electronics

JULY · 1951

PRICE 75 CENTS

A McGRAW-HILL PUBLICATION

TESTING AIRCRAFT FUEL GAGES

Linear Standard Units...

THE ULTIMATE IN QUALITY...

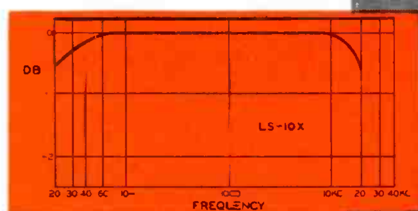
UTC Linear Standard Audio Transformers represent the closest approach to the ideal component from the standpoint of uniform frequency response, low wave form distortion, high efficiency, thorough shielding and utmost dependability.

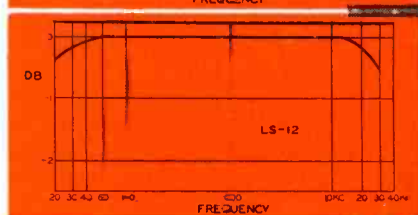
UTC Linear Standard Transformers feature ...

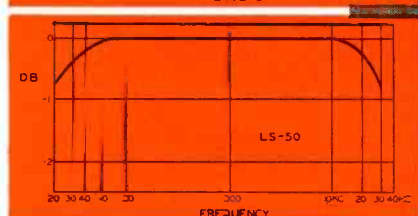
- **True Hum Balancing Coil Structure** ... maximum neutralization of stray fields.
- **Balanced Variable Impedance Line** ... permits highest fidelity on every tap of a universal unit ... no line reflections or transverse coupling.
- **Reversible Mounting** ... permits above chassis or sub-chassis wiring.
- **Alloy Shields** ... maximum shielding from inductive pickup.
- **Hiperm-Alloy** ... a stable, high permeability nickel-iron core material.
- **Semi-Toroidal Multiple Coil Structure** ... minimum distributed capacity and leakage reactance.
- **Precision Winding** ... accuracy of winding .1%, perfect balance of inductance and capacity; exact impedance reflection.
- **High Fidelity** ... UTC Linear Standard Transformers are the *only* audio units with a *guaranteed* uniform response of ± 1 DB from 20-20,000 cycles.

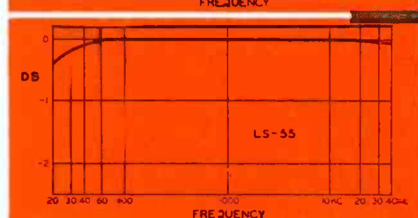
TYPICAL LS LOW LEVEL TRANSFORMERS

Type No.	Application	Primary Impedance	Secondary Impedance	±1 db from	Max. Level	Relative hum-pickup reduction	Max. Unbalanced DC in prim'y	List Price
LS-10	Low impedance mike, pickup, or multiple line to grid	50, 125, 200, 250, 333, 500/600 ohms	60,000 ohms in two sections	20-20,000	+15 DB	—74 DB	5 MA	$25.00
LS-10X	As Above	As above	50,000 ohms	20-20,000	+14 DB	—92 DB	5 MA	32.00
LS-12	Low impedance mike, pickup, or multiple line to push pull grids	50, 125, 200, 250, 333, 500/600 ohms	120,000 ohms overall, in two sections	20-20,000	+15 DB	—74 DB	5 MA	28.00
LS-12X	As above	As above	80,000 ohms overall, in two sections	20-20,000	+14 DB	—92 DB	5 MA	35.00
LS-26	Bridging line to single or push pull grids	5,000 ohms	60,000 ohms in two sections	15-20,000	+20 DB	—74 DB	0 MA	25.00
LS-19	Single plate to push pull grids like 2A3, 6L6, 300A. Split secondary	15,000 ohms	95,000 ohms; 1.25:1 each side	20-20,000	+17 DB	—50 DB	0 MA	24.00
LS-21	Single plate to push pull grids. Split primary and secondary	15,000 ohms	135,000 ohms; turn ratio 3:1 overall	20-20,000	+14 DB	—74 DB	0 MA	24.00
LS-22	Push pull plates to push pull grids. Split primary and secondary	30,000 ohms plate to plate	80,000 ohms; turn ratio 1.6:1 overall	20-20,000	+26 DB	—50 DB	.25 MA	31.00
LS-30	Mixing, low impedance mike, pickup, or multiple line to multiple line	50, 125, 200, 250, 333, 500/600 ohms	50, 125, 200, 250, 333, 500/600 ohms	20-20,000	+17 DB	—74 DB	5 MA	25.00
LS-30X	As above	As above	As above	20-20,000	+15 DB	—92 DB	3 MA	32.00
LS-27	Single plate to multiple line	15,000 ohms	50, 125, 200, 250, 333, 500/600 ohms	30-12,000 cycles	+20 DB	—74 DB	8 MA	24.00
LS-50	Single plate to multiple line	15,000 ohms	50, 125, 200, 250, 333, 500/600 ohms	20-20,000	+17 DB	—74 DB	0 MA	24.00
LS-51	Push pull low level plates to multiple line	30,000 ohms plate to plate	50, 125, 200, 250, 333, 500/600 ohms	20-20,000	+20 DB	—74 DB	1 MA	24.00
LS-141	Three sets of balanced windings for hybrid service, centertapped	500/600 ohms	500/600 ohms	30-12,000	+10 DB	—74 DB	0 MA	28.00









TYPICAL LS OUTPUT TRANSFORMERS

Type No.	Primary will match following typical tubes	Primary Impedance	Secondary Impedance	±1 db from	Max. Level	List Price
LS-52	Push pull 245, 250, 6V6, 42 or 2A5 A prime	8,000 ohms	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	15 watts	$28.00
LS-55	Push pull 2A3's, 6A5G's, 300A's, 275A's, 6A3's, 6L6's	5,000 ohms plate to plate and 3,000 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	20 watts	28.00
LS-57	Same as above	5,000 ohms plate to plate and 3,000 ohms plate to plate	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	20 watts	20.00
LS-58	Push pull parallel 2A3's, 6A5G's, 300A's, 6A3's	2,500 ohms plate to plate and 1,500 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	40 watts	50.00
LS-6L1	Push pull 6L6's self bias	9,000 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	30 watts	42.00

Write for our Catalog PS-510

United Transformer Co.

150 VARICK STREET NEW YORK 13, N. Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"

electronics

A McGRAW-HILL PUBLICATION

July • 1951

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July, 1951 — ELECTRONICS — Vol. 24, No. 7

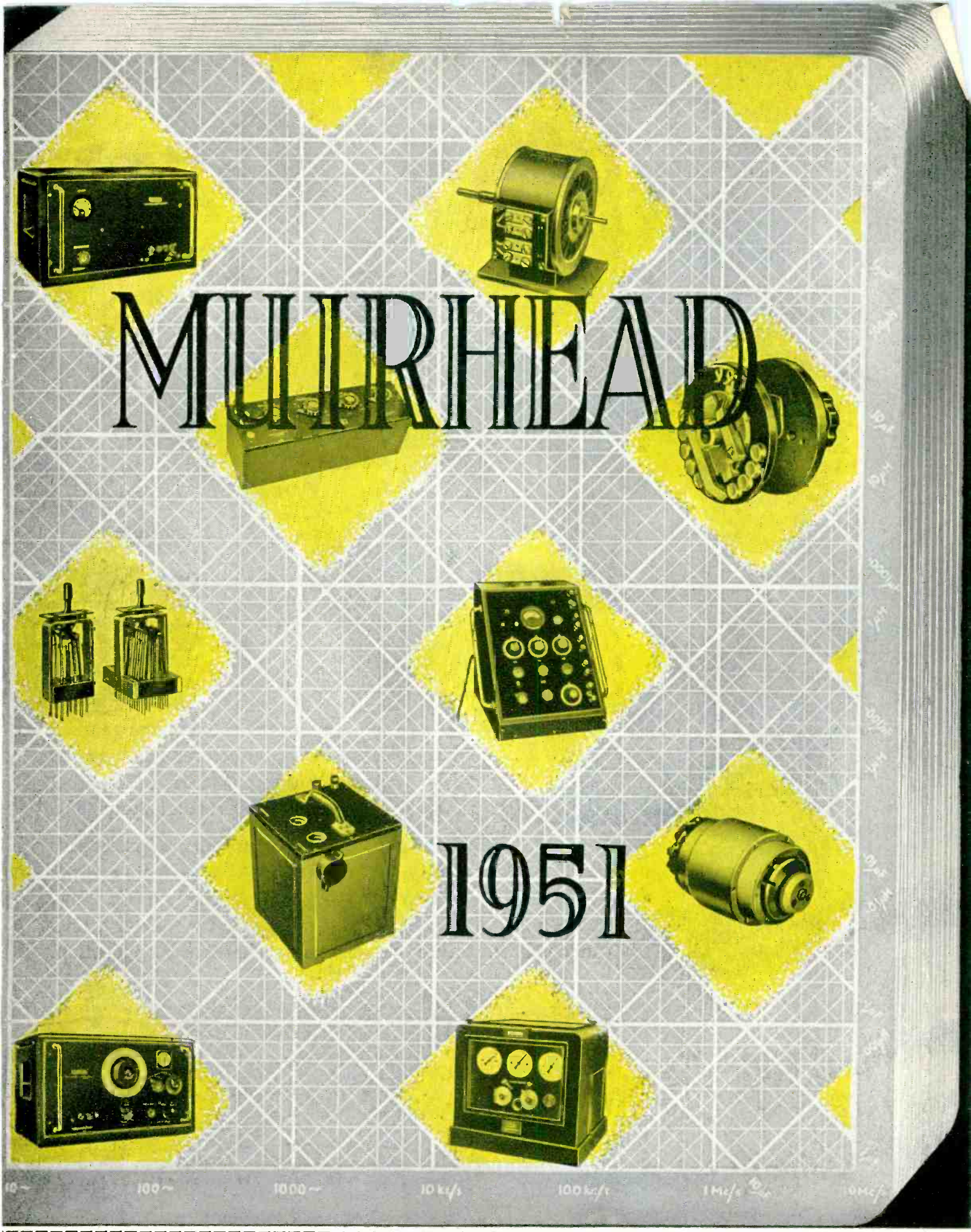
Member ABC and ABP

Published monthly with an additional issue in June by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. **Publication Office**, 99-129 North Broadway, Albany 1, N. Y.

Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 W. 42nd St., New York 18, N. Y. Curtis W. McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Paul Montgomery, Senior Vice-President, Publications Division; Ralph B. Smith, Editorial Director; Nelson Bond, Vice-President and Director of Advertising; J. E. Blackburn, Jr., Vice-President and Director of Circulation.

Subscriptions: Address correspondence to Electronics—Subscription service, 99-129 N. Broadway, Albany 1, N. Y., or 330 W. 42nd St., New York 18, N. Y. Allow ten days for change of address. Please indicate position and company connection on all subscription orders.

Single copies 75¢ for United States and possessions, and Canada; $1.50 for Latin America; $2.00 for all other foreign countries. Buyers' Guide $2.00. Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years; $12.00 for three years. Canada, $10.00 a year; $16.00 for two years; $20.00 for three years. Pan American countries, $15.00 a year; $25.00 for two years; $30.00 for three years. All other countries $20.00 a year; $30.00 for two years; $40.00 for three years. 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. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; Aldwych House, Aldwych, London, WC. 2; Washington, D. C., 4; Philadelphia 3; Cleveland 15; Detroit 26; St. Louis 8; Boston 16; Atlanta 3, Ga.; 1111 Wilshire Blvd., Los Angeles 17; 738-9 Oliver Building, Pittsburgh 22. ELECTRONICS is indexed regularly in The Engineering Index.



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*Please send me, free of charge, your **1951 CATALOGUE.*** 48

NAME ____________________

COMPANY ____________________

POSITION ____________________

MAILING ADDRESS ____________________

Compactness

for resistors

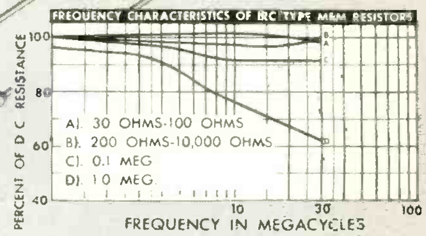
More and more components in less and less space! That's the manufacturer's dilemma as necessity shrinks the size of electrical and electronic instruments and equipment.

But compactness need not create bottlenecks —if you specify IRC *miniature resistors*. Years ago, we foresaw the trend to compactness and got ready for it. Now, with the widest line of resistor types in the industry, IRC can supply miniature components for almost any application.

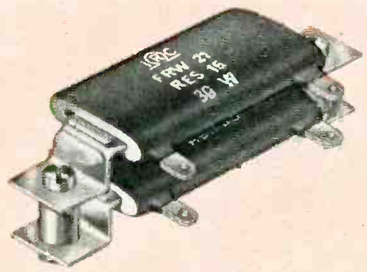
Only 15/16" in diameter, compact new IRC Type Q Controls adapt to a wide variety of small-space applications. Rugged construction features one-piece dual contactor of thin, high-stress alloy—simplified single-unit collector ring—molded voltage baffles—special brass element terminals that will not loosen or become noisy when bent or soldered. Salt-spray materials, when specified, protect against humidity; change in resistance is negligible even after long exposure. Noise level is low and Type Q Controls have unusual durability and efficiency. Coupon brings you full details in Catalog A-4.

is essential

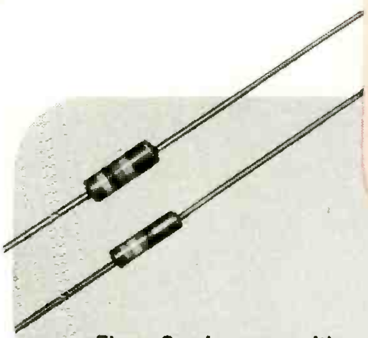
too!



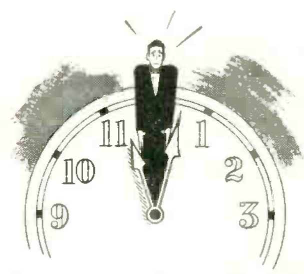
Miniature MPM Resistors are ideally suited to high frequency receiver and similar applications. Frequency characteristics are outstanding, but absolute balance has been maintained with all other significant electrical characteristics. These are the same as in larger IRC Type MP Resistors. MPM's are constructed of solid steatite ceramic rods, to which a thin resistance film is permanently bonded. Changes due to humidity and aging are held to a minimum. Resistor body is 9/16'' long, and active resistance section only 3/8'' long. Send for complete information in Catalog F-1.



Higher space-power ratio than tubular wire wounds suits small, flat Type FRW fixed and adjustable wire wounds to voltage dropping applications in limited space. FRW's may be mounted vertically or horizontally, singly or in stacks. Non-magnetic mounting brackets extend through resistors—allow easy and economical mounting—aid in heat distribution along entire length—and transfer internal heat to chassis. Light-weight construction combines with exceptional mechanical strength and ability to withstand severe vibration. Bulletin C-1 gives full performance data.



Tiny fixed composition resistors—Types BTR and BTS—are only 13/32'' in body length. At 1/3 and 1/2 watts, respectively, these miniature units set new performance standards for fixed composition resistors. Advanced BT's easily meet the rigorous requirements of television—actually exceed JAN-R-11 Specifications! Balanced in every characteristic, BT's are especially well suited to high ambient temperatures. Power dissipation is excellent. Other Advanced Type BT's meet and surpass JAN-R-11 Specifications at 1 and 2 watts. Write for full particulars in Catalog B-1.



When you're squeezed for "small-orders" of standard resistors in a hurry, simply call your IRC Distributor. IRC's Industrial Service Plan enables him to give you fast, 'round-the-corner delivery of standard resistors for experimental work, pilot runs, maintenance. We'll be glad to send you his name and address.

IRC

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...NCE COMPANY
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...national Resistance Company, Toronto, Licensee

Wherever the Circuit Says —

Power Resistors • Voltmeter Multipliers • Insulated Composition Resistors • Low Wattage Wire Wounds • Volume Controls • Voltage Dividers • Precision Wire Wounds • Deposited Carbon Precistors • Ultra-HF and High Voltage Resistors • Insulated Chokes

INTERNATIONAL RESISTANCE COMPANY A

403 N. Broad St., Phila. 8, Pa.

Send me additional data on the items checked below:—

☐ Q Controls ☐ Flat FRW Resistors

☐ Advanced BT Resistors ☐ MPM Resistors

☐ Name and Address of local IRC Distributor

NAME..

TITLE..

COMPANY..

ADDRESS..

THOMPSON EXPANDS ITS SERVICE INTO ELECTRONIC PRODUCTION

new!

precision built

coaxial switches

BY **Thompson**

Model No. 10829 one-pole two-throw coaxial switch.

Model No. 10567 one-pole four-throw coaxial switch.

TYPICAL PERFORMANCE

Frequency range, 0 to 10,750 Mc./Sec.
V. S. W. R., 1.5 maximum
Insertion loss, .5 decibels or less at 3,000 Mc./Sec.
Cross-talk, 50 decibels minimum at 3,000 Mc./Sec.
Characteristic impedance, 50 ohms nominal
Maximum RF voltage, 500 volts RMS
Power rating, CW maximum continuous 100 watts at 3,000 Mc./Sec.

THESE SWITCHES are available in several types, including single pole 2-throw, 3-throw, 4-throw and 6-throw, double pole double-throw, and lobing or sensing. Remote actuation is available for all.

The Thompson Products Electronics Division has a competent staff of engineers, electronic and environmental test equipment, model shop facilities, and production facilities ready to work with you on your coaxial switch problems.

WRITE *for further technical information and descriptive brochure. Your inquiry will bring a prompt reply.*

ELECTRONICS DIVISION, 2196 CLARKWOOD ROAD, CLEVELAND 3,

Thompson Products, Inc.

MANUFACTURERS OF PRECISION AIRCRAFT PARTS AND ACCESSORIES
CLEVELAND • DETROIT • LOS ANGELES • ST. CATHARINES, ONTARI

MITCHELL-RAND

Electrical Insulation Headquarters

features GLASTIC

The fiberglas-polyester laminate that provides greater insulation protection per dollar cost

GLASTIC Laminates are made by combining glass fibers with alkyd base polyester resins . . . the resultant laminate, combining the best electrical and physical features of both, is an insulating material significantly superior in heat, arc and moisture resistance; flexural, impact and tensile strength . . . also it is tough, rigid and dimensionally stable. GLASTIC Laminates are easy to fabricate; they punch and shear without requiring pre-heating.

GLASTIC Laminates are available in six grades to meet all known insulation requirements:

GLASTIC MM	Distinctly superior to cotton fabric reinforced phenolic laminates and similar materials, yet competitive in price.
GLASTIC GF	Similar to Glastic MM but made with a resin of greater strength and flame resistance; well suited to resist pounding, required in driving slot wedges.
GLASTIC GW	Premium grade, much greater strength than either MM or GF; 45,000 psi at 150°C after 200 hours; requires sharp carbide tools in fabricating.
GLASTIC GU	Similar to GW but uses unidirectional glass cloth for maximum tensile strength in one direction (70,000 psi).
GLASTIC MP	Tough, semi-rigid sheet stock available in .038" nominal thickness only; well suited to cold shearing and punching.
GLASTIC A FLEXIBLE	Tough and thin; will crease without serious loss in dielectric (500-700 V/M); shearing and handling qualities far superior to mica glass materials; will not puff or distort regardless of long storage under heat or humidity; standard thicknesses .015" and .020"

MECHANICAL AND ELECTRICAL PROPERTIES	GRADE MM	GRADE GF	GRADE GW
Flexural Strength (psi)	23,800	34,000	53,200
Rigidity (Young's Mod. x 10")	1.87	2.84	3.38
Impact Strength (Izod)	13.5	19.2	25.0
Tensile Strength (psi)	11,100	17,300	44,500
Compressive Strength (psi)	33,500	53,100	57,500
Hardness (Rockwell M)	90	90	90
Specific Gravity	1.59	1.51	1.75
Water Absorption (% ASTM)	.54	.36	.61
Arc Resistance (ASTM)	150	60	120
Dielectric Strength (V/M)	300	280	210
Dielectric Constant (at 60 cy.)	4.3	4.1	5.4
Power Factor (% at 60 cy.)	3.1	2.4	11.2
AFTER 200 HRS. Exposure at 150°C.			
Flexural Strength (psi)	25,200	32,200	45,000
Impact Strength (Izod)	15.7	25.2	22.0
Dielectric Strength (V/M)	325	315	200
Water Absorption (% ASTM)	1.32	.61	2.15

GRADE B INSULATION FOR THE PRICE OF GRADE A

GREATER
- IMPACT STRENGTH
- ARC RESISTANCE
- HEAT RESISTANCE
- DIMENSIONAL STABILITY
- MOISTURE RESISTANCE

- MOLDED GLASTIC parts, Grade MG, are available to specification.
- Special GLASTIC for particular requirements will be developed on request.
- Information detailing the superiority of GLASTIC with grade C phenolics and melamine G5 laminates is available . . . Write for GLASTIC bulletin MR; also for free test samples—they'll be sent upon written request.

Write for GLASTIC bulletin MR; also for free test samples

MITCHELL-RAND · Electrical Insulation Headquarters · SINCE 1889

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A PARTIAL LIST OF M-R PRODUCTS: FIBERGLAS VARNISHED TUBING, TAPE AND CLOTH · IN AND TWINES · CABLE FILLING AND POTHEAD COMPOUNDS · FRICTION TAPE AND SPLICE · T POUNDS · FIBERGLAS SATURATED SLEEVING · ASBESTOS SLEEVING AND TAPE · VARNISHED C TAPE · MICA PLATE, TAPE, PAPER, CLOTH, TUBING · FIBERGLAS BRAIDED SLEEVING · COTTON T SLEEVINGS · IMPREGNATED VARNISH TUBING · INSULATING VARNISHES OF ALL TYPES · EXTR

Noise Suppression?

Engineers think of FILTRON for noise suppression!

FILTRON might not be able to lick the problem shown above, but we can solve all of your problems of RF Interference Suppression on electronic equipment.

FILTRON will design the right filter for your circuit conditions to meet size, weight and electrical characteristics — and meet RF Interference Suppression Specifications wherever RF Interference must be eliminated.

FILTRON's advanced engineering, due to constant research and development, together with **FILTRON**'s production know-how, insures quality components to meet your delivery requirements.

RF INTERFERENCE SUPPRESSION FILTERS FOR:

Motors	Dynamotors
Generators	Power Plants
Inverters	Actuators
Electronic Controls	Gasoline Engines

And other RF Interference producing equipment

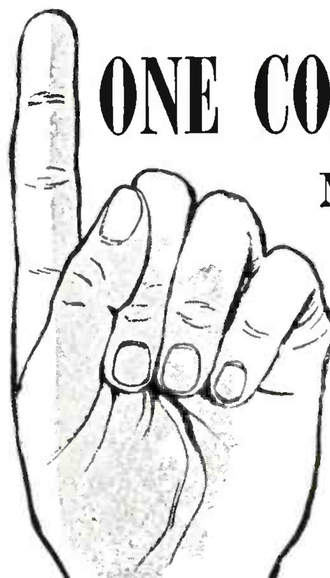
filtered by **FILTRON**

LOCKHEED XF-90

Send for your copy of our NEW CATALOG on your company letterhead.

THE FILTRON CO., INC.
FLUSHING, LONG ISLAND, N. Y.
LARGEST EXCLUSIVE MANUFACTURERS OF RF INTERFERENCE FILTERS

ALL RANGES WITH THIS ONE CONTROL



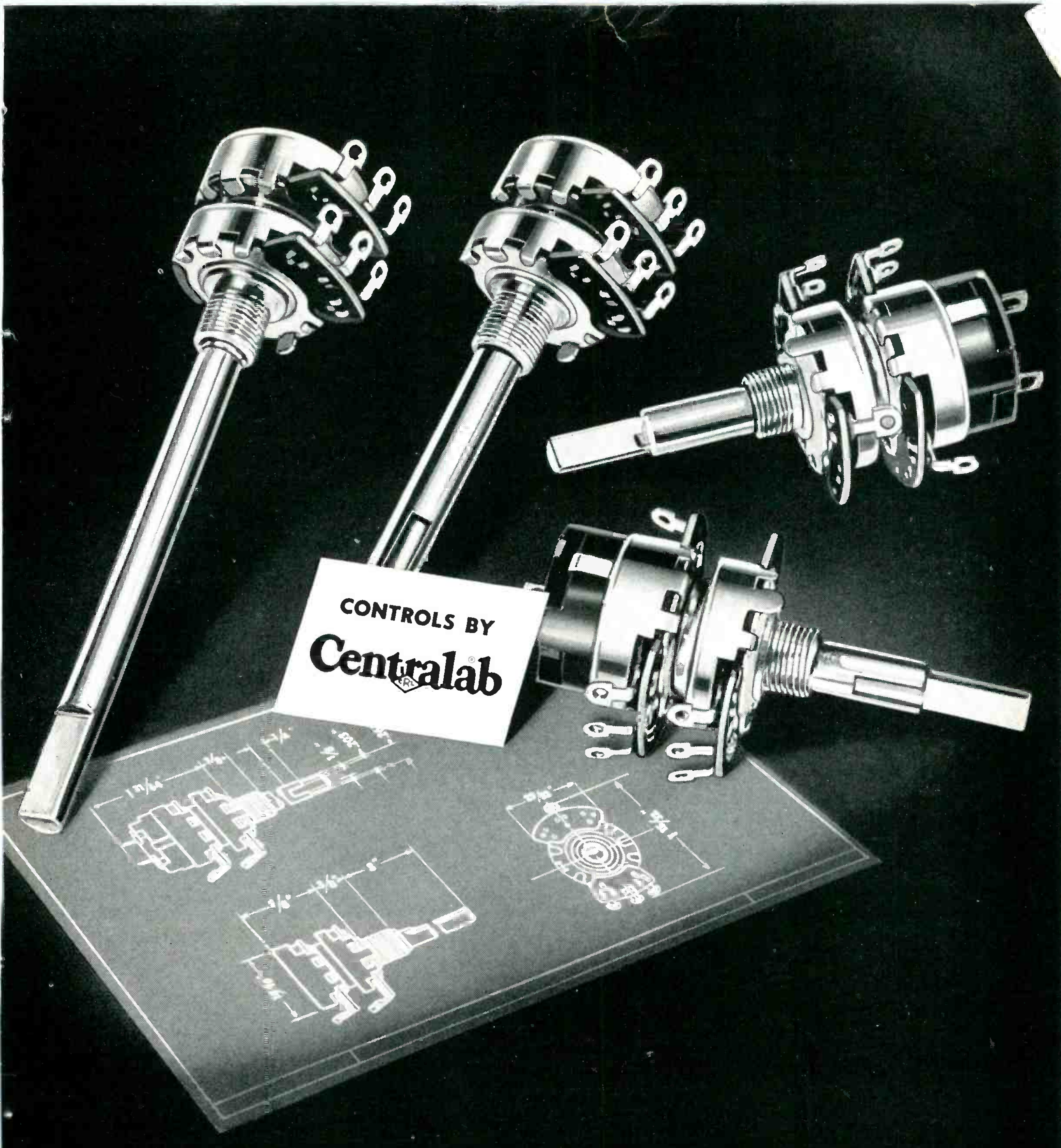
Model 630

Just *one* knob—extra large—easy to turn—flush with the panel, controls all ranges. This one knob saves your time—minimizes the chances of "burn-outs" because you don't have to remember to set another control. You can work fast with Model 630 with your eyes as well as your hands. Look at that scale—wide open—easy to read, accurately. Yes, this is a *smooth TV* tester. Fast, safe, no projecting knobs, or jacks, or meter case. Get your hand on that single control and you'll see why thousands of "Model 630's" are already in use in almost every kind of electrical testing

FOR THE MAN WHO TAKES PRIDE IN HIS WORK

Triplett

TRIPLETT ELECTRICAL INSTRUMENT COMPANY • BLUFFTON, OHIO, U. S. A.



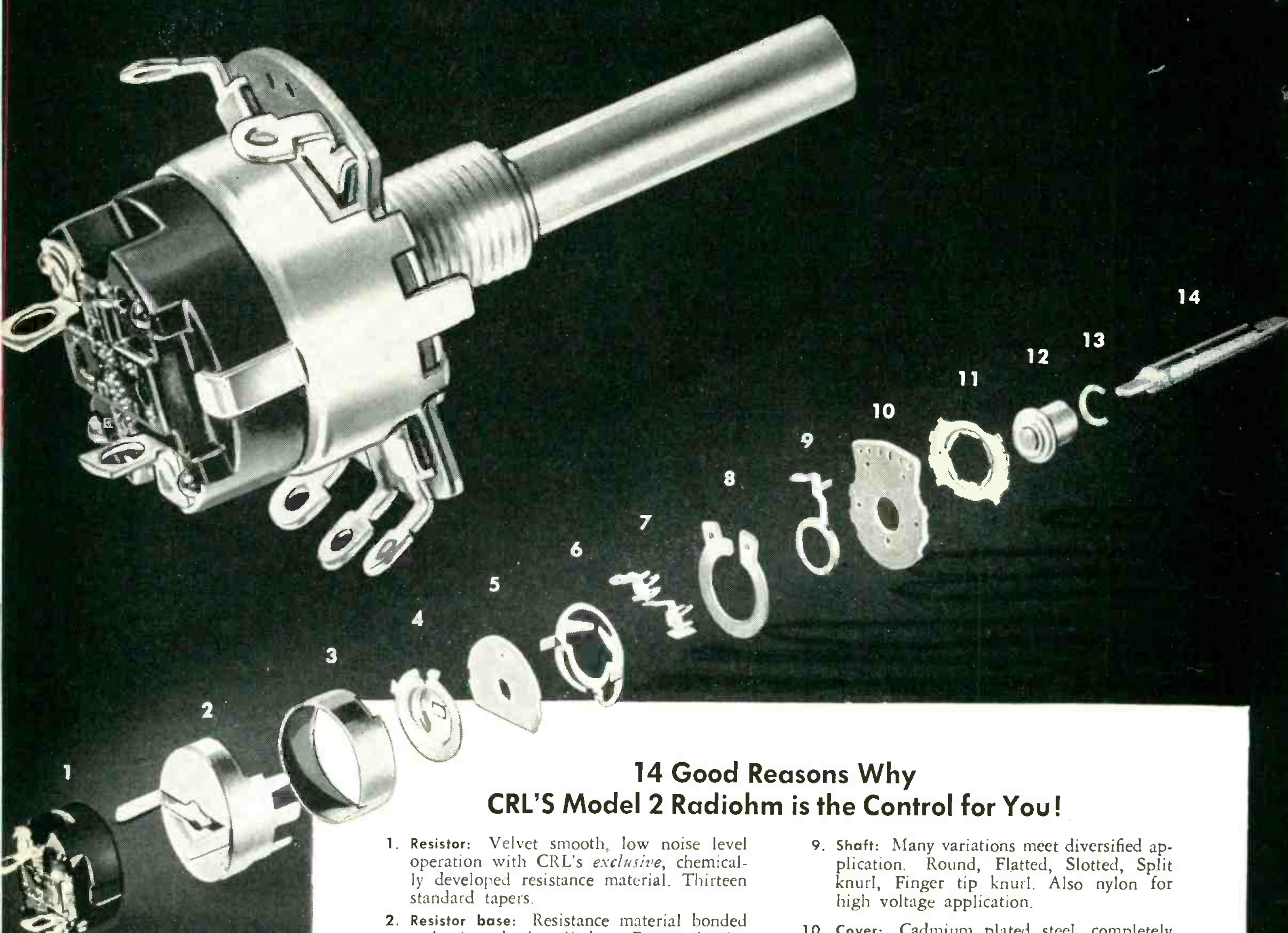
Nowhere can you obtain a broader variety of finer quality controls than those made by Centralab—the Company which introduced carbon controls to the electronic industry more than 25 years ago!

For more information see next two pages →

SPECIFY CENTRALAB CONTROLS FOR

CENTRALAB OFFERS A VARIETY OF STANDARD AND CUSTOM

Centralab's New Model 2 Radiohm



14 Good Reasons Why CRL'S Model 2 Radiohm is the Control for You!

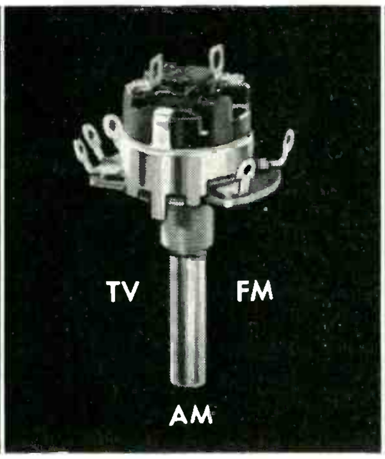
1. **Resistor:** Velvet smooth, low noise level operation with CRL's *exclusive*, chemically developed resistance material. Thirteen standard tapers.
2. **Resistor base:** Resistance material bonded to laminated, phenolic base. Base maintains high insulation resistance in high humidity.
3. **Contact spring:** Phosphor-bronze. Double wiping. Uniform mechanical pressure and positive electrical contact on resistor element and contact ring assures noiseless action.
4. **Shoe:** High grade, laminated phenolic. High insulation resistance in humidity.
5. **Center terminal:** Cadmium tipped, non-oxidizing. Easily soldered.
6. **Terminals:** Clinch type, tightly crimped to resistor element for mechanical rigidity and electrical continuity when soldered or in humidity.
7. **Ground plate:** Cadmium plated steel.
8. **Bushing:** Cadmium plated steel. Accurately machined for minimum shaft-bushing clearance, smooth rotation.
9. **Shaft:** Many variations meet diversified application. Round, Flatted, Slotted, Split knurl, Finger tip knurl. Also nylon for high voltage application.
10. **Cover:** Cadmium plated steel, completely shields resistor element.
11. **Switch:** Directly operated from shaft. Positive on and off action. Standard, high and low current ratings in varied combinations.
12. **Switch terminals:** Ends shaped for wrap-around leads. Hot tin-dipped for easy soldering. Mechanically anchored — will not loosen during soldering operations. Surfaces elevated; cannot short to cover legs.
13. **Insulator:** High dielectric strength permits breakdown rating of 1,000 volts, R.M.S.
14. **Variety of unit types:** Single or twin, concentric shaft twins, plain or switch type, any of these tapped or untapped. Simple design permits wide variation at minimum cost.

YOUR AM—FM—TV APPLICATIONS

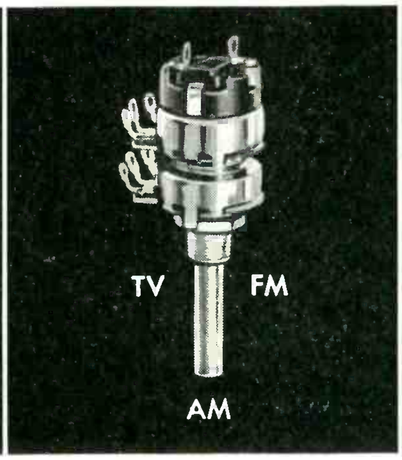
SPECIFICATIONS TO MEET COMMERCIAL AND GOVERNMENT REQUIREMENTS

Famous new Centralab Model 2 Radiohms now available in plain or switch types—standard or custom designs—with plain or dual concentric shafts. 15/16" control diameter meets today's demand for smaller size.

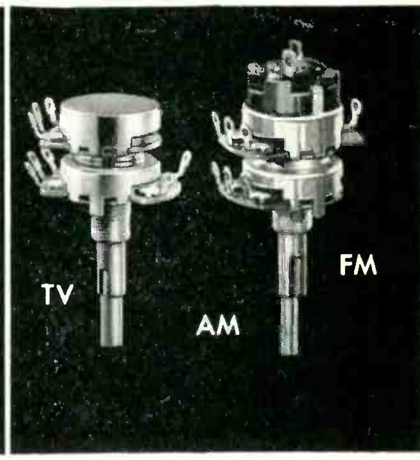
New Centralab Model 2 Radiohm Control — Left, single unit plain type, untapped; right, twin unit plain type, untapped. Both with single shafts.



New Centralab Model 2 Radiohm Control—control shown is a single unit switch type, tapped. Control has single shaft.



New Centralab Model 2 Radiohm Control — this control is a twin unit switch type, untapped. It has a single shaft.



New Centralab Model 2 Radiohm Control — Left, twin unit plain type, front section tapped; right, twin unit switch type, rear section tapped. Both units have concentric shafts.

OF SPECIAL INTEREST.....

The World's Smallest Volume Control — Centralab's Model 1

Smaller than a dime! Less than 1/4" thick.
Available in plain or switch type.
Ideal for miniature electronic gear.

FOR COMPLETE SPECIFICATIONS AND SAMPLES

If you want further information — taper curves, physical dimensions, engineering specifications on Centralab's Model 2 Radiohms or Model 1's, mail in coupon below. *Manufacturer's samples on request.*

Centralab CRL

Division of GLOBE-UNION INC. • Milwaukee

Centralab Div. Globe-Union Inc.
914 E. Keefe Ave., Milwaukee 1, Wis.

Please send me Control bulletin No. 42-85 on Centralab Model 2 Radiohms. ☐ Also include Control bulletin No. 42-19 on Centralab's Model 1 miniature control.

Name...Title.................................

Company...Address.................................

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

For Negative Resistance-Voltage Characteristics

GLOBAR

TRADE MARK

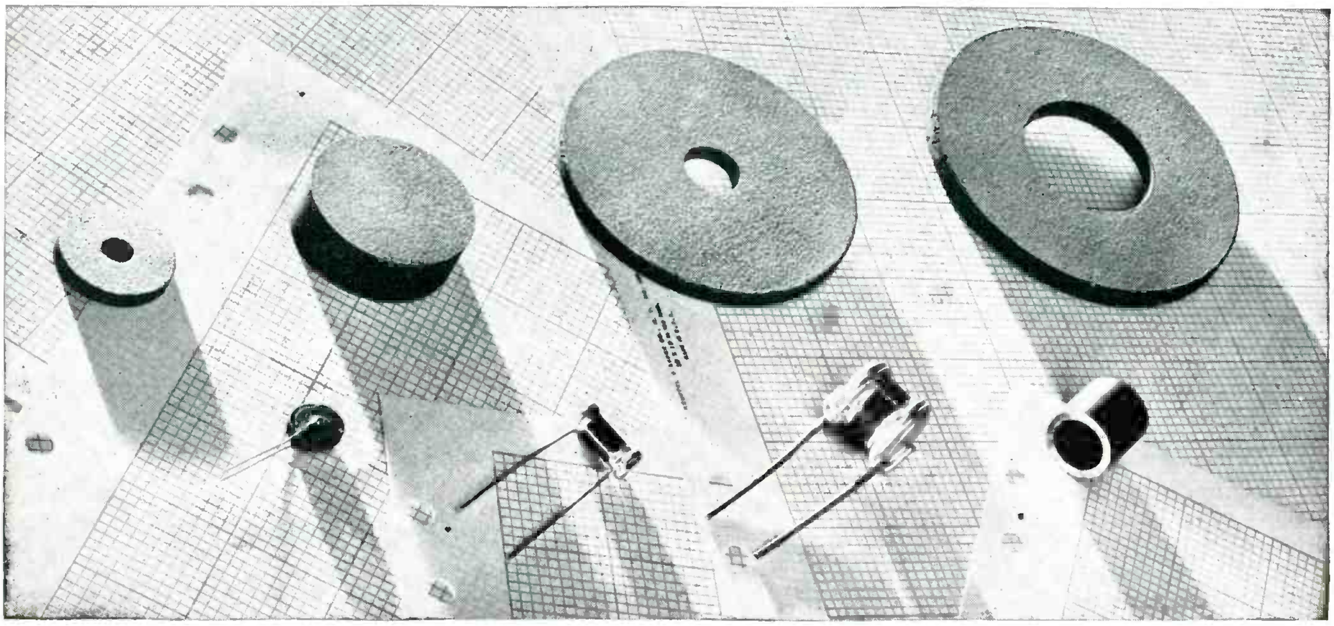
TYPE BNR RESISTORS

Responding instantly to voltage changes, GLOBAR type BNR Silicon Carbide Resistors provide increased resistance as a potential is decreased. Conversely, as a potential is applied, resistance decreases. These resistors are what is commonly referred to as voltage sensitive. They are used to dampen the effect of transient voltages and provide instant protection for electrical circuits.

Bulletin GR2 contains useful engineering data on GLOBAR BNR Ceramic Resistors. Copies will be supplied immediately upon request. Write Dept. V-71, The Carborundum Company, GLOBAR Division, Niagara Falls, N. Y.

Typical applications where these resistors operate successfully include:

1. Small motors to prevent arcing of governor contact points.
2. Stabilizing rectifier circuits by limiting peak voltages.
3. Voltage control circuits in electronic devices.
4. Protection of solenoids in direct current circuits.



Resistors of this type are readily made to meet exact specifications. Working samples are available when necessary. To be sure of receiving resistors made to correct specifications, the following information should be furnished:

a. Type of apparatus in which resistors are to be used.
b. Method of mounting and space limitations.
c. Normal operating voltage and peak voltage if available.
d. Resistance and inductance of the circuit if available.
e. Ohmic resistance of the resistor and allowable plus or minus tolerance.
f. Maximum voltage applied continuously or intermittently.
g. Duration of load and elapse of time between applications.

Furnishing these data will also avoid unnecessary delay and confusion.

GLOBAR Ceramic Resistors BY CARBORUNDUM

TRADE MARK

"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company, Niagara, Falls, N. Y

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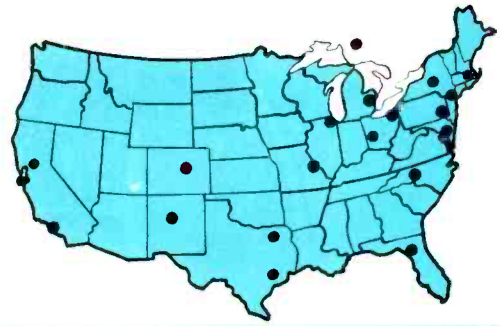

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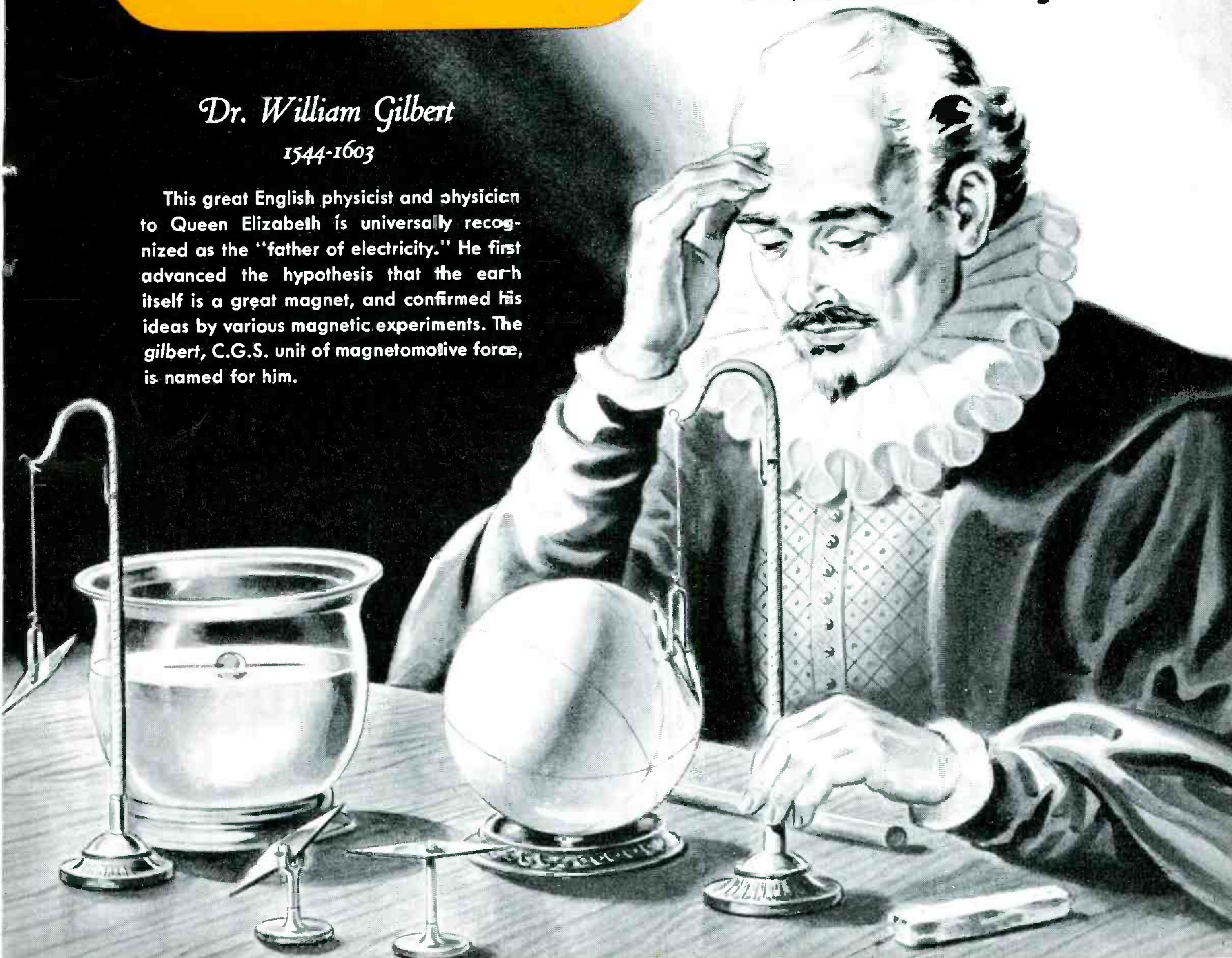
HEWLETT-PACKARD -hp- INSTRUMENTS

GILBERT ...FIRST to investigate the Phenomenon of Magnetism



Dr. William Gilbert
1544-1603

This great English physicist and physician to Queen Elizabeth is universally recognized as the "father of electricity." He first advanced the hypothesis that the earth itself is a great magnet, and confirmed his ideas by various magnetic experiments. The *gilbert*, C.G.S. unit of magnetomotive force, is named for him.

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More manufacturers have standardized on Ohmite rheostats for their products . . . more companies are buying Ohmite rheostats for their own use . . . than any other make of rheostat on the market, today. The primary reason for this industry-wide preference for Ohmite rheostats is their proven dependability . . . their ability to give *extra* years of unfailing, trouble-free service.

G-E Instrument NEWS

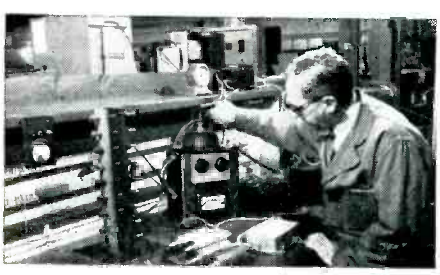
Spoilage Costs Cut 90% With G-E Roughness Scales

Air Maze Company, Cleveland, Ohio, manufacturers of filters for all purposes say that their G-E surface roughness scales and specimens cut spoilage costs 90% which otherwise would have increased manufacturing expenses. "They have provided us with real savings in both time and money," says H. W. Matlock, chief draftsman for Air Maze.

Daily use is made of the roughness specimens in preparing the specifications and blueprints for component filter parts. Then, with the handy lightweight scales, Air Maze makes certain that the finishes on parts received from their vendors are correct. When there is a question as to the suitability of a standard part, they end the argument.

G-E surface roughness scales and specimens are particularly adaptable when any parts, manufactured by several subcontractors or by different departments in one manufacturing plant, must have uniform surfaces roughness. The scales and specimens provide a common basis for the engineer, draftsman, machinist, and inspector in determining, supplying, and approving the correct surface finish.

Jet Engine Opposite-Polarity Ignition Coils are shown below being tested with a General Electric crest voltmeter. The crest voltmeter measures either positive or negative crest voltages. Portable—it does not need an external power supply.

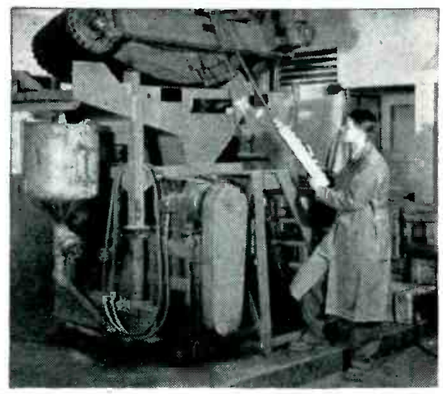


DINGS MAGNETIC SEPARATOR COMPANY RECOMMENDS USE OF G-E GAUSS METER

Dings Magnetic Separator Co., Milwaukee, Wis., manufacturer of magnetic separators, recommends the G-E gauss meter for determining the strength of the horseshoe magnets used in their separators. Reports Mr. Karl A. Blind, Chief Engineer at Dings, "We are recommending the G-E gauss meter to operating personnel in plants where magnetic separators are an essential part of production machinery. We believe operators should acquire and use the gauss meter for purposes of effectively and rapidly checking the full operating efficiency of the magnet."

Magnetic separators consist of either one or a series of permanent or electromagnets. Materials which contain magnetic foreign particles are passed in a steady flow near the magnets—which remove these foreign particles. This process sometimes requires much repetition, with the strength of the magnets varied each time. In order to do this, the exact strength of each magnet has to be controlled to within narrow limits. The General Electric gauss meter enables operators to maintain these limits.

Designed for unidirectional fluxes, the gauss meter can be used for checking flux densities and flux gradients in air gaps, and for measuring flux density in iron structures.



Ten Photoelectric Recorders Used at Battelle Institute

Battelle Institute, Columbus, Ohio, is now using ten General Electric photoelectric recorders in its industrial-research laboratory.

Some of the recent applications for which photoelectric recorders have been used at Battelle are: differential thermal analysis, and recording short-time high-temperature creep qualities of various metallic and plastic substances. It is also used as a sensitive recording instrument for use in measurement and non-destructive testing where it responds to and signals from devices such as: ionization gages, photoelectric cells, thermocouples, transducers, and strain gages.

The Type CE photoelectric recorder measures d-c volts or amperes directly, and will record almost any quantity that can produce a d-c signal which varies in proportion to the quantity being measured. Chart speeds range from ½ inch per hour to 72 inches per minute; sensitivities are as high as 1.0 microampere full scale; response periods as fast as 1/5 second for full-scale deflection.

SECTION A 602-213, GENERAL ELECTRIC
SCHENECTADY 5, N. Y.
Please send me the following bulletins:
Indicate:
√ for reference only
× for planning an immediate project
☐ Gauss Meter (GEC-238A)
☐ Surface Specimens & Roughness Scales (GEC-774)
☐ Type CE Photoelectric Recorder (GEC-254)
☐ Crest Voltmeter (GEC-380)

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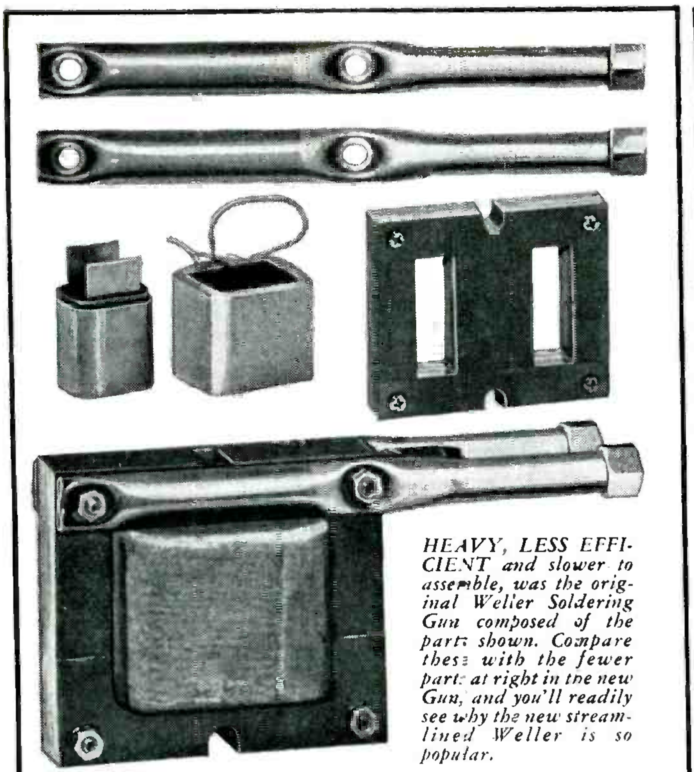
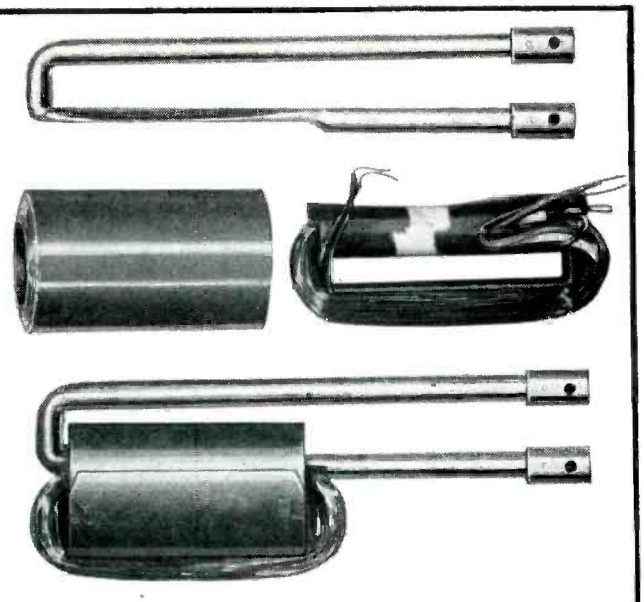
CITY .... ZONE ...... STATE ....

GENERAL ELECTRIC



HEAVY, LESS EFFICIENT and slower to assemble, was the original Weller Soldering Gun composed of the parts shown. Compare these with the fewer parts at right in the new Gun, and you'll readily see why the new streamlined Weller is so popular.



THE NEW WELLER SOLDERING GUN handles 250 watts; heats, ready for use, in five seconds; has longer range to get into the tight spots, and is equipped with spot light. Uses current only when trigger is operated. It is assembled faster. Requires no bolts or nuts. The ⅜" Revere Copper Rod that replaces the secondary coil in the transformer is sheared, flattened, and bent at right angles in a 200-ton press in a single operation.

COPPER TREATS YOUR PRODUCT BETTER WHEN YOU

Control Your Temper

Revere Copper Rod replaces Secondary Coil in Soldering Gun Transformer . . . reduces number of parts, makes for a speedier, more efficient assembly . . . also makes possible a lighter, more compact unit of increased capacity.

WHEN the Weller Manufacturing Company, Easton, Pa., was completing the development of its new electric soldering gun, they were confronted with this problem: The ⅜" Revere Copper Rod used to replace the secondary coil in the transformer had to maintain its rigidity yet be sufficiently soft so that during the shearing, coining, and bending operations there would be no breaking or splitting of the rod.

Revere's Technical Advisory Service recommended a certain temper copper rod. It was discovered that Weller was getting a twist in the rod when it was installed in the assembled gun. Other tempers were tried and tested. Then a copper rod of a slightly harder temper than the first was recommended. That was it! Proper temper was the key. Proper temper was also the key to the .291 dia. copper rod used for the Soldering tip itself. For this, too, had to retain its rigidity and yet remain soft enough to be coined, punched, and formed without fracture.

"In addition to being extremely helpful in arriving at the proper tempers, Revere also recommended that we specify our rod in multiple lengths, and thus save considerably on scrap. They were also helpful in solving the problem of attaching the brass sleeve to the secondary rod in our Soldering Gun," the Weller Manufacturing Company tells us.

So you see, Revere's interest in your problem does not stop with the recommendation of its products. Perhaps Revere can help you. Why not take your current problem to the nearest Revere Sales Office and see?

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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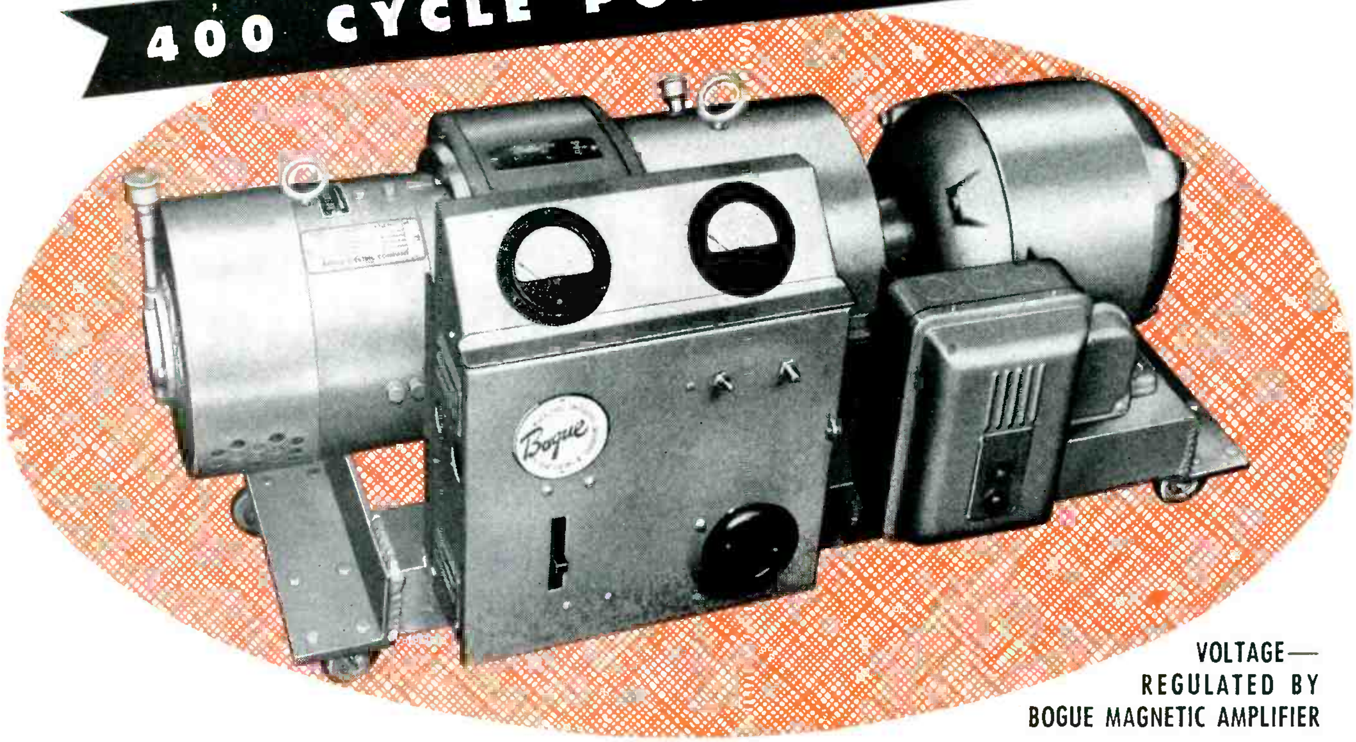
Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.

Sales Offices in Principal Cities, Distributors Everywhere.

The NEW Bogue Portable

400 CYCLE POWER SUPPLY



VOLTAGE—
REGULATED BY
BOGUE MAGNETIC AMPLIFIER

This compact completely self-contained motor generator set operates from commercial 60 cycle power to furnish up to 5 KW of 400 cycle power for use in testing 400 cycle radio and aircraft equipment as well as operation of high speed machine tools, etc. The unit is complete with starting equipment and automatic voltage regulator to maintain the output voltage constant over varying loads. It can be supplied with either single phase or three phase 60 cycle motor and either single or three phase 400 cycle generator. The output wave form is extremely pure, the total harmonic content of the three phase design being approximately 1%. In order to move the unit from one location to another casters are supplied as standard equipment.

HOW BOGUE SERVES INDUSTRY

Bogue Electric specializes in producing electrical equipment required for special applications such as pure 400 cycle power . . . less than 1% harmonics; low ripple dc generators for precision testing of electronic equipment; magnetic amplifiers for reliable, constant speed and voltage control. Bogue electronic engineers have solved hundreds of confidential problems. They are always available to talk over your specialized control or power problems, too!

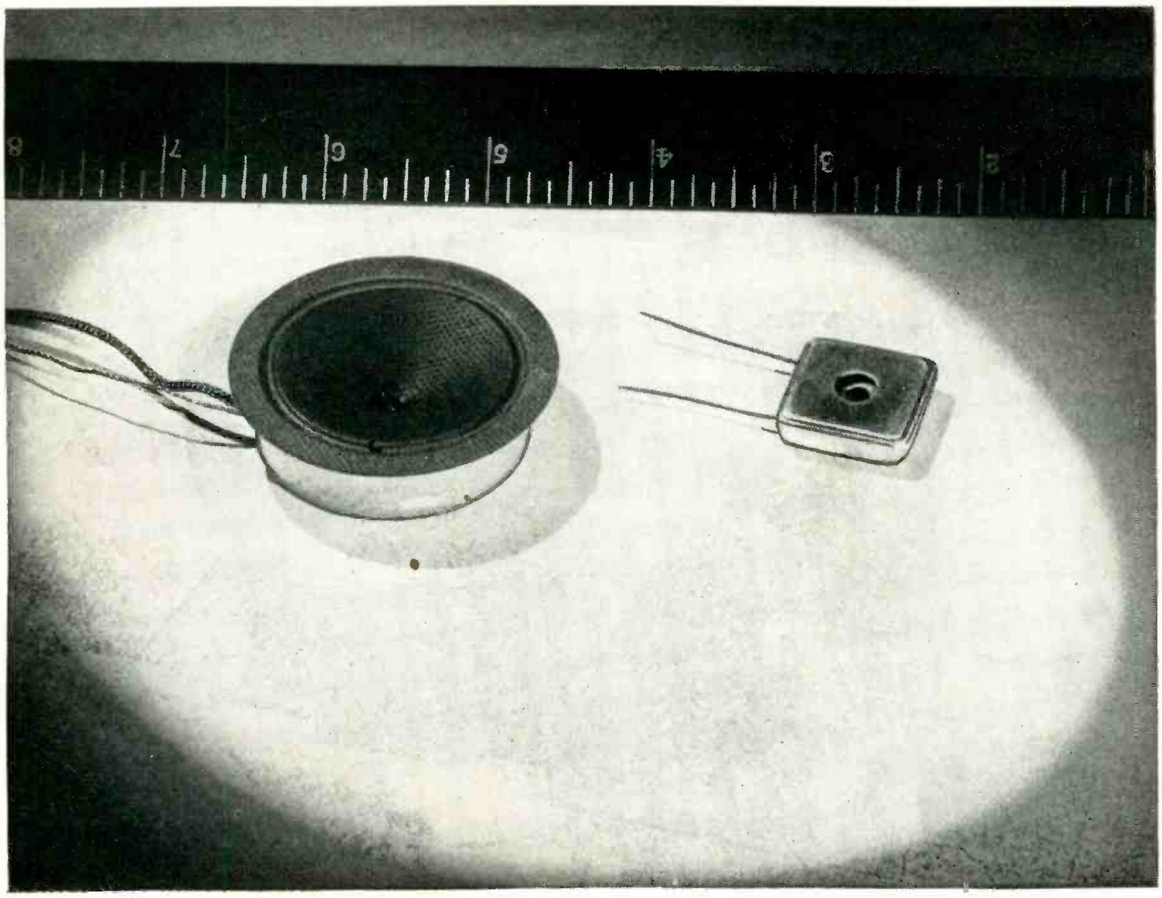
BOGUE ELECTRIC MANUFACTURING COMPANY

Where Precision Coordinated Design... Counts!

50 IOWA AVENUE • PATERSON 3, NEW JERSEY

SINCE 1892 SPECIALISTS IN FINE MOTORS & GENERATORS — Bogue

MAGNETIC AMPLIFIERS • MAGNETIC CONTROLLERS • AC & DC MOTORS
AC & DC GENERATORS • VOLTAGE & SPEED REGULATORS • SWITCHBOARDS



A *Brush* DEVELOPMENT

hearing aids have shrunk to half their size

• Brush has been the leader in cutting the size of hearing-aid microphones. Now hearing aids are small, almost unobservable and, most important of all, do their job better. Deaf people no longer have to wear bulky, unsightly and hard-to-operate hearing aids.

The Brush Development Company for more than 21 years has studied the intricate, though powerful, piezoelectric effects of crystals. The principle of this smaller, more powerful microphone, as pioneered and developed by Brush, is that a tiny, jewel-like crystal converts sound waves into powerful electric signals. This is an example of continued engineering effort by Brush to make available to industry the many benefits and uses of piezoelectric materials, whether in hearing aids, measuring instruments or recording devices.

Manufacturers of

ACOUSTICAL EQUIPMENT
- Microphones—General Purpose and Specialized
- Hearing Aid Microphones
- Earphones—Of Many Types

MAGNETIC RECORDING DEVICES
- Tape
- Plated Wire, Disc and Drum
- Multichannel Recorders
- Recording and Erase Heads
- Memory Storage Units
- Computer Components

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- Universal Strain Analyzers
- Surface Analyzers
- Multichannel Direct Writing Oscillographs
- AC, DC and Carrier-type Amplifiers
- Uniformity Analyzers
- Transient Recorders

PIEZOELECTRIC CRYSTALS

ULTRASONIC EQUIPMENT
- Generators and Analyzers
- Laboratory Equipment

OUR BUSINESS IS THE FUTURE

THE BRUSH DEVELOPMENT COMPANY

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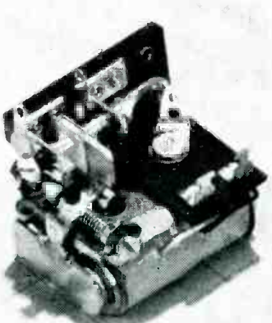
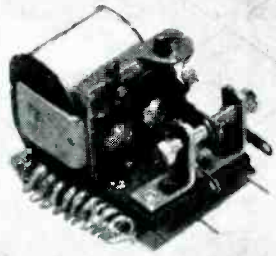
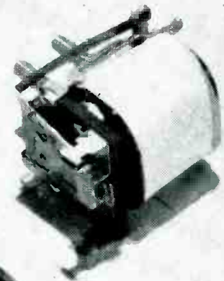
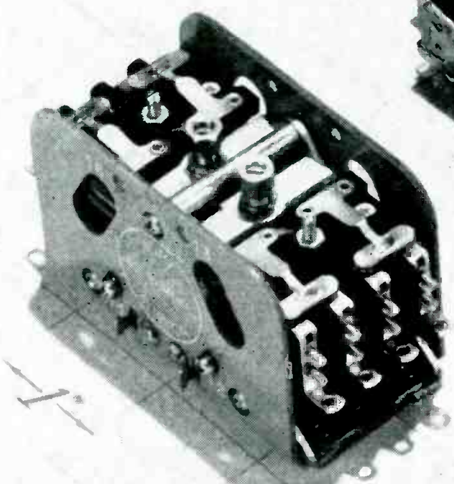
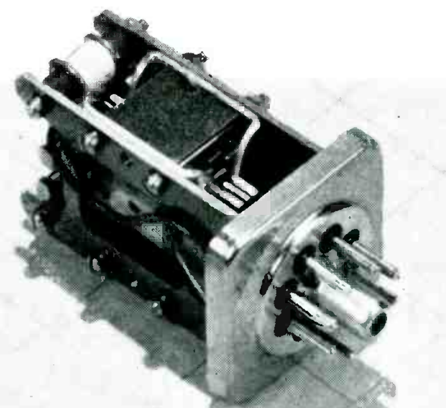
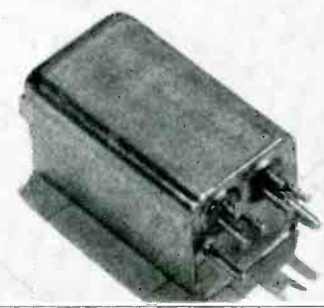












SIGMA

Sensitive Relays

AVAILABLE SERVICE

1. Selection from six basic designs, each with many enclosure and mounting styles. Each such selection may be ordered with a coil resistance and adjustment chosen from a list of standard codes. The classification chart below, from the new catalog, calls attention to the most obvious points of comparison between design series.

2. Specification by our application engineers of the relay they would use if faced with your problem.* This includes selection of type and enclosure as well as design of special adjustment and electrical characteristics, all subject to your approval and test. The resulting specification is your property and will be disclosed only at your request.

****Don't fail to describe all of it, so as to reduce to a minimum our guesswork!***

RELAY SERIES	SWITCH TYPE (MAX. CONTACT ARRANGEMENT)	SWITCH RATING*	SENSITIVITY		MAXIMUM COIL RESISTANCE OR IMPEDANCE	MAXIMUM COIL DISSIPATION (40°C rise)§	SPEED RANGE**	MOUNTINGS, ENCLOSURES, AND DESIGNATIONS			PARTICULAR FEATURES
			Maximum (Standard)	"Aircraft"†				Open Frame	Dust Cover	Hermetic Seal	
4	SPDT (1-C)	2 amp.	.02 watt DC	.04 watt DC	12,000 ohms	1.5 watts 85°C	.002-.015 sec.	4F	4A, 4R	4RJ	Medium price, sensitivity, and precision.
5	SPDT (1-C)	2 amp.	.001 watt DC	.010 watt DC	16,000 ohms	2.0 watts 100°C	.004-.020 sec. Slow-release, with slug, available.	5F	5AH, 5R	5RJ, 5JO	High sensitivity, shock resistance, stability, and vibration resistance.
			.007 watt AC, internal rectifier	.015 watt AC, internal rectifier							
41	SPDT (1-C)	2 amp. (some styles 5 amp)	.04 watt DC	Not generally recommended	12,000 ohms	1.5 watts 100°C	.002-.015 sec.	41F (other open mountings available)	41R, 41RO	41RJ, 41JO	High AC sensitivity, long mechanical life; fast—good for pulsing; high load ratings possible; low price.
			0.1 VA AC 60 cps.	Not generally recommended	‡90,000 ohms	2.5 VA 100°C	Operates in 1st half cycle.				
6	4PDT (4C)	2 amp. (5 amp. with SPDT DPDT)	.05 watt — 4C contacts; .012 watt — 1C contacts; DC *POLARIZED*		25,000 ohms (12000/12000 in dual coils)	3.0 watts 85°C	.007-.05 sec.	6FX, 6FY, 6FZ	——	6HX, 6HY, 6HZ	Polarized; biased, latching or 3-position (null-seeking); high gain (load power/operating power ratio); multi-contact.
7	SPDT (1-C)	2 amp.	.001 watt, switching, gen'l; .0001 watt, keying setting; DC *POLARIZED*		12,000 ohms (3200/3200 in dual coils)	1.5 watts 85°C	.001-.007 sec.	——	7AOX, 7AOY, 7AOZ	7JOX, 7JOY, 7JOZ	Polarized; biased, latching, or 3-position (null-seeking). For teletype and keying or pulsing, also switching and control functions.
22	DPDT (2-C)	2 amp.	.04 watt DC — 2C contacts; .02 watt DC — 1C contacts		12,000 ohms	1.0 watts 100°C	.004-.020 sec.	——	——	22RJ	Miniature double-pole; maximum shock resistance and precision.

* Nominal, 24VDC or 115VAC resistive; medium-duty life, eg. 100,000 operations.

** Approximate, as governed by normal variations in driving circuit.

† Any duty involving vibration up to 10g while in use.

‡ At operate voltage, operated. Unoperated, approx. 1/2 this value. Varies inversely with applied voltage.

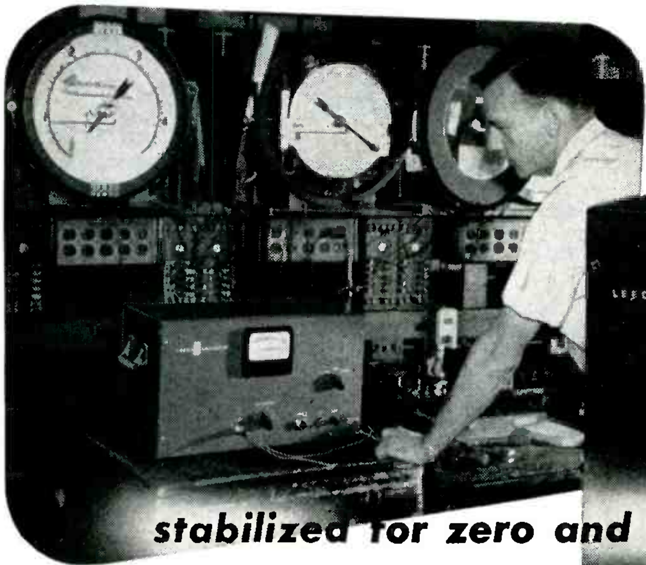
§ Sum of ambient plus temperature rise not to exceed temperature given for each relay. Thermal time constant varies from 10 to 30 minutes. For higher temperatures, inquire of factory.

Write for fully descriptive catalog

SIGMA INSTRUMENTS, INC., 62 PEARL STREET, SOUTH BRAINTREE 85, MASS.

For low-level d-c measurements use these new, L&N triple-purpose

Amplifiers



High precision checking and calibrating under factory conditions using D-C Indicating Amplifier as null detector for accurate bridge and potentiometer circuits. Through combination of a-c amplification and balanced feedback network, zero and gain stability are designed right into instrument. Trimmer controls are eliminated.

SPECIFICATIONS

MICROVOLT UNIT No. 9835	MICRO-MICRO-AMPERE UNIT No. 9836
FULL SCALE RANGES WITH BUILT-IN 4" METERS	
0 to 50 or −25 to +25 Microvolts; scale multipliers: 1, 2, 4, 10, 20, 40	0 to 1000 or −500 to +500 Micro - Microamps; scale multipliers: 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000
ACCURACY	
Of amplifier: ±0.4% of reading; Of meter: ±1%	Of amplifier: ±0.5 to 0.8%* of reading; Of meter: ±1%
ZERO OFFSET	
Max. offset: ±0.5 Microvolt	Max. offset: ±2% of scale
***SOURCE RESISTANCE**	
Up to 10,000 ohms.	0.1 megohm or more.
REPONSE TIME	
2 to 3* sec.	2 to 3* sec.

OUTPUT

For full scale input on any range: 10 millivolts at output impedance of 500 ohms for null recorder; 1 volt for 20,000-ohm external meter.

Front panel fits standard 19" relay rack.

**Accuracy and Response Time depend on Source Resistance.*

Jrl. Ad EM9-51(2)

can be used as . . .

- √ **DIRECT-READING MICROVOLTMETER OR MICRO-MICROAMMETER**
- √ **RECORDER PREAMPLIFIER**
- √ **NULL DETECTOR**

THESE new D-C Indicating Amplifiers are the answer for all your low-level measurements with thermocouples, strain gages, bolometers—bridge and potentiometer circuits—ionization, leakage, and phototube currents—almost any measurement of extremely small direct current or voltage.

Actually 3 instruments in 1, Amplifiers can be used as:

√ Direct-reading instruments—Scale multiplier knob lets you select the range in which you want to work.

√ Recorder preamplifiers—with broad flexibility. One or two degrees temperature difference can be spread right across a 10″ Speedomax recorder chart.

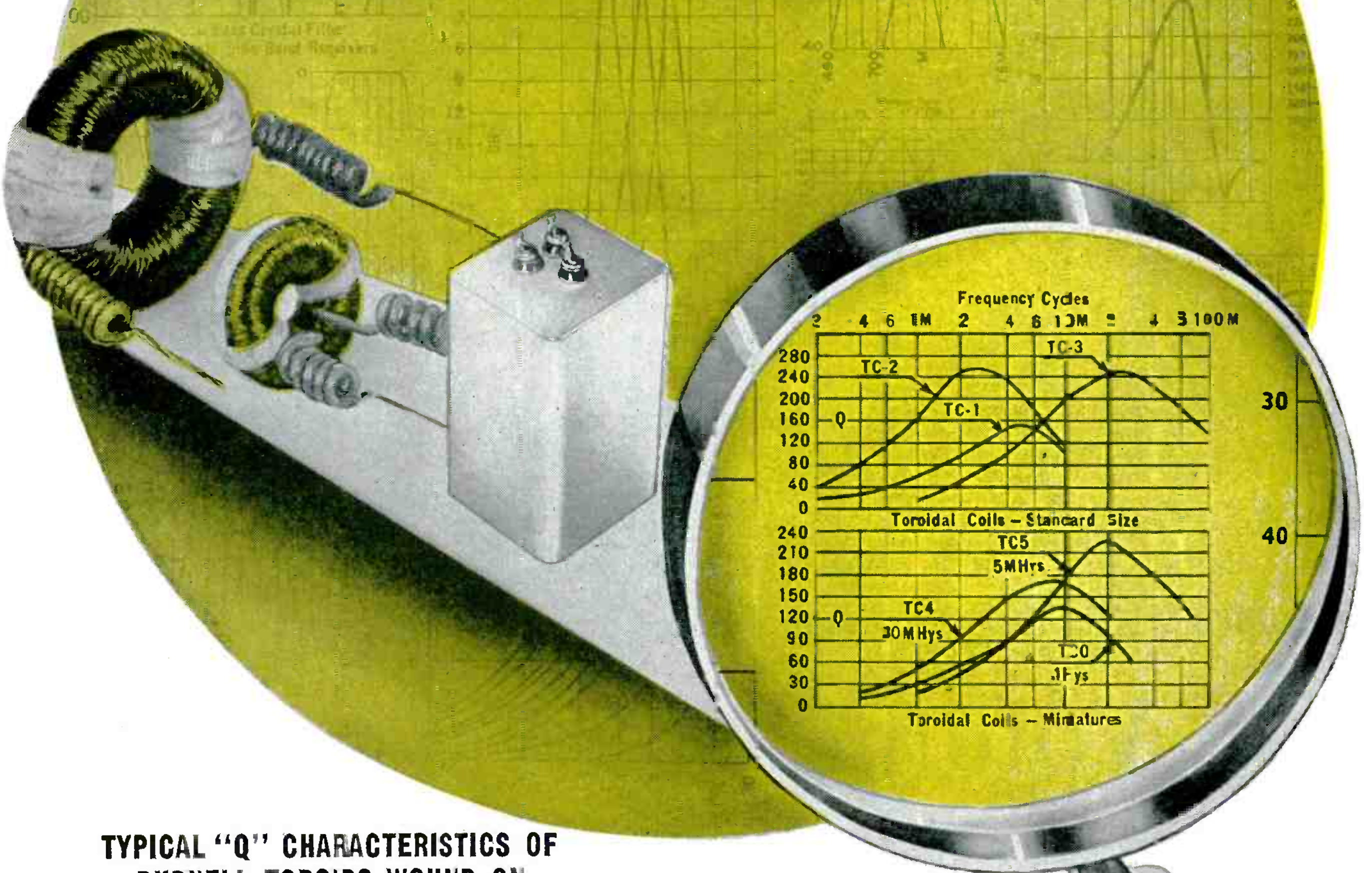
√ Null detectors—more sensitive than most reflecting galvanometers, yet with full scale response time of only 2 to 3 seconds. Leveling is unnecessary; the instrument is not affected by vibration. At the turn of a range knob, you have available a wide choice of sensitivities. And when using non-linear response, not only does the instrument stay on scale at extreme unbalance; sensitivity increases automatically as the null point is approached.

For details, send for Folder EM9-51(1). Write our nearest office, or 4979 Stenton Ave., Phila. 44, Pa.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Burnell NOW BIGGER THAN EVER IN THE PRODUCTION OF TOROIDS AND FILTERS



TYPICAL "Q" CHARACTERISTICS OF BURNELL TOROIDS WOUND ON MOLYBDENUM PERMALLOY CORES

Several years ago we began to specialize in the design and manufacture of toroidal coils and audio filter networks. At that time too few electronic engineers were aware of the full value of toroids (particularly those wound on molybdenum permalloy dust cores) as very little publicity had ever been devoted to a product that was fast becoming one of the most vital in the development of modern communications and control equipment.

We believe that since then through our technical service and advertising methods we have helped thousands of engineers to understand and appreciate the toroid as an essential in network applications.

The resulting popularity and industry acceptance of our toroidal coils and filters have necessitated an expansion of our production facilities to ten times what they were five years ago and we are proud to point to this growth as an expression from our customers of their satisfaction in the quality of our product and our service.

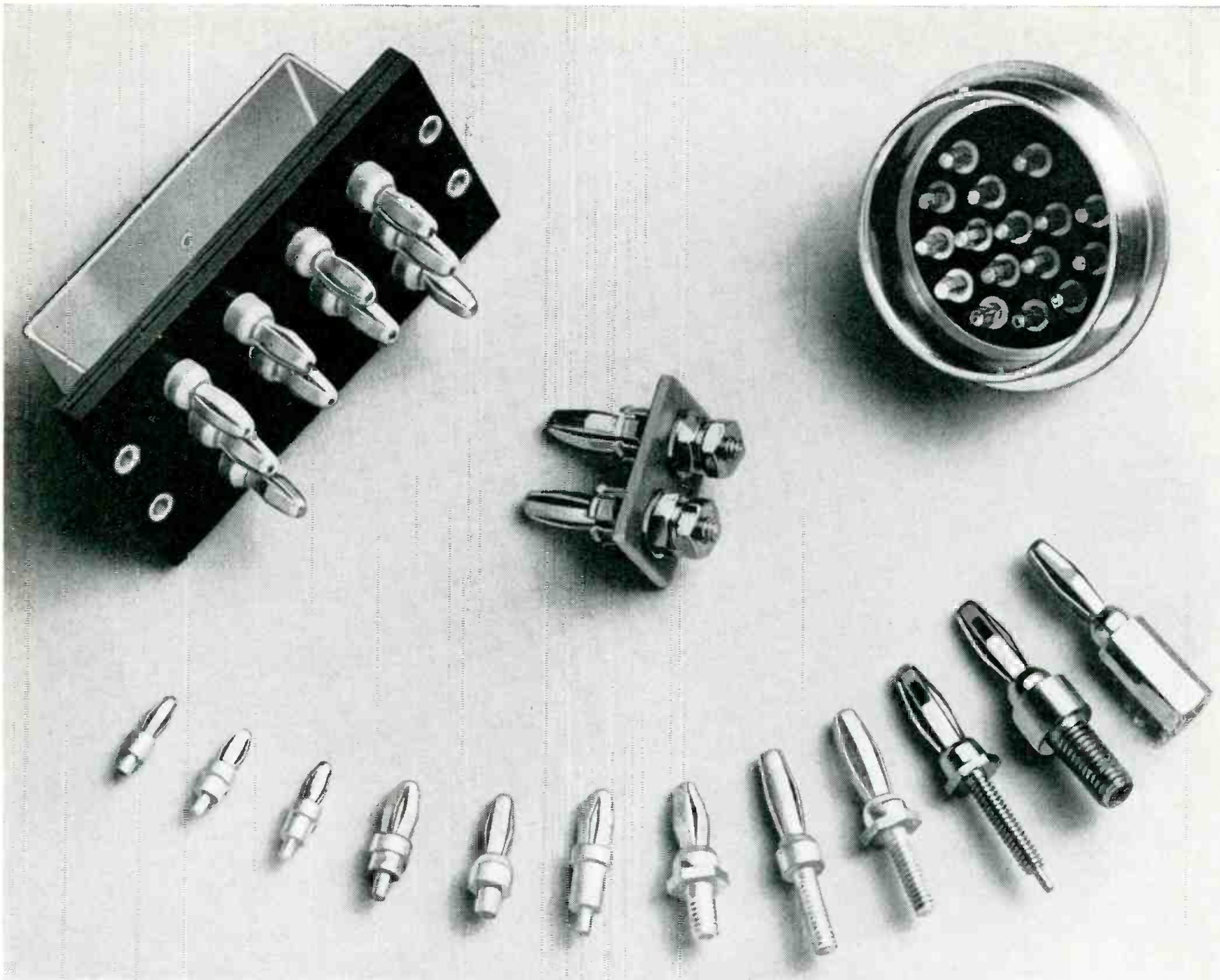
STANDARD SIZES
TC-1 = 1⅝" O.D. x ⅝"
TC-2 = 2¼" O.D. x ⅞"
TC-3 = 1½" O.D. x 9/16"

MINIATURE SIZES
TC-0 = ⅞" O.D. x ⅜"
TC-4 = 1-3/16" O.D. x 9/16"
TC-5 = 1-3/16" O.D. x 9/16"

MAXIMUM INDUCTANCE
TC-1 — Ind.-Up to 10 Hys.
TC-2 — Ind.-Up to 100 Hys.
TC-3 — Ind. MHY-Up to 750
TC-0 — Ind.-Up to 2 Hys.
TC-4 — Ind.-Up to 10 Hys.
TC-5 — Ind. MHY-Up to 750

EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

Burnell & Company
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"



Volume and Variety

You can count on Banana Pins to keep contact in mobile connections, even under conditions of extreme vibration. They come in a wide range of shapes and sizes, and are easily adapted to special assemblies. Here at Ucinite, we have the plant capacity to manufacture standard types in volume and are capable of engineering special types as required. We are also set up to turn out complete banana pin assemblies to your specifications.

Ucinite, with a wealth of experience in the development and production of electric components and assemblies, stands ready as before to supply parts promptly to manufacturers engaged in the present expanding defense production program.

The UCINITE CO.

Newtonville 60, Mass.

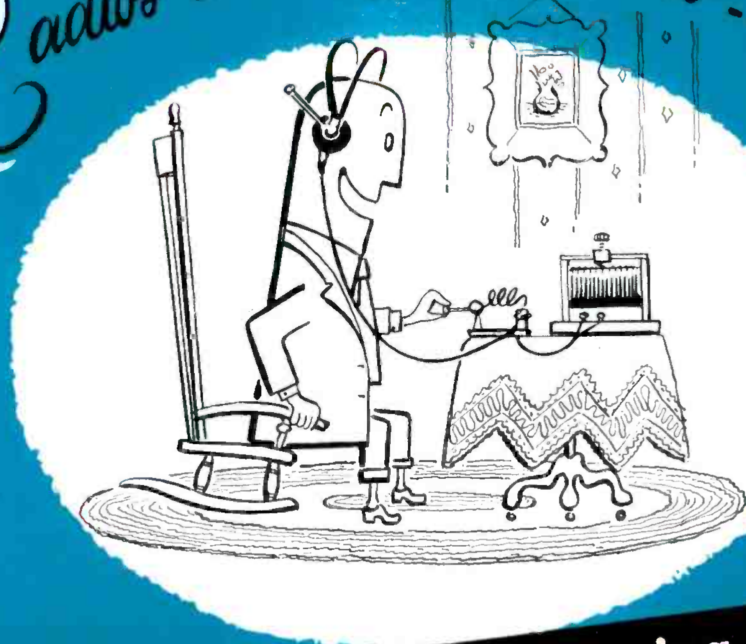
Division of United-Carr Fastener Corp.

Specialists in

ELECTRICAL ASSEMBLIES,

RADIO AND AUTOMOTIVE

Radios are different now....

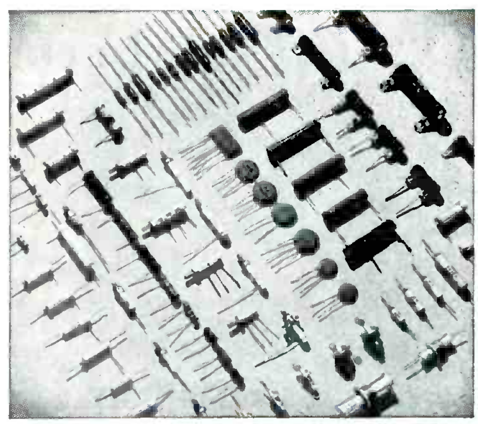


...and in this era of engineering progress
MODERN ELECTRONICS LOOK TO Hi-Q*
Capacitors • Trimmers • Choke Coils • Wire Wound Resistors

● No science has grown faster or gone farther than electronics since those first amazing crystal receivers picked words and music out of the air. And in the development of modern radio, TV, communications and other electronic equipment, one of the prime contributions to dependability, long life and compactness has come from the use of ceramic components as perfected by **Hi-Q.**

Though **Hi-Q** output in four plants is now at the rate of several million units a month, there is no variation in the quality or high performance characteristics of its capacitors, trimmers, choke coils and wire wound resistors. Engineering watchfulness and rigid production control insure the maintenance of uniform precision standards well within the limits of minute tolerances. And it has become an industry maxim that in the development of special components to meet unusual requirements, **Hi-Q** engineers are the most competent and resourceful in their field. Their services are available to your organization in helping solve any problems you may have.

JOBBERS—ADDRESS: 740 Belleville Ave., New Bedford, Mass.



BETTER 4 WAYS

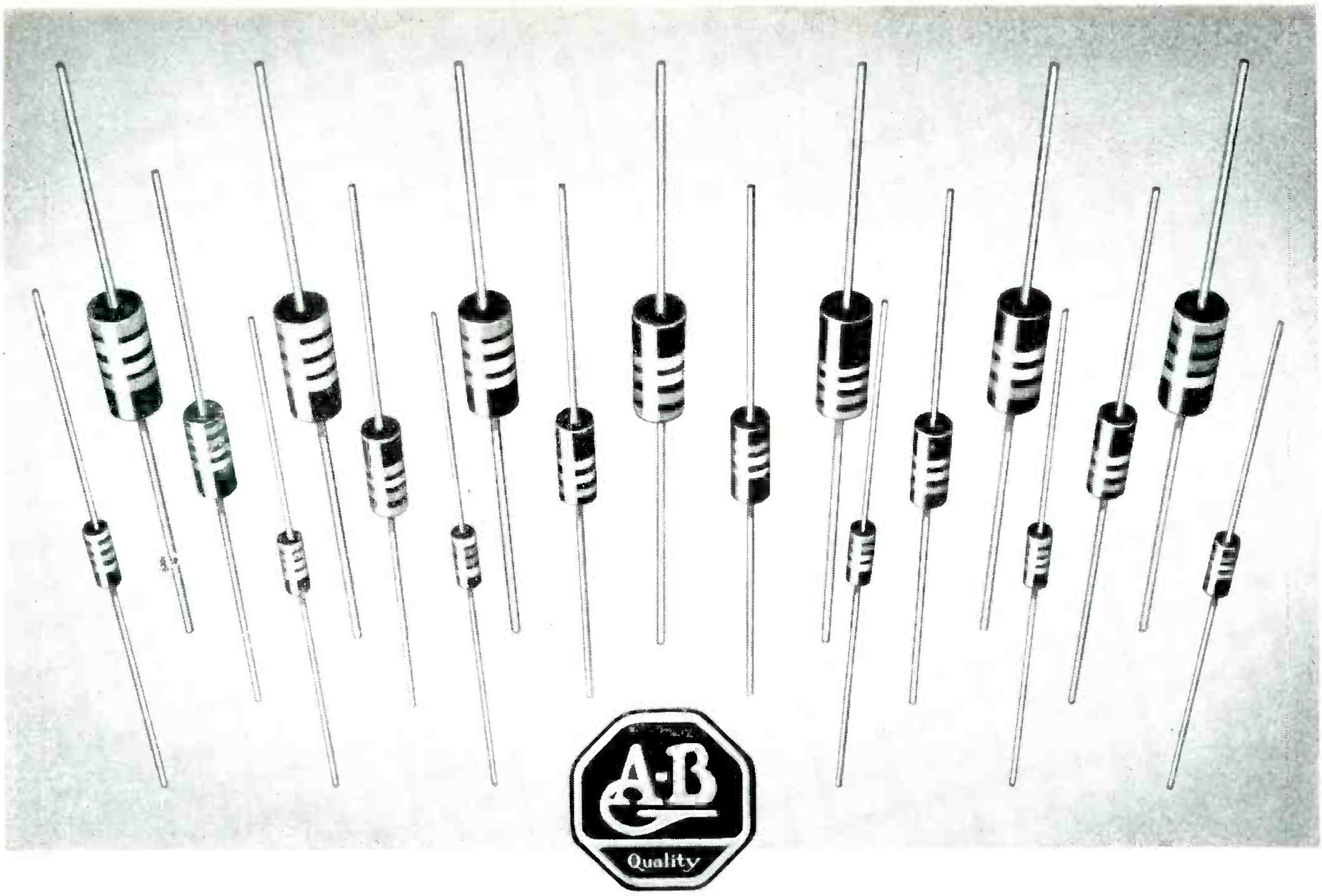
- ✓ PRECISION
- ✓ UNIFORMITY
- ✓ DEPENDABILITY
- ✓ MINIATURIZATION

** Trade Mark Registered, U. S. Patent Office*

Hi-Q* **Electrical Reactance Corp.**
OLEAN, N. Y.

SALES OFFICES: New York, Philadelphia, Detroit, Chicago, Los Angeles

PLANTS: Olean, N. Y., Franklinville, N. Y. Jessup, Pa., Myrtle Beach, S. C.



FIXED RESISTORS THAT STAY FIXED . . .
because they are rated at 70C

Differentially tempered leads

The leads of all Bradleyunits are differentially tempered. This graduated softness of leads near the body of the resistor prevents sharp bends and avoids damage to resistor.

SIZES OF UNITS

Rating	L	D
½-w	3/8″	9/64″
1-w	9/16″	7/32″
2-w	11/16″	5/16″

Bradleyunits have a wide safety factor. They are not crowded for performance because they are rated at 70C . . . not at the usual 40C.

Another thing . . . under continuous full load for 1000 hours, the resistance change is less than 5 per cent. They withstand all extremes of temperature, pressure, and humidity. And, don't forget that Bradleyunits require no wax impregnation to pass salt water immersion tests.

Bradleyunits are packed in honeycomb cartons to keep the leads straight and to avoid tangling during assembly operations. They are available in ½, 1, and 2-watt ratings in standard R.T.M.A. values up to 22 megohms.

Allen-Bradley Co.
110 W. Greenfield Ave., Milwaukee 4, Wis.

A-B Quality

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

Sold exclusively to manufacturers QUALITY of radio and electronic equipment

FOR EXTRA FAST STOPS STARTS REVERSES

New TYPE R-24 process control motor

Holtzer-Cabot Type R-24 motors are designed especially to provide the rapid starts, stops and reverses required by modern, high-speed process control equipment. Extremely low rotor inertia, *plus* high accelerating and decelerating torques, provide extremely quick response. Tests show that, with the dynamic braking connection, the unloaded rotor will *always stop within three-quarters of one revolution!* On geared motors, of course, this means that the output shaft stops in a very small fraction of a revolution.

These motors are 2-phase, squirrel-cage, nonsynchronous induction type. For operation on a single-phase circuit, a capacitor is used in series with one phase. Special high impedance windings are available, suitable for matching standard power tubes.

Available speeds, 1300 RPM (1800 synchronous speed) to ¾ RPM (geared), with torque ratings from 0.5 to 75 oz. in. Can be provided for odd voltages and frequencies, with ball or sleeve bearings. These motors are ideal for Servo-Mechanisms.

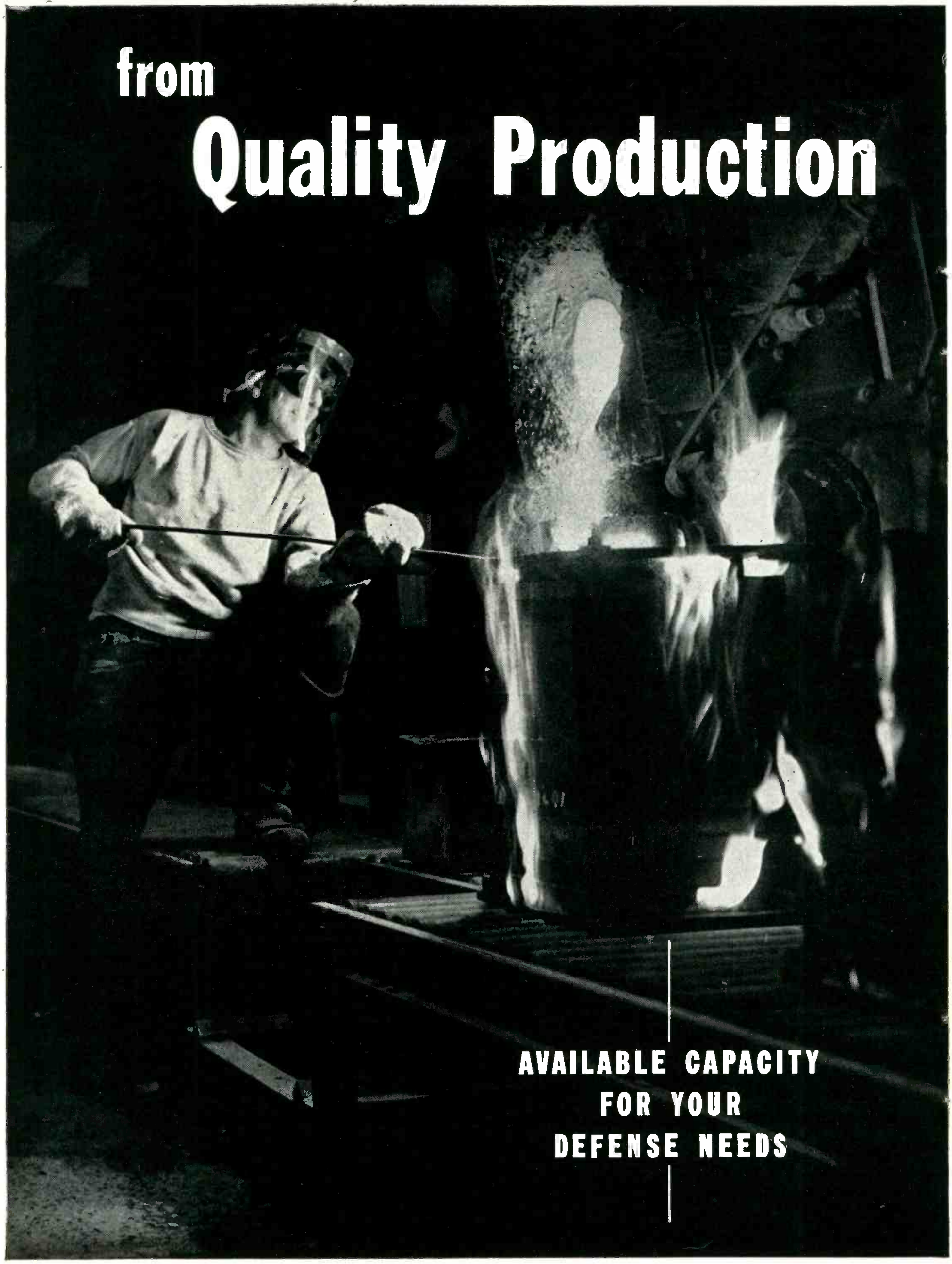
INVESTIGATE NOW . . . Holtzer-Cabot welcomes inquiries involving special motors

HOLTZER-CABOT

DIVISION OF NATIONAL PNEUMATIC CO., INC.

BOSTON 19, MASSACHUSETTS

"Manufacturers of fine electrical apparatus since 1875"


from
Quality Production
AVAILABLE CAPACITY
FOR YOUR
DEFENSE NEEDS

to Delivery on Schedule

Dependable

is the word for

For over 22 years the Carboloy organization has led in *quality* and *uniformity* of man-made metals.

Carboloy Alnico Permanent Magnets are no exception. From the raw materials to finished permanent magnets, each stage of manufacture is subject to a rigid system of continuous quality control.

Quality checks and recordings, tests and retests are run to strict specifications by highly skilled personnel working with the latest equipment.

More, the same dependable control applies to *shipments*, too. Once your defense order is accepted and scheduled, delivery is made as promised.

Result: Carboloy Alnico Permanent Magnets of the *highest uniform quality* roll into your plant on the dot.

For information on the availability of Alnico Permanent Magnets, write today. Carboloy's engineering consultants and technicians will give immediate attention to your magnet problems.

CARBOLOY
DEPARTMENT OF GENERAL ELECTRIC COMPANY
11139 E. 8 Mile Road, Detroit 32, Michigan

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"Carboloy" is the trademark for the products of Carboloy Department of General Electric Company

ALNICO PERMANENT MAGNETS

this is it!

UP
The TL-10 in raised position allows discs to be played

DOWN
The TL-10 mounted and ready for perfect tape reproduction

new PRESTO Turntable Tape Reproducer

When we introduced the PRESTO TL-10 at the IRE, NARTB and Parts Show this spring we knew it was good—and we knew that there was a place for it in the nation's stations, recording studios and schools.

But we never realized just *how* popular it would be. This inexpensive turntable tape reproducer has turned into the sensation of the industry—and here are a few of the reasons why!

- Easy to attach to and remove from any standard 16″ turntable.
- No motor—turntable acts as motor.
- Can be plugged into any standard speech input equipment.
- Speeds of 7½″ and 15″ per second, response up to 15,000 cps.
- Low cost—but has reproduction quality and fidelity of a high priced machine.
- Easy to operate—and maintain.

If you haven't ordered your TL-10 already, do it today. Its addition to your studio will save you time . . . space . . . and money!

PRESTO RECORDING CORPORATION
PARAMUS, NEW JERSEY

Export Division: 25 Warren Street, New York 7, N. Y.
Canadian Division: Walter P. Downs, Ltd., Dominion Square Bldg., Montreal

We Mobilize for Freedom

CONTROLS . . . A Two-Edged Sword

It may seem dangerously premature to talk about getting rid of emergency government controls while all-out war is still an imminent possibility.

But success in this strange struggle for our freedom into which the Russian Communists have plunged us requires that we:

1. Maintain a whole battery of controls designed to speed defense production and curb inflation, and at the same time

2. Work to end the controls at the earliest possible moment.

Here is the reason why this editorial—fourth in a special series on mobilization for defense—is devoted to the need for a speedy release from controls.

If the Russian Communists can force us to maintain indefinitely the present system of government controls, they will have won a tremendous victory. They will have saddled us with a system of collectivism which, over a period of years, would be fairly certain death to freedom of business enterprise.

Make no mistake about it. This is not an argument against emergency controls. We need controls now to break a right of way for our mobilization program through the business boom. Indeed, the third editorial in this special series was titled "Why Controls Are Necessary." It stressed both the need for controls and the need for positive cooperation to make them work.

Controls Can Undermine Our Economy

But these controls surely chisel at the foundation of our normal economic system. So long as we have them, many if not most key business decisions will be made in Washington bureaus rather than in the free market place. For example, the *National Production Authority* administers a *Controlled* Materials Plan (italics ours) which directs the flow of basic metals, and decides who can use them for what purposes.

Happily, the people who operate these controls are not using the methods of a secret police state.

Even more happily, most of the leaders who have been drafted to manage the controls are not in love with their jobs. They are doing their best in the thankless task of making controls work. They recognize the danger of chronic controls.

But the fact remains that our economy is operating under arrangements which carry it a long way toward the pattern of centralized control the Russians would inflict on the world.

The Wilson Plan

A plan for getting rid of these controls has already been developed. It was put together by our Director of Mobilization, Charles E. Wilson—while he was working day and night to set up the necessary emergency controls.

The Wilson Plan—if we escape all-out war—will strengthen our defenses and our economy. By 1953, it calls for:

1. Providing the weapons to equip an armed force of 3½ to 4 million, together with a supply of weapons for our allies.

2. Building a stockpile of weapons which, with current production, would be sufficient to carry on an all-out war for a year.

3. Building the manufacturing capacity by which we could rapidly expand our production of weapons if all-out war should come.

4. Increasing the productive capacity of industry enough to resume the expansion of our civilian economy.

With these jobs done our economy would be big enough and strong enough to meet both civilian and military requirements. And the government controls needed for mobilization could be speedily dropped.

Call for Sacrifice

The Wilson Plan requires a major effort—it means spending more than $50 billion a year for mobilization. That is almost 20 percent of our total production. And this cannot be done without sacrifice. For a time, particularly in the next year, living standards will drop.

But the sacrifice required is amazingly small. At the peak of the defense effort, civilians will still have available to meet their needs about as much as they did in any year before 1948.

To make the Wilson Plan succeed we must curb inflation. A second year of inflation such as that which we have had since the Korean war started would multiply disastrously the costs of our defense program. One key part of a successful program to curb inflationary pressure, which soon will be building up again, is a pay-as-we-go tax program. The second editorial in this series urged that we do our utmost to pay as we go.

We Cannot Out-Control the Communists

But, above all, to make the Wilson Plan work we must keep our sights set on the crucial importance of increased production. Our problem is to increase our capacity to produce so that we can carry both a major military program and an expanding civilian economy for as many years—General Bradley thinks it might be fifteen or twenty—as the menace of Russian Communist aggression persists.

If we do not produce enough to do this double job, we shall be confronted with the prospect of having to live indefinitely under government controls of the sort that have been set up since the start of the Korean war. That would be delightful to the Russian Communists. It would go far toward making over our economy on the Moscow model.

Even if we wanted to, we never could hope to out-control the Russians. They are miles ahead of us in that line. But we can out-produce them, by a tremendous margin. By doing that we shall travel the surest road to victory.

McGraw-Hill Publishing Company, Inc.

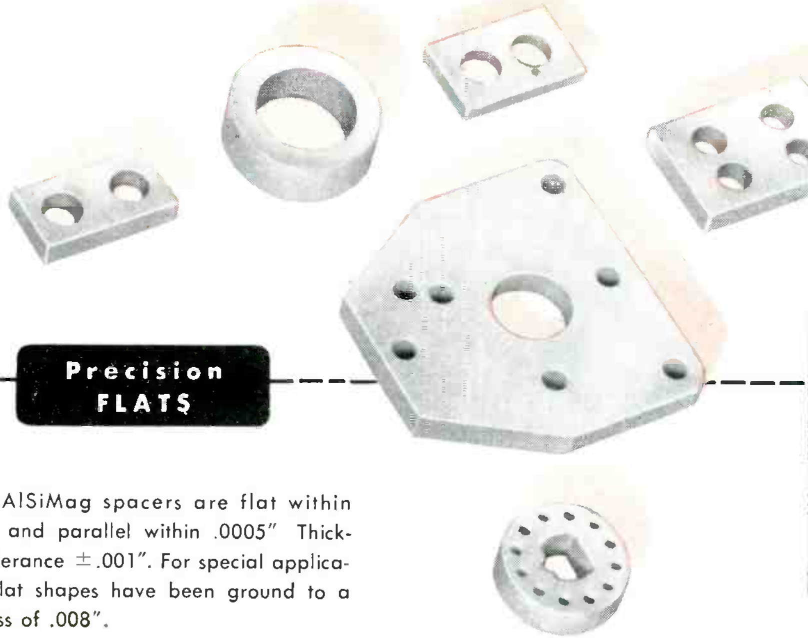
It's a fact that

✓ We have advanced the technique of grinding AlSiMag ceramics so that we can obtain, on critical dimensions which lend themselves to grinding, the accuracy of comparable precision metal parts.

✓ Moreover, AlSiMag ceramics are more wear resistant than steel and, in many designs, can be manufactured to close tolerances at lower cost.

✓ Grinding is most practical on flat and round surfaces. We are equipped to grind flats up to 50 sq. in., rods up to 10″ diameter and holes as small as 3/16″

ALSIMAG
TRADE MARK REG. U.S. PAT. OFF.



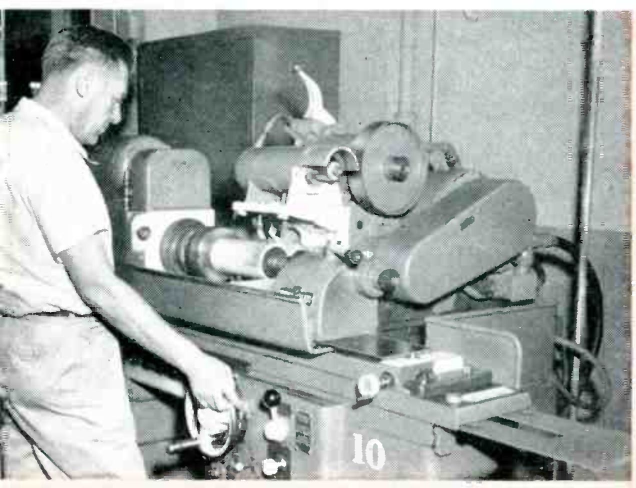
Precision FLATS

These AlSiMag spacers are flat within .0002″ and parallel within .0005″ Thickness tolerance ±.001″. For special applications, flat shapes have been ground to a thickness of .008″.

Precision ROUNDS

These centerless ground AlSiMag shafts are held to diameter tolerances of ±.0002″ and straight within .010, total indicator reading (.005 Camber), in lengths up to 9″.

Our advanced grinding and lapping methods now permit dimensional accuracy formerly considered impossible in technical ceramics.



• If you have a design problem which might be solved by an AlSiMag technical ceramic made to close tolerances, send us your blue print and an outline of your requirements. Our comments and recommendations will be furnished promptly.

AMERICAN LAVA CORPORATION

50TH YEAR OF CERAMIC LEADERSHIP

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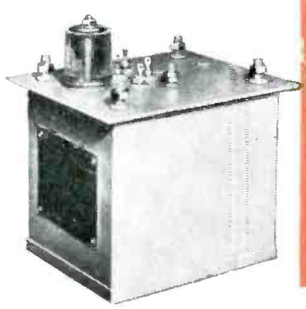
NEW ENGLAND, 38-B Brattle St., Cambridge, Mass Kirkland 7-4498 • ST. LOUIS, 1123 Washington Ave., Garfield 4959

a complete line of hermetically sealed oil-filled

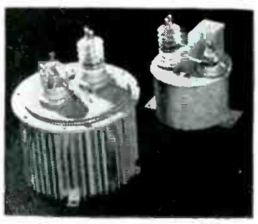
HIGH-VOLTAGE COMPONENTS

Rectifiers

Small, lightweight a-c to d-c power supply units for use with cathode-ray tubes, television camera tubes and radar indicator scopes, electron microscopes, and similar jobs. Typical outputs are 7, 9 and 13 kv. Low regulation—the 7-kv unit illustrated does not exceed 3.5% regulation per 0.1 milliampere load, holds ripple on output voltage to less than 1%. Size, only 6" x 6" x 7"; weight 8 lb.

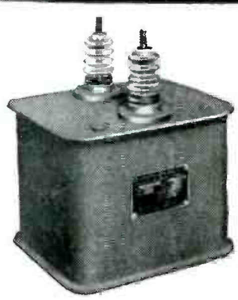


Pulse Transformers



Pulse transformers for use with either hard-tube or line-type modulators. Available in voltage ratings of 10 kv or above. These units are ideal for radar applications, stepping up or down, impedance matching, phase reversing and plate-current measurements. Also suitable for nuclear physics research work, television and numerous special applications in and out of the communications fields.

Resonant Reactors



Resonant-charging reactors, accurately designed and constructed for radar service. Usually required in ratings of 40 kv and below, 1 ampere and below and 300 henries and below. Higher ratings are being built, and can be considered. When required, small- and medium-size designs can be provided with 3 to 1 range of inductance adjustment.

Filament Transformers

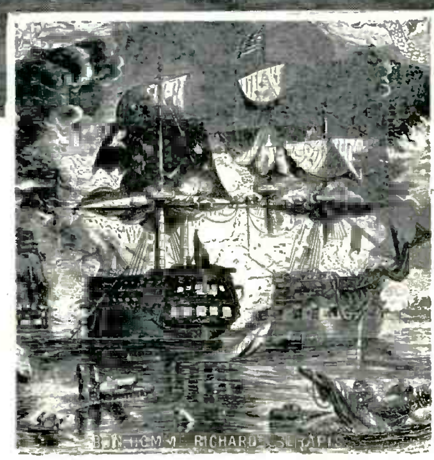
Filament transformers available with or without tube socket mounted integral with the high-voltage terminal. Low capacitance. Ratings to match any tubes; insulated to practically any required level.

