.0	0.6	38500	115	2.6	1.00
2131-0463600	115	55	4.0	0.6	38500	115	2.6	1.00
2131-0470600	115	P-P	4.0	0.6	38500	115	2.6	1.00
	volts	volts	watts	Oz-n	rad/sec²	volts	watts	volts

Latest catalog and/or complete specification drawings will be sent upon request.

kollsman INSTRUMENT CORPORATION

80-10A 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.

STANDARDIZE WITH CANNON

Standardize with Cannon Audio Connectors . . . designed to meet all audio equipment disconnect needs. Simplify circuitry and cabling. Get quiet, continuous operation with the standard connectors of the industry—*Cannon Plugs.*

You'll find exactly the type you need in 14 extensive series expressly designed for radio, sound, TV and related fields . . . in cord, rack or panel chassis, audio and low-level, portable, hermetic sealed, miniature and subminiature, and power-supply types. Standard equipment with leading manufacturers of electronic equipment. The old reliable "Latchlock" feature on Cannon microphone connectors . . . standard on top-ranking microphones.

Complete Audio Connector Bulletin is yours for the asking . . . D Series in separate bulletin coded D-4.

CANNON PLUGS

SINCE 1915 CANNON ELECTRIC

Please refer to Dept. 120

CANNON ELECTRIC COMPANY
3209 Humboldt St.
Los Angeles 31, California

Factories in Los Angeles; East Haven; Toronto, Canada; London, England. Licensees in Paris, Tokyo, Melbourne. Representatives in all principal cities. Distributors everywhere.

FOR HIGH RELIABILITY

THE NEWEST in G.E.'s wide germanium rectifier line is the 1N315. Specifically designed for *high* operating temperatures—up to 85°C.—and for *low* reverse current. (Note: The 1N315A *exceptionally* low-leakage design is also available.) Ideal for use in magnetic amplifiers or other circuits where low-leakage current is important. Write today for details. *General Electric Company, Section X435, Germanium Products, Electronics Park, Syracuse, N.Y.*

Production quantities are now available!

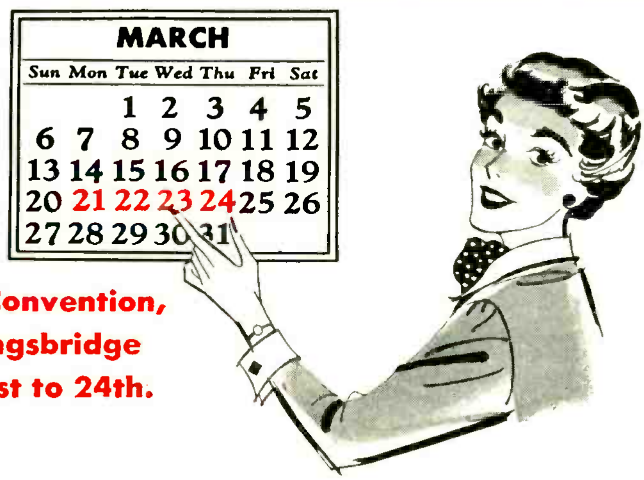
AT HIGH TEMPERATURES...

NEW G-E GERMANIUM JUNCTION RECTIFIER

SPECIFICATIONS FOR 1N315A

(Resistive or Inductive Load)

	55°C	71°C	85°C	
Maximum Allowable Peak Inverse Voltage	200	200	100	V
Maximum Allowable D-C Output Current	100	100	100	ma
Maximum Full Load Forward Voltage Drop	.48	.46	.44	V
Continuous Reverse Working Voltage	150	100	50	V
Minimum Forward to Reverse Current Ratio (Average Forward/Average Reverse at Full Load)	2000	800	500	
Maximum Operating Frequency (70% Rectification Efficiency)	50	50	50	KC
Storage Temperature	95	95	95	°C

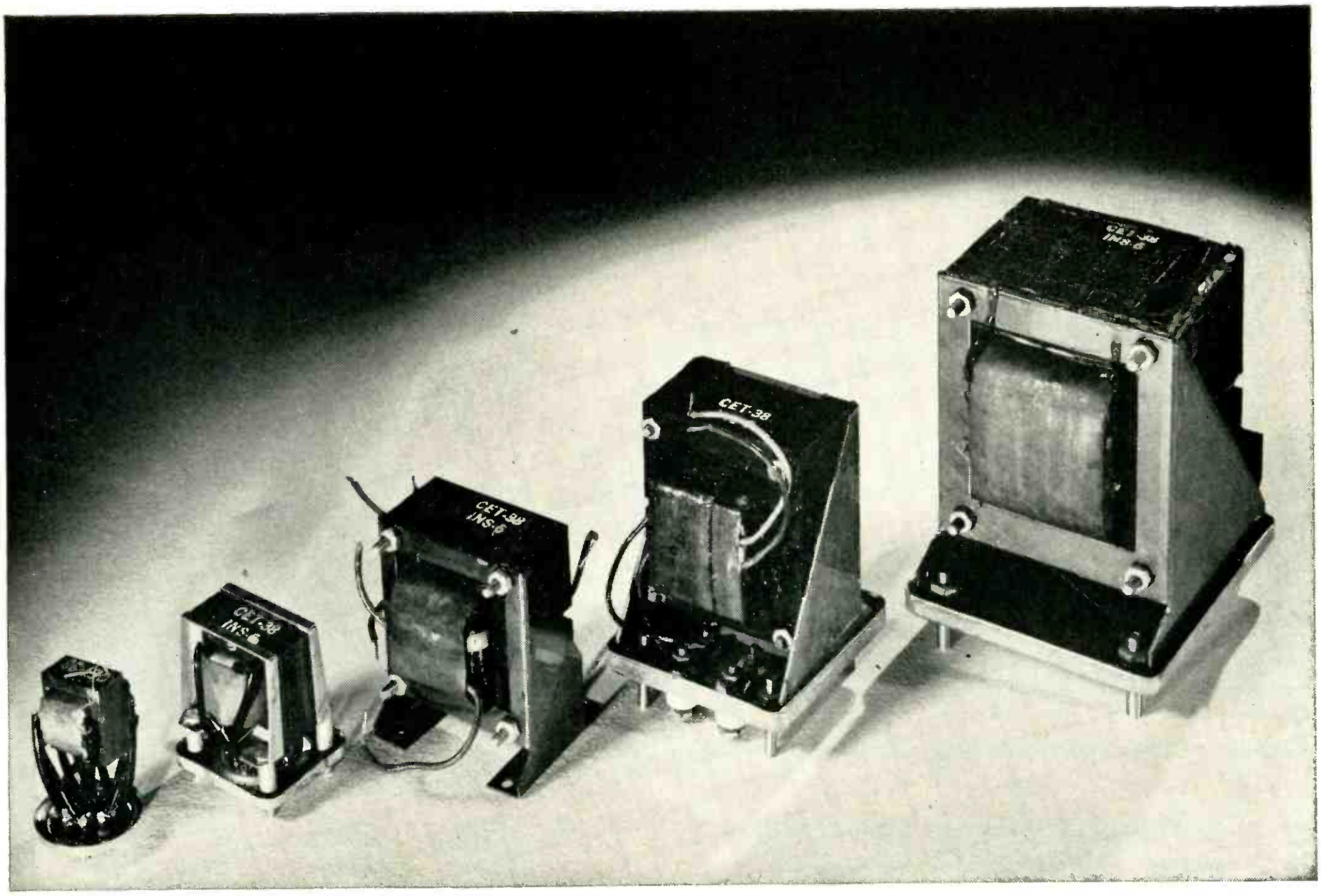


● **Tell your secretary to mark the calendar now. See the G-E Germanium Products Exhibit at I.R.E. Convention, Booths 192 and 194 at Kingsbridge Armory, N.Y.C. March 21st to 24th.**

Progress Is Our Most Important Product

GENERAL ELECTRIC

Want more information? Use post card on last page.



A Transformer becomes a precision device with Allegheny Magnetic Materials in the core

Write for your Copy

"TRANSFORMER LAMINATIONS"

84 pages of valuable technical data on standard and custom-made laminations from all grades of Allegheny Ludlum magnetic core materials. Prepared from carefully checked and certified laboratory and service tests—includes standard dimensions, specifications, weights, etc. Sent free on request . . . ask for your copy.

ADDRESS DEPT. E-63

★ **ALLEGHENY SILICON STEEL**

★ **ALLEGHENY 4750**

★ **ALLEGHENY MUMETAL**

The operation of a transformer is no better than the magnetic core around which it is built. With Allegheny magnetic materials in the core, you get the *best*—uniformly and consistently.

Sure there are reasons why! For one thing, there's the long experience of a pioneer in development and quality control of electrical alloys. But most important, the A-L line offers complete coverage of any requirement you may have, any service specification. It includes all grades of silicon steel sheets or coil strip, as well as Allegheny Silectron (grain-oriented silicon steel), and a wide selection of special high-permeability alloys such as Allegheny 4750, Mumetal, etc.

In addition, our service on magnetic materials includes complete lamination fabrication and heat treatment facilities. What's more, this extensive experience in our own lamination stamping department is a bonus value for all users of A-L electrical sheets or strip. ● Let us supply *your* needs. *Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.*

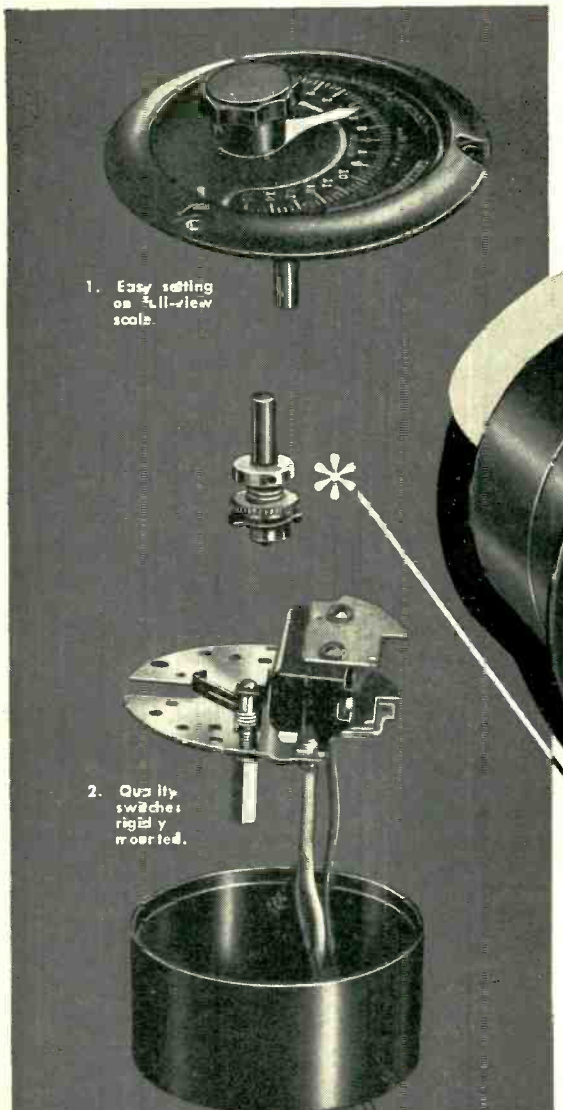
STEELMAKERS to the Electrical Industry

Allegheny Ludlum

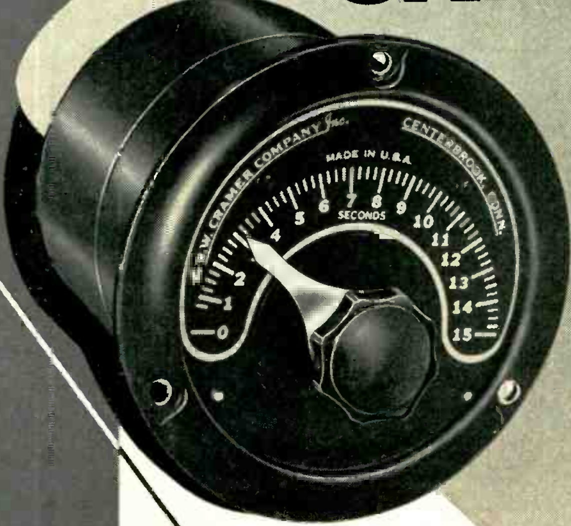
AL STEELS FOR THE ELECTRONIC AGE

W&D 5333

Design Simplicity — Key to Trouble-Free Operation

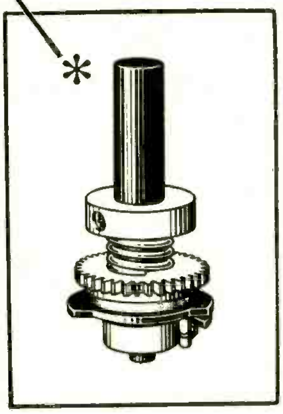


CRAMER



type 230 INTERVAL TIMER

. . . manually set to control the opening of one circuit and closing of another for a selected time interval.



A "look inside" the Type 230 Interval Timer illustrates how design simplicity and precision workmanship contribute to trouble-free performance.

For example, the friction clutch assembly shown at left has few operating parts, yet is highly efficient. All friction forces are held internally within the clutch. No force is exerted either up or down to cause unnecessary load on the motor. The clutch essentially "floats" in the timer, thus minimizing wear, increasing reliability, and contributing to long motor and timer life.

Every component of every Cramer timer has been designed for simplicity, accuracy and operating dependability. For the complete story on interval timers, write for Bulletin PB-210.

Cramer TIMING DEVICES

SPECIALISTS IN TIME CONTROL

The R. W. CRAMER CO., Inc.

BOX 3, CENTERBROOK, CONNECTICUT

7CR55

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In the past decade, our organization has developed extensive know-how and experience in the service of the ARMED FORCES, and others, in the DESIGN—DEVELOPMENT—and MANUFACTURE of specialized ELECTRONIC and ELECTRO-MECHANICAL EQUIPMENT in the fields of:

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.... on time!

Write for Facilities Brochure Dept. E-3

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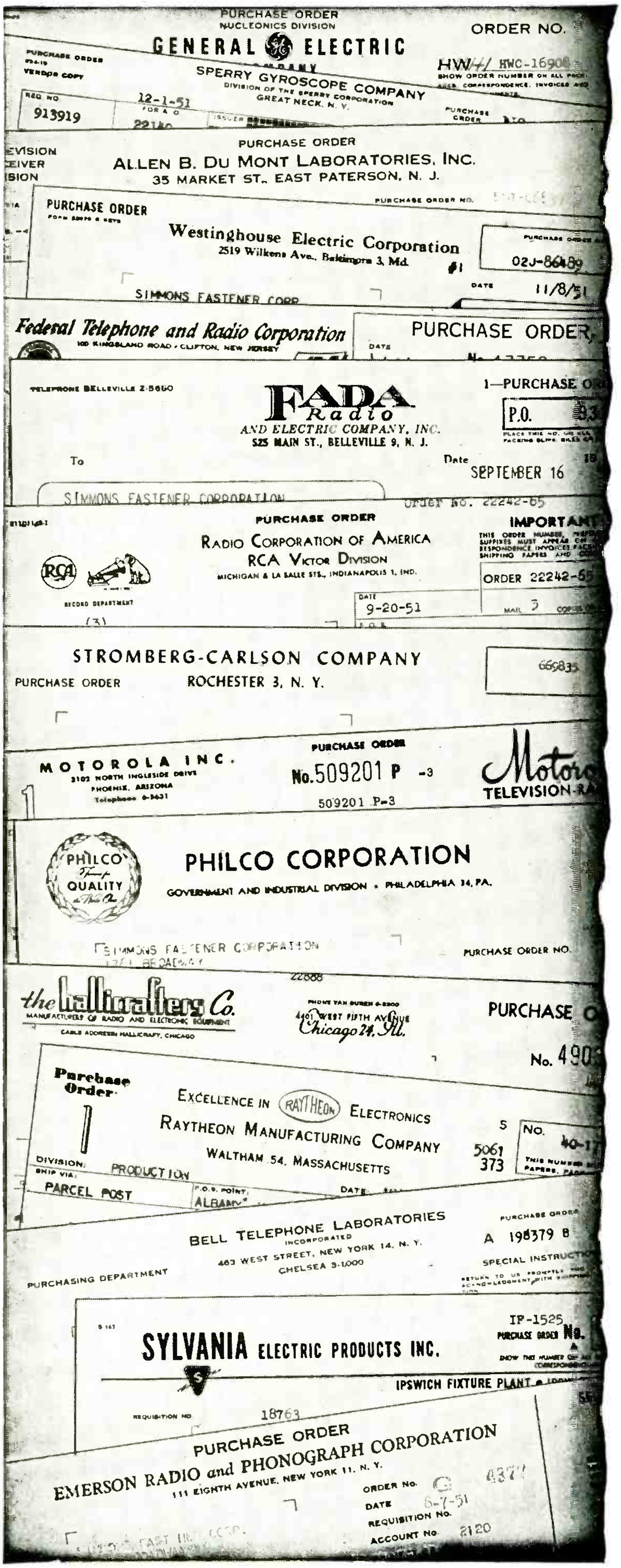

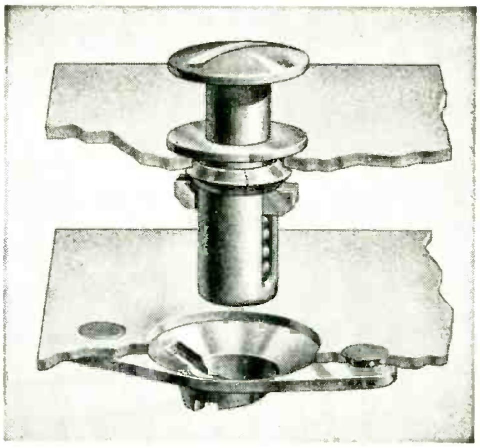

For Electronics:

Faster Assembly... Better Design

Why do leading electronic manufacturers order and re-order Simmons' QUICK-LOCKS in quantity? For good dollar-wise reasons:

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- No special tools are needed for installation.
- Flexible mounting takes care of curved sheets and misalignment.
- Various material thicknesses can be handled.

IN DESIGN—

- Initial loads taken by helical spring. Increased loads carried on solid supports.
- 90-deg. rotation locks and unlocks fastener.
- Stud is self-ejecting when unlocked.
- Stud is self-aligning. Makes mounting and demounting detachable panels simple.

QUICK-LOCK can help reduce your assembly costs and can add unusual advantages to your designs. Send for data and samples today.

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DUAL-LOCK

JUST OUT!
NEW 36-PAGE CATALOG WITH APPLICATIONS.
SEND FOR IT!

Fasteners that improve products and reduce assembly costs.

See Us At The
New York I.R.E. Show
March 21 to 24
ROOM A
Next Door to First Aid Room

Announcing the new Model 581 Oscillograph, designed to fill the need for an extremely small flight-test instrument when automatic features are needed. Dimensions have been held to a minimum without affecting its ability to obtain highly accurate recordings. It measures stresses, strains, vibrations and other physical phenomena under extreme acceleration, shock and temperature conditions. Components will withstand severe conditions of both laboratory and field usage. A few features are: *Automatic record-numbering* • *Automatic length control (resettable by remote control)* • *No-record warning* • *Lamp burn-out indicators* • *Full width timing lines at 0.01 and 0.1 seconds* • *Trace identification* • *Footage indicator* • *Wide selection of paper speeds*

WRITE FOR COMPLETE DETAILS

products

- OSCILLOGRAPHS (LABORATORY AND FLIGHT TEST)
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- GALVANOMETERS
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- TORQUE MOTORS
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MIDWESTERN MI INSTRUMENTS

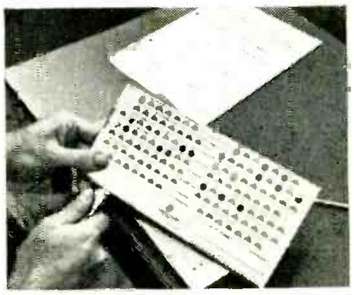
MIDWESTERN INSTRUMENTS

41st and Sheridan Road Tulsa, Oklahoma

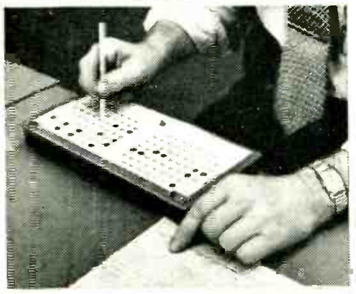
Want more information? Use post card on last page.

How your telephone call asks directions... and gets quick answers

1

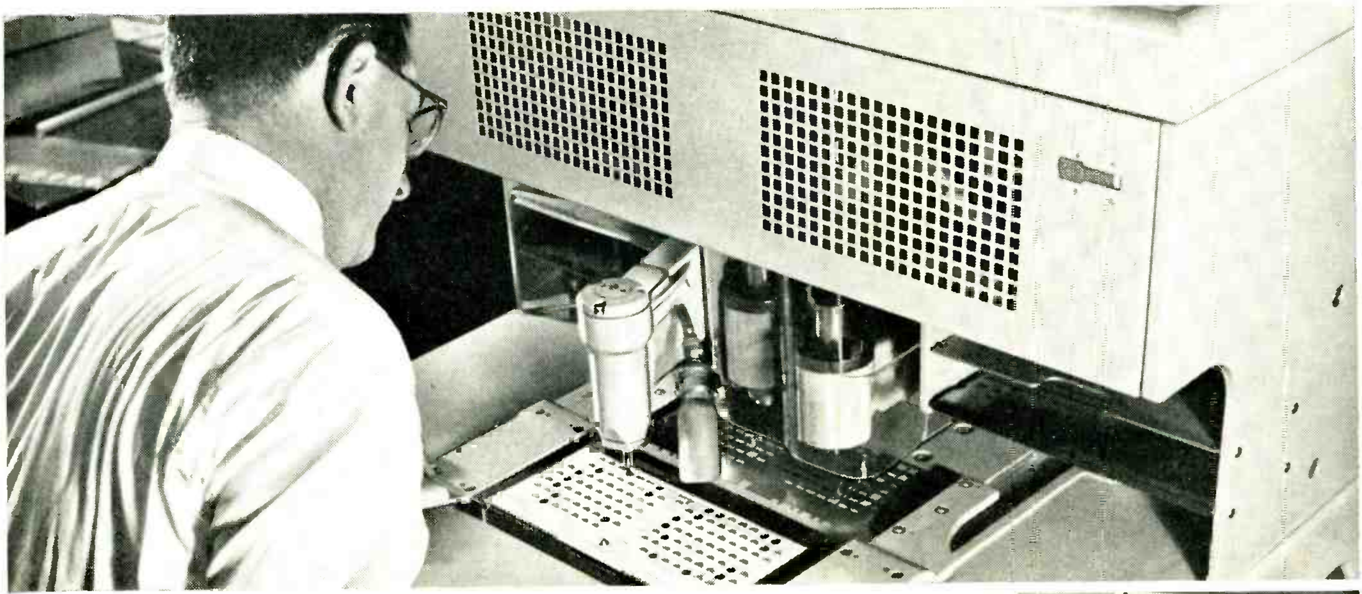


2



Perforated steel cards, which give directions to the Long Distance dial telephone system, are easy to keep up to date. New information is clipped (1) and punched (2) by hand on a cardboard template. This guides the punch-press that perforates a steel card (3), and the two are checked (4). The new card is put into service in the card translator (5).

↓3



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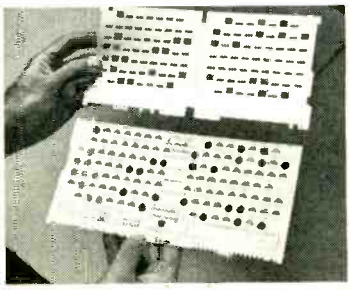

5

When the Bell System's latest dial equipment receives orders to connect your telephone with another in a distant city, it must find—quickly and automatically—the best route.

Route information is supplied in code—as holes punched on steel cards. When a call comes in, the dial system selects the appropriate card, then reads it by means of light beams and phototransistors. Should the preferred route be in use the system looks up an alternate route.

It is a simple matter to keep thousands of cards up to date when new switching points are added or routing patterns are changed to improve service. New cards are quickly and easily punched with the latest information to replace out-of-date cards.

This efficient, flexible way of keeping your dial system up to the minute was devised by switching engineers of Bell Telephone Laboratories, who are continually searching for ways to improve service and to lower costs. Right now most of the Long Distance dialing is done by operators, but research is hastening the day when you will be able to dial directly to other telephones all over the nation.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in scientific and technical fields.

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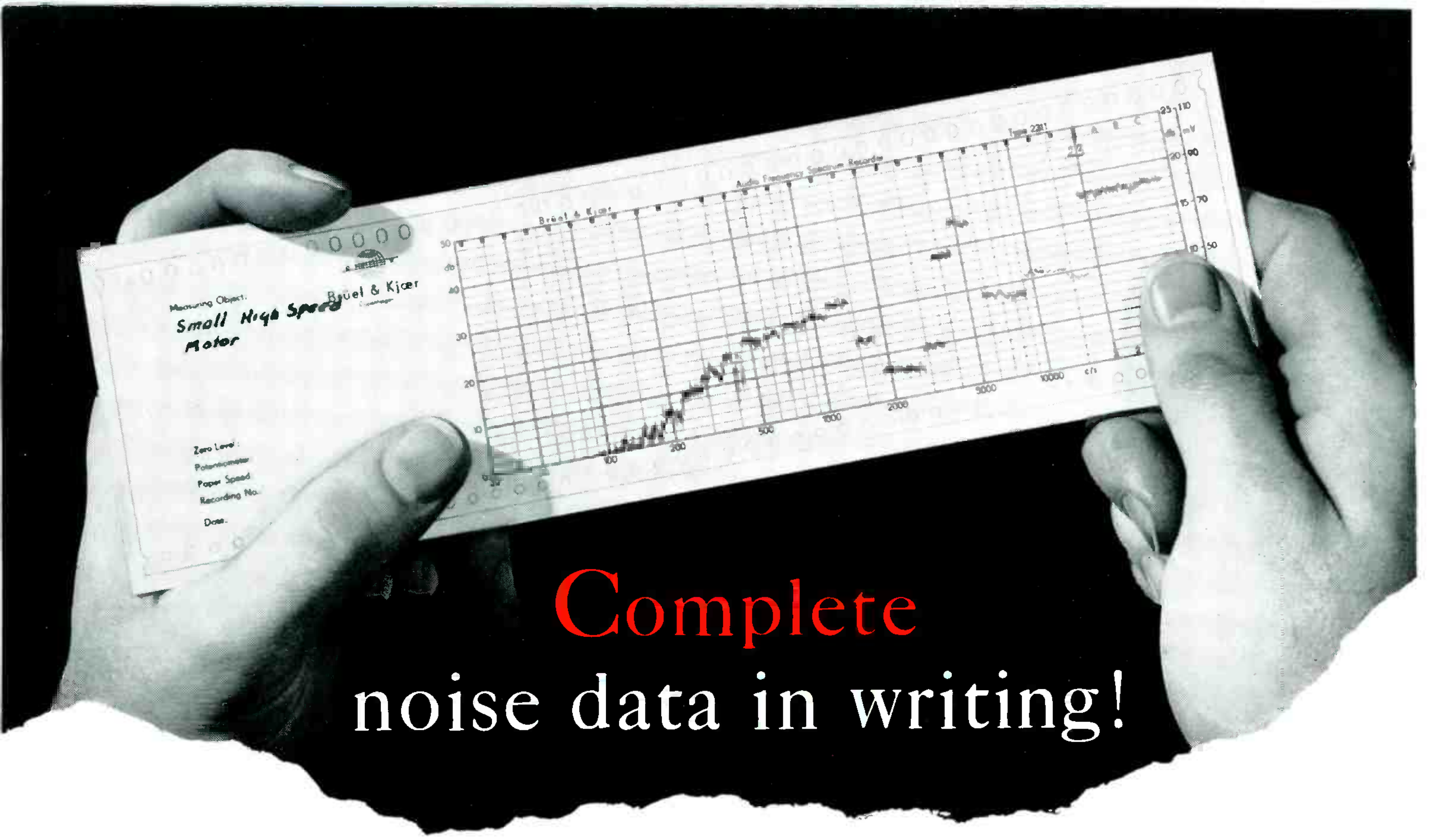


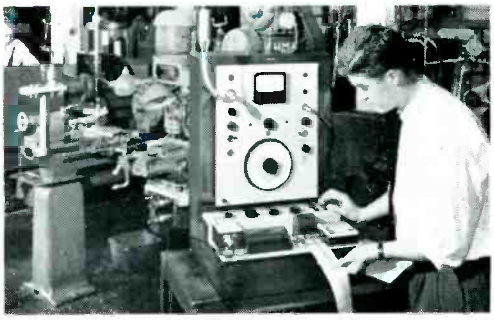
Complete noise data in writing!

Brush Third-Octave Spectrum Recorder simplifies noise and vibration analysis

This sound analysis and recording system provides a written chart record of noise levels—in ⅓ octave bands. The chart gives you complete and accurate data for noise analysis.

Above is a complete frequency and noise level analysis chart for a small electric motor—recorded in 18 seconds! Thus, the system speeds and simplifies noise studies. The Third-Octave Spectrum Recorder also can operate unattended for 24 hours or more, where long-duration records of factory noise levels are desired.

The only recording system of its type that provides narrow frequency band analysis, the Third-Octave Spectrum Recorder is also used in data reduction from magnetic tape, frequency analysis measurements, etc. Write now for complete information.



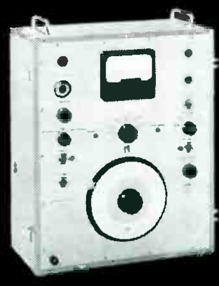
Third-Octave Spectrum Recorder provides a complete, self-contained system for noise analysis and recording—no extras to buy. Precision microphone and microphone calibration apparatus available. System automatically scans and plots sounds from 35 cycles to 18,000 cycles per second in ⅓ octave steps.

SOUND AND ELECTRO-ACOUSTICAL MEASUREMENTS

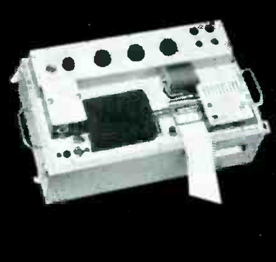
Brush offers a completely integrated line of equipment for sound measurement systems. Developed for laboratory use by Bruel & Kjaer, these precision instruments are finding ever broader use throughout industry.

- **BL-1012** Beat Frequency Oscillator
- **BL-1502** Deviation Test Bridge
- **BL-1604** Integration network for Vibration Pickup BL-4304
- **BL-4304** Vibration Pickup
- **BL-2002** Heterodyne Voltmeter
- **BL-2105** Frequency Analyzer
- **BL-2109** Audio Frequency Spectrometer
- **BL-2304** Level Recorder
- **BL-2423** Megohmmeter and D.C. Voltmeter
- **BL-3423** Megohmmeter High Tension Accessory
- **BL-4002** Standing Wave Apparatus
- **BL-4111** Condenser Microphone
- **BL-4120** Microphone Reciprocity Calibration Apparatus
- **BL-4708** Automatic Frequency Response Tracer

VERSATILE SIGNAL SOURCE Beat Frequency Oscillator has continuously tuned frequency range, metered output, frequency modulating circuit, variable compression and noiseless oscillator stop switch



MEASURES FREQUENCY COMPONENTS... Audio Frequency Spectrometer measures amplitudes of frequency components in complex AC voltages. A high-gain, precision instrument.



HIGH SPEED RECORDING.. Level Recorder permits high speed recording of variations in level of AC voltages from 20 to 200,000 cycles per second. Simplifies recording noise levels, frequency response curves, etc.

BRUSH ELECTRONICS COMPANY

BRUSH ELECTRONICS

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

Division of Clevite Corporation

For brochure write Brush Electronics Company, Dept. K-3, 3405 Perkins Avenue, Cleveland 14, Ohio.

Why Superior 5-WAY Binding Posts are No. 1 Choice

with Equipment Makers Exhibiting at the 1955 Radio Engineering Show

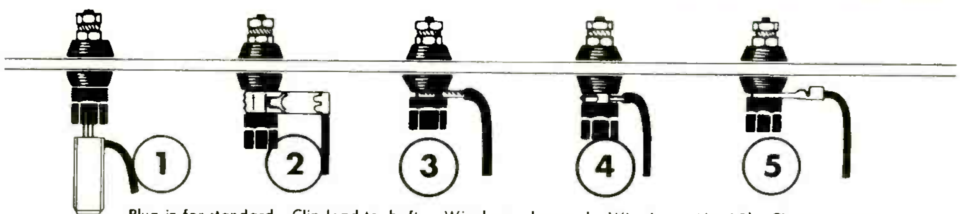
It is the same reason that 5-WAY Binding Posts are the first choice among *all* makers of electrical and electronic equipment. These binding posts help the manufacturer design and deliver a better product — both in performance and appearance. They give the maker and the user *more* for his money.

Send coupon below for Bulletin BP652 giving full details on 5-WAY Binding Posts.

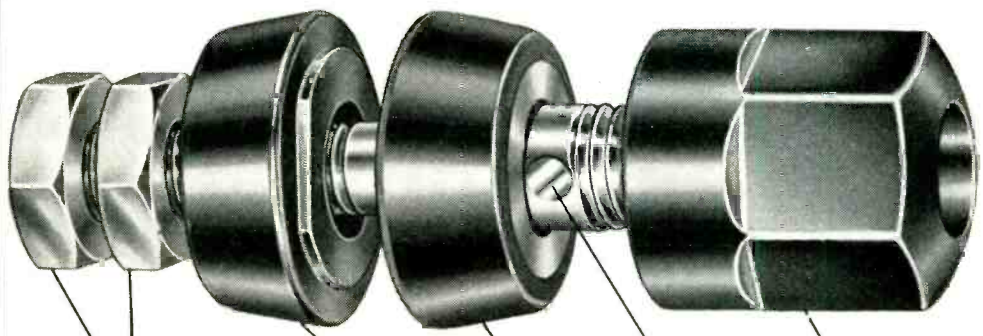
New Flexibility

Rugged Construction

Complete Insulation



1. Plug-in for standard ¾" banana plug
2. Clip-lead to shaft
3. Wire looped around shaft and clamped
4. Wire (up to No. 12) permanently clamped through center hole
5. Clamped spade lug connection



Twin hexagonal 10x32 brass nuts

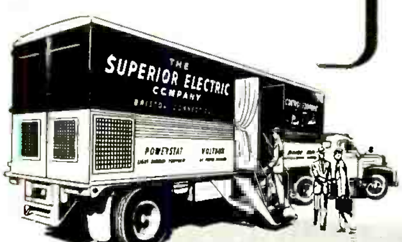
Sliding panel-mounted insulator. Flatted insert for locking to panel.

Panel insulator over brass cone frozen to shaft. Flatted insert for locking to panel.

Hole in center shaft for wire up to size No. 12.

Hex thumb nut with insert captive with stud.

Visit Superior Electric's exhibit at the 1955 Radio Engineering Show — March 21 to 24. Kingsbridge Armory in New York. Booths 101, 102, 103, 104.



See Superior Electric's Mobile Display when it visits your area.

THE SUPERIOR ELECTRIC COMPANY

Bristol, Connecticut

Manufacturers of: POWERSTAT Variable Transformers • STABILINE Automatic Voltage Regulators • VOLTBOX A-C Power Supplies LUXTROL Light Control Equipment • VARICELL D-C Power Supplies Superior 5-WAY Binding Posts

THE SUPERIOR ELECTRIC COMPANY
203 Reynolds Avenue, Bristol, Connecticut

Please send me your 5-WAY Binding Post Bulletin BP652.

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City.......... Zone..... State..........

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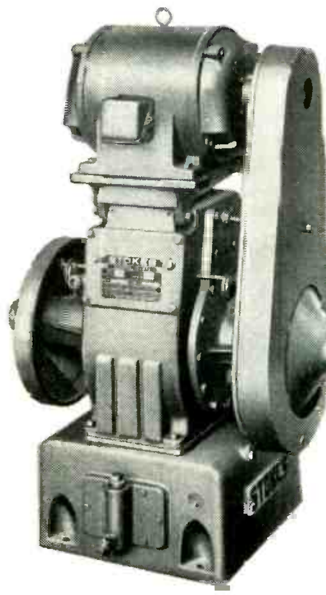
RCA ALUMINIZES TV TUBES ON

Overall view of Stokes continuous vacuum metallizing dolly system for aluminizing TV tubes at RCA's Marion, Indiana plant. Operator is required only to load and unload tubes from the 22 carts.

THE COMPLETE LINE OF STOKES

Stokes manufactures a complete line of vacuum pumping equipment. This includes mechanical vacuum pumps, diffusion and booster pumps, vacuum valves and gages, and complete vacuum instrumentation. In engineered high vacuum equipment, Stokes builds vacuum metallizers, vacuum furnaces and other vacuum processing equipment.

Stokes has for many years been active in vacuum research. Vacuum experience among our engineers covers the range from laboratory equipment to some of the largest vacuum equipment in service. This experience is available to help solve your vacuum problems.



STOKES MECHANICAL VACUUM PUMPS

For vacuum processing systems and for maintaining low forepressures in high-vacuum systems, the Stokes Microvac pump provides efficient, economical operation. Designed with fully automatic lubrication and a long-lasting exhaust valve assembly, every Microvac pump is assured of smooth, trouble-free operation. Six sizes give capacities from 15 to 500 cfm. Gas-ballast available on all sizes. Send for catalog listed.

Want more information? Use post card on last page.

STOKES METALLIZING DOLLIES

The new Stokes installation at RCA's Marion, Indiana, plant is a valveless, rugged system capable of aluminizing up to 120 TV picture tubes per hour. Low in operating cost, it is by far the least complex continuous aluminizing system available. It is designed without timers, gadgets or intricate accessories, any of which could fail and stall production. The system is so free of vibration that a five-cent piece can be balanced on the dollies while they are in motion.

Operation is simplicity itself: the operator loads one tube to a cart; pressure is automatically reduced to the required vacuum, the filament is automatically flashed and the completed metallized tube delivered to the operator's station.

For metallizing COLOR or BLACK AND WHITE TV tubes, Stokes designs and installs automatic or semi-automatic in-line systems or stationary units, in standard designs or to customer's requirements.

The latest development in TV dollies will be on display at the Institute of Radio Engineers' Show in New York City this month. Come and see the results of Stokes' experience in high vacuum technology and in the development of automatic production equipment.

F. J. STOKES MACHINE COMPANY
PHILADELPHIA 20, PA.

SEND FOR TECHNICAL LITERATURE:

- Microvac Pumps—Catalog 750
- Diffusion and Booster Pump Specification sheets and performance curves
- The Story of the Ring-Jet Pump
- Complete Vacuum Processing Systems—Catalog 730
- How to Care for Your Vacuum Pump—Booklet 755
- Vacuum Impregnation—Catalog 760
- Vacuum Drying—Catalog 720
- Vacuum Furnaces—Catalog 790
- Vacuum Metallizing—Catalog 780
- Vacuum Calculator Slide Rule

VACUUM EQUIPMENT

STOKES RING-JET DIFFUSION AND BOOSTER PUMPS

The new Stokes Ring-Jet Pumps embody a new concept of the diffusion principle. Size for size, they have pumping speeds of 10% to more than 100% above any other diffusion pump for a given heat input. Ring-Jet Diffusion Pumps are available in sizes of 4, 6, 10, 14 and 16 inches; Booster Pumps in sizes of 4, 6, 10 and 16 inches. Send for information listed.

STOKES VACUUM VALVES

To control vacuum safely and surely, Stokes vacuum valves are available in 4, 6, 10 and 16-inch standard flange sizes.

STOKES-McLEOD VACUUM GAGES

For measuring vacuums from fractions of a micron up to 50 mm, Stokes-McLeod gages are the standard of reference. Four sizes available.

STOKES

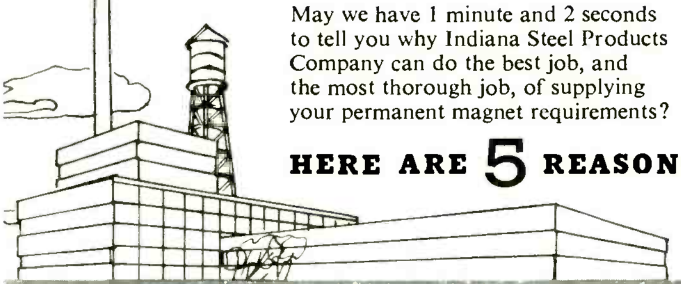
ENGINEERS: Stokes is continually adding to its engineering and technical sales staffs in the high vacuum, industrial tabletting, powder metal and plastics molding fields. If you can qualify, there may be a position for you.

OFFICES IN PRINCIPAL CITIES, REPRESENTATIVES THROUGHOUT THE WORLD

 Want more information? Use post card on last page.

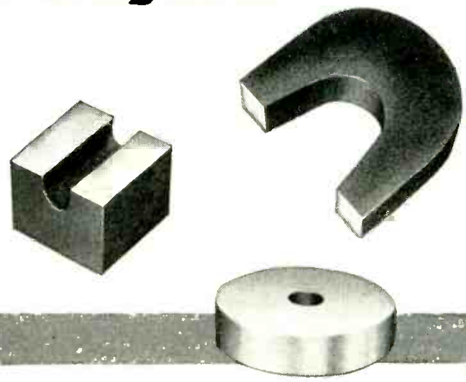
a message

to Original Equipment Manufacturers Who Use Permanent Magnets



May we have 1 minute and 2 seconds to tell you why Indiana Steel Products Company can do the best job, and the most thorough job, of supplying your permanent magnet requirements?

HERE ARE 5 REASONS:



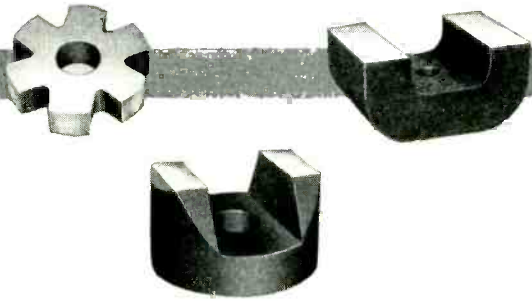
FIRST . . . we're specialists. Indiana Steel Products Company has concentrated on manufacturing permanent magnets for more than 45 years! Attention and interest are not spread over many different and unrelated products.

SECOND . . . all Indiana salesmen are trained *engineers*. In many cases, they can give on-the-spot assistance with immediate problems . . . no delay while they check with the home office.

THIRD . . . Indiana sales engineers draw on our company's 45 years' experience in designing and producing permanent magnets for every conceivable type of application. More often than not, he has *already* encountered problems similar to yours.

FOURTH . . . competently staffed local offices, with direct communication with the home office, assure you of the best possible service . . . expedite rush and emergency deliveries, when necessary.

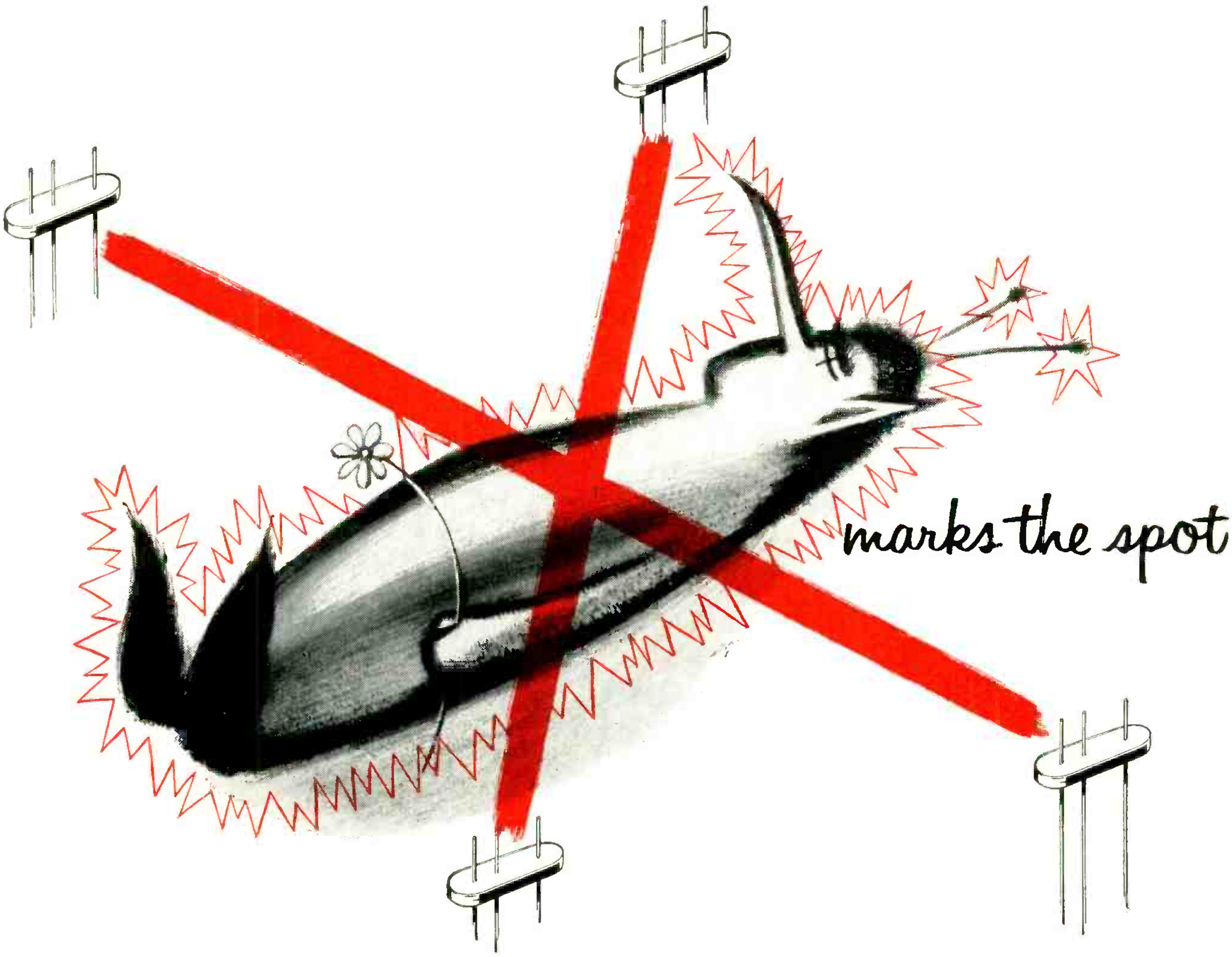
FIFTH . . . Indiana salesmen are backed by the World's largest engineering staff devoted solely to the design and application of permanent magnets . . . and the World's largest and most complete magnetic research and production facilities.



DO YOU ANTICIPATE a need for magnets in your experimental work, or for use around the plant? Catalog #11-A3 lists a wide assortment. Drop us a line . . . we'd like to send you a copy.

INDIANA PERMANENT MAGNETS

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



...That's Where Hermetic Kills Sputter "Bugs" in Transistor Housing Bases—

We have used *all glass* in the internally exposed area of our No. 1619 Transistor Base. This all-glass construction prevents contamination of a transistor wafer when closure is made after mounting. Had we left this area as *metal*... your "buttoning-up" operation would float solder and flux right in under the wafer. When this occurs, the possibility of contamination or degradation of the wafer is raised, and with results that are difficult to predict.

Hermetic's specialist-engineers can help you avoid trouble in all your hermetic sealing problems. Why not draw upon their knowledge and skill?... it covers the full range of matched glass or VAC-TITE* hermetic sealing for the most advanced components.

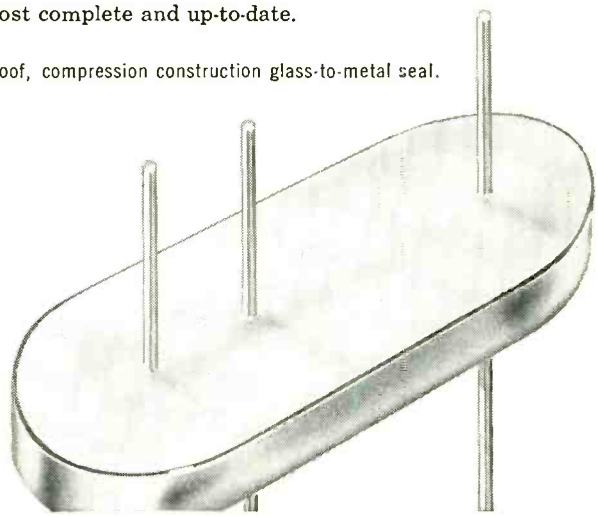
Write us about your problem, and for your copy of our latest addition to the "Encyclopedia Hermetica." You'll find it most complete and up-to-date.

*Vac-Tite is Hermetic's new vacuum-proof, compression construction glass-to-metal seal.

SEALED IN by HERMETIC HEADERS

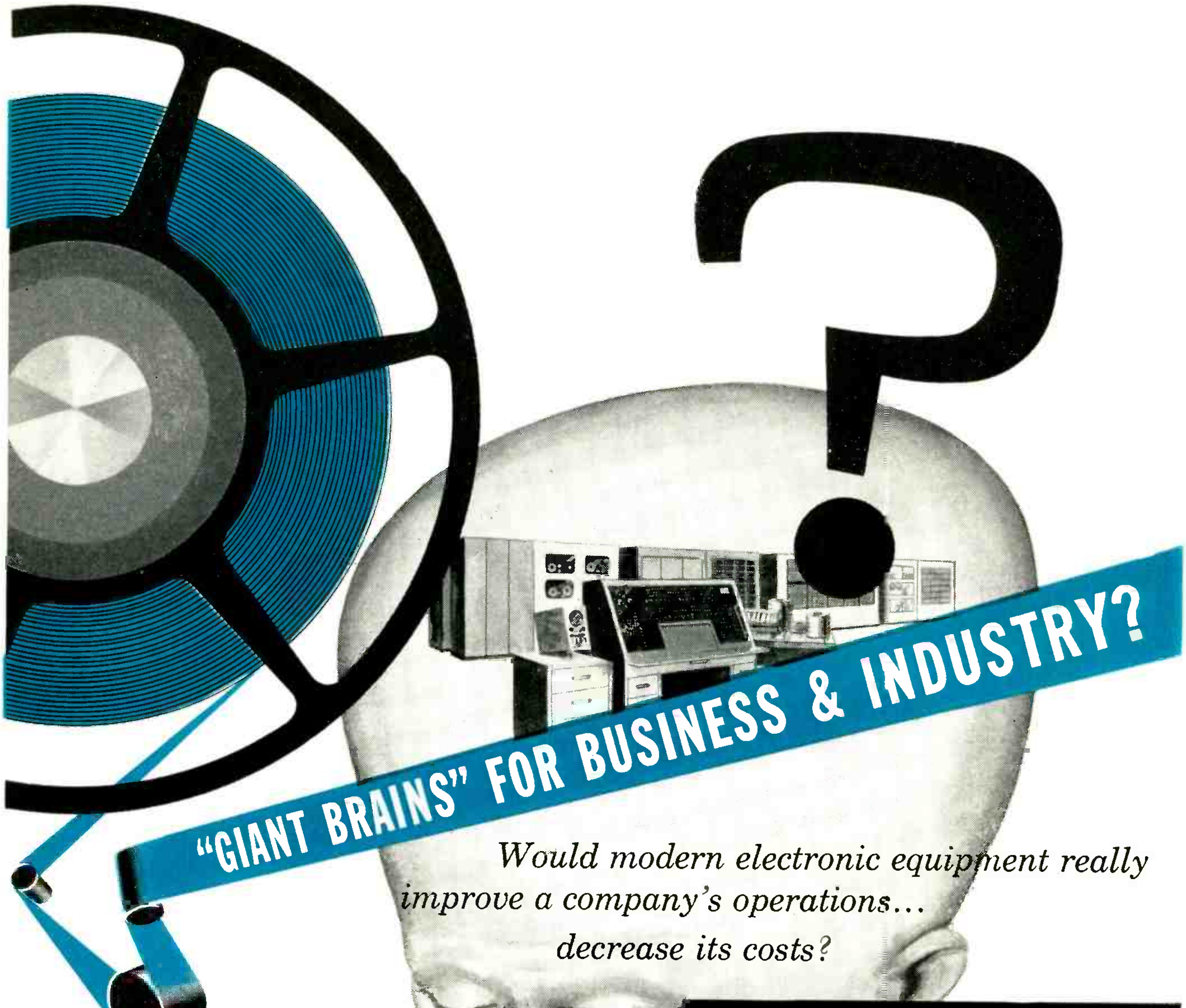
Hermetic Seal Products Company
31 South 6th Street,
Newark 7, New Jersey

Visit us at the IRE Show—
199 Broadcast Way



FIRST AND FOREMOST IN MINIATURIZATION

Want more information? Use post card on last page.



Would modern electronic equipment really improve a company's operations... decrease its costs?

If so—where?

In production control? Payroll accounting? Customer billing? Factory automation?

What make of equipment is best? What changes in company methods and procedures would be required?

To assist managements in answering such questions, The Ramo-Wooldridge Corporation through its Computer Systems Division, offers to business and industry the consulting services of a team of scientists, engineers and business methods and procedure analysts experienced in the application of modern analytical and machine methods. With no equipment of their own to sell to non-military customers, but with understanding of available machines and techniques, this group is in a position to be objective in its recommendations.

Other activities of the Computer Systems Division include a program of development of an advanced type of digital computer for military applications and operation of the company's own computing center, consisting of extensive, general-purpose computing equipment.

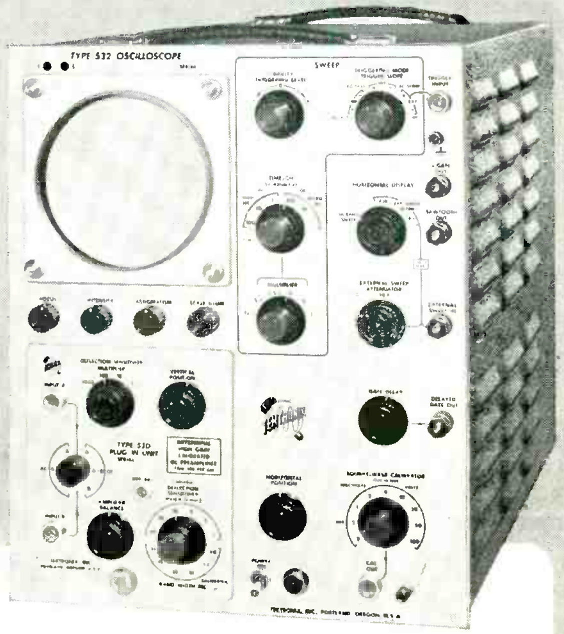
These activities comprise a part of the program whereby The Ramo-Wooldridge Corporation seeks to maintain broad coverage of the important field of automation, computation and control.

The Ramo-Wooldridge Corporation

DEPT. E-7, 8820 BELLANCA AVENUE, LOS ANGELES 45, CALIFORNIA

NEW

5-MEGACYCLE OSCILLOSCOPE
joins the Tektronix Type 530 Series



TYPE 532
the most *Versatile* oscilloscope in its class!

This new oscilloscope offers the advantages of all six Type 53 Plug-In Units now available — plus those yet to come. Only the wide-band units are limited by its dc-to-5 mc response. Wide sweep range (0.2 μsec/cm to 12 sec/cm) and 4-kv accelerating potential complement the signal-handling versatility of the Type 532 . . . resulting in performance characteristics desirable for a great many laboratory applications.

Extra dependability is designed into the Type 532, mainly through circuit simplicity and conservative tube loading. Yet it retains all the precision and stability you've come to expect in Tektronix oscilloscopes. It is an instrument that will give lasting satisfaction in all applications within its capabilities.

BASIC CHARACTERISTICS

Wide Sweep Range
21 calibrated sweeps from 1 μsec/cm to 5 sec/cm, accurate within 3%. 5-x magnifier, accurate and valid on all sweep speeds, extends calibrated range to 0.2 μsec/cm. Full range — 0.2 μsec/cm to 12 sec/cm, continuously variable.

DC-Coupled Output Amplifier
Less than 3 db down at 5 mc. Adjusted for optimum transient response with wide-band units plugged in.

Advanced Cathode-Ray Tube
Tektronix 5" flat-faced precision crt with 4-kv accelerating potential provides 8 centimeters of linear vertical deflection.

Sensitive Horizontal Amplifier
0.2 v/cm to 20 v/cm sensitivity.

Versatile Triggering
Internal or external, with amplitude level selection or automatic triggering.

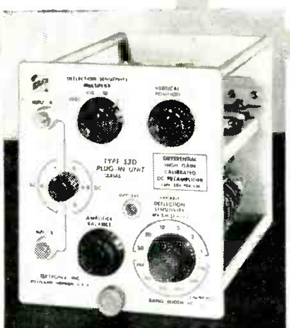
Accurate Amplitude Calibrator
Square wave, 0.2 mv to 100 v in 18 steps, accurate within 3%.

DC-Coupled Unblanking

Vertical Beam Position Indicators

Electronic Voltage Regulation

TYPE 532 — $825.00 *plus price of desired plug-in units.*
Prices f.o.b. Portland (Beaverton), Oregon



Vertical Characteristics of the Type 532 with these Plug-in Units

TYPE 53A — DC to 5 mc, 0.07-μsec risetime. Sensitivity 0.05 v/cm to 50 v/cm, ac or dc, continuously variable, with 9 calibrated steps from 0.05 v/cm to 20 v/cm, **$85.00**

TYPE 53B — Same as Type 53A with additional calibrated ac-sensitivity to 5 mv/cm **$125.00**

TYPE 53C — Dual-Trace Unit. Two identical amplifier channels, dc to 5 mc, 0.05 v/cm to 50 v/cm. Electronic switching triggered by oscilloscope sweep . . . or free running at about 100 kc **$275.00**

TYPE 53D — Differential-input high-gain unit. DC to 350 kc at 1 mv/cm; passband increasing to 2 mc at 50 mv/cm. Full range — 1 mv/cm to 125 v/cm **$145.00**

TYPE 53E — Low-level differential-input unit. 50 microvolt/cm to 10 millivolt/cm, calibrated. Passband 0.06 cycles to 60 kc. Maximum combined noise and hum, 7 μv rms, with input grids grounded **$165.00**

TYPE 53G — Differential wide-band unit. DC to 5 mc, 0.07 μsec risetime. 0.05 v/cm to 20 v/cm calibrated, with separate attenuators for both inputs. Better than 100-to-1 common-mode rejection for the entire passband **$175.00**

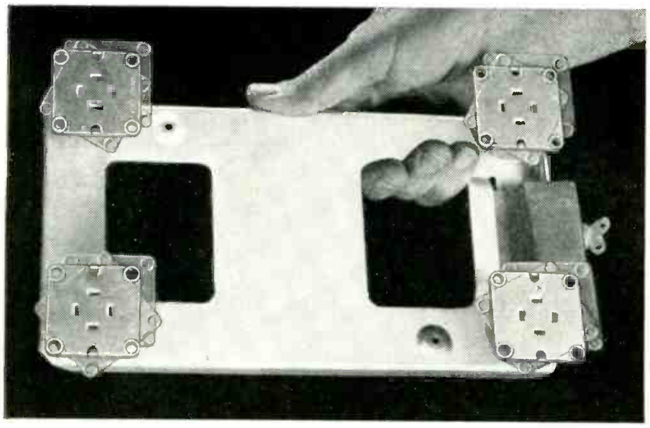
Be sure to see the Type 532 and many other new Tektronix instruments at the 1955 IRE show.

Tektronix, Inc.

P. O. BOX 831A, PORTLAND 7, OREGON
CYpress 2-2611 • Cable: TEKTRONIX

PLAIN FACTS ABOUT VIBRATION AND SHOCK MOUNTINGS

FOR AIRBORNE ELECTRONIC EQUIPMENT

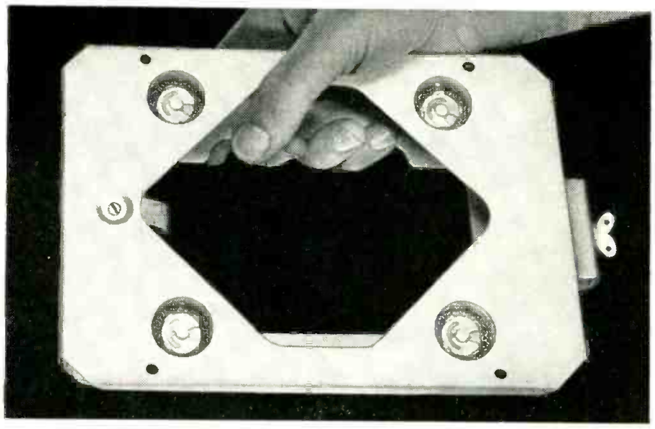


OUT-DATED UNIT MOUNT BASE

16 mounting holes and 16 bolts required.

Unit mountings may be improperly attached to the rack, and are very likely to be seriously misaligned during attachment to aircraft or missile structure.

Even minor discrepancies in spacing and attachment of unit mounts can defeat the whole purpose of the mounting base, and result in poor performance and deterioration of equipment.

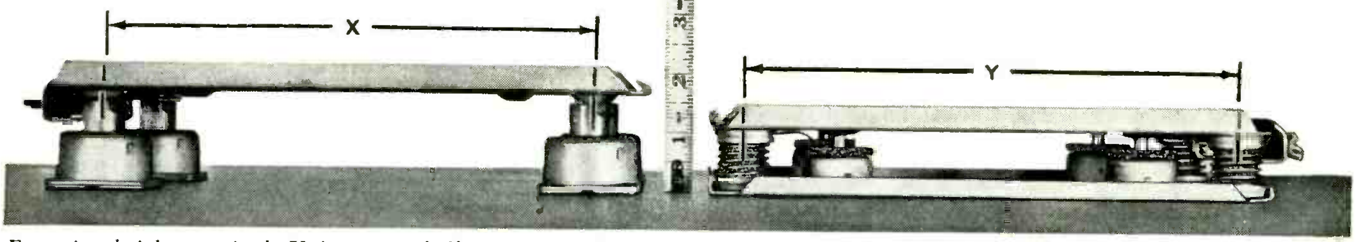


TODAY'S ENGINEERED MOUNTING SYSTEM

Only 4 mounting holes required.

Prespaced holes in a one piece base plate assure quick, accurate attachment. Relationship of all 4 holes is definitely fixed (holes spaced for interchangeability with unit mounts).

No installation errors or misalignment can occur to disturb the precise performance of the mounting system as checked and approved on acceptance tests.



Excessive height required. Unit mount bulk imposes reduced spacing (X) between support centers, resulting in impaired stability (critical in lateral direction). Greater sway space required.

Note reduction in mounting height. Important space saved. Maximum spacing (Y) of resilient elements at extreme corners provides stability. Less sway space required.

Well Designed Electronic Equipment, *If Poorly Mounted,* Too Often Operates Inefficiently and Unreliably

Failure also can result from use of inadequate mountings which are not engineered for the particular equipment and purpose. Conventional shock mounts or so called "isolators", reasonably effective when installed under ideal laboratory conditions, become dangerous trouble makers when installed by usual production line methods.

Attachment of a base plate to unit mounts to achieve spacing control is a makeshift arrangement resulting in excessive weight with no height reduction.

Failure also can result from obsolescent unit mounts employing internal rubber, organic or synthetic materials which deteriorate rapidly and are susceptible to temperature and environmental changes.

The importance of today's electronic equipment surely justifies the use of integrated mounting systems designed to meet specific problems rather than the unreliable application of assembled "catalogue" mounts.

Robinson All-Metal Engineered Mounting Systems Assure Outstanding Performance and Reliability of Equipment

The Robinson concept of vibration and shock control is the design and application of 100% all-metal mounting systems. Engineered with careful understanding of the equipment to be protected and performance expected, Robinson mounting systems come to you completely manufactured, ready to receive the electronic equipment or instrument.

The integration of these mounting systems into the electronic equipment of aircraft and missiles results in reduction of elapsed design time and basic development cost.

Robinson Mountings utilize, as main resilient elements, metal wire cushions (MET-L-FLEX), exclusive with Robinson. This construction has been thoroughly proven by years of use in nearly all military and commercial aircraft.

Some other important characteristics of Robinson Mountings: inherent high damping, non-linear spring rate, performance unaffected by grease, oil, water, dust, extreme temperatures or environmental changes.

USE OF ROBINSON ENGINEERED MOUNTING SYSTEMS results in:

A. **Reliable and uniform performance in every installation under all types of environmental conditions.**

B. **Reduced cost through "de"ruggedization of equipment — substantial reduction of size and weight is possible by simplified and compact design.**

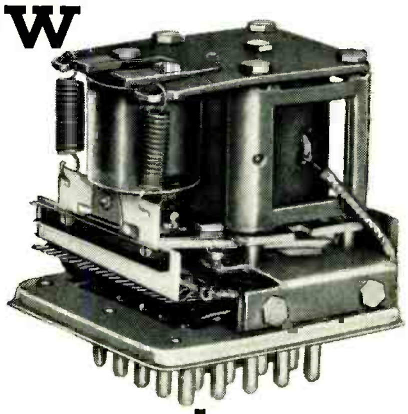
C. **Simplified installation — only four attachment holes required—pre-spaced to save time and assure accuracy.**

For full information about this new concept of vibration and shock control, write or wire today.

ROBINSON AVIATION INC.
TETERBORO, NEW JERSEY
Vibration Control Engineers

West Coast Engineering Office:
3006 Wilshire Boulevard, Santa Monica, California

What you don't know about Regohm may change all your ideas about control systems



Regohm control offers many advantages to the design engineer

By W. H. WALTER
Sales Manager, Electric Regulator Corp.
Norwalk, Conn.

Take Length of Life, For Instance:

Unlike vacuum tubes which have a limited life, REGOHM's life can be unlimited, for this finger-type regulator can withstand extremes of vibration, shock and other ambients. Units in the field with contacts loaded at 2–3 watts per step are still operating after four years. When contact fingers are conservatively loaded at 6–8 watts per step, many thousands of hours of life will be obtained. In applications where REGOHM contact fingers are loaded at 12 watts and one ampere, life can be at least 1000 hours.

REGOHM and its associated chassis is a simple self-contained unit. It is a manufactured rather than an assembled regulator, with firm internal connections, pre-tested and ready for original use or replacement. By proper use the REGOHM can outlast the equipment it controls. Most other regulating devices comprise a system of numerous interconnected components. System failure depends on the number and life of its components and the required complexity of its circuitry. *The simplest self-contained device is the most reliable.* REGOHM is the simplest.

Regohm's Stability Permits Simplicity in System Design:

In electronic or magnetic control systems, stability frequently can only be achieved by adding anti-hunt networks. REGOHM's built-in dashpot acts as a reliable system stabilizer, eliminating engineering time and simplifying the system. Electronic systems and magnetic amplifiers, which require many hours of engineering and experimentation to achieve system stability, can be advantageously replaced by REGOHM with its built-in system stability.

Maintenance? Simple!

Once the REGOHM control characteristic has been set and its dashpot adjusted at the factory, the unit should never be touched again. Should a REGOHM fail due to external circumstances or for any other reason, replacement can be speedily made by unskilled personnel—is simplified by REGOHM's plug-in construction. Since all units for the same application are interchangeable, no adjustments or tests are needed.

Regohm is Compact, Small sized, Lightweight, Inexpensive:

REGOHM and associated equipment require but a fraction of the space taken up by tubes or magnetic amplifiers. With requirements for miniaturization, where space and weight are at a premium, the design engineer can incorporate REGOHM in a system and replace a cabinet full of tubes or the bulky, heavy magnetic amplifier, frequently improving system performance. REGOHM gives four-way economy: 1-long life . . . 2-low initial cost . . . 3-low service and maintenance costs . . . 4-smallest space and weight.

Regohm is a Versatile Unit:

In line load regulation, design engineers find REGOHM a reliable, economic controller. Whether the job is regulating filament voltage or light intensity . . . saturable reactors or rotating machines . . . arc lamp current or over-under relays, REGOHM is without peer.

REGOHMS are controlling rotating equipment made by every major power equipment manufacturer in the country. They are now standard on units meeting the toughest commercial and military requirements. Generators using REGOHM range from watts to kilowatts.

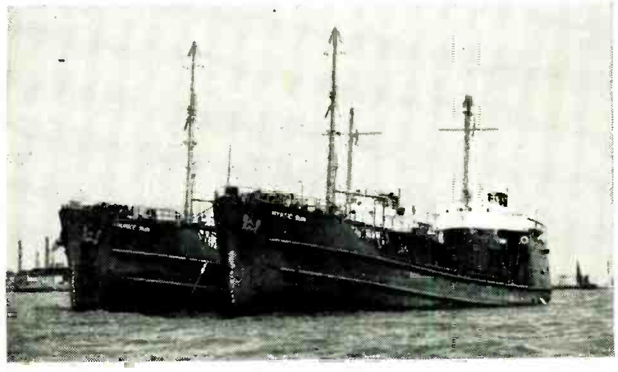
REGOHM is used as a power amplifier in precision frequency controllers, precision filament voltage regulators, dynamotor voltage regulators and light intensity regulators. Also in governor-sensed speed regulators and tension controllers for winding machines. REGOHM's high power gain simplifies system design and improves performance. Stability problems are efficiently and economically solved by the built-in dashpot. Since REGOHM's signal coil and resistor circuits are completely independent, they may be connected in circuits of widely differing impedance levels.

Want more information? Use post card on last page.

Regohm Gives You These Additional Advantages:

Unlike tubes REGOHM requires no preheat period: it operates from the word "go." It is faster acting than any other finger-type regulator and its shock resistance is higher. REGOHM will operate at high temperatures. It can be used in circuits requiring very low impedance. In applications where variations in voltage occur, REGOHM means reliable, close control.

More than three years of regulating voltage of motor alternators on Sun Oil motor barges



REGOHM is regulating speed and voltage of a motor alternator that powers Radiomarine Type CR103 radar equipment aboard the motor barge Mystic Sun, owned and operated by Sun Oil Company. Installed on three other barges as well, REGOHM has been operating for more than three years on each without replacement or failure, and is still going strong.

Sun Oil engineers tested REGOHM and applied it to their system. Their reasons? The regulator's long life, simple replacement feature, stability and very fast speed of response. And, as the barges are equipped with electric pumps and winches and other equipment that present continuously and violently varying loads, REGOHM's ability in maintaining constant voltage won the approval of Sun Oil's engineers.

REGOHM's regulation of Electric Specialty's motor alternator operating from 110 Volt DC input and furnishing 400 Cycle, 115 Volt AC output, relieved the radar operator of manually controlling voltage. At the same time, REGOHM's close, continuous regulation prevented the rapid defocusing of the pattern on the cathode ray tube that previously resulted from any marked voltage change.

To Radiomarine equipment, this automatic control means a reliable power supply that enables radar operation at full efficiency. To the skippers and the men who man Sun Oil's barges, REGOHM spells safety at sea.

It is important for you to know: *Regohm Sales Representatives across the nation assist you at no cost in applying Regohm to your control system*

Within driving range or the reach of telegram or your local telephone a seasoned sales engineer is ready to assist you, *at no cost*, with your control problem. Given the necessary data, they will help you engineer required circuitry . . . recommend the proper REGOHM type . . . calculate the resistor network . . . suggest design modifications for optimum performance . . . analyze final designs . . . assist in testing pre-production models . . . service your requirements.

And behind this network of field engineers, stands the able research, development and production team of Electric Regulator Corporation, ready to tackle your control problem, whether it involves existing systems or advanced developments. Here is an engineering assurance policy for optimum system performance at minimum cost. Take advantage of it.

Check this list:

- ☐ Battery Chargers
- ☐ Airborne Equipment
- ☐ Portable and Stationary Generators
- ☐ Marine Radar
- ☐ Underwater Sound Systems
- ☐ Telephone Central Station Equipment
- ☐ Railroad Signal Systems
- ☐ Refrigeration Equipment
- ☐ Filament Regulation
- ☐ Computers
- ☐ Airport Lighting Systems
- ☐ Inverters
- ☐ Railroad Car Lighting Systems
- ☐ Locomotive Braking Systems
- ☐ Wire and Radio Communication Systems
- ☐ Air Navigational Systems
- ☐ Guided Missiles
- ☐ Oil Field Exploration Systems
- ☐ Signal and Alarm Systems
- ☐ Instrumentation Systems
- ☐ Magnetic Clutches
- ☐ Tension Control Equipment
- ☐ Saturable Reactors

If you find your equipment or system listed, or have a problem in other fields, contact Electric Regulator Corporation, 100 Pearl Street, Norwalk, Conn., or your local sales engineer. Their know-how in the control field will promptly be made available.

SALES REPRESENTATIVES

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Electric Regulator Corporation
HOME OFFICE: Norwalk, Connecticut

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Roselawn Center Building, Cincinnati 37, Ohio

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1925 Cedar Street, Dallas 1, Texas

C. B. Parsons and Company
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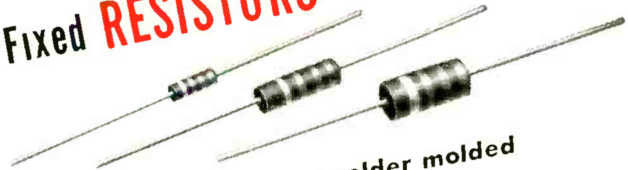
E. L. Berman Company
780 Natoma Street, San Francisco 3, California

Richard T. Puelicher, E. E.
3151 E. Colorado Street, Pasadena 8, California

REGOHM

ELECTRIC REGULATOR CORPORATION
NORWALK, CONNECTICUT TEMPLE 8-4311

STACKPOLE
Fixed RESISTORS



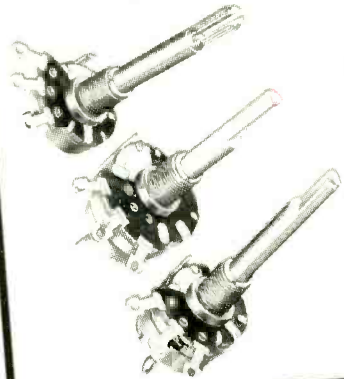
. . . dependable, easy-to-solder molded composition types

Stackpole ½-, 1- and 2-watt resistors not only meet exacting performance standards, but save assembly time thanks to their highly-tinned, easily-soldered leads.

MIL-R-11A TYPES—in styles RC20, RC30, RC31, and RC42 available. Write for data on all MIL types.

. . . A dependable source of reliable components for over 30 years

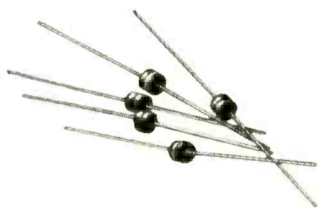
STACKPOLE
Variable RESISTORS



with versatile switching

Single, ganged and concentric shaft dual types in smallest sizes consistent with real dependability offer long, trouble-free performance for today's requirements. Gold plated "ring spring" contactors assure low noise level. A complete array of unique midget line switches offers practically any desired switching arrangement, with types for both civilian and military use.

STACKPOLE
Composition CAPACITORS



Cost-saving, low-value, fixed types

Originated by Stackpole, these tiny units not only represent the simplest, most inexpensive capacitor design yet produced — but likewise have characteristics that make them more desirable than larger, more costly capacitors for many uses. 47 standard types, 0.1 to 10.0 mmf. Write for Stackpole GA Capacitor Bulletin.

New!

Tab-mounting Bakelite shaft control

Just right for rear-of-chassis or concealed front panel controls in TV receivers . . . especially in high voltage circuits. Measures only 0.894" in diameter, yet handles a full .5-watt. Write for data on Stackpole Type LR-6.

STACKPOLE
Iron CORES

. . . to match any electrical or mechanical specification

Pioneers in modern iron core development, Stackpole offers practically any desired style and with assured uniformity of both electrical and mechanical characteristics.
Write for Iron Core Bulletin.

New "EE" Engineered Economy Cores

. . . standardized to meet 80% of all requirements at low cost. Write for data on any type.

AVAILABLE THROUGH PARTS DISTRIBUTORS! For name of nearest distributor stocking Stackpole resistors, switches and "EE" iron cores write: Distributors' Division, Stackpole Carbon Co., 26 Rittenhouse Place, Ardmore, Pa.

STACKPOLE *Ceramag*® CORES
(Ferromagnetic)

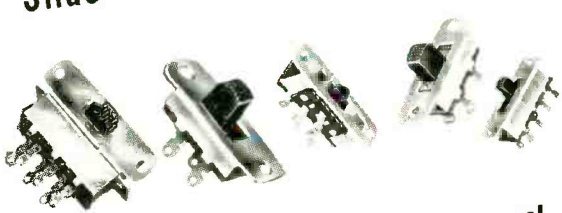
for real uniformity! Wherever ferromagnetic cores are used, Stackpole Ceramag Cores have set the quality standards. But proved superiority in essential characteristics is only part of the story. Even more important is the fact that Stackpole Ceramag core characteristics are maintained with remarkable uniformity regardless of size, shape or production quantity. *The sample matches your specification "on the nose"—and each production unit is exactly like the sample!* Write for Ceramag Bulletin RC-9A including details on available grades and latest characteristic curves.

STACKPOLE Molded COIL FORMS

Cut Assembly Costs!

Reduce coil sizes and cut assembly costs with simplified point-to-point wiring and fewer soldered connections. Over 35 new types available in phenolic, iron, or phenolic with iron center sections. Axial or "hairpin" leads. Write for complete specifications on all types.

STACKPOLE Slide SWITCHES



. . . the economy switches of 1001 uses!

Over 20 types of these inexpensive little Stackpole slide switches cover just about every mechanical and electrical switching requirement for radio and television equipment, small motors, appliances, electrical toys, instruments, etc. For complete details, write for Stackpole Switch Bulletin RC-9B.

Engineering Samples are proof of the pudding!

Engineering samples of standard Stackpole components are available to quantity users. Send details of your requirement for recommendation by Stackpole engineers.

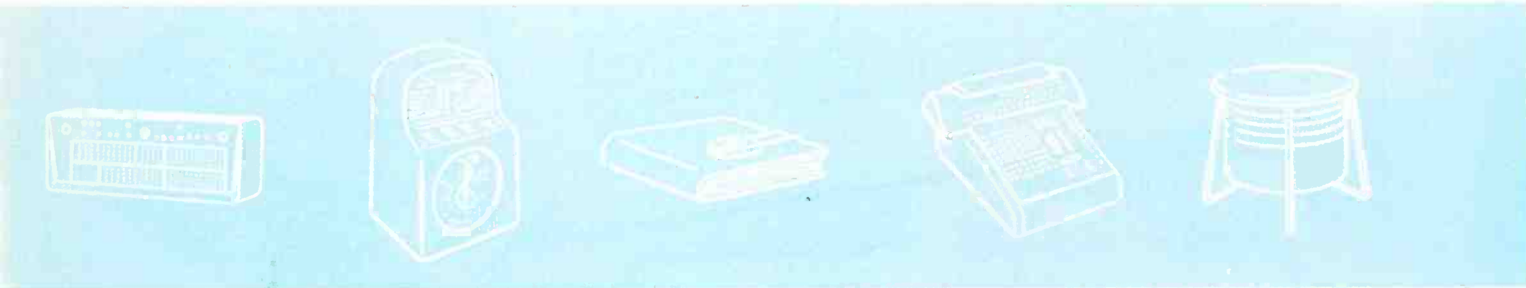
ELECTRONIC COMPONENTS DIVISION

STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

STACKPOLE

Want more information? Use post card on last page.

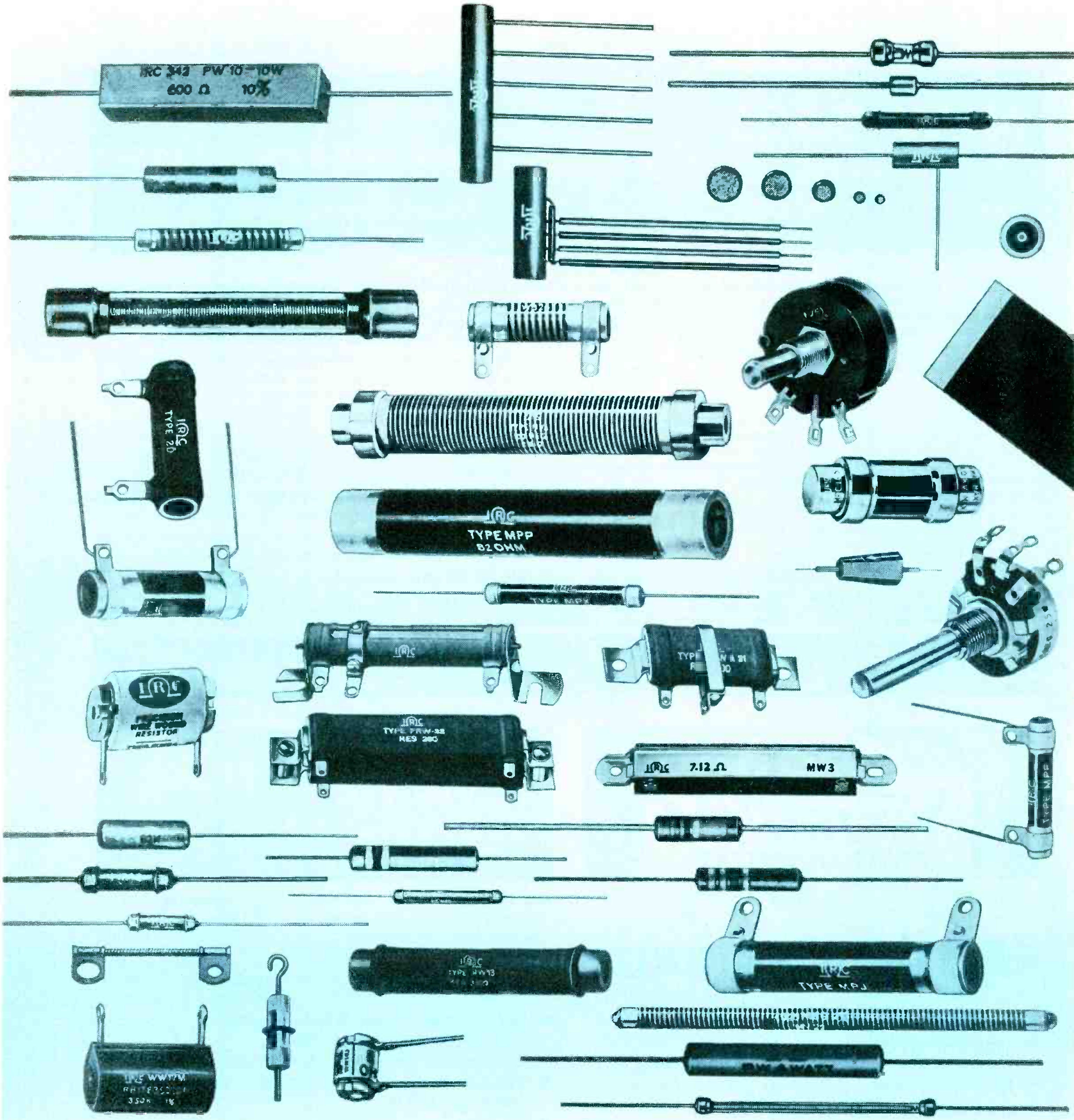
More IRC resistors are used by manufacturers



of military devices, instruments, computers,

electronic and electrical equipment, appliances,

radio and television sets than any other brand.



IRC makes over 140 types of resistors
. . . can afford to recommend without bias.

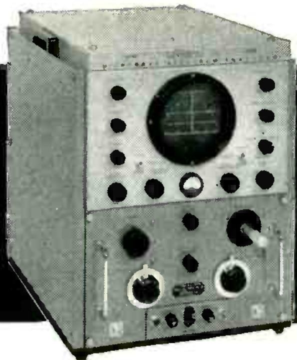
IRC

International Resistance Company, 401 North Broad Street, Philadelphia 8, Pa.

Wholly Owned Subsidiaries: *IRCAL INDUSTRIES, Los Angeles, California*
VAN DYKE INSTRUMENTS, Inc., St. Petersburg, Florida
INTERNATIONAL RESISTANCE CO., Ltd., London, England

International Resistance Co., Ltd., 349 Carlaw Ave., Toronto

NEW SA25 Microwave Spectrum Analyzer



800 mc/s to 10,250 mc/s ON FUNDAMENTALS

K-Band Coverage to 40,000 mc/s

ACCURATE — Calibrated micrometer wavemeters . . . lifetime accuracy to .05% with incremental accuracy to better than .005% independent of Klystrom changes. Transmission wavemeters for maximum indication without "pulling".

RELIABLE — Double conversion for stability with maximum drift . . . standard replaceable klystrons . . . no complex harmonic interference. Highly efficient circuits with minimum power consumption, designed for cool, continuous operation.

ECONOMICAL — 99.8% of all microwave research, development, production, test, installation and maintenance requires precise work in a specific portion of the microwave spectrum, usually only a few hundred megacycles wide. Compromise coverage of large areas costs more and delivers less.

The SA25 Spectrum Analyzer includes:
- 5% medium persistence CRT display.
- Choice of I. F. Amplifier.
- Dual range sweep—2 to 20 or 6 to 60 CPS in two overlapping ranges.
- Standard CRT bezel for camera or hood.
- Improved frequency spread control.
- New wavemeter marked gain control.

THE VECTRON 25 SERIES K-BAND MICROWAVE SPECTRUM ANALYZERS are complete, including a display unit, and R.F. assembly and a K-band mixer to cover the desired portions of the "K-Band" region of the microwave spectrum.

Due to the relatively recent development of the equipment for use in K-band and the band's extremely broad range, it has been necessary to develop several assemblies to cover economically the most active portions of the spectrum.

SA25K1	15.3 kmc/s to 17.7 kmc/s
SA25K2	22.8 kmc/s to 26.4 kmc/s
SA25KQ1	34.0 kmc/s to 38.6 kmc/s

SPECIAL K-BAND MIXER — R.F. ASSEMBLY COMBINATIONS provide coverage of other ranges from 12.4 to 40.0 kmc/s.

Individual K-Band R.F. Heads may be purchased separately, or with the new Vectron SA25 Microwave Spectrum Analyzer.

Interchangeable R.F. Heads Available to 40 kilomegacycles

25L1	800-2400mc/s	25C1b	4240-4910mc/s	25X2b	5700-6600mc/s	25X1b	9500-10,250mc/s	25K1	15,300-17,700mc/s
20S1	2400-3650mc/s	25C1a	4240-5900mc/s	25X2a	5700-7425mc/s	25X1a	8500-10,250mc/s	25K2	22,800-26,400mc/s
20S1a	2400-4040mc/s	25C1	5100-5900mc/s	25X2	6250-7425mc/s	25X1	8500-9660mc/s	25KQ1	34,000-38,500mc/s

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- **Standard Quality** . . . to meet all usual precision requirements.
- **Standard Prices** . . . from our published price list.
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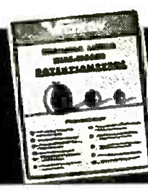

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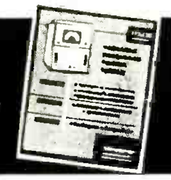

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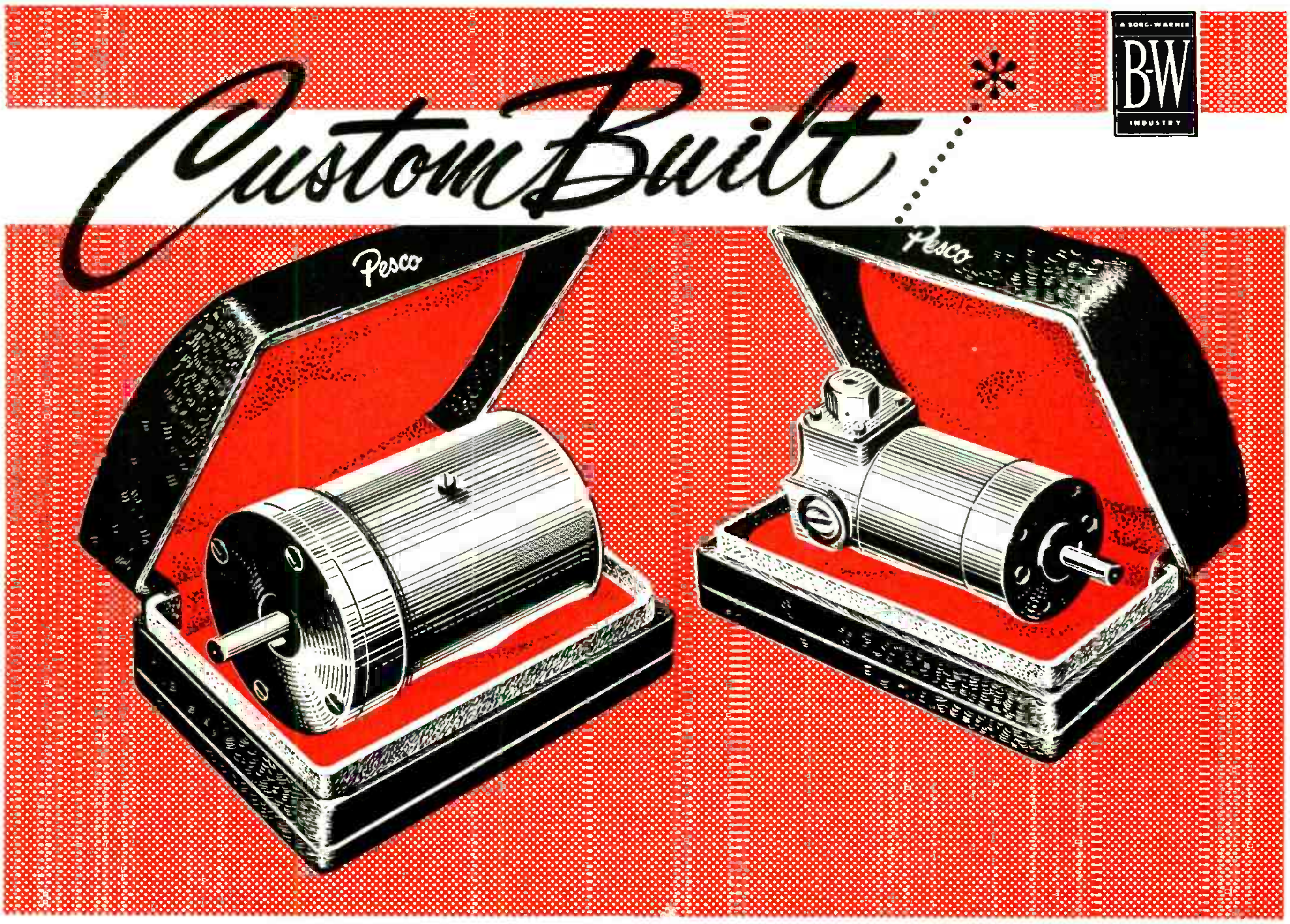

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engineering Pesco production

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GENERAL-PURPOSE RELAY

TYPE FC-6 (6 D.T. Contacts)

Withstands 0 to 2,000 cycles vibration to 30G

Withstands up to 60 G shock without contact opening, 2,000 ft.-lbs. without contact transfer or damage.

Designed to exceed MIL-R-5757B and to meet MIL-R-25018 (USAF) and MS24115 (USAF) specifications.

Available for both 85°C and 125°C ambient Nominal coil voltage 26.5 volts DC.

...and priced materially lower than existing relays in its class!

Far superior in performance and durability to previous types, the new Dunco FC-6 hermetically-sealed general-purpose relay is priced materially lower.

Designed from a background of 5 years experience with the Dunco 220XFX100, the FC-6 offers far greater simplicity in its moving parts; easier construction and adjustment; extreme rigidity for high vibration and shock; high contact pressures; low contact bounce; plenty of contact over-travel; and complete absence of internal gaseous materials which might cause contact unreliability.

Vibration resistance of 0 to 2,000 cycles up to 30 G's is attained . . . a heretofore unheard of performance for relays of this class.

Throughout, the Dunco FC-6 incorporates safety factors that make it ideally suited for difficult applications, even in low-energy circuits.

Write, wire or 'phone for Dunco FC-6 Relay Data Bulletin L2406 giving complete specifications.

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STRUTHERS-DUNN, INCORPORATED, Pitman, N. J.

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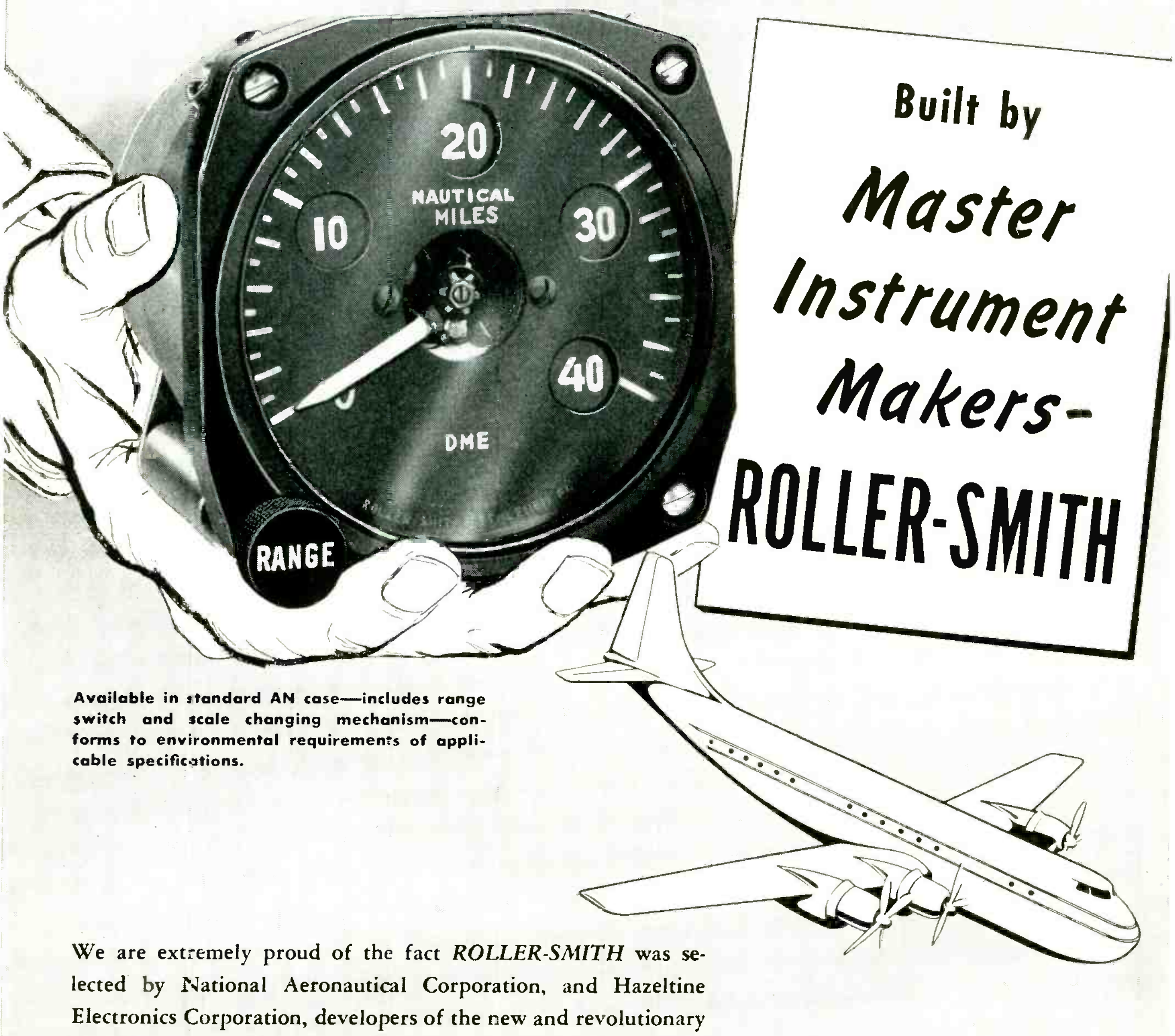

Available in standard AN case—includes range switch and scale changing mechanism—conforms to environmental requirements of applicable specifications.

We are extremely proud of the fact *ROLLER-SMITH* was selected by National Aeronautical Corporation, and Hazeltine Electronics Corporation, developers of the new and revolutionary DME*, to produce the panel indicator for their equipment.

Because we have been a leading manufacturer of precision instruments of all types since 1908, we were able to supply them with one single source for the necessary engineering, designing, and manufacturing skill needed to produce this complex mechanism dependably and in quantity.

If you, too, have a problem involving the design or production of precision instruments, why not consult us? Our staff of experts will assist you in arriving at an economical, workable solution.

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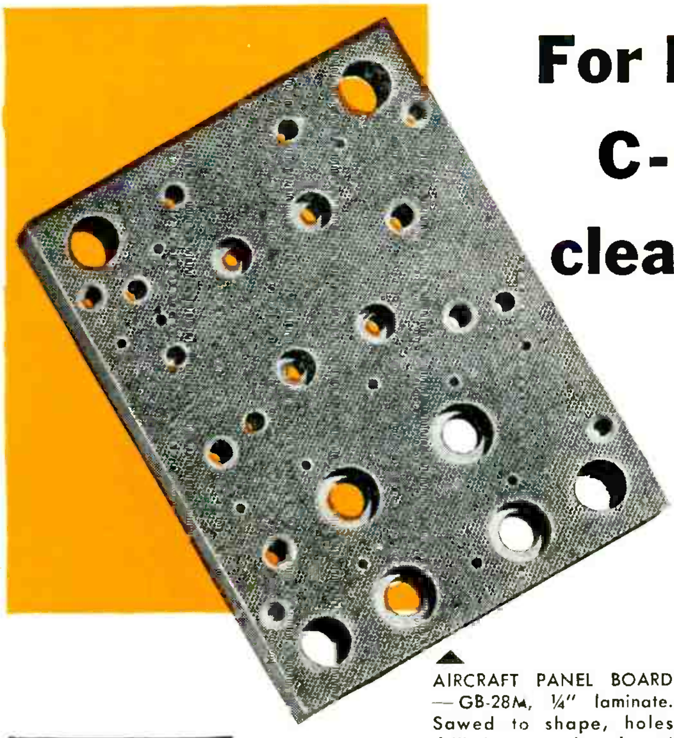
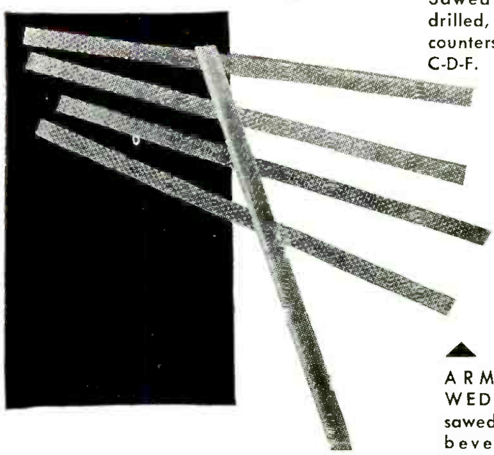
For high heat applications C-D-F Melamine Dilecto cleanly machined by C-D-F



AIRCRAFT PANEL BOARD — GB-28M, ¼" laminate. Sawed to shape, holes drilled, counterbored and countersunk. Machined by C-D-F.



ARMATURE SLOT WEDGES — GB-28M, sawed into strips, then beveled edges were broached to angle of 21° 23′, and strips were cut to exact length. Machined by C-D-F.

RF COIL FORM — Natural GB-112M Dilecto rolled tubing, smooth edged. Sawed to length; drilled and burred by C-D-F.

As operating temperatures rise, melamine laminated plastics can satisfy many requirements for component parts. Glass base melamine grades of Dilecto resist elevated temperatures —up to 300° F. continuously, 350° F. intermittently. They have extremely high impact strength; excellent arc resistance and self-extinguishing properties. C-D-F melamine Dilecto grades are usually specified for many electrical applications requiring high arc resistance, mechanical strength, flame and heat resistance.

C-D-F can supply melamine Dilecto in sheets, tubes and rods in the following grades:

GB-28M—Medium weight glass base laminate with melamine resin. Highest mechanical strength; excellent arc resistance, high heat and flame resistance; self-extinguishing. Dimensionally stable—little affected by temperature and humidity.

GB-112M—Lightweight glass fabric with melamine resin. Substantially same characteristics as GB-28M. Usually produced in thickness less than 1/32".

GM-1—Glass mat base melamine resin bonded laminate. A lower cost product suitable for many applications requiring arc resistance along with good mechanical strength and flame resistance.

USE COMPLETE MANUFACTURING FACILITIES OF C-D-F. Make us responsible for your complete job . . . from laminates to finish machining of components. C-D-F has the know-how to cleanly machine melamine Dilecto to close tolerances. C-D-F can save you time, money and waste of material. And when you make C-D-F responsible for the complete job, you know what you're getting: components machined to exact specifications; strict adherence to quoted prices; and prompt delivery.

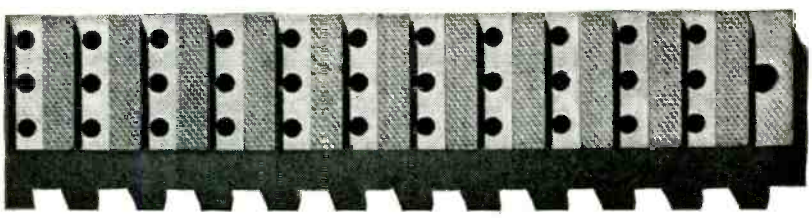
Write for samples and technical bulletins on melamine Dilecto components. Call in a C-D-F sales engineer, tell him your problem. He'll help you.

See our general catalog in Sweet's Design File for more data, the address and telephone number of your nearest C-D-F sales engineer. Also write for technical bulletin and specific catalog, free test samples, or send us your print for quotation.

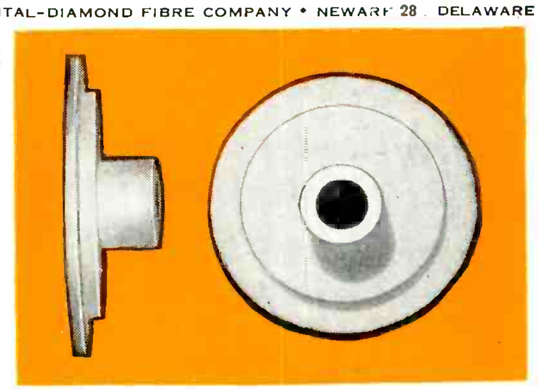
CDF *Continental-Diamond Fibre*

CONTINENTAL-DIAMOND FIBRE COMPANY • NEWARK 28 . DELAWARE

TERMINAL BLOCK—GB-28M. Sawed to shape, grooves milled, corners sanded round. Holes were drilled, counterbored, characters stamped. Machined by C-D-F.



INSULATOR — ML rod. Turned on automatic screw machine by C-D-F. Grade ML is a fine weave cotton fabric base laminate bonded with a melamine resin. Easy to machine.



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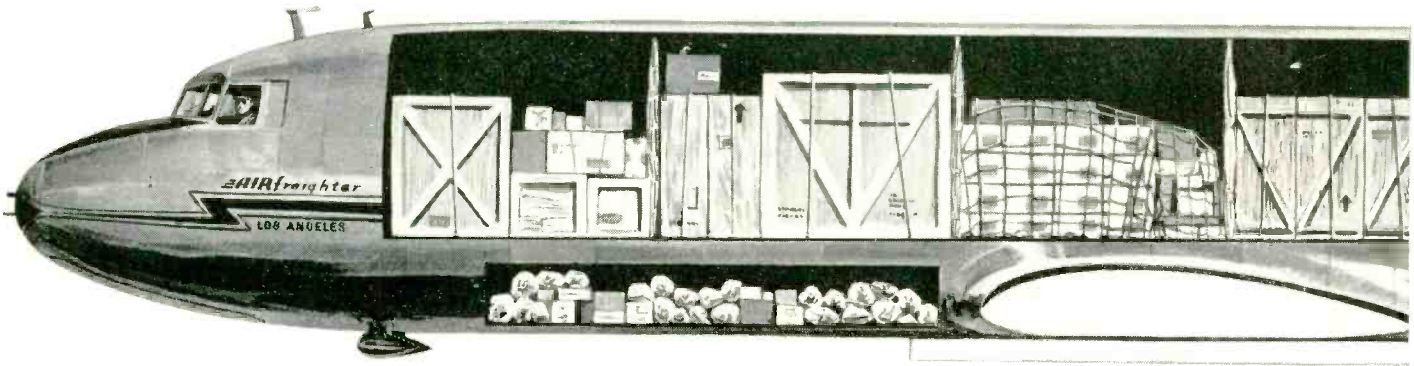

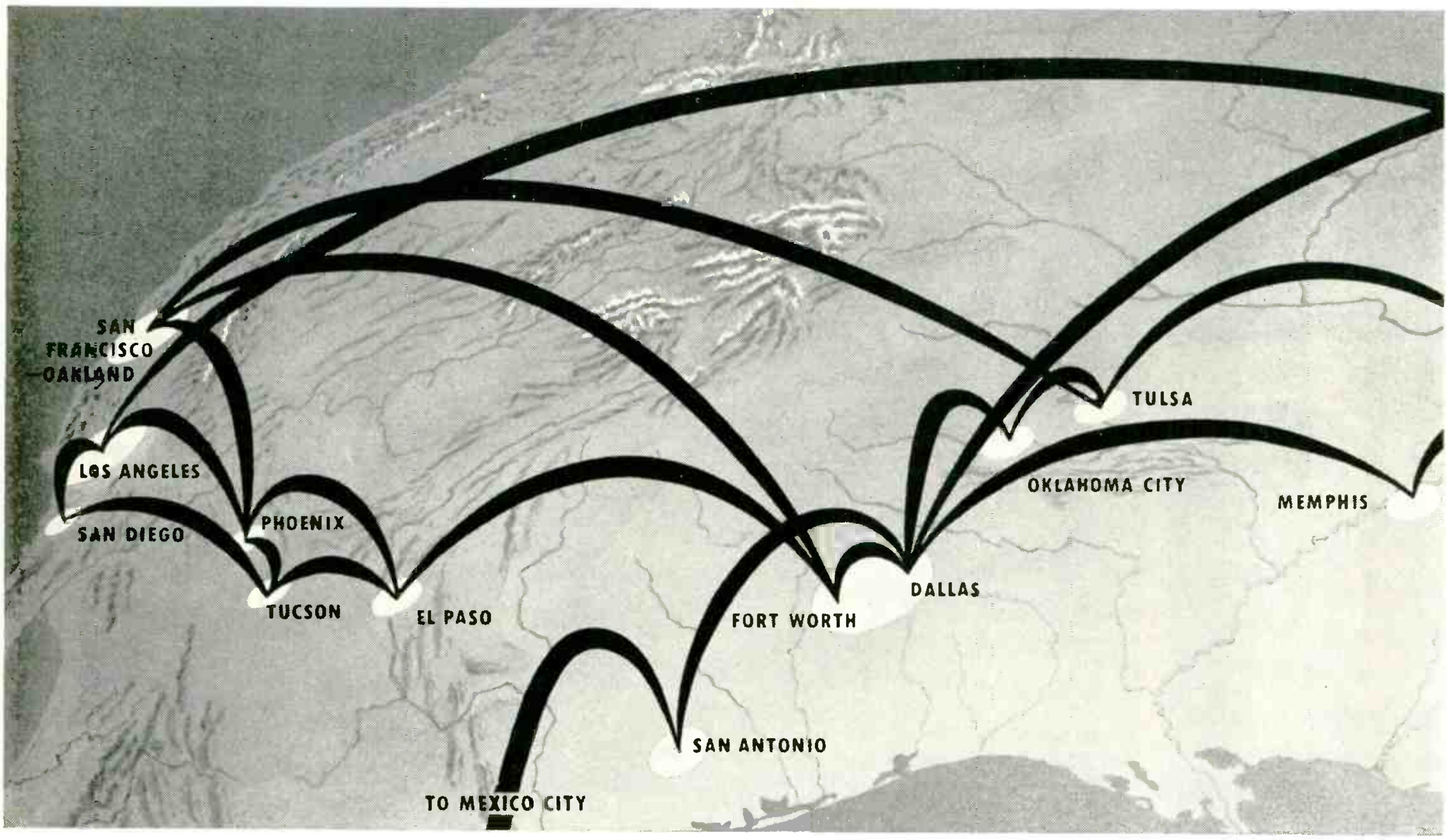

Capacity, of course, is one measure of a carrier's ability to deliver the goods. That's why it's important for you to know American Airlines has the greatest cargo capacity in the airfreight field.

But, equally important, when it comes to specifying a carrier, is the availability of that space—having it where and when it can best serve you. Here again, American leads all others.

• While providing fast and frequent service to seventy-seven key cities throughout the Country, *only American serves two-thirds of the top thirty retail markets—all twenty-three of the leading industrial states.*

Add this to American's superiority in expe-

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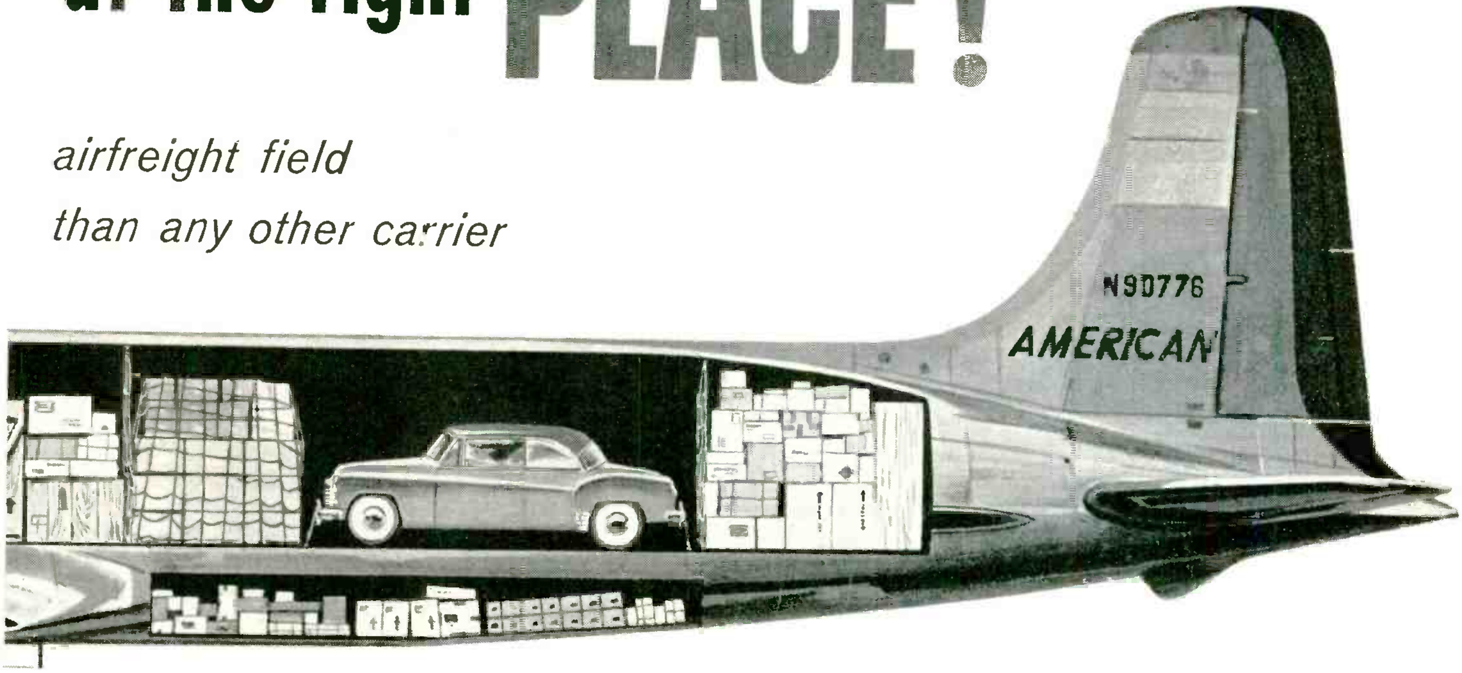
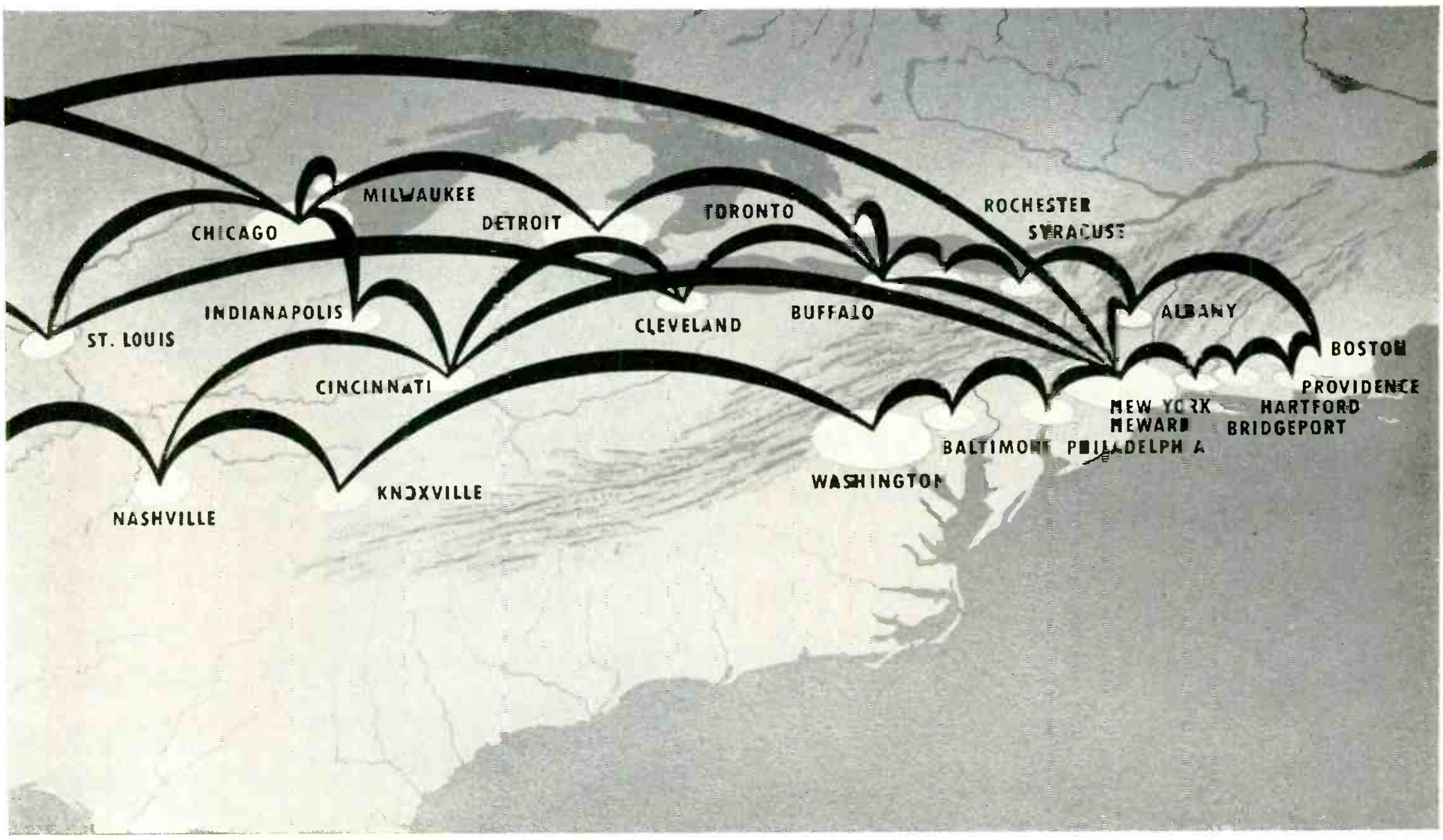
airfreight field
than any other carrier





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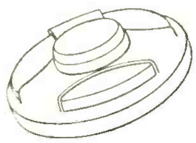
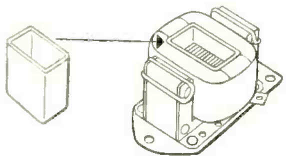
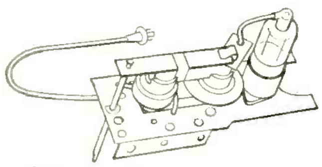
Tips for designers



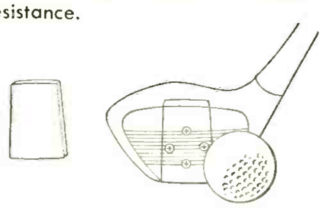
Fuel pump valve seat made of Taylor Grade LE phenol laminate resists attack by gasoline . . . is tough, long-wearing.



Coil forms for this solenoid have to operate at high temperature . . . an ideal application for Taylor Glass Melamine Laminate.



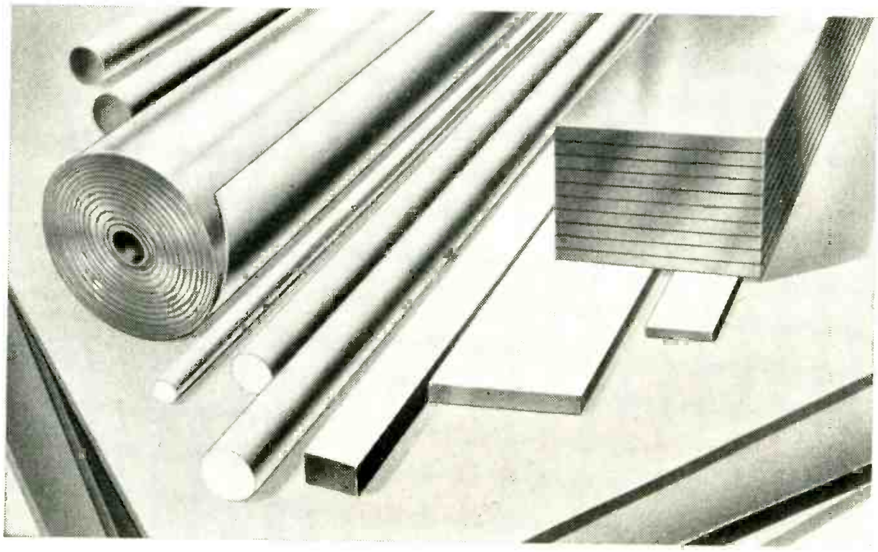
Base plate for high-voltage TV chassis, punched from Taylor Canvas Melamine Laminate, has high dielectric strength and arc resistance.



Insert in face of golf club, made of Taylor Vulcanized Fibre, withstands severe impact . . . gives long-lasting, long-hitting surface.

TAYLOR FABRICATING FACILITIES

Your production can be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts to your specifications. Efficient, modern facilities are ready to serve you. Get in touch with Taylor about your specific requirements.



Taylor Vulcanized Fibre comes in a variety of forms . . . single and built-up sheets, rolls, strips, rods . . . from which you can manufacture thousands of kinds of parts at economical cost.

Call on Taylor Vulcanized Fibre *for thousands of product uses*

One of the most versatile of materials, Taylor Vulcanized Fibre is constantly finding new applications in new product designs. And for good reason. For this time-proved material affords an unequalled combination of economy, machinability and performance characteristics.

It's light weight and tough. It resists severe wear and abrasion. It withstands heavy impact without denting, cracking or deformation. It's a good electrical insulator. Its flexibility makes it readily formed into a variety of shapes. Its ease of punching, stamping, drilling and cutting offers real economies in production.

The variety of grades in which Taylor Vulcanized Fibre is available gives designers a broad range from which to choose the characteristics best fitted to the job at hand.

Commercial Grade—a general-purpose material with high strength and density.

Bone Grade—best machining properties, high impact strength.

Taylor Insulation (Fish Paper)—tough, abrasion-resistant, readily formed, high dielectric strength.

Trunk and Case Fibre—excellent surface finish, good bending and bonding qualities . . . in a variety of colors.

Super White—high-purity grade with smooth finish.

Abrasive Backing—grades for drum and discs, with high flexibility, resiliency, toughness.

Flexible Fibre—soft grade for gaskets.

Built-up Fibre—multiple plies bonded to thickness of several inches.

This versatile family of materials comes in the largest sheet size in the industry . . . in rolls, strips and turned rods . . . to give you the maximum utilization of the material you purchase. Ask your Taylor representative to stop in for a discussion on how you can profitably use Vulcanized Fibre in your products.

color tv controls

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3. TYPES—carbon and wirewound with and without attached switch.
4. MOUNTINGS—conventional bushing, twist ear and snap-in bracket for printed circuits.
5. TERMINAL STYLES—for conventional soldering, printed circuits and wire wrap.
6. COMBINATIONS—an endless variety of tandems, both single and dual shaft.

A CTS control can be tailored to your specific requirement.

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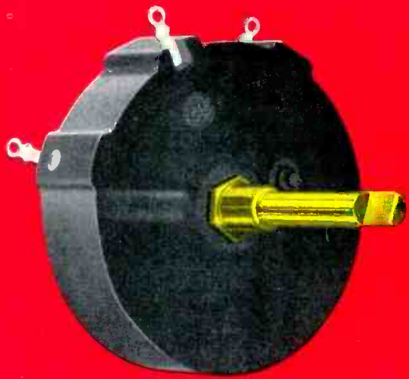
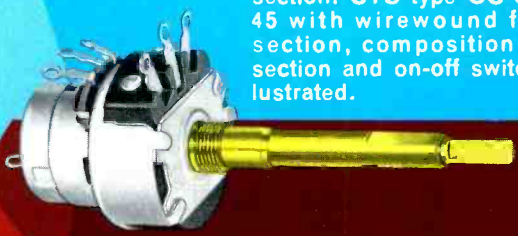


High voltage control for focus applications. Rated up to 5,000 volts DC across end terminals and 2 1/2 watts depending on total resistance. Will operate up to 15,000 volts DC above ground when mounted on insulated panel. CTS type 85.

Miniature 3/4" "dime size" composition control. Conserves panel space at price comparable to larger size bushing mounted controls. CTS type 70.

1 1/8" diameter composition control for applications where ratings up to 3/4 watt required. CTS type 35.

Concentric shaft tandem control with conventional bushing mounting. Designed for front panel dual knob applications, such as contrast and volume. Available in various combinations of composition or wirewound front and rear sections with or without on-off switch attached to rear section. CTS type GC-C252-45 with wirewound front section, composition rear section and on-off switch illustrated.



Ear mounted composition control. Simply twist two ears for rigid mounting. Eliminates bushing and mounting hardware. Available with shafts for knob operation or for preset applications with insulated or metal shaft. CTS type P45 with metal shaft illustrated.

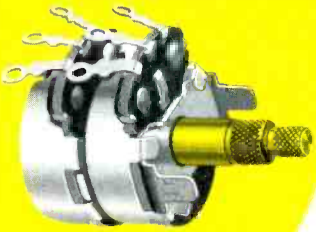
Ear mounted two watt wirewound available with or without center tap. CTS type P-254 with tap illustrated.

Four watt wirewound control available with or without center tap. CTS type 27 with tap illustrated.

Higher Wattage Carbon Controls With Exceptional Stability Available

- **ONE WATT:** Entire 45 series 15/16" diameter line available with 90 series special one watt military resistance elements.
- **TWO WATT:** Entire 35 series 1 1/8" diameter line available with 95 series special two watt military resistance elements.

Ear mounted tandem for preset applications. Combines panel space saving features of a concentric tandem with the economy of an ear mounted unit. Available in various combinations of composition or wirewound front and rear sections. CTS type P-C2-45 with composition front and rear sections illustrated.



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CTS also makes a complete line of controls for military, black and white TV, radio and other commercial applications. Consultation without obligation available for **all** your control applications. Write for complete catalog TODAY.

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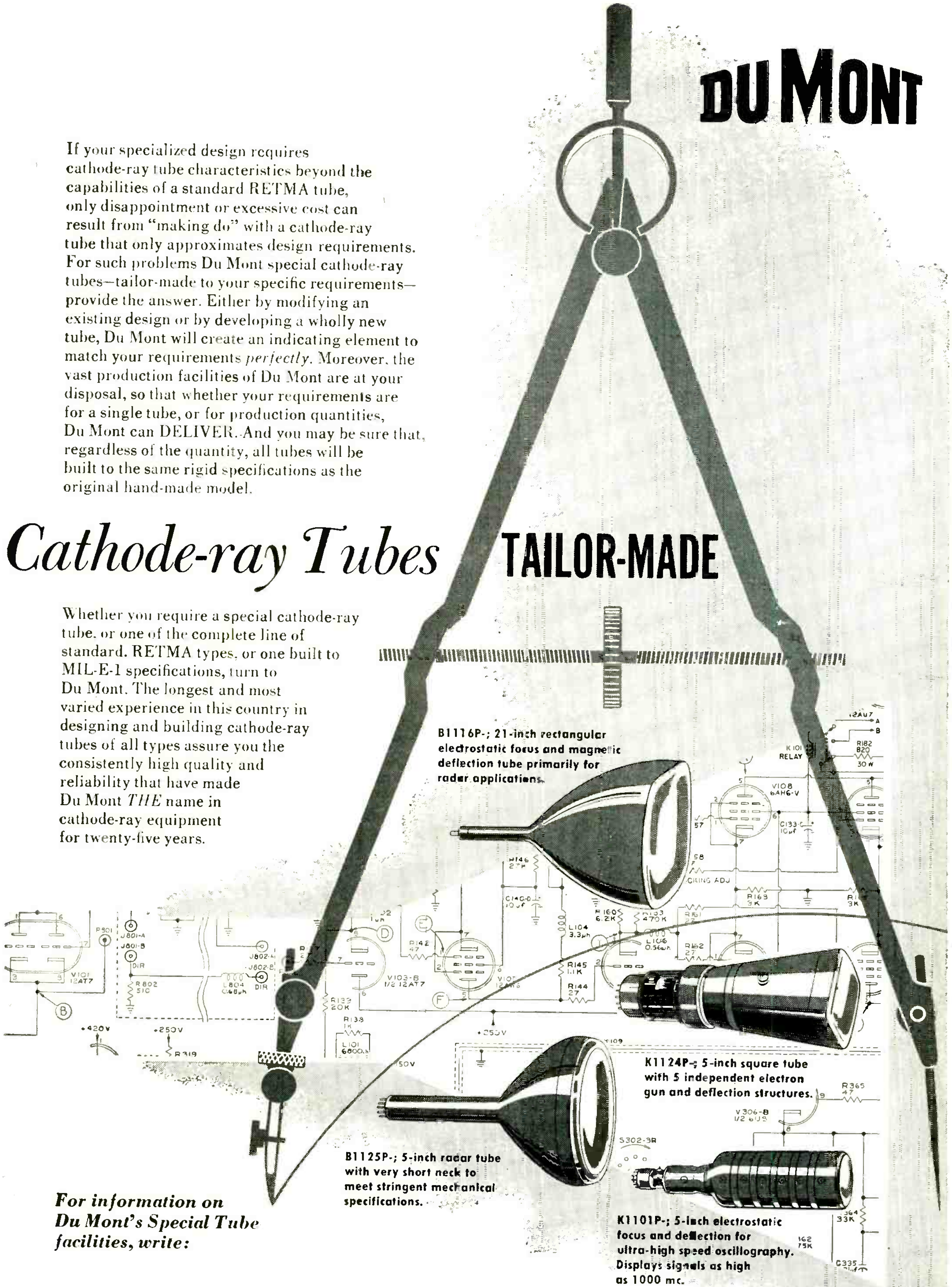
If your specialized design requires cathode-ray tube characteristics beyond the capabilities of a standard RETMA tube, only disappointment or excessive cost can result from "making do" with a cathode-ray tube that only approximates design requirements. For such problems Du Mont special cathode-ray tubes—tailor-made to your specific requirements—provide the answer. Either by modifying an existing design or by developing a wholly new tube, Du Mont will create an indicating element to match your requirements *perfectly*. Moreover, the vast production facilities of Du Mont are at your disposal, so that whether your requirements are for a single tube, or for production quantities, Du Mont can DELIVER. And you may be sure that, regardless of the quantity, all tubes will be built to the same rigid specifications as the original hand-made model.

Cathode-ray Tubes TAILOR-MADE

Whether you require a special cathode-ray tube, or one of the complete line of standard RETMA types, or one built to MIL-E-1 specifications, turn to Du Mont. The longest and most varied experience in this country in designing and building cathode-ray tubes of all types assure you the consistently high quality and reliability that have made Du Mont *THE* name in cathode-ray equipment for twenty-five years.



For information on Du Mont's Special Tube facilities, write:

TECHNICAL SALES DEPARTMENT, ALLEN B. DU MONT LABORATORIES, INC. 760 BLOOMFIELD AVENUE, CLIFTON, NEW JERSEY

SEE THE DU MONT EXHIBIT AT THE IRE SHOW BOOTHS 264-266-268

(SEE NEXT PAGE)

IDENTICAL AMPLIFIERS IN NEW PRECISION CATHODE-RAY OSCILLOGRAPH

THE DU MONT TYPE 340

- Identical, sensitive X- and Y-amplifiers
- Amplifier response dc to 100 kc
- All potentials regulated for stability
- Hard-tube linear sweeps with beam gate
- Mono-accelerator cathode-ray tube for distortionless presentation

Yes, and also precision, simple operation, ruggedness, reliability, ease of maintenance all characterize the *new* Du Mont Type 340 which can well take its place as the oscillograph for those who require the *best* for their important studies.

Identical amplifiers, unexcelled in other commercial instruments, make the Type 340 a powerful tool for measuring electrical phase or mechanical resonance. Controls can be adjusted for less than 1° relative phase shift between amplifiers below 100 kc. Distortion in amplifiers and sweeps is negligible. D-C stability sets new standards. Shifts in level are scarcely observable, even over long periods of operation. The Type 340 truly fits the needs of the discriminating engineer and scientist.

For further information on the Type 340 write to: Technical Sales Department, Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Avenue, Clifton, New Jersey.

In less than a year you have seen a complete new line of *precision* instruments by Du Mont typified by:

Type 336 CRO	dc to more than 20 mc, high brightness
Type 329 CRO	dc to 10 mc, high voltage
Type 327 CRO	dc to 5 mc, precision calibration
Type 324 CRO	microvolt sensitivity, dc to 300 kc
Type 330	universal electronic switch: dc to 15 mc
Type 300	precision time calibrator

***And now* the Type 340 with identical amplifiers, dc to 100 kc — PRICE $335.00**

TECHNICAL SALES DEPARTMENT
ALLEN B. DU MONT LABORATORIES, INC.,
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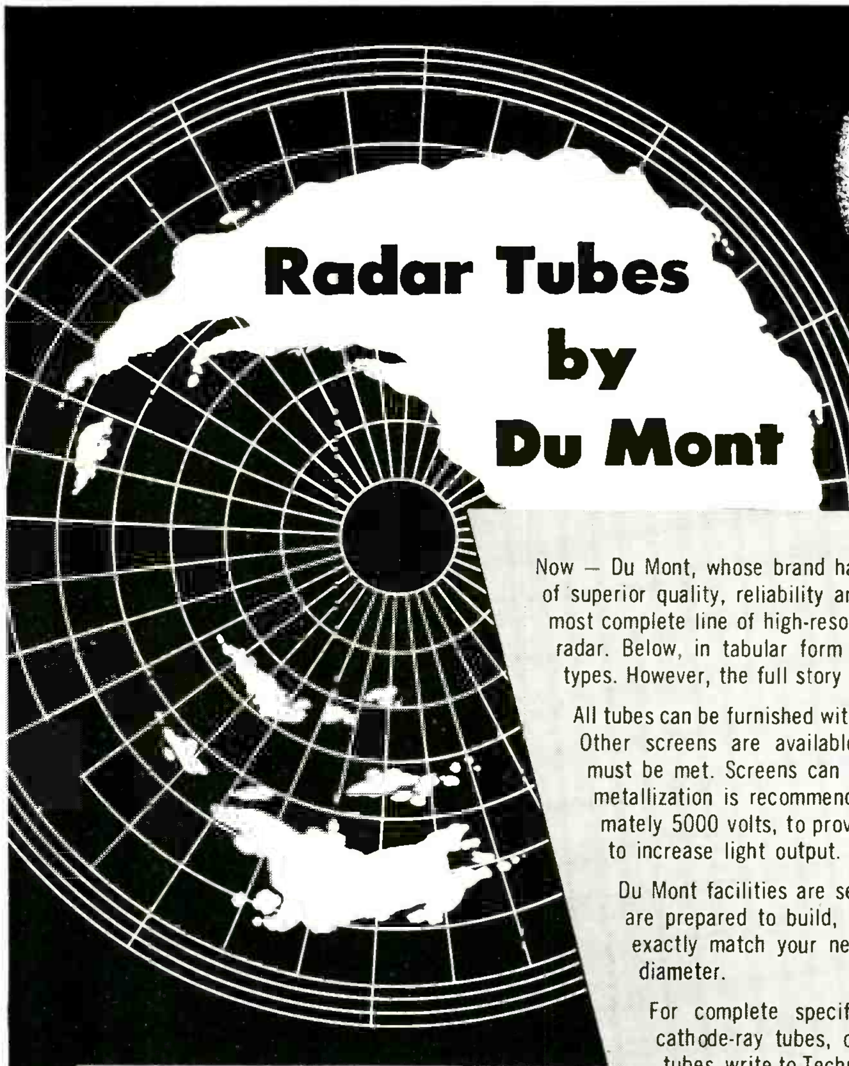
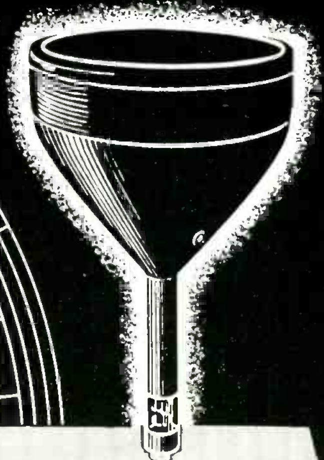
DU MONT

SEE THE DU MONT EXHIBIT AT THE IRE SHOW BOOTHS 264-266-268

(SEE NEXT PAGE)



Radar Tubes by Du Mont

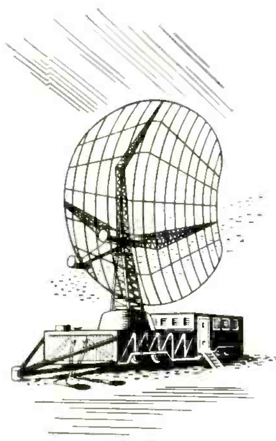


Now — Du Mont, whose brand has long been the hallmark of superior quality, reliability and performance, offers the most complete line of high-resolution cathode-ray tubes for radar. Below, in tabular form is listed a cross-section of types. However, the full story cannot be told here.

All tubes can be furnished with P7, P14, P19 or P21 screens. Other screens are available where special requirements must be met. Screens can be metallized on any tube, and metallization is recommended for operation above approximately 5000 volts, to provide optimum screen stability and to increase light output.

Du Mont facilities are set up to work closely with you. We are prepared to build, to your specifications, tubes which exactly match your needs in any size up to 30-inches in diameter.

For complete specifications on these or any Du Mont cathode-ray tubes, or for information on Du Mont special tubes, write to Technical Sales Department at address below.



Typical Radar Tubes Available From Du Mont

(Not a Complete Listing)

	TUBE TYPE	LENGTH (INCHES)	TYPICAL ANODE VOLTS	NO. LINES IN USEFUL DIAM	TYPICAL LINE WIDTH (INCHES)
ELECTROSTATIC FOCUS Magnetic Deflection	5AHP—	11⅛	7,000	550	0.008
	7ABP—	13¼	7,000	650	0.009
	10UP—	17⅝	10,000	900	0.01
	10WP—	16 15/16	10,000	650	0.014
	12ABP—	18⅜	10,000	700	0.016
	B1116P— (Rectangular)	23⅜	16,000	700	0.02
MAGNETIC FOCUS Magnetic Deflection	B1125P—	7 (seated)	8,000	450	0.01
	5FP-A	11⅛	5,000	450	0.01
	7BP—	13¼	7,000	550	0.01
	10KP—	17⅝	9,000	650	0.015
	12DP-A	19⅝	7,000	550	0.018
	12SP—	18¾	9,000	625	0.018
ELECTROSTATIC FOCUS Electrostatic Deflection	K1233P—	18	8,000	400	0.015
	K1137P— (Dual Beam)	24⅞	7,500	725	0.015
	K1187P—	22½	10,000	625	0.017

DU MONT

TECHNICAL SALES DEPARTMENT
ALLEN B. DU MONT LABORATORIES, INC.
760 BLOOMFIELD AVENUE, CLIFTON, NEW JERSEY

SEE THE DU MONT EXHIBIT AT THE IRE SHOW BOOTHS 264-266-268

(SEE NEXT PAGE)

Yours for the asking... up-to-date listing of New Instruments by

DU MONT

We have been adding so rapidly to our new line of high-precision instruments, that we know any Du Mont catalog you may have is obsolete. A new 8-page quick-reference catalog that outlines in greater detail the new Du Mont line of high precision instruments is just off the press.

Get your copy now by writing to us at the address below.

Meanwhile, here is a brief review of these great new instruments, together with some of their more important characteristics.

TYPE	BANDWIDTH	SWEEP RANGE	SENSITIVITY	RECORDABLE WRITING RATE	APPLICATIONS
323	DC to 30% down at 10 MC	1 sec to 0.1 usec per major division	0.2 to 400 volts full scale	2.8 in/usec	Medium voltage, wide band, high-precision, quantitative oscillograph
324	DC to 30% down at 300 KC	1 sec/inch to 1 usec/inch	0.004 to 400 volts full scale	2.8 in/usec	Very high sensitivity (1.33 millivolt/inch) in the low frequency range
327	DC to 30% down at 5 MC	1 sec/inch to 1 usec/inch	.5 to 500 volts full scale	2.8 in/usec	Modest cost, highly linear, precision measurements at medium high frequencies
329	DC to 30% down at 10 MC	1 sec to 0.1 usec/major division	.2 to 400 volts full scale	35 in/usec	High precision, high accelerating potential for the ultimate in high-frequency measurements
340	DC to 30% down at 100 KC	2 to 30,000 cps	25 mv/in p-p	———	Identical X and Y amplifiers with negligible phase shift
341	DC to 30% down at 600 KC	2 to 30,000 cps	125 mv/in p-p	———	Identical X and Y amplifiers with negligible phase shift to 1 megacycle
336	DC to 30% down at 18 MC	1 sec to 0.1 usec/major division	.5 v/major division	35 in/usec	Superior instrument for advanced, precision high frequency measurements

ACCESSORY INSTRUMENTS

And don't forget these new accessory instruments, any of which may be used with *any* cathode-ray oscillograph.

TYPE	APPLICATIONS
300	Crystal-controlled time calibration pulses for use as accurate and dependable time-marker standard
325	TV line selector for converting any cathode-ray oscillograph into a video signal monitor
330	Electronic switch converts any single channel cathode-ray oscillograph to dual-channel or any a-c coupled oscillograph to d-c operation
332	Differential transformer control is complete unit for differential transformer operation
335	Strain gage control for use with any commercial strain-gage

TECHNICAL SALES DEPARTMENT, ALLEN B. DU MONT LABORATORIES, INC., 760 Bloomfield Ave., Clifton, New Jersey

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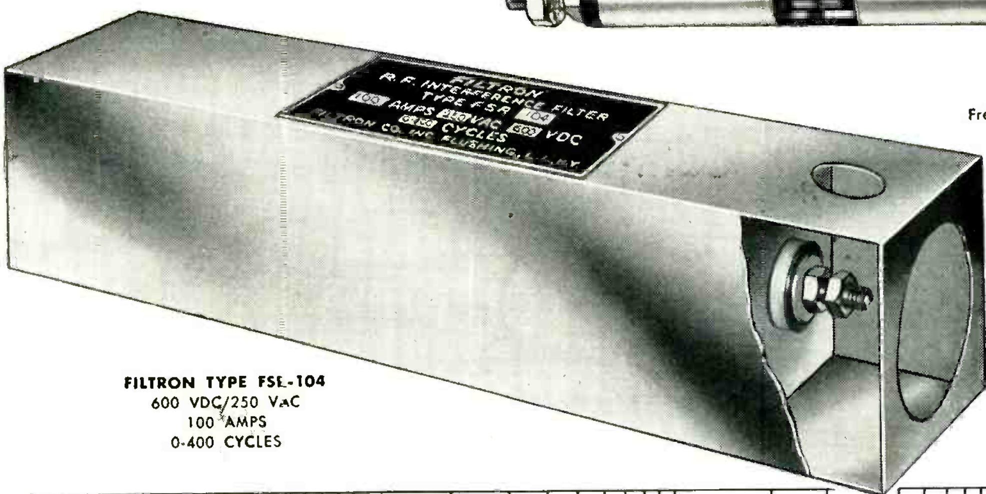
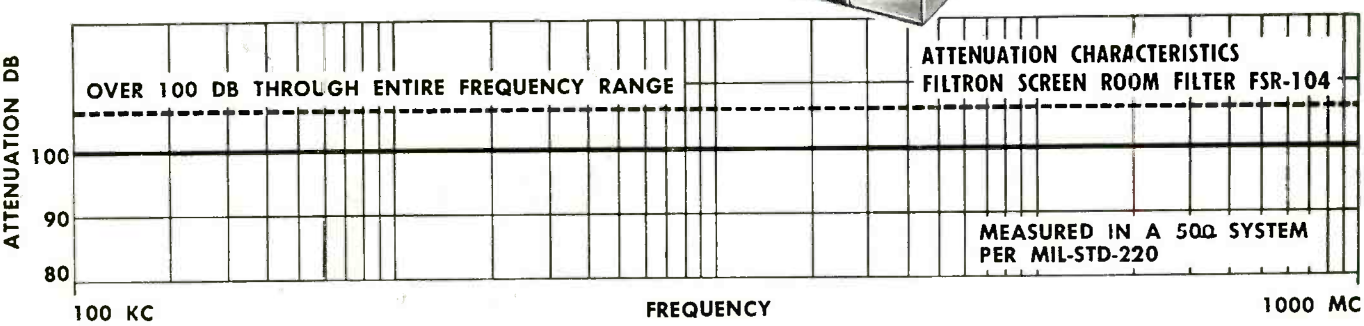
FILTRON

SCREEN ROOM FILTERS

FILTRON TYPE FSR-502
500 VAC/DC
100 AMPS
Frequency Range 1000 to 15,000 MC



FILTRON TYPE FSR-104
600 VDC/250 VAC
100 AMPS
0-400 CYCLES



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RADIO INTERFERENCE FILTER CATALOG

This 20 page catalog contains valuable data on FILTRON RADIO INTERFERENCE FILTERS for SCREEN ROOMS, INDUCTION HEATING EQUIPMENT, DIATHERMY SETS, X-RAY UNITS and other electrical interference producing equipment. Included are illustrated installation recommendations, essential information on applications, attenuation characteristics and mechanical dimensions . . . Your copy gladly sent free upon request.

Screen room manufacturers specify and install FILTRON Screen Room Filters as standard equipment.

FILTRON Screen Room Filters are used in the majority of industrial, government and military screen rooms, to meet the requirements of specification MIL-S-4957, and wherever critical RF measurements are required.

FILTRON has over 40 types of Screen Room Filters available, ranging from 1 Amp to 1000 Amps, 28 VDC to 500 Volt AC/DC, 0 to 1000 cycles. Complete technical information available.

FILTRON RF Interference Filters are also specified in the latest types of Radar, Radio Transmitters, Receivers, Motor Generator Sets, Inverters, Aircraft, Electronic Systems, and numerous other "restricted" equipments.

When you have an RF Interference Filter problem, consult FILTRON—the most dependable name in RF Interference Filters.

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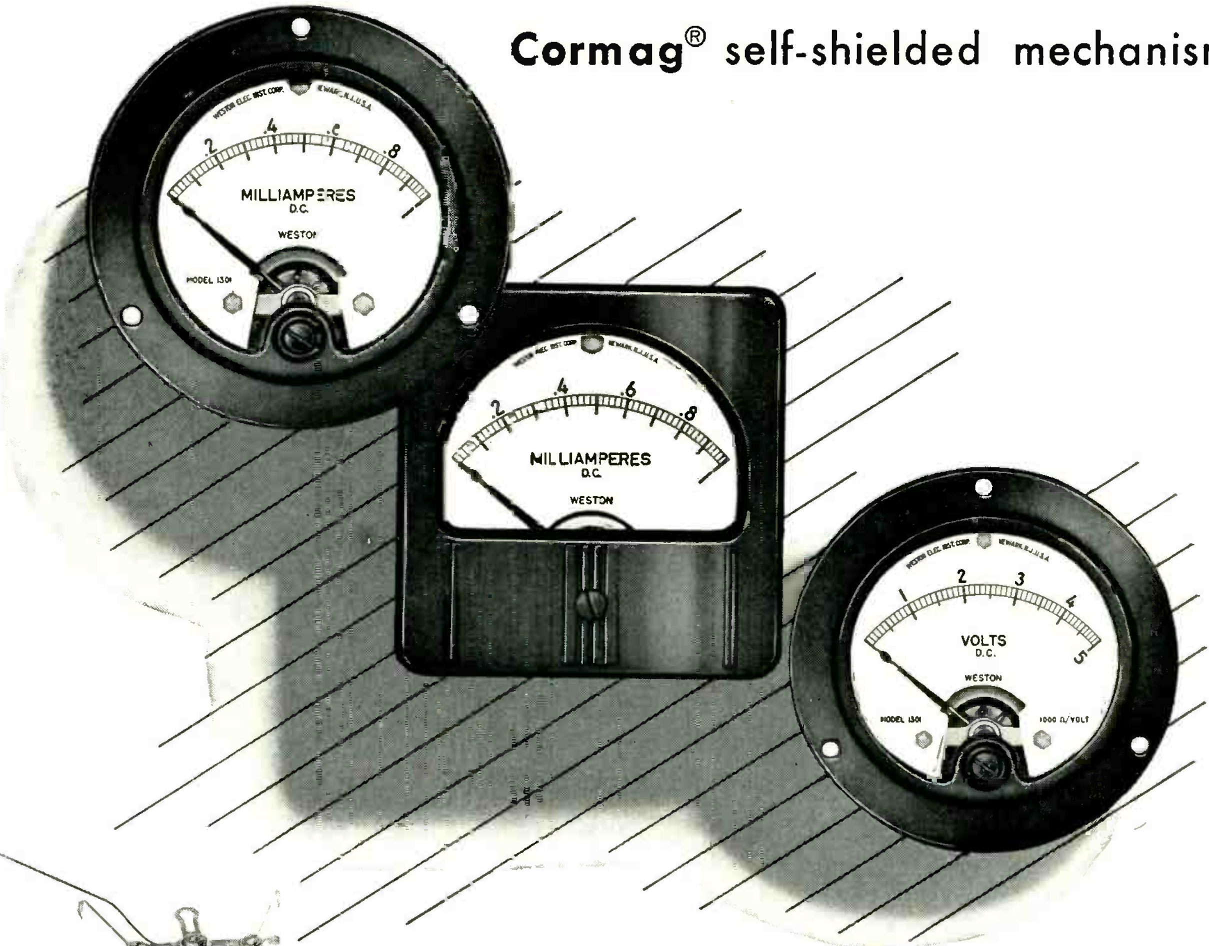
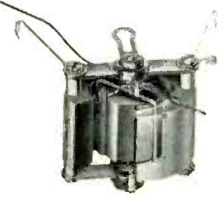
NEW in design concept...in dependability

Weston 1301 line panel instruments with Cormag® self-shielded mechanism





Weston CORMAG® Mechanism (shown in combination cutaway and phantom)

A compact, lightweight permanent magnet moving-coil mechanism, self-shielded from the effects of external magnetic fields.