Illustrated here are typical high-voltage components manufactured by General Electric. They can be built to meet Armed Services requirements. All are oil-filled and hermetically sealed—with excellent ability to withstand mechanical shocks and to operate continuously for long periods in widely varying temperatures. Apparatus Dept., General Electric Company, Schenectady, N. Y.

Your inquiries will receive prompt attention. Since these components are usually tailored to individual jobs, please include with your inquiry, functional requirements and any physical limitations. *Write to Apparatus Dept., 42-328A, General Electric Co., Pittsfield, Mass.*

GENERAL ELECTRIC

401-63



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"ON TARGET" TODAY

demands split-second mathematics

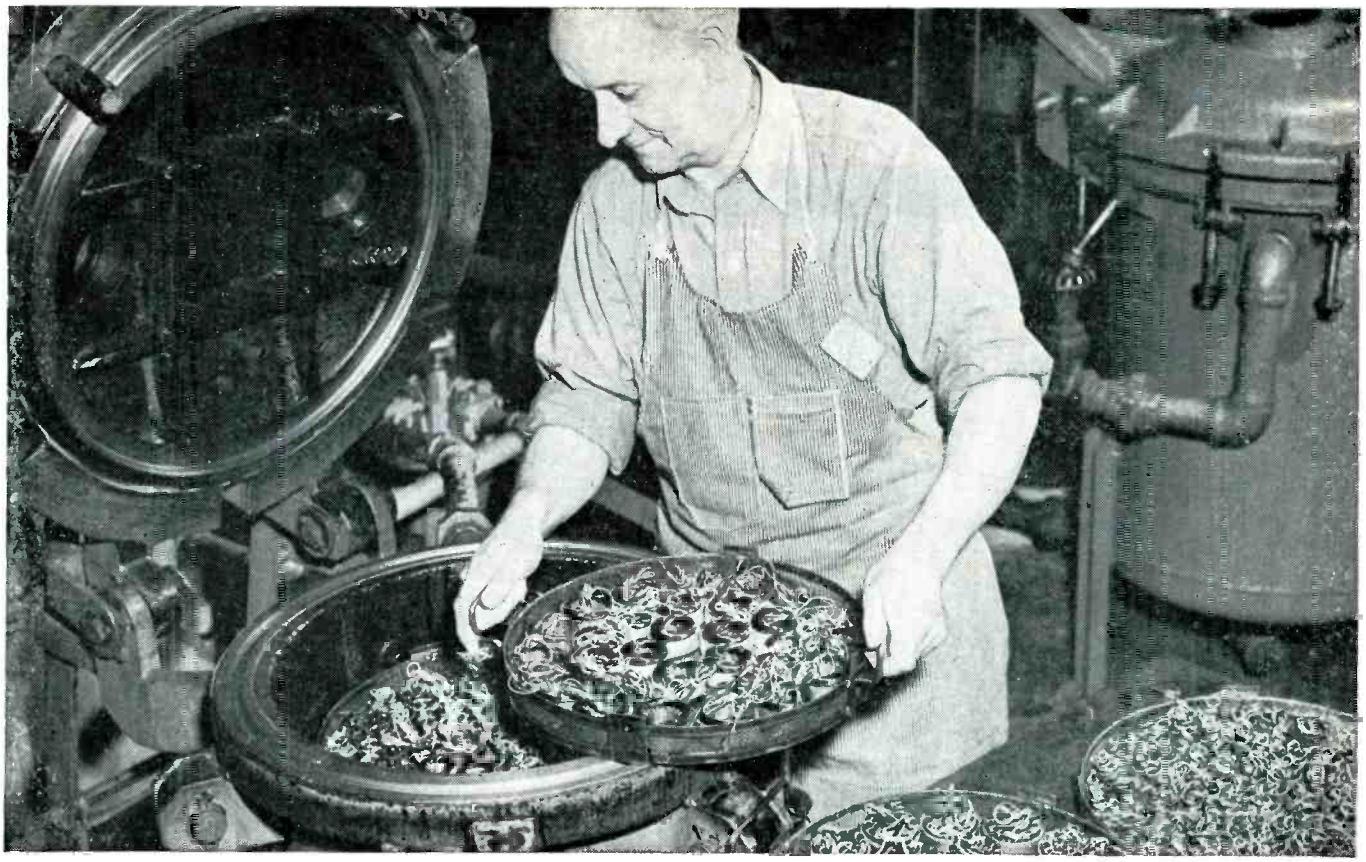
Today's gunnery problems are a far cry from the days of slugging it out at close range. They demand instantaneous solutions to ever-increasing complex factors. Only continuing advance in electronic instrumentation can accomplish this feat. Through years of outstanding engineering design and precision manufacture, Arma leads in this vital supply link to our *nation's Armed Forces.*

QUALITY ARMA INSTRUMENT PRECISION

ARMA CORPORATION

254 36th STREET, BROOKLYN 32, N.Y.

SUBSIDIARY OF AMERICAN BOSCH CORPORATION



For *lasting* insulation strength, Sperry counts on HARVEL 912-C

For more than 10 years, Sperry Gyroscope Company has been insulating coils and other components with Harvel Internal Curing Varnishes, because of their excellent mechanical and electrical properties. Sperry . . . world famous for the quality and performance of its instruments . . . reports these specific advantages from the use of Harvel 912-C, electrical insulating varnish:

1. *High mechanical strength.* Conductors rigidly bonded into a compact mass. No soft, tacky varnish interiors to allow movement of conductors.
2. *High dielectric strength* . . . 2200 vpm. Electrical properties retained at high temperatures—unaffected by oil.
3. *Fast baking time.* 912-C cuts baking schedules as much as 50%—materially reduces production costs.

Sperry also turns to Irvington for Class "H" flexible insulations when space and weight are at a premium. Running safely at temperatures as high as 500°F, these insulations permit using smaller conductors, and thus open the way to lighter, more compact designs. It will pay *you* to investigate these Irvington products—mail coupon today for the full story.

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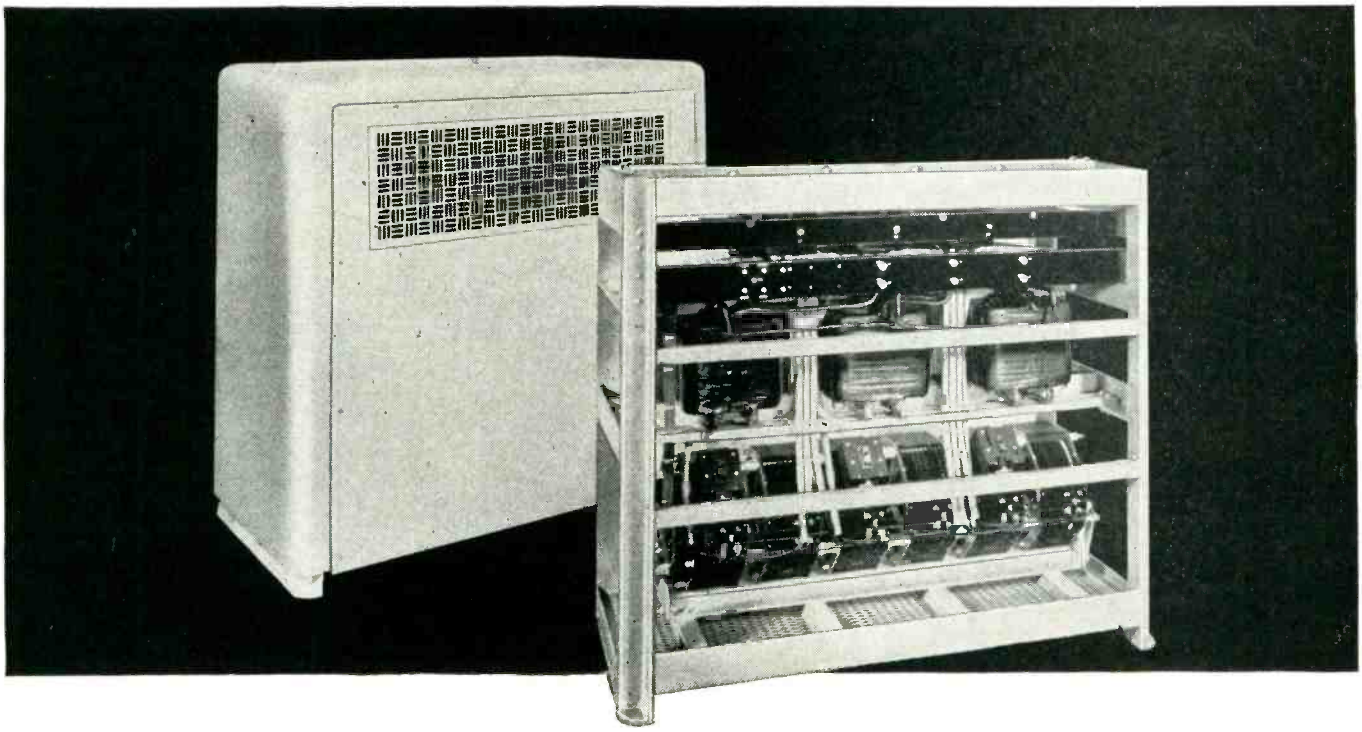


A Tough Transformer Problem Solved with
STEPLESS VOLTAGE CONTROL

Here's a unique problem . . . but the solution illustrates the modern engineering available at Westinghouse to tackle all types of transformer problems.

The application: A transmitter required a d-c power supply of 4,000 volts, variable under full load . . . from plus 10% to minus 40%.

The Westinghouse solution: A combination of a three-phase, dry-type transformer to produce the required 4,000 volts, with a three-phase, buck-boost transformer, and a three-phase, motor-driven powerstat, serving a d-c rectifier. Quality-proven class B insulation and HIPERSIL® cores result in compact, lightweight installation that completely eliminates the need for bulky, oil-immersed, tap-changing equipment.

The main transformer is rated 73 kva, 230 volts delta on the primary, 4,240 volts wye on the secondary. The secondary of the buck-boost is in series with the output of the main transformer, and the powerstat acts to adjust the primary voltage on the buck-boost, so that stepless control of the entire assembly can be achieved under full load of the d-c rectifier. The operator stands in front of the transmitter itself, and raises or lowers the voltage by means of pushbuttons, while he watches the d-c plate voltmeter of the rectifier.

If you have a tough transformer problem, take advantage of the facilities of Westinghouse for quick, practical solutions. Transformers specially designed for all types of electrical and electronic circuits, as well as a wide selection of standardized designs . . . produced in quantity . . . with quality. Call your nearby Westinghouse representative, or write Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.
J-70565

Westinghouse
SPECIALTY
TRANSFORMERS

NEO-SIL CORPORATION

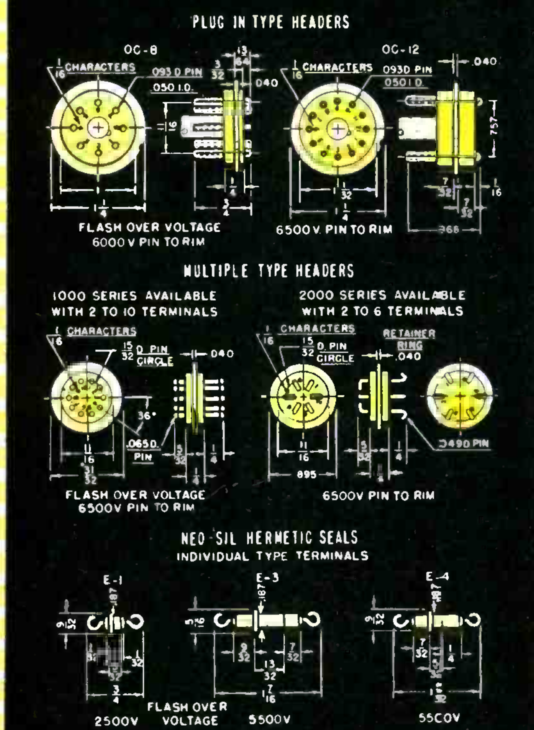
Master Pieces of Hermetic Sealing —Proven to Eliminate Rejects!

E3-LW TERMINAL

"E-Series terminals are applicable on MIL requirements and will withstand thermal shock, vibrations, mechanical strains, and excessive pressures with no impairment of the seal or other functional characteristics. E-3LW terminals are now being used at 1000 psi static oil pressure and undergo 5000 psi tests."

¼" SHAFT WATERSEAL BUSHING

"Rotary Waterseal Panel Assemblies, with GRAF-SIL Packing Glands, have an excellent five year customer history on gas filled pressurized components. They are available for ¼" shafts and for potentiometers and switch bushings."



TEST DATA

The result of the Electrical Testing Laboratories Inc., Report #330655, dated March 18, 1949, on this material shows the following:

Volume Resistivity at 800 Volts d-c

Room Temperature 25°C	R.H. 30 percent
Megohm-inches	*ohm-centimeters*
1.4×10^6	3.5×10^{12}

Dielectric Constant and Dissipation Factor

Dielectric Constant	*Dissipation Factor*	*Loss Factor*
	@ 60 cycles per second	
9.22	.058	5.32
	@ 1 megacycle per second	
6.17	.0455	.28
	@ 50 megacycles per second	
5.35	0.20	1.1

Dielectric Strength at 60 cycles Volts per mil — 370

Durometer Average — 80 ± 5

Temperature — Rated as a Class A material conservatively + 105° to —70° centigrade.

The Flashover Voltages indicated were taken at a temperature of 68° Fahrenheit, and 47% Relative Humidity.

"NEO-SIL's proven Hermetic sealing components will eliminate rejects resulting from breakage, strains, cracks, etc. Each NEO-SIL component is pressure checked at 25 psi — to meet military requirements and as applied to our units, NEO-SIL rubber will resist abusive temperature cycling, salt water, most acids and alkalies, and withstand high pressures and vacuums."

"In addition to the items illustrated above, NEO-SIL offers many other components, such as Hermetically Sealed Fuse Holders, Octal Type Plug In Headers, Multiple Pin Headers, Hermetically Sealed Cables, Hermetically Sealed Line Cords With Plugs For European use, Meter Gaskets, Panel Gaskets, Adapters (U.S. to Continental), Coil Forms, Crystal Contacts and other molded bakelite and NEO-SIL rubber units."

"Hermetically Sealed Fuse Holders are available for 3-AG and 4-AG fuses. These units are completely sealed from moisture with or without the cap or fuse inserted and are applicable for use on vacuum or gas filled units."

Your special problems are solicited.

NEO-SIL CORPORATION

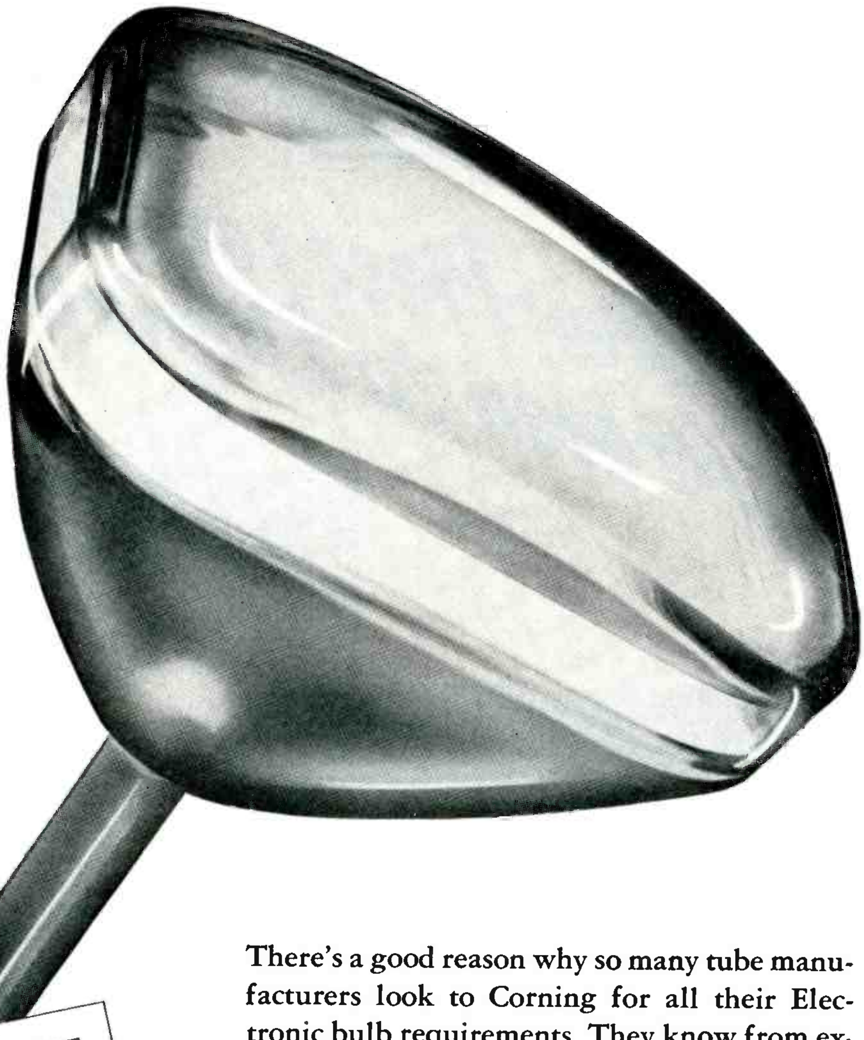
26 CORNELISON AVE., JERSEY CITY 4, N. J.

QUALITY CONTROL

DESIGN ENGINEERING

PRODUCT ENGINEERING

GLASS TECHNOLOGY



There's a good reason why so many tube manufacturers look to Corning for all their Electronic bulb requirements. They know from experience that Corning's technical services will help them maintain maximum production efficiency—that Corning is "at your service" in many ways.

Corning's staff of highly trained and experienced specialists in glass working techniques, quality control, product engineering and design are ready to help solve your tube processing problems. They will work with your production personnel on any problem concerning the use of glass, from detecting operating variables which cause shrinkage to the properties of glass itself.

Complete technical service is but one reason why it pays to do business with Corning—the one source for *all* your bulb requirements.

PYREX T.M. REG. U.S. PAT. OFF.

CORNING GLASS WORKS, CORNING, N. Y.

Corning means research in Glass

ELECTRONIC SALES DEPARTMENT—ELECTRICAL PRODUCTS DIVISION

1851 · 100 YEARS OF MAKING GLASS BETTER AND MORE USEFUL · 1951

MODEL VH-91

FOR HIGH EFFICIENCY SOUND REPRODUCTION

MODEL VH-15

MODEL VH-20

MODEL VH-24

Jensen
Hypex
PROJECTOR

Jensen Hypex Projectors for indoor and outdoor PA and sound reinforcement are highly efficient, sturdy, weather-proof, corrosion resistant loudspeakers with many exclusive advanced features. For example, the Hypex (hyperbolic exponential) flare formula—patent 2,338,262—provides the most effective acoustic loading right down to l. f. cut-off. Special plastic diaphragm driver unit gives powerful reproduction with a "punch"—yet free from unpleasant harshness. And soundly engineered adjustable mounting facilities make installation a pleasure.

JENSEN MANUFACTURING COMPANY
Division of The Muter Company
6601 S. Laramie Ave., Chicago 38, Illinois
Phone; POrtsmouth 7-7600.

Rauland Now Offers The First

LOW FOCUS VOLTAGE ELECTROSTATIC TUBE

Rauland's new low potential electrostatic-focus picture tube is not just a "defense period" substitute but a permanent and major advance in television cathode ray tube development

FOCUSES with D.C. voltage already available from the receiver's power supply.

ELIMINATES focusing coils and magnets—saves critically scarce copper and cobalt.

REQUIRES NO re-engineering of present television chassis . . . **NO** added high voltage focus circuit . . . **NO** added receiver tubes—**NO** additional components except an inexpensive potentiometer.

BETTER in all ways! Not only saves materials but also gives an actual improvement in picture quality because the over-all focus is better . . . and because it is completely stable in focus under considerable variations in voltage.

This new Rauland development is now available in substantial quantities in 17 and 20 inch rectangular tubes. For further information, address . . .

THE RAULAND CORPORATION

Perfection Through Research

4245 N. KNOX AVENUE • CHICAGO 41, ILLINOIS

Never Before!

STABLE DURING EXTREME TEMPERATURE AND HUMIDITY CHANGES—*for* MILITARY USE

Delivers top performance in an unprecedented temperature range from the bitterest cold in arctic regions or extreme altitudes to fiery hot tropical battlefields . . . and in an unparalleled humidity range from complete aridity to the saturation point.

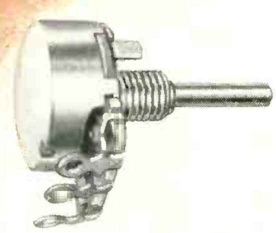
Highly recommended for use in airplanes, tanks, ships, portable or mobile equipment and all other military communications.

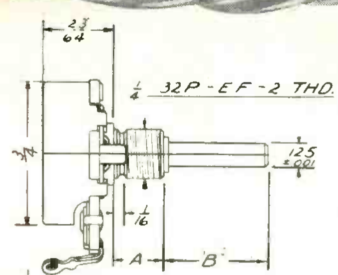
Manufactured from specially developed materials, this absolutely unique variable resistor is available in *miniaturized* size (Type 65) or in conventional size (Type 95) in resistance ranges from 250 ohms to 10 megohms.

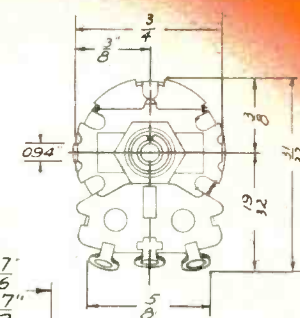
Exceptionally good delivery cycle due to tremendous precision mass production facilities.

Please give complete details on your requirements when writing or phoning for further information.

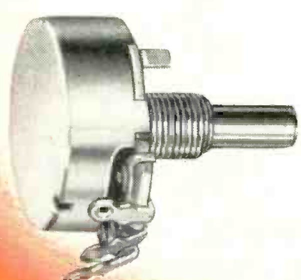
TYPE 65

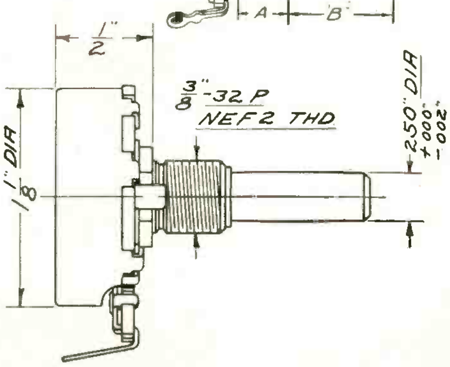


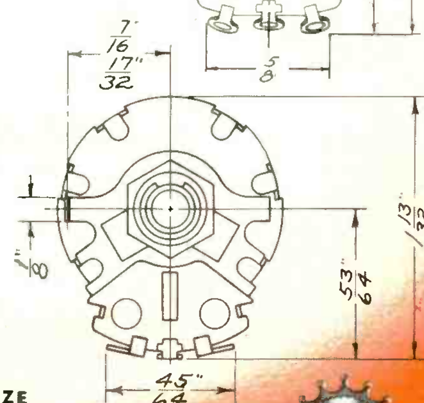




TYPE 95







ILLUSTRATIONS ARE ACTUAL SIZE

A COMPLETE LINE OF VARIABLE RESISTORS (COMPOSITION AND WIRE WOUND) WITH OR WITHOUT ASSOCIATED SWITCH COMBINATIONS

CTS

CHICAGO TELEPHONE SUPPLY
Corporation

ELKHART ★ INDIANA

Specialists in Precision Mass Production of Variable Resistors

FOUNDED 1896

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401 North Broad Street
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Phone: Walnut 2-5369

W. S. Harmon Company
1638 South La Cienega Blvd.
Los Angeles, California
Phone: Axminister 3-6219

IN CANADA

C. C. Meredith & Co.
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SOUTH AMERICA

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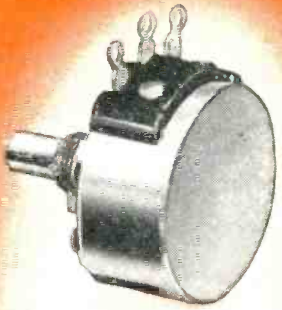
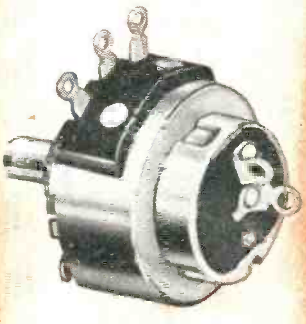
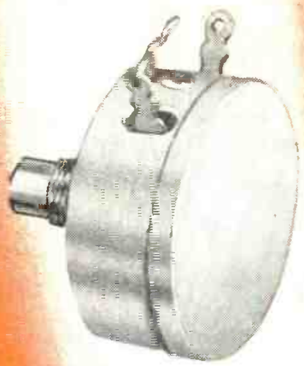


JAN Type RA 20A
2 Watt (CTS Type 252)



JAN Type RA 20B
2 Watt (CTS Type GC-252)



JAN TYPE RA 25A
3 Watt (CTS Type 25)

Meets JAN-R-19

VARIABLE WIRE WOUND RESISTORS TO ALL SPECIFICATIONS IN JAN-R-19

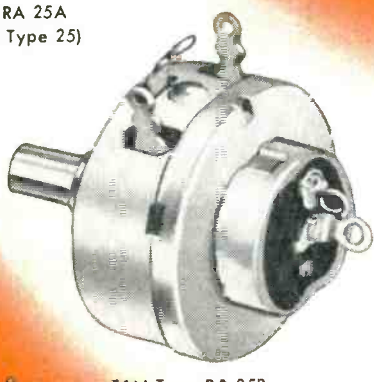
TYPES NOW AVAILABLE

JAN TYPE	CTS TYPE		WATT RATING
RA 20A	252	(without switch)	2
RA 20B	GC-252	(with switch)	2
RA 25A	25	(without switch)	3
RA 25B	GC-25	(with switch)	3
RA 30A	25	(without switch)	4
RA 30B	GC-25	(with switch)	4

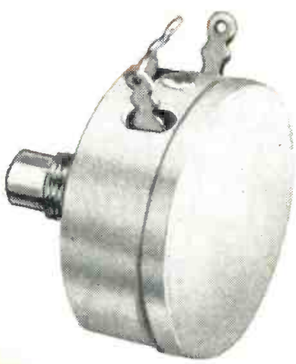
Exceptionally good delivery cycle due to tremendous precision mass production facilities.

Please give complete details on your requirements when writing or phoning for further information.

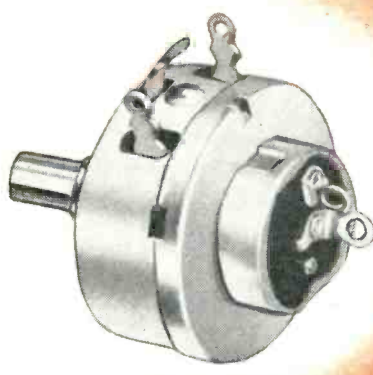
ILLUSTRATIONS ARE ACTUAL SIZE.



JAN Type RA 25B
3 Watt (CTS Type GC-25)



JAN Type RA 30A
4 Watt (CTS Type 25)



JAN Type RA 30B
4 Watt (CTS Type GC-25)

CHICAGO TELEPHONE SUPPLY *Corporation*

ELKHART • INDIANA

REPRESENTATIVES

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Philadelphia 8, Pennsylvania
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Sao Paulo, Brazil

OTHER EXPORT

Sylvan Ginsbury
8 West 40th Street
New York 8, N. Y.

A COMPLETE LINE OF VARIABLE RESISTORS (COMPOSITION AND WIRE WOUND) FOR MILITARY APPLICATIONS:

Specialists in Precision Mass Production of Variable Resistors

FOUNDED 1896

Watch Master

AMERICAN TIME PRODUCTS INC. NEW YORK

Frequency Standards

GUARANTEED ACCURACY 1 part in 100,000 (.001%)

Type 212

TERMINATION
Front and Rear

CONSTRUCTION
Standard 8¾" x 19" Panel

HOUSING
8¾" x 19" x 8" Metal Cabinet

WEIGHT
25 pounds

Uses

Time bases, rate indicators, clock systems, chronographs, geo-physical prospecting, control devices and for running small synchronous motors.

Features

1. **Bimetallic, temperature-compensated fork, no heating or heat-up time is required.**
2. **Fork is hermetically sealed, no barometric effects on frequency.**
3. **Precision type, non-ageing, low coefficient resistors used where advantageous.**
4. **Non-linear negative feedback for constant amplitude control.**
5. **No multi-vibrators used.**
6. **Synchronous clock simplifies checking with time signal.**

Specifications

Accuracy—1 part in 100,000 (.001%).
Temperature coefficient—1 part in 1,000,000 per degree centigrade (or better).
Outputs—

1. **60 cycles, sine wave, 0-110 volts at 0 to 10 watts (adjustable).**
2. **120 cycle pulses, 30 volts negative.**
3. **240 cycle pulses, 30 volts positive and negative. Pulse duration, 100 micro-seconds.**

American Time Products, Inc.,
580 Fifth Ave., New York 19, N. Y.
Gentlemen:
Please send descriptive folder, No. 212

Name..........

Company..........

Address..........

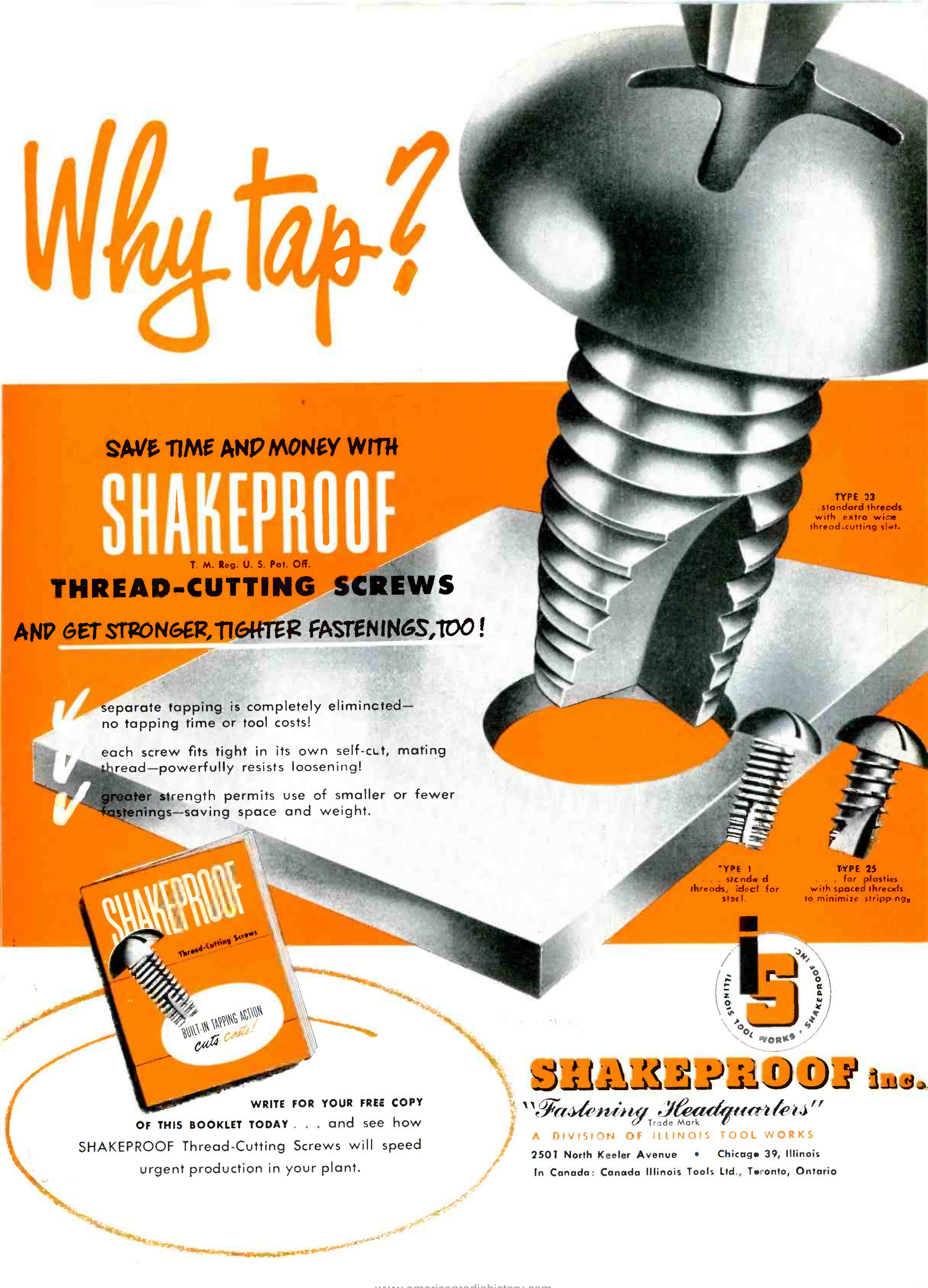
City.......... State..........

product of

AMERICAN TIME PRODUCTS INC.

580 Fifth Avenue **New York 19, N. Y.**

Operating under patents of the Western Electric Company


Why tap?
SAVE TIME AND MONEY WITH
SHAKEPROOF
T. M. Reg. U. S. Pat. Off.
THREAD-CUTTING SCREWS
AND GET STRONGER, TIGHTER FASTENINGS, TOO!
separate tapping is completely eliminated—no tapping time or tool costs!
each screw fits tight in its own self-cut, mating thread—powerfully resists loosening!
greater strength permits use of smaller or fewer fastenings—saving space and weight.
TYPE 23 . . . standard threads with extra wide thread-cutting slot.
TYPE 1 . . . standard threads, ideal for steel.
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BUILT-IN TAPPING ACTION cuts costs!
WRITE FOR YOUR FREE COPY OF THIS BOOKLET TODAY . . . and see how SHAKEPROOF Thread-Cutting Screws will speed urgent production in your plant.
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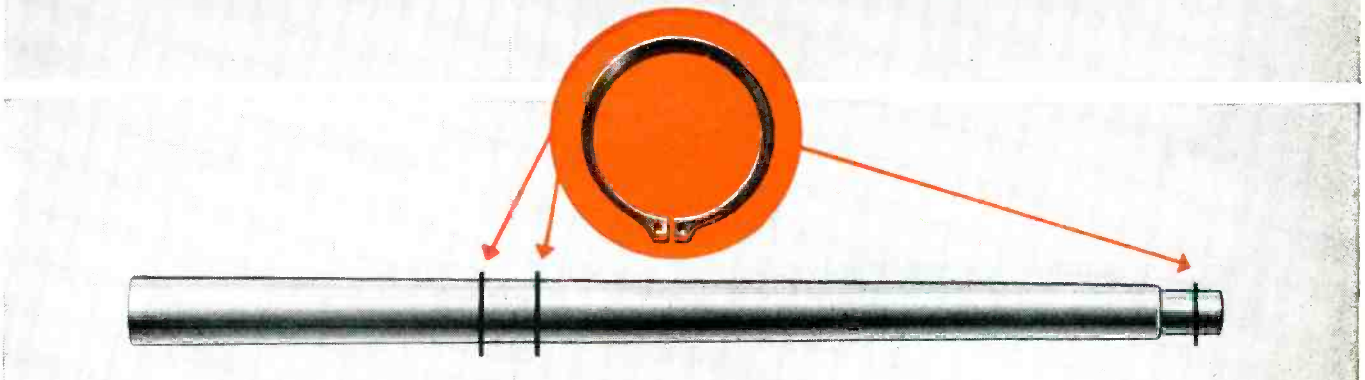
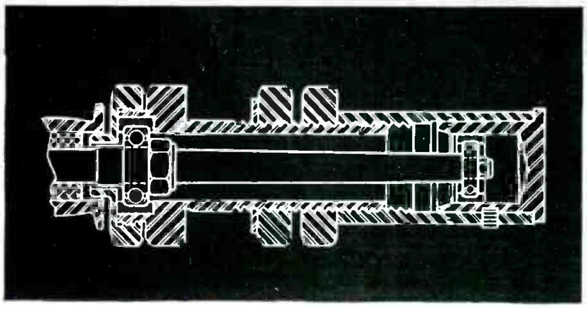
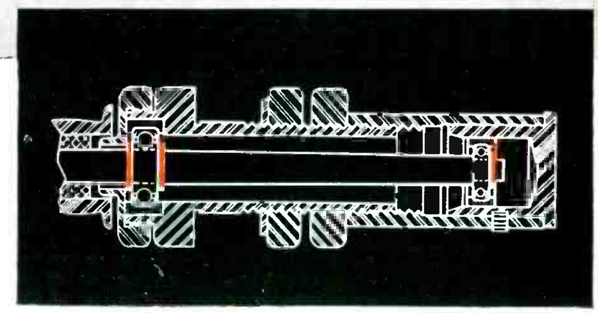
3 TRUARC RETAINING RINGS LOWER COST... IMPROVE PERFORMANCE OF REVOLUTIONARY NEW TEXTILE SPINDLE!





OLD CONSTRUCTION. To position 2 ball bearings, an oversize diameter rod had to be turned on a lathe to provide 3 shoulders. In addition, blade required 2 threading operations . . . 2 lock nuts . . . separate tapering operation. Proper pressure of nuts against ball bearings required skilled labor adjustment.



NEW CONSTRUCTION. Standard rod, equal in diameter to finished blade is used. Three grooves for Truarc Rings and shoulder are made quickly and easily on screw machine. Blade is economically tapered by centerless grinding. Truarc Rings maintain correct pressure on ball bearings for life of unit!

The H & B American Machine Company's new anti-friction CENTURY spindle is probably the most mechanically advanced spindle on the market today. Waldes Truarc Retaining Rings have eliminated many of the material, tooling and assembly costs...have kept its price competitive. Truarc Rings not only simplify spindle assembly, they position ball bearings accurately...simplify maintenance...eliminate skilled labor...improve performance! And there are Truarc Rings to solve any design or re-design problem!

Redesign with Truarc Rings and you too will cut costs.

Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Truarc Rings are precision-engineered...quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

Waldes Truarc Retaining Rings are available for immediate delivery from stock, from leading ball bearing distributors throughout the country.

SEND FOR NEW BULLETINS

WALDES

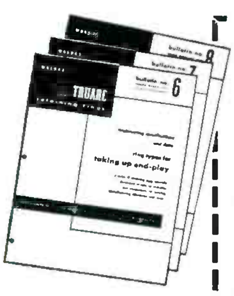
TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

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

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY THE FOLLOWING PATENT NUMBERS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; AND OTHER PATS. PEND.



Waldes Kohinoor, Inc., 47-16 Austel Place E073
Long Island City 1, N. Y.

Please send Bulletins 6, 7 and 8—giving engineering specifications for all types of Waldes Truarc Rings.

Name________

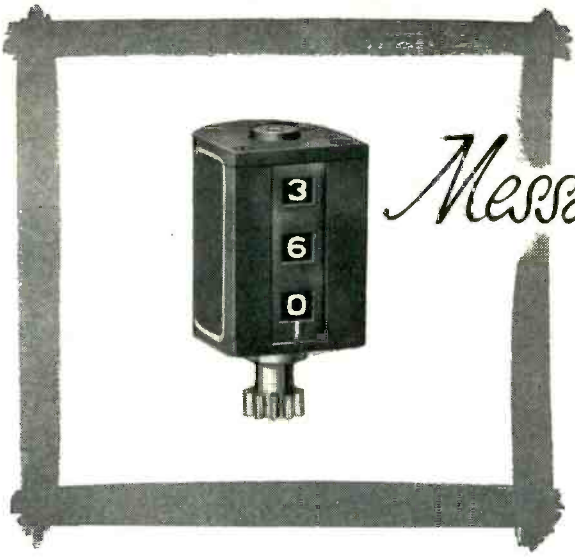
Title________

Company________

Business Address________

City______ Zone____ State______

678

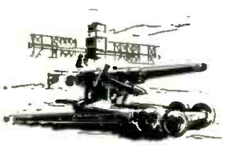


Messages or Missiles . . .

. . . the men who dispatch them count on Veeder-Root . . .

. . . in fact . . .

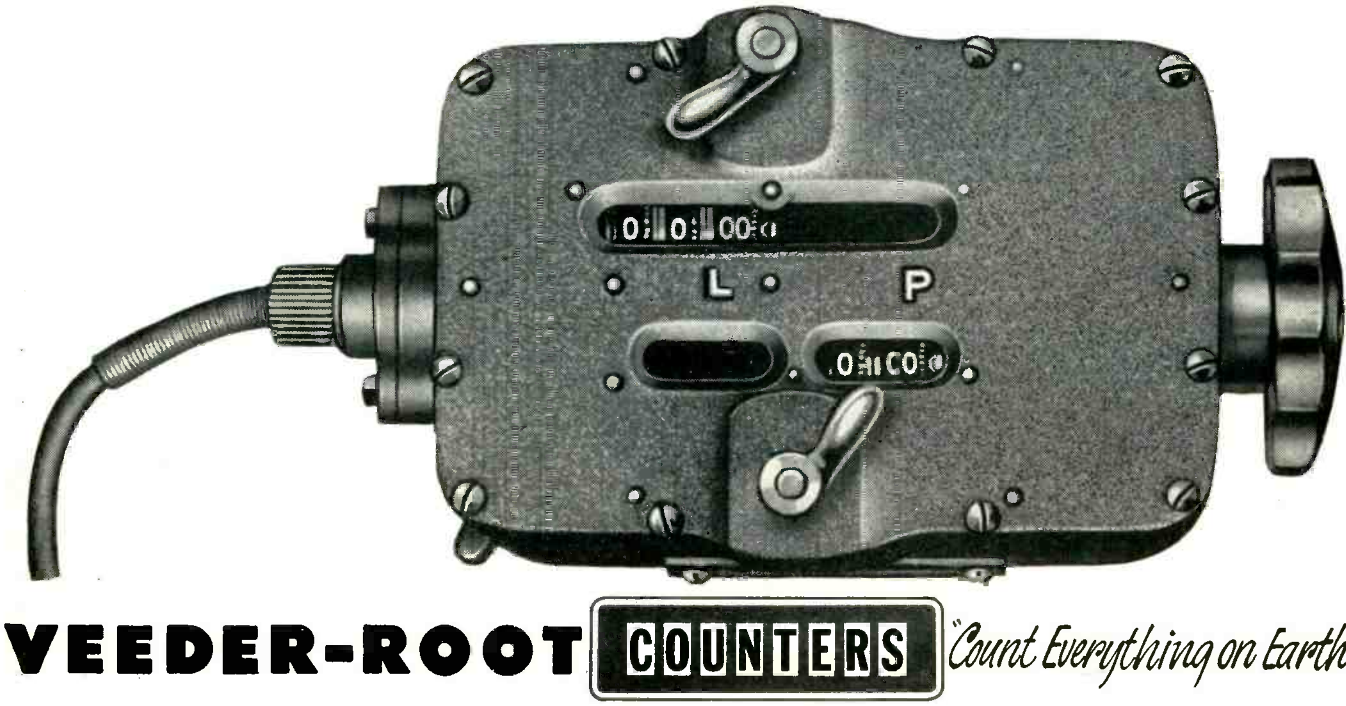
Everyone Can Count on VEEDER-ROOT



Radar, communications, gunfire *Count*rol . . . and many other military "musts" . . . count on Veeder-Root Counters for dependable, continuous Facts-in-Figures. Never mind how. Just count on it that the job is being done . . . right up "to the nines."

If *anything* is worth keeping track of, then you can count on Veeder-Root to do the job as it needs to be done . . . within the limitations of defense production, of course.

VEEDER-ROOT INC.
HARTFORD 2, CONN. • GREENVILLE, S. C.
Montreal, Canada Dundee, Scotland
Offices and agents in principal cities



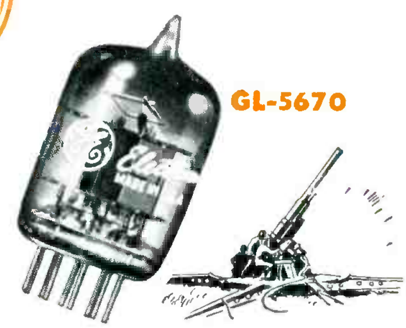
VEEDER-ROOT COUNTERS *"Count Everything on Earth"*

TV DESIGNER'S DEFENSE PROBLEM

"Can standard receiving tubes be specified for military electronic equipment?"

GL-5654

In some cases, no. But all General Electric 5-STAR TUBES are on the Armed Services' Preferred List. They're the last word in dependability! *Every 5-Star Tube* gets 48 hours' service at the factory under Class A conditions. Frequent life tests also are made. During manufacture, 5-Star Tube parts are inspected individually prior to careful and precise hand-assembly.



GL-5670

That new military circuit you've been asked to design, will do its task better—*far more reliably*—with G-E 5-Star Tubes to help assure steady performance under fire. You have nine types to choose from, covering a wide range of applications. Other types will be added later. They will further extend G-E 5-Star usefulness.

Aviation—for which 5-Star Tubes originally were developed—pays enthusiastic tribute to the job these special G-E tubes have done in making airborne travel safer. Now General Electric offers the same fine tube performance to *you*, so that equipment you're designing may approach absolute standards of reliability— may meet stiff military performance requirements. Fill out, clip, and mail the coupon below! *Electronics Department, General Electric Company, Schenectady 5, New York.*

GL-5686

GL-5654	Sharp-cutoff r-f pentode
GL-5670	H-f twin triode
GL-5686	Beam power amplifier
GL-5725	Dual-control sharp-cutoff r-f pentode
GL-5726	Twin diode
GL-5749	Remote-cutoff r-f pentode
GL-5750	Pentagrid converter
GL-5751	High-mu twin triode
GL-5814	Medium-mu twin triode

General Electric Company—Section 4,
Building 267—Schenectady 5, N. Y.

☐ Please mail me the facts about G-E 5-Star Tubes—their performance characteristics; how they are manufactured, how tested.

☐ Please have a tube engineer call on me, to discuss G-E 5-Star Tubes and their applications in circuits I am designing.

NAME.. COMPANY..................................

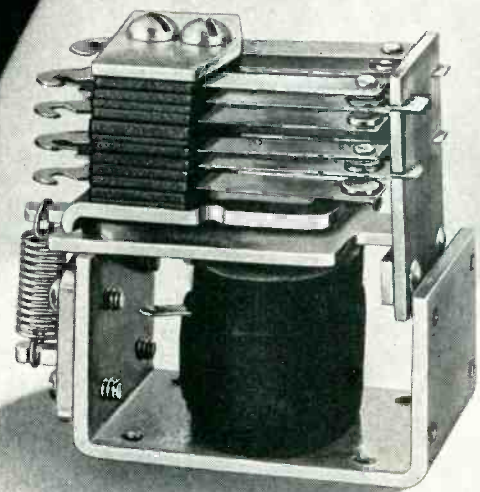
STREET ADDRESS................................ CITY, STATE..............................

GENERAL ELECTRIC

181-K3

PEAK

IN POWER VERSATILITY QUALITY PERFORMANCE



TYPE PK RELAY

HERE ARE THE FACTS AND FIGURES:

CONTACTS: 10 amp. standard. 24 volts D.C., 115 volts A.C.
15 amp. contacts available.

SENSITIVITY: D.C.: 4 pole 1.5 watts
2 pole .7 watts
A.C.: 4 pole 5 volt amperes
2 pole 2.5 volt amperes
Can also be furnished in 6 pole AC and DC up to 4000 Ohms.

COIL: To 115 volts D.C., 230 volts A.C.

NOMINAL HEAT RISE: D.C. 30°C above room ambient
A.C. 45°C above room ambient

MAX. INPUT FOR 85° RISE: D.C. 5 watts
A.C. 11 volt amperes

MOUNTING: Base or end mounting

WEIGHT: 4.5 oz. 4 P.D.T.

WEIGHT HERMETICALLY SEALED: 7.7 oz.

DIMENSIONS: Open Relay—2 1/16", 1 1/8", 2 1/16"
Sealed Relay—3 1/8", 1 1/2", 2 5/16"
Overall Mounting Flange—3 1/8"
Center to Center Mounting Holes—2 11/16"

A Quality Relay

The new Allied PK Relay is designed to offer versatility in a power relay where quality and low cost are factors. Besides stability in operation its reliability allows a range in applications from high quality instruments to vending machines. The PKU relay will comply with Underwriters' Laboratories requirements and can also be supplied hermetically sealed.

Bulletin PK gives complete details. Send for your copy today.

Be sure to send for your copy of Allied's Relay Guide. It gives the engineering data for 27 Allied relays in a concise tabular form for easy reference.

AL-143

ALLIED CONTROL COMPANY, INC. 2 EAST END AVENUE, NEW YORK 21, N.Y.

GOT A HOOK-UP PROBLEM?

Then you'll want to know about "Synkote"® wire

W-H-Y???

Well, right off the bat, there's the fact that many types of Synkote Hook Up Wire are approved constructions, conforming to JAN-C-76. SO . . . they fit right into a big share of the jobs that the electronics industry is working on today.

Or you can pick other constructions for special requirements. If yours is a "hot spot" application, for instance, use Synkote wire that carries UL approval for continuous operation at 105°C.

You can get Synkote wire in all the sizes used in electronic applications; with nylon jacketing or with woven glass, rayon or cotton braid; with shielding to meet any requirements; with one, two or three color stripes in addition to the full standard color coded line.

And of course, *all* constructions give you *all* the advantages for which Synkote thermoplastic insulation has long been famous. Almost complete imperviousness to water, acids, alkalies, oils, sunlight, heat, cold, fungus growths. Exceptional resistance to abrasion, flexing and tearing. *Naturally*, high dielectric strength and low dielectric leakage!

Other Synkote Products

AIRCRAFT CABLE

COAXIAL CABLE

TV WIRE

MULTI-CONDUCTOR CABLE

Engineering Service

Just tell us your requirements in electronic wiring. We'll be glad to help you select, from the comprehensive Synkote line, the type of insulated conductor that best meets your needs. And we're prepared, on short notice, to engineer new designs to fit your problem — and to produce them in practically any quantity.

Worth looking into, isn't it? Mail coupon for full information.

PLASTOID Corporation

42-61 24th Street, Long Island City 1, N.Y.

PLASTOID CORPORATION, Dept. E
42-61 24th Street • Long Island City 1, N. Y.

Gentlemen:

Please send me additional information on Synkote Hook Up Wire Type ....

Name ....

Company ....

Address ....

City .... State ....

Again a

D-H ALLOY

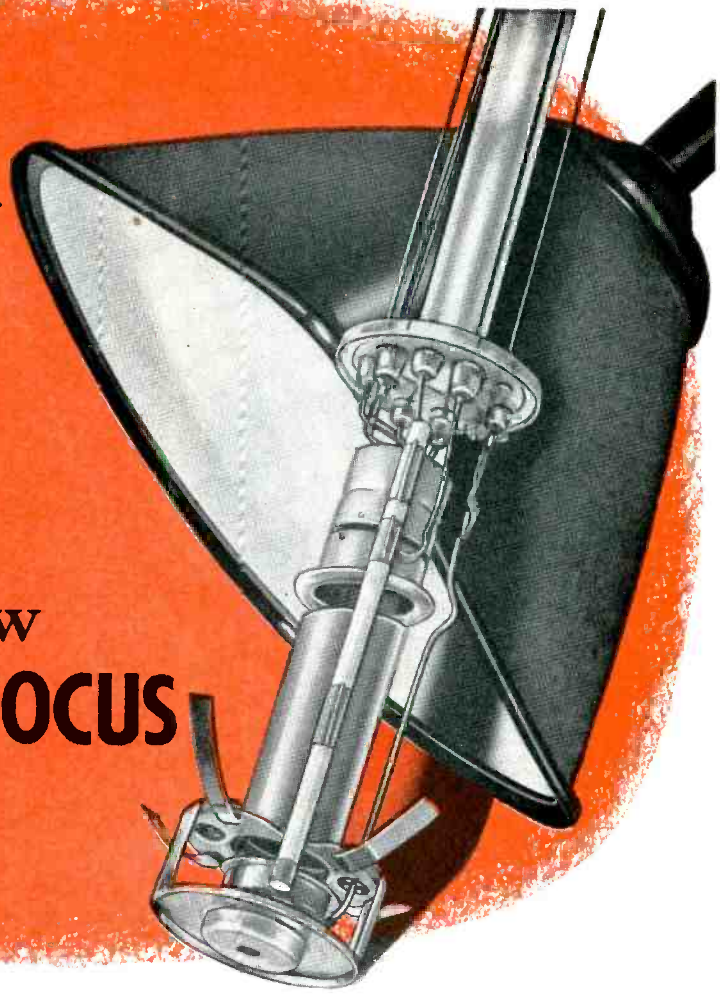
contributes as

RCA

introduces new

ELECTROSTATIC-FOCUS

TV TUBES



Once more, RCA leads the field! This time, with new rectangular picture tubes which require no focusing coil or focusing magnet . . . thus effecting important savings in critical materials.

The currently used magnetic focus in TV sets requires coils and magnets containing the metals cobalt and copper . . . both on the Government's restricted list.

To meet the shortages, RCA engineers have developed improved electrostatic focusing for wide-deflection-angle TV tubes—eliminating need for a focusing magnet or coil. Result: The new RCA kinescopes—which not only make possible savings in critical materials, but introduce advantages that destine them to become industry's most widely used picture tubes.

Such advantages, for example, as: (a) An improved electron gun which provides excellent uniformity of focus over the entire picture area, and is so designed that the focusing electrode takes negligible current—permitting voltage for the electrode to be supplied easily and economically; (b) Focus automatically maintained with variation in line voltage and adjustment of picture brightness; (c) Simplification of tube installation and adjustment for optimum performance.

When RCA produced its outstanding Image Orthicon, "eye" of the television camera, it called upon the superlative Driver-Harris radio alloy Nichrome* V to provide 95% of the metal components of the tube. Now, in the case of the kinescopes, a Driver-Harris produced alloy fills a need.

Here are typical examples of how Driver-Harris stands ready to serve all industry with alloys necessary for new or standard applications.

During the present emergency, of course, strategic materials and the alloys made from them are on strict allocation. However, we shall be glad to make recommendations based upon your specific needs, and serve you to the best of our ability.

Makers of world-famous Nichrome and over 80 other alloys for the electronic, electrical and heat-treating fields*

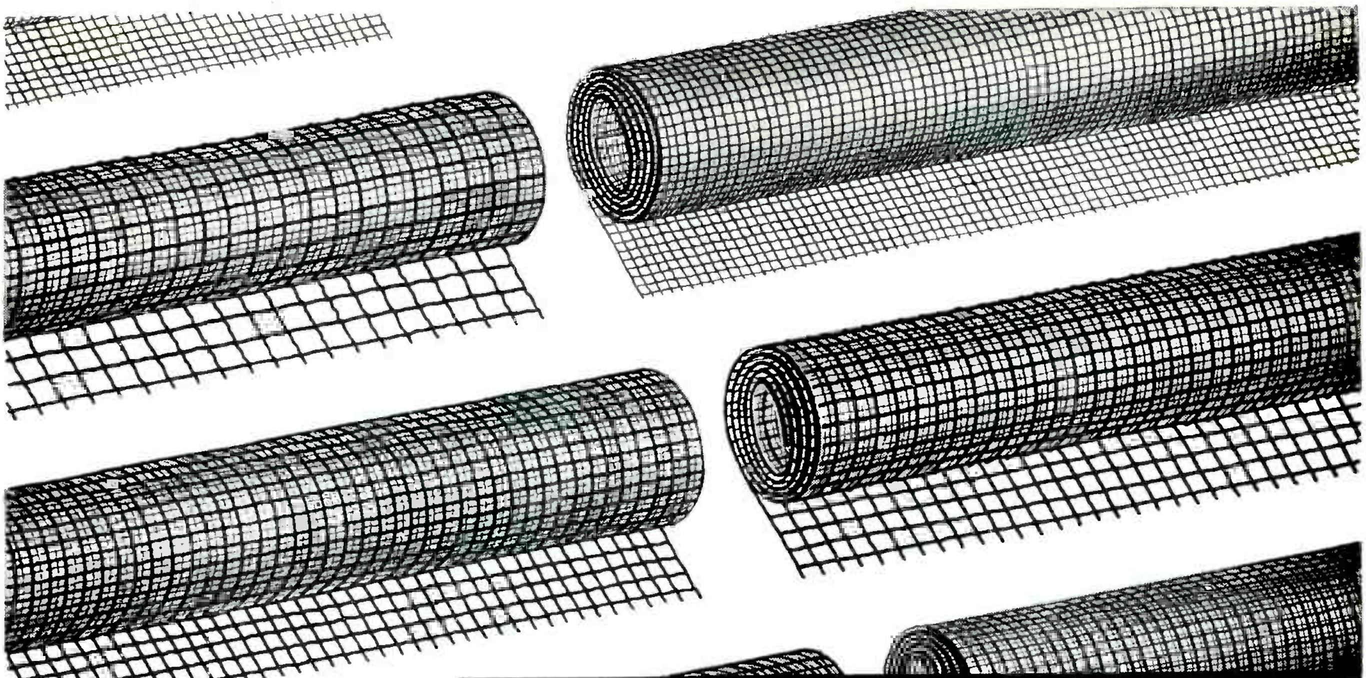
Driver-Harris Company

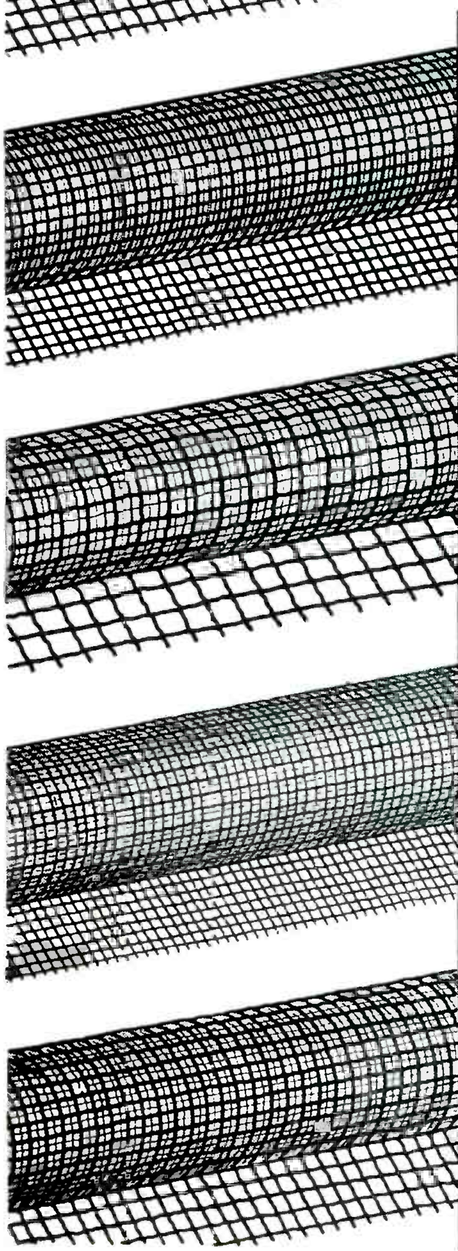
HARRISON, NEW JERSEY

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

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

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





BRASS AND COPPER WIRE CLOTH

Have you a "DO" order?

When you need Industrial Wire Cloth or Strainer Cloth for a Defense Order, your nearest Chase Warehouse is the place to inquire for it.

Chase Brass and Copper Wire Cloth is available in meshes from No. 2 to No. 100 and in varying gauges for a wide variety of industrial uses. The mesh is uniform and the wires double crimped to keep openings square and true.

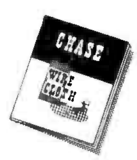
One of the 23 Chase Warehouses or the four Chase Sales Offices will give you full information on the type of wire cloth best suited for your production problem. Send the coupon below for free Chase book describing the full line of Chase Brass and Copper Wire Cloth.

Chase BRASS & COPPER

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

• *The Nation's Headquarters for Brass & Copper*

Albany†	Chicago	Denver†	Kansas City, Mo.	Newark	Pittsburgh	San Francisco
Atlanta	Cincinnati	Detroit	Los Angeles	New Orleans	Providence	Seattle
Baltimore	Cleveland	Houston†	Milwaukee	New York	Rochester†	Waterbury
Boston	Dallas	Indianapolis	Minneapolis	Philadelphia	St. Louis	(† sales office only)



FREE Chase Book lists mesh, diameter of wire, per cent of open area, weight and other important data.

Chase Brass & Copper Co., Dept. EL751
Waterbury 20, Conn.
Please send me your FREE book on Chase Brass & Copper Wire Cloth.

Name____________________________

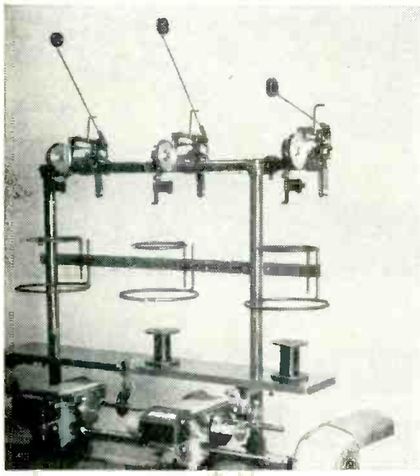
Position____________________________

Firm____________________________

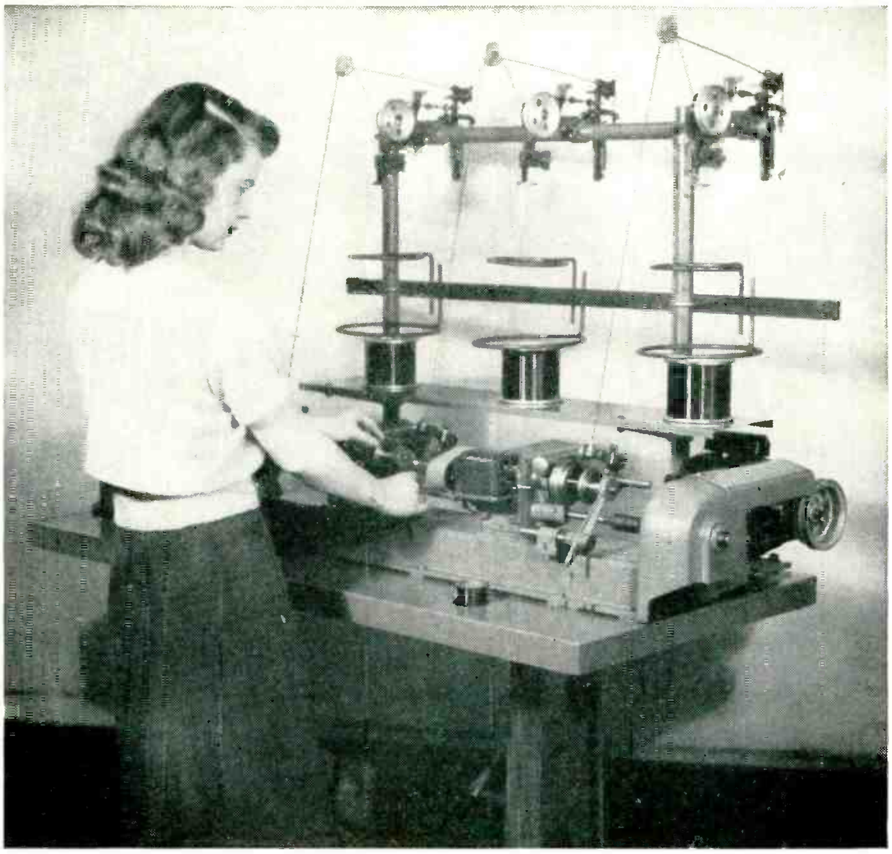
Address____________________________

City______________________State__________

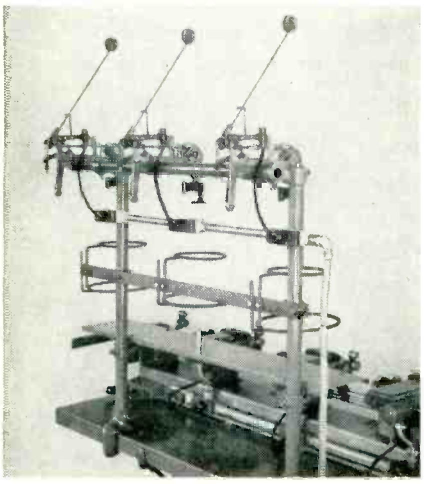
NON-INSULATED COILS WOUND AT 5000 RPM



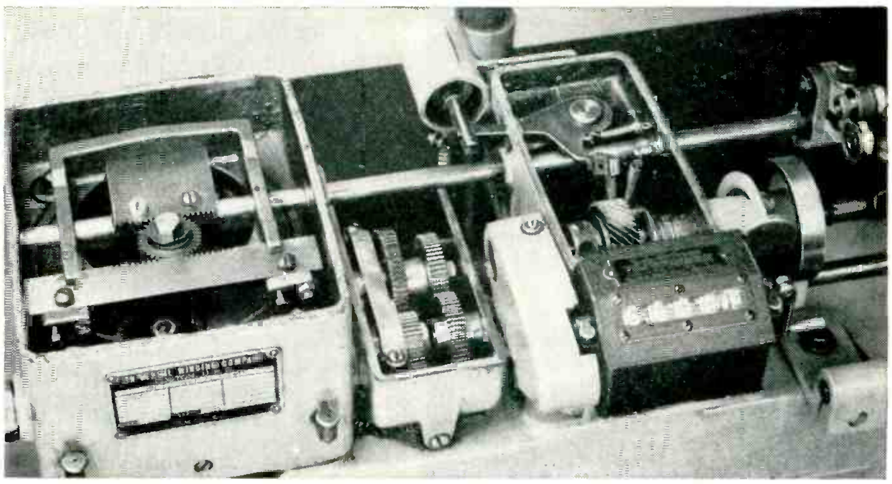
WINDING STARTS INSTANTLY WITHOUT DANGER OF WIRE BREAKAGE with the over-end tension. The first turn can be started tightly against the spool or bobbin head, improving "lay".



WHEN OPERATOR FINISHES manual procedure on one head, another coil will have just been completed. By synchronizing winding and handling time on the No. 102 Universal Hi-Speed Coil Winder, you get maximum production per operator. Coils up to 15,000 turns can as a rule be handled efficiently on a 3-head machine at a maximum of 5000 rpm.



WIRE BREAKAGE DETECTOR is optional equipment for stopping arbor promptly when wire breaks or runs out. This relieves operator of having to watch wire spool continually and prevents counting of turns when wire is not being wound.

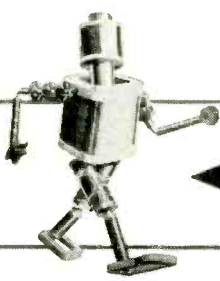


READILY-ADJUSTABLE TRAVERSE MECHANISM permits winding any length of coil from 1/16 in. to 2 13/16 in. without changing cams. A single setting applies to all the winding heads.

Write for Bulletin 102-H

UNIVERSAL WINDING COMPANY

P. O. Box 1605, Providence 1, R. I.



LEESONA ®

For winding coils in quantity accurately . . . automatically use Universal Winding Machines

238.1.1

Lapp

GAS-FILLED CONDENSERS

More than 15 years service on thousands of Lapp Gas-Filled Condensers proves them to be completely reliable—electrically and mechanically. They offer the advantages of extreme compactness for high voltage and high current ratings... low loss... high safety factors... puncture-proof design... constant capacitance under temperature variation.

In construction, the condenser assembly is supported on a top aluminum ring, the steel tank serving only as a support for this ring and as a leak-proof gas container. The high potential plates are stationary, carried on a rigid aluminum center stud, supported by a ceramic bowl. Rotor plates are grounded, carried on ball-bearings in a race almost the full diameter of the tank. This construction provides a grounded tuning shaft on variable models, makes possible efficient and complete water cooling for high current operation, and results in direct and short current paths to condenser plates.

Write for complete description and specifications. Radio Specialties Division, Lapp Insulator Co., Inc., Le Roy, N. Y.

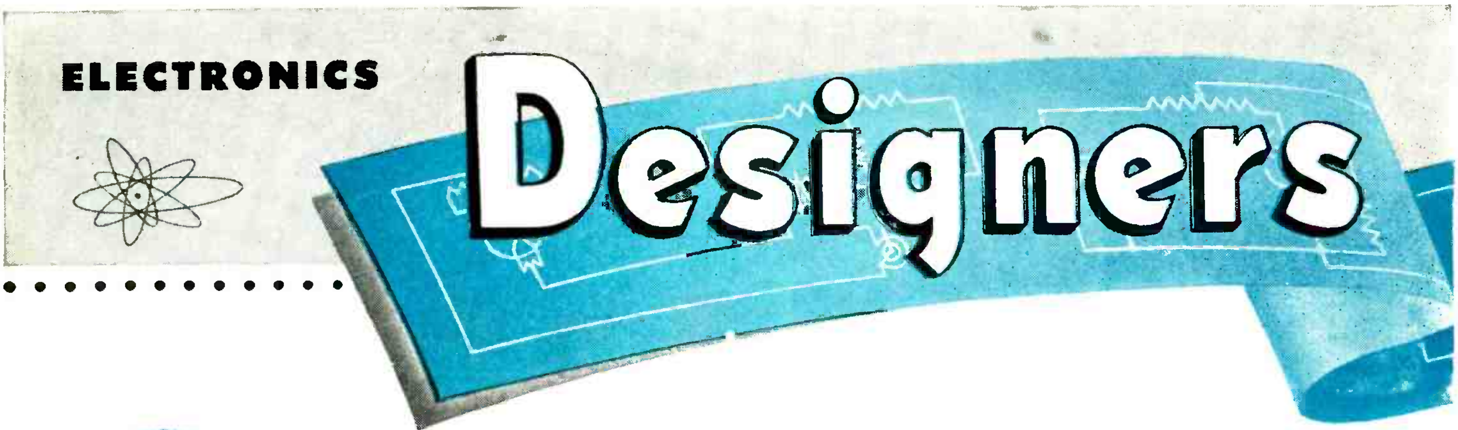
MODEL 24 IF
Fixed only
Capacitances up to 60,000 mmf.; 1 mc. current ratings: 175, 350, 525 amps.; Safety gap settings: 14, 25, 38 Kv peak.

MODEL 18 R—*Fixed or Variable*
MODEL 18 I—*Variable only*
MODEL 18 IF—*Fixed only*
Capacitances up to 30,000 mmf.; 1 mc. current ratings: 120, 240, 360 amps.; Safety gap settings: 6, 14, 25, 38, 50, 63, 72 Kv peak.

MODEL 12 R—*Fixed or Variable*
MODEL 12 IF—*Fixed only*
Capacitances up to 15,000 mmf.; 1 mc. current ratings: 105, 210, 315 amps.; Safety gap settings: 6, 14, 25, 38, 50, 63 Kv peak.

MODEL 9 R
Fixed or Variable
Capacitances up to 8000 mmf.; 1 mc current ratings: 85, 170, 255 amps.; Safety gap settings: 6, 14, 25, 38, 50 Kv peak.

MODEL 7 R
Fixed or Variable
Capacitances up to 8000 mmf.; 1 mc. current ratings: 70, 140, 210 amps.; Safety gap settings: 2½, 6, 14, 25, 38 Kv peak.

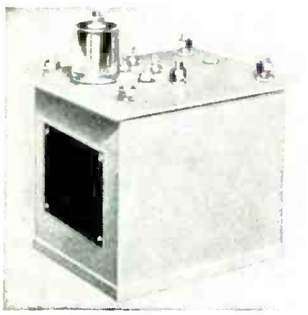


OIL-FILLED, HERMETICALLY SEALED, COMPACT

HIGH VOLTAGE COMPONENTS

- **Withstand Mechanical Shocks**
- **Operate Continuously for Long Periods in Widely Varying Temperatures**

Available in a wide range of ratings, high-voltage components shown here are typical of units manufactured by General Electric for applications 5000 volts and above where corona must be held to a minimum. They represent many years of experience in meeting Armed Services requirements, and can be built for today's military specifications. Because these components are usually tailored for each job, please include functional requirements and any physical limitations with your inquiry. Write to *43-328A, General Electric Company, Pittsfield, Mass.*

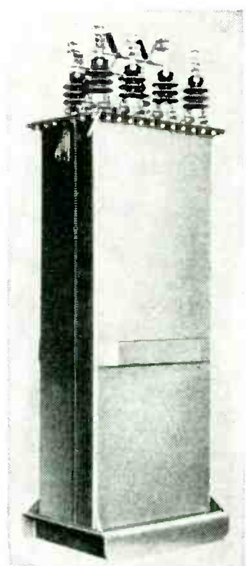


RECTIFIERS—A-c to d-c power-supply units especially built for precision work where unusually low regulation, light weight, and small size are necessary. Typical outputs available are 7, 9, and 13 kv. Illustrated 7-kv unit measures 6 x 6 x 7 in., weighs 8 lb.

PULSE TRANSFORMERS—For use with either hard-tube or line-type modulators. Available in peak-voltage ratings from 10 to 100 kv or higher; peak-power ratings up to 30,000 kva or more. Designed for operation on pulse durations from 0.1 to 20 microseconds at rates up to 4000 pps.

RESONANT REACTORS—Accurately designed and built for radar service. Currently available in peak operating voltages from 5 to 45 kv, current ratings up to 2.25 amp. Higher ratings can be provided. Inductance ratings ranging from 0.25 to 300 henrys remain constant within 5 percent at above 50 percent load current.

FILAMENT TRANSFORMERS—For special applications or for use with standard high-voltage rectifier tubes. Supplied with or without tube socket mounted integrally with high-voltage terminal. Insulated to nearly any required level.



MODULATION TRANSFORMERS—High-fidelity, low-phase shift, Pyranol* or oil-modulation transformers and reactors for high-power AM transmitters are available as integral or separate units. Highly developed designs in ratings from 3.5 to 500 kw provide wide transmission frequency range, keep down harmonic-voltage insertion. Low phase shift gives flexibility and range.

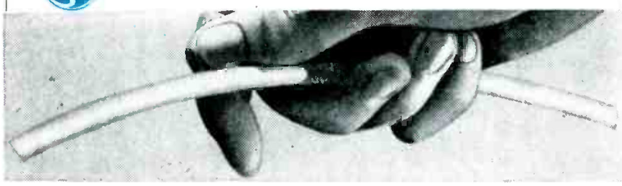
*Reg. TM of General Electric Co.

GENERAL ELECTRIC

667-16

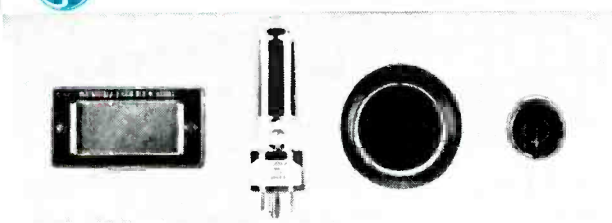
TIMELY HIGHLIGHTS ON G-E COMPONENTS

DELAY LINES—ORDER IN BULK, CUT OFF AS MUCH AS YOU NEED



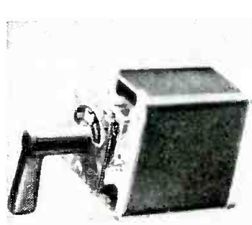
Signals with band widths up to 2 megacycles can be delayed from 0.25 to 10 microseconds. Available in lengths up to 100 ft. Delay equals approximately ½ microsecond per foot. Characteristic impedances of 1100 and 400 ohms per foot are available. By ordering in bulk, lengths can be cut to fit specific needs. Can be bent into 4-inch diameter coils. Uses include research and development of special circuits for electronic devices. See Bulletin GEC-459 for further information.

PHOTOVOLTAIC CELLS—MINIATURE POWER PLANTS



For accurately detecting, controlling, and measuring light and for detecting and measuring even the smallest variations in colors. These cells are especially useful where long life and stability are required or where electronic amplifiers are not practical. Available in a new hermetically sealed series with standard mounting and a wide variety of unmounted sizes. More G-E photovoltaic cells than any other make are used in scientific instruments. Characteristics, dimensions, circuits, and technical data are available in Bulletin GEC-690.

TRANSFER AND CONTROL SWITCH—OVER 10,000 POSSIBLE COMBINATIONS



Built for reliability and long service life, the G-E Type SB-1 transfer and control switch can be used for more than 10,000 possible circuit-sequence combinations. Precision construction permits as many as 40 stages—four banks of ten stages each—to be operated in tandem. Switches with up to 16 stages and 12 positions are commonly furnished. Ratings go up to 20 amp at 600 volts a-c or d-c. Standard components are interchangeable. Complete description in Bulletin GEA-4746.

SELENIUM RECTIFIERS

. . . HIGH-VOLTAGE UNITS HAVE LIFE EXPECTANCY OF OVER 60,000 HOURS

Now available from General Electric, these 26-volt RMS selenium rectifier cells have a continuous-service life expectancy of over 60,000 hours. Their initial forward resistance is very low and samples tested after 10,000 hours of operation show an average resistance increase of less than 6 per cent.

The high-voltage output means that stacks made up of these units are about 25 percent smaller than is possible with 12-volt cells. Low resistance means cooler operation and the space saving that goes with it.

If your application calls for compact selenium stacks for use in cramped quarters, these cells provide the solution. Stacks made with the new G-E cells may be obtained with rated outputs from 18 to 126 volts d-c at 0.15 to 3.75 amp. Check Bulletin GEA-5280.

General Electric Company, Section A667-16
Schenectady 5, N. Y.

Please send me the following bulletins:

(√) Indicate for reference only

(x) For planning an immediate project

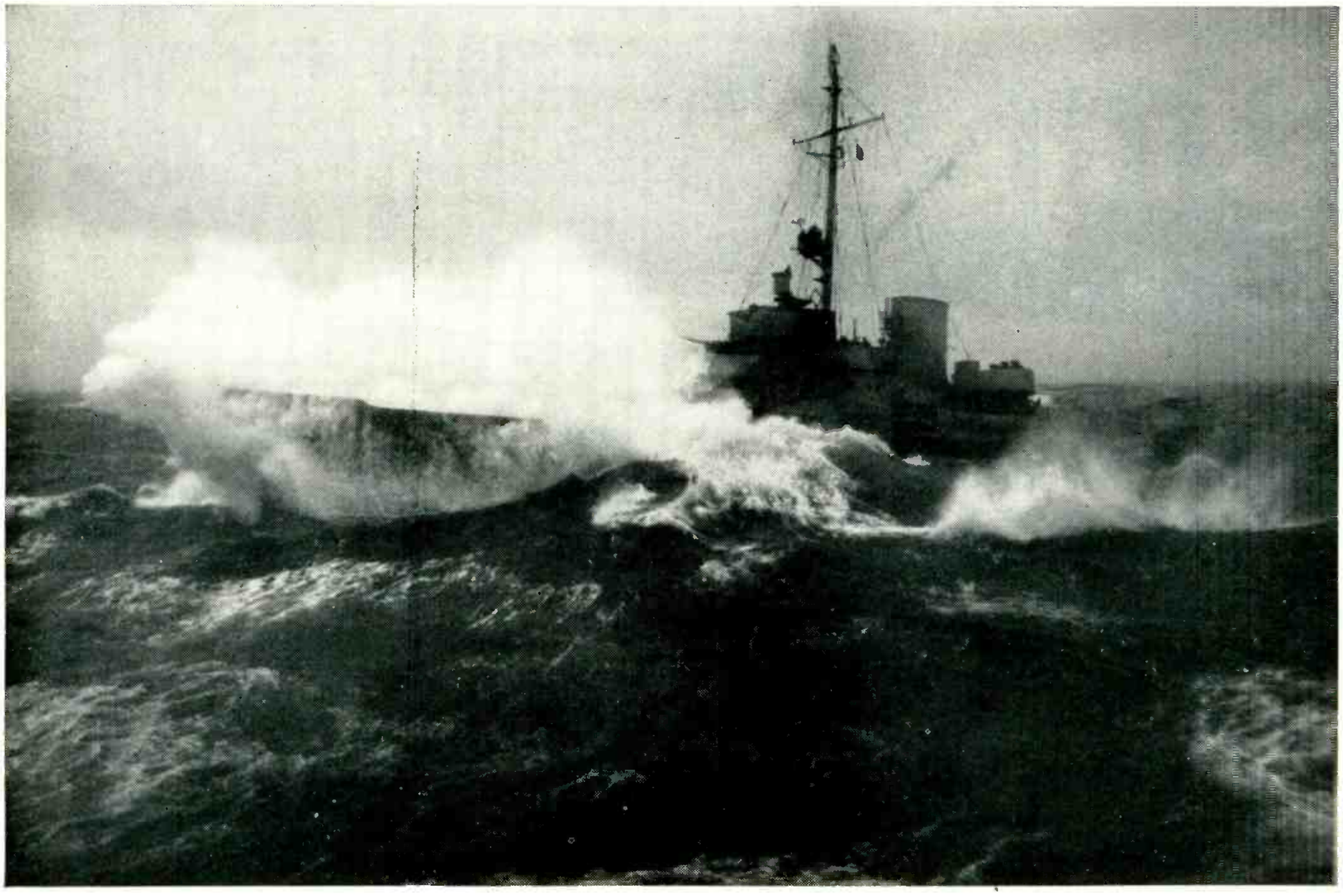
☐ GEC-459 Delay Lines
☐ GEC-690 Photovoltaic Cell
☐ GEA-4746 Here's the All-Purpose Switch
☐ GEA-5280 Selenium Rectifiers

Name ____________________

Company ____________________

Address ____________________

City ____________ State ____________



Official U. S. Coast Guard Photo

seamanship . . .

When the going gets rough, the safety of a ship depends largely on the seamanship of its crew and the good judgment of its officers. To help give the master of a ship full data on conditions contributing to the situation at hand, extraordinary new electronic devices ferret out underwater information of great value.

The Edo Corporation has become a leader in the design, development and manufacture of many of these new underwater detection devices which have far greater accuracy, range and dependability than previously thought possible.

Edo sonar equipments are being produced in ever increasing quantities to help give ships of the United States Navy better underwater "eyes" for both navigation and submarine detection.

OVER A QUARTER OF A CENTURY

Edo's emergence as a leader in the field of sonar development is the result of more than a quarter of a century of experience in the marine and aviation field.

To this intimate knowledge of a field where electronics has become increasingly important has been added the unexcelled experience of a staff of top electronic research and engineering personnel.

Edo development work in electronics, therefore, achieves not only increased electronic performance but does it while keeping in mind the practical necessities of rugged construction and miniaturization for space and weight saving.

If you'd like to learn more about Edo—our background, facilities, and products—we'll be glad to send you a copy of our 25th anniversary booklet. Just drop a note to Dept. M-7, Edo Corporation, College Point, L. I., N. Y.

EDO CORPORATION · COLLEGE POINT, N. Y.

CINTEL

70 DIFFERENT PHOTOTUBES

TYPE VTA FLAT TRANSPARENT CATHODE

"CINTEL" PHOTOTUBES

are manufactured with three different types of cathode surface as follows:—

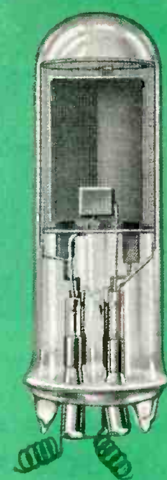
TYPE 'A' Antimony-Caesium, sensitive to daylight and blue light.

TYPE 'B' Bismuth etc. - Caesium, sensitivity similar to that of the human eye.

TYPE 'S' Silver-Oxygen-Caesium, sensitive to red-infra-red light.

There are over seventy different types covering every known application, and included in this range are:—

★ Push-pull types for double sound tracks ★ Special cells for dye image sound tracks ★ Cells of high insulation, linearity and stability for accurate photometric work ★ Cells for use in the ultra violet region of the spectrum ★ Multiplier cells ★ Transparent cathode cells, etc.



TYPE QVA.39 QUARTZ ENVELOPE SENSITIVE DOWN TO 1900 A°

TYPE VS. 39 FOR ACCURATE PHOTOMETRIC WORK

Full technical information will be rushed to you air mail, on application to —

CINEMA-TELEVISION LIMITED

A company within the J. Arthur Rank Organisation

FOREMOST IN THE MANUFACTURE OF

● Counters & Chronometers ● Metal Detectors ● Oscilloscopes ● Photo-Electric Cells ● Cathode Ray Tubes ● Geiger-Muller Tubes ● Electronic Instruments

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"Quicker than Quick" ARCO
24 HOURS
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OF El-Menco
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Manufactured In Accordance With JAN C-5 Spec.
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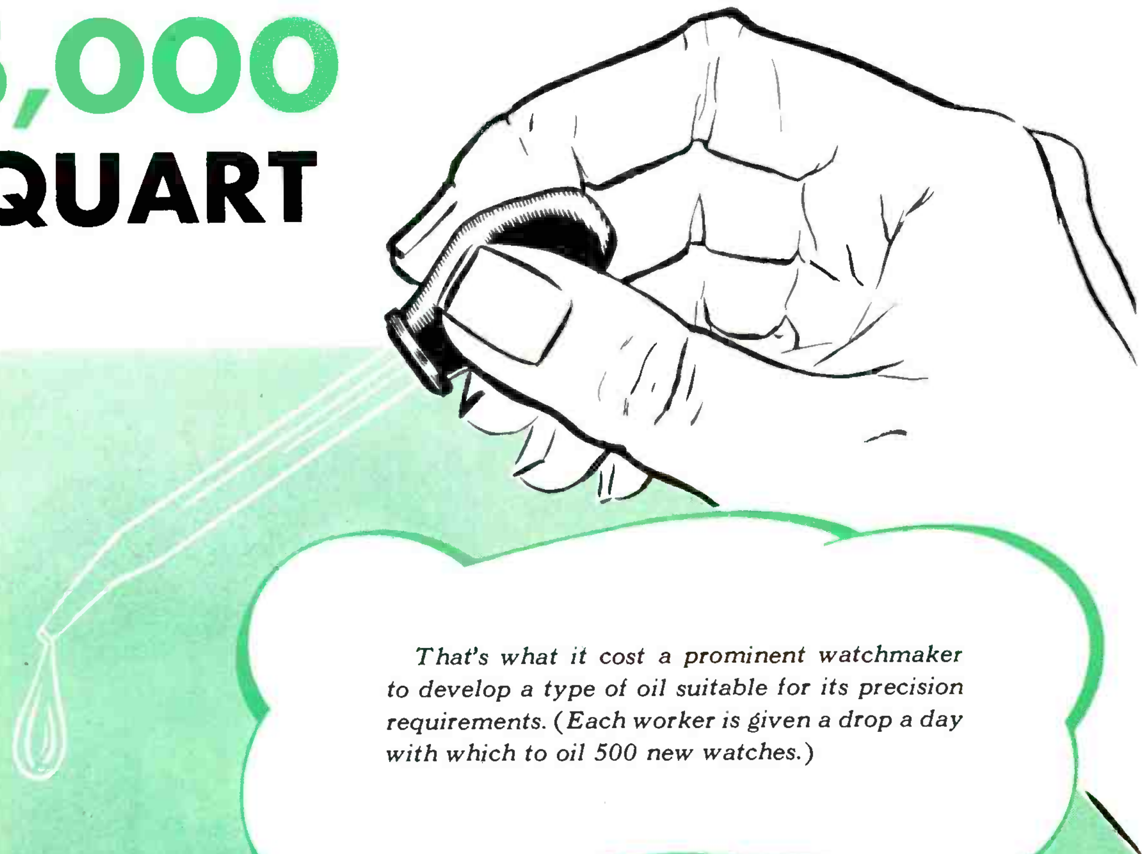
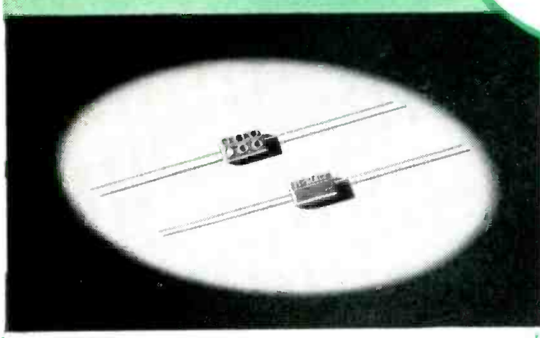
2,000,000 MICA CAPACITORS
From To
CM15 Silvered Min. Mica Capacitors 1 MMF— 510 MMF
CM19 Foil or Silvered Mica Cap. 3 MMF— 1,000 MMF
CM20 Foil or Silvered Mica Cap. 3 MMF— 1,800 MMF
CM25 Foil or Silvered Mica Cap. 3 MMF— 2,000 MMF
CM30-35 Foil or Silvered Mica Cap. 5 MMF—15,000 MMF
CM40 Foil or Silvered Mica Cap. 5 MMF—15,000 MMF
Also A Complete Line Of:—
Trimmers Ranging From 1.5 MMF to 780 MMF
Padders Ranging From 15 MMF to 3,055 MMF
Paper (Steatite) Ranging From .001 MFD to .5 MFD
Ceramic (Silver High "K" Capacitors)
From 270 MMFD to 12,000 MMFD
ALL ABOVE UNITS ARE MANUFACTURED BY
THE ELECTRO MOTIVE MFG. CO. Inc.
WILLIMANTIC CONNECTICUT
Catalogue on Request — Write to
ARCO
ELECTRONICS INC.
103 LAFAYETTE ST., NEW YORK 13, N. Y.
Sole Agent for Jobbers and Distributors In U. S. and Canada.

$15,000 A QUART



That's what it cost a prominent watchmaker to develop a type of oil suitable for its precision requirements. (Each worker is given a drop a day with which to oil 500 new watches.)



CM-15 MINIATURE CAPACITOR

Actual Size 9/32" x 1/2" x 3/16"

For Television, Radio and other Electronic Applications.

2 mmf.-420 mmf. cap. at 500v DCw.

2 mmf.-525 mmf. cap. at 300v DCw.

Temp. Co-efficient ± 50 parts per million per degree C for most capacity values.

6-dot color coded.

That quantity is no indication of quality is amply demonstrated by the CM-15 El Menco Capacitor. Tiny as it is, it will give sustained superior performance under the most adverse conditions.

Before it leaves the factory it is tested at *double* its working voltage to *insure* this unfailing performance.

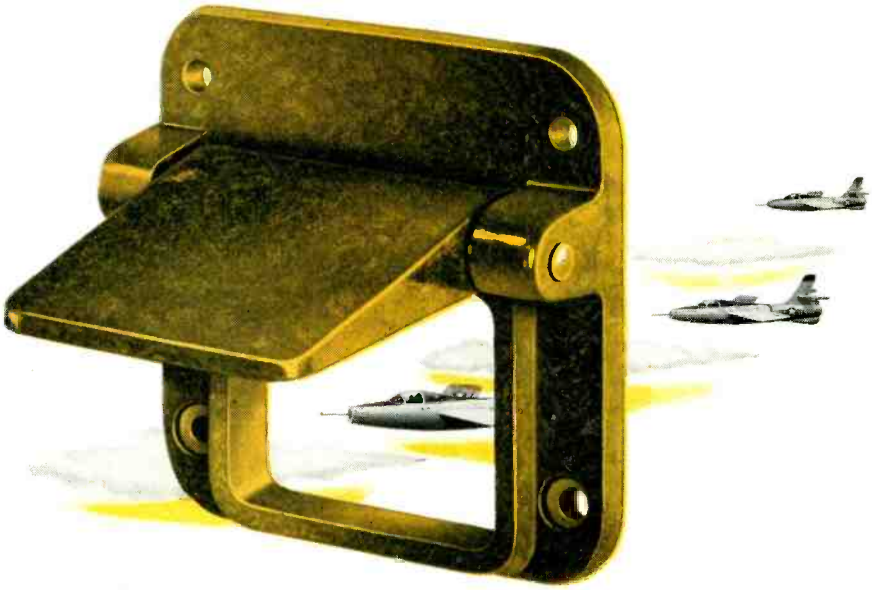
THE ELECTRO MOTIVE MFG. CO., Inc.
Willimantic, Connecticut

MANUFACTURERS ARE INVITED TO SEND FOR SAMPLES

MOLDED MICA El-Menco MICA TRIMMER CAPACITORS

FOREIGN RADIO AND ELECTRONIC MANUFACTURERS COMMUNICATE DIRECT WITH OUR EXPORT DEPT. AT WILLIMANTIC, CONN. FOR INFORMATION.

ARCO ELECTRONICS, INC. 103 Lafayette St., New York, N. Y.—Sole Agent for Jobbers and Distributors in U. S. and Canada



How to discipline fuel—in flight

It takes more than an experienced pilot and well engineered control surfaces to keep an airplane in straight and level flight.

Fuel must be delivered to the engine without fail. The fuel must be controlled—prevented from sloshing from one cell to another or from end to end of the cells.

That's where the little flapper valve, manufactured for the B. F. Goodrich Company, comes in. Placed in fuel cell baffles, and opening inboard, these devices keep the fuel in place despite any changes in flight attitude, permit the fuel to flow only in the proper direction.

They must be positive in operation. The material from which they are made must be inert in the presence of "loaded" aviation fuels, dimensionally stable, nonabsorptive, light in weight . . . and, for reasons of economy, be easy to manufacture.

All these requirements add up to a call for Synthane molded-macerated plastics. But there is much more to the story. Synthane has a wide and rare *combination* of chemical, mechanical and electrical characteristics which make it a material for almost all industry.

It is hard, dense, exceptionally strong for its weight. Synthane is an excellent electrical insulator, has low dielectric constant and low power factor. It is economically produced in molded forms of moderately complex shapes. Parts may be quickly machined from Synthane sheets, rods or tubes on standard equipment. It is moisture and corrosion resistant, and is thermo-*setting*.

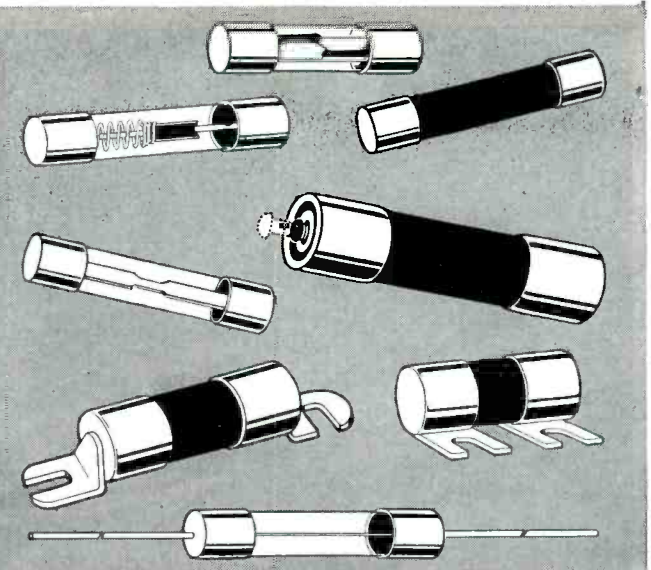
These few of Synthane's many advantages may suggest its value to you. If you would know more about Synthane, send for the Synthane Catalog. Synthane Corporation, 6 River Road, Oaks, Pennsylvania.

PLASTICS WHERE PLASTICS BELONG

SYNTHANE

Oaks S Pennsylvania

When you need a FUSE—think of BUSS



THE MOST COMPLETE LINE OF FUSES FOR THE *Electronic Industries*

- RADIO
- TELEVISION
- RADAR
- INSTRUMENTS
- CONTROLS
- AVIONICS

Whatever your needs in electrical protection there's a Buss fuse made to fit.

Send for Bulletin SFB—showing full line of fuses and fuse mountings.

A complete line of fuses made to dimensions smaller than National Electrical Code fuses.

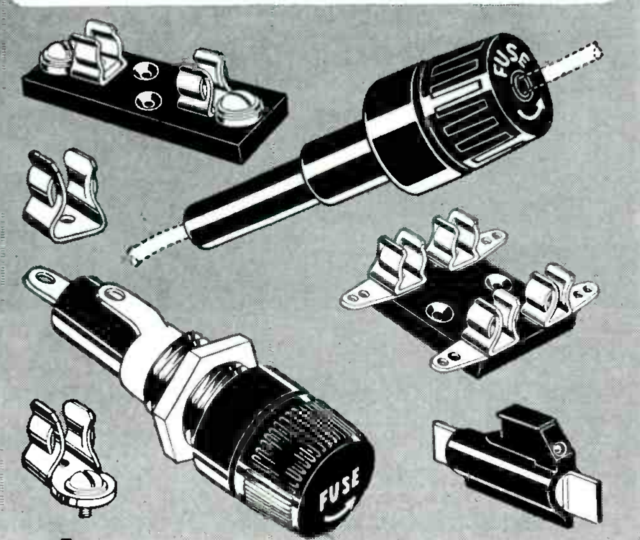
These fuses are SPACE SAVERS.

They are particularly well suited to the protection of instruments, radios, television and electronic equipment of all kinds, aircraft, automobiles, coin-operated devices and any apparatus where space for the protective device is at a premium.

Fuses of the Dual-Element, Renewable and One-Time type are available.

Companion lines for FUSETRON and BUSS small dimension fuses are BUSS Fuse Clips, Blocks and Fuse Holders. They are made in many types and sizes to make it easy to select the fuse and fuse-mounting needed to give the required protection.

For full information ask for the BUSS Bulletin on Small Dimension Fuses and Fuse Holders — Form SFB.



SPECIAL FUSES, FUSE CLIPS, FUSE BLOCKS and FUSE HOLDERS

Sometimes a special fuse or fuse mounting is required. In such cases we welcome your requests either to quote—or to help in designing or selecting the special type of fuse or fuse mounting best suited to your particular conditions.

Submit description or sketch, showing type of fuse to be used, number of circuits, type of terminal, etc. If your protection problem is still in the engineering state, tell us current, voltage, load characteristics, etc.

At any time our staff of fuse engineers is at your service to help solve your problems in electrical protection.

USE THIS COUPON — *Get all the facts*

Bussmann Mfg. Co., University at Jefferson
St. Louis 7, Mo. (Division McGraw Electric Co.)

Please send me Bulletin SFB containing complete facts on Buss Small Dimension Fuses.

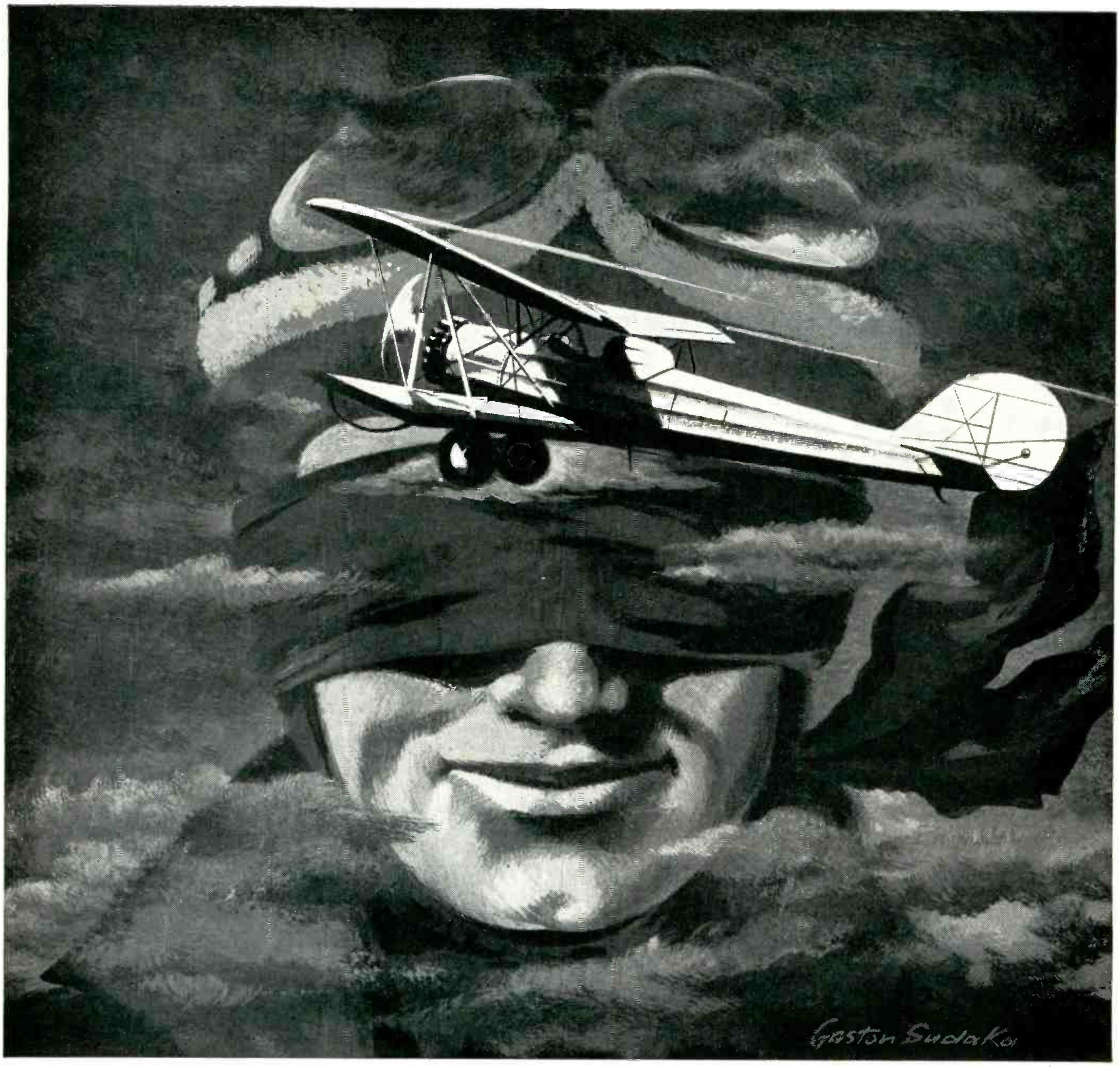
Name ______________________

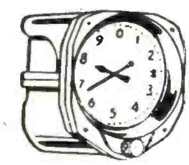
Title ______________________

Company ______________________

Address ______________________

City ______________ State ______________


Gaston Sudaka



ASK *Erie* RESISTOR

. . . about custom designed trimmers

Pictured above are several custom designed trimmers that incorporate the elements of standard Erie Disc and Tubular Ceramicon Trimmers. Each has been developed for a specific purpose, and each does its job efficiently and economically. Proper design and precision manufacturing, plus our years of experience, are the keynote to Erie quality.

Look at these units carefully. They should suggest the possibility of using Erie Resistor know-how and facilities to make your equipment more compact and more efficient.

Erie has the most complete trimmer line in the industry. We would like to work with you on combining trimmers, fixed capacitors, and other circuit elements into integrated sub-assemblies. Inquiries should specify complete mechanical and electrical requirements.

(1) Standard Style TD2A Dual Trimmer with mounting pillars.

(2) Special ribbon type terminals on standard Style TS2B Trimmer for direct connection to other components.

(3) Compact Trimmer—Capacitor—Resistor—Coil Design. A complete oscillator unit.

(4) (5) (6) Where special mounting is desired, standard Erie Style TS2A and Style 557 Trimmers can be supplied mounted on brackets.

(7) (8) Two trimmer elements become an integral part of this coil form and I. F. top section.

(9) Special bracket and terminal arrangements on dual trimmer unit.

(10) A compact pluggable assembly for mounting a trimmer in parallel with a plug-in crystal.

(11) Special tubular ceramic trimmer and variable inductance having one common terminal.

(12) Special steatite tubular dual trimmer.

(13) Standard Erie Style 557 Trimmer with special bent rotor terminal.

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND . . . TORONTO, CANADA

1. Low Installation Cost
2. Low Inspection Cost
3. Fewer Rejects
4. Less Returned Goods
5. Less Failures in Service
6. Satisfied Customers

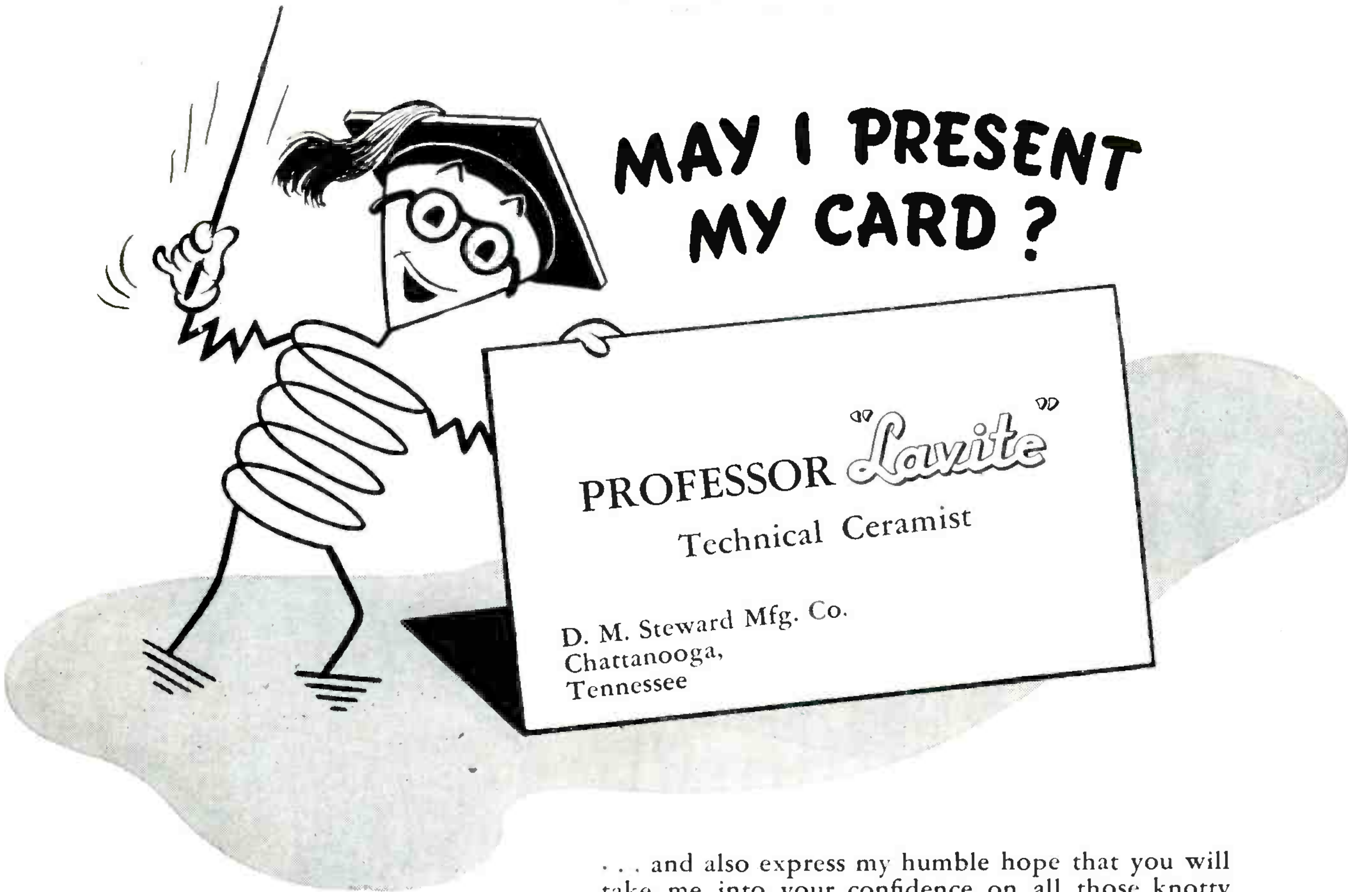
WRITE: Belden Manufacturing Co.
4625 West Van Buren Street
Chicago 44, Illinois

CORDITIS-FREE CORDS BY...

Belden

WIREMAKER FOR INDUSTRY

MAY I PRESENT MY CARD?



. . . and also express my humble hope that you will take me into your confidence on all those knotty problems involving technical ceramics. You see, "Lavite" is more than just my name—it is the name by which the wide selection of Steward Technical Ceramics ("Lavite" Steatites, "Lavite" Titanates, "Lavite" Ferrites and many others) have become widely known. In fact, I am truly flattered to know that "Lavite" has become the name and standard that many of the most exacting users of technical ceramics insist on and specify religiously. "Lavite" Ceramics are not new developments—in fact, they have been in research and redevelopment for 75 years. "Lavite" Ceramics offer you practically any desired combination, or balance, of physical properties to satisfy your needs—from ordinary radio and general medium-frequency applications to those demanding precise qualities of low electrical loss, high mechanical strength and thermal shock resistance, plus the advantages of excellent machineability which permits production of your ceramic parts to closest tolerances.

Send me your specifications for practical and proved recommendations, or ask for a testing sample of any one of this famous family of technical ceramics without obligation.

Ask for your copy of our booklet, "Lavite" Technical Ceramics, Table of Properties. (Steatites, Titanates, Ferrites and others.)

D. M. STEWARD MANUFACTURING CO.

3604 Jerrome Avenue Chattanooga, Tennessee

Sales Offices in Principal Cities

RURAL transformer & equipment co.

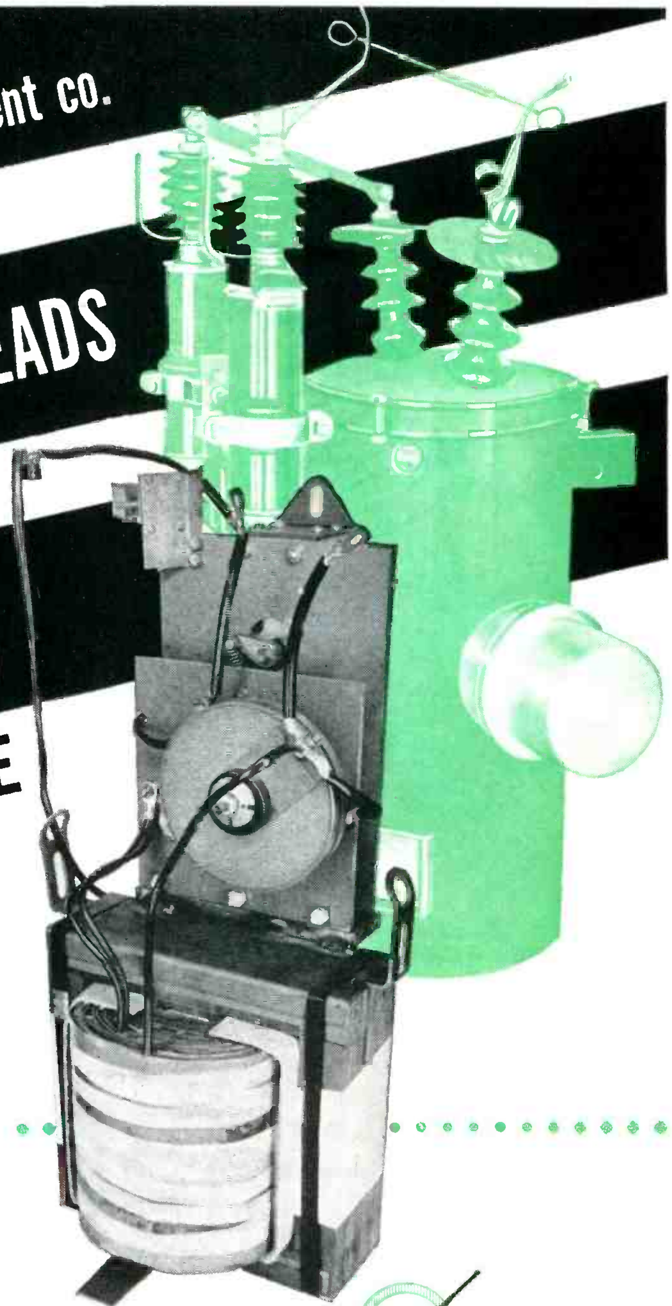
SINGLE STEP, LINE TYPE

VOLTAGE REGULATOR LEADS

ARE INSULATED AND PROTECTED WITH

NATVAR 400

EXTRUDED VINYL-BASE TUBING



Newest addition to the Ruralformer line is this low cost pole mounted Type 1R Voltage Regulator. It helps save line copper and reduces customer complaints by automatically furnishing a 3.75% boost when required. This inside tank view shows core and coil assembly and the resistor side of the main switching assembly. All leads are insulated and protected with Natvar 400 extruded vinyl-base tubing.

The Rural Transformer & Equipment Co., Milwaukee, manufactures distribution transformers and associated equipment. They have developed a low cost, high surge strength transformer for distribution of rural power at 14,000 volts. With externally operated tap changer, bonded coils, and externally mounted protection against lightning surges and overload, Ruralformers carry a strong service guarantee.

Component parts and materials have been carefully picked. Natvar 400 extruded vinyl-base tubing is used to insulate and protect leads because of its consistently superior resistance to both oil and heat.

It will pay you to use Natvar 400 tubing, tape, and other Natvar flexible insulating materials for your requirements. They are available either from your wholesaler's stock or direct from our own.

Natvar

Natvar Products

- Varnished cambric—straight cut and bias
- Varnished cable tape
- Varnished canvas
- Varnished duck
- Varnished silk
- Varnished special rayon
- Varnished Fiberglas cloth
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- Varnished papers
- Slot insulation
- Varnished tubings and sleevings
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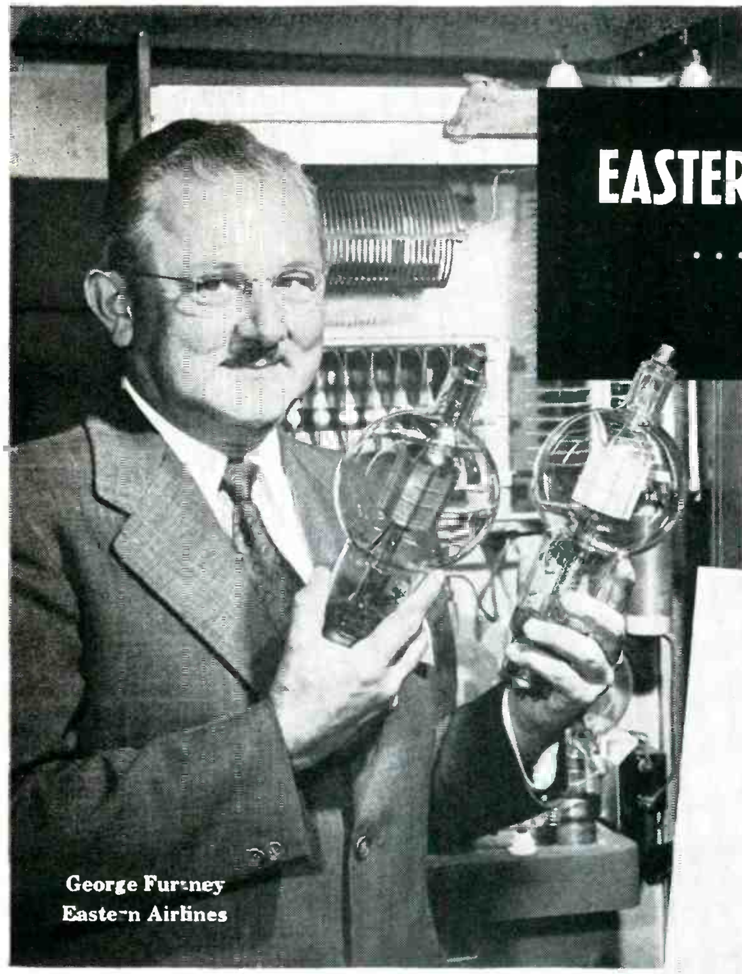
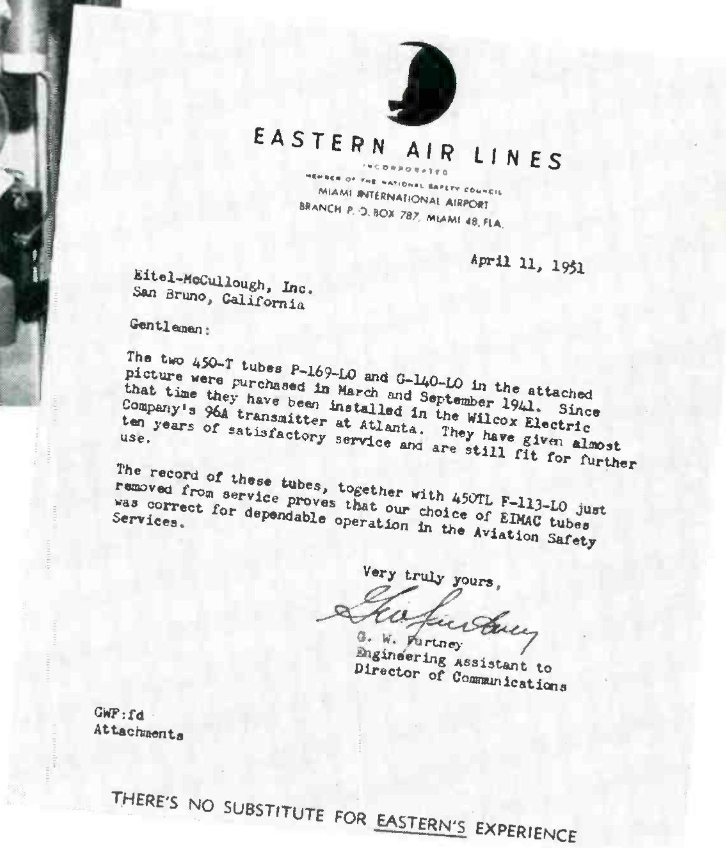


George Furtney
Eastern Airlines



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MEMBER OF THE NATIONAL SAFETY COUNCIL
MIAMI INTERNATIONAL AIRPORT
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April 11, 1951

Eitel-McCullough, Inc.
San Bruno, California

Gentlemen:

The two 450-T tubes P-169-LO and G-140-LO in the attached picture were purchased in March and September 1941. Since that time they have been installed in the Wilcox Electric Company's 96A transmitter at Atlanta. They have given almost ten years of satisfactory service and are still fit for further use.

The record of these tubes, together with 450TL F-113-LO just removed from service proves that our choice of EIMAC tubes was correct for dependable operation in the Aviation Safety Services.

Very truly yours,

G. W. Furtney
Engineering Assistant to
Director of Communications

GWF:fd
Attachments

THERE'S NO SUBSTITUTE FOR EASTERN'S EXPERIENCE

The statement by George Furtney of Eastern Air Lines once more proves that the work-horses of modern commercial communication systems are the Eimac 450T type triodes. Their dependability is unchallenged.

The 450T is rated at 450 watts plate dissipation, 6000 max. plate volts, and 600 ma. max. plate current at frequencies as high as 40 Mc. They are widely used as either amplifiers, oscillators, or modulators. Complete data and application notes will be furnished upon request.

The 450T type triodes and other outstanding Eimac vacuum tubes are today specified in ever increasing numbers to fill key sockets in important military, communications, and industrial equipments. Consider them for your equipment . . . they have been proved in service . . . an unbiased proof that is your assurance of undeniable dependability.

A new Eimac quick-reference catalogue is now available. Write for yours.

290

Eitel-McCullough, Inc.
San Bruno, California
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

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the Little Indian

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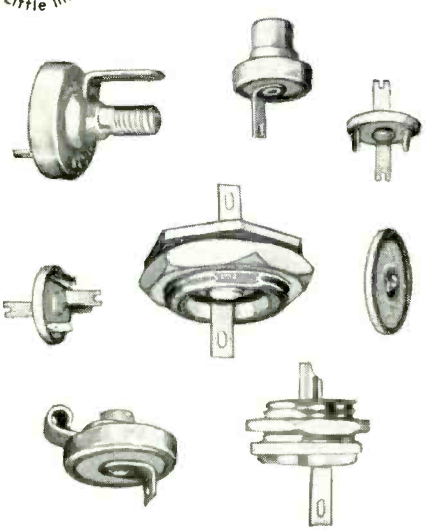
for any requirement...



You can look to Sangamo whenever you need small sized, light weight button capacitors, with extremely low series inductance, for application in high frequency circuits. Sangamo Button Capacitors are encased in silver plated, corrosion resistant brass and are exceptionally stable over a wide temperature range. The case is utilized as the low potential terminal.

Sangamo Silvered Mica Button Capacitors meet all requirements of V.H.F. and U.H.F. applications. They can be furnished with temperature coefficients and drift characteristics up to and including "E" of Armed Services specification JAN-C-5. The normal operating temperature range is from minus 50° C. to plus 85° C. Higher operating temperature requirements will be considered and may be negotiated with The Sangamo Capacitor Engineering Department. Catalog No. 830 gives full details—write for your copy.

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ALL of the General Electric diode products listed below have the following advantages over other types of rectifiers commonly used: welded contact . . . low shunt capacity...insulating case...small physical size...long life...no filaments... no contact potential...self-healing...high moisture resistance. Complete bulletins sent on request. Write: *General Electric Co., Sec. 471, Electronics Park, Syracuse, N. Y.*

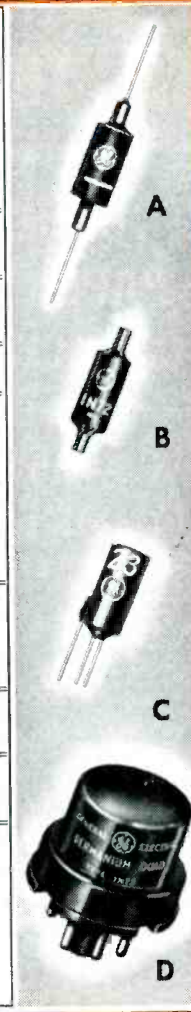
CATEGORY	RTMA DESIGNATION	G-E TYPE	PEAK INVERSE VOLTAGE	CONTIN. OPER. INV. VOLTAGE	MIN. FORWARD CURRENT (MA) AT +1V	MAX. INV. CURRENT (μa) AT —50V	AV RECTIFIED CURRENT (MA)	PEAK RECTIFIED CURRENT (MA)	SURGE CURRENT (MA)	SIZE
GENERAL PURPOSE	1N48	G5	85	70	4.0	833	50	150	400	A
	1N51	G5C	50	40	2.5	1667	25	100	300	A
	1N52	G5D	85	70	4.0	150	50	150	400	A
	1N63	G5E	125	100	4.0	50	50	150	400	A
	1N75	G5M	125	100	2.5	50	50	150	400	A
TV	1N64	G5F	20	Min. dc current in 44 mc rectifier—100μa						A
	1N65	G5G	85	70	2.5	200	50	150	400	A
JAN	1N69	G5K	75	60	5.0	850	40	125	400	A
	1N70	G5L	125	100	3.0	410	30	90	350	A
VHF		G6	15	Min. Rect. Eff. at 100 mc and 2 v signal—60%						A
UHF	1N72	G7		+3db max. noise factor over 1N21B in 500 mc mixer CKT			25	75		B
		G7A					25	75		A
		G7B	5	75% min. rec. eff. at 100 mc for detector			25	75		B
		G7C	5				25	75		A
		G7D	5	Tested for sharpness of break E-I char. for freq. multiplier			25	75		B
		G7E	5				25	75		A
		G7F	5	60% min. rec. eff. at 100 mc for detector			25	75		B
		G7G	5				25	75		A
MATCHED PAIRS Note (1)		G8	85	70	4.0	833	50	150	400	A
		G8A	85	70	4.0	150	50	150	400	A
		G8B	125	100	4.0	50	50	150	400	A
		G8C	125	100	2.5	50	50	150	400	A
QUADS	1N73	G9	75		Note (2)	50@ —10v	22.5	60	100	D
	1N74	G9A	75		Note (3)	50@ —10v	22.5	60	100	D
TRANSISTORS Note (4)		G11	Max. RMS emitter signal level—.3v; max. DC emitter current—.5 ma;							C
		G11A	Max. DC collector current—2.0 ma; power gain 17 to 21 db; power output 25 mw							C

(1) Matched at +1v so that current through higher resistance unit is within 10% of lower resistance unit.

(2) Consists of 4 balanced diodes. With 15 ma forward current; the voltage drop of each diode is 1.3v min. and 1.7v max., all diodes are within 0.1 volt of each other, and voltage drop of a pair is 0.03 volts of each other.

(3) Consists of 4 balanced diodes. With 15 ma forward current; the voltage drop of each diode is 1.2v min. and 1.8v max., all diodes are within 0.2v of each other, and voltage drop of a pair is 0.1v of each other.

(4) Additional test over G11 for negative resistance of base current vs. base voltage characteristic for trigger circuit operation.



A

B

C

D

You can put your confidence in—

GENERAL ELECTRIC

BUSINESS BRIEFS

By W. W. MacDONALD

Washington's Attitude during the last war appears to us to have been "take care of the assemblers of complete equipment and they will take care of the component makers." It has been quite a while developing, but this time we think we see signs that it will be "keep component makers in business during the unsettled period and let assemblers paddle at least part of their own canoe."

Some time will elapse before this new thinking is translated into action that all component makers can feel. Action seems, however, to be definitely on its way.

Another Trend we see developing in the nation's capital is a long-overdue shift from the "study and statistics" phase of the mobilization effort into the "action even if every possible contingency cannot be foreseen" stage. Personnel changes within several government agencies are partially responsible for the trend. In particular, association of more men from our industry with government agencies, on a part-time or full-time basis, is responsible.

Most Important Date for our industry is July 1, when the Controlled Materials Plan goes into effect.

CMP is designed to insure adequate supplies of critical materials for essential defense and defense-supporting projects. It leaves manufacturers of nonessential civilian items out in the cold to scramble for any materials that are left over. The pickings may be lean, or they may be lush.

Just what CMP will do to civilian equipment production cannot be evaluated in advance because the situation is quite different from that during World War II. Then, production facilities were heavily engaged on military equipment and no one worried much about civilian equipment production. Now, production facilities are only partially devoted to military equipment and civilian equipment production is important in the economy, particularly the production of television sets.

Several government officials to whom we talked in Washington just before press time thought there might be enough materials available in the open market for the balance of the year to support a healthy civilian business, particularly if the use of noncritical substitutes expanded. Others thought it might eventually be necessary to bring certain materials required for the production of civilian goods under CMP.

Munitions Board is currently inviting responsible electronic-equipment manufacturers and their technical personnel to look at gear recently designed and built for the Air Force and the Navy. Such gear is being exhibited, despite the fact that it is classified, in certain major cities with the hope that by examining it new government contracts will be more acceptably executed.

We looked over the equipment recently exhibited in New York, and while identification cannot be made without violating security regulations, we can tell you that some of the construction, components and materials opened our eyes. If you have an opportunity to look over the equipment, by all means do so.

Elmer's Law is the one which says that if you are measuring a d-c voltage the initial arrangement of your voltmeter leads will be wrongly polarized.

Scientific Instrument Makers are unhappy about a recent tariff cut on certain imported apparatus. They point out that our government had to scramble for such apparatus when the supply was cut off from abroad during the last war and that an American industry virtually had to be started

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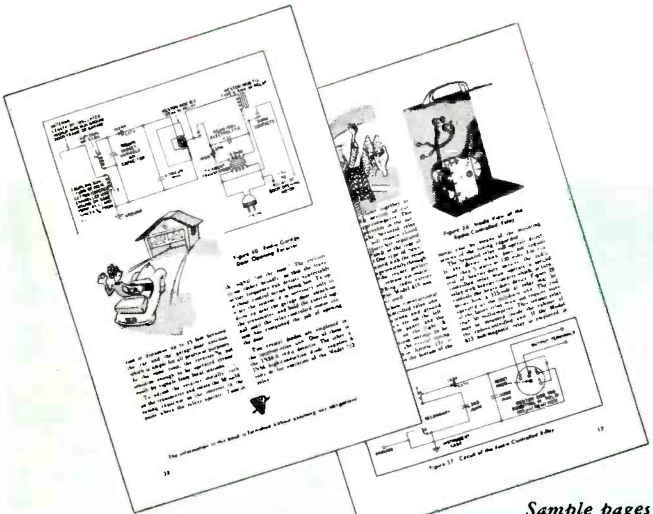
IN YOUR HOME!



Sample pages showing easy-to-read diagrams.

HERE'S HOW TO MAKE 24 VALUABLE TIME- AND LABOR-SAVERS

You don't have to be an electronics engineer to build these useful household gadgets. The step-by-step instructions in Sylvania's fascinating new book, "Electronic Shortcuts for Hobbyists," are written expressly for the home hobbyist, model maker and electrical experimenter. With this book you can build:

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ONLY 25¢

All you need is some inexpensive Sylvania Crystal Diodes and a few everyday materials. Book contains full instructions and easy-to-follow diagrams. Send a quarter along with the coupon for your copy.

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Enclosed please find my 25¢ for copy of "Electronic Shortcuts for Hobbyists."

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SYLVANIA ELECTRIC 1901-1951 PRODUCTS INC. 50th ANNIVERSARY — FIVE DECADES OF PROGRESS

SYLVANIA ELECTRIC

ELECTRONIC DEVICES; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS from scratch. Now, they say, there is some danger that that industry may dwindle away. The other side of the picture is the desirability of supporting friendly European countries by supplying a market for their goods.

Here's another case in which it appears necessary for our government, faced by a half-war and half-peace situation that is unique in its history, to at least temporarily try to carry water on both shoulders.

Direct Quote much to the point is this one from a talk by GE's W. R. G. Baker before the Foreman's Association at Electronics Park:

"The real cost of mobilization must be paid by workers and . . . concerns engaged in production of civilian goods and services. The fewer persons and concerns producing civilian goods and services the less money there will be to finance military production."

Four War Years 1942 through 1945 saw our industry delivering 1,500,000 radio sets and 20,000 radar sets to the military.

Production of radio sets in the first quarter of this year totalled 4,235,597 and there were 2,199,669 television receivers made, according to RTMA. This represents increases of 27 and 37 percent over the first quarter of 1950. It is pointed out, however, that preliminary second quarter reports indicate a decline as against last year.

Some 95 percent of the tv sets made in the first quarter used picture tubes 16 inches or larger in diameter.

TV Receiver Inventory as of May 1 is estimated as between 1,750,000 and 1,850,000 sets by Television-Electronics Fund, Inc. of Chicago. This, according to the source, represents about three to three and a half months supply based on average monthly sales for the preceding 12 months.

TV Chassis intended for custom building into special cabinets or home recesses were bought by 90,-

000 people in 1950, according to an estimate by John H. Cashman of Radio Craftsmen. Retail value of the chassis is estimated at $10,000,000.

Government Purchases of radio transmitting and communications equipment during 1950 totalled $116,477,892, according to RTMA. $92,297,971 of the total was for radar. Purchases during 1949 totalled $141,288,869.

North American Aviation says the present goal in automatic airplane guidance is a flight control system capable of directing an interceptor airplane through an entire combat mission. Takeoff, climb-out, target pursuit and destruction, and return to base would be accomplished automatically, with the human pilot merely selecting the target and monitoring the mission.

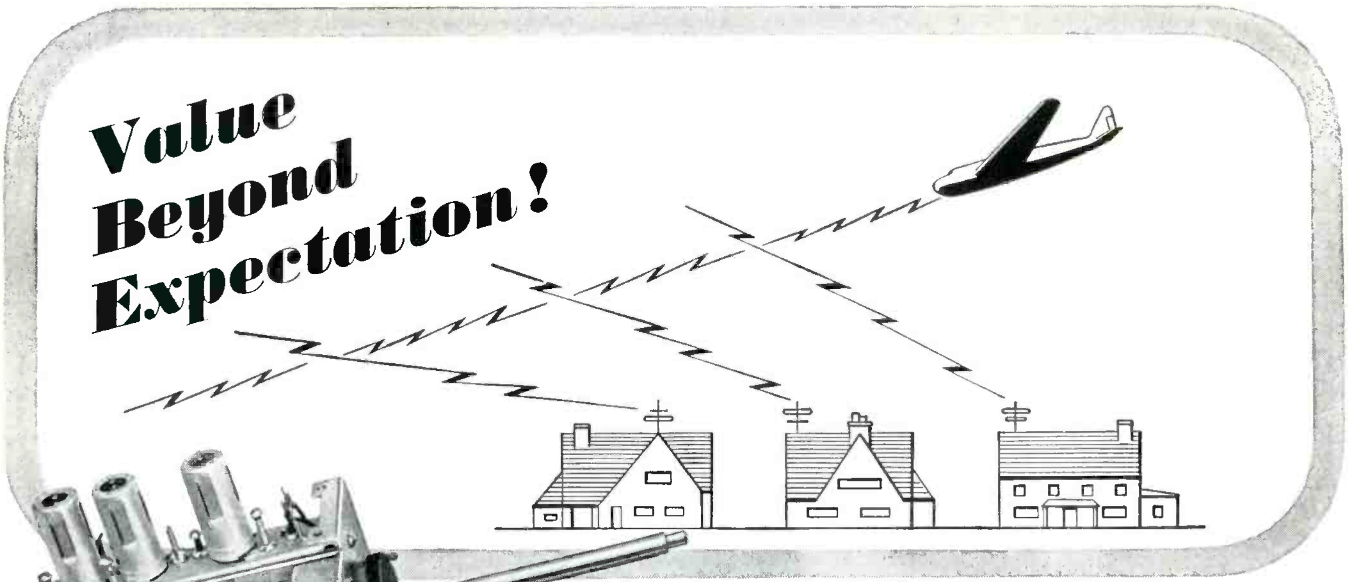
Once Before (p 60, Aug. 1950) we commented on the interest of horse players in electronic equipment. One of them had, we noted, used radio to send race results out of a park before said results reached the horse parlors, and so bet on sure things until dissuaded by the gendarmes.

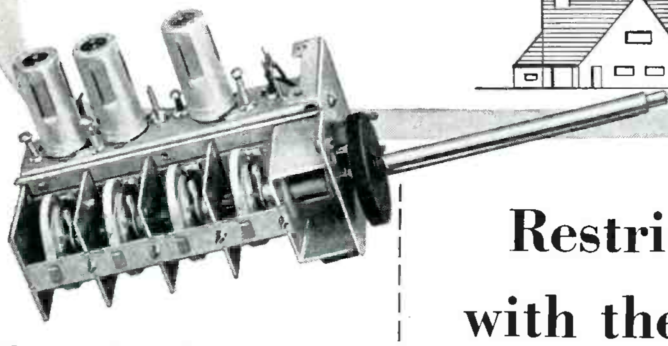
Now the bookies are harnessing our art. One of them was picked up just the other day for interconnecting three successive telephones located at different places around New York City through automatic relays, making it difficult for the police to wiretap or raid.

Philco has 2,000 electronics field engineers serving with the armed forces all over the world.

This Month's Masterpiece of understatement: Electronics industry official, showing great restraint when discussing a government-proposed change in broadcasting equipment operating procedure, said . . .

"We agreed to try the suggestion in conversations at Washington, and at Washington there wasn't much trouble involved. However, the nearer we approached the site of the work the more interesting the problem became."





Restrict Oscillator Radiation with the Mallory TV Teletuner*

The development of a TV front end assembly which avoids interference with other electronic equipment is a recent and far-reaching accomplishment of Mallory research and engineering.

Built around the four-tuned-circuit Spiral Inductuner, this new front end is designed and constructed to limit radiation from the oscillator. Further precaution is taken by shielding the oscillator and converter from the RF amplifier. And, each section of the Inductuner is individually shielded. Thus, Mallory offers TV manufacturers a complete front end capable of performing within strict standards for oscillator radiation.

That's value beyond expectation!

The Mallory Teletuner is universally adaptable. It features higher gain and lower noise figure. It is available in 3, 4 and 6 revolution designs, incorporating the characteristics of the Spiral Inductuner listed at the left. Complete technical data sheets are available on request.

*Outstanding Advantages of the new Mallory Spiral Inductuner***

1. A single control for easy selection and fine tuning of any television or FM channel.
2. Easily adapted to UHF converter use.
3. Excellent stability eliminates frequency drift.
4. Supplied in two-, three-, or four-section designs.
5. Far more quiet operation; permits lower noise figures in front end designs.
6. Free from microphonics.
7. Greater selectivity on high frequency channels.
8. Eliminates "bunching" of high band channels.
9. Simplifies front end design and production.
10. Reduces assembly costs.
11. Choice of: 6 turn unit continuously tunes from channels 2 to 13; 4 turn unit tunes only channels 2 to 6, FM, 7 to 13; 3 turn unit tunes only the 12 television channels.

**Trademark*
***Reg. trademark of P. R. Mallory & Co., Inc. for inductance tuning devices covered by Mallory-Ware patents.*

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P. R. MALLORY & CO., Inc.
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CROSS TALK

▶ **PICKUP** . . . Last year about this time we irked our American friends in tv broadcasting somewhat by reporting that British tv stations do a conspicuously better job of televising film than we do, despite the fact that the British video band is 1.25 mc narrower than the American. Some of those who doubted the report have since been to London to see for themselves and have confirmed the superior quality of British film transmissions. The explanation, one of the reasons advanced in favor of the European scanning standard of 25 frames per second, is the fact that flying-spot scanning can be used, with this standard, merely by running the film about 4 percent faster than normal. With the American standard of 30 frames per second this is not feasible, so we use storage-type cameras, notably the iconoscope, to perform the transfer from 24 film frames to 30 scanning frames per second.

Sporadically reports have appeared that a new scanner was in process of development that would overcome the impasse and permit flying-spot scanning of film on the American standard. Such a film scanner was, in fact, shown to the SMPTE a few weeks ago by the Bell Telephone Labs (p 114, this issue). The new device uses two clever electronic servos to overcome vertical jitter and flicker, and produces a picture that is very, very good—better than anything on the air today anywhere. For various reasons, Ma Bell does not intend to produce the scanner commercially, but is willing to license others to do so. Our guess is that, when the development is complete, several large corporations will be competing for the privilege.

▶ **SECOND CHANCE** . . . In view of the great importance of education in our field, we note with pleasure the establishment of the Majestic Research Fund, Inc. which will provide 48 "second-chance" scholarships per year, valued at about $2,000 each, to persons over 35 years of age who were unable to secure or complete their formal education in earlier years. The fund of $500,000 was set up by Majestic Radio and will be administered by a board of officials of NYU, Columbia, Brooklyn Polytech, and the Textile Workers of America. A worthy project, and one which can be copied by other companies without fear of committing infringement.

The growing realization of industry's stake in higher education was voiced recently by Alfred P. Sloan, Chairman of General Motors, at a dinner signalizing his gift of $5 million to found a school of industrial management at MIT. Mr. Sloan pointed out that it is becoming impossible to operate colleges and universities by the investment of endowment funds, and that no relief from this difficulty is in sight. He suggests that industry at large ought to set up a foundation to make outright grants to such institutions, for education and research, without expecting direct monetary return, the funds to be liquidated over periods as short as five years. Continuing support of a given research project would then depend on actual results and potential value. The big foundations and many individual companies are already doing this, but the base has to be very broad to support a program as big as this country needs.

▶ **ODE** . . . As we write, the Supreme Court has just rendered its opinion on the color television case of RCA vs FCC. Also, within a few days we take our departure for Geneva, for the Sixth Plenary Session of the C.C.I.R. So, all in all, we think it safe to print the following ditty, which is not original with us or Rudyard Kipling:

The filters and dichroics die,
The mirrors and the disks depart
Still stands our basic raster type
And readings on the testing chart.
Dear FCC, be with us yet,
May we forget, may we forget!

——Production Planning

The six post-war years have seen per-man-hour production of electronic equipment more than double, at the Sperry Gyroscope Company, despite increased complexity of products and an increase in the unskilled-to-skilled operator ratio. Details of production planning program that made this increase possible are presented

FIG. 1—Setup for cutting uniform wire lengths. Shear jaws are actuated when wire end comes in contact with switch

FIG. 2—Old method of removing shields involved snipping with shears. New methods are shown in Fig. 3 and 4

PRODUCTION of electronic equipment reached an all-time high during World War II. Some of the methods used to attain these high production figures were of necessity inefficient, but they were nevertheless effective. One fortunate aspect of the present state of affairs is the fact that industry today has an opportunity to plan ahead. While there is no *certainty* of another global conflict, there is a *threat*, and by laying careful plans now, the occurrence of such a disaster can be met with methods that are efficient, as well as effective.

At the Sperry Gyroscope Company, production per man hour of military electronic equipment has more than doubled since the end of the war. This is on an average basis—in some instances increases of 8 and 10 have been realized. This statement is even more impressive than it appears at first because of the increased complexity of the equipment being turned out today. Also adding to the impressiveness is the fact that production progress is being accomplished with the use of less-skilled help. The end products, again as a result of planning and specialization, are of better quality. Quality improvement was, in fact, the motivating influence that started the program that made the increases possible.

The Sperry System

Many of the new ideas that enable a company of Sperry's size to increase production come about through paper work and the shuffling of personnel both on the management side and in the shop.

Key to the system is the letter-sized operations sheet. These sheets break each job down into step-by-step functions. Descriptions of these various functions are in plain language, written so that operators even in the lowest skill categories can understand them and carry out the prescribed operations.

The use of such sheets offers many advantages:

(1) Because of the great detail used on operations sheets, in contrast to that which could be placed on a blueprint without undue complication, greater quality and uniformity of products is obtainable.

(2) An operator who has used one sheet can follow similar sheets almost without further instruction, which relieves shop foremen for other duties. This also enables the production department to run one job for a time and then to switch to another without lost motion.

(3) Fewer mistakes are likely to occur when an operator has only to follow a description of his particular job, rather than an over-all blueprint. In fact, little knowledge of blueprints is required—instructions are in words and sketches.

(4) The sheets, being of small and uniform size, are readily filed and easily available for reference—the unfolding of monstrous blueprints is always time consuming and distracting to others.

(5) If production on a particular

• DURING WORLD WAR II, approximately 40 man hours were required at Sperry for turning out a particular amplifier chassis, and the average skill classification was B.

• Today, as a result of production planning and technological advancement, the same amplifier chassis is completed in 6 man hours, and the average skill is D. (Skill D is one step above trainee!)

Speeds Military Orders——

FIG. 3—Production shield-removing operation. At left, operator forms pyramid from shield. Co-worker removes pyramid with nibbling machine so that shield end falls free

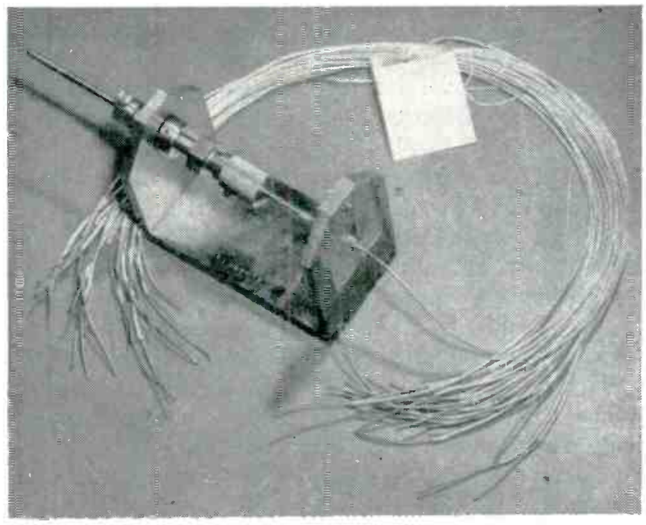

FIG. 4—New shield remover involves one simple operation. Use of this tool is explained in text. Note wire tag containing instructions attached to bundle

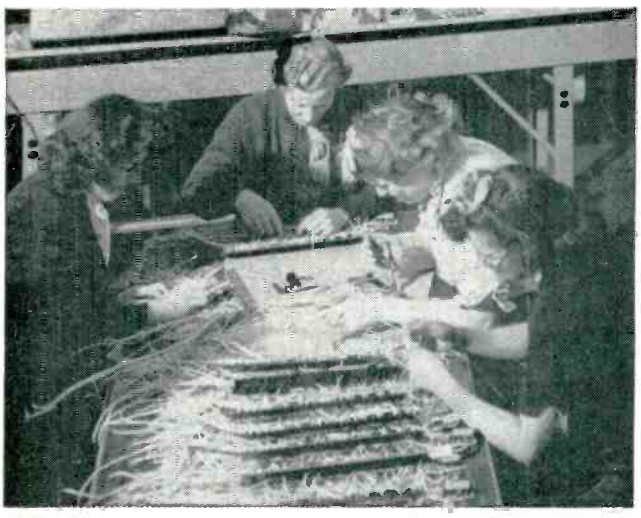

FIG. 5—During World War II, harness making became an important adjunct to equipment fabrication This photograph shows a typical installation from that period

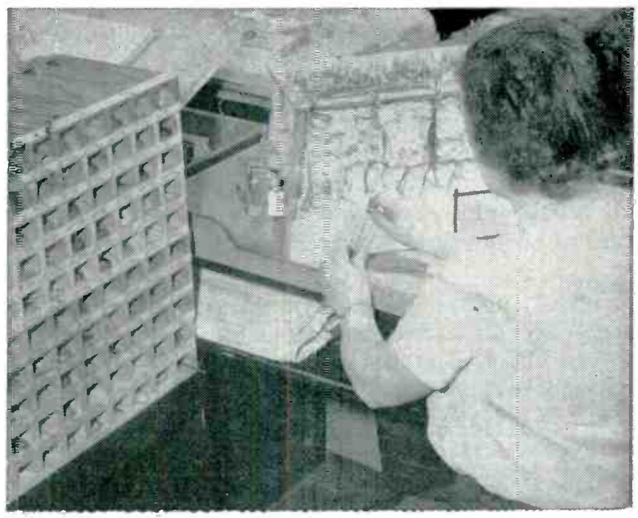

FIG. 6—Since the war, Sperry has developed and adopted the wire-rack shown at extreme left for holding wires in proper sequence of use in harness

job must be stepped up, the operations sheets may be further subdivided so that each worker does only half of the steps, thereby speeding the operation without additional training and indoctrination. Extra workers are simply sandwiched in between the regulars and given their share of the operations.

Each job has its operations sheets. In fact, at Sperry, as many as 175 different varieties of products may be turned out in a single month. In the accompanying illustrations, it will be noticed that most of the workers have their operations sheets conveniently located for quick reference—unless their jobs are of a nature where reference is unnecessary.

Production Procedure

The wire preparation department at Sperry provides a good example of recent improvements. Looking back, the day is not too far gone when a chassis was wired by a skilled technician armed with a coil of wire, a pair of needle-nosed pliers and a soldering iron. His knowledge had to include complete familiarity with schematic diagrams, or drawings, and experience with soldering, identifying components and contact numbers, cabling and lacing, and it was desirable that he appreciate the importance of lead dress and circuit functions.

That type of operation more or less disappeared in the last war, but significant improvements have been made even in the past five years.

Today all wires are prepared in bundles prior to assembly. A small tag is the start of each bundle. On receipt of instructions from the production department, a shop worker refers to a list of wires that will be needed for a given job. A tag is then made out for each wire in the job. This tag tells the wire preparation department all it has to know to prepare the bundle. Length, type of insulation, gage of wire and end preparation details are included. Special instructions are given to shielded wires, telling what length of outer insulation is to be removed, where the shielding is to be cut, whether or not a ground wire for the shield is required, and so on.

The completed tags then follow each wire bundle through cutting, stripping, tinning and any other operations, so that the worker at each operation can abstract his instructions without reference to anything but the tag. Tags are visible in many of the accompanying photographs. Similar orders simultaneously go to all other production departments, with the result that necessary components converge on the assembly area at just the right time. Small parts are parcelled into convenient stack bins and numbered in sequence in the order of their use in the particular job.

Finally, appropriate operations sheets are dispatched among employees. Each employee goes to the appropriate departmental storage area, withdraws his necessary equipment, and production begins without delay.

Wire Preparation Details

When a tag is issued for a batch of wires, it first goes to the cutting department. Small sizes are then cut to length and stripped on conventional Artos automatic wire-preparation machines. Special lots are allocated to either hand operations, or special machines of the type shown in Fig. 1. This why-didn't-I-think-of-that idea is typical of aids that can drastically cut down on production time and increase efficiency. It consists simply of a pair of pneumatically-operated cutting jaws, a yardstick, and a snap-action switch which slides along the yardstick. The heavy wire, which cannot be processed by the Artos machines, is pulled from a coil through the cutting jaws until its end comes in physical contact with an improvised target that is fixed to the snap-action switch. At that instant, the jaws cut the wire to the desired length. A pointer on the yardstick permits adjustment for different lengths.

From the cutting operation, the smaller wires go to the twisting and tinning operation. Several other time-saving operations are applied at this step, where larger wires—especially shielded cable — are processed.

Figures 2, 3 and 4 show the old and two new ways for removing outer shielding. The old way, and this method is now in use at many plants, involved an operator using a pair of shears to remove the prescribed amount of shielding. The first of the new systems (Fig. 3) consists of two processes, each handled by separate operators. The first is referred to as pyramiding. The operator grasps the shield with two pairs of V-shaped jaws. He then bunches the shielding by pushing the jaws toward each other, with the result that a pyramid-shaped flange of shielding forms around the wire. The wire, thus prepared, is then passed to the next operation, which is known as nibbling. Here a pair of flush cutting surfaces nibble away at the raised portion of the shield as the operator turns the wire. Then the shield between the end of the wire and the removed pyramid drops free.

The second shield remover is a recent addition, and is still undergoing evaluation. The operation is much simpler and faster. The tool is shown in Fig. 4. A hardened steel tube, attached to a universal joint, passes through a circular inside cutting surface. The tube's inside diameter is sufficient to accept the insulated inner wire, while the shielding fits over the tube. It is relatively simple to push the wire onto the tube in this fashion. After inserting the wire, the tube is moved circularly around the inside cutting surface of the tool. The blade shears the shield in several motions and leaves the shield conveniently flared for insertion of a ferrule. The steel tube is held in place by a chuck to facilitate rapid changes for different wire sizes. A graduated rod in the tube measures the amount of shielding to be removed.

Most marking is done as a matter of manufacturing convenience, though some jobs call for marked leads for certain terminal board connections where marking facilitates service in the field. Commercial markers may be used, or small pieces of premarked tubing fitted over the ends of the wires. In the latter case, a slight bend in the end of the wire will hold on a piece of rigid tubing until the lead is soldered in and the marker removed.

It was found in using commercial marking machines that a conventional typewriter ribbon would serve well as a source of ink, if the imprints were subjected to a drying process. An ordinary 200-watt infrared lamp shining on a boxfull of pieces of tubing does the job of drying thoroughly and quickly.

Conventional automatic and manually operated lug and ferrule machines insure good connections to wires at their terminations.

Harness-Making Hints

The value of prefabricating wire harnesses for complicated chassis has long been known. Harness boards save countless hours in production time. By prewiring multiconnection plugs before the harnessing operation, even more time is saved. Dugouts must be provided to accept the plugs in the proper plane. Figures 5 and 6 show typical old and new harness-making locations at Sperry. The job, shown in Fig. 6, involves a three-dimensional harness with plugs brought out at right angles to one of the planes. Cotter pins hold wire ends in place, while simple nails secure eyelets. Numbers at the ends of each wire enable the worker to proceed on a job, working from his operations sheet, with no experience on a particular model, but with certainty that what is done is right.

The wire rack at the left in Fig. 6 is a development that has generously rewarded its inventors. The wires are placed in the rack in advance, and in the order in which they are to be added to the harness,

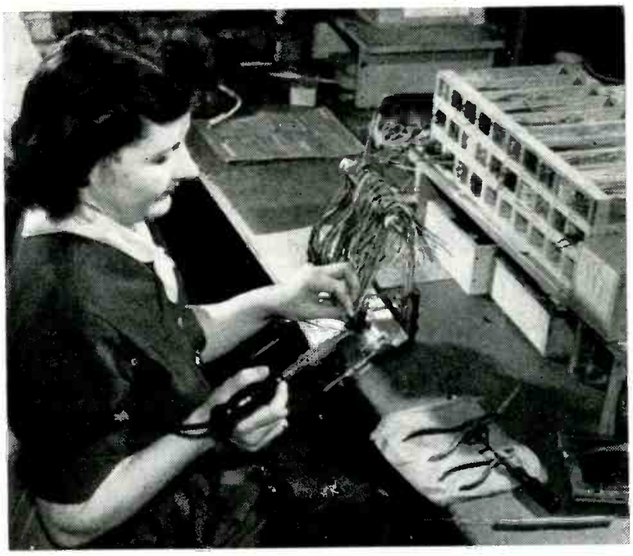

FIG. 7—All plugs are prewired at locations such as these. Note convenient position of operations sheet for quick reference

FIG. 8—Subassembly location shows block of stack bins, soldering-iron holder, rubber flap over a-c outlet and tool drawers

starting at the upper left and working down as one reads a page of written text. Each wire is precut to exact lengths and properly processed for the particular job. The wire racks are built of basic building-block rows of ten pigeonholes that may be placed on top of one another and in back of one another to accommodate more wires or longer wires.

Figure 7 shows a typical plug-wiring station. Universal fixtures, used throughout the plant, and completely adjustable, hold one or several plugs. Notice the operator has her operations sheet at her left and the wire rack conveniently located. A spring fixed over the jig holds wires out of the way after they have been soldered in place.

Subassembly Prefabrication

Figure 8 shows a typical subassembly location. The stack bins are, as might be expected, all prefilled with the specified number and types of components, all placed in order of use, corresponding to the operations sheet for that job. The tool in the hand of the operator on the left is a wiping tool which bends the wire around lugs on terminal boards. The cradle type fixture permits rapid changes in position of subassembly.

The soldering-iron stand shown in the background has several convenient features. The iron may either be inserted from the back, as shown, for work requiring two hands, or from the front for removal and application to fixed assemblies. A specially-treated pad in front of the iron makes it easy for the operator to keep his iron clean, with resulting improvement in soldered joints. The chest of drawers under the table is provided for the employees' tools and personal effects. The use of these relatively simple facilities greatly reduces cluttering of the working area with cosmetics, cigarette packages and so on. A clip-on rubber protector over the 110-volt outlet under the bench prevents down time as a result of loose wire ends shorting out power lines and eliminates certain human hazards.

The leads of all small parts are preformed, prior to assembly, on special machines designed for that purpose. When a resistor arrives at the assembly area, it has already been trimmed and bent to conform to the points between which it is to be soldered. Short bus pieces are also thus preformed.

Inspection locations are dispersed through the plant so that rejects take the form of small subassemblies instead of completed units.

The plant is at present in the process of installing swinging ash trays that may be moved out of sight under the bench when not in use. This reduces the possibility of ashes getting into work, and adds generally to the appearance and efficiency of the shop.

Soldering irons are assigned to each individual operator. Simple hand tools are his personal property; these are made available at cost to him through the plant tool room. This scheme introduces an actual improvement in work through pride of personal ownership.

It was found that ten minutes of production time was wasted at the end of each shift because the operators pulled their plugs to let their soldering irons cool for storage. This waste was eliminated by providing asbestos scabbards for the irons, which allowed them to be disconnected at quitting time and stored while still hot. Soldering iron tips are maintained by a special crew. Special partly-chromium-plated tips are used.

Future Planning

The basic operations outlined are, for the most part, typical of the things that make increased production efficiency possible. They are mostly simple things, brought about by cooperation and understanding and a will to turn out good work efficiently. Their incorporation was not a matter of chance, but the result of a five-year study of methods and facilities.

Carried through other assembly operations, the same kind of planning that has facilitated wiring is making it possible for less-skilled production workers, backed up by experienced foremen working with a highly skilled group of production engineers, to do a better job.—J.D.F.

Horizontally-Polarized

Provides azimuth ratio less than 3 db for frequency range of 2,970 to 3,125 mc with good voltage standing-wave ratio. Vertical pattern has half-power points at 45 degrees, which gives antenna a gain of approximately 2 db over half-wave dipole

By CHARLES BRASSE, JR. and RICHARD THOMAS

*Bendix Radio Division
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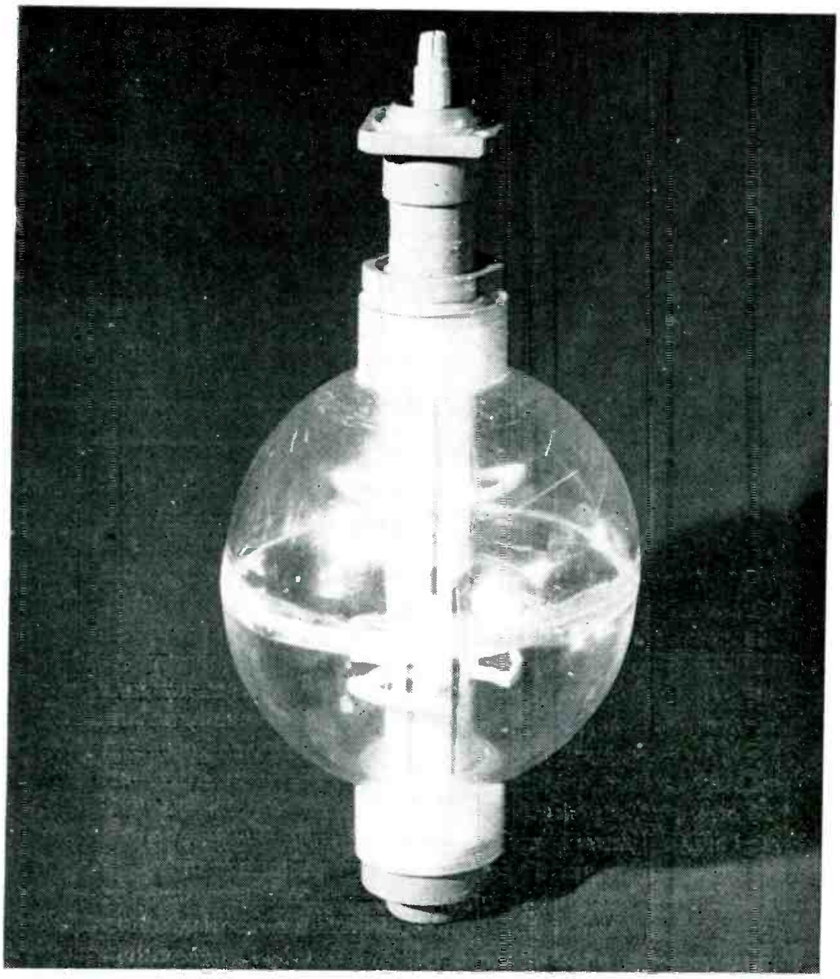

Horizontally-polarized omnidirectional antenna for 10-cm region mounts directly on rigid ⅞-inch coax. Plexiglas ball permits pressurizing antenna

THE ANTENNA described herein was designed for use in the 10-centimeter band, and the particular application for which it was intended required that the azimuth ratio be less than 1.5 db at the center of the band.

To achieve a perfectly omnidirectional pattern in the horizontal plane, with the polarization in this plane, the ideal radiating element should consist of a ring of uniform current. In practice, this type of current distribution may be approximated by means of a number of dipoles, slots, or loops arranged in a circular fashion and equally phased. All three types were considered in connection with the manner in which the elements could be mounted on a ⅞-inch rigid coaxial line, for convenience of manufacture, and it was decided that best results would be obtained through the use of loops as radiators.

Constructional Details

A very rugged feed system for loops can be easily built on the ⅞-inch line by inserting an even number of radial rods equally spaced about the periphery of the coax, alternate rods passing through to the center conductor. Loops are then formed by joining the ends of pairs of adjacent rods, as shown in Fig. 1A, where three loops are arranged on six rods.

This model was constructed by

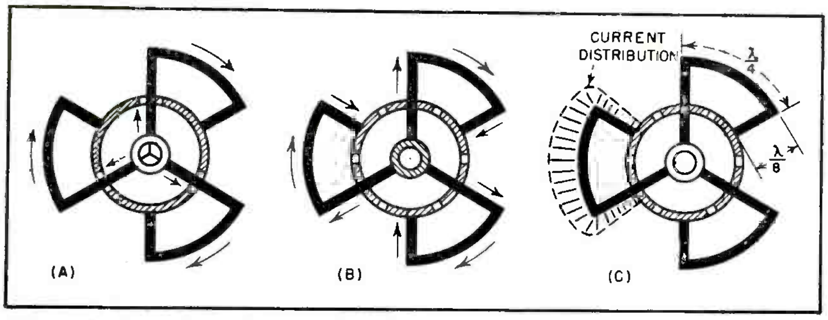

FIG. 1—Configurations shown at *B* and *C* are improvements of that shown at *A*. Addition of balun slots improves electrical and mechanical characteristics

Omnidirectional Antenna

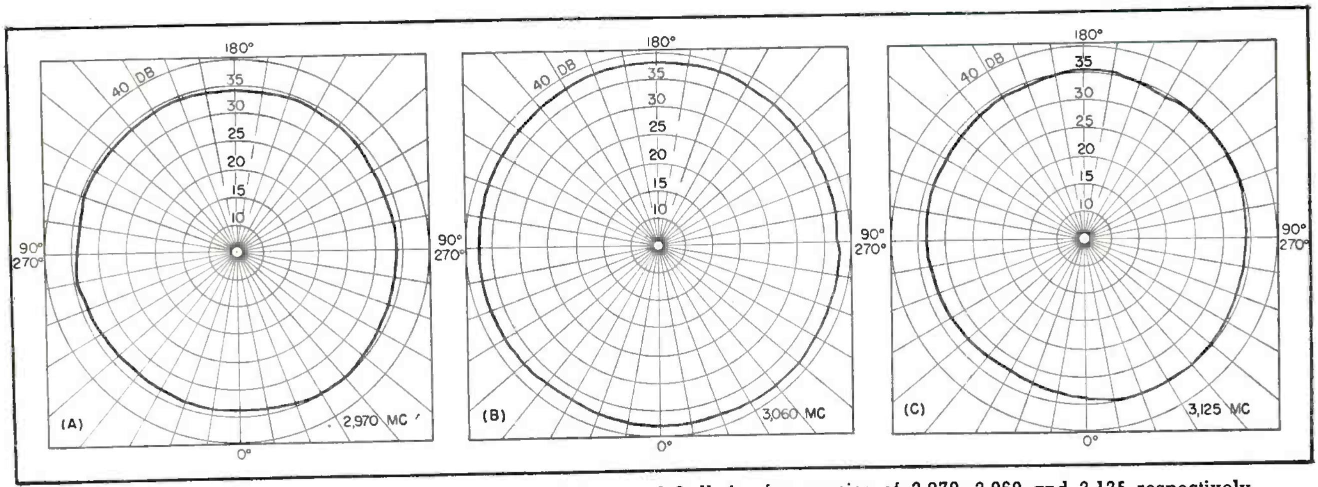

FIG. 3—Azimuth patterns show azimuth ratios of 1.25, 1 and 3 db for frequencies of 2,970, 3,060 and 3,125 respectively

using screws for rods, the ones joining the inner conductor passing through clearance holes in the outer conductor. This feed system can be improved mechanically and electrically by the use of slots as baluns and impedance-matching elements. Figure 2 shows a side view of this configuration, and Fig. 1B shows how the slots permit the proper polarities to be established. In this model, the screws entering the inner conductor are also soldered to the outer conductor, thus forming a rigid support for the entire assembly.

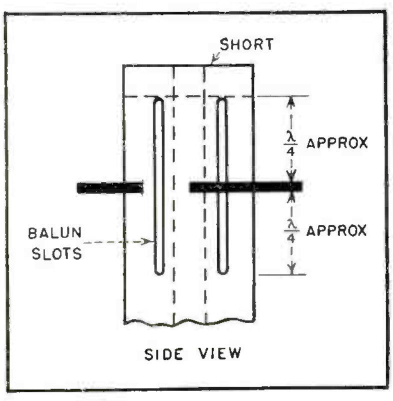

FIG. 2—Side view of configuration giving best results

The dimensions of the loops and the resulting current distribution are given in Fig. 1C from which it can be seen that the current is at a relatively high level at the rod ends. Dipoles could be used, but they would have to be longer, and the antenna would not be as mechanically rigid as the quarter-wave loops.

It would of course be possible to use the slots alone as radiating elements, by suitable probe feeding. In this case, however, the depth of the probes is somewhat critical and involves a tedious procedure of adjustment, especially if it is desired to stack two or more sets of elements to increase directivity in the vertical plane. By the use of loops, tuning is easily accomplished by increasing the length of the slots, which should be initially cut slightly less than a half wavelength.

A given set of loops will in general present an impedance which has low resistance and a capacitive reactance, and the negative shunt susceptance contributed by the slots will serve to match the antenna to the line with a minimum vswr of about 1.5. Increasing the loop perimeter will lower its apparent resistance and will produce a greater departure from a circular azimuth pattern, due to the shift of current distribution along the loops.

The photograph shows a two-stack array which was enclosed in a hollow Plexiglas ball as a simple means of pressurizing the antenna. The upper loops are located ¼ wavelength below the shorted end of the coax, and the lower loops, with feed reversed to obtain proper phasing, are spaced ½ wavelength below the upper set. The vertical pattern has a half-power beamwidth of 45 degrees, equivalent to a gain of approximately 2 db over a half-wave dipole. Figure 3 shows azimuth patterns taken at 2,970, 3,060 and 3,125 megacycles respectively, and the corresponding azimuth ratios are seen to be 1.25, 1 and 3 db. These patterns were taken on the Bendix automatic pattern-measuring equipment which provides a continuous recording covering a field strength range of 50 db, and incorporates facilities for self calibration in order to insure accuracy at all times.

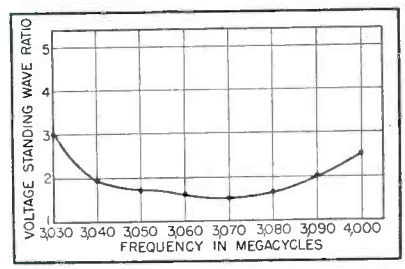

FIG. 4—Curve shows vswr for frequency range. No effort was made to extend range by broadbanding techniques

The vswr characteristics of this antenna are shown in Fig. 4.

Only three loops were required for each element, and the resulting antenna combines satisfactory electrical performance together with mechanical simplicity, ruggedness and ease of adjustment.

Community CIVIL DEFENSE

Onondaga County, N. Y., which embraces the city of Syracuse, is setting up a system which utilizes the existing two-way radio facilities of 13 commercial and civic services, plus amateurs, and expects to have it in fully-coordinated operation by mid-August

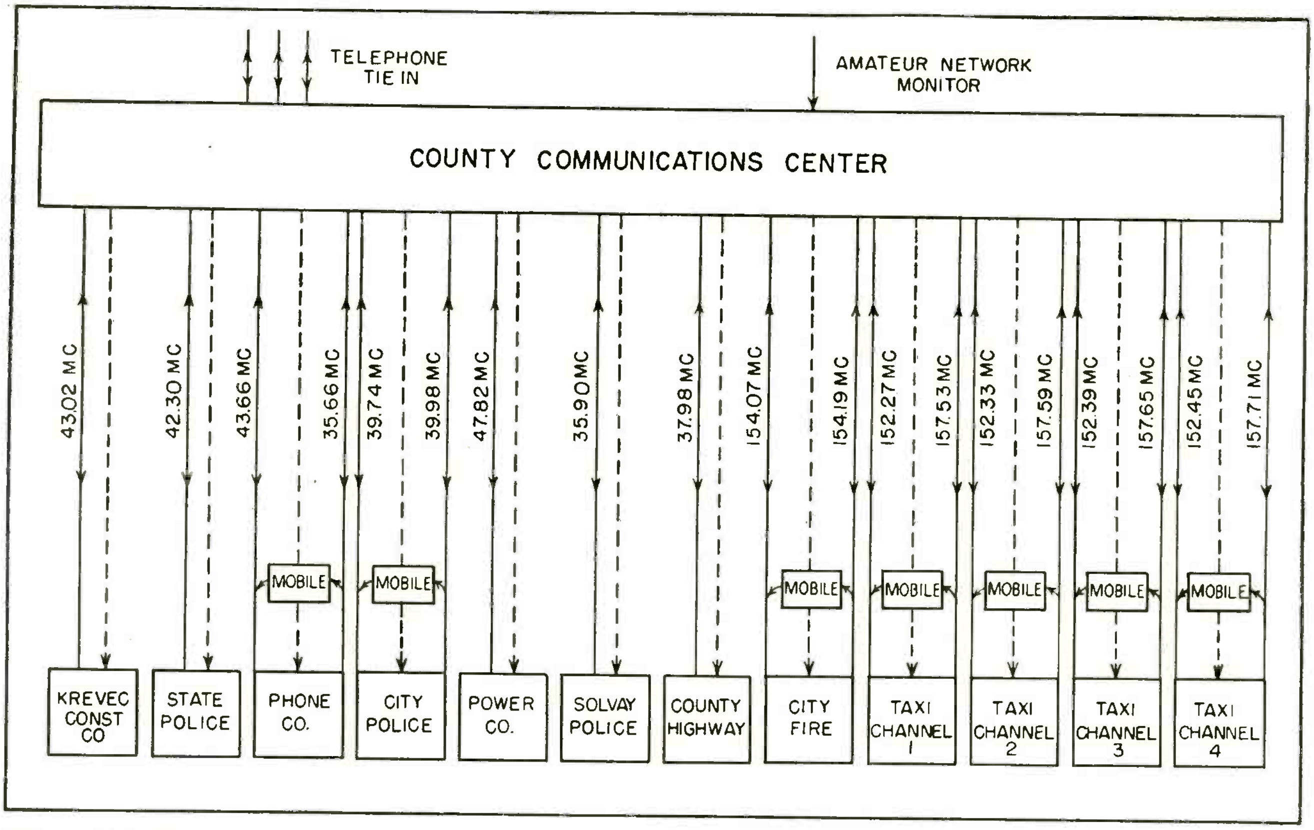

FIG. 2—Civil-defense system set up to make fullest use of available facilities and to provide an emergency backstop for them in the event of damage by sabotage or bombing. Dashed lines show paths of county-communications-center coordinating transmissions. Taxi-channel 1 is used by two independent companies

By NEAL F. HARMON

Civil Defense Coordinator
Electronics Department
General Electric Company
Electronics Park
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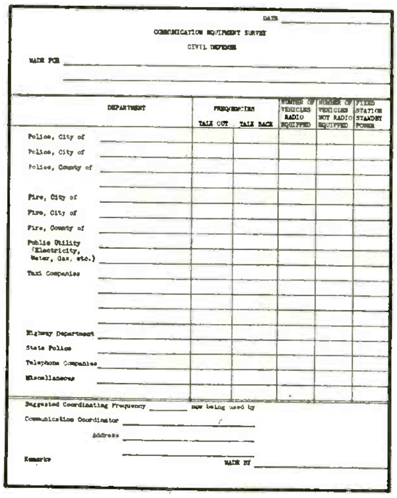
CIVIL DEFENSE authorities of Onondaga County, N. Y., including the city of Syracuse, are building a close-knit emergency communications system which will soon be ready for operation. The system will be flexible to the extent that it can supplement present communications in the area when needed, or take over for all present facilities in the event they are sabotaged or damaged in bombing attacks. It



DATE

COMMUNICATION EQUIPMENT SURVEY

CIVIL DEFENSE

MADE FOR

DEPARTMENT	FREQUENCIES TALK OUT	FREQUENCIES TALK BACK	NUMBER OF VEHICLES RADIO EQUIPPED	NUMBER OF VEHICLES NOT RADIO EQUIPPED	FIXED STATION STANDBY POWER
Police, City of					
Police, City of					
Police, County of					
Fire, City of					
Fire, City of					
Fire, County of					
Public Utility (Electricity, Water, Gas, etc.)					
Taxi Companies					
Highway Department					
State Police					
Telephone Companies					
Miscellaneous					

Suggested Coordinating Frequency ______ now being used by

Communication Coordinator

Address

Remarks

MADE BY

FIG. 1—Form used to determine two-way commercial radio facilities already available in Onondaga County

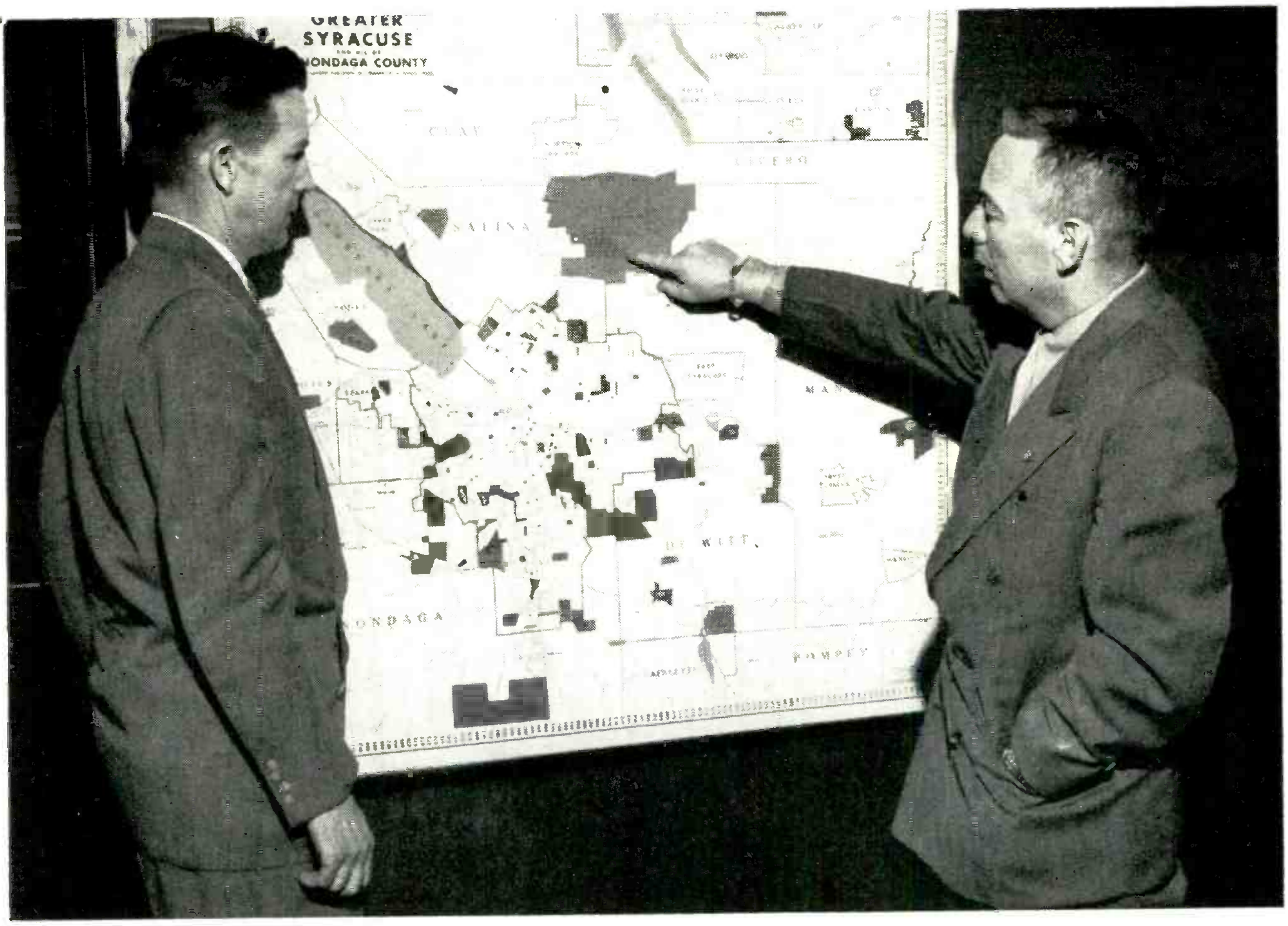
adds new radio facilities which can be used in peace as well as war emergencies.

Basically, the Onondaga County system revolves around a communications center equipped to (1) coordinate all existing commercial and civic two-way radio facilities in the area, (2) act as a standby system for any or all of these facilities if they are damaged in an emergency and (3) tie into other methods of communication such as the public telephone system and an amateur radio network.

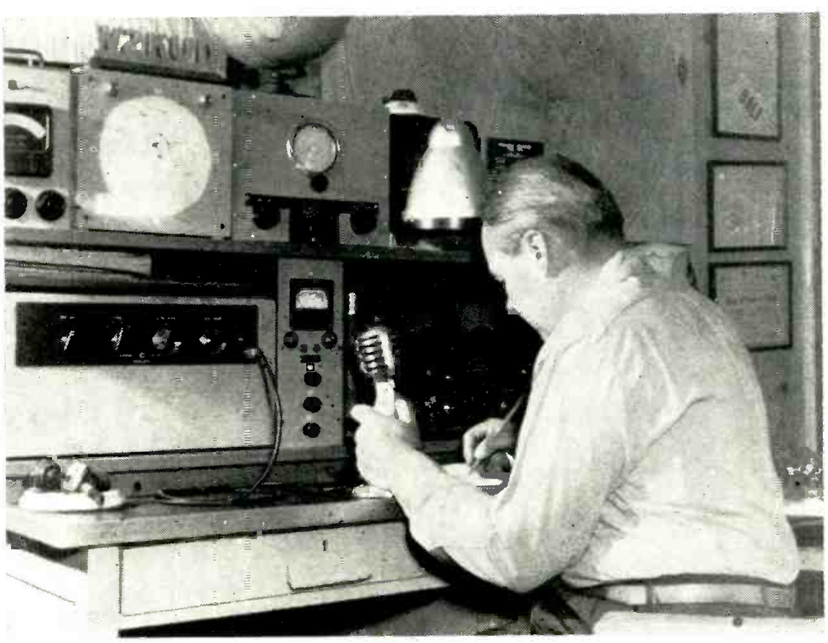
Setting Up the System

Using the form in Fig. 1, a survey was made of local two-way

COMMUNICATIONS Plan



Author Harmon (left) looks over map of Greater Syracuse area preliminary to survey of civil-defense-communications requirements by local officials, with Harvey S. Smith, Onondaga County Civil Defense Director, at right



AMATEURS are tied into the system and their network monitored from the county communications center

POLICE provide an important part of the facilities radio systems. Any community could utilize the same form to accumulate maximum information on available facilities. Using information recorded on the form a chart, Fig. 2, was made to pictorially present the entire system.

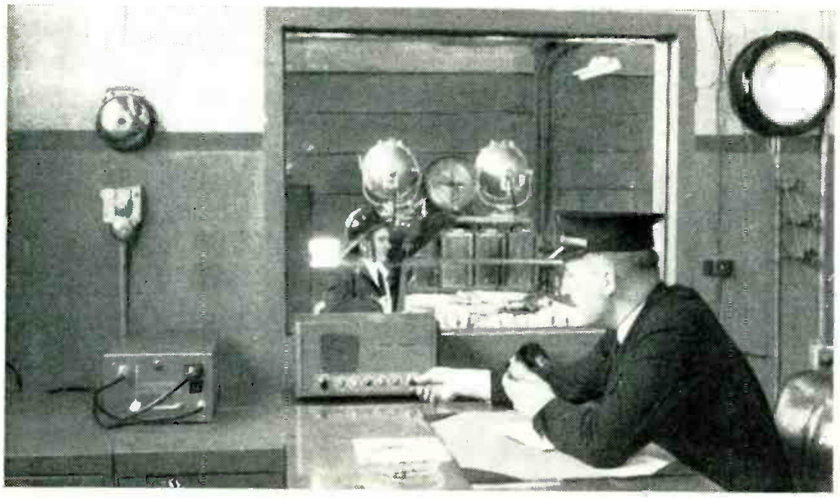
The survey revealed 13 services operating on 19 frequencies. These are the New York State Police, Syracuse Police, Village of Solvay Police, Syracuse Fire Department, Onondaga County Highway Department, telephone company mobile telephone subscribers, electric power company, a construction company, and five taxicab companies utilizing four frequencies. The County Sheriff's department shares the facilities and frequencies of the Syracuse Police Department. Seven of the services employ two-frequency operation, with mobile units transmitting on a different frequency than the main-station transmitter. The 13 services operate more than 400 mobile units throughout the county.

Communications Center

Civil defense authorities will maintain only supervisory control over the various services unless forced to take over for them because of loss of equipment, power or personnel. This means the CD center must be able to operate (1) as a mobile unit on any of the service frequencies, (2) as an auxiliary fixed station for any or all of the services should the need arise and (3) as a station from which to supervise and coordinate the entire system.

To do this, the center will be equipped with transmitters and receivers for each of the services. Seven transmitters will operate on two frequencies. There will also be a transmitter on a separate frequency for transmitting supervisory and coordinating messages, and a transmitter and receiver on the amateur frequencies.

Current plans call for the communications headquarters to be located in a large trailer (motor-truck-line type). Several remote locations will be established for tieing into telephone and power lines. As safety measures against possible sabotage, the center will be moved from time to time, and it will be unidentified insofar as call-letters are concerned. In addition to power connections at selected points, the trailer will be equipped with a gasoline-driven 110-volt a-c 10,000-watt generator.



FIRE DEPARTMENT radio equipment is incorporated into the overall network

UTILITIES are tied in

TAXICAB COMPANIES operating mobile two-way radiophones cooperate with C-D

It will be possible to operate all of the center's transmitters, and monitor transmissions for all of the coordinated services, from any one of four operating desks. Interlocks will prevent operation interference between desks.

When traffic is light, one operator will be able to perform all functions of monitoring, transmitting, and coordination. As traffic increases, a portion of it will be taken over by one or more additional operators at the other control desks. This division of duties will be conducted according to a predetermined plan.

Each operating desk will be equipped with key switches and relays to permit operation of all facilities. Each transmitter will be

TELEPHONE COMPANY mobile radio installations are incorporated in the plan

HIGHWAY MAINTENANCE radio equipment maintained by the county constitute an important link

CONSTRUCTION COMPANY maintaining its own private mobile radio system is part of the Onondaga County emergency network

protected by an interlock so that only one operator can operate it at one time. This plan affords maximum flexibility of control with a minimum of equipment.

"Alert" Receivers

Transmissions from the center on the coordinating frequency will be received at the dispatching points of the 13 services by means of an inexpensive receiver employing selective dispatch. All such receivers will be activated from the center by means of a tone-signalling system. They will, therefore, remain silent except to receive alerts and instructions from the center.

A tone-operated switch can be incorporated in these receivers, and used to activate warning and all-clear sirens directly from the trailer center. This will be extremely advantageous in some instances because the center will instantly receive alerts broadcast by the state-wide attack warning radio system.

All of the county's existing communication services are being encouraged to provide standby power equipment at their main stations. In addition, those services employing two-frequency operation are being asked to provide at least one of their mobile units with proper equipment to permit it to serve as an auxiliary dispatch station. Services operating on a single frequency need not alter a mobile unit to accomplish this but should have one mobile unit designated as an auxiliary dispatch station.

Four-Way Emergency Plan

Under the plan, there will be four possible dispatching conditions for each service. The first will be normal operation on regular power, then normal operation on standby power, then an auxiliary station in a mobile unit, and finally the trailer communications center will take over in case of failure of the first three.

In event of an alert, the operators will go to the trailer, whose location will be known to them at all times.

The operators will monitor the various services, including the New York State attack warning system, and coordinate alerting that remains to be done. All alerting and general instructions will be transmitted on the coordinating frequency, and received by the selective-dispatch receivers. Transmissions will be kept at a minimum, as will transmissions on all frequencies. The primary consideration will be to allow the various services to continue their own dispatching so long as they are able to do so in accordance with the established plan set forth by Civil Defense Authorities.

Following the dropping of bombs, or other disaster, the trailer center will be moved to a location near the scene, or to an advantageous site previously determined. It will be moved by one of the tractors offered by four trucking companies.

Much of the equipment for this system is currently being installed. The system is scheduled to be ready for operation by mid-August.

Remote Control of

Simple follow-up control circuit using two double-triodes permits moving industrial valves, levers and other motor loads to any desired position at full speed merely by changing the setting of a remotely located control knob

By GEORGE M. CHUTE

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THERE are many applications for simple electronic controls that operate relays to make a motor turn at full speed in one direction or the other to move an object or a load into a desired position. A small motor (up to 1/6 hp) may operate directly from the relay contacts. For large motors to 1½ hp, these relays may control the contactors of a reversing switch.

The electronic positioning control circuit shown in Fig. 1 is a general-purpose follow-up control that may be used with any type of motor to move an object into any position selected by turning a small dial.

As an example, a motor-operated valve can be controlled from a distance by turning potentiometer slider A to any point on its dial; immediately, perhaps 500 feet distant, the motor will turn at full speed until it has brought potentiometer slider B on the valve to the position that matches the setting of slider A.

Briefly, when no action is desired and the slider of B is in the same position as the slider of A, transformer T receives no voltage so tubes V_{1A} and V_{1B} are both passing current, and neither V_{2A} nor V_{2B} is passing enough current to pick up its relay. If the slider of A is moved up, this turns off V_{1A} so that V_{2A} passes current and picks up relay 1; the motor then turns FORWARD and its shaft drives the slider of B up also. Conversely, if the slider of A is moved down, this turns off V_{1B} so that V_{2B} picks up relay 2; the motor then runs in REVERSE so that the slider of B is moved down also.

This article is based on material contained in a book by the author, "Electronic Motor and Welder Controls", published this year by McGraw-Hill Book Co.

Although a-c voltages are applied to the plates of all tubes, no tube can pass current during the negative half-cycles of plate voltage. During the positive half-cycles, the left-hand terminal of dead-zone potentiometer R is 4 volts more negative than the cathode of V_{1A}. When transformer T is producing no voltage (so that no voltage appears across R_1, R_2, C_1 and C_2), the grid voltages of V_{1A} and V_{1B} may be varied between −4 and +14 volts, depending on the setting of R. Even when R is set so that the grids are negative, V_{1A} and V_{1B} pass a tiny current which, flowing through the high resistance of R_3 or R_4, causes a large voltage drop across these resistors. The grids of V_{2A} and V_{2B} are held far more negative than their cathodes, so tubes V_{2A} and V_{2B} do not pick up relays 1 or 2. This condition continues so long as the slider of A is not turned away from the same position as the slider of B.

Potentiometers A and B are connected to the same 115-volt a-c supply, with polarity such that when their sliders are in the same position, the two sliders are at the same potential and no voltage is applied to transformer T.

Follow-up Action

Assume the slider of R is set at its extreme left, for minimum voltage. As shown in Fig. 1C, the potential of the slider now is close to the cutoff potential of V_1. If the slider of A now is turned a small amount to the right, a small voltage difference (often called the error voltage) is applied to transformer T during the positive half-cycles to make its secondary terminal positive.

Position-controller potentiometer A causes a phase shift between the signal voltage of T and the line voltage (or anode voltage of the tubes). Capacitor C_1 acts with R_1 to bring the voltage across C_1 in phase; this is the voltage used to control V_{1A}, as shown in Fig. 1B. This small signal voltage from T forces the grid of V_{1A} closer to cutoff, reducing the plate current through R_3 and thereby swinging the grid of V_{2A} in a positive direction so plate current of V_{2A} increases to pick up relay 1. The same signal voltage has the opposite effect on tubes V_{1B} and V_{2B}, hence relay 2 remains de-energized.

Tubes V_1 and V_2 actually serve as a two-stage amplifier. Moving the slider of A through half a degree causes only 1/5 volt across the secondary of T. This tiny voltage at the grid changes the plate current of V_{1A} enough to vary the grid of V_{2A} by 6 or 8 volts; this makes the plate current of V_{2A} increase by 10 milliamperes, enough to pick up relay 1.

When relay 1 is picked up, a circuit is completed to the FORWARD contactor coil. The motor drives the valve load in the forward direction and also moves the slider of B to the right. This movement decreases the error voltage applied to T until the V_{1A} current increases and relay 1 drops out.

If the slider of A now is turned to the left, a voltage difference (or error voltage) again is applied to transformer T, but with opposite phase relation to the previous error voltage. Now, as shown in Fig. 1C, the grid of V_{1A} becomes more positive and relay 1 is not affected; the

Positioning Motors

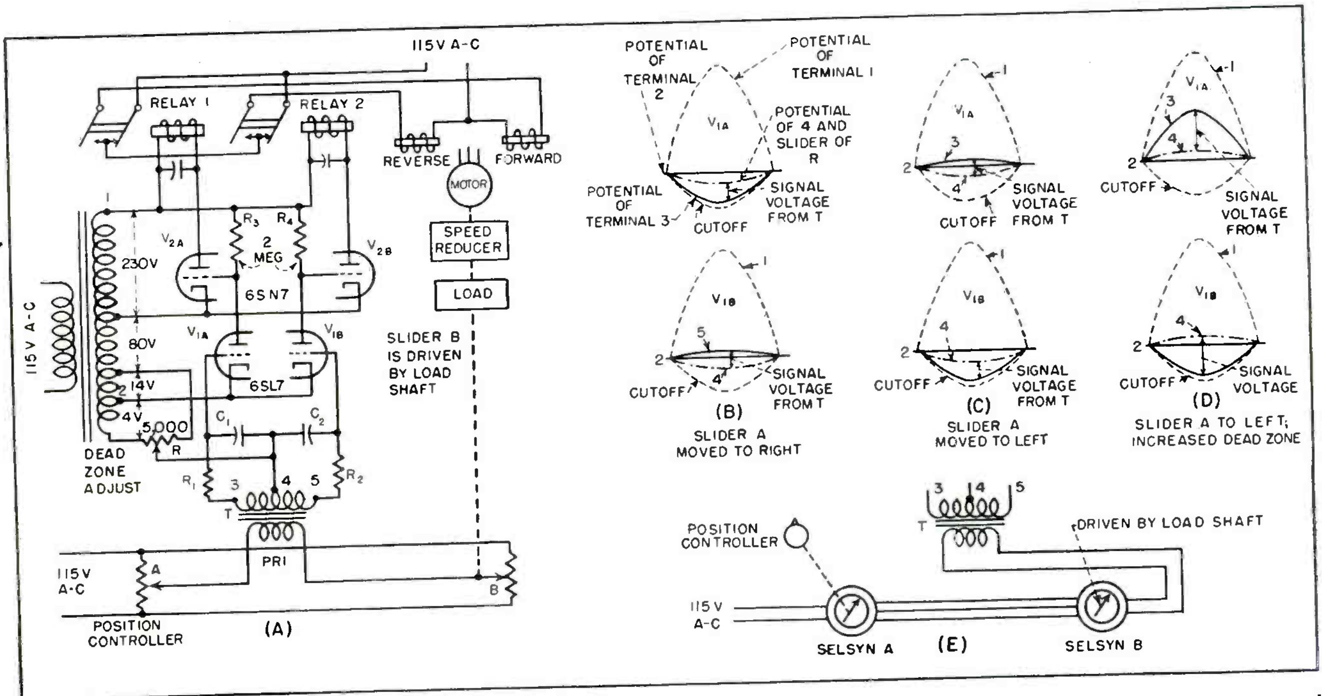


FIG. 1—General-purpose follow-up circuit for actuating contactors of reversible motor when knob of position controller is turned, waveforms of circuit voltages, and alternative controller arrangement using selsyns. Numbers on curves refer to potentials of correspondingly numbered transformer terminals in the circuit

grid of V_{1B} is forced more negative, decreasing the plate current of this tube and swinging the grid of V_{2B} more positive so that this tube picks up relay 2. This relay completes the circuit to the REVERSE contactor coil, so the motor drives the valve load in the reverse direction and moves the slider of *B* to the left until the error voltage at *T* decreases and relay 2 drops out.

Accuracy Versus Dead Zone

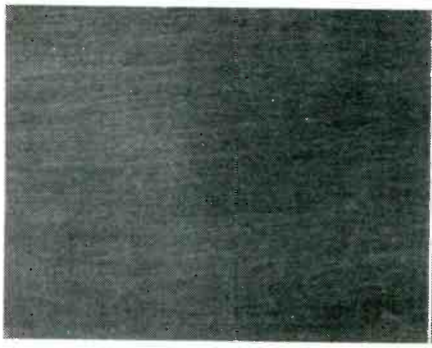
When dead-zone adjusting potentiometer *R* in Fig. 1A is set for minimum potential, a very small movement of the slider of *A* (perhaps only ¼ degree) may pick up relay 1 or 2; the motor turns, trying to position the load (such as a valve) and the slider of *B* to within this ¼-deg accuracy. However, such close follow-up or accuracy can rarely be used unless the motor is stopped quickly (as by a brake on the motor shaft). When the motor brings the slider of *B* to the position where relay 1 drops out (thereby removing power from the motor), the motor and its load may coast far enough to move the slider of *B* beyond the slider of *A* so that relay 2 picks up, reversing the motor. This may cause the motor to turn back and forth, although the slider of *A* is not being moved; this hunting action must be stopped.

If potentiometer *R* is now adjusted to raise the potential of its slider, as shown in Fig. 1D, the slider of *A* must be turned a greater amount (such as 2 deg) before the signal voltage of *T* is large enough to force the grid of V_{1A} low enough to make V_{2A} pick up relay 1. Similarly, as the motor drives the slider of *B* toward the same position as the slider of *A*, relay 1 may drop out while the slider of *B* still is 2 deg out of line. This permits the coasting motor to drive the load and the slider of *B* through an extra 2 or 3 deg without causing V_{2B} to pick up relay 2. Advancing the slider of *R* thus produces a larger neutral or dead zone within which no correction occurs.

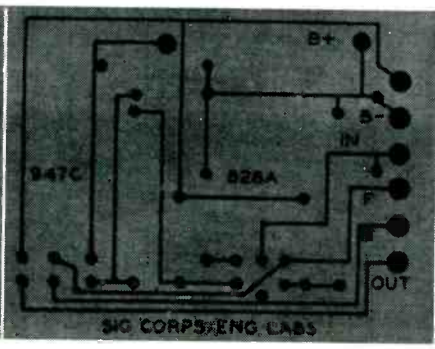
If the motor and load coast far enough to move the slider of *B* through 3 deg after relay 1 drops out, then *R* must be set to provide a dead zone of nearly 4 deg; this limits the accuracy to plus or minus 2 deg, since the slider of *A* may be turned 2 deg before either relay operates. The accuracy of any follow-up system depends on the width of the neutral or dead zone needed to prevent hunting.

Selsyn Control of Positioning

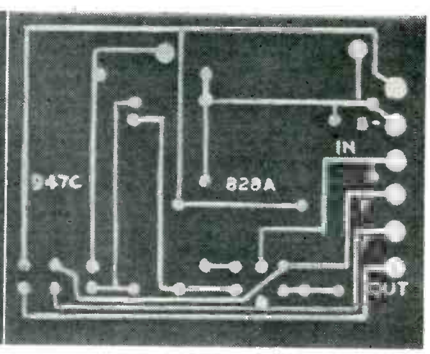
In place of potentiometers *A* and *B* in Fig. 1, two selsyns may be used as shown in Fig. 1E. Three wires connect the stationary parts of the two selsyns. The rotor of selsyn *A* may be turned through 180 deg by the position controller dial; the rotor of selsyn *B* is driven by the load shaft. When the rotor of *B* is exactly in line with the rotor of *A*, no voltage is delivered by selsyn *B* to transformer *T*, so the motor does not move the load. If selsyn *A* is turned to the right, selsyn *B* produces an a-c voltage at *T* that may turn off tube V_{1A} and pick up relay 1; the motor then drives selsyn *B* to the right, decreasing this a-c voltage. When selsyn *A* is turned to the left, the voltage produced by selsyn *B* is of opposite phase and turns off V_{2A}, picking up relay 2; the motor then drives selsyn *B* to the left until relay 2 drops out.



1 Copper-foil-coated phenolic chassis is starting point for auto-sembly of battery-powered audio amplifier



2 Conductor pattern is applied in acid-resistant ink by silk-screening or offset printing



3 Chassis after etching away unwanted metal in ferric chloride solution and removing resist

Auto-Sembly of Miniature

By S. F. DANKO
and
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THE SYSTEM of miniature circuit assembly to be described was evolved as a result of several Signal Corps study programs, aimed at providing relief from the production, performance and maintenance problems attendant on highly compact sub-miniature equipment designs. The system designated as auto-sembly borrows the very convenient prefabricated conductor pattern of printed circuits, and permits rapid and effective electrical combination of this pattern with conventional quality components by a one-shot solder dip process. The elements of auto-sembly are: (1) Formation of the conductor pattern; (2) selection of components; (3) rapid assembly; (4) packaging.

Of the many techniques of metallization extant today, the etching of copper-faced laminates (electrolytic copper foil bonded to an insulating base) provides one of the most convenient means of pattern fabrication. In this subtractive process, a resist image of the desired conductor pattern is printed or otherwise delineated on the copper foil surface and the laminate then exposed to an etchant. The resist material protects the metal against the action of the etchant during the short etching period. The Signal Corps Laboratories demonstrated early in 1949, in collaboration with the Etched Products Corp. of Long Island, that the commercial offset presses of the etched nameplate industry could be readily adapted to the deposition of such resists on commercially available foil laminates for subsequent etching.

The photo-etch technique of the graphic arts industry was equally well adapted to such resist fabrications, particularly where higher orders of definitions or reproducibility were desired. Several other metallizing techniques, including the Mallory pressed powder technique and the Franklin Air-Loop stamping process, are also compat-

Mobilization Advantages

SAVES LABOR by eliminating manual wiring, which ordinarily requires more man-hours than any other step in electronic equipment manufacture

MINIMIZES REJECTS because etched wiring is absolutely uniform from chassis to chassis

ELIMINATES UNSOLDERED JOINTS because all joints are made simultaneously in one solder-dip operation

REDUCES INSPECTION TIME because mechanization reduces probability of errors practically to zero

SPEEDS ASSEMBLY TIME because leads of components are simply pushed into holes, with no hook or wrap-around joints

PERMITS GREATER MINIATURIZATION, because etched wiring takes practically no space and lends itself to stacking of chassis layers

IMPROVES RELIABILITY, because auto-sembly practically eliminates short-circuits between connections and leads

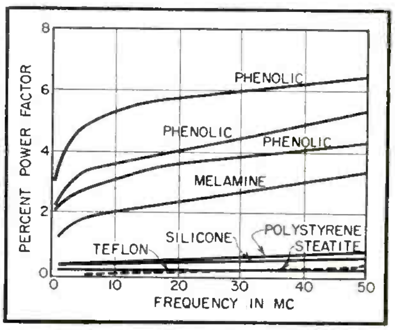
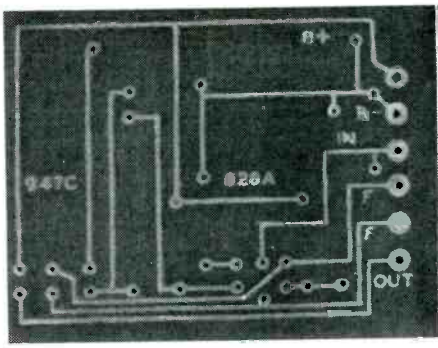
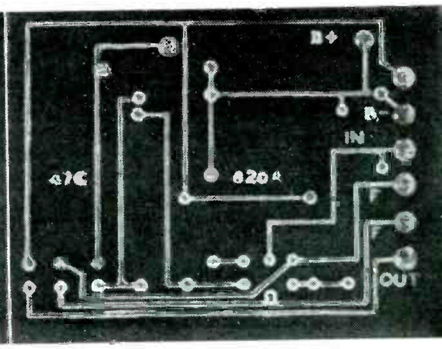


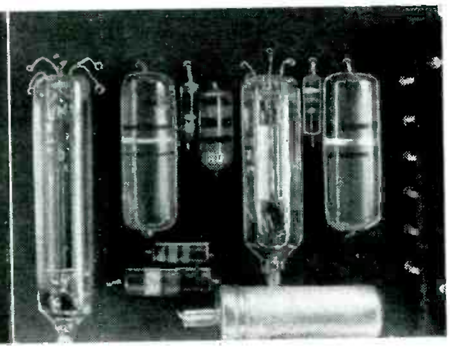
FIG. 1—Variation of power factor with frequency for some of the double-faced laminates used in auto-sembly. Note variations in phenolics from three different suppliers. Melamine, polystyrene, silicone and Teflon materials are glass-fabric or glass-mat loaded



4 Next step is punching or drilling of holes through which leads of components are inserted from rear



5 Underside of chassis after components are mounted and assembled by one-shot solder dip



6 Top of completed chassis, showing layout of tubes and components, with plug-in terminals at right

Military Equipment

Production of wiring by acid etching of copper-faced insulating laminates permits rapid assembly of high-quality conventional JAN components by inserting leads in punched holes, then immersing chassis surface in molten solder to make all joints simultaneously

ible with the auto-sembly system since they yield high-conductivity patterns which are amenable to component assembly by solder dipping.

It is the intention of this presentation to emphasize the etched-foil technique of preparing a conductor pattern, inasmuch as this process lends itself excellently to pattern fabrication by the laboratory designer for prototype model constructions. The choice of a process for forming the pattern for production depends on such factors as the detail required in the pattern, quantities involved, tooling costs, production rate and delivery time.

Laminates

The physical characteristics of the commercially available copper-faced laminates which are of prime interest for auto-sembly include bond strength of the foil to the laminate, compatibility of this bond with the temperature shock conditions which it will experience during solder dipping, dielectric constant, power factor, arc resistance and moisture absorption. Table I lists in a general way some of this physical data for comparison purposes, and Fig. 1 shows the relation of losses to frequency for several of these laminates. It should be noted that these loss curves apply where the base material is used as the total dielectric, between metallized faces on opposite sides of the material. In the usual application, where capacitances between adjacent lines are of concern, the losses are substantially lower than indicated since the dielectric is part air.

The laminates are also available with copper on both sides to permit fabrication of aligned patterns on both faces. Most common thicknesses of copper are 0.00135″, 0.003″ and 0.005″.

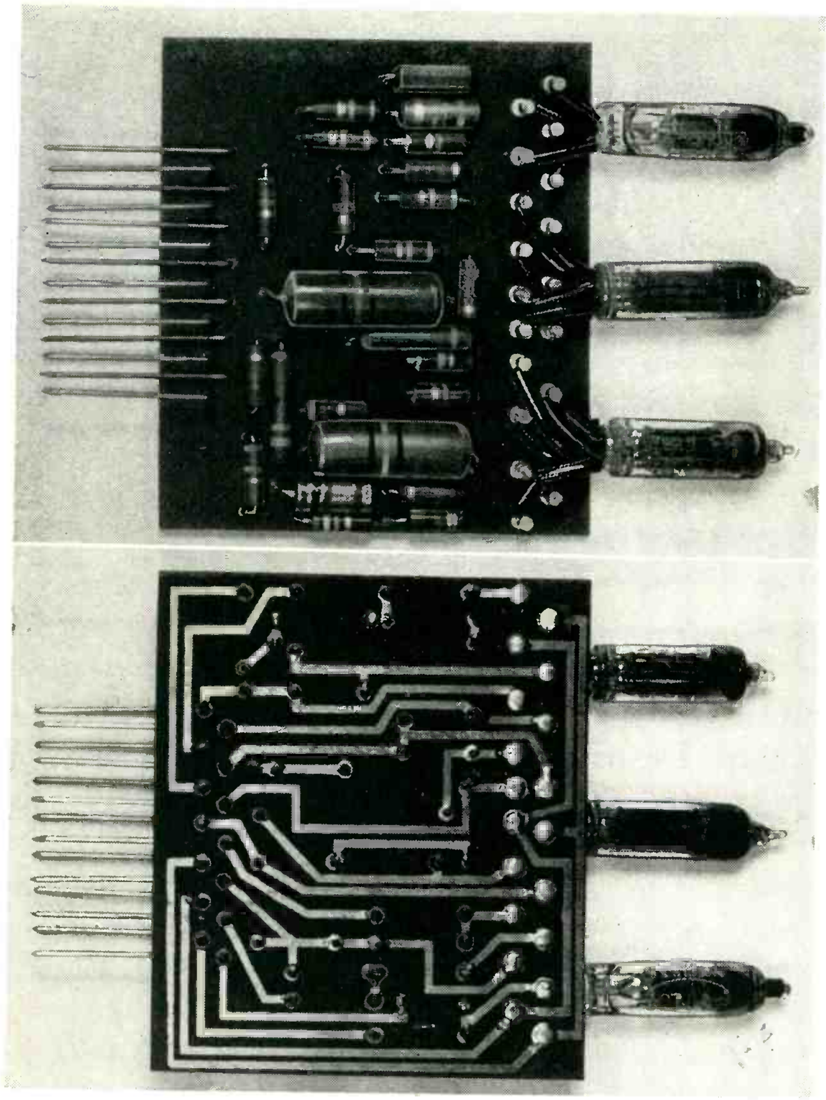
Resists

Within the design laboratory, screening of the resist is perhaps the simplest and most convenient method of printing the pattern prior to etching. The screens themselves may be prepared by any of

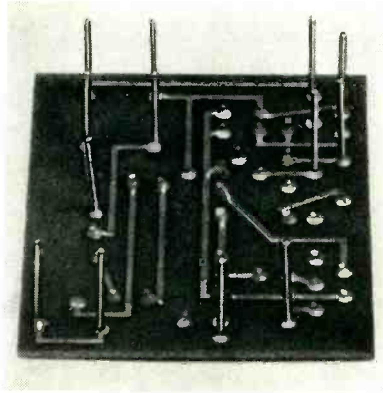
Table I—Characteristics of Copper-Faced Laminates

Laminate Chassis	Reported Bond Strengths* (lb)	App. Dielectric Constant	Power Factor at 1 mc	Moisture Absorption (24 hr)	Arc Resistance	Max. Operating Temp.
XXXP Phenolic	6–8	3.5–5.5	2.8 %	1.3 %	Poor	125°C
Melamine—Glass Fabric	7–9	6.8	1.3 %	2.0 %	V G	135°C
Silicone—Glass Fabric	2–8	——	0.35%	0.3 %	V G	200°C
Teflon—Glass Fabric	3–7	3.3	0.10%	0.3 %	V G	200°C
Polystyrene—Glass Mat	2–3	——	0.38%	0.55%	——	85°C
Polyester—Glass Fabric	(Under Development)				Fair	135°C

* Bond strengths are measured by pulling a scored one-inch copper strip vertically away from the laminate surface. The bond strengths vary among manufacturers but the values shown indicate the general range of values measured. (The bond strength of copper-phenolic is an exception, being representative of one manufacturer's item.)



Top and bottom views of auto-sembled chassis containing phase-shift oscillator, avc, and clipper-limiter circuits that serve as a unitized packaged plug-in assembly for a complex electronic fault locator. Embedment of chassis in casting resin will provide protection against moisture and give rigidity to plug-in terminals at left



Detailed view of solder-dipped pattern. Fillets at termination points are obtained by using a waxy flux. Long protruding leads go between components and into holes in next layer

the many commercial screening organizations or may be prepared within the laboratory without too much art or effort. For most general line work for conductors, a screen mesh of about 150 per inch is adequate.

Satisfactory resists for screening are many, but synthetic screening enamels available from the art supply houses have been particularly useful in this application. An example is the Synthetic Screen Enamel, series 1500, any color, obtainable from the Colonial Process Supply Co., New York City. Resists made by dissolving asphaltum in an appropriate vehicle are also convenient, but care must be taken to get the proper screening consistency. The synthetic enamel resists require approximately 8 hours to dry (overnight, or may be oven dried in a few hours).

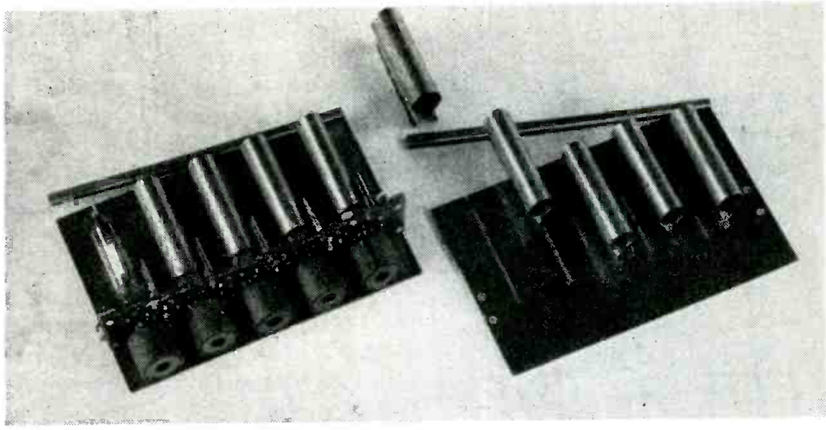
The foil laminates with the resist patterns may be etched in a rocking tray or may be mounted copper face down about one-half inch over the surface of the etchant, which can then be agitated by bubbling air violently through the solution. The recommended etchant for copper is a 50-percent solution of ferric chloride. This will etch through a 1.35-mil foil in about 5 to 7 minutes depending on the freshness and temperature of the bath. The patterns are then washed in running water, following which the enamel resist can be removed by use of a thinner or by light abrasion. Commercially these patterns would then be processed through a die stamping operation to provide the necessary holes through the pattern at each termination point. In the laboratory, of course, these perforations would be drilled or punched.

Conductor Characteristics

The thinner copper foils have more than adequate conductivity for general miniature circuit applications, as indicated in Table II. A 1.35-mil-thick conductor $\frac{1}{32}$-inch wide on a representative 3 x 2-inch phenolic plate will carry over 3.5 amperes continuously with a 40-degree C maximum temperature rise of the conductor. A similar 3-mil-thick conductor under the same conditions will carry over 5 amperes. A studied effort has been made to discourage use of such ratings as fusing currents, peak current capacity and similar short-time ratings which do not provide useful information for a designer's guidance.

For general conductor applications a line width of about $\frac{1}{32}$-inch is recommended, although widths down to 1/64-inch are dipped consistently. Experience to date indicates that an area of metal equivalent to about a $\frac{1}{16}$-inch-diameter circle at each junction point is desirable since a well-formed and substantial fillet of solder will then be built up. Spacing of lines, in general, should be kept at least at $\frac{1}{32}$-inch unless otherwise demanded by pattern layout.

On phenolic surfaces, the peak flash-over voltages at room ambient conditions with no coating protection over the $\frac{1}{32}$-inch pattern spacings were about 1,800 v. This



Experimental five-stage impedance-coupled i-f amplifier having heat-dissipating metal back plate and individual metal tube envelopes for conducting tube heat to the plate

$\frac{1}{32}$-inch spacing has been used consistently on 300-v d-c circuits, with no failures recorded. In this respect, the desirable arc resistance features of some of the laminates are strong points in their favor. With this spacing, insulation resistances well over 100,000 megohms under ambient room conditions are measured between 3-inch-long copper lines on phenolic with no protective finishes applied.

The distributed capacitance between lines is significant and cannot be ignored at the higher frequencies. On XXXP phenolic, this capacitance is of the order of 1 $\mu\mu$f per inch for $\frac{1}{32}$-inch spacing and 0.7 $\mu\mu$f per inch for $\frac{1}{8}$-inch spacing. These values will be lower for the lower dielectric constant materials. Proper pattern layout will allow use of very short sections of r-f conductors, and it has been convenient at times to run short ground lines between two critical conductors to reduce this electrostatic coupling to a still lower figure.

Although the inherent power factor of such materials as phenolic is fairly high, the effective power factor is considerably better inasmuch as the dielectric of the distributed capacitance is part air and part insulating material. As a generality, this pattern capacitance can be said to be comparable in magnitude to that which may be encountered in conventionally wired compact assemblies, but with the advantageous feature of being identical from pattern to pattern.

The commercial offset press process can yield line work of the order of 8 to 10 mils in width as a matter of routine production. The photo-etch technique yields conductor widths down to about 4 mils without premium charges. These higher definitions are useful in delineating the precise geometry required of spiral-formed coils such as have been used in television tuners and high-frequency i-f coil patterns.

It is recommended that the finished copper patterns be silver-surfaced by dip plating (which yields a satisfactory flash coat) or by direct plating to eliminate oxidization of the metal on long storage with the subsequently increased difficulties of cleaning. The commercial etching houses will supply such surfacing as a matter of normal production processing.

Table II — Resistances of Etched Copper-Foil Conductors

Line Width (inches)	Ohms per Inch at 20°C for 100% Conductivity Copper		
	0.00135″ Thick	0.003″ Thick	0.005″ Thick
1/100	0.050	0.023	0.014
1/64	0.032	0.015	0.0087
1/32	0.016	0.007	0.0043
3/64	0.011	0.005	0.0029
1/16	0.008	0.0035	0.0022
3/32	0.0054	0.0024	0.0015
1/10	0.0050	0.0022	0.0014
1/8	0.0040	0.0018	0.0011
5/32	0.0032	0.0015	0.0009
3/16	0.0027	0.0012	0.0007
1/4	0.0020	0.0009	0.00055
3/8	0.0013	0.0006	0.00037

Copper has been mentioned exclusively as the conductor material because of commercial availability of the copper-surfaced laminate. However, some of the etching sources which do their own laminating have prepared patterns of brass, silver, iron, aluminum, bronze and even spring-tempered steel for special purposes. Some of these metals have proven particularly useful in delineating patterns for switches. It should be mentioned, too, that these laminators-etchers can supply embossed, flush or subsurfaced patterns for special purposes or provide upset metal nodules on the patterns where required for switch contact points.

Components

Auto-sembly requires that the components have stiff protruding terminations, preferably of a radial type, such that the component can be conveniently inserted into its designated place on the insulated side of the chassis. Resistors, capacitors or other components having axial leads can have these leads cut and shaped by jigging machines built for this purpose. The production arrangement can be such as to have the operator hold the conventional component momentarily in the jig for shaping and then in the next motion insert it into place on the pattern. The alternate proposition would be to supply the operator with pre-jigged components. Components where stiff protruding terminations are desired include termination devices such as sockets, connectors and receptacles. Current Signal Corps developments aim to provide such electro-mechanical devices that are particularly adapted to auto-sembly or other card-type systems.

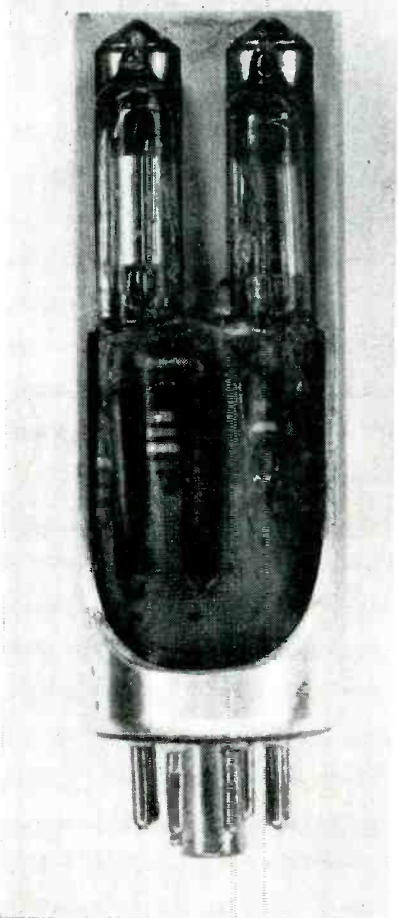
Most conventional components can be readily adapted to auto-sembly mountings. The use of conventional components is considered a desirable and realistic approach in this miniaturization technique. The designer has available for his choice not only the variety of components but also the full range of tolerances, electrical characteristics and physical sizes in the established quality lines of JAN or commercial components. There are no special skills imposed on the assembler of the equipment such as would be required if he were to deposit or print his own resistors or capacitors. The fabrication of such deposited components is still a highly specialized art. Where economic or performance advantages can be realized in any fabrication through the use of these printed circuit aggregates, then such groupings of deposited components (such as Couplates, Bulplates and multi-value capacitors) can be treated like any other component for auto-sembly.

Assembly

The use of the one-shot solder-dip technique has been particularly convenient in the fabrication of highly miniaturized assemblies. In this operation the insulating base, with the fluxed pattern on the underside and the components mounted on the topside, is momentarily dipped in a eutectic solder bath (63 percent tin, 37 percent lead) maintained at about 450 F. The period of dip recommended is of the order of two or three seconds, but this time may be increased if large areas of copper are left on the pattern for shield purposes or as heat radiation surfaces. Periods of dip as high as ten seconds have been made without delamination or deleterious effects on such base materials as phenolic, Teflon or silicone.

The success of the solder dip procedure is particularly dependent on the flux used just prior to solder dipping. The following formulation has been found successful: 1 part Glyco Wax No. S932 made by the Glyco Corp., Brooklyn, N. Y.; 1 part Kester No. 1015 (activated rosin in alcohol flux) made by the Kester Solder Co., Newark, N. J.; 1 part toluene (more toluene may be added if a thinner consistency is desired). The bath should be kept warm during use (about 110 F). The flux itself may be applied by dipping the pattern side momentarily in the flux or by brushing the flux over the pattern.

It is important that the pattern be removed from the surface of the solder bath with a sidewise lifting motion. This technique yields a soldered pattern with well-formed fillets at each termination point and a more or less hemispherical cross-



One-watt audio amplifier with portion of metal heat-dissipating container cut away to show use of folded circuit. Components are auto-sembled on flexible Teflon chassis that is rolled up and inserted in container, then cast in resin. Subminiature tubes fit into machined holes in solid metal end of container

section of solder on the conductor lines. The pick-up of solder on the conductor lines is extraneous and incidental to the process but it does add to the total conductivity of the conductors. One manufacturer on a production line basis has evolved a variation of this technique wherein his solder dip procedure deposits mechanized solder only at the termination points, a desirable process from the point of view of solder economy.

Packaging

Packaging includes ruggedization, moisture protection, adequate heat transfer and provision of connective components such as may be required for plug-in use. Use of right-angled connectors provides a convenient means of integrating a connector quickly to the pattern since such a connector is treated as any other component in the course of the assembly operation.

Although stiff laminates have been discussed up to now, flexible laminates have been used as the chassis for the pattern in making folding circuits. Assemblies on thin sheet Teflon glass laminates and on silicone rubber (thicknesses of 3 to 10 mils) have been auto-sembled and then folded and inserted into capsules.

Conclusions

The complete and detailed coverage of all aspects of the auto-sembly system have not been presented here because of the voluminous nature of an exhaustive treatment of the subject. It can be shown, for example, that sections of auto-sembly circuitry can be decked by providing completed solder-dipped auto-sembled sections with stiff swaged-on protruding connectors which can be inserted into place on another deck and then solder-dipped into place. Crossovers can be made by eyeletting and subsequent spot-soldering on double-faced laminates, or by use of staple-shaped wires as components.

The information as presented has been intended to show some of the more basic concepts and techniques of auto-sembly and the major considerations which govern its current applications in service and commercial equipment application. The use of the etched pattern and the auto-sembly system of integration both provide effective tools which are not necessarily limited to electronic circuit fabrication. These patterns, for example, are used in the preparation of heaters, Faraday shields, switching devices, and in one instance even for forming low value bypass capacitors. Auto-sembly is being used in new military equipment designs and is currently applied commercially to repetitive types of circuits such as are used in counters. The extrapolation of auto-sembly to other applications is dependent almost entirely on the imagination of designers familiar with the capabilities of these tools.

Automatic TV Sync Lock

Facilities for special effects can be applied to an incoming video signal from a remote point, such as a network broadcast. The local sync generator is synchronized to the remote with horizontal afc control and phase-correction control of the vertical interval

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TELEVISION programming requirements continually demand increased versatility on the part of the technical facilities.

Equipment is available to perform various special effects such as montage, superposition, lap, fade and wipe dissolve, as long as all program material is obtained from studio and film channels referenced to the same synchronizing generator. The application of these local technical facilities to program material originating at a remote point necessitates that the local synchronizing generator be synchronized, both in frequency and phase, with the mixed sync of the composite remote signal. A sync lock unit performs this synchronizing function.

With a sync lock system a picture signal coming in from a remote point of origination, such as the signal from a network, an off-the-air receiver, a satellite studio, or a remote pickup, can be treated and handled just as though it originated in an adjoining local studio. All of the special effects facilities can be applied to this remote signal.

For example, local commercials can be surreptitiously inserted into a network show of a nationally advertised product. On a local remote pickup it is not necessary to transport extensive additional equipment to the pickup point or, alternatively, to switch composite video signal to the local sync generator, with a flapping disturbance, for each commercial or local program insertion.

A remote signal, either from the network or off the air, frequently exhibits bad spiking of the front porch, sync distortion, obliteration of the sync by noise or improper front-porch width. With an adequate sync lock system such a distorted composite remote signal can be reconstructed with clean sync.

The sync lock must provide solid and undisturbed synchronization of the local sync generator. Additionally, it must provide front-porch width adjustment, remotely controlled from the station video control position, so that the time phase between remote signal blanking and reintroduced local sync can be matched quickly to the local system setup. For maximum utility the sync lock should be automatic in operation and free from critical adjustment such as clipping level controls. A sync lock unit which meets these requirements has been developed.

Locking Method

Synchronization of the associated local sync generator to the remote sync generator is accomplished by automatic frequency control of the master oscillator of the local sync generator and automatic phase-correction control of the vertical interval. Since the remote signal is composite video and sync, as obtained from a network connection or from an off-the-air receiver, it is necessary to separate out the video and retain the

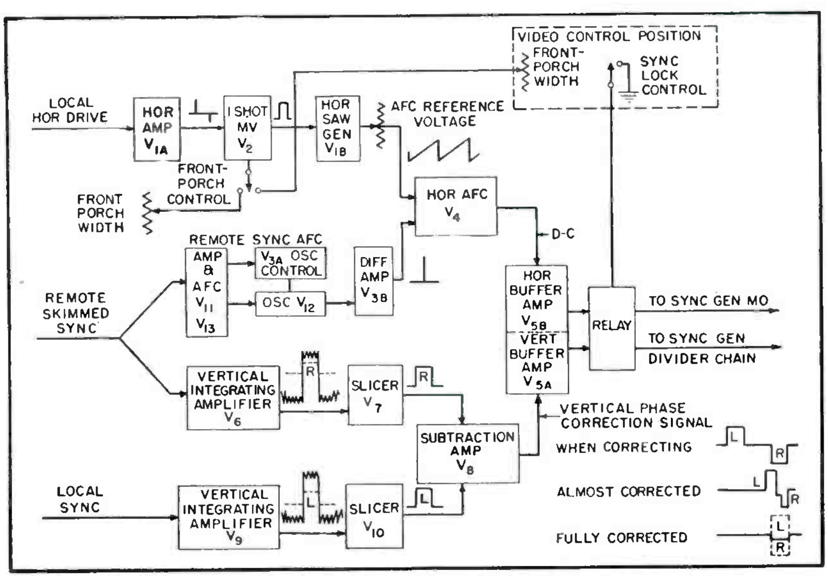


FIG. 1—Stages of the sync lock and their functions

skimmed sync for use as the input remote mixed sync signal. Skimming of the sync is normally accomplished through the use of a stabilizing amplifier.

The basic functions of the various portions of the sync lock are shown in Fig. 1. There are only two operational controls, both of which are most conveniently located at the video control position of the station. These controls are the sync lock REMOTE-LOCAL with push-button switch and the FRONT-PORCH WIDTH adjustment for the sync lock.