The 1301 line (3½") furnishes panel instrument users with the added dependability, the mounting facility, and the new economy which CORMAG self-shielded construction provides. These instruments can be mounted on magnetic or nonmagnetic panels interchangeably, and there is no magnetic intereffect of instruments on one another when mounted in close proximity. For complete information, see your local WESTON representative or write...WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.

WESTON instruments

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(YET)

THIS TRANSISTORIZED TELEMETER IS ONLY A "PROGRESS REPORT"

This 3-channel transistorized telemeter although not yet available for sale as standard equipment, is indicative of the advanced thinking of *Bendix-Pacific* engineers and represents another example of this Division's efforts to have new designs available in advance of rapidly expanding instrumentation requirements. This particular unit includes a transmitter and three subcarrier oscillators, all encapsulated as a single plug-in component. Although present development has been confined to the solution of special instrumentation problems, a possible pattern for future telemeters is indicated. The special features of transistorized components — extremely high shock resistance — low heat generation — very low power consumption — small size — light weight — provide design tools for a major advance in instrumentation techniques.

Imagination at ***Bendix-Pacific*** *today is building better products for tomorrow.*

BENDIX ★ PACIFIC ★

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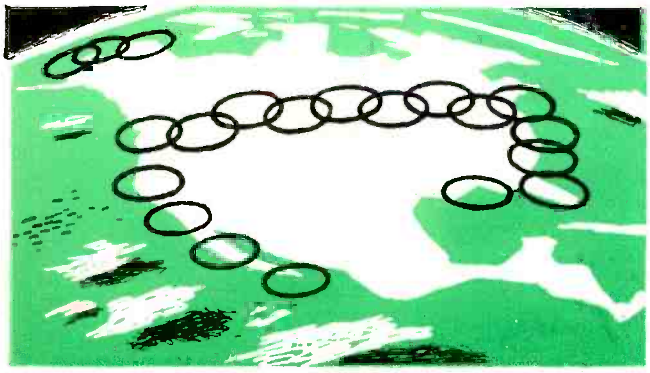
FOR **KLYSTRONS AND TRAVELLING WAVE TUBES**

SPERRY CAN MEET



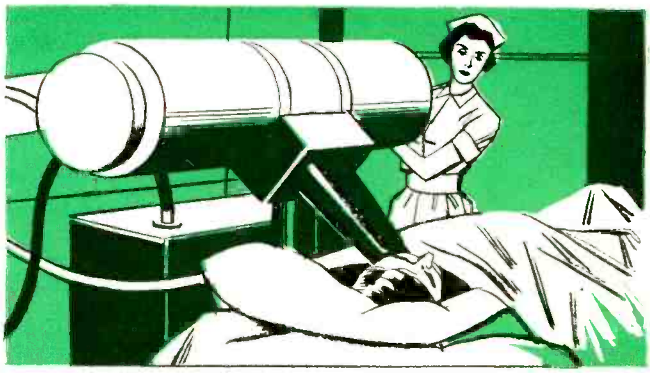
IN RADAR DEFENSE, Sperry's Multi-Megawatt Klystrons hold frequencies 20 to 200 times closer than conventional radar limits, permit obtaining improved information from search radars.

IN GUIDED MISSILES, Sperry's Multi-Megawatt Klystrons make possible more accurate control of missiles, permitting guidance over longer paths.

IN COMMUNICATIONS, Sperry's low powered microwave beam tubes are providing years of trouble-free service at unattended relay stations.

IN CONTINENTAL DEFENSE, Sperry's microwave beam tubes meet the needs of military radars and communications' networks which protect our shores.

IN TELEVISION, present Sperry Klystrons extend TV microwave networks. More improvements in TV transmission are possible with new Sperry microwave beam tubes.



IN MEDICINE, newly developed linear accelerators give promise of improved X-ray treatment.

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YOUR NEEDS

This is the 17th year of continuous development and production of microwave tubes by Sperry. Out of this experience has come a wide range of tubes for today's important microwave uses, covering frequencies from 200 mc. to 40,000 mc., and with power from a few milliwatts to many million watts. Sperry microwave beam tubes meet military and industrial requirements because of their dependability and economy.

Tomorrow's needs of the development engineer in advanced system design will be aided by the specialized knowledge of new microwave beam tube development available at Sperry.

The facilities of the Sperry laboratories, devoted to microwave beam tube and microwave test equipment development, and the new production plant of the Sperry Electronic Tube Division in Gainesville, Florida, are at your service.

IN ATOMIC ENERGY, Sperry's Multi-Megawatt Klystrons provide stable driving power for atom smashers and high energy X-ray devices for scientific research.

IN AIR NAVIGATION, Sperry Klystrons power a military radio system to guide air traffic precisely.

IN UTILITY AND IN INDUSTRIAL USE, Sperry microwave beam tubes permit accurate long distance controls, such as regulating pipe line flow of oil and gas throughout the country.

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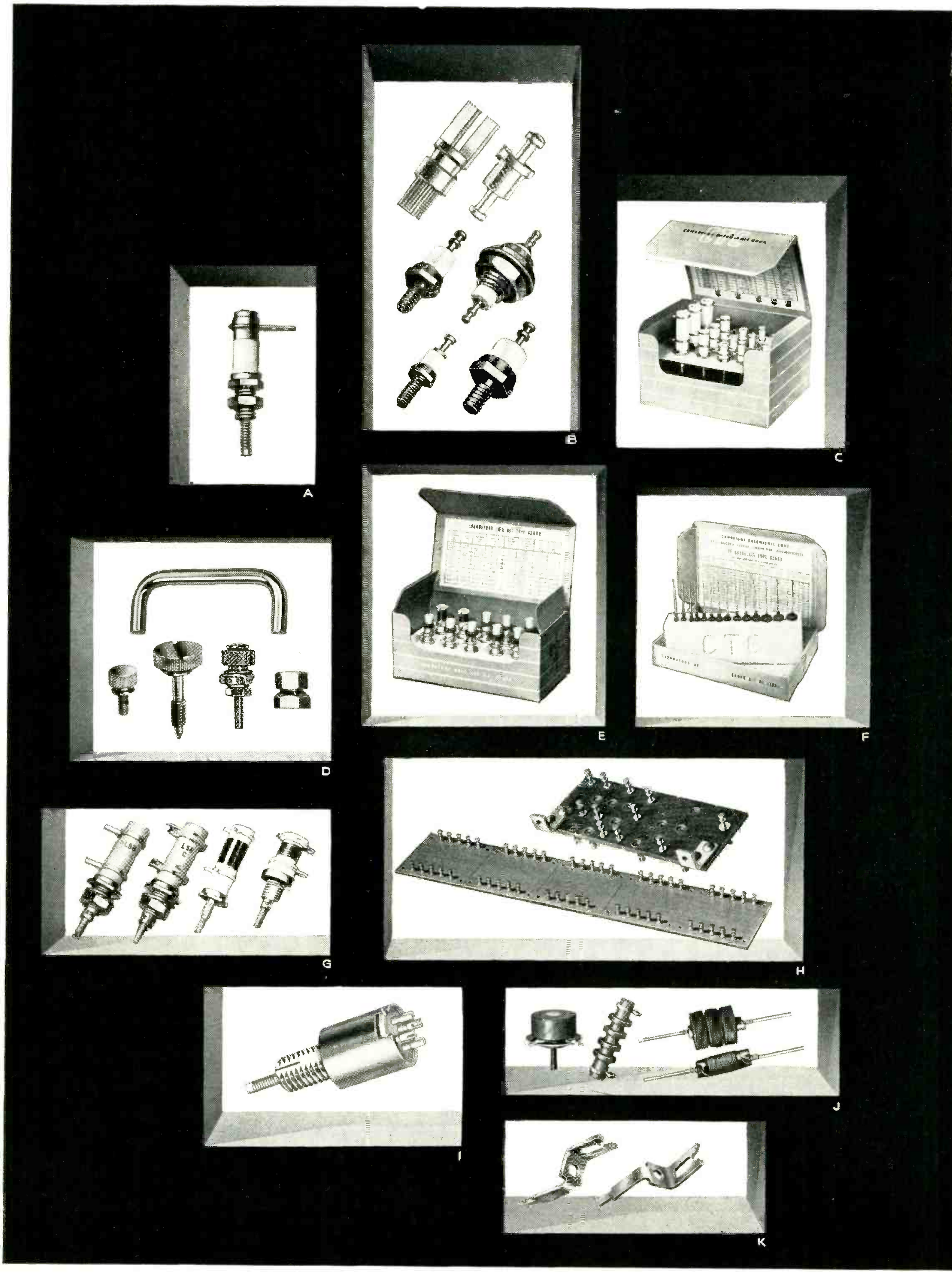
Visit our Booths 351-2-3 at the Radio Engineering Show, March 21-24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One big family with a single thought

Whether you need terminals, clips, coils, chokes, capacitors — or any of a number of electronic components — you can be sure they're right if they're made by CTC.

One continuing basic idea governs the manufacture of every CTC product. And that idea is: *quality control*. We could not guarantee our products as we do without a constant check of numerous details that determine reliable performance. Our quality control engineers see to it that these manufacturing standards are consistently maintained — from close scrutiny of raw materials right through to inspection of finished product.

Pictured here are a number of components available at CTC including our three kits. These components come in standard form and are also custom engineered to meet your particular requirements. We would be glad to give you complete details, including specifications and prices, on any or all CTC units — as well as information on how CTC components can be specially designed to solve your electronic components problems.

You will find it well worthwhile to use components that are *guaranteed*. Write to Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast Manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market Street, San Francisco, California.

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makers of guaranteed electronic components, custom or standard

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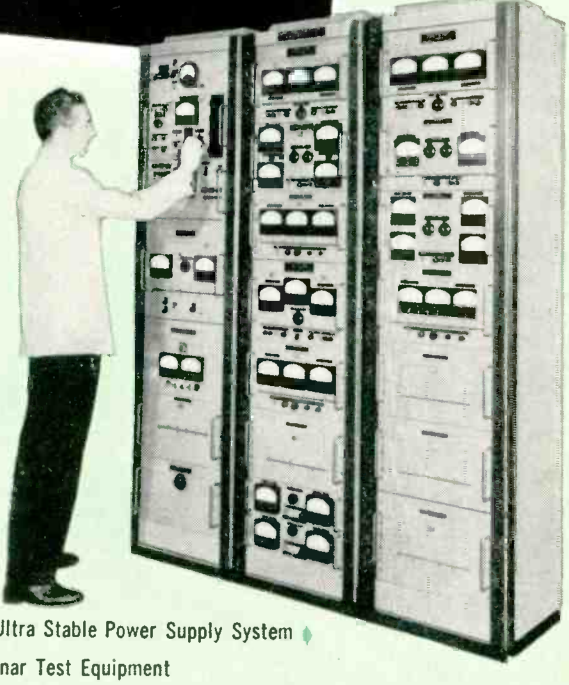
◀ *CTC Components* shown include: A. capacitor; B. standard and insulated terminals; C. coil form kit; D. panel hardware; E. coil kit; F. RF choke kit; G. coil forms and coils; H. standard and custom terminal boards; I. shielded coil form; J. RF chokes; K. diode clips.

Want more information? Use post card on last page.

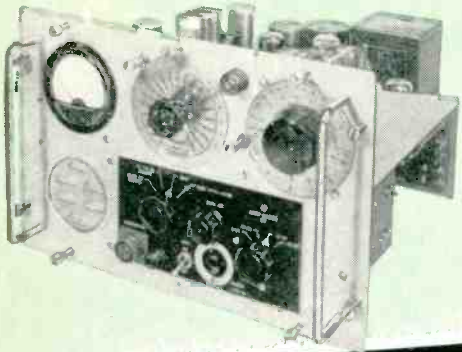
CHATHAM EQUIPMENT DIVISION...

Standard and Custom Constructions

The Equipment Division of Chatham Electronics specializes in the design and manufacture of electronic equipment for government, industrial, communication and research organizations. The types of equipment produced are highly diversified. Typical examples include electronic switches, sonar equipment, test sets, speech amplifiers and modulators, high power pulse generators to 60 megawatts, ultra-stable power supplies, induction heaters, tube production, life test equipment, and many others.



Ultra Stable Power Supply System



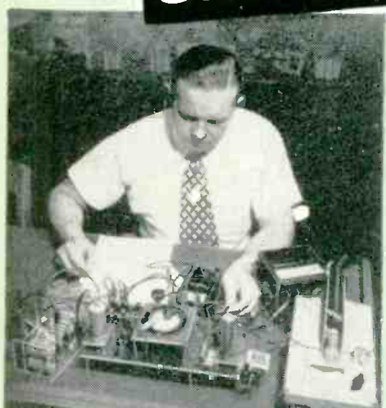
Sonar Test Equipment

Chatham engineers are available for consultation on problems involving custom equipments. For estimates on your requirements . . . call or write.

CHATHAM RADIAC DIVISION...

Pioneer Developer and Producer of Atomic Energy Instrumentation Equipment

The Chatham Radiac Division is a pioneer developer of Atomic Energy Instrumentation Equipment of unusual design. For example, portable and field equipment of this type was formerly battery powered. Battery life, corrosion and logistics were a constant problem. By the application of new methods of power generation, batteries are no longer required. Further, in some cases even the tubes are replaced by a compact, trouble-free electro-mechanical amplifier. Similar advances are reflected in Chatham Radiac Detector Chargers, Rate Meters, Dosimeters, Influence Generators, etc.



Operating tests of all Chatham Radiac Chargers employ Dosimeters of various manufacture.

Model XA-100 Radiac Detector Charger — compact, easy to use, this unit is completely self contained . . . requires no batteries.

CHATHAM RECTIFIERS

Type 1Z2 A high voltage vacuum rectifie for constant supply circuits. Filament 1.25 volts, 275 ma. Peak inverse anode voltage 15,000, aver. anode current 1.5 ma.

Type 3B25 Half wave, Xenon Rectifier. Wide ambient range −75° to +90° C. Filament 2.5 volts 5.0 amp. Peak inverse anode voltage 4500. Aver. anode current 0.5 amp.

Type 3B28 Half-wave, Xenon rectifier. Wide ambient range of −75° to +90°C. Filament 2.5 volts, 5.0 amps. Peak inverse anode voltage 10,000. Aver. anode current 250 ma.

Type 4B32 Half-wave, Xenon rectifier. Wide ambient range −75° to +90°C. Filament 5 volts, 7.5 amps. Peak Inverse anode voltage 10,000. Aver. anode current 1.25 amp.

Type 5R4WGY Full wave rectifier ruggedized to stand 980 g shock. Max. inverse voltage 2800 volts at 165 milliamperes or inverse voltage 2400 volts at 275 milliamperes.

Type 5R4WGA Same as 5R4WGY but designed to operate at full inverse ratings up to 40,000 ft. altitude and at reduced rating to 60,000 ft. altitude.

Type 6H6WGT Ruggedized twin diode with octal base. Heater 6.3 volts 300 ma. Peak inverse anode voltage 465 volts. D.C. output current 8.8 ma. per plate.

Type 6AL5W Ruggedized miniature twin diode. Heater 6.3 volts, 0.3 amp. Peak inverse anode voltage 330. D.C. output current per plate 9 ma. max.

Type 5R4WGB A reliable version of the 5R4WGA designed and manufactured to MIL-E-1B reliable tube specifications.

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Booths 474, 476 and 478

ELECTRONIC AVENUE

Kingsbridge Armory

New York City

March 21st to 24th, 1955

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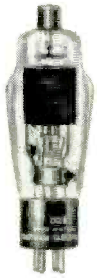
CHATHAM

CHATHAM THYRATRONS

Type 2D21 Xenon filled, shield grid thyratron for relay-pulse and grid controlled rectifier service. Heater 6.3 volts, 0.6 amp. Peak inverse anode voltage 1300, average anode current 100 ma.

Type 2D21W Similar to 2D21 except ruggedized to conform to MIL-E-1B specifications.

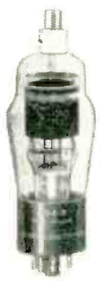


Type 3C23 Mercury Vapor Argon filled thyratron for grid controlled rectifier service. Wide ambient temperature tolerance. Medium 4 pin phenolic base — Medium metal cap. Heater 2.5 volt 7.0 amperes; Peak inverse anode voltage 1250 volts; Average anode current 1.5 amps.

Type 323B Same as 3C23 but has medium shell 5 pin base and small top cap.

Type 2050 Xenon filled, shield grid thyratron for grid controlled rectifier service. Heater 6.3 volts, 0.6 amp. Peak inverse anode voltage 1300, average anode current 100 ma.

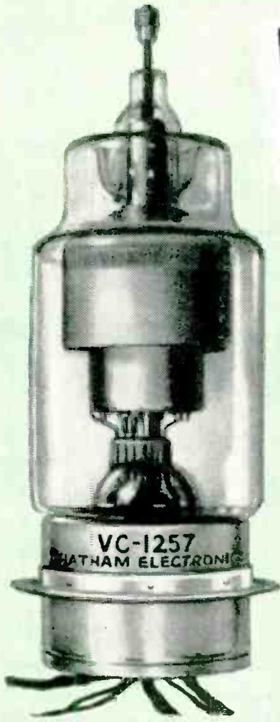
Type 2050W Similar to 2050 except ruggedized to conform to MIL-E-1B specifications.

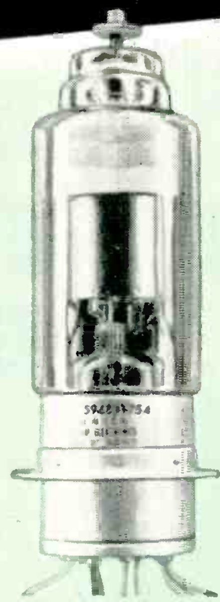


Type 394-A Mercury vapor and Argon filled thyratron for grid controlled rectifier service. Wide ambient temperature tolerance. Heater 2.5 volts, 3.2 amps. Peak inverse anode voltage 1250, aver. anode current 640 ma.

CHATHAM HYDROGEN THYRATRONS...

Chatham Hydrogen Thyratrons are the product of many years of concentrated experience in this specialized field. Embodying the most advanced developments in the art, many of which were pioneered by Chatham, these tubes offer uniformly high performance when employed in the generation of pulse voltages in the order of micro-seconds.





Type VC-1257 Hydrogen filled, zero bias thyratron with hydrogen generator for generation of pulse power up to 33 megawatts.

Type 5948/1754 Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 12.5 megawatts.

Type 5949/1907 Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 6.25 megawatts.

Type 5C22 Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 2.6 megawatts.

Type VC-1258 Zero bias miniature hydrogen thyratron for the generation of peak pulse power up to 10 KW.

ELECTRICAL DATA*

Type	VC-1258	5C22	5949/1907	5948/1754	VC-1257
Maximum Peak Foward Anode Potential	1000 volts	1600 volts	25000 volts	25000 volts	33000 volts
Maximum Peak Anode Current	20 amps	325 amps	500 amps	1000 amps	2000 amps
Maximum Average Anode Current	0.05 amps	0.200 amps	0.50 amps	1.0 amps	2.0 amps
Maxiumum Heating Factor (epy x prr x ib)	1.0x10⁸	3.2x10⁹	6.25x10⁹	9.0x10⁹	20.0x10⁹
Nominal Filament Power	12.6 watts	67 watts	95 watts	190 watts	230 watts
Hydrogen Reservoir	No	Yes	Yes	Yes	Yes

*More detailed information on electrical and mechanical data will be supplied on request.

TWIN POWER TRIODES...

Type 6336 Low mu, high perveance twin power triode for use as a series regulator tube in D.C. power supplies. Plate Dissipation 30 watts per sect.; Amplification Factor 2.7; Plate Resistance 250 ohm per sect.; Plate Current 165-200 ma per sect.; Heater 6.3 volts 4.75 amps total for both sections.

Type 6394 Same as Type 6336 with 26.5 volt 1.25 amp. heater.

Type 6AS7G Low mu, high perveance twin power triode for use as a regulator tube in D.C. Power Supply Units. Plate dissipation 13 watts per sect.; Amp. Factor 2.0 per sect.; Plate Res. 280 ohms per sect.; Heater 6.3 volts 2.5 amperes total for both sections.

TYPE 6520 Characteristics same as 6AS7G but intended for applications where utmost reliability is required in respect to triode balance, absence of excessive plate current drift and high grid to plate insulation.

Type 5594 Xenon filled thyratron. Operates in ambient temperatures from −55° to +90°C. Filament 2.5 volts, 5 amps. Peak inverse anode voltage 4500. aver. anode current 0.5 amp.

Type 884 Argon filled thyratron for use as sweep circuit oscillator in CRT circuits. High stability. Heater 6.3 volts, 0.6 amp. Peak forward anode voltage 300, aver. plate current 75 ma.

Type 885 Similar to Type 884 except heater rating of 2.5 volts, 1.5 amp. Both the 884 and 885 are suitable for grid controlled rectifier applications as well as sweep circuit oscillators.

Type 395-A A cold cathode thyratron. Requires no filament supply. For grid controlled rectifier and relay applications. Max. D.C. anode voltage 150, Max. anode current 10 ma.

Type 359-A Cold cathode thyratron. No filament supply needed. Suitable for grid controlled rectifier and relay applications. Max. D.C. anode voltage 180, max. anode current 12 ma.

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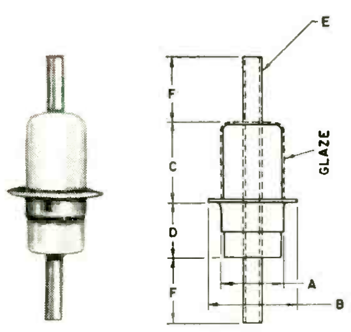
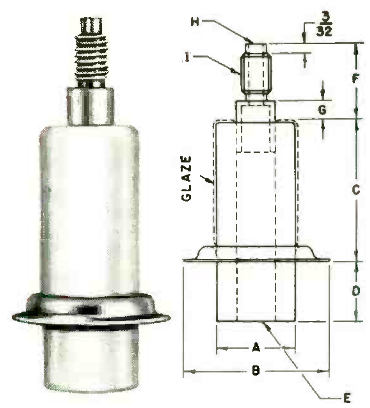
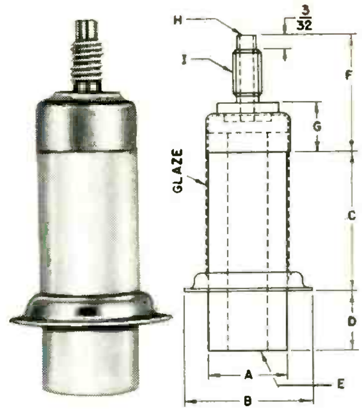
ADVAC CERAMIC-TO-METAL HERMETIC SEALS

...withstand temperatures to 1400°F **...pressures** to 2000 p.s.i.

ADVAC Hermetic Seals are the result of a new metallizing process that actually integrates the metal coating into the ceramic body. This bonding "by integration" effects a seal that is virtually immune to thermal shock, withstands far higher temperature and pressure. ADVAC Seals are readily brazed or soldered to metal parts. Call, write or wire for details!







DIMEN.	PART NO. 187-A	PART NO. 250-A	PART NO. 312-A	PART NO. 375-B	PART NO. 500-B	PART NO. 750-B	PART NO. 1000-B	PART NO. 375-C	PART NO. 500-C	PART NO. 750-C	PART NO. 1000-C
A	3/16	1/4	5/16	3/8	1/2	3/4	1	3/8	1/2	3/4	1
B	5/16	3/8	7/16	11/16	13/16	1-1/4	1-1/2	11/16	13/16	1-1/4	1-1/2
C	3/16	5/16	7/16	1/2	1	1-1/8	1-1/4	5/8	7/8	1	1-1/8
D	1/8	1/4	1/4	3/16	3/8	3/8	3/8	3/16	3/8	3/8	3/8
E	.060x.010	.075x.010	.075x.010	7/32	1/4	3/8	1/2	7/32	1/4	3/8	1/2
F	3/16	1/4	5/16	9/16	9/16	11/16	11/16	11/16	11/16	27/32	27/32
G				3/16	3/16	7/32	7/32	19/64	19/64	23/64	23/64
H				5/64	3/32	3/32	3/32	5/64	3/32	3/32	3/32
I				8/32	10/32	1/4-28	3/8-24	8/32	10/32	1/4-28	3/8-24

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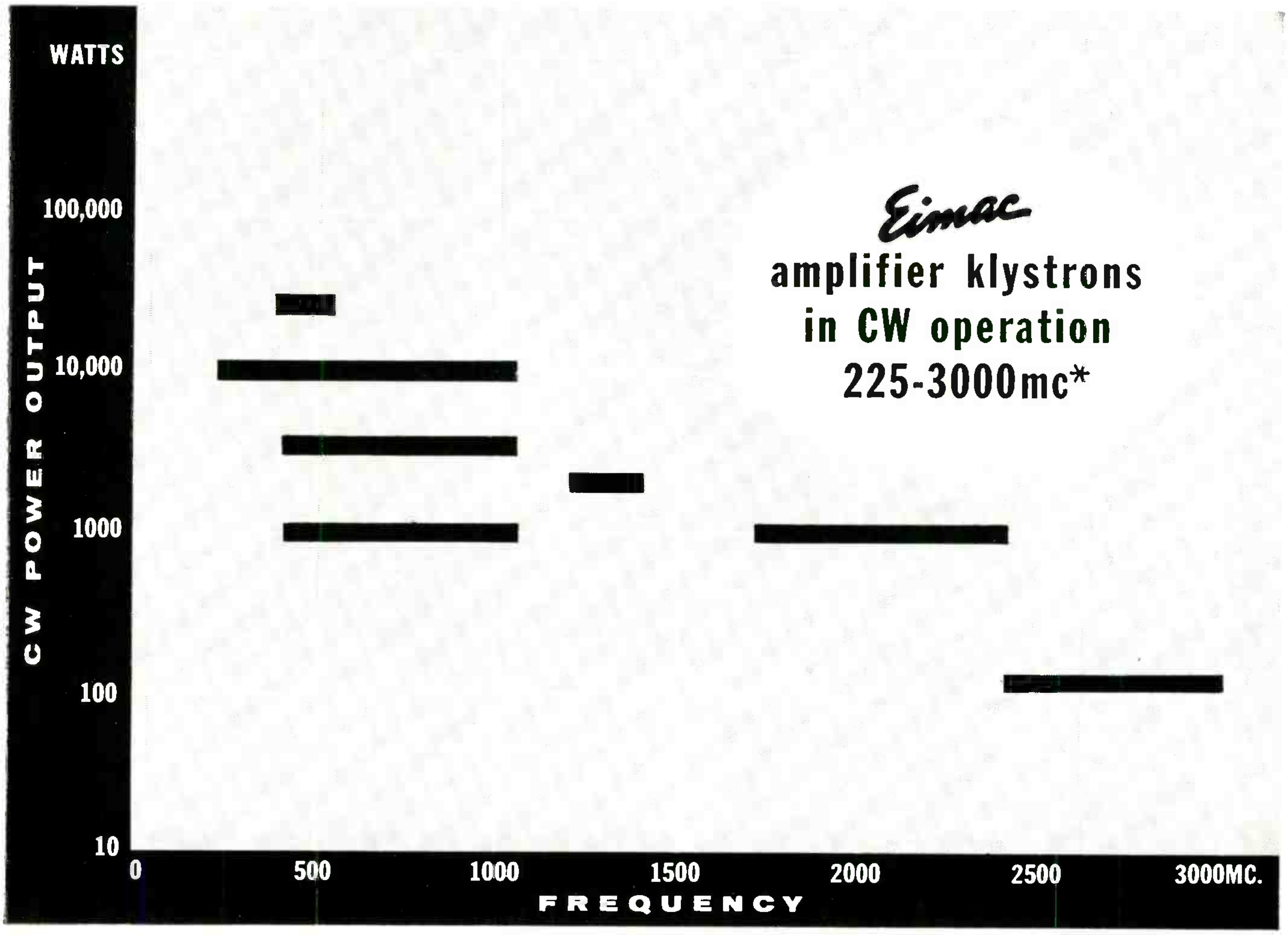

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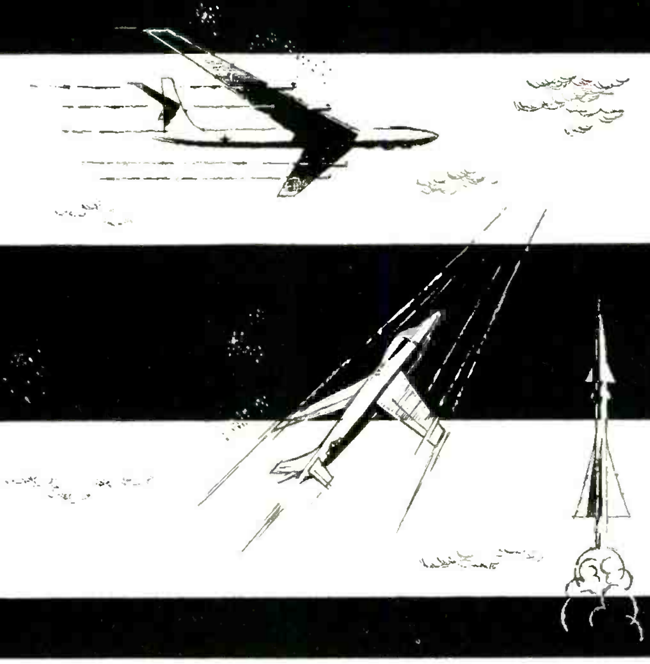

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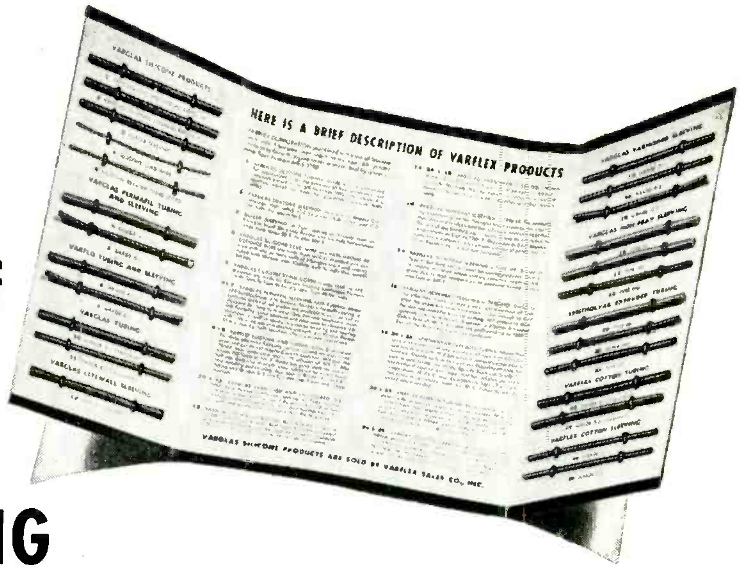

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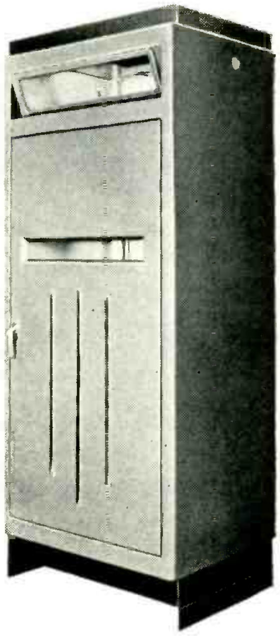

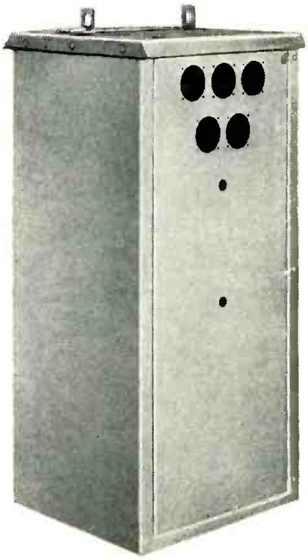

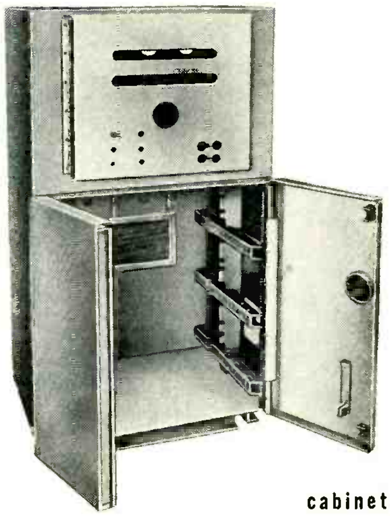

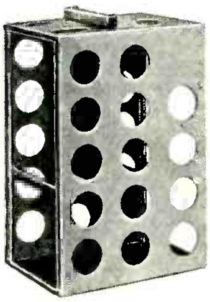

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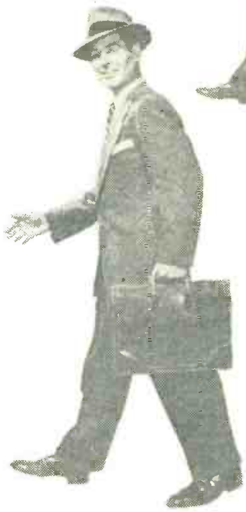

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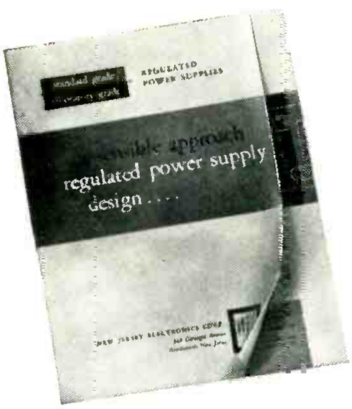

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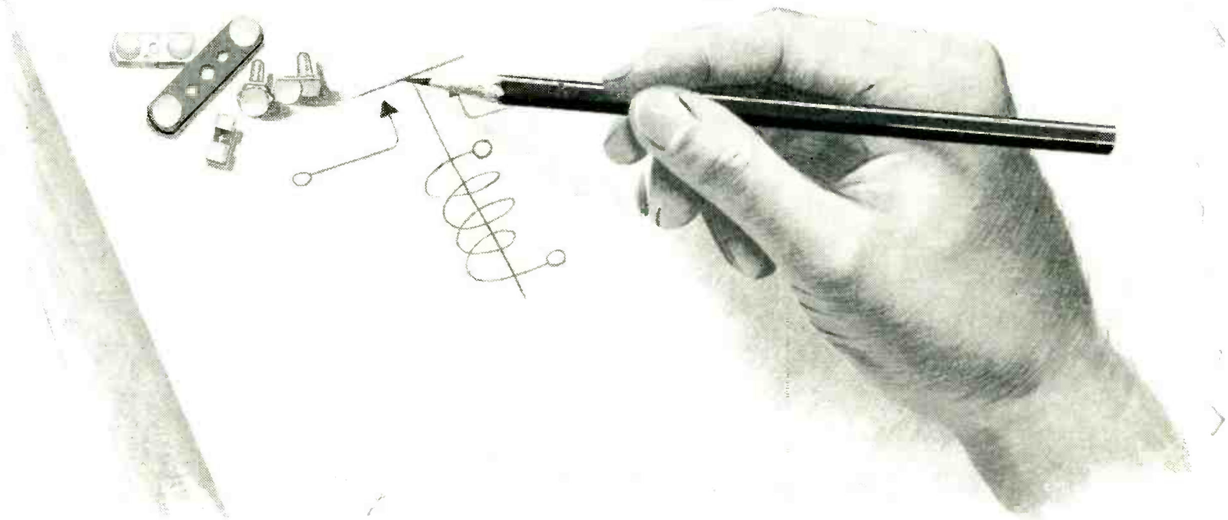

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W. W. MacDONALD, Editor

MARCH • 1955

CROSS TALK

▶ **FRONTIERS** . . . Forward scatter of radio waves, an increasingly popular topic at meetings devoted to propagation theory, appears to be what prewar amateurs experienced on 5 and 2½ meters. Back in the mid-thirties they noted that such signals sometimes go far beyond the optical horizon.

How far they go and how strong they are at extreme distances is being established by Bell Labs, government engineers and others working with high power at much higher frequencies. One experimental path with predicted attenuation of 700 db produced actual loss of only 75 to 82 db at 3,700 mc. The smooth spherical earth with a standard atmosphere, classical basis of propagation computations, is being pushed back on the shelf by practical communications planners.

All this may eventually have a profound effect upon utilization of the spectrum. Permission recently granted for experimental use of inactive uhf television broadcast frequencies for relay tests between Florida and Cuba is one possible straw in the wind.

▶ **QUOTE** . . . Back in May 1953 we commented on the color-television timetable as follows:

"The public is not now waiting with bated (we misspelled it 'baited'!) breath for color.

"Industry will build color sets as soon as it can do so and make a dollar.

"The broadcasters will expand their service in precise proportion to advertising support.

"Premature pressure can do both the public and the industry a disservice. Even after all technical problems are solved it will take time and orderly economic processes to superimpose color on top of the present monochrome system."

All of this seems just as valid today, nearly two years later.

▶ **PROJECTITIS** . . . Much has been written about the difficulties of directing the activities of an engineering project leader, but the project leader himself has rarely broken into print. Here, to show the other side of the coin, is what many of them cry for:

Authority to go with responsibility; there is a very fine line between guidance and direction. Adequate assistance; it is sometimes hard to insert even a razorblade between the words help and dictation. Fewer changes in the basic objective; designs are not readily altered by a mere wave of the verbal wand.

▶ **MINIMUM REQUIREMENTS** . . . Some months ago it was pointed out in these columns that certain types of electronic instruments meeting minimum rather than maximum application requirements might find a market.

Now, in two widely separated cities, we've seen simple analog computers designed to perform the less sophisticated jobs at relatively low cost. One, just going into production, comes with a separate external "problem board." The user clips in his own resistors, capacitors and other components, choosing tolerances to fit each application. Even more interesting, several dissimilar problems can be set up on separate boards and plugged in and out at will without disturbing basic instrument settings, permitting one computer to serve a plurality of engineers.

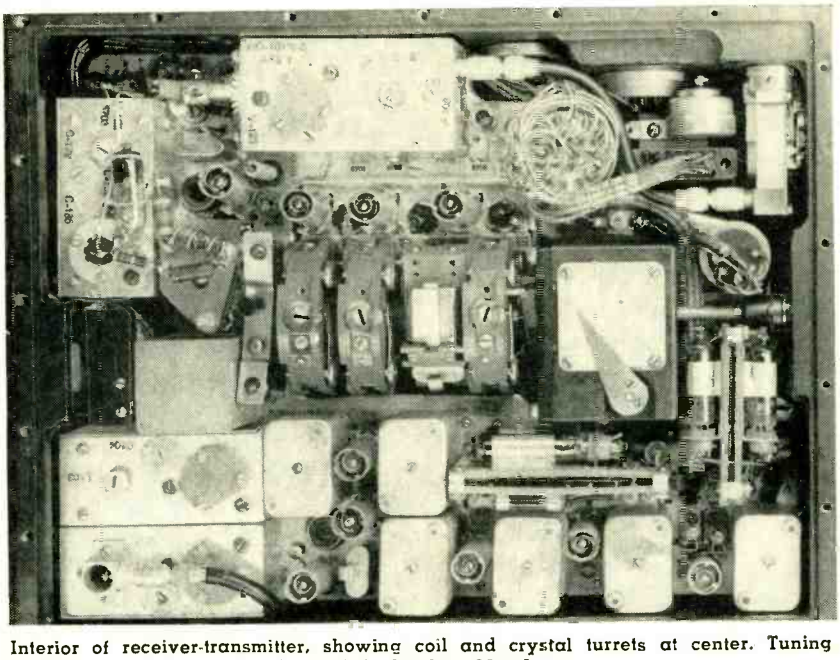
▶ **HOW'S THAT AGAIN?** . . . Slip of the tongue by the owner of a plant who meant to say that engineers sometimes take a very involved approach came out like this:

"Engineers should be more simple-minded."

Two-Way UHF Pack Set

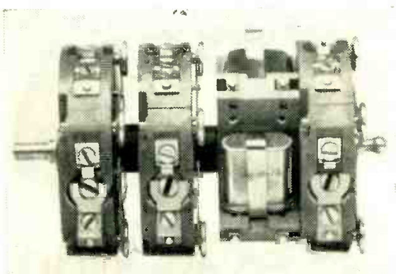
Unique circuit design and construction techniques give compact one-man portable 23-tube transmitter-receiver unit operating on choice of four crystal-controlled frequencies in 225-400-mc band, with all circuits automatically tuned by switch. Subassemblies are dip-soldered. Range is up to 110 miles for ground-to-air work

By DONALD C. JENSEN and MILTON SCHWARTZ
Associate Engineer *Technical Editor*
Air Associates, Inc.,
Electronic Equipment Division
Orange, New Jersey

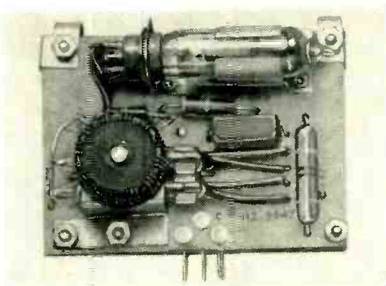


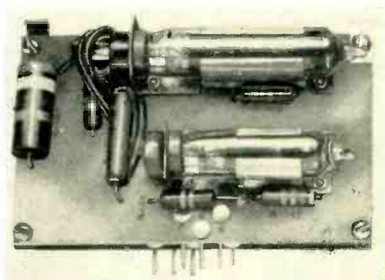
Interior of receiver-transmitter, showing coil and crystal turrets at center. Tuning cavities are at top and at lower left. Set has 23 tubes

Although portable short-range receiver-transmitters for communication between small groups of troops have been widely used, the Armed Forces found need for a transceiver that would give greater range, for communication between larger units of troops and supporting aircraft. Radio set AN/PRC-14 was developed and mass-produced to meet these exacting standards. It is a compact uhf receiver-transmitter carried and operated by one man, and used for tactical military ground-to-air and ground-to-ground communication. With aircraft at an altitude of 10,000 feet, operation at a range up to 110 miles has been experienced. Reliability and range of operation with aircraft at lower altitudes is governed by the terrain. Emergency ground-to-ground operation is prac-



Movable arms tune turret coils





Plug-in panels produced by dip-soldering for squelch circuit (left) and a-f amplifier

Uses Helmet Antenna

tical within line-of-sight limitations.

The frequency range of the 23-tube receiver-transmitter is 225 to 400 mc, but only one of four preset crystal-controlled frequencies is selectable at one time by a four-position selector switch. The channel spacing is 100 kc, permitting operation on about 1,750 different channels. The transmitter section final amplifier has a carrier power output of one watt. An automatic modulation control prevents modulation in excess of 100 percent. The sensitivity of the receiver section with the squelch circuit inoperative is approximately 5 microvolts. With the squelch circuit operative, the level at which signals become audible is threshold sensitivity. Selectivity is more than 85 kc at −6 db and less than 225 kc at −60 db. The receiver section audio amplifier delivers a power output of over 250 milliwatts into a pair of 500-ohm headphones.

Transmitter Circuits

The block diagram of the complete receiver-transmitter is given in Fig. 1 and the schematic in Fig. 2. The transmitter consists of a crystal-controlled cathode-coupled oscillator followed by two frequency doublers, a mixer stage where the quadrupled oscillator frequency is heterodyned with the output of a crystal-controlled 27-mc oscillator, and a third frequency doubler which drives the grounded-grid final power amplifier. It was necessary to use mixing in the transmitter so that transmission and reception might be accomplished on the same frequency without the use of a separate set of crystals for both receiver and transmitter.

All components of the cathode-coupled oscillator and first two doublers are mounted on a subassembly, with the exception of the tank inductances and frequency control crystals. These coils and crystals are in a turret assembly

Receiver-transmitter is strapped to chest and power pack is on back, with antenna on helmet. Total weight is 26 lb. All units are waterproof, with controls accessible through watertight plugs and fittings

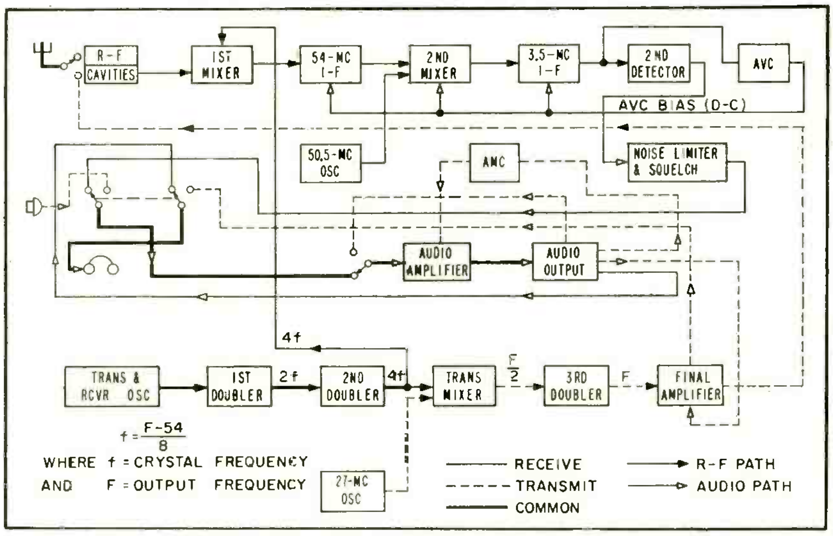


FIG. 1—Block diagram of Radio Set AN/PRC-14, designed for optimum operation with minimum number of stages and minimum space and weight

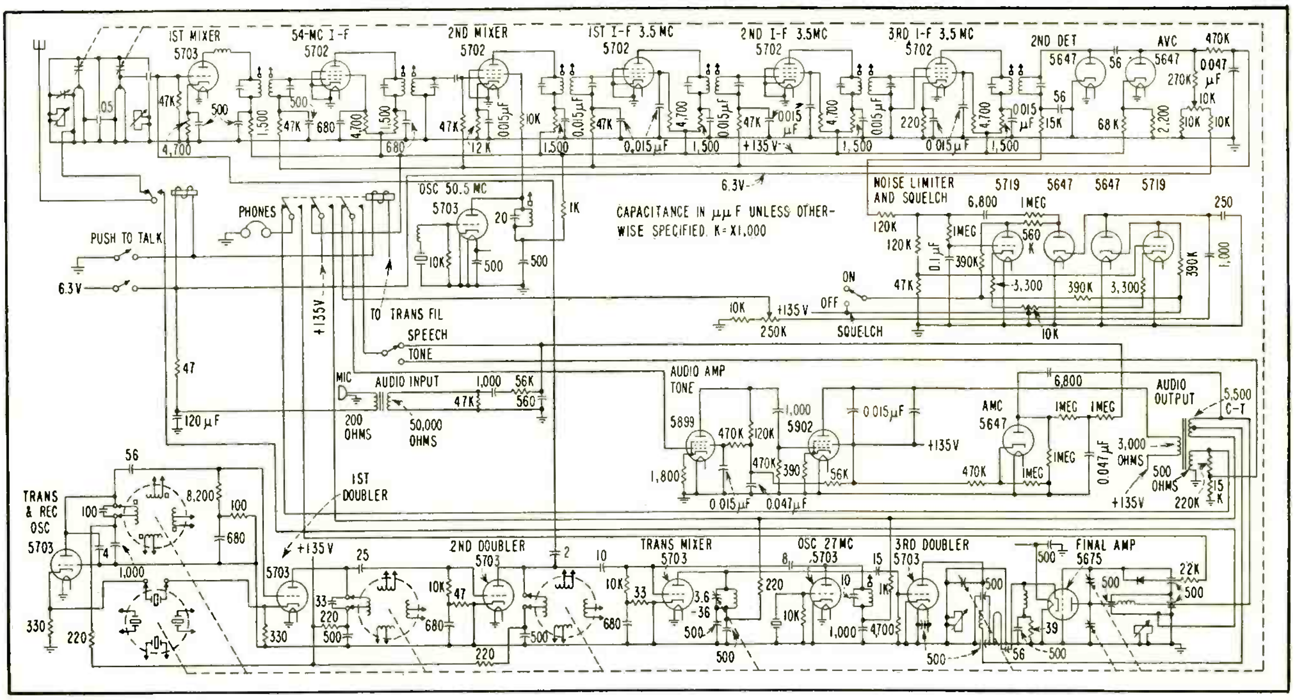


FIG. 2—Complete circuit, with plug-in connectors omitted for simplicity. Dashed lines connect all units mechanically ganged to crystal selector switch (lower left) for automatic tuning

that connects to the r-f chassis through gold-plated spring contacts. The coils are tuned by a movable tap which moves along a helix molded into the ceramic coil form in which silver wire is laid. Four identical sections spaced 90 degrees apart around the circumference of the turret allow the technician or operator to preset four separate channels.

Receiver Circuits

The receiver section of the radio set is a double conversion unit with delayed automatic volume control and noise limiting. The heterodyne frequency for the first mixer is obtained from the second doubler on the r-f chassis. By using second-order mixing to obtain the first conversion to 54 mc, it was possible to save an additional doubler stage and its associated tuned circuit. No r-f amplifier is used before the first mixer.

The noise limiter circuit (Fig. 3) is a modified series diode limiter with the diode acting as a switch to open the input line to the audio amplifier-modulator circuit in the presence of noise pulses. Under steady carrier the plate voltage of V_1 is greater than that of V_4 because of the smaller current flow through R_5 and the higher bias on V_1. Under this condition the plate voltage of diode V_2 will be higher than that on the cathode of diode V_3 and both diodes will conduct. Upon reception of a noise pulse, the plate voltage on V_4 increases, but the plate voltage of V_1 remains momentarily the same because of the time constant of R_3 and C_2 in the grid circuit of V_1.

When the plate voltage on V_4 exceeds the plate voltage on V_1, the diodes stop conducting and the a-f input is cut off for the duration of the pulse. A low-impedance noise path is provided by C_1 and R_4. This produces an accelerating action tending to amplify the effectiveness of the noise limiter.

Since the application of a noise pulse to the circuit places the plate of V_1 at a lower potential than that of V_4, a negative potential relative to V_4 is impressed upon the plate of V_1, assuring a simultaneous stop when the diodes cease conducting. The modulation voltage at that instant will be held stationary, as there is no path for a discharge current through C_3. When noise ceases, the diodes again conduct, and the voltage across C_3 follows the instantaneous level.

The noise limiter also acts as a squelch circuit giving gradual action, which may be used at the discretion of the operator. Under zero-signal conditions with the squelch switch open (squelch on). R_7 is added in series with R_5 as the plate load of V_1. The plate voltage of V_1 is now lower than the plate voltage of V_4, and the diodes do not conduct.

Upon arrival of a carrier of predetermined strength, the voltage drop in the plate circuit of V_1 becomes less than the corresponding drop in the circuit of V_4, which causes the plate voltage of diode V_2 to exceed the cathode voltage of diode V_3, and the diodes conduct intelligence in the normal manner. A squelch threshold control permits muting the receiver output over a range of carrier strengths from 2.5 to 5 microvolts when the squelch switch is on.

For proper operation, the two triodes must draw the same plate current. This adjustment is made with 10,000-ohm potentiometer R_6 in the cathode circuits.

Audio System

The audio circuit, shown in Fig. 2, operates both as a modulator for the transmitter and as an audio power amplifier for the receiver. By feeding part of the audio voltage on the receiver secondary of the output transformer back to the first audio grid, the circuit will oscillate at approximately 1,000 cps, making it possible to transmit either a voice or tone-modulated carrier depending on the position of a selector switch.

A vibrator power pack supplies plate voltage to the radio set. Power to drive the vibrator and to heat the tube filaments is obtained from a 6-volt rechargeable silver-zinc wet-cell battery rated at 80 ampere-hours.

Design Considerations

While designing the receiver it was found that conventional control grid mixing in the second mixer produced a large number of spurious responses due to beats between harmonics of the first and second oscillators. To reduce harmonics of the second oscillator the signal was injected on the screen grid of a pentode. Parameters were selected so that the second oscillator signal operates in the linear portion of the screen characteristic, thus suppressing second-oscillator harmonics. The sensitivity of the receiver is not adversely affected because the large amount of signal available from the crystal-controlled 50.5-mc second oscillator makes it possible to achieve sensitivities comparable with those obtained using conventional mixing methods. Adjacent-channel rejection is achieved in the 3.5-mc i-f strip.[1]

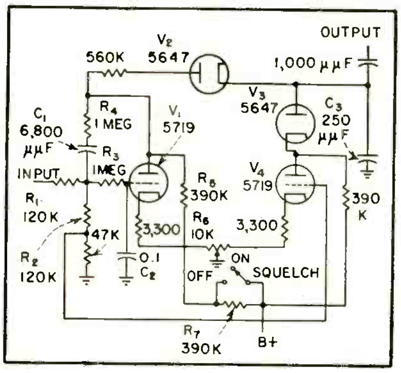


FIG. 3—Noise limiter and squelch circuits of receiver

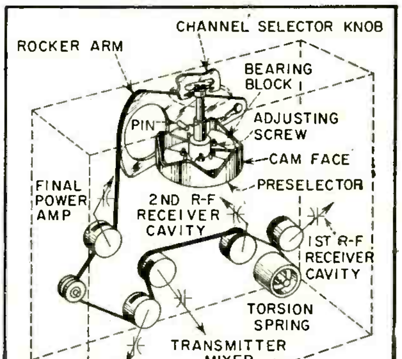
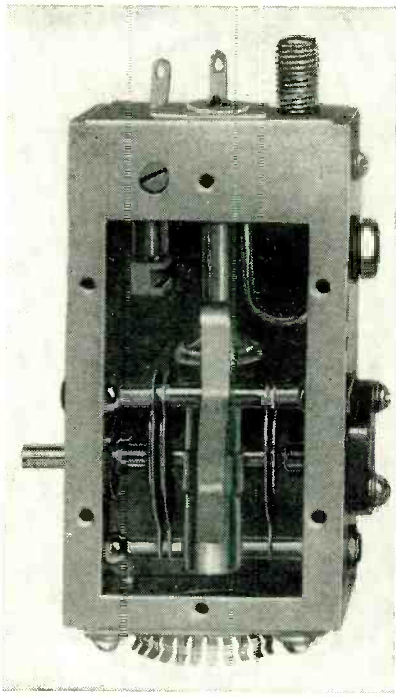


FIG. 4—Method of linking all tunable controls with the four-position channel selector knob for automatic tuning

Both the audio circuit and the squelch circuit were designed as plug-in units using the auto-sembly techniques developed at Squiers Signal Laboratory, Fort Monmouth, N. J.[2]



Transmitter tuning cavity, with pulley shaft projecting at left

Tuning System

The receiver input and transmitter output and driver circuits are tuned simultaneously by a system of molded nylon pulleys, one to each variable capacitor, linked in sequence by lengths of stainless steel strip to a rocker arm attached to the mechanical preselector. The preselector contains four independent bearing blocks spaced 90 degrees apart, each variable in vertical position by an adjusting screw, as shown in Fig. 4. The rocker arm is spring-loaded against the bearing blocks. The coil turret is mechanically coupled to the preselector by a yoke. When properly aligned, the preselector will place the correct turret section in operating position and tune the r-f circuits to the correct frequency.

When the channel selector knob is turned, the rocker arm pin rides along high parts of the cam face and comes to rest on the bearing blocks in between the cam peaks. Turning the adjusting screw of a bearing block changes its level, thereby moving the rocker arm and changing the settings of the tuning capacitors.

Antenna

The regulation military steel helmet acts as the ground plane for the quarter-wave vertical helmet-mounted antenna. The mounting strap is a length of beryllium copper with a hook at each end to catch the helmet at back and front. The front hook is tightened by a thumb screw. A channel in the strap accommodates the coaxial feed cable, so that effectively the cable lies below the ground plane. This gives a reasonably omnidirectional radiation pattern. The length of the antenna is adjustable by means of detents placed to accommodate portions of the frequency spectrum.

During field tests it was found that a high standing-wave ratio occurred at 385 mc. At this frequency the antenna becomes a dipole with a high-Q section (the antenna spike) and a low-Q section (the helmet), resulting in a resistive mismatch at the output circuits. Placement of a detent on the antenna at the 385-mc point holds the standing-wave ratio to the best obtainable figure.

In the production of the radio, each subassembly was tested under conditions simulating actual operation as part of a complete radio. Special test circuits simulating operational conditions were built in order to carry out this program. In this way, testing and alignment of the complete receiver-transmitter was accelerated and simplified. After adjustments were completed, the units were mounted in the case for final operational tests.

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Studio Amplifier Design

By JOHN O. SCHROEDER
National Broadcasting Co.
New York, N. Y.

DEFICIENCIES of various video amplifiers used for distribution, line feed and switching isolation were not fully appreciated until attempts were made to use existing distribution channels for the handling of color signals.

Compression, nonlinear phase characteristic, phase-modulation effects and insufficient bandwidth are detrimental in black-and-white television. They are magnified many times when present in color systems since they produce in the final picture faults that are easily discernible to the eye.

To deal faithfully with color signals, every link in the distribution chain must be vastly improved to virtually eliminate deficiencies. For this reason the feedback video amplifier to be described was designed.

General Theory

Circuit behavior with negative feedback can be represented by the simplified circuits in Fig. 1. Figure 1A represents a two-stage amplifier with two R-C type low-pass filter sections acting within the feedback loop.

When negative feedback is applied from output to input of an amplifier with a certain initial gain, the gain is reduced by the factor $1+\mu\beta$, where μ is the gain without feedback and β is the fractional amount of the output voltage fed back in series with the input. Furthermore, there are other characteristics that are desirably affected by the application of negative voltage feedback, such as reduction of the amplifier's output impedance, improvement in gain stability, reduction of nonlinearity and the reduction of input capacitance provided that feedback is applied back in series with the input and not in shunt with it.

All the above benefits and more are obtained as long as the feedback is truly negative, that is, provided that the phase angle between the fed-back voltage and the input voltage is 180 degrees or reasonably close to this figure. In the design of broadband video amplifiers, considerable attention must be paid to the amplifier's phase characteristic before adding the feedback loop.

It is necessary to insure that the condition of approximately 180 degrees relative phase difference is met over the very wide frequency range required to handle television signals. Otherwise, it will be impossible to achieve improvements owing to production of undesirable effects such as phase nonlinearity, a tendency to produce phase modulation of the NTSC color subcarrier and the occurrence of peaks in the frequency-response characteristic.

If two time constants R_1C_1 and R_2C_2 are equal, that is, if both stages are designed to have the same cutoff frequency, the amount of negative feedback that can be applied without causing a peak in the frequency response is limited to 6 db or less. This amount is scarcely worthwhile. However, if one of the time constants is made n times the other, the amount of feedback allowable before a response peak occurs is increased as the ratio n is increased.

When n is increased from 1 to 10, the amount of feedback permissible before peaking commences goes from 6 db to 15.75 db and if n is increased further to 100, the amount of feedback may be increased to slightly over 34 db.

This is the maximum feedback permissible without causing a peak or rise in the frequency response characteristic; it is not the maximum amount allowable for stability. In a two-stage amplifier such as this, instability in the form of continuous oscillation can never occur, theoretically, unless the gain of the amplifier is infinitely high.

The value of n and the amplifier gain without feedback are usually interrelated since they both change as a function of the R-C time constant of either stage. Although the required numerical value of n is known, choice of the two time constants involved must be intelligently made so the open-loop amplifier phase shift is considerably less than 90 degrees at all frequencies up to and including the highest frequency the amplifier is required to handle faithfully.

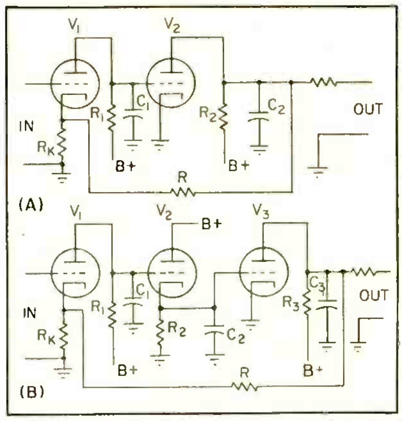


FIG. 1—Development of negative feedback amplifier with two low-pass sections (A) and three-section circuit (B)

Specifically, this means that the cutoff frequency of one stage should preferably be in the region of 4 mc and the cutoff frequency of the other should be n times higher, depending upon the amount of negative feedback involved. To meet these conditions and obtain the benefits of truly wideband negative feedback, use of relatively high-transconductance tubes having low interelectrode capacitances is generally required.

In the theoretical amplifier of Fig. 1A only two frequency-conscious networks exist. For any practical amplifier, there are usually others present and sometimes their characteristics can be used to advantage.

For instance, amplifier stage V_2 may be cathode-biased by means of a resistor between cathode and ground and this resistor shunted with a capacitance, or resistance

for Color Television

Distribution amplifiers requiring linear phase characteristic and freedom from phase modulation have been designed using feedback techniques that employ unequal time constants in separates stages. Double-triode bootstrap input circuit is used

and capacitance in series, to modify the open-loop phase characteristic of the amplifier. Near the cutoff frequency the phase-advance characteristic of the cathode circuit can help cancel the phase lag introduced in some other circuit.

Although the feedback factor is determined by the resistors R_k and R, there is inevitable stray capacitance across R_k that causes the feedback factor to decrease and lag in phase at the very high frequencies. To compensate for this effect, resistor R must be shunted with capacitance so the two R-C products are equal, thereby making the feedback factor independent of frequency.

Three-Stage Feedback

The somewhat more elaborate circuit shown in Fig. 1B has three stages and three R-C low-pass filter sections acting within the feedback loop. As with the two-stage amplifier, the beneficial effects of negative feedback can only be obtained over a wide frequency range if the open-loop phase shift of the amplifier is carefully controlled considerably beyond the limits of the frequency spectrum to be handled.

There is an additional problem when there are three phase-shifting networks in cascade. It is now possible to obtain a phase shift of 180 degrees without the amplification falling to zero, which means that the amplifier can easily become unstable and go into oscillation at any frequency at which the total phase shift is 180 degrees and the gain around the loop is equal to or greater than unity.

If the cutoff frequencies of the three R-C networks in Fig. 1B are made equal, the amount of negative feedback usable before a peak begins to appear in the frequency-response characteristic is a mere 3.5 db, which is insufficient to accomplish much gain stability or reduction of nonlinearity. This problem is solved by staggering the time constants R_1C_1, R_2C_2 and R_3C_3 in such manner as to prevent total phase shift from approaching 90 degrees until the frequency has increased well outside of the passband to be handled. Even then, loop gain must have decreased to a sufficiently low value to prevent peaking.

Although the three time constants can be staggered in a variety of ways, the most satisfactory is to make two of the time constants equal and the remaining one n times the value of these two. In this way, one of the time constants comes into effect at a frequency n times lower than the other two. Thus, the most desirable amplitude and phase characteristics result over the widest frequency range.

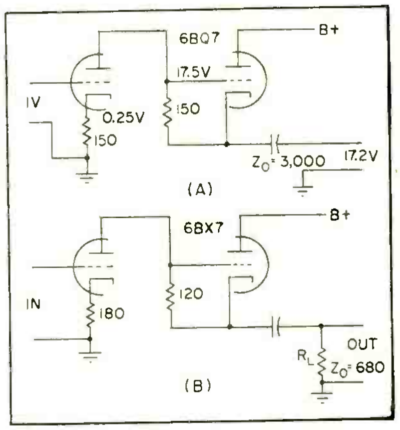


FIG. 3—Double-triode circuit uses cathode-follower principle (A) that evolves into current amplifier type (B)

Permissible Feedback

In the three-stage amplifier the amount of permissible feedback increases from 3.5 db to 10.7 db as the staggering factor n is increased from unity to 10, while increasing n to 100 raises the amount of feedback allowable to 28.3 db before any peak occurs in the frequency response characteristic.

It is important that the lowest cutoff frequency of one of the R-C filter sections is not chosen too low relative to the highest frequency to be faithfully handled by the amplifier. Otherwise the phase angle between the input signal and the fed-back signal will approach quadrature. With this condition, the phase characteristic of the amplifier departs seriously from linearity. Because ideal conditions for phase modulation exist, any dynamic change in amplifier loop-gain with signal level will result in the NTSC color subcarrier having its phase shifted as a function of

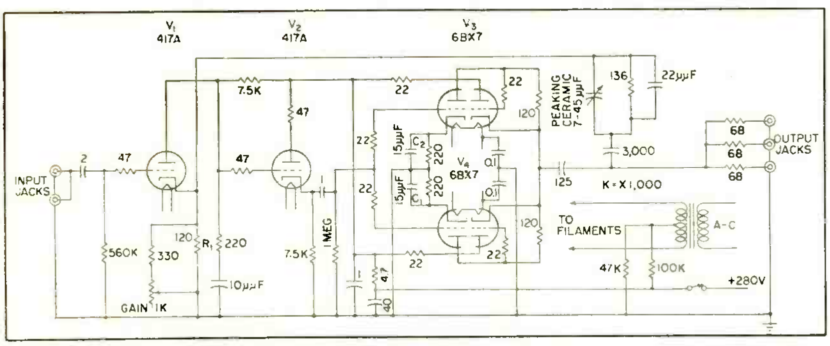


FIG. 2—Operting version of video distribution amplifier includes special bootstrap output stage further explained in Fig. 3

instantaneous signal level, producing a shift in hue in picture color.

The schematic diagram shown in Fig. 2 of an actual amplifier illustrates the practical use of the design principles relative to three-stage amplifiers. Cutoff frequency of the interstage coupling between V_1 and V_2 is about 2 mc, despite the relatively high value of plate-load resistor. It results from the low input capacitance of cathode follower V_2, absence of any bulky coupling components and the low output capacitance of V_1. Cutoff frequency of cathode follower V_2 is considerably higher than 2 mc owing to its extremely low effective source impedance, which is about 75 ohms. The cutoff frequency of the output stage is also much higher because of the low value of the effective load resistance.

Phase Advance

The staggering factor was purposely made somewhat less than theoretically required and a variable capacitor placed across the feedback resistor to control the frequency at which phase advance started. This control makes possible adjustment of the high-frequency response to obtain either a drooping, flat or rising characteristic and also compensates for the stray shunting capacitance existing across cathode resistor R_1, which would decrease the feedback factor and retard its phase at the higher frequencies.

Cathode-bypass capacitors C_1 and C_2 of the 6BX7 output stage introduce a leading phase characteristic at the very high frequencies where the open-loop phase characteristic tends to lag considerably owing to the combined effects of the three interstage coupling networks. The capacitors decrease the rate of lag and thereby increase the margin of stability of the amplifier at very high frequencies.

Very low-frequency response of feedback amplifiers is subject to the same general rules as the high-frequency response so far as the occurrence of peaks and instability is concerned when the feedback factor is increased. The technique of staggering the interstage coupling time-constants properly and using phase-correcting networks when necessary can produce an amplifier with the required low-frequency characteristics.

In some respects the low-frequency end of the spectrum is easier to deal with because the required values of coupling capacitors can be computed and measured even though the designer is limited in choice of other time-constants. Considerations include the recommended maximum value of grid resistor, large-size coupling capacitors conflicting with high-frequency performance, leakage resistance of high-capacitance coupling capacitors and the limited values of capacitance available in electrolytic capacitors.

Matters are further complicated by the existence of a series capacitor in the feedback circuit, which causes a reduction in the feedback factor at extremely low frequencies and also causes its relative phase to advance. Eliminating this capacitor and bucking out the d-c existing at the output with an externally supplied negative voltage is one solution, but the use of an external negative supply was not considered desirable. Therefore, properly staggered coupling time-constants and/or low-frequency phase correction networks are used to obtain desired low-frequency response.

Bootstrap Adaptation

The unusual amplifier circuit shown in Fig. 3 was independently conceived by the writer in 1952 and given the name direct-coupled bootstrap circuit. A similar type of circuit had, however, been previously published in Valley and Wallman's "Vacuum Tube Amplifiers", in the direct-coupled amplifier section. Since the circuit can be used both as a voltage amplifier and a current amplifier in video amplifiers here, its use as a voltage amplifier (Fig. 3A) is first considered.

So far as the direct-current flow is concerned, the two triodes are connected in series from B+ to ground, current flowing through the 150-ohm cathode resistor of the first triode, through this triode, then through the 150-ohm resistor in the plate circuit of the first triode and thence through the second triode. Bias voltage is developed across each 150-ohm resistor for each triode section and the B+ supply voltage divides equally between the two tubes.

To understand circuit operation from a signal or a-c viewpoint, it is easiest first to consider the operation of the output triode section (Fig. 3A) that looks much like a cathode-follower and behaves like one in some respects. With 17.5 volts of signal on its grid, the tube's cathode puts out 17.2 volts. Considering it as a cathode follower, it then has a gain of 0.982.

Load Resistance

In a cathode-follower, any impedance connected between grid and cathode is divided by a factor of $(1-\alpha)$ where α is the gain. The 150-ohm grid-to-cathode resistor is made to appear like a resistance from grid to ground of 150 divided by $1-0.982$ or about 8,330 ohms. Since this resistance is the effective plate load impedance seen by the first triode, this stage operates as though it had a physical load resistor of 8,330 ohms in its plate circuit thereby providing a grid-to-plate gain of about 17.5.

Although the effective impedance from plate to ground is high, consisting of the plate resistance of the first triode (modified by the unbypassed cathode resistor) in parallel with 8,330 ohms, the bandwidth is not unreasonably low because of the low value of effective shunt capacitance from plate to ground.

Effective output impedance of the circuit is approximately 3,000 ohms, not the very low output impedance expected from a cathode-follower. For true cathode-follower action to develop low effective generator impedance, there must be no a-c coupling between cathode and grid. In other words, the grid must be held steady while any change tries to take place in the cathode voltage. This condition does not exist here because of the 150-ohm resistor between grid and cathode, which passes back to the grid most of the change that takes place in cathode voltage. Advantages of this circuit are reasonable gain-bandwidth, low distortion, efficiency in use of plate power and components and relative insensitivity of gain versus tube characteristics.

The same type of circuit is suited

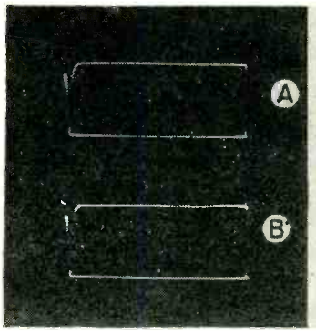


FIG. 4—Sweep generator with 10-mc marker direct (A) and through amplier (B)

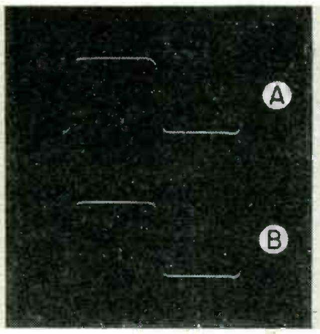


FIG. 5—Square wave (1 mc) displayed directly (A) and via amplifier (B)

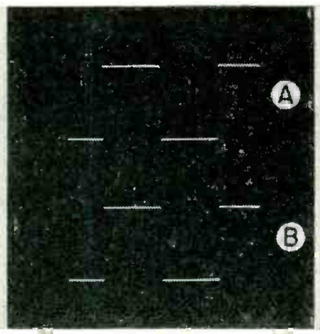


FIG. 6—Square wave of 15-kc frequency shows no impairment through amplifier

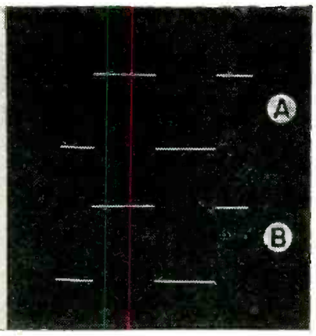


FIG. 7—Sixty - cycle square wave has minor tilt (oscillogram is reversed)

for use as an output or current amplifier as illustrated by Fig. 3B. The same theory applies to the operation of this circuit as applied to Fig. 3A. It differs by addition of a comparatively low external load R_L. This reduces the gain of the cathode-follower section to considerably less than unity and therefore the effective value of the 120-ohm grid-to-cathode resistor is only multiplied about twice.

The stage is therefore inherently broad band owing to the comparatively low impedance levels existing. It is ideally suited for driving low-impedance loads at reasonably high levels with a minimum of distortion. The reason for this low distortion results from the manner in which the circuit operates when driving fairly low values of R_L, since it combines the good capabilities of a plate-output stage for negative-output voltage swings and the cathode-output stage for positive-output voltage swings.

When a sine wave is applied to the input of the stage, current flow through the first triode is increased on the positive half-cycle causing a heavier flow of electrons up through the 180-ohm cathode resistor, through the first triode and the 120-ohm resistor and through the coupling capacitor and load back to ground. The coupling capacitor may be considered a zero-impedance source of d-c voltage since it is sufficiently large to prevent any appreciable change in its charge from occurring during the time of one cycle.

When the input signal swings negative, current flow through the first triode is decreased, causing its plate voltage to rise and carry with it into the positive region the grid of the output triode, which now takes over the burden of conducting the load current like a cathode follower. Under these conditions current flows through the load and coupling capacitor, the tube and B+ supply. The effective source impedance of the stage again is not extremely low as if it were a true cathode-follower, which is advantageous. If it were extremely low, the coupling capacitor required for adequate low-frequency response would be prohibitively large.

Hum Reduction

Another advantage of the circuit over a straight cathode-follower is that any hum or noise voltages fed back from the line to the cathode are also passed on to the grid so that their modulating effect is insignificant. This is not true of a cathode-follower output stage wherein the total noise or hum voltage impressed back across the cathode to ground appears as a change in bias of the stage, allowing comparatively low hum and noise voltages to produce modulation of the desired video output waveform.

Source impedance of the circuit in Fig. 3B is about 680 ohms using a 6BX7 tube and constants shown. With load R_L of 75 ohms, the gain achieved is about 0.46. This means that the effective transconductance of the output stage from grid to load is about 6,500 micromhos even with the comparatively large amount of cathode degeneration existing. Such degeneration adds further to the stage's gain stability and amplitude linearity.

Advantages of this type of output circuit are: good gain-bandwidth, fairly low input capacitance, good linearity, minimum number of components required, efficient use of B+ power input—since no power is wasted in the usual high-wattage plate or cathode load resistor—good gain stability with changes in tube characteristics owing to the self-regulating d-c conditions that establish themselves and the large amount of current degeneration inherent.

Control of Gain

Control of gain has been limited to about ±5 percent around unity in the final amplifier design for two reasons. Since the characteristics of the amplifier are related to the amount of feedback used, especially at the extremes of the frequency spectrum, it is undesirable to change the feedback factor much since doing so will change the shape of the response curve. Owing to the bandwidth being much wider than necessary, a 5-percent maximum change in feedback will not appreciably affect the response curve in the range of interest for television but will still allow latitude of gain control to compensate normal tolerances in load impedances and components tolerances.

In an amplifier employing a considerable amount of negative feedback, gain becomes almost entirely dependent upon the feedback factor and quite independent of the internal amplifier gain. Since correct gain is maintained regardless of the condition of tubes, the maintenance man has no convenient way of knowing when tubes are beginning to fall off in transconductance unless provision is made for accurately metering the individual plate currents of each stage.

In this group of amplifiers, an average of about 15-db negative feedback is used so any change in internal loop gain is reduced by a factor of about 5.6. Therefore, if the proper gain cannot be obtained with the 5-percent change in feedback factor provided by the gain control, internal gain has changed by a factor of more than 5.6 times 5 percent or about 28 percent. This indicates either the necessity for new tubes or a serious change in component values.

Performance

Performance of the amplifier is shown in the oscillograms of Fig. 4 through 7 for which various signals are compared directly (A) and through the amplifier (B). Response to differential-gain test signals is shown in Fig. 8 to 10.

Figure 4 indicates the smooth wide-band response available beyond 10 mc. Point-by-point tests indicate a response flat within ±2 percent to 10 mc and down less than 5 percent at 20 mc. Low-frequency response is smooth and free from peaks down to 1 cycle a second, falling off about 3 db at 0.7 cps.

Figure 5 shows the amplifier's response to a 1-mc square wave with a rise time of about 0.03 microsecond. Freedom from overshoot and ringing indicates good phase characteristics and the rise time of the signal after going through the amplifier is still the same. Measured envelope delay is about 0.019 microsecond and is constant within +0.0015 and −0 microsecond to over 4.5 mc.

Response to a 15-kc square wave in Fig. 6 shows lack of tilt or bowing to indicate good midfrequency phase characteristics.

The small tilt introduced on a 60-cycle square wave in Fig. 7 is 1.5 percent by actual measurement. Although the photograph shows a positive tilt characterizing phase lag at low frequencies, this is only apparent since the oscillographic camera has reversed the trace. On the picture, the spot is traveling from right to left. Tilt is actually negative as would be expected from a smooth low-frequency response falling off at 0.7 cycle.

Figure 8 pictures the output of a differential-gain test generator that was developed to show compression or nonlinearity. The test waveform is difficult for an amplifier to handle without distortion because it provides a full-level signal of widely varying a-c axis. The dynamic transfer characteristic explored with the test signal is wider than any possible composite television signal at equal peak-to-peak level. In the low-frequency rectangular wave with duty cycle continuously adjustable between 10 and 90 percent, white occurs at a 120-cycle rate, while the sine wave that is added to this in a ratio of about 10-to-1 is at a frequency of 3.5 mc.

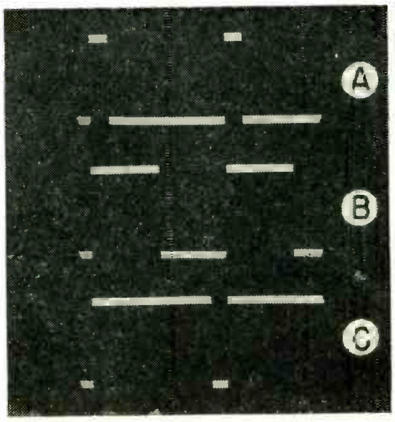


FIG. 8—Differential gain with 10-percent duty cycle (A) 50 percent (B) and 90 percent (C)

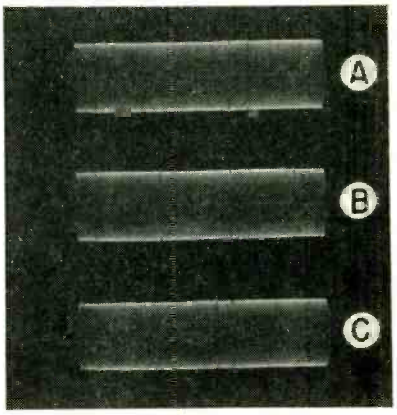


FIG. 9—Differential gain signal through high-pass filter for 10, 50 and 90-percent duty cycle, viewed from top to bottom

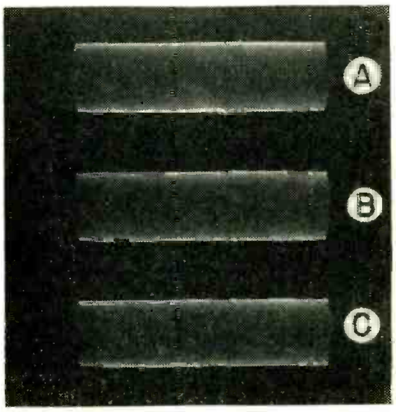


FIG. 10—Differential gain test signal through amplifier and high-pass filter at amplitude of 1.5 volt, peak-to-peak. Duty cycles of 10 (A) 50 (B) and 90 percent (C)

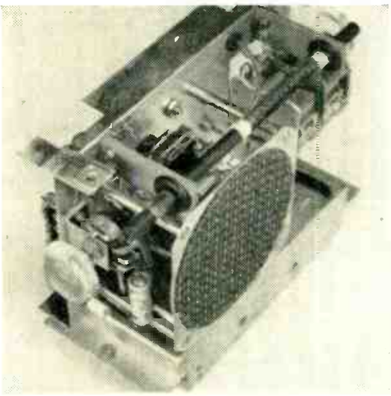
The waveform obtained by feeding the test signal through a high-pass filter, leaving just the 3.5-mc sine wave envelope, is shown in Fig. 9. This demonstrates the lack of any compression in the test generator. Although close inspection of the oscillogram seems to indicate a slight sign of compression at 50-percent duty cycle (B) this effect is caused by a small amount of hum in the oscilloscope mixing with the desired envelope.

The last oscillograms, Fig. 10, show output of the high-pass filter inserted at the amplifier's output, the input being the test signal shown in Fig. 8. Close inspection may reveal less than 1 percent of compression on the 90-percent duty cycle (C) but this represents an infinitesimal amount of sync compression on a composite television signal with 100-percent all-white field.

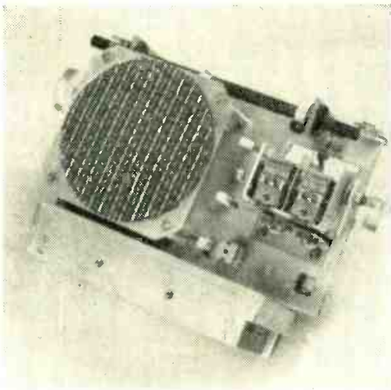
Measurements

When measured with the telephone company's so-called Kelly Generator (ELECTRONICS, p 128, Sept. 1954) at 2 volts peak-to-peak, differential phase distortion of the amplifier was in the vicinity of 0.25 degree. As measured with a 0.7-volt peak-to-peak composite step signal mixed with 0.165 volt of subcarrier, the differential phase distortion was less than 0.166 deg. Stability of the amplifier characteristics is indicated by the fact that a ±10-percent change in either B+ voltage or heater voltage caused a change of less than ±1 percent at subcarrier frequency. The hum and noise is extremely low, averaging 60 db below 0.5 volt, peak-to-peak.

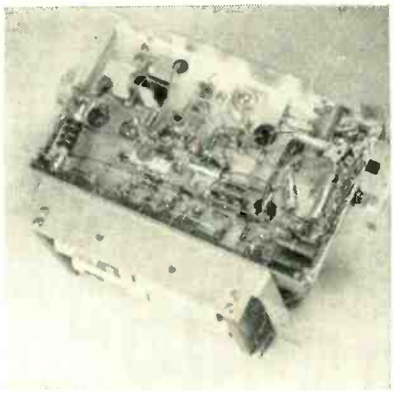
The author thanks the many persons engaged in the color television field at NBC for co-operation, encouragement and the helpful information provided by their operational tests on developmental models. Particular thanks are due E. B. Pores, R. A. Monfort, E. P. Bertero and R. A. Nies; Hazeltine Laboratories furnished valuable information regarding amplifier phase characteristics, which was obtained by the use of their phase-plotting device.



Top view of laboratory model showing ferrite rod antenna and output transformer, located behind loudspeaker



Front of set. Transistors are mounted on chassis between loudspeaker and tuning capacitor



Rear of chassis showing interconnecting wiring. Flashlight batteries are mounted below case

Design of Transistorized High-Gain Portable

By W. E. SHEEHAN and J. H. IVERS

Raytheon Manufacturing Company
Newton, Massachusetts

Superheterodyne using eight transistors delivers 100 milliwatts undistorted output. Sensitivity is 300-500 microvolts per meter. Receiver operates 500 hours on its four flashlight batteries and weighs only five pounds

PERFORMANCE comparable to that obtained from conventional electron-tube portable radios is obtained using an 8-transistor superheterodyne receiver. Overall gain is at least 120 db, selectivity is good, maximum undistorted power to the 4-in. round loudspeaker is slightly over 100 mw and frequency response extends from 100 cps to 8 kc. Further design refinements should bring about still better selectivity and improved sensitivity. Present sensitivity is 300–500 microvolts per meter. Greater power output (250 mw maximum) can be obtained by designing the output transformer for it. Characteristics are listed in Table I.

The receiver uses two CK760 high-frequency transistors as i-f amplifiers; two CK761 high-frequency transistors in the mixer and oscillator circuits; and one other CK760 or CK761 as the second detector. Three CK721 or CK722 transistors are used in the audio section. Figure 1 is a complete schematic diagram.

Power Requirements

The receiver operates on 6 volts furnished by four 1.5-volt D cells (flashlight batteries) in series. However, C or penlight cells may be substituted at a corresponding decrease in battery life. If the receiver is operated several hours a day, battery life using D cells is estimated at 500 hours. This corresponds to an operating cost of about 1/10 cent an hour.

The overall power gain of the audio section is in excess of 50 db. Since the output stage is class B push-pull the current drain varies with the signal level. At maximum rated output the drain for this stage is 27 ma. The idling current is about 1 ma plus 1.2 ma in the bias bleeder.

Three-db negative feedback has been incorporated in the audio amplifier to improve the low-frequency response and reduce distortion. Total harmonic distortion at 400 cycles and 100-mw output is 5 percent. When enclosed in a cabinet, fidelity and tone are excellent.

The audio driver stage operates at about 1-ma collector current. The audio interstage transformer impedance ratio is 10,000 ohms to

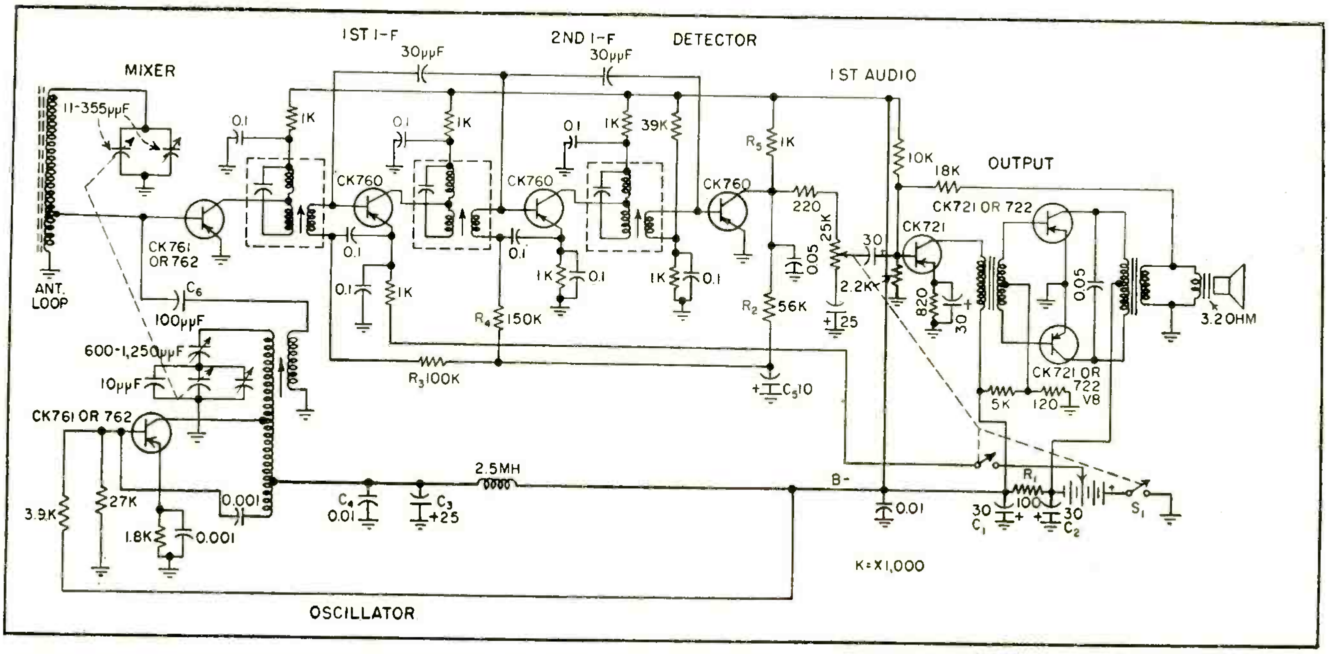


FIG. 1—Superheterodyne receiver uses eight pnp transistors. Note that collectors are negative with respect to grounded emitters

2,000 ohms base to base, center tapped. The transformer is small, being wound on a 3/16-in. laminated core.

The output transformer is slightly larger, being wound on a 1/4-in. core. The impedance ratio is 500 ohms collector to collector, center tapped, to a 3.2-ohm voice coil. Both these transformers were especially designed for transistor circuits.

An important feature of the transformers is their high inductance and low d-c resistance. The d-c resistance of the primary of the output transformer is 20 ohms. The d-c resistance of the secondary of the driver transformer is less than 50 ohms. Transformers of this type may be obtained from the New England Transformer Company, Somerville, Massachusetts, or the Gramer Transformer Corporation, Chicago, Illinois.

Resistor R_1 together with C_1 and C_2 form an audio filter. While this resistor represents a small power loss it was inserted to prevent audio from the output stage getting back on the B− lead.

Capacitor C_3 was paralleled with C_4 in the oscillator circuit to prevent any audio modulation of the oscillator.

This receiver employs two i-f stages and a class B power detector. The overall power gain of the i-f detector section is at least 60 db. Type CK760 transistors were used. These units have an average alpha cutoff frequency of 5 mc. If desired, CK761 transistors may be used in the i-f and detector stages to obtain several db more gain.

I-F Neutralization

Neutralization was accomplished by using 30-μμf capacitors feeding back from the base of the second detector to the base of the second i-f, and from the base of the second i-f to the base of the first i-f. Neutralization is necessary because high-frequency transistors are inherently regenerative in the grounded-emitter connection.

To approximate roughly the size neutralizing capacitor required, multiply collector capacitance of the transistor by the step-down ratio between the tap on the primary of the i-f transformer and the secondary. In this case, there are 55 turns at the tap and 18 turns on the secondary, for a ratio of three, times a C_c of 10 μμf to give a neutralizing capacitance of 30 μμf.

The i-f transformers are EXO—3015 manufactured by the Automatic Manufacturing Company, Newark, New Jersey. These transformers have 155 total turns on the primary, tapped at 55 turns, with an 18-turn secondary. The coils are bifilar wound and enclosed in an adjustable ferrite cup. They are tuned by a fixed 125-μμf capacitor across the primary.

Studies indicate that a better choice for the i-f transformers would be to have more capacitance and less inductance. More important, the turns ratio between primary at the tap and the secondary should be higher—perhaps 6 or 7 to one to match 25,000 ohms to 600 ohms.

Detector

The receiver uses a class B power detector for demodulation and as a source of avc voltage. This type of detector has the advantage of providing about 10-db gain and a suitable avc voltage. However, if adequate i-f gain is available as can be obtained by improvement of the i-f stages, a diode detector can be used. Unfortunately, the derivation of adequate avc from a diode is not as simple as from a power detector.

The avc voltage is derived from the collector of the detector and fed back through the filtering and dropping network R_2, C_5 and R_3 to the base of the first i-f stage and through R_4 to the base of the second i-f stage. Under no-signal conditions the detector collector voltage is approximately the B− voltage. This voltage, when fed back to the base of the first i-f is such that about 250 μa of emitter current flows in this stage.

In the presence of a signal, the d-c voltage at the collector of the detector decreases—that is, goes toward ground potential—due to the rectified carrier current drop across R_5. This decreasing voltage reduces the emitter current of the first i-f stage proportionately. As the emitter current is reduced the current gain of the transistor decreases, lowering the gain of the stage.

Under strong signal conditions, the emitter current of the first stage may go down to 50 μa or less. This reduces the gain of the stage to a low value. The emitter resistor of the first stage is not returned to ground but returns to the negative 3-volt tap on the battery. This permits the gain of the first i-f to be reduced sufficiently to prevent overload of either the second i-f or the detector.

The second i-f stage contributes to the avc action to a small extent. No-signal emitter current is about 500 μa and under strong signals it reduces to about 250 μa.

The avc curve of this receiver has proven to be quite adequate and under even extremely strong signal conditions no overload has been experienced.

Oscillator-Mixer

A ferrite-cored loop antenna is used which consists of 65–70 turns of 10–38 Litz wire space wound on a 7-inch long by ½-inch diameter ferrite rod. The loop is tapped at 12 turns. The unloaded Q of the antenna is about 280. Antenna coil data are given in Fig. 2A.

The oscillator uses a tapped coil with a separate secondary. The collector of the oscillator is tapped at about ⅓ of the total turns. This decreases the effect of collector capacitance, provides better impedance matching and improves the frequency stability and tracking. Oscillator coil data is given in Fig. 2B. For a laboratory design, three-point tracking was obtained by using a slug in the oscillator coil, a padder and the gang capacitor trimmer. Undoubtedly a cut-plate tuning capacitor could be used to obtain three-point tracking with equal success. A 10-$\mu\mu f$ fixed capacitor is connected in parallel with the oscillator trimmer to make the high end of the tracking curve fall in the proper place.

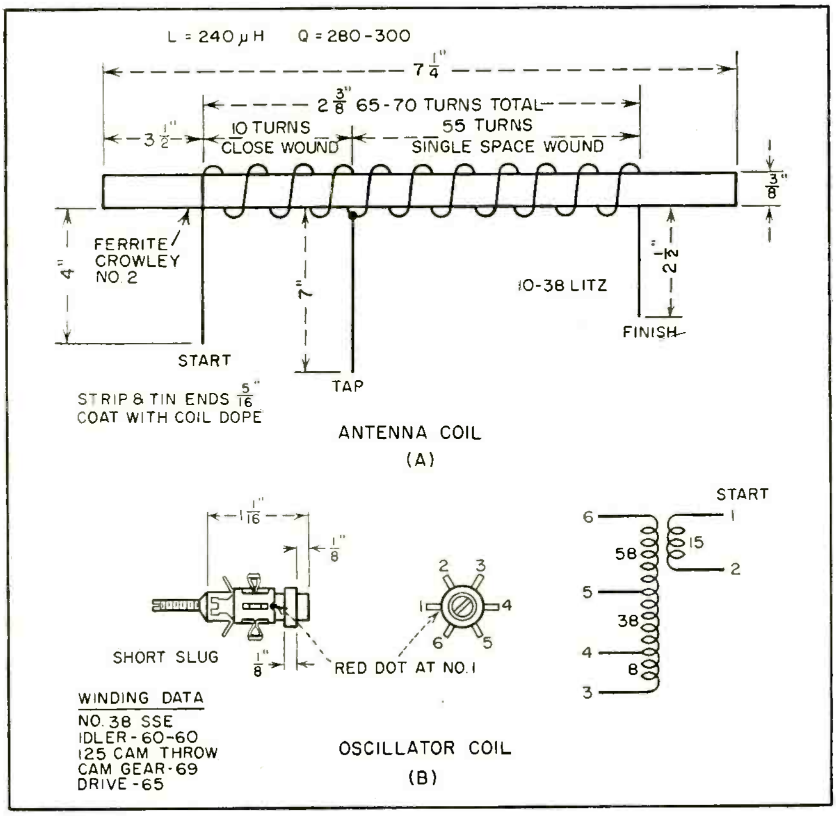


FIG. 2—Winding data for antenna (A) and oscillator (B) coils. Other components are available commercially

Table I—Receiver Characteristics

Frequency Range	530–1,620 kc
Sensitivity	300–500 μvolts per meter
Rated Power Output	100 mw
Maximum Power Output	250 mw
Battery Voltage	6 v
Total Current No Signal	7 ma
Total Current, Average Signal and Volume	17 ma
Total Current at 100-mw Output	30 ma

The output of the oscillator is coupled into the mixer through the secondary of the oscillator coil and capacitor C_6. This combination of capacitive and inductive coupling produces a more constant injection voltage. However, due to resonance effects and the close coupling between oscillator and mixer there is still considerable variation in injection voltage and mixer current.

The injection voltage on the base of the mixer varies from 0.01 to 0.03 volt depending on the setting of the tuning control, while the mixer current varies from 250 μa to 1 ma. While this causes some variation in conversion gain the effect is not pronounced and the sensitivity is reasonably uniform over the band. The value of C_6, 100 $\mu\mu f$, was chosen to give a maximum mixer current of 1 ma.

With the oscillator voltage injected on the base together with the signal voltage, the emitter is directly grounded. Thus the i-f frequency has a direct path from ground as do the signal and oscillator frequencies. Conversion gain is estimated between 10 and 15 db.

The oscillator and mixer track well together reaching both ends of the band easily (530 and 1,620 kc respectively). On the initial adjustment it is necessary to rock in the crossover points.

A power output up to a quarter of a watt may be obtained by using two CK721 or CK722 transistors in class B push pull operating at 6 volts into a 250-ohm (collector to collector) output transformer without exceeding CK721/722 power handling capabilities.

COMPONENT DESIGN TRENDS

Metallic Rectifiers

By FRANK ROCKETT

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MATERIALS AND metallurgical processes being developed for transistors are providing radically improved metallic rectifiers, some with apparently infinite life. Concurrently with these innovations, selenium rectifiers are being improved, especially for operation in the vicinity of 100 C. Copper-oxide rectifiers continue to be economical for low-voltage service, selenium for low-current high-voltage service and germanium for high-current applications (see Fig. 1).

Of the components surveyed in this series of component parts articles, activity appears greatest in advancing the variety and extending the performance of metallic rectifiers. Indicative of the trend is a silicon cell soon to be marketed that withstands 1,000 v and passes 200 ma with only a 1.5-v drop.

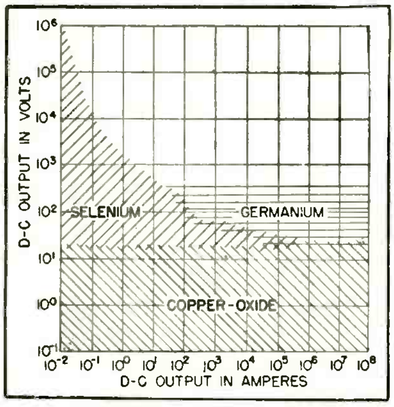


FIG. 1—Economical operating ranges of principal types of metallic rectifiers (General Electric Co.)

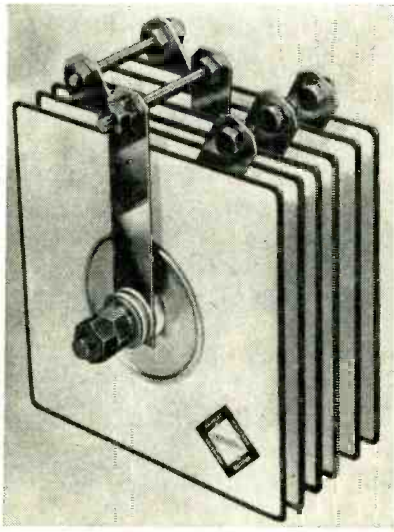


FIG. 2—Three-phase full-wave bridge rectifier rated for maximum a-c input of 40 v rms and d-c output of 32 amperes has selenium cells 6 inches square (Bogue Electric Mfg. Co.)

Any type of rectifier cell can be stacked in series to withstand the desired voltage, or the stacks can be connected in parallel to pass the required current. The ultimate limitation is permissible operating temperature.

Selenium Cells

Illustrative of the performance available from selenium cells is the Belcon rectifier of Fig. 2. Operated at full rating in an ambient of 75 C, the output voltage drops no more than 5 percent in 5,000 hours; in an ambient of 150 C, the output voltage drops no more than 10 percent in 500 hours. Continuous recycling from −65 to +75 C produces no deleterious effect. In developing this high-temperature selenium rectifier, chemically stable artificial barrier materials and materials with similar expansion coefficients were selected. Forward voltage drop and reverse leakage current remain low at high temperature so that internally generated heat is no more apt to cause this cell to run away as temperature rises than it is for a conventional low-temperature selenium cell.

Life test curves for Bradley high-temperature selenium rectifiers are given in Fig. 3 for almost 2,500 hours of operation at 150 C. The tests have since then passed 3,300 hours with no sign of cell deterioration.

Manufacturers provide rectifiers with low leakage currents for magnetic amplifiers. Ratios of forward to reverse current range from 100:1 to 5,000:1, the higher ratios being typical of cells for service in magnetic amplifiers. Such cells may be prestabilized to minimize changes as a result of temperature, storage or operation. For use in limiter circuits, cells are engineered to provide a steep slope to the d-c voltage-current characteristic curve. At 0.4 v d-c, the current is below 0.7 ma per square inch; at 1.0 v d-c, the current is above 40 ma per square inch.

Using radioactive tracer elements to speed research, engineers at Fansteel have devloped a cell that operates at full rating to 100 C and with only moderate derating to 150 C. A particularly troublesome problem with dry-disk rectifiers,

Previous Articles in Series

Approach Infinite Life

Final article of series surveys developments in copper-oxide, selenium, silicon, germanium and titanium-dioxide rectifiers. New designs give reduced size and longer life along with higher operating temperature, output current and inverse voltage ratings

becoming more acute as temperature rises, is that of a protective coating that is relatively inert to the barrier layer, into which the coating may penetrate if the counterelectrode is porous. Fan-steel uses various chlorinated rubber coatings applied in multiple layers that are resistant to mercury vapor, corrosive atmospheres, salt spray, high humidity and fungus. Also, provision for thermal expansion, such as in Fig. 4, becomes essential.

Development of a high-temperature selenium rectifier at Radio Receptor has proceeded along somewhat different lines. Because life of a conventional selenium cell decreases rapidly above 85 C, precautions are taken in the preparation of cells to use only materials of high uniform purity. At several steps during production, tests of forward and reverse resistance are made to anticipate final performance. Accelerated life tests are also made on samples from each batch. The resulting performance is shown in Fig. 5. The curves are for a bridge rectifier having one 1½-inch-square cell in each leg. This high-temperature selenium rectifier is designed to operate in ambients of 85 to 125 C with cell temperatures from 100 to 145 C. In an ambient of 85 C a life of 2,500 to 4,000 hours can be expected; in an ambient of 125 C a life of 500 to 1,000 hours can be expected. Cells are rated for 24 maximum reverse rms volts and are available with continuous d-c ratings from 5 ma (¼ inch in diameter) to 1.2 amperes (3 inches square) in half-wave rectifiers (twice these currents in bridge or full-wave rectifiers). An experimental high-temperature selenium rectifier has delivered 30 amperes.

The variety obtainable in rectifier characteristics by combining selenium cells is illustrated by the many different rectifier assemblies that manufacturers list in their catalogs. For example, Federal lists over two dozen basic industrial stack configurations with a total of about 350 different stack arrangements, in addition to a complete line of radio and television replace-

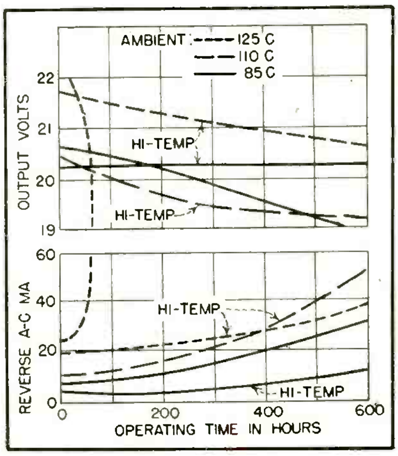


FIG. 5—Comparison of conventional selenium rectifier (unlabeled curves) and high-temperature selenium rectifier in single-phase bridge circuit with 26 v rms input and 1 ampere d-c output (Radio Receptor Co.)

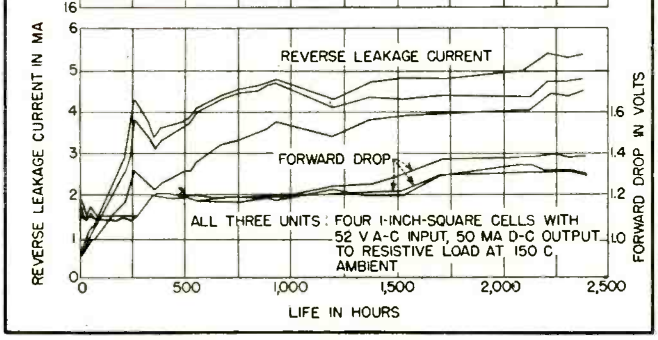


FIG. 3—Life test data on three developmental selenium rectifiers (Bradley Laboratories, Inc.)

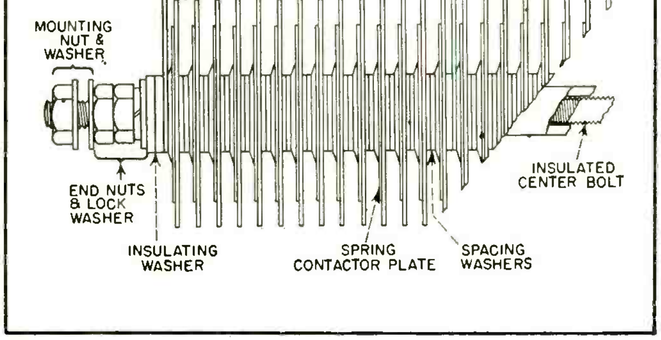


FIG. 4—Typical selenium rectifier assembly (Fansteel Metallurgical Corp.)

COMPONENT DESIGN TRENDS

- High-temperature selenium cells operate reliably at 150 C ambient
- Back-to-back selenium rectifiers across inductive load protect relay contacts
- Diffused-junction germanium cells with near 100-percent efficiency come with pigtail leads
- Developmental germanium cell using heat sink is rated at 35 amperes for 200 peak inverse volts

ment rectifiers. These include a small plastic-cased unit with pigtails for rectifying a few milliwatts and a large unit with busbar connections for rectifying power to an electroplater.

For high-voltage supplies such as for cathode-ray tubes, Federal selenium rectifiers are assembled in enclosed stacks rated from 250 to 5,000 v at 5 ma for half-wave rectifiers and 40 ma for full-wave rectifiers. Fiber enclosures protect the stacks from normal environments; hermetically sealed glass enclosures protect the stacks in applications at high temperature and humidity. Smaller stacks in nylon enclosures are rated from 26 to 500 v rms for applications in bridge or doubler circuits. Units are also available in hermetically sealed metal cans.

To protect relay contacts, two selenium rectifiers are connected back to back in Federal's contact protector. The nonlinear resistance of this composite rectifier is paralleled across the inductive load to be controlled by relay contacts. When the load is opened by the relay, the momentary inductive surge develops a high reverse voltage (over 100 v per cell) across the protector, under which condition the nonlinear resistance of the rectifier is low (in the order of 10^3 ohms per cell). The protector thus acts as a damping resistor across the inductive load. As soon as the induced voltage across the load decreases, the impedance of the protector returns to normal (about 10^6 ohms per cell).

Temperature rise in the protector is low so no permanent damage is done by the reverse current.

Stacks are usually wired for single-phase or three-phase half-wave circuits, single-phase or three-phase full-wave circuits and single-phase or three-phase bridge circuits. As many cells as necessary are connected in series in each leg to provide the required voltage. Cells of the required area or several stacks in parallel are used to provide the required current. The selenium cells used in standard Federal stacks are rated for 26 v rms with a continuous forward current capacity of 50 ma per sq cm of effective rectifying area and a maximum safe plate temperature of 75 C. Rectifiers can be operated at higher current densities by building the stacks with wider spacing between plates, by using forced air cooling or by immersing them in oil, if the stack has originally been processed for such cooling.

Where size and weight are primary considerations, Federal processes selenium cells for 36 v rms. For magnetic amplifiers, these cells permit much reduced reverse current when operated at 26 v. For airborne power supplies, two of these cells replace three 26-v cells for a 30-percent reduction in space. Output d-c falls off about 4 percent in 13,000 hours of continuous operation at 35 C ambient. Efficiency and regulation are somewhat improved because the fewer cells in a stack result in a decrease in forward voltage drop. Above 1,000 cps, efficiency decreases appreciably. Usual efficiencies are about 85 percent.

Although the voltage rating of a selenium cell cannot be safely exceeded even momentarily, the current rating can be exceeded by as much as ten times for a few seconds provided the overload duty cycle allows the rectifier to remain within

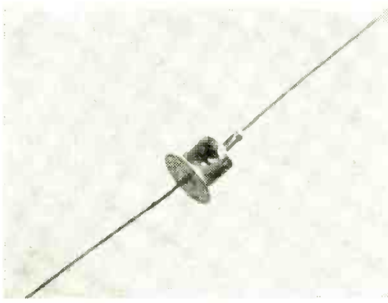


FIG. 6—Diffused-junction germanium rectifier has axial pigtail leads

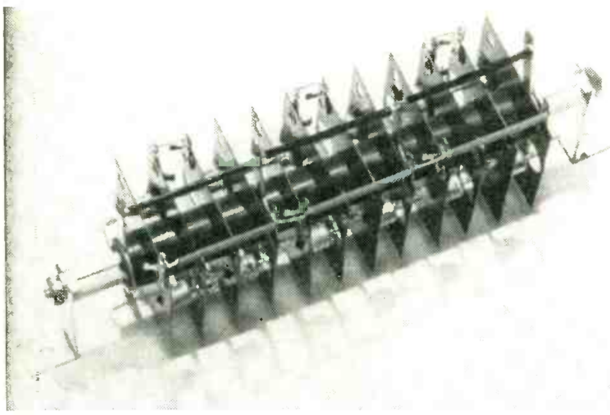


FIG. 7—Stacked germanium rectifiers on radiating fins, rated 70 v rms input per cell and 0.5 amp d-c output to resistive load

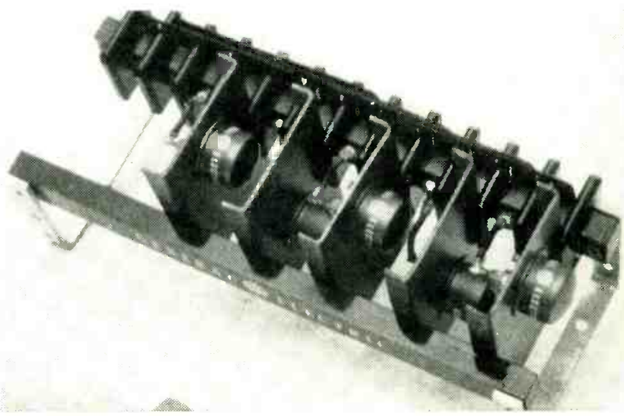


FIG. 8—Stacked germanium rectifiers, under development, provide 5 amp d-c output per cell

its rated temperature range. Most rectifiers are designed to dissipate heat at rated current at 25 to 35 C above the ambient temperature.

Forward voltage drop of a selenium rectifier has a slightly negative temperature coefficient. Thus best regulation is obtained for operation near the maximum safe temperature. Voltage regulation of a single-phase full-wave rectifier is between 10 to 15 percent, depending on voltage, current density and size of cell. The greatest change in voltage occurs between zero and 20 percent of full load. Leakage current remains substantially constant with temperature for an applied voltage of 18 v per cell for a cell processed to 26 v. At lower voltages, leakage current increases with temperature. At higher voltages, leakage current decreases with temperature up to the rated maximum temperature.

Germanium Rectifiers

Radically smaller than previously developed metallic rectifiers is the germanium rectifier which manufacturers are introducing. General Electric's diffused-junction rectifier exemplifies the trend. The cell approaches 100-percent efficiency (98 to 99 percent in a three-phase rectifier), has low forward resistance and high back resistance (ratio of reverse to forward resistance of 400,000 to 1), is hermetically sealed for reliability and is rated for operation in ambients to 55 C. The smaller cells are supplied with pigtails as in Fig. 6. For higher ratings the cells are on brackets and carry radiating fins, as in Fig. 7. Several such cells can be stacked to provide usual circuit configurations and ratings from 35 v rms input and 0.3 ampere d-c output to 630 v rms input and 2.0 amperes output, the later assembly being about 7 inches long with square radiating fins about 1½ inch on a side.

Several styles of germanium cells are manufactured. Typical operating characteristics (absolute maximum at 55 C) are: 200 v peak inverse voltage, 0.3 amp peak forward current (current density may be as high as 300 amperes per square inch or 2,000 times the current density for a selenium cell), 100 ma d-c output current, 25 amperes d-c surge current, and 65 v continuous reverse working voltage. Full-load voltage drop is 0.5 v; leakage current at rated peak inverse voltage is 1.9 ma. These cells can be stored without damage at 85 C and will operate to 50 kc without appreciable frequency effect.

General Electric plans to introduce the germanium rectifier of Fig. 8, rated for 5 amperes d-c yet only one-fourth the size of comparable metallic rectifiers. Another rectifier can also be expected shortly from them; it will be rated for 200 peak inverse volts and 35 amperes, with construction as in Fig. 9.

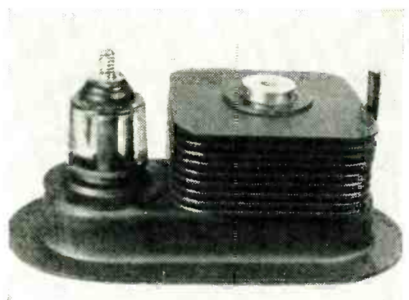


FIG. 9—Developmental germanium cell expected to provide 85 amperes d-c

The cutaway drawing in Fig. 10 shows a germanium power rectifier developed by Transistor Products. Three cooling fins enable the germanium crystal mounted at one end of the metallic tube to conduct an average of 400 ma without overheating. The complete assembly occupies only half a cubic inch. A comparable selenium rectifier occupies six times this volume.

Performance of equivalent germanium and selenium cells is indicated by their volt-ampere characteristics in Fig. 11. The germanium cell has a higher ratio of forward to reverse resistance and a lower shunt capacitance. Resonance of rectifier capacitance with load inductance during the reverse half of a cycle, producing an oscillatory reverse current as shown for the selenium rectifier, is unlikely with a germanium cell.

Silicon

Silicon power rectifiers are now available with junction areas of 0.05 sq cm that pass 200 amperes per sq cm of forward current at 1 v. Characteristics of such cells as developed at Westinghouse Electric Corp. show a rectification ratio in the order of 10^5 at normal ambients, decreasing to 10^3 at about 200 C. Operation at a peak inverse of 100 v appears practical with an output of 6.5 amperes d-c. At temperatures in the vicinity of 65 C, efficiency is about 98 percent. Whereas germanium rectifiers fail abruptly if overloaded, silicon rectifiers pass excessive reverse current if subjected to overload; if de-

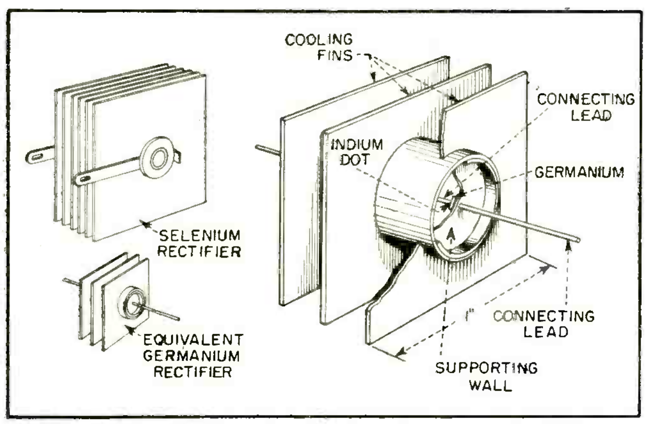


FIG. 10—Construction of germanium power rectifier (Transistor Products, Inc.) and comparison with equivalent selenium unit

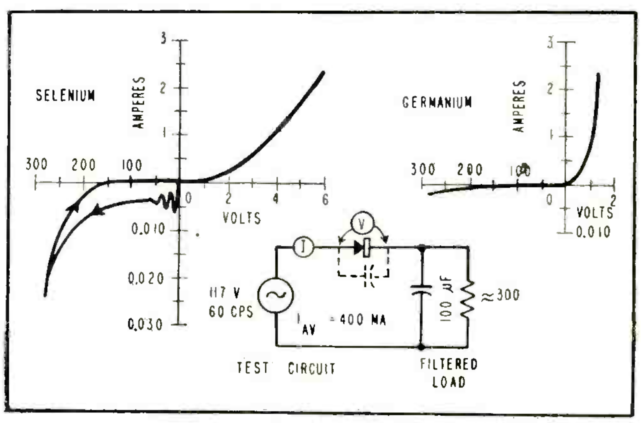


FIG. 11—Volt-ampere characteristics of selenium rectifier and equivalent germanium rectifier (Tranisistor Products, Inc.)

COMPONENT DESIGN TRENDS

- Silicon power rectifiers give warning of failure when overloaded
- Rectification ratios of 100 to 1 are obtained with silicon cells at 200 C ambient
- Silicon and germanium rectifiers have practically infinite life and efficiencies upwards of 98 percent at normal ratings
- Units utilizing rectifying interface between bismuth and titanium dioxide show promise in lab for high-temperature applications

tected, this can be used to control the power demand in time to protect the rectifiers and associated circuit.

Engineers at General Electric anticipate that silicon rectifiers can surpass other types for operation at high temperature and can provide the extremely low reverse currents so desirable in magnetic amplifiers, as well as withstand greater reverse voltages.

A comparison of a silicon rectifier with comparable selenium and thermionic rectifiers in Fig. 12 shows what can be expected in an actual circuit. A surge-limiting resistor is used with the selenium rectifier, whereas the internal resistance of the silicon rectifier limits its surge current and gives better overall regulation.

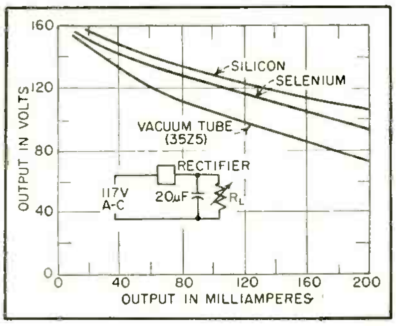


FIG. 12—Regulation curves of three rectifiers (Transitron Electronic Corp.)

The low leakage current of silicon cells makes practical operation to 100 C ambient temperature; peak inverse voltage actually increases slightly at high temperatures. Germanium power rectifiers, on the other band, pass substantial reverse current at 100 C, requiring severe derating.

For comparison, Fig. 13 shows a selenium rectifier and a silicon cell, both with the same ratings. For operation above 75 C an 8-inch aluminum plate with at least 2 square inches of area per cell is recommended as a heat sink. The cathode connection (case) can be electrically insulated from this sink with a thin mica washer without seriously decreasing the ability of the assembly to dissipate heat.

The silicon rectifiers developed at Transitron Electronic Corp. under a contract with the U. S. Army Signal Corps are capable of efficient operation from −60 to +150 C. within ratings, silicon and germanium rectifiers have practically infinite life.

Titanium-Dioxide Cells

With the goal of developing a dry-disk rectifier for operation at ambient temperatures from −65 to +200 C, several materials have been studied at Battelle Memorial Institute. Principal effort has been on titanium dioxide. Experimental rectifiers are produced by oxidizing titanium disks in oxygen at from 825 to 900 C to form a thin adherent film of oxygen-deficient titanium base. This semiconducting film is anodized in a sodium hydroxide solution to improve surface homogeneity. Bismuth is vacuum-evaporated onto the surface to form the counterelectrode. The rectifying barrier region is the interface between the titanium dioxide and the bismuth.

In such a rectifier, leakage current becomes appreciable above about 20 v (0.2 ampere per square inch). Forward rectifier resistance decreases in a reproducible manner as ambient temperature increases. Reverse resistance increases reproducibly as temperature decreases from room level, but when ambient temperature increases, changes in reverse resistance are less predictable. Usually efficiency increases at elevated temperature. Figure 14 shows the observed range of characteristics caused by temperature variations from 65 C to 200 C.

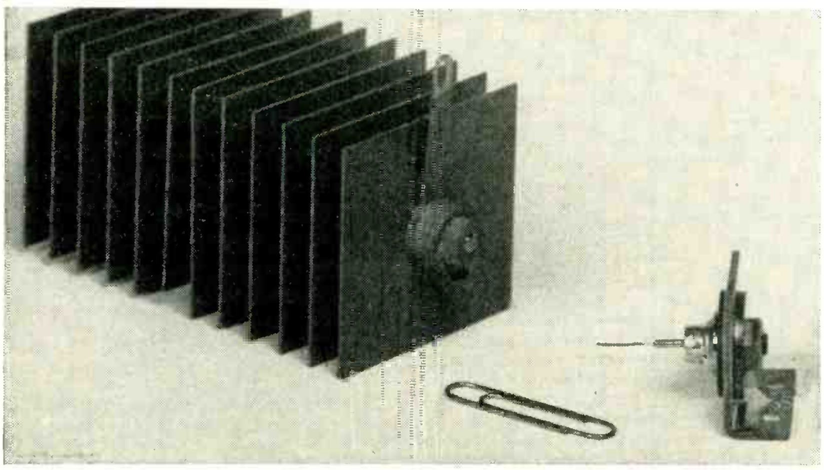


FIG. 13—Relative sizes of silicon junction rectifier (right) and conventional selenium rectifier having the same power-handling capacity

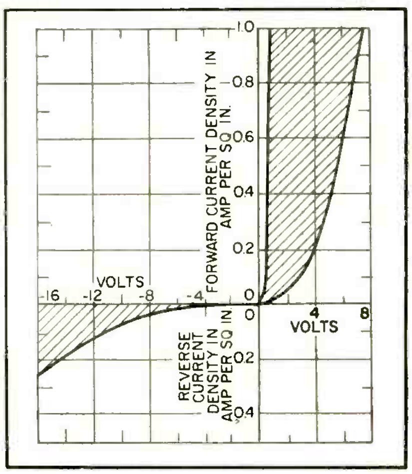
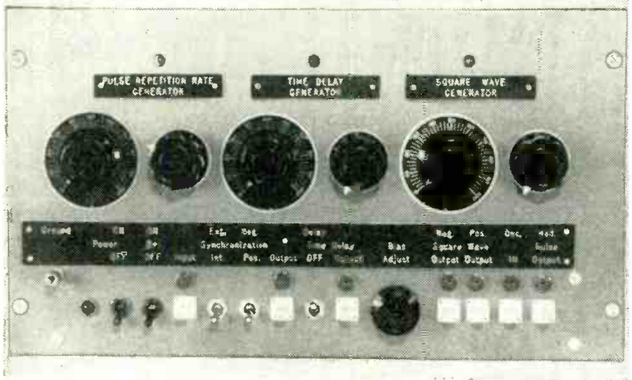
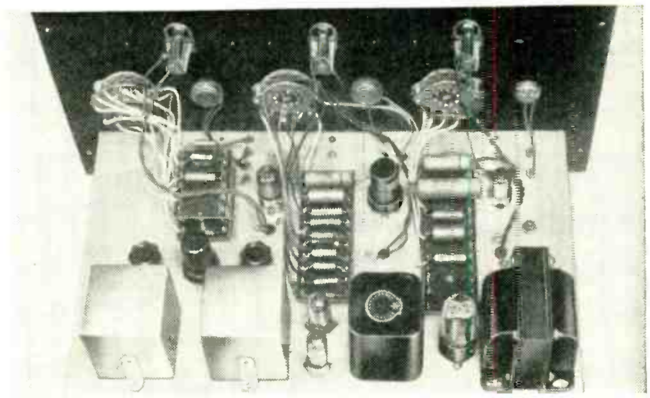


FIG. 14—Effect of temperature on titanium-dioxide cells. Shading shows range.





Front and rear views of sonar target simulator. Tip-jack test points above outlets on front panel permit oscilloscope monitoring

Sonar Target Simulator

Artificial echoes are produced by combination of repetition-rate, time-delay and square-wave generators, for range of 0 to 4,000 yards, to facilitate servicing of sonar equipment. Pulse rate is variable from 3 pulses per second to 1 pulse per 6 seconds

By KNOX M. COLOGNE and EDMUND H. MARRINER

Electronics Engineers
U. S. Navy Electronics Laboratory
Point Loma, California

WITH INCREASED use of sonar equipment, both in the U. S. Navy and in industry, there has developed a need for test equipment to produce an artificial echo for servicing, just as an artificial test pattern is used to check television receivers.

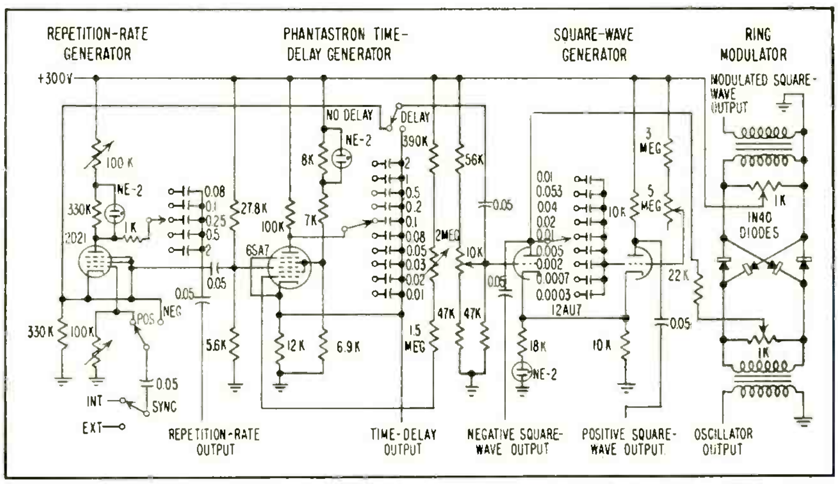
Such an instrument has been developed at the Navy Electronics Laboratory in connection with the evaluation of sonar equipment. It comprises a pulse-repetition generator, time-delay generator and square-wave generator, all enclosed in one cabinet for compactness and handling ease.

The repetition-rate generator simulates the pulse-repetition rate of the sonar set and has a range from 3 pps to one pulse every 6 seconds. This is accomplished by a thyratron circuit, which can be triggered internally or externally to lock in with a particular sonar set.

The pulse-width generator produces a square-wave pulse modulated with any desired frequency. Pulse width can be varied from 0.5 to 300 milliseconds and can be delayed a given time after the repetition-rate generator has initiated the signal to simulate range. The delay, or range, is achieved by a phantastron circuit and can be adjusted over a range of 0 to 5 seconds, corresponding to a distance range of 0 to 4,000 yards.

Variation in time for all three generators is obtained by changing the R-C time constants in the phantastron circuits. The three potentiometer and capacitor banks are placed on the panel and on top of the chassis for accessibility.

Pilot lights in each circuit indicate circuit operation and aid in trouble shooting. All output jacks are 290-U coaxial fittings. A tip jack above each outlet facilitates oscilloscope monitoring of the signal.



Target simulator combines repetition-rate, time-delay and square-wave generators in one unit. Neon lamps show if circuits are operating

Modern Fifty-Kilowatt

Doherty amplifier modified for grounded-grid operation conserves driver power and avoids neutralization problems. Other features include switchover for reduced-power operation at night and simplified water-cooling system

By W. M. WITTY

General Manager
Continental Electronics Manufacturing Co.
Dallas, Texas

IN THE 50-KW broadcast transmitter to be described the basic Doherty amplifier[1] shown in Fig. 1A has been modified to realize certain fundamental advantages in r-f amplifier design. The carrier amplifier is operated with its grid at ground potential insofar as signal is concerned. The excitation voltage is applied to the directly heated cathode which is maintained above ground potential by a special reactor through which the filament power is fed. The grid of the tube is completely bypassed to ground by capacitors.

The carrier amplifier does not require neutralization since its grid acts as a grounded shield between cathode and plate.

In the conventional r-f linear amplifier that must handle a modulated signal, it is necessary to employ heavy loading on the driver to improve the regulation of the excitation voltage. This swamping resistor loading often consumes more power than is utilized in the form of grid current of the driven stage. In this cathode-driven arrangement, the cathode reactance is effectively in series with the output plate load circuit. Consequently the driving power applied to the cathode is also delivered to the load circuit. This results in the driver being effectively swamped by the resistance of the antenna or load circuit and the need for the conventional swamping resistor is eliminated. This means that no driver power, other than that represented in grid current, is lost or dissipated and that excellent swamping is accomplished.

The 50-kw transmitter is normally supplied with a 5-kw driver. This driver is a complete 5-kw transmitter and switching facilities are included that permit instantaneous cut back to 5-kw during nighttime hours if the station license specifies this mode of operation. The transmitter may also be obtained with a 10-kw driver if the user is licensed for 10-kw at night.

Since the output power of the 5-kw driver is utilized in the antenna circuit, less power is required from the 50-kw power amplifier. Actually this has been determined to be somewhere in the vicinity of 45 kw for a nominal 50-kw output from the transmitter.

An advance network is normally used in the carrier tube grid circuit

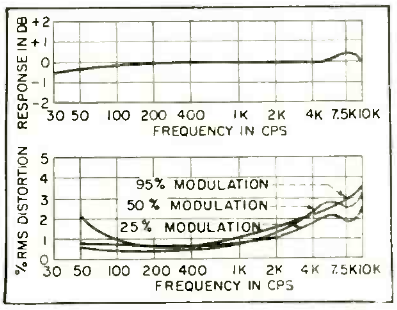


FIG. 3—Performance of transmitter, showing frequency response (top) and distortion (bottom)

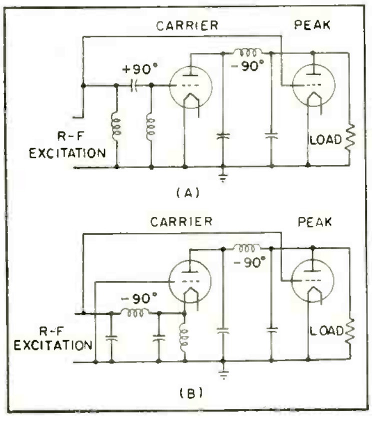


FIG. 1—Conventional Doherty amplifier (A) and grounded-grid version (B)

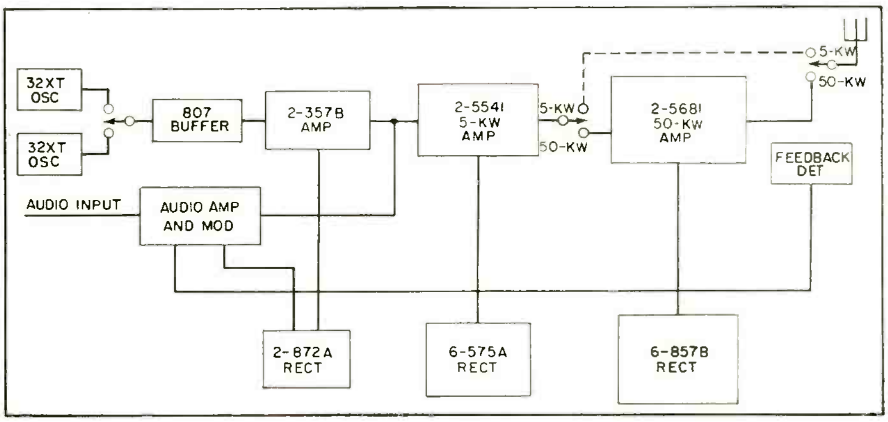
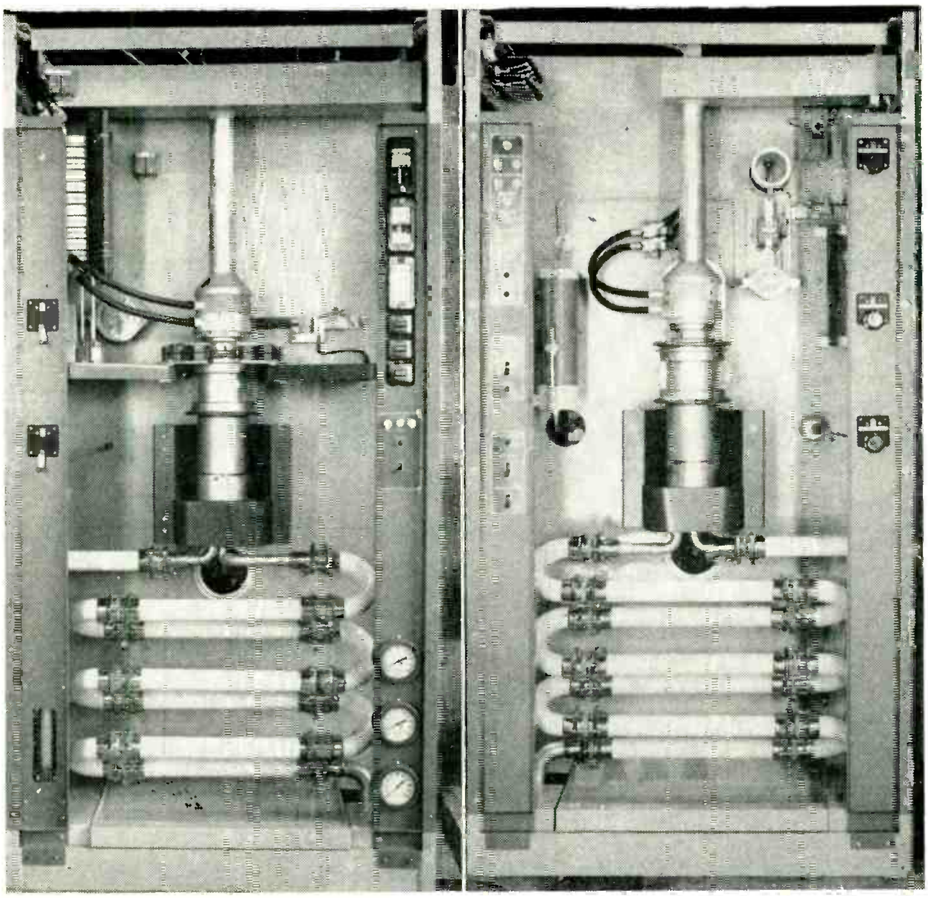


FIG. 2—Complete 50-kw transmitter, showing power switchover provisions for daytime and nighttime operation

Broadcast Transmitter



Fifty-kilowatt final amplifier. Closeup view of carrier amplifier shows grounded-grid arrangement (left). Peak amplifier is shown at right

of the conventional Doherty system to correct for the phase lag incurred in the impedance-inverting network in the plate circuit. The combination of these two networks restores the phase relation of the carrier output to the same as is present in output of the peak tube which is driven directly by the excitation source and which is directly connected to the load.

To obtain in-phase relations of the two tubes in the load circuit of the modified r-f amplifier, the phase-advance network in the grid circuit has been supplanted by a lag network connected between the driver and the cathode of the carrier tube as illustrated in Fig. 1B. This phase-lag network is a pi section constructed of variable components and usually adjusted for a 90-deg shift.

Since a pi network of this type has the characteristics of a low-pass filter, an added advantage is realized in that additional harmonic suppression occurs between the driver source and the cathode of the carrier amplifier.

The transmitter utilizes two ML-5681 power tubes in the output stage. One of these is the carrier amplifier and one is the peak amplifier. They are shown in the photographs. The ML-5681 is a coaxial-terminal, thoriated-tungsten-filament triode capable of 50-kw output up to 110 mc. Mechanically it features an integral anode water jacket and a quick-change, leak-proof bayonet type water coupling. The tubes are conservatively operated at 12.5 kv and excellent anode cooling is accomplished by a unitized water cooling system furnished in duplicate. An air-cooled version of the transmitter is also available. Figure 2 is a functional block diagram of the complete type 317 50-kw broadcast transmitter.

The transmitter proper is contained in six cubicles which require a floor space 22 × 5 ft. Power components are all of the dry type and are furnished with an enclosure that occupies approximately 100 square feet at the rear of the transmitter. The water-cooling system requires about 100 square feet.

Extremely good performance and stability are obtained from the type 317 transmitter with an overall efficiency from power line to antenna of better than 50 percent. Performance data are contained in the curves of Fig. 3.

REFERENCE

(1) W. H. Doherty, A New High Efficiency Power Amplifier for Modulated Waves, *Proc IRE*, Sept. 1936.

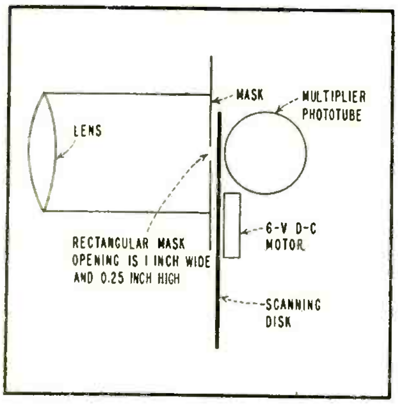


FIG. 1—Simplest optical arrangement of scanner-type dimmer

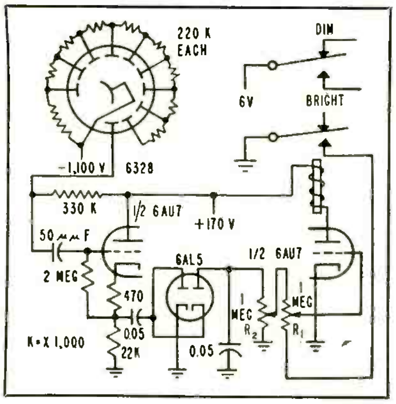


FIG. 2—Circuit uses special automotive type multiplier phototube

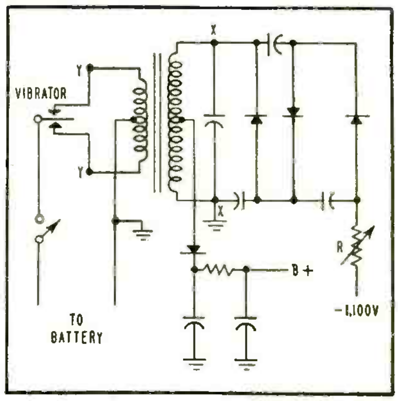


FIG. 3—Selenium-rectifier voltage tripler for phototube dynodes

Scanning Disk Improves

Use of inexpensive small motor to drive Nipkow scanning disk in front of multiplier phototube makes automatic headlight dimmer independent of general illumination yet sensitive enough to detect oncoming headlights at 1,500 feet and taillights at 300 feet

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HEADLIGHTS of an automobile are of necessity a compromise. A large output of light is desired to floodlight the road, yet the light must not blind the driver of an oncoming vehicle. The compromise arrived at in present-day cars is to provide the headlights with two beams, so a lower beam can be selected when another vehicle appears. Until quite recently this has been done by the driver. The advent of multiplier phototubes having the required sensitivity for use in lowering headlights automatically made the automatic headlight dimmer possible in various types that are now in production or in the laboratory.

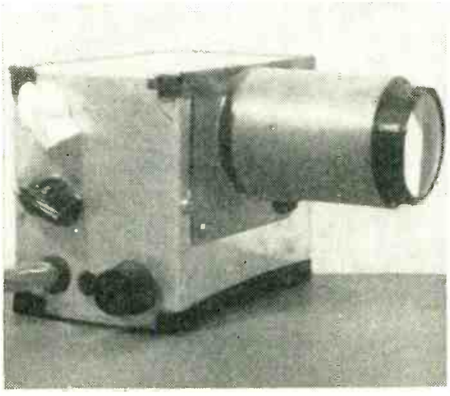
A headlight dimmer should detect the headlights of an opposing vehicle at about 1,500 feet and should detect taillights at approximately 300 feet. This latter requirement is necessary to avoid the annoyance and danger of blinding the operator ahead by the reflection of the high-beam headlights in his rearview mirror. The dimmer, moreover, must be such that if it lowers the lights before the opposing car does so, it must keep the lights down when the opposing car lowers its lights.

An ideal headlight dimmer should not respond to lights other than those of an automobile. It should not respond to light coming from the sky during the transition hours between day and night, nor should it respond to moonlight, to the light of illuminated signs and particularly to the reflected light of its own headlights.

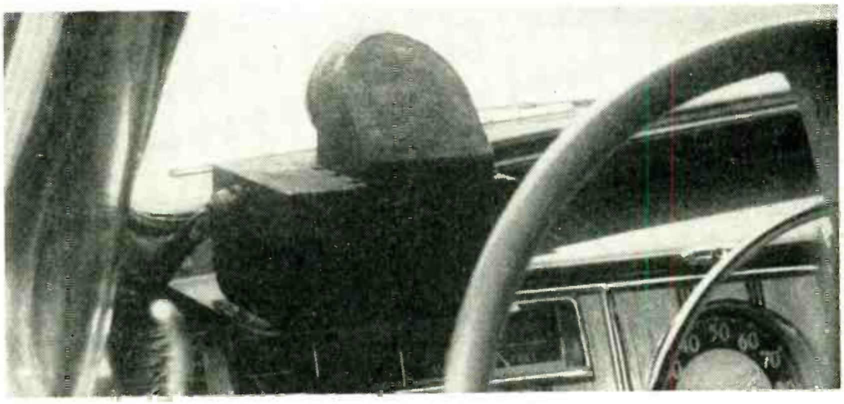
Total-Light Dimmers

Up to now, dimmers have operated on the principle of gathering a portion of the light from the entire field of view covered by the optical system of the device. A dimmer of this type sees not only opposing headlights, but also the ever-present light from the sky, from illuminated roadside signs and the very considerable amount of light from the car's own headlights reflected by the road surface and the objects around it. The gain of such a device must, therefore, be adjusted and maintained between two rather critical limits. The gain must be high enough to respond to dim headlights at a distance but must not be high enough to respond to the other sources of light or to cause oscillation by picking up the reflected light of the car's headlights.

The difficulties stated above hold true regardless of whether the dimmer is of the d-c type or employs a chopper to convert the received light into pulses. An incidental disadvantage of a total-light dimmer is that it becomes more sensitive to headlights as the background illumination increases. This is directly opposite to the effect required to reduce the effect of glare on the driver's vision. In the presence of high ambient light, he can tolerate brighter spots of light. An ideal dimmer, from the point of view of



Experimental model of oscillating-mirror headlight dimmer that increases selectivity



Method of mounting dimmer in automobile for tests. Unit here is made more compact by mounting scanning disk horizontally and using mirror to bend light beam

Auto Headlight Dimmer

minimizing danger from glare, should have its highest gain in total darkness.

Scanner-Type Dimmer

The dimmer described in this article meets most but not all of the ideal requirements. It differs from other dimmers developed thus far, in that it employs a scanning system which almost completely suppresses the background illumination yet keeping the dimmer sensitive to small intense light sources.

Figure 1 shows one of the early models of this scanner-type dimmer. A small Nipkow scanning disk driven by a permanent-magnet d-c motor is mounted just ahead of the phototube opening and arranged to scan the complete field of view during every revolution. The openings in the disk are a function of the quality of the lens; the better the lens and the sharper the image of a headlight that it produces, the smaller can be the openings in the disk. In the model illustrated, these holes are 0.015 inch in diameter, arranged in a spiral so that each hole overlaps the next approximately by 50 percent.

An ideal scanning disk would have only one hole before the mask opening at any one time. The opening in this case is 0.25 inch high and 1 inch wide. An image of this size with a lens of 85-mm focal length gives satisfactory coverage of the field of view ahead of the car. A large disk would be needed to meet the one-hole-at-a-time requirement. No effort to meet this requirement was made and several holes are present in the image field at all times. While this causes more pickup of extraneous light, the area of the holes is still so small in comparison to the area of the whole field that suppression of background light is adequate. The exact ratio of suppression is the ratio of the area of the holes in the image field to the area of the entire image field.

How Circuit Works

The phototube used is the type 6328, automobile equivalent of the 931A. A voltage of 1,100 volts is applied across a string of dynodes, as shown in Fig. 2. The power supply, shown in Fig. 3, is conventional except that a voltage tripler is used to obtain the high negative voltage. Special transformers are available which, together with high-voltage rectifiers, can be used in place of the selenium rectifier voltage tripler.

The output of the multiplier phototube is fed to a cathode follower through a small coupling capacitor which differentiates the spikes of voltage produced by the scanning system and thus produces positive and negative voltage pulses at the grid of the cathode follower. The output of the cathode follower is fed to a 6AL5 voltage-doubling peak detector which in turn feeds the triode that operates a relay. This relay controls the headlights directly.

The circuit is so arranged that when there are no bright spots in the field of view, the relay is energized. It remains energized until the peak detector produces a negative voltage in response to light signals of sufficient magnitude to reduce the current through the triode and release the relay.

To eliminate the oscillations that would occur at the threshold condition of sensitivity if the opposing vehicle also dimmed its lights, a holding circuit is provided that raises the sensitivity of the device by a factor of approximately 10 when the lights are down. This circuit uses an additional set of contacts on the relay to make the output tube grid bias voltage more negative simultaneously with the dimming action. Potentiometer R_1 controls the gain when the headlight dimmer is in bright condition. When the relay is in the dim position, R_1 is disconnected from ground, thus raising the voltage on the grid to the value determined by master gain control R_2. The voltage differential actually produced by these two potenti-

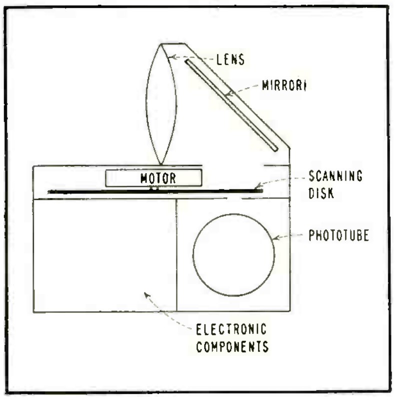


FIG. 4—Method of using mirror

ometers need not be 10 to 1 because the relay has considerable differential between its pull-in and release voltages. This differential can even be made great enough to eliminate the special grid circuit. The ease of adjustment of the two potentiometers makes them preferable for experimental use, however.

Alternative Arrangement

An alternative optical arrangement is shown in Fig. 4. The optical path is bent by a 45-degree mirror so that the Nipkow disk is horizontal, resulting in a more compact assembly.

The motor in Fig. 4 is of the a-c synchronous type used in clocks. Its windings are connected to points X-X in the power supply circuit of Fig. 3. A better arrangement would be to use a low-voltage motor connected to points Y-Y. A pneumatic motor driven by the vacuum of the engine may also be employed, since speed regulation of the Nipkow disk is of little consequence. A preferred speed from the point of view of noise and life of bearings is approximately 1,000 rpm. The lower limit of the speed is determined by the time constant of the detectors and the relay. The upper limit is controlled by the pass band of any amplifier that may be used and by mechanical considerations.

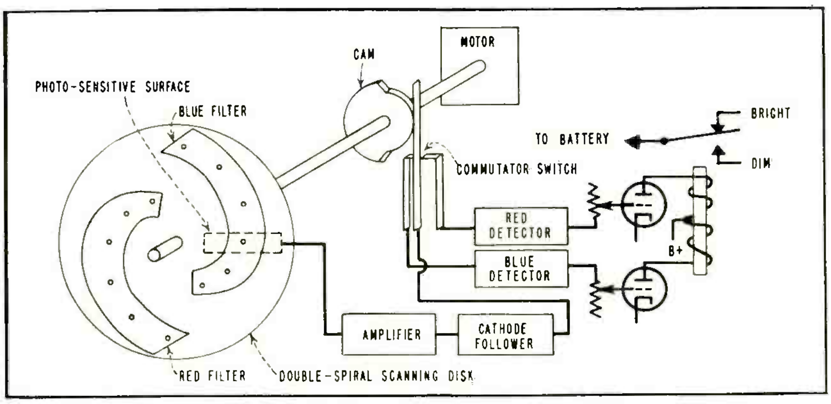


FIG. 5—Dual-channel circuit gives high sensitivity for taillights

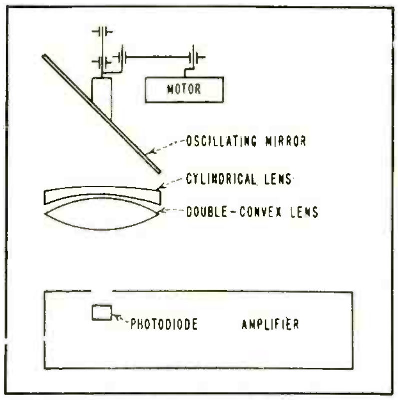


FIG. 6—Oscillating mirror scanner

Voltage Regulation Problem

No provision was made in the experimental models to take care of voltage variations of the battery supply in the automobile. These variations may be as great as 3 volts and are quite serious because the amplification of a multiplier phototube is particularly sensitive to voltage. It was found that by adjusting power supply rheostat R in any particular car installation, with the lights on and the engine running at cruising speed, satisfactory results were obtained. Here the voltage and gain drop when the car is standing still and the battery not charging.

In commercial versions of headlight dimmers, automatic voltage regulation is employed and such difficulties are avoided. A string of neon lights has been used successfully to regulate the voltage fed to the phototube but primary regulation with a variable resistance of the high-temperature-coefficient type is more economical.

Taillight Problem

The type 6328 phototubes are unfortunately blue-sensitive, while the peak energy of taillights and headlights is in the infrared. Red-sensitive multiplier phototubes are available, but at present are far too expensive for use in this application. To raise the gain for red taillights as far as possible without raising the gain for white headlights, a red color filter may be used over the lens. This, however, does not equalize the gain sufficiently. Even through a red filter, headlights are so much brighter that if the taillights were picked up at 300 feet, the headlights would be seen at several miles.

A method of overcoming this problem is now being developed, using the arrangement of Fig. 5. A double detection system is employed which is sensitive to red light and blue light separately. A special Nipkow disk has two spirals of holes, each designed to cover the entire field of view during one revolution of the wheel. One of the spirals is covered by a red filter and the other by a blue filter. The phototubes, while not being particularly red-sensitive, nevertheless are sufficiently sensitive when used with the additional amplifier to detect taillights at the correct distance. The overall gain to headlights under these conditions is much too great. A bucking circuit responsive to blue light is therefore employed to reduce the gain when blue light is present in the source being detected.

When the red half of the scanning disk is in front of the phototube the output of the amplifier is proportional to the energy in the red end of the spectrum of the light being detected. The resulting spikes of voltage are passed through a commutating switch to a peak detector for red that operates a relay in the manner shown. If no blue light is present, this is all that happens.

If headlights are being detected,

voltage is also developed at the output of the blue detector. This output is made to pass through an additional coil in the relay to buck the current in the red coil. By properly adjusting the two grid-circuit gain controls, the sensitivity to white light can be made as low as desired.

Use of Phototransistors

The availability of photodiodes and phototransistors with high sensitivity to the red regions of the spectrum has led to efforts to adapt them to headlight dimmers. Figures 6, 7 and 8 show such an experimental device. Because of the small area of sensitivity in the usual photodiode, a different method of scanning is employed. Instead of using a Nipkow disk, the whole image is moved relative to the diode.

The ideal method would be to use a photocell of extremely small area, of the order of the image of a headlight when the latter is approximately 1,000 feet away. Moving such a small photocell in a zig-zag fashion over the entire image would give the largest possible signal-to-noise ratio. Mechanical difficulties are encountered in doing this fast enough, however.

In the more practical arrangement of Fig. 6, the photodiode is stationary and a 45-degree mirror is oscillated through a small arc to cover the entire field of view. The double convex lens focuses the light from this field of view on the plane of the diode. As the mirror oscillates, this image moves across the diode from left to right and back again.

To eliminate the need for a vertical scan, a cylindrical lens is used over the main lens in such a manner as to produce a line image of each point of light, instead of the normal circular image. If this line image of a distant headlight is made approximately 0.25 inch high, a portion of the illumination from all lights in the field of view will impinge upon the photocell once during each scan of the mirror. The resulting loss of efficiency is justified by the simplification achieved.

It was found that germanium photodiodes followed by a two-stage triode amplifier as in Fig. 7 are sufficiently sensitive for automobile dimmer applications. The chief drawback of these cells is their lack of stability. Sensitivity varies with temperature, necessitating adjustable voltage and/or load control for each diode. Automatic stabilizing methods are now being tested. A later photodiode model uses a ground-surface mirror to serve the function of the double convex lens. This permits use of the simpler and more compact design of Fig. 8.

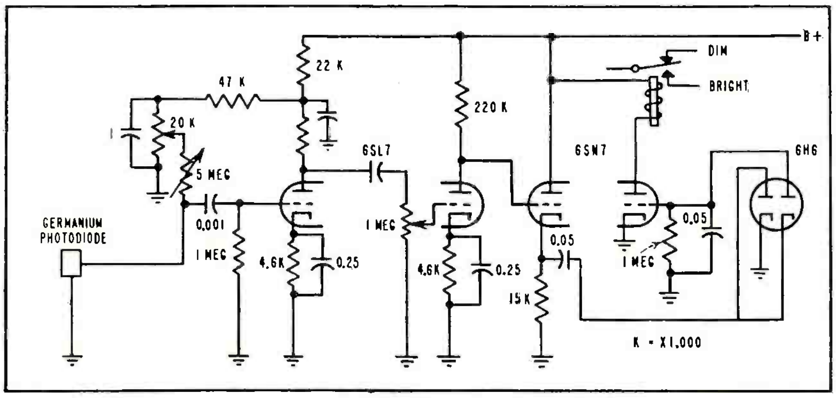


FIG. 7—Method of providing required amplification for photodiode

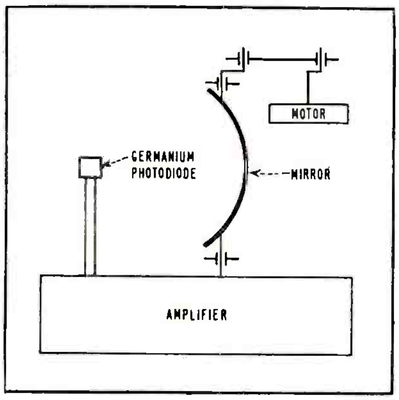
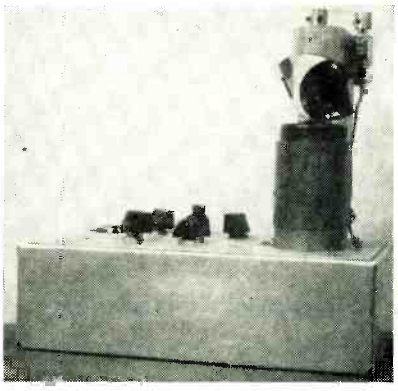


FIG. 8—Combining lens with mirror



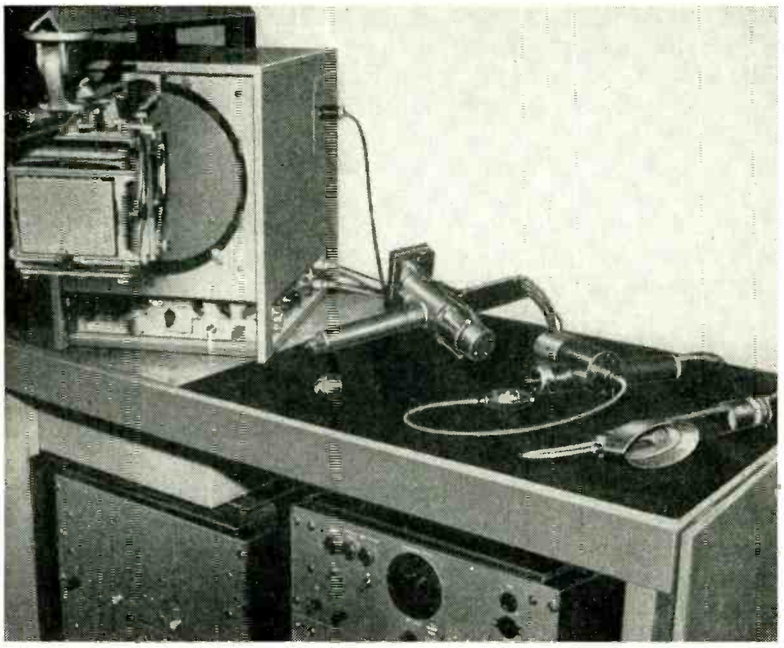
Experimental model of scanner-type dimmer using optical system of Fig. 1

The need for cylindrical curvature in either the lens or the mirror can be avoided by having the photodiodes made in the shape of a thin line so that the vertical position of the light would be of little consequence. Whether the signal-to-noise ratio in such a device would be better or worse than that obtained by optical stretching of the light is at present unknown.

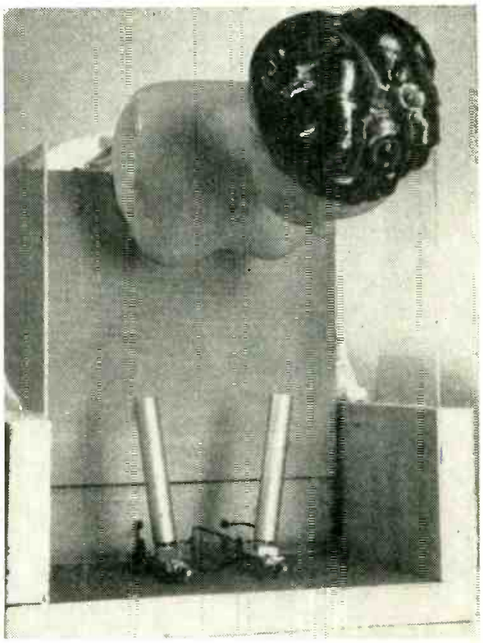
If large-area photocells can be developed having low noise and sufficiently high sensitivity, then scanning disks or drums of conventional type will be as useful here as they are with multiplier phototubes. An intriguing possibility exists in using a simultaneous system of analysis of the image of the field of view by using a mosaic of small photocells. If and when such photocells and their attendant amplifiers are economically available, this approach should lead to headlight dimmers that retain the great advantages of scanning without the need for moving parts.

With presently available equipment it is possible to build an excellent device for the automatic control of headlights, having all the features reasonably desired. It is even feasible to use 120-cycle filters in the output of the dimmer, so arranged that the dimmer can distinguish and disregard street and house lights which are normally operated by a-c, responding only to automobile lights which are d-c operated. The present problem is to design a headlight dimmer that can be manufactured at a cost sufficiently low to receive widespread acceptance by the automobile industry.

The Front Cover



New electronic equipment used for cancer detection. Left to right: cathode-ray display unit and camera; vaginal sector-scanning crystal applicator with tip removed to show crystal mounting; ppi bowel-scanning crystal applicator; body surface scanning crystal applicator of type shown on the cover



Model of one method for systematically scanning the breasts, suitable for mass surveys. Motor reciprocates transducers at the bottom of a large water-filled tank

Ultrasonic Ranging

EARLY WORK on human tissues with an A scope presentation indicated that the amount of sound returned from cancer tissue was greater than the amount of sound returned from equivalent normal tissue.[1,2,3] Conversely, non-cancerous lesions returned less sound than normal tissue. These results suggested that direct visualization of tumors in the tissues could be realized. Direct visualization would provide additional information for subsequent evaluation.

The basic echo-ranging apparatus (Echograph)[1] transmits a 1-μsec pulse of ultrasound at a carrier frequency of 15 mc and a repetition rate of 1 kc. A thickness-resonant, air-backed, x-cut quartz crystal is used as a reciprocal electro-acoustic transducer. A 15-mc superheterodyne receiver is connected in parallel with the transmitter across the crystal to detect pulses reflected from the tissues. The indicator unit is an oscilloscope which displays the video signal from the receiver on a time base triggered by the transmitter. This provides an A scope display.

Preliminary experiments with two-dimensional displays similar to a radar sector scan[4] were sufficiently encouraging to justify more elaborate equipment. The scanning equipment used was a simple modification of the original A scope. It had the drawbacks inherent in intensity-modulated displays presented on ordinary electrostatic cathode-ray tubes.

The scanning apparatus now in clinical use[5] consists of the crystal applicator units (Echoscopes), an electromagnetic cathode-ray tube display unit and the basic echo-ranging apparatus.

Applicator Unit Design

The design of applicator units is conditioned by electronic, mechanical and medical factors.

Electronically, an applicator unit consists of a crystal separated from the tissues by a suitable sound-conducting medium (water). The water delays the echo-signals from the membrane in Fig. 1 until the transmitted pulse, stretched by the crystal, decays below the receiver threshold level. The water also fills in the irregularities existing between the tissue surface and the line of crystal travel.

Mechanical design problems lie in providing a scanning motion and in coupling the driving energy to the crystal.

B Scan Echoscope

Medical aspects of design are chiefly concerned with the ability to apply instruments to desired sites with the minimum of discomfort to the patient.

The B scan instrument, applied to the skin to investigate tissues, is shown sectionally in Fig. 1. The instrument is hand-held and applied over the suspected area. To obtain

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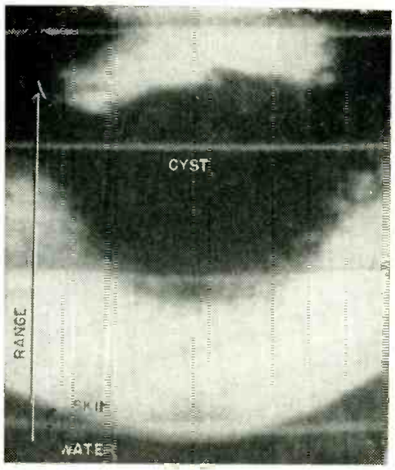

FIG. 2—Liquid-filled cyst within the tissues. Echoes from tissues on far side appear as bright area extending to limit of range. Eange marks are 1 cm apart

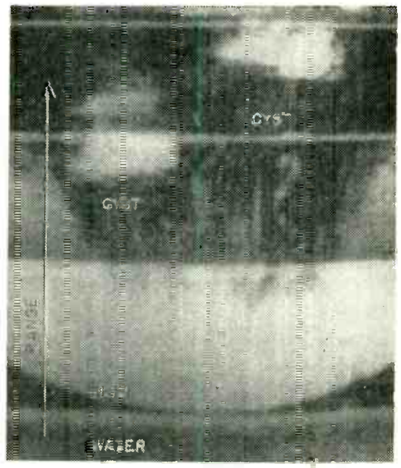

FIG. 3—Double cyst filled with jelly-like substance and cellular debris that may account for lack of clarity compared to Fig. 2

Early detection of cancer and identification of tumors are made possible by new ultrasonic techniques and equipment. Surface scanning of the breast for cysts and tumors gives two-dimensional display on cathode-ray tube. Water acts as sound-conducting medium between tissues and quartz crystal transducer

Speeds Cancer Diagnosis

maximum skin coverage, the crystal reciprocates within the elliptical water chamber instead of pivoting on an axis in the manner of the conventional B scan.[4] The crystal is driven at a constant velocity within the water chamber by means of a dual-direction screw. This keeps the sound beam normal to the axis of reciprocation throughout the 6.5-cm range of movement.

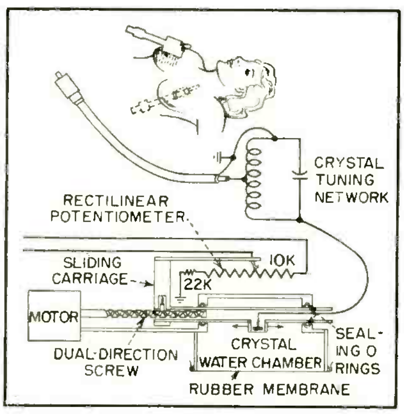

FIG. 1—Composite view of body-surface scanning crystal applicator. Sketch at top shows how the instrument is applied to the breast

In use, the chamber is filled with degassed distilled water and sealed with a 0.003-inch rubber sheet. The length of the water column is 3.5 cm.

The transmitted pulse of ultrasound is partly reflected from the membrane and travels back to the crystal. It is reflected from the crystal to travel back through the water column to the rubber membrane. The second echo returning from the membrane masks any echoes from tissues deeper than 3.5 cm.

A rectilinear potentiometer is coupled mechanically to the reciprocating crystal-supporting rod to obtain positioning information for the scanning line.

Some records obtained with the instrument are shown in Fig. 2 through 6.

Figure 2 is of a large nonmalignant breast cyst. At operation, it was found to be filled with watery liquid.

Two cysts in the same breast lump were diagnosed in Fig. 3. The contents were found at subsequent operation to be jelly-like and contained cellular debris.

A solid nonmalignant tumor was recognized (from prior work) in Fig. 4 as the area of less dense signals occurring in denser normal tissue. The forecast was found to be correct at subsequent operation.

As was expected from pilot studies, cancerous lumps were recognizable as an area of dense signals in a less dense normal background in Fig. 5.

The records in Fig. 6 are of interest, since they were the first recognizable records taken of cancer in living tissue. Echographic examination of the inflamed nipple at right showed the bright area not found in the normal nipple at left. The diagnosis of cancer was proven correct at operation when a cancer 7-mm in diameter was found in the nipple. This cancer could not be felt by the attending surgeons.

Sector Scan Echoscope

Some of the first two-dimensional representations of tissue irregularities were obtained by modifying the original apparatus to display a sector scan.[4] Although unsuitable for the present type of skin work, sector scanning is useful for sites to which access is restricted, such as the womb and the brain (after removal of a piece of skull).

A preliminary instrument is shown in exploded view in Fig. 7.

The instrument, designed for examination of the mouth of the womb, has a projecting tube with a crystal cartridge mounted on pivots at the end. The end of the instrument is domed to facilitate easy insertion and has a slot cut out to permit emergence of the sound beam.

A positive-drive rubber belt drives the crystal cartridge through an angle of 120 deg. The belt is connected to a shaft within the main body of the instrument.

A scotch yoke drives the shaft through a rack and pinion gear. The shaft then moves in simple harmonic motion. A crank, turned by a small d-c motor and a worm reduction gear, drives the Scotch yoke. The blanking cam is attached to the crank shaft as shown. The sweep resolver is connected directly to the crystal drive shaft.

In use, a thin rubber balloon is tied over the end of the instrument and the entire tube is filled with degassed distilled water. After the instrument is inserted, more water is run into the instrument until the balloon is distended to fill the vagina. Thus, connection of the crystal to the tissues through clean, degassed water is assured. The whole of the end of the vaginal vault is explored by rotating the instrument.

A mercury column in a polyvinylchloride tube is used to connect the high-voltage pulse to the crystal cartridge, which is immersed in water.

Multi-strand flexible wire rapidly succumbed to the acute flexing. In later designs, it is hoped to use water-sealed rotating contacts.

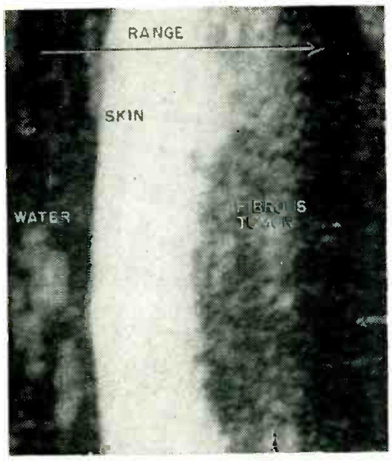

FIG. 4—Solid, nonmalignant tumor recognized as a mottled area at a range in which normal tissue gave a denser pattern of echoes

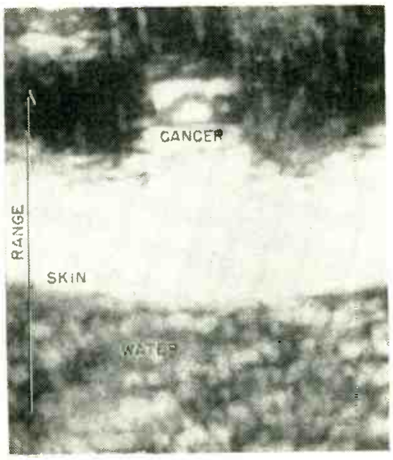

FIG. 5—A small nodule of the breast shows up as bright area at a range where normal tissue produced less dense echo patterns

PPI Echoscope

For the investigation of tissue tubes such as the alimentary tract, and including the prostate and possibly the internal female genitals, the ppi presentation of data is most suitable.

A pilot instrument, having a sound head small enough for examination of the rectum, was constructed to iron out the mechanical details of construction pending the development of a smaller sound head suitable for swallowing.

A drawing of the instrument is shown in Fig. 8. A small d-c motor and a worm reduction gear drive a shaft. One end of the shaft drives a sweep resolver and the other end drives the high-voltage cable assembly. The crystal lead is fed through a slip ring and coaxial cable. The outer plastic sheath of the standard coaxial cable is removed. The coaxial cable is attached to the crystal mount and is used to drive the crystal unit. A flexible metal sheath covered by a thin polyvinyl tube surrounds the coaxial cable.

In use, a thin rubber balloon is tied onto the outer polyvinyl tube and onto the small peg on the end of the crystal mount. The peg runs on a bearing. The system is filled with degassed distilled water and inserted into the rectum with the balloon deflated. After the balloon is in the rectum, the balloon is filled with water to give the desired spacing between the crystal and the balloon.

A similar instrument has been constructed for investigation from the mouth. This will allow investigation of the food passage and surrounding structures, the stomach (which when empty forms a tube), and further into the bowel. Except for cancer of the head of the pancreas, cancer of the small intestine is rare, so that the necessity for the laborious procedure necessary to examine the small intestine does not arise.

This instrument has a smaller and more highly refined flexible drive and awaits the construction of a suitable sound head and crystal.

Display Unit Design

The scanning indicator was designed for use with the basic echo-ranging apparatus. Sector scan, B scan and ppi presentations required for the investigation of disease sites about the body are provided. Block and circuit diagrams of the indicator are shown in Fig. 9 and 10. Circuits for generating and positioning the time base sweeps are modified from radar remote-indicator circuits.[6] The marker generator and deflection amplifiers are modified from those in the AN/APS-2 that supplied a deflection yoke and focus assembly and the sweep resolvers.

Video echo signals and a repetition-rate trigger coinciding with the transmitted pulse are supplied by the main circuits of the echograph.

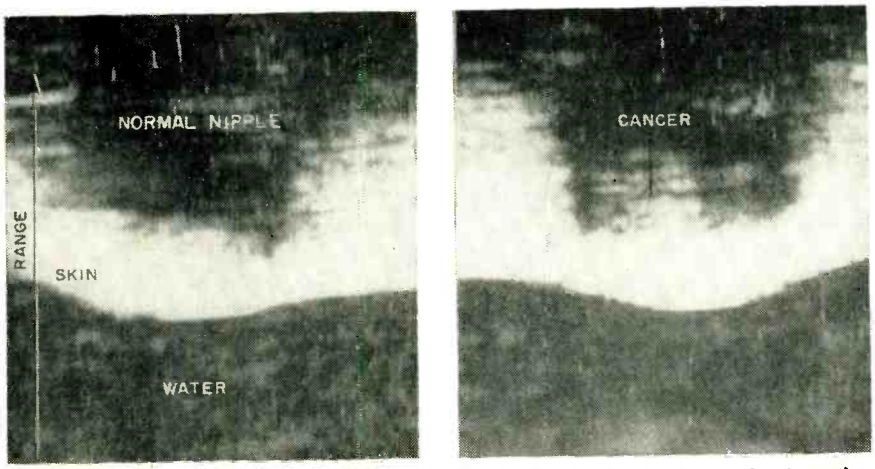

FIG. 6—The normal nipple of a patient is shown at left; the opposite nipple showed a bright area of stronger echoes right. These are the first recognizable records of cancer in living tissue. Basic echo-ranging equipment transmits a 1-μsec pulse of ultrasound at a carrier frequency of 15 mc

Video input at a 10-volt peak level drives the 12DP7 cathode through a one-stage amplifier and a limiter. A rooter stage may be switched in to give gamma correction. The output voltage of this stage is the 2.2 root of the instantaneous video-input signal, to correct for the curvature of the 12DP7 grid-voltage control characteristic.

The repetition-rate trigger synchronizes the range-sweep generator in Fig. 11, which produces sweeps of 60 to 300-μsec duration. These speeds are faster than those for which the original components were designed. Thus trouble was encountered in obtaining a linear start on the sweep. The sweep generator adds a spike to the leading edge of the usual step-plus-sawtooth voltage waveform. This provides a linear start by rapidly charging the stray capacitance across the resolver.

The spike is produced by differentiating the rectangular sweep multivibrator output with the short time constant of coupling capacitor C_1 and R_1 in Fig. 10. The positive spike across R_1 causes diode V_1 to conduct so that the spike appears across R_2. This resistor also causes the step to appear on the sweep waveform as in the conventional circuit. The feedback sweep amplifier provides a low-impedance output from V_2, the cathode follower output stage.

When using ppi or sector scan, the sweep output is split by the resolver into x and y components. The sweep amplitude is proportional to the cosine and sine, respectively, of the angle of crystal rotation. The resolved sweep voltages deflect the crt beam through single-stage, push-pull sweep amplifiers. Double-triode clamps are used at the grids of these amplifiers to determine the starting position of the sweep. This position may be off-centered one radius horizontally and two radii vertically to allow a sector display to be spread out over most of the screen.

B Scan Circuitry

A ppi-to-B transfer switch reroutes the range-sweep voltage so that the same crt may be used for both displays. In the B scan display the range sweep is applied only to the vertical-deflection amplifiers. Transformer T_1 loads the feedback sweep amplifier about the same as the resolver rotor, with the necessary phase inversion provided by $V_{3,4}$. The horizontal position of the range sweep must follow the side-to-side displacement of the crystal. A rectilinear potentiometer with

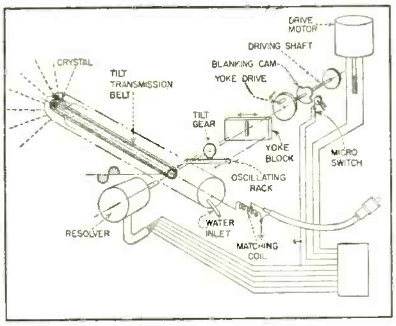

FIG. 7—Mechanical details shown by the exploded view of the sector-scanning crystal applicator

the arm coupled mechanically to the crystal travel is, in effect, a horizontal centering control. The ppi-to-B switch transfers the grid of horizontal deflection tube V_4 from the clamp to the arm of the potentiometer that has 40 volts d-c applied across it. The transfer switch also removes the clamps from the grid of V_5 and the bypass capacitor from the common cathode resistor of the horizontal amplifier, so that the deflection is essentially push-pull.

Retrace Blanking

Provision is made for blanking the crt spot during the retrace time of the range sweep and on one direction of the mechanical sweep. Retrace blanking for the range sweep on both B and ppi operation is provided by V_{1B} in Fig. 11. Normally, conduction of V_{1B} lowers the grid voltage on the crt, which is then cut off by the positive potential on its cathode. A negative gate from the range multivibrator cuts off V_{1B} during the sweep so that the plate voltage rises to a value determined by voltage divider R_1 and R_2, unblanking the crt. Stray capacitance limits the rate of rise of the unblanking voltage so that the entire transmitted pulse does not appear on the screen. The range marks also appear on the crt grid.

Mechanical retrace blanking is provided for the two oscillatory scanning motions, sector and B scan. This forestalls trouble if the scope pattern shifts between the two directions of motion because of backlash or beam tilt in the mechanical drive. The mechanical arrangement is dictated by clinical considerations, such as ease of handling and insertion, as well as space limitations within the patient. The extra work required to eliminate the backlash would be prohibitive. In the sector-scan instrument, the motor drive shaft carries a cam to actuate a snap-action switch during one direction of scan. Closing the switch when the blanking switch is on grounds the plate of V_{1B}, preventing unblanking of the range sweep.

On the B scan instrument no mechanical member has a unique position dependent on the direction of scan. Therefore blanking is derived from the horizontal sweep

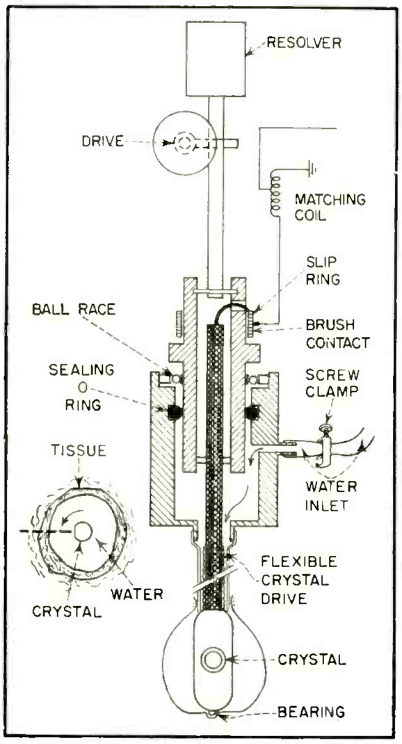

FIG. 8—Composite view of rotary scanning ppi crystal applicator, with mechanical details shown in section

voltage. This is a triangular wave with a period of about one second at normal scanning speed. The derivative of this sweep will be a square wave, whose flat top and bottom can be used alternately to blank and unblank the crt spot. The sweep voltage is differentiated by C_1 and R_3 and then amplified by V_2.

The two voltage levels are determined by cutoff and grid current at the grid of blanking tube V_{3B}. Returning grid resistor R_4 to B+ insures that the tube normally conducts. This lowers the potential at the plate end of the load resistor, which is the intensity control, to 60 volts. This is the normal condition for operation with all the scanning heads.

When the blanking square wave from the B scanner goes positive, V_{3B} grid current charges coupling capacitor C_2, the grid acting as a d-c restorer. The spot intensity remains constant during this part of the cycle. When the blanking square wave goes negative, its voltage is added to that on C_2, cutting off V_{3B}. This allows the intensity control voltage and the crt cathode voltage to rise to B+, cutting off the spot. Coupling capacitors C_3 and C_2 are too small for faithful reproduction of the square wave, but the tube has sufficient gain so that the limiting action determines the flat top. Several shunt capacitors are required to eliminate the effects of hum and transient pickup on the wires to the scanning head.

Refraction of the sound beam at the membrane is not a serious problem, since the velocities of sound in tissue and water differ by less than 10 percent. The difference in attenuation, however, is large. This has required changing the sensitivity time control circuit in the receiver. The control compensates for the attenuation of sound in the tissue by making the receiver gain an increasing function of time after the first skin signal is received.

With the hand-held crystal probe, the time delay for the water column was constant and was provided by a delay multivibrator. In internal scanning the crystal-tissue distance varies, and the time delay must be adjusted accordingly. A gating circuit is being added to the receiver to select and shape the rubber membrane echo to serve as a trigger for the sensitivity time control channel.

Systematic Scanning Systems

One of the problems in the control of cancer is the insidious onset. The victim may not have symptoms until the cancer has spread from its original site and has attacked a more vital part of the body. At present, the only hope of curing cancer is removal of the primary growth at the earliest possible moment. The problem is to find the growth in an apparently healthy individual.

Experience has enabled the medical profession to specify the most common sites of cancer, so that instrumentation designed for a mass survey of these sites could detect cancers early enough for cure.

Development of a reasonably accurate blood test would greatly help in screening subjects, but the problem would still remain of locating the cancer. Present methods of diagnosis of early cancer at common sites such as the stomach and the lower bowel are costly, time-consuming and are not suitable for screening a population at regular intervals. There is no method at present to detect directly small masses of abnormal tissue buried within the normal tissues.

There is some hope that suitable ultrasonic instrumentation can be developed to make practical the examination at common sites of a large number of subjects.

The clinical studies carried out on the living human breast were conducted to determine the nature of or diagnose lumps discovered in the breast (diagnose malignant or

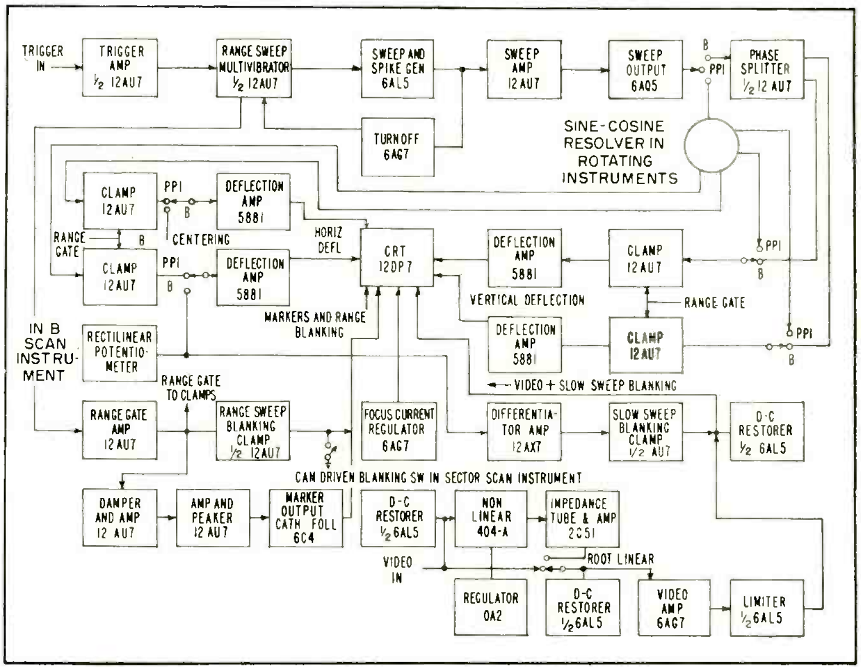

FIG. 9—Functional block diagram of the indicator. An unregulated oscillator supply provides 6 kv for the crt

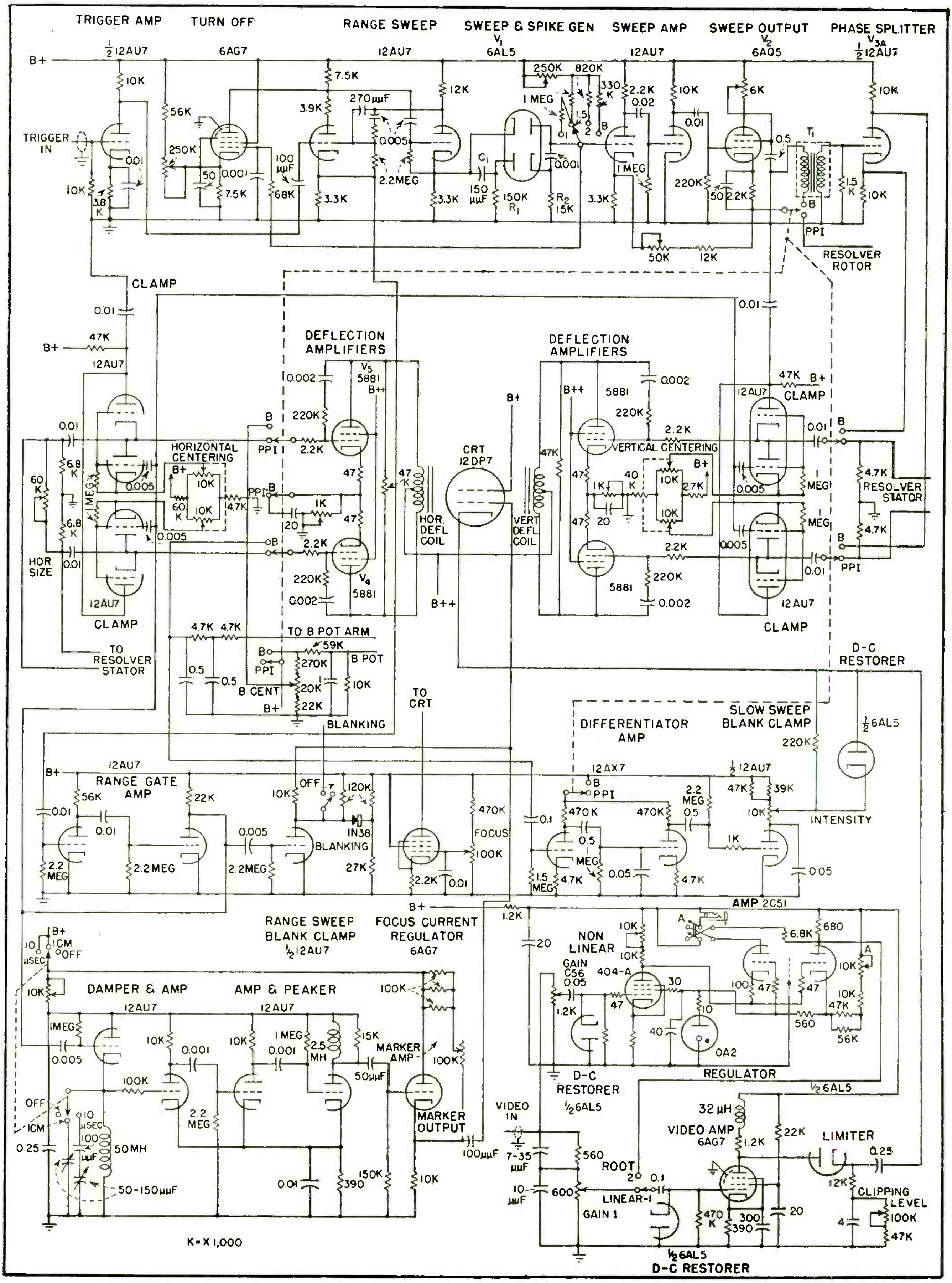

FIG. 10—Schematic diagram of the scanning indicator. One power supply provides 330 volts at 200 ma for the deflection amplifiers and focus coil. A regulated supply furnishes 275 volts at 250 ma for all other tubes

nonmalignant conditions.

It is probable that instrumentation can be developed to search the breasts for abnormal masses of tissues which cannot be felt. This would be detection.

A model of such a system is shown in the photograph. The subject would lie with the chest submerged and both breasts would be scanned simultaneously by two sound beams emanating from the bottom of a tank of degassed water. Several ways of using the information obtained from such a system are possible; comparable areas on each breast could be compared or each breast could be scanned.

For work in the alimentary canal where relative locations are difficult to determine, and the sound beam cannot be directed by hand or eye as in the case of the breast, a systematic search of the area is obligatory for detection of tissue abnormalities.

Pilot instrumentation designed for systematic scanning of the lower bowel up to ten inches from the anus is already far advanced. This is a common site for cancer.

The system is arranged as shown in Fig. 12. The echoscope is designed to be inserted into the bowel from the anus. The crystal is mounted on a rod with a machined screw thread so that the crystal moves to the exterior helically as the instrument is held fixed relative to the patient.

A snap-action switch actuated by a dog on the crystal drive shaft energizes a single-pole double-throw latching relay. One position of the relay holds the camera shutter open; the other advances the film. The shutter will thus be open during the duration of every other rotation and each picture will be a complete section.

This arrangement provides information in three dimensions. One dimension is obtained from the range sweep; the second is obtained from the mechanical rotation of the direction of range sweep and the third is obtained by indexing the plane of the first two dimensions along the axis of the instrument.

The time required to complete the range sweep is in the order of microseconds. The mechanical rotation takes approximately 1 second to complete, since the crystal must not move more than one-half the beam width during the duration of the range sweep. The third dimension is longer still, since the indexing along the axis of the instrument may occur only once per revolution of the crystal.

This slow rate of indexing permits the use of present two-dimensional equipment in obtaining records, since one complete two-dimensional record can be made for each of the index positions.

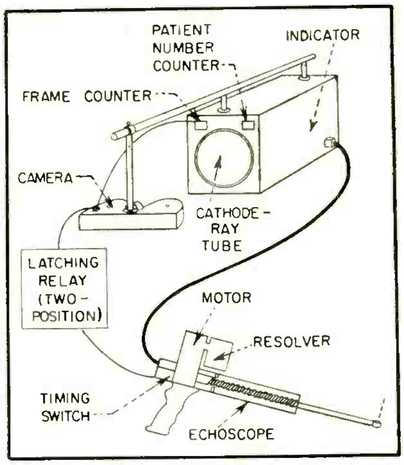

FIG. 12—Equipment for three-dimensional mass rectal scanning. Crystal follows a helical path with alternate revolutions photographed

Apart from convenience, the system of multiple two-dimensional records has advantages medically over the three-dimensional display which would involve considerable additional equipment. The three-dimensional display would give little information on the internal structure of a tumor as compared to the multiple two-dimensional display, which is essentially a serial sectioning of the tissue.

The authors are indebted to Robert Benassi, James Dimond and Paul I. Wolf of St. Barnabas Hospital for their considerate help in the preparation of this paper. This investigation was supported by a research grant from the National Cancer Institute; Department of Health, Education, and Welfare; U. S. Public Health Service.

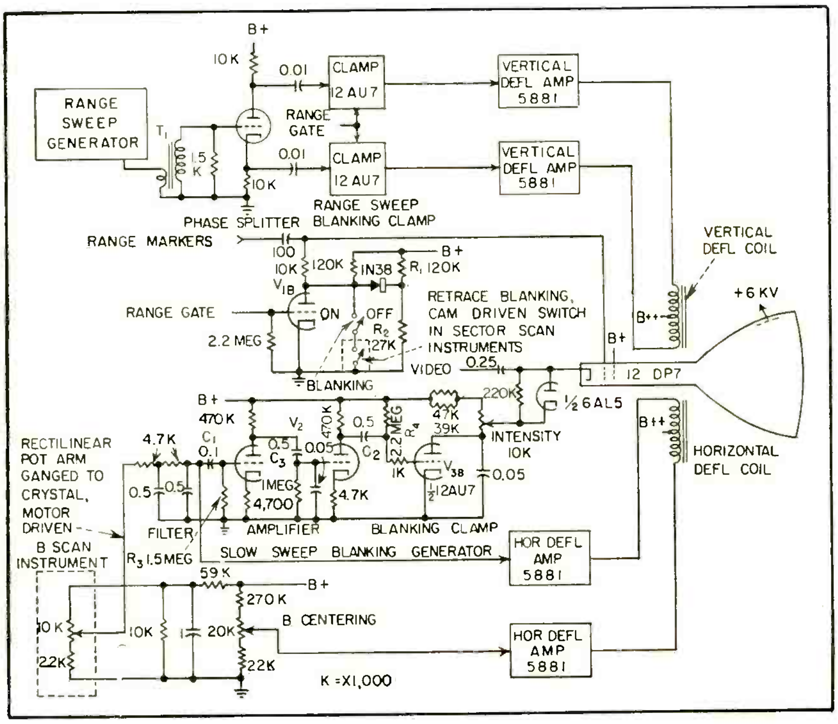

FIG. 11—B scan and retrace blanking circuit, with B-ppi transfer switch shown in B position

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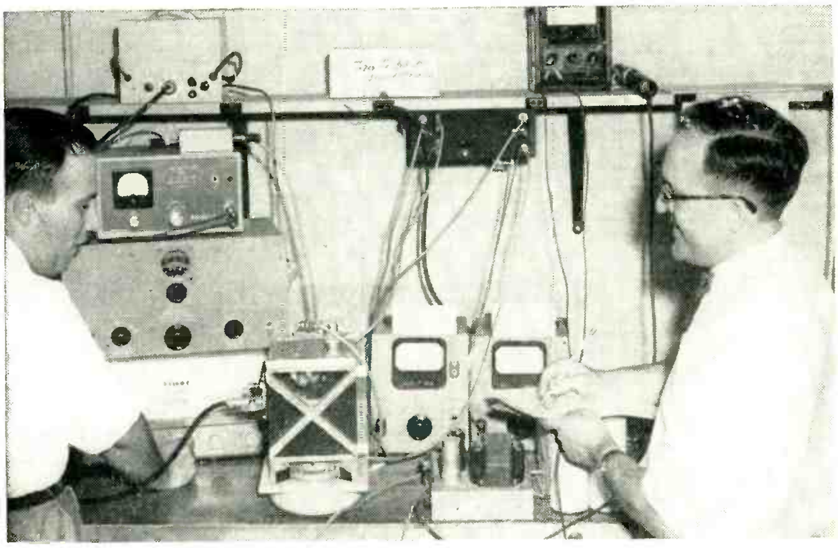
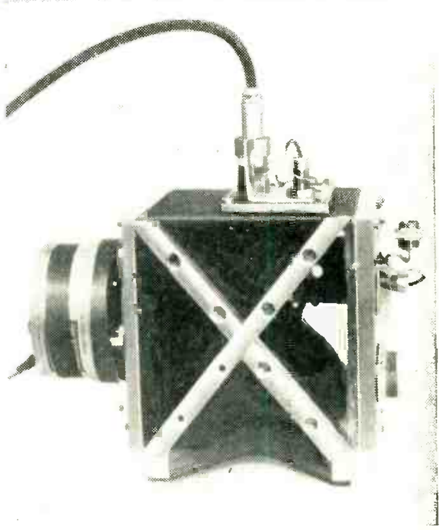


Typical operating setup of test chamber. Tube under test is visible through plastic window in high-intensity noise chamber



High-intensity sound chamber with driver and sensor elements

Testing Airborne Electronic Components

High-intensity noise chamber tests electron tubes, relays and other parts for use in jet aircraft and guided missiles. Tests help produce components designed to withstand high levels of acoustical noise encountered in actual operation

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USE OF JET and rocket engines in aircraft and guided missiles creates a significant noise problem. Sound intensities encountered are sufficiently high to affect adversely the reliability of electronic components, particularly vacuum tubes. In view of the amount and complexity of the electronic equipment aboard a modern military aircraft or guided missile, this lowering of reliability, leading to malfunction or failure, is an important problem.

Mechanical design of electronic components intended for airborne applications requires data on the environmental conditions encountered in use and on reliability of existing electronic components and systems under these conditions. The mechanics instrumentation and vibration group at ARF is engaged in an experimental program for the Air Force concerned with this problem.[1] In connection with the acoustic-testing phase of this program, a simple laboratory device has been designed and built for obtaining moderately high-intensity sound fields. This device consists of a sound chamber based on the reverberant-chamber principle and utilizes inexpensive commercially available components.

Figure 1 shows the sound intensity spectra found aboard and in the proximity of an Air Force jet aircraft. Curve *A* is the average sound level in each octave band measured approximately 10 feet from the tailpipe of the jet engine operating at full thrust. The sound pressure level at the inboard equipment bay is shown by *B*. These two curves do not represent the worst possible conditions but are typical of conditions found in service. Curve *C* is an average sound-pressure level obtainable in the chamber both with random-noise-generator and audio-oscillator input. This is well above the maximum sound level of 139 db encountered at the equipment locations and as such represents a useful test.

Sound Chamber

To achieve high sound level with modest acoustic-power input, a low

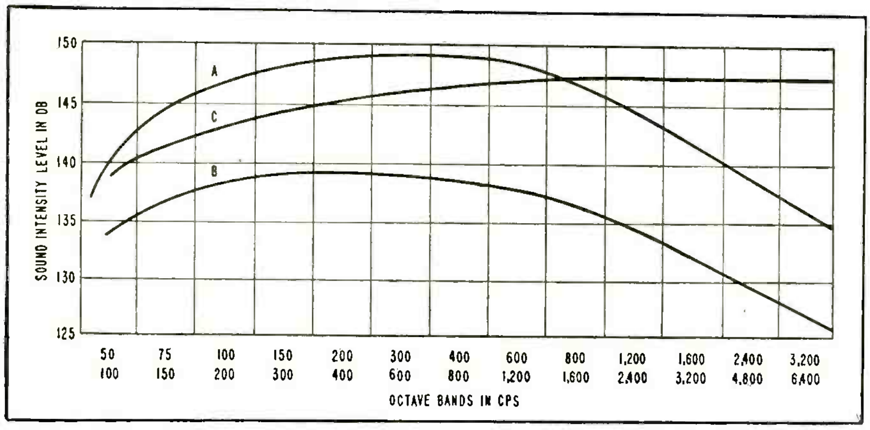

FIG. 1—Typical sound spectra of aircraft jet engine at full thrust measured 10 feet from tailpipe (A), sound level at inboard equipment bay of aircraft (B) and average sound pressure level obtainable in test chamber (C). The 0-db reference level for airborne sound intensity is 10^{-16} watt per sq cm

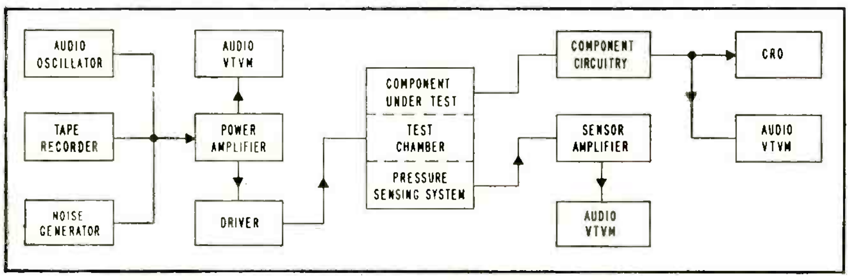

FIG. 2—High-intensity-sound test chamber and associated driving, sensing and monitoring equipment used for testing components

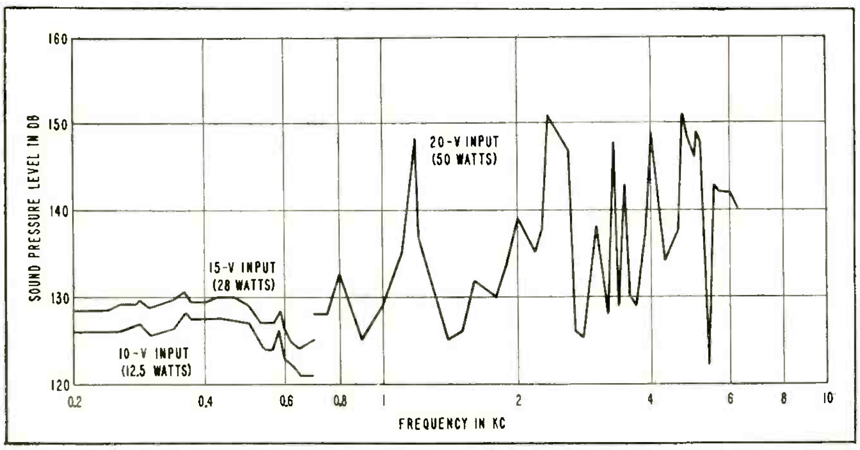

FIG. 3—Sound pressure levels in test chamber at different frequencies for constant voltage inputs. Reference level of 0-db is taken at 2 × 10^{-4} dynes per sq cm

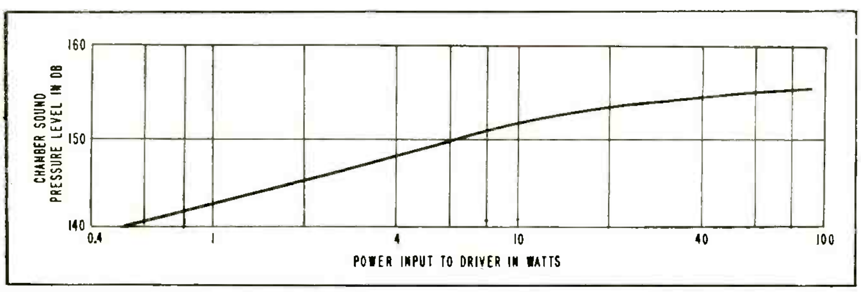

FIG. 4—Sound pressure level in test chamber at test chamber resonance of 2,300 cps. Reference level is same as that in Fig. 3

total absorption is required dictating use of a small chamber with acoustically hard walls and construction.

The chamber shown in the photographs is 6 × 6 × 6 inches. Its sides are constructed from 12-gage sheet metal and reinforced with aluminum ribs. The removable end plates are of ½-inch aluminum and are held in place by studs into the body of the chamber. A 40-watt loudspeaker driver is mounted on the back plate to provide excitation. The front plate mounts the connectors necessary for leads in and out of the chamber.

The only instrumentation directly associated with the chamber is the pressure measuring system. Since it would be impractical to mount the microphone of a commercial sound-level meter within the chamber,

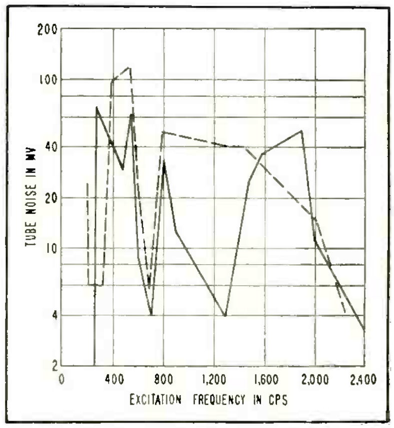

FIG. 5—Microphonics spectra for two tubes in 120-db sound field

special microphones are used.

Three gages may be seen in the photograph of the sound chamber; two are barium titanate pressure sensors,[2, 3] the third is a capacitor microphone designed for measurement of fairly high acoustic pressures. Sound pressure level in the chamber is determined by reading voltage output of the microphone on an a-f vacuum-tube voltmeter.

Signal Source

In operation, the basic signal may come from one of three sources, as shown in Fig. 2: an audio oscillator, providing single-frequency sine-wave input; a random-noise generator, which provides sound of a general nature covering the frequency range of 20 to 20,000 cps; or a tape recorder, which provides

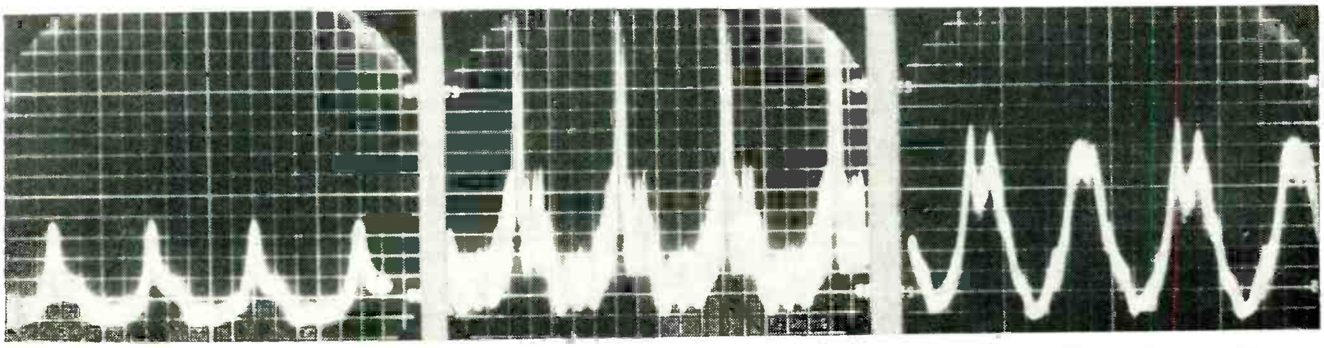

FIG. 6—Relay-contact resistance variations in 130-db sound field. Excitation frequencies are, left to right: 950, 1,000 and 1,400 cps

special signal inputs such as recorded sounds of a jet engine.

The signal source drives a 40 to 50-watt power amplifier to operate the driver at maximum rated input. An a-f vtvm across the driver input ascertains the input power.

The component under test is located in the sound chamber in the area of the windows. The circuitry for the component under test is located outside the chamber. Instrumentation for detecting the effect of the sound field upon the test component is connected to this external circuitry. The oscilloscope and a-f vtvm shown in Fig. 2 are used with electron tube tests.

Calibration

The sound chamber is calibrated by supplying a known amount of electrical power at a given frequency to the driver and reading out the sound pressure level in the chamber by the pressure gages. Figure 3 illustrates the frequency response of the sound chamber at several values of constant-power input. The variations in intensity at the higher frequencies are due to resonances within the chamber. With approximately 50-watts electrical input, sound pressure levels of 145 to 150 db are obtainable. With the random-noise generator used as signal source, this same power level yields a sound level of 140 to 143 db in a frequency band of 20 to 20,000 cps.

Operation from a sine-wave source is particularly useful in determining resonances of components. Figure 4 is based on data taken at 2,300 cps, which is one of the chamber resonances. At these chamber resonances 150 db is obtained with 7-watts electrical input.

Since the microphonic qualities of electron tubes are well known, a 6J5GTW tube was chosen as the first component to be tested.

The tube was mounted in a standard socket at the window end of the chamber and was tested in operation as a capacitance-coupled amplifier with self-bias. The bias, plate voltage, filament voltage and plate current were selected in accordance with JAN specifications; the JAN specification of 75 millivolts of noise was used as the failure or malfunction criterion.

Testing was carried out both with the audio oscillator supplying single frequencies and with the random-noise generator as input. Noise voltage was read with an audio-frequency vtvm and the waveform was viewed on an oscilloscope to determine the nature of the noise.

A test of five tubes, using a 120-db sound field and variable frequency input, indicated a resonance of the grid support structures at about 250 cps. Some of these tubes exhibited a second resonance at about 500 cps. The spectra of tube microphonics in Fig. 5 show these resonances along with several others not disclosed in the vibration testing. A level of 120 db is only a moderately high sound intensity in terms of jet engine sound fields, yet the data of Fig. 5 show microphonic output near or above the JAN specification limit over a large range of frequencies.

Relay Testing

Sensitive relays of the null-seeking variety are used in aircraft and guided missiles as the power amplifying output of the guidance or control servos. While the effects of shock and vibration on those sensitive components are generally recognized, the effect of high-intensity sound is not.

Such a relay was subjected to both single-frequency sound fields and white noise and it was found that 110 db was sufficient to cause disturbance.

The waveforms of Fig. 6 show variations in contact resistance. If the contact resistance had remained constant, the waveforms would have appeared as straight lines. The lower limits of the traces represent the effective zero resistance obtained with maximum contact pressure, while deviations from the lower limit indicate increasing resistance as contact pressure decreases. At the sharp peaks shown for 1,100 cps, the contacts opened.

Testing at single frequencies with the control coils energized to produce positive closing of one set of contacts indicated a band of resonant frequencies extending from 1,000 to 1,600 cps and from 2,200 to 2,500 cps. Resonances in the region of 1,100 to 1,200 cps resulted in intermittent opening of the contacts and thus appear to be the most destructive. The resonances and resultant malfunctions occurred far above the upper limit of frequencies for vibration testing, 55 cps, specified in military specifications for relays.

The test sound-pressure level of 130 db is not unusual for jet aircraft; consequently, this test should not be considered excessively severe.

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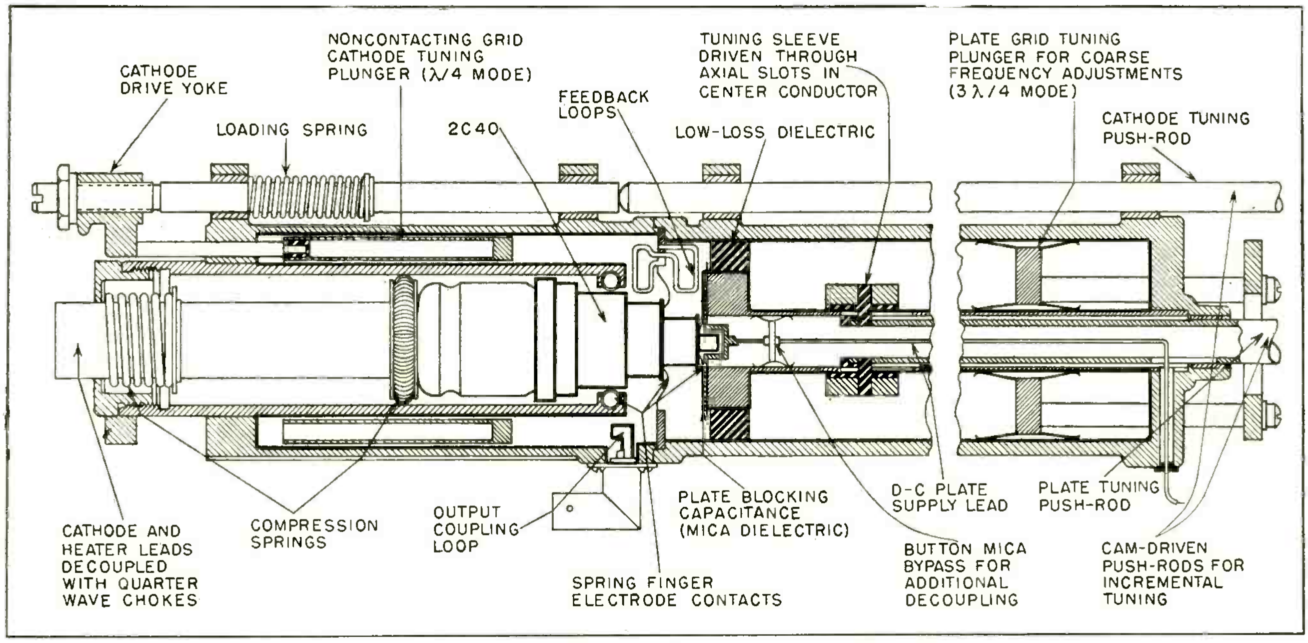

FIG. 1—End-to-end form of grid-separation circuit using a 2C40 oscillator operating in the 1,000 to 1,500-mc region

Designing Stable Triode

Tunable triode in self-excited circuit has excellent short-term frequency stability that does not generally require external high-Q cavities, discriminators or external amplifiers. Output covers frequencies from one to three kilomegacycles

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WITH CARE in design and construction it is possible to build tunable triode microwave oscillators with short-term frequency stabilities of 1 part in 10^8 or better and power outputs of 50 to 100 milliwatts. Such oscillators compare favorably with other means of stable-frequency generation because of their simplicity, tunability and small size. External high-Q cavities, discriminators or auxiliary amplifiers are not required.[1,2,3,4]

Short-term frequency stability here refers to frequency changes taking place in time intervals of hundredths of a second. Long-term stability refers to frequency drifts over periods of seconds or minutes. Mechanically tuned oscillators of this type can use a slow-acting automatic frequency control to make occasional corrections to the average frequency for counteracting long-term drift.[5,6]

Triode Characteristics

Planar triodes offer relatively high inherent frequency stability in coaxial grid-separation oscillator circuits. The susceptibility of the generated frequency to modulation by power supply ripple is 50 to 400 times smaller for a triode than for a reflex klystron operating at the same frequency and without external means of frequency stabilization. Best results are obtained with a triode having an upper frequency limit of oscillation well above the operating frequency; a potential power output at least ten times the required stable output at the operating frequency; high transconductance; extremely rugged physical construction, and low heater power consumption.

Adequate feedback in the grid-separation circuit insures vigorous oscillation over the desired frequency range, but excessive grid current should be avoided. The end-to-end form of the grid separation circuit is illustrated in Fig. 1, a typical oscillator designed for operation in the 1,000 to 1,500-mc region. The folded-back construction is shown in the 3,000-mc oscillator of Fig. 2.

Measurement of short-term frequency stability during this development employed a method involving the heterodyning of the oscillator output against stable harmonics of a piezoelectric crystal oscillator.

It is desirable to minimize the

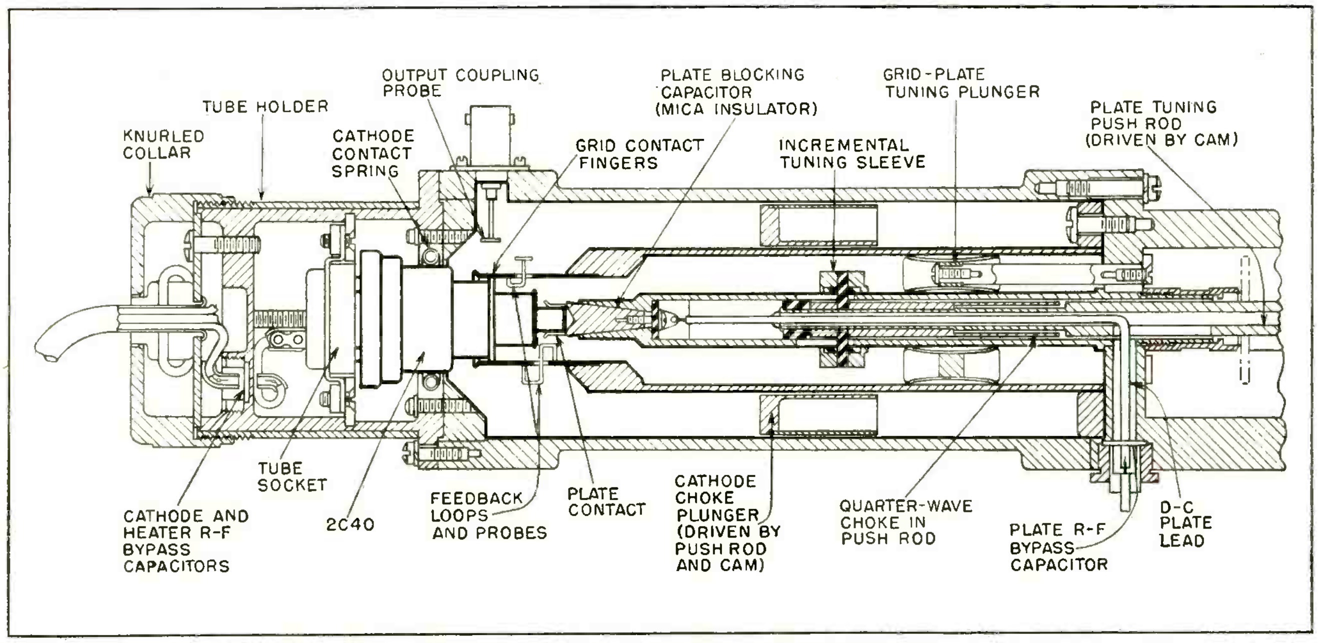

FIG. 2—Folded-back construction, using a 2C40 tube, designed to operate in the 3,000-mc region

Microwave Oscillators

anode and heater input power, consistent with the required power output and the necessity for loose coupling to the r-f load. Low input power minimizes the effects of electrode heating and deformation with a consequent reduction in long-term frequency drift. To produce the required power output with small planar triodes, especially at frequencies approaching 3,000 mc, requires self-bias amplitude limiting in class B or C operation.

Cathode bias is best for triode oscillators tuning over a considerable range. Operation is fail-safe in that cessation of oscillation results in a small plate current. The rise in plate current when oscillation begins serves as a convenient tuning indication. The required bias is produced with relatively little resistance in the grid-cathode circuit and this is helpful in controlling quenching. The nonlinear resistance characteristics of small tungsten lamps are useful for cathode-bias resistances because a degree of automatic amplitude control during wide tuning variations can be exerted by their use.

A tube should be operated well below its upper-frequency limit to avoid excessive dependence of the generated frequency on plate voltage due to transit-time effects. Table I indicates results achieved with oscillators using 2C40 and 2C-39A triodes. Type I oscillator is illustrated in Fig. 1 and Type III in Fig. 2. Type II is similar in basic configuration to the oscillator of Fig. 2.

Quenching or intermittent operation can be a problem in any oscillator of the type under discussion, particularly at frequencies not far from the upper limit of the tube. Experience has shown the following steps to be important in the control of quenching:

A cathode bias resistance of 50 to 300 ohms is used, with plate supply voltage adjustment, if necessary, to control the input power. A supplementary grid-leak resistance, if used at all, should not exceed a few hundred ohms.

A minimum of total bypass capacitance between grid and cathode is employed, consistent with r-f isolation of the external cathode and heater connections. The use of small quarter-wave chokes is helpful in achieving high r-f attenuation with small added capacitance to ground. Button-type silvered-mica feed-through capacitors of 35 to 50 $\mu\mu f$ also provide excellent r-f bypassing, even at 3,000 mc.

The grid-cathode resonant circuit is tuned to a frequency slightly higher than that corresponding to maximum d-c plate current. This tuning adjustment for 5 to 10 percent drop in plate current minimizes grid current. A slight decrease in output power results.

Tank Circuit

The grid-separation oscillator frequency is determined mainly by the resonant frequency of the grid-plate coaxial-line tank circuit. To a lesser extent it is determined by the tuning of the grid-cathode circuit, whose primary function is to adjust the phase and amplitude of the grid-drive voltage. Frequency is also influenced by: variation of electrode voltages; external reactances and resistances coupled into the tank circuit; changes in tube interelectrode capacitances and transconductance due to mechanical motion of the electrodes; and the phase angle of the transconductance as determined by transit-time effects. Frequency changes due to all these factors are minimized by a high operating Q in the grid-plate tank circuit.

Loss conductance contributed by r-f loading for useful power output must be kept as low as possible by loose load coupling. This requires that the oscillator tube have a large reserve of power capability over the output that is delivered. Useful power is taken from either the grid-plate cavity or the grid-cathode cavity, because these circuits are closely coupled by feedback and the flow of r-f plate-cathode current in the input circuit imposed by the common grid connection.

Tank Circuit Losses

To insure lowest losses in the tank circuit, interior cavity surfaces are machined to a smooth finish (surface roughness 16 microinches or better). Sharp corners or discontinuities are avoided. Uniform silver plating at least 0.0005-inch thick is important, especially at the higher frequencies. Rhodium flash, if used at all, must be thin (10 microinches or less).

Poor contacts either in tuning devices or at tube electrodes, in addition to mechanical instability, can cause significant losses in the tank circuit. A multiplicity of good finger contacts is essential wherever contact to a plunger or tube electrode is made.[7] A single finger which almost makes contact can form a mechanically unstable member that couples a variable reactance into the main tank circuit to affect frequency stability.

The use of double sets of fingers extending on both sides of a movable plunger is important for mechanical stability and to minimize electrical contact loss and leakage through the fingers. The presence of screw threads in the active part of the tank circuit is undesirable, because such joints introduce losses and may not be mechanically stable.

Energy storage in a coaxial tank circuit can be increased by operation in the higher resonant modes and in some cases by addition of lumped capacitance to augment the tube interelectrode capacitance. The effective Q of the tank circuit may be expressed as

$$Q = \omega_0 R C_E = \frac{\omega_0 R C_1}{2}\left[1 + \theta_0(\cot\theta_0 + \tan\theta_0)\right]$$

Where C_1 is the equivalent lumped capacitance terminating the line and θ_0 is the angular length. Shunt resistance R includes contributions from output loading, cavity losses, transit-time, grid-loading and dielectric losses in the tube. The value of R decreases slowly as the order of the mode is increased, but the energy storage increases rapidly on the higher order modes, resulting in improved operating Q.

Operation on higher order modes is equivalent to swamping the tube interelectrode capacitance with another larger and more stable capacitance, thus decoupling the tube from the tank circuit. Considerations of mechanical rigidity and overall length preclude the use of modes higher than $5\lambda/4$. The choice of characteristic impedance Z_0 of the coaxial tank circuit has only a slight effect on operating Q on the higher modes; values of 50 to 70 ohms are satisfactory.

Decoupling and Filtering

The coupling of r-f loads to the tank circuit is kept as low as possible consistent with the required output power. Residual effects are minimized by using matched loads at the output end of the r-f cables coupled to the oscillator.

An important factor is the degree of decoupling required on all power leads, push-rods and other conductors that are coupled to the r-f

Table I—Test Data on Stable Oscillator Designs

	Type I	Type II	Type III
Tube type	2C40	2C39A	2C40
Resonant mode, grid-anode cavity	$3\lambda/4$	$3\lambda/4$	$5\lambda/4$
Resonant mode, grid-cathode cavity	$\lambda/4$	$3\lambda/4$	$3\lambda/4$
Anode d-c power input, watts	5.0	20.0	5.0
R-F power output, watts	0.05	0.22	0.05
Heater power input, watts	4.5	4.0[A]	4.5
Anode voltage, volts	300	500	300
Anode power supply ripple, mv rms	<2	<2	<1
Heater supply ripple, mv rms	<100	<100	<100
Frequency of measurements, mc	1,300	1,300	2,800
Total maximum tuning range, mc	270	200	400
Total incremental tuning range, mc	90	12	65

	Type I	Type II	Type III
Anode voltage frequency sensitivity, B, cycles per mc per volt	1.1	1.8	4.7
Total warm-up frequency drift from cold start, mc	0.81	2.1	2.7[C]
Time required to reach drift rate below 20 kc per min from cold start in minutes	6.0	9.5	6.5
Total bandwidth of oscillator energy, cycles per sec (short-term variations)	5.0	10.0	13.6
Maximum observed rate of frequency change, cycles per sec per sec	625	1,300	5,800
In sampling interval, millisec	4.0	4.0	1.2
Additional notes	no forced cooling	blower cooling	no forced cooling

A Heater operated at reduced voltage because of r-f back-heating effects.
B Comparable figure for 40 mc overtone crystal oscillator is 0.10 to 0.15 cycle per mc per volt.
C Various values depending on the methods of constructing the tank circuit.

fields in the interior of the oscillator. Ordinary values of bypass capacitance that are adequate for most applications can allow large changes in frequency due to varying external conditions, such as hand capacitance and relative motion of metal parts due to vibration. Button mica feed-through capacitors and quarter-wave chokes have been helpful in obtaining the required supplementary decoupling of power leads.

Sensitivity of the generated frequency to plate-voltage changes varies from just over 1 cycle per megacycle per volt for the oscillator of Fig. 1 at 1,300 mc to about 5 cycles per megacycle per volt for the oscillator of Fig. 2 at 2,800 mc. To realize the best frequency stability the rms plate-supply ripple is kept below 1 millivolt in most cases, and as low as 200 microvolts for operation near 3,000 mc with the oscillator of Fig. 2.

Direct-current excitation of the heater should be employed, but ripple in this supply can be as high as 100 millivolts without noticeable effects on stability.

Tuning Methods

Contacting type finger plungers for repetitive tuning operations are not employed because of the inevitable contact irregularities, tuning noise and lack of resettability. A well-designed noncontacting plunger may be satisfactory if it has low internal losses and sufficient isolation of the back cavity portion of the resonator. Noncontacting plungers are supported mechanically so that no radial mechanical motion is possible during vibration. Axial motion of the plunger is precisely controlled by a tuning mechanism with no backlash.

A movable tuning sleeve, driven axially by a push-rod, provides a simple and noiseless control of tuning over a frequency band of up to 25 percent. This method is used in the oscillators shown in Fig. 1 and 2 for repetitive tuning over an incremental frequency range about the center frequency. Tuning results from the displacement of an electrical discontinuity along the standing wave in the coaxial cavity[8]. The tuning sleeve can be made of a low-loss dielectric or of metal supported on a thin low-loss dielectric bearing material to avoid all metal-to-metal contacts in the tuning motion. It may be supported and driven either from the outside or inside walls of the cavity.

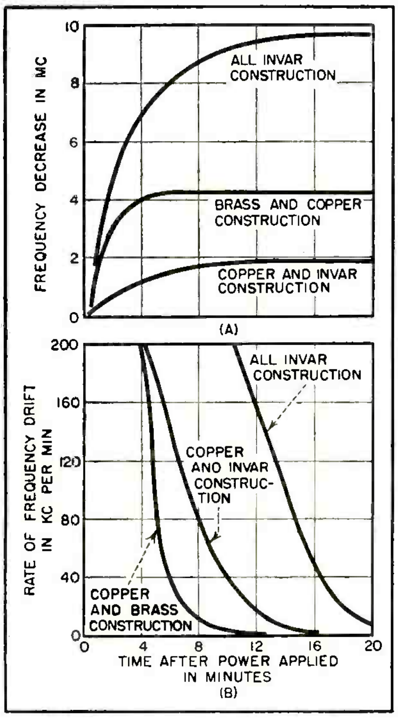

FIG. 3—Poor thermal conductivity of Invar, in one oscillator design, overshadows its dimensional stability

If the incremental tuning range exceeds about 2 percent, a coordinated motion of both grid-plate and grid-cathode tuning is used to prevent undue variations in grid drive and power output. A motor-driven cam arrangement can tune both cavities.

Thermal Effects

Heat dissipated in the oscillator causes a rise in temperature of both the cavity and the tube electrodes, resulting in a long-term frequency drift or warm-up effect. Severe transients of this nature cause a measurable deterioration of short-term stability.

High thermal conductivity is more important than a low coefficient of thermal expansion, particularly in members that conduct heat directly from tube elements. The dimensional stability of Invar is overshadowed by the effects of its poor thermal conductivity in one oscillator design as shown in Fig. 3. Excessive temperature rise of the tube electrodes and severe frequency drift were greatly reduced when a copper center conductor was substituted for Invar in the cavity.

Mechanical Vibration

The necessity for extreme rigidity and mechanical strength of the coaxial cavities cannot be overemphasized. However, the dimensions and hence the resonant frequency will be influenced to some extent by external mechanical forces. Good vibration isolators are desirable for minimizing frequency modulation caused by external mechanical vibration.

Good results have been obtained with special mounts designed for a natural resonant frequency of about 3 cycles per second in all directions of freedom. For operation near 3,000 mc under severe vibration, a two-stage isolator may be necessary. Isolation factors of over 300 to 1 for vibration at 60 cps have been obtained using air-damped mounts in a two-stage vibration filter. With soft mounts that have very low resonant frequencies, a snubbing type of secondary protection is needed to prevent damage from accidental shock.

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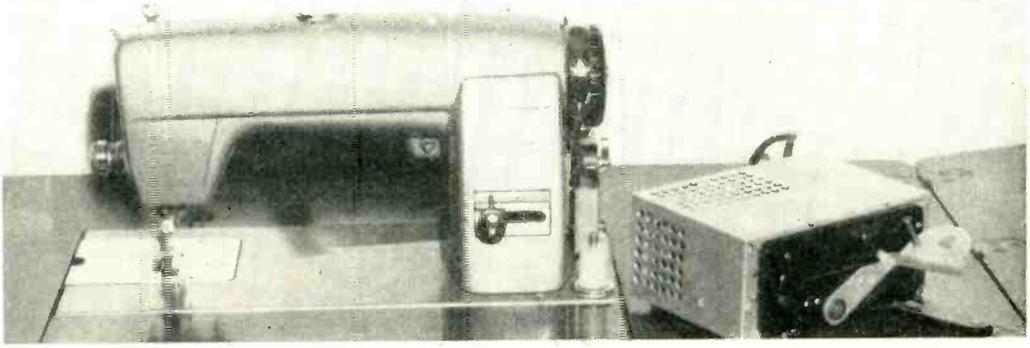


New phase-shifting circuit reduces size of motor control circuit (in box) used to vary speed of sewing machine. Control circuit uses inductance-capacitance combination instead of conventional carbon pile

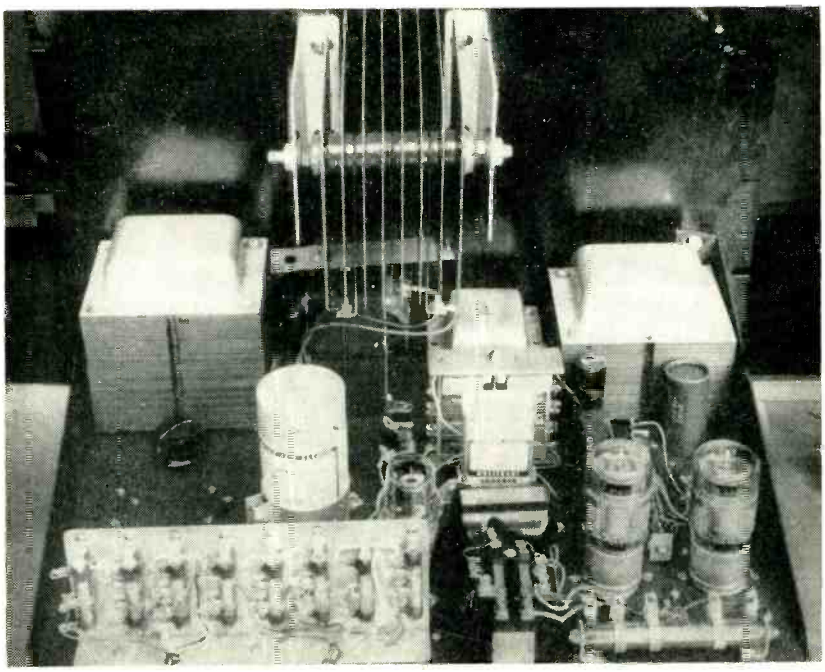
Wide-Angle Phase Shifter

By W. J. BROWN

President
Brownthorn Electronics, Inc.
Stamford, Conn.

A TECHNIQUE has been developed for obtaining a wide angle of phase shift, with constant amplitude, by an unusually small variation in the impedance of a single reactive element. The reactive element may comprise a saturable reactor or transductor, a reactance tube, a coil with a movable core, a variable capacitor, or any kind of variable reactance.

This principle is embodied in a patented circuit, termed a VecTrol, which may be used for sensitive and accurate indication or control of any effect that can be translated into a proportional reactance change. When used with a grid-controlled rectifier and an a-c source, it provides a sensitive and stable form of d-c amplification having good long-term constancy. It is suited to a great variety of feedback control circuits in which considerable power must be controlled by a small error signal. Alternatively, when used as a phase modulator it simplifies the circuitry of frequency-modulated transmitters.



Prototype chassis for automatic program control of mass production machines. No error amplifier tubes are used because of the sensitivity of the phase-shifting circuit

Classical Phase Shifting

The simple phase shifter shown in Fig. 1A has variable inductance L connected in series with resistance R across a-c reference voltage source AB, which is tapped at O. Point P between L and R forms one output terminal, while center-tap O forms the other output terminal.

In the voltage vector diagram of Fig. 1B, angle $A'P'B'$ is always a right angle and the locus of P' is a semicircle having reference voltage $A'B'$ as its diameter. Maximum phase shift theoretically obtainable is 180 deg, but to attain this it would be necessary to vary the impedance of L from zero to infinity, which is impossible. Such phase shifters are widely used with thyratrons supplying variable-speed d-c motors from an a-c input; for such applications a phase shift of between 90 deg and 180 deg is required in a single-phase system or 60 deg to 120 deg in a three-phase system. The variable inductance usually comprises the a-c windings of a saturable reactor or transductor, the inductance value of

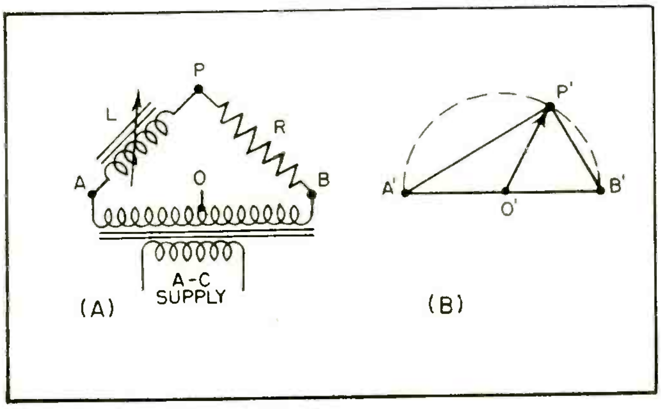


FIG. 1—Classical phase-shifter used to control ignition angle of control rectifiers. Maximum theoretical phase shift is 180 deg

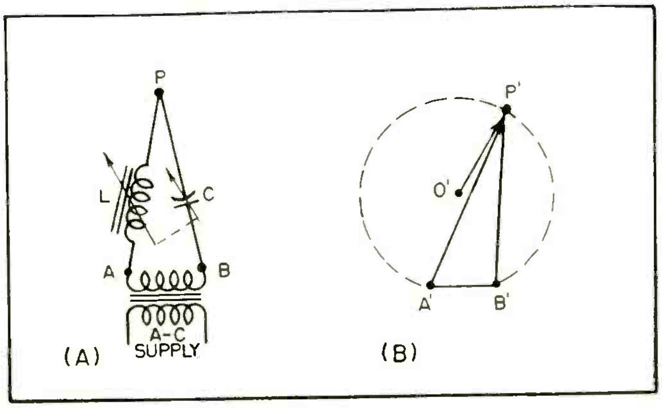


FIG. 2—Basic new phase-shifting circuit uses variable capacitive reactance and variable inductive reactance

for Industrial Controls

High sensitivity permits thyratron feedback control without need for control tubes. Small variation in single reactive element produces up to 360-deg phase shift. Applications include motor control and wide-angle phase modulation of f-m transmitters

which can be varied by passing a unidirectional current through its d-c control winding. Due to the wide range of inductance variation required it has been necessary, in any closed-loop feedback system, to amplify the d-c control signal through one or more vacuum tubes before applying it to the control winding of the saturable reactor.

Principle of New Circuit

In the new phase shifter, which is illustrated in Fig. 2 reactances L and C are connected in series, with an output terminal at P. The vectors of the voltages across the inductive reactance and the capacitive reactance, $A'P'$ and $P'B'$, form a triangle with reference voltage $A'B'$ as base. The magnitude of the acute angle $A'P'B'$ depends upon the ratio of reactance to resistance of each of the elements L and C; the higher the ratio or Q, the smaller the angle.

If the relative impedances of the inductive and capacitive reactances are varied without altering their Q values, the ratio of $A'P'$ to $P'B'$ will be altered without altering angle $A'P'B'$. If the ratio of impedances of L and C is varied in this manner, point P' will describe a locus which lies on the arc of a circle of which $A'B'$ is a chord. Additional fixed circuit elements are provided, as described later, together with a second output terminal O' so connected that its potential lies, in the voltage vector diagram, at a point approximately at the center of curvature of the circular arc, as shown in Fig. 2B.

Accordingly, when L and C are varied relative to one another, output voltage vector $O'P'$ rotates while remaining substantially constant in amplitude. If the reactance ratio could be varied from zero to infinity, the phase shift of the output voltage would approach 360 deg.

A phase shift of 180 deg is obtainable with a relatively small variation in reactance ratio and the relation of phase angle to reactance change is approximately linear within this range. If the Q of the L-C circuit is reasonably high, a phase shift of ± 90 deg is obtained (180-deg total) when the reactance ratio is varied in the ratio $\pm 1/Q$. The required variation in reactance ratio is tabulated in Table I. It should be remembered that these figures compare with a hypothetical ratio of infinity-to-zero for the conventional phase shifter.

Circuits

Several alternative methods are available for establishing reference voltage AB and for locating the potential of output terminal O in its correct position in relation thereto. These may be grouped into four types of circuits, of which the two most important will be described.

The first circuit is shown in Fig. 3A. Reference voltage AB is derived directly from the a-c supply by tapping the transformer secondary winding XY. Reactances L and C are connected in series across these taps and output terminal P is in the series connection between the reactances. In the vector diagram of Fig. 3B, the locus of P' lies upon a circular arc spanning reference vector $A'B'$. Potential point O' is established at the center of curvature of this arc by R and C_1 connected in series across X and Y as shown.

In the vector diagram, voltages $X'O'$ and $O'Y'$ across R and C_1 form a right-angle triangle. By

Table I—Reactance-Phase Shift Relations

Q	Reactance Ratio for ±90-deg Phase Shift	Remarks
3	±0.33	Usual range for 60 cps
4	±0.25	
5	±0.20	
10	±0.10	
20	±0.05	Usual range for 400 cps
50	±0.02	
100	±0.01	Usual range for radio freq
200	±0.005	

Table II—Operating Characteristics of Four Designs

	A	B	C	M
Total resistance of d-c control windings (ohms)	3,600	2,000	400	250
D-C signal for 0-deg lag (volts)	2.04	1.46	0.72	1.70
D-C signal for 90-deg lag (volts)	1.06	0.74	0.40	0.78
D-C control sensitivity (volts)	0.98	0.72	0.32	0.92
Power sensitivity (milliwatts)	0.27	0.26	0.26	3.45

suitable choice of voltage $X'Y'$, capacitance C_1 and resistance R, point O' may be located at the center of the locus.

In the circuit just described, when the two series-connected reactances have equal impedance, output voltage $O'P'$ is in quadrature with the input voltage and lags $Y'X'$ by 90 deg. As the inductive reactance is increased, this angle of lag is increased to 180 deg and then to more than 180 deg; at this stage output voltage $O'P'$ leads input voltage $Y'X'$ by nearly 180 deg. While this characteristic is suitable for some applications, it is not suitable for thyratron control in single-phase circuits.

In a single-phase thyratron control circuit, the phase shifter input is in phase with the thyratron anode voltage and the phase shifter output voltage is applied to the grid. If the grid voltage lags more than 180 deg behind the anode voltage, it fires the thyratron full-on during the subsequent cycle, resulting in a sudden and dangerous transition from zero to maximum anode current. Accordingly, additional fail-safe types of circuits were devised to ensure that the thyratron output falls substantially to zero when the grid voltage is lagging to its greatest extent. One such circuit is shown in Fig. 4.

Fail-Safe Circuit

Referring to Fig. 4B, a-c reference voltage $A'B'$ is derived from input voltage $B'X'$ by setting up right-angle triangle $X'A'B'$. This is accomplished with C_1 and R in Fig. 4A. The series-connected inductive and capacitive reactances L and C are connected across R and accordingly the locus of P' lies on the arc of a circle spanning the reference voltage vector $A'B'$. By adjusting R in relation to C_1 and having regard to the Q of the L-C circuit, the circle may be made to pass through X'; $X'B'$ is then a diameter since $X'A'B'$ is a right angle. Accordingly, the center point of $X'B'$ is at the center of the circle and a center tap on the input circuit can be used as the output terminal O.

When inductance L is increased to its maximum value for the purpose of reducing the thyratron output, point P' will move clockwise around the circle to a point such as P'_o. Grid voltage $O'P'_o$ will then be lagging behind anode voltage $O'X'$ by nearly 180 deg so that the anode current is reduced almost to zero; however, $O'P'_o$ can never lag behind $O'X'$ by more than 180 deg so there is no danger of firing the thyratron full-on and this circuit is fail-safe.

Usually inductance L comprises the a-c windings of a saturable reactor, which is also provided with a d-c control winding to which a signal may be applied to saturate the reactor core and advance the phase angle. In the arrangement of Fig. 4, the grid voltage returns to its safe phase angle, nearly 180 deg lagging the anode voltage when the d-c control signal is removed. Even if L should accidentally become open-circuited or C short-circuited, the grid voltage will lag the anode voltage by exactly 180 deg, thus entirely cutting off the anode current.

The variable inductance and/or capacitance may take a great variety of forms, depending upon the nature of the application.

Saturable Reactors

A saturable reactor or transductor combination, having a pair of a-c windings of which the inductance is varied by applying a

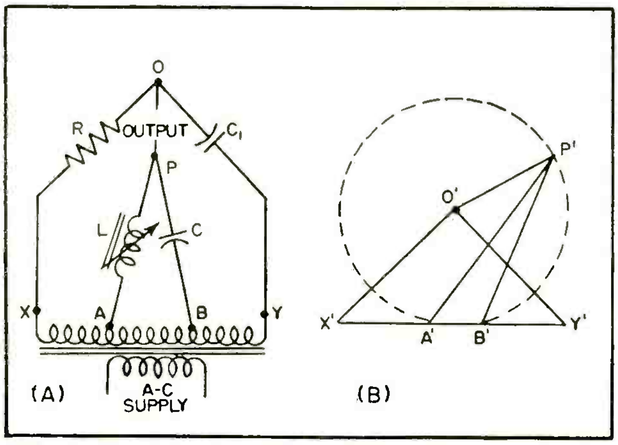


FIG. 3—Circuit for transmitter phase-modulator applications

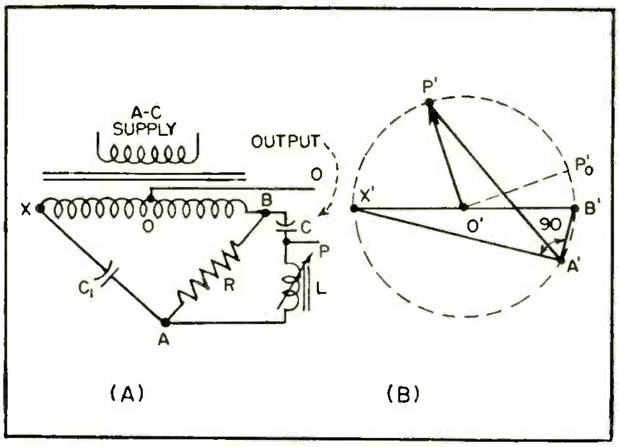


FIG. 4—Thyratron control circuit is fail-safe

d-c signal to a saturating winding or windings, provides a simple variable inductive reactance that is rugged and conveniently flexible, especially for use at power frequencies.

Figure 5 shows the new circuit using a saturable reactor, arranged to control a pair of thyratrons; it has the same configuration and vector diagram as Fig. 4. In this case, however, the phase shifter output OP is split into two equal opposing voltages by R_1 and R_2 to drive the grids of thyratrons V_1 and V_2 as a full-wave rectifier. The saturable reactor is provided with a d-c control winding for varying the inductance of its a-c windings.

This circuit comprises only the saturable reactor, two capacitors and a resistor, as illustrated in the photograph.

Signal Magnitude

The d-c signal voltage required by the saturable reactor to produce the necessary phase shift depends upon the resistance and number of turns of the d-c control winding, since the degree of saturation is solely dependent upon ampere-turns. Also, when no d-c control signal is applied, L will have its maximum value, which will however not be infinite, so that the output phase angle $O'P'_0$ (Fig. 4) will lag the input voltage $O'X'$ by less than 180 deg. This angle is called the initial phase angle and is dependent on the inductance of the a-c windings and the capacitance of C. For thyratron controls, an initial phase angle of 130 to 160 deg lagging is very convenient, since the output is then very low, especially if the d-c load is partially inductive. The new circuits for thyratron control are designed accordingly.

The results of measurements made on four of these designs are shown in Table II. Types A, B and C are designed for controlling a pair of thyratrons with sinusoidal voltages applied to the grids. Type M is designed for controlling a pair of mercury-pool rectifier grids using a slightly different circuit with a peaking transformer to apply pulses of several hundred volts to the grids. Other types are available for three-phase and six-phase rectifier control.

Sensitivity in the table is defined as the d-c signal change required to vary the phase angle from 90 to 0 deg lagging, thus varying the thyratron output from zero to maximum with an inductive load. Note the very small voltage and power (fraction of a volt and milliwatt required to control the full output of the rectifiers).

The initial phase angle of standard types A, B and C is approximately 160 deg lagging. The d-c control windings of types A, B and C each comprise four windings having resistances in the ratios 1:1:3:3. The resistances listed are the totals of all windings in series. For many applications, one or both of the large windings only are used in the main control circuit, connected in series or parallel. The two small windings may be used for auxiliary functions such as current limiting, compensation for IR drop in the load or stabilization.

By suitable design, a linear relationship of phase shift to d-c control signal may be obtained over the whole range required for thyratron control, as shown in the curves of Fig. 6. These curves illustrate that the circuit may be designed so that the grid phase angle is automatically retarded when the input or line voltage is increased, thus providing some automatic compensation for line voltage variation.

Constant-Voltage Rectifiers

Figure 7 shows a typical single-phase full-wave thyratron rectifier using the phase shifter in a negative-feedback circuit to deliver a constant voltage to a d-c load. The rectifier drives the grids of the thyratrons through the phase-splitting resistors R_1 and R_2.

The d-c load voltage is balanced against a constant d-c reference voltage and the difference is applied as an error signal directly to the d-c control winding of the saturable reactor, without any amplification. Since a change of a small fraction of a volt in this error signal will vary the thyratron output from zero to maximum, the d-c load voltage will be maintained almost precisely constant in relation to the reference voltage. This provides an

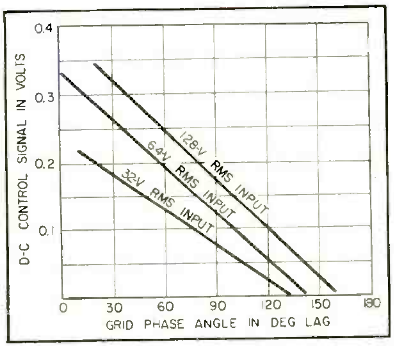
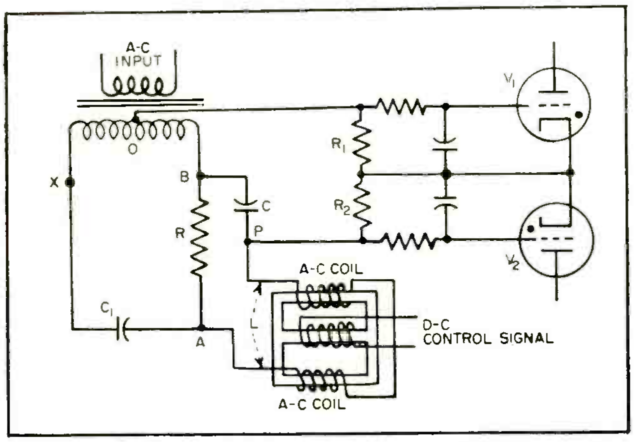


FIG. 6—Control characteristics of saturable reactor circuit of Fig. 5



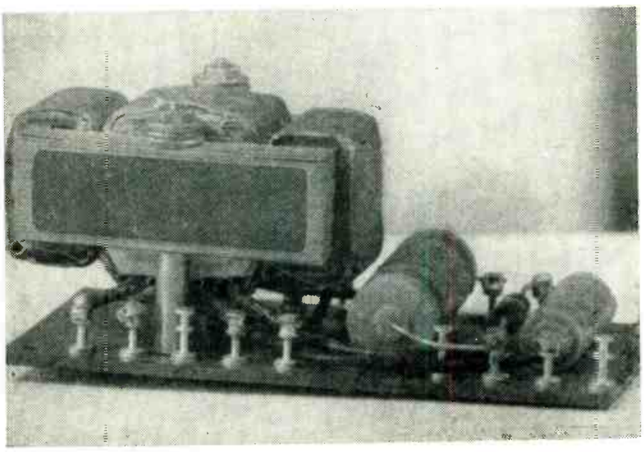


FIG. 5—Circuit uses saturable reactor to control thyratrons. Components are shown in photograph

almost ideal voltage regulator or constant d-c source of simple design.

In a laboratory test, a d-c output voltage variation from 300.00 to 300.05 volts was obtained when the load was reduced from 10 amp to 1 amp and the a-c line voltage simultaneously increased from 190 to 260 volts. A commercial regulator using this rectifier control has a regulation accuracy of ±0.25 percent with a load range of 1 amp to 10 amp, a line voltage range of 190 to 260 volts and a d-c output voltage adjustable between 100 and 300 volts.

The circuits of Fig. 5 and Fig. 7 may be modified to produce special output voltage-current characteristics by adding d-c control windings on the saturable reactor. For instance, the output voltage may be made to increase in proportion to load current to compensate for the IR drop in a filter or in the connections to the load. Conversely, the current may be sharply limited for protection of the tubes and equipment if the load current exceeds a predetermined safe value.

Sensitivity

The sensitivity of the new circuit makes it unnecessary to amplify the error signal. In systems using the conventional type of phase shifter (Fig. 1A) it is necessary to use one or more vacuum tubes to amplify the d-c error signal sufficiently to produce the necessary degree of phase shift. Since the feedback voltage may contain several-hundred-volts ripple from the thyratrons, it is necessary to filter the d-c error signal to avoid over-swinging the grid of the signal amplifier tube. This filtering introduces an undesirable time constant and usually results in the system becoming unstable, thus requiring stabilizing or antihunt circuits. On the other hand, the saturable reactor here is substantially unaffected by ripple in its d-c control winding, so that the cost and complication of vacuum tubes together with their power supplies, grid circuit filters and antihunt circuits may be avoided.

Motor Speed Control

The circuit of Fig. 7 also forms the basis of an adjustable-speed motor drive. The armature of a shunt or permanent-magnet d-c motor is connected in place of the d-c load and the shunt field is connected to a separate fixed d-c source, which also supplies the d-c reference voltage. The armature voltage may be adjusted by altering the d-c reference voltage, while the field voltage remains constant; accordingly the motor speed may be adjusted from standstill up to the base speed of the motor.

Compensation for the armature drop may be provided to increase the armature voltage in proportion to the armature current maintaining constant motor speed over a wide range of loads.

Typical voltage and speed regulation curves are shown in Fig. 8 for a low-cost fractional-horsepower drive. It can be seen that as the load is increased up to full-load torque, the armature voltage increases and the speed remains substantially constant. When the load is increased beyond its safe value, however, the armature voltage is sharply reduced to prevent excessive overload. This is accomplished by balancing the voltage drop in a resistance in series with the armature against a d-c reference voltage through one of the control windings. The control winding is in series with a selenium rectifier, which permits a reverse signal current to flow only when the voltage drop in the series resistance exceeds the reference voltage due to excessive armature current.[2] This current-limiting circuit not only protects the motor and tubes against excessive current, but also permits smooth, controlled acceleration to any predetermined speed; it will also provide smooth but rapid reversal, with the addition of a few circuit components.

Speed Lowering Control

A further refinement consists of a precision speed-lowering arrangement, which rapidly reduces motor speed by disconnecting the armature from the thyratrons and connecting it across a dynamic-braking resistor, then removing the dynamic-braking resistor when the speed is reduced to the precise value required. By combining this pre-

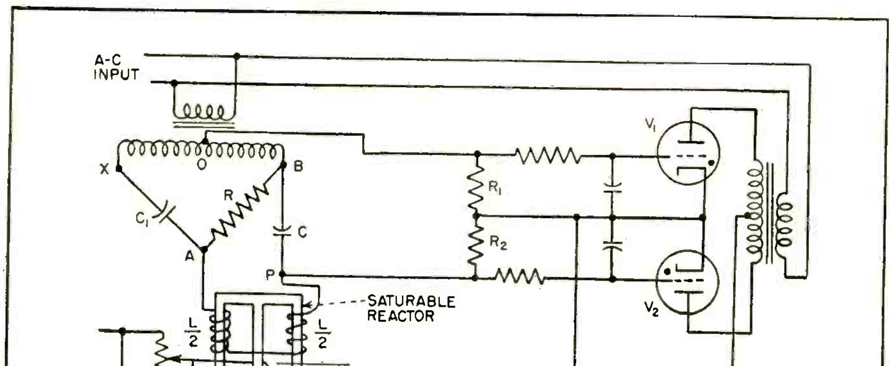


FIG. 7—Negative-feedback circuit delivers constant voltage to d-c load from full-wave thyratron rectifier

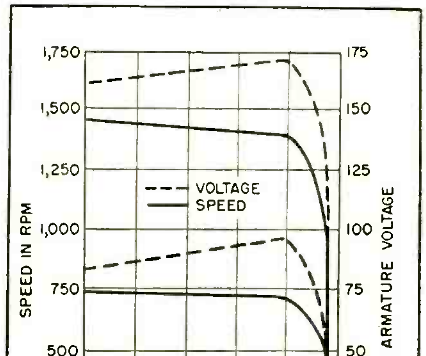


FIG. 8—Regulation curves for shunt-motor controlled by circuit of Fig. 7

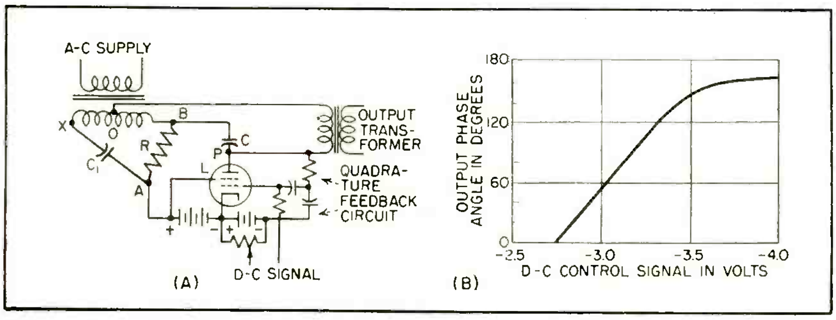


FIG. 9—Variable inductive reactance is replaced by reactance tube (A) to achieve desired phase-shift control voltage characteristic (B)

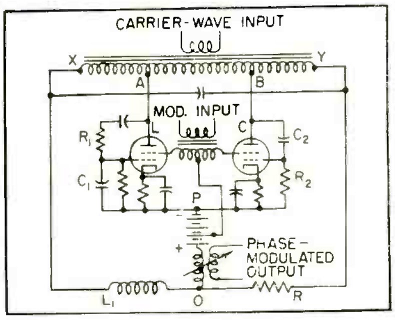


FIG. 10—Reactance-tube wide-angle phase modulator has low distortion

cision speed-lowering circuit with the current-limited acceleration circuit, rapid and smooth speed changes can be made both up and down, making the arrangement useful for program control of mass-production machines. Prototypes having these features have been engineered for the automatic control of machine tools.

By using mercury-pool rectifiers instead of thyratrons, the horsepower range of the control circuit may be increased almost indefinitely.

Adjustable-speed drives have also been developed in fractional and subfractional horsepower ratings, using an exceptionally simple circuit in which the phase shifter is combined with a single thyratron as a half-wave rectifier supplying a series motor. The basic circuit requires only a dozen electrical components including the single thyratron tube. No control tubes are used and even the d-c reference-voltage rectifier and voltage-regulating tube are eliminated. The armature and series field are both supplied from the thyratron. The control winding is connected to balance the armature and field voltages against the voltages in a potential divider which is connected across the motor circuit. In this way the thyratron output is automatically regulated to maintain a constant ratio of armature voltage to field voltage, which results in constant speed independent of load. The motor speed may be adjusted, however, by the potential divider.

This series-motor control has been developed for ratings of 1/18, 1/4, 1/3, 1/2 and 3/4 hp.

Extension of the series-motor drive into integral-horsepower ratings will provide a main spindle drive for machine tools. Such a drive will have a constant-maximum-horsepower characteristic, giving extra-high torque at slow speed and extra-high speeds at reduced torque.

Sensitivity

The sensitivity of the phase shifter is proportional to the Q of the reactor. This value increases at the higher frequencies. A 400-cycle design has been developed which gives full continuous control of a thyratron output up to 1,000 watts, with a control signal of only 0.001 microwatt; this represents a power gain of 10^{12} in a single stage. This sensitivity is adequate for the close control of temperature by thermocouples, without any further amplification.

At still higher frequencies, the system may be used for phase modulation of mobile f-m radio transmitters, using a high-frequency saturable reactor in place of the microphone transformer. The microphone current is passed directly through the control winding of the saturable reactor. The a-c windings are connected in a circuit of the type shown in Fig. 3 to phase-modulate the output from a crystal oscillator by approximately ± 120 deg with sufficient linearity for good speech transmission. This wide angle of phase modulation allows the elimination of at least one multiplier stage. The phase-modulator tube and preamplifier are also eliminated, resulting in a reduction of two to four vacuum tubes.

Reactance-Tube Circuits

Figure 9A shows a single tube connected to have the properties of a variable reactance. A pentode or beam tetrode is used, in which the plate current is substantially independent of plate voltage while it is dependent upon quite small changes of grid voltage. A quadrature-feedback circuit is provided from plate to grid, so that the grid voltage and therefore the plate current is in quadrature phase with the plate voltage.

The plate circuit exhibits characteristics of an almost pure reactance and accordingly has a high Q value. The magnitude of the reactance is varied, without varying its Q, by superimposing a d-c control signal on the grid. This arrangement provides full control of a pair of thyratrons with a signal-voltage variation of less than 0.7 volt into the high-impedance grid circuit as shown in the control voltage characteristic of Fig. 9B.

Phase Modulator

The reactance-tube circuit also provides a phase modulator for high-frequency applications requiring wide-angle modulation with a minimum of distortion, such as broadcast f-m transmitters and multiplex f-m radio links.

The phase modulator circuit of Fig. 10 includes two reactance tubes connected as a variable inductance and a variable capacitance, taking the places of L and C in the circuit of Fig. 3; accordingly, some of the properties of a push-pull modulating circuit are obtained. Quadrature feedback networks R_1-C_1 and R_2-C_2 are respectively lagging and leading.

When extreme freedom from distortion is not required, a single reactance tube may be used with a fixed reactance of opposite sign, in the circuit of Fig. 10 or in other circuits that have been devised.

New Ferrite-Core Memory

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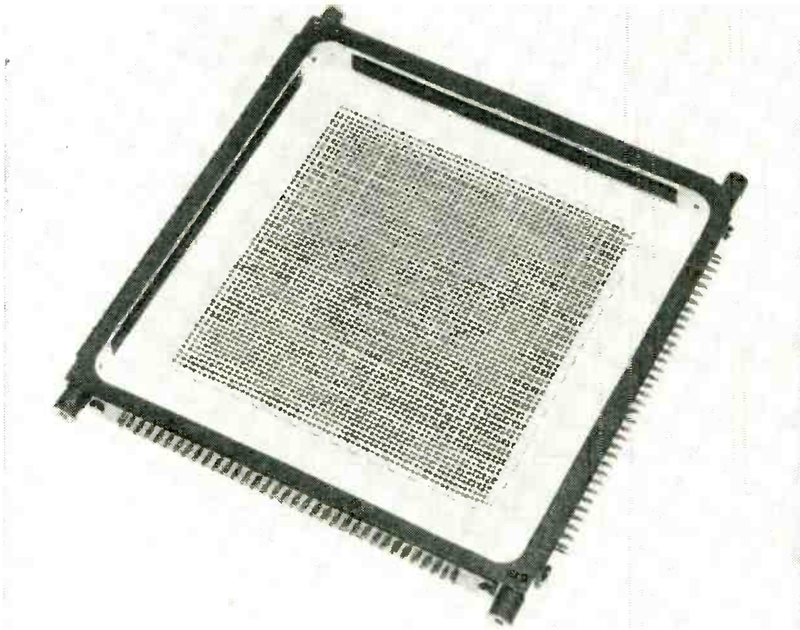
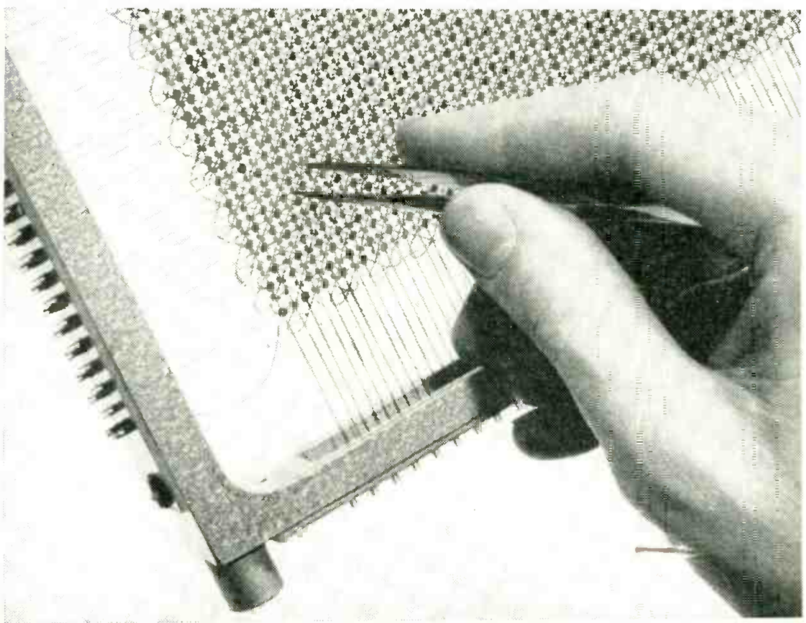


Completed core-memory digit plane with the 4,096 cores spaced on 0.1-inch centers. Overall dimensions of the plane are about 10×10×¾ inches. Memory employs simultaneous excitation of *x* and *y* coordinates, a 2-beat cycle and the principle of sampling of the output signal



Closeup view of the plane. Four lines pass through each core, one each for *x*, *y*, digit (parallel to *x*) and sense (diagonal)

HIGH-SPEED parallel electronic digital computers require large memories that allow rapid access to their registers in any sequence. A recent arrangement involves storing each binary digit in the remanent magnetic flux of a small core, combining many of these cores into an array mounted on a coordinate-grid system of wires and providing access to register groupings of the cores by exciting selected coordinate lines.

Operation

Salient features of the 64 × 64 × 17 (4096 registers each 17 digits long) magnetic-core memory are outlined in the block diagram of Fig. 1.

The memory operates on a coincident-current basis, utilizing coordinates x and y for register selection during the read half of the memory cycle. The number written into the selected register during the write half of the cycle is determined by the excitation of the 17 digit-plane drivers. The cores are arranged in a square array, that is, the register-selection coordinates x and y are each 64 lines in length. These coordinates are excited simultaneously rather than in a staggered sequence. The exciting currents are supplied to the coordinate lines from linear pulse transformers driven by vacuum tubes. Translation or conversion from a binary-memory address to the x and y 64-position systems is accomplished by two crystal-diode matrices.

As indicated in Fig. 2, the unit runs on a basic two-beat cycle, read followed by write. The information

Uses Pulse Transformers

Ferrite doughnuts only 80 mils in outside diameter store coded information in 64 × 64 × 17 magnetic-core memory. Improved circuit techniques give increased capacity while employing considerably fewer tube cathodes. Balanced linear pulse transformers step up memory signal between driver tubes and coordinate lines of the array

in the selected core register is destroyed during the read half of the cycle. It may be replaced during the write half of the cycle or new information inserted in its stead.

Discrimination of the output signal is performed on a magnitude basis at an optimum time by sampling or strobing with a very short pulse. Signal-to-noise ratios are more than adequate without recourse to an integration technique. The resultant cycle time of the memory is under 6 microseconds.

Basic Circuits

The significant portions of the read-write and address-selection circuitry for the y coordinate are shown in Fig. 3. When selected, one of the 64 output lines of the crystal-diode matrix is pulled down to a voltage level which cuts off the first 5965 section. The resulting rise in plate voltage is coupled through the cathode follower and raises both grids of the 5998-array driver. The 5998 resembles a 6AS7 with a higher mu.

No current flows, however, because the cathodes of the 5998 are normally held at a high voltage level by the read and write gate generators. At the appropriate time a start-read pulse from control turns on the read flipflop which, through its two direct-coupled stages, turns off the two 5998 output tubes of the read-gate generator. All 64 y-read cathodes of the array-driver-tube sections then drop to a voltage level such that the proper current is drawn by the selected section. The current is shut

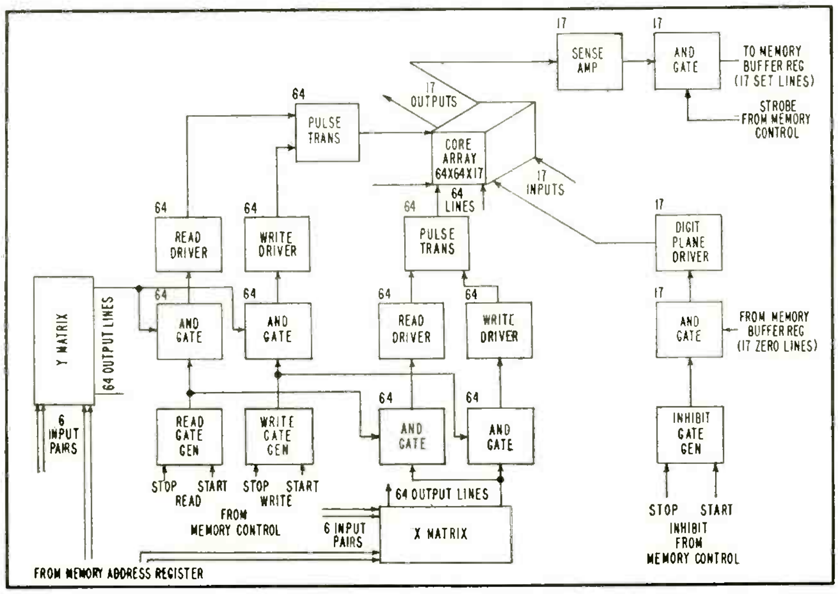


FIG. 1—Magnetic-core memory gives arbitrary or random access to any one of its registers every 6 microseconds

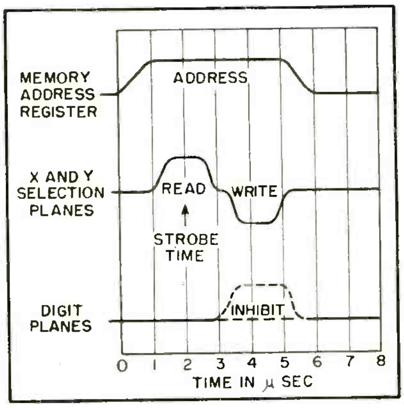


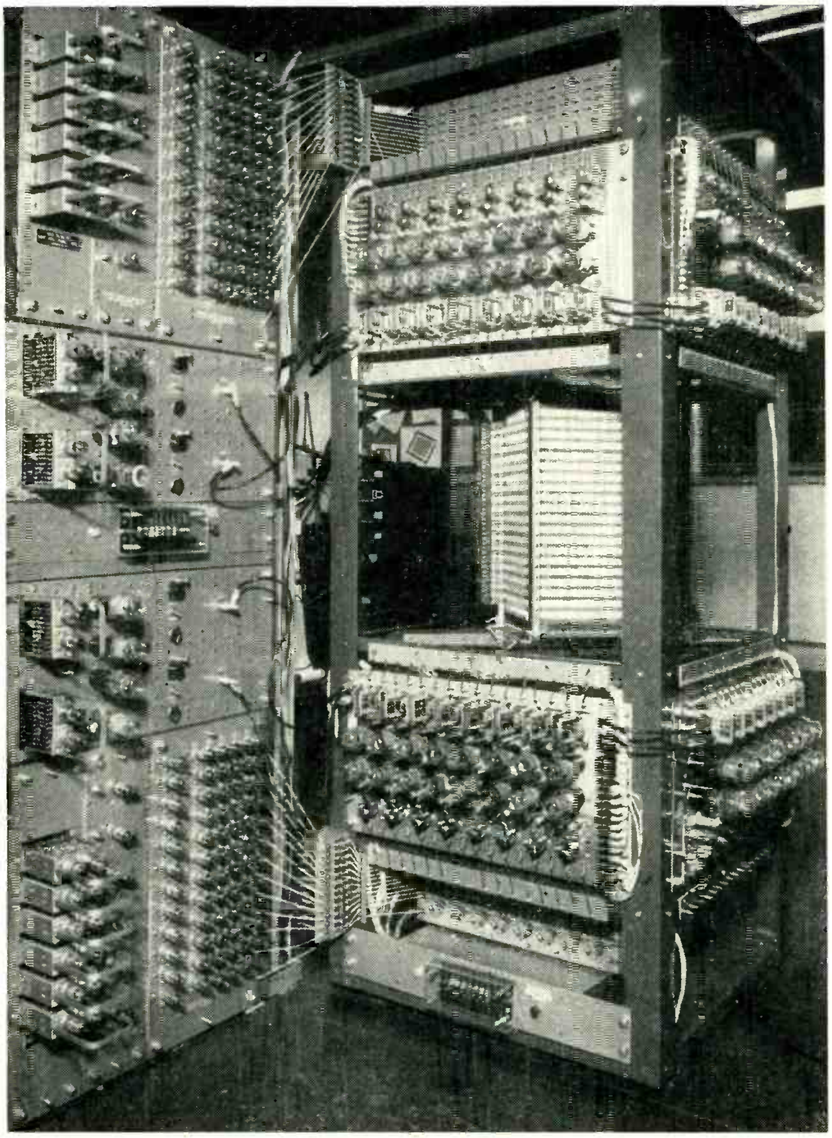
FIG. 2—Timing diagram of the currents in the core-memory array lines

off about 1 microsecond later by the stop-read pulse.

The current pulse from the array-driver section is stepped up by approximately 2 to 1 in the ferrite-core pulse transformer and delivered to the series-connected lines of the proper coordinate in the core array. The 2-ohm terminating resistor is largely for purposes of observing the shape and size of this current pulse. Current amplitudes are set by the two large variable resistors which connect the y-read and y-write cathodes to the −300-volt supply.

There is a good deal of cathode degeneration inherent in most of the stages. This, plus overdrive with grid clipping in other stages, makes memory currents fairly independent of the vacuum-tube characteristics. For example, a 40-percent drop in the emission characteristic of the driver tube results in a drop of less than 5 percent in the array current.

Digit-plane currents are sup-



Completed stack is shown installed in the stall. Rack at left of stall contains the cathode followers. The two wide panels in the center contain the read and write gate generators

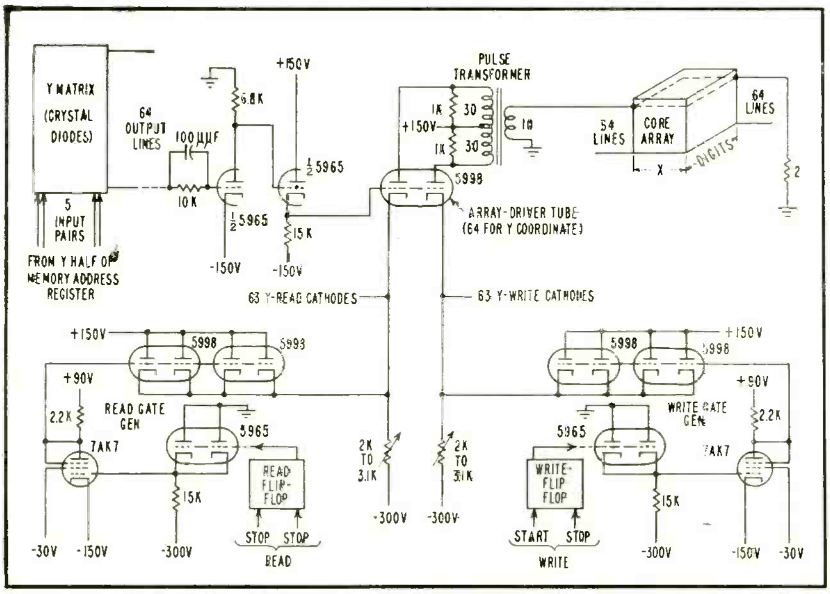


FIG. 3—Schematic illustrates read-write and address selection in one coordinate. Components such as parasitic-suppression resistors and power-supply decoupling filters are omitted to simplify diagram

plied directly from both sections of a 5998 driven by a stable amplifier.

Sense Amplifiers

Two circuit approaches are being tested in operation for the sense-amplifier application. In one, the memory output signal is linearly amplified from the 100-millivolt level up to approximately 30 volts in a balanced a-c coupled feedback amplifier. The signal is then rectified and applied to the suppressor grid of a 7AK7 gate tube on a negative-bias level of about 20 volts. The cathode count for this circuit comes to ten, excluding the gate tube. In the second design, the memory signal is stepped up in a balanced linear pulse transformer to about the 1/2-volt level. It is then rectified by crystal diodes in a full-wave circuit and subsequently amplified by simple pulse amplifiers up to the 30-volt level preceding the 7AK7 gate tube. The circuit for this amplifier, shown in Fig. 4, uses only three cathodes.

A 7AK7 is used in a fairly standard *and*-gate circuit, receiving the signal from the sense amplifier on its suppressor grid and the 0.1-μsec sampling pulse on its control grid.

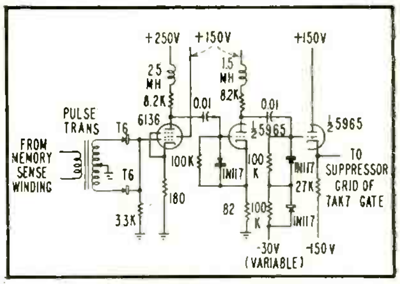


FIG. 4—Simplified schematic of sense amplifier. Cathode degeneration is used to help stabilize gain

The output from this gate tube, a standard 0.1-μsec pulse for a one and nothing for a zero, goes to the set input of the corresponding flip-flop in the memory buffer register.

Cores and Planes

The cores in this memory are General Ceramics ferrites S1, 80 mils in outside diameter. The individual cores were selected after passing a series of pulse tests consisting of an upper and lower limit on the voltage output from each

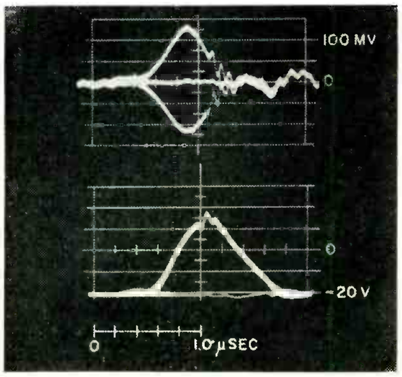


FIG. 5—Digit-plane output (upper), and pulse fed into gate tube after amplification and rectification (lower)

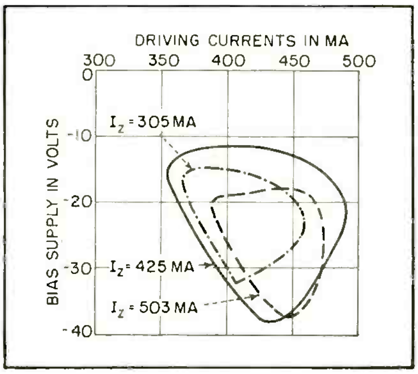


FIG. 6—Failure bias bounds in sense gates plotted as a function of the driving currents

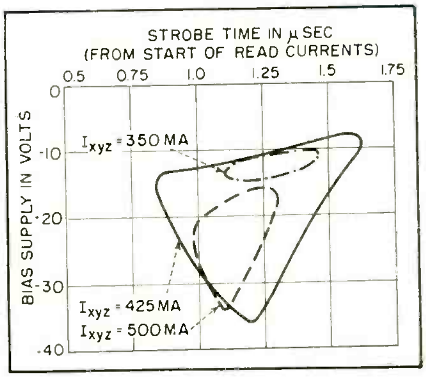


FIG. 7—Failure bias bounds in sense gates as a function of the sample or strobe time

core when the core was excited by the proper sequence of pulses.

Each coordinate line consists of only one wire, a change from a previous arrangement made possible by the use of a pulse transformer between the driver tubes and the memory. The diagonal sense winding is arranged so that contributed signals from half-selected cores cancel by pairs. Inductive coupling to the x and y driver lines is also minimized.

Nineteen memory planes appear in the finished stack shown in the photograph. Two of these are wired-in spares; only two connections, sense and digit drive, need be moved from any plane to one of the spares in order to place that spare into operation.

The memory tube count is 1,232 cathodes or 625 envelopes, most of them visible in the photograph.

Results

The outputs from a memory plane during the operation of an average program in the computer are shown in Fig. 5. Note that the amplified and rectified signal (lower pulse) is shown as it goes into the gate-tube suppressor grid riding on a bias level slightly greater than −20 volts. This bias level is a very handy variable with which to measure the operating margins of the memory. Raising this level toward zero volts will soon result in computer alarms due to binary zeros being mistaken for ones. Lowering the bias level causes alarms for the opposite reason. Fig. 6 shows these failure bias bounds plotted against the x and y driving currents for three settings of the digit-plane currents. Note that the bias supply to all seventeen of the sense gates is the variable. This same variable is plotted versus strobe time in Fig. 7. The size of the enclosed areas indicates that fairly large variations in memory currents and voltages are tolerable. These areas are approximately as large as comparable ones taken for smaller memories.

Improvements

A paper redesign of this memory indicates that cathode counts can be drastically reduced without serious sacrifice of operating margins. This may be accomplished in good part by improvements in the circuitry throughout the unit and partly by changing the logic of the address-selection system. One arrangement connects the 5998 array-driver-tube grids for each coordinate in groups of eight, selecting among these groups by an 8-position diode matrix driven from three of the six address digits for that coordinate, as shown in Fig. 8.

The cathodes of the same 5998 tubes can now be cross-grouped by eights and selected in a like manner from the remaining three address digits. The resultant reduction in the number of buffer-amplifier tubes for driving the 5998 grids is only partially offset by the increase in gate-generator units.

Another paper study indicates that the same basic techniques can probably be carried even further. A 256 × 256 (65,536-register) memory of this general type and with approximately the same speed and reliability seems feasible. Investigative work in these directions now under way has already demonstrated that this larger unit

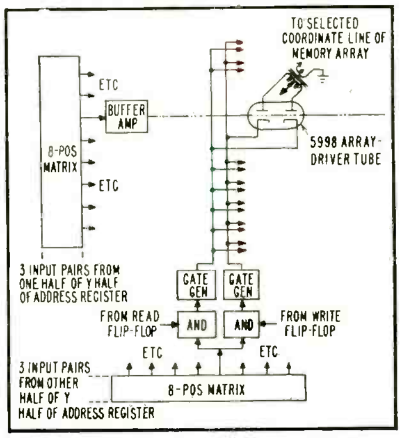


FIG. 8—Efficient 8 × 8 rearrangement of the array-drivers for one coordinate

will require approximately three times as many cathodes as the present unit if vacuum-tube drive is used on the x and y coordinate lines, and about the same number of cathodes if magnetic-core matrix switches prove capable of driving these lines directly.

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Double Base Expands

Single *p-n* rectifying junction made to a semiconductor bar whose ends are terminated in ohmic connections results in double-base diode of relative simplicity and high power dissipation. Stable negative-resistance input characteristic permits variety of applications

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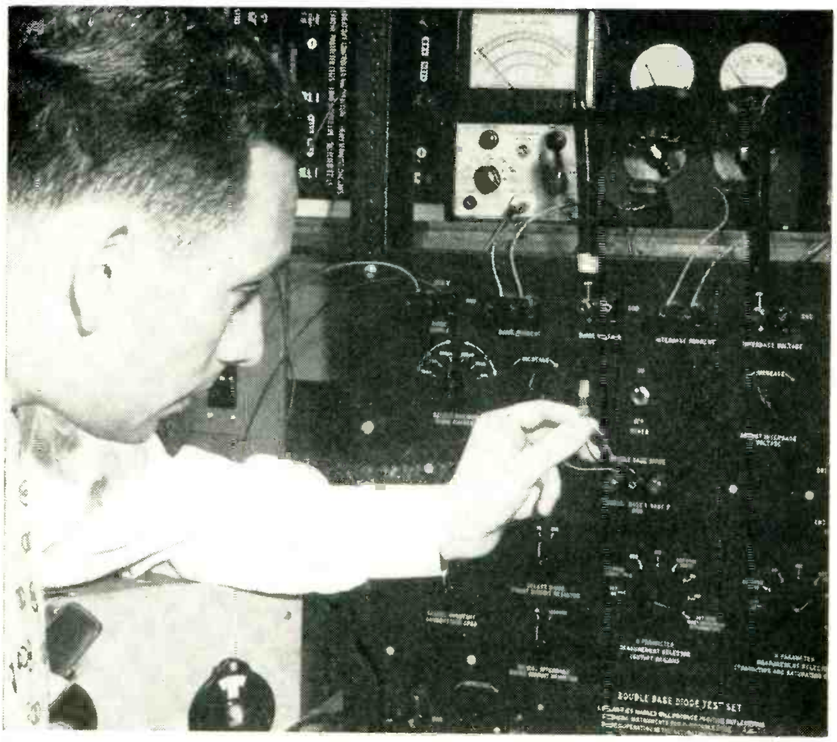

Laboratory test in progress checks characteristics of a double-base diode

A SEMICONDUCTOR having two bases and a single junction may be thought of as the solid-state counterpart of the gas-tube thyratron.

An important property of the double-base diode[1] is its negative-resistance input characteristic, which makes it adaptable to such applications as oscillators, relays and regenerative pulse amplifiers. It offers high-power potentialities and allows comparatively simple and rugged construction.

The basic construction of the double-base diode is illustrated in Fig. 1A. It consists of a rectifying junction made to a bar, the ends of which are terminated in ohmic connections. The nomenclature, double-base diode, has been applied because this device is similar in construction to an ordinary crystal diode that has two bases. If the two ohmic contacts were tied together, the double-base diode would function as an ordinary rectifying diode.

Terminology

The signs associated with the potentials in Fig. 1B are indicative of the usual battery connections to the device terminals and the current directions shown correspond to the flow of direct currents when the junction is biased in its forward direction. The terminology associated with the symbols in Fig. 1B is as follows: V_d = junction voltage, V_b = interbase voltage, I_d = junction current, I_{b2} = base-two

Table I—*h*-Parameters for Three Semiconductor Switching Devices—Low Frequencies

	CUTOFF REGION			TRANSITION REGION			SATURATING REGION		
	point-contact transistor*	double-base diode***	junction transistor**	point-contact transistor*	double-base diode***	junction transistor**	point-contact transistor*	double-base diode***	junction transistor**
h_{11}	50K	50K	250K	−1500	−2500	50	50	10	20
h_{12}	0.02	0.8	0.0002	0.05	0.8	0.0005	0.5	0.02	0.1
h_{21}	−0.05	−0.8	−0.0005	−2.5	+2.0	−0.98	−0.8	0.5	−0.98
h_{22}	50μ	100μ	2.0μ	50μ	100μ	2.0μ	750μ	750μ	1000μ

Notes: * Includes effect of external 1,000-ohm base resistance. Grounded base connection
** Assumes external bistable driving source. Grounded base connection
*** Grounded base-one connection

Diode Applications

current and I_{b1} = base-one current.

If the junction is open-circuited and a potential is applied between the bases, the potential distribution through the bar is linear (the bar acts as a passive resistance). However, if the junction is biased in its forward direction, minority carriers are injected into the bar in much the same way as minority carriers are emitted into the base region of a transistor. If the resistivity of the bar is sufficiently high and if the double-base diode is properly proportioned, the injected carriers will cause a significant reduction in the resistivity of the base-one region.

Modulation

This modulation of the base-one resistivity in the presence of an electric field gradient, created by the interbase potential, is essentially responsible for the negative-resistance characteristic of the double-base diode[2]. If the resistivity of the base-one region is lowered at a faster rate than current is increased in the junction the resistance between the junction and the base-one lead will be negative.

Characteristics

The input characteristic of an experimental double-base diode is illustrated in Fig. 2. Figure 3 illustrates the three distinct regions obtained from these experimental curves.

The cutoff region corresponds to the condition that the junction is biased in its reverse direction and the slope of the input characteristic in this region is effectively equal to the back resistance of the junction. A typical range of values of this resistance for experimental germanium units is approximately 50,000 to 200,000 ohms.

The transition, or negative-resistance, region is due to the resistance-modulation of the base-one portion of the bar by the injected minority carriers. A typical value for the negative resistance in experimental germanium devices is 1,000 ohms. When the input current, I_d, becomes sufficiently high, the base-one modulation effect decreases and the input resistance assumes the positive value of a passive rectifying junction biased in its forward direction. This part of the characteristic has been termed the saturating region. A typical value for the input resistance in the saturating region is 20 ohms.

Thyratron Analogy

It is possible for the input resistance to be negative when the input current is zero. This fact makes it possible to design an oscillator that consists of only one circuit element in addition to the double-base diode and energy source. Such a circuit, in effect the semiconductor analog of an R-C thyratron relaxation oscillator, is illustrated in Fig. 4.

Capacitor C is charged from battery E_b through the back-resistance of the junction. Since the charging current is essentially constant the voltage across the capacitor is given by

$$V_d = \frac{1}{C}\int_0^t I_d dt = \frac{1}{C}\,[I_d t]$$

Hence the junction voltage is a linear function of time during the charging cycle. When the potential V_d reaches a value sufficiently high to cause the junction to start emitting minority carriers into the bar, the resistance of the base-one region becomes negative and the capacitor discharges rapidly through the lower base. At the end of the discharge, the operating point of the input characteristic reverts to the cutoff region and the cycle becomes self-sustaining. Double-base diode relaxation oscillators have been operated in the megacycle range of frequencies from supply potentials as low as 1.5 volts.

In addition to the astable mode of an oscillator, the double-base diode may be operated as a bistable (flip-

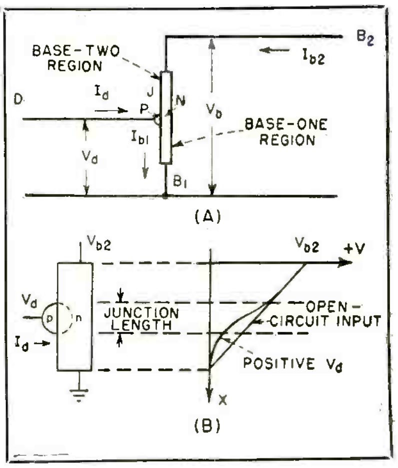

FIG. 1—Double-base diode construction (A) and potential through bar (B)

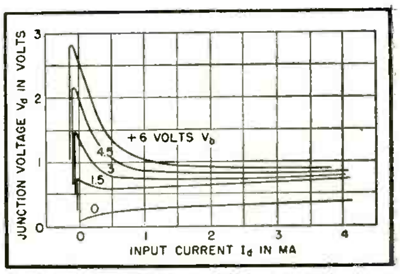

FIG. 2—Input characteristic of a double-base diode

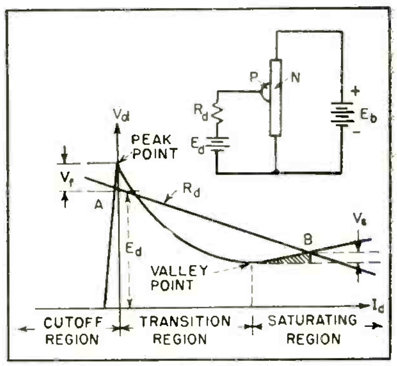

FIG. 3—Three regions are obtained from experimental input chaarcteristic

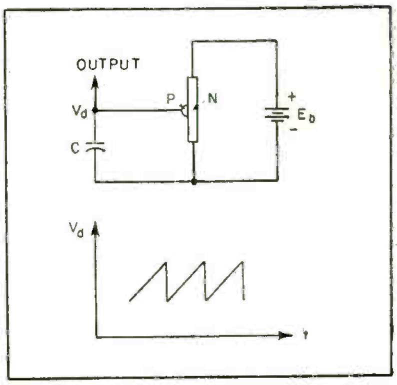

FIG. 4—Saw-tooth waveform produced by double-base diode oscillator circuit

flop) or a monostable (one-shot) device.

Pulse Amplifier

Figure 5A illustrates the monostable operation of a double-base diode in a regenerative pulse amplifier circuit. The input load line intersects the input characteristic of the double-base diode only in the cutoff region. When a positive pulse of amplitude E_t is applied to the input, the operating point of the double-base diode shifts to the saturating region and thence back to the cutoff region, stabilizing only at point I in Fig. 5B. The waveform of the regenerated pulse is controlled by the relative values of R and C in the circuit of Fig. 5A. Power gains in the order of 40 to 60 db have been obtained in experimental double-base diode regenerative-pulse amplifier circuits.

In the pulse amplifier circuit of Fig. 5A the auxiliary diode D in combination with resistor R_s and battery E_s, is used for valley-point stabilization and input-current limiting. The slope of the input characteristic in the saturating region is approximately equal to R_s and the valley point occurs at an input current given by approximately $(E_s/R_s) + I_{b2}$.

Coincident Diode

The use of an auxiliary diode in combination with a double-base diode, for such purposes as valley-point stabilization, suggested the fabrication of the auxiliary diode directly on the same bar of germanium that was used for the parent component. This led to a new component, which was named the coincident diode consisting of a single bar of germanium to which two ohmic contacts and two junctions are made. Relative spacing of the ohmic contacts and junctions are such that the component may be connected as a double-base diode as well as used separately as a diode.

Thus the coincident diode by itself may be used in place of the double-base diode and the auxiliary diode in the circuit of Fig. 5A. The coincident diode was so named because of its applicability to coincident switching networks.

Double-base diode germanium

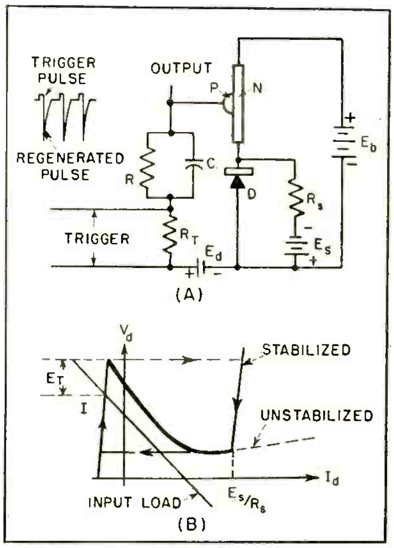

FIG. 5—Regenerative-pulse amplifier circuit (A) and input characteristic of amplifier (B)

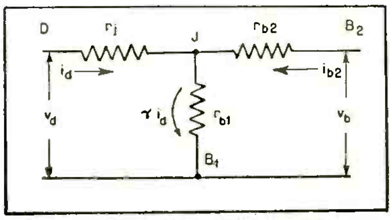

FIG. 6—Equivalent a-c small-signal circuit of double-base diode

units have maintained a usable negative-resistance input characteristic, without benefit of temperature-compensating networks, over ambient temperature variations from minus 70 to plus 100 C. More recent experimental silicon devices have performed satisfactorily over an ambient temperature range of minus 70 to plus 180 C.

Because of the fused-junction construction of double-base diodes their power capabilities are high. Ordinary experimental units in transistor cases, such as those used for type 2N43, are capable of continuous power dissipations up to ¼ watt. Experimental vapor-cooled units have been constructed that are capable of continuous power dissipation up to 3 watts. In switching applications the efficiencies of these units are in the order of 60 percent.

Switching Circuit Applications

An essential characteristic of a switching device is that it have two stable states, which may be characterized in terms of input or output impedance levels. One of these states must be associated with a high impedance level at either, or both, the input and output terminals of the switching device. Conversely, the other state must be associated with a low impedance level.

Another desirable characteristic of a switching element is that it may be triggered into either of its stable states by application of a transient signal. Although the latter property may be obtained by auxiliary holding circuits, (an additional set of contacts for self-locking in mechanical relays or clamping diodes in combination with a junction transistor) it is inherent in the device if a negative-resistance characteristic is associated with the switching properties of the device.

Equivalent Circuit

Figure 6 illustrates an equivalent a-c small-signal circuit of the double-base diode. The nomenclature associated with the symbols in Fig. 6 is as follows: v_d = diode voltage, i_d = diode current, v_b = interbase voltage, i_{b2} = base-two current, r_j = junction resistance (a-c) r_{b1} = base-one resistance (a-c), r_{b2} = base-two resistance and γ = internal current-amplification factor.

It has been found useful to specify the circuit characteristics of a double-base diode in terms of the h-parameters familiar to transistor analysis. For the double-base diode the h-parameters are defined by the following equations:

$$v_d = h_{11}i_d + h_{12}v_{b2}$$
$$i_{b2} = h_{21}i_d + h_{22}v_{b2}$$

It can be shown that the h-parameters relate to the equivalent circuit of Fig. 6 as follows:

$$h_{11} = r_j + \frac{r_{b2}r_{b1}(1 - \gamma)}{r_{b1} + r_{b2}}$$

$$h_{12} = \frac{r_{b1}}{r_{b1} + r_{b2}}$$

$$h_{21} = \frac{-r_{b1}(1 - \gamma)}{r_{b1} + r_{b2}}$$

$$h_{22} = \frac{1}{r_{b1} + r_{b2}}$$

When the double-base diode is used as a switch, a stable operating point must exist in both the cutoff and saturating regions. This condition can be obtained from the simple circuit illustrated in Fig. 3.

Resistance R_d constitutes the input load and in combination with E_d determines the bistable characteristic of the circuit. If R_d intersects the input characteristic in both the cutoff and saturating regions, a switching circuit is obtained. Since h_{11} represents the short-circuited input impedance of the double-base diode, h_{11} will be very high in the cutoff region and very low in the saturating region.

An electric-field gradient of considerable magnitude may exist in the base-one portion of the bar when the double-base diode is biased in the cutoff region. For this condition the interbase voltage divides between the upper and lower bases, which are represented by r_{b2} and r_{b1} in the equivalent circuit, in the ratio given by h_{12}.

In the saturating region the electric-field gradient in the lower base is drastically reduced due to the resistance change caused by injected carriers. Consequently, the reduction of h_{12} in switching from the cutoff region to the saturating region is a measure of the reduction in r_{b1} owing to the transition from a negatively-biased (collecting) junction to a positively-biased (emitting) junction.

The parameter h_{21} has the same significance in double-base diode circuit analysis as α has in transistor analysis. Theoretically, h_{21} approaches the value of $-h_{12}$ in the cutoff region and tends toward zero in the saturating region. Defined formally, h_{21} is the short-circuit current transfer ratio.

Modulation of r_{b1} by carriers injected from the junction will cause a change in the output conductance of the double-base diode. In terms of the h-parameters, the output conductance is given by h_{22}. Thus, h_{22} is a minimum in the cutoff region and a maximum in the saturating region.

It is interesting to compare the low- frequency h-parameters of an experimental double-base diode switch with the h-parameters of a point-contact transistor in a switching circuit. If an external resistance is included in the base circuit of the point-contact transistor, a stable negative-input resistance may be obtained. Consequently, the h-parameters pertaining to the point contact transistor will here include the effect of the external base resistance. In addition, the h-parameters of a junction transistor switch will be listed. It is assumed that the junction transistor is driven as a switch by an external flip-flop.

The three switches are illustrated in Fig. 7. A comparison of the h-parameters for the three-switching devices of Fig. 7 is given in Table I. These figures were derived on the basis of experimental units and should not be construed as indicative of typical devices. However, the table does serve as an interesting comparison of semiconductor devices that perform approximately the same switching functions. The on-off (saturating region-cutoff region) impedance ratios, both input and output, are approximately the same for both the point-contact transistor (with external 1,000-ohm base resistance) and the double-base diode. The voltage feedback ratio, h_{12}, is considerable for the double-base diode but negligible for the transistors in the cutoff region; however, the reverse is true in the saturating region.