Horizontal AFC

The horizontal afc, V_4, performs the function of automatic frequency control of the master oscillator of the local sync generator. It utilizes a sawtooth waveform, derived from the local horizontal drive, and a narrow pip derived from the horizontal sync of the incoming remote sync signal.

The narrow pip allows the instantaneous value of the sawtooth voltage occurring at the time of the pip to charge the output capacitor of the afc. This voltage controls the frequency of the master oscillator of the sync generator. If this oscillator, and hence the repetition rate of the sawtooth, is not at the correct frequency the subsequent pips will alter the d-c output voltage of the afc, thus changing the oscillator frequency.

The phase relations of the afc, the d-c control voltage and the oscillator frequency are such as to adjust the frequency so that the pip will always occur at the same voltage level point on the fast part of the sawtooth. Any attempt on the part of the oscillator to change frequency is immediately counteracted by a change in the d-c controlling voltage in a direction to correct the frequency change.

The narrow pips at horizontal rate, to feed the horizontal afc, are derived from the incoming remote skimmed sync. They are maintained synchronous, even though the input sync may be badly distorted by noise, by the utilization of a closed-loop sync afc system. These circuits are analogous to the horizontal sync circuits used in a modern receiver. In this adaptation the sync afc is a pair of diodes, a part of V_{11} and associated circuits.

Filter circuits are employed to stabilize the afc and to prevent frequency modulation of the generated narrow pip, output of V_{3B}, caused by the disturbing action of the equalizing pulses and serrated pulses occurring during the vertical interval. The d-c output of the sync afc controls the effective resistance of the oscillator control tube, V_{3A}. Change in this effective resistance controls the frequency of the syn oscillator, V_{12}.

Although this is a sine-wave oscillator, the circuit arrangement is such as to generate a sawtooth waveshape at the plate and this is fed back to the sync afc. Also, the sawtooth is differentiated in the grid of V_{3B} and amplified, thus forming the narrow pip signal required to feed the horizontal afc.

The sawtooth waveshape for the afc is generated in V_{1B} and is synchronous with the local sync generator horizontal drive. The d-c axis for this a-c voltage is set by the afc reference voltage, the value of which is determined by the particular sync generator with which the sync lock is associated.

The time duration of the fast part of the sawtooth is determined by the width of the pulse generated in the one-shot multivibrator, V_2, and is adjustable over a suitable range by the front-porch width control.

Front-Porch Width

The multivibrator pulse, the length of which determines the front-porch width, is initiated by the leading edge of the local horizontal drive input signal. Since the width of the multivibrator pulse is controlled by a d-c voltage, a very simple remote control of the front-porch width is obtained.

The way in which an incorrect front-porch width on the incoming remote sync is corrected through the front-porch width adjustment, where the system is operated with reintroduced local sync on remote blanking, is shown in the phase relations diagrams of Fig. 2.

Figure 2 shows the conditions when the remote sync has a narrow front-porch width. For illustration, remote blanking, sync, and front-porch are assumed as 11, 4.8, and 0.5 microseconds respectively. The narrow pip signal, output of V_{3B}, is shown as being one microsecond delayed from the leading edge of remote sync. This delay of about one microsecond was designed into the

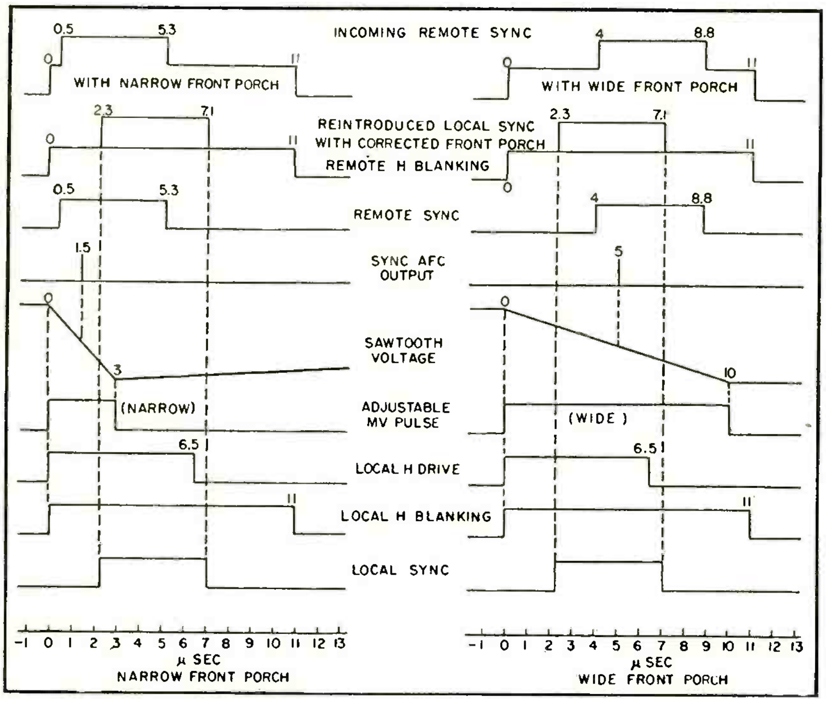


FIG. 2—Time-phase relations when correcting narrow and wide front porch on incoming remote sync

sync afc to obtain the most effective range of front-porch width adjustment.

If the afc reference voltage has been centered with respect to the local sync generator master oscillator control voltage, the sawtooth voltage, output of V_{1B}, will straddle the narrow pip signal equally in time as shown. This fast part of the sawtooth was caused by the multivibrator pulse which, in this example, was set to be 3 microseconds in length. Since the leading edge of local horizontal drive initiated the multivibrator pulse, and since local sync, as determined in the sync generator, is assumed as 2.3 microseconds later, reintroduced local sync will time-phase with remote horizontal blanking as a front-porch width of 2.3 microseconds.

When the incoming remote sync has a wide front porch, correction is obtained by setting the front-porch width adjustment so that the multivibrator generates a long pulse, as also shown in Fig. 2. In this illustration the front-porch width on the incoming remote sync is assumed as 4 microseconds. By setting the length of the pulse to 10 microseconds the time phase of local horizontal drive and local sync will be shifted so that reintroduced local sync will again be corrected to 2.3 microseconds. Thus the width of the multivibrator pulse serves to alter the time phase of the local sync generator relative to the remote sync and blanking, hence providing front-porch width control.

Vertical Phase Correction

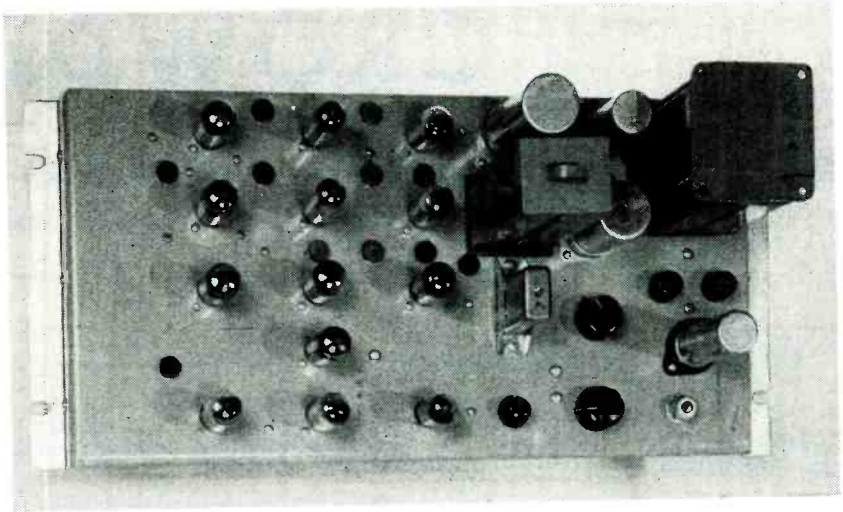
Automatic phase correction of the vertical interval is obtained by the comparison in time phase of pulses corresponding to the serrated intervals of the local and remote sync. When these pulses are not in time coincidence, that corresponding to the local is used to suspend or hold the count down between the twice-horizontal rate pulses and the counted-down field rate pulse of the local sync generator by, presumably, four half-lines each field. This suspension of count continues in subsequent fields.

As the correction approaches finality, the pulses from the remote and local start to overlap. A portion of the positive-going local pulse disappears in the negative-going remote pulse, thus reducing the number of suspended counts. When the phase is fully corrected to coincide with the correct field, the correcting signal has been cancelled. Since at the time of initiating sync lock the vertical phases of the local and remote are perfectly random, it works out that the most probable value for the time of vertical pull-in is 1.1 seconds. Horizontal pull-in is practically instantaneous, a matter of only a few horizontal lines.

In obtaining the vertical rate pulses corresponding to the serrated intervals, the mixed sync in both local and remote channels is integrated and then sliced. The slicing operation is equivalent to a simultaneous top and bottom clipping and is accomplished with circuits which require no clipping level controls, nor are any provided. Slicing is precise and independent of the channel input voltage between the design levels of 3.5 to 8 volts.

Slicing on the local channel is done at a higher level on the integrated pulse than on the remote channel, thus assuring that the local pulse will always be slightly narrower than the remote pulse so that, in the subtraction amplifier, the positive-going local pulse will always completely disappear in the negative-going remote pulse when phase coincidence is obtained.

The General Electric Sync Lock Type TV-30-A was designed to operate in conjunction with synchronizing generators of both GE and RCA manufacture. Operation with other sync generators has not been fully investigated.



Rack-mounting chassis connects to associated equipment by coaxial cables feeding from backside

System Considerations

In system operation with a sync lock, especially when a station has only one sync generator, consideration should be given to the time required for the local sync generator to get back to local power line lock when it is desired to leave the remote signal. This situation should be anticipated at the termination of a remote program since network sync may be opened as a result of repatching of the system. The time requirement is dependent upon the design of the sync generator and has nothing to do with the sync lock. Sync generator GE type PG-2-B, which employs a comparatively rapid afc, is especially adaptable to a sync lock system since pull-in time to local power line lock can normally be accomplished during the switching time from remote to local picture.

Consideration also should be given to the local film projector to obtain maximum flexibility and utilization of a sync lock system. When the special effects are to be applied between a remote program and local movie film, it is necessary that the projector be completely synchronized to the local sync generator rather than to the power line. Such projectors are now available thereby making possible a completely synchronized system.

CROWDED-BAND

Transmitter-receiver combination operates in 148 to 174-mc range. Receiver uses triple-tuned i-f transformers to minimize adjacent-channel interference and controlled r-f gain to minimize intermodulation interference. Field test results are given

THE ever-increasing use of the channels in the 148 to 174-mc range has brought with it many equipment design problems. The solution of these problems has led to the development of many improvements in receivers and transmitters. The design of equipment capable of performing satisfactorily under present-day crowded-band conditions is further complicated by the requirements of simplicity, reliability and ease of serviceability.

Types of Interference

There are two general types of interference that are especially troublesome to mobile equipment operating in this range. These are adjacent-channel interference and intermodulation interference. These two types are quite different, both in their nature and in the measures that must be taken to minimize them.

Adjacent-channel interference caused by the presence of a strong signal on the next channel 60 kc off, takes three forms, desensitization or reduction of gain due to self-bias being developed on the grids of the i-f amplifiers or mixers; break-through of adjacent channel signal reaching the discriminator although greatly attenuated; and noise interference produced by on-frequency noise sidebands radiated by the adjacent channel transmitter.

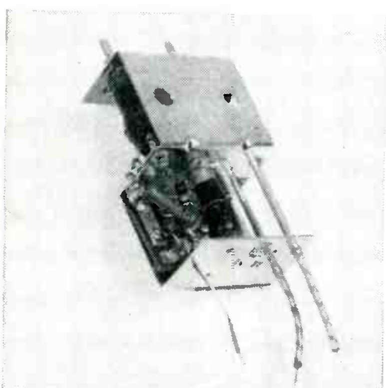
Desensitization is minimized by keeping the gain ahead of the selectivity determining stages (usually low i-f stages) as low as possible consistent with good sensitivity. With good design desensitization effects can be kept small compared with noise interference.

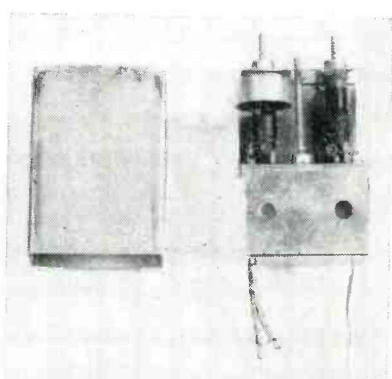
Modulation break-through can be reduced until it is less than the noise interference by adequate i-f selectivity. Noise interference, which is a characteristic of the transmitter and, therefore, unaffected by receiver design, will then be the limiting factor in adjacent-channel interference. A study of the various ways of achieving the required selectivity showed that triple-tuned low i-f stages in a double superheterodyne circuit resulted in the most efficient use of tuned circuits, the fewest number of tubes, and the simplest circuitry.

Intermodulation interference results from the generation of a carrier by two signals spaced n channels and $2n$ channels from the signal frequency, where n is any integer. This kind of interference results from components generated in the r-f tubes and appears as an on-frequency high i-f signal. Any circuitry after the first mixer will have equal effect on the desired signal as well as the interference.

The steps that can be taken to change the intermodulation characteristics of a receiver are limited, particularly with regard to that produced by the adjacent and the alternate channel signals. With choke channel spacings these signals pass through any practical 150-mc circuits virtually unattenuated. It takes a resonant circuit with a Q of the order of 2,000 to 3,000 to produce any appreciable attenuation. This can be accomplished with a well-designed cavity resonator but it is impractical as the cavity is larger than the whole mobile unit and costly to build. Some improvement in intermodulation attenuation can be realized by using only enough r-f gain to obtain the required sensitivity, because changes in r-f gain will have greater effect on the intermodulation product than on the desired signal. It is more effective to reduce the gain of the first r-f stage than that of the second. For areas in which the desired signal is greater than the level required to produce 20-db quieting, it is advantageous to use automatic gain control to reduce the r-f gain.

In any receiver it is important to have enough selectivity to insure that the adjacent-channel performance is at least equal to the intermodulation performance. Freedom from intermodulation interference





Upper compartment of i-f transformer assembly houses primary and tertiary windings. Secondary winding is housed in lower compartment

MOBILE EQUIPMENT

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at a given point is valueless if adjacent-channel breakthrough occurs. In a practical design, it is often advantageous for the adjacent-channel performance to exceed the intermodulation performance, for interference from the latter requires simultaneous operation of both interfering stations, and therefore in many applications will occur only a fraction of the time the adjacent-channel station is on the air.

Receiver Design

The receiver whose block diagram is shown in Fig. 1 was designed in accordance with the considerations mentioned above. It has been thoroughly field tested to prove its ability to operate under conditions of severe adjacent-channel and intermodulation interference resulting from the presence of both adjacent and alternate channels.

The receiver has a guaranteed 20-db quieting sensitivity of better than 0.6 microvolt and an image and spurious response rejection of greater than 95 db. In production the sensitivity is actually running between 0.35 and 0.5 microvolt. This is achieved by using five slug-tuned coils of 1½ turns of bus wire, ¼ inch in inside diameter, mounted in individual ⅞-inch diameter shield cans. Two ceramic tuning capacitors in parallel are mounted inside the can, so connected that by clipping an external link on the coil base the range can be changed from 148 to 162 mc to 162 to 174 mc. One of these coils has a capacitance tap to match down to a 50-ohm coaxial cable and constitutes the antenna transformer. The other four are coupled together in pairs with high side capacitance coupling to form two double-tuned r-f stages.

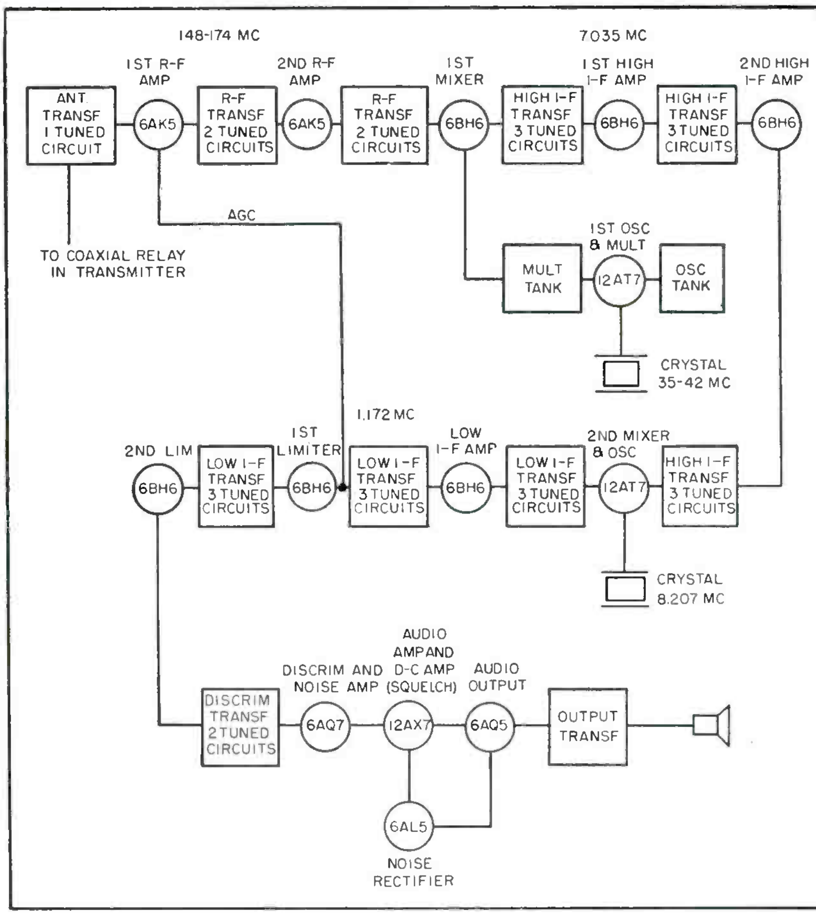


FIG. 1—Receiver block diagram shows double superheterodyne circuit

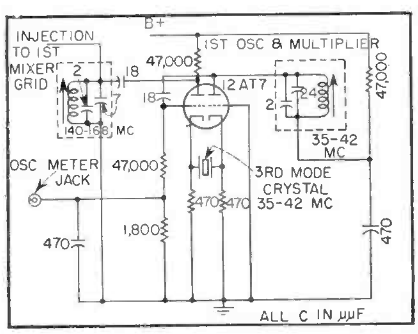


FIG. 2—First local oscillator employs third-mode crystal in 40-mc region

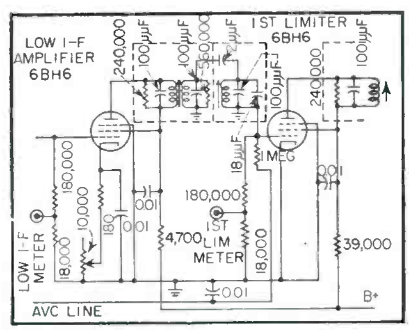


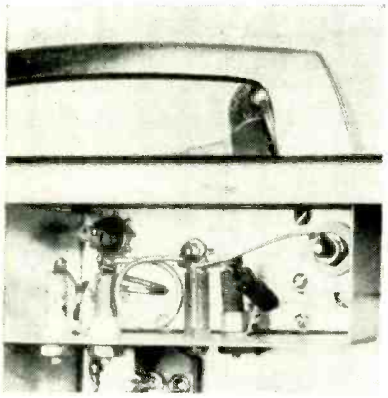
FIG. 3—Circuit of low i-f amplifier and first limiter shows use of triple-tuned i-f's

The performance of these tuned circuits compares very favorably with that of resonant concentric lines and this construction is much more simple and trouble free.

For the same considerations of sensitivity and r-f selectivity, 6AK5 tubes are used in the r-f stages, since the input resistance of any other suitable tube at 160 mc is much lower, resulting in increased loading and loss of gain and selectivity.

Other than the individual coil shields, the only r-f shielding necessary is a vertical shield between the r-f stages and oscillator-mixer stage.

Another factor in the excellent spurious rejection of this receiver is the use of separate crystals for high and low i-f injection, permit-



Under-chassis view of low-pass filter used in series with antenna coil

ting the use of a third mechanical mode crystal for the high injection. This type of crystal operates at a frequency of from 35 to 42 mc depending on the signal frequency, and requires only quadrupling before injection. This greatly reduces the number of undesired oscillator harmonics that would be produced if a lower frequency crystal were used and the number of multiplications increased. Moreover, these fewer harmonics are widely spaced from the desired injection frequency, 35 to 42 mc for the nearest, so that the r-f selectivity gives ample protection.

A cathode-coupled oscillator circuit is used for the first oscillator as this circuit gives very stable operation with a mode crystal, and also provides multiplication by tuning the second tank circuit to a harmonic. The oscillator circuit is shown in Fig. 2.

Triple-tuned i-f transformers are used in the two high i-f stages. While the selectivity of the high i-f contributes only a little to the overall selectivity, it does protect the receiver against spurious responses occurring at the second mixer.

I-F Design

Both high and low i-f transformers are of the same basic design. A folded metal frame provides a means of mounting the coils and complete shielding between the primary and secondary. The primary and tertiary in the upper compartment are inductively coupled, the coupling being controlled by a coaxial shield around the upper part of the primary winding. The tertiary is coupled to the secondary by means of a feedthrough in the frame and a coupling capacitor. Connection is made to primary through two leads passing through plated copper tubing. Since the tubing is drawn down on the leads before assembly and the tubing is soldered to the frame, the leads are permanently anchored and there is no need for terminal boards to secure their upper ends. All the coils are tuned from the top. This i-f structure provides a compact, rigid transformer that is inexpensive to build. The windings are given a double impregnation with electrical grade resin lacquer and a wax flash dip to insure stability under the extremes of temperature and humidity experienced in operation.

A 12AT7 is used as a second mixer and second oscillator. The oscillator circuit has a ceramic trimmer that provides for small adjustments of second oscillator frequency so that the receiver can be zeroed on the transmitter with which it is to operate, without realignment of the discriminator and low i-f transformers.

The low i-f amplifier has a gain potentiometer in its cathode circuit. This permits the second limiter current for noise to be set initially to the value for optimum squelch circuit action and the gain to be brought back to this level as the gain decreases over a period of time due to tube aging. This feature should prevent unnecessary tube replacements and peaking of transformers. As long as the serviceman can maintain the proper second limiter current, he will know that he does not need to touch the tubes or transformer tuning.

A differential squelch circuit is used. This type of circuit is used to give a fast transition from squelch to no squelch. A gain control in the cathode circuit of the noise amplifier tube allows the squelch to be set to the correct level for the noise conditions that are being encountered.

Transmitter Design

The transmitter block diagram is shown in Fig 4.

With the crowded condition of this portion of the spectrum, it is necessary to limit the swing of the transmitter to ±15 kc to prevent adjacent-channel interference. To do this, it is necessary to limit the slope, or rate of change, of the audio modulating wave. The modulation limiter employed to accomplish this slope limiting is composed of a pre-emphasis circuit, a voltage limiter, and a de-emphasis circuit, as shown in the block diagram.

The pre-emphasis circuit changes the audio input voltage into a wave whose amplitude is proportional to the slope of the audio input wave. The limiter tube is a double triode which amplifies in the first section and limits, as an overdriven amplifier, in the second section. A potentiometer in the output of this stage adjusts the point at which modulation limiting takes place. This symmetrically-limited output is fed to the de-emphasis circuit which changes the audio signal back to a wave whose amplitude is inversely proportional to the slope of the wave at the output of the limiter tube, and then to the grid of the modulator tube.

Thus, below limiting, the voltage output of the de-emphasis circuit is unchanged from the original audio input, while above limiting, the only change is that all slopes are limited to values that will prevent frequency deviation greater than desired. A visual representation of this limiting is shown in Fig. 5.

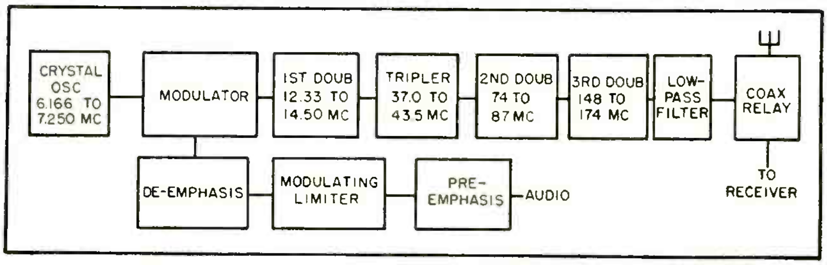


FIG. 4—Transmitter block diagram. Deviation at modulator output is ± 625 cps

The modified Pierce oscillator is capacitance coupled to the grid of the modulator tube and inductively coupled to the plate of this tube. The output of this stage is then fed to the grid of the first multiplier tube as phase modulated r-f with a maximum deviation of ±625 cps.

As can be seen in Fig. 4, the frequency is then multiplied 2 × 3 × 2 × 2 or 24 times to the output frequency, and hence the deviation is 24 × ±625 or ±15,000 cps. Double-tuned coupling circuits are used from the tripler on to attenuate the spurious emission from the transmitter below the carrier frequency at least 70 db below the carrier output level.

The antenna circuit, which consists of a movable coupling coil with a series tuning capacitor, permits extremely simple tuning because the functions of antenna tuning and coupling are separate. The transmitter may be tuned into an antenna with a standing-wave ratio of 2 to 1 by merely resonating the final tank capacitor, resonating the antenna capacitor, and coupling to full power.

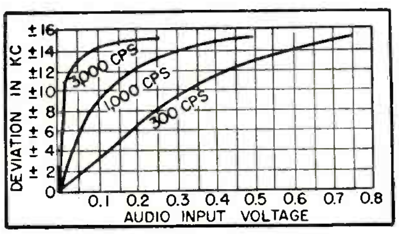


FIG. 5 — Typical modulation limiting curves for transmitter

Field Tests

Two series of field tests were used to evaluate this equipment.

The first was conducted under conditions that might be frequently encountered in practice. It was made by using the transmissions of some of the City of Syracuse taxicab companies. Three of the companies operating on channels 5, 6, 7, are located as shown in Fig. 6A on level terrain. All of the transmitters have 50-watt output. They are equipped with high-gain antennas with gains of 2, 3 and 3, respectively at heights of approximately 105, 110, 115 feet, respectively. The receiver was tuned to channel 7 and the test car driven around the downtown area in the vicinity of the transmitter on channel 6. A number of test runs were made, and in no case was any adjacent-channel interference experienced even when the test car was in the street alongside the building upon which the channel 6 transmitter was located.

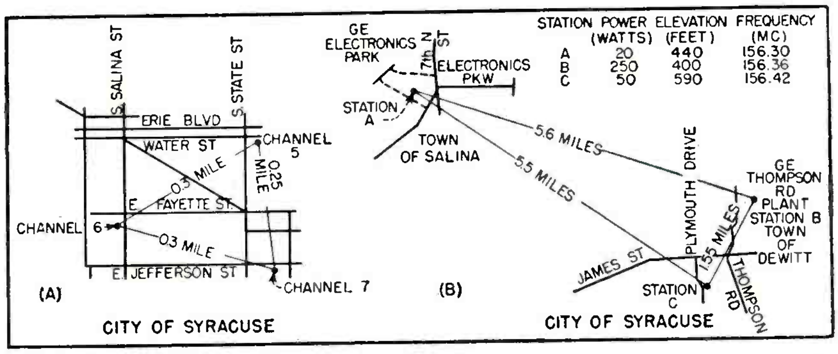


FIG. 6—Two series of field tests were made over area shown in these maps of the Syracuse area

Careful checking revealed a few very restricted spots in the area around the channel 6 antenna where intermodulation interference could be heard when channels 5 and 6 were on but channel 7 was off. In every case, channel 7 completely captured as there was no trace of interference.

The second set of tests was made using special test stations on experimental frequencies.

Station A, a 20-watt station, was located at the Electronics Park Plant, elevation 406 feet, with a dipole antenna mounted on top of one of the buildings at a height of 50 feet. Station B at the Thompson Road Plant at an elevation of 400 feet, consisted of a 250-watt transmitter with a dipole antenna mounted on the roof at a height of 75 feet. Station C was a 50-watt transmitter, located on rising ground at an elevation of 590 feet, 1½ miles from Station B. A high-gain antenna on a 38-foot mast gave station C an output equivalent to a 175-watt transmitter, and a relative height of 228 feet with respect to B.

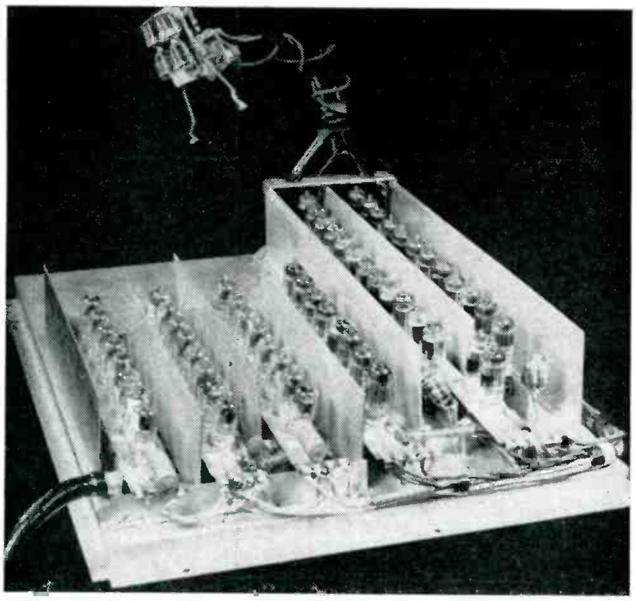
The stations were operated on the following frequencies: A, 156.30 mc; B, 156.36 mc; C, 156.42 mc. The output of Station A was reduced to give a signal of 2 to 5 microvolts in the region of Station B, 5½ miles away (see Fig. 6B), and tests of adjacent-channel and intermodulation interference were made in the vicinity of Station B with a receiver tuned to Station A. These conditions were far more severe than any usually encountered in practice but were so chosen that changes in design that caused only small changes in test bench measurements could be evaluated.

Under these conditions while slight adjacent channel interference was apparent in the background of the desired signal at a distance of 1,000 feet from the antenna of Station B, the desired signal was clearly readable to within 600 feet or less, and unintelligible at 300 feet.

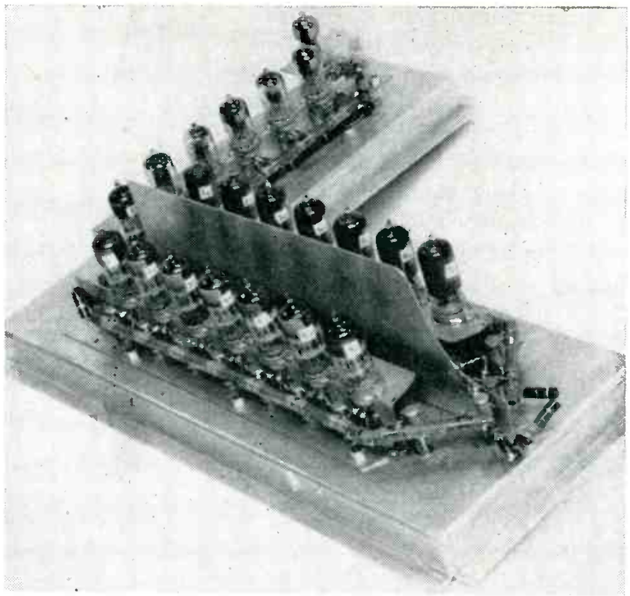
In the case of intermodulation interference resulting from the simultaneous transmissions of Stations B and C, although it was present in the absence of a signal from A, the latter completely captured the set up to a distance of about 800 feet from the antenna of Station B. Then there was a transition period where there was an intermingling of signals, and at approximately 600 feet, the intermodulation produced captured the receiver. The distance to Station C was approximately 1½ miles in all cases.

These field tests proved that the design of the equipment (designated type MC203) had accomplished very satisfactorily its objectives of practical adjacent-channel operation with the maximum simplicity of circuits and lowest cost consistent with reliability and high-quality performance.

The authors wish to acknowledge their indebtedness to G. A. Kious and many others of their associates in the Radio Communication Engineering Section in the development, design and testing of the equipment.



A 150-mc distributed amplifier with a gain of 5,000



An 85-mc distributed amplifier with a gain of 180

Millimicrosecond

Pulses as short as 0.5 millimicrosecond can be viewed or recorded through use of high-gain distributed amplifiers and high-vacuum linear-sweep generators. Distributed amplifiers show promise for utilization to 500 mc or higher

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OBSERVATION and measurement of pulses of the order of 10^{-9} to 10^{-10} sec have assumed increasing importance. This paper will discuss some recent oscillographic developments in circuits for measurement of these time intervals.

Development of high-speed sweep circuits[1, 2], refinements in reflection systems[3, 4, 5, 6], and waveform analysis using signal delay systems[4] have been described in the literature. This paper is mainly concerned with the development of distributed amplifiers.

This article is based on a paper presented at the 1950 National Electronics Conference. The Conference paper will appear in *Proc. NEC*.

The development of amplifiers capable of satisfactory reproduction of signals containing signal components in the order of hundreds of megacycles has been hampered by the limitations imposed by practical values of transconductance, interelectrode capacitances and input loading of vacuum tubes. The suggestion of increasing effective transconductance without increasing shunt capacitance by incorporating a number of tubes into a transmission line network was made many years ago,[8] but only recently[6,9,10,11] has it been utilized to some degree. The principle of distributed amplification appears to be the most promising for use with presently available tubes and components, and a number of practical designs have been evolved.

Distributed Amplifiers

Figure 1 shows the basic circuit of a distributed amplifier stage. Two artificial transmission lines are connected separately to plates and grids of the amplifier tubes, which become part of the lines. A signal voltage e_g applied to the input terminal is transmitted along the grid line to the grid of V_1, producing a corresponding change in plate current $g_m e_g$, which is transmitted along the plate line. When

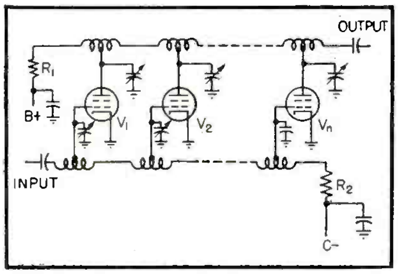

FIG. 1—Basic circuit diagram of a distributed amplifier

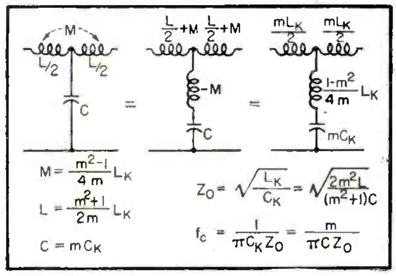

FIG. 2—Typical *m*-derived section and its equivalents

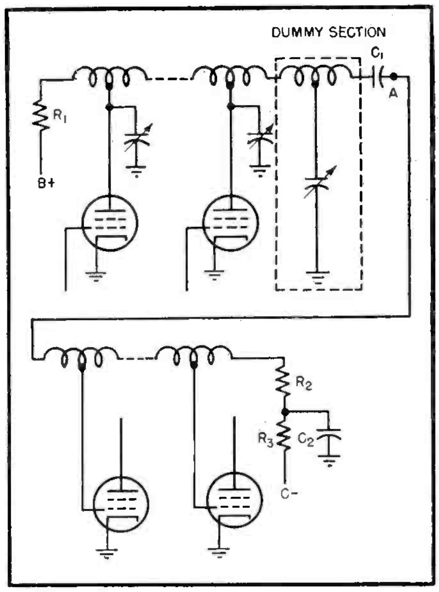

FIG. 3—Method of coupling two stages of a distributed amplifier

Oscillography

the applied signal reaches the grid of V_2, a similar change of plate current will be produced in that tube.

If the propagation constants of these two lines are equal, the signal components of plate currents produced by various tubes will arrive at the output terminal at the same time and will add. The usual undesirable effects resulting from paralleling of tube capacitances are thereby eliminated.

When resistor R_1 is made equal to the characteristic impedance of the plate line, signal currents transmitted to the left will be completely absorbed. Similarly, the applied signal e_g will also be absorbed after the grid of V_n when R_2 is made equal to the characteristic impedance of the grid line.

Practical Considerations

For simplicity, both the grid and plate lines can be made of constant-*k* low-pass T-sections. However, *m*-derived sections have at least two advantages compared with constant-*k* sections. First, time delay can be made substantially constant over the entire pass band with less resulting phase distortion. Second, greater shunting capacitance can be used when *m* is greater than unity. This would permit either greater bandwidth or higher line impedance and correspondingly higher stage gain.

The *m*-derived network with substantially constant time delay up to two-thirds of the cutoff frequency is known to be that with $m = 1.27$. A typical *m*-derived section is shown in Fig. 2 together with its equivalents. The negative inductance $-M$ in series with the shunt capacitance C results from the aiding magnetic coupling between the two halves of L.

With L and C defined as in Fig. 2, the characteristic impedance becomes

$$Z_o = \sqrt{\frac{L_k}{C_k}} = \sqrt{\frac{2_m{}^2L}{(m^2+1)\,C}} \qquad (1)$$

and the cutoff frequency is

$$f_c = \frac{1}{\pi C_k Z_o} = \frac{m}{\pi C Z_o} \qquad (2)$$

The above expression indicates that the cutoff frequency of an *m*-derived section is *m* times that of a constant-*k* section.

Bridged-T networks offer the advantage of more constant characteristic impedance, but this is offset by the need for twice the number of critical circuit elements.

The signals traveling along both the grid and plate lines are subject to losses that will cause considerable attenuation at high frequencies because of the presence of impedance in the cathode circuit and the transit-time effect.

In a distributed amplifier stage the signal at the grid of the first tube is attenuated by these losses once, at the second tube grid twice, and so forth. An analysis assumes that the signal is attenuated by α db in the first section, by 2α db in the second, and so on by $n\alpha$ db in the nth section. The effective sum of all signal components of plate currents is then reduced from ng_me_g on the output of an n-tube distributed amplifier stage to g_me_g $(a + a^2 + \ldots + a^n)$, where $a =$ antilog $\alpha/20$. The value of this sum is $g_me_ga(1 - a^n)/(1 - a)$ and the resulting loss in db is 20 log $a(1 - a^n)/n(1 - a)$. For a typical case of $n = 7$ and $\alpha = 0.6$ db, the resulting loss is 2.5 db.

Plate Line Losses

Similar consideration may apply to losses in the plate line due to low plate impedance of some tubes, such as the type 6AN5, whose plate impedance is likely to be below 10,000 ohms. The losses so caused, are perhaps 0.5 db per stage.

Because of these losses there is obviously a limiting number of tubes per stage beyond which the amplification of the stage will decrease instead of increase. A mathematical analysis assuming 0.6-db losses per section in both grid and plate lines shows the gain increases very slowly after $n = 8$, becomes maximum when $n = 12$ and decreases thereafter. The effect of coil losses due to skin effect and other factors is small compared with tube losses, about 1 db for 40 sections of 200-ohm networks.

Other factors such as grid and plate-lead inductances result in lowering the amplifier cutoff frequency and in altering the characteristic impedance of the transmission lines. Fortunately, it is possible to minimize such undesirable effects to a small percentage

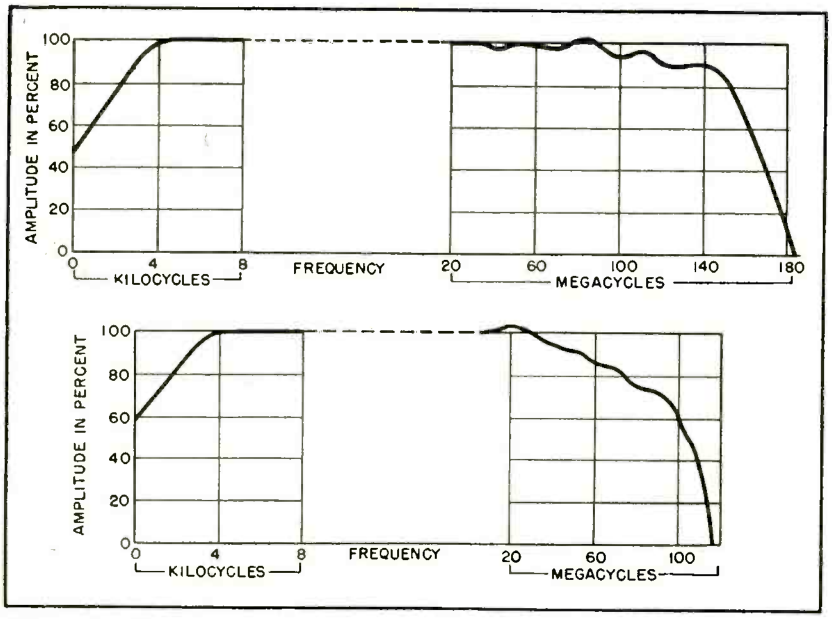

FIG. 4—Amplitude-frequency characteristics of distributed amplifier A (upper curve) and distributed amplifier B (lower curve)

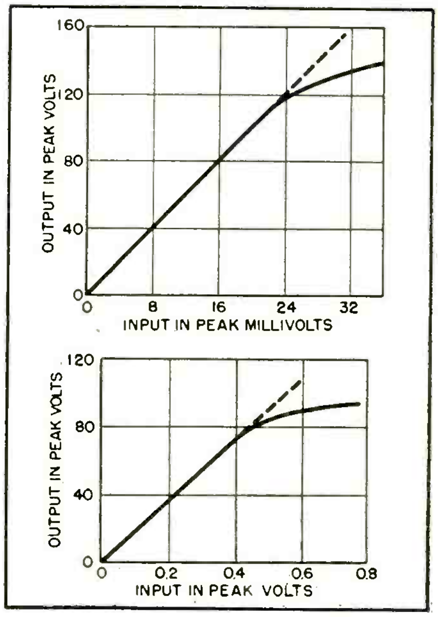

FIG. 5—Amplitude-amplitude characteristics of amplifier A (upper curve) and B (lower)

in a well-designed amplifier.

It is important to point out that uniform amplification with respect to frequency variation cannot be obtained in a stage of distributed amplification when the receiving end of the plate line is open. The reasons are: (1) The input impedance of a transmission line is no longer constant if it is not terminated by its own characteristic impedance, thus the line impedance looking at the plates of the amplifier tubes changes as the signal frequency varies; (2) The phase relations between the reflected wave and the signal components of various plate currents change as the signal frequency varies; therefore, they may add at one frequency and subtract at another.

Since the load of an oscillograph deflection amplifier is the deflecting plate of a cathode-ray tube, which is essentially a capacitive load of not less than 2 $\mu\mu$f, it cannot be connected directly across the terminating resistor of the output line without introducing reflections.

To avoid this undesirable effect, an additional section is used, and the deflecting plates of the cathode-ray tube are connected as part of the shunt capacitance. This capacitance is adjusted so that the total shunting capacitance is equal to that of other sections of the same line.

For amplification of pulses, the transient response of the amplifier is important, particularly the rise time and the percentage of overshoot. In order to minimize the overshoot of a multistage amplifier, it is necessary that the phase distortion be kept very low and that the frequency response drop slowly and steadily, following the Gaussian error curve. If f_1 is the frequency at the 70-percent point of the frequency response curve, the 37-percent point should be located approximately at 1.5 f_1. The shape of the response below 30 percent is not critical, but it also should drop slowly and steadily.

Multistage Operation

The rise time of an amplifier stage is approximately equal to the ratio of $0.35/W$, where W is the 3-db bandwidth of the amplifier. For n stages, the over-all rise time is approximately equal to the square root of the sum of the squares of those of the individual stages when the percentage of overshoot is negligible. It may be noted here that the effect of an oscillograph amplifier having rise time T_a on a signal pulse having rise time T_p can be estimated from the following expression:

$$T_{resultant} = \sqrt{T_a^2 + T_p^2} \quad (3)$$

Thus a signal pulse with a rise time of 0.01 μsec will appear to be slowed down by 11 percent in an oscillograph amplifier with T_a = 0.005 μsec to a resultant rise time of 0.011 μsec.

Since there must always be certain physical distances existing between stages, the inductance of the leads employed for connecting stages affects the response of the amplifier. To overcome this difficulty, additional dummy sections are used. These sections serve as a continuation of the line, with tube capacitances replaced by the increased trimmer capacitances.

Distributed amplifier stages may be coupled directly in order that response may be extended down to d-c signals. For such operation, suitable means must be provided to overcome the difficulty of the presence of quiescent plate potential.[12] When d-c response is not required, the arrangement shown in Fig. 3 has been found suitable to allow signals of very low frequencies to pass with the use of standard components and without affecting the response at high frequencies. The physical size of the coupling capacitors should be kept as small as possible in order to avoid difficulties caused by both distributed capacitance and lead inductance of the coupling capacitor.

In Fig. 3, R_1 and R_2 are made equal to the characteristic impedance of the line, C_1 is made equal to C_2, and R_3 is made as large as possible for the type of amplifier tubes used. Under this condition, the impedance to the right of point A essentially equals that to the left except for the existence of a high resistance R_3. Theoretically, the frequency response will be uniform as long as the resistance of R_3 is very large compared with the reactance of C_2. Experimental results show that frequency response can be kept flat to as low as 200 cps even when the line impedance is 200 ohms and the coupling capacitance is only 0.01μf.

Impedance transformation can be secured through the use of a stage of distributed amplification. For such operations the characteristic impedances of grid and plate lines are made respectively equal to the input and output impedances. When the stage consists of more than one tube, the propagation constants of both grid and plate lines should be made identical.

The amplification of a multistage distributed amplifier may be controlled by changing the number of stages or by inserting attenuators. The former may offer the advantage of better frequency response and shorter rise time, while the latter has been proved to be more practical in actual cases, since it minimizes the number of plug-in connections or switches required. While stage gain can also be controlled by variation of grid bias, this method is undesirable because it seriously affects the amplitude-amplitude characteristic, producing nonlinearity.

Results

Two multistage distributed amplifiers are shown in the photographs. Amplifier A consists of six stages, four single-ended stages, a phase inverter, and a push-pull output stage. Amplifier B consists of a single-tube stage used as impedance transformation for coupling to a 50-ohm coaxial cable, a single-ended stage, a phase inverter, and a push-pull output stage.

The individual stages of amplifier A were designed to have their theoretical cutoff frequency at 250 mc and their time delay approximately 1.26×10^{-9} second, while those of amplifier B are at 125 mc and 2.52×10^{-9} second, respectively. The amplitude-frequency characteristics of these two amplifiers are shown in Fig. 4, and curves showing amplitude-amplitude characteristics of both amplifiers are shown in Fig. 5.

The rise time of amplifier A was measured to be approximately 0.004 μsec and of amplifier B, 0.005 μsec by the use of a special pulse generator capable of producing square pulses of 0.012-μsec duration. The upper curve of Fig. 6 shows the shape of the applied pulse as it appeared on the screen of a cathode-ray tube. The lower curve shows the shape of the same pulse after transmission through a 50-db attenuator and distributed amplifier A. Amplifier A has a gain of approximately 5,000 and is capable of delivering a balanced undistorted output voltage of 130 volts peak to peak. Amplifier B has a gain of approximately 180 and its maximum undistorted output voltage is 85 volts peak to peak, balanced about ground. A tabulation of technical data for both amplifiers is given in Tables I and II.

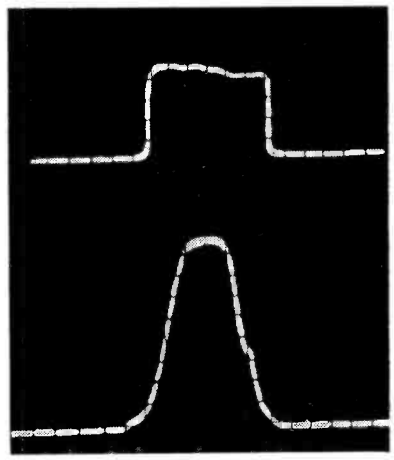

FIG. 6—Waveform of 0.012 μsec test pulse applied directly to vertical deflecting plates of cathode-ray tube (upper waveform) and same pulse after transmission through a 50-db attenuator and amplifier A (lower waveform)

Table I—Technical Data for Distributed Amplifier A

Stages	Tubes	Function	Grid Line Ohms	Plate Line Ohms	Plate Current in Ma	Approx. Gain	Output Volts Peak-to-Peak
1st	8 6AK5's	Preamplifier	200	200	60	4	0.1
2nd	8 6AK5's	Preamplifier	200	200	60	4	0.4
3rd	8 6AK5's	Impedance Transformation	200	125	60	2.5	1
4th	8 6AN5's	Driver	125	125	270	6.5	6.5
5th	2 6AN5's	Phase Invertor	125	125	65	1	6.5
6th	24 6AN5's	Push-Pull Output	125	200	800	20	130
Total	58 Tubes	———	200	200	1.285 amp	5,000	130

Table II—Technical Data for Distributed Amplifier B

Stages	Tubes	Function	Grid Line Ohms	Plate Line Ohms	Plate Current in Ma	Approx. Gain	Output Volts Peak-to-Peak
1st	1 6AK5	Impedance Transformation	50	400	9	2	2
2nd	5 6AK5's	Preamplifier	400	300	45	3.8	6
3rd	1 6CB6	Phase Inverter	300	300	15	1	2.5
4th	14 6CB6's	Push-Pull Output	300	520	210	23	85
Total	21 Tubes	———	50	520	279	175	85

High-Speed Sweep Circuits

Since the deflection of the cathode-ray beam is accomplished by a variation of electric field potential between the horizontal deflecting plates, it is necessary to have this field potential changed at a rate dv/dt such that the spot will move at the required speed. For instance, a type 5XP cathode-ray tube operating with a second-anode potential of 4 kv and an intensifier potential of 25 kv requires approximately 300 volts change in electric field potential for one inch of horizontal deflection. The capacitance between these two plates, including wiring capacitance, is approximately 15 $\mu\mu$f. The current required for a sweep speed of 400 inches per μsec becomes $I = C\,dv/dt = 2$ amperes. This result indicates that a tube with high current capacity is required in a high-speed sweep circuit.

The requirement of high current capacity suggests immediately the use of a thyratron but time jitter is then produced on the screen of the cathode-ray tube. Furthermore, it is difficult to operate gas-tube sweeps at repetition rates above 10,000 or even 5,000 per second because of the relatively long time required for deionization.

If a high-vacuum tube is considered for use as a switch tube it will be required to conduct between successive sweeps in a conventional circuit. For high sweep speeds it becomes difficult to find a vacuum tube that can pass 2 amperes of plate current and that has interelectrode capacitances and lead inductances small enough for the highest sweep speeds desired.

A vacuum-tube sweep circuit in which the switch tube is normally cut off and conducts only during the time of sweep is shown in Fig. 7. In this circuit the switch tube V_5 is a vacuum tetrode type 4X150A. The lead inductances and interelectrode capacitances of this tube are quite small, yet its peak current capacity is over 2 amperes. If the repetition rate is kept under 100,000 per second, forced-air cooling of the tube is unnecessary.

Use of Tetrode

The reasons for using a tetrode instead of a triode as a switching tube are: (1) The input capacitance is substantially smaller because Miller effect is greatly minimized by the presence of a screen grid. This enables the sweep speed to become higher and simplifies somewhat the requirements of the trigger circuit. (2) Constant plate current can be obtained when the potential at the screen is made to rise or fall by the same amount as that at the cathode. Constant plate current is very important when linear sweep is required. In the circuit of Fig. 7 the potential at the screen of the switch tube is made to follow that of the cathode by the use of coupling capacitor C_4.

Before the application of an input trigger pulse, all tubes are cut off. This results in low plate power consumption and permits the use of circuit components of low power rating.

When a trigger pulse is introduced to the grid of V_1, plate current flows and a positive pulse is introduced at the grid of V_2 through magnetic coupling in transformer T_1. Tube V_2 operates as a blocking oscillator. The time constant of R_1C_1 determines the width of the pulse produced by this blocking oscillator. The pulse is taken from the third winding of transformer T_1 to the grid of the cathode-ray tube for beam gating and to the input terminal of the delay cable for triggering the second blocking oscillator V_3 and V_4. Use of the delay cable was found necessary in order to have the beam on at the instant when the sweep voltage starts. The time delay introduced by the cable of Fig. 7 is about 0.02 μsec. Components C_2 and R_3 are employed as a differentiating circuit.

The time constant of C_3R_5 determines the width of the rectangular pulse on the grid of V_5. Normally, tetrode V_5 is cut off, the voltage across capacitor C_6 is equal to about 2,000 volts and the voltage across C_5 is zero. During the pulse, the grid-to-cathode potential of V_5 is driven to zero or even slightly positive. Capacitor C_6 is discharged by the plate current of V_5 and capacitor C_5 is charged by the plate and screen currents of the same tube.

Since the screen-to-cathode voltage of V_5 is kept constant by the use of coupling capacitor C_4, both plate and screen currents are expected to be essentially constant during the pulse, thus permitting substantially linear sweep voltages to be developed across C_5 and C_6.

The value of C_5 is slightly larger than that of C_6 because the current flowing to C_5 is larger than that

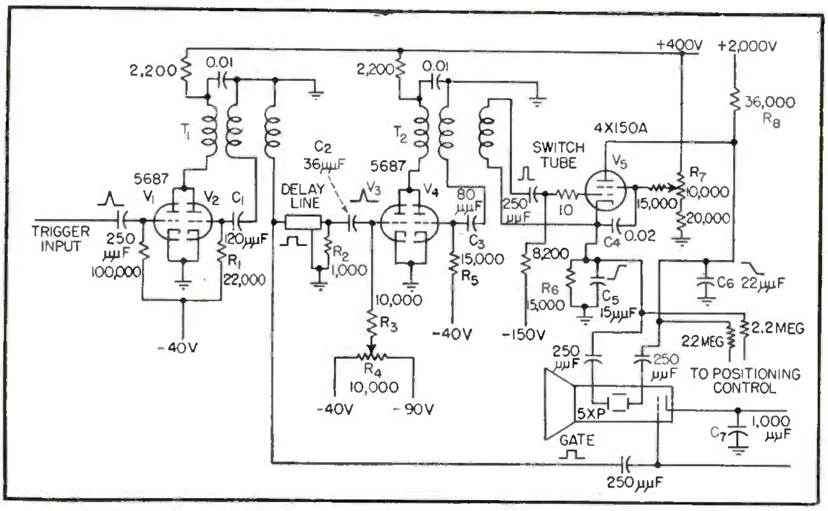

FIG. 7—Schematic diagram of high-speed sweep circuit

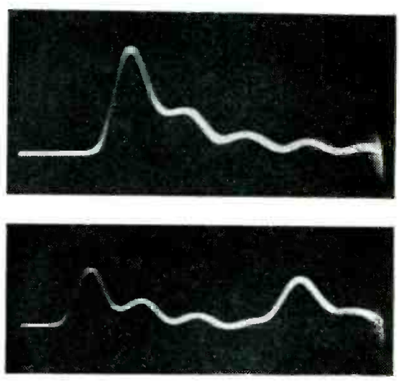

FIG. 8—Upper curve shows a 5×10^{-10} second pulse displayed on a sweep generated by the circuit of Fig. 7. Lower curve is the same pulse and its reflection produced by a 30-inch open-circuited stub of RG-58/U cable

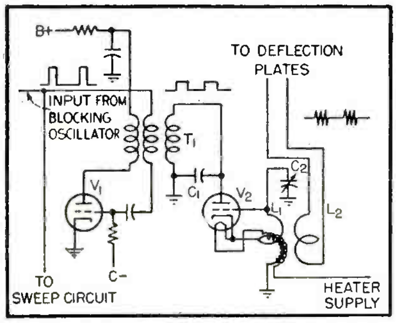

FIG. 9—Schematic diagram of high-frequency timing signal generator

flowing out from C_6. After the pulse, tube V_5 is cut off, capacitor C_5 discharges through R_6 and capacitor C_6 charges through R_8. The sweep speed can be changed by varying capacitors C_5 and C_6.

Experimental Results

Experimental results show that the circuit can generate a balanced sweep voltage of about 1,500 volts peak to peak. The maximum sweep speed obtainable is over 800 inches per μsec when the sweep voltage is applied to the horizontal plates of a type 5XP cathode-ray tube with its second anode at 2,000 volts and third anode at 14 kilovolts. The speed is reduced by one-half when the second anode voltage is increased to 4,000 volts and the third anode is increased to 29 kilovolts. The sweep speed may be increased to 1,200 inches per microsecond when the sweep voltage is applied to the vertical deflecting plates of the cathode-ray tube.

The amount of time jitter is not more than the width of a normal trace on the cathode-ray tube and is estimated to be less than 0.0001 μsec. Departure from linearity was found to be less than 5 percent. The starting time from the instant of input trigger to the beginning of the sweep voltage is estimated to be 0.045 μsec. The maximum repetition rate is over 100,000 per second. The total consumption of plate and screen power is under 10 watts average.

Results of employing this sweep circuit to view a pulse signal of 0.5 millimicrosecond duration are shown in the curves Fig. 8. This pulse was generated by a circuit developed by the Purdue Research Foundation for the United States Air Force and the Signal Corps. The oscillations at the trailing edge of the upper pulse curve of Fig. 8 were produced by the pulse generator itself, since it employs the principle of reflection to generate narrow pulses. The lower curve of Fig. 8 shows the results of connecting a 30-inch open-circuited stub of RG-58/U coaxial cable at the signal deflecting plates. This arrangement will allow an accurate calibration of the time axis. Since RG-58/U coaxial cable has a characteristic impedance of 53 ohms and a capacitance per foot of 28 $\mu\mu$f, the time delay will be 1.5 millimicroseconds per foot. Thus the time between the two major peaks of the lower curve of Fig. 8 is 7.5 $\times$ 10^{-9} second. The waveform of the pulse as shown may differ from the true waveform because of transit time effects in the cathode-ray tube and the frequency characteristic of the coaxial cable.

In order to calibrate the speed of the sweep, either a sine-wave oscillator that oscillates at some known frequency or a pulse generator that produces sharp pulses at some known repetition rate can be employed to produce timing marks as vertical deflection. For sweep speeds of 400 inches per μsec, sharp pulses with rise times of less than 0.1 millimicrosecond would be required. Such pulses are difficult to generate and to apply to the deflecting plates or the control grid of the cathode-ray tube because of the leakage capacitances and inductances of all commercial circuit components involved. On the other hand, sine waves at frequencies of 1,000 mc or lower are comparatively less difficult to produce and to apply since the undesirable effects can generally be eliminated by the use of appropriate resonant circuits.

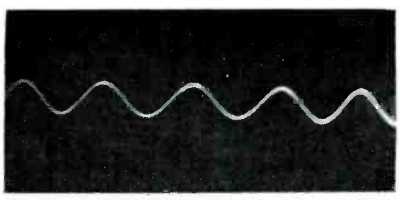

FIG. 10—A keyed 400-mc timing signal with a 2,500 prf, generated by the circuit of Fig. 9

Synchronization of the timing signal to the sweep voltage is another important problem to be considered. For reasons described previously, the jitter should be less than 0.25 millimicrosecond in order to produce a satisfactory trace with a sweep speed of 400 inches per μsec. It was found that a plate-pulsed oscillator can be arranged to satisfy these requirements.

Timing Signal Generator

The schematic diagram of such a circuit is shown in Fig. 9. In this circuit, the first blocking oscillator provides a trigger pulse to the sweep circuit and at the same time serves to trigger the second blocking oscillator V_1. The output from the third winding of transformer T_1 provides the plate current needed for oscillator tube V_2. The heater of V_2 is raised above a-c ground potential by the use of a choke wound on the lower half of coil L_1. This is necessary because the cathode of V_2 is above a-c ground potential. Capacitor C_2 is employed for frequency adjustment. The coupling between L_1 and L_2 should be adjusted experimentally until maximum deflection is obtained on the screen of the cathode-ray tube. Figure 10 shows the trace of a 400-mc sine wave generated by this circuit at a repetition rate of 2,500 per second on the screen of a type 5XP cathode-ray tube.

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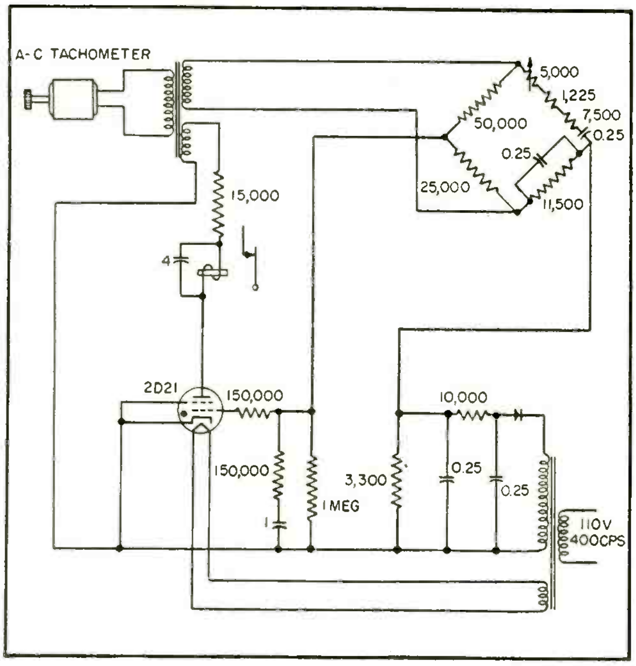


FIG. 1—Schematic diagram of electronic speed switch. The output frequency of an a-c tachometer is used as input to the frequency-sensitive network

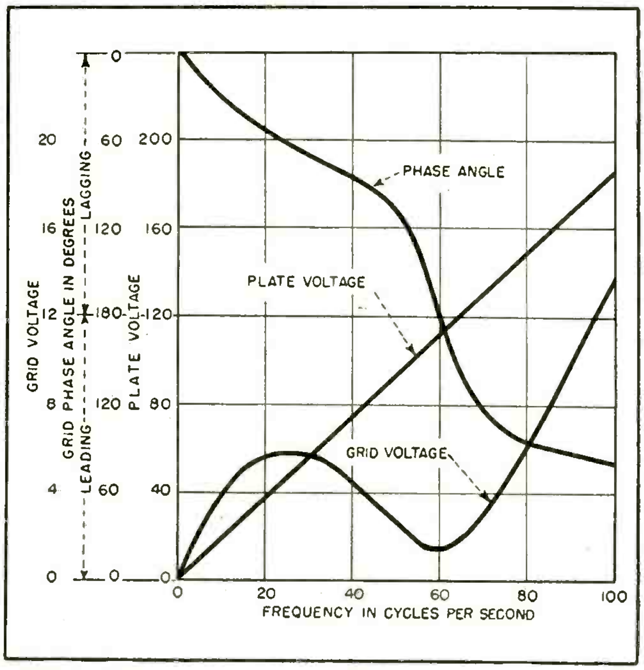


FIG. 2—Voltage and phase relationships for thyratron with Wien bridge arbitrarily balanced at 60 cps. Operating frequency of bridge is adjusted by the 5,000-ohm resistor

SPEED-CONTROLLED

Designed to operate from a standard a-c tachometer, an electronic switch makes or breaks contacts at a predetermined speed without materially increasing existing load. Switching on or off of auxiliary equipment can thus be done at the selected speed setting

SPEED CONTROL by the use of tachometers is less well known than speed measurement by the use of d-c and a-c tachometers. The simplicity of mechanical systems, such as a fly-ball governor whose output may be coupled directly to the speed-regulating mechanism, makes their use popular.

There are instances where an electrical system, particularly one using an a-c tachometer, offers distinct advantages over a mechanical system. An a-c signal whose frequency is accurately proportional to the speed of the rotating shaft can be generated without mechanical contact and brushes. In high-speed applications where gearing down to lower speeds for measuring purposes is not practical, the tachometer speed-control system may be applied advantageously.

Remote indicators for speed are most likely to be electrical. If control signals at a certain speed are required, they can be derived from the same elements used for indication by use of a tachometer system.

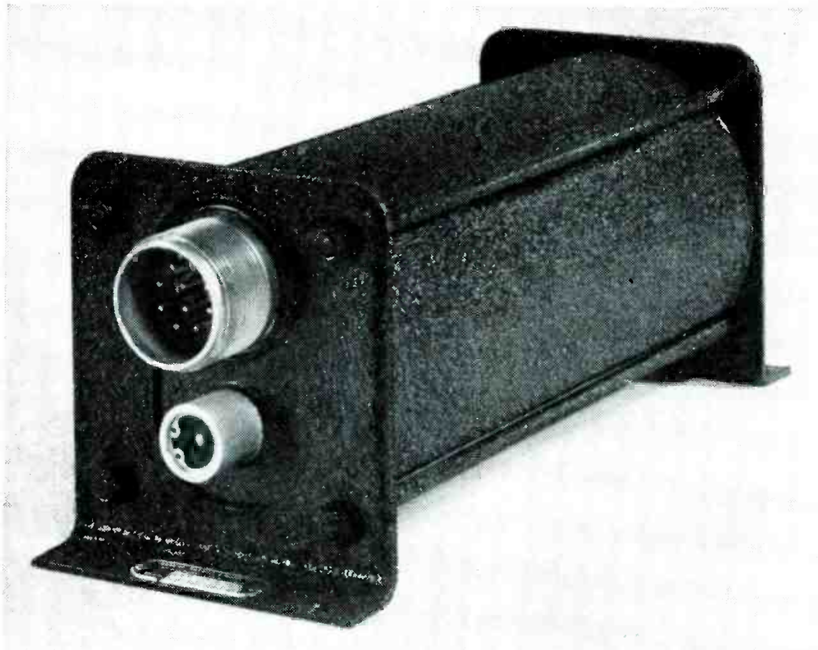
Switch Operation

The electronic speed switch operates a relay at a preselected speed. The switch obtains its signal from an a-c tachometer whose output frequency is used for speed measurement. Figure 1 shows a schematic diagram of the speed switch circuit.

The tachometer output is applied through two different transformer windings to the plate of a 2D21 thyratron and to a Wien bridge. The output of the Wien bridge is connected to the grid of the thyratron. A negative d-c bias prevents the thyratron from firing unless voltages of proper phase are superimposed from the output of the bridge. The sensitive double-pole double-throw d-c relay in the plate circuit becomes energized when the thyratron conducts.

Figure 2 shows the plate and grid voltages of the thyratron and their phase relationship for a Wien bridge arbitrarily balanced at 60 cycles and a tachometer voltage which rises linearly with frequency.

If the frequency of the tachometer is equal to the balance frequency of the bridge, the grid voltage is 180 degrees out of phase with the plate voltage and the tube does not conduct. As the tachometer frequency increases, the grid volt-



Complete switch assembly. All electrical components are hermetically sealed in one container for greater economy in size and weight. Internal parts are supported by rubber bumpers

SWITCH

By H. W. KRETSCH and F. J. WALKER

Manning, Maxwell and Moore, Inc.
Bridgeport, Conn.

age increases and leads the plate by an angle less than 180 degrees. Thus, somewhere at the beginning of each positive plate-voltage cycle the grid will become sufficiently positive to fire the thyratron for the balance of the half cycle and a current will flow sufficient to energize the relay.

Frequencies below the balance point will also cause a rise in the grid voltage, but in this case the grid voltage will lag the plate voltage by less than 180 degrees. The grid will be negative at the start of each positive plate-voltage cycle but will go positive at some point near the end of the half cycle. The average current created in this manner can be kept well below the value required to energize the relay.

The average current value might become critical for very low frequencies were it not for the fact that the tachometer voltage also decreases with frequency. The relationship between grid and plate voltage at any one point can be obtained by the choice of the transformer winding feeding the bridge and plate circuit.

Even though a phase-controlled thyratron circuit has been chosen to make the operation dependent primarily on frequency, variations of the tachometer output voltage will influence the accuracy of the switch to some degree. A decrease in plate voltage, for instance, will require a larger grid voltage to fire the thyratron, as can be determined from the characteristics. To produce this larger grid voltage, a higher frequency is necessary which in turn results in a change of the set point. For the values used in Fig. 2, a 10-percent change in tachometer voltage causes a shift of 1.2 percent in the operating point.

Line-Voltage and Temperature Effects

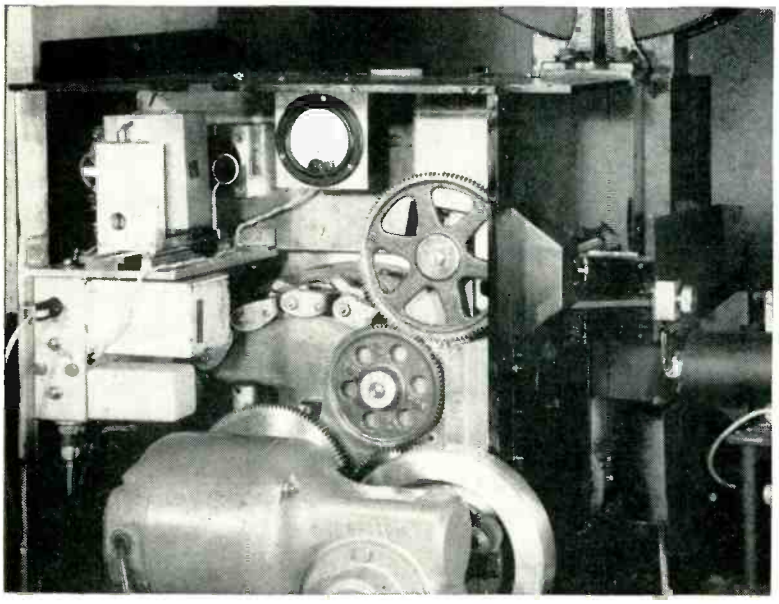
Line-voltage variations do not affect the operation of the switch because filament and bias voltage are both derived from the same a-c source. An increase in filament voltage decreases the operating point, opposite to the effect of an increase in bias voltage. With proper choice of the bias voltage the switch can be made independent of normal line-voltage variations.

To eliminate the influence of temperature variations, the 1,225-ohm bridge resistor is made of copper. Its value is determined so that it compensates for variations of the other bridge components and the thyratron to make the switch practically independent of ambient temperature variations.

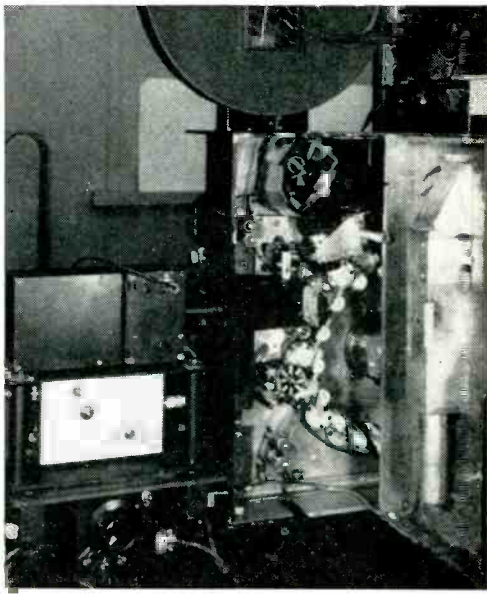
All electric components, including the relays, are hermetically sealed into one container to protect them from altitude, temperature and humidity variations, which are quite severe in aircraft applications for which this particular model was designed. Sealing all parts into one container, rather than providing individual hermetically sealed components, gives greater economy in size and weight, which is of utmost importance for aircraft installations. The chassis is connected to the container by means of rubber bumpers which furnish the necessary shock and vibration protection. One AN type connector has prongs for the dpdt relay as well as for the tachometer and power supply. Also accessible from the outside is a rheostat permitting a change in the speed setting.

Connected between the tachometer and speed indicator of an aircraft engine, this switch will actuate its relay at a predetermined setting without interfering with the indicating system. The power drawn from the tachometer to actuate the switch is not enough to disturb the indication. It can be used to operate auxiliary equipment at the selected speed setting without mechanical connection to the engine.

Continuous FILM



Motor drive, cam and rollers (left of center) of new projector. High precision is required on cam surface only over active angle of about 32°



Film transport, mirrors, gate (below center) and compensating mirror (above center)

SINCE the advent of the multiplier phototube in 1938, it has been recognized that the flying-spot method of televising transparencies, using a photomultiplier as the transducer, produces a higher quality signal than do most other pickup devices. One result of this situation is the fact that film transmissions from the BBC stations in England, using the flying-spot technique and a video bandwidth of 2.75 mc, are considered by most observers to be superior to film transmissions in the United States, using the iconoscope camera and a band of 4 mc. This marked difference in quality appears, despite the wider bandwidth available to American broadcasters, because of the limitations on contrast and background inherent in the storage action of the iconoscope. American technicians have sought for the past decade for a suitable nonstorage method of televising 24-frame-per-second film on the American scanning standard of 30 frames per second. In Great Britain, the difficulty is circumvented by running the film at a speed about 4 percent above normal, at 25 frames per second, which coincides with the European scanning standard.

One such group of technicians is the television research group of the Bell Telephone Laboratories, headed by Axel G. Jensen, which has developed a number of television film scanners to serve as sources of high-quality television signals for laboratory purposes. One such projector, demonstrated in recent years, used a special form of the Farnsworth image dissector (a nonstorage device) in conjunction with specially printed motion picture film. But since special film was needed, the range of subject matter available for testing purposes was restricted. To overcome this limitation, the group decided to design a continuous film projector, similar in some respects to the German Mechau machine now used by the BBC for some of its film transmissions, but containing a number of refinements which would

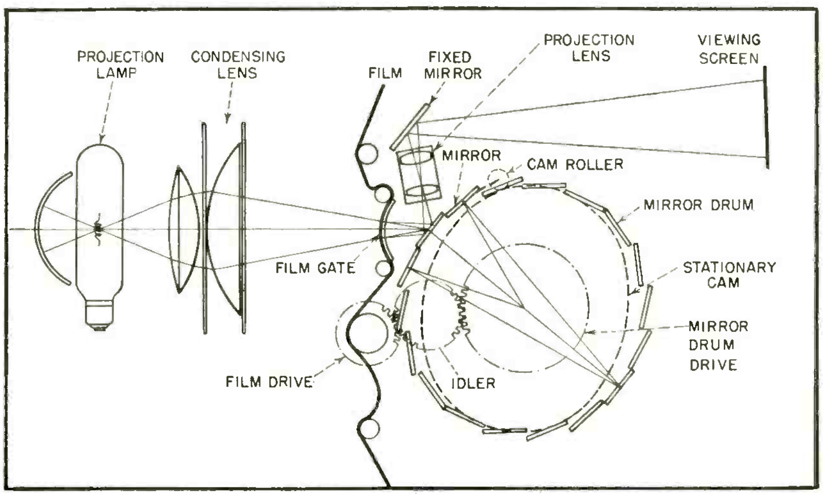


FIG. 1—Elements of projector when used for conventional projection on viewing screen. Roller attached to each mirror runs on stationary cam, turns mirror through angle to compensate for continuous motion of film past gate. Projected image contains vertical jitter and flicker

SCANNER for TV

Designed as high-fidelity television signal source by research staff of Bell Telephone Laboratories, mirror-drum projector uses two electronic servo controls to compensate for jitter and flicker, permits flying spot scanning of 24-frame film at 60 fields

adapt it to the American scanning standard and make its operation and maintenance relatively simple.

This new scanner, which is still under development, was described and demonstrated informally by Mr. Jensen and his associates before the recent convention of the SMPTE, whose members visited the Laboratories at Murray Hill on May 1. This account is derived from the information released at that meeting.

Nonintermittent Principle

Figure 1 shows the essential mechanical and optical elements of the new scanner, as it would be used for conventional projection of film on a viewing screen (rather than with a photomultiplier tube as described below). A projection lamp and condenser lens system pass light through a film gate of curved shape, over which the film passes. The film moves at constant speed, not intermittently as in conventional pulldown projectors. The image projected on the screen would therefore be moving were it not for the fact that the optical path contains a series of mirrors in motion, their motion being such as to counteract the motion of the image.

The mirrors, eighteen in number, are mounted on the periphery of a drum or crown which rotates at constant speed, geared directly to the film drive at such a ratio that there is a crown mirror associated with each frame of the moving film. In other words, for 24 frame-per-second film, the crown rotates at 80 rpm.

Each crown mirror is free to rotate about an axis in the plane of its reflecting surface and at right angles to the plane of the diagram. Each mirror is caused to move about this axis by a lever attached to a roller, which rolls on the surface of a stationary cam. The shape of the cam is such that the motion of the mirror precisely counteracts the motion of the film, and a stationary image is thereby reflected through the projection lens to a fixed mirror and thence the viewing screen as shown in Fig. 1.

Each mirror is active during about 32 degrees of motion. Since this is 60 percent more than the angular spacing of the crown mirrors, there is a lap dissolve of one frame into the next on the screen. In this manner, the image projected is continuous, one mirror alone being active for a portion of the time, two adjacent mirrors being active during the transition from one mirror to the next. When two mirrors are active the amount of light transmitted through the system changes somewhat, and this causes flicker at the film frame repetition rate of 24 per second. This flicker will be removed by an electronic servomechanism as described below.

Vertical Jitter

Aside from the flicker introduced by the successive action of the mirrors, this projector, in common with all other non-intermittent machines, is susceptible to vertical jitter, a slight upward and downward motion of the projected image with

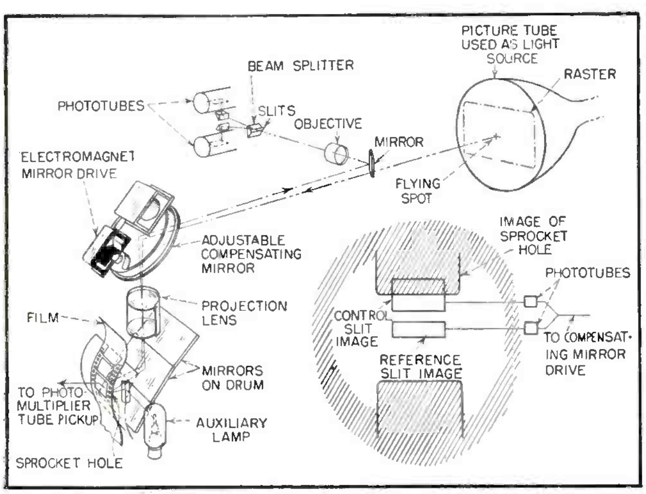


FIG. 2—Flying spot system and compensating servo which removes vertical jitter. Image of sprocket holes actuates mirror which rotates as required to compensate for any vertical motion of film frame as projected

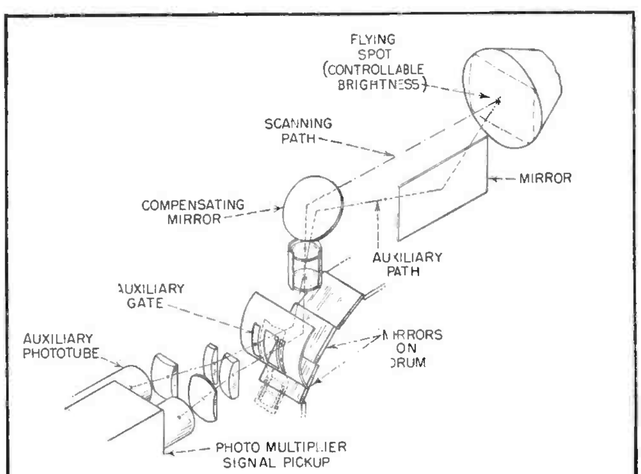


FIG. 3—Flicker-compensating servo. Light from flying spot is reflected from mirrors through auxiliary gate to phototube. Light passing through film changes through active cycle, but servo changes brightness of flying spot proportionately

respect to the frame edges. This effect arises mainly from the difficulty of maintaining absolute uniformity of film motion in the gate. This difficulty has been one of the outstanding objections to continuous projectors in the past, all of which have been found to require highly trained operators to maintain the mechanism in proper adjustment. In intermittent type projectors, this difficulty is avoided by the fact that the individual film frames are accurately aligned with the sprocket holes in the film, and these holes are accurately located, by the sprocket drive, with the respect to the film position in the gate during the dwell time of the intermittent motion. In this new projector, the vertical jitter is automatically corrected by means of an electronic servo which adjusts the position of the projected image by reference to an optical image of the sprocket holes. In addition, the servo decreases the accuracy required in the entire optical and mechanical assembly and alignment. It finally also tends to eliminate errors due to film shrinkage.

Jitter Compensation

Figure 2 shows the adaptation of the projector to the flying-spot method of pickup together with the elements of the jitter-correcting servomechanism. At the upper right is the picture tube (type 5ZP16) which serves as the source of light. The screen of this tube, which uses a very short persistence phosphor, is scanned in the usual manner (525 lines, 30 frames per second). The light from the scanning spot passes to the jitter compensating element, a front-surface plane mirror which reflects the light through a projection lens to the crown mirrors. These mirrors move past the film gate, and are turned by the cam mechanism through the proper angle to cause the spot of light to move downward with the film. The image of the raster is therefore stationary with respect to the film frame.

The light, having passed through the film, is collected and passed to a photomultiplier tube which develops a video signal amplitude proportional to the transmission factor of the film. As the scanning proceeds, the spot moves over the whole frame in the conventional series of alternate (interlaced) scanning lines, each line being stationary with respect to the film frame.

The jitter-compensating servo begins with an auxiliary projection lamp which illuminates, through a right-angle prism, the portion of the film containing the sprocket holes. The light is reflected by the film surface surrounding the sprocket holes. Consequently an image of the area of one of the sprocket holes, in motion, is reflected back to the crown mirrors, whose rotation arrests the motion in the manner described previously. Thus a stationary image of the sprocket holes is reflected back through the system, is picked off to one side as shown, and is imaged onto a pair of slits.

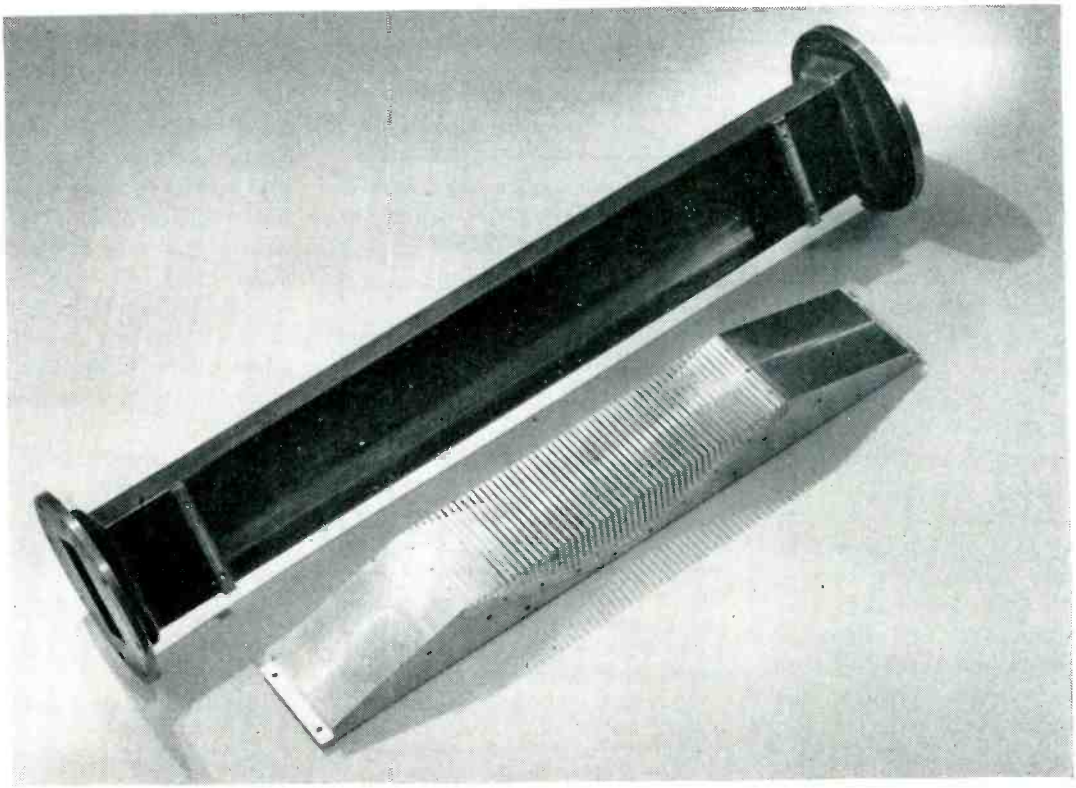
The light through one of the slits is controlled by the position of the sprocket hole edge, the light through the other slit is not affected by the edge position, and serves as a reference, as shown at the lower right of the diagram. The light from the two slits is fed through prisms to two phototubes. These in turn are connected to a differential amplifier whose output is proportional to the difference in light through the two slits.

If a sprocket hole tends to get ahead of its correct position, due to jitter introduced by film or mirror drum, the light through the control slit increases and a control current of one polarity results, whereas if the sprocket hole falls behind, a current of the opposite polarity is produced. The control current, suitably amplified, is applied to a pair of electromagnets attached to the compensating mirror previously mentioned, at the left of the center of the diagram. The magnets cause the mirror to move in the proper direction and by the proper amount to shift the direction of the beams reflected by it so as to restore the edge of the sprocket hole to its proper position. This shift also corrects the direction of the beam from the flying spot to the film, and thereby maintains the raster image stationary with respect to the film frame.

The degree of compensation is such that the vertical jitter is reduced to less than 0.1 percent of the picture height, or less than half the width of a scanning line, which is well within the usual tolerance specified for scanning systems. To achieve this performance, the servomechanism operates at high speed, and the compensating mirror moves through the required angle in a time of the order of a millisecond. Fortunately the angle through which the compensating mirror must rotate is of the order of a few minutes of arc, so the amount of driving power required is not excessive. In fact, the driving means consists of a pair of 5-inch speaker voice coil units, and the peak power is of the order of one watt.

Flicker Compensation

Figure 3 shows a servomechanism proposed to compensate for the frame flicker previously mentioned. This feature was not a part of the apparatus demonstrated but no difficulty in incorporating it in the demonstration equipment was anticipated. The light from the flying spot is picked up by a mirror at the side which reflects the beam along an auxiliary path to the compensating mirror and projection lens and thence to the crown mirrors. The two beams, one on the regular scanning path, the other on the auxiliary path, fall on the mirror surfaces side by side as shown. Consequently the intensity of the two beams changes in the same manner through the active cycle of the crown mirrors. The auxiliary beam then passes through an open gate off to the side of the film gate and into a phototube which measures the light flux in the auxiliary beam. The phototube current, suitably transduced, is then applied as a control signal on the electron gun of the flying-spot cathode-ray tube, changing the intensity of the spot by an amount sufficient to compensate for the change in the light efficiency throughout the cycle. The servo thus acts to maintain the intensity of the light passing through the film at a constant level, and the video signal variations are representative only of variations of the transmission factor of the film being televised.—D.G.F.



Section of waveguide and corrugated surface which fits into it

Corrugated-Waveguide Band-Pass Filters

High-pass properties of a waveguide are combined with low-pass properties of a corrugated surface in a filter designed to give a rapid transition between pass and attenuation bands. Single corrugated element does work of several elements in conventional designs

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RAPID TRANSITION between pass and attenuation bands and a wide frequency range free of spurious responses are desirable properties of a band-pass filter. Such a filter can be realized readily by combining the high-pass properties of a waveguide with the low-pass property of a corrugated surface.

In a particular application a filter was designed which had a passband between 2,080 mc and 2,800 mc and 70-db attenuation, relative to the pass-band response, at 2,900 mc. There were no responses which were not attenuated by at least 60 db from 2,900 mc to above 10,000 mc.

Because of the high-pass characteristic of a waveguide, a band-pass filter can be formed readily by incorporating a low-pass structure into the waveguide. One such low-pass structure is the corrugated surface for which approximate field solutions have been given in the literature[1-6].

The design considered in this paper for utilizing the corrugated surface structure is shown in Fig. 1, where one broad face of the waveguide is replaced by a tapered corrugated surface. Approximate solutions for the attenuation and phase characteristics of the filter in Fig. 1 are obtained by combining design relations[5] with a loaded-line equivalent circuit representation[1].

An idealized pass-band shape is illustrated in Fig. 2. The low-frequency cutoff f_c is provided by the normal cutoff of the waveguide, while the high-frequency cutoff $f\infty$, at which there is infinite attenuation, is provided by a resonance of the slots in region C of the corrugated surface.

The slots in region B of the corrugated surface serve a twofold purpose. They provide additional resonant elements in the upper rejection band ($f > f\infty$) to prevent repetitive pass bands. In addition they serve as a smooth taper which transforms the characteristic impedance of region C into the characteristic impedance of the waveguide through the taper in region A.

Filter Characteristics

The loaded transmission-line representation of one slot in the corrugated surface is shown in Fig. 3. The characteristic equation of the frequency spectrum relating the phase shift ϕ across one element of the loaded line (including both the slot and the transmission line of length l' to the phase shift Θ along l' between two adjacent slots is

$$\cos\varphi = \cos\theta - (Z/2Z_0)\sin\theta\tan(p\theta) \quad (1)$$

where $\varphi = 2\pi l'/\lambda_s$
$\theta = 2\pi l'/\lambda_g$
$p = (b - b')/2l'$
Z = characteristic impedance of the slot
Z_0 = characteristic impedance of the unloaded line
λ_g = guide wavelength in the unloaded line
λ = free-space wavelength
λ_s = guide wavelength in the loaded line
λ_g is related to λ by the expression

$$\lambda_g = \lambda/\sqrt{1 - (\lambda/2a)^2} \quad (2)$$

where a is the broad dimension of the waveguide.

Putting $\phi = \beta - j\alpha$ and neglecting resistive losses one obtains for the pass band ($\alpha = 0$)

$$\cos(\beta + 2n\pi) = \cos\theta - (Z/2Z_0)\sin\theta\tan(p\theta) \quad (3)$$

where $n = 0, \pm 1, \pm 2$, etc and in the cutoff band ($\beta = 0$ or π)

$$\pm\cosh\alpha = \cos\theta - (Z/2Z_0)\sin\theta\tan(p\theta) \quad (4)$$

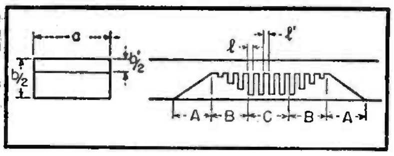

FIG. 1—Mechanical drawing of tapered corrugated surface which replaces one face of the waveguide

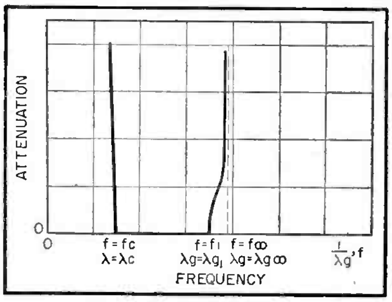

FIG. 2—Idealized pass-band shape. High-frequency attenuation at $f = \infty$ is provided by resonance of the slots in region C of corrugated surface (see Fig. 1)

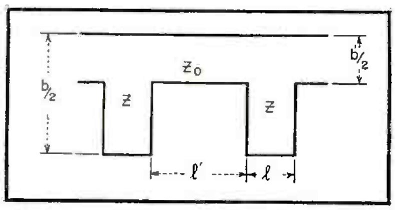

FIG. 3—Loaded transmission line representation of one slot in the corrugated surface

where α = attenuation in nepers per section of loaded line, $(\beta + 2n\pi)$ = phaseshift per section of loaded line.

The values of $n \neq 0$ in Eq. 3 represent space harmonics of the fundamental ($n = 0$) component of the wave. The positive values of n represent transmitted waves, the negative values reflected waves. All of these components are necessary to fully describe the propagated wave.

To simplify the analysis, the space harmonic components are neglected. This is a valid assumption in the pass band, since the amplitudes of the space harmonics are greatly reduced in the pass band[6]. The assumption becomes less valid as the frequency approaches that at which the slots become resonant.

Design relationships among the dimensions of a slot are[5]

$$b'/2 < l' < (\lambda_{g1})^2/10 \quad (5)$$

$$b'/b < 0.1 \quad (6)$$

where λ_{g1} is the guide wavelength in the unloaded section at the upper cutoff frequency, f_1. It can be demonstrated that the pass-band resistive losses due to a finite conductivity in the conducting surfaces vary inversely with the quantity b'/b. This value was chosen to be as large as possible, namely 0.1. It may be seen from Eq. 4 that an infinite attenuation occurs when $p\Theta = \pi/2$. The frequency at which this infinite attenuation occurs is $f\infty$. However,

$$\theta = 2\pi l'/\lambda_g = \frac{2\pi}{\lambda_g}\frac{(b - b')}{2p}$$

Hence at the infinite attenuation frequency ($\lambda_g = \lambda_g\infty$)

$$p\,\theta_\infty = \pi/2 = \frac{2\pi}{\lambda_{g\infty}}\frac{(b - b')}{2}$$

or

$$\frac{(b - b')}{2\lambda_{g\infty}} = 1/4 \quad (7)$$

Eq. 7 means that at the infinite attenuation frequency, the slot depth, $(b - b')/2$, equals one quarter of a guide wavelength.

The values of l and l' are not critical and are generally chosen to keep the over-all length of the filter as short as possible. Typical values are $l' = 2l = 0.1\lambda_{cg}\infty$. The value of the ratio Z/Z_o is taken to be $2l/b'$, the ratio of the slot height to the line height.

Theoretical curves relating ϕ and α in db to Θ are shown in Fig. 4. The curves have been calculated for $p = 2$ and $Z/Z_o = 2$. At the point of infinite attenuation, $\Theta = 45$ deg, while at the upper cutoff point $\Theta = 36$ deg. Hence the ratio of the cutoff wavelength, λ_{g1}, to the infinite attenuation wavelength, $\lambda_g\infty$ is $\lambda_{g1}/\lambda_g\infty = 45$ deg/36 deg $= 1.25$. The slot requires the cutoff wavelength to be decreased by 25 percent before its attenuation becomes infinite.

Referring to Fig. 4, representing the characteristics of the slots in region C of the filter, it can be seen that repetitive pass bands will occur. The first repetitive pass band occurs when $\lambda_g = \lambda_{g1}/2$. To avoid this pass band as well as higher ones, it is necessary to include slots in region B of the filter which will resonate in the vicinity of the higher passbands. In general, this condition is fulfilled merely by having a reasonable length of taper.

Design Procedure

The filter can be easily incorporated as an inserted section in a waveguide, with waveguide input and output. It can also be incorporated into a coaxial line through the use of waveguide to coaxial transformers. The transforming sections form the input and output of the filter.

The low-frequency cutoff determines the wide dimension of the waveguide, a, and is simply related to it by

$$\lambda_c = 2a$$

Generally, both the upper cutoff frequency f_1 and a minimum attenuation at a point between f_1 and $f\infty$ are specified. Once these are known, the slot depth and number of slots in region C can be determined. First λ_{g1} is calculated from the high-frequency cutoff f_1 by Eq. 2. Because $\lambda_{g1}/\lambda_g\infty = 1.25$, $\lambda_g\infty$ may be readily found. The slot depth is then made equal to $\lambda_g\infty/4$.

The number of slots required is the desired attenuation in db at some frequency between f_1 and $f\infty$ divided by the attenuation of one slot at that frequency as determined from Fig. 4.

The lengths of the tapered sections in regions A and B should be about equal and as long as possible for the best match. A theoretical curve relating the vswr introduced by a taper as a function of its length has been given by Frank[7]. From this curve and a consideration of the variation in guide wavelength in the pass band, a value giving small mismatch reflections over the entire pass band is found to be 1.5 λ_c or $3a$.

Experimental Results

An experimental curve for the filter based on the previous design considerations is given in Fig. 5. The corrugated surface was designed to be inserted in standard 1.5 by 3-in. waveguide having a cutoff frequency of 2,080 mc. The desired upper cutoff frequency was 2,800 mc ($\lambda_{g1} = 16.0$ cm.) This gives the infinite attenuation frequency as 3,200 mc ($\lambda_g\infty = 12.8$ cm). It was also desired to have at least 70 db of attenuation at 2,900 mc ($\lambda_g = 15.0$ cm).

Because λ_{g1} corresponds to $\Theta = 36$ deg on the curve of Fig. 4, at $\lambda_g = 15.0$) cm, $\Theta = 38.4$ deg. From Fig. 4, the attenuation in db per slot at $\Theta = 38.4$ deg is 9 db. Hence eight slots in region C should be sufficient to give the desired attenuation. Actually ten slots were used because the attenuation of a slot will be slightly less than shown in Fig. 4 due to resistive losses in the slot. The pass-band loss, averaging approximately 2.5 db, is a combination of resistive loss in the slots and mismatch loss in the tapers.

Higher Order Modes

In the above analysis it was assumed that only the dominant mode $TE_{1,0}$ is propagated. For the usual waveguide dimensions (broad face twice as wide as the narrow face) higher-order modes may be propagated at frequencies greater than twice the normal cutoff frequency. If these higher-order modes are propagated, spurious responses may appear in the rejection band.

Because of the symmetry of the filter, only $TE_{1,2n}$ ($n = 0,1,2, \ldots$) and $TM_{1,2n}$ ($n = 1,2,3, \ldots$) modes can be excited within the filter itself[4]. The first of these modes, the $TE_{1,2}$ and the $TM_{1,2}$ will not be propagated for frequencies less than four times the normal cutoff frequency. In general this is far enough into the rejection band to be of little consequence.

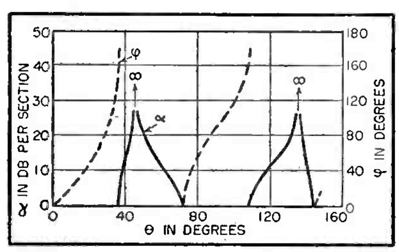

FIG. 4—Theoretical curves relating attenuation in db per section and phase shift across one slot for transmission line of length *l'* (see Fig. 1) to the phase shift along the distance between two slots

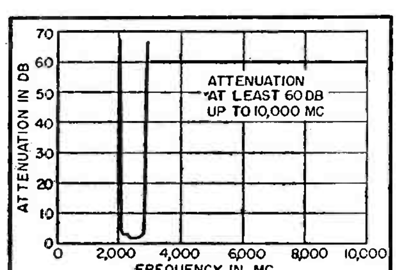

FIG. 5—Attenuation curve for actual filter constructed

Should higher-order modes, such as the $TE_{2,0}$, $TE_{3,0}$ be set up in the input section leading to the filter, they will pass through the filter and produce narrow spurious pass bands for frequencies in the vicinity of twice the normal cutoff frequency, three times this frequency, and so on.

At the cutoff frequency for the higher modes, the guide wavelength for these modes is infinite and rapidly decreases as the frequency is increased. Until the wavelength decreases to a value such that the slots in region C become resonant, no attenuation is offered to the modes.

The higher modes can often be eliminated by careful design of the input circuit to eliminate asymmetrical structures tending to excite the higher-order modes. They may also be eliminated in the output section when of a special type, such as ridged waveguide output. In this case, the ridged section is designed so that it passes the dominant mode, but is cut off for the higher-order modes in the vicinity of the spurious response pass bands. Compensating sections of different widths, a, can be included in the filter proper so that they are below cutoff for the higher-order modes over the frequency range of the spurious responses[8].

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BROADCAST TAPE

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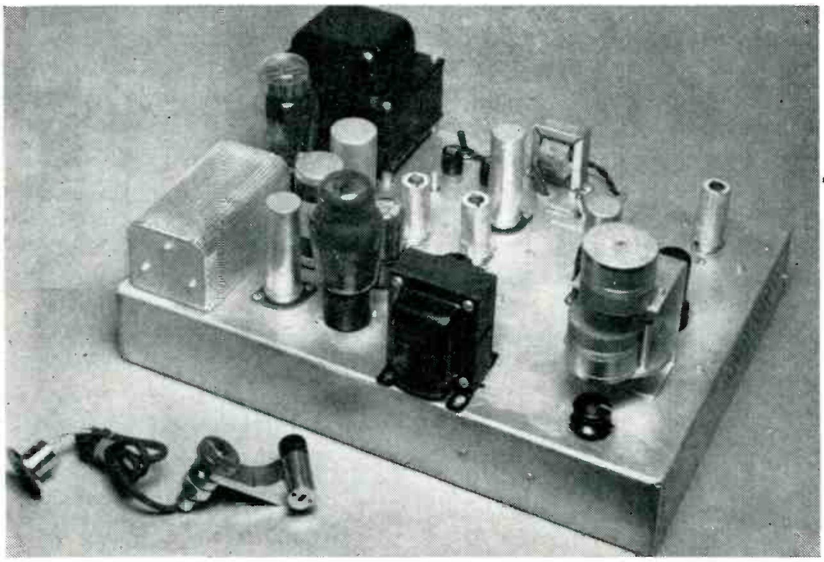

Complete equipment except for audio amplifier to drive capstan motor. Scanning unit cylinder at lower left is ¾ inch in diameter and 2 inches long

THE MANY conveniences of magnetic tape as a medium for recording radio programs are attractive to producers and artists, as well as broadcast technicians. A complete show can now be recorded in a manner similar to the production of a Hollywood movie, with each selection recorded over and over until the director is entirely satisfied. The producer can then edit the recordings to produce precisely the type of show he desires. Fluffs may be easily removed and replaced. This practice provides a freedom of expression for the artist that is extremely convenient. During the editing process the show can be carefully timed so that it will be completed without sacrificing valuable commercial time.

To insure desirable continuity, the program must be timed within one second in a half hour. The dimensional stability of plastic-base tape is not sufficient to guarantee that the recorded time will be maintained to such close tolerances during reproduction of the program.

Conditions of temperature and humidity as well as tension affect the physical dimensions of plastic materials. These dimensional changes may increase with time. Therefore, programs that are shipped to other locations having different climatic conditions or those stored for long periods of time may suffer severely in this respect. In such cases, the time required for reproducing the program may vary considerably from the recording time.

Timing Controls

Several different methods of controlling the playing time of tape recordings have been suggested or tried. One utilizes transverse magnetization to record a reference signal on the tape during the recording of the program.[1] This effect is accomplished by rotating the signal recording head 90 degrees so that the gap is placed parallel to the direction of tape travel. The signal recorded in this manner is reproduced during playback by a similarly oriented head and is used for synchronizing purposes.

A second system[2] makes use of a 14-kc carrier that is modulated with a timing signal. During reproduction, the carrier is filtered from the program signal and after demodulation is used for synchronization.

The system we have developed utilizes optical markings to furnish the timing signal. Since the signal markings are not magnetic, no unwanted signal is generated in the reproducing head by the additional information stored on the recording medium.

The signal is produced by equally spaced bars, printed on the reverse side of the tape, as they are scanned with an optical transducer. This transducer comprises an extremely simple optical system. A grid, placed directly over the printed side of the tape, consists of a mask with one or more holes to correspond with the markings on the tape. A light source is directed towards the grid and as the tape changes in color beneath the hole in the grid, more or less light is reflected back into a photocell.

Figure 1 shows a cut-away view of a scanner to illustrate the operation of such an optical system. Part of the light from source *B* goes through the aperture or grid *C* onto the tape *A*. The intensity of the light reflected back to the photocell *D* is partially governed by the color and gloss of the tape surface. The printed markings therefore produce a signal in the photocell whose frequency is directly proportional to the speed of the tape past the aperture.

The signal generated by the motion of the tape must be compared with some standard or reference frequency, which may be obtained from a regular power supply or from a stable clock-circuit power supply. Some large broadcasting studios have the latter to insure the accuracy of clocks used for program timing. Since available clock motors are designed to operate on 60 cps and the NAB standard tape speed is fifteen inches per second,

SPEED CONTROL

Magnetic-tape programs can be played back within less than a second of original half-hour recording time despite 2-percent stretch or shrink. Printed bars on back of tape are scanned photoelectrically to produce a comparison signal that is held at exactly 60 cps

the markings on the tape are placed at four bars per inch. If it is desirable to operate the tape at the secondary standard of 7.5 inches per second, the marking of four bars per inch may still be used to produce a 60-cps signal by means of a frequency-doubling circuit.

Comparing Speeds

Several methods of comparison between reference and photocell frequencies could have been used. One utilizes a simple beat note for driving the capstan motor. The signal from the photocell is mixed with a signal of twice the reference frequency and the beat note produced will then vary in frequency inversely with the frequency of the photocell signal. This system decreases the error but can never introduce sufficient compensation for complete correction.

A second method uses a two-phase motor as an integrator. The signal from the reference frequency is used to furnish power for one winding of a two-phase capstan motor. The signal furnished by the motion of the tape is amplified to excite the second winding of the motor. If the phase of the current through the first winding leads that of the current in the second winding, the torque of the motor is increased, and conversely, if the phase of the current through the second winding leads that of the current in the first winding, the torque of the motor is decreased. Such a system, however, is an instantaneous or phase-integrating device and does not furnish the time-integrating system desirable for broadcast timing.

Small, fast deviations may produce extremely high percentages of wow. This fact makes it imperative that any correction in speed be accomplished at a very slow rate.

A third method providing a slow time-integrating device may be designed using two synchronous clock motors. One operates from the clock power supply, using no more than 4 watts from this source. A second clock motor operates from the signal generated by the photocell, with rotation counter to that of the first motor. The shafts of the two clock motors are joined by a flexible coupling. As long as the two frequencies governing the speed of the two motors are identical nothing happens, but any difference in the two frequencies causes the frame of one of the motors to rotate with respect to the frame of the second one. This might be described as a simple mechanical differential, which needs no special gears or precision parts.

Capstan Speed Correction

The rotation of the clock frame may be utilized in a number of different ways to obtain correction of

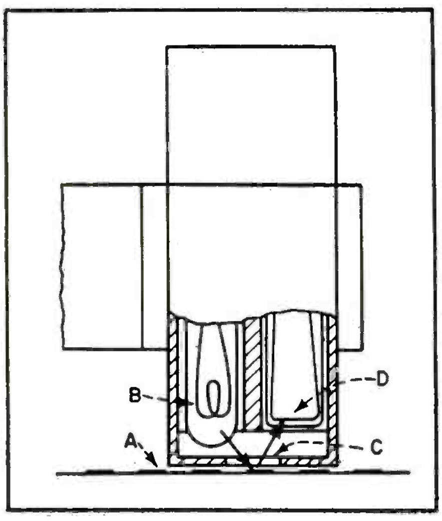

FIG. 1—Light from lamp *B* reaches photocell *D* by reflection from tape *A*

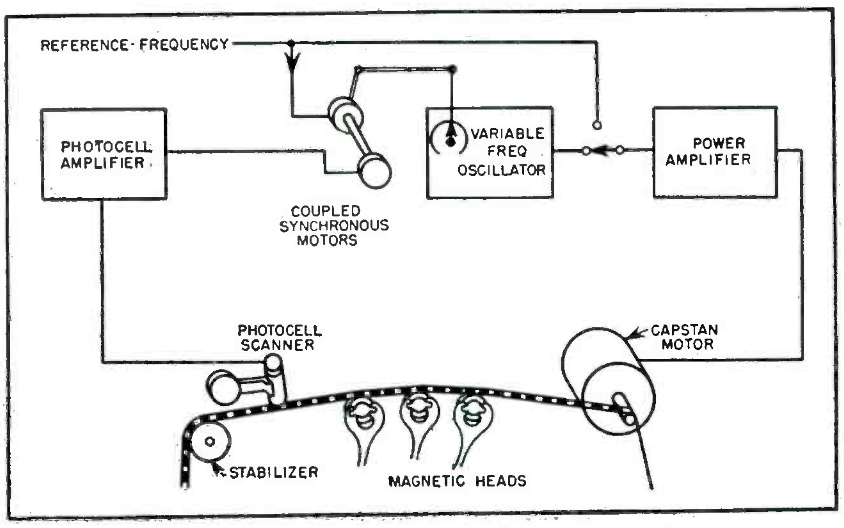

FIG. 2—Block diagram of the final system in which closed-circuit servo operates capstan motor so that signal from tape is exactly 60 cps

the capstan speed. One scheme is mechanically to shift a belt sideways on a tapered pulley. Such a method provides surprisingly accurate correction for timing purposes.

A second mechanical method may be arranged by driving a disk with a friction roller. Speed corrections may be introduced by shifting the roller radially with respect to the disk. The timing with such a system may be controlled very satisfactorily. Such a method is again handicapped with inherent mechanical difficulties that introduce wow in the program material. The precision necessary in the construction of such a device to overcome these difficulties would probably make the cost prohibitive.

Any type of mechanical system is handicapped because the mechanical power developed by standard clock motors is extremely limited.

Overdrive System

The dual clock-motor integrating system may be used satisfactorily by providing an electronic correcting system. One means of doing this is to have the speed of the capstan slightly more than required to drive the tape at the desired speed. The capstan may then be slowed down to the proper speed by an electronic brake. The power delivered to the electronic brake may be controlled by the rotation produced by the dual clock-motor differential.

There is one serious difficulty encountered in using any type of overdriven system. If, for any reason, it is desirable to record or reproduce tape without synchronization, the machine will be operated at some speed that is higher than normal, making the system incompatible with standard unmarked tape. This incompatibility can be eliminated by driving the capstan with a synchronous motor as shown in Fig. 2. The motor is driven with a power source of variable frequency when utilizing the synchronizing system, or with fixed-frequency power at other times.

The motion of the dual clock-motor differential is used to vary the frequency of a local oscillator having a mean frequency of approximately 60 cps. The signal from the oscillator is amplified with an inexpensive narrow-band power amplifier to drive the capstan motor. A relay is also incorporated so that the input signal to the power amplifier is derived from the local oscillator when the optically marked tape is used. If standard unmarked tape is used, the signal that drives the capstan motor is automatically derived from the clock circuit or other exact reference frequency.

The circuit diagram of the photocell amplifier is shown in Fig. 3. The exciter lamp in the scanning unit must be heated with either direct current or alternating current having a frequency that will not interfere with the operation of the clock motor driven by the signal from the photocell.

Exciter Voltage

Direct current for the exciter lamp might be obtained simply by inserting it in series with the amplifier power supply. However, if such a method is used, it is extremely difficult to filter the power supply sufficiently to eliminate low-frequency feedback effects or motorboating. This difficulty was avoided by using a high-voltage, low-current lamp and connecting it in the bleeder circuit of the d-c power supply.

This particular lamp was designed to be operated with 55 v and 0.047 amp. Many such lamps are now available requiring currents as low as 0.032 amp.