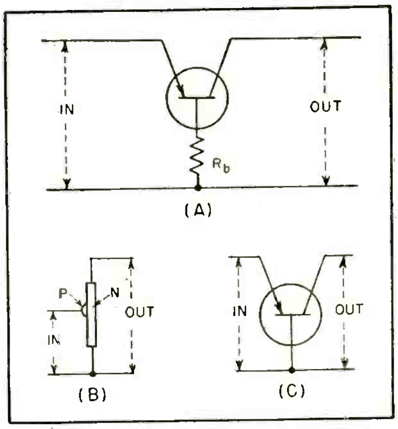

FIG. 7—Point-contact transistor switch (A) double-base diode switch (B) and driven junction transistor switch (C)

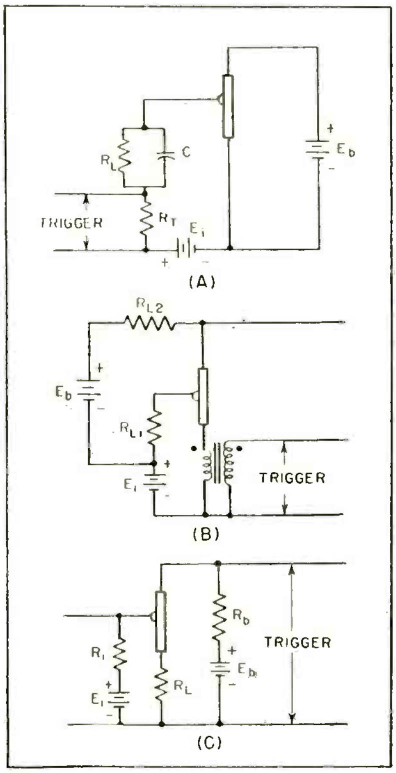

FIG. 8—Variations of double-base diode switching circuits showing junction-triggered type (A) base-one triggered (B) and base-two triggered (C)

Switching Circuits

The basic bistable characteristic, which permits double-base diodes to be used as switches, is illustrated in Fig. 3. For bistable operation, the load line must intersect the input characteristic at the two stable points, A and B. Point A corresponds to an off condition and B corresponds to an on condition. Triggering sensitivity is determined by the relation of the stable points, A and B, to the peak and valley points. The voltage required to trigger the double-base diode to its on position is V_f and the voltage required to trigger from the on position to the off position is V_r. The corresponding power requirements are represented by the shaded areas.

Circuit Variations

Three variations of double-base diode switching circuits are illustrated in Fig. 8. The load, R_L, is contained on the input (junction) side in Fig. 8A. Resistors $R_L + R_T$ constitute the input load line. The device is triggered on by applying a positive pulse to R_T and is triggered off by applying a negative pulse at the same point. Figure 8B illustrates a form of base-one triggering. The load element may be either R_{L1} or R_{L2}, or both, and the circuit is triggered on by applying a negative pulse to the base-one lead.

A positive pulse which is now applied to the same point will trigger the circuit off. Figure 8C illustrates a form of base-two trigger-

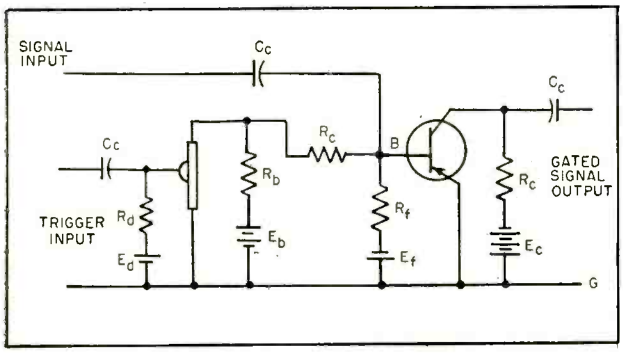

FIG. 9—Gating circuit employs double-base diode to gate transistors

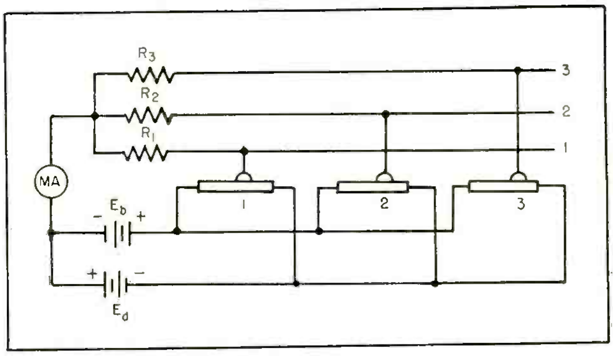

FIG 10—Three-bit binary decoding network. Switching units are turned on by positive pulses at the input

ing. In this circuit the load element is contained in the base-one lead and the double-base diode is triggered on by applying a negative pulse to the trigger point. It may be triggered off by applying a positive pulse to the trigger input.

The load element should be contained in series with the junction if a maximum ratio of power-on to power-off is desired. For this specification, then, circuits of the type illustrated in Fig. 8A and 8B should be used. Maximum power transfer may be obtained when the load is contained in the base-one branch, as illustrated in Fig. 8C. In this circuit, the power supplied by E_i plus the power supplied by E_b is transferred to the load when the device is switched on. However, in the off state, although E_i is effectively isolated from the load, considerable power may be supplied to R_L from the interbase source, E_b.

An example of the low-power switching characteristics obtained from early experimental germanium double-base diodes, using circuits of the types illustrated in Figs. 8A and 8B, is given below:

Standby (off) power	=5 mw
Power delivered to load	
off	=1.0 μw
on	=30 mw
Power-on efficiency	=50 percent
Trigger pulse amplitude	=0.5 volt
Minimum trigger pulse width	=10 μsec
Trigger pulse (turn-on) power	=10 μw
Trigger pulse (turn-off) power	=0.5 mw

Higher power switching circuits, using configurations of the type illustrated in Fig. 8C, are able to deliver 300 mw to a load at an on efficiency of 75 percent. For these circuits the standby power is in the order of 5 to 30 mw and the off power delivered to the load is in the order of 3 mw.

Gating Circuit

Bistable double-base diode circuits may be used to gate transistors. An example of this application is illustrated in Fig. 9. In this circuit the base-two potential of the double-base diode determines the bias at the base of the transistor. When the double-base diode is in the cutoff state, the potential at B is high and thus the transistor is cut off. A positive pulse applied to the junction of the double-base diode triggers the latter into the on state. For this condition the potential at B is reduced, thus allowing the transistor to function as a linear amplifier. When the transistor is cut off the signal input appears greatly attenuated in the collector-circuit output. However, when the transistor is biased into its operative state the input signal is amplified through the transistor stage.

Decoding

Digital computing and telemetering systems frequently require coding and decoding circuits. The function of a decoding circuit, for example, is to translate a pulse sequence into some analog output.

A simple double-base diode binary-decoding network is illustrated in Fig. 10. The devices may be switched on or off by applying positive or negative pulses, respectively, to the input terminals, which, in this configuration, are connected to the junctions of the double-base diodes.

Resistors R_1, R_2 and R_3, in combination with battery E_d, determine the input load lines for the three bistable stages. Thus, the switching units may be turned on by positive pulses at the input to any desired current levels that are preselected by adjustment of R_1, R_2 and R_3. The current flowing through the output meter is the sum of the individual device input currents. A total of eight discrete meter positions may be obtained for any combination of input pulses applied to terminals 1, 2 and 3.

The basic simplicity of the double-base diode has led to some experimentation regarding multiple-cell construction. For example, it has been possible to construct three switching cells on a single tiny bar of germanium, thus giving the equivalent of three double-base diodes in the space of one. Such a device could be used in the binary decoding circuit of Fig. 10 with considerable reduction in circuit size and an attendant savings in circuit cost. Using the multiple-cell technique, it may someday be possible to build an 8 to 10 bit binary decoder in the space currently required by a subminiature tube.

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Delay Line Subcarrier Discriminator

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Multivibrator triggered by input signal is stopped by delayed version of same signal, producing pulses whose spacing is function of phase. Conversion produces voltage proportional to frequency. Designed for telemetering, the circuits can be used for automatic correction of wow and flutter in tape recorders

A NEW f-m subcarrier discriminator utilizes a delay line as the frequency-stable element. When the equipment is used as a telemetering discriminator under field conditions, linearities within 0.25 percent of full scale can be readily obtained. Theoretically, the linearity is perfect and linearities within 0.1 percent can be attained under controlled conditions.

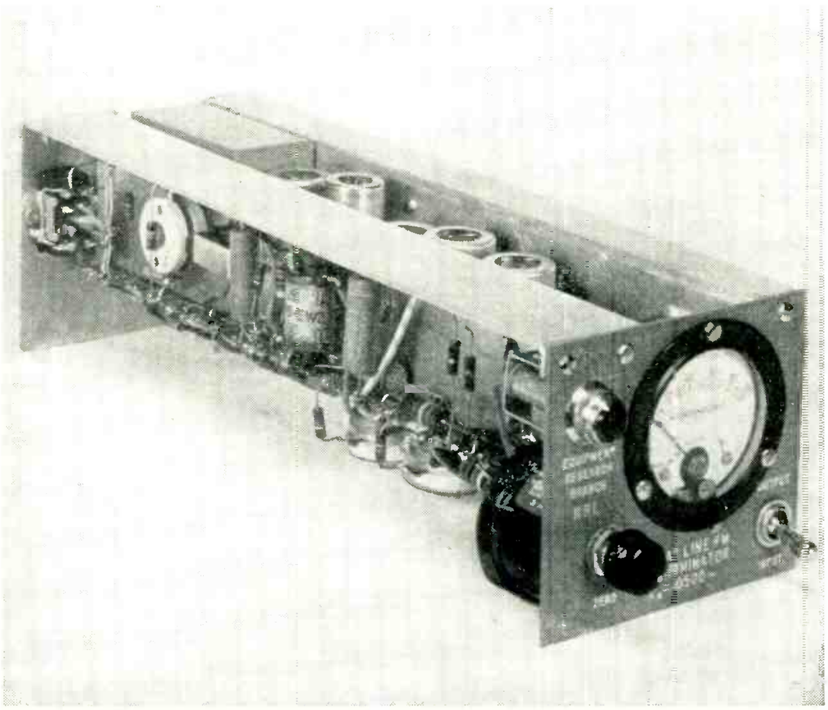
No adjustments are necessary, with the exception of zero balance in the output voltmeter circuit, because the output has been made essentially independent of tube characteristics and component tolerances by the utilization of low-power pulse techniques together with clamping and gating circuits. Sensitivity is determined by the delay line in combination with a regulated reference voltage that is provided.

Dependence Upon Input

The equipment operates reliably for input signals larger than 0.2 volt at the output of the band-pass filter shown in Fig. 1.

Variations of the input-signal amplitude that may happen to occur over a dynamic range of 100-to-1 have negligible effect upon the output. Misinformation is avoided by rejection of weak signals. Preliminary tests indicate that the stability is as good as the delay line selected since the drift in the other circuits can be neglected.

In the prototype equipment, only six tubes and a minimum number



Prototype model of the f-m discriminator shows its small size and single control

*Now with Emerson Research Laboratories, Washington, D. C.

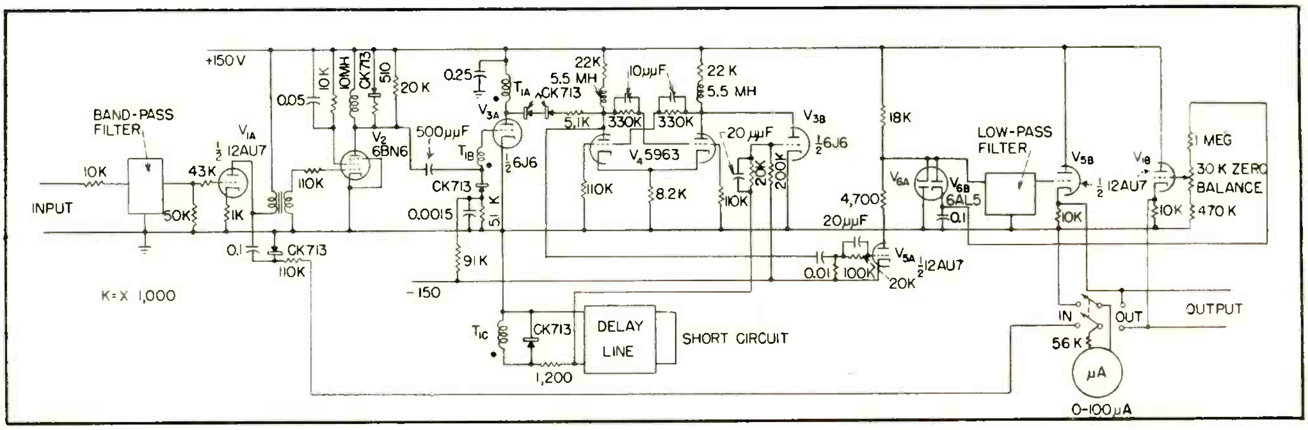


FIG. 1—Complete circuit of the new discriminator. Band-pass filter, delay line and low-pass filters selected for frequency

of components are used so that subminiaturization techniques are directly applicable to the design. The subcarrier bandwidth and center frequency are determined by the plug-in band-pass filter and the sensitivity is determined by the delay line selected. The prototype will operate reliably from 2 to 20 kc and minor modifications will extend this range to 100 kc. Low-frequency operation is somewhat limited by commercially available delay lines, but new techniques should remove this limitation in the near future.

The basic principles involved in the use of a delay line as the frequency-stable element for f-m discrimination are illustrated in Fig. 2A. The f-m signal is passed through a delay line to a phase detector that compares the phase of the delayed signal with the phase of the reference signal. Since a delay line has inherently linear phase-versus-frequency characteristics as shown in Fig. 2B, the output signal is linear with frequency if a linear phase detector is used.

Phase Difference

Precision measurement of phase difference is relatively difficult using such a discriminator. The same effect can be achieved and the circuitry is greatly simplified by forming one pulse per cycle to represent the phase of the reference signal. This pulse is passed through a delay line as shown in Fig. 2C so the delayed pulse represents the phase of the delayed signal.

The phase difference is the same for both methods, but the use of pulse techniques improves the accuracy and stability of the measurement. The relative ease of forming one pulse per cycle permits the input signal amplitude to vary over wide ranges without affecting the phase difference established by the delay line.

An Eccles-Jordan multivibrator

COMPARATIVE EVALUATION

Frequency-modulation subcarrier discriminators in common usage fall into four general types for which comparative data are given below.

(1) The L-C types tend to exhibit nonlinear characteristics. Inductance values change with age, temperature variations and fluctuations in signal level when operated at subcarrier frequencies.

(2) The R-C parallel-T type is more suitable for subcarrier frequencies. Good stability and linearity can be achieved only by extremely careful parts selection and alignment procedures. Both R-C and L-C types require a complex limiter to remove amplitude and waveform fluctuations from the input signal.

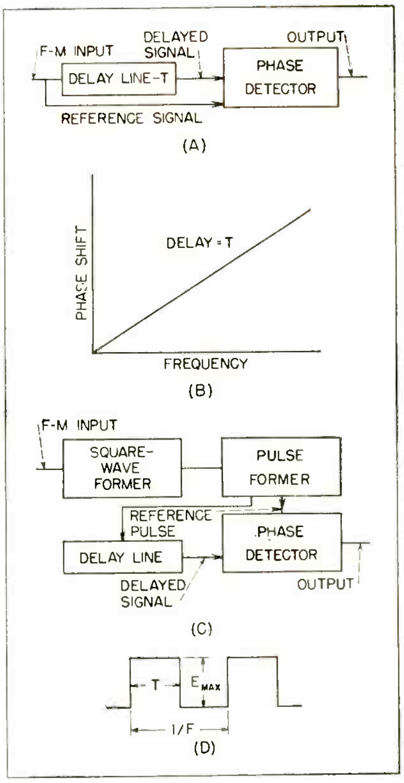


FIG. 2—Basic delay-line discriminator (A), characteristics (B), pulse formation to represent phase angle (C) and multivibrator output waveform (D)

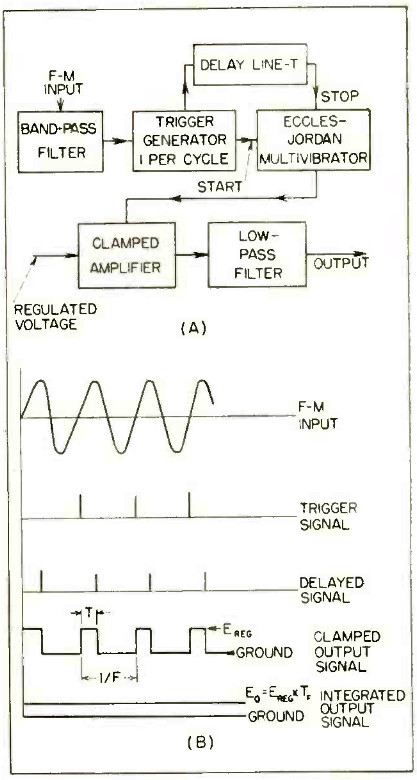


FIG. 3—Final form of f-m discriminator (A) using band-pass filter and trigger generator to start multivibrator. Pertinent waveforms at (B)

shown in Fig. 1 is used to convert the phase difference between the reference and delayed pulses into a direct voltage proportional to frequency. The reference pulse triggers the multivibrator to the on condition and the delayed pulse triggers it off, forming the output waveform illustrated in Fig. 2D. The on time is determined by the delay line and the off time is determined by the signal frequency. The average output voltage as measured on a d-c meter is given by the formula

$$E_{out} = E_{max}\ (f)\ (T)$$

where E_{out} is the d-c output voltage, E_{max} is the peak value of the waveform, f is the input signal frequency in cps and T is the time of the delay line, which is measured in seconds.

Since most delay lines are highly stable elements, the only factor in the output equation subject to appreciable drift is E_{max}. Variations in the tubes or components of the Eccles-Jordan multivibrator or variations in the power supply will seriously affect E_{max} and thereby the output stability. However, this limitation can be readily overcome by regulating the power supply and clamping the output voltage between fixed reference levels.

The output of the multivibrator is therefore passed through a limiting and clamping amplifier. The regulated output is integrated by a low-pass filter network to obtain a direct voltage directly proportional to frequency. The block diagram of the complete delay line controlled f-m discriminator is shown in Fig. 3A and selected waveforms in Fig. 3B. A balanced cathode-follower output circuit provides stable low-impedance drive for indicating and recording instruments.

(3) Trigger-type discriminators are capable of good linearity. Stability is poor owing to use of R-C time-constant multivibrators as the frequency-stable element. Only a simple limiter is required.

(4) Counter types use diode charging and resistance discharging of a capacitor. This is the simplest type. Stability, however, is poor and output is nonlinear.

Linearity and stability of the delay-line controlled subcarrier discriminator is equivalent to or better than the types listed above. The circuit is relatively independent of tube and component tolerances

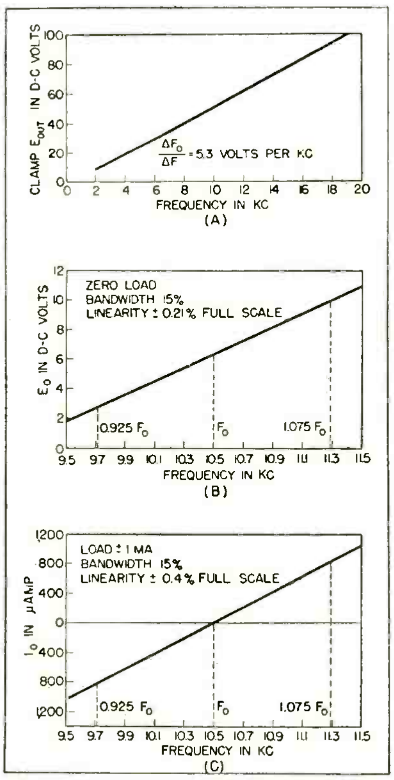
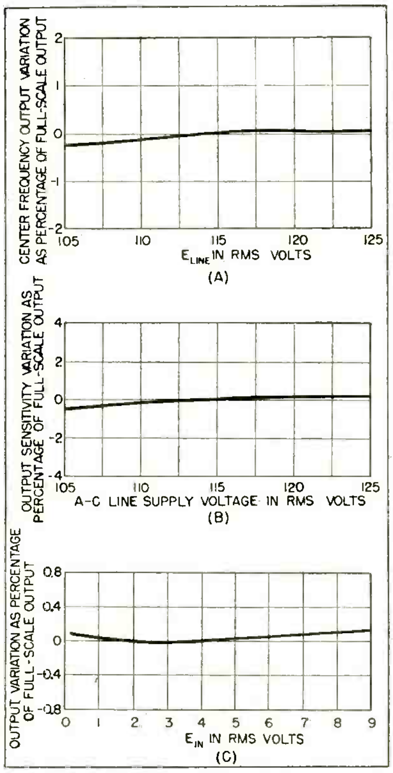


FIG. 4—Linearity characteristics for wide-band operation (A), telemetering band voltage output (B) and current output (C)



Performance characteristics, showing effects of line-voltage fluctuation on center frequency (A), output sensitivity (B) and input level on output sensitivity (C)

Operating Characteristics

Figure 4A illustrates the linearity for wide-band operation. For telemetering operation the linearity is shown in Fig. 4B and 4C.

The linearity can be improved by changing the output tube. Tests conducted with a 5692 gave a linearity of ±0.05 percent with an output current of ±1 ma. Linearity within ±0.25 percent of full scale for both types of operation can readily be achieved for voltage output from the cathode-follower circuit. The linearity deteriorates somewhat, in accordance with the tube characteristics, for current outputs. For example, the linearity is within ±0.5 percent for a current output of plus and minus 1 milliampere.

Test Measurements

The following measurements were made with the equipment being used as a telemetering discriminator at 10.5 kc with a bandwidth of plus and minus 7.5 percent. Readings were taken at room temperature after a one-half hour warmup.

Center frequency stability is less than ±0.25 percent of the bandwidth drift in one hour and less than ±1.0 percent of the bandwidth drift in 24 hours. Fluctuations in the line voltage between 105 and 130 volts cause less than ±1 percent of the bandwidth variation in the center frequency adjustment and less than 0.25 percent variation in the sensitivity.

Tests conducted by changing all of the tubes indicate that the center frequency zero adjustment does not vary more than 2.5 percent of the bandwidth and the sensitivity does not vary more than 0.25 percent for normal tube tolerance. Sensitivity is 3.6 volts for ±7.5 percent frequency deviation at no load or 3.5 ma for ±7.5 percent frequency deviation at full load. Linearity is ±0.21 percent of full scale for voltage output.

Exposure Timer for the

Timer for the electron microscope permits accurate, wide-range control of exposure, eliminates the fluorescent screen as a shutter with its attendant vibration and minimizes the effects of specimen drift owing to thermal and mechanical causes

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ELECTRON microscopes having a hinged fluorescent screen mounted above the photographic plate use this screen to observe and focus the image of the specimen. In addition, by pushing a cable release it acts as a shutter to make the exposure. The abrupt opening of this shutter may set up vibrations in the microscope that will have a deleterious effect on the image especially at high magnifications.

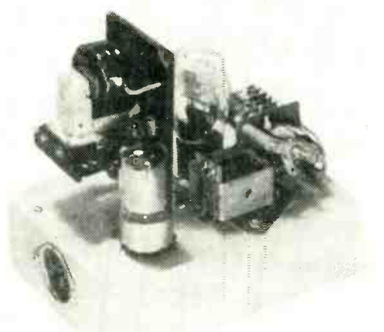
An electronic timer was constructed that would eliminate the fluorescent screen as a shutter and permit accurate timing of the exposure. Another feature was the prevention of either double exposures or skipped exposures on the five-exposure photographic plate.

Timer Circuit

The timer consists of a resistance-capacitance combination controlling the grid of a sharp cutoff pentode that operates a thyratron tube and relay as shown in Fig. 1. With the timer switch S_2 open, capacitor C_1 charges, through the grid-cathode circuit acting as a diode, to a value beyond the cutoff of V_1, a 6SJ7. Closing switch S_2 completes the plate circuit of the thyratron through relay 1, which pulls in, starting the exposure.

At the same time S_2 connects the potentiometer R_2 to the cathode of tube V_1. The charge on C_1 leaks off through R_1 and the grid of V_1 eventually takes the potential determined by the setting of R_2 and current flows through resistor R_3 in the plate circuit of V_1. The voltage drop across this resistor is applied to the grid of the thyratron, which cuts off, causing relay 1 to fall out completing the exposure of the photographic plate.

Exposures are timed by magnetically deflecting the electron beam of the microscope off the photographic plate, just before the screen is lifted, and deflecting it off the plate again at the end of the exposure. The deflection coils are operated in series on 6 volts d-c. The anode block has been counterbored to allow the coils to approach 2½-in. separation.



Timer chassis measures 5 by 7 by 2 inches including relays

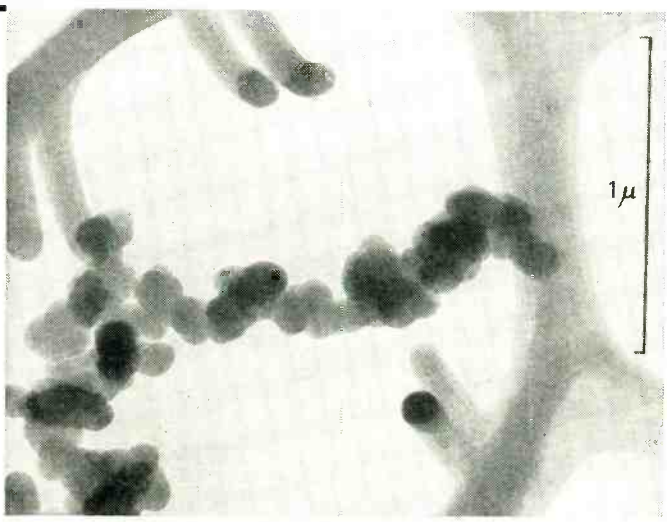
Time control and pilot lights are mounted below the photometer

The sequence of events is as follows: The image of the specimen falls on the fluorescent screen and is focused. Operating the cable release first closes snap-action switch S_1, which energizes the deflection coils mounted between the electron gun and the condenser lens and pulls the beam off the screen. The voltage to the deflecting coils must be sufficiently well filtered so that the field remains at or above that required to pull the beam completely off the photographic plate.

Closing switch S_1 also energizes a solenoid that disengages a lock allowing the fluorescent screen to be lifted. The fluorescent screen when fully open, causes another switch S_2 to close, starting the timer. To allow any vibrations caused by lifting the fluorescent screen to die out, capacitor C_2, which charges due to the voltage drop across the plate resistor R_3 at the same time as C_1 is charging, will momentarily bias the thyratron beyond cutoff when S_2 is first closed and will not permit the thyratron to fire until the charge has leaked off through R_3. The value chosen was sufficient to introduce a delay of approximately 1/2 sec from the time the screen is completely lifted to the beginning of the exposure.

When relay 1 closes, the current to the deflecting coils is interrupted and the beam snaps back to expose

Electron Microscope



Holes in collodion film and attached smoke particles at a magnification of 22,000 times (1μ equals 2.5 inch in original half-tone)

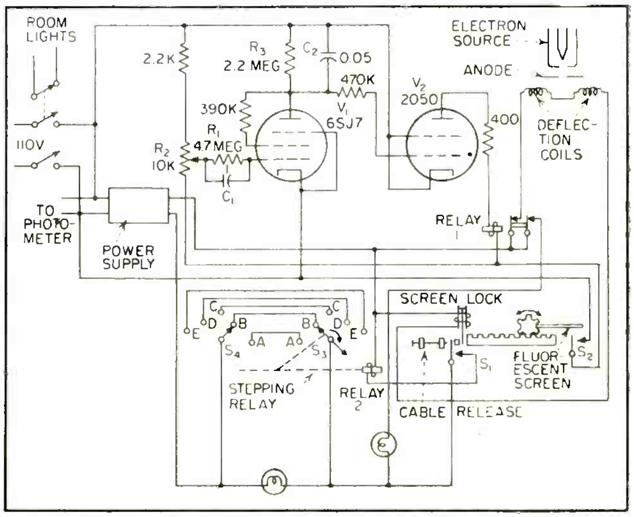


FIG. 1—Circuit diagram of exposure timer. The charge on C_1 controls the tube operation

the photographic plate. At the end of the exposure, relay 1 falls out and the beam is again pulled off the plate. Release of the cable-release opens S_2 and S_1 in sequence, drops the fluorescent screen and opens the circuit to the screen lock and allows the beam to return to the fluorescent screen. This much of the instrument, less the screen lock and associated equipment, is all that is necessary for the timing device.

However, it would now be possible to make another exposure on the same plate area except for a second relay. Relay 2 is a stepping relay that is energized through S_1 before the timer itself is started. This stepping relay has been modified so it does not advance to the next step until it falls out with the opening of S_1. The switch S_3 is a drum made with ten contacts and a corresponding ten-tooth ratchet so that it will go successively through five contacts corresponding to exposures A, B, C, D and E and back through A.

The spring that restores the armature also advances this switch to the next position. When this occurs the circuit to S_1 is opened and is not restored until the plate advancing mechanism is moved to the next or corresponding position. Switch S_4 is a five-point switch, similar to one installed as part of a coupled through-focus control described in another report[1] and is operated by the photographic plate-advancing knob.

The timer is fed from the high-voltage transformer power supply of the microscope through one leg of the room-light switch as is a photometer.[2] It is not possible to lift the fluorescent screen by means of the cable release unless high voltage to the microscope is on and room lights are off.

Exposure Precautions

A green pilot light goes on if the plate is in the proper position to be exposed, goes out during the exposure and comes on again at the end of the exposure. If the plate is not advanced to the next position or is advanced beyond the next position after the cable release is released, a red pilot light goes on and the green light goes off. With S_3 and S_4 closed, the red pilot lamp is short-circuited and the green light will light at full brilliance. With either S_3 or S_4 open, the two lamps are in series across the power source. However, only the red lamp lights at this time because the green lamp is of low resistance compared with the red bulb.

The pilot lamps do not pass sufficient current to operate the solenoids if the cable release is pressed at this time although the electron beam may be slightly deflected. This, and the red light, gives warning that the photographic plate has not been advanced to the next exposure. The present timer has a range from 0.1 sec to 12 seconds.

The range is easily changed by altering the values of C_1 or R_1 or both. The solenoid is shielded with Mumetal to avoid stray magnetic fields and operates the lock of the fluorescent screen through a mechanical linkage.

The movement of the beam on and off the plate does not cause any blurring of the image since this transit time is extremely short compared with any exposure times possible with the electron microscope.

The use of the timer permits the much shorter exposures in the electron microscope which in turn reduces the effects of specimen movements from thermal or mechanical causes.

This paper was based on work performed under Contract AT-04-1-GEN-12 between the AEC and the University of California at Los Angeles.

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(1) F. W. Bishop and M. L. Cook, Coupled Through-Focus Control for the RCA Type EMU-2B Electron Microscope, *Rev Sci Inst*, Nov. 1953.

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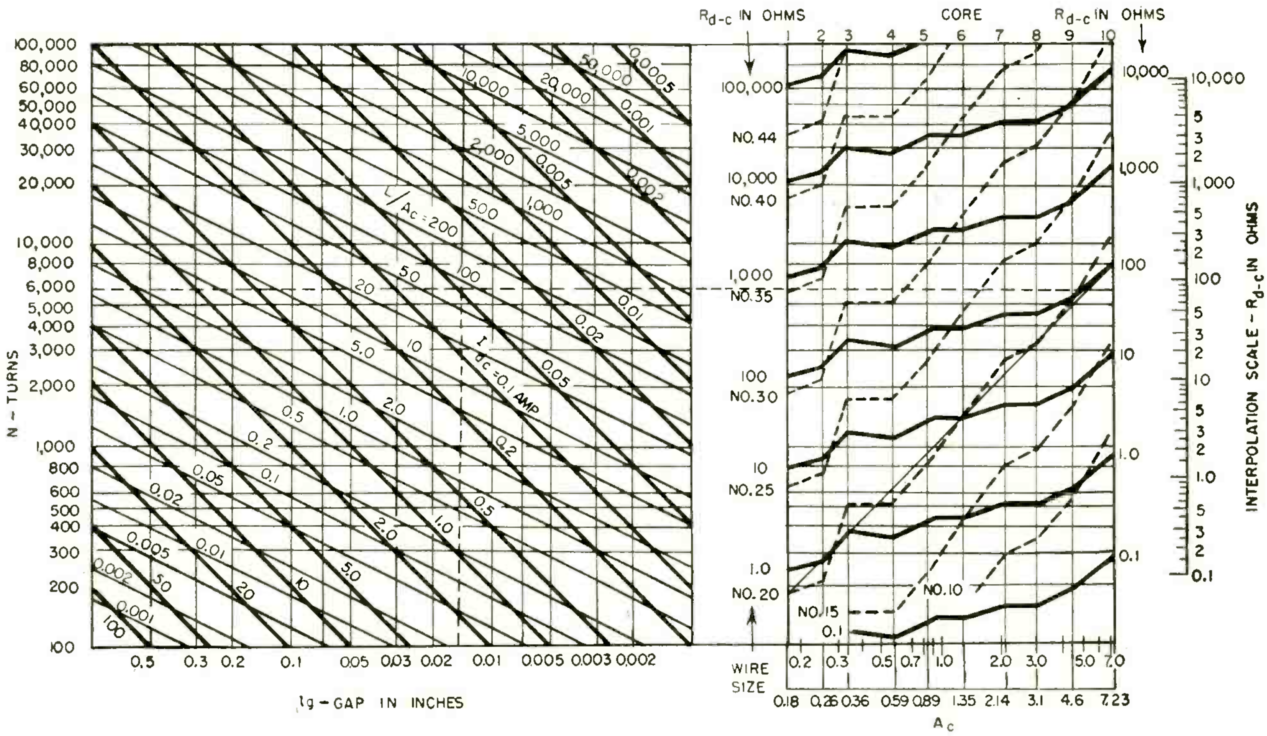


Linear Reactor Chart

Design data for iron-core reactors that must provide constant inductance under varying d-c and a-c conditions can be obtained from the chart. Additional lines can be drawn for silicon-steel laminations and other types of core materials

By REUBEN LEE

Electronics Division
Westinghouse Electric Corp.
Baltimore, Md.

In some applications, such as modulators, it is desirable that inductance of iron-core reactors be constant under conditions of varying direct current through the winding or varying a-c voltage across it. In such reactors, the usual design curves based on negligible a-c flux are not applicable because they lead to nonlinearity and core saturation.

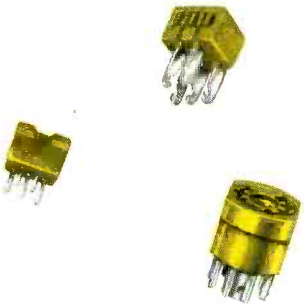
Cut-and-try methods may require several hours design time for linear reactors. The chart shown here reduces this time to a few minutes.

Total effective length of magnetic path in a reactor is $l_g + l_c/\mu$, where l_g is the length of the air-gap, l_c is the length of the flux path in the iron and μ is the permeability of the iron. In a linear reactor, the permeability should be high enough so that l_c/μ is always small compared to l_g. Then variations in μ due to varying direct current or varying a-c voltage do not affect the total effective magnetic path or the inductance. The complete expression for inductance is

$$L = \frac{3.2\,N^2A_c}{10^8(l_g + l_c/\mu)} \qquad (1)$$

where L is in henrys, N is turns in reactor winding, A_c is cross-section area of core in square inches and dimensions l_c and l_g

continued on p 210



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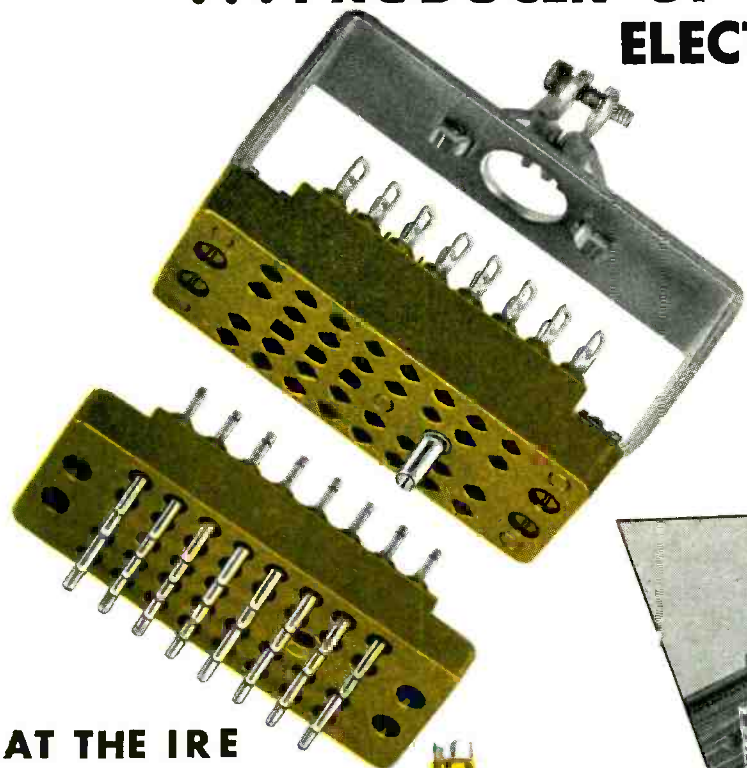

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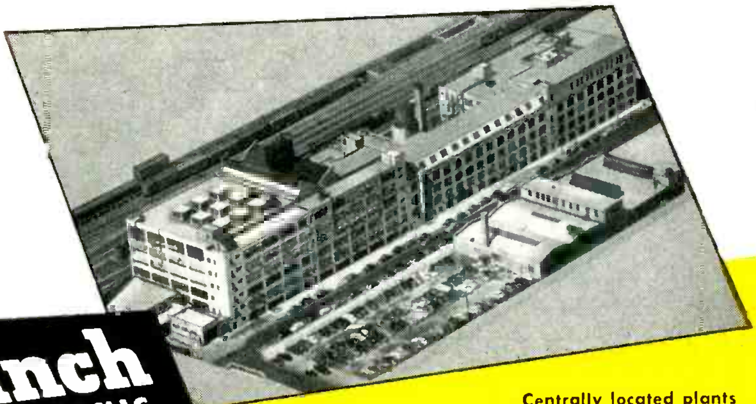

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Loktal-Miniature-Multiplug-Noval-Octal (Molded bakelite, steatite, teflon, Kel-F and laminated)
Plexicon
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Sub-Miniature; Hearing Aid Types
TV; 110V Circuit Breakaway
Vibrator
Pencil Tube Transistor
Diode

Linear Reactor Chart

(Continued from p 208)

are in inches.

The equation may be transposed to

$$N = 10^4 \sqrt{\frac{L}{A_c} \frac{(l_g + l_c/\mu)}{3.2}} \quad (2)$$

If l_c/μ is negligibly small, the equation reduces to

$$N = 10^4 \sqrt{\left(\frac{L}{A_c}\right) \frac{l_g}{3.2}} \quad (3)$$

Equation 3 is plotted with N as the ordinate, l_g as the abscissa and L/A_c as a parameter on the set of lines with a slope of ½ to the left of the chart.

To keep the reactor linear, it is necessary to limit flux density. For Hipersil cores, inductance is usually linear within 10 percent if the d-c component of flux, $B_{d\text{-}c}$, is limited to 12,000 gauss and the a-c component, $B_{a\text{-}c}$, to 3,000 gauss. The d-c component is

$$B_{d\text{-}c} = \frac{0.6 N I_{d\text{-}c}}{l_g} = 12{,}000$$

where $I_{d\text{-}c}$ is the direct current in the winding. Hence,

$$N = \frac{20{,}000 l_g}{I_{d\text{-}c}} \quad (4)$$

With $I_{d\text{-}c}$ as parameter, Eq. 4 is plotted on the left-hand side of the chart on lines with a slope of one.

Core Size

For a series of cores with similar proportions but varying size, the number of turns of a given wire size that can be fitted into a core increases as the window area. Since the proportions are similar, the turns are also proportional to A_c, the core area. The dotted lines in the right-hand section of the chart are plots of turns-versus-core area for a given wire size, and apply to low-voltage coils where insulation and margins are governed largely by mechanical considerations. Dotted lines have an average slope of one. Solid lines in the right-hand section are turns-versus-core area for constant winding resistance; these lines have less slope than the dotted lines. As the cores increase in size the window space increases proportionately, but the coil mean turn length increases also and this reduces the number of turns for constant resistance.

Cores 1 to 10 listed at the top of the right-hand section of the chart have properties shown in Table I.

To insure a good design, a check should be made of a-c flux density $B_{a\text{-}c}$ in gauss in the core according to the formula

$$B_{a\text{-}c} = \frac{(3.49)(E)(10^6)}{(f)(A_c)(N)} \quad (5)$$

where E is the a-c voltage and f the frequency. If the limit at 3,000 gauss is materially exceeded, the core will saturate and the reactor may become nonlinear or noisy. If $B_{a\text{-}c}$ is very small, less than 100 gauss, μ_Δ is small also, and a larger core is needed.

Table I—Core Properties

Core	A_c in sq in.	l_c in in.	Core weight in lb
1	0.18	3.9	0.2
2	0.26	4.7	0.3
3	0.36	6.2	0.6
4	0.59	6.6	1.1
5	0.89	7.9	1.9
6	1.35	10.5	3.9
7	2.14	13.4	7.8
8	3.10	14.9	12.2
9	4.60	19.0	23.5
10	7.23	26.9	54.3

If the estimated core is too small, winding resistance found by the chart will be excessive, or $B_{a\text{-}c}$ greater than the maximum. A larger core should then be tried. If the reactor is for high-voltage use, allowance should be made in the core estimate. In case the chart cannot be interpolated accurately enough, it is best to calculate the reactor, using the chart as a guide.

Use of Chart

To use the design chart, core size should first be estimated. Then required inductance is divided by area A_c of estimated core to obtain value of L/A_c. Follow L/A_c line on left side of chart to point where it intersects with line of rated $I_{d\text{-}c}$. Read total gap length L_g and number of turns N from margins of chart. Projecting the point of intersection to the right-hand section of the chart will give d-c resistance and wire size at the point of intersection with the vertical line corresponding to the estimated core.

Example

Required: 15 henrys at $I_{d\text{-}c}$ = 50 ma.

(1) Estimate core No. 1 (A_c = 0.18 in.²)

(2) L/A_c = 15/0.18 = 83.5.

(3) Intersection at L/A_c = 83.5 and $I_{d\text{-}c}$ = 50 ma gives l_g = 0.015 in., N = 6,000, as shown by dashed line on chart.

(4) Projection on intersection horizontally to right-hand curves gives d-c resistance at 800 ohms (interpolated between $R_{d\text{-}c}$ curves 100 and 1,000); wire size is No. 36 (interpolated between wire size curves for No. 35 and No. 40).

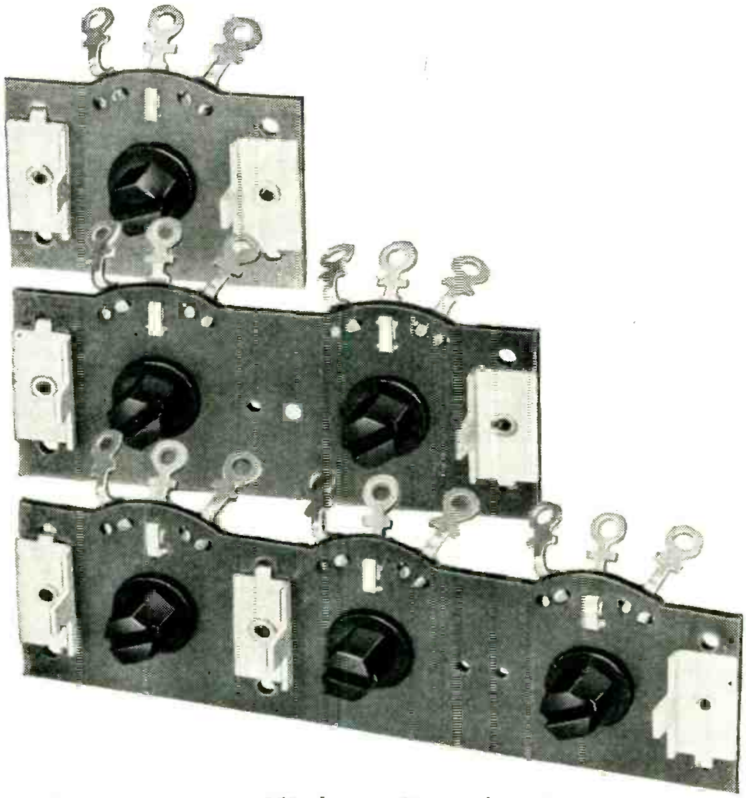
Other Materials

Similar charts can be drawn for other types of core materials. To maintain linearity, maximum flux density should be limited to that suitable for the core material used. For unoriented silicon-steel laminations, a practical maximum flux density would be 11,000 gauss. This could be arbitrarily divided into $B_{d\text{-}c}$ = 9,000 and $B_{a\text{-}c}$ = 2,000 gauss. Equation 4 would then become

$$N = \frac{15{,}000 l_g}{I_{d\text{-}c}} \quad (4a)$$

Equation 4A could be plotted on the left half of the chart as a set of $I_{d\text{-}c}$ lines with slope = 1, but spaced below the heavy $I_{d\text{-}c}$ lines already there. Lines of L/A_c would be affected slightly. The right-hand portion of the chart would remain the same.

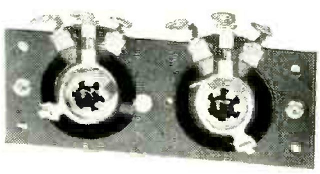
Multiple Unit Carbon Controls —in *New* Cost-Saving Design



Resistance values: *250 ohms to 10 megohms, in a variety of tapers.*

Shaft: *Hex phenolic, with slotted end; lengths — zero up to 7/8" FMS in 1/8" increments.*

Rear view shows simple, rugged design, with resistance wafer attached directly to phenolic panel.



A COMPLETELY new type of carbon control just developed by Mallory offers opportunities for important savings in your production. Available in single, dual and triple units, this model features a unique strip-type phenolic panel construction that is particularly applicable to TV alignment controls.

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The new simplified design makes it possible for Mallory to produce multiple units at costs materially lower than that for a corresponding number of conventional single controls.

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Minimum spacing of shafts . . . 1 5/32" between centers . . . is identical with that required for single controls. You can install the new units as direct replacements in many existing chassis and mounting plate designs. Special center spacings can, of course, be supplied.

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Electrons At Work

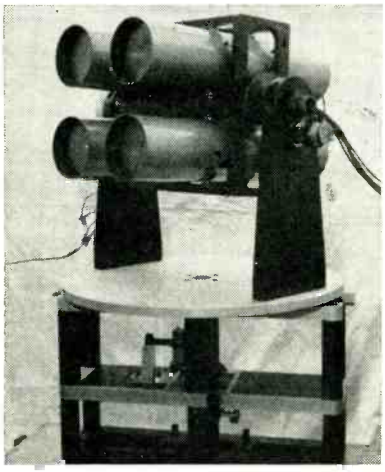
Edited by ALEXANDER A. McKENZIE

Night Airglow Aids Ionosphere Research

DIM LIGHT of the night airglow, originating high in the atmosphere, is the subject of a study recently initiated by National Bureau of Standards at Boulder, Colorado. The Colorado mountains are an ideal site for observing the night sky since there is no interference from city lights and a good view of the entire sky can be obtained from mountain tops.

A photoelectric photometer is the principal equipment used in studying airglow from the top of Fritz Peak, 20 miles west of Boulder. Studies must be carried out in the absence of moonlight, which dazzles measuring instruments and thereby obscures airglow.

Airglow is often spread over large portions of the sky and is too dim to be noted by the human eye in any one direction. However, total light coming from the whole sky is often greater than the total from much more obvious stars.



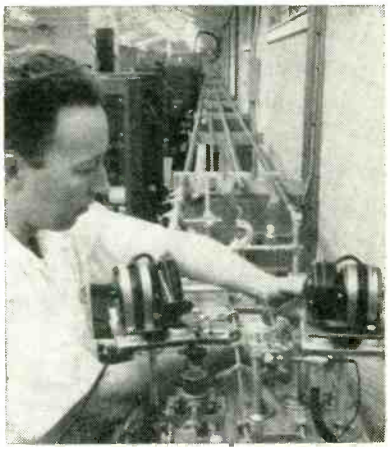
Multiple photoelectric photometer used to measure and record night airglow. Colored filters in each telescope allow various light frequencies to be observed

The photometer used comprises a group of telescopes mounted together. The telescope increases the effective sensitivity of the photoelectric device. Each telescope has a different colored filter. The group automatically scans the entire sky and results are recorded. These are compared with other ionosphere information.

It is expected that several such installations that will measure, in addition, radio noise, radio propagation and aurora, will become part of the International Geophysical Year 1957-1958. Thirty-eight nations have already signified their intent to participate.

The last world-wide series of observations, known as the Second International Polar Year, 1932-1933, was held on the 50th anniversary of the First Polar Year.

Long-Distance Waveguide May Rival Coaxial Cables



Flexible hollow tubes of two-inch diameter under test at Holmdel, N. J. permit transmission of 50-kmc waves with less loss than conventional waveguides

PROGRESS in development of new transmission techniques using tubular waveguides at frequencies in the order of 50 kilomegacycles has recently been reported by Bell Telephone Laboratories. Activity in this field by Bell Labs and Prof. Harold M. Barlow of University College, London, was summarized in these columns, p 198, Mar. 1953.

Currently, tubes approximately two inches in diameter are being used. They are different from conventional waveguides in that the latter are generally fabricated as solid metal tubes. The new waveguides for use over much longer distances are hollow tubes constructed of a thin copper wire, very tightly coiled and wrapped inside a flexible outer coating that holds the coiled wire (which is like a spring under pressure) in place.

Experiments at the Holmdel, N. J. laboratory of the Bell System showed favorable behavior of the new technique over a simulated distance of 40 miles. In practice, signals were bounced back and forth in a copper pipe 500 feet long. It has been calculated that the same waves could have traveled only 12 miles in conventional coaxial cable for the same transmission loss.

New waveguide for 50-kmc signals can be bent to around corners. Wood forms having various radii of curvature are used in propagation tests

Top capacity for a modern coaxial cable system is 1,860 two-way telephone conversations or 600 telephone conversations and two tv programs, using a pair of coaxial tubes. There are eight such tubes in a coaxial-cable, two of which are

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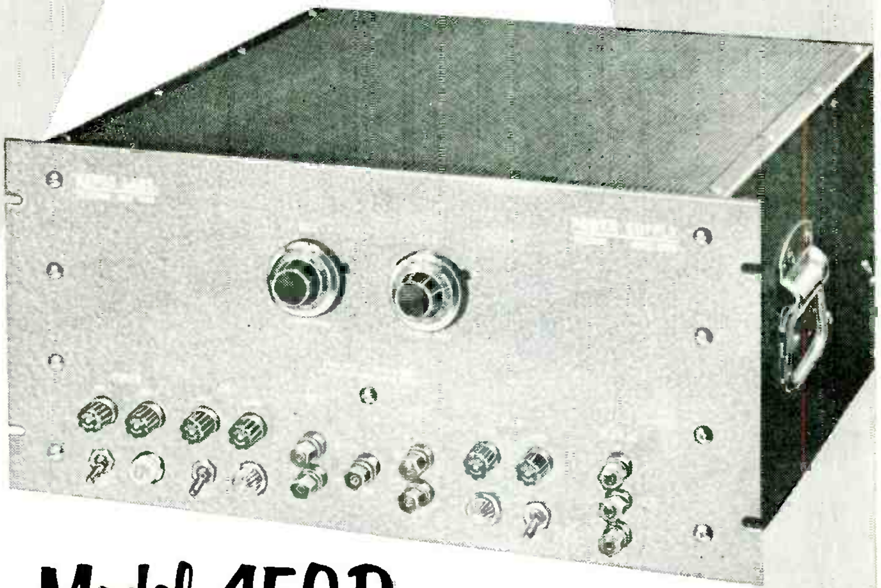

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OUTPUT	VOLTS	CURRENT	REGULATION	RIPPLE
1	0-150	0-75 ma.	0.1 volts	3 mv.
2	0-150	0-75 ma.	0.1 volts	3 mv.
1 + 2 series	0-300	0-75 ma.	0.1 volts	3 mv.
3	6.3 AC	10 amp.	†	

REGULATION: As shown in table for both line fluctuations from 105-125 volts and load variation from minimum to maximum current.

† AC Voltage unregulated.

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kept as spares for emergency use.

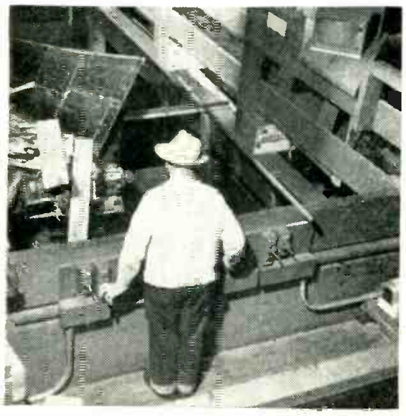
It is expected that the new waveguide may be capable of carrying tens of thousands of telephone conversations together with hundreds of television programs. Beyond this possibility, engineers hope to learn how to use wavelengths in the order of a millimeter (about 1/25th inch). If this becomes possible, future waveguides no thicker than a fountain pen may be developed.

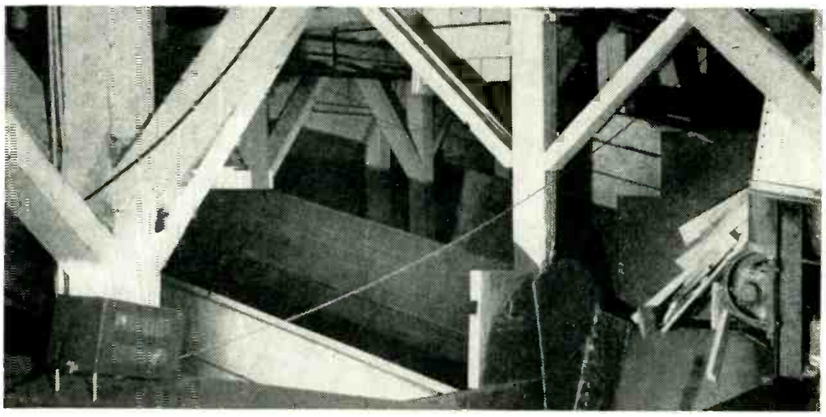
Flat Cathode-Ray Tube Simplifies Cockpit Instrumentation

Naval aircraft may soon use a transparent television-type tube as combined inner windshield and radar display. In addition, other information could be similarly displayed before the pilot by means of another flat cathode-ray tube set into a shallow instrument panel. The tube has been developed by the West Coast Electronics Division of Willys Motors. It may have future use in home television receivers.

Technical details are lacking, but the tube is said to comprise a phosphor screen between two glass plates. The horizontal beam from an electron gun is first deflected vertically by an appropriate electrode and again forward, against the transparent phosphor, by one of several horizontal plates. Resolution is said to be equivalent to 2,000 lines

Closed-Circuit Television Adds Eyes In Sawmill





In the Weyerhauser Timber Co. sawmill at Longview, Wash., mill ends and edgings are recovered for production of pulp. The salvage is conveyed to chipper machines that cut the scrap into small pieces before being sent on to a chemical digester.

The conveyor operator (left) actuates switches controlling conveyor transfer points before him. With the help of a television receiver, he likewise controls a transfer point on another floor, about 100 feet away. Each transfer point has a flipper mechanism that enables the operator to divide the load or input to individual chipper machines.

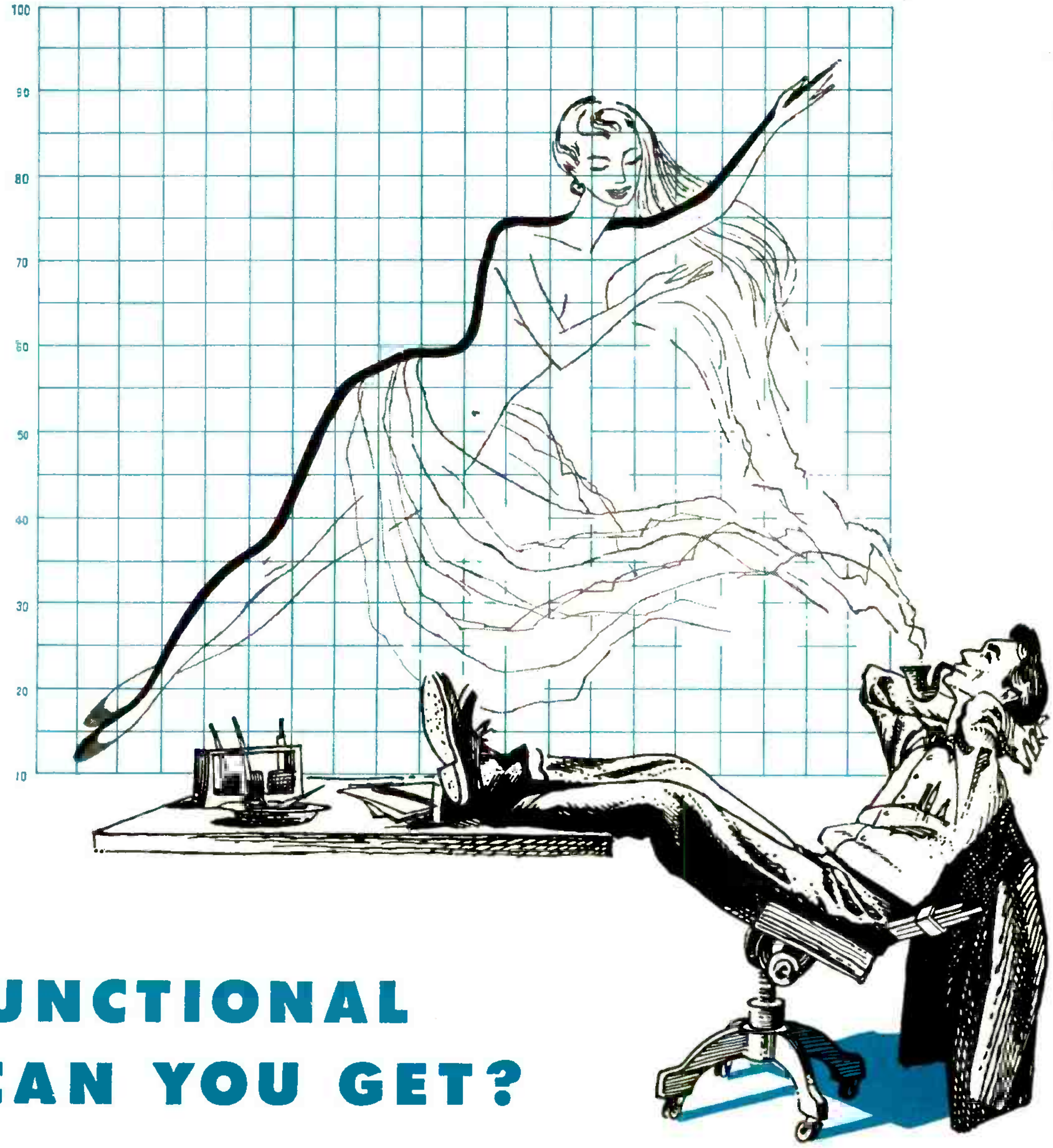
Camera (right) trained on the remote flipper enables the operator to insure smooth flow of materials to the pulp chippers

Optical Images Superimposed On Radar Oscilloscope

NAVAL RESEARCH LABORATORY has developed an optical imaging oscilloscope, called optimascope, on which black-and-white or colored optical images can be superimposed. One part of the optical system can also be used to photograph the display.

The optimascope uses a standard cathode-ray tube modified by having two small plane mirrors mounted on angle brackets fastened to the horizontal deflection-plate structure of the tube. They are set at a 45-degree angle to the center line of the electron-gun assembly, so that optical images can be projected through the neck of the tube and reflected onto the phosphor-coated inner surface of the tube face.

Before reassembly, about 0.75 inch was added to the glass tube neck to permit the beam from the



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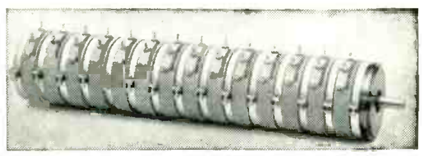

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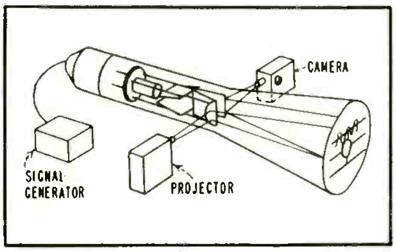
projector to enter the tube wall at a region of minimum curvature and so reduce optical distortion of the projected images.

Colored test slides projected by a modified film-strip projector onto one of the two optimascope mirrors gave reflected images that were extremely sharp, relatively undistorted and in brilliant color. Although no effort was made to use two projectors and both mirrors at the same time, this would be possible. A camera could be substituted for one of the projectors, allowing simultaneous photography of the scope face and projected image. Four or more mirrors could be used, if required.

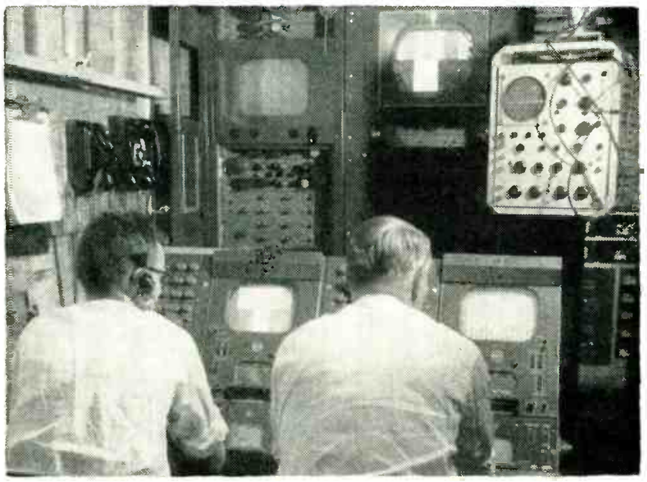
Possible military applications for the device include use of optical cursors with radar or sonar information or the use of electronic cursors with optically projected information: superimposition of photographs of ordinary or radar maps on raw video for navigation and use of a periscope and the optimascope to project an optical picture of the visual space ahead of an airplane onto the active scope face—by this means a pilot could see ahead while he was tracking simultaneously through radar.

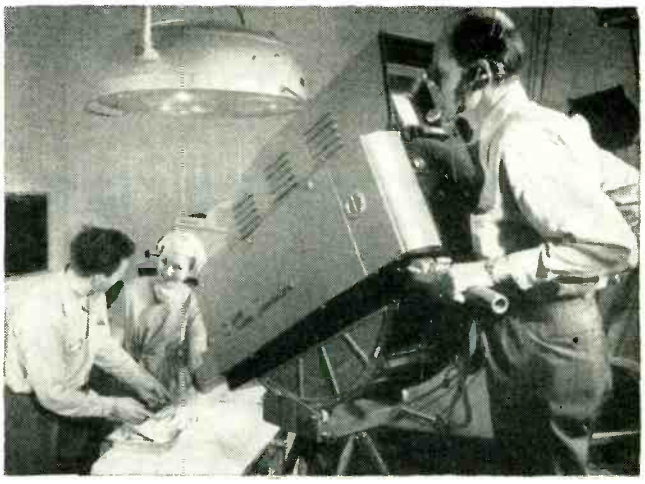


Optical images can be projected through the neck of a crt and reflected onto the inner surface of the tube face. One mirror can be used in photographing the resultant display

If very small instrument dials were mounted behind the instrument panel around the base of a multimirror optimascope—each dial might have its own source of illumination so that the dials could be projected onto the tube face one at a time or all at once—it might be arranged that a given dial would be projected automatically whenever it registered a reading outside a set tolerance limit.

Intercity Consultation Uses Color Television





Surgeons and pathologists in Philadelphia, Baltimore and Washington saw practical demonstrations of RCA compatible color television applied to their professional problems recently when microscopic specimens of human tissue were simultaneously viewed in the three cities. Occasion for the demonstration was a three-day symposium sponsored by the Armed Forces Institute of Pathology. Mobile control room at left was used to tie in cameras like that at right, shown in operating room

Fixed *LC* Oscillator Without Taps

By L. Fleming
Instrumentation Consultant
Falls Church, Va.

Need frequently arises in the laboratory for a fixed-frequency oscillator in the audio or low r-f region. Common single-tube oscillator circuits require an inductor with a tap or multiple windings, or one or more chokes. With toroidal inductors or any large coils, special items must be designed and procured and are difficult to modify if the specifications happen to be in error. For this reason, negative-resistance oscillator circuits of the Franklin or the transitron type are often used, since they will operate with available two-terminal inductors.

Simpler than these is the circuit of Fig. 1, a modification of a circuit originally described by Harris[1] as a Q multiplier and later shown in oscillator form by Clapp[2]. It is inherently a stable and vigorous oscillator, noncritical as to circuit constants. Like other circuits in which most of the tank circuit is between grid and cathode, this oscillator is primarily a source of a-c voltage, not a power generator.

Some quick observation showed that the best stability and waveform are obtained when the cathode

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SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS L (inches)	D	MAXIMUM RESISTANCE
151E	3	17/32	13/64	10,000 Ω
27E	5	1 1/8	5/16	30,000 Ω
28E	10	1 7/8	5/16	50,000 Ω

Standard Resistance Tolerance: ±5%

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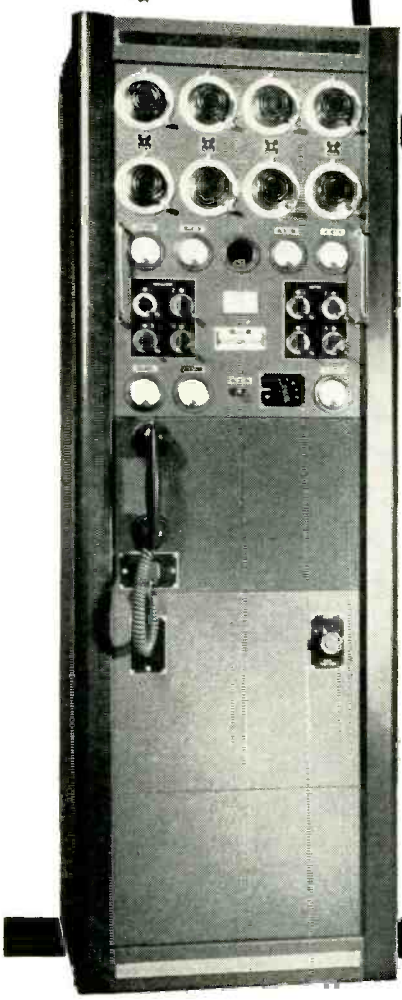

Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-24.0 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3. Stability .003%. Operates in ambient −35° to 45°C.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

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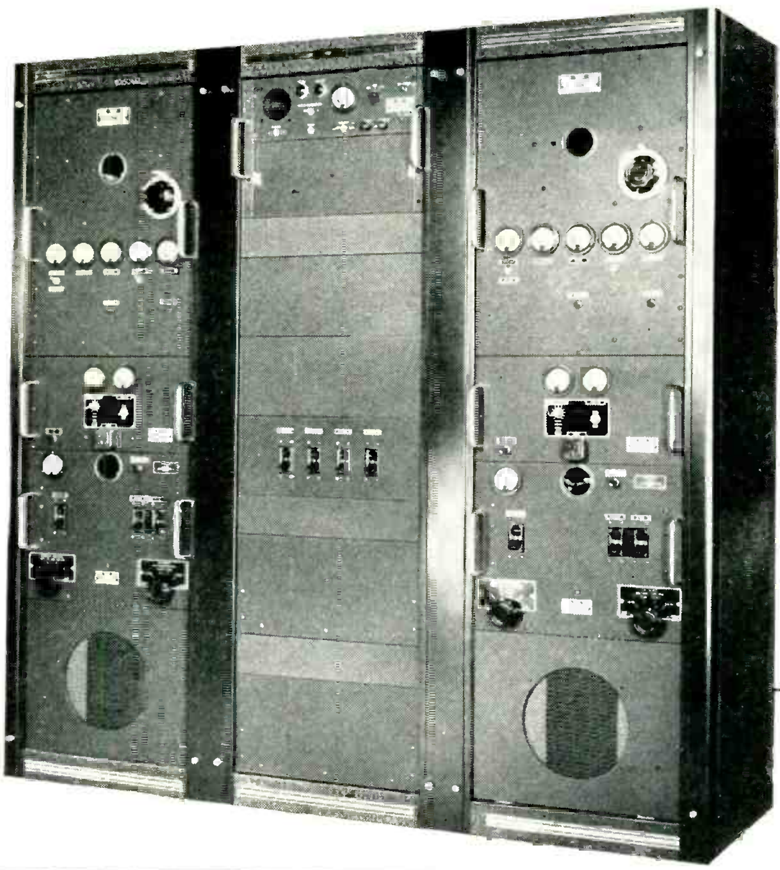
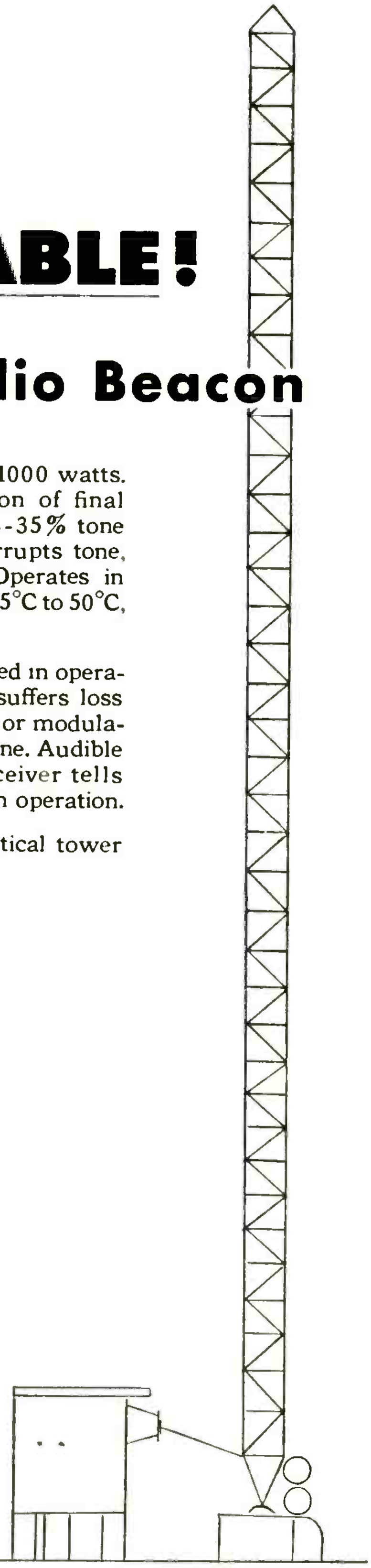
Uses single phase power supply, nominal 220 volts, 50 or 60 cycles. Consists of two 1 kw transmitters with keyer (2 keyers if desired), automatic transfer unit and weatherproof antenna tuner. Each transmitter housed in separate standard rack cabinet, with controls in rack cabinet between the transmitters.

Nominal carrier power is 1000 watts. High level plate modulation of final amplifier is used, giving 30%-35% tone modulation. P-T switch interrupts tone, permitting voice operation. Operates in ambient temperatures from -35°C to 50°C, humidity up to 95%.

Standby transmitter is placed in operation when main transmitter suffers loss (or low level) of carrier power or modulation, or continuous (30 sec.) tone. Audible indication in monitoring receiver tells when standby transmitter is in operation.

Antenna may be either vertical tower or symmetrical T type.





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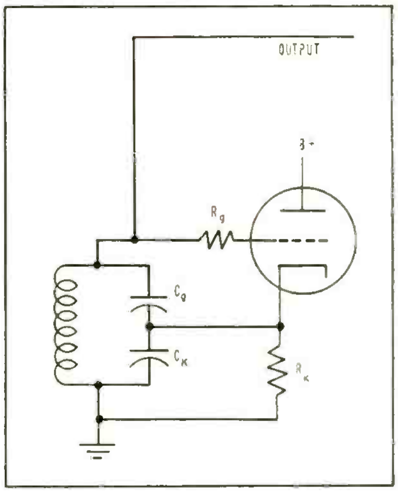

FIG. 1—Modified Harris oscillator circuit requires no chokes or inductor taps

tap is far down on the tuned circuit (C_k about 100 times larger than C_g) and when cathode resistor R_k is high, 10,000 ohms or greater. For maximum output the opposite conditions apply. The smallest ratio of excitation C_g/C_k that will sustain oscillations is a function of the Q of the tuned circuit. In general it should not be greater than $\frac{1}{4}$ and 1/10 to 1/100 are typical values for inductors having a Q in the order of 100. Grid resistor R_g is typically 1 megohm for audio frequencies. It can be omitted for noncritical applications.

Circuit Operation

When the Q of the tuned circuit is reasonably high, the voltage developed across it is about proportional to the resonant impedance $Z_o = L\omega Q$. The oscillator behaves like a constant-current generator.

The tube operates in class AB_1 or in Class B if the amplitude is high and the grid resistor omitted. Amplitude limitation normally results from slight clipping by grid-current flow on peaks, as in the resistance-stabilized oscillator shown by Terman[3]. There is no mechanism at work corresponding to the grid leak and capacitor of a regular class C oscillator.

The plate current increases with amplitude of oscillation, so that the effect of circuit loading is downward on plate current. Typically the plate current is low, but decreases by a factor of 4 or 5 if oscillation is stopped. The implication of the downward loading is that the oscillator can supply power

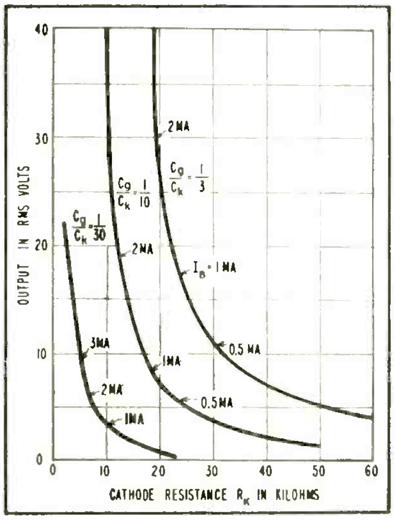

FIG. 2—Oscillator output versus cathode resistance. Plate current is given on curves at points of interest

efficiently only to a particular value of load resistance.

Figures 2 and 3 are curves of experimental data showing some aspects of the behavior of a typical oscillator of this type. Figure 2 is a plot of output voltage as a function of the cathode resistance R_k for three different excitation ratios. Using a type 12BH7 tube the frequency was approximately 1 kc when plate supply was 150 volts and the inductor 0.9 henry. Resonant impedance Z_o was held at 100,000 ohms by a resistor across the tuned circuit.

Figure 2 shows that the output voltage tends to vary inversely with

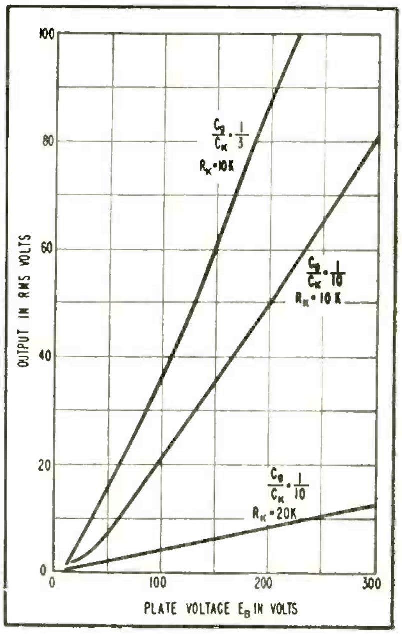

FIG. 3—Oscillator output versus plate voltage for several conditions

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R_k and directly as some power of the excitation ratio C_g/C_k. The output attainable per milliampere of plate current increases with C_g/C_k. The best waveform (and likely the best stability) is obtained with small values of C_g/C_k and large values of R_k. The waveform is, however, very pure under most conditions.

Figure 3 shows the variation of output voltage with plate supply voltage for some typical conditions. The relation is linear under practically all conditions. Further investigation of this property might lead to an oscillator capable of unusually deep modulation with low envelope distortion.

It should be noted also that the loss factor and stability of the upper capacitor, C_g in Fig. 1 is significant for the two if the ratio C_g/C_k is reasonably small, for example, 1/10. Thus for audio-frequency work where C_k may have to be large, it is generally permissible to use a cheap paper capacitor for C_k, since a change in C_k of 1 percent would change the total tank capacitance by only 1/10 percent. Only the smaller capacitor C_g need be of high quality.

Almost any tube type will work in this circuit. The circuit is also suitable for use with pentodes, in electron-coupled oscillators.

References

(1) H. E. Harris, Simplified Q Multiplier, ELECTRONICS, p 130, May 1951.
(2) J. K. Clapp, Frequency Stable LC Oscillators, *Proc IRE*, p 1,295, Aug. 1954.
(3) F. E. Terman, "Radio Engineering", 3rd edition, p 437, McGraw-Hill Book Co., New York, N. Y.

Pulse-Series Generator

By N. T. GRISAMORE and G. U. UYEHARA

The George Washington University Washington, D. C.

TO TEST RESOLUTION time of a fast scaler it was necessary to produce short pulses at arbitrary time intervals. The first approach to this problem was to use a commercially available pulse generator and branch the output into two or more 50-ohm cables of varying lengths. However, as these pulses were to be

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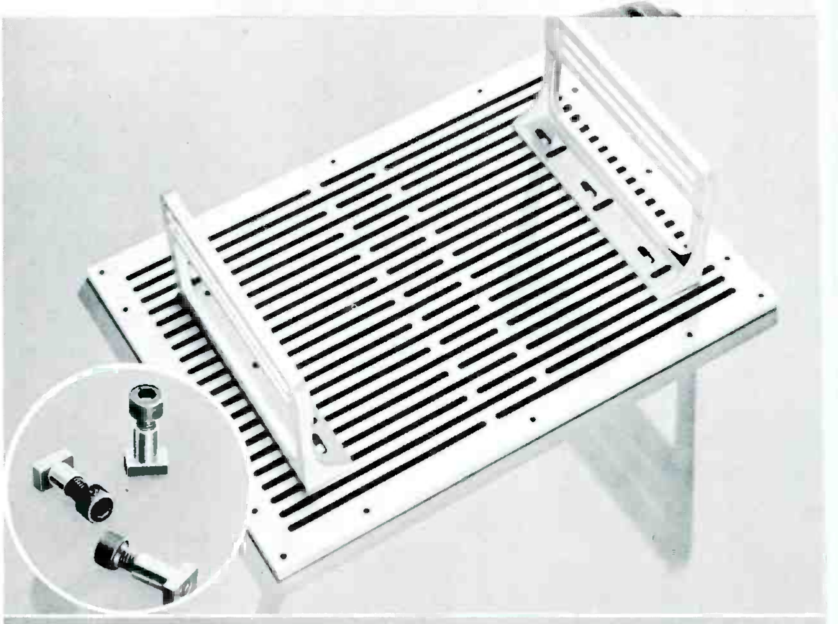

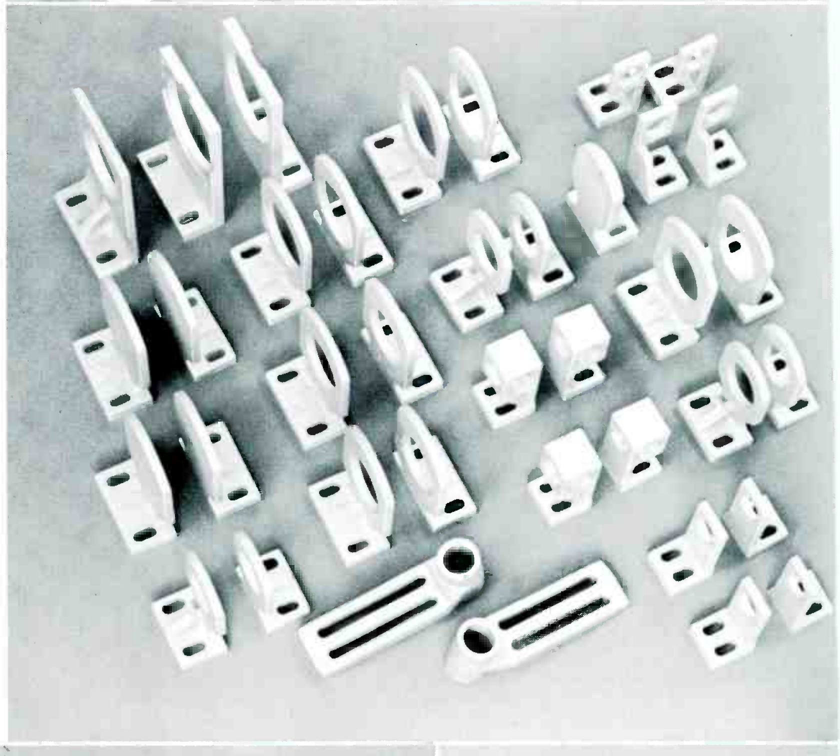

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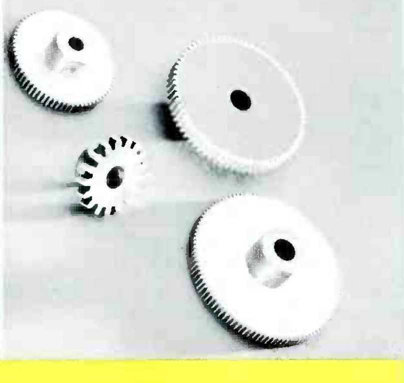

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introduced into a circuit at a common point, a satisfactory matching at the ends of the cables was never achieved and difficulties arose owing to reflections from this common point.

The circuit shown in Fig. 1 has the property of delivering four pulses separated by arbitrary time intervals to a common point with-

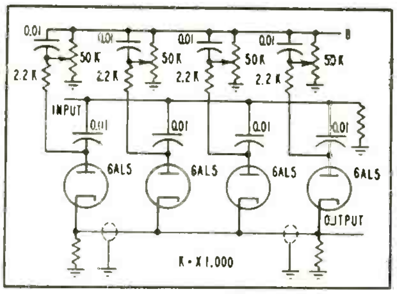

FIG. 1—Pulse multiplier produces four output pulses for single input pulse

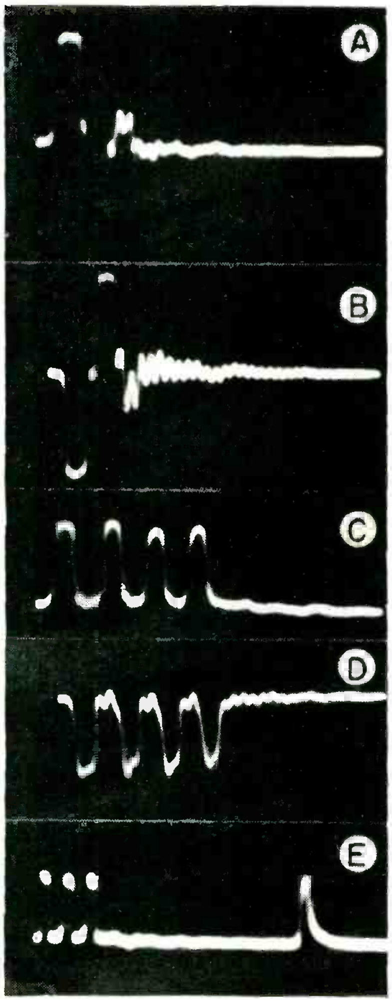

FIG. 2—Positive (A) and negative (B) 20-μsec input pulses to multiplier. Four output pulses (C) and (D) are separated by equivalent of 10 meters of RG-59/U cable. Final pulse of (E) is separated from group by equivalent of 100 meters of cable

out interference from reflections. By inverting the diodes and changing the polarity of the input signals and bias voltage, negative pulses can be obtained from the output. The curves in Fig. 2 show the outputs with both phases of operation.

When one pulse is to be separated from another pulse by a considerable length in time, attenuation in the cable becomes a factor to be considered. In this case the input to each of the diodes, except the one producing the smallest pulse output, is clipped so as to match all of the output pulses to the one of least amplitude. This is accomplished by adjusting the d-c voltage level of the input signal at each diode by means of the potentiometers. None of the component values in the circuit is critical except that of the matching impedances for the output cable.

This circuit design has been extended to one producing ten output pulses and another circuit has been constructed using crystal diodes in place of tubes.

Work on the pulse multiplier has been supported by the Office of Naval Research and the description is from a dissertation submitted in partial fullfillment of requirements for the PhD degree at The George Washington University.

Electrostrictive Ceramic Relay

UNLIKE most ceramic materials such as porcelain, steatite and other silica crystal materials, which exhibit only moderate dielectric constants, various forms of barium titanate ceramics with high dielectric constants provide large dimensional change when subjected to electrostatic fields.

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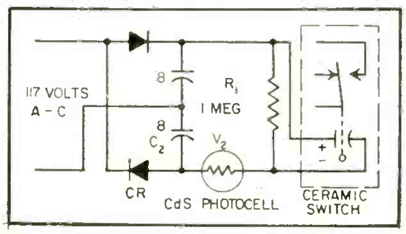
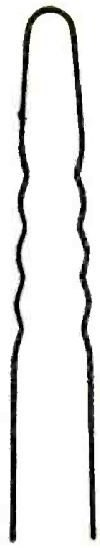


FIG. 1—Fast-acting photoelectric circuit requiring no amplication



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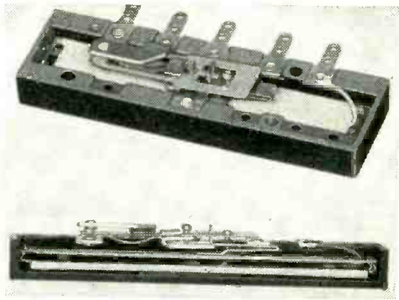
application of an electric field in the order of 1,000 volts per mm. This dimensional change takes place in a direction parallel to the applied electric field.

One use of such material is exemplified in the Capaswitch manufactured by Mullenbach Electrical Mfg. Co. of Los Angeles, Calif. The photograph shows the nature of the device and the circuit of Fig. 1 indicates one possible application. The circuit utilizes a full-wave voltage



Electrostrictive ceramic bar shown at bottom of switch

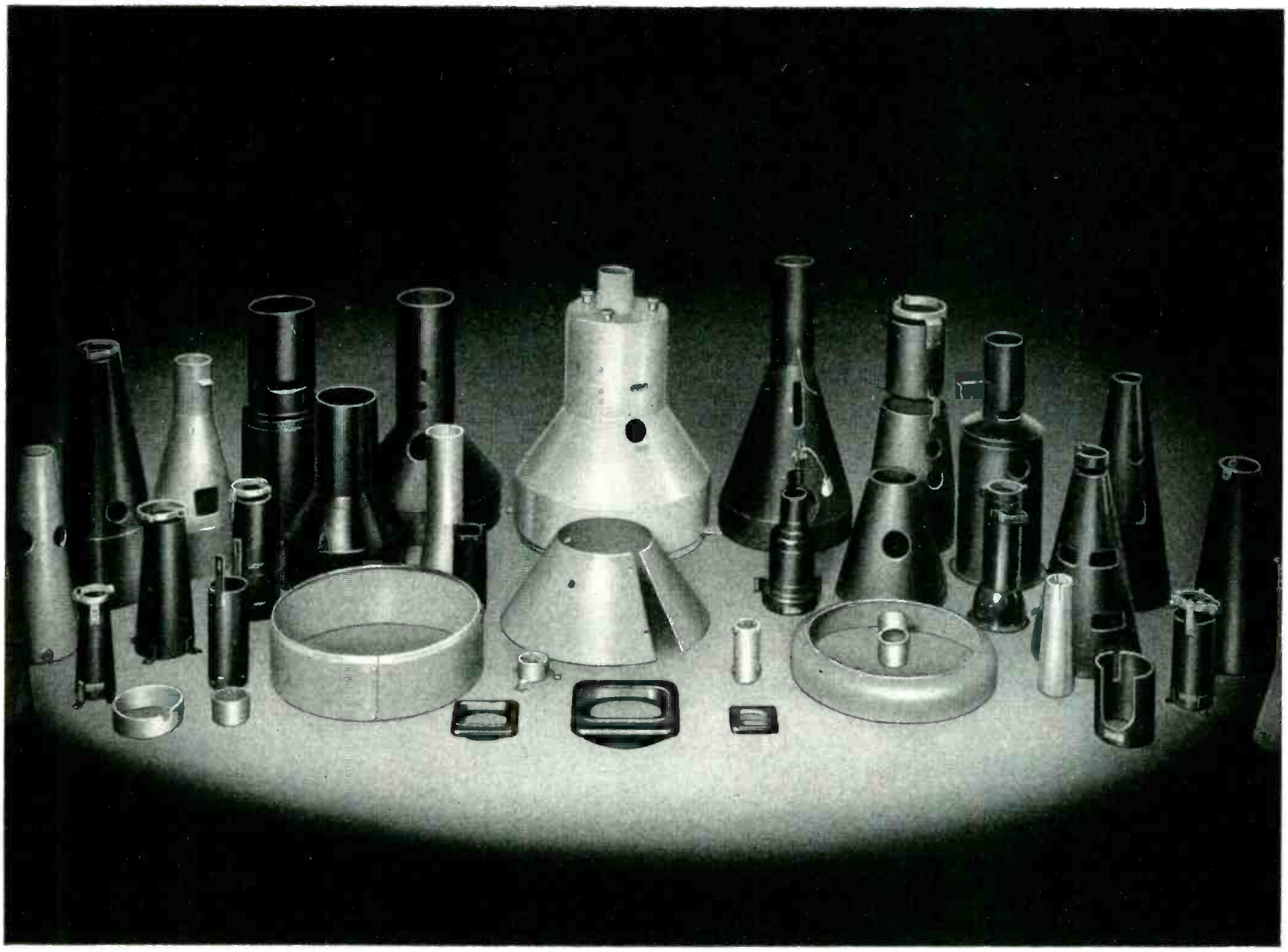
doubler. It has proved reliable and fast for counting operations.

Voltage swing across R_1 from almost 0 volts with no incident light on photocell V_2 to 250 volts with light provides satisfactory action under widely varying ambient conditions.

Electrostriction has been differentiated from piezoelectric phenomena (which it includes) by the following definition. It is the effect wherein the deformation of a dielectric material subjected to an electrostatic field is proportional to the square of the impressed electric field, being independent of the applied field's polarity. Deformation of a dielectric resulting from piezoelectric properties is proportional to the first power of the imposed electric field and therefore reverses direction of deformation upon reversal of the field.

Equipment Data Sheets

GOVERNMENT-SPONSORED collections of equipment data sheets have recently been made available for general use through Carl L. Frederick and Associates, Bethesda, Maryland. The equipment, identified by armed forces stock numbers and



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described in terms of function, electromechanical characteristics, manufacturers' data and tube complement is listed in three separate volumes. Among the categories included are waveform measuring equipment, signal generating equipment and calibrating devices. Some 900 different items are listed.

Automatic Damping Improves TV Monitor

By H. E. Thomas, S. A. Demars and M. E. Jones

Federal Telecommunication Laboratories International Telephone and Telegraph Corp. Nutley, N. J.

Design of vertical output systems in conventional tv receivers is governed by the deflection requirements of the picture tube and the character of the scanning currents required to deflect the electron beam. In transformer-coupled output circuits, adjustments are provided for obtaining linear output and also for regulating the height of the raster. Fixed-constant circuits are usually employed to damp the transient voltages developed during rapid reversal of the scanning currents. Adjustable control of transient damping has seldom been attempted.

Incorrect damping-circuit performance in a tv display can affect linearity at the top of the raster although these effects attract little notice since poor scanning performance in this region does not usually persist after blanking is completed. There are times, however, when it is desirable to view an entire perfect raster when adjusting for wide ranges of height. At these times an unsuitably damped transient will distort its linearity. Changes in driving-oscillator-output amplitude when applied to the deflection system also affect damping because its governing factors vary under those conditions.

In conventional receiver circuits, this transient is damped almost entirely by plate resistance of the output tube, the exact amount of damping being determined by the degree of preshaping of the grid driving-voltage waveshape during the re-

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RPM	20,000	11,000
CFM	58 @ 0" SP 40 @ 1.0" SP	32 @ 0" SP 25 @ .32" SP
Current	0.2 amp.	0.1 amp.
Volts	115	115
Cycles (Frequency)	400	400

STATIC PRESSURE IN INCHES OF H_2O

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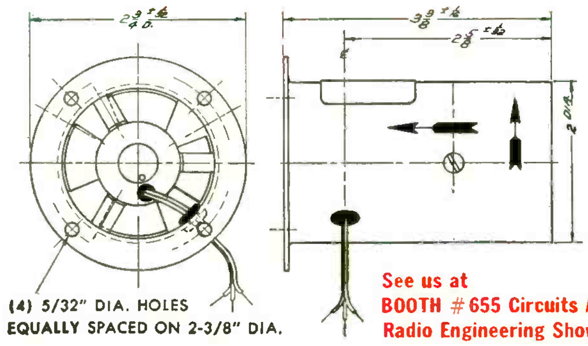
0 10 20 30

CFM AT STANDARD AIR



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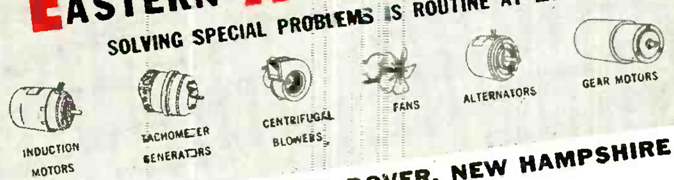

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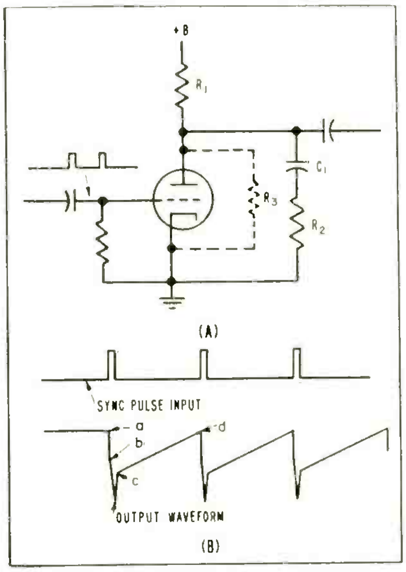

FIG. 1—Sawtooth generator (A) and output waveform produced (B)

trace period. The character of this grid voltage reflects control on the amount of plate resistance over which the output tube is allowed to operate and thus regulates the shunting effect in damping transients during the retrace period.

The problem of practical design for correct damping of a vertical-output system resolves into five sections: the driving voltage waveshapes, the damping required to give optimum deflection and transient performance of the deflection system, critical damping versus optimum damping, the range of plate resistance available and necessary for correct damping and automatic-damping circuits arrived at through a correlation of the above four factors.

Waveshapes usually employed to drive vertical deflection amplifiers may be derived directly from either a multivibrator or from a sawtooth generator such as is pictured in Fig. 1A.

The character of such a trapezoidal waveshape is shown in Figure 1B. The particular shape of such an output wave has a twofold purpose when applied to a vertical-deflection amplifier. First, the application of it as a source across the inductive output system is a contributing step toward the generation of a sawtooth output current in the deflection coils and although this effect is relatively small because vertical-output systems operating at 60 cps are essentially pure

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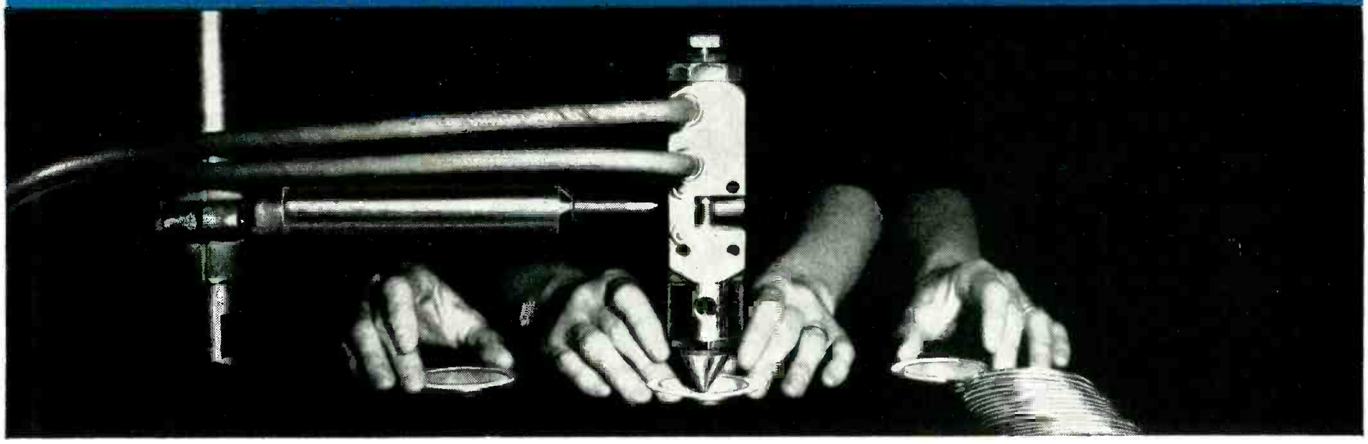

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resistances, a trapezoidal waveshape helps somewhat in improving output-current linearity.

Addition of the pulse portion of the trapezoid waveshape provides the opportunity to initiate a variable amount of damping, since the instantaneous value of the bias on the output-amplifier tube and the positive excursion of the plate of this tube, and hence the damping, is determined by pulse amplitude.

The generation of the particular pulse shape requires that the initiating sync pulse that triggers the sawtooth generator be narrow enough to be less than the retrace cycle allowed for the whole deflecting system. A sync pulse that carries over longer than the retrace period would obviously eliminate the opportunity to control damping during this time.

Observation of the voltage waveshapes at the output of a sawtooth generator shows their dependence upon several factors. The slope of the waveshape from point c to d is dependent upon the size of charging capacitor C_1 and the plate-supply resistor R_1. This section of the waveform is not particularly concerned in the damping problem.

Waveform Shape

The slope of the waveform during the capacitor discharge, which is the retrace interval b to c depends upon the plate resistance of the tube in its grid positive-driven condition. The discharge path follows an exponential curve from b to c, which is dependent upon the size of C_1 and the series-parallel resistance of R_2 in series with the combined parallel value of supply resistor R_1 and R_3, the discharge resistance path. Supply resistor R_1 is usually so large compared to R_3 that it can be neglected. The amplitude of the peaking pulse is essentially dependent upon the size of this resistance combination and more particularly on the value of R_2. This is because at the start of the sync-pulse application, the tube's discharge plate resistance is low compared to the size of peaking resistor R_2. Instantaneously at the start of the pulse the total voltage appears across this resistor.

It is the amplitude of the peaking pulse that is of prime interest in

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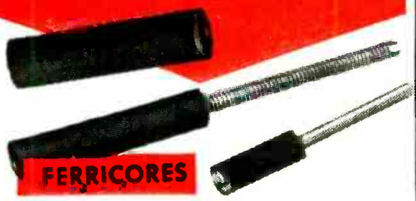

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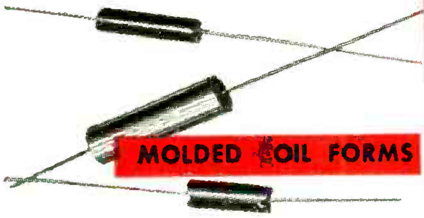

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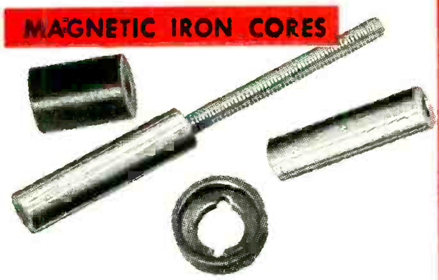

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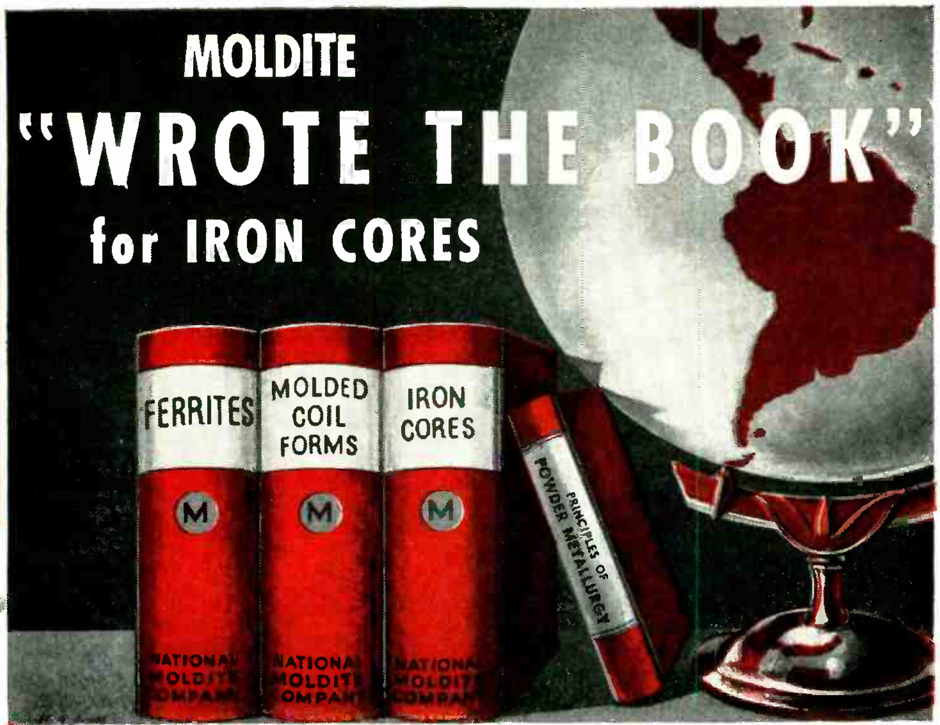

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this discussion since it controls the damping of the over-all system.

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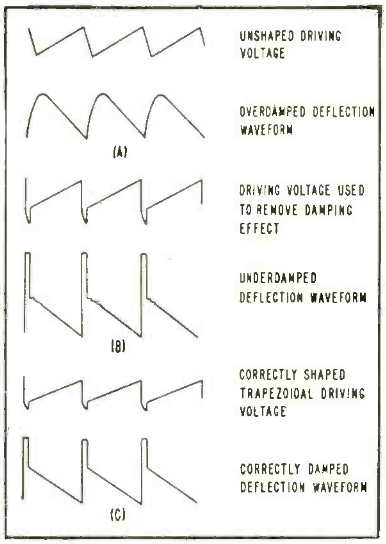

FIG. 2—Driving-voltage waveforms and deflection-voltage waveforms showing effects of overdamping (A), underdamping (B) and correct damping (C)

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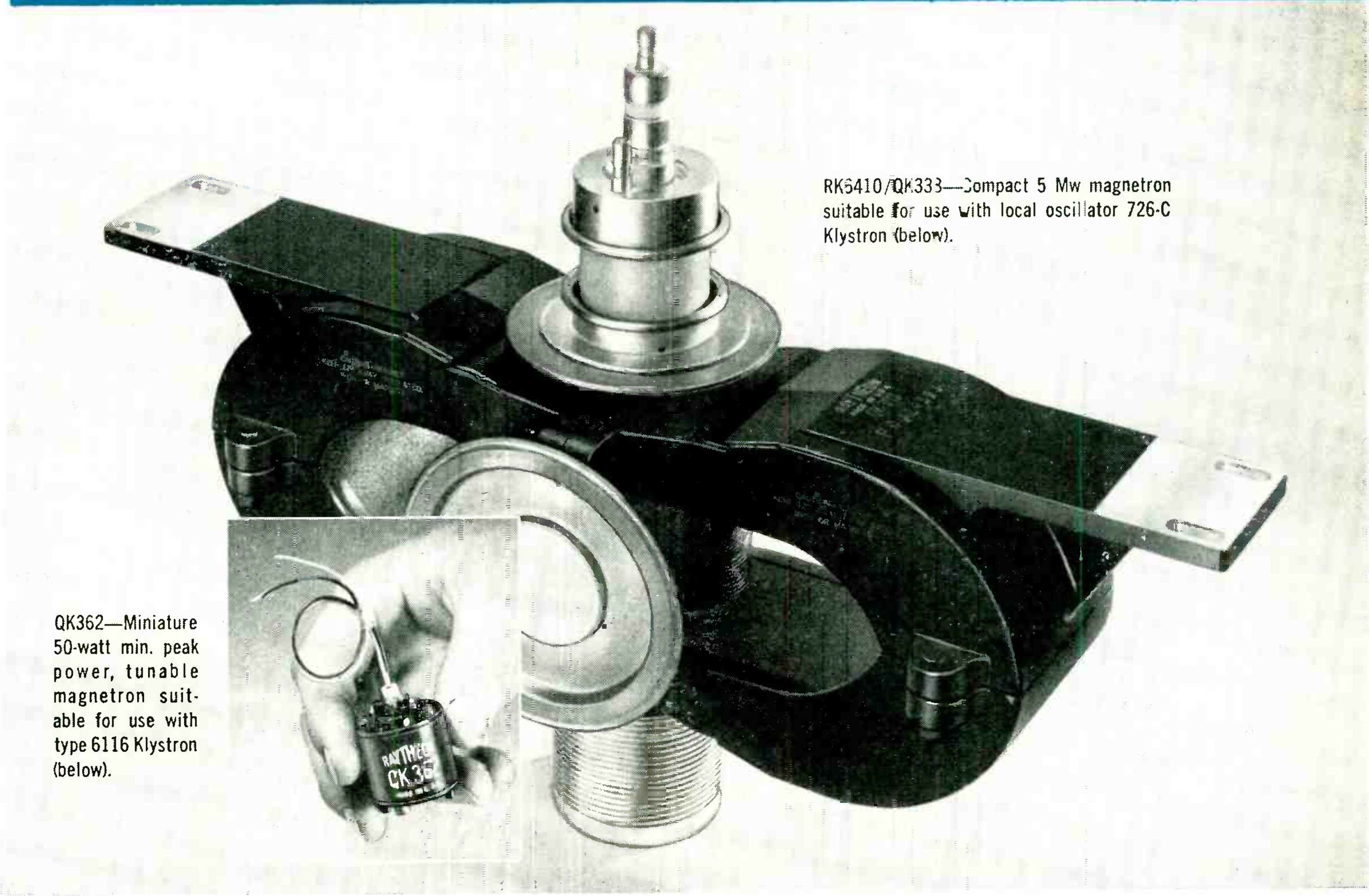

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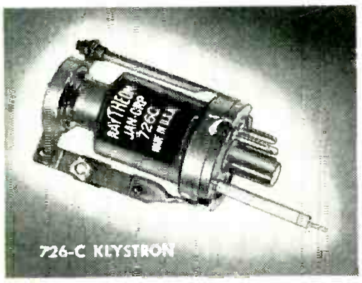

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Kingsbridge Armory—Booths 145, 147, 149 Kingsbridge Palace—Booths 2, 4 sary for this may be provided by the plate resistance of the amplifier tube which, without the preshaping at the driving voltage, overdamps such transients. The effect of overdamping is shown in Figure 2A and affects the linearity of the deflection currents at the beginning of trace time. If the damping action of the tube is removed by biasing the grid sufficiently negative, waveform transients appear as in Fig. 2B. Here again the undamped transients reflect themselves onto output deflection currents and thus carry over into the retrace time to affect linearity at the raster top.

If the optimum amount of damping is arranged as shown in Fig. 2C, a minimum of transient voltage is developed and the linearity characteristics of the sawtooth deflecting currents are unaffected by transient carry-over at the start of the trace interval.

These characteristics vary under different amplitudes of sawtooth driving voltage, as well as of peaking-pulse amplitude, since the voltage generated across the primary of the output transformer and the damping effect of the output tube depends upon the total voltage applied. The damping effect controlled by the peaking pulse must be tailored to fit variations in the total driving-waveform amplitude, if optimum plate-circuit damping is to be attained.

In deflection systems where the driving voltage is maintained constant, a fixed combination of peaking pulse and driving voltage can be arrived at that gives optimum damping and such is the case in tv receivers. In cases where inputs vary widely, it is inconvenient to alter the peaking voltage each time vertical driving-level changes.

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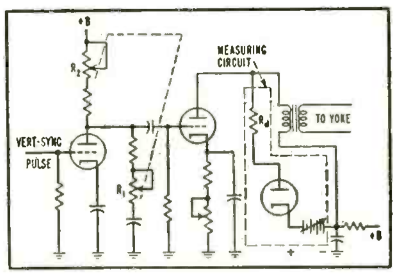

FIG 3—Circuit for automatic damping of vertical-deflection waveform. Diode circuit has been added for the purpose of making dynamic measurements

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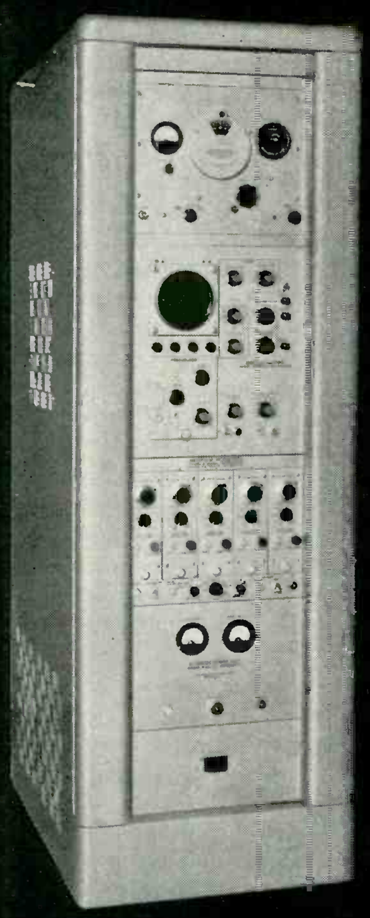

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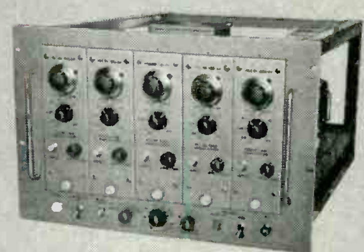

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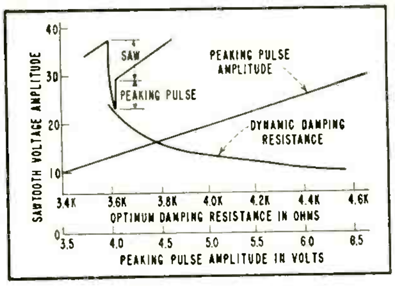

FIG. 4—Peaking-pulse amplitude and dynamic damping resistance plotted against sawtooth driving voltage

self into the determination of optimum damping needed, the range of damping resistances provided by the output tube and arrival at a correlation of output-tube driving-voltage waveforms that give optimum damping over a wide level of driving voltage.

By mathematical derivation using actual commercial constants and under normal variations in these components the critical-damping resistance that would have to be connected in parallel across the primary of a vertical-output transformer is in the region of 80,000 ohms.

Damping due to plate resistance is a dynamic quantity that depends upon tube characteristics during the retrace period. At this time two opposing actions are taking place: the grid is being driven negative by the combined sawtooth and peaking pulse, the net result being an increase of plate resistance, and the added effect of the peaking pulse produces a relatively high induced voltage across the plate of the tube. This voltage tends to produce a decrease in plate resistance, particularly if plate current flows.

The determination of the effective damping resistance of the output tube was derived experimentally by a substitution method shown in Fig. 3. By applying varying amounts of sawtooth driving voltage, each value accompanied with a high peaking pulse, the circuit was arranged for optimum damping through adjustment of R_d by observation of the output waveform. The high peaking pulse was applied in order to bias the tube excessively, so that its damping effect was removed, the only damping remaining being that provided on the physical resistance R_d. This resistance was

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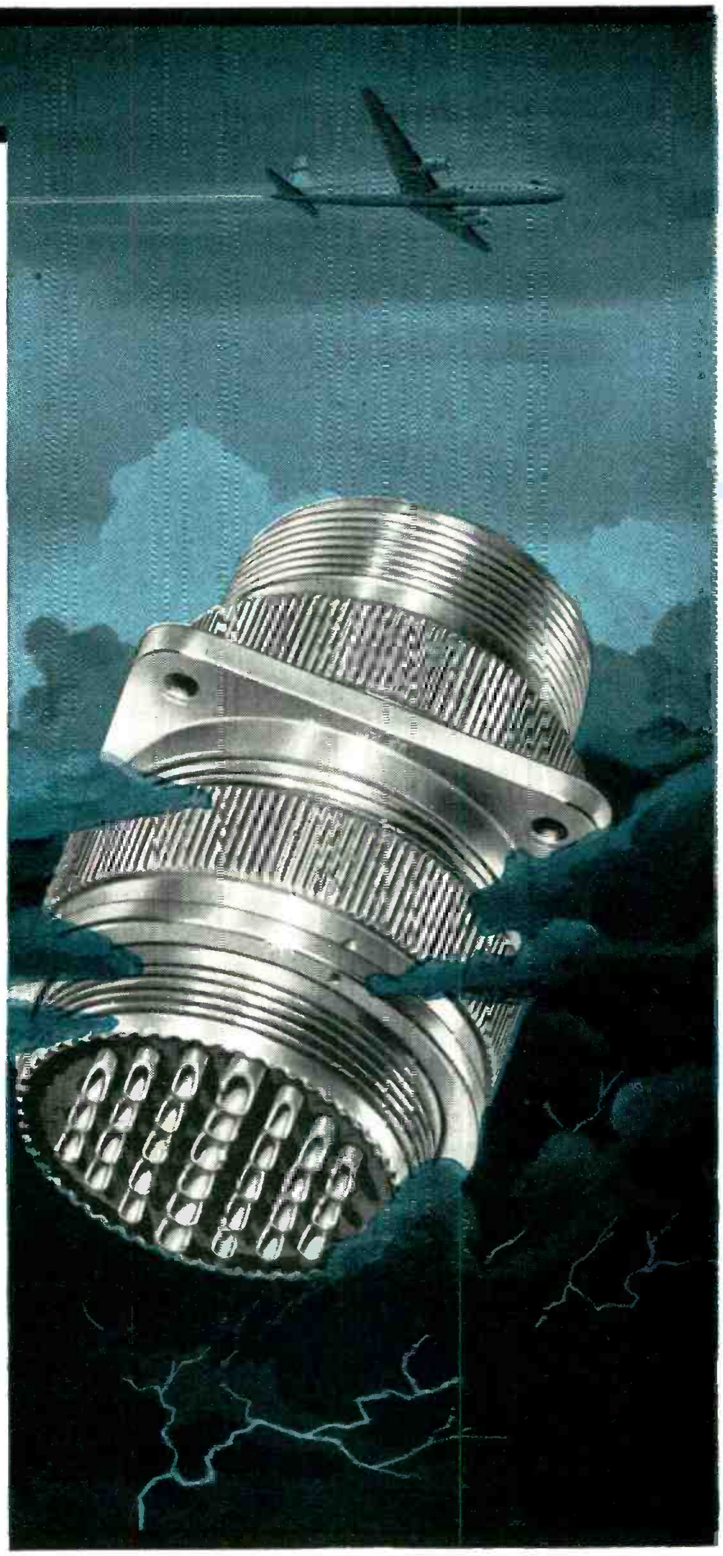

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so biased to the peak value of the sawtooth that it conducted only during the peaking-pulse interval.

A plot of these values versus applied sawtooth voltage is given on Fig. 4. Note that the range of this resistance was around 4,000 ohms.

To further analyze overall operation a conventional circuit was set up so that the grid-driving sawtooth and peaking voltages could be varied and the results observed while adjusting for optimum damping. Figure 5 shows these measurements with sawtooth-plus-peaking amplitudes plotted for various sawtooth inputs against output plate voltage.

Optimum damping occurred at the points indicated on the lower bend of each sawtooth curve showing that damping effect occurred for relatively small values of added peaking voltages. These values may seem small on the grid of the output tube but when reflected on the plate circuit of the amplifier their relative amplitudes with respect to the sawtooth is considerably greater due to the sharp rise time of such peaking pulses and the attendent generation of relatively high voltages across the output-transformer primary.

Analysis and correlation of this material shows that an automatic device with the correct proportionment of constants could be determined such that damping would always be correct no matter what the driving sawtooth-voltage level. In other words, each driving voltage or sawtooth voltage could have its corresponding peaking voltage if the peaking pulse is made to follow in amplitude the main sawtooth

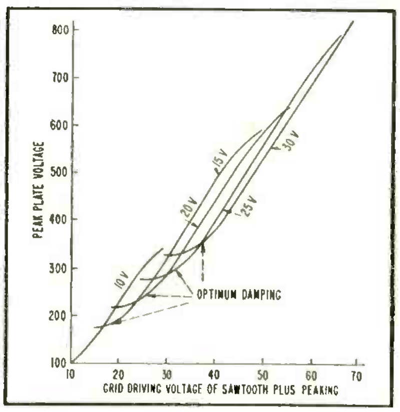

FIG. 5—Sawtooth-plus-peaking values for various levels of sawtooth input

driving pulse that is generated.

The obvious move is to make the peaking resistor a variably controlled element and to gang it to a control of the driving sawtooth-voltage input. Such an arrangement is shown in Fig. 3 where the values of peaking voltage are directly linked to the amplitude of the input control potentiometer. Potentiometer R_1 was proportioned so its range of values delivered the appropriate values of damping as the input driving sawtooth was controlled over a range from 10 to 30 volts. Ganging the input potentiometer R_2 with the correct range and taper of R_1 makes the device automatically self-compensating for correct damping at any value of input setting.

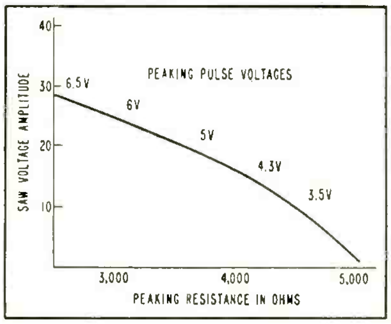

FIG. 6—Peaking resistance for optimum damping plotted against sawtooth amplitude

An analysis of the performance of the compensated vertical damping systems was made on the curve plotted in Fig. 6, which was initially taken to determine the value of R_1. The value of R_1 decreases as the driving sawtooth is increased. This is explained by the fact that as sawtooth amplitude is increased, the damping effect is also increased due to the tube's inclination to draw plate current under higher voltages. Consequently, although more pulse is needed to cut off the tube, it is not provided entirely by an increase in the size of the peaking resistor.

The automatic version of such a damping device is shown in the schematic diagram of Fig. 7. This circuit uses the plate resistance of V_1 as the peaking resistor and ties the variability of this resistance to the driving pulse by applying bias that is developed from the output voltage. The grid of the peaking

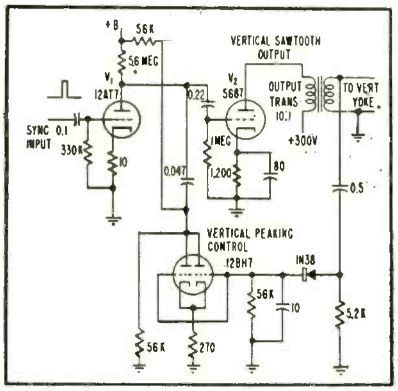

FIG. 7—Automatic damping circuit for vertical output system

tube thus has a variable bias, which in this case is applied and controlled to vary the peaking pulse automatically so correct damping results no matter what the sawtooth amplitude.

In commercial television receivers the application of this device would hardly be worthwhile since vertical driving voltages do not vary greatly and nonlinearities owing to improper peaking do not appear past the blanking interval. The application in horizontal-deflection systems has been practically simulated in regulated high-voltage systems where the driver tube is gated on by separate pulses during the retrace time to obtain improved regulation of the flyback developed. Automatic control of the peaking pulse might be considered as an adjunct to this system although plate-circuit damping of the entire output system would probably not be practical.

The circuit may be used in the measurement of spot size by the shrinking-raster technique. Here a complete linear raster is desired with as many lines as possible over considerable height variation. Automatically damped vertical circuits will give quickly obtainable linear rasters with a minimum of adjustment so that in the shrinking process the division calculations are not destroyed by nonlinearities due to under or over damping.

The device was also considered when it was desired to utilize a greater proportion of the vertical blanking interval for the display of additional video information. Correctly damped outputs kept the sweep currents in this interval linear and free from extraneous inter-

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ference. The information obtained in the accompanying experiments also aided in correctly proportioning peaking circuits so excess plate voltages were avoided while maintaining optimum damping.

Vibrating-Ignitor Tube Consumes Less Power

By YOSHISUKE HATTA and SHOJI HIRAGA

*Electrical Engineering Dept.
Tohoku University
Sendai, Japan*

IGNITORS FOR SINGLE ANODE mercury-arc rectifiers can be classified into two-types; the boron carbide ignitors of the ignitron and the dielectric-shell ignitor. Although these two types of ignitors are widely used, they have defects that are difficult to overcome.

The former is not only inadequate for light-load operation owing to its considerable power demand for arc ignition but also its mass-production with uniform quality is difficult. On the other hand, the dielectric shell is not suited for continuous operation, although its

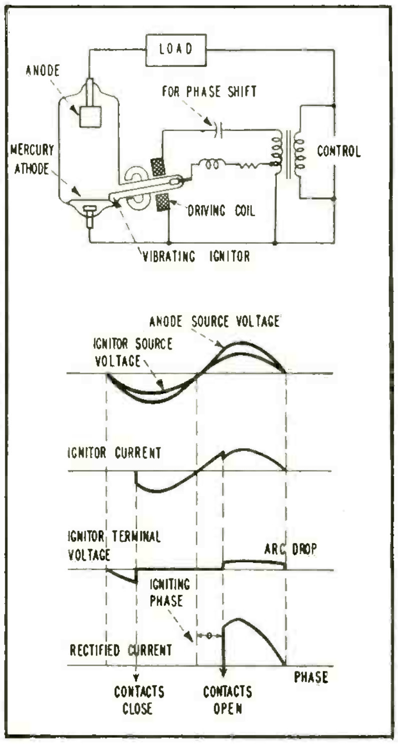

FIG. 1—Vibrating-ignitor ignitron with operating circuit. Waveforms are at various points in circuit during operating cycle

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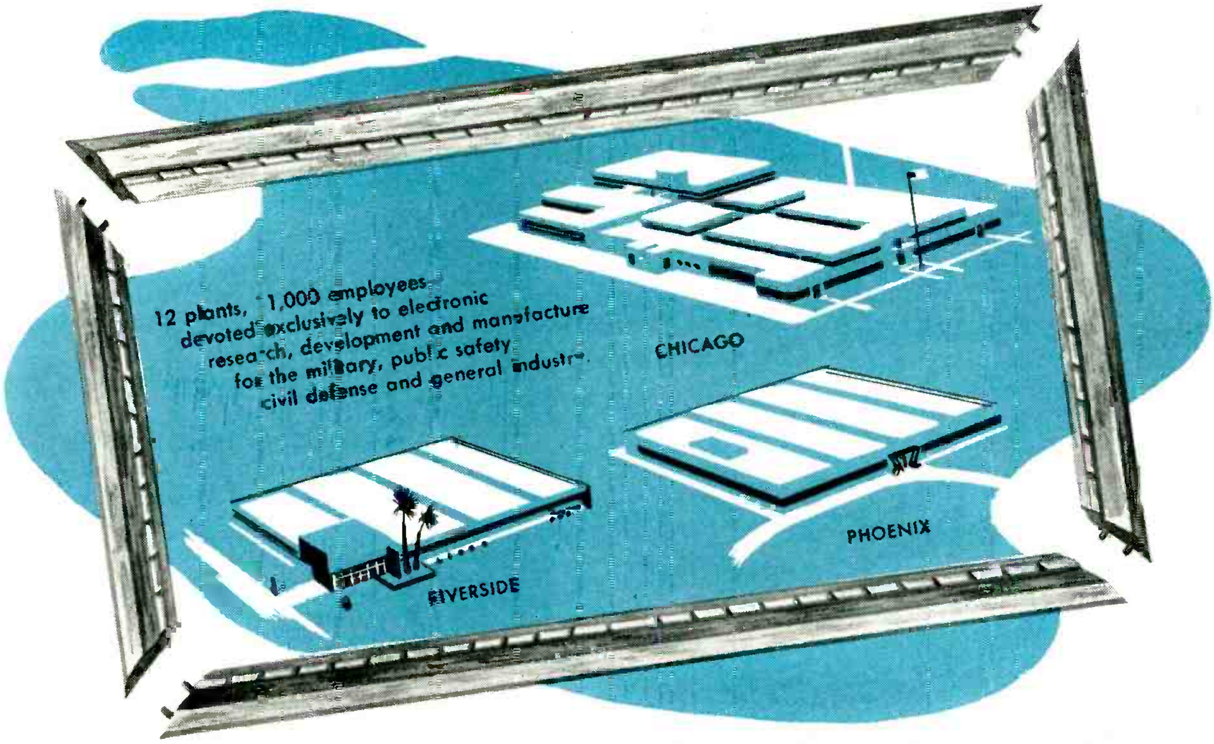

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ignition power requirement is much less and mass-production is easy.

Efforts have been made toward developing a new ignitor having long life for continuous operation as well as small ignition-power requirements.

Present ignitors make use of arc ignition at the delicate contact between the ignitor surface and the mercury cathode, which may be readily violated by the powerful cathode spot during arc conduction. Consequently, there is difficulty in improving ignitors of old types. The ignitor described here makes use of arc initiation that takes place at breaking of electrical contact.

When instantaneous values of current and terminal voltage of electrical contacts at their breaking moment exceed 60 ma and 20 volts, an arc can be ignited between the mercury-pool cathode and the anode.

Igniting Vibrator

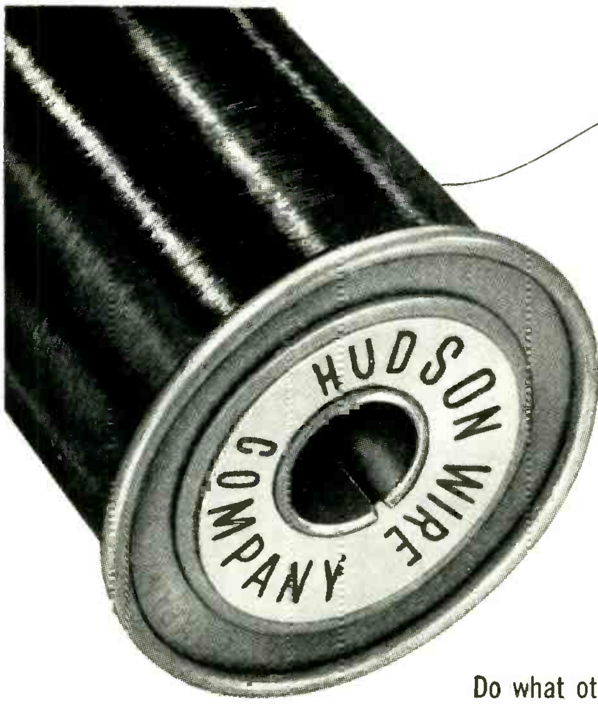
The vibrating ignitor under present study is an application of these phenomena. Figure 1 shows the structure and basic circuit of the discharge tube employing it.

The ignitor consists of a steel reed having a needle tip at its end. Since this ignitor is driven by an electromagnet excited by the supply frequency and is polarized by a permanent magnet, its vibration is perfectly synchronized with anode voltage.

If the breaking phase of the contact between ignitor tip and mercury surface is properly adjusted so the ignitor current and its terminal voltage at the moment fulfill the above mentioned conditions, stable arc initiations to the anode can be attained. Experimental tubes display fairly stable operation. Waveforms shown in Fig. 1 illustrate the relationship between current and voltage of the ignitor and anode.

Consumption of the tip of the ignitor is negligibly small. Such slight deterioration may be attributed to cooling the tip by mercury and absence of oxygen in the tube.

At the cathode spot, the mercury-pool surface moves up and down resulting in considerable fluctua-



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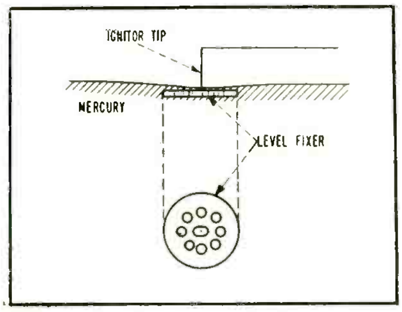

FIG. 2—Level fixing unit in mercury pool eliminates timing changes resulting from variation in mercury level

tion in the igniting phase. This can be avoided by use of a mercury level fixer. Figure 2 shows the structure of the level fixer. It is a metal disk with a number of small holes and is fixed at the level of mercury surface. When its whole surface is covered by a mercury layer, the cathode spot runs on this layer eliminating wave motion on the pool surface.

The mercury within this layer is continuously supplied through the holes of the level fixer, though it evaporates during arc conduction.

To investigate the effect of the level fixer, distributions of igniting phases have been measured on tubes with and without the device.

Figure 3 shows the observed results of the distribution function $P(\Theta)$, where $P(\theta)\, d\theta$ means the probability that the igniting phase, θ of Fig. 1 lies between θ and $\Theta + d\theta$.

Standard deviation of θ under operating conditions is about 1 degree. In most applications, fluctuation of this order is permitted.

Vibrating System

The driving device consists of a coil and a permanent magnet. It vibrates the ignitor tip with an amplitude of about 3 mm. If the

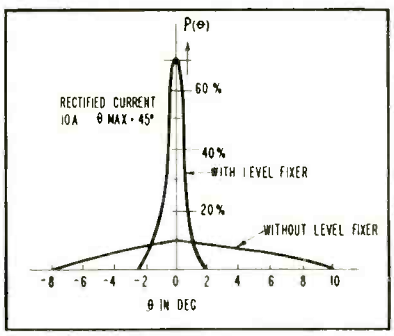

FIG. 3—Range of ignition phasing with and without level fixer

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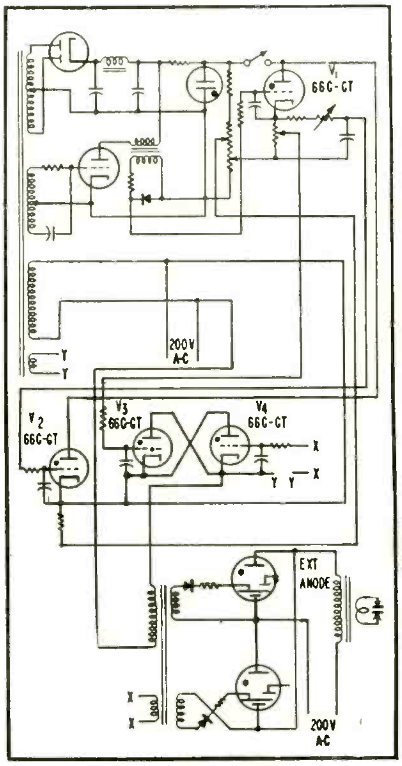

FIG. 4—Spot welder control circuit using two vibrating-ignitor tubes. Circuits of exciting anodes are not shown

natural frequency of the ignitor f_o is nearly equal to the line frequency f, the amplitude of vibration and igniting phase are considerably affected by small changes of f. To reduce these effects, f_o should be larger than f. Ignitors under test have an f_o equal to about 1.2 f. Tolerance of f is from 90 to 105 percent.

The effect of fatigue of the vibrating reed on its function is

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Commander C. M. Caldwell, Bureau of Ships, and Robert Dressler, Chromatic Television Labs, view multicolor radar indicator at National Airport, Washington, D. C. Heart of the new display system is a single-gun color crt

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thought to be extremely small.

This tube can be used for controlling and rectifying a-c power of commercial frequency, which demands use of thyratron, ignitron or excitron at present. Figure 4 shows the circuit of a control device for timing the cycle of a spot welder.

Since small capacity thyratrons are used at V_3 and V_4, the whole set is not expensive compared with a one using power thyratrons.

The authors wish to express their thanks to Prof. Watanabe under whose direction the work was carried out. They are also indebted to Tatsuo Suzuki, assistant professor of Tokoku University, for his help in designing the vibrating system and to all members of the laboratory for help and encouragement.

This study has been supported by grant in aid for the Miscellaneous Scientific Research of the Japanese Government.

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(2) Arnott, *Journ App Phys*, p 660, 1941.
(3) Watanabe, Kasahara and Nakamura, *ETJ of Japan*, 2, p 180, 1938.
(4) Watanabe and Hatta, *ETP of Japan*, 1, p 150, 1949.

PERTINENT PATENTS

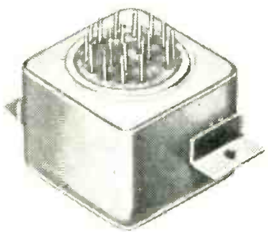
BY NORMAN L. CHALFIN
Hughes Aircraft Co.
Culver City, Calif.

AUTOMATIC PRODUCTION depends upon sensing devices, methods of quality control and counting. The patents reviewed this month encompass these elements, including two devices for nondestructive testing with ultrasonic signals.

Comparative Standardizing

Subject of patent 2,667,063 awarded F. Cunningham, Jr., of Springfield Center, N. Y., is an ultrasonic inspection device.

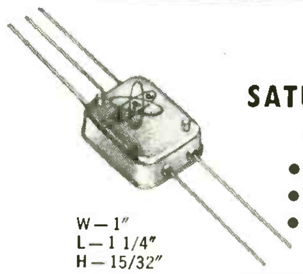
The invention, shown in block form in Fig. 1, utilizes a frequency-modulated ultrasonic signal to excite a standard part and a similar part to be tested. The parts are driven by piezoelectric or other transducers and the energy picked up from the parts by similar pickup



POWER TRANSFORMERS

Range — 400 - 6000 cps
Efficiency — up to 95%
Wattage — 6mw - 200 watts
Temperature — -55 to +155° C.

Depicted — 6KC 100 Watt Unit
Less than 1.65 cubic inches

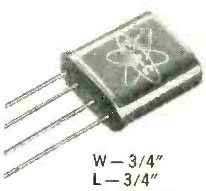


SATURABLE REACTORS

Applications
- Servo Systems
- Data Telemetering
- Remote Frequency Control

W — 1″
L — 1 1/4″
H — 15/32″

Illustrated — High Frequency Reactor Tuned by Varying D. C. Current



PULSE TRANSFORMERS

Pulse Width — .2 - 50 microseconds
Rise Time — from .03 microseconds

- Blocking oscillator
- Pulse coupling
- Toroidal construction

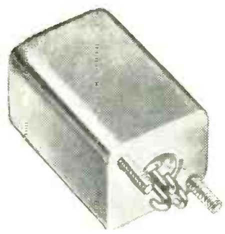
W — 3/4″
L — 3/4″
H — 5/16″

MAGNETIC AMPLIFIERS

Wattage (output) .5 - 200 watts
Response — 1 cycle up

W — 1 1/4″
L — 1 3/4″
H — 2 5/32″

Illustrated — Auto Pilot Application for Printed Circuit Mounting



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Illustrated
4KC
Band Pass

SUB-MINIATURE TUNED CIRCUITS

For Printed Circuit Applications

- Multiple Tuned Transformers
- Delay Lines
- Tuned Circuits

W — 1″
L — 4 1/4″
H — 7/16″

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devices and reconverted.

If the standard and test part are identical, a zero-output signal is developed in the indicating device. If the parts differ, the differential voltages developed result in an output signal.

This invention exemplifies the tendency of industry to seek non-

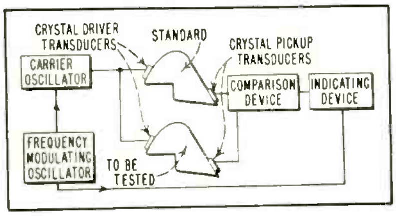


FIG. 1—Standard and part tested are excited by ultrasonic signal and reflected characteristics compared

destructive methods of determining the accuracy or quality of machined parts.

Nondestructive Testing

Another example of the use of ultrasonic-frequency signals to inspect machined or other metal parts is the subject of patent 2,667,780 awarded to H. E. Van Valkenburg of Danbury, Conn. The patent is assigned to Sperry Products, Inc., of the same city.

The invention entitled "Ultrasonic Inspection Device" is shown in Fig. 2. It utilizes two ultrasonic vibration drive and pickup units installed in a search unit making contact with the surface of the material producing a transverse or normal beam and an oblique beam into the material under inspection.

The test depends upon the beam entering an object, traveling through the object until it strikes a reflecting surface which may be the end wall of the object or a defect such as a fissure), and being reflected back to the point of transmission. Such testing presupposes good coupling between the search unit that generates the vibrations and the object under test. The mere failure to receive back reflections is not an indication of poor coupling because such failure may result from other causes such as:

(1) There may be no abrupt discontinuity, as in the case of a large round cylinder.

(2) The object under test may be too long to permit reception of a re-

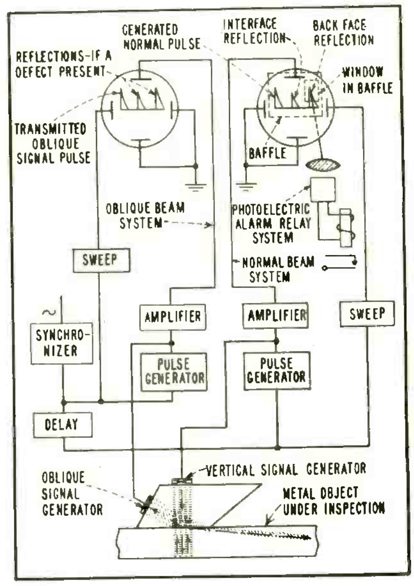


FIG. 2—Oblique and vertical signals insure that false indications do not result when using ultrasonic inspection techniques

flection within the repetition rate or oscilloscope sweep length, as in the case of a 40-foot rail.

(3) The material may be too absorptive to allow the beam to penetrate the entire length of the object.

(4) The contour of the object may be a cross-section that results in dispersal of the beam before it can be reflected from the end of the object.

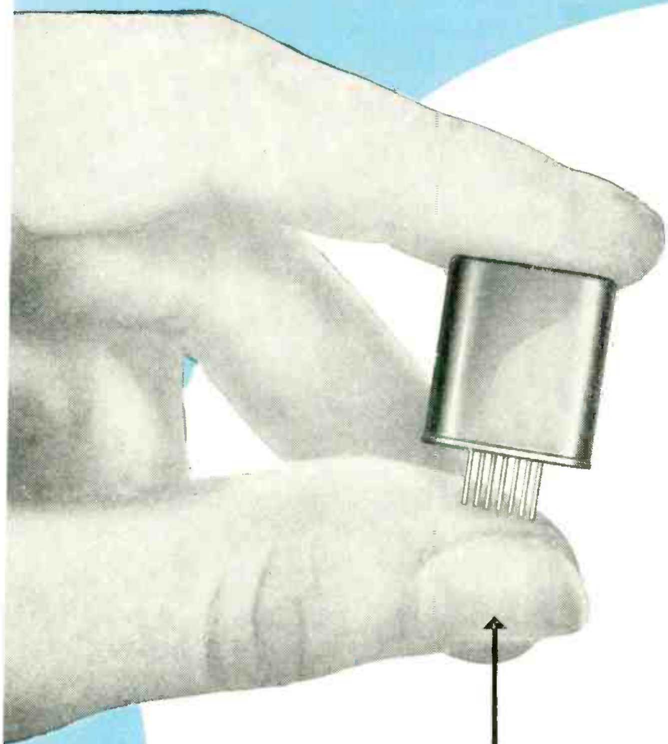
It is therefore necessary to be able to determine whether the ultrasonic beam is actually entering the object under test, that is, whether there is good coupling between the search unit and the object to permit effective transmission and reception of the ultrasonic beam.

To achieve the test the inventor causes the normal and oblique beams to be alternately transmitted through the object under test with a considerable delay between the normal beam transmission and propagation time of the oblique beam.

Two oscilloscope indications are provided for the determinations. One responds to the oblique pulse; and the second to the normal pulse. The scope responsive to the normal pulse system has its indications baffled except for the back-face reflection that appears through a window in the baffle. The scope is arranged to allow the light of

New Sub-Miniature Relay

APPLICABLE TO PRINTED CIRCUITS



ACTUAL SIZE

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weighs .032 oz. — has low capacity for RF switching

ELECTRICAL SPECIFICATIONS:

CONTACTS: Maximum of double pole rated at .25 amperes at 26.5 volts DC or 115 volts AC resistive

COIL: Sensitivity—nominal 1.0 watts, maximum 0.3 watts
Resistance—up to 1500 ohms
Voltage—up to 40 volts DC

TEMPERATURE: Minus 60° C to plus 125° C

VIBRATION: 10G up to 500 cycles

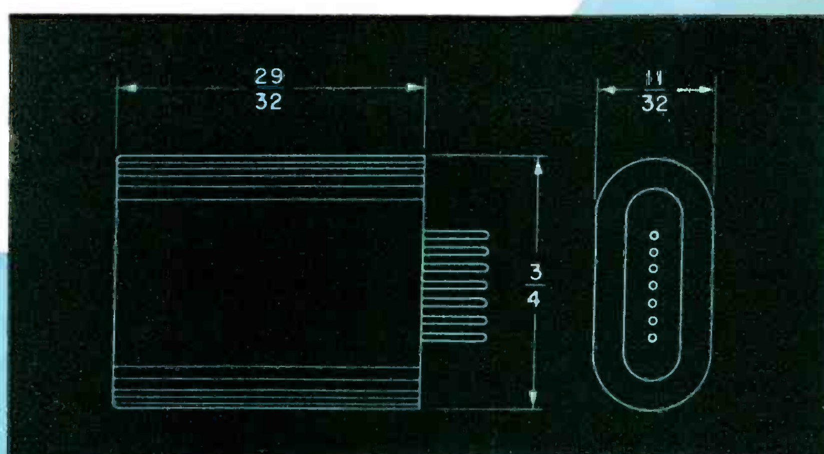
SHOCK: 50G plus (operating)

SPEED OF OPERATION: 1.5 millisecond at nominal voltage direct from battery supply and 1 millisecond with series resistance

ALTITUDE: 70,000 feet or 1.3 inches of mercury

TERMINAL TYPES: Printed circuit, solder terminals and plug-in

CAPACITY: N. O. contact to case 0.85 mmf



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the indication of the back-face reflection to fall on a photocell and relay circuit. Any flaw in the material under test will upset the reflection and either change its position or reduce the brightness, resulting in an alarm when the change in light condition is detected by the photocell.

The scope responsive to the oblique signal system will show a reflection whenever a flaw in the material is present but, as pointed out above, the absence of an indication is not the criterion of a flaw unless the beam is actually entering the material. This is determined by the normal beam-indicating system as described above.

Tolerance Testing

Patent 2,667,970 for an "Automatic Limit Bridge" has been awarded to Joseph C. Bregar of Winston-Salem, N. C., and assigned to Western Electric Co. of New York.

This invention relates to a limit bridge circuit comprising two conventional Wheatstone bridges electrically separated by two rectifier units. The device is used for tolerance testing of circuit elements.

"In the past," according to the patent specifications, "attempts have been made to utilize two separate Wheatstone bridges wherein an element to be tested was connected in common with the two bridges. One of the bridges contained a standard low-limit resistance arm, the other bridge contained a standard high-limit resistance arm. The two bridges were then balanced so that current-responsive indicating means connected across each of the bridge circuits would indicate an unbalance in either of the bridges in the event that the element to be tested did not fall within the required tolerance range.

"This method of testing necessarily involved rather tedious adjustment of each of the bridges inasmuch as the current flowing through the common arm containing the element to be tested was a combination of the currents from each of the two bridges. A further disadvantage encountered by the use of this method was that it required two indicating means that

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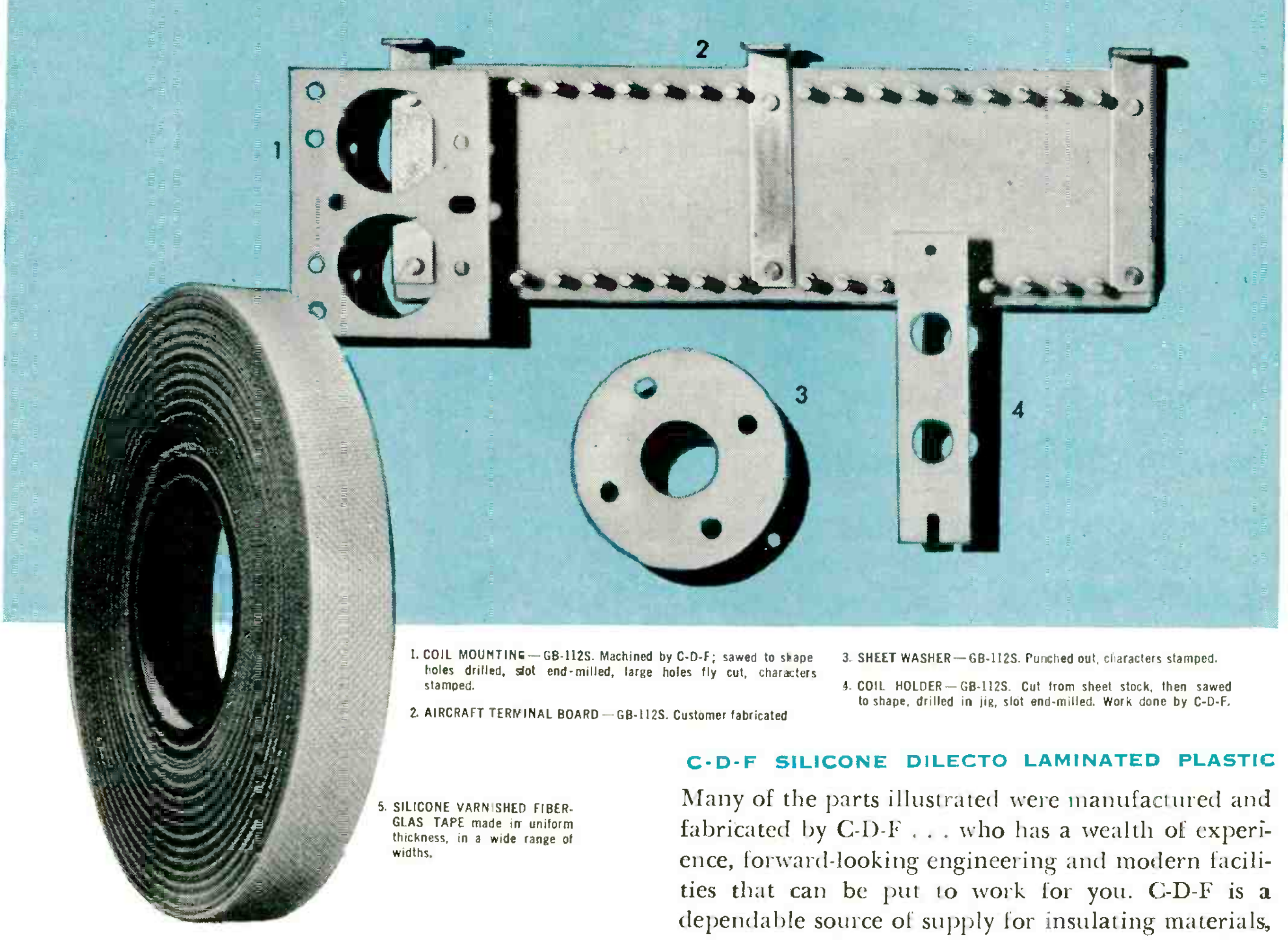

1. COIL MOUNTING—GB-112S. Machined by C-D-F; sawed to shape holes drilled, slot end-milled, large holes fly cut, characters stamped.

2. AIRCRAFT TERMINAL BOARD—GB-112S. Customer fabricated

3. SHEET WASHER—GB-112S. Punched out, characters stamped.

4. COIL HOLDER—GB-112S. Cut from sheet stock, then sawed to shape, drilled in jig, slot end-milled. Work done by C-D-F.

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had to be correlated in some manner in order that a single indication would be given as to the acceptability of the tested element.

"This invention provides a completely automatic double bridge for tolerance-testing circuit elements wherein only one of a connected pair of high and low-limit bridges passes a current at any one time through a single indicating means connected to both of the bridges to give an indication of the magnitude of the element under test."

Three arrangements of the circuit of the invention are shown in Fig. 3.

Two Wheatstone bridges are shown in Fig. 3A formed by resistors R_1, R_2, R and R_4 and by resistors R, R_4, R_5 and R_6. Resistors R and R_4 are common to both bridges. If the unbalance occurs in the right-hand bridge, conduction occurs in diode V_2 through the meter. If the unbalance is in the left-hand bridge, diode V_1 conducts through the meter.

The arrangements of Fig. 3B and (C) are modifications of the circuit shown at (A) described above.

High-Speed Counting

A counting and grouping device has been awarded patent 2,617,593.

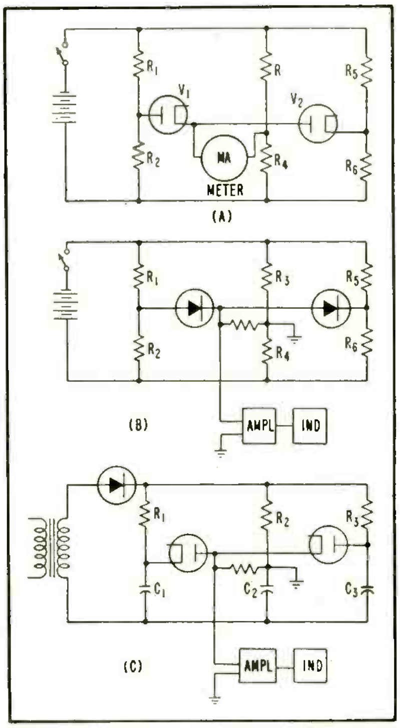


FIG. 3—Basic comparison circuit (A) and modifications (B) and (C)

The inventors are M. Audier and E. W. Seeger who have assigned the patent to Cutler-Hammer, Inc., of Milwaukee, Wis.

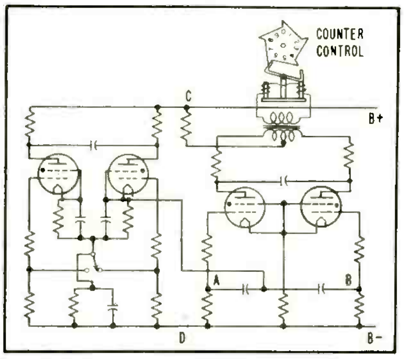


FIG. 4—High-speed counting and collecting device uses make-and-break contact as shown

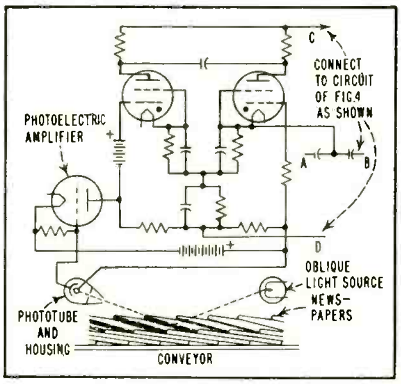


FIG. 5—Photoelectric modification of the circuit of Fig. 4 employs light source

The purpose of this invention is the automatic high-speed counting and grouping of such things as the newspapers leaving a press room on the delivery conveyor.

Figure 4 is a representation of the circuit of the invention and Fig. 5 is a photoelectric modification of the circuit. The circuit is built around a pair of thyratrons operated in flip-flop fashion by signals derived either from a contact switch that changes the bias voltage on a particular input of the flip-flop or by the output of a photoelectric amplifier. The switch is designed to make contact after each paper passes.

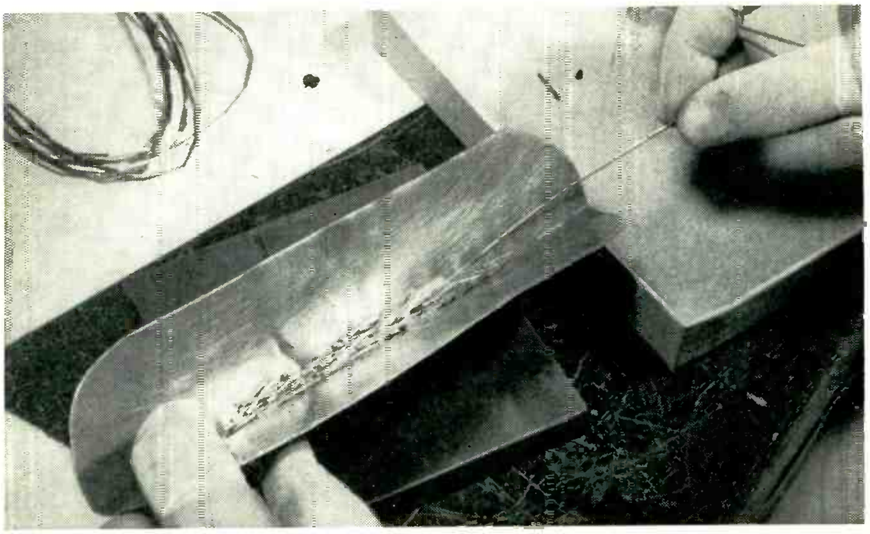
In the phototube application, reflected light from an oblique light source results in light and shadow areas, which result in alternate pulses to drive the counter flip-flop.

The output of the flip-flop operates a ratchet counter device in the plate circuits.

Production Techniques

Edited by JOHN MARKUS

V-Shaped Trough Aids Threading of Cathodes for Electropolishing



Method of loading cathodes for reliable type tubes on conductive wire in preparation for electropolishing before spraying with electron-emitting coating

LOADING of cathode sleeves onto long lengths of wire in preparation for electropolishing is accomplished in Tung-Sol's Bloomfield, N. J. plant with the aid of a V-shaped metal trough attached to a metal base. The sleeves are placed in the trough and the wire is poked through them repeatedly until filled. This eliminates eye strain previously encountered when placing the sleeves one by one on the wire.

Rubber fingers are worn by the operator to prevent contamination of the sleeves. The electropolishing operation removes oxides and surface impurities acquired during manufacture. About three minutes cleaning gives the desired results.

Flush-Panel Doors Serve as Tops for Engineering Desks

SINGLE-PANEL flush-type doors used in connection with two-drawer steel filing cabinets and legs made from closet rods provide versatile work centers for engineers in the Paramus, N. J. plant of Avion Instrument Corp.

The most common arrangement involves placing the filing cabinet at the end of the door. A length of two-by-four is screwed under the door at the right end and holes are

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going...

going...

gone!

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COMPANY 4204 Wrightwood Avenue, Chicago 39, Illinois; Newark 5, N. J.; Brantford, Canada drilled in this to take wood rods of the size used in clothes closets. A single drawer is then suspended under the center of the door to complete the assembly of the desk.

A variation found satisfactory where space is critical involves placing the file cabinet in the center of the door, with legs at both ends and the pencil drawer on each side of the filing cabinet, to serve two engineers.

Deep-Well Bins Hold Precut Leads on TV Assembly Line

BECAUSE OF the large size of a color tv chassis, it is desirable to support it as close to the front edge of the bench as possible during assembly on a moving-conveyor line. In the Westinghouse plant at Metuchen, N. J., the wood pallets are so designed that the edge of the chassis rides just about directly over the edge of the bench. This places all terminals within easy arm reach of the operator. Parts needed at each work position are therefore stored in various types of containers that hook over the front edge of the bench.

Deep-well wire holders and cake pans support parts on moving-conveyor line

Cake pans are widely used for small parts such as resistors and capacitors. These pans are held by U-shaped pieces of strap metal that are bolted to the pan and hook over the angle iron that runs the length of the bench.

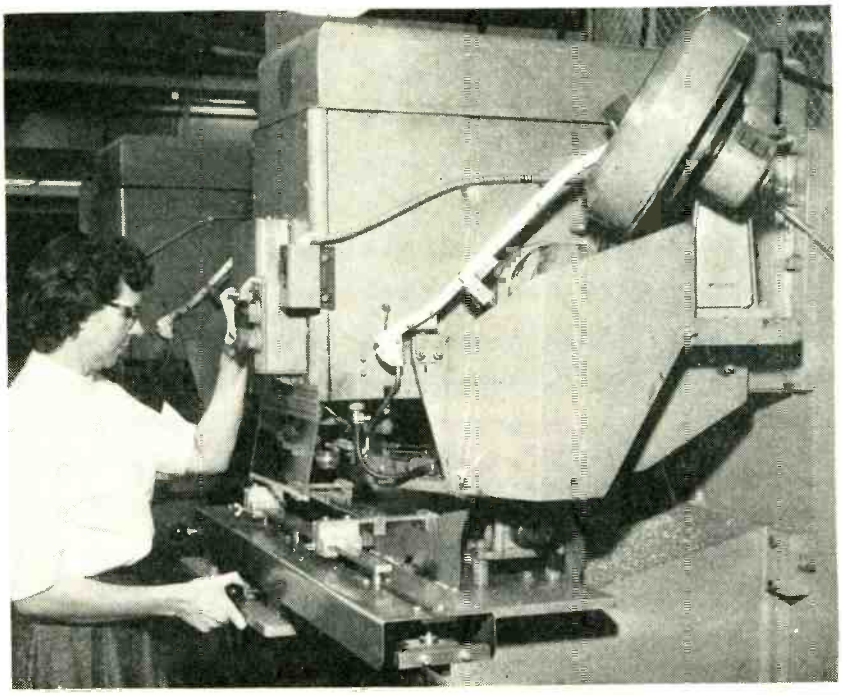
Lengths of wire are stored in deep-well containers made by tacking various lengths of cardboard tubing into holes drilled in pieces of plywood. Again strap iron is used for hooking the plywood pieces onto the bench. Masking tape is used to close the lower end of each length of tubing. Some plywood supports have five containers and some have seven.

Automatic Riveter Makes Resistor Terminal Boards

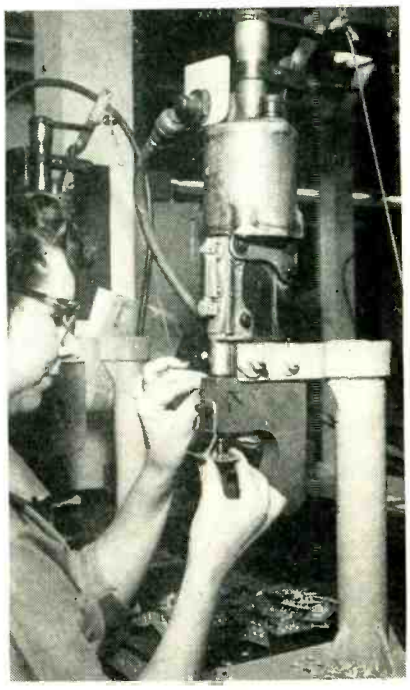
PHENOLIC PLASTIC resistor boards are drilled and turret terminals installed automatically at a rate of 18 terminals per minute by a machine in the Baltimore guided missile plant of The Glenn L. Martin Co. This compares with a production rate of 6 per minute when the lugs were installed by hand and drilling was a separate operation.

The basic machine employed is a General Drivmatic, made by General Riveters Inc., Buffalo, N. Y., having an automatic indexing carriage. A rotating hopper on the side of the machine feeds turret lugs in an inverted position down a chute to a release gate. The standard riveting head has been replaced with a dual head.

At the start of an operating cycle,

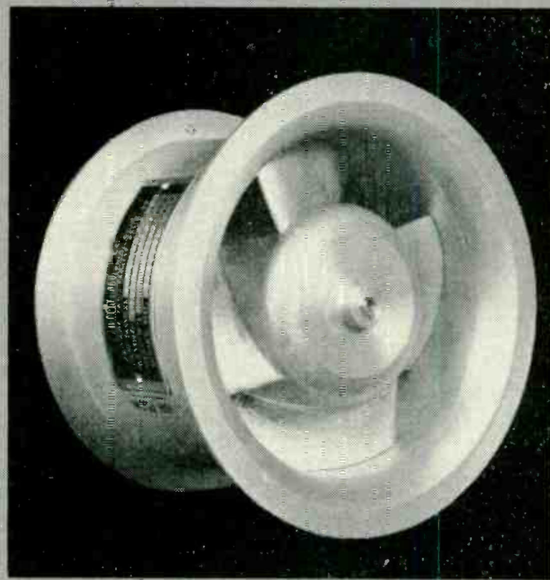


When the start button is pressed, this machine automatically produces terminal boards from phenolic blanks. The operator can tend three or more machines simultaneously since her work merely involves removing finished boards and reloading



Manual method of staking turret terminals in plastic boards, using air-actuated squeeze-type riveter

From VERY SMALL ...to LARGE CAPACITY



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Available in sizes from 2″ I.D. up, these Joy Fans are built to meet all present Air Force and Naval electronic specifications. They can be furnished with totally enclosed or explosion-proof motors, if desired.

In general, keep these facts in mind: that the light, compact design, low power consumption and high overall efficiency of Joy AXIVANE Fans provide more satisfactory cooling for electronic equipment in either air-borne or surface units.

If you have a problem in heat dissipation from electronic units, let us place at your disposal JOY'S experience as the world's largest manufacturer of vaneaxial-type fans. ● Write *Joy Manufacturing Company, Oliver Building, Pittsburg 22, Pa.* In Canada; *Joy Manufacturing Company, (Canada) Limited, Galt, Ontario.*

Consult a Joy Engineer

W&D I 5375

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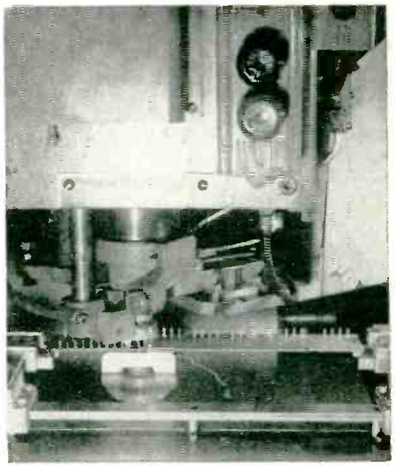
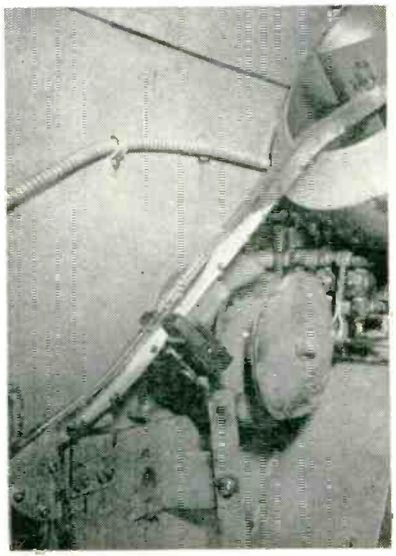


After putting in terminals on one side of board, the machine automatically shifts the board over and starts installing the other row of terminals. Air cylinders are used for actuation

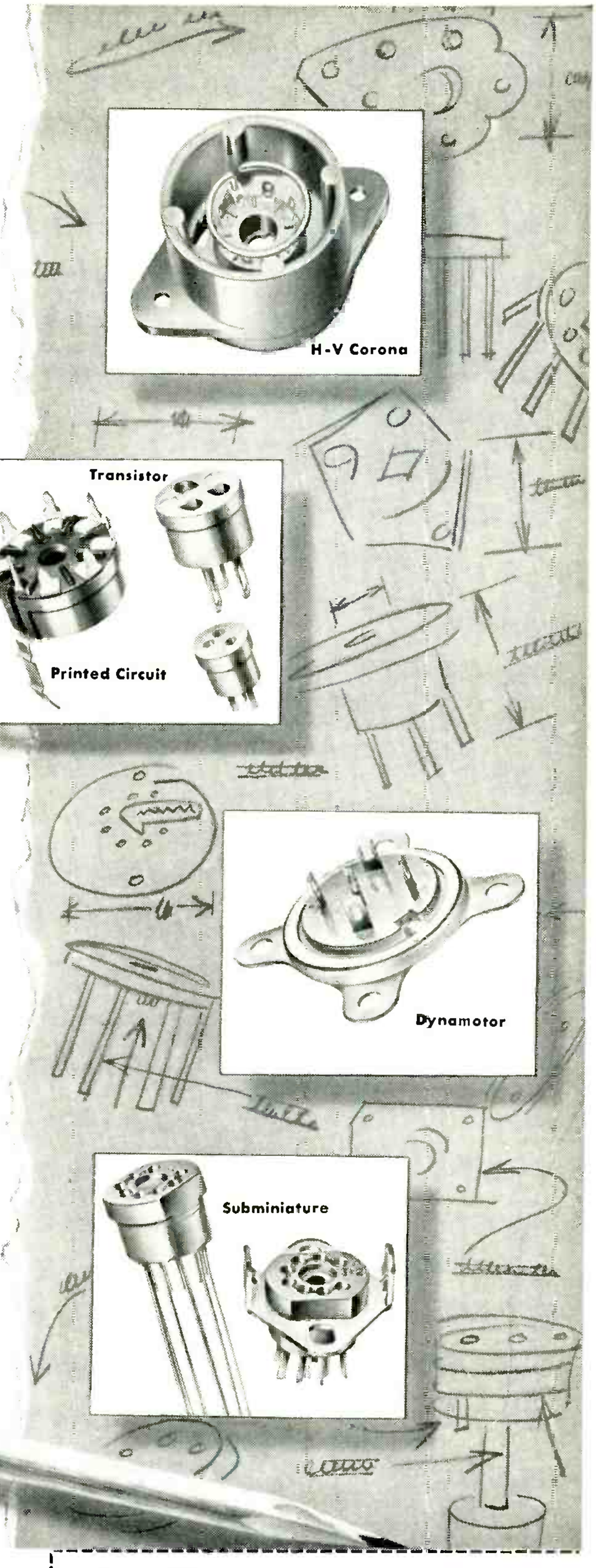


Terminal feed mechanism on side of machine. Rotating hopper orients terminals and feeds them upside down to chute. Gate in chute holds terminals and releases them one at a time

one head descends to drill the hole for a terminal. Simultaneously a linkage opens the terminal gate, allowing one terminal to continue down the chute, invert itself at the end of the chute, then slide down copper tubing into the riveting head which is then in its standby position.

Next, the drill retracts automatically, the riveting head swings into position and the riveting punch comes down to push the terminal into the drilled hole with sufficient force to swage it against the anvil underneath. The riveting head then retracts and the carriage indexes automatically to the next position

Let Sylvania make your tube socket "doodling" come to life!



DESIGNERS find quick, economical solutions to tube socket problems by taking their special designs to Sylvania. (More often than not they're in doodle form.) We can do the same for you. If you need something new in a socket, go ahead and doodle it. Sylvania will translate it into three dimensions and supply you with engineering samples.

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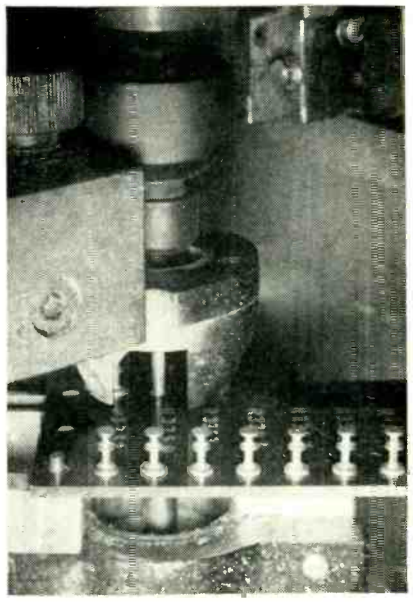
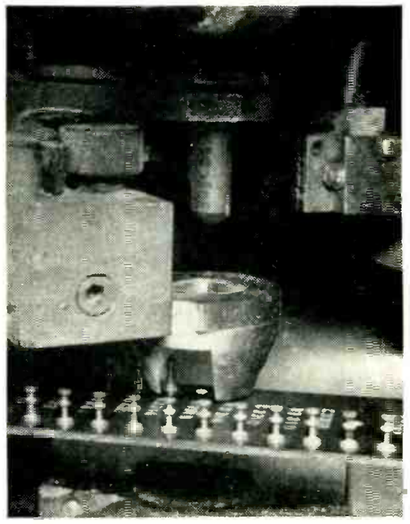
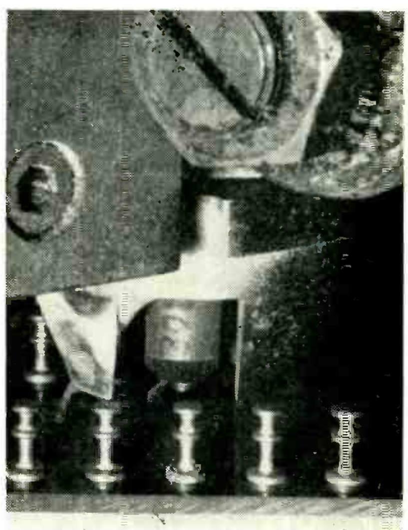


Drilling head in position



Riveting head in position. Terminal was previously dropped into conical lower member where it is held by spring in upright position until die descends



Die in lowest position, for holding down lug while it is being swaged underneath

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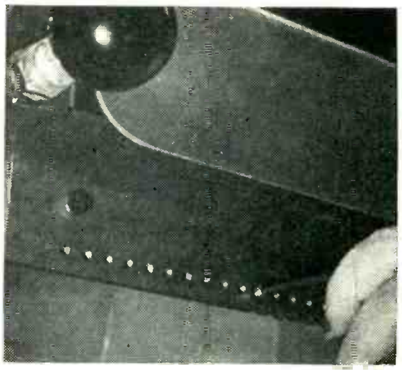
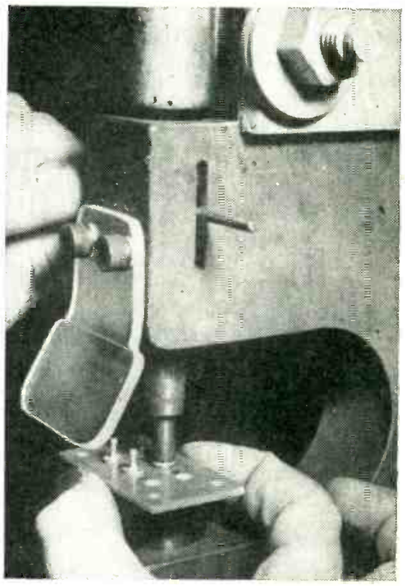


Method of inserting hole-skipping pin on indexing member under carriage

that is to receive a rivet.

Positions can be skipped simply by inserting threaded pins into holes provided for the purpose on the sawtooth indexing member under the carriage. These pins prevent the indexing pawl from dropping into that notch.

The method formerly used involved drilling all holes first, then having the operator install each rivet in turn with a one-shot rivet squeezer made by Chicago Pneumatic Tool Co., Detroit, Mich. and modified by addition of a new jaw for the turret terminals. The operator inserted a terminal, lifted board and terminal up to the upper



Operating the manual riveter. Protruding rod moves upper die down against light spring action. Operator inserts terminal in board, brings board into upper jaw as shown, then pulls down jaw with left hand to insure that terminal seats perfectly. Pressing foot pedal then pulls down cable attached to actuating air valve of riveter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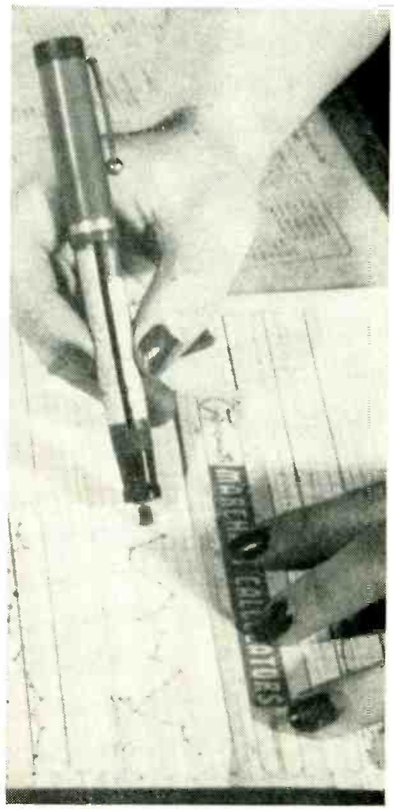
jaw to insure that the terminal was properly seated in the board, pushed a projecting rod to bring jaw and work down, then pushed the foot pedal to actuate the machine and anchor the terminal.

Sliding-Average Computer for Tube Quality Charts



Method of using sliding-average computer. Straightedge is held on zero line of chart to serve as convenient stop

WITH QUALITY control charts it is often desirable to keep a moving or sliding average of the ten preceding points on the chart. The tediousness of this task has been overcome in Tung-Sol's Bloomfield, N. J. plant with the aid of a small computing device utilizing the body of an old fountain pen. The ink mechanism is replaced with a three-inch length of 6/32 threaded rod having a small roller projecting at the former position of the pen. On this threaded rod is a small loop of wire that protrudes through a slot cut lengthwise in the barrel of the pen, to serve as the indicator. Alongside the slot is cemented a scale that is developed by relating the diameter of the roller to the value assigned to the horizontal lines on

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for quality...
specify...

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EFCON Polystyrene Miniature Capacitors have become in two brief years the *standard* for the electronics industry . . . wherever *close tolerances* are important. They have proven exceedingly successful for filters, timing circuits, precision instruments, analog and digital computors . . . plus many other applications.

EFCON *Close Tolerance* Polystyrene Capacitors are mass produced in two styles: Type PC has a rigid cardboard tube construction: Type PH is hermetically sealed in a metal case with glass-to-metal, solder-sealed terminals. Both types feature non-inductive extended foil construction with leads soldered directly to the foil . . . assuring minimum contact resistance.

Thanks to advanced engineering and special production techniques . . . EFCON Polystyrene Capacitors are consistently made to tolerances closer than ±1%. They are available in a range of standard capacitance values from .001 to 2 Mfd. Non-standard values are made tc customers' specifications.

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...where close tolerance is standard tolerance

PERFORMANCE DATA

EFCON Close Tolerance Polystyrene Capacitors provide excellent stability over an extended temperature range . . . along with an extremely high insulation resistance (10^{12} ohms at 25°C). They have a negative temperature coefficient of less than −100 PPM/°C). In addition to a very low dielectric absorption . . . EFCON Polystyrene Capacitors feature the lowest dissipation factor of any film capacitor. They are tested at a DC voltage of at least 250% of rated voltage at 25°C.

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Type MH "Mylar"* Film Capacitors . . . hermetically sealed in metal cases and mass produced with tolerances of ±5%, ±2% and ±1%.

Type MC "Mylar"* Film Capacitors . . . made with wax impregnated cardboard tubes.

Type S Molded Silver Mica Capacitors.

Write Dept. C for technical data which includes new charts describing average temperature characteristics . . . for capacitance . . . power factor . . . insulation resistance.

*DuPont Trademark

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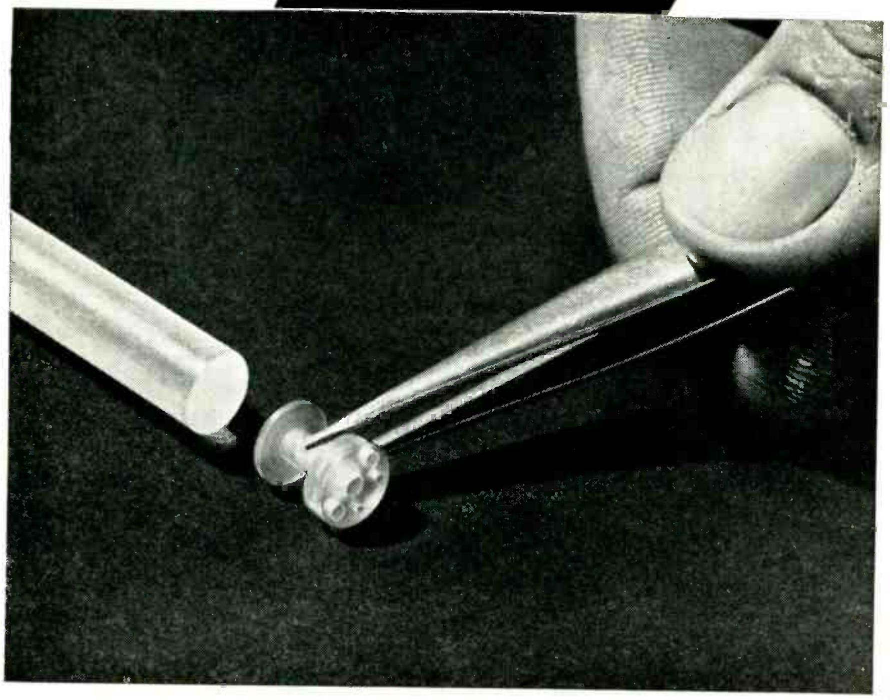
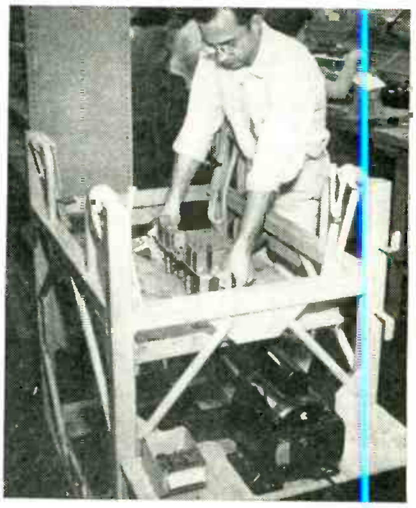


the chart. Additional scales can be placed on the pen to accommodate other chart ranges.

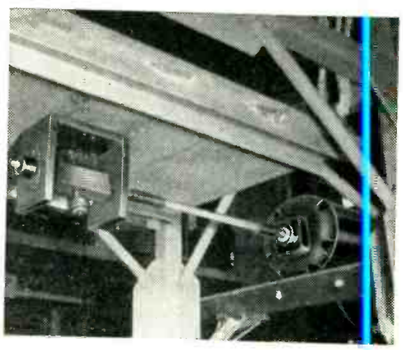
In use, a straight edge is placed along the lowest horizontal line of a chart. The computer is zeroed by rolling in reverse, then held on the first point and rolled down until it hits the straightedge. This is repeated in turn for the nine other points. The indicator then reads the value of the sliding average for those ten points.

Rotating Bolt Actuates Shake Table

REQUIRED VIBRATION tests of complete electronic assemblies for the Matador guided missile are made in minimum time at the Baltimore plant of The Glenn L. Martin Co. on a simple shop-improvised shake table. The frame of the machine was constructed in the plant by welding together various pieces of structural steel plates and tubing. The heavy steel table is supported



Placing amplifier on shake table

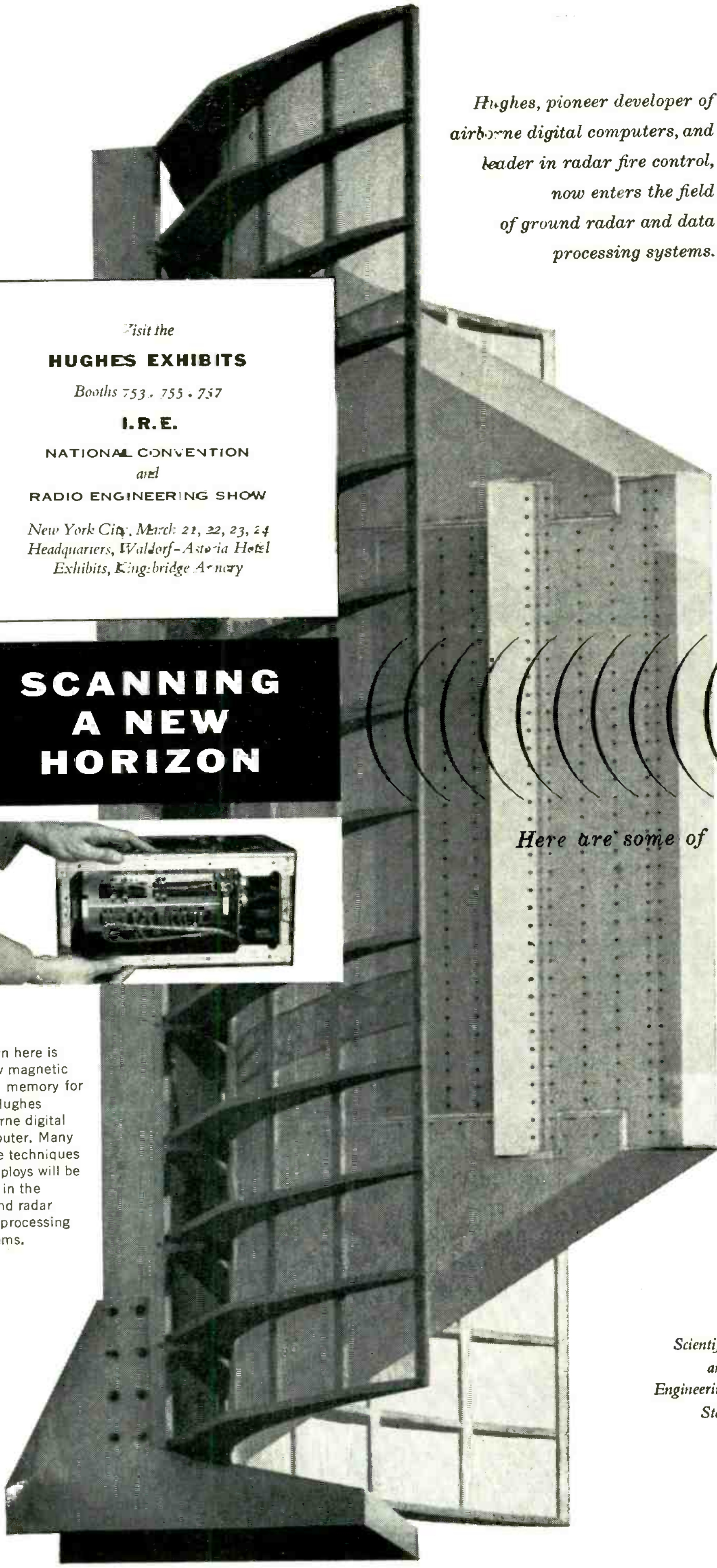


Bottom view of shake table, showing bearing supports for eccentric weight and method of extending motor shaft to drive the weight

Hughes, pioneer developer of airborne digital computers, and leader in radar fire control, now enters the field of ground radar and data processing systems.

Important new programs are under way in the Radar Research and Development Division for the development of ground radar and data processing networks. In these projects, Hughes engineers are drawing on their extensive experience in the successful development of radar fire control systems and airborne computers.

The data gathering for these ground networks will be performed by very high power radar using advanced high-speed scanning techniques developed by Hughes under sponsorship of the U. S. Navy. The processing, transmission, and correlation of the great mass of data involved will be handled by large-scale digital systems. This equipment must be designed to meet stringent tactical requirements for reliability and maintainability.



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SCANNING A NEW HORIZON

Shown here is a new magnetic drum memory for the Hughes airborne digital computer. Many of the techniques it employs will be used in the ground radar data processing systems.

Here are some of the types of work included:

- TRANSISTOR CIRCUITS
- DIGITAL CIRCUITS
- MAGNETIC DRUM AND CORE MEMORIES
- LOGICAL DESIGN
- PROGRAMMING
- ADVANCED RADAR TECHNIQUES

Engineers and Physicists

Application of the techniques, special knowledges and individual talents indicated here is creating positions at all levels in the Ground Systems Department. Engineers and physicists with experience in the fields listed, or those with exceptional ability in these directions, are invited to consider joining our Staff.

Scientific and Engineering Staff

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California from the four corners of the frame by Bungee cord such as is used in aircraft for shock-mounting equipment. This cord consists of long, fine strips of rubber encased in a braided covering.

On a shelf at one end, below the table, is mounted a ½-hp Westinghouse capacitor-start motor. An extension shaft with two flexible couplings drives an eccentric weight rotating on bearings that are attached to the underside of the table. The eccentric weight is simply a projecting bolt on which various quantities of washers are held in position with a nut to achieve the desired degree of vibration.

The unit to be tested is held in place on top of the vibrating table by metal dogs that fasten to the table with thumb nuts.

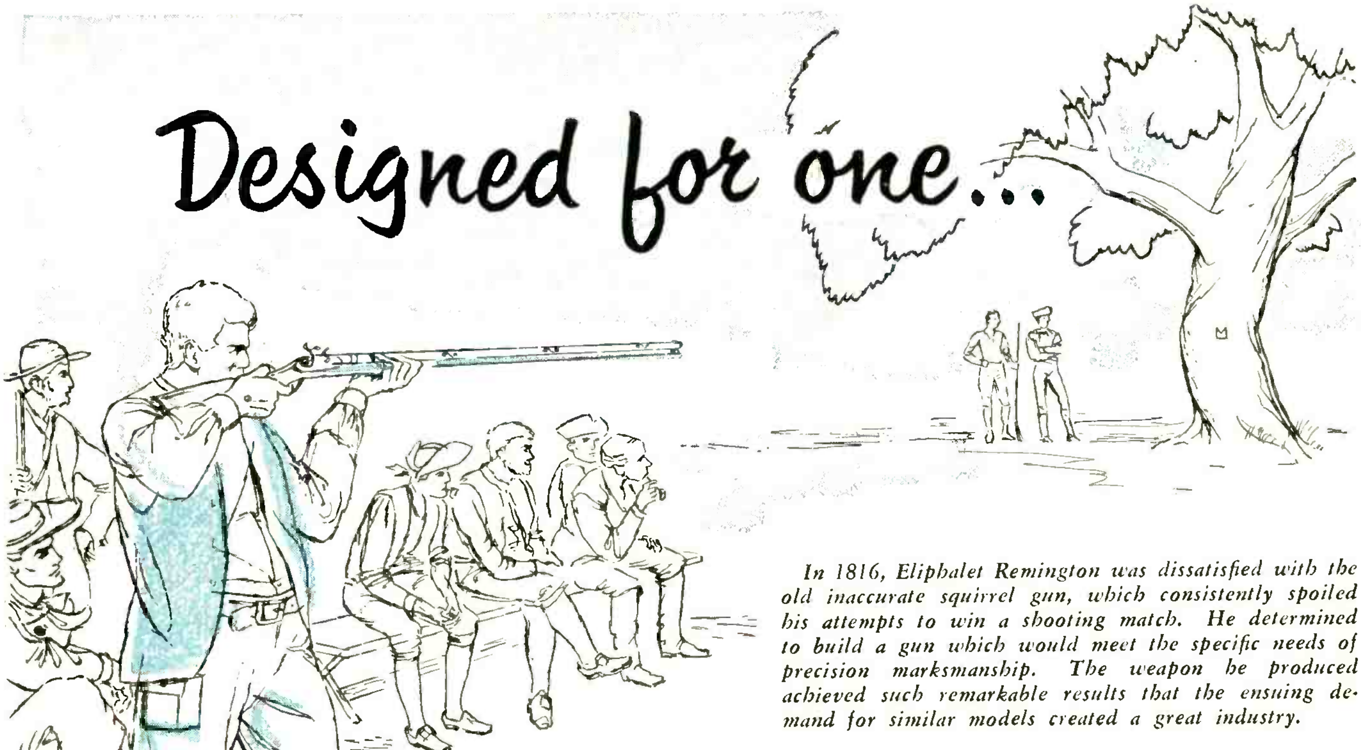
Assembly Fixtures for Precision Potentiometers

As first step, coil is threaded onto drum while gate is held out of way

Holding housing against gate while turning crank to thread coil and drum into housing

A HELIXED DRUM rotated by a hand crank on a bench fixture aids in inserting multiturn resistance coils in precision potentiometers at the South Pasadena, Calif. plant of Helipot Corp. The operator starts an assembly by raising an internally threaded gate and holding the coil against the helixed drum, then turns the handle at the other end of the

Designed for one...



In 1816, Eliphalet Remington was dissatisfied with the old inaccurate squirrel gun, which consistently spoiled his attempts to win a shooting match. He determined to build a gun which would meet the specific needs of precision marksmanship. The weapon he produced achieved such remarkable results that the ensuing demand for similar models created a great industry.

...SOUGHT BY MANY

Seeking to overcome the deficiencies in many of today's standard electronic devices, engineers at Airborne Instruments Laboratory created the devices shown here. Though developed for use at AIL, their adaptability for many applications has resulted in a wide demand by manufacturers and users of electronic equipment. Thus, production and sales have become important areas of operations at Airborne.

For complete information on these and other advanced devices, now in production or available soon, be sure to visit **Booths 63 and 65, at the IRE Show, Kingsbridge Palace, New York.** Literature on request.

AIRBORNE INSTRUMENTS LABORATORY
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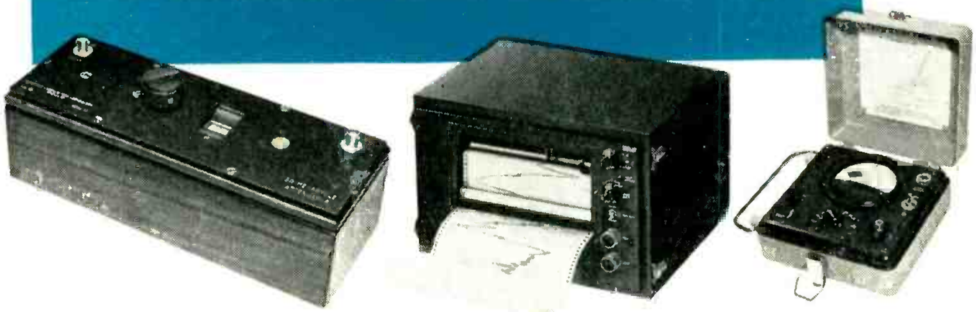

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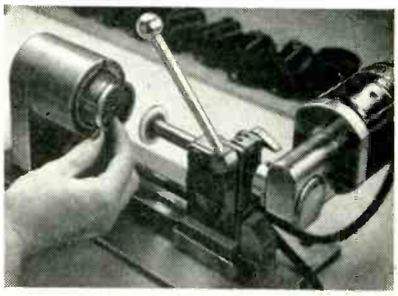
Tapping first drive pin into housing to anchor far end of coil



Motor-driven fixture uses grooved nylon wheel to press turns of coil outward for firm seating in internal spiral grooves of housing

fixture to thread the coil onto the drum. The gate is then dropped down and the potentiometer housing is held against it. Reversing the direction of rotation, the operator rotates coil and drum together, the coil acting as an external thread which engages the internal thread of the housing, so that the coil is accurately positioned in the housing without deformation.

The coil is anchored in its housing by tapping a drive screw through two previously drilled holes, one in the housing and one near the end of the coil. The drum is then rotated again while holding the housing, to feed coil and housing together off the drum.

The potentiometer housing with the coil seated in it is then inserted in another specially developed device, this one motor driven. Before turning on the power, the operator uses the lever handle to thrust a shaft-mounted grooved nylon wheel to the far end of the housing. Since the outside diameter of the wheel is much less than the inside diameter of the mounted coil, this is instantly accomplished. When the motor is turned on, the shaft is eccentrically driven as it retracts; the grooved wheel trolleys helically on the coil and tensions the coil firmly and

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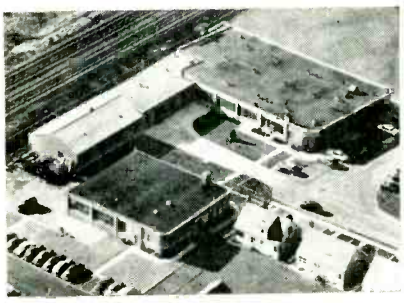

VOLKERT STAMPINGS, INC.
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FOR DESIGN...TOOLING...AND PRODUCTION OF PRECISION STAMPINGS evenly against the internal thread in the housing.

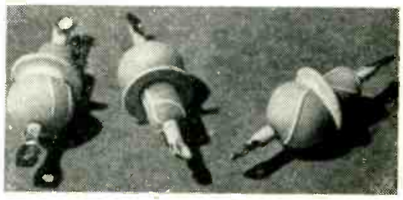
The final step involves drilling a hole through the housing and near end of the coil, then tapping in another drive screw at this point.

Detecting Cracks in Glass-to-Metal Seals

By H. N. STAATS
Manager, Special Products Group Magnaflux Corp., Chicago, Ill.

TINY, INVISIBLE CRACKS in glass-to-metal seals may be located with the electrified particle inspection method. This nondestructive testing method, employing Statiflux equipment marketed by Magnaflux Corp., has come into general use within the past few years for the inspection of nonconducting materials such as glass, ceramics and certain plastic materials.

Positively charged powder being blown from special gun

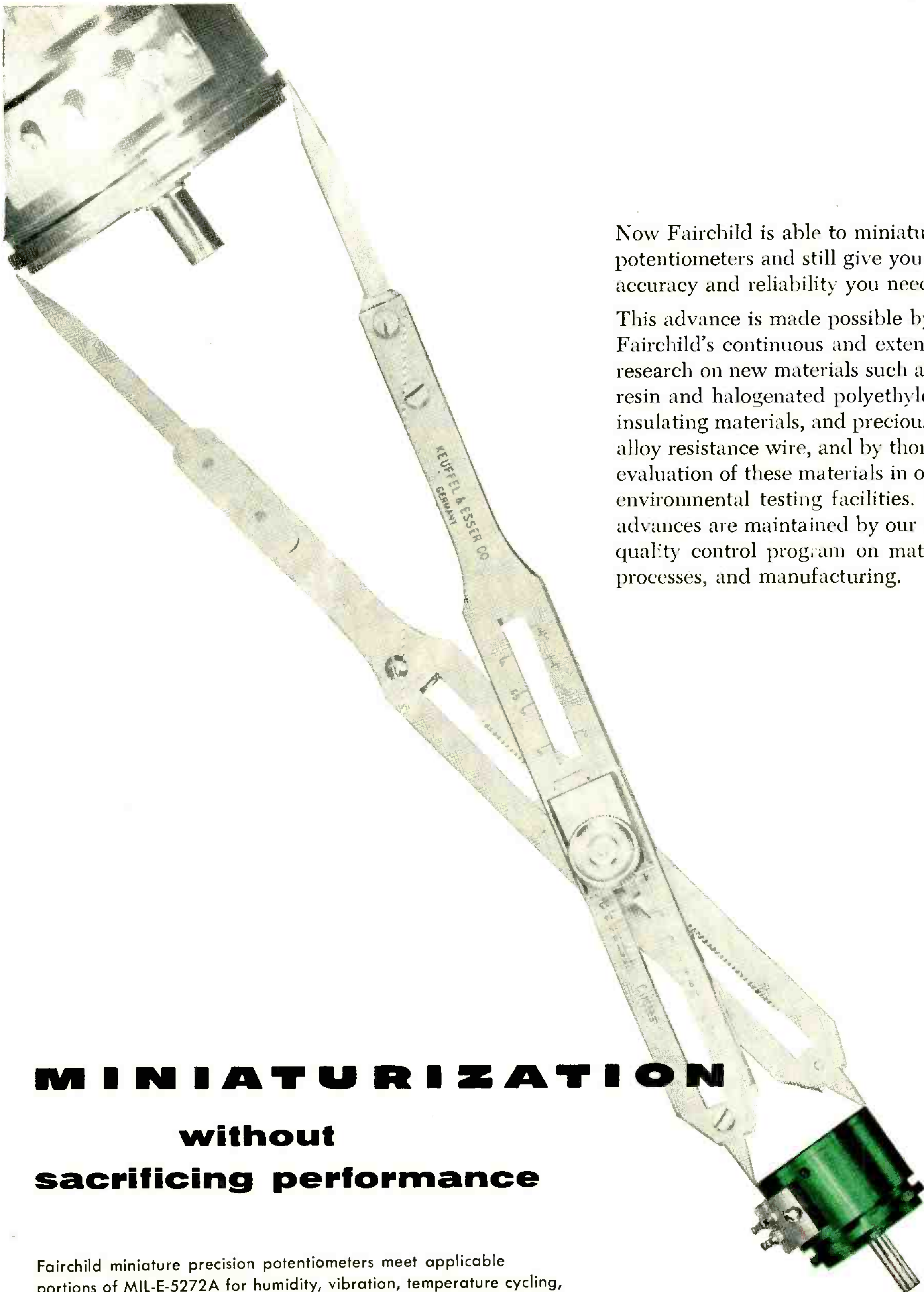


Typical Statiflux indications of cracks in glass-to-metal seals

The method employs a unique form of calcium carbonate powder which is blown through a specially constructed powder gun. During passage of the powder through the nozzle of the gun, electrons are removed and the powder emerges with a high positive charge.

If positively charged powder is directed at glass backed with metal, electrons are attracted from the base metal and attempt to leak through cracks. Once this leakage effect occurs, the crack tends to attract positively charged powder.

For glassy materials without metal, the particles are directed at



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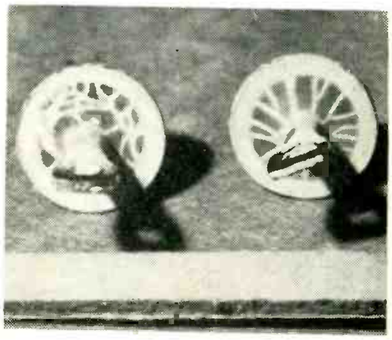
without sacrificing performance

Fairchild miniature precision potentiometers meet applicable portions of MIL-E-5272A for humidity, vibration, temperature cycling, fungus resistance and salt spray. These units, in ⅞″ and 1⅛″ diameters, meet the same requirements for accuracy and reliability as most standard precision units up to 2″ in diameter.

No matter what factors govern your choice of precision potentiometers, you'll find the answer in Fairchild's complete line. Write Dept. 140-59A1, Fairchild Camera and Instrument Corporation, Potentiometer Division, 225 Park Avenue, Hicksville, Long Island, New York.

FAIRCHILD
PRECISION POTENTIOMETERS



Indications of cracks in tiny glass-to-metal seals (paper match in foreground indicates size)

a surface which has previously been treated with a water-base penetrant and thoroughly dried. Again there is re-orientation of the electrons within the cracks, and powder indications are built up.

A glass-to-metal seal is not a simple structure like either of the foregoing examples, hence it is not always possible to predict whether or not a penetrant is required for the inspection procedure. Some header configurations permit metallic inserts to exert their electron influence up and through defects, whereas other types always require the assistance of penetrants.

The static flux technique will detect cracks in glass so small that they are completely invisible to the eye. Indications can be developed on cracks which do not reflect light, (cracks less than a quarter-wavelength of light, or less than four millionths of an inch in width).

Characteristics of Cracks

A crack is an indication of a stress that was present in the piece at some earlier time. A characteristic property of cracks in glassy materials is that they will tend to grow under certain conditions. The most common growth-provoking causes are heat and vibration. These effects generally apply cyclic loading which when coupled with secondary causes will cause growth of cracks.

Factors contributing to the growth of cracks in glass are:

1. Ordinary Tension. Tension stresses on the surface of a part tend to tear the glass apart.

2. Heat via Arc. If a crack system joins two terminals or a terminal and ground where a large enough voltage differential exists, it is pos-

sible for the ensuing arc or breakdown to develop heat within the fluid. High vapor pressures may develop, thrust outward and encourage crack growth.

3. Random Dirt Wedge. A crack may receive random dirt and, if followed by compression loading, wedging action contributes to the growth of the crack.

4. Crack Debris. Debris from the inside of the crack may break off and drop to the bottom of the crack. When compression loading is applied, the debris acts as a wedge and stress level at the base of the crack increases, causing crack growth.

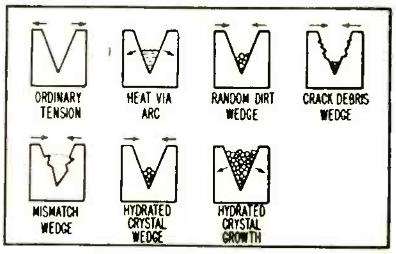
5. Mismatch. If the walls of the crack do not mesh under compression loading, wedge action will be exerted, resulting in crack growth.

6. Hydrated Crystal Wedge. It is possible for water to combine with some of the glass constituents to form hydrated crystals. A compression loading in combination with the wedging action of the crystals will also promote crack growth.

7. Hydrated Crystal Growth. It is possible for crystal growth to occur over a long period of time and exert considerable thrust outward upon the sidewalls of the crack, causing it to split still further.

Effects of Cracks in Seals

When cracks on one side of a glass-to-metal seal do not go through the entire glass thickness, there is generally no gaseous leakage in either direction. When crack patterns on top and bottom of a seal do not coincide, there likewise may be no leakage. Any crack system which does have coincidental cracks on both sides of a seal should be viewed with suspicion, however. Despite their small size, such cracks may serve to cause gaseous leakage which is undetectable by crude bubble tests. The use of the



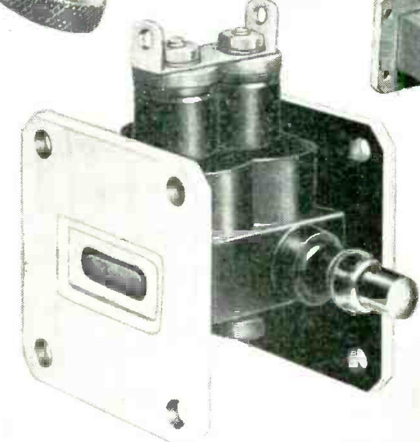
Factors contributing to the growth of cracks in glass

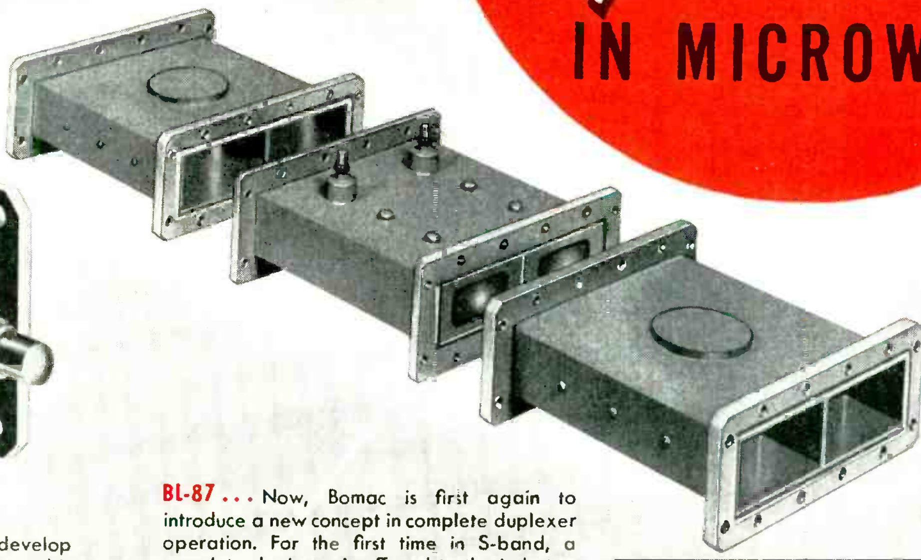
6738 . . . First again in the field of tube miniaturization, Bomac developed a new type TR tube designated the 6378. Designed specifically for airborne radar equipment, the 6378 is a miniaturized version of the 1B24A (another Bomac first), 1B60 and the 1B24. Size was cut in half, and weight was reduced by one fifth with no sacrifice in performance or efficiency.

1N23D . . . Bomac was the first to manufacture the 1N23D silicon diode. System designers, for the first time, could obtain a diode with greatly increased sensitivity and superior electrical characteristics in relation to existing types.

Bomac Firsts IN MICROWAVE

BL-25 . . . The BL-25 TR tube, designed and developed by Bomac, was the first cell-type tube system — engineered to withstand high power levels and maintain recovery time over a long period of life. The BL-25, although originally designed for a specific piece of equipment, has proven its versatility in various applications within the industry.





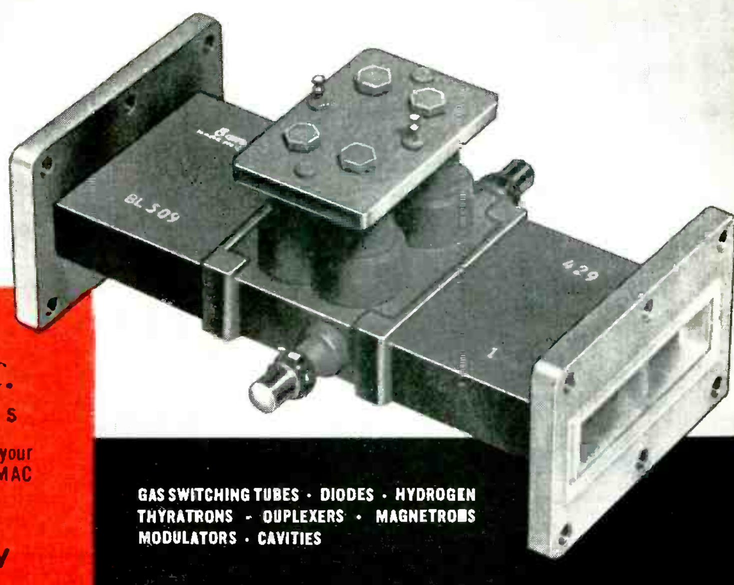
BL-58 . . . Bomac was the first to develop shutter tubes and integral TR-shutter combinations for continuous crystal protection. The BL-58 was the first integral TR-shutter combination developed by Bomac. With integral TR-shutter operation, bulky waveguide shutters could be eliminated at considerable savings in size and weight. This tube has now been superceded by improved models.

BL-87 . . . Now, Bomac is first again to introduce a new concept in complete duplexer operation. For the first time in S-band, a complete duplexer is offered to the industry. The BL-87 is a dual TR tube, complete with perfectly matched hybrids to assure maximum efficiency and long life. Systems designers can now be assured of reliable duplexer operation because Bomac's hybrids are designed specifically for their dual TR tubes. Bomac is first again in design and development of microwave tubes.

BOMAC DUAL TR DUPLEXERS

Tube	Frequency (MC)	Tube	Frequency (MC)
6334 (BL-27)	8490-9578	BL71	8500-9600
		BL78	8490-9578
BL29	9325-9425	BL87	2700-2900
BL35	15000-17000	BL507	8490-9578
BL47	9325-9425	BL600	8490-9578
BL60	5400-5900		

BL-509 . . . Bomac's BL-509 was the first complete duplexer offered in one compact unit. Combining a Bomac dual TR tube having integral shutters with two perfectly matched hybrid junctions in a single unit, the BL-509 provides duplexer operation and continuous crystal protection in one package. Light weight and compact, the BL-509 assures superior electrical performance and mechanical simplicity.



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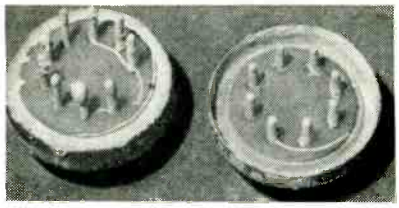
GAS SWITCHING TUBES · DIODES · HYDROGEN THYRATRONS · DUPLEXERS · MAGNETRONS MODULATORS · CAVITIES mass spectrograph confirms the fact that through cracks can and do leak.

Under some conditions, moisture condenses on glass surfaces in an exceptionally thin layer. If a crack is present, moisture seems to penetrate it readily and lower the resistance of the seal. Such electrical leakage may be intermittent and difficult to troubleshoot in service. If a crack contains moisture and the equipment is activated, a breakdown may occur until the moisture within the crack is heated by the passage of current and is driven out. When the equipment cools down, more moisture may condense on the glass surface. If the equipment is energized continuously, the chances of electrical breakdown are less since the moisture is driven out and stays out as long as the equipment is warm. However, this same heat may contribute to the growth of cracks, so the situation may gradually become worse.



Headers with similar crack patterns on both surfaces. Note lack of coincidence

Under some conditions, carbon will deposit in cracks and provide a permanent breakdown path. This is an easier condition to locate if found in time to prevent total loss of the completed assembly.

Types of Cracks

Classification of cracks in glass-to-metal seals makes it possible to consider intelligent specifications. Generally speaking, there are five types of crack patterns. Some are caused by the original manufacturer of the headers and some are caused by the assembler of the complete hermetic package, whereas others are caused by improper use in service. More than one type may occur on the same piece. The five types are listed in order of their increasing seriousness with regard to possible vacuum and electrical leakage.

Type I. Cracks start from the surrounding ring or terminal. The

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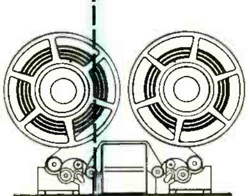

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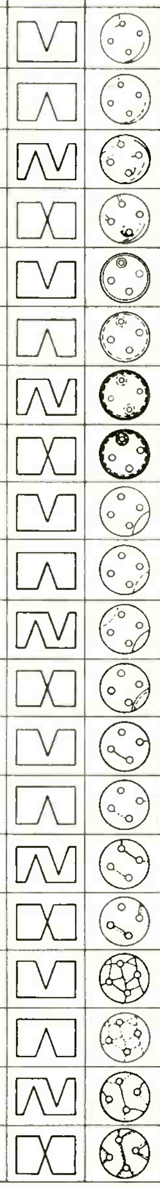
cracks are short and may not be dangerous as is, unless they occur coincidentally on both sides of the seal. These cracks generally are typical original manufacturing defects and may grow.

Type II. This is comparatively rare and consists mainly of concentric circular cracks paralleling the ring or the terminals themselves. They may only be dangerous if appearing coincidentally on top and bottom of seals.

Type III. These cracks seem to be a typical manufacturing defect and may only be of concern if appearing coincidentally on top and bottom surfaces of headers.

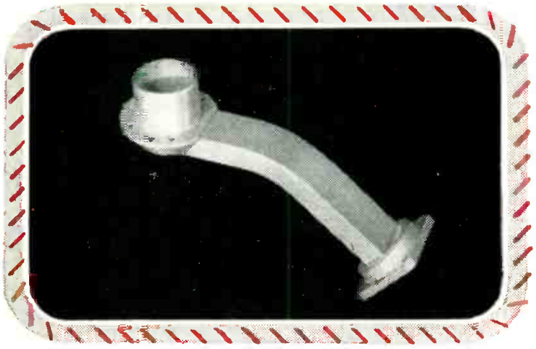
Type IV. Typical of thermal



TYPE	CROSS-SECTION	PLAN	HERMETIC LEAKAGE	ELECTRICAL LEAKAGE
I			NO	NO
I			NO	NO
I			NO	NO
I			POSSIBLE	NO
II			NO	NO
II			NO	NO
II			NO	NO
II			YES	NO
III			NO	NO
III			NO	NO
III			NO	NO
III			YES	NO
IV			NO	YES
IV			NO	NO
IV			NO	YES
IV			YES	YES
V			NO	YES
V			NO	NO
V			NO	YES
V			YES	YES

Typical crack patterns on five types of glass-to-metal seals

problem: Electronic Assemblies



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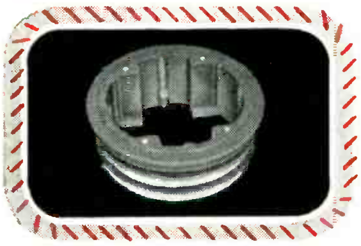

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shock, this condition sometimes is noted in new seals, but is more commonly detected as the result of improper soldering techniques. If the cracks are coincidental on top and bottom, gaseous leakage may occur. Electrical leakage will occur if the crack patterns are appropriately located.

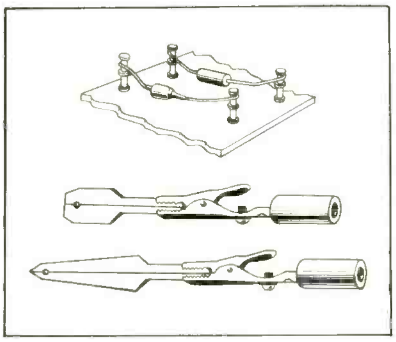
Type V. This is the most common type of defect and seems to be more typical of processing techniques than original seal manufacturing operations. Field repair work also may contribute to the creation of this type of defect. This can be dangerous under the same conditions mentioned for Type IV.

Conclusions

Simple visual and microscopic techniques for inspecting hermetic seals are time-consuming, expensive and inaccurate if it is desirable to locate all defects. Nondestructive tests may be used as a final inspection to guarantee crack-free parts, but if the part gets as far as final inspection and contains cracks, an economic loss has already been suffered. If a cracked part gets into service and fails, the economic loss is even greater, to say nothing of the possible loss of human lives.

In practice, large savings in time and money have been made by using the static flux method as a process control tool. In this way it is possible to correct improper manufacturing procedures before they have gone too far.

Soldering Crystal Diodes



GERMANIUM and silicon crystal diodes often require special care in assembly to prevent damage to sensitive elements. When soldering is required, allow extra lead length for strain relief, and use heat-dissipating clamps on leads to prevent

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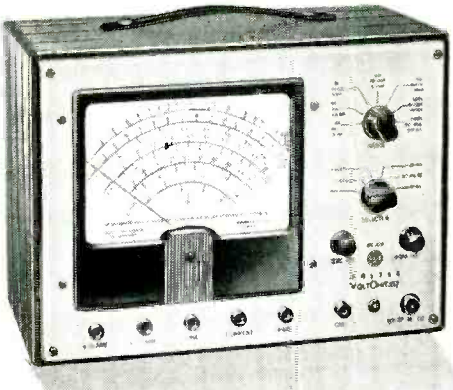

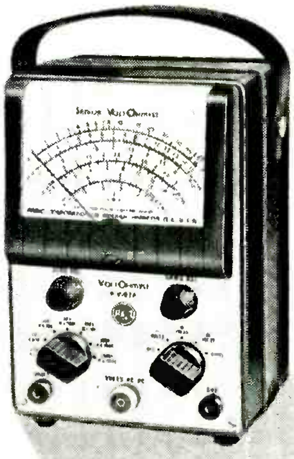

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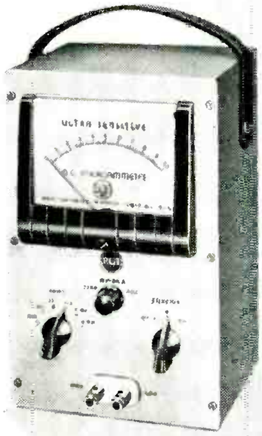

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Crystal-Diode Probe WG-264 extends frequency range of RCA VoltOhmysts to 250 Mc. This probe is a "slip-on" type for use with VoltOhmyst Direct Probe and cable, such as supplied with the WV-97A \$7.75*

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AC (rms) Voltage	0.1 -1500 v	0.1 -1500 v	0.1 -1200 v
Peak-to-peak Voltage	0.2 -4200 v	0.2 -4200 v	——
Resistance	0.2-1000 meg.	0.2-1000 meg.	0.2-1000 meg.
Current	10 μamp-15 amp	——	——
Accuracy:			
DC current	±3%**	——	——
DC voltage	±3%**	±3%**	+volts: ±3%** —volts: ±5%**
AC voltage	±5%**	±5%**	±5%**
Meter size	7½"	4½"	4½"

Note: All three instruments have an electronically protected meter
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heat from reacting on sensitive elements. These clamps can be jaw extensions machined from solid copper and soldered to the jaws of alligator clips. The holes in the jaws should be the same diameter as the lead wire, to insure good conductivity of heat from the wire to the jaws.—Glenn L. Martin Co. training bulletin.

Centering Fixtures for Color TV Picture Tubes

THE FIRST STEP in mounting a color picture tube in the Westinghouse Metuchen, N. J. plant involves marking the exact center of the tube with a grease pencil. For this, a combination hardwood and pressed wood fixture is placed over the face of the tube. A grease crayon is then inserted through holes in the wood cross pieces and rotated to mark the center.

The tube next goes to a special wood jig that holds it while metal horsecollar brackets are placed over the tube and bolted in position. Centering fixtures insure accuracy of this part of the operation.

The final step involves bolting

Marking center of picture tube by rotating crayon in centering fixture

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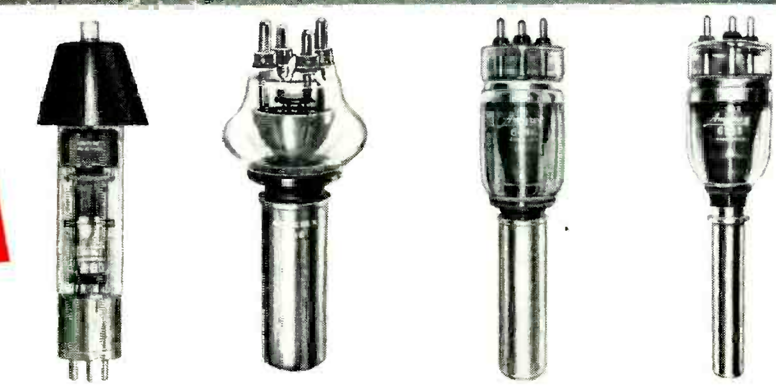

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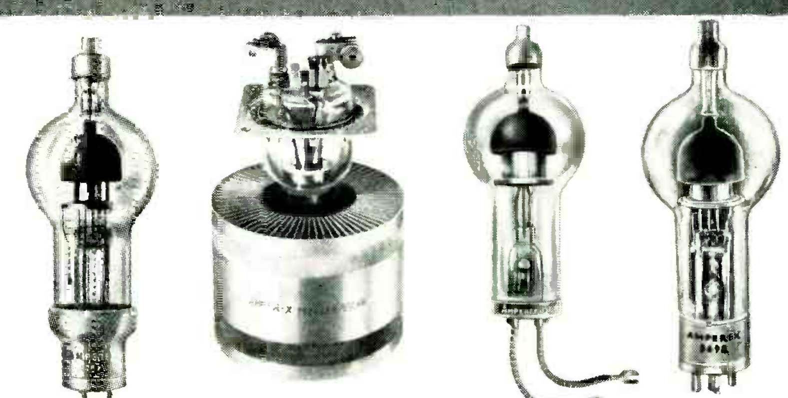

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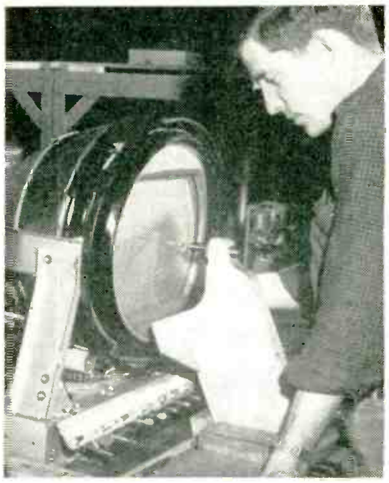
Bolting mounting yoke in position on color picture tube



Centering picture tube on chassis by lining up crayon mark with centering plunger

the framed picture tube to the completed television receiver chassis. This is done on a special table equipped with centering gages. One is mounted directly in front of the picture tube and has a graduated plunger that is lined up with the spot previously marked with crayon at the center of the tube. This plunger also tells whether the tube is within tolerance of its forward and back movement on the chassis. If adjustments are necessary, they are made in the picture tube mounting yoke at this time, to insure that the chassis will later fit properly into its cabinet.

Cam-Action Grid Former

GRIDS for close-tolerance vacuum tubes are quickly formed and shaped to proper size in Tung-Sol's Bloomfield, N. J. plant with the aid of a hand-operated press that uses choose from this complete line of

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Type 10Z
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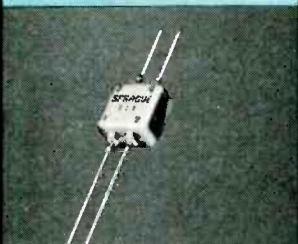

Type 15Z
miniature bathtub pulse transformer

Type 20Z
drawn-shell bathtub pulse transformer

Type 40Z
plug-in pulse transformer

NOW YOU CAN CHOOSE from eighteen standard pulse transformers in four major construction styles, all in quantity production at Sprague. The standard transformers covered in the table below offer a complete range of characteristics for computer circuits, blocking oscillator circuits, memory array driving circuits, etc.

These hermetically sealed units will meet such stringent military specifications as MIL-T-27, and operate at temperatures up to 85°C. Special designs are available for high acceleration and high ambient temperature operation. In addition, the electrical counterparts of each transformer can be obtained in lower cost housings designed for typical commercial environment requirements.

Complete information on this high-reliability pulse transformer line is provided in Engineering Bulletin 502A, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

ELECTRICAL CHARACTERISTICS OF SPRAGUE PULSE TRANSFORMERS

Type No.	Turns Ratio	Pulse Width μ seconds	Rise Time μ seconds	Primary Inductance	Leakage Inductance	Repetition Rate	Load and Output	Typical Applications
10Z1	5:1	0.1	0.04	200 μH	5 μH	1 to 2 MC	15 volts 100 ohms	Used in digital computer circuitry for impedance matching and inter-stage coupling. Pulses are of sine wave type.
10Z2	4:1	0.07	0.03	200 μH	20 μH	1 to 2 MC	20 volts 100 ohms	
10Z3	1:1	0.07	0.03	125 μH	12 μH	1 to 2 MC	20 volts 200 ohms	
10Z4	3:1	0.07	0.03	160 μH	15 μH	1 to 2 MC	20 volts 100 ohms	
10Z6	4:1	0.1	0.04	200 μH	6 μH	1 to 2 MC	17 volts 100 ohms	
10Z12	1:1	0.25	0.02	200 μH	2 μH	12KC	100 volts	Blocking Oscillator
10Z13	1:1	0.33	0.07	240 μH	2 μH	2KC	50 volts	Blocking Oscillator
10Z14	7:1:1	0.50	0.05	1.2 mH	20 μH	1MC	25 volts	Impedance Matching
15Z1	3:1	5.0	0.04	7.5 mH	22 μH	10 KC	10 volts 100 ohms	Impedance Matching and Pulse Inversion
15Z2	2:1	0.5	0.07	6 mH	15 μH		40 volts	Blocking Oscillator
15Z3	5:1	10.0	0.04	12 mH	70 μH	10 KC	10 volts	Impedance Matching
15Z4	1:1.4	6.0	0.1	16 mH	15 μH	0.4 KC	15 volts	Blocking Oscillator
20Z1	5:5:1 Push-Pull	1.5	0.25	4.0 mH	0.3 MH		5 volts 10 ohms	Memory Core Current Driver
20Z3	6:1	1 to 4	0.22	18 mH	0.8 MH	250 KC (max.)	21 volts 200 ohms	Current Driver
20Z4	6:1:1	1 to 7	0.25	55 mH	0.3 MH	50 KC (max.)	22 volts 400 ohms	Current Driver and Pulse Inversion
20Z5	3.3:3.3:1 Push-Pull	2.4	0.2	2.8 mH	0.2 MH		2.5 volts 6 ohms	Memory Core Current Driver
20Z6	11:1	6.0	0.2	90 mH	0.2 MH	50 KC (max.)	10 volts 75 ohms	Current Transformer
40Z1	7:1:1	0.50	0.05	1.2 mH	20 μH	1 MC	25 volts	Impedance Matching

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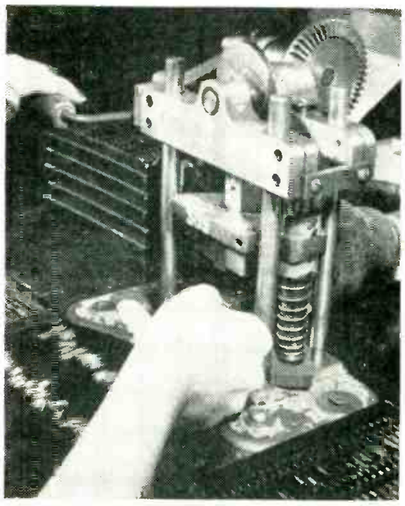

Forming anvil containing grid is held in position on bed of press with right hand while operator brings down crank with left hand

a gear-driven cam to push down the forming die. Tolerances for major and minor axis dimensions can be held to within 0.0005 inch largely because of the motion control achieved with the cam, which is simply a wheel mounted off-center.

The operating crank of the press is mounted on the shaft of a large bevel gear. This gear mates with a smaller gear on the cam shaft, at right angles to the crank shaft. Spring loading keeps the arbor tightly up against the cam.

Burn-In Rack Cuts Early Tube Failures

By JAMES A. K. RICHARDS
Engineering Group Leader
Pacific Division
Bendix Aviation Corp.
Los Angeles, Calif.

SUBMINIATURE tubes for military electronic equipment are paralleled as contact-potential-biased triodes on simple burn-in racks that were developed to eliminate early life failures. A second purpose of the burn-in process is to stabilize tube characteristics at some point which is determined by the type of circuit in which the tube is to be used. Burn-in for this second purpose is not always desirable, however, and should not be attempted without advice from either electron-tube engineers or an engineer experienced in tube processing.

Properly supervised burn-in processing can reduce interelectrode leakage, reduce heater-

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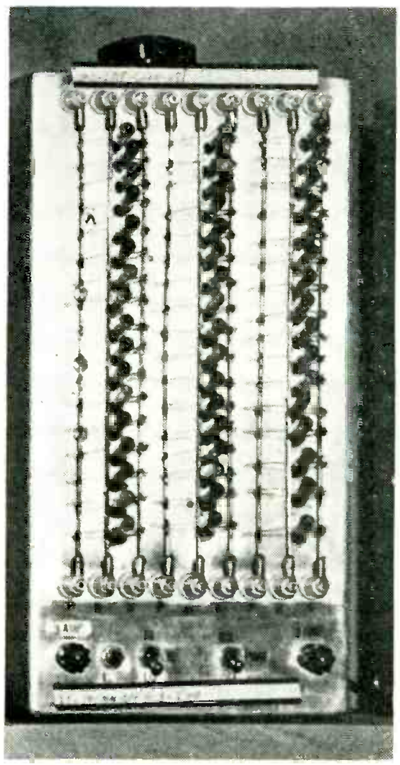
cathode leakage, give closer grouping of tube parameters and stabilize parameters with changes in heater voltage. An example of the beneficial aspects of burn-in processing is a d-c amplifier assembly, where burn-in reduced field failures and eliminated the necessity for balanced-tube selection.

Diodes are also processed on the wire burn-in racks. Labor required for burn-in, chiefly involving wiring tubes into the rack and unsoldering again at the end of the run, averages 1.5 minutes per tube. Three vertical busbars are provided for each row of tubes. The plate leads are soldered to the first, one heater lead of each tube is soldered to the second, and all remaining leads of each tube are soldered to the third, using temporary joints.

The charts show some of the effects of a burn-in process. The initial wide spread in mutual-conductance values (solid bars) is greatly narrowed after burn-in, as indicated by the shaded bars. The range of plate current values also narrowed for the 6BF7, though less spectacularly.

Visual inspection, which supplements the burn-in procedure for critical tubes, includes microscopic



Burn-in rack for 50 miniature tubes. Temporary lap joints are used for soldering tube leads to the vertical busbars

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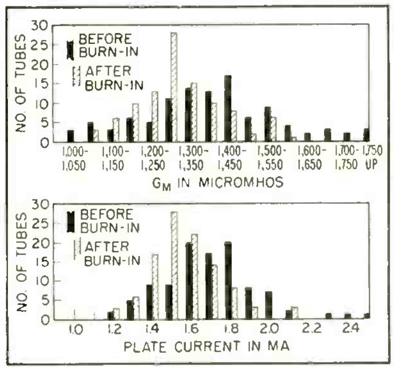
observation of more than seventy points in search of ten categories of faults, listed here in the order of their prevalence as causes of rejection: Heater insulation, foreign particles, getter faults, glass faults, damaged cathode or coating, wrong lead or tab spacing, bad welds, wrong element spacing, faulty mica and broken leads.

Vibration Tests

Vibration testing of individual tubes is not always used in connection with production of military electronic equipment. The philosophy behind this involves the fact



Effect of burn-in on range of mutual conductance and plate current for batch of 6BF7 tubes

that, when required, equipment is vibration-tested after completion. It has been found that careful visual inspection of tubes culls out a sufficiently high percentage of vibration rejects to make it economically feasible to replace tubes and retest equipments in lieu of vibration-testing indivdual tubes.

These are instances when the calculated risk of accepting a number of field failures is precluded by the number of key tubes in a unit. A key tube may be considered as any tube which, in failing, will cause a complete unit to cease operating. Vibration-testing of tubes for a telemeter subcarrier oscillator may be unnecessarily expensive because a tube failure means a loss of relatively small amounts of information, whereas the failure of a telemeter transmitter tube will result in a loss of 50 to 100 percent of the intelligence.

Individual vibration-testing of tubes has been found desirable in equipment which has an extremely low noise specification.

Vibration testing of individual

Good-ALL capacitors

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*Du Ponts Trade Mark for its Polyester Film

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MODELS 620S and 621S

. . . combine the excellent electric characteristics of "MYLAR" with the superior humidity resistance properties of "Seramelites" to produce a completely new capacitor for exacting applications at reasonable prices.

These competitively priced new miniature capacitors closely approximate the performance of expensive hermetically sealed units. They are designed to cover the entire capacitance and voltage range.

CHARACTERISTICS:

- Insulation resistance 20,000 megohm-microfarads
- Power Factor is Less than 1%
- Operating Temperature −55° C to +125° C
- Generally smaller than RETMA Standards
- Tolerances as close as ½ of 1%

CONSTRUCTION FEATURES:

- Tubular Ceramic Enclosure
- New Plastic End Seal
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- Miracle X Impregnated

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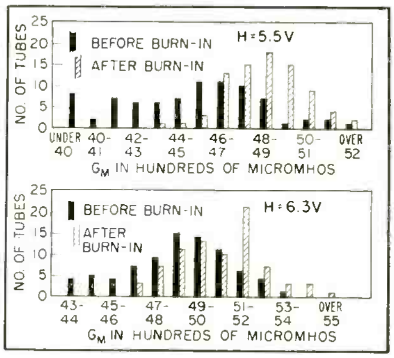


Effect of burn-in on two batches of type 5702WA tubes, using different heater voltages

tubes is conducted over a frequency range of 20 cps to 1,000 cps. A few single frequencies are used during vibration tests, with the choice of frequency dependent on the tube type.

Cost Comparisons

Over a period of more than two years before the tube pretesting program was inaugurated, approximately 24 percent of the subminiature tubes permanently wired in during production were later rejected by the test and calibration laboratory. To the time lost by the production department while rewiring the equipment must be added the much higher cost of another test and calibration. In addition, the time of a valuable skilled technician was lost.

The rejection rate of tubes used in identical equipments since the introduction of a tube processing and selection program two years ago has dropped to 7 percent (554 rejects out of 7,748 tubes supplied). Generalizing, this means that by doubling the cost of tubes, the total production time was reduced by a conservative 10 percent.

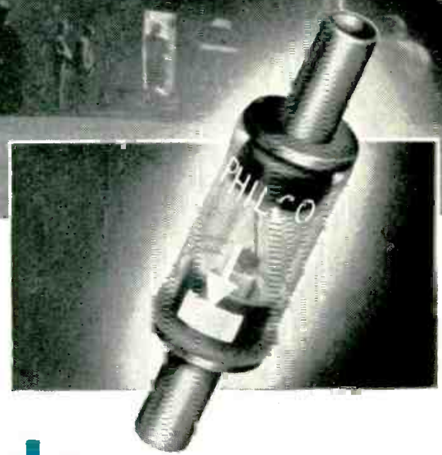
Figures pertaining to increased reliability are somewhat harder to obtain. Telemetry field test records indicate an increase in reliability of 1 to 2 percent. The old figure was 97 percent.

The labor required for the complete processing of a subminiature tube is:

Burn-in (wiring into rack, etc)	1.5 min.
Visual inspection	1.5 min.
Electrical test	4.5 min.
Vibration test	5.0 min.
Color coding and data recording	1.0 min.
Total	13.5 min.

This is the average time to run

U.S. Navy Photo



with the new PHILCO 1N263 Crystal Diode

PHILCO Famous for QUALITY the World Over

FEATURES

- Superior detection ability.
- Greatly improved noise figure over previous types.
- Reversible for use in balanced mixer circuits.
- 20° higher range in ambient operating temperatures.
- Controlled processing . . . rigid testing assures uniform diode characteristics . . .

The greatest mixer crystal advance in over 15 years! Philco's intensive program to reduce noise in radar front ends brings you this new "X" band diode, the 1N263. Now the noise figure is improved 2 to 3 db over the performance of ordinary crystals . . . equivalent in over-all performance to a power increase of 100%.

The 1N263 is a hermetically sealed point-contact germanium diode, designed to withstand environmental testing far beyond present military specifications. Maximum ambient operating temperatures have been increased 20° C over present mixer diode ratings to reach 90° C.

This new Philco diode will, with minor circuit modifications, operate in present radar systems. It is the only diode that can be reversed for use in either side of a balanced circuit.

Now in production and available. For complete information write Philco Dept. E.

PHILCO CORPORATION

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In Canada: Philco Corporation of Canada Limited, Don Mills, Ontario one tube through complete tests. To arrive at a cost figure, the time must be modified by several factors before applying the hourly rate and burden. The first to be considered is efficiency since the time quoted is based on 100-percent efficiency. The second is the fact that some of the tubes are rejected along the way, which on the average would reduce the total time per tube for both good and bad tubes, or increase the time per tube considering only the acceptable tubes. Third, amortization of equipment and, if desired, the cost of tube attrition should be added.

Acknowledgement is made to the military services, Raytheon Manufacturing Co. and Sylvania Electric Products, Inc., for many valuable ideas contributed to this program.

Test Sets Heat Plant

OPERATING HEAT from 64 hydrogen thyratron test sets, each rated at 50 kva, helps heat the new General Electric industrial and transmitting tube plant in Scranton, Pa.

The sets, installed by the Army Signal Corps to test the tubes for radar applications, produce a total of over 10 million Btu per hour. Practically all of this is available, if needed, to supplement the output of the regular heating system in the 200,000-square foot plant.

The plant has five boilers, whose

Four of the 64 hydrogen thyratron test sets from which hot exhaust air is ducted into building's heating system

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steam passes through coils in the building's air intakes to warm incoming air. Use of heat from the test sets enables the plant to use only two or three boilers, depending upon weather conditions.

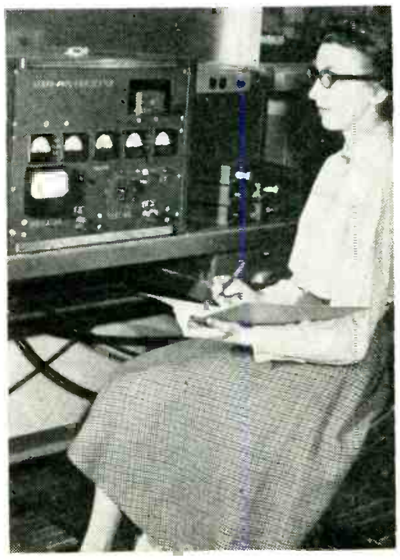
Outdoor air, passed through a circulating oil filter and tempered by a portion of the warm exhaust air from the test sets, is blown in at the bottom of each test set. The air circulates upward in the set, and is exhausted at the top by three fans.

The warm exhaust air, at about 100 F, then is ducted through an electrostatic filter and into the building's heating system. If the temperature of the exhaust air from the sets is under 75 F, or if it is not needed for heating, it is ducted outdoors.

Servo Amplifier Tester for Production Use

By JAMES ALMAN
International Business Machines Corp. Endicott, N. Y.

RAPID testing of servo amplifiers on a production basis is achieved with a tester developed under a U. S. Air Force contract. Insertion of the servo amplifier into an opening in the face of the tester completes the test circuits through mating connectors. On the panel of the tester is an eleven-position test selection switch which selects the type of test to be made. Results are indi-



Production-bench setup for testing packaged servo amplifiers

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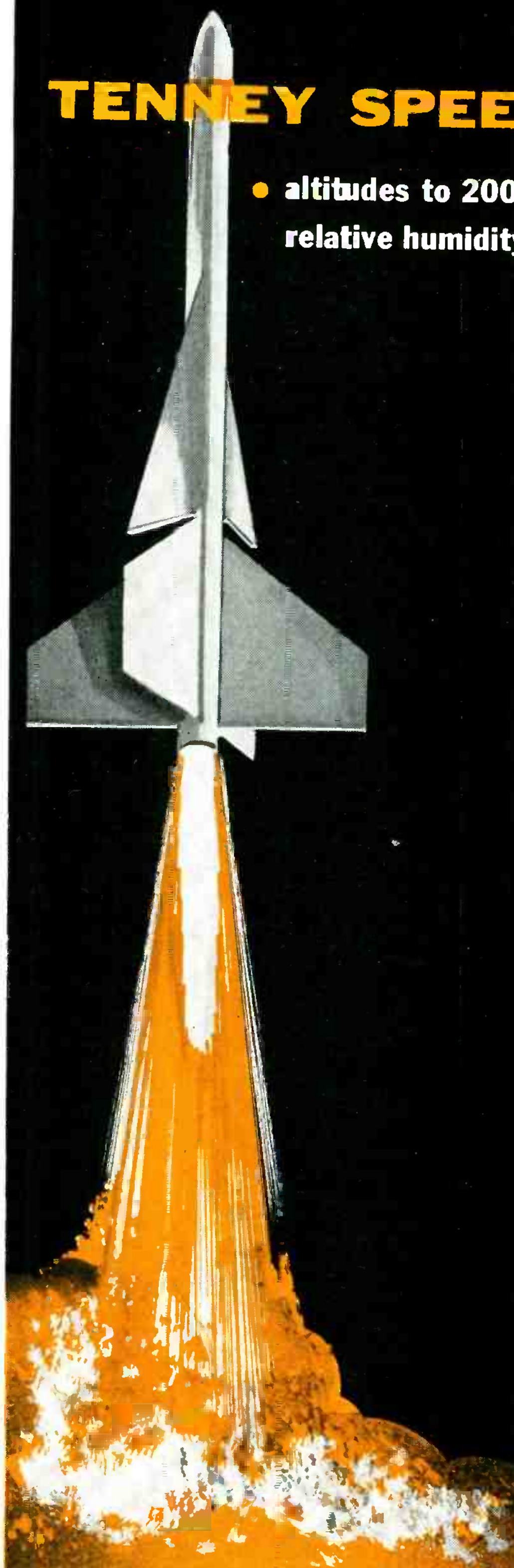

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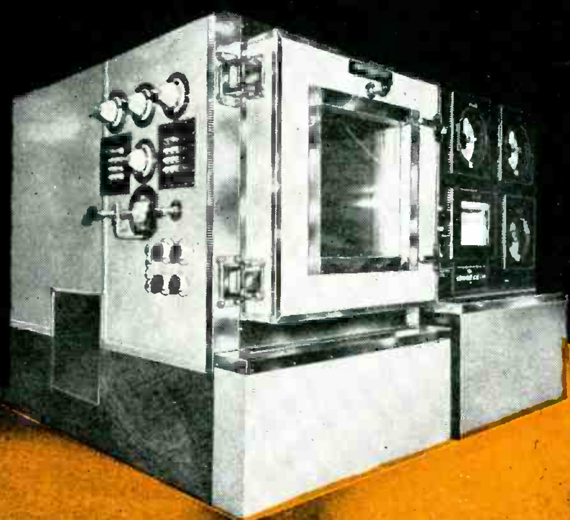
control accuracy ±2°F.
relative humidity 20% to 95%
cubic interior 27 cubic feet
exterior 7′6″ D. x 8′ W. x 7′ H.



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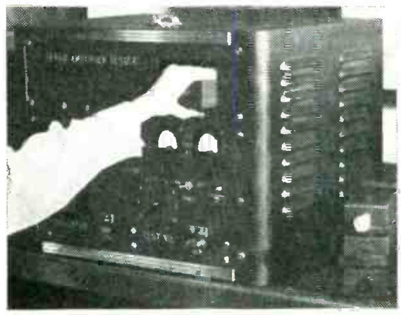
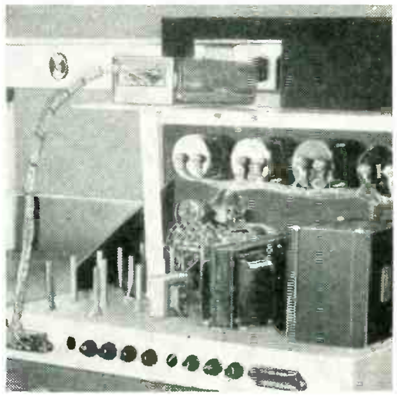
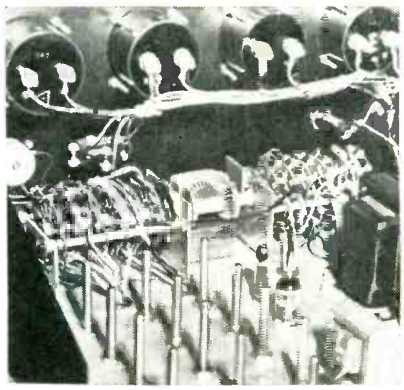


Method of plugging amplifier into panel for test



Rear of tester, showing plug and cable at upper left for making connections automatically to amplifier under test

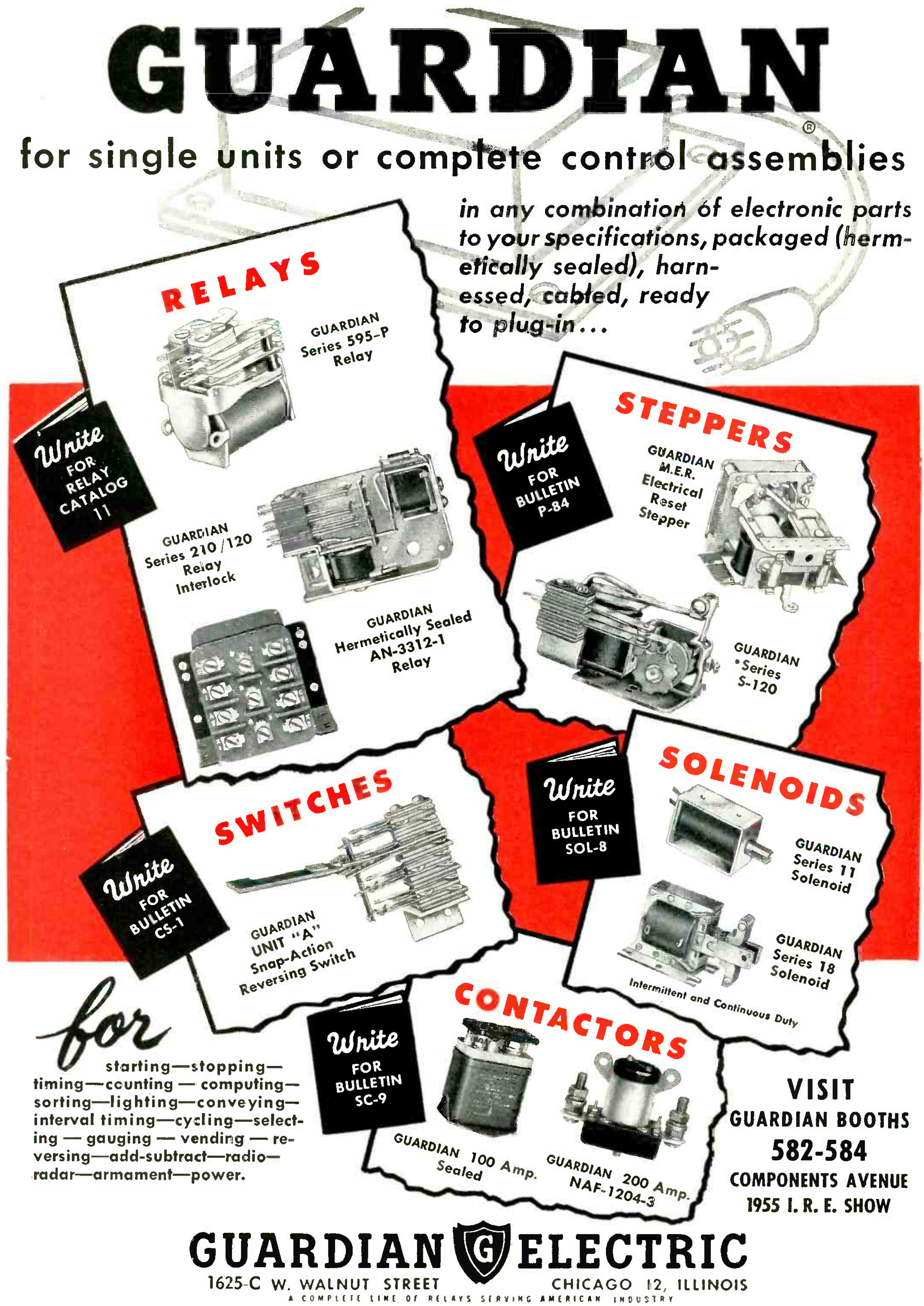


Gear drive system for eleven-position test selector switch

cated on a good-bad meter on the panel of the tester, making it possible to run through all eleven tests in a few seconds. The tests are:

(1) maximum power output; (2) high gain to dummy load; (3) low gain to dummy load; (4) high gain to low voltage output tap; (5) accuracy of adding resistor No. 1; (6) accuracy of adding resistor No. 2; (7) accuracy of adding resistor No. 3; (8) accuracy of adding resistor No. 4; (9) phase shift measurement; (10) in-phase noise measurement; (11) 90-degree phase noise measurement.

Figure 1 gives the four basic



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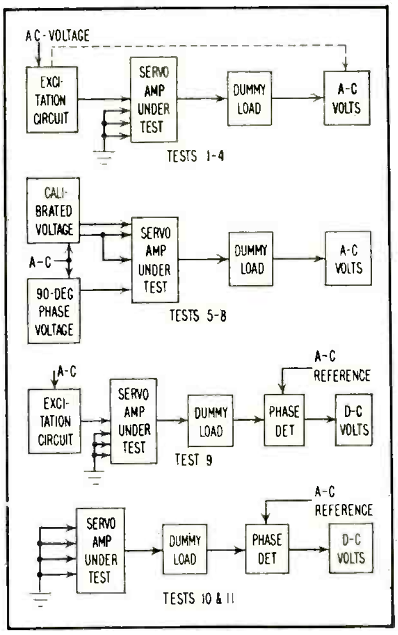


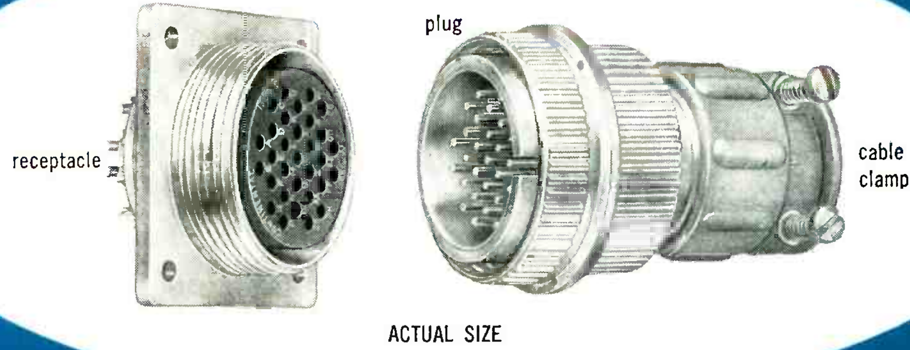
FIG. 1—Block diagrams of test circuits

block diagrams of the test circuits. Meters monitor the filament voltage, plate voltage and plate current. The good-bad indicator is calibrated from 0 to 100 microamperes; 0 to 30 and 70 to 100 microamperes are considered bad regions, while 30 to 70 microamperes is the good region.

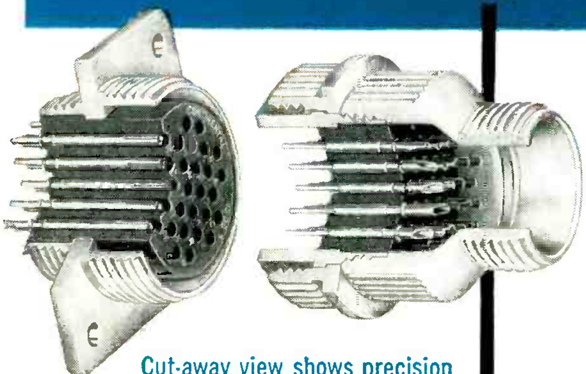
To check the maximum power output, a signal of amplitude large enough to saturate the amplifier under test is applied to one of the inputs, as shown in the complete circuit of Fig. 2. The output is applied to a dummy load and measured by a rectifier-type voltmeter. This indicates the maximum power available out of the servo amplifier.

The high gain of the servo amplifier is measured by a bridge circuit which balances the output voltage of the amplifier against the voltage input. This permits the checking of phase shift through the amplifier and prevents a 180-degree phase shift. A bias voltage applied through a variable resistor prevents a bad indication when the input voltage of the servo amplifier is in a fixed proportion to the output voltage. A defective amplifier will cause a bad indication, while a good amplifier will balance the bridge and cause a good indication on the meter.

Test No. 3, the measurement of low gain, is similar to Test No. 2. However, this position of the selector switch changes the gain of, and new...precision **Continental Connectors**



miniature AN-type



Cut-away view shows precision construction of Continental Series 1300

CONTACTS FOR #20 AWG WIRE

NO. OF CONTACTS	SHELL SIZE
4 and 5	9/16 -24
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If you have been looking for a dependable, miniaturized version of the popular A N-type connector, then consider this new Continental Connector Series 1300.

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One-piece molded inserts prevent moisture traps and possible electrical breakdown. They can be interchanged between the plug and receptacle shells for greater versatility. Our standard molding compound is Mineral filled Melamine (MIL-P-14D, Type MME). However, other compounds are available on order.

Write to our sales engineering department for technical data on the Series 1300, PLUS other special designs and circuit applications requiring the use of sub-miniature, printed circuit, hermetic seal, pressurized, high voltage or power connectors.

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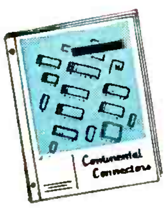

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Electronic Sales Division **DeJUR**

DeJUR-Amsco Corporation, 45-01 Northern Boulevard, Long Island City, I, N. Y.

See us at Booth 200, "Production Road," I.R.E. Show the input voltage level to, the servo amplifier.

In Test No. 4, the high-gain position again is used to determine the voltage output at the low-voltage tap on the output transformer of the servo amplifier. This test determines whether or not the tap on the output transformer is located properly.

Tests No. 5, 6, 7 and 8 check the accuracy of the input circuits by checking the input resistors against accurate standard resistors. One input places an adjustable quadrature voltage in the circuit to balance

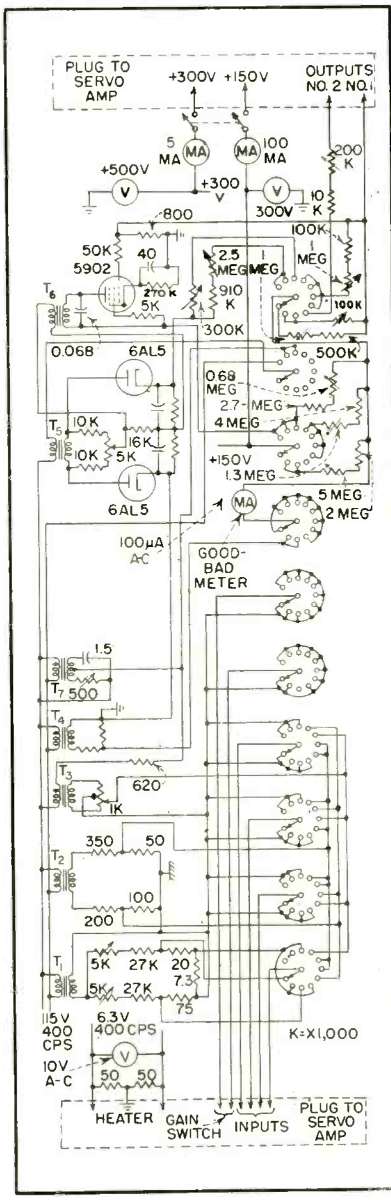

FIG. 2—When amplifier under test is plugged in, its terminals automatically make contact with plug terminals at top and bottom of circuit. Ten-deck, eleven-position selector switch is then swung through its positions while watching good-bad scale of microammeter

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out any phase shift which occurs in the input adding network. The amplitude of this quadrature voltage is limited so that an input resistor which shows too much capacitive reactance will cause a bad indication on the meter, and thus will register as a bad resistor. Therefore, this test can check both the resistive and reactive components of these resistors. The results are again measured on the 100-microampere a-c meter, which is connected to the output of the servo amplifier under test. Each resistor is checked in turn for accuracy and capacitive reactance. During these tests, the amplifier under test acts as its own null detector.

Test No. 9 measures the phase shift of the output of the amplifier under test. A standard phase detector circuit is employed. The indicator meter is nulled at its center so that a leading or lagging phase which is of greater than acceptable magnitude will drive the indicator needle into the bad region, indicating a defective unit.

The last two tests check the magnitude of pickup noise in the amplifier. The phase and magnitude of the output are measured with all inputs grounded. Output noise will be induced by tube heaters which are operated at the same frequency as the servo carrier. Test No. 10 measures the in-phase component of the output with the input grounded; test No. 11 measures the quadrature component of output voltage. This is accomplished by switching the reference voltage of the phase detector from 90 to 0 degrees.

A resistance of 0.5 ohm is inserted between power ground and signal ground, so that an amplifier with its signal and power grounds reversed will not operate correctly in the servo amplifier tester.

Color TV Pallet Design

A simple wood frame mounted at an angle of approximately 15 degrees on a plywood pallet serves to hold the chassis of a color television receiver at the start of the 400-foot U-shaped assembly line in the Westinghouse Metuchen, N. J. plant. The operator merely drops

At Minnesota Mining and Manufacturing Company (known as "3 M"), they say,

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Placing subassembly chassis plate in position on main color receiver chassis resting in special wood pallet

the empty chassis into the frame. Slots cut into the side of the frame provide access to mounting holes that would otherwise be within the frame.

One-Hand Vacuum Lift Moves TV Tubes Safely

A NEW VACUUM CUP lift developed by Ingersoll-Rand Co. permits faster and safer handling of large television picture tubes on production lines. Merely placing the vacuum cup on the face of the tube creates a safety-tight seal, after which the operator can raise or lower the tube by pushing fingertip levers on the control handle. A release button between these levers breaks the vacuum to release the load.

This unit is made up of the Ingersoll-Rand Air-Bloc hoist, a Pendent throttle and a specially designed vacuum cup. No special

Lowering picture tube into shipping carton after completion of final tests

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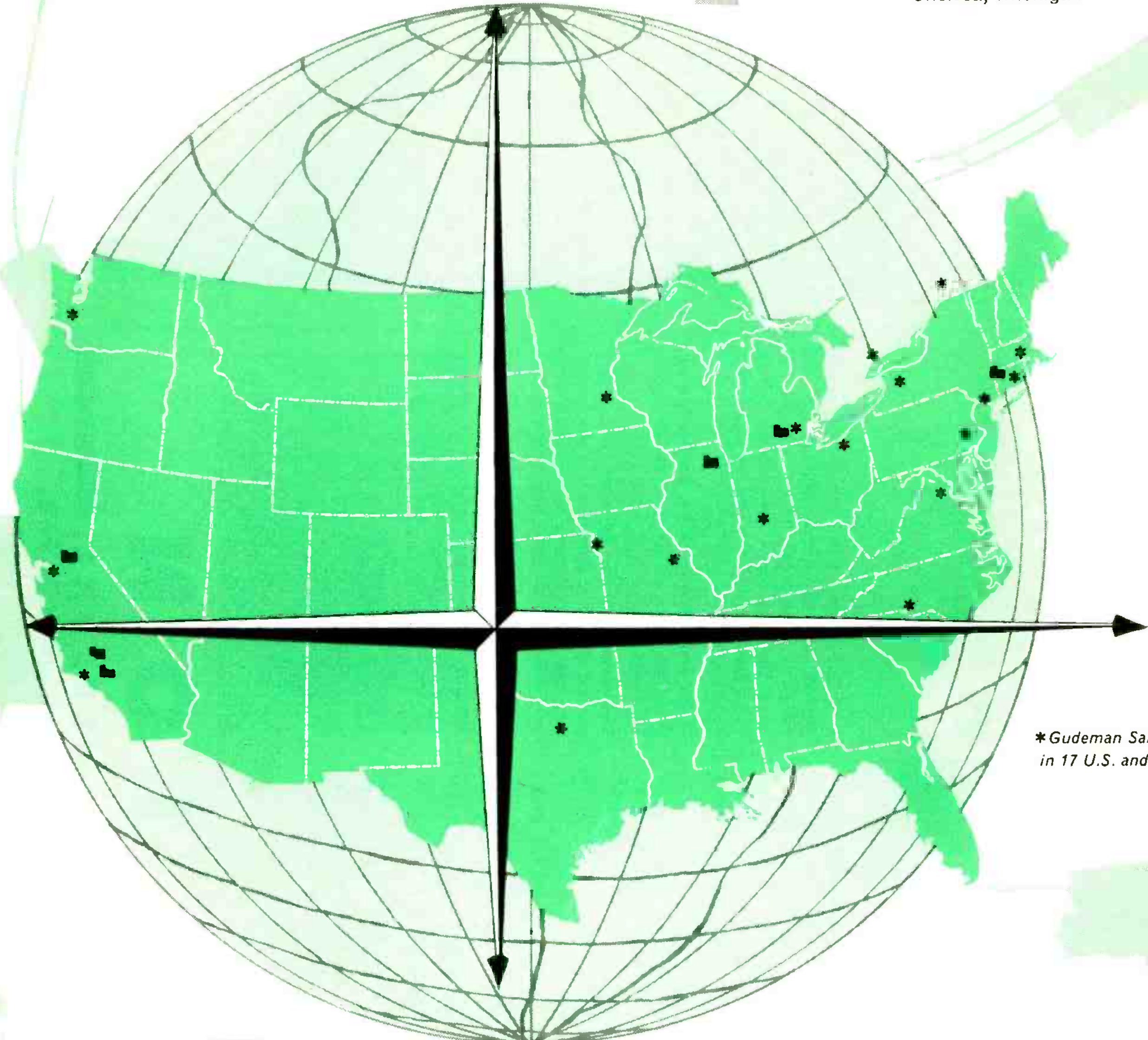

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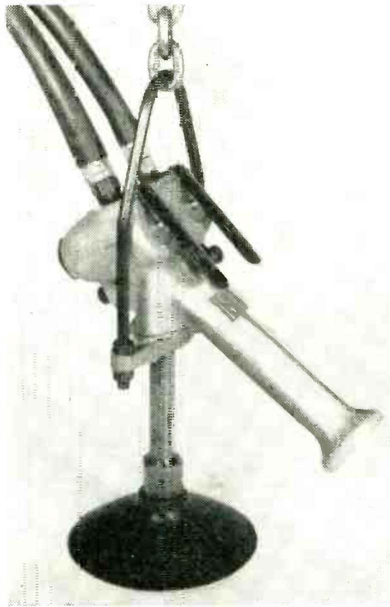
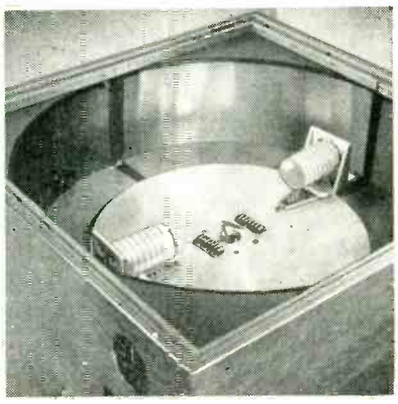


Left lever lowers, right lever raises, and center button on handle breaks vacuum of vacuum lifting tool

vacuum system is needed; a small amount of the air that operates the hoist is bled through a Venturi to obtain the required vacuum.

Accelerator Tests Parts Whirling at 100 G

AN ACCELERATOR at Helipot Corp., South Pasadena, Calif. was designed and built by the firm's Research and Development Division to provide acceleration adjustable from 0 to 100 g at a one-foot radius, for testing precision potentiometers. The mounts are rotatable so units under test can be oriented in various planes. Ten leads connecting through slip rings beneath the table permit monitoring of the units during testing. Units are mounted 180 deg apart.



Method of mounting two eight-potentiometer units on turntable

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DESIGNERS: For information about Federal Selenium Rectifiers —write Dept. F-513

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New Products

Edited by WILLIAM P. O'BRIEN

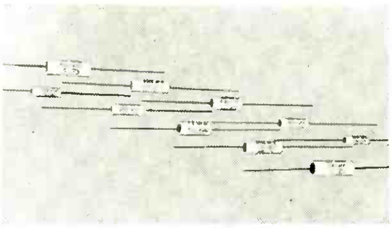
90 New Products and 56 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

FLEXIBLE WAVEGUIDE
for C-band or X-band radars

AIRTRON, INC., Linden, N. J. Type ARA-136 flexible waveguide provides the solution to difficult interconnections in double-ridge waveguide systems where vibration or mechanical alignment tolerances are involved. These waveguides are employed in combination with straight sections, twists, transitions, circular bends, quick disconnects, bulkhead assemblies, flanges, and gaskets to form a permanent waveguide run. By using these components, an aircraft waveguide installation becomes fully adaptable to either C-band or X-band radars. Flexible, straight lengths of double ridge guide are fabricated from Airtron type-S flexible tubing. At 5,400 mc (C-band), flexible ridge waveguide has a maximum vswr of 1.08, maximum attenuation of 0.10 db per ft, and power capacity at atmospheric pressure of 500 kw. The corresponding values for operation at 9,300 mc (X-band) are 1.10, 0.10 db per ft and 400 kw. The flexible ridge guides are supplied with any combination of gasket or mating r-f and pressure flange.

PAPER TUBULARS
in miniaturized versions

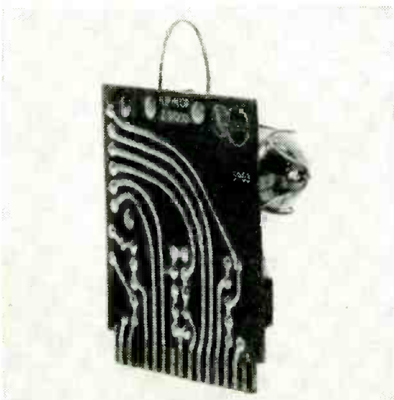
CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J., announces the production of STT midget Budroc steatite-cased paper tubular capacitors. These are miniaturized versions of the regular Budroc line retaining all the outstanding features in much smaller dimensions.



The new Midgets range in size from $\frac{7}{32}$ in. in diameter and $1\frac{1}{16}$ in. in length to $\frac{3}{8}$ in. diameter and $1\frac{1}{8}$ in. length. Those rated up to 400 v d-c are impregnated in HT compound and have an operating temperature range from -40 C to $+90$ C while those rated at 600 v d-c are impregnated in Vikane and have an operating temperature from -55 C to $+100$ C.

PLUG-IN UNIT
uses etched circuitry

EECO PRODUCTION CO., 827 S. Vermont Ave., Los Angeles 5, Calif.



Type Z-91000 plug-in unit, using etched circuitry, was designed to provide a low cost and light weight plug-in unit. It is a medium-speed bistable multivibrator circuit designed for use in counting, frequency division, switching and time selection applications. The output of one Z-91000 may be directly coupled into another without the use of amplifiers. The Z-91000 is wired so it may be used for linear, binary or feedback counting applications. It is $3\frac{1}{2}$ in. high, $2\frac{3}{4}$ in. wide and $1\frac{1}{8}$ in. thick. It weighs 1.5 oz and uses a $\frac{1}{16}$-in. phenolic etched circuit board. It plugs into a standard 15-contact printed circuit connector. The unit uses a 5963 tube with a tube hold-down and is designed to operate in the 0 to 100-kc range. It requires 200 v d-c at 3.5 ma and a filament of either 6.3 or 12.6 v. Other units to customer specifications are also available.

RESISTORS
in eight encapsulated types

SHALLCROSS MFG. CO., Collingdale, Pa., has available 8 additional P-type encapsulated resistors that are self-supporting on No. 20 Awg wire

Sylvania "600 ma" Tubes

99.7 proof*

FOR SERIES-STRING TV

** In a 15-tube series string, analysis proved that 99.7% of all probable combinations of Sylvania types operated within 2% of the heater-current design center. Sylvania's tight heater-current limit is one of the most important contributions to tube performance for series string operation.*

Best for Set Designers In 4 big ways

Sylvania pioneered the development of "600 ma" series string tubes to make possible the cost, space and weight saving features of series-string TV design. And Sylvania gives you these important advantages to insure dependable set performance.

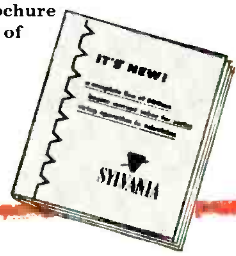
1. Less heater voltage variations—as a result of Sylvania's 99.7 proof tolerances on heater current, fluctuations in line voltage have less harmful effect on heater voltage. Steady-state heater voltage distribution is improved.

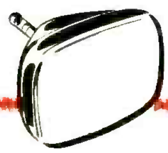
2. Less heater burn-outs—Rated heater warm-up time of approximately 11 seconds provides control of thermal characteristics. Voltage surges are alleviated.

3. Less time for normal set operation—Thermal control permits the use of a series resistor instead of a thermistor. Receiver reaches normal operation in less than half the time.

4. More uniformity—Because Sylvania makes everything but the bulb, quality is controlled from raw materials straight through to finished product.

Get the full story on the use of series-string tubes in TV sets by writing for this handy wall-chart brochure on the complete line of Sylvania "600 ma" tubes.





All Sylvania TV PICTURE TUBES now have heaters specially controlled for series string operation!

SYLVANIA

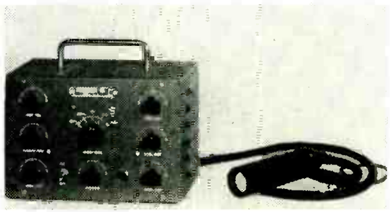
Dept. C 20 P

Sylvania Electric Products Inc.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., St. Catherine St.
Montreal, P. Q.

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

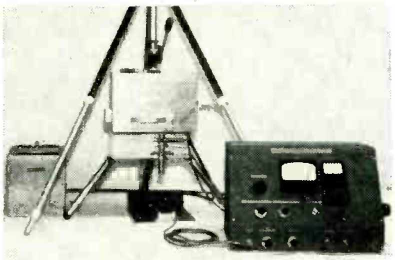
SEE SYLVANIA IN BOOTHS 168-170-172 AT THE 1955 I.R.E. SHOW axial leads. Wattage ratings are from 0.50 to 2.75 and maximum resistance ratings are from 0.05 to 15 megohms. Especially valuable in compact, crowded assemblies where space and weight are limited, these highly stable axial-lead resistors require no support other than that derived from their connected leads. The resistors discussed are wound with carefully tested resistance wire and sealed with mineral-filled epoxy resin. This coating provides maximum environmental protection, permits rapid heat dissipation, and is light in weight. Complete specifications on all P-type resistors are given in bulletin L-30.

SCOPE AND PROBE
is a portable unit



PROBESCOPE CO., 44-05 30th Ave., Long Island City 3, N. Y., has designed a portable combination probe and oscilloscope, an ideal instrument for quick trouble shooting and waveform analyzing. Model PO-1 Probe-Scope is one of the smallest complete scopes on the market. It measures 6 in. high, 9 in. long, 5 in. deep, taking up less than half a sq ft on the bench and weighs only 7½ lb. The Probe-Scope has a 1-in. Mumetal shielded crt incorporated into a probe small enough to be held in the palm of a hand, yet the waveform is even sharper and clearer than on larger oscilloscopes.

TEST SET
measures carrier lifetime



SCIENTIFIC SPECIALTIES CORP., Snow and Union Sts., Brighton Station, Boston 35, Mass. Model GL-131 test set was developed for separate measurement of bulk lifetime of minority carriers and surface recombination velocity constant of germanium and other semiconductors. The instrument's operation is based on the photo-magneto-electric effect in semiconductors. When a sample of a semiconductor is placed in a uniform magnetic field with a modulated beam of light totally illuminating the top surface, a sinusoidal photo-magneto-electric voltage appears across the ends. If a direct current is passed through the ends, the ohmic drop ($I_o \Delta R$) will cancel the p-m-e voltage since the two are opposite in phase. Resistance across the ends in the absence of light, known as R, is obtained by measuring the voltage when the d-c is passed through the specimen in the absence of light. Knowing I_o and R, we can compute bulk lifetime by substituting in the Aigran-Bulliard equations. Direct measurements are made by a single adjustment of the measuring circuit and the deflection of a d-c meter.

DOUBLE TRIODE
for switching circuit use

MULLARD LTD., Century House, Shaftesbury Ave., London, WC2, England, has introduced the type E90CC low-impedance double-triode tube which has a life expectancy of over 10,000 hr. It is intended for use in electronic switching circuits such as are used in digital computers, high-speed counters and scalers. Closely controlled are mutual conductance, anode current, balance between halves and cutoff. With a standing current of 8.5 ma, the mutual conductance has a value of 6 ma per v ±1.2 ma per v. In a typical circuit, under fixed bias conditions, the tolerance on anode current at 5.6 ma is 0.6 ma. Negative grid voltage required to reduce the anode current to 100 μa is less than 10 v. The E90CC is on a miniature all-glass base. It has a heater rating of 6.3 v, 0.4 ampere and an anode dissipation of 2 w per anode.

STRAIN-GAGE CONTROL
for use with cro's

ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J. Type 335 strain-gage control may be used with any c-r oscillograph using suitable preamplifiers. It is a complete, self-contained unit which contains necessary battery supplies and balance system to operate whatever strain-gage setup may be used. Internal voltages from 6 to 90 v in 8 steps may be selected or an external voltage may be ap-

At the I.R.E. SHOW!
BOOTHS #133, 135 TELEVISION AVE.
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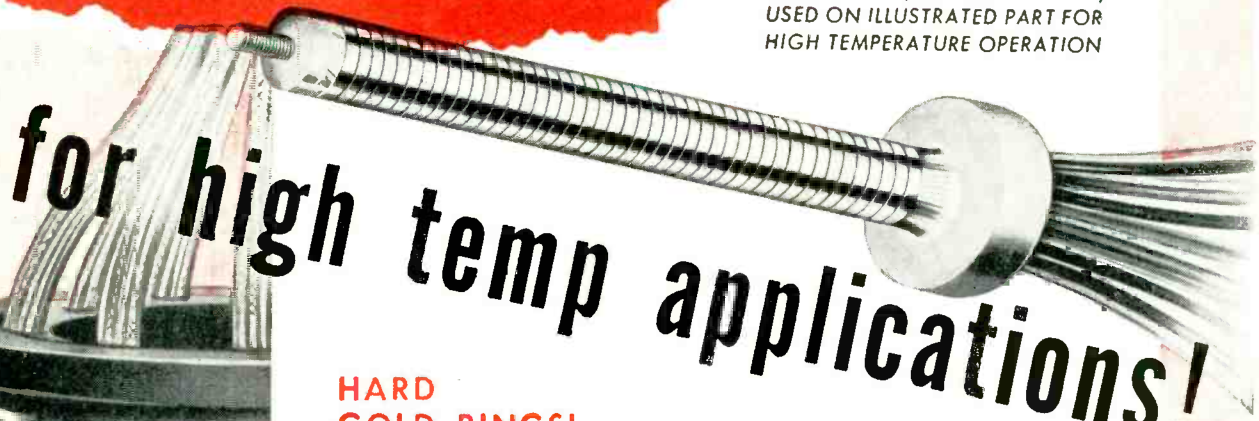
ELECTRO TEC SLIP RING ASSEMBLIES



—for high temp applications!

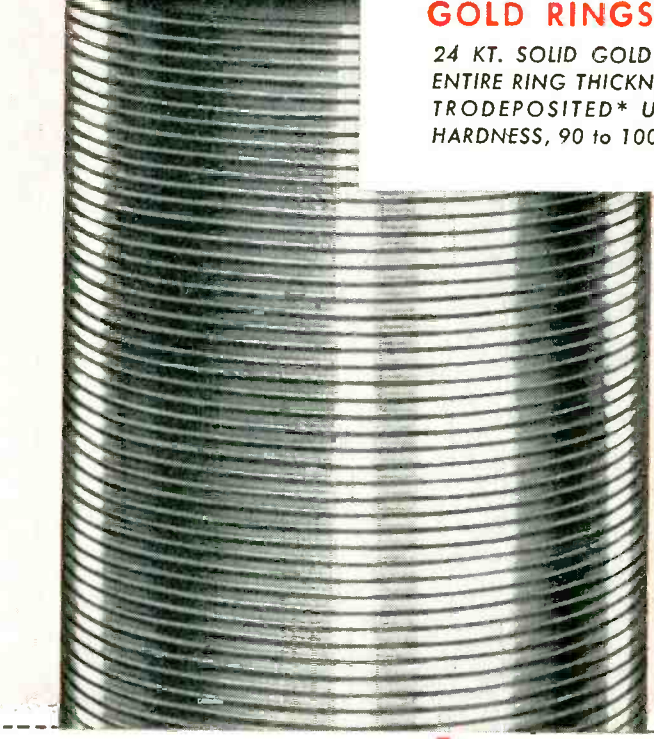
HIGH TEMP PLASTIC!

NEW ETC-7 (POLYESTER RESIN) USED ON ILLUSTRATED PART FOR HIGH TEMPERATURE OPERATION

HARD GOLD RINGS!

24 KT. SOLID GOLD RINGS — ENTIRE RING THICKNESS ELECTRODEPOSITED UNIFORM HARDNESS, 90 to 100 BRINELL.*

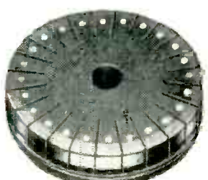
COURTESY LEAR, INC.
— these two features were incorporated in the assembly illustrated above, having 45 rings, dia. .180", ring width .020", barrier width .010". Overall length, less leads 1.763".



Electro Tec Corp., in its constant endeavor to keep pace with the most exacting requirements, has developed these new processes and products. They provide flawless performance under conditions far exceeding the capabilities of other types of construction. Where high temperature is involved, the superiority of these assemblies is so marked, that acceptance has been industry-wide. At the same time, an increasing number of users are specifying these assemblies for the ultimate in dependability under normal operating conditions. Inquiries will receive prompt attention; no obligation.

← 72 rings on integral support — no accumulated tolerances — fulfills electrical, minimum weight and space requirements.

Dual purpose assembly combining "V" grooved signal circuits and wide power rings.



Miniature high speed sampling switch — 24 channels.

Combining low friction torque slip rings (.060 dia.) with reference switch segments.

NEW ETC-7 (POLYESTER RESIN) WITHSTANDS TEMPERATURE RANGE FROM −60° to +500°F.

PRODUCTS OF PRECISION CRAFTSMANSHIP BY A NEW AND REVOLUTIONARY PROCESS

ELECTRO TEC CORP.
SOUTH HACKENSACK, NEW JERSEY

*PAT. NO. 2,696,570

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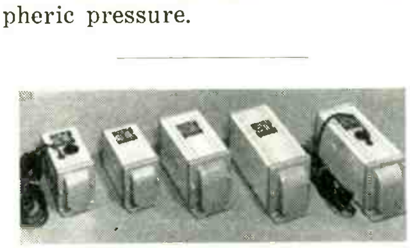
plied if desired. A front-panel meter checks internal battery condition or reads from 0 to 100 v when an external supply is used. Type 335 includes provision for 1 or 2 strain gages of any impedance or 4 gages of 120, 500, 1,000 or 2,000 ohms impedance. Precision calibrating resistances to supply multiplying factors from 0.1 to 100 meg may be switched in to calibrate the bridge in microinches per inch. A precision, 10-turn potentiometer is provided to balance out discrepancies in gage resistance and achieve an initial condition of zero output voltage from the bridge.

THERMOCOUPLE GAGE with printed circuit

CONSOLIDATED VACUUM CORP., a subsidiary of Consolidated Engineering Corp., 1775 Mt. Read Blvd., Rochester, N. Y. Type TG-029 single-station thermocouple gage with printed circuit is compact and portable. The instrument is calibrated for air with one direct reading meter scale covering the range from 1 to 1,000 microns Hg. It measures the total pressure of condensable vapors and permanent gases present in a system. The gage is not harmed by exposure to atmospheric pressure.



TRANSFORMERS regulate magnetic voltage

SORENSEN & CO., INC., 375 Fairfield Ave., Stamford, Conn., have available the first 4 models of what will be an extensive line of magnetic

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For the answers to your high precision gear and miniature motor problems, call on Western Gear! Complete engineering service and manufacturing facilities are available for the application of high precision gearing and miniature motors in electronic equipment.

Gears available from 200 to 6 diametral pitch and dimensions from .125" to 10" in diameter.

More than 50 basic types of miniature motor designs are available, ranging from .001 to 2HP, from 50 to 1,000 cycles in frequency, in any voltage required. Line includes blowers, generators, alternators, converters and dynamotors for all applications.

For further information, or engineering assistance, please detail your requirements for quotation. Address Western Gear, Executive Offices, P.O. Box 182, Lynwood, Calif.

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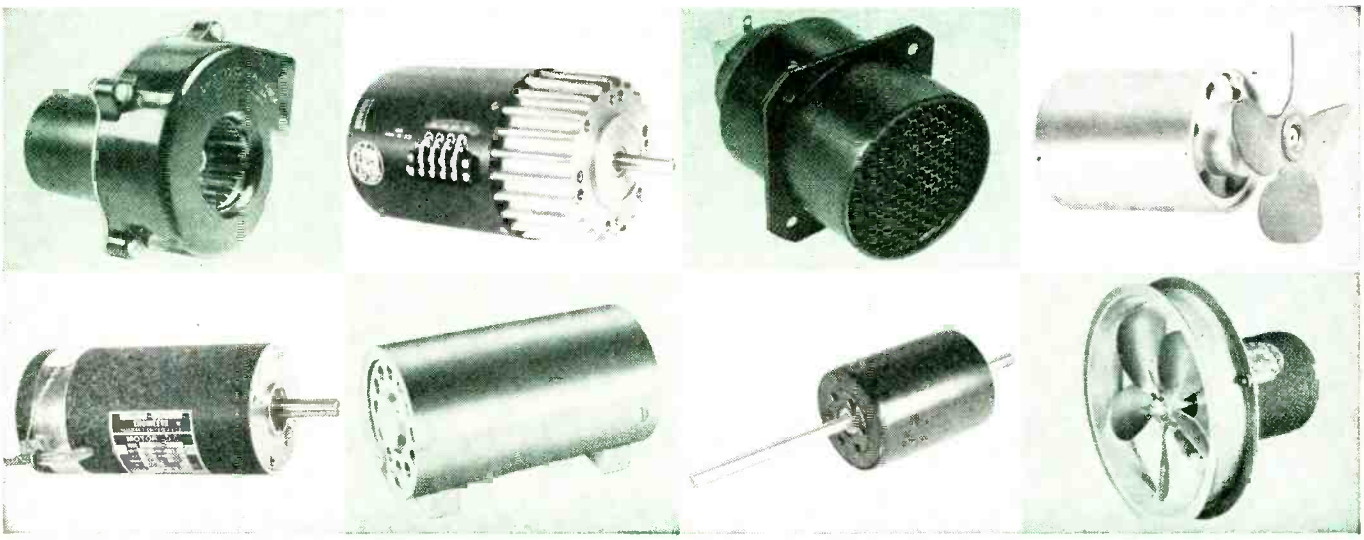


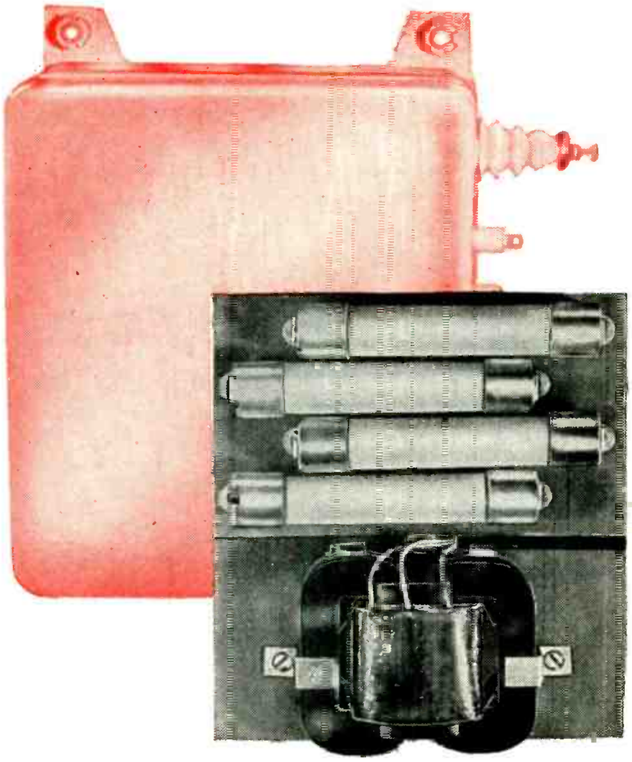
voltage regulators, or regulating transformers. The units now available have capacities of 15, 30, 60 and 120 va. Soon to be added will be units of 250, 500 and 1,000 va. They are primarily intended for incorporation into other equipment, where performance becomes more effective when the incoming line voltage is stabilized. However, they can be used as auxiliary line stabilizers. Full information, including mechanical configurations, is presented in catalog MVR1.

DECADE DELAY LINE
has overall delay of 1 usec

THE GUDEMAN CO. OF CALIFORNIA, INC., 9200 Exposition Blvd., Los Angeles 34, Calif., has in production a decade delay line, model GDDL-1000-1, with an overall delay of 1 μsec. Dial-selected taps are at 0.1-μsec intervals. Impedance is 1,000 ohms, and overall rise time is 0.1 μsec. The delay element is hermetically sealed in epoxy resin and the selectors for delay and termination are equipped with ceramic wafer switches which have solid silver contacts. Size is 7⅝ in. long × 4⅜ in. × 4⅜ in. exclusive of terminals.

OHMMETER
is low-resistance unit

INDUSTRIAL INSTRUMENTS, INC., Cedar Grove, N. J. Model LRO low-resistance ohmmeter is especially adaptable to measurement of relay contact resistance, fuse resistance, bonding and ground wire resistance and any other application requiring low-resistance measurements with minimum test current. It has an accuracy of ±1 percent of full-scale reading. Ranges include full-scale readings of 0.1 ohm, 1 ohm



high voltage—
low current

D. C. POWER SUPPLY

ideal for aircraft, guided missiles, other applications with limited space and weight

This special D.C. power supply, now being produced by Keystone, has an output of 4500 volts at 1 milliamp with an operating frequency of 6000-13,000 cycles per second. Input is 150 volts. The unit is oil filled, hermetically sealed, and can be used effectively from —55°C. to +75°C., and to altitudes of 60,000 feet.

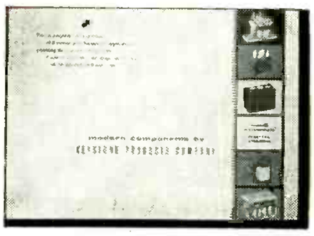
This versatile component is ideal for any application, military or commercial, where space and weight are critical factors . . . and it is typical of the unique components produced by Keystone to meet unusual standards of performance, adaptability and reliability. Each is a custom-engineered unit designed to solve specific problems which standard transformers or magnetic amplifiers cannot solve.

If you have an application for a low-input D.C. power supply like the one above—or if you have an unusual specification demanding unique performance from a transformer or magnetic amplifier—contact the Engineering Department today.

See Keystone's new transformers and "Moto Mags" at booth #804, I.R.E. Show

write for new illustrated brochure, "Modern Components"

This new brochure describes and illustrates a wide variety of transformers and magnetic amplifiers produced to meet unusual and difficult specifications.



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keystone PRODUCTS COMPANY

904 23RD STREET UNION CITY 2, N. J.

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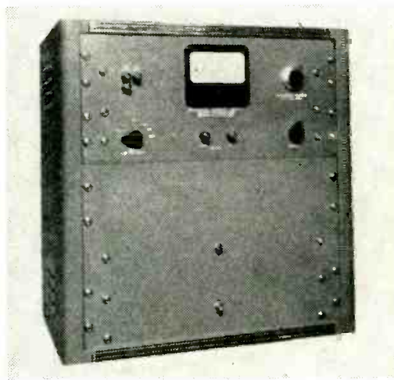
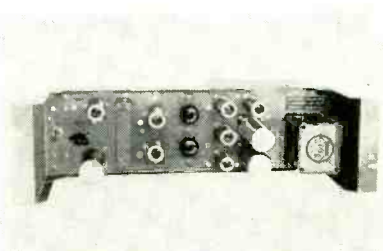
and 10 ohms. The scale is divided into 100 divisions (one scale division on the 0.1 range being 0.001 ohm). With the model LRO current passing through test piece never exceeds 10 ma on any range.



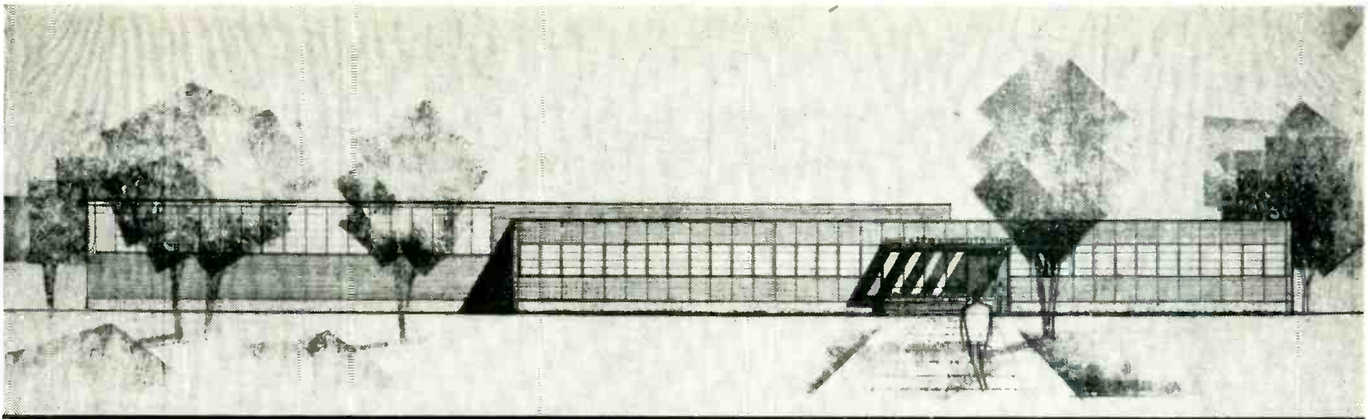
POWER SUPPLY
for transistor measurements

SCIENTIFIC SPECIALTIES CORP., Snow and Union Sts., Brighton Station, Boston 35, Mass. The PS-171 electronically regulated power supply was developed expressly for use in high accuracy transistor measurements. The regulated output current of 1 ampere maximum is high enough to accommodate power transistors. It features 4 regulated voltage ranges from 10 v to 100 v. Absolute accuracy of voltage or current output indication on the front panel meter is better than 0.25 percent. Precise setting to 0.1 percent is by a 10-turn Helipot. Regulation is better than 0.1 percent for load changes from zero to full load and line voltage changes from 105 to 125 v. Hum is below 0.05 percent of full scale on all ranges.



APERTURE EQUALIZER
peaks up wide-band circuits

HARRISON LABORATORIES, 53 Industrial Rd., Berkeley Heights, N. J., announces an aperture equalizer



We're Curing Our Growing Pains

Due to the tremendous increased demand made upon us by our many customers, for which we are truly grateful, we are pleased to announce the commencement of construction of our new quarters at West Caldwell, New Jersey, having six times as much space and ten times as much production potential as here-to-fore,

This means that we can maintain faster production schedules and at the same time carry on greater research and development projects to meet every requirement.

I. C. I. engineers have always been available for consultation and cooperation at every stage of manufacture of any printed circuit or printed circuit assembly . . . ready to work with you from the inception of the idea to the completion of the project. With our new working space and production equipment their creative planning will be even broader.

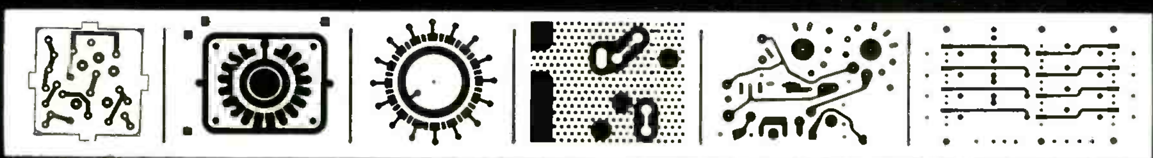
KEEP YOUR EYE ON I. C. I.

Watch for the first announcement of a startling new high insulation resistance development for printed circuits. This patented process will open your eyes to new fields of electronic development.

iCi *Insulated Circuits*

INCORPORATED

115 Roosevelt Avenue, Belleville, N. J. PLymouth 9-0700



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Pittsfield, Mass., 50 South Street 8618
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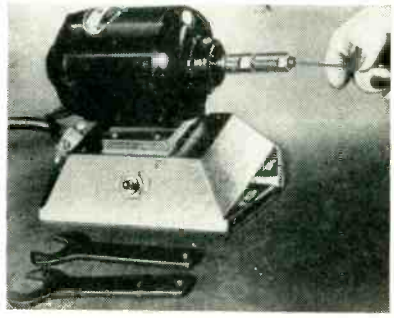
which provides a phaseless high boost for tv. It is generally useful for peaking-up wide-band circuits. The instrument can be used to over-equalize a tv picture to give a natural crispened effect. It is readily adaptable to flying spot scanners, film pickup, kine-recording, radar and ppi displays. The aperture equalizer combines a transversal-type filter with v-t circuits to obtain a symmetrical response. Three models provide a versatile selection of frequency characteristics free of phase distortion.



WIRE STRIPPER
removes film insulation

RUSH WIRE STRIPPER DIV., THE ERASER CO., INC., 1068 S. Clinton St., Syracuse 4, N. Y. A new rotary wire stripper removes film insulation. The unit is readily adjusted for stripping sizes 20 to 29 Awg. Similar units for larger wires are available. The machine can strip to within 1/32 in. of the component and is particularly adaptable for use on coils similar to choke coils. The end of the wire is simply inserted and withdrawn. There are no pedals or levers to operate. The machine can be mounted alongside coil-winding machine for stripping wires before winding. The stripping insert can easily be resharpened on the side of a grinding wheel.

TRANSDUCERS
for pressure measurement

HATHAWAY INSTRUMENT CO., 1315 South Clarkson, Denver, Colorado. Type PS-20-pressure transducer is equipped with a sensing element in the form of a small metallic cylinder with resistance gage windings on the outside. It has been designed for use with any system developed

PRECISION POTENTIOMETER HANDBOOK AND CATALOG

a fact packed addition to your design bookshelf

An authoritative engineering text covering the principles underlying the design and use of precision potentiometers has been prepared by TIC as an informational guide for you. This handbook of material is bound with a complete catalog giving specifications for all standard TIC potentiometers and test instruments.

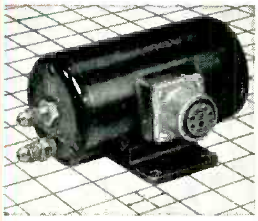
You can familiarize yourself with accepted potentiometer terminology, circuits for potentiometer adjustment, non-linear loading techniques, resolution standards, causes of residual noise, and potentiometer design and construction features. This material is covered in the following chapters:

- Elements of a precision potentiometer
- Potentiometer terms
- Linearity
- Non-linear conformity
- Resolution and residual noise
- Operational characteristics
- Special designs
- Linear functions
- Non-linear functions by contoured resistance elements
- Non-linear functions by loading, clamping and ganging
- Mounting and ganging
- Bibliography

With this beautifully bound, flexible cover, loose-leaf book is provided a continuing subscription service, consisting of up-to-the-minute information on new developments in potentiometer technology and TIC models as they are introduced.

DIELECTRIC POTENTIOMETER

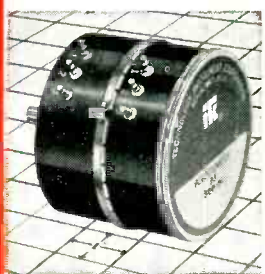
For broad band applications up to 10 mc., the PD-2 Dielectric Potentiometer uses variable capacitor electrodes immersed in a lossy liquid dielectric. Loss is independent of frequency, phase shift is zero. Total attenuation range is 25 db., resolution is infinite, a wide range of input impedance is available, and adaptation to specific non-linear functions or mechanical drive can be supplied. Inquiries on specific applicatons are invited.



PRESSURE TRANSDUCER

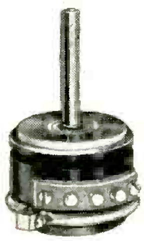
This dual element air flow differential pressure transducer is designed for speed-altitude measurement in the ranges 0-580 knots, and −1000 to 20,000 feet, or similar applications. Double pairs of precision potentiometers are actuated by pressure response of static and dynamic bellows. Resistance ratios vs. pressure is linear within 0.5%, hysteresis within 0.5%, resolution increment is less than 0.2% of pressure range, withstands 10g of vibration up to 200 cycles, and 40g of shock.

continues to SET STANDARDS with NEW ADDITIONS to the PRECISION POTENTIOMETER FAMILY



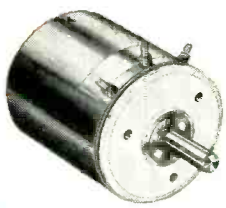
LOW COST PRECISION POTENTIOMETERS

The "P" series is a low cost line especially appropriate for automation and industrial electronic test equipment. These units retain many precision features developed for stringent military requirements and feature TIC standards of accuracy, long life, low noise, and low torque. Available in linear or non-linear function. Bakelite cups instead of metal contribute higher breakdown voltage and insulation resistance, and lower distributed capacity. Type P1 ¼: 100 to 100K ohms, 0.75% linearity — Type P1 ⅝: 100 to 150K ohms, 0.3% linearity — Type P3: 100 to 200K ohms, 0.15% linearity.