The photocell selected is a lead sulphide type of small physical dimensions. The glass bulb of the particular one chosen measures only $\frac{5}{8}$ inch long and $\frac{1}{4}$ inch in diameter. Cadmium sulphide cells are available in even smaller sizes (approxi-

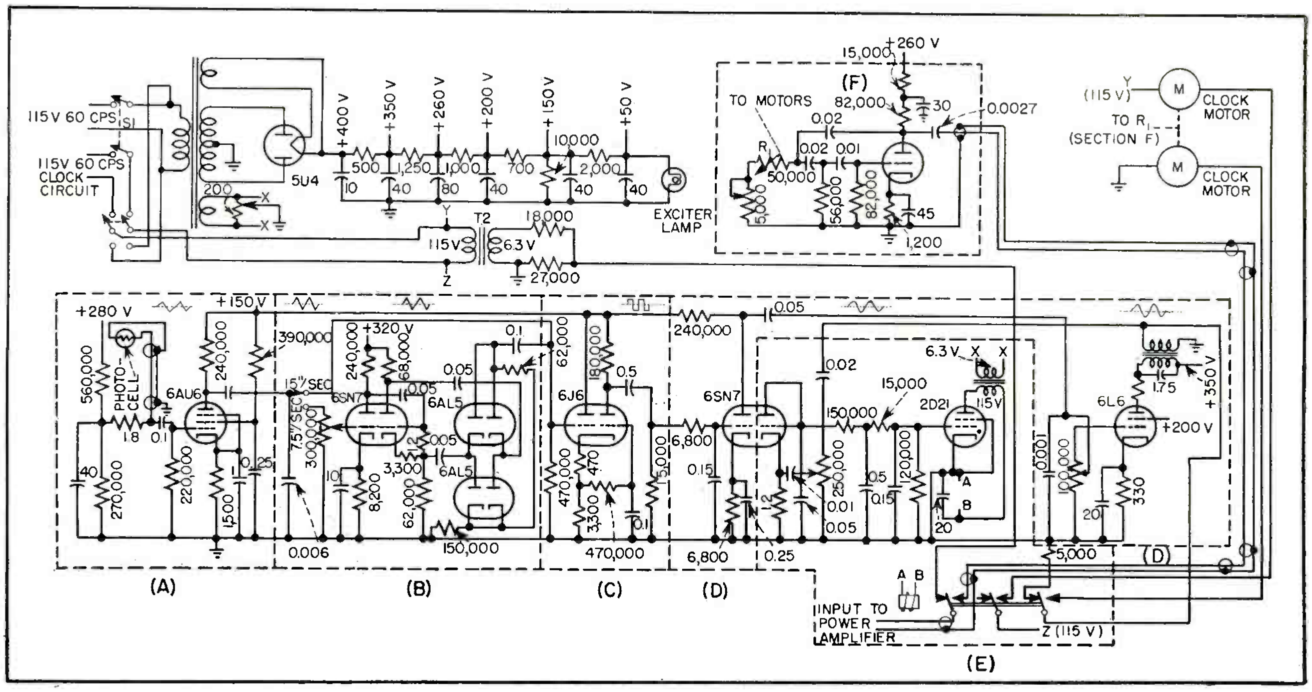

FIG. 3—Complete circuit diagram showing approximate waveforms and their relative amplitudes. Circuits in the dashed boxes are individually described in the text

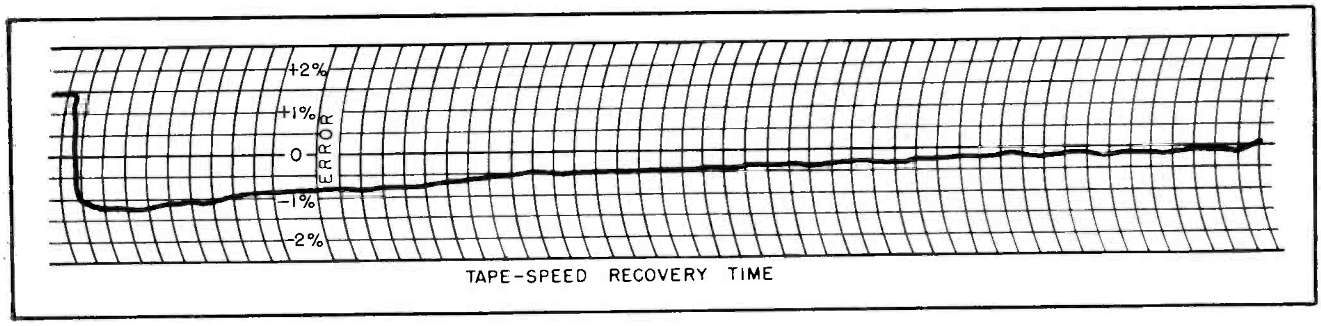

FIG. 4—Recovery time after drastic intentional error was introduced into the system

mately ¼-inch cube). The lead sulphide type was chosen also because of its sensitivity at the red end of the visible spectrum.

Since all the better quality plastic-base tapes are coated with ferric oxide, their color is a reddish brown. The markings can be printed on this color with black ink and produce good contrast when scanned with a red-sensitive photocell. If black tape is used with white markings, the contrast is also sufficient with the same photocell.

The lead sulphide photocell has an internal resistance that varies inversely with the light applied to its sensitive area. The circuit requires a voltage supplied through a load resistance or inductance in the same manner as the anode of a vacuum tube.

The output from the photocell is fed to a conventional preamplifier (Fig. 3A). If the tape is being operated at half speed or 7.5 inches per sec, the signal is diverted through a frequency-doubling circuit (Fig. 3B). This circuit consists of an amplifier, to regain the losses caused by the other stages; an isolation stage, to provide balanced input for the bridge; and a full-wave bridge-type rectifier, to provide the frequency doubling. The gain of the amplifier is so adjusted that the output signal has approximately the same level as that of the input but at twice the frequency.

The output from the frequency-doubling circuit or preamplifier, as the case may be, is passed through a limiter or clipper circuit (Fig. 3C). This circuit provides an output of constant amplitude even though the input signal may vary as much as five to one.

The output from the clipping circuit is then amplified sufficiently to operate one of the clock motors (Fig. 3D). Since the signal is changed to approximately a square wave in the clipping circuit, it is necessary to reshape the signal in the amplifier circuits. A nearly sinusoidal signal is provided by resistance-capacitance filters as well as by a capacitor tuning the inductance of the clock motor itself. Changes in the waveform of the signal are indicated on different sections of the diagram. Signals from the photocell and preamplifier are shown for a tape speed of 15 in. per second.

Control Relay

The relay that stops the clock motors and switches the signal for the capstan motor is electronically controlled (Fig. 3E). The coil is in series with the cathode circuit of a thyratron tube and the relay is normally energized. When the grid of the thyratron is biased negatively, the tube is cut off and the relay is denergized.

Bias for the thyratron is furnished by rectifying some of the signal generated by the photocell. The signal is furnished to the diode rectifier through a high-pass filter network from the output of the power amplifier stage. This filter network may be adjusted so the relay will become de-energized as the frequency of the photocell signal approaches 60 cps.

The variable-frequency oscillator (Fig. 3F), furnishing the signal for the capstan motor, uses an R-C circuit of the phase-shift type. Three R-C phase-shifting elements are used, with each unit shifting the phase approximately 60 degrees. One of the resistance elements is varied with the motion developed by the dual clock-motor differential, and so drifts the frequency of the oscillator.

It may be noted that the impedances of the R-C circuits are kept as low as possible. This precaution was used to decrease the possibility of hum pickup in the grid circuit. Any oscillator has a tendency to lock-in on any signal appearing on the grid of the tube. If lock-in occurs, the usefulness of the entire system will be jeopardized.

No circuit is shown for the power amplifier needed to drive the capstan motor. A conventional audio power amplifier may be used or a much simpler narrow-band amplifier could be constructed.

Performance

Repeated timing tests have been made with this synchronizing system. A synchronized tape was recorded with timing markers exactly 15 minutes apart. Reproduction of this tape was again timed. The timer was operated from the same source of power as that furnishing the reference frequency in both cases. The greatest differential between recording and reproducing time in several tests was 0.3 second. This error might be reduced still further at the expense of speed variation or wow. A recovery rate was selected so that any speed changes would occur as slow drift and not be detected as wow.

The curve in Fig. 4 depicts the recovery rate of tape speed after an intentional error that had been introduced into the correcting device by manually rotating the clock-motor differential.

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Measuring Vector Relationships

Imaginary and real components of an unknown voltage in terms of a reference voltage are indicated directly over a frequency range of 8 cycles to 500 mc. Other applications include study of phase delay in amplifiers, wave filters and attenuators

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VECTOR RELATIONS of alternating voltages over a wide frequency range, from 8 cycles to 500 megacycles, can be measured by means of the instrument to be described. In most applications, the operating principle is based essentially on the vector theory of addition and subtraction. The operating principles underlying two frequent applications, measurement of the phase angle between two given voltages and measurement of complex components of an unknown voltage, will be discussed.

Phase-Angle Measurement

Figure 1 shows a block diagram of the instrument as it is used for the measurement of the phase angle between two given voltages, E_1 and E_2. Variable attenuators R_1 and R_2 are used for adjusting the amplitudes of E_1 and E_2. Phase inverters P_1 and P_2 are capable of producing a constant phase shift of 180 degrees over the entire range of operating frequency.

When terminals 4 and 8 are connected to terminals 1 and 6 respectively, output meter V will read the vector difference of E_1' and E_2'. If the absolute amplitudes of E_1' and E_2' are made equal by adjusting R_1 and R_2, the reading E_o on the output meter may be expressed as

$$E_o = E_2' - E_1' = |E_1'| (\cos\theta + j\sin\theta - 1) \qquad (1)$$

where θ is the phase angle between E_1 and E_2. The absolute magnitude of E_o may be written as

$$|E_o| = |E_1'| \sqrt{(\cos\theta - 1)^2 + \sin^2\theta} = 2|E_1'| \sin\frac{\theta}{2} \qquad (2)$$

For simplicity, the magnitude of $|E_1'|$ is made equal to one volt during adjustment of attenuator R_1, whereby the term $|E_1'|$ may be omitted in Eq. 2, and

$$|E_o| = 2\sin\frac{\theta}{2}$$

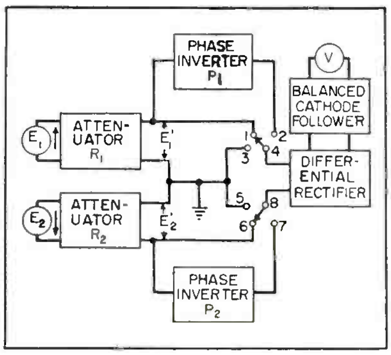


FIG. 1—Block diagram of the Vectorlyzer

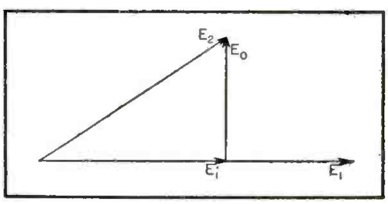


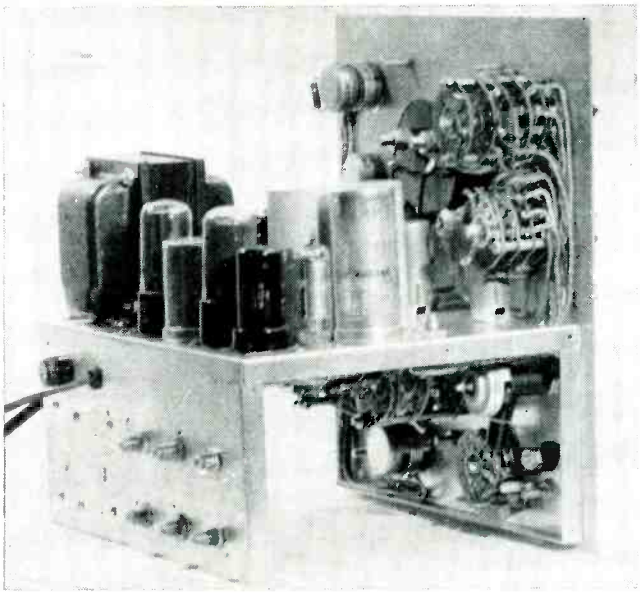
FIG. 2—Vector diagram used in connection with measurement of complex components of an unknown voltage

The output meter may be calibrated to indicate directly the phase angle in degrees between any two voltages. For instance, a meter with full-scale sensitivity of two volts will read 60 degrees at its center and 180 degrees at full scale.

The distribution of readings on a meter face is an important factor in the design of measuring instruments. A linear-scale meter which has a guarantee of one percent error at full scale would produce an error of 10 percent at one-tenth full scale. Sinusoidal distribution of meter readings is a desirable feature since the percentage accuracy of readings is nearly uniform over the entire scale.

Where the two voltages under consideration are nearly opposite in phase, the accuracy of reading can be greatly increased by introducing a phase shift of 180 degrees to either one. This is done with phase inverter P_1 or P_2. A second scale starting with 180 degrees at its normal zero position is established.

Without altering the value of any circuit element the full-scale sensitivity may be increased to any value between 0 and 180 degrees or between 180 and 360 degrees by increasing the value of $|E'_1|$.



Instrument chassis with cover removed

Front-panel view of the complete instrument

The principle underlying this feasibility can best be explained by referring to Eq. 2. As the phase angle θ of this equation decreases, the magnitude of the resultant voltage $|E_o|$ may be held constant if the amplitudes of the input voltages increase accordingly. This in turn keeps the indication on the output meter unchanged, since it is energized by the resultant voltage $|E_o|$.

If it is desired to increase the full-scale angular sensitivity of the instrument from 180 degrees to 60 degrees with the voltage sensitivity of the output meter remaining at 2 volts, R_1 and R_2 are readjusted so that the magnitudes of $|E_1'|$ and $|E_2'|$ will be two volts instead of one volt. After this readjustment the angular sensitivity of the output meter will be increased by three times.

Measuring Complex Voltages

The instrument is a simple and convenient device for direct indication of the imaginary and real components of an unknown voltage in terms of a reference voltage. The block diagram of Fig. 1 may also be used to explain the operating principle underlying this application.

In Fig. 1, E_1 and E_2 are assumed to be the reference and unknown voltages respectively. Attenuator R_2 is adjusted to give zero attenuation so that E_2' will be equal to E_2. Attenuator R_1 is adjusted until the deflection at the output meter reaches a minimum with terminals 4 and 8 connected respectively to terminals 1 and 6. To represent this condition, a vector diagram is drawn in Fig. 2 for voltages E_1', E_2, and E_o. Symbol E_o denotes the reading on output meter V, which is also the potential developed across terminals 1 and 6 when the meter is correctly calibrated.

Since these three vectors form a right triangle, the diagram indicates that E_o is equal to the imaginary component of E_2 and that E_1' is equal to the real component of E_2. The output meter will read directly the imaginary component with terminals 4 and 8 connected to the positions shown in Fig. 1 and read directly the real component when terminal 8 is connected to terminal 5.

If the phase angle between the unknown voltage and the reference voltage is greater than 90 degrees but less than 270 degrees, the above method of measuring complex components still is useful when E_1' is shifted 180 degrees with respect to E_1 by inserting phase inverter P_1.

High-Impedance Attenuator

The attenuator circuit shown in Fig. 3 is designed to minimize phase-distortion difficulties encountered with conventional volume controls at high frequencies. The triode is arranged as a cathode follower to provide a high input impedance and to allow the resistance of the potentiometer at its cathode to become very low. The first feature is essential for many practical applications while the second helps to minimize the error caused by the stray capacitances of the potentiometer.

Experimental results show that the maximum error introduced by the circuit of Fig. 3 is less than 2 degrees at 2.5 mc with a 1,000-ohm carbon potentiometer for R_4. At low frequencies, the error angle is determined by the values of C_2 and R_5—the larger these two elements are, the smaller the error angle. Capacitor C_2 keeps the d-c potential constant at the output terminal during adjustment.

Figure 4 shows the schematic diagram of the differential rectifier and the balanced cathode-follower circuits appearing in Fig. 1. Diode V_1 functions as a differential rectifier. During the positive loop of the applied voltage, C_1 and C_2 charge through V_1. During the negative loop of the applied voltage these two capacitors discharge through the series combination of R_1, R_2 and the other part of the circuit.

The time constant during discharge is made very large compared with that during charge, and therefore the sum of the average potentials across C_1 and C_2 is only slightly less than the peak value of the positive loop of the applied voltage. Resistors R_1 and R_2 are used to isolate both input terminals from the other part of the circuit. Both input terminals can be connected to points which are above a-c ground potential.

Triodes V_2 and V_3 function as a balanced cathode follower. The impedance between points C and D looking into the cathode follower is $R_3/(1 - A)$, where A is the gain of the cathode follower. This impedance becomes very large compared with R_3 when A approaches unity. In practice, the value of $R_3/(1 - A)$ can be conveniently made equal to 100 megohms or higher if R_3 is chosen to be 10 megohms. This high impedance makes it possible to operate the instrument at frequencies as low as a few cycles since the time constant $[C_1C_2/(C_1 + C_2)][R_3/(1 - A)]$ determines the lower limit of the frequency response.

Another feature of the circuits described is good stability. This is achieved by the use of balanced arrangement. Physically, R_5, R_8, V_1-V_2 and V_3-V_4 perform as four arms of a balanced bridge in which R_6 and R_8 correspond to the ratio arms, V_1-V_2 to the unknown arm and V_3-V_4 to the standard arm.

VHF Operation

With available circuit elements and technical knowledge it is extremely difficult to construct a variable attenuator which will produce negligible or constant phase shift from 10 to 500 mc while also having a high input impedance. It is equally difficult to construct a high-impedance network which will introduce a constant phase shift over this range.

Figure 5 shows the basic circuit of the instrument when it is used at high frequencies. In this circuit, rectification is performed by the probe which consists of a germanium crystal, two capacitors and two resistors. The resonant frequency of the probe can be made very high, over 700 mc, when care is taken during construction. Potentiometer R_4 is used for panel zero adjustment. Before operation the variable arms of potentiometers R_3 and R_9 are set at their extreme right positions.

In order to explain the operation of this circuit, consider the case of measuring the phase angle between two given voltages. Assume that symbols E_1 and E_2 represent the two given voltages and the magnitude of E_1 is smaller than that of E_2. The procedure for handling various controls is as follows: (1) Connect input terminal 6 to ground and connect terminals 4 and 5 to terminals 1 and 2, respectively. Adjust potentiometer R_3 until a half-scale deflection is obtained on the output meter. This step serves to adjust the sensitivity of the instrument so that a full-scale deflection will occur if the phase angle to be measured is 180 degrees. (2) Connect terminal 4 to ground and terminal 6 back to terminal 3, then adjust potentiometer R_9 until a half-scale deflection is again obtained on the output meter. This step serves to adjust the zero indication of the instrument so that the output meter will read zero when the two input voltages are in phase. (3) Connect terminal 4 back to terminal 1. Now enter the reading of the output meter into one of the curves of Fig. 6 and find the answer on the X axis. If the absolute magnitudes of both input voltages are equal, the phase angle can be read directly on the output meter and it is possible to omit both the second step and the use of the curves of Fig. 6.

To explain the operating principle, an expression for the voltage E_o developed across terminals 1 and 6, which is also the reading on the output meter, is written as follows:

$$E_o = E_2 - E_1 = |E_1|(n\cos\theta + jn\sin\theta - 1) \quad (3)$$

where $n = |E_2|/|E_1|$ and Θ is the phase angle between E_1 and E_2. The absolute amplitude of E_o is

$$|E_o| = |E_1|\sqrt{n^2 + 1 - 2n\cos\theta} \quad (4)$$

Equation 4 indicates that $|E_o|$ varies from $(n - 1)\,|E_1|$ to $(n + 1)\,|E_1|$ as the angle Θ varies from zero to 180 degrees. Thus the maximum variation is $2\,|E_1|$ which is independent of the ratio n. This relation is very important in using the instrument at high frequencies.

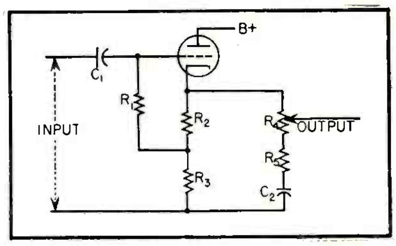


FIG. 3—Basic circuit diagram of the attenuator for audio and radio frequencies

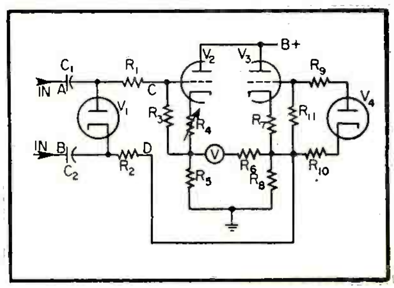


FIG. 4—Differential rectifier and balanced cathode follower

Assume that Θ_1 is the reading of the output meter and Θ is the true phase angle between E_1 and E_2. Since the scale of the output meter is calibrated in degrees for the case when both input voltages have equal amplitude, we may write

$$2|E_1|\sin\frac{\theta_1}{2} = |E_1|\left[\sqrt{n^2+1-2n\cos\theta} - (n-1)\right] \quad (5)$$

In Eq. 5, the term at the left is obtained by substituting $n = 1$ into Eq. 3, while the term at the right is derived from Eq. 4 and the fact that a voltage with amplitude equal to $(n - 1)\,|E_1|$ is balanced out from the output meter during the second step of adjustment. By rearrangment of terms, Eq. 5 becomes

$$\cos\theta = 2\left(1 - \sin\frac{\theta_1}{2}\right)\left(1 + \frac{1}{n}\sin\frac{\theta_1}{2}\right) - 1 \quad (6)$$

Graphical representation of Eq. 6 is shown in Fig. 6.

Complete Instrument

A simplified circuit diagram of the complete instrument is shown in Fig. 7. Essentially the instrument is a combination of the following elements: two variable attenuators, two phase inverters, a differential rectifier, a balanced cathode follower, a high-frequency probe,

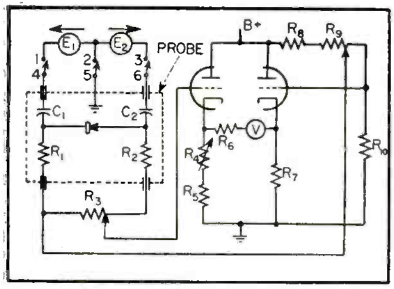


FIG. 5—Circuit diagram of the Vectorlyzer for operation at high frequencies

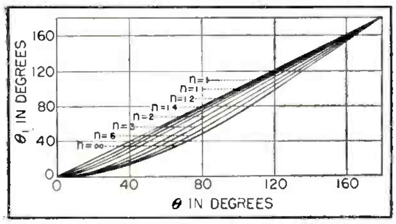


FIG. 6—Curves used in conjunction with the high-frequency probe

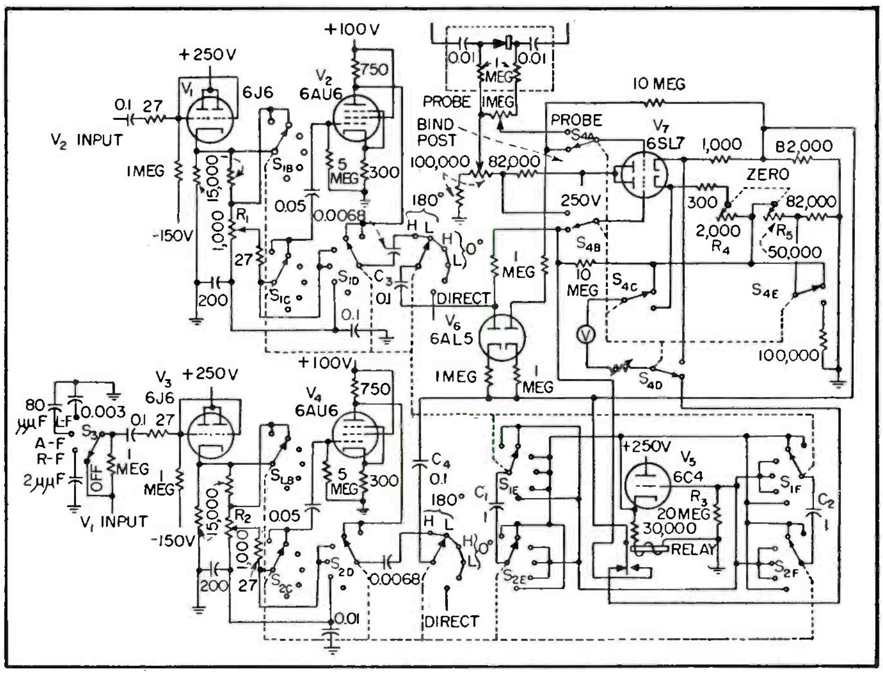


FIG. 7—Schematic diagram of complete instrument. Duo-triodes V_1 and V_3 are employed as cathode followers in the attenuator circuits

an automatic relay circuit and a regulated power supply. Duo-triodes V_1 and V_3, having a transconductance of approximately 10,000 micromhos with both sections connected in parallel, are employed as cathode followers in the attenuator circuits, permitting the use of low-resistance potentiometers R_1 and R_2 for adjustment.

Two single-stage degenerative amplifiers using pentodes V_2 and V_4 are employed for phase inversion. When switch S_4 is at the position marked BINDING POST, duo-diode V_6 and duo-triode V_7 are connected respectively as a differential rectifier and a balanced cathode follower similar to those described in the early part of this paper.

The high-frequency probe consists of a germanium crystal, two resistors and two capacitors. When switch S_4 is at the position marked PROBE, the balanced cathode follower is connected to the probe for operation at high frequencies. Potentiometer R_5 is inserted for panel zero adjustment when the probe is in use, otherwise potentiometer R_4 is used alone for the same purpose. This arrangement was found necessary in order to avoid initial rush of pointer movement during zero setting. Switch S_3 is used for sense identification. If voltage V_1 lags V_2, the turning of switch S_3 will cause the meter reading to increase since an additional phase angle is added to voltage V_1.

During operation, when switch S_1 or S_2 is turned from the position shown in Fig. 7 to the position marked 0° or the position marked DIRECT, a sudden large variation in potential difference may develop across capacitors C_3 and C_4. This variation in turn causes a heavy transient current to overload the output meter. The operation will be interrupted until the charges on C_3 and C_4 return to the steady-state condition. This condition may take as long as several minutes to establish since the input impedance of the balanced cathode follower is very high, over 100 megohms. The heavy transient current may even damage the output meter in some cases unless an automatic relay circuit is added to the instrument.

The relay circuit embodies a triode V_5, which normally operates slightly above its cutoff, an R-C circuit of proper time constant and an electromagnetic relay of which the action is controlled by the plate current of the triode. When switch S_1 is turned to the position marked 0° from the position shown in Fig. 7, C_1 is short circuited and C_2 with zero initial charge is connected across the grid and cathode of triode V_5. The plate current of V_5 rises abruptly and the relay in its cathode circuit is energized immediately. Capacitor C_2 charges through R_3 and the potential at the grid of V_5 decreases exponentially toward zero.

The relay will be deenergized again as soon as the plate current of V_5 decreases to a certain value. The energizing of the relay serves to short-circuit the input terminals of the balanced cathode follower and to disconnect the output meter. The charges on C_3 and C_4 will reach their steady-state condition in a much shorter interval and the pointer of the output meter will stay at its zero position until the steady-state condition has been established if a proper time constant is chosen for R_3C_2. During the next switching action that includes the turning of switch S_1 to its original position or the position marked DIRECT, or the turning of switch S_2 to the position marked 0°, C_2 will be short-circuited and C_1 will be connected across the grid and cathode of triode V_5. The relay operates and the process repeats.

The author wishes to acknowledge that the instrument described was developed for the Advance Electronics Company.

SQUARE-WAVE GENERATOR

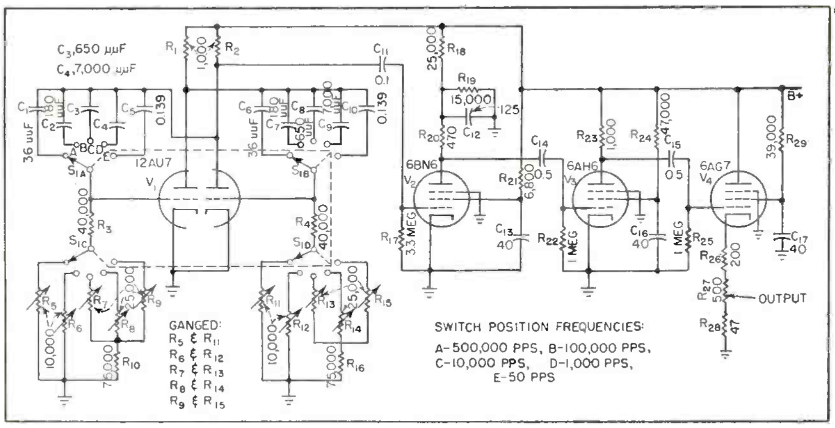


FIG. 1—Circuit diagram for square-wave generator. The clipper stage employs a 6BN6 gated-beam tube

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MOST SQUARE-WAVE generators are fairly expensive because they employ several cascaded amplifier stages to provide adequate clipping action. With only five tubes used in the complete instrument, a square-wave generator using a 6BN6 gated-beam tube as a clipper[1] delivers a signal with good waveform, fast rise time and wide frequency range. The schematic diagram of such an instrument is shown in Fig. 1.

Circuit Description

Referring to the schematic diagram of Fig. 1, a 12AU7 twin-triode, V_1, is used as a plate-coupled symmetrical multivibrator. Five separate frequencies of operation are provided with each frequency obtained by changing the grid-plate R-C circuits by means of switch S_1. The grid resistors are dual potentiometers which can be adjusted to supply exact frequencies on each switch position regardless of coupling-capacitor tolerances.

The nonsinusoidal signal appearing across plate load R_2 is applied through C_{11} to the gated-beam clipper V_2. Both plate and screen voltages on this tube must be kept low for good clipping.

A square-wave signal appears across plate load R_{20} and is applied through C_{14} to the wide-band voltage amplifier V_3. The amplified square-wave signal is then applied through C_{16} to the cathode-follower output stage V_4 which permits a low-impedance output.

Direct voltages to operate the instrument are supplied by a conventional full-wave rectifier power supply using a 5Y3GT.

Design Features

Small-value plate-load resistors are used in each amplifier stage to provide wide frequency response and to minimize the effect of distributed capacitance.

To amplify a square-wave signal with minimum waveform distortion, an amplifier should be capable of amplifying frequencies without attenuation to at least the tenth harmonic of the square-wave fundamental frequency. Since the highest frequency square-wave signal supplied by this unit is 500,000 pps, the amplifiers must be reasonably flat to better than 5 megacycles. By using small plate-load resistors and care in wiring it has been possible to accomplish this without having to use peaking coils or other means to boost the high-frequency response. This is desirable so that the final square wave will be free of overshoots, ringing and high-frequency phase shift.

At low frequencies, other problems are encountered. Since a low-frequency square wave may be considered as a switched d-c signal, the amplifier circuits must be capable of holding a steady level during a period equal to one-half a cycle of the lowest-frequency square wave to be obtained. Towards this end, large R-C time constants are used in coupling between stages and large-capacitance electrolytics are used in filtering and by-pass circuits.

Several requirements dictated the design of the output circuit. In common with all wide-band devices, the output impedance had to be low. At the same time, it was desired to provide control over the output level at minimum cost and without distortion of signal waveform at different levels.

A cathode-follower output circuit was selected and a low-resistance potentiometer, R_{27}, used to control the output level. Even with these precautions, the waveform suffered near the ends of rotation of the control. This was due to the frequency consciousness of a potentiometer type of control. To minimize this effect, fixed resistances, R_{26} and R_{28}, were added to prevent adjusting the control to extreme limits.

In the final circuit, it is possible to adjust the output level over the desired range without waveform distortion from 50 to 500,000 pulses per second.

Choice of Frequencies

Since a square-wave signal is satisfactory for checking an amplifier to at least the tenth harmonic of its fundamental repetition rate,

USING GATED-BEAM TUBE

Output from 50 to 500,000 pulses per second is provided in five steps for checking frequency response, phase shift or transient response. Simple circuit includes a symmetrical multivibrator, gated-beam tube, wide-band amplifier and cathode-follower output

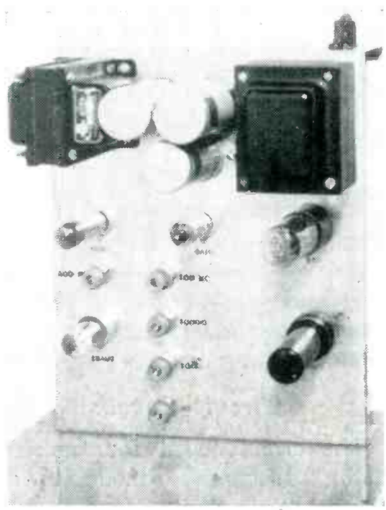
it is not necessary to provide continuous frequency coverage in a square-wave generator. Four or five frequencies, if carefully chosen, are satisfactory for all normal work.

Frequencies permitting the final instrument to be applied with equal versatility to the design of audio amplifiers and pulse and video amplifiers were selected. For these reasons, repetition rates of 50, 1,000, 10,000, 100,000 and 500,000 pps were chosen.

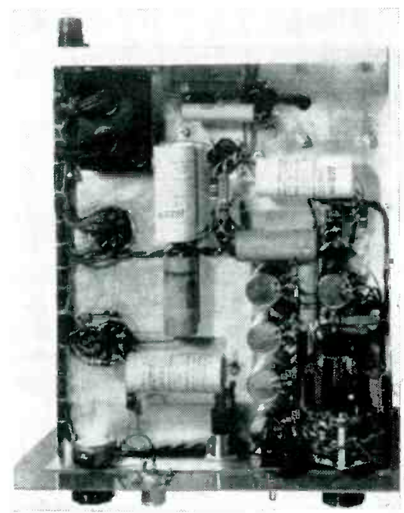
Another model will be made available for wide-band, high-fidelity audio-amplifier work. It will supply signals at 50, 500, 5,000, 10,000 and 20,000 pps.

Output-signal level may be adjusted by means of R_{27} from approximately 0.8 to 8 volts peak-to-peak. This permits checking not only complete amplifier circuits but also individual stages and attenuator circuits. Output impedance varies from about 50 ohms to approximately 550 ohms, depending on the attenuator setting.

Rise time is good, and for the 500-kc signal is better than 0.07 microsecond.



Chassis of square-wave generator, showing dual-potentiometer adjusting screws for the five output frequencies



Underside of chassis with output potentiometer, output jack, power switch and frequency-selector switch visible

Applications

The final instrument may be used for checking amplifiers, peaking or ringing networks, attenuator circuits, phase-shift circuits and pulsing circuits or devices.

For pulse formation, a conventional differentiating circuit may be used in conjunction with the square-wave generator.

When the instrument is used, normal precautions should be followed. Unless necessary to minimize hum pickup, a shielded output cable should not be used. An open line is preferred to prevent high-frequency signal loss and resultant rounding of the square-wave signal.

Since a direct voltage is present along with the square-wave signal at the output terminal, a blocking capacitor should be connected in series with the hot lead if d-c cannot be tolerated in the circuit to which the generator is connected. The size of this capacitor will be determined by the input impedance of the circuit to be tested and, for this reason, a capacitor was not incorporated as part of the instrument. The capacitor used should be selected to provide an R-C time constant, with the input impedance of the circuit to be tested, at least 25 times greater than the time of one cycle of the lowest-frequency square-wave to be used.

In all cases, connections to and from the circuit tested should be kept as short as practicable. Long leads may introduce sufficient inductance in some amplifier circuits so that resonance at comparatively low frequencies occurs. This results in overshoots and transient oscillation when signals having a short rise time are used. Such distortion of the square-wave signal may lead to incorrect conclusions concerning the circuit tested.

The author wishes to thank Joseph Kaufman, Director of Education, National Radio Institute, for his encouragement and suggestions during the design of this instrument and Mort Massie for his help in securing special samples necessary for the construction of an experimental model.

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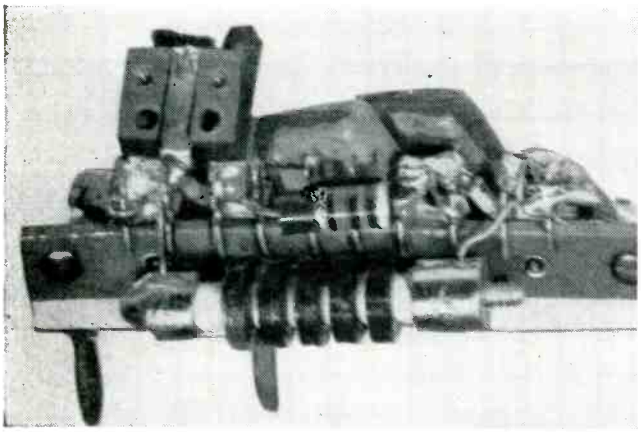
TRANSISTOR FREQUENCY



Actual-size photograph of transistor frequency modulator shows simplicity and compactness as compared to vacuum-tube modulator

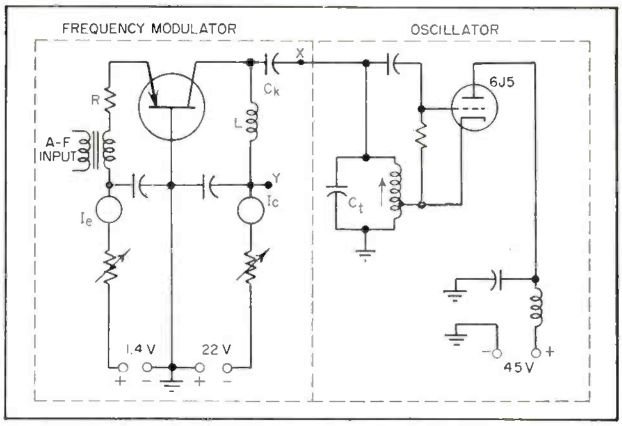


FIG. 1—Transistor frequency modulator provides low-distortion modulation with low d-c and a-f power input requirements. Signal frequencies up to 1.5 mc may be used

TRANSISTORS, since their introduction several years ago, have successfully been applied in many circuits originally designed to operate with vacuum tubes. Experimental work described here shows suitability of transistors for use as frequency modulators.

The control element of the transistor in this application is the emitter as in conventional amplifier circuits. The controlled element is, however, the internal impedance of the collector-base path. Measurements on transistors show that the internal collector impedance changes between broad limits if the voltage and the current are changed slightly between the emitter and base. The measurements further show that instead of the internal collector impedance being purely resistive, it is actually complex for some values of emitter current.

In some transistors the reactive component of the collector impedance changes its value from inductive to capacitive as the emitter current is changed. In other transistors the sign of the internal collector impedance remains the same within the range of emitter currents used.

The wide variation of internal collector impedance is used to produce frequency modulation in an oscillator circuit. A conventional tube circuit is used for the oscillator. The production of frequency modulation by resistance changes has been proposed before[1,2]. These methods use the variable internal plate resistance of tubes and some resistance-transforming means for coupling variable reactive elements to an oscillator tank.

Circuit Details

The circuit used for the transistor frequency modulator is somewhat simpler. Figure 1 shows the diagram of the experimental setup. The collector circuit of the transistor is fed with direct current through r-f choke *L*. A capacitor, C_k, not greater than about 1/10 of the oscillator tank capacitor, couples the collector to the oscillator tank. The emitter circuit is biased to class A amplifier service. The audio input is applied to the emitter circuit through series resistance *R*. This resistance reduces distortion caused by the nonlinear characteristic of the emitter circuit. The transistor cannot develop an audio-output voltage in the collector-load circuit, even if the collector current is varied, because r-f choke *L* acts as a short-circuit for the audio output. The audio signal applied to the emitter, however, varies the collector resistance between broad limits at an audio-frequency rate. Coupling capacitor C_k is coupled to the tank through the variable internal collector resistance of the transistor and the ground return. The r-f choke in parallel with the collector represents a high r-f reactance and can be neglected.

The coupling capacitor draws more or less capacitive current from the tank according to the instantaneous value of the transistor internal collector resistance. This produces a frequency modulation. The oscillator tank, however, is loaded through C_k with a variable resistance, which is the internal collector resistance. This variable loading effect produces some amplitude modulation. By proper selection of the oscillator tank capacitor, C_t, which should be of low reactance, the amplitude-modulation effect of the variable collector resistance can be kept below any desired value. A high value of reactance for the tank capacitor is needed, however, to produce a large frequency deviation for a given collector resistance variation. A sound compromise is possible between these contradictory requirements.

Figure 2 shows a typical static linearity curve for a transistor frequency modulator operating at 1.03-mc carrier frequency. During the static deviation measurements the flow of modulation current was simulated by varying the emitter bias-current resistor. Also shown in Fig. 2 is the amplitude variation of the frequency-modulated oscillator tank.

Figure 3A shows the equipment used to test the deviation and static linearity of the circuit. The signal from the oscillator under test is

MODULATOR CIRCUIT

Use of transistor in frequency-modulation circuit saves a-c filament power, reduces size and weight, requires less a-f driving power and reduces d-c power requirements. Distortion in transistor frequency modulator can be kept as low as in tube modulators

By L. L. KOROS and R. F. SCHWARTZ

Engineering Products Department,
Advanced Development Section
RCA Victor Division
Radio Corporation of America
Camden, New Jersey

picked up on a communications receiver (with c-w oscillator on) and the receiver output frequency deviations are measured by comparison with a calibrated audio signal generator using Lissajous figures.

The circuit of Fig. 1 was tested for its dynamic performance with a 400-cycle modulating signal. This was done by applying the audio signal to the a-f input terminals and observing the output by means of a discriminator and wave analyzer. Two 6SH7 limiter stages preceding the 6H6 discriminator seemed to give sufficient limiting for all signal levels encountered in this work and assured a linear output response of ±2.5 volts d-c for ±5,000-cps frequency variation with a 0.05-volt rms frequency-modulated input.

A distortion analysis of the modulator was made for three different values of deviation. Figure 3B shows graphically the relationship between the input voltage and the deviation for one of the transistors investigated. The results of the distortion analysis are shown in Table I. The distortion components were read on the wave analyzer at the discriminator output.

A measurement on the audio oscillator indicates that for the maximum deviation setting shown in Table I, and for a resistive load of the same order of magnitude as that represented by the modulator circuit, the output distortion of the audio oscillator was 0.3 percent rms. For output settings corresponding to the lower inputs used, the distortion is so low as to be considered negligible. No correction was used, therefore, on the data of Table I. Figure 3C shows the plot

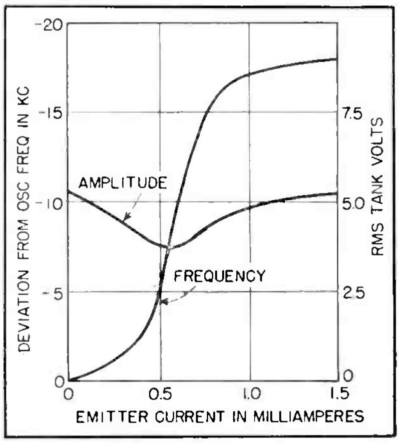


FIG. 2—Curves show linearity of modulation characteristics and effect of modulation on oscillator output amplitude

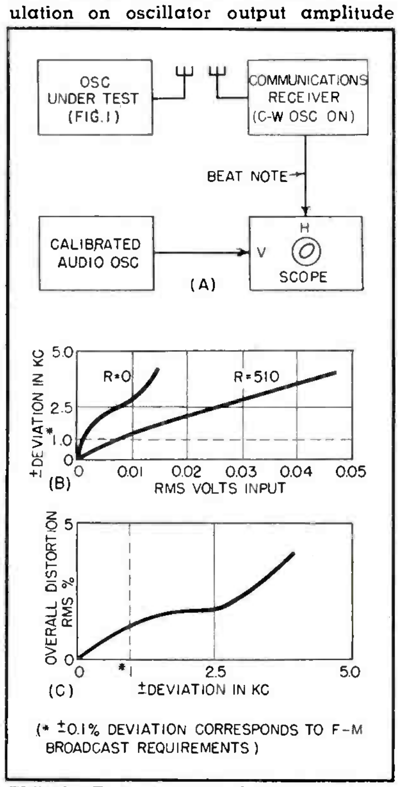


FIG. 3—Equipment used to test transistor frequency modulator is shown in *A*. Resulting curves for a typical transistor are given in *B* and *C*

of overall distortion versus deviation for the transistor considered here. The audio-frequency response of the transistor modulator was measured and is substantially constant from 20 to 15,000 cps for all of the transistors investigated.

The data given in Table I and Fig. 3C show that for a ±0.1-percent deviation of the carrier frequency, which is the upper limit required in the f-m services, the distortion was reasonably low. The interpolated value was only 1 percent rms. Figure 3B shows that the input voltage to the modulator to obtain this deviation was also low. The ±0.1-percent frequency deviation was achieved with about 0.008 volt rms input. The input resistance of the emitter circuit with a 510-ohm series resistor R was about 650 ohms. For maximum deviation the input requirement of the modulator with the linearizing resistor was therefore about −40 db (0 level 1 milliwatt). The input without linearizing resistor was −55 db. The input requirement showed fluctuations in the order of 6 db from transistor to transistor.

Internal Collector Resistance

Two equivalent circuits of the modulator are shown in the insert in Fig. 4. Any collector reactance is included in C_s. This form of representation does not follow the real situation because the coupling capacitor has a predetermined value and the changing element is the collector impedance. It is more convenient, however, to separate the resistive and reactive elements into two groups and to consider the modulator as a series or parallel combination of a capacitor and resistor. The equivalence of the series and parallel representation is expressed by

$$R_s - jX_s = -\frac{R_p j X_p}{R_p - jX_p} \quad (1)$$

$$\frac{X_s}{R_s} = \frac{R_p}{X_p} \quad (2)$$

where X_s and X_p are the reactances

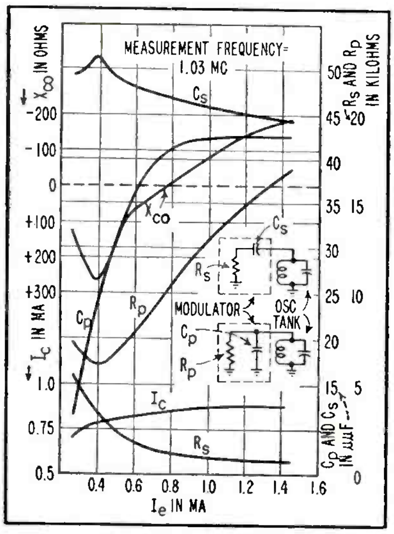


FIG. 4—Curves show relationship between emitter current and other circuit variables for two forms of equivalent circuit

of C_s and C_p respectively at the oscillator frequency.

For practical purposes, the data which can be measured directly by the easiest method are C_p and ΔC_p, the change of C_p. Resistance R_p can be measured by a Q-meter, and C_s and R_s can be computed.

From Eq. 1 and 2

$$C_s = C_p \frac{X_p^2 + R_p^2}{R_p^2} \quad (3)$$

$$R_s = R_p \frac{X_p^2}{X_p^2 + R_p^2} \quad (4)$$

The frequency deviation Δf is expressed by

$$\Delta f = -\frac{f}{2C_t} \Delta C_p \quad (5)$$

If it is found that the calculated $C_s = C_k$, which is the coupling capacitor actually used, the internal collector impedance is purely resistive and its value is identical with R_s. If, however, it is found that C_s is less than C_k it means that the internal collector impedance can be represented by a resistor and capacitor in series. If C_s is greater than C_k the internal collector impedance can be represented by a series combination of a resistance and inductance.

The technique used to measure C_p, ΔC_p and R_p consists of the determination of the Q of the network formed by the internal collector impedance and the coupling capacitor C_k connected in series. The frequency modulator part of Fig. 1 is coupled to the Q-meter at X and Y. The inductance of the Q-meter, for obtaining the most exact figures, should be chosen lower than recommended for normal use of the instrument at the same frequency, in order to make the Q reading on a convenient range on the meter. If lower inductance is used it is necessary to add capacitors in parallel to the variable capacitor of the Q-meter to tune the circuit to resonance at the investigated frequencies. The techniques of the measurement are as follows: (1) Tune the Q-meter's variable capacitor to maximum Q-reading, before the transistor is inserted in its socket. Read Q_o and C_o. (2) Plug in the transistor and select different emitter current values I_e. (3) Tune the Q-meter's variable capacitor to maximum Q-reading again with each I_e setting and read the $Q(I_e)$ and the changes on the Q-meter capacitor ΔC_p. From the Q readings for the different emitter currents, R_p is computed as

$$R_p = \frac{Q_o Q(I_e)}{Q_o - Q(I_e)} X_L \quad (6)$$

where X_L is the reactance of the Q-meter coil used. To minimize errors due to distributed capacitances and lead inductances, the transistor socket with the coupling capacitor C_k and the r-f feed choke L was built as a compact unit which was directly plugged into the terminals of the Q-meter. A photograph of this frequency modulator unit is shown.

The curves of Fig. 4 show the values of C_p, R_p, C_s and R_s as functions of the emitter current at 1.03 mc for one transistor. The experimental data are presented in Table II. The values of the collector current I_c are also shown in the same figure. The values of C_p and Q were measured, and the values of R_p, C_s and R_s were calculated from Eq. 6, 3 and 4. The reactive component of the internal collector impedance is represented by X_{co}. The computation of X_{co} was done with the expression $X_{co} = X_{ck} - X_s$ where X_{ck} is the reactance of the coupling capacitor and X_s is the reactance of C_s at the r-f carrier frequency. As Fig. 4 shows, the value of the reactive component X_{co} was found to be low compared with R_s. Nevertheless, it had an influence on the frequency deviation. Reactance X_{co} changed in this case from inductive to capacitive values. There were found, however, transistors where X_{co} was even smaller and the internal collector impedance was, for the main part, resistive. It was also found that the collector resistance and reactance depended upon the electrical history of the transistor. In the investigated cases, however, if the transistor showed amplification properties, the frequency-modulation property also was present.

Figure 4 shows that a large variation of the resistive component of the collector impedance, about 600 to 5,000 ohms, takes place for only a small change of the order of one milliampere in emitter current. Since the emitter resistance is of the order of 100 ohms, only a small input power is required for a relatively large change in collector resistance, as we have previously seen. Such a variation is an interesting feature which makes the transistor especially useful as a frequency modulator.

The transistor frequency modulator may introduce some jittering of the oscillator frequency due to instability of the transistor constants and to temperature changes. If the center frequency of the oscillator is stabilized by means of a discriminator and standard frequency

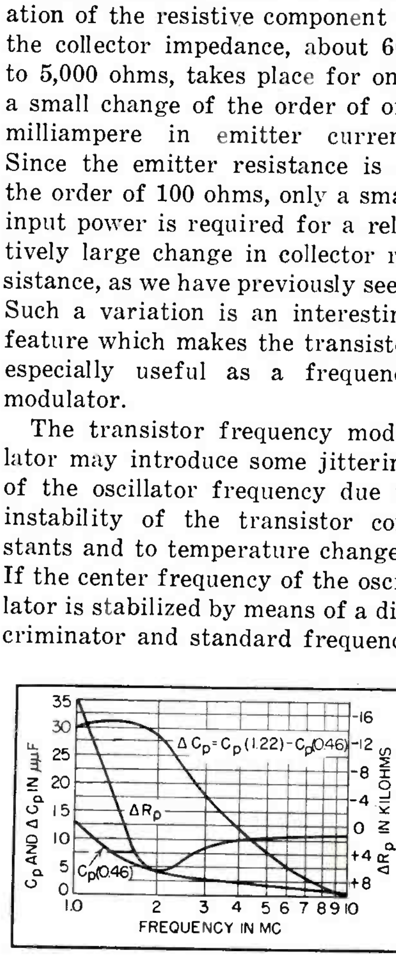


FIG. 5—By careful choice of transistors, operating frequency of frequency modulator can be extended up to 10 mc

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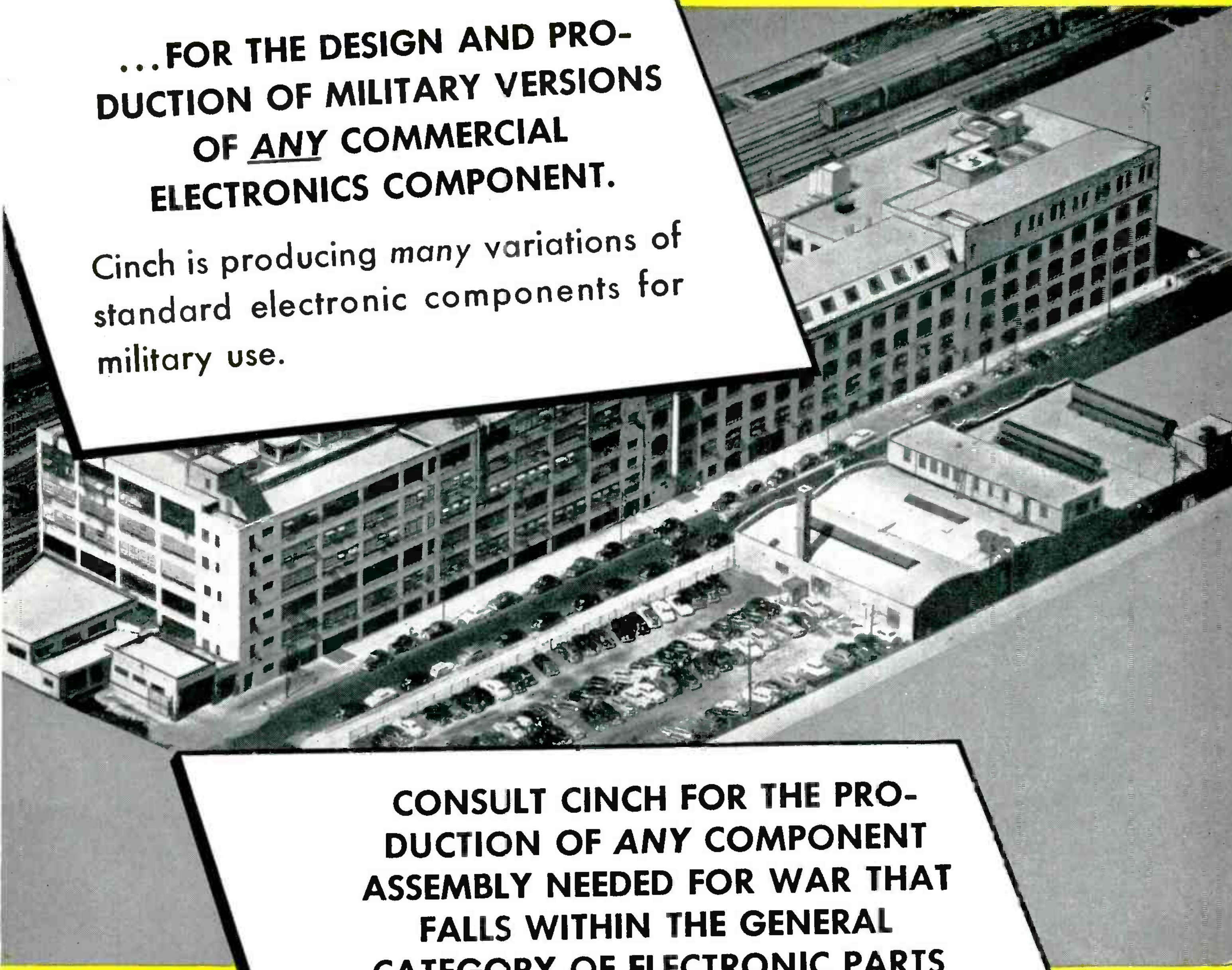

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source, as is the standard practice for broadcast transmitters, a considerable part of the effect of transistor instability is eliminated.

Modulating Higher Frequencies

The relatively low output power of the frequency-modulated oscillator cannot be considered as a limitation of the system, because the frequency multiplier stages amplify and multiply the r-f excitation to the necessary power level to excite the f-m power amplifier tube.

To obtain information about the capability of the transistors to modulate oscillators at higher frequencies, several transistors were tried with the previously described Q-meter method at frequencies between 1 and 10 mc. Figure 5 represents typical experimental data. Table III shows the measured values.

The emitter current limits of 0.46 ma to 1.22 ma (with the corresponding collector current units of 0.74 ma to 0.86 ma) were selected to produce high C_p changes around the linear response part of the frequency-modulation characteristic. The R_p values were computed again by Eq. 4. The changes of R_p (ΔR_p) are represented also in Fig. 5. The sign of ΔR_p indicates whether the parallel resistance value is going down with increasing emitter current, in which case ΔR_p is shown as positive, or going up, in which ΔR_p is shown as negative. This increasing or decreasing character depends, in the case of one investigated transistor, upon the applied frequency. In the case of another transistor, R_p decreased with increasing emitter current for all frequencies between 1 and 10 mc.

Figure 5 shows that this transistor unit with the coupling capacitor of 47 $\mu\mu$f has a reasonably high ΔC_p value, and consequently has frequency modulation capability up to 2.5 mc. The behavior of the transistors is not uniform at higher frequencies. It is too early to say what is the upper frequency limit of the transistor in f-m service. Of course the flexibility of the modulator will be higher if the oscillator frequency can be increased. Otherwise, at least one more frequency multiplier stage must be used. This additional stage might also be necessary for high-power transmitters due to the low oscillator power. As transistor development advances and the similarity between units becomes greater, the reasonable upper frequency limit and oscillator tank voltage limit for the transistor frequency modulator can be determined.

Table I—Overall Measured Distortion

Input Voltage to Modulator (rms volts)	Deviation (± cps)	Distortion Components of 400-cps modulating tone		Overall Distortion (rms %)
		Harmonic	% Fund.	
0.0132	1,350	2nd	0.979	
		3rd	0.769	
		4th	0.419	
		5th	.....	1.32
0.0330	2,850	2nd	1.91	
		3rd	0.800	
		4th	0.450	
		5th	.....	2.12
0.0160	3,900	2nd	3.62	
		3rd	0.[illegible]75	
		4th	0.[illegible]30	
		5th	0.337	3.72

Table II—Measurement of Collector Variables

I_e (ma)	I_c (ma)	Q	C_Q*	C_p ($\mu\mu$f)	R_p (Kilohms)	C_s ($\mu\mu$f)	R_s (Kilohms)	X_{co} (Kilohms)
		106**	177	0	Before inserting transistor			
0.46	0.74	55	165	12	7.37	48.4	5.55	+0.09
0.58	0.78	50	155	22	6.12	51.1	3.48	+0.26
0.75	0.81	54	142.5	34.5	7.12	48.2	2.02	+0.08
0.96	0.84	62.5	136	41	9.84	47	1.26	0
1.22	0.86	70	134.5	42.5	13.35	45.7	0.92	−0.09
1.64	0.86	75.5	134.5	42.5	16.98	44.4	0.74	−0.19

* C_Q is the reading of variable capacitor in Q-meter. A fixed capacitor was used parallel to C_Q to tune the 10-microhenry coil to 1.03 mc.
** The first line represents Q_o, the others Q (I_e).

Table III—Measurement of Frequency Response

f (mc)	Coil (μh)	Q (0.46)	Q (1.22)	C_Q (0.46)* ($\mu\mu$f)	C_Q (1.22)* ($\mu\mu$f)	C_p** ($\mu\mu$f)	ΔC_p ($\mu\mu$f)
1.03	10	55	70	165	134.5	12	30.5
2	5	60	39	204	175	4	29
3	1	56	42	261	243	3	18
4	1	71	40	268	255		13
5	1	72	32	126	120	2	6
7.5	1	71	21	418	414	2	4
10	1	59	20	225	225	1	0

* C_Q (0.46) and C_Q (1.22) represent readings of variable capacitor in Q-meter at 0.46 and 1.22-ma emitter currents.
** C_p is capacitor value represented by transistor at 0.46-ma emitter current.

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(2) B. E. Montgomery, Inductively Coupled Frequency Modulator, *Proc. IRE*, p 559, Oct. 1941.

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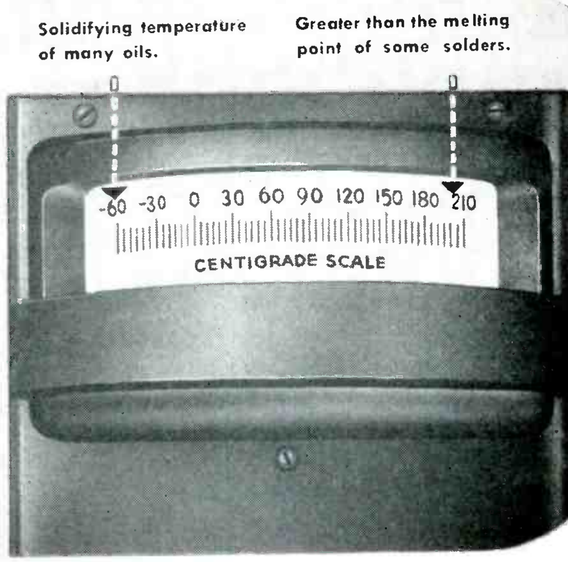

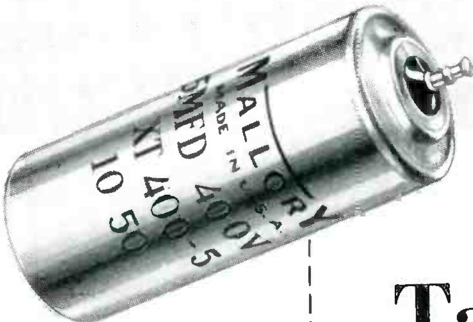

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TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by RONALD K. JURGEN

Acoustic Mill-Feed Controller

PULVERIZED FUEL for modern draught-fed furnaces and boilers is processed in what are known as tube mills. Coal fed continuously into this type of mill is reduced to the consistency of fine grade powder by the action of cascading steel balls within a rotating tube or drum. Efficiency is almost entirely dependent on the correct amount of raw coal being continuously maintained within the tube.

In fuel processing mills, the rate of feed required is dictated by a number of variable factors. Therefore, to be effective, any method of automatic feed control must be based on the actual, and not estimated, amount of raw coal within the tube or drum.

Controller Apparatus

Since it is not possible to make an assessment of the quantity within the tube based on the amount of coal fed into the mill or its output, the acoustic mill-feed controller has been designed to determine the actual contents of the mill from the noise level of the cascading coal and balls in contact with each other and the walls of the drum. As with the human ear, this determination calls for fine distinctions in noise level taken at a reference point in the immediate vicinity of the drum.

The basic apparatus consists of a microphone, adequately protected against dust and dirt, placed immediately beneath the drum. The microphone is connected by cable to the main controller unit which is set up at any desired distance from the tube mill.

The output stage of the controller unit comprises a series of pads for lining-up purposes, an amplifier and a high-pass filter. The function of the filter is to segregate the significant high-frequency noises emanating chiefly from inside the drum from the low-frequency noises associated chiefly with the external gearing and drive of the mill itself.

The most significant noise frequencies have been found to exist at about 4 kc. These frequencies give a noise discrimination of about 14 db between the full and empty condition of the tube as compared with about 3 db, which is the best discrimination possible when considering the over-all noise frequency spectrum of the mill.

The output from the amplifier-filter stage of the controller is used to actuate a sensitive relay adjusted to operate in accordance with fluctuations in noise above and below a set figure corresponding to the optimum amount of coal in the tube. The relay serves to provide, through suitable heating coils and

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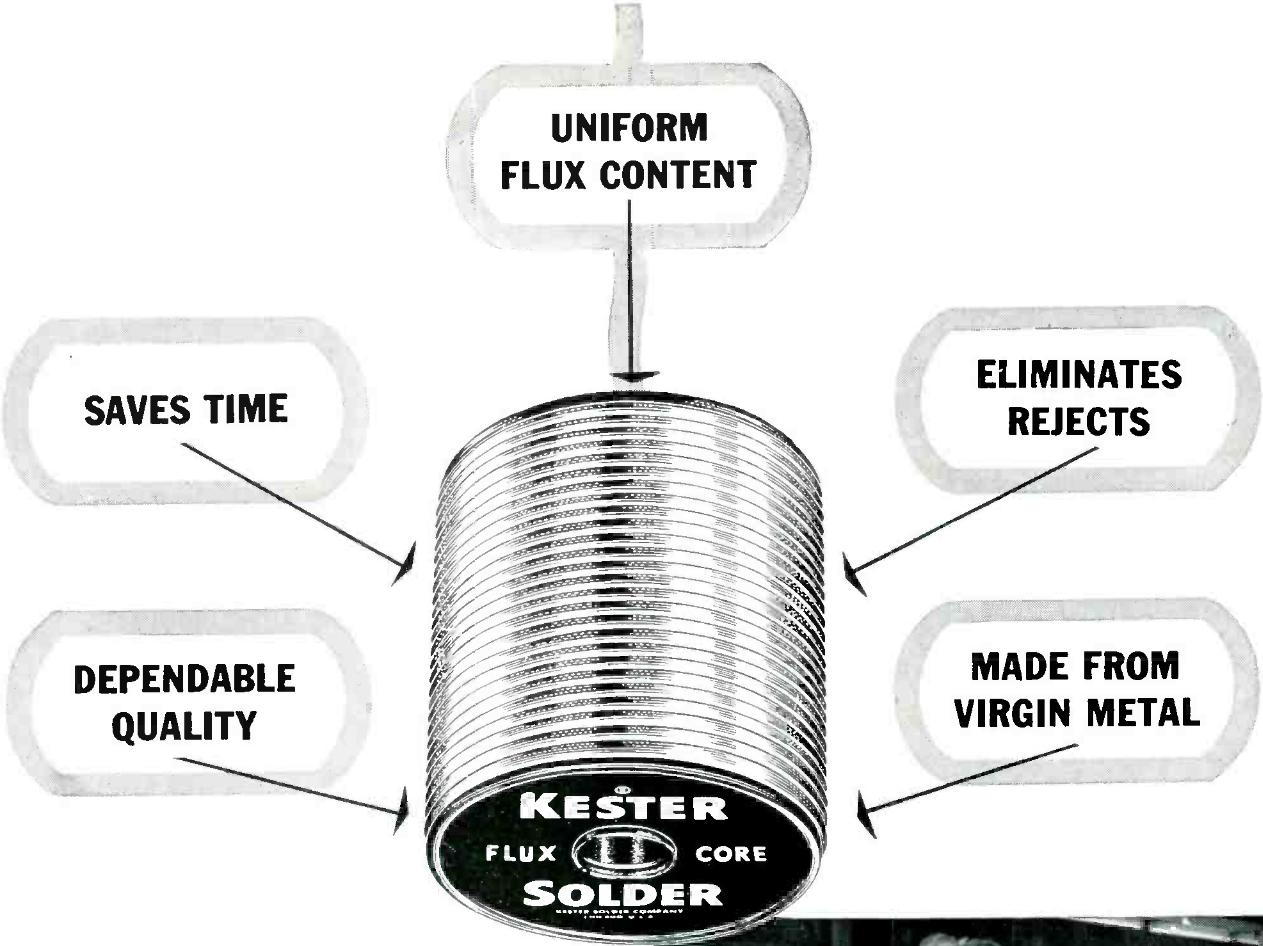

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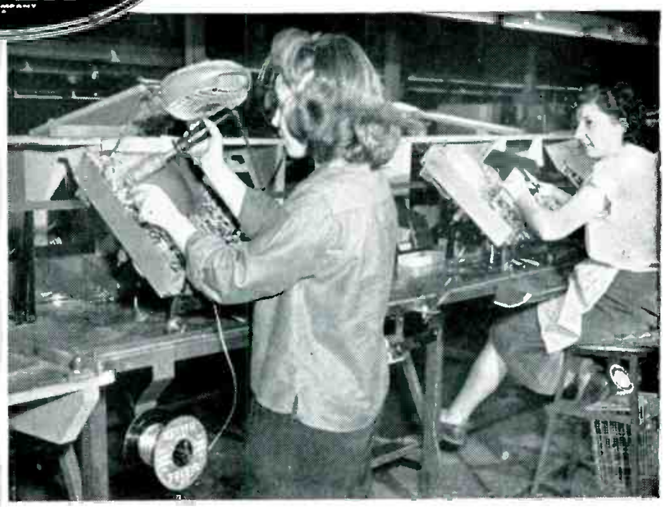

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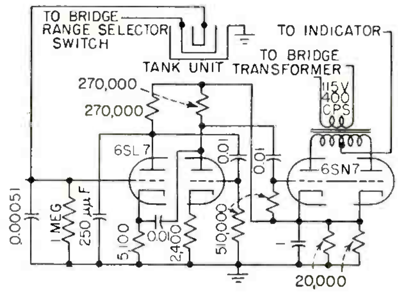
THE FRONT COVER

THE COVER photograph this month shows a production tank unit for the Simmonds electronic fuel gage in the process of being tested to see if tank unit electrical capacitance compares favorably with quality control requirements. The inspection is being made on a Master Laboratory capacitance bridge.



The capacitance bridge network consists of a Campbell Shackelton shielded ratio box, a Hewlett-Packard a-f signal generator to supply alternating voltage and a detector which works through an amplifier and a 1,000-cycle selective filter or straight through for other frequencies. Leeds and Northrup single-range potentiometer indicators are also used.

The Pacitron Gage system consists of a tank unit of variable capacitance, an amplifier as shown in the accompanying schematic, a bridge calibrator and a motor-driven indicator. In the system, the capacity of the tank unit is constantly compared with a fixed-capacitance reference capacitor.

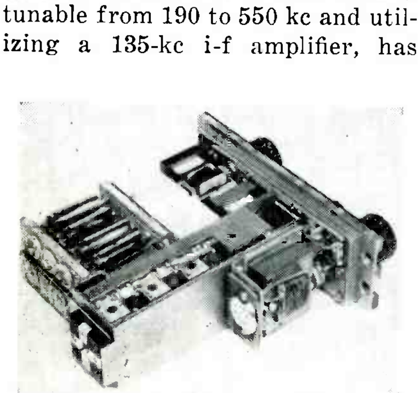
The voltage resulting from a difference in capacitance is amplified and applied to a motor-driven potentiometer which restores the bridge to balance. The quantity of fuel, as sensed by the tank unit, determines the potentiometer wiper position. An indicator pointer attached to the potentiometer indicates the quantity of fuel.

relay trains, a means of altering the speed of the feed motor or, alternatively, for manual control purposes, of actuating a suitable gage to afford visual indication of the contents of the tube mill.

The equipment is manufactured by Standard Telephones and Cables Limited in Aldwych, London, England.

Subminiature Low-Frequency Receiver

A SUBMINIATURE radio receiver for aircraft use, continuously tunable from 190 to 550 kc and utilizing a 135-kc i-f amplifier, has been developed by the National Bureau of Standards. This assembly occupies about 55 cubic inches and is the functional equivalent of a World War II unit more than five times as large.



New subminiature receiver chassis ready for encasement and hermetic sealing in nitrogen

The new 12-tube receiver, in conjunction with a previous high-frequency project (a 60-mc, 11-tube i-f amplifier assembly), effectively brackets the communication spectrum. The receiver is used to keep aircraft on course. It has a sensitivity of 5 μv for 6 db signal-to-noise ratio and a power output of 100 milliwatts.

The 12 tubes provide two tuned r-f amplifier stages, a mixer, a local oscillator, two 135-kc i-f amplifier stages with a bandwidth of about 2 kc, a diode detector, an avc diode, a beat-frequency oscillator, an audio amplifier stage and a push-pull-parallel power output stage. All stages operate with 26 volts d-c on heaters, screens, and plates. Under these conditions of operation, four subminiature audio power output tubes are required for adequate power output.

To facilitate mass production, seven detachable subassemblies, each of which can be built independently, are employed in the receiver. This also permits easier servicing. The subassemblies are fastened to one another and to the front panel, which takes the place of a chassis.

Printed circuits are used to a considerable extent. They are of value both in conserving space and for economical mass production. The wiring is printed on steatite or silicone-impregnated fiber-glass.

Hermetic Sealing

Hermetic sealing of the entire unit affords protection against moisture and contamination. It also permits elimination of protective coatings for the individual components, which saves space. A soldered copper band seals the housing to the front panel. The band can be removed for repair purposes with a key of the type used for opening coffee cans. The air in the unit is replaced with nitrogen before sealing to prevent oxidation.

The tuning of the receiver over its wide operating frequency range was a difficult engineering problem. A straight-line tuning characteristic (frequency proportional to control angle) was attained in the limited space allowable by the use of a variable-pitch screw to drive the slugs in and out of the r-f coils.

The tuning slugs are made of the newly developed ferrite base materials, more stable at high temperatures than powdered-iron cores. It was expected that production control of these new materials might present a difficulty; mechanical means were therefore provided in the tuner to compensate for nonuniformity of core material.

The i-f transformers have an over-all size of ½ by ½ by 1⅜ inches;

(continued on page 156)

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THE ELECTRON ART

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Checking Quality of Aluminized Screens

By Howard J. Evans

Tube Department
Radio Corporation of America
Harrison, New Jersey

To avoid waste manufacturing steps, two methods have been developed to test aluminized picture screens before the gun structures are sealed into the bulbs. These developments were necessary because the standard test on nonaluminized screens cannot be used on aluminized ones.

Test Procedure

In the test on nonaluminized screens, after the phosphor has been deposited on the faceplate, the bulb is partially evacuated, and a high-frequency spark coil is moved over the faceplate. The resultant intense electric fields inside the bulb cause high-velocity electrons to strike the phosphor, exciting it so that actual operation of the finished tube is simulated and the quality of screen luminescence can be visually examined.

However, in bulbs which use an aluminized coating on the back of the phosphor to prevent ion-spot formation, the aluminum acts as a radio-frequency shield which prevents any outside electric fields from penetrating into the bulb enclosure. Formerly, therefore, the screens of aluminized picture tubes could not be fully tested until the tube was completed and examined in actual operation. Each defective screen, consequently, resulted in virtually a total loss, for the cost of salvaging the good parts of the tube almost equalled the original cost.

Two Methods Devised

The two methods devised to prevent this waste permit a check of the quality of aluminized screens earlier in the manufacturing process. One, the radio-frequency method, uses a high-frequency oscillator to produce an electric field which impels high-speed electrons against the phosphor. The second, the direct-current method, accelerates the excitatory electrons by means of direct voltage. This d-c method, although not now used in practice, will be described because it conceivably might be preferable if the presence of a strong radio-frequency field were undesirable.

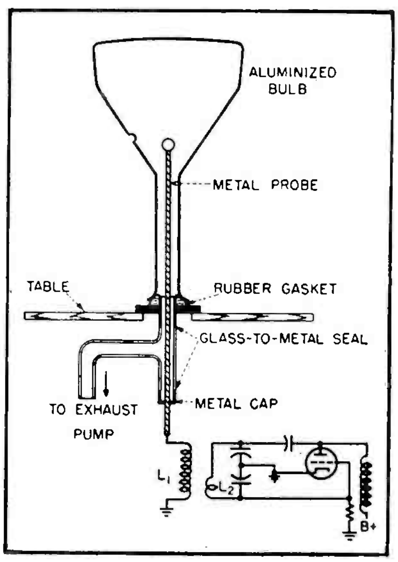


FIG. 1—Apparatus for examining screens of aluminized picture tubes by r-f method

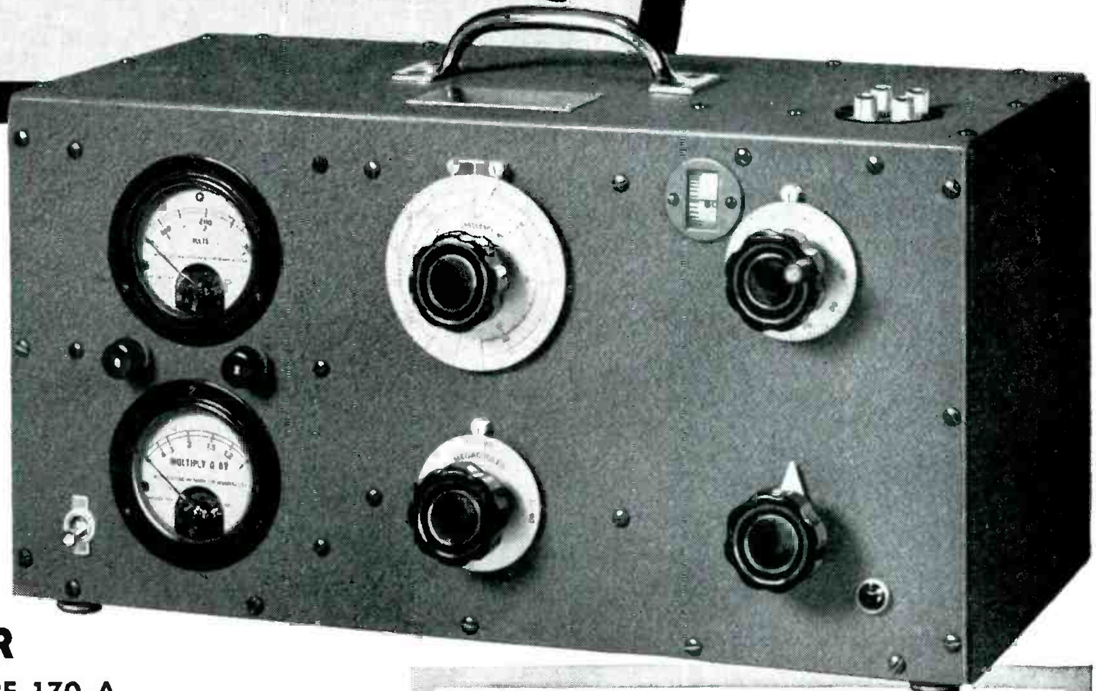
Radio-Frequency Method

A representation of the r-f method is shown in Fig. 1. The bulb to be examined is connected in an upright position to the intake port of a vacuum system and the bulb is evacuated. The flanged portion of the bulb neck presses against the rubber gasket with sufficient force to form a gas-tight seal. When the final vacuum is established, this force is equal to the weight of the bulb plus the product of the atmospheric pressure and the area of the bulb flange. The rubber gasket is restrained from collapsing inward by the metal cylinder which is placed inside the gasket.

The electrical energy which causes screen excitation enters the evacuated bulb through the probe. When the probe is driven positive or negative, an electric field set up between the probe and the aluminized coating accelerates the free electrons or ions. The ions have a mean free path of the order of 1 centimeter when the pressure is 5 microns. This path is long compared with the radius of the neck, so that few ionization collisions occur in the neck region. However, the mean free path is short compared with the probe-to-screen distance, so that sufficient ionization collisions occur in the cone region to maintain the supply of ions and electrons. On the positive half of the r-f cycle the positive ions are repelled toward the screen. Since there is no electrical connection to the screen, these positive charges cause the screen to assume a positive potential with respect to ground. On the negative half of the cycle the probe becomes negative, and electrons and negative ions strike the aluminum coating with a maximum energy which, when measured in terms of electron volts, exceeds the maximum voltage between probe and ground. This energy is sufficient to cause the electrons to penetrate the alumi-

(continued on page 184)

Extends the ADVANTAGES of Q measurements to the VHF range



The Q METER
TYPE 170-A
Freq. 30-200 mc.

Since the first use of **tuned circuits,** the ratio of their reactance to their losses at resonance has been an important **factor of merit.** This ratio, known as Q, specifies the band-width, cut-off rate and potential gain of the tuned circuit when used in an amplifier. The **Q Meter** is a standard of the industry because it quickly and accurately measures this fundamental, unchanging quantity.

Frequency ranges, tuned circuit designs and circuit applications have changed. To keep pace with these changing requirements, Q Meters have been introduced for different frequency ranges and with other design changes. The **Type 170-A Q Meter** is one of the results of our continuous program of developing precision equipment to meet the needs of laboratory and industry.

Write for complete information.

MEASURES

- **Q of VHF Coils.**
- **Effective Inductance of Coils.**
- **Losses in Condensers and Dielectrics.**
- **Characteristics of VHF Antennas.**
- **Distributed Capacity of Coils.**

SPECIFICATIONS:

Oscillator Frequency Range: Continuously variable from 30 mc. to 200 mc. in 3 ranges.

Frequency Calibration Accuracy: ± 1%.

Range of Q Measurements: Directly Calibrated—80 to 300. By use of Multiplier—80 to 1200.

Accuracy of Q Measurements: Directly Calibrated Scale ± 10% to 100 mc.
Accuracy decreases with frequency above 100 mc.

Capacitance Calibration of Q Condenser:
Range 11 to 60 mmfd. with 1 mmfd. divisions.
Micrometer Vernier marked with 100 divisions.
Accuracy: 1% or 0.5 mmfd., whichever is greater.

Inductance Range: 0.05 microhenry to 1.3 microhenry.

Power Supply: 110-120 volts, 50-60 cycles.
Also 220-240 volts, 50-60 cycles.
Power Consumption—50 watts.

DESIGNERS AND MANUFACTURERS OF THE Q METER · QX CHECKER
FREQUENCY MODULATED SIGNAL GENERATOR · BEAT FREQUENCY
GENERATOR AND OTHER DIRECT READING INSTRUMENTS

BOONTON RADIO *Corporation*
BOONTON · N · J · U · S · A ·

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Military Electronics Program Extends Miniaturization Trend . . . Noncritical Materials Stand Out in Design for Civilian Use . . . Available Manufacturers' Catalogs Are Listed

Tiny Electronic Amplifier

BENDIX RADIO DIVISION OF BENDIX AVIATION CORP., Baltimore 4, Md., has developed a tiny electronic amplifier for miniaturized airborne radar equipment. It is a band-pass type amplifier with a rated electrical gain of 130 db. Weighing less than 2 ounces and requiring only 35 component parts, its cost in large production quantities should be small enough to make feasible replacement of the entire amplifier in case of tube or component failure and because of its plug-in design replacement can be made in a matter of seconds. Illustrated is the unit as compared to a conventional band-pass amplifier as used in radar equipment.

Polyphase Reproducer

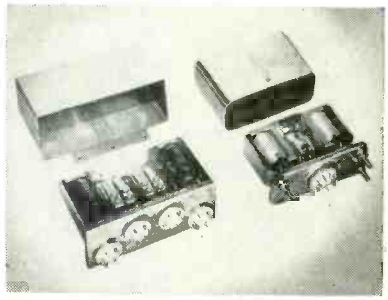
AUDAK CO., 500 Fifth Ave., New York 18, N. Y., has announced the Audax L-6-G, a new polyphase reproducer. This single magnetic unit will play any and all lateral recordings at speeds of 33⅓, 45 or 78 rpm. A special connector is available which permits the unit to be plugged into the Garrard changer arm. Point pressure is 8 grams for all discs. Output is approximately 20 mv. Response is from 20 to over 10,000 cps. The sapphire or diamond stylus is easily replaceable.

High-Temperature Variable Resistor

CHICAGO TELEPHONE SUPPLY CORP., Elkhart, Ill. Type 65 miniaturized variable composition resistor has extremely high temperature and humidity stability. It is specially designed for use in all types of military communications.

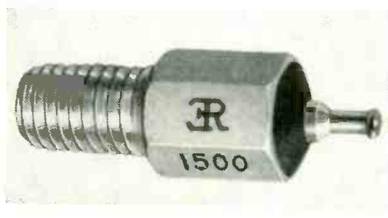
Mounting Bases

T. R. FINN & CO., INC., 333 Jackson Ave., Bronx 54, N. Y. Finnflex mounting bases, designed to protect airborne equipment such as aircraft radios, radar, loran and similar electronic apparatus, exceed Army-Navy E-19 drop test requirements. They are designed to meet dimensional and metal requirements of JAN C-172A specifications. Load range is from 6 to 80 lb. The unit illustrated is carried by four metallic spring-type isolators, which provide protection by maintaining their high vibration-isolating efficiency from −80 F to +250 F.



Sealed Multiple Relays

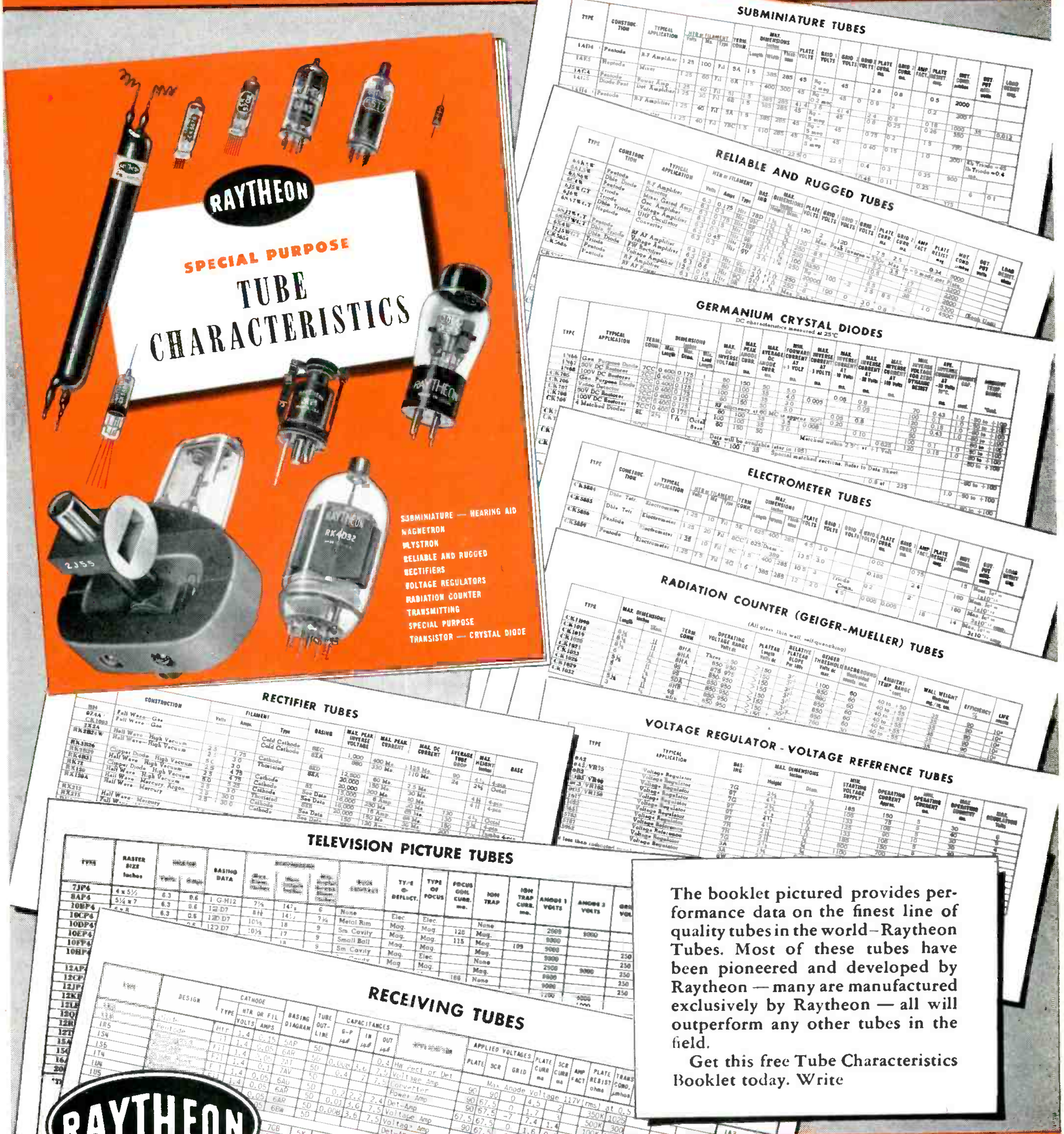
POTTER AND BRUMFIELD, Princeton, Indiana, has developed a line of 2-in-a-can and 4-in-a-can sealed relays for use in military airborne equipment. The 2-in-1 assembly has two-ampere palladium contacts on each relay. It has overall dimensions of 3 in. × 1⅛ in. × 2 in. high and weighs 6 oz. The 4-in-1 assembly has 5-ampere silver contacts. It measures 3⅞ in. × 1½ in. × 2 in. high and weighs 13 oz. The relays are thoroughly desiccated and hermetically sealed in inert gas.



Sealed Stand-Off

ERIE RESISTOR CORP., 644 W. 12th St., Erie, Pa. Basic design of the style 326 stand-off Ceramicon for vhf and uhf applications provides, in a hermetically sealed case, a by-pass-to-ground through the shortest possible path. Post terminal provides a sturdy tie point for several connections, and is made essentially to match tube socket terminal height in the interest of

Write For Your Free Copy Of This Complete RAYTHEON TUBE GUIDE



The booklet pictured provides performance data on the finest line of quality tubes in the world—Raytheon Tubes. Most of these tubes have been pioneered and developed by Raytheon — many are manufactured exclusively by Raytheon — all will outperform any other tubes in the field.

Get this free Tube Characteristics Booklet today. Write

RAYTHEON

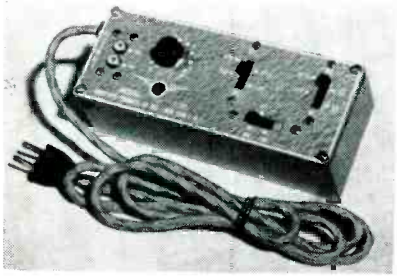
Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

Special Tube Section

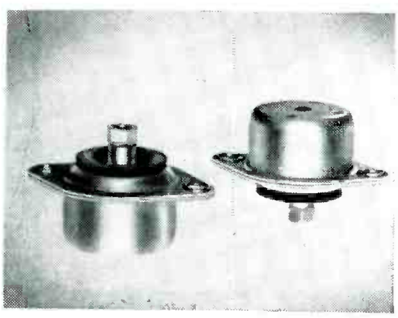
NEWTON 58 • MASSACHUSETTS

maintaining uniform short leads. Designed for threaded mounting installation, it is available in standard capacitance values in $\mu\mu$f: 10, 33, 47, 68, 82, 100, 680, 1,000 and 1,500. Voltage rating is 500 v d-c.



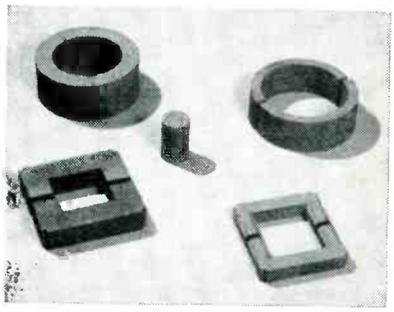
Miniature Signal Generator

RADIO CITY PRODUCTS CO., INC., 152 W. 25th St., New York 1, N. Y. Model 730 pocket-size, signal generator combines a real f-m signal generator, an r-f signal generator, and an audio oscillator. The four f-m fixed frequencies are modulated to give ample sweep for use with ratio detectors. Alignment can be quickly made at the ends of the band at the 88 and 108-mc switch position. Correspondingly, the 10.7 and 9.1-mc switch positions permit alignment of the i-f sections. The ends of the broadcast band can be readily aligned at the 1,500-kc and 550-kc switch positions. Intermediate-frequency alignment is provided by fixed frequency switch positions of 456 kc and 465 kc. An audio outlet terminal is provided for supplying a 400-cycle signal externally. Weight of the instrument is 2 lb and price is $32.95.



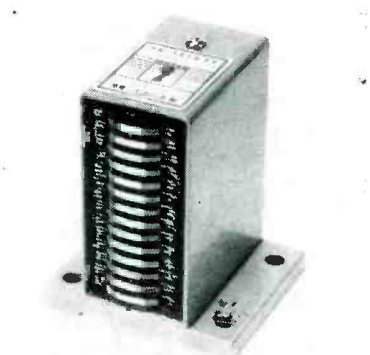
Air-Damped Mountings

THE BARRY CORP., 700 Pleasant St., Watertown 72, Mass. Series 6475 Barrymounts provide effective vibration isolation with all the advantages of air damping. Equipment supported on the mountings is raised only $\frac{1}{2}$ in. above the mounting surface. Unit mounts are 1 in. in diameter and have an overall height of 1 in. under minimum rated load. Load ratings range from 0.3 to 3.0 pounds per mount. The center stud is tapped to a depth of $\frac{1}{4}$ in. with an 8–32 thread.



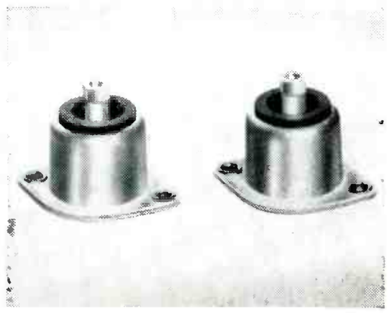
Noncritical Ferrites

FERROXCUBE CORP. OF AMERICA, 50 E. 41st St., New York 17, N. Y., has announced availability of high-permeability ferrite parts using noncritical materials. Transformer cores, deflection yoke cores, antenna cores, and permeability tuning cores for television and electronics are available in types 3 and 3C materials, which are nickel-free. Complete technical information is contained in engineering bulletin FC-5101.



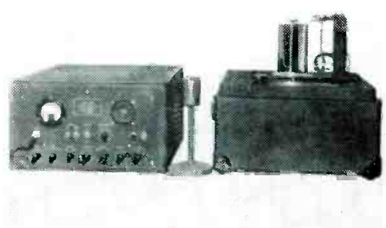
Record-Reproduce Head

THE BRUSH DEVELOPMENT CO., 3405 Perkins Ave., Cleveland 14, Ohio, has announced the BK-1500 series multichannel (available from 3 to 14 channels) record-reproduce head. Design features include balanced magnetic construction with gaps at front and rear. All gaps are in perfect alignment and individual channels are cast into one integral block of specially selected synthetic resin. Complete assembly is nonmicrophonic and impervious to moisture. The head has a channel width of 0.050 in. with center-to-center spacing of 0.125 in.; gap is 0.0005 in. Maximum output level at 1,000 cps and 7.5 in. per second tape speed is 0.002 volt rms.



Shock and Vibration Isolators

THE BARRY CORP., 700 Pleasant St., Watertown 72, Mass. Series 6465 Barrymounts are designed to meet requirements for smaller isolators to be used with miniaturized equipment. The mountings employ air damping to minimize the shock of aircraft landing and taxiing and to limit excursion so that there is no snubber contact, even at resonance. Load ratings of bases using these mounts are 0.1 to 3.0 pounds per mount. The isolators are 1 in. in diameter and $1\frac{1}{32}$ in. high under maximum rated load. The attachment stud has an axial hole $\frac{1}{2}$ in. deep, tapped with 6–32 thread.

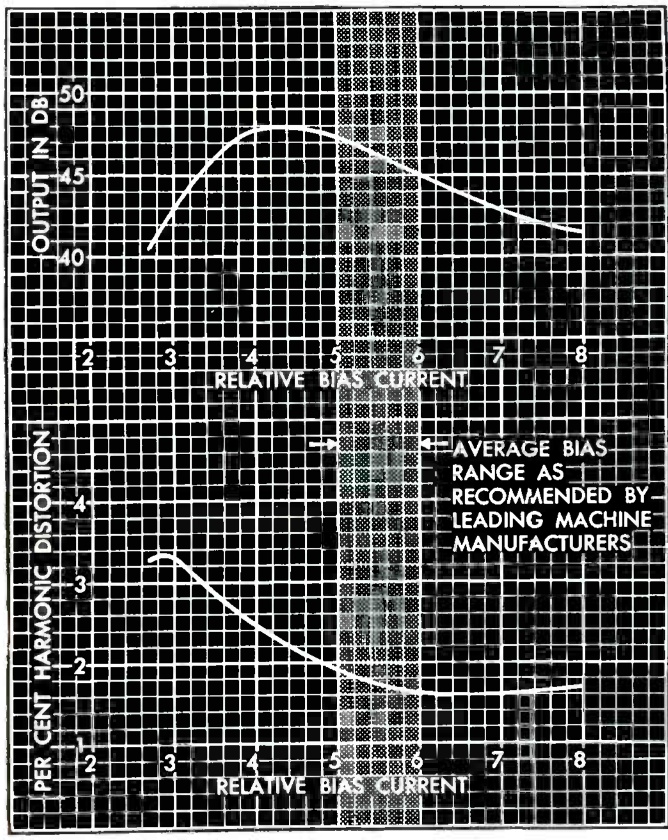


Vibration Analyzer

KAY ELECTRIC CO., Pine Brook, N. J. The Vibralyzer is applicable to the

(Continued on p 220)

For MAXIMUM OUTPUT with MINIMUM DISTORTION



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audiotape

As all professional recordists know, the proper operation of any tape recorder involves a compromise between *decibels* and *distortion.* And Audiotape has been especially formulated with this important relationship in mind—to give you higher output (and thus better signal to noise ratio) and lower distortion in the normal bias range of all machines.

Test it. Compare it with any other tape. Plot your own output vs distortion curves, similar to the ones shown above. You'll find that in the useful, low-distortion bias range, Audiotape combines maximum output with maximum fidelity and freedom from distortion.

That's just one of many reasons why more and more professional recordists are specifying Audiotape for their most exacting magnetic recording requirements. Remember—Audiotape is made *by* audio engineers, *for* audio engineers. *It speaks for itself.*

And there's PROOF of UNEQUALLED UNIFORMITY in Every Package

YOU GET an Esterline-Angus output curve in every five-reel package of plastic-base Audiotape. This curve, made from one of the reels in that package, actually measures the output characteristics of all five reels, since they are all slit from the same roll after coating. Now you can *see,* as well as *hear,* the exceptionally high output uniformity that you get only in Audiotape. What's more, every 1250-ft. and 2500-ft. reel is guaranteed FREE FROM SPLICES!

AUDIO DEVICES, Inc.

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audiodiscs audiotape audiofilm audiopoints

NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

DPA Electronics Production Board Appointed

EDMUND T. MORRIS, JR., formerly with Westinghouse Electric Corp. in engineering and managerial capacities, has been appointed to head the Defense Production Authority's Electronics Production Board. Serving with him are: Capt. F. R. Furth, director of Naval Research Laboratory, Washington, D. C.; Harry A. Ehle, vice-president of International Resistance Corp., Philadelphia, Pa.; John G. Daley, chief of the Electronics Division, National Production Authority; M. W. Boyer, general manager of the Atomic Energy Commission; Don G. Mitchell, president of Sylvania Electric Products, Inc., New York, N. Y.; and C. W. Middleton, vice-chairman for production of the Munitions Board.

E. T. Morris, Jr.

The Electronics Board has the primary responsibility in DPA of assuring that electronics equipment is produced in sufficient quantities and on time to meet requirements of defense and essential civilian programs. Electronics is defined as including not only radio, tv and radar but also extensive application in other fields such as electric motors, fluorescent lighting, automobiles, business machines, fire control and industrial control devices, test and measuring equipment and communications equipment, as well as being an essential component of many basic weapons.

Britain's 1951 Radio Convention

THE British Institution of Radio Engineers' third convention will be held this year during the Festival of Britain. Six separate sessions, to be held at intervals staggered over the period of the Festival, will cover almost the whole field of radio and electronic engineering.

Topic, time and place scheduled for each session are as follows:

Session 1—Electronic Instrumentation in Nucleonics—July 3 and 4, University College, London.

Session 2—Valve Technology and Manufacture—July 5 and 6, University College, London.

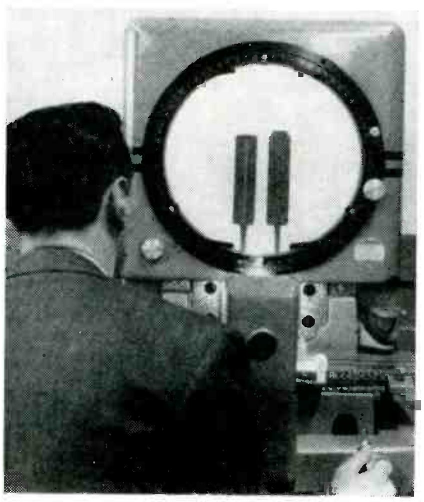
Session 3—Radio-Communication and Broadcasting—July 24 and 25, University College, Southampton.

Session 4—Radio Aids to Navigation—July 26 and 27, University College, Southampton.

Session 5—Television Engineering—August 21 to 24, King's College, Cambridge.

Session 6—Audio Frequency Engineering—Sept. 4 to 6, The Richmond Hall, Earls Court.

PRODUCING GERMANIUM DIODES



Girls use microscopes while welding whiskers to pin assemblies at GE's new germanium products plant in Clyde, N. Y. The new plant has a potential capacity of 12 million diodes annually. Photo at right shows a new contour projector in use at the plant. Here the whisker and pellet assemblies are inspected at a magnification of 20 times

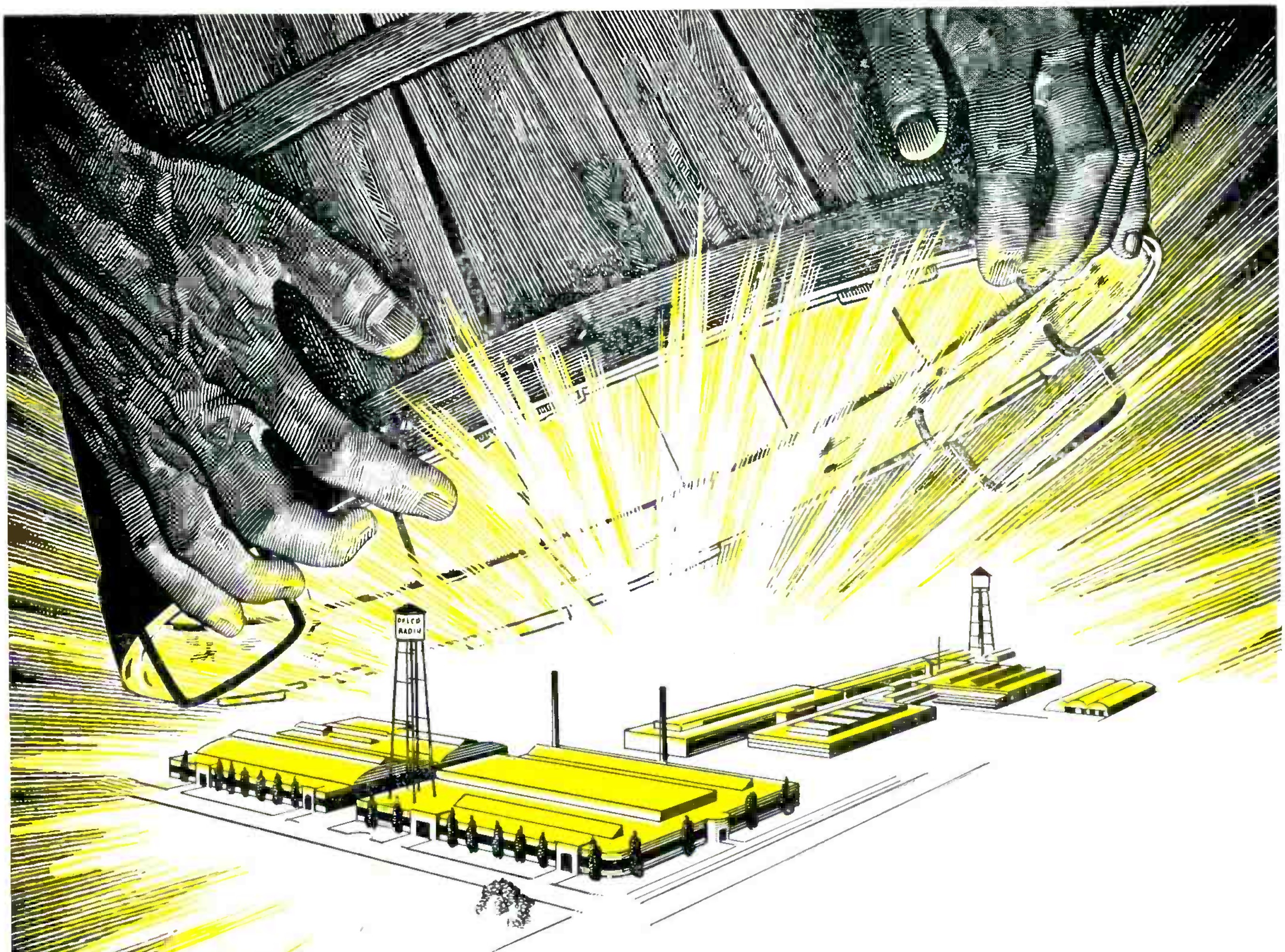
Amateur Radio to Aid Civil Defense

SUPPLEMENTING commercial communications facilities, the New York State Civil Defense Commission is forming a state-wide amateur radio system to be used for operations in atomic attacks when power or wire communications may be disrupted.

Colonel Lawrence Wilkinson, acting chairman and director of the Commission, has issued a bulletin to the 104 county and city C-D directors, urging them to enlist the support of qualified radio amateurs and their equipment for communications. Under the New York State Emergency Defense Act the State C-D Commission is empowered to control all communication facilities and personnel in event of an attack and during drills and tests prior and subsequent to an attack.

Control will be exercised through the enrollment of operators as members of the New York State Civil Defense Amateur Radio Service. This service will function under the policies, plans and instructions of the commission, of which Vincent T. Kenney is coordinator at the State C-D headquarters in New York City.

All local C-D directors in the



WE'RE LIFTING THE BUSHEL BASKET— AND LETTING OUT OUR LIGHT!

Probably you didn't know it because we haven't told you. BUT—for the past five years we've been building car and truck radios for General Motors. In 1950 alone we built nearly 2,000,000 radios for practically all types of vehicles. Our production tops that of any other car radio manufacturer.

Since we stopped making radio and electronic equipment for the armed forces during World War II, we've concentrated on making our facilities the largest and our products the finest in the industry. Unlike most others, we're not just an assembly plant. We make practically all the parts that go into our products. Our design and research engineers are tops in their field. Our laboratory and production equipment is the finest that can be obtained.

With our vast experience, our facilities, engineering know-how, our productive manpower bigger and better than ever before, we believe we can be of service to our country. We are ready to go to work immediately for national defense and count it a privilege to volunteer for service.

Delco Radio

DIVISION, GENERAL MOTORS CORPORATION
KOKOMO, INDIANA

State have been informed that a trained nucleus of operating personnel can be obtained from the New York members of the Amateur Radio Emergency Corps, an affiliate of the American Radio Relay League.

MEETINGS

AUG. 15-18: 1951 APCO Conference, Everglades Hotel, Miami, Florida.

AUG. 20-23: AIEE Pacific General Meeting, Multnomah Hotel, Portland, Oregon.

AUG. 22-24: Seventh Annual Pacific Electronic Exhibit and West Coast Annual IRE Convention, San Francisco Civic Auditorium, San Francisco, Calif.

AUG. 28-SEPT. 8; Eighteenth British National Radio Show, Earls Court, London, England.

SEPT. 10-14: Sixth National Instrument Conference and Exhibit, sponsored by Instrument Society of America, San Houston Coliseum, Houston, Texas.

OCT. 8-10: AIEE Conference on Aircraft Equipment, Hollywood Roosevelt Hotel, Los Angeles, Calif.

OCT. 22-24: 1951 National Electronics Conference, Edgewater Beach Hotel, Chicago, Ill.

OCT. 22-26: AIEE Fall General Meeting, Hotel Cleveland, Cleveland, Ohio.

NOV. 12-15: NEMA Convention, Haddon Hall, Atlantic City, N. J.

Powdered Iron Core Dimensions Standardized

ALL of the types of cores made from iron powder and commonly in use by the radio and television industry have been listed in a new Standard just released by the Metal Powder Association. The Standard was prepared by the Electronic Core Subcommittee of the Metal Powder Association Standards Committee to meet a long felt need in the pulverized core industry for standardization of dimensions and tolerances.

The Standard, designated 11–51–T, defines the terms commonly associated with cores made from powdered magnetic materials and specifies the preferred dimensions of standard sizes and shapes. Preferred dimensions are listed in detail for plain iron cores, insert iron cores, threaded iron cores, tuning cores and sleeve iron cores. In addition to diameters and lengths, data is provided for concentricity, screw-driver slot dimensions, hexagonal hole sizes as well as threaded spring type and spaded insert sizes.

Developed after careful consideration by the members of the Electronic Core Subcommittee, it reflects, in substance, the practices established by the RTMA. Members of the Electronic Core Subcommittee include the following companies: Empire Coil Co. of New Rochelle, N. Y.; Magnetic Core Corp., of Ossining, N. Y.; National Moldite Co. of Hillside, N. J.; Powdered Metal Products Corp. of Franklin Park, Ill.; Pyroferric Co. of New York, N. Y.; Radio Cores, Inc., of Oak Lawn, Ill.; Speer Resistor Corp. of St. Marys, Pa.; and Stackpole Carbon Co. of St. Marys, Pa.

William E. Cairnes, president of Radio Cores, Inc., is chairman of the subcommittee.

Copies of the new Standard and other Standards published by the Metal Powder Association may be obtained by writing to the Association at 420 Lexington Ave., New York 17, N. Y., and enclosing 25 cents per copy.

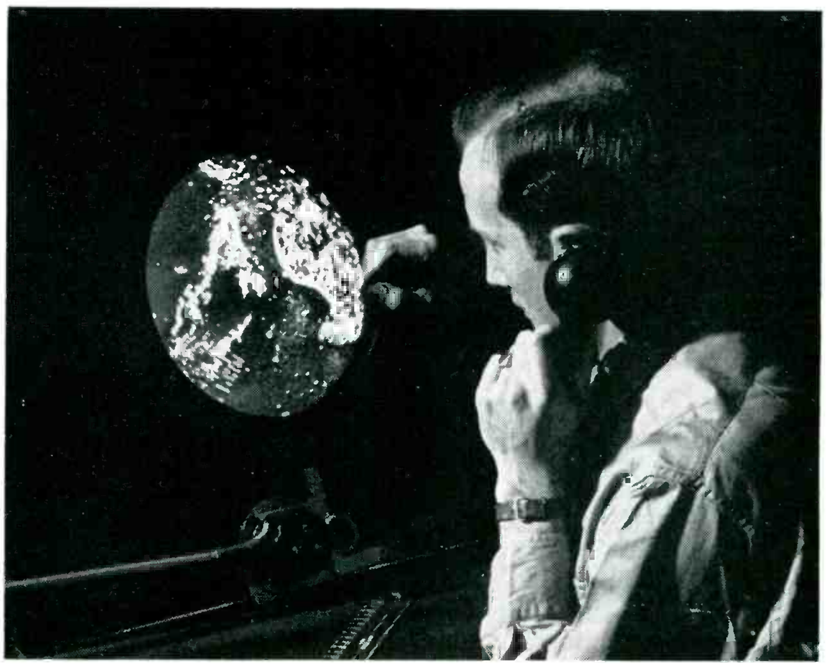
Harbor-Control Radar Tested

PORT of New York Authority, operated jointly by the states of New Jersey and New York, has inaugurated an experimental program to test the feasibility of harbor-control radar as an aid to pilotage during foggy weather.

Shore-based radar installations are now in regular service at Liverpool, England, and Long Beach, California. They are operated experimentally in the harbors at San Francisco and Baltimore. Other installations are under construction in Le Havre, France, and Southampton, England.

Although no figures are available at present to show the savings that might result with this navigational aid, it is known, for example, that the fixed cost of delaying a 10,000-

(Continued on page 238)



Scope presentation of the New Jersey-New York harbor from Fort Wadsworth, Staten Island, overlooking the Narrows. Ships, islands, buoys and shore lines between Ambrose Light and the Battery are clearly visible

Sylvania Tubes help keep U. N. Building free from smoke

Showing chassis of "Vericon" Picture Monitor equipped with Sylvania tubes. These monitors are finding a wide variety of uses today in industries and institutions. They were designed to the exacting requirements of the Remington Rand "Vericon" System and built by Television Utilities Corp.

The problem of smoke at New York's beautiful U. N. Area is being solved with the help of Remington Rand's "Vericon" Industrial Television System equipped with Sylvania Tubes.

In reaching a satisfactory solution, much credit goes to the Consolidated Edison Company, located near by, for their all-out cooperation. Among other preventive measures, this company installed and focused a set of Remington Rand "Vericon" TV cameras on their towering stacks.

These cameras are hooked up to five strategically located viewing monitors—(soundless TV sets)—made by Television Utilities Corp. and equipped with Sylvania picture tubes and receiving tubes.

Every day, these monitors are in operation. If at any time smoke should appear, Consolidated Edison observers on watch immediately operate special controls to clear up the situation.