ST09 MINIATURE POTENTIOMETER

This is a miniature precision potentiometer of the standard line. Only ⅞ of an inch in diameter, this new addition, built to military specifications, incorporates the precision TIC features: Independent linearity 1% of total resistance, standard, or 0.3% on special models; resistance range 100 to 50K ohms; electrical rotation 320° ±5° with special angles and closer tolerances available; torque 0.5 oz. in. standard, 0.1 oz. in. special; power rating 2 watts. Available in linear and non-linear functions.



MULTITURN POTENTIOMETER

The M10T servo wound Multiturn Potentiometer combines extraordinary mechanical precision and high electrical accuracy at lower cost. Independent linearity 0.05% standard, 0.025 or better in special units — resistance range 1000 ohms to 10,000 ohms ±5% — effective electrical angle: 3600° +1° −0° — one piece machined aluminum base, spring loaded ball bearings — mechanical rotation 3660° ±2.5° — stops withstand 100 pound-inch torque — starting torque 1.3 oz. in. — stainless steel cover.

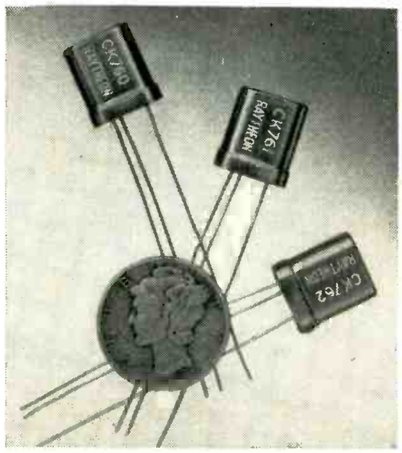
Write Technology Instrument Corp. how to obtain the Potentiometer Handbook subscription service and the recent additions to the TIC line of potentiometers.

TECHNOLOGY INSTRUMENT CORP.

553 MAIN ST., ACTON, MASS. COlonial 3-7711
West Coast Mail Address P.O. Box 3941 North Hollywood, Calif. POplar 5-8620

See us at booth #226-228 Instruments Avenue at the IRE Show

for resistance strain gages such as the Hathaway type MRC-21. The PS-20 unit can measure and record static and dynamic pressure ranging from 50 to 5,000 psi.



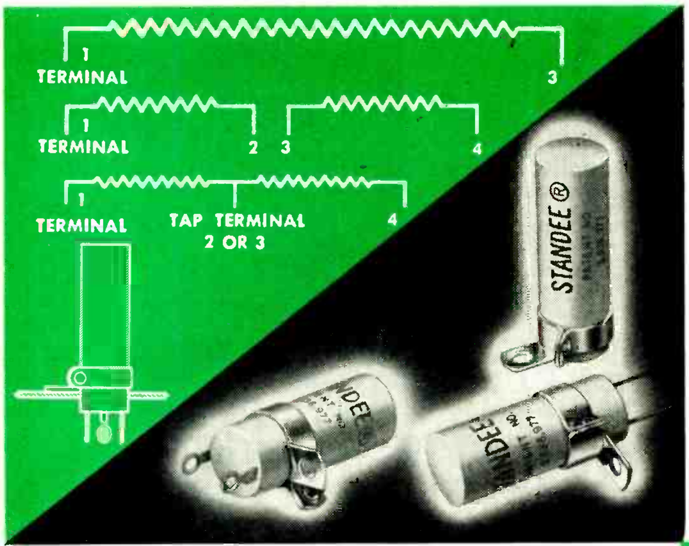
TRANSISTORS
of the r-f germanium type

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass., announces three radio-frequency fusion-alloy germanium transistors, types CK760, CK761 and CK762 with alpha cutoff frequencies of 5, 10 and 20 mc respectively. All are hermetically sealed and use a polarized lead arrangement for ease in socketing. Collector capacitance for each type averages 14μμf and extrinsic base resistance for each is about 75 ohms.

MICROAMMETER
measures minute currents

SCIENTIFIC SPECIALTIES CORP., Snow and Union Sts., Boston 35, Mass. Model d-c 151 millimicro-microammeter is an a-c operated instrument for measurement of d-c from 3×10^{-15} to 10^{-7} amperes. The unit utilizes a direct-coupled v-t amplifier with a voltage gain of about 400 times, output negative

Take that HEAT out of the CHASSIS, by either of these methods...



STANDEE*

Clarostat Series KS above-chassis-mounted power resistors. Handy terminals (lug, standard; or pigtail, at extra cost) for easy wiring. These unique components solve the problem of safe heat dissipation, yet terminals are below chassis, to fulfill UL requirements. Wire winding on glass fiber core, permanently sealed in smooth ceramic casing. Available in single, dual and tapped-section types as shown in wiring diagrams. Adjustable mounting ring provides for any protrusion above or below chassis. In 1½, 2, 2½ and 3" h. sizes. 10, 15, 20 and 25 watt ratings, respectively. Wide range of resistance values.

METAL-CLAD MOLDED

Clarostat Series MMR metal-clad resistors. Resistance winding sealed in molded phenolic and further protected by metal casing, for electrical and mechanical ruggedness. Adequate, but not excessive, phenolic insulation seals against moisture without hampering heat transfer to outer metal casing. No hot-spot troubles. Mounted flush against metal surface for maximum heat dissipation, unit is rated at 5 watts per winding inch, as against 2½ watts in free air. Sizes from 2" to 6" mounting centers. 1 to 10 sections. Breakdown strength over 1000 V.A.C.

ASK FOR LITERATURE!

Engineering Bulletins sent on request. Let our resistor-specialists collaborate on your application problems. and let us quote.

CLAROSTAT

Controls and Resistors

CLAROSTAT MFG. CO., INC., DOVER, NEW HAMPSHIRE

In Canada: Canadian Marconi, Co., Ltd., Toronto 17, Ont.

*Reg. U.S. Pat. Off.

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with respect to input. Inverse feedback is so employed that a small current applied to the input produces an equal and opposite current through the feedback resistor. Current gain is substantially independent of the amplifier gain and is thus independent of the characteristics of the amplifier tubes. Dynamic input resistance rises from 2,500 ohms on the 10^{-7} ampere range to 25,000 megohms on the 10^{-14} range.

LITTLE SPEAKER
for transistorized radios

JENSEN MFG. CO., 6601 S. Laramie, Chicago, Ill., is now producing the P275-Y miniature, compact, highly sensitive loudspeaker designed for transistorized pocket radios. It is 2$\frac{3}{4}$ in. in diameter, 1$\frac{3}{32}$ in. in depth, and weighs less than 2$\frac{1}{4}$ oz. An unusually high output performance with relatively low signal input is attained through unique design and engineering features which make fullest use of energy from the magnet. Nominal voice coil impedance at 1,000 cycles is 16 ohms. The P275-Y has future applications in miniature and portable radios, transceivers, paging units and equipment of similar size and weight.

BAND-PASS FILTERS
cover 200 to 2,000-mc range

APPLIED RESEARCH, INC., 163-07 Depot Rd., Flushing, N. Y., is introducing a new line of band-pass filters covering the frequency range of 200 mc to 2,000 mc. These filters incorporate multiple tuned resonant circuits with an insertion loss of

RMC Wedg-loc DISCAPS

RMC "Wedg-Loc" DISCAPS are designed specifically to cut assembly time on all types of electronic equipment using printed circuits.

The exclusive wedge design of the leads on these new type DISCAPS locks them firmly in place on printed circuits . . . eliminates their falling out during production line operations . . . insures a uniform connection with a minimum amount of solder.

Available in capacities between 2 MMF and 20,000 MMF in temperature compensating, by-pass and stable capacity types, "Wedg-Loc" DISCAPS will provide worthwhile economies on printed circuit assembly. Suggested hole size for "Wedg-Loc" DISCAPS is a .062 square hole.

BOOTH 518, Components Ave., I.R.E. Show

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION

GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Two RMC Plants Devoted Exclusively to Ceramic Capacitors

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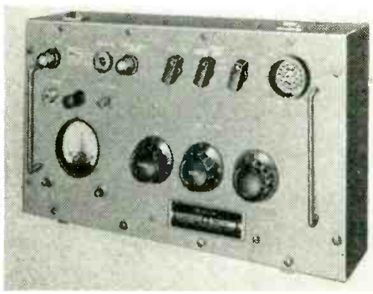
less than 1 db, and will display the typical Tschebycheff response. The size of the filters has been kept to a minimum, consistent with the number of resonant circuits, so that the units may be readily incorporated as external adjuncts to any existing equipment. Bandwidth is 10 to 150 mc; impedance, 52 ohms; insertion loss, less than 1 db; peak-to-valley ratio, less than 1 db; and standard frequencies, 400 mc, 1,000 mc and 1,680 mc.



COMPARATOR
measures voltage ratios

TELECTRO INDUSTRIES CORP., 35-18 37th St., Long Island City 1, N. Y. Model 592 standard voltage ratio comparator is used for setting accurate voltage ratios, both a-c and d-c, by means of an accurately calibrated voltage divider network and a zero-center microammeter. It is capable of measuring ratios from 1-to-1 to 10,000-to-1 with an accuracy of 0.01 percent in an operating temperature range of −40 F to 160 F. The model 592 compares voltage ratios in the range of +150 to −150 v d-c, compares voltages across 120-v 350-cps source, and can be supplied to compare a-c voltage ratios at any frequency. The unit has three sensitivity ranges and polarity or phase selector switching.

TRANSDUCER
for severe temperature use

THE HARRIS TRANSDUCER CORP., Southbury, Conn., Model PS-23 transducer is designed for use in the 22 to 28-kc band or at lower frequencies, where pressures and temperatures are severe. It is serviceable at static pressures up to 12,000 lb per sq in. and at temperatures up to 300 F. It has an im-

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NATVAR Styroflex® Film

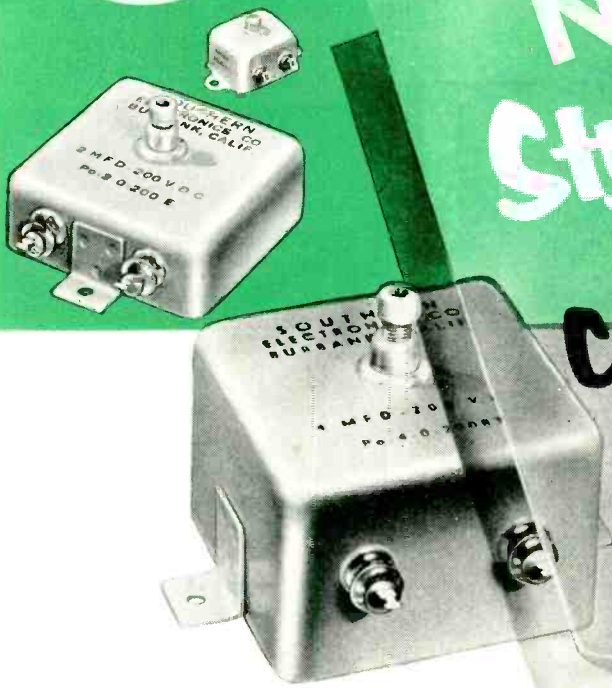
TO MAINTAIN

Capacity Tolerance

AND

Longtime Stability

IN THEIR ADJUSTABLE CAPACITORS



These SEC Polystyrene Capacitors have an accuracy in the order of 0.1% or better and longtime stability in the order of 0.03%. Natvar Styroflex film is used as the dielectric.

SOUTHERN ELECTRONICS CORPORATION, Burbank, California, manufactures precision capacitors for applications where difficult specifications have to be met, such as computer integrators, test equipment, secondary standards and certain weapons programs.

Because polystyrene comes closest to meeting specifications for a perfect dielectric, various polystyrene films were tested. Natvar Styroflex film was selected because of its uniformly excellent pliability, freedom from faults, high shock resistance and excellent dielectric characteristics.

Natvar Styroflex film is available in standard thicknesses From .0004″ to .006″ in widths from ½″ to approximately 10″ or in special put-ups to meet manufacturing requirements.

Natvar

Natvar Products

- Varnished cambric—cloth and tape
- Varnished canvas and duck
- Varnished silk and special rayon
- Varnished—Silicone coated Fiberglas
- Varnished papers—rope and kraft
- Slot cell combinations, Aboglas®
- Vinyl coated—varnished—lacquered tubing and sleeving
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- Styroflex® flexible polystyrene tape
- Extruded identification markers

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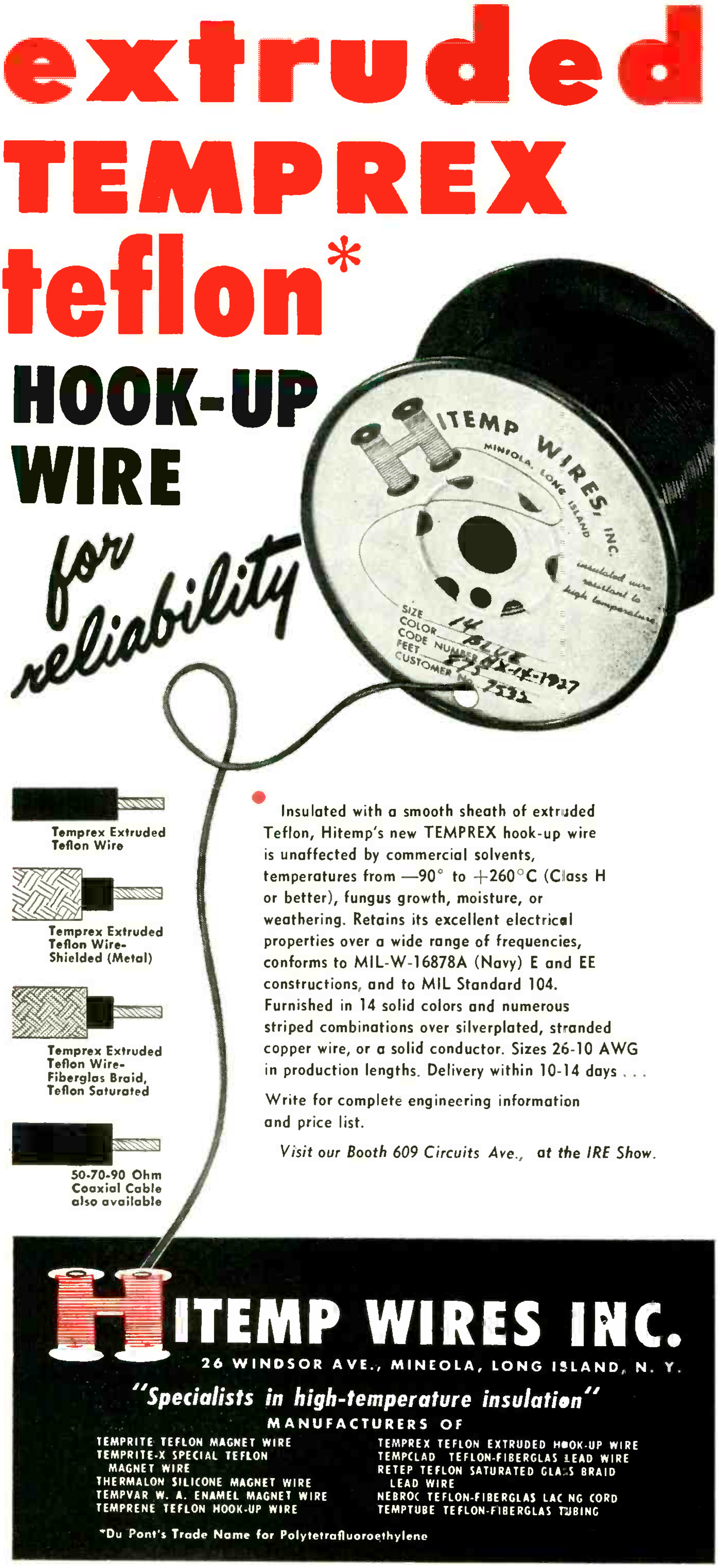
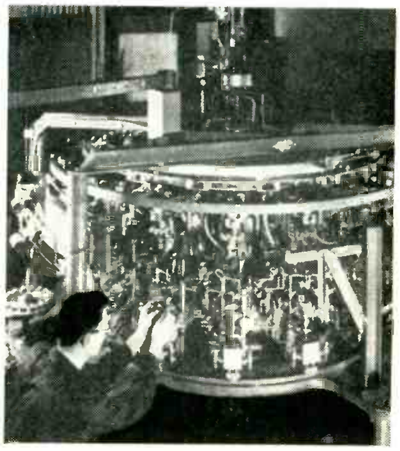


pedance of 16+ j 56 ohms at 24 kc, and a receiving sensitivity of −102 to −104 db vs 1 v per microbar in the 22 to 28-kc band. Its electro-acoustic efficiency is approximately 20 percent for transmitting or receiving in water. The transducer measures 3½ in. in length and 3¼ in. in diameter.

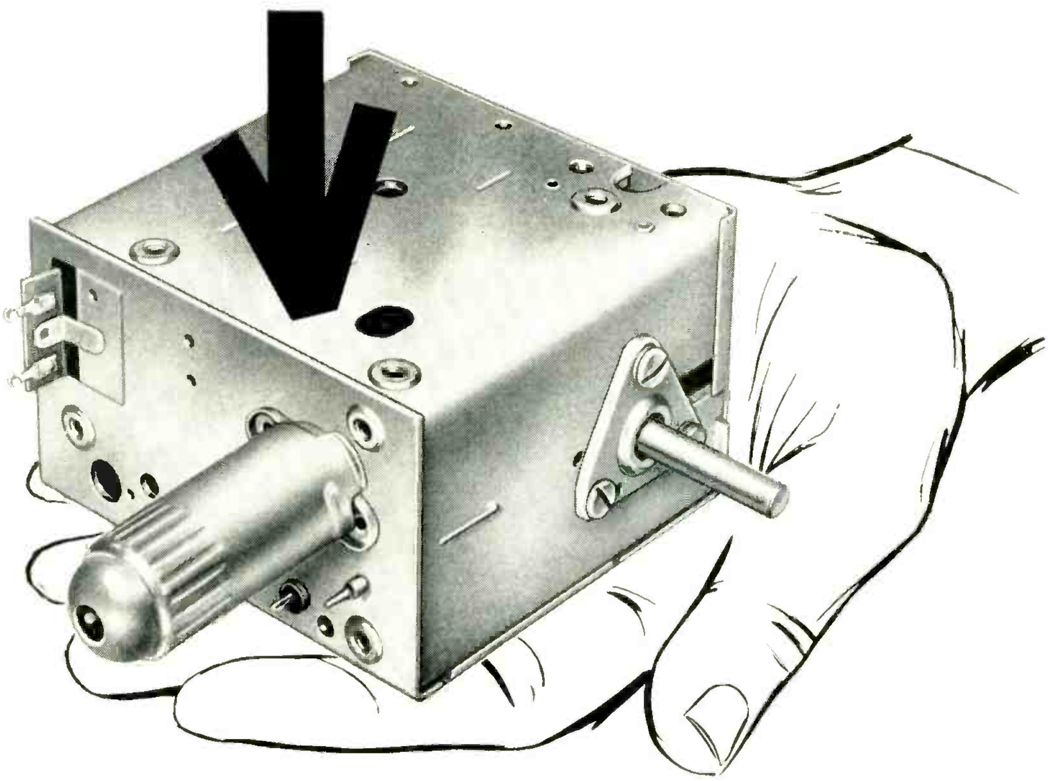


TUBE MACHINE
requires only one operator

CONSOLIDATED VACUUM CORP., 1775 Mt. Read Blvd., Rochester 3, N. Y., announces a new automatic sealing and exhaust machine that can turn out up to 1,800 miniature, subminiature, standard or special tubes per hour. Final operation of machine is flame-polishing of exhaust tip, so that tube is ready for basing. The rotating turret carries 16 pumping heads, having individual pumps all driven by a single 5-hp motor through a planetary gear system. The vacuum achieved is in the range of 1 micron. In 57.5 seconds each tube goes through two revolutions of the turret—once at the lower level for preheating, sealing of envelope to mount and gas-flushing. A cam-operated mechanism then raises the tube to the upper level for pumping, r-f bombardment and tip-off. The machine is 8 ft in diameter and 7 ft high.

PAPER TUBULARS
are ceramic-cased

AEROVOX CORP., New Bedford, Mass. Type P84 CM or Duramics are ceramic-cased paper tubulars intended for engineers, designers and equipment builders seeking per-



NEW

low cost UHF tuner

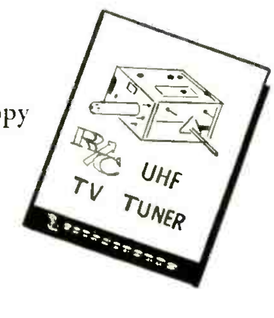
FEATURES OSCILLATOR RADIATION FIXES

Here's famous R/C quality at the lowest price ever! The new T-90 Series uhf t-v tuner meets all RETMA spurious radiation requirements. Yet it costs less than any previous Radio Condenser uhf tuner.

The double-circuit tuned T-90 Series has excellent i-f and image rejection, giving remarkably high selectivity. As indicated by R/C statistical quality control, the noise figure of the new tuner exceeds most requirements, and the drift characteristics are equally good. Field results to date have been uniformly excellent.

If you want information fast on the T-90 Series, we'll be happy to have one of our engineers call at your convenience.

Or, see it at the I.R.E. Show, 780 Airborne Avenue



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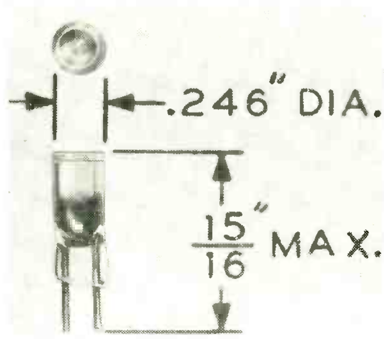
formance above that of conventional cardboard tubulars. The dense steatite casing, with specially-developed end-sealing material, provides exceptional protection against humidity. End-seals firmly adhered to the ceramic tubing, will not soften or flow at any rated temperature. Terminal lead wires will not loosen or pull out with severe handling. Duramics are for an operating temperature of from −55 C to +85 C. Life test is 1½ times rated voltage of 85 C for 250 hours. These units meet requirements of RETMA specification REC-118, high-temperature range, class M capacitors, including the 250-hr humidity resistance test.



LEAD SULFIDE CELL
activates magnetic tape unit

THE CONTINENTAL ELECTRIC CO., Geneva, Ill., has announced development of a new lead sulfide photoconductive cell, the CE705. The new miniature cell, among other applications, is being used extensively in the IBM electronic data processing machine, type 702. These photoconductive cells are used to detect the beginning and end of the magnetic tape.

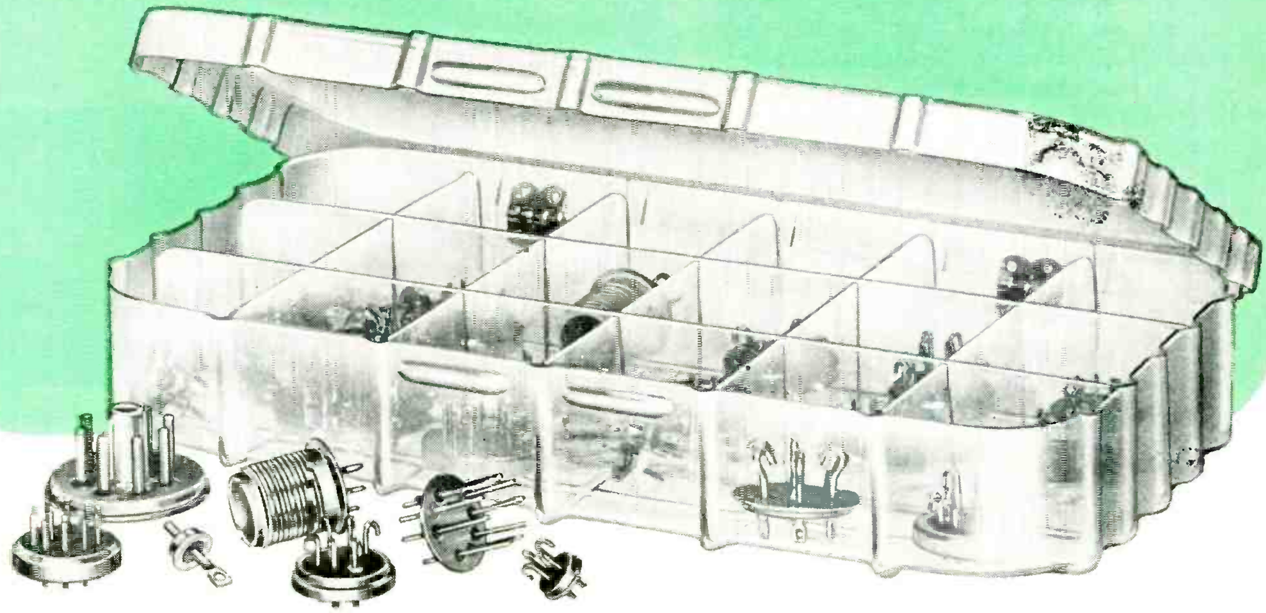
TRANSMITTER RACKS
for heavy-duty use

PREMIER METAL PRODUCTS CO., 3160 Webster Ave., New York 67, N. Y. A line of heavy-duty transmitter racks for 19-in. and 30-in. rack panels are constructed of No. 16 gage sheet steel with a No. 12 gage steel bottom, and welded throughout. Panel mounting angles are 3/16 in. thick and are tapped 12-14 on

Try *Constantin's*

NEW COMPRESSION KIT #3

...for any glass-to-metal sealing problem



Electronic Engineers and Designers . . . we're convinced that you'll find Constantin's new Kit #3 will really help those of you who have not used glass-to-metal vacuum seals before. We're sure that once you try this type of seal you'll find, as thousands of others have, that their performance characteristics will solve many of your present design problems.

The kit contains over two-dozen of the more popular, high-compression glass-to-metal headers, connectors, and terminals. Packed in an attractive, sturdy plastic case, the assortment features hooked, straight, and pierced-flat pin styles. Plug-in types including octals, as well as 7 and 9 pin units to fit the standard R.M.A. miniature and noval sockets, are also contained. The range of header diameters includes the most commonly used sizes from .375″ to over 1.000″. Header and single terminal eyelets include straight-sided, shoulder, and flanged types to satisfy a wide variety of mounting requirements.

These are standard seals, selected from the complete line of glass-to-metal vacuum seals for which L. L. Constantin is famous. Send for your kit today. Only $14.95.

L. L. Constantin & Co.,
Lodi, N.J.

Enclosed is check/money order for______ #3 Compression Kits at $14.95 each.

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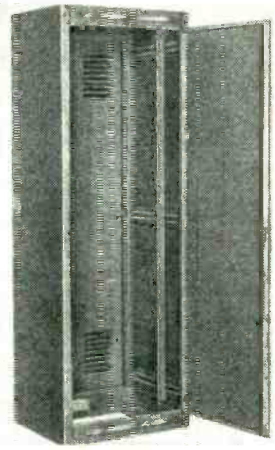


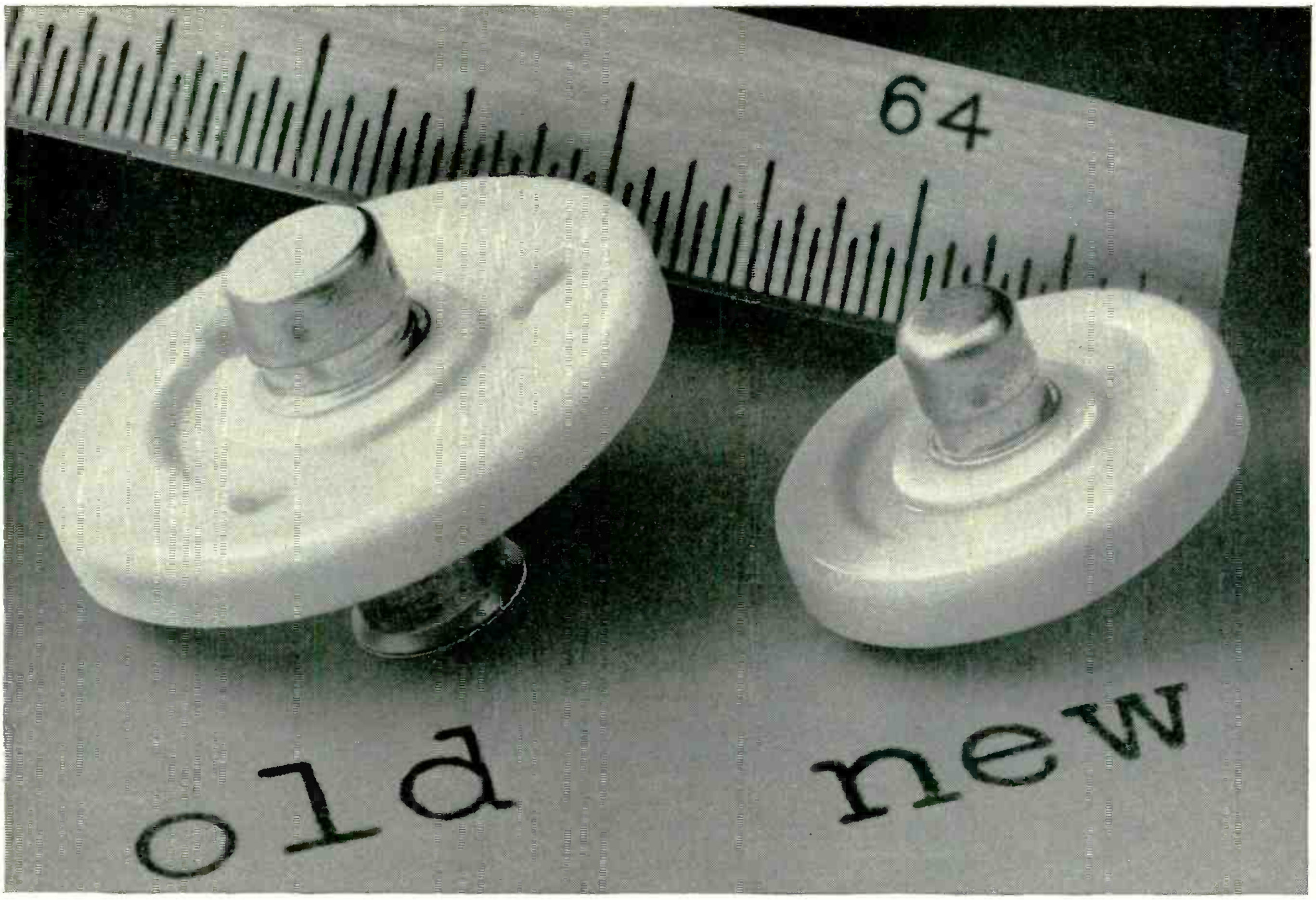
universal spacings. Racks are supplied with or without louvres and are available in 8 sizes—36¾-in., 61¼-in., 70-in. and 77-in. panel spaces in both 18-in. and 24-in. depths.

TAPPED DELAY LINE
is a new 0.5-μsec unit

THE GUDEMAN CO. OF CALIFORNIA, INC., 9200 Exposition Blvd., Los Angeles 34, Calif. Model GDL.5-1K-T9, is a new 0.3-μsec tapped delay line, which is tapped at 0.05-μsec intervals and hermetically sealed in epoxy resin. Impedance is 1,000 ohms. Rise time is 0.05 μsec. Size is 6¼ in. × ⅞ in. × ¾ in., exclusive of terminals.

TERMINAL INSTALLER
is an automatic machine

BURNDY ENGINEERING CO., INC., Norwalk, Conn. The Bandolug machine automatically installs belt-mounted, fully-formed, fully-plated, nylon-insulated compression terminals on flexible cables AN22 through AN14, for stud sizes No. 4 through 5/16. The Bandolug terminals are color-coded for wire size and are mounted on a flexible metal strip wound on disposable reels holding either 1,000 or 3,000 ter-



New miniature disc cathode shank diameter and length are reduced by approximately 25% from the previous model. Ceramic also is about 25% smaller. Concentric groove in ceramic inhibits leakage from sublimation deposits. Magnification 8x.

NEW SUPERIOR TUBE MINIATURE DISC CATHODE SAVES 25% SPACE, UP TO 50% HEATER POWER

Up to now, practically all cathode ray tubes were equipped with disc cathodes as large as the one shown on the left in the above picture. But since the aperture in the first grid of most cathode ray tubes is normally so much smaller than the cap of the cathode, Superior Tube engineers reasoned that the cathode could be smaller and still give as good emission. They were right. The new cathode is shown above.

Think what this means: Tri-gun color TV tubes can have more slender necks. So also can multi-gun special purpose cathode ray tubes. Cost can be saved in the glass, the base, and the socket. Even single gun tubes can benefit. Less metal and ceramic means a lower heater power requirement.

These miniature disc cathodes are available in all regular Superior Tube cathode alloys. Ceramics can be either 0.365″ or 0.490″ dia., with or without breather holes. Cap to ceramic dimensional tolerance (the "E" dimension) guaranteed within ±.0005″.

Ask for a sample quantity of these new cathodes and try them for performance. Write for engineering information. Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.

All analyses .010″ to ⅝″ O.D. Certain analyses in light walls up to 2½″ O.D.

Superior Tube
The big name in small tubing

Radius of Curvature of edge of cap lessens the danger of high temperature "dishing" frequently experienced with large area, sharp edge cathodes. "Dishing" would affect cut-off voltage of tube, require use of more expensive variable resistor in grid circuit. A small flat surface is retained to provide a satisfactory source of emission current.

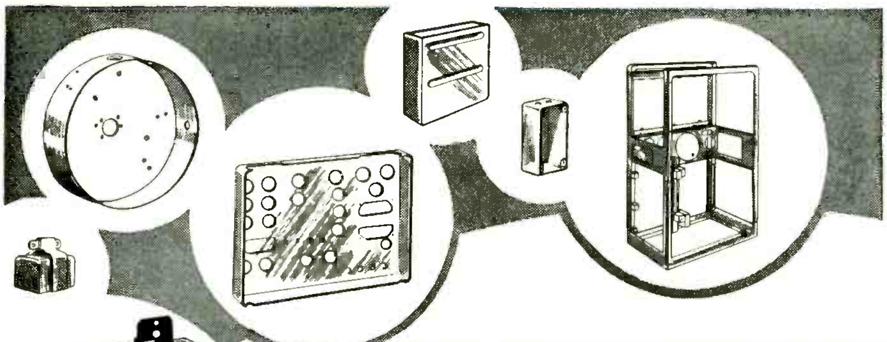
Size Comparison of Color TV Guns. Note how much more compact gun can be with miniature disc cathodes. Permits more slender tube neck.

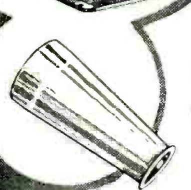
Want more information? Use post card on last page.

minals. The reel may be changed in seconds and the Bandolug belt rapidly guided into the universal die set. The operator merely depresses the single control and feeds stripped wire into the lug barrel. As fast as the machine is fed, an electrical device activates the compression dies and a complete terminal installation is made.

TINY PILOT LIGHTS are fully insulated

DIALIGHT CORP., 60 Stewart Ave., Brooklyn 37, N. Y. The Dialco line of pilot light assemblies now includes a new subminiature series which mounts in a single $\frac{15}{32}$-in. clearance hole and requires no insulating mounts. The socket, lamp and all connections are well-insulated from the mounting bushing by phenolic material of military specification grade. Two terminals are provided for the electrical connections. The mounting bushing may be grounded to the panel, and the integral insulation of the pilot light completely isolates the lamp circuit from ground. This series is designed to employ any of the five





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COMPLETE FABRICATING FACILITIES FOR

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• Heat Treating • Assembly • Anodizing • Finishing

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Stock dies on hand for many shapes.

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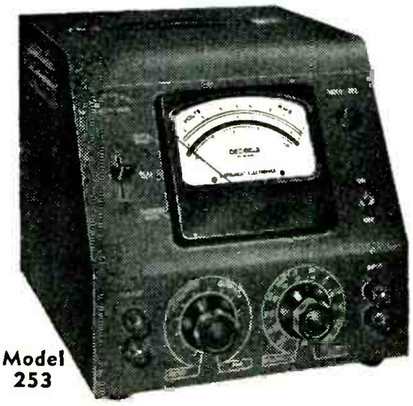
Sensitive Logarithmic
AC VOLTMETERS



Model
253

FEATURING

- Effective isolation of sensitive amplifier stages against shock and vibration.
- Provision for changing linear response of instrument to either narrow band (center frequency 400 CPS—24 DB down at 60 CPS) or to low pass (3 DB down at 1.5 KC and 20 DB down at 5 KC).
- Limiting circuit to protect meter against all overloads within range of instrument.
- Mirror scale indicating meter with two logarithmic voltage scales (10 DB overlap) and one linear DB scale —5 to +15 DB.

All Instruments having 30% scale overlap have narrow bandpass feature

Model	Sensitivity in Volts	Switch Positions	Ranges Overlap	Frequency Response	Input Impedance	Amp. Gain
245 B	.0005-500	6	10%	10C-250KC	7 Megohms 15 MMF	3000
247	.00005-500	13	30%	10C- 50KC	7 Megohms 15 MMF	30000
247 B	.00005-15	10	30%	10C- 50KC	50 Megohms 15 MMF	30000
253	.00015-500	12	30%	5C-300KC	7 Megohms 15 MMF	10000
255	.0005-500	6	10%	10C-1MC	7 Megohms 15 MMF	3000

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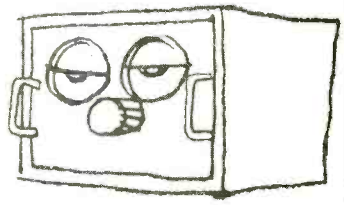
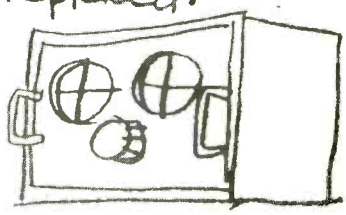
Instrument Electronics Corp. 90 MAIN ST. PORT WASHINGTON, N. Y.

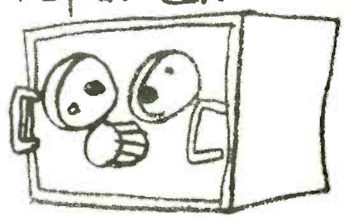
When a component needs to be tested:



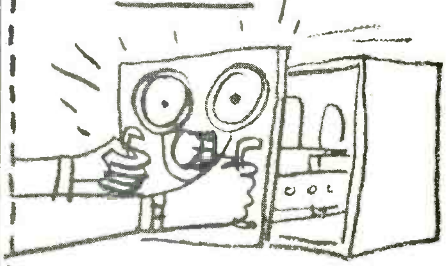
or replaced:



or repaired:



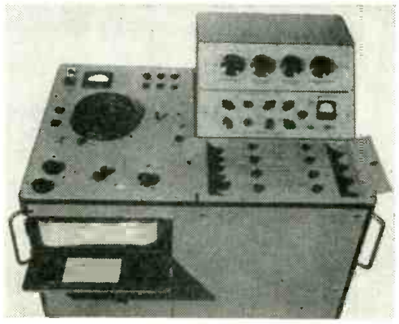
it takes less time if it's mounted on slides:



One second to open... one second to close.

We have a folder that will give you an idea of the scope of Grant Industrial Slides, which we'd like to send you. Write to Grant Pulley and Hardware Corporation, 31-73 Whitestone Parkway, Flushing, N.Y.

Visit us at Booths #301, 303—Radio Engineering Show standard midget flanged base incandescent lamps of voltages 1.3; 2.7; 6.0; 14.0 and 28.0. AN specifications are fully met. Omnidirectional visibility is afforded by the stovepipe-shaped cap of high heat plastic, into which the bulb extends so that its glow is visible from all angles. The series is designated as No. 101-3830-951 and is fully described in bulletin L-156.



VECTORSCOPE
for hospital lab use

TECHNICON CARDIOGRAPH CORP., 215 E. 149th St., New York 51, N. Y. Although the unit illustrated was developed for work in vectorcardiography, its high sensitivity and novel recording technique suggest its application in the recording of l-f nonrepetitive transients. Traces are shown on a dual-beam cro and may be photographed with a built-in 70-mm camera (either paper or film may be used). Eight fixed synchronous speeds from 25 mm per sec to 250 mm per sec are available through a gear shift lever. A 1-mm grid lattice is superimposed on the record during the recording and remains constant at the 1-mm spacing, irrespective of speed. Included are 4 direct-coupled amplifiers with balanced or unbalanced inputs. There are 2 built-in preamplifiers which feature a frequency range of 0.1 cps to 8 kc, a maximum sensitivity of 10 in. per mv, and stepped low and high-frequency filters.

CAPACITOR
is miniaturized, feed-through

ALLEN-BRADLEY CO., 136 W. Greenfield Ave., Milwaukee 4, Wisc., has available tiny discoidal feed-through capacitors that do not ex-

New!

LAMBDA MODEL 71 PORTABLE POWER SUPPLY

WIDE RANGE! 0-500 VDC @ 0-200 MA
LIGHT! Weighs only 49 lbs.
COMPACT! 13" high, 8¾" wide, 14½" deep

A de luxe unit that combines every good engineering feature with maximum compactness and portability.

$289.50 F.O.B. Factory, Corona, N. Y.

A VERSATILE, HEAVY-DUTY PORTABLE WITH BROAD FIELD AND LABORATORY APPLICATIONS

Cannot be damaged by external overloads! No down time! Circuit breakers provide complete protection!

SPECIAL FEATURES

- Overload Circuit Breakers. AC and DC Circuit Protection
- No "Down Time" due to External Overloads
- Stable 5651 Reference Tube
- Vernier High Voltage Control
- Hermetically-Sealed, Oil Filled Condensers
- Time Delay Tube Protection
- All-Aluminum Construction
- Made by America's Leading Power Supply Specialists

SPECIFICATIONS FOR LAMBDA MODEL 71 PORTABLE

INPUT............105-125 VAC, 50-60 CPS, 475 W (max)

DC OUTPUT NO. 1 (regulated for line and load)
Voltage............0-500 VDC (continuously variable)
Current............0-200 MA (over entire voltage range)
Regulation (line)....0.15% or 0.3 volt (whichever is greater)
Regulation (load)....0.15% or 0.3 volt (whichever is greater)
Internal Impedance............Less than 4 ohms
Ripple and Noise............Less than 5 millivolts rms
Polarity............Either positive or negative may be grounded

DC OUTPUT NO. 2 (regulated for line only)

Voltage ranges:	Internal Impedances:
(a) 0-50 VDC (no load)	5,500 ohms
(b) 0-200 VDC (no load)	25,000 ohms

Current range:
Any value of external load impedance may be used including continuous low impedance or short-circuit. Insignificant inter-action on Output No. 1 Short Circuit Current: 9 MA (Max.)
Regulation (line)............Better than 0.1%
Ripple and Noise............Less than 5 millivolts rms
Polarity............Positive terminal connected internally to negative terminal of DC Output No. 1.

AC OUTPUTS (unregulated)
Two outputs, isolated and ungrounded. Each is 6.5 VAC at 5A (at 115 VAC input). Allows for drop in connecting leads. May be connected in series for 12.6V (nominal) at 5A, or in parallel for 6.3V (nominal) at 10A.

AMBIENT TEMPERATURE AND DUTY CYCLE:
Continuous duty at full load up to 40°C (104°F) ambient.

OVERLOAD PROTECTION:
External overload protection......AC and DC magnetic circuit breakers. Trip-Free. Instant manual reset. Front panel.
Internal failure protection..........Fuses, access through rear of cabinet.

INPUT AND OUTPUT CONNECTIONS:
Input............8 foot heavy duty rubber covered line cord with integral molded plug, rear of cabinet.
Output............Sturdy insulated "5-way" binding posts, front panel.

METERS:
Output voltage............Multi-range 3½" rectangular voltmeter calibrated 0-50 VDC, 0-200 VDC, 0-500 VDC.
Output current............3½" rectangular milliameter calibrated 0-200 MA.

VOLTAGE REFERENCE TUBE:
A stable 5651 reference tube is used to obtain superior long-time voltage stability.

TIME-DELAY RELAY CIRCUIT:
A 30 second time delay circuit is provided to allow tube heaters to come to proper operating temperature before high voltage can be applied.

SIZE AND WEIGHT AND FINISH:
Size............13" H x 8¾" W x 14½" D
Weight............49 lbs.
Finish............Two-tone gray

LAMBDA Electronics Corp.

THE FIRST NAME IN POWER SUPPLIES

103-02 NORTHERN BLVD. • CORONA 68, NEW YORK • TWINING 8-9400

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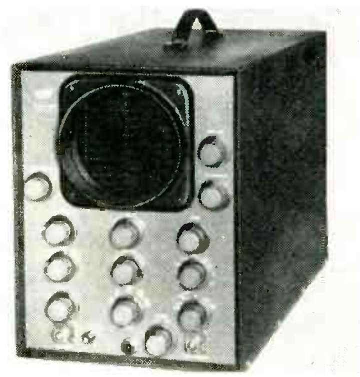
hibit such resonance effects as ordinary feed-through capacitors at frequencies of 1,000 mc or less. Absence of the parallel resonance effects and the relatively high capacitance values with resultant low coupling impedances make them ideal for uhf tv receiver applications. Measurements have shown improvements in filtering of more than 20 db through their use. Capacitance values are between 1,000 $\mu\mu$f and 2,000 $\mu\mu$f for all usual operating temperatures; insulation resistance, in excess of 10,000 megohms. Rated continuous working voltage is 500 v dc; Hi-pot test, 1,250 v d-c.



OSCILLOSCOPE
with identical amplification

CROSBY LABORATORIES, INC., Box 233, Hicksville, L. I., N. Y. Model 320 wide-band oscilloscope uses identical horizontal and vertical amplifiers which allow phase shift indication for frequencies up to 5 mc. The high deflection sensitivity of 35 mv rms per in., from 10 cycles to 5 mc on both amplifiers, is another feature. This general-purpose, high-gain instrument is particularly designed for color tv measurements.

VARIABLE TOROIDS
in two miniature types

BURNELL & CO., INC., 45 Warburton Ave., Yonkers 2, N. Y. The Rotoroid variable toroid inductor is now available in two miniature types, the VTI-C and VTI-D. Ranges of nominal inductance are 0.001 to 3.2 henrys for the VTI-C and 0.00032 to 0.5 henry for the VTI-D. As normally furnished, the inductance

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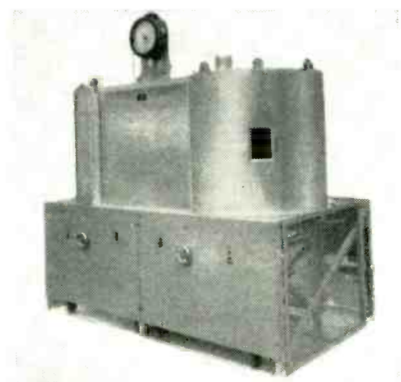
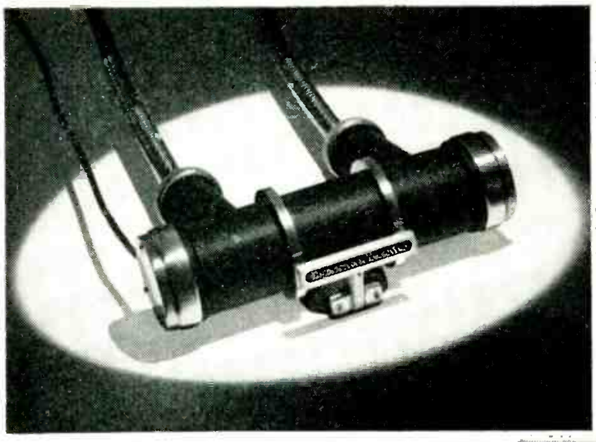
range for any individual Rotoroid is from 50 to 150 percent of the nominal value. Inductance variation in the Rotoroid is obtained by the rotation of one of a pair of permanent magnets placed on apposite sides of the winding. As a result, no external d-c power is required for biasing, the inductance variation with rotation of the control knob is nearly linear, and high Q and low harmonic distortion are preserved even with extreme variation of inductance.



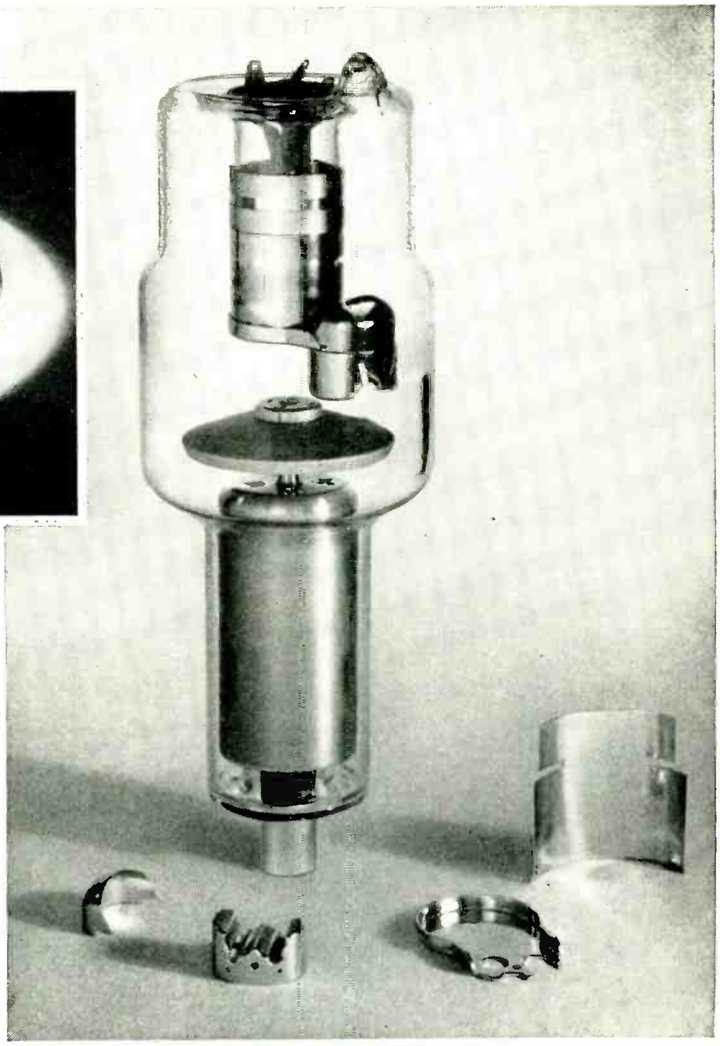
SCREEN BAKE OVEN
for tv tube manufacturers

MICROTRONICS, INC., Porete Ave., No. Arlington, N. J. This gas-fired screen bake, oven, semiautomatic in operation, is designed to give the small tube manufacturer high production and exacting quality control in the manufacture of c-r tubes. Compact in size, measuring $4\frac{1}{2}$ ft × 8 ft × 7 ft, the screen bake oven will accommodate two tubes up to 30-in. size in one operation. The unit, recommended for use in manufacturing color or black-and-white tubes, is equipped with an auto-



Assembled view of Machlett Dynamax 20-DF rotating anode X-ray tube and mounting.

Why Machlett chooses Nickel for nearly 400 X-ray tube parts



Dynamax 20-DF (Double Focus) — X-ray tube manufactured by Machlett Laboratories Inc. uses pure Nickel for cathode head and parts connected to it. Nickel parts are easy to fabricate, stand rugged service.

Today, free X-ray clinics sometimes take as many as 1200 exposures in a six-hour day.

Until recently, this was an impossible task. Every exposure means that millions of electrons have been focused in an ideal pattern at the nickel cathode head, then slammed against a tungsten target, spinning in a vacuum. The heat at the target is so intense that the target metal would melt or vaporize if the anode were not rotating.

The sharp focus of these tubes, says the manufacturer, depends upon accuracy of the contours and dimensions of the nickel cathode head, as well as on placement of the filament within the focussing slots.

Resistance to high temperatures, and retention of critical dimensions are important reasons why Machlett Laboratories, Springdale, Conn., specified Inco Electronic Grade "A" Nickel for this cathode head . . . and for nearly 400 other X-ray tube parts, too!

Nickel not distorted by high temperature

For Machlett's tube designers know how much Inco Nickel contributes to longer tube life. Nickel's high temperature strength and low vapor pressure are essential in maintaining a vacuum over a wide range of temperatures. Nickel's resistance to oxidation, moderate expansion, and ready fabrication aid in processing and holding the precise tolerances needed for these critical tube parts.

Nickel's very easy to work with too.

In tube production Inco Nickel is readily out-gassed at high temperatures . . . easily *formed* and *welded* into sturdy tube parts, despite intricate design.

When you need metals that perform better longer . . .

When you have a metal problem — a part that should last longer or perform better — think of Inco Nickel and Inco Nickel Alloys. And write Inco's Development & Research Division for helpful information on where *you* may improve a design or end a production difficulty by using these metals.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK **NICKEL ALLOYS**

MONEL® • "R"® MONEL • "K"® MONEL
"KR"® MONEL • "S"® MONEL • INCONEL®
INCONEL "X"® • INCONEL "W"®
INCOLOY® • NIMONIC® Alloys • NICKEL
LOW CARBON NICKEL • DURANICKEL®

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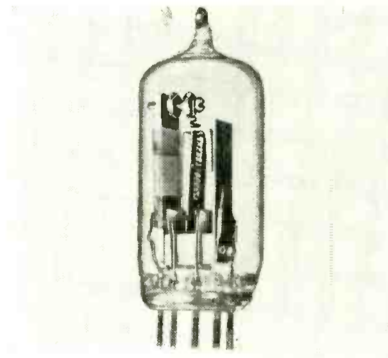
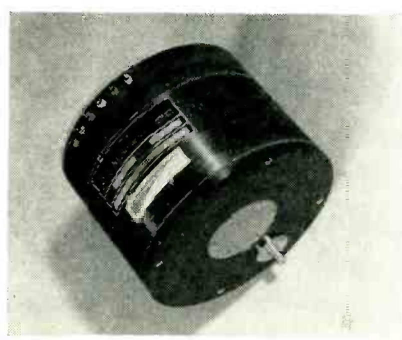
matic temperature program controller which can be set for any desired operation. A heat exchanger built into each unit allows heated air at controlled temperatures to be distributed into the tubes during baking operation eliminating moisture staining.



TIME DELAY RELAY
features snap action

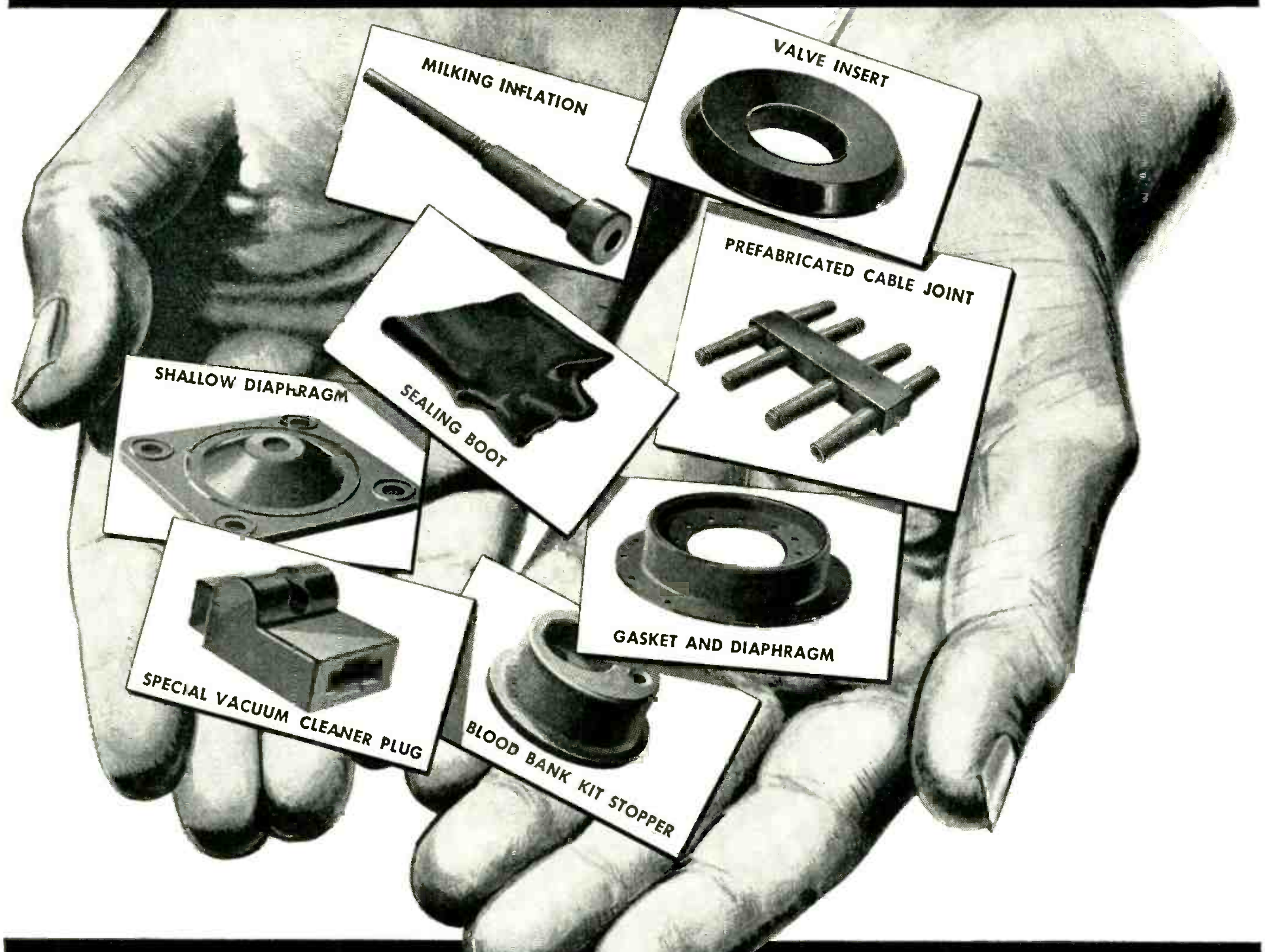
ELLY ELECTRONICS CORP., 22–02 Raphael St., Fairlawn, N. J., announces a new commercial type G series snap action thermal time delay relay in a 9-pin miniature glass envelope. These relays feature spdt contacts, time delays preset from 5 seconds up, and ambient temperature operation from −60C to +80 C. They are available in 6.3, 26.5 and 115 v a-c or d-c heater ratings. Other features are small size, light weight, low operating temperature, operation in any position, high contact rating, consistent time and long life. Height of the relay is 1½ in.



POTENTIOMETER
is a dual cosine unit

GYROMECHANISMS, INC., Halesite, L. I., N. Y. Model No. 35,000 dual cosine potentiometer has an accuracy of 4 parts in 10,000. It con-

Rubber in the right hands



can do wonders!

AVAIL YOURSELF OF THE SKILL, ENGINEERING ADVICE, SPECIAL COMPOUNDS AND PRECISION MOLDING OF UNITED STATES RUBBER COMPANY.

★ A maker of milking inflations picked "U. S." molded rubber—because of its flexing characteristics (up to 400 hours in a flexing cycle test—where normal requirement is a 100 hour test.)

★ A utility company selected "U. S." molded rubber cable joints because "U. S." could fabricate an entirely *uniform* wall thickness in an extremely complex design. The high dielectric resistant compound provides top safety.

★ A lawn mower manufacturer cut labor time of treading from 7 minutes to 49 seconds—just by specifying "U. S." molded-drive roller rubbers.

These are only a few of the hundreds of applications wherein U. S. Rubber's molded rubber works wonders. In the hands of "U. S." technicians, molded rubber becomes a basic material that will *do jobs no other material can do.* "U. S." research stockpiles, nationwide facilities and laboratories are joined with "U. S." experts in tackling any molded rubber goods problem quickly—and from every angle. Let "U. S." show you what it can do with molded rubber.

Get in touch with United States Rubber Company's Molding and Extrusions Department through address below.

"U. S." Research perfects it . . . "U. S." Production builds it . . . U. S. Industry depends on it.

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MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

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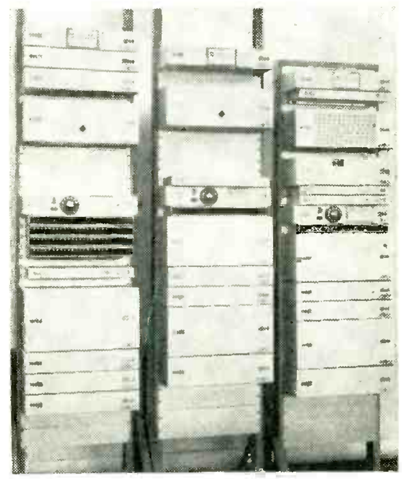
sists of two electrically isolated potentiometers driven from the same shaft, with individual output proportion to the cosine (θ/36-75 deg), where θ is the shaft rotation. For any given position of the input shaft, model No. 35,000 gives a voltage output within 0.0004 of the correct output at that point. It is available with resistance values as high as 200,000 ohms. Range is +75 to −75 deg, which may be extended to −90 to +90 deg. Temperature range is −65 to +71 C. The potentiometer, which weighs 4.2 lb, is housed hermetically sealed in nitrogen atmosphere, in a case of anodized aluminum. It is expected to find wide commercial and military application, particularly in control processes, computers, servomechanisms and telemetering because of its high accuracy.



CONTROL SYSTEM
for remote equipment

LENKURT ELECTRIC CO., San Carlos, Calif., has developed the type 51B system that provides for two essentially independent functions: (1) a means for supervising conditions at remote locations from a control center, and (2) a means for controlling operations of equipment at the remote locations from the control center. Information for both functions consists of d-c pulses translated into tone signals for transmission over any suitable wire or radio circuit. The system can supervise as many as 80 remote conditions and control up to 90 remote operations. Eight or more remote locations can be associated

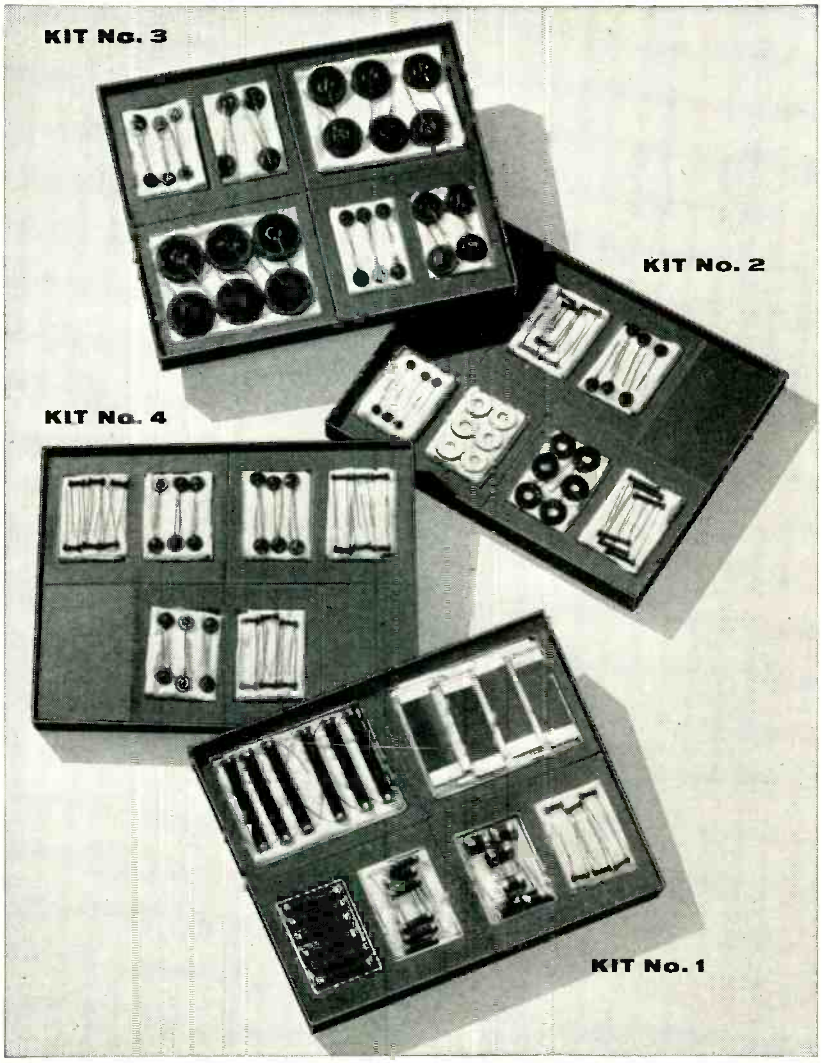
NEW!

GLOBAR®

THERMISTOR-VARISTOR

TEST KITS

for evaluating your circuitry problems



These new Test Kits of GLOBAR® Ceramic Varistors and Thermistors offer the most favorable combination of properties to satisfy all circuit requirements . . . give you a most economical means of evaluating your circuitry problems—and finding the answers. Widest range of characteristics within each kit—at a minimum investment.

KIT No. 1 PRICE $29.25

Type F THERMISTORS

- To evaluate series filament circuit applications in radio and television receivers.

Quantity	Cat. No.	R @ 25°C	R @ Rated Current	B Constant	Load Watts
6	763	15		1500	0.5
6	441	880	100 ohms @ 150 ma	1900	2.7
6	341	375	40 ohms @ 300 ma	1950	3.6
6	525	250	20 ohms @ 600 ma	1900	7.2
6	327	460	35 ohms @ 600 ma	1900	12.6
6	421	125	43 ohms @ 600 ma	1100	16.5

KIT No. 2 PRICE $24.50

Type H THERMISTORS

- To evaluate time delay in relay and solenoid circuits; stabilization of television oscillator circuitry during warm-up.

Quantity	Cat. No.	R @ 25°C	B Constant	Load Watts
6	416	1200	3200	0.7
6	479	1000	3800	1.85
6	373	10	2700	3.0
6	343	20	2700	3.0
6	549	5000	3200	1.5
6	588	11000	3200	2.0

KIT No. 3 PRICE $20.00

Type BNR VARISTORS

- To evaluate reduction of surge voltage peaks and contact arcing; stabilizing voltage and amplifier gain.

Quantity	Cat. No.	R @ Calibration Voltage	Load Watts
6	432	100000 @ 10 volts	0.25
6	479	100000 @ 100 volts	0.3
6	328	10000 @ 40 volts	0.5
6	463	24000 @ 40 volts	1.0
6	524	24000 @ 100 volts	1.5
6	430	17500 @ 175 volts	2.7

KIT No. 4 PRICE $18.25

Type F, Type BNR VARISTORS and THERMISTORS

- A selection of smaller size thermistors and varistors for overall usage evaluation.

Quantity	Type BNR Cat. No.	R @ Calibration Voltage		Load Watts
6	432	25000 @ 10 volts		0.25
6	432	100000 @ 10 volts		0.25
6	432	200000 @ 10 volts		0.25
	Type F Cat. No.	R @ 25°C	B Constant	Load Watts
6	763	15	1500	0.50
6	763	120	1750	0.50
6	763	330000	2150	0.50

EACH KIT CONTAINS 36 resistors—6 of each specified type, packaged in attractive transparent plastic boxes. Pertinent engineering bulletins giving detailed engineering data are sent with each kit. Kits will be shipped postpaid to any point in the United States and Canada.

ORDER YOUR KITS NOW...

use this Handy Coupon

THE CARBORUNDUM COMPANY
Dept. E 87-54, Niagara Falls, New York
Please ship kits as follows:

______ No. 1 (Quantity) ______ No. 2 (Quantity)

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☐ Check enclosed (to which we have added applicable local tax)

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Please send FREE engineering bulletin on Kit No.____

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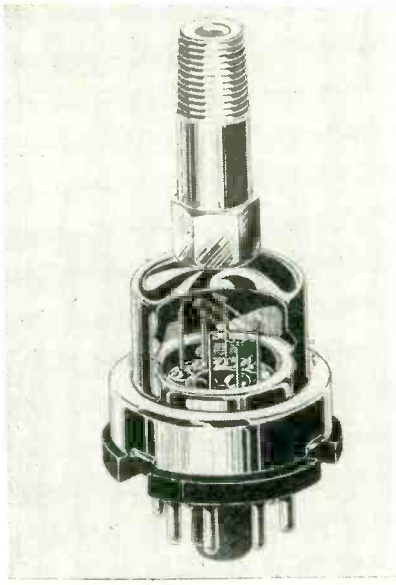
with each control center. Additional information is available from the company.



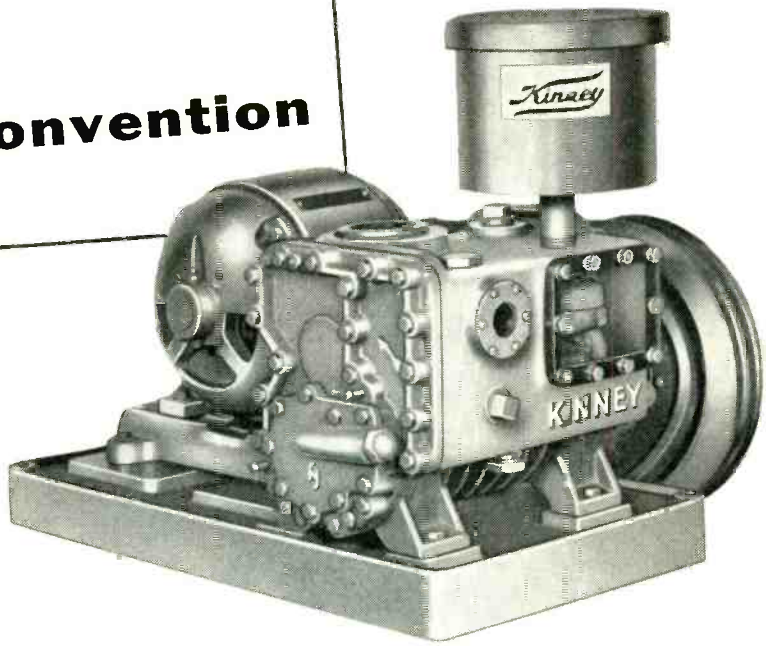
VACUUM-GAGE TUBE withstands shock, vibration

HASTINGS INSTRUMENT CO., INC., Hampton, Va. The vacuum gage tube illustrated is designed to retain permanent calibration while withstanding intense vibration, shock and temperature change. Sensing elements of the gage tube are short, butt-welded noble metal thermocouples. The couples are arranged in a thermopile so as to compensate for temperature changes and even rate of change in temperature. Welded construction makes the gage tube particularly resistant to damage by vibration. The gage tubes described respond in 0.5 sec.

SENSITIVE RELAY has thorough wiping action

HEDIN TELE TECHNICAL CORP., 640 W. Mt. Pleasant Ave., Livingston, N. J., has announced a new development in relays combining high sensitivity with thorough wiping action on each contact. Relay 100-B

See us at the 1955 IRE Convention



We'll be in Booth 90 at the Kingsbridge Palace, from March 21 to March 24 . . . ready to discuss the many new features of Kinney High Vacuum Pumps with you.

controlled gas ballasting

Kinney Pumps can now be equipped with the Kinney Controlled Gas Ballast valve . . . it prevents vapors from condensing within the pump . . . keeps oil clean for continuous operation. Kinney design *controls* the amount of gas ballasting air for maximum pump efficiency.

reduced vibration

Kinney dynamic balance has reduced vibration on compound pumps to an acceptable amount for all practical purposes. These pumps are ideal for use on such applications as dollies and carts.

Feature for feature, no other vacuum pumps can match Kinney. Bring us your vacuum problems. Our district offices in Boston, New York, Philadelphia, Cleveland, Chicago, and Los Angeles are all competently staffed to discuss vacuum problems with you. SEND COUPON FOR FULL DETAILS.

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Please send Bulletin V54 describing the complete line of Kinney Vacuum Pumps.

Name..............................

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Address..............................

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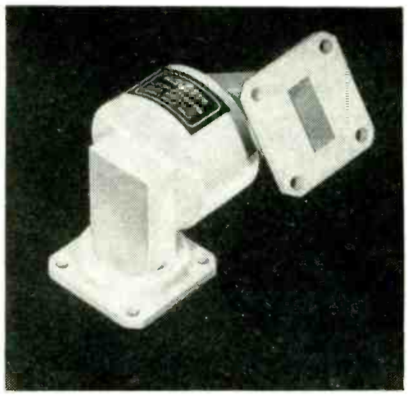
is available hermetically sealed or with dust cover. Features are highlighted by its low wattage consumption of only 25 mw per contact together with a genuine wiping action. Designed for d-c applications, it has the advantage of a very long operating life. Capacity is up to 1-ampere inductive and 3-ampere resistive load with coil resistance to a maximum of 30,000 ohms. Relays are available in spst up to dpdt contacts. The effect of residual magnetism and iron aging are eliminated by nonferrous metals and hydrogen annealing of the magnetic components. Hermetic sealing is done exclusively by welding. Diameter is $1\frac{1}{4} \times 3\frac{5}{8}$ in. above mounting line.

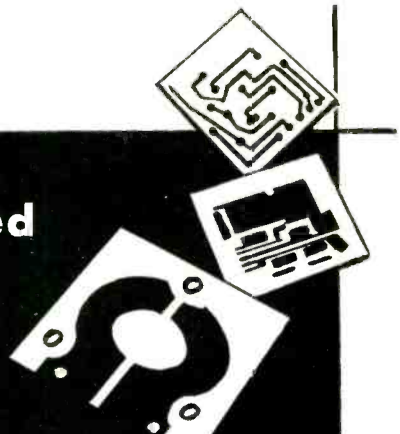


ROTARY JOINT for X-band systems

LITTON INDUSTRIES, 336 N. Foothill Road, Beverly Hills, Calif., has available a new rotary joint designed for operation in 250-kw X-band systems. It eases antenna packaging problems where space is at a premium. A maximum vswr of 1.15 is maintained over the 8.6 kmc to 9.6 kmc band, and variations of vswr and phase with rotation are negligible. It is available with either RG51/U or RG52/U waveguides.

CONTACT METER has many applications

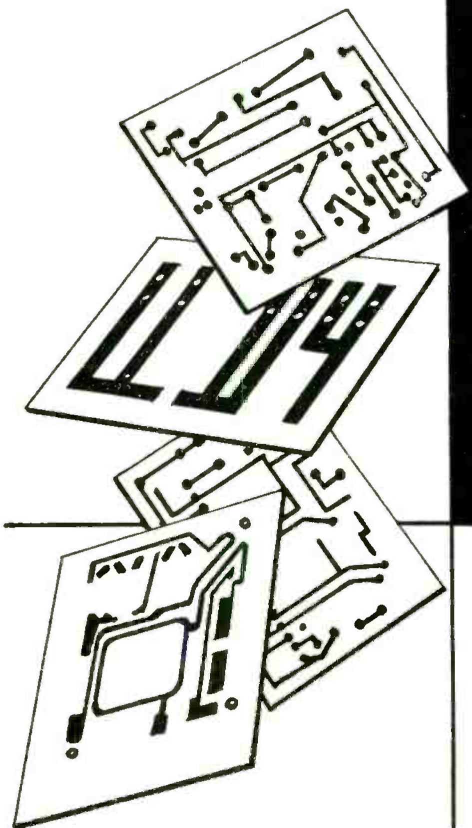
LARSON INSTRUMENT CO., 24 Orchard St., Tarrytown, N. Y. Model MR contact meter is a precise instrument, which continuously indicates any electrical variable and provides reliable accurate high or



For superior printed or etched circuits use copper-clad

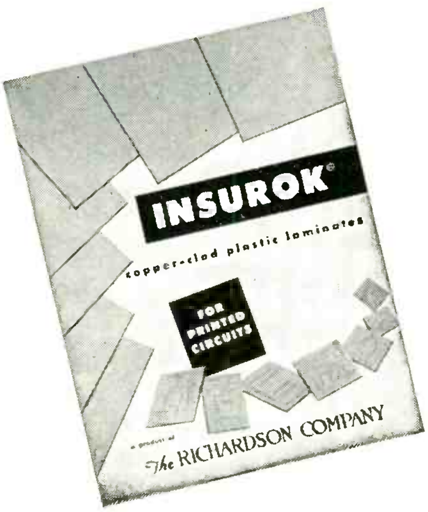
INSUROK T-725 and T-812

plastic laminates



ASK FOR BULLETIN ON COPPER-CLAD

INSUROK®



For printed circuits, the important consideration is the laminate base since other characteristics are often similar. In buying printed circuits, therefore, it pays to insist on the best —INSUROK T-725 or T-812—because of their outstanding electrical properties which remain remarkably stable under repeated temperature and humidity cycling.

Laminated INSUROK Grades T-725 and T-812 have made history ever since they were first introduced to the electronics industry. Possessing a unique combination of properties, they have been used successfully for many years in critical high-frequency applications.

INSUROK T-725 and T-812 have high physical strength and low cold flow, and are readily punched into intricate shapes. Richardson also furnishes copper-clad INSUROK in many other grades, in addition to T-725 and T-812.

Experienced Richardson engineers will gladly assist you in the selection and application of copper-clad INSUROK . . . write or phone your nearest Richardson sales office today.

The RICHARDSON COMPANY

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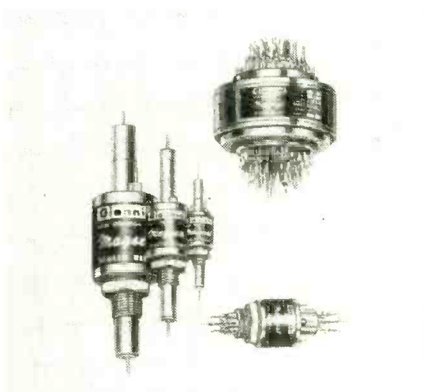
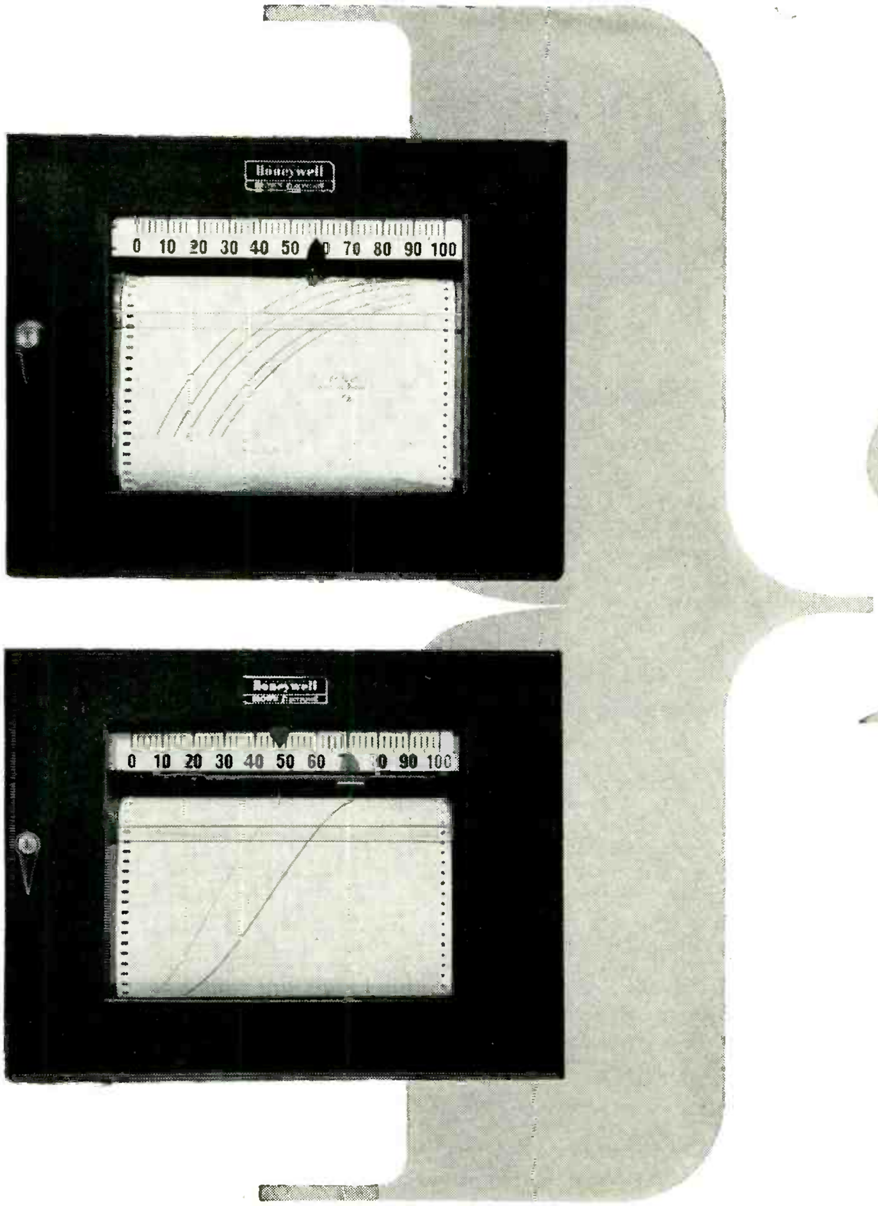
low-limit control. It can also be used as a continuous control with automatic reset. High or low-limit contacts are furnished to indicate the point of operation. No magnetic contacts or locking coils are used. Reset can be remote and does not require manual lever or solenoids. The portable controller is also furnished for wall or panel mounting. It has countless applications where reliable high or low-limit contact or ultrasensitive control is required.



CONTACT RELAYS
have compact construction

G. M. GIANNINI & CO., INC., 918 E. Green St., Pasadena 1, Calif. Made by enclosing two magnetic cylinders in a sealed envelope and causing them to contact each other by bringing a magnetic field into close proximity, thus closing a preset gap between the cylinders, the new Magseal relays are characterized by a very compact construction and a large variety of operational characteristics. Because of their long life (1 billion cycles) and high switching rates (up to 60 cps), these relays can be used in high-speed switching applications. Single and multiple element units (up



2 time-saving instruments for research men

The *Electronik*® Function Plotter

... Automatically produces a continuous curve of x = f (y). Eliminates time and possibility of error in transcribing data into the form required for analysis. Independent measuring systems actuate the pen and the chart.

The Duplex Function Plotter

... A two-pen model of the Function Plotter, which records two variables as a function of a third, or x, x′ = f (y). The three inputs can be different calibrations, since the measuring circuits are completely independent. This model gives two distinct curves ... does the work of two instruments simultaneously.

Both versions of the Function Plotter are standard instruments. They're an economical investment which can be repaid quickly in saving of scientist's time, in acceleration of critical research projects, and in reduction of manual errors. Both are readily adapted to such uses as recording antenna radiation patterns, vacuum tube characteristics, transistor operation, temperature-viscosity curves, and literally innumerable other research applications.

For a discussion of your specific requirements, call your local Honeywell sales engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

• **REFERENCE DATA:** Write for Data Sheets No. 10.0-5a and 10.0-17.

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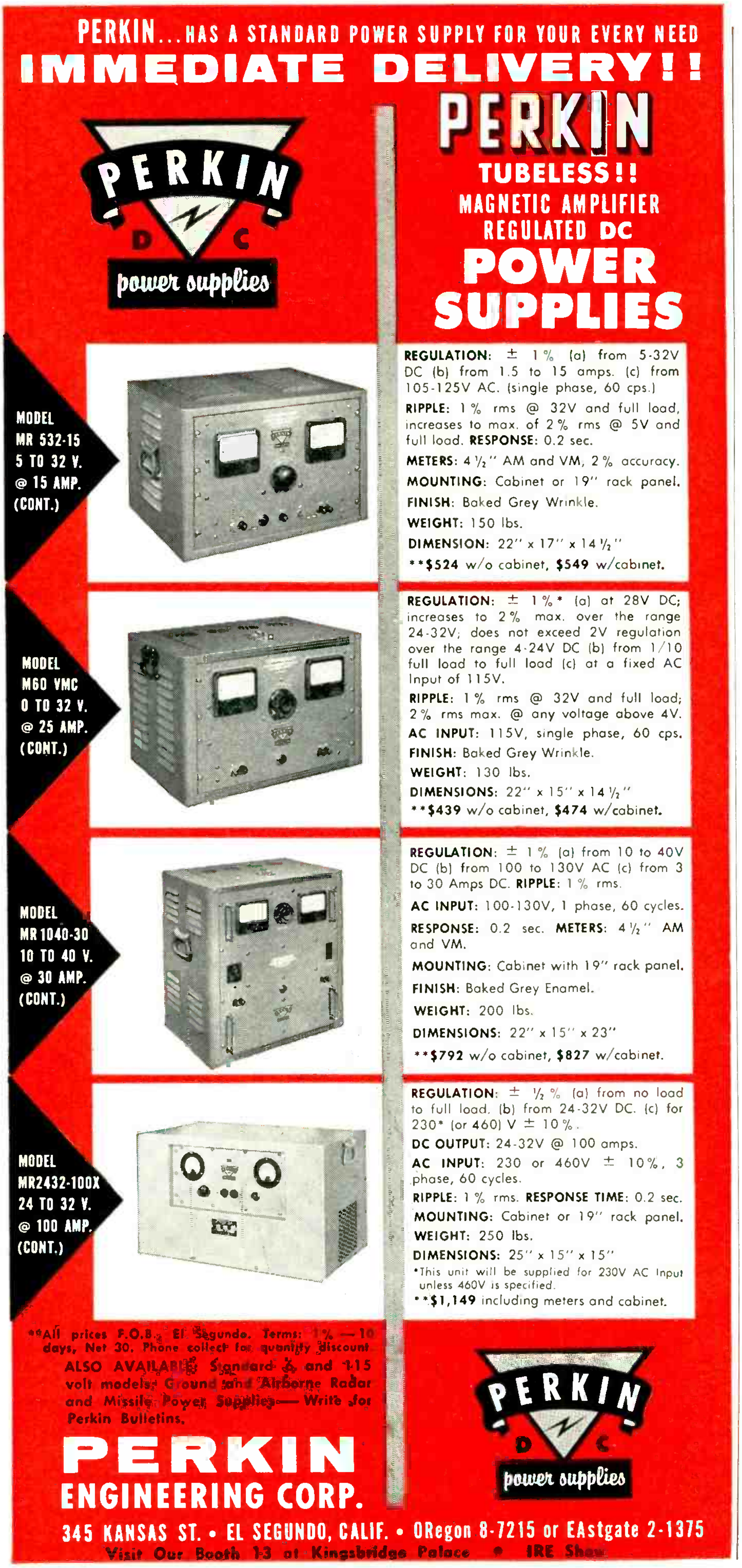
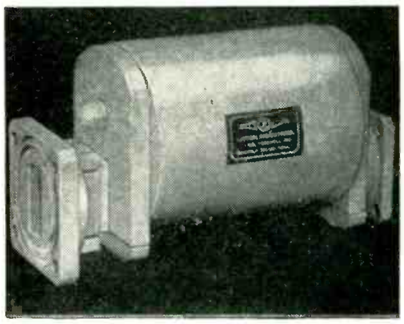
Honeywell
BROWN INSTRUMENTS

H HONEYWELL *First in Controls*



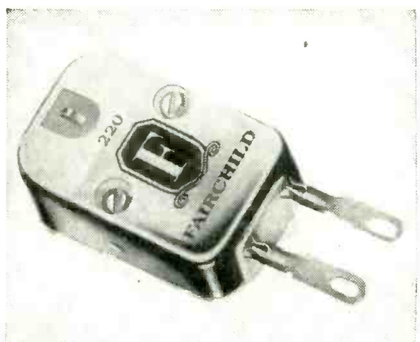
to 109 contacts) are available, and simultaneous contact closure on multiple element units is within 1 millisecond.



LOAD ISOLATOR

for system applications

Litton Industries, 336 No. Foothill Road, Beverly Hills, Calif. Model X100 ferrite load isolator, designed for system applications, makes it possible to operate high-power magnetrons and klystrons into long lines or high vswr's without the usual adverse effects. This isolator is particularly valuable in tunable systems. Model X100 provides a minimum attenuation of the reflected wave of 9 db while attenuating the forward wave 1 db or less by utilizing the nonreciprocal absorption properties of ferrites at microwave frequencies. It is designed to operate with magnetrons and klystrons covering the band of 8,600 mc to 9,600 mc and at power levels of 100-kw peak and 100-w average.



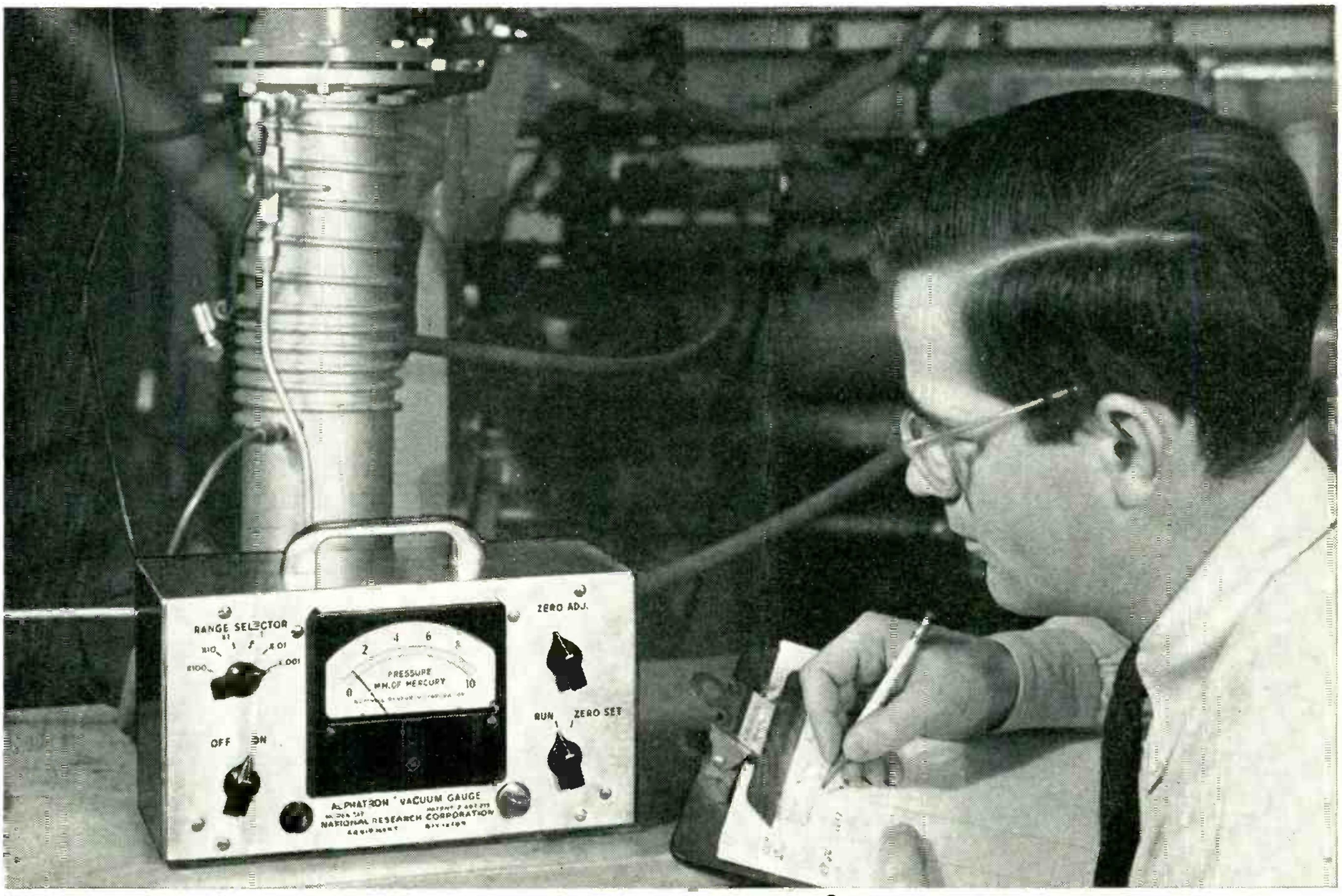
MAGNETIC CARTRIDGE

for high-fidelity use

Fairchild Recording Equipment Co., 154th St. and 7th Ave., Whitestone, N. Y. Based on the high compliance moving coil principle, the series 220 cartridge has higher

How to Measure Vacuum from 1000 to .0001 mm. Hg.

with One Trouble-free Gauge...Quickly...Easily...Accurately



The AC-operated Model 517, newest of the Alphatron® Vacuum Gauges, with 6 ranges covering pressures from 1000 to .0001 mm. Hg. **Price: $425.**

For a combination of instantaneous response, high continuing accuracy, long trouble-free life and simple operation, the family of Alphatron® Vacuum Gauges has never been equalled. These gauges are also finding increasing use as efficient, low cost leak detectors.

Now the Model 517 Alphatron Vacuum Gauge provides accurate measurement over the widest range of any AC-operated vacuum gauge. It has a linear response with unusually high stability, and provides a connection for a recorder or controller.

Also just out—the AC-operated Model 515 Alphatron Vacuum Gauge has a single logarithmic scale covering the range 10 to .001 mm. Hg. Price: $225.

Send for Data Sheets on these new Alphatron Vacuum Gauges and on our complete line of vacuum gauges and accessories.

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NRC
NARESCO EQUIPMENT CORPORATION

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Equipment Sales Subsidiary of National Research Corporation
43 Charlemont St., Newton Highlands 61, Mass.

Please send me Data Sheets as follows: ☐ Model 517 Alphatron® Vacuum Gauge ☐ Model 515 Alphatron® Vacuum Gauge ☐ All other NRC Vacuum Gauges

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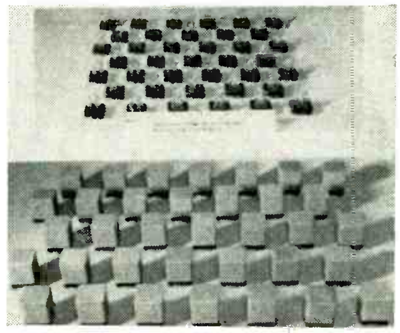
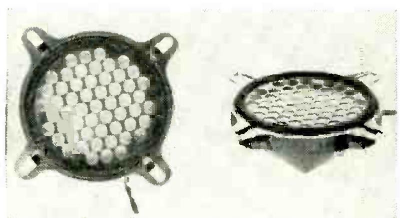
compliance and improved characteristics. Frequency response flat to 17,000 cycles with a very gradual roll off results in a cartridge with constant overall response over the entire audio range. A 4 to 6-db increase in signal level simplifies installation in any high-fidelity system. Models of the series 220 are available for either microgroove or 78-rpm records.



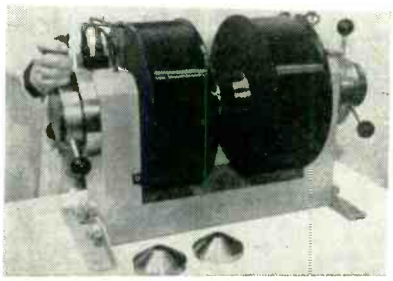
CASTING RESIN
features excellent adhesion

Emerson & Cumming, Inc., 869 Washington St., Canton, Mass., has announced a 2-part casting resin that is easy to use and requires no additional catalyst. Stycast 2340M has excellent electrical and mechanical properties. Warming the two components to about 125 F results in an easy-to-mix and easy-to-pour material that quickly cures to a tack-free, brown, opaque resin that is very tough but quite flexible. Its adhesion to metals, plastics and glass is featured. It is easily machined and is usable over a temperature range of −100 F to −400 F without loss of physical or electrical properties.



LOUDSPEAKERS
of the electrostatic type

A.R.F. Products, Inc., 7627 Lake St., River Forest, Ill. Two sizes of electrostatic loudspeakers, suitable for reproduction in the audible range of 7,000 to 15,000 cycles, are now available. They are characterized by their relatively low capacitance of 900 and 1,800 $\mu\mu$f respectively. They are capable of handling the power output of a single pentode stage and can be operated satisfactorily in push-pull systems with the proper circuitry. They must be fed through crossover networks which attenuate the audio output below 7,000 cycles to provide optimum conditions for minimum distortion, and should be matched with one or more cone speakers of complementary efficiency and fidelity to obtain a complete wide range reproducer at low cost. Physically they are 2¾ in. and 5 in. in diameter and 1½ in. and ¾ in. deep respectively.

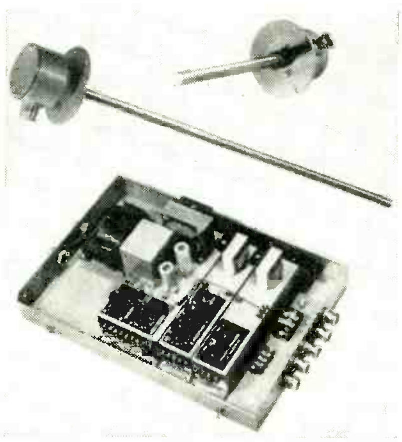


LABORATORY MAGNET
for widespread application

VARIAN ASSOCIATES, 611 Hansen Way, Palo Alto, Calif. The V-4004 laboratory electromagnet has two fixed energizing coils with adjustable poles and readily changeable pole caps. A wide range of field contours can be set with ease. By a simple adjustment of each pole, any air gap width up to 4.3 in. can be achieved. A variety of cylindrical, conical or specially-shaped pole caps are available for wide choice of flux patterns. A gap field flux density as high as 28,600 gauss can be attained.

FLEXIBLE COATING
cures at room temperatures

RADAR RELAY INC., 2260 Westwood Blvd., Los Angeles 64, Calif. Micro-Lite ML88 is a new type coating with excellent dielectric properties that cures at room temperatures and may be applied by brushing, spraying or dipping. Tests have disclosed the material to have a dielectric strength of 1,000 v per mil, with isolated tests showing as much as 2,000 v per mil. High and low-temperature characteristics are excellent, with no cracking or breaking under flexing at −65 F. A fully cured film may be intermittently subjected to 400 F without deformation. The ML88 has a wide range of applications including encapsulating resistors, transformer windings and relay coils. The material's ability to cure at room temperatures makes it useable with components unable to withstand the high temperatures required to cure other encapsulating compounds. It is available in ¼, ½ pint, pint and quart containers together with a small can of necessary catalyst.



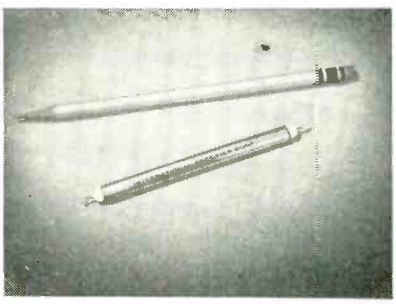
CONTROL SYSTEM
with thermistor elements

THERMOCONTROL INST. CO. LTD., 2-10 Valentine Place, London, S.E.1, England. Series E9 electronic compensated control equipment with thermistor temperature detectors is designed for temperature control for heating, ventilating and air conditioning. The system is designed on the principle of the Wheatstone bridge circuit and, according to the temperature at the various measuring points, the voltages from the bridges add or subtract to a resultant voltage which, via the electronic relays, positions the controlling unit.

POTENTIOMETER
for commercial applications

THE GEORGE W. BORG CORP., Janesville, Wis., announces a new pre-

cision 10-turn Micropot potentiometer for commercial applications. The 1100 series Micropot is specifically designed for original equipment manufacturers of precision electrical devices. Lead wires are provided instead of terminals. This permits greater flexibility of application and added ease of installation without changing the present wiring system. Rear shaft extension is optional for both single units and ganged installations. The shaft is firmly supported on two bearings located at either end. Standard resistance values are from 50 to 100,000 ohms. The series is available in independent linearity to an accuracy of 0.1 percent to 0.5 percent.

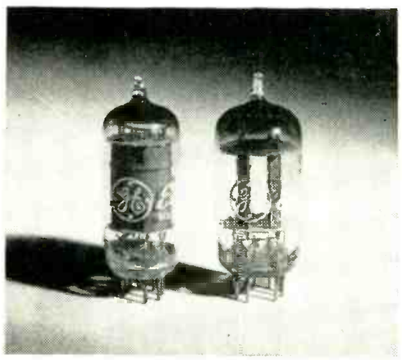


SELENIUM RECTIFIERS
for airborne equipment

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., is now producing a series of hermetically sealed, h-v selenium rectifiers for use in airborne equipment where adverse atmospheric conditions, severe vibration and rigid electrical specifications must be met. The U100HM hermetically sealed selenium rectifier has a maximum a-c input of 3,300 v rms. Output rating is 1,420 v d-c and 1.5 ma d-c at 35 C ambient temperature into a resistive load. At 71 C ambient temperature this unit delivers 1.2 ma d-c at 1,360 v d-c from 2,130 v rms a-c input. This selenium rectifier measures $5\frac{1}{8}$ in. in overall length, with an outside diameter of $\frac{7}{16}$ in.

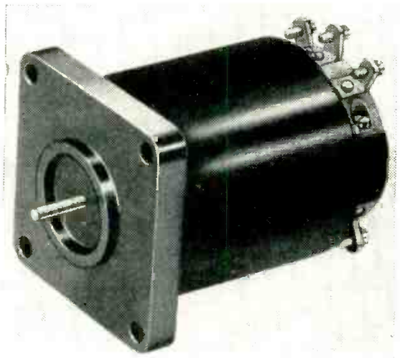
DIAL DRIVES
powered by small sync motor

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. A new, low-cost motor drive unit widens the field of application for the types 907 and 908 dials. The two available models have output speeds at the driving pinion of 4 rpm and 30 rpm respectively. A power switch is provided, as well as a manual disengage lever which lifts the pinion off the dial ring gear. The motor characteristics are such that the drive reverses itself whenever a stop is encountered. This makes it possible to use the type 908-P dial drives as sweep drives and to produce warble tones. Stops are provided to attach to the dials to limit the sweep as desired. Because the drives are synchronous, they are readily used with recording systems.



NEW TUBE TYPES
for computer applications

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has added two new types to its line of tubes designed especially for computer applications. The GL-5915-A is a dual control heptode, for use primarily as a coincidence-gating tube. Each of the two independent control grids exhibits a sharp-cutoff characteristic. Electrically and physically, the new type may be used as a replacement for the 5915 type. The GL-6211 is a 9-pin medium-mu twin triode for binary-counter or amplifier applications. Its electrical characteristics are essentially equivalent to those of the GL-5844, except that each section of the new type is provided with a separate cathode connection. The new types, designed for dependable service under conditions of intermittent operation, also feature high perveance and low heater-power requirements and are life tested under cutoff conditions.

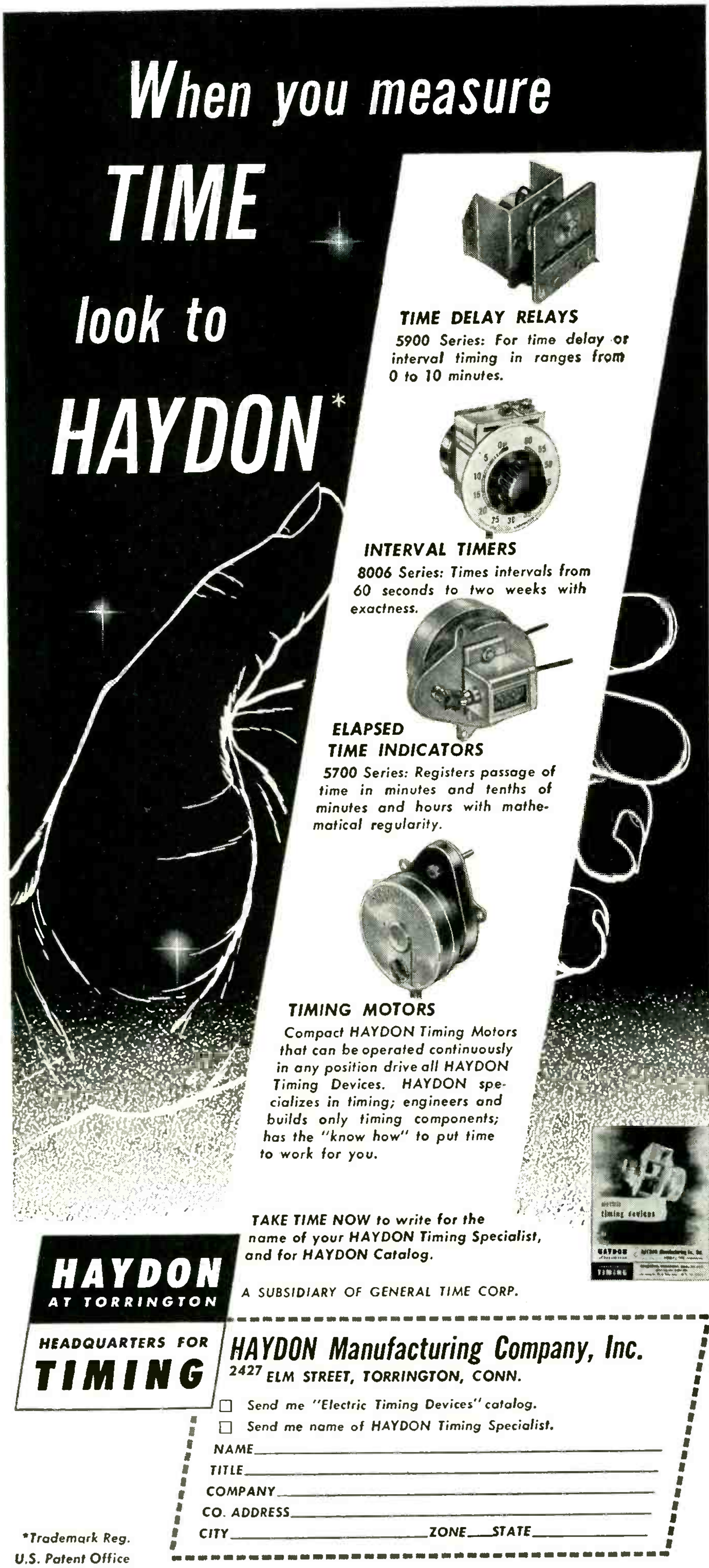


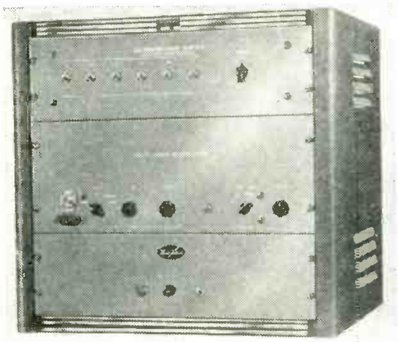
MAGNETIC RESOLVER
features fast response

JOHN OSTER MFG. CO., Racine, Wisc. A very rapid response to step function waves is given by the high permeability steel core of the series 1800 magnetic resolver. A typical production test requirement is as follows: when checking null voltage output, the voltage decays to 2 mv within 175 μsec after switchover with a 13-v, 1,000-cycle square wave applied to the primary. The unit can be supplied with rotor and stator inductance values held within ±3 percent when desired. Minimum brush noise level makes series 1800 specially suited for driving circular sweep radar presentations.

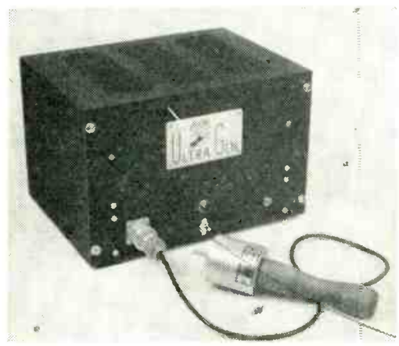
PHASE ANALYZER
tests color video signals

WICKES ENGINEERING AND CONSTRUCTION CO., 12th St. and Ferry





Ave., Camden 4, N. J. The CPA-1 color phase analyzer is designed to analyze the chrominance components of composite color video signals. The equipment compares phase of chrominance components with respect to reference subcarrier, or between any two portions of color signal. It measures phase delay over the entire range of 0 to 360 deg. The unit facilitates alignment of color coders, and checks accuracy of color signal. It can be used to measure differential gain of any amplifier or system. Switching circuitry permits comprehensive analysis of composite color signal. Complete equipment includes a CPS-1 calibrated phase shifter, a CSD-1 color signal demodulator, and a PS-7 regulated power supply, plus cabinet rack and interconnecting cables.

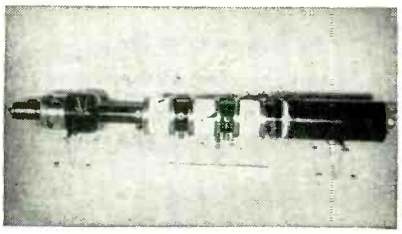


FLUXLESS SOLDERER
for aluminum alloys

ALCAR INSTRUMENTS, INC., 17 Industrial Ave., Little Ferry, N. J. The Solder-Gun is a magneto-strictive transducer driven by an electronic generator. The transducer, resembling a conventional soldering iron, cleans the surface oxides beneath the pool of molten solder on the aluminum or other material. Wetting is completed before any reoxidation can occur. Thus the need for flux is eliminated and a stronger bond and superior electric conductivity are assured. The generator operates from a 60-cycle 115-v source. Bench space is 10 in. × 14 in. The entire unit weighs 50 lb. The tip may be supplied with or without an integral heater.

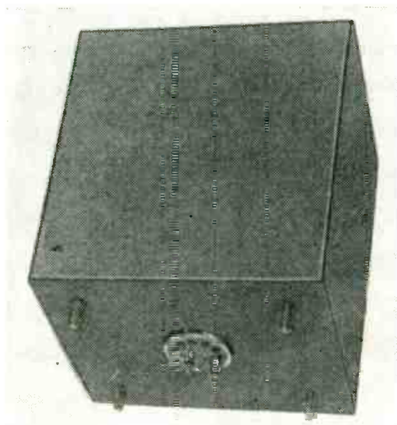
30-CHANNEL RECORDER for engineering development

ALDEN ELECTRONIC AND IMPULSE RECORDING EQUIPMENT CO., Westboro, Mass., has announced a 30-channel recorder. It can do everything from recording humidity changes, indicate the level of liquids, record the time of cessation of guinea pig life or increased activity of same, to recording activity or inactivity of equipment and machines. It is a rugged tool that has multiple uses in the laboratory and is not limited to special-purpose recording. No special training is necessary to set it up, operate it, maintain it, use it and understand it. The Fact-Finder illustrated enables the monitoring of up to 30 phases of an experiment with continuous simultaneous recordings of the activities on one paper.



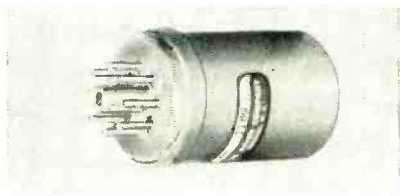
AMPLIFIER KLYSTRON gives high power at uhf

EITEL-MCCULLOUGH, INC., San Bruno, Calif., has announced a new high-power uhf amplifier klystron, the 3K50,000 LQ. In c-w operation at 850 to 1,050 mc, it delivers 10-kw output with only 10-w drive—a power gain of 1,000 times. Of practical design, the klystron features resonant cavities completed outside the vacuum system, which is free of r-f circuitry—permitting easy wide range tuning and uncomplicated input and output coupling adjustment. Price is $4,200. Complete circuit components are also available.



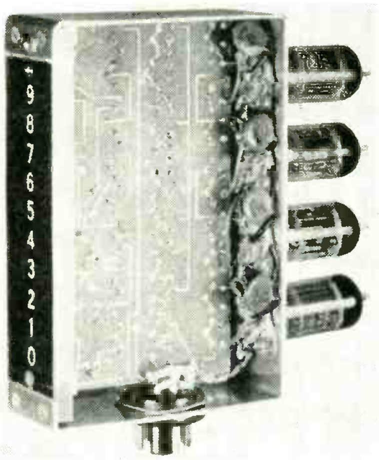
MAGNETIC AMPLIFIER
uses half-wave circuitry

FEEDBACK CONTROLS, INC., 1332 N. Henry St., Alexandria, Va., has developed a 400-cycle self-saturating magnetic amplifier for use with BuOrd Mark 7, Mark 8 and Mark 14 Mod 2 servo motors. The use of half-wave circuits with their inherently high speed of response enables these amplifiers to be used in systems with required bandwidths of up to 20 cps. Standard units are hermetically sealed with gain and compensation fixed for a given system. Units with adjustable gain and compensation also can be supplied.



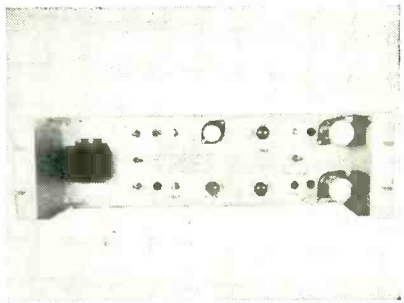
RESISTANCE NETWORK
is hermetically sealed

THE DAVEN CO., 191 Central Ave., Newark 4, N. J., announces availability of its hermetically sealed resistance and resistance-capacitance networks. They can be supplied with resistance values to ±0.02 percent and temperature coefficients matched to within ±3 parts per million per deg C. These networks of wire-wound resistors and capacitors are encased in the company's Seald-Ohm cases available with plug-in or solder terminals. The networks can track and maintain constant voltage division or null over a full temperature range of −65 C to +125 C with no derating of wattage at 125 C. Resistors can be had with specific temperature coefficients to compensate for the temperature coefficient of the capacitors in the network. Using special techniques, it is possible to match temperature coefficients of various sets of resistors in pure resistive networks to within ±3 parts per million per deg C.



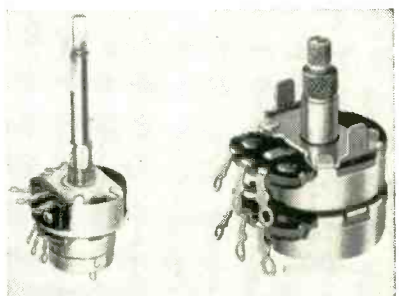
DECADE COUNTERS
are new digital types

BRUSH ELECTRONICS CO., 3405 Perkins Ave., Cleveland 14, Ohio, announces two new type digital decade counters, each available in three variations, for use wherever high-speed electronic counting is required. Both types employ the printed circuit principle, thereby permitting maximum ventilation, lower operating temperature and longer life. Both A and B types are applied to models 100, N-100, and N-101. These are high-speed electronic counters which will accept input pulses at rates varying from 0 to 100,000 counts per sec. For each 10 impulses received at the input, 1 pulse is generated at the output. Progress of the count and the final value are displayed on a direct-reading meter as a single digit in the decimal system. The addition of a simple external switching accessory permits selection of an output pulse at any value from 1 to 9.



AMPLIFIER AND MIXER for video distribution

FOTO-VIDEO LABORATORIES, P. O. Box 296, Clifton, N. J. Model V-1A video distribution amplifier and mixer is designed for the amplification, mixing and distribution of color monochrome tv video signals. It may also be used in non-tv applications where flat amplitude, frequency and time delay characteristics to 10 mc are desired. The unit handles 2 inputs and provides 1 output for each input. Amplitude characteristic is flat to 10 mc and 3 db down at 13 mc. The envelope delay characteristic is excellently suited for the requirements of color tv, being essentially flat from 200 kc to 10 mc. The unit occupies 5¼ in. of height in a standard 19-in. rack cabinet.



COLOR TV CONTROLS are carbon and wire wound

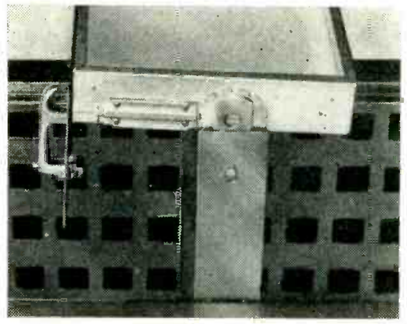
CHICAGO TELEPHONE SUPPLY CORP., Elkhart, Ind. has available a line of variable resistors for all color tv applications. The complete color tv line includes $\frac{3}{4}$ in. to $2\frac{1}{2}$ in. diameter controls with wattages from 0.2 w to 4 w. Control types are carbon and wire-wound with and without attached switch. Mountings are conventional bushing, twist ear and snap-in bracket for printed circuits. Terminal styles are for conventional soldering printed circuits and wire wrap. An endless combination of tandems with both single and dual shaft is possible. The entire 45 series, $\frac{15}{16}$-in. diameter line, is also available with 90 series special 1-w military resistance elements with exceptional stability. The entire 35 series $1\frac{1}{8}$-in. diameter line is also available with 95 series special 2-w military resistance elements with high stability.

MAGNET WIRE
with better heat stability

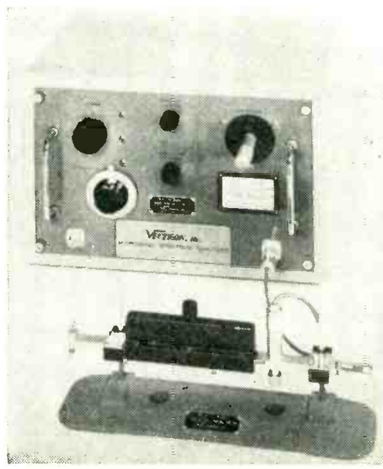
PHELPS DODGE COPPER PRODUCTS CORP., Inca Mfg. Div., Fort Wayne, Ind. A new development in class A film-insulated magnet wire offers greatly improved heat stability for electrical windings. Thermaleze magnet wire gives assurance of increased margins of safety for overloads in existing designs and greatly prolonged thermal life. It also has the advantages of good space factor, adequate abrasion for windings and excellent solvent and moisture resistance, which readily permit substitution for conventional film wires in use today. Comparative tests for thermal life with conventional film insulated magnet wires show Thermaleze to have remarkable retention of dielectric strength under sustained heat at 150 C for well over 6 months.

CHASSIS SLIDE
is versatile, drawer-type

VENTRAK CORP., 11 W 42nd St., New York, N. Y., has developed a new, versatile, drawer-type chassis slide for the electronics industry, designated as Chassis-Trak. A chassis mounted upon it can not only slide out from the rack-cabinet to a locked "out" position, but the chassis can be rotated while in this position, so that top or underside



can be serviced while in the rack. Chassis-Trak is available in two variants: type CTD is provided with a tilt-lock detent mechanism locking at 30-deg intervals of rotation from −90 deg to +120 deg; type CTB tilts back to +120 deg for underside servicing. With either type the chassis may be easily released from the slides for removal by means of a finger-tip control.



K-BAND R-F HEADS cover 12,400 to 40,000 mc

VECTRON, INC., 404 Main St., Waltham 54, Mass. The new K-band r-f heads, covering the microwave spectrum from 12,400 to 40,000 mc, are complete microwave tuning units which include an r-f assembly and a K-band mixer. They were specifically designed for use with the SA25 microwave spectrum analyzer, but other analyzers can be modified or adapted to use these assemblies. The extremely broad range of K-band requires three K-band mixers, with different size waveguides, to cover the full range in conjunction with special r-f assemblies. The 25K1 tunes from 15,300 to 17,700 mc; the 25K2 covers 22,800 to 26,400 mc; and the 25KQ1 includes 34,000 to 38,600 mc. Other portions of the band are covered by special combinations as required.

SYNCHRO
is corrosion resistant

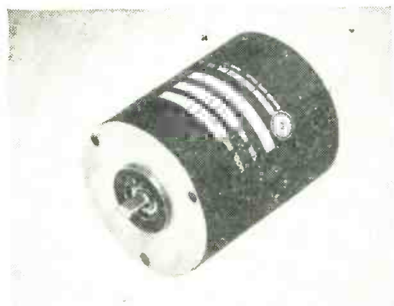
KEARFOTT CO., INC., 1378 Main Ave., Clifton, N. J., has introduced a new low-cost corrosion-resistant synchro. Stator integrally bonded with housing prevents null shifts when rotating or clamping synchro in its mount. High accuracy is featured—10 minutes maximum deviation spread from electrical zero. Size is 1.062 in. diameter $\times$ $1\frac{45}{64}$ in. long, and weight is 4 oz. It is available with leads or terminals, single or double ended shafts. Designated as the R900 series, these synchros ars available for all functions, including transmitters, control transformers, receivers, resolvers and differentials.

PANEL INSTRUMENTS
with curved or flat face

SENSITIVE RESEARCH INSTRUMENT CORP., 9-11 Elm Ave., Mt. Vernon, N. Y., offers a line of precision reference standard panel instruments in both the edgewise and

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

vertically mounted panel types. Edgewise types (curved face) are available in a-c and d-c current meters, thermocouple instruments, differential galvanometers and many specialized types. Accuracies are 0.5 of 1 percent and 0.25 of 1 percent depending on sensitivities desired. Normal sensitivities for d-c are 4 μa and 2 mv full scale; for a-c, 2 ma and 200 mv full scale. Vertical panel types for all current voltage instruments have accuracies of 0.5 of 1 percent in the model UPP, and 1 percent in other models. Maximum sensitivities for d-c are 30 μa and 50 mv full scale; for a-c, 15 ma and 5 v full scale.

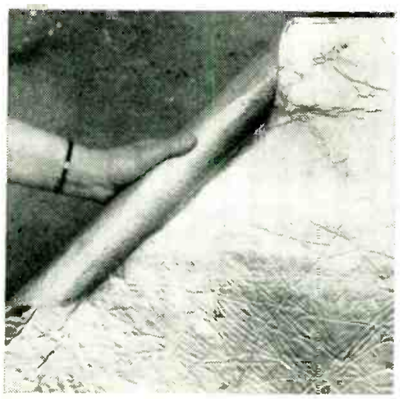


ACTUATOR MOTOR
in miniature size

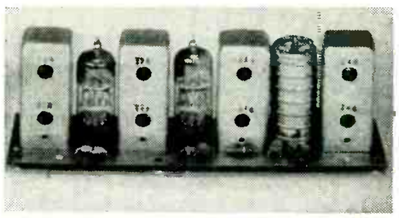
AMERICAN ELECTRONIC MFG., INC., 9503 W. Jefferson Blvd., Culver City, Calif., is now in production on a small actuator motor measuring only 1.705 in. o-d × 2 9/16 in. long. The motor operates on 400 cps. It is excited with 115 v on the fixed phase and 24 v on the control phase. Torque at stall is 2.9 in.-oz with a power factor at stall torque of 50 percent. No load speed is 5,100 rpm. Temperature range is –55 C to 90 C. Weight is 13.7 oz.

MICROWAVE ABSORBENT
is lightweight and flexible

MCMILLAN INDUSTRIAL CORP., Brownville Ave., Ipswich, Mass. Type T microwave absorbing material is especially suited to aircraft and antenna applications. It has been used to prevent side-lobe reflection from aircraft fuselage and other antenna obstructions within a radome. The material can be designed for any particular frequency

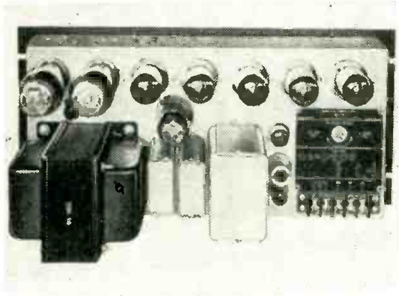


within a range from K band through L band. It is broadbanded within approximately ±7 percent of the specified frequency and has a power-reflection coefficient of less than 1 percent (20 db) within this band. Typical X-band material, supplied in 18 in. × 36 in. sheets weighs 0.25 lb per sq ft and is approximately 0.100 in. thick. Type T absorbing material is aluminum-backed and is easily mounted with standard adhesives. Due to its construction the material can be designed to have the same absorption characteristics at two unrelated characteristics, such as 22,000 mc and 9,500 mc.



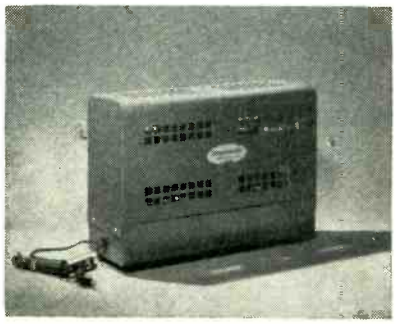
I-F STRIP
with advanced design

THE ALLEN D. CARDWELL ELECTRONICS PRODUCTIONS CORP., 97 Whiting St., Plainville, Conn., has developed the PC-4 printed circuit i-f strip which is a low cost component designed for use in monochrome tv sets having a sound carrier i-f of 41.25 mc and a video carrier i-f of 45.75 mc. The unit combines established printed circuit techniques with progressive circuit design, thereby resulting in an efficient and inexpensive strip. The i-f bandwidth is greater than 3.25 mc. The PC-4 can be supplied with base and coils fabricated of XXXP phenolic or in cases where maximum electrical and mechanical dependability are required, of Epecard II, a new laminate with extremely low loss and high strength.



POWER SUPPLY
features compactness

POWER DESIGNS INC., 119-22 Atlantic Ave., Richmond Hill 19, N. Y. Model 323 is a very compact 200–235 v, 300-ma regulated d-c power supply. Panel height is 8 in. and depth behind panel 9¼ in. Stability is better than 0.1 percent for line or load variations, ripple less than 1.0 mv and transient response less than 150 μsec. The unit features reliable type series tubes, oil-filled capacitors, boro-carbon resistors, Helipot voltage control, 40 deg rise transformers and Weston meters. It is also available without meters.



VOLTAGE REGULATOR
operates automatically

CBC ELECTRONICS CO., INC., 2601 N. Howard St., Philadelphia 33, Pa., is in production on its new Regomatic automatic voltage regulator. It is designed to operate with tv receivers and is available in 2 models. Model 200 is a 200-w unit designed for use with small and medium size receivers. Model 300 is a 300-w unit accommodating larger sets. Fluctuating voltages ranging from 95 to 130 v are kept at a constant 115 v, ±3 percent, automatically. Regomatic is compact and light in weight. In addition to its use with tv receivers, Regomatic has a wide range of industrial and laboratory applications where a stabilized, constant voltage source is required.

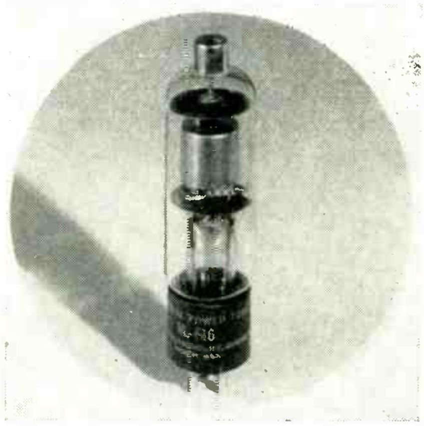
PRECISION CHOPPER
meets rigid requirements

RUMPLE, INC., 2308 Beloit Ave., West Los Angeles 64, Calif., presents a new precision chopper designed to meet the most rigid electrical and mechanical requirements. Model C102 chopper has a frequency from 380 to 420 cps; a drive of 6.3 v ±10 percent; an impedance of 38 ohms ±25 percent at 400 cps. Phase lag between coil reference voltages at 90 deg or 270 deg points and center of developed square wave is 65 deg ±15 deg. Contacts are spdt, 100 v maximum and 0.002 ampere maximum. Noise is less than 3 mv peak-to-peak, measured at each terminal connected to ground through a 1-megohm resistor. Dimensions are 2⅝ in. long, 1 9/16 in. in diameter.

RECTIFIER TUBE
for industrial control

NATIONAL ELECTRONICS, INC., Geneva, Ill., has developed a new quick-heating rectifier tube for industrial control applications. Designated NL-616, it is rated at 2.5 amperes d-c and 30 amperes peak current. The high peak current rating permits use in motor speed control applications requiring high starting currents. The NL-616 is gas and mercury-filled for quick starting and long life. Other ratings are:

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



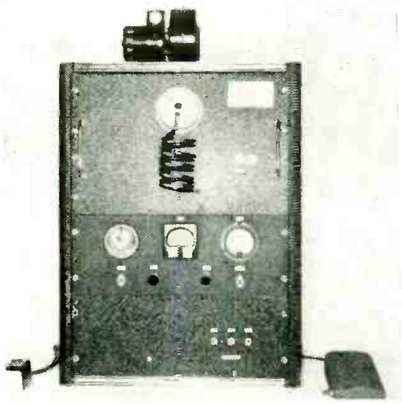
filament voltage, 2.5 v; filament current, 9 amperes; peak inverse voltage, 1,250.

BLOWER
cools airborne equipment

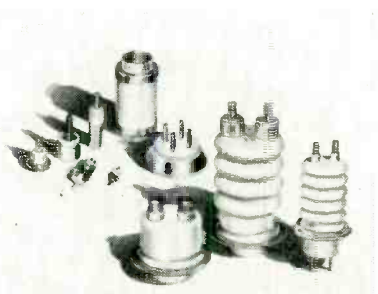
SERVOMECHANISMS, INC., Components Division, 625 Main St., Westbury, N. Y., has available a high-efficiency, small-size blower for the cooling or airborne electronic equipment. The unit has a 3-in. tunnel and is rated at 70 cu ft per minute at 1 in. of water static pressure. It weighs 20 oz and measures $3\frac{1}{8}$ in wide, $3\frac{1}{2}$ in. high and 3 12/32 in. long. Its compact design affords a large volume of cooling air with minimum external projection. Operating directly from a 115-v, 400-cycle line in conjunction with a phasing capacitor, the unit is designed to meet all applicable military environmental specifications.

DIELECTRIC HEATER
operates at 4 power levels

SCIENTIFIC SPECIALTIES CORP., Snow and Union Sts., Boston 35, Mass. The DH122 is especially designed for sealing of plastics, but it may



be used wherever a strong r-f field is needed for dielectric heating, such as on automatic machines in packaging, dehydration, and instantaneous drying. An important feature is the ability to operate at 4 different power levels selected by front-panel switching. This permits optimum heating and prevents flash-over due to excess r-f voltage. The power supply is conservatively rated at 1,600-w continuous duty, permitting unusually long heating cycles. Safety interlocks are provided throughout for the protection of operating personnel. Shielding of the oscillator section and line filtering eliminate undesirable radiation.

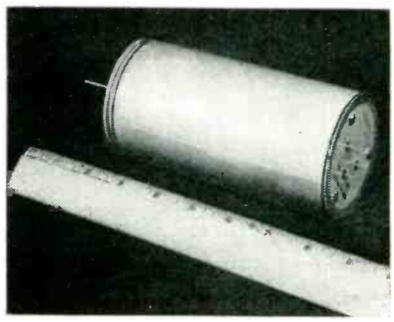


SEALS
withstand high temperatures

ADVANCED VACUUM PRODUCT INC., Division of General Ceramics Corp., 18–22 Liberty St., Stamford, Conn., has produced a new line of ceramic-to-metal seals. The Advac metalizing process makes it possible to produce hermetic seals capable of withstanding higher temperatures and severe thermal shock. Wedding of the metal coating and the ceramic furnishes a bond for the soldering or brazing of metal parts. A complete line of standard terminals is available. Custom seals are fabricated for special requirements. The new Advac seals can be inside or outside diameter and butt seals. Various metals are used to meet the conditions of different environments.

TAPE RECORDER
uses printed circuits

THE DAVIES LABORATORIES INC., 4705 Queensbury Road, Riverdale, Md. Series 550 miniaturized airborne magnetic tape recorder is packaged in two units 7 in. wide × 7¾ in. long. The recorder and oscillator unit is 8 in. high and weighs 15 lb, and the power supply unit is 6 in. high and weighs 10 lb. Reels holding 450 ft of thin (1.5 mil) 1-in. width tape permit 6 minutes of recording time at 15 ips. The standard model contains 6 f-m recording oscillators on printed circuit plug-in cards having a 1 to 2,000-cps data bandwidth and 1 crystal-controlled reference channel oscillator; it operates from 25–29 v dc. The unit has been shock and vibration tested and operates from −20 C to +60 C with no additional accessories.



POTENTIOMETER
has varied applications

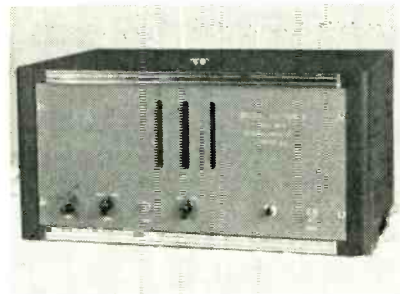
LINK AVIATION, INC., Binghamton, N. Y., has introduced the Resomax potentiometer, a highly accurate unit with infinite resolution for close servo followup loops. It provides a linear resistance change with rotation rather than an incremental change with rotation as found in helically wound types. When used in servomechanisms where high accuracy is required, its linear resistance feature prevents undesirable hunting or chatter. Other areas of application are in analog computers, test equipment, industrial instruments and process control equipment. It provides resistance ranges of from 500 to 2,000 ohms in steps of 500, infinite resolution, and a normal and zero base linearity of 0.02 percent.

SOLDERING IRON TIPS
feature long life

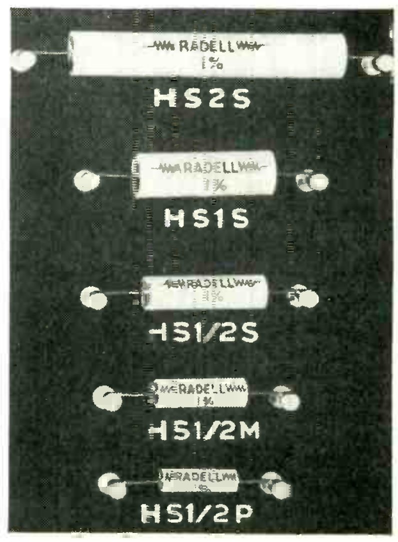
HEXACON ELECTRIC CO., 130 W. Clay Ave., Roselle Park, N. J., announces a new line of long-life Hexclad soldering iron tips. Because of new design these tips outlast plain copper tips as much as ten to one with practically no loss of heat. These Hexclad plug and screw tips have a heavy durable coating of iron alloy over copper base on all exposed surfaces for long wearing qualities. The inserted part of the plug tips also have a coating (to protect against oxidation of the copper) which is sufficiently thin so that good heat transfer to the tip is maintained. Hexclad tips retain their original shape because they do not erode or pit, thus deliver the same heat consistently for uniform joints. They are furnished tinned ready to use.

DIGITAL VOLTMETER
reads from 000 to 999

DELAWARE PRODUCTS CO., 811 Broadway, Camden 3, N. J., has developed a digital voltmeter that reads d-c voltages onto three decimal decade scales. Readings are from 000 to 999. These readings may be calibrated as volts, millivolts or any specified linear range within wide limits. Multiple ranges are available, and both positive and

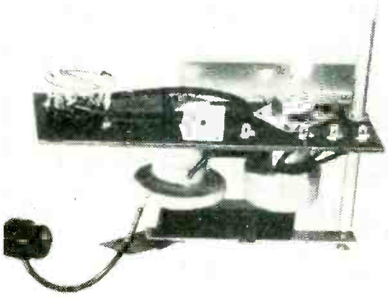


negative voltages may be measured. Readings may be periodic at intervals suited to visual or machine read out. Readings may be made on demand, and the reading will hold until a subsequent reading is called for. More than 20 complete readings per sec are possible. This digital voltmeter uses the principle of converting voltage levels to time intervals, and indicating time as counts on decimal counting units. An internal standard cell is used as a reference. Standardization is continuous. No manual standardization is necessary.



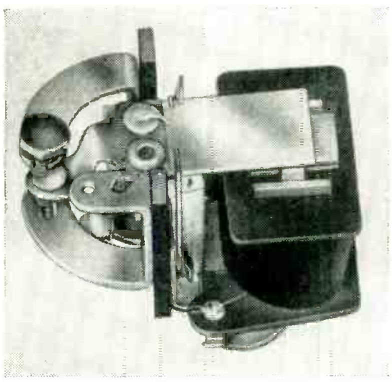
RESISTORS
are deposited carbon type

RADELL DIVISION, I.D.E.A., INC., 7900 Pendleton Pike, Indianapolis, Ind. A new line of hermetically sealed deposited carbon resistors features a treated ceramic shell which provides the highest mechanical and electrical protection for the resistive element under unusually severe extremes of humidity and temperature, and the requirements invoked by MIL specification MIL-R-10509A are far exceeded. The resistors are available in 5 sizes, including 3 in the half-watt rating, as well as 1-w and 2-w units. Of special interest is the HS½P size, which conforms to all dimensional specifications for the unsealed and uninsulated RN20 size of the same wattage rating of MIL specification 10509A.



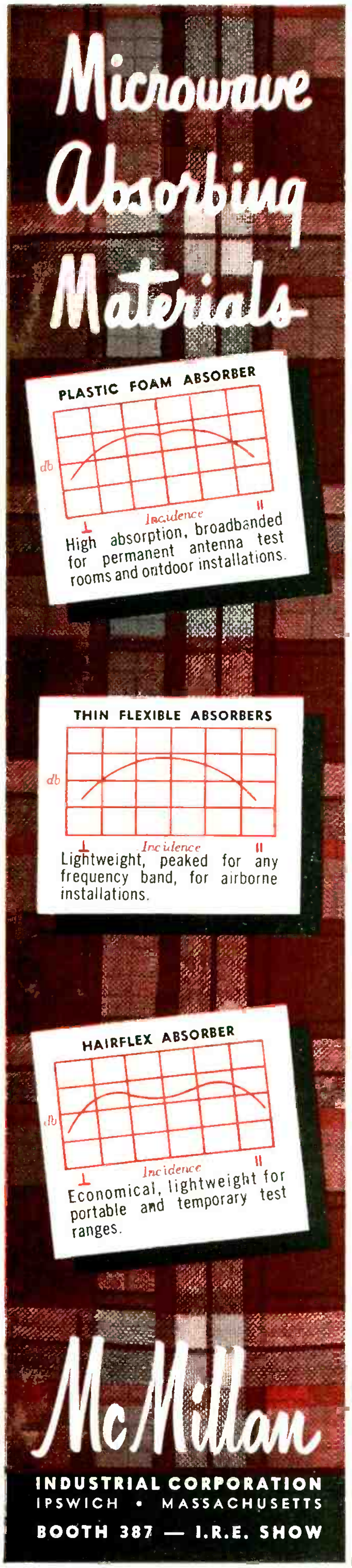
FLYBACKS
allow fast installation

MERIT COIL & TRANSFORMER CORP., 4427 N. Clark St., Chicago 40, Ill., has available a new series of flybacks, models HVO-28, 29 and 30. They were designed specifically to replace a number of Motorola units, but will also cover similar units found in Crosley, Hallicrafters and Hoffman tv receivers. A tube socket for the 1B3 rectifier, horizontal centering pot and variable gap width control are incorporated in each unit. Application of these units will allow accomplishment of a fast, simple and complete installation in a very short time.

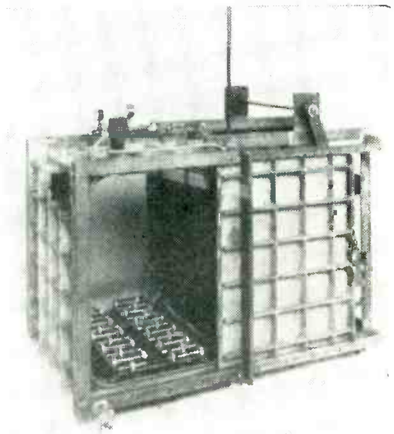


RELAY
for both a-c and d-c use

KURMAN ELECTRIC CO., 35-18 37th St., Long Island City 1, N. Y., is manufacturing a new relay equipped with a flexible armature



and adjustable contacts. The series 23 relay is ideal for a-c as well as d-c use, and is easily readjusted after the unit has been placed in service. It is a highly sensitive unit (30 mw) which exhibits excellent high-speed keying characteristics and weighs less than 2 oz. Coil resistances up to 5,000 ohms are available with a maximum continuous coil dissipation of 1w. Adjustable spdt contacts are rated at 1 ampere, 110 v a-c. The series 23 relay is suited for various applications—as a plate circuit relay, for a-c or battery-operated remote control units, and any control apparatus where space economy and current drain are the chief design factors. Additional features are available for special applications.



PRESSURE TESTER
for tv and vacuum tubes

Glasco Equipment Corp., 12 Wait St., Paterson, N. J. A new testing unit provides a simple mechanical, and inexpensive means of testing tv and other vacuum tubes against collapse, prior to installation in sets. Tubes up to 27 in. can be shock- and external pressure-tested right in their cartons, thereby eliminating any chance of flying glass, and the like, in the event of collapse. The unit provides a flexible range of varying testing pressures up to 30 lb, and for any desired interval of time. A complete operating cycle of as short as 1 minute can be obtained. Two simple pushbuttons control the complete operation. An important feature of the rapid cycle is a patented quick-release pressure valve which permits com-

plete pressure release in seconds. The unit takes up an area of about $3\frac{1}{2}$ ft $\times$ $5\frac{1}{2}$ ft, and is 4 ft high.

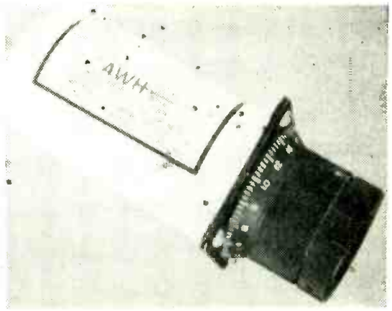
DPDT CHOPPER
has wide opening range

JAMES VIBRAPOWR CO., 4036 N. Rockwell St., Chicago 18, Ill. A modified form of the new dpdt chopper, model C-976 for 60 cps, was recently announced. It may be used for operations from 20 cps to 420 cps. The wide operating range offers new solutions to the design engineer for special switching and dual input chopper circuits. An engineering report has also been prepared on the electrical and mechanical characteristics of the C-976 and the full frequency range choppers.

POTENTIOMETER
is small sinusoidal type

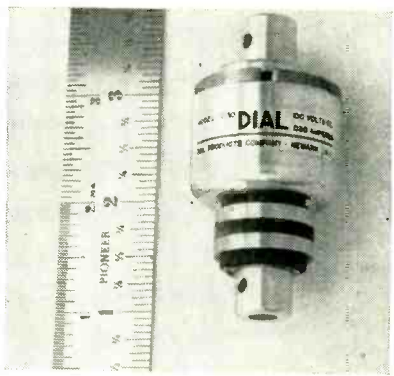
THE GAMEWELL CO., Newton Upper Falls 64, Mass., is manufacturing a miniature version of the conventional RL-11 and RL-14 sinusoidal potentiometers. Functions are accurately and smoothly developed. Four brush contacts move circularly over a uniformly wound rectangular card and pick off output voltages that are proportional to the sine and cosine of the input angle at speeds up to 60 rpm. Standard resistance value is 16,000 ohms. Resistances from 14,000 to 25,000 ohms can be supplied. Accuracy at higher values is 1 percent. Power rating is 1 w at 40 C. The envelope is $1\frac{1}{16}$ in. diameter and $1\frac{7}{16}$ long with standard servo mounting flange, $\frac{1}{8}$ shaft in ball bearings, and with 6 turret-type terminals on the rear. It meets or exceeds applicable section

MIL-E-5272A for high and low temperature and vibration.



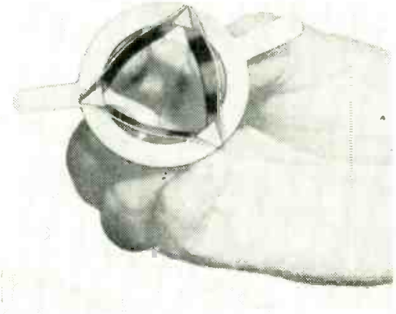
TIME-DELAY RELAYS
are miniaturized units

THE A. W. HAYDON CO., 232 N. Elm St., Waterbury, Conn., has announced a new line of precision adjustable time delay relays. The timers are supplied in a 2.2-in. diameter housing only 4¼ in. long. A large calibrated dial with a positive detent makes rapid and accurate adjustment easy. Accuracy is 1 percent and one model, adjustable from 2 to 30 sec, is calibrated in 0.2-sec increments. Calibrations are on the perimeter of the dial. Weight of the unit is about 1¼ lb. The unit, which is for use on 24 to 29 v d-c, features the 5600 series chronometrically governed motor. Control current is low. Designed for military applications, the unit is ideal where accuracy is important and ease of adjustment essential.



MAGNETIC CLUTCH
is compact and light

DIAL PRODUCTS CO., 55 Evergreen Ave., Newark 5, N. J., has developed a miniature electromagnetic clutch, model C130. This clutch does not require precise alignment of the driven member with respect to the driving member; and appreciable angular misalignment will not cause the clutch to malfunction. The driven member comprises 3 individual shoes to prevent chattering upon engagement. A 4-page folder contains an illustrated description, dimensional diagram, specifications and technical information.



CENTERING DEVICE
is time-saving unit

HEPPNER MFG. CO., Round Lake, Ill., has announced a time-saving centering device. The tilt-open slip-on design saves valuable production time in assembling tv sets. A gentle squeeze tilts open the device. It is then slipped instantly on the tube's neck. A distortion-free beam is assured by uniformity of field. The beam cannot be defocused. Each unit is tested in both open and closed position before shipment. The device is adjustable from 0 to 18 gauss.

Literature

Electronic Components. Centralab, division of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc. Catalog No. 29 is a completely revised 48-page booklet. It has a thumb index for easy reference to the company's five complete lines of stock components. Included is information on controls, capacitors, switch and printed circuit kits.

Precision Variable Resistance Units. Helipot Corp., 916 Meridan Ave., S. Pasadena, Calif. Helipot series T-10-A, precision variable resistance units for instantaneous setting, are the subject of data sheet 54–86. Designed for use as potentiometers or rheostats in experimental circuits, Helipot laboratory models are described and illustrated in detail, including specifications and characteristics of coils.

Thermostats. Stevens Mfg. Co., Inc., Lexington and Mansfield, Ohio. Bulletin L-9070A describes type A thermostats for electronic and avionic devices, appliances and apparatus. Hermetically sealed and semienclosed styles are covered. Punched for insertion in standard 3-ring binders, the bulletin is printed in 2 colors. It describes the operating principle and illustrates it with a schematic diagram. The bulletin also gives performance data, ratings, dimensions and construction details. Various mounting arrangements are illustrated with photographs.

Voltage Regulator. INET Division of Leach Corp., 4441 Santa Fe Ave., Los Angeles 58, Calif. Bulletin No. T-8300 describes the type RX60 all static voltage regulator for 60-cycle a-c alternators. Designed for use with any type 60-cycle alternator in ratings from 1 kva to upwards of 5,000 kva, the unit discussed offers regulation of ±0.5 percent. The brochure gives detailed information on construction, operation, installation and models and specifications. Also included is a list of suggested applications.

Microwave Gas Control Tubes. Roger White Electron Devices, Inc., Route 17 and Erie R.R., Ramsey, N. J. Bulletin A-20 discusses the nature and purpose of microwave gas tubes. Information is given on absorption attenuators, reactance modulators and switches, and phase shifters. Brief mention is also given to new developments—gyrators, detectors and mixers and noise sources.

P-M Motors. Barber-Colman Co., Rockford, Ill., has announced catalog F4344-1, describing p-m d-c motors with outputs up to 0.1 horsepower. It contains data sheets on typical motors from 6 v to 115 v d-c. Units having radio noise filters, gear heads and centrifugal blowers are described. The motors discussed are ideally suited to power electromechanical actuators, transfer switches and programming devices and for use as tachometer generators.

Lens System For Industrial TV. Radio Corp. of America, Camden 2, N. J. Catalog E. 52 describes the water-cooled lens system developed and manufactured by the company. Designed for use with RCA industrial tv equipment, the water-cooled system permits direct viewing of furnaces, boilers and other operations. Industrial tv facilitates close control and continuous observation of furnace combustion conditions, since the closed circuit picture can be relayed to panel boards or other convenient viewing locations.

Facilities Booklet. Gyromechanisms, Inc., Halesite, L. I., N. Y., is making available on request a 12-page illustrated facilities booklet describing the firm's products, operation and key personnel. As shown, the company manufactures an extensive line including gyros, potentiometers and magnetic amplifiers, and is equipped to handle specific design and engineering problems.

Products Catalog. Moran Electronic Components, Inc., 10515 Metropolitan Ave., Kensington, Md., has published a catalog giving general specifications and an illustration for a line of r-f solenoid coils (fixed inductance) and r-f chokes (single or multiple pie universal). A section contains detailed information on special order coils and a line drawing showing coil form assembly. The special order coils discussed are available as standard items and not for an extra price.

Expanded Scale Panel Voltmeters. Arga Div. of Beckman Instruments, Inc., 220 Pasadena Ave., South Pasadena, Calif. A new 4-page illustrated bulletin describing d-c and a-c expanded scale panel voltmeters is available. The

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

tiny, new 2½-in. panel meter is also described. Tables are given for base voltages, spans and accuracy. In all of these meters, only the range of interest is included on the scale; the rest of the scale has been discarded entirely for greater expansion, ease and accuracy of reading.

R-F Load and Calorimeter. Allen B. DuMont Laboratories, Inc., Clifton, N. J. Bulletin TR-785 covers the 5403-A r-f load and calorimeter which is designed to facilitate accurate measurements of the r-f power capabilities of either an aural or visual tv transmitter rated at a peak power of 50 kw or less within the frequency range of 54 to 216 mc. The bulletin illustrates the device, lists its chief features and includes complete technical data.

Regulated Power Supplies. N. J. Electronics Corp., 345 Carnegie Ave., Kenilworth, N. J. Catalog PR5 discusses the company's line of standard and laboratory grades of regulated power supplies. Thirty-two models of each grade are included in the line. The laboratory grade described features blower cooling; selenium power rectifiers; exclusive use of 10,000-hr tubes; complete elimination of carbon resistors and carbon potentiometers; all hermetically sealed capacitors; all components derated at least 30 percent; and magnetic circuit breakers.

Oscillograph Recording Systems. Sanborn Co., 195 Massachusetts Ave., Cambridge 39, Mass. A 6-page folder describing the very versatile 150 series oscillographic recording systems and components has been released. It contains illustrations, technical data and specifications on 2 and 4-channel systems, 6 available plug-in preamplifiers, single-channel recorder, 4 channel system for use with analog computers, and individual portable cases for recorders and amplifier-power supply units.

Rotary Relays. S. H. Couch Co., Inc., North Quincy 71, Mass. Bulletin 127 deals with the model 4A subminiature, hermetically sealed, 4-pole double-throw, d-c relay which meets and in several respects exceeds the requirements of USAF military specification MIL-R-5757B. Specifications, coil data and dimensional diagrams are included.

Soldering Oven. Electrical Industries, Division of Amperex Electronic Corp., 44 Summer Ave., Newark 4, N. J., has available a catalog sheet illustrating and describing the new Livingston far-infrared soldering oven. The unit's conveyor belt operating provides continuous, automatic soldering production with 5 conveyor speeds available. Complete specifications are given in the literature.

V-T Electrometers and Accessories. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio, has released a new 12-page catalog describing vacuum-tube electrometers and accessories. Designed in part as a manual for engineers and scientists, the catalog includes introductory data on electrometer characteristics, circuit discussions and equipment photographs. Seventeen connection diagrams show how the instruments are used as ultra high-input impedance d-c millivoltmeters, voltmeters and kilovoltmeters; sensitive microammeters and micromicroammeters; accurate megohmmeters, megmegohmmeters, d-c preamplifiers and static detectors.

TV Microwave Relay. Raytheon Mfg. Co., 100 River St., Waltham 54, Mass., has announced a new 8-page brochure describing the company's KTR-100A tv microwave relay equipment. The equipment described will now carry both color or monochrome video and audio simultaneously. The same basic system in readily adaptable for broadcast, common carrier industrial or government bands.

Recording Spectrophotometers. Applied Physics Corp., 362 W. Colorado St., Pasadena, Calif., has available a 16-page catalog which gives a detailed description of performance, construction, specifications, accessories and modifications on the model 11 and model 14 Cary recording spectrophotometers. Model 11 is for ultraviolet and visible spectra recording. Model 14 covers ultraviolet, visible and infrared regions. Bulletin P53 also includes a brief description of features of other Cary instruments: Raman spectrograph, electrometers, infrared analyzers and ultraviolet analyzers.

Instrument Calibration Standards. Radio Frequency Laboratories, Inc., Boonton, N. J. A single-sheet bulletin gives a general description of the model 261B a-c instrument calibration standard, designed for the accurate calibration of ac voltmeters, ammeters and milliammeters. Included is information on accuracy, power supply, standard instrumentation, safety features and application. Electrical specifications are shown.

Klystrons. Varian Associates, 611 Hansen Way, Palo Alto, Calif. Illustrated descriptions and typical operation data are given for 4 new type klystrons in a single-sheet bulletin. The company's klystrons range in frequency from 350 mc into K-band; in c-w power up to 15 kw; and in pulsed power to over 1 megawatt.

Arbor Listing. Precision Paper Tube Co., 2035 W. Charleston St., Chicago 47, Ill. A 12-page listing contains specifications on over 2,000 coil forms in all shapes, sizes, i-d's and o-d's. It also contains technical data and other important information.

Precision Resistors. Monson Mfg. Corp., 6059 W. Belmont Ave., Chicago 34, Ill., is offering a catalog page picturing and describing its new line of low cost, flat rectangular modular construction bobbinless precision noninductive-wire resistors. Full technical information includes data on fiber glass epoxy or polyester resin housing, vibration and shock resistance, temperature characteristics, resistance, range from 0.1 ohm to 2.5 megohms, tolerances, resistance wire, terminals, wide variety of sizes, thicknesses from $\frac{1}{16}$ in. up, applications and a table showing typical sizes and resistances available.

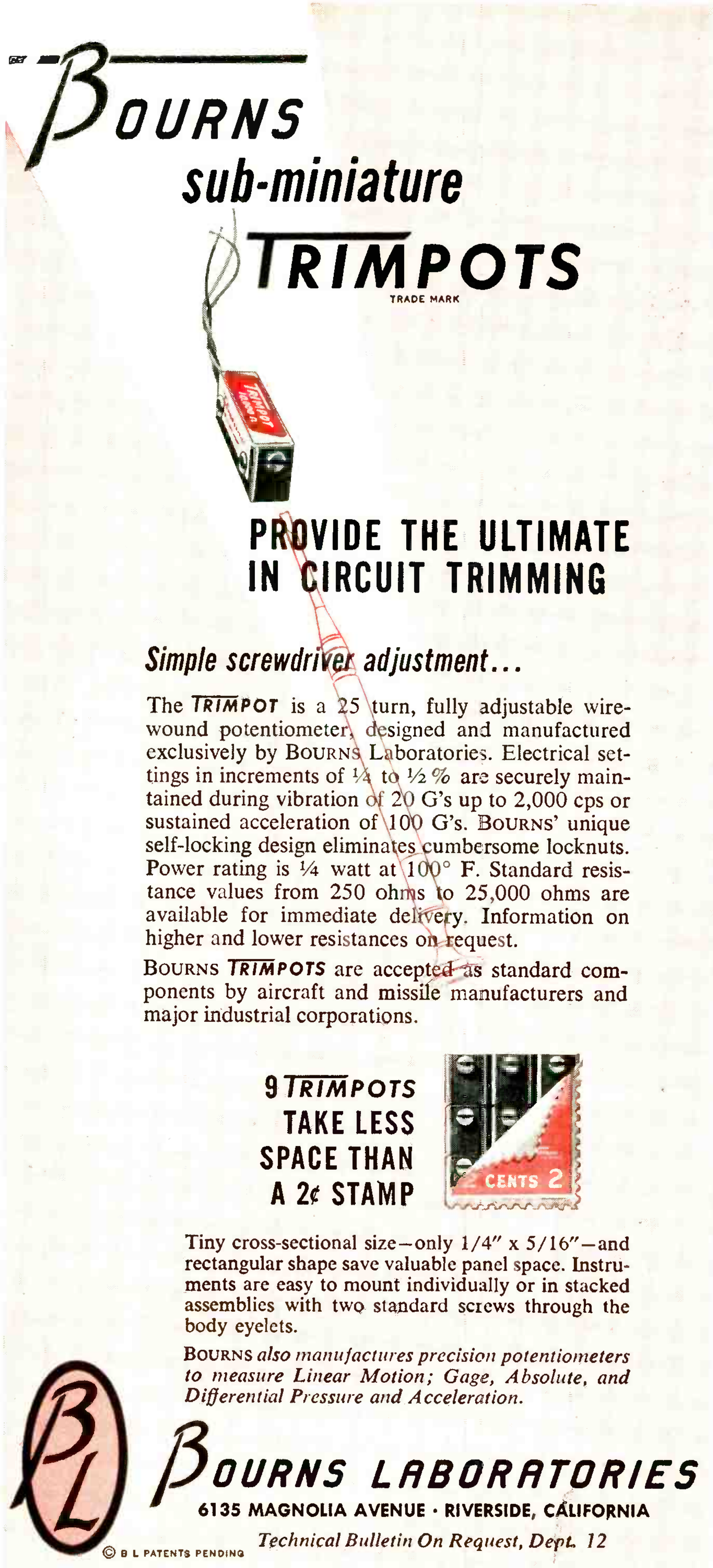
Cathode-Ray Oscillograph. Allen B. DuMont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J. A recent bulletin gives an illustrated description and specifications for the type 329 cathode-ray oscillograph. The unit described provides the high accelerating potential and high pattern brilliance required for viewing rapidly rising wave fronts of low repetition rate and high speed single transients.

Process Control Unit. North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y. A 4-page folder titled "Norelco Autrometer" describes the principle and operation of a new instrument for automatic analysis of incoming raw materials, constituents in various stages of combinations, and the finished products. Illustrated with photos and diagrams, the folder tells how the automatic multielement indexing spectrometer for process and quality control works.

Magnetic Cores. General Ceramics Corp., Keasbey, N. J. Specifications and data on standard-grade Ferramic Q magnetic cores are given in a recent 4-page folder. The magnetic data shown in curve form are based on average measurements made on a representative group of samples. A table of magnetic properties of other Ferramic bodies is included.

Transistor and Diode Bases and Closures. Electrical Industries, 44 Summer Ave., Newark 4, N. J. A line of hermetically sealed miniature transistor and diode bases and closures is described in a single-page bulletin. Illustrations and dimensional drawings are included.

Potentiometers. General Scientific Corp., 12017 Vose St., North Hollywood, Calif., has issued a set of three new bulletins on single-turn, multiple-turn and rectilinear potentiometers, respectively. The brochures briefly describe the company's newly expanded facilities and picture many of the poten-



tiometers available with or without customer modification.

Camera Pan and Tilt Mechanism. Radio Corp. of America, Camden 2, N. J. Catalog E. 54 describes the camera pan and tilt mechanism developed for use with RCA industrial tv. The equipment discussed consists of 2 units—a control unit and a remote unit—and is particularly suitable for applications where the industrial tv camera's position must be changed frequently. The mechanism described permits tilting the camera up or down 45 deg from horizontal and allows horizontal panning over a 320-deg arc.

Titanium Tubing. Superior Tube Co., 1523 Germantown Pike, Norristown, Pa. Tubing of titanium is described in bulletin 43. The 8-page bulletin—"Titanium, New Member of the Family of Metals"—presents information on the fabrication of unalloyed titanium tubing. Subjects covered include heat treating, pickling, welding, brazing and machining. The advantages of titanium, described in bulletin 43, include light weight, high strength, high ratio of fatigue limit to tensile range, low linear coefficient of expansion, corrosion resistance, good ductility, formability and heat resistance. A separate section on corrosion resistance gives details on titanium's behavior with many of the common reagents.

A-F Two-Way Terminal. Radio Frequency Laboratories, Inc., Boonton, N. J., has available a 4-page folder dealing with the model 812 audio-frequency two-way terminal. Purpose of the unit, complete description including diagrammatical data, application information and chief features are included.

Radar System Test Equipment. Hillyer Instrument Co., Inc., 54 Lafayette St., New York 13, N. Y. Bulletin No. 12 discusses a complete series of modular units for the generation of simulated radar target echo signals—for testing and evaluating radar circuits and systems in the laboratory and on the production line. Typical applications, illustrations, and tabular data on video modulars and motion modulars are given.

Magnetic Tape. Minnesota Mining and Mfg. Co., St. Paul, Minn. The seven questions recording engineers have asked most often about Scotch brand Extra-Play magnetic tape No. 190 are answered in a new, 8-page booklet. Discussed in the 2-color, $5\frac{1}{2} \times 10\frac{3}{4}$-in. booklet are such points as playing time, tape strength, reel sizes, recorder settings and performance characteristics of the new magnetic tape. Ask for the 190 booklet.

Waveguide Components. Microwave Associates, Inc., 22 Cummington St., Boston, Mass., announces a new two-color catalog 55W of over 60 pages, giving full data and outline drawings of its waveguide components for 3 to 75 kmc. This brochure is a useful reference manual for design, standards, production and purchasing personnel in the microwave field.

Delay Lines. Helipot Corp., 916 Meridian Ave., South Pasadena, Calif. The new Helidel delay lines are thoroughly covered in data sheet 54-81. This literature describes and illustrates construction, specifications and applications of these continuously variable, distributed-constant delay lines.

Transformer Catalog. General Transformer Co., 18240 Harwood Ave., Homewood, Ill. Custom-specifying of transformers will be greatly simplified for the purchaser and the design engineer with the new 20-page catalog. It illustrates prototypes covering the complete range of transformer applications, to make it easier and simpler to accurately specify electrical and mechanical requirements.

Drafting Templates. E-Z-Way Templates, 2242 S. Colby Ave., W. Los Angeles 64, Calif., has available literature on templates for electronic engineers, draftsmen and designers. It covers Vinyl plastic templates for layout of vacuum-tube sockets, capacitor twist-lock bases, rotary selector switches and vacuum-tube envelope outlines.

Precision Connectors. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A recent bulletin contains description and specifications on the series HC-20 hexagonal hermetic plug (available in 4, 5, 7, 9 and 10 contacts, with solid glass insulation) and the series G20 rectangular pin and socket connectors (available in 2, 3 and 4 contacts). Illustrations and dimensional diagrams are included.

Industrial TV Housings. Radio Corp. of America, Camden 2, N. J. Catalog E. 55 describes two special housings developed for use with the company's industrial tv equipment. Features and specifications for the explosionproof housing and for the weatherproof housing are included in the catalog sheet.

Gager System. Helipot Corp., South Pasadena, Calif. A new 4-page application data sheet covers an electronic gager system widely used in pipeline operations. Application data sheet 102 describes and illustrates principles of operation, equipment, circuitry and the use of Helipot precision potentiometers in this telemetering system.

Capacitors and Filters. Astron Corp., 255 Grant Ave., East Newark, N. J. A 6-page folder gives a fully-illustrated description of the company's facilities and products. Safety Margin electrolytics, paper capacitors, subminiature capacitors, metallized paper capacitors, and filters are covered. A brochure written in Spanish on the same subject indicates how the Foreign Operations Administration of the U. S. Government has singled out the company to participate in the progress which contributed to the technical program of friendly nations. The Spanish version is also available.

Data Bulletins. Pacific Scientific Co., 1430 Grande Vista Ave., Los Angeles, Calif., has announced publication of 14 technical data bulletins on rectilinear potentiometers, accelerometers, rate, free and vertical gyros. The new bulletins give application information, weight, size, performance data and general specifications.

Epoxy Resins and Hardeners. Bakelite Co., a Division of Union Carbide and Carbon Corp., 260 Madison Ave., New York 16, N. Y. A new 16-page booklet describes the use of C-8 epoxy resins for tools, dies, jigs, fixtures, adhesives, laminating, casting, potting, embedding and encapsulating. A special section is appended on release agents for molds. Data on storage life and handling of these epoxy resin compounds, their working life, mixing, fillers and cleaning equipment are explained in the section on compounding.

Technical Problems Affecting National Defense. National Inventors Council, U. S. Dept. of Commerce, OTS, Washington 25, D. C. A second list of technical problems confronting the Armed Services has been released. This list supplements one issued last August. It is hoped that this will broaden the scope of technical aid that inventors, research groups and scientists can offer to the defense effort. The publication covers a wide variety of inventive fields, including electronics. As an example, the list includes miniature i-f transformers.

Laboratory Tube Tester. Sylvania Electric Products Inc., 1221 W. Third St., Williamsport, Pa., has available a specification sheet illustrating and describing the type 600 laboratory tube tester. Features, information on use, and specifications are included. The instrument described is being sold for $469.50 to manufacturers of original equipment.

Resistor-Capacitor Wall Chart. Stackpole Carbon Co., St. Marys, Pa., is offering a new plastic wall chart for users of fixed composition resistors and capacitors. One side of the chart lists ½, 1 and 2-w standard fixed composition resistors in all 269 RETMA preferred values from 10 ohms to 22

megohms, with tolerances of 5, 10 and 20 percent. The other side, printed in different colors for easy identification, lists the 46 RETMA values for Stackpole GA fixed composition capacitors from 0.10 μμf to 10.0 μμf, also in tolerances of 5, 10 and 20 percent. An additional advantage of the chart is its convenient explanation of the RETMA 3 and 4-band color code used on all Stackpole resistors and capacitors.

Microphone Catalog. Turner Co., 905 17th St., N.E., Cedar Rapids, Iowa. General Catalog No. 961-A covers microphones, phonograph pickup cartridges, microphone interiors and microphone accessories. It gives detailed ordering information on dynamic, carbon, crystal and ceramic replacement cartridges for Turner microphones. Forty models of hand microphones of various types and impedances are described, with stock numbers assigned for ease of ordering.

X-Y Recorder. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. A new 2-page data sheet E-ND46(1) describes the Speedomax x-y recorder. Examples of various testing applications are cited together with complete specifications of stocked and special purpose instruments. The operation of the recorder is described with the aid of a schematic diagram. Also included are optional ranges, optional features and complete instrument ordering instructions.

Electromechanical Amplifier. Electomic Designs, P. O. Box 1156, Greenwich, Conn. A 4-page booklet describes a new electromechanical amplifier for servo motor applications. The device discussed is designed as a control for machines, mechanisms and instruments where a source of torque is available or a rotating device is employed as a source, and is ideally suited for use with computers and calculators, guided missiles, radar equipment, aircraft and numerous other general and precision applications. A full description of the operation and ap-

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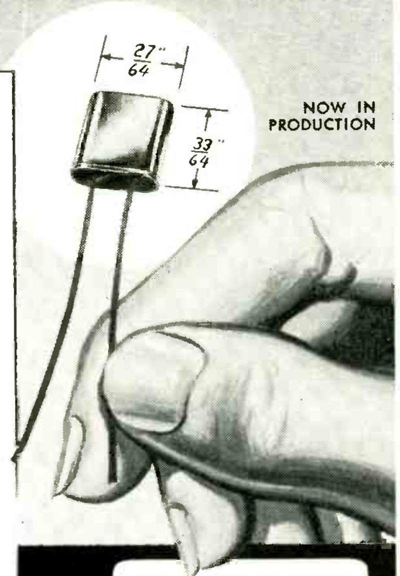

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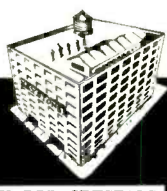

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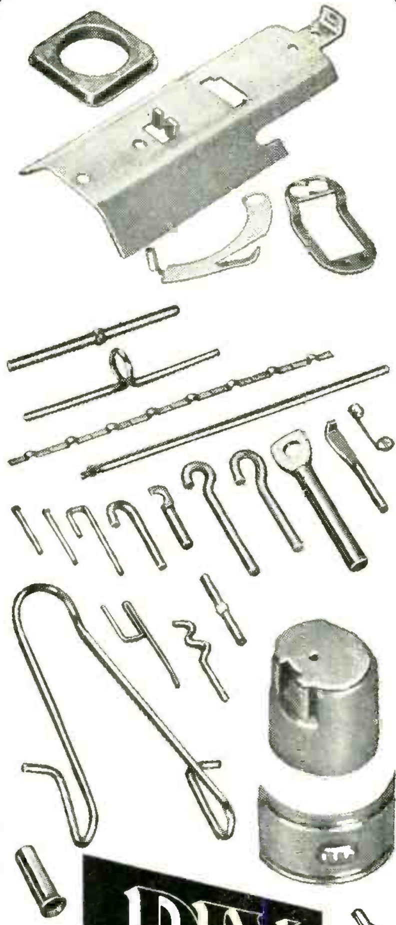

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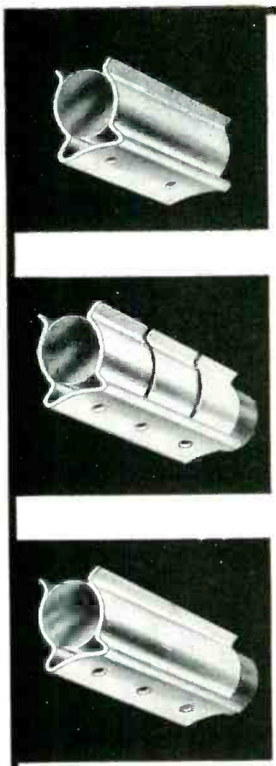
plication of the device is contained in the booklet. Charts and diagrams illustrate some of the device's many features, which include proportional and reversible torque control, high power gain, fast response and high sensitivity. The amplifying unit is rated at 5 in.-lb torque at 60 rpm and is available for most standard line frequencies and voltages as well as a variety of gear ratios. The amplifier described is 2¼ in. in diameter, 4¾ in. long, and weighs 3 lb. 2 oz.

Shielded Wire and Cable. Whitney Blake Co., New Haven 14, Conn., has available a new illustrated bulletin on shielded wire and cable for microphone and sound system use. Bulletin SW-1 describes the company's new microphone cables with semiconducting textile shield as well as the conventional types with braided copper shield. The company's new speech input and sound system cables with semi-rigid polyvinyl chloride insulation are also included. Cables for intercommunication signalling and low voltage control systems are listed in No. 24 and No. 22 Awg in up to 76 pair.

Universal Magnetic Amplifier Regulator. Regulator Equipment Corp., Paterson, N. J. Type 1101 Recostat generator voltage regulator is illustrated and described in an 8-page brochure. Included is information on application, special features and performance.

House Organ. Canadian Marconi Co., Marconi Bldg., 2442 Trenton Ave., Montreal 16, Canada, has announced the first issue of *Canadian Marconi* magazine. It is designed to explain in a nontechnical manner some of the interesting aspects of the Canadian electronics and communications industry—its past, present and future. It will be published five times yearly to inform its readers about progress in the science and industry of electronics.

Aircraft Instrumentation. Avien, Inc., 58-15 Northern Blvd., Woodside 77, N. Y. Extensive facilities



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Augat Tube Cradles come in three types as shown on the left and may be obtained in cadmium plated spring steel; beryllium copper, silver plated; or silver magnesium nickel where heat dissipation is desired. The base of cradles is convex shaped to provide additional tension when cradle is fastened to chassis. Where additional conductivity is required, shields are available in copper silver plated with gold flash or in silver magnesium nickel material.

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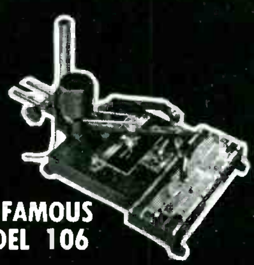

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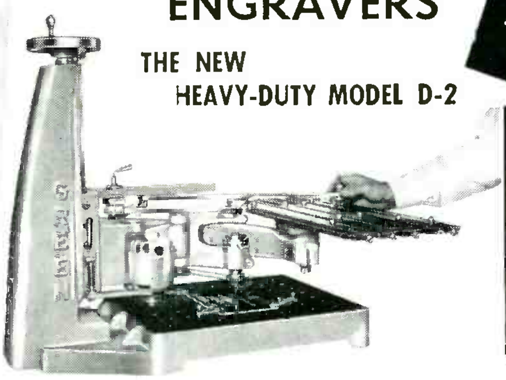

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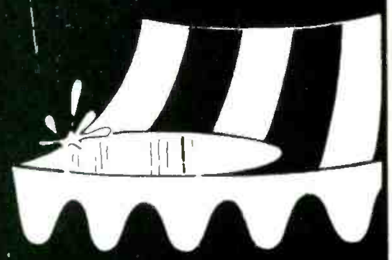

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for research, development and design of instrumentation for aircraft and guided missiles are described in a new brochure entitled "Thrust." The 16-page, 2-color publication presents graphically a wide variety of engineering resources which Avien makes available to government and industry for instrumentation development.

Digital Instruments. Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio, has available a 4-page brochure detailing a series of five related digital instruments for automatic counting, recording and control. The units discussed consists of a cycling counter, a time interval meter, a combination counter-timer, a preset counter and a recording unit. Basic components for these instruments are also described and illustrated.

Inverter-Recorder Selection Chart. American Television & Radio Co., 300 E. 4th St., St. Paul 1, Minn., announces an inverter-recorder selection chart which covers all standard a-c tape recorder models and enables anyone, at a glance, to determine which inverter should be used for any given tape recorder depending on where the tape recorder is to be used in automobiles, trains, planes, or d-c districts.

Control Switch. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Ave., Philadelphia 44, Pa. The Brown Electr-O-Vane control unit is an electronic control switch. Data sheet 10.20–6 describes the unit in detail and explains how it can be applied as a sensitive limit switch in weighing, position-counting, and other devices.

D-C Decade Amplifier. Kalbfell Laboratories, Inc., 1090 Morena Blvd., San Diago 10, Calif. A recent catalog sheet illustrates and describes the model No. 103 d-c decade amplifier which contains a high-gain, wideband, direct-coupled amplifier operated with negative feedback and frequency corrective networks to provide uniform response from d-c through high a-c frequencies in step-controlled gains of 0, 20, 40 and 60 db. Specifications are included.

Want more information? Use post card on last page.

Plants and People

Edited by WILLIAM G. ARNOLD

IRE announces technical program and exhibit plans for its 1955 National Convention. Technical societies name new officers and manufacturers promote engineering personnel. More electronic firms plan expansions of facilities and production

Record Attendance Expected At 1955 IRE National Convention

THE 1955 IRE National Convention, to be held on March 21-24 in New York City, is expected to draw 40,000 visitors. The attraction will feature 55 technical sessions and 704 engineering exhibits, covering almost every new development in the communication and electronic field.

The centers of activity will be the Waldorf-Astoria Hotel and the Kingsbridge Armory. Technical sessions are scheduled for all four days at the Waldorf-Astoria, Kingsbridge Armory and Belmont-Plaza Hotel. The Radio Engineering Show exhibits will fill the 4-acre floor of the Kingsbridge Armory and overflow into the Kingsbridge Palace, located one and one-half blocks away.

Among the other features of the convention will be the annual meeting of the IRE on the opening Monday morning. It will feature a talk by A. V. Loughren, director of research of the Hazeltine Corp. A get-together cocktail party will be held Monday evening. On Wednesday evening at the annual IRE banquet, Gen. Matthew B. Ridgway, chief of staff of the U. S. Army, will be the principal speaker. These events will all take place in the grand ballroom of the Waldorf-Astoria.

SUBWAY DIRECTIONS BETWEEN THE HOTELS AND ARMORY

From the Waldorf and Belmont-Plaza Hotels, walk north on Lexington Avenue to the 51st St. station of the Lexington Avenue IRT (Interborough Rapid Transit) and take the Lexington Avenue IRT local to 86th St. Go to the lower level and take the train marked "Jerome-Woodlawn Express" to Kingsbridge Road and Armory. The Waldorf is located at 50th St. & Park Avenue; the Belmont-Plaza is located at Lexington Ave. between 49th and 50th Sts.

The technical program, which is published in this issue beginning on page 440, will have included two special symposia on Tuesday evening on Magnetic Recording for the Engineer and Trends in Automatization of Procedures and Processes in Business and Industry. The remainder of the program will cover a wide variety of topics such as Spurious Radiation, Remote Control of Space Stations and Designing Machines to Simulate the Behavior of the Human Brain.

Registration for the Convention can be made at either the Waldorf Astoria or the Kingsbridge Armory. Special IRE busses will provide registrants with free transporta-

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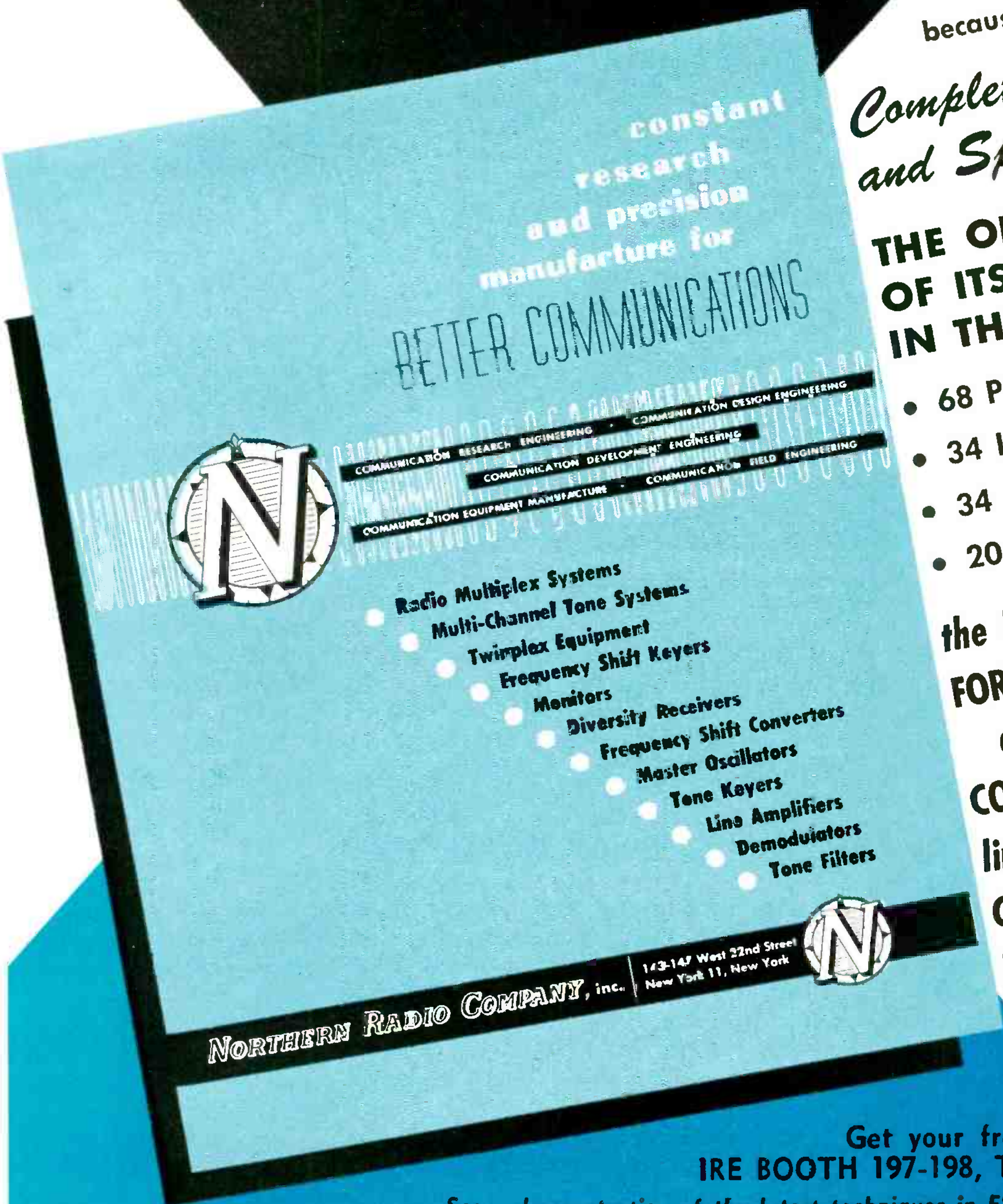

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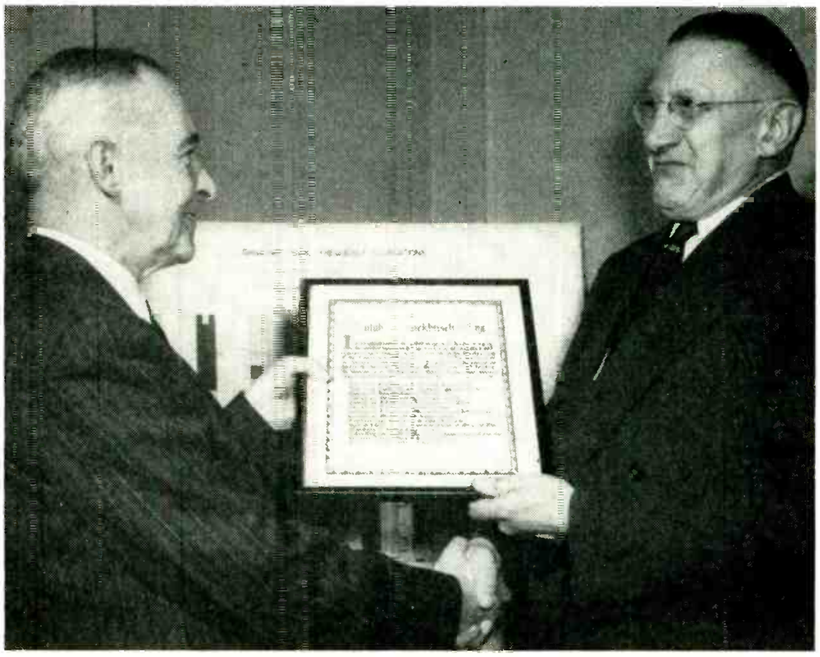
tion between the two locations. Subway directions between the two locations are listed in the box on page 412.

IRE also announced the appointment of six members to its board of directors for 1955. Reappointed as treasurer of the IRE was W. R. G. Baker of GE. Haraden Pratt was appointed to his thirteenth term as secretary and John R. Pierce of Bell Labs was reappointed editor.

Alfred N. Goldsmith, consulting engineer and editor emeritus of the IRE, A. V. Loughren of Hazeltine Corp. and Howard Vollum of Tektronix were also appointed to the IRE board of directors.

Canadian Engineering Group Honors Hackbusch



G. C. W. Browne, left, controller of telecommunications for Canada and Ralph A. Hackbusch, engineering director of RTMA of Canada

AT THE TENTH annual meeting of the Canadian Radio Technical Planning Board in Ottawa, Ralph A. Hackbusch, director of engineering of RTMA, was presented with a citation in recognition of his "enterprise and leadership in formulating sound engineering principles and organizing technical facts to assist in the development of the Canadian radio industry and radio services of the nation."

Hackbusch was president of the CRTPB from 1949 until the recent meeting when C. W. Boadway, communications engineer with the Hydro-Electric Power Commission of Ontario, was elected president. H. S. Dawson, of Canadian GE and chairman of the technical products division of RTMA, was elected vice-president. Stuart D. Brownlee, general manager of RTMA, was reelected secretary-treasurer.

The Canadian Radio Technical Planning Board is a non-profit organization which makes recommendations to the Canadian government and to industry on matters relating to the use of the radio spectrum, interference elimination in electronic apparatus of all types and related engineering problems. It is sponsored by fourteen associations and groups, including RTMA, comprising over one hundred scientists and engineers.

Daystrom Purchases Heath Company In Michigan

DAYSTROM has purchased the Heath Co. of Benton Harbor, Mich., manufacturers of the Heathkit precision electronic instruments. The company will be operated as a subsidiary.

Daystrom has three electronic operations and controls more than 50 percent of the stock of the Weston Electrical Instrument Corp. of Newark, N. J.

Jones also announced that Robert Erickson, vice-presiden of Daystrom, would direct operations at Heath as president while continuing as an officer of the parent organization.

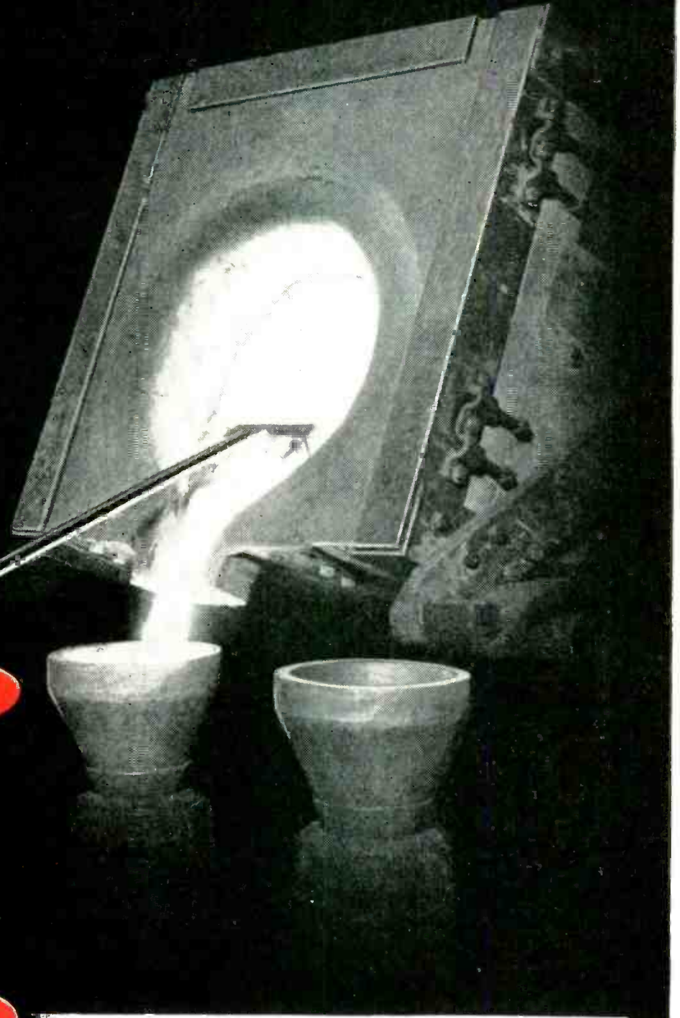
With annual sales of $6,000,000, Heath has a line of more than 60 test instruments, amplifiers, transmitters and receivers. The company owns a 22,500 sq ft plant in Benton Harbor and operations will continue there.

With the addition of the Heath Company, Daystrom has six wholly-owned subsidiary operations: Daystrom Instrument in Archbald, Penna., makers of electronic gunfire control devices; Daystrom Electric Corp. of Poughkeepsie, N. Y., manufacturers of tape recorders and other electronic products; Daystrom Pacific Corp. of Santa Monica, Cal., makers of gyroscopes and electronic control equipment; Daystrom Furniture of Olean, N. Y., and American Type Founders in the printing equipment field.

WCEMA Elects Officers For 1955

H. MYRL STEARNS was named president of WCEMA. He is executive vice-president and general manager of Varian Associates. Stearns has served on the board of directors of the association for several years. In 1954, he was vice-chairman of the San Francisco council and in

Starting here it's mostly nickel and chromium...



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1953 secretary-treasurer.

Gramer Yarbrough, assistant manager of American Microphone Co. of Pasadena, was elected vice-president of the 180-company Western association. He is also chairman of the Los Angeles Council.

D. C. Duncan was named secretary of the association. Duncan is vice-president and general manager of Helipot Corp. of South Pasadena, California.

Named to the post of treasurer for 1955 is Calvin K. Townsend, vice-president and general manager of Jennings Radio Manufacturing Co. of San Jose, California.

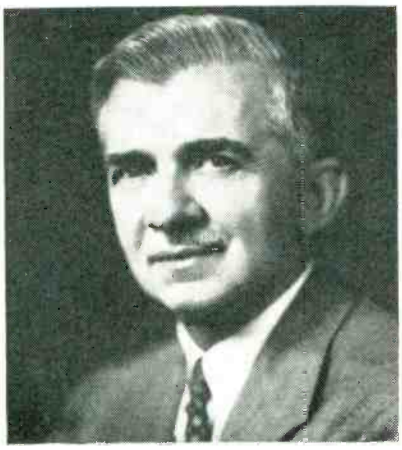
Sperry Promotes Top Executives

PRESTON R. BASSETT is retiring as president of Sperry Gyroscope but will continue as a vice-president of the parent firm, The Sperry Corp.

Succeeding him as president is Charles M. Green, who has been executive vice-president and general manager since 1945. Carl G. Holschuh is appointed executive vice-president and general manager succeeding Green.

President Green first joined Sperry Gyroscope in 1944 as vice-president for manufacturing. He previously had more than 10 years experience in manufacturing requirements for the military with Remington Arms Company.

Executive vice-president Holschuh joined the company in 1931. He advanced to chief engineer in 1946, vice-president and works man-



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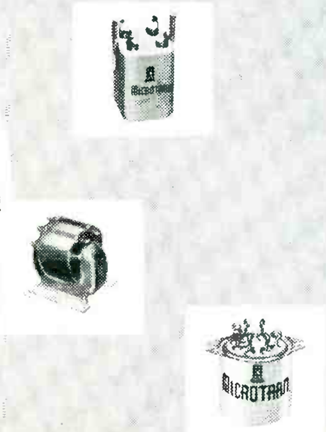

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Charles M. Green

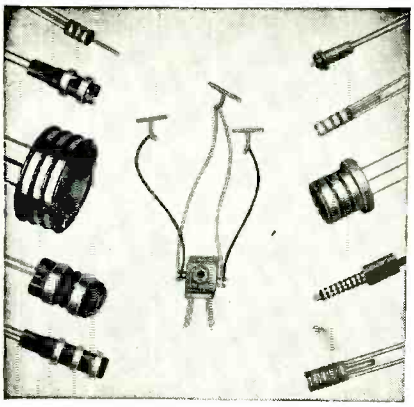
ager in 1947 and vice-president for manufacturing in 1949. This led to his assignment in 1951 as vice-president and assistant general manager.

Bassett's move to the parent corporation comes after 40 years of service. He became chief engineer in 1929, and general manager in 1944. He advanced to the presidency in 1945 at that time also becoming vice-president of The Sperry Corp.

In the Sperry Gyroscope division of Sperry Corp., George A. Richroath has been named vice-president and works manager. He joined Sperry in 1941, having been general manager of another concern, and was given the responsibility for setting up the present plant in Lake Success, N. Y. Upon the beginning of operations there he was made factory superintendent, later was appointed manufacturing manager and became works manager in 1952.

Percy Halpert has been named engineering director for aeronautical equipment of Sperry Gyroscope. He succeeds O. E. Esval who has

Carl G. Holschuh



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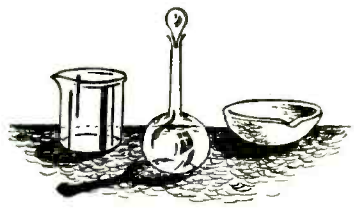

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been named vice president and chief engineer of Sperry's Wright Machinery Co.

Halpert's new duties cover engineering responsibility for all phases of flight instruments, flight controls and engine instruments from initial research through development of products for manufacture. He joined Sperry in 1937 and in 1942 became a research engineer. Since 1948 he has been engineering department head for flight controls.

Link Buys Two Plants

LINK AVIATION has purchased two buildings in Binghamton, N. Y. with a total area of 78,000 sq ft from the Drybak Corp.

The company will occupy the property by March 1, 1955.

The plant will be used primarily for light manufacturing.

Texas Instruments Names Teal

GORDON K. TEAL, assistant vice-president, has been appointed to head the research division of Texas Instruments. He will now have charge of all TI research involving work in many phases of electronics and geophysics. Previously Dr. Teal headed the materials and components research department with primary responsibility for semiconductor research.

R. W. Olson, TI vice-president formerly in charge of research and engineering, assumed the presidency of Houston Technical Laboratories, TI subsidiary.

Dr. Teal was associated with Bell

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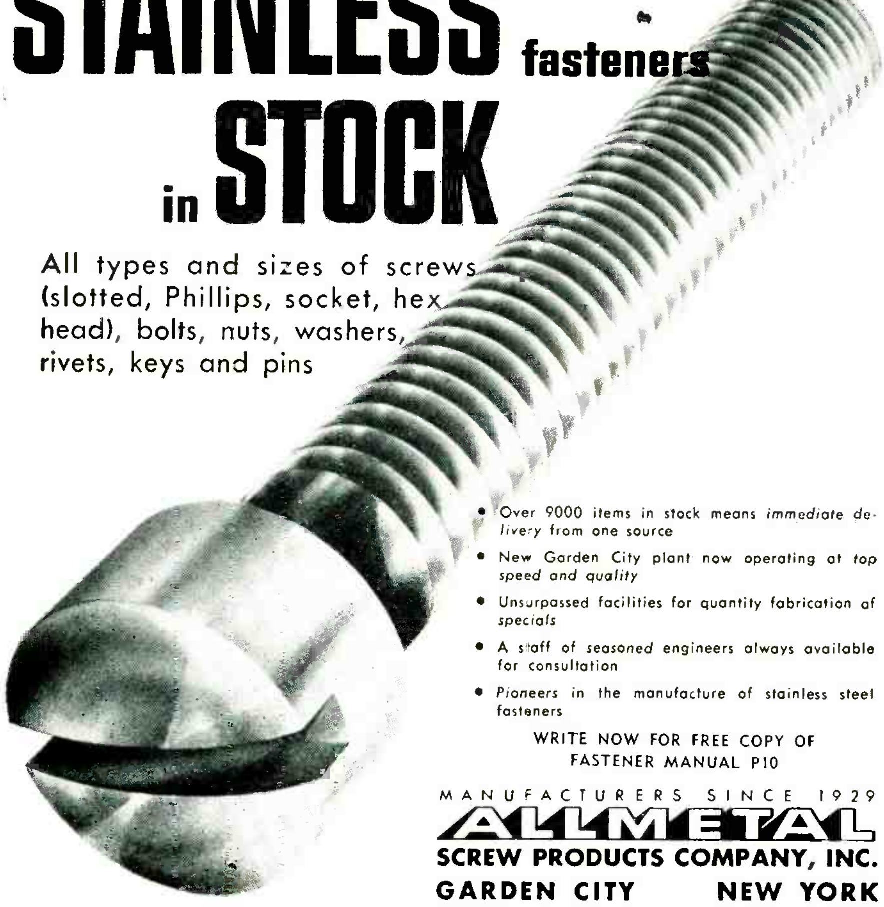

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- Over 9000 items in stock means *immediate delivery* from one source
- New Garden City plant now operating at *top speed and quality*
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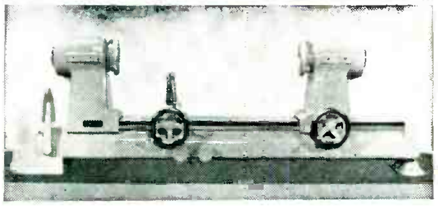

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GENERAL SPECIFICATIONS

Maximum length overall	63½"
Maximum width overall	18½"
Maximum length spindle nose to spindle nose	36½"
Height	20½"
Radial clearance above apron	9"
Spindle hole diameter	2⅝"
Approximate shipping weight	550 pounds
Net weight	Approx. 400 pounds

STANDARD EQUIPMENT

Variable speed pulley assembly

Two face plates

One collet draw-in bar

One twelve-fire single jet adjustable oxygen-gas or oxygen-hydrogen burner

Hand carburetion control

Foot pedal control of air or nitrogen supply and of oxygen-gas volume

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⅓ h.p. Motor, 110 volt, single phase, single speed, 60 cycle, AC

Face plate wrench

Two motor belts

One motor pulley

DO YOU KNOW?

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That special chucking for your industrial procedures, or laboratory practices are available?

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That Litton Lathes have been the standard of the vacuum tube industry for 22 years, and have been constantly improved?

That you can get these precision tools at reasonable cost, in eight sizes, with swing from 8" to 42", and working length from 20" to 75½"?

Let us send you complete specifications and prices on our line of equipment and tools for the Vacuum Tube industry and for general research and development laboratory use.

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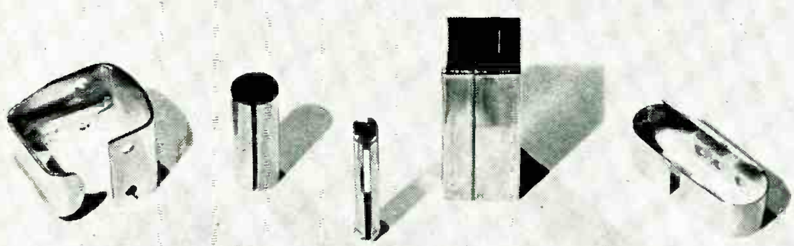
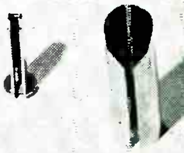


THOMAS



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Telephone Laboratories for 22 years before coming with Texas Instruments in January of 1953. He has conducted research in the fields of photoelectricity, secondary emission, photoconductance, electron multipliers, silicon carbide varistors, heavy hydrogen, germanium and silicon rectifiers, microwave attenuators, borocarbon resistors, germanium and silicon single crystals, and transistors.

He has some 46 patents granted or applied for as a result of his research in these fields.

Aerovox Appoints Head For Automatic Production

WILLIAM C. BAINBRIDGE has been appointed director of automation of Aerovox Corp. in New Bedford, Mass. He will work with Aerovox product engineers in all divisions on the design of all products to facilitate their use in automatic assembly equipment, including the problems related to proper packaging. He will also be contacting manufacturers of automatic assembly equipment and customers for automation components.

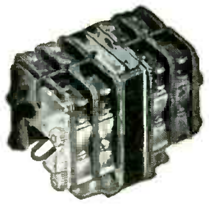
Tung-Sol Selects Color Tube Head

A. MELVIN SKELLETT, research engineer who holds more than 70 patents in electronics, was named director of color television tube

A. Melvin Skellett

RELAYS

POWER AND SENSITIVE TYPES



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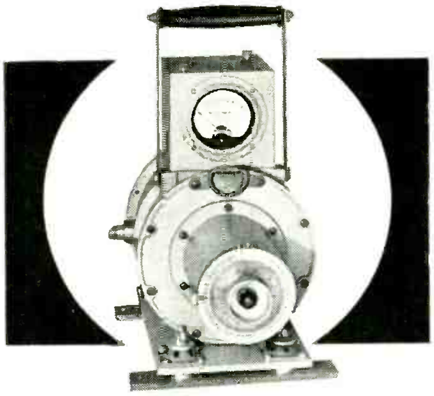

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Convenient Warehouses in New York and New Jersey planning and development for Tung-Sol Electric.

For the past 25 years he has been active in the electronics industry in research and administrative capacities. He was on the technical staff of Bell Telephone Laboratories for 15 years.

He has also served the government as a consultant to the Research and Development Board of the Department of Defense.

Budd Co. Offers To Buy Diamond Fibre

AN OFFER to purchase the entire assets of the Continental Fibre Company has been made by The Budd Company. The offer, based on a share for share exchange of Budd common stock for the 450,000 shares of Continental Diamond outstanding, is subject to approval of the board of directors of both firms and of Continental Diamond shareholders.

Continental Diamond Fibre, producer of plastic laminates, fibre, industrial tapes, mica insulation and molded plastic products, employs approximately twenty-five hundred persons.

The Budd Company makes automobile body parts and railroad cars. It employs twenty thousand persons in its five plants.

Armed Forces Group Elects Officers

COLONEL ALLEN E. WHARTON, assistant chief engineer of New Jersey Bell Telephone, has been elected president of the New York chapter Armed Forces Communications and Electronics Association. He succeeds Vice-Admiral W. S. Anderson, USN (Retired), of International Automatic Electric Co., named to the board of directors.

Newly elected vice-presidents are Benjamin H. Oliver Jr., general plant manager of New York Telephone; Stanley F. Patten, vice-president of Allen B. DuMont Laboratories and A. F. Van Dyck of RCA.

T. N. Pope of Bell Telephone

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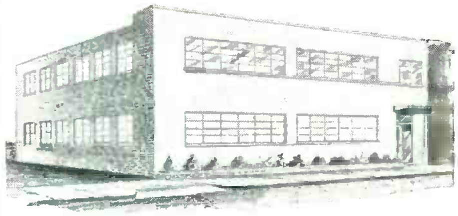

This architect's sketch illustrates the new headquarters building now under construction by the HENRY P. SEGEL COMPANY in Brookline (Boston Postal District) Massachusetts.

Here in these air-conditioned surroundings, industrial users and distributors will be able to view complete displays, inspect samples and obtain sales and engineering counsel regarding products made by the following manufacturers:

- BUD RADIO, INC.
- CAMPBELL INDUSTRIES, INC.
- CIRCUITRON, INC.
- CLAROSTAT MFG. CO., INC.
- CONNECTICUT TELEPHONE & ELECTRIC CORP.
- FREED TRANSFORMER CO., INC.
- GARDE MANUFACTURING COMPANY
- T V PRODUCTS COMPANY
- THE TURNER COMPANY

This modern building is strategically located in close proximity to all major routes in and out of Metropolitan Boston, the country's *leading* research and development center. A thorough survey of the New England market indicates that this structure will provide a long-needed facility to properly serve the requirements of the industry.

Manufacturers, wherever located, interested in having a type of representation in New England which will fulfill ALL requirements with vision and efficiency, plus warehousing facilities if desired, are invited to write for further information about this far-sighted and aggressive project.

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Laboratories, treasurer; Colonel David Talley of Federal Telephone and Radio Company, secretary and R. F. Jewett of Western Electric, recording secretary, were reelected, as were all present members of the board.

Bendix Promotes Missile Engineers

A. C. OMBERG has been named assistant general manager and W. P. Bollinger has been promoted to assistant director of engineering of the guided missile section of Bendix Aviation.

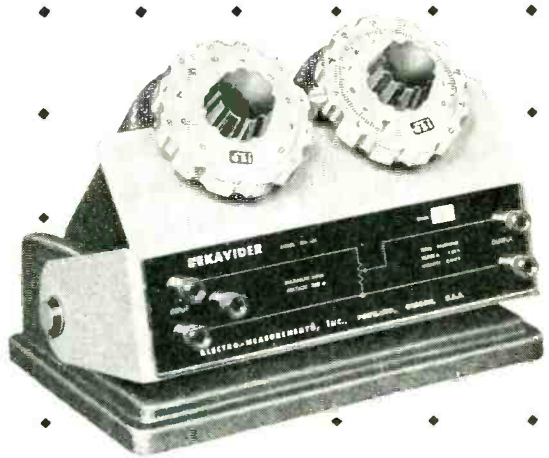
Omberg, who joined Bendix in 1944, has been director of engineering and research at the Bendix radio division in Baltimore. From 1932 to 1941 he was a transmitter engineer for WSM in Nashville.

Bollinger joined the missile section in 1953 as manager of weapons system development. He became active in the missile field in 1946, at which time he collaborated closely with the applied physics laboratory of the Johns Hopkins University in the development of control systems of missiles.

Adam E. Abel has been named director of engineering and research for Bendix radio communications succeeding Omberg. He had been serving as assistant director for more than two years. From 1935-36 he was a project engineer for RCA and worked primarily with aircraft transmitters. In 1937 he joined the predecessor of the pres-

A. C. Omberg

DEKAVIDERS



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1

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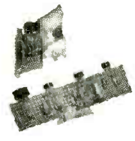
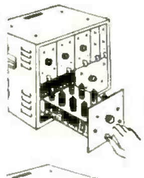
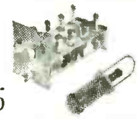


ALDEN TERMINAL CARD SYSTEM

2

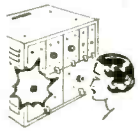


Plug in replacement spares in 30 seconds.



ALDEN BASIC CHASSIS & PLUG-IN PACKAGES

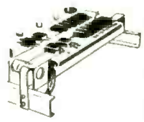
3



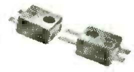
Tiny tell-tales spot trouble instantly.

ALDEN "TELL TALES"

4



All leads brought to single, accessible point of check, color coded and numbered so layman can make first-level check.



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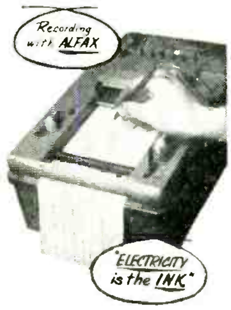
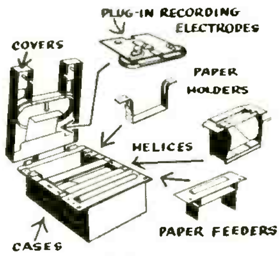
Scientific recording now accomplished by Alfax Paper, where previously photography had seemed necessary.

New Alfax Paper — in which electricity is the ink — makes possible simple, uncomplicated recorders that operate unattended, get great amounts of related information compactly with high accuracy. Alfax paper is different-non-toxic, stable in storage, requires little current yet cannot overload, records at slow or high speeds, does not smudge or transfer.



See the Alfax Paper and Engineering Co. IRE Show Booth No. 191 or write Westboro, Massachusetts.

Helix recording simplified by new "assemble yourself" recorders.



New horizons in graphic recording opened up by Alfax Paper — electricity is the ink — now can be explored quickly with these Alden adjusterless helix recorders and components.

See the Alden Electronic and Impulse Recording Equipment Co. IRE Booth No. 189 or write Westboro, Mass.

Want more information? Use post card on last page.

W. P. Bollinger

ent division and has been with the organization ever since.

Prior to receiving his assignment as assistant director in 1952, he was chief engineer in charge of radar for eight years.

General Instrument Expands In Canada

GENERAL INSTRUMENT CORP., manufacturer of electronic components, is expanding its Canadian operations with the construction of an expandable, 250-employee plant at Waterloo, Ontario. The company plans increased development and production of "made in Canada" parts and the establishment of a product research laboratory in the new plant. Additional personnel and new equipment and machinery will be utilized.

The new 21,000 sq ft Waterloo plant is to be built so that it can be tripled in size without a day's loss of production. The new plant, expected to be in operation in January, will more than double the firm's Canadian production rate of components.

The production research laboratory will develop components for Canadian television set manufacturers and a special engineering service group, based at Waterloo, will work with Canadian customers on all of the firm's products.

The Waterloo plant will be staffed and managed by Canadian employees and technicians of F. W. Sickles of Canada, the company's Canadian

subsidiary. Present employees will be shifted from Kitchener to neighboring Waterloo and more taken on, up to an eventual total of 250—or more, whenever the market warrants an addition to the plant.

Operational chief of the Waterloo plant will be Hugh T. Watt of Kitchener, who joined Sickles of Canada as vice-president when the company acquired his firm, Watt Electronics Products, last year.

Over-all responsibility for coordination and expansion of the company's Canadian activities remains with Edgar Messing, a vice-president of F. W. Sickles division. Design and construction of the new plant were under the supervision of plant engineer Samuel A. March.

Rockett Joins Airpax Products

FRANK H. ROCKETT, JR. has joined Airpax Products Co. of Middle River and Cambridge, Md. as director of sales and advertising, where he will coordiante the marketing and promotion of the firm's products.

For the past six years, Rockett was associated with Airborne Instruments Laboratory of Mineola, N. Y. as patent engineer and as technical report consultant in the office of the vice-president for research and development, in which capacity he assisted with and coordinated the preparation of engineering reports and instruction manuals. Prior to that, he was associate editor of ELECTRONICS. He

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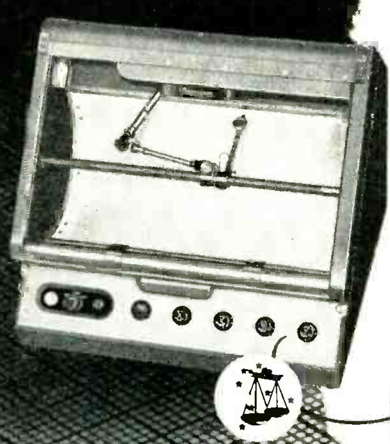

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Visit us at Booth 412 Radio Engineering Show has taught at Lehigh and Columbia University, and participated in research at the radiation laboratory of The John Hopkins University.

He is author of various interpretive and survey articles, and of numerous reviews of technical books. His current series of articles on components has been appearing in ELECTRONICS.

Radio Club Re-elects Officers

THE RADIO CLUB of America elected the following officers for 1955: president, Frank H. Shepard, Jr.; vice-president, Frank A. Gunther; treasurer, Joseph J. Stantley; corresponding secretary, O. James Morelock and recording secretary, Charles F. Jacobs. All of the officers except C. F. Jacobs held similar positions last year.

The following directors were also elected: Ernest V. Amy, George E. Burghard, Paul F. Godley, Harry W. Houck, F. A. Klingenschmitt, Jerry Minter and Harry Sadenwater.

Erie Appoints Chief Engineer

ERIE RESISTOR CORP. promoted Nello Coda to chief engineer of its electronics division to bring about a closer integration of Erie's engineering functions. Coda was previously chief electrical engineer for the firm which he joined in 1942.

GE Forms Materials Lab

GE ESTABLISHED a materials and processes laboratory in Syracuse.

Robert N. Gillmor was appointed manager of the new laboratory, which has a staff of approximately 50 engineers and laboratory assistants.

The newly established laboratory will be responsible for the control and quality of materials and processes used by the operating departments in the Electronics Division. Members of the staff of consultants

will be engaged in development of new materials and processes, as well as the test and analysis of incoming materials in each of the Electronics Division plants in central New York.

Prior to his new appointment, Gillmor, a veteran of 23 years with GE, had been manager of the materials and processes sub-section in the Electronics Laboratory since 1949.

N. J. Electronics Names Gams

THEODORE C. GAMS has been appointed director of research of N. J. Electronics Corp. He will direct the company's new development program in the field of electronic instruments. He has previously acted as consultant to the company in this work and has been a consultant in industrial electronics, instrumentation, and radar equipment design for the past eight years.

IT&T Promotes Two Engineers

BRIGADIER GENERAL PETER C. SANDRETTO, U. S. Air Force Reserve, and A. G. Clavier have been named assistant vice-presidents of Federal Telecommunication Labs.

General Sandretto, a technical director of FTL, will act as general coordinator for military research and development projects. Clavier, also a technical director, will act as general coordinator for company-sponsored research.

General Sandretto joined IT&T

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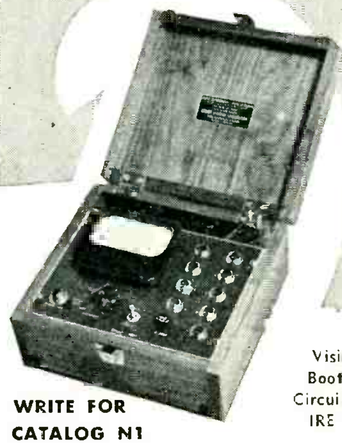
MODEL 741
SQUARE
SEMI-FLUSH



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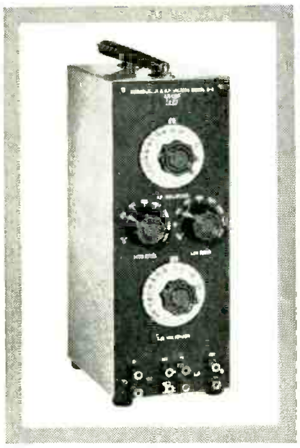

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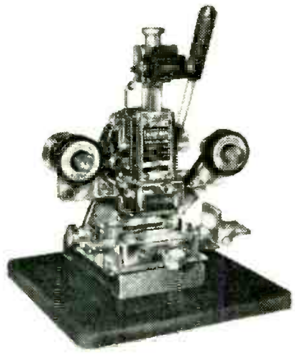

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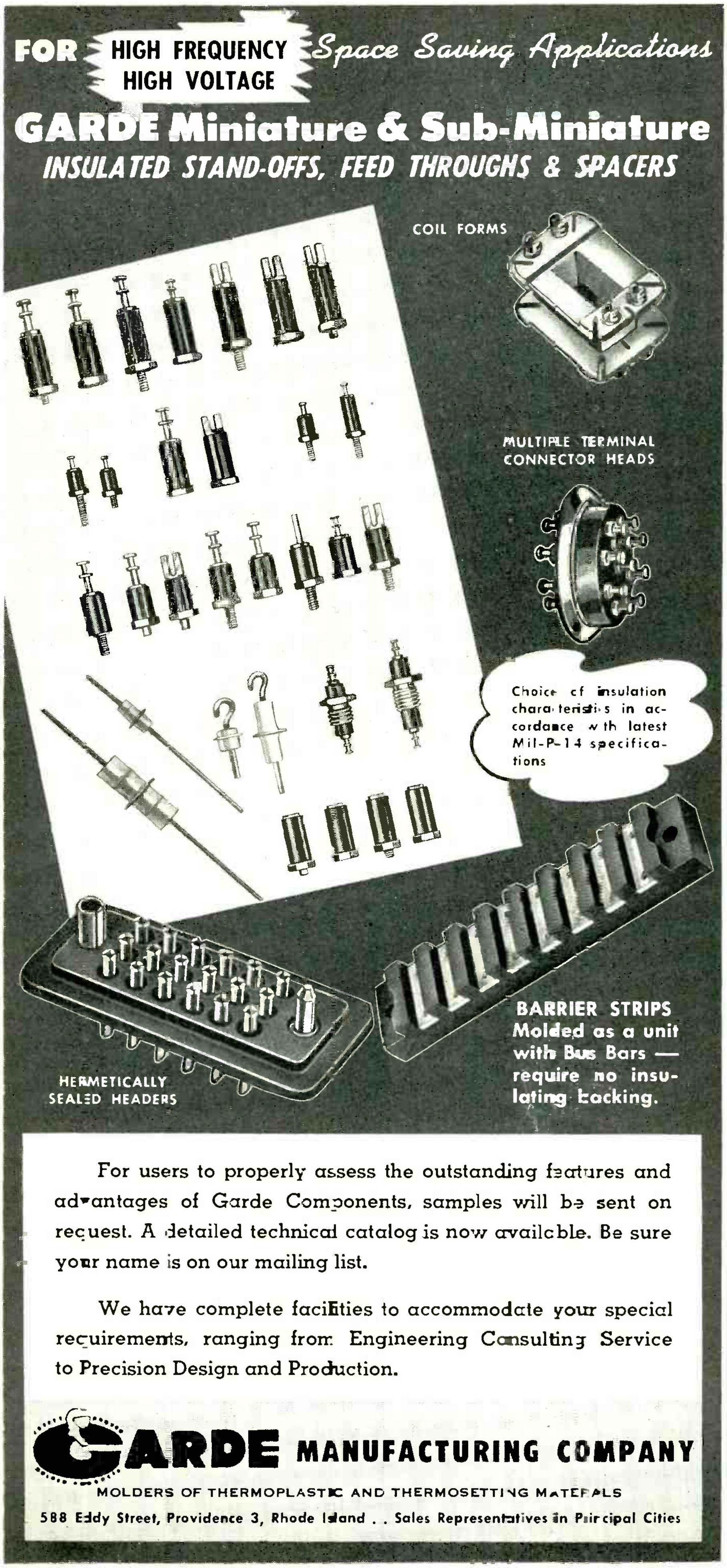

in 1946 and has held a number of positions in the aeronautical radio research and development activities of the corporation. He was made an assistant technical director of the laboratories in 1948 and was promoted to technical director in 1953.

Clavier joined IT&T in 1929 as a member of the engineering staff of Laboratoire Central de Telecommunications, an IT&T associate in Paris, and later became assistant director of the company. He was named an assistant technical director of FTL in 1946 and a technical director in 1952.

Norden-Ketay Merger Approved

STOCKHOLDERS of The Norden Laboratories Corp. approved a proposal for the integration of its business property and assets with Ketay Instrument Corp.

The integrated business will be conducted under the name of Norden-Ketay Corp. Morris Ketay, president of Ketay, will be president of Norden-Ketay and Paul W. Adams, president of Norden, will be executive vice-president. It is expected that the combined volume of the two companies will be more than $20,000,000.

Pyramid Appoints Chief Engineer

HOWARD S. ORCUTT has been appointed chief engineer of the rectifier division of the Pyramid Electric Co. of North Bergen, N. J.

He came to the company from Federal Telephone & Radio where he was senior engineer, rectifier department, components division. He was associated with that company for 11 years.

Prior to that, he served as assistant engineer for Consolidated Edison of New York City.

Midwestern Geophysical Makes New Changes

MIDWESTERN GEOPHYSICAL LABORATORY has changed its name to Midwestern Instruments. A subsidiary corporation has been formed which

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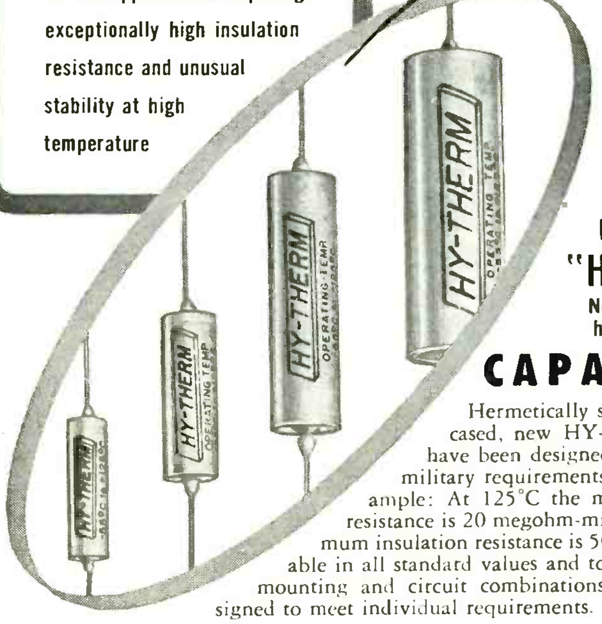

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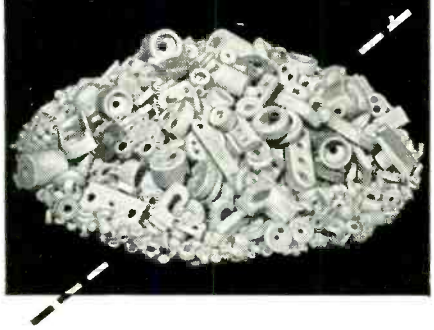

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Rutherford **ELECTRONICS CO.** 3707 S. ROBERTSON BLVD. CULVER CITY, CALIFORNIA will take over completely all geopsysical activities of the former corporation. It will be known by the old name of Midwestern Geophysical Laboratory.

The firm will build a new plant containing 78,000 sq ft of floor space.

Midwestern Instruments will continue to be primarily engaged in solving the problems associated with the recording of dynamic information.

Electronics Corp. Acquires Macdonald

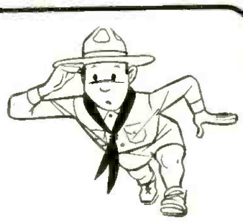
ELECTRONICS CORPORATION of America, acquired the W. S. Macdonald Co. of Cambridge, Mass., manufacturers of an electronic business machine, Magnefile. W. S. Macdonald founder and head of the company, and his staff, have become members of ECA.

Convair Selects Martin Kiebert

MARTIN V. KIEBERT, JR. has been appointed assistant to the chief engineer of Convair of Pomona, Calif. He was chief engineer of the tuner division of the P. R. Mallory.

Before that, he was director of the special products research department of Bendix Aviation where he was in charge of the LOKI missile project.

He has been a member of the Aeronautical Board, Guided Missile Committee while serving as a Commander in charge of the Guided



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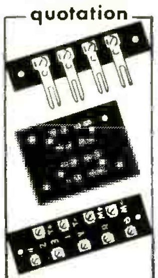

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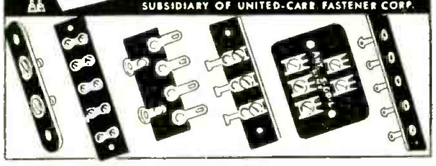

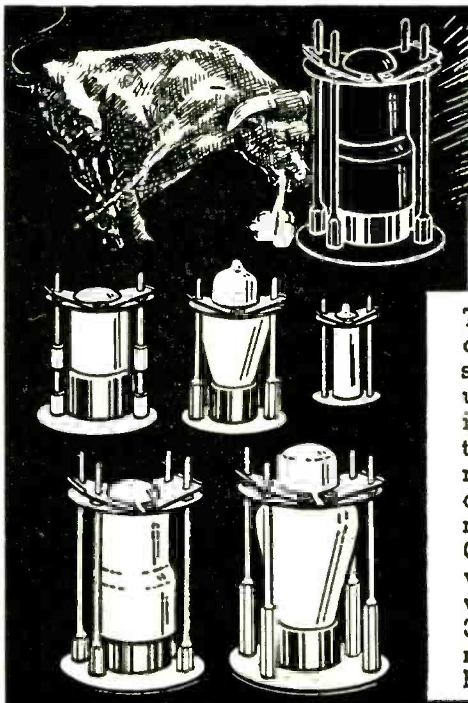

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Missile Branch, of the Navy's Bureau of Aeronautics.

Simmonds Names Development Chief

MYRON G. DOMSITZ, formerly associate technical director of Diamond Ordnance Fuze Laboratory, has been appointed chief engineer of Simmonds Aerocessories.

In his new position, he will direct the entire Simmonds research and development program. Prior to joining Simmonds, Domsitz was for more than ten years employed in ordnance development work at the National Bureau of Standards.

Hamilton Watch Acquires Hathaway

THE HAMILTON WATCH CO. acquired all the outstanding shares of the Hathaway Instrument Company of Denver, Colorado, producers of electronic instruments and measuring devices.

IRE Sets Technical Papers For 1955 Convention

The following is the complete list of technical papers and program events to be presented at the 1955 IRE National Convention in New York City on March 21-24:

Monday Afternoon, March 21

INSTRUMENTATION I

Direct-Reading Instrument for the Measurement of RMS Pulse Jitter by Jesse J. Taub and Charles I. Smith.

An Automatic Sonic Spectrum Analyzer and Curve Tracer by Edward F. Feldman.

A Simplified Method for the Measurement of Highly Linear Sawtooth Waveforms by Sherwood King.

The Diagraph, a Direct-Reading Instrument for Graphic Presentation of Complex Impedances and Admittances by Richard C. Hess.

Measurement of Parameters that Determine Front Edge Response of Pulse Transformers by Isidore Bady.

ANTENNAS & PROPAGATION 1—ANTENNAS

Efficiency of Surface Wave Excitation by A. F. Kay and F. J. Zucker.

Serrated Waveguide: Theory and Experiment by R. S. Elliott and K. C. Kelly.

Properties of a Radiating Discontinuity on a Corrugated Surface Transmission Line by M. J. Ehrlich and I. K. Williams.

Symmetrical Microwave Lenses by C. Goatley and C. F. Parker.

Lens and Feed System for Volumetric Scanning GCA Antenna by G. D. M. Peeler and W. F. Gabriel.

MOBILE COMMUNICATIONS

An Experimental Mobile Dispatching System by R. W. Collins and V. A. Douglas.

450 Megacycle Mobile Equipment Em-

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ploying Direct Frequency Modulation by W. Ornstein.

Design Problems of VHF Repeater Stations by J. R. Neubauer.

Evaluation of Sideband Noise and Modulation Splatter of VHF Transmitters by W. Firestone.

A Miniature Reflectometer for Portable and Mobile Transmitters by Edwin M. Stryker, Jr.

COMMUNICATIONS SYSTEMS

A New Horizon in Communication Theory—The Polyphase Concept by Allan A. Kunze and John G. Schermerhorn.

A Theorem Concerning Noise Figures by A. G. Bose and S. D. Pezaris.

Automatic Operation of a High Power Amplifier by V. R. DeLong.

The Use of Reflex Techniques in a VHF-UHF Communication System by Paul G. Wulfsberg.

A New Teletypewriter Using the Integration Method of Detection by Henning F. Harmuth.

INDUSTRIAL ELECTRONICS

An Instrument to Count and Size Particles Suspended in a Gas by Ernest S. Gordon.

Design Considerations of Microwave Ovens by Robert A. Rapuano and Robert V. Smith.

High-Speed Electronic Fault Protection for Power Tubes & their Circuitry by W. N. Parker and M. V. Hoover.

A Magnetic Thyratron Grid Control Circuit by James H. Burnett.

A Static Frequency Detector, Magnetic Type by Henry W. Patton.

TELEMETRY & REMOTE CONTROL—I —SYMPOSIUM: SOME PROBLEMS ASSOCIATED WITH TELEMETERING AND REMOTE CONTROL OF A SPACE STATION

The Use of Piloted Balloons as Space Laboratories by M. D. Ross

Ionic and Nuclear Problems of Rocket Propulsion by F. J. Murray

Instrumentation of a Minimum Satellite for Astro-Physical Research by S. F. Singer

Telemetering and Control of a Space Station by W. Von Braun.

Telemetering in the Development of Space Flight by C. E. Ruckstuhl, Jr.

Synthetic Training for Space Flight by G. V. Amico.

CIRCUIT THEORY I—SYMPOSIUM: NETWORK DESIGN

Influence of Computing Machines on Network Design Methods by John T. Bangert.

The Use of Potential Analogs in Network Synthesis by R. E. Scott.

Iterative Network Synthesis by Howard B. Demuth, George A. Caryotakis, A. Donald Moore.

The Use of Least Squares in Network Design by M. R. Aaron.

Summation and Outlook by Ernest A. Guillemin.

AUTOMATIC CONTROL—I

Analysis of Combined Sampled-and-Continuous Data Systems on an Electronic Analog Computer by Louis B. Wadel.

An Adaptive Servo System by A. H. Benner and R. F. Drenick.

Application of a Magnetic Amplifier to High-Performance Instrument Servo by Paul R. Johannessen.

A Nonlinear Compensating Configuration for Saturating Servomechanisms by W. H. Surber.

Delay-Line Methods for Compensating Closed-Loop Systems in the Time Domain by R. E. Scott and Y. C. Ho.

Tuesday Morning, March 22

TELEMETRY & REMOTE CONTROL II —REMOTE CONTROL

New Apparatus and Techniques of Air Traffic Control Data Handling and Display by David J. Anthony.

The Role of the Digital Computer in Processing Guided Missile Data by H. N. Morris.

A New Method for Designing the Compensation of Feedback Control Systems by Gilbert S. Stubbs.

Analysis of Sampled Data Systems and Digital Computers in the Frequency Domain by Rubin Boxer.

ANTENNAS & PROPOGATION II—ANTENNAS

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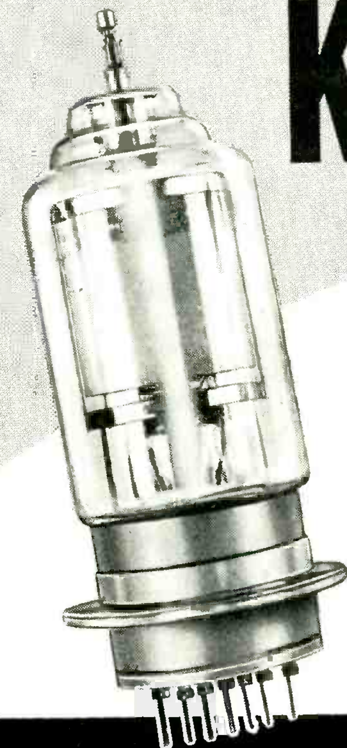

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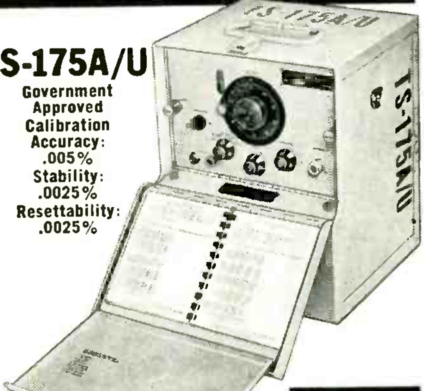

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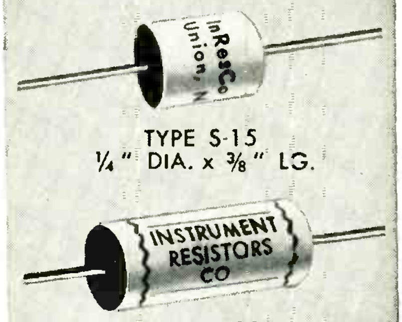

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tenna by D. L. Holzschuh.

The Omniguide Antenna; an Omnidirectional Waveguide Array for UHF-TV Broadcasting by O. M. Woodward, Jr. and James Gibson.

The Circular Traveling-Wave Antenna by W. J. Bergman and F. V. Schultz.

Stripline Radiators by James A. McDonough.

AERONAUTICAL & NAVIGATIONAL ELECTRONICS I—AIRBORNE DEVICES AND ENVIRONMENT

Aircraft Electronics — Environment, Specifications and Survival by M. B. Levine and F. Mintz.

Dynamic Environmental Testing of Airborne Electronic Components by R. H. Jacobson and M. B. Levine.

A Communication Theory Approach Toward the Design of Aircraft Instrument Displays by Lawrence J. Fogel.

The C19K Charactron by J. T. McNaney.

Versatility of Floated-Type Rate Integrating Gyroscopes in Systems Applications by J. W. Lower.

BROADCAST TRANSMISSION SYSTEMS I—TV BROADCASTING

Synchronization of Multiplex Systems for Recording Video Signals on Magnetic Tape by Donald E. Maxwell and William P. Bartley.

Channel Response Requirements of Multiplex Systems for Recording Video Signals on Magnetic Tape by Benjamin G. Walker.

Ferrite Heads for Magnetic Recording in the Megacycle Range by William R. Chynoweth.

Attenuation Measurements on Short Line Samples by Louis E. Raburn.

A New Television Transmitting Antenna by R. W. Masters and C. J. Rauch.

Spurious Emission Filters for High Power TV Transmitters by William J. Judge, Jr.

AUDIO I—GENERAL

Electronically Controlled Audio Filters by L. O. Dolansky.

Distortion in Class B Transistor Amplifiers by Maurice V. Joyce.

Detection of Audio Power Spectrum Dispersion by H. S. Littleboy and J. Wiren.

Calibration of Test Records by B-Line Patterns by B. B. Bauer.

Design and Performance of a High Frequency Electrostatic Speaker by Lloyd J. Bobb, R. B. Goldman and R. W. Roop.

Electronic Music Synthesizer by H. F. Olson and H. Belar.

INFORMATION THEORY I

Coding for Noisy Channels by Peter Elias.

Rate of Approach to Ideal Coding by C. E. Shannon.

The Mathematics of Information Theory by Brockway McMillan.

Session Commentary by Robert M. Fano.

INSTRUMENTATION & TELEMETRY AND REMOTE CONTROL

Compound Modulation: Method of Recording Data on Magnetic Tape by George B. Newhouse.

Development of a Portable Magnetic Tape Recorder for Precision Data Recording by Glenn D. Maxwell.

A System for Precise Time-Storage and Expansion of Electrical Data by Clarence B. Stanley.

Automatic Oscillograph Readers by L. L. Fisher and G. L. Hatchett.

Analysis of Data Recording Systems by Thomas L. Greenwood.

ELECTRON DEVICES I—TUBES

A Gas Discharge Noise Source by Philip Parzen and W. Honig.

Corrections to the Theory of the Grounded-Grid Triode by W. A. Harris.

Development of a Large-Diameter Dumet Lead for Sealing to Soft Glass by D. L. Swartz and J. C. Turnbull.

Novel Design Approach for Microwave Tubes by J. E. McLinden and D. Lichtman.

Magnetron Operation at Very-Long Pulses by Marcus Nowogrodzki.

Tuesday Afternoon, March 22
INSTRUMENTATION II

A New Instrument for the Automatic Measurement of Transistor Noise Figure by D. D. Grieg and S. Moskowitz.

A Radio Frequency Parameter Bridge for Junction Transistors by Anthony Hlavacek and Ge Yao Chu

A Versatile Transistor Tester for Measuring Open Circuit "T" Parameters by R. P. Crow.

A Transistorized Oscillograph by W. G. Reichert, Jr.

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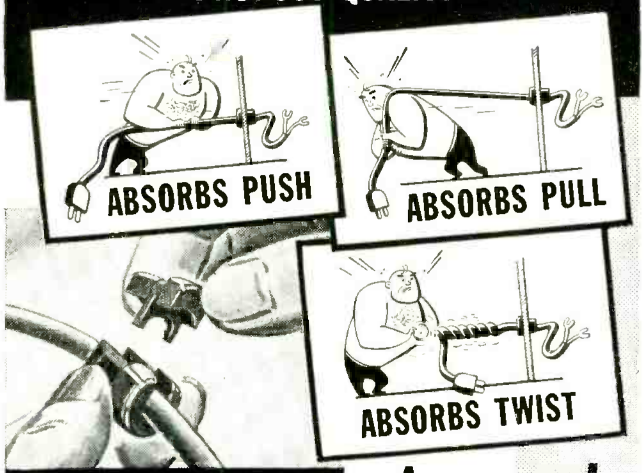

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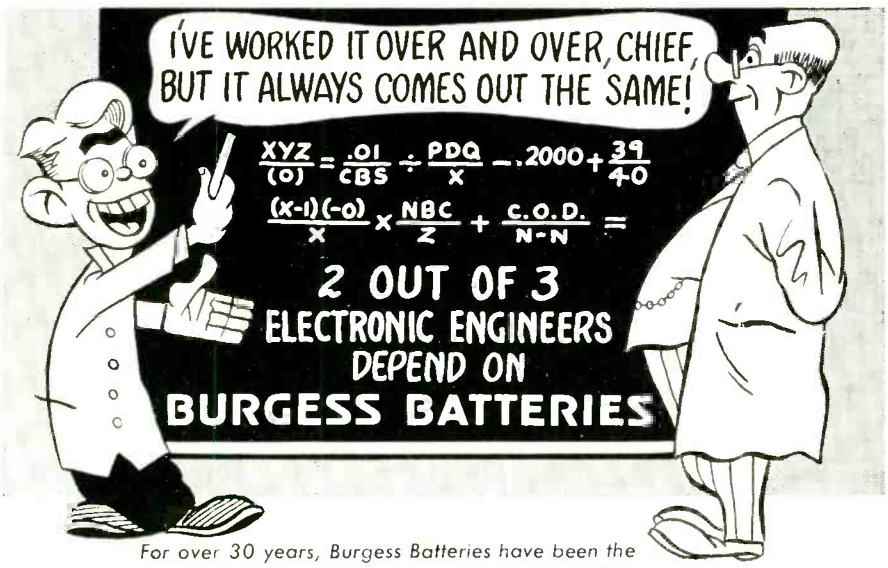

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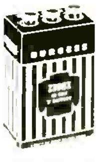

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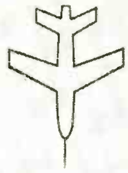

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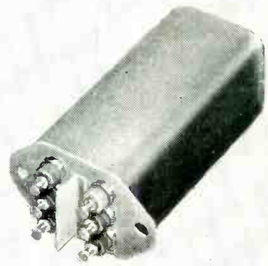

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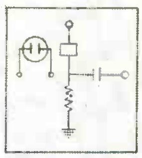

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ment by Charles C. Comstock.

ENGINEERING MANAGEMENT I PANEL DISCUSSION: OPERATIONS RESEARCH—A TOOL OF ENGINEERING MANAGEMENT

AERONAUTICAL & NAVIGATIONAL ELECTRONICS II—RADAR AND AIRCRAFT LANDNG AIDS

Airport Surface Detection Equipment by J. E. Woodward.
A Marine Radar Identification System by Charles M. Titlin.
Statistical Techniques for Analysis of ILS Flight-Test Data by Abe Tatz.
An Analysis of Angular Accuracy in Search Radar by Robert Bernstein.
Radio Direction Finding from the Standpoint of Sampling and Interpolation by M. Masonson.

BROADCAST TRANSMISSION SYSTEMS II—COLOR TELEVISION

Proposed Controls for Electronic Masking in Color Television by W. L. Brewer, J. H. Ladd and J. E. Pinney.
Experimental Equipment for Recording and Reproducing Color Television Images on Black and White Film by W. L. Hughes.
Cathode-Ray Vectrograph by Frank Uzel, Jr.
Automatic Balance Control of Colorplexers in Color TV by J. R. Popkin-Curman.
Television in Europe by Hubert A. S. Gibas.

AUDIO II—SYMPOSIUM: MUSIC, HIGH FIDELITY, AND THE LISTENER

Electronic Organ Tone Radiation by Daniel W. Martin.
The Role of Room Acoustics in Music Listening by J. A. Kessler.
Environment-fitness Considerations of High Fidelity Audio Systems by Robert D. Darrell.
Acoustic Requirements of a Sound System Determined by the Listener by Cyril M. Harris.
Man, A Somewhat Neglected Component of Hi-Fi Systems by Walter A. Rosenblith.

TELEMETRY AND REMOTE CONTROL III—RECENT TELEMETERING DEVELOPMENTS

A Multiple Frequency Antenna Coupling System by H. R. Sigler.
Germanium Photo-Conductor as Missile Spin Counter in an All-Transistor FM/FM Telemeter Transmitter by C. M. Kortman.
Linear Voltage Controlled Frequency Modulation of the Hartley Oscillator by W. F. Link.
Application of Process Circuitry to Telemetering Components by L. A. G. Ter Veen.
Wide Band AC Rate Networks by L. F. Lyons.

ELECTRON DEVICES II—MICROWAVE TUBES

Klystron Power Amplifiers for Long-Hop Microwave Relay by N. P. Hiestand.
Wide-Band, High Power Traveling-Wave Tubes at S-Band by S. F. Kaisel and W. L. Rorden.
A 1 KW Pulsed Traveling-Wave Tube Amplifier at X-Band by J. E. Nevins. S. F. Kaisel and M. Chodorow.
Noise Analysis of Traveling-Wave Tube Video Detector by Glen Wade.

Tuesday Evening, March 22

AUTOMATIC CONTROL II—TRENDS IN AUTOMATIZATION OF PROCEDURES AND PROCESSES IN BUSINESS AND INDUSTRY

Panel Members: Richard L. Meier, W. R. G. Baker, Low K. Lee, Roger W. Bolz.

AUDIO III—SEMINAR: MAGNETIC RECORDING FOR THE ENGINEER

Magnetic Tape as a Recording Medium by Frank Radocy.
Recorder-Reproducer Design by Walter T. Selsted.
Tape Recording Applications by Marvin Camras.
Tape Life by William S. Latham.
The Future of Tape Recording by J. S. Boyers.

Wednesday Morning, March 23

ULTRASONICS I

Antenna-Type Transducers for Ultrasonic Flowmetering by R. C. Swengel.
Electrokinetic-Hydrophones by Ernest Yeager.
Characteristics of Torsional Transducers by R. N. Thurston and P. Andreatch.
Parameters Affecting the Q of Quartz Crystal Units by A. W. Warner.
The Frequency-Temperature Behavior of

Piezoelectric Resonators Made of Natural and Synthetic Quartz by Rudolph Bechmann.

Ultrasonics in Decortication of Natural Fibers by E. R. Fleming.

ELECTRONIC COMPUTERS I

Experiments on a Three-Core Cell for High-Speed Memories by J. Raffel and S. Bradspies.

Bimag Circuits for Digital Data--Processing Systems by David Loev, William Miehle, John O. Paivinen and Joseph Wylen.

A Transistor-Magnetic Core Circuit; A New Device Applied to Digital Computing Techniques by S. S. Guterman and W. M. Carey, Jr.

A "One Turn" Magnetic Reading and Recording Head for Computer Use by D. F. Brower.

Magnetic Selection Systems Using a Single Pyramid for Both Selective Writing and Reading in Large-Scale Electronic Computers by Amir H. Sepahban.

MICROWAVE THEORY & TECHNIQUES I—MICROWAVE COMPONENTS

Wideband Waveguide Rotary Joint by Henry Schwiebert.

The Use of Modified Coaxial Structures for the Instrumentation of Components in Coaxial Line by B. Dwork and A. A. Oliver.

High Power Breakdown of Microwave Components by G. K. Hart and M. S. Tannenbaum.

A Low Noise Figure Microwave Crystal Diode by G. Messenger and C. T. McCoy.

Tapered Velocity Couplers by J. S. Cook and A. G. Fox.

PRODUCTION TECHNIQUES — ELECTRONIC EQUIPMENT ASSEMBLY METHODS

Electronic Design for a Digital Computer by R. J. O'Neill.

A Flexible Automatic Component Assembly System by Ben Warriner and George W. Gamble.

Principles of Circuit Packaging for Auto-Sembly by Sherman G. Bassler and Myron Hinebaugh.

Standards for Automation by J. J. Graham.

Mechanization of Electronic Equipment by Frank B. Iles.

An Engineering Approach to Printed Circuitry and Automation for Television Receivers by Rinaldo DeCola and George Harrigan.

INSTRUMENTATION AND NUCLEAR SCIENCE

An Atomic Frequency Standard by Jerrold R. Zacharias, James G. Yates and R. D. Haun, Jr.

A Molecular Microwave Amplifier, Oscillator, and Frequency Standard by Charles H. Townes.

Collision Reduced Doppler Effect. A Sodium Clock? by R. H. Dicke

Eddy-Current Bridge for Measurement of Skin Losses by Quentin A. Kerns.

Modifications to the Hutchinson-Scarrott Pulse Height Analyser to Obtain a Coded Decimal Presentation and a Decimal Print-Out by J. L. McKibben, J. D. Gallagher and H. J. Lang.

SYMPOSIUM ON SPURIOUS RADIATION

CIRCUIT THEORY II—GENERAL THEORY

A Generalization of Foster's and Cauer's Theorems by F. M. Reza.

On the Separability of LaPlace Transform Variable and its Applications in Carrier Systems by Sheldon S. L. Chang.

A New Approach to the Approximation Problem by W. L. Baker.

A New Series Representation for Correlation Function by W. M. Kaufman and J. B. Woodford.

Theory of Low-Frequency Oscillators Employing Point-Contact Transistors by B. J. Dasher, D. L. Finn and T. N. Lowry.

ANTENNAS AND PROPAGATION III: PANEL DISCUSSION EXTENDED RANGE VHF AND UHF PROPAGATION

Panel Members: Kenneth Bullington, William E. Gordon, Oswald Villard, Dana Bailey and Walter Morrow.

Wednesday Afternoon, March 23

ULTRASONICS II

Nondestructive Testers by Means of Ultrasonics by Bertram M. Harrison.

Ultrasonic Echo-Ranging for Tissue Diagnostic Studies by John M. Reid and

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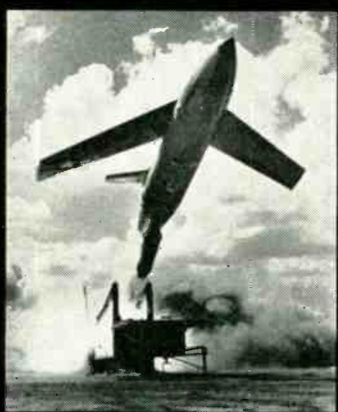

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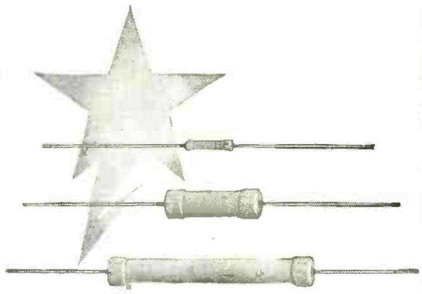

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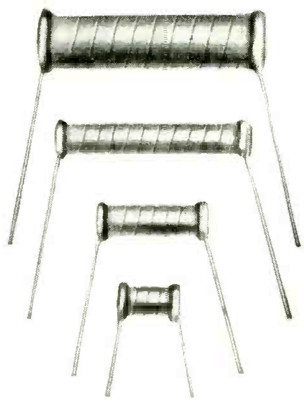

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Techniques Used in the Ultrasonic Visualization of Soft Tissue Structures of the Body by Douglas H. Howry.

Technical Aspects of the Cavitron Ultrasonic Process in Dentistry by Lewis Balamuth.

Application of Ultrasonics to Clinical Dentistry by Alvin E. Strock.

Ultrasonic Destruction of Erythrocytes by Eugene Ackerman and David B. Lombard.

ELECTRONIC COMPUTERS II—SYMPOSIUM: THE DESIGN OF MACHINES TO SIMULATE THE BEHAVIOR OF THE HUMAN BRAIN

Panel Members: Anthony G. Oettinger, Warren S. McCulloch, Nathaniel Rochester and Otto H. Schmitt.

MICROWAVE THEORY & TECHNIQUES II—MICROWAVE TECHNIQUES

A Broadband Electronic Doppler Simulator by Gershon J. Wheeler and John Reed.

A Contribution to Microwave Measurements by F. J. Tischer.

Measurement of Electromagnetic Parameters by Use of Spheres Placed Near a Wall in a Resonant Cavity by W. K. Saunders.

Impedance Measurement Through a Discontinuity in a Transmission Line by R. Mittra.

Measurement of Small Complex Reflection Coefficient by Howard Scharfman.

QUALITY CONTROL AND RELIABILITY STUDIES OF ELECTRONIC TUBES AND SYSTEMS

Prediction of Missile Reliability by M. J. Kirby and H. R. Powell.

Detection of Intermittent Circuit Faults by Sidney Wald.

Statistics of Electronic System Failures by J. H. Parsons, K. L. Wong, and A. S. Yeiser.

New Reliable Voltage Reference Tubes for Severe Environmental Conditions by Earl J. Handly.

Guided Missile Reliability and Electronic Production Techniques by Alfred R. Gray.

BROADCAST AND TELEVISION

A Developmental Pocket-Size Broadcast Receiver Employing Transistors by D. D. Holmes, T. O. Stanley and L. A. Freedman.

Progress in Ferrite Components for Television and Radio Receivers by H. M. Schlicke.

What Price Horizontal Linearity by M. Burgett and J. Tossberg.

A Compatible High Definition Monochrome Television System by Pierre M. G. Toulon and Francis T. Thompson.

Determination of the Optimum Demodulation Angles in Color Receivers by Stephen K. Altes.

A Color Projection Receiver by W. F. Bailey and R. P. Burr.

CIRCUIT THEORY III—FILTERS AND LINES

A Method of Rational Function Approximation for Network Synthesis by N. DeClaris.

Input Capacitance of Maximally-Flat Filters by John L. Stewart.

Application of Time Series to the Calculation of the Transient Response of Band-Pass Systems by C. J. Peters and J. B. Woodford.

Maximizing the Band-Pass Ratio in Impedance Transforming Filters by D. H. Geipel and R. L. Bright.

Miniaturized High Impedance Magnetic Core Delay Line by H. W. Katz and R. E. Schultz.

ANTENNAS & PROPAGATION IV—PROPAGATION

Airborne Measurement of Effective Ground Conductivity at Low Frequency in Alaska by Glenn M. Stanley and T. Neil Davis.

Atmospheric Attenuation of Microwave Radiation by Gene R. Marner.

Back-Scattering from the Sea Surface by Martin Katzin.

Measurements of Correlation, Height Gain, and Path Antenna Gain at 1046 Megacycles on Spaced Antennas Far Beyond the Radio Horizon by A. F. Barghausen, M. T. Decker and L. J. Maloney.

An Airborne Radar and Wave Propagation Laboratory by David L. Ringwalt.

Thursday Morning, March 24

MEDICAL ELECTRONICS I:—PANEL DISCUSSION

Stanley Briller, Coleman C. Johnston, Joseph Moldaver, J. W. Buchta, Britton

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Chance, H. F. Skifter and Saul R. Gilford.

INFORMATION THEORY II

Time-Varying Filters for Nonstationary Signals on a Finite Interval by Arnold H. Koschmann

Analysis of Linear Systems with Randomly Varying Inputs and Parameters by A. Rosenblum, J. Heilfron and D. L. Trautman.

Detection of Coherent and Noncoherent Pulsed Signals by P. Nesbeda, R. F. Drenick and S. Gartenhaus.

The Linear Filtering of Sampled Data by Gene Franklin.

ELECTRON DEVICES III—CATHODE RAY TYPE TUBES

A Time-Sampling and Amplitude-Quantizing Tube by R. P. Stone, C. W. Mueller and W. M. Webster.

Cathode-Ray Tube with Single Step Intensifier by Jenny E. Rosenthal.

An Electrostatic Shutter Image Converter Tube by B. R. Linden and P. A. Snell.

A New High Efficiency Parallax Mask Color Tube by M. E. Amdursky, R. G. Pohl and C. S. Szegho.

The Tricolor Vidicon, An Experimental Camera Tube for Color Television by P. K. Weimer, S. Gray, H. Borkan, S. A. Ochs and H. C. Thompson.

COMPONENT PARTS I—ELECTROMAGNETIC DEVICES

Blocking Oscillator Transformer Design by P. R. Gillette, K. W. Henderson and K. Oshima.

Improvements in Pulse-Switching Reactor Design by R. A. Mathias and E. M. Williams.

Magnetostriction Resonators as Circuit Elements by R. T. Adams.

Wide-Range Electrically Tunable Oscillators by John L. Stewart and Kermit S. Watkins.

Fluorochemical Liquid and Gases as Transformer Design Parameters by L. F. Kilham, Jr., and R. R. Ursch.

NUCLEAR SCIENCE I

A Study of a Variable Frequency Cyclotron Resonant System by M. R. Donaldson, R. E. Worsham and N. F. Ziegler.

Bevatron Operation by Dick A. Mack.

A 100 Channel Pulse Height Analyser Using Magnetic Core Storage by Preston W. Byington and C. Wilkin Johnstone.

One Hundred Channel Serial Memory Pulse Height Analyser by T. L. Emmer.

Nuclear Reactor Control Systems Utilizing Solid-State Devices by Shephen F. Malaker and Edward Rathje.

A New Frequency-Modulation System for the UCRL 184-inch Cyclotron by Quentin A. Kerns.

ENGINEERING MANAGEMENT II—GENERAL

Cost Consideration in Automatic Production by E. Finley Carter.

Personal Responsibilities of the Professional Engineer by D. J. Simmons.

The Management of Basic Research by T. M. Linville.

The Organization and Management of Engineering in a Small Company by Roderick M. Scott.

MICROWAVE THEORY & TECHNIQUES III—FERRITES

Behavior of Ferroxdure at Microwave Frequencies by Max T. Weiss.

Some Applications and Characteristics of Ferrite at Wave-Lengths of 0.87 cms and 1.9 cms by Clyde Stewart.

Microwave Devices Using Ferrite and Transverse Magnetic Field by Jorgen P. Vinding.

Broadband Ferrite Characteristics by Murray B. Loss.

Measurement of Microwave Electric and Magnetic Susceptibilities of Ferrite Spheres by E. G. Spencer, R. C. LeCraw and F. Reggia.

ELECTRONIC COMPUTERS III

The Typotron—A Novel Character Display Storage Tube by H. M. Smith.

Electrographic Recording by H. Epstein and F. T. Innes.

Surface-Barrier Transistor Computer Circuits by R. H. Beter, Wm. E. Bradley, Ralph B. Brown and Morris Rubinoff.

Semi-Conductor Diode Amplifier Considerations by Henry W. Kaufmann.

An Electronic Circuit for the Generation

of Functions of Several Variables by Hans F. Meissinger.

Thursday Afternoon, March 24

MEDICAL ELECTRONICS II—GENERAL

New Linear Electron Accelerators for Radiotherapy by John C. Nygard, M. G. Kelliher and L. S. Skaggs.

Cineradiography by L. B. Lusted, E. R. Miller and E. Nickel.

The Use of U-V Microspectrophotographic and Phase and U-V Television Densitometry Techniques in Medical Research by Philip O'B. Montgomery.

Application of the Television Ultraviolet Microscope to the Direct Visualization of Cytological Absorption Characteristics by George Z. Williams.

Some Applications of Scanning Techniques in Instrumentation by C. Berkley and H. P. Mansberg.

ENGINEERING MANAGEMENT III—SYMPOSIUM: MANAGEMENT SELECTION AS VIEWED BY PSYCHOLOGISTS AND ENGINEERING EXECUTIVES

Selection of Technical Managers as Viewed by a Personnel Psychologist by A. P. Johnson.

Psychological Means for the Selection of Managers by John C. Flannigan.

Selection of Engineering Executives by Leroy N. Vernon.

Balance in Management Selection by Ronald L. McFarlan.

The Selection of Technical Management Personnel by Dean E. Wooldridge.

ELECTRON DEVICES IV—TRANSISTORS

Thermal Properties of Semiconductor Diodes by J. N. Carman and W. R. Sittner.

Grain Boundaries and Transistor Action by Herbert F. Matare.

Developments in Silicon Junction Diodes and Power Rectifiers, by H. Gunther Rudenberg.

Comparative High-Frequency Operation of Junction Transistors Made of Different Semiconductor Materials by L. J. Giacoletto.

Characteristics and Some Applications of Fused Junction PNP Germanium Transistors for High Frequency Use by R. D. Greene.

COMPONENTS PARTS II—GENERAL

A Miniature Precision Delay Line by James B. Hickey.

Criteria And Test Procedures For Electro-Magnetic Delay Lines by Norman Gaw and David Silverman.

Evolution of Selenium Rectifier Voltage Ratings by Norman Bechtold.

A Precision Deflection Yoke by Harold J. Benzuly.

Ceramic-To-Metal Seals For Magnetrons by Leo J. Cronin.

INFORMATION THEORY III

Communication Theory Model and Economics by Samuel Bagno.

Removal of the Redundancy Due to Intersymbol Interference by H. Davis and D. L. Trautman.

Noise Through Nonlinear Devices. by Ralph Deutsch.

Linear Filter Optimization with Game Theory Considerations by M. C. Yovits and J. L. Jackson.

The Effect of AGC on Radar Tracking Noise by R. H. DeLano and I. Pfeffer.

MICROWAVE COMMUNICATIONS AND SYSTEMS

Evaluation of Survey Methods for Use in Microwave Path Analysis by W. C. Eddy.

A Monopulse Radar Technique by R. M. Page.

A Frequency Selective Directional Coupler for Multiplexing by Herbert J. Carlin.

Application of Ferrites for Audio Modulation of Microwaves by Philip Zirkind.

A Narrow Band Radar Relay System by J. L. McLucas and C. W. Doerr.

AERONAUTICAL & NAVIGATIONAL ELECTRONICS III—NAVIGATION

An All Weather Radio Sextant by D. O. McCoy.

A UHF Ground Based Automatic Direction Finder by L. Cattoi.

Wullenweber Type Ultra High Frequency Radio Direction Finder by Richard C. Benoit, Jr. and W. M. Furlow, Jr.

High Precision Computer for Automatic Solution of the Celestial Triangle by Gene R. Marner.

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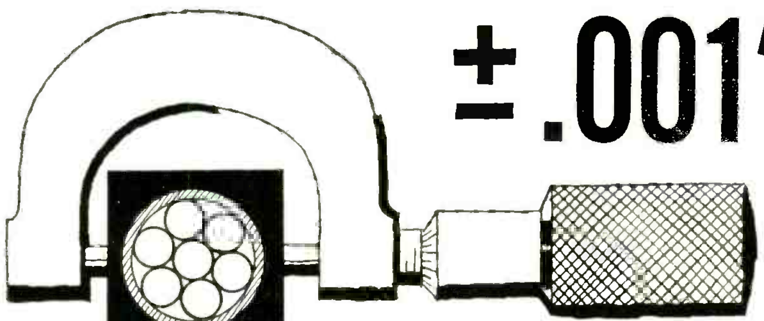

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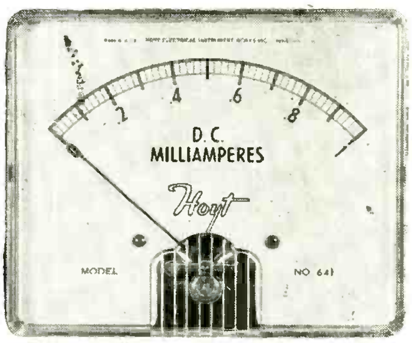

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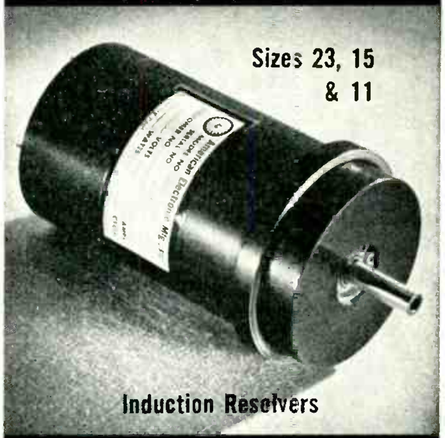

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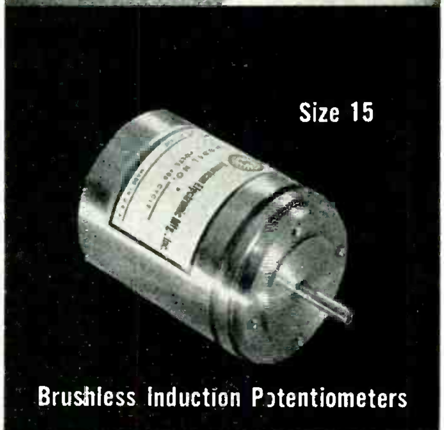

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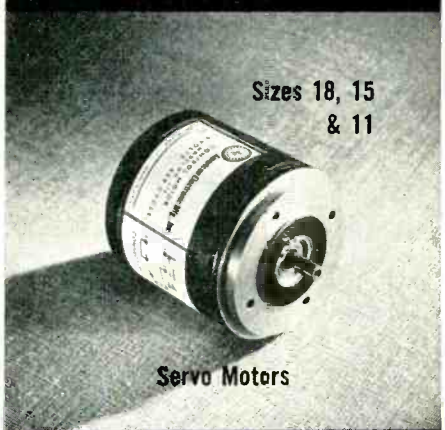

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NEW BOOKS

Electronic Measuring Instruments

BY E. H. W. BANNER. *Chapman & Hall, London, England* 1954, 395 p, 45s.

AS THE AUTHOR points out in the preface, this book is an out-growth of public interest in a survey of the field of electronic instruments published in *Electronic Engineering* in May 1950.

The author, a consultant, has paid tribute to the assistance rendered by his colleagues, Messrs. Carter, Reyner and Walker, in compiling chapters on their specialty fields of vacuum tubes, cathode ray tubes and instruments, and photo-electric devices, respectively. A notable section is also contributed by Dr. Denis Taylor of the Atomic Energy Research Establishment, England on radiation and nucleonic measurement devices.

Contents

This book is essentially a survey of the field of electronic measuring instruments and should not be confused with a teaching textbook or scientific treatise. The working is entirely descriptive, with scarcely any formulas or mathematics. It is clearly the object of the author to give mention in passing to as many electronic instruments as possible. This is certainly redeemed by a good bibliography which allows a reader to obtain fuller knowledge of any particular instrument.

The title, incidentally, seems somewhat of a misnomer to the reviewer since notable omissions in the treatment include radio test equipment such as signal generators and oscillators. Indeed, most of the treatment leads up to the detailing, in the latter half of the book, of nucleonic measuring instruments of British design circa 1951-1952.

Succinctly, the book divides into some four parts.

Part I, touching on electrical indicating mechanisms rather lightly.

Part II, dealing with the components that might go into the electronic part of any measuring in-

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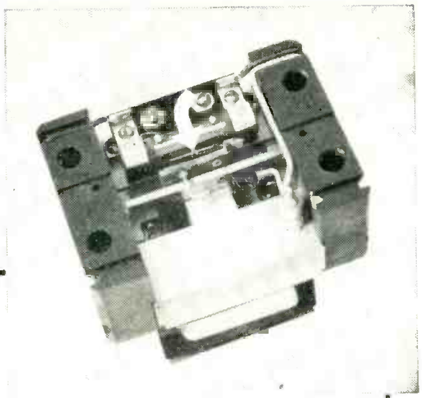

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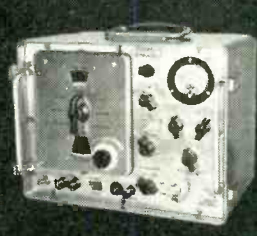

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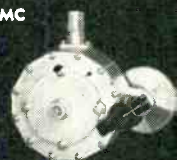

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strument, together with a very good description of some basic components required in nucleonics, such as radiation detectors.

Part III, covering the marriage of indicating mechanisms, electronic and nucleonic components to cover the field of nucleonic detectors and measuring equipment.

Part IV, dealing with various electro-mechanical transducers, counters and scalers that come under the heading of quasi-electronic devices.

Summary

The book gives an extended survey of British practice up to 1951-1952 with a full bibliography. The book describes fully the method of operation of these instruments but quotes little in the way of end results, almost nothing in the way of mathematical equations and does not say too much on the limitations of usage. It, however, does have a very considerable appeal to the engineer seeking to enlarge his knowledge of the boundaries of the electronic field and above all, gives a good picture of the British contribution to the science of radiation and nucleonic measurement, up to 1952.—R. C. LANGFORD, *Weston Electrical Instrument Corp., Newark, N. J.*

Acoustics

BY LEO L. BERANEK, *McGraw-Hill Book Co., New York, N. Y.*, 1954, 481 *p*, $9.00.

THIS BOOK constitutes the subject matter of a course that the author taught to seniors and first-year graduate students in electrical engineering and communication physics at the Massachusetts Institute of Technology. Accordingly, the general format is that of a textbook rather than a reference book. This treatment is emphasized by 104 problems at the end of the book illustrating the application of the subject matter of each chapter. Although there are many references to contemporary publications, the usefulness of the book as a reference text is reduced somewhat because many important references are omitted.

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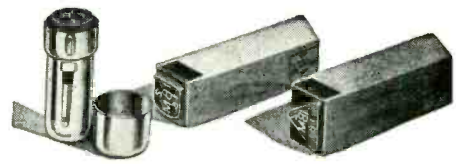

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eral introduction and the terminology of acoustics. The author promotes the MKS system of units, but fortunately he has not abandoned the CGS system because the latter system is particularly useful in the design of sound reproducers.

The second chapter includes the development of the fundamental wave equation in one and three dimensions, a solution of the wave equation, the resultant expressions for the pressure, particle velocity, intensity and energy density in plane and spherical waves and some considerations of the expressions for standing waves.

The third chapter deals with electro-mechano-acoustical circuits. Use is made of analogies with electrical circuits in the solution of the problems of mechanical and acoustical vibrating systems. The author introduces and uses both the impedance and mobility analogies. In this connection, the use of symbols in acoustic and mechanical networks is developed to a very high order by the author.

The fourth chapter involves the radiation of sound from simple, doublet, multiple, piston, curved and horn sources. Included is a consideration of the directivity index.

Acoustic Elements

The fifth chapter is devoted to a complete exposition of the acoustic impedance of various acoustical elements. However, there are no considerations of the vibrations of bars, plates, membranes, etc used in transducers.

Microphones, direct radiator and horn loudspeakers and enclosures are considered in the next four chapters. The principles of some of the common microphones are developed. However, descriptions of many important microphones are omitted. The outstanding feature in these chapters is the original and very extensive consideration of baffles and enclosures for direct-radiator loudspeakers. A large section is devoted to the bass reflex enclosure.

The consideration of sound fields in both small and large rooms is very complete. This chapter considers the normal modes and normal

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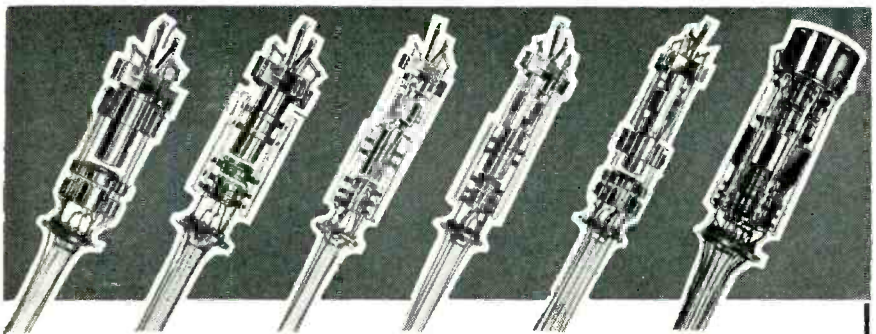

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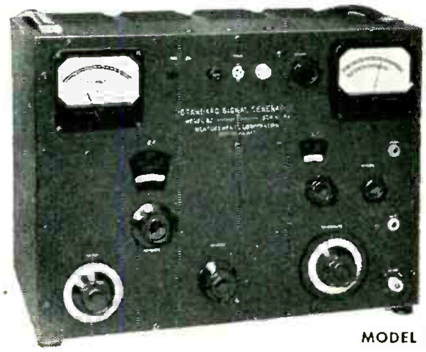

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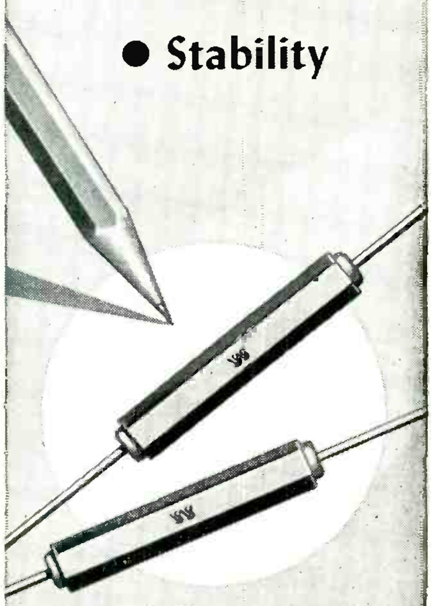

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frequencies in a room, the transient and steady-state sound pressures and the reverberation characteristics. This is followed by a description of the effects of air and boundary absorption. The performance of directional and nondirectional sound sources in a room is also given. The final section in this chapter covers the transmission of sound through walls between enclosures.

Chapter eleven contains an excellent exposition of a subject of timely interest, namely, noise control. The subject matter of this chapter includes: noise control procedures, power levels of typical sound sources, acoustic transmission paths both indoors and outdoors, mufflers, ducts and filters.

The next chapter on measurements describes the selection and calibration of apparatus for the measurement of sound pressure, power levels and frequency analyzers. The factors involved in the use of the sound level meter are outlined. The reciprocity theory is developed and applied to the calibration of microphones.

The last chapter covers the subjects of hearing, speech intelligibility and psychological criteria. The subjects considered include the following: thresholds of hearing, pitch, loudness, differential sensitivities, masking, speech intelligibility, the effects of noise, tolerable noise levels, etc.

The book clearly and concisely presents the basic theory and applications of modern acoustics. The book is well illustrated and reinforced by an extensive list of problems illustrating the subject matter of the book.—HARRY F. OLSON, *RCA Laboratories, Princeton, N. J.*

Ultrasonic and Ultrashort Waves In Medicine

BY JOHANNA M. VAN WENT, M. D., *Director, Institute for Physical Medicine and Rheumatism, Amsterdam. Elsevier Publishing Company, N. Y.*, 1954, 384 *p.*, $9.00.

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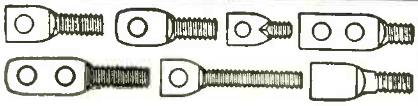

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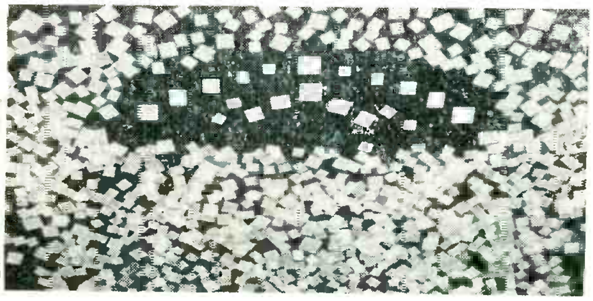

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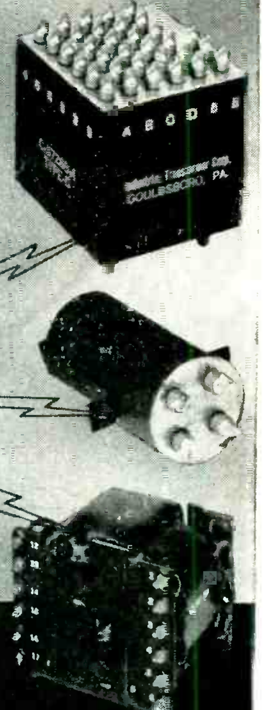

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plete absence of scientific thoroughness.

The above defects may be indicated by the following two quotations: Page 38: "Krusen et al. report on investigations in which a very high dosage was given purposely; various changes were found." Page 110: "Of the other cutaneous affections which have been treated with ultrasonic waves by various therapists, the following are mentioned: Personal experience. Two patients were treated. Satisfactory results." These quotations have not lost meaning by being taken out of context.

The bibliography in fine print covers 86 pages. The book appears to be of value only as an annotated bibliography.—W. E. GILSON, M.D., *University Hospitals, Madison, Wis.*

Methods of Theoretical Physics

BY P. M. MORSE AND H. FESHBACH, *McGraw-Hill, N. Y.*, 1953, 1,978, *pages in two parts*, $15 *each part.*

FOR MANY YEARS, the mimeographed notes on theoretical physics by Morse and Feshbach have proven invaluable as a source of reference material to research workers in the field of advanced waveguide theory and propagation theory. These notes, which were originally used in the graduate school at MIT, have been greatly expanded and form the basis for the present two-volume treatise. These volumes will prove useful, not only to the workers mentioned but to all those who apply mathematical methods to physical problems.

Until recently, the only extensive advanced treaties on mathematical physics have been written in German. Although graduate students are supposed to have a reading knowledge of German, this reviewer has yet to meet very many who professed to be really expert at the language. While such books as those by Frank and von Mises or Courant and Hilbert have been the bible of many mathematical physicists, it is safe to say that the aver-

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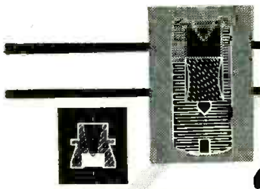
age American student would be just as happy if his initial introduction to difficult mathematical and physical concepts was not further complicated by the nuances of an unfamiliar language.

This situation has been partially alleviated by the translation of the first volume of Courant and Hilbert and by the translation of the series on physics by Sommerfeld. Nonetheless, the appearance of the volumes by Monse and Feshbach will be heartily welcomed since not only is it the most comprehensive treatment of its subject available in English, or any other language for that matter, but is quite up to date and includes a thorough treatment of those problems and methods which have become of increasing interest in the past two decades.

This treatise is particularly concerned with field problems of all kinds and the mathematical techniques used in their solution. The first three chapters are devoted to the formulation of physical problems in mathematical terms. The next six chapters are an excellent development of the mathematical tools useful for solving physical problems. Finally, the last three chapters give a large number of detailed problems in the various branches of physics which have been solved by use of the mathematical tools developed earlier.

Specific Contents

Of particular interest to those in the electronics field will be the discussion of problems encountered in electromagnetics and acoustics. Problems relating to waveguides, resonators, discontinuities, scattering and radiation will be found in large number as well as some electrostatic problems. The reader will find an excellent exposition of Green's functions, integral equations, perturbation methods and variational methods. The useful techniques of the Weiner-Hopf method, WKBJ methods and the method of steepest descent are explained in considerable detail. There are a few additional problems the reviewer would like to have seen included; in particular, the well-known problem of Sommerfeld concerning radiation over



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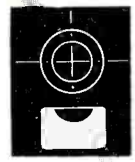

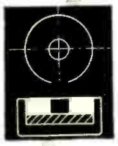

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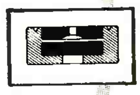

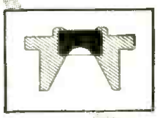

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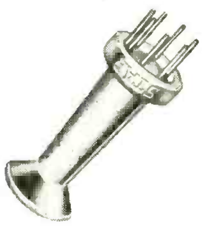

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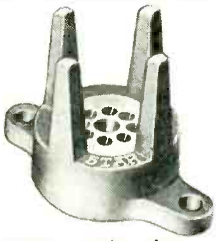

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a plane earth and the problem of radiation over a spherical earth which was first solved in usable form by Watson. In both these important problems, there are some interesting transformations of integration contours as well as the elusive question of surface waves. In all fairness to the authors, however, the techniques for solving these problems are partly implicit in the mathematical material covered and they do not claim to treat everything in the way of applications.

The work is arranged to be convenient for reference purposes. At the end of each chapter will be found a bibliography and tables of formulas and methods. At the end of the work is a collection of short numerical tables as well as a glossary and a very complete index, so that the book is reasonably self-contained for those who plan to work some of the numerous problems given in the book. One interesting feature is a number of three-dimension figures drawn for stereoscopic viewing.

These volumes will prove extremely useful to those readers who have an adequate mathematical background and are interested in applying the more sophisticated methods of mathematics to physical problems.—HENRY JASIK, *Consulting Engineer, Mineola, New York*

Nuclear Radiation Physics

BY R. E. LAPP and H. L. ANDREWS. *Prentice-Hall, Inc., New York*, 1954, 532 *p*, *2nd ed.*, $9.00.

THIS IS THE SECOND edition of a text that first appeared in 1948. The authors have found it necessary completely to revise the original in order to include new material. The treatment of the subject remains on the undergraduate level: a knowledge of the calculus is not necessary for thorough understanding, but nevertheless remains very desirable.

The subject matter of the new text ranges from such essential fundamentals as the nature of particles and waves, the atomic structure, and discussions of x-rays,

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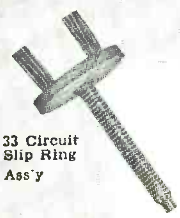

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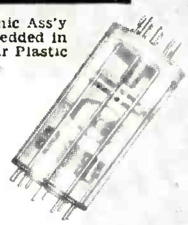

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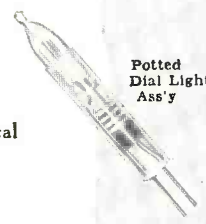

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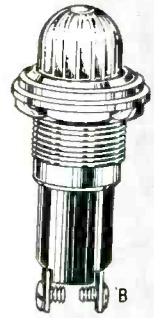

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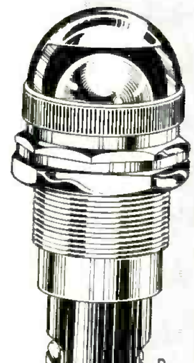

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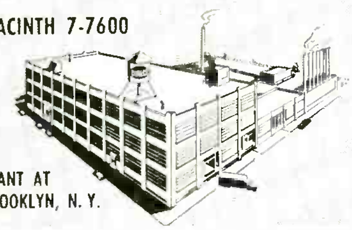

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gamma rays, alpha particles and beta particles. There is an up-to-date (though necessarily superficial) discussion of the main types of particle accelerators and a rather more thorough discussion of their uses in nuclear physics. The subjects of nuclear fission and nuclear power are also touched upon.

That is not to say that the book remains on a highly theoretical level. Such practical matters as the techniques used in measuring radiation and in radioactive tracer work are given a chapter apiece, as is the subject of radiation health protection.

The book is well written throughout and includes many problems conducive to self-study. The treatment has been carefully arranged to appeal not only to the physics student but also to advanced workers in such allied fields as nuclear engineering and radiation biology. Moreover, the authors have managed, by dint of including a large number of extremely useful graphs and tables, to go a long way toward making Nuclear Radiation Physics into a handbook that is certain to be used for quick reference by workers in this field.—CHARLES SUSSKIND, *Stanford University, Stanford, Calif.*

Differential Equations in Engineering Problems

BY MARIO G. SALVADORI AND RALPH J. SCHWARZ. *Prentice-Hall Inc., New York*, 1954, 432 *p*, $8.65.

INTENDED as a text for a junior-year course in engineering mathematics, this book is based upon notes and course material used by the senior author at Columbia University. As such it is written for the engineer who uses mathematics as a tool rather than for mathematicians or scientists who require a solid background in the methods of rigorous mathematical analysis. Mathematical operations are closely tied to engineering problems and particular stress is laid upon expressing these problems in mathematical terms and equations to arrive at meaningful engineering solutions.

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particularly high. Each type of equation is introduced by framing it as an engineering problem. The problems are taken from the fields of civil, chemical, electrical and mechanical engineering and engineering physics.

Contents

The first chapter, 39 pages less problems, gives a basic definition of differential equations and shows how they enter the solution of engineering problems by considering a tank of concentrated salt solution into which clear water flows and out of which brine is drawn. The essentials of the calculus are reviewed as well as the elements of mechanics, electricity and thermodynamics.

In chapter 2, 32 pages, fourteen actual engineering problems are analyzed to illustrate the techniques of setting up differential equations. Electrical problems include an RL circuit, an RLC circuit and a two-mesh network. Chapters 3 and 4, 55 pages, give classical methods for solving homogeneous and nonhomogeneous linear differential equations with constant coefficients.

The Laplace transforms as a method for solving homogeneous and nonhomogeneous linear differential equations are given without rigor and recourse to complex variable theory in chapter 5 of 36 pages. The basis is laid for electrical engineering to continue on to solving problems in electrical transients, which many engineering colleges are now presenting in senior-level courses.

Chapter 6, 17 pages, concerns itself with the solution of simultaneous linear differential equations. The electric transformer is presented as an illustrative example. Chapters 7 to 10 deal with integration by series and Bessel functions nonlinear differential equations and solution by Fourier series. The last chapter includes determining the resulting charge on the plates of the capacitor of a series LC circuit when a saw-tooth voltage is applied.

The last chapter also deals with the solution of partial differential equations. Examples given concern a vibrating string and transient

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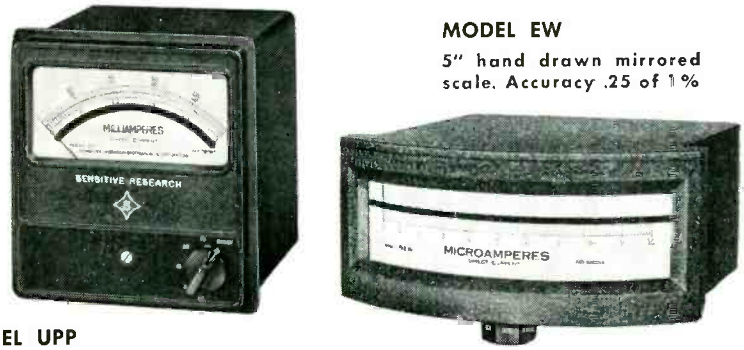

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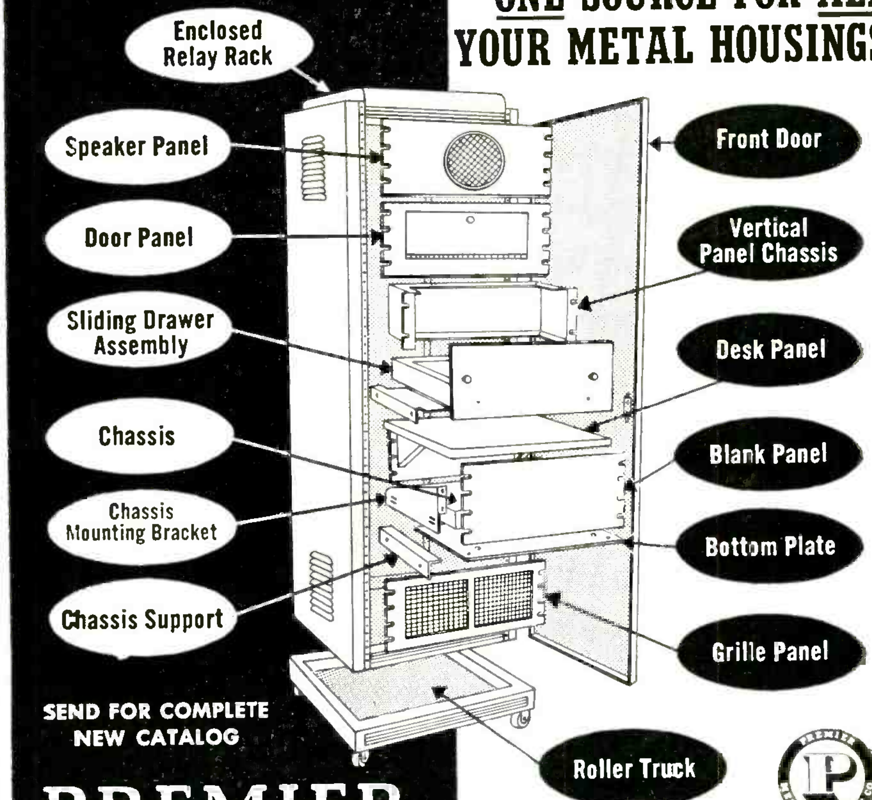

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heat flow although electrical engineers would probably have preferred to see electromagnetic field problems solved here.

Problems and Answers

The book contains a wealth of problems, 685 by count, certainly adequate for a year-long course presented annually. Answers are given to numerous problems, a feature which recommends the book to practicing engineers whose college preparation omitted this important subject as well as those who want to review their math. The first four chapters will go smoothly for the solo student but he may require assistance over rough spots later on.

Conclusions

The book is adequately indexed and on the whole fulfills its stated objectives admirably. It will work well as a text for an integrated engineering mathematics course constructed along the lines of the one presented at Columbia.—J.M.C.

Soft Magnetic Materials For Telecommunications

BY C. E. RICHARDS AND A. C. LYNCH. *Interscience Publishers, Inc., New York, N. Y.*, 1953, 346 *p*, $9.00.

IN APRIL 1952, an informal conference on soft magnetic materials was held at the British Post Office Engineering Research Station. This book is a compilation of 35 papers presented by European scientists and engineers at that conference. The editors of the book played active roles in organizing the conference and in presenting papers and discussions. Moreover, they performed a commendable service for the reader of the book by unifying nearly all of the symbols and units common to any of the papers. Other reading aids are the abstracts preceding each paper and the reference and subject indexes.

The papers might be divided roughly into groups on magnetic theory, properties of soft magnetic materials, measurements of magnetic properties and direct applications to communication circuits. Several of the general fields of magnetic theory discussed are initial

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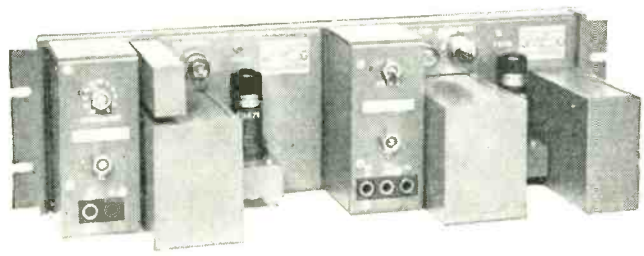

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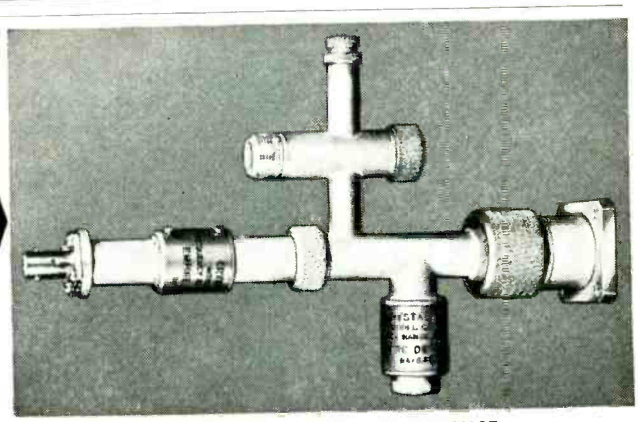

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permeability, high-frequency and pulse permeability, ferromagnetic losses and magnetostriction of ferrites. Considerable attention was devoted to ferromagnetic losses in such areas as eddy loss anomaly, losses in ferrites, losses under special excitations and residual and stratification losses.

The principal magnetic materials whose properties are discussed are ferrites, carbonyl-iron, cold reduced nickel-iron, iron powders, silicon-iron and flake-iron. Some of the topics included in the field of measurements of magnetic properties are measurements of losses, frequency and pulse dependency of magnetic properties, permeability measurements, characteristics of rectangular-loop materials, and x-ray diffraction methods.

The descriptions of direct applications to the field of communications include hysteresis intermodulation in directional filters, silicon-iron applications, instrument transductors using magnetic materials and use of flake-iron cores in communication receivers.

The 35 papers comprise subjects which are for the most part original investigations into many aspects of magnetics. This wide range of recent contributions should be of value to those in fields of research and application of soft magnetic materials, and to others who wish only to keep informed of advances in the field.—ROBERT A. MATHIAS, *Carnegie Institute of Technology, Pittsburgh, Pa.*

THUMBNAIL REVIEWS

How to Use Test Probes. By Alfred A. Ghirardi and Robert G. Middleton. J. F. Rider Publisher, Inc., New York, 1954, 172 p, $2.90. Design, construction and use of auxiliary probe-packaged devices to add new ranges and functions to vacuum-tube voltmeters, cathode-ray oscilloscopes and volt-ohm-milliammeters.

Preferred Circuits Manual. NBS Report 3492, August 1, 1954. As part of a project for Bureau of Aeronautics, Navy Department, Bureau of Standards engineers studied many military and other electronic equipments to determine if there was not some common denominator to circuit design—circuits which could be used with a high degree of standardization. This book contains

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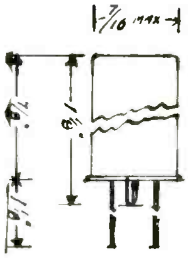

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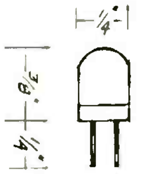

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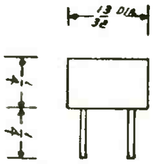

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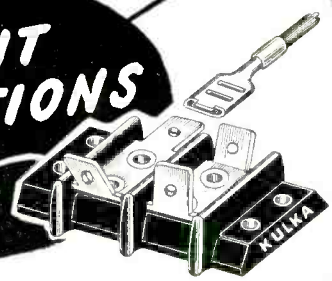

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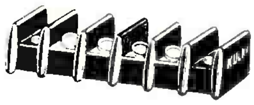

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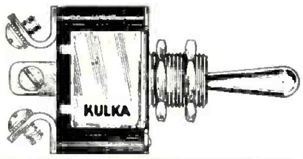

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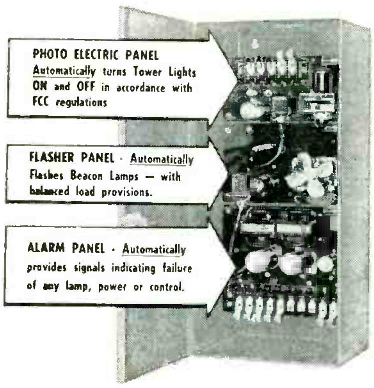

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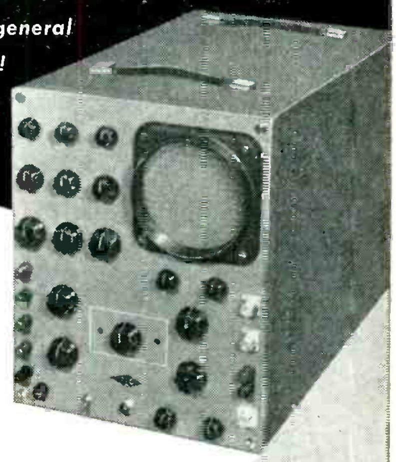

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Elements of Electrical Engineering. By Arthur L. Cook and Clifford C. Carr. John Wiley & Sons, Inc., New York., 6th Edition, 1954, 682 p, $6.75. Approximately 80 pages devoted to electronics; the remainder to machines, transformers, distribution and other aspects of power generation and utilization.

Induction and Dielectric Heating. By J. Wesley Cable. Reinhold Publishing Co., New York, N. Y., 1954, 576 p, $12.50. The practical accomplishments of electronic heating and applications to industry, with very little theory. For the practicing engineer, not the designer of the electronic equipment.

Formulas for Computing Capacitance and Inductance. By Chester Snow. NBS Circular 544, 69 p, 40¢. Government Printing Office, Washington, D. C. Formulas for ordinary calculations plus formulas for precision work or capacitance between conductors of various configurations, inductance of circuits of various shapes, and forces acting between coils carrying current.

Modern Plastics Encyclopedia, 1954. Breskin Publications, New York, N. Y., 955 p, 1954, available only to subscribers to Modern Plastics. Guide to the selection and use of commercially available materials in the manufacture of products and parts.

Patent Abstracts of Government-Owned Inventions in the Field of Instrumentation Available for License. PB 111464, 65 pages, 1954, $2.00. OTS, U. S. Department of Commerce, Washington 25, D. C. Brief descriptions of 775 patents owned by the government and available for license; arranged in eight classes for easy search.

Successful Commercial Chemical Development. H. M. Corley, editor. John Wiley & Sons Inc., New York, 1954, 275 p, $7.75. A group effort authorized and sponsored by the Commercial Chemical Development Association. How to select new products, manage their development and sell them.

High Fidelity. Trend Inc., Los Angeles, Calif., 127 p, 1954, 75¢. For the uninitiated and nonelectronic general public.

RCA Receiving Tube Manual RC-17. RCA, Harrison, N. J., 300 p, 1954, 60¢. Technical data on more than 500 receiving type tubes plus new application data not appearing in other editions.

The Automatic Office. By Wm. L. Alden, James D. Clemenshaw, Earl L. Dinsmore, Douglas W. Maclay, Gilbert H. Pearsall, David H. Williams and John C. Windsor. Alden Research Center, Westboro, Mass. 48 p, 5th Printing, September 1953, $5.00. A study of the application of electronic digital computer principles to the automatization of clerical and accounting routines.

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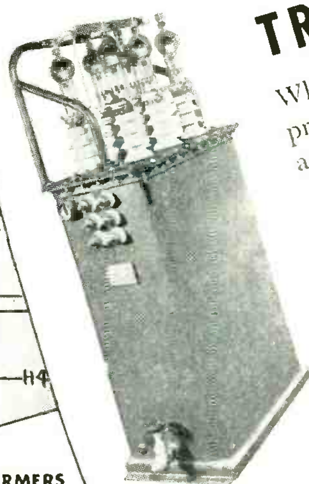

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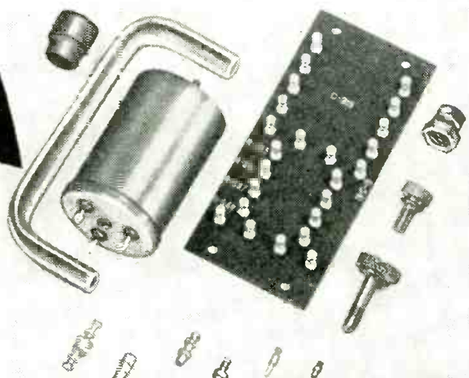

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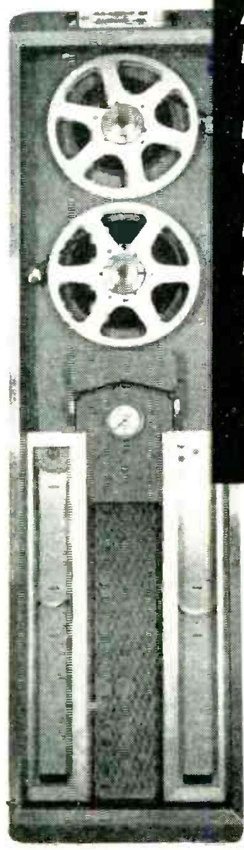

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BACKTALK

Staple Problem

DEAR SIRS:

REGARDING THE USE of "weaker staples" as suggested by one of your subscribers ("Crosstalk," Oct., 1954 issue), I'm almost tempted to say amen; however, I have found that staples made of smaller gage wire often snap during the removal procedure, thereby causing complications. But I do agree with the aforementioned subscriber that the dismemberment of an issue of ELECTRONICS is not an easy undertaking!

Fellow clippers may find my method of staple removal worth trying: (1) Lift the bent ends of the staples with the blade of an old knife; (2) Raise the flat portion of the staple about a sixteenth of an inch with a screwdriver; (3) Open a pair of long-nose pliers, and use the lower jaw as a wedge to further raise the staple; (4) Close the jaws of the pliers and carefully lift out the staple.

Duckbill pliers might possibly prove to be more helpful. . . .

JOSEPH PASTOR, JR.
Radio Corporation of America
Harrison, New Jersey

Editor's Note: We have tried this technique and find it very good indeed. Several readers seem to have mastered it and are now seeking a solvent or other means of removing the glued pages from the backing.

Distortion Correction

DEAR SIRS:

A WEEK AGO I finally had the opportunity to test an amplifier built to Mr. Diamond's circuit. Although it was not a production model it was well constructed (by some one else) and it was equipped with a high-quality output transformer.

The distortion curves that I took on this amplifier agreed quite closely with those published in the "Backtalk" column in the January ELECTRONICS. I measured the unbalance in drive to the output tubes

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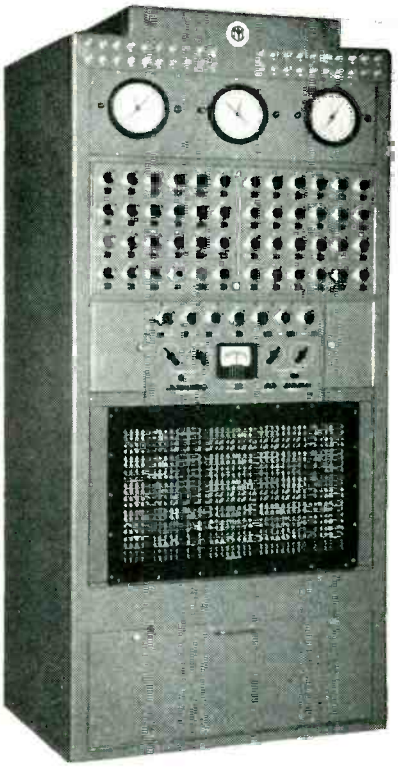

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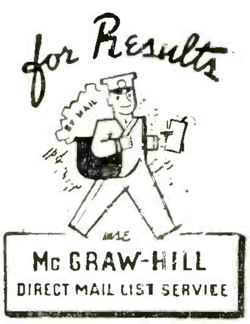

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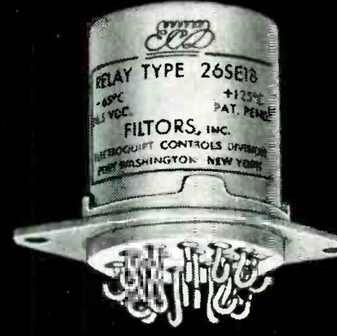

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caused by the substitution of a 6CB6 for a 6AU6 and found it to be approximately 20 percent.