Writes Mr. A. E. Siegel, President of Television Utilities: *"Our monitors have been running all day long without stop for more than three months. All are equipped with Sylvania radio and picture tubes. We are wondering how long the Sylvania tubes will continue to take this kind of abuse without talking back."*

★ ★ ★ ★

The above is another interesting record of the durability and excellent performance of Sylvania tubes. Let us tell you something about the reasons behind this quality. For full technical data about any types of Sylvania receiving, transmitting, or picture tubes write today to: Sylvania Electric Products Inc., Dept. R-1107, Emporium, Pa. ***Sylvania Representatives are also located in all foreign countries.***

SYLVANIA ELECTRIC

Sylvania Electric Products Inc. 1901–1951 50th Anniversary · Five Decades of Progress

TELEVISION PICTURE TUBES; RADIO TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

NEW BOOKS

Piezoelectric Crystals and Their Application to Ultrasonics

BY WARREN P. MASON. *D. Van Nostrand Co., Inc., New York, 1950, 508 pages, $7.50.*

THE RECENT book by Dr. Mason constitutes a noteworthy addition to his many publications and contributions in this highly specialized field. Not intended for swift or easy reading, this work will become a reference to workers in the field, as opposed to a descriptive treatment for those wishing an elementary survey.

In the opening chapters are developed the basic expressions for the elastic, piezoelectric, pyroelectric, and dielectric relations of solids. Coupled with a concise treatment in the appendix, wherein these relations are erected in tensor form, the development leads to the establishment and individual listing of the fundamental mathematical forms of the seven groups and thirty-two classes into which all crystals fall, as determined by their physical properties and symmetry properties.

The major part of the book summarizes the work and findings of the Bell Laboratories resulting from their many years of significant research in this field. The properties of quartz and rochelle salt are described, but main emphasis is given to such new crystal developments as dipotassium tartrate (DKT), ethylene diamene tartrate (EDT), ammonium dihydrogen phosphate (ADP), potassium dihy-

(continued on page 254)

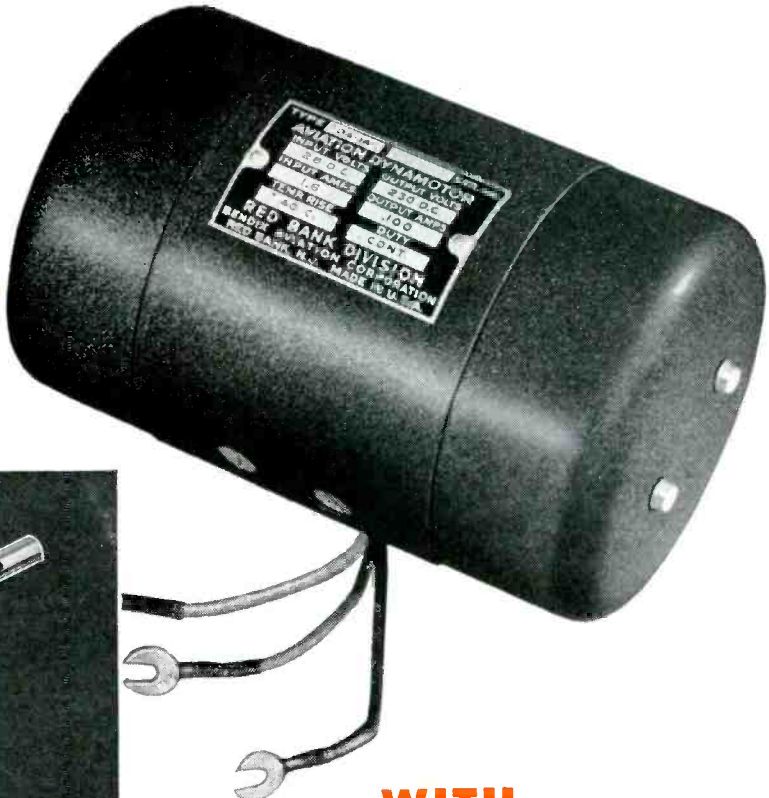
RELEASED THIS MONTH

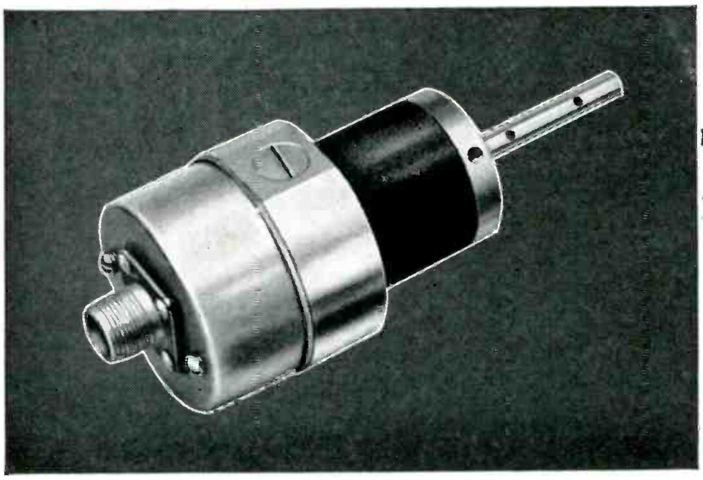
Electronic Motor and Welder Controls; G. M. Chute; McGraw-Hill; $6.50.

Elements of Television Systems; G. E. Anner; Prentice-Hall; $10.35.

Synthesis of Electronic Computing and Control Circuits; Harvard University Press; $8.00.

Let Bendix Solve Your Problems





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Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

Familiar Music

DEAR SIRS:

I HAVE READ with considerable interest Robert M. Strassner's article on Gas-Diode Electronic Organs in ELECTRONICS for January, 1951.

You undoubtedly will be interested to hear that the principle disclosed in the article is by no means original with Strassner but has been developed by me approximately 17 years ago, together with Francis R. O'Leary my assistant at that time. In this connection, your attention is directed to O'Leary patent 1,986,599 and Langer patent 2,252,189, copies of which accompany this letter.

To complete the references appearing at the end of Strassner's article, I would like to add the following complete list of my pertinent patents which resulted from my experimental work on gas-diode electronic musical instruments extending over the period of nearly a quarter of a century:

1,832,402	2,044,360
1,937,389	2,247,728
1,993,890	2,252,189
2,017,542	2,365,566
2,035,238	2,365,567
2,039,651	2,365,568
2,040,439	2,403,664

NICHOLAS LANGER
New York, N. Y.

Medical Electronics

DEAR SIRS:

FOR SOME TIME I have felt the need for an organization to bring together those of us who are working in the field of medical electronics. This was further confirmed by the

(Continued on page 268)

"Fourteen little superintendents . . ."

Fourteen little angels with eyes glued to the home movie screen. A well planned birthday party proceeding according to schedule. Then . . . pfft . . . and the projector stops. At once fourteen little angels change to fourteen little devils. Pity the poor host, a mechanical dud, trying to figure out what's wrong. Add fourteen little superintendents and a few assorted mothers, all anxious to take an active part—the perfect set-up for male frustration. When the repairman gets around—after a few days—and the trouble turns out to be electrical insulation failure . . . there goes a projector manufacturer's reputation, for a few pennies saved by using an inferior insulation.

Electrical insulation is a decisive factor in successful product operation.

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Tough and long lasting, Ex-Flex Fiberglas Sleeving has perpetual flexibility, under all conditions of temperature and aging, because no hardening varnish is used.

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BH Ex-Flex Fiberglas Sleeving is one of a family of electrical insulations, each designed to meet particular conditions in service. Give us a few facts about your requirements—product, temperatures, voltages—we will gladly furnish free samples for testing purposes.

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BH *Fiberglas** **SLEEVINGS**

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U. S. Pat. No. 2393530). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp

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Wire for Defense Projects !

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FOR almost a half century Lenz has been producing insulated Wires and Cables for the Communications Industries, wires that are engineered and designed under high quality standards.

Now, Lenz is prepared to furnish hook-up wire and cables for defense projects, conforming to Government specification JAN-C-76 TYPES WL, SRIR and SRHV.

These Thermo-Plastic Insulated Wires, with or without Lacquered Braids, and the cables constructed of same, are available for use in Communications Equipment and Electronic Instruments.

For a dependable source for your wire and cable requirements, consult Lenz.

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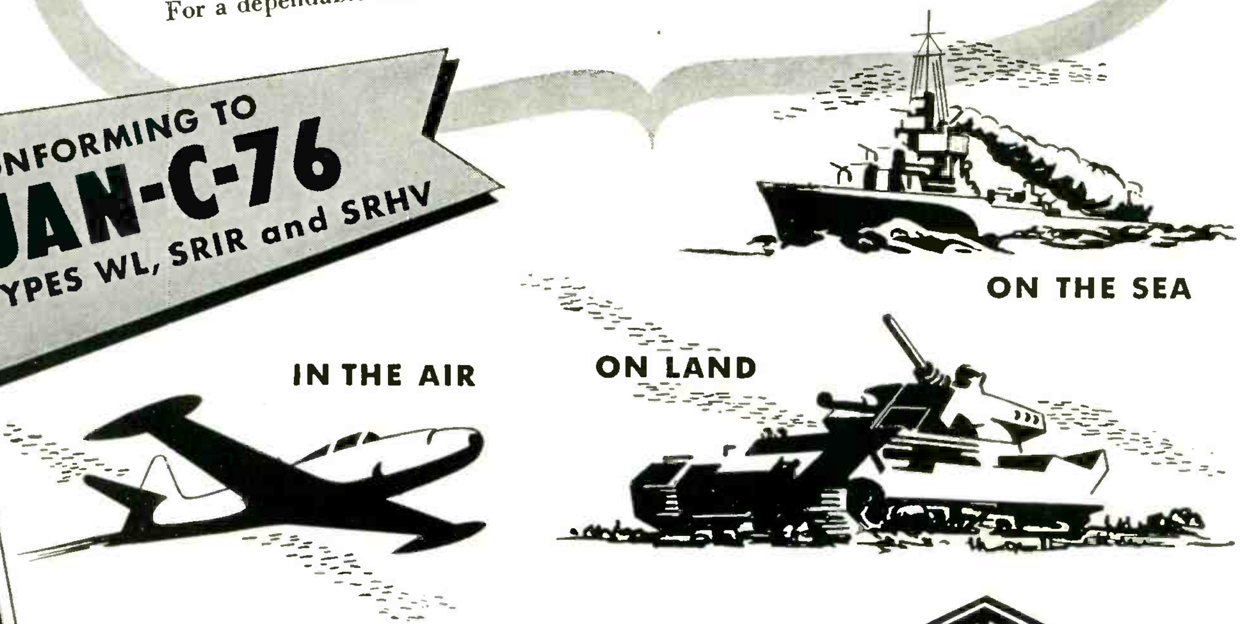
JAN-C-76
TYPES WL, SRIR and SRHV



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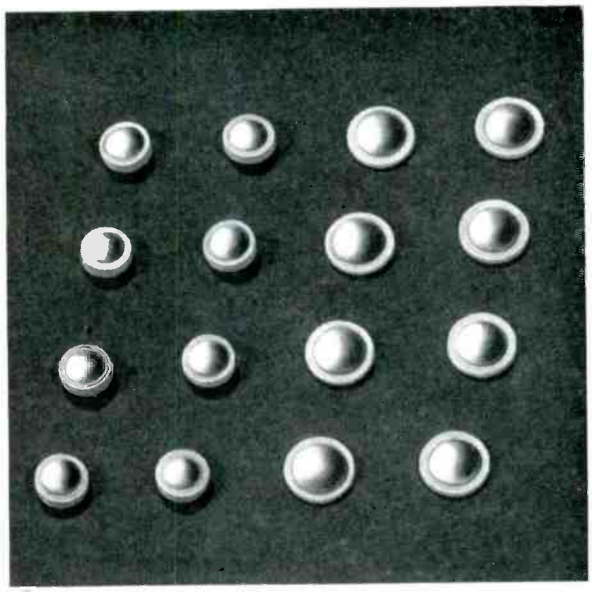
DISCAP®

"SOLDER-INS"



Of special importance to the ultra high frequency TV receiver designer is the problem of inherent inductance found in standard capacitors. Tests show that the inductance of a Hi-K by-pass ceramic disc is very low but, when wire leads are used for mounting, the inductance increases with the length of the leads.

RMC "Solder-ins" are low-cost presoldered, silvered ceramic disc capacitors which can be soldered directly between ground and a tube socket lug or, in fact, to any vital by-pass point. The effect is to cancel lead inductance, providing a minimum of over-all inductance.

RMC DISCAP "Solder-ins" are available in capacities between .000010 and .0015 MFD.

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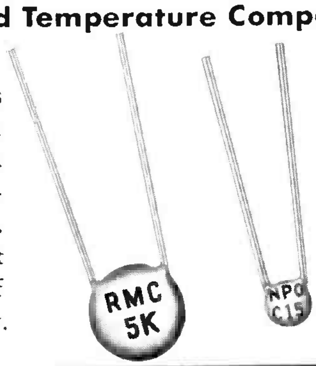
Are You Using RMC By-Pass and Temperature Compensating DISCAPS?

RMC Type B-GMV by-pass DISCAPS are available in single and dual units in a full range of capacities between .008 and .02 MFD. Their wide use throughout radio and TV is proof of their superiority.



Approved and used by leading TV and electronic producers. RMC Type C temperature compensating DISCAPS are designed to replace tubular ceramic and mica condensers at *lower cost.*

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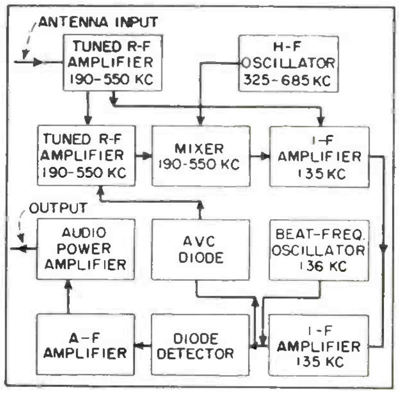
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Two RMC Plants Devoted Exclusively to Ceramic Condensers

TUBES AT WORK

(continued from page 138)



Block diagram of the receiver. Compactness is achieved through use of subminiature components

they are double-tuned and use permeability-tuned inductors of about 2.8 millihenries which have Q's of 70 at 135 kc. The resonating capacitors are washer-shaped and mounted in the ends of the transformers. The r-f coil structures resemble those of the i-f transformers so that similar parts may be used in both.

Panel controls involved a design problem. The small size of the panel ($5\frac{3}{4}$ by $1\frac{7}{8}$ inches) and the need for hermetic seals made it undesirable to have more than two external controls. Since one of these was required for tuning, the other had to fill the three distinct functions of gain control, power on-off switch and beat-frequency-oscillator on-off switch. All these latter functions are performed by a special compact switch, designed to be produced entirely by stamping operations.

The specially designed miniature gain control uses a high-temperature adhesive-tape resistor, also developed by NBS. The tape is applied around a small glass cylinder, $\frac{3}{16}$ inch in length and $\frac{1}{2}$ inch in diameter, on which 120 axial lines of silver paint have been deposited to form commutator segments. A precious-metal brush makes contact with the projecting ends of these silver lines.

Aside from its inherent usefulness as an ultra compact piece of airborne communication equipment, the new range receiver has also served as the focal point for the development of several novel components and fabrication techniques. These components, engineered to

NEW GL-6044 THYRATRON FEATURES

NEW BASE CONSTRUCTION

—stronger, safer, steadier!

Study these important design plusses:

TIGHT, DEPENDABLE CONTACTS. Bolted electrical contacts are firm and substantial. There are no springs to relax because of heat. No risk of the tube slipping from its socket due to vibration.

HIGH-TEMPERATURE OPERATION. Since the GL-6044 has no base in the customary sense, the tube's operating temperature is not limited by decomposition of a basing compound.

BUILT-IN STURDINESS. *Strength* marks every detail. The tube is short and compact. Its internal structure is solidly braced. Thimble-type terminal seals, of fernico-to-glass construction, are long-lived, resist strain. Contact fingers, extending out from the tube, have a factor of resilience which helps to ward off shocks.

CLEAN EQUIPMENT LAYOUT. GL-6044 installation involves no cumbersome conventional socket. No provision need be made for a top anode terminal connection, since all leads come out at the bottom of the tube.

SPACE-SAVING. GL-6044's are *only half the height* of 5528 thyratrons—yet rated the same! They will mount more closely side-by-side; their bolted terminals can be inter-arranged on a panel so that the tubes are compactly grouped.

GL-6044
6.4-amp thyratron

Inert-gas-filled, for efficiency within the wide ambient temperature limits of −55C to approx 120C (at normal atmospheric pressures). Designed for use in aircraft, but also available for industrial control applications . . . Wire or write today for Bulletin ETD-155, giving ratings and performance facts! *Electronics Dept., Sec. 3, General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

180-K3

meet the rigorous size and temperature requirements of subminiature equipment, may well afford superior permanence and reliability when used in equipment of more conventional and less compact design.

Reducing Transmitter Out Time

BY JAMES H. GREENWOOD
Station WCAE, Inc.
Pittsburgh, Pa.

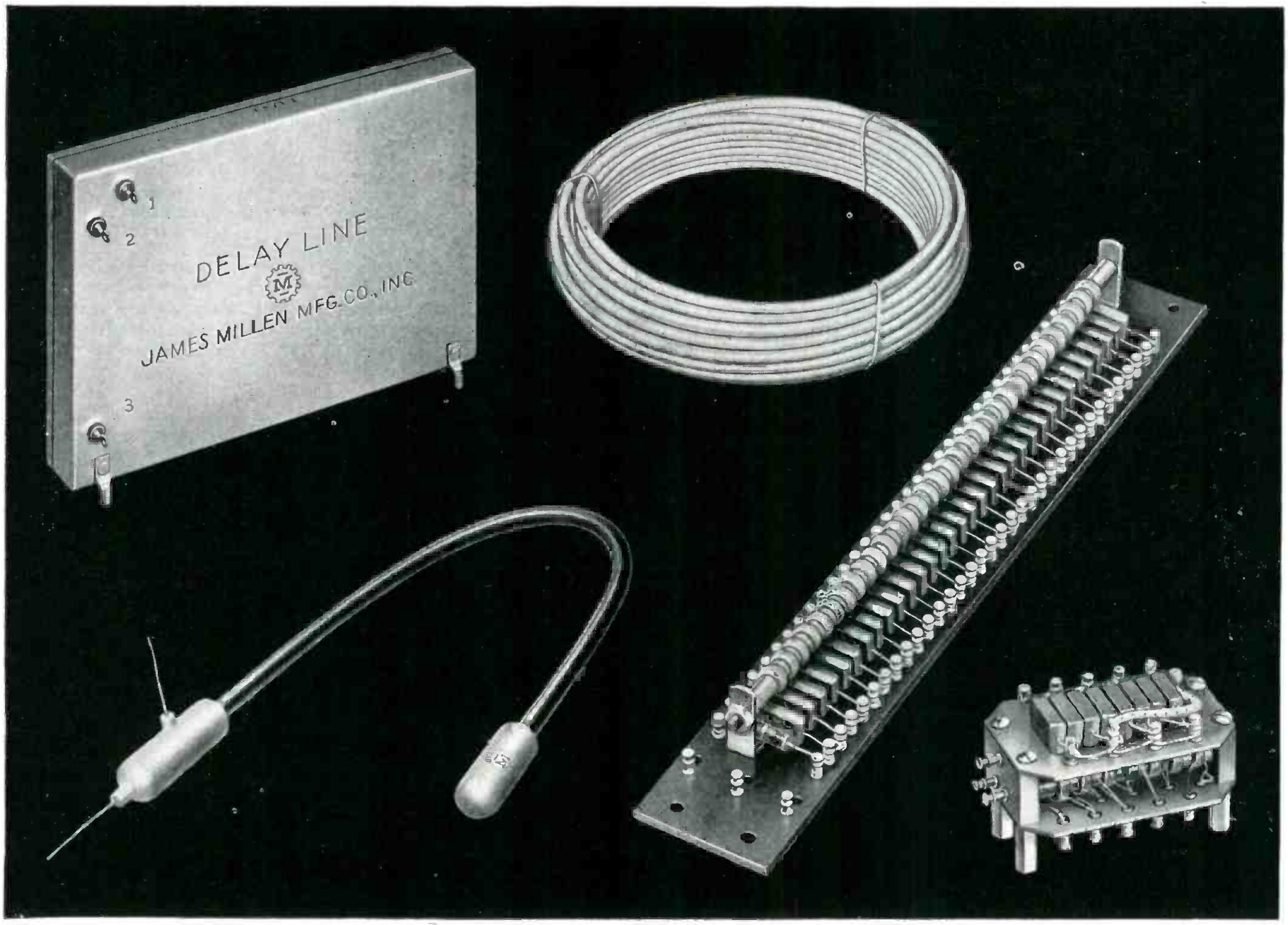
CONTINUITY of service is important to a radio station and the listening public. A minute of silence in the middle of a program may destroy the continuity and annoy the listeners, many of whom would tune in another station.

All of the facilities at WCAE are installed at least in duplicate. Lost time therefore becomes only that time required to isolate the unit in trouble and switch to the alternate unit. This time may be subdivided into four categories; time in which the existence of trouble is observed and realized, time in which to classify or locate the trouble and determine its seriousness, warm-up time for the alternate equipment and actual time involved in switching the alternate equipment into service.

The distribution of time among these classifications varies widely for different types of failure. For some components, the diagnosis and replacement are completely automatic; for others, the human element enters into each step of the process.

At one time, the emergency transmitter at WCAE consumed 45 seconds in warming up. Switching it into service could be accomplished during this time. However, the human element entered into the first two categories mentioned previously and another 15 seconds was added, bringing the total time lost on each occasion of transmitter failure to approximately one minute.

The one-minute loss time has now been reduced to between 12 and 15 seconds. On the surface, it appears to be a gain of four to one but in listener reaction the gain is



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The James Millen Mfg. Co., Inc. has been producing continuous delay lines and lump constant delay networks since the origination of the demand for these components in pulse formation and other circuits requiring time delay. The most modern of these is the distributed constant delay line designed to comply with the most stringent electrical and mechanical requirements for military, commercial and laboratory equipment.

Millen distributed constant line is available as bulk line for laboratory use and in either flexible or metallic hermetically sealed units adjusted to exact time delay for use in production equipment. Lump constant delay networks may be preferred for some specialized applications and can be furnished in open or hermetically sealed construction. The above illustrates several typical lines of both types. Our engineers are available to assist you in your delay line problems.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY

MALDEN, MASSACHUSETTS, U. S. A.

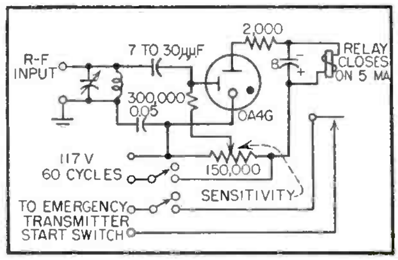


FIG. 1—Schematic diagram of the circuit for starting the emergency transmitter automatically whenever the carrier is interrupted

much greater, for the first quarter minute of silence is not nearly as annoying as the fourth.

Reduced Warm-Up Time

Warm-up time was reduced to 12 seconds by applying heater current continously to all heater-type tubes. This practice has not resulted in any observable reduction in useful tube life since only one heater-type tube has been replaced for any cause since 1939 when the system was installed in its original form.

The human element was removed from observing and realizing the existence of trouble by additional circuitry, as shown in Fig. 1. A small sampling antenna and tank circuit excite the grid of an OA4G. In its plate circuit is a relay which starts the emergency transmitter warm up whenever the r-f grid excitation falls below a safe, preset value. This relay does not apply plate voltage to the emergency transmitter.

If the loss of carrier is caused only by a momentary flashover within a tube or a transient arc caused by a lightning discharge, there is no need for the emergency transmitter and the operator merely shuts it off instead of completing the transfer. Observance of the nature and seriousness of the trouble is accomplished while the equipment is warming up and by the time the decision has been made, the equipment is ready for use.

To reduce the time necessary to switch the alternate equipment into operation, some of the operations performed had to be simplified. The original switching operation consisted of the following steps: removing final-stage plate voltage from the transmitter being taken

out of service, switching six circuits from one transmitter to the other (antenna, program input, frequency monitor, modulation monitor, audio monitor and cathode-ray monitor) and applying plate voltage to the transmitter being placed in service.

Controls for most of these operations were grouped at one location. The exceptions were the frequency, modulation and cathode-ray monitors. They were fed from the same sampling antenna which excites the OA4G and therefore indicate operating conditions automatically for whichever transmitter is in use.

With a little practice, all remaining circuits can be switched in a fraction of a second. A completely automatic change-over could have been devised but it would have been considerably more complex and less reliable. Also, it would still require the minimum warm-up time of 12 seconds. The system described retains all of the advantages of human judgment with no added delay.

Pulse-Sharpening Circuit

IT IS OFTEN necessary to sharpen the output pulse of a detector in many applications. Sharpening of the pulse is usually done either to keep a fast discriminator or pulse-standardizing circuit from functioning improperly or to define the time of occurrence of an event more positively.

A pulse-sharpening circuit described by Leonard Reiffel on page 214 of *The Review of Scientific Instruments* for March 1951 was originally designed for use with a Geiger tube but may be adapted for other applications. Figure 1 shows this circuit.

The resonant circuit consisting of the parallel combination of *L*

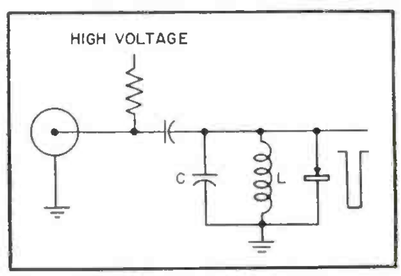
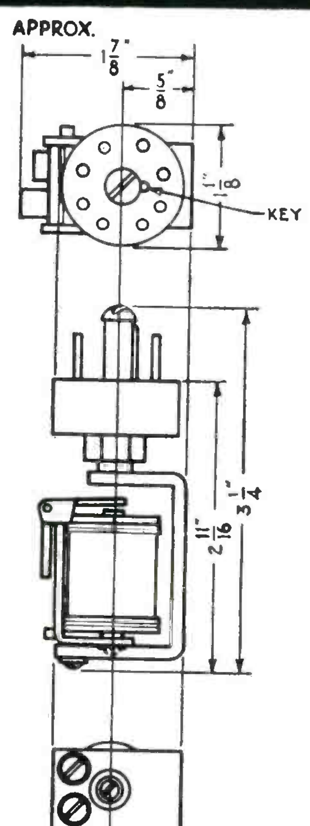


FIG. 1—Pulse-sharpening circuit



Dimensions of typical Class "S" relay with compact "plug-in" mounting.

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You specify "plug-in" relays to permit rapid replacement where continuous operation is vital. Be sure of the relays themselves, so *rapid* replacement doesn't become *frequent* replacement! Combine "plug-in" convenience with recognized quality in Automatic Electric relays.

COMPLETE LINE—typical assemblies are shown above. Notice that plugs are available with up to 20 pins, and for hermetically sealed relays if desired. Popular assemblies of Class "S", "Z", "B", "A", and "F" relays with "plug-ins" are available from stock. Others will be assembled to your order.

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RELAYS **SWITCHES**

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and C is excited by the current pulse from the Geiger tube. When the resonant circuit is excited, a series of damped oscillations occur. The first half cycle of oscillation is negative and damping is comparatively slight during this period. When the second half cycle of oscillation begins and the polarity is reversed, the germanium diode begins to conduct and heavy damping is placed on the circuit. This damping may be large enough to dissipate all of the energy in the circuit during the first positive half cycle.

If the damping were heavy enough to dissipate the energy during the first half cycle, the output waveform would consist of one-half cycle of oscillation with negative polarity. The output pulse will be very short if the resonant frequency of the circuit is made high.

Constant-Amplitude Oscillator

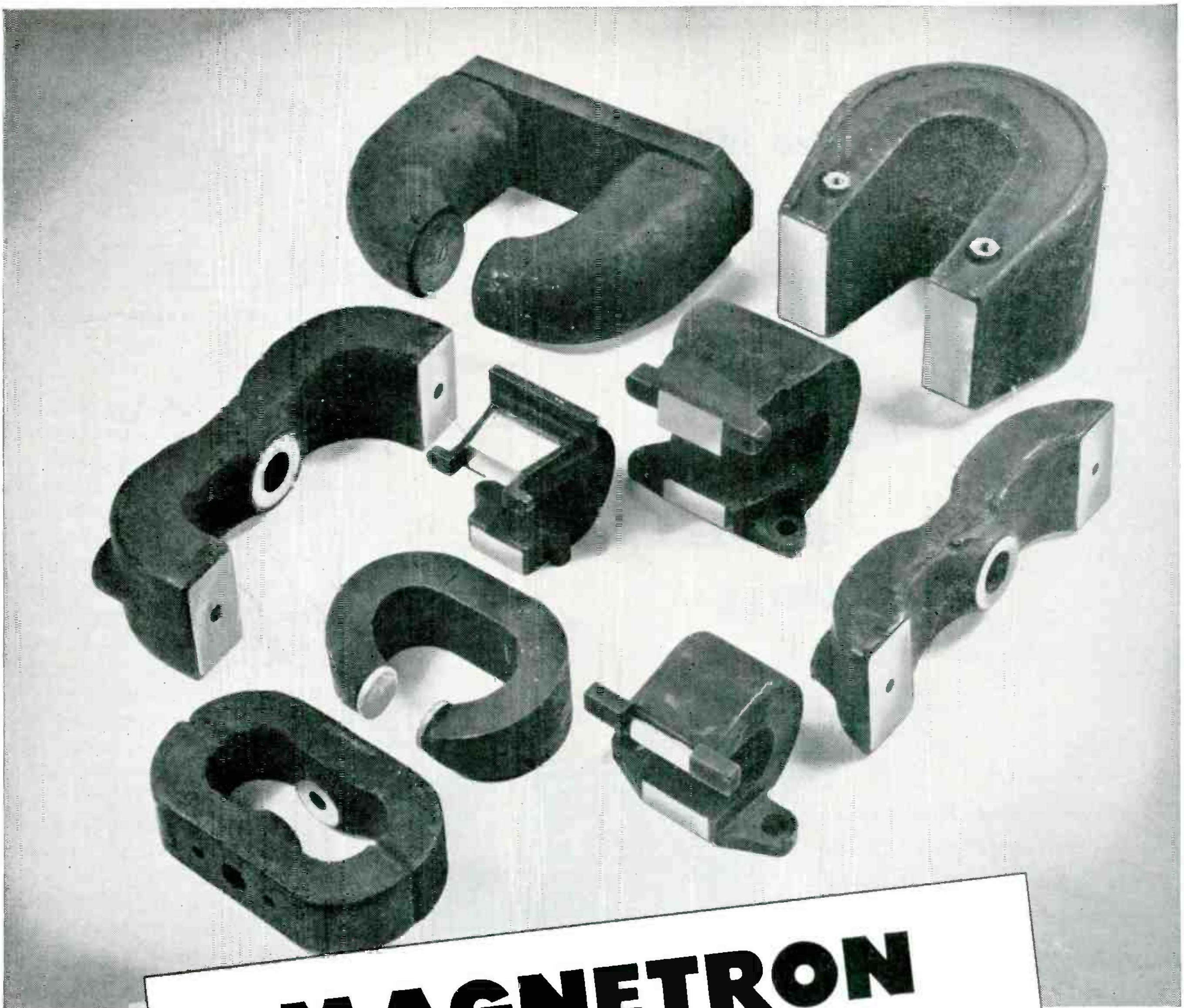
By Norris C. Hekimian
Radio Engineer
Central Radio Propagation Laboratory
National Bureau of Standards
Washington, D. C.

For many applications it is desirable to have a source of r-f voltage which remains reasonably constant in spite of changes in tube parameters, supply voltage, heater voltage and load impedances. Adjustable-frequency oscillators should be stabilized against changes arising from variations in component parts and circuit reactances.

In the past, several systems have been devised to stabilize oscillators, including a modified avc system and fixed-level clipper circuits. The avc system is ineffective in stabilizing class-C oscillators because of the self-biasing feature of such oscillators.

The fixed-level clipper has a strong harmonic content in the output waveform. This effect can be reduced by adding a second resonant circuit after the clipper, resulting in increased output impedance and attendant circuit-tracking difficulties.

The oscillator to be described does not suffer from the foregoing



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Complete assemblies with Permendur, steel or aluminum bases, inserts and keepers as specified. Magnetized and stabilized as required.

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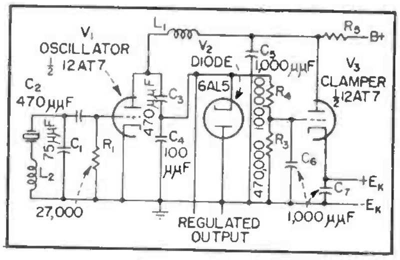


FIG. 1—Clamped oscillator circuit

difficulties to any appreciable extent. It offers the advantage, in application to oscillators which are adjustable over a wide frequency range, of tending to maintain Miller effect capacitance constant by keeping the apparent grid-plate gain of the oscillator reasonably constant. Oscillator frequency calibration drift is minimized by maintaining the tube input and output capacitances practically constant. Clipping of the output waveform is reduced to very low levels. The only clipping that occurs is due to the diode across the output.

The circuit arrangement as shown in Fig. 1, is essentially that of a conventional oscillator followed by a diode across the output terminals. The diode-rectified output is applied to a biased control or clamper tube sharing the same plate-dropping resistor with the oscillator.

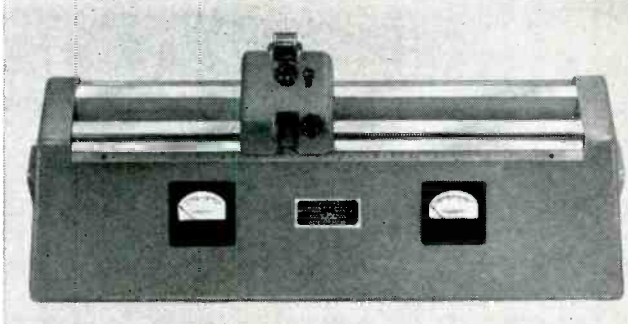
With the clamper initially biased in the region of plate cut-off, the rectified oscillator output is applied as a positive voltage to the control tube grid. When the oscillator output voltage reaches a sufficiently high level, the clamper draws plate current and reduces the oscillator plate voltage, thus dropping the voltage to a relatively fixed level.

Normally, the bias voltage E_k is adjusted so that the control tube is always slightly conductive at the minimum level of oscillator voltage anticipated so that positive control action is had at all times. Under these conditions, Fig. 2, the best regulating characteristics are obtained with as large a value of R_5 as is practical to obtain the desired output voltages.

Figure 3 shows the controlling effect of E_k upon the output voltage. The bias voltage supply for E_k should be of low impedance to

LITTON INDUSTRIES NEWS

NEW LITTON TEST AND CONTROL EQUIPMENT SPEEDS, SIMPLIFIES HIGH POWER MICROWAVE WORK


New Litton Model 4000 U-Line

New Litton U-Lines, Water Loads and Thermopiles are now available for faster, more efficient laboratory measurements in microwave problems. New Litton Electromagnets, Electromagnet Controllers and Filament Controllers are also offered to facilitate testing and control of magnetrons.

LITTON U-LINE

New Model 4000 U-Line offers utmost convenience and accuracy in quickly determining VSWR in high-power coaxial lines. The equipment transduces power from a standard 1⅝" coaxial line to a U-shaped configuration with round central conductor. Both central and outer conductors are mechanically rigid. A traveling probe moves on a precision carriage through the open end of the "U." The probe circuit includes assemblies from the Hewlett-Packard Model 805 Slotted Line. A millimeter scale with vernier indicates probe position. 50 centimeters of travel is available.

HIGH POWER RATING

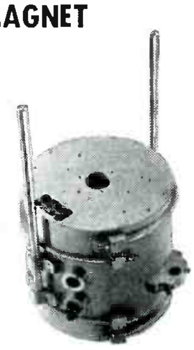
Model 4000 offers continuous frequency coverage from 450 to 2,750 mc. with insertion VSWR of less than 1.05. Special Teflon bead supports make possible a conservative CW power rating of two kilowatts through the line. VSWR measurements may be made at any power level from kilowatts to microwatts. Standard equipment includes UG-50/U female couplings.

Auxiliary equipment available includes male couplings, VSWR meter, rf power output meter, and range switches to specification.

THERMOPILE

Model 3900 Thermopile is a sensitive, accurate indicator of small-differential temperatures. The unit is equipped with 30 pairs of copper-constantan junctions, and is tapped at 10 and 20 pairs. Uniflare ¼" fittings are provided for water connection. Recommended auxiliary meter has a 7-millivolt movement.

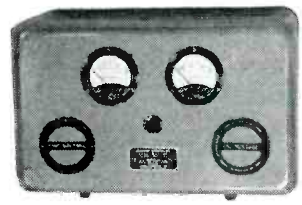
ELECTROMAGNET



Model 4807 Electromagnet is a low-voltage, high-current unit designed for general, across-the-line rectified service. It is shell-type in design, and will produce a field of 9,000 gauss across a ½" gap. Model 4807 is the standard Electromagnet recommended for use with Litton high-power CW magnetrons.

ELECTROMAGNET CONTROLLERS CATHODE SOCKETS

Litton Electromagnet Controllers and Cathode Sockets are available for use with Litton magnetrons.



FILAMENT CONTROLLER

By regulating cathode temperature of Litton or other high-power magnetrons, Model 5001 Filament Controller can extend magnetron life as much as a factor of ten. The Controller holds cathode temperature constant over wide ranges of magnetron input power and load conditions. The Filament Controller operates on 115-v, 60-cps input and includes filament transformer.

WATER LOAD

As a termination for 1⅝", 50-ohm coaxial lines, Litton Model 4100 Water Load is particularly useful in high-power applications where power output must be accurately measured. The Load is conservatively rated at 2 kilowatts capacity between 950 and 3,000 mc. VSWR is less than 1.2 over full range, and less than 1.1 above 2,000 mc.

For convenience in sampling rf power, the Water Load also includes two adjustable-depth probes.

For accurate power measurement Litton Model 3900 Thermopile and associated meter are recommended.

Many Litton CW and pulsed magnetrons are classified. With proper clearance established, we will gladly discuss our ability to fill your requirements.

Write for price and delivery information. Data subject to change without notice.

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SAN CARLOS, CALIFORNIA, U. S. A.

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maintain E_k constant. In the test model of the constant-amplitude oscillator, E_k was obtained from batteries with internal resistances of about 5 ohms.

In Fig. 1, C_1 is a frequency-shifting trimmer and L_2 is a crystal-peaking coil employed when using a fifth overtone crystal (30 mc), the particular application for which the constant-amplitude oscillator was developed. Coil L_1 resonates at the crystal frequency with the circuit capacities shown.

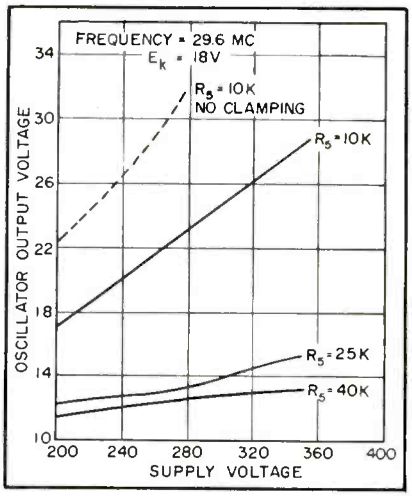
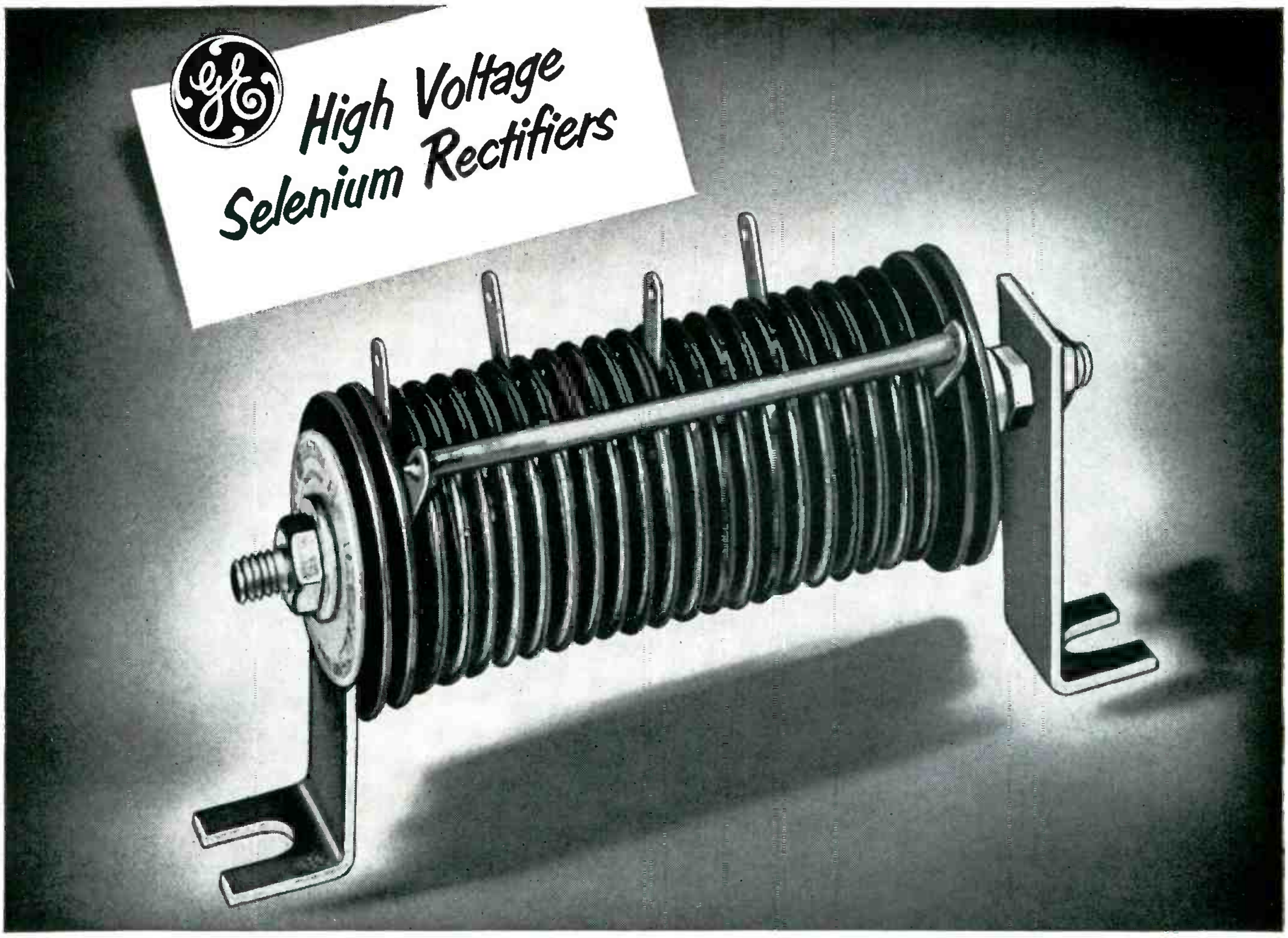


FIG. 2—Oscillator characteristic curves for different values of voltage-dropping resistance

Figures 2 and 3 illustrate the output amplitude stability obtained when the supply voltage, the bias voltage on V_3 and plate-resistor R_5 are varied. Constancy of amplitude versus supply voltage is easily measured and reflects to some extent the increased stabilization against tube parameter changes.

While it is possible to analyze graphically the constant-amplitude oscillator circuit, it is necessary to obtain at least one oscillator characteristic to do so. In most cases it may be advisable to determine circuit values roughly and then adjust the actual oscillator for optimum operation. In practice the output voltage is determined largely by the bias voltage E_k, as shown in Fig. 3, with R_5 adjusted for satisfactory regulation. Care should be taken to allow for sufficient dissipation in R_5. A power-type resistor is generally necessary.

Improved clamping may be ob-



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Whether you buy selenium rectifiers for your own use or to build into your product, you want to know just what you are getting. We want you to compare G-E rectifiers with other rectifiers of the same rating. That way you can see for yourself the superior qualities of G-E selenium rectifiers before you buy.

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COMPARE FORWARD RESISTANCE—Comparison will show the extremely low forward resistance of G-E cells—will show you why they deliver higher output voltage—will show how you can cut costs in circuit components and design.

COMPARE BACK LEAKAGE—Comparison will show the low back leakage of G-E cells—will show you why their lower internal losses mean higher output. Lower leakages mean less heating, longer life, economical operation for G-E high-voltage rectifiers and the equipment they ably service.

COMPARE TEMPERATURE RISE—Because of their low forward resistance and low back leakage, they are cooler operating—don't overheat nearby parts—require less ventilation—have longer life.

We want you to make these comparison tests. We want you to prove to yourself conclusively that G-E selenium high-voltage rectifiers are superior. Compare, and you'll decide to use them in your next job—to make the long-term high output of G-E stacks help keep your product out front.

* * *

Write Section 461-15, *Apparatus Department, General Electric Company, Schenectady 5, New York* for a copy of GEA-5524 which gives details on comparative testing. Or, arrange for test details and sample units through the General Electric specialist at your local G-E office.

461-15

GENERAL ELECTRIC

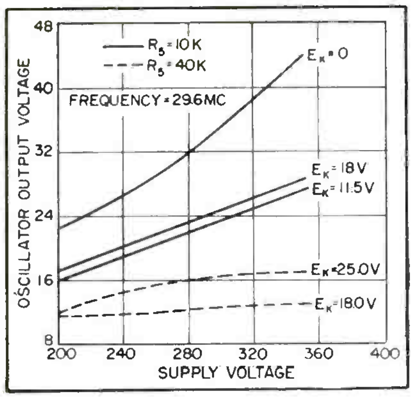

FIG. 2—Oscillator characteristic curves for different values of voltage-dropping resistance

tained by certain circuit modifications. By employing a voltage-multiplier type of rectifier to drive the clamper tube, a greater ratio of d-c control bias to r-f output voltage is obtained with resulting improved regulation. By using a power amplifier as a clamper instead of a type similar to the oscillator, the greater plate-current capabilities result in more positive control action.

If the clipper diode is fed from the final output of oscillator-buffer circuits with more gain included between the oscillator and the rectifier-control circuit, the sensitivity to small changes in output is increased and increased stability results.

Although the circuit described was designed for use as a fixed-frequency local oscillator in a gain-stable receiver, it is of value in other applications. Some suggested uses are in exciters, signal generators and high-quality communications receivers.

Home-Heating Control Modification

By E. M. Howe
Air Conditioning Engineer
McEldowney and Son, Inc.
Oklahoma City, Oklahoma

In the southwestern portion of the United States, heating engineers are confronted with both summer and winter air-conditioning control problems. Practically all new buildings now under construction, or in contemplation, throughout this part of the country are to be cooled by refrigeration as well as heated.

There are times in the spring and

fall when it is desirable to have a small amount of heat in the early morning and late evening with the cooling equipment operating during the day. This gives rise to the problem of a suitable control system which will provide just enough heating or cooling to balance the heat loss or gain of the structure, as well as one which can be easily shifted from the heating cycle to the cooling cycle.

A control system of this type must be inexpensive if it is to have a wide application in the field. It is reasonable for a contractor to spend five percent of the contract price on heating and cooling controls, but he could not be expected to spend 15 or 20 percent of the price on a good control system.

The use of electronic controls in the field of heating comfort gave results never before believed practical and this same control system applied to cooling was equally successful. However, the cost of most electronic control systems for year-round heating and cooling application was too large a percent of the contract price on the small business and residential applications for it to have a wide usage.

A modification of the Minneapolis-Honeywell R-7012A Relay for electronic control of home heating has been developed by the author. The modification is inexpensive and gives results closely approximating the ultimate goal for heating and cooling comfort. The original electronic system for heating was described in an article by J. M. Wilson in the December 1950 issue of

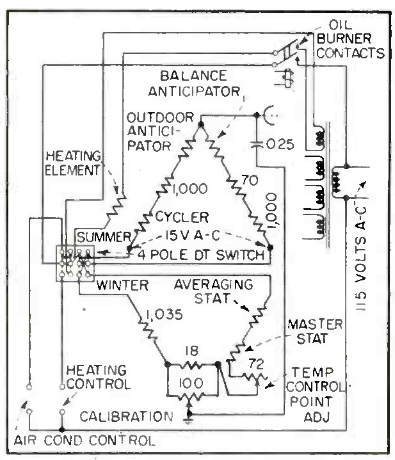

FIG. 1—Circuit modification to Minneapolis-Honeywell R7012A relay for summer-winter application

ELECTRONICS, page 84. A schematic diagram of the modification is shown in Fig. 1.

Circuit Analysis

Basically, the circuit consists of a Wheatstone Bridge, an amplifier and a relay, with one leg of the bridge sensitive to temperature changes. The lower right-hand leg of the bridge has two resistors in series, a master thermostat and an averaging thermostat. It is intended that the two thermostats be located in different portions of the conditioned area to give an average temperature indication.

The thermostats themselves are temperature-sensitive resistors. When the temperature decreases, the resistors change in value and cause an unbalance in the bridge circuit. A signal voltage is then applied to the grid of the voltage amplifier. When this voltage indicates sufficient unbalance in the bridge, it will cause the relay to close an external circuit controlling the heating device.

As the bridge circuit approaches balance because of the increase of temperature in the controlled area, the voltage across the relay will decrease and the relay armature will drop out, breaking the external control circuit and stopping the furnace.

If the circuit position of the lower right-hand leg of the bridge were exchanged with that of the lower left-hand leg, the reaction previously described would occur in reverse. When the temperature decreased, the signal would decrease and cause the relay to open. Conversely, upon temperature rise a signal increasing in value would cause the relay to close.

Circuit Modification

To make this exchange in position of the legs of the bridge, a four-pole double-throw switch was inserted in the circuit as shown in Fig. 1. It is necessary to connect the relay to the cooling system when the switch is inserted and another pole of the switch is utilized for this purpose.

It was found undesirable to have the cycler operate the relay during the cooling cycle as the recovery of

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A new *Microline* instrument, Model 555 Klystron Signal Source, is an extremely well-regulated power supply. It features a continuously adjustable beam supply from 250 to 3600 volts. In addition, a reflector power supply is continuously variable from 0 to 1000 volts, and a control electrode supply is continuously variable from 0 to 300 volts. The versatility of this signal source permits operation of low voltage as well as high voltage klystrons.

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2K29	726A,B,C	QK-292
2K33	QK-140	QK-293
2K39	QK-141	QK-294
2K41	QK-142	QK-295
2K42	QK-143	QK-306
2K43	QK-159	6 BL6
2K44	QK-226	6 BM6
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2K56	QK-246	X-12
2K57	QK-269	X-13
		X-21

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the cooling system is not as fast as that of the heating system. In addition, the human body is not too susceptible to slight variations in temperature during the cooling cycle. To remove the operation of the cycler during cooling, only the circuit to the heater of the cycler was opened by the fourth contact of the switch.

The modified system described, fulfills all requirements in that the modification is inexpensive, it eliminates the usual assortment of heating and cooling thermostats and it makes only one installation necessary.

The system gives more accurate control during the cooling cycle than is possible to obtain with the usual line-voltage thermostat which has a wide differential, usually two to five degrees. The relay when modified retains the desirable characteristics of the electronic heating control during the heating season and when applied to cooling gives a simple one switch change-over.

Thermal Shunt for Soldering Resistors

SOLDERING of resistors in miniature and subminiature equipment is difficult because the resistors may easily become overheated and a permanent change in their values may result. One method developed to help overcome this difficulty is the use of a thermal shunt placed between the body of the resistor and the soldering lug during the soldering process.

A simple way of applying a thermal shunt is to use a pair of long-nose pliers, however, the pliers must not be removed for at least 15

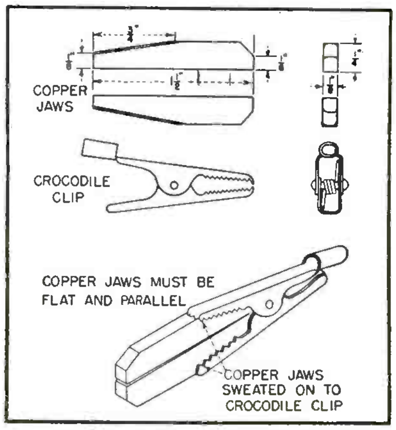
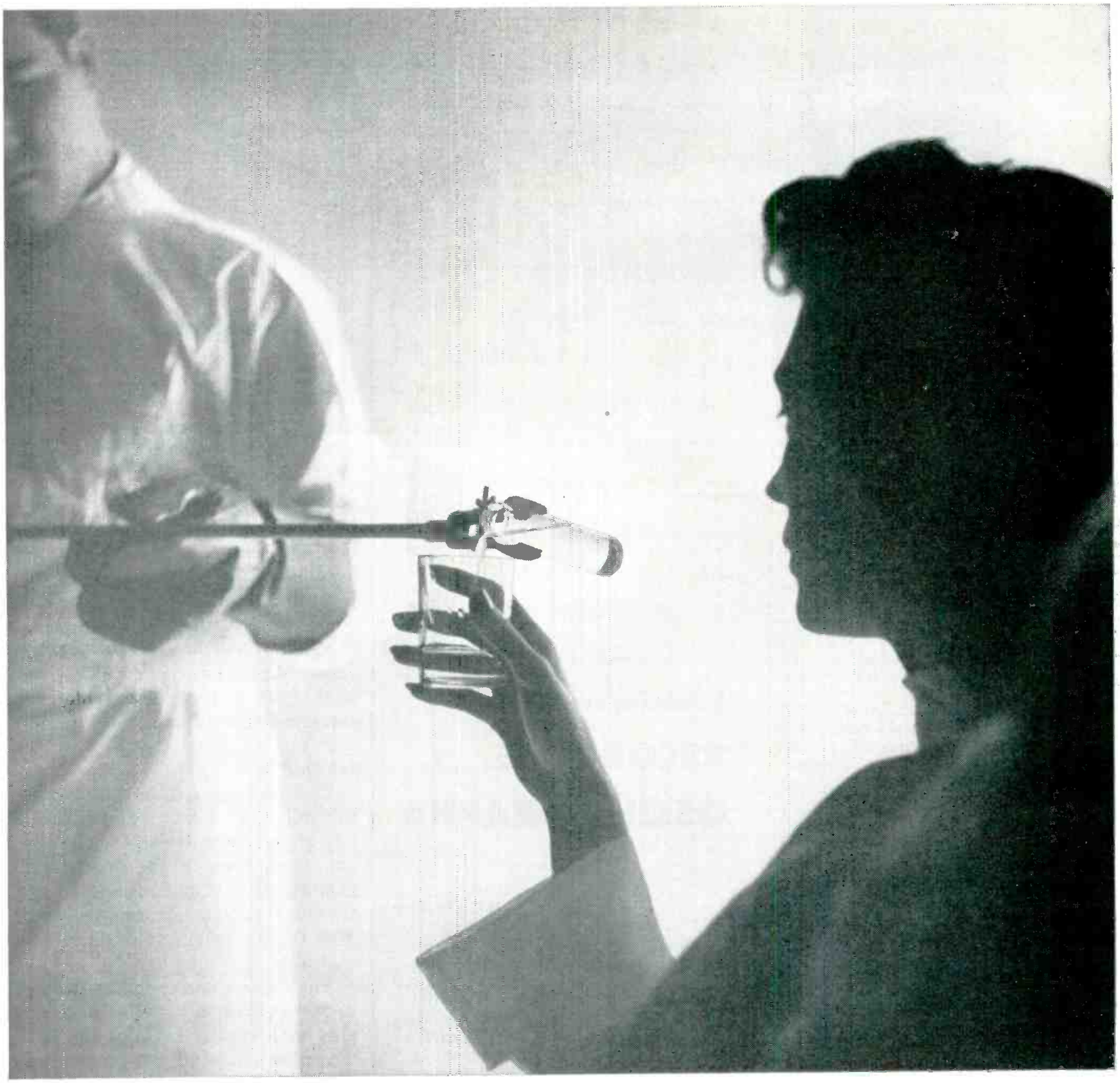


FIG. 1—Component parts and details of the clip-on thermal shunt



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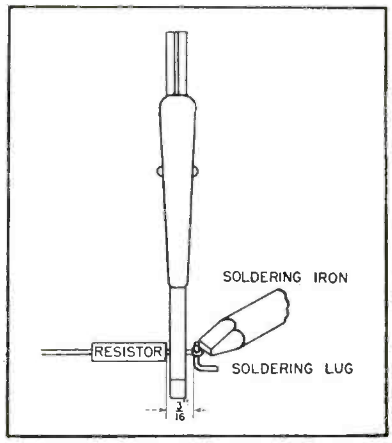


FIG. 2—Sketch showing how the shunt is used when soldering

seconds after the soldering joint has been completed. Copper pliers are more effective than steel ones because of the better conductivity but, in either case, the operator would tend to remove the pliers at the same time the soldering iron is removed. This practice allows the heat stored in the molten solder, the terminating lead and in the soldering lug to flow freely into the resistor body.

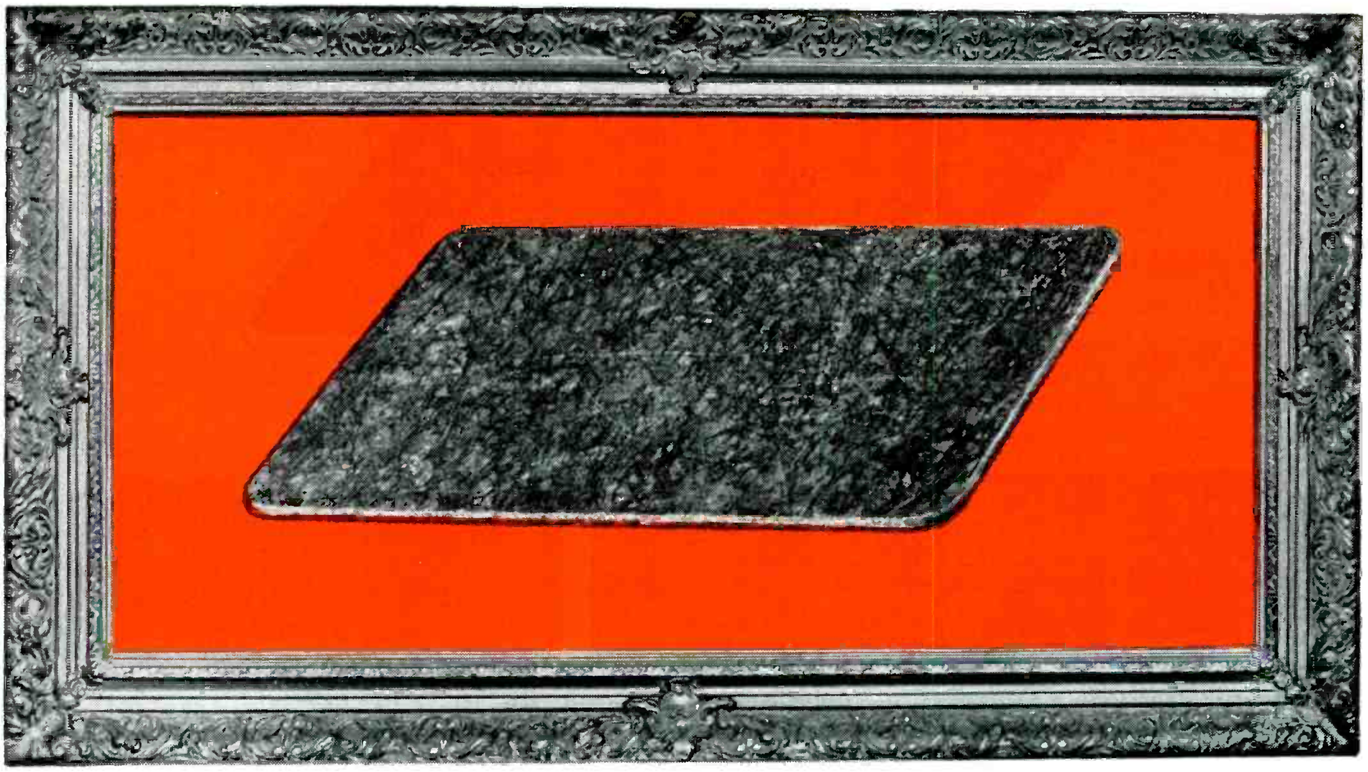
To guard against the operator removing the shunt too quickly, a clip-on device is desirable. The clip-on action compels the operator to remove the shunt forcibly and thereby tends to prevent the operator from removing the shunt prematurely.

The clip-on device finally decided upon utilizes a simple crocodile clip with copper bars in its jaws. The dimensions of the copper bars are ⅛-in. thick, ¼-in. wide and 1½-in. long. The component parts and details of the clip-on thermal shunt are shown in Fig. 1. Figure 2 shows a sketch of the shunt in use.

The information in this article was abstracted from a report by E. N. Shaw entitled "The Overheating of Miniature Resistors During Soldering" published by the Telecommunications Research Establishment of Worcester, England.

Position Indicator

A RECENT DEVELOPMENT in the field of position indication consists of a magnetic measuring system coupled to an electronic circuit for control or remote indication purposes. The instrument is espe-



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It matches—even surpasses—the electrical and mechanical properties of laminates reinforced with organic materials . . . *yet it costs as much as 50% less!*

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If you make or use electrical apparatus, and want top-flight insulation at rock-bottom cost, consider laminates reinforced with Fiberglas mat.

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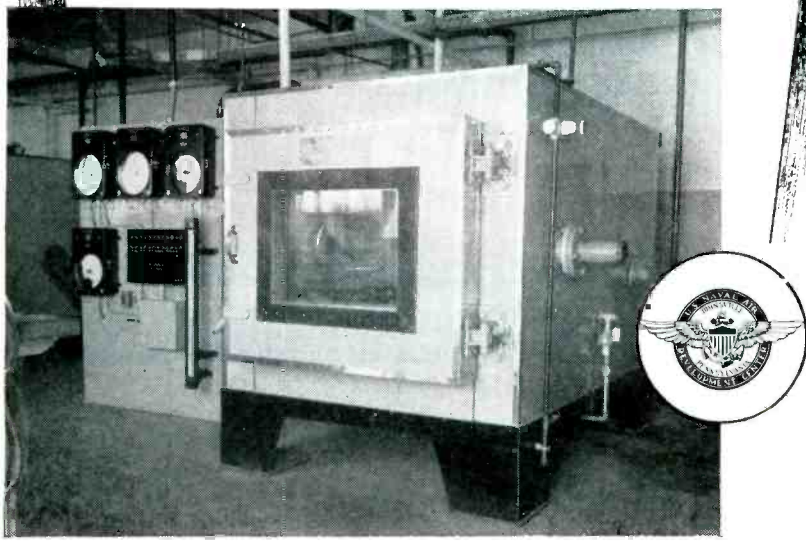


cially suited for the indication of liquid levels particularly under high pressures and where seals would be undesirable.

The principle of operation used is that of a cylindrical float with a bar magnet mounted on its axis so that as the float rises or falls, the magnet rolls in vertical guides. A vertical strip magnet is located outside the float chamber. This magnet is magnetized in such a way that the poles lie along the vertical sides of the strip.

The magnetized strip is pivoted horizontally at a point in its length which corresponds to the normal level of liquid in the chamber with a suitable adjustment for height. The strip is mounted so that its magnetic poles and those on the floating magnet repel each other. The floating cylinder therefore rolls against the guides without friction. When the cylinder leaves its normal position, it tends to repel the strip magnet and cause it to rotate slightly one way or the other and close a pair of contacts fixed to it.

The contacts are connected to the grid circuit of an amplifying tube whose output may be used to operate automatic control equipment to change the liquid level or operate remote indication devices.

A restoring force for the strip magnet and contact arm is provided by electromagnetic or pneumatic means.

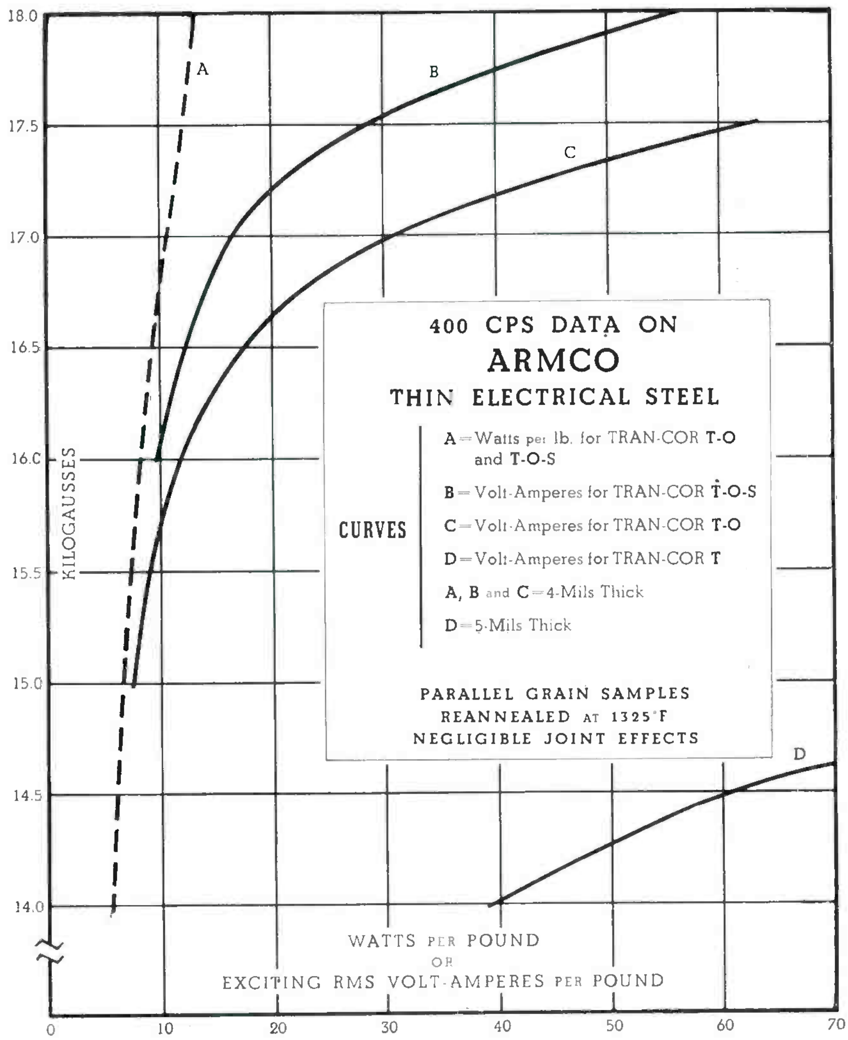
Measuring Muzzle Velocity

CONVENTIONAL equipment used for testing muzzle velocities of large-calibre pistols utilize magnetic pick-ups. Such equipment is not applicable for determining the muzzle velocity of pistols firing pellets of the order of 0.177 calibre.

The problem of determining the muzzle velocities of air pistols firing small-calibre lead pellets may be solved by the arrangement shown in Fig. 1. Each photocell is located opposite a narrow-beam light source. The air pistol is mounted in a cradle and aimed so that the pellet passes between the photocells and the light sources.

When the pellet passes between

NEW! THIN ELECTRICAL STEELS FOR OPERATION *at 400 Cycles*



Two new thin (4-mil) oriented electrical steels for operation at 400 cycles have been developed by Armco Research. They are known as Armco TRAN-COR T-O and TRAN-COR T-O-S.

TRAN-COR T-O was developed for use at 400 cps and higher with inductions up to 16 kilogausses. TRAN-COR T-O-S is recommended for equipment where more perfect orientation permits operations at still higher induction without excessive excitation.

The new TRAN-COR T-O-S can be operated at inductions 20% higher than any nickel-iron alloy. It was developed under a contract with the Bureau of Aeronautics of the Navy Department to make possible a great reduction in weight of airborne electrical equipment.

Curves on this page show a comparison of the excitation required by the two grades of oriented 4-mil material. TRAN-COR T-O-S is so carefully controlled in processing that the minimum permeability at 18 kilogausses is 1800. This value is not usually attained even at 14 kilogausses by the best grades of non-oriented high silicon steel.

TRAN-COR T-O-S has a density of 7.65, a volume resistivity of 47 microhm cm. or 282 ohms/mil ft., and a lamination factor of 95% solid.

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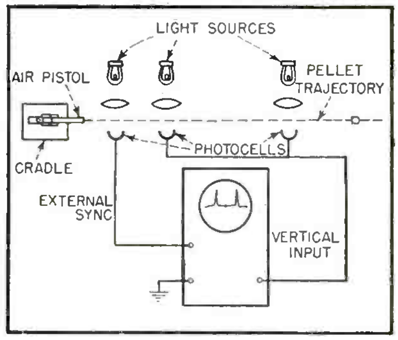


FIG. 1—Sketch of the arrangement for measuring the muzzle velocity of air pistols

the first photocell and light source, interrupting the beam of light, the low-speed driven sweep of the oscilloscope is initiated. As the pellet passes between the second and third beams, the electrical impulses generated are applied to the vertical deflection plates of the oscilloscope. These impulses appear on the screen as vertical deflections.

The muzzle velocity can be computed by measuring the distance between the two vertical deflections. For continual use in a production setup, the limits representing maximum and minimum tolerable muzzle velocity may be marked on the screen. By so doing, testing can be done by wholly unskilled workers.

This material was abstracted from the 1950 July-September issue of *The Oscillographer*, published by the Allen B. DuMont Laboratories, Inc.

Robot Control for TV Transmitter

AN EXPERIMENTAL robot control for the new BBC tv transmitter at Daventry, England, has been incorporated in the control room. The robot rings an alarm bell if anything goes wrong with the transmitter and engineers in the transmitting building several hundred yards away or in London can switch over transmitters by means of a system of telephone signals.

A giant fan and air-cooled valves are used in the new transmitter. The fan brings in fresh air and uses the heated air, if necessary, to circulate through the station for heating purposes.

THE ELECTRON ART

(continued from p 140)

num film and excite the phosphor.

In general, excitation occurs only over a short portion of alternate half-cycles. It occurs on the negative swings, because the penetrating power of the electrons is greater than that of the positive ions. At radio frequencies the number of exciting pulses per second is sufficiently large to produce, as far as the eye can detect, a uniformly illuminated screen. The frequency of the exciting pulses is not critical; in apparatus devised by the author, it is of the order of one megacycle. The r-f voltage must exceed 5,000 volts.

Although the electron and ion current during excitation of the screen is of the order of a milliampere, the displacement current may be 100 times as large. It is important, therefore, that care be exercised to minimize stray capacitance between the probe and ground, especially if several tubes are to be operated simultaneously from the same oscillator.

Small bulbs or enclosures containing a phosphor screen may be successfully examined simply by plugging the stem with a rubber stopper containing two holes, one in the center for a metal probe, the other for a piece of glass exhaust tubing. After the pressure range

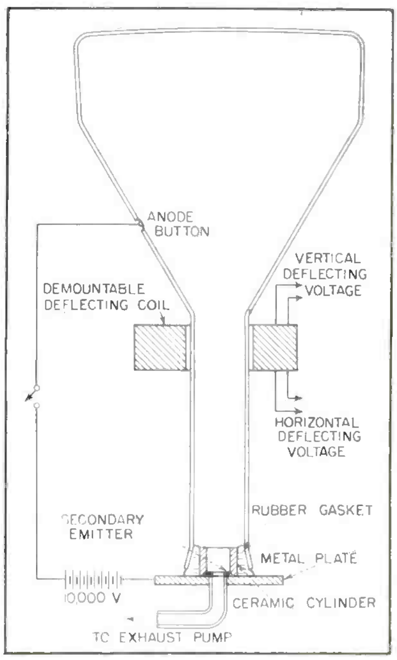


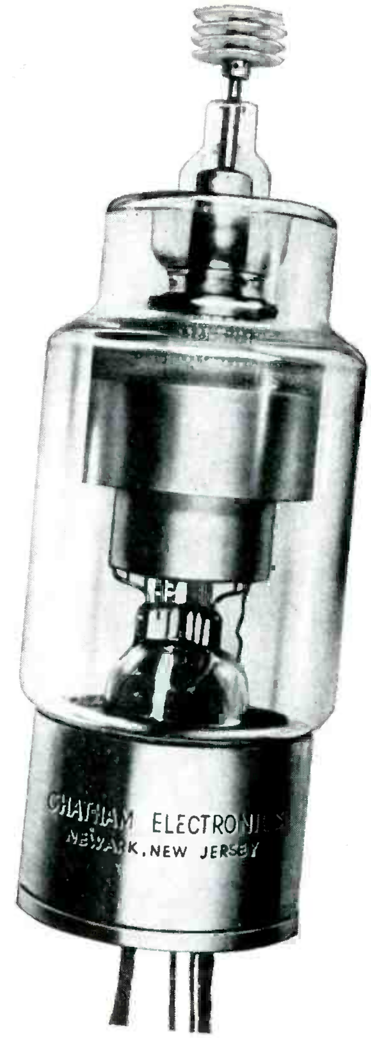
FIG. 2—Schematic of d-c method for testing picture tube screens

40,000,000 watts

in a single envelope

...with the help of LOW CARBON NICKEL

Low Carbon Nickel spun anode sleeve 1¼" diam. x 4" deep. Fabricated by E. L. Ewertsen, of Hillside, N. J., one of the country's leading spinners. Mr. Ewertsen had believed a nickel spinning of this depth and thin wall was impossible until he tried Low Carbon Nickel.



Specifications for the Armed Services' VC-1257, a large hydrogen thyratron tube, call for an output of 40 megawatts. This requires tube operation at 40,000 volts, at a peak current of 2000 amperes.

When approached with the problem, engineers at Chatham Electronics Corp., Newark 2, N. J., knew that the metal parts of the tube should have the following qualities:

1. A low carbon content to prevent the hydrogen in the tube from forming hydro-carbons.
2. Good de-gassing properties.
3. High resistance to corrosion.
4. Good workability and weldability.

At the suggestion of INCO's sales and engineering men, Chatham tried Low Carbon Nickel (carbon content 0.01 to 0.02 per cent), for the tube parts where good workability was one of the important features. The metal proved more than satisfactory, and full advantage of its favorable characteristics was taken in designing certain critical tube parts. Today the Armed Services' VC-1257 tube has one of the largest peak power outputs on record.

Supplying information on suitable alloys that solve problems such as corrosion resistance, heat resistance and high purity is the function of INCO's Engineering Service. Although metals are hard to get at the present time, our engineers will be happy to consult with you on your particular design problems, if you will write, stating your requirements.

Low Carbon Nickel is produced under controls assuring no more than a 0.02% carbon content. It is resistant to corrosion and can be used in oxidizing temperatures up to 2000°F. Softer than pure nickel, it is slow to work harden. It is chiefly used for difficult deep-drawing and spinning operations.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

LOW CARBON NICKEL (ANNEALED)
AVERAGE PROPERTIES

Yield Strength (0.2% offset) 1000 psi	15	Specific Heat (32°-212°F.) Btu./lb./°F.	0.11
Tensile Strength 1000 psi	60	Thermal Expansion Coefficient (32°-212°F.) 10^{6} in./in./°F.	7.2
Elongation in 2 in., per cent	50	Thermal Conductivity (32°-212°F.) Btu./sq. ft./hr./°F./in.	420
Hardness Brinell	90	Electrical Resistivity (32°F.) ohms/cir. mil. ft.	50
Density lb./cu. in.	0.321	Tensile Modulus of Elasticity 10^{-6} psi	30
Melting Point (°F)	2615-2635	Torsional Modulus of Elasticity 10^{-6} psi	11

LOW CARBON NICKEL
Limiting Composition %

Ni (+Co)	99.00 min.
Cu	.25 max.
Fe	.40 max.
Mn	.35 max.
C	.02 max.
Si	.35 max.
S	.01 max.

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Nickel • Low Carbon Nickel • Duranickel®
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has been reached, an ordinary spark coil may be touched to the external lead of the probe. For large bulbs more power is needed for stable operation, and it is advisable to use some type of radio-frequency power oscillator having an output of 100 to 200 watts.

For tests on picture tubes having metal shells, the r-f oscillator and transformer can be replaced by a high-voltage, low-current, 60-cycle transformer. In this test, the metal shell is grounded. This circuit arrangement is not satisfactory for tubes having glass bulbs, because the high current through the anode button would probably damage the connection between the conductive coating and the button.

Direct-Current Method

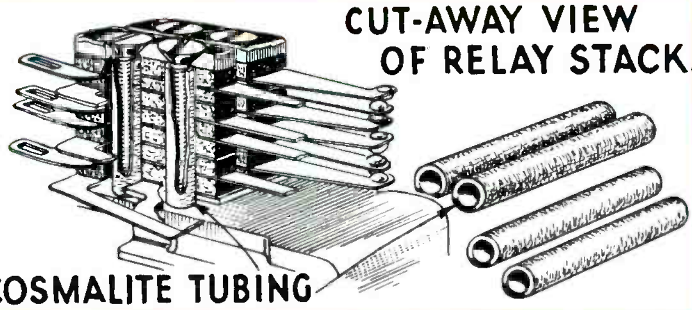
In the d-c method (see Fig. 2) the vacuum seal of the bulb is made in the same way as that described for the r-f method, except that a ceramic cylinder rather than a metal one must be used to support the gasket in order to prevent arc discharges during the test. The ceramic and rubber gasket are held in place by screws fastened into the ceramic from the metal plate and then soldered. The surface of the metal plate inside the ceramic cylinder is covered with a flat disc composed of some type of secondary emitter such as sodium silicate with just enough micronized graphite added to give the silicate some conductivity.

To carry out the test, the operator opens the valve to the exhaust pump and exhausts the bulb to a pressure within the range of 5 to 20 microns. When this pressure range has been reached, a positive voltage of approximately 10,000 volts with respect to the metal plate is impressed on the anode button of the bulb. Within this pressure range sufficient ionization occurs to maintain the desired excitation. At higher pressures the system has a tendency to arc; at lower pressures the excitation becomes too faint or ceases. In normal operation positive ions produced in the bulb by collisions strike the secondary emitter and liberate electrons. These electrons form a beam which, collimated by the bulb neck, pro-

ALLIED CONTROL RELAYS
built with
Cleveland PHENOLIC TUBES

ensure

- ★ DEPENDABILITY
- ★ PRECISION PERFORMANCE
- ★ LONG LIFE
- ★ ECONOMY



The Allied Control Co. has built a long and enviable record as a quality supplier of control relays to both private industry and governmental services.

Their S K Relay shown above, is typical of the various Allied Relays in which CLEVELAND CONTAINER tubing provides excellent service.

It is likewise the answer for hundreds of other problems of manufacturers in the electrical industry.

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Laminated Phenolic Tubing
combines electrical and physical properties to meet the most exacting requirements.

CLEVELITE is produced in six grades . . .
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A grade for **EVERY** need.

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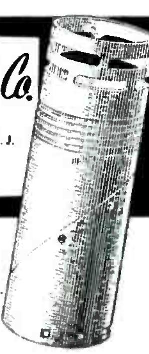

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duces an illuminated spot on the phosphor screen just slightly larger in diameter than the diameter of the bulb neck. This beam may be deflected by a demountable scanning yoke. The deflection coils may be energized by sinusoidal voltages, provided that the voltages are sufficient to considerably overscan. Under this condition, the scanning rate over the faceplate is relatively constant, so that the illumination is nearly uniform. One voltage can be obtained from the regular 60-cycle line and the other from an audio power oscillator operating at 12 to 15 kilocycles. The use of sinusoidal waveforms instead of sawtooth waves simplifies the circuitry without sacrificing any features needed for detecting flaws in the screens.

Current Transformers for Audio Measurements

By Lawrence T. Fleming
National Bureau of Standards
Washington, D. C.

A well known method for the measurement of heavy current at low frequency involves the use of a current transformer with a rectifier ammeter connected to its secondary winding. The feasibility of using this method for measuring a current of the order of a few amperes is probably frequently overlooked. Moreover, measurements made on an improvised arrangement of this type have shown fair accuracy over the range 50 to 50,000 cycles per second.

This note is written to call attention to the following attractive features of this method: (1) the scale is nearly linear; (2) the instrument can withstand considerable overloading without injury; (3) the power required for indication is less than for thermal-type ammeters. One may improvise an arrangement of components on hand in many laboratories that will give satisfactory performance over the audio range.

Thus for the measurement of the order of one to three amperes we have improvised a current transformer through the use of a

Seletron SELENIUM RECTIFIERS

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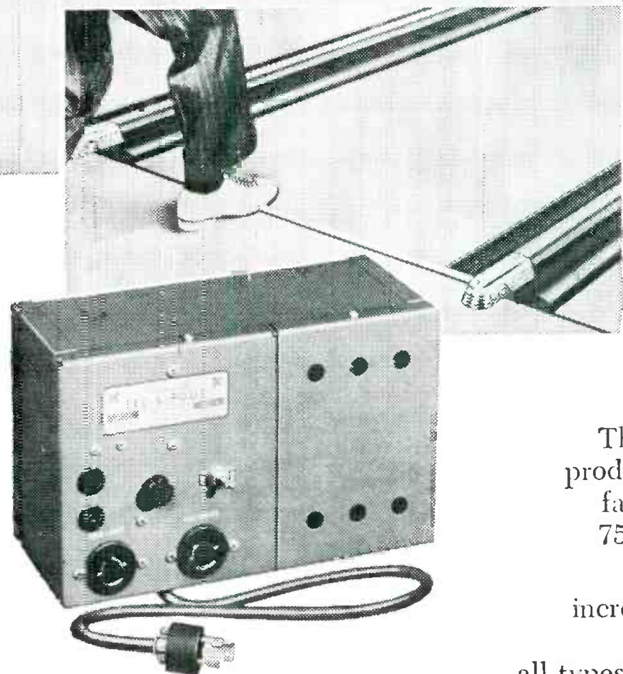

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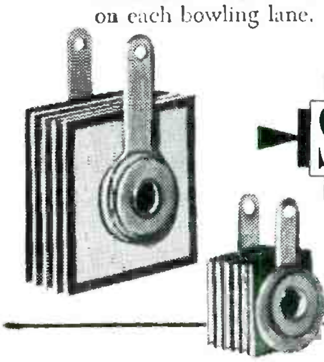

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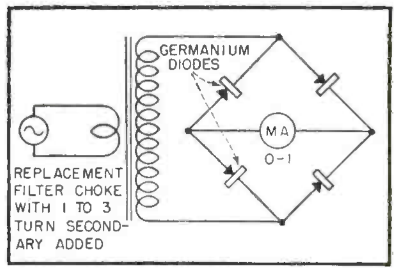

FIG. 1—Basic circuit shows use of current transformer for audio-frequency measurements

replacement choke, constructed a suitable bridge-type rectifier using germanium diodes, and for current indication used a one-milliampere d-c instrument. Figure 1 shows the circuit arrangement. In one case the rectifier-instrument combination employed four-IN34 crystal diodes and a 1-milliampere 50-ohm indicating instrument.

The transformer was made by winding 1 to 4 turns around the outside of the winding of an ordinary radio replacement-type choke coil and interleaving the core laminations to secure low reluctance and thus low magnetizing current. The secondary of the transformer had an inductance of about 40 henrys after interleaving and a transformer ratio of the order of 1 to 1,000.

Such an arrangement in which the reactance of the secondary of the transformer is quite high, offers the advantage that the d-c milliammeter may be shunted by a resistor to secure the desired nominal value of current ratio for the combination. This procedure has little adverse effect on frequency response of the combination for adjustments as large as 30 percent of the full scale value of the milliammeter. Further adjustment may of course be made by changing the number of primary turns.

It should be noted that the transformer is operated as a true current transformer, because the equivalent impedance of this combination as seen from the primary will ordinarily be low compared to the impedance of the source, and the secondary reactance is high compared to the impedance of the rectifier-instrument load connected across it. In this respect the arrangement is quite like the much

larger current transformers used in measuring large currents at power frequencies. Its purpose is to provide an impedance and voltage level at the secondary which is suitable for the linear and efficient operation of a rectifier instrument.

The essential requirement in the transformer design is that the secondary reactance be high compared to the total d-c resistance in the secondary circuit, at the lowest frequency at which the instrument is to be used.

High-Frequency Limitations

In Fig. 2 are shown experimental curves of voltage drop and instrument error with respect to frequency, for an arrangement of the kind shown in Fig. 1. The error at low frequencies depends on the ratio of the impedance of the rectifier instrument to the impedance looking into the secondary of the transformer, as will be discussed later. Error does not begin to be noticeable at high frequencies until slightly above 50 kc. An increase in voltage drop across the primary of the transformer is, however, evident some time before this, beginning at 10 kilocycles.

The high-frequency limitations cannot be readily estimated on paper because at high audio frequencies the effect of distributed capacitance in the secondary coil windings will be to shunt secondary current away from the rectifier instrument and thus change the effective current ratio. Essentially the method should be good at the higher frequencies because the rectifier instrument impedance is comparatively low and in effect constitutes a short circuit of the high-impedance secondary winding. Thus the voltage developed across sec-

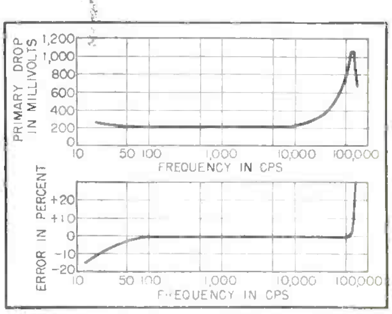

FIG. 2—Curves show error and primary voltage drop at different frequencies


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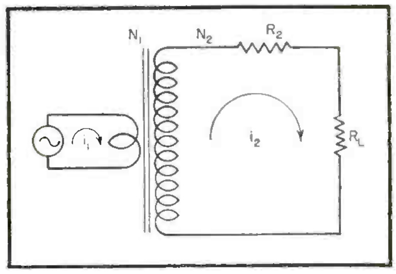


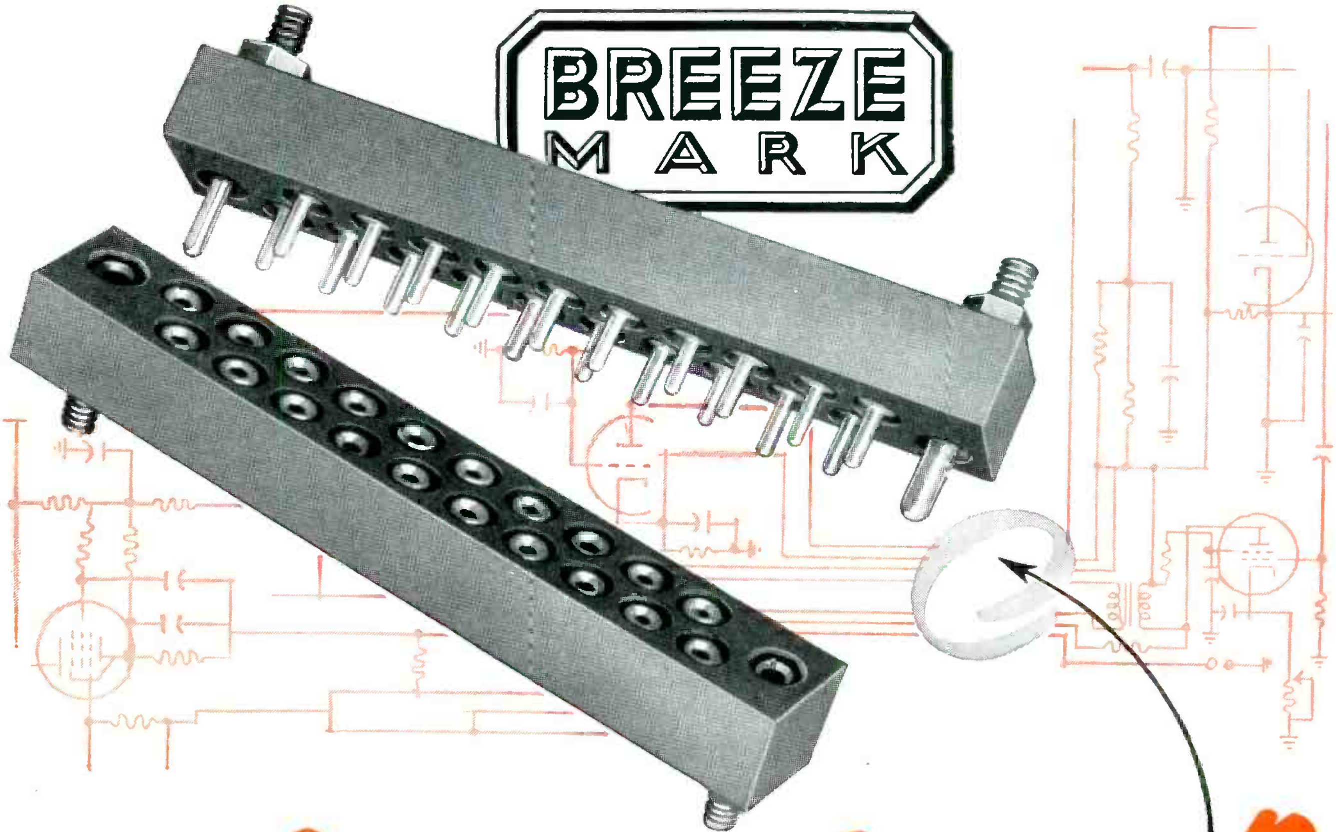
FIG. 3—Equivalent circuit used in calculating low-frequency performance

tions where distributed capacitance is high would normally be quite low. Secondary resonance should therefore only become troublesome at rather high frequencies.

Design improvements should be possible through minimizing secondary leakage reactance, through reducing the number of primary and secondary turns (commensurate with the required secondary reactance) in order to reduce stray and distributed capacitances, and through the proper selection of core material if it were desired to increase the upper frequency limit. On the other hand this might restrict the low-frequency useful limit and make it desirable to have two transformers with overlapping frequency ranges—one for low frequencies and the other for very high audio frequencies for use with the rectifier-type instrument. It is very likely that the frequency range can be substantially widened by employing high permeability core material, and reducing the number of secondary turns to the minimum required for the necessary inductance.

This method has the inherent wave-form limitation of rectifier-type instruments in that the deflection of such instruments are proportional to the average rather than the effective value of current. Thus if calibrated on a sine wave to read effective values they do not indicate properly on distorted wave-forms. The arrangement, however, is not particularly sensitive to change in resistance of the rectifiers with temperature as this effect is swamped by the high reactance of the transformer secondary. Except on distorted wave-forms an arrangement of this sort should be considered in the 5-percent-accuracy class unless special precautions are taken in its calibration.

The circuit behavior for low fre-



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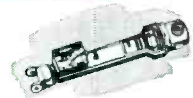

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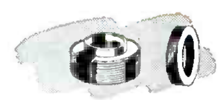

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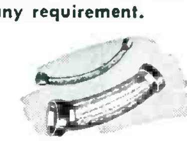

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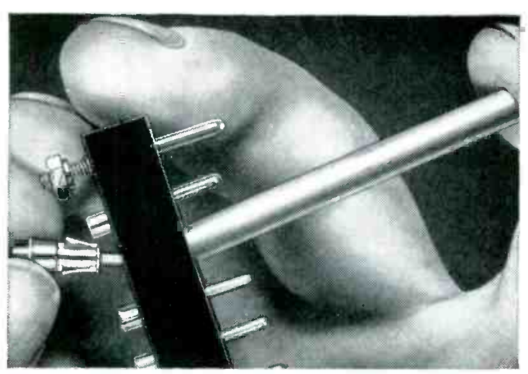


Removable pins in Breeze connectors speed soldering, save time, trouble. Pins snap back into block.

quencies may be analyzed as follows:

Referring to Fig. 3, the current ratio is

$$\frac{I_2}{I_1} = K\frac{N_1}{N_2}\left(\frac{1}{1 - j\dfrac{R_2 + R_L}{\omega L_2}}\right)$$

where I_1 = primary current, I_2 = secondary current, K = coupling coefficient, N_1 = primary turns, N_2 = secondary turns, R_2 = resistance of secondary winding, R_L = secondary load resistance, and L_2 = secondary inductance. To retain a constant ratio we must have

$$\omega L_2 >> (R_2 + R_L)$$

This determines the lower frequency limit. For example, for a 5-percent error at the low frequency end of the range,

$$\left[1 + \left(\frac{R_2 + R_L}{\omega L_2}\right)^2\right]^{\frac{1}{2}} = 1.05$$

Approximately,

$$\left(\frac{R_2 + R_L}{\omega L_2}\right)^2 = 0.1$$

so

$$\omega L_2 = \frac{R_2 + R_L}{0.31} = 3.1\,(R_2 + R_L)$$

If $R_2 + R_L$ = 600 ohms, and the low-frequency limit is taken at 20 cps, L = 14.8 henrys.

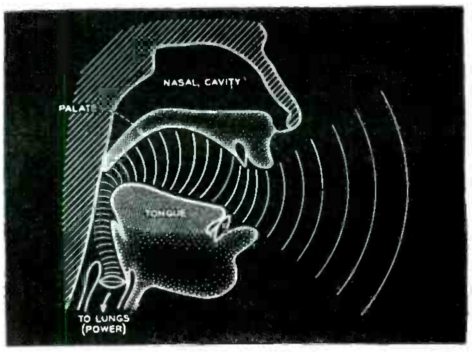
REFERENCE

(1) Edgecombe and Ockenden, "Industrial Electrical Measuring Instruments", p 175, Sir Isaac Pitman and Sons, 1933.

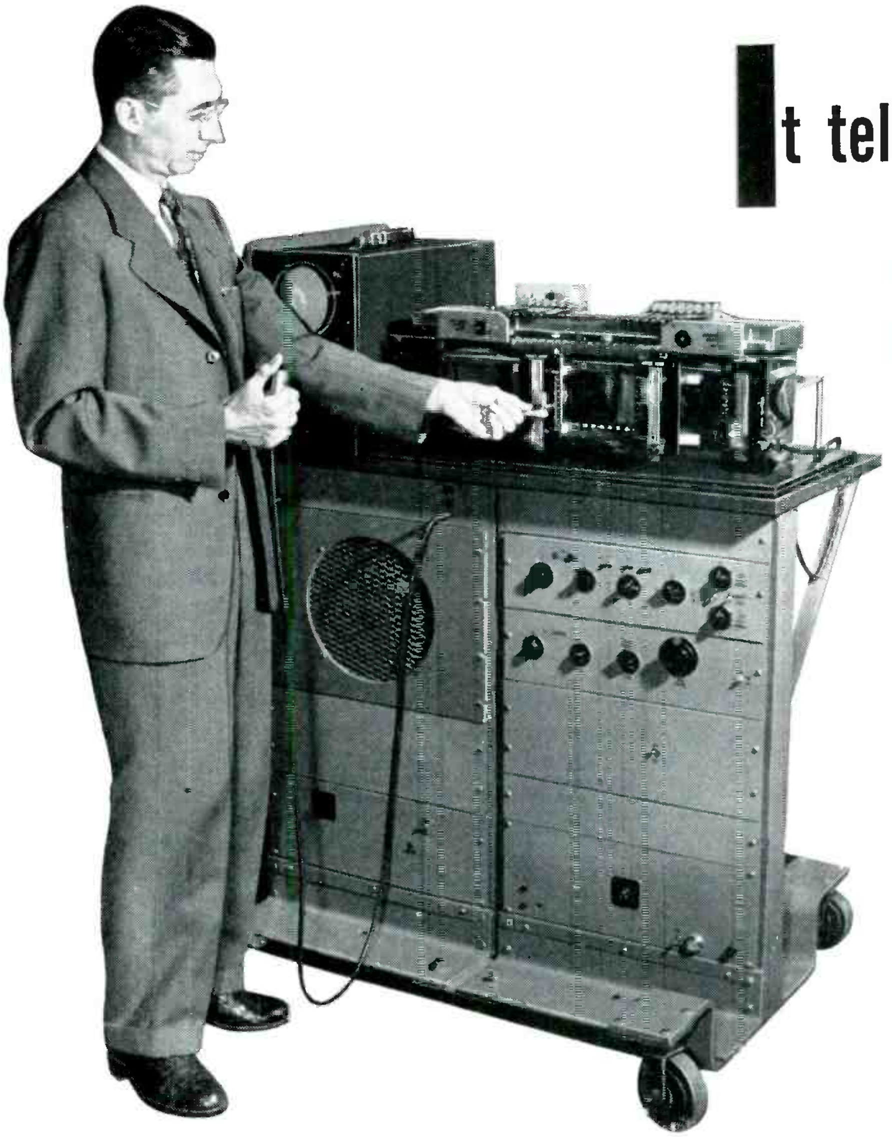
Improved Terratex

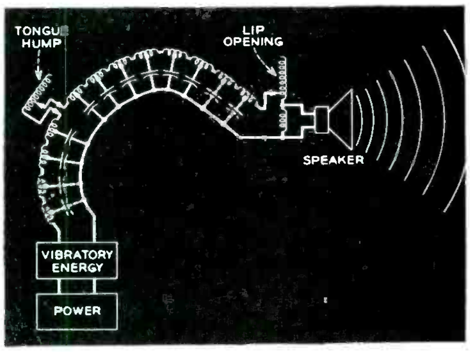
CONSIDERABLE ACTIVITY has been devoted to the development of a satisfactory mica substitute. It has been the hope of those working in this field to develop a material having all the physical and chemical characteristics of mica. We are all more or less familiar with the progress which has been made in this field, and certainly that progress has been significant. Nevertheless, an easily producible material satisfactory for vacuum-tube applications, which are very demanding indeed, has not yet been reported.

In a paper presented to the AIEE in 1948, T. R. Walters, of G-E Works Laboratory at Pittsfield, reported the original development of a material known as terratex. The



It tells how you talk





The machine at the left is saying "Ah!" It's the new electrical vocal system developed at Bell Laboratories. Top sketch shows human vocal system also saying "Ah!" The electrical model is sketched below it. Energy source at bottom of "tract" can emit a buzz sound, like vocal cord tone, or the hiss sound of a whisper.

No one else speaks exactly like you. Each of us uses different tones to say the same words. To study and measure *how* we make speech, acoustic scientists of Bell Telephone Laboratories built a model of the vocal system.

Electric waves copy those of the vocal cords, electric elements simulate the vocal tract, and, by adjustments, vowels and consonants are produced at pitches imitating a man's or woman's voice.

Using this electrical system, telephone scientists will be able the better to measure the properties of people's voices. Knowing more about speech they can find better and cheaper ways to transmit it.

This is another step in the research at Bell Telephone Laboratories which pioneered the exact knowledge of speech. Past work in the field is important in today's fine telephone service. A still deeper understanding of speech is essential in planning for tomorrow.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting, for continued improvements and economies in telephone service.

untreated paper-like sheet of terratex is mechanically weak, but a process has been developed to give it desirable physical characteristics. To make it suitable for use in vacuum tubes, the spacer material is impregnated with partially hydrolyzed ethyl silicate which, when dried, yields the tough terratex that is usable for spacers. Care must be taken in the choice of hydrolyzing acids used when forming silicate-treated terratex for vacuum tube use so that contaminants are not introduced which would be harmful in the tube. Although the processing of the spacer material is not yet complete at this stage in the manufacturing process, the terratex in this condition can be stored or shipped conveniently without noticeable deterioration.

Vacuum tube spacers have some dimensions with very close tolerances. To assure reasonable uniformity of spacers, the material should punch cleanly and easily and should not flake or split when handled. In addition, it should retain a certain amount of resiliency in order for the points of the spacer which contact the bulb of the miniature tube to yield slightly as the mount is inserted in a bulb which is slightly out of round or undersize. Chemically, the material should be stable so that storage problems are minimized and so that uniformity can be achieved from one tube production lot to another. Electrically, the material should have high resistivity and a low dielectric constant. In addition, for vacuum tube applications considerable surface roughness is desirable

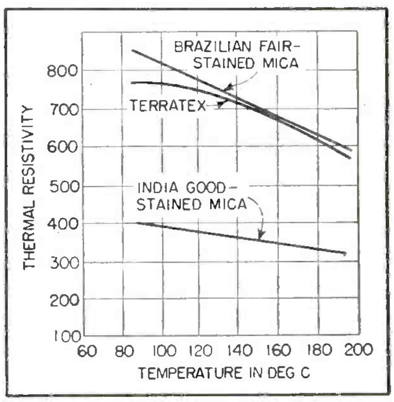


FIG. 1—Thermal resistivity of terratex is almost the same as that of Brazilian fair-stained mica

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in order to minimize the development of leakage paths during the operating life of the tube.

For vacuum tube applications, particular characteristics of the spacer material are of special significance. A comparison of the thermal resistivities of mica and terratex is shown in Fig. 1. From these curves it can be seen that terratex has approximately the same thermal resistivity as Brazilian fair-stained mica and is somewhat superior to Indian good-stained mica. The characteristics are, of course, difficult to measure accurately due to the variation in air spaces in the mica specimens. An interesting comparison of performance is that the cathode temperatures are about the same for tubes spaced with 20-mil terratex or 10-mil mica.

The effects of temperature upon the insulation resistance of mica and terratex are essentially the same over the normal temperature range for the mica and terratex specimens. Measurements have been made of power factor and dielectric constant to 50 megacycles. At this frequency the power factor of mica and terratex are about the same, and the dielectric constant is approximately 3.5 as compared to the mica constant of 4.5 for the specimens measured.

Figure 2 shows an operating time comparison between the transconductance of type 12AT7 tubes spaced with micas and the same type tubes, identically processed, spaced with processed and plain terratex spacers. It can be seen from these curves that the results are quite comparable and satisfactory. Those familiar with the characteristics of the type 12AT7 probably realize that this is a tube extremely susceptible to modifica-

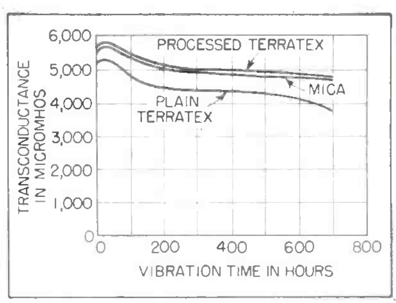
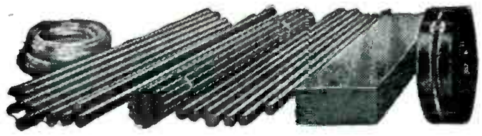


FIG. 2—Curves show desirable characteristics of terratex for use in vacuum tubes that will encounter vibration



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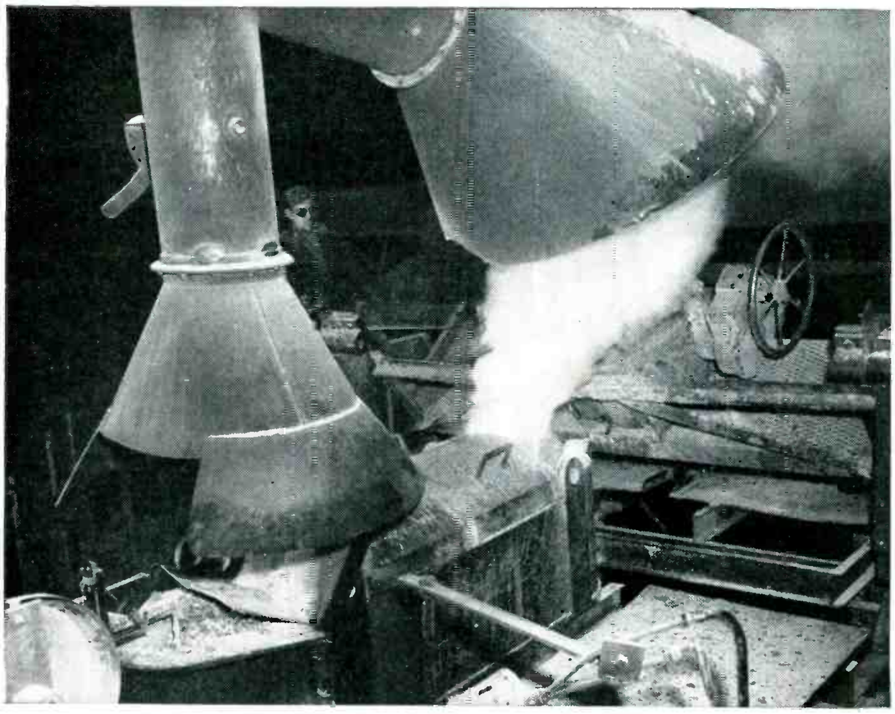


Continuous Casting of Brass at Bridgeport Brass Co., Bridgeport, Conn.

Brass Scrap Situation and Its Effect on Brass Production

Copper and zinc, essential metals for both military and civilian needs, have been in short supply for many months and the situation has been growing worse. After taking care of the mounting volume of DO orders, there is not enough remaining to take care of civilian needs even at the reduced allotment.

As far as we can learn, there has not been a sufficient increase in the production of copper and zinc to satisfy this unprecedented demand and to take care of the requirement of the government stock piling, defense and foreign rearmament programs.

The high volume of production of brass mill products during 1950 and the early part of 1951, has been possible only because the mills have dipped into their metal inventories which are at their lowest ebb today.

From the brass mill standpoint, the short supply of zinc has been critical because it is needed for alloying with copper to produce brass. Zinc acts as a means of stretching the available supply of copper because when alloyed with 100 pounds of copper it can result in about 145 pounds of brass. This increased tonnage will serve a larger number of users.

However, to augment the supply of zinc and copper, the brass mills use clean brass scrap, viz., clippings, rod ends, and shavings generated during metal goods fabrication. The scrap is added to the melt with new metal and is eventually turned into new mill products.

It has always been the custom for the brass mills to buy back the brass scrap from their mill products, customers and metal dealers at definite published prices which reflect the prevailing prices of new copper and new zinc.

Today, because of the voracious demand for brass scrap, its price has been raised considerably beyond that of virgin metal. As a result, a portion of this scrap, which would ordinarily be returned to the brass mills, has been diverted to other channels.

The serious shortage of copper and zinc, plus the insufficient brass scraps being returned to the mills explains in part why the brass mills are operating on a reduced schedule and are not able to fill the many orders which have piled up.

Some Scrap Diverted

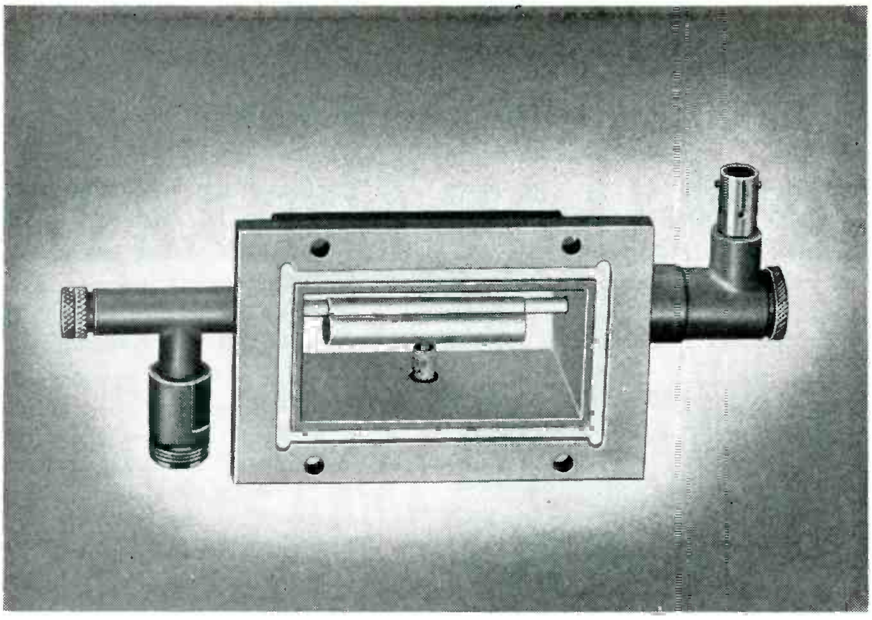
The scrap situation can be improved if metal goods manufacturers will make sure that *all* their scrap is returned to the brass mills. Although most manufacturers make it a practice to do so, there are some smaller ones who think that their scrap generation is insufficient to count. However, when the scrap generation of all small manufacturers are added up, the total becomes worthwhile.

It is true that in some cases brass scrap can fetch higher prices than that offered by the brass mills. Unfortunately, if this scrap does not find its way back to the brass mills, the brass mill tonnage is reduced and all brass users suffer.

How Brass Users Can Help

Here are a few suggestions which, if followed by metal goods manufacturers, would help the scrap situation considerably.

1. Store all scrap in clean containers, keeping it separated by alloy and properly identified.
2. When a sufficient quantity has been collected, notify the brass mill for whom it is intended. Give details as to weight, alloy, character of scrap. Ask the brass mill to collect it either in their own trucks or to designate the particular scrap dealer which does this work for the brass mill.
3. If you know where there are clippings of zinc resulting from manufacturers' cups or stampings, or scrap copper wire or other forms of good clean scrap of brass, bronze or copper not generated by brass goods manufacturers, please notify your supplier of brass mill products. (6867)



tions of any type. Consequently, satisfactory experience with this tube represents a considerable achievement as far as utilization of the new spacer material is concerned. Another interesting result was obtained when a number of terratex-spaced and mica-spaced 6J5-GT tubes were tested on a vibration-life test.

Figure 3 shows the remarkable difference in the vibration output characteristics of the two lots of tubes. The tubes were vibrated sinusoidally at 25 cps with an acceleration of 2½ g and were read daily for a total vibration time of 400 hours. It can be seen that the terratex-spaced tubes had much lower vibration output than the mica-spaced tubes over the entire

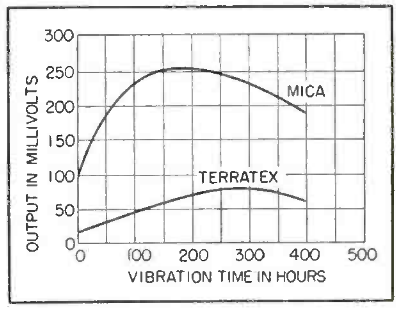
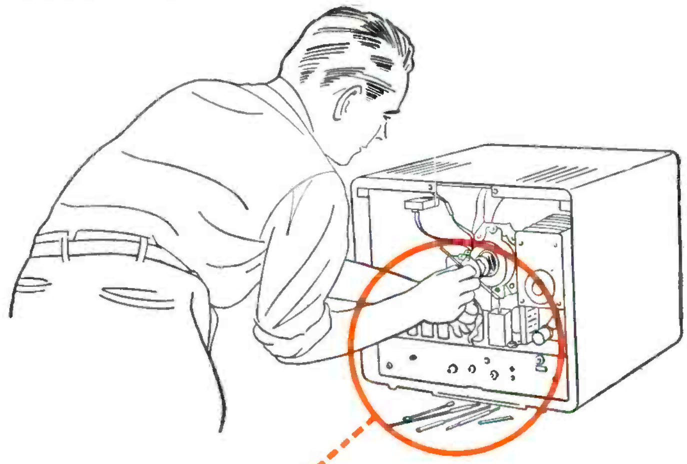


FIG. 3—Tubes employing terratex are less susceptible to microphonics

period of testing. Another particularly interesting characteristic of the material is the high surface roughness, which makes for good interelectrode insulation. Measurements of interelectrode leakage were made over a life-test period of 500 hours, and it was found that the terratex-spaced tubes were considerably superior to the mica-spaced tubes at all testing intervals.

From this brief discussion of the material, it is apparent that there are several advantages associated with the use of terratex. From the standpoint of supply and fabrication, it is possible to obtain strips or sheets of terratex of uniform thickness made from materials available in this country. Further, the material has high thermal and surface resistivities and exhibits certain physical properties which make it appear to be superior to mica in some cases.

It is not known that terratex can be applied successfully as spacer material for all tube types, nor in



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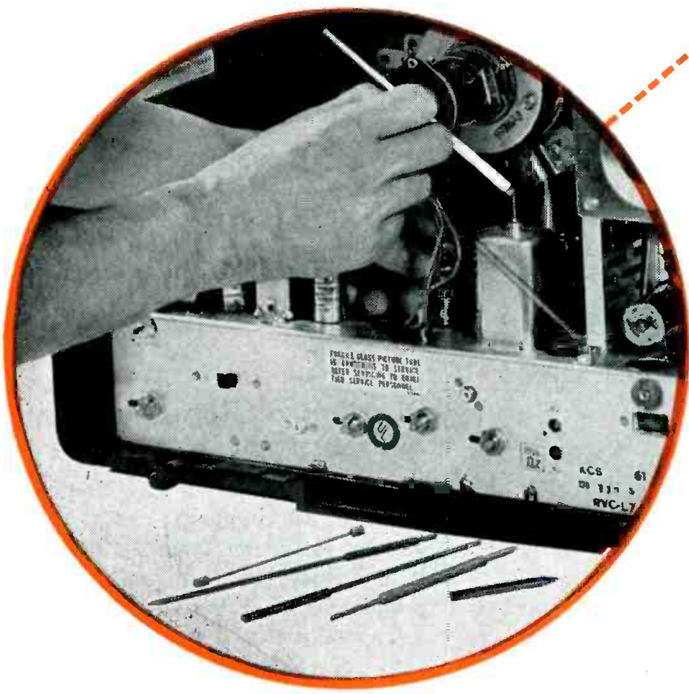

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Aligning the tuning circuit in television sets is a delicate job. It's precision work in hard-to-reach places within the set, working close to high-voltage equipment. These aligning tools made with nylon plastic make the job easier and safer.

Because of the flexibility of Du Pont nylon, the tools can be bent to reach awkward locations. It's tough enough to withstand the abuse that such tools get. And the insulating characteristics of nylon protect service men from shock if the tools contact parts of the set that carry high voltage.

There are many uses in electronics and related fields for the unique combination of dielectric properties and toughness, resiliency and heat-resistance offered by Du Pont nylon. Its properties may well help you improve your product.

Demand for nylon plastic currently exceeds supply. However, we suggest you investigate its properties for future applications. We will gladly discuss the availability of experimental quantities for development work. For additional information on nylon and other Du Pont plastics, write:

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its present development stage can it be used without decreasing exhaust machine production rates on certain tube types. However, upon the basis of the measurements which have been made on the material and upon the experience obtained in applying the processed terratex to vacuum tubes, it is likely that terratex could be applied to some types of tubes immediately that its several advantages over conventional mica spacers could be realized without sacrificing production rates or tube quality. In order to evaluate the material more fully and to improve it, work is being continued on the project at the G-E Owensboro Development Laboratory. Terratex processed for use in vacuum tube application is not commercially available at this time, although small samples for experimental use may be obtained through the Electronics Department of the General Electric Company.

This article is based on a paper presented by A. P. Haase and E. B. Fehr at the 1951 IRE Convention in New York.

Distributed Resistance Ignition Cable

FOR MANY YEARS it has been the practice to suppress radio frequency radiation from an automobile engine by the addition of resistance in series with the high-voltage ignition circuit. The addition of this resistance quickly damps out the radio-frequency oscillations set up by the discharge of the spark plugs.

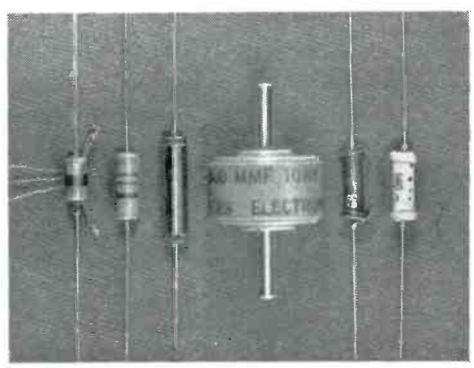
The most conventional form of resistor is a separate unit placed in series with the ignition leads either at the spark plug terminal or at the point where the high-voltage coil wire enters the center tower of the distributor. In some cases, resistances are built into the spark plugs. While each car presents a different problem of radio suppression, it is usually found that a 10,000-ohm resistor on the coil to distributor lead is all that is necessary to suppress radio interference to the point where ignition noise does not interfere with reception in the car radio.

With the advent of f-m and tele-

we'll realize your visions of design FOR YOU

...if electronic components, such as molded coils are your problem

Other electronic components also built in quantity to your most exacting specifications for stability in service



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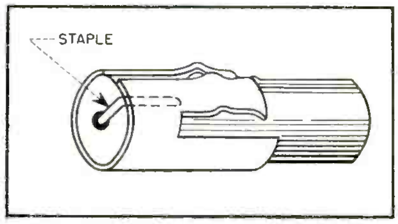
7662

vision, the interference from automobile engines became more serious. Most cars, even those suppressed for ordinary radio, constitute a public nuisance and interfere with reception when operated in close proximity to tv sets.

It has been found by engineers at the Packard Electric Division of General Motor Corporation that the use of suppressor ignition cable having a distributed resistance of approximately 5,000 ohms per foot completely eliminates this objectionable interference. The conductor of this cable consists of multiple threads of high-strength materials, such as linen and rayon, enclosed in a rayon braid. The desired conductivity is imparted to this structure by impregnation with graphite solutions and treatment with special conducting coatings so



Distributed-resistance cable used in connecting automobile spark plugs reduces f-m and television interference

that cable insulation will properly adhere to the conductor.

Special techniques are employed in attaching terminals to this high resistance conductor. It has been found that a piece of metal wire approximately ⅛ in. long must be inserted in the end of the conductor in order to provide a well-distributed area of contact with the fabric conductor, as shown in the accompanying diagram. An extension of this metal pin is carried across the end of the cable and is firmly contacted by a conventional terminal.

Extensive field and laboratory endurance tests indicate that this method of connection will stand up satisfactorily under even the most rigorous service conditions.

Tests showed the high-resistance cable and the standard neoprene ignition cable tested equivalent on all tests except the voltage breakdown on the new cable is approximately 5 kv less than standard

cable, also the capacitance is 5 $\mu\mu f$ per foot greater. The high resistance cable is satisfactory for automotive ignition.

Logarithmic Counting Rate Meter

By W. F. Goodyear
Tracerlab, Inc.
Boston, Massachusetts

COUNTING RATE METERS in conjunction with chart records have found wide application in laboratories where measurements of radioactivity are being conducted. They possess distinct advantages over scaling type instruments in that counting rate can be observed directly without computations and that with a time record inconsistencies in statistical variations can be instantly spotted and either accounted for or disregarded.

If the rate-meter response can be made logarithmic, its utility can be further extended. As an unattended monitoring device it is ideal for measuring wide variations in rate with precisions that are unattainable in a linear instrument without range switching.

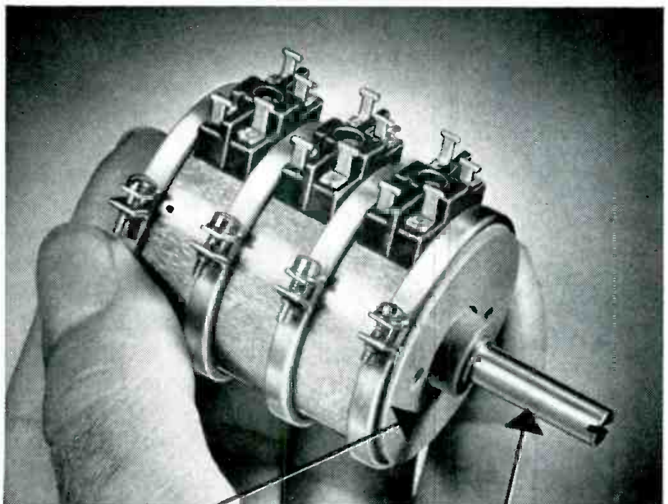
Figure 1 shows the front panel of such an instrument designed with the logarithmic response in the circuit itself, permitting the use of conventional panel meters and external linear recorders. The logarithmic element is a thermal diode operating under retarding plate conditions. The operation of such tubes has been described elsewhere,[1,2,3] and where the leakage resistance can be made sufficiently large, they maintain their logarithmic response over extremely wide ranges of plate current.

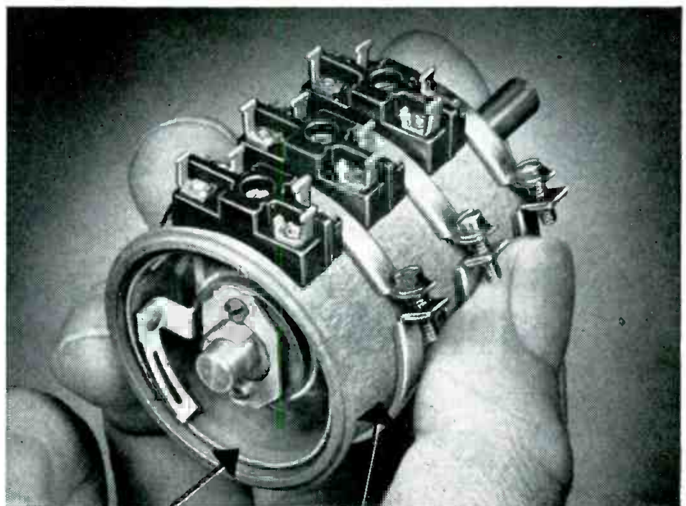
In this circuit, intended to operate from the a-c line, heater-to-

FIG. 1—Front view of logarithmic counting rate meter

How do you put PRECISION into a potentiometer?...

... At Fairchild we do it by careful design plus scrupulous attention to every phase of manufacture from the selection of raw materials to the precision machining of all mechanical components. Every mechanical part that affects the potentiometer's accuracy is made in our own plant. The result? ***Let's find out by examining one of our new 746 units for precision.***





PRECISION in the shaft. The shaft is centerless-ground from stainless steel to a tolerance of +.0000, −.0002 in. which, together with the precision-bored bearings, results in radial shaft play of less than .0009 in. These accuracies are essential to the utilization of the full precision of the windings and associated gearing.

PRECISION in the housing. Precision-machined out of solid aluminum bar stock, every housing is *perfectly cylindrical*—and stays that way—resulting in better accuracy of potentiometer output. This construction also results in perfect fit and alignment between housings to permit ganging of up to 20 units on a single shaft without any eccentricity of the center cups even though only two bearings are used for the entire gang.

PRECISION in the mounting plate. All critical surfaces of the mounting plate are accurately machined at one setting to insure a shaft-to-mounting surface squareness within .001 in./inch and concentricity of shaft to pilot bushing within .001 in. FIR. Such precision is essential in order to eliminate backlash or binding in the precision gearing used to drive these potentiometers.

PRECISION in the windings. The windings of all Fairchild precision potentiometers are custom-made by an exclusive technique on machines designed and built by Fairchild expressly for the purpose. Guaranteed accuracy of linear windings in this potentiometer is 0.5%; non-linear, 1.0%. Higher accuracies available in other types. Guaranteed service life—1,000,000 cycles.

Do your requirements call for this kind of precision? If you have a special problem, Fairchild Potentiometer Sample Laboratory engineers are always available to help you. For complete data, write, stating your requirements, to *Fairchild Camera and Instrument Corporation, 88-06 Van Wyck Boulevard, Jamaica 1, N. Y. Dept. 140-17A.*

FAIRCHILD
PRECISION POTENTIOMETERS

cathode leakage was largely the limiting factor at the lowest current ranges. The results of a small portion of a group of unselected 6AL5 diodes operated in this fashion are shown in Fig. 2. The curves are displaced horizontally for clarity in showing consistency of slope. If not displaced, all of the curves would very closely coincide with each other giving a resultant slope of about 200 millivolts per decade of current.

At 10^{-9} amperes, the leakage resistance is just becoming appreciable. Actually the tubes were measured down to 10^{-10} amperes at which point the leakage is up to 100 percent of the signal current. As shown in Fig. 4, the logarithmic diode V_{14} is operated with its cathode at +105 volts, which, with a 10^{-10} ampere limit on leakage, requires a resistance of at least 10^{-12} ohms to ground. Since heater-to-cathode leakage is far in excess of this figure, a special heater transformer was constructed in which the secondary was wound separately and wrapped with Teflon tape before assembly to ensure a high d-c resistance.

At 10^{-4} amperes, five of the six diodes shown in Fig. 2 have a departure from the ideal slope of less than 25 percent. Assuming that the departure is a linear error at both the high and low current limits, it may be predicted that these errors will be less than 2.5 percent for the current range of

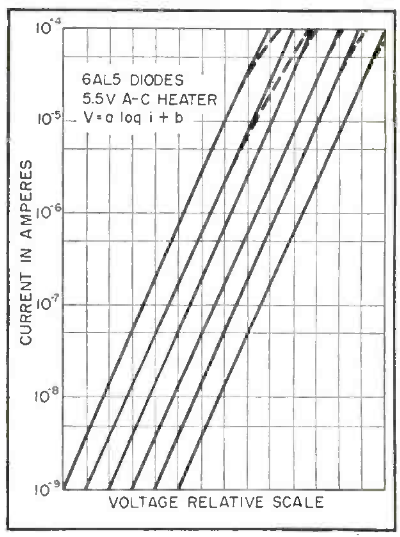
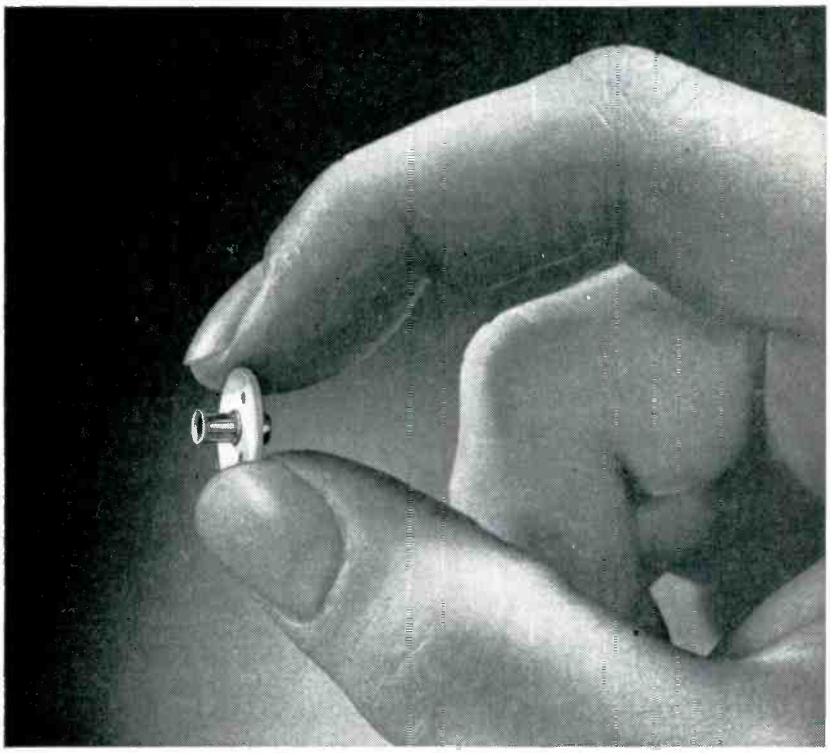


FIG. 2—Results of small sample of random 6AL5 diodes. Curves are displaced horizontally for clarity

Disc Cathode Speeds Assembly-Improves Performance



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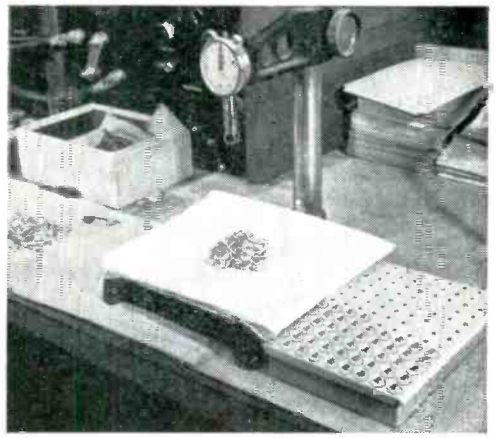

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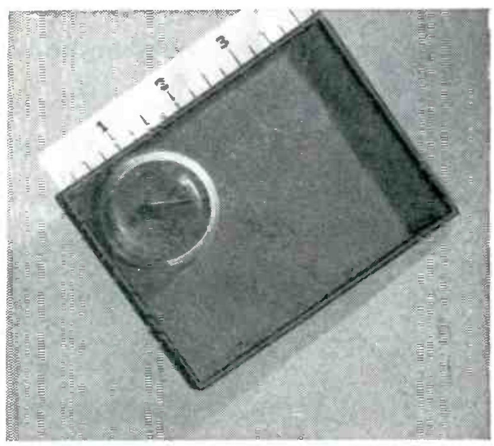

52,600 Seamless Nickel Cathodes, compared under a lens with an ordinary pin.

● Electronics manufacturers find it pays to be a customer of Superior. They receive good service, quality products and the benefits of Superior's methods and metals research that constantly improves upon already good products.

An example is the new, improved Disc Cathode. Investigation proved that a slight flaring of the open end minimized the danger of heater cathode "shorts" caused by scraping of the heater wire coating during insertion, while speeding the operation.

This feature added to an already excellent cathode, resulted in a part that does a better job at a lower cost.

The Disc Cathode is only one of the hundreds of products which Superior supplies . . . but the same program of product improvement is applied to all of them. That's why most manufacturers in the electronics field are already friends and customers. If you are one of the exceptions, it will pay you to find out more about Superior and Superior products. For information, consultation about production problems, design help or research assistance, write today to Superior Tube Company, 2500 Germantown Ave., Norristown, Pennsylvania.

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10^{-5} to 10^{-8} amperes. Subsequent tests have verified this and later tests on the Raytheon CK5829 subminiature equivalent of the 6AL5 have indicated this type is even more consistent and more linear at the higher currents, permitting errors of less than 1 percent for the range just mentioned.

With this accuracy over three decades, a Brown type potentiometer recorder with its wide chart was selected to enable an operator to utilize fully the inherent instrument accuracy. For the same reason a panel meter with a 270-degree movement was selected for operation in the absence of a recorder.

The counting rate range was chosen to be from 1 count per second to 1,000 counts per second for the three most useful decades of operation. Conversion of counting rate to average diode current was accomplished in a circuit shown simplified in Fig. 3.

The switch is closed for a fixed duration t for each individual impulse. A large capacitor shunts the diode to keep its average voltage from changing to any extent during individual impulses so that on a peak, current E/R flows for each input signal if E is much larger than the diode voltage. From this the average current can be readily calculated.

The diode response has been given as

$$V = \frac{KT}{e} \log i + b \quad (1)$$

where K is Boltzmann's constant, e is the electronic charge, and T is the cathode temperature in de-

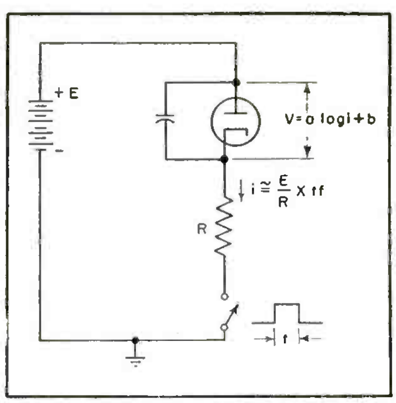
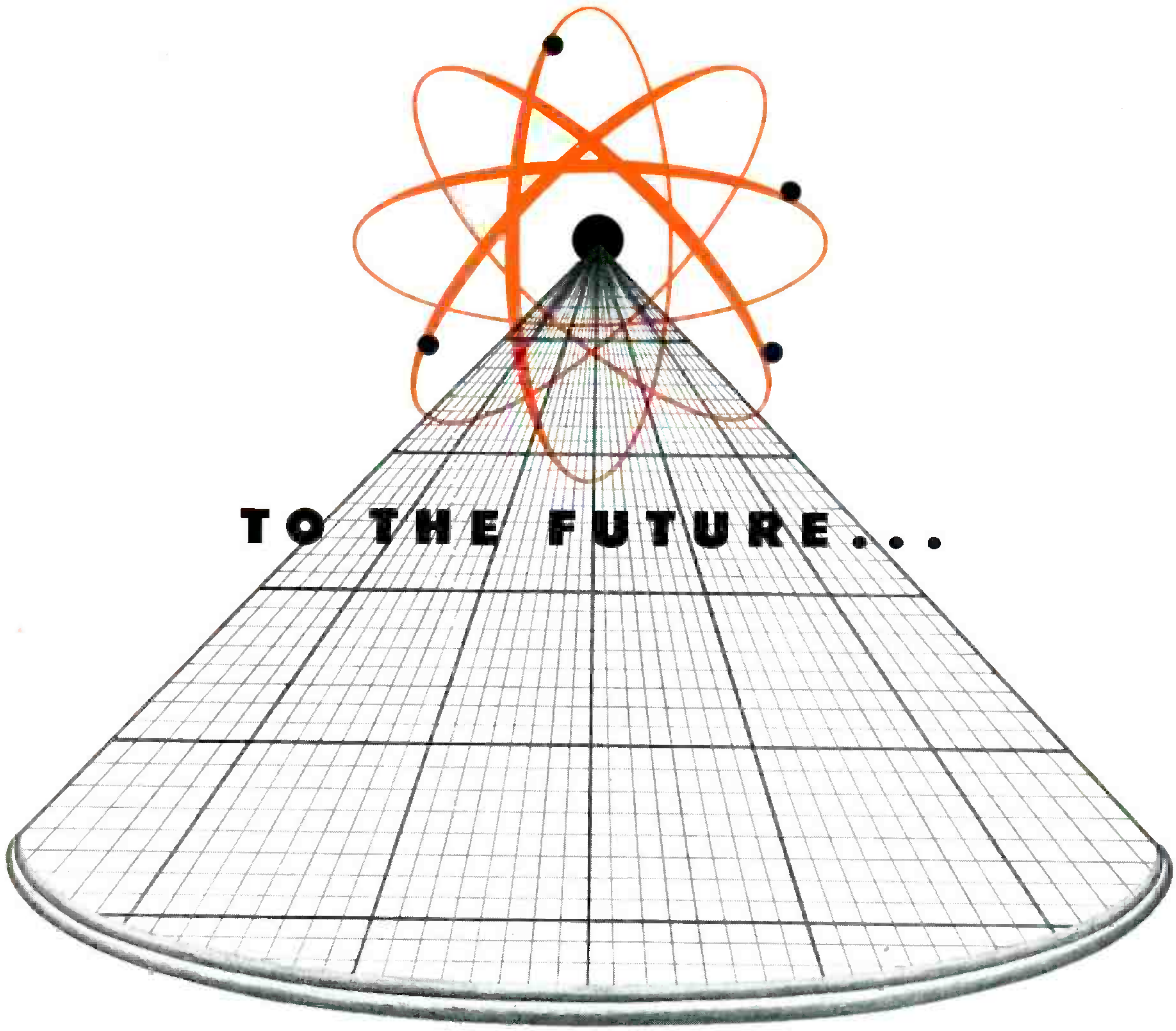


FIG. 3—Basic circuit for converting counting rate to average diode current



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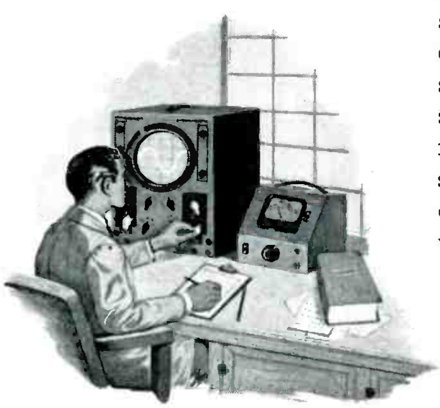

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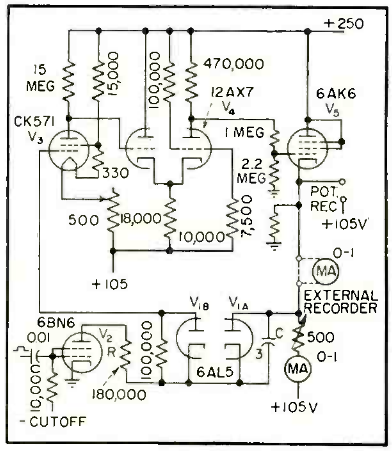


FIG. 4—Complete schematic of logarithmic counting rate meter

grees Kelvin. Differentiating,

$$\frac{dV}{di} = \frac{KT/e}{i} \qquad (2)$$

which for conventionally operated oxide coated cathodes becomes simply

$$\frac{dV}{di} = \frac{0.1}{i}$$

This is recognizable as the dynamic resistance of the diode and indicates that the resistance will vary inversely with counting rate.

This resistance in parallel with the tank capacitor forms the circuit time constant

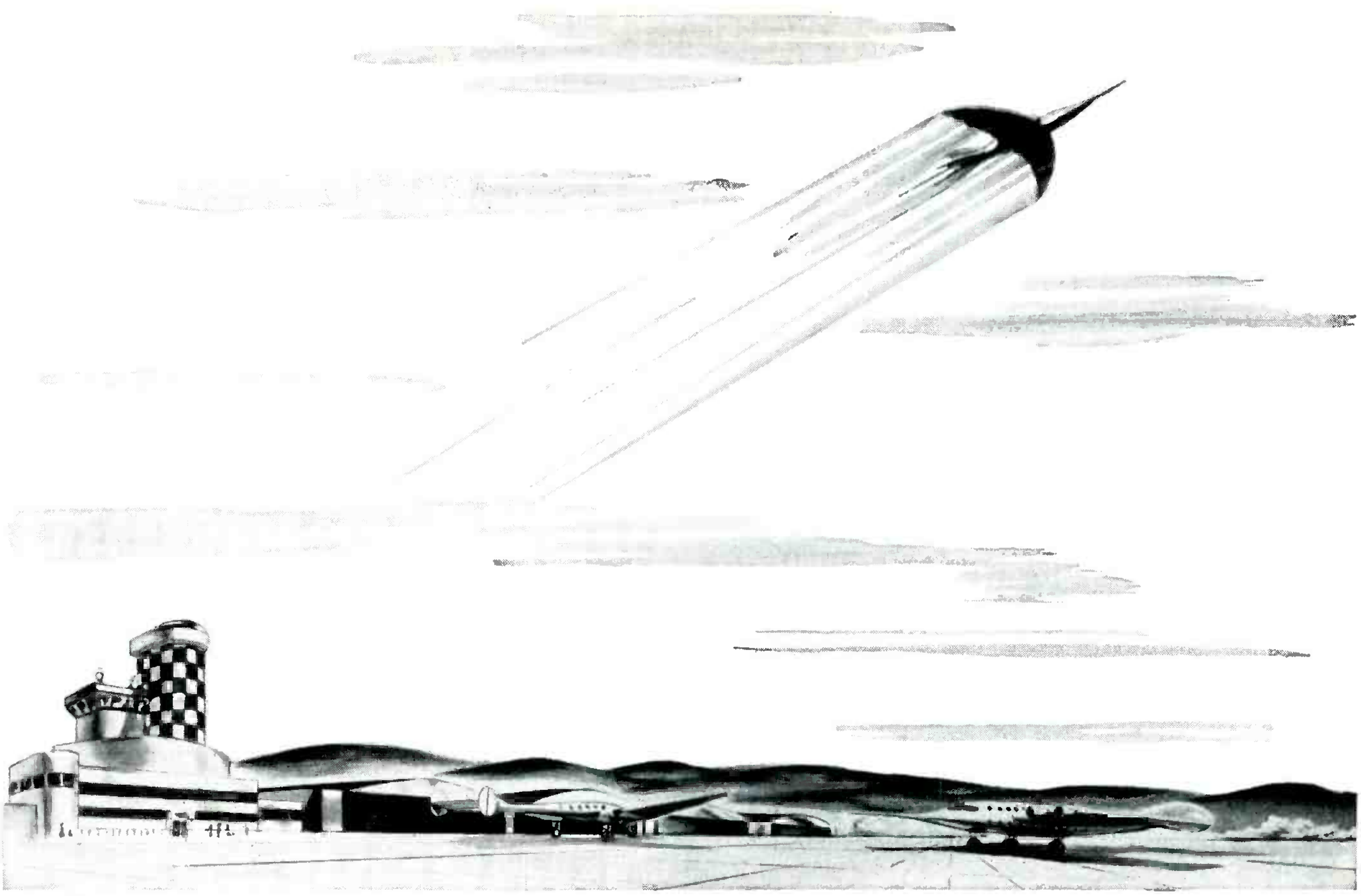
$$RC = \frac{0.1C}{i}$$

Unlike a conventional ratemeter, the time constant is not fixed but varies with counting rate. Since the fractional error in counting rate at any given instant is

$$E = 0.67 \frac{1}{\sqrt{2n\,RC}} \qquad (4)$$

where n is the number of pulses in the time RC, the fractional error in this type of circuit tends to remain constant for a wide range of actual counting rates. Also, because of the progressive resistance change this logarithmic circuit will respond more quickly to large changes in counting rate and reach equilibrium faster than a linear circuit with the same time constant for the initial rates.

Figure 4 shows the voltmeter and charging circuits designed for this circuit. The 6BN6 (V_2) is used as the switching device in series with the current limiting resistor and the diode. Stringent demands



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Makers of Electrical Insulating Tubing and Sleeving

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are placed on this switching tube. During conduction, the tube must pass peak currents of about 10^{-8} amperes, yet between conducting intervals its plate current due to all causes including leakage must be less than 10^{-10} amperes to permit 1 percent accuracy at 10^{-8} amp diode current. Many tube types were tested for this application with the final selection being the recently announced beam type 6BN6 designed as an f-m discriminator-limiter. The full conduction current is relatively independent of control pulse amplitude and its leakage current is considerably better than the 10^{-10} amperes required. In fact this tube's performance under these somewhat unique conditions is far superior and far more consistent than with any other conventional type tested.

Voltmeter Circuit

The voltmeter circuit is of the feedback amplifier type consisting of V_3, V_4 and V_5. The grid of V_3 sees the sum of the diode voltage, applied through V_{1B} in series with the feedback voltage developed across the sensitivity control and milliammeter. As a result the voltage from the cathode of the logarthmic diode to ground is maintained nearly constant and since the feedback voltage must nearly equal the signal voltage, the current required to supply the feedback voltage depends on the amount of resistance in the sensitivity control. An external recording milliammeter can be also connected in the feedback loop since current is supplied, or a potentiometer type recorder can read the feedback voltage.

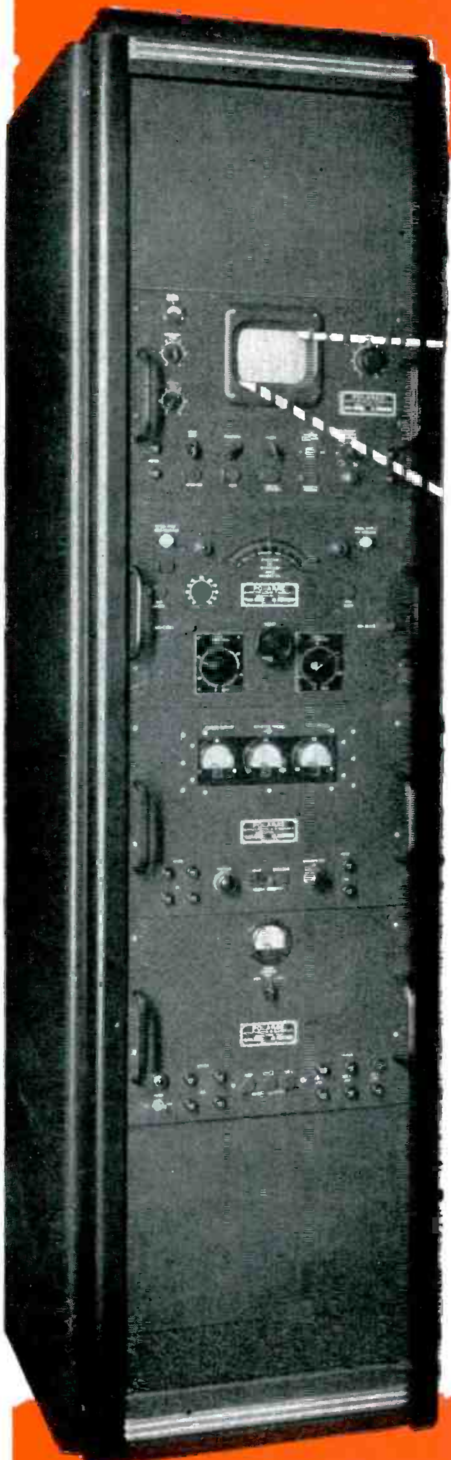
Tube V_3 is an electrometer-type tube with its d-c heater operated from the regulated B+ supply voltage. The zero control is in the heater circuit and operates by changing the relative grid bias. Tube V_{1B} is the unused section of the logarithmic diode and is connected to help buck out the effects of line voltage changes on V_{1A}.

Despite this latter precaution, for low long-term drifts, it is also necessary to regulate the line voltage supply to the instrument. Likewise, B+ supply regulation is essential.

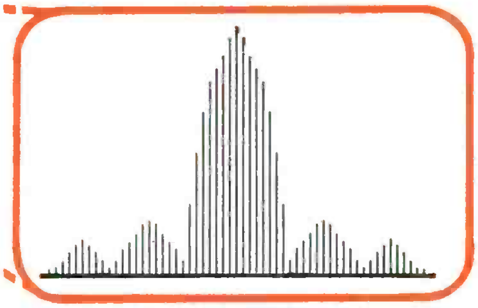
Calibration of this type instru-

The FIRST all-band direct reading SPECTRUM ANALYZER

10 MCS to 16,520 MCS



Polarad's Model LSA Spectrum Analyzer is the result of years of research and development. It provides a simple and direct means of rapid and accurate measurement and spectral display of an r.f. signal.



Outstanding Features:

- Continuous tuning.
- One tuning control.
- 5 KC resolution at all frequencies.
- 250 KC to 25 MCS display at all frequencies.
- Tuning dial frequency accuracy 1 percent.
- No Klystron modes to set.
- Broadband attenuators supplied with equipment above 1000 MCS.
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- Only three tuning units required to cover entire range.
- Microwave components used latest design non-contacting shorts for long mechanical life.
- Maximum frequency coverage per dollar invested.
- 5 inch CRT display.

Where Used:

Polarad's Model LSA Spectrum Analyzer is a laboratory instrument used to provide a visual indication of the frequency of distribution of energy in an r.f. signal in the range 10 to 16,520 MCS.

Other uses are:

1 Observe and measure sidebands associated with amplitude and frequency modulated signals.

2 Determine the presence and accurately measure the frequency of radio and/or radar signals.

3. Check the spectrum of magnetron oscillators.

4. Measures noise spectra.

5. Check and observe tracking of r.f. components of a radar system.

5. Check two r.f. signals differing by a small frequency separation.

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the instrument consists of the following units:

Model LTU-1 R.F. Tuning Unit—10 to 1000 MCS.
Model LTU-2 R.F. Tuning Unit—940 to 4500 MCS.
Model LTU-3 R.F. Tuning Unit—4460 to 16,520 MCS.
Model LDU-1 Spectrum Display Unit.
Model LPU-1 Power Unit.
Model LKU-1 Klystron Power Unit.

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ment is difficult without two accurately known rates spaced far enough apart to adequately define the slope. In this case a decade scale of ten was employed to divide the line frequency to the input pulse forming circuits preceding the charging tube. Sixty cycles was used directly for the other calibration point. The plug-in decade scale can be seen in Fig. 5. It is also used to divide the signal rate if desirable, shifting the 1 to 1,000 count per second range by a factor of 10. Figure 5 also shows the large tank capacitor mounted directly beneath the speaker. It is the polystyrene dielectric type and is used to minimize hysteresis effects due to dielectric absorption and because of its high leakage resistance.

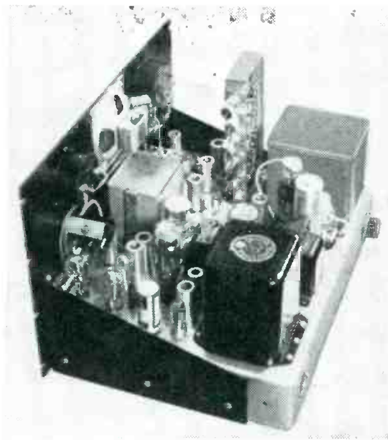

FIG. 5—Rear view of unit shows plug-in decade unit and large tank capacitor (directly behind speaker)

The remaining circuitry is fairly conventional. A regulated high-voltage supply is provided for Geiger counters or similar-type radiation detectors. The output of the detector is amplified and shaped to give constant width pulses in the input circuits. An aural monitor has also been included to give a rough indication of counting rate at very low levels.

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(1) R. E. Meagher and E. P. Bentley, *Rev. Sci. Inst.*, Nov. 1939.

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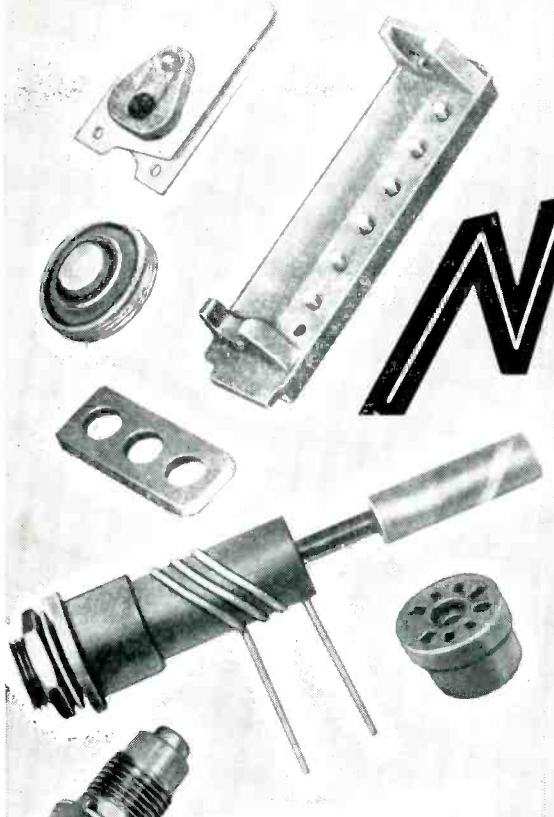
(4) W. C. Elmore and M. Sands, "Electronic Techniques," p 252, National Nuclear Energy Series.



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CHARACTERISTICS OF MYCALEX GRADE 410

Power factor, 1 megacycle	0.0015
Dielectric constant, 1 megacycle	9.2
Loss factor, 1 megacycle	0.014
Dielectric strength, volts/mil	400
Volume resistivity, ohm-cm	1×10^{15}
Arc resistance, seconds	250
Impact strength, Izod, ft.—lb/in. of notch	0.7
Maximum safe operating temperature, °C	350
Maximum safe operating temperature, °F	650
Water absorption % in 24 hours	nil
Coefficient of linear expansion, °C	11×10^{-6}
Tensile strength, psi	6000

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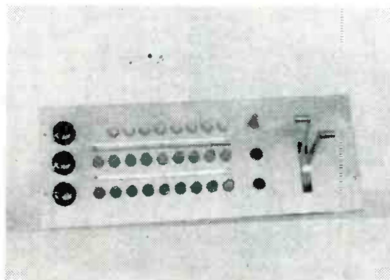
NEW PRODUCTS

(continued from page 144)

study of transient and steady state vibrations and noise in many engineering and scientific fields. It is useful in measurements on aircraft, ships, rotating and reciprocating machinery and in the fields of ordnance, ballistics, seismology and acoustics; and also may be used for l-f underwater studies. With the new instrument one can obtain Fournier analyses of signals in the 5 to 4,400-cps range by a direct-writing process. Power supply is 115 volts, 60 cps; price, $2,500.



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GENERAL ELECTRIC CO., Syracuse, N. Y. Type TV-35-B television montage amplifier permits vertical, horizontal and wedge wipes, and preset superpositions. The unit and its control panel (Type TC-34-A) allow two-signal self-keyed or three signal keyed insertions of sponsors' products or advertising material. They are fast acting, allowing sharp clear keying of irregularly shaped areas. To assure proper positioning and picture composition, a locating signal may be fed to the studio camera viewfinder. Horizontal, vertical and wedge-wipe action may be stopped at any point.

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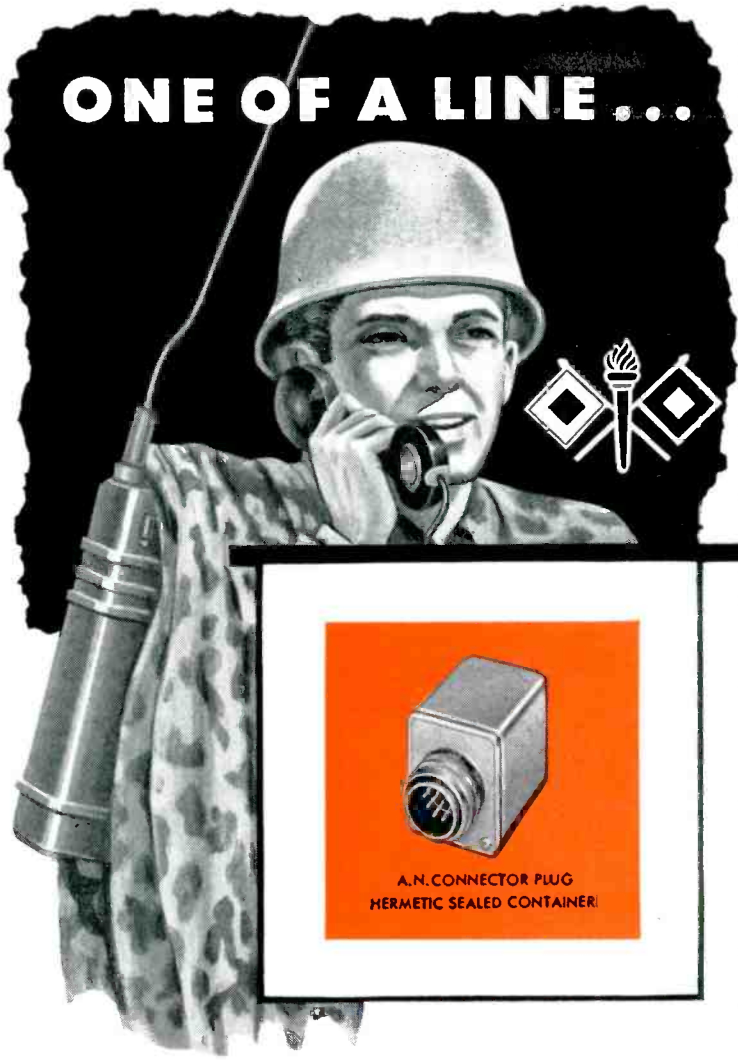
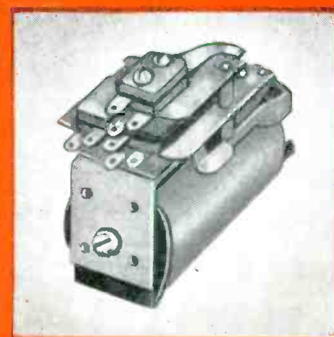
VALPEY CRYSTAL CORP., Highland St., Holliston, Mass. Type DFS





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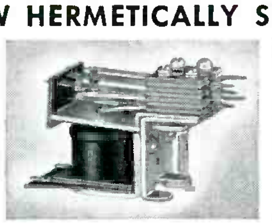

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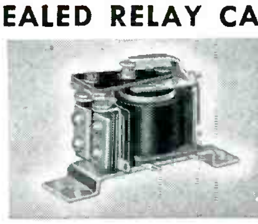
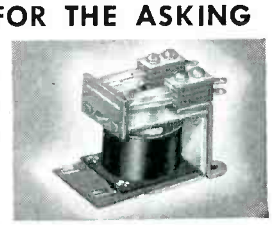


Series 220 A.C.

Series 595 D.C.



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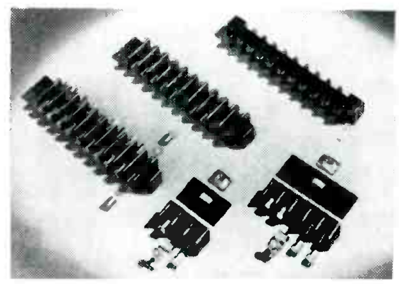
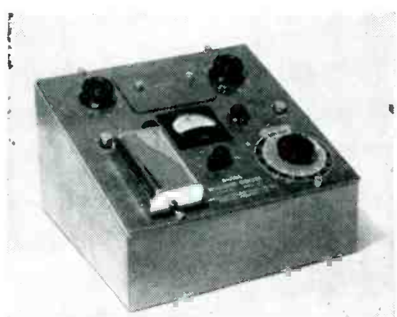
A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY crystal unit for standard frequency applications incorporates two separate quartz crystals entirely independent of one another but so designed that frequency stability and zero frequency adjustment are equal on 100 and 1,000 kc. Both crystals are highly active and capable of producing high oscillator output together with instant starting when used in conventional circuits. Calibration accuracy at 28 C is plus or minus 0.005 percent. Crystals are matched so that one trimmer may be used for both crystals which can be easily adjusted to zero beat with WWV or other standard frequency.



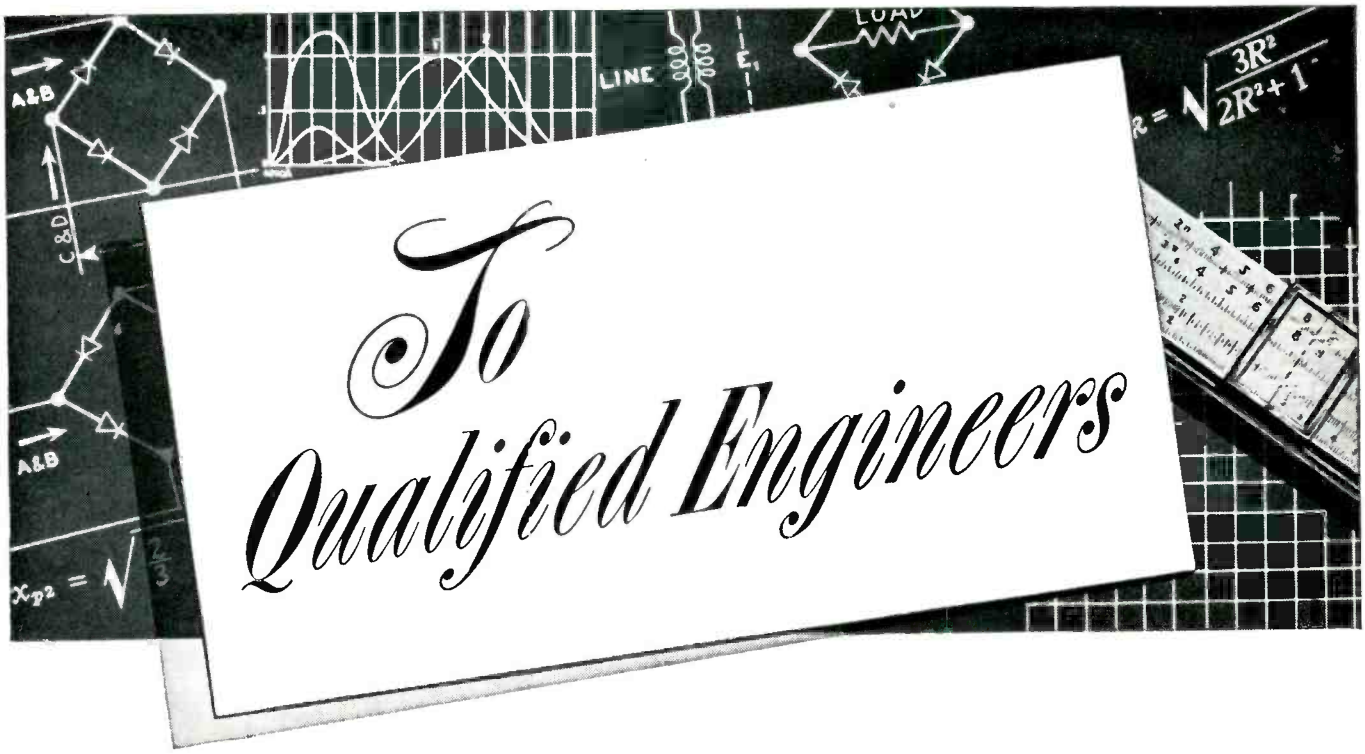
Terminal Block

SHAW INSULATOR CO., 160 Coil St., Irvington, N. J. The terminal block illustrated is made of maximum-strength molded phenolic plastic and is designed for high-voltage insulation. It completely eliminates nonfunctional materials and its compactness takes advantage of the smallest operating space. Segregated, individually accessible connections make installation and service fast and efficient. It comes with or without related hardware.



Megohm Bridge

SPECIAL INSTRUMENTS LABORATORY, INC., 1003 Highland Ave., Knox-



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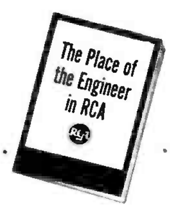
Whatever your plans for the future—you will find the booklet "The Place of the Engineer in RCA" interesting reading. Mail the coupon for your free copy.



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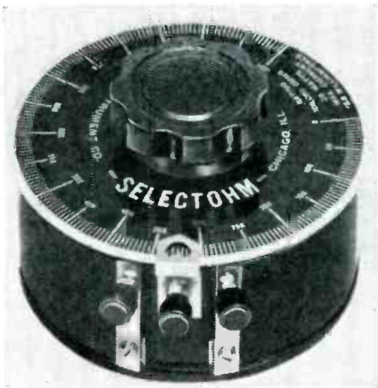
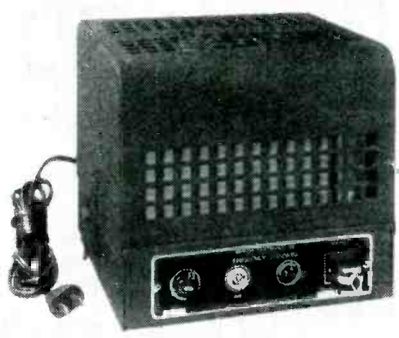
ville, Tenn. Model 144 megohm bridge is a Wheatstone bridge specially designed for measurement of high resistances. Resistances of 10^7 to 10^{14} ohms can be measured. Special insulation, shielding and an electrometer type detector are incorporated to permit measurements in this range. A set of resistors calibrated by the National Bureau of Standards is supplied with each instrument. The bridge operates from self-contained batteries.



Linear Potentiometer

Chicago Industrial Instrument Co., 536 W. Elm St., Chicago 10, Ill., has introduced the Selectohm, a new accurately calibrated 0 to 100,000-ohm linear potentiometer for use as a resistance substitute for service or laboratory work. It serves as a precision rheostat, shunt or multiplier, and is rated at 25 watts. Price is $7.50.



Frequency Standard

American Time Products, Inc., 580 Fifth Ave., New York 19, N. Y. Type 2005 frequency standard is a

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A NOVEL and UNIQUE CIRCUIT INDICATOR

DESIGNED FOR NE-51 NEON LAMP

For 110 or 220 volt circuits

The required resistor is an integral part of this assembly —"built-in."

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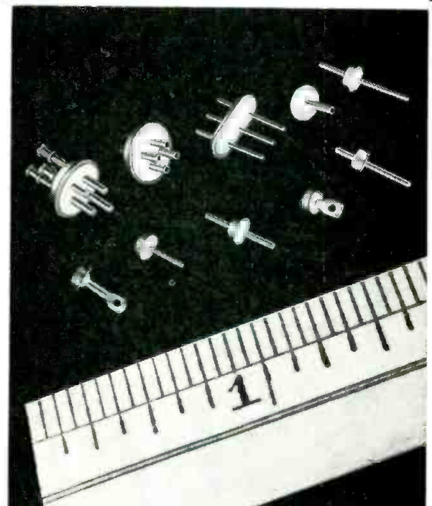

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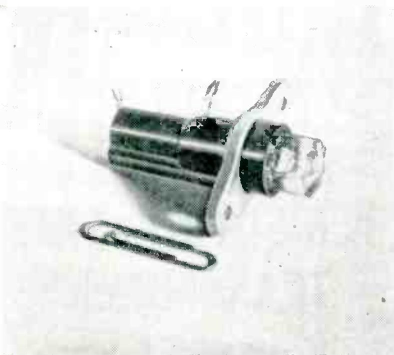
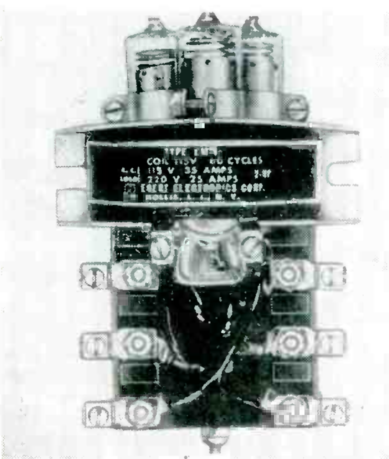
useful laboratory tool, suitable for running gyros, small motors, controlling inverters, stroboscopes and the like. Input power is 45 watts at 110 volts from 50 to 500 cycles. Output power is 10 watts at 115 volts at any specified frequency from 50 to 500 cycles. Accuracy is ±0.001 percent in room temperature range. It measures 8 in. × 8 in. × 7¼ in. high.



Indicating Fuseholder

ALDEN PRODUCTS CO., 117 N. Main St., Brockton 64, Mass., has developed model 440-3FH miniaturized indicating fuseholder that instantly spots a blown fuse. Its design features a neon bulb and double contacts molded as an integral part of the crystal-clear lens. The unit is ideally suited to mass production assembly techniques. It has easily accessible solder tabs that facilitate wiring and assembly to other circuit elements.



Three-Pole Relay

EBERT ELECTRONICS CORP., 185-09 Jamaica Ave., Hollis 7, N. Y. Type

AEROCOM MEANS TROUBLE-FREE SERVICE!
From Ground To Air or Point to Point

Although demand for Aerocom equipment still exceeds our ability to offer immediate deliveries, you may wish to evaluate its possible future use in solving your communication, navigation, or meteorological problems.

The model 12GLX-M, 1KW Beacon Transmitter illustrated, operates on a single frequency in the range 200-415 Kcs. Oscillator coil can be supplied crystal-controlled or self-excited. Tone oscillator provides 30% high level modulation for identification when keyed with Aerocom's model AK-3B automatic keyer. The unit can also be voice modulated. Power supply . . . any stable voltage in the range 200-240 volts, 50/60 cycles, single phase. Overall dimensions in CM, 56W x 62D x 177H. Net weight 286 kilos.

AER -O- COM

3090 DOUGLAS ROAD MIAMI 33, FLA.

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A MODERN CRYSTAL
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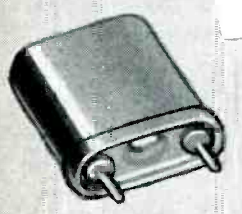

SPECIFICATIONS

Frequency range 200 kc to 100 mc. Hermetically sealed metal holders. Wire mounted, silver plated crystals. Two type H-17 holders fit loctal socket. H-17 is military type HC6/U, CAATC #3R1-3.

Don't limit the performance of your new electronic equipment by specifying yesterday's crystals. The crystal industry has made tremendous advances in recent years and new type JK Crystals and Crystal Holders meet the most modern requirements of precision and stability.

The JAMES KNIGHTS COMPANY invites your attention to the exceptionally fine H-17 series — a typical line of truly modern and dependable JK crystals. Compare the specifications and features of the H-17 with the "old fashioned" units of five years ago. Then you, too, will want to specify JK Stabilized Crystals!

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SMALL TRANSFORMERS

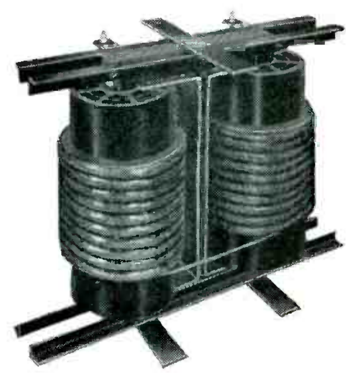
Reactors or miniature transformers produced to high quality specifications in production line quantities.

Hermetically sealed type transformers to specifications.

MEDIUM SIZE TRANSFORMERS

MIL-T-27

LARGE TRANSFORMERS

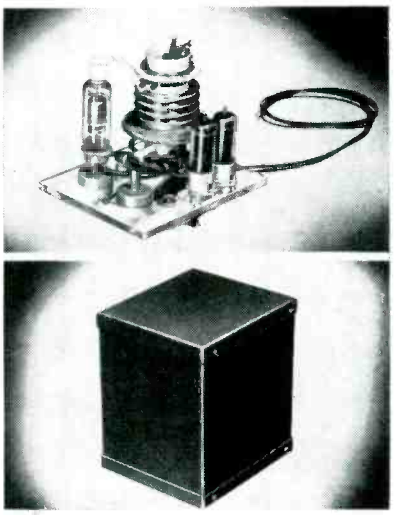


Transformers up to 225 KVA are built with attention to detail perfection to assure high performance, long-life service.

ACME ELECTRIC CORP.
317 Water St. Cuba, N. Y., U. S. A.

Acme Electric TRANSFORMERS

Em-7 three-pole relay employs one coil and its tungsten contacts are hermetically sealed in hydrogen-filled glass tubes. This construction provides a reliable and positive simultaneous contacting means for loads up to 35 amperes at 115 volts a-c, or 25 amperes at 220 volts a-c per contact. These relays can be supplied with all three contacts either normally open or normally closed, or with any combination of normally open and normally closed contacts. Dimensions are 4$\frac{1}{16}$ in. wide, 5$\frac{3}{8}$ in. tall by 3 in. deep.



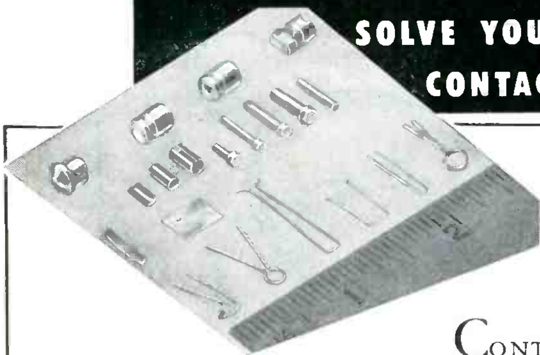
D-C Power Supply

SPELLMAN TELEVISION CORP., 3029 Webster Ave., New York 67, N. Y., has announced a new compact high-voltage unit designed for industrial or laboratory applications. It is a well-filtered 4,500 volt r-f d-c power supply, completely enclosed measuring only 5$\frac{5}{8}$ in. $\times$ 4$\frac{1}{2}$ $\times$ 5 in. Voltages up to 7,500 volts at 1 ma may be obtained. It is available with either negative or positive polarity outputs.

ULF Oscillator

KROHN-HITE INSTRUMENT CO., 580 Massachusetts Ave., Cambridge 39, Mass. Model 410-A ultralow frequency oscillator covers the sub-audio and the entire audio range. It provides both sine wave and square wave at any frequency range between 0.02 and 20,000 cps. The unit is ideal for medical research,

LET NEY EXPERIENCE AND EXPANDED PRODUCTION FACILITIES SOLVE YOUR CONTACT PROBLEMS



CONTACTS, brushes, wipers, slip rings, commutator segments and similar components for electrical instruments and apparatus represent a field in which Ney Research has a long list of important accomplishments. Ney precious metal alloys specially developed for these applications are widely and very successfully used. And now enlarged manufacturing facilities have been added to meet the steadily increasing demand. If you have applications in any of these categories, write at once for the Ney Technical Data Book No. R-12. Or call our Engineering Department outlining your needs.

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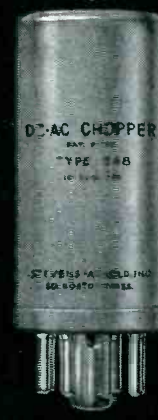
DC-AC CHOPPER

A model for every use
10 — 500 cycles AC
Meets AN Specifications
also 60 cycles
Single pole and double pole
Make-before-break contacts
Contacts in air or in liquid



These Choppers convert low level DC into pulsating DC or AC so that servo-mechanism error voltages and the output of thermocouples and strain gauges, may be amplified by means of an AC rather than a DC amplifier.

They are hermetically sealed, precision vibrators having special features which contribute to long life and low noise level.

WRITE FOR THESE CATALOGS . . .
#280 10-500 cycles
#246A 60 cycles

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for geophysical and seismological instruments, for design and development of servomechanisms and for vibration controls. Sine-wave amplitude varies less than 0.25 db (3 percent) over the entire frequency range. Distortion and hum are less than 0.25 percent over the entire range.

Literature

Data Bulletins. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa., has available 7 catalog data bulletins dealing with the following: type MP high-frequency resistors; type MV high-voltage resistors; type BW insulated wire-wound resistors; type UHR ultrahigh wire-wound resistors; type UHR ultrahigh resistance resistor; a line of precision wire-wound resistors; the 1101 general-purpose digital computer; and the type W 2-watt rheostat potentiometer. Complete technical information and illustrations are included.

Autographic Recorder. Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa., announces the 4-page bulletin 330 describing and illustrating the model MD-2 autograph recorder. The instrument described is a portable, self-contained Microformer type that will plot automatically on rectangular coordinates any two variables that can actuate the movable cores of miniature variable transformers, either directly or through accessory Bourdon tube units.

Cellular Rubber. The Sponge Rubber Products Co., Derby Place, Shelton, Conn. A 20-page booklet deals with the properties of test data on and specifications for cellular rubber. The product is useful as a turntable cushion to prevent transmission of motor vibrations to recording discs; as an amplifier insulator to provide a wall of insulation between plug-in amplifier and main electrical chassis; and as hand microphone spacers to protect the element from damage and insulate it against transmitting the sound that would oth-

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Test analyzer for use in development and PRODUCTION of SERVOMECHANISMS and PROCESS CONTROLS. Measures FREQUENCY RESPONSE, PHASE SHIFT 0.1 to 20 CYCLES SINE WAVE, SQUARE WAVE, MODULATED CARRIER, 50 to 800 CYCLES.

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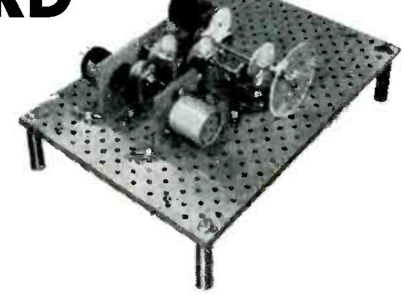

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ALLIED maintains in stock *for quick shipment*, the world's largest distributor inventory of RCA special-purpose tubes—*of all types*. We specialize in supplying the needs of industrial, broadcast, governmental and other users. To save time, effort and money—phone, wire or write to ALLIED. Fill *all* your needs quickly from the *complete, dependable* electronic supply source.

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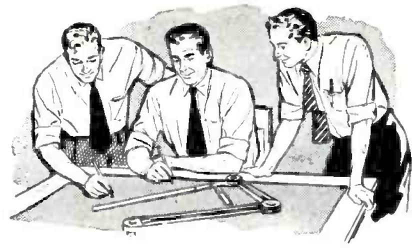
Everything in Electronics from ONE Source



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Opportunity of a Lifetime!

Continued expansion in many of the divisions of Minneapolis-Honeywell—America's leading manufacturer of automatic controls—has created some wonderful new opportunities for graduate electrical and mechanical engineers with research, design or development experience.

Jobs are now available in the all-important heating, ventilating, air-conditioning, industrial processing, and a myriad of other fields—wherever there is a need for automatic controls. And this includes the fascinating new fields of atomic energy, guided missiles and aviation!

These permanent engineering jobs offer you advantages most men spend a lifetime looking for: an opportunity to use the latest electronic techniques and equipment; a chance to do work bordering on basic research; diversification that affords security, and at the same time allows you to choose the kind of work you like most.

If this sounds like your kind of opportunity, we'd be glad to tell you more about it—and about the fine living conditions and salaries in Minneapolis and Philadelphia. Depending on the location you prefer, write to H. D. Elverum, Personnel Department EL-1, Minneapolis 8, Minn., or W. Reiterman, Personnel Department EL-1, Philadelphia 44, Pa., giving your qualifications and experience. Your correspondence will be held in the strictest confidence, of course.

MINNEAPOLIS **Honeywell**
First in Controls

erwise result from dropping or banging the microphone.

Connectors. American Phenolic Corp., 1830 South 54th Ave., Chicago, Ill. Catalog A2 contains information for selecting and ordering AN connectors for power, signal and control circuits in aircraft and electronic equipment. The different types of connector shells, insert arrangements and fittings are illustrated. Complete listings of the thousands of arrangements are given. Dimensions, weights and electrical data are shown in detail.

Vibration Isolators. The Barry Corp., 700 Pleasant St., Watertown, Mass. Catalog 509 discusses the structural features of all-metal vibration isolators that employ no organic material and are unaffected by extreme temperatures. Unit mountings, for direct attachment to equipment, and standard size mounting bases are described. The mountings covered meet the requirements of JAN-C-172A, MIL-E 5272 and MIL-T-5422. The publication lists load ranges and dimensions of both unit and mounting base types.

Direct-Writing Recorder Amplifier. Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa., has published bulletin 332 covering the model 141 direct-writing recorder-amplifier assembly. The instrument described is designed for inkless recording of electrical unbalance of a resistance bridge when using strain sensitive elements such as SR-4 strain gages or temperature-sensitive elements. The bulletin deals with performance and operation of amplifier and recorder assemblies, and lists available accessories.

Miniature Standard Cell. Muirhead & Co., Ltd., Beckenham, Kent, England, has issued a 2-page bulletin dealing with the type D-550-B miniature standard cell that has been produced especially for use in educational establishments where it is desirable that its internal construction should be visible so that its working may be more easily understood. Specifi-

cations given include general description, electrical characteristics, current discharge rate and dimensions.

Pneumatic Tools. Newage International, Inc., 235 E. 42nd St., New York, N. Y. Catalog PT deals with a complete line of pneumatic tools including drills, screwdrivers and nut runners, countersinking tools, shears, nibblers, grinders and accessories. An illustrated description of each tool is given.

Tube Catalog. General Electric Co., Syracuse, N. Y. A new 107-page pocket-size handbook lists the essential characteristics of every tube likely to be found in any a-m, f-m or tv home receiver. The reference contains ratings and other data essential to fast, efficient trouble shooting. Basing diagrams for each of the 856 different tube types listed are shown on the page with the data. Price is 35 cents.

Electrical Insulation. The INSL-X Co., Inc., Water St., Ossining, N. Y., has issued a booklet on its electrical insulating and specialty compounds. Among the many uses of the basic raw material covered are fungicidal coatings, arc-resisting coatings, coil coatings, tool insulation and insulating varnishes. Complete technical description, curing-time-hours chart and price list are included.

Microwave Test Equipment. Kings Microwave Co., Inc., 50 Marbledale Rd., Tuckahoe 7, N. Y. A recent 24-page booklet deals with a line of microwave test equipment and components. Included are illustrated descriptions of high-power terminations, tees, water loads, low-power waveguide terminations, glide screw tuners, flap attenuators, bidirectional couplers, micrometer wavemeters, waveguide chokes and flanges and similar equipment.

Silvered Mica Capacitor. Cornell-Dubilier Electric Corp., South Plainfield, N. J. Bulletin NB 141 announces the type 22R high-stability silvered mica capacitor in

NEWS OF THE INDUSTRY

(continued from page 148)

ton cargo vessel is at least $2,000 a day.

Equipment to be used until the close of the experiment in December, 1951, has been furnished without cost by Sperry and Raytheon. Certain government and private craft have volunteered as target vessels and the local pilots' associations are also cooperating in the experiment.

Among the problems to be worked out are reliable radiotelephone communications between ships and the information center at Fort Wadsworth and a sure means of identifying craft from the radar scope.

MIT Promotions

FACULTY promotions at Massachusetts Institute of Technology which will become effective July 1 were recently announced. Those taking place in the department of electrical engineering are as follows:

William H. Radford of Watertown is raised to the rank of full professor; Donald P. Campbell and Robert M. Fano of Brookline are promoted from assistant to associate professors; F. Ralph Kotter, Jordan J. Baruch, Elery F. Buckley and James M. Ham of Cambridge, Ronald E. Scott of West Newton and Albert B. Van Rennes of Weston become assistant professors. Maurice Boisvert of Winthrop, Edward J. Craig of West Newton, and Cedric F. O'Donnell, Arthur L. Pike, William M. Siebert, Kenneth N. Stevens and Robert E. Turkington of Cambridge are advanced to the rank of instructor.

International Standardization Makes Progress

CONTINUING progress is being made in the direction of international standardization of electric and magnetic magnitudes and units under the auspices of Technical Committee No. 24 of the International Electro-technical Commission. Existing differences of definitions in different countries are being gradually eliminated. This, it is anticipated, will be of substan-

tial benefit to electrical engineering throughout the world.

One of the overall objectives of Technical Committee No. 24 is to formulate for general acceptance the MKS (meter-kilogram-second) system, sometimes called the Giorgi System. The MKS system has the advantage that its use results in units of current, voltage, and resistance which are respectively the ampere, the volt, and the ohm. This makes it more suitable for engineering work than the CGS (centimeter-gram-second) system, which is in widespread use. It is recognized, however, that the CGS System has certain advantages for physicists. There is no thought of replacing one by the other, but simply of providing a second system that will be particularly helpful to engineers.

Prior to World War II, meetings of Technical Committee No. 24 were held on an average of about once every two years. Due to the war and later the death of the committee's chairman, Professor Kennelly of MIT, no meetings were held from 1938 until last summer when the Committee met in Paris on July 17 and 18.

Questions raised by delegates at the Paris meeting were also proposed for consideration at the Committee's next meeting. These included (1) the most satisfactory name to be assigned to the MKS System; (2) the name to be assigned to the unit of induction; and (3) possible merger of Technical Committees No. 24 and 25. Opinions are being sought from all of the National Committees concerning these matters. This work in the United States is being done through the Sectional Committee on Electric and Magnetic Magnitudes and Units, C61, under the procedure of the American Standards Association, 70 E. 45th St., New York, N. Y.

Cooperative Research Program Announced

A PROGRAM by which Philco Corp. will join Massachusetts Institute of Technology in many fields of scientific research useful both to national defense and to the civil-

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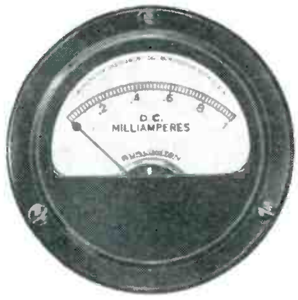

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C 2	6.3	171	2.15	0.44	
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C 44	4.1	252	2.1	1.03	

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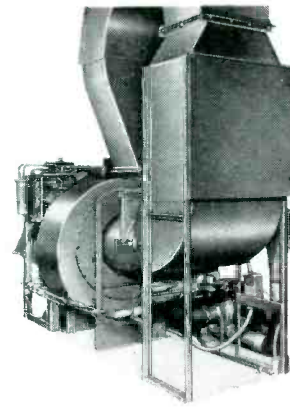

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ian economy was recently announced.

Both Philco and the Institute have cooperated for the past 10 years in a program of training engineers, in many forms of electronic development work and in the exchange of technical information. Under the new agreement both will exchange information on research results in a variety of fields. Military and commercial electronics, television and radio are among the subjects of joint interest.

The program also calls for special conferences and seminars, an exchange of visits by MIT and Philco executive and technical personnel, use of scientific libraries and a joint policy to cover inventions and patents.

BUSINESS NEWS

CANNON ELECTRIC CO., is the new name of the Cannon Electric Development Co., Division of Cannon Mfg. Corp., Los Angeles, Calif., manufacturers of plugs and signal equipment.

KEYSTONE CARBON CO., St. Marys, Pa., has recently completed the addition of 20,000 sq ft of floor space for the manufacture of powdered metal parts and negative-temperature-coefficient resistors.

PHILCO CORP. has purchased three new plants in Bedford, Ind., about 65 miles southwest of Indianapolis. This will add about 175,000 sq ft to the company's overall manufacturing facilities of 4,200,000 sq ft.

RAYTHEON MFG. CO., Newton, Mass., has announced plans for the erection of a new plant in Quincy, Mass., by the Receiving Tube Division of the company. The 86,000-sq ft plant will be devoted exclusively to the manufacture of subminiature-type electronic tubes.

WESTINGHOUSE ELECTRIC CORP. has purchased 75 acres on a corner of the Baltimore Friendship airport to build a plant for the production of automatic computers to direct gun and rocket fire, radar and autopilots for fighter planes and guided missiles, and complete airborne ar-

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For these applications:

- AUTOMATIC MACHINE CONTROL
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The ONLY counter with ALL these features!

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Potter Predetermined Electronic Counters extend the field of automatic counting and control far beyond the scope and capabilities of existing mechanical and electromechanical devices. There are no moving parts, therefore, wear, slippage and inertial effects are eliminated.

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A complete line of photoelectric and electromagnetic detectors, for counting any material or action, can be supplied.

The instruments are easily applied to any problem requiring the precise measurement or control of QUANTITY, LENGTH, TIME, FREQUENCY, REVOLUTION or CAM SEQUENCE. Absolute accuracy of count is guaranteed.

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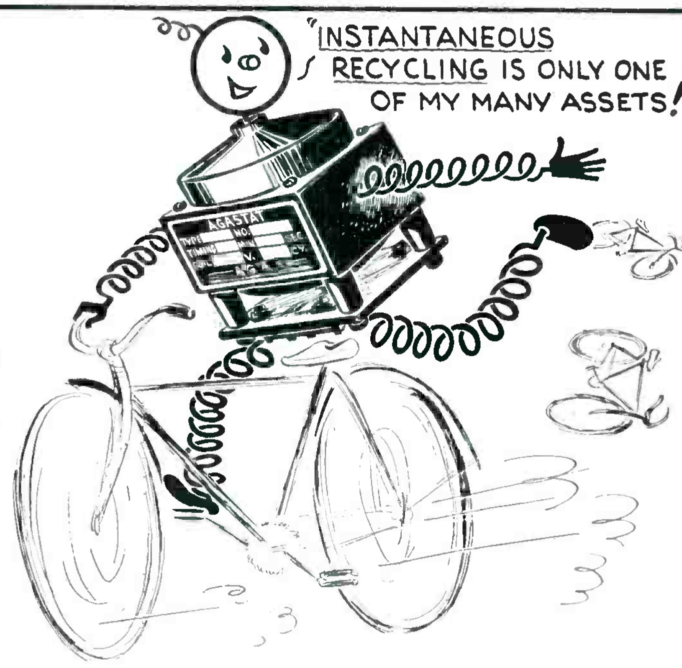

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The AiResearch Rate of Change Control regulates the rate at which pressure in the airplane's cabin changes. An A. W. Haydon Motor was chosen to drive the instrument because of its proved performance record in scores of important aircraft applications. Other functions for which similar A. W. Haydon Motors are used include controls for wing and propeller de-icing, propeller feathering, camera intervalometer, hydraulic bypass, fuel tank purging as well as recorder chart drives, trim control, telemetering and destructor control, etc.

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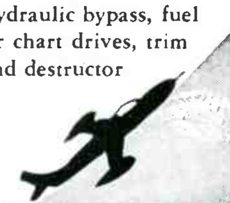

The A.W. HAYDON COMPANY
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Design and Manufacture of Electrical Timing Devices

mament systems. The new 400,000-sq ft plant is expected to be completed by autumn.

ZENITH RADIO CORP. has begun excavation on its new 453,000-sq ft plant at 1500 N. Kostner Ave., Chicago, Ill. The plant will be used for manufacturing components and the assembling and testing of electronic equipment for the military services.

NATIONAL ELECTRONIC MFG. CORP., Long Island City, N. Y., manufacturers of quartz crystals, crystal holders and other electronic parts during World War II, has resumed production of these items to meet current military demand.

THE WORKSHOP ASSOCIATES, INC., Needham, Mass., recently became a wholly-owned subsidiary of The Gabriel Co., Cleveland, Ohio.

LISTON-FOLB, Div. of Atlas Coil Winders, has now incorporated as Liston-Folb Instrument Co., Inc., and has moved into new quarters at 20 Beckley Ave., Stamford, Conn., thus expanding facilities for production of d-c breaker amplifiers and other special electronic equipment.

JERROLD ELECTRONICS CORP., manufacturer of multiple tv antenna systems, has expanded production and laboratory facilities by moving to new plant space at 26th and Dickinson Sts., Philadelphia, Pa.

MCCORMICK SELPH ASSOCIATES, designers and manufacturers of glass-to-metal seals for guided-mis-

sile and other specialized applications, have moved from Belmont, Calif., to new quarters in Palo Alto, Calif.

ANDERSEN LABORATORIES, INC., West Hartford, Conn., has taken over the business and personnel of

2 KW VACUUM TUBE BOMBARDER OR INDUCTION HEATING UNIT

For Only $650.

Never before a value like this new 2-KW bench model "Bombarder" or high frequency induction heater . . . for saving time and money in surface hardening, brazing, soldering, annealing and many other heat treating operations.

Simple . . . Easy to Operate . . . Economical Standardization of Unit Makes This New Low Price Possible.

This compact induction heater saves space, yet performs with high efficiency. Operates from 220-volt line. Complete with foot switch and one heating coil made to customer's requirements. Send samples of work wanted. We will advise time cycle required for your particular job. Cost, complete, only $650. Immediate delivery from stock.

Scientific Electric Electronic Heaters are made in the following ranges of Power: 1 -2 - 3½ -5-7½-10-12½-15-18-25-40-60-80-100-250KW.

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- √ Heating head sealed at working end, protects against flux fumes.
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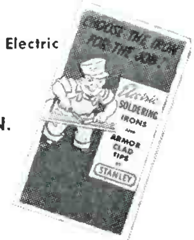

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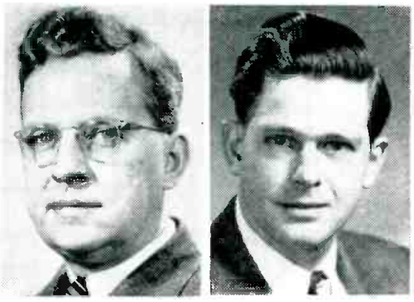
the Andersen-Shaw Laboratories and is continuing research and development work in the ultrasonic field. In addition the new company is manufacturing ultrasonic delay lines and ultrasonic generators.

PERSONNEL

W. B. WHALLEY, engineering specialist for Sylvania Electric Products Inc., Bayside, N. Y., was recently appointed adjunct professor in electrical engineering for the Polytechnic Institute of Brooklyn.



W. B. Whalley L. C. Kunz

LOUIS C. KUNZ was recently promoted from section engineer on c-r tubes at GE's Electronics Park to product manager for c-r tubes in the company's tube division, with headquarters at Schenectady, N. Y.

EMANUEL R. PIORE, formerly deputy for natural sciences at the Office of Naval Research, Washington, D. C., has been appointed deputy chief of research and chief scientist of the ONR.

FREDERICK N. JACOB, formerly chief engineer of Aladdin Radio Industries, Inc., has joined Belmont Radio Corp., Chicago, Ill., as products manager for infrared equipment.

EUGENE F. GRANT, former chief of the Computer Branch at Air Force Cambridge Research Laboratories, has been appointed to the post of coordinator of electronics research and development for the W. L. Maxson Corp., New York, N. Y.

GEORGE H. PHELPS, formerly associated with RCA Victor, was recently appointed chief engineer of Hammarlund Mfg. Co., Inc., New York City, manufacturers of commercial receivers, selective calling

and remote control apparatus, variable air capacitors and radar components.

JOSEPH A. IDANK has joined the staff of Parco Design Corp., New York, N. Y., as chief engineer of the Special Devices Division where he will direct research, development and engineering on precision mechanical and electronic devices and instruments for use on highly specialized industrial and Armed Services projects.

H. B. FANCHER, with General Electric Co. since 1936, has been promoted to division engineer of commercial products for the company's Commercial Equipment Division, Syracuse, N. Y.

H. B. Fancher

R. H. Dorf

RICHARD H. DORF, former audio and tv systems consultant, has joined the staff of Brach Mfg. Div. of General Bronze Corp. as electronics project engineer. He will take charge of the company's government electronics projects.

JOHN J. FARRELL, formerly engineer in charge of commercial products for General Electric Co.'s transmitter division, has been appointed assistant manager of engineering for the company's commercial equipment division.

REX WILSON, formerly chief engineer of Tele-Vogue, Inc., Chicago, Ill., has been elected vice-president in charge of engineering for the company.

W. G. HENKE, formerly test equipment design engineer of Admiral Corp., has joined Tele-Vogue, Inc., as coordinator of engineering.

E. B. STEINBERG, previously affiliated with Remington Rand Inc., is now associated with The Reflectone

Corp., Myano Lane, Stamford, Conn., as engineer in charge of its science division.

HAROLD W. GIESECKE, recently promoted to assistant to the general manager of Bendix Radio Division of Bendix Aviation Corp., had been previously associated with Westinghouse Electric Corp. Pittsburgh, Pa.

ADOLPH H. ROSENTHAL, inventor of the Skiatron dark-trace c-r tube, has been elected vice-president and director of research and development of Freed Radio Corp., New York, N. Y.

A. H. Rosenthal

J. D. Schantz

JOSEPH D. SCHANTZ has been promoted from assistant chief to chief engineer of Bell Aircraft Corp., Buffalo, N. Y. As a member of the Radio Technical Planning Board No. Six, he had helped to develop the code of tv standards in use today.

JOSHUA SIEGER of White Plains, N. Y., a member of the technical committees of RTMA and NTSC, will now act as an independent technical consultant in the fields of radar, communications and television.

ROBERT M. ULMER of Cleveland, Ohio, has joined Horizons Inc., of the same city, as a laboratory assistant.

CURTIS B. PLUMMER, formerly chief engineer, has been named head of the new Broadcast Bureau of the Federal Communications Commission.

LEON HILLMAN, previously with New York University's Research Division, was recently appointed head of the engineering department of Production Research Corp.,

Thornwood, N. Y., specialists in research, development and production of electronic equipment for the Armed Forces.

DEVEREAUX MARTIN, formerly chief engineer at Radio Receptor Co., Inc., Brooklyn, N. Y., has been named assistant to the president, to work on special assignments, particularly in the field of new-product exploration.

JOSEPH B. HERSH, with the Utility Electronics Corp., Newark, N. J., for the past three years, has been named executive vice-president and general manager of the company. He was formerly chief engineer with the David Bogen Co., Inc.

L. H. JUNKEN has been promoted from designing engineer to division engineer of engineering services for General Electric Co., commercial equipment division, at Syracuse, N. Y.


L. H. Junken


P. L. Spencer

PERCY L. SPENCER, vice-president in charge of the Power Tube Division of the Raytheon Mfg. Co., Waltham, Mass., was recently awarded priority of invention of basic magnetron strapping by the U. S. Patent Office.

ALFRED C. HAEMER, JR., a member of the National Research and Development Board, has been named head of the field engineering department of General Precision Laboratory, Inc., Pleasantville, N. Y.

GEORGE O. SMITH, author of instruction manuals covering the technical use of sonar, radar and other specialized electronic devices during World War II, was recently appointed manager of components engineering at Emerson Radio and Phonograph Corp., New York, N. Y.

NEW BOOKS

(Continued from page 150)

drogen phosphate (KDP) and barium titanate. While the treatment is always attentive to theory, the experimenter will find much of value in the substantial amount of practical information on measurement procedure, orientation of cuts and values of physical constants. Of special interest to those who follow theoretical development in this field, will be Dr. Mason's theory on ferroelectricity, more completely presented in this work than in any other writing.

The final three chapters of the book discuss the application and production of ultrasonic waves to measure the properties of gases, liquids and solids. Here too the experimenter will find much of interest in the procedures described, the sketches of equipment and the many graphs and tables of measured data.

It need hardly be said that this work, written by one of the foremost researchers of a laboratory distinguished, among other things, for its contributions to this field is strongly recommended to all who have serious interest in the properties of crystals.—J. F. MCALLISTER, *General Electric Co., Syracuse, New York.*

Vacuum-Tube Voltmeters

BY JOHN F. RIDER. *Second edition, published by John F. Rider Publisher, Inc., New York,* 422 *pages,* $4.50.

THE IMPORTANCE of the vacuum-tube voltmeter has been stressed repeatedly. Many engineers, however, overlook some of the less obvious jobs that can be done with vtvm's. It is hard to imagine a person involved in laboratory work who could not discover at least five new ideas from reading Rider's book.

This second edition brings the first (1941) edition up to date. The applications section alone will be worth the price of the book to many. It gives easy-to-follow instructions for measuring such things as inductance, resistance, capacitance, r-f, a-f and d-c voltages and currents with a vtvm. A completely new chapter deals with d-c and r-f probes of all types.

One section is devoted to a comparison of the more than 40 com-

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Follow the lead of military communications experts and use the easy-to-erect, efficient and economical vertical antennas for those point-to-point frequencies in the 160, 80 and 75 meter bands, plus CAP, MARS and joint disaster channels.

Premax can supply aluminum, stainless steel and steel Antennas at heights up to 35 feet with base and standoff insulators. Also coil-loaded Antennas at 9½ and 17-foot heights which give super-efficiency with smaller size.

Vertical Antennas with their omnidirectional coverage work better with vertically equipped mobiles.

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may be the perfect answer to your microwave transmission problems in:

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Designers of microwave transmission equipment are now taking full advantage of the flexibility of WAVEFLEX flexible waveguides *without sacrificing any of the advantages of rigid waveguides.* As a result, design problems are greatly simplified. WAVEFLEX waveguides offer lower attenuation loss, excellent impedance match, and extreme flexibility without loss of efficiency.

Standard WAVEFLEX flexible waveguides are made in accordance with joint Army-Navy specifications. We will gladly work with you in developing special Waveguides to serve in special applications.

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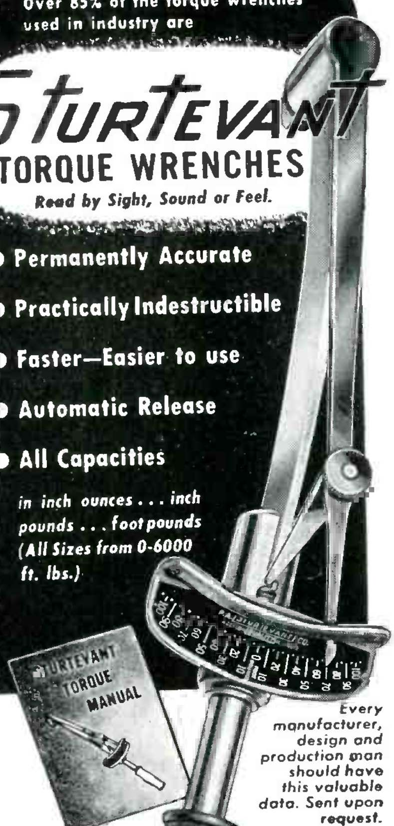

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mercial types of vacuum-tube voltmeters available on the market today. Complete circuit diagrams are given, along with tabulated comparative data for guiding the prospective buyer. All types are included, from inexpensive kits to the most elaborate instruments. A bibliography of over 200 listings aids further investigation of particular instruments or topics.

It is difficult to think of a single aspect of this particular instrument that has been neglected. The industry is fortunate in having a book available that can acquaint its engineers so thoroughly with one of their most valuable tools. Such an understanding in any field is an asset.—J.F.

Transformers

BY F. C. CONNELLY. *Pitman Publishing Corp., New York*, 1950, 490 *pages*, $7.50.

IN RESEARCH work involving electrical and electronic circuitry, the need often arises for transformers having special characteristics. Quite often the circuit specialist finds himself stymied by the nonexistence of an appropriate transformer for his needs. In some of the more elaborate setups, special shops and trained personnel are provided for such cases. More often, the engineer himself must rewind or start from scratch and prepare his own.

This British-authored book is designed as a guide in such cases. Carefully read, it can furnish the general engineer with transformer know-how and allow him to proceed logically and methodically in designing a special transformer for a specific application. Well-planned step-by-step procedures are suggested.

Basic principles are supplemented by separate sections on even the most advanced details of transformer work. Included are separate sections on multi-phase, power, high-voltage, vibrator, instrument, audio and output transformers, as well as autotransformers. A short section in the back of the book is devoted to special television types. Among the theoreti-

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DESIGNERS
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THE Aerophysics & Atomic Energy Research Division of North American Aviation, Inc. offers unparalleled opportunities in Research, Development, Design and Test work in the fields of Long Range Guided Missiles, Automatic Flight and Fire Control Equipment and Atomic Energy. Well-qualified engineers, designers and physicists urgently needed for all phases of work in

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Navigation Equipment,
Controls,
Servos,
Rocket Motors,
Propulsion Systems,
Thermodynamics,
Airframe Design,
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Salaries Commensurate with training & experience.
Excellent working conditions.
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Write now — Give complete resume of education, background and experience

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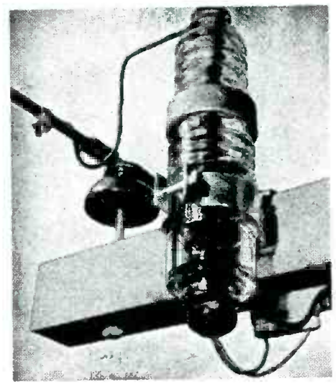
S·S·White MOLDED RESISTORS

The All-Weather Resistors

ARE USED IN HIGH VOLTAGE "HIPOT" COUPLERS



S.S.White resistors are connected in series to permit a current flow to ground, when the "Hipot" Coupler is used to measure or to synchronize voltage of high voltage lines.

Canadian Line Materials, Ltd.—maker of "Hipot" Couplers and other transmission, distribution and lighting equipment says—"We have always found S.S.White resistors of the highest quality". This checks with the experience of the many other producers of electrical and electronic equipment who use S.S.White resistors.

WRITE FOR BULLETIN 4906

It gives details of S.S.White Resistors including construction, characteristics, dimensions, etc. Copy with price list on request.

S.S.WHITE RESISTORS
are of particular interest to all who need resistors with *low noise level* and *good stability* in all climates.

HIGH VALUE RANGE
10 to 10,000,000 Megohms

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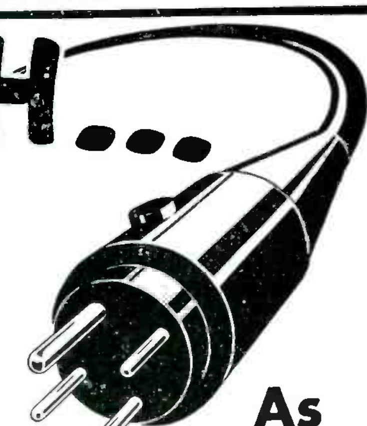

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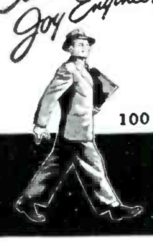

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cal discussions are chapters on magnetic leakage, core excitation, transients, losses, efficiency and regulation.

The introductory material is quite easy to understand. The analogies between the electrical circuit and the magnetic circuit are clearly emphasized and helpful in creating an understanding of the latter. The book is highly recommended for the beginner or the expert.—J.F.

Semi-Conductors

BY D. A. WRIGHT. *Methuen's Monographs, John Wiley & Sons, Inc., New York, 1951, 130 pages, $1.75.*

THIS condensed, elementary treatment of basic semi-conductor theory should be of considerable value as a means of review for the physicist or as an introduction to the subject for the student. Engineers could particularly benefit because its logical sequence of presentation of concepts would give them a basic understanding of the subject and permit more intelligent use of the more rigorous and fundamental texts.—J. P. JORDAN, *Electronics Laboratory, General Electric Co., Syracuse, N. Y.*

Receiver Circuitry and Operation

BY A. A. GHIRARDI AND J. R. JOHNSON. *Rinehart Books, Inc., New York,* 1951, 669 *pages,* $6.00.

HERE is basic coverage of the circuits most often encountered in modern television, a-m radio and f-m radio receivers, written for the technician and student who seeks to bring his education up to date. The treatment is nonmathematical and has a minimum of complicated theoretical analysis of circuit operation. Even the number of graphs is held to an absolute minimum. A knowledge of radio and electrical fundamentals, including vacuum-tube theory, is assumed to have been obtained elsewhere; practical servicing and troubleshooting procedures are likewise absent but are scheduled for a second volume now in preparation. Chapters dealing with construction and operation features of components and acces-

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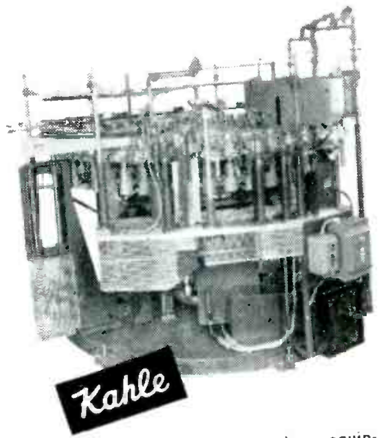

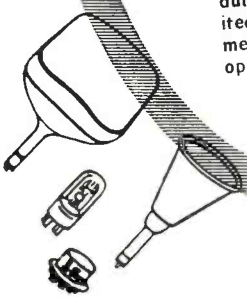

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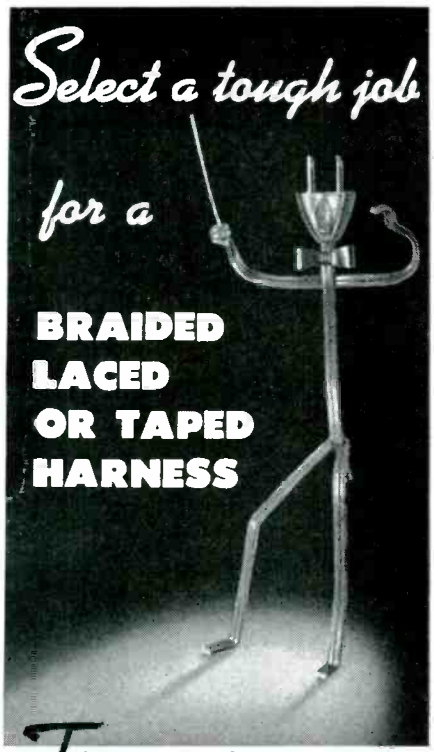

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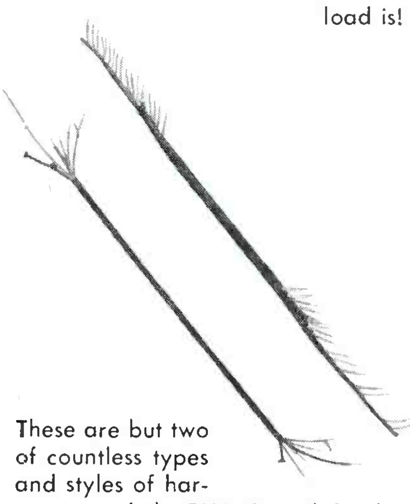

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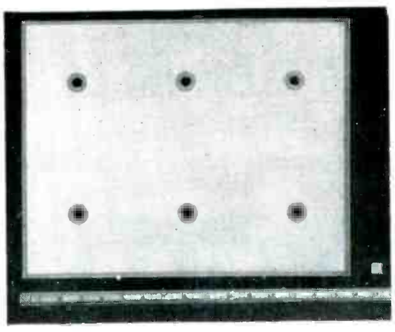

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Explanations in this book are clear and concise throughout, and questions at the ends of chapters provide a thorough test of mastery of the contents. Equally deserving of commendation are the excellent drawings, which show that the artist understood what he was doing. Long waited for, the book goes far toward filling the demand for up-to-date information in a style comparable to Ghirardi's still-selling 1931 edition of *Radio Physics Course* and his almost equally out-of-date *Modern Radio Servicing*.—J.M.

Advances in Electronics

vide a clear picture of absorption phenomena, and an analysis of theoretical and practical resolution capabilities is presented.

The second chapter contains information compiled by R. R. Warnecke, P. R. Guenard, M. Chodorow, and E. L. Ginzton. The first two are affiliates of the Laboratories de Recherches de la Compagnie Générale de T.S.F., Paris, France; the latter two are on the staff of Stanford University, Stanford, California. This chapter discusses velocity-modulated tubes, beginning with the basic concepts that led to the development of the klystron, and working into even the most detailed aspects of klystron operation in low-noise, low-power and power klystron amplifiers.

Electronic theory of the plane magnetron is discussed by L. Brillouin, of International Business Machines Corporation of New York, in the third chapter. Here again the discussion starts off with basic concepts and evolves into a detailed description from beginning to end in the field of plane magnetrons. Cylindrical magnetron history and theory are presented by L. Brillouin and F. Bloch of International Business Machines Corp. and Stanford University respectively. Through the engineer's medium of curves and equations, the subject is covered quite concisely.

John E. White, of the National Bureau of Standards at the time of writing but now with General Electric Co., Schenectady, describes tube miniaturization. Physical and electrical problems peculiar to the subminiature tube field are presented. The next chapter serves to supplement White's chapter by giving details on subminiaturization techniques. In this chapter Gustave Shapiro, of the National Bureau of Standards, presents a general picture of the methods and problems of constructing electronic equipment using subminiature tubes and components. Much of the subminiature information presented has been set down elsewhere, in various manufacturer's catalogs, but the organization of this summary is quite good, and the subject made interesting.

H. F. Mayer, of the School of

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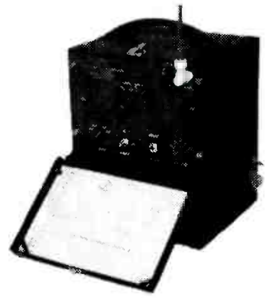

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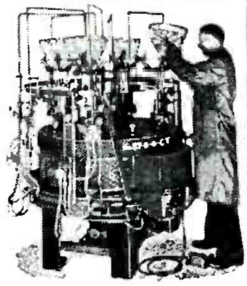

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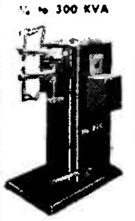

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F-23

Electrical Engineering, Cornell University, Ithaca, New York, writes on principles of pulse code modulation, with emphasis on noise, power and bandwidth. Next is presented a summary of modern methods of network synthesis by E. A. Guillemin of Massachusetts Institute of Technology. Theoretical and practical methods are covered, with typical examples furnished as illustrations.

The final chapter, prepared by Meyer Leifer and William F. Schreiber of the Sylvania Electric Products Inc., Bayside, New York, is an excellent discussion of communication theory. The authors have written from a standard outline on this subject, but their individual explanations are helpfully clear and easy to follow. They begin conventionally with summaries of the contributions of Hartley, Gabor, Tuller, Goldman and Shannon, and carry the theoretical analysis straight through to application in television and related fields. Here again sections of the analysis will be recognized as having been taken directly from the literature, but the organization increases their individual value many times.

The book is conveniently indexed, and a moderate number of pertinent references are included. The engineer who wishes to increase his knowledge beyond his particular project would do well to acquire a copy of *Advances in Electronics*, Volume Three.—J.D.F.

THUMBNAIL REVIEWS

THE ENGINEERING METHOD. By J. C. Fish. Stanford University Press, Stanford, Calif., 1950, 186 pages, $3.00. Philosophy and practice of reaching engineering decisions as to which method, which equipment and which material to use in solving a particular problem. Comprises separate publication of chapters 9, 10 and 11 written by this author for "The Engineering Profession" (Hoover and Fish, Stanford University Press, 2nd edition, 1950).

MATHEMATICAL ENGINEERING ANALYSIS. By Rufus Oldenburger. The Macmillan Co., New York, 1950, 426 pages, $6.00. Aimed at easing the transition from physical engineering situations to corresponding mathematics. Divided into five major parts, one of which is Electricity and Magnetism; this covers fundamentals, electric and electronic circuits and systems, tubes, transistors, A *new* Family of High Speed

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transducers; electromagnetic fields and procedures for setting up electrical problems.

F-M SIMPLIFIED. By Milton S. Kiver. D. Van Nostrand Co., New York, 1951, Second Edition, 458 pages, $6.50. Completely revised to cover recent developments in both transmitters and receivers at an engineering level, with introductory chapters giving basic principles.

TELEVISION AND FM ANTENNA GUIDE. By E. M. Noll and M. Mandl. Macmillan Co., New York, 1951, 311 pages, $5.50. Combination textbook and practical installation guide. First part gives principles of antenna systems, including wave propagation and transmission line theory. Second part, arranged as reference guide, covers antenna site surveys, choice of antenna, erection, installation of transmission line, use of boosters, characteristics of various antenna types, rotating antennas, multiple-outlet antenna systems, and interference reduction.

ALTERNATING-CURRENT ELECTRICAL SYSTEMS FOR AIRCRAFT. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh, 70 pages loose-leaf, $1.50. Latest design requirements, maintenance hints, and data on various aspects of a-c power supply systems for large aircraft.

ADVANCES IN RADIOCHEMISTRY. By E. Broda. Cambridge Monograph on Physics, Cambridge University Press, New York, 1950, 152 pages, $2.75. Production of radioelements, chemical properties, and aspects of transmutation relevant to nuclear synthesis. Final chapter covers new developments in technique of measuring radioactivity.

NUCLEAR SCIENCE ABSTRACTS, Cumulative Index to Vol. 1, 2, 3 and 4. U. S. Atomic Energy Commission, Technical Information Service, Oak Ridge, Tenn., 1951, 241 pages, $.60. Cumulative author index, subject index, nuclide index, foreign geographic index, numerical index of AEC reports with indications of availability, list of AEC depository libraries and list of periodicals abstracted.

TELEVISION PROGRAMMING AND PRODUCTION. By Richard Hubbell. Rinehart & Co., New York, 1951, 240 pages, $4.50. Second edition, revised and enlarged, with technical chapters brought up to date and with much new program material and many new illustrations.

UNDERSTANDING RADIO. By H. M. Watson, H. E. Welch and G. S. Eby. McGraw-Hill Book Co., New York, 1951, Second Edition, 716 pages, $5.50. Revision of fundamental text for students with little or no background in electricity or science.

SOUND SLIDEFILM GUIDE. Operadio Mfg. Co., St. Charles, Illinois, 1951, 62 pages, $1.00. Over 1,000 available sound slidefilms are listed, each with data on source, availability (free loan, rental rate or sale price), running time and nature of film. Includes 40 sound slidefilms giving technical training in electronics.

FOURIER TRANSFORMS. Ian N. Sneddon, University of Glasgow. International Series in Pure and Applied Mathematics, McGraw-Hill Book Co., New York, 1951, 542 pages, $10.00. Theory of Fourier transforms and related topics, presented in a form suitable for students and research workers interested in boundary-value problems of physics and engineering. Seven of the ten chapters illustrate the use of the theory in solving problems of vibration, heat conduction, slowing of neutrons, hydrodynamics, atomic and nuclear physics, and elasticity.

BACKTALK

(continued from page 152)

questions raised in the various symposia of the recent IRE convention in New York. It appears that a number of persons are interested in certain branches of medical electronics which are outside the scope of existing professional groups. However, the organization of such a group is quite a task at the best and it may be to our advantage to organize it within the IRE.

I have been assured that the IRE is interested and will do what it can to help. The task at hand now is to locate those persons who wish to become members of this group. The location of these people is complicated by the fact that they are scattered geographically, and in addition the papers they have published on medical-electronic subjects are scattered through all types of technical and medical publications. Therefore I am turning to ELECTRONICS to help locate them through this letter.

In other words, if any one is interested in becoming a member of the medical electronics group of the IRE, when organized, it would be appreciated if he would send me his name, address and state whether or not he is now a member of the IRE. Those interested will then be placed on the mailing list and notified as to the progress of the organization.

L. H. MONTGOMERY
Dept. of Anatomy
Vanderbilt University
School of Medicine
Nashville 4, Tennessee

Too Big

DEAR SIRS:

I HAVE JUST finished reading your editorial in May 1951 *Crosstalk* on the recent six-ring circus otherwise known as the IRE Convention and I want to take this opportunity to assure you that there are many others who agree with your sentiments. It was all too obvious to many that the attempt to funnel the large number of people present into six simultaneous sessions was disastrous, and that those who wished to pick up an early paper in one session and then transfer to another found themselves just as you mentioned—"out of luck." You may be sure that your final com-

ment in regard to the use of "a sharp and heavy axe" has found a responsive chord in me.

I have heard numerous expressions to the effect that it would have been much better to have had a major reduction in the number of papers and a major improvement in their technical excellence.

Since this is the first time I have ever written to an editor of any magazine, I may as well comment further on the sound editorials which now appear over the signature of McGraw-Hill Publishing Co., Inc. The sound advice on economic questions offered so many times in the past would seem sufficient reason for placing the President and the members of our Congress on your mailing list.

ELLSWORTH D. COOK
General Engineering Laboratory
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And, It Works!

DEAR SIRS:

ALTHOUGH I do not subscribe to ELECTRONICS, I always try to read every issue. For quite some time I have been doing a lot of experimental work with neon relaxation oscillators for use in electronic organs and I won't hesitate one moment to say these simple little oscillators have almost driven me to the point of throwing everything into the junk box and quitting.

I have tried and tested all circuits that have appeared lately in other magazines, but all these articles and circuits dwell on theory as to what these circuits should do. But they never work out in practice. Every article and writer has had a different theory on the way the neon tubes are to be synchronized with the master oscillators. The main difficulty was, of course, with frequency stability.

Then along comes a swell article on "Gas-Diode Electronic Organ" by Robert M. Strassner in your January 1951 issue. After all the hard work up to now I decided to give the circuits shown in his article a try. What a surprise. For the first time in months I had something put together that really worked.

My research into the subject of

electronic organs has covered all articles and every circuit I could lay my hands on, but Strassner's way of using an electrostatic coupling between the master oscillators and the neon relaxation oscillators in the octave divider chain is the best I've seen and tried.

As you must already know, this subject of electronic organs has become quite popular in the last year or so, and is given quite some space in other magazines; Richard Dorf, writing these articles, has been snowed under with letters asking for more information on the subject. These articles of his offer nothing concrete, but just enough to get the fellows started.

With what Strassner offered in his first article, why can't we have another by him and let him go a little deeper into the subject of master oscillators and the way the switches are mechanically linked to the playing keys. This subject demands another article giving a complete schematic and other constructional details.

Robert Strassner has kindled the spark in lots of fellows like myself, and now all we need is another good article to keep the fire going. I know that a swell magazine like ELECTRONICS won't let us readers down.

GLEN E. TURNER
Fresno, California

Student Answers Briton

DEAR SIRS:

I SHOULD like to comment on the letter by C. H. Banthorpe published in the April, 1951 issue of ELECTRONICS. One might almost say I should like to take issue with him, for I feel that his statements are rather dogmatic on the basis of what has apparently been somewhat limited listening to vhf programs. There are no doubt many desirable features of a-m for vhf broadcasting, not the least of these being the use of the same detector for both the medium-frequency band and the vhf band during this changeover period when in most communities reception of both media is necessary to full program coverage. However, I should like to point out some considerations which

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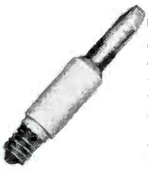

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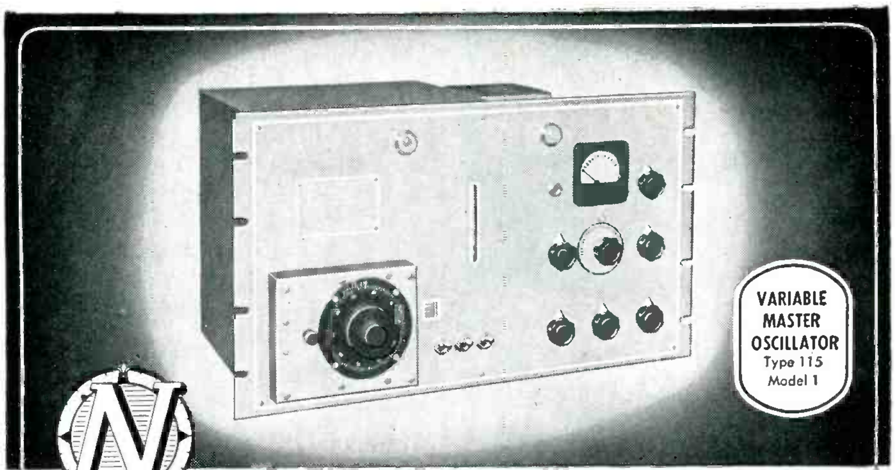

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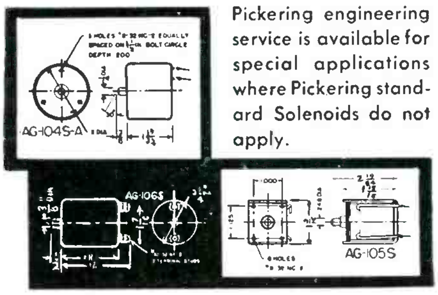

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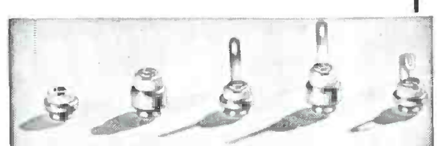

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I believe favor f-m, at the same time inviting criticism of my views by any and all who are qualified.

Banthorpe makes the very good point that comparison of f-m on vhf with a-m on m-f is often misleading. This is quite true. But he then goes on to apparently commit this same misleading comparison in commenting on the relatively complex nature of the vhf f-m receiver compared to the m-f a-m receiver. I cannot see how the method of detection would materially influence the major problems of oscillator stability and low gain per stage. The first appears to be a consequence of the very high frequency at which the local oscillator must operate, and the second to be a consequence of the high intermediate frequency necessary to prevent the local oscillator locking in with the incoming signal. As a matter of fact, the gated beam tube recently developed in this country may make the f-m vhf set less complex than its a-m complement. This tube and very few associated components produces near zero time constant limiting, and is a discriminator that delivers sufficient output to permit doing away with the first audio tube. It also obviates the necessity for an automatic gain control circuit, saving several parts.

Automatic gain control deserves a bit more comment. Fades that reach the lower audio frequencies in their rates of occurrence are not uncommon on vhf. They are particularly noticeable in the presence of nearby aircraft, a problem far from negligible now, and one not likely to decrease. To design a circuit with time constants such that it can deal with these fades with anything approaching the effectiveness of the f-m limiter and which will yet not act to attenuate or distort the lowest modulation frequencies of the a-m signal sounds to me like quite a project, and one not likely to contribute to economy.

And that brings up attenuation of frequencies in the reproduced signal and distortion. In the a-m receiver, if flat response is to be achieved, along with good signal-to-noise ratio and adjacent-channel selectivity, the i-f curve must approach the ideal very closely. In the f-m set, minor departures from the ideal are cleaned up by the limiter. And since the i-f curve and tuning are so closely linked, it might be well here to point out that if the i-f response were made optimum for adjacent channel selectivity and noise level, the same amount of detuning that causes moderate distortion on f-m (this considered to be a weakness of f-m) would not only cause distortion, but might even tune right off the station completely.

Banthorpe has excited my curiosity about several new English developments. He notes that there is available a simple diode noise limiter of value for broadcast work. This is obviously a considerable improvement over the latest type of noise limiter I have seen for a-m receivers, for this type is capable of limiting noise only to the level of the maximum modulation of the received signal. Since the noise level for good reception of entertainment should be somewhat lower than this, I had always supposed the device to be virtually useless for broadcast reception, even discounting the extremely critical adjustment of the threshold control.