This great discrepancy from my original calculations led me to search for the reason for this error. I finally discovered that the error resulted from neglecting the resistances of the two halves of the primary of the output transformer. Problems in the output stage of the amplifier stem from these resistances which of course are not coupled to each other.

I am sorry that I made this error. however the tests made on this amplifier support my contention that the plate-to-grid feedback around the output tubes is detrimental and may be removed with beneficial results.

When the plate-to-grid feedback resistors were disconnected and the overall feedback loop adjusted to maintain 12 db overall feedback, the distortion of the output of the amplifier was reduced by a factor of about two and when a 6CB6 was substituted for a 6AU6 the resulting unbalance was less than 5 percent. There was no apparent reduction of stability when this change was made.

I also still maintain that equally good amplification can be obtained by simpler methods and I offer the results described in my article published in *Radio and TV News* (Jan. 1955) as proof. . . .

Thank you for your courtesy in publishing my two earlier letters. I resolve to be more careful about over-idealizing components in the future.

W. B. Bernard
San Diego, California

German TV Transmitters

Dear Sirs:

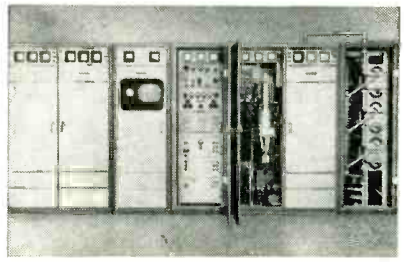
In the March 1954 issue of Electronics (p 16) you reported the local suppliers of television station equipment in Germany to be Fernseh G.m.b.H. and Siemens & Halske.

All good things are three and the third one, in this case, is our company. We have not only supplied television station equipment even before World War II but also in-

stalled, after the war, the following television transmitters: FTZ, Fernmelde-Technisches Zentralamt at Feldberg, 1-kw rating, and NWDD, Nord-West-Deutischer Rundfunk, at Hannover , 1-kw and NWDR, Langenberg, 10-kw.

DR. W. LUX
Telefunken
Gesellschaft fur drahtlose Telegraphie
Zentrale Berlin

(Editors Note: Two views of Telefunken television transmitters are shown below.



One-kw tv transmitter at NWDR, Hanover

The 10-kw transmitter at NWDR Langenberg

Lissajous Therapy

DEAR SIRS:

I MUST COMPLIMENT you on the extremely interesting, educational, and unusually amusing letter by Harwell G. Davis Jr., of the Evanston Hospital Association, Evanston, Ill., which you published in the January 1955 issue of ELECTRONICS, in the "Backtalk" section.

Dr. Davis' pithy and cogent remarks, presented in a very amusing technical writing style, combine important design engineering information with a basic design approach that has long been lacking in electronic equipment for medical applications.

Very often, due to our proximity in New York City to many of the

large medical research centers, we are approached to design or quote on electronic equipment. I agree with Dr. Davis that generally speaking, the ignorance that medical men manifest in the field of electronics is exceeded only by the ignorance on the part of electronic engineers of biological phenomena (with the possible exception of certain very limited subjects).

The section on electroencephalography and the "nearby broadcasting station" had me laughing so hard that secretaries and engineers came running in from adjacent offices to find out what the joke was.

Dr. Davis is talking about legitimate applications in therapy, of electronic equipment, and therefore he states "the more knobs on the panel, the less likely will the user be able to make even the best instrument work."

I would like to describe briefly a reverse experience we had here in building oscilloscopes for a medical device. The oscilloscope specifications were of a most unusual nature frequency-wise, both horizontally and vertically, in the sweeps. There were switching devices for external signal selection, and control knobs for synchronization and other functions which did not even exist in the oscilloscope.

In addition, the customer insisted on a separate on-off switch, instead of the integral intensity switch and on-off control that is normally employed in low-cost, moderate-frequency-response oscilloscopes.

It was only after the termination of the contract, and delivery of the last unit, that I learned the purpose of the oscilloscopes. The instruments were included in a rather gaudy cabinet, with many flashing lights and other knobs; emanating from the cabinet were two cables with electrodes, the electrodes being applied to the patient, and the waveform of current going through the patient being demonstrated on the oscilloscope's face.

The entire objective was to keep the patient happy for one-half hour or more, while the doctor, or technician, manipulated the dials at regular intervals to change waveforms. The therapeutic value of the electrical treatment was negligible; however, the psychological

effect on the patient was apparently great enough to enable the manufacturer of the equipment to sell quite a number of these in fields where the psychological effect is more important than medical therapy.

VICTOR WOUK
Chief Engineer
Beta Electric Corp.
New York, N. Y.

Editor's Note: Which leads us to speculate on the possibility that an electronics engineer may some day be a patient at the establishment. Armed with a diode and a few feet of wire, he might reverse the psychological treatment and confound the medical man.

Gas Glow Potentials

DEAR SIRS:

THERE APPEARS in the December, 1954 issue of ELECTRONICS (p 184) a news report involving an Ionization Transducer Micrometer. It is stated that Professor Kurt S. Lion of the Massachusetts Institute of Technology discoved the phenomena involving the generation of a d-c potential by a two-electrode gas tube situated assymetrically in a high frequency field.

I sincerely hope it becomes a matter of record that I recognize the application of this principle in the aforementioned device as an invention involving great ingenuity on the part of Professor Lion. However, I wish to call attention to my article, Novel Applications for Neon Diodes, p180, January, 1951 edition of ELECTRONICS. . . .

Insofar as I have been able to ascertain there have been, at least since the introduction of radar, spasmodic reports concerning the observation of d-c potentials across the electrodes of a gas tube subjected to ionization in a high-frequency field. It is my belief, however, that I was the first to call attention to the fact that the intensity of ionization must be higher in the vicinity of one electrode than the other. (For gas tubes with symmetrical electrodes).

I would welcome comment regarding this matter.

I. GOTTLIEB
Mountain View, Calif.

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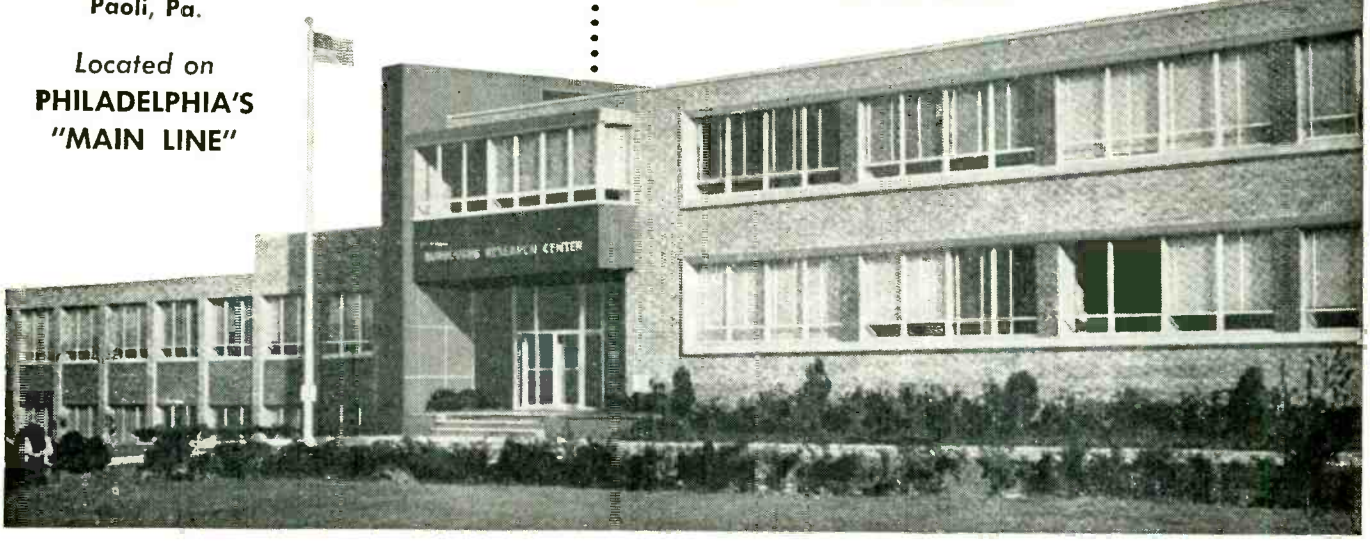

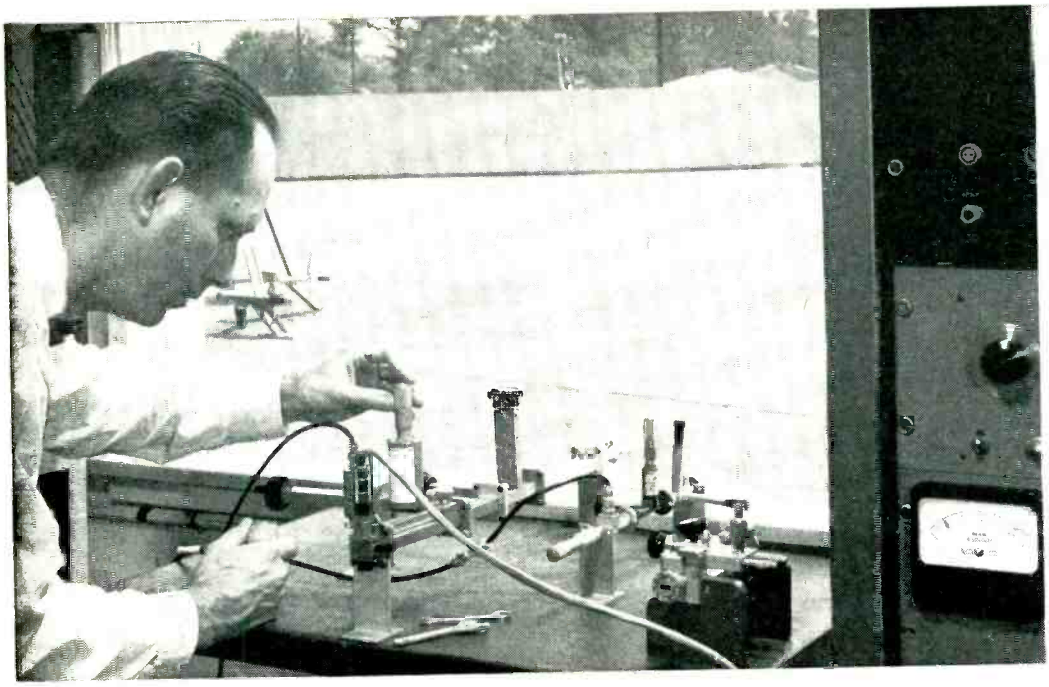

Research Specialist Edward Lovick measures reflection coefficient of dielectric materials in the K-band region. Lockheed is expanding K-band studies to meet future radar requirements.

Lockheed expands airborne antenna program

Lockheed's diversified expansion program is causing a major increase in airborne antenna research and development. Antenna design is one of the fastest growing areas at Lockheed, with research and development being applied to: extremely high-speed fighters, advanced jet trainers and jet transports; advanced versions of vertical-rising aircraft, turbo-prop transports, radar search planes (developed and produced exclusively by Lockheed) and a number of significant classified projects.

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Electronics Research Engineer Irving Alne records radiation antenna patterns. Twenty-two foot plastic tower in background eliminates ground reflections, approximates free space. Tower is of Lockheed design, as are pattern integrator, high gain amplifier, square root amplifier, logarithmic amplifier.

E. O. Richter, Electronics Research department manager (seated), W. R. Martin, antenna laboratory group engineer (standing), and J. L. Rodgers, electronics research engineer, discuss design of corrugated surface antenna.

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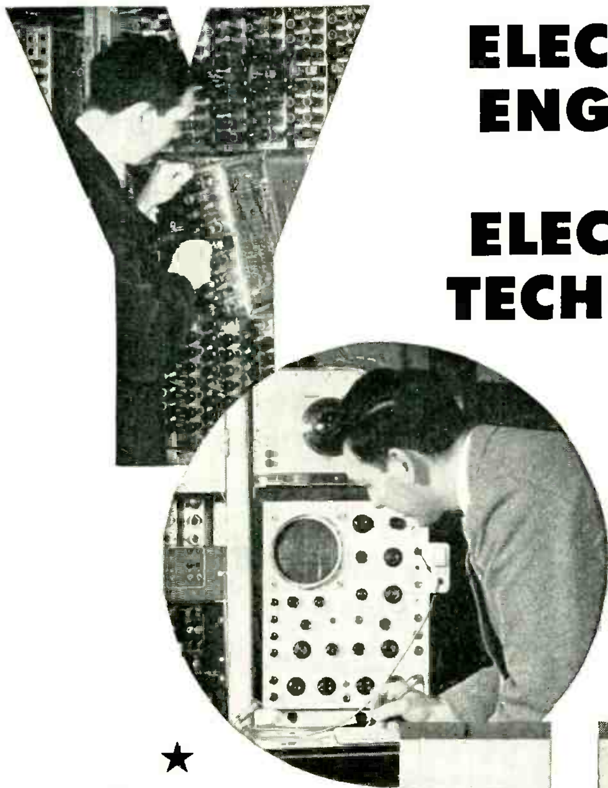

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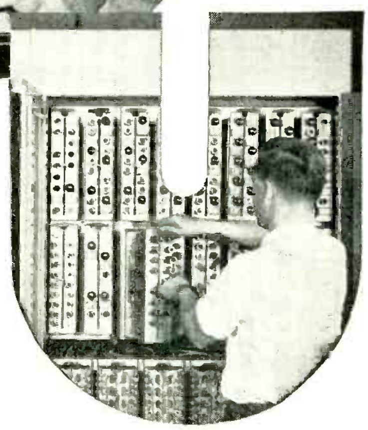

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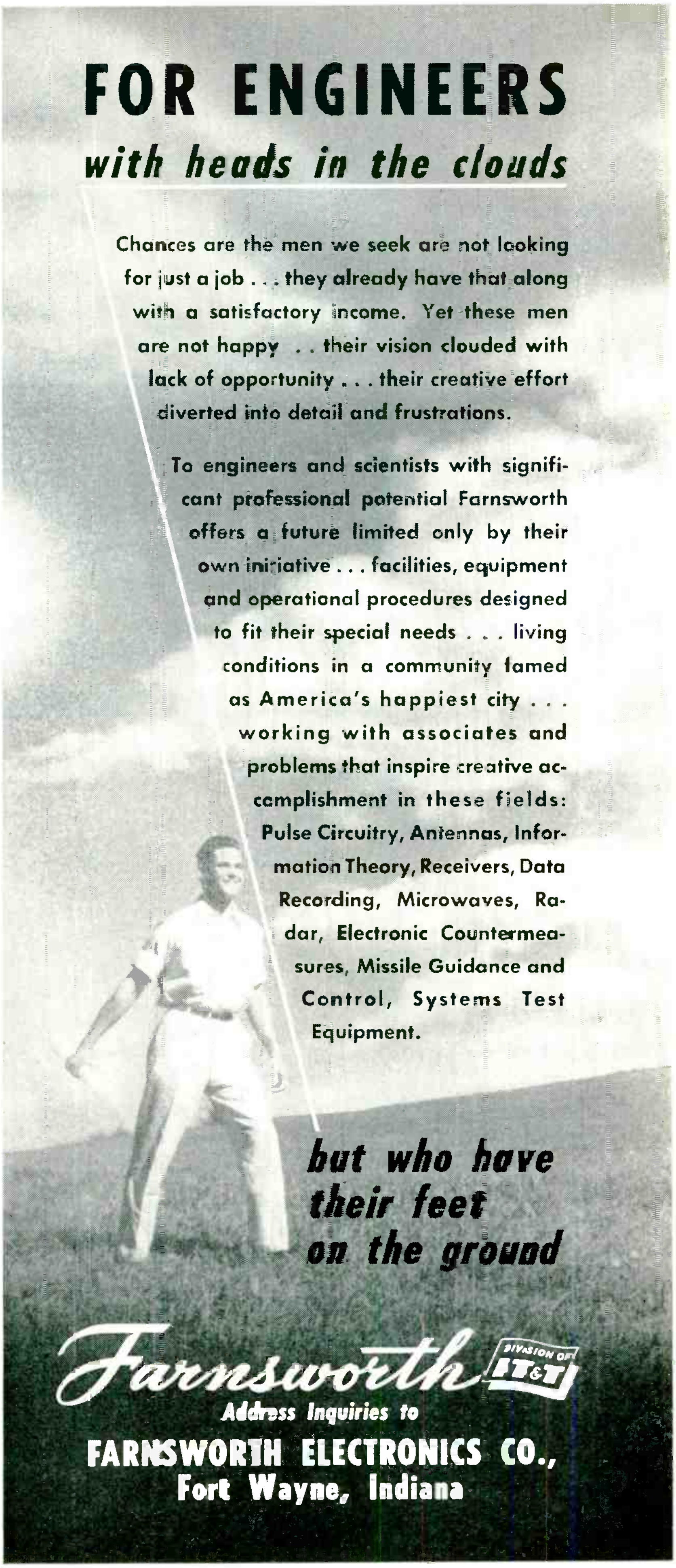

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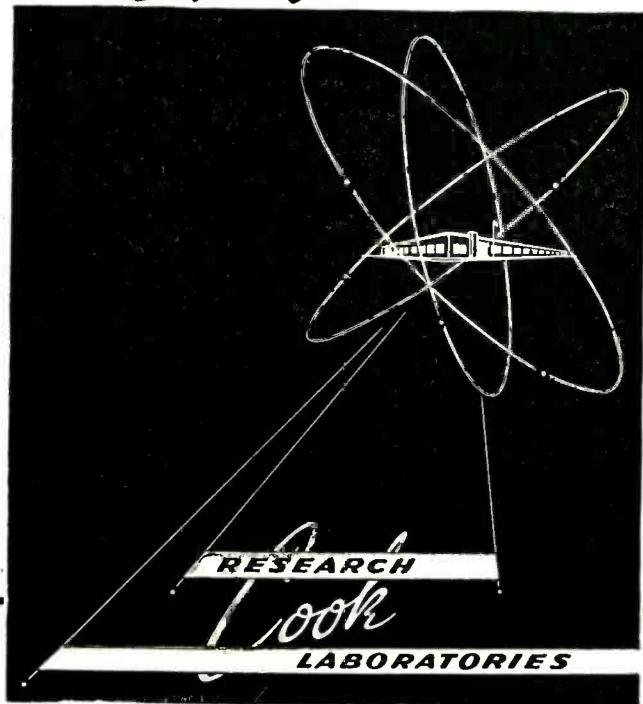

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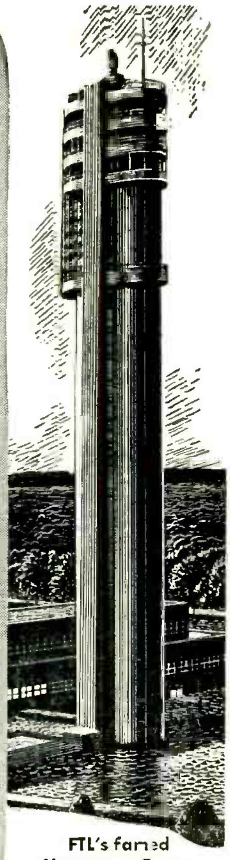

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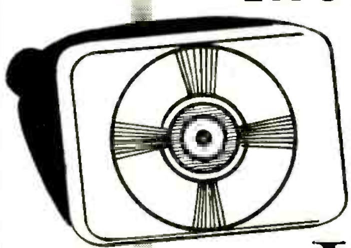

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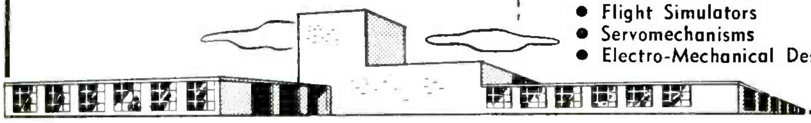

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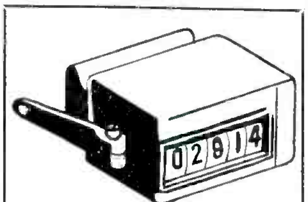

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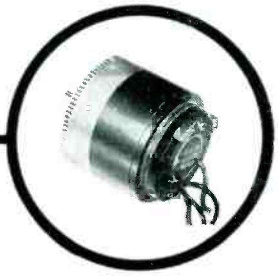

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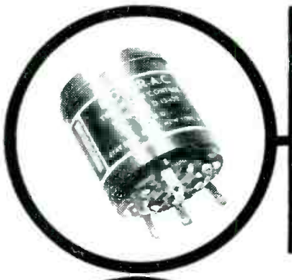
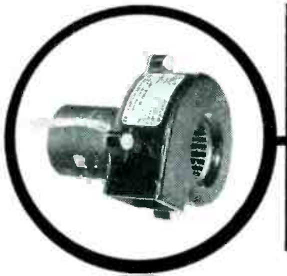


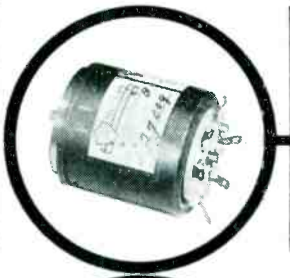
D-13430 Motor-AC: 2 phase control; 115 volts; 400 cycle single phase; no load speed 4800 rpm; stalled torque 1.45'' oz; weight 8 oz.; length $1\frac{5}{8}$''; OD $1\frac{3}{8}$''; Ketoy Mfg. Corp.
$22.50 each

Stock No. 124



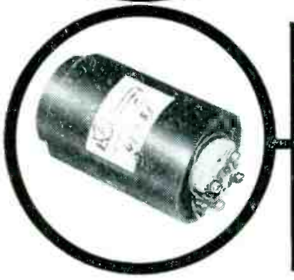
50 CFM Blower: 115 volts; 320/1000 cycle; single phase continuous duty; length $4\frac{1}{4}$''; Eastern Air Devices #B302H-1C; **$9.95 each**

Stock No. 125



Model No. 172B Control Motor: 115 volts; 400 cycle; approximate length $2\frac{3}{8}$''; OD $1\frac{3}{4}$''; American Electronic Mfg. Inc.
$17.50 each

Stock No. 126



Model No. 183 Drive Motor: 115 volts; 400 cycle; single phase; OD 1.675; weight 14 oz; length 2.625; 1/20 h.p.; speed 10,500; American Electronic Mfg. Inc. **$4.95 each**

Stock No. 127

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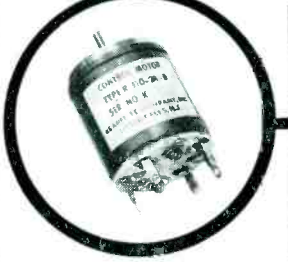
Stock No. 128



Type R110-2A-B Control Motor: 115 volts; 400 cycle; OD 1.437; length $1\frac{21}{32}$; speed at maximum power output 2800 rpm; Kearfott Company Inc. **$22.50 each**

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30' Parabolic Reflector Spun Aluminum dish.....$4.85
AN/APA-12—Sector Scan adaptor for APS-2 radar—Complete Kit..............................$37.50
TPS-3, 10 Ft. Dish, "Chicken Wire" Parabola. Extremely lightweight, portable................$125.00
AN-154 3 vertical dipoles working against a rectangular mesh approx. 3'x4'. Freq. 140-200 mc. with lobing switch (115v, 60 cy) and portable slatted crate. Extremely rugged...........................$27.95
Loops, LP23, LP18A, LP24 in stock

DYNAMOTORS

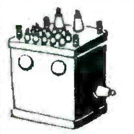
TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
BDAR 83	14	...	375	.150	$6.50
35X.059	19	3.8	405	.095	4.35
POSX-15	14	2.8	220	.08	8.95
DA-7A	28	27	1100	.400	15.00
DM 33A	28	7	540	.250	3.95
23350	27	1.75	285	.075	3.95
B-19	12	9.4	275	.110	6.95
			500	.050	
DA-3A*	28	10	300	.260	3.95
			150	.010	
			14.5	5.	
PE 73CM	28	19	1000	.350	17.50
BD69‡	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	2.50
DM 25†	12	2.3	250	.05	6.95
BDAR 93	28	3.25	375	.150	6.95

‡ Less Filter. • Replacement for PE 94.
† Used, Excellent.
PE 94-, Brand New............................ 5.95

INVERTERS

800-1B Input 24 vdc, 62 A. Output: 115 V, 800 cy. 7A, 1 phase. Used, excellent....................$18.75
PE-218H: Input: 25/38 vdc, 92 amp. Output 115V 350/500 cy 1500 Volt-ampere. NEW...............$32.50
PE206: Input: 28 vdc, 36 amps. Output: 80 V 800 cy, 500 volt-amp. Dim. 13 x 5½ x 10½. New.....$22.50
EICOR—ML 3011-5. Input: 13.75V; 18.4A. Output: 115 V/400~, 3ϕ, 0.95 PF. New......................$59
PU 7/AP. Input: 28 vdc/160A. Output: 115 VAC, 400~, 1ϕ. 500 VA., 21.6 Amp. Volt. and Freq. Reg. Used, Exc..$75

POWER TRANSFORMERS



H. V. TRANSFORMER

PRI: 115V/60~, 1ϕ. SEC: 4500V/.005A, 650 VCT/.175A, 5V/3.8A, 5V/3.8A, 6.4V/10A, 2.5V/3A (9500V. RMS TEST) Size: 7"x7"x5¼" D.
$7.45

COMBINATION—115V/60 ~ INPUT

CT-133	150-C-150V/65MA, 6.3V/2.5A, 6.3V/0.6A	$1.79
CT-127	900V/25MA PK, 5V/2A, 2V/7.5A	2.79
CT-006	350-0-350V/120MA, 5VCT/3A, 2.5VCT 12.5A, 2.5VCT/3.5A	4.39
CT-965	78V/0.6A, 6.3V/2A	1.95
CT-004	350-0-350V/90MA, 5VCT/3A, 2.5VCT/12.5A	4.60
CT-002	350-0-350V/50MA, 5VCT/2A, 2.5VCT/7.5A	3.65
CT-479	7000V/.018V, 2.5V/5A/17,800V, Test	22.50
CT-013	450-0-450V @ 200MA, 10V/1.5A, 2.5. 3.5A, 5V/3A	4.35
CT-403	350VCT .026A 5V/3A	2.75
CT-931	585VCT .086A 5V/3A, 6.3V/6A	4.25
CT-929	4200V/.001A, 2.5V/2A, 6.3VCT/.6A	5.35

PLATE—115V/60 ~ INPUT

PT-07	400VCT/4.0 AMPS For RA43	17.50
PT-034	125V/45MA (For Preamp)	1.15
PT-157	660-0-660VAC (500VDC) or 550-0-550 VAC (400 VDC) at 250 MADC	8.70
PT-371	210-0-210V at 2.12 Amp	9.45
PT-133	3140/1570V, 236KVA	85.00
PT-801	22,000V/234 MA., 5.35 KVA	115.00
PT-521	7500V/.06A, Half Wave	59.50
PT-913	2500V/12 MA H'SLD	4.95
PT-12A	280VCT/1.2A	3.95
PT-38-2	37.5/40V AT 750 MA	2.15

FILAMENT—115V/60 ~ INPUT

FT-140	5VCT @ 10A 25KV Test	17.50
FT-157	4V/16A, 2.5V/2.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25A/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 1.2V/7A, 6.4V/10A 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-38A	6.3/2.5A, 2x2.5V/7A 5KV Test	2.79
FT-650	2.5V/10A-3KV TEST LO-CAP	7.50
FT-025	2.5VCT/10A, 10KV TEST	6.95
FT-BT-5	7.5VCT/12A, 10KV TEST	7.50

JAN WAVEGUIDE FLANGES

UG 39/U ....$1.10 | UG 51/U $1.65
UG 40/U ....$1.25 | UG 52/U $3.40
UG 40A/U ....$1.85 | UG 52A/U $3.40

—IN STOCK—

AIA	APT-4	SD
APN-1	ART-9	SE
APN-3	ART-22	SF
APN-4	ASD	SG
APN-7	IFF	SN
APN-9A	APX-1	SQ
APS-2	APX-2	TAJ
APS-3	RC145	TBK
APS-4	RC148	TDE
APS-15	RC184	MK4
APT-2	"BG"	MKX

VACUUM TUBES

1N21	28¢	5J30	$14.50	703A	$1.50
1P5GT	45¢	C5B/5C30	$1.10	704A	95¢
1P30	$1.10	C6J/5C21	$4.50	705A	75¢
2C21	35¢	7C4/1203A	$.18	706A	$9.75
2C22/7193	7¢	9GP7	$3.45	706D	$14.75
2C26A	8¢	10Y	10¢	706EY	$9.75
2J21A	$2.90	15R	15¢	706CY	$9.75
2J22	$2.50	39/44	8¢	708A	$2.10
2J26	$2.50	QK59	$60.00	709A	$2.45
2J27	$3.00	QK60	$35	713A	85¢
2J29	$18.50	QK61	$50	C-722A	90¢
2J31	$15	QK62	$54	730A	$8.50
2J32	$14.50	ML-100	$69.50	800	65¢
2J38	$9.00	HY/14B	25¢	801	25¢
2J39	$8.25	227A	$2.50	837	85¢
2J48	$22.50	268A	$2.25	843	19¢
2J56	$48.50	316A	50¢	861	$15
2J62	$7.50	355A	$12.50	864	19¢
3EP1	$1.75	356B	$10.50	876	75¢
3FP7	$1.10	393A	$4.50	884	$1.10
4J34	$23.50	417A	$6.10	CK1005	35¢
4J38	$85	GL471A	$2.10	1625	20¢
4J42	$47.50	WL531	$2.75	1619	15¢
5FP7	$1.10	532/1B32	$1.10	1626	10¢
5GP1	$4.50	GL559	75¢	1629	10¢
5HP4	$3.50	700B	$8.75	8012	$1.75
5J23	$34.50	700D	$8.75		

I. F. AMPLIFIER STRIPS

Model 15: 30 Mc center frequency. Bandwidth 2.5 Mc. gain figure: 65 db. Uses 5 stages of 6AC7's. Has D. C. Restorer and Video Detector A.F.C. Strip included. Input impedance: 50 Ohms. Less tubes...........**$17.50**
60 MC. Miniature IF strip, using 6AK5's 60 Mc center Freq. Gain: 95db at Bandwidth of 2.7 Mc. New. Complete with tubes.**$17.50**

AUDIO TRANSFORMERS

AT 071: Interstage: 10,000 ohm pp plates to 80,000 up grids. For BC 614 Speech Amplifier............$2.15
AT 199: Output: 6000 ohm plate to line (200/600 ohms) Response: 200-12 kc. For CFIA and CF 3A....$2.45
AT 087: Mike to grid: 75 ohms to 125,000 ohms...$.65
J-871: Output: Pri: 20,000/16,000 ohms P-P. Or 5,000/4,000 ohms. Sec: 500/15/7.5/5/3.75/1.25 ohms. Silcor, hi-fi...$2.75
AT SUB Subouncer, Multimatch, 200 ohms to 15 K ohm C.T. and 100 K ohm Grids..............$.69
AT501 HI-Fi Special: PRI: 3000 ohms P-P/Sec: 4/16/12/50/200 ohms 60-10,000 CY.—1 db 50W......$3.49
AT152 HI-Fi Driver Pri: 10,000 ohms Sec: 40,000 ohms PP Grids 50-15 KC/1 db...................$1.49
AT602 Output to H. S. or line PRI: 14,200 ohms SEC: 8000/600 ohms.................................$1.10
AT449 HI-Fi Driver (5000 ohms) to P-P. output grids (4,000 ohms) 100-10,000 CY, 10 W 6V6 to PP 805's.......................................$2.39
AT666 Intercon Input: Spkr (-4-8 ohms) to grid (250,000 ohms).................................$0.69
AT415 Plate (18,000 ohms C.T.) to line (125 ohms) 175 w.—500-600 CY.............................$1.95
AT858 Plate (10,000 ohms C.T.) to line (125 ohms) (125130 ohms) HI-FI—50 W.....................$6.95
AT070 Mike-or-Line (250 ohms) to grid (250,000 ohms C.T.)..$1.20
AT-694 HI-Fi Output: 3 Watts, 8500 Ohms P-P to V.C. (15 Ohms) 15-15KC PM 1 db....................$1.49
AT4-1: Mike (35 ohms Carbon) to Line 600 ohm/200 ohm...$1.19
AT-649: Line (500 ohms) to Grid (75K ohms)...$0.89
AT-448: Line (600 ohms) to V.C. (6 ohms) 17 d.b. Level...$1.19
AT-631: Mike-or-Line (200 ohms) To Single or P-P Grids (50K Ohms).............................$0.59
AT 718 Line (300 ohms) to Line (600/30 Ohm) Response 50-20KC P.M. 1 db.........................$0.49

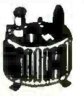
CRYSTALS—CR1/AR*—59¢ ea.

6370KC	6470KC	6730KC	7290KC
6410	6670KC	7270	7300
6450	6690	7280	

*For ARC-3, ARC-1, etc.

PULSE TRANSFORMERS

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC: 16KV-16 AMP DUTY RATIO: 001 400 CYCLE FIL. TRANS. "BUILT-IN"..................$42.50
WECO: KS 9948; Primary 700 ohms; Sec: 50 ohms. Plate Voltage: 18 KV. Part of APQ-13.......$12.50
WECO: D-163247 For Modulator of SCR 720....$22.50



GE #K-2449A
Primary: 9.33 KV, 50 ohms Imp.
Secondary: 28 KV, 450 ohms.
Pulse length: 1.0/5 usec @ 635/120 PPS, PK Power Out: 1,740 KW
Bifilar: 1.5 amps (as shown)......$62.50

GE #K-2748-A. 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well.............$24.50
K-2745 Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV 1025 ohms Z. Pulse Length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar: 1.3 Amp. Has "built-in" magnetron well.....$32.50
K-2461-A. Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar 1.3 Amp. Fitted with magnetron well..........$29.50
K35J45—Pulse Inversion: PRI: 5 KV PK. Pulse Negative. Sec: Pos. Pulse, 4 KV; 1 usec. and .001 DUTY RATIO..$6.50
54J318-1—3 wdgs. Ratio: 1:1:1, 1.10 uh. /wdg., 2.5 ohms DCR......................................$3.50
UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 30 ohms DCR...$5.00
UTAH X-150T-1: Two sections, 3 Wdgs. per section. 1:1:1 Ratio, 3 MH. 6 ohms DCR per Wdg.....$5.00
68G711: Ratio: 4:1 Pri: 200V. Sec. 53V. 1.0 usec Pulse @ 2000 PPS. 0.016 KVA.........................$4.50
TR1049 Ratio 2:1 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
Ray UX 7896—Pulse Output Pri, 5v sec. 41v.....$7.50

DELAY NETWORKS

D-168184: 0.5 usec. up to 2000 PPS, 1800 ohms..$4.00
D-170499: 0.25/.5/.75/usec. 8 KV., 50 ohms.....$12.50
D-165997 Delay 1.25 usec..........................$6.50
RCA #255686-502: 1.7 usec, 1400 ohm impedance.$2.00
D-162311. Delay of 0.5 usec, 72 ohms with 4 MC. Bandwidth...$4.75
D-168435. Delay 0.5 usec, 555 ohms, 5mc. BW....$4.50

PULSE NETWORKS

D-172578. 416 ohms imp., 0.22 usec. Delay......$4.75
D-150979: Oscillating network. Oscillates at 81.955 kc. When normal current of 10ma. is interrupted. Has built-in temperature control for stability. Assembled in shielded can 4" L x 4" Diam.................$4.50
15A—1-400-50; 15 KV, "A" CKT, 1 microsec, 400 PPS 50 ohms imp.......................................$12.50
G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3 KV "E" CKT Dual Unit; Unit 1, 3 sections, 0.84 Microsec. 810 PPS, 50 ohms imp; Unit 2, 8 Sections, 2.24 microsec. 405 PPS 50 ohms imp..................$6.50
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
KS8865 CHARGING CHOKE: 115-150 H @ .02A. 32 40H @ .08A, 21 KV Test..........................$37.50
G.E. 25E5-1-350-50 P2T, "E", CKT, 1 Microsec. Pulse @ 350 PPS. 50 OHMS Impedance................$69.50
KS9623 CHARGING CHOKE: 16H @ 75 MA, 380 Ohms DCR. 9000 Vac Test..........................$14.95
G.E. 6E3-5-2000, 50 P2T; 6 KV., "E" Circuit 0.5 usec /2000 PPS/50 ohms/2 sections.................$7.50

PULSE MODULATORS

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio: .001 max. Pulse duration: 5. 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses: 1-71B, 4-89-B, 3-'72's, 1-'73. New..................Less Cover—$135
ASD Modulator-Units, mfd. by Sperry. Hard tube pulser delivers Pk. pulse of 144 kw. Similar to Mod 3 unit. Brand new, less tubes.........................$85.00
Airborne RF head, model A1A, delivers 50 Kw peak output at 9000 mc. at .001 duty. Complete with pulser unit and all tubes..........................$185.00

SPARES FOR APN-9

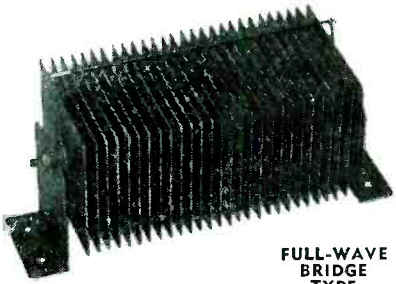
Power Trans., Pt. No. 352-7295-2..............$4.95
Counter Trans., T111, T112, T117, Pt. No. 352-7251-2 $2.50
Counter Trans., T113, T114, T115, T116, T118, T119, T120, Pt. No. 352-7250-2........................$2.50
I. F. Trans: T107-T110 Pt. #352-1554S..........$1.00
Resistor: R150, R157, R162 84,000 OHMS........ .50
Resistor: R130, 220.000 ohms.................. .50
Resistor: R159 120.000 ohms................... .50
Resistor: T152, R164, 17,000 ohms............. .35
Resistor: R142, 4300 ohms..................... .35
Condenser: C214A&B—0.1-0.5 mfd/2000 vdc......$1.69
Lamp Socket for I-101 Indicator, x-137.......... .19

APN-3 SPARE PARTS

K-901684-501: SCS #229632.306, Trans..........$2.49
K-901689-501: SCS #229631.238, Trans........... 2.25
K-901692-503: SCS #229617-70, Xfmr, Fil....... 2.49
K-901699-501: SCS #229617-68, Fil. Xfmr....... 3.45
K-901698-501: SCS #229618-38, Plate Xfmr...... 4.29
K-901695-501: SCS #229627-19, Pulse Xfmr...... 3.50

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. 25% DEPOSIT WITH ORDER. BALANCE C.O D. RATED CONCERNS SEND P.O.

131 Liberty St., New York 7, N. Y. Dept E-3 Chas. Rosen Phone: Digby 9-4124



FULL-WAVE BRIDGE TYPE

SELENIUM RECTIFIERS

Max. Amps	18/14 Volts	36/28 Volts	54/42 Volts	72/56 Volts	130/100 Volts
1	1.35	2.35	3.80	4.60	7.50
2	2.00	2.75	5.40	6.00	9.25
3	2.95	4.15	6.00	7.90	12.90
4	3.50	6.50	11.50	14.50	22.00
6	4.10	8.00	13.00	17.50	29.95
10	5.95	11.50	20.00	25.00	41.50
12	7.50	14.50	22.50	30.00	44.50
20	12.00	23.00	38.00	49.00	72.00
24	14.50	29.00	45.00	58.00	81.50
30	18.00	34.50	57.50	72.00	110.00
36	22.50	42.50	66.00	88.00	135.00
50	29.75	54.50	......	......	175.00
100	60.00	120.00	......	......	......

We Build other Selenium Rectifiers, Transformers and Chokes to your specifications.
Buy from the Direct Source for Quick Delivery.
Rectifiers Built to Jan & Mil Specs

NEW RECTIFIER TRANSFORMERS

Pri: 115 V., 60 cycles in.
SEC: 9, 12, 18, 24, and 36 Volts....................
Continuous Ratings.

1 Amp....$5.60
2 Amps.....6.60
4 Amps.... 8.60
12 Amps....16.60
24 Amps....35.60
30 Amps....46.60
50 Amps....58.60

NEW RECTIFIER CHOKES

1 Amp	.1 Hy	1.5 ohm	$3.95
2 Amps	.04 Hy	.9 ohm	4.15
4 Amps	.07 Hy	6 ohm	7.95
12 Amps	.01 Hy	.1 ohm	14.95
24 Amps	.004 Hy	.025 ohm	29.95
30 Amps	.005Hy	.02 ohms	37.95
50 Amps	.005 Hy	.01 ohm	53.95

FILTER CAPACITORS

Capacity	W. Voltage	Each
500 MFD	200 V.	$1.95
500 MFD	50 V.	.85
1000 MFD	15 V.	.35
6000 MFD	15 V.	1.50

RADIOSONDE 500 Pieces Meteorological Transmitter

Type T-49C. Uses RCA 3A5. Complete with tube, antenna, battery harness. Sizes 4½" x 2½" x 2¼". Brand New .... Only 1.75

TUBE CARTONS

Two-Colored Cartons With New Safety Partitions—Super-Gloss Red and Black Carton Is the Most Distinctive Box Available Today.

SIZE	EACH	SIZE	EACH
Miniature (6AU6, 6AL5, etc.)	$ .01	LARGE GT (1B3, 6BQ6GT, etc.)	.015
GT (6SN7, 6W4, etc.)	.0125	LARGE G (5U4G, 6BG6G, etc.)	.02

"Quantity Users—Buy These Cartons by the Case. Write for Quantity Discounts.—"

Terms: F O B—N Y C—25% Deposit with order—or send full remittance to save C O D charges—D & B Rated Firms (F2½ or Better) Net 10 Days. CABLE BARRYLECT, N. Y. TELEGRAPH BARRY ELECTRONICS, FAX, N. Y.

Immediate Shipment from one of the Most Complete Inventories of HIGH QUALITY

SPECIAL PURPOSE, TRANSMITTING, RADIO AND TV RECEIVING TUBES

TRANSFORMER SPECIALS

- **Filament Transformer** CHICAGO TRANSFORMER **Cat. No. FH-610**
  Primary: 115 v or 230 volt—50-60 cycles. Secondary: 6.3 VCT at 10 amps.
  Test Volts: 2500.................................$4.95
- **Power Transformer** CHICAGO TRANSFORMER **Cat. No. PHC-70**
  Primary: 117 v, 50-60 cycles. Delivers 320 volts DC (after choke) @ 70 MA. Also delivers 6.3 VCT @ 3 amps and 5.0 volts @ 2 amps.
  Test Volts: 1750.................................$3.95
- **Choke to match above** CHICAGO TRANSFORMER **Cat. No. PH1585**
  12 Hy @ 85 MA.................................$2.75
- **G. E. Transformer** **Cat. No. 2PB2C1**
  Primary: 115 v, 60 c—Secondary 15 v, 12 amp....$6.95

THORDARSON JOBBER BOXED TRANSFORMERS

T-19R32 BIAS 115-60 cy—sec 400 VDC, 200 MA..$4.75
T-15D83 MULTI MATCH DRIVER..............$4.95
T-15A75 P.P. PLATES TO P.P. GRIDS.........$3.95
T-19F85 FILAMENT TRANSFORMER 115 AC 60 cy—5 VCT @ 13 Amps.........................$3.95
T-74F23 FILAMENT TRANSFORMER 105-110-115-60c—5.25 VCT @ 13 Amps........................$4.25

STANCOR JOBBER BOXED TRANSFORMERS

A-4208 P.P. INTERSTAGE.....................$1.95
A-4772 P.P. INTERSTAGE.....................$1.95

KENYON FILAMENT TRANSFORMERS

T358. 115 VAC. 60 c—5.25 VCT. 20 Amps........$6.95

WE PLATE & FILAMENT TRANSFORMERS

D159841—In original wood cases, 46 lbs. 115 AC, 60 cy, tapped primary. Various filament and one plate winding, C.T. write for specs..................$9.95

MEDIUM TO LARGE QUANTITIES OF THE FOLLOWING TUBES ARE IN STOCK

1N21	.40
1N34	.50
1N38A	.75
1P30	2.75
1P41	2.50
2K45	65.00
2K55	17.50
3BP11	7.00
3B24	1.50
3B26	2.75
3B29	9.00
3C22	55.00
3DP1	2.25
3J30	75.00
3J31	75.00
4X500F Eimac Surplus	65.00
5BP1	2.50
5D21	8.75
6J4 RCA	3.95
FG17/557	3.90
RCA26A7/GT	3.75
FG32	8.50
QK60	30.00

211/VT4C... 50c
in lots of 100 40c
in lots of 500 30c

GL299 Thyratrons 2.95

715C	11.00
723A/B	8.50

750 TL Eimac Surplus...30.00
in lots of 10 .27.50
in lots of 25 .25.00

803.......... 1.50
in lots of 10. 1.40
in lots of 50. 1.30
in lots of 100 1.20

838.......... 1.50
in lots of 10. 1.40
in lots of 50. 1.30
in lots of 100 1.00

866A RCA	1.25
872A Gen Elec	2.75
917 RCA	1.10
921	1.40
1624	1.00
1625	.25
5763	.95
5814	2.25

A CORDIAL INVITATION IS EXTENDED TO ALL OUR FRIENDS—OLD AND NEW—AS WELL AS I.R.E. SHOW VISITORS TO NEW YORK TO STOP IN AND SEE US IN OUR NEW QUARTERS.

DUAL FILAMENT TRANSFORMERS

115 AC, 60 cy, tapped primary. Dual 6.3 @ 8 Amps. 5" x 4" x 4"..................................$5.95

W.E. TRANSFORMERS—NEW

255D INPUT TRANSFORMER...................$3.50
289A INPUT TRANSFORMER...................$1.95
172A REPEATER COIL........................$3.50
174B OUTPUT TRANSFORMER..................$2.50
174C OUTPUT TRANSFORMER..................$1.95

RELAY SPECIALS

PRICE ELECTRIC HERMETICALLY SEALED DPST, 24 V DC, 2" x 1⅝" x 1⅝".
#5707-2HSX—NORMALLY OPEN..........
#5708-2HS—NORMALLY CLOSED......... **$1.75** each

TIME DELAY RELAYS

24 VDC—HERMETICALLY SEALED
Type 650-3060—2 second delay...................$4.50
Type 650-3061—60 second delay..................$4.95

G.E. DW52 RF AMMETERS

2½" ROUND—0-5 AMPS R.F.
Built in Thermocouple.............................3.95

SELENIUM POWER SUPPLY

115 VAC to 24-30 VDC, at 6 amps (conservative rating) consists of one hermetically sealed transformer with tapped primary and secondary and full wave bridge selenium rectifier $11.95

100 Amp (Fan Cooled) SELENIUM RECTIFIER STOCK

Input: Up to 10—0—10 V.A.C.
Output: 7½ V.D.C.

This rectifier will handle 50 amps, convection cooled, or up to 150 amps, fan cooled, depending on air flow. $11 each in lots of 3 or more.... **$11.98**

FAST CHARGER STACKS MADE TO ORDER — 48 HOUR SERVICE

Victoreen Voltage Regulator VXR-130, subminiature. Brand New. Users net cost $5. Quantity in stock .... only **75¢**

Western Electric Steel Blank Panels. 10½" high, 19" wide, ⅛" thick. Brand new, individually boxed. W. E. No. 296 A & B, in commercial grey or telephone black. Special.................each **85¢**

Johnson No. 122-101, 829B, 3E29 Ceramic Sockets, only .... **69¢**

NEW 6MFD 600 VDC Oil Capacitors .... **85¢**

BC-160 Filter Choke, 20 Hys.—300 MA—125 ohms resis, insulated for 15 kv......... **9.95**

Jefferson Filament Transformer, 115 v, 60 cycle input secondary, 20 v at 10 amps. Brand new, boxed **8.95**

304TH Surplus	6.75
304TL Surplus	7.75
403B/5591	3.15
404A/5847	12.00
407A	4.75
408A/6028	2.25
416A	35.00
416B	55.00
417A Westinghouse Klystron orig. sealed carton	4.95
GL434A	4.00
707B	4.00

5656 New Jan Raytheon Late...... 7.95

5670 New Jan Gen. Elec. Late....... 2.15

5879	1.10
6080	3.25
6080/WA	5.50

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- Ruggedized 5000 & 6000 series

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SUPER SPECIAL!

3000 Volts DC—330 Ma.

BASIC COMPONENT POWER SUPPLY KIT

Contains:
- 3500 V. AC. XFMR @ 400 MA. Primary—115 V., 60c.
- 400 MA. Matched Smoothing Choke.
- 115 Volts Primary Bridge Filament for Four 866-A's

Complete Only $39.95 with Schematics

Also These Individual Components for Sale—Write

Miniature High-Voltage Converter for Geiger Counter

- Operate your geiger counter from standard 1½ volt flashlight cells.
- This compact powerful unit converts regular battery voltage to 900 volts for direct operation of geiger counter tubes. Actual range of output is 0 to 7,000 Volts AC (easily rectified and regulated with circuits supplied) so that any type of geiger counter or photo multiplier tube can be operated from unit. Weighs only 4 ounces and small enough to fit in the palm of your hand.

$10.00 each with instructions

Many Other Types in Stock. Phone, wire or write for quotations.

BARRY ELECTRONICS CORP.

Authorized Distributors for Eimac, CBS-Hytron (CBS), Cetron, Lewis & Kaufman and Penta Tubes.

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IMMEDIATE DELIVERY
PRODUCTION QUANTITIES

RELAYS

And Many Others

WESTON TYPE 705 SENSITROL

#R561

15,800 NOW IN STOCK!

Operation is as follows: The stationary contact is a small powerful permanent magnet and movable contact is iron "rider" mounted on pointer which travels over relay scale. Operating torque moves pointer into magnetic field of stationary contact. This contact then draws movable contact and holds it firmly. Perfect contact is assured and chattering is eliminated. Contacts remain closed until reset. Accuracy in general may be considered as within 5% of the range. Operates directly from a photocell or a group of thermocouples. Net weight 14 oz.

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

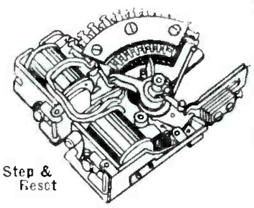
Same as #R560 but with glass face; Weston Model 705 Type 6 #R561.**19.75; 10 for $180.00**

Single contact (Normally Open), Solenoid Reset; Sensitivity; 10 Microamperes; Reset coil; 6-24 V DC or 24 V AC; Contact: "Twintact", capacity 100 ma at 110 volts; Glass Face: Weston Model 705 Type 4 #R523.**17.75**
10 for $160.00

Same as #R523 with Brass Cover Weston Model 705 Type 4 #R523N............**16.75**
10 for $150.00

**Production Quantities Available.
Call Us for Prices.**

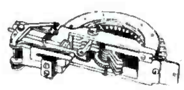
STEPPING SWITCHES



Step & Reset

Mfg by Western Electric, Automatic Electric Sales
Minor Switch 10 steps and off
Contacts: Gold plated brass;
Bridging Wiper;
Operating Voltage 6.0 to 12.0 V. DC
Net Weight: 1 lb.

SS5	Each	Lots of 10
#R960; Single Level; 6 to 12 VDC	**10.95**	**9.00**
#R975; Single Level; 24 to 36 VDC	**11.95**	**10.00**
#R976; Single Level; 48 to 60 VDC	**12.95**	**11.00**
#R977; Two Level; 6 to 12 VDC	**12.95**	**11.00**
#R978; Two Level; 24 to 36 VDC	**13.95**	**12.00**
#R979; Two Level; 48 to 60 VDC	**14.95**	**13.00**



Mfg. by Western Electric Co., Automatic Electric Sales; 22 step; 5 levels; Bridging Wipers; Contacts: Gold plated brass
Interrupter Switch: 1 Break-Make; Net Weight: 2 lb. 2 oz.

SS6 "Homing" Type; Double-Ended Wipers; Step in One Direction

#R926; 6 to 12 VDC	**14.75**	**12.00**
#R980; 24 to 36 VDC	**15.75**	**13.00**
#R981; 48 to 60 VDC	**16.75**	**14.00**

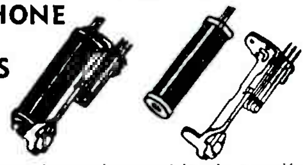
Mfg by Western Electric Co., Automatic Electric Sales; 44 step; 2 levels; Bridging Wipers: Contacts: Gold plated brass; Interrupter Switch; 1 Break-Make; Net Weight: 1 lb. 14 oz.

SS7 "Homing" Type; Double-Ended Wipers; Step in One Direction

#R927; 6 to 12 VDC	**14.75**	**12.00**
#R982; 24 to 36 VDC	**15.75**	**13.00**
#R983; 48 to 60 VDC	**16.75**	**14.00**

ELECTRICAL COUNTER: Automatic Electric Series CDC; Non-Reset type; Auxiliary SPST (1A) Contacts; Speed; 4 steps/sec; 4 digits; 223 ohms; 24VDC; #R897......**$5.00**

TELEPHONE TYPE RELAYS



These relays have been standardized so that coils and frames of most manufacturers can be interchanged without affecting adjustments. A wide variety of applicable combinations are thus possible from a comparatively small number of relays.

Listed below are frames and coils from our stock. They may be purchased separately. However, a complete relay consists of coil and frame. In ordering complete relays specify which coil with which frame, i.e.: F101 with K117.

**10% off on orders of 10 to 99.
20% off on orders of 100 or more.**

Types may be mixed for discount.

FRAMES

(For Cost of Relay Add Price of Frame to Price of Coil)

Stock No.	Contacts	Price each	Stock No.	Contacts	Price each
F101	1A	**$1.25**	F122	2A, 2B, 2C	**$3.00**
F102	2A	**1.50**	F129	2A, 2B, 6C	**5.00**
F103	3A	**1.75**	F114	3A, 1B	**2.00**
F104	4A	**2.00**	F162	3A, 1B, 1C	**2.25**
F138	5A	**2.25**	F163	3A, 1B, 1D	**2.25**
F139	10A	**3.50**	F115	3A, 2	**2.75**
F128	12A	**4.00**	F164	3A, 4C, 1D	**3.75**
F106	1A, 1B	**1.50**	F165	4A. 1B	**2.00**
F107	1A, 2B	**1.75**	F117	5A, 1C	**2.75**
F140	1A, 3B	**2.00**	F166	6A, 2B	**2.50**
F108	1A, 1B, 1C	**2.00**	F143	6A, 4C	**4.50**
F152	1A, 1B, 2C	**1.80**	F131	9A, 1B, 1C	**4.00**
F153	1A, 2B, 1C	**2.00**	F120	1B	**1.25**
F154	1A, 2B, 1E	**2.50**	F132	2B	**1.50**
F109	1A, 1C	**1.75**	F167	2B, 1C, 1D	**2.25**
F155	1A, 2C	**2.00**	F168	2B. 3C	**2.75**
F141	1A, 3C	**2.75**	F133	1B, 1C	**1.75**
F147	1A, 2D	**2.75**	F144	1B, 4C	**3.25**
F156	1A, 4C, 2D	**3.75**	F121	5B, 1C	**2.75**
F111	2A, 1B	**1.75**	F122	1C	**1.50**
F157	2A, 1B, 1C	**2.00**	F169	1C, 2D	**2.25**
F158	2A, 1B, 2C, 1D	**2.90**	F123	2C	**2.00**
F159	2A, 1D	**1.75**	F145	3C	**2.50**
F142	2A, 2B	**2.00**	F124	4C	**3.00**
F160	2A, 2B, 1C	**2.75**	F149	1C, 1D	**2.25**
F137	2A, 1C	**2.00**	F150	3C, 1D	**3.25**
F171	2A, 2C	**2.50**	F170	7C, 1D	**4.25**
F161	2A, 3C	**3.75**	F151	1D	**1.75**

Additional pileups also available
A = Normally open; B = Normally closed;
C = Double throw; D = Make before break

COILS

(For Cost of Relay Add Price of Coil to Price of Frame)

Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K101	0.75	**$1.25**	K134	700	**$1.50**
K131	5.0	**1.25**	K107	750	**1.50**
K102	12	**1.25**	K135	800	**1.75**
K156	50	**1.25**	K109	1000	**1.75**
K157	70	**1.25**	K111	1300	**1.75**
K168	100	**1.25**	K158	1400	**2.00**
K132	175	**1.25**	K112	2000	**2.25**
K169	200	**1.25**	K159	2250	**2.50**
K153	300	**1.50**	K155	2500	**2.50**
K154	400	**1.50**	K113	3000	**2.50**
K104	450	**1.50**	K116	6500	**2.75**
K105	500	**1.50**	K167	12,000	**3.00**
K133	600	**1.50**	K118	40,000	**3.25**

SLOW-ACTION COILS

SLOW-MAKE			SLOW-RELEASE		
Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K160	20	**$1.50**	K161	30	**$1.50**
K122	33	**1.50**	K149	3.9	**1.50**
K146	125/1300	**2.50**	K123	75	**1.50**
K171	500	**2.00**	K124	200	**1.50**
K147	500/1500	**2.50**	K150	800	**2.00**
K148	1300	**2.00**	K151	1000	**2.00**
K146	1300/125	**2.50**	K152	1300	**2.25**
K147	1506/50	**2.50**			
K172	1800	**2.50**			

DUAL COILS

Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K162	20/400	**$2.25**	K106	500/1100	**$2.00**
K163	25/200	**2.25**	K144	500/1800	**2.50**
K141	50/2000	**2.25**	K165	55/550	**2.25**
K166	125/125	**2.25**	K170	800/800	**2.25**
K142	125/1300	**2.25**	K143	1000/200	**2.00**
K164	200/200	**2.25**	K106	1100/500	**2.00**
K163	200/25	**2.25**	K142	1300/125	**2.25**
K143	200/1000	**2.00**	K144	1800/500	**2.50**
K162	400/20	**2.25**	K141	2000/500	**2.25**

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TERMS:—All Prices F.O.B. Our Plant. Rated Firms Net 10 Days; All Others Remittance with Order. Orders Under $10 Remittance With Order. Plus Approximate Shipping Charges (overage will be returned.)

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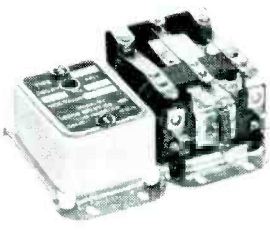
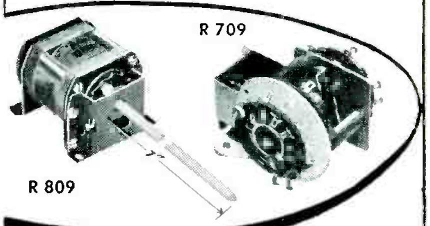


ADJUSTABLE THERMAL TYPE TIME DELAY RELAY

Operates on 115 V.A.C. Continuously adjustable delay from 5 to 20 seconds. ¼ Inch D.P.D.T. 12½ amp. contacts. Primarily designed for use with radio transmitters but has wide variety of other applications.
Catalog No. R 686 Price $6.10 each



STEPPING UNIT

Operates on 22 to 30 V.D.C. 12 Position driving mechanism operates through 360° in progressive steps. Indexes one position for each momentary current impulse. Attached wafer switch may be used for self interruption. 7 inch flatted shaft will drive pulley, gear or one or more wafer switches.
Catalog No. R 809 Price $2.45 each

SOLENOID OPERATED RATCHET STEPPER

Operates on 6 V.D.C. Operates three 12 position wafer switches. Most standard wafers are interchangeable with those supplied. Rotates 30° with each impulse.
Catalog No. R 709 Price $3.90 each

HUNDREDS OF RELAY TYPES IN STOCK

- Standard Telephone Relays
- Short Telephone Relays
- Midget Relays
- Timers
- Aircraft Contactors
- Rotary Relays
- Western Electric Type "E" Relays
- Keying Relays
- Hermetically Sealed Relays
- Voltage Regulators and Cutouts
- Differential and Polarized Relays
- Special Relays
- BK-Series
- Antenna and Ceramic Relays
- Motor and Control Relays
- Relay Assemblies
- Latching and Interlocking Relays
- Mechanical Action Relays
- Ratchet and Stepping Relays

All relays are new, individually inspected and unconditionally guaranteed. They are first line products of leading manufacturers. Special attention given to orders of one or more relays. 24 Hour delivery.
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Relay Sales

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STANDARD BRANDS – TRANSMITTING & RECEIVING

Type	Price
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CEP-120/ZB	.94
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CK-521AX	.99
CRP-72	**.79**
DG-1290	3.99
EF-50	.39
E-1148	.39
EC1	.39
F123A	5.99
F127A	3.99
F128A	**29.50**
HF-100	6.99
HF-150	15.99
HF-200	10.99
HF-300	19.99
HK-24	**3.99**
HK-54	4.59
HY-114B	**.19**
HY-615	**.19**
KU-610	**4.99**
QK-61	**63.50**
QK-62	**69.00**
RK-34	**.29**
RK-38	1.89
RK-59	1.89
RK-60	2.49
RK-65	**16.99**
RX-21A	**8.99**
UV-217C	3.50
UH-50	1.99
10S/VT-25A	.29
VR-78	.89
VR-90	.82
VR-105	.89
VR-150	.80
VT-52	.19
30S/VT-67	.19
VT-127A	2.99
VT-158	15.99
VU-111	**.19**
OA2	.84
OB2	.84
1B22	1.19
1B24	**6.99**
1B26	1.46
1B27	10.45
1B29	2.59
1B32/532A	1.19
1N21	.69
1N23	2.10
1N27	1.39
1P28	11.70
1P30	2.99
2AP1	6.99
2B22	1.49
2BP11	7.99
2C22	.99
2C26	**.11**
2C20	4.95
2C33/RX233	1.69
2C39A	**11.99**
2C40	7.29
2C43	**14.77**
2C44	.85

Type	Price
2C46	9.99
2C51	3.59
2D21	.94
2E22	2.49
2E24	3.29
2E30	1.89
2G-22	1.19
2J-21	**1.50**
2J-22	**1.50**
2J-26	**2.50**
2J-27	**3.00**
2J-31	17.50
2J-32	15.99
2J-33	17.50
2J-34	17.50
2J-38	16.50
2J40	29.50
2J-42	69.95
2J-49	49.50
2J-61	19.99
2J-62	9.99
2K-22	**16.99**
2K-23	**17.95**
2K25	**14.99**
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2K45	**69.50**
2K52	59.50
2K54	**23.90**
2K55	**19.50**
2X2/879	.26
2V3	.86
3A5	.69
3BP1	2.99
3B22	1.49
3B23	3.99
3B24	**3.29**
3B25	3.39
3B27	11.69
3B28	3.69
3C21	.94
3C22	**64.95**
3C23	7.45
3C24	.99
3C28	**4.99**
3C30	1.42
3C45	7.95
3D23	4.99
3E29	10.49
3EP1	2.99
3FP7	1.99
3GP1	2.99
3HP7	1.77
3J21	59.50
4A-11	**.19**
4AP-10	2.99
4B22	7.22
4B25/EL6C	8.95
4B28/CE225	2.99
4-125A	25.00
4B36	3.69
4C27	8.95
4C28	33.50

Type	Price
4C35	**14.99**
4D22	19.95
4D32	19.89
4E27	15.99
4J22	79.60
4J23	79.60
4J26	**79.50**
4J28	**79.50**
4J31	99.50
5AP1	4.99
5BP1	2.99
5BP4	**2.99**
5CP1	4.49
5CP1A	10.50
5CP7	10.50
5CP11A	15.50
5C21/C6J	8.49
5C22	**31.75**
5D21	**9.49**
5FP7	1.99
5HP4	3.99
5HP1	3.99
5JP1	14.50
5JP5	16.50
5RP2	16.50
5J29	**9.00**
5J30	16.65
5J33	**5.90**
5LP1	15.95
5NP1	11.95
5R4GYW	**2.05**
5R4GY	.99
6-4	.19
6C21	16.99
7C22	**69.00**
7C25	**89.50**
7BP1	6.99
7BP7	6.99
9LP7	5.50
10Y	**.21**
12X3	1.66
15E	1.09
15R	.19
18C	.19
24R	1.99
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53A	1.99
89Y	**.10**
100TH	6.99
100TL	8.99
203	3.99
204A	9.49
205B	.89
207	**42.50**
211	.89
215A	3.49
217A	2.49
217C	6.99
221A	2.99
231D	2.39
242C	6.99
249B	4.39
250R	4.99
250TH	19.50
250TL	21.50

Type	Price
253A	7.99
258B	4.49
259A	6.99
264C	4.19
271A	12.99
274B	3.35
282A/B	8.49
286A	7.49
287A	6.51
304TH	7.75
304TL	8.75
307A/RK75	1.99
310A	3.60
316A	.99
327A	3.69
329A	4.69
336A	4.99

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Type	Price
347A	3.99
350B	4.99
371B	.89
388A	.99
393A	4.99
394A	5.99
417A	**6.49**
434A	**8.66**
446A	1.49
446B	3.99
WL460A	9.99
WL464A	6.99
GL471A	2.35
527	16.50
WL530	14.99
WL531	3.69
WL532	2.10
GL559	.99
700A/B/E/D	9.99
701A	5.35
702A	1.99
703A	3.22
704A	1.09
705A	.99
706B	18.95
706C	18.95
707A	3.99
707B	**6.99**
708A	2.45
709A	2.75
713A	.99
714AY	27.99
715A	3.95
715B	5.95
715C	15.75
717A	.89
718AY/BY/CY/EY	21.99
719A	14.95
720AY/CY/EY/DY	29.75
721A	1.95

Type	Price
721B	9.95
722	1.99
723A/B	8.99
724A/B	1.99
725A	7.50
726C	**39.50**
800	.98
801A	.29
802	3.59
803	1.85
805	2.99
807	1.29
808	2.45
809	3.49
812	2.95
813	9.95
814	3.49
815	1.99
816	1.39
827R	79.50
828	9.75
829B	9.50
830B	1.99
832A	**7.49**
833A	37.49
836	3.20
837	1.22
838	2.90
841	**.19**
843	**.19**
845	11.99
849	49.69
851	24.99
860	3.99
861	16.99
864	**.19**
865	1.89
866A	.99
869B	**19.99**
872A	1.99
874	.86
876	.96
878	1.29
884	1.19
885	1.49
891R	199.50
892	199.50
9-3	**.19**
902A	6.49
918	2.10
927	1.95
931A	5.99
954	**.16**
955	**.29**
956	.26
957	.26
958	.59
959	1.99

Type	Price
991	.44
1500T	84.50
CK1005	.49
CK1006	3.19
1608	.99
1613	1.70
1614	1.99
1616	.99
1622	1.55
1624	1.64
1625	**.19**
1626	**.11**
1629	**.11**
1630	.69
1632	.89
1639	.89
1641	**2.49**
1642	**.29**
1806P1	3.99
1851	1.39
1960	.99
2050	1.19
2050W	2.20
2051	.81
1A3	.69
1B3	.89
1G6GT	.69
1LC5	.94
1LD5	.94
1L4	.84
1T4	.69
1A5	.79
1H5	.69
1N5	.89
1R5	.69
1S4	.84
1S5	.69
1U4	.69
1U5	.65
1X2A	.89
1V2	.69
2A3	.99
2A4	.99
3B7	.39
3D6	.39
3V4	.73
3Q4	.83
3S4	.69
5U4	.59
5Y3	.50
5T4	.91
5V4	.89
5Z4	1.19
5W4	.89
6AC7	.89
6AB7	.99
6AF4	1.29
6AG5	.84
6AG7	1.19
6AH6	.89
6AL5	.59
6AJ5	1.69
6AK5	.74
6AK6	.79
6AN4	1.35
6AQ6	.59
6AR6	2.70
6AS5	.76
6AS7G	3.69
6AX4	.79

Type	Price
6B4G	.99
6BA7	.89
6B5	.99
6B8	.69
6BG6G	1.99
6BH6	.79
6BE6	.69
6BJ6	.69
6BK7A	1.21
6BL7	1.10
6BN6	1.24
6BQ6	1.19
6BQ7A	1.19
6BX7	1.24
6CD6	1.72
6CB6	.69
6C4	.40
6C5	.49
6C6	.49
6C8G	.99
6D4	2.75
6E5	.79
6F5	.49
6F6	.99
6F6G	.69
6J4	3.99
6J6	.72
6J7	.94
6J8	.96
6K4	2.69
6K5	.79
6K6	.69
6K7	.79
6K8	1.19
6L6M	1.49
6L6G	.99
6L7	.99
6N7	1.10
6R7GT	.69
6S4	.59
6SC7	.74
6SF5	.74
6SG7	.69
6SH7	.79
6SK7	.64
6SL7	.79
6SR7	.59
6SS7	.79
6W4	.69
6W6	.84
6V6GT	.66
6X4	.49
6X5	.49
6T4	1.44
6T8	.99
7A5	.95
7A6	.85
7A7	.85
7A8	.79
7B5	.69
7C4	.39
7C5	.79
7F7	.89
7G7	.89
7H7	.69
7N7	.89
7Q7	.99
7Y4	.69
7Z4	.69
12A6	.59
12AT6	.49
12AU7	.79

Type	Price
12AT7	.99
12AV7	.94
12AX4	.83
12AX7	.79
12AY7	1.31
12BA6	.64
12BA7	.64
12C8	.69
12SC7	.89
12SQ7	.59
12SR7	.59
12SF7	.82
12SG7	.85
12H6	.65
12SH7	.69
12SJ7	.69
12K8	.69
12SK7	.69
12SN7	.79
12SL7	.89
12Z3	.49
14A7	.79
14B6	.69
14B8	.79
14N7	.99
14R7	.99
14W7	.99
19T8	.99
25L6	.64
25Z6	.61
26D6	1.75
28D7	1.21
35L6	.69
35Z3	.69
35Z5	.51
35Y4	.69
50A5	.69
50B5	.69
50C5	.69
50L6	.69
77	.49
78	.59
80	.49
83V	.99
5516	6.99
5559	18.99
5560	24.40
5633	10.95
5634	4.99
5638	8.70
5651	1.71
5654	1.10
5670	2.39
5687	3.49
5718	5.69
5763	1.59
5796	7.99
5814	1.29
5964	1.15
7193	.09
8002R	24.95
8005	4.99
8012	1.94
8013A	4.69
8020	2.59
8025	2.95
8602	.69
9001	.99
9002	.69
9003	1.29
9004	**.19**

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CABLE FITTINGS, PLUGS & CONNECTORS

(AN-3108-18-5S)	.35 EA.
AN-3108-18-20P	.35 EA.
97-3108-18-20P	.35 EA.
AN-3108-18-20S	.35 EA.
97-3057-10-6	.15 EA.
PLUG—Navy Type No. 49195 PL259A	.41 EA.
ADAPTORS—Right Angle M359A	.31 EA.
CHASSIS CONNECTOR—SO 239A	.39 EA.

FAY-BILL DISTRIBUTING CO. DEPT. E1
418 Broome St., N. Y. 13, N. Y.
Telephone CAnal 6-8404

APN-9A AUTOMATIC COUNTER LORAN

This set provides greatly simplified operation over the regular APN-9 or APN-4. To take a bearing it is necessary only to match PPI'S on the screen and read the time difference directly on a dial, no interpolation is necessary.

Accuracy within 1%. Furnishes position information at far greater distance from transmitting stations than possible by any other means. The unit consists of the R249/APN-9A, receiver—Indicator. Input is 110V. 400 cyc. Large quantity available. Each Loran is completely checked out and guaranteed. PRICE **$365.00**

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A Division of Compass Communications Corporation

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TEST SETS

TS-3A/AP
TS-10A and B
TS-12/AP
TS-13/AP
TS-14
TS-16/AP
TS-36/AP
TS-61/AP
TS-62/AP
TS-74/UPM
TS-89/AP
TS-101/AP
TS-125/AP
TS-173/UR
TS-278
TS-323
TS-UPM-1
OAA
OAP
OBU
LAE
LM
LU
IE-19
1-46
1-56
1-208
1-222
SCR-211
AND OTHERS

TRANSMITTERS

TAJ
TAQ
TBL
TBK
TBM
TBN
TCE
TCP
TDE
TDQ
TDO
AND OTHERS

RECEIVERS

ARB
ARC-1
ARC-3
ARC-4
ARC-5
AR-88
ART-13
CR-91
SLR
RAK
RAL
RAO
RBB
RBO
RBG
RBL
RBA
RBM
RCH
BC-224
BC-312
BC-314
BC-344
BC-348
AND OTHERS

FIELD EQUIPMENT

SCR-274
284
300
399
503
536
808
828
BC-191
375
603
604
610E
683
684
923
924
1000
1306

TEST SETS

*—**TS-13/AP-X BAND RADAR TEST SET**—Measures power, freq. signal-to-noise ratio, I.F. Bandpass, etc. Input—115/1/60—800 .... **WRITE**

TS-35A/AP-X BAND—Measures transmitted power & frequency of Radar Transmitters, also used for receiver adjustments. **NEW** $375.00

TS-69/AP—FREQ. METER. Absorption type—340-1000 mcs—with calibration charts & antenna. Uses 0.200μ ammeter. **EXC.**—$75.00

TS-100/AP—TEST SCOPE, type A, R, J & X indications, gated &ungated sweep. Int. or Ext. trigger .... **WRITE**

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15 lb. **ALNICO-V MAGNET**—approx 4800 gauss $16.00

WAVEGUIDE, FLEX. with flanges. 3 cm., 12"l. .... 12.50 ea.
3 CM., 24"l.—$14.00 ea. 10 CM., 60"l.—$22.50 ea.

BENDS, E. & H plane; 3 & 10 CM .... **WRITE**

DUPLEXER, Mixer & Preamp Ass'y., 3 CM .... **WRITE**
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WESTERN ELECTRIC VARISTORS, THERMISTORS, Res. Networks, Relay Ass'y, Precision Potentiometer, #60 A Key Selectors, etc. .... **WRITE**

RADAR BEACONS

YJ and YG.....for shipboard use
AN/CPN-6 ....3 cm.
AN/CPN-8 ....10 cm.
AN/APS-2, APS-3, APS-4, APS-6, APS-15

Also SA, SF, SG, SD, SJ, SK, SN, SQ—both equipment and spare parts

SA-2 RADAR Used for air traffic control, tracking and search, both land-based and ship-borne. 5 microsec. pulse., PPI indication, operates at 200 mcs, peak power of 150 K.W. Input 110/120 volts a.c. 4 complete installations in stock.—Write for price.

Write for More Details on Any Particular Item in Which You are Interested
These are partial listings only of our stock. Please write for other types.

393 Greenwich St. New York 13, N. Y.
BEEKMAN 3-6510 *Cable:* COMPRADIO, N. Y.

MOTOR GENERATORS AND CONVERTORS

50, 60, 400 and 800 cycle and DC Power Supplies

28dc 110/1/800@1kva **$49.50**
overall length: 12 inches
110dc 110/1/800@350va **150.00**
110ac 110/1/800@350va **235.00**
110dc 110/1/400@2kva **395.00**
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440/3/60 110/1/400@2kva **435.00**
32dc 110/1/60@350va **100.00**
110dc 110/1/60@350va **100.00**
110dc 28dc@250va **95.00**
110/1/60 28dc@250va **115.00**
220/1,3/60 28dc@250va **115.00**
110dc 110/1/60@1.25kva... **135.00**
220dc 110/1/60@1.25kva **145.00**
Partial listing—write for offers

SYNCHROS & SELSYNS

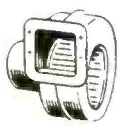
5F **$40.00**
5G **45.00**
5CT ... **45.00**
5SDG.. **27.50**
6G **55.00**
7G.... **$70.00**
2J1F1.. **10.00**
2J1G1. **10.00**
2J1H1. **10.00**

115 V AC BLOWER
w/motor, 1/150 h.p. 3000 RPM
$10.00

CENTRIFUGAL BLOWERS

Continuous Duty—110 V.—A.C.—60 Cycles

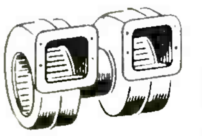
BRAND NEW • TOP QUALITY • FULLY GUARANTEED



100 C.F.M.—3" DIAMETER ROTOR Powered by choice of Fasco or Heinze shaded pole, two pole, enclosed motors. 3" inlet. 2" outlet. Sheet steel housing. No. BL100 .... **$7.75**

600 C.F.M.—6" DIAMETER ROTOR Powered by Westinghouse 1/4 H.P. 1725 rpm motor. 5½" inlet and 7" x 3½" outlet. Base mounted. No. BL600 .... **$28.50**

200 C.F.M.—4½" DIAMETER ROTOR Powered by Bodine split phase, 1725 rpm 40°C. Ball bearing motor. 4½" inlet and 5½" x 3" outlet. No. BL200B **$16.50**



TWIN BLOWER —520 C.F.M.—5¼" DIAMETER ROTORS Redmond shaded pole four pole motor. 5" inlets and 3½"x3½" outlets. Discharge flanges shipped unmounted. No. BL520R...... **$22.50**

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FOB N.Y.C. Warehouse

ELECTRIC TRADING CO. 313-315 H Canal St., New York 13, N. Y.
Air Equipment Experience Since 1906

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**

RADAR TEST SET

Phantom Target RF4/AP is used for permanent installation in planes equipped with radar set in the S band while plane is in flight. With instruction book, new condition. Wt. 10 lbs. **$49.50**

ECHO BOX

A hand tuned ring box with an associated dipole which picks up the RF energy from the radar set. Frequency range of 3140-3640 MC. Ideal unit for experimental lab. Wt. 7 lbs. New Condition **$4.95**

NEW CATALOGUE NO. 114
1955 ISSUE
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BC 433G RADIO COMPASS $16.95
1D57-APQ7 INDICATOR 15.95
TU6B FOR SCR375 .... 2.95
RA/105 POWER SUPPLY 25.00

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General Electric OX-200, XRD Diffraction, Picker, Standard, Westinghouse and Kelekket units from 100 KV up. Special inspection booths made to order.

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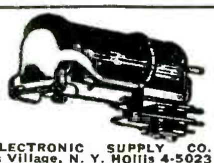

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1AB5	.39
1B32	.44
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1B56	14.00
1P23	.44
2C33/RX233A	.88
2C43	12.75
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2E24	1.75
2J21	1.95
2J21A	1.95
2J22	1.75
2J26	4.75
2J32	9.95
2K28	25.00
2K31	77.00
2K45	57.00
2K56	55.00
2X2/879	.22
3A5	.22
3B7	.35
3BP1	2.75
3B24W	9.45
3B27	7.75
3CP1S1	2.00
3E29	9.45
3JP7	3.75
4B28	3.75
4J25	55.00
4X100A	22.00
5AP1	2.15
5B21	2.75
5BP1	.99
5BP4	1.75
5CP1	3.95
5D21	7.95
5FP7	1.75
5HP1	3.75
5R4WGY	1.45
6AC7W	1.25
6AJ5	1.25

7BP7	2.75
7C4/1203A	.12
9GP7	3.75
10	.19
10 Special	.19
10Y	.19
12A6	.29
15R	.29
T20	2.00
TZ20	2.00
T21	2.00
23D4	.44
30 Special	.22
FG32	.99
RK34	.29
35T Ion Gauge	1.75
39/44	.12
T40	2.00
HY40Z	2.00
RK49	3.95
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RK65/5D23	7.50
VR65	.39
RK72	.77
RKR73	.77
100TH	5.95
101F	1.35
101L W.E.	.99
VU-111S	.77
F-127A	17.75
205B	.66
207	50.00
211	.49
212A	.45
215A W.E.	2.00
217C	3.75
249B	3.75
249C	3.75
250R	4.75
250TH	22.00
311A W.E.	2.75
311B W.E.	3.75

312A	2.95
313CA	1.75
313CC	1.75
322CA	9.45
371B	.75
373A W.E.	1.75
374A W.E.	1.75
388A W.E.	1.75
393A W.E.	4.50
404A W.E.	12.50
407A W.E.	2.95
408A W.E.	2.95
416A W.E.	Write
417A W.E.	13.75
421A W.E.	2.45
422A W.E.	2.45
464	3.75
471A	2.00
CK507AX	.44
WL5 32A	.44
575A	19.45
705A	.95
713A	.41
715B	5.50
717A	.55
721A	1.00
722A	.77
730A	12.50
807	1.35
813	10.00
815	4.75
826	.55
830B	1.75
832	6.50
832A	7.75
841	.19
851	19.00
861	9.75
864	.17
866A	1.19
872A	2.75
889R	99.00
891	77.50
921	.39
931A	3.35

954	.14
955	.24
CK-1006	1.25
CK-1089	.84
1616	.49
1619	.22
1625	.19
1626	.19
1629	.10
1630	.55
1632	.22
1680	1.00
5687	3.50
5691	5.00
5692	6.75
CK-5702	1.45
5726	1.00
CK-5744	.77
CK-5784	2.25
5803 Victoreen	1.75
5814	2.25
5825	5.50
5933	7.50
5964	.44
6035	10.00
6038	3.85
6045	1.00
6096	1.00
6099	.75
6101	1.35
7193	.14
8002R	25.00
8011	.44
8012	1.95
8025	2.95
8025A	3.45
9002	.65
9006	.24
38111A Low capacitance 211 for crystal application	.55

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O1A	.29
1A5GT	.50
1A7GT	.50
1F7G	.99
1H6G	.59
1LA4	.50
1LA5	.64
1LC5	.64
1LG5	.79
1LH4	.65
1P5GT	.34
1Q5GT	.64
2A3	.89
2A5	.55
2A6	.49
2A7	.66
2X2/879	.22
3A5	.22
3B7	.35
5R4WGY	.45
5X4	.50
5Y4G	.55

5Z3	.55
6-7 Ballast	.29
6AC7	.66
6AC7W	1.25
6AG5	.55
6AG7	.77
6AJ5	1.25
6AK5	.55
6AL5	.42
6AQ5	.45
6AS7G	3.35
6B8	.55
6D6	.55
6F5	.22
6F6	.50
6F6GT	.55
6F8G	.33
6G6G	.60
6H6	.25
6J5GT	.39
6J6	.55

6J7	.65
6K7	.44
6K8G	.60
6L5G	.59
6L6M	1.25
6L6GA	.77
6L7G	.39
6N7GT	.44
6R7	.50
6R7GT	.22
6SA7GT	.55
6SC7	.77
6SF5	.55
6SG7	.66
6SG7GT	.59
6SH7	.55
6SL7GT	.65
6SK7GT	.44
6SN7GT	.65
6SQ7GT	.40
6V6GT	.50
6Y6G	.85
7A6	.22
7C4/1203A	.12
12A6	.29
12A8GT	.39
12AU7	.66
12B8GT	.29
12C8	.22

12K8	.44
12SG7	.65
12SK7GT	.48
12SL7GT	.55
12SQ7GT	.44
12SR7	.33
14A4	.75
14C7	.64
19	.65
25L6GT	.55
26	.44
28D7	.99
30	.75
33	.15
35Z5GT	.37
35Z3	.45
37	.12
38	.12
39/44	.12
41	.40
43	.59
46	.50
57	.50
70L7GT	1.00
71A	.45
75	.40
76	.49
77	.45
83V	.75
89Y	.25

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CLEARANCE OF TUBES

Jan-Commercial-Standard Brands
In lots of 100 only

1B32/WL532A	.24
1P23	.25
2C33	.17
6F5	.22
6F8G	.20
7A6	.19
37	.10
38	.10
250R(Eimac)	1.10
713A	.14
1619	.15
1629	.10
5964	.44

"The switch is to Calvert"

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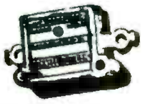


600 W.V.D.C.
Standard Brands

.0002	.17
.003	.21
.004	.23
.005	.25
.03	.35
.06	.50

1200 W. V.D.C.
Standard Brands

.001	9AH	.19

2500 W. V.D.C.
Standard Brands

.00005	.15
.00027	.19
.0004	.22
.0015	.27
.002	.29
.003	.39
.004	.44
.005	.50

600 W. V.D.C.
Standard Brands

.0015	.15
.002	.15
.0025	.17
.003	.21
.004	.23
.005	.25
.006	.27
.008	.29
.01	.33
.01	.33
.015	.42
.015	.42
.015	.50

1200 W.V.D.C.
Standard Brands

.00005	.15
.0001	.19
.0002	.22
.00025	.24
.0003	.25
.0004	.27
.022	.33
.006	.39
.01	.44

2500 W.V.D.C.
Standard Brands

.00025	.25
.0003	.27
.0004	.29
.0005	.31
.0025	.33
.003	.45
	.55

WANTED
BC-788, T-47A/ART-13, BC-348R, R-5/ARN-7, RT-18/ARC-1

RADALAB
87-17 124th STREET
Richmond Hill 18, New York
Phone VIrginia 9-8181-2-3

Prices FOB NYC. Rated firms open account. Prices subject to change without notice.
CABLE: Radalab, NY
TELETYPE: NY-4-4361

AN/ARC-2
2-9.5 mc autotune transmitter-receiver. This equipment will provide 8 channel autotune operation on voice or C.W. power output is app. 30 watts. This set is similar to ART-13 but incorporates a receiver which is automatically tuned to the trans. freq. as channels are changed, providing a very compact communication pkge. for air or ground use. Power input is 28v DC. POR.

TDQ VHF GROUND STATION
100-156 MC Ground to Air 50 watt Transmitter. Can be supplied with remote telephone control panel. 110 V 60 cy. input. POR.

AN/TXC-1, RC-120 FACSIMILE SETS
Page sending and receiving equipment. These sets will transmit and receive a 12 by 18 inch or a 7 by 8 inch page of written or picture material over a telephone line or a radio circuit in 20 minutes. The copy may be sent on or received on either photographic printing paper or on direct recording paper. Power input is 110v 60 cyc. POR.

AN/ASQ-1 and 1A MAGNETOMETERS
This is an airborne magnetometer used to measure the magnetic flux of the earth and to locate submarines and other metallic objects by their distortion of the magnetic field. Sensitivity 2-3 gamma or better. POR.

SCR-506A
2-6mc mobile or field radio transmitting and receiving equipment. This equipment is a currently used mobile communication set by many govts. The power output is 90 watts CW and 25 watts phone. The trans. may be set to 4 pre-selected channels or tuned manually. Power input is either 12 of 24v DC. POR.

SCR-694
3-6mc. portable field radio. This equipment provides reliable communications in the field or vehicle. Provisions are made for 2 preset channels, or the set may be tuned manually. Power output is 5 watts phone and 20 CW. This set can be supplied with either a vibrapack for 6 or 12 volt operation in a vehicle; or a hand generator for field use. POR.

AN/TRC-1
70-100 mc point to point VHF radiotelephone equip. This is a frequency modulated 50 watts point to point radio trans. and receiver. The range is approx. 60 miles line of sight. The set is completely portable and operates from 110v 60 cyc. POR.

TUBE SPECIALS

2J41	$149.50	4J31	$79.50
2J55	49.55	7C22	50.00
3B24	2.50	723AB	7.25
3C22	64.75	725A WE	5.50

All Tubes Completely Guaranteed.
New Standard Brands

AN/ARN-6 RADIO COMPASS
This is a very compact light weight automatic radio compass covering 100 KC to 1750 KC in 4 bands. All components are miniaturized including the loop for use in high speed aircraft. Complete sets and components are available. Input 110 Volts 400 cyc. and 28 Volts DC. POR.

AN/GSQ1-A SPEECH SCRAMBLERS
Speech scrambler for use on any comm. channel to insure privacy. We can supply complete installations of this equipment 28v DC input. Also 110v, 60 cyc.

RC-115B 75 MC FAN MARKER
This is a 75 C Marker Beacon Ground Station. This equipment comes mounted in a transporting trunk. The set can emit either inner, outer, or airways signals. The transmitter is crystal controlled and operated from 110 Volts 60 cyc. POR.

SCR-291A
Automatic ground direction finder covering 1.5mc-30mc. Provides instant bearings on a C.R. indicator of any signal in its range. This equipment is transportable and can be set up quickly. 110v 60 cyc. POR.

AN/ARC-1
100-156 mc. VHF transmitter-receiver. This equip. provides phone operation in 10 crystal controlled automatically selected channels from 100-156 mc. with one guard channel. We can also modify these sets for 20 and 50 channel operation and can supply complete sets for ground operation from 110v 60 cyc supply. Normal input 28v DC. POR.

SCR-682 A RADAR
10CM high power long range harbor surveillance and early warning RADAR. This equipment is a 3000 mc mobile search radar that can be transported in a truck. The equipment incorporates a 7" PPI for operation up to 240,-000 yards. Azimuth accuracy is ± 1%. Range accuracy is 100 yards at 10,000 yard range and 5000 yards at 240,00 yard range. Trans. output is approx. 225KW, pulse width is one microsecond. Antenna beam width is 6". Input is 110v 60 cyc. Can be supplied with or without operating shelter or antenna tower. POR.

AN/APQ-15
Multiple echo equipment. This set will pick up signals from a ground search radar and re-transmit from making the plane carrying it look like an entire fleet of planes on the ground radar .... POR

NEW REPAIR PARTS FOR BC 348
MODELS H, K, L, R, ONLY

Main Tuning Capacitor	$ 2.00
1st I-F Transformer Assembly	2.00
2nd I-F Transformer Assembly	2.00
3rd I-F Transformer Assembly	2.00
4th I-F Transformer Assembly	2.00
Crystal Filter Assembly	6.50
C. W. Oscillator Assembly	2.00
915 kc Crystal mounted	2.75
R. F. Unit Assembly	12.50
Resistor: Volume Control	2.75
Knob for Main Tuning Condenser.	.50
Band #1 Coils—per set of 6	3.00
Band #2 Coils—per set of 4	2.00
Band #3 Coils—per set of 4	2.00
Band #4 Coils—per set of 4	2.00
Band #5 Coils—per set of 4	2.00
Band #6 Coils—per set of 4	2.00
Complete dial assembly	$9.95

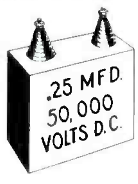
RADAR ANTENNAS
SO-1 (10CM) assembly with reflector waveguide nozzle and drive motor. New $279.50
SO-3 (3CM) Surface Search type with reflector and drive motor. but less plumbing. New in original cases $149.50
SO-13 (10 CM) Complete assembly with 24" dish, dipole, drive motor and gearing. New $89.50

G. E. SERVO AMPLIFIERS
Used in B29 planes for Central Station Fire Control Systems B2, B3 and B4. Used to drive Amplidyne 5AM31NJ9A and Control Motor 5BA50LJ2A listed in this ad. New less tubes $29.50

SCR-522 EQUIPMENT
Complete BC-624 C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, dynamotor. Brand new equipment with instruction manuals. Write for full details.

RA38 RECTIFIER
Variable output 0-15000 V DC @ 500 MA. Input 115V 60 cy. 1 ph. Size 63 x 53 x 56 in. Write for detailed information.

HIGH-VOLT OIL CAPACITORS



Mfd.	Volts	Price	Mfd.	Volts	Price
.001	50 KV	$22.50	.25	15 KV	$13.95
.01	5 KV	1.29	.25	20 KV	15.95
.02	8 KV	2.65	.25	50 KV	44.50
.02	20 KV	9.75	.5	25 KV	49.50
.025	50 KV	17.95	1.	7.5 KV	6.95
.025/.025	50 KV	34.50	1.	15 KV	29.50
.1	3 KV	.95	1.	20 KV	49.50
.1-.1	4.5 KV	3.50	2.	5.5 KV	9.50
.135	7.5 KV	6.95	2.	6 KV	12.50
.2	50 KV	29.50			

ALL TOP BRANDS

BARGAINS IN TEST EQUIPMENT

FLUXMETER. Measures field strength of magnets from 500 to 4000 gauss. Indicates polarity. Probe gap 1¼". British handicraft in fine hardwood case with hinged cover. Operating instructions on underside of cover. Size 12-¾ x 9 x 6 in. A lab instrument. Also ideal for classroom magnetics instruction. A real buy at only $24.50

FREQUENCY METER 375 to 725 Mcs. Model TS-127/U. Compact, Self-contained, precision (± 1 Mc). Sturdily constructed Hi-"Q" resonator has average "Q" of 3000. Uses 957, 1S6 and 3S4 tubes. Requires standard 1½V "A" and 45V "B" battery, not supplied. Brand new with instruction book, probe and spare kit of tubes $47.50

PANORAMIC ADAPTER AN/APA-10. A combined Panoramic Adapter and Scope. Has 3 inputs for feeding in receiver I.F.'s of 455 KC, 5.2Mc or 30 Mc. Designed also to be used as regular scope for testing other equipment. Has both vertical and horizontal push-pull amplifier inputs, etc. Complete with 21 tubes including 3" CR tube and instruction manual. For operation on 115V 60 Cy. Price $145.00

SPECIAL OFFER! 80 page Tech. Manual for Panoramic Adapter AN/APA-10. Full of circuitry, descriptive data, theory, etc. Postpaid in U. S. A. Only $2.75

TEST OSCILLATOR TS-47/APR, 40-2000+ Mc. Fundamental coverage 40-500 Mc 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 with handbook of Maintenance Instructions $169.50

FREQUENCY STANDARD TELRAD 18A. Provides 1000, 100 and 10 Kc check points from 100 to 45,000 Kc. Employs dual 100/1000 Kc Bliley Crystal. Calibrates with WWV. Operates 110/220, 60 Cy. New with instructions. $23.95

AN/APR-1 RECEIVER. For use with tuning units TN-1, and N-2, and N-3. Range 38-1000 megacycles. Price with tubes less tuning units $149.50

158-210 Mc RECEIVER BC-1068A. Has 2 tuned RF stages, tuned converter and oscillator, 5 IF stages, diode detector, tuning eye, and 2 stages of adio. Tuning coils may be altered for lowering or increasing coverage. Operates from 115V, 60 Cy. Gov't. cost estimated at $700.00. Our special price including 14 tubes. Shipping Weight. Approx. 60 Lbs. Only $29.50

300-1200 Mc TRANSMITTER T85/APT5. Nominal output 10 to 30 watts. Tunable cavity provides range from 300-1200 Mc. Filament transformer operates from 115 V 60 Cy. Uses 8 tubes: 1—931A, 2—6AC7, 2—6AG7, 1—6L6G, 2—829B, 1—3C22 (oscillator). Price with tubes $139.50

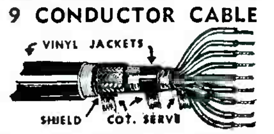
AMPLIDYNES
5 AM21JJ7. Input 27 VDC @ 15 A. Output 60 VDC @ 2.5A 4600 RPM. New $34.50
5AM31NJ9A. Input 27 VDC @ 44 A. Output 60 VDC @ 8.8 A., 7500 RPM. New $23. 0
5AM31NJ18A. Input 27 VDC @ 44 A. Output 60 VDC @ 8.8 A., 8300 RPM. New $12.50

INVERTERS
Leland Elec. Co. PE206A. Input: 28DC at 38 Amp. Output, 80V, 800 Cy., 1 Ph., 485W. New $16.50
PE218H. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5 KVA. New $32.50
G.E. 5AS131JJ11A. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5 KVA. Regulated. New $89.50

DYNAMOTORS
Navy type CAJO-211444. Input: 105 to 130 VDC. Output: either 26 VDC at 20 amps. or 13 VDC at 40 amps. Radio filtered and complete with line switch. New $89.50

SMALL DC MOTORS
G.E. 5BA50LJ2A. Armature 60 VDC at 8.3 Amps. Field 27.5 VDC at 2.3A RPM 4000. H.P. 0.5 New $27.50
Oster E-7-5. 27.5DC. 1/20 HP. 3600 RPM. Shunt Wound. New $9.50

9 CONDUCTOR CABLE



Army spec. CO-215 Weatherproof 9 Cond. No. 20 AWG stranded tinned copper, plastic ins., color coded, double vinyl jackets with tinned copper braid between. Dia. 9/16" made by G.E. Available 1000, 1500, 2000 ft. reels.
Price $.10 ft. Sample 100 ft. Coil $10.00

TERMS: Rated Concerns Net 30 FOB Bronxville, New York. All Merchandise Guaranteed. Prices Subject to Change.

PHONE: DEERFIELD 7-0044
ELECTRONICRAFT INC.
Cable Address: Electraft, N.Y.
27 MILBURN ST. BRONXVILLE 8, N. Y.

CONDENSERS

10 mfd. 600 V . . . . $.98
Three term. bot. mntg. channel type. Dims. 3¾"x3½"x2". Two 5 mfd. sections rated 400 V at 72 deg. "C". 1800 V test. Meets commercial specs. for 600 V operation up to 40 degs. "C". Ideal for filter or power factor application where ruggedness and quality are paramount. Carton or 24 weight 42 lbs. **$.89**

4 mfd.—600 V. Type TLA . $1.39
Brand New. Factory Cartons. Qua. Disc.

1 mfd.—400 V.—Channel Type . $.29

16 mfd.—600 V $1.89
Dual 8 mfd oil filled cond. hermetically sealed and packed. Tobe type PT-SC-11 measuring 3¾"x2⅝"x2⅝". Stud mntg. centers 2". Plugs into standard four prong socket.

24 mfd.—500 V $1.98
3-3-3 mfd.—400 V . . . . $ .65

.5-.5 mfd.—9 KV $14.95
50 mmfd.—32 KV Vacuum . . $10.95

AUTO TRANS.

115 V—60 Cy. Inp.
24 V.—28 A. Out.
Test Volts—1500 R.M.S.
Price $6.95

Mfd.	Volts	Price
.01	5000V	.89
.016	15KV	5.75
.0023	16KV	5.95
.01	10KV	4.95
.012	25KV	12.95
.02	8000V	4.75
.02	10KV	5.25
.02	20KV	9.95
2x.025	50KV	34.50
.03	7500V	4.50
.035	10KV	7.50
.05	5KV	1.98
.05	7500V	2.95
.08	12.5KV	9.95
.1	1500V	.59
.1	2000V	.49
.1	2500V	.99
.1	3000V	1.29
.1	5000V	1.95
.1	7500V	1.75
.1	7500V	4.25
.1	10KV	6.50
.1	12KV	7.75
.1	25KV	24.95
.1-.1	2000	.98
.1-.1	7000	3.50
2x.15	6000	2.75
.2	10KV	8.25
.2	15KV	8.95
3x.2	4000V	2.85
.25	1500V	1.19
.25	2000V	1.09
.25	2500V	1.29
.25	3000V	1.59
.25	4000	2.25
.25	6000	1.24
.25	15KV	15.95
.25	20KV	18.95
.25	25KV	44.50
.25	50KV	67.50
.3	2000V	.89
.4	10KV	13.95
2x.4	7500V	5.25
.5	1500V	.67
.5	2000V	1.49
.5	2500V	1.69
.5	3000V	2.39
.5	4000V	3.10
.5	5000V	3.95
.5	7500V	6.95

Mfd.	Volts	Price
.5-.1	2000V	.79
.5-.5	600V	.69
.5-.5	1000V	.69
.5-.5	9KV	14.95
.5	25KV	49.50
1	400V	.39
1	500V	.55
1	1000V	.69
1	1500V	.99
1	2000V	1.95
1	2500V	2.50
1	3000V	2.95
1	5000V	6.85
1	6000V	5.95
1	6000V	6.95
1	7500V	14.95
1	10KV	23.50
1	15KV	39.75
1	16KV	35.00
1	20KV	49.50
1	25KV	59.50
1	25KV	70.00
2x.1	7500	21.95
1.75	330VAC	.79
2	600V	.69
2	1000V	.79
2	1000Y TLA	1.29
2	1500V	1.39
2	2000V	2.80
2	2500V	3.45
2	3000V	4.25
2	4000V	7.95
2	5000V	12.50
2	7500V	22.95
2	20KV	98.50
2	10KV	39.95
2x2	600V	.98
3	1000V	1.05
3	2000V	2.95
3	4000V	10.45
3	8000V	34.50
3-3	150V	.35
3x3	400V	.65
4	500V	.75
4	600V	.98
4	600V	1.25
4	600V TLA	1.39

Mfd.	Volts	Price
4	600V TLAD	1.39
4	1000V	1.89
4	1500V	2.65
4	2000V	3.75
4	2500V	4.95
4	3000V	7.55
4	4000V	13.95
4	5000V	24.95
5	330VAC	1.49
5	600V	1.59
5	1000V	1.95
5	1500V	1.98
5-5	400V	.98
5-5	600V	1.32
7	110VAC	.98
7	600V	1.15
7	600V	1.45
7	800V	1.99
7	5000V	32.95
8	110VAC	1.29
8	500V	1.25
8	600V RD	1.49
8	600V	1.98
8	1000V	2.98
8	1500V	3.65
8	2000V	5.25
8-8	600V	1.89
10	50VAC	.65
10	600V	2.50
10	1000V	3.75
10	1500V	4.50
10	2000V	5.50
15	330VAC	3.50
15	440VAC	3.95
15	600V	2.95
15	1000V	3.95
15	1500V	5.40
15	5000V	63.50
16	1500V	5.30
20	330VAC	3.95
24	500V	1.98
28	1000V	6.50
30	330VAC	5.25
30	2500V	14.50
50	330VAC	6.59
70	220VAC	9.95
80	4000VAC	49.50

ALSO

BATHTUB & CHANNELS—TUBULAR OILS—MICAS—TRANS & REVG—"J" POTS—RHEOSTAT—25 WATT

WANTED

Oil & Mica Condensers in any quantity. Also other Standard Components.
Write: Art Hankins

See FEB. Issue

MONMOUTH RADIO LABS.

BOX 159 OAKHURST, N. J.
Long Branch 6-5192

NEW YORK'S RADIO TUBE EXCHANGE

NEW TUBES

Standard brands. First grade only. No pull outs. No rejects. No rebrands. At lowest prices. Wholesale and export only. Minimum order, per type, 100.

Type	Price
OA2	51.00
OA3	1.10
OB2	.99
OB3	1.10
OC3	.96
OD3	.89
C1B	2.95
1B22	1.50
1B23	6.95
1B24	12.00
1B26	1.75
1B27	12.50
1B38	35.00
1B50	23.00
1B51	7.50
1B56	35.00
1B60	35.00
1N21	1.25
1N21A	1.75
1N21B	2.75
1N21C	14.50
1N22	1.00
1N23	1.95
1M23A	2.75
1M23B	2.75
1N23C	7.50
1N25	4.50
1N26	6.75
1N27	3.50
1N34A	.79
1N43	2.25
2C40	9.00
2C43	14.50
2C44	.60
2C46	7.50
2J21A	12.00
2J22	9.00
2J26	15.00
2J27	15.00
2J31	24.00
2J32	29.00
2J33	32.00
2J34	36.00
2J36	90.00

Type	Price
2J38	8.95
2J39	8.59
2J40	29.00
2J42	135.00
2J49	60.00
2J50	55.00
2J55	150.00
2J56	110.00
2J61	35.00
2J62	35.00
2K22	29.00
2K23	15.00
2K25	19.50
2K26	68.00
2K28	35.00
2K29	35.00
2K33A	75.00
2K39	140.00
2K41	135.00
2K45	80.00
2K50	275.00
2K54	35.00
2K55	25.00
2K56	72.00
3AP1A	10.00
3BP1	7.20
3B24	5.50
3B25	5.50
3B26	5.00
3B28	8.00
EL3C	5.50
3C22	75.00
3C24	1.75
3C31	2.95
3DP1	7.50
3DP1A	10.00
3DP1A-52	10.00
3EP1	5.00
3E29	15.50
3GP1	5.00
3J21	75.00
4B26	5.40
4C27	10.00

Type	Price
4C28	35.00
4E27	16.00
4J25	150.00
4J26	150.00
4J27	150.00
4J28	150.00
4J29	150.00
4J30	150.00
4J31	150.00
4J32	150.00
4J33	150.00
4J34	100.00
4J35	150.00
4J36	150.00
4J37	150.00
4J38	150.00
4J39	150.00
4J40	150.00
4J41	150.00
4J42	190.00
4J51	190.00
4J52	225.00
4J53	225.00
5BP1	3.95
5BP2A	12.00
5BP4	3.95
5CP1	7.50
5CP7	9.95
5CP7A	18.00
5D21	10.00
5JP1	27.50
5JP2	19.50
5JP4	27.50
5J23	25.00
C6A	11.00
C6J	7.50
7BP7	5.00
7DP4	9.00
12AP4	50.00
12DP7A	59.00
LM15	225.00
15E	1.75
15R	.75
NE16	.59

Type	Price
20-4	.75
KY21A	8.25
RX21	8.00
KH24G	1.50
25T	2.95
RK39	2.75
HF50	1.75
HK54	4.50
RK72	1.00
RK73	1.00
FG95	19.95
100TH	7.95
FG105	20.00
122A	1.75
203A	7.50
211	.95
217C	12.00
242C	10.90
244C	9.50
249C	4.25
250TH	19.95
250TL	12.00
252A	3.00
274B	2.75
304TH	10.00
304TL	10.00
307A	3.50
310A	4.50
310P	4.95
311A	6.50
312A	3.50
323A	15.0
327A	3.75
323A	6.75
350A	4.50
350B	5.95
HK354C	15.00
357A	15.00
368AS	4.95
371B	1.50
385A	4.50
388A	1.80
393A	7.50
394A	3.95

Type	Price
MX408U	.50
417A	15.00
434A	15.00
446A	1.95
446B	3.95
450TL	45.00
450TH	52.50
464A	7.50
471A	1.25
527	18.00
WL530	23.00
WL531	22.50
WL533	15.00
HK654	35.00
700A/D	10.00
701A	4.50
703A	3.95
704A	1.95
705A	2.75
706AY/FY	25.00
707A	9.75
707B	15.00
714AY	18.00
715A	4.50
715B	9.00
715C	22.50
717A	1.50
719A	22.50
720AY/GY	50.00
721A	1.50
721A	1.50
723A/B	18.00
724A	1.95
724B	2.25
725A	18.00
726A	18.00
726B	45.00
726C	45.00
730A	22.50
750TL	45.00
801A	.90

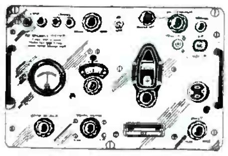
Type	Price
802	3.95
803	5.95
805	4.95
807	1.25
808	1.95
809	2.95
810	10.50
811A	3.75
812A	3.95
813	13.75
814	3.75
815	3.25
816	1.45
829	11.00
829A	12.00
829B	12.50
830B	2.00
832A	9.95
833A	45.00
834	7.50
836	3.95
837	2.75
838	5.95
849	35.00
860	3.50
861	25.00
866A	1.50
869B	67.50
869BX	50.00
872A	3.50
878	1.50
879	.50
884	1.50
885	1.50
914A	75.00
931A	5.00
954	.35
955	.50
956	.75
957	.25
958A	.60
959	2.25
E1148	.25
1280	.95

Type	Price
1500T	135.00
HK1554	75.00
1603	5.00
1612	1.50
1613	1.25
1616	1.25
1619	.45
1622	1.50
1624	1.75
1625	.35
1626	.25
1851	1.80
2000T	150.00
2050	1.80
2051	1.00

Various 5000 and 6000 series of new production

Type	Price
5280	475.00
8012	2.00
8012A	2.50
8013	3.00
8013A	3.50
8019	1.75
8020	1.80
8025	3.75
PD8365	96.00
9001	1.52
9002	.90
9003	1.25
9004	.35
9005	2.75
9006	.25

Thousands of other tubes



NEW

TS-147 B AND C/UP TEST SET SIGNAL GENERATOR

Hard-to-get X-Band Now Available

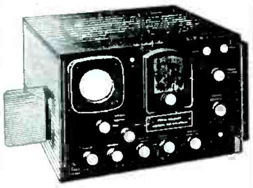
Test Set TS 147 UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9600 MC.

NEW UNUSED SURPLUS TS 259 K BAND

23400-24500 MEGACYCLES SIGNAL GENERATOR

NEW

MICROWAVE TEST EQUIPMENT TS148/UP SPECTRUM ANALYZER



Field type X Band Spectrum Analyzer. Band 8430-9580 Megacycles.

Will Check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

SPECIAL! 5,000 V. POWER SUPPLY

For IP25 Infrared Image Converter from 3 V. Battery Source. NEW, Complete with RCA 1654 Tube $990

OTHER TEST EQUIPMENT USED CHECKED OUT, SURPLUS

TSKI SE	T35/AP	TS108	TS182	APA38
TS3A/AP	TS36/AP	TS110/AP	TS226	APS 3 APS 4
RF4/AP	I-96A	TS125/AP	TS239A-TS239C	APR4
TS12/AP	TS45	TS126/AP	TS251	APR5A
TS13/AP	TS47/APR	TS147	TF890/1	APT2-APT5
TS14/AP	TS69/AP	TS270	834	
TS33/AP	TS100	TS174/AP	SURPLUS EQUIP.	
TS34/AP	TS102A/AP	TS175/AP	APA10	

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Crystal Holders: FT243, FT171B others.
Quartz Crystal Comparators.
North American Philips Fluoroscopes Type 80
Large quantity of Polystryrene beaded coaxial cable.

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Cables: TELSERUP

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DEMONSTRATOR—WITH ACCESSORIES
New Condition—Reasonably Priced
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HOUDE SUPPLY COMPANY
PHONE KEYPORT 7-1286
M. R. #1 Box 86X Keyport, N. J.

SPECIALISTS JAN, RUGGEDIZED SPECIAL PURPOSE TUBES

Type	Price	Type	Price
1B24	$6.75	5J29	9.25
1B26	1.50	5J33	10.00
1B29	9.00	5R4WGY	4.50
1B35	7.50	C5B	2.35
1B35A	7.50	6A3	.75
1B42	7.00	6AQ5W	2.00
1B63A	20.00	6AL5W	1.10

SPECIAL — 5691 ...... 6.75

Type	Price	Type	Price
1P28	7.50	6AS6	1.75
1P41	2.50	6AS6W	2.35
1Z2	2.75	6AS7G	3.25
2C22	1.60	6D4	2.15
2C33	1.95	6F4	3.25
2C39A	17.00	6J4	4.00
2C40	9.50	6L6WGA	8.50
2C43	15.00	9C24	400.00
2C46	7.50	9LP7	3.50
2C51	3.95	15R	.25
2C53	13.25	24G	.95
2D21	.85	25T	6.50
2D21W	2.00	26A7GT	3.95
2E24	2.70	FG27A	11.00
2E30	2.30	28D7	.90
2J21	3.50	FG32	8.50
2J21A	3.50	35T	8.00
2J22	3.25	35TG	4.50
2J26	5.75	100R	15.00
2J37	11.00	FG105	15.00
2J40	25.00	F123A	6.25
2J51	250.00	152TL	22.00
2J62	15.00	211	.75
2K25	17.50	215A	2.25
2K28	25.00	249C	7.00
2K33A	47.50	250TL	17.50
3B28	3.75	305A	4.25
3CP1(S1)	2.00	312A	2.50
3C24	.95	316A	.55
3HP14	6.00	TR317	10.00
4C35	20.00	412A	5.00
4D22	20.50	416A	75.00
4E27	13.00	416B	75.00
5BP1	2.25	WL417A	10.00
5D21	10.00	434A	9.00

Type	Price	Type	Price
464A	6.00	5628	26.00
471A	2.00	5629	21.00
532	3.25	5635	9.00
700A/B/C/D	7.50	5636	5.50
701A	3.75	5638	12.00
702A	1.50	5639	9.00
705A	1.00	5641	7.50
CK705	.80	5643	8.00
706B	15.00	5644	11.50
706C	15.00	5645	7.00
707A	4.00	5646	7.00
708A	2.00	5647	7.00
709A	1.75	5651	1.40
713A	.75	5651WA	2.50
715B	3.00	5652	6.50
CK716	17.50	5653	1.10
717A	.80	5654	1.50
CK721	7.50	5656	11.00
CK722	4.40	5670	2.15
724B	1.50	5672	1.25
722A	1.25	5675	7.50
800	3.00	5676	1.00
803	1.90	5678	1.15
811A	3.75	5686	2.00
812A	3.75	5687	3.00
813	15.00	5691	6.75
829	6.00	5692	6.50
829B	9.00	5693	5.10
832A	7.50	5696	1.75
836	3.00	5702	3.50
837	.90	5702WA	5.00
865	.75	5703	1.50
HK953D	75.00	5703WA	5.25
CK1090	6.00	5704	1.90
1620	4.20	5718	4.25
1615	1.00	5719	3.00
1625	1.50	5725	2.35
1632	2.00	5726	1.10
1633	1.00	5744	1.00
1636	2.50	5744WA	5.00
1654	4.00	5749	1.60
2050	1.00	5750	1.75
5627	27.00	5751	2.50

SPECIAL — 5692 ...... 6.50

Type	Price	Type	Price
5763	1.10	1N21A	1.80
5784	4.25	1N21B	1.90
5784WA	7.50	1N23A	2.25
5787	4.50	1N23B	1.75
5814	1.75	1N34	.90
5814A	2.25	1N34A	.75
5823	1.00	1N35	2.10

SPECIAL — 5693 ...... 5.10

Type	Price	Type	Price
5829	2.20	1N38	1.75
5840	5.50	1N38A	.95
5851	6.00	1N44	1.10
5879	1.40	1N45	1.20
5881	2.95	1N48	.65
5896	4.50	1N51	.50
5902	8.00	1N52	1.30
5910	.75	1N54	.75
5932	8.50	1N54A	1.45
5937	33.50	1N55	2.90
5963	1.20	1N55A	4.30
5964	1.35	1N56A	1.10
5987	4.00	1N58	1.45
5995	6.00	1N58A	1.80
6005	2.50	1N60	.75
6021	5.00	1N63	1.80
6073	1.65	1N64	.65
6074	3.75	1N65	.70
6080	3.25	1N69	.80
6080WA	5.00	1N70	2.40
6082	3.25	1N72	.85
6095	1.25	1N75	2.50
6097	1.50	1N81	1.95
6098	1.90	1N91	1.50
6099	1.50	1N92	2.50
6101	1.50	1N93	3.50
6110	11.00	1N110	1.05
6111	8.00	1N111	2.40
6112	8.00	1N112	1.90
6113	1.25	1N113	2.30
6136	2.00	1N114	1.80
6146	4.65	1N115	1.55
6201	3.75	1N152	3.50
6116	3.25	2N34 ... $	10.00
1N21	1.50		

JAN CAPACITORS

CV11A070 variable ceramic 1.5-7	.25
CV11A120 variable ceramic 3.5-12	.25
CV11A250 variable ceramic 4.5-25	.25
CV11B130 variable ceramic 3-13	.25
CV11B200 variable ceramic 5-20	.25
CV11D060 variable ceramic 2-6	.25
CV11D300 variable cermaic 4-30	.25
CV11D450 variable ceramic 7-45	.25
CP53B1EB405V 4MFD-100 WVOE	.30
CP53B4EF254V .25MFD-.25MFD 600WVDC	.40
CP53E1EF105V 1MFD-600 WVDC	.30
CP55B5FF504V .5-5-.5MFD 600 WVDC	.30
CP67B1EG503V .05MFD-1000 WVDC	.35
CP68B5FF503V .05MFD-.05MFD 600 WVDC	.35
CP26A1EF504M .5MFD 600 WVDC	.20
CP26A1EG104M .1MFD-1000 WVDC	.20
CP26A1EG254M .25MFD-1000 WVDC	.20
CP26A1EH104M .1MFD-1500 WVDC	.20
CP67B1EG203V .02-1000 WVDC	.20
CP70E1EF605V 6MFD-600 WVDC	1.00
CP70E1EF805V 8MFD-600 WVDC	1.10
CP70E1EF106V 10MFD-600 WVDC	1.25
CP70E1EG105V 1MFD-1000 WVDC	1.10
CP70E1EG405V 4MFD-1000 WVDC	1.25
CP70E1EG605V 6MFD-1000 WVDC	1.50
CP70E1EF205V 2MFD-600V	.50
CP70E1EJ104V .1MFD-2000 WVDC	1.00
CP70E1EJ504V .5MFD-2000 WVDC	1.10
CP70E1EJ105J 1MFD-2000 WVDC	1.25
CM70B472J 4700MFD-3000 WVDC	.30
CN20A202M 2000 MMFD-200 WVDC	.15
CN20A602M 6000MMFD-200 WVDC	.15
CN20E101M 10,000MMFD-120 WVDC	.15
CN35A302M 3000MMFD-800 WVDC	.15
CM20B390J 39MMF-500 WVDC	.07
CN43E503M 50,000MMF-400 WVDC	.20
100,000 Ohms 1% ½W Precision Resistors	.19
12.500 Ohms 1% ½W Precision Resistors	.19

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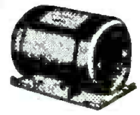
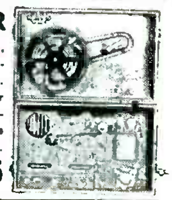


DYNAMOTORS

Compare Murry's Low Price!

Type	Input	Excellent Output	Used	BRAND NEW
DM-40	14V 3.4A	1.2V.138A	$1.95	$3.95
DN-42A	14V 46A	515/1030/2/8 MA215/260	12.95	16.95
DM-42A	28V 23A	515/1030/2/8 MA215/260	29.50	.....
DM-32A	28V 1.1A	250V .05A	2.95	7.50
DM-34D	12V 2.8A	220V .080A	11.95	.....
DM-36	28V 1.4A	220V .080A	9.95	.....
DM-37	25.5V 9.2A	625V .225A	12.95	.....
DM-28	28V	224V .07A	1.95	4.95
DM-53A	28V 1.4A	220V .080A	2.95	6.95
DM-33A	28V 5A	575V .16A		
	28V 7A	540V .25A	1.95	3.95
PE-73C	28V 20A	1000V .350A	9.50	12.50
PE-101C	13V 12.6A	400V .135A		
	26V 6.3A	9VAC 1.12A	3.75	6.95
PE-94A	28V 10A	300V .200A		
		150V .101A	3.95	7.50
PE-94C	26V 10A	300V .200A		
		150V. 101A	7.95	12.75
PE-103	6V	500V. 160A		
	12V	500V .160A	24.50	39.50
PE-98	14V 21A	300V .200A		
		150V .101A	22.50	32.50
PE-36	28V 1.25A	250V .060A	2.95	5.24

TG-34A CODE KEYER



Self-contained automatic unit, reproduces code practice signals recorded on paper tape. By use of built-in speaker provides code-practice signals to one or more persons at speeds from 5 to 25 WPM. BRAND NEW, in original carton .. **$16.45**

HEADPHONES

Model	Description	Excellent Used	BRAND NEW
HS-23	High Impedance	$2.25	$4.35
HS-33	Low Impedance	1.79	4.65
HS-30	Low Imp. (featherwt.)	1.49	1.85
H-16/U	High Imp. (2 units)	2.75	7.95
CD-307A	cords with PL55 plug and JK26 Jack	....	.88

MICROPHONES

Model	Description	Excellent Used	BRAND NEW
T-17	Carbon Hand Mike	$5.45	$7.95
T-30	Carbon Throat Mike	.33	.69
T-45	Navy Lip Mike	....	1.25
RS-38	Navy Type	1.95	5.95
T-24	Carbon Mike	....	3.95

FAMOUS BC-645 XMITTER-RECEIVER

Makes wonderful mobile rig for 420-500 Mc. Easy to convert for phone or CW 2-way communication. CONVERSION DIAGRAM INCLUDED. This swell rig originally cost over $1000 — yours for practically a song! You get it all, in original factory carton. BRAND NEW, complete with 17 tubes, less power supply. Shpg. wt. 25 lbs... **$29.50**

PE-101C DYNAMOTOR for BC-645, has 12-24V input (easy to convert for 6V Battery operation) ......only **$4.85**

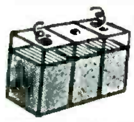
UHF ANTENNA ASSEMBLY, for BC-645 ...... **$2.45**

CONVERSION BOOKLET. Instructions for most useful surplus rigs...... **$2.50**

TUNING UNITS FOR BC 375 & 191

Type	Excellent Cond.	BRAND NEW	Type	Excellent Cond.	BRAND NEW
TU-10	$2.25	$2.95	TU-7	$2.25	$2.95
TU-9	2.25	2.95	TU-6	3.95	4.95
TU-8	2.25	2.95	TU-5	3.95	4.95

WILLARD 6-VOLT Midget Storage Battery



3 Amp. Hour. BRAND NEW. 3⅝" x 1-13/16" x 2-⅝". Uses Standard Electrolyte only **$1.85**

WILLARD 2-VOLT STORAGE BATTERY

20 Amp. Hour. BRAND NEW Transparent plastic case **$1.95**

BEACON RECEIVER BC 1206C

5 Tubes. 195 to 420kc. IF Freq. 135kc. Output 300 or 400 ohm imp. Power—24 or 28 V.D.C., .75 Amps. BRAND NEW **$11.95**

Please include 25% Deposit with order—Balance C.O.D. MINIMUM ORDER $3.00. All Shipments F.O.B. Our Warehouse N.Y.C.

MURRY'S RADIO

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BRANCH: BOX 404 LITTLETON, MASS.

EMMONS RADIO SUPPLY CO.

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All prices FOB Oakland, Calif., subject to change without notice.
Terms 25% cash with order. Balance COD.

HIGH VOLTAGE CONDENSERS Oil Filled

CAT. No.	MFD.	WVDC	
26F444	8	2 KV	5.95
	2	3 KV	2.95
	.5	3 KV	1.00
23F47	2	4 KV	3.95
25F509G2	.1	6 KV	1.75
	.25	6 KV	1.95
25F774	.1X.1	7 KV	1.95
25F450	.1	7.5 KV	1.75
	.5	7.5 KV	2.25
25F360	.1	12 KV	6.95
Inerteen	.25	15 KV	14.95
14F91	1.0	15 KV	17.50
Inerteen	.5	25 KV	22.50
Inerteen	1.0	25 KV	37.50
Fast A6734	1.0	25 KV	39.95
14F52	.1	25 KV	15.00

HIGH CURRENT MICA CONDENSERS

Ceramic Cased, Type G-1, or Similar

Mfd	WVDC	Amp @ 1 mc	
.04	1 KV	25	7.50
.05	1.5 KV	35	12.50
.08	1.5 KV	40	15.00
.02	3 KV	21 (600 Kc)	15.00
.00035	6 KV	5	12.50
.00075	6 KV	7	14.50
.0005	6 KV	5	12.95

Type G-2 or Similar

Mfd	WVDC	Amp @ 1 mc	
.0012	5 KV	8	17.50
.003	7 KV	15	19.00
.0002	10 KV		19.50
.00025	10 KV	3	19.50
.0003	10 KV	5	19.50
.0005	10 KV	6	19.50
.00057	10 KV	8	19.50
.00065	10 KV	6	19.50

Type G-3 or Similar

Mfd	WVDC	Amp @ 1 mc	
.05	3 KV	50	45.00
.005	5.5 KV	25	37.50
.00015	20 KV	5	36.00
.0012	20 KV	15	36.00

Type F-2, Type 6, or Similar $1.50 each

Mfd	VDC	Amps @ 1 Mc.	Mfd	VDC	Amps @ 1 Mc.
.00005	5 KV	.8	.001	5 KV	4
.00009	5 KV	.8	.0012	5 KV	4.5
.0001	5 KV	1	.0015	5 KV	5
.00015	5 KV	1.5	.002	5 KV	5
.0002	5 KV	1.7	.002	6 KV	6.5
.00025	5 KV	2.5	.002	6 KV	6.5
.0003	5 KV	2	.0025	5 KV	6
.00035	5 KV	2	.003	2 KV	6
.000375	5 KV	2	.003	3 KV	6
.00039	5 KV	2.7	.004	3 KV	6
.0004	5 KV	2.5	.005	3 KV	5
.0004	5 KV	2.5	.005	5 KV	11
.0005	5 KV	2.5	.01	2 KV	8
.0005	7.5 KV	3	.02	2 KV	12
.0006	2.5 KV	1.5	.03	2 KV	12
.0006	5 KV	3	.07	1 KV	13
.00072	5 KV	3.5	.12	.5 KV	18
.0008	5 KV	4			
.0008	6 KV	4			

WATER COOLED RADAR TRANSMITTER T-75/APT-4

Tunes upper half of "P" band or lower third of "L" band. Contains 5J29 magnetron in lecher line oscilator with water pump, heat exchanger, three blowers, water-flow interlocks etc. Adaptable to many other liquid cooled tubes. Cooling system alone worth many times our price...... **$75.00**

MD-30/APT-4

Modulator for T-75. Complete with tubes, 2 ea 813, 1 ea 6D4, 1 ea 807, 2 ea 6AG7, 1 ea 5R4GY...... **$45.00**

300 TO 1000MC

CU-27/SPR-1, Network, Broadband Impedance Matching balanced to unbalanced line 300 to 1000 Mc **$12.50**
Type "N" fittings. NEW...... **$12.50**
CU-19/SPR-1—Same except 40 to 300 Mc......

UHF CONVERTER

ZB-3 Homing adapter—"front end" for 234 to 258 MC.
NEW $4.95

AN/APQ-4

Radar blind booming equipment. Range 18 miles Altitude 65 ft to 50,000 ft. Includes all operating units, SN-8/APQ5-B, PP-21/-B, C-82/-B, C-83/-B, ID-3/-B, MX-12/-A, MX-30/-A, J10/-A w/ Cables......
NEW BOXED $250.00

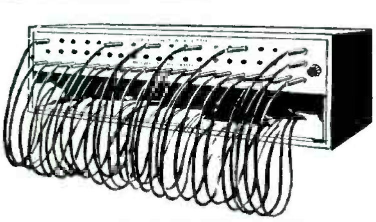
TIME INTERVAL COMPUTER

CP-15A/ASG-10 for computing elapsed time over predetermined distance. (Sorry, no other information available).
Give away price...... **$14.95**

F-1, Type 15L or Similar $1.00 each

Mfd	VDC	Amps @ 1 Mc.	Mfd	VDC	Amps @ 1 Mc.
.00005	3 KV	.6	.0008	3 KV	2.5
.00009	3 KV	.8	.001	3 KV	3
.0001	3 KV	.08	.0012	2 KV	3
.00015	3 KV	1	.00125	2 KV	3
.000175	3 KV	1	.0015	3 KV	3.5
.0002	3 KV	2	.0016	2.5 KV	3.5
.0003	2 KV	8	.002	3 KV	4
.0003	3 KV	2	.0025	2 KV	4.5
.0004	3 KV	4	.003	2 KV	5
.0005	3 KV	2	.004	2 KV	6
.0006	2.5 KV	2	.005	2.5 KV	6.5
.0006	3 KV	2	.006	2 KV	5.5
.000625	3 KV	2.5	.008	1.5 KV	8.
.0007	3 KV	2.5	.01	2 KV	14
.00075	3 KV	2.5	.1	1 KV	12

1000 WATT
G40 long-life spotlight bulbs
mogul base
Case of 12...... **1.50 ea.**
Each 2.00
This is a steal



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Tcs Rcvr	12V	225V	100	12.50
TCS Xmtr	12V	400V	180	22.50
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DY2-ARR2	28	250	60	1.25
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D 101	27	285	60	.95
DM-416	28	330	170	1.95
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Westinghouse, style 867885, 20 KW output, 43 KVA input, 460 volts, 3 phase, 60 cycles, equipped with the following:

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b. ¾ HP Westinghouse 1150 RPM motor, 220/440 volt, 3 phase, 60 cycle, frame 203, class I, style 1168505, 3.1/1.55 amps.
c. Westinghouse rectifier—transformer, secondary tested 9.6 KV, mfgr's #98R49, 3 phase, RMS to primary arch to ground, serial #3531075. Rectifier normal output 9600 volt at 3.7 amps, primary volts 480 @ 45 amps, secondary volts 7100 @ 3.5 amps, diagram 8D8961.
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e. 2 spare tubes, type 889RA with radiators (spare tubes are packed in shock-proof shipping containers.)

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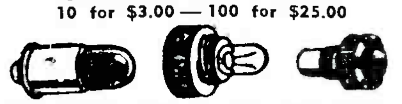
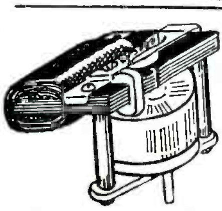


#328, 26 Volts #32G, 2½ Volts #32J, 28 Volts



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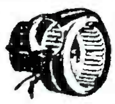

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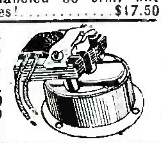

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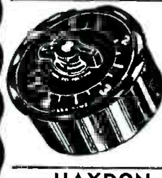

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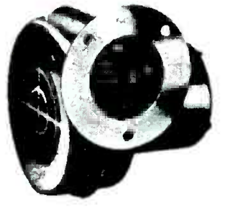

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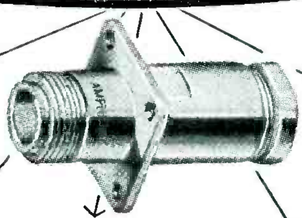

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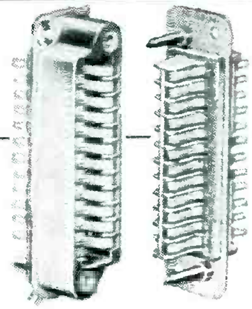

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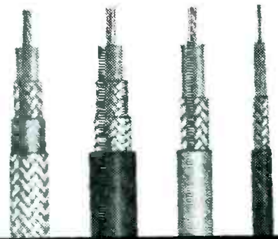

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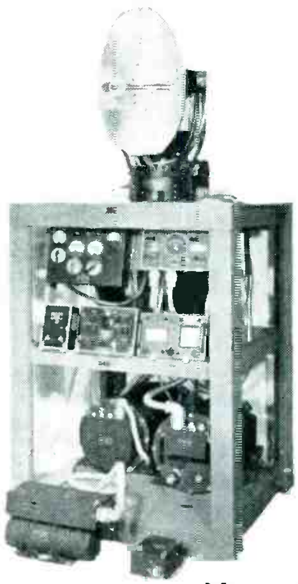

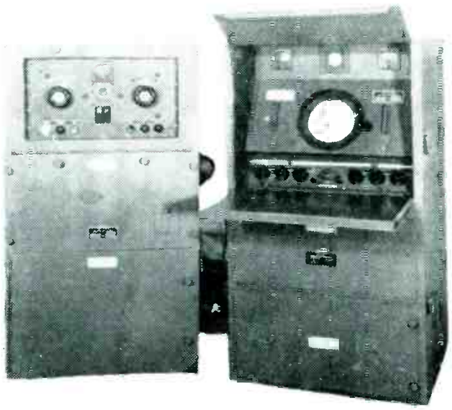

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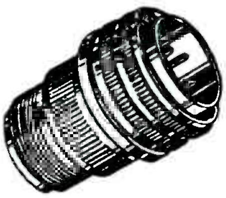

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10 CFM BLOWER (Pictured—right)—27.5 VDC; 1/100 HP.; 7000 RPM; Oster Motor C2BP-1A; L-R Mfg. Co. Bakelite Blower #2, overall size: 3-½" x 4-½". Price............$5.95

Same as above, 12 VDC operation: Price $5.95

10 CFM BLOWER (Pictured at left)—28 VDC—.6 A.; 5000 RPM. Pioneer Motor SS-2345. Aluminum Blower Housing; Overall Size: 4-½" x 3-¼". Price $5.95

DYNAMOTORS:

INPUT VOLTS:	OUTPUT: VOLTS:	MA:	STOCK No.:	PRICES: USED:	NEW:
14 VDC	230	90	DM-21	$6.95	
14	330	150	BD-87	3.95	$6.95
14	250	50	DM-25	6.95	8.95
14	1000	350	BD-77	14.95	29.95
14	500	500	BD-500		12.95
14	600	300	BD-86		12.95
14	1030	260			
	515	215	DM-42	8.95	12.95
28	1000	350	PE-73	8.95	
12 or 24	500	50	USA/0515		4.95
12 or 24	275	110	USA/0516		4.95
12	230	90	PE-133	4.95	6.95
14 VDC	375	150	BD-83	3.95	4.95

POWER SUPPLY — 24 VDC — 3 Amp output: 115 Volt 60 cycle input. Completely filtered with 0-75 VDC Output Meter & 2 Tungar Bulbs—Used. Tested.$12.95

MOTORS:

24 VDC REVERSIBLE MOTOR — 3.7 RPM, 40 lb. Torque. Motor size: 5-½" x 4-1/32" x 3-5/16". Shaft size: 21/32" x 5/16". Also operates 24 VAC. Philco No. 441-1008............................$5.95

27.5 VDC—6000 RPM. 1.5 oz. in Shaft size: 1⅛" x ¼". Motor size: 2½" x 1½". No. 5069-267....$4.95

26 VOLT 60 CYCLE—60 RPM Synchronous Cramer Motor #1147. Shaft size: 1" x ⅛"...........$1.95

110 VDC 1/70 HP., 1550 RPM. Motor size: 4" x 2½". Shaft size: 1" x 3/16". Redmond #157.......$4.95

6 VDC 1/20 HP., 4000 RPM. Motor size: 5" x 3". Shaft size: ¾" x ¼". Redmond #E-56......$4.95

12 VDC 1/30 HP., 4500 RPM. Motor size: 3" x 2½". Shaft size: 1" x 3/16". Delco #5047520......$4.95

27 VDC 1/10 HP., 3500 RPM. Shaft size: ⅝" x ¼". Motor size: 4"x3-½". Air Assoc. No. EE-763..$6.95

80 VDC 1/50 HP., 3000 RPM. Shaft size: ⅜" x ¼". Motor size: 5" x 3". G.E. #5-PN38HA10....$8.95

28.5 VDC 1/35 HP., 2200 RPM. Shaft size: 1½" x ¼". Motor size: 4½" x 3¾". Electrolux #16876 ....$5.95

GEARED HEAD MOTOR — 110 Volt 60 cycle, 24 RPM. 1/100 HP., Right Angle Drive—Size: 7½" x 4" x 4". Shaft size: 3/16" x ¾".........New: $9.95

115 VAC 60 Cycle INDUCTION MOTOR — 1.9 RPM. 75 Torque oz. in; 9 Watts—with variable Multi Disc. Coder Wheel & Micro Switch, mounted on bracket assay. Holtzer Cabot Motor Type RWC 2505 ....$9.95

GEARED HEAD MOTOR — Heavy duty. 24 VDC 8 Amp. 2½ lb. Torque. 100/200 RPM. Shaft size: 5/16" x 1". Right Angle Drive...............$8.95

27 VDC GEAR HEAD MOTOR—960 RPM; 1/75 HP; 1.75 A. Size: 5" x 3". Shaft: ¼" x ⅝". Air Assoc. #EE120M1 ....Price: $7.95

27.5 VDC GEAR HEAD MOTOR—324-1 Ratio; 4050 RPM; Right Angle Drive Motor, Size: 5" x 3-½". Shaft: 5/16" x ¾". Bodine Type #V-10R. Price $7.95

24 V. GENEVA LOC ACTUATOR MOTOR ASS'Y.—1/25 HP.; 15000 RPM. w/Gear Head & Limit Switches. Motor Size: 5-½" x 3-½"; Angle Drive Shaft: ¼" x ½". Bendix #LM-106524. Price..$7.95

27 VDC MOTOR—1.5 A.; 1/50 HP.; 3000 RPM Shunt Motor; Motor Size: 3" x 2-¼". Shaft: 5/16" x ¾". Oster #D8-1 or WEVS-5876..........Price: $2.95

27.5 VDC MOTOR—1/100 HP; 7000R PM; Motor Size: 3" x 1-¾"; Shaft: ¼" x ¾" L. Oster #C2BP-1A—Price $2.95

27.5 PERMANENT MAGNET ALNICO FIELD MOTOR—.03 Amp.; 10000 RPM; Size: 1" x 1-⅛" x 2". Shaft: ⅛" x ½". Delco #5068571.....Price: $7.95

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(Pictured) In portable Metal Case, with Test Leads. 4-½" Fan, Mirrored Scale — 0-15 ADC $4.95

WESTON AC Ammeter:

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Type RF-3-A. Designed for 88-108 mc operation, but easily converted to lower frequency operation, with power output to 17.5 KW possible. NEW EQP'T., not Gov't. surplus.

WESTERN ELECTRIC MODEL 248A RADIOTELEPHONE EQP'T.

250/350 W. output, 2-20 mc, 30-Channels transmit and up to 30-Channels receiving; crystal control, Remote Control, 110 V. AC operation, many other features. NEW EQP'T., not Gov't. surplus.

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Complete Station in 5 carrying Trunks, includes 2-speed turntable. Studio-Console, Transmitter, Power Supply. Microphone, Cables, Spare Parts, etc. Freq. range 1100 to 1500 KC, crystal or VFO controlled. Power Output 50 watts; operates from 90 to 240 volts, 50/60 cycles AC. ALL NEW EQPT. Available in Quantity.

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Bausch & Lomb .... Ea. $10.00
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Part of GCA equipment. Manufactured by Philadelphia Naval Yard. Approx. 200 each required.

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BC-312 Receiver $40.00
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ART-13 transmitters, parts, and components, DY-12 and DY17 dynamotors, CU-25 etc. Also ARC-1 and ARN-7 material.
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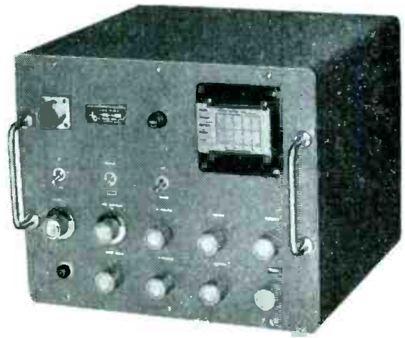

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- Standard conditions of test.
- For DC, 60 or 400 cps. loops.
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Send for specification sheet, application data sheet and prices. Your inquiry will receive prompt attention.

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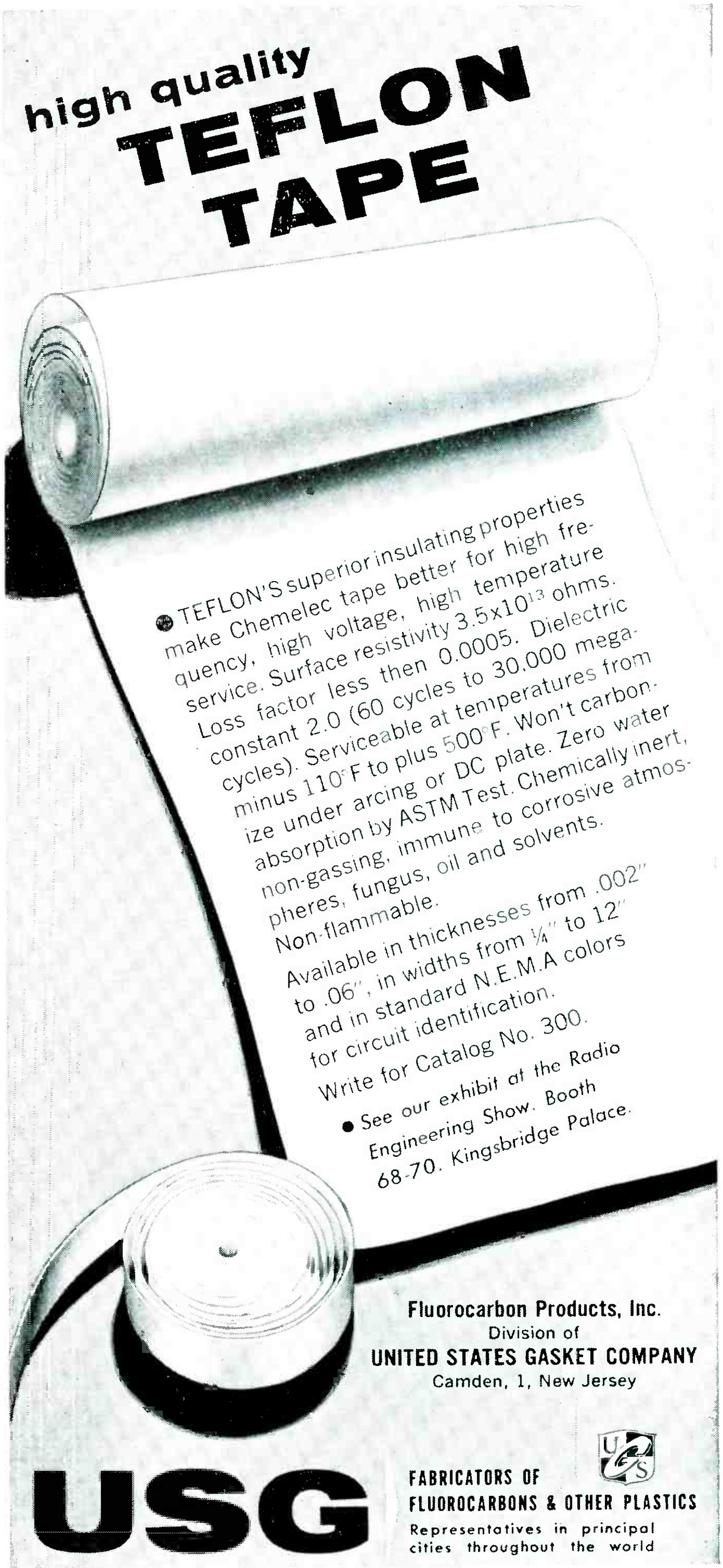

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PRODUCTS OF WORLD-FAMOUS

DAVEN

CREATIVE-ENGINEERING

TYPE T-330

DAVEN ATTENUATORS

Exclusive Features:

1. "Knee-Action" Blade
   - Tamper proof
   - Uniform contact pressure and low contact resistance over the life of every unit.
   - Each rotor blade individually supported to give positive contact in operation under all types of conditions.
2. Brass Case of 2-Piece Construction
   - Greatly reduces clearance space required for removal of cover in rear of unit.
3. "Lock-Tite" Dust Cover
   - Held by positive, bayonet-type lock which prevents cover from falling off under stress of vibration.
4. Enclosed Roller-Type Detent Mechanism
   - For extra long life and positive indexing.
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5. Low-Loss Molded Terminal Board
   - For high resistance to leakage.
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YEARS AHEAD, CREATIVE-ENGINEERING has always characterized Daven's efforts in the production of electronic components and equipment.

The unit illustrated above is only one in a complete line of Daven's world-famous attenuators. Because this Company has pioneered and created so many worth-while improvements in units of this type, you can do no better than to specify Daven Attenuators.

Daven's skilled staff of specialist-engineers is at your "beck and call" to help with your problems in the selection of the right attenuators for the equipment you are designing.

Write for complete catalog data.

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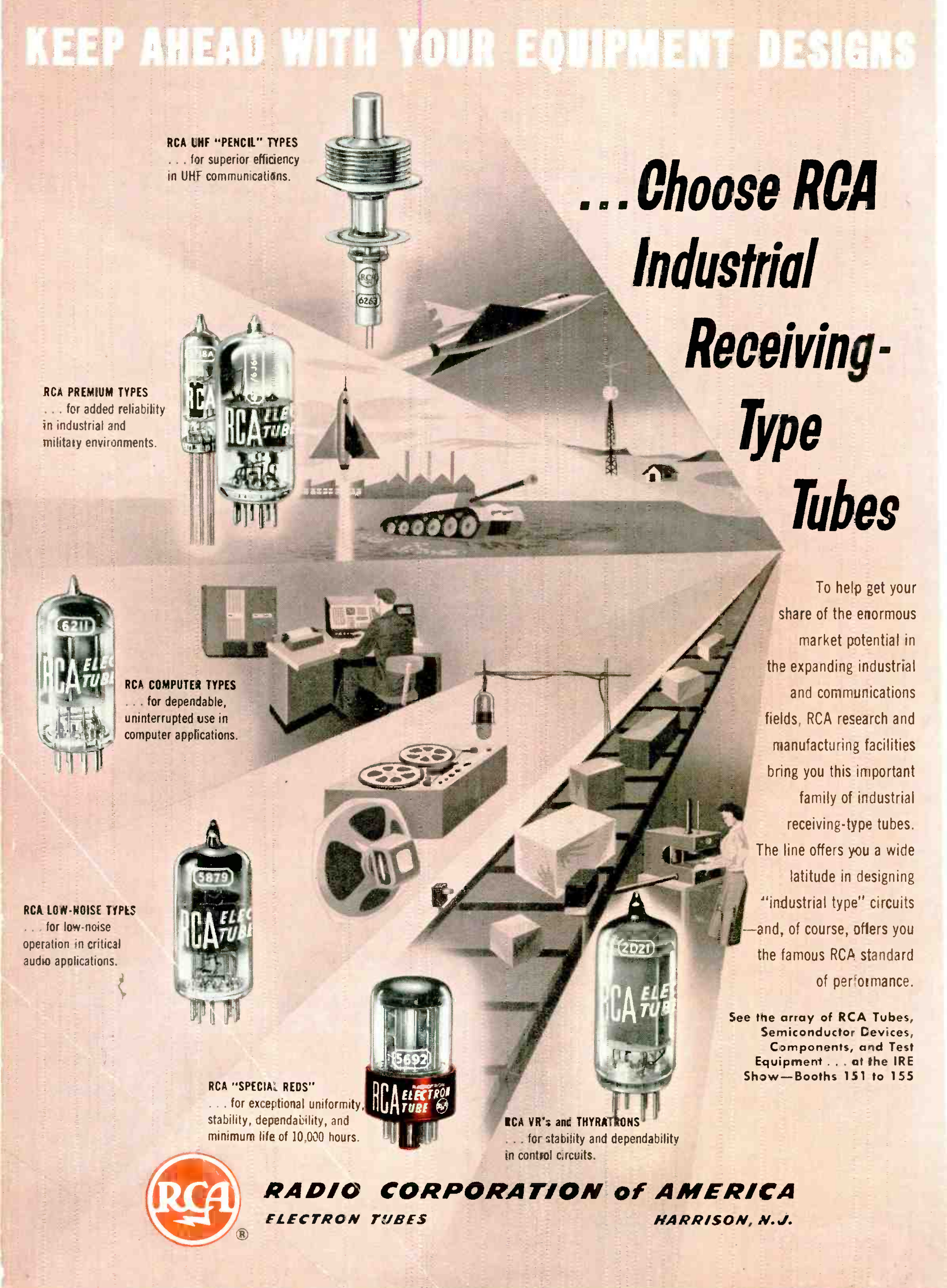
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