He has also whetted my interest in the BBC tests. I am a little chagrined that the only comment on the method of modulation used in the BBC f-m transmitter is that it is a "simplified design". (This is not Banthorpe's statement, but comes from another publication and is the most description I have so far been fortunate enough to find.) Despite my great faith in the high engineering standards of the BBC, this reticence to comment tends to disturb me. It also appears that Banthorpe has been willing to draw conclusions somewhat before the BBC itself was willing to do so.

Now as to the use of f-m sound with television, in addition to the foregoing we may sight the ease of separation of sight and sound intelligence when different modulation systems are employed for the video and audio portions of the signal. Indeed, the intercarrier technique of beating the sound against the picture carrier to obtain the 4.5 i-f would doubtless be impossible with a-m, and this is one of the tools that contributes to low cost of many of the cheaper receivers in this country.

As to overwhelming arguments for 405 lines, suffice it to point out that on the 20-inch tubes now becoming popular for use in even quite small rooms, the lines of such a system would be of the order of $\frac{1}{32}$ inch. The trend here has continually been one of greater definition—a progressive, not a retrogressive trend.

As I commented at the start, I submit these comments with a degree of humility, as befits a college student coming before the learned group that is the ELECTRONICS circulation. If I have at least shown that there might be another side to the discussion, I shall be satisfied.

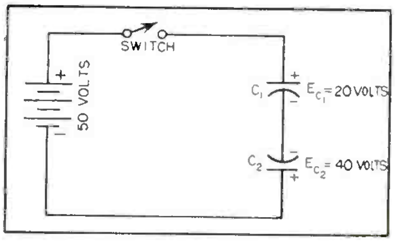
ROBERT F. HOOPER
Student
Albion College
Albion, Michigan

Electronics Quiz

THIS month's puzzler was submitted by Robert C. Burns of Hicksville, Long Island. For this contribution, Burns will receive our check for \$5.00, as will all other contributors whose problems are accepted and published in this department.

This Month's Problem

Given the following circuit, and assuming a perfect battery and perfect capacitors,



what will be the final capacitor voltages after the switch is closed?

Answer will appear next month.

Last Month's Problem

Last month's problem involved the charging of the capacitor in the circuit diagram of Fig. 1A. It was desired to determine the initial charging current flowing into the capacitor at the time the

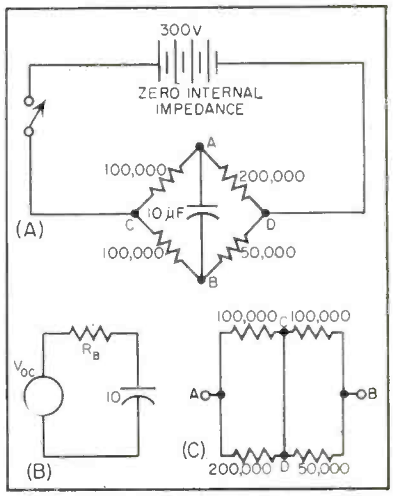


FIG. 1—Solution of last month's quiz problem

switch was closed, and also to determine the time constant of the circuit.

The answer submitted by the author of the problem is as follows: "By Thevenin's theorem, the circuit can be reduced to that shown in Fig. 1B where V_{oc} is the open-circuit voltage at AB (that is, with capacitor removed) and R_B is the output resistance (the resistance looking back into AB, with all sources of emf replaced by their internal resistance). Clearly, V_{oc} is 100 volts, and by Fig. 1C, R_B is 100,000 ohms. At the instant of closing the switch the capacitor appears as a short-circuit, and the initial current is V_{oc}/R_B or 1 ma. The time constant $= CR_B = 10 \times 10^{-6} \times 10^5 = 1$ second.

It is worth noting that the initial current can be found using Kirchhoff's Laws and replacing the capacitor by a short-circuit, but the time constant cannot be easily found in this manner.

Electronic Organ

DEAR SIRS:

SINCE the publication of my article entitled, "Gas-Diode Electronic Organ" (ELECTRONICS, Jan. 1951, p 70), two mistakes in diagrams have been brought to my attention. On page 72, Fig. 2, the lead marked −100 v should be connected to the ground bus. In Fig. 3 the waveforms should show initial discharge peaks at the beginning of each positive and negative half-cycle.

ROBERT M. STRASSNER
Monterey Park, Calif.

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(Continued on page 285)

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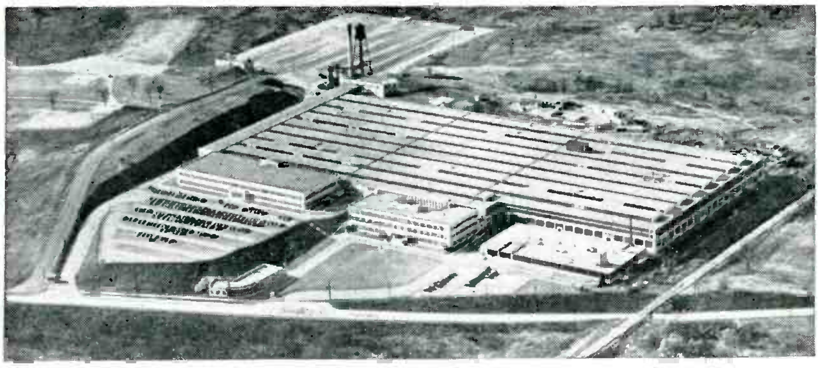

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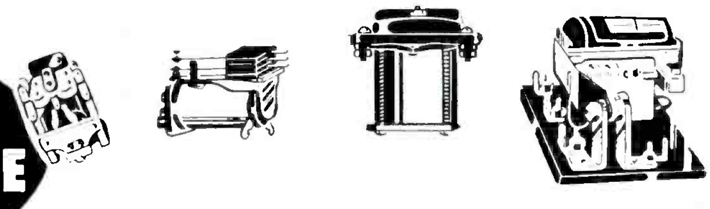

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R-801	115*	——	None	1.45
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R-115	24	500	1C	1.70
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R-680	6	3	1A/50 Amps.	3.90
R-677	6	3.5	1A/50 Amps.	3.90
R-532	6	15	1A/50 Amps.	3.90
R-676	12	16	1A/50 Amps. 1 Aux/25A	3.90
R-678	12	18	1A/50 Amps.	3.90
R-656	12	100	1A/100 Amps.	2.60
R-553	24	55	1A/5 Amps.	4.05
R-679	24	80	1A/50 Amps.	3.90
R-610	24	80	1A Double Break	2.05
R-555	24	100	1A/50 Amps.	4.80
R-533	24	150	1A/50 Amps.	4.05
R-717	24	200	1A/50 Amps.	3.45
R-703	12	20	2A/25 Amps.	2.80
R-748	24	60	1A/30 Amps.	2.45
R-655	24	80	1A/50 Amps.	6.05
R-654	24	150	2A/40 Amps.	2.40
R-742	24†	70	1A/25 Amps.	3.05

ROTARY RELAYS

Stk. No.	DC Voltage	Ohmage	Contacts	Unit Price
R-709	6/8	1	12 Pos. 3 Wafer	$3.90
R-197	9/16	70	2C	1.45
R-713	9/14	125	1C & 1A	2.05
R-198	9/14	125	3B, 3A, 1C	2.05
R-616	28	7	5B & 1A	1.90
R-712	24	200	2B	2.05
R-711	24	200	2C & 1B	2.05
R-573	28	200	1C & 1B	2.05
R-284	28	200	4C & 1B	1.45
R-200	24/32	275	3C & 1B	2.05
R-766	24	230	12 Pos. 8 Deck.	4.90
R-809	28	7	1B & 12 Pos. W/ 7" Shaft for Wafers.	2.45

W-E- TYPE "E" RELAYS

Stk. No.	DC Voltage	Ohmage	Contacts	Unit Price
R-736	18/24	600	3C	$1.50
R-585	12	650	2C	1.30
R-287	12/24	650	2C	1.30
R-164	24/32	1000	1A	1.50
R-646	24/48	1300	1B	1.50

DIFFERENTIAL RELAYS

Stk. No.	DC Voltage	Ohmage	Contacts	Unit Price
R-208	120	2000	2C/3 Amps.	$2.45
R-209	220/250	8000	1C/3 Amps.	3.10

SEALED RELAYS

Stk. No.	DC Voltage	Ohmage	Contacts	Unit Price
R-658	6	35	2C/Octal Plug	$3.45
R-125	24	300	2C/Octal Plug	3.45
R-261	12/24	1900	1C/5 Pin Plug	3.75
R-673	48/150	7500	1C/5 Amps.	2.80

VOLTAGE REGULATORS

Stk. No.	DC Voltage	Ohmage	Contacts	Unit Price
R-745	6	2	1A/10 Amps.	$1.05
R-780	24	350	1C/6 Amps.	1.05
R-509	6/12	35	1B/2 Amps.	1.05

SPECIAL RELAYS

Stk. No.	DC Voltage	Ohmage	Contacts	Unit Price
R-503	12/32	100	3A, 2C	$2.80
R-749	600	——	Max. 28 Amps.	7.45
R-804	550*	——	1B/38 Amps.	4.35
R-250	115*	——	Adj. Cir. Bk.-.04-.16A	17.50
R-579	220*	——	1B	8.70
R-294	27.5	200	1B	5.35
R-686	115*	——	2C	6.10
R-246	115*	——	1B	11.20
R-246A	115*	——	1A	11.20
R-611	24*	——	1A/30 Amps.	5.35
R-283	12	125	1C/10 Amps.	1.25
R-614	12/24	60	1A/15 Amps.	4.35
R-262	——	200	1C	4.70
R-245	12	25	4" Micalex Lever	1.20
R-527	6/12	50/50	In Series	1.20
R-544	12/24	60/60	1C	2.05
R-255	——	——	1A	1.20
R-669	75*	400 Cy.	1B, 1A	1.20
R-660	6	——	3/8" Stroke	1.20
R-651	24	100	Solenoid Valve	3.10
R-295	12	275	Annunciator Drop	2.70
R-230	5/8	2	2A, 1C	2.70
R-813	12	12	Wafer	5.35
R-275	12	750	1A, 1B, 1C	3.45
R-716	24	70	2A/5 Amps.	1.80
R-620	6/12	35	2C, 1A	1.30
R-629	9/14	40	1C/10 Amps.	1.55
R-720	24	50	2C, Ceramic	1.70
R-500	12	10/10	2C/6 Amps.	3.55
R-816	12	10/15	2C/6 Amps.	3.55
R-524	24			1.20
R-566	115*	Coil Only		1.00
R-710		150 Coil Only		.75

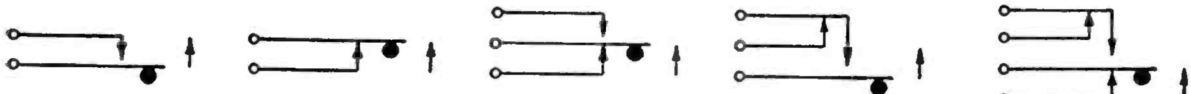
* AC † AC/DC

SPECIAL!

CO-AXIAL RELAY

D153766 SPDT, 6 VDC. 19 OHM Coil. Designed to accommodate 75 watts maximum. Perfect for all types of antenna switching. Designed for using standard 83-1SP coaxial fittings. Part of RAX-1 equipment. No. R-845 $6.95 ea.

BASIC CONTACT ASSEMBLIES SHOWN IN UNOPERATED NORMAL POSITION



Form A—"Make" (Single Throw, Normally Open) | Form B—"Break" (Single-Throw, Normally Closed) | Form C—"Break-Make" (Double-Throw) | Form D—"Make-Before-Break" | Form E—"Break-Make-Before-Break"

WRITE FOR WELLS CATALOG

TELEPHONE **SEeley 8-4143**

WELLS SALES, INC.

833 W. CHICAGO AVE., DEPT. SL, CHICAGO 22, ILL.

EE8 TELEPHONE PARTS LARGE QUANTITY COILS, BLOCKS, CORDS

ARC/5 SPARES & PARTS

2830 KC IFs for 6-9 Rec. (3 coils, inp, int, out) per set	$1.25
#6234 6-9 RF...........ea.	.65
5856 2830 KC BFO coil 6-9 Rec.	.49
5414 Cond. 3 x .05 300V	.05
5415 Cond. .05-.01-.05 300V.	.10
6261 Xfrmr. Mike to Grd...	.79
6029 Osc. coil	.79
6030 Osc. coil	.79
6032 Osc. coil	.79
7247 coil Pa	.79
Parasitic Surpressors	.05
Plug 6 pin for IF	.10
Plug 7 pin for Rec. chassis	.10
Plug 3 png. rec. dyn. male — female	.15
Plug 3 png. mod dyn. female.	.15
#7023 5 png chassis mnt	.29
5842 plug rear Rec. & Xmtr. male	.39
5577 Plug 5 png. chassis Rec. mnt.	.29
6418 Plug 8 png. chassis Rec. Mnt.	.29
7027 plug 18 pin mod. chassis.	.29
PL 154A 12 png. male	.49
PL 153A 18 png. male	.49
PL 148 3 png. male	.49
PL 156A 5 png. male	.49
#2674 3 png. plug for HF Rack	.29
Rec. plates 190-550 KC	.10
Control Box plates 190-550	.10
#6035 Loading coil	.59
#6034 Loading coil	.59
#7992 Loading coil	.59
Dual Fuse mnts	.12
Xtals for Xmttrs Tube Type	1.00

Tubes: 1626 1029 1625

ARC 5 MODULATOR MD7/ARC5 w/ dynamotor complete w/ Tubes 1-12J5, 2-1625, 1-UR 50. Good cond. Price ...$6.95

EE89A Telephone Repeater

Used to extend range of field telephones. Simplex Teleg. and 20 cycle ringing possible over lines equipped with unit. Supplied w/305 tube. Phone supplied. (Feather-weight) $9.45

SCR274 Screen Mod. XFRMR for pair of 807's PP — PP or Parll Sidetone Wndg. ...95c

Xmfrs VFO Drivers 40 Watts Output 274N (ARC5)

4-5.3 MC $5.95
5.3-7 MC $5.95
7-9.1 MC $13.95
Used Good Cond.

NEW TEST EQUIPMENT

Frequency Modulated Generator, Type 155A Frequency 38 MC—50 MC. Range 1 MC—10 MC. Boonton Radio.
Solar Exameter Capacitor Analyzer
Tube Tester Model 7050. Philco 110/120 AC 60 Cy.
3" scope No. 155A C. R. Oscillograph R.C.A.
Test Set I-180A. Hickok Model 540 Test Equipment Tube checker.
Sweep Signal Generator Model 909.
McMurdo (Silver). Range 2-226 MC. Output 0-.5 V Max. 105/125V 50/60 Cy. 35W.
Frequency Meter BC221N 125-20000 KC.
Precision Series E-400. Sweep Generator FM-TV-AM.
Signal Generator Model 702. Radio City Products.
Standard Signal Generator Model 78B. Boonton (Measurements Corp.)
Television Calibrator WR-39A. R.C.A.
Microvolter Model 20-B Ferris Instrument Boonton.
Signal Generator I-216 15-26 MC CKE 115V/60 Cy. 180-235 MC.
Model LU-1. Radar Test Equipment. Frequency meter & Test Oscillator.
Industrial Instrument Bridge. LB2 DR1. 10 Watt 115V 60 Cy.
Industrial Instrument Bridge RN-1
Hunter charging control analyzer Model 372K2.
Hickock Thermo Ammeter Model 14T #1-4270.
Weston DC Milliameter Model #155
Leeds & North Type S Test Set #5300 #5410.
RCA Voltmeter Ohmyst.
Leeds North Galvanometer #2420A.
GR Output Meter #783A.
Boonton Q Meter Type 160A & 170A
Industrial Bridge LBID.

Write or Phone for Price

Miniature Water Tube Socket, 10 for 45c.

VARIABLE CERAMICONS

395-475 MMF	.20c
170-315 MMF	.20c
22-195 MMF	.20c
12-145 MMF	.20c
15-160 MMF	.20c
5-50 MMF	.20c
Set of 6 for	$1.00

MODULATION XFMRS

#T104 P-P 6L6's to 832 RF, 20W........$1.49
#5651 Screen Mod. 807 to P-P or Par. 807's: Sidetone Wdg........95c

METER SPECIALS

AMPS—RF

0-4 Amp RF GE Type DW52. 2% Accuracy. Expanded Scale, 2.19" dia. Int. Thermocouple. List Price $19.75. Our Price............$2.95

10 MFD 600 V Oil Condenser (2.5-2.5-5 MFD) Special Price $2.95

AVAILABLE IN STOCK LARGE QTY. RC 375 or SCR 191 PARTS AND EQUIPMENT PHONE—WRITE

AIR TRIMMER CONDENSERS

C89015 MMF
C993 50MMF
C881 20MMF
C677 60MMF
32c ea.

INVERTER PE 218

IN: 28VDC 92A. Out: 115V, 500 cy. 1500 VA.
NEW $49.50
USED, EX $35.00

THERMISTORS

D-166288	$1.50
D-168392	$1.75
D-167332 (tube)	$1.50
D-170396 (bead)	$1.50
D-167613 (button)	$1.50
D-164699 for MTG in "X" band Guide	$2.50

VARISTORS

D-167176	$ .95
D-172155	$2.25
D-172307	$1.75
D-167208E	$1.85
D-172155	$1.65
D-168687	$ .95
D-171812	$ .95
D-171528	$ .95
D-165593	$1.25
D-162356(308A)	$1.50

SELSYN MOTORS

115VAC 60 cy #C78248. Can be used to turn Ant. Small Ind. Also Differential C-78249 3½"x5½". Set of both **$15.95 PR.**

MOBILES! C.A.P. C.D.!

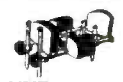
6 V. DYNAMOTOR SUPPLY RATINGS

	OUTPUT	INPUT
Volts	450 VDC	6 VDC
Amps	350 MA	45A
OR		
Volts	450 VDC	6 VDC
Amps	200 MA	22A

Originally designed for 14V. but mobiles over U.S.A. report ex. results on 6V. Brand New, w/Filter Box, Starting Relay, Mounting Plate. Plugs. Set of 2....$1.00 (With Dynamotor only) **$12.95**

BATHTUB CAPACITORS

MFD	Volt	Type	Price Each	10 for
.5	400	2BT	$0.23	$2.20
.5	600	2TT	.25	2.40
3x.1	600	3TT	.45	4.35
3x.1	600	3ST	.45	4.35
2x.1	400	3ST	.26	2.50
2x.1	600	3ST	.28	2.65
2x.1	600	3BT	.28	2.65
2x.1	400	2TT	.26	2.50
2x.1	200	2ST	.23	2.20
2x.1	600	2BT	.26	2.50
2x.1	600	3TT	.26	2.50
.1-.1-.025	400	3ST	.28	2.65
.1	600	2BT	.22	2.10
.1	600	1ST	.22	2.10
.1	600	2TT	.22	2.10
.1	600	2ST	.22	2.10
.13	600	2ST	.25	2.40
2x.25	600	3ST	.30	2.85
.05	600	2TT	.21	2.00
1	100	2TT	.23	2.20
20	50	2ST	.26	2.50



30 MMF per sect. 2 Sections Very Good U.H.F. High Power Final Complete w/ins. Coupling $2.49

BC605 Interphone Amplifier

Easily converted to an ideal intercommunications set for office—home—or factory. Brand New **$4.75**

VARIABLE TRIMMER CONDENSERS

C890 15 MMF
C881 20 MMF
C993 50 MMF
C677 60 MMF
32c ea.

NEW!! Electrolytic Capacitors Condensers

DY Twist PNG

Mfd.	Volt
80	150
60	300
40	250
80	250
80	300
30	300
100	150
20-20	400-25
2 x 30	25
20-10	150
40-20	150-25
150-50	25
40	150
2 x 10	150
10-2 x 20	400-50

Price 18c ea.

50	500
50	400
80	450
100	350
2 x 4	500
2 x 8	450
20-80	450-350
15-10	450
80-10	400
80-20	450-350
3 x 8	150
3 x 10	150
800	15
30	450
32	450
2 x 10	350
2 x 15	350
8	450
20-10	350-300
2 x 15-20	350-25
2 x 10-20	450-25
2 x 8-10	35

Price 29c ea.

80	500
40	450
100	400
90	450
2 x 10	450
2 x 20	400
2 x 20	450
20-8	500
2 x 80	300
40-10	450-350
40-35	450-350
80-20	450
80-10	450
3 x 16	350
8-50	450-50
40-50	400-300
40-10	475
90-10	350
3 x 10	450
50-40	450
20-10	350
40-15	450
2 x 30	350

16	450
2 x 16	450
20-10 (50)	450 (50)
20	150
(250-100)	(15)
80-50	450-50
2 x 8 (10)	450- (25)
10-15 (20)	350 (25)
2 x 16-25	450-50
2 x 10-20	450-25
10-10-20	450

Price 39c ea.

250-1000	10-6
2 x 15-1200	150-1.6
10-50-100	350-100-50
1000-500	6

Price 69c ea.

Mfd.	Volt
2 x 20 (60)	450 (350)
2 x 30 (20)	350
80-40 (150)	400 (50)
2 x 40 (20)	350 (25)
20-10 (50)	450 (50)
50-40	425

Price 49c ea.

1000-250	12-8
250-1000	10-6

Price 89c ea.

★★★★★★★★

MINICAPS PIGTAIL

Mfd.	Volt	Price
2	50	.10
4	50	.10
4	100	.15
4	150	.10
4	220	.18
5	25	.10
5	50	.10
5	150	.10
8	25	.15
8	100	.18
8	150	.18
8	350	.20
10	50	.18
10	150	.20
12	450	.23
16	100	.20
16	150	.22
16	300	.30
16	450	.40
20	25	.10

20	50	.15
20	80	.18
20	350	.30
24	350	.30
25	25	.10
30	300	.25
30	450	.30
40	150	.22
40	450	.40
50	25	.22
50	50	.25
50	150	.39
100	50	.60
250	15	.50
500	8	.60
500	25	.75
1000	6	1.20
2000	6	1.35
1200	1.5	1.10
8-8	450	.60
8-16	450	.65
10-10	150	.30
10-10	450	.35
16-16	450	.70
20-20	150	.40
20-20	450	.50
40-20	450	.55
50-50	150	.40
50-30	150	.35
70-70	175	.85

ELECTROLYTICS Prong Mount D. Y. Type A.C. Cond.

13-15	220-1.20
20-24	110-1.00
26-30	220-1.35
43-65	110-1.25
43-48	110-1.25
50-75	110-1.25
53-60	220-1.50
61-69	320-1.60
64-72	110-1.25
72-87	110-1.25
75-84	110-1.25
88-106	110-1.50
107-129	110-1.65
130-157	110-1.75
130-150	70-1.50
130-180	110-1.85
158-191	110-1.85
161-180	110-1.75
189-210	110-1.95
200-220	110-1.95
270-300	110-2.40
324-360	110-2.40
378-420	175-3.00
432-480	110-2.75
485-540	110-2.85

HIGH CURRENT CERAMIC MICAS

.0012	20000	$32.50
.0001	20000	32.95
.001	6000	4.95
.002	6000	4.95
.01	4000	3.95

DO Plug in Type C

2 x 20/25	.25
2 x 10/450	.40
16/450	.35
16/600	.45
10/450	.35
15/450	.35
8/600	.45
3 x 10/450	.40
10-10/20/450	.40
2 x 160/150	.35
2 x 80/50	.25
100-10-10/250	.35
3 x 100/25	.35
2/ 40/150	.35
80/450	.45
30/450	.40
50/100	.25

DT Pigtail Type J

100/25	$ .08
10/25	.08
10/50	.08
8/300	.15
8/50	.08
2/25	.08
4/50	.08
8/150	.10
4/150	.10
12/450	.15
10/150	.10

DHS Leads Paper Type J

8-8/450	.40
8-16/450	.45
50-30/250	.40

DI Screw Lug Type B

2 x 20/450	$ .60
2 x 10/450	.50
16-8/450	.60
20-51/450	.50
16/450	.50
8-8/450	.60
25/25	.25
24/475	.30
40/450	.40
2 x 24/400	.50
50/50	.30

D Screw Leads Type B

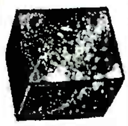
12/250	$ .40
40/250	.40
8/250	.40
8/450	.45
2 x 8/450	.55
4/600	.60
8/600	.75
24/250	.50
20/450	.55
24/250	.40
16/600	.75
30/450	.65
16/450	.65
12/450	.50

Elimostat Bell Aircraft Solar Type EA 105 $3.95

CRYSTALS Low Frequency

FT-241. A holder ½" pin spacing. for ham and general use. Xtal controlled Signal Generators, marked in army Mc harmonic frequencies—Directions for deriving fundamental frequencies enclosed. Listed below by fundamental frequency, fractions omitted.

370	424	472	505	537	
372	425	473	506	390	
374	426	474	507	391	
375	427	475	508	392	
376	429	476	509	393	
377	430	477	511	394	447
379	431	479	512	395	448
380	433	480	513	396	450
381	434	481	514	397	451
383	435	483	515	398	453
384	436	484	516	400	457
385	437	485	518	401	463
386	438	486	519	402	465
387	440	487	520	403	498
388	441	488	522	404	501
412	442	490	523	405	538
413	443	491	525	406	540
414	444	492	526	407	
415	445	493	527	408	
416	458	494	529	409	each
418	459	495	530	411	$1.49
419	460	496	531	each	
420	462	497	533	59c	
422	469	503	534		
423	470	504	536		



400 MA 12 HY Choke

90 ohms Herm. sealed. Special $3.75

932 PHOTO TUBE

Gas Phototube having SI response, particularly sensitive to Red and Near Infrared Radiation. Can be used with incandescent light source. Send for Data

Price 75c

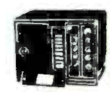
RL 9 or RL 7

Interphone Amplifier Convert to High Fidelity Phone Amp. or Spch. Amp. Complete w/12A6, 12SL7, 2 Chokes, 1XFRMR DYN for 24v operation, etc. $2.75

MODEL GO-9 TRANSMITTER

All brand New. 100 Watts CW, or MCW. emission. Operates from 110 V., 800 Cycle, easily converted to 60 Cycle operation. Low frequency range, 300 KC. to 600 KC. High Frequency 3,000 KC. to 18,000 KC. using an E.C.O. We furnish complete conversion data with each transmitter. Complete with schematics $69.95

BC-604-FM TRANSMITTER: 20-28 mc. 11 and 15 meters. Ideal for C.D. Can be put on 10-meter, 10-channel, push-button control. Complete with tubes and dynamotor. Used. Excel. cond........ $19.95



PRECISION RESISTORS

1.01	128	2230	30000
3	150	4300	33000
5	200	5000	35000
5.05	250	7500	40000
10.1	300	8500	50000
18	430	10000	55000
43.5	468	12000	57000
50	800	17000	75000
75	920	17300	We ship
82	1000	20000	type in
120	1100	25000	stock
125	1450		

Above Ea...30¢ Ten For....$2.50

100000 150000 200000
120000 170000 220000 500000

Above Ea...40¢ Ten For... $3.50

1,000,000 ohms...........Each 75¢

W.E. PRECISION RESISTORS

D-164886A	2.65 ohms
D-164886AA	3.83 ohms
D-167026	13,500/10,500 ohms
D-162025AT	1400/135/270 ohms
D-164285	40,600/1500 ohms
D-166860FL	1155 ohms
D162707CY	2500 ohms
D-171862	279 ohms
D-171863	591 ohms
D-164286	10,000/15,000/62,000 ohms
D-164284	100,000/50,000 ohms
D-172241	400/600/700/750 ohms

@ 75c ea.

All merch. guar. Mail orders promptly filled. All prices F.O.B. N.Y.C. Send MO or Chk. Only shipping chgs. sent C.O.D. Rated concerns send P.O.

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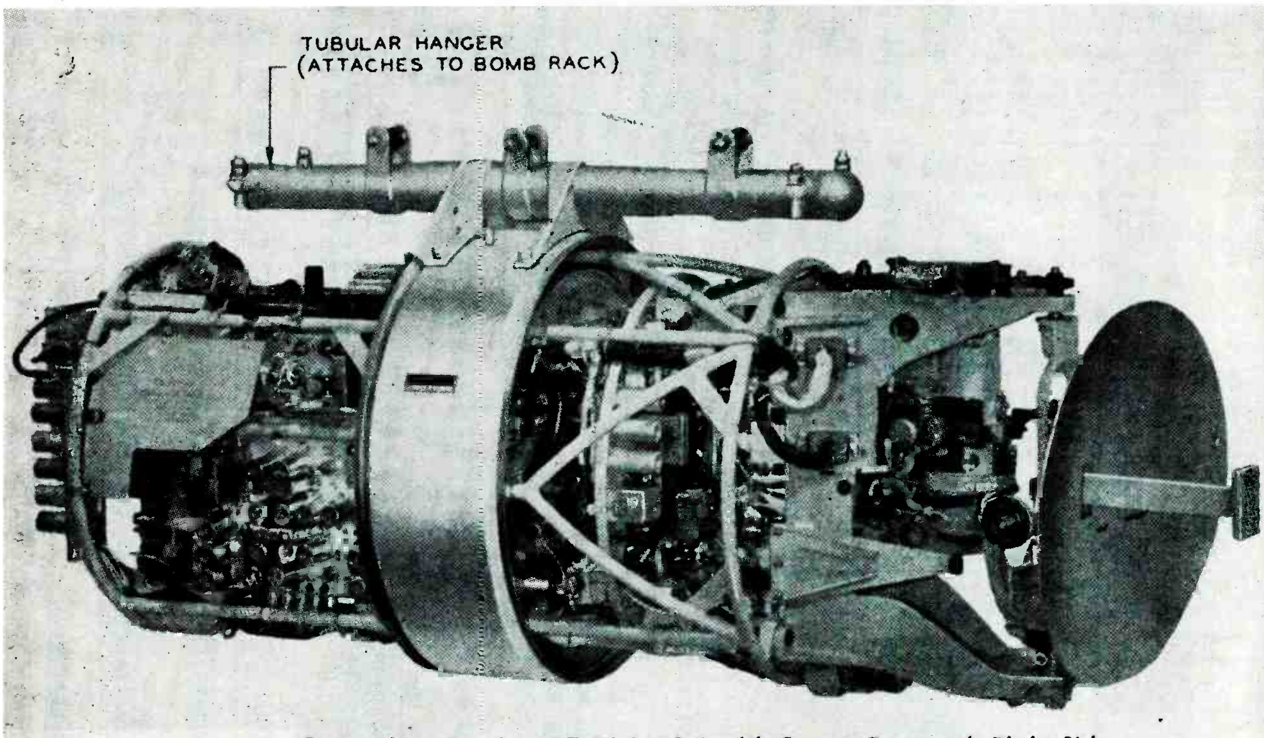
COMMUNICATIONS EQUIPMENT CO.

AN/APS-4 RADAR

COMMUNICATIONS EQUIPMENT CO.

Airborne Search-Intercept equipment—A light weight airborne equipment for operation at frequencies in the X Band designed primarily for use on the Navy's carrier-based planes. It can be employed to perform the following functions on *any type aircraft*.

1. **Radar Search operation over large bodies of water for the detection of vessels on the surface.**
2. **Mapping and navigational operation.**
3. **Detection and location of other aircraft to permit their interception.**
4. **Picking up the coded signals from the beacon stations in the X-band to facilitate the return of the searching plane.**
5. **Operation as the search element in conjunction with identification equipment.**



Transmitter-Receiver RT-5A/APS-4 with Covers Removed, Right Side

Complete Installation—Packed—Write for Price and Details—"Underbelly Assembly" As Illustrated Less Tubes $375

This equipment searches by use of a "nodding" and sweeping paraboloid antenna which emits a beam of RF pulses into space and receives reflected pulses back from targets in the path of the emitted beam. The received pulses, together with "antenna position" information and time they are received, are displayed on indicators in a manner which determines azimuth and "slant range" of targets within the area searched. The antenna can be oscillated to scan 75 degrees of azimuth on either side of dead ahead and can be tilted vertically to direct the beam at any angle from 10 degrees above horizontal axis of the plane to 30 degrees below that axis but, due to "leakage" of the radiated beam, the "30 degree below axis" antenna position affords sufficient radiation to scan directly below the plane and for a considerable distance surrounding that point, which makes it deal for detection of **SUBMARINES**. Nominal ranges of operation for this equipment are as follows:

(1) Ships ....30 Miles
(2) Aircraft ....3 Miles
(3) Land Targets ....75 Miles

Power requirements for the complete equipment are as follows:
28 volts DC. — 3 to 4 amps. or 115 Volts — 800 to 2400 cyc AC, 6 amps.
Frequency of operation is inthe order or 9, 310-9, 375 MCS.

(a) Receiver — Transmitter Unit

I. RT-5A/3PS-4

The receiver-transmitter is contained within a "bomb-shaped" fibre-composition housing and is commonly called the "bomb." The bomb-unit is sealed and pressurized on the ground with dry air to a gage pressure of 5 lbs. per square inch. It is usually mounted beneath the plane's lower wing and supported in a standard Navy bomb rack whereby (in emergency) the pilot can dispose of the unit by activating the release mechanism. Located in the nose of the "bomb" is the paraboloid reflector and wave-guide fed antenna. The transmitter portion comprises four major circuits, namely:

(1) Triggering Circuit
(2) Charging Network
(3) Discharge Circuit
(4) Magnetron Oscillator

The charging network is charged to a high potential, then rapidly discharged thorugh a pulse transformer which impresses a large negative voltage of short duration to the cathode of a "grounded-plate" magnetron oscillator which causes the magnetron to vigorously oscillate, for the duration of its cathode impressed pulse, and send forth to the antenna a powerful burst of RF energy at a frequency of 9, 375 MC. The triggering circuit initiates the pulse which causes the discharge of the network. When the magnetron oscillator "fires" its burst, that energy passes through a T-R Box enroute to the antenna. The T-R Box acts as a valve which functions to isolate the receiver input from the transmitter output, yet when the weaker reflected signals are picked up by the antenna, this same T-R Box allows that weak signal to be accepted by the receiver portion undamped by the transmitter portion of the equipment because of its isolation. The incoming signal, after clearing the T-R Box, is then mixed with the output from a local oscillator, in a crystal converter from the output of which is picked off a 60 MC IF signal. There are two local oscillators, one of which is used during SEARCH and INTERCEPT operations and is tuned to 60 megacycles above the transmitter frequency while the other (used for BEACON operation) is tuned to 60 Mc below the transmitter frequency. The 60 MC signal is fed into 2 stages of IF preamplification which is then followed by 5 single-tuned IF stages.

Following this a 6AK5 detector (connected as a cathode follower feeds the video amplifier. Part of the output from the 2-stage preamplifier is used to energize an AFC circuit which controls the frequency of the local oscillator. At the video amplifier (which is a separate unit from the Receiver-Transmitter) the video echo signals are mixed with RANGE MARK PIPS and the combination is applied to cause signal indications to appear on indicator screen which describe the range of the object from which the initial transmitter output signal was reflected.

Tube Complement:

TRANSMITTER PORTION

1 ea. — JAN 1B22	1 ea. — 725A
4 ea. — JAN 3B24	1 ea. — JAN 807
3 ea. — JAN 6J6	

IF AMPLIFIER PORTION

6 ea. — JAN 6AK5

RANGE AND ALARM UNIT

15 ea. — JAN 6J6	1 ea. — JAN 6AK5

LOW VOLTAGE POWER SUPPLY

3 ea. — JAN 5U4G	1 ea. — JAN 6SL7GT
1 ea. — JAN 6J6	1 ea. — OC3/VR105-30
5 ea. — JAN 6V6GT	4 ea. — OD3/VR150-30

RECEIVER PORTION

2 ea. — JAN 6J6	2 ea. — 723A/B
3 ea. — JAN 6AK5	2 ea. — 724A
1 ea. — JAN 6SL7GT	

CONTROL AMPLIFIER PORTION

1 ea. — JAN 6AK5	2 ea. — JAN 6J6

BEACON TUNER PORTION

1 ea. — JAN 6J6

(b) Indicator—Amplifier 1. AM-5A/APS-4

Consists of video amplifier and range-mark generator circuits. The range-mark pips are mixed with the receiver video signal, amplified and fed into a cathode follower stage; the output of which is used to feed the cathode-ray indicator proper.

Tube complement:
2 ea. — JAN 6J6 2 ea. — JAN 6SL7GT 4 ea. — JAN 6V6GT

(c) ID-11/APS-4 Indicator

Employs a 3FP7 cathode-ray tube with a 6J6 acting as a diode DC resistor and a second 6J6 functioning as a push-pull amplifier. Displays the information which the AN/APS-4 is designed to compute and gather.

Tube complement:
1 ea. — JAN 3FP7 2 ea. — JAN 6J6

One of these indicators are employed on a normal installation.

(d) C-12A/APS-4 Control Box

Comprises beacon-search, intercept-search, and warning on-off toggle switches, range and tilt controls, receiver gain control, and F.R.S. control knob. For controlling the AN/APS-4 equipment.

(e) J-84/APS-4 Junction Box

Mounts within the aircraft and forms junctions between Indicator-Amplifier Units, Control Box, and the Receiver-Transmitter of the AN/APS-4 equipment.

(f) Bomb-Rack Attaches rigidly to the plane and contains the mechanism for releasing the receiver-transmitter "bomb" if necessary.

All merch. guar. Mail orders promptly filled. All prices, F.O.B. N.Y.C. Send M. O. or Chk. Only shipping chgs. sent C.O.D. Rated concerns send P.O.

COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y. Dept. E-7 P. J. PLISHNER **Phone: Main 4-8373**

Audio TRANSFORMERS

AT666	Input 6 ohms: 250K ohms	$0.79
AT SUB	Multimatch Subouncer 200 ohms 15K ohms C. T.: 100K ohms/20K ohms	.69
AT070	Input to Grid 250 ohms: 60K ohms Hi Fl...	1.19
AT566	Input to Grid, 500/200 ohms: 50K ohms	.95
AT227	Output to line, 7500K 500 ohms CT 200—5kcy	1.45
AT353	Output PP 6L6 to 300/20/12/16 ohms 25 Watt	2.95
AT871	UNIV. Output, Hi Fl. Pri 20K ohms sec. 15/7.5/5/3.75/1.25/500 ohms	2.79
AT554	Interstage, 10K ohms: 250K ohms 15db Level	1.95
AT765	Input 600 ohms to 50K ohms	.79
AT707	Interstage ouncer 10K ohms: 125/125K ohms	.79
AT449	Driver 5K ohm to 4K ohm PP6L6 to PP805 Class B	3.89
AT21	Dual XFRMR 300 ohms: 300 ohms and 600 ohms: 250K ohms	1.35
AT383	Output 8500 ohms: 19 ohms 25W	1.79
AT415	Output 18K ohms CT to Line 125 ohms 175W	2.95
AT649	Input Line 500 ohms T Grid, 75K ohms	.79

MANY OTHERS

OIL CONDENSERS

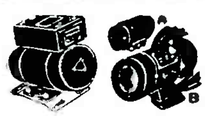
Mfd.	Volt.	Price
5	50	$0.45
650	80	1.95
5	150 AC	1.45
15	220 AC	2.20
1	500	.40
7	600	1.25
20	600	2.10
0.5	750 AC	1.59
0.5	1000	.69
2x0.5	1000	.70
1	1000	.75
1.5	1000	.85
2	1000	.90
4	1000	1.75
3x.01	1200	1.35
0.0016	1500	1.25
1	1500	1.30
1.5	1500	1.40
2	1500	1.45
2x0.1	2000	1.10
1	2000	1.45
2	2000	2.25
3	2200	2.45
0.5	2500	1.35
1.5	2500	1.35
0.15	4000	1.20
2x0.1	4800	1.20
0.1	6000	1.20
2x0.1	7000	1.25
0.1	7500	1.25
2x0.15	8000	4.75

MANY OTHERS

Tuning Units for BC-375 & 191 Diag. for Conver. to VHF Freq. Meter in Oct., 1950.

TU7	4500—62000KC
TU8	6200—7700KC
TU9	7700—10000KC
TU26	200—500KC

Price $2.49 ea.



DYNAMOTORS

Type	Input Volts	Input Amps
PE 86	28	1.25
DM 416	14	6.2
DY-2/ARR-2	28	1.1
DM 36	28	1.4
DM 53AZ	14	2.8
PE 73CM	28	19
DM 21	14	3.3
DM 25	12	2.3
DM 28R	28	1.25
DM 33A	28	7
DM 42	14	46
PE 101C	13/26	12.6
		6.3
BD AR 93	28	3.25
23350	27	1.75
35X045B	28	1.2
ZA.0515	12/24	4/2
ZA.0516	12/24	8/4
B-19 pack	12	9.4
D-104	12	
DA-3A*	28	10
#5053	28	1.4
CW 21AAX	13	12.6
	26	6.3
BD 77KM	14	40
PE 94	28	10

CAPACITORS CERAMICON

MMF.	MMF	MMF
3	35	82
3.1	47	125
4	50	200
11	51	240
13	60	250
14	62	345
15	65	350
20	70	500
220		1000
25		

$7 PER 100

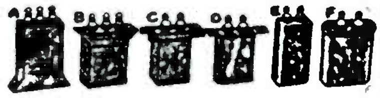
SILVER MICA BUTTONS

MMF.	MMF	MMF.
40	175	500
50	180	2000
100	185	

$7.50 PER 100

HEADSETS

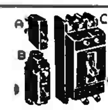
Dynamic Mike and Headset Combination. A high quality, efficient unit, used in B-19 tank Xmtrs. Mike and phones complete new. $3.75



UPRIGHTS

Mfd.	Volt	Type	Cat. No.	Price
.0025	1500	2TT	D164209	30¢
.03	600	2ST	RO3	25¢
2.0515	600	2TT		45¢
.05	400	2BT	616M	25¢
.05	600	2BT	C51481918-20	28¢
.05	600	2BT	7700BR	28¢
3x.05	300	3BT	NJOCA195	30¢
3x.05	300	3BT	CA195	30¢
.125-.05	400	2TT	CMR481380-40	25¢
.1	600	2BT	616M-14842	35¢
.1	600	2BT	R11-616MB	35¢
.1	400	2BT	418CB	30¢
.1	600	2BT	7701BR	35¢
.1	600	2BT	CP69B1AF101K	35¢
.1	600	2BT	XMRBW4-1	30¢
.1	600	2BT	C69B1AF104	35¢
2x.1	600	2BT	P9711	39¢
3x.1	400	3BT	CA255	39¢
3x.1	400	3TT	ROBC	39¢
3x.1	400	3BT		39¢
3x.1	600	3TT	C168B5EF104V	42¢
3x.1	600	3BT	7710BR	42¢
3x.1	600	3BT	CD516	42¢
2x125	400	2TT		
.25	800	2WTT		69¢
.4	600	2BT	M-7725BR	30¢
.25	600	2BT	C168B1EF254K	30¢
.5	600	2BT	SO1	32¢
.5	600	2BT	PO8	32¢
.5	400	2TT	416T	30¢
.5	600	2BT	616MB	32¢
2x.5	250	2TT	A-8B515	30¢
2x.5	400	3BT	418MCB	35¢
2x.875	400	2BT	CWS-P-72076-503	39¢
1	400	2TT	305-1605S	35¢
1	600	2BT	616MCB	38¢
1	600	2BT	YAB6100	38¢
1	250	2TT	CBV48553-15	30¢
1	100	1BT	104M59	25¢
1	600	2BT	616MCB	38¢
1	400	2BT	418MCB	35¢
1.75	50	2TT	CRY48861	45¢

WRITE FOR CATALOG VG OF 1,000,000 CONDENSERS



Heineman Ckt Bkrs for AC-DC operation.

AM	1510M	7 Amp
	1614	80 Amp
	1614	50 Amp

Price each $1.10

MICA COND.

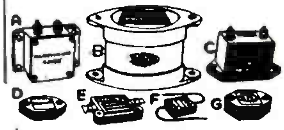
XM Screw Type G 5000 VT

15	45¢
21	45¢
50	45¢
140	45¢
235	45¢
250	45¢
295	45¢
300	45¢
375	45¢
400	45¢
490	45¢
500	45¢
575	45¢
750	45¢
850	45¢
1000	50¢
1150	50¢
1250	50¢
1500	50¢
1700	50¢
1850	50¢
2000	55¢
2550	55¢
3000	55¢
3450	55¢
4000	60¢
4800	60¢
5000	60¢
5900	60¢
6900	65¢
7000	65¢
8500	65¢
10000	70¢
10500	70¢
12500	70¢
40000	85¢

XM Screw Type G 7500 VT

750	50¢
850	50¢
1000	55¢
1500	55¢
2000	60¢

MICA CAPACITORS



THE CONDENSERS LISTED BELOW ARE NEW, UNMARKED, TESTED FOR CAPACITY. MFG BY SOLAR

XQ Lug Type E 1200 VT

MMF	Price
20	$.25
25	.25
28	.25
35	.25
58	.25
85	.25
100	.25
125	.25
130	.25
140	.25
150	.25
190	.25
200	.25
210	.25
225	.25
250	.25
375	.25
400	.25
500	.25
600	.25
750	.35
850	.35
925	.35
1000	.40
1150	.40
1175	.40
1300	.40
1500	.40
1850	.40
2000	.45
2250	.45
2300	.45
2500	.45
2575	.45
3000	.50
3450	.50
3900	.50
4000	.55
4250	.55
4280	.55
4550	.60
5500	.60
6000	.60
10000	.60
11500	.60
13800	.60
15500	.60

XQ Lug Type E 2500 VT

15	30¢
20	30¢
25	30¢
30	30¢
35	30¢
50	30¢
100	30¢
130	30¢
210	30¢
215	30¢
235	30¢
250	30¢
290	30¢
500	30¢
825	30¢
850	30¢
1150	35¢
1175	35¢
1750	35¢
1890	35¢
2000	40¢
2075	40¢
2100	.40
2150	40¢
2250	40¢
2400	40¢
2500	40¢
2550	40¢
2600	40¢
3000	45¢
3500	45¢
4000	45¢
5000	50¢
6000	50¢
7500	50¢
8000	50¢
8500	50¢
10000	55¢

XQ Lug Type E 5000 VT

5	35¢
10	35¢
15	35¢
20	35¢
35	35¢
58	35¢
40	35¢
68	35¢
100	35¢
130	35¢
150	35¢
190	35¢
200	35¢
250	35¢
325	35¢
425	35¢
470	35¢
500	35¢
515	35¢
525	35¢
750	35¢
825	35¢
850	35¢
1000	40¢
1250	40¢
5000	45¢

XM Screw Type D 1200 VT

38	35¢
40	35¢
50	35¢
125	35¢
140	35¢
425	35¢
500	35¢
850	35¢
1300	40¢
1700	40¢
2000	45¢
2900	45¢
4000	50¢
4200	50¢
4800	50¢
5000	50¢
5400	50¢
5500	50¢
6300	50¢
6700	50¢
6900	55¢
8500	55¢
10000	60¢
11500	60¢
16750	60¢
30000	60¢
32000	60¢
35000	60¢
38000	60¢
50000	65¢

XM Screw Type D 2500 VT

30	40¢
50	40¢
100	40¢
250	40¢
1000	45¢
1150	45¢
1250	45¢
1700	45¢
2000	50¢
2900	50¢
3000	50¢
3500	50¢
4000	55¢
4450	55¢
4750	55¢
5000	55¢
6000	60¢
6900	60¢
6950	60¢
7000	60¢
7400	60¢
8000	60¢
10000	65¢
12000	65¢
15000	65¢
16750	65¢
17000	65¢
17250	65¢
19700	70¢
20000	70¢
21000	75¢
25000	75¢
30000	80¢

400 CYCLE TRANSFORMERS
115 V 400 CYCLE INPUT

Ratings	Price Each
6.3 V/1.8A P/O APG2	$1.49
6.4V/2.5, 400VCT/ 35Ma, 6.4/.150a	3.95
6.4V/7.5, 6.4/3.8, 6.4/2.5a	3.49
780V/.27V/4.7, 6.3/2.9, 1.25/.2a	2.49
6.4V/8a, 6.4V/1A	1.95
6.3V, 9.1A, 6.3VCT/6.5a, 2 x 2.5/3.5a	2.49
5V/2a, 6.3V 2a, 5V/2a, 6.3/.5a	2.99
5V/15A, 5000V Ins	3.95
6.3/2.7, 6.3/66, 6.3VCT/21A	5.95
760V, 6.3V, 6.3V, 5V, 320V, 6.3V/20A 6.4/7.5, 6.4/3.8, 6.4/2.5	2.95
592V/118Ma, 6.3/8.1a, 5V/2 W.E	4.95
6.3V/9.1, 6.3VCT/.65a, 2 x 2.5V/3.5A	2.95
6VCT .00006 KVA	.98
6.4V/8a, 6.4V/1a	1.49
1034VCT/.111a, 6.9V/10, 2 x 6.3V/1, 5V2, 6.3/2, 63/1	6.49
526VCT/.50a, 6.3VCT/2a, 5VCT/29	3.49
400VCT/35Ma, 6.4/2.5, 6.4/15a	3.25
2300VCT Large Qty	2.25
600VCT/36Ma	1.49
2.5V/1.75, 5V/3A, 6.5V/6.5, 6.5/2a. For SCR729	3.95
640V/500Ma. 2.5V/1.75a P/o APS/15B	2.95
360VCT/20Ma, 1500V/1Ma, 2.5V, 6.3/2.5, 6.3V/6a, P/o 729A	3.95
2 x 2.5V/5A, 2.5V/10A, P/O APT 4	4.95
2 x 2.5V/2.5a, 6.3V/2.25a, 1200 V Tap 1000V-750V P/o AN/APS-15	4.95
742.5V/50MA, 709V, 47MA, 671V/45Ma	2.95
600VCT/36MA, 2¾ x 2¼ x 3¼	
1150-1150, 2 ¾ x 2¼ x 3¼	
640VCT/250MA, 6.3V/.9, 6.3V/.6, 5V/6A	3.95
6.3V/9.1a, 2.5V/3.5a, 6.3VCT/65a, 2.5V/3.5a	3.25
9800V or 8600V/32MA	12.50
592VCT/120MA, 6.3V/8a, 5V/2a	3.50
4540VCT/250MA	7.50
5V/3a, 6.3V/2a	1.75
5000V/290MA, 5V/10A	12.50
2200V/350	5.45
2.5V/5, 5200V/2MA	14.95
13.5KV/3.5MA	11.50
734VCT/.177a, 1710VCT/177a	6.95
6.3V/9A, 7.7V/.365A	2.79
2.5/20A	4.85
6.3V/12a, 6.3V/2a, 6.3V/1a, P/o AN/APQ-5	5.85
6.4VCT/7.5, 6.4VCT/3.8, 6.4VCT/2.5a	4.35
6.3V/2.7, 6.3V/.66A, 6.3VCT/21A	2.95
6.5V/12A, 250V/100MA, 5V/2a, P/o AN/APS-15	3.50
400VCT/35MA, 6.4/.15a, 6.4V/2.5a	2.25
650VCT/50MA, 6.3VCT/2A, 5VCT/2a, P/o R58/ARQ8	2.45
2400CT/.5MA, 640V/.5MA, 2.5V/1.75A	3.85
15.35VCT/1A	1.95
59.2V/.118, 63V/8.1, 5V/2A, P/o APQ 13	3.95
6.3/.9, 6/3V/.6.5V/6, 640/200MA	4.95
2 x 14CV/00014A, 12QV/00012a, P/o APG2	1.95
3640V/400Ma, P/o APT4	7.95
23.5V Tapped 22V/47MA	1.95
600VCT/36Ma	1.95
780V, 27V/4.3, 6.3V/2.9, 1.25V/20A	3.95
6.4V/11 Amp. P/o APQ7	2.25
2 x 6.3V/1.25a, P/o APQ13	1.95

TOP TRANSFORMER BUYS

These XFRMRS are Army Spec. All Underrated.

Comb. Transformers—115V/50-60 cps Input

Item	H.V.	Amp.	Filaments	Price
CT-861	2100VCT	175	7.5VCT/4A, 2.5V/10A	$10.95
CT-142	645VCT	.060	5V/2A, 6.3V/1.2A	4.25
CT-825	360VCT	.340	6.3VCT/3.6, 6.3VCT/3A	3.95
CT-076	600V	100	2 x 12.6V/1	1.95
CT-626	1500V	.160	2.5/12. 30/.100	9.95
CT-15A	350VCT	.070	6.3/.6, 6.3/1.8 3 lbs	2.95
CT-071	110V	.200	33/.200, 5V/10, 2.5/10	4.95
CT-378	2300V	4MA	2.5/2	6.95
CT-367	580VCT	.050	5VCT/3A	2.25
CT-721	550VCT	.100	6.3/1, 2.5VCT/2	2.95
CT-99A	2x110VCT	.010	6.3/1A, 2.5VCT/7A	3.25
CT-91A	726V	.100	5V/3A, 6.3/3.5	3.25
CT-441	50V	.200	5V/2.4, 5V/1.2	2.29
CT-408	350VCT	.026MA	5V/3A	2.75
CT-931	585VCT	.086	5V/3A, 6.3V/6A	4.25
CT-610	1250	.002MA	2.5V/2.1A, 2.5V/1.75A	4.95
CT-137	350VCT	.026MA	5V/3A	2.75
CT-102	1080VCT	.055	25V/3A, 6.3V/1.8A, 6.3V/1.2A	5.95
CT-866	330V	.065	6.3V/1.2, 6.3V/600 MA	1.75
CT-319	330VCT	.085	5V/2, 6.3/7.5, 6.3/3.3	3.25

Filament Transformers—115V/50-60 cps input

Item	Rating	Each
FT-029	13.5V/1.11A	$ .79
FT-346	5VCT/13/5, 5VCT/6.75, 5VCT/6.75	5.95
FT-781	866 Trans. 2 x 2.5/5A	2.25
FTG-31	2.5V/2.5, 7V/7A(Tape @ 2.5V/2.5A), 16 lbs	9.95
FT-674	8.1V/1.5A	1.10
FT-157	4V/16A, 2.5V/1.75A	2.95
FT-391	6.4V/3A	1.10
FT-736	2 x 6.3VCT/3.2-1.2A	1.49
FT-899	2 x 5 V/5.5A 29000 Rms	22.95
FT-418	6.3VCT/1A, 6.3VCT/7A	1.95
FT-735	6.3VCT/5A, 6.3VCT/1A	1.79
FT-101	6V/.25A	.79
FT-738	6.3VCT1A, 5V/2A	1.69

Plate Transformers—115V/50-60 cps input

Item	Rating	Each
PT-976	Auto; 120VCT/10 MA	$ 0.69
PT-31A	2 x 300V/5 MA	.79
PT-46A	4080VCT N.L. 3% to 1 8" H x 6" W x 7" L 20 lbs	29.95
PT-033	4150V/400 MA 11½ x 9¼ W x 9" D 70 lbs	49.95
PT-75-2	3780/3446/3112VCT/77 MA	10.95
PT-28-1	4600VCT/.077	12.95
PT-403	Auto; 70V/1A	2.29
PT-160	1120VCT/770 MA, 590VCT/82 MA, 25 lbs	24.95
PT-170	Auto; 156/146/137/128-.71A	3.29
PT-139	42V/46V/50/V55V/15.2A 7⅜x7" W x 6¾" H	10.95
PT-31A	2 x 300V/5 MA	.79
PT-976	120VCT/10 MA	.79
PT-67-1	62V/3.5A	2.95
PT-12A	280VCT/1.2A	2.95

All mer. guar. Mail orders promptly filled. All prices F.O.B. N.Y.C. Send MO or Chk. Only shipping chgs. sent C.O.D. Rated concerns send P.O.

MIN. ORDER $3.00 **COMMUNICATIONS EQUIPMENT CO.** MIN. ORDER $3.00

131 Liberty St., New York, N. Y. Dept. E-7 Chas. Rosen Phone: Digby 9-4124

MOTOR GENERATORS DYNAMOTORS, INVERTERS, ETC.

2.5 KVA MG Set. Diehl Elec. Co. 120V D.C. to 120V A.C. 60 cy. 1Ph., .4PF. Complete with Magnetic Controller, 2 Field Rheos and Full Set of Spare Parts including Spare Armatures for Generator and Motor. Full specs. on request. New $285.00

2 KVA MG SET. O'Keefe and Merritt. 115V DC to 120V AC, 50 cy. Idles at 3 Ph. syncs motor on 208V, 50 cy. New. Export crated $165.00

1.25 KVA MG SET. Allis-Chalmers. 230 DC To 120 AC, 60 cy. 1 Ph. Fully enclosed, Splashproof Ball Bearings, centrifugal starter. New, complete with kit of Spare Parts....$150.00

MG Set. Onan MG-215H. Navy type PU/13. Input 115/230, 60 cy, 1 Ph. Output 115, 480 cy, 1 Ph. 1200W and 26V DC at 4 amps. New......$295.00

MG SET FOR NAVY TBS TRANSMITTER. Type CG-21302. 440V AC, 60 cy, 3 Ph, 1500 VA to 875 DC and 300V DC. New $69.50

DYNAMOTOR. Navy-Type CAJO-211444. 105/130V-DC to 13V DC at 40A or 26V DC at 20A. Radio filtered. Complete with Line Switch. New. $69.50

DYNAMOTOR. Elcor. 64V DC to 110V AC, 60 cy. 1 Ph, 2.04 Amps. New..................$24.50

DYNAMOTOR. Elcor. 32V DC to 110V AC, 60 cy. 1 Ph, 0.43 Amps. New..................$17.50

DYNAMOTOR — Type PE94C. For use with SCR522 Transmitter-Receiver. Brand new in export cases $9.50

AMPLIDYNE—G. E. Model 5AM21JJ7. 4600 R.P.M. Motor Compound wound. 150 Watts. Input: 27V. DC. Output: 60V. DC Sig Corps. U. S. Army MG-27-B. New....................$26.50

AMPLIDYNE—Edison type 5AM31NJ18A. Input: 27 volts 44 Amps., 8300 RPM. Output: 60V DC at 8.8 amps. 530 Watts. New................$22.50

INVERTER—G.E. Model 5D-21NJ3A. Input: 24V. DC, Output; 115V. 400 cy. 485 Va. New...$24.50

INVERTER—Leland Elec. Co. Model PE206A. Input: 28V. DC, 38 Amps. Output, 80V., 800 cy. 485 VA. New $17.50

PE 218 INVERTER—G. E. J8169172. Input: 28V. DC, Output: 115, 400 cycles at 1.5 KVA...$24.50

GENEMOTOR—Carter 6V DC to 400 V DC at 375 mils. New $39.50

D.C. MOTOR—G.E. Model 5BA50LJ2A. Armature 27V D.C. at 8.3A. Field 60 V D.C. at 2.3A. RPM 4000. H.P. 0.5. New $22.50

MOTOR GENERATOR M.G. 164. Holtzer-Cabot Motor: 440V, 3PH, 60 cy., .90A, 1/3HP, 1750 RPM. Generator: 70V. 3Ph, 146 Cy., .140KVA Exciter: 115DC, 1A. New..................$67.50

BC-348 RECEIVER PARTS

Dial Mechanism assemblies. 1st, 2nd, 3rd, 4th I.F. transformers. C.W. osc. and xtal filter trans. with xtals. All R.F. coils. Front panels. Shock mounts. Large quantity misc. hardware sub assemblies, etc. Write your requirements.

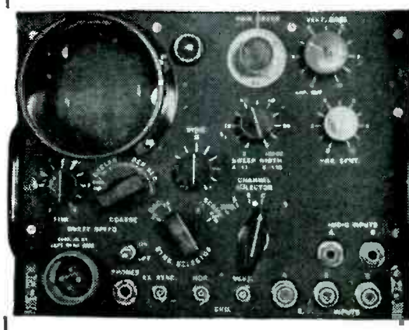
MISCELLANEOUS EQUIPMENT

TS-127/U Lavoie Freq. Meter—375 to 725 MC.
TS-47APR Test Set—40 to 500 MC.
213-A DuMont C.R. Modulation Monitor.
BC1203B APN-4 Test Set.
6255A H.P. Interpolation Osc.
TS-23/APN Test Set.
TS-487/U Peak to Peak VTVM.
BC-221AE Freq. Meter.
LM-13 Freq. Meter.

MICROWAVE RECEIVERS

AN/APR-1 Receivers and tuning units TN-1 (38 to 95 MC) TN-2 (76-300 MC) TN-3 (300-1000 MC).
AN/APR-4 Receivers and tuning units TN-16 (38-95 MC) TN-17 (76-300 MC) TN-18 (300-1000 MC).
R111A/APR-5A Receivers. 1000 to 6000 MC Range.

MODEL AN/APA-10 PANORAMIC ADAPTER



Provides 4 Types of Presentation: (1) Panoramic (2) Aural (3) Oscillographic (4) Oscilloscopic

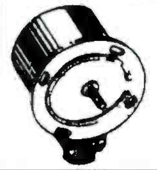
Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I. F. of 455kc. 5.2mc, or 30mc.

SUMMARY OF CHARACTERISTICS:

SENSITIVITY: "A" channel, 400 microvolts or less per ¼" beam deflection. "B" channel, 400 microvolts or less per ¼" beam deflection. "C" channel, 1 volt or less per ¼" beam deflection.
RESOLUTION: 12 kilocycles at 3 db down from peak, sweep control at maximum, using CW signal.
PRESENTATION: Panoramic ("A" & "B" channels): Oscillographic, "C" channel.
SWEEP WIDTH: Channel A, ± 50 kc (100 kc overall) Channel B, ± 500 kc (1 Mc overall) Channel C, ± 1 Mc (2 Mc overall).
CATHODE RAY SWEEP: Oscillatory or non-oscillatory (Servo) Variable Sawtooth Generator, 35 to 40,000 cycles per second.
AUDIO OUTPUT: 50 milliwatts into 600 or 8000 ohm load.
VERTICAL AMPLIFIER: Single stage, ± 2db from 30 cycles to 100 kc or higher. Amplifier out position permits direct connection to one vertical plate through coupling capacitor.
HORIZONTAL AMPLIFIER: Single stage, ± 2db from 30 cycles to 100 kc. No provision for direct connection to deflection plates.
CATHODE RAY TUBE VOLTAGE: Cathode to accelerating anode; 1200V DC for 115V A.C. input.
SENSITIVITY OF CATHODE RAY OSCILLOSCOPE: Maximum through Amplifier. Horizontal: 10 volts peak to peak per inch. Vertical: 1.5 volts peak to peak per inch.
DIRECT TO VERTICAL PLATE: 150 volts peak to peak per inch.
NOISE: No disturbance in excess of 25,000 microvolts between 200kc to 200Mc generated by equipment.
Overall Dimensions: 19-9/16" x 10¼" x 7⅝".
Weight: 40 lbs.
Power Requirements: 115V. A.C. 60 cycles, 1 phase. With 21 tubes including 3" scope tube, for operation on 115 V. 60 cycle source. PRICE..........$245.00

AN/APA-10 80 Page Tech Manual............$2.75

LINEAR SAWTOOTH POTENTIOMETER



W.E KS-15138

Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output.
Brand New $5.50

G. E. SERVO AMPLIFIER

Type 2CV1C1 Aircraft Amplidyne control amplifier. 115 volts—400 cycles. Dual channel. Employs 2-6SN7GT and 4-6V6GT tubes. Supplied less tubes. New $22.50

400 CYCLE TRANSFORMERS

AUTO. 400 cy. G.E. Cat No 80G184. KVA .945S—520P. Volts 460/345/230/115. New. $4.95
FILAMENT. 400/2600 cy. Input: 0/75/80/85/105/115/125V. Output: 5V3A/5V3A/5V3A/5V3A/5V6A/5V6A/6.3V6A/6.35A. New $2.95
THYRATHRON POWER. 400/1600 cy. Raytheon UX-8876. 400/1600 cy. Pri: 115. Sec: 50-0-50V at 1.5A, 6.3V at 1.2A. Test r.m.s. 1780. New..$2.75
PLATE WECO KS9560. 400/800 cy. Pri: 115V. Sec: 1350-0-1350 at .057A (2700 V Total). Elecstat shlded. Wt. 2.3 lbs. New..................$2.95
Plate. Thordarson #T46889. 1650 VA. Pri: 105-120V. 500 cy. 1 PH. Sec: 5600V. Center tapped. 1.5KV insulation. Brand new.............$49.50
SCOPE PL. & FIL. WECO 9556. 400/2400 cy Pri: 115. HV Wdg. 1125V at .008A. Fil. Wdgs. 6.4V4A/2.5V1.75A/6.4V.6A. Elecstat shlded. Wt. 1.4 lbs. New $2.75
FILAMENT. 400/2400 cps. WECO KS9553. Pri: 115V. Sec: 8.2V1.25A/6.35V1.5A Elecstat shlded. Wt. 0.5 lbs. New $1.95
PLATE & FIL. 400/2600 cy. Pri: 0/80/115V. Sec: #1=1200VDC at 1.5MA. Sec. #2=400VDC at 130MA. Fil. Secs: 6.4V4.3A/6.35VO.8A. (ins. 1500V)/5V2A/5V2A $4.95
RETARD. 400 cy. WECO KS9598. 4 Henry 100MA $1.75

60 CYCLE TRANSFORMERS

FILAMENT. Raytheon Hypersil Core. Pri: 115V. Sec: 6.3V22A/6.3V2.4A/6.3V2.25A/6.3VO.6A Ins. for 1700V $5.95
High Reactance Trans. G. E. type Y-3502A.—60 cy., Voltage 11200-135. Inductance H.V. Winding 135 Henries. Output: Peak Voltage 22.8KV. Cat. 8318065G1. New $89.50
High Voltage Trans. Westinghouse Pri: 115. 60 cy. Sec: 15,000 C.T., 60 MA. Good for Hi-Pot test set up $24.50

PULSE TRANSFORMERS

PULSE. WECO KS-9563. Supplies voltage peaks of 3500 from 807 tube. Tested at 2000 Pulses/sec and 5000V peak. Wdg. 1-2=18 ohms. Wdg. 1-3=72 ohms. L of Wdg. 1-3=.073-.082H at 100 cps.$5.00
PULSE. WECO KS-161310, 50 KC to 4MC. 1¾" Dia. x 1⅞" high. 120 to 2350 ohms. New $1.95

RAYTHEON VOLTAGE REGULATOR

Adj. input taps 95-130V., 60 cy. 1 Ph. Output: 115V., 60 Watts, ½ of 1% Reg. Wt. 20 lbs. 6⅛" H x 8¼" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized. Special.........$14.75

HIGH VOLTAGE CAPACITORS

.25 MFD., 20KV	$26.50
.25 MFD., 15KV	22.50
.5 MFD., 25KV	34.50
1 MFD., 15KV	34.50
1 MFD., 7.5KV	12.50

SOUND POWERED PHONES

Western Electric No. D173312, Type O. Combination headset and chest microphone. Brand new including 20 ft. of rubber covered cable.......$17.50
Automatic Elec. Co. No. GL843AO. Similar to above but including Throat microphone in addition to chest microphone. Brand new with 20 ft. rubber covered cable $10.00
U. S. Instrument Co. No. A-260. Complete with 20' cable and plug. Brand new...........$13.50
W. E. type TS-10M Handset. New........$16.50

PARABOLOIDS

Spun Magnesium dishes 17½" dia. 4" deep. Mounting brackets for elevation and azimuth control on rear. 1½ x 1⅝" opening in center for dipole. Brand new, per pair.......................$8.75

SWEEP GENERATOR CAPACITOR

High speed ball bearings. Split stator silver plated coaxial type 5/10 mmfd. Brand new........$2.50

WESTERN ELECTRIC CRYSTAL UNITS

Type CR-1A/AR. Available in quantity—following frequencies—fundamentals.
5910—6350—6370—6470—6510—6610—6670—6690—6940—7270—7350—7380—7390—7480—7580—9720—Kilocycles.

$1.25 each

All prices indicated are F O B Bronxville, New York. Shipments will be made via Railway Express unless other instructions issued.

ELECTRONICRAFT INC.

27 MILBURN ST. BRONXVILLE 8, N. Y.
PHONE: BRONXVILLE 2-0044

All merchandise guaranteed. Immediate delivery, subject to prior sale.

All Prices Subject to Change Without Notice

Reliance Specials

TIMING MOTOR

8 RPM 1115V 60 cyc
E. Ingraham Co.
$1.95

GEAR ASSORTMENT

100 small assorted gears. Most are stainless steel or brass. Experimenters dream!................Only $6.50

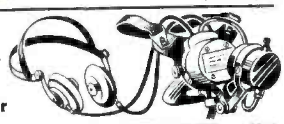
VERNIER DIAL or DRUM (From BC-221)

DIAL—2⅝" dia. 0-100 in 360°. Black with silver marks. Has thumblock. DRUM—0-50 in 180°. Black with silver marks.................................either, 85c

SOUND POWER HANDSET

Brand New!
Includes 6 ft. cord. No batteries or external power source used. $17.60 pr.

Sound Powered Chest Set RCA—With 24 Ft. Cord
$17.60 per pair



Variac—General Radio 100W removed from equipment **$10.00**

400 CYCLE INVERTERS

Leeland Electric Co.

#10800 In: 20-28 V.D.C., 92 A. 8000 R.P.M. Out: 115V, 400 Cyc. 1 phase, 1500 V.A. 90 PF..............$12.95

3AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
⅛	$4.00	1	3.00	6	$3.00
½	4.00	1½	3.00	10	3.00
¾	$4.00	5	3.00	15	3.00
				20	3.00

DELAY NETWORK—ALL 1400Ω

T 113—Approx. 1.2 micro sec. delay............
T 114—Approx. 2.2 micro sec. delay..........
T 115 Similar to T 114 with tap brought out....
95¢ each

BEARINGS

Mfg. No.	ID	OD	Thickness	Price
MRC5028-1	5 1/2	6 1/2"	1"	$3.50
MRC7026-1	5 5/64	6 15/64	9/16	3.50
Timken 37625	4 5/16	6 1/4	29/32	4.25
MRC-7021-200	4 1/8	5 9/32	23/64	2.95
Fafnir B545	2 1/16	2 5/8	1/4"	1.00
MRC 106 M2	1 17/64	2 7/16	25/64	1.75
MRC 106 M1	1 13/64	2 7/16	25/64	1.60
Federal LS 11	1 1/8	2 1/2	5/8	1.75
Norma S 11 R	1 1/8	2 1/8	3/8	1.25
Fafnir B 541	1 1/16	1 1/2	9/32	.55
Hoover 7203	5/8	1 9/16	7/16	.90
Norma 203 S	5/8	1 9/16	7/16	.90
Schatz	3/4	1 3/4	9/16	1.00
N5 5202-C13M	1/2	1 3/8	1 3/8	1.00
ND 3200	25/64	1 5/32	11/32	.55
Fafnir S 3K	3/8	7/8	7/32	.45
MRC 39 R1	11/32	1 1/32	5/16	.45
ND CW 8008	5/16	5/16	13/32	.45
MRC 38 R3	5/16	55/64	9/32	.45
Fafnir 33K5	3/16	1/2	5/32	.25

NEEDLE BEARINGS

TORRINGTON B108 1/2" wide 5/8" 13/16" 30¢

Brand New METERS—Guaranteed

0-1 Amp. R.F. 2½" $3.29 | 0-80 Amp. D.C. 2½".$2.25
0-7.5V. A. C. 3½"... 3.46

SELENIUM RECTIFIERS

Full Wave 200 MA 115V..............................$1.79
Half Wave 100 MA 115V.............................. .91

SPAGHETTI SLEEVING—assortment—99 feet.....$1.00

TYPE "J" POTENTIOMETERS

150	SD	2000	SD	5000	3/8"	50K	SD *
300	SD	2000	1/2"	10K	3/8"	70K	SD
300	3/8	2000	SD*	10K	SD*	80K	SD
400	3/8	2500	1/2"	15K	1/4"	100K	3/8
500	3/8	2500	SD	15K	SD*	200K	SD*
1000	7/8	3000	3/8	25K	3/8"	250K	SD
1000	SD*	4000	3/8	25K	SD*	500K	1/2"
1500	SD	5000	SD*	30K	SD*	1 Meg	SD

* Split locking bushing — $1.25 each

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$0.13	4-141W	$0.30	9-141Y	$0.64
3-140¾W	.19	5-141	.26	10-141	.50
6-140	.25	5-141¾W	.37	17-141Y	1.17
10-140¾W	.53	7-141	.36	3-142	.21
2-141	.13	7-141¾W	.49	8-142	.69
3-141¾W	.24	8-141¾W	.58	2-150	.39
3-141W	.24	9-141	.64	3-150	.54

TIME DELAY RELAY

Raytheon CPX 24166 KS 10193-60 Sec. • 115 V., 60 cycle • Adj. 50-70 Seconds • 2½ second recycling time—spring return • Micro-switch contact, 10A • Holds ON as long as power is applied • Fully cased • ONLY $6.50

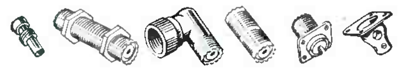
AN CONNECTORS
IMMEDIATE SERVICE
PHONE! WIRE! WRITE! YOUR NEEDS

NEW COAXIAL CABLES

	Ohms	Price per 1,000 Ft.		Ohms	Price per 1,000 Ft.
RG-6/U	76	$150	RG-35/U	71	$450
RG-7/U*	97.5	65	RG-37/U	55	40
RG-15/U	76	160	RG-39/U	72.5	180
RG-21/U	53	100	RG-41/U	67.5	295
RG-22A/U*	95	150	RG-54/U	58	65
RG-24/U	125	240	RG-55/U	53.5	65
RG-25/U	48	575	RG-57/U*	95	100
RG-26/U	48	75	RG-58/U*	53.5	60
RG-27/U	48	290	RG-59/U*	73	70
RG-29/U*	53.5	50	RG-77/U*	48	100
RG-34/U	71	175	RG-78/U	48	80

Add 25% for orders less than 1,000 feet.
*No minimum order—others 250' minimum.

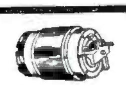
COAXIAL CABLE CONNECTORS



15¢ UG 175/U — $1.30 83-1F — 30¢ ANGLE — 80¢ 83-1J — 45¢ 83-1R — 9¢ HOOD

83-1AC	$ .42	83-22J	$1.40	UG58/U	$ .63
83-1AP	.30	83-22SP	1.15	UG59A/U	2.25
83-1F	1.30	UG-12/U	.63	UG60/U	2.40
83-1H	.09	UG13/U	.63	UG85/U	.88
83-1J	.80	UG19B/U	1.95	UG87/U	.79
83-1R	.45	UG21/U	.67	UG88/U	1.25
83-168	.15	UG22/U	1.10	UG167/U	2.00
83-185	.15	UG24/U	.67	UG175/U	.15
83-2AP	2.00	UG25/U	.60	UG176/U	.15
83-2H	.25	UG27/U	.68	UG201/U	2.05
83-2J	1.65	UG27A/U	2.95	UG206/U	.63
83-2R	1.30	UG29/U	.83	UG281/U	.60
83-21SP	2.10	UG30/U	2.50	UG290/U	1.15
83-22AP	1.10	UG57/U	2.30	UG499/U	1.25

DIFFERENTIAL



115 V., 60 Cyc. #C78249 — $3.95 ea.
3⅜" dia. x 5⅜" long

Used between two #C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted)......$4.50
Mounting Brackets — (Bakelite for selsyns, and differentials shown above................35¢ pair

2J1G1 SELSYNS $2.95

BRAND NEW 400 CYCLE
Can be used on 60 cycle

POSTAGE STAMP MICAS

MMF	MMF	MMF	MMF	MMF	MFD	MFD
8.2	40	90	240	510	.0011	.0051
10	43	100	250	560	.0012	.006
15	47	110	270	580	.0013	.0062
20	51	120	300	600	.00136	.0065
22	56	125	350	620	.0015	.0068
24	60	130	370	680	.001625	.007
25	62	150	390	800	.002	.0075
26	68	160	400	820	.0026	.008
30	75	175	430	910	.0027	.0082
35	82	180	470	MFD	.003	.009
39	85	220	500	.001	.0033	.01

Price Schedule

8.2 MMF to .001 MFD............................5¢
.0011 MFD to .001625 MFD.......................7¢
.002 MFD to .009 MFD..........................12¢
.01 MFD.......................................22¢

SILVER MICAS

MMF	MMF	MMF	MMF	MMF	MMF	MFD
10	51	120	270	470	875	.00282
18	60	125	300	488	900	.002826
20	62	150	325	500	MFD	.003
22	66	170	360	510	.001	.0033
23	68	180	370	525	.0011	.0039
24	75	200	390	560	.001625	.005
30	82	208	400	570	.0022	.0051
39	100	225	410	680	.0023	.0056
40	110	240	430	700	.0024	.006
50	115	250	466	800	.0026	.0082

Price Schedule

10 MMF to .001 MFD............................10¢
.001 MFD to .0024 MFD.........................20¢
.0026 MFD to .0082 MFD........................50¢

FILAMENT TRANSFORMER

Pri., 115V., 60 Cyc. — Sec. 6 V. @ 35 A. or 12 V. @ 18 A. or 24 V. @ 9 A. **$6.50**

PULSE TRANSFORMERS

UTAH—9262 9278 9340
WESTERN ELECTRIC—D166173 D161310
KS8696, KS9365, KS9565, KS9800, KS9862, KS13161
GENERAL ELECTRIC—K2731, 80-G-5
JEFFERSON ELECTRIC—C-12A-1318
CROSLEY—W-226262-4
DINION COIL—TR1048, TR1049
also 352-7250-2A; 352-7251-2A; T-1-229621-60

PRECISION RESISTORS

1/4 WATT—30c

2	10.48	12.32	16.37	125	705
2.5	10.84	13.02	32	147.5	2,193
3.5	11	13.52	62.54	220.4	3,500
5	11.25	13.89	79.81	301.8	59,148
6.68	11.74	14.98	105.8	366.6	
		15.8	123.8	414.3	

1/2 WATT—30c

.1	13.3	120	855	5,900	31,500
.2	13.52	123.8	900	6,000	32,700
.250	15	125	970	6,500	32,888
.334	18.75	147.5	1,060	7,000	33,000
.444	20	148.7	1,100	7,300	33,300
.502	21.5	150	1,150	7,500	35,888
.557	25	178	1,200	8,000	36,000
.627	30	179.5	1,264	8,500	37,000
.76	34.75	180	1,375	8,800	39,000
1	40	210	1,400	8,909	40,000
1.01	44.73	220	1,490	9,000	41,700
1.02	45	230	1,500	10,000	43,766
2	46	235	1,573	12,000	45,000
2.04	49	240	1,876	13,333	47,000
2.5	50	250	2,230	14,825	50,000
2.54	52	260	2,250	15,000	56,000
3.07	55.1	270	2,500	15,750	59,000
3.25	60	286	2,850	15,755	59,905
3.7	61	290	3,330	15,810	68,000
3.87	65	298.3	3,400	16,000	70,000
5.24	66	389	3,427	16,700	75,000
5.26	66.6	397	3,500	17,000	79,012
5.89	69	400	3,995	19,860	80,000
7.	70	500	4,000	20,000	90,000
7.6	71	600	4,101	20,150	92,000
8	75	607	4,285	21,300	100,000
10	80	705	4,300	22,500	120,000
10.58	87	723.1	4,451	23,300	140,000
11.1	90	785	4,750	25,000	180,000
13.15	97.8	800	5,000	26,667	400,000
	100		5,714	30,000	

1 WATT—35c

.1	2.66	38	312	3,300	25,000
.11	3	43.6	321.7	3,800	30,000
.147	3.1	45.5	400	4,572	34,000
.2	3.39	49.75	420	5,000	35,000
.25	4.29	50	425	5,221	37,000
.31	4.3	54.25	565	5,400	40,000
.4	4.7	60	800	6,000	45,000
.861	5.21	71	1,000	7,000	50,000
1	10.1	75	1,200	7,500	55,000
1.01	10.5	80	1,500	7,800	56,000
1.166	12.8	100	1,800	8,000	60,000
1.17	15	112.8	1,900	8,250	65,000
1.21	18	120	2,000	9,000	68,000
1.25	25	179.5	2,200	10,000	70,000
2	27.4	206	2,215	12,000	75,000
2.5	28	215	2,250	12,420	80,000
2.55	30	250	2,413	12,500	84,000
2.58	35	270	2,500	15,000	90,000
2.6		300	3,055	18,000	95,000
				20,000	

1 WATT—45c

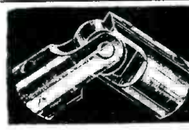
100,000	175,000	296,000	390,000	550,000
105,000	195,000	300,000	399,000	560,000
120,000	200,000	310,000	400,000	590,000
125,000	220,000	320,000	413,000	600,000
132,000	245,000	340,000	423,400	645,000
145,000	249,000	348,000	450,000	650,000
149,500	250,000	350,000	500,000	700,000
150,000	260,000	375,000	520,000	750,000
166,100	270,000	376,000	522,000	876,457

1 MEGOHM 1 WATT 1%—65c; 5%—45c

2 WATT—60c

4,385 5,000 6,000 10,000 23,000

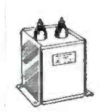
UNIVERSAL JOINT



3/16" hole x 3/8" O.D.
1 1/8" long
Steel or Aluminum
50¢

OIL FILLED

MFD.	V.D.C.	Price	MFD.	V.D.C	Price
.125	35,000	$34.95	.25	2,000	1.05
.125	27,000	28.95	.1-.1	2,000	.95
.25	20,000	18.95	.02	2,000	.70
.05	16,000	2.95	2	1,500	1.75
.03	16,000	1.95	1	1,500	1.50
.1	12,000	1.95	12	1,000	2.45
1	10,000	9.75	6	1,000	1.79
.15-.15	8,000	2.45	4	1,000	1.39
.02	8,000	1.69	3	1,000	.80
.05	7,500	1.50	2	1,000	.65
.03	7,500	1.40	1.02	1,000	.59
.1-.1	7,000	1.69	1	1,000	.59
.02-.03	7,000	1.35	7	800	1.59
1	6,000	5.25	1	800	.45
.03-.03	6,000	1.35	8-8	600	1.49
.03	6,000	1.25	8	600	1.60
.01-.03	6,000	1.35	7	600	1.40
2	5,000	4.65	5	600	1.30
.25	5,000	2.25	4	600	1.25
3	4,000	4.50	4x3	600	1.95
2	4,000	3.95	2	600	.45
3x.2	4,000	2.35	1	600	.39
.1	4,000	1.55	.5	600	.35
.06	4,000	1.35	8	500	1.45
.25	3,000	1.50	4	500	.89
.1	3,000	1.45	4	300	.59
			4	200	.39
4	2,500	4.25			
8	2,000	4.45			
6	2,000	4.25			
4	2,000	3.65			
3	2,000	3.50			
2	2,000	2.95			
1	2,000	1.95			
.5	2,000	1.60			
.3	2,000	1.35			



2 mfd
4,000
V.D.C.
G.E.
$3.95

1N31 Crystal Diode.......................................79¢

Minimum Orders $3........ All orders f.o.b. PHILA. PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. Telephone RIttenhouse 6-4927

METERS

3 MA DC 2½" R—Simpson black scale........$3.35
500 Microamps, DC—2½" round—Sun......... 4.30
1 ma. DC Fan type—4" scale (rem. from equipt) 3.95
500 ma. DC 2½" R.—General Electric......... 2.95
2 amp. RF 2½ Sq.—Simpson................ 3.15
5 amp. AC 4½ R.—JBT..................... 4.11
10 amp. RF 3½" R.—Simpson................ 4.95
50 amp. AC 3½" R.—General Electric......... 4.11
3 amp. RF 3½" R.—Weston.................. 6.00

MAGNETRONS

2J21A	2J36	2J61	706CY
2J22	2J37	5J23	706FY
2J26	2J38	5J29	706GY
2J27	2J39	700B	714AY
2J31	2J40	700C	718AY
2J32	2J41	700D	720B/C/DY
2J33	2J48	706AY	725A
2J34	2J49	706BY	730A

KLYSTRONS

2K23	2K33	707A	726A
2K25	2K54	707B	726B
2K26	2K55	723A	5611
2K29	417A	723A/B	

OIL-FILLED HIGH VOLTAGE ISOLATION TRANSFORMERS

Pri. 460V 60 cy. Sec. 115V 200VA Insulated for 50KV DC—G. E. Form EIR—36"H x 13"D......$125.00
Pri. 115V 60 cy. Sec. 115V 250VA Insulated for 35KV DC—G. E. Form EIR—29"H x 12½"D....$125.00

VOLTAGE DIVIDER

G.E. Cat. 8248886G-1 and 9001934G-1 17,246,400 ohms 35KV 70:1 ratio wire wound shielded oil-filled 40"H x 12"D......................$77.50

2ϕ LOW INERTIA SERVO MOTORS

KOLLSMAN Type 936-0240—85/68V 100 cy 5 watts 2650 RPM—new $12.95
DIEHL. Type FPE-25-11 75V 60cy 4 watts—new $34.50

OIL FILLED CONDENSERS

MFD	VDC		Price	MFD	VDC	Price
2	600		$ .45	.1	2500	.49
4	600		1.25	1-1	2500	3.85
4	600	R'd	1.25	32	2500	15.80
6	600		1.65	3x.2	4000	2.95
8	600	R'd	1.39	1	5000	4.88
10	600	R'd	1.52	.01-.03	6000	1.65
8-8	600		1.49	.1	7000	1.79
1	1000		.62	2	12500	28.95
2	1000		.89	.045	16KV	4.70
4	1000		1.65	.05	16KV	4.95
8	1000		2.45	.075	16KV	8.95
1	1500		.89	.25	20KV	18.95
4	1500		2.95	50	220VAC	3.95
.1-.5	2000		.87	7	660VAC	4.25
1	2000		1.50	8	660VAC	4.50

HIGH VOLTAGE TRANSFORMERS

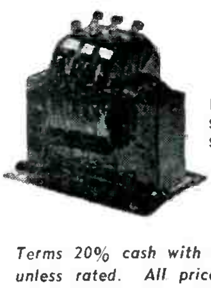
G.E.—Pri. 115V 60 cy
Sec. 6250V 80 MA—12.5 KV Ins..............$18.50
G.E.—Pri 115V 60 cy. Sec. 6250//3850/2600V 56 MA 12.5 KV Ins...............................$18.50
Raytheon—Pri. 115V 60 cy. Sec. 8500/6450V CT 43 MA Hermetically sealed...................$22.50

CRYSTAL DIODES

1N21	$1.19	1N23	$1.49	1N34	$ .79
1N21A	1.69	1N23A	3.25	1N38	1.66
1N21B	3.75	1N23B	5.25	1N45	.94
1N22	1.09	1N27	1.79	1N52	1.05

ANTENNAS

AT-38A/APT (70 to 400MC)..................$13.70
AT-49/APR-4 (300 to 3300MC)................ 13.70
DZ-2 Loop antenna with pedestal............. 14.50
AN-74B (125 to 150MC)...................... 1.65
AN-65A (P/O SCR-521)....................... .95
AN-66A (P/O SCR-521)....................... 1.15
AIA—3CM conical scan....................... 125.00
ASB Yagi—5 element 450 to 560MC............ 7.00
ASB Yagi—Double stacked 6 element.......... 12.70
ASA Yagi—Double stacked 370 to 430MC....... 29.40



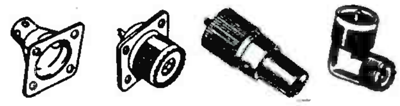
WESTINGHOUSE HYPERSIL TRANSFORMER

PRI-115V. 60CY ¾ KVA
SEC #1 - 240V - 1.56A
SEC #2 - 240V - 1.56A
WT. 30 LBS.

$14.50 EACH

Terms 20% cash with order, balance C. O. D. unless rated. All prices F.O.B our warehouse, Phila., Penna., subject to change without notice.

COAXIAL CONNECTORS



83-1AC	$ .42	83-1R	$.45	83-22AP	$1.10
83-1AP	.30	83-1RTY	.65	83-22R	.68
83-1F	1.30	83-1SP	.45	83-22SP	1.15
83-1H	.10	83-1SPN	.45	83-168	.15
83-1J	.80	83-1T	1.30	83-185	.15

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

UHF		N	BN	BNC	
UG-7	UG-23	UG-37	UG-102	UG-175	UG-254
UG-12	UG-24	UG-57	UG-103	UG-176	UG-255
UG-18	UG-27	UG-58	UG-104	UG-185	UG-260
UG-19	UG-27A	UG-83	UG-106	MX-195	UG-264
UG-21	UG-29	UG-85	UG-108	UG-197	UG-274
UG-21B	UG-30	UG-86	UG-109	UG-201	UG-275
UG-22	UG-34	UG-87	UG-167	UG-206	UG-290
UG-22B		UG-88	UG-171	UG-236	UG-291
					UG-306

M-358	MC-277	PL-259A	PL-325
M-359	MC-320	PL-274	SO-239
M-359A	PL-258	PL-284	SO-264
M-360	PL-259	PL-293	TM-201

93-C	49120	D-163950	ES-685696-5
93-M	49121A	D-166132	ES-689172-1

TYPE "J" POTENTIOMETERS

$1.25 each

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
60	SS	5K	1/4"	50K	3/8"
60	9/16"	5K	3/8"	50K	1/2"
100	SS	5K	1/2"	100K	SS
200	SS	10K	SS	100K	3/8"
500	SS	10K	3/8"	150K	1/2"
250	1/8"	10K	1/2"	200K	3/8"
500	5/16"	15K	SS	250K	SS
500	1/2"	15K	1/2"	250K	3/4"
500	5/8"	20K	SS	250K	3/8"
650	1/2"	25K	SS	500K	SS
1K	SS	25K	1/4"	500K	1/4"
2K	3/8"	30K	1 1/8"	500K	7/16"
2500	SS	40K	SS	1 Meg SS	
4K	SS	50K	SS	2.5 Meg SS	
5K	SS	50K	1/4"	5 Meg SS	

DUAL "JJ" POTENTIOMETERS—$1.95 each

50	SS	500	SS	1 Meg SS
100	SS	1K	SS	2.5 Meg SS
250	SS	2500	SS	5 Meg SS
330	SS	10K	SS	1K/25K 3/8"

Triple "JJJ" Potentiometers............$1.95 each.
100K/100K/100K—⅜" 20K/150K/15K—⅜"

SOUND POWERED TELEPHONES

U. S. NAVY TYPE M HEAD AND CHEST SETS
U.S.I. A-260 W.E. D-173013
A.E. GL832BAO
ANY TYPE—$14.88 EACH
TS-10 Type Handsets......................$8.92 ea.

F. W. BRIDGE SELENIUM RECTIFIERS

AC Volts Input — 18 DC Volts Out — 14.5		AC Volts Input — 40 DC Volts Out — 34	
1.3 Amps......	3.85	0.6 Amps......	4.60
2.4..........	4.95	1.2..........	5.95
6.6..........	7.75	3.2..........	8.95
13.0..........	12.75	6.0..........	15.50
17.5..........	15.75	9.0..........	17.50
26..........	22.75	12..........	26.95
39..........	35.50	18..........	32.50
52..........	38.50	25..........	42.50
70..........	49.50	36..........	55.50

130 VAC ½ WAVE STACKS

75MA	$ .88	150MA	$1.30	250MA	$1.75
100MA	1.10	200MA	1.57	400MA	2.60

GENERATORS

- Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output—AC 115V 10.4A 800 to 1400cy. 1 ϕ; DC 30 Volts 60 Amps. Brand New....................$38.50
- Eclipse-Pioneer type 1235-1A. Output—30 Volts DC 15 Amps. Brand New—Original Packing..$15.50

THYRATRONS & IGNITRONS

OA4G	FG-41	FG-271	722A
C1A	FG-57	393A	873
1C21	FG-67	394A	884
2A4G	FG-81A	GL-415	885
2B4	91	KU-610	1665
2D21	FG-95	KU-623	1904
3C31	FG-105	KU-628	2050
4C35	FG-166	KU-634	2051
C5B	FG-172	WL-652	5550
C6J	FG-178	WL-672	5551
FG-17	RX233A	WL-677	5552
FG-33	FG-235A	WL-681	5557
			5560

TEST EQUIPMENT

- I-222A Signal Generator................* $79.50
- I-72K Signal Generator..................$48.50
- Vibrotest Mod. 218 Megger...............* $45.00
- TN-1B/APR-1 Tuning Unit..................$95.00
- C-D Quietone Filter Type IF-16 110/220 V AC/DC 20 Amps..................................* $9.00
- TS-127/U Freq. Meter w/spares............$69.50
- TS-143/CPN Oscilloscope ....* $95.00
- Dumont 175A Oscilloscope.................* $225.00
- LM-20 Frequency Meter....................* $49.50
- Gen. Radio 757-P1 Power Supply...........* $27.00
- I-130 A Signal Generator.................* $70.00
- TS-6/AP Frequency Meter..................* $42.00
- L & N KS-7470 Null Volt Test Set.........* $60.00
- A.W. Barber Labs. VM-25 VTVM.............* $86.00
- TS-10A/APN Delay Line Test Set...........$45.00
- TS-19/APQ-5 Calibrator $75.00
- REL W-1158 Frequency Meter 160-220 Mc.$32.95
- CW1-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars $39.95
- CRV-14AAS Phantom Antenna for Transmitters up to 400 MC...............................$11.75

3 CM. Pickup Horn Antenna.....................$9.95
Gen. Radio 736A Wave Analyzer.............$600.00

All Items New Except Where Noted * (Exc. Used Condition)

MISCELLANEOUS EQUIPMENT

Amperex 1B98 Gamma Counter..............$ 9.87
Powerstat 1226—115/230V input—0-270V out @ 9 amp..................................... 37.00
G.E. 2CV2A1 Servo Amplifier................ 6.95
Sperry A-3 Hydraulic Servos................ 3.95
EIMAC 35 TG Ionization Gauge.............. 5.95
ATR Inverters 6VDC to 110 VAC 60 cy 75W.. 19.95
ID-6/APN-4 Indicator 29.50
R-7/APS-2 Receiver 49.50
R-78/APS-15 Receiver 49.50
SCR-522 Transceiver 36.95
RT-7/APN-1 Transceiver—less tubes......... 6.95
FL-8 1020 cycle filter.................... 1.37
RM-29 remote control unit................. 8.95
RM-14 remote control unit................. 8.95
RTA-1B 12/24 V dynamotor.................. 40.00
BC-1206-CM2 Receiver 7.95
CY-230/MPG-1 Radar Console................ 575.00
G.E. Type JP-1 portable current transformer.. 32.50
ASB-4 Radar equip. Complete............... 69.75
AN/APS-13 less tubes...................... 12.95
T-9/APQ-2 less tubes 16.50
BC-645A complete 18.95
RCA AVR-15 Beacon Recvr................... 15.50
TBY Trans-Recvr 29.95
Pioneer Type 800-1B Inverters—28VDC to 120V 800 cy 7 amp AC (used)..................... 22.65
G.E. Inverter—28VDC to 120 VAC 800 cy 750VA 1 ϕ.................................. 39.50
Navy SD-3 Radar complete..................$1200.00
Navy DP-14 Direction Finder complete......$385.00

PULSE TRANSFORMERS

UTAH 9262 9278 9280 — **UTAH** 9318 9340 9350

G.E. 68G828	AN/APN-4 Block Osc.
G.E. 68G-627	Philco 352-7149
G.E. K-2469A	Philco 352-7150
AN/APN-9 (901756-501)	Philco 352-7071
AN/APN-9 (901756-502)	Philco 352-7178
AN/APN-9 (352-7250)	Raytheon UX-7350
AN/APN-9 (352-7251)	W.E. D-161310
Westinghouse 132-AW	W.E. D-163247
Westinghouse 232-AW2	W.E. D-163325
Westinghouse 232-BW2	W.E. D-164661

AN/APA-23 RECORDER

Sweeps any receiver through its tuning range and permanently records frequency and time of received signals on paper chart. Power input—(motor) 27V DC 1.5A. and (recorder) 80/115V AC 60-2600 cy 135W.

Originally designed to record pulse or sine-wave modulated signals received by AN-APR-1, AN/APR-2, AN-APR-4, AN/APR-5, BC-348, S-27, SX-28. BRAND NEW $147.50

SPRAGUE PULSE NETWORKS

7.5 E3-1-200-67P, 7.5 KV, "E" Circuit 1 Microsec. 200 PPS, 67 ohms imped. 3 sections.......$4.30
7.5 E3-3-200-67P, 7.5 KV, "E" Circuit 3 microsec. 200 PPS, 67 ohms inped. 3 sections........$6.75
7.5 E4-16-60-67P, 7.5 KV, "E" Circuit 4 sections. 16 microsec. 60 PPS, 67 ohms imped.......$8.25
15 E-4-91-400-50P, 15KV "E" circuit .91 microsec. 400 PPS, 50 ohms imped. 4 sections.......$12.00
15-A-1-400-50P, 15KV, "A" Circuit, 1 microsec. 400 PPS, 50 ohms imped.................$37.5
15 E7-2-200-50P, 15KV "E" Circuit, 2 microsec. 200 PPS, 50 ohms imped., 7 sections......$42.00

SYNCHROS

Size 1, 3, 5, 6, 7 and 8 generators, motors, control transformers, differential generators, and differential motors in stock.

1F	6DG	X	C-78248
5B	6G	2J1F1	C-78249
5CT	7DG	2J1G1	C-78410
5D	7G	2J1H1	C-78411
5DG	A	C-44968-6	C-78415
5F	B	C-56701	C-79331
5G	M	C-69405-2	C-78254
5N	N	C-69406-1	C-78670

SEND FOR COMPLETE LISTING

LECTRONIC RESEARCH LABORATORIES

715-19 ARCH ST. PHILA. 6, PA.

Telephones - MARKET 7-6771-2-3

A LEADING SUPPLIER OF ELECTRONIC & AIRCRAFT EQUIPMENT

IMMEDIATE DELIVERY -- FULLY GUARANTEED

A C MOTORS

5071930 DELCO, 115 V., 60 Cy., 7000 RPM. PRICE $6.50 EA.
TELECHRON SYNCHRONOUS MOTOR, Type B3, 110 V., 60 Cy., 4 W., 2 RPM. PRICE $5.00 EA.
TELECHRON SYNCHRONOUS MOTOR, Type BC, 110 V, 60 Cy., 6 W., 60 RPM. PRICE $4.00 EA.
EASTERN AIR DEVICES, Type J33, Synchonous, 115 V., 400 Cy., 3 φ, 8000 RPM. PRICE $15.00 EA.

HAYDON TIMING MOTORS 110 V., 60 CY.

TYPE 1600, 2.2 W., 4/5 RPM. PRICE $3.00 EA.
TYPE 1600, 2.2 W., 1/240 RPM. PRICE $3.00 EA.
TYPE 1600, 2.3 W., 1 RPM. PRICE $3.00 EA.
TYPE 1600, 2.2 W., 1-1/5 RPM. PRICE $3.00 EA.
TYPE 1600, 3.5 W., 1 RPM. With shift unit automatic engaging and disengaging shaft. PRICE $3.75 EA.
TYPE 1600, 2.2 W., 1/60 RPM. PRICE $3.00 EA.

SERVO MOTORS

CK1, PIONEER, 2 φ, 400 Cy. PRICE $10.00 EA.
CK2, PIONEER, 2 φ, 400 Cy. PRICE $14.00 EA.
CK2, PIONEER, 2 φ, 400 Cy., with 40:1 reduction gear. PRICE $15.50 EA.
10047-2-A, PIONEER, 2 φ, 400 Cy., with 40:1 reduction gear. PRICE $10.00 EA.
MINNEAPOLIS HONEYWELL Type B, Part No. G303AY, 115 V., 400 Cy., 2 φ, built-in reduction gear, 50 lbs. in torque. PRICE $10.00 EA.
MINNEAPOLIS HONEYWELL Amplifier Type G403, 115 V., 400 Cy., Used with above motor. PRICE $10.00 EA, WITH TUBES

REMOTE INDICATING COMPASSES 26 V., 400 CY.

PIONEER TYPE AN5730-2 Indicator and AN5730-3 Transmitter. PRICE $40.00 PER SET
KOLLSMAN TYPE 680K-03 Indicator and 679-01 Transmitter. PRICE $15.00 PER SET

D C MOTORS

DELCO TYPE 5069625 Constant Speed, 27 V. D.C., 120 RPM. PRICE $15.00 EA.
JOHN OSTER TYPE C-28P-1, 27 V., 0.7 Amp., 7,000 RPM, 1/100 H. P. PRICE $5.00 EA.
JAEGER WATCH CO. TYPE 44K-2 Contactor Motor, 3 to 4.5 V. Makes one contact per second. PRICE $2.50 EA.
GENERAL ELECTRIC TYPE 5BA10AJ52C, 27 V., 0.65 Amp., 14 oz. in torque, 145 RPM. PRICE $6.50 EA.
GENERAL ELECTRIC TYPE 5BA10AJ37, 27 V., 0.5 amps., 8 oz. in. torque, 250 RPM. PRICE $6.50 EA.
GENERAL ELECTRIC TYPE 5BA10AJ18D, 27 V., 0.7 Amps., 110 RPM, 1 oz. ft. torque. PRICE $6.50 EA.
BARBER-COLMAN CONTROL MOTOR, Type AYLC 5091, 27 V., 0.7 Amps., 1 RPM. Contains 2 adj. limit switches. 500 in. lbs. torque. PRICE $6.50 EA.
WHITE RODGERS ELECTRIC CO., Type 6905 No. 3, 12 V., 1.3 Amps., 1½ RPM, torque 75 in. lbs. PRICE $10.50 EA.

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INVERTERS

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HOLTZER CABOT TYPE 149 H, Input 24 V. D.C. at 44 Amps., Output 26 V. at 250 V.A., 400 Cy., and 115 V., 400 Cy., at 500 V.A., 1 φ. PRICE $55.00 EA.
HOLTZER CABOT TYPE 149F, Input 24 V. D.C. at 36 Amps., Output 26 V. at 250 V.A., 400 Cy., and 115 V., 400 Cy., at 500 V.A., 1 φ. PRICE $55.00 EA.
PIONEER TYPE 12117. Input 12 V. D.C., Output 26 V., 400 Cy. at 6 V.A. PRICE $30.00 EA.
PIONEER TYPE 12117. Input 24 V. D.C., Output 26 V., 400 Cy. at 6 V.A. PRICE $30.00 EA.
PIONEER TYPE 12116-2-A. Input 24 V. D.C. at 5 Amps. Output 115 V., 400 Cy., 1 φ at 45 watts. PRICE $100.00 EA.
GENERAL ELECTRIC TYPE 5D21NJ3A. Input 24 V. D.C. at 35 Amps. Output 115 V., 400 Cy., 485 V.A., 1 φ. PRICE $25.00 EA.
LELAND PE 218. Input 24 V. D.C. at 90 Amps. Output 115 V., 400 Cy., 1 φ at 1.5 K.V.A. PRICE $47.50 EA.

PIONEER AUTOSYNS

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TYPE AY5, 26 V., 400 Cy. PRICE $8.50 EA.
TYPE AY14G, 26 V., 400 Cy. PRICE $15.00 EA.
TYPE AY14D, 26 V., 400 Cy. PRICE $15.00 EA.
TYPE AY54D, 26 V., 400 Cy. PRICE $10.00 EA.
TYPE AY131D Precision Autosyn. Price $35.00 EA.

PIONEER AUTOSYN POSITION INDICATORS & TRANSMITTERS

TYPE 5907-17. Dial graduated 0 to 360°, 26 V., 400 Cy. PRICE $25.00 EA.
TYPE 6007-39. Dual Dial graduated 0 to 360°, 26 V., 400 Cy. PRICE $40.00 EA.
TYPE 4550-2-A Transmitter, 26 V., 400 Cy., 2:1 gear ratio. PRICE $20.00 EA.

VOLTAGE REGULATORS

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WESTERN ELECTRIC TRANSTAT VOLTAGE REGULATOR Spec. No. V-122855, Load K.V.A. 0.5. Input 115 V., 400 Cy. Output adjustable from 92 to 115 V. PRICE $10.50 EA.

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GENERAL ELECTRIC TACHOMETER GENERATOR TYPE AN5531-1. Variable frequency, 3 φ output. PRICE $20.00 EA.
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5G GENERATOR, 115 V., 60 Cy. PRICE $50.00 EA.
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DELCO TYPE 5069466, 27 V., 10,000 RPM. PRICE $15.00 EA.
DELCO TYPE 5069370, 27 V., 10,000 RPM. PRICE $15.00 EA.
DELCO TYPE 5072400, 27 V., 10,000 RPM. PRICE $10.00 EA.

BLOWER ASSEMBLIES

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OA4G	1.35	2J38	17.95	5D21	27.50	350A	7.95	725A	9.95	884	1.95
OB2	3.00	2J42	150.00	5JP1	27.50	350B	5.95	726A	6.95	885	1.75
OC3	1.75	2J49	109.00	5JP2	17.50	357A	27.50	726B	56.00	889R	199.50
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1B22	3.95	2K28	37.50	6C21	29.50	393A	8.95	802	4.25	955	.55
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1S21	6.95	4J26	199.00	F123A	8.95	706A	17.95	832A	9.95	2050	1.85
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2B26	3.75	4J30	395.00	211	.75	714AY	5.95	834	7.95	8012	4.25
2C34	.35	4J31	99.00	217C	18.00	715A	7.95	836	4.95	8013	2.95
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5 **Amps**, General Electric DO-44, 3½" round flush bakelite case with external thermocouple @ $8.50
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A. C. VOLTMETERS

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D. C. MILLIAMMETERS

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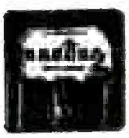
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Solenoids
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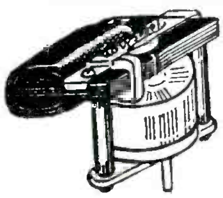
Genuine TELECHRON Motors



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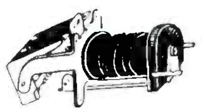
One of Each $12.00

CH 4 pole 35 ampere 115v. AC relay. **$4.90**
GE 3 ampere Mercury Switch ½" glass tube....3 for **$2.50**



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3 Amp. and 15 Amp. A.C.
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Ready to attach to any device that needs turning from remote point. A complete $30.00 unit made by one of the greatest Video Companies. Sorry, can't name it here! **$13.95**

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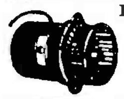

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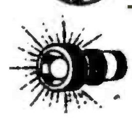

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10 for $1.00
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Although rated at 400V against an operating temperature of 72°C, these nationally famous 5+5 MFD capacitors will meet all commercial specifications and operate at 600V provided that the operating temperature does not exceed 40°C. Measuring 3 5/16 x 2 x 3 25/32 and packed 24 to a carton, weighing 42 pounds this item fills the need for an excellent filter and power correction device. Long lasting, extremely low in dielectric leakage and available in sufficient quantity for a large manufacturer. Small quantities—$.87. Carton quantities—$.65. Samples upon request.

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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. *Quantity discount.*

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Side terms. Mtg. dim. 2⅛" c-c. Large quantity available.

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2 amps	$2.50	$2.75	$5.25
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6N7GT 1.29
6P5GT .89
6Q7 .89
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6SJ7Y 1.49
6SK7GT .89
6SL7GT .89
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6SN7WGT 2.25
6SQ7GT .79
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6SS7 1.09
6ST7 1.33
6SU7GTY 3.37
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6B5 1.19
6B6G .89
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6B8G 1.09
6BA4 1.08
6BA5 1.98
6BA6 .79
6BA7 1.19
6BC5 .69
6BC7 1.23
6BD6 .89
6BF5 .79
6BF6 1.49
6BG6G 1.19
6BH5 .89
6BJ6 .99
6BL7GT 2.75
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6U7G .69
6V6 2.19
6V6GT .69
6V6GTY 1.65
6V7G 1.18
6V8 1.98
6W4GT .69
6W4WGT 1.70
6W5GT .98
6W6GT .89
6W7G 1.33
6X4 .49
6X5GT .49
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6Y6G .89
6Y7G .89
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6J6 1.29
6J7 1.09
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6K5GT 1.09
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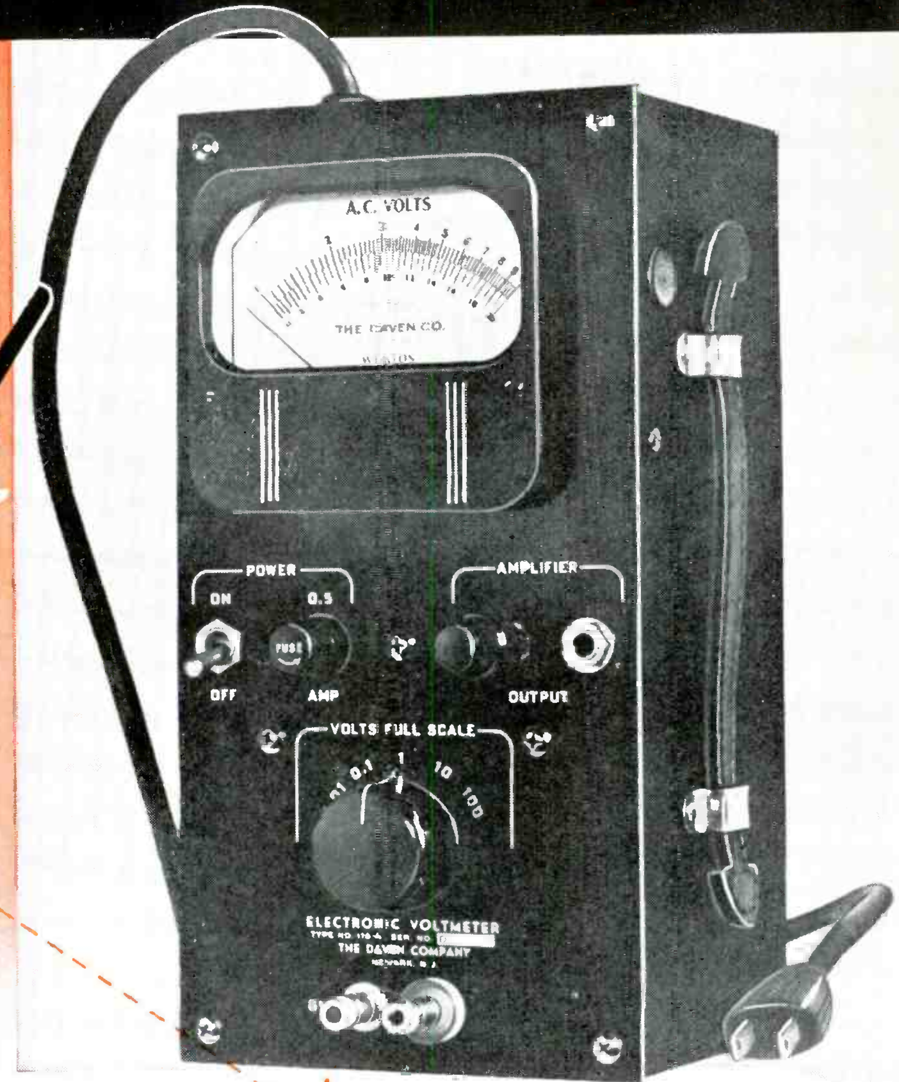

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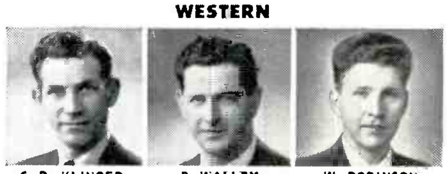

